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P A G E S 1 - 317

The above entitled meeting was called to order by Tyler J. Fox

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The following NINTH CONFERENCEE ON AIR QUALITY MODELING, was held at the United States Environmental Protection Agency, Building C, Auditorium C-111, Research Triangle Park, North Carolina, and was transcribed by, Judy D Hall, Transcriptionist, Quality Staffing, Cary, NC on Thursday, October 10, 2008, commencing at 8:30 a.m.

Tyler Fox: We got a little off schedule yesterday afternoon at the end so we have some revisions and catch up to do today. We'll bypass the summary of day 1 and jump right in of the continuation of the CALPUFF session, but in order to facilitate that further what we'll do is have Bret take his evaluation of Long Range Transport and combine it with what he was going to do in respect to CALPUFF. So we'll start with those two and have our Q&A sessions and go into the model evaluation session right after that.

Here's Bret.

Bret Anderson: We kind of had a change in the schedule as Tyler mentioned and the presentation I was going to give yesterday afternoon was on the performance evaluation project I was working on when I came out here on detail for OAQPS.

Later on in this session we were suppose to talk about the methods and metrics that were used in that. I thought it might be worthwhile rather than have it in reverse order to actually give this first so that there was a little bit of explanation of the methodology that we were employing in evaluating CALPUFF and the other long range transport models that we were looking at.

The evaluation paradigm for long range transport models. LRT models play a unique role in air quality modeling. This class of models plays several roles. In the non regulatory sense, we use them for emergency response modeling so we use non steady state (inaudible) puff model, particle model for these types of activities. In the regulatory community we use these for Class I increments and for what we call visibility (inaudible) modeling. As such as Joe had mentioned yesterday, the causability effects accumulative analysis he’s placed an additional level or you know replaced the requirement for additional level of skill to reflect both space and time considerations of the LRT model use. As such, we believe statistical measures should examine spatiotemporal pairing ability of LRT models. This project and I’ll get more into it when we get into the project but the over arcing goals of this project were to develop meteorological and tracer databases for evaluation of long range transport models.

As you know, there have been a number of mesoscale tracer studies but there is no one archive of these data sets. So the first goal was to assemble an archive of both meteorological and tracers for observations that we can use for standard evaluation. Develop a consistent and objective method for evaluating long range transport (LRT) models used by the EPA.

What we’ve learned from this and I think this is one of the more important aspects of it is to reflect what we’ve learned from those evaluations and reflect that in our guidance. For example we will talk a little bit more about the update of the IWAQM and Phase 2 guidance is to use the lessons that we have learned from these evaluations to update that guidance.

There were several methods I think I’m a little bit out of order here. The background evaluation on the original performance evaluations there were three or four evaluations done on these mesocale tracer studies. The two that you can find on the EPA web site are done by the Great Plains Tracer Mesocale Tracer Study and the Savannah River, and the INEL74 study in 1974 and the measures employed for these studies I called them the Irwin methodology. They focus on the plume center line statistics and so those were the methods that were used for that particular study. That was one method we used to do the evaluation was just try to repeat what John had done in those previous studies.

In addition to the Irwin methodology, we did decide to augmented statistical measures focusing upon spatiotemporal comparisons of model-observation pairings. This is the Irwin methodology and kind of how I have it broken out in terms of the logical how it’s organized logically. It’s broken into three segments where you see the spatial component, a temporal component, then a performance component.

The spatial component consists of looking at the model’s ability to correctly predict the azimuth of plume centerline on an arc. Then it also looks at the horizontal spread of the plume to see how well how low in space it is you know the definition of the horizontal of the plume.

For temporal pairing we looked at plume arrival time and transit time on an arch. For performance we looked at things crosswind integrated concentration and observed the fitted maximum concentrations on that arch. That method that John had employed to basically compute n-hour average so depending upon however the sampling frequency was and the duration of the sampling on the arc was to create like a three hour or twelve hour arc concentration on that arc. Then to use trapezoidal integration program to fit an average plume on arc so these were programs that John had written ten years ago that we had the pleasure of figuring out how they operate.

In addition to this, we augmented that analysis with the evaluation procedures that have been developed for the (inaudible) 2 study so these are articles that were published in the Atmospheric Environment, Mosca et al. (1998) and Draxler et al. (2001). These statistical measures are a broad set of statistical measures. They basically fall into four broad categories that are Scatter, Bias, Spatial, Cumulative distribution. I'll show you in a minute here.

This data set and these programs on the NOAA ARL DATEM performance evaluation program. What we did (STATMAIN) program and then augmented with additional spatial statistics for false alarm rates, probability of detection, and threat scores to give us a little bit more flavor on how the model is doing. This is just an example on what NOAA has done in terms of trying to you know there are archived so this is kind of our goal is to have this sort of an archive so we can have those performance those data base out there to evaluate CALPUFF and the other models.

These are the statistical measures and these are for Scatter. You have factor of exceedance which ranges from -50% to +50% so the lower the lower the score base the negative 50% is the you know factor towards over prediction and the positive score toward under to normalized. Then you have the factor of 2 whichever one is familiar with. The normalize mean square error and then the correlation coefficient.

Cumulative distributions uses the (KSP) Kolmogorov-Smirnov Parameter and basically it looks at the maximum difference between the two distributions of the model predictions. So this is not pairing in space and time but just looks at the absolute distribution and the differences in the absolute distribution of the concentration. For Bias, we have just mean bias (B) and the fractional bias (FB).

Then for spatial statistics the metric that's called the figure of merit in space (FMS) and then we've added additional EPA metrics, the false alarm rate (FAR), the probability of detection (POD), and the threat score (TS). Then Draxler in 2001 in the paper he wrote that is up on the NOAA webs site introduced a final metric which is basically a model success story, a model ranking which looks at one major statistic across each of those four broad categories to assign a model score to see how well it did across each of those parameters.

This is just the model ranking and you can see it used the correlation coefficient fractional bias to figure the merit in space and the KS parameter and then assigns a score from 0 to 4, with 0 poorest and 4 best performances.

This is the unique measure that allows not only allows to give you an idea how the model performs across all the broad categories but also allows for direct modeling or comparison because you have one score that is assigned to ability so when you are comparing your four models you can see how they compare against one another very easily.

This is an example from a trajectory particle model that we evaluated as part of this project. This is the (inaudible) part of the model; this is a European tracer experiment and I just wanted to show you this is what the results come out from the stat name program that we were working with. As you can see, we get all the values; we get our fig of merit in space; we get our false alarm ratio; the KS parameter, the correlation of bias and the final model rating down here.

This assigns an overall rank as to how well the model performed in that particular tracer study. That is the evaluation methodology used for this statistical component of it. So that’s that portion of it. We’ll get back on schedule real fast today.

So this is what we were supposed to talk about yesterday afternoon. As Tyler mentioned I came down on rotation to OAQPS in January and my project was to start this up basically. Back in the 8th Modeling Conference – EPA recognized the fact that CALPUFF model science had evolved significantly and the IWAQM Phase 2 recommendations in many cases were clearly outdated. We had the new turbulence options; we had puffs splitting; we had all these other things that clearly be used but were not reflected in the EPA long range guidance.

So we discussed the need to form a committee to prioritize or identify what the issues were and to prioritize the tasks. Then we also the need to form an updated model performance evaluation to examine new science enhancements to model which are not mentioned in the current guidance which are not reflected in current guidance. So we initiated this long range modeling project and they said we are performing five tasks for this project: The first one I mentioned earlier is to assemble a tracer and meteorological database for use with LRT model evaluations. The ultimate goal would be to have something similar what the NOAA archive is where we have an archive of the meteorology so we’ll have the MM5 data that was run up there and have all the observations within the program. Anybody can go on the web site and get that data and do the statistics themselves. That’s the ultimate goal as part of this project. Unfortunately I’ve got the dog ate my lunch excuse in fact as Joe had mentioned yesterday in trying to get the data out in a timely manner has been kind of difficult.

Back in June right before the Denver meeting, we had all the data assembled that I was working on and we had a hard drive failure. We lost 90% of all we had been working on and we’re in the process of trying to reconstitute those data sets and get those out there. So that was an unfortunate set back in the whole thing. That’s the ultimate goal to get those data sets assembled and get them up on the web site so that everybody can look at. You know the (inaudible) themselves similar to the datum web site and similar to what Roger has on the web site for

SCRAM for the evaluation data sets for the developmental data sets that were used for AERMOD.

As I mentioned previously, the other goal was to develop a comprehensive evaluation framework (methodologies and tools) and I think this is another point that Joe made a very good point yesterday about you know this is a modeling system we’re talking about here. The dispersion model can only perform as well as the meteorological you supply it with. So another part of this evaluation paradigm will be and I’m not going to get into it today because we’re still wrestling with it a little bit is to look at it as a coupled system. The model’s ability is only as good as your abilities to apply it with meteorology. So that’s going to be the comprehensive evaluation framework looking at both meteorological aspects of it and the LRT model aspects of it.

Then basically like I said you’re exercising and testing the meteorological LRT models for the assembled tracer database. Then like I said you’re exercising and testing meteorological and

LRT models for the assembled tracer database to provide full documentation of model evaluation measures and results from meteorological and LRT evaluations. And then provide the ultimate goal to updating existing EPA LRT modeling guidance (IWAQM Phase 2) to reflect lessons learned from this project.

From the guidance goals basically what we said was to examine science evolution of CALPUFF modeling system to incorporate recent enhancements to model system in updated guidance but there were some overarching questions is that you can see comments that were made in the 7th and 8th Modeling Conference that talk about these things. Can puff-splitting extend the effective range of CALPUFF beyond recommended distance of 200-300 km? At the 7th Modeling Conference, EPA’s response comments said that they were anxiously awaiting any tracer evaluations that had been done that would do this. They said and as soon as those results were available they would put them up on the SCRAM web site. That was 2000 and now its 2008 and none of that are up there. In the absence of doing that we’re going to try to fill that void.

The next question is can guidance migrate to recommend turbulence based dispersion (CALPUFF and AERMOD options) over P-G? As Tyler mentioned, back in 2006, EPA issued a Model Clearinghouse memorandum basically in agreement affirming that more tests needed to be done. That’s part of this thing is to evaluate against these tracer data bases looking at both P-G and turbulence options there. Then the final one as Bill was mentioning yesterday was how best to supply meteorological data to CALPUFF? As you know, it is like any other transport model and it is very sensitive to wind field (inaudible) you know things like that.

I realize this is a statement you make to see how best to apply the meteorology to it because you can’t have one set of fixed options in CALMET. Perhaps Hybrid method verses NOOB = 1 or NOOB = 2. Maybe there’s a better was to do it so that’s one of the goals to evaluate the different ways in which we supply data to CALMET to see is there something or one that is better than another.

The tracer experiments that we have currently we have the Great Plains Tracer Experiment which we are currently and will show a lot today. Savannah River Laboratory Tracer Experiment which was another one which had been done. That one is underway. We had started with the Cross-Appalachian Tracer Experiment but that was one you know where the dog ate my lunch or ate my homework. That one suffered you know the one that was consumed in the hard drive there. Then the European Tracer Experiment which is a new one that was not considered an original one. I'll get more into the European experiment in this presentation.

Additional tracers to be included that we would like to look at more as you see in the IWAQM Phase 2 there's talk about project MOHAVE which is one that John (inaudible) and (inaudible) from DRI had published extensively on. The other one is the VTMX where the urban 2000 study in Salt Lake City. That has a very good complex terrain to it which would be useful. And then Joe Chang is here today and he published a paper about comparing CALPUFF to (inaudible) and to DLS Tract. For these two experiments here the Dipole Pride 26, and the Overland Along-Wind Dispersion thing we'd like to get hold of that to include in the database.

As part of this project we are also evaluating additional models because the question is how well any model can do in any one of these situations. It isn't fair to isolate one model and say okay it either does good or does poorly. You know you have to look at it in context because what if all models are performing poorly. Then that's not a good tracer evaluation to compare it against. It's not fair to do it that way. You have to create a framework to understand how well can any model reasonably do with these experiments. It is important to include these other models so basically what we did was to include the two Lagrangian particle models which most maybe most of them are familiar with height split. Then the European one that is called FLEXPART that's widely distributed throughout Europe and both of these were selected because they have are routinely used and they have widely (inaudible) in other words it is easy to take the meteorological data from MM5 and apply to this model.

In addition we are also looking at the transport capability of CAMx and Kirk Baker has been working with us on this one too. Basically it is to also create a framework to help us understand how any model can reasonably do under these experiments. As I mentioned before, these were the different methods the evaluation methods.

Now to get into this into it a little bit here. The first one that we're going to talk about is the Great Plains Mesoscale Tracer Experiment. This is one of the original ones that was published supporting the promulgation of CALPUFF. Briefly what is was there were two perflourocarbaon tracer releases from Norman, OK on July 8 and July 11, 1980. Basically what we had is you had two arcs of monitors that were deployed one at 100 km and another arc at 600 km. So we basically have a sampling interval was 45 minutes on the 100 km arch and then the same frequency of every 3 hours on the 600 km arc. I'm trying to give you a little flavor for the (inaudible) meteorology because this influences the performance of the model. Basically what we had were Low Level Jets that go over the Central Plains and you can see this is a [ed. vertical] (inaudible) cross section from the MM5 simulation performed with this. What you can see is a very strong and deep Low Level Jet [ed. Stream](inaudible) here and you know this is from 750 meters up in the air and the height in the atmosphere and you can see the presence of the Jet here. This plays a major role in especially the 600 km or the results for the 600 km arc. I'll explain a little bit why in a minute. Basically, the model experimental design was to look at CALPUFF, FLEXPART and HYSPLIT and basically, what we did with CALMET meteorology we looked at (inaudible) the Hybrid mode, then NOOBS =1, then NOOBS = 2. Then at the presentation that Herman gave yesterday, we also included the MM5 CALPUFF and this is one of the data sets that we're testing the proto type against here. Puff-Splitting was turned on for the 600 km situation or the 600 km simulation and none for the 100 km. So this was a deviation and this is one of the areas there was a deviation from the earlier experiment was that that one did not consider puff splitting. But since we were operating at 600 km we thought it was important to test that feature. Basically like I said we had two domains, two CALMET domains. For the 100 km arc we used the 4 km CALMET which was consistent with the previous basically what we tried to do was be as consistent with the previous CALMET and CALPUFF simulations to do this. So we had a 20 km CALMET for 600 km simulation and a 4 km CALMET for 100 km and then set those other two models there.

This is the MM5 configuration and I’ll skip through this. It’s just an idea of what we’re using some of the more advanced (inaudible) in MM5 like ETA PBL and NOAH LSM. We’re not necessarily wed to EPA (inaudible) scheme but that’s one thing that would have to be evaluated as part of any publication of these results is to validate the MM5 data and that’s something we have done but haven’t looked at it as extensively. We have domain wide statistics that we haven't went down in detail to evaluate but we do have general performance. In general they gave me kind of the ad hoc statistics that people use for meteorological model evaluation.

This is the basically what I talked about and these are from the Irwin methodology and want to point out that this is the result of the 100 km and this was for the 600 km. As you can see CALPUFF with CALMET is doing about the same. Both put in MM5 CALPUFF within the CALMET one too. This is with the NOOBS only with this one. Then for the 600 km this is again you can see this is fairly consistent with (inaudible) we saw in the previous study which is we over predicted CALPUFF in the 100 km and unpredicted under 600 km. Which was basically, the same result from the previous study from the degree of which I haven't gotten into here as far as the absolute difference.

This is one thing I think may be one take home message that I see encouragement here in terms of you know you can see the plume you know the plume is wide here. I am encouraged by the turbulence here. I think that's one I mean obviously we need to look at this more but this is one area if you take a look at both the CALPUFF turbulence and the AERMOD turbulence in this the plume signal were not exactly matching and more in line with reality than what you would see. I am encouraged by seeing this here. As you can see the plume spread with P-G tends to be larger than what we saw and maybe we need to investigate this further but clearly it s seems we can see it consistent (inaudible) over prediction of the plume width with the P-G class now.

You can see here the CALMET winds did very well at the arrival time at the 100 km; it did better than the MM5 winds in terms of the arrival time at the 100 km arc. CALMET almost (inaudible) it. The MM5 had a slight delay of about an hour. So we get down here where this is where you can see you know basically depending upon which P-G or turbulence we have a little bit of variation. They are all fairly consistent either close or -1 hour, but they’re doing pretty well there.

Where this created some concern for me was as you can on the 100 km arch, CALMET does very good in terms of arrival time but also the duration and the time that the tracer cloud arrived on the arc where (inaudible) does a very good job. MM5 is (inaudible) arrived late and faster. But this is what I need to talk to Joe more about this. We couldn’t reproduce from the original experiment was when you look at the 600 km arc we detected tracers above background concentrations for 15 hours on the arc. So what we have is in the original dating back to 1997 – 1998 timeframe, they ran in CALMET and NOOBS mode and they were able to get either 13 or 14 hours on the arc. They had generally a decent agreement with the travel and the transit time on the arc. And I’ve tried it every which way and this is the one thing I’m still confused about whether I’m doing something wrong or maybe something has changed inside CALMET I don’t know. Basically, as you can see we’re basically narrowing it down to about half the travel time on the arc and show a little bit of why we’re seeing that in terms of where the wind shield was placed in the tracer cloud. What we did see here is that when we were feeding the MM5 only winds (inaudible) CALPUFF we weren't getting the transit time on the arc was consistent with what the observation was. This is where we clearly need to go back and take another look and try to get a better understanding of what's going on. This is one of the things we were not able to replicate from the previous experiment.

Now Plume Centerline, this is one of the Euro methodologies. As you can see, this is where the MM5 winds did markedly better than CALMET. CALMET was much better in terms of arrival time and the time on the arc. But the plume was a little bit displaced to the NE of where it should have been and the MM5 was like depending upon having it a bit little closer. We're about 10 degrees off here I think we're about 20 to 30 degrees off on this one here. So the MM5 winds were doing slightly better, but you can see the MM5 winds have it displaced more directly to the West and these are more to the East.

Then on the 600 km arc the plume (inaudible) from the Euro program, you can see generally they are within range from about 25 to nearly 30 degrees as compared to 10. The displacement is about 20 degrees off and with the NOOB we're getting into like right here it's getting closer to what the MM5 was looking at like the MM5 was a little bit closer over here. That was an encouraging sign for the MM5 CALPUFF.

I'm going to see if the animation works here to kind of give you an idea what we're seeing here. Sorry about this. I'm going to break out of this if I can. Okay this is the animation from the observed and …oh great. Sorry about all this. And as you can see, this is what we were seeing basically from the published literature dating back to 1982 – 1983. The observations were basically the plume was detected from Nebraska to Hamilton Missouri. So basically it had it sitting somewhere right here to here. It appears that the wind field was steering it l little too far to the South and East and I think that explains why we're not seeing the terrain of the faster (inaudible) on the arc because from a meteorological perspective you don't want to be right in the Jet coare there. Up here in

Nebraska we have a fontal boundary that starting to set up over here so what I think was happening was that the plume came up in this area here and encountered the frontal boundary and started to slow down. That in fact is why you saw the 15 hour transit time because we are sliding a little bit too far to the South and East on this one so we’re not encountering that frontal boundary and I think that’s why it’s (inaudible). Obviously that’s what it looks like. Okay.

For the MM5 CALPUFF, as you can see, it actually a lot of it has to do with the initial displacement it had the plume you can see that the plume took it a little bit further trip to the North and West than it did with the other one. It did catch the transport path a little bit closer. That’s one of the things we need to go back and look at with this tracer evaluation. It’s like why weren’t we able to replicate the CALMET wind fields from the previous one. I presumed that’s what was helping to contribute the transport differences that we were seeing from the first study to the second. Okay.

This is another one. This is the European tracer experiment and basically this is probably I call it the granddaddy of all the tracer experiments. This is probably the most prominent tracer experiment we have. This was Europeans response to Chernobyl accident decided it was necessary to test the results of the LRT models. So the European's tracer experiments or ETEX was designed to validate long-range transport models used for emergency response situations and to develop a database which could be used for model evaluation purposes.

They had at least 168 monitoring sites located over 17 European countries and they had two releases of perflourocarbon (PFC) tracer were made in October and November 1994 from France. They were basically 2-hour releases. It has a fairly robust network to look at here. Basically the experimental design here you can see (inaudible). This is what the synoptic features that will flavor the simulations; we have the (inaudible) over the north sea and another low developing in the Adriatic plus we have some (inaudible) passage through here and this is going to be what flavors the transport patterns that you will see.

MM5 is run again and was initialized with NCEP Reanalysis Data and was consistent with what was run with Great Plains with the exception we ran a 43 vertical layer and I think I transpose my numbers so I think it was 43 layers instead of 34 for this one. I'll show results for this one for these three models. I think it's important to caveat this is an experiment that's well we're talking distances of 1,000 – 2,000 km here. So this is well beyond what CALPUFF what is recommended for regulatory. It's not sitting and shows how well one model does and how bad one does. This is a good test for puff splitting because you have one arc at 600 km and now we're at how far out can we really go with this. We felt this was a good test for puff splitting. Basically each of the models was supplied with the MM5 and there's no CALMET in this simulation. It's only MM5 CALPUFF so basically you have the comparison that all three models help with (inaudible) MM5. Basically we're looking at each of the models ability with the same meteorological data.

This is just a snap shot of the FLEXPART time series at 24, 36, 48 and 60 and you'll see that basically this is similar to what was observed in terms of the absolute transport pattern if you're just looking at the spatial pattern. Basically what it is that within the first 24 hours of plume as it (inaudible) along the low country up here in to Germany? As it gets into this area up here we start with wind field (inaudible) starts (inaudible) and we get the (inaudible) in to the low up here and then we start (inaudible) low down here. At 48 hours and at 60 hours, this is basically the transport patterns would look like.

This is what CALPUFF was showing here. I apologize for this I used different software (inaudible) Hysplit and CALPUFF were a lot easier to use with Surfer so this is the Surfer plot. We were able to pull in the observations so that you would have an idea what the actual observation were looking like for this. CALPUFF is doing just as well as the other models within the first 24 hours of the release. None of the models were able to get this (inaudible) extent of it. All three models CALPUFF, FLEXPART and HYSPLIT they all had the same general convection pattern toward the northeast and were not getting the Westward or Eastward extent of it. By 36 hours, this is where you can see things are even with the puff-splitting turn on we weren’t getting caught up in the deforming wind field the way it was.

As you can see by 48 and 60 hours the simulation has pretty much broken down by that point. We are not able to do that. As I said this is well beyond the regulatory range of CALPUFF and was just an experiment to take a look and see how this puff-splitting will make a difference. I think that’s the thing here.

HYSPLIT was comparable with CALPUFF in the first 24 hours here and we’re not getting eastward (inaudible). By 36 hours we’re not getting the southern (inaudible) here, but HYSPLIT‘s performance improved dramatically between 48 and 60 hours. By 60 hours HYSPLIT has it almost perfect in terms of the spatial pattern.

So the spatial statistics…this is what we’re looking at merit in space as you can see the

HYSPLIT did its best in terms of basically what the model observed it had the best of spatial representation. This was the coare of the performing one here. In the end you can see because of the way the plume was transported with CALPUFF on that one here where the high false alarm rate with this one which was putting the plume in an area where nothing was being detected. So as you can see FLEXPART has a high false alarm rate as well. As you can see HYSPLIT did the better of the three models in that.

In terms of the global statistics that I talked about before, as you can see, HYSPLIT was the clear winner in this one and you can see the final ranking overall. This is the Lagrangian part of the model it didn’t do much better in terms of the statistical data. It did marginally better than CALPUFF here and you know you can look at the factor of 2, the factor of 5, clearly in each case HYSPLIT was the clear winner in that one. It’s just what it is.

These are some of our initial observations from that and I would like to remind everybody there are an insufficient number of tracer experiments here to draw any conclusions from current data.

As I mentioned before, there are pieces of information we can pull out of this. I was very encouraged with the turbulence in terms of the plume width. It looked like it was doing better than PG. But we obviously have a lot of work to do and I stick to the dog ate my homework.

Basically for the Great Plains Tracer Experiment, CALPUFF/CALMET 100 km results performed well except for plume azimuth as I said it was off centered about 20 or 30 degrees. The MM5 results were better for azimuth, but worse for time of arrival and duration on 100 km arc.

We were unable to replicate 600 km arc statistics from original GP80 and SRL studies conducted by EPA in 1997 despite using same raw meteorological data, horizontal, and vertical grid configurations. We are now into the Savannah River one and we’re off a little bit and unable to replicate the statistics for the Savannah River one so that’s something we need to go back and look at.

The two major differences from original EPA study are updated terrain and land use from old

CALPUFF 1.0 distribution and use of lambert conformal projection for GP80 and SRL, all other CALMET options remained constant. CALPUFF performance varied due to variations in CALMET options selected. As you can see, CALPUFF results appear sensitive to manner in which meteorology is supplied to the model. Joe mentioned yester that CALPUFF is sensitive as to how you apply the model and that’s one of the area we need to focus on the evaluation aspect of it. I agree completely with Joe on the tone. The European Tracer Experiment and as you can see CALPUFF performs reasonably compared to particle models for first 24 hours, has more difficulty further into transport simulation, but you can see it had more difficulty as it went further into the transport simulation and we need to investigate that further. When we were looking at Puff-splitting did not change CALPUFF performance significantly. When we were looking at puff-splitting (eliminating mixing height restrictions) increased number of puffs, but did not augment model performance. We had puffs going in different directions. That’s one of the messages we need to see how we can improve the puff-splitting in CALPUFF.

The next steps are and this is the last time and I'm on time. Project results shown today are work-in-progress. We have a model evaluation protocol drafted and it describes the meteorological metrics and the LRT metrics. The goal is to provide the full documentation and data availability necessary. Clearly we need to engage with model developer to help us understand some of our observations. Did we go wrong in model setup? What can we do better?

Has the model changed since the previous evaluations? So those are questions we have to answer. That's my presentation.

Tyler Fox: Thank you Bret. Appreciate that. We will venture into the Q&A session now. Let me just mention where are we at from the EPA perspective. As Bret indicated, we have worked diligently into trying to compile the evaluation information outlined understanding and documenting some of the issues we have found in respect to the science and implementation within the model and will fully document that. What we intend to do and we've made resource requests for this is to conduct a peer review of the model and that will follow the completion of the evaluation and the documentation of that and release of the information as Bret indicated. We will move forward with that and not only take the information we will put together but also information the community and others want to provide either through this process, provide comments as it relates to this conference or other information that is made available that can include the evaluation Joe wants to do and others want to do and the work that AER have done.

We'll be conducting a peer review both to charge them to evaluate models and give us their opinion about the performance and the underlying science in these models and the long range transport context to meet the regulatory needs under Appendix W.

And as to a future question of any recommendations or options for us to consider in terms of addressing long range transport in the future in terms of the models and their ability to meet those needs. So that is where we are just so you know and again look forward to getting any comments or input through this process and in the future as we move forward.

We'll take Q&A until about 9:30 to get back on schedule.

Bob Paine: ENSR. I have a question for Joe Scire or EPA. There is guidance for grid spacing in CALPUFF such as you resolve the terrain features to 5 or 10 grid elements. But recently I've seen some critiques that the finer you go with the grid spacing, the lower the concentrations go. Is that really true or it is really unbiased?

Joe Scire: I think there are several factors that can influence how the model responds to grid spacing. One is the nature of the terrain and also the source location relative to the Class I analysis and exactly where the source is relative to that in the mean flow. What we did is….my experience is it goes both ways sometimes finer resolution produces higher impacts where the terrain may channel the flow into a Class I area. And in other cases it produces lower impacts -- maybe it's channeled away or maybe it just takes a different trajectory. One example is a situation where a stack is in the valley -- with coarse resolution, the terrain may get smoothed so much so that the stacks are no longer below the terrain height. Therefore it goes to the gradient flow, where in the finer resolution, the valley floor is deeper and the peaks are higher so maybe the stack now is within the valley and is subject to channeling. That can drastically affect the trajectory of the plume. As a test, back when we were working on the VISTAS project, we looked at the effect of terrain resolution from 90 differenr source – Class I area pairs -- looking at 12 km resolution and 4 km resolution and I distributed these results to the Federal Land Managers and others.

Basically what we found in 52% of the cases or whatever that works out to be 47 out of 90 -- the concentrations went up with finer resolution, not down, and in 48% of the cases, (43 of them), they went down. So I think there was pretty much a split of higher and lower terrain resolution.

Christine Chambers: From Trinity

Consultants. I have a follow up to that question to that. Recently I’ve had numerous conversations with Tim Allen that there was in a memo distributed by EPA that specifically said for PSD Class I increments that, in all cases, less than 4 km grid spacing would not be accepted for PSD Class I increments. This was from Tim Allen in his own words based on an application in the Pacific Northwest. All projects less than 4 km show a decrease in concentrations. There have been recent studies conducted by EPA to document this. I have similar studies as Joe said that depending on the case it can be up or down. Can you provide a little more insight on this memo that was supposedly issued by EPA that was submitted to the Federal Land Managers?

Tyler Fox: I wish Tim was here because I’d ask him the question what memorandum he is referring to. We have not issued any memorandum to that effect. I’ve not seen any memorandum to that effect. I know Clint Bowman and others and Herman if you want to address it. Others have provided information about that. We from the program office stand point have not issued any memorandum to that effect. Herman if you want to address that.

Herman Wong: That memorandum I wrote to the State of Washington said that I would not accept the 1 km grid resolution they use. The reason I did not accept it was that we had an agreement with the State in which a common protocol had been developed and the State wanted to change the agreement we had. So they changed the agreement, and the State of Washington did not discuss these changes with the EPA or the FLM or the other two states.

So I fired back an email saying that it was inappropriate for you to automatically decide to make a change in the current protocol to go from a 4-km grid resolution to 1-km grid resolution. I think they had even adopted a grid with a 500-meter resolution. The reason I didn’t sign off on it is was the feedback came from the Forest Service and the Fish & Wildlife and the Park Service because they wanted some demonstrations, arguments, or justification as to why should they be allowed to go down to below 4-km. We did do some-- well, Bret did some testing that came up recent results so we went to some additional analysis from Clint [Bowman of WDOE] to justify why he would be allowed to go to from 4-km down to 1,000 meters and provide that to EPA, the FLMs and the other states before we accepted it. At this point, no, we are not accepting as Joe says and this is the first I've heard of it from Joe with an explanation as to why we should expect mixed results. Until Clint provides that information to us as we requested a couple of months ago, we are not going to change our position with respect to BART and with respect to PSD.

Bret Anderson: The true story is that Clint was kind enough of to share his presentation with Roger and I back in May of this year. He said, "Hey look at these results." and they were intriguing and what he was showing. I was working on the Great Plains Tracer Experiment at that time and at the 20 and 4 km resolution. So I created a 12 km domain and ran CALMET just running with the NOOBS only and with P-G, and sent Clint the results on that. We didn't conduct any independent analysis on our own we just said we already had something here and maybe you can find something useful of this. Clint sent back a graph that he was using in the arc statistical program and he was plotting up the results for each time step. What he saw was 20 big 12 kind of comparable to 20 and 4 for the concentration was smaller. On advice from the Park Service we said okay and what is it that the terrain causing this or the land use. So I wrote a computer program to create dummy GEO.DAT files at the same resolutions so I basically flattened the terrain so that is was 1 meter terrain for the single land use. I had all the physical properties at that same level and what we saw was when you fix all that there were no changes in concentration: 20, 12 and 4 were very comparable to one another. We didn’t draw any conclusions from that. We said clearly the terrain and land use were making a difference there. That was the extent of what we did there. What we did provide to Clint was what the Great Plains Tracer Study did and that’s probably where this thing snow balled from you know was from that where Clint did show with that resolution what the change in the resolution you did get a fairly consistent decrease in the concentration. So we did that one additional sensitivity test and we saw no change.

We had no opinion whatsoever with that and that's the real story about this whole thing. I think it goes back to a good point that these decisions we make are made on the basis of science and we should have good justification one way or the other. If Herman had a protocol in place, he was justified to say if you are going to deviate from the protocol you have to have justification. I think that's a fair explanation. But with respect to and I know there's a lot of communication in the community that EPA has issued memos or these tests have been done. That was the extent of the testing that was done. We don't have any information one way or another and I have never given the information to Tyler to show anything about grid resolution. That's the reality of that discussion.

Tyler Fox: We are aware of the issue and Herman did exactly what he needed to do and requiring that justification just as any deviation of a protocol or questioning about the underlying basis that’s being put forward. We need to balance the process and understand things and stay away from this EPA has demanded stuff. The Regional Office has the authority and works within that authority to do things. When there a broad precedent thing they will send it through and we have the Clearinghouse and other types of mechanism in place to then get to the final interpretation of guidance or decision in a particular case. Once we have that information and once it’s brought to us we move forward in the Clearinghouse action, but nothing has been brought to us. We are aware of Clint’s presentations at the workshop and as Bret described understanding what data he’s working with in trying to help in that process. We need to …if there are any other questions about CALPUFF people can ask those before we get into the public session. But we need to move forward to respect the schedule and the like. Especially for some of the presenters who may need to leave. I’ll just make some quick remarks here.

Going back to the 8th Modeling Conference, we covered the first, the second and the fourth element that we had brought up so here’s the third element that we talked about which is basically said we really need to focus on appropriate evaluation methods. The focus and the purpose of identifying areas of improvement in the modeling system understanding that emphasis on modeling systems, recognizing that the emissions meterology and underlying modeling science are all part of that system working concert. But we need to understand the influence and effect on each.

Therefore with that understanding we can seek the types of improvements we need by prioritizing the research either in the community or within EPA with our Office of Research and Development and will ultimately lead to an overall improvement and understanding of the performance of these models as they are applied in the regulatory policy context.

So one note is that a year and a half ago, there was an evaluation work shop and this is just an example of the framework that one can use for model evaluation. This one refers to the community multi scale air quality model from the EPA (inaudible) Office of Research and Development. Basically you’re looking at a model and in this case CMAQ and typically what we say is when we’re doing an operational evaluation. So we’re looking at a base line situation 2002, 2005 and we’re looking across the different chemical (inaudible) species geographically and saying are we getting the right answers? Are we predicting the level of air quality compared to observations, the predictions to our models to the observations we see?

That’s a standard fair. There’s a lot of work that we put forward as EPA in doing these operational evaluations. There are ways we can improve those types of operational evaluations that get more of the spatial nuance of the (inaudible). It is critical for us to go a couple steps further and look at things such as dynamic evaluation which can start to address the questions are we capturing the changes in air quality? Over time for example a publication on the (inaudible) call we had a kind of controlled experiment; we had a major regulation come into play and (inaudible) country (inaudible) and we had a time period in 2002 without it. And we had a time period in 2004 and 2005 with it.

You can start to test the models and see how well they replicated that change. It’s not too often we have those types of major changes and we can observe both from the observational standpoint and the model standpoint to see whether our models are responding in the way we would expect them to.

The other question is we getting the right answers for the right reasons or the wrong reasons? That’s where we need to look at the diagnostic evaluation tools and from that make sure we feed that back in to the model. This loop is important if not the ultimate goal here.

These are fine and dandy but if we don’t come back and focus on improving these models we are not doing a service to the community.

And lastly, we can look at probabilistic evaluation in terms of getting and understanding of the confidence of these outcomes. Here’s a framework that is being worked on; there’s no official mandate or anything, but this is where our Office of Research and Development (ORD) are trying to frame this so we can work together better as a community as we conduct evaluations of all the models. I wanted to share that with you. And to start off we’ll start with Wyat Appel from our Office of Research and Development. He will present a tool as Bret mentioned its one thing to talk about methods and techniques and the like. It’s another thing to apply them. Wyat has worked with others in ORD to deliver the atmospheric model evaluation tool available through CMAQ so he’s going to walk us through that.

Wyat Appel: I work in the atmospheric modeling division in ORD here at EPA. And as Tyler said we have developed an evaluation tool and I’m just going to give an overview of it. It’s really focused to the (inaudible) like CMAQ and MM5 but it can be extended to other applications as well. In that the Atmospheric Model Evaluation Tool (AMET) consists of two modules. One that focuses on meteorology in this case typically MM5 or WRF and one focuses on air quality typically our case CMAQ but also CAMx. It's a combination of several Open Source Software packages so these are all free of charge, license free. One is a database called MYSQL, another one is R a statistical package that Bret mentioned that. Then Perl and all of these are available open source and we designed on a Linux Operating System.

Actually others have extended it to other platforms as well. AMET is specifically designed to compare observations against meteorological (e.g. MM5, WRF) or air quality model (e.g. CMAQ, CAMx) predictions. We're actually not importing an entire gridded data set. We're just using paired model observation sets which are actually a different forum for some of the applications this group will do and I'll get into that in a second.

This is a kind of a flow chart of how the system works. There is a quality side but essentially the meteorology works the same with slight differences. It starts with the observations and then model output. These are paired in space and time through software we developed. But you can do this on your own with other software as well if you’re not working with these models. It is paired in space and time, we generate database records and then those records go into the MySQL database. In essence we are jus populating the database with model predictions and observations.

We’ve been in to the evaluation part so when all the data and observation are in the database we use a set of [ed. Perl] (inaudible) scripts pre-generated scripts to query that database, poll the type of data you want and then create statistics or plots that we pre-generated. I will get in to some of those. For example, model performance plots; this can be normalized Mean Bias, Fraction Bias, and any number of statistical metrics. Diurnal Statistics, Time series, Spatial Statistics, Box Plots, Scatter Plots, Bar Plots, “Soccer Goal” Plots, Bugle Plots.

Then often because R is open source users can develop their own scripts to do their own type of analysis. The difference with the met side is it’s a different observations and a different set of model output. Instead here of the MM5 or WRF and here it’s a meta data set that is maintained by the Forecast System Lab. But essentially from that point on it works virtually the same. They are paired in space and time as they do in the database.

What are the advantages of a system like this? A somewhat automated/interactive system. Data stored in relational database which is great because one it puts all your data in a single spot. If you have multiple simulations different models, it doesn’t matter; it’s all in the same database and treated the same way. The real power is it allows data queries based on many factors. For example, geographic, if you have (inaudible) information you can box down to a certain latitude or longitude. You can look at a state and if you have county information figure sites, you can do it by pretty much any met data you can query by. You can also query by the data itself. Like concentration if you want to limit to a certain concentration you can do that as well. We have pre-generated analysis scripts so this uses the same analysis for multiple simulations for other groups. One group, in doing their analysis, if they use this, you would see a similar type of analysis from possibly other groups doing it. We're always trying to figure out what did someone do a little different. It kind of like using this type of analysis among different groups. And then it's open source pretty much free of charge.

These are the types of analysis that are available on the met side and I'll show some examples of these. There's a met model performance summary which I have an example of and some of the plots you may be more familiar with such as Timeseries, Spatial Plots, and statistics. Bar Plots, and some specific plots to the met side includes Rawindsonde, Wind Profiler, and Aircraft Profiler.

This is an example of a model performance summary. This is a plot that's available on the met side. You see here this one is for temperature and the one on the right for wind direction. It includes a number of different plots and statistics scatter plot, model performance summary statistics, metric across different temperature ranges and then a box plot showing the distribution of the model. This is a single plot so you just kind of pick this for whatever your data set is and this is what gets generated. And similarly on the wind direction side in the wind direction plots where you can see the distribution and wind speed in your data and some other summary statistics, etc.

Also available are time series plots, your mixing ratio, wind speed, wind direction, but pretty much any meteorological metric you have available you will be able to apply just like this. Spatial plots are summary statistics so this is …. don't worry about the data showed here it's just for example. This is actually four different work simulations that are shown and these are the R (inaudible) for each of those plots. And you see color coded and then you would also be to window this down to other regions. One may say about R at least for the United States is it contains more detailed maps. If you do go down to looking at a smaller location like a state you would be able to

include a county map on top of that.
This is a wind profiler comparison over time and then (inaudible) and you see the wind speed, a very nice plot. This would be specific where you have wind profile information,. a nice plot.
Similarly for aircraft comparisons similar types of plots are available with similar types of plots available and different distributions in height.
On the AQ side there is similar analysis available slightly different. Rob and I work together but we do things differently with different data. Scatter plots this includes model observation, model to model, summary statistics which usually is output as a csv text file so it’s easily imported into EXCEL. Spatial plots and box plots and these are a little more specific; stack box plots (inaudible) box plots.
On the scatter plots, a basic scatter plot, it has the ability to include select statistics on it. In this case, on CMAQ, we usually prepare to admit a number of different (inaudible) so we like to keep it separated because they behave differently. But this is -- imagine if you

included model to model (inaudible) single network, multi network. And also, the ability to temporally average this over different time periods such as seasonally, monthly, annually, and daily.

Spatial plots are very similar to what I showed on the met side. Implied statistics (inaudible) we have a number of different of statistics available. And also concentrations, model observed, the bias between the model observed and also you can sub region this out like that. Again time series plots. We're only showing observed and (inaudible) but you could also include another model data so you could compare two model runs and see how they compare. Box plots. This is a box plot in time of day and you can … the behavior of the data across the hours of the day. Also this is a box plot for monthly so you can see the behavior across the entire year. Stack bar plots, this is more specific to some of the data available for comparing with the model like CMAQ. But it shows the type of plots you could create that are specific. And R is very powerful as related to a lot of different plots and if someone is familiar with R it's generally easy to tailor it to whatever your data or skip a type of plot you would like to see.

Some of the other parts includes some of the metrics are some Bugle Plots where it includes performance criteria. These are available by default AQ side and then the Soccer Goal Plot is a little hard to see but there are lines for the bias and a kind of outline there. One of the nice things about expanding beyond CMAQ is if you have any set of model predictions in time and space you should really be able to import that into the database and analysis just like you would any other database. Even if you are not using CMAQ or CMAx or a model like that, if you have data generally in the common (inaudible) that includes a model of and some space and time information there would be a way to get back into the database and analysis just like you would CMAQ and anything else. We just pre-generated it some scripts that will take the raw CMAQ output and bring it right into the database.

Then also the analysis scripts themselves can be used outside of data met. There are scripts so if you got data and you don’t want to go through the hassle of putting it in the database, take the R script and you can read it directly in the R so that you can extend these plots or use these plots outside of the met system itself.

We have been working on this for a few years and early this year we released it publicly. This a script based version both the Met and AQ versions available and it includes an extensive users guide included which we have gotten good feedback. The script tit is very helpful for setting up and using. It contains most of the functionality shown here and some things developed but not included in the release but in the future we will include them. You can install the Met and AQ versions separately. Includes tutorial data and example output plots and then there’s also a Bugzilla available for AMET which you can submit any questions or problems you have with this system.

For future improvements we have to build a Java interface which will be real nice since a lot of the system is picking different options, time of day, state and region so it really lends itself to a Java type of interface. It’s really in the background. That would able to runs AMET locally and accesses remote database. It would be a little bit more user friendly than the script database. Hopefully we can do some additional analysis scripts similar to the ones we have build over the year. And also the ones developed externally by the user community. Then more query options. The great thing is no matter what met data you put in you can use as a query option. That’s it. Thanks.

Tyler Fox: Wyat has to leave a little early so are there any specific so are there any questions about AMET. We’ll take a couple of questions.

Pete Manousos: First Energy. You rolled this out publically this year you said?

Wyat Appel: Yes.

Pete Manousos: Okay. How far in the future do you see this being supported?

Wyat Appel: That’s a good question. It’s not something we have talked about it’s still in development and I don't know specifically that we've talked about how far we will keep supporting it. I think no matter what's out there it doesn't really become defunked in any way which is a nice thing. Even if we stopped putting out new capabilities, that doesn't stop users from putting in new capabilities. But certainly in the near future we see putting it out more scripts and then maybe putting out a Java version.

Pete Manousos: And support would be through Bugzilla?

Wyat Appel: Well through CMAS. It's available through CMAS that's the entity we go through to put it out to the public. We basically did the development internally at EPA and then go through them to get it out externally. Then we monitor the bugs that the users have.

Pete Manousos: Thanks

Wyat Appel: Sure.

Tyler Fox: Just a side note we at EPA will be continuing to develope model evaluation tools so as long as we have the need I would imagine at least from the OAPQS standpoint I can't speak for ORD, we certainly will be wanting to see this tool developed and expanded both by the user community and internally as we move things forward. Next on our list for the evaluation session is Bob Paine.

Bob Paine: I'll probably be able to go through these very quickly because others have addressed many of the points here. I come from the point of view of the previous AERMIC committee having done a lot of the evaluation work with Roger and others on the previous versions of AERMOD. I'm going to talk about the AERMOD evaluation review, evaluation tools, and for short range modeling evaluations the somewhat dated Cox-Tikvart evaluation procedure. I will also address the BOOT/ASTM evaluation procedure and Joe Chang has been very gracious in providing some slides for this presentation. He should probably give it but I'm here anyway. I will also mention some evaluation databases that Joe has collected and should probably hand over to EPA, and also a brief comment on the gridded met evaluation.

I'd like to say that Jeff Connors who is my colleague here has done an urban evaluation and provided that database to EPA for AERMOD. And we used some of the evaluation tools and we will talk about. In the future, we will be doing an evaluation of low wind speed databases with API funding and working with EPA on that issue as well.

There are generally two types of short-range types for evaluation of databases. One involves tracer studies and short-term intensive studies, typically with multiple rows of samplers, each with many sites where you can determine plume centerline and plume sigma-y. You can determine concentration trends with distance and maximum concentrations on tracer arcs that are used for the evaluation. You can evaluate predictions paired in time and distance in this type of evaluation. Here the limitation is the short duration of the study and you have a limited number of meteorological conditions and seasons, where the other type of database -- the long-term monitoring networks featuring year-long sampling at a few sites -- has the advantage of temporal resolution. You really have to do things in unpaired in time and if necessary; paired in space; so the limitation is spatial resolution and advantage is a large number of hours in the database.

So in the AERMOD evaluation, we have the question: how well does AERMOD predict peak ground-level concentrations used for compliance with air quality (AQ) standards? Is AERMOD's performance significantly better than that of similar models? Evaluation databases were a mixture of tracer experiments and long-term studies

We tended to rely on plots used extensively; they are often better than "black box" statistics like the robust highest concentration. For example, the Quantile-Quantile (Q-Q) plots will plot pairs of ranked predictions and observations, unpaired in time and can be used for both types of evaluation databases. Residual plots are plots of ratios of predicted/observed conc vs. downwind distance or wind speed, etc. They are generally used only for tracer databases. Estimates of Robust Highest

Concentration, or the RHC, represent a smoothed estimate of the highest concentrations (from Cox-Tikvart evaluation technique). Generally, the scatter plot (data paired in time and space) is only used for tracer databases.

We go to the Quantile-Quantile plot which is a ranked observation verses prediction plot and hopefully the peak concentrations are close to the one-to-one line. Peaks on this plot here indicate where it’s closer to this model. In the range of the moderate concentrations we are a little low here.

Other types of tools are the plotted model residuals, which are plots of predictions/observations as a function of an independent variable where we have group residuals according to ranges of an independent variable. You actually have a box where the midpoint is marked here. In general you see the trend is very low as a function of the independent variable. We use a box plot to indicate the distribution of the “n” points in each group. For example, the significant points for each box indicate the 2nd, 16th, 50th, 84th, and

98th percentiles. A good model should have no trend in model residuals.

This is a poor model example where you can see this trend for the hour of the day is very dependent on the wind speed as well. When you see that, you see the model has some bias due to a function that is variable. We have to understand what is going on here because the model does have a possible problem. These are very useful tools. According to evaluation statistics that have been mentioned, the fractional bias (FB) is used in the BOOT and ASTM systems. It is basically a function of the observed and predicted concentrations where an FB of zero is a perfect model, while an FB of +/- 0.67 is within a factor of 2.

The major features of the older Cox-Tikvart Method would be use of the RHC statistic, re-sampling of data used to determine confidence interval for differences in performances of models, and the composite performance measure (CPM), which combines absolute FBs for several averaging times. The model comparison measure looks at differences in CPM between models to determine the statistical significance of differences among models and this is best suited to long-term, sparse network evaluation databases.

These next comparisons are borrowed from Roger Brode actually. Several models are shown here where we have a CPM score, and obviously, the lower the score, the better the model. If the the model comparison measure straddles zero, then that means the models are not statistically different. In most cases here, this one is maybe just barely significantly different. Those are the features of the Cox-Tikvart method.

Here we used the BOOT software, and it is used a lot in Europe. It was developed by Hanna and Chang, and is available through them. It is best suited to tracer databases and is widely distributed to (> 200) scientists in the field, mainly through the European's Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes – Model Validation Kit. It is generic and can be used to evaluate different kinds of models, different kinds of outputs, and different kinds of data pairings

Some of the performance metrics in the BOOT software you have seen before: factional bias, normalized mean square error, and another way to do the variance and bias using statistics like geometric mean, cases within a factor of 2, and correlation coefficient.

A way to plot the variance and bias in one plot is here, where the X-AXIS would be the geometric mean, with over prediction on the left and under prediction on the right. The variance is on the Y-AXIS, so a perfect model is as low as you can go while keeping the bias in the middle. You can compare the two models and determine if they are significantly different. Actually, this is a plot of the various data values such that if they cross zero, they are statistically unbiased within a confidence in 95% on this case.

The question comes up “What are Observations”? Observations can be measured by instruments or products of other models or analysis procedures. John Irwin three years ago was talking about the American Society for Testing Material Procedures similar to BOOT -- treating observations as snapshots of an ensemble, while model predictions often represent ensemble averages. That’s one way you can do a fitted observation.

The two cannot be directly compared unless you do something with the observation. The way you do that is group them in regimes of similar conditions as atmospheric stability or downwind distance. For a particular tracer arc if you have a cross wind concentration like this you would try to fit it with a best-fit Gaussian curve in order to depict an ensemble peak concentration and so on.

These are again from Joe Chang and some results are sensitive to how the limited regimes are defined. You might have to idealize the experiments with concentric sampling arcs to make this work easily. To get into how the procedure should be applied to the evaluation of 3-D Eulerian air quality models, where predicted concentrations represent averages over a grid volume, but observed concentrations represent point measurements, it is difficult to figure out how you would apply this procedure.

I am getting mercifully to the end now.

Just want to show you a couple of slides from Joe Chang. We have a lot of archives -- or Joe has a lot of archived databases, but unfortunately the budget for maintaining this is very, very slim. The budget for collecting and analysis is a little bit more. He would say that the more realistic or optimistic scenario would be to have more budget set aside for archining evaluation databases. You probably can’t see this, but you can see this on the presentations that there are over a 100 database references. For the existing data, I would like somehow to make sure with EPA that we don’t have another hard drive crash. Literally, these are about a hundred databases, so it would be nice for EPA to take ownership of these databases.

I have one last comment on evaluation of gridded meteorological data. It’s almost like a new concept do we trust MM5 data instead of a meteorological tower. We need to thoroughly analysis the gridded met data. There be may be situations with poor met performance (e.g., complex terrain). Conditions of concern for dispersion modeling are how often are the winds very low from the tower verses the computed meteorological data.

How about the Low Level Jet, which we've seen before -- for example, in that Great Plains experiment? The problem with the Low Level Jet is that you have a sounding at 6:00 PM and 6:00 AM and the Low Level Jet happens in between. In North Dakota, we found that the EPA model missed the Low Level Jet and underestimated the dispersion. The use of better meteorology got the plume dispersion predictions in CALPUFF better. You've got to have, I think, an understanding of the Low Level Jet and the wind rose profile misrepresentation, among other issues.

Sources of data for testing that I would like to recommend are: we need to find tall tower data, not just surface data because a lot of the applications are for tall stacks. For example private industrial met towers for which the data has been provided to the agencies are now in the public domain. There are numerous wind energy assessment towers that are available to the public. I would recommend that these databases be used for the independent assessment for the evaluation of the gridded met data. That concludes my talk.

Tyler Fox: Thank you Bob. Alright, we will finish the evaluation with Roger who will go through some recent evaluations beyond the typical Cox/Tixvart evaluation methods that are appropriate in the way we use AERMOD under Appendix W [ed. for NSR and] (inaudible) PSD. But obviously as mentioned yesterday by Lee and we’re seeing more use of these types of models for exposure and other type of risks assessments which puts more stress on them from a space and time perspective. So Roger will give us some information on what we’ve learned so far on that.

Roger Brode: Thank you Tyler. I appreciate the presentations that have been made. Want to mention I want to follow up in some of the work here in terms of AERMOD evaluation and some (inaudible) that has been doing to look at the model in a more robust evaluation. This is going to be more (inaudible) information that has come along recently. Very brief slide on requirements of operational Regulatory Dispersion

Models vs. ER [ed. Emergency Response] Models or other types of models that might be used.

Again some of this have already been covered but for regulatory models need to predict the peak of the concentration distribution, unpaired in time and space, for comparison to AQ standards. But in emergency response models, and perhaps models used for risk and exposure assessments, require skill at predicting concentration distributions paired in time and space. At least understand their ability to do that. And we expect the need for that type of model performance to increase in the future and it is going to be a challenge to meet those requirements.

Just some real quick examples. For regulatory model evaluation this is prairie grass one of the best databases ever collected back in the 1950's. It is an intense tracer study as Bob Paine just mentioned so we actually had I forget how many arcs receptors densely located on a series of arcs. This is a Q-Q Plot of AERMOD evaluation in stable conditions. Sort of unpaired but sort of loosely paired in space because these are the arc (inaudible) maximum concentration at each arc not the individual concentrations that each receptor along the arc. If you just unpair them in time you get a little bit of difference a little bit more scatter plot. But not much they are loosely paired in terms of the arc (inaudible) maximum being applied here. Another example is for Indianapolis that’s a tall stack or evaluation data base that was used in AERMOD performance evaluation. Again this is unpaired looks pretty good the Q-Q plot shows pretty close to one line. Then unpaired it’s a little bit messier more of a scattered plot. Just a couple of examples I’ll try to be correct. These are applications of AERMOD that have come to our attention within the agency. But someone has run AERMOD and getting results they don’t like and don’t understand so we want to share what we’ve learned. Not a real robust formalized evaluation procedure but it’s an opportunity for us to help others in their application models. But also learn ourselves how the model performs in different situation. This one sort of gets into the wind speed issue as Bob Paine mentioned and we appreciate the effort he will be undertaking soon to evaluate model performance under these specific conditions. We look forward to collaborating on that.

I got permission from Lee to use this. You heard about this the Alabama DEM study for the Birmingham Local Area Analysis (LAA) for PM-2.5 SIP. Basically AERMOD was run initially with airport data and with the SEARCH data sets that include sonic anemometer with lower wind speed stretched so they had lots of light wind speed and the SEARCH met data. The model seemed to be over predicting.

This is actually for the Wylam this is how it originally came to us and you can see a dramatic over prediction. This is actually time series plot running the model with the airport only data which that blue line down near zero and you have the SEARCH data. As you can see there’s a dramatic difference there. Won’t go into all the details here but this is the Wylam monitor which Lee presented yesterday. It’s actually pretty satisfied with the results there, it’s not perfect but at least it looks a lot better.

There are a number of reasons for that.

One of which had to do with I think the initial comparison was based on the maximum concentration of AERMOD across the gridded receptors (inaudible) on the monitor location to the actual monitored concentration. It actually had receptors in AERMOD that were either very close to the fence on property of facility close to the fence line being compared to concentrations from the monitor. This just shows again at the airport for Birmingham that the SEARCH site pretty closes by showing the proximity but different settings. Low roughness which would be typical of a met tower at an airport. Then higher roughness at the SEARCH site. It was sited direct within a neighborhood with buildings and trees around. I suppose it is more typical of the sources.

One thing that came to our attention here:

This is a terrain plot and it’s not very clear here. There are some slopes involved. There’s more significant terrain features around the site. It’s not real dramatic terrain features but there are definitely slopes there. First of all this is a plot again concentrations a time series plot based on airport data the light blue line. Not sure about the dark line plotted against the frequency of calms each day from the airport.

So this is 24 hour averages and what you can see is a pretty good correlation when the observed concentration goes up it’s often highly correlated with high frequency calm. For example if you have 18-20 hours of calm, it indicated a lot of light wind speed, upward spike in the observed concentration. That certainly suggests an important presence of local sources of PM for that monitor. But if you look at the airport date, it actually goes down. Sort of an in birth correlation and there’s a couple of cases where you can see that trend. I think at Birmingham airport this is a case where between calm and variable winds we are looking at 25 or 30% of the data period missing either to calms or winds.

So that was a sort of (inaudible) information that if you do have low level sources you will be expected high concentration under light wind conditions. There may be some question of the representative of that airport data for that applications because you can see a pretty clear pattern as the light wind speeds go down, calms go up, observed concentrations go up but the model concentration with that data without (inaudible) the calms go down. This is the first case where we got into the use of the one ASOS data which we shared.

The other thing I'll point out here is this is with the SEARCH data showing a high concentration. This period stood out initially I guess a period in here the SEARCH was missing and that was one of the issues with the quality of data. Just looking at the wind direction compared with met SEARCH site and airport site to be fairly close about 5 or 6 km separation. We discovered there was an offset in the first three weeks of the year and they verified this later that the SEARCH wind directions were offset by about 120 degrees so that kind of stands out as different in some ways.

This is sort of (inaudible) information.

They come, we help and they go and we don't know.

Hopefully we can close the loop on a little bit better. One of the things we are looking at more closely, we sort of realized once we supplemented the airport with the 1-minute ASOS we looked at what is going on under these very light wind. For the SEARCH site you can clearly see low wind, drainage flow, showing up under those conditions at night. Sort of from off of this ridge here from a northern sort of North West direction would be the typical light wind, cold air and drainage flow. At the airport it’s more from the East that direction. Once we supplemented it with 1-minute ASOS it doesn’t show up at all with this standard airport data because they’re all missing the calms.

I don’t have the plot on here but from the….guess they didn’t put it in here. Here’s the SEARCH site that’s matched with the model where they had the PM 2.5 concentrations and there was actually a facility just east of the site. One of the things that is going on there is that when you use the airport data under the light winds conditions that show up at the airport when you supplement it you are getting a drainage flow towards the West basically at the monitor from the source that is the closest source.

Whereas the SEARCH site which is right next to the source the drainage flow is more from the North West not directly so that the plume from the facility would be going right at the monitor, it would be going towards the South. That's contributing to what you've seen here as because (inaudible) offset the drainage from the SEARCH data was in the wrong direction and was basically pulling a different source.

That's one example just to see again is there a problem with the model that these light wind conditions? It's not a clear answer one way or another but there is some concern if you use airport data and 25-30% is calm those results may be biased in the wrong directions. Whether the results are realistic or whether the problems there are sort of not clear yet.

Another issue that comes up is surface roughness sensitivity and this is more recent. Example is AERMOD being applied to support exposure assessment for the Atlanta area to support current NO2 NAAQS review. Majority of NO2 impacts attributed to mobile sources so major roadways were modeled as links and minor roadways as area sources; sort of temporally and spatially distributed so the initial model-to-monitor comparisons showed AERMOD concentrations significantly exceeding monitored NO2 concentrations at 3 Atlanta monitors. An initial assessment was that low surface roughness used to process airport data was not representative of roughness typical of source locations, and suggestion was to re-process airport data with 1m roughness to address that.

We kind of suggested there are other ways.

We did a broader assessment of modeling analysis, recommendation were made to acquire and process SEARCH met data as more representative of source surface characteristics of the sources.

Another issue is to apply OLMGROUP option within Ozone Limiting Method to better account for NO to NO2 conversion. We suggested to apply the OLMGROUP options be applied to perhaps get a better account for the NO2 chemistry in this context. Also we looked at the source characteristics for the mobile sources and suggested some changes to better account for vehicle induced turbulence. Especially for the light duty vehicles they are being modeled as basically tail pipe with the release pipe in the small (inaudible). Those changes were made.

Just a very quick I didn’t have plots that were on the same scale. This is sort of model to monitor comparison at one of the NO2 monitors before. The black is the measured NO2 concentration and the lighter blue is the model concentration from AERMOD. Again most of this is due to multiple sources (inaudible). Thousands of sources over the whole Atlanta area and again you’re up 300 (inaudible) and the purpose of this study is due to the exposure assessment is what the frequency of the exceedence was. There was some concern whether AERMOD could be used in this context. Once we addressed some of these issues this is the model comparison after I think the period from the previous slide was sort of in here.

You can see much better (inaudible) it’s not perfect but considering all the uncertainties in the emissions and so on, we felt that was pretty good. This same kind of pattern is pretty consistent from one month to the next at the other monitors as well. So they seemed encouraged by that.

Just for interest sake I went back and modeled multiple sources again that’s majority impacts. Again with the airport date this is the Q-Q plot of modeled concentrations using SEARCH. These are AERMOD concentrations using the SEARCH data process with surface characteristics using AERSURFACE pretty high roughness about 0.8 meters 0.7 meters verses concentration process with the airport data with the 1-minute ASOS supplementation with its roughness which is pretty low for an airport. And pretty close to the 1 to 1 line except there’s only one point I don’t know if you can see it. It’s about 2 to 1 over prediction or difference between two models. But interestingly enough the met data that produced the higher concentration was the from the SEARCH site with the higher roughness.

Not sure what that says but it’s an interesting result to see that the issue of surface characteristics differences between the airport and the SEARCH site didn’t seem to be playing a very major role here. One caveat this is right in the urban options so the urban boundary layer enhancement is certainly helping mitigate some of the differences you would expect to see due to surface roughness itself.

The next one is more on the source characterization side of this. These are issues that kind of come up. I mean all three of these issues in all three of these cases but this is a little bit more focused on that. This a model comparison and they were doing with Benzene concentrations from refineries in Texas for Residual Risk review. Actually, initial results from standard ISHD airport data showed significant under predictions and the conclusions that issue was well we need far background concentrations. We recommended using 1-minute ASOS wind data to reduce the number of calms, which contributed to under prediction. And a more detailed assessment of representativeness of met data resulted in selection of another nearby station. This was fairly close to the coast down in the Gulf Coast but not right on the coast but there are a number of sites there. And also another non standard airport site, the Texas (inaudible) site, I think we looked at. This is sort of a quick end look and see if we can learn. It’s hard to close the loop on it. The other thing is the sensitivity of model results to source characterization options for storage tanks examined, with recommendations to improve characterization. So we looked at different options and there’s a lot on this slide. I think what they initially did was elevated area sources with no initial Sigma Z. That’s the very low impact that starts to come up. The monitor was kind of within 100 meters range and that could be pretty important. That might be why they were getting some un- predictions. The other was the calms. Looking at different ways to model it there’s an area source with an initial Sigma Z or volume source but one thinks they may need to look at in terms of guidance or recommendations something from the implementation guidance is the SEARCH tank. I think a better way to do it these days with the PRIME downwash algorithms since it exclusively treats the cavity impact region is to model tanks maybe series non buoyant point searches around the top of the tank and input the tank itself as a building. That is kind of the blue curve here. So depending on where you are you can have a whole lot of sensitivity or not that much. But if you're close to the sources it can be pretty significant.

These are just a range of results based on different met data and different source characterization and I think we ended up feeling that Galveston would be the most representative data and including some Sigma Z so this is putting the plume the release sight more in the middle of it and some initial Sigma Zz. There's the 100 mile about 5.65 and here about with the Hybrid met data about 5.96 so we're getting reasonably close. This other monitor didn't do as well I think there were some other concerns there about whether there could be other background sources impacting that monitor. This one was pretty much downwind from one of the refineries.

That's again just some (inaudible)

information. What I'd like to do is take these opportunities to learn about the model. They are not robust or formalized evaluations but at least they can give us some information as to what the limitations of the model are and the sensitivities are. And what we need to focus on in terms of providing better guidance. And how to apply the model and we also want to do is build on what Bret is doing in model performance. Looking at more paired in time space basis and find out how well AERMOD does or doesn't do with that more robust demand on its performance.

Tyler Fox: Thanks Roger. So now we have any questions as it relates to the model evaluation section.

Arney Srackangast: This pertains to this last evaluation that Roger was presenting related to storage tanks. I haven't seen the study that you have but the storage tanks have been modeled quite commonly now. They're doing maintenance, startup, shutdown permits down in the Texas area, and so they are being looked at quite closely for regulatory review. There's a wide variation, as far as impacts go, with no clear guidance on how we should really be modeleing these. One is almost always gravitated in the regulatory perspective to go all the way to the highest to be protective. But those variations close in for receptors that are always going to show maximum impacts on the fence line are three or four orders of magnitude. You would almost, -- if you picked a certain source type, -- you may not be able to permit those sources in that context. Given the need for realistic impacts what would be your suggestions for going forward with modeling storage tanks.

Roger Brode: I don’t think I want to go on record as providing a recommendation here. I just want to point to something that we have been discussing is recognizing the need to provide the need to updated guidance or recommendations for…there’s a table in the ISC users guide and in the AERMOD users guide in terms of defining volume sources and that’s often been used in the past. To look at it in light of the capabilities of the model to deal with downwash that’s more directly and more completely where that may be equivalent or better ways to do some of these types of sources.

Arney Srackangast: I guess my general question is -- I'm not familiar with all the evaluation databases and what types of sources have been evaluated but it seems in the grand scheme of things, this has primarily been stacks, elevated stacks. To what degree do we have good confidence and in low-level fugitive sources given the PM issues we were just talking about. In Alabama, and these other source types, are woefully inadequate in evaluating the model in these other source types which drive all these analysis.

Roger Brode: I think that's a very good point especially to make in terms of Bob Paine mentioning that he's going to be doing some evaluations looking at performance of specifically under light wind speed conditions is that's a problem we don't have that I'm aware of any good databases to look at especially low level fugitive type of releases under very light wind stable wind conditions. One reason for that these are small sources so the facility releasing it doesn't have a lot of resources to go out and collect the data to show well we're not causing impact or not. But it's the worst kinds of conditions to conduct a field study. The plume is going to meander a lot, field studies are expensive, so you could go out and put out a lot of monitors and spend a lot of money and miss the plume completely because it went that way instead of that way. Even if you do have a study like that how much confidence do we have that the metric concentration really captured the plume effectively for evaluation purposes. I think it's an issue but maybe Joe Chang kind of build off the work he's doing. Other databases out there can be used to inform the issue and that's something we are trying to pursue the best we can. But for these kind of cases that come along sort of an (inaudible) case. Let's see what we can learn from it. Is there information we can glean from that operations. It's not very robust and it's not going to be a clear signal yes or no. But at least it gives us some information to work with. It may be the weight of evidence will start to build up one way or the other.

Arney Srackangast: I guess my last comment is as you were talking about the storage tanks being considered downwash structures. In GEP guidance, there seems to be suggestions that you be careful about using spherical structures as downwash structures. There seems to be some remarks to that effect.

Tyler Fox: Just one note. The work that Roger was showing came through the Residual Risk Program and Review there. As we mentioned yesterday, and I'll plug the Model Clearinghouse one more time as we illustrate it to the process. To come up with the EPA guidance, I think it would be pretty presumptive of us to issue guidance with limited understanding of issues. The reason we have a clearing house process and other types of processes is to get the information from you all about these issues and be able to and either specific situations make determinations what will be appropriate at that moment. And over time as these issues come to us time and time again and we build this understanding and learning of this then we can conform guidance. Guidance to lead at a starting point is the wrong way to go about it.

We need to gather information in order to provide you with an informed and appropriate guidance. So we need input from you all about these issues and situations that we may be handling or working through and learning from internally such as the NATS reviews and the like. The opportunity we are taking upon ourselves to learn in order to better exercise and understand the model and the models that we deal with. We need information from you all through the processes, from the Regional Offices, through the states and local to share and gain that same experience.

Again I would urge you all to be working with your state and local agencies with the Regional Offices to use the clearing house process in a way such as the program office we here can start to understand and inform and come up with the type of guidance you need.

Why don’t we meet back here at 10:45 so that’s a ten minute break and we’ll start with the last session on New and Emerging Techniques. Thank you.

Alright, Bret Anderson will give a brief introductory on the Long Range Transport component here. Then we'll have Roland Drexler on HYSPLIT and Joe Scire on the Puff Particle Model and then we'll take some Q&A soon after that.

Bret Anderson: This is more of a philosophical interlude as to why we're actually having this session. In my mind, we have had in the regulatory not necessarily in the regulatory modeling community. In the modeling community as a whole in the last five to seven years, we have had two major themes that I think have kind of exposed us to some new technologies.

One area is the emergency response. As you know after 9/11 a lot of the regulatory agencies had to double up on duties that provide response capabilities. So a lot of my counter parts in the EPA regions have been tasked with providing emergency response support for air modeling in case of any natural disaster or terrorist attacks.

In the emergency response modeling community they have been using you know a much different class of modeling technology that is new to us. Essentially there may be some potential application in the future and for the regulatory modeling community. That is one area where we have been exposed to (interruption on phone line). The other is you have heard a lot of talk about the BART program which is we’ve seen a lot of CALPUFF modeling you know we’ve also seen a number of states who have tried to use photochemical models in a more of a single source capacity.

We are now seeing as I like to call it the collision of the worlds where we are seeing (inaudible) come into the near field range. So these are some new and emerging technologies that the regulatory community will have to deal with. And so we thought this session might be a good opportunity as to where the future will lie. As you know already these are just the various classes of models that the community has had to use over the years: Gaussian Plume Models (ISC, AERMOD), Gaussian Puff Models (INPUFF, CALPUFF, SCIPUFF), Lagrangian Particle Models (KSP, HYSPLIT, FLEXPART), Computational Fluid Dynamics

(CFD) (FLUENT, OPENFLOW), Eulerian Models (CMAQ, CAMx), Plume-in-Grid, Single Source Apportionment Techniques.

As (inaudible) had mentioned earlier on the other side is the grid models. You know we have CMAQ and CMAx but we have new capabilities. In these models are Plume in Grid and single Source Apportionment technique which may have a role in the future in the regulatory realm. I just wanted to give you an example of how we’ve used particle models in Region 7 for quite a while.

Just to kind of give you how we use them in a non regulatory capacity. We use them for fire forecast simulations in the Kansas Flint Hills. We have an event that goes on every spring that is (sorry) and about fire emissions model and MM5 met model linked to FLEXPART. We are using it as a tool for fire forecasting. This is the Lagrangian particle model called FLEXPART. We use it for diagnostic purposes just to give us an idea of what we can reasonably expect here. These models have the capability of you know they have potential as an application in the future.

This is one I like to woo the management with as it changes colors. It doesn’t mean anything. But it is there as are those models in the research community and the emergency response community that may have application in the future.

I’m going to turn this over to Roland Draxler and we going to talk about one of the models that is in the community. It’s called HYSPLIT.

Roland Draxler: Okay can you hear me?

Tyler Fox: You’re fine Roland.

Roland Draxler: Okay. What was that laugh to?

Tyler Fox: They were laughing at me. Don’t worry.

Roland Draxler: Alright. I think I can start.

Tyler Fox: Hold on a minute. Alright we’re all set. Speaking for management Bret I don’t want to see that picture again. Go right ahead Roland.

Roland Draxler: Alright. I’m going to give a brief overview of HYSPLIT and the acronym is a little awkward. HYbrid Single Particle Lagrangian Integrated Trajectory model. I try not to use it but it’s like brand recognition and I can’t change it anymore. But we do have a web page and there is a lot more detailed documentation and it goes into a lot more detail and training materials you can go through on how to use the model.

I’m going to cover quickly the computation method; how to simulate plume dispersion, how to get air concentrations, deposition; and some examples of calculations and verification.

If you go on to slide 2, you have already gotten the introduction of the variations of the lagrangian model. Basically the difference in the Eulerian approach where computing the local derivative of the concentration change which is essentially of the contribution of the advective flow and dispersion across the interface and you have to solve the entire domain.

It lends itself to easily handle complex chemistry and multiple sources, but there are some issues for the computation: for problems with artificial diffusion. That also might slowly disappear as the grid size of these models become smaller and smaller.

The lagrangian approach we're computing the total derivative and it's basically the same equation but we're taking the advection and putting it outside the equation and considering that the trajectory. These kinds of approaches are ideal for looking at single point sources. There is an implicit linearity for chemistry. That means if you have multiple point sources and want to get the concentration at a particular location you will be adding together the contribution from all sources.

There are non-linear solutions available and I'll talk about that later. And the approach is not that efficient when dealing with many sources. We're essentially computing the same information over and over again. If you have multiple point sources, you're doing the same calculations in the meteorology for each source.

The next slide number 3. I'm going to give you a brief overview of all the features and not going into too much detail. The predictor-corrector advection scheme; forward or backward and that means forward trajectory or dispersion. The meteorology is external and its offline and that means someone else provided this. The model needs it from somewhere. Then interpolation is linear, spatially and temporally to the computation point.

As far as getting the meteorology from elsewhere. We have converters available ARW, ECMWF, RAMS, MM5, NMM, GFS and so on. It's not too hard to use one of those as a base for the other converters to get something different. The next thing is vertical mixing based upon SL (surface layer) similarity, BL, Ri, or TKE. The horizontal mixing based upon velocity deformation, SL similarity, or TKE. Mixing coefficients converted to velocity variances for dispersion. The dispersion is computed using 3D particles, puffs, or both simultaneously.

Modelled particle distributions (puffs) can be either Top-Hat or Gaussian. If you are modeling air concentrations, it is from particles-in-cell or at a point from puffs. One of the features is that we can work with multiple simultaneous meteorology and concentration grids.

What this means is that you might have a high resolution or stimulation and a global lower resolution stimulation and you can use them both in a calculationc, when the particle is over the high resolution terrain it would use that data and switch to the global model.

As far as meteorology we support latitude-longitude or conformal projections. I mentioned the meteorology. Now the non-linear chemistry modules use a hybrid Lagrangian-Eulerian exchange. It’s not part of the standard package but there’s constant rate simple transformation form one species to another. People have developed other modules for sulphur species, the ozone model, CD4, and we’ve got a mercury module. Basically the chemistry works in its hybrid approach. You release from point sources or area sources and do the computation of dispersion and transport in a lagrangian framework. The particle then contributes to the eularian concentration grid and the chemistry solution is run. The concentration change is linearly applied to the mass and the change is put back on the particle and the advection continues on.

The standard graphical output in Postscript, Shape files, or Google Earth (kml), distribution: PC and Mac executables, and UNIX (LINUX) source.

Slide 4. I’m not going to cover all the changes in the model. It’s not that new we started in the early 1980. The great points I want to highlight are the original version of the model used was rawinsonde data with day/night (on/off) mixing. Later we basically we switched to gridded meteorological data. Based on the experiments done in the 1980, we found that we could do a better job using meteorological data instead of using observation.

This is true only in the regional large scale type of situation. I’m not going to argue that a gridded meteorological model might be better when you are 5 km from power plant where you have on site meteorology. But for these large scale experiments the resolution of the rawinsonde data was really insufficient to capture regional kinds of flow patterns. We need some kind of other approach.

The other thing that came later back in early 2002 we started adding a lot more options to the dispersion code because the interest shifted away from the deterministic solution and more probablistic solutions so we added the ensemble, matrix, and source attribution options. More recently we have tried to link up with the staggered WRF grids, turbulence ensemble, urban TKE.

The last point version 4.9 which will come out early 2009 I hope, we're going to have rather than a plume-in-grid, we're going to have a grid-in-plume model. Essentially a subroutine for HYSPLIT. What that means is for very long range simulations and what we're interested in are contributions of pollutants to the United States from China as a background contribution. If you're running the lagrangian model for all the sources in China you're going to need a whole lot of particles and it becomes a staggering computational problem.

But for a situation like that it is very reasonable to look at an Eulerian model to provide the concentration background and combine that with Lagrangian plume model. From that stand point the way it would work would be to find the point sources all over the world and at some predefined time the particles would be transferred to the Eulerian model.

Let’s go on to slide 5 now. Just briefly on how the trajectory is computed. It’s a 2 step process (inaudible) it actually starts with equation 2 the first-guess position.

$$P(t+dt) = P(t) + 0.5 [V(P\{t\}) + V(P'\{t+dt\})] dt$$

$$P'(t+dt) = P(t) + V(P\{t\}) dt$$

The integration time step is variable: $Vmax \, dt < 0.75$. So that’s a pretty basic approach and I think all the models use some variation of that. It goes back to a 1935 meteorology book and it a pretty traditional approach.

Number 6 slide. Now we compute these trajectories. A single trajectory cannot properly represent the growth of a pollutant cloud when the wind field varies in space and height. This was an interesting example. Just to show you that in this case in starting a trajectory, this is Spain in case you don’t recognize the geography. Why would I run Spain?

Invited to a meeting there. In any event what we’re doing is starting a trajectory in the illustration on the right, new trajectories are started every 4-h at 10, 100, and 200 m AGL to represent the boundary layer transport. It looks like a plume because wind speed and direction varies with height in the boundary layer.

As you can see the thing sort of spreads out and looks like a plume. But it’s just a mean wind coming out of the East (inaudible). And so you’re getting this growth in a horizontal that is a result of the wind direction shear and wind speed shear with height. And that is really driving the dispersion process. If you added any kind of turbulence on this it would have a minor effect. That is a big thing for boundary layer dispersion.

In HYSPLIT we can compute the mean trajectory for each one of these. If I’m releasing thousands of particles and each one has a little bit of pollutant mass on it, that’s the 3D-particle model with just the mean motion. We have to add on a turbulent component that would represent the dispersive component of the atmosphere. That’s the complete 3D-particle approach.

Another one of the possibilities is the PUFF approach where we’re not modeling the individual particles, but we’re modeling how that particle distribution changes with time. How the standard deviation of the plume as it changes with time. In this case it would be like a 3-D cylinder with a growing concentration distribution in the vertical and horizontal. Puffs may split if they become too large.

We also have a Hybrid approach where we look at the particle motion in one direction and a puff type approach in the other direction. The hybrid method always puts the particle in the vertical and puffs in the horizontal. Mainly the particle approach would give us a more accurate representation of what’s happening in the boundary layer as there is a lot more shear with height than in horizontal direction.

Slide 8 shows an example of the 3D-Particles (5000). If you don’t recognize the terrain this is Fairbanks Alaska. It was in September and a very nice trip. The approach on the left illustrates what I was saying about the 3-D particle concentrations you can see from the illustration what that turbulent particle distribution looks like when added to each of those mean particle trajectories. It's a lot more interesting as a vertical than a horizontal.

If you look on the right side of slide 8, this is running with 3-D Puffs and we are not really seeing any dispersion here because we're looking at the center of the puff and that represents the mean trajectory. So about those puffs you have some distribution you just don't see it in this plot. Everything I'm showing you on this presentation I did on my PC with the PC version of HYSPLIT.

Slide 9. As far as the puff distribution, just for example, I said that there are two for modeling the distribution, it could either be a top hat or could be a Gaussian. With the top hat computation, you're either in or out, and when you're in you have a mean concentration and the mean concentration would be the top hat. It represents the half the mass of the Gaussian distribution.

Slide 10. This just shows the equations that are involved. Now some of these equations are simplified. I dropped off some terms, so don't take this back and try to compute these values. You need to go back to the original documentation which is on the web page. But for 3-D particle approach, just briefly, we're computing a mean trajectory, but actually in this case we're adding another term, a u-prime turbulent dispersion. That u-prime is computed from the turbulence from the previous time step, to which is added the last term here. u-double prime, which is the standard deviation of velocity component that comes out of the computer. The Gaussian random number is weighted in proportion to the turbulence that comes out of the model. That's the particle approach.

Now for the puff approach we're using the same kind of thing, in that we're computing the standard deviation in terms of the growth of the puff. It's also a function of the turbulent velocity. If you would take the individual particles from the 3D calculations and compute their deviation, the square of the deviation from the mean position. That gives you the standard deviation, the made as modeling the puff if you had stationary homogeneous turbulence. You're supposed to get the same answer but you won't always get the same answer.

Slide 11 is an example of the calculation using 5000 particles or 500 puffs. In this case what's happening at the end of the particle is spread out it becomes a noisy simulation because you don't have enough particle density to give you a smooth plume and that's one of the limitations with the particle approach. When you get to very long distance scales and the global scale (inaudible) for global background, it is difficult to (inaudible) to get a smooth type of simulation. That's why we have this puff approach and especially the hybrid approach in HYSPLIT.

Slide 12. Just briefly how do we compute concentrations? Well each particle if you're running the 3D particle model the change in concentration in any grid cell will be the mass contributed by that particle divided by the grid cell volume. If you're using some kind of puff approach it's the mass of the puff divided by the volume of the puff, basically. The approach is the same as summing the mass dividing by the volume.

Slide 13. This goes back and is just a summary of why the hybrid HYSPLIT is used for the puff approach. Here's an example on the right when you only have 500 3-D particles and you can see how they break up sooner. That's why that 500 Hybrid puff approach gives a smoother looking plume. As we saw in that vertical distribution there's a lot more shear and lot more things going on in the vertical than in the horizontal and having the puff approach in the horizontal helps give us a smoother type of representation.

Slide 14. I'm not going into much detail here but there are all kinds of deposition computations here and different ways to treat dry and wet deposition including using the resistance method which goes back to the Models-3 if you want to turn that on. Refer to the guide for this. The point I want to make is that in

HYSPLIT we’re not losing particles but we are actually depleting the mass of the particles. In this case, we don’t want to lose particles because there are too few in the computation so we just lose mass.

Slide 15. I’m going to work my way down in scale. This was the massive dust storm from China in 2001. This was running the 3-D particle model and what you see here is the particle positions coming out of HYSPLIT just a day or two after the dust storm started. About a week later when it first started approaching the United States and the HYSPLIT particles are the black dots and the TOMS aerosol index is the color pattern underneath. We get a lot of questions from the web. People were asking how accurate was these calculations. They always try to pin you down on this and when they try to pin us down we say it’s about 20%. What they don’t believe and have a hard time believing is the longer the distance and the more dispersed the particles, the more accurate it becomes.

As you can see on the right is what’s happened is the particle starts lining up with the large scale weather patterns at the frontal boundaries and the meteorological model has captured those features very well. You may be off in the source location but you might be (inaudible) as long as you are in the avenue I should say the caveat.

Slide 16 is the same event now and it arrived over the US over the 14th like a week later. And the following week we started measuring concentrations over the US and I just have it in the table in the middle of the graph. The numbers are in the order of 30, 40, 50 micrograms per cubic meter, contributed from that event. The HYSPLIT predictions are shown in the graph and we're actually over predicting, what might be the 100 for a low value. The timing was about the right, but concentrations a little bit high because we didn't have deposition turned on, just standard transport and dispersion.

In fact the emissions came from a dust storm module that was developed originally for looking at sand storms in Kuwait. Its self predicting what you saw in the previous slide the emissions of dust were initiated automatically, when you turn on that module, over desert land-use regions that had a high wind velocity.

Slide 17. We’re moving down now and we’re just covering the US. We do have an operational wildfire smoke forecast that is running. You can go to our web page and also the weather service page. Our page is better than the weather service page partly because we offer ways for verification whereas the weather page only shows the forecast. We are showing the verification every day with what was occurring yesterday as to what was observed by visible satellite imagery. You can like manipulate the times and so on. The reference is there and you can take a look at that.

The last slide, 18, here is on verification down on the local scale. This is down to the 80 km scale we’re looking at a tracer experiment we did in Washington DC area. This particular graph shows the monthly sampling results. The 8 hour sampling was only a few locations and was difficult. But at the monthly locations, essentially, the model didn’t show a lot of bias and we’re kind of happy with those results.

Verification is the big thing and on my way to wrapping this up and it’s important to us. You know there has been a lot published about how to verify models and you know for us a lot of this you make a change or you’re trying to improve the calculations and did it really improve. Then you know the correlation goes up or the bias might go down. You can always get different results and we’re trying to come up with some to know if I make these changes to my model what my overall results will be. We tried to come up with a number and this number is what we call a ranking. It is composed of 4 components such as the correlation (R) represents the scatter; the fractional bias (FB) is the mean difference between paired predictions and measurements and yields a normalized measure of the prediction bias in normalized units; the Figure-of-Merit-in-Space (FMS) is defined as the percentage of overlap between measured and predicted areas and is computed as the intersection over the union of predicted and measured concentrations; the Kolomogorov-Smirnov (KS) parameter is the maximum difference between the unpaired measured and calculated cumulative distributions. And then these are normalized and the perfect model would give us a rank of 4.0. Obviously you can add other parameters if you want.

Slide 20. One of the things we have on the web all the tracer experiments we have been involved with over the past 20 years. And for those tracer experiments we have run….the first question is if it’s 20 or 30 years old how can it be still relevant today? We sort of fell away from going back to these experiments because each one of them had different meteorological data available. Some of the earlier ones there was only Rawinsondes. Then we started seeing the gridded data so when we were doing later experiments.

Recently NCEP completed this North American Regional Reanalysis. You can go to their web site download and convert that data so that you can use it in the model. So all of a sudden we have a consistent meteorological database that is available and we can use modeling methods and we can go back and look at the old data and see how well we are performing. This is a big thing. And now for the first time we have statistics that are consistent using the same meteorology. It’s not shown here but the difference that you find changing dispersion in the model and changing anything you try to change when you look at one experiment it makes a big difference. When you start using experiment that represents 3 months or 2 years worth like in METREX. So there’s lots of data. This is available on our web site. Let’s look at one briefly. Of course I’m only going to look at the best one which is ANATEX. You can see the average on the left and the paired on the right.

EXPERIMENT
Average
Paired
ACURATE
3.25
1.77
ANATEX GGW
3.48
1.84
ANATEX STC

2.66

1.63

CAPTEX

3.24

1.63

1ETEX

2.37

1.55

1INEL74

1.71

1.37

METREX (t1)

2.81

1.77

METREX (t2)

2.27

1.58

OKC80

2.50

1.73

Slide 21. On the left here it shows what the ANATEX experiment looked like and the G over in Montana is where the release occurred and all the stations represent the samples that if we're averaging together. So when you click on that 3.48 this is the page that would come up which is the overall statistics and you can see the correlation is .97 which is (inaudible) probably a little bit small for you to read. But the thing is this represents a 3 month experiment so if we average each individual station by time we get a 3 months average we're looking at the spatial distribution. The spatial performance of the model is .97 correlation coefficient and the bias was a ratio 1.37. Okay.

Anyway the point I wanted to make this is available for you to look at what's important to you. Everybody may have a different idea what is important depending on what your requirements are.

Slide 22. What's in the pipeline for version 4.9? We've got all these tracer experiments on the web. We want to have web interactive verification linked to DATEM. We

will have the integrated global model for background contributions.
The Chemical (CAMEO) and radiological effects database (web) and not the PC version; GIS-like map background layers for graphical display (pc); model physics ensemble (pc/unix); meteorology and turbulence already in existing version and completely revised user's guide with examples but not started yet. That's the end. I hope I stayed within my time limits.

Tyler Fox: Yeah that was great Roland. Are you going to stay with us during Joe's presentation?

Roland Draxler: Yeah.

Tyler Fox: We have Joe Scire presenting an overview of puff particle model.

Joe Scire: Okay. Last week I was asked about the particle puff model the PPM module that's in a version of CALPUFF and I said I would be happy to write a presentation. I was traveling during that time and didn't get back to the office so I don't have graphics. I'll describe the model and a little bit of history about it.

This is the work of Dr. Peter de Haan as part of his Ph.D thesis at the Swiss Federal Institute of Technology in Zurich, Switzerland. He spent a few months with us when I was at (inaudible) he stayed and worked with us for a summer. He was hard at work on his Ph.D and there were several papers as a result of this work. The two that I used in developing this presentation are shown on this slide. So really this is his module that was incorporated in to CALPUFF.

Basically it’s a module that is an alternative or an option to treat dispersion in a more detailed way in the near field. What the purpose of the PPM the puff particle model is to try to combine the advantages of both puff and particle approaches. In one of the elements of the PPM is that it will allow you to calculate and predict the mean concentration and give (inaudible) and an averaging time. So you are computing the higher moments of the density function.

Now in terms of models (inaudible) one advantage is particle models over plume models has to do with the ability of (inaudible) spatial variably of accounting for spatial variability of meteorological and dispersion conditions, causality effects, low wind speed dispersion, memory of previous hour’s emissions, spatial variability in dispersion rates, etc. Lagrangian stochastic particle models are state-of-the-science approach, especially for simulation of inhomogeneous (convective) turbulence. They are computationally demanding and there is more difficult to deal with wet and dry deposition, chemistry.

If you look at the Puff model types there are a couple of types within the class of puff models. One is the ensemble average puff model and CALPUFF would this type. We have a puff that consists of a center of mass and a 3-D distribution of total mass around the center. This represents the ensemble average of the concentration distribution belong to a “piece” of the pollutant release. The other type is a cluster dispersion puff model where a puff is a physical cluster of particles. Now then the concept of relative dispersion (due to turbulent eddies smaller than the puff) contribute to puff cluster growth. Larger eddies move puffs as a whole without changing the relative separation of particles within the cluster (meander component). Both of these are important.

Instantaneous puff releases require use of relative dispersion but update frequency of flow field is too low to resolve turbulent eddies not covered by relative dispersion concept. PPM uses a full stochastic Lagrangian particle dispersion model to determine the puff trajectory. I'll explain this a little more in a couple of slides.

Kinematic turbulent energy associated with eddies smaller than the puff size is removed since they are already accounted for the in relative dispersion. Every puff carries along its position along with the position and turbulent velocity components of the stochastic particle to which it belongs.

The effect of meandering caused by turbulent eddies larger than the puff but not resolved by the flow is simulated by the puff center trajectories. Two contributions of dispersion process are the relative dispersion (small eddies) and the meander (large eddies). The Stochastic path artificially produces the meandering behavior, but it is necessary to account for the spatial and temporal correlation of turbulence. The tendency of neighboring puffs should show similar meandering.

The way this is implemented into CALPUFF are multiple steps. Every time there's a newly released puff a "mirror ensemble" is attached. This mirror ensemble consists of a user-defined number of puff-particles. The time step broken into sub-steps (sampling steps) in CALPUFF. For each sub-step the mirror ensemble is advected with a PPM time step (~1-10 seconds). For every PPM time step, new particle trajectories are computed, from which the puff trajectories are derived. At the end of a sampling step, mirror ensemble's first and second moments of mass distribution are used to compute the parent puff's size and position and then handed back to main CALPUFF routine.

CALPUFF then computes any physical process changing the puff's mass or chemical composition (but not its size or location). At some point, the size of the particle-puffs in the mirror ensemble will be large enough so that most of the energy spectrum will be within the puff-particle. Relative dispersion ~ same as absolute dispersion. At that point, the parent puff location and size is recomputed, the mirror ensemble is deleted and the parent puff is restored. Parent puff treated in normal CALPUFF way using absolute dispersion.

Peter evaluated the model of several different data sets which included:

•The PPM was evaluated using measurements from three tracer experiments.

•Copenhagen

•9 hours measurements under convective conditions

•115m release height, suburban area

•Lillestrom

•8 observations, 15-minute averaging times

•Strongly stable winter conditions

•36m release height, suburban area

•Kincaid

•Mostly convective conditions

•171 hours of measurements

•187m power plant stack, rural environment

Datasets are “reference datasets” developed as part of European short-range dispersion model harmonization workshops.

This is where I wish I had graphics but I don’t and will have to describe it to you.

Copenhagen had good agreement of arcwise maximum concentrations with little overall bias and nearly all data points within factor of two of observations; some under prediction of cross-wind integrated concentration (CIC). Very similar results to those obtained with a full Lagrangian particle dispersion model (LPFM)

Lillestrom: Generally good prediction of arc-maximum concentrations and some displacement of location of peak concentrations.

Kincaid used QI=3 (highest quality) data

So overall this was considered a pretty good starting point that exists in a version of CALPUFF and it’s an older version. But it’s something if there’s interest could be put in a current version of the model. You can turn the switch on or off and you can get some experience in determining its performance in other data sets. That's basically all I have.

Tyler Fox: Are there any questions for Joe or any others. We are going to move quickly to the next part of this which is the Single Source Modeling. We'll start with presentation from Prakash on Overview of CMAQ MADRID with SCICHEM. Then depending on the time we have left, we will either finish up with Kirk or Ralph or break for lunch to continue those presentations.

Prakash Karamchandani: I'll be talking about plume–in-grid modeling, which basically consists of using a plume model within a grid model to capture fine scale variability next to emissions sources. And the whole idea is that the grid models that we use typically have coarse horizontal resolution of 4 km and 12 km and cannot capture the subgrid-scale variability that we have in the emissions. So why do we use it? If you look at a grid model with a resolution of 4 km or 12 km, the plume has to travel through several grid cells before it reaches the size of the grid.

That leads to unrealistic treatment of the transport of the emissions and chemistry of the plume. So what we're trying to do with a plume–in-grid model is to combine the plume model and the grid model and carry the plume along until it approaches a size that is comparable to the grid size.

I showed this slide yesterday and what we're trying to do with the plume–in-grid model is to capture the first two stages, which I talked about yesterday – the early plume dispersion and the mid-range plume dispersion, and the grid model cannot predict these two stages correctly. Stage 3 is the point at which we hand over the plume to the grid model.

So, like I mentioned earlier, the model consists of a reactive plume model embedded within a 3-D grid model. The plume model captures the local scale variability and the grid model provides background concentrations to the plume model. At the time we hand over the plume model to the grid model, the grid model concentrations are adjusted. There's a two way feedback between the host grid model and the plume model.

Plume-in-grid modeling is not new; it began in the 1980s – one of the first models was called PARIS - Plume-Airshed Reactive-Interacting System. Early models were overly simplified – simplified treatment of chemistry in some models, no treatment of wind shear or plume overlaps, no treatment of effect of atmospheric turbulence on chemical kinetics. The development of a state-of-the-science PiG model for ozone was initiated in 1997 under EPRI sponsorship.

The embedded plume Model is SCICHEM (state-of-the science treatment of stack plumes at the sub-grid scale)-developed by L-3 Communications/Titan and AER. SCICHEM is based on SCIPUFF, an alternative model recommended by EPA on a case-by-case basis for regulatory applications (also used by DTRA and referred to as HPAC). It’s a three-dimensional puff-based model, with second-order closure approach for plume dispersion and treatment of puff splitting and merging. SCICHEM adds the full chemistry mechanism to SCIPUFF.

Before CMAQ became available, SCICHEM was first embedded in MAQSIP, the precursor to the U.S. EPA Model, CMAQ. In 2000, AER incorporated SCICHEM into CMAQ. The model is called CMAQ-APT (Advanced Plume Treatment).

The early applications of the model were for ozone, where we conducted simulations for episodes in the eastern United States with two nested grid domains (12 and 4 km resolution) for July 1995. We also applied the model to Central California (4 km resolution) for July-August 2000. The key conclusion from the eastern U.S. application: for isolated point sources, CMAQ-APT predicts lower O3 and HNO3 formation compared to the base model.

We added PM and aqueous-phase chemistry treatments in 2004-2005 Two versions were developed: one including the EPA treatment of PM (CMAQ-AERO3-APT), and the second including the MADRID treatment of PM (CMAQ-MADRID-APT), developed by AER. MADRID is the Model of Aerosol Dynamics, Reaction, Ionization and Dissolution (Zhang et al., 2004, JGR)

If you look at the current version we have of the plume-in-grid model, it is based on CMAQ 4.6, which is the latest available release. It was released in 2006 and I believe 4.7 will be coming out in a few weeks. But at the time, this is what we had to work with. So we had the MADRID PM treatment and the EPA PM treatment which is AERO3. So we have two versions: CMAQ-AERO3-APT and CMAQ-MADRID-APT.

Once we incorporated PM, we applied it to the southeastern United States. This was a study designed to supplement RPO modeling being conducted by the Visibility Improvement State and Tribal Association of the Southeast (VISTAS). 2 months were simulated (January and July 2002) with Base CMAQ v 4.4 and CMAQ-APT-PM. 14 power plant plumes were explicitly simulated with the plume-in-grid approach. Model performance evaluation was conducted for Base CMAQ vs. CMAQ-APT-PM. Power plant contributions to PM2.5 components were calculated and compared for Base CMAQ and CMAQ-APT-PM. This slide shows you the modeling domain for the application and locations of 14 PiG sources

This slide shows the power-plant contributions to average July PM2.5 sulfate concentrations. The left side shows you the Base CMAQ results without plume–in-grid. The right side shows the results of CMAQ-AERO3-APT with plume–in-grid. There is a big difference between the contributions especially near the source regions and even further away from the source regions. The maximum contributions are 4.8 µg/m3 for the grid model and 2.4 µg/m3 for the plume-in- grid model.

This slide shows the same results in a different way. It shows the change in the contribution by using the PIG treatment. You can see that the contributions drop by about 43% near the source region. Even further away it’s about 1 to 5 % lower.

The conclusions were that using a purely gridded approach will typically overestimate power plant contributions to PM because SO2 to sulfate and NOx to nitrate conversion rates are overestimated. Plume-in-grid PM modeling provides a better representation of the near-source transport and chemistry of point source emissions and their contributions to PM2.5 concentrations. CMAQ-AERO3-APT predicts lower power plant contributions than base CMAQ to local and regional sulfate and total nitrate, particularly in summer.

The next improvement was the addition of mercury in the model. The implementation of mercury modules in CMAQ-MADRID-APT was completed in 2006. An application of CMAQ-MADRID-APT (with Hg) to the southeastern U.S. (12 km grid resolution) was conducted for 2002. An application of CMAQ-MADRID-APT (with Hg) to the continental U.S. (36 km grid resolution) was conducted for 2001 (Vijayaraghavan et al., 2008, JGR).

This slide shows mercury deposition with the grid model on the left hand side and the change in mercury deposition using the PIG treatment on the right hand side. What we found was the grid model overpredicted mercury deposition, especially in Pennsylvania downwind of the emissions in Ohio, and we found this overprediction was corrected by using PIG treatment.

Next we looked at an issue that's becoming important and that is population exposure to hazardous air pollutants (HAPs), which is an important health concern. Measurements show a large spatial variability in air toxics concentrations near roadways. Exposure levels near roadways are factors of 10 larger than in the background–models need to capture this subgrid-scale variability in exposure levels. Many of the species of interest are chemically reactive–e.g., formaldehyde, 1,3-butadiene, acetaldehyde–models need to treat the chemistry of these species. Traditional modeling approaches are inadequate to provide both chemistry treatment and fine spatial resolution. Based on CMAQ-APT, we developed the prototype version in 2007 (Karamchandani et al., 2008, Env. Fluid Mech.). The model simulates near-source CO and benzene concentrations from roadway emissions. Chemistry is switched off for this application. Roadway emissions are treated as series of area sources along the roadway with initial size equal to the roadway width. Concentrations are calculated at discrete receptor locations by combining incremental puff concentrations with the grid-cell average background concentration.

This slide shows the application for the prototype – we looked at a busy interstate highway in New York City (I278). This was done for the July 11-15, 1999 period of the NARSTO/Northeast Program. The bottom figure shows the grid model domain.

If you look at this plot, which shows the qualitative evaluation of CO concentrations from model results compared with CO concentration profiles measured in Los Angeles by Zhu et al. (2002), Atmos. Environ., we get good agreement.

The challenge with P-in-G modeling is that it can be computationally expensive if a large number of point sources are treated with the puff model – computational requirements increase by a factor of two to three for 50 to 100 sources. Point sources have to be selected carefully to limit the number of sources treated. To obtain results in a reasonable amount of time, annual simulations are usually conducted by dividing the calendar year into quarters and simulating each quarter on different processors or machines. A parallel version of the code can address these constraints.

We started the development of a parallel version of CMAQ-MADRID-APT and completed it in late 2007. So on a 4-processor machine, the parallel version is about 2.5 times faster than the single-processor version. We have an on-going project to apply the model to the central and eastern United States at 12 km resolution and to evaluate it with available data. Over 150 point sources are explicitly treated with APT. The simulations include annual actual and typical simulations for 2002, as well as future year emission scenarios and other emission sensitivity scenarios.

This slide shows the modeling domain for the application that is currently on-going. As you can see it is a very large domain with a large number of PiG sources, and this application would not have been possible without developing the parallel version of the model.

I’d like to end by acknowledging the funding from Electric Power Research Institute (EPRI), Southern Company, California Energy Commission (CEC), Atmospheric & Environmental Research, Inc.; Collaboration in Model Development: L-3

COM; Parallelization Insights: David Wong, EPA; and data sources like VISTAS; Atmospheric Research & Analysis, Inc. (ARA) and the Georgia Environmental Protection Division (GEPD). Thank you.

Tyler Fox: What I’d like to do is if there are any questions for Prakash on the CMAQ Madrid why not ask them now. Then we can break for lunch and then start back so that Kirk and Ralph will have time to complete their presentations and we don’t have to rush. Are there any questions? Alright. We’ll see you back here at 1:00

We’ll all get back together. There doesn’t seem to be as many people. So as we said, we will conclude the session on New and Emerging Models with presentations by Kirk Baker and Ralph Morris on single source models and photochemical models. We’ll take some questions on that and go right in to the public session and go according to the order in the final agenda yesterday. There are a couple additions or at least one addition we can add. I’ll hand this off to Kirk.

Kirk Baker: I appreciate those of you who came back after lunch. I'm going to talk a little bit about photochemical modeling and in general some of the features of the photochemical models that are starting to lend itself to single source modeling and tracking that type of thing. I'm going to start way back at the beginning simple (inaudible) for all types of air quality modeling systems whether it's dispersion, or photochemical grid model system. Essentially you will use the same emissions input, meteorological inputs and process that for the air quality model.

Generally speaking the model started off as a dispersion model, simple photochemical box models that moved on to second generation photochemical models like urban REMSAD models. Those photochemical models are geared to specific type of pollutant. UAM, REMSAD for Ozone, REMSAD was primarily was developed for PM 2.5 deposition type applications. Recently in the last five or ten years, the latest generation of photochemical grid models are a one atmosphere modeling system approach where we are trying to treat all types of precursors species ozone and

PM in the same modeling system. An example would be CMAQ and CAMx.

So the One Atmosphere approach may not be particularly meaningful to people but the way we look at it is we put in all different types of sources, mobile, stationary point, area sources and all the different types of precursors, NOx, VOC, SOx, PM and toxics and use data science chemistry and transport and meteorology inputs to predict ozone, PM acid rain, visibility and toxics, and even deposition.

This was a (inaudible) slide and wasn’t going to use it but got interested in the slide on the right and how that fit into this big picture and how that fit into this big picture. I ended up interpreting this as we’re trying to prevent kids in this terrible dooms day air pollution nightmare we’re having up above. That’s what we’re trying to do here is kind of bring it back so we know why we’re doing what we’re doing. We’re trying to save these kids.

Photochemical models the governing equation is at the bottom. Basically what is going on in photochemical we’re trying to make chemical transformations (Gas- & Aqueous-phase and Heterogeneous Chemistry); advection (Horizontal & Vertical); diffusion (Horizontal & Vertical); removal processes (Dry & Wet Deposition).

Just in case people are not that familiar with photochemical models. The dispersion model shown on the left with the plume (inaudible) at a particular source plume kind of in its own universe. On the right you have the entire universe (inaudible) into one universe model. Kind of like taking the emission sources and putting a huge set of 3-D boxes on it to solving for all these different processes going on in each grid cell.

For photochemical models advantages, one of the things in using a photochemical model for single source is full state of the science gas-phase chemistry, ability to estimate realistic ozone concentrations, no need for a constant ozone background value for PM, advanced aqueous phase chemistry provides realistic sulfate estimates; wet and dry deposition processes included, photochemical models generally have good temporal and spatial estimates of ammonia concentrations, spatial/temporal representation of ammonia and nitric acid concentrations and state of the science inorganic chemistry (ISORROPIA) allow for realistic nitrate partitioning between gas and particle phase and Source Apportionment tools allow for tracking of single emissions sources or groups of emissions sources.

More recently, Source Apportionment tools have been implemented in photochemical models which allows (inaudible) single or multiple emission influences. This type of technology combined with the science that is already in the grid base models is starting to lend itself to single source applications. I’ll show some examples in a minute. Source Apportionment tracks the formation and transport of PM2.5/ozone from emissions sources and allows the calculation of contributions at receptors. Chemically speciated PM2.5 contribution can be converted to light extinction for visibility applications.

On the right I just plotted out how the tracking occurs for PM on the top precursor to particulate species. NOX --> NO3; SOX --> SO4; NH3

--> NH4+ ; Primary OC --> POC; Primary species are pretty self explanatory. Source Apportionment also tracks VOC emissions too and secondary organic aerosol, and inert species. Estimates contributions from emissions source groups, emissions source regions, and initial and boundary conditions to PM2.5 by adding duplicate model species for each contributing source. Additionally NOx and VOC emissions get tracked for their contribution to ozone if you choose that. There are also some toxics components but I wasn’t going to get into that in this presentation.

So on the particulate side you see that CAMx has particulate apportionment implemented and that tracks all the chemical species: mercury and PM sulfate, nitrate, ammonium, secondary organic aerosol, and inert species. Basically, the process in which to (inaudible) for a particular source you would just include additional model species. Just put in those emissions and the models can track that with duplicate model species. And goes with the same type of atmospheric processes as all the others species do in the photochemical model. The only difference is for non-linear processes like gas and aqueous phase chemistry are solved for bulk species and then apportioned to the tagged species.

This is an example of ozone source apportionment that has been implemented in CAMx v4.5 (OSAT & APCA) and CMAQ v4.6 (OPTM). Tracks ozone contribution from sources similarly to PM with reactive tracers, July maximum ozone contribution from a source shown at right and OSAT is simulated separately from particulate source apportionment.

This is an example of using Source Apportionment type technology. We converted the output to 1 extinction but basically at the top left is the maximum ammonium light extinction estimation from that particular source in each grid cell. You can see the hot spot over there the source would be located. The photochemical offers speciated data so it can figure out the contribution from that source to ammonium nitrate, ammonium sulfate and the primary species. So clearly this particular source has emissions dominated by sulfur dioxide.

This is the same thing I showed on the right with the total of the maximum contribution from a particular source over an entire year. Just comparing that back to a very simple metric emissions over distance to show that this type of screening metric states they obviously agree with each other, but there’s a lot more detail going on with the photochemical model because it’s taking a lot more processes into consideration.

Issues for using PCM for Single Source Applications was touched on Photochemical models resource intensive (computational, disk space, staff) for multi-year applications, especially at grid resolutions <= 12km. Additional level of staff expertise to get people who are comfortable doing that. Existing community emissions inputs (from States, RPOs, etc) for photochemical models are actual emissions and may need to be modified if more conservative emissions estimates are necessary and useful for near-field applications.

The other thing about photochemical grid models is how useful clearly it has gotten a lot of utility for long range applications but what about near-field applications? I think we need to do some more testing and looking at the earlier types of applications that have been done working with near-field with photochemical models. With the CPU getting cheaper and the different types of extensions being added to photochemical models like sub-cell receptor locations, and 2-way nesting capability. And to review existing near-field applications using PCMs, evaluate tracer studies. The picture on the right was a tracer experiment we just did a preliminary test of that where we ran that through a photochemical model and that's just an example of what the concentrations look like. Those are the types of evaluations we want to keep working on and keep looking at.

Other work I will talk about briefly.

The mid west RPO did some preliminary testing (not an evaluation of CAMx PSAT or CALPUFF) of single source modeling with CAMx PSAT to compare with CALPUFF visibility estimates. Several States did single source visibility modeling for sources less than 50 km from Class I areas; used sub-grid plume treatment. To make a long story short the (inaudible) modeling just try to apply these consistently, they both use the same meteorology output from MM5. CALPUFF was run in a NOOBS mode. They were both processed to look at the number of times in each grid cell that had a 24 hour average [ed. concentration] (inaudible) over background and they were both using actual facility emissions not any potentials or maximuns.

The other thing I want to point out before I show these result is this is not intended to be an evaluation of CAMx, PSAT or CALPUFF. We are not trying to say which is right or wrong but to find out what the differences are. This is an example for a few facilities on the top we've got the CALPUFF results and on the bottom are the CAMx PSAT results. One important caveat to put on this is that CALPUFF look at sulfate and nitrate impacts and CAMx just has sulfate. That could be a part of the differences, but I don't think we expect to see a lot of visibility from nitrate. It wasn't as common.

Generally qualitatively we saw a

similar type of response from both models. Not amazing was CALPUFF had some larger extinction (?) of the contribution. We applied CALPUFF with the regulatory set of options which probably closer to the most conservative types of things. So you expect a larger contribution when you use more conservative sets of assumptions. And with the photochemical model really not a lot of conservative assumptions you can make because it is what it is.

This is just another group of sources in the same area. Qualitatively, they are pretty similar but the extent is slightly different.

Final remarks. I think the photochemical grid models provide an opportunity for credible single source modeling with Source Apportionment methodology. These models have the advantage of state of the science chemistry, but that comes with increased resource burden. These models are routinely used for other regulatory purposes like O3/PM2.5/Regional Haze State Implementation Plans so they do have regulatory history and people are more comfortable with using them in that way.

Tyler Fox: Thank you Kirk. Now we will get more details from Ralph on single source modeling for Ozone and PM.

Ralph Morris: Thank you. I guess Kirk set the stage pretty well giving the goal and concept in using photo grid models for single source or groups of sources impacts. We’re not talking about fence line impacts, we’re talking more about the regional or further down wind a little. There’s no reason to go to a smaller grid size if you can’t use it for this. I’m going to give some examples afterwards. This is more of a slide for another group since this group knows the guidelines and the guidance.

One of the emphasis for considering the photo grid models for the single source assessment are the new more stringent Ozone and PM (inaudible) standards, and to pinpoint contribution (?) (inaudible) components. We are seeing now more and more what is my source or are regional offices or states are asking: “What are the contributions of source to the Ozone and PM2.5?”

New 0.075 ppm 8-hour and 35 μg/m3 24-hr

PM2.5 NAAQSs will bring many more areas into nonattainment, PM2.5 NAAQS increases importance of secondary PM2.5. Capability needed to obtain individual contributions to ozone and PM2.5 concentrations, deposition and visibility. Current guideline models have no (AERMOD) or highly simplified (CALPUFF) representation of chemistry. Photochemical Grid Models (PGMs) have capability to correctly treat chemistry. But how can they resolve and correctly simulate near source plume chemistry and dispersion? PGMs can only resolve impacts to the grid resolution. Fine grid size is needed near the source to resolve near-source plume chemistry and dispersion. Need many grid cells to assess downwind impacts. High computer resource requirements. Must account for all emission sources. Needed to correctly simulate chemistry. Databases more costly to develop. MM5/WRF applications. SMOKE or other emissions model and more expertise needed in their application. So why are we considering this now? There has been a lot of development in modeling capability for PGM for single source but we do have two-way interactive grid nesting. Allows fine grid over sources with coarser grid downwind when plumes are larger. Flexi-nesting where you can specify fine grid to resolve point source plume chemistry and dispersion without providing met and emission inputs and full chemistry Plume-in-Grid Modules. Treats unique near-source chemistry of point source plumes. Both CMAx and CMAQ have PM and Ozone Source Apportionment and allows individual source(s) assessments. Of course computational advances. Availability of PGM Databases and model set ups. RPOs, AIRPACT, SIPs, etc. and EPA has been developing stuff.

I talked about the two-way interactive grid nesting and the flexi-nesting and in CAMx you have to specify the grid it interpolates. Allows specification of high resolution grid over sources with coarser grids downwind where plumes are larger. Interpolate meteorology, emissions and/or other inputs for nested fine grid from coarse grid data. Allows fine grid treatment of point source plumes. Available within the CAMx model (just specify where fine grid domains are desired in job script). Have developed tool to generate flexi-nest fine grid inputs for CMAQ (for EPA/OAQPS)

I think I borrowed this from Prakash.

He talked about the Stage 1 and Stage 2 and the evolution of the plume where there’s no Ozone formed, no secondary PM formed and no stages are very little. Whereas in a grid model you dump those emissions and it starts forming Ozone and PM2.5 immediately. That’s one of the purposes of the Plume in Grid model.

I think Kirk talked about the Ozone and PM Source Apportionment so I don’t have to talk about that. We’ll get back on time here. I’m going to talk about applications. One is down in Texas Group BART application. CAMx 36/12 km with P-in-G and PSAT. Estimation of individual contributions of 31 point sources to annual PM2.5 in the eastern U.S. Individual point source contributions to 2009 annual PM2.5 concentrations. Visibility Improvements for States and Tribal Association of the Southeast (VISTAS) and Association for Integrated Planning of the Southeast (ASIP). Annual PM2.5 SIP modeling for St. Louis. Effects of local sources on PM2.5

nonattainment.

I have one slide on the Texas Bart but Texas had like 200 potential Bart eligible sources. Rather than running each one individually we decided to do group analysis and run them in groups of 10. In each group Bart analysis of 10 sources at a point use PSAT to obtain PM2.5 contributions of groups of Texas BART sources for comparison with 0.5 deciview threshold. CENRAP 2002 36 km modeling CAMx database. Add 12 km flexi-nest grid covering Texas and nearby Class I areas. Use IRON P-in-G for Texas BART Source.

Another application is the PM2.5 Ozone ASIP model a part of VISTAS ASIP. Here’s a 36 km: 148 x 112 (4 days), 12 km: 168 x 177 (10 days), 2002 Annual Runs, 4 Quarters w/ ~15 day spin up, MPI w/ 6 CPUs, 19 Vertical Layers, M3Dry, CBM-IV/AE4/SORGAM, SOA mods. In 2005 VISTAS enhanced CMAQ to include SOA from sesquiterpenes and isoprene (Morris et al., 2006).

Some ASIP/VISTAS states wanted to know individual contributions of several point sources to 2009 PM2.5 levels. 31 individual point sources in 6 states identified. Contributions due to SO2 and primary PM emissions requested. CALPUFF considered for assessment. Not consistent with CMAQ full-science chemistry. Provide inconsistent source contributions with 2009 PM2.5 SIP projections. ASIP 36/12 km database inappropriate for individual point source modeling. 12 km grid cell size too coarse to treat chemistry and dispersion of point source plumes. Use of high enough resolution to resolve point source plume would be computationally prohibitive. Would need to perform base case and 31 zero-out runs to get individual source contributions. Elected to develop a new CAMx 2002 database, 12/4 km domain with two-way nested grids. Plume-in-Grid to address near-source chemistry and dispersion. PM Source Apportionment Technology (PSAT) to obtain individual source contributions.

This is our CAMx 12/4 km domain nested within ASIP 12 km CMAQ domain (one-way nesting). CAMx 12/4 modeling using two-way interactive grid nesting. 2002 base case using standard model. 2009 base case with PSAT PM2.5 source apportionment for 31 point sources.

Here's the Huntington and Ashland and Charleston 4 km domains. Little crosses are point sources and circles are (inaudible) method monitors where we are asked to get the PM2.5 impacts. You can see in some cases the sources are located close to the grid model to the monitor and sometimes almost (inaudible) I admit that when you are doing primary PM impacts (inaudible) for that other model CALPUFF. Something that has finer grid. So they're pretty close there in some cases. Okay.

Here's the source apportionment. The largest contributions are the boundary conditions. The boundary conditions are outside the 12 km grid of (inaudible) and the second largest is the purple all the sources. These things here are the contributions of the 31 point sources. It doesn't give us much information so get rid of the boundaries and other sources and have a contribution of 31 point sources. The projected 2009 design barriers at these monitors and these are the contributions. One thing we did compare (inaudible) to CAMx projections from the l2 and 4 km with the CMAx from the 12 point grid.

For these 31 sources the contributions are (inaudible) and those are pretty large contributions. The largest single source contribution is this source right near the monitor and that's about 2 µg which is a large contribution source on a monitor. In this case it's not above 15. Here's 1 µg for this model.

In St. Louis Regional 36/12 km grid and CMAQ V4.5 SOAmods. Projected 2009 and 2012 PM2.5 Design Values at Granite City and East St. Louis still exceed the annual PM2.5 NAAQS.

Evidence that local sources contribute to PM2.5 nonattainment at Granite City Monitor (B) and Washington St. Monitor (A).

Turner and co-workers (2007a,b,c,d) have developed a Conceptual Model for PM2.5 exceedences in the St. Louis area. They found that local sources contribute ~3.2 µg/m3 to PM2.5 at the Granite City monitor on average. The CAMx 12/4/1 km PiG modeling attributes 3.4 µg/m3 to local sources at Granite City. Recent advances in PGMs make them more suitable for assessing "single source" contributions to ozone, PM2.5, visibility and deposition. Fine resolution grids, two-way grid nesting, and flexi-nesting. Full chemistry Plume-in-Grid modules. Ozone and PM source apportionment. Full gas-phase and aqueous-phase chemistry and aerosol thermodynamic modules. The use PGM modeling to assess "single source" air quality, visibility and deposition issues have become more routine. ASIP point source PM2.5 assessment. Oil and gas AQ and AQRV assessments as part of NEPA, Texas and Arkansas BART assessment. PM2.5 SIP modeling.

Conclusions are that recent advances in PGMs make them more suitable for assessing "single source" contributions to ozone, PM2.5, visibility and deposition. Fine resolution grids, two-way grid nesting, and flexi-nesting. Full chemistry Plume-in-Grid modules. Ozone and PM source apportionment. Full gas-phase and aqueous-phase chemistry and aerosol thermodynamic modules. The use of PGM modeling, to assess "single source" air quality, visibility and deposition issues, has become more routine. ASIP point source PM2.5 assessment. Oil and gas AQ and

AQRV assessments as part of NEPA. Texas and Arkansas BART assessment. PM2.5 SIP modeling. That's all I have.

Tyler Fox: Thank you Ralph. Are there any questions on single source?

Joe Scire: TRC. I have a question for Ralph. When you do the (inaudible) cell analysis do you treat terrain elevations of the receptors within the cells. The second question is do you treat any wind variability within the cell due to (inaudible)?

Ralph Morris: No just using the wind that comes from the whatever you (inaudible) whether it's a gridded wind field or (inaudible). It's a simple application from that respect. And as far as the terrain the receptors are at the ground level so I imagine you could elevate the receptor if you like. These models are terrain (inaudible) a simple representation at this point.

Joe Scire: There's no terrain variability in the cell? That's my question really.

Ralph Morris: Yes, the terrain

(inaudible) so any terrain effects are in the wind fields that come out of MM5.

Joe Scire: That would be a resolution of the (inaudible) the cell itself.

Ralph Morris: Yes.

Bob Paine: ENSR. I have a question for EPA. Basically Appendix W Guidance on modeling single source for Ozone PM2.5 seems to be sort of lacking. Are there any plans to enhance that?

Tyler Fox: The purpose of this conference is to introduce these types of methods I think as we continue to evolve and as people have shown today and recognizing applications like Ralph has mentioned here. We need to begin to consider these things. As for changes from Appendix W would have to fall out of discussions both internally, with you in the community and with our policy folks in the Air Quality division. The intent here is to make us all aware and to identify that they could build an important need. As folks know with respect to the PM2.5 there may be some aspects of the implementation rules lacking in terms of

accounting for secondary formation in some parts
of the country, that could be a significant
contribution. And if we are not accounting for
that in our permit programs that may not be
getting us where we need to be in terms of
attainment in those standards. Any other
questions?
That concludes this part of the
conference sessions and what we have now is the
public session. Let me walk through the line up
for that.
Peter Eckhoff: Some of you might be
leaving here pretty soon. You're welcome to keep
your badges, but if you want us to recycle them
for later use, I'll put a box on the registration
table. Thanks.
Tyler Fox: so that everybody knows,
we've got the schedule laid out for the
presentations. We'll start with Bruce Egan
comments on behalf of API. Doug Blewitt has two
presentations, and then there is a presentation
for Peter Manousos and then multiple
presentations on behalf of AWMA. Then we have
comments on behalf of UARG from Hunton &

Williams. There’s another presentation from George Delic and another addition from Mark Garrison from ERM and that’s the long and short of our public presentations. Is there anybody here who is not accounted for who plans to make a presentation. Then I’m assuming I have everything here. Bruce if you would like to come on up. If you would just say your name and affiliation for the record, please recognize these will be made public.

Bruce Egan: Good afternoon I’m Bruce Egan from Egan Environmental. My co authors are Steven R. Hanna, Hanna Consultants, who is talking about the same topic in Crotia at the moment and Elizabeth M. Hendrick, CCM, of Epsilon Associates Inc. We are providing comments for the API.

Promulgation of more stringent ambient air standards has resulted in more non-attainment areas and the need for more complex and more regional modeling. These comments cover many issues relating to aspects of the EPA’s Guideline on Air Quality Models. Highlights are listed here and our written comments will contain details and references. We are going to provide written documentation of this. We'll go through an abbreviated version of our prepared slides as we see there are a lot of things ongoing and there will be redundancy.

We had discussions yesterday of CALPUFF and documentation. We would like to see that completed and brought up to date. And there is a general concern that API has more EPA Guidance Workshops and training. Over the past two days I have seen a lot of response from EPA even before we put the comment in. It is pleasing to see much more discussion about the models and the background.

One of the topics is distance limits on models especially on CALPUFF and AERMOD. As you know there is a 50 km cut off that differentiates CALPUFF and AERMOD at this time. We don't think the distance should be arbitrary like that and should depend on the scientific issues including meteorological data and land use variations. Can you hear me? Okay. What is the minimum domain size and grid size where grid models such as CMAQ or CAMx can be used, and what is the recommendation for Plume in Grid (PinG) modeling? Distance limits should not be arbitrary, but should depend upon scientific issues, including topography, wind persistence data and land use variations.

There has been an increase in the use of meteorological drivers (e.g., diagnostic models such as CALMET and prognostic full-physics models such as MM5) for both steady state and time varying dispersion models (e.g., AERMOD, CALPUFF, CMAQ). Prognostic meteorological models such as MM5 and WRF (often called ‘Met models’) have been improving with advances in science and resolution. We’d like to see EPA reach out to talk to some other agencies that are working on this including DTRA and NOAA who have linked MET models with MM5 and WRF and the Puff models. We’ll come back to this issue.

One of the research efforts we think is needed is to optimize use of Met model and CALMET model predictions with observations. Specific issues to clarify differences between full-physics Met models (e.g. MM5) and CALMET; look at assessing the effects of grid size and vertical grid spacing on bias and accuracy and to develop recommendations for optimal grid sizes for different topographic and meteorological settings; minimum grid size (Penn State MM5 developers recommend 4 km as a safe general rule, although 1 km can be used in special cases; this is due to physical assumptions in the model).

We'd like to see overall model performance of Met models coupled with dispersion models vs. field study data sets; and possible new field experiments to determine how met observations can best be used and assimilated in Met models? (e.g. note differences between NCAR and Penn State MM5 Met model data assimilation methods). We'd like to assess if CALMET (or any diagnostic model) is truly needed as an intermediate step between the Met model and the AQM. EPA should work with other agencies (DTRA, NOAA) who have operational Met model-AQM systems operating and make use of their technology where appropriate.

Determine overall model performance of Met models coupled with dispersion models vs. field study data sets; possible new field experiments. Determine how met observations can best be used and assimilated in Met models? (e.g. note differences between NCAR and Penn State MM5 Met model data assimilation methods). Assess if CALMET (or any diagnostic model) is truly needed as an intermediate step between the Met model and the AQM.

Work with other agencies (DTRA, NOAA) who have operational Met model-AQM systems operating and make use of their technology where appropriate.

We'll talk some more about data gathering in Wyoming and we'd like to see databases developed further which would provide monitoring data and emissions data inventory.

We see a need for an overall model evaluations of CALPUFF using full chemistry as very limited evaluations of the model in the mode that it is being used have been conducted. Evaluation should include other models such as SCIPUFF And the ability to handle complex terrain, short term puff dispersion, chemical reactions, and other incorporated capabilities (e.g. FOG) needs to be evaluated. We recommend that EPA modify the chemistry, based on API/AER recommended revisions.

We think that documentation is incomplete, and lack of detail causes many users to rely heavily on default values. Need to resolve met input questions (CALMET or Met model such as MM5 – see previous slides on Met inputs). Need to test the use of CALPUFF for regional AQRV analyses (NEPA studies are currently using this approach in the West). Operational use should be based on peer and stake holder review using best science approach as opposed to IWAQM mandates.

We'd like to see this (field experiment) happen. Purpose: to test and improve the linkage of Met models and air quality models in mountainous terrain, such as Wyoming where there is much current mesoscale and regional modeling underway. EPA should lead the effort with invited participation of API and other industries and stakeholders. Include meteorological observations, tracer releases, and PM and visibility observations over an area of about 200 km by 200 km, sufficient to test the use of Met model (e.g., MM5) direct input versus CALMET diagnostic model.

I’d like to switch to model evaluation uncertainty and these slides were written before we knew all the things EPA is doing. Recent improvements in regional dispersion model performance measures have been made; EPA efforts (in collaboration with members of an international workgroup) are described in a recently submitted paper by Dennis et al. I think Bob Paine has captured a lot of what we were talking about here. Rather than having different evaluation approaches and performance measures for the different model scales, a comprehensive set of performance measures should be devised for use at all model scales. I realize this differs on applications but I think we’re talking about the context of regulatory models and we understand that some of the models response is entirely dependent upon the set of priority performance methods.

The bootstrap method was talked about this morning and I won’t spend much time on this. John Irwin was instrumental in the ASTM software and Joe Chang and Steve Hanna have been active with the BOOT software. We think the model acceptance criteria should be set and used in modeling protocols and decision making. We also believe uncertainty in model predictions (also called “probabilistic forecasts”) should become available to and used by regulatory decision makers. EPA should investigate and possibly make use of the probabilistic AQM system (Met model – SCIPUFF) in use at DTRA.

We understand the screening model, AERSCREEN, is coming out soon. We’d like to see the establishment of a peer–review panel from all segments of the community to review planned improvements and draft documents produced and EPA incorporate algorithms for near calm winds and test with appropriate field data sets; improve algorithms for use in urban areas, especially for near-ground sources in built-up downtown areas and determine science-based criteria for deciding distance limits and whether “complex terrain” is significant.

Based on EPA guidance, EPA limits the influence of nearby land use in parameterizing surface roughness to a 1 km radius of ASOS anemometers generally located on airport property. For many pollutant sources this means that the dispersion modeling domain is dominated by surface roughness of airport property. Better guidance is needed for translating the airport wind observations to the land characteristics of the pollutant source domain. For most pollutant sources that use airport data, the dispersion model domain is going to be entirely dominated by the surface modeling of the airport roughness. We’d like to see better guidance for translating the airport wind observation to the land characteristics of the pollutant source domain. This is the bottom line out of this.

Issues on the AERMET output. AERMET Stage 3 output should summarize the processed met data so the user knows during the AERMET processing steps if that year of data is suitable for regulatory modeling purposes (>90% available). We’d like to see that summarized. Currently this summary information is not provided until AERMOD is run.

We are interested in the Plume Molar Volume Ratio Model (PMVRM. We like for EPA to further test this model and, if acceptable, recommend the use of this model for predicting NO2 concentrations in the presence of ambient air ozone concentrations. This should be performed for both AERMOD and CALPUFF.

Little change of subject here. We believe EPA has asked questions and asked for advice on non-regulatory driven studies concerned, for example, with health risk assessments use AQ monitoring data combined with statistical correlations as a substitute for the use of detailed dispersion models (AERMOD, CALPUFF, or CMAQ) for estimating air quality concentrations.

EPA should promote consistent and general use of dispersion models that are based on physical understanding of meteorological principles (e.g., AERMOD, CALPUFF, CMAQ, CAMx etc.) as opposed to statistical fits to site specific concentration data sets. The use of statistical models in place of more rigorous dispersion models should be reviewed by an expert panel that includes all scientific and stakeholder communities. We'd like to see EPA deal with that. I don't know if they can do it in the context of the guidelines, but it would be good for the overall community instead of approving statistical fits.

Avoid arbitrary non-scientific criteria for model selection (such as eliminating models with a bias for over-prediction). Encourage scientific peer review of all models (i.e., both internal EPA and outside models) and of proposed modifications to model algorithms. Model acceptance criteria should be developed through discussions with the entire community of model developers and stakeholders.

Need to update and improve model guidance and documentation. Encourage development and use of science–based models through model evaluation efforts and enhanced public involvement. Test, validate, and recommend procedures for using meteorological models to drive dispersion models. Conduct a Mesoscale/Regional collaborative model evaluation using the existing databases and/or conduct a field experiment that could be used to evaluate regional models in rural regions in the intermountain west or similar location. Thank you.

Tyler Fox: Okay next we have Doug Blewitt.

I did want to mention one other thing, it’s come up here and other contexts in terms of ASIP modeling and the like. I just want to emphasize a couple of things. One is EPA guidance, it’s just that and sometimes it’s interpreted as prescriptions and if you don’t follow exactly what we say you won’t be allowed to do something. I think we need to recognize and I know it cuts both way. But guidance is just that, guidance. Second point is that guidance we provide is only as good as the information you provide us or the information we have.

As a community and as it relates to issues here, guidance has to have a basis and has to be informed through experiences. Experiences learned not just by us but by you all. And so to the extent that in three years we would hear of your experiences. But in the interim, sharing those experiences here either through these specific applications with the state and local folks and regional folks and making sure those are understood, and will promote more communication and discussion within the region and state and local modeling.

Sharing that information through publications; the folks in ORD in developing CMAQ will look to the peer review literature as we would and so to the extent these things are published to the extent there are other conferences.

Having more of an opportunity to get that information into our zone of awareness if you will, will definitely help that out and we can build a consensus and understanding so that we can provide the type of guidance that is needed. Providing guidance that is just complained about and not useful to you all. If we can work better together that we can provide guidance that meets your needs and has more of a long term value. I think that will be more useful to us. I just wanted to make that comment in terms of the general concept of EPA guidance.

Doug Blewitt: Thank you. What I'd like to do is present issues related to air quality modeling for regional analysis for oil and gas development in the West. I'm not presenting this in the context of an end user and will try to present you with some of the challenges and issues and try to communicate to EPA some of the things we need to work together on. I am going to propose some long term solutions to this. What we're really talking about and you mentioned yesterday that we need consistency. The reason we developed guideline models was to take a model and look at it against observational data and see how it performed under a wide range of conditions.

And if we got reasonable agreement with that evaluation, we could use the model in future forecasting situations without additional verifications. And what I'm going to challenge EPA here is that in the context of AQRV analysis which is what we are concerned with in terms of oil and gas development in the West. We haven't lived up to that standard because as Bruce just said the model has not been evaluated to a large extent in a full chemistry mode. And that's the way we're using the model and there are some challenges and issues with that.

Most of this work is being done for oil and gas in the context of NEPA. You heard Ralph talk about that. CALPUFF is being used for analysis of future year regional air quality impacts under NEPA (Environmental Impact Statements) for oil and gas development in the West. A typical NEPA analysis includes up to 700 sources and impacts are projected over a 20 year period. Air quality modeling approach is: "Use the best available science to support NEPA analyses, and give greater consideration to peer-reviewed science and methodology over that which is not peer-reviewed." (Bureau of Land Management (BLM) National Environmental Policy Act Handbook H-1790 H-1790-1). Visibility and deposition impacts from NO_x emissions are the pollutants of concern. AQRV modeling approach is to develop a baseline emission inventory of sources not included in the monitoring data which is then added to cumulative emissions from new sources.

Formulation of CALPUFF chemistry. Lack of a robust model performance evaluation in a full chemistry mode. Indication of model bias for NO3 impacts compared to monitored values. Outdated and prescriptive IWAQM methodology is required for model application.

In the MESOPUFF II chemistry module used in CALPUFF, SO4 formation is described by 4 variables:

1) Solar Radiation;

2) Background Ozone (surface, user provided);

3) Atmospheric Stability; and

4) Relative Humidity (surrogate for aqueous-phase)

NO3 formation is described by 3 variables:

1) Background Ozone;

2) Atmospheric Stability; and

3) Plume NOx Concentration

Aqueous-phase SO4 formation is inaccurate because it is solely based on surface relative humidity (RH). In reality, aqueous-phase SO4 formation is not at all affected by RH. The MESOPUFF II transformation rates were developed using temperatures of 86, 68 and 50°F. A 50°F minimum temperature will overstate SO4 and NO3 formation under cold conditions. – A major issue in the intermountain West.

This is some work Ralph Morris did. It’s a comparison of CMAQ chemistry verses CMAQ MESO PUFF II chemistry. The blue dots are MESOPUFF II and the red dots are CMAQ and you can see there is a substantial over prediction to the MESOPUFF chemistry compared to the CMAQ chemistry. This is done for all improved sites and all CASTNET sites in the US. This is an indication that the system we’re using here is that the chemistry is not working as it should be. This is another figure that was in Prakash’s discussion yesterday. This is a different graph out of his results. There are big differences between MESOPUFF chemistry and RIVAD and some modified RIVAD that API has done. We have this issue of developing nitrate concentrations in excess of theoretical limits and we need more discussions on that.

Joe mentioned yesterday the SWWYTAF analysis and presented some graphs. This is really the only model verification that has been done in terms of CALPUFF. RIVAD chemistry was used. When boundary conditions were included model agreement was very good. Results were unpaired in time and space. Analysis indicated that NO3 formation was limited by NH3 concentrations. This is not the way that agencies are requiring that the model should be used. The following examples present a strong indication that the as CALPUFF Model using the IWAQM protocol, has a substantial bias towards over predicting NO3 concentrations. This was the frequency distribution for Bridger CLASS I area outside of Pinedale

Wyoming. An area very heavily in oil and gas development; a lot of oil and gas wells. The blue line is the 05 frequency distribution site and the red line is what CALPUFF is predicting. Now we can get into issues of is the monitor in the right locations and I think those are valid questions. The issue is the source region is probably 30 to 50 km maybe even more away from the Class I areas. So you are not going to see sharp concentration gradients up there. But I’m going to challenge you with some things to think about.

In this context, the model is not performing very well at all. If you look at the improved monitoring data at Bridger over the period of record, 88 through 05 there’s no change in nitrate out there. There’s been a lot of growth in NOx emissions over the time period but nitrate really hasn’t changed dramatically.

I would submit if the monitor wasn’t placed in the right location, you would see some differences in these frequency distributions. If you look at the measured concentrations the maximum measured there’s no change. The difference in maximum concentrations is certainly not enough to say the monitor is in the wrong location and that the model is performing correctly.

Relative extinction contribution for various species for the 100 Worst Days at Bridger (Raleigh Scattering is not included). What is the composition of that material? The blue is sulfate and the red is nitrate. Nitrate isn’t playing much of a role of visibility [ed. reduction] yet the model is saying it is playing a very substantial role. In this context we’re not really doing a very good job of model accuracy.

If you look at Bridger a little bit further, this is the total visibility. We’ve had growth in non emissions and visibility is not improving. This is a very different picture than what the model is saying. This has become a political model and the public is believing the model. This has become a very emotional issue in the West. Both in Wyoming and the Four Corners area. I think we are doing some disservice to the science here and not looking at this in a more complete fashion.

Another example, I did some analysis of the Hayden Power Plant Bart analysis done by CDPHE. And I looked at this in kind of a quick fashion but what I came away with and this is a single source area in Central Colorado, if you look at the ratio at the mountain circle as to what nitrate to sulfate in CALPUFF, it’s saying the nitrate is much larger than the sulfate. The way the model is being used is not realistic. This is another analysis and it is not clear cut. Estimated Change in NOx Emissions in Southwestern Colorado and Northern New Mexico Verses Measured Visual Range At Mesa Verde. I could argue this could be a 50 to 100,000 ton increase. The issue is as new production was run in that area, the emissions dramatically increased in that time and yet we seem to have changed in the monitoring data.

Monitoring data versus CALPUFF, 80,000 ton no change about 7,000 ton you see a little change. Again, the model doesn’t seem to be working well. What do we do about this? I think there are some long and short term solutions. In a long term process there is a clear need for comprehensive model evaluation of CALPUFF in a full chemistry model. Without a doubt this is the most important thing that can be done with this model.

There are currently data sets being developed in Wyoming, New Mexico and Colorado of emission inventory of actually of 05 and 06. It seems one of the biggest limitations in emission inventories. We’re starting to build some databases here, but it needs to be done in a public collaborative process. As Bruce mentioned, API would like to be involved in some of this work. It’s a long term thing.

The conclusions and recommendations include the widespread use of meteorological model output in air quality modeling requires: The accuracy of MM5/CALMET model output must be tested for each dispersion model application; EPA needs to coordinate a stakeholder group to develop guidelines for the use of meteorological models in air quality analyses.

Topics that the modeling community needs to address are: Which meteorological model should be used? Grid size? How should meteorological monitoring sites be included in modeling? Model performance criteria? Meteorological model accuracy is more important than the number of years of model results used in an air quality analysis

With that I'll let you think about it.

Tyler Fox: Next we have Peter Manousos for use of NOAA reanalysis data.

Peter Manousos: This is going to be pretty quick it's just 10 slides. This is sort of a mechanical experiment to see if we can use reanalysis as a source for meteorological input in AERMOD and AERMET.

There are reanalysis data assets outside that might now be suitable for use as a meteorolgical input into AERMOD. So that's the goal I'll show you what we've done so far. Not to put you to sleep and I guess I'll answer questions after that.

Just really quickly. I'm from a company called First Energy a really great company in Akron, Ohio and this, the borders don't show up very well, but this Ohio, Pennsylvania and New Jersey. These are our service areas. I've only been there for one year and a half. I used to work for the weather service for about 15 years. That's why I'm dealing with some of the reanalysis. If you don't know what it is.

Reanalysis data is a dynamically consistent 3D analysis ("gridded snapshot") of the atmosphere for a given point in time. It's based off of observed data and not a prognostic product. Every so many hours NOOA cycles their models with initial data and what they've done they have gone back as far back as 1948 to create a reanalysis data set. More recently you heard in the HYSPLIT discussion this morning there is a reanalysis data set that goes back to 1979 that is available at 32 km resolution across the US.

Who supplies it? NOAA and ECMWF.

Why the interest for AERMOD?

Potentially a source for site specific data - more representative and more complete than standard upper air and surface observations sets. Public domain (data and conversion software) and its free. Before I embarked on this study I guess or activity I went and dug around and ask some questions has anyone done this before or am I reinventing the wheel? Not much has been done. Google on AERMET and Reanalysis gives only 4 relevant hits – an end to end process has not been formally outlined.

I thought I had a typo so I typed it over.

This is going to be hard to see but

these are your upper air sites across the CONUS (lower 48 States of the (inaudible) US) and some of Canada. This is a reanalysis data set of 2.5 degree by 2.5 degree resolution. This data set goes back to 1948 and is available at 6 hours increments now. So you can see you might get some more site specific data but if you use the North American Reanalysis data and hope you can see this.

This is a 32 km grid so it's really attractive at least in upper air data source for input in to AERMOD. And so being kind of a weather and technical geek, let me see if I can pull some of this data in and run it through the model. Again it was more of a mechanical exercise. I haven't gotten to the point of creating wind roses and finding out how many calms verses what the observed data might have. I just wanted to see if it would work first.

Just to give you an idea; this is an observed sounding and it has some really good vertical resolution. The red squares here give you an idea of the mandatory levels that are required by a sounding. But in our data of North American Reanalysis the blue ovals show the vertical resolution of the upper air data set and it's in 25 mb resolution from the surface up to 700 mb and above 200 mb. Between

700 mb and 300 mb, you only have 50 mb resolution. Again it seems like you know something that is worthy to investigate.

So I talked to Bret Anderson at a recent conference in Boulder at the Ad Hoc conference. You know I've got a method that I can extract the gridded data and put it in a text format. How do I test it? He said to go on the SCRAM site and use some of the cases that are there. It wasn't as straight forward as I thought it would be so I got one case.

Well it was really difficult I found some issues that some of the cases were using older versions of AERMOD that couldn't quite run in AERMET and I couldn't repeat. I didn't have the older code so I had to be selective and I only could get one site so I used this case called WAVCO I don't know what that stands for. It was just a data set for me and I used it.

It uses Pittsburgh PA surface and upper air data (and on site data). Re-run with NARR (ed. North American Regional Reanalysis). Upper air data extracted from NARR grid and interpolated to a point at the location of Pittsburgh upper air site.

All other data remained consistent with the control case. Comparison of runs (24h max concentration for SO2). NARR run within 5% of control for 1st high. NARR run within .07% for 2nd high. Receptor location and data of 1st and 2nd high identical in both runs.

You're looking at a newbie I mean real newbie when it comes to running AERMET and AERMOD. I need someone to review this to see if I did the right thing, but I was encouraged to present it here. So just a real quick summary, 32km horizontal, 25 mb vertical, 3h (back to 1979) temporal resolution. Neither satisfy the hourly temporal resolution requirements of surface data for AERMOD. However, preliminary runs show NARR may be suitable as an upper air resource – need to formalize comparative testing. Mechanical process already tested Grib ==> Grid ==> Text File ==> AERMET ==> AERMOD. GEMPAK tools convert grib to grid AND list output in text format at any lat/lon input by user (via interpolation).

That's all I have.

Tyler Fox: Thanks Peter. We have a host of presentations made by AWMA and I'm going to turn it over to George Schewe and let you manage this assortment of presentations.

George Schewe: Thanks Tyler. Good afternoon my name is George Schewe, an attorney consultant. I am the current chair of the AWMA so called AB3 Committee of meteorological and modeling. I'm going to introduce the AB3 model review group, enter comment areas, and offer comments now that we did not fit into other presentations. I think I'm the last remaining staff member from 1978 and 1979 from the model application group who are still at this meeting. Even you Peter [ed. Eckhoff]were not there yet. I was also the Project Officer of the original contract with the HG Cramer company to develop and release the Industrial Source [ed. Complex (ISC)] model. I'm not sure if that is good or bad but I'm the last one here. I'm very happy to have seen the progression to AERMOD and CALPUFF. I think Harry Cramer, rest his soul, would be pleased too.

We at AB3 applaud the efforts and progress like [ed. AERMOD] (inaudible) and we offer our comments in the spirit of cooperation with the goal of best model performance built on best science. That's all I have written and wanted to get those thoughts out. We have an illustrious group here, myself and all of the people have mentioned here. Some of us are going to speak and some are not. The order of presentation is a little bit different than on your schedule and we will try and hold to 10 or 11 minutes per person except for Ron Peterson.

The comment areas that we are going to emphasize are building and down wash, and meteorology inputs. I know you can read but these are the areas we will be talking about this afternoon. I'm going to make quick comments here so it didn't fit in to any others and have been addressed over these two days.

We're a little concerned about resources you guys have to really keep the Clearinghouse and getting it really rolling. We just wanted to express that concern. We're also little concerned about the time that is required to review the comments and vetted nationwide will take place to do that. So we just wanted to express that concern and we want say that we're a little displeased or unhappy but we'd like to have some technical input from the affected parties such as a consultant who is working for a company making suggestions.

We are just asking for a little more involvement there and would make your jobs a little easier too to have us involved. Our recommendation is for affected parties involved in this process. Lastly to introduce the increase use of ozone models and I think this was brought up this morning. We are going to need some guidance on this. That's all I have right now. Next is Ron Peterson.

Ron Petersen: Thank you George. I'm Ron Petersen from CPP and I'm going to be commenting building and downwash issues. Basically the main areas of comments will be problems with BPIP. AERMOD/PRIME Problem for Short/Large Buildings. AERMOD/PRIME Underestimation For Corner Vortex and Terrain Wake Effects.

As Roger mentioned yesterday some of the problems working with BPIP and working with

Prime, it’s going to be hard to treat complex geometries, may merge two structures into one large structure, may pick the wrong dominant building. May place the building at the wrong location to get correct dispersion. Does not account for lattice or cylindrical structures. Ultimately, PRIME needs the building shape and position that places stack in the correct Snyder/Lawson Data Base Flow Region (i.e., Data Base Used to Develop Downwash Algorithms). Other considerations are building downwash algorithms in AERMOD are designed for simple rectangular buildings. Building downwash algorithms in AERMOD only appropriate for certain building aspect ratios. Use of wind tunnel testing to determine Equivalent Building Dimensions (EBD) has been used to help solve the problem. EBD guidance provided in Tikvart July 1994 Memorandum - Thus, the analysis is viewed as a source characterization study which generally has been considered under the purview of the Regional Offices. All testing to determine EBD under neutral stratification, similar to assumptions in Prime Algorithms. With AERMOD/PRIME building location is also a variable and new methods may be appropriate and has been used on recent studies. You may have to improve this EBD procedure and more guidance needed. Roger mentioned that yesterday also.

Picking the right dominant structure here's kind of an example a hypothetical example. You have a power plant with a residential upwind tower, a site drawing as you might call it. Now BPIP picked this as an input so it picked the up wind residential tower to go in to the model. Maybe you need to pick something closer that's going to be more influential. Because if you take away the residential tower this is what BPIP would put in which is really the power plant structure itself. An EBD study was done in the wind tunnel to determine the shape that would really match the dispersion for that whole complex and that's the shape of the building that matches the dispersion. It's much closer to the power plant structure.

An example of that was a Mirant Power Station study. AERMOD with BPIP predicting high concentrations at ground level and on a nearby building. AERMOD with Equivalent Building Dimensions gave lower concentrations and ones that agreed better with field observations.

Here’s a new situation that has come up for Short/Large Buildings. The wake algorithms have only been developed/tested for limited building aspect ratios. Short/large industrial facilities fall outside this range.

Here’s a case kind of a foot print of a large industrial facility and the red square on that chart represents what the model BPIP gave for the input. That’s 17 meter high building, H = 17, L/H = 23, H/W = 0.02 very short big building. PRIME cavity and wake dimensions: W = H and L/H = 0 – 4, W = L and H/W = 1 – 3. It doesn’t really fit into what has been developed.

So what was done to develop building inputs was to do a building equivalent study for this facility. Actually looking at the flow visualizations what happens is the plume essentially the wake reattaches on the roof and it’s almost like a new (inaudible) level basically. So the weight kind of falls off the end of the building.

What does it really mean as far as the concentrations predictions. We ran five typical sources on this facility and that’s the input for the five sources. 1 year met data kind of a standard AERMOD default mode. And we ran with the BPIP inputs right here, match 24074 and when you put the EBD in drops it to 44. So you can see we took a closer look at what was going on. We think the plume is being caught in the cavity region and being concentrated heavily. Right outside of the cavity region the concentrations drop for a factor of 3 or 4. There something in the cavity calculation that’s going [ed. wrong (?)] we think. We are still doing more research what’s happening there. These predictions are just overall maximums right in the cavities. The effect as you move further downwind becomes less.

Now in the corner vortex situation which in the picture you can see that when the flow flows over a building you get two vortex almost like a tornado. Current building wake equations do not account for corner vortex. Corner vortex causes higher concentrations than currently predicted in

AERMOD.

To demonstrate that I have a couple of slides here. I've got 3 different building shapes. 39 meters high, 1 to 1 and 1 to 4. The building rotated at 45 degrees so the angle the diagonals of wind. Now I have some input and I ran AERMOD for these 3 cases for 1 wind speed. You can see the worst case was this building here. That was given the highest concentrations. The lower concentrations are these two here.

We actually tested these 3 shapes in the wind tunnel so I will show you what concentrations looked like in the wind tunnel. These two shapes are right here the corner of Vortex is this case right here so that the corner of vortex is increasing the concentrations by about of a factor of 2. This is all due to the downward motion created by that mini tornado off the corner.

Terrain wake effects; currently the GEP stack height regulation defines nearby terrain for the purpose of limiting stack heights. Past EPA research shows that the effect of upwind terrain can be significant. Currently this effect is neglected. Recent study1) showed concentrations increased by a nearly a factor of two when terrain wake effect is accounted for using Equivalent Building Dimensions in AERMOD. A method should be developed to determine when upwind terrain wake effects should be considered. We’re saying that a method should be developed to determine wind up wind terrain and wake effects might be a controlling situation. That’s just the short of some of the past summaries by Snyder and some of the group at the EPA wind tunnel where they showed these terrain application factors for different hill shapes. In that application factor just really the increase of concentration as if the hill weren’t there.

So basically kind of maybe I did it within 10 minutes George. Basically, continue your research on ways to improve BPIP so input dimensions match assumptions in algorithms. If needed, update guidance on use of EBD in place of BPIP for AERMOD/PRIME. Develop algorithms for the corner vortex situation. Develop method for accounting for upwind terrain wake effects. That concludes my comments here. Thanks. Our next presenter is Joe Scire.

Joe Scire: Okay. I have just a very short presentation about the use of gridded meterological data on the air quality model which we’ve talked about the last couple of days. Use of existing tools, Two step evaluation process, Evaluation variables, Sensitivity to prognostic model options and Metric for evaluating success. The existing tools I listened to the talks of Roger and Herman about the efforts to produce a converter for MM5 and one of the things was that resources are limited. There are some existing tools that might be helpful that could be used for this type of purpose. There are processes that are a part of the CALPUFF system but are available for use and no restriction on the use to concert MM5 data and WRF and (inaudible) (inaudible) into a standard format. What happens all these models will fit into this format so any subsequent process needs only to get to the (inaudible) files and not to the specific data sets. It’s one way of reducing the effort in the post processing by having everything to fit into a common format. I mentioned this to Herman and thought I would mention it while we’re here.

The other point is the processor. Do not change the wind data. It’s exactly as it came out of the prognostic model. Although they do interpolate the scalars to the grid point locations, if that isn’t what is to be done then you would have to change it or use another approach. Another item in terms of redundancy in existing tools is to mention there is going to be software produced to interface the output of MM5 converted to wind rose software. That already exists. No restrictions on use. Meteorological evaluation software is very close to be released. If you don’t have to reproduce these items, there are more resources for doing the other elements of this system.

The other thing is producing met data sets for running AERMOD or CALPUFF. I think it seems appropriate to have this as a 2 step process. Evaluate gridded meteorological data performance separately from dispersion model performance. There will likely be a large sensitivity of dispersion model to met database. Separately determine best available dataset for each parameter. Sensitivity of prognostic model parameters. Use of NCEP products (e.g., RUC fields) and they are free. Sensitivity of dispersion model to different variables. Model parameterizations and grid resolution.

Then separately use the data sets to determine available observational datasets. Evaluate all meteorological variables. Wind speed, wind direction, Frequency of light wind speeds, etc., vertical wind and temperature structure, temperature & relative humidity, micrometeorological parameters, solar radiation, cloud cover, and ceiling height, precipitation and allow for potential use of sub-hourly prognostic data.

In planning ahead I would also recommend that provision is reserved in the structure of the data set to allow sub hourly prognostic data. The reason why the MM5 simulations can’t deal with a 10 min intervals, 5 min intervals or 30 min intervals. There may be applications where sub hourly data has its advantage.

Then how do we determine what's good enough? I mean some of the results presented earlier that the ratios were about a factor of 2 or 1.5 to 2 times higher results using prognostic data than observation. That sounds high to me. Consistency with results using observational data? No under-prediction bias relative to observed met results. Evaluate results under many different types of conditions. Coastal, flat, rolling terrain, mountainous, tracer or other observational datasets. That's all I have. My pleasure to introduce Bob Paine who will be talking about PM.25.

Bob Paine: Okay. This has been brought up in questions before and I'm going to talk more about it. This is the newest and possibly least understood criteria pollutant. My topics are: quantifying PM2.5 emissions, current and proposed regulatory requirements, challenges to PM2.5 implementation, emission inventories – direct and precursors, modeling techniques – guidance, background concentrations – how to treat, and looking forward.

PM2.5 is unlike other gaseous criteria

pollutants, because PM2.5 generally comprises a mixture of solid particles and liquid droplets, some condensing from vapor – source/fuel-specific. It is emitted directly from a source (“primary” or “direct” emissions) and also formed in the atmosphere (“secondary formation”) from precursor emissions of SO_2 and NO_x . PM2.5 contains filterable and condensable components that may be organic or inorganic.

This slide comes from a VISTAS BART protocol, and basically, we have all the condensable side which is basically small enough to be 2.5 µg or less in size. Looking at the condensable side of this chart, the inorganic PM2.5 includes H_2SO_4 that adds significant measurement and quantitfication problems. The inorganic fraction could have some S04 components and then you have the organic. Looking at the filterable side, the EC is generally 2.5 µg or less and then the rest of this is shaded out -- the coarse particles which are higher than 2.5 µg are shaded out. Those are the only components of PM10 that would be excluded from PM 2.5, so it’s a fairly complicated structure. This is needed for visibility modeling because each of these components has a different extinction efficiency in scattering.

The measurement techniques have an interesting history. Historically, only filterable PM was measured and quantified. Only filterable PM has traditionally been measured, quantified, and modeled based on EPA Reference Method 5. Existing reference methods for condensable PM have known biases and work is underway to propose more reliable methods. EPA is well aware of limitations to existing PM2.5 measurement methods – sulfates can be significantly overestimated. Uncertain emission factors exist for condensable PM – this can be a high percentage of PM2.5.

So with that back drop of course we’ve been 11 years with the new PM2.5 pollutant. In 1997, EPA had a PM10 surrogate policies for compliance modeling that are still in effect, Best Available Retrofit Technology implementation guidance, PM2.5 NSR implementation rule, PM2.5 PSD SILs, SMCs, and increments (proposed 9/21/07; final rule pending), and the PSD increment modeling procedures (proposed 6/6/07; final rule pending). So let’s talk about modeling Primary vs. Secondary PM2.5. AERMOD considers primary PM2.5 only. Primary PM2.5 provides highest near-field impacts. Secondary PM2.5 is important only at large distances, and would probably not contribute at location of highest primary impact. Secondary PM2.5 could be modeled with CALPUFF. Large SO2 and NOx emission reductions may lead to PM2.5 increment expansion – does this require an unbiased model to take modeling credit? Are we ready to compile cumulative emission inventories for 3 pollutants?

I’d like to address the issues with CALPUFF over predicting nitrate. If you use an inappropriate ammonia background like 10 ppb, you can get the results that over predicts by a factor of 3 verses if you use an appropriate background of the West at 0.2 ppb or even lower (and measured at 0.1 ppb in Wyoming). You will find that CALPUFF will be mostly unbiased and I think that one is one way to eliminate this problem with the perceived nitrate over predictions of CALPUFF.

PM2.5 Regulations and Guidance – Unresolved Issues. Are we okay to ignore secondary PM2.5 modeling for short-range applications? Include secondary PM2.5 modeling for long-range applications (e.g., Class I increment)? How to credit precursor emission reductions? What is the form of the 24-hour PM2.5 increment standard? To be consistent with the NAAQS, the 24-hour increment should be the highest, 8th – highest. CALPUFF and AERMOD can provide that statistic. PM 2.5 emissions analysis. Emissions factors are available for certain source types from EPA’s AP-42, SPECIATE, and FIRE databases. Certain industry groups have also reviewed stack test data to develop emission factors. EPA demonstrates possible approach in its Interim Regulatory Impact Analysis (RIA) for the Proposed National Ambient Air Quality Standards for Particulate Matter, Appendix B – Local Scale Analysis (2005). Any of these factors are based on stack test methods known to be unreliable and have biases.

Example Modeling Challenge: Compute Total

PM2.5 NAAQS Impact: Background + Source Impact. Conservative approach: add peak percentile source impact to peak percentile background, unpaired in time. It is unlikely that these two components happen at the same time. A refined approach adds concurrent daily background and source impact concentrations. If daily background concentrations are not available, fill in missing days from higher of two bounding values

To summarize: PM2.5 modeling in a regulatory context poses challenges not previously experienced for other criteria pollutants. Emissions measurement and modeling techniques need to be resolved. Background concentrations can be much higher than modeled concentrations. Due to stringent standards, there is more need for refined modeling approaches. Collaboration is necessary to implement reasonable PM2.5 impact assessment requirements.

In looking ahead, unique and important issues remain unresolved for PM2.5 – little EPA guidance, PSD increments and modeling procedures. There is a role for CALPUFF (or other models) for secondary PM2.5 in long-range applications for both increases and decreases in SO2 and NOx . Application of local/regional background levels in a regulatory context. That's it. Let's see who's our next one? George is next and will talk about AERMOD.

George Schewe: Good afternoon. I'm George Schewe and I'm with Trinity Consultants. Just a few comments on AERMOD. First of all we like AERMOD. It does things ISC3 could never do. I do want to mention a few issues.

The Low wind speed issues. Modeling of roadways for NO2 and PM. Problems with modeling small urban areas. Need for post-processor to combine multiple AERMOD runs. Deposition support. Adjustments for international applications.

Many investigators report that the worst-case AERMOD impacts occur for very low wind speeds, especially for low-level sources. AERMOD has limited evaluation for these conditions.

ASOS use of sonic anemometer data and averaging of sub-hourly ASOS data will likely create more hours with very low wind speeds. AERMOD needs supplemental evaluation to assess the accuracy of these “design concentration” predictions.

Roadways are characterized by enhanced turbulence and low wind speeds generated by traffic itself. Review of data from tracer studies and adjustments to AERMOD modeling procedures for roadway is an important issue for EPA to pursue. Problems - few long-term monitors near roadways & quantification of emissions, especially PM, is questionable

Nocturnal urban mixing height (Ziu) is a function of population. For small populations, Ziu can be quite low (e.g., about 200 m for a population of 50,000). This has been found to result in plume capping at night for all plumes, no matter how buoyant, leading to counter-intuitive results. EPA should investigate this issue and correct the problem.

AERMOD runs can be very long. Runs cannot be done separately and combined in postprocessor, as is done with CALPUFF. EPA should develop a system like that of the CALPUFF system, or translate AERMOD conc. files to CALPUFF-like files. TRC may have a draft code that can do this.

Dry gas deposition is not included in the implementation guides but in the 2004 addendum – makes for some confusion. Recommend that AERMOD guidance provide further implementation guidance to address use of dry gas deposition factors and the use of ANL physical parameters for common pollutants (Wesely, et.al, 2002).

International applications have challenges due to 12Z sounding times not at sunrise. Bob Paine provided EPA (in October 2007) with several possible enhancements. Swapping of 12Z and 00Z sounding time labels. Adjustment of lower part of sounding to reflect morning minimum sfc temp. Enhanced debugging output. EPA should make these enhancements available, at least in beta test form.

Issues with AERSURFACE implementation.

Sensitivity of modeling to surface characteristics. Land use determination very localized - within 1 km. Greater chance of mismatch in surface type between met tower and source. For tall stack, buoyant releases, 1 km is too short of a fetch distance. Low roughness near towers increases likelihood of low u* and low wind speed issues. Moisture assigned only on an annual basis.

Brode et al. have written paper for A&WMA 2008 Annual Meeting on sensitivity modeling. We recommend use of AERSCREEN with different runs for met and application site surface characteristics. If peak predictions are reasonably similar (say, within 10%), then assume that differences in site surface characteristics have a minor effect.

A couple of comments on AERMET is that states advocating use of more recent data sets. Many more calms in recent data sets – if considered missing as suggested in GAQM, does not meet 90% capture criteria. If many calms, does CALMS preprocessor work properly? Conc artificially too low? Guidance needed on use of recent met data. If my interpretation of the Guideline on Air Quality Models is right, a calm is considered a missing data? Is that right?

Roger Brode: Technically, if a site specific is considered a valid observation if the wind speed threshold is treated the same way as a missing calm.

George Schewe: Okay. That’s basically all of my comments on AERMOD today. We’re commenting off the off the shelf of AERMOD and not talking all of the other things that need talking about. Our next speaker is Gale Hofffnagle and he will be talking about CALPUFF and the comments of the AB3 Committee on CALPUFF. Let me see if I can find it for you. I can’t open this file.

Comments from participants: The issue is you should have a new version of PP. Do you have a computer here Gale? No I don’t. Talk among yourselves.

Gale Hoffnagle: These are the comments about CALPUFF and talking about CALPUFF filling your needs. About EPA concerns about CALPUFF and EPA controlling the model developing coding and using less than 50 km and use it greater 200 – 300 km. Many applications in air quality modeling for the guideline purposes require air quality impact from (inaudible) stacks from long distance.

We need a 3-D Lagrangian model for (inadible) will not work well for individual sources yet. We don’t believe that they sub grid modules were single sources are up to snuff or demonstrated. CALPUFF is a model with community usage experience. We know how to run it and have been running it for years. It has better handling, low wind speed stagnation, coastal and air issues. Complex terrain and slow reversal and it has better handling of deposition.

In general what AWMA is saying is that we need to have better models. We’ve been saying that consistently for the last 9 conferences.

EPA concerns about CALPUFF are relatively unfounded. EPA’s concern about near field evaluation and CALPUFF we are going to show in our comments some 8 studies have been done and demonstrate CALPUFF in near field areas.

Substantial resources from EPA will be needed to evaluate and approve the upgrades.

The chemistry is fine for NOx , SO2 and PM and we need to do some other things for Ozone .

EPA doesn’t have direct control of CALPUFF and there are some advantages to that. EPA does have control of the regulatory code. The developer has multiple funding sources and the resources to provide for advancement in this model. The developer will continue to have these resources. The developer has training classes for CALPUFF. AWMA supports an independent work group for advancing CALPUFF and will work to that end. EPA doesn’t have direct control of the CALPUFF code and there are some disadvantages. EPA has not been able to supply any funding to provide updates that EPA wants, but the developer is willing to do this. As a result EPA says that CALPUFF lags behind in the code releases. The last users guide was released 2006. We have a new users guide for Version 6 and all we need is the EPA approval for the code. There are code changes made without EPA oversight and funding that requires EPA review. What is needed is for EPA to review the code changes that are available. We urge stronger coordination between EPA and TRC to keep the string going of improving the model.

CALPUFF at less than 50 km. Why is it 50 km? Bruce mentioned this as well and it should be based on the transport time. 50 km per hour is a long hour and a lot of wind speeds in most applications. I’ve been trying to find out where the 50 km came from. I’m sure Joe Tikvart said it one time.

Requiring equivalency demonstrations of less than 50 km is too restrictive. We need a better method to define precisely when complex winds occur and require PUFF modeling. We’ll be referring to paper I gave 3 years ago on complex modeling and a better definition of complex winds. But I think the answer is in the definition of complex winds.

Adding bells and whistles to AERMOD will not make it a Lagrangian model. Another issue is that CALPUFF comparison to LRT studies have been shown relative accuracy out to 200 km. FLAG went beyond the 200 km to say 300 km. So that’s what we’re using now. Many states are using CALPUFF results and CAMx out to 600 km or more. There is no justification for going beyond 200 km in our opinion. There should be defying outer limit for more LRT field studies to be conducted.

The last thing is an easier comment to make. We’re going to have an A&WMA specialty conference one year from this month. Next October we can come back to RTP and the Call for Papers will be out soon. I look forward on the www.awma.org web site. And for those of you are interested, AWMA will be conducting a modeling conference in Toronto this Spring on Canadian modeling issues. There will be 2 modeling conferences next year. Is that the same date as the RSL Workshop? We'll talk about that. That concludes the AWMA comments.

Tyler Fox: The next scheduled speaker is Penny Shamblin

Penny Shamblin: These will be very short. I have some sort of creeping crude that I cannot get over. My name is Penny Shamblin and I'm making this statement on behalf of the Utility Air Regulatory Group (UARG). UARG is an ad hoc group of public and private electric utility companies and their trade associations. UARG participates on behalf of its members collectively and roll makings and related proceedings under the federal Clean Air Act. We appreciate the opportunity to appear here today and make these comments. UARG has participated in all of the EPA modeling conferences to date. We have participated in the rulemakings associated with promulgation and revisions of Appendix W Guideline. The Modeling Guideline is used for several purposes, including to determine if new or modified sources that can built and operated without causing or contributing to a violation of the ambient standards or the PSD increments. What is in the guideline and how EPA interprets it and applies it has a direct and important impact on UARG members and everyone else who is trying to permit facilities.

EPA’s September 25th federal registry notice announcing the time and place of the conference did not provide information on specific changes that EPA is planning to make to the Modeling Guidelines to Appendix W. So our comments are preliminary and may be supplemented with more detailed comments during the 30 day public participation period.

The first issue that UARG would like to raise today arises directly from the fact that the September 25 Federal Register notice provides very little information on what, if any, changes

EPA is planning. If EPA wants meaningful comments from the public concerning key questions on the use of the air quality models, then we need more information as to what changes will be made. It’s not sufficient for EPA to place a draft meeting agenda on the agency web site such as SCRAM nor is it sufficient to publish the conference announcement two weeks before the meeting. Rather, EPA must publish notice of these proceedings in the Federal Register at least 30 days ahead of time. And also provide the public with background information of all significant issues on which it is seeking comment.

Instead of following the standard notice procedures and instead of engaging in notice-and-comment of rulemaking to change any outdated portion of the modeling guideline, EPA is moving toward using informal guidance to try and change the status quo. From discussions today, I understand guidance does not come lightly out of EPA. There are instances where it appears to do.

Preceding this conference, EPA posted

on its web site several guidance memoranda that purport to make significant changes to the procedures that affected parties have been using to get approval for the use of non EPA preferred models. EPA's new procedures will uniformly make it difficult to use anything other than the preferred models or EPA developed models.

For example, the August 13 guidance memorandum about the regulatory status of CALPUFF for near field applications states that the use of CALPUFF must go through a more extensive review process than historically required if you want to use it for near field applications.

In particular, without conducting any notice of comment, EPA has concluded in its guidance document that a modeling system like CALPUFF, will be subject to a higher burden of proof before its use will be approved in individual cases. Then, even if the permit-issuing agency permit applicants are able to do what is necessary to meet the more onerous review standards, the August 13th guidance document throws another obstacle in the way; mainly the Model Clearinghouse process. A drill that is likely to add several months or longer to the overall new permit process which I can attest already takes 2 or 3 years. One more layer is not what we would like.

UARG believes that the EPA’s recently posted guidance memoranda have placed unfair burdens on parties trying to use CALPUFF in situations in which that model has shown to work and function well.

Appendix W allows the choice of modeling techniques in new source permitting situations to be made on a case by case basis taking into account the unique characteristics of each case. The recent guidance document, (I apologize if I get rid of the cough drop I won’t make it through this), removes the Guideline’s promise of reasonableness and flexibility and imposes what are likely to be insurmountable obstacles to the use of any models other than EPA preferred or EPA developed models even if the alternative model would make more sense in that situation.

UARG believes that it is inappropriate for EPA to use informal guidance documents to make such major changes to the rules and procedures that state permitting agencies and permit applicants have been using for years and have worked well for years.

The second general issue that URAG would like to raise today concerns the maintenance of the models and the need for more timely approval of changes to fix bugs and problems, both EPA approved models, preferred models and alternative models. As time passes and as input to such models change, it’s almost inevitable that model users will occasionally encounter and identify problems and bugs in the model.

For years EPA has done an admirable job in responding to such identified problems. In particular EPA has made timely fixes to their models. Also when developers of alternative models have reported problems and provided well founded fixes, EPA has a history of approving and promptly approving those fixes. Unfortunately during the past 2 years, URAG has seen delay in EPA review of implementation fixes for identified problems for all preferred models.

In particular, URAG has seen delays for over a year in EPA’s consideration and approval of fixes that users have encountered in running developmental models and the ones that Bob Paine has identified in AERMOD. URAG encourages EPA to return to its earlier approach of giving priority to fixing the problems.

The final issue is another one that Bob Paine spoke of dealing with PM2.5 modeling requirements for both development of SIPs and for the evaluation of new source permitting. PM2.5 ambient standards have been on the books for over a decade but we still have very little guidance and no model that does a credible job of predicting the air quality impacts of emissions for PM2.5 and PM2.5 precursors.

For example, even though most PM2.5 nonattainment areas are urban areas where, organics are a major component of PM2.5, existing models do a poor job of addressing the organic component. Also, for single source new permitting there’s no clear guidance on the modeling tools to use for the permit application. Until the new recent rule, this was not much of an issue because most people were using PM 10 as a surrogate. But now with the EPA delegated states, you’re required to do the PM 2.5 NAAQS modeling and we still have no guidance on how to do that.

So we urge EPA to take the time and resources now to develop credible tools for PM2.5 SIP and pre-contruction permitting. That’s it. Thank you.

Tyler Fox: Alright next is George Delic.

George Delic: Thank you very much. Now for something completely different. My Ph.D was in nuclear physics which was in another life. Since coming to the US, I have focused on high performance computing and started with air quality modeling when I was a contractor in the Park for 10 years. That’s where I got to know these models. 15 years with CMAQ and 10 years with AERMOD. I’m now a private consultant. Efficiency for me is very important and that is the focus of this discussion.

Here’s the layout of what we are going to talk about:

1.Introduction

2.Identifying the problem

3.Computer hardware

4.Examples of AQM performance

5.U.S. EPA AQM models: lessons learned

6.Can software and hardware help?

7.Next steps

8.Outcomes

9.Disclaimer

Regulatory Air Quality Models (AQM). They are developed by the U.S. EPA (and contractors). Their use is mandatory for SIPs. They require long model runs. They have a dedicated user community forced to invest in support infrastructure: software, hardware, HR staff, hardware and programming environment. Revolutionary developments are here now! Other modeling disciplines report cost benefit enhancements of 50 to 100 times more Performance: HiPERiSM's investigations with such models show: Many inefficiencies with mediocre to poor performance, mismatch to current commodity-off-the-shelf (COTS) hardware, and worse performance on next generation computers. The situation for AQM's: the AQM community needs help and leadership. Does the U.S. EPA have a plan to face the challenges for change in COTS hardware?

What is the problem? Movement of data is now considered to be the single most expensive operation on commodity platforms. Don’t modern architectures solve the problem?

They do this by inserting complex memory hierarchies, but this challenges an application’s ability to extract optimal performance from commodity solutions.

What can be done to fix the problem? Full understanding of the memory’s architecture’s impact on application performance and then fix the problem at the source. Multi-core processors exacerbate the problem because concurrently executing threads compete for memory bandwidth the effective cache size per thread is diminished.

Current generation: multi-core: 2-4 cores per CPU. Cache Level 1, 2, or 3. CPUs access memory via bus. Next generation: many-core: 8 – 100’s cores per CPU. Level 1 for each core and Level 2 shared across cores. Cores access subset of L2 and memory via bus. The GPGPU revolution: Multi-processing graphics hardware with on outboard processors and programming tools for hundreds of parallel threads.

Memory and cache: The memory hierarchy uses cache to hide the negative effects of memory latency. Cache space is wasted when data resides there but is unused. Unused data in cache consumes precious bandwidth when it was loaded from memory.

Examples of AQM performance: SOM an Ocean Model: example (a). Used as a reference. CMAQ: examples (b) and (c). Rosenbrock solver (ROS3). Euler Backward solver (EBI). AERMOD: example (d). All the above models used these HiPERiSM resources: A 64-bit (x86_64) Linux platform with a 16KB L1 data cache and 1MB L2 cache with compilers typically used by the U.S. EPA (using EPA code for CMAQ and AERMOD). SlowSpotter™ software from Acumem®, Inc. to collect performance data (for details see HiPERiSM’s Web URL).

Example (a) SOM Ocean Model: Excellent cache utilization: GREEN on the right hand-side bars shows no wasted cache space – i.e. all data loaded from memory is used by the CPU. (Single

CPU with one core and two cache levels).

Example (b) CMAQ ROS3 Solver: Mediocre cache utilization: RED on the right hand-side bars shows wasted cache space – i.e. data loaded from memory but never used. (Single CPU with one core and two cache levels).

Example (c) CMAQ EBI Solver: Comparing CMAQ solvers* (EBI versus ROS3): EBI: 3x more wasted cache space. EBI: 4x worse memory prefetching performance. Linux platform with a 16KB L1 data cache and 1MB L2 cache for the mid-morning hours of a summer episode (14 August, 2006).

Example (d) AERMOD. Poor cache utilization: RED on the right hand-side bars shows wasted cache space – i.e. data loaded from memory but never used. (Single CPU with one core and two cache levels).

Lessons learned: Memory footprint of AQM’s: Inherent in the current state of models: inefficient use of COTS hardware, lost performance opportunities. Critical bottle-necks in memory access: cache utilization is wasteful and cost of latency leads to CPU stalls

Can software or hardware help? Compilers will not solve the performance bottle-necks because: The code lacks the right structure. Requires too much disorganized data movement. Next generation hardware requires data parallelism: Needs to be expressed in the code by the developer and it cannot be discovered by compilers.

Next Steps: U.S. EPA needs to show leadership by: Soliciting input from the community, developing an action plan to meet the challenge, provide resources for change.

Consequences of inaction include: lowered performance, and escalating support infrastructure costs.

Outcomes: GREEN COMPUTING ! More efficient use of COTS computers. Lower cost of AQM support infrastructure. Higher throughput = fewer resources required. Cost benefit analysis suggests: Modification of AQM’s will yield. Boost in throughput by orders of magnitude and lower TCO (total cost of ownership).

None of the work reported here has been sponsored or funded by the U.S. EPA. Further information is available at:

http://www.hiperism.com and http://www.hiclas1.com.

I recommend the transition to the modern generation of compiler technology for AERMOD development at the EPA and also the decision to go with the double precision release of AERMOD. This will remove certain problems that have worried us. That’s it.

Tyler Fox: The last presentation is from Mark Garrison from ERM.

Mark Garrison: Thank you for the opportunity to say a few words this afternoon and given the hour there will be very few words spoken. I don’t have a presentation but was inspired to make these comments by the presentations yesterday. For the record, I am Mark Garrison from ERM. We service the Air Integrator for the Maryland Department of Natural Resources Power Plant Research Program. In this role we are responsible for providing technical support in the review and evaluation of air quality impacts from power plants.

The analyses we are involved with range from local scale analysis using AERMOD to (inaudible) using CALPUFF to (inaudible) with CALPUFF. We've done some quasi studies with CALPUFF looking at visibility impacts, nitrate deposition impacts and Mercury impacts. For the past couple of years, we have been experimenting with different ways for extracting data from MM5 and WRF file outputs and processed through CALMET to develop inputs for AERMOD.

We have kind of settled into a preferred approach which is to extract wind profiles from prognostic models and treat them as pseudo observations and combine them with more broadly representative cloud cover and temperatures from National Weather Service Stations. Then essentially allowing AERSURFACE and AERMET to do their thing in terms of customizing the land use to (inaudible) and create inputs in to AERMOD.

Now we have done some evaluations with this approach both in (inaudible) in terms of comparing the prognostic model derived wind profiles with data collected on met towers. And also an intent to do an sensitivity studies as to what kind of concentration are the result of the various approaches. And while we are somewhat limited, the evaluations I think anyway are pretty promising in terms of coming up with an approach, at least in my mind, that allows AERMOD to do its thing for customizing meteorological data on a site specific basis without relying on land use that essentially represents airport runways.

That’s about it. I think we are going to provide written comments and add some summaries of our evaluations. Hopefully it will be of some interest. Thank you.

Tyler Fox: It is 4:30. I appreciate your time and all your input and we will be getting the transcript done and submitting that. Also, just as we have in the past, we will be compiling some of the major comments putting them together and then providing a summary or response to comments from the agency. As soon as we know what the timing will be we’ll send out a memo to everybody and let them know. Everybody have a safe trip back to your homes.

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6. algorithms
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12. boundary
13. calm
14. CALMET
15. calms
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17. cell
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20. Class I
21. clearing house
22. complex
23. concentration
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27. database
28. databases
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166	17	the user knows during the AERMET processing steps
180	25	meteorological input in AERMOD and AERMET.
182	17	much has been done. Google on AERMET and
184	16	AERMET and I couldn’t repeat. I didn’t have
185	10	newbie when it comes to running AERMET and
185	22	==> AERMET ==> AERMOD. GEMPAK tools convert grib to
207	13	A couple of comments on AERMET is that
226	16	essentially allowing AERSURFACE and AERMET to do

Page	Ref No.	Keyword = "AERMOD"
16	4	AERMOD.
18	5	and AERMOD options) over P-G? As Tyler
25	4	CALPUFF turbulence and the AERMOD turbulence in
62	14	versions of AERMOD. I’m going to talk about the
62	15	AERMOD evaluation review, evaluation tools, and
63	4	provided that database to EPA for AERMOD. And we
64	7	So in the AERMOD evaluation, we have the
64	8	question: how well does AERMOD predict peak
64	10	with air quality (AQ) standards? Is AERMOD’s
72	9	appropriate in the way we use AERMOD under
72	20	the work here in terms of AERMOD evaluation and
73	23	series of arcs. This is a Q-Q Plot of AERMOD
74	11	in AERMOD performance evaluation. Again this is
74	16	These are applications of AERMOD that have come
74	18	has run AERMOD and getting results they don’t
75	9	SIP. Basically AERMOD was run initially with
76	5	concentration of AERMOD across the gridded
76	8	had receptors in AERMOD that were either very
80	23	Example is AERMOD being applied to support
81	6	comparisons showed AERMOD concentrations
82	12	concentration from AERMOD. Again most of this is
82	18	some concern whether AERMOD could be used in this
83	10	These are AERMOD concentrations using the SEARCH
87	12	find out how well AERMOD does or doesn’t do with
88	20	the AERMOD users guide in terms of defining
94	23	AERMOD), Gaussian Puff Models (INPUFF, CALPUFF,
159	17	models especially on CALPUFF and AERMOD. As you
159	19	CALPUFF and AERMOD at this time. We don’t think
160	11	time varying dispersion models (e.g., AERMOD,
166	21	information is not provided until AERMOD is run.
167	4	for both AERMOD and CALPUFF.
167	16	principles (e.g., AERMOD, CALPUFF, CMAQ, CAMx

Page	Ref No.	Keyword = "aermod"
180	25	meteorological input in AERMOD and AERMET.
181	4	meteorolgical input into AERMOD. So that’s
182	8	Why the interest for AERMOD?
183	9	for input in to AERMOD. And so being kind of a
184	15	versions of AERMOD that couldn’t quite run in
185	11	AERMOD. I need someone to review this to see
185	17	requirements of surface data for AERMOD.
185	22	==> AERMET ==> AERMOD. GEMPAK tools convert grib to
186	22	happy to have seen the progression to AERMOD and
187	2	like [ed. AERMOD] (inaudible) and we offer our
188	21	AERMOD/PRIME Problem for Short/Large Buildings.
188	22	AERMOD/PRIME Underestimation For Corner Vortex
189	13	in AERMOD are designed for simple rectangular
189	15	AERMOD only appropriate for certain building
189	25	Prime Algorithms. With AERMOD/PRIME building
190	25	Station study. AERMOD with BPIP predicting high
191	3	building. AERMOD with Equivalent Building
192	7	standard AERMOD default mode. And we ran with
193	2	AERMOD.
193	8	ran AERMOD for these 3 cases for 1 wind speed.
194	5	using Equivalent Building Dimensions in AERMOD.
194	23	BPIP for AERMOD/PRIME. Develop algorithms for
196	21	for running AERMOD or CALPUFF. I think it seems
201	4	Secondary PM2.5. AERMOD considers primary PM2.5
202	11	CALPUFF and AERMOD can provide that statistic.
204	7	about AERMOD.
204	10	few comments on AERMOD. First of all we like
204	11	AERMOD. It does things ISC3 could never do. I
204	16	combine multiple AERMOD runs. Deposition
204	20	AERMOD impacts occur for very low wind speeds,
204	21	especially for low-level sources. AERMOD has
204	25	hours with very low wind speeds. AERMOD needs
205	7	studies and adjustments to AERMOD modeling
205	20	AERMOD runs can be very long. Runs cannot
205	24	translate AERMOD conc. files to CALPUFF-like
206	5	makes for some confusion. Recommend that AERMOD
208	4	of my comments on AERMOD today. We’re commenting
208	5	off the off the shelf of AERMOD and not talking
211	13	Adding bells and whistles to AERMOD will not
218	4	has identified in AERMOD. URAG encourages EPA to
219	18	with AERMOD. I’m now a private consultant.
222	13	Euler Backward solver (EBI). AERMOD: example
222	18	EPA code for CMAQ and AERMOD). SlowSpotter™
223	14	Example (d) AERMOD. Poor cache utilization:
225	5	generation of compiler technology for AERMOD

Page	Ref No.	Keyword = "aermod"
225	7	go with the double precision release of AERMOD.
225	25	local scale analysis using AERMOD to (inaudible)
226	9	inputs for AERMOD.
226	18	to (inaudible) and create inputs in to AERMOD.

Page	Ref No.	Keyword = "AERSCREEN"
165	11	AERSCREEN, is coming out soon. We'd like to see
207	7	recommend use of AERSCREEN with different runs

Page	Ref No.	Keyword = "AERSURFACE"
83	12	AERSURFACE pretty high roughness about 0.8 meters
206	19	Issues with AERSURFACE implementation.
226	16	essentially allowing AERSURFACE and AERMET to do

Page	Ref No.	Keyword = "air"
7	7	in air quality modeling. This class of models
22	10	750 meters up in the air and the height in the
48	4	community multi scale air quality model from the
48	13	predicting the level of air quality compared to
48	24	questions are we capturing the changes in air
51	2	case typically MM5 or WRF and one focuses on air
51	14	(e.g. MM5, WRF) or air quality model (e.g. CMAQ,
54	19	Profiler, and Aircraft Profiler.
56	7	Similarly for aircraft comparisons similar types
64	10	with air quality (AQ) standards? Is AERMOD's
69	20	Eulerian air quality models, where predicted
75	10	airport data and with the SEARCH data sets that
75	18	series plot running the model with the airport
76	12	again at the airport for Birmingham that the
76	16	airport. Then higher roughness at the SEARCH
77	3	series plot based on airport data the light blue
77	6	airport.
77	15	that monitor. But if you look at the airport
77	19	airport this is a case where between calm and
78	2	question of the representative of that airport
78	16	compared with met SEARCH site and airport site to
79	4	supplemented the airport with the 1-minute ASOS
79	11	cold air and drainage flow. At the airport it's
79	14	show up at all with this standard airport data

Page	Ref No.	Keyword = "air"
79	22	is that when you use the airport data under the
79	24	airport when you supplement it you are getting a
80	17	airport data and 25-30% is calm those results may
81	10	process airport data was not representative of
81	12	suggestion was to re-process airport data with 1m
83	8	impacts. Again with the airport date this is the
83	14	airport data with the 1-minute ASOS
83	16	pretty low for an airport. And pretty close to
84	2	airport and the SEARCH site didn’t seem to be
84	16	from standard ISHD airport data showed
85	3	And also another non standard airport site,
93	21	emergency response support for air modeling in
97	12	get air concentrations, deposition; and some
99	22	modeling air concentrations, it is from
131	25	hazardous air pollutants (HAPs), which is an
132	3	large spatial variability in air toxics
136	8	simple (inaudible) for all types of air quality
136	12	inputs and process that for the air quality
137	18	prevent kids in this terrible dooms day air
148	13	PGM Databases and model set ups. RPOs, AIRPACT,
154	9	source” air quality, visibility and deposition
154	23	“single source” air quality, visibility and
156	20	with our policy folks in the Air Quality
158	20	air standards has resulted in more non-attainment
158	24	on Air Quality Models. Highlights are listed
163	15	of Met models and air quality models in
165	25	anemometers generally located on airport
166	4	by surface roughness of airport property. Better
166	5	guidance is needed for translating the airport
166	8	sources that use airport data, the dispersion
166	10	the surface modeling of the airport roughness.
166	12	the airport wind observation to the land
167	2	concentrations in the presence of ambient air
167	12	CMAQ) for estimating air quality concentrations.
170	24	like to do is present issues related to air
172	10	air quality impacts under NEPA
172	15	Air quality modeling approach is: “Use
180	2	model output in air quality modeling
180	7	the use of meteorological models in air
180	16	model results used in an air quality
182	11	standard upper air and surface observations
182	22	these are your upper air sites across the CONUS
183	8	attractive at least in upper air data source
183	23	the vertical resolution of the upper air data
184	21	It uses Pittsburgh PA surface and upper air

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184	23	North American Regional Reanalysis). Upper air
185	2	air site.
185	19	suitable as an upper air resource – need to
195	6	meterological data on the air quality model which
202	19	the Proposed National Ambient Air Quality
207	21	Guideline on Air Quality Models is right, a calm
208	20	300 km. Many applications in air quality
208	21	modeling for the guideline purposes require air
209	8	air issues. Complex terrain and slow reversal
212	17	Air Regulatory Group (UARG). UARG is an ad hoc
212	22	proceedings under the federal Clean Air Act.
214	4	on the use of the air quality models, then we
218	14	predicting the air quality impacts of emissions
219	14	performance computing and started with air
220	8	Regulatory Air Quality Models (AQM). They
225	18	Mark Garrison from ERM. We service the Air
225	22	support in the review and evaluation of air

Page	Ref No.	Keyword = "algorithms"
85	25	with the PRIME downwash algorithms since it
165	15	incorporate algorithms for near calm winds and
165	17	algorithms for use in urban areas, especially for
168	8	modifications to model algorithms. Model
189	11	Base Used to Develop Downwash Algorithms). Other
189	12	considerations are building downwash algorithms
189	14	buildings. Building downwash algorithms in
189	25	Prime Algorithms. With AERMOD/PRIME building
191	7	Short/Large Buildings. The wake algorithms have
194	21	dimensions match assumptions in algorithms. If
194	23	BPIP for AERMOD/PRIME. Develop algorithms for

Page	Ref No.	Keyword = "appendix"
38	20	Appendix W.
72	10	Appendix W [ed. for NSR and] (inaudible) PSD.
156	8	for EPA. Basically Appendix W Guidance on
156	18	Appendix W would have to fall out of discussions
202	20	Standards for Particulate Matter, Appendix B –
213	4	revisions of Appendix W Guideline. The Modeling
213	18	Guidelines to Appendix W. So our comments are
216	11	Appendix W allows the choice of modeling

Page	Ref No.	Keyword = "ASOS"
78	9	one ASOS data which we shared.
79	4	supplemented the airport with the 1-minute ASOS
79	13	supplemented it with 1-minute ASOS it doesn’t
83	14	airport data with the 1-minute ASOS
84	20	ASOS wind data to reduce the number of calms,
165	24	surface roughness to a 1 km radius of ASOS
204	23	ASOS use of sonic anemometer data and averaging
204	24	of sub-hourly ASOS data will likely create more

Page	Ref No.	Keyword = "atmosphere"
22	11	atmosphere and you can see the presence of the
105	2	atmosphere. That’s the complete 3D-particle
136	23	photochemical grid models are a one atmosphere
137	4	So the One Atmosphere approach may not be
181	20	atmosphere for a given point in time. It’s
199	7	in the atmosphere (“secondary formation”) from

Page	Ref No.	Keyword = "BART"
43	13	position with respect to BART and with respect to
94	8	about the BART program which is we’ve seen a lot
149	16	Texas Group BART application. CAMx 36/12 km with
150	3	I have one slide on the Texas Bart but Texas
150	4	had like 200 potential Bart eligible sources.
150	7	groups of 10. In each group Bart analysis of 10
150	9	contributions of groups of Texas BART sources for
150	13	areas. Use IRON P-in-G for Texas BART Source.
154	13	BART assessment. PM2.5 SIP modeling.
155	3	Arkansas BART assessment. PM2.5 SIP modeling.
178	8	the Hayden Power Plant Bart analysis done by
199	11	This slide comes from a VISTAS BART

Page	Ref No.	Keyword = "Birmingham"
75	8	Birmingham Local Area Analysis (LAA) for PM-2.5
76	12	again at the airport for Birmingham that the
77	18	you can see that trend. I think at Birmingham

Page	Ref No.	Keyword = "boundary"
29	2	Nebraska we have a fontal boundary that starting
29	5	encountered the frontal boundary and started to
29	9	we’re not encountering that frontal boundary and
84	5	boundary layer enhancement is certainly helping
104	6	represent the boundary layer transport. It looks
104	8	varies with height in the boundary layer.
104	17	effect. That is a big thing for boundary layer
105	21	boundary layer as there is a lot more shear with
140	8	boundary conditions to PM2.5 by adding duplicate
152	15	largest contributions are the boundary
152	16	conditions. The boundary conditions are outside
175	13	chemistry was used. When boundary

Page	Ref No.	Keyword = "calm"
18	20	in CALMET. Perhaps Hybrid method verses NOOB = 1
18	23	different ways in which we supply data to CALMET
22	18	we did with CALMET meteorology we looked at
23	8	had two domains, two CALMET domains. For the 100
23	9	km arc we used the 4 km CALMET which was
23	12	previous CALMET and CALPUFF simulations to do
23	13	this. So we had a 20 km CALMET for 600 km
23	14	simulation and a 4 km CALMET for 100 km and then
24	10	CALPUFF with CALMET is doing about the same.
24	11	Both put in MM5 CALPUFF within the CALMET one
25	14	You can see here the CALMET winds did very
25	17	time at the 100 km arc. CALMET almost
26	2	as you can on the 100 km arch, CALMET does very
26	13	1998 timeframe, they ran in CALMET and NOOBS mode
26	20	something has changed inside CALMET I don’t know.
27	13	CALMET. CALMET was much better in terms of
29	21	CALMET wind fields from the previous one. I
31	20	with the MM5 and there’s no CALMET in this
36	4	CALMET options remained constant. CALPUFF
36	5	performance varied due to variations in CALMET
43	22	So I created a 12 km domain and ran CALMET just
77	10	correlated with high frequency calm. For example
77	11	if you have 18-20 hours of calm, it indicated a
77	19	airport this is a case where between calm and
80	17	airport data and 25-30% is calm those results may
160	9	models such as CALMET and prognostic full-physics
160	21	needed is to optimize use of Met model and CALMET
160	24	physics Met models (e.g. MM5) and CALMET; look at
161	16	methods). We’d like to assess if CALMET (or any

Page	Ref No.	Keyword = "calm"
162	6	CALMET (or any diagnostic model) is truly needed
163	24	model (e.g., MM5) direct input versus CALMET
165	15	incorporate algorithms for near calm winds and
207	21	Guideline on Air Quality Models is right, a calm
208	2	missing calm.
226	8	outputs and processed through CALMET to develop

Page	Ref No.	Keyword = "CALMET"
18	20	in CALMET. Perhaps Hybrid method verses NOOB = 1
18	23	different ways in which we supply data to CALMET
22	18	we did with CALMET meteorology we looked at
23	8	had two domains, two CALMET domains. For the 100
23	9	km arc we used the 4 km CALMET which was
23	12	previous CALMET and CALPUFF simulations to do
23	13	this. So we had a 20 km CALMET for 600 km
23	14	simulation and a 4 km CALMET for 100 km and then
24	10	CALPUFF with CALMET is doing about the same.
24	11	Both put in MM5 CALPUFF within the CALMET one
25	14	You can see here the CALMET winds did very
25	17	time at the 100 km arc. CALMET almost
26	2	as you can on the 100 km arch, CALMET does very
26	13	1998 timeframe, they ran in CALMET and NOOBS mode
26	20	something has changed inside CALMET I don’t know.
27	13	CALMET. CALMET was much better in terms of
29	21	CALMET wind fields from the previous one. I
31	20	with the MM5 and there’s no CALMET in this
36	4	CALMET options remained constant. CALPUFF
36	5	performance varied due to variations in CALMET
43	22	So I created a 12 km domain and ran CALMET just
160	9	models such as CALMET and prognostic full-physics
160	21	needed is to optimize use of Met model and CALMET
160	24	physics Met models (e.g. MM5) and CALMET; look at
161	16	methods). We’d like to assess if CALMET (or any
162	6	CALMET (or any diagnostic model) is truly needed
163	24	model (e.g., MM5) direct input versus CALMET
226	8	outputs and processed through CALMET to develop

Page	Ref No.	Keyword = "calms"
77	5	against the frequency of calms each day from the
77	21	data period missing either to calms or winds.
78	5	down, calms go up, observed concentrations go up

Page	Ref No.	Keyword = "calms"
78	7	without (inaudible) the calms go down. This is
79	15	because they’re all missing the calms.
84	20	ASOS wind data to reduce the number of calms,
85	18	predictions. The other was the calms. Looking
183	15	calms verses what the observed data might have.
207	15	Many more calms in recent data sets – if
207	17	meet 90% capture criteria. If many calms, does
207	18	CALMS preprocessor work properly? Conc

Page	Ref No.	Keyword = "CALPUFF"
6	6	continuation of the CALPUFF session, but in order
6	10	respect to CALPUFF. So we’ll start with those
7	2	employing in evaluating CALPUFF and the other
11	13	evaluate CALPUFF and the other models.
14	7	fact that CALPUFF model science had evolved
17	10	was to examine science evolution of CALPUFF
17	17	range of CALPUFF beyond recommended distance of
18	13	to supply meteorological data to CALPUFF? As you
19	25	a paper about comparing CALPUFF to (inaudible)
21	16	published supporting the promulgation of CALPUFF.
22	17	CALPUFF, FLEXPART and HYSPLIT and basically, what
22	21	gave yesterday, we also included the MM5 CALPUFF
23	12	previous CALMET and CALPUFF simulations to do
24	10	CALPUFF with CALMET is doing about the same.
24	11	Both put in MM5 CALPUFF within the CALMET one
24	16	CALPUFF in the 100 km and unpredicted under 600
25	4	CALPUFF turbulence and the AERMOD turbulence in
27	3	(inaudible) CALPUFF we weren’t getting the
28	8	encouraging sign for the MM5 CALPUFF.
29	12	For the MM5 CALPUFF, as you can see, it
31	12	this is well beyond what CALPUFF what is
31	21	simulation. It’s only MM5 CALPUFF so basically
32	16	This is what CALPUFF was showing here. I
32	18	(inaudible) Hysplit and CALPUFF were a lot easier
32	22	observation were looking like for this. CALPUFF
33	2	of it. All three models CALPUFF, FLEXPART and
33	14	CALPUFF and was just an experiment to take a look
33	17	HYSPLIT was comparable with CALPUFF in the first
34	7	CALPUFF on that one here where the high false
34	19	better than CALPUFF here and you know you can
35	10	Experiment, CALPUFF/CALMET 100 km results
36	2	CALPUFF 1.0 distribution and use of lambert
36	4	CALMET options remained constant. CALPUFF

Page	Ref No.	Keyword = "calpuff"
36	6	options selected. As you can see, CALPUFF
36	9	mentioned yester that CALPUFF is sensitive as to
36	14	see CALPUFF performs reasonably compared to
36	20	looking at Puff-splitting did not change CALPUFF
37	3	puff-splitting in CALPUFF.
39	9	in CALPUFF such as you resolve the terrain
46	21	about CALPUFF people can ask those before we get
71	12	the plume dispersion predictions in CALPUFF
94	9	of CALPUFF modeling you know we’ve also seen a
94	23	AERMOD), Gaussian Puff Models (INPUFF, CALPUFF,
118	20	that’s in a version of CALPUFF and I said I would
119	12	CALPUFF.
120	17	and CALPUFF would this type. We have a puff that
122	8	The way this is implemented into CALPUFF are
122	13	into sub-steps (sampling steps) in CALPUFF. For
122	22	main CALPUFF routine.
122	23	CALPUFF then computes any physical process
123	9	restored. Parent puff treated in normal CALPUFF
124	24	CALPUFF and it’s an older version. But it’s
143	20	(not an evaluation of CAMx PSAT or CALPUFF) of
143	22	with CALPUFF visibility estimates. Several
144	4	meteorology output from MM5. CALPUFF was run in
144	14	CALPUFF. We are not trying to say which is right
144	17	the top we’ve got the CALPUFF results and on the
144	19	caveat to put on this is that CALPUFF look at
145	3	amazing was CALPUFF had some larger extinction
145	4	(?) of the contribution. We applied CALPUFF with
151	2	and primary PM emissions requested. CALPUFF
152	11	(inaudible) for that other model CALPUFF.
159	7	We had discussions yesterday of CALPUFF
159	17	models especially on CALPUFF and AERMOD. As you
159	19	CALPUFF and AERMOD at this time. We don’t think
160	12	CALPUFF, CMAQ). Prognostic meteorological models
162	17	evaluations of CALPUFF using full chemistry as
163	8	test the use of CALPUFF for regional AQRV
167	4	for both AERMOD and CALPUFF.
167	11	detailed dispersion models (AERMOD, CALPUFF, or
167	16	principles (e.g., AERMOD, CALPUFF, CMAQ, CAMx
172	8	Ralph talk about that. CALPUFF is being
173	6	Formulation of CALPUFF chemistry. Lack
173	14	used in CALPUFF, SO4 formation is described
175	12	been done in terms of CALPUFF. RIVAD
175	21	indication that the as CALPUFF Model using
176	6	CALPUFF is predicting. Now we can get into
178	14	sulfate in CALPUFF, it’s saying the nitrate

Page	Ref No.	Keyword = "calpuff"
179	3	Monitoring data versus CALPUFF, 80,000
179	10	comprehensive model evaluation of CALPUFF in
186	23	CALPUFF. I think Harry Cramer, rest his soul,
195	17	processes that are a part of the CALPUFF system
196	21	for running AERMOD or CALPUFF. I think it seems
201	9	Secondary PM2.5 could be modeled with CALPUFF.
201	15	I'd like to address the issues with CALPUFF
201	22	find that CALPUFF will be mostly unbiased and I
201	25	predictions of CALPUFF.
202	11	CALPUFF and AERMOD can provide that statistic.
203	25	There is a role for CALPUFF (or other models) for
205	22	as is done with CALPUFF. EPA should develop a
205	23	system like that of the CALPUFF system, or
205	24	translate AERMOD conc. files to CALPUFF-like
208	8	be talking about CALPUFF and the comments of the
208	9	AB3 Committee on CALPUFF. Let me see if I can
208	16	about CALPUFF and talking about CALPUFF filling
208	17	your needs. About EPA concerns about CALPUFF and
209	4	demonstrated. CALPUFF is a model with community
209	13	EPA concerns about CALPUFF are relatively
209	15	evaluation and CALPUFF we are going to show in
209	17	demonstrate CALPUFF in near field areas.
209	22	EPA doesn't have direct control of CALPUFF and
210	4	The developer has training classes for CALPUFF.
210	6	advancing CALPUFF and will work to that end. EPA
210	7	doesn't have direct control of the CALPUFF code
210	12	CALPUFF lags behind in the code releases. The
210	22	CALPUFF at less than 50 km. Why is it 50
211	15	that CALPUFF comparison to LRT studies have been
211	18	we're using now. Many states are using CALPUFF
215	10	memorandum about the regulatory status of CALPUFF
215	12	of CALPUFF must go through a more extensive
215	17	document that a modeling system like CALPUFF,
216	8	parties trying to use CALPUFF in situations in
226	2	using CALPUFF to (inaudible) with CALPUFF. We've
226	3	done some quasi studies with CALPUFF looking at

Page	Ref No.	Keyword = "cell"
108	25	concentration in any grid cell will be the mass
109	3	cell volume. If you're using some kind of puff
138	15	each grid cell.
141	20	grid cell. You can see the hot spot over there
144	6	at the number of times in each grid cell that had

Page	Ref No.	Keyword = "cell"
151	8	modeling. 12 km grid cell size too coarse to
155	8	for Ralph. When you do the (inaudible) cell
155	12	cell due to (inaudible)?
155	23	variability in the cell? That’s my question
156	5	of the (inaudible) the cell itself.

Page	Ref No.	Keyword = "cells"
125	25	several grid cells before it reaches the size of
147	16	and dispersion. Need many grid cells to assess
155	10	receptors within the cells. The second question

Page	Ref No.	Keyword = "chemistry"
81	23	better account for the NO2 chemistry in this
97	23	chemistry and multiple sources, but there are
98	10	There is an implicit linearity for chemistry.
100	10	the meteorology. Now the non-linear chemistry
100	17	Basically the chemistry works in its hybrid
100	22	concentration grid and the chemistry solution is
120	13	chemistry.
126	4	transport of the emissions and chemistry of the
127	8	simplified treatment of chemistry in some models,
127	24	adds the full chemistry mechanism to SCIPUFF.
128	16	We added PM and aqueous-phase chemistry
130	22	source transport and chemistry of point source
132	10	acetaldehyde–models need to treat the chemistry
132	13	chemistry treatment and fine spatial resolution.
132	18	emissions. Chemistry is switched off for this
137	10	chemistry and transport and meteorology inputs to
138	3	Heterogeneous Chemistry); advection (Horizontal &
138	19	phase chemistry, ability to estimate realistic
138	22	phase chemistry provides realistic sulfate
139	4	state of the science inorganic chemistry
141	4	and aqueous phase chemistry are solved for bulk
145	19	advantage of state of the science chemistry, but
147	9	chemistry. Photochemical Grid Models (PGMs) have
147	10	capability to correctly treat chemistry. But how
147	12	source plume chemistry and dispersion?
147	15	the source to resolve near-source plume chemistry
147	19	sources. Needed to correctly simulate chemistry.
148	6	plume chemistry and dispersion without providing
148	7	met and emission inputs and full chemistry Plume-

Page	Ref No.	Keyword = "chemistry"
148	9	chemistry of point source plumes. Both CMAx and
151	4	CMAQ full-science chemistry. Provide
151	9	treat chemistry and dispersion of point source
151	17	chemistry and dispersion. PM Source
154	5	Full chemistry Plume-in-Grid modules. Ozone and
154	7	aqueous-phase chemistry and aerosol thermodynamic
154	19	Full chemistry Plume-in-Grid modules. Ozone and
154	21	aqueous-phase chemistry and aerosol thermodynamic
162	17	evaluations of CALPUFF using full chemistry as
162	25	that EPA modify the chemistry, based on API/AER
172	2	large extent in a full chemistry mode. And
173	6	Formulation of CALPUFF chemistry. Lack
173	8	a full chemistry mode. Indication of model
173	13	In the MESOPUFF II chemistry module
174	14	It’s a comparison of CMAQ chemistry verses
174	15	CMAQ MESO PUFF II chemistry. The blue dots
174	18	prediction to the MESOPUFF chemistry
174	19	compared to the CMAQ chemistry. This is
174	23	chemistry is not working as it should be.
175	4	chemistry and RIVAD and some modified RIVAD
175	13	chemistry was used. When boundary
179	11	a full chemistry model. Without a doubt
209	20	The chemistry is fine for NOx , SO2 and PM

Page	Ref No.	Keyword = "Class I"
7	13	these for Class I increments and for what we call
39	19	the Class I analysis and exactly where the source
39	24	into a Class I area. And in other cases it
40	15	differenr source – Class I area pairs -- looking
41	6	for PSD Class I increments that, in all cases,
41	8	for PSD Class I increments. This was from Tim
143	24	sources less than 50 km from Class I areas; used
150	12	flexi-nest grid covering Texas and nearby Class I
175	25	Bridger CLASS I area outside of Pinedale
176	11	from the Class I areas. So you are not
202	6	applications (e.g., Class I increment)? How to

Page	Ref No.	Keyword = "clearing house"
91	17	The reason we have a clearing house process and
92	18	Regional Offices to use the clearing house

Page	Ref No.	Keyword = "complex"
19	23	good complex terrain to it which would be useful.
70	24	complex terrain). Conditions of concern for
97	22	It lends itself to easily handle complex
158	21	areas and the need for more complex and more
162	21	SCIPUFF And the ability to handle complex
186	20	Complex (ISC)] model. I'm not sure if that is
189	2	Prime, it's going to be hard to treat complex
190	20	complex and that's the shape of the building that
209	8	air issues. Complex terrain and slow reversal
211	7	method to define precisely when complex winds
211	9	referring to paper I gave 3 years ago on complex
211	10	modeling and a better definition of complex
211	12	definition of complex winds.
221	7	They do this by inserting complex memory

Page	Ref No.	Keyword = "concentration"
10	4	integrated concentration and observed the fitted
10	10	hour or twelve hour arc concentration on that
12	6	concentration. For Bias, we have just mean bias
44	8	the concentration was smaller. On advice from
44	17	changes in concentration: 20, 12 and 4 were very
45	3	fairly consistent decrease in the concentration.
53	23	itself. Like concentration if you want to limit
53	24	to a certain concentration you can do that as
63	16	concentration trends with distance and maximum
64	17	like the robust highest concentration. For
65	2	Concentration, or the RHC, represent a smoothed
69	10	have a cross wind concentration like this you
69	13	concentration and so on.
73	6	peak of the concentration distribution, unpaired
73	11	concentration distributions paired in time and
74	3	concentration at each arc not the individual
76	5	concentration of AERMOD across the gridded
76	7	the actual monitored concentration. It actually
77	9	observed concentration goes up it's often highly
77	13	observed concentration. That certainly suggests
77	24	you will be expected high concentration under
78	6	but the model concentration with that data
78	12	concentration. This period stood out initially I
82	11	concentration and the lighter blue is the model
82	12	concentration from AERMOD. Again most of this is
83	13	0.7 meters verses concentration process with the
83	21	produced the higher concentration was the from

Page	Ref No.	Keyword = "concentration"
90	11	metric concentration really captured the plume
97	18	derivative of the concentration change which is
98	12	want to get the concentration at a particular
99	25	simultaneous meteorology and concentration grids.
100	22	concentration grid and the chemistry solution is
100	23	run. The concentration change is linearly
102	23	provide the concentration background and combine
105	10	a growing concentration distribution in the
106	24	you’re in you have a mean concentration and the
106	25	mean concentration would be the top hat. It
108	25	concentration in any grid cell will be the mass
119	20	and predict the mean concentration and give
120	21	concentration distribution belong to a “piece” of
124	15	wind integrated concentration (CIC). Very
132	25	background concentration.
133	10	model results compared with CO concentration
144	7	a 24 hour average [ed. concentration] (inaudible)
167	18	specific concentration data sets. The use of
174	2	3) Plume NOx Concentration
176	12	going to see sharp concentration gradients
185	5	concentration for SO2). NARR run within 5% of
194	16	increase of concentration as if the hill weren’t
205	3	these “design concentration” predictions.
226	24	what kind of concentration are the result of the

Page	Ref No.	Keyword = "concentrations"
10	5	maximum concentrations on that arch. That method
26	11	concentrations for 15 hours on the arc. So what
39	13	concentrations go. Is that really true or it is
40	21	the concentrations went up with finer resolution,
41	11	km show a decrease in concentrations. There have
57	10	statistics available. And also concentrations,
63	17	concentrations on tracer arcs that are used for
64	9	ground-level concentrations used for compliance
65	3	estimate of the highest concentrations (from Cox-
65	9	hopefully the peak concentrations are close to
65	12	range of the moderate concentrations we are a
66	15	observed and predicted concentrations where an FB
69	21	concentrations represent averages over a grid
69	22	volume, but observed concentrations represent
74	4	concentrations that each receptor along the arc.
76	11	concentrations from the monitor. This just shows
77	2	all this is a plot again concentrations a time

Page	Ref No.	Keyword = "concentrations"
78	5	down, calms go up, observed concentrations go up
79	19	where they had the PM 2.5 concentrations and
81	6	comparisons showed AERMOD concentrations
81	8	concentrations at 3 Atlanta monitors. An initial
83	9	Q-Q plot of modeled concentrations using SEARCH.
83	10	These are AERMOD concentrations using the SEARCH
84	14	concentrations from refineries in Texas for
84	19	concentrations. We recommended using 1-minute
97	12	get air concentrations, deposition; and some
99	22	modeling air concentrations, it is from
106	4	particle concentrations you can see from the
108	23	concentrations? Well each particle if you’re
111	11	measuring concentrations over the US and I just
111	18	about the right, but concentrations a little bit
113	24	measured concentrations; the Kolomogorov-Smirnov
124	12	maximum concentrations with little overall bias
124	19	maximum concentrations and some displacement of
124	20	location of peak concentrations.
126	22	model provides background concentrations to the
126	25	concentrations are adjusted. There’s a two way
129	25	to average July PM2.5 sulfate concentrations. The
130	24	concentrations. CMAQ-AERO3-APT predicts lower
132	4	concentrations near roadways. Exposure levels
132	17	and benzene concentrations from roadway
132	22	Concentrations are calculated at discrete
132	24	concentrations with the grid-cell average
133	9	qualitative evaluation of CO concentrations from
138	20	ozone concentrations, no need for a constant
139	2	concentrations, spatial/temporal representation
139	3	of ammonia and nitric acid concentrations and
143	15	example of what the concentrations look like.
147	6	concentrations, deposition and visibility.
149	20	contributions to 2009 annual PM2.5 concentrations.
167	2	concentrations in the presence of ambient air
167	3	ozone concentrations. This should be performed
167	12	CMAQ) for estimating air quality concentrations.
175	6	developing nitrate concentrations in excess
175	17	formation was limited by NH3 concentrations.
175	23	towards over predicting NO3 concentrations.
177	3	concentrations the maximum measured there’s
177	5	concentrations is certainly not enough to
191	2	concentrations at ground level and on a nearby
191	4	Dimensions gave lower concentrations and ones
192	4	concentrations predictions. We ran five typical
192	13	outside of the cavity region the concentrations

Page	Ref No.	Keyword = "concentrations"
192	25	higher concentrations than currently predicted in
193	10	here. That was given the highest concentrations.
193	11	The lower concentrations are these two here.
193	14	concentrations looked like in the wind tunnel.
193	17	of vortex is increasing the concentrations by
194	3	concentrations increased by a nearly a factor of
198	23	background concentrations – how to treat, and
203	8	source impact concentrations. If daily
203	9	background concentrations are not available, fill
203	16	need to be resolved. Background concentrations
203	17	can be much higher than modeled concentrations.

Page	Ref No.	Keyword = "convective"
123	18	convective conditions
124	2	•Mostly convective conditions

Page	Ref No.	Keyword = "data"
7	25	meteorological and tracer databases for
8	5	archive of these data sets. So the first goal
11	2	This data set and these programs on the NOAA ARL
11	12	those performance those data base out there to
14	25	meteorological database for use with LRT model
15	5	have the MM5 data that was run up there and have
15	7	can go on the web site and get that data and do
15	11	had mentioned yesterday in trying to get the data
15	15	meeting, we had all the data assembled that I was
15	19	data sets and get those out there. So that was
15	21	That’s the ultimate goal to get those data sets
16	2	SCRAM for the evaluation data sets for the
16	3	developmental data sets that were used for
16	24	assembled tracer database. Then like I said
17	2	LRT models for the assembled tracer database to
18	10	these tracer data bases looking at both
18	13	to supply meteorological data to CALPUFF? As you
18	23	different ways in which we supply data to CALMET
20	5	include in the database.
21	2	to take the meteorological data from MM5 and
22	22	and this is one of the data sets that we’re
23	23	validate the MM5 data and that’s something we
30	11	develop a database which could be used for model
31	4	NCEP Reanalysis Data and was consistent with what

Page	Ref No.	Keyword = "data"
31	25	same meteorological data.
34	18	terms of the statistical data. It did marginally
35	2	here to draw any conclusions from current data.
35	18	data, horizontal, and vertical grid
37	10	data availability necessary. Clearly we need to
46	18	described understanding what data he’s working
51	6	charge, license free. One is a database called
51	16	an entire gridded data set. We’re just using
52	6	generate database records and then those records
52	7	go into the MySQL database. In essence we are
52	8	jus populating the database with model
52	11	all the data and observation are in the database
52	13	pre-generated scripts to query that database,
52	14	poll the type of data you want and then create
53	4	the MM5 or WRF and here it’s a meta data set that
53	8	they do in the database.
53	11	Data stored in relational database which is great
53	12	because one it puts all your data in a single
53	15	database and treated the same way. The real
53	16	power is it allows data queries based on many
53	21	sites, you can do it by pretty much any met data
53	22	you can query by. You can also query by the data
55	6	whatever your data set is and this is what gets
55	9	see the distribution and wind speed in your data
55	16	this is …. don’t worry about the data showed
56	14	different data. Scatter plots this includes
57	15	also include another model data so you could
57	18	you can … the behavior of the data across the
57	22	specific to some of the data available for
58	4	whatever your data or skip a type of plot you
58	15	into the database and analysis just like you
58	16	would any other database. Even if you are not
58	18	have data generally in the common (inaudible)
58	21	the database and analysis just like you would
58	24	and bring it right into the database.
59	2	can be used outside of data met. There are
59	3	scripts so if you got data and you don’t want to
59	5	database, take the R script and you can read it
59	20	tutorial data and example output plots and then
60	6	locally and accesses remote database. It would
60	8	script database. Hopefully we can do some
60	13	what met data you put in you can use as a query
62	22	I will also mention some evaluation databases
63	4	provided that database to EPA for AERMOD. And we
63	7	evaluation of low wind speed databases with API

Page	Ref No.	Keyword = "data"
63	11	types for evaluation of databases. One involves
63	23	where the other type of database -- the long-term
64	6	database.
64	12	similar models? Evaluation databases were a
64	21	for both types of evaluation databases. Residual
64	25	databases. Estimates of Robust Highest
65	6	only used for tracer databases.
66	20	sampling of data used to determine confidence
67	5	databases.
67	18	best suited to tracer databases and is widely
67	25	different kinds of data pairings
68	16	is a plot of the various data values such that if
70	4	lot of archived databases, but unfortunately the
70	10	databases. You probably can't see this, but you
70	12	over a 100 database references. For the existing
70	13	data, I would like somehow to make sure with EPA
70	15	Literally, these are about a hundred databases,
70	17	these databases.
70	19	gridded meteorological data. It's almost like a
70	20	new concept do we trust MM5 data instead of a
70	22	analysis the gridded met data. There be may be
71	3	meteorological data.
71	17	Sources of data for testing that I would
71	19	tower data, not just surface data because a lot
71	22	the data has been provided to the agencies are
72	2	databases be used for the independent assessment
72	3	for the evaluation of the gridded met data. That
73	19	one of the best databases ever collected back in
74	10	tall stack or evaluation data base that was used
75	10	airport data and with the SEARCH data sets that
75	13	and the SEARCH met data. The model seemed to be
75	19	only data which that blue line down near zero and
75	20	you have the SEARCH data. As you can see there's
77	3	series plot based on airport data the light blue
77	21	data period missing either to calms or winds.
78	3	data for that applications because you can see a
78	6	but the model concentration with that data
78	9	one ASOS data which we shared.
78	11	is with the SEARCH data showing a high
78	15	data. Just looking at the wind direction
79	14	show up at all with this standard airport data
79	22	is that when you use the airport data under the
80	11	data was in the wrong direction and was basically
80	17	airport data and 25-30% is calm those results may
81	10	process airport data was not representative of

Page	Ref No.	Keyword = "data"
81	12	suggestion was to re-process airport data with 1m
81	17	process SEARCH met data as more representative of
83	11	data process with surface characteristics using
83	14	airport data with the 1-minute ASOS
83	20	But interestingly enough the met data that
84	16	from standard ISHD airport data showed
84	20	ASOS wind data to reduce the number of calms,
84	23	met data resulted in selection of another nearby
86	11	different met data and different source
86	14	data and including some Sigma Z so this is
86	18	Hybrid met data about 5.96 so we’re getting
89	5	evaluation databases and what types of sources
89	21	any good databases to look at especially low
90	2	collect the data to show well we’re not causing
90	14	off the work he’s doing. Other databases out
100	6	high resolution terrain it would use that data
101	9	model used was rawinsonde data with day/night
101	11	to gridded meteorological data. Based on the
101	13	could do a better job using meteorological data
101	21	rawinsonde data was really insufficient to
114	14	one of them had different meteorological data
114	17	gridded data so when we were doing later
114	21	site download and convert that data so that you
114	23	have a consistent meteorological database that is
114	25	can go back and look at the old data and see how
115	11	there’s lots of data. This is available on our
118	5	database (web) and not the PC version; GIS-like
123	12	different data sets which included:
124	13	and nearly all data points within factor of two
124	21	Kincaid used QI=3 (highest quality) data
125	4	in determining its performance in other data
134	9	to evaluate it with available data. Over 150
135	3	and data sources like VISTAS; Atmospheric
137	9	VOC, SOx, PM and toxics and use data science
141	22	offers speciated data so it can figure out the
147	20	Databases more costly to develop. MM5/WRF
148	13	PGM Databases and model set ups. RPOs, AIRPACT,
148	22	coarse grid data. Allows fine grid treatment of
150	11	2002 36 km modeling CAMx database. Add 12 km
151	6	SIP projections. ASIP 36/12 km database
151	15	2002 database, 12/4 km domain with two-way nested
159	22	meteorological data and land use variations. Can
160	5	topography, wind persistence data and land use
161	11	models vs. field study data sets; and possible
161	15	and Penn State MM5 Met model data assimilation

Page	Ref No.	Keyword = "data"
161	25	field study data sets; possible new field
162	5	Met model data assimilation methods). Assess if
162	12	We'll talk some more about data gathering in
162	13	Wyoming and we'd like to see databases developed
162	14	further which would provide monitoring data and
162	15	emissions data inventory.
165	16	test with appropriate field data sets; improve
166	8	sources that use airport data, the dispersion
166	16	output should summarize the processed met data so
166	18	if that year of data is suitable for regulatory
167	9	monitoring data combined with statistical
167	18	specific concentration data sets. The use of
168	19	evaluation using the existing databases and/or
171	13	look at it against observational data and
173	2	included in the monitoring data which is
176	17	the improved monitoring data at Bridger over
179	2	in the monitoring data.
179	3	Monitoring data versus CALPUFF, 80,000
179	14	There are currently data sets being
179	19	starting to build some databases here, but
180	20	for use of NOAA reanalysis data.
181	2	There are reanalysis data assets outside
181	18	Reanalysis data is a dynamically consistent
181	21	based off of observed data and not a
181	23	NOOA cycles their models with initial data
181	25	far back as 1948 to create a reanalysis data
182	4	reanalysis data set that goes back to 1979
182	9	Potentially a source for site specific data -
182	24	some of Canada. This is a reanalysis data set
183	2	data set goes back to 1948 and is available at
183	4	might get some more site specific data but if
183	5	you use the North American Reanalysis data and
183	8	attractive at least in upper air data source
183	11	pull some of this data in and run it through
183	15	calms verses what the observed data might have.
183	21	required by a sounding. But in our data of
183	23	the vertical resolution of the upper air data
184	8	the gridded data and put it in a text format.
184	20	It was just a data set for me and I used it.
184	22	data (and on site data). Re-run with NARR (ed.
184	24	data extracted from NARR grid and interpolated
185	3	All other data remained consistent with the
185	7	2nd high. Receptor location and data of 1st and
185	17	requirements of surface data for AERMOD.
189	10	Snyder/Lawson Data Base Flow Region (i.e., Data

Page	Ref No.	Keyword = "data"
192	6	the five sources. 1 year met data kind of a
195	6	meterological data on the air quality model which
195	19	the use to concert MM5 data and WRF and
195	24	specific data sets. It’s one way of reducing the
196	6	change the wind data. It’s exactly as it came
196	20	The other thing is producing met data sets
196	23	Evaluate gridded meteorological data performance
197	2	dispersion model to met database. Separately
197	9	Then separately use the data sets to
197	18	prognostic data.
197	21	the data set to allow sub hourly prognostic data.
197	25	sub hourly data has its advantage.
198	5	times higher results using prognostic data than
198	8	data? No under-prediction bias relative to
202	15	databases. Certain industry groups have also
202	16	reviewed stack test data to develop emission
204	23	ASOS use of sonic anemometer data and averaging
204	24	of sub-hourly ASOS data will likely create more
205	6	traffic itself. Review of data from tracer
207	14	states advocating use of more recent data sets.
207	15	Many more calms in recent data sets – if
207	20	recent met data. If my interpretation of the
207	22	is considered a missing data? Is that right?
221	3	What is the problem? Movement of data is
222	6	latency. Cache space is wasted when data resides
222	7	there but is unused. Unused data in cache
222	16	a 16KB L1 data cache and 1MB L2 cache with
222	20	performance data (for details see HiPERiSM’s Web
222	24	bars shows no wasted cache space – i.e. all data
223	5	bars shows wasted cache space – i.e. data loaded
223	11	performance. Linux platform with a 16KB L1 data
223	16	cache space – i.e. data loaded from memory but
224	4	Requires too much disorganized data movement.
224	5	Next generation hardware requires data
226	7	ways for extracting data from MM5 and WRF file
226	22	profiles with data collected on met towers. And

Page	Ref No.	Keyword = "database"
14	25	meteorological database for use with LRT model
16	24	assembled tracer database. Then like I said
17	2	LRT models for the assembled tracer database to
20	5	include in the database.
30	11	develop a database which could be used for model

Page	Ref No.	Keyword = "database"
51	6	charge, license free. One is a database called
52	6	generate database records and then those records
52	7	go into the MySQL database. In essence we are
52	8	jus populating the database with model
52	11	all the data and observation are in the database
52	13	pre-generated scripts to query that database,
53	8	they do in the database.
53	11	Data stored in relational database which is great
53	15	database and treated the same way. The real
58	15	into the database and analysis just like you
58	16	would any other database. Even if you are not
58	21	the database and analysis just like you would
58	24	and bring it right into the database.
59	5	database, take the R script and you can read it
60	6	locally and accesses remote database. It would
60	8	script database. Hopefully we can do some
63	4	provided that database to EPA for AERMOD. And we
63	23	where the other type of database -- the long-term
64	6	database.
70	12	over a 100 database references. For the existing
114	23	have a consistent meteorological database that is
118	5	database (web) and not the PC version; GIS-like
150	11	2002 36 km modeling CAMx database. Add 12 km
151	6	SIP projections. ASIP 36/12 km database
151	15	2002 database, 12/4 km domain with two-way nested
197	2	dispersion model to met database. Separately

Page	Ref No.	Keyword = "databases"
7	25	meteorological and tracer databases for
62	22	I will also mention some evaluation databases
63	7	evaluation of low wind speed databases with API
63	11	types for evaluation of databases. One involves
64	12	similar models? Evaluation databases were a
64	21	for both types of evaluation databases. Residual
64	25	databases. Estimates of Robust Highest
65	6	only used for tracer databases.
67	5	databases.
67	18	best suited to tracer databases and is widely
70	4	lot of archived databases, but unfortunately the
70	10	databases. You probably can’t see this, but you
70	15	Literally, these are about a hundred databases,
70	17	these databases.
72	2	databases be used for the independent assessment

Page	Ref No.	Keyword = "databases"
73	19	one of the best databases ever collected back in
89	5	evaluation databases and what types of sources
89	21	any good databases to look at especially low
90	14	off the work he’s doing. Other databases out
147	20	Databases more costly to develop. MM5/WRF
148	13	PGM Databases and model set ups. RPOs, AIRPACT,
162	13	Wyoming and we’d like to see databases developed
168	19	evaluation using the existing databases and/or
179	19	starting to build some databases here, but
202	15	databases. Certain industry groups have also

Page	Ref No.	Keyword = "datum"
15	24	themselves similar to the datum web site and

Page	Ref No.	Keyword = "default"
58	9	default AQ side and then the Soccer Goal Plot is
163	5	heavily on default values. Need to resolve met
192	7	standard AERMOD default mode. And we ran with

Page	Ref No.	Keyword = "DEM"
42	22	Service because they wanted some demonstrations,
46	6	and stay away from this EPA has demanded stuff.
75	7	heard about this the Alabama DEM study for the
87	13	that more robust demand on its performance.
120	11	computationally demanding and there is more
193	3	To demonstrate that I have a couple of
202	17	factors. EPA demonstrates possible approach in
209	4	demonstrated. CALPUFF is a model with community
209	17	demonstrate CALPUFF in near field areas.
211	5	Requiring equivalency demonstrations of less

Page	Ref No.	Keyword = "dispersion"
16	10	system we’re talking about here. The dispersion
18	4	recommend turbulence based dispersion (CALPUFF
20	4	Dispersion thing we’d like to get hold of that to
67	21	within Atmospheric Dispersion Modelling for
70	25	dispersion modeling are how often are the winds

Page	Ref No.	Keyword = "dispersion"
71	11	dispersion. The use of better meteorology got
71	12	the plume dispersion predictions in CALPUFF
72	25	requirements of operational Regulatory Dispersion
97	11	method; how to simulate plume dispersion, how to
97	20	flow and dispersion across the interface and you
99	2	and that means forward trajectory or dispersion.
99	18	dispersion. The dispersion is computed using 3D
100	19	sources and do the computation of dispersion and
102	2	to the dispersion code because the interest
104	15	driving the dispersion process. If you added any
104	18	dispersion.
106	12	really seeing any dispersion here because we’re
107	13	turbulent dispersion. That u-prime is computed
111	20	just standard transport and dispersion.
115	6	you find changing dispersion in the model and
119	14	alternative or an option to treat dispersion in a
120	4	meteorological and dispersion conditions,
120	5	causality effects, low wind speed dispersion,
120	7	variability in dispersion rates, etc. Lagrangian
120	23	cluster dispersion puff model where a puff is a
120	25	concept of relative dispersion (due to turbulent
121	8	relative dispersion but update frequency of flow
121	10	covered by relative dispersion concept. PPM uses
121	11	a full stochastic Lagrangian particle dispersion
121	17	relative dispersion. Every puff carries along
121	24	trajectories. Two contributions of dispersion
121	25	process are the relative dispersion (small
123	5	Relative dispersion ~ same as absolute
123	6	dispersion. At that point, the parent puff
123	10	way using absolute dispersion.
124	7	part of European short-range dispersion model
124	17	Lagrangian particle dispersion model (LPFM)
126	13	about yesterday – the early plume dispersion and
126	14	the mid-range plume dispersion, and the grid
127	22	order closure approach for plume dispersion and
136	9	modeling systems whether it’s dispersion, or
136	15	a dispersion model, simple photochemical box
138	7	with photochemical models. The dispersion model
147	12	source plume chemistry and dispersion?
147	16	and dispersion. Need many grid cells to assess
148	6	plume chemistry and dispersion without providing
151	9	treat chemistry and dispersion of point source
151	17	chemistry and dispersion. PM Source
160	11	time varying dispersion models (e.g., AERMOD,
161	10	performance of Met models coupled with dispersion

Page	Ref No.	Keyword = "dispersion"
161	24	Met models coupled with dispersion models vs.
162	22	terrain, short term puff dispersion, chemical
164	5	improvements in regional dispersion model
166	3	that the dispersion modeling domain is dominated
166	8	sources that use airport data, the dispersion
167	11	detailed dispersion models (AERMOD, CALPUFF, or
167	14	use of dispersion models that are based on
167	20	dispersion models should be reviewed by an expert
168	17	meteorological models to drive dispersion models.
180	4	output must be tested for each dispersion
189	6	location to get correct dispersion. Does not
190	19	really match the dispersion for that whole
190	21	matches the dispersion. It’s much closer to the
196	24	separately from dispersion model performance.
197	2	dispersion model to met database. Separately
197	7	dispersion model to different variables. Model

Page	Ref No.	Keyword = "domain"
23	25	extensively. We have domain wide statistics that
43	22	So I created a 12 km domain and ran CALMET just
71	23	now in the public domain. There are numerous
97	21	have to solve the entire domain.
129	22	modeling domain for the application and locations
133	7	shows the grid model domain.
134	15	This slide shows the modeling domain for the
134	17	can see it is a very large domain with a large
151	15	2002 database, 12/4 km domain with two-way nested
151	21	This is our CAMx 12/4 km domain nested
151	22	within ASIP 12 km CMAQ domain (one-way nesting).
159	23	you hear me? Okay. What is the minimum domain
166	3	that the dispersion modeling domain is dominated
166	7	the pollutant source domain. For most pollutant
166	9	model domain is going to be entirely dominated by
166	13	characteristics of the pollutant source domain.
182	12	sets. Public domain (data and conversion

Page	Ref No.	Keyword = "downwash"
85	25	with the PRIME downwash algorithms since it
88	23	of the model to deal with downwash that’s more
91	4	being considered downwash structures. In GEP
91	7	downwash structures. There seems to be some

Page	Ref No.	Keyword = "downwash"
188	19	building and downwash issues. Basically the main
189	11	Base Used to Develop Downwash Algorithms). Other
189	12	considerations are building downwash algorithms
189	14	buildings. Building downwash algorithms in

Page	Ref No.	Keyword = "downwind"
64	23	conc vs. downwind distance or wind speed, etc.
69	8	conditions as atmospheric stability or downwind
86	23	one was pretty much downwind from one of the
131	19	especially in Pennsylvania downwind of the
147	17	downwind impacts. High computer resource
148	3	fine grid over sources with coarser grid downwind
148	19	sources with coarser grids downwind where plumes
192	19	effect as you move further downwind becomes less.

Page	Ref No.	Keyword = "EPA"
8	10	transport (LRT) models used by the EPA.
8	24	that you can find on the EPA web site are done by
12	10	and then we’ve added additional EPA metrics, the
14	6	the 8th Modeling Conference – EPA recognized the
14	13	reflected in the EPA long range guidance.
17	6	to updating existing EPA LRT modeling guidance
17	18	200-300 km? At the 7th Modeling Conference, EPA’s
18	6	mentioned, back in 2006, EPA issued a Model
23	20	necessarily wed to EPA (inaudible) scheme but
35	17	EPA in 1997 despite using same raw meteorological
35	24	The two major differences from original EPA
37	19	Let me just mention where are we at from the EPA
39	8	Scire or EPA. There is guidance for grid spacing
41	5	memo distributed by EPA that specifically said
41	12	been recent studies conducted by EPA to document
41	16	that was supposedly issued by EPA that was
42	12	changes with the EPA or the FLM or the other two
43	5	to 1,000 meters and provide that to EPA, the FLMs
45	17	that EPA has issued memos or these tests have
46	6	and stay away from this EPA has demanded stuff.
47	19	or within EPA with our Office of Research and
48	5	EPA (inaudible) Office of Research and
48	17	work that we put forward as EPA in doing these
50	18	modeling division in ORD here at EPA. And as
61	17	basically did the development internally at EPA

Page	Ref No.	Keyword = "epa"
61	23	Tyler Fox: Just a side note we at EPA will
62	24	over to EPA, and also a brief comment on the
63	4	provided that database to EPA for AERMOD. And we
63	8	funding and working with EPA on that issue as
70	13	data, I would like somehow to make sure with EPA
70	16	so it would be nice for EPA to take ownership of
71	9	North Dakota, we found that the EPA model missed
91	14	To come up with the EPA guidance, I think it
93	20	the EPA regions have been tasked with providing
127	18	alternative model recommended by EPA on a case-
128	2	embedded in MAQSIP, the precursor to the U.S. EPA
128	18	developed: one including the EPA treatment of PM
129	6	PM treatment and the EPA PM treatment which is
135	2	COM; Parallelization Insights: David Wong, EPA;
148	14	SIPs, etc. and EPA has been developing stuff.
149	3	(for EPA/OAQPS)
156	8	for EPA. Basically Appendix W Guidance on
158	23	issues relating to aspects of the EPA’s Guideline
159	10	general concern that API has more EPA Guidance
159	12	have seen a lot of response from EPA even before
160	15	resolution. We’d like to see EPA reach out to
161	19	AQM. EPA should work with other agencies (DTRA,
162	25	that EPA modify the chemistry, based on API/AER
163	18	underway. EPA should lead the effort with
164	4	we knew all the things EPA is doing. Recent
164	6	performance measures have been made; EPA efforts
165	7	makers. EPA should investigate and possibly make
165	14	improvements and draft documents produced and EPA
165	22	Based on EPA guidance, EPA limits the
166	23	Ratio Model (PMVRM. We like for EPA to further
167	6	EPA has asked questions and asked for advice on
167	13	EPA should promote consistent and general
167	22	stakeholder communities. We’d like to see EPA
168	7	internal EPA and outside models) and of proposed
169	4	emphasize a couple of things. One is EPA
170	22	EPA guidance.
171	6	communicate to EPA some of the things we
171	20	going to challenge EPA here is that in the
180	5	model application; EPA needs to coordinate a
193	24	EPA research shows that the effect of upwind
194	13	EPA wind tunnel where they showed these terrain
200	9	quantified, and modeled based on EPA Reference
200	12	underway to propose more reliable methods. EPA
200	20	EPA had a PM10 surrogate policies for compliance
202	14	source types from EPA’s AP-42, SPECIATE, and FIRE

Page	Ref No.	Keyword = "epa"
202	17	factors. EPA demonstrates possible approach in
203	23	issues remain unresolved for PM2.5 – little EPA
205	9	EPA to pursue. Problems - few long-term monitors
205	18	intuitive results. EPA should investigate this
205	22	as is done with CALPUFF. EPA should develop a
206	12	Paine provided EPA (in October 2007) with several
206	16	Enhanced debugging output. EPA should make these
208	17	your needs. About EPA concerns about CALPUFF and
208	18	EPA controlling the model developing coding and
209	13	EPA concerns about CALPUFF are relatively
209	14	unfounded. EPA’s concern about near field
209	18	Substantial resources from EPA will be needed to
209	22	EPA doesn’t have direct control of CALPUFF and
209	23	there are some advantages to that. EPA does have
210	6	advancing CALPUFF and will work to that end. EPA
210	8	and there are some disadvantages. EPA has not
210	10	updates that EPA wants, but the developer is
210	11	willing to do this. As a result EPA says that
210	15	the EPA approval for the code. There are code
210	16	changes made without EPA oversight and funding
210	17	that requires EPA review. What is needed is for
210	18	EPA to review the code changes that are
210	20	EPA and TRC to keep the string going of improving
212	25	participated in all of the EPA modeling
213	10	guideline and how EPA interprets it and applies
213	14	EPA’s September 25th federal registry notice
213	17	that EPA is planning to make to the Modeling
214	2	EPA is planning. If EPA wants meaningful
214	6	made. It’s not sufficient for EPA to place a
214	10	meeting. Rather, EPA must publish notice of
214	19	outdated portion of the modeling guideline, EPA
214	23	lightly out of EPA. There are instances where it
214	25	Preceding this conference, EPA posted
215	5	to get approval for the use of non EPA preferred
215	6	models. EPA’s new procedures will uniformly make
215	8	preferred models or EPA developed models.
215	16	of comment, EPA has concluded in its guidance
216	6	UARG believes that the EPA’s recently posted
216	20	use of any models other than EPA preferred or EPA
216	24	EPA to use informal guidance documents to make
217	8	of changes to fix bugs and problems, both EPA
217	14	For years EPA has done an admirable job in
217	16	particular EPA has made timely fixes to their
217	19	founded fixes, EPA has a history of approving and
217	22	EPA review of implementation fixes for identified

Page	Ref No.	Keyword = "epa"
217	25	a year in EPA’s consideration and approval of
218	4	has identified in AERMOD. URAG encourages EPA to
218	25	a surrogate. But now with the EPA delegated
219	5	So we urge EPA to take the time and
220	3	5.U.S. EPA AQM models: lessons learned
220	9	are developed by the U.S. EPA (and contractors).
220	24	help and leadership. Does the U.S. EPA have a
222	17	compilers typically used by the U.S. EPA (using
222	18	EPA code for CMAQ and AERMOD). SlowSpotter™
224	9	Next Steps: U.S. EPA needs to show
224	24	sponsored or funded by the U.S. EPA. Further
225	6	development at the EPA and also the decision to

Page	Ref No.	Keyword = "ETA"
23	19	MM5 like ETA PBL and NOAH LSM. We’re not

Page	Ref No.	Keyword = "Federal"
40	17	distributed these results to the Federal Land
41	17	submitted to the Federal Land Managers?
119	3	part of his Ph.D thesis at the Swiss Federal
212	22	proceedings under the federal Clean Air Act.
213	14	EPA’s September 25th federal registry notice
213	24	the September 25 Federal Register notice provides
214	11	these proceedings in the Federal Register at

Page	Ref No.	Keyword = "fence line"
76	10	to the fence line being compared to
88	7	impacts on the fence line are three or four
146	9	talking about fence line impacts, we’re talking

Page	Ref No.	Keyword = "file"
56	17	file so it’s easily imported into EXCEL. Spatial
185	21	process already tested Grib ==> Grid ==> Text File
208	10	find it for you. I can’t open this file.
226	7	ways for extracting data from MM5 and WRF file

Page	Ref No.	Keyword = "files"
44	12	files at the same resolutions so I basically
101	3	Shape files, or Google Earth (kml), distribution:
195	23	get to the (inaudible) files and not to the
205	24	translate AERMOD conc. files to CALPUFF-like
205	25	files. TRC may have a draft code that can do

Page	Ref No.	Keyword = "FLEXPART"
20	22	called FLEXPART that’s widely distributed
22	17	CALPUFF, FLEXPART and HYSPLIT and basically, what
32	2	This is just a snap shot of the FLEXPART
33	2	of it. All three models CALPUFF, FLEXPART and
34	10	detected. So as you can see FLEXPART has a high
94	25	HYSPLIT, FLEXPART), Computational Fluid Dynamics
95	19	met model linked to FLEXPART. We are using it as
95	21	Lagrangian particle model called FLEXPART. We

Page	Ref No.	Keyword = "gridded"
51	16	an entire gridded data set. We’re just using
62	25	gridded met evaluation.
70	19	gridded meteorological data. It’s almost like a
70	22	analysis the gridded met data. There be may be
72	3	for the evaluation of the gridded met data. That
76	5	concentration of AERMOD across the gridded
101	11	to gridded meteorological data. Based on the
101	17	that a gridded meteorological model might be
114	17	gridded data so when we were doing later
130	17	gridded approach will typically overestimate
155	15	whether it’s a gridded wind field or (inaudible).
184	8	the gridded data and put it in a text format.
195	5	presentation about the use of gridded
196	23	Evaluate gridded meteorological data performance

Page	Ref No.	Keyword = "group"
51	19	this group will do and I’ll get into that in a
65	17	independent variable where we have group
65	24	each group. For example, the significant points
69	7	you do that is group them in regimes of similar
145	12	This is just another group of sources
146	14	more of a slide for another group since this

Page	Ref No.	Keyword = "group"
146	15	group knows the guidelines and the guidance.
149	16	Texas Group BART application. CAMx 36/12 km with
150	6	decided to do group analysis and run them in
180	6	stakeholder group to develop guidelines for
186	11	review group, enter comment areas, and offer
186	15	application group who are still at this meeting.
187	7	group here, myself and all of the people have
194	12	summaries by Snyder and some of the group at the
210	5	AWMA supports an independent work group for
212	17	Air Regulatory Group (UARG). UARG is an ad hoc
212	18	group of public and private electric utility

Page	Ref No.	Keyword = "groups"
54	3	simulations for other groups. One group, in
54	6	other groups doing it. We’re always trying to
54	9	analysis among different groups. And then it’s
139	8	single emissions sources or groups of emissions
140	6	contributions from emissions source groups,
146	8	source or groups of sources impacts. We’re not
150	7	groups of 10. In each group Bart analysis of 10
150	9	contributions of groups of Texas BART sources for
202	15	databases. Certain industry groups have also

Page	Ref No.	Keyword = "guidance"
8	14	evaluations and reflect that in our guidance.
8	16	the update of the IWAQM and Phase 2 guidance is
8	18	these evaluations to update that guidance.
14	13	reflected in the EPA long range guidance.
14	20	guidance which are not reflected in current
14	21	guidance. So we initiated this long range
17	6	to updating existing EPA LRT modeling guidance
17	9	From the guidance goals basically what we said
17	12	enhancements to model system in updated guidance
18	3	The next question is can guidance migrate to
39	8	Scire or EPA. There is guidance for grid spacing
46	12	interpretation of guidance or decision in a
85	22	of guidance or recommendations something from the
85	23	implementation guidance is the SEARCH tank.
87	8	in terms of providing better guidance. And how
87	25	as far as impacts go, with no clear guidance on
88	18	need to updated guidance or recommendations

Page	Ref No.	Keyword = "guidance"
91	5	guidance, there seems to be suggestions that you
91	14	To come up with the EPA guidance, I think it
91	16	guidance with limited understanding of issues.
91	25	conform guidance. Guidance to lead at a starting
92	5	guidance. So we need input from you all about
92	21	up with the type of guidance you need.
146	15	group knows the guidelines and the guidance.
156	8	for EPA. Basically Appendix W Guidance on
159	10	general concern that API has more EPA Guidance
165	22	Based on EPA guidance, EPA limits the
166	5	guidance is needed for translating the airport
166	11	We’d like to see better guidance for translating
168	12	Need to update and improve model guidance
169	5	guidance, it’s just that and sometimes it’s
169	10	But guidance is just that, guidance. Second
169	11	point is that guidance we provide is only as
169	15	issues here, guidance has to have a basis
170	14	type of guidance that is needed. Providing
170	15	guidance that is just complained about and
170	17	better together that we can provide guidance
170	22	EPA guidance.
188	15	some guidance on this. That’s all I have right
189	19	EBD guidance provided in Tikvart July 1994
190	5	procedure and more guidance needed. Roger
194	22	needed, update guidance on use of EBD in place of
198	22	precursors, modeling techniques – guidance,
200	22	Retrofit Technology implementation guidance, PM2.5
202	2	PM2.5 Regulations and Guidance – Unresolved
203	24	guidance, PSD increments and modeling procedures.
206	6	guidance provide further implementation guidance
207	19	artificially too low? Guidance needed on use of
214	20	is moving toward using informal guidance to try
214	22	today, I understand guidance does not come
215	2	on its web site several guidance memoranda that
215	9	For example, the August 13 guidance
215	16	of comment, EPA has concluded in its guidance
215	23	standards, the August 13th guidance document
216	7	guidance memoranda have placed unfair burdens on
216	15	The recent guidance document, (I apologize if I
216	24	EPA to use informal guidance documents to make
218	12	a decade but we still have very little guidance
218	21	permitting there’s no clear guidance on the
219	3	modeling and we still have no guidance on how to

Page	Ref No.	Keyword = "guide"
59	13	users guide included which we have gotten good
88	19	for…there’s a table in the ISC users guide and in
88	20	the AERMOD users guide in terms of defining
109	24	want to turn that on. Refer to the guide for
118	9	completely revised user’s guide with examples but
146	15	group knows the guidelines and the guidance.
147	7	Current guideline models have no (AERMOD) or
158	23	issues relating to aspects of the EPA’s Guideline
167	24	in the context of the guidelines, but it would be
171	12	guideline models was to take a model and
180	6	stakeholder group to develop guidelines for
207	21	Guideline on Air Quality Models is right, a calm
208	21	modeling for the guideline purposes require air
210	13	last users guide was released 2006. We have a
210	14	new users guide for Version 6 and all we need is
213	4	revisions of Appendix W Guideline. The Modeling
213	5	Guideline is used for several purposes, including
213	10	guideline and how EPA interprets it and applies
213	18	Guidelines to Appendix W. So our comments are
214	19	outdated portion of the modeling guideline, EPA
216	17	this), removes the Guideline’s promise of

Page	Ref No.	Keyword = "guideline"
147	7	Current guideline models have no (AERMOD) or
158	23	issues relating to aspects of the EPA’s Guideline
171	12	guideline models was to take a model and
207	21	Guideline on Air Quality Models is right, a calm
208	21	modeling for the guideline purposes require air
213	4	revisions of Appendix W Guideline. The Modeling
213	5	Guideline is used for several purposes, including
213	10	guideline and how EPA interprets it and applies
214	19	outdated portion of the modeling guideline, EPA
216	17	this), removes the Guideline’s promise of

Page	Ref No.	Keyword = "guidelines"
146	15	group knows the guidelines and the guidance.
167	24	in the context of the guidelines, but it would be
180	6	stakeholder group to develop guidelines for
213	18	Guidelines to Appendix W. So our comments are

Page	Ref No.	Keyword = "humidity"
173	20	4) Relative Humidity (surrogate for
174	5	surface relative humidity (RH). In reality,
197	14	structure, temperature & relative humidity,

Page	Ref No.	Keyword = "implement"
37	24	respect to the science and implementation within
85	23	implementation guidance is the SEARCH tank.
122	8	The way this is implemented into CALPUFF are
131	5	mercury in the model. The implementation of
139	11	have been implemented in photochemical models
140	16	CAMx has particulate apportionment implemented
141	8	apportionment that has been implemented in CAMx
145	23	Implementation Plans so they do have regulatory
156	25	implementation rules lacking in terms of
198	21	implementation, emission inventories – direct and
200	22	Retrofit Technology implementation guidance, PM2.5
200	23	NSR implementation rule, PM2.5 PSD SILs, SMCs, and
203	20	is necessary to implement reasonable PM2.5 impact
206	4	implementation guides but in the 2004 addendum –
206	6	guidance provide further implementation guidance
206	19	Issues with AERSURFACE implementation.
217	22	EPA review of implementation fixes for identified

Page	Ref No.	Keyword = "implementation"
37	24	respect to the science and implementation within
85	23	implementation guidance is the SEARCH tank.
131	5	mercury in the model. The implementation of
145	23	Implementation Plans so they do have regulatory
156	25	implementation rules lacking in terms of
198	21	implementation, emission inventories – direct and
200	22	Retrofit Technology implementation guidance, PM2.5
200	23	NSR implementation rule, PM2.5 PSD SILs, SMCs, and
206	4	implementation guides but in the 2004 addendum –
206	6	guidance provide further implementation guidance
206	19	Issues with AERSURFACE implementation.
217	22	EPA review of implementation fixes for identified

Page	Ref No.	Keyword = "ISC"
88	19	for…there’s a table in the ISC users guide and in
204	11	AERMOD. It does things ISC3 could never do. I

Page	Ref No.	Keyword = "IWAQM"
8	16	the update of the IWAQM and Phase 2 guidance is
14	8	significantly and the IWAQM Phase 2
19	18	IWAQM Phase 2 there’s talk about project MOHAVE
163	12	science approach as opposed to IWAQM mandates.
173	10	values. Outdated and prescriptive IWAQM
175	22	the IWAQM protocol, has a substantial bias

Page	Ref No.	Keyword = "Lagrangian"
20	19	did was to include the two Lagrangian particle
34	16	final ranking overall. This is the Lagrangian
94	24	SCIPUFF), Lagrangian Particle Models (KSP,
95	21	Lagrangian particle model called FLEXPART. We
97	3	Lagrangian Integrated Trajectory model. I try
97	16	lagrangian model. Basically the difference in
98	4	The lagrangian approach we’re computing the
100	11	modules use a hybrid Lagrangian-Eulerian
100	20	transport in a lagrangian framework. The
102	17	you’re running the lagrangian model for all the
102	24	that with Lagrangian plume model. From that
120	7	variability in dispersion rates, etc. Lagrangian
121	11	a full stochastic Lagrangian particle dispersion
124	17	Lagrangian particle dispersion model (LPFM)
208	24	We need a 3-D Lagrangian model for
211	14	make it a Lagrangian model. Another issue is

Page	Ref No.	Keyword = "layer"
31	6	ran a 43 vertical layer and I think I transpose
84	5	boundary layer enhancement is certainly helping
99	14	(surface layer) similarity, BL, Ri, or TKE. The
104	6	represent the boundary layer transport. It looks
104	8	varies with height in the boundary layer.
104	17	effect. That is a big thing for boundary layer
105	21	boundary layer as there is a lot more shear with
216	4	already takes 2 or 3 years. One more layer is

Page	Ref No.	Keyword = "layers"
31	7	my numbers so I think it was 43 layers instead of
118	6	map background layers for graphical display (pc);
150	18	w/ 6 CPUs, 19 Vertical Layers, M3Dry, CBM-

Page	Ref No.	Keyword = "long range transport"
6	8	Bret take his evaluation of Long Range Transport
7	3	long range transport models that we were looking
8	2	evaluation of long range transport models.
38	18	in these models and the long range transport
38	23	terms of addressing long range transport in the
93	3	introductory on the Long Range Transport

Page	Ref No.	Keyword = "mesoscale"
8	4	mesoscale tracer studies but there is no one
21	14	the Great Plains Mesoscale Tracer Experiment.
163	17	is much current mesoscale and regional modeling
168	18	Conduct a Mesoscale/Regional collaborative model

Page	Ref No.	Keyword = "met"
6	21	talk about the methods and metrics that were used
6	25	explanation of the methodology that we were
7	25	meteorological and tracer databases for
8	6	was to assemble an archive of both meteorological
8	9	objective method for evaluating long range
8	19	There were several methods I think I’m a
9	4	I called them the Irwin methodology. They focus
9	6	were the methods that were used for that
9	7	particular study. That was one method we used to
9	10	In addition to the Irwin methodology, we did
9	14	methodology and kind of how I have it broken out
10	5	maximum concentrations on that arch. That method
12	8	Then for spatial statistics the metric
12	10	and then we’ve added additional EPA metrics, the
12	14	on the NOAA webs site introduced a final metric
13	22	study. That is the evaluation methodology used
14	25	meteorological database for use with LRT model
15	4	we have an archive of the meteorology so we’ll
16	12	meteorological you supply it with. So another
16	18	with meteorology. So that’s going to be the

Page	Ref No.	Keyword = "met"
16	20	both meteorological aspects of it and the LRT
16	23	and testing the meteorological LRT models for the
16	25	you’re exercising and testing meteorological and
17	4	measures and results from meteorological and LRT
18	13	to supply meteorological data to CALPUFF? As you
18	18	see how best to apply the meteorology to it
18	20	in CALMET. Perhaps Hybrid method verses NOOB = 1
21	2	to take the meteorological data from MM5 and
21	10	were the different methods the evaluation
21	11	methods.
22	2	the (inaudible) meteorology because this
22	10	750 meters up in the air and the height in the
22	18	we did with CALMET meteorology we looked at
24	5	use for meteorological model evaluation.
24	7	and these are from the Irwin methodology and want
27	11	Euro methodologies. As you can see, this is
28	24	meteorological perspective you don’t want to be
31	25	same meteorological data.
35	17	EPA in 1997 despite using same raw meteorological
36	8	meteorology is supplied to the model. Joe
37	8	meteorological metrics and the LRT metrics. The
42	19	meter resolution. The reason I didn’t sign off
43	5	to 1,000 meters and provide that to EPA, the FLMs
44	13	flattened the terrain so that is was 1 meter
47	8	appropriate evaluation methods. The focus and
47	12	the emissions meterology and underlying modeling
50	11	mentioned its one thing to talk about methods and
50	25	modules. One that focuses on meteorology in this
51	13	to compare observations against meteorological
51	23	essentially the meteorology works the same with
52	19	statistical metrics. Diurnal Statistics, Time
52	25	type of analysis. The difference with the met
53	4	the MM5 or WRF and here it’s a meta data set that
53	21	sites, you can do it by pretty much any met data
54	12	available on the met side and I’ll show some
54	13	examples of these. There’s a met model
54	18	to the met side includes Rawindsonde, Wind
54	22	met side. You see here this one is for
55	2	performance summary statistics, metric across
55	13	pretty much any meteorological metric you have
57	8	showed on the met side. Implied statistics
58	7	metrics are some Bugle Plots where it includes
59	2	can be used outside of data met. There are
59	7	plots or use these plots outside of the met
59	11	This a script based version both the Met and AQ

Page	Ref No.	Keyword = "met"
59	19	the Met and AQ versions separately. Includes
60	13	what met data you put in you can use as a query
62	25	gridded met evaluation.
63	22	number of meteorological conditions and seasons,
66	19	Method would be use of the RHC statistic, re-
67	14	the features of the Cox-Tikvart method.
68	2	Some of the performance metrics in the BOOT
70	19	gridded meteorological data. It’s almost like a
70	21	meteorological tower. We need to thoroughly
70	22	analysis the gridded met data. There be may be
70	23	situations with poor met performance (e.g.,
71	3	meteorological data.
71	11	dispersion. The use of better meteorology got
71	21	example private industrial met towers for which
72	3	for the evaluation of the gridded met data. That
72	8	typical Cox/Tixvart evaluation methods that are
75	13	and the SEARCH met data. The model seemed to be
76	15	which would be typical of a met tower at an
78	16	compared with met SEARCH site and airport site to
81	17	process SEARCH met data as more representative of
81	20	Ozone Limiting Method to better account for NO to
83	12	AERSURFACE pretty high roughness about 0.8 meters
83	13	0.7 meters verses concentration process with the
83	20	But interestingly enough the met data that
84	23	met data resulted in selection of another nearby
85	15	up. The monitor was kind of within 100 meters
86	11	different met data and different source
86	18	Hybrid met data about 5.96 so we’re getting
90	11	metric concentration really captured the plume
95	19	met model linked to FLEXPART. We are using it as
97	11	method; how to simulate plume dispersion, how to
98	21	calculations in the meteorology for each source.
99	3	The meteorology is external and its offline and
99	8	As far as getting the meteorology from
99	25	simultaneous meteorology and concentration grids.
100	8	As far as meteorology we support latitude-
100	10	the meteorology. Now the non-linear chemistry
101	11	to gridded meteorological data. Based on the
101	13	could do a better job using meteorological data
101	17	that a gridded meteorological model might be
101	19	you have on site meteorology. But for these
103	15	It goes back to a 1935 meteorology book and it a
105	17	hybrid method always puts the particle in the
109	23	method which goes back to the Models-3 if you
111	3	boundaries and the meteorological model has

Page	Ref No.	Keyword = "met"
111	14	micrograms per cubic meter, contributed from that
114	14	one of them had different meteorological data
114	23	have a consistent meteorological database that is
114	24	available and we can use modeling methods and we
115	4	that are consistent using the same meteorology.
115	10	months or 2 years worth like in METREX. So
116	13	METREX (t1)
116	18	METREX (t2)
118	7	model physics ensemble (pc/unix); meteorology and
120	4	meteorological and dispersion conditions,
136	11	will use the same emissions input, meteorological
137	10	chemistry and transport and meteorology inputs to
142	6	Just comparing that back to a very simple metric
142	8	screening metric states they obviously agree with
144	4	meteorology output from MM5. CALPUFF was run in
145	18	Apportionment methodology. These models have the
148	7	met and emission inputs and full chemistry Plume-
148	20	are larger. Interpolate meteorology, emissions
152	5	point sources and circles are (inaudible) method
156	13	conference is to introduce these types of methods
159	22	meteorological data and land use variations. Can
160	8	of meteorological drivers (e.g., diagnostic
160	12	CALPUFF, CMAQ). Prognostic meteorological models
160	17	this including DTRA and NOAA who have linked MET
160	21	needed is to optimize use of Met model and CALMET
160	24	physics Met models (e.g. MM5) and CALMET; look at
161	4	different topographic and meteorological
161	10	performance of Met models coupled with dispersion
161	12	new field experiments to determine how met
161	14	Met models? (e.g. note differences between NCAR
161	15	and Penn State MM5 Met model data assimilation
161	16	methods). We’d like to assess if CALMET (or any
161	18	intermediate step between the Met model and the
161	20	NOAA) who have operational Met model-AQM systems
161	24	Met models coupled with dispersion models vs.
162	2	experiments. Determine how met observations can
162	3	best be used and assimilated in Met models? (e.g.
162	5	Met model data assimilation methods). Assess if
162	7	as an intermediate step between the Met model and
162	10	operational Met model-AQM systems operating and
163	5	heavily on default values. Need to resolve met
163	6	input questions (CALMET or Met model such as MM5
163	7	– see previous slides on Met inputs). Need to
163	15	of Met models and air quality models in
163	20	and stakeholders. Include meteorological

Page	Ref No.	Keyword = "met"
163	23	km by 200 km, sufficient to test the use of Met
164	20	priority performance methods.
164	21	The bootstrap method was talked about this
166	16	output should summarize the processed met data so
167	15	physical understanding of meteorological
168	17	meteorological models to drive dispersion models.
172	18	peer-reviewed science and methodology over
173	11	methodology is required for model
179	25	include the widespread use of meteorological
180	7	the use of meteorological models in air
180	10	needs to address are: Which meteorological
180	12	should meteorological monitoring sites be
180	14	criteria? Meteorological model accuracy is
180	25	meteorological input in AERMOD and AERMET.
181	4	meteorolgical input into AERMOD. So that’s
184	7	You know I’ve got a method that I can extract
186	9	so called AB3 Committee of meteorological and
187	15	meteorology inputs. I know you can read but
190	2	location is also a variable and new methods may
191	14	for the input. That’s 17 meter high building, H
192	6	the five sources. 1 year met data kind of a
193	5	shapes. 39 meters high, 1 to 1 and 1 to 4. The
194	6	A method should be developed to determine when
194	8	We’re saying that a method should be
194	24	the corner vortex situation. Develop method for
195	6	meterological data on the air quality model which
195	10	model options and Metric for evaluating success.
196	16	Meteorological evaluation software is very close
196	20	The other thing is producing met data sets
196	23	Evaluate gridded meteorological data performance
197	2	dispersion model to met database. Separately
197	11	Evaluate all meteorological variables. Wind
198	9	observed met results. Evaluate results under
200	10	Method 5. Existing reference methods for
200	12	underway to propose more reliable methods. EPA
200	14	measurement methods – sulfates can be
202	22	factors are based on stack test methods known to
206	23	mismatch in surface type between met tower and
207	8	for met and application site surface
207	20	recent met data. If my interpretation of the
211	7	method to define precisely when complex winds
226	22	profiles with data collected on met towers. And

Page	Ref No.	Keyword = "meteorological"
7	25	meteorological and tracer databases for
8	6	was to assemble an archive of both meteorological
14	25	meteorological database for use with LRT model
16	12	meteorological you supply it with. So another
16	20	both meteorological aspects of it and the LRT
16	23	and testing the meteorological LRT models for the
16	25	you’re exercising and testing meteorological and
17	4	measures and results from meteorological and LRT
18	13	to supply meteorological data to CALPUFF? As you
21	2	to take the meteorological data from MM5 and
24	5	use for meteorological model evaluation.
28	24	meteorological perspective you don’t want to be
31	25	same meteorological data.
35	17	EPA in 1997 despite using same raw meteorological
37	8	meteorological metrics and the LRT metrics. The
51	13	to compare observations against meteorological
55	13	pretty much any meteorological metric you have
63	22	number of meteorological conditions and seasons,
70	19	gridded meteorological data. It’s almost like a
70	21	meteorological tower. We need to thoroughly
71	3	meteorological data.
101	11	to gridded meteorological data. Based on the
101	13	could do a better job using meteorological data
101	17	that a gridded meteorological model might be
111	3	boundaries and the meteorological model has
114	14	one of them had different meteorological data
114	23	have a consistent meteorological database that is
120	4	meteorological and dispersion conditions,
136	11	will use the same emissions input, meteorological
159	22	meteorological data and land use variations. Can
160	8	of meteorological drivers (e.g., diagnostic
160	12	CALPUFF, CMAQ). Prognostic meteorological models
161	4	different topographic and meteorological
163	20	and stakeholders. Include meteorological
167	15	physical understanding of meteorological
168	17	meteorological models to drive dispersion models.
179	25	include the widespread use of meteorological
180	7	the use of meteorological models in air
180	10	needs to address are: Which meteorological
180	12	should meteorological monitoring sites be
180	14	criteria? Meteorological model accuracy is
180	25	meteorological input in AERMOD and AERMET.
186	9	so called AB3 Committee of meteorological and
196	16	Meteorological evaluation software is very close
196	23	Evaluate gridded meteorological data performance

Page	Ref No.	Keyword = "meteorological"
197	11	Evaluate all meteorological variables. Wind

Page	Ref No.	Keyword = "mixing"
36	22	at puff-splitting (eliminating mixing height
55	12	mixing ratio, wind speed, wind direction, but
99	13	next thing is vertical mixing based upon SL
99	15	horizontal mixing based upon velocity
99	16	deformation, SL similarity, or TKE. Mixing
101	10	(on/off) mixing. Later we basically we switched
205	12	Nocturnal urban mixing height (Ziu) is a

Page	Ref No.	Keyword = "MM5"
15	5	have the MM5 data that was run up there and have
21	2	to take the meteorological data from MM5 and
22	7	MM5 simulation performed with this. What you can
22	21	gave yesterday, we also included the MM5 CALPUFF
23	16	This is the MM5 configuration and I'll skip
23	19	MM5 like ETA PBL and NOAH LSM. We're not
23	23	validate the MM5 data and that's something we
24	11	Both put in MM5 CALPUFF within the CALMET one
25	16	better than the MM5 winds in terms of the arrival
25	18	(inaudible) it. The MM5 had a slight delay of
26	6	good job. MM5 is (inaudible) arrived late and
27	2	is that when we were feeding the MM5 only winds
27	12	where the MM5 winds did markedly better than
27	16	where it should have been and the MM5 was like
27	20	the MM5 winds were doing slightly better, but you
27	21	can see the MM5 winds have it displaced more
28	6	to what the MM5 was looking at like the MM5 was a
28	8	encouraging sign for the MM5 CALPUFF.
29	12	For the MM5 CALPUFF, as you can see, it
31	3	MM5 is run again and was initialized with
31	20	with the MM5 and there's no CALMET in this
31	21	simulation. It's only MM5 CALPUFF so basically
31	23	help with (inaudible) MM5. Basically we're
35	13	MM5 results were better for azimuth, but worse
50	22	and MM5 but it can be extended to other
51	2	case typically MM5 or WRF and one focuses on air
51	14	(e.g. MM5, WRF) or air quality model (e.g. CMAQ,
53	4	the MM5 or WRF and here it's a meta data set that
70	20	new concept do we trust MM5 data instead of a

Page	Ref No.	Keyword = "mm5"
95	18	is (sorry) and about fire emissions model and MM5
99	10	ECMWF, RAMS, MM5, NMM, GFS and so on. It's not
144	4	meteorology output from MM5. CALPUFF was run in
147	20	Databases more costly to develop. MM5/WRF
156	3	wind fields that come out of MM5.
160	10	models such as MM5) for both steady state and
160	13	such as MM5 and WRF (often called 'Met models')
160	18	models with MM5 and WRF and the Puff models.
160	24	physics Met models (e.g. MM5) and CALMET; look at
161	5	settings; minimum grid size (Penn State MM5
161	15	and Penn State MM5 Met model data assimilation
162	4	note differences between NCAR and Penn State MM5
163	6	input questions (CALMET or Met model such as MM5
163	24	model (e.g., MM5) direct input versus CALMET
180	3	requires: The accuracy of MM5/CALMET model
195	13	a converter for MM5 and one of the things was
195	19	the use to concert MM5 data and WRF and
196	14	output of MM5 converted to wind rose software.
197	22	The reason why the MM5 simulations can't deal
226	7	ways for extracting data from MM5 and WRF file

Page	Ref No.	Keyword = "model"
6	12	model evaluation session right after that.
7	10	modeling so we use non steady state (inaudible)
7	11	puff model, particle model for these types of
7	14	visibility (inaudible) modeling. As such as Joe
7	19	and time considerations of the LRT model use. As
9	12	upon spatiotemporal comparisons of model-
9	20	the model's ability to correctly predict the
11	8	the model is doing. This is just an example on
12	2	distributions of the model predictions. So this
12	15	which is basically a model success story, a model
12	18	model score to see how well it did across each of
12	20	This is just the model ranking and you can
13	2	allows to give you an idea how the model performs
13	4	for direct modeling or comparison because you
13	10	particle model that we evaluated as part of this
13	12	model; this is a European tracer experiment and I
13	18	correlation of bias and the final model rating
13	21	the model performed in that particular tracer
14	6	the 8th Modeling Conference – EPA recognized the
14	7	fact that CALPUFF model science had evolved
14	17	need to form an updated model performance

Page	Ref No.	Keyword = "model"
14	19	model which are not mentioned in the current
14	22	modeling project and they said we are performing
14	25	meteorological database for use with LRT model
16	9	point yesterday about you know this is a modeling
16	11	model can only perform as well as the
16	16	at it as a coupled system. The model’s ability
16	21	model aspects of it.
17	3	provide full documentation of model evaluation
17	6	to updating existing EPA LRT modeling guidance
17	11	modeling system to incorporate recent
17	12	enhancements to model system in updated guidance
17	15	8th Modeling Conference that talk about these
17	18	200-300 km? At the 7th Modeling Conference, EPA’s
18	6	mentioned, back in 2006, EPA issued a Model
18	14	know, it is like any other transport model and it
20	8	is how well any model can do in any one of these
20	9	situations. It isn’t fair to isolate one model
20	16	understand how well can any model reasonably do
21	3	apply to this model.
21	8	understand how any model can reasonably do under
22	3	influences the performance of the model.
22	16	the model experimental design was to look at
24	5	use for meteorological model evaluation.
30	11	develop a database which could be used for model
31	14	shows how well one model does and how bad one
34	3	the model observed it had the best of spatial
34	17	part of the model it didn’t do much better in
36	8	meteorology is supplied to the model. Joe
36	10	how you apply the model and that’s one of the
36	24	not augment model performance. We had puffs
37	6	work-in-progress. We have a model evaluation
37	11	engage with model developer to help us understand
37	13	model setup? What can we do better?
37	14	Has the model changed since the previous
37	25	the model and will fully document that. What we
38	3	this is to conduct a peer review of the model and
39	16	factors that can influence how the model responds
47	3	Going back to the 8th Modeling Conference, we
47	10	in the modeling system understanding that
47	11	emphasis on modeling systems, recognizing that
47	12	the emissions meterology and underlying modeling
48	3	for model evaluation. This one refers to the
48	4	community multi scale air quality model from the
48	6	Development. Basically you’re looking at a model
49	11	standpoint and the model standpoint to see

Page	Ref No.	Keyword = "model"
49	18	sure we feed that back in to the model. This
50	14	to deliver the atmospheric model evaluation tool
50	18	modeling division in ORD here at EPA. And as
50	24	Model Evaluation Tool (AMET) consists of two
51	14	(e.g. MM5, WRF) or air quality model (e.g. CMAQ,
51	17	paired model observation sets which are actually
51	25	observations and then model output. These are
52	8	jus populating the database with model
52	16	will get in to some of those. For example, model
53	3	different set of model output. Instead here of
54	13	examples of these. There’s a met model
54	20	This is an example of a model performance
54	25	plots and statistics scatter plot, model
55	4	showing the distribution of the model. This is a
56	15	model observation, model to model, summary
57	2	included model to model (inaudible) single
57	11	model observed, the bias between the model
57	15	also include another model data so you could
57	16	compare two model runs and see how they compare.
57	23	comparing with the model like CMAQ. But it shows
58	13	have any set of model predictions in time and
58	17	using CMAQ or CMAx or a model like that, if you
58	19	that includes a model of and some space and time
61	24	be continuing to develope model evaluation tools
62	16	for short range modeling evaluations the somewhat
65	11	indicate where it’s closer to this model. In the
65	14	Other types of tools are the plotted model
66	2	98th percentiles. A good model should have no
66	3	trend in model residuals.
66	4	This is a poor model example where you can
66	7	see that, you see the model has some bias due to
66	10	model does have a possible problem. These are
66	16	of zero is a perfect model, while an FB of +/-
66	24	averaging times. The model comparison measure
67	9	the lower the score, the better the model. If
67	10	the the model comparison measure straddles zero,
67	21	within Atmospheric Dispersion Modelling for
67	22	Regulatory Purposes – Model Validation Kit. It is
68	12	is on the Y-AXIS, so a perfect model is as low as
69	2	ensemble, while model predictions often represent
70	25	dispersion modeling are how often are the winds
71	9	North Dakota, we found that the EPA model missed
72	22	the model in a more robust evaluation. This is
73	14	model performance to increase in the future and
73	18	regulatory model evaluation this is prairie grass

Page	Ref No.	Keyword = "model"
74	23	But also learn ourselves how the model performs
75	3	undertaking soon to evaluate model performance
75	13	and the SEARCH met data. The model seemed to be
75	18	series plot running the model with the airport
78	6	but the model concentration with that data
79	18	the SEARCH site that's matched with the model
80	14	there a problem with the model that these light
81	3	roadways were modeled as links and minor roadways
81	5	distributed so the initial model-to-monitor
81	15	We did a broader assessment of modeling
82	4	light duty vehicles they are being modeled as
82	8	were on the same scale. This is sort of model to
82	11	concentration and the lighter blue is the model
82	20	this is the model comparison after I think the
83	7	modeled multiple sources again that's majority
83	9	Q-Q plot of modeled concentrations using SEARCH.
84	12	little bit more focused on that. This a model
85	7	The other thing is the sensitivity of model
85	19	at different ways to model it there's an area
86	3	model tanks maybe series non buoyant point
87	3	opportunities to learn about the model. They are
87	6	limitations of the model are and the
87	9	to apply the model and we also want to do is
87	10	build on what Bret is doing in model performance.
87	15	any questions as it relates to the model
87	20	you have but the storage tanks have been modeled
88	2	how we should really be modeleing these. One is
88	13	modeling storage tanks.
88	23	of the model to deal with downwash that's more
89	12	woefully inadequate in evaluating the model in
91	12	yesterday, and I'll plug the Model Clearinghouse
93	6	Model and then we'll take some Q&A soon after
93	12	modeling community. In the modeling community as
93	21	emergency response support for air modeling in
93	24	In the emergency response modeling community
94	2	class of modeling technology that is new to us.
94	5	modeling community. That is one area where we
94	9	of CALPUFF modeling you know we've also seen a
95	18	is (sorry) and about fire emissions model and MM5
95	19	met model linked to FLEXPART. We are using it as
95	21	Lagrangian particle model called FLEXPART. We
97	3	Lagrangian Integrated Trajectory model. I try
97	9	to use the model.
97	16	lagrangian model. Basically the difference in
99	4	that means someone else provided this. The model

Page	Ref No.	Keyword = "model"
99	20	Modelled particle distributions (puffs) can
99	22	modeling air concentrations, it is from
100	7	and switch to the global model.
100	16	ozone model, CD4, and we’ve got a mercury module.
101	6	changes in the model. It’s not that new we
101	9	model used was rawinsonde data with day/night
101	17	that a gridded meteorological model might be
102	12	in-plume model. Essentially a subroutine for
102	17	you’re running the lagrangian model for all the
102	22	reasonable to look at an Eulerian model to
102	24	that with Lagrangian plume model. From that
103	4	transferred to the Eulerian model.
104	23	3D-particle model with just the mean motion. We
105	5	approach where we’re not modeling the individual
105	6	particles, but we’re modeling how that particle
106	21	modeling the distribution, it could either be a
107	20	the model. That’s the particle approach.
108	5	deviation, the made as modeling the puff if you
108	24	running the 3D particle model the change in
110	10	model and what you see here is the particle
111	3	boundaries and the meteorological model has
112	24	essentially, the model didn’t show a lot of bias
113	12	model what my overall results will be.
114	4	the perfect model would give us a rank of 4.0.
114	22	can use it in the model. So all of a sudden we
114	24	available and we can use modeling methods and we
115	6	you find changing dispersion in the model and
117	15	the model is .97 correlation coefficient and the
118	2	will have the integrated global model for
118	7	model physics ensemble (pc/unix); meteorology and
118	17	overview of puff particle model.
118	19	about the particle puff model the PPM module
118	24	describe the model and a little bit of history
119	16	purpose of the PPM the puff particle model is to
120	14	If you look at the Puff model types there
120	23	cluster dispersion puff model where a puff is a
121	12	model to determine the puff trajectory. I’ll
123	11	Peter evaluated the model of several
124	7	part of European short-range dispersion model
124	17	Lagrangian particle dispersion model (LPFM)
125	2	current version of the model. You can turn the
125	9	Modeling. We’ll start with presentation from
125	15	plume–in-grid modeling, which basically consists
125	16	of using a plume model within a grid model to
125	23	If you look at a grid model with a resolution of

Page	Ref No.	Keyword = "model"
126	6	in-grid model is to combine the plume model and
126	7	the grid model and carry the plume along until it
126	11	trying to do with the plume–in-grid model is to
126	15	model cannot predict these two stages correctly.
126	17	plume to the grid model.
126	18	So, like I mentioned earlier, the model
126	19	consists of a reactive plume model embedded
126	20	within a 3-D grid model. The plume model
126	22	model provides background concentrations to the
126	23	plume model. At the time we hand over the plume
126	24	model to the grid model, the grid model
127	2	feedback between the host grid model and the
127	3	plume model.
127	4	Plume-in-grid modeling is not new; it began in
127	12	of-the-science PiG model for ozone was initiated
127	14	The embedded plume Model is SCICHEM (state-of-
127	18	alternative model recommended by EPA on a case-
127	21	three-dimensional puff-based model, with second-
128	3	Model, CMAQ. In 2000, AER incorporated SCICHEM
128	4	into CMAQ. The model is called CMAQ-APT
128	6	The early applications of the model were for
128	10	July 1995. We also applied the model to Central
128	15	the base model.
128	21	developed by AER. MADRID is the Model of Aerosol
128	25	the plume-in-grid model, it is based on CMAQ 4.6,
129	11	designed to supplement RPO modeling being
129	17	plume-in-grid approach. Model performance
129	22	modeling domain for the application and locations
130	9	model and 2.4 μg/m3 for the plume-in- grid model.
130	20	overestimated. Plume-in-grid PM modeling
131	5	mercury in the model. The implementation of
131	15	grid model on the left hand side and the change
131	18	model overpredicted mercury deposition,
132	11	of these species. Traditional modeling
132	16	Fluid Mech.). The model simulates near-source CO
133	7	shows the grid model domain.
133	10	model results compared with CO concentration
133	13	The challenge with P-in-G modeling is that it
133	16	model – computational requirements increase by a
134	7	going project to apply the model to the central
134	15	This slide shows the modeling domain for the
134	20	parallel version of the model.
134	25	Inc.; Collaboration in Model Development: L-3
136	3	little bit about photochemical modeling and in
136	6	source modeling and tracking that type of thing.

Page	Ref No.	Keyword = "model"
136	9	modeling systems whether it’s dispersion, or
136	10	photochemical grid model system. Essentially you
136	13	model.
136	14	Generally speaking the model started off as
136	15	a dispersion model, simple photochemical box
136	24	modeling system approach where we are trying to
137	2	PM in the same modeling system. An example
138	11	universe (inaudible) into one universe model.
138	17	the things in using a photochemical model for
140	9	model species for each contributing source.
140	22	additional model species. Just put in those
140	24	duplicate model species. And goes with the same
141	2	species do in the photochemical model. The only
142	10	on with the photochemical model because it’s
143	14	through a photochemical model and that’s just an
143	21	single source modeling with CAMx PSAT to compare
143	23	States did single source visibility modeling for
144	2	short the (inaudible) modeling just try to apply
145	9	the photochemical model really not a lot of
145	17	for credible single source modeling with Source
146	4	modeling for Ozone and PM.
147	21	applications. SMOKE or other emissions model
147	24	There has been a lot of development in modeling
148	13	PGM Databases and model set ups. RPOs, AIRPACT,
148	24	model (just specify where fine grid domains are
149	8	very little. Whereas in a grid model you dump
149	11	the Plume in Grid model.
149	24	Southeast (ASIP). Annual PM2.5 SIP modeling for
150	11	2002 36 km modeling CAMx database. Add 12 km
150	15	model a part of VISTAS ASIP. Here’s a 36 km: 148
151	8	modeling. 12 km grid cell size too coarse to
151	23	CAMx 12/4 modeling using two-way interactive grid
151	24	nesting. 2002 base case using standard model.
152	8	are located close to the grid model to the
152	11	(inaudible) for that other model CALPUFF.
153	10	it’s not above 15. Here’s 1 µg for this model.
153	19	have developed a Conceptual Model for PM2.5
153	23	12/4/1 km PiG modeling attributes 3.4 µg/m3 to
154	8	modules. The use PGM modeling to assess “single
154	13	BART assessment. PM2.5 SIP modeling.
154	22	modules. The use of PGM modeling, to assess
155	3	Arkansas BART assessment. PM2.5 SIP modeling.
156	9	modeling single source for Ozone PM2.5 seems to
158	22	regional modeling. These comments cover many
160	2	recommendation for Plume in Grid (PinG) modeling?

Page	Ref No.	Keyword = "model"
160	21	needed is to optimize use of Met model and CALMET
160	22	model predictions with observations. Specific
161	8	is due to physical assumptions in the model).
161	9	We'd like to see overall model
161	15	and Penn State MM5 Met model data assimilation
161	17	diagnostic model) is truly needed as an
161	18	intermediate step between the Met model and the
161	20	NOAA) who have operational Met model-AQM systems
161	23	Determine overall model performance of
162	5	Met model data assimilation methods). Assess if
162	6	CALMET (or any diagnostic model) is truly needed
162	7	as an intermediate step between the Met model and
162	10	operational Met model-AQM systems operating and
162	16	We see a need for an overall model
162	18	very limited evaluations of the model in the mode
163	6	input questions (CALMET or Met model such as MM5
163	17	is much current mesoscale and regional modeling
163	24	model (e.g., MM5) direct input versus CALMET
163	25	diagnostic model.
164	2	I'd like to switch to model evaluation
164	5	improvements in regional dispersion model
164	13	measures for the different model scales, a
164	15	be devised for use at all model scales. I
164	25	with the BOOT software. We think the model
165	3	modeling protocols and decision making. We also
165	4	believe uncertainty in model predictions (also
165	8	use of the probabilistic AQM system (Met model –
165	10	We understand the screening model,
166	3	that the dispersion modeling domain is dominated
166	9	model domain is going to be entirely dominated by
166	10	the surface modeling of the airport roughness.
166	19	modeling purposes (>90% available). We'd like to
166	23	Ratio Model (PMVRM. We like for EPA to further
166	24	test this model and, if acceptable, recommend the
166	25	use of this model for predicting NO2
168	8	modifications to model algorithms. Model
168	10	discussions with the entire community of model
168	12	Need to update and improve model guidance
168	18	Conduct a Mesoscale/Regional collaborative model
169	3	ASIP modeling and the like. I just want to
170	2	region and state and local modeling.
170	25	quality modeling for regional analysis for
171	17	that evaluation, we could use the model in
171	25	said the model has not been evaluated to a
172	3	that's the way we're using the model and

Page	Ref No.	Keyword = "model"
172	15	Air quality modeling approach is: “Use
172	24	AQRV modeling approach is to develop a
173	7	of a robust model performance evaluation in
173	8	a full chemistry mode. Indication of model
173	11	methodology is required for model
175	11	really the only model verification that has
175	14	conditions were included model agreement was
175	19	requiring that the model should be used.
175	21	indication that the as CALPUFF Model using
176	15	In this context, the model is not
177	7	that the model is performing correctly.
177	15	model is saying it is playing a very
177	17	really doing a very good job of model
177	23	different picture than what the model is
177	24	saying. This has become a political model
177	25	and the public is believing the model. This
178	16	the model is being used is not realistic.
179	5	little change. Again, the model doesn’t
179	10	comprehensive model evaluation of CALPUFF in
179	11	a full chemistry model. Without a doubt
179	13	done with this model.
180	2	model output in air quality modeling
180	3	requires: The accuracy of MM5/CALMET model
180	5	model application; EPA needs to coordinate a
180	9	Topics that the modeling community
180	11	model should be used? Grid size? How
180	13	included in modeling? Model performance
180	14	criteria? Meteorological model accuracy is
180	16	model results used in an air quality
183	12	the model. Again it was more of a mechanical
186	10	modeling. I’m going to introduce the AB3 model
186	14	staff member from 1978 and 1979 from the model
186	20	Complex (ISC)] model. I’m not sure if that is
187	4	goal of best model performance built on best
190	12	wind residential tower to go in to the model.
191	13	that chart represents what the model BPIP gave
195	6	meterological data on the air quality model which
195	10	model options and Metric for evaluating success.
196	7	out of the prognostic model. Although they do
196	24	separately from dispersion model performance.
197	2	dispersion model to met database. Separately
197	4	parameter. Sensitivity of prognostic model
197	7	dispersion model to different variables. Model
198	22	precursors, modeling techniques – guidance,
200	2	for visibility modeling because each of these

Page	Ref No.	Keyword = "model"
200	9	quantified, and modeled based on EPA Reference
200	21	modeling that are still in effect, Best Available
200	25	pending), and the PSD increment modeling
201	3	So let’s talk about modeling Primary vs.
201	9	Secondary PM2.5 could be modeled with CALPUFF.
201	12	unbiased model to take modeling credit? Are we
202	4	modeling for short-range applications? Include
202	5	secondary PM2.5 modeling for long-range
202	25	Example Modeling Challenge: Compute Total
203	12	To summarize: PM2.5 modeling in a regulatory
203	15	Emissions measurement and modeling techniques
203	17	can be much higher than modeled concentrations.
203	19	for refined modeling approaches. Collaboration
203	24	guidance, PSD increments and modeling procedures.
204	13	The Low wind speed issues. Modeling of
204	14	roadways for NO2 and PM. Problems with modeling
205	7	studies and adjustments to AERMOD modeling
206	20	Sensitivity of modeling to surface
207	6	2008 Annual Meeting on sensitivity modeling. We
208	18	EPA controlling the model developing coding and
208	21	modeling for the guideline purposes require air
208	24	We need a 3-D Lagrangian model for
209	4	demonstrated. CALPUFF is a model with community
210	2	provide for advancement in this model. The
210	21	the model.
211	8	occur and require PUFF modeling. We’ll be
211	10	modeling and a better definition of complex
211	14	make it a Lagrangian model. Another issue is
212	5	will be conducting a modeling conference in
212	6	Toronto this Spring on Canadian modeling issues.
212	7	There will be 2 modeling conferences next year.
212	25	participated in all of the EPA modeling
213	4	revisions of Appendix W Guideline. The Modeling
213	17	that EPA is planning to make to the Modeling
214	19	outdated portion of the modeling guideline, EPA
215	17	document that a modeling system like CALPUFF,
215	25	Model Clearinghouse process. A drill that is
216	9	which that model has shown to work and function
216	11	Appendix W allows the choice of modeling
217	12	that model users will occasionally encounter and
217	13	identify problems and bugs in the model.
218	8	Paine spoke of dealing with PM2.5 modeling
218	13	and no model that does a credible job of
218	22	modeling tools to use for the permit application.
219	3	modeling and we still have no guidance on how to

Page	Ref No.	Keyword = "model"
219	15	quality modeling when I was a contractor in the
220	11	long model runs. They have a dedicated user
220	16	modeling disciplines report cost benefit
222	11	Model: example (a). Used as a reference. CMAQ:
222	22	Example (a) SOM Ocean Model: Excellent
226	21	comparing the prognostic model derived wind

Page	Ref No.	Keyword = "model evaluation"
6	12	model evaluation session right after that.
17	3	provide full documentation of model evaluation
24	5	use for meteorological model evaluation.
37	6	work-in-progress. We have a model evaluation
48	3	for model evaluation. This one refers to the
50	14	to deliver the atmospheric model evaluation tool
50	24	Model Evaluation Tool (AMET) consists of two
61	24	be continuing to develope model evaluation tools
73	18	regulatory model evaluation this is prairie grass
164	2	I’d like to switch to model evaluation
168	14	of science–based models through model evaluation
179	10	comprehensive model evaluation of CALPUFF in

Page	Ref No.	Keyword = "modeling"
7	7	in air quality modeling. This class of models
7	10	modeling so we use non steady state (inaudible)
7	14	visibility (inaudible) modeling. As such as Joe
13	4	for direct modeling or comparison because you
14	6	the 8th Modeling Conference – EPA recognized the
14	22	modeling project and they said we are performing
16	9	point yesterday about you know this is a modeling
17	6	to updating existing EPA LRT modeling guidance
17	11	modeling system to incorporate recent
17	15	8th Modeling Conference that talk about these
17	18	200-300 km? At the 7th Modeling Conference, EPA’s
47	3	Going back to the 8th Modeling Conference, we
47	10	in the modeling system understanding that
47	11	emphasis on modeling systems, recognizing that
47	12	the emissions meterology and underlying modeling
50	18	modeling division in ORD here at EPA. And as
62	16	for short range modeling evaluations the somewhat
70	25	dispersion modeling are how often are the winds
81	15	We did a broader assessment of modeling

Page	Ref No.	Keyword = "modeling"
88	13	modeling storage tanks.
93	12	modeling community. In the modeling community as
93	21	emergency response support for air modeling in
93	24	In the emergency response modeling community
94	2	class of modeling technology that is new to us.
94	5	modeling community. That is one area where we
94	9	of CALPUFF modeling you know we've also seen a
99	22	modeling air concentrations, it is from
105	5	approach where we're not modeling the individual
105	6	particles, but we're modeling how that particle
106	21	modeling the distribution, it could either be a
108	5	deviation, the made as modeling the puff if you
114	24	available and we can use modeling methods and we
125	9	Modeling. We'll start with presentation from
125	15	plume–in-grid modeling, which basically consists
127	4	Plume-in-grid modeling is not new; it began in
129	11	designed to supplement RPO modeling being
129	22	modeling domain for the application and locations
130	20	overestimated. Plume-in-grid PM modeling
132	11	of these species. Traditional modeling
133	13	The challenge with P-in-G modeling is that it
134	15	This slide shows the modeling domain for the
136	3	little bit about photochemical modeling and in
136	6	source modeling and tracking that type of thing.
136	9	modeling systems whether it's dispersion, or
136	24	modeling system approach where we are trying to
137	2	PM in the same modeling system. An example
143	21	single source modeling with CAMx PSAT to compare
143	23	States did single source visibility modeling for
144	2	short the (inaudible) modeling just try to apply
145	17	for credible single source modeling with Source
146	4	modeling for Ozone and PM.
147	24	There has been a lot of development in modeling
149	24	Southeast (ASIP). Annual PM2.5 SIP modeling for
150	11	2002 36 km modeling CAMx database. Add 12 km
151	8	modeling. 12 km grid cell size too coarse to
151	23	CAMx 12/4 modeling using two-way interactive grid
153	23	12/4/1 km PiG modeling attributes 3.4 μg/m3 to
154	8	modules. The use PGM modeling to assess "single
154	13	BART assessment. PM2.5 SIP modeling.
154	22	modules. The use of PGM modeling, to assess
155	3	Arkansas BART assessment. PM2.5 SIP modeling.
156	9	modeling single source for Ozone PM2.5 seems to
158	22	regional modeling. These comments cover many
160	2	recommendation for Plume in Grid (PinG) modeling?

Page	Ref No.	Keyword = "modeling"
163	17	is much current mesoscale and regional modeling
165	3	modeling protocols and decision making. We also
166	3	that the dispersion modeling domain is dominated
166	10	the surface modeling of the airport roughness.
166	19	modeling purposes (>90% available). We'd like to
169	3	ASIP modeling and the like. I just want to
170	2	region and state and local modeling.
170	25	quality modeling for regional analysis for
172	15	Air quality modeling approach is: "Use
172	24	AQRV modeling approach is to develop a
180	2	model output in air quality modeling
180	9	Topics that the modeling community
180	13	included in modeling? Model performance
186	10	modeling. I'm going to introduce the AB3 model
198	22	precursors, modeling techniques – guidance,
200	2	for visibility modeling because each of these
200	21	modeling that are still in effect, Best Available
200	25	pending), and the PSD increment modeling
201	3	So let's talk about modeling Primary vs.
201	12	unbiased model to take modeling credit? Are we
202	4	modeling for short-range applications? Include
202	5	secondary PM2.5 modeling for long-range
202	25	Example Modeling Challenge: Compute Total
203	12	To summarize: PM2.5 modeling in a regulatory
203	15	Emissions measurement and modeling techniques
203	19	for refined modeling approaches. Collaboration
203	24	guidance, PSD increments and modeling procedures.
204	13	The Low wind speed issues. Modeling of
204	14	roadways for NO2 and PM. Problems with modeling
205	7	studies and adjustments to AERMOD modeling
206	20	Sensitivity of modeling to surface
207	6	2008 Annual Meeting on sensitivity modeling. We
208	21	modeling for the guideline purposes require air
211	8	occur and require PUFF modeling. We'll be
211	10	modeling and a better definition of complex
212	5	will be conducting a modeling conference in
212	6	Toronto this Spring on Canadian modeling issues.
212	7	There will be 2 modeling conferences next year.
212	25	participated in all of the EPA modeling
213	4	revisions of Appendix W Guideline. The Modeling
213	17	that EPA is planning to make to the Modeling
214	19	outdated portion of the modeling guideline, EPA
215	17	document that a modeling system like CALPUFF,
216	11	Appendix W allows the choice of modeling
218	8	Paine spoke of dealing with PM2.5 modeling

Page	Ref No.	Keyword = "modeling"
218	22	modeling tools to use for the permit application.
219	3	modeling and we still have no guidance on how to
219	15	quality modeling when I was a contractor in the
220	16	modeling disciplines report cost benefit

Page	Ref No.	Keyword = "monitor"
30	13	They had at least 168 monitoring sites
61	19	externally. Then we monitor the bugs that the
63	24	monitoring networks featuring year-long sampling
75	22	the details here but this is the Wylam monitor
76	6	receptors (inaudible) on the monitor location to
76	7	the actual monitored concentration. It actually
76	11	concentrations from the monitor. This just shows
77	15	that monitor. But if you look at the airport
80	2	monitor from the source that is the closest
80	7	the facility would be going right at the monitor,
81	7	significantly exceeding monitored NO2
85	15	up. The monitor was kind of within 100 meters
86	19	reasonably close. This other monitor didn’t do
86	22	background sources impacting that monitor. This
152	9	monitor and sometimes almost (inaudible) I admit
153	8	monitor and that’s about 2 μg which is a large
153	9	contribution source on a monitor. In this case
153	16	to PM2.5 nonattainment at Granite City Monitor
153	17	(B) and Washington St. Monitor (A).
153	22	at the Granite City monitor on average. The CAMx
162	14	further which would provide monitoring data and
167	9	monitoring data combined with statistical
173	2	included in the monitoring data which is
173	9	bias for NO3 impacts compared to monitored
176	7	issues of is the monitor in the right
176	17	the improved monitoring data at Bridger over
176	23	I would submit if the monitor wasn’t
177	6	say the monitor is in the wrong location and
179	2	in the monitoring data.
179	3	Monitoring data versus CALPUFF, 80,000
180	12	should meteorological monitoring sites be

Page	Ref No.	Keyword = "monitors"
21	20	had is you had two arcs of monitors that were
81	8	concentrations at 3 Atlanta monitors. An initial
82	9	monitor comparison at one of the NO2 monitors
83	4	other monitors as well. So they seemed
90	7	of monitors and spend a lot of money and miss the
152	6	monitors where we are asked to get the PM2.5
152	23	projected 2009 design barriers at these monitors
205	9	EPA to pursue. Problems - few long-term monitors

Page	Ref No.	Keyword = "near-field"
142	22	necessary and useful for near-field applications.
143	2	what about near-field applications? I think we
143	5	working with near-field with photochemical
143	10	review existing near-field applications using
201	5	only. Primary PM2.5 provides highest near-field

Page	Ref No.	Keyword = "NEPA"
154	12	assessments as part of NEPA, Texas and Arkansas
155	2	AQRV assessments as part of NEPA. Texas and
172	7	and gas in the context of NEPA. You heard
172	10	air quality impacts under NEPA
172	13	NEPA analysis includes up to 700 sources and
172	16	the best available science to support NEPA

Page	Ref No.	Keyword = "non regulatory"
7	8	plays several roles. In the non regulatory
95	15	a non regulatory capacity. We use them for fire

Page	Ref No.	Keyword = "NOAA"
11	2	This data set and these programs on the NOAA ARL
11	9	what NOAA has done in terms of trying to you know
12	14	on the NOAA webs site introduced a final metric
15	3	something similar what the NOAA archive is where
160	17	this including DTRA and NOAA who have linked MET
161	20	NOAA) who have operational Met model-AQM systems
162	9	Work with other agencies (DTRA, NOAA) who have
180	20	for use of NOAA reanalysis data.

Page	Ref No.	Keyword = "noaa"
182	7	Who supplies it? NOAA and ECMWF.

Page	Ref No.	Keyword = "NSR"
72	10	Appendix W [ed. for NSR and] (inaudible) PSD.
200	23	NSR implementation rule, PM2.5 PSD SILs, SMCs, and

Page	Ref No.	Keyword = "OAQPS"
6	19	detail for OAQPS.
14	4	came down on rotation to OAQPS in January and my

Page	Ref No.	Keyword = "observation"
9	13	observation pairings. This is the Irwin
27	5	the observation was. This is where we clearly
32	22	observation were looking like for this. CALPUFF
49	10	can observe both from the observational
51	17	paired model observation sets which are actually
52	11	all the data and observation are in the database
56	15	model observation, model to model, summary
65	8	a ranked observation verses prediction plot and
69	4	fitted observation.
69	6	you do something with the observation. The way
101	14	instead of using observation.
166	12	the airport wind observation to the land
171	13	look at it against observational data and
197	10	determine available observational datasets.
198	6	observation. That sounds high to me.
198	7	Consistency with results using observational
198	12	other observational datasets. That’s all I have.
207	24	specific is considered a valid observation if the

Page	Ref No.	Keyword = "observations"
8	7	and tracers for observations that we can use for
15	6	all the observations within the program. Anybody
28	16	dating back to 1982 – 1983. The observations
32	20	We were able to pull in the observations so that
34	23	These are some of our initial observations from
37	12	some of our observations. Did we go wrong in

Page	Ref No.	Keyword = "observations"
48	14	observations, the predictions to our models to
48	15	the observations we see?
51	13	to compare observations against meteorological
51	25	observations and then model output. These are
52	9	predictions and observations.
53	2	side is it’s a different observations and a
64	20	observations, unpaired in time and can be used
68	20	Observations”? Observations can be measured by
68	25	treating observations as snapshots of an
123	21	•8 observations, 15-minute
124	14	of observations; some under prediction of cross-
160	22	model predictions with observations. Specific
161	13	observations can best be used and assimilated in
162	2	experiments. Determine how met observations can
163	21	observations, tracer releases, and PM and
163	22	visibility observations over an area of about 200
166	6	wind observations to the land characteristics of
182	11	standard upper air and surface observations
191	5	that agreed better with field observations.
226	13	observations and combine them with more broadly

Page	Ref No.	Keyword = "observed"
10	4	integrated concentration and observed the fitted
28	13	from the observed and …oh great. Sorry about all
32	5	observed in terms of the absolute transport
34	3	the model observed it had the best of spatial
57	11	model observed, the bias between the model
57	12	observed and also you can sub region this out
57	14	showing observed and (inaudible) but you could
66	15	observed and predicted concentrations where an FB
69	22	volume, but observed concentrations represent
77	9	observed concentration goes up it’s often highly
77	13	observed concentration. That certainly suggests
78	5	down, calms go up, observed concentrations go up
112	13	what was observed by visible satellite imagery.
181	21	based off of observed data and not a
183	15	calms verses what the observed data might have.
183	18	observed sounding and it has some really good
198	9	observed met results. Evaluate results under

Page	Ref No.	Keyword = "ozone"
81	20	Ozone Limiting Method to better account for NO to
100	16	ozone model, CD4, and we’ve got a mercury module.
127	12	of-the-science PiG model for ozone was initiated
128	7	ozone, where we conducted simulations for
136	19	type of pollutant. UAM, REMSAD for Ozone, REMSAD
136	25	treat all types of precursors species ozone and
137	11	predict ozone, PM acid rain, visibility and
138	20	ozone concentrations, no need for a constant
138	21	ozone background value for PM, advanced aqueous
140	11	for their contribution to ozone if you choose
141	7	This is an example of ozone source
141	10	ozone contribution from sources similarly to PM
141	11	with reactive tracers, July maximum ozone
146	4	modeling for Ozone and PM.
146	18	assessment are the new more stringent Ozone and
146	23	the contributions of source to the Ozone and
147	5	individual contributions to ozone and PM2.5
148	10	CMAQ have PM and Ozone Source Apportionment and
149	6	evolution of the plume where there’s no Ozone
149	9	those emissions and it starts forming Ozone and
149	12	I think Kirk talked about the Ozone and
150	14	Another application is the PM2.5 Ozone ASIP
154	2	“single source” contributions to ozone, PM2.5,
154	5	Full chemistry Plume-in-Grid modules. Ozone and
154	16	“single source” contributions to ozone, PM2.5,
154	19	Full chemistry Plume-in-Grid modules. Ozone and
156	9	modeling single source for Ozone PM2.5 seems to
167	3	ozone concentrations. This should be performed
173	17	2) Background Ozone (surface, user
173	24	1) Background Ozone;
188	13	increase use of ozone models and I think this was
209	21	and we need to do some other things for Ozone .

Page	Ref No.	Keyword = "parameter"
11	24	Kolmogorov-Smirnov Parameter and basically it
12	23	the KS parameter and then assigns a score from 0
13	17	our false alarm ratio; the KS parameter, the
113	25	(KS) parameter is the maximum difference between
165	23	influence of nearby land use in parameterizing
197	4	parameter. Sensitivity of prognostic model
197	8	parameterizations and grid resolution.

Page	Ref No.	Keyword = "parameters"
12	19	those parameters.
114	5	Obviously you can add other parameters if you
197	5	parameters. Use of NCEP products (e.g., RUC
197	15	micrometeorological parameters, solar radiation,
206	8	the use of ANL physical parameters for common

Page	Ref No.	Keyword = "particle"
7	11	puff model, particle model for these types of
13	10	particle model that we evaluated as part of this
20	19	did was to include the two Lagrangian particle
36	15	particle models for first 24 hours, has more
93	5	on HYSPLIT and Joe Scire on the Puff Particle
94	24	SCIPUFF), Lagrangian Particle Models (KSP,
95	12	example of how we’ve used particle models in
95	21	Lagrangian particle model called FLEXPART. We
97	2	little awkward. HYbrid Single Particle
99	20	Modelled particle distributions (puffs) can
100	5	in a calculationc, when the particle is over the
100	21	particle then contributes to the eularian
100	25	the particle and the advection continues on.
105	15	at the particle motion in one direction and a
105	17	hybrid method always puts the particle in the
105	19	particle approach would give us a more accurate
106	4	particle concentrations you can see from the
106	5	illustration what that turbulent particle
106	7	those mean particle trajectories. It’s a
107	10	3-D particle approach, just briefly, we’re
107	20	the model. That’s the particle approach.
108	11	what’s happening at the end of the particle is
108	13	you don’t have enough particle density to give
108	15	limitations with the particle approach. When you
108	23	concentrations? Well each particle if you’re
108	24	running the 3D particle model the change in
109	2	contributed by that particle divided by the grid
110	9	China in 2001. This was running the 3-D particle
110	10	model and what you see here is the particle
110	25	happened is the particle starts lining up with
118	17	overview of puff particle model.
118	19	about the particle puff model the PPM module
119	16	purpose of the PPM the puff particle model is to
119	18	particle approaches. In one of the elements of
119	25	advantage is particle models over plume models
120	8	stochastic particle models are state-of-the-

Page	Ref No.	Keyword = "particle"
121	11	a full stochastic Lagrangian particle dispersion
121	20	particle to which it belongs.
122	16	PPM time step, new particle trajectories are
123	2	the size of the particle-puffs in the mirror
124	17	Lagrangian particle dispersion model (LPFM)
139	6	partitioning between gas and particle phase and

Page	Ref No.	Keyword = "PBL"
23	19	MM5 like ETA PBL and NOAH LSM. We're not

Page	Ref No.	Keyword = "Phase 2"
8	16	the update of the IWAQM and Phase 2 guidance is
14	8	significantly and the IWAQM Phase 2
17	7	(IWAQM Phase 2) to reflect lessons learned from
19	18	IWAQM Phase 2 there's talk about project MOHAVE

Page	Ref No.	Keyword = "photochemical"
94	11	photochemical models in a more of a single source
135	19	Morris on single source models and photochemical
136	3	little bit about photochemical modeling and in
136	4	general some of the features of the photochemical
136	10	photochemical grid model system. Essentially you
136	15	a dispersion model, simple photochemical box
136	17	photochemical models like urban REMSAD models.
136	18	Those photochemical models are geared to specific
136	23	photochemical grid models are a one atmosphere
137	23	Photochemical models the governing equation
137	25	photochemical we're trying to make chemical
138	7	with photochemical models. The dispersion model
138	16	For photochemical models advantages, one of
138	17	the things in using a photochemical model for
138	24	included, photochemical models generally have
139	11	have been implemented in photochemical models
141	2	species do in the photochemical model. The only
141	21	the source would be located. The photochemical
142	10	on with the photochemical model because it's
142	13	Applications was touched on Photochemical models
142	19	(from States, RPOs, etc) for photochemical models
142	23	The other thing about photochemical

Page	Ref No.	Keyword = "photochemical"
143	5	working with near-field with photochemical
143	8	photochemical models like sub-cell receptor
143	14	through a photochemical model and that’s just an
145	9	the photochemical model really not a lot of
145	16	photochemical grid models provide an opportunity
147	9	chemistry. Photochemical Grid Models (PGMs) have

Page	Ref No.	Keyword = "PiG"
127	12	of-the-science PiG model for ozone was initiated
129	23	of 14 PiG sources
130	12	contribution by using the PIG treatment. You can
131	16	in mercury deposition using the PIG treatment on
131	21	overprediction was corrected by using PIG
134	18	number of PiG sources, and this application would
153	23	12/4/1 km PiG modeling attributes 3.4 μg/m3 to

Page	Ref No.	Keyword = "plume"
9	5	on the plume center line statistics and so those
9	21	azimuth of plume centerline on an arc. Then it
9	22	also looks at the horizontal spread of the plume
9	24	the definition of the horizontal of the plume.
9	25	For temporal pairing we looked at plume arrival
10	12	to fit an average plume on arc so these were
24	23	terms of you know you can see the plume you know
24	24	the plume is wide here. I am encouraged by the
25	5	this the plume signal were not exactly matching
25	8	you can see the plume spread with P-G tends to be
25	12	prediction of the plume width with the P-G class
27	10	Now Plume Centerline, this is one of the
27	15	plume was a little bit displaced to the NE of
27	24	Then on the 600 km arc the plume (inaudible)
28	17	were basically the plume was detected from
29	4	was that the plume came up in this area here and
29	14	displacement it had the plume you can see that
29	15	the plume took it a little bit further trip to
32	8	first 24 hours of plume as it (inaudible) along
34	6	because of the way the plume was transported with
34	9	plume in an area where nothing was being
35	6	plume width. It looked like it was doing better
35	11	performed well except for plume azimuth as I said
40	12	trajectory of the plume. As a test, back when we

Page	Ref No.	Keyword = "plume"
63	14	with many sites where you can determine plume
63	15	centerline and plume sigma-y. You can determine
71	12	the plume dispersion predictions in CALPUFF
80	6	North West not directly so that the plume from
86	15	putting the plume the release sight more in the
90	4	conditions to conduct a field study. The plume
90	8	plume completely because it went that way instead
90	11	metric concentration really captured the plume
94	22	use over the years: Gaussian Plume Models (ISC,
95	3	CAMx), Plume-in-Grid, Single Source Apportionment
95	8	capabilities. In these models are Plume in
97	11	method; how to simulate plume dispersion, how to
102	11	than a plume-in-grid, we’re going to have a grid-
102	24	that with Lagrangian plume model. From that
104	7	like a plume because wind speed and direction
104	10	and looks like a plume. But it’s just a mean
105	8	deviation of the plume as it changes with time.
108	14	you a smooth plume and that’s one of the
109	14	plume. As we saw in that vertical distribution
119	25	advantage is particle models over plume models
125	15	plume–in-grid modeling, which basically consists
125	16	of using a plume model within a grid model to
125	24	4 km or 12 km, the plume has to travel through
126	5	plume. So what we’re trying to do with a plume–
126	6	in-grid model is to combine the plume model and
126	7	the grid model and carry the plume along until it
126	11	trying to do with the plume–in-grid model is to
126	13	about yesterday – the early plume dispersion and
126	14	the mid-range plume dispersion, and the grid
126	17	plume to the grid model.
126	19	consists of a reactive plume model embedded
126	20	within a 3-D grid model. The plume model
126	23	plume model. At the time we hand over the plume
127	3	plume model.
127	4	Plume-in-grid modeling is not new; it began in
127	6	PARIS - Plume-Airshed Reactive-Interacting
127	9	no treatment of wind shear or plume overlaps, no
127	14	The embedded plume Model is SCICHEM (state-of-
127	22	order closure approach for plume dispersion and
128	5	(Advanced Plume Treatment).
128	25	the plume-in-grid model, it is based on CMAQ 4.6,
129	17	plume-in-grid approach. Model performance
130	3	plume–in-grid. The right side shows the results
130	4	of CMAQ-AERO3-APT with plume–in-grid. There is a
130	9	model and 2.4 μg/m3 for the plume-in- grid model.

Page	Ref No.	Keyword = "plume"
130	20	overestimated. Plume-in-grid PM modeling
138	8	shown on the left with the plume (inaudible) at a
138	9	particular source plume kind of in its own
143	25	sub-grid plume treatment. To make a long story
147	12	source plume chemistry and dispersion?
147	15	the source to resolve near-source plume chemistry
148	6	plume chemistry and dispersion without providing
148	7	met and emission inputs and full chemistry Plume-
149	6	evolution of the plume where there’s no Ozone
149	11	the Plume in Grid model.
151	11	point source plume would be computationally
151	16	grids. Plume-in-Grid to address near-source
154	5	Full chemistry Plume-in-Grid modules. Ozone and
154	19	Full chemistry Plume-in-Grid modules. Ozone and
160	2	recommendation for Plume in Grid (PinG) modeling?
166	22	We are interested in the Plume Molar Volume
174	2	3) Plume NOx Concentration
191	22	visualizations what happens is the plume
192	11	We think the plume is being caught in the cavity

Page	Ref No.	Keyword = "PRIME"
85	25	with the PRIME downwash algorithms since it
107	16	prime, which is the standard deviation of
189	2	Prime, it’s going to be hard to treat complex
189	8	Ultimately, PRIME needs the building shape
189	25	Prime Algorithms. With AERMOD/PRIME building
191	16	building. PRIME cavity and wake dimensions: W =

Page	Ref No.	Keyword = "processor"
196	5	The other point is the processor. Do not

Page	Ref No.	Keyword = "processors"
133	23	quarter on different processors or machines. A
221	14	the problem at the source. Multi-core processors
222	2	outboard processors and programming tools for

Page	Ref No.	Keyword = "profile"
54	19	Profiler, and Aircraft Profiler.
56	3	This is a wind profiler comparison over time
56	6	you have wind profile information,. a nice plot.
71	15	rose profile misrepresentation, among other

Page	Ref No.	Keyword = "promulgation"
21	16	published supporting the promulgation of CALPUFF.
158	19	Promulgation of more stringent ambient
213	3	rulemakings associated with promulgation and

Page	Ref No.	Keyword = "protocol"
37	7	protocol drafted and it describes the
42	8	with the State in which a common protocol had
42	16	make a change in the current protocol to go from
45	11	way or the other. If Herman had a protocol in
45	13	to deviate from the protocol you have to have
46	3	deviation of a protocol or questioning about the
175	22	the IWAQM protocol, has a substantial bias
199	12	protocol, and basically, we have all the

Page	Ref No.	Keyword = "protocols"
165	3	modeling protocols and decision making. We also

Page	Ref No.	Keyword = "PSD"
41	6	for PSD Class I increments that, in all cases,
41	8	for PSD Class I increments. This was from Tim
43	14	PSD.
72	10	Appendix W [ed. for NSR and] (inaudible) PSD.
200	23	NSR implementation rule, PM2.5 PSD SILs, SMCs, and
200	25	pending), and the PSD increment modeling
203	24	guidance, PSD increments and modeling procedures.
213	9	standards or the PSD increments. What is in the

Page	Ref No.	Keyword = "puff"
7	11	puff model, particle model for these types of
17	16	things. Can puff-splitting extend the effective
22	24	Puff-Splitting was turned on for the 600 km
23	5	consider puff splitting. But since we were
31	15	does. This is a good test for puff splitting
31	18	felt this was a good test for puff splitting.
33	7	with the puff-splitting turn on we weren’t
33	15	and see how this puff-splitting will make a
36	20	looking at Puff-splitting did not change CALPUFF
36	22	at puff-splitting (eliminating mixing height
37	3	puff-splitting in CALPUFF.
93	5	on HYSPLIT and Joe Scire on the Puff Particle
94	23	AERMOD), Gaussian Puff Models (INPUFF, CALPUFF,
105	4	Another one of the possibilities is the PUFF
105	16	puff type approach in the other direction. The
106	13	looking at the center of the puff and that
106	19	Slide 9. As far as the puff distribution,
107	21	Now for the puff approach we’re using the
107	24	puff. It’s also a function of the turbulent
108	5	deviation, the made as modeling the puff if you
108	19	simulation. That’s why we have this puff
109	3	cell volume. If you’re using some kind of puff
109	4	approach it’s the mass of the puff divided by the
109	5	volume of the puff, basically. The approach is
109	10	puff approach. Here’s an example on the right
109	13	500 Hybrid puff approach gives a smoother looking
109	17	and having the puff approach in the horizontal
118	17	overview of puff particle model.
118	19	about the particle puff model the PPM module
119	16	purpose of the PPM the puff particle model is to
119	17	try to combine the advantages of both puff and
120	14	If you look at the Puff model types there
120	15	are a couple of types within the class of puff
120	16	models. One is the ensemble average puff model
120	17	and CALPUFF would this type. We have a puff that
120	23	cluster dispersion puff model where a puff is a
121	2	eddies smaller than the puff) contribute to puff
121	7	Instantaneous puff releases require use of
121	12	model to determine the puff trajectory. I’ll
121	15	eddies smaller than the puff size is removed
121	17	relative dispersion. Every puff carries along
121	22	eddies larger than the puff but not resolved by
121	23	the flow is simulated by the puff center
122	10	released puff a “mirror ensemble” is attached.
122	12	number of puff-particles. The time step broken

Page	Ref No.	Keyword = "puff"
122	17	computed, from which the puff trajectories are
122	21	puff’s size and position and then handed back to
122	24	changing the puff’s mass or chemical composition
123	4	energy spectrum will be within the puff-particle.
123	6	dispersion. At that point, the parent puff
123	8	ensemble is deleted and the parent puff is
123	9	restored. Parent puff treated in normal CALPUFF
127	21	three-dimensional puff-based model, with second-
127	23	treatment of puff splitting and merging. SCICHEM
132	23	receptor locations by combining incremental puff
133	15	number of point sources are treated with the puff
160	18	models with MM5 and WRF and the Puff models.
162	22	terrain, short term puff dispersion, chemical
174	15	CMAQ MESO PUFF II chemistry. The blue dots
211	8	occur and require PUFF modeling. We’ll be

Page	Ref No.	Keyword = "ratio"
13	17	our false alarm ratio; the KS parameter, the
55	12	mixing ratio, wind speed, wind direction, but
117	16	bias was a ratio 1.37. Okay.
166	23	Ratio Model (PMVRM. We like for EPA to further
178	12	Colorado, if you look at the ratio at the

Page	Ref No.	Keyword = "ratios"
64	22	plots are plots of ratios of predicted/observed
189	16	aspect ratios. Use of wind tunnel testing to
191	9	aspect ratios. Short/large industrial facilities
198	4	the ratios were about a factor of 2 or 1.5 to 2

Page	Ref No.	Keyword = "receptor"
74	4	concentrations that each receptor along the arc.
132	23	receptor locations by combining incremental puff
143	8	photochemical models like sub-cell receptor
155	19	receptor if you like. These models are terrain
185	7	2nd high. Receptor location and data of 1st and

Page	Ref No.	Keyword = "regulatory"
7	8	plays several roles. In the non regulatory
7	12	activities. In the regulatory community we use
31	13	recommended for regulatory. It’s not sitting and
33	13	this is well beyond the regulatory range of
38	19	context to meet the regulatory needs under
47	23	in the regulatory policy context.
67	22	Regulatory Purposes – Model Validation Kit. It is
72	25	requirements of operational Regulatory Dispersion
73	5	but for regulatory models need to predict the
73	18	regulatory model evaluation this is prairie grass
87	24	for regulatory review. There’s a wide variation,
88	3	almost always gravitated in the regulatory
93	11	the regulatory not necessarily in the regulatory
93	17	know after 9/11 a lot of the regulatory agencies
94	4	application in the future and for the regulatory
94	17	the regulatory community will have to deal with.
95	11	regulatory realm. I just wanted to give you an
95	15	a non regulatory capacity. We use them for fire
127	19	by-case basis for regulatory applications (also
145	5	the regulatory set of options which probably
145	21	models are routinely used for other regulatory
145	23	Implementation Plans so they do have regulatory
164	17	we’re talking about the context of regulatory
165	6	available to and used by regulatory decision
166	18	if that year of data is suitable for regulatory
198	20	regulatory requirements, challenges to PM2.5
202	18	its Interim Regulatory Impact Analysis (RIA) for
203	12	To summarize: PM2.5 modeling in a regulatory
204	5	in a regulatory context. That’s it. Let’s see
209	24	control of the regulatory code. The developer
212	17	Air Regulatory Group (UARG). UARG is an ad hoc
215	10	memorandum about the regulatory status of CALPUFF
220	8	Regulatory Air Quality Models (AQM). They

Page	Ref No.	Keyword = "roughness"
76	14	proximity but different settings. Low roughness
76	16	airport. Then higher roughness at the SEARCH
80	22	roughness sensitivity and this is more recent.
81	9	assessment was that low surface roughness used to
81	11	roughness typical of source locations, and
81	13	roughness to address that.
83	12	AERSURFACE pretty high roughness about 0.8 meters
83	15	supplementation with its roughness which is

Page	Ref No.	Keyword = "roughness"
83	22	the SEARCH site with the higher roughness.
84	7	to see due to surface roughness itself.
165	24	surface roughness to a 1 km radius of ASOS
166	4	by surface roughness of airport property. Better
166	10	the surface modeling of the airport roughness.
206	25	is too short of a fetch distance. Low roughness

Page	Ref No.	Keyword = "RUC"
197	5	parameters. Use of NCEP products (e.g., RUC

Page	Ref No.	Keyword = "rule"
161	6	developers recommend 4 km as a safe general rule,
200	23	NSR implementation rule, PM2.5 PSD SILs, SMCs, and
200	24	increments (proposed 9/21/07; final rule
201	2	procedures (proposed 6/6/07; final rule pending).
213	3	rulemakings associated with promulgation and
214	18	notice-and-comment of rulemaking to change any
218	23	Until the new recent rule, this was not much of

Page	Ref No.	Keyword = "run"
15	5	have the MM5 data that was run up there and have
31	3	MM5 is run again and was initialized with
31	5	was run with Great Plains with the exception we
43	23	running with the NOOBS only and with P-G, and
74	18	has run AERMOD and getting results they don’t
75	9	SIP. Basically AERMOD was run initially with
75	18	series plot running the model with the airport
100	23	run. The concentration change is linearly
102	17	you’re running the lagrangian model for all the
103	25	recognize the geography. Why would I run Spain?
106	11	this is running with 3-D Puffs and we are not
108	24	running the 3D particle model the change in
110	9	China in 2001. This was running the 3-D particle
112	6	wildfire smoke forecast that is running. You can
114	10	those tracer experiments we have run….the first
144	4	meteorology output from MM5. CALPUFF was run in
150	5	Rather than running each one individually we
150	6	decided to do group analysis and run them in
166	21	information is not provided until AERMOD is run.

Page	Ref No.	Keyword = "run"
178	23	issue is as new production was run in that
183	11	pull some of this data in and run it through
184	15	versions of AERMOD that couldn’t quite run in
185	5	concentration for SO2). NARR run within 5% of
185	6	control for 1st high. NARR run within .07% for
185	10	newbie when it comes to running AERMET and
196	21	for running AERMOD or CALPUFF. I think it seems
209	5	usage experience. We know how to run it and have
209	6	been running it for years. It has better
218	2	fixes that users have encountered in running

Page	Ref No.	Keyword = "rural"
124	4	•187m power plant stack, rural
168	21	evaluate regional models in rural regions in the

Page	Ref No.	Keyword = "scale"
48	4	community multi scale air quality model from the
82	8	were on the same scale. This is sort of model to
101	16	scale type of situation. I’m not going to argue
101	20	large scale experiments the resolution of the
108	17	scale (inaudible) for global background, it is
110	8	scale. This was the massive dust storm from
111	2	the large scale weather patterns at the frontal
112	18	down on the local scale. This is down to the 80
112	19	km scale we’re looking at a tracer experiment we
125	17	capture fine scale variability next to emissions
126	21	captures the local scale variability and the grid
127	16	grid scale)-developed by L-3 Communications/Titan
202	21	Local Scale Analysis (2005). Any of these
225	25	local scale analysis using AERMOD to (inaudible)

Page	Ref No.	Keyword = "SCRAM"
16	2	SCRAM for the evaluation data sets for the
17	23	them up on the SCRAM web site. That was 2000 and
184	9	How do I test it? He said to go on the SCRAM
214	8	as SCRAM nor is it sufficient to publish the

Page	Ref No.	Keyword = "screening"
142	8	screening metric states they obviously agree with
165	10	We understand the screening model,

Page	Ref No.	Keyword = "sensitivity"
45	4	So we did that one additional sensitivity test
80	22	roughness sensitivity and this is more recent.
85	7	The other thing is the sensitivity of model
86	7	you can have a whole lot of sensitivity or not
134	13	emission scenarios and other emission sensitivity
195	9	Evaluation variables, Sensitivity to prognostic
196	25	There will likely be a large sensitivity of
197	4	parameter. Sensitivity of prognostic model
197	6	fields) and they are free. Sensitivity of
206	20	Sensitivity of modeling to surface
207	6	2008 Annual Meeting on sensitivity modeling. We
226	23	also an intent to do an sensitivity studies as to

Page	Ref No.	Keyword = "service"
42	21	Service and the Fish & Wildlife and the Park
42	22	Service because they wanted some demonstrations,
44	9	the Park Service we said okay and what is it that
49	22	not doing a service to the community.
112	7	go to our web page and also the weather service
112	9	service page partly because we offer ways for
181	13	service areas. I’ve only been there for one
181	15	weather service for about 15 years. That’s
225	18	Mark Garrison from ERM. We service the Air
226	15	National Weather Service Stations. Then

Page	Ref No.	Keyword = "site"
8	24	that you can find on the EPA web site are done by
12	14	on the NOAA webs site introduced a final metric
15	7	can go on the web site and get that data and do
15	22	assembled and get them up on the web site so that
15	24	themselves similar to the datum web site and
15	25	similar to what Roger has on the web site for
17	23	them up on the SCRAM web site. That was 2000 and
76	13	SEARCH site pretty closes by showing the
76	17	site. It was sited direct within a neighborhood

Page	Ref No.	Keyword = "site"
76	24	site. It’s not real dramatic terrain features
78	16	compared with met SEARCH site and airport site to
79	6	light wind. For the SEARCH site you can clearly
79	18	the SEARCH site that’s matched with the model
79	21	site. One of the things that is going on there
80	4	Whereas the SEARCH site which is right next
83	22	the SEARCH site with the higher roughness.
84	2	airport and the SEARCH site didn’t seem to be
85	3	And also another non standard airport site,
85	4	the Texas (inaudible) site, I think we looked at.
101	19	you have on site meteorology. But for these
114	21	site download and convert that data so that you
115	12	web site. Let’s look at one briefly. Of course
167	17	etc.) as opposed to statistical fits to site
176	5	distribution site and the red line is what
182	9	Potentially a source for site specific data -
183	4	might get some more site specific data but if
184	10	site and use some of the cases that are there.
184	18	only could get one site so I used this case
184	22	data (and on site data). Re-run with NARR (ed.
185	2	air site.
190	10	tower, a site drawing as you might call it. Now
207	8	for met and application site surface
207	11	that differences in site surface characteristics
207	23	Roger Brode: Technically, if a site
212	4	site. And for those of you are interested, AWMA
214	7	draft meeting agenda on the agency web site such
215	2	on its web site several guidance memoranda that

Page	Ref No.	Keyword = "source"
39	18	terrain and also the source location relative to
39	19	the Class I analysis and exactly where the source
40	15	differenr source – Class I area pairs -- looking
51	4	It’s a combination of several Open Source
51	9	these are available open source and we designed
52	23	Then often because R is open source users
54	10	open source pretty much free of charge.
80	2	monitor from the source that is the closest
80	3	source.
80	5	to the source the drainage flow is more from the
80	12	pulling a different source.
81	11	roughness typical of source locations, and
81	24	context. Also we looked at the source

Page	Ref No.	Keyword = "source"
84	8	The next one is more on the source
85	8	results to source characterization options for
85	20	source with an initial Sigma Z or volume source
86	11	different met data and different source
88	9	picked a certain source type, -- you may not be
89	11	In Alabama, and these other source types, are
89	13	these other source types which drive all these
94	11	photochemical models in a more of a single source
95	3	CAMx), Plume-in-Grid, Single Source Apportionment
95	9	Grid and single Source Apportionment technique
98	21	calculations in the meteorology for each source.
101	4	PC and Mac executables, and UNIX (LINUX) source.
102	5	ensemble, matrix, and source attribution options.
111	5	off in the source location but you might be
125	8	next part of this which is the Single Source
130	6	especially near the source regions and even
130	7	further away from the source regions. The
130	14	the source region. Even further away it’s about
130	22	source transport and chemistry of point source
135	19	Morris on single source models and photochemical
136	6	source modeling and tracking that type of thing.
138	9	particular source plume kind of in its own
138	18	single source is full state of the science gas-
139	7	Source Apportionment tools allow for tracking of
139	10	More recently, Source Apportionment tools
139	16	single source applications. I’ll show some
139	17	examples in a minute. Source Apportionment
140	3	pretty self explanatory. Source Apportionment
140	6	contributions from emissions source groups,
140	7	emissions source regions, and initial and
140	9	model species for each contributing source.
140	21	particular source you would just include
141	7	This is an example of ozone source
141	12	contribution from a source shown at right and
141	14	source apportionment.
141	15	This is an example of using Source
141	19	estimation from that particular source in each
141	21	the source would be located. The photochemical
141	23	contribution from that source to ammonium
141	25	species. So clearly this particular source has
142	5	from a particular source over an entire year.
142	12	Issues for using PCM for Single Source
143	21	single source modeling with CAMx PSAT to compare
143	23	States did single source visibility modeling for
145	17	for credible single source modeling with Source

Page	Ref No.	Keyword = "source"
146	3	will get more details from Ralph on single source
146	17	photo grid models for the single source
146	21	seeing now more and more what is my source or are
146	23	the contributions of source to the Ozone and
147	12	source plume chemistry and dispersion?
147	15	the source to resolve near-source plume chemistry
147	25	capability for PGM for single source but we do
148	5	can specify fine grid to resolve point source
148	9	chemistry of point source plumes. Both CMAx and
148	10	CMAQ have PM and Ozone Source Apportionment and
148	11	allows individual source(s) assessments. Of
148	23	point source plumes. Available within the CAMx
149	13	PM Source Apportionment so I don’t have to talk
149	19	in the eastern U.S. Individual point source
150	13	areas. Use IRON P-in-G for Texas BART Source.
151	5	inconsistent source contributions with 2009 PM2.5
151	7	inappropriate for individual point source
151	9	treat chemistry and dispersion of point source
151	11	point source plume would be computationally
151	13	31 zero-out runs to get individual source
151	17	chemistry and dispersion. PM Source
151	19	individual source contributions.
151	25	2009 base case with PSAT PM2.5 source
152	14	Here’s the source apportionment. The
153	6	contributions. The largest single source
153	7	contribution is this source right near the
153	9	contribution source on a monitor. In this case
154	2	“single source” contributions to ozone, PM2.5,
154	6	PM source apportionment. Full gas-phase and
154	9	source” air quality, visibility and deposition
154	11	source PM2.5 assessment. Oil and gas AQ and AQRV
154	16	“single source” contributions to ozone, PM2.5,
154	20	PM source apportionment. Full gas-phase and
154	23	“single source” air quality, visibility and
154	25	point source PM2.5 assessment. Oil and gas AQ and
155	6	any questions on single source?
156	9	modeling single source for Ozone PM2.5 seems to
166	7	the pollutant source domain. For most pollutant
166	13	characteristics of the pollutant source domain.
176	9	questions. The issue is the source region
178	11	this is a single source area in Central
180	24	can use reanalysis as a source for
182	9	Potentially a source for site specific data -
183	8	attractive at least in upper air data source
186	19	develop and release the Industrial Source [ed.

Page	Ref No.	Keyword = "source"
189	21	source characterization study which generally has
199	4	some condensing from vapor – source/fuel-
199	5	specific. It is emitted directly from a source
202	14	source types from EPA’s AP-42, SPECIATE, and FIRE
203	2	PM2.5 NAAQS Impact: Background + Source Impact.
203	4	source impact to peak percentile background,
203	8	source impact concentrations. If daily
206	24	source. For tall stack, buoyant releases, 1 km
216	12	techniques in new source permitting situations to
218	10	the evaluation of new source permitting. PM2.5
218	20	component. Also, for single source new
221	14	the problem at the source. Multi-core processors

Page	Ref No.	Keyword = "speed"
55	9	see the distribution and wind speed in your data
55	12	mixing ratio, wind speed, wind direction, but
56	4	and then (inaudible) and you see the wind speed,
63	7	evaluation of low wind speed databases with API
64	23	conc vs. downwind distance or wind speed, etc.
66	6	dependent on the wind speed as well. When you
74	25	into the wind speed issue as Bob Paine mentioned
75	11	include sonic anemometer with lower wind speed
75	12	stretched so they had lots of light wind speed
77	12	lot of light wind speed, upward spike in the
89	19	specifically under light wind speed conditions is
104	7	like a plume because wind speed and direction
104	14	speed shear with height. And that is really
120	5	causality effects, low wind speed dispersion,
193	8	ran AERMOD for these 3 cases for 1 wind speed.
197	12	speed, wind direction, Frequency of light wind
204	13	The Low wind speed issues. Modeling of
207	3	wind speed issues. Moisture assigned only on an
207	25	wind speed threshold is treated the same way as a
209	7	handling, low wind speed stagnation, coastal and

Page	Ref No.	Keyword = "stack"
40	4	stack is in the valley -- with coarse resolution,
40	9	and the peaks are higher so maybe the stack now
56	19	specific; stack box plots (inaudible) box plots.
57	21	entire year. Stack bar plots, this is more
74	10	tall stack or evaluation data base that was used

Page	Ref No.	Keyword = "stack"
124	4	•187m power plant stack, rural
127	15	the science treatment of stack plumes at the sub-
189	9	and position that places stack in the correct
193	22	stack height regulation defines nearby terrain
193	23	for the purpose of limiting stack heights. Past
202	16	reviewed stack test data to develop emission
202	22	factors are based on stack test methods known to
206	24	source. For tall stack, buoyant releases, 1 km

Page	Ref No.	Keyword = "stacks"
40	6	stacks are no longer below the terrain height.
71	20	of the applications are for tall stacks. For
89	7	scheme of things, this has primarily been stacks,
89	8	elevated stacks. To what degree do we have good
208	22	quality impact from (inaudible) stacks from long

Page	Ref No.	Keyword = "statistical"
7	20	such, we believe statistical measures should
9	11	decide to augmented statistical measures focusing
10	21	Draxler et al. (2001). These statistical
10	22	measures are a broad set of statistical measures.
11	14	These are the statistical measures and these
13	23	for this statistical component of it. So that's
34	18	terms of the statistical data. It did marginally
44	5	the arc statistical program and he was plotting
51	7	MYSQL, another one is R a statistical package
52	19	statistical metrics. Diurnal Statistics, Time
67	2	determine the statistical significance of
67	11	then that means the models are not statistically
68	17	they cross zero, they are statistically unbiased
167	9	monitoring data combined with statistical
167	17	etc.) as opposed to statistical fits to site
167	19	statistical models in place of more rigorous
168	2	approving statistical fits.

Page	Ref No.	Keyword = "steady state"
7	10	modeling so we use non steady state (inaudible)
160	10	models such as MM5) for both steady state and

Page	Ref No.	Keyword = "surface"
71	19	tower data, not just surface data because a lot
80	21	Another issue that comes up is surface
81	9	assessment was that low surface roughness used to
81	18	source surface characteristics of the sources.
83	11	data process with surface characteristics using
83	25	surface characteristics differences between the
84	7	to see due to surface roughness itself.
165	24	surface roughness to a 1 km radius of ASOS
166	4	by surface roughness of airport property. Better
166	10	the surface modeling of the airport roughness.
174	5	surface relative humidity (RH). In reality,
182	11	standard upper air and surface observations
183	25	surface up to 700 mb and above 200 mb. Between
184	21	It uses Pittsburgh PA surface and upper air
185	17	requirements of surface data for AERMOD.
206	20	Sensitivity of modeling to surface
206	23	mismatch in surface type between met tower and
207	8	for met and application site surface
207	11	that differences in site surface characteristics

Page	Ref No.	Keyword = "surrogate"
200	20	EPA had a PM10 surrogate policies for compliance
218	25	a surrogate. But now with the EPA delegated

Page	Ref No.	Keyword = "temperature"
54	23	temperature and the one on the right for wind
55	3	different temperature ranges and then a box plot
174	10	minimum temperature will overstate SO4 and
197	13	speeds, etc., vertical wind and temperature
197	14	structure, temperature & relative humidity,

Page	Ref No.	Keyword = "terrain"
19	23	good complex terrain to it which would be useful.
28	22	that explains why we’re not seeing the terrain of
35	25	study are updated terrain and land use from old
39	9	in CALPUFF such as you resolve the terrain
39	18	terrain and also the source location relative to
39	23	impacts where the terrain may channel the flow
40	5	the terrain may get smoothed so much so that the

Page	Ref No.	Keyword = "terrain"
40	6	stacks are no longer below the terrain height.
40	14	the effect of terrain resolution from 90
40	24	a split of higher and lower terrain resolution.
44	10	the terrain causing this or the land use. So I
44	13	flattened the terrain so that is was 1 meter
44	14	terrain for the single land use. I had all the
44	20	terrain and land use were making a difference
70	24	complex terrain). Conditions of concern for
76	21	This is a terrain plot and it’s not very clear
76	23	more significant terrain features around the
76	24	site. It’s not real dramatic terrain features
100	6	high resolution terrain it would use that data
105	24	(5000). If you don’t recognize the terrain this
155	9	analysis do you treat terrain elevations of the
155	17	as far as the terrain the receptors are at the
155	19	receptor if you like. These models are terrain
155	22	Joe Scire: There’s no terrain
155	25	Ralph Morris: Yes, the terrain
156	2	(inaudible) so any terrain effects are in the
162	22	terrain, short term puff dispersion, chemical
163	16	mountainous terrain, such as Wyoming where there
165	20	distance limits and whether “complex terrain” is
188	23	and Terrain Wake Effects.
193	21	Terrain wake effects; currently the GEP
193	22	stack height regulation defines nearby terrain
193	25	terrain can be significant. Currently this effect
194	4	two when terrain wake effect is accounted for
194	7	upwind terrain wake effects should be considered.
194	9	developed to determine wind up wind terrain and
194	13	EPA wind tunnel where they showed these terrain
194	25	accounting for upwind terrain wake effects. That
198	11	flat, rolling terrain, mountainous, tracer or
209	8	air issues. Complex terrain and slow reversal

Page	Ref No.	Keyword = "toxics"
132	3	large spatial variability in air toxics
137	9	VOC, SOx, PM and toxics and use data science
137	12	toxics, and even deposition.
140	12	that. There are also some toxics components but

Page	Ref No.	Keyword = "tracer"
7	25	meteorological and tracer databases for
8	4	mesoscale tracer studies but there is no one
8	23	done on these mesocale tracer studies. The two
8	25	the Great Plains Tracer Mesocale Tracer Study and
13	12	model; this is a European tracer experiment and I
13	21	the model performed in that particular tracer
14	24	mentioned earlier is to assemble a tracer and
16	24	assembled tracer database. Then like I said
17	2	LRT models for the assembled tracer database to
17	20	awaiting any tracer evaluations that had been
18	10	these tracer data bases looking at both
19	2	The tracer experiments that we have
19	3	currently we have the Great Plains Tracer
19	5	lot today. Savannah River Laboratory Tracer
19	8	the Cross-Appalachian Tracer Experiment but that
19	12	Then the European Tracer Experiment which is a
20	13	Then that’s not a good tracer evaluation to
21	14	the Great Plains Mesoscale Tracer Experiment.
21	18	perflourocarbaon tracer releases from Norman, OK
26	4	duration and the time that the tracer cloud
26	25	placed in the tracer cloud. What we did see here
29	19	go back and look at with this tracer evaluation.
30	2	tracer experiment and basically this is probably
30	3	I call it the granddaddy of all the tracer
30	5	tracer experiment we have. This was Europeans
30	8	So the European’s tracer experiments or ETEX was
30	15	two releases of perflourocarbon (PFC) tracer were
34	25	are an insufficient number of tracer experiments
35	9	Basically for the Great Plains Tracer
36	13	The European Tracer Experiment and as you can
43	20	was working on the Great Plains Tracer Experiment
44	23	Plains Tracer Study did and that’s probably where
63	12	tracer studies and short-term intensive studies,
63	17	concentrations on tracer arcs that are used for
64	13	mixture of tracer experiments and long-term
64	24	They are generally used only for tracer
65	6	only used for tracer databases.
67	18	best suited to tracer databases and is widely
69	9	distance. For a particular tracer arc if you
73	20	the 1950’s. It is an intense tracer study as Bob
112	19	km scale we’re looking at a tracer experiment we
114	8	web all the tracer experiments we have been
114	10	those tracer experiments we have run….the first
117	23	version 4.9? We’ve got all these tracer
123	14	measurements from three tracer

Page	Ref No.	Keyword = "tracer"
143	11	PCMs, evaluate tracer studies. The picture on
143	12	the right was a tracer experiment we just did a
163	21	observations, tracer releases, and PM and
198	11	flat, rolling terrain, mountainous, tracer or
205	6	traffic itself. Review of data from tracer

Page	Ref No.	Keyword = "turbulence"
14	10	outdated. We had the new turbulence options; we
18	4	recommend turbulence based dispersion (CALPUFF
18	11	P-G and turbulence options there. Then the final
24	25	turbulence here. I think that’s one I mean
25	4	CALPUFF turbulence and the AERMOD turbulence in
25	21	upon which P-G or turbulence we have a little bit
35	5	encouraged with the turbulence in terms of the
82	3	vehicle induced turbulence. Especially for the
102	7	staggered WRF grids, turbulence ensemble, urban
104	16	kind of turbulence on this it would have a minor
107	14	from the turbulence from the previous time step,
107	19	in proportion to the turbulence that comes out of
108	6	had stationary homogeneous turbulence. You’re
118	8	turbulence already in existing version and
120	10	inhomogeneous (convective) turbulence. They are
122	6	of turbulence. The tendency of neighboring puffs
127	10	treatment of effect of atmospheric turbulence on
205	5	turbulence and low wind speeds generated by

Page	Ref No.	Keyword = "urban"
19	21	on. The other one is the VTMX where the urban
63	3	colleague here has done an urban evaluation and
84	4	is right in the urban options so the urban
102	7	staggered WRF grids, turbulence ensemble, urban
136	17	photochemical models like urban REMSAD models.
165	17	algorithms for use in urban areas, especially for
204	15	small urban areas. Need for post-processor to
205	12	Nocturnal urban mixing height (Ziu) is a
218	17	nonattainment areas are urban areas where,

Page	Ref No.	Keyword = "variability"
120	3	variably of accounting for spatial variability of
120	7	variability in dispersion rates, etc. Lagrangian
125	17	capture fine scale variability next to emissions
125	21	cannot capture the subgrid-scale variability that
126	21	captures the local scale variability and the grid
132	3	large spatial variability in air toxics
132	7	subgrid-scale variability in exposure levels.
155	11	is do you treat any wind variability within the
155	23	variability in the cell? That’s my question

Page	Ref No.	Keyword = "weather"
111	2	the large scale weather patterns at the frontal
112	7	go to our web page and also the weather service
112	8	page. Our page is better than the weather
112	10	verification whereas the weather page only shows
181	15	weather service for about 15 years. That’s
183	10	weather and technical geek, let me see if I can
226	15	National Weather Service Stations. Then

Page	Ref No.	Keyword = "wind"
18	15	is very sensitive to wind field (inaudible) you
26	24	seeing that in terms of where the wind shield was
28	20	appears that the wind field was steering it l
29	21	CALMET wind fields from the previous one. I
32	10	gets into this area up here we start with wind
33	8	getting caught up in the deforming wind field the
54	18	to the met side includes Rawindsonde, Wind
54	23	temperature and the one on the right for wind
55	7	generated. And similarly on the wind direction
55	8	side in the wind direction plots where you can
55	9	see the distribution and wind speed in your data
55	12	mixing ratio, wind speed, wind direction, but
55	21	would also be to window this down to other
56	3	This is a wind profiler comparison over time
56	4	and then (inaudible) and you see the wind speed,
56	6	you have wind profile information,. a nice plot.
63	7	evaluation of low wind speed databases with API
64	23	conc vs. downwind distance or wind speed, etc.
66	6	dependent on the wind speed as well. When you
69	10	have a cross wind concentration like this you
71	14	understanding of the Low Level Jet and the wind

Page	Ref No.	Keyword = "wind"
71	24	wind energy assessment towers that are available
74	25	into the wind speed issue as Bob Paine mentioned
75	11	include sonic anemometer with lower wind speed
75	12	stretched so they had lots of light wind speed
77	12	lot of light wind speed, upward spike in the
77	25	light wind conditions. There may be some
78	4	pretty clear pattern as the light wind speeds go
78	15	data. Just looking at the wind direction
78	20	that the SEARCH wind directions were offset by
79	6	light wind. For the SEARCH site you can clearly
79	7	see low wind, drainage flow, showing up under
79	10	West direction would be the typical light wind,
80	15	wind conditions? It’s not a clear answer one way
84	20	ASOS wind data to reduce the number of calms,
89	19	specifically under light wind speed conditions is
89	23	wind stable wind conditions. One reason for that
103	21	cloud when the wind field varies in space and
104	7	like a plume because wind speed and direction
104	11	wind coming out of the East (inaudible). And so
104	13	is a result of the wind direction shear and wind
112	3	that had a high wind velocity.
120	5	causality effects, low wind speed dispersion,
124	15	wind integrated concentration (CIC). Very
127	9	no treatment of wind shear or plume overlaps, no
146	10	more about the regional or further down wind a
155	11	is do you treat any wind variability within the
155	13	Ralph Morris: No just using the wind
155	15	whether it’s a gridded wind field or (inaudible).
156	3	wind fields that come out of MM5.
160	5	topography, wind persistence data and land use
166	6	wind observations to the land characteristics of
166	12	the airport wind observation to the land
183	14	creating wind roses and finding out how many
189	16	aspect ratios. Use of wind tunnel testing to
190	12	wind residential tower to go in to the model.
190	18	wind tunnel to determine the shape that would
193	7	diagonals of wind. Now I have some input and I
193	8	ran AERMOD for these 3 cases for 1 wind speed.
193	13	wind tunnel so I will show you what
193	14	concentrations looked like in the wind tunnel.
194	9	developed to determine wind up wind terrain and
194	13	EPA wind tunnel where they showed these terrain
196	6	change the wind data. It’s exactly as it came
196	14	output of MM5 converted to wind rose software.
197	11	Evaluate all meteorological variables. Wind

Page	Ref No.	Keyword = "wind"
197	12	speed, wind direction, Frequency of light wind
197	13	speeds, etc., vertical wind and temperature
204	13	The Low wind speed issues. Modeling of
204	20	AERMOD impacts occur for very low wind speeds,
204	25	hours with very low wind speeds. AERMOD needs
205	5	turbulence and low wind speeds generated by
207	3	wind speed issues. Moisture assigned only on an
207	25	wind speed threshold is treated the same way as a
209	7	handling, low wind speed stagnation, coastal and
210	25	is a long hour and a lot of wind speeds in most
226	11	approach which is to extract wind profiles from
226	21	comparing the prognostic model derived wind

Page	Ref No.	Keyword = "wind speed"
55	9	see the distribution and wind speed in your data
55	12	mixing ratio, wind speed, wind direction, but
56	4	and then (inaudible) and you see the wind speed,
63	7	evaluation of low wind speed databases with API
64	23	conc vs. downwind distance or wind speed, etc.
66	6	dependent on the wind speed as well. When you
74	25	into the wind speed issue as Bob Paine mentioned
75	11	include sonic anemometer with lower wind speed
75	12	stretched so they had lots of light wind speed
77	12	lot of light wind speed, upward spike in the
89	19	specifically under light wind speed conditions is
104	7	like a plume because wind speed and direction
120	5	causality effects, low wind speed dispersion,
193	8	ran AERMOD for these 3 cases for 1 wind speed.
204	13	The Low wind speed issues. Modeling of
207	3	wind speed issues. Moisture assigned only on an
207	25	wind speed threshold is treated the same way as a
209	7	handling, low wind speed stagnation, coastal and

Page	Ref No.	Keyword = "wind speeds"
78	4	pretty clear pattern as the light wind speeds go
204	20	AERMOD impacts occur for very low wind speeds,
204	25	hours with very low wind speeds. AERMOD needs
205	5	turbulence and low wind speeds generated by
210	25	is a long hour and a lot of wind speeds in most

Page	Ref No.	Keyword = "winds"
25	14	You can see here the CALMET winds did very
25	16	better than the MM5 winds in terms of the arrival
27	2	is that when we were feeding the MM5 only winds
27	12	where the MM5 winds did markedly better than
27	20	the MM5 winds were doing slightly better, but you
27	21	can see the MM5 winds have it displaced more
70	25	dispersion modeling are how often are the winds
77	20	variable winds we are looking at 25 or 30% of the
77	21	data period missing either to calms or winds.
79	23	light winds conditions that show up at the
165	15	incorporate algorithms for near calm winds and
211	7	method to define precisely when complex winds
211	11	winds. But I think the answer is in the
211	12	definition of complex winds.

Page	Ref No.	Keyword = "work group"
210	5	AWMA supports an independent work group for