**Topical Report** 

# A Comparison of MM5 Model Estimates for February and July 2001 Using Alternative Model Physics Options

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## 1 INTRODUCTION

One very desirable feature of the Pennsylvania State University/National Center for Atmospheric Research (NCAR) Mesoscale Model (MM5) is the ability to select from a host of different physics options. Over the past two decades researchers from diverse areas of study have implemented options in the MM5 model to handle physical parameterizations of Cumulus Clouds, planetary boundary layer, atmospheric moisture, land processes and atmospheric radiation.

This range of options is also a challenge for model application. The meteorological modeler is faced with selection of options with no theoretically "optimal" setting. Rather, the options chosen are based on the set that produce the "best" model simulation. Choosing a set of model options, performing the model simulation, and analyzing the model output thus determine selection of the final selections options.

This report presents the results of 7 different sets of model simulations performed for a winter and summer case in 2001.

## 2 METHODOLOGY

The methodology for this approach is very straightforward. The MM5 model is applied to two three-week periods, a winter case (2001 February) and a summer case (2001 July) and the model results are compared with available observations and synoptic weather charts.

## 2.1 Model Selection and Application

Below we give a brief summary of the MM5 input data preparation procedures we propose for the episodic and annual modeling exercises.

<u>Model Selection</u>: The most recent version of the publicly available non-hydrostatic version of MM5 (version 3.5) is used. The MM5 released terrain, pregrid, little\_r and interpf processor were used to develop model inputs.

<u>Horizontal Domain Definition</u>: The computational is presented in Figures 2-1. The domain is a single 36km domain with 165 x 129 grid cells, selected to maximize the coverage of the ETA analysis region. The projection is Lambert Conformal with the "national RPO" grid projection pole of  $40^{\circ}$ , -97<sup>o</sup> with true latitudes of 33<sup>o</sup> and 45<sup>o</sup>.

<u>Vertical Domain Definition:</u> The MM5 modeling is based on 34 vertical layers with an approximately 50 meter deep surface layer. The MM5 vertical domain is presented in both sigma and height coordinates in Table 2-1.

<u>Topographic Inputs:</u> Topographic information for the MM5 is developed using the NCAR and the United States Geological Survey (USGS) terrain databases. The 108 and

36 km grids are based the 5 min (~9 km) Geophysical Data Center global data. Terrain data is interpolated to the model grid using a Cressman-type objective analysis scheme. To avoid interpolating elevated terrain over water, after the terrain databases are interpolated onto the MM5 grid, the NCAR graphic water body database will be used to correct elevations over water bodies.

<u>Vegetation Type and Land Use Inputs</u>: Vegetation type and land use information is developed using the most recently released NCAR/PSU databases provided with the MM5 distribution. The 108 and 36 km grids use the 2 min. (~ 4 km). Standard MM5 surface characteristics corresponding to each land use category will be employed.

<u>Atmospheric Data Inputs</u>: The focus of this study is to examine the influence the choice of "first guess" meteorological fields has on the MM5 model predictions. For the ETA case, the first guess fields are taken from the NCAR ETA archives. For the NNRP case, the data are extracted from the NCAR archives. Surface and upper-air observations used in the objective analyses, following the procedures outlined by Stauffer and Seaman at PSU, are quality-inspected by MM5 pre-processors using automated gross-error checks and "buddy" checks. In addition, rawinsonde soundings undergo vertical consistency checks. The synoptic-scale data used for this initialization (and in the analysis nudging discussed below) are obtained from the conventional National Weather Service (NWS) twice-daily radiosondes and 3-hr NWS surface observations.

<u>Water Temperature Inputs:</u> The NNRP and ETA database contains a "skin temperature" field. This can be used as a water temperature input to MM5. It is recognized that these skin temperatures can lead to temperature errors along coastlines. However, for this sort of analysis focusing on bulk continental scale transport, this issue is likely not important.

<u>FDDA Data Assimilation</u>: This simulation uses an analysis-nudging technique were the observations are nudged toward a field prepared by objective analyzing surface and aloft monitor data into the first-guess fields. For these simulations a nudging coefficient of  $2.5 \times 10^{-4}$  was used for winds and temperature and  $1 \times 10^{-5}$  for mixing ratio. Only 3D analysis nudging was performed and thermodynamic variables are not nudged within the boundary layer.

Physics Options: The Base MM5 model physics options in these simulations are as follows:

Kain-Fritsch Cumulus Parameterization Blackadar PBL Scheme Simple Ice Moisture Scheme RRTM Atmospheric Radiation Scheme Multi-layer Soil Temperature Model

Sensitivity Simulation Description:

The seven (7) sensitivity simulations performed were:

Eta: "Baseline" model configuration

Hifdda: Baseline model configuration with the FDDA nudging coefficient doubled.

NoFDDA: Baseline model configuration without FDDA.

Reisner2: Baseline model configuration with the Reisner2 moisture scheme substituted for the simple ice scheme.

ZFAC: Baseline model configuration with the Penn. State "ZFAC" modifications to remove all nudging below 850 mbars.

Pleim-Xu: Baseline model configuration with the MM5 3.5 Pleim-Xu PBL and land surface model. Not "INTERPX" model reinitialization scheme was used and no soil nudging was performed.

Pleim-Xu2: Baseline model configuration with an updated version of the Pleim-Xu PBL and land surface model supplied by John Pleim in July 2002. The INTERPX model reinitialization scheme was used and soil nudging was performed. To use the soil nudging necessitated nudging to three hourly observations, instead of the 12 hourly nudging used in the other simulations.

## 2.2 Evaluation Approach

The model evaluation approach is based on a combination of qualitative and quantitative analyses. The qualitative approach is to compare the model estimated sea level pressure and radar reflectivity fields with observed values from historical weather chart archives. The statistical approach is to examine the model bias and error for temperature, mixing ratio and the Index of Agreement for the windfields.

Interpretation of bulk statistics over a continental scale domain is problematic. It is difficult to detect if the model is missing important sub-regional features. For this analysis the statistics are performed on a state by state basis, a Regional Planning Organization (RPO) basis, and on a domain-wide basis.

The observed database for winds, temperature, and water mixing ratio used in this analysis is the NOAA Techniques Development Lab (TDL) Surface Hourly Observation database obtained from the NCAR archives. The rain observations are taken from the National Climatic Data Center (NCDC) 3240 hourly rainfall archives.

k(MM5)	sigma	press.(mb)	height(m)	depth(m)
34	0.000	10000	15674	2004
33	0.050	14500	13670	1585
32	0.100	19000	12085	1321
31	0.150	23500	10764	1139
30	0.200	28000	9625	1004
29	0.250	32500	8621	900
28	0.300	37000	7720	817
27	0.350	41500	6903	750
26	0.400	46000	6153	693
25	0.450	50500	5461	645
24	0.500	55000	4816	604
23	0.550	59500	4212	568
22	0.600	64000	3644	536
21	0.650	68500	3108	508
20	0.700	73000	2600	388
19	0.740	76600	2212	282
18	0.770	79300	1930	274
17	0.800	82000	1657	178
16	0.820	83800	1478	175
15	0.840	85600	1303	172
14	0.860	87400	1130	169
13	0.880	89200	961	167
12	0.900	91000	794	82
11	0.910	91900	712	82
10	0.920	92800	631	81
9	0.930	93700	550	80
8	0.940	94600	469	80
7	0.950	95500	389	79
6	0.960	96400	310	78
5	0.970	97300	232	78
4	0.980	98200	154	39
3	0.985	98650	115	39
2	0.990	99100	77	38
1	0.995	99550	38	38
0	1.000	100000	0	0

 Table 2-1: MM5 Vertical Domain Specification.

Figure 2-1: National ETA Computational Grid.



## **3 RESULTS**

## 3.1 Model Resource Requirements

The model resource requirements for the simulations are presented in Table 3-1. These times are approximate and are total elapsed times based on a dedicated computer. The times are approximate since all input/output was performed over a shared network onto an NFS server that was serving all simulations.

## **3.2 Model Evaluation Results**

The synoptic and statistical evaluations for the two episodes using the difference model configuration options are presented in the following sections. The Pleim-Xiu configuration was unable to complete the July simulation. The model became unstable in the simulation. For this reason, no statistics are included for the Pleim-Xiu simulation and the synoptic evaluation is missing results for periods where the model was not operational.

## **3.2.1** Synoptic Evaluation

One very important metric of model performance is to qualitatively assess whether how well the model is able to capture the evolution of synoptic systems. Sea level pressure and radar reflectivity plots for the February and July episodes are presented in Figures 3-1 through 3-12 and 3-13 through 3-24, respectively. On each figure, the first frame presents the archived surface chart from weather.unisys.com. The other frames present the plots for the other simulations with the simulation name under each frame. For the model simulations, the model estimate sea-level pressure is the blue line. Shaded areas on both the model estimated and analyzed charts denote regions of high radar reflectivity.

Some general conclusions from these figures are:

The Reisner-2 configuration tends to produce the smallest regions of radar reflectivity. All configurations underestimate the extent of the regions of high radar reflectivity, particularly for the July episode.

The model generally captures long wave patterns. None of the configurations has a tendency to either lag systems behind the observations, or to advance systems faster than suggested by the observations.

The NoFDDA simulation is able to capture the general flow patterns that suggest that the FDDA scheme is not inappropriately driving the model results.

## **3.2.2** Statistical Evaluation

The results for the statistical evaluation are presented in this section. The tables present the statistical metric for each state, for each Regional Planning Organization, and for the entire modeling domain (including only the United States). In all figures, a state is shaded the color corresponding to the simulation which performed the best for that variable and metric.

Temperature bias scores for the two MM5 model applications averaged over the February episode are presented in Table 3-2. A graphical depiction of Table 3-2 is presented in Figure 3-25. The Pleim-Xiu and Pleim-Xiu 2 configurations are superior for the majority of the states. For the nation as a whole, the ETA configuration has a slightly lower temperature bias than any other configuration. Temperature bias error data are presented in Table 3-3 and Figure 3-25. The Pleim-Xiu 2 configuration shows the lowest temperature bias over the Midwest and Eastern US and the ETA configuration shows the lowest bias over the Western States. For the entire domain, the Pleim-Xiu configuration has the overall lowest bias.

Mixing ratio bias data are presented in Table 3-4 and Figure 3-37. Except for a tendencty for the Pleim-Xiu 2 configuration to do better in the south-east, no clear regional trends are evident. For the overall domain, the Pleim-Xiu 2 configuration has the lowest bias. Mixing ratio error is presented in Tables 3-5 and Figures 3-38. For the country as a whole, the ETA, HiFDDA and Pleim-Xiu 2 configurations show similar scores. On a state wise basis, the Pleim-Xiu 2 configuration is superior along the majority of the Atlantic seaboard and no clear trends are evident in the rest of the US.

Accumulated precipitation bias data for February are presented in Table 3-6 and Figure 3-29. The HiFDDA simulation performs the best over the majority of the Midwest and Western US. The Pleim-Xiu 2 configuration performs the best in the majority of the Southeast. Averaged over the entire domain, the ZFAC configuration performs best. Accumulated precipitation error data are presented in Table 3-7 and Figure 3-30. The HiFDDA simulation again performs best in the Midwest and West, with no clear trends in the East. For the whole country, the Pleim-Xiu 2 configuration performs the best.

Wind comparison index of agreement for the February episode are presented in Table 3-8 and Figure 3-31. No clear regional trends are evident and surprisingly the NoFDDA simulation has the highest index of agreement.

Temperature bias for the July episode is presented in Table 3-9 and Figure 3-32. Averaged over the country, the HiFDDA configuration appears superior. State wise, the Pleim-Xiu 2 configuration is superior in the majority of the states. Table 310 and Figure 3-33 present the temperature error statistics. As was seen with temperature bias, the Pleim-Xiu 2 configuration is superior over the majority of the United States and for the US as a whole.

Mixing ratio bias is presented in Table 3-11 and Figure 3-34. Averaged over the United States, the HiFDDA and Pleim-Xiu 2 configurations have lower overall error. On a state by state basis, the Pleim-Xiu 2 is generally better in the Southeast with no clear trends in the rest of the county. Mixing ratio error is presented in Table 3-12 and Figure 3-35. Again, the HiFDDA and Pleim-Xiu 2 configurations are superior on a domain wide basis and regionally in the southeast.

Accumulated precipitation bias data for July are presented in Table 3-13 and Figure 3-36. No regional trends are evident. Averaged over the entire domain, the ZFAC configuration performs best. Accumulated precipitation error data are presented in Table 3-14 and Figure 3-37. The ZFAC and NoFDDA simulations perform best throughout most of the US. For the whole country, the ZFAC configuration performs the best.

The July index of agreement data are presented in Table 3-15 and Figure 3-38. No clear regional trends are evident and as with the February case, the NoFDDA simulation performs the best on a domain wide basis.

Table 3-1: MM5 model computational requirements per 6 day simulation. CPU times are on a dual 1GHz P-III computer system running Linux and the Portland Group FORTRAN compiler. Times are Hours:Minutes.

Model Configuration	CPU Time Per Block	
ETA	18.48	
Hi FDDA	18:23	]
No FDDA	18:23	
Reisner 2	24:50	]
Pleim-Xiu	26:10	

#### Figure 3-1: Analyzed and Model Estimated Surface Synoptic Charts at 12 Z 3 Feb. 2002.



Observation





Dataset HIFDDA RIP: dbs Foot: 48.00 Hortscrift Hortscrift



High FDDA

Bataset NOFDIM SIP dba Fox: 48.09 Trail. 1200 UTC Sat 03 Feb 01 (5000 CST Sat 03 Feb 01) in stgar. - 5.00 Bataset - 5.00



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 MP: dbg
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 Foot.
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 Hompoold wind westers
 nt tems = 5.590



Pleim-Xiu

Dotaset PLEDI-3028 RIP dbd Foot 48.00 Yako 1200 UTC Sat 03 Feb 01 (5000 CST Sat 03 Feb 01) Managaa = 0.990 Itanapada wind westers





Totanet: SPAC BIP: dot Foot: 46.05 Foot: 1000 Foot:





#### Figure 3-2: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 5 Feb. 2002.



Observation





Dataset HIFDDA RIP dia Foot 90.00 Bunderstein Bunderst



 
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 Fail, 1200, UTC, fail 01, Fab 01, Foct, 96,000
 Fab 01, Fab 01



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Pleim-Xiu

Dolaset: PLEDH-2028 HIP, dba Init, 1300 UTC fhu 01 Peb 01 Prot. 90.00 Yalid: 1300 UTC Mon 05 Peb 01 (2002 CST Mon 05 Peb 01) Molectivity Hufscolal wild vectors singuas = 0.990



Dataset REI2MERS REP: db2 Foot: 90.00 Valid: 1200 UTC Mon 05 Feb 01 (2000 CST Mon 05 Feb 01) pdfartering and restorn stagma = 0.780 Dataset: 2FAC BIP: dbs Foot: 96:09 Marticolal wild vectors Marticola





#### Figure 3-3: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 7 Feb. 2002.



Observation

Dataset ETA RP: dbs Fost 24.00 Beflectivity Harinootal wind rectors Sna-level pressure

Telid: 1200 UTC Wed 07 Feb 01 (0000 CST Wed 07 Feb 01) #1 Mgma = 0.780 n1 Mgma = 0.590



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## High FDDA

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 missas = D3780



Dutaset PLEDH-3UU RIP: db2 Init: 1800 UTC Tae 06 Feb 0; Foot: 24.00 Feb 0: Feb 01 (0000 CST Wei 07 Feb 01) Ministrative standards und restorn st standard = 0.990



Pleim-Xiu

Dotaset PLEDI-2028 BIP dbd Inti: 1800 UTC The 06 Feb 01 Fost: 24.00 Boffording Hald t200 UTC Wed 07 Feb 01 (0000 CST Wed 07 Feb 01) Hartscords wind vectors ni Agana = 0.790











#### Figure 3-4: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 9 Feb. 2002.



Observation

Dataset: ETA RP: dbs Fost: 72.00 Reflectivity Hariacetal wind vectors fos-level pressure Valid: 1200 UTC Try op Feb 01 1010 UTC Try op Feb 01 (0060 CST Fri 09 Feb 01) 11 Mana = 0.109 11 Mana = 0.190



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Pleim-Xiu

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#### Figure 3-5: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 11 Feb. 2002.



Observation





Dataset HIFDDA REP. dbs Foot: 12900 Marketsing Marketsi



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Pleim-Xiu

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Dataset: SFNC RIP: dot. Foot: 125:00 Reflectivity Intraceoda wind reactors in square = 0.780 in square = 0.780





#### Figure 3-6: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 14 Feb. 2002.



Observation





Dataset HIFDDA BIP dbs Frot. 72.00 Buttertority Buttertor



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Toroart PEDI-DD NP: db2 Foot 92.00 Field 1200 UTC Ved 14 Feb 01 (0000 CST Fed 14 Feb 01) Policitude Ved 14 Feb 01 (0000 CST Fed 14 Feb 01) Policitude Ved Ved 14 Feb 01 (0000 CST Fed 14 Feb 01)



Pleim-Xiu

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 0000
 CST Wed 14. Feb 01

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 ut sigms = 0.5900
 0.5900



Dutaset RE290ES2 REP doz Foot 72.00 Foot 72.00 Miscliwite Miscliwi Dataset SPAC BIP: dos Foct. 92.00 Horizottal Martinostal wind vectors Dis-level pressure st stagess = 0.590





#### Figure 3-7: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 16 Feb. 2002.



Observation

Dataset: ETA RIP: dbs Fost: 129.00 Selfactative Harizontal wind rectors

Buit 1350 UTC Pri 16 Feb 01 (2000 CST Fri 16 Feb 01) wi sigma = 5.700 ul sigma = 5.700



ETA

huit 1350 UTC Sun 11 Peb 01 Vald: 5200 UTC Pri 16 Feb 01 (2000 CST Fri 16 Feb 01) af sigma = 5390 at sigma = 5.900 Dataset HIFDOA RIP: dit2 Fost 129.00 Seffectivity tal wind partor



### High FDDA

Dataset NOPDIA BIP: dbs Fest: 129.00 Selectivity Hariacetal wind vectors

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 Dutaset
 PLEDM-3UU
 MP: db2
 Init.
 1300 UTC Sun 11 Feb 01

 Foot.
 120:00
 Valid.
 120:00 UTC Fpi 16 Feb 01 (00:00 CST Fpi 16 Feb 01)

 Multichritig
 mt signa = 0.780
 unit signa = 0.780

 Turtisorda vind restore
 nt signa = 0.590



Pleim-Xiu

Dofaset: PLEDH-3028 HIP dbs hut 1200 UTC Pri 16 Feb 01 (0000 CST Pri 16 Feb 01) Post 120:00 wind senters wind senters 10760 minigana = 0.7800 minigana = 0.780





Reisner 2



arte 7350 Rose-Freek Hinckeder Hangle (m. 36 km, 32 kmmi, 100 am

#### Figure 3-8: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 18 Feb. 2002.



Observation



Init 1200 UTC Sun 10 Feb 01 (0000 CST Sun 18 Feb 01) 100 UTC Sun 19 Feb 03 (0000 CST Sun 18 Feb 01) 11 Magnas = 0.990



Init 1200 UTC Sun 18 Feb 01 Telid: 1200 UTC Sun 18 Feb 01 (0100 CST Sun 18 Feb 01) 18 status - 56590 Dataset HIFDDA RIP: db2 Fest: 48.00



## High FDDA

 Dataset, NGTDDA SEP, dba
 fmit. 2330 UTC 3ri 16 Fab 0;

 Food, AR 60;
 Falidi 1200 UTC 3an, 16 Feb 01 (0000 CST Fau 18 Feb 01)

 Montevinie
 mit.stars = 0.7580

 Montevinie
 ni signs = 6.1900



Dataset PLEDH-JUU KEP: db2 Init 1200 UTC Pri 18 Feb 01 Foot: 48.00 Feldt 1200 UTC Sun 18 Feb 01 (0600 CST Sun 18 Feb 01) Mintertwite wind vectors in Aguas = 0.760 Utriscontal wind vectors in Aguas = 0.700



Pleim-Xiu

 Dotaset
 PLEDM-3028
 RHP
 dbst
 Init 1200 UTC Pri 16 Feb 01

 Foot
 48.09
 Telidi 1200 UTC Sun 18 Feb 01 (0000 CST Sun 18 Feb 01)
 isigmax = 0.786

 Strateorial wind vectors
 in sigmax = 0.786
 in sigmax = 0.786





Dutanet SFAC BIP: dbt Frot 46.09 Twildttring Informania wind restorn Informania wind restorn





#### Figure 3-9: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 20 Feb. 2002.



Observation





Dataset HIFDDA REP. dbs Foot 90.00 Montestering Montester



Dotant. NGTDIA SHP: dba Food: 90.002 Tri 19 Fab 01 Fold: 90.002 Tri 19 Fab 02 Fold: 90.002 Tri 19 Fab 02 Fold: 90.002 Tri 19 Fab 03 Fab 04 Fab 05 Fab 05



Dutaset: PLEDH-3UU REP: db2 Endt: 1200 UTC Tor 20 Feb 01 (0060 CST Tor 20 Feb 01) Fox: 90.00 Walds (2000 UTC Tor 20 Feb 01 (0060 CST Tor 20 Feb 01) Monactivity Wald reactors of Ages = 0.980



Pleim-Xiu

Dataset: PLEIN-2012 HIP dbs Init: 1200 UTC Pri 10 Feb 01 Feet: 90.00 Valid: 1200 UTC Tue 20 Feb 01 (0060 CST Tue 20 Feb 01) Beflectivity stagma = 0.990





Dutanet 22:4C BIP: dbs Foct: 96.09 Suffictivity Industry endowed Table 1200 UTC Tue 20 Feb 01 (0600 CST Tue 20 Feb 01) Intraportal wind restore Int signs = 0.196 Int signs = 0.196





#### Figure 3-10: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 22 Feb. 2002.



Observation

Dataset EDA REP dtg Foot 24.00 Seflectivity Harizontal wind vectors Sea-lessed pressors

hut 1200 UTC Yes 21 Feb 01 Vald. 1200 UTC Yes 25 Feb 03 (0600 C37 Tho 22 Feb 01) of signs = 0.590





Dataset HIFDDA REP. dbs Frot. 24.09 Bufferdivity Horizontal wind vectors Sub-level pressure at legans = 5.990



## High FDDA

 Dataset, NGFDDA BEP, dba
 Not. 1,000 UTC Wed 21 Feb 01

 Foot: 24.00
 Foot: 24.00
 UTC Thy 22 Feb 01 (5600 G27 UTC 22 Feb 01)

 Mattership
 Index 500 UTC Thy 22 Feb 01 (5600 G27 UTC 22 Feb 01)

 Mattership
 Index 50 UTC Thy 22 Feb 01 (5600 G27 UTC 22 Feb 01)

 Mattership
 Index 50 UTC Thy 22 Feb 01 (5600 G27 UTC 22 Feb 01)



Dutaset PLEDH-3DU REP db2 Fost 24.00 Vald 1200 UTC Tbs 22 Feb 01 (0600 C3T (bo 22 Feb 01) Mediarduring wind restorn in Agena = 0.780 in Agena = 0.590



Pleim-Xiu

Dotaset PLEDH-3028 BIP dbs But 1250 UTC Ked 21 Feb 01 Foot: 24.09 Vald (2000 UTC Thy 22 Feb 01 (0600 GST The 22 Feb 01) mbsterley; in signs = 0.786 turiscontal wind vectors in signs = 0.780











#### Figure 3-11: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 24 Feb. 2002.



Observation

Dataset ETA RP: dbs Fost 72.00 Seflectivity Harizontal wind vectors Sea-level pressure

But. 1250 UTC Not 21 Feb 01 Taild: 1200 UTC Sat 24 Feb 01 (5000 CST Sat 24 Feb 01) at stars = 0.590 at stars = 0.590





Dataset HIFDDA RIP: dbs Frot. 72.00 Martinetic: Martinetal wind vectors State-Invel pressure State-Invel pressure (State-Invel pressure (State-Invel pressure) (State-Invel pressure (State-Invel pressure (State-Invel pressure) (State-Invel pressure (State-Invel pressure (State-Invel pressure) (State-Invel pressure (State-Invel pressure) (State-Invel pressure (State-Invel pressure) (State-



High FDDA

Bataset NOFDIM SIP dba Froit 22.09 Instant Sector Sat 24 Feb 01 (5000 CST Sat 24 Feb 01) Instant Sector Sat 24 Feb 01 (5000 CST Sat 24 Feb 01) Instant Sector Sat 24 Feb 01 (5000 CST Sat 24 Feb 01) Instant Sector Sat 24 Feb 01 (5000 CST Sat 24 Feb 01)



Dutaset PLEDH-3DU KIP: db2 Foxt 22.00 Yadio, 1200 UTC Sat 24 Feb 01 (5000 CST Sat 24 Feb 01) Mediactivity wind restorn in Agence - 0.950



Pleim-Xiu

Dataset PLEDH-2028 HIP dbd Hait 1200 UTC Sat 24 Feb 01 (5000 CST Sat 24 Feb 01) Reflectivity Hardword wind vectors ni Agama = 0.796 ni Agama = 0.796





Reisner-2

20 W

140
#### Figure 3-12: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 26 Feb. 2002.



## Observation

Dataset ETX RP dbs Fost 129.00 Reflectivity Haritoctal wind vectors See-level pressure Init. 1200 UTC Mon. 26 Feb 01 atigms = 0.750 at sigms = 0.750



Init. 1250 UTC Mon. 26 Feb 01 (2010 CST Mon. 26 Feb 01) nf sigma = 0.760 nf sigma = 0.560 Dataset HIPDDA RP: db2 Fost: 129.00 Sefericies



## High FDDA

Dataset NOFDIA SEP dia Fost 128.00 Talid 1300 UTC Mon 26 Feb 01 (2000 CST Mon 26 Feb 01) Reflectivity and vectors n types = 0.766



 Dotomet, PEEDI-DD, MP: dby
 htt: 1320 CFC Ned 21 Fab 01

 Foot: 158-00; Foot: 058-00; Foot: 010 Fab 01
 Fabilit: 1300 CFC Ned 20 Fab 01

 Pointpotd: wind vectors
 nt stams = 0.0960



#### Pleim-Xiu

Dotaset: PLEEN-3028 RIP dbs Reit, 1300 UTC Ned 21 Feb 0; Foot: 120.00 Yalid: 1300 UTC Mon 26 Feb 01 (2000 C27 Mon 26 Feb 01) Reflectivity relations to target = 0.766 international wind vectors nitagens = 0.766



3-27

Decause: RESUBER: REP: dos Foot: 129:00 Mild: 1300 UTC Mon 26 Feb 01 (2000 CST Mon 26 Feb 01) Montorial: Marianetal wind vectors Montorial: Marianetal wind vectors strangens = 5.590 Durawet SFAC RIP: dbs. Frot: 120:00 Pedicetivity India esclore India 1200 UTC Mon 26 Feb 01 (0000 CST Mon 26 Feb 01) Indiana = 0.760 Indiana = 0.760





#### Figure 3-13: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 3 July 2002.



Observation

Dataset EDL RP: dbs Feat 48.00 Metactivity Harizontal wind rectors Son-Level pressure

bill 1200 UTC Tue 03 Aul 01 (0700 CDT Tue 03 Aul 01 0700 CDT Tue 03 Aul 01 0700 CDT Tue 03 Aul 011 0700 CDT Tue 03 Aul 011 01 04000 cDT Tue 03 Aul 011





Dataset HIFDDA RIP: dbs Foot: 48.00 Montestrip Montestrip Montestrip Montestrip Montestrip Montestrip Montestrip



High FDDA

Dataset: NGFDDa SEP, dba Foot: 48.00 Menetority Horizortal wild restree interference and the sector interference a



 Dotomet.PEEDI-DD
 MP: dbg
 MD: 1200
 MD: 1200



Pleim-Xiu

Dotaset PLED-3028-0NT MIP dog Frot. 48.09 Wellettvig Horizonial wind westers in Agena = 0.990





#### Figure 3-14: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 5 July 2002.



Observation







Dataset HIFDDA RIP dbs Feet 90.00 Burlenster Burlenstal wind vectors Burlenster Burlenst





 Dataset:
 PLEDI-BUD
 PIF:
 dba
 Init:
 1200
 UTC
 Built:
 1200
 UTC</t



Pleim-Xiu

Doraset: PLEDH-3008-0NT MIP dog Foot: 90.00 Valid: 1200 DTC Thu 05 Jal 05 (0700 CDT Thu 05 Jal 01) Methodskip vind vectors ni signa = 0.7900 ni signa = 0.5900





140

#### Figure 3-15: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 7 July 2002.



## Observation



Valid. 1250 UTC Sot 07 Jul 01 (0709 CD7 Sat 07 Jul 01) of segme = 0.750 of sigme = 0.750





Dataset HIFDDA RIP: dbs Feet: 24.00 Montestate Montestate Management = 5.750 stat. 1200 UTC Set 07 Jul 01 (0700 CBT Sat 07 Jul 01) mathematics statgmas = 5.750



## High FDDA

Defense t. NOFDIM SIP: dba Prot. 24.09 Introductar ward sectors Int



Dataset PLEDH-RUU RIP: db2 Front: 24.00 Valid: 1200 UTC Set 07 Aul 01 (0700 CBT Set 07 Aul 01) Monethrite Infinitedal wind reactors of August = 0.950



Pleim-Xiu

Dataset: PLEDH-3UUS-UNI BIP: dbs [hilt: 1200 UTC 5ri 06 Jul 0] Post: 24.09 Valid: 1200 UTC 5ri 07 Jul 01 (0706 (BT Sat 07 Jul 01) Monocluip vind vectors ni sgma = 0.766 ni sgma = 0.766







ZFAC

Figure 3-16: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 9 July 2002.



Observation







Dataset HIFDDA REP: db2 Fect 72.00 Main: 1800 UTC Men: 08 Jul 01 (0700 CCT Mon: 09 Jul 01) Main: 1800 UTC Men: 08 Jul 01 (0700 CCT Mon: 09 Jul 01) with stgma = 6.596 with stgma = 6.596



Botawet NOFDIN SP: dba Fost - 22.00 Walie 1300 UTC Won 04 Jul 01 (0700 CDT Mon 09 Jul 01) Walie 1300 UTC Won 04 Jul 01 (0700 CDT Mon 09 Jul 01) Waliester - 100 walies - 0.590



 Rotaett, PEEDI-300, KEP; doc
 Dir.
 Dir.
 State
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 State
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 State
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Pleim-Xiu

Dataset: PLEDH-NUCS-UNI MIP: dbs Prost. 72.00 Medic 1000 UTC Mon 04 Jul 01 (0700 CDT Mon 04 Jul 01) Mediceticity Instructed wind vectors n sigma = 0.796











#### Figure 3-17: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 11 July 2002.



Observation







Dataset HIFDDA REP. dbs Foot 12000 Marketsty M



Dataset: NOFDIA REP: dba Feet: 120:00 Sufficienting Management of Agena = 0.7980 Management of Agena = 0.7980



Dotomet, PEEDI-DD, MP: dbg Foot 18500 Valid: 1200 UTC Wed (1 Jul 01 UTC) Fig 06 Jul 01 Policitation Policitat



Pleim-Xiu

Datawet: PLEIN-2018-CNT MF: dbg Enit: 120.0 UTC Wed 11 Jul 01 (0700 CDT Wed 11 Jul 01) Prot: 120.00 Valid: 1200 UTC Wed 11 Jul 01 (0700 CDT Wed 11 Jul 01) Martenetics Martineetal wind vectors nt signa = 0.990





Figure 3-18: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 14 July 2002. Intensities (Dbz): 20 🔳 30

Observation

Dataset HIFDDA RIP: db2. Fest 72.00

liult: 1250 UTC Sot 14 Jul 01 (0700 CET Sot 14 Jul 01) vet segme = 0.990 st sigma = 0.990





Dataset ETA RIP: dbs Fest: 48.00

Built 1200 UTC Pri 13 Aul 01 Molid: 1200 UTC Pri 13 Aul 01 (0700 CDT Pri 13 Aul 01) mi signa = 0.790 mi signa = 0.590



 Dotamet.PEEDI-DD
 MP: dbz
 Valid. 1250 UTC Soft 14 Aud 01. (2000 CTC Mod 11 Jul 01.

 Poder 72:00
 Valid. 1250 UTC Soft 14 Aud 01. (2000 CTC 300 L1 Jul 01.
 Not 14 Jul 01. (2000 CTC 300 L1 Jul 01.)

 Poderstoring
 Minimotod wind vectors
 Not 14 Jul 01. (2000 CTC 300 L1 Jul 01.)



Pleim-Xiu

Dotaset: PLEUM-3008-0NI BIF dos Frot: - 22.00 Reflectivity Reflectivity Instances wind vectors in signa = 0.990





003

#### Figure 3-19: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 16 July 2002.



Observation

Dataset, EDA RP: dbs Foot, 129:00 Solicetrativ Harinocital wind vectors Son-level pressure

Bait 1200 UTC Mon 16 Jul 61 (0700 CDT Mon 16 Jul 61) wind marks = 5,790 windges = 5,790



Balt. 1290 UTC West 11 Job 0; Valid: 1800 UTC Mest 16 Jul 01 (0700 CDT Mest 16 Jul 01) wit sigma = 0.590 Dataset HIFDDA RIP: dis2 Fest: 129.00 Seferitaria



## High FDDA

Valid: 1000 UTC Mone 16 Jul 01 (0700 CDT Mone 16 Jul 01) with segmen = 5.590 si sigmen = 5.590 Dataset: NGPDDA RIP: dba Fest: 129.00 Reflectivity Hariacodal wind vectors



 Dataset.PEED-300
 MP: dot
 Batt. 1250 (700 Kod 11 Jul 0);

 Foot 10-001
 Valid: 1000 (770 Kod 10 Jul 0);
 Foot 10-10 Jul 0);

 Policitativity
 Intrasta = 5190
 Status = 5190



Pleim-Xiu

Dataset: PLEDH-NDUR-ONI MIP: dos Frot: 120:00 Valid: 1200 UTC Won 16 Jul 01 (0700 CDT Mon 16 Jul 01) Medicularity mini vectors n' signa = 0.780 infracensi wind vectors n' signa = 0.780











Figure 3-20: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 18 July 2002. Intensities (Dbz): 20 Observation Valid: 1200 UTC Wed 15 Jal 01 (0700 CDT Wed 15 Jal 01) m stars = 0.700 n1 stars = 0.700 Dataset ETA RP: dbg Fest: 48.00 193.1 110 % 108 B00- 14913 \$082.0 STREET, LOOP

12.5.0 Esse-Freek Easteniar Simple ine - 36 km, 24 beele, 200





Dataset HIFDDA RIP: db2 Fost: 48.00 Inst: 1390 UTC Non 16 Jul 01 Valid: 1300 UTC Wed 16 Jul 01 (0700 CDT Wed 16 Jul 01) of sigma = 0.750

Hi FDDA

Dotaset NGFDIA RP dba Foot 48.00 Ministrate 48.00 Ministr





Model Would Not Operate

### Pleim-Xiu

Dataset PLEIN-3023-ONT MP: dbg Frot: 48.00 Valid 1200 UTC Wed 18 Jai D1 (0700 CDT Wed 18 Jai D1 Martentels Mart



Pleim-Xiu 2



Reisner 2





Figure 3-21: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 20 July 2002.



Observation









Dataset HIFDDA RIP dist 90.00

Robel info 122.0 Loss-Proch Elaskadar Simple ine - 26 km, 34 levels

## High FDDA



Inst: 1200 UTC Wed 18 Jul 51 (0700 CDT Wed 16 Jul 91) of sigma = 5.755 Dataset NOFDIA RIP: dbg Fest: 48.00

#### Model Would Not Operate

# Pleim-Xiu

Dataset PLEDS-2008-0NI RIP-Post 96.09 Seflecturits - dbd: Nolid: 1209 UTC Py: 32 Jul 01 (0700 CDT Py: 30 Jul 01) at signa = D390 miningma = 0.990



Pleim-Xiu 2



Reisner 2

YE R

Figure 3-22: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 22 July 2002.

Observation



Fred Kaskeler Simple in: 36 km 78



Dataset HIFDDA RE: disz Frost: 24.00 Bedievletig: Bardsonal wind wester: Star-twest resumer: Bardsonal wind wester: Bardsonal wester: Bardso



Dotanst NOFDDA BIP: dba Prot: 24.09 Milet 1200 UTC Sun 22 Jul 01 (0760 CDT Sun 22 Jul 01) Margan = 0.766 of signa = 0.960



Doramet, PERDI-JUD, MP: db2 Foot, 34, 00 Valid: 1200 UTC Sun 32 Jal 01, 0700 CDT Sun 32 Jal 01, Peterstein Instance Stress Instance Stress



Pleim-Xiu

 Dataset
 PLEDI-3028-0NI
 MP: dim
 Init: 1200 UTC Sat 21 Jul 01

 Fest:
 24.00
 Valid: 1200 UTC San 22 Jul 01 (0700 CDT San 22 Jul 01)

 Beforetherig:
 in signa = 0.796

 thatmondal wind vectors
 in signa = 0.596





Figure 3-23: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 24 July 2002.

45 50 55 Observation

Intensities (Dbz): 20 🔳 30 🔳





Dataset HIFDDA RE<sup>2</sup>, dbs Frot. 22.09 Bofischering Bardschaf wedres Bardsc



Dataset NOFDDA SHP dba Peck 22.09 Minterial stad sectors historical stad sectors historical



 Dotomet. PERDI-300
 MP: dbz

 Pool. 72.00
 Pool. 72.00

 Pool. 72.00
 Pool. 72.00



Pleim-Xiu

Dataset: PLEDH-3U28-DNI BIP, dbs Indt: 1200 UTC Sea 21 Job 01 Foot: 72.00 Reflectivity Valid: 1200 UTC Twe 24 Aul 01 (0700 UDT Twe 24 Aul 01) Infrancesiant wind vectors in Agena = 0.990





Figure 3-24: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 26 July 2002.



Observation



Dataset HIFDDA RIP: dbs Foot: 12900 Refuelting: Mantochai wind restors in sigma = 0.990



Dataset NGPDIA SIP dba Front 12000 Walld 1200 UTC Thu 20 Aul 01 (0200 UTC Thu 20 Aul 01 (0200 CDT Thu 20 Aul 01) Marketster Marketster National mind restore ni signa = 0.900



 Dataset:
 PLEDM-200
 NIP:
 dbd
 Inst:
 1200
 UTC
 Thu
 20
 July
 State
 Stat



Model Not Exercised





	ETA	HIFDDA	NOFDDA	РХ	PX2	REISNER2	ZFAC
ALL	-0.46	-0.68	-0.29	-0.3	-0.58	-0.87	-0.14
AL	-0.87	-1.01	-1.28	0.18	-0.21	-0.9	-0.96
AK	-1.13	-1.07	-1.31	-1.22	-1.42	-1.21	-1.42
AZ	-0.86	-0.98	-1.49	0.05	-1.05	-0.83	-1.02
AR	-0.41	-0.62	-1.02	0.03	-0.2	-0.6	-0.25
CA	-0.84	-1.01	-0.63	-0.06	-0.42	-0.76	-0.77
со	-0.27	-0.64	0.53	-1.47	-1.9	-0.63	0.97
СТ	-0.41	-0.57	-0.52	-1.1	-1.09	-1.01	-0.71
DE	-0.57	-0.75	-1.18	-0.05	-0.18	-1.01	-0.92
DC	-1.72	-1.92	-2.66	-1.17	-1.32	-2.25	-2.14
FL	-1.37	-1.44	-1.27	0.15	-0.07	-1.25	-1.41
GA	-0.91	-1.07	-1.61	0.5	0.14	-0.93	-1.39
ID	-0.17	-0.49	0.71	-0.99	-1.78	-0.68	0.81
IL	-0.4	-0.61	-0.43	-0.47	-0.57	-1.2	-0.15
IN	-0.56	-0.78	-1.23	-0.35	-0.41	-1.17	-0.73
IA	0.27	-0.03	2.38	-0.31	-0.43	-0.85	1.95
KS	0.31	0.14	2.2	0.42	-0.1	-0.37	1.9
KY	-0.84	-1.04	-1.92	-0.46	-0.57	-1.05	-1.23
LA	-0.86	-1.02	-1.65	0.32	-0.12	-0.9	-0.94
ME	-0.51	-0.75	-0.12	-1.1	-0.9	-1.05	-0.57
MD	-0.69	-0.83	-1.51	-0.09	-0.26	-1.07	-1.06
MA	-0.66	-0.81	-0.71	-1.57	-1.37	-1.14	-1.04
МІ	-0.59	-0.74	-0.33	-1.09	-0.86	-1.25	-0.5
MN	0.41	0.06	2.07	0.09	-0.06	-0.42	1.78
MS	-0.69	-0.87	-1.36	0.41	-0.09	-0.79	-0.76
MO	-0.33	-0.51	-0.14	-0.09	-0.31	-0.86	0.18
МТ	0.49	0.13	1.38	-0.11	-0.78	0	1.86

 Table 3-2: Temperature Bias (K) for Base and Sensitivity Simulations for 2001 February 2-26.

NE	0.75	0.46	2.96	-0.02	-0.48	-0.2	2.55
NV	-1.4	-1.55	-1.31	-1.42	-2.4	-1.72	-1.11
NH	0.01	-0.26	0.2	-1.02	-0.89	-0.48	-0.15
NJ	-0.91	-1.12	-1.24	-0.66	-0.84	-1.47	-1.06
NM	-0.62	-0.81	-0.9	-0.32	-1.19	-0.67	-0.26
NY	-0.58	-0.82	-0.66	-1.19	-1.12	-1.04	-0.67
NC	-0.76	-0.98	-1.92	0.1	-0.06	-0.94	-1.53
ND	0.76	0.38	2.15	0.5	0.19	-0.14	2.46
ОН	-1.03	-1.31	-1.84	-0.9	-0.88	-1.49	-1.46
ок	-0.01	-0.24	0.37	0.22	-0.19	-0.36	0.65
OR	-0.65	-0.88	-0.46	-0.8	-1.36	-1.1	-0.08
PA	-1.09	-1.36	-1.6	-1.01	-1.01	-1.48	-1.2
RI	-0.44	-0.5	-0.74	-1.14	-0.93	-0.88	-1.02
SC	-0.95	-1.08	-1.86	0.46	0.19	-0.98	-1.59
SD	1.5	1.19	3.5	1.02	0.68	0.65	3.38
TN	-0.87	-1.07	-1.73	-0.32	-0.49	-1.07	-1.17
тх	-0.52	-0.65	-1.42	0.5	-0.16	-0.52	-0.72
UT	-0.6	-0.82	-0.5	-1.4	-2.03	-1	0.03
VT	-0.94	-1.2	-0.66	-2.02	-1.97	-1.47	-0.99
VA	-1.06	-1.27	-2.17	-0.52	-0.62	-1.39	-1.54
WA	-0.34	-0.47	-0.16	-0.16	-0.75	-1.05	0.08
wv	-1.12	-1.39	-2.14	-0.89	-0.88	-1.47	-1.36
WI	-0.64	-0.93	0.49	-0.99	-1.01	-1.83	0.24
WY	1.15	0.78	2.26	0.03	-0.44	0.89	2.41
CENRAP	-0.01	-0.24	0.7	0.16	-0.2	-0.54	0.82
MANE_VU	-0.68	-0.89	-0.83	-1.09	-1.04	-1.15	-0.86
MW	-0.65	-0.88	-0.49	-0.87	-0.82	-1.43	-0.45
VISTAS	-0.99	-1.16	-1.7	0.02	-0.2	-1.1	-1.37
WRAP	-0.33	-0.56	0.08	-0.35	-0.91	-0.62	0.28

Table 3-3: Temperature Error (K) for Base and SensitivitySimulations for 2001 February 2-26.

	eta	hifdda	nofdda	рх	px2	reisner2	zfac
ALL	2.13	2.23	2.71	2.15	1.94	2.32	2.5
AL	2.04	2.1	2.68	1.85	1.64	2.08	2.35
AK	1.78	1.75	1.98	1.86	1.95	1.86	1.96
AZ	2.35	2.33	3.09	2.48	2.39	2.41	2.77
AR	1.84	1.99	2.5	1.75	1.48	1.98	2.45
СА	2.16	2.23	2.42	2.27	2.18	2.17	2.36
со	3.08	3.15	3.64	3.65	3.52	3.19	3.38
СТ	1.47	1.54	1.97	2.05	1.75	1.82	1.65
DE	2.06	2.13	2.82	1.97	1.64	2.43	2.54
DC	2.31	2.44	3.17	1.95	1.75	2.81	2.81
FL	2.47	2.48	2.7	1.9	1.85	2.4	2.68
GA	2.21	2.24	3.02	1.92	1.75	2.25	2.8
ID	2.4	2.47	2.77	2.62	2.83	2.57	2.61
IL	1.65	1.8	2.09	1.84	1.5	2.15	1.92
IN	1.63	1.81	2.08	1.8	1.43	1.95	1.81
IA	2.29	2.41	3.13	2.01	1.78	2.69	2.88
KS	2.01	2.08	3	1.96	1.68	2.2	2.79
KY	1.76	1.94	2.6	1.8	1.44	1.89	2.25
LA	2.33	2.39	2.88	2.08	1.83	2.38	2.58
ME	1.91	2.03	2.33	2.19	1.86	2.2	2.21
MD	2	2.09	2.64	1.92	1.7	2.3	2.3
МА	1.75	1.85	2.1	2.37	2.09	2.01	1.94
мі	1.71	1.81	2	1.8	1.52	2.17	1.79
MN	2.36	2.45	3.12	2.25	1.87	2.59	2.86
MS	2.05	2.17	2.67	1.81	1.6	2.12	2.35
мо	1.9	2.02	2.34	1.71	1.43	2.21	2.36
мт	2.85	2.92	3.26	3.12	2.95	2.87	3.38
NE	2.27	2.36	3.37	2.29	2	2.52	3.07
NV	2.64	2.64	3.26	2.79	3.12	2.82	2.97
NH	2.43	2.54	2.85	3.08	2.79	2.55	2.64

	1 01	1 02	2 21	1 0/	1 60	2 10	2 02
	1.01	1.90	2.31	1.94	1.00	2.19	2.03
NM	2.45	2.48	3.04	2.71	2.56	2.53	2.71
NY	1.74	1.9	2.19	2.22	1.91	1.98	1.85
NC	2.23	2.34	3.05	1.91	1.74	2.33	2.68
ND	2.1	2.18	2.79	2.16	1.81	2.41	2.9
ОН	1.77	2.03	2.32	1.84	1.51	2.12	1.97
ок	1.93	2.06	2.5	1.88	1.63	2.08	2.71
OR	2.02	2.08	2.34	2.2	2.31	2.28	2.19
PA	2	2.19	2.41	2.08	1.76	2.28	2.14
RI	1.33	1.4	1.8	1.66	1.46	1.68	1.56
SC	2.19	2.24	3.03	1.76	1.59	2.26	2.84
SD	2.68	2.69	3.95	2.64	2.26	2.67	3.83
TN	1.87	2	2.61	1.79	1.59	2	2.35
тх	1.87	2	2.68	1.82	1.56	1.89	2.43
UT	2.4	2.48	2.88	2.79	3	2.6	2.5
VT	2.01	2.17	2.39	2.91	2.57	2.21	2.13
VA	2.3	2.43	3.07	2.15	1.88	2.55	2.71
WA	1.82	1.85	2.25	1.79	1.85	2.16	2.05
wv	2.16	2.37	2.89	2.25	1.93	2.37	2.4
wi	2.01	2.2	2.21	2.23	1.9	2.75	1.92
WY	2.96	2.97	3.63	3.21	2.99	2.94	3.5
CENRAP	2.11	2.22	2.89	2	1.71	2.29	2.69
MANE_VU	1.87	2	2.31	2.23	1.93	2.14	2.06
MW	1.78	1.95	2.13	1.93	1.6	2.29	1.88
VISTAS	2.22	2.3	2.87	1.93	1.74	2.3	2.62
WRAP	2.37	2.41	2.86	2.54	2.49	2.48	2.71

Figure 3-25: Temperature Bias for Base and Sensitivity Simulations for 2001 February 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

MM5 Sensitivity Comparisons February 2001 Temperature Bias



Figure 3-26: Temperature Error for Base and Sensitivity Simulations for 2001 February 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

MM5 Sensitivity Comparisons February 2001 Temperature Error



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Feb MIXR Bias	eta	hifdda	nofdda	рх	px2	reisner2	zfac
ALL	0.24	0.2	0.17	-0.35	-0.14	-0.06	0.24
AL	0.61	0.57	0.43	-0.69	-0.12	0.03	0.58
AK	0.09	0.15	-0.05	-0.08	-0.15	0.14	-0.07
AZ	0.4	0.35	0.26	-0.77	-0.41	-0.82	0.4
AR	0.53	0.5	0.16	-0.33	-0.18	0.04	0.54
CA	0.25	0.22	0.12	-0.31	-0.31	0.23	0.17
со	0.01	-0.05	0.14	-0.34	-0.24	-0.04	0.13
СТ	0.33	0.31	0.34	-0.05	0.08	0.1	0.28
DE	0.32	0.27	0.1	-0.23	-0.02	0.98	0.26
DC	-0.02	-0.09	-0.41	-0.9	-0.65	0.65	-0.1
FL	0.63	0.66	0.86	-0.59	0.15	0.95	0.51
GA	0.51	0.45	0.25	-0.82	-0.12	0.7	0.32
ID	-0.11	-0.18	0.14	-0.21	-0.22	-0.1	0.07
IL	0.12	0.08	0.07	-0.48	-0.25	0.01	0.16
IN	0.03	-0.01	-0.17	-0.7	-0.39	-0.06	0
IA	0.1	0.06	0.5	-0.06	0.02	-0.03	0.37
KS	0.06	0.03	0.34	-0.45	-0.31	-0.06	0.38
KY	0.47	0.43	0.15	-0.56	-0.23	0.43	0.38
LA	0.39	0.3	-0.07	-0.59	-0.34	0.38	0.41
ME	0.15	0.13	0.23	0.04	0.1	0.12	0.12
MD	0.42	0.37	0.07	-0.36	-0.1	0.37	0.34
MA	0.29	0.28	0.34	0.02	0.11	0.25	0.22
МІ	-0.01	-0.03	0.05	-0.3	-0.11	-0.06	0.01
MN	0.03	0	0.25	0.06	0.08	-0.01	0.16
MS	0.56	0.49	0.25	-0.68	-0.2	0.54	0.6
МО	0.22	0.19	0.21	-0.48	-0.32	0.12	0.34
мт	0.16	0.12	0.32	0.11	0.1	0.19	0.33
NE	0.1	0.07	0.46	-0.15	-0.07	0.01	0.41

Table 3-4: N	fixing Ratio Bias (g/kc) for Base and Sensitivity
Simulations	for 2001 February 2-26.

NV	0.08	0.04	0.26	-0.31	-0.21	0.09	0.14
NH	0.24	0.2	0.29	0.08	0.12	0.21	0.2
NJ	0.27	0.21	0.16	-0.3	-0.07	0.22	0.27
NM	0.44	0.35	0.4	-0.54	-0.23	0.45	0.5
NY	0.2	0.15	0.16	-0.15	0	0.17	0.2
NC	0.64	0.59	0.09	-0.39	-0.04	0.61	0.25
ND	0.03	-0.01	0.19	0.04	0.06	-0.01	0.19
ОН	0.16	0.09	-0.04	-0.55	-0.28	0.11	0.11
ок	0.01	-0.06	-0.17	-0.66	-0.5	-0.07	0.17
OR	0.03	0	0.1	-0.36	-0.33	0.04	0.12
PA	0.34	0.26	0.17	-0.3	-0.01	0.31	0.36
RI	0.39	0.37	0.4	0.02	0.12	0.35	0.29
SC	0.63	0.61	0.14	-0.64	-0.07	0.62	0.26
SD	0.14	0.1	0.38	0.12	0.16	0.1	0.37
TN	0.6	0.54	0.28	-0.45	-0.15	0.57	0.46
тх	0.3	0.24	-0.41	-0.83	-0.43	0.29	0.14
UT	-0.14	-0.18	0.06	-0.31	-0.13	-0.15	-0.04
VT	0.14	0.1	0.15	-0.02	0.02	0.11	0.11
VA	0.42	0.37	-0.02	-0.5	-0.27	0.37	0.26
WA	-0.03	-0.02	0.04	-0.45	-0.41	-0.04	-0.02
wv	0.51	0.44	0.17	-0.28	-0.05	0.46	0.46
WI	-0.04	-0.07	0.18	-0.11	0	-0.13	0.08
WY	0.16	0.1	0.31	0.12	0.13	0.2	0.31
CENRAP	0.18	0.13	0.1	-0.36	-0.19	0.12	0.27
MANE_VU	0.26	0.22	0.21	-0.13	0.02	0.23	0.24
мw	0.03	0	0.05	-0.36	-0.16	-0.04	0.06
VISTAS	0.57	0.53	0.3	-0.56	-0.08	0.55	0.38
WRAP	0.14	0.1	0.18	-0.28	-0.21	0.14	0.19

Table 3-5:	Mixing Ratio	Error (g/kg)	for Base an	nd Sensitivity
Simulation	s for 2001 Feb	oruary 2-26.		

	eta	hifdda	nofdda	рх	px2	reisner2	zfac
ALL	0.62	0.62	0.73	0.77	0.63	0.66	0.66
AL	1.00	1.00	1.06	1.27	0.96	0.81	1.02
AK	0.40	0.40	0.48	0.45	0.45	0.36	0.43
AZ	0.91	0.88	0.87	1.12	0.96	0.92	0.92
AR	0.82	0.83	0.86	1.03	0.82	0.25	0.88
CA	0.77	0.78	0.77	0.88	0.84	0.75	0.72
со	0.53	0.52	0.65	0.66	0.61	0.59	0.61
СТ	0.49	0.46	0.57	0.49	0.36	0.39	0.46
DE	0.48	0.47	0.54	0.52	0.39	0.99	0.48
DC	0.51	0.52	0.67	1.03	0.78	0.65	0.57
FL	1.28	1.28	1.34	1.47	1.14	1.56	1.21
GA	1.03	1.03	0.99	1.32	0.96	0.92	1.00
ID	0.51	0.51	0.65	0.52	0.50	0.50	0.55
IL	0.40	0.38	0.58	0.68	0.51	0.43	0.47
IN	0.47	0.47	0.62	0.90	0.64	0.48	0.51
IA	0.33	0.33	0.63	0.39	0.33	0.36	0.49
KS	0.46	0.45	0.71	0.67	0.55	0.47	0.65
KY	0.68	0.67	0.76	0.94	0.68	0.66	0.69
LA	1.07	1.11	1.20	1.23	1.10	1.07	1.08
ME	0.33	0.32	0.43	0.31	0.28	0.33	0.33
MD	0.61	0.61	0.65	0.74	0.56	0.61	0.61
МА	0.45	0.44	0.56	0.46	0.38	0.44	0.42
мі	0.32	0.32	0.44	0.45	0.31	0.36	0.35
MN	0.25	0.26	0.39	0.27	0.24	0.27	0.32
MS	1.02	1.03	1.07	1.27	0.99	1.01	1.05
мо	0.53	0.52	0.67	0.75	0.59	0.54	0.64
МТ	0.38	0.37	0.50	0.40	0.38	0.39	0.46
NE	0.35	0.35	0.61	0.42	0.37	0.36	0.53
NV	0.57	0.56	0.69	0.61	0.56	0.56	0.59

NH	0.37	0.35	0.48	0.38	0.34	0.35	0.36
NJ	0.55	0.53	0.64	0.65	0.49	0.55	0.55
NM	0.89	0.83	0.94	0.93	0.79	0.89	0.94
NY	0.40	0.38	0.48	0.46	0.34	0.40	0.39
NC	0.99	1.00	0.92	1.01	0.89	0.98	0.90
ND	0.21	0.21	0.31	0.23	0.22	0.23	0.28
ОН	0.47	0.46	0.57	0.81	0.59	0.46	0.48
ок	0.65	0.66	0.96	1.06	0.86	0.66	0.90
OR	0.49	0.49	0.60	0.65	0.61	0.47	0.54
PA	0.56	0.53	0.60	0.67	0.50	0.56	0.56
RI	0.51	0.50	0.61	0.48	0.36	0.51	0.46
SC	1.03	1.05	0.95	1.11	0.93	1.02	0.95
SD	0.29	0.28	0.49	0.33	0.32	0.30	0.44
TN	0.81	0.79	0.79	1.00	0.81	0.80	0.79
тх	0.96	0.98	1.18	1.37	1.07	0.97	1.03
UT	0.58	0.57	0.70	0.56	0.50	0.57	0.58
VT	0.32	0.31	0.41	0.34	0.32	0.31	0.32
VA	0.77	0.77	0.77	0.89	0.71	0.75	0.76
WA	0.43	0.43	0.62	0.65	0.60	0.44	0.47
wv	0.71	0.68	0.73	0.76	0.61	0.70	0.68
wi	0.28	0.29	0.43	0.34	0.27	0.34	0.31
WY	0.43	0.41	0.56	0.42	0.42	0.44	0.52
CENRAP	0.58	0.59	0.78	0.78	0.64	0.60	0.69
MANE_VU	0.45	0.44	0.54	0.51	0.40	0.45	0.45
мw	0.36	0.36	0.50	0.56	0.41	0.39	0.39
VISTAS	0.99	0.99	0.99	1.15	0.91	0.98	0.95
WRAP	0.59	0.58	0.68	0.69	0.64	0.59	0.62

Figure 3-27: Mixing Ratio Bias for Base and Sensitivity Simulations for 2001 February 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

## MM5 Sensitivity Comparisons February 2001 Mixing Ratio Bias



Figure 3-28: Mixing Ratio Error for Base and Sensitivity Simulations for 2001 February 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

MM5 Sensitivity Comparisons February 2001 Mixing Ratio Error



Table 3-6: Accumulated Precipitation Bias (cm) for Base andSensitivity Simulations for 2001 February 2-26.

Feb RAIN bias	eta	hifdda	nofdda	рх	px2	reisner2	zfac
ALL	-0.59	-1.20	0.83	-0.80	0.36	-0.77	-0.25
AL	-3.10	-3.34	-2.05	-3.75	-2.31	-3.07	-2.36
AK	4.40	3.94	6.09	3.87	3.63	4.21	3.81
AZ	1.66	0.85	2.19	1.27	2.78	1.57	1.53
AR	-2.21	-2.90	-3.62	-2.12	-0.63	-2.33	-2.09
СА	-5.31	-5.60	-3.39	-5.08	-3.72	-5.95	-4.21
СО	0.12	-0.16	2.24	0.01	0.50	-0.02	0.40
СТ	-0.56	-1.21	0.63	-0.94	0.98	-0.54	-0.36
DE	-3.61	-4.09	-1.67	-3.68	-0.97	-3.49	-3.49
FL	0.93	0.98	0.53	-0.13	0.66	0.87	0.65
GA	-1.29	-1.37	1.12	-1.75	-0.64	-1.23	-1.08
ID	1.13	0.32	4.04	0.99	1.48	0.68	1.39
IL	0.10	0.01	-0.97	-0.31	0.75	-0.03	-0.38
IN	-1.15	-1.93	-0.57	-1.54	-0.19	-1.17	-0.93
IA	-0.92	-1.09	2.12	-1.18	0.98	-1.36	-0.81
KS	-0.84	-1.44	-0.71	-0.99	0.11	-1.07	-0.53
KY	-1.97	-3.78	0.52	-2.17	0.36	-1.97	-0.89
LA	0.07	0.61	0.21	-0.83	0.69	0.12	-1.06
ME	-0.42	-0.78	2.58	-0.37	1.24	-0.41	-0.35
MD	-1.08	-1.46	1.45	-1.22	1.24	-0.97	-0.62
MA	0.89	0.31	0.81	0.60	1.15	0.73	-0.12
МІ	0.69	0.35	1.10	0.20	0.75	0.33	0.41
MN	0.75	0.24	4.15	0.97	2.10	0.58	1.01
MS	-5.01	-5.41	-3.06	-5.45	-2.68	-4.86	-4.68
мо	-2.27	-2.95	-3.11	-2.32	-1.00	-2.44	-2.43
МТ	1.07	0.70	2.58	1.24	1.80	0.87	1.20
NE	-0.05	-0.01	2.67	-0.23	1.19	-0.35	0.27
NV	0.87	0.26	1.89	0.74	1.19	0.92	0.82
NH	-1.22	-1.38	-1.86	-1.30	0.16	-1.67	-1.75

NJ	-2.69	-3.16	-0.86	-3.06	0.35	-2.59	-2.79
NM	0.81	0.48	1.32	0.55	1.11	0.73	0.46
NY	1.26	0.80	1.54	0.68	1.76	0.81	1.51
NC	-1.26	-2.03	5.01	-1.76	-0.01	-1.31	-0.72
ND	0.48	0.31	1.87	0.73	1.18	0.38	0.54
он	-0.18	-1.10	2.07	-0.71	0.45	-0.27	0.29
ок	1.77	-0.02	-1.62	1.81	2.34	1.69	2.06
OR	1.12	0.11	2.02	0.96	0.38	0.88	1.13
PA	0.07	-0.78	1.69	-0.30	0.78	0.05	0.27
RI	-1.37	-1.58	0.72	-1.93	-1.54	-1.31	-1.91
SC	-0.79	-0.65	2.36	-1.45	-0.21	-0.71	-0.57
SD	0.95	0.63	2.54	1.05	2.25	0.70	1.24
TN	-7.04	-8.09	-1.79	-6.88	-4.40	-7.38	-5.76
тх	0.74	-0.89	1.56	0.06	2.35	0.85	2.39
UT	0.70	-0.20	2.60	0.41	1.44	0.54	0.51
VT	0.40	0.27	0.65	0.23	1.05	-0.23	0.46
VA	-0.28	-1.10	3.74	-0.39	0.07	-0.34	0.26
WA	0.96	0.28	2.44	0.79	0.96	0.67	0.71
wv	1.08	0.36	3.23	0.96	2.25	0.90	1.40
wi	-0.28	-0.79	3.95	-0.27	0.91	-0.56	0.37
WY	1.22	0.65	2.59	1.32	1.87	1.02	1.82
CENRAP	-0.21	-1.04	0.39	-0.48	1.12	-0.33	0.28
MANE_VU	0.11	-0.44	1.14	-0.25	1.04	-0.10	0.18
MW	-0.21	-0.75	1.00	-0.58	0.50	-0.37	-0.09
VISTAS	-2.02	-2.60	0.83	-2.43	-0.79	-2.05	-1.54
WRAP	-0.54	-1.07	1.01	-0.55	0.10	-0.84	-0.24

Table 3-7: Accumulated Precipitation Error (cm) for Base andSensitivity Simulations for 2001 February 2-26.

Feb RAIN error	eta	hifdda	nofdda	рх	px2	reisner2	zfac
ALL	2.43	2.41	2.99	2.43	2.31	2.43	2.45
AL	3.38	3.60	2.54	3.99	3.02	3.43	2.87
AK	4.40	3.94	6.09	3.87	3.63	4.21	3.81
AZ	1.80	1.28	2.35	1.61	2.84	1.77	1.70
AR	4.61	4.11	4.07	4.76	3.74	4.48	5.12
СА	6.76	6.82	5.98	6.59	5.72	7.22	6.17
со	0.69	0.57	2.40	0.63	0.79	0.68	0.77
СТ	1.73	1.85	1.65	1.87	1.81	1.65	1.57
DE	3.61	4.09	1.67	3.68	0.97	3.49	3.49
FL	1.44	1.50	1.18	1.02	1.40	1.34	1.19
GA	1.85	1.93	1.53	2.04	1.66	1.80	1.74
ID	1.60	1.37	4.04	1.55	1.77	1.49	1.73
IL	2.13	2.23	1.92	2.14	1.76	2.02	1.71
IN	1.81	2.43	2.14	2.08	1.71	1.80	1.76
IA	1.81	2.03	2.99	2.05	1.46	1.93	1.81
KS	1.66	1.78	1.57	1.75	1.36	1.71	1.73
KY	2.85	3.85	1.46	2.97	2.00	2.78	2.46
LA	1.54	1.53	1.35	1.49	1.52	1.48	1.70
ME	1.12	1.26	2.61	1.06	1.29	1.00	1.01
MD	1.08	1.46	1.45	1.22	1.24	0.97	0.64
MA	1.15	1.03	1.65	1.01	1.15	1.18	0.98
MI	1.85	1.90	2.84	1.83	1.65	1.77	1.82
MN	1.12	0.92	4.15	1.26	2.12	1.05	1.25
MS	5.89	6.38	4.71	6.28	4.97	5.77	5.64
МО	3.06	3.29	3.64	3.16	2.67	2.99	3.10
МТ	1.35	1.06	2.63	1.48	1.94	1.29	1.47
NE	1.34	0.88	2.80	1.29	1.41	1.28	1.54
NV	1.54	1.27	2.08	1.53	1.70	1.55	1.40
NH	2.44	2.51	2.75	2.46	2.50	2.60	2.69

NJ	2.69	3.16	1.16	3.06	1.10	2.59	2.79
NM	1.09	0.84	1.45	0.93	1.25	1.04	0.81
NY	2.01	1.78	1.80	1.70	1.94	1.75	2.17
NC	1.68	2.29	5.01	2.07	1.26	1.72	1.40
ND	0.61	0.49	1.87	0.78	1.18	0.58	0.71
ОН	0.94	1.45	2.25	1.10	0.86	0.97	0.78
ок	3.41	2.16	2.36	3.48	3.31	3.39	3.36
OR	1.73	1.39	2.26	1.68	1.33	1.72	1.63
РА	1.60	1.44	2.11	1.34	1.15	1.51	1.55
RI	1.37	1.58	0.99	1.93	1.54	1.40	1.91
SC	1.75	1.71	2.57	2.09	1.62	1.69	1.75
SD	1.53	1.39	2.82	1.58	2.50	1.37	1.73
TN	8.01	8.63	3.64	7.85	5.53	8.20	7.29
тх	2.20	2.38	3.08	1.97	2.88	2.28	3.53
UT	1.58	1.30	3.05	1.49	2.04	1.48	1.52
VT	1.58	1.40	1.91	1.43	1.47	1.49	1.84
VA	1.59	1.93	3.74	1.65	1.07	1.60	1.73
WA	1.94	1.86	2.89	1.89	2.00	1.98	1.91
wv	1.65	1.37	3.29	1.67	2.34	1.50	1.94
wi	0.91	1.10	4.16	1.08	1.15	0.94	1.09
WY	1.40	0.96	2.61	1.49	1.90	1.25	1.88
CENRAP	2.31	2.21	2.99	2.32	2.39	2.31	2.76
MANE_VU	1.79	1.71	1.99	1.63	1.53	1.67	1.83
MW	1.53	1.84	2.57	1.65	1.41	1.50	1.41
VISTAS	3.11	3.45	3.07	3.27	2.56	3.09	2.90
WRAP	2.67	2.49	3.34	2.62	2.63	2.74	2.55

Figure 3-29: Accumulated Precipitation Bias for Base and Sensitivity Simulations for 2001 February 2-26. States are Shaded to Reflect the Simulation with the Best Performance. Figure 3-30: Accumulated Precipitation Eror for Base and Sensitivity Simulations for 2001 February 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

## MM5 Sensitivity Comparisons February 2001 Precipitation Bias



## MM5 Sensitivity Comparisons February 2001 Precipitation Error



Table 3-8: Wind Index of Agreement for Base and SensitivitySimulations for 2001 February 2-26.

	eta	hifdda	nofdda	рх	px2	reisner2	zfac
ALL	0.59	0.57	0.76	0.48	0.48	0.59	0.63
AL	0.53	0.54	0.56	0.53	0.52	0.54	0.73
AK	0.52	0.47	0.44	0.35	0.52	0.45	0.57
AZ	0.55	0.56	0.67	0.46	0.56	0.53	0.67
AR	0.52	0.52	0.63	0.39	0.36	0.53	0.44
CA	0.66	0.63	0.81	0.60	0.59	0.62	0.73
СО	0.45	0.42	0.67	0.46	0.43	0.46	0.61
СТ	0.42	0.38	0.49	0.49	0.60	0.45	0.39
DE	0.49	0.41	0.52	0.46	0.42	0.50	0.49
DC							
FL	0.48	0.46	0.74	0.46	0.46	0.46	0.57
GA	0.67	0.67	0.61	0.55	0.57	0.66	0.59
HI							
ID	0.73	0.73	0.91	0.82	0.78	0.80	0.84
IL	0.54	0.51	0.63	0.44	0.50	0.56	0.68
IN	0.49	0.43	0.49	0.36	0.39	0.56	0.50
IA	0.49	0.46	0.83	0.43	0.55	0.49	0.69
KS	0.45	0.42	0.76	0.42	0.43	0.48	0.58
KY	0.43	0.46	0.43	0.26	0.30	0.49	0.37
LA	0.41	0.47	0.72	0.48	0.52	0.40	0.64
ME	0.70	0.71	0.87	0.66	0.71	0.70	0.78
MD	0.47	0.50	0.44	0.45	0.39	0.43	0.59
MA	0.51	0.52	0.78	0.62	0.82	0.51	0.61
МІ	0.63	0.61	0.78	0.59	0.63	0.68	0.63
MN	0.44	0.46	1.29	0.39	0.47	0.48	0.57
MS	0.53	0.52	0.48	0.58	0.64	0.53	0.93
МО	0.61	0.59	1.04	0.62	0.66	0.61	0.88
мт	0.48	0.44	0.67	0.55	0.59	0.51	0.70
NE	0.46	0.42	0.71	0.42	0.40	0.48	0.66
NV	0.53	0.46	0.59	0.47	0.53	0.53	0.74
NH	0.22	0.22	0.29	0.26	0.29	0.25	0.24
NJ	0.57	0.65	0.54	0.59	0.57	0.66	0.50

NM	0.52	0.52	0.57	0.55	0.52	0.53	0.62
NY	0.55	0.60	0.61	0.55	0.60	0.63	0.48
NC	0.61	0.66	0.91	0.58	0.55	0.60	0.67
ND	0.44	0.47	0.64	0.39	0.45	0.49	0.42
ОН	0.52	0.47	0.62	0.45	0.49	0.55	0.62
ок	0.42	0.37	0.76	0.39	0.36	0.39	0.55
OR	0.74	0.71	0.97	0.74	0.72	0.79	0.87
PA	0.48	0.52	0.58	0.40	0.38	0.51	0.40
RI	0.32	0.34	0.63	0.42	0.44	0.42	0.52
SC	0.68	0.68	0.95	0.51	0.44	0.71	0.81
SD	0.40	0.43	0.75	0.42	0.46	0.41	0.45
TN	0.39	0.37	0.42	0.35	0.33	0.40	0.33
тх	0.45	0.43	0.68	0.45	0.44	0.44	0.65
UT	0.57	0.51	0.68	0.58	0.61	0.59	0.73
VT	0.46	0.52	0.48	0.52	0.36	0.55	0.44
VA	0.46	0.50	0.54	0.38	0.34	0.45	0.42
WA	0.54	0.54	0.93	0.62	0.61	0.57	0.82
wv	1.03	1.09	1.01	0.82	0.73	1.05	1.02
WI	0.61	0.58	0.92	0.54	0.52	0.60	0.70
WY	0.64	0.63	0.74	0.55	0.56	0.65	0.59
CENRAP	0.48	0.47	0.75	0.43	0.42	0.50	0.54
MANE_VU	0.54	0.54	0.70	0.49	0.54	0.57	0.54
MW	0.74	0.71	0.89	0.60	0.60	0.78	0.75
VISTAS	0.65	0.61	0.80	0.51	0.52	0.64	0.75
WRAP	0.60	0.58	0.80	0.57	0.58	0.59	0.70
Figure 3-31: Wind Index of Agreement for Base and Sensitivity Simulations for 2001 February 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

> MM5 Sensitivity Comparisons February 2001 Index of Agreement



	eta	hifdda	nofdda	px2	reisner2	zfac
ALL	-0.41	-0.39	-0.98	-0.53	-0.41	-0.57
AL	0.74	0.71	0.86	-0.03	0.68	1.11
AK	-1.40	-1.45	-1.37	-0.97	-1.30	-1.38
AZ	-2.94	-2.72	-3.19	-2.97	-2.98	-3.65
AR	0.55	0.63	0.69	0.58	0.50	0.61
CA	-2.86	-2.85	-2.82	-1.65	-2.75	-2.76
со	-2.22	-2.35	-3.82	-2.52	-2.07	-2.56
СТ	0.07	0.00	-0.65	0.12	0.18	-0.20
DE	-0.88	-0.88	-1.36	-0.21	-0.85	-1.06
DC	-0.62	-0.63	-0.79	-0.90	-0.57	-0.66
FL	-0.06	-0.05	-0.10	-0.41	-0.08	-0.03
GA	0.56	0.56	0.65	-0.35	0.50	0.77
ID	-1.62	-1.50	-2.85	-1.53	-1.63	-2.50
IL	0.76	0.76	-0.07	0.19	0.67	0.55
IN	1.11	1.11	0.49	0.49	1.03	1.01
IA	0.69	0.71	-0.59	0.11	0.63	0.48
KS	-0.86	-0.57	-1.37	-0.37	-0.88	-1.45
KY	0.71	0.77	0.85	0.14	0.64	0.90
LA	-0.02	0.00	-0.15	-0.23	-0.04	-0.06
ME	0.19	0.18	-0.10	-0.05	0.48	0.28
MD	0.18	0.18	-0.10	0.00	0.22	0.17
МА	-0.07	-0.08	-0.57	0.11	0.05	-0.15
МІ	0.08	0.06	-0.55	-0.16	0.13	0.30
MN	1.21	1.16	-0.15	0.63	1.03	1.20
MS	0.72	0.67	0.85	-0.10	0.63	0.98
МО	0.90	0.96	0.39	0.38	0.81	0.65
мт	-1.48	-1.37	-3.01	-1.59	-1.45	-1.83
NE	0.44	0.49	-1.17	0.08	0.44	-0.38
NV	-3.90	-3.80	-5.17	-4.01	-3.89	-4.64

Table 3-9: Temperature Bias (K) for Base and Sensitivity Simulations for 2001 July 2-26.

NH	0.78	0.75	0.04	0.53	1.00	0.84
NJ	-0.07	-0.05	-0.65	-0.03	-0.02	-0.21
NM	-2.39	-2.44	-3.12	-2.48	-2.29	-2.89
NY	-0.16	-0.19	-0.68	-0.37	-0.10	-0.14
NC	0.36	0.32	0.32	-0.40	0.32	0.35
ND	0.86	0.88	-0.61	0.17	0.57	0.79
он	0.59	0.60	-0.09	0.24	0.56	0.41
ок	-0.96	-0.82	-0.77	-0.29	-0.97	-1.41
OR	-2.60	-2.46	-4.04	-1.76	-2.52	-3.21
PA	0.21	0.19	-0.17	0.15	0.24	0.26
RI	0.06	0.00	-0.58	0.09	0.16	-0.32
SC	0.35	0.35	0.47	-0.47	0.31	0.21
SD	0.48	0.52	-1.17	0.06	0.36	0.19
TN	0.35	0.36	0.58	-0.33	0.30	0.79
тх	-1.24	-1.15	-1.28	-0.70	-1.21	-1.88
UT	-3.41	-3.30	-3.80	-4.03	-3.42	-4.06
VT	-0.02	-0.16	-0.49	-0.65	0.14	0.16
VA	-0.06	-0.08	-0.16	-0.31	-0.02	0.00
WA	-1.11	-1.05	-2.14	-0.34	-0.97	-1.52
wv	0.75	0.76	0.82	0.61	0.74	0.87
wi	0.86	0.92	-0.30	0.16	0.79	0.85
WY	-2.38	-2.38	-3.89	-2.71	-2.23	-2.98
CENRAP	0.08	0.14	-0.58	0.01	0.02	-0.25
MANE_VU	0.05	0.03	-0.43	-0.03	0.16	0.03
мw	0.57	0.58	-0.23	0.10	0.54	0.57
VISTAS	0.31	0.31	0.34	-0.27	0.28	0.42
WRAP	-2.15	-2.11	-2.98	-1.82	-2.09	-2.49

Table 3-10:	Temperature Error (K)	for Base and Sensitivity
Simulations	for 2001 July 2-26.	

	eta	hifdda	nofdda	px2	reisner2	zfac
ALL	2.22	2.18	2.74	2.10	2.24	2.44
AL	1.71	1.68	2.14	1.71	1.70	2.05
AK	1.62	1.66	1.66	1.14	1.55	1.63
AZ	3.99	3.76	4.08	3.96	4.07	4.57
AR	1.64	1.63	1.92	1.70	1.68	1.79
CA	3.44	3.42	3.61	2.91	3.37	3.49
СО	3.33	3.37	4.49	3.33	3.41	3.51
СТ	1.70	1.71	2.27	1.57	1.67	1.77
DE	2.13	2.10	2.97	1.56	2.12	2.36
DC	1.37	1.37	2.27	1.29	1.30	1.52
FL	1.72	1.70	1.93	1.76	1.73	1.79
GA	1.62	1.57	2.01	1.75	1.64	1.81
ID	3.38	3.28	3.97	3.34	3.51	3.93
IL	1.91	1.90	2.45	1.84	1.91	2.00
IN	1.82	1.80	2.25	1.65	1.79	1.91
IA	1.79	1.73	2.49	1.71	1.81	2.09
KS	2.18	2.04	2.90	1.69	2.21	2.58
KY	1.68	1.67	2.20	1.83	1.69	1.82
LA	1.80	1.77	2.08	1.73	1.83	1.99
ME	1.52	1.54	2.18	1.33	1.54	1.71
MD	1.81	1.79	2.56	1.84	1.78	1.95
MA	1.90	1.90	2.38	1.55	1.89	1.94
МІ	2.08	2.06	2.55	2.01	2.10	2.12
MN	2.20	2.16	2.51	2.00	2.22	2.26
MS	1.65	1.60	2.09	1.78	1.69	1.95
МО	1.79	1.76	2.14	1.58	1.80	2.02
МТ	2.96	2.89	4.02	2.93	3.09	3.26
NE	2.04	2.00	2.60	1.70	2.11	2.53

NV	4.63	4.48	5.67	4.70	4.72	5.29
NH	2.45	2.46	3.18	2.25	2.52	2.63
NJ	1.72	1.70	2.45	1.61	1.70	1.86
NM	3.09	3.09	3.70	3.02	3.16	3.53
NY	1.69	1.71	2.42	1.68	1.69	1.82
NC	1.57	1.55	2.19	1.68	1.59	1.68
ND	1.95	1.93	2.43	1.65	2.12	2.15
ОН	1.68	1.66	2.36	1.70	1.70	1.79
ок	1.82	1.78	2.50	1.62	1.86	2.27
OR	3.34	3.24	4.53	2.80	3.37	3.83
PA	1.68	1.68	2.29	1.65	1.68	1.79
RI	1.53	1.55	2.01	1.34	1.50	1.70
SC	1.38	1.37	2.05	1.60	1.39	1.53
SD	2.13	2.03	2.75	1.96	2.26	2.67
TN	1.56	1.54	1.97	1.81	1.57	1.79
тх	1.90	1.88	2.16	1.48	1.93	2.42
UT	4.32	4.17	4.60	4.62	4.43	4.92
VT	1.71	1.78	2.45	1.61	1.76	1.88
VA	1.83	1.83	2.58	2.05	1.85	2.00
WA	2.49	2.47	3.12	2.31	2.49	2.70
wv	1.74	1.74	2.35	1.84	1.75	1.91
wi	2.06	2.04	2.67	2.04	2.09	2.06
WY	3.33	3.27	4.60	3.47	3.44	3.89
CENRAP	1.95	1.91	2.37	1.71	1.98	2.26
MANE_VU	1.76	1.77	2.42	1.64	1.77	1.89
MW	1.96	1.94	2.51	1.91	1.97	2.01
VISTAS	1.66	1.64	2.15	1.79	1.68	1.82
WRAP	3.23	3.18	3.83	3.02	3.27	3.55

Figure 3-32: Temperature Bias for Base and Sensitivity Simulations for 2001 July 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

MM5 Sensitivity Comparisons July 2001 Temperature Bias



Figure 3-33: Temperature Error for Base and Sensitivity Simulations for 2001 July 2-26. States are Shaded to Reflect the Simulation with the Best Performance.





Table 3-11:	Mixing Ratio Bias (g/kg)	for Base and Sensitivity
Simulations	for 2001 July 2-26.	

	eta	hifdda	nofdda	px2	reisner2	zfac
ALL	-0.97	-0.74	-0.82	-0.76	-0.89	-0.89
AL	-2.15	-1.67	-0.81	-0.62	-2.10	-2.51
AK	0.09	0.08	0.09	0.23	0.08	0.09
AZ	0.35	0.29	-1.10	0.27	0.41	0.72
AR	-1.93	-1.30	-1.70	-1.26	-1.86	-2.75
CA	0.15	0.21	0.40	-0.61	0.15	0.53
со	-1.18	-1.12	-0.39	-1.19	-1.10	-0.53
СТ	-1.36	-1.21	-0.76	-1.11	-1.33	-1.21
DE	-0.91	-0.80	-0.50	-1.05	-0.87	-0.70
DC	-1.74	-1.56	-1.30	-1.30	-1.66	-1.70
FL	-0.89	-0.55	0.46	-0.70	-0.83	-0.60
GA	-1.96	-1.60	-0.62	-0.43	-1.89	-2.06
ID	-0.25	-0.35	-0.81	-0.62	-0.18	0.33
IL	-1.22	-0.91	-2.00	-0.95	-1.17	-1.50
IN	-1.74	-1.51	-2.24	-1.24	-1.69	-1.90
IA	-1.97	-1.75	-2.14	-1.32	-1.91	-1.72
KS	-0.78	-0.36	-1.34	-1.37	-0.72	-0.80
KY	-1.30	-0.99	-2.12	-0.53	-1.23	-1.58
LA	-1.14	-0.58	0.23	-0.75	-1.12	-1.17
ME	-0.55	-0.52	-0.32	-0.27	-0.45	-0.55
MD	-1.02	-0.85	-0.57	-0.83	-0.97	-0.86
MA	-0.79	-0.72	-0.34	-0.51	-0.76	-0.73
МІ	-0.74	-0.52	-0.86	-0.40	-0.63	-0.87
MN	-0.86	-0.63	-0.88	-1.02	-0.65	-0.88
MS	-2.33	-1.81	-1.22	-0.73	-2.26	-2.68
МО	-2.21	-1.72	-2.74	-1.20	-2.14	-2.52
МТ	-0.83	-0.86	-1.04	-0.73	-0.78	-0.39
NE	-1.27	-1.11	-1.82	-0.95	-1.19	-0.70
NV	0.33	0.34	-0.01	-0.13	0.40	0.79

NH	-1.16	-1.03	-0.63	-0.91	-1.09	-1.22
NJ	-1.27	-1.11	-0.56	-1.09	-1.22	-0.96
NM	-0.74	-0.41	0.02	-0.30	-0.63	-0.18
NY	-1.19	-1.00	-0.64	-0.88	-1.13	-1.27
NC	-1.14	-0.93	-0.44	-0.02	-1.08	-0.94
ND	-2.07	-1.95	-2.12	-1.47	-1.84	-1.72
ОН	-1.28	-1.10	-1.73	-0.80	-1.19	-1.37
ок	-1.50	-0.98	-1.49	-2.27	-1.43	-1.63
OR	-0.02	0.09	-0.10	-0.33	0.01	0.10
PA	-1.20	-1.01	-0.92	-0.89	-1.12	-1.18
RI	-0.49	-0.44	-0.12	-0.28	-0.48	-0.33
SC	-1.46	-1.10	-0.48	0.27	-1.42	-1.24
SD	-1.38	-1.22	-1.94	-0.69	-1.22	-0.87
TN	-1.95	-1.51	-2.25	-0.58	-1.91	-2.63
тх	-0.33	0.14	-0.36	-0.99	-0.23	-0.46
UT	0.38	0.14	-0.52	1.00	0.46	1.06
VT	-1.25	-1.09	-0.72	-0.95	-1.17	-1.46
VA	-1.61	-1.43	-1.23	-1.21	-1.52	-1.52
WA	-0.25	-0.19	-0.29	-0.69	-0.22	-0.23
wv	-1.84	-1.65	-1.90	-1.42	-1.76	-2.05
wi	-1.11	-0.92	-1.33	-0.63	-1.01	-1.18
WY	-0.50	-0.63	-0.41	-0.08	-0.41	0.11
CENRAP	-1.13	25.64	-1.17	-1.18	-1.02	-1.18
MANE_VU	-1.05	-0.91	-0.60	-0.79	-0.99	-1.02
мw	-1.09	-0.87	-1.42	-0.68	-1.00	-1.21
VISTAS	-1.49	-1.18	-0.69	-0.57	-1.42	-1.47
WRAP	-0.32	-0.27	-0.35	-0.48	-0.26	0.08

Table 3-12: Mixing Ratio Error (g/kg) for Base and SensitivitySimulations for 2001 July 2-26.

	eta	hifdda	nofdda	px2	reisner2	zfac
ALL	1.91	1.78	1.99	1.79	1.88	1.91
AL	2.46	2.08	2.09	1.82	2.42	2.81
AK	0.59	0.59	0.60	0.63	0.60	0.58
AZ	2.62	2.41	2.53	2.82	2.64	2.51
AR	2.35	1.91	2.30	2.22	2.31	3.02
CA	1.44	1.46	1.35	1.60	1.45	1.39
со	2.11	2.01	1.95	2.40	2.09	1.86
СТ	1.74	1.66	1.70	1.54	1.72	1.59
DE	1.38	1.33	1.70	1.34	1.37	1.29
DC	1.98	1.84	2.26	1.60	1.93	1.91
FL	1.69	1.54	1.70	1.57	1.67	1.65
GA	2.34	2.05	2.10	1.90	2.29	2.53
ID	1.59	1.60	1.77	2.22	1.60	1.58
IL	2.02	1.85	2.52	1.81	1.99	2.14
IN	2.20	2.04	2.52	1.95	2.16	2.27
IA	2.53	2.39	2.68	1.96	2.49	2.37
KS	2.30	2.19	2.79	2.41	2.28	2.24
KY	1.83	1.63	2.49	1.76	1.80	2.02
LA	2.75	2.42	2.47	2.47	2.73	2.88
ME	1.30	1.32	1.33	1.05	1.29	1.31
MD	1.62	1.50	1.97	1.35	1.59	1.57
MA	1.39	1.38	1.40	1.17	1.39	1.38
МІ	1.55	1.44	1.74	1.30	1.51	1.59
MN	1.85	1.75	1.95	1.85	1.75	1.81
MS	2.63	2.18	2.22	1.86	2.57	3.00
мо	2.59	2.23	3.06	1.92	2.53	2.81
мт	1.64	1.66	1.92	1.90	1.63	1.45
NE	2.28	2.14	2.76	1.90	2.23	1.92
NV	2.10	1.99	1.90	2.43	2.10	2.21
NH	1.49	1.44	1.41	1.23	1.49	1.57
NJ	1.81	1.73	2.02	1.60	1.79	1.64
NM	2.10	1.87	2.17	2.33	2.10	2.00

NY	1.65	1.56	1.67	1.39	1.63	1.68
NC	1.84	1.71	2.04	1.46	1.81	1.84
ND	2.36	2.28	2.62	1.95	2.16	2.11
он	1.76	1.65	2.14	1.47	1.72	1.83
ок	2.48	2.26	2.60	2.99	2.47	2.52
OR	1.22	1.21	1.14	1.45	1.23	1.19
PA	1.75	1.64	2.11	1.57	1.72	1.78
RI	1.23	1.27	1.36	1.17	1.22	1.16
SC	1.89	1.65	1.87	1.45	1.86	1.86
SD	2.10	1.94	2.64	1.66	2.01	1.83
TN	2.26	1.91	2.57	1.84	2.25	2.84
тх	2.02	1.91	1.72	1.97	2.02	1.94
UT	1.98	1.86	2.09	2.44	1.98	2.11
VT	1.60	1.53	1.49	1.29	1.56	1.75
VA	2.01	1.89	2.27	1.81	1.97	2.02
WA	1.14	1.12	1.01	1.34	1.15	1.09
wv	2.15	2.03	2.49	2.01	2.11	2.36
WI	1.85	1.71	2.01	1.56	1.79	1.81
WY	1.82	1.80	1.85	1.86	1.81	1.67
CENRAP	2.22	28.44	2.28	2.09	2.18	2.21
MANE_VU	1.58	1.52	1.69	1.36	1.56	1.57
MW	1.79	1.66	2.06	1.52	1.75	1.83
VISTAS	2.02	1.81	2.08	1.69	1.98	2.12
WRAP	1.71	1.65	1.72	1.88	1.70	1.62

Figure 3-34: Mixing Ratio Bias for Base and Sensitivity Simulations for 2001 July 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

MM5 Sensitivity Comparisons July 2001 Mixing Ratio Bias



Figure 3-35: Mixing Ratio Error for Base and Sensitivity Simulations for 2001 July 2-26. States are Shaded to Reflect the Simulation with the Best Performance.





Table 3-13: Accumulated Precipitation Bias (cm) for Base and
Sensitivity Simulations for 2001 July 2-26.

/	eta	hifdda	nofdda	px2	reisner2	zfac
ALL	1.51	1.61	0.83	3.29	1.32	0.41
AL	-1.24	0.94	2.65	4.95	-1.42	-1.29
AK	-5.23	-7.07	-0.62	-3.69	-6.41	-4.72
AZ	4.17	2.29	-0.65	6.77	4.11	1.99
AR	6.88	7.57	3.24	7.69	6.84	3.73
CA	1.72	1.63	0.68	2.03	1.64	0.98
СО	-0.95	-0.76	5.59	-0.29	-1.12	-0.88
СТ	-1.43	-1.02	11.10	0.70	-1.51	-0.08
DE	1.49	1.19	3.52	0.94	1.15	0.04
FL	4.57	6.61	4.84	7.42	3.33	3.22
GA	0.50	1.05	2.80	4.91	-0.09	-0.22
ID	2.03	1.53	0.65	3.22	1.84	1.93
IL	5.70	7.05	-3.85	5.86	5.08	0.07
IN	-1.26	-1.78	-4.04	0.48	-1.98	-2.90
IA	1.33	0.68	1.28	2.40	1.19	1.59
KS	9.90	9.20	1.40	7.14	10.64	5.22
KY	4.96	4.10	-6.14	9.26	4.72	1.49
LA	0.02	2.16	-0.05	3.06	-0.46	-3.07
ME	-1.17	-1.41	-1.06	1.75	-1.65	-1.29
MD	-2.07	-2.74	-0.12	-2.28	-2.04	-2.91
MA	-3.17	-3.14	7.25	-1.04	-3.18	-2.01
мі	-0.68	0.03	0.95	1.00	-1.04	-0.97
MN	-0.13	0.35	2.51	1.17	-0.34	-0.73
MS	-2.34	0.13	0.11	6.93	-2.67	-4.06
мо	5.32	5.13	-1.42	7.10	5.53	2.20
мт	1.72	1.08	1.09	2.82	1.50	0.88
NE	0.95	0.21	1.13	1.72	0.93	0.09
NV	2.34	2.61	1.37	3.65	2.37	1.36
NH	-4.22	-4.24	0.47	-1.43	-4.48	-3.52

NJ	-1.72	-1.48	-0.18	-0.97	-1.96	-1.24
NM	3.85	4.49	4.16	3.95	3.82	2.24
NY	-2.28	-2.19	3.79	-0.27	-2.38	-2.17
NC	0.49	0.59	3.93	6.25	-0.16	0.51
ND	-2.89	-2.52	-2.57	2.25	-3.00	-2.54
ОН	1.15	0.70	0.07	3.65	0.88	1.29
ок	3.65	2.89	2.65	3.38	3.62	1.62
OR	0.55	0.36	0.22	0.69	0.47	0.14
РА	-0.07	0.11	1.38	2.21	-0.41	0.19
RI	-2.81	-2.61	5.96	0.56	-3.08	-0.77
SC	8.65	9.73	6.42	9.93	8.05	5.93
SD	-0.33	-0.31	-1.10	2.34	-0.21	-1.59
TN	2.85	4.81	-1.84	9.66	2.00	0.85
тх	3.47	3.76	1.61	2.66	3.26	2.38
UT	3.30	1.98	0.38	4.95	3.53	2.15
νт	-2.73	-2.50	3.98	0.06	-2.81	-2.81
VA	0.13	-0.25	0.25	3.01	-0.01	0.85
WA	-0.36	-0.26	-0.12	0.09	-0.34	-0.36
wv	-0.25	-1.17	-6.99	-0.89	0.11	-2.42
wi	-1.22	-1.77	1.47	-0.68	-1.63	-1.01
WY	2.70	2.66	1.48	5.41	2.60	1.50
CENRAP	3.65	3.61	1.27	4.02	3.64	1.78
MANE_VU	-1.58	-1.50	2.55	0.58	-1.80	-1.34
MW	1.07	1.17	-1.31	2.43	0.59	-0.53
VISTAS	1.24	2.15	0.44	6.04	0.78	0.00
WRAP	1.30	1.09	1.02	2.58	1.24	0.59

Table 3-14: Accumulated Precipitation Error (cm) for Base and
Sensitivity Simulations for 2001 July 2-26.

	eta	hifdda	nofdda	px2	reisner2	zfac
ALL	4.28	4.21	3.72	4.68	4.25	3.37
AL	3.32	3.48	4.71	5.45	3.29	2.94
AK	5.23	7.07	0.62	3.69	6.41	4.72
AZ	5.99	4.62	2.09	8.61	6.03	3.89
AR	6.89	7.66	3.93	7.91	6.88	4.17
CA	2.00	1.93	1.02	2.34	1.93	1.28
со	3.24	2.84	6.22	2.71	3.32	2.52
СТ	1.43	1.05	11.10	0.70	1.51	0.59
DE	1.49	1.19	3.52	0.94	1.15	0.86
FL	8.49	9.98	8.96	9.58	7.77	7.65
GA	6.00	5.44	6.88	8.89	5.56	5.48
ID	2.93	2.53	1.46	3.68	2.85	2.77
IL	7.17	7.61	4.55	7.14	6.21	3.58
IN	7.19	6.34	5.20	5.65	7.17	5.23
IA	4.76	4.16	3.49	4.82	4.69	5.56
KS	10.51	9.58	4.45	7.33	11.16	6.44
KY	7.62	7.01	6.67	9.75	7.79	4.94
LA	5.19	6.39	6.04	4.69	4.56	5.21
ME	3.23	3.18	3.40	3.60	3.45	2.82
MD	3.44	3.57	4.41	3.81	3.16	3.48
MA	3.40	3.14	7.25	1.91	3.44	2.22
МІ	1.96	1.99	2.62	2.33	2.05	1.77
MN	2.21	2.65	3.27	2.89	2.20	2.50
MS	5.16	5.19	5.09	7.66	5.34	4.89
мо	7.44	7.05	5.72	8.06	7.62	4.88
мт	2.70	2.22	2.36	3.38	2.72	1.96
NE	5.25	4.85	3.72	3.68	5.38	3.47
NV	2.60	2.76	1.62	4.09	2.66	1.66
NH	4.22	4.24	3.46	1.67	4.48	3.72

NJ	2.73	2.35	1.09	2.40	3.14	2.11
NM	4.69	5.14	4.32	4.88	4.81	3.20
NY	2.51	2.38	3.99	1.59	2.59	2.43
NC	4.93	4.87	6.72	7.03	4.55	4.20
ND	3.62	3.20	4.02	3.63	3.72	3.39
ОН	3.36	3.30	2.63	4.25	3.44	3.02
ок	4.34	3.58	3.64	3.97	4.15	2.97
OR	1.19	1.04	0.83	1.22	1.10	0.82
PA	2.03	2.31	2.70	3.37	1.94	2.23
RI	2.81	2.61	5.96	0.56	3.08	0.77
SC	10.41	10.46	7.82	10.31	9.86	8.11
SD	4.04	4.13	4.45	4.31	4.43	3.73
TN	4.67	6.48	4.15	9.90	4.48	3.76
тх	3.97	4.27	2.35	3.27	3.84	3.10
UT	3.72	3.15	1.30	5.23	4.14	2.48
VT	3.67	4.05	4.03	1.63	3.67	3.40
VA	2.55	2.76	2.56	3.94	2.64	2.68
WA	0.87	0.92	0.76	0.90	0.87	0.72
wv	7.13	6.77	7.53	4.63	6.88	6.03
wi	2.58	2.82	2.90	3.16	2.56	2.85
WY	3.57	2.97	3.05	5.61	3.58	2.96
CENRAP	5.60	5.51	3.87	5.15	5.63	4.24
MANE_VU	2.64	2.67	3.77	2.42	2.68	2.47
MW	4.69	4.65	3.64	4.75	4.49	3.39
VISTAS	5.69	5.92	5.91	7.64	5.51	4.88
WRAP	2.95	2.70	2.49	3.52	3.01	2.23

Figure 3-36: Accumulated Precipitation Bias for Base and Sensitivity Simulations for 2001 July 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

MM5 Sensitivity Comparisons July 2001 Precipitation Bias



Figure 3-37: Accumulated Precipitation Error for Base and Sensitivity Simulations for 2001 July 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

> MM5 Sensitivity Comparisons July 2001 Precipitation Error



Table 3-15:	Wind Index of Agreement	for Base and Sensitivity
Simulations	for 2001 July 2-26.	

	eta	hifdda	nofdda	px2	reisner2	zfac
ALL	0.54	0.53	0.72	0.56	0.54	0.66
AL	0.52	0.59	1.07	0.61	0.53	0.49
AK	0.47	0.46	0.47	0.61	0.49	0.59
AZ	0.50	0.47	0.52	0.59	0.50	0.57
AR	0.54	0.50	1.11	0.60	0.52	1.08
CA	0.64	0.60	0.76	0.49	0.62	0.74
СО	0.57	0.57	0.65	0.48	0.56	0.61
СТ	0.58	0.64	0.70	0.34	0.57	0.75
DE	0.39	0.42	0.33	0.44	0.40	0.31
FL						
GA	0.67	0.65	0.79	0.69	0.68	0.91
ID	0.99	0.85	0.79	0.77	0.99	1.19
IL						
IN	0.49	0.47	0.81	0.48	0.48	0.64
IA	0.82	0.85	0.47	0.46	0.81	1.02
KS	0.65	0.67	0.43	0.62	0.64	0.69
KY	0.43	0.48	0.52	0.76	0.39	0.38
LA	0.46	0.43	0.52	0.43	0.45	0.52
ME	0.60	0.59	0.41	0.47	0.60	0.76
MD	0.67	0.64	0.49	0.95	0.65	0.73
MA	0.40	0.39	0.61	0.93	0.41	0.38
МІ	0.77	0.80	0.76	0.46	0.81	0.53
MN	0.54	0.56	1.05	0.73	0.55	1.03
MS	0.64	0.64	0.96	0.60	0.61	0.80
мо	0.42	0.41	0.63	0.61	0.40	0.51
мт	0.63	0.68	0.81	0.62	0.62	0.67
NE	0.94	0.88	0.42	0.35	0.93	1.02
NV	0.47	0.47	0.88	0.48	0.47	0.55
NH	0.49	0.46	0.44	0.43	0.48	0.46

NJ	0.66	0.57	0.62	0.46	0.63	0.58
NM	0.19	0.19	0.22	0.37	0.19	0.25
NY	0.59	0.58	0.72	0.71	0.58	0.87
NC	0.49	0.46	0.63	0.52	0.51	0.60
ND	0.56	0.64	0.63	0.76	0.56	0.64
он	0.77	0.79	1.40	1.01	0.77	0.90
ок	0.50	0.52	0.63	0.56	0.49	0.62
OR	0.67	0.70	0.71	0.57	0.66	0.87
PA	0.54	0.51	0.56	0.61	0.54	0.69
RI	0.45	0.44	0.57	0.46	0.45	0.56
SC	0.61	0.63	0.59	0.82	0.62	0.74
SD	0.37	0.40	0.60	0.42	0.38	0.60
TN	0.49	0.47	1.11	0.67	0.51	0.60
тх	0.50	0.51	0.45	0.43	0.48	0.63
UT	0.57	0.56	0.97	0.59	0.56	0.63
VT	0.60	0.55	0.70	0.60	0.60	0.69
VA	0.42	0.47	0.53	0.42	0.43	0.42
WA	0.17	0.19	0.24	0.47	0.19	0.21
wv	0.67	0.69	0.80	0.87	0.66	0.58
wi	0.68	0.62	0.77	0.48	0.68	0.85
WY	0.78	0.71	0.56	1.05	0.79	0.96
CENRAP	0.69	0.73	0.74	0.61	0.69	0.69
MANE_VU	0.41	0.40	0.67	0.54	0.41	0.52
MW	0.60	0.56	0.75	0.60	0.60	0.76
VISTAS	0.53	0.55	0.68	0.78	0.53	0.68
WRAP	0.69	0.71	0.80	0.61	0.68	0.82

Figure 3-38: Wind Index of Agreement for Base and Sensitivity Simulations for 2001 July 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

MM5 Sensitivity Comparisons July 2001 Index of Agreement



## 4 **DISCUSSION**

As was expected going into this analysis, no one model configuration is clearly superior to all the others. Each model configuration has certain strengths and weaknesses. Selection of a single configuration to use for a whole year of annual modeling becomes a subjective judgment.

The Pleim-Xiu 2 configuration has some desirable attributes. For the February case, the Pleim-Xiu 2 configuration had the lowest temperature error and accumulated precipitation error, with the second lowest mixing ratio bias and error. For the July case, the Pleim-Xiu 2 configuration has the lowest domain wide temperature error and the second lowest mixing ratio bias and error. Of concern however, was the tendency for the Pleim-Xiu 2 configuration to overestimate rainfall during the July case, with the highest bias and error scores of any tested configuration.