Topical Report

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

Prepared for:
Pat Dolwick
USEPA

Prepared by:
Dennis McNally

Alpine Geophysics, LLC
7341 Poppy Way
Arvada, CO 80007
(303) 421-2211

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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.

Model Selection: 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.

Horizontal Domain Definition: 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 40^0, -97^0 with true latitudes of 33^0 and 45^0.

Vertical Domain Definition: 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.

Topographic Inputs: 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.

Vegetation Type and Land Use Inputs: 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.

Atmospheric Data Inputs: 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.

Water Temperature Inputs: 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.

FDDA Data Assimilation: 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 $2.5x10^{-4}$ was used for winds and temperature and $1x10^{-5}$ 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.

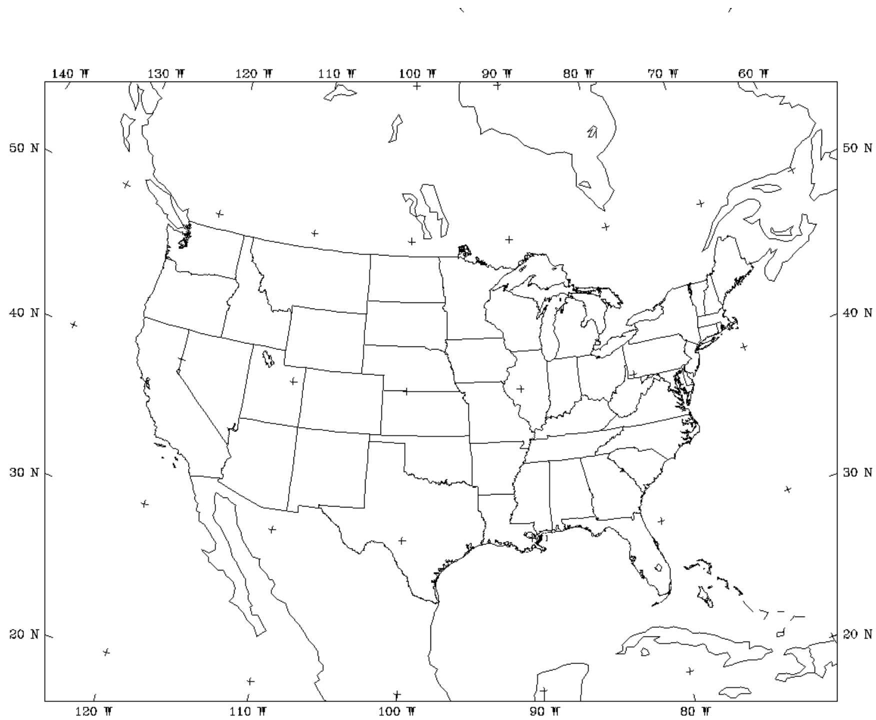
Interpretation of bulk statistics over a continental scale domain is problematic. It is difficult to detect if the model is missing important sub-regional features. For this analysis the statistics are performed on a state by state basis, a Regional Planning Organization (RPO) basis, and on a domain-wide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

Table 2-1: MM5 Vertical Domain Specification.

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

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 3-10 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.

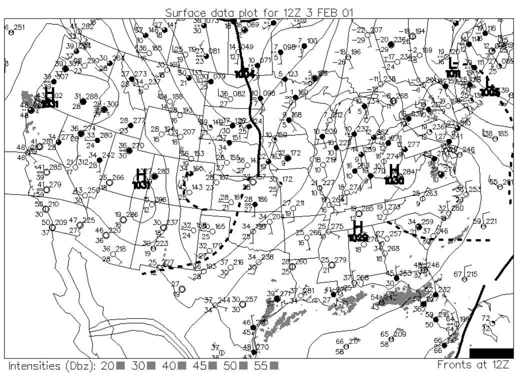
Accumulated precipitation bias data for July are presented in Table 3-13 and Figure 3-36. No regional trends are evident. Averaged over the entire domain, the ZFAC configuration performs best. Accumulated precipitation error data are presented in Table 3-14 and Figure 3-37. The ZFAC and NoFDDA simulations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

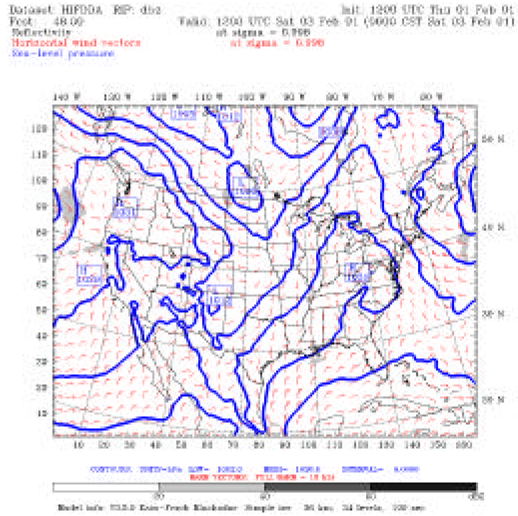
Table 3-1: MM5 model computational requirements per 6 day simulation. CPU times are on a dual 1GHz P-III computer system running Linux and the Portland Group FORTRAN compiler. Times are Hours:Minutes.

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

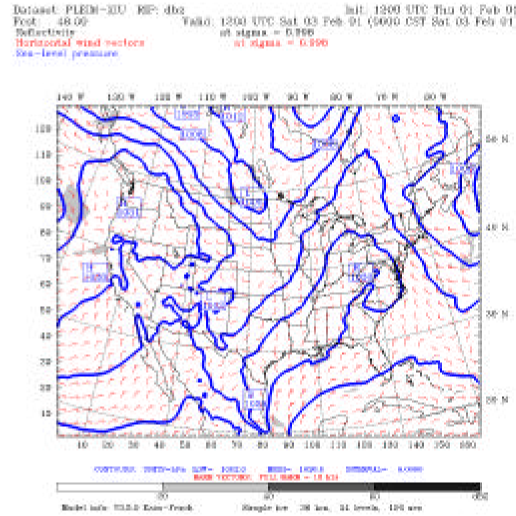
Figure 3-1: Analyzed and Model Estimated Surface Synoptic Charts at 12 Z 3 Feb. 2002.



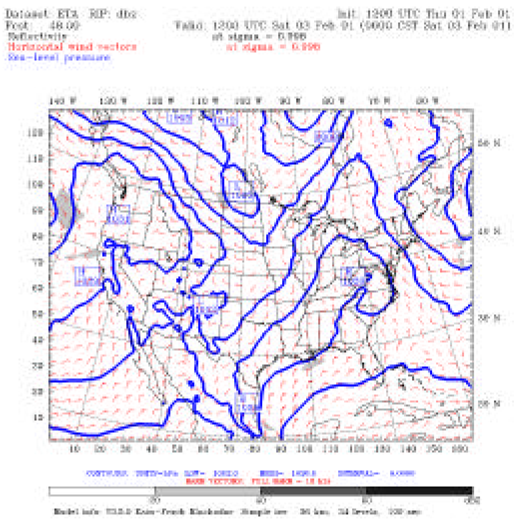
Observation



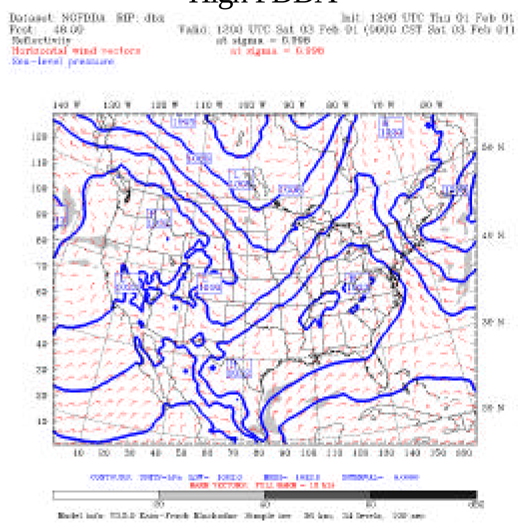
High FDDA



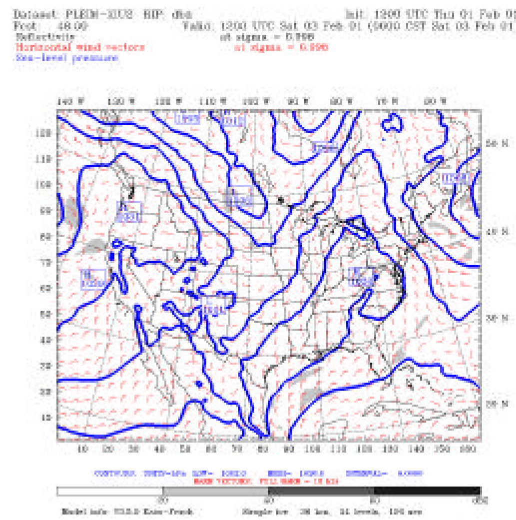
Pleim-Xiu



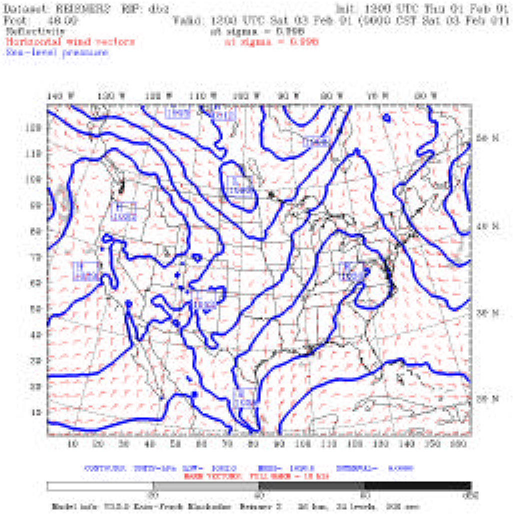
ETA



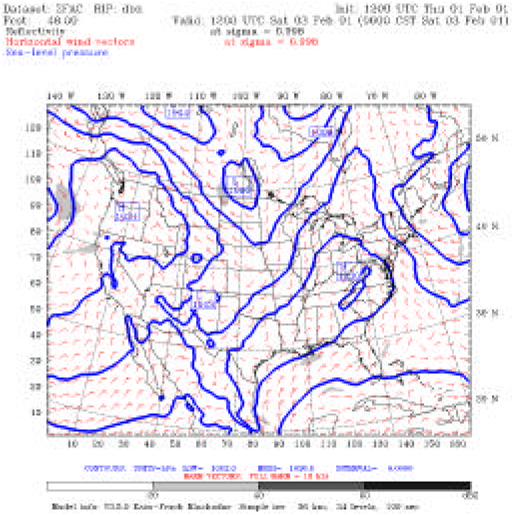
No FDDA



Pleim-Xu 2

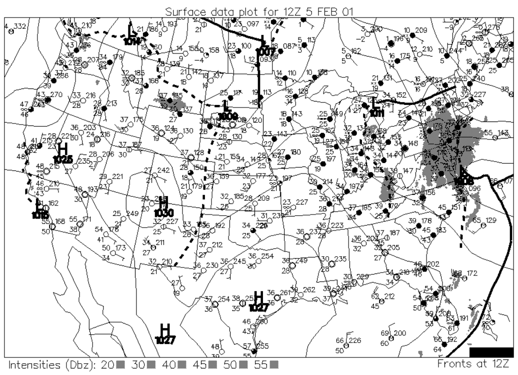


Reisner 2

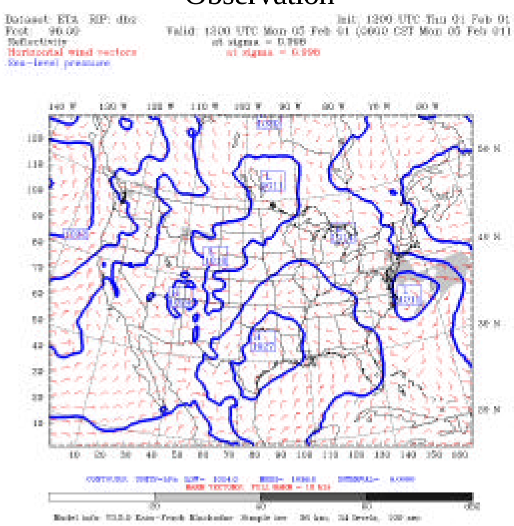


ZFAC

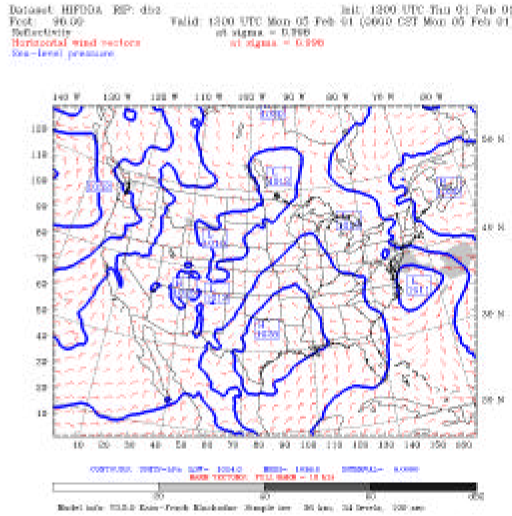
Figure 3-2: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 5 Feb. 2002.



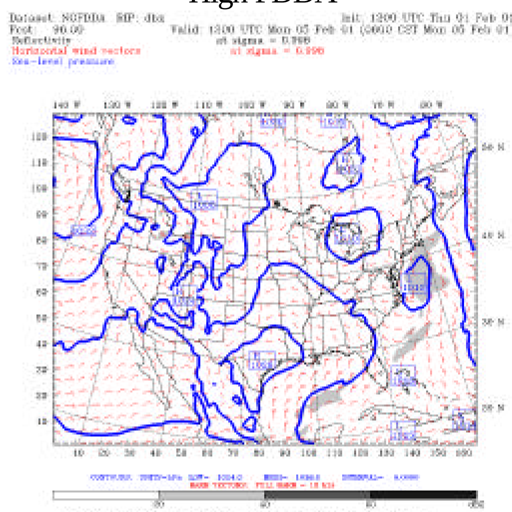
Observation



ETA



High FDDA



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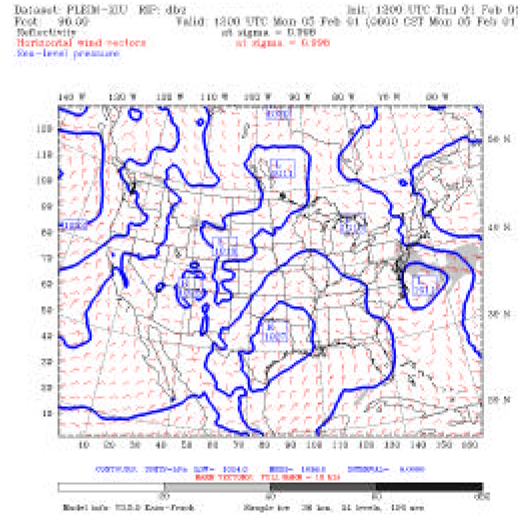
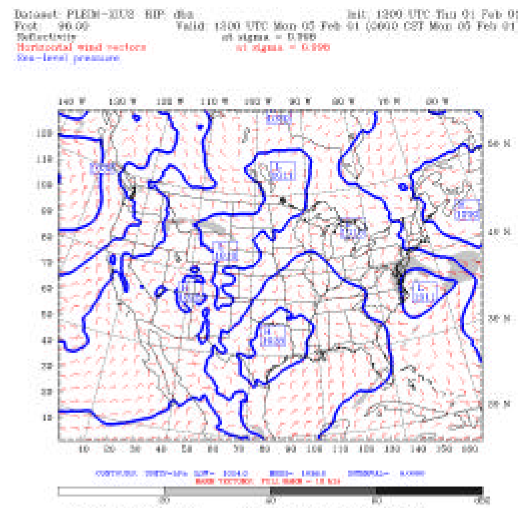
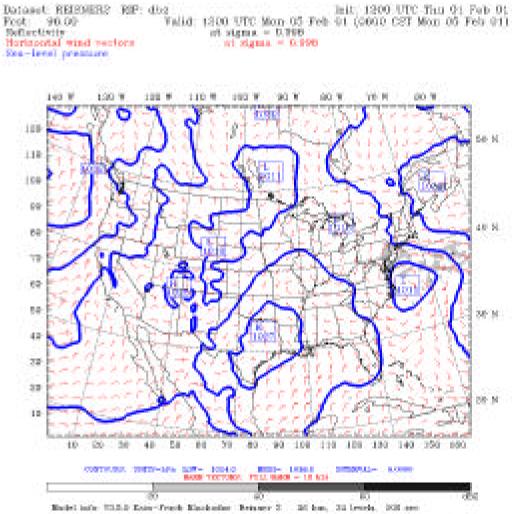


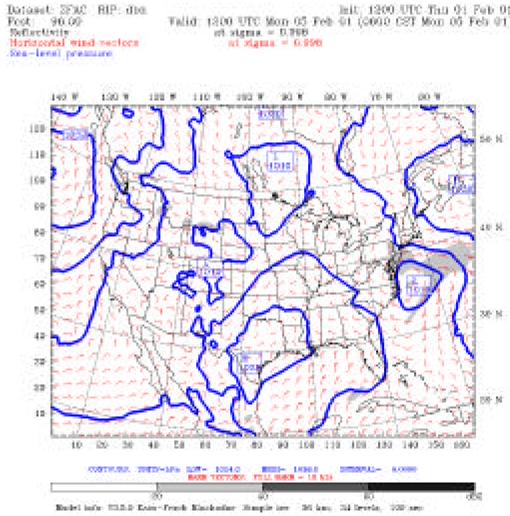
Pleim-Xiu



Pleim-Xiu 2

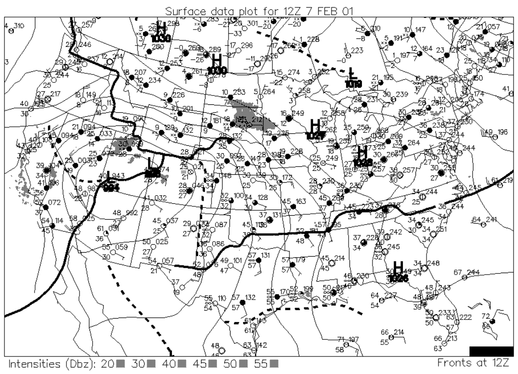


Reisner 2

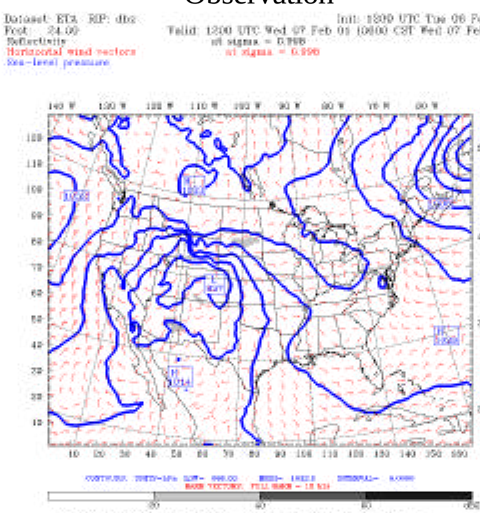


ZFAC

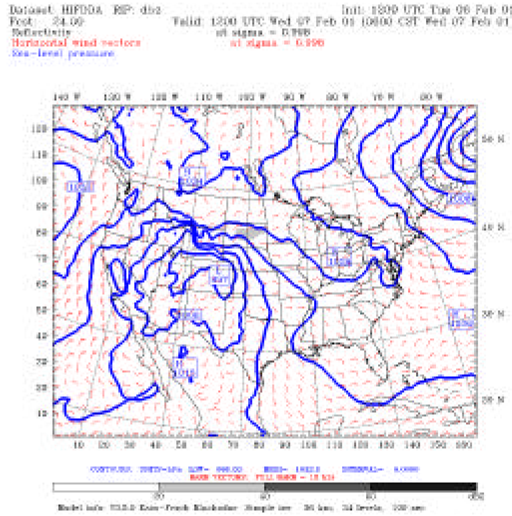
Figure 3-3: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 7 Feb. 2002.



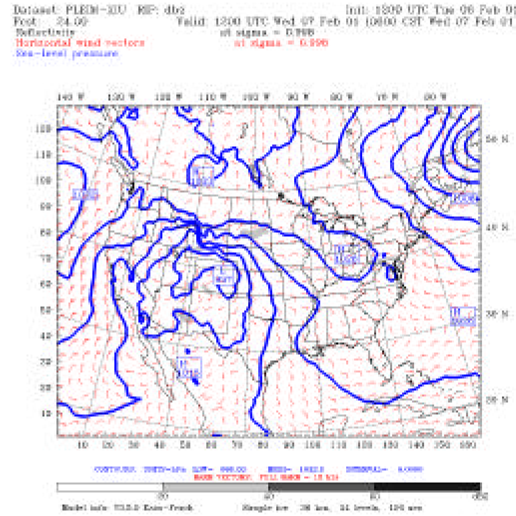
Observation



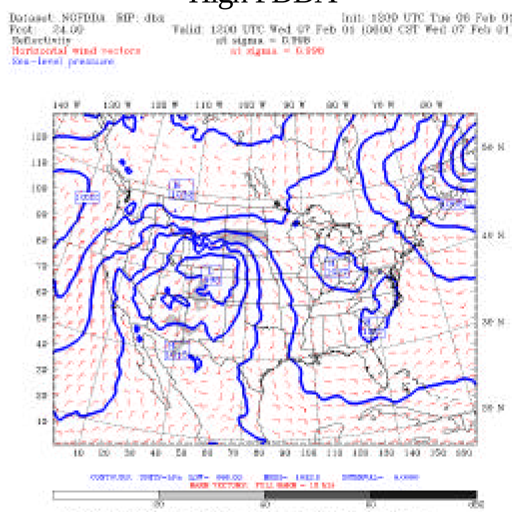
ETA



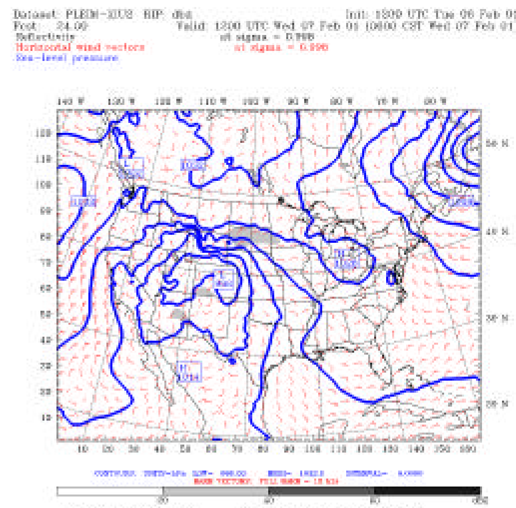
High FDDA



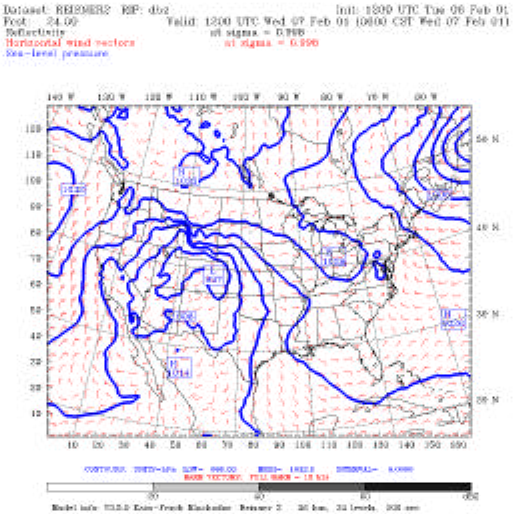
Pleim-Xiu



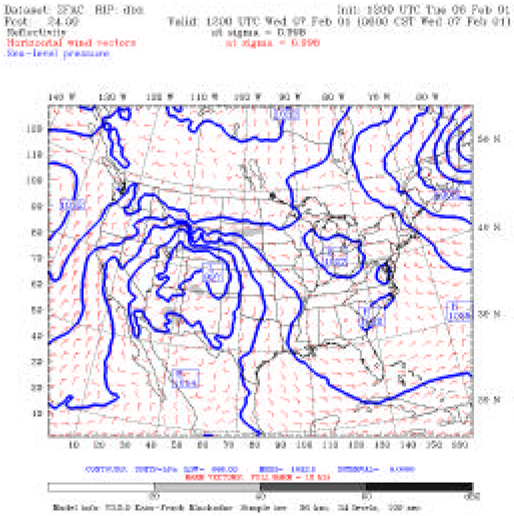
No FDDA



Pleim-Xui 2

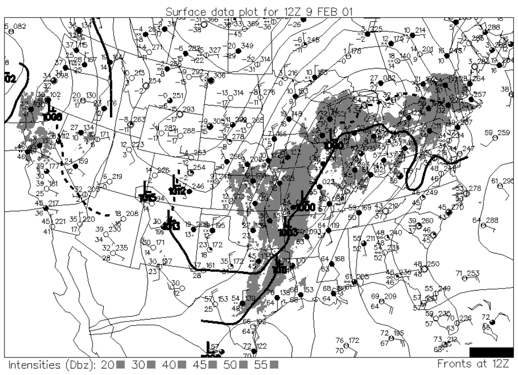


Reisner 2

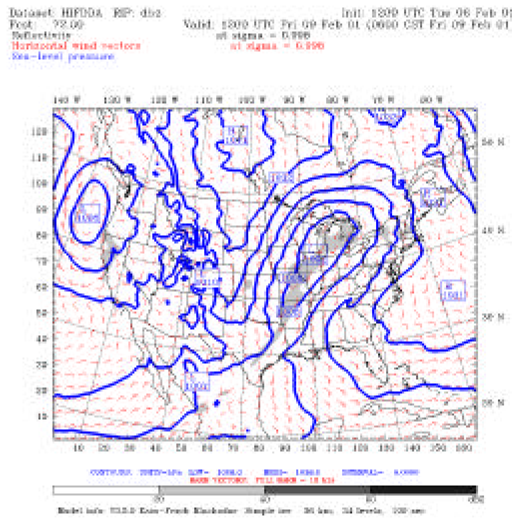


ZFAC

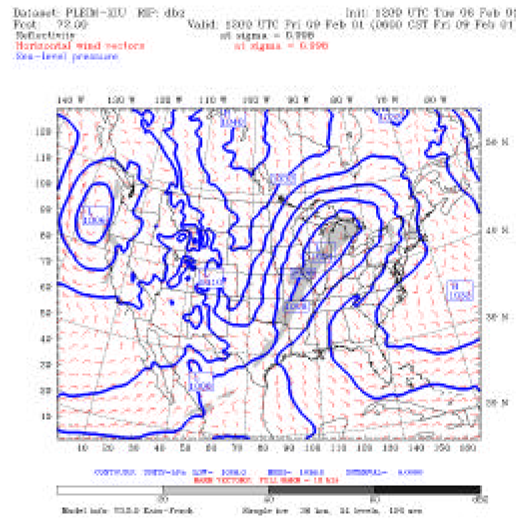
Figure 3-4: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 9 Feb. 2002.



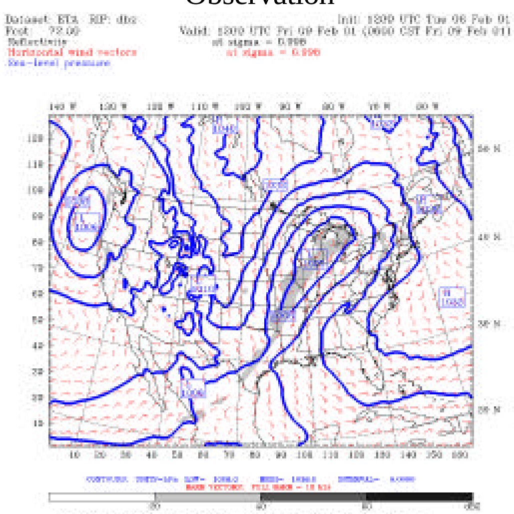
Observation



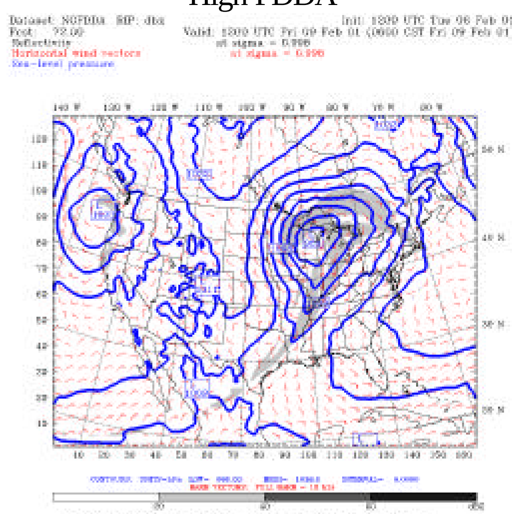
High FDDA



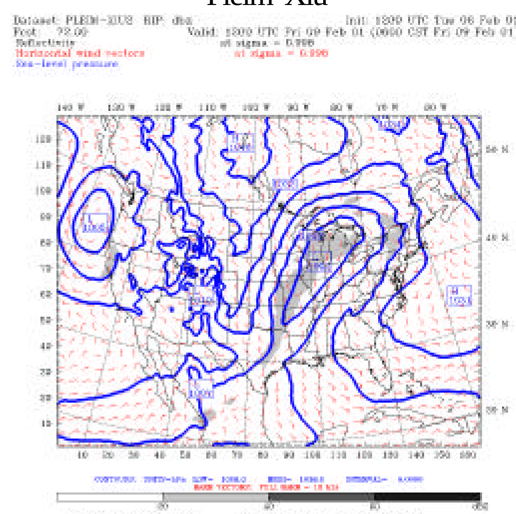
Pleim-Xiu



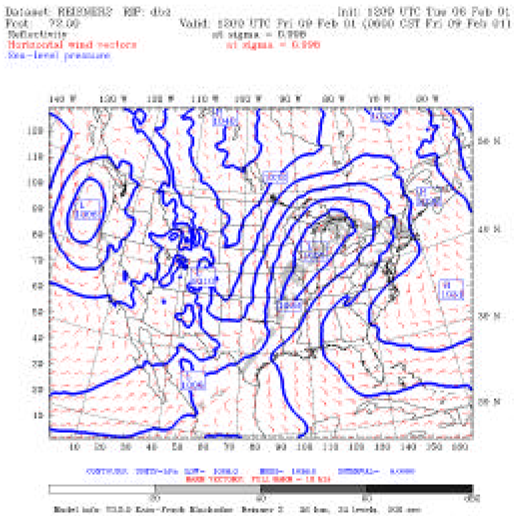
ETA



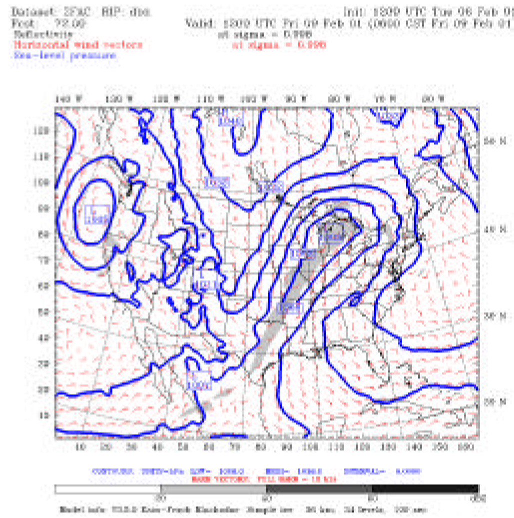
No FDDA



Pleim-Xiu 2

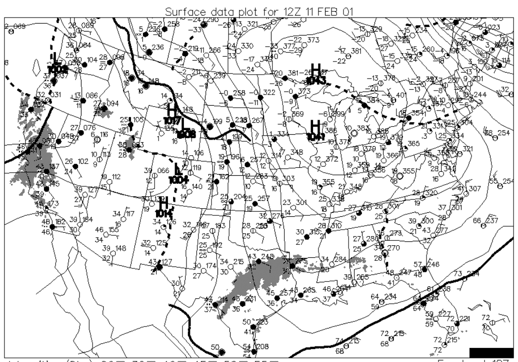


Reisner 2

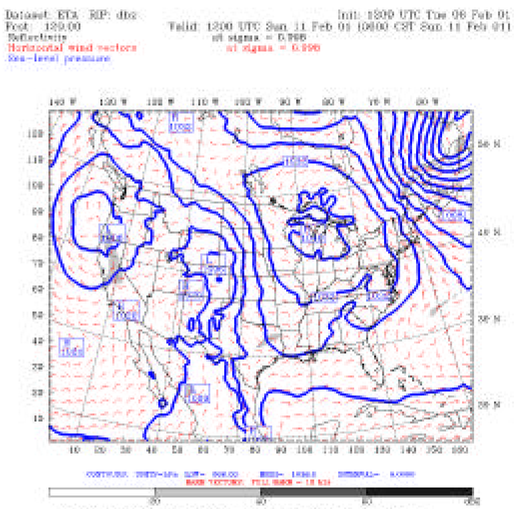


ZFAC

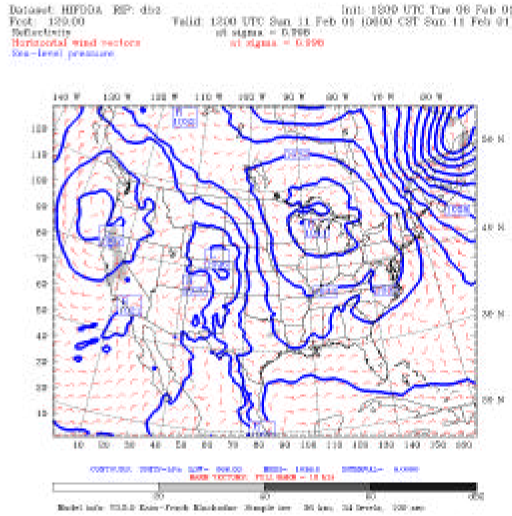
Figure 3-5: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 11 Feb. 2002.



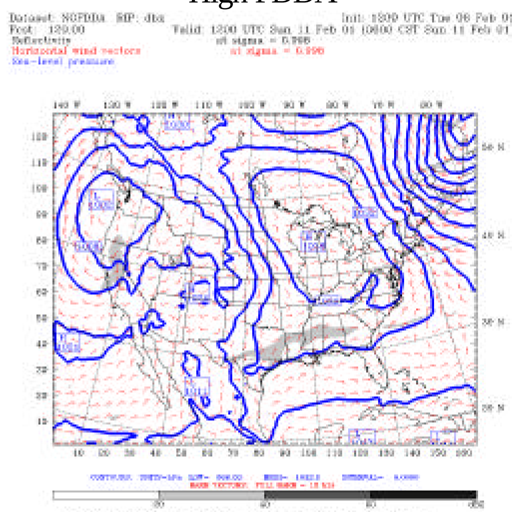
Observation



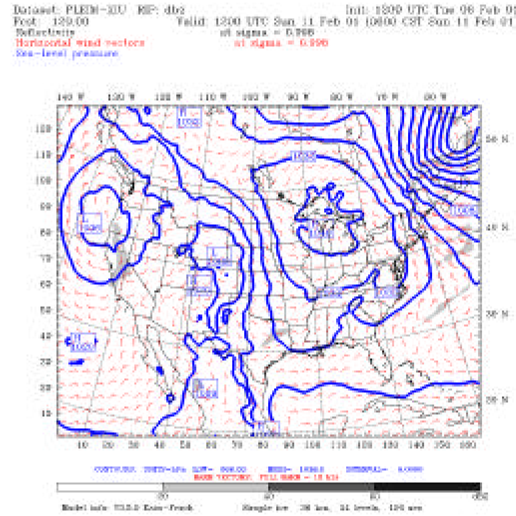
ETA



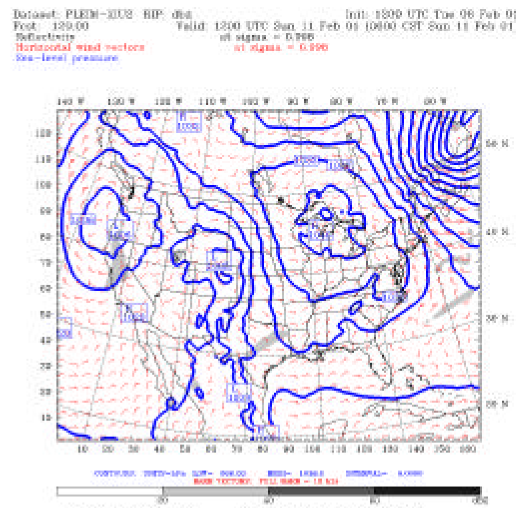
High FDDA



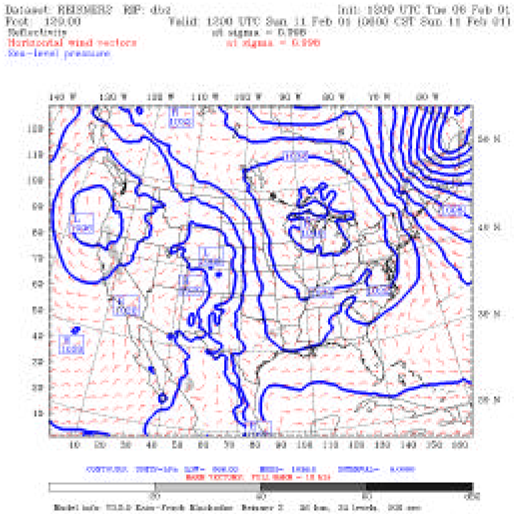
No FDDA



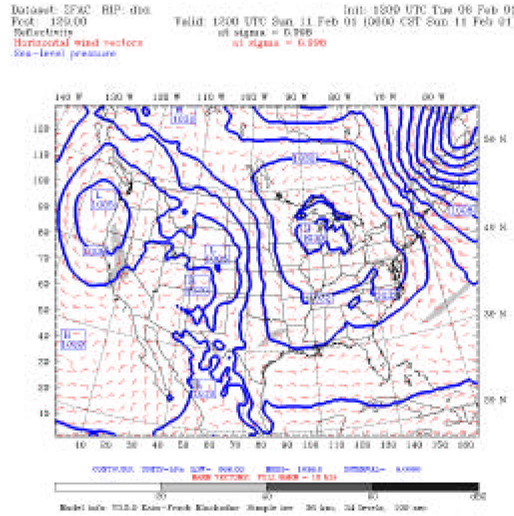
Pleim-Xiu



Pleim-Xiu 2

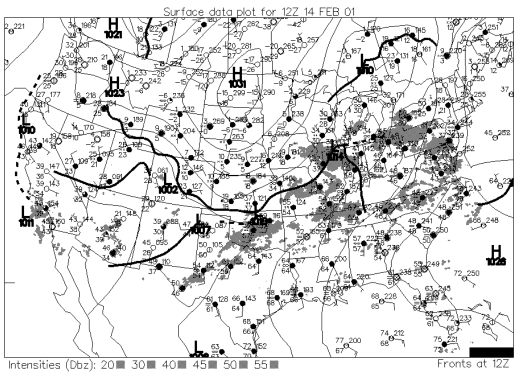


Reisner 2

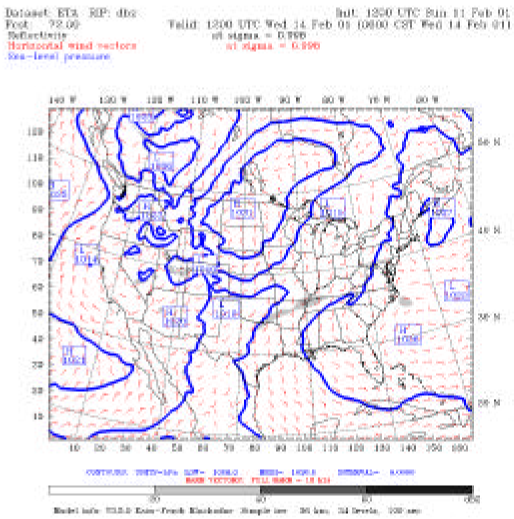


ZFAC

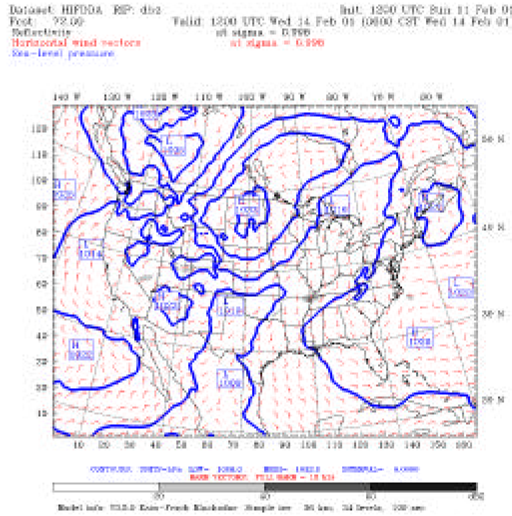
Figure 3-6: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 14 Feb. 2002.



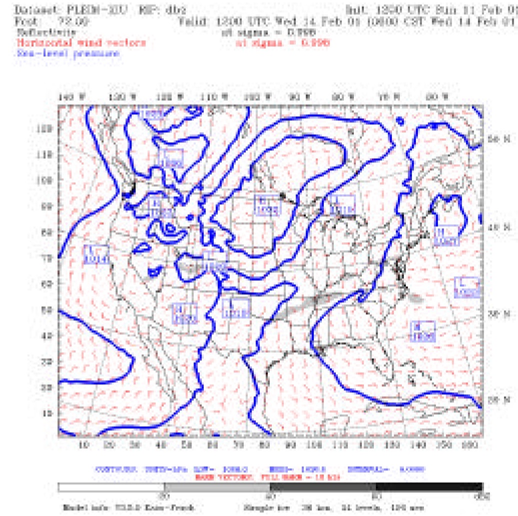
Observation



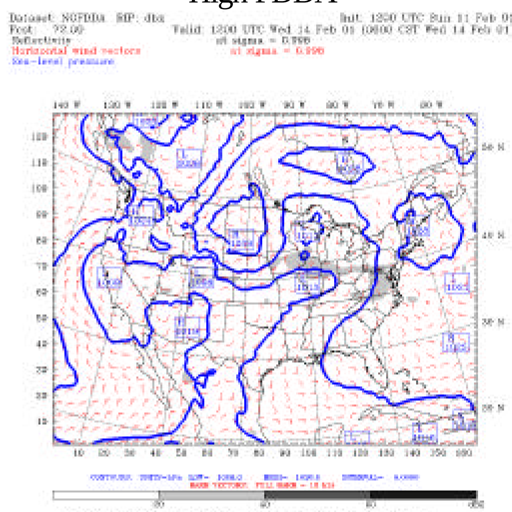
ETA



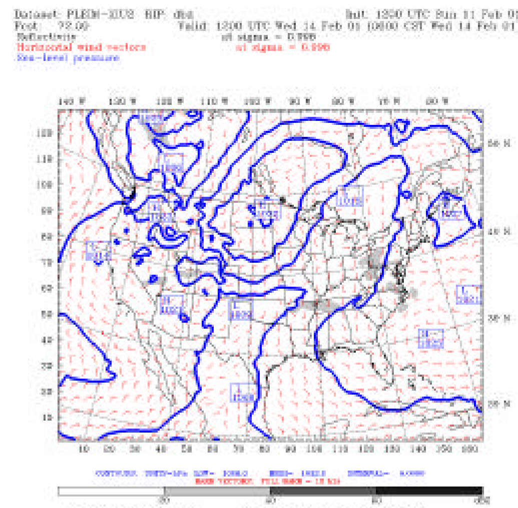
High FDDA



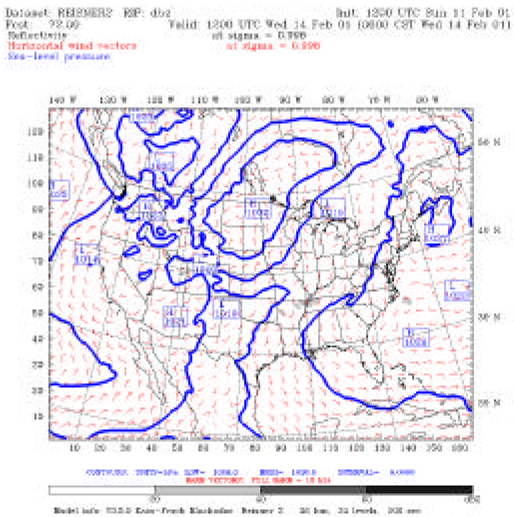
Pleim-Xiu



No FDDA



Pleim-Xiu 2



Reisner 2

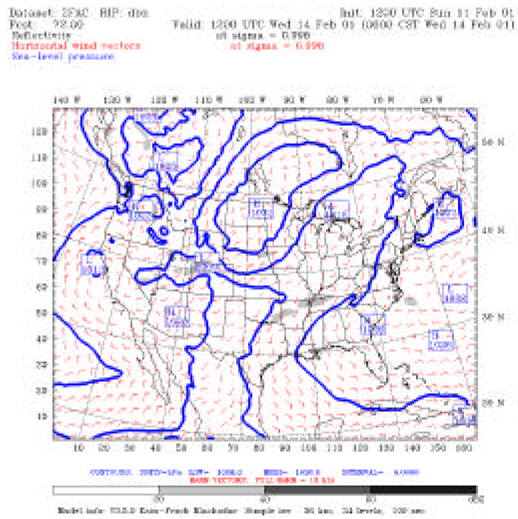


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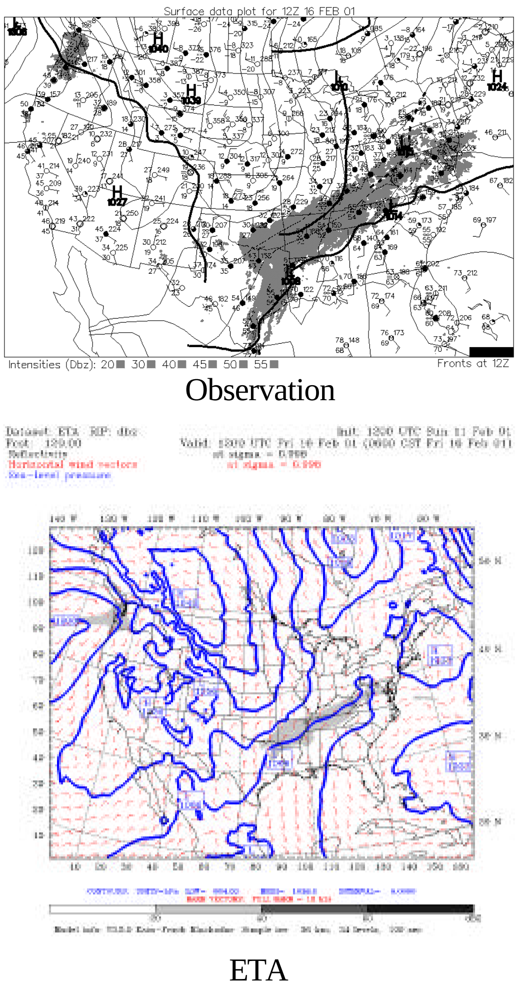
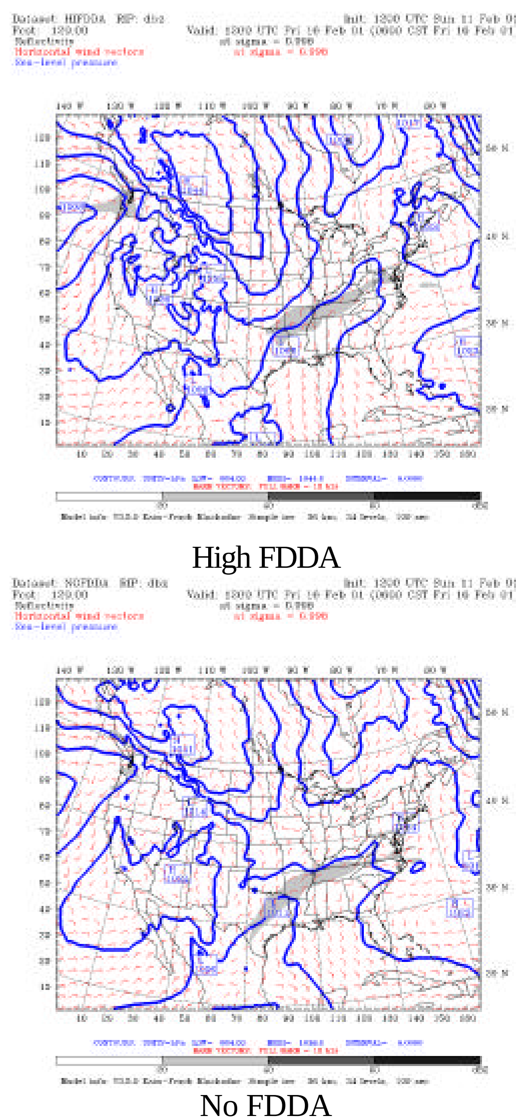
Figure 3-7: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 16 Feb. 2002.



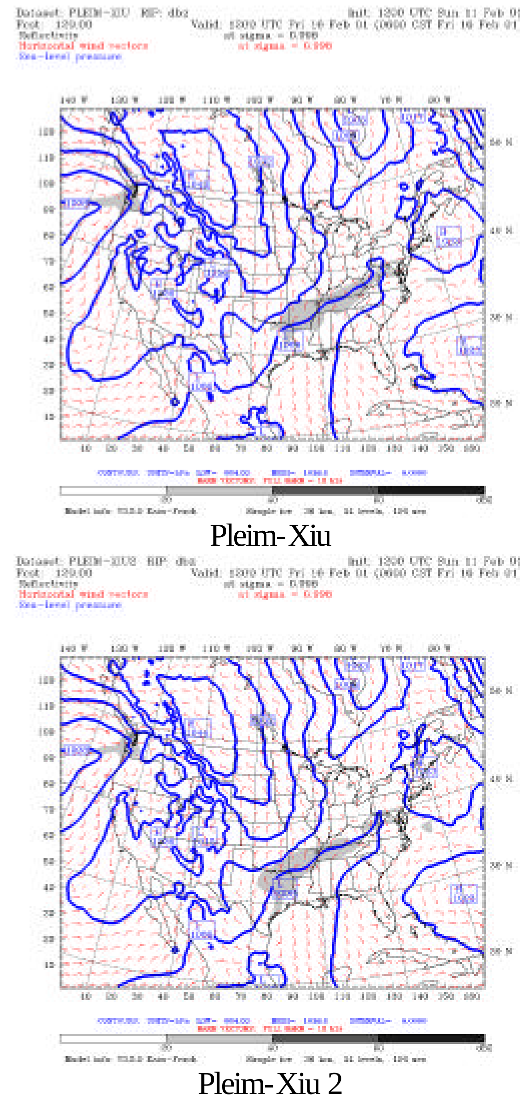
Observation

ETA



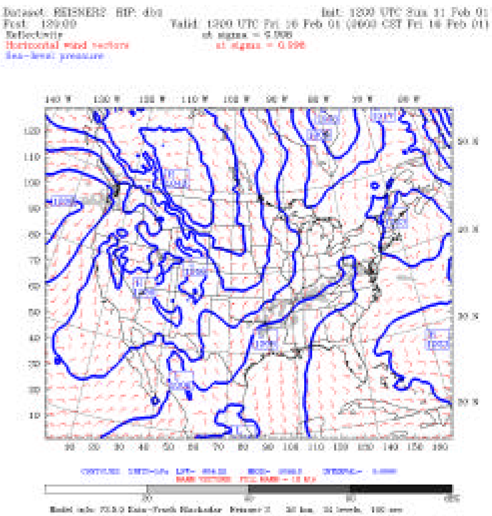
High FDDA

No FDDA

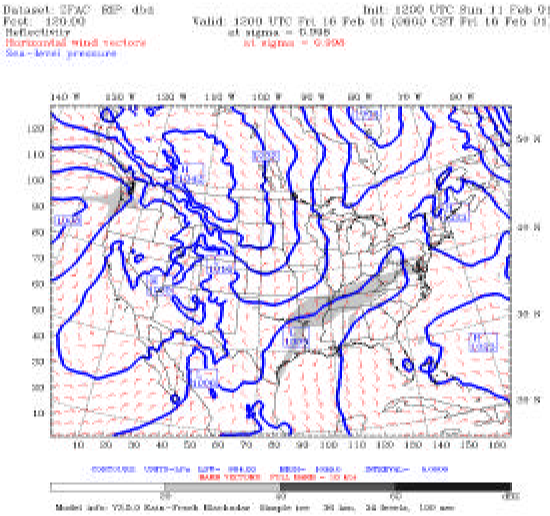


Pleim-Xiu

Pleim-Xiu 2

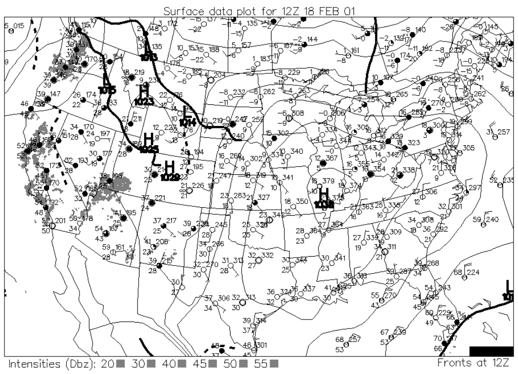


Reisner 2

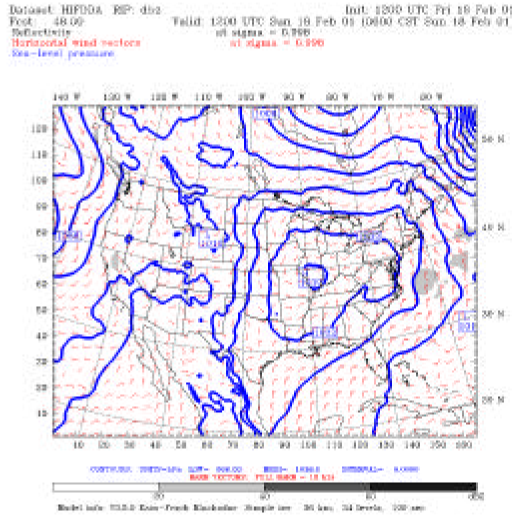


ZFAC

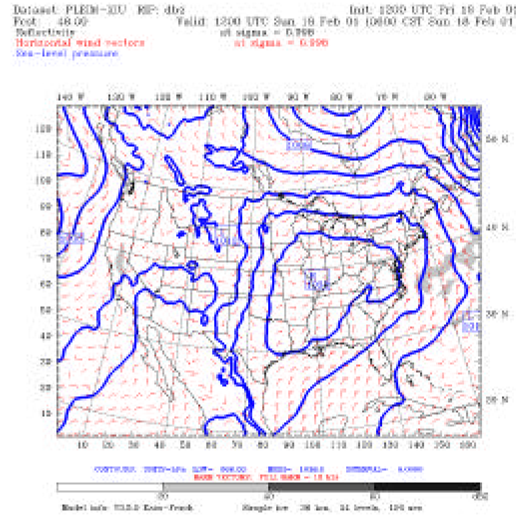
Figure 3-8: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 18 Feb. 2002.



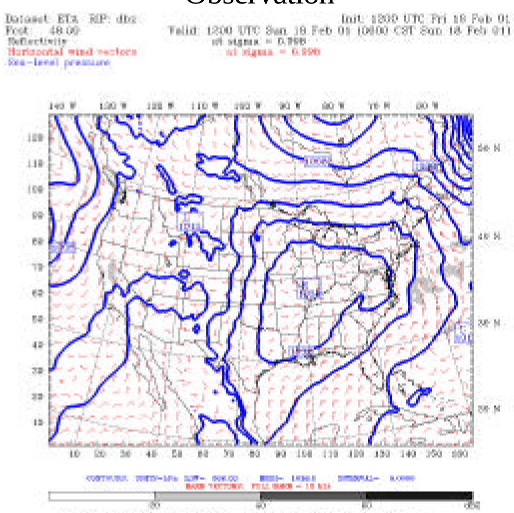
Observation



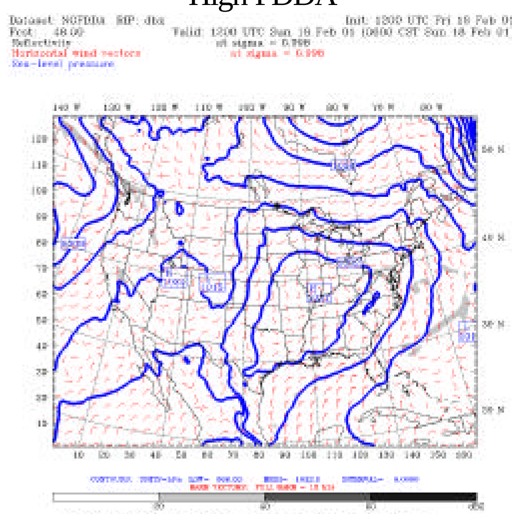
High FDDA



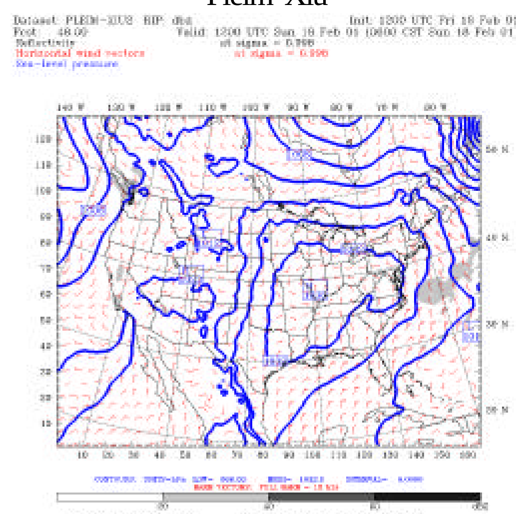
Pleim-Xiu



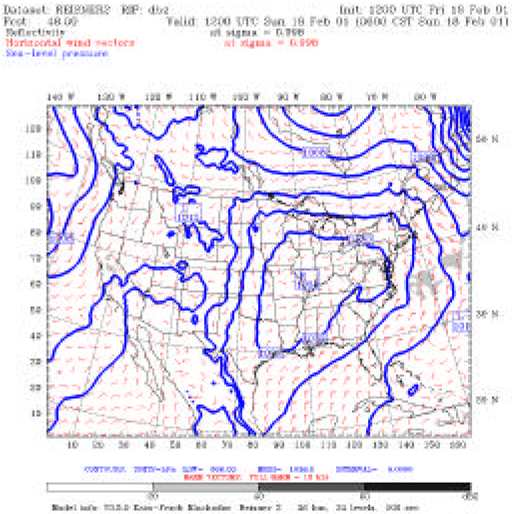
ETA



No FDDA



Pleim-Xiu 2



Reisner 2

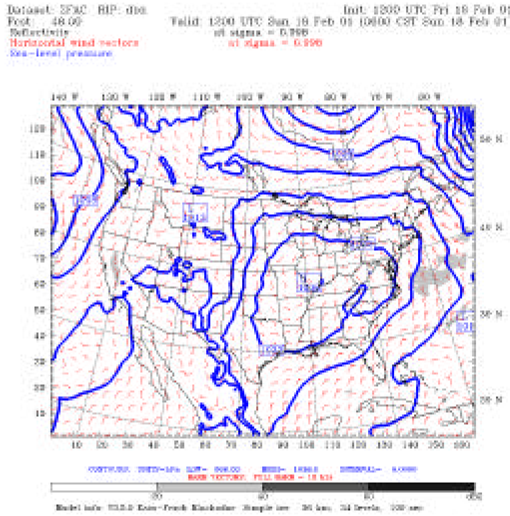


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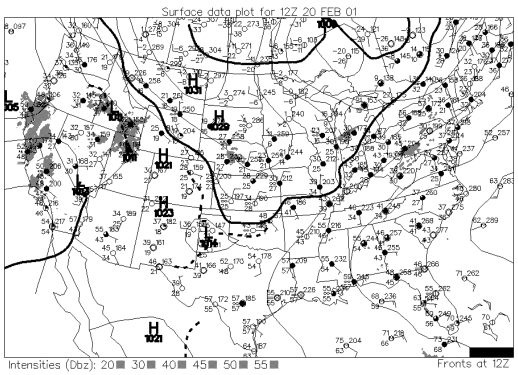
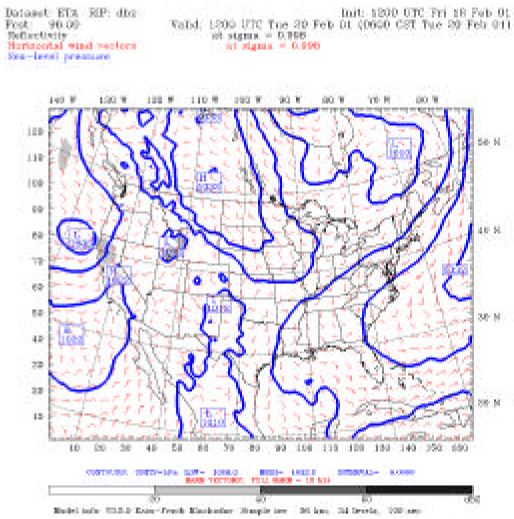
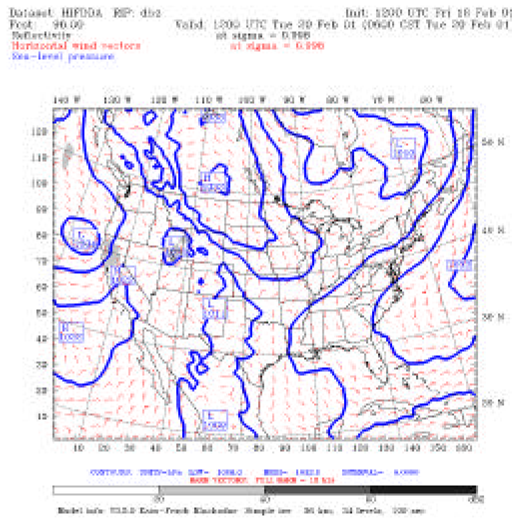
Figure 3-9: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 20 Feb. 2002.



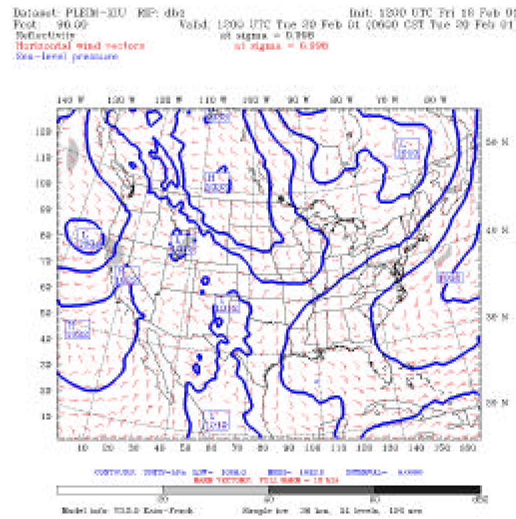
Observation



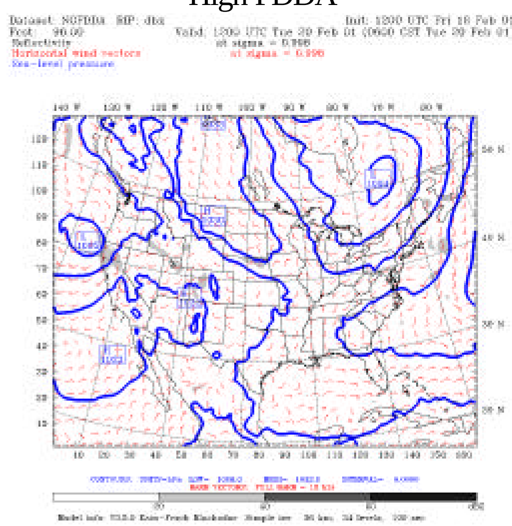
ETA



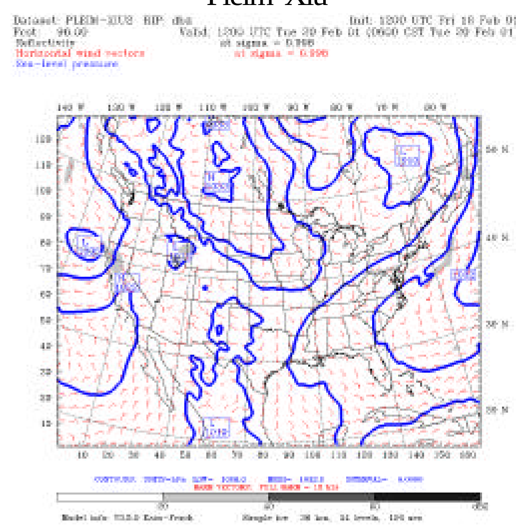
High FDDA



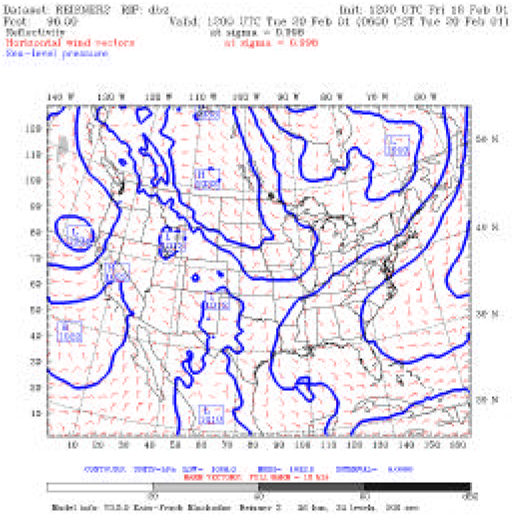
Pleim-Xiu



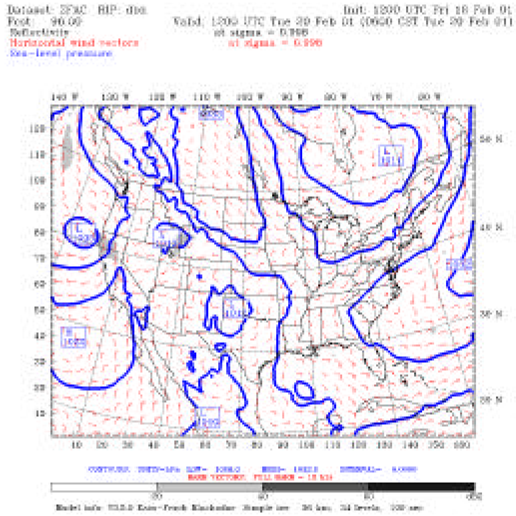
No FDDA



Pleim-Xiu 2

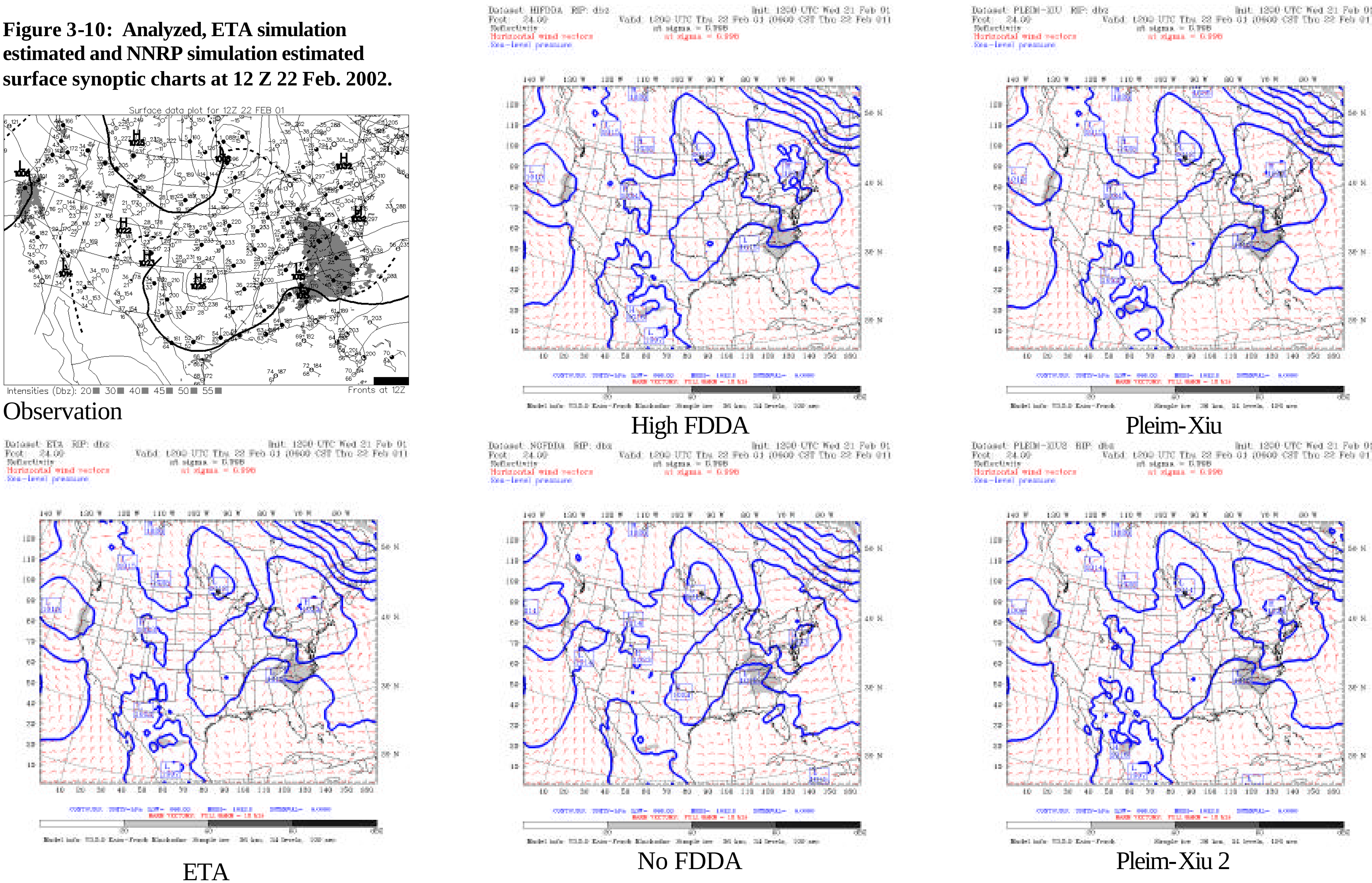


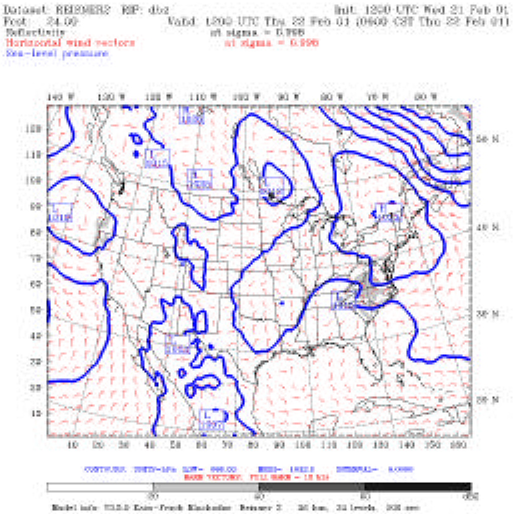
Reisner 2



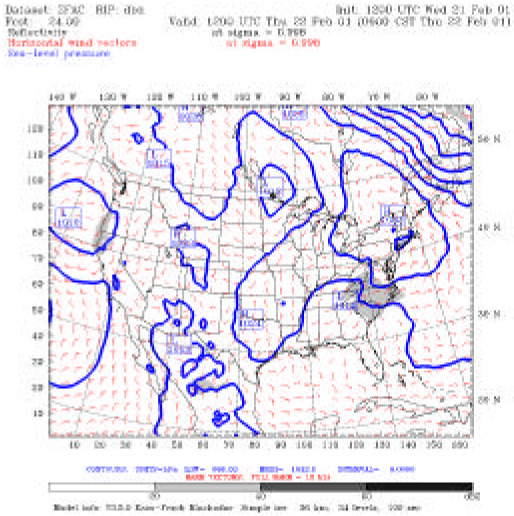
ZFAC

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



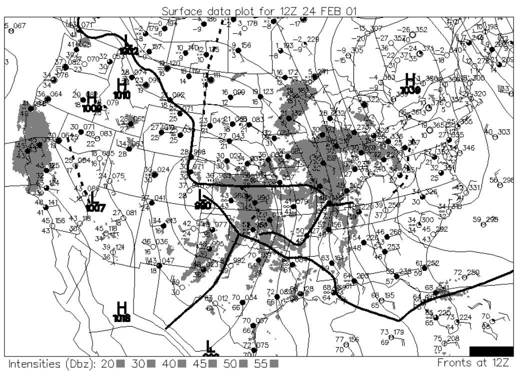


Reisner 2

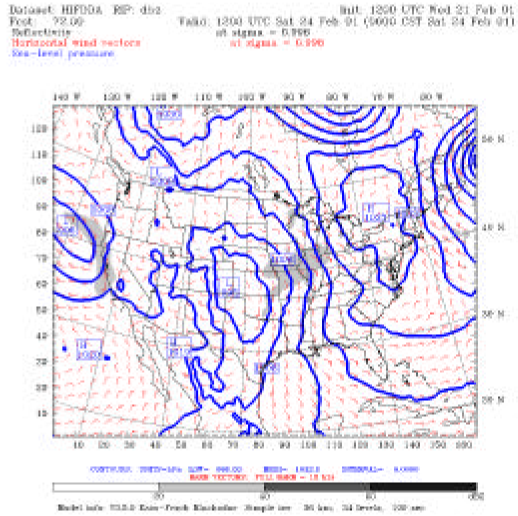


ZFAC

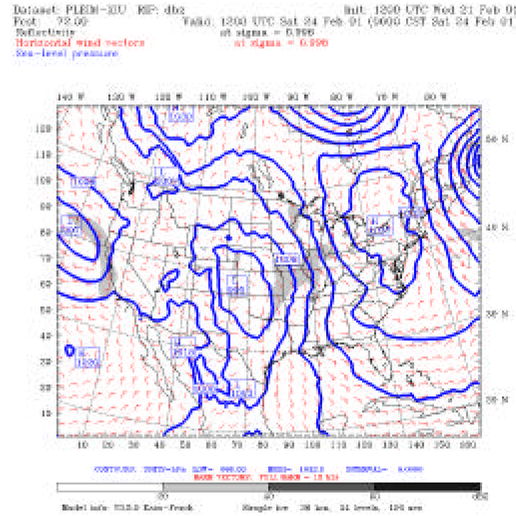
Figure 3-11: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 24 Feb. 2002.



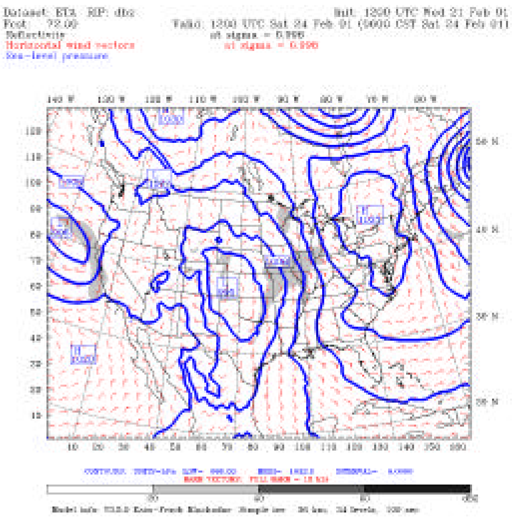
Observation



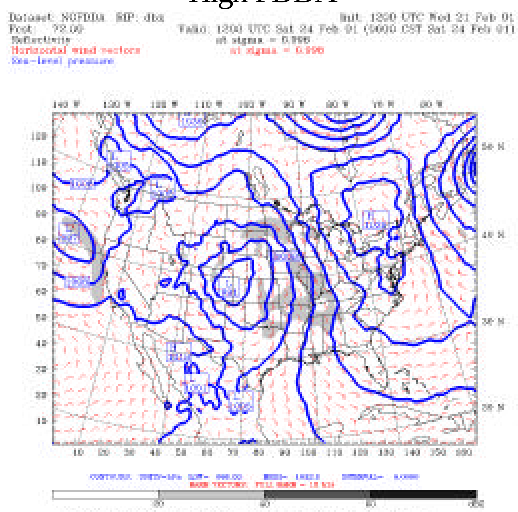
High FDDA



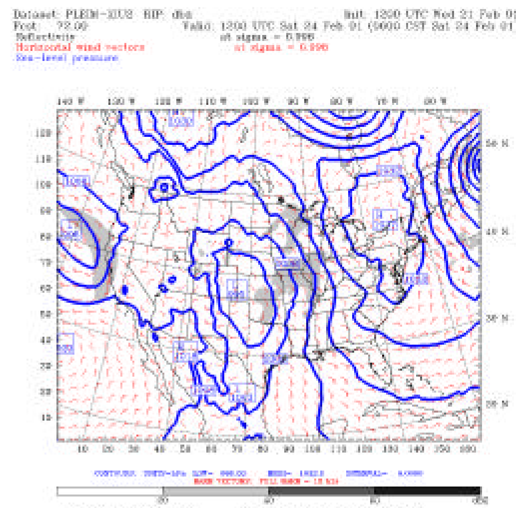
Pleim-Xiu



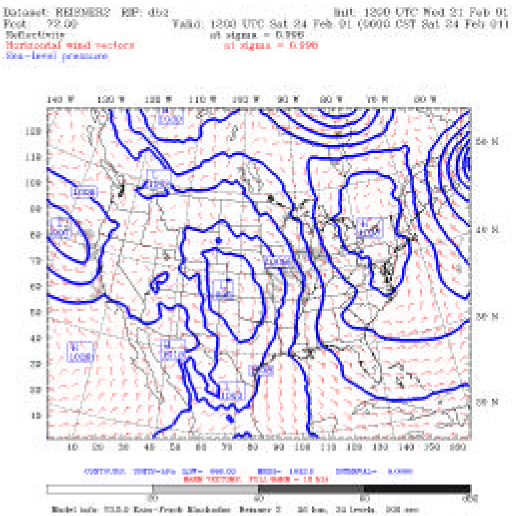
ETA



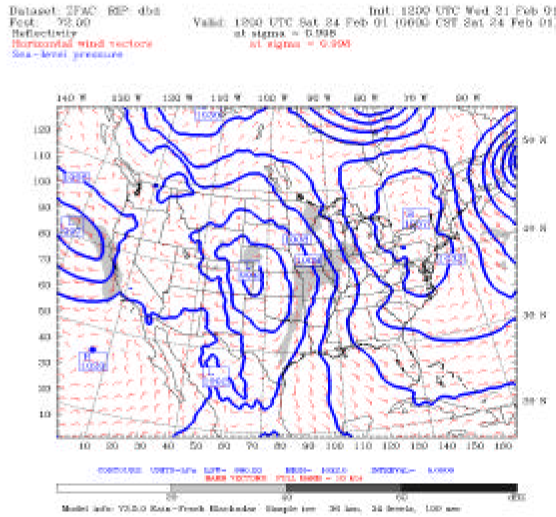
No FDDA



Pleim-Xiu2

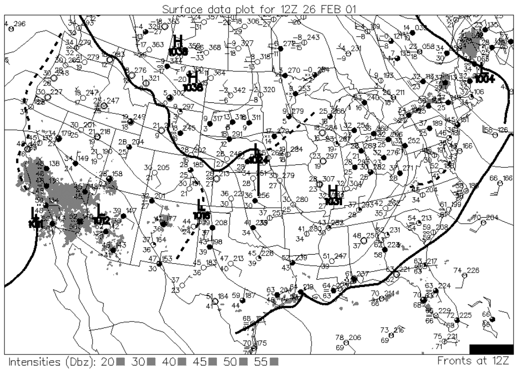


Reisner-2

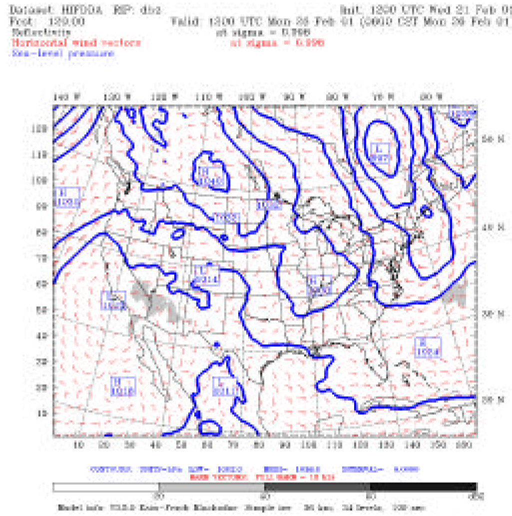


ZFAC

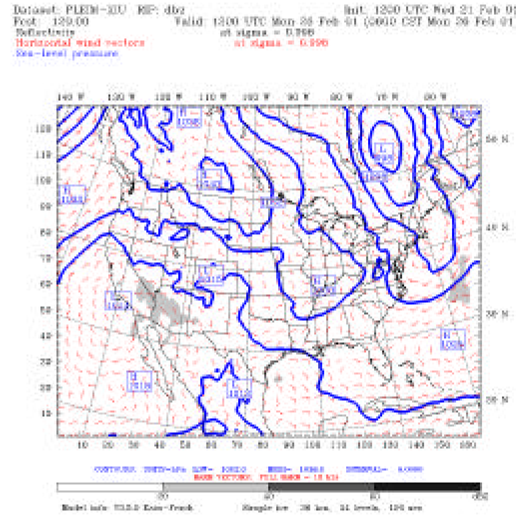
Figure 3-12: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 26 Feb. 2002.



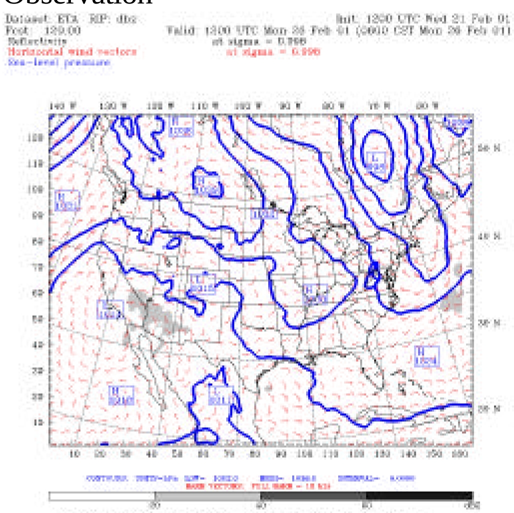
Observation



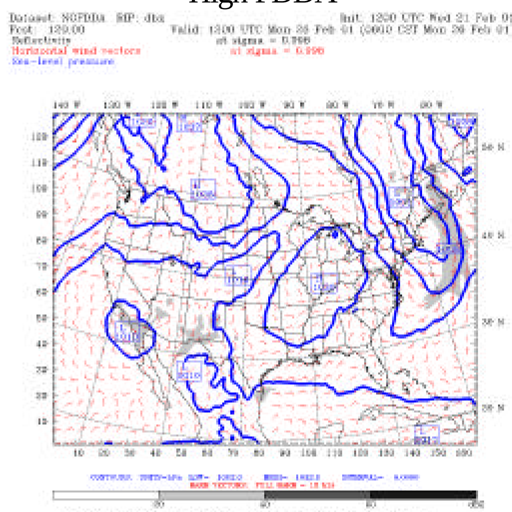
High FDDA



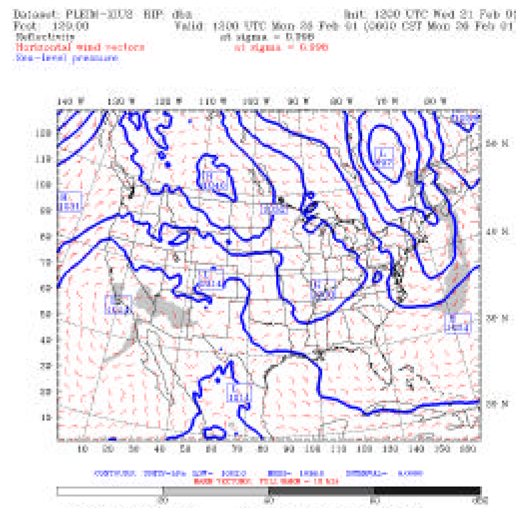
Pleim-Xiu



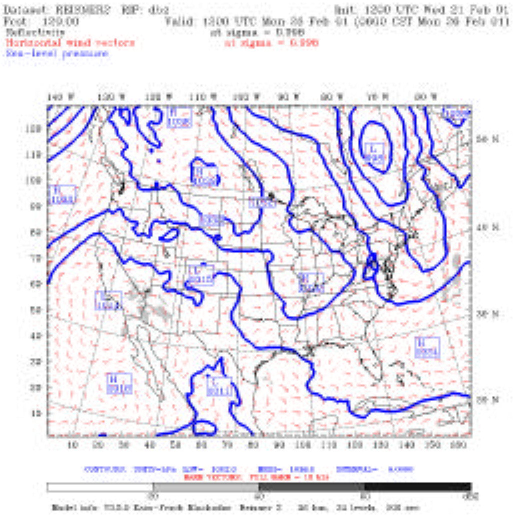
ETA



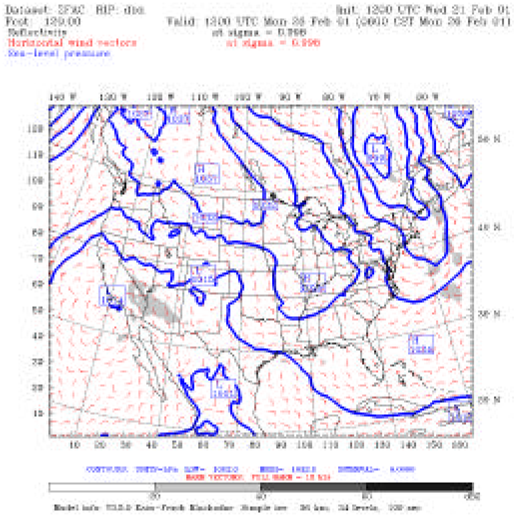
No FDDA



Pleim-Xiu 2

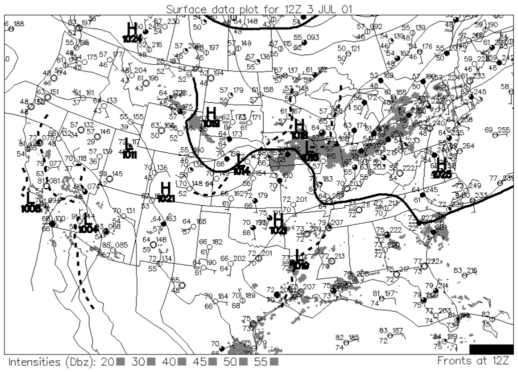


Reisner 2

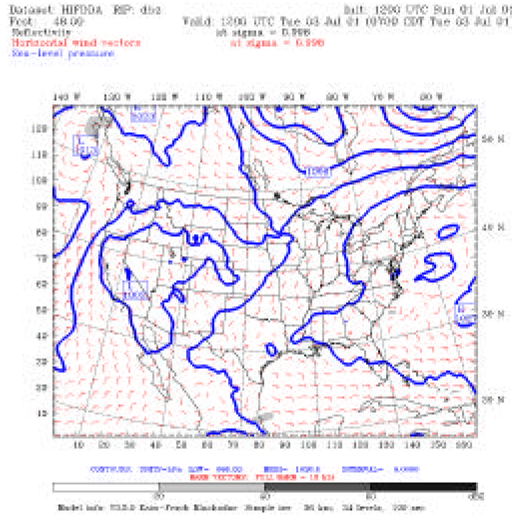


ZFAC

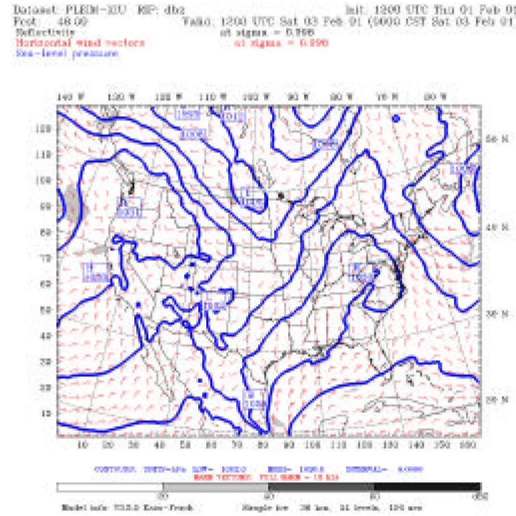
Figure 3-13: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 3 July 2002.



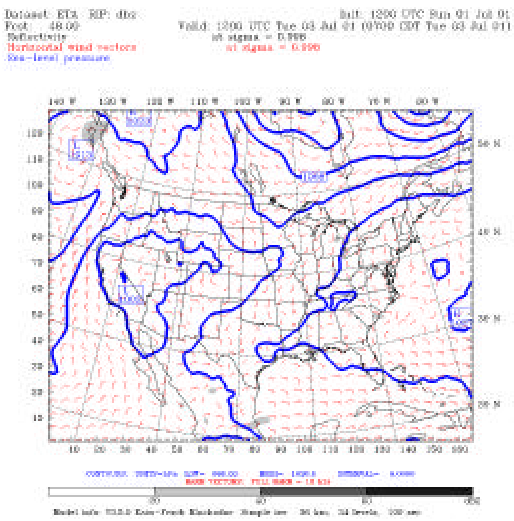
Observation



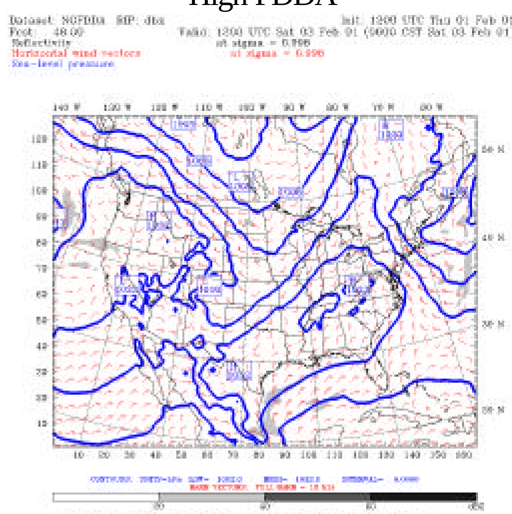
High FDDA



Pleim-Xiu



ETA



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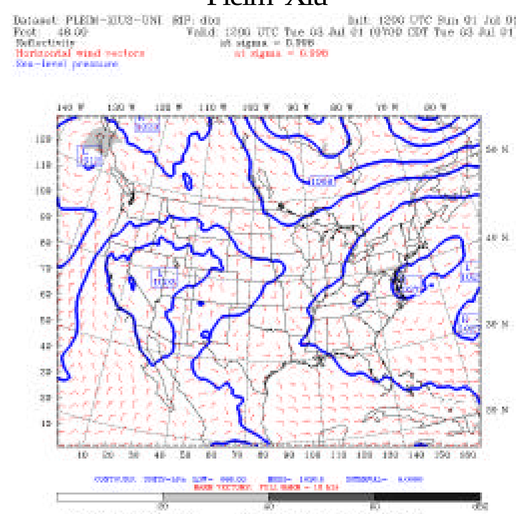
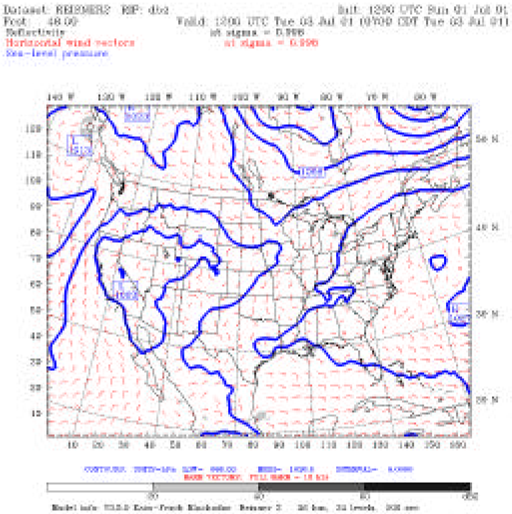
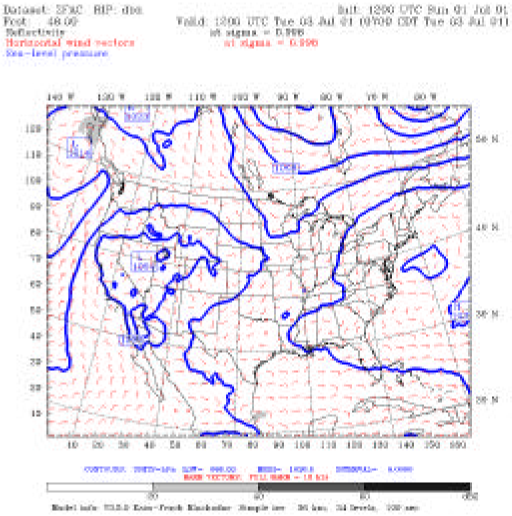


Pleim-Xiu 2

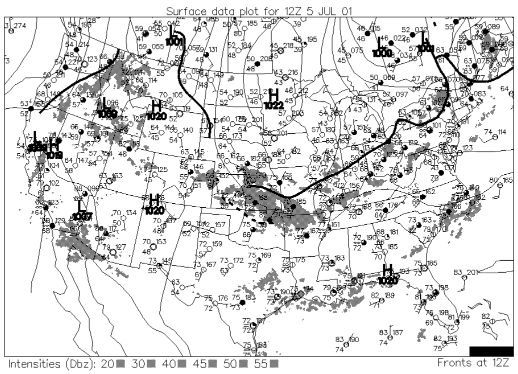


Reisner 2

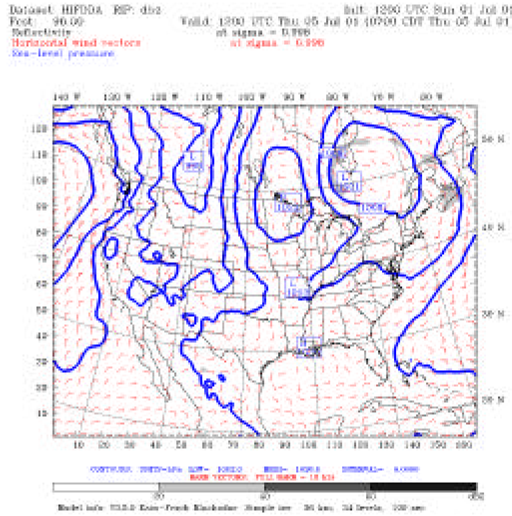


ZFAC

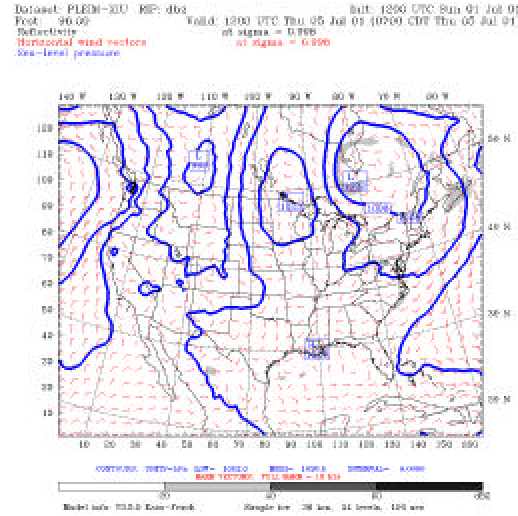
Figure 3-14: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 5 July 2002.



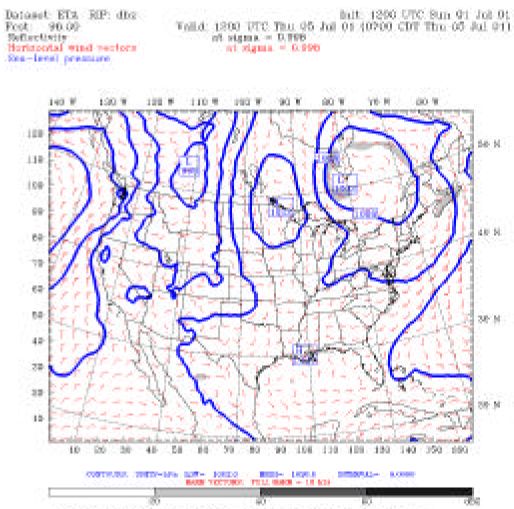
Observation



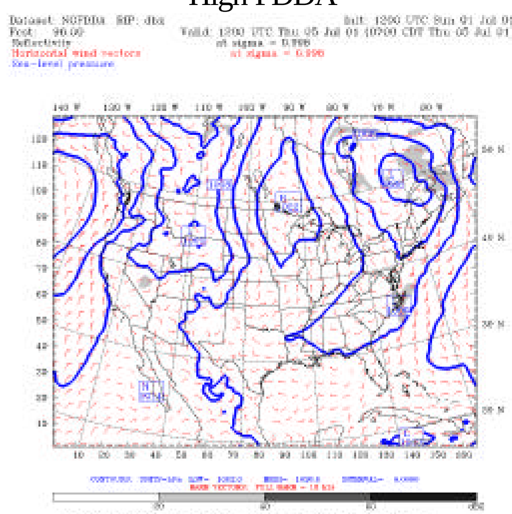
High FDDA



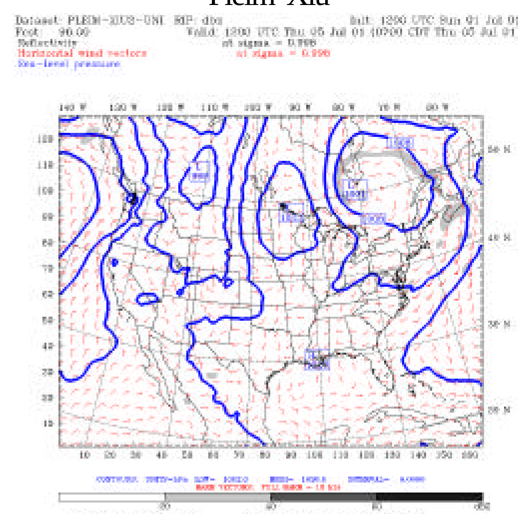
Pleim-Xiu



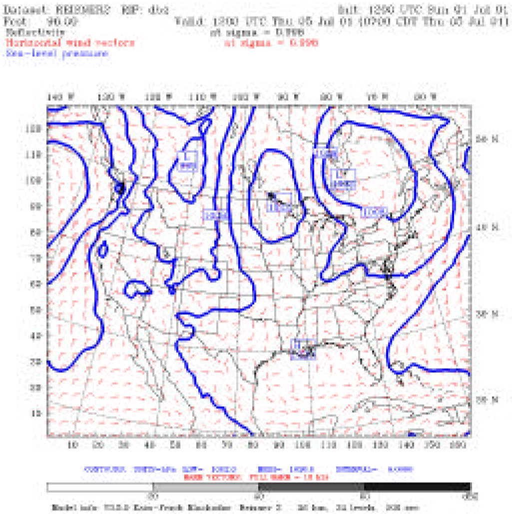
ETA



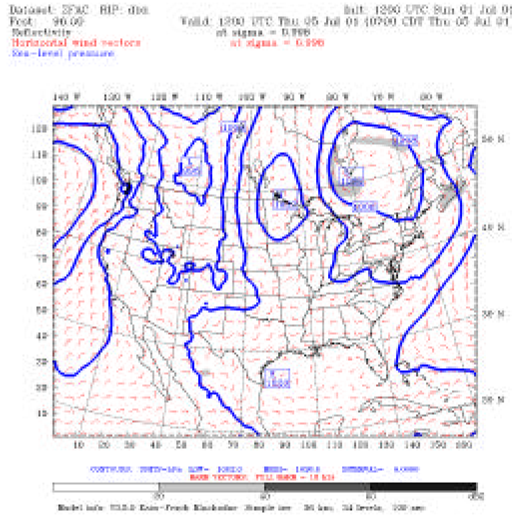
No FDDA



Pleim-Xiu 2

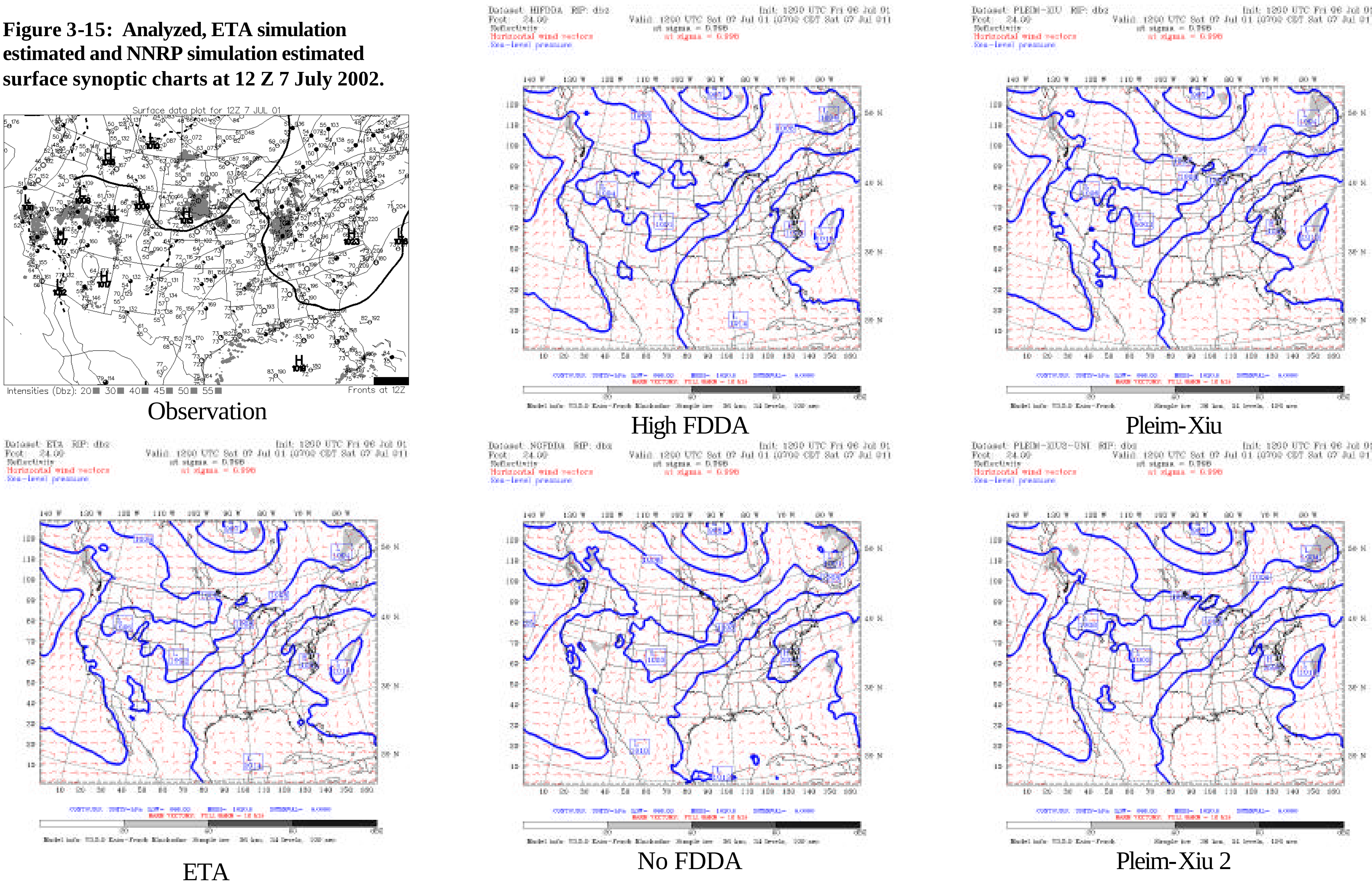


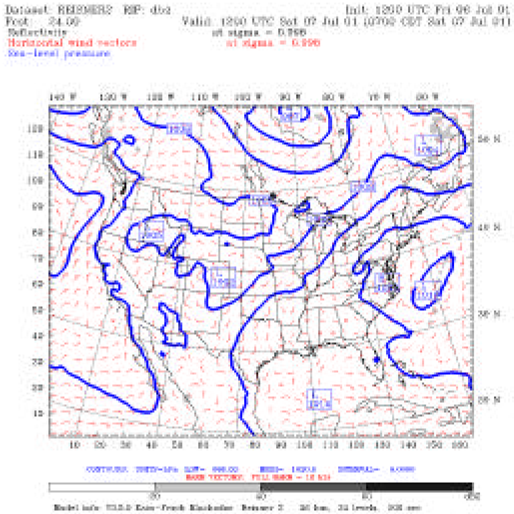
Reisner 2



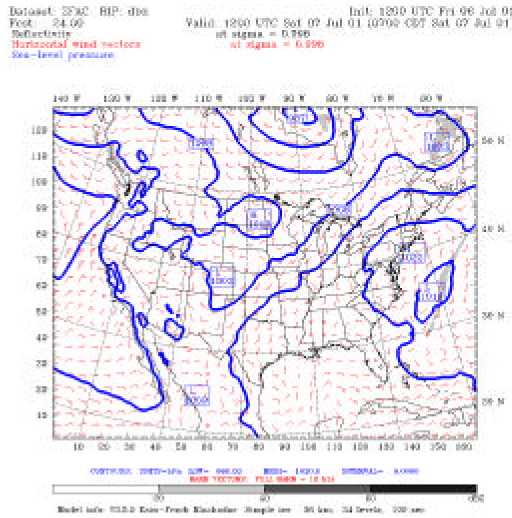
ZFAC

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



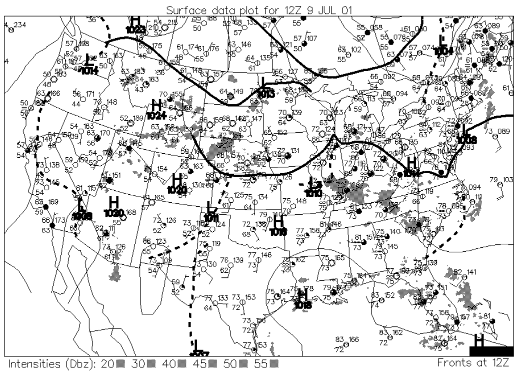


Reisner 2

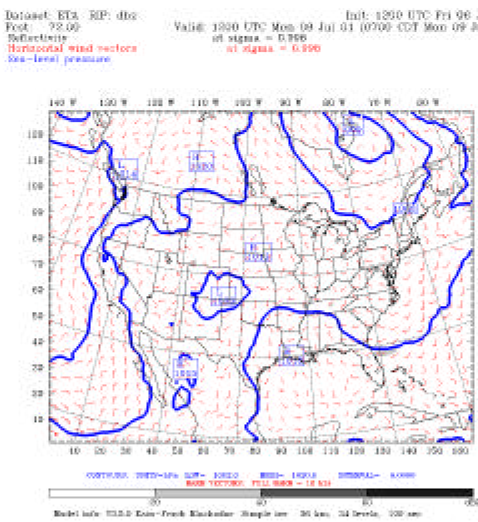


ZFAC

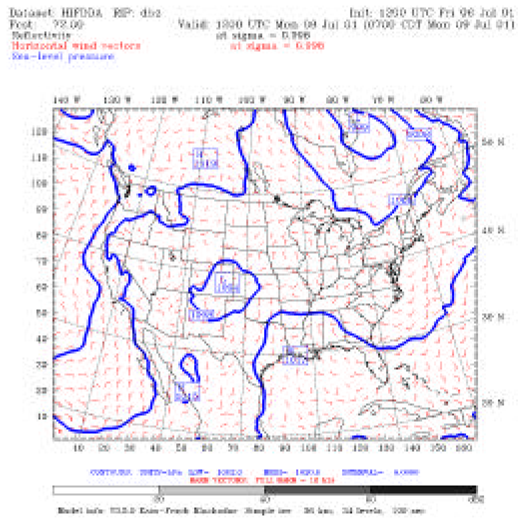
Figure 3-16: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 9 July 2002.



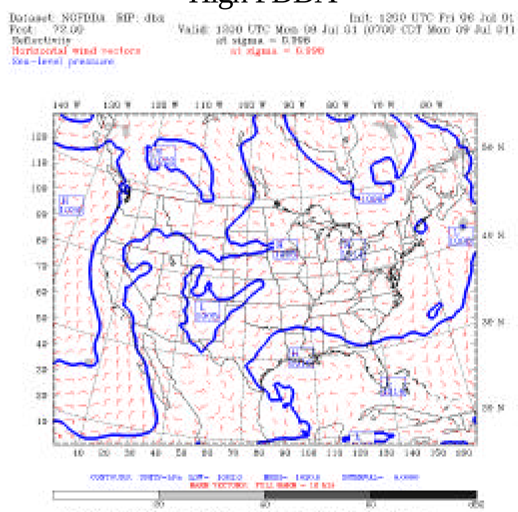
Observation



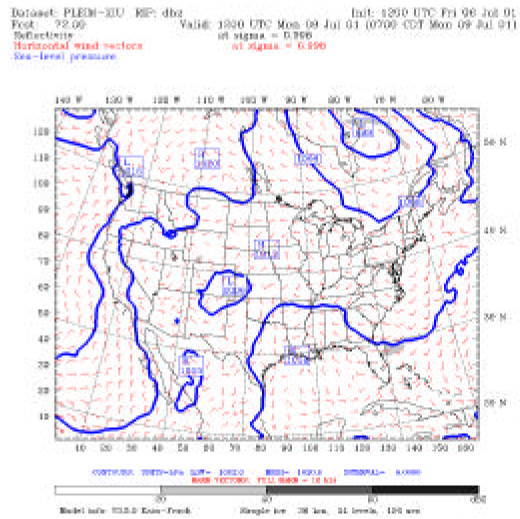
ETA



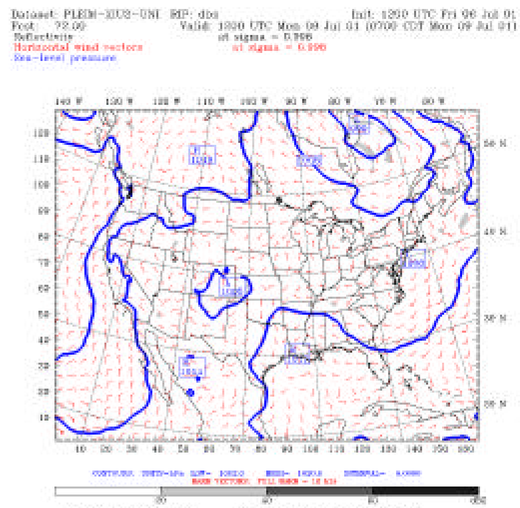
High FDDA



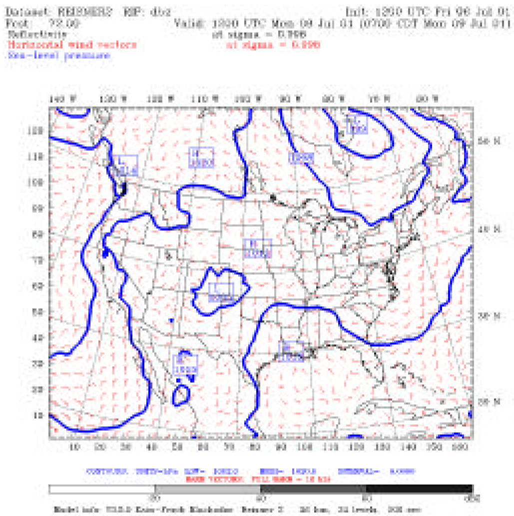
No FDDA



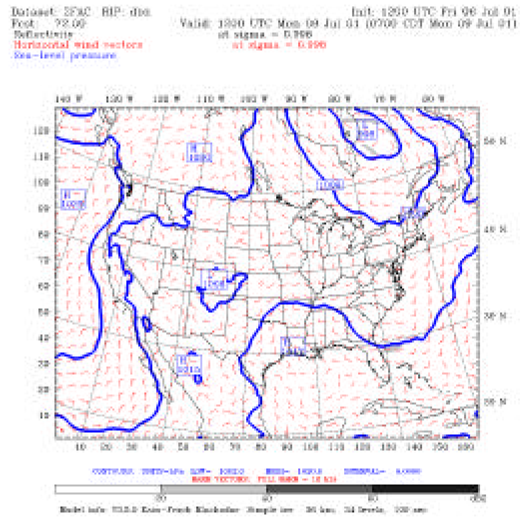
Pleim-Xiu



Pleim-Xiu 2

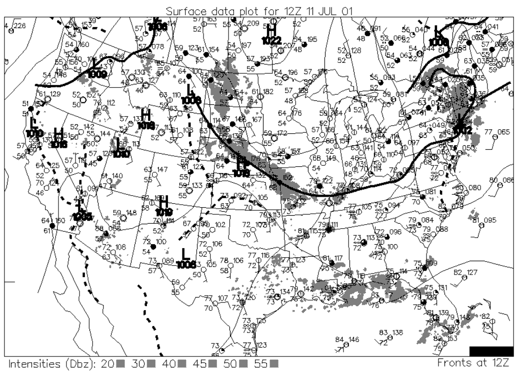


Reisner 2

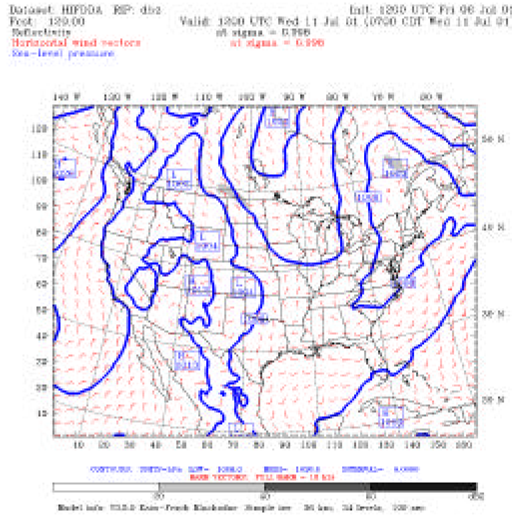


ZFAC

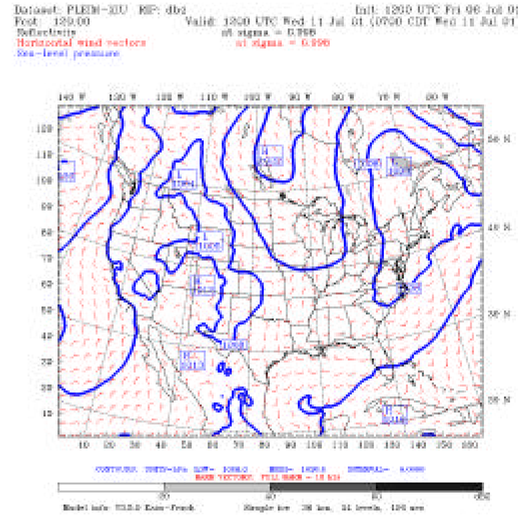
Figure 3-17: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 11 July 2002.



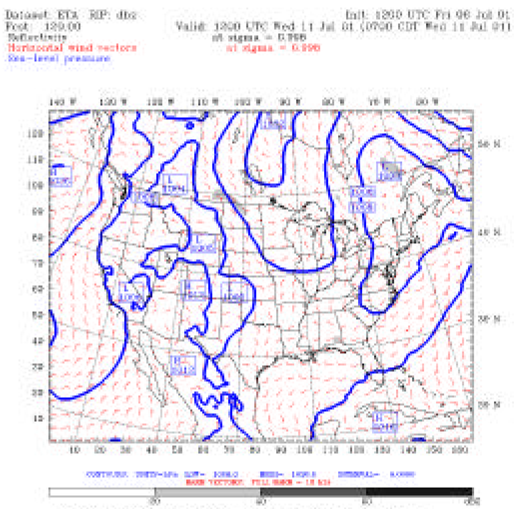
Observation



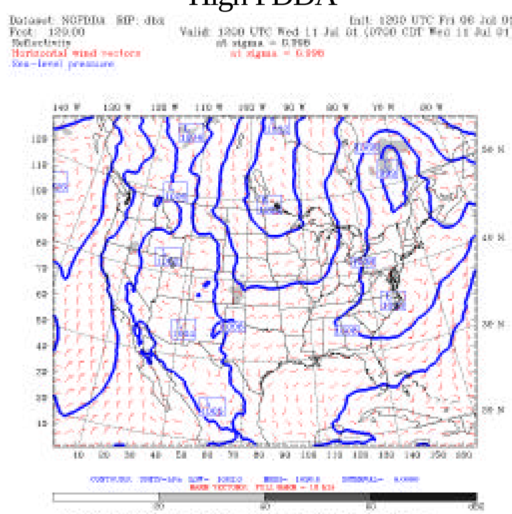
High FDDA



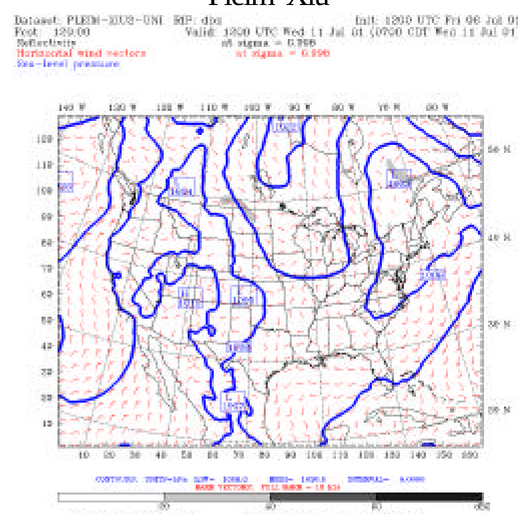
Pleim-Xiu



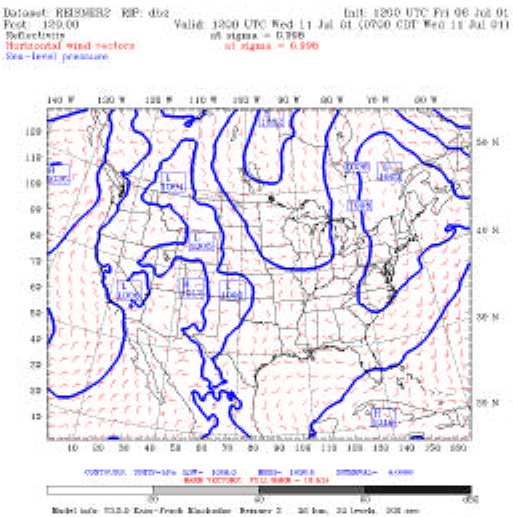
ETA



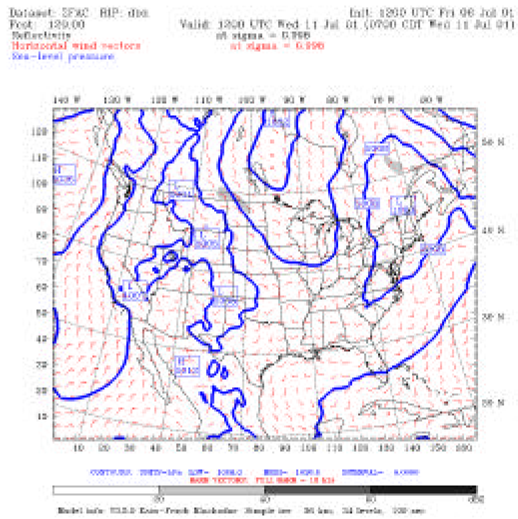
No FDDA



Pleim-Xiu 2

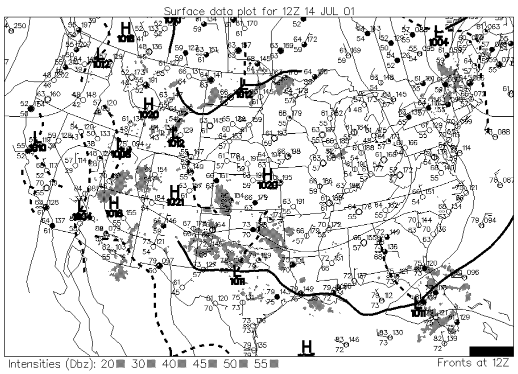


Reisner 2

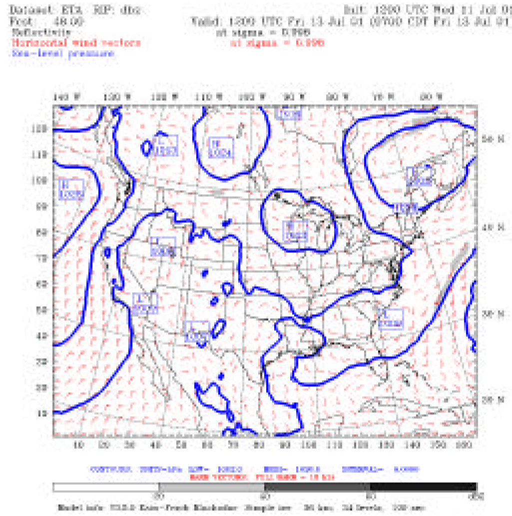


ZFAC

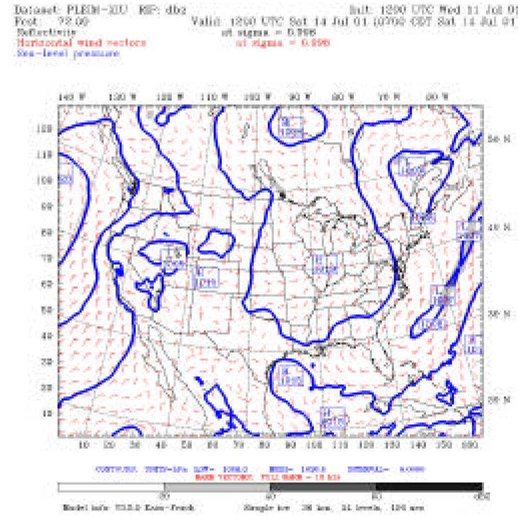
Figure 3-18: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 14 July 2002.



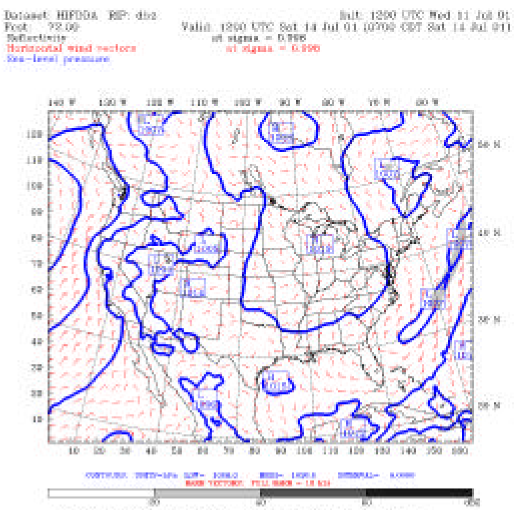
Observation



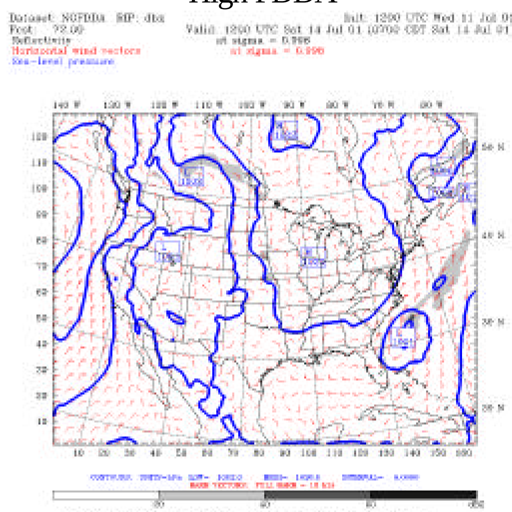
High FDDA



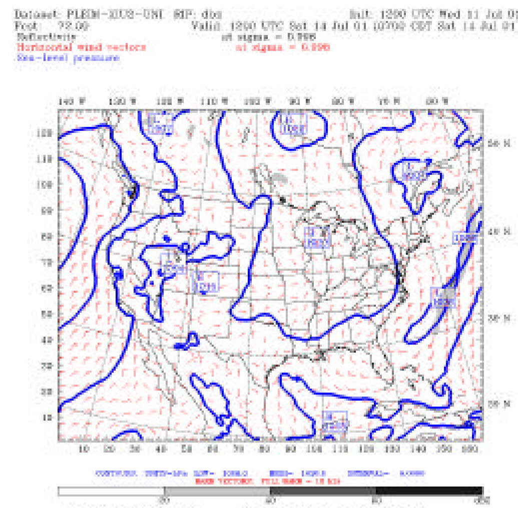
Pleim-Xiu



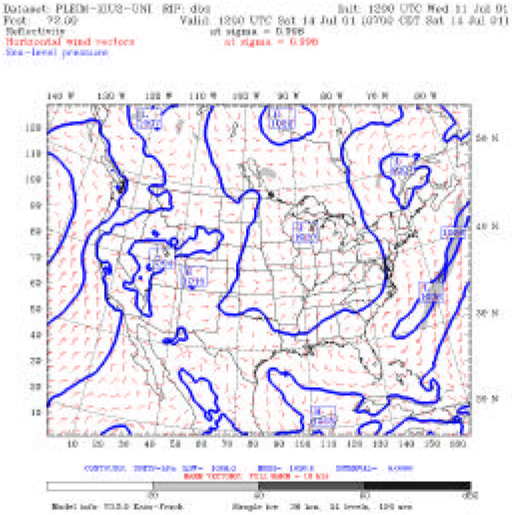
ETA



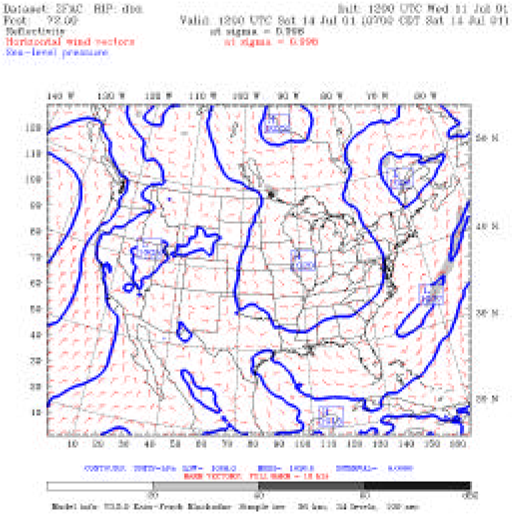
No FDDA



Pleim-Xiu 2

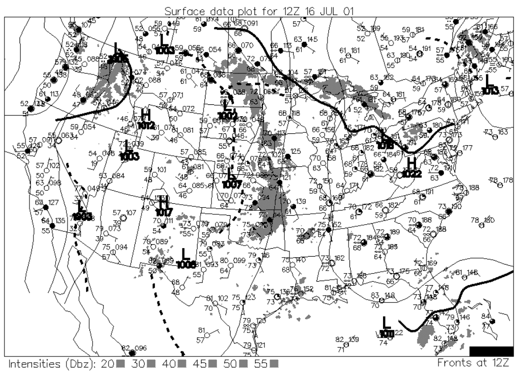


Reisner 2

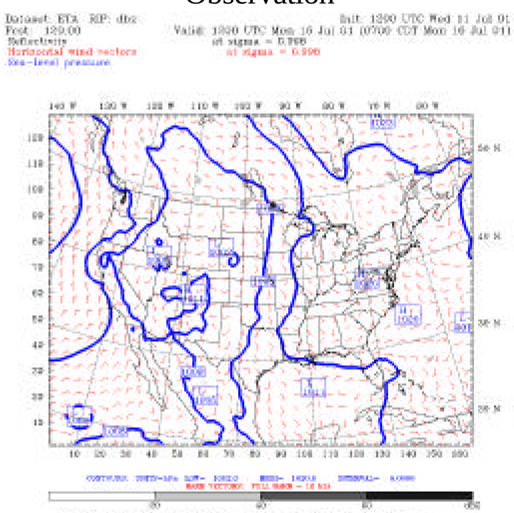


ZFAC

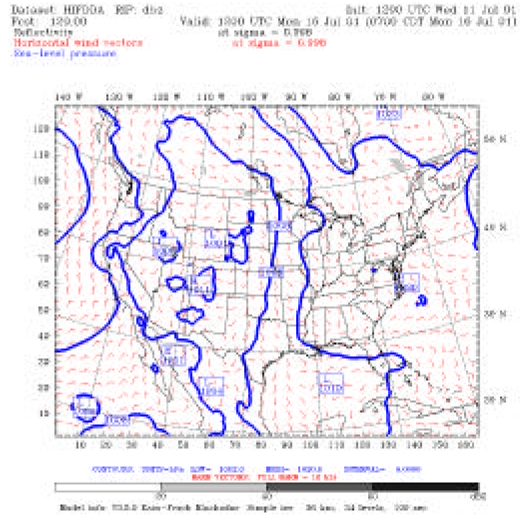
Figure 3-19: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 16 July 2002.



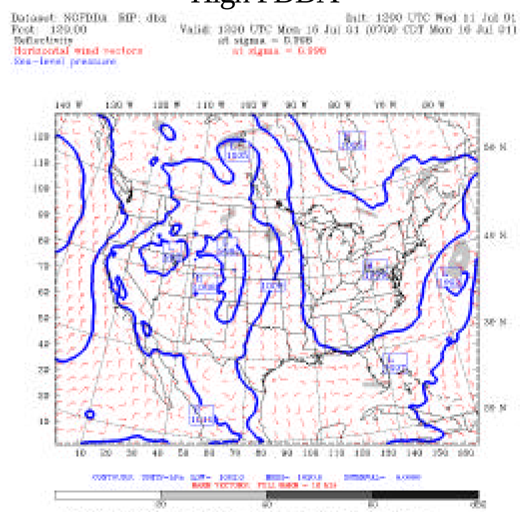
Observation



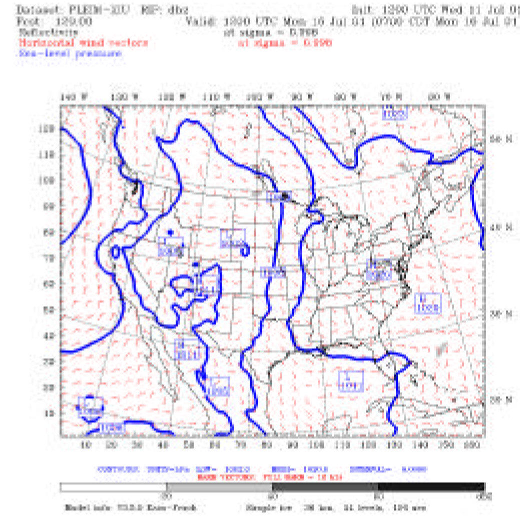
ETA



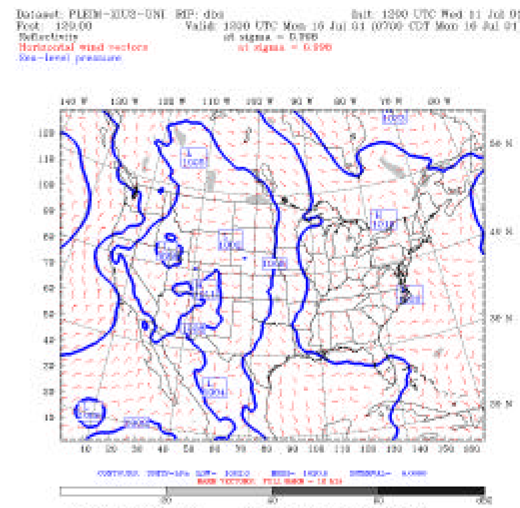
High FDDA



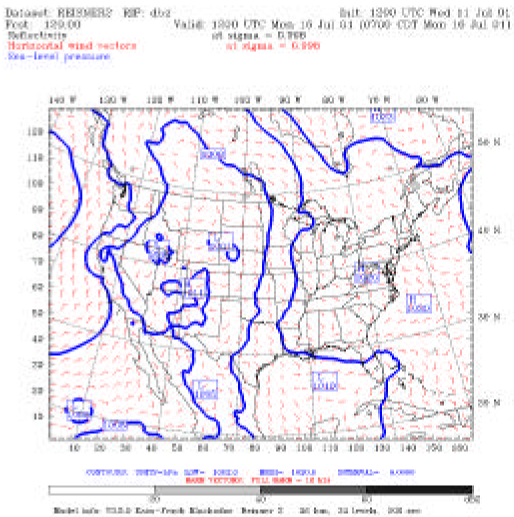
No FDDA



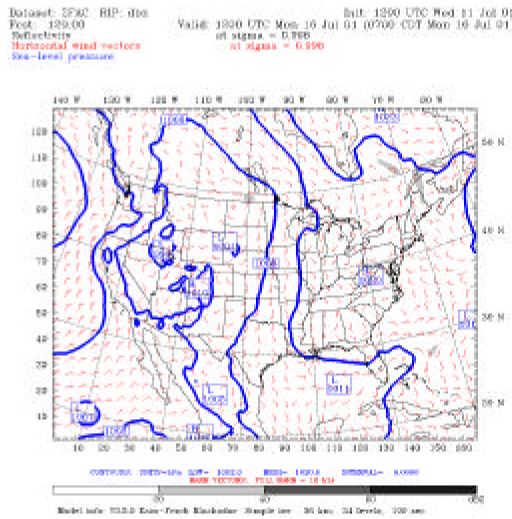
Pleim-Xiu



Pleim-Xiu 2

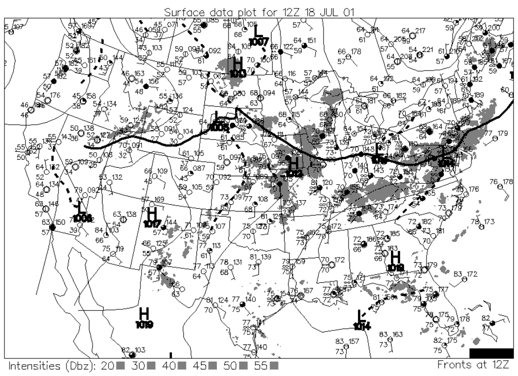


Reisner 2

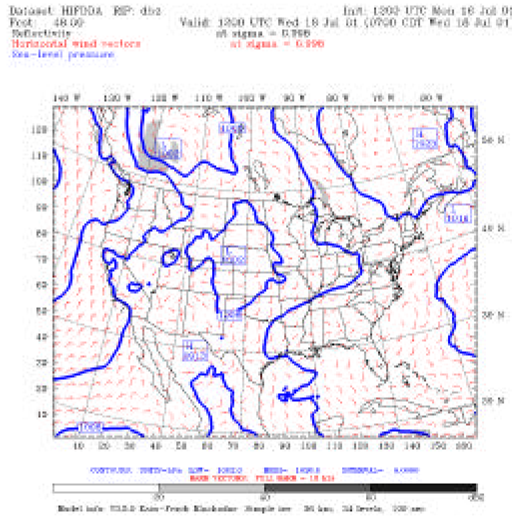


ZFAC

Figure 3-20: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 18 July 2002.



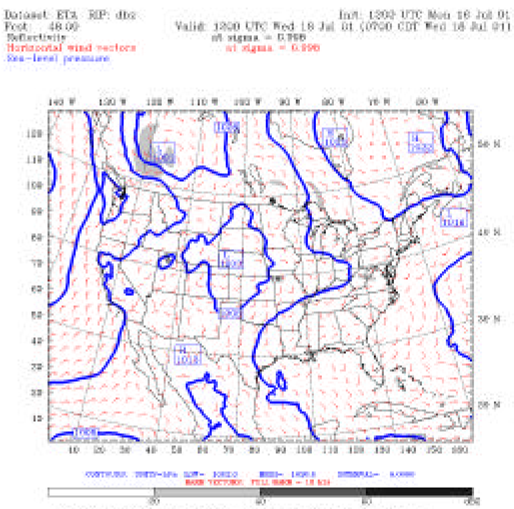
Observation



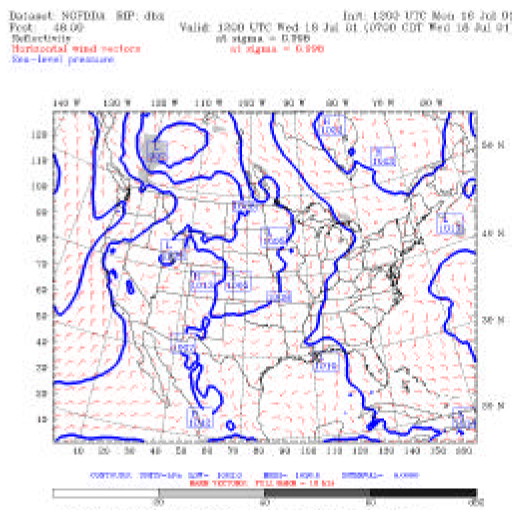
Hi FDDA

Model Would Not Operate

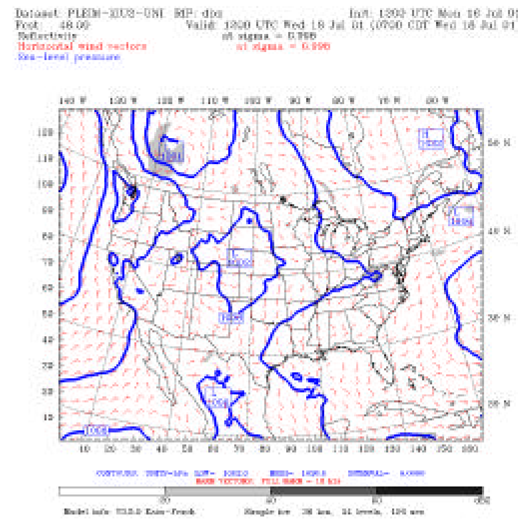
Pleim-Xiu



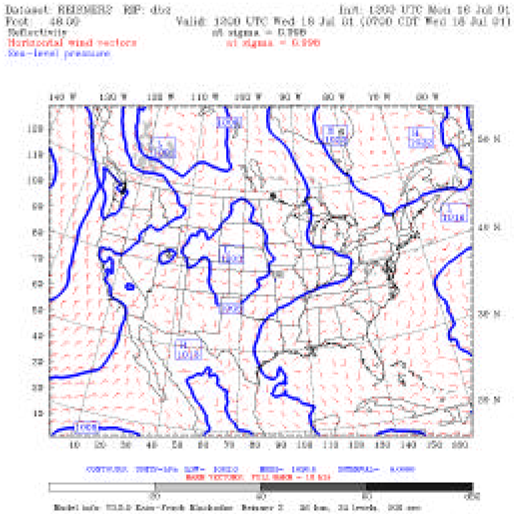
ETA



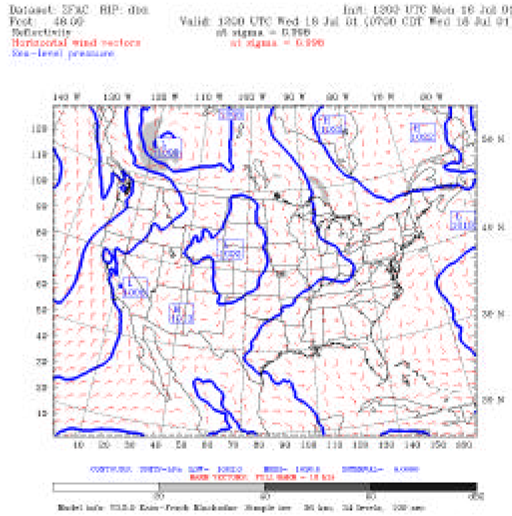
No FDDA



Pleim-Xiu 2

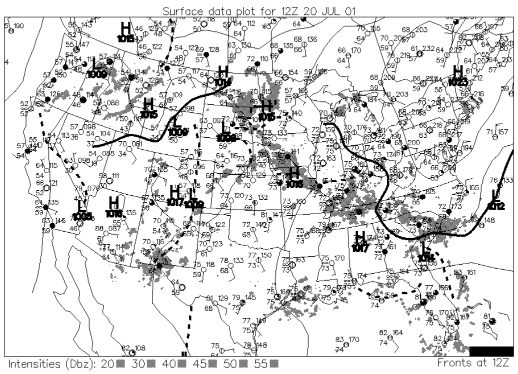


Reisner 2

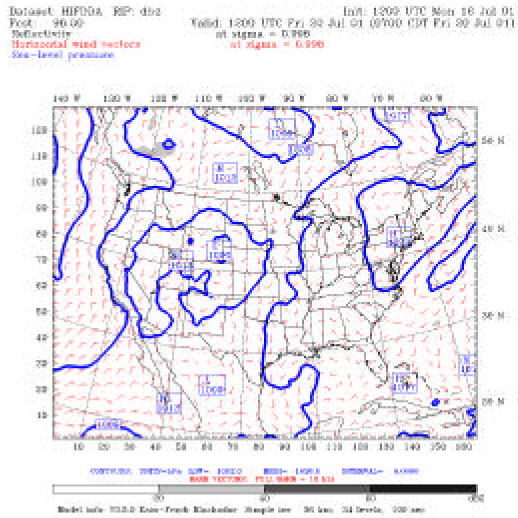


ZFAC

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



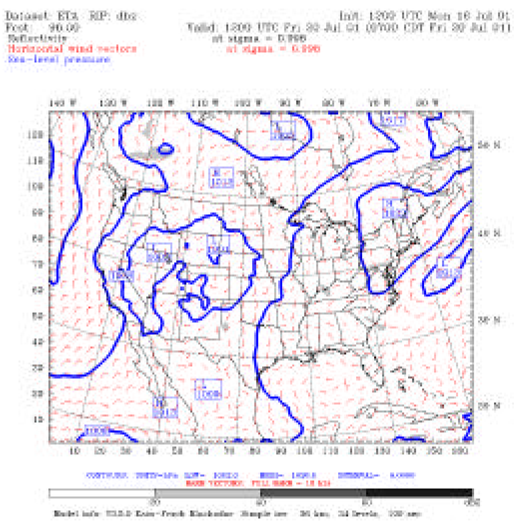
Observation



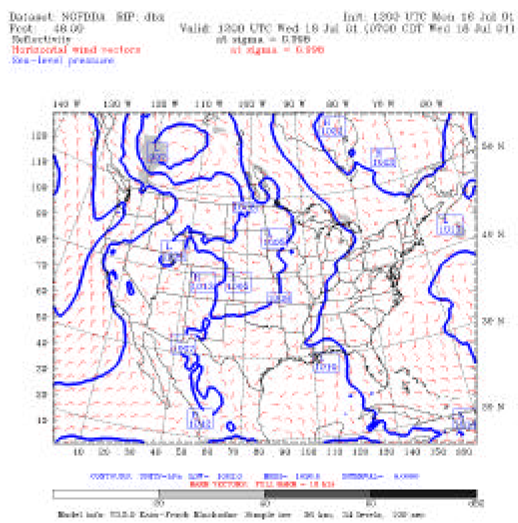
High FDDA

Model Would Not Operate

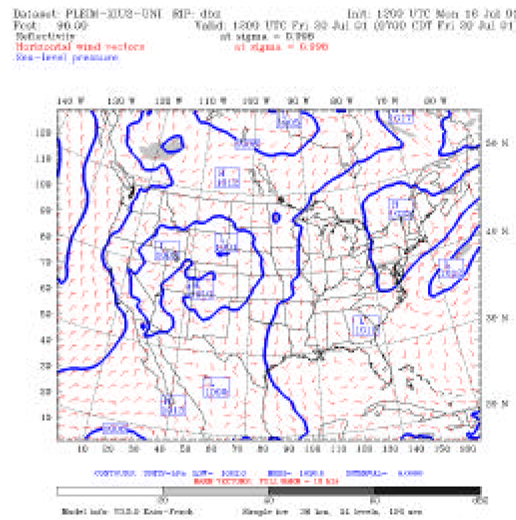
Pleim-Xiu



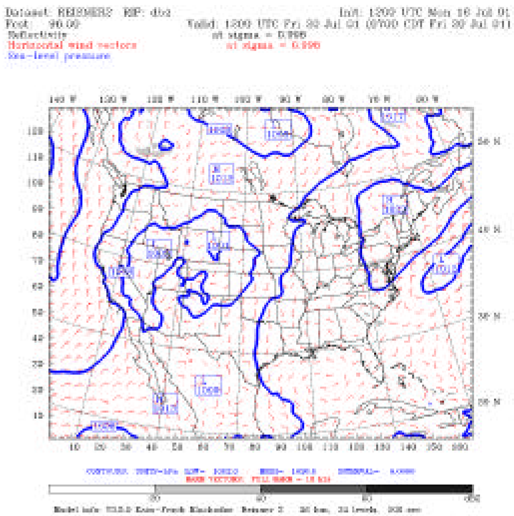
ETA



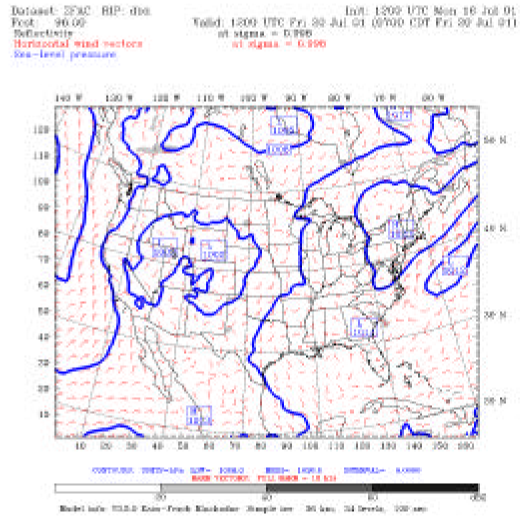
No FDDA



Pleim-Xiu 2

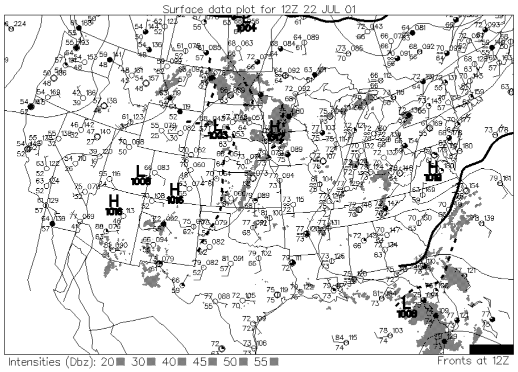


Reisner 2

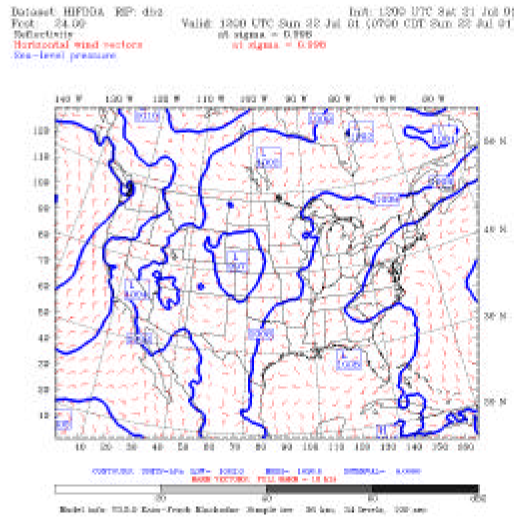


ZFAC

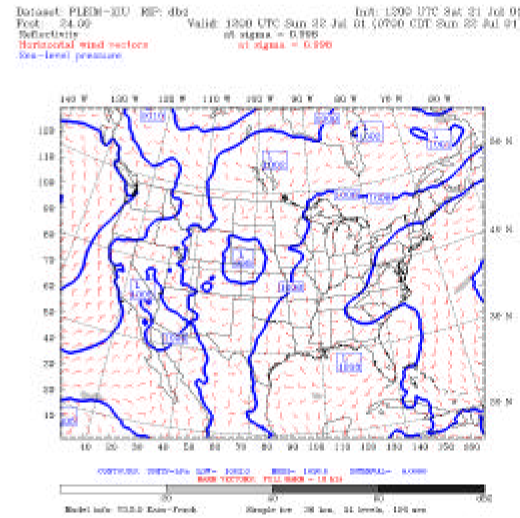
Figure 3-22: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 22 July 2002.



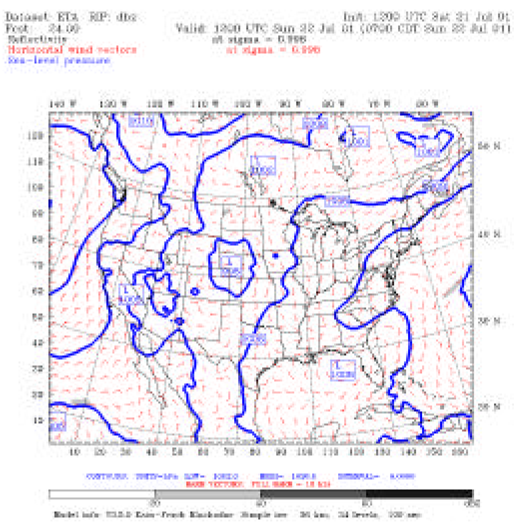
Observation



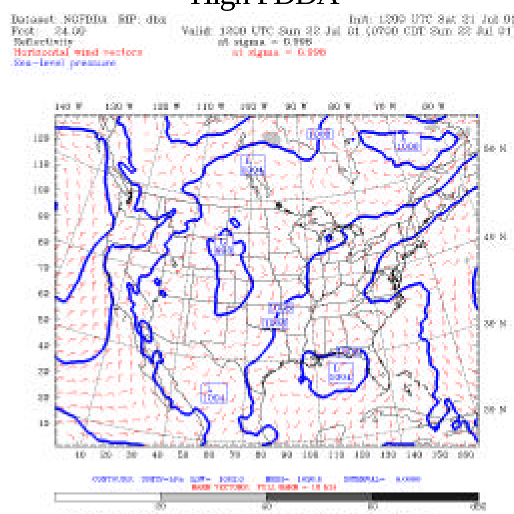
High FDDA



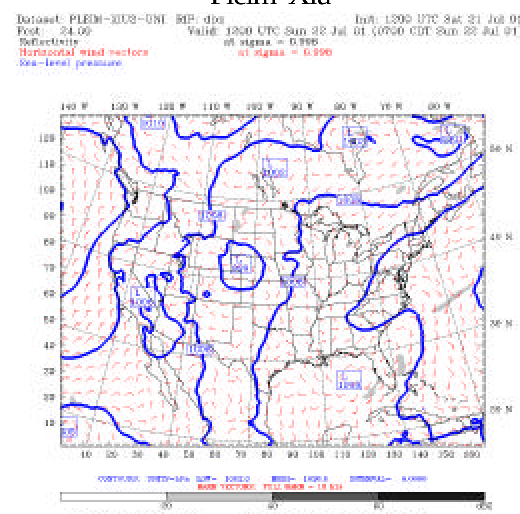
Pleim-Xiu



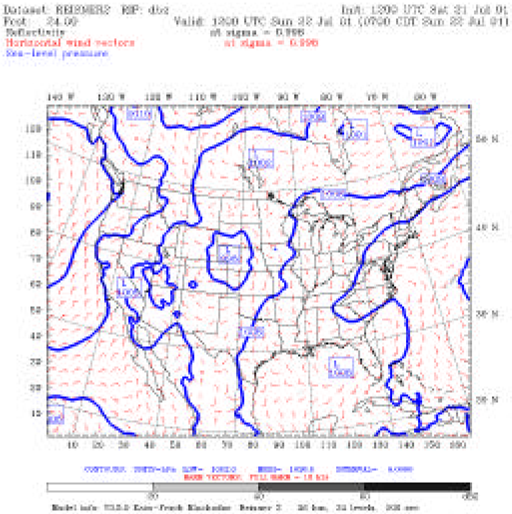
ETA



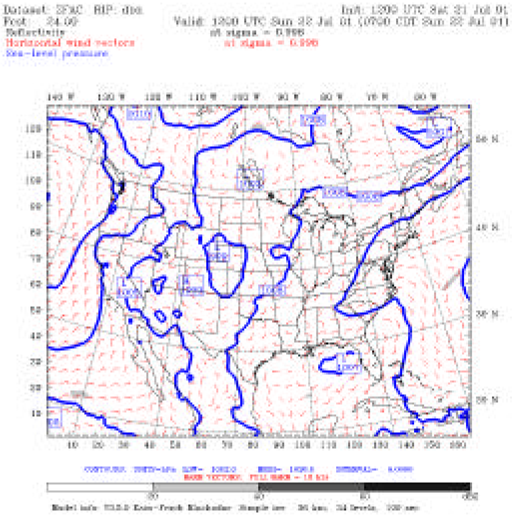
No FDDA



Pleim-Xiu 2

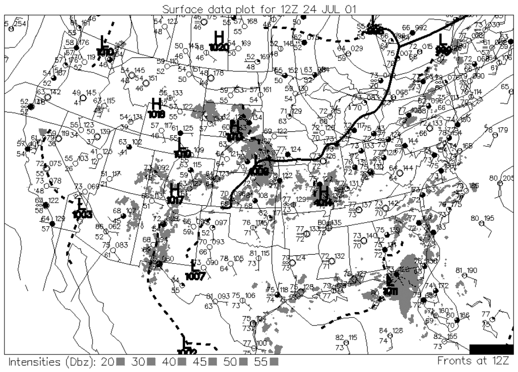


Reisner 2

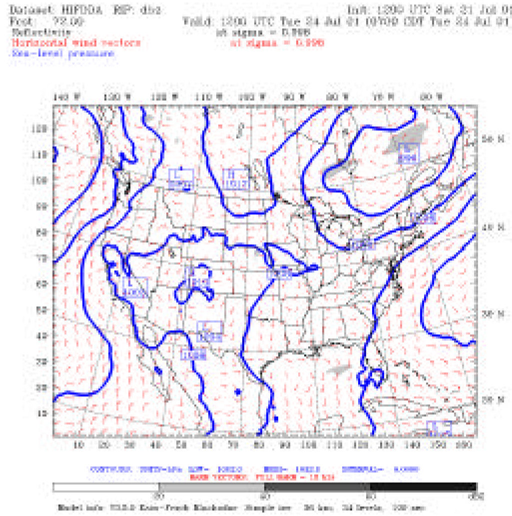


ZFAC

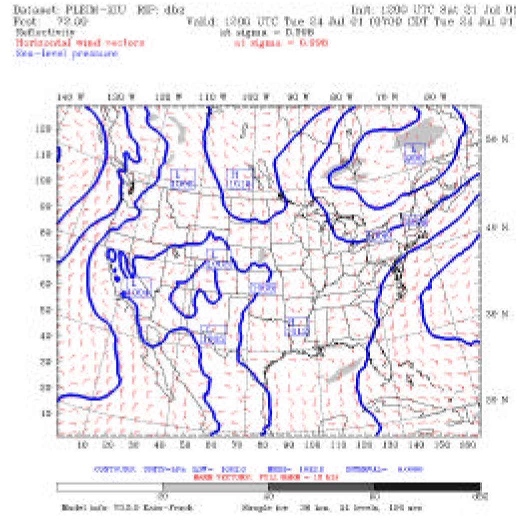
Figure 3-23: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 24 July 2002.



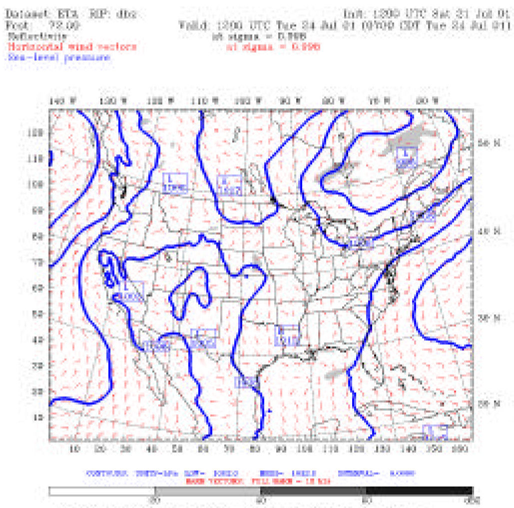
Observation



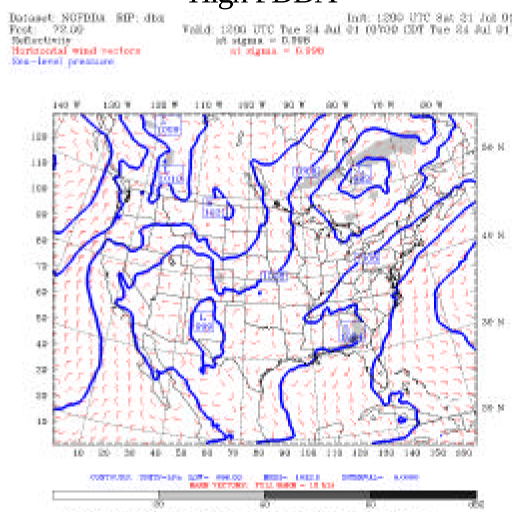
High FDDA



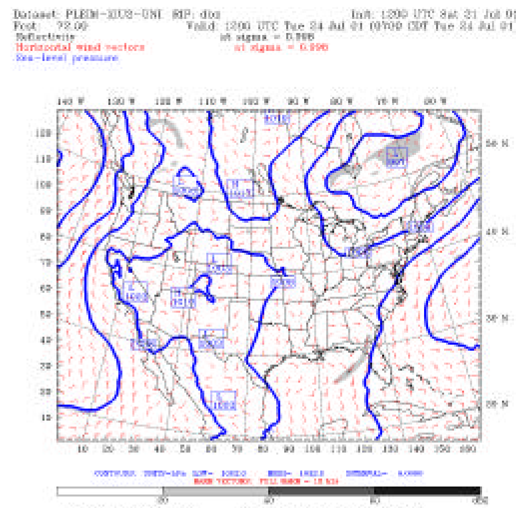
Pleim-Xiu



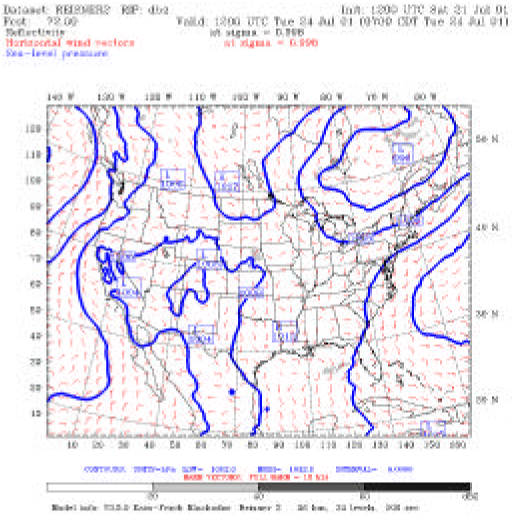
ETA



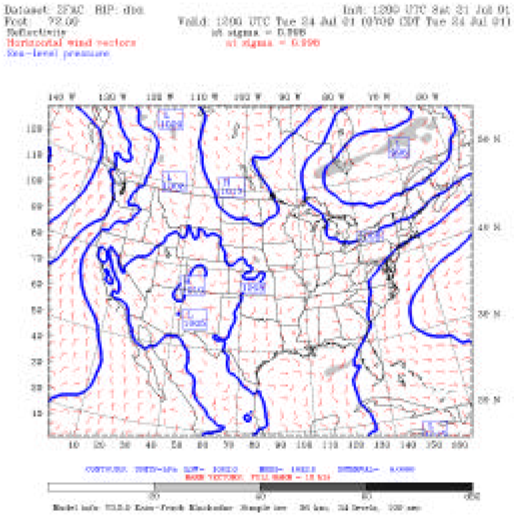
No FDDA



Pleim-Xiu 2

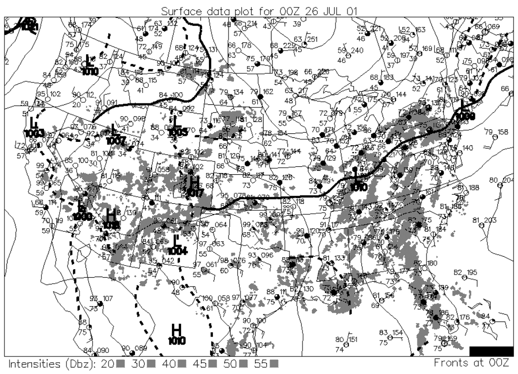


Reisner 2

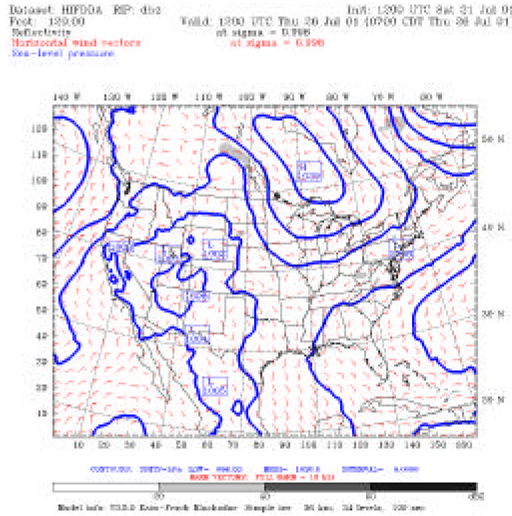


ZFAC

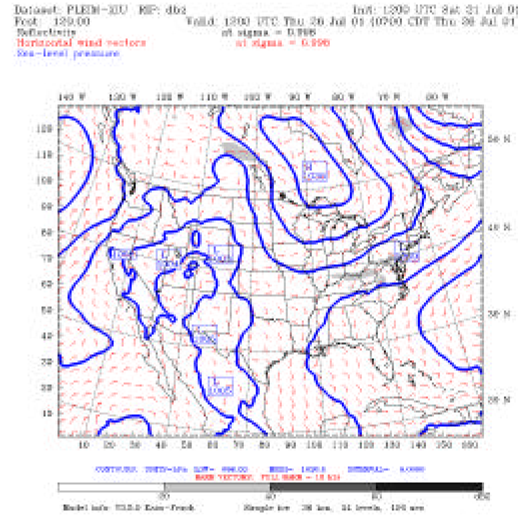
Figure 3-24: Analyzed, ETA simulation estimated and NNRP simulation estimated surface synoptic charts at 12 Z 26 July 2002.



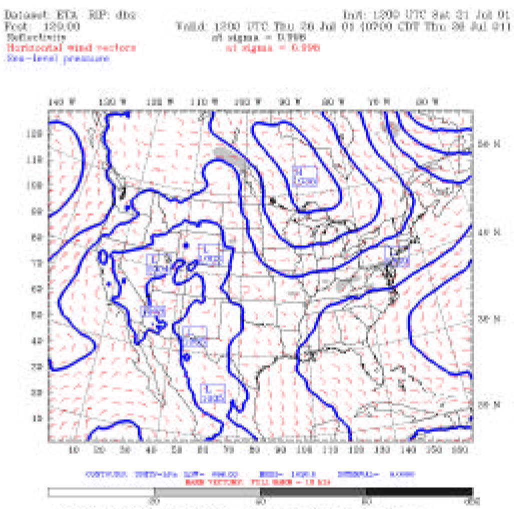
Observation



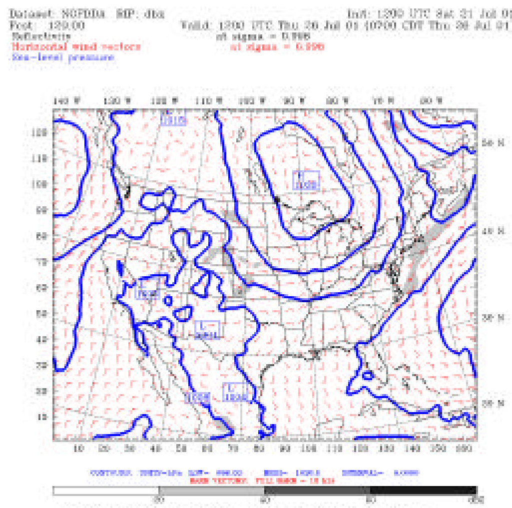
High FDDA



Pleim-Xiu



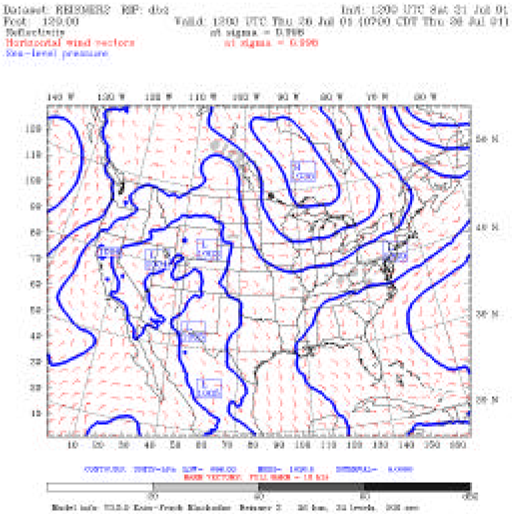
ETA



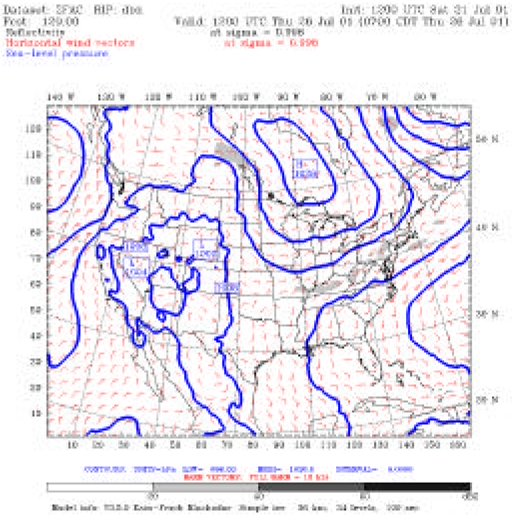
No FDDA

Model Not Exercised

Pleim-Xiu 2



Reisner 2



ZFAC

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

	ETA	HIFDDA	NOFDDA	PX	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
CO	-0.27	-0.64	0.53	-1.47	-1.9	-0.63	0.97
CT	-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
MI	-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
MT	0.49	0.13	1.38	-0.11	-0.78	0	1.86
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
OH	-1.03	-1.31	-1.84	-0.9	-0.88	-1.49	-1.46
OK	-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
TX	-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 Sensitivity Simulations for 2001 February 2-26.

	eta	hifdda	nofdda	px	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
CA	2.16	2.23	2.42	2.27	2.18	2.17	2.36
CO	3.08	3.15	3.64	3.65	3.52	3.19	3.38
CT	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
MA	1.75	1.85	2.1	2.37	2.09	2.01	1.94
MI	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
MO	1.9	2.02	2.34	1.71	1.43	2.21	2.36
MT	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
NJ	1.81	1.93	2.31	1.94	1.68	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
OH	1.77	2.03	2.32	1.84	1.51	2.12	1.97
OK	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
TX	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.

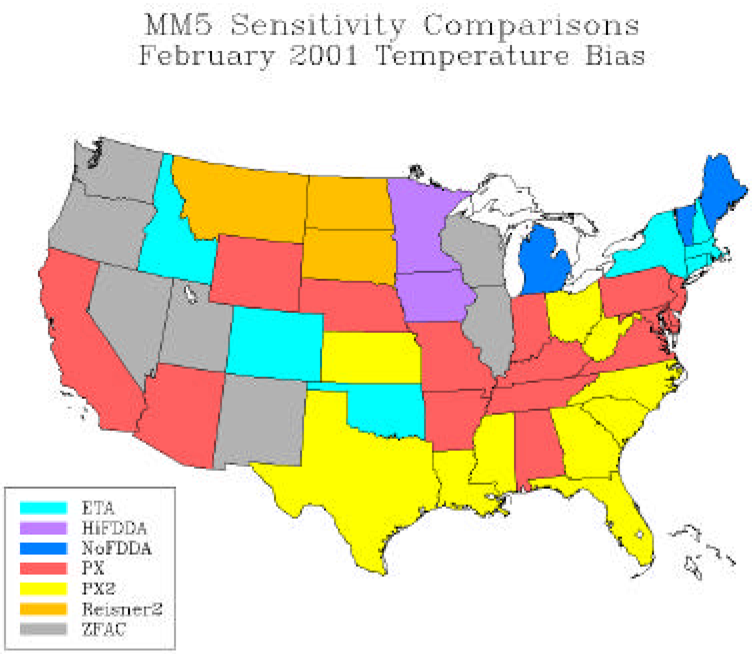


Figure 3-26: Temperature Error for Base and Sensitivity Simulations for 2001 February 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

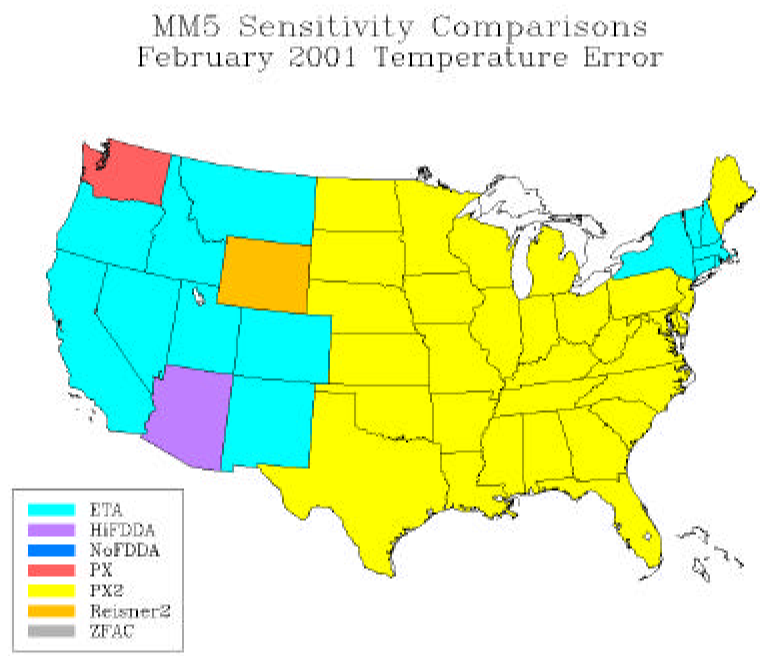


Table 3-4: Mixing Ratio Bias (g/kc) for Base and Sensitivity Simulations for 2001 February 2-26.

Feb MIXR Bias	eta	hifdda	nofdda	px	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
CO	0.01	-0.05	0.14	-0.34	-0.24	-0.04	0.13
CT	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
MI	-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
MO	0.22	0.19	0.21	-0.48	-0.32	0.12	0.34
MT	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
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
OH	0.16	0.09	-0.04	-0.55	-0.28	0.11	0.11
OK	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
TX	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
MW	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 and Sensitivity Simulations for 2001 February 2-26.

	eta	hifdda	nofdda	px	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
CO	0.53	0.52	0.65	0.66	0.61	0.59	0.61
CT	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
MA	0.45	0.44	0.56	0.46	0.38	0.44	0.42
MI	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
MO	0.53	0.52	0.67	0.75	0.59	0.54	0.64
MT	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
OH	0.47	0.46	0.57	0.81	0.59	0.46	0.48
OK	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
TX	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
MW	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.

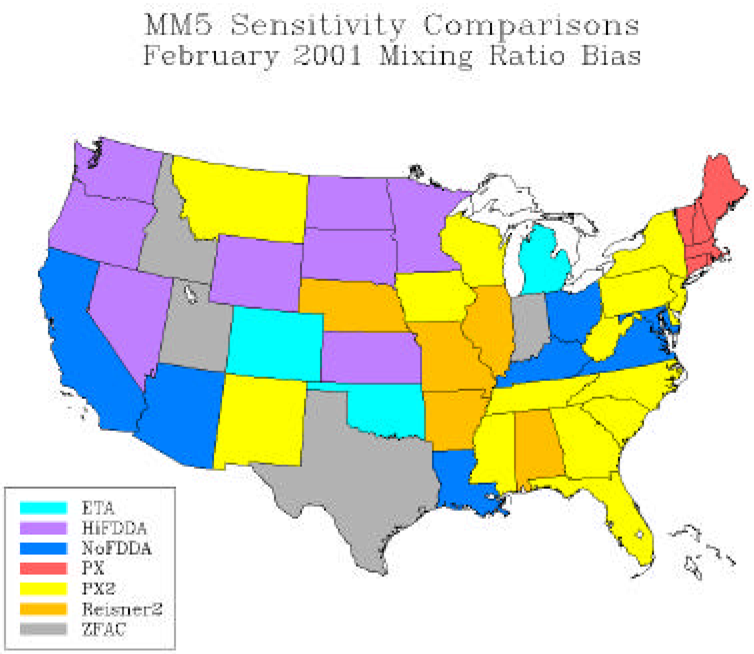


Figure 3-28: Mixing Ratio Error for Base and Sensitivity Simulations for 2001 February 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

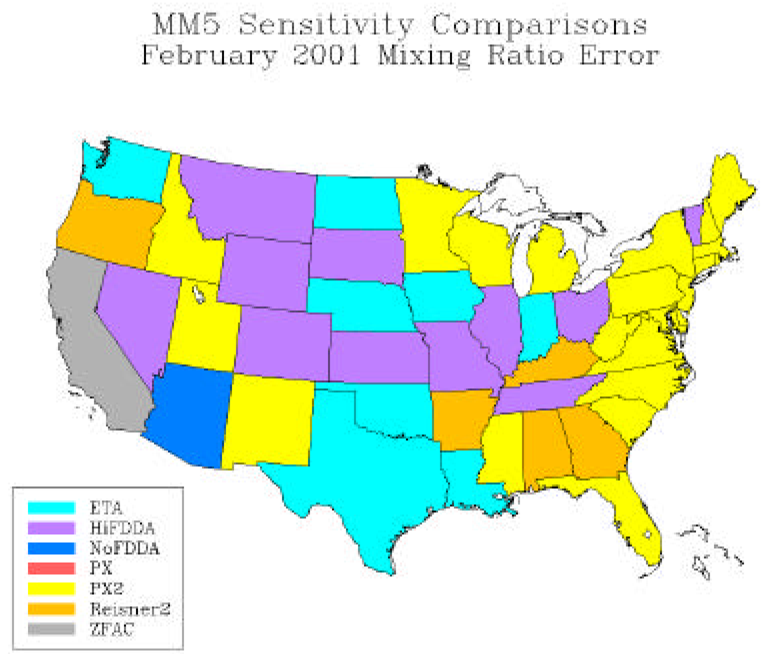


Table 3-6: Accumulated Precipitation Bias (cm) for Base and Sensitivity Simulations for 2001 February 2-26.

Feb RAIN bias	eta	hifdda	nofdda	px	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
CA	-5.31	-5.60	-3.39	-5.08	-3.72	-5.95	-4.21
CO	0.12	-0.16	2.24	0.01	0.50	-0.02	0.40
CT	-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
MI	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
MO	-2.27	-2.95	-3.11	-2.32	-1.00	-2.44	-2.43
MT	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
OH	-0.18	-1.10	2.07	-0.71	0.45	-0.27	0.29
OK	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
TX	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 and Sensitivity Simulations for 2001 February 2-26.

Feb ~~RAIN error~~	eta	hifdda	nofdda	px	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
CA	6.76	6.82	5.98	6.59	5.72	7.22	6.17
CO	0.69	0.57	2.40	0.63	0.79	0.68	0.77
CT	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
MO	3.06	3.29	3.64	3.16	2.67	2.99	3.10
MT	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
OH	0.94	1.45	2.25	1.10	0.86	0.97	0.78
OK	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
PA	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
TX	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.

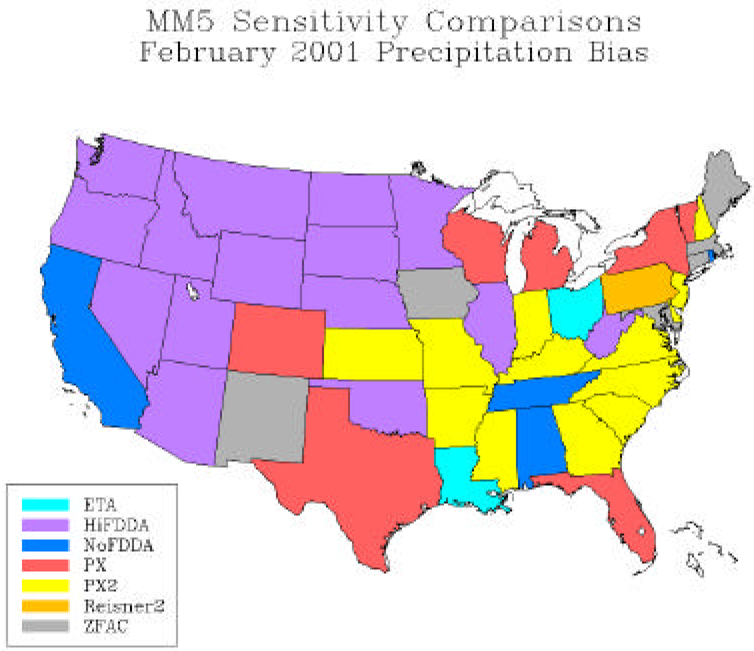


Figure 3-30: Accumulated Precipitation Eror for Base and Sensitivity Simulations for 2001 February 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

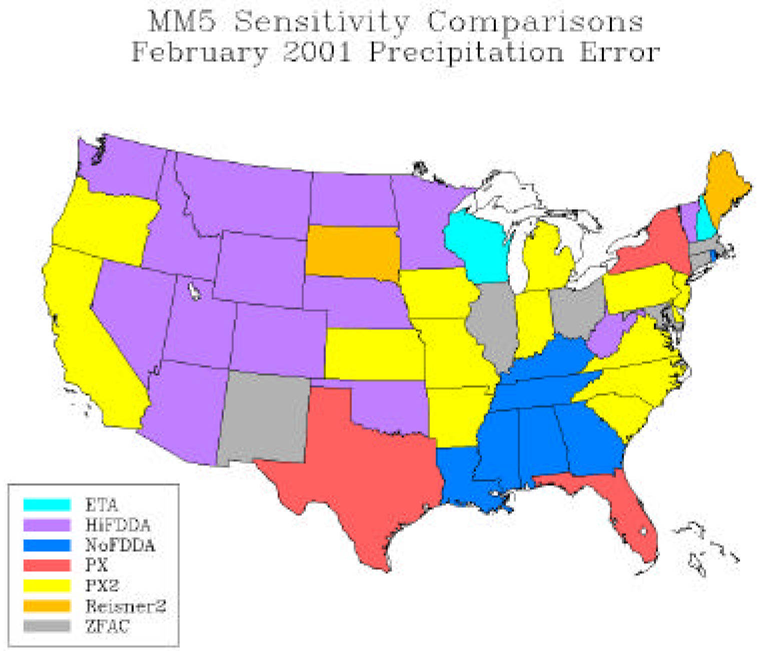


Table 3-8: Wind Index of Agreement for Base and Sensitivity Simulations for 2001 February 2-26.

	eta	hifdda	nofdda	px	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
CO	0.45	0.42	0.67	0.46	0.43	0.46	0.61
CT	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
MI	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
MO	0.61	0.59	1.04	0.62	0.66	0.61	0.88
MT	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
OH	0.52	0.47	0.62	0.45	0.49	0.55	0.62
OK	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
TX	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.

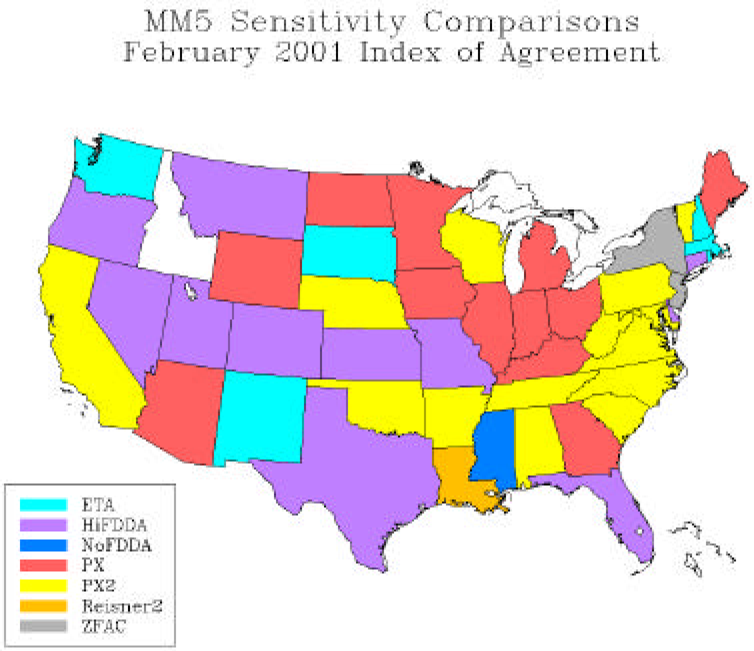


Table 3-9: Temperature Bias (K) for Base and Sensitivity Simulations for 2001 July 2-26.

	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
CO	-2.22	-2.35	-3.82	-2.52	-2.07	-2.56
CT	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
MA	-0.07	-0.08	-0.57	0.11	0.05	-0.15
MI	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
MO	0.90	0.96	0.39	0.38	0.81	0.65
MT	-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
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
OH	0.59	0.60	-0.09	0.24	0.56	0.41
OK	-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
TX	-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
MW	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
CO	3.33	3.37	4.49	3.33	3.41	3.51
CT	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
MI	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
MO	1.79	1.76	2.14	1.58	1.80	2.02
MT	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
OH	1.68	1.66	2.36	1.70	1.70	1.79
OK	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
TX	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.

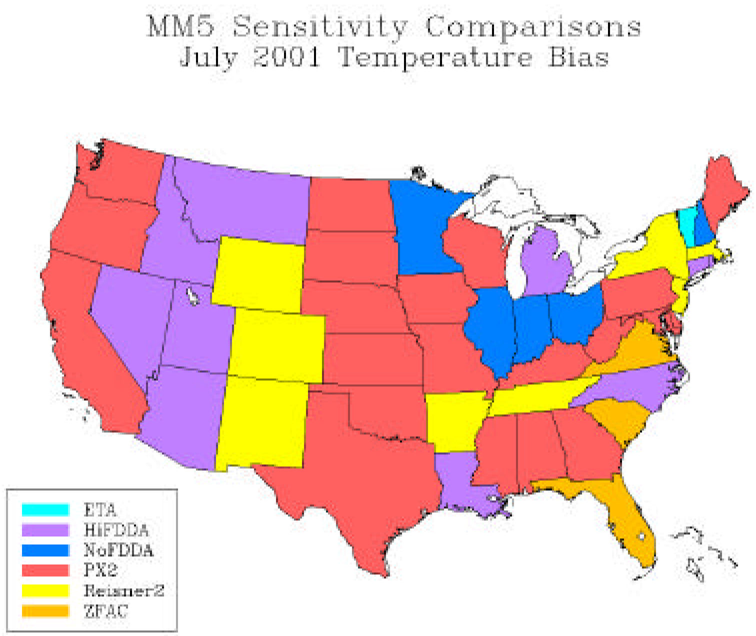


Figure 3-33: Temperature Error for Base and Sensitivity Simulations for 2001 July 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

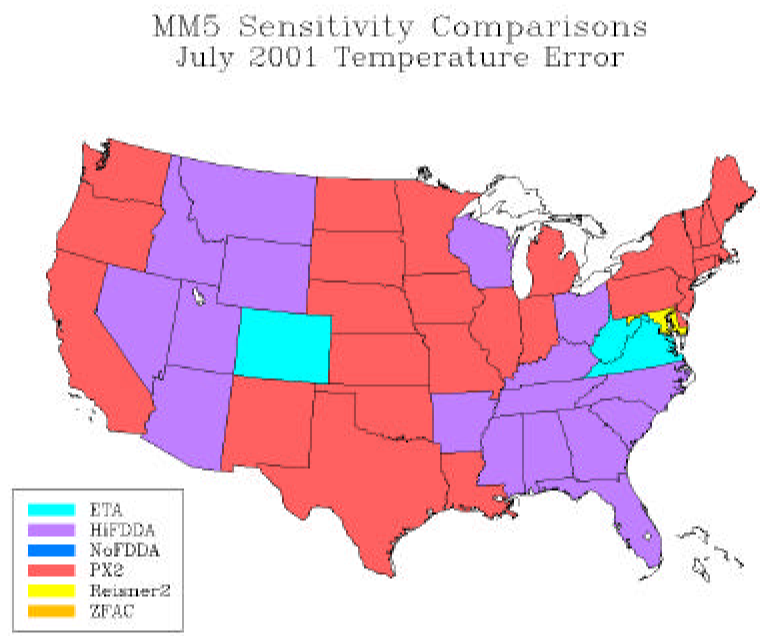


Table 3-11: Mixing Ratio Bias (g/kg) for Base and Sensitivity Simulations for 2001 July 2-26.

	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
CO	-1.18	-1.12	-0.39	-1.19	-1.10	-0.53
CT	-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
MI	-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
MO	-2.21	-1.72	-2.74	-1.20	-2.14	-2.52
MT	-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
OH	-1.28	-1.10	-1.73	-0.80	-1.19	-1.37
OK	-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
TX	-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
MW	-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 Sensitivity Simulations 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
CO	2.11	2.01	1.95	2.40	2.09	1.86
CT	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
MI	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
MO	2.59	2.23	3.06	1.92	2.53	2.81
MT	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
OH	1.76	1.65	2.14	1.47	1.72	1.83
OK	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
TX	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.

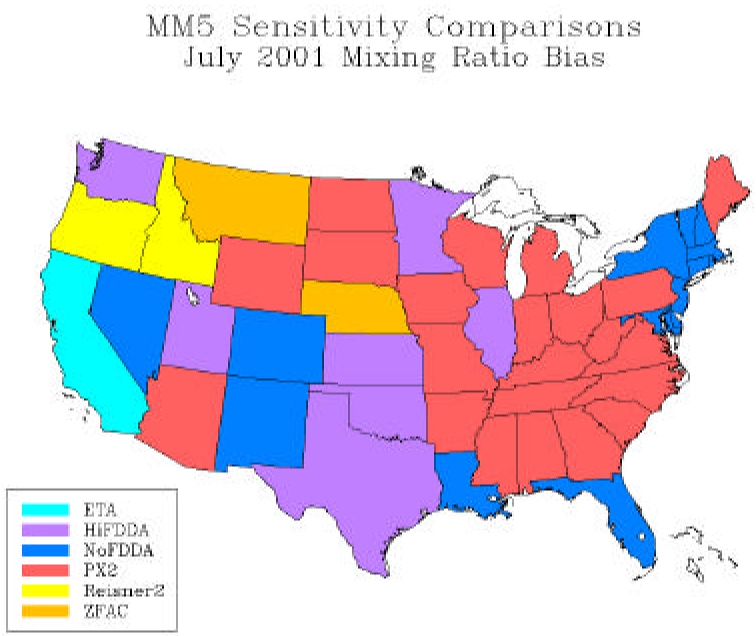


Figure 3-35: Mixing Ratio Error for Base and Sensitivity Simulations for 2001 July 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

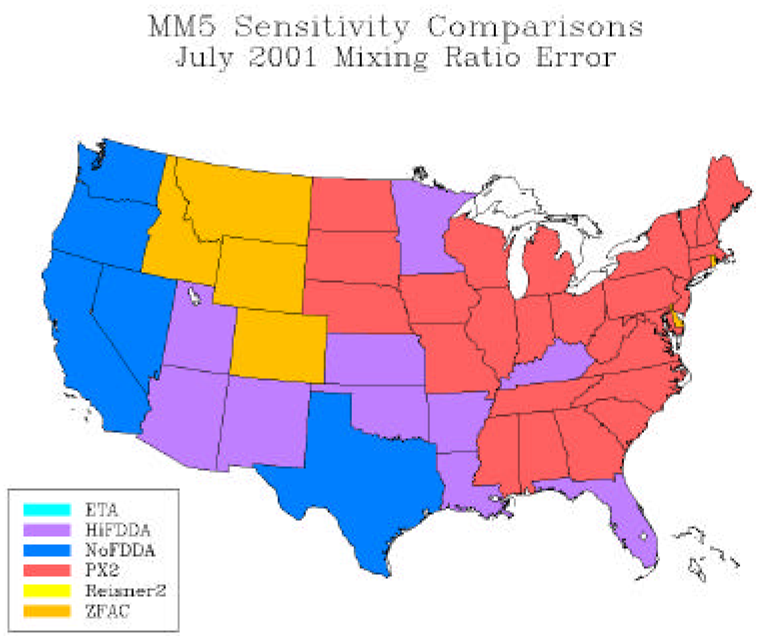


Table 3-13: Accumulated Precipitation Bias (cm) for Base and Sensitivity Simulations for 2001 July 2-26.

	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
CO	-0.95	-0.76	5.59	-0.29	-1.12	-0.88
CT	-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
MI	-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
MO	5.32	5.13	-1.42	7.10	5.53	2.20
MT	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
OH	1.15	0.70	0.07	3.65	0.88	1.29
OK	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
PA	-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
TX	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
VT	-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
CO	3.24	2.84	6.22	2.71	3.32	2.52
CT	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
MI	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
MO	7.44	7.05	5.72	8.06	7.62	4.88
MT	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
OH	3.36	3.30	2.63	4.25	3.44	3.02
OK	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
TX	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 Sensitivi ty Simulations for 2001 July 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

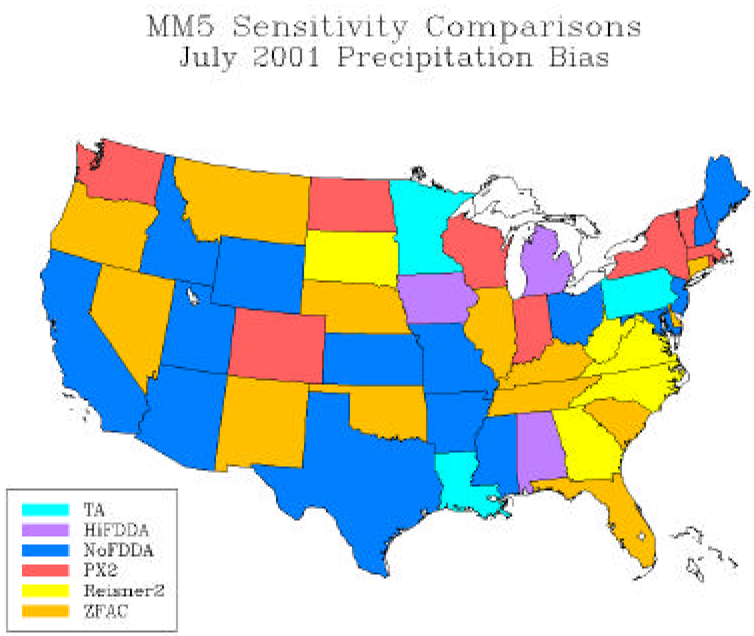


Figure 3-37: Accumulated Precipitation Error for Base and Sensitivity Simulations for 2001 July 2-26. States are Shaded to Reflect the Simulation with the Best Performance.

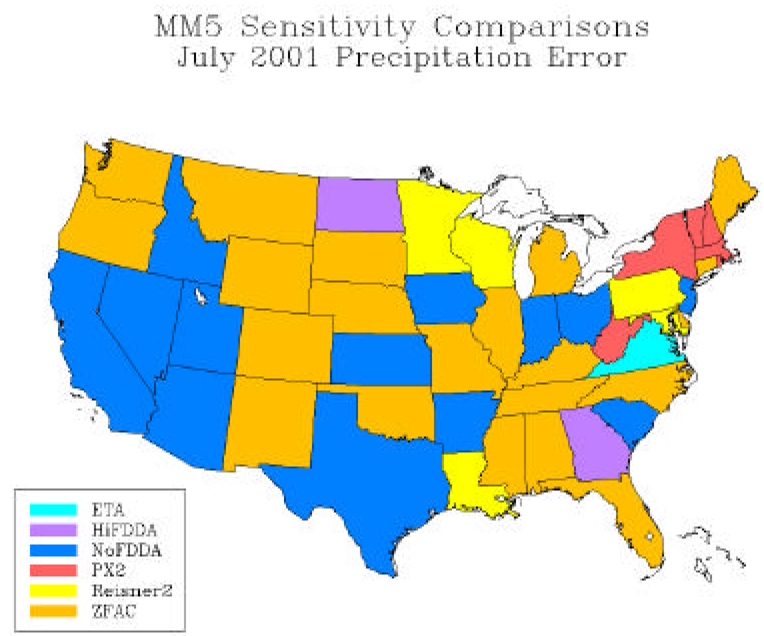
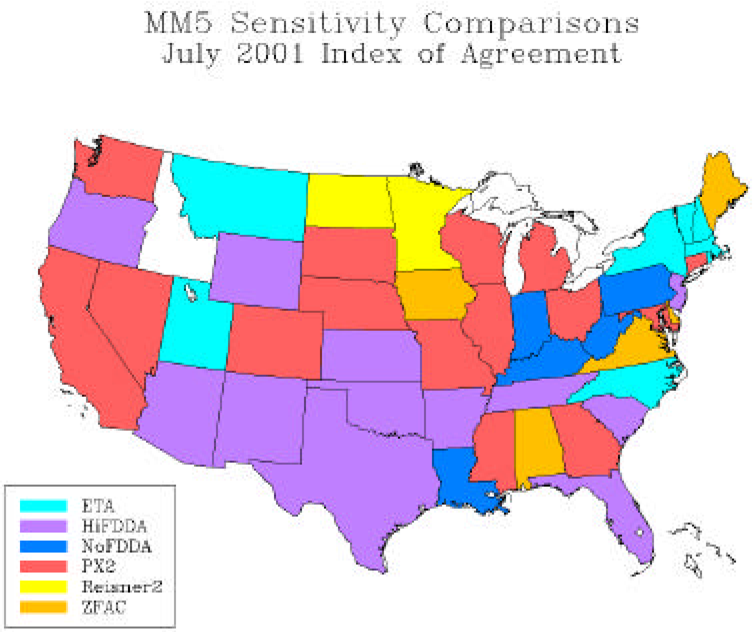


Table 3-15: Wind Index of Agreement for Base and Sensitivity Simulations for 2001 July 2-26.

	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
CO	0.57	0.57	0.65	0.48	0.56	0.61
CT	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
MI	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
MO	0.42	0.41	0.63	0.61	0.40	0.51
MT	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
OH	0.77	0.79	1.40	1.01	0.77	0.90
OK	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
TX	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.



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.