Topical Report

Annual Application of MM5 for Calendar Year 2001

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1 INTRODUCTION

Over the past half decade, emergent requirements for direct numerical simulation of urban and regional scale photochemical and secondary aerosol air quality—spawned largely by the new particulate matter ($PM_{2.5}$) and regional haze regulations—have led to intensified efforts to construct high-resolution emissions, meteorological and air quality data sets. The concomitant increase in computational throughput of low-cost modern scientific workstations has ushered in a new era of regional air quality modeling. It is now possible, for example, to exercise sophisticated mesoscale prognostic meteorological models and Eulerian and Lagrangian photochemical/aerosol models for the full annual period, simulating ozone, sulfate and nitrate deposition, and secondary organic aerosols (SOA) across the entire United States (U.S.) or over discrete subregions.

This report describes an application of the Pennsylvania State University/National Center for Atmospheric Research (NCAR) Mesoscale Model (MM5) for a simulation from 15 December 2000 through 28 February 2002 for a domain covering the continental United States.

2 METHODOLOGY

The methodology for this approach is very straightforward. The MM5 model is applied for the annual period and the model results are compared with available observations and synoptic weather charts.

2.1 Model Selection and Application

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

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

<u>Horizontal Domain Definition:</u> The computational domain is presented in Figures 2-1. The domain is a single 36km grid with 165 x 129 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.

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

<u>Topographic Inputs:</u> Topographic information for the MM5 is developed using the NCAR and the United States Geological Survey (USGS) terrain databases. The 36 km grid is 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. 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. The first guess fields are taken from the NCAR ETA 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 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 MM5 model physics options in this simulations are as follows:

Kain-Fritsch Cumulus Parameterization
Pleim-Xiu PBL and Land Surface Schemes
Simple Ice Moisture Scheme
RRTM Atmospheric Radiation Scheme
Multi-layer Soil Temperature Model

Model Timing: The model was run in the 5 periods presented in Table 2-2. Within each of these periods the model was run for 5 ½ days with a restart occurring at 12Z every fifth day. To assure continuity in the surface moisture, the model initial conditions were updated with the soil conditions from the end of the previous 5 ½ day period using the USEPA "INTERPX" processor.

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.

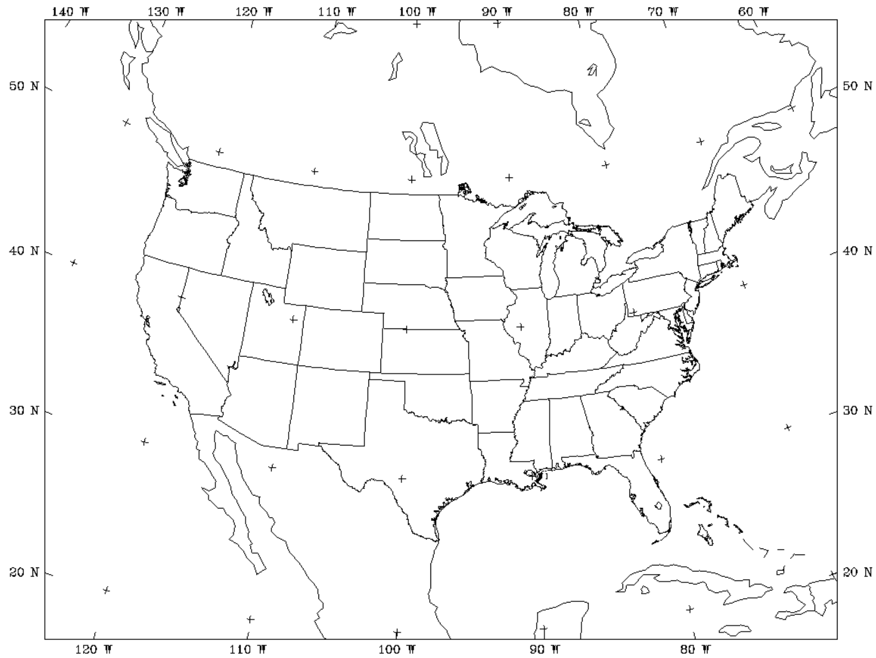


Table 2-2: Starting and Ending Date for Each Computational Period in the MM5 Simulation.

Period Number	Starting Date	Ending Date
1	12Z 16 December 2000	12Z 5 April 2001
2	12Z 16 March 2001	12Z 5 July 2001
3	12Z 14 June 2001	12Z 2 October 2001
4	12Z 17 September 2001	12Z 4 February 2002
5	12Z 15 January 2002	12Z 21 March 2002

3 RESULTS

3.1 Model Evaluation Results

The synoptic and statistical evaluations for simulation are presented in the following sections.

3.1.1 Synoptic Evaluation

One very important metric of model performance is to qualitatively assess how well the model is able to capture the evolution of synoptic systems. Sea level pressure and radar reflectivity plots for every 5 ½ days throughout the episode are presented in Figures 3-1 through 3-80. On each figure, the first frame presents the model estimated fields with the blue lines being 850 mbar heights, the red vectors are wind barbs and the shaded areas are regions of simulated radar reflectivity. The bottom plots are the archived surface chart from weather.unisys.com with the 850 Mbar heights in bold lines and shaded regions of radar reflectivity.

Some general conclusions from these figures are:

The model tends to generate more mesoscale structure in the 850 Mbar height fields, particularly over the western mountains.

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 model generally captures the regions of organized radar reflectivity, but the model underestimates the geographic extent.

3.1.2 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 (RPO), and for the entire modeling domain (including only the United States.

Temperature bias results are presented in Table 3-1 for each state and RPO, for both two month periods and for the entire episode. For the United States for the entire episode, the model has a bias of –0.6 K. This is, the model is too cool by 0.6 K. A graphical depiction by state of the episode average results is presented in Figure 3-81. The model tends to perform better in the Midwestern and Eastern US than in the West.

Temperature error results are presented in tabular and graphical for in Table 3-2, and Figure 3-82, respectively. For the entire United States for the entire episode, the model has an error of 2.08 K. The model is showing lower error in the Midwestern and Eastern US than in the West. Domain mean temperature plots for two month periods are presented in Figures 3-84 through 3-89. The model generally tracks within a couple of degrees of the observations, with the model tending to overestimate nighttime winter temperatures by a couple of degrees. Mean temperature plots for two month periods in the CENRAP states are presented in Figures 3-90 through 3-96. The model is able to capture overall trends very well and can pickup the passage of wintertime synoptic patterns very accurately.

Temperature spatial mean plots for the MANE-VU RPO region are presented in Figures 3-97 through 3-103. Plots for the Midwestern RPO are presented in Figures 3-104 through 3-110. VISTAS RPO plots are presented in Figure 3-111 through Figure 3-117. For all these regions the seasonal patterns are generally captured and nominally week long synoptic patterns are replicated.

Finally, the WRAP RPO mean temperature bias are presented in Figure 3-118 through 3-124. For the WRAP region the model is performing less well than the other regions. While the model is able to capture general seasonal and synoptic trends, for nearly the entire period the model is overestimating nighttime temperatures by a couple of degrees C.

Mixing ratio bias (g/kg) results are presented in Table 3-3 and Figure 3-125. Averaged over the entire US, for the entire period, the model shows a negative bias of 0.19 g/kg. This means that the model is slightly too dry. On a two month average, the model is tending to perform with lower bias in the winter months than other seasons. No clear trends are revealed examining the episode average results on a state by state basis.

Mixing ratio error (g/kg) results are presented in Table 3-4 and Figure 3-126. The episode and domain averaged mean is 0.97 g/kg. The model shows lower error in the winter months than the summer months and lower bias in the northern portion of the domain than the southern. It is possible that the lower bias in the northern region and in the winter is a result of the overall lower mixing ratio in these cooler regions and times.

Domain averaged mean mixing ratio for two-month periods in the episode are presented in Figures 3-127 though 3-133. The model results track the observations very closely in January through March, but the model is too dry, particularly during mid-day during the rest of the year. Mean mixing ratio for the CENRAP region is presented in Figures 3-134 through 3-140. In the CENRAP region the model tracks the observations closely and shows very accurate synoptic patterns. The model is however slightly too dry coming out of synoptic drying periods. Figures 3-141 through 3-147 present the spatial mean mixing ratio results in the northeastern MANE-VU states. For the majority of the year the model results track the observations very closely. For certain periods the model is dry by a couple of g/kg. The Midwestern RPO results are presented in Figures 3-148 through 3-154. As with MANE-VU, the results generally track well, with the model tending to be slightly dry. The southeastern VISTAS states are in Figures 3-155 through 3-161. The VISTAS results agree very closely, with the model being only slightly too dry on a handful of days. Finally, the WRAP results are presented in Figures 3-162 through 3-168. As with the temperature results, the model performs less well in the WRAP states than any of the other RPO's. For the majority of the year the model is too dry by 1 to 2 g/kg.

Accumulated precipitation bias for the entire domain, and each state and RPO region are presented in Table 3-5. The accumulated precipitation is computed by summing the observed precipition over the entire period at each station, and summing the model estimated precipitation at the station location over the same period. By using the accumulated precipitation metric we are able to relax the timing of rainfall events and to focus on rainfall trends. For the entire domain summed over the entire episode, the model is overestimating rainfall by 1.55 cm. Accumulated precipitation error is presented in Table 3-6. The domain averaged episode total error is 3.5 cm.

Monthly observed and estimated total precipitation are presented in Figure 3-172. The model is able to replicate the observations fairly accurately in the spring, fall and winter. In the summer months the model is tending to overestimate rainfall. Monthly rainfall comparisons for the CENRAP region are presented in Figure 3-173. Again, the largest errors are in the summer. Monthly rainfall comparisons for the MANE-VU region are presented in Figure 3-174. In the MANE-VU region the model replicates the observed data closely throughout the year. Midwestern RPO results are presented in Figure 3-175 and show general agreement, except in the summer when the model is tending to be too wet. In the VISTAS states (Figure 2-176) the familiar pattern of better results in seasons other than summer are once again observed. In Figure 3-177 the WRAP region shows generally pretty good agreement, with the model somewhat too wet in the summer months

Wind speed index of agreement are presented in Table 3-6. Over the entire domain for the year the results are very consistent at between 0.85 and 0.88 with an annual mean of 0.86. Examination of Figure 3-178 reveals that the index of agreement is generally higher in the Midwest and West than in the East. Index of Agreement time series plots for the entire domain, and for each RPO are presented in Figures 3-179 through 3-220.

Figure 3-1: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 02 January 2001.

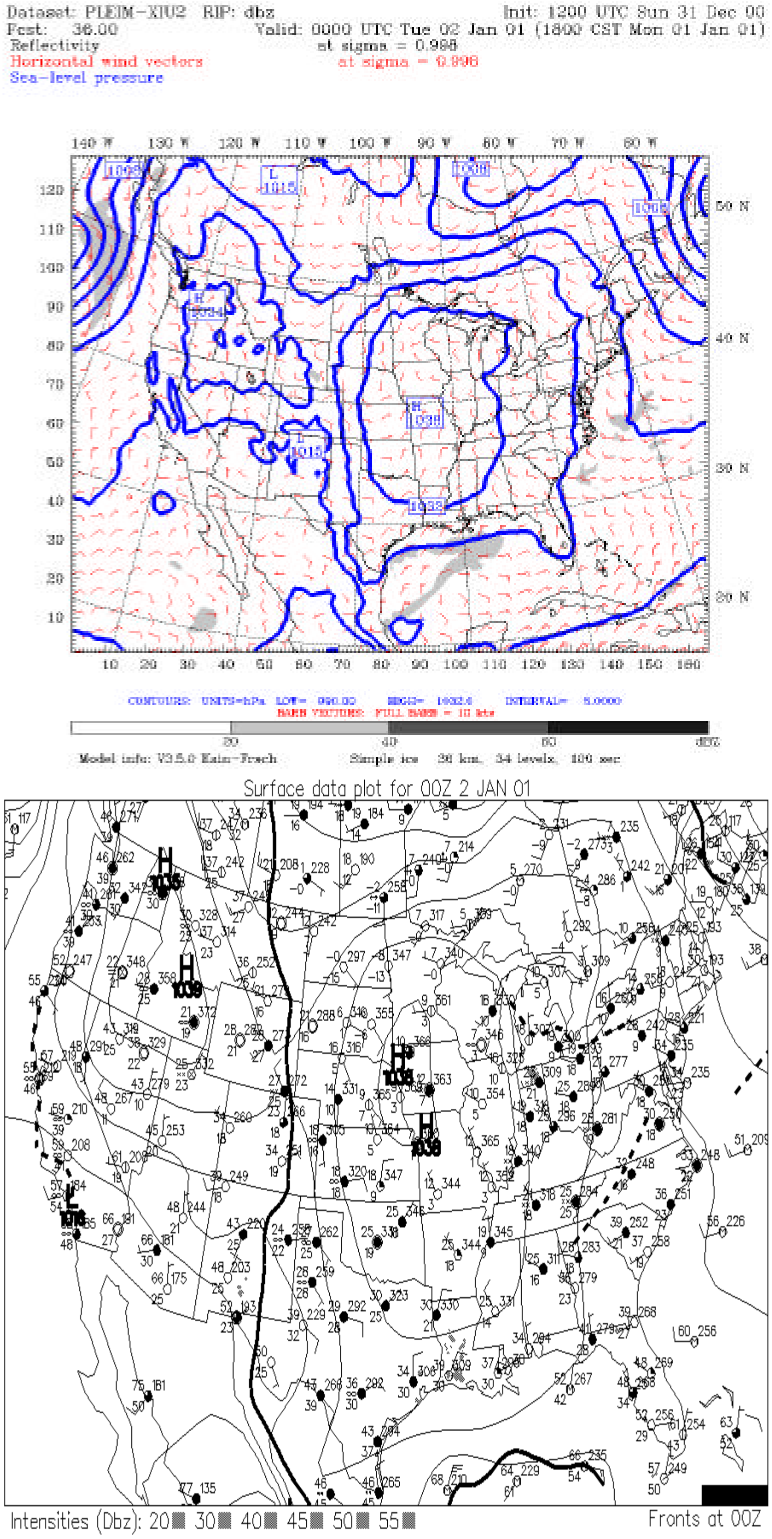


Figure 3-2: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 07 January 2001.

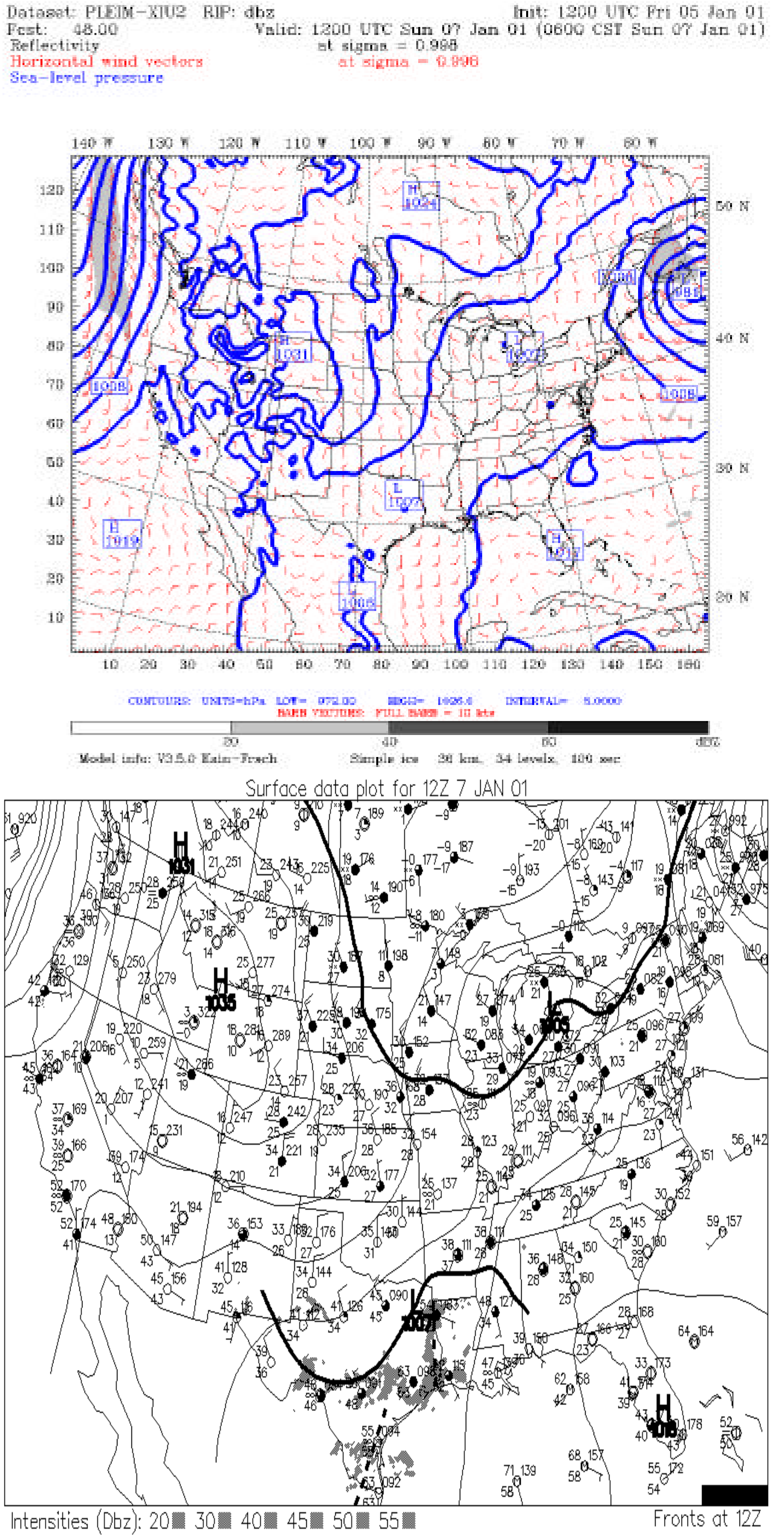


Figure 3-3: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 13 January 2001.

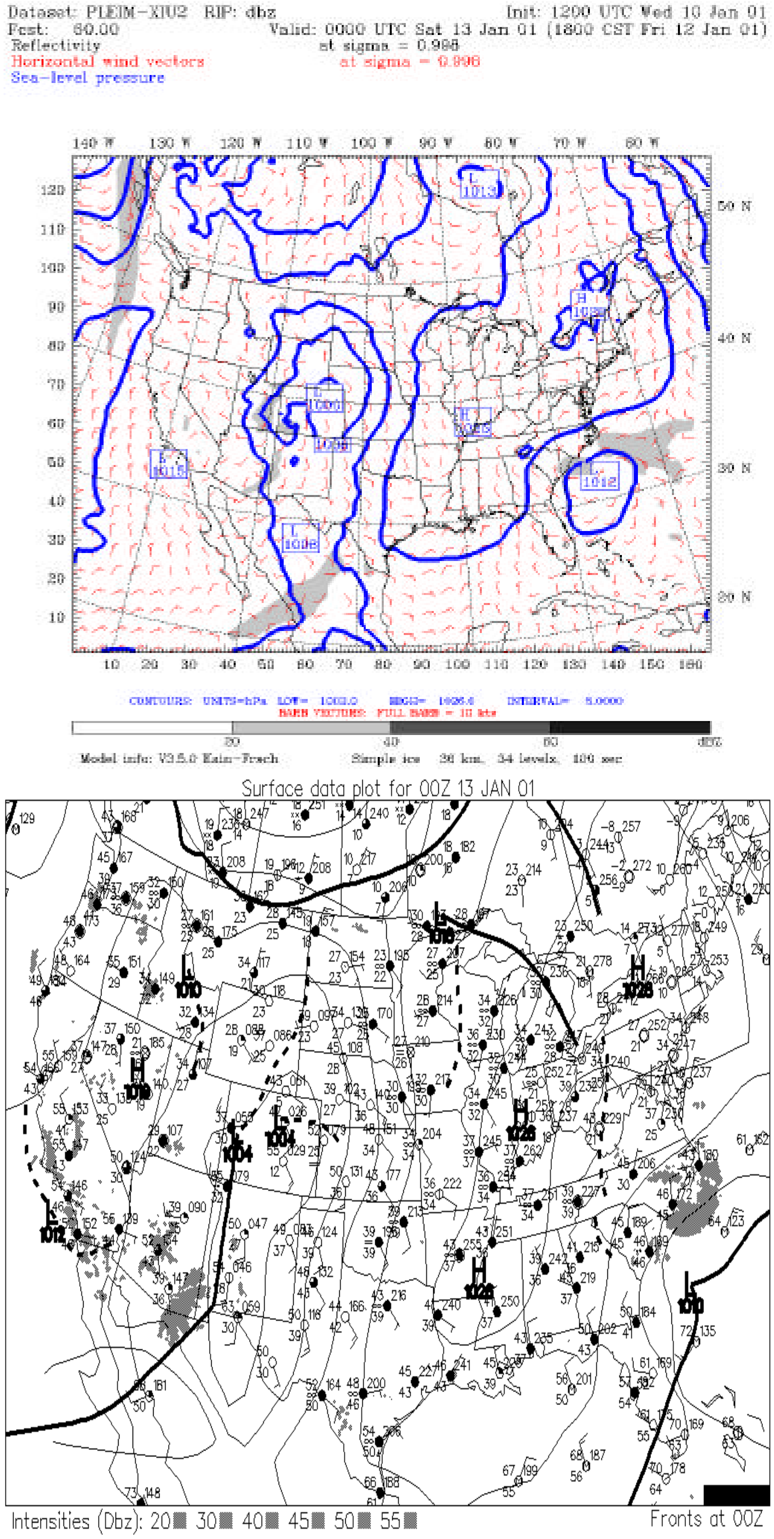


Figure 3-4: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 18 January 2001.

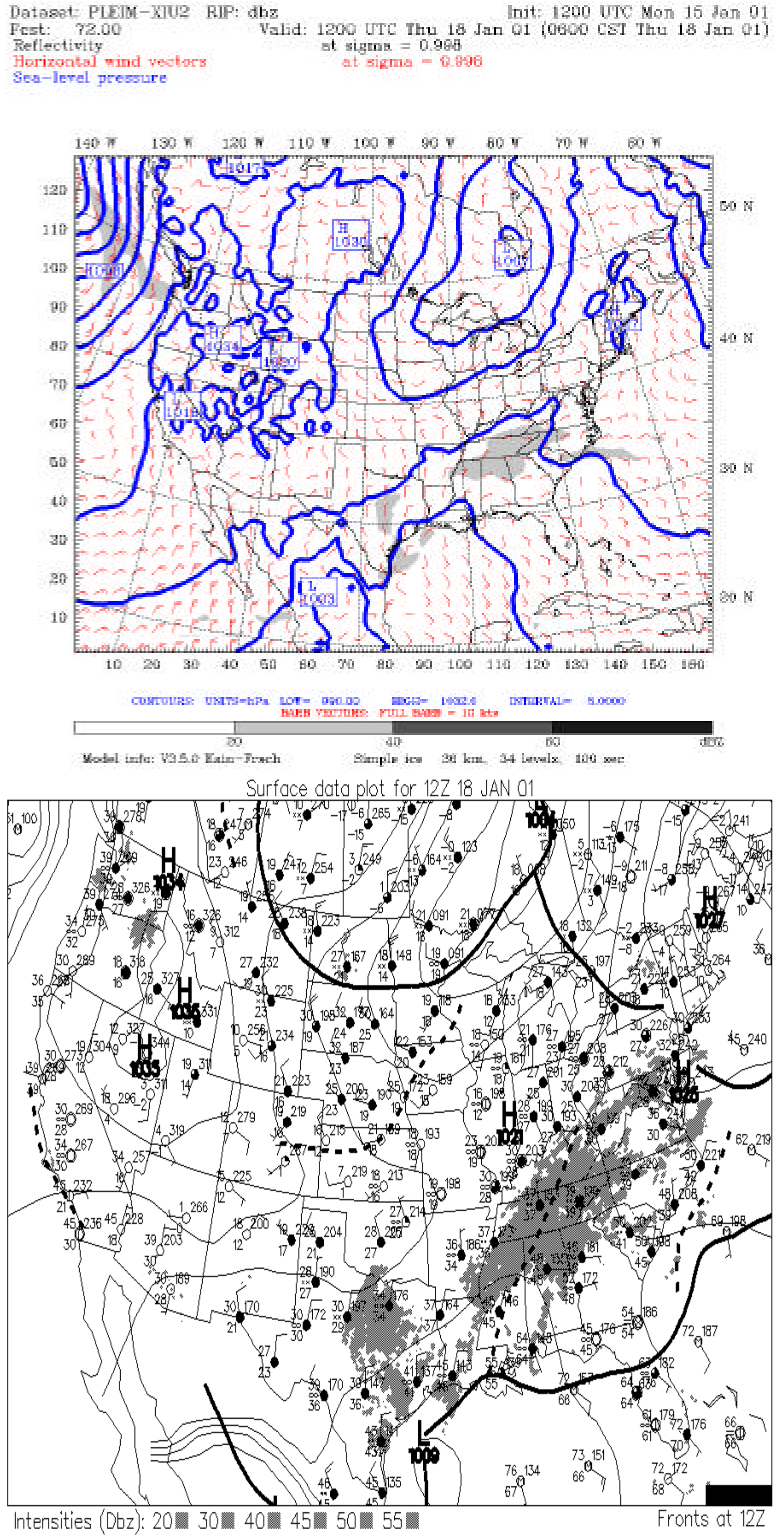
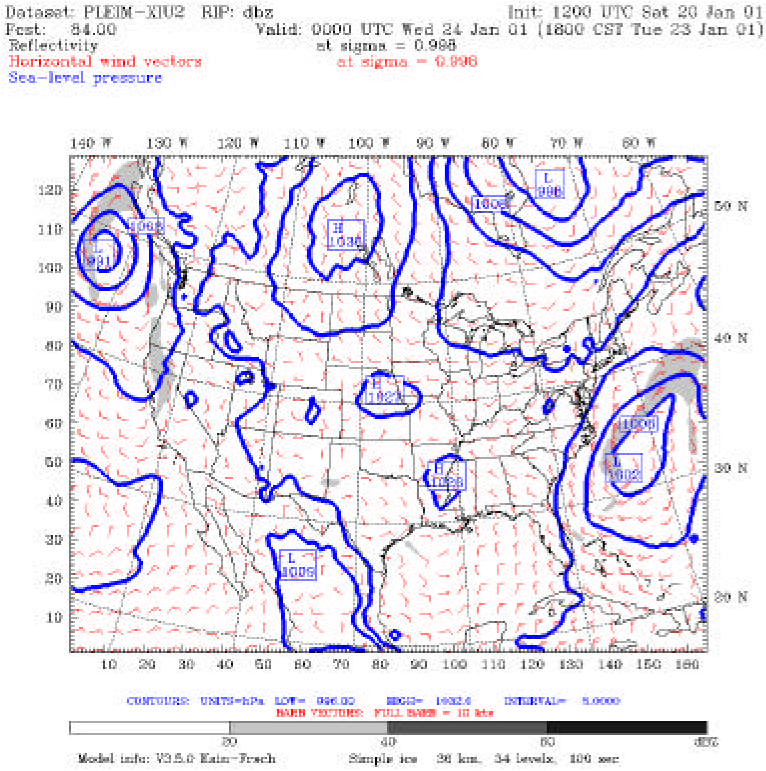


Figure 3-5: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 24 January 2001.



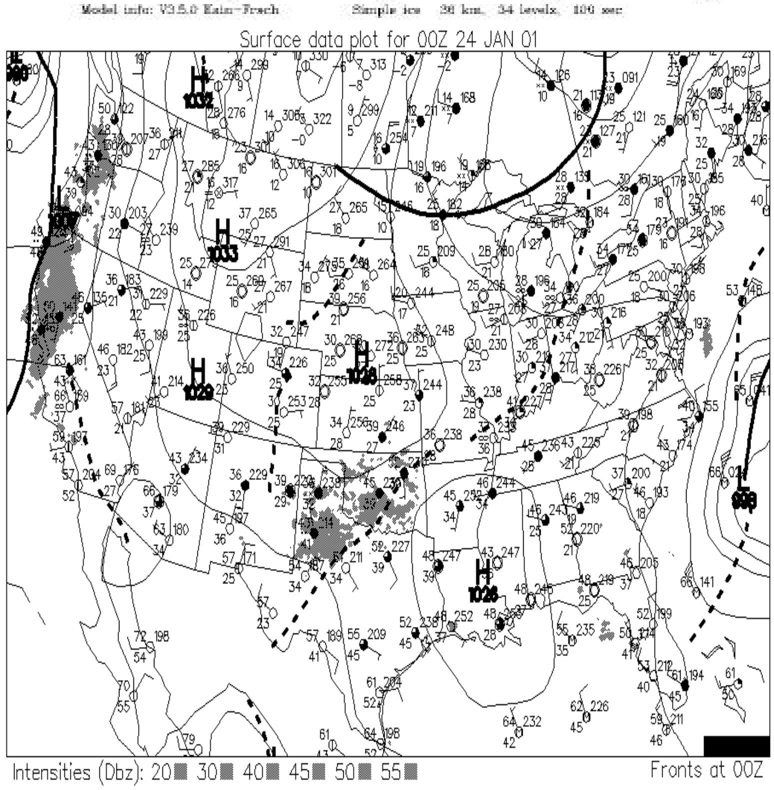


Figure 3-6: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 29 January 2001.

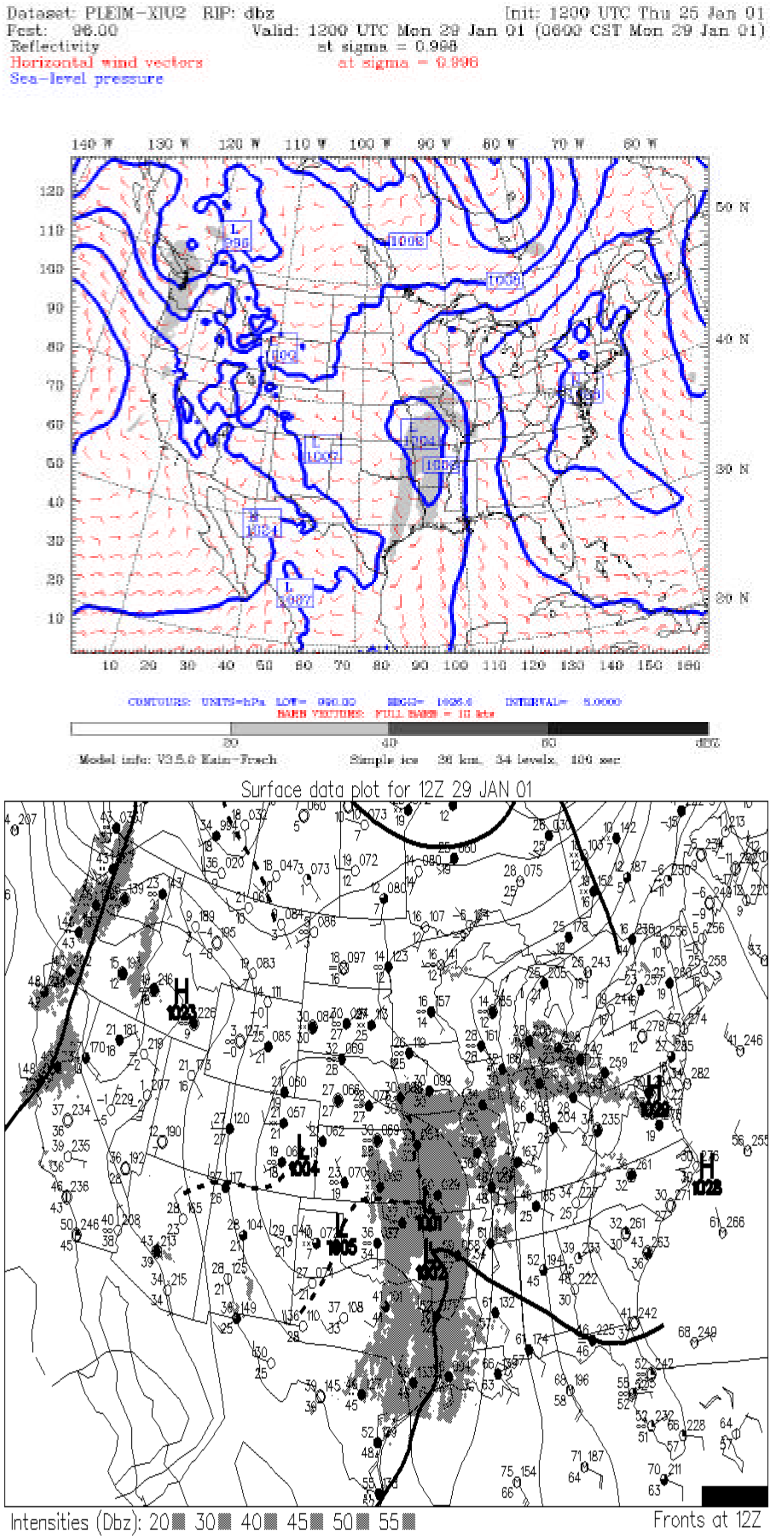
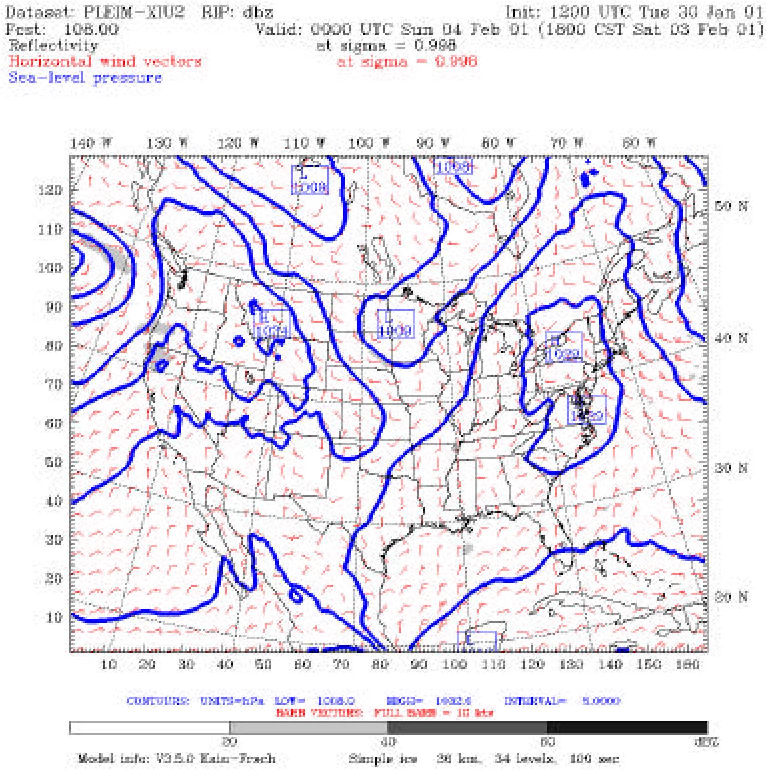


Figure 3-7: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 04 February 2001.



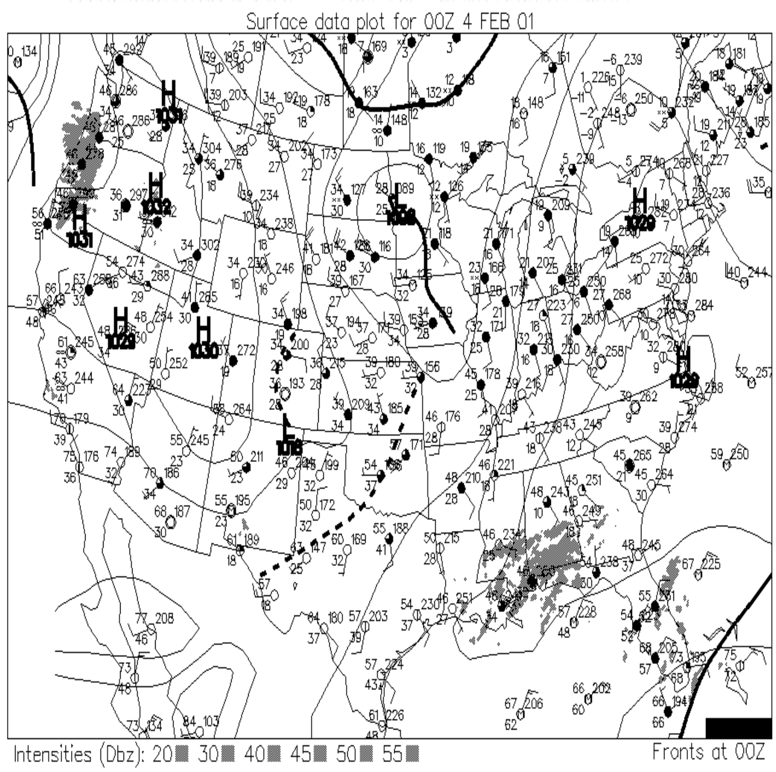


Figure 3-8: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 09 Frbruary 2001.

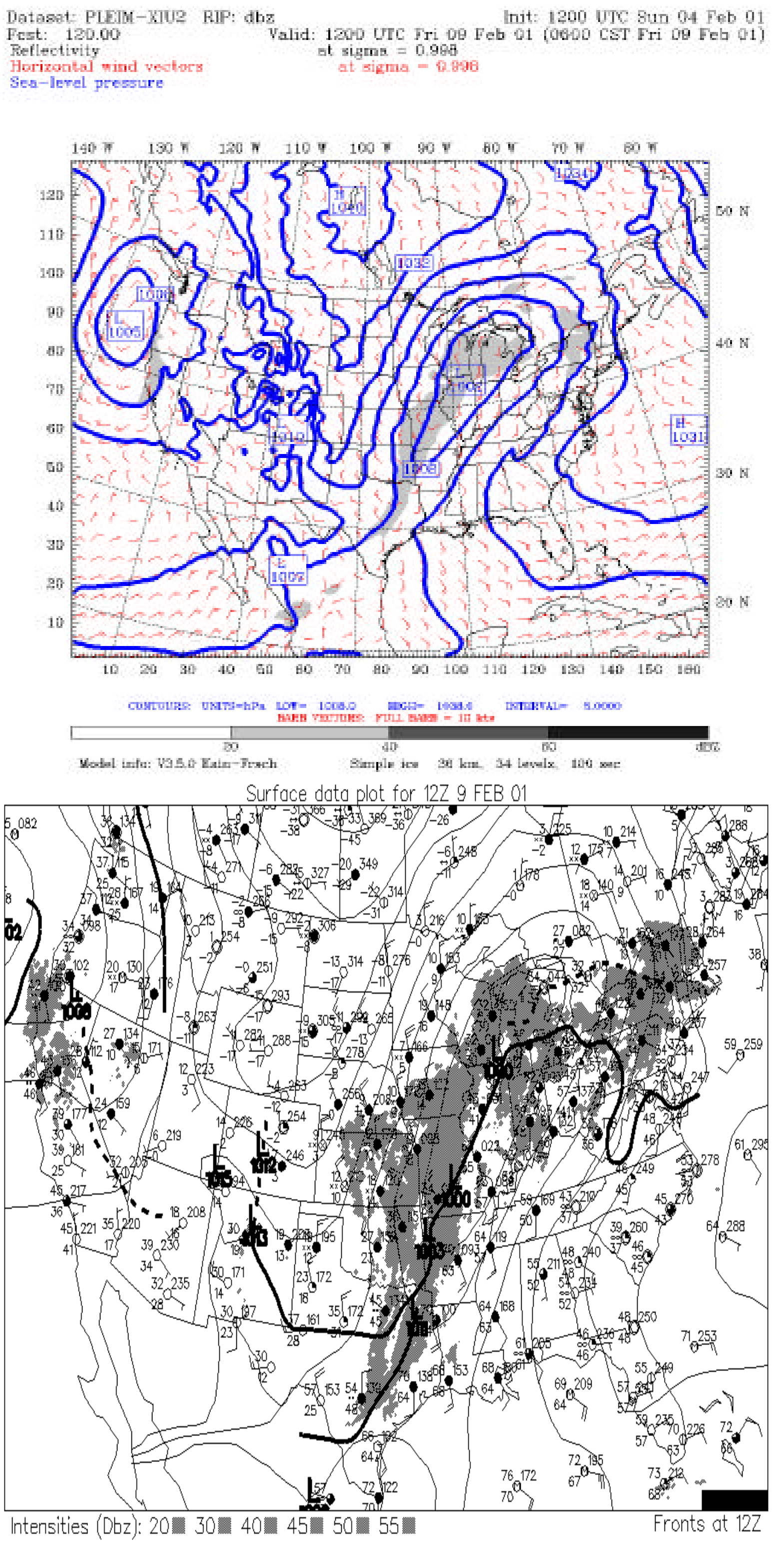


Figure 3-9: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 15 February 2001.

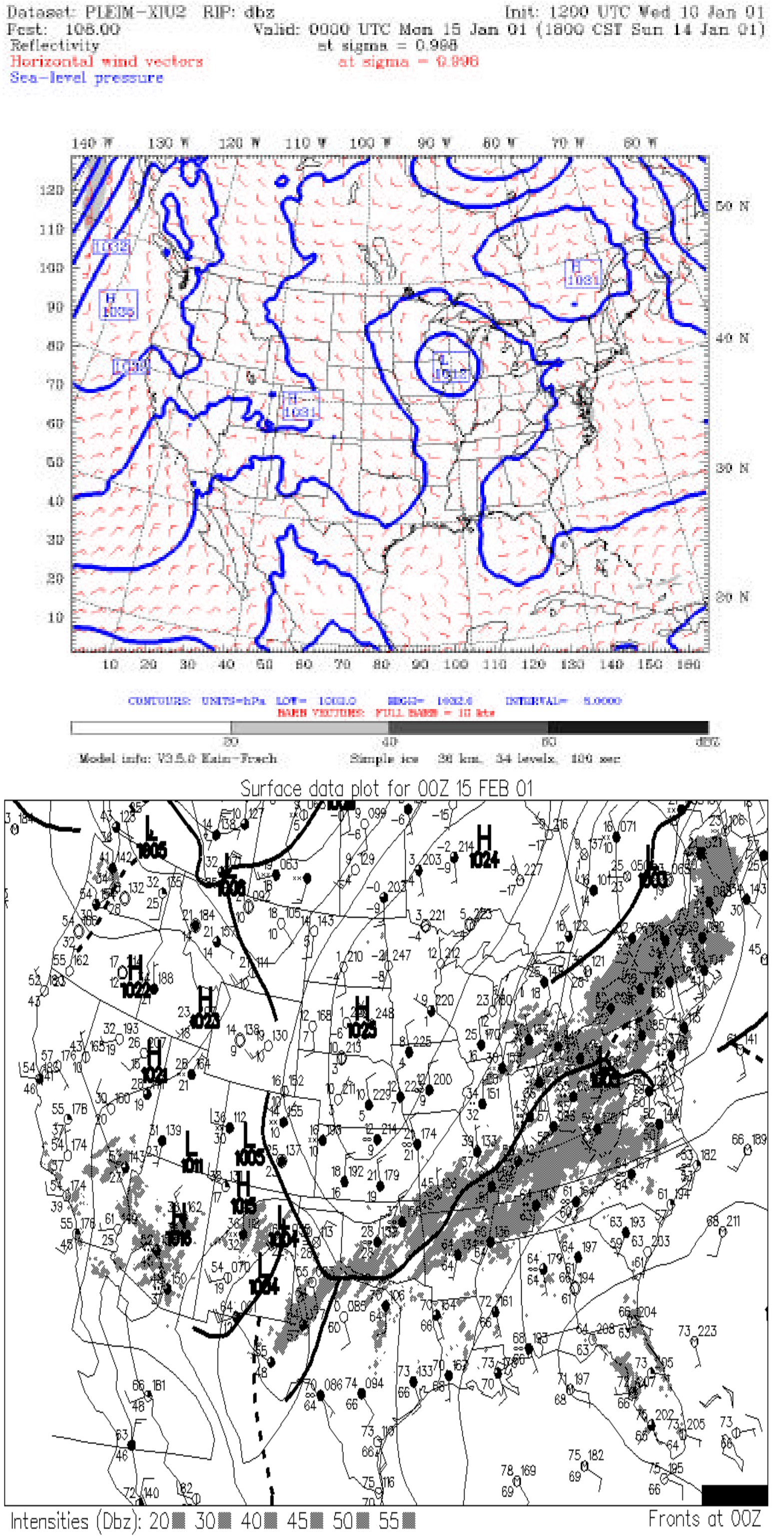


Figure 3-10: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 20 February 2001.

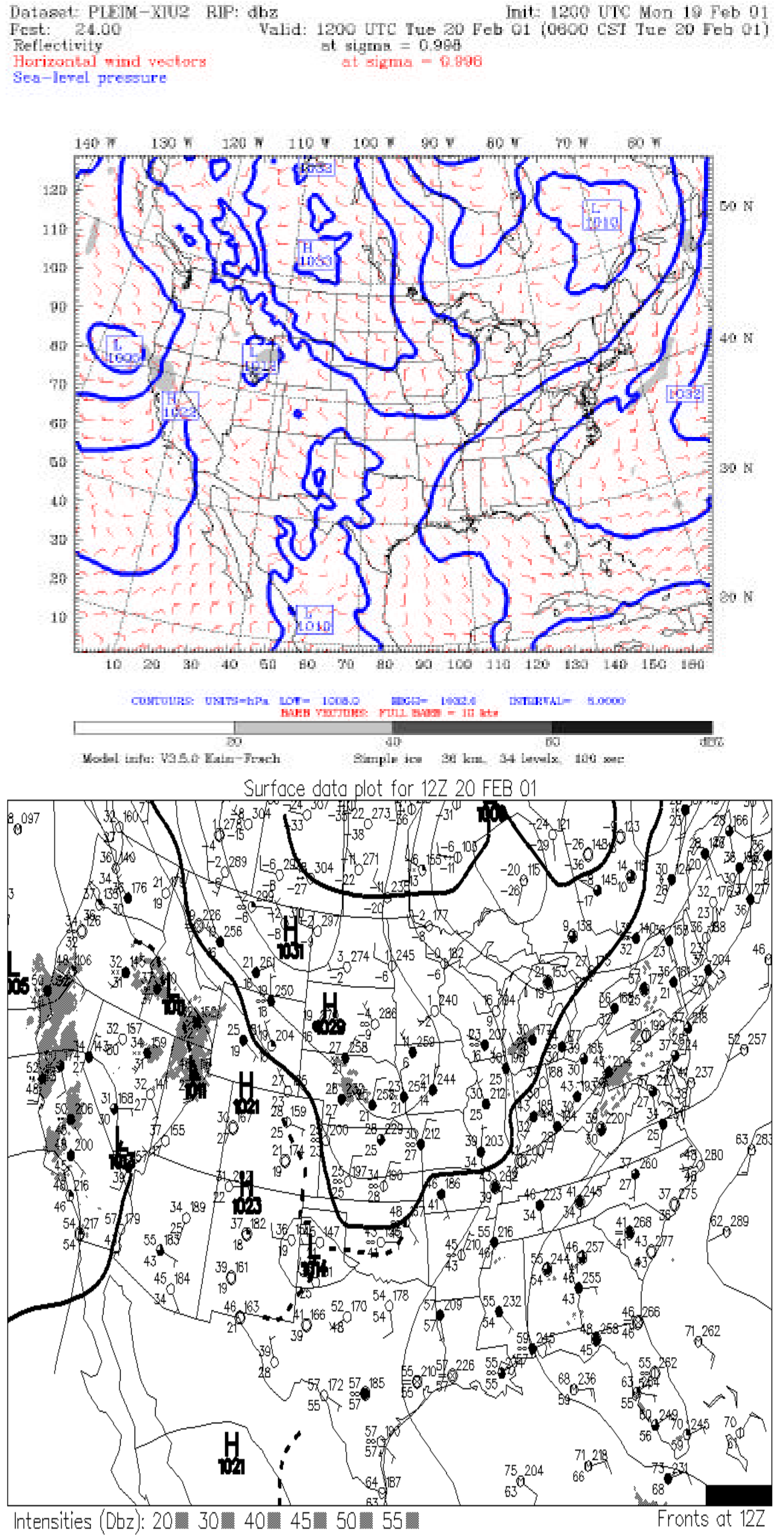


Figure 3-11: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 26 February 2001.

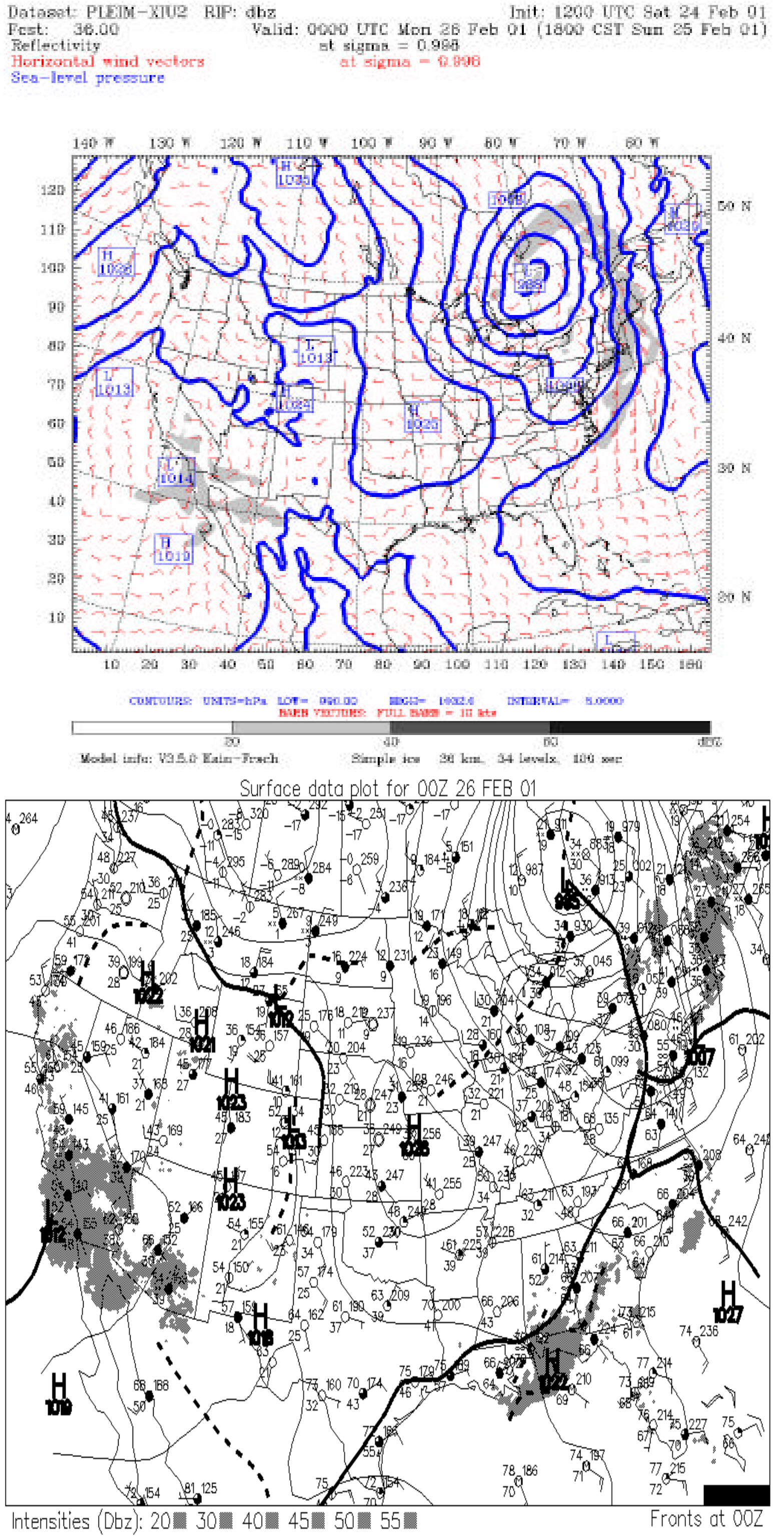


Figure 3-12: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 03 March 2001.

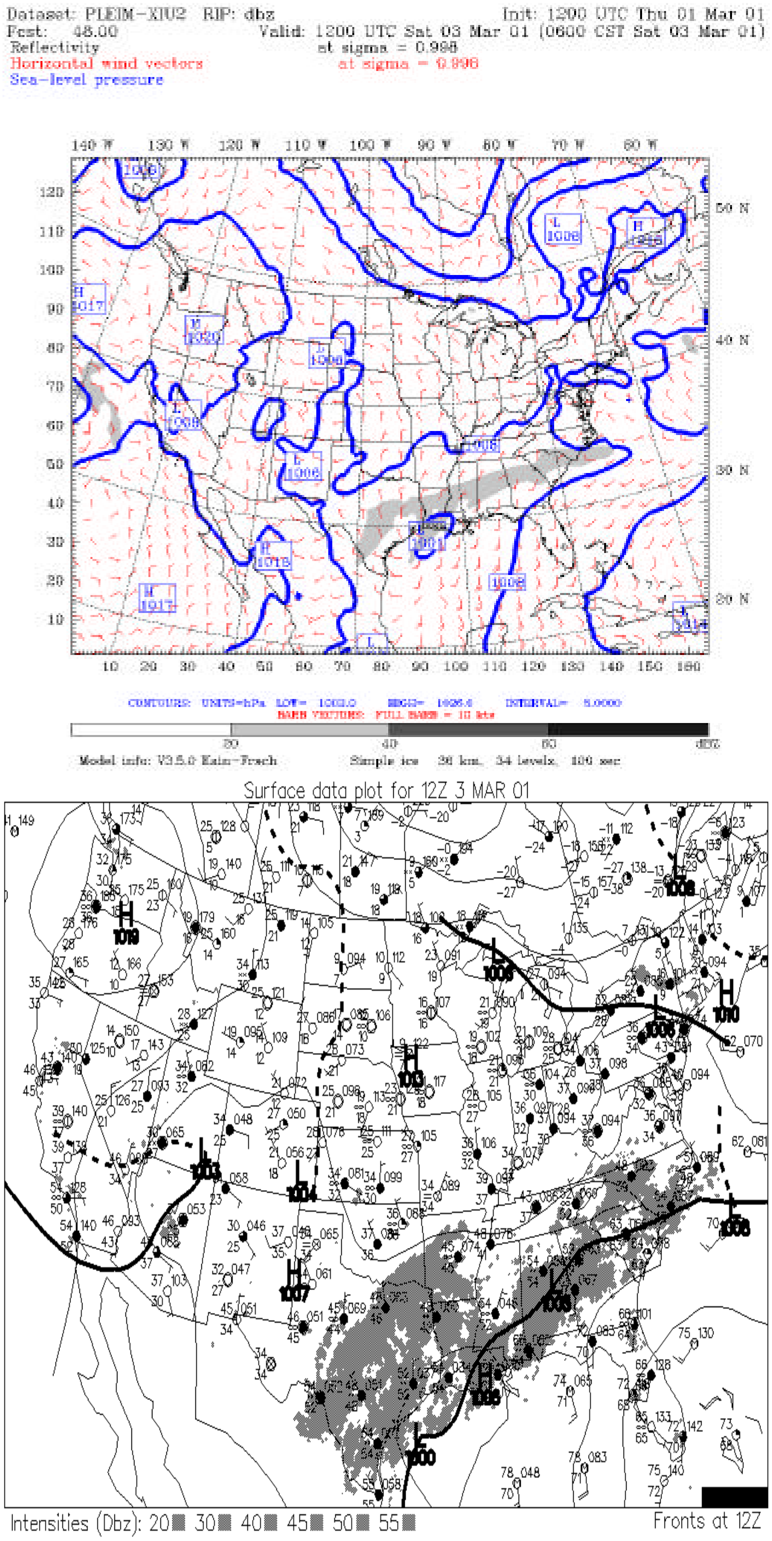


Figure 3-13: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 09 March 2001.

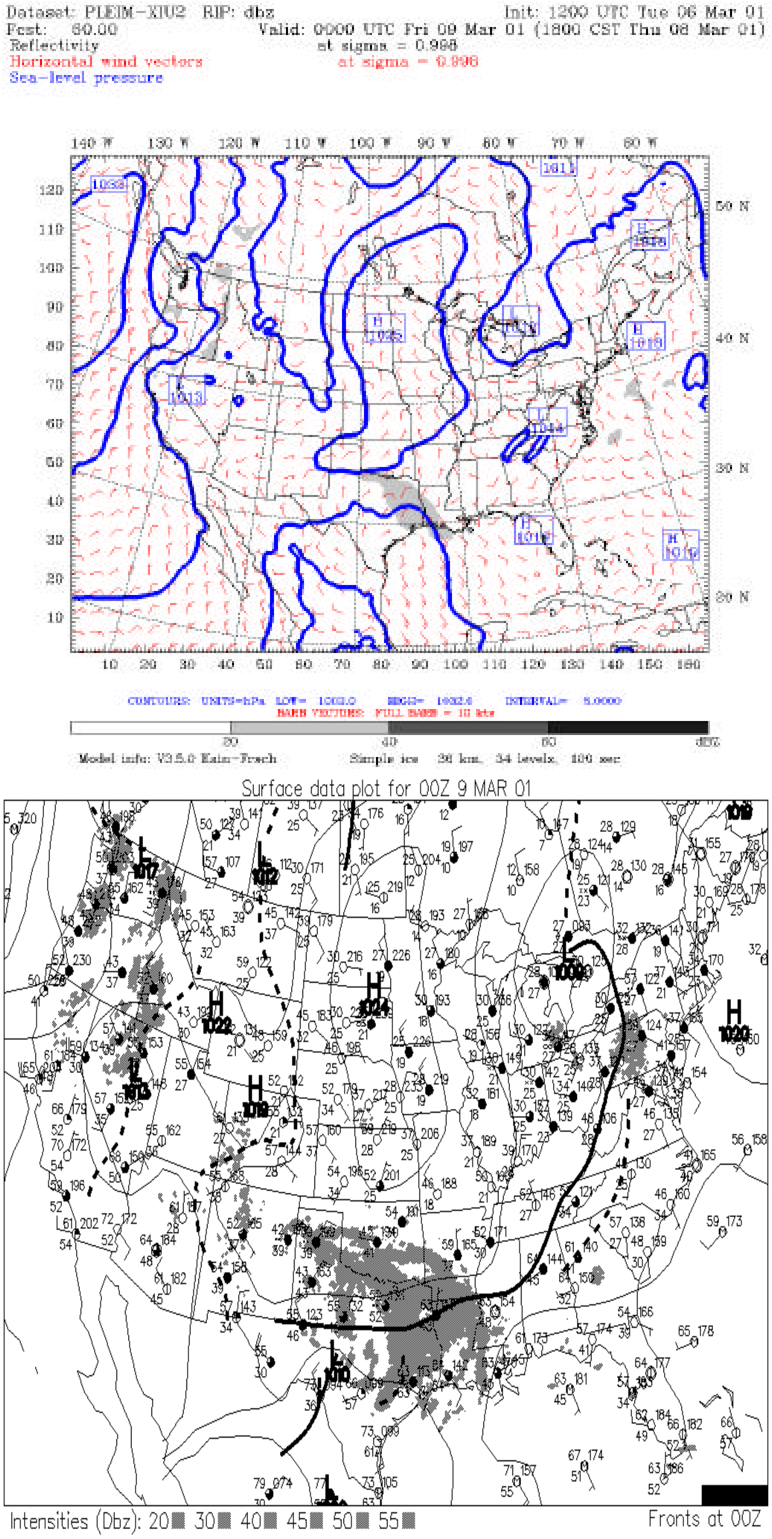


Figure 3-14: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 14 March 2001.

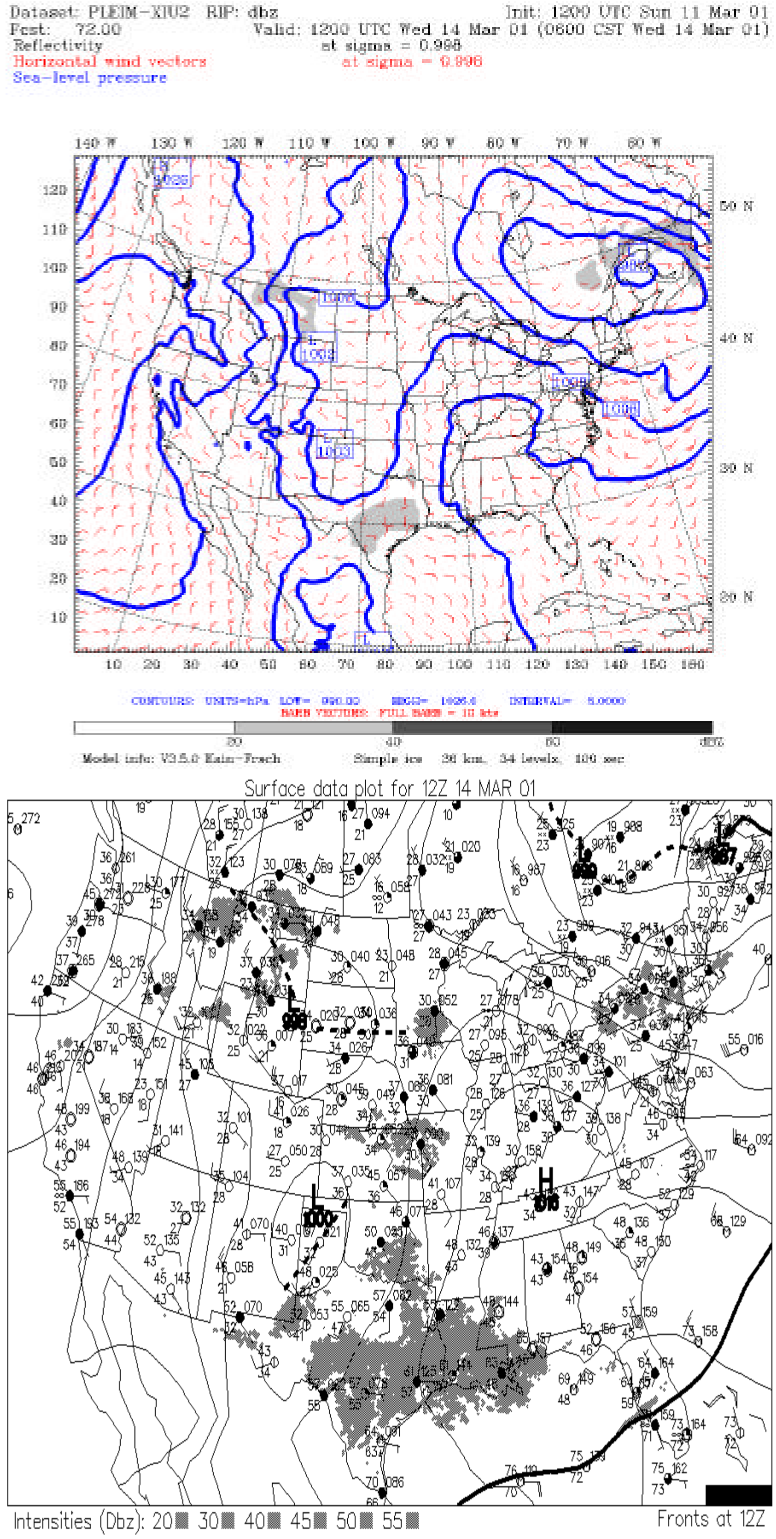


Figure 3-15: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 20 March 2001.

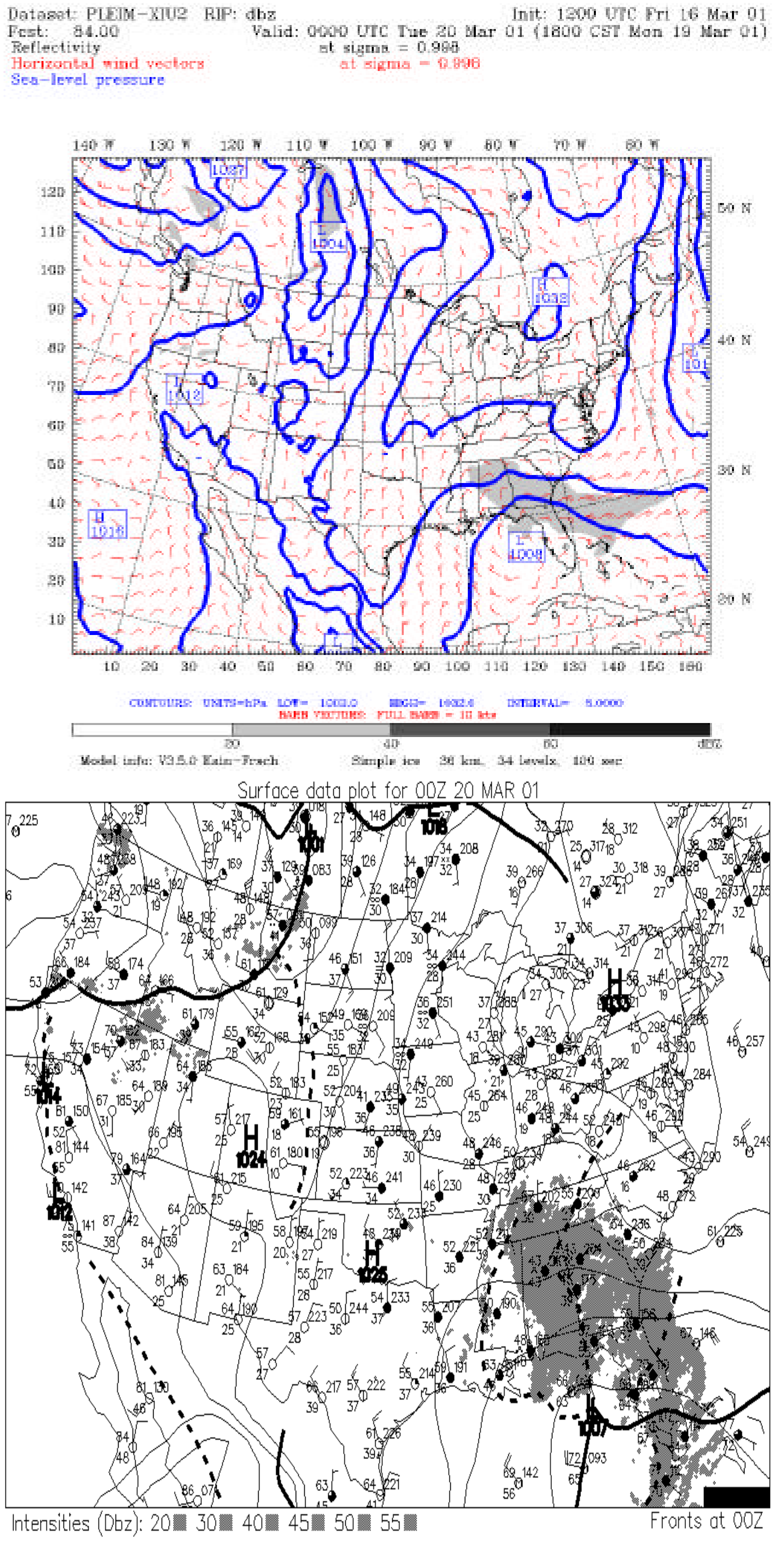


Figure 3-16: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 25 March 2001.

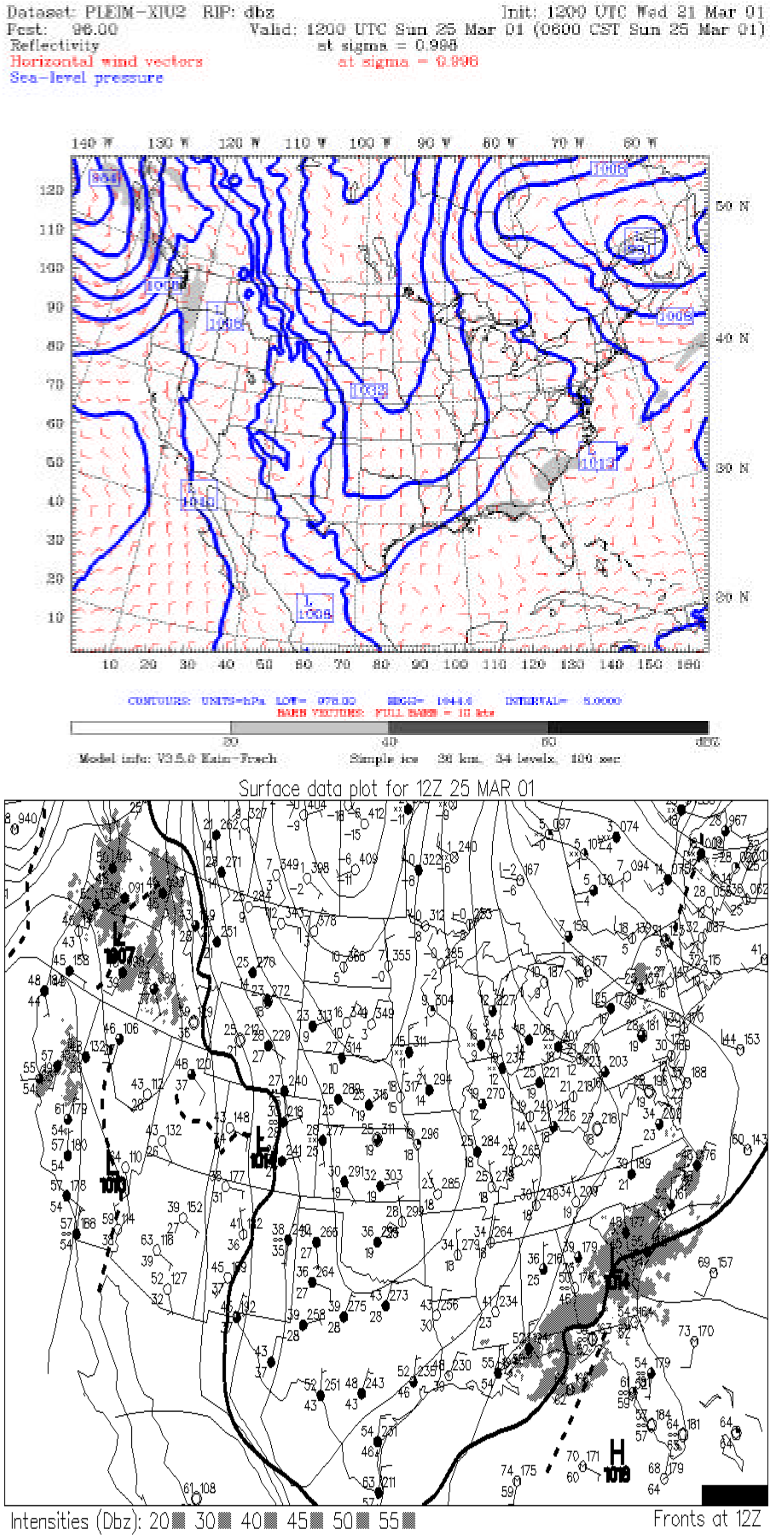


Figure 3-17: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 31 March 2001.

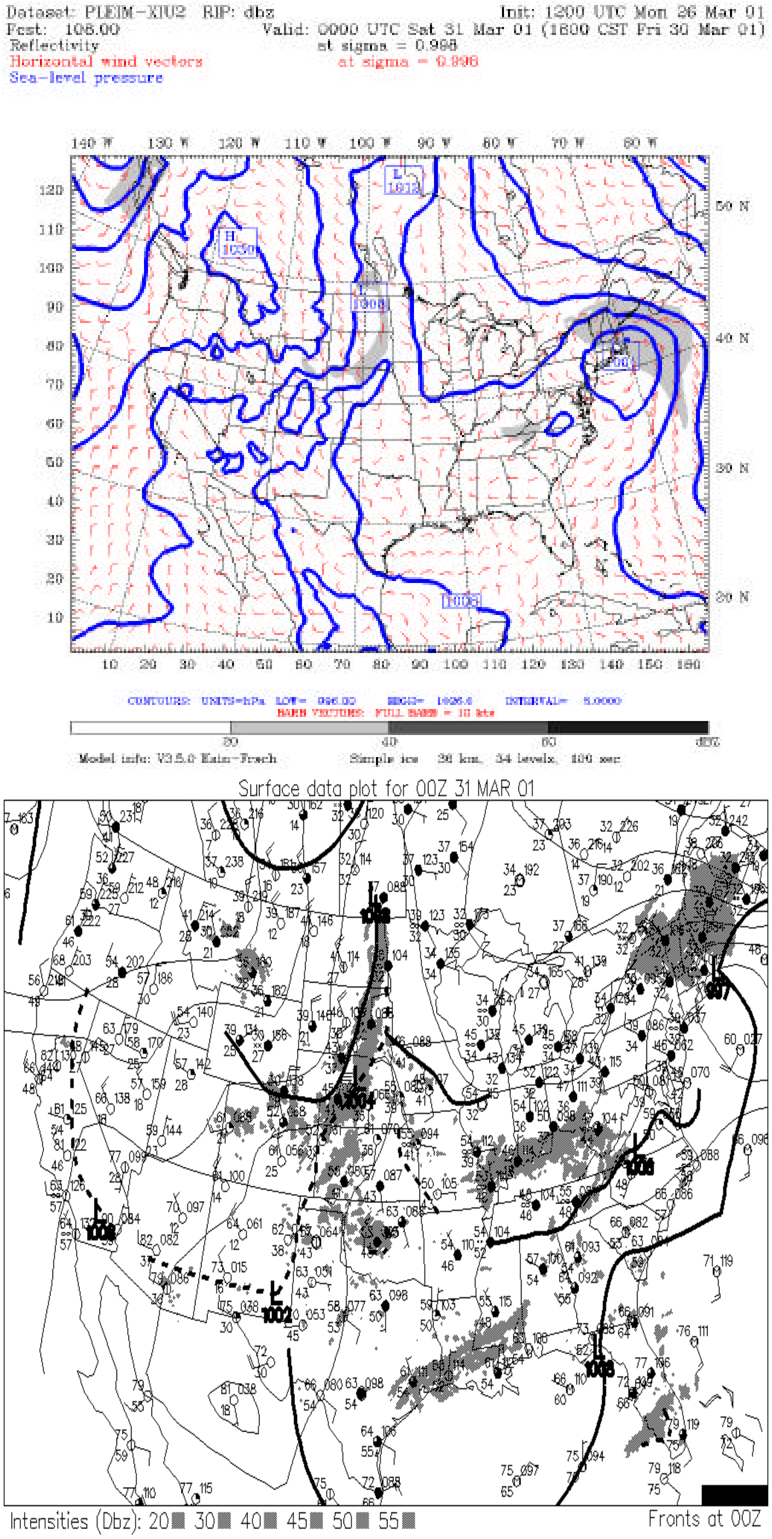


Figure 3-18: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 05 April 2001.

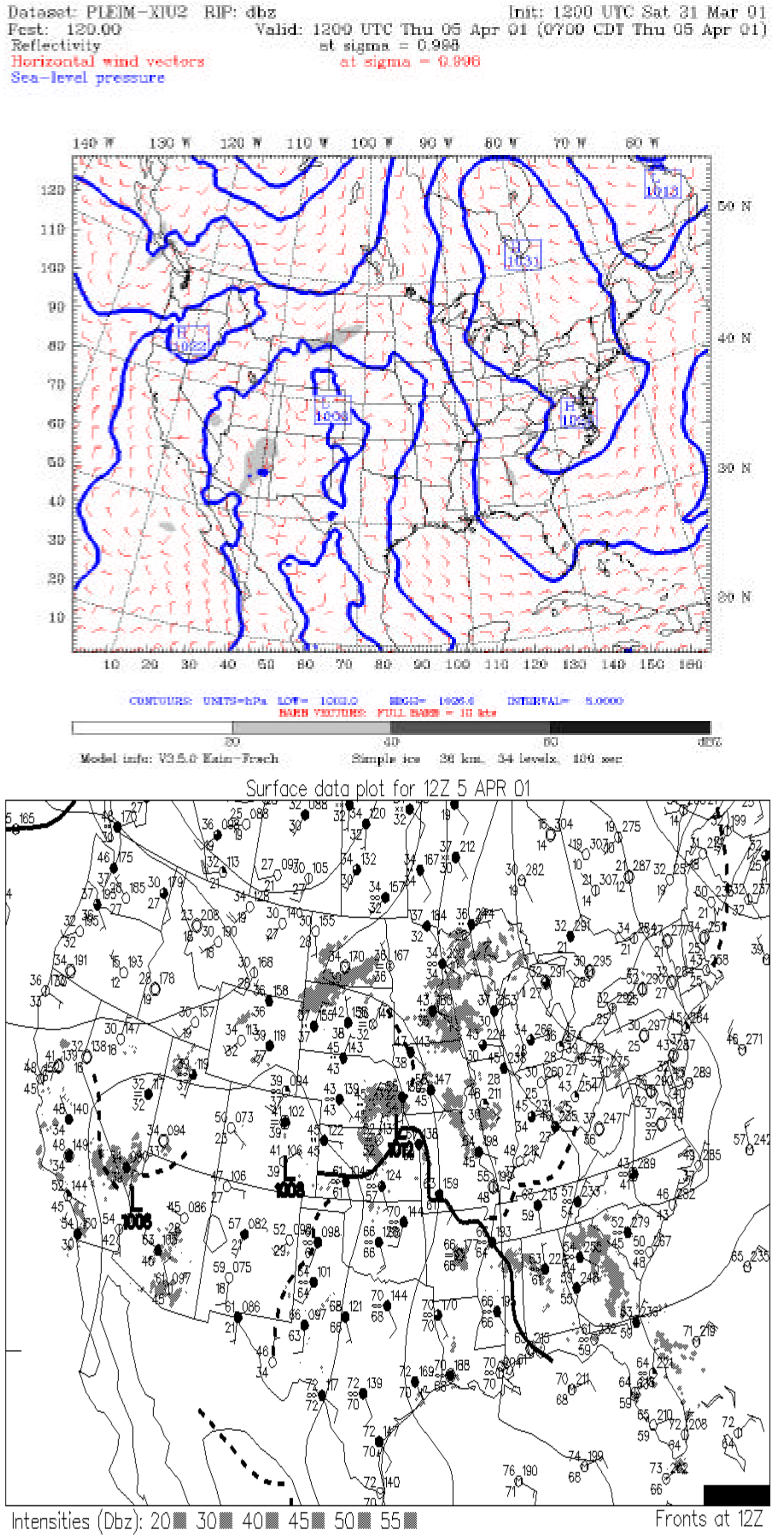
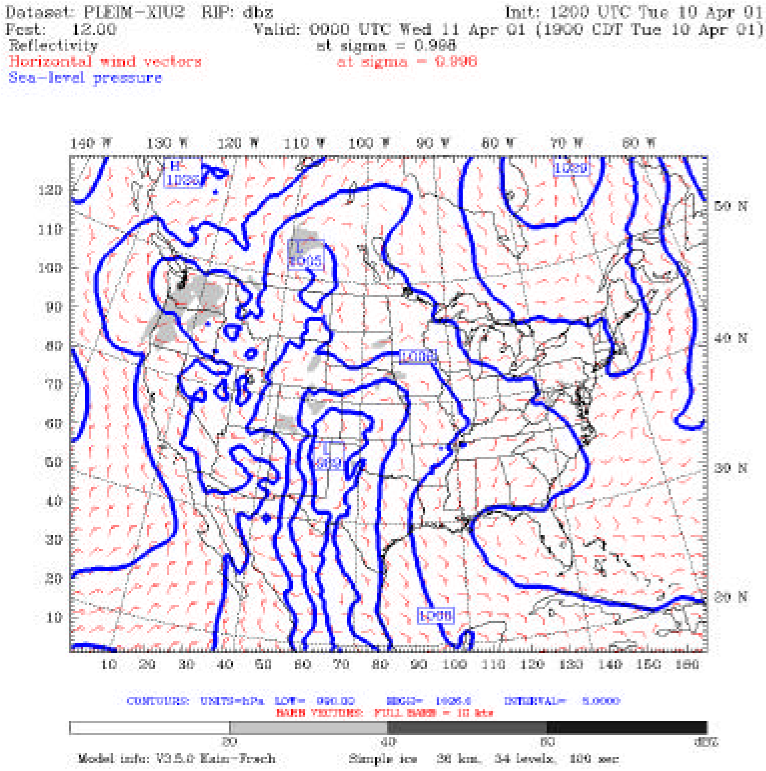


Figure 3-19: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 11 April 2001.



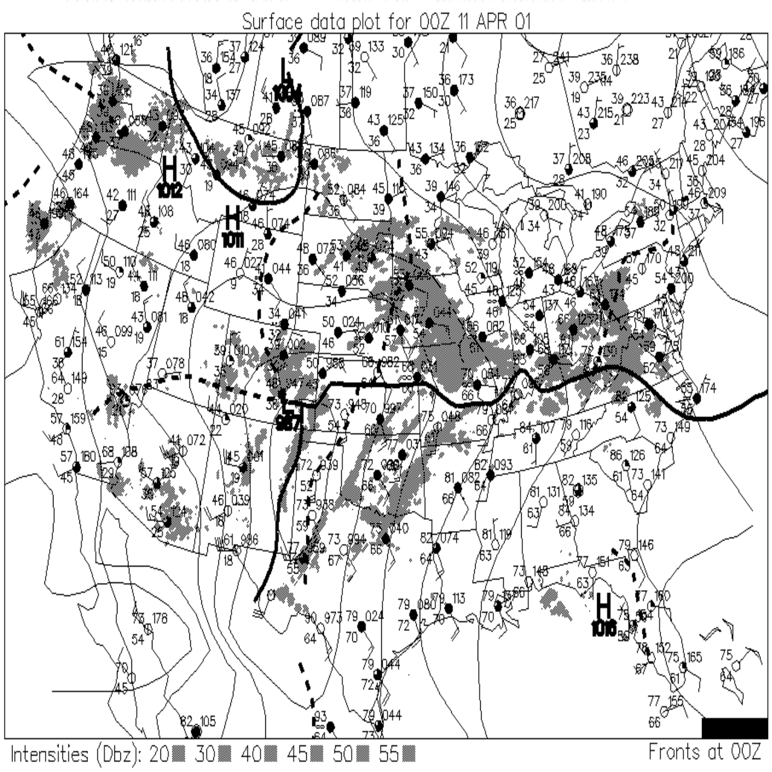


Figure 3-20: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 16 April 2001.

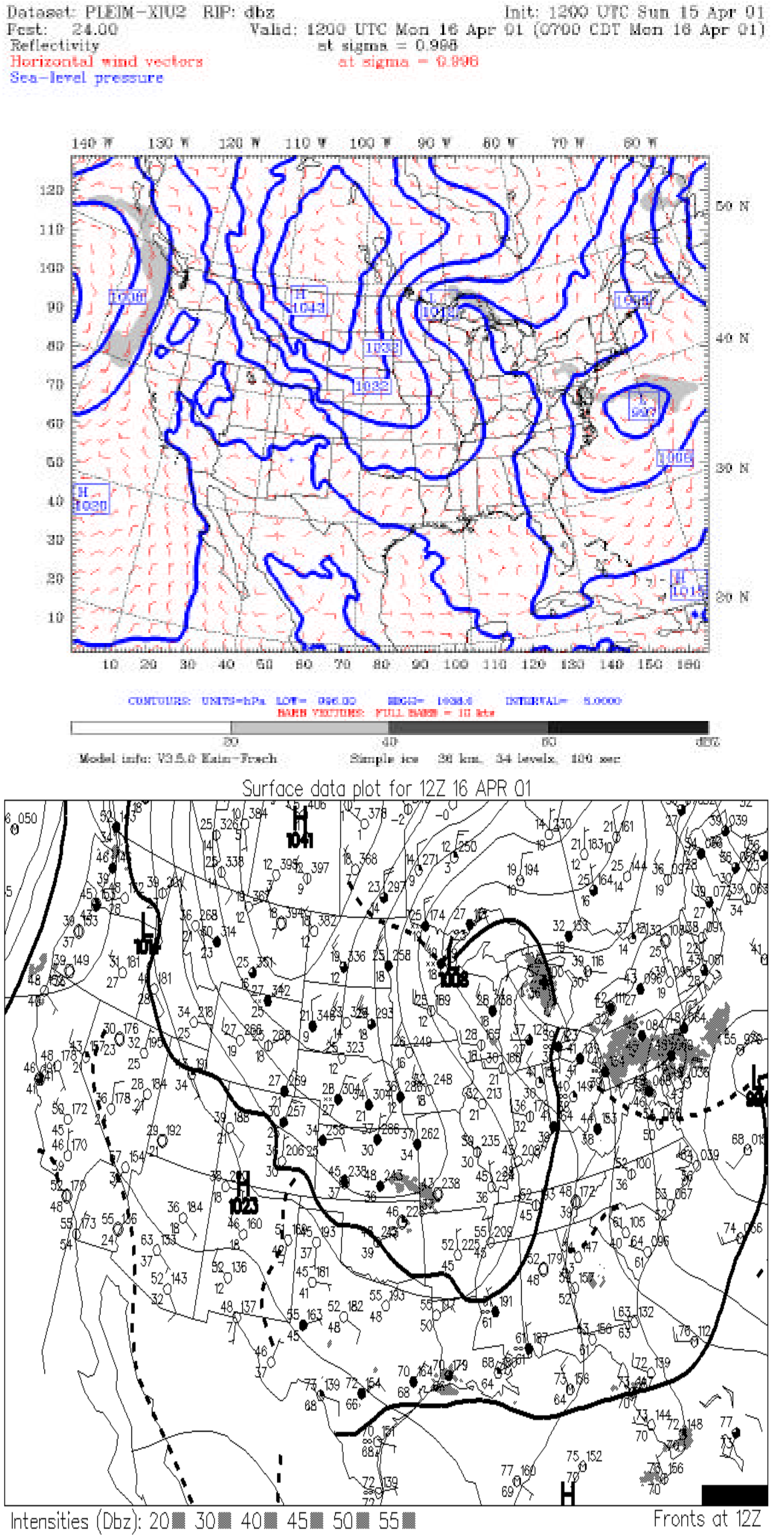


Figure 3-21: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 22 April 2001.

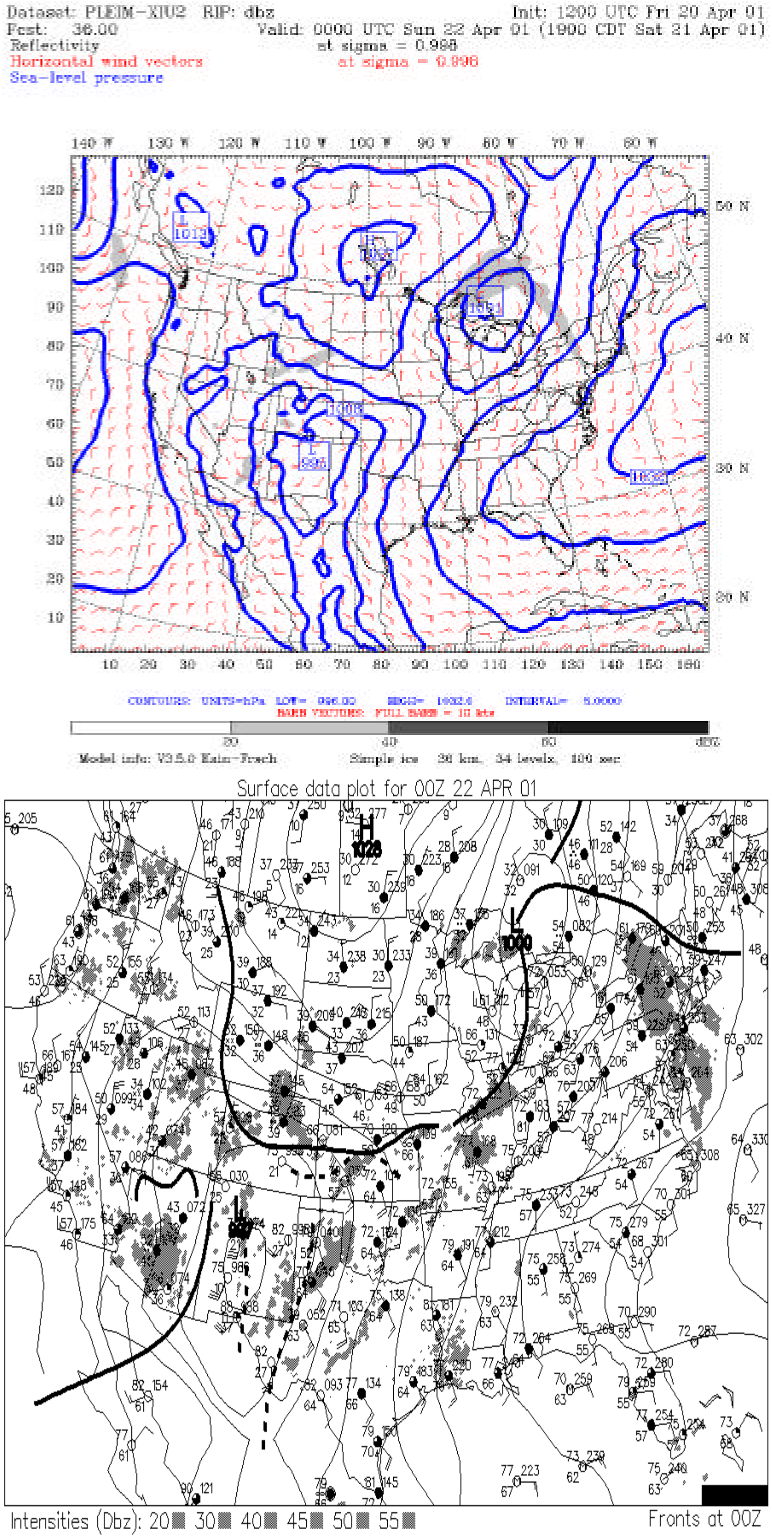


Figure 3-22: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 27 April 2001.

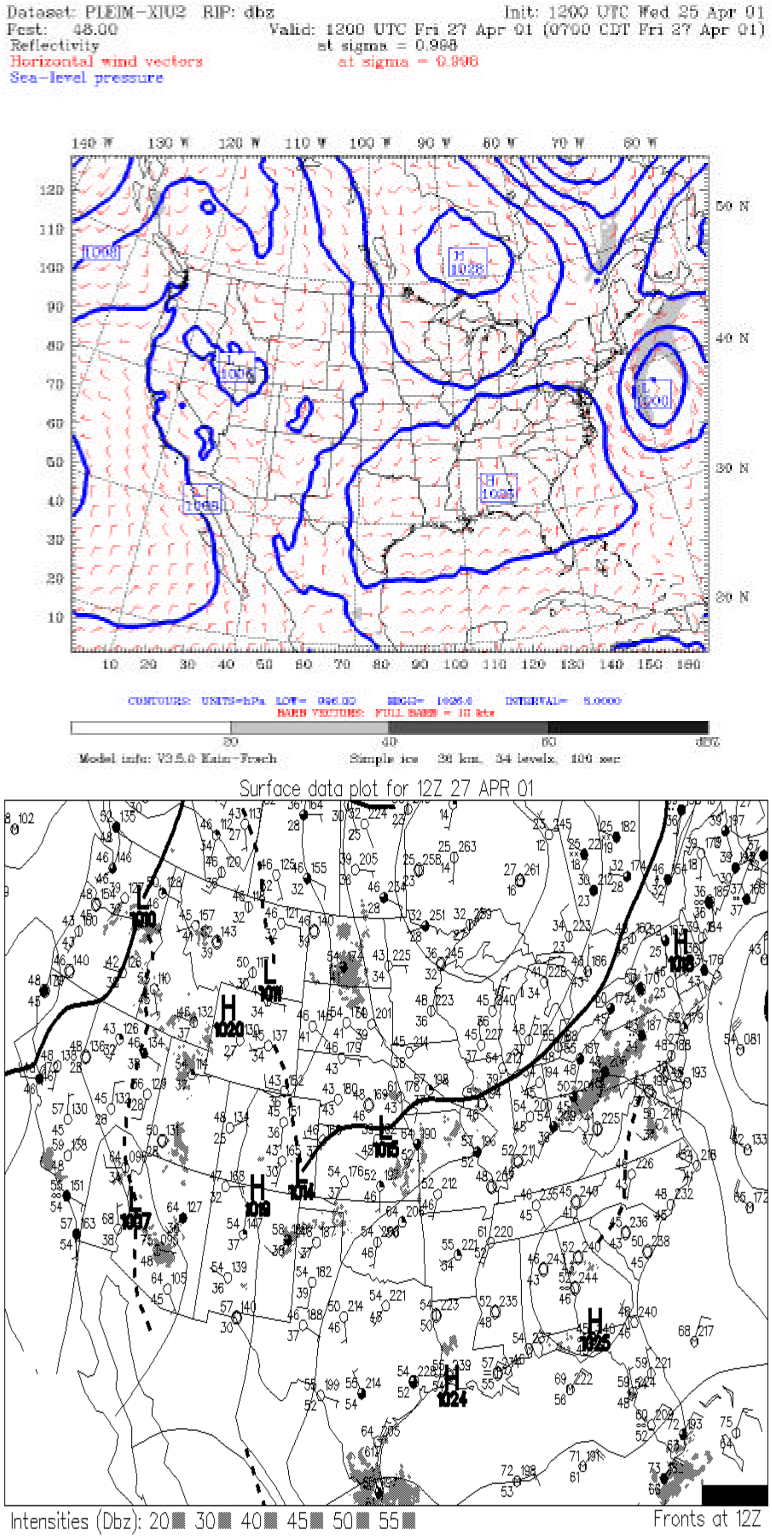


Figure 3-23: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 03 May 2001.

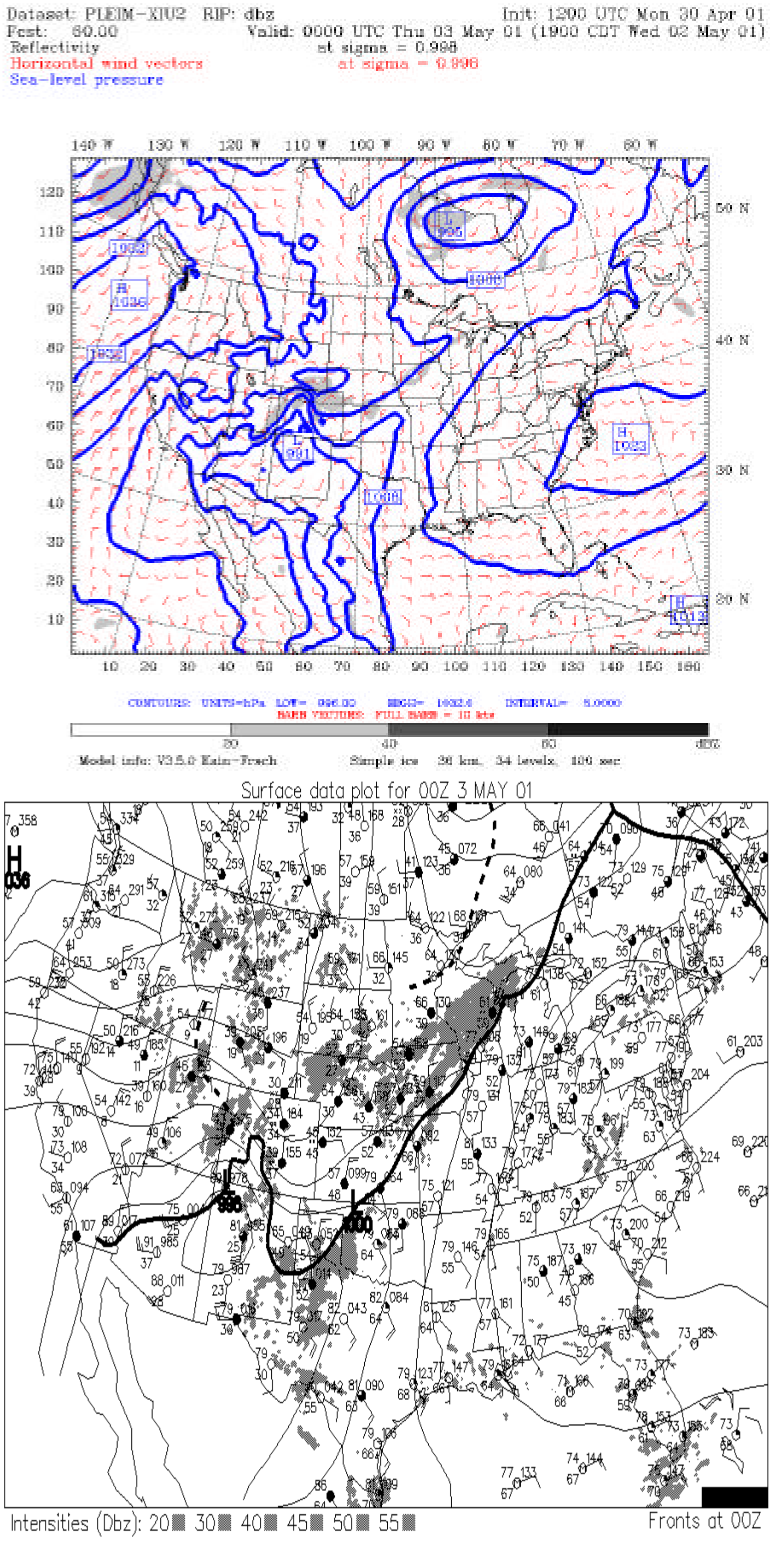
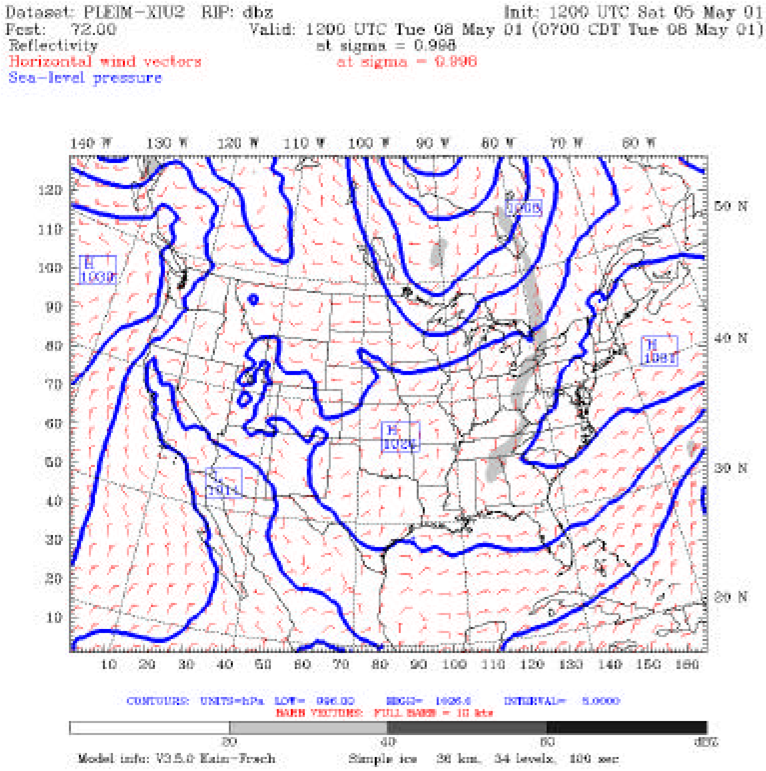


Figure 3-24: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 08 May 2001.



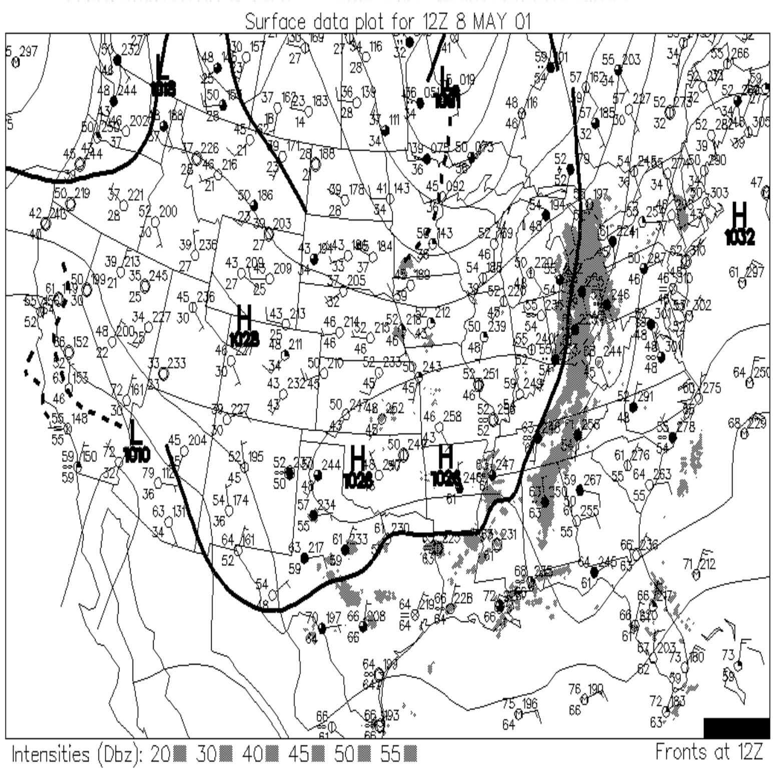


Figure 3-25: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 14 May 2001.

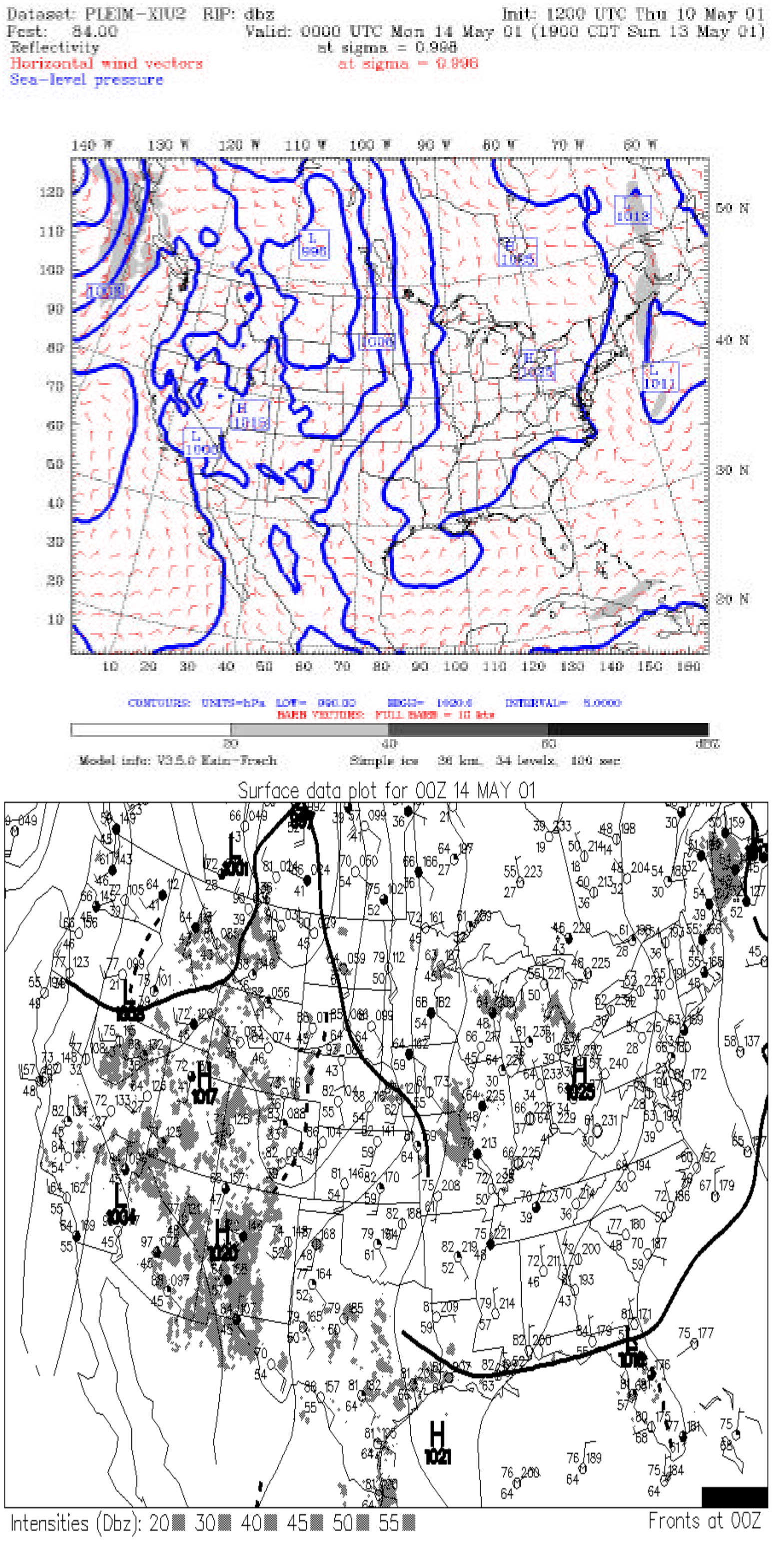


Figure 3-26: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 19 May 2001.

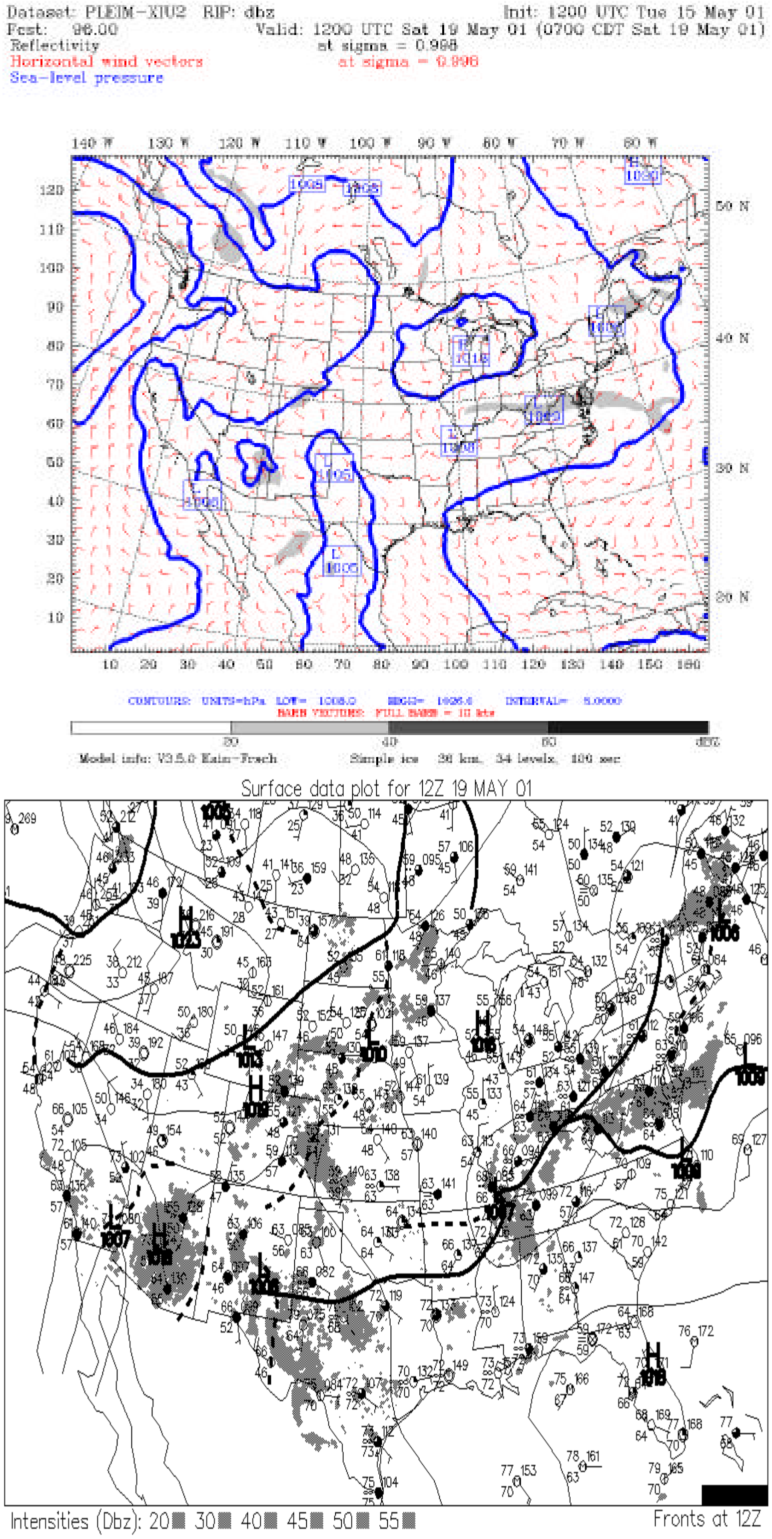


Figure 3-27: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 25 May 2001.

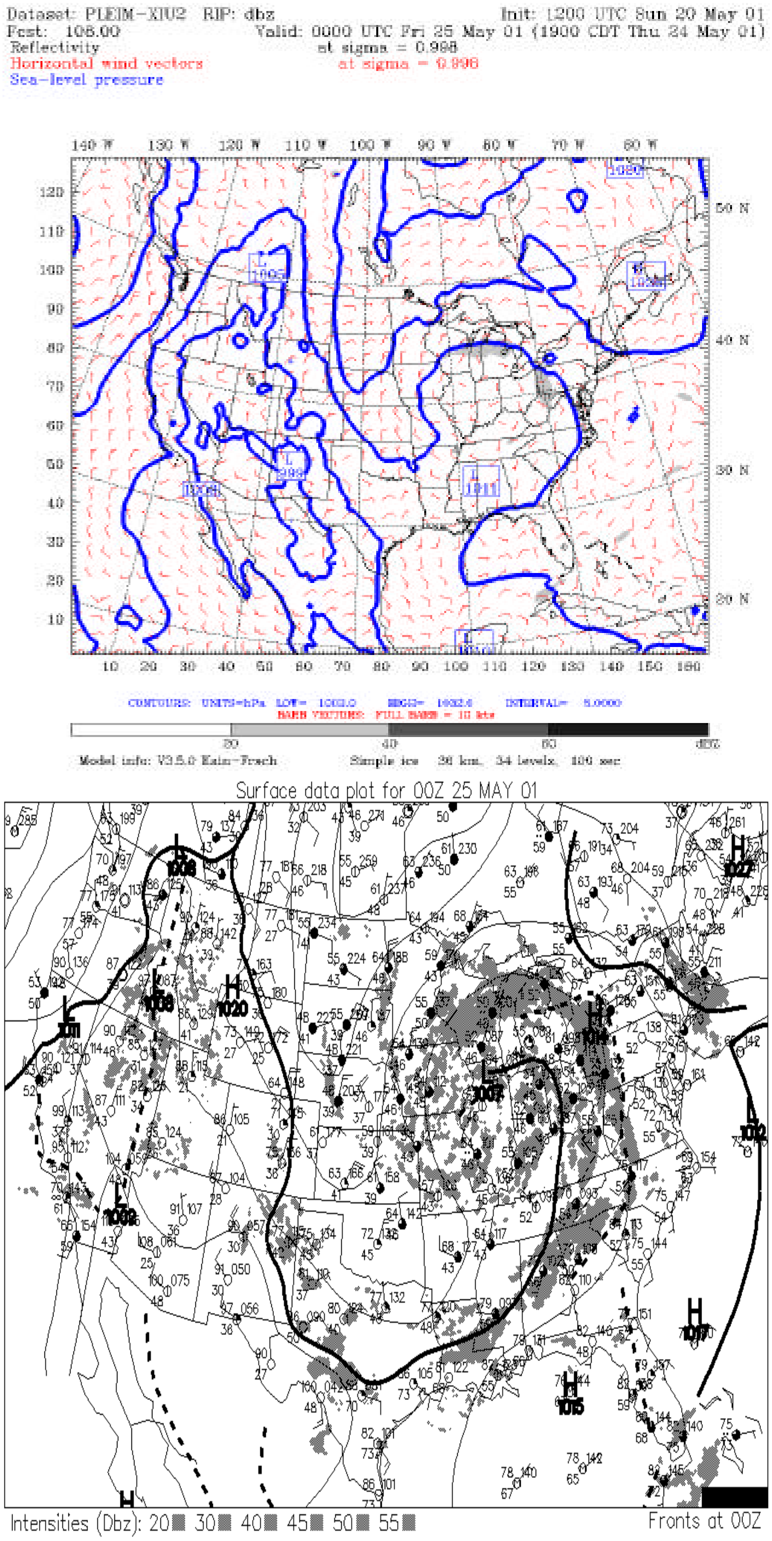


Figure 3-28: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 30 May 2001.

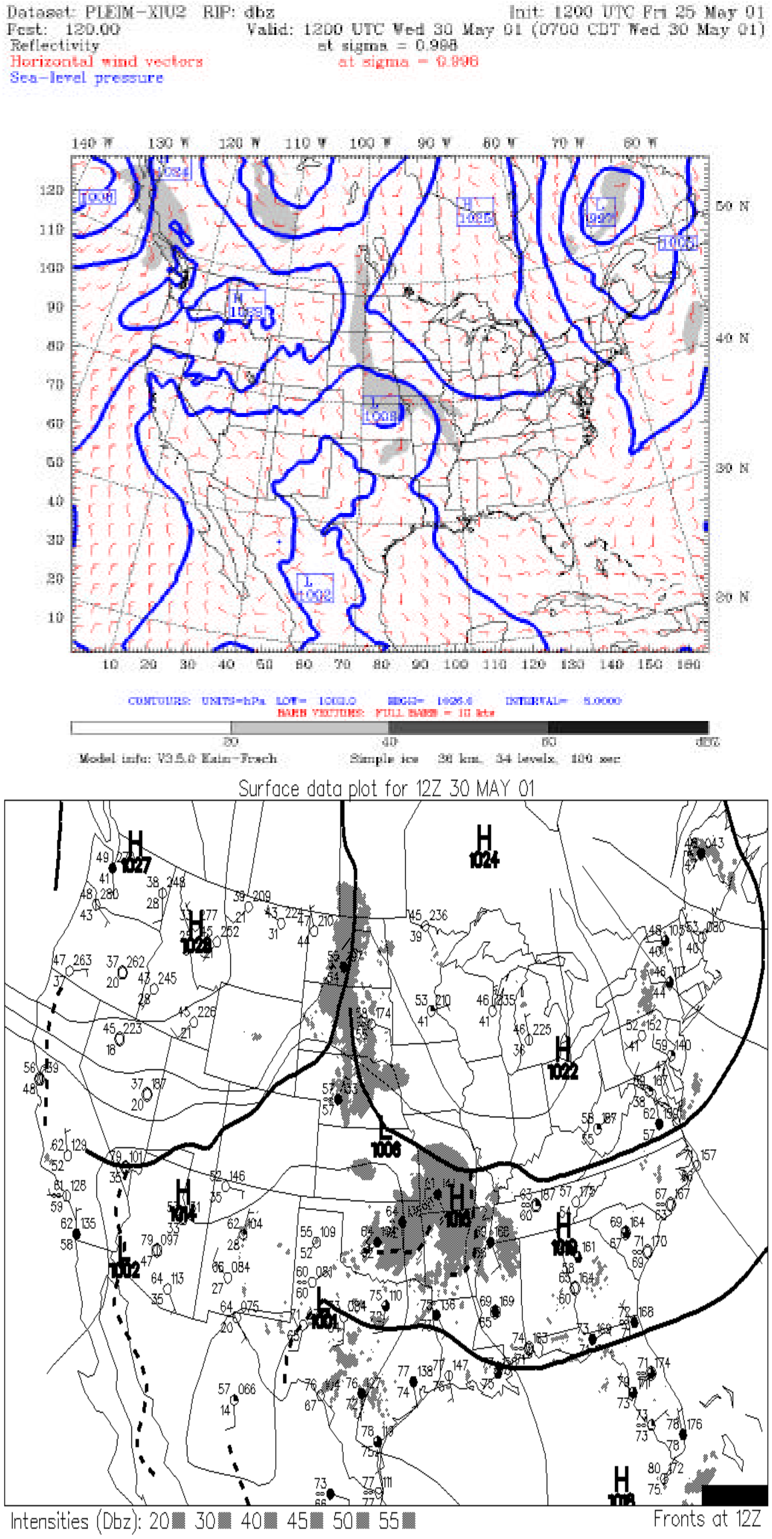
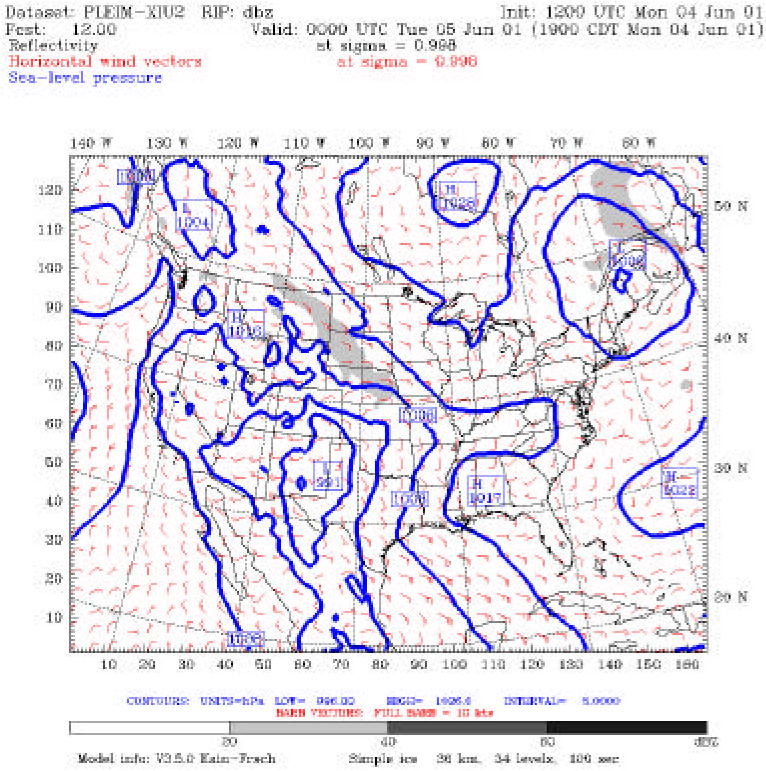


Figure 3-29: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 05 June 2001.



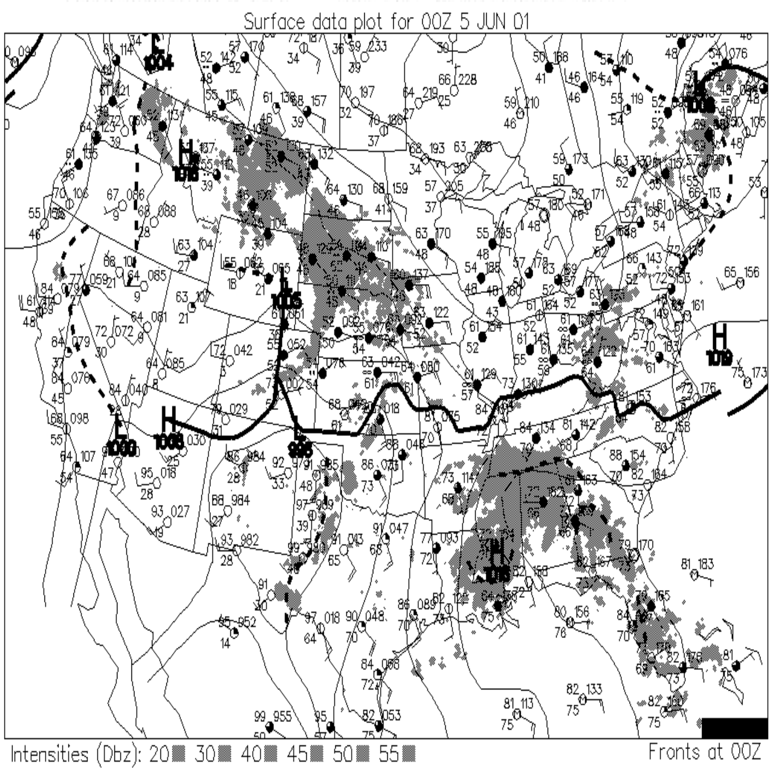


Figure 3-30: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 10 June 2001.

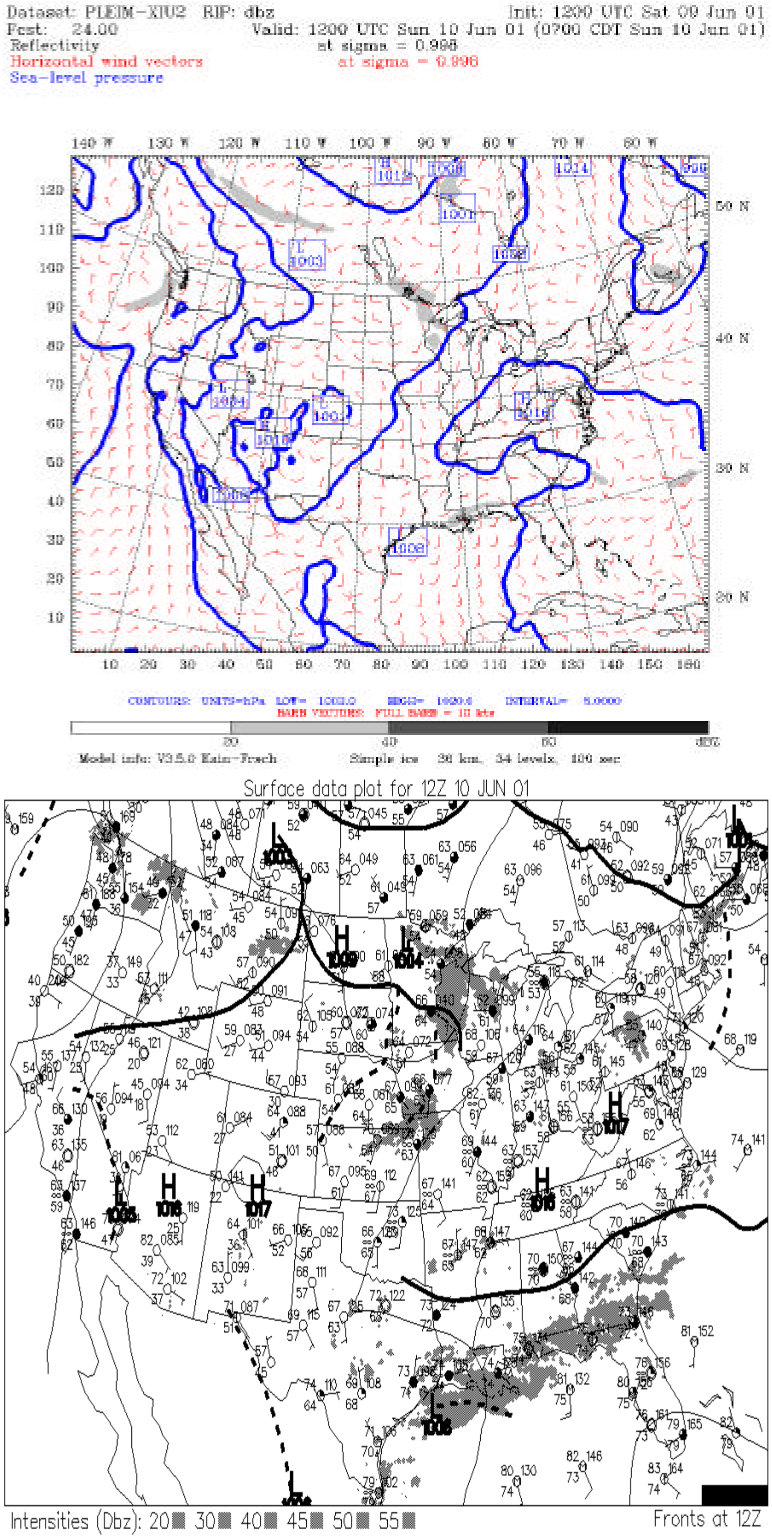


Figure 3-31: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 16 June 2001.

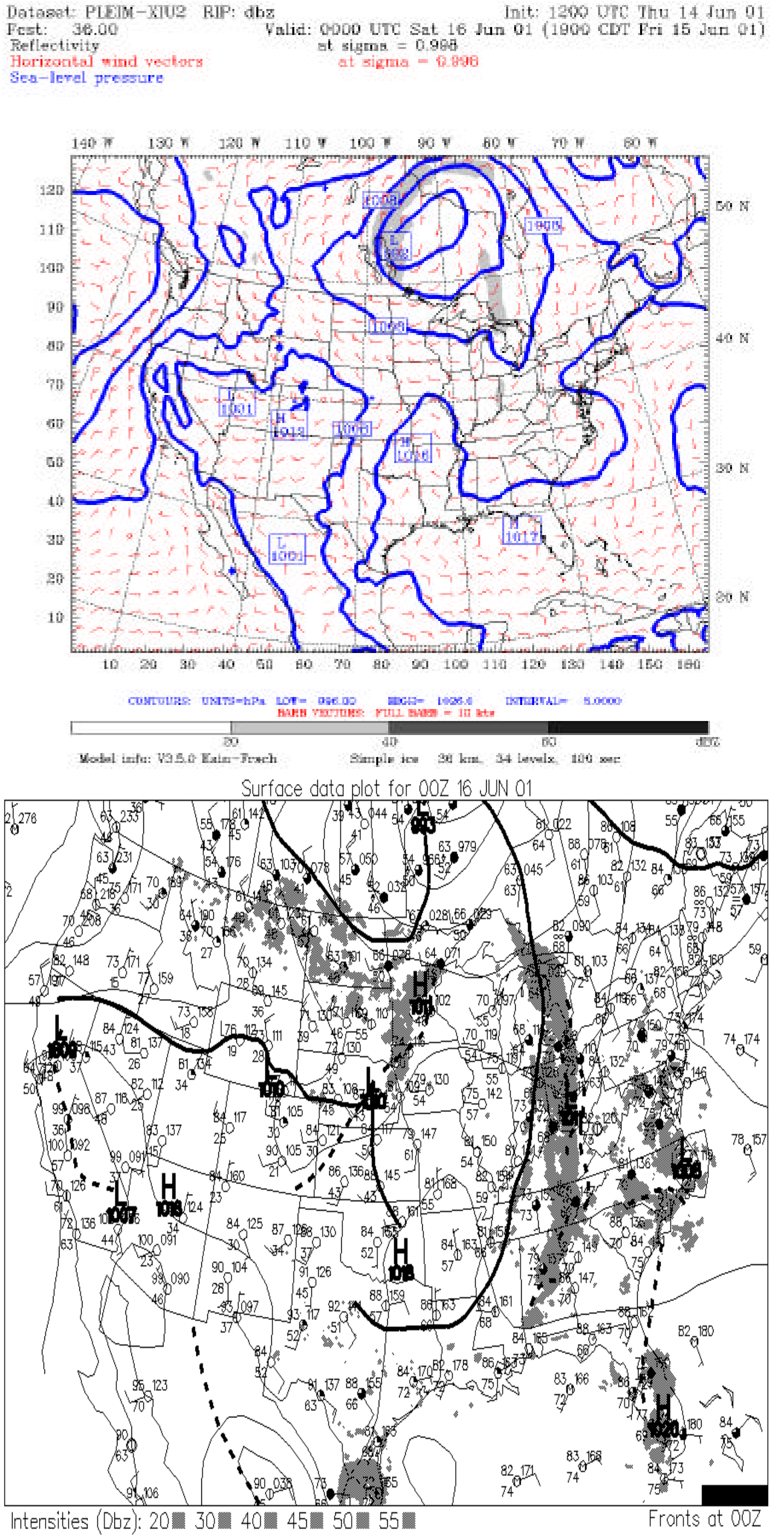


Figure 3-32: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 21 June 2001.

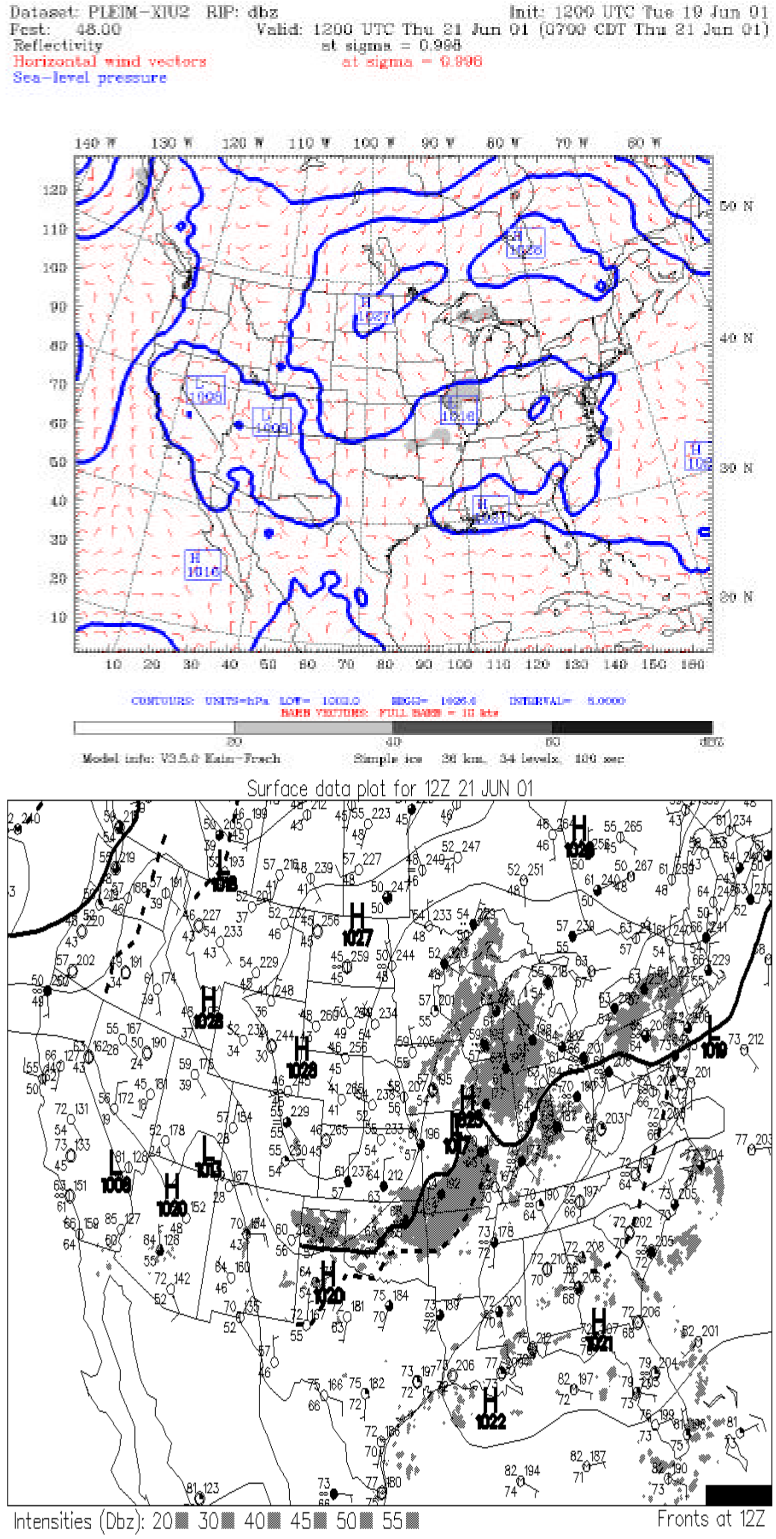


Figure 3-33: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 27 June 2001.

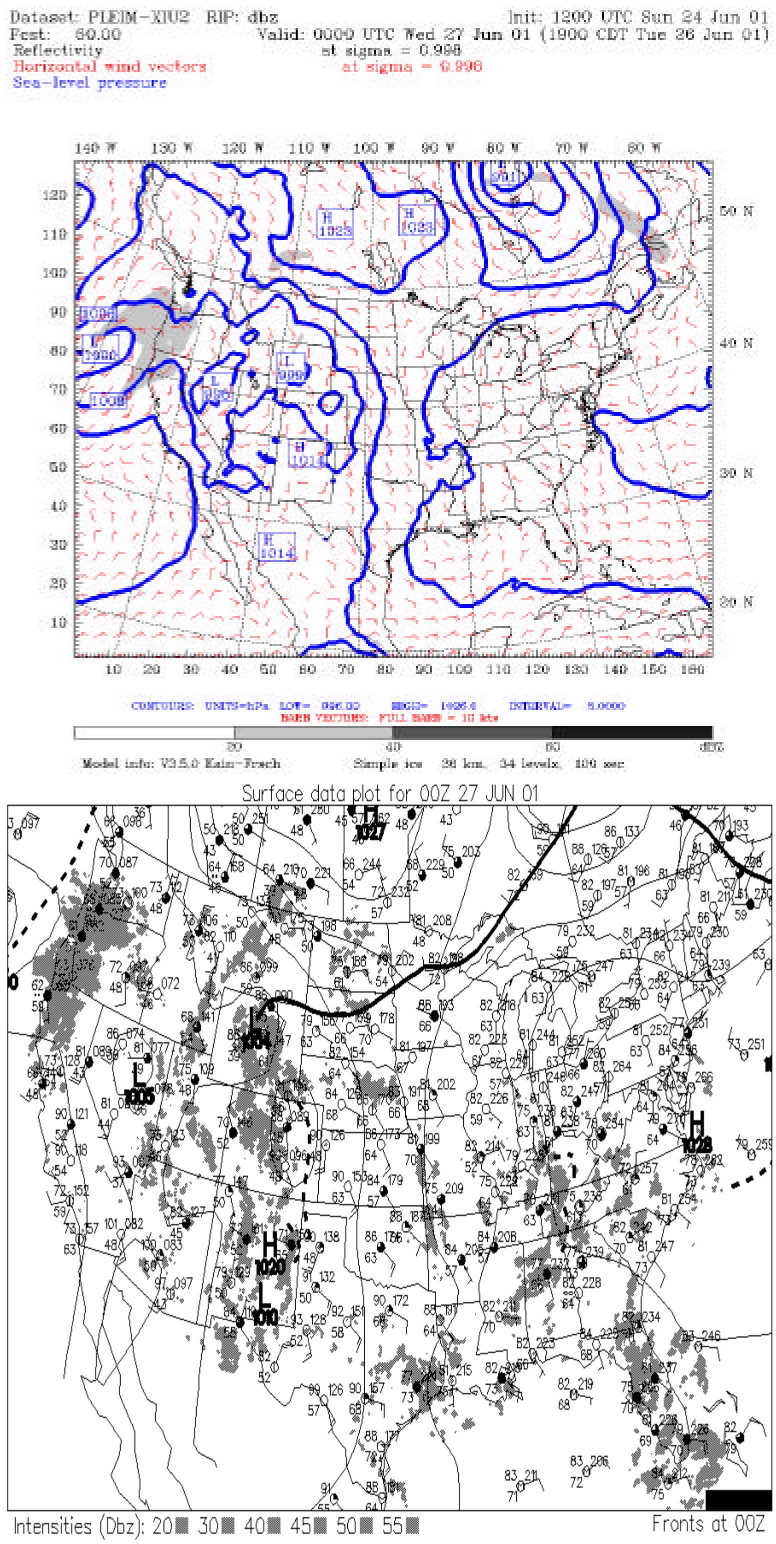


Figure 3-34: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 02 July 2001.

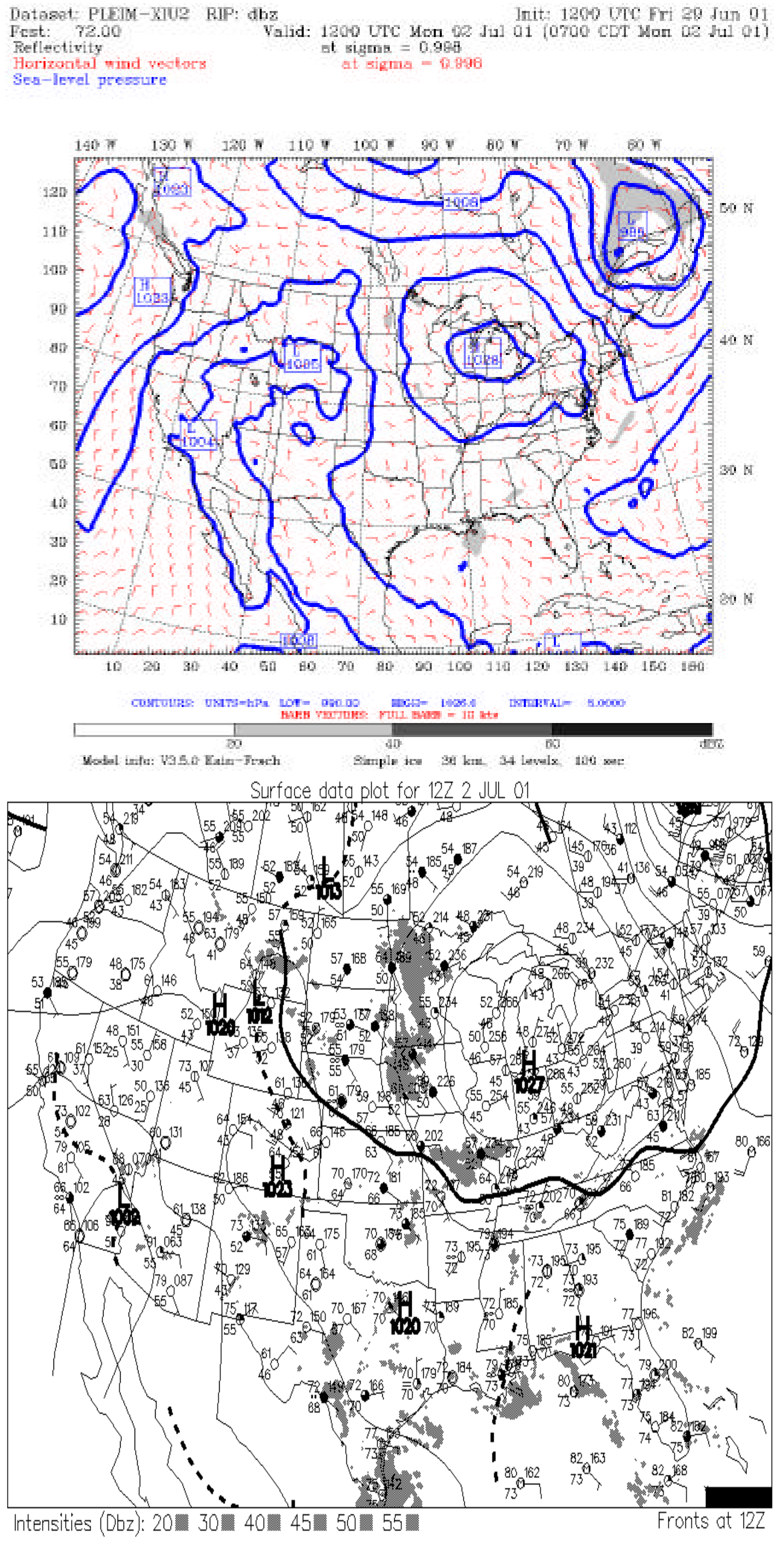


Figure 3-35: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 08 July 2001.

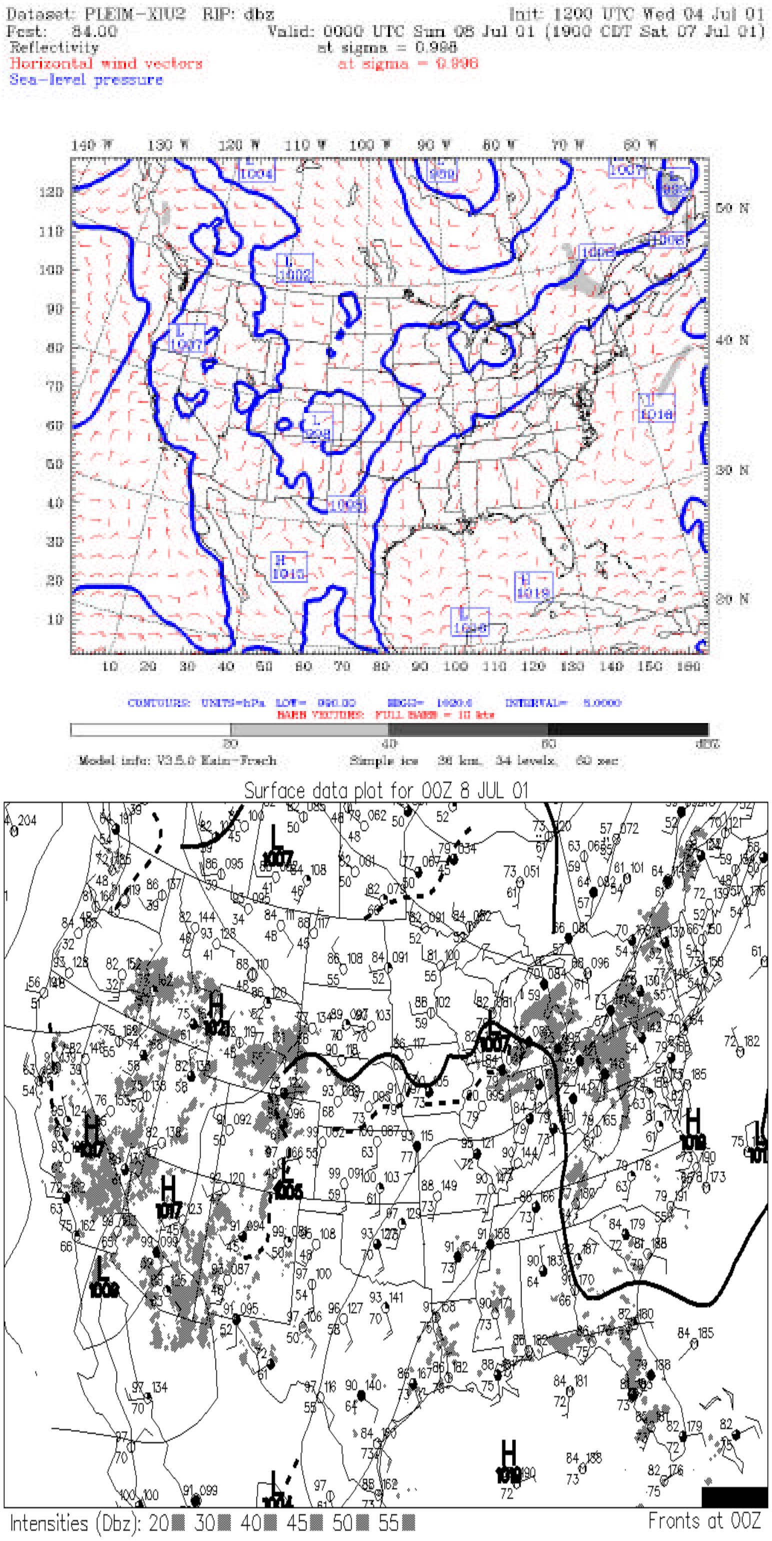


Figure 3-36: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 13 July 2001.

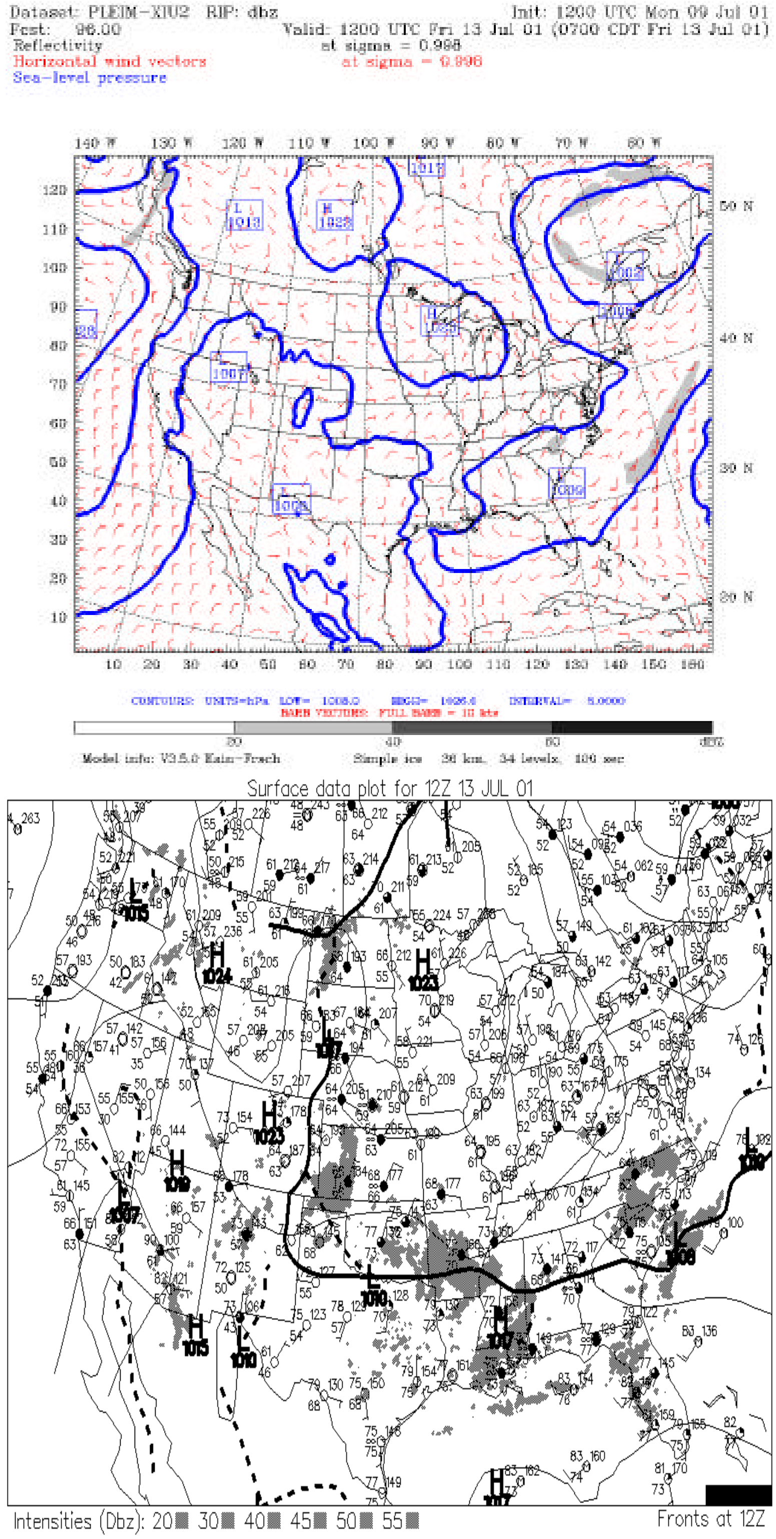


Figure 3-37: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 19 July 2001.

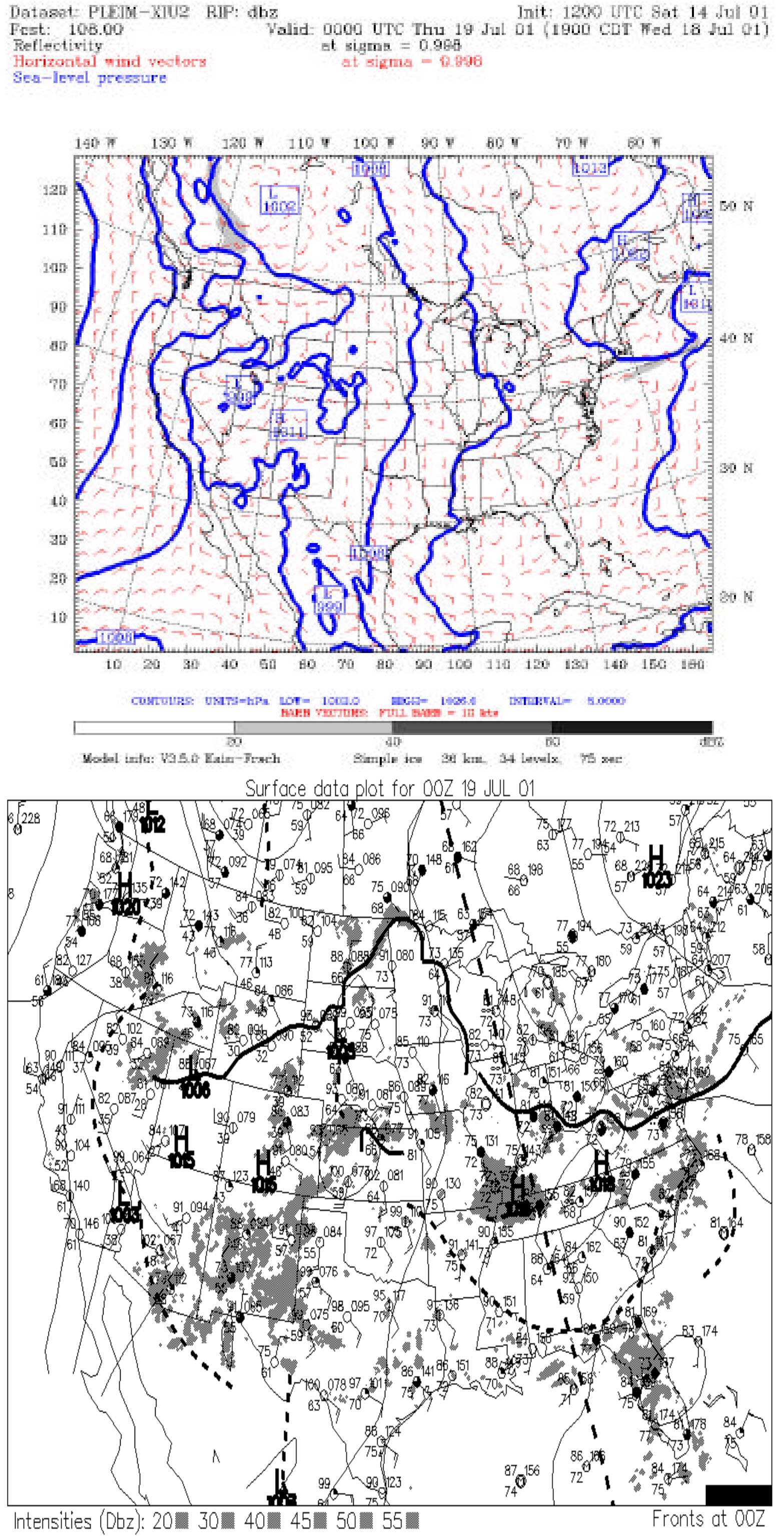


Figure 3-38: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 24 July 2001.

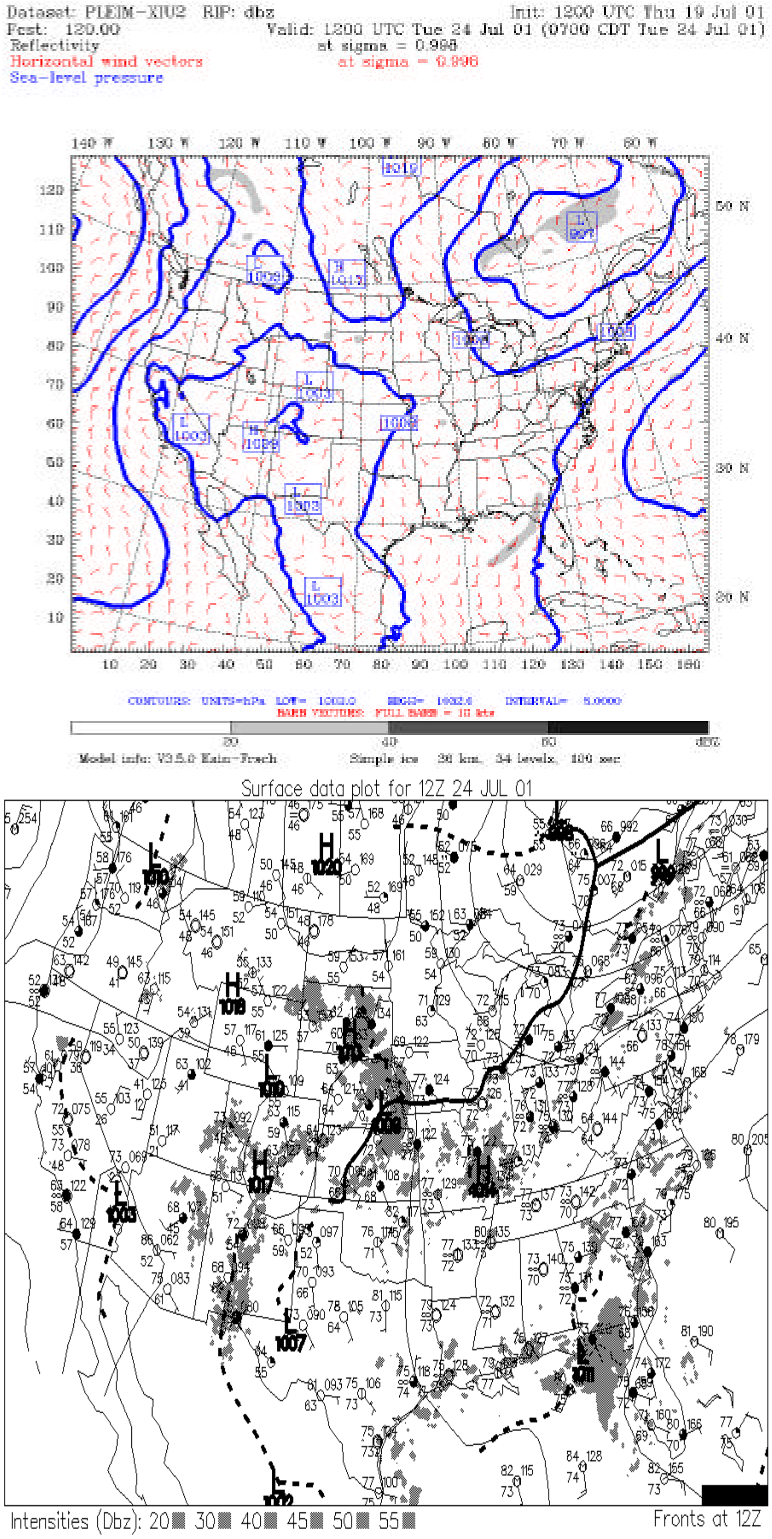


Figure 3-39: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 30 July 2001.

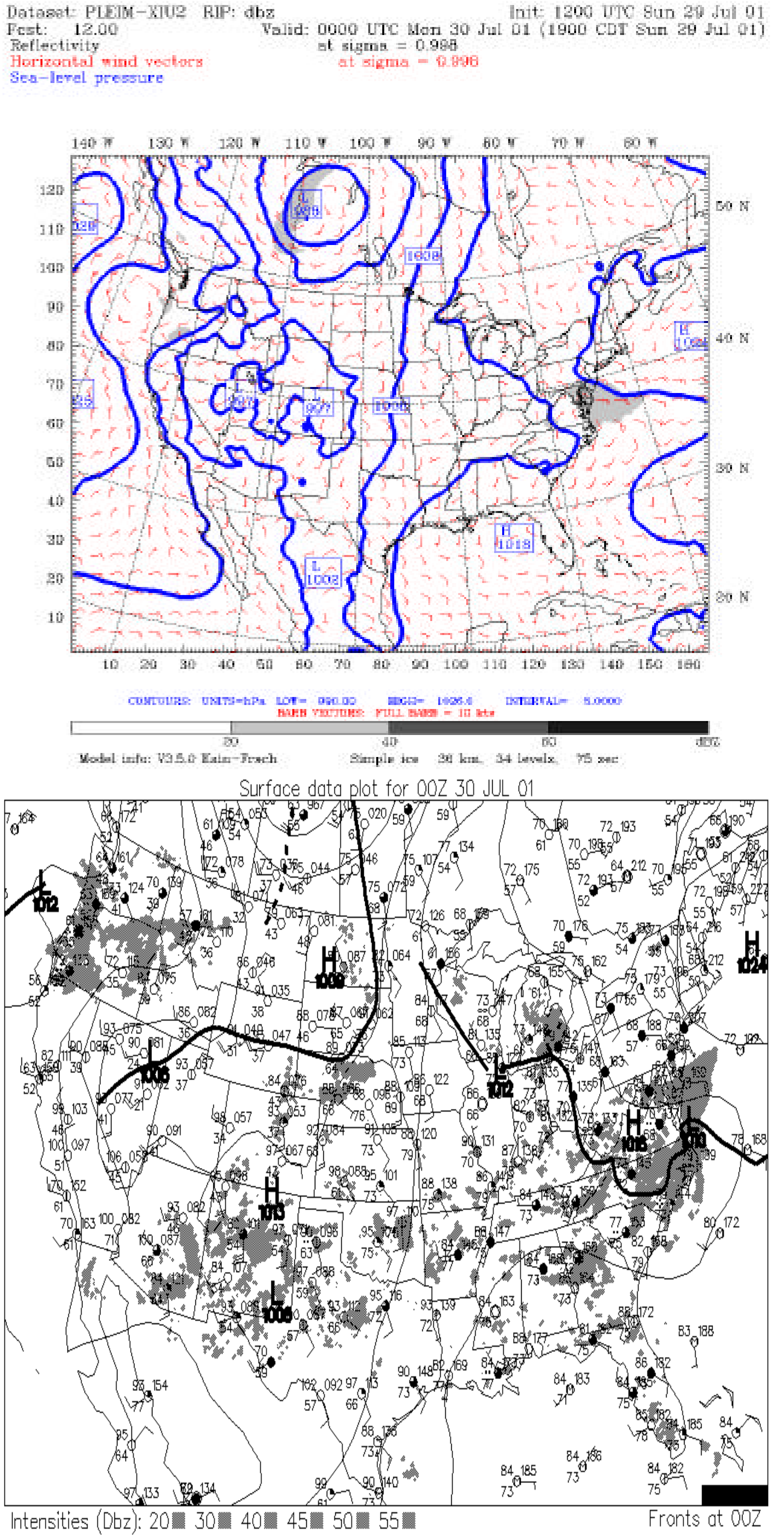


Figure 3-40: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 04 August 2001.

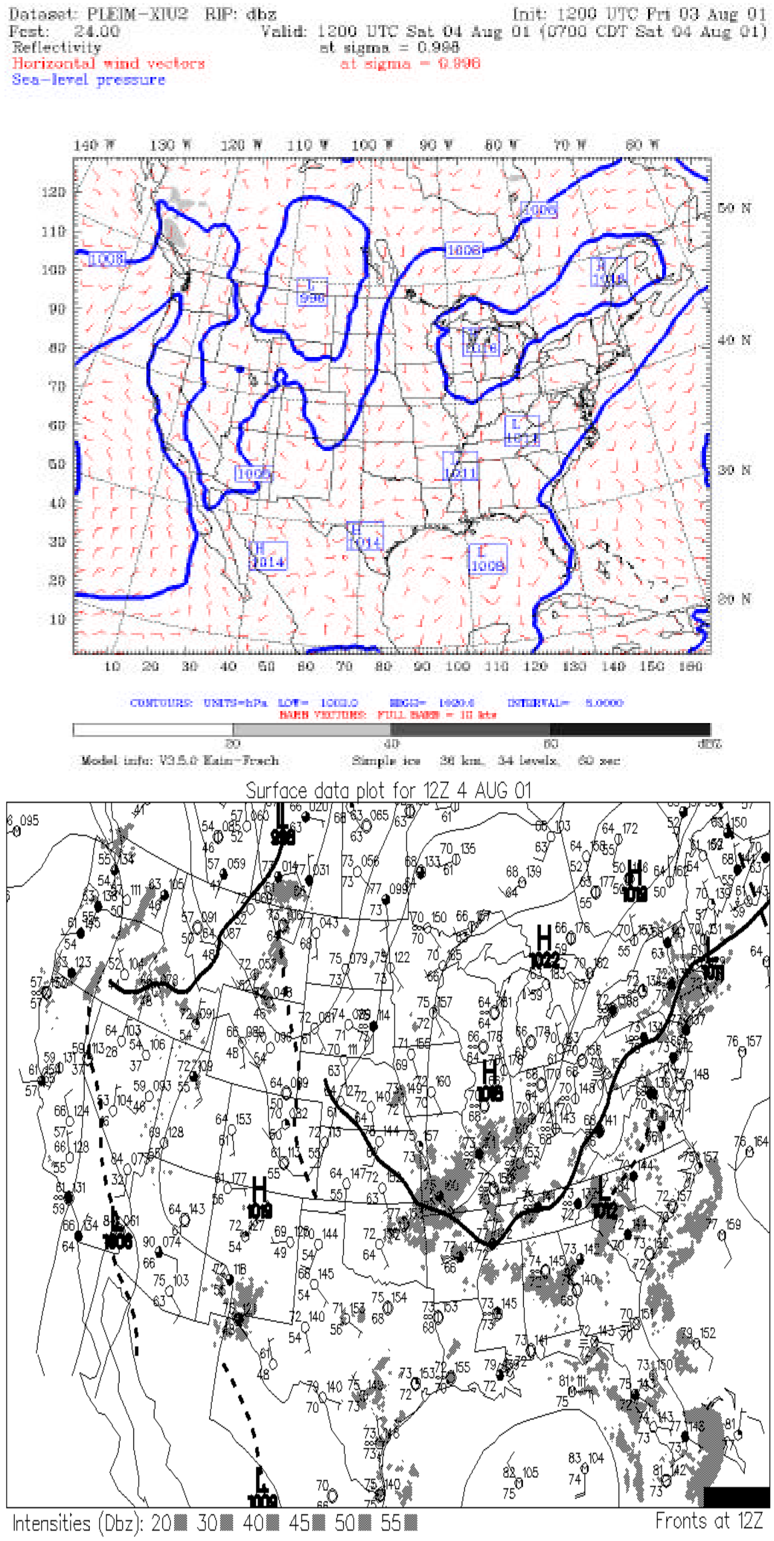


Figure 3-41: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 10 August 2001.

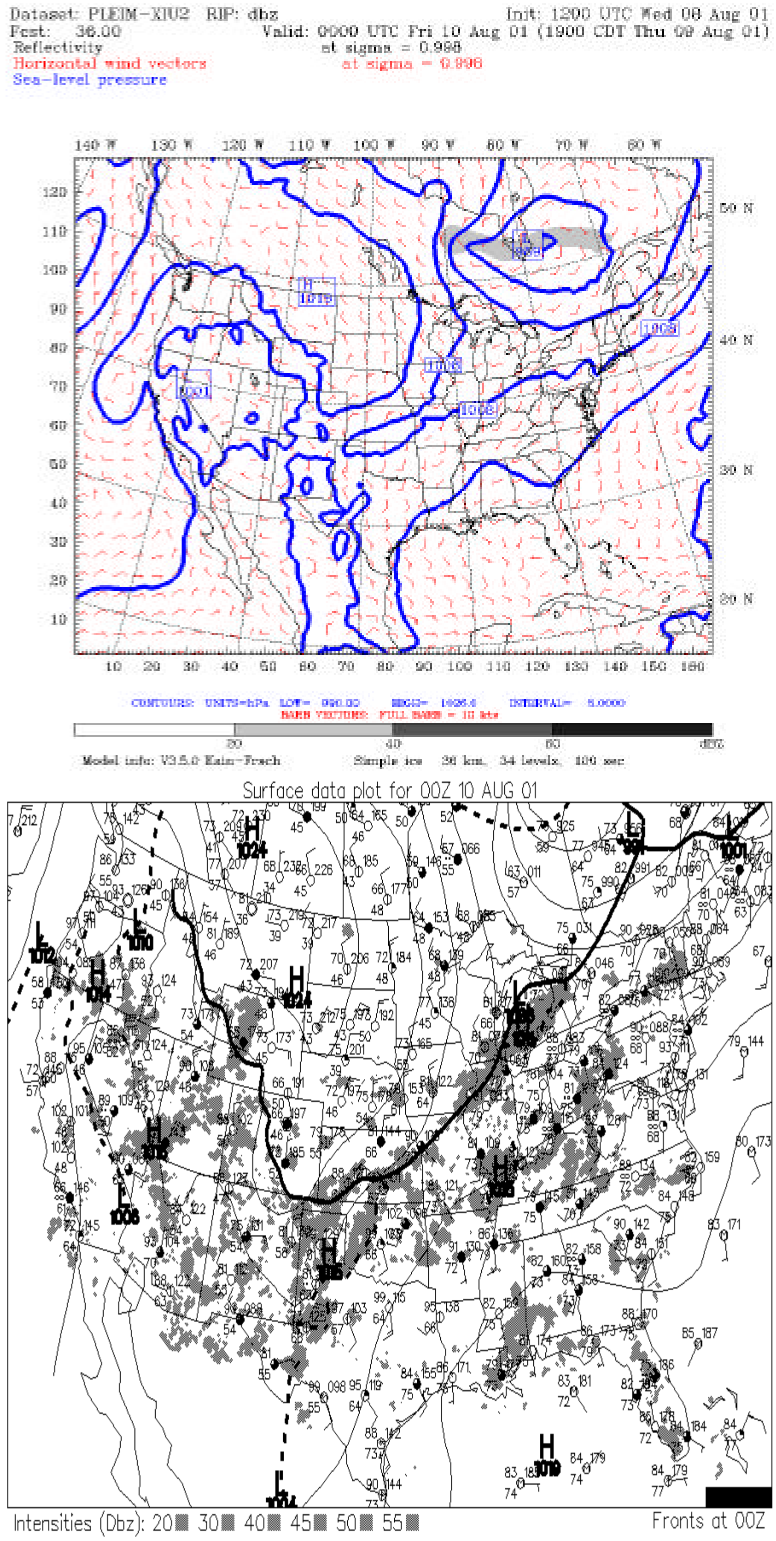


Figure 3-42: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 15 August 2001.

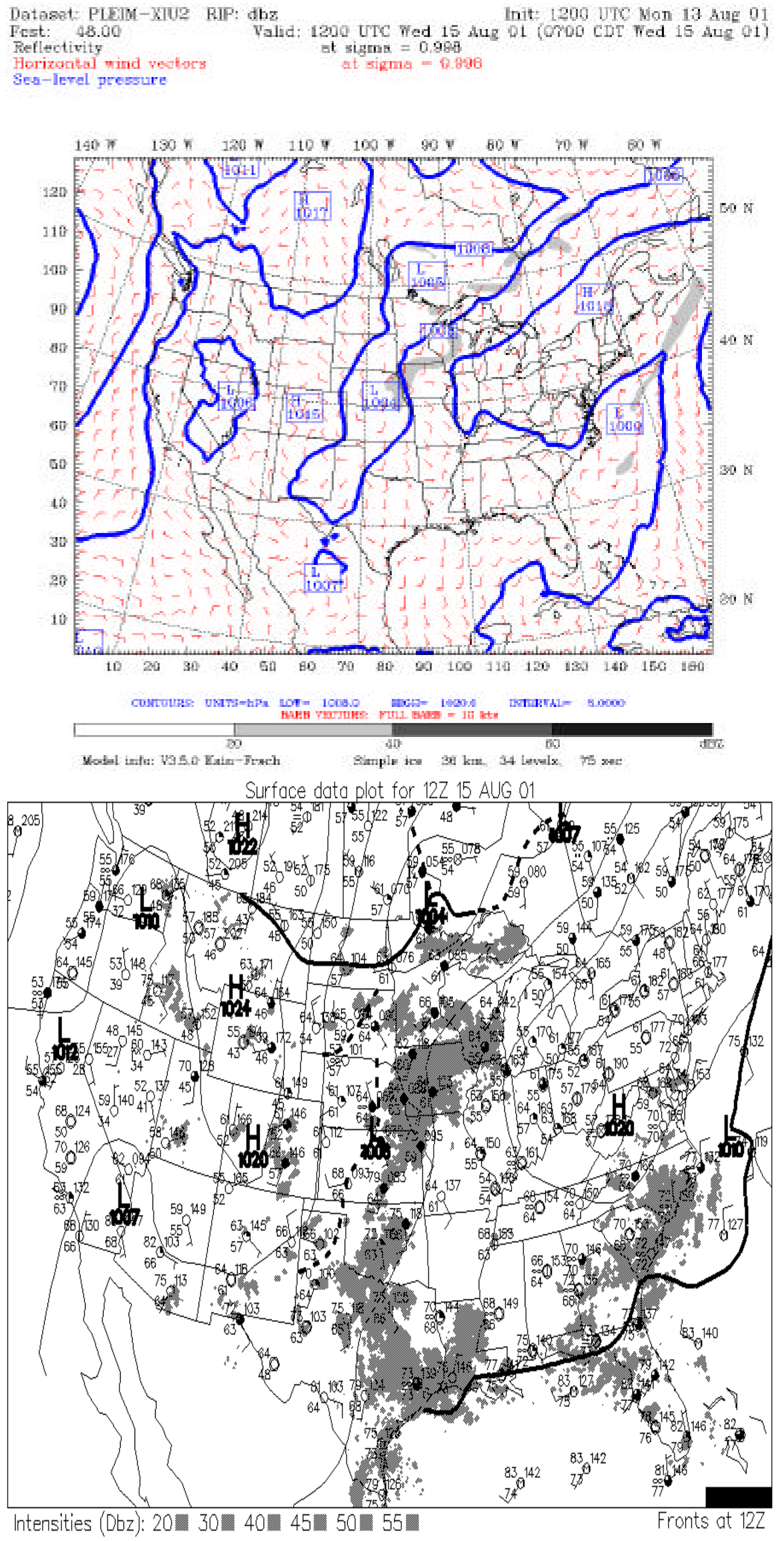
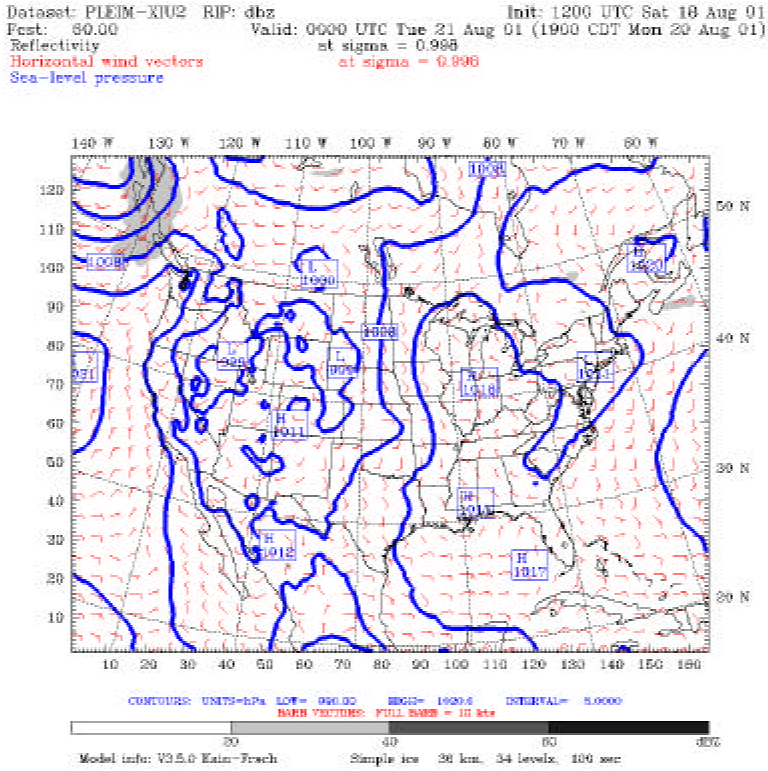


Figure 3-43: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 21 August 2001.



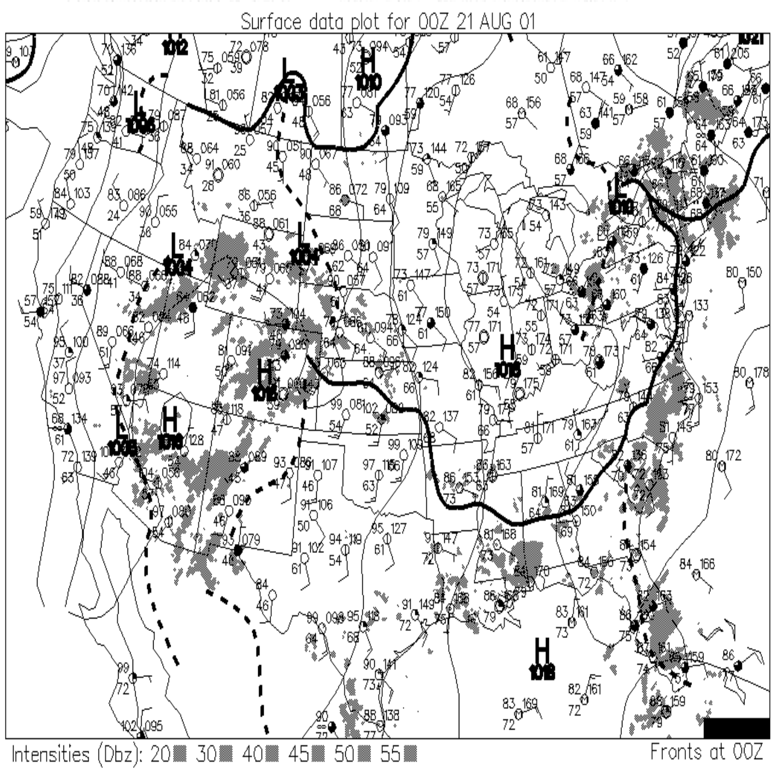


Figure 3-44: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 26 August 2001.

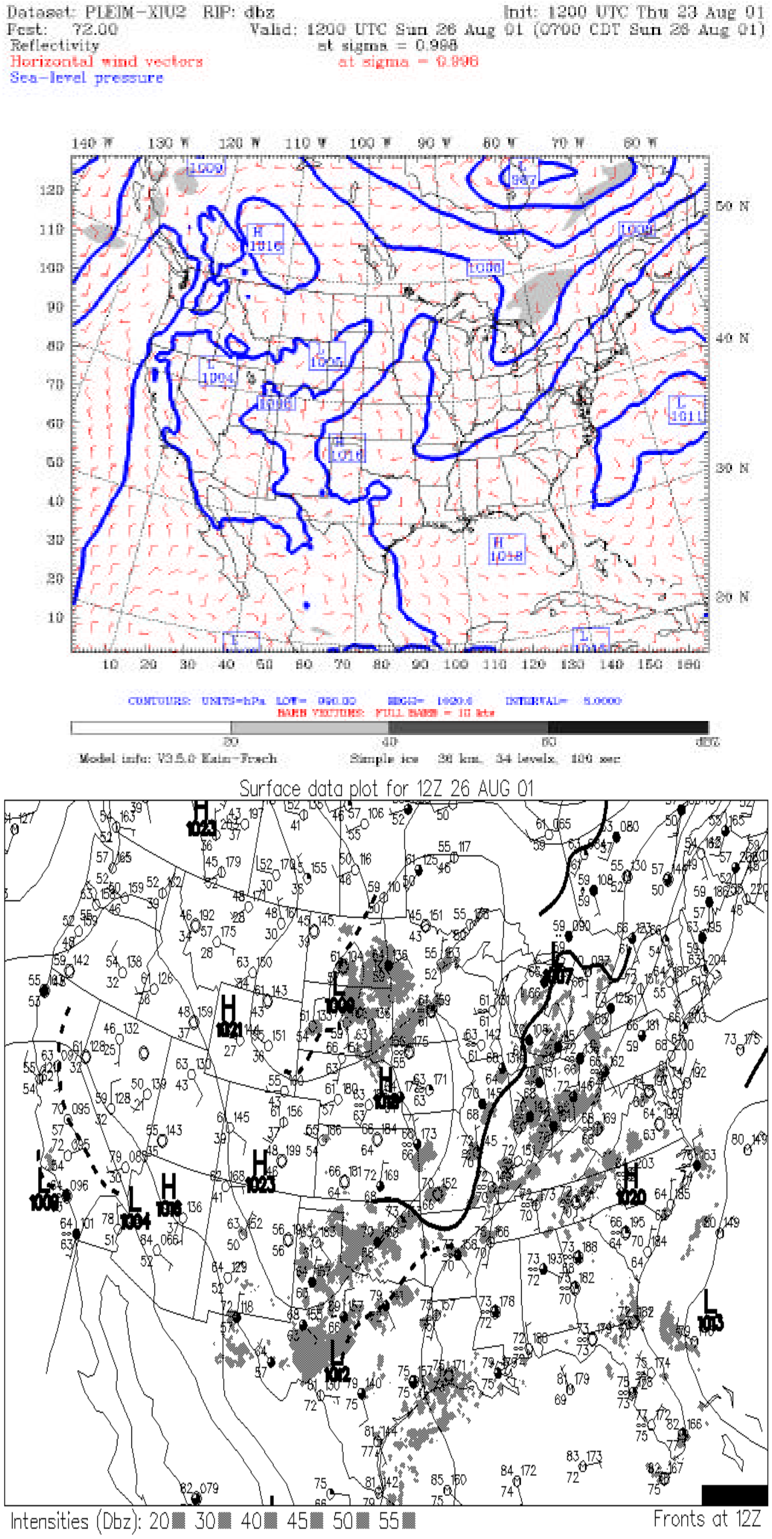


Figure 3-45: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 01 September 2001.

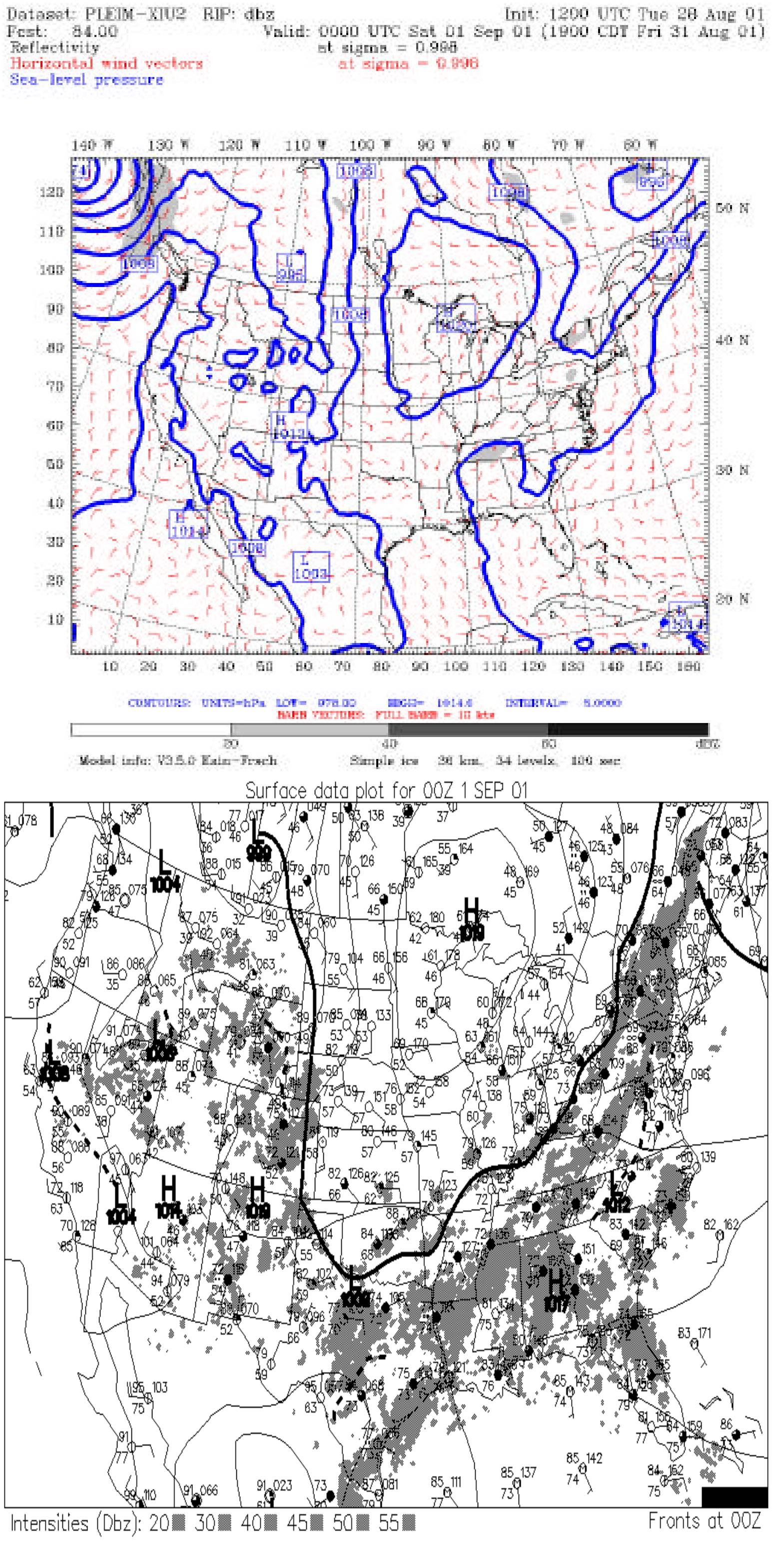


Figure 3-46: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 06 September 2001.

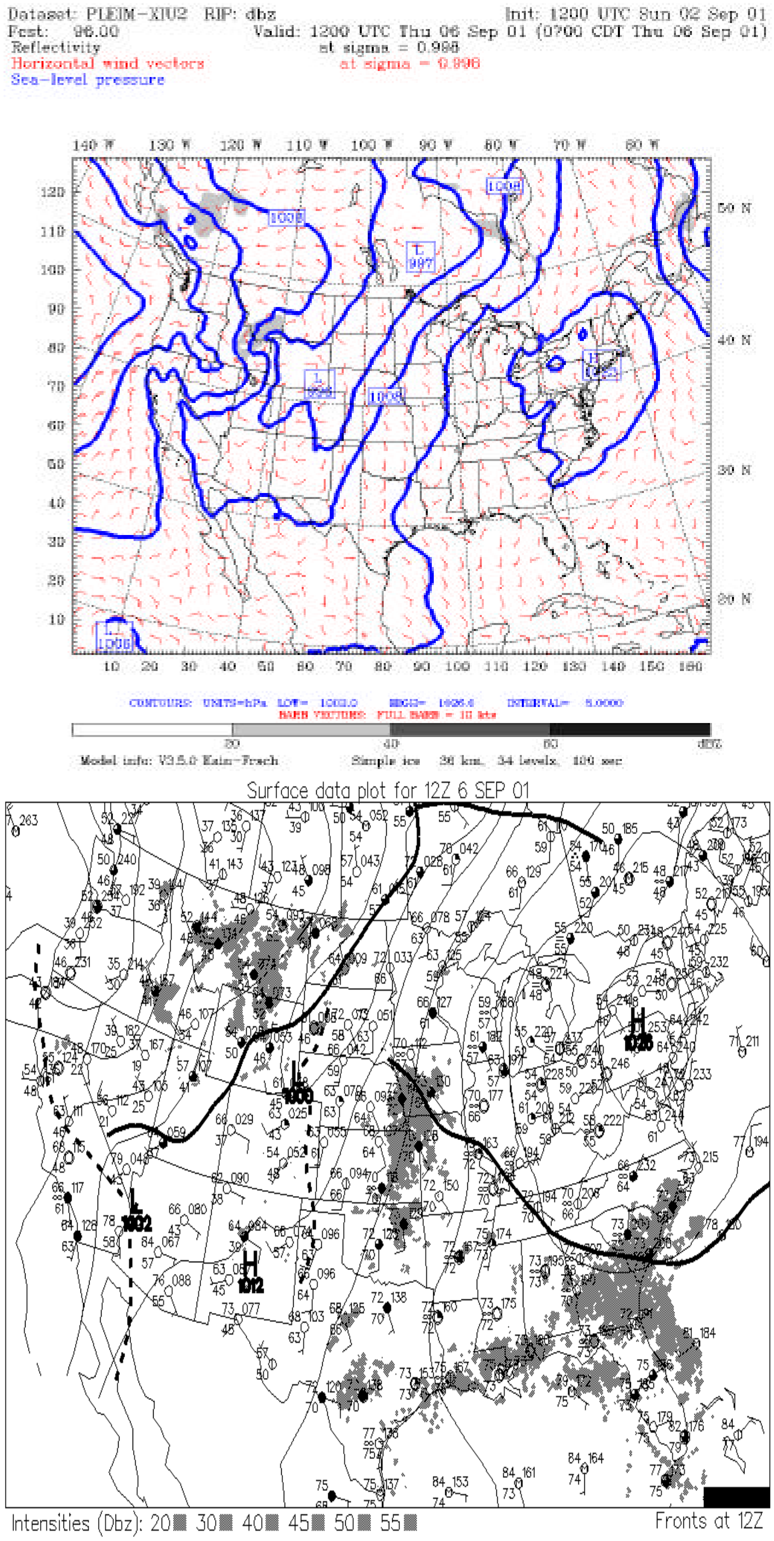


Figure 3-47: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 12 September 2001.

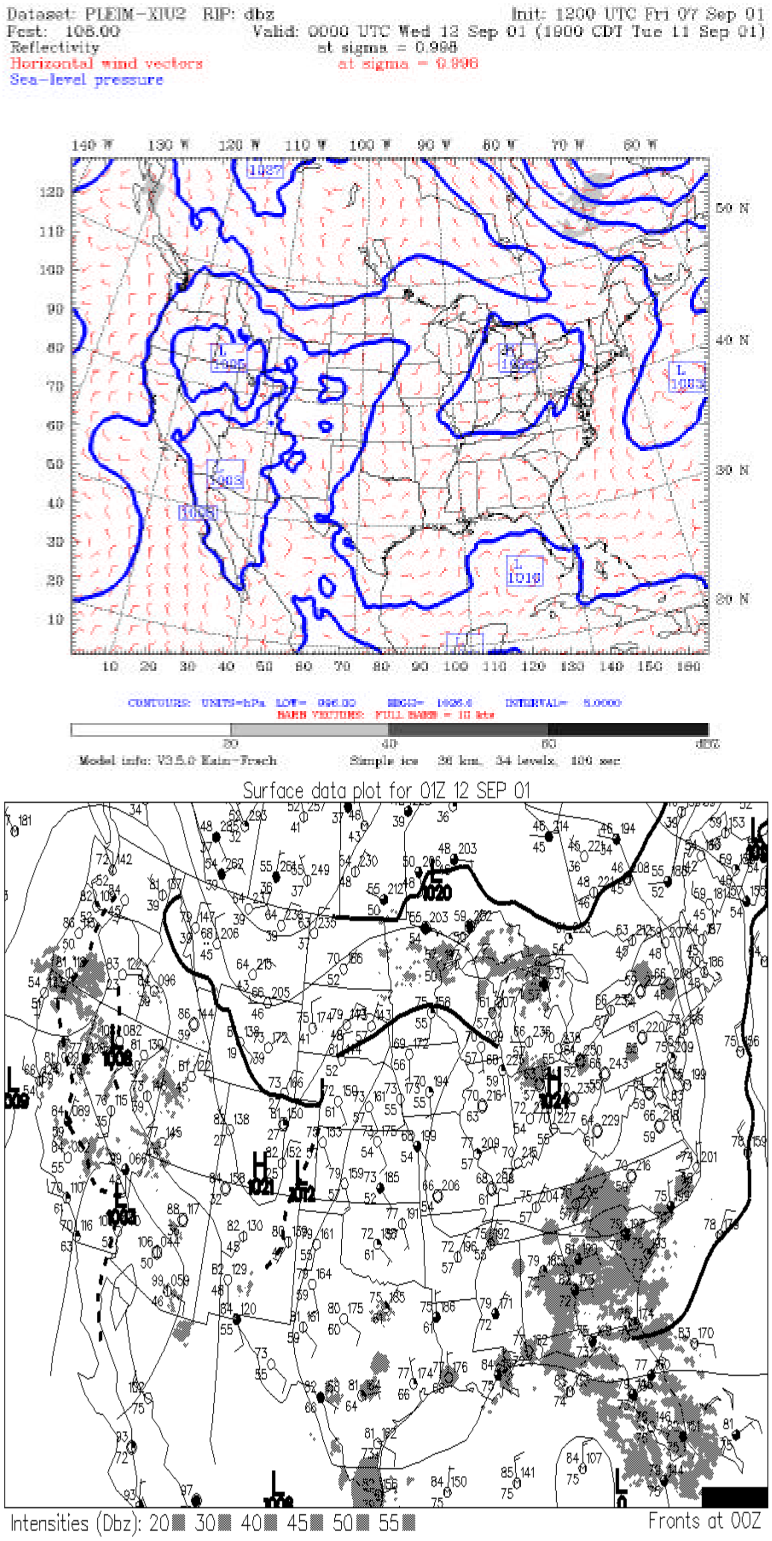


Figure 3-48: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 17 September 2001.

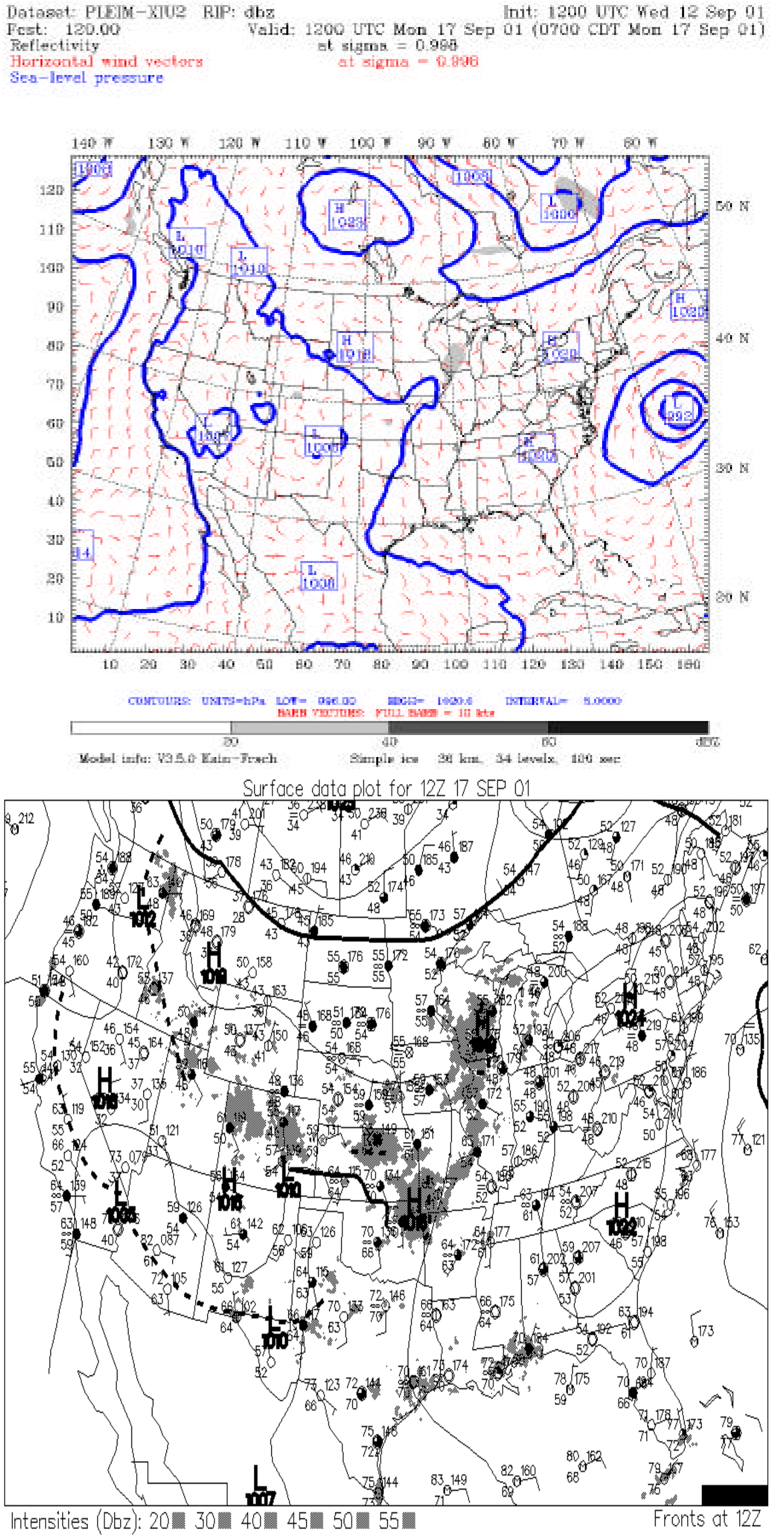


Figure 3-49: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 23 September 2001.

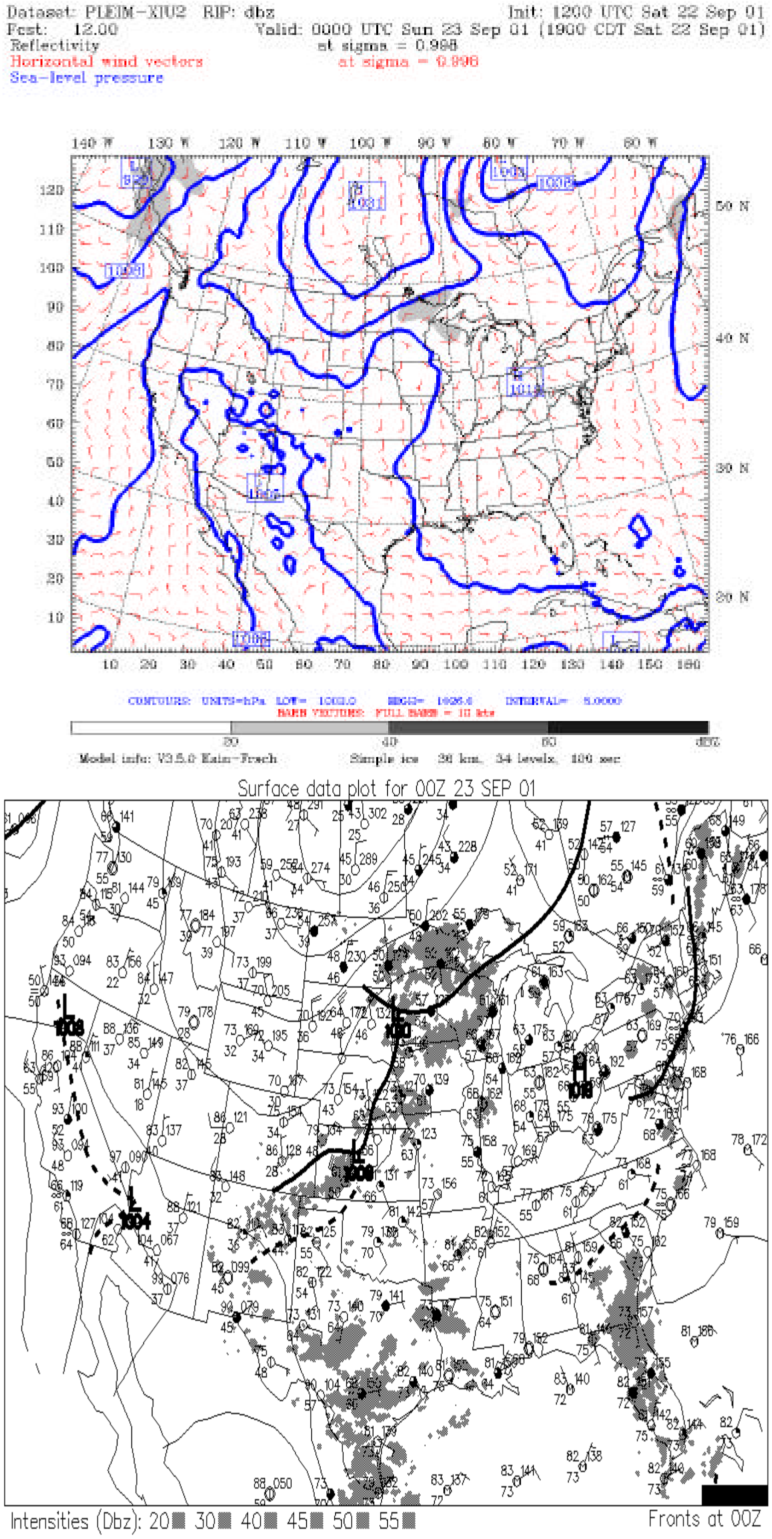


Figure 3-50: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 28 September 2001.

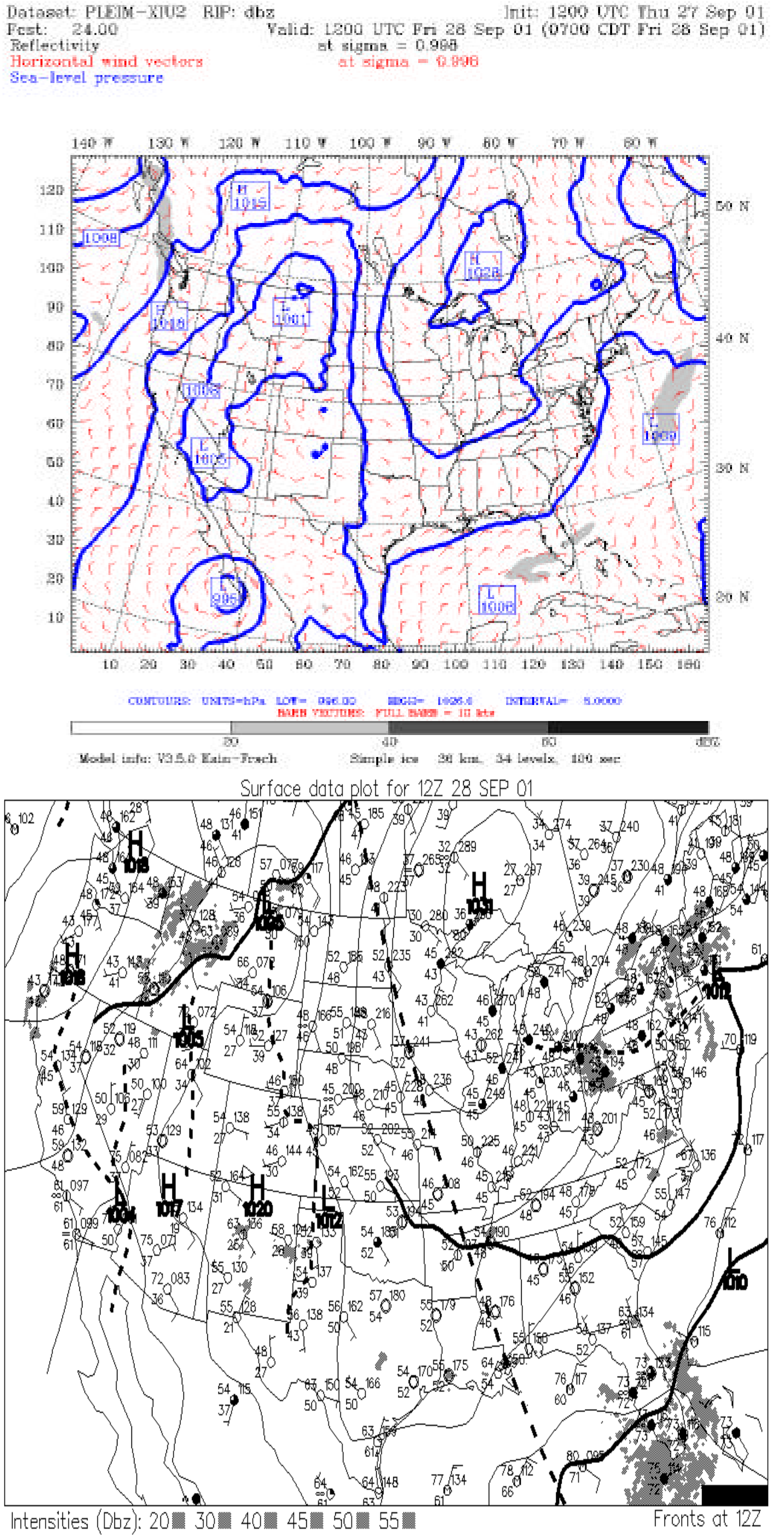


Figure 3-51: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 04 October 2001.

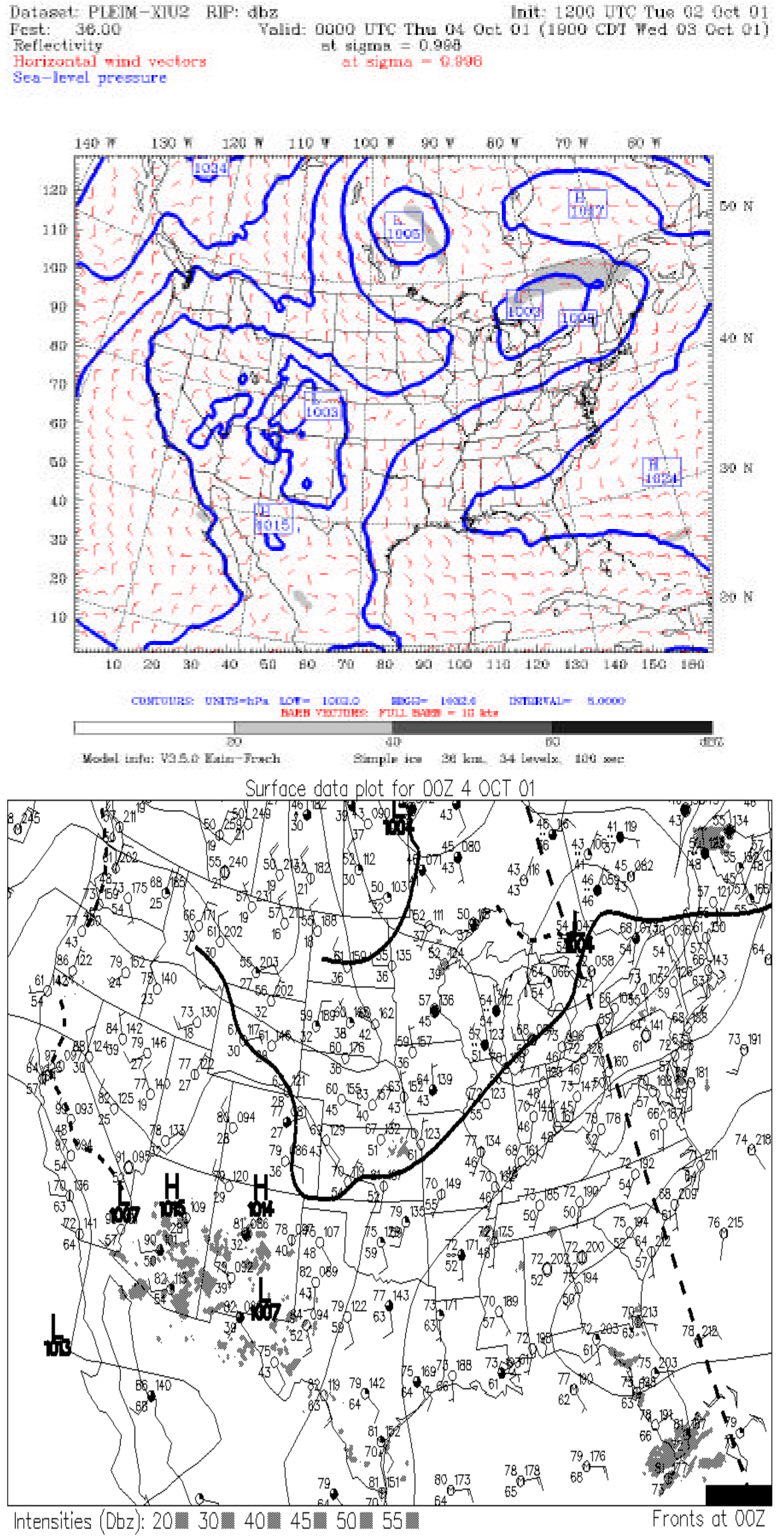
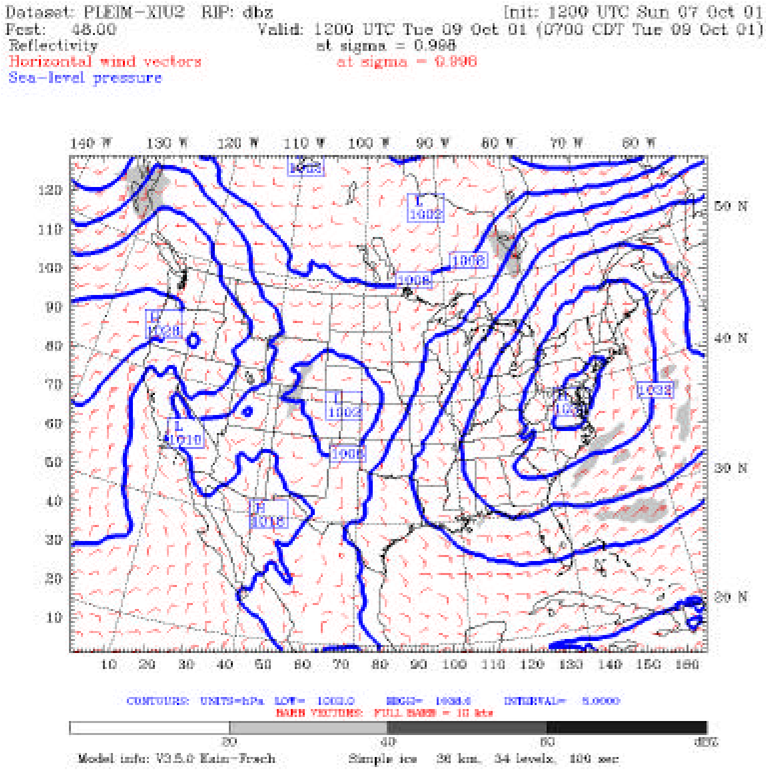


Figure 3-52: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 09 October 2001.



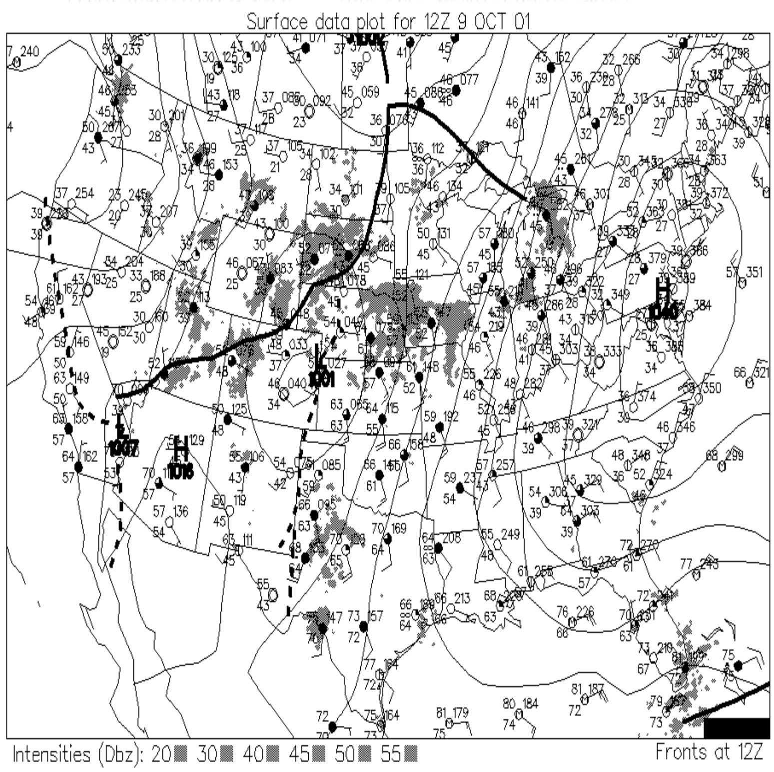
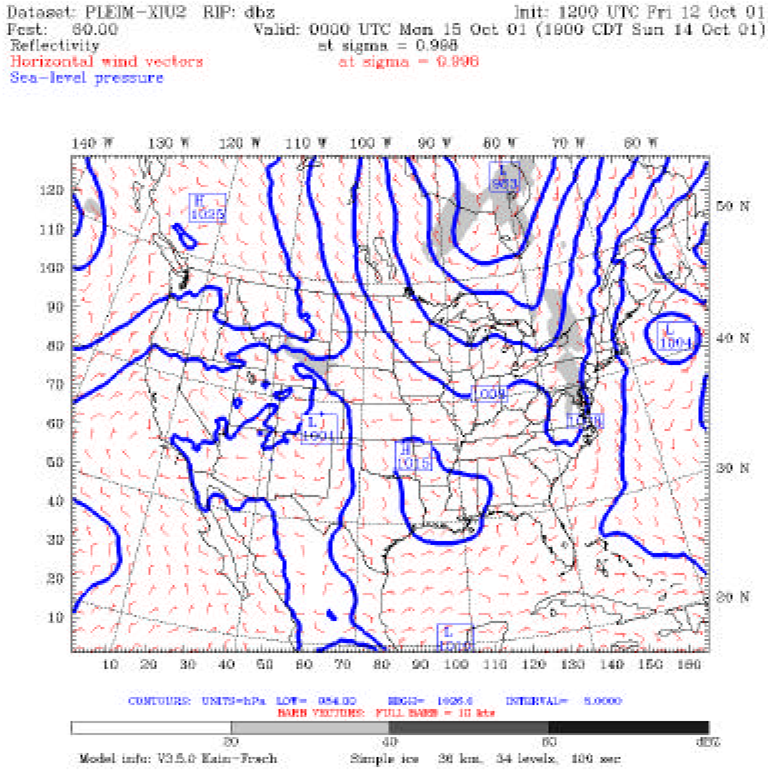


Figure 3-53: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 15 October 2001.



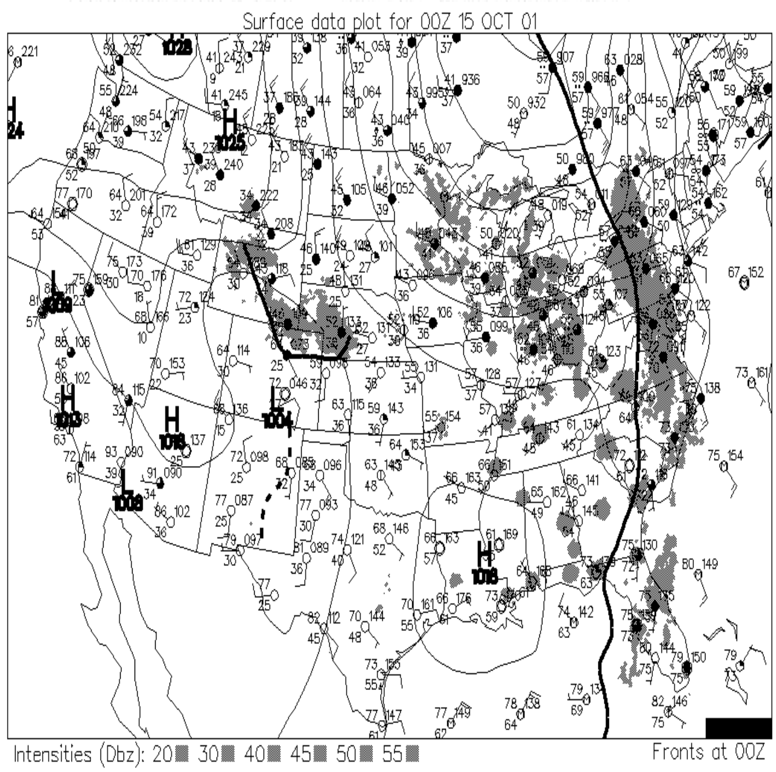


Figure 3-54: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 20 October 2001.

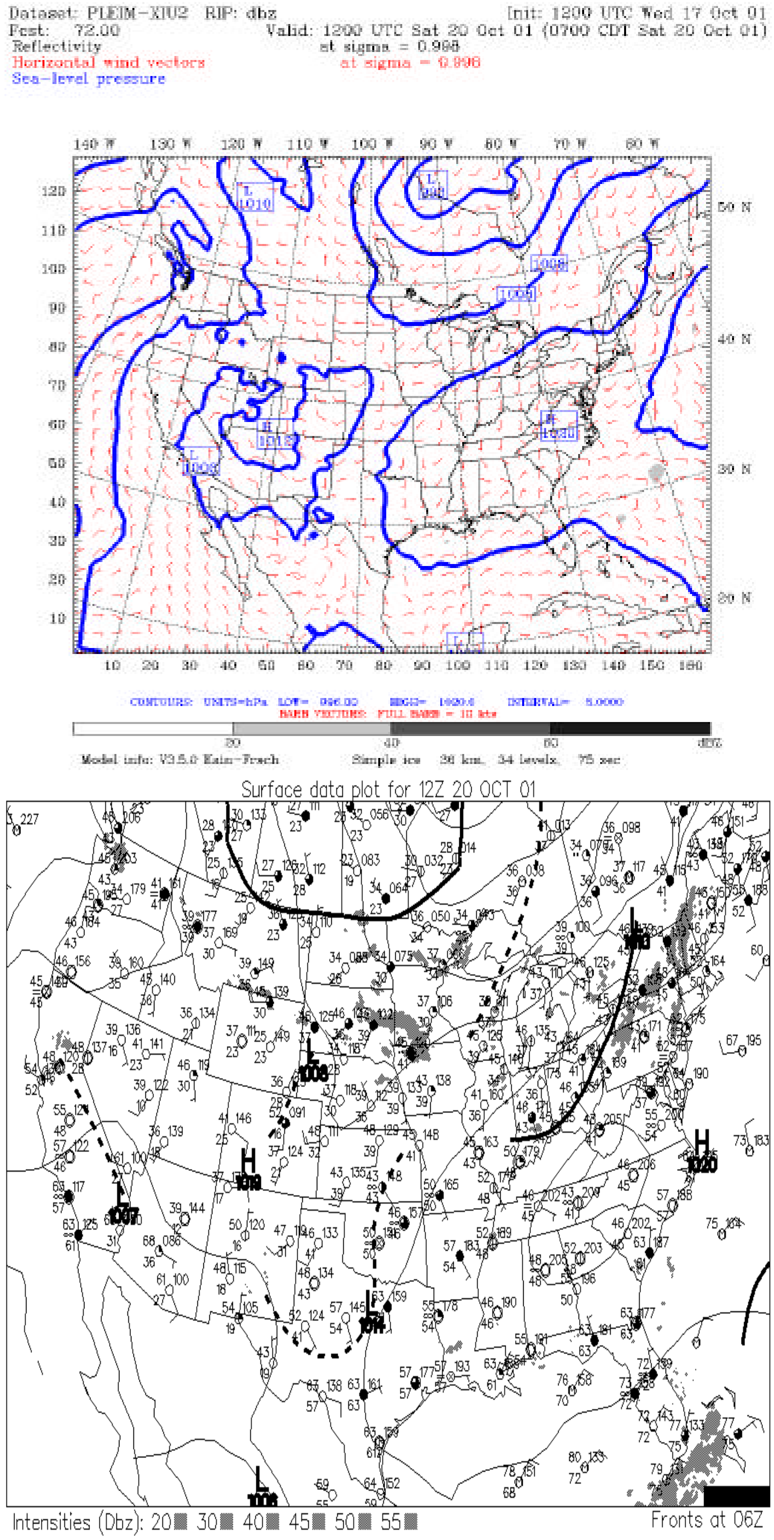


Figure 3-55: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 26 October 2001.

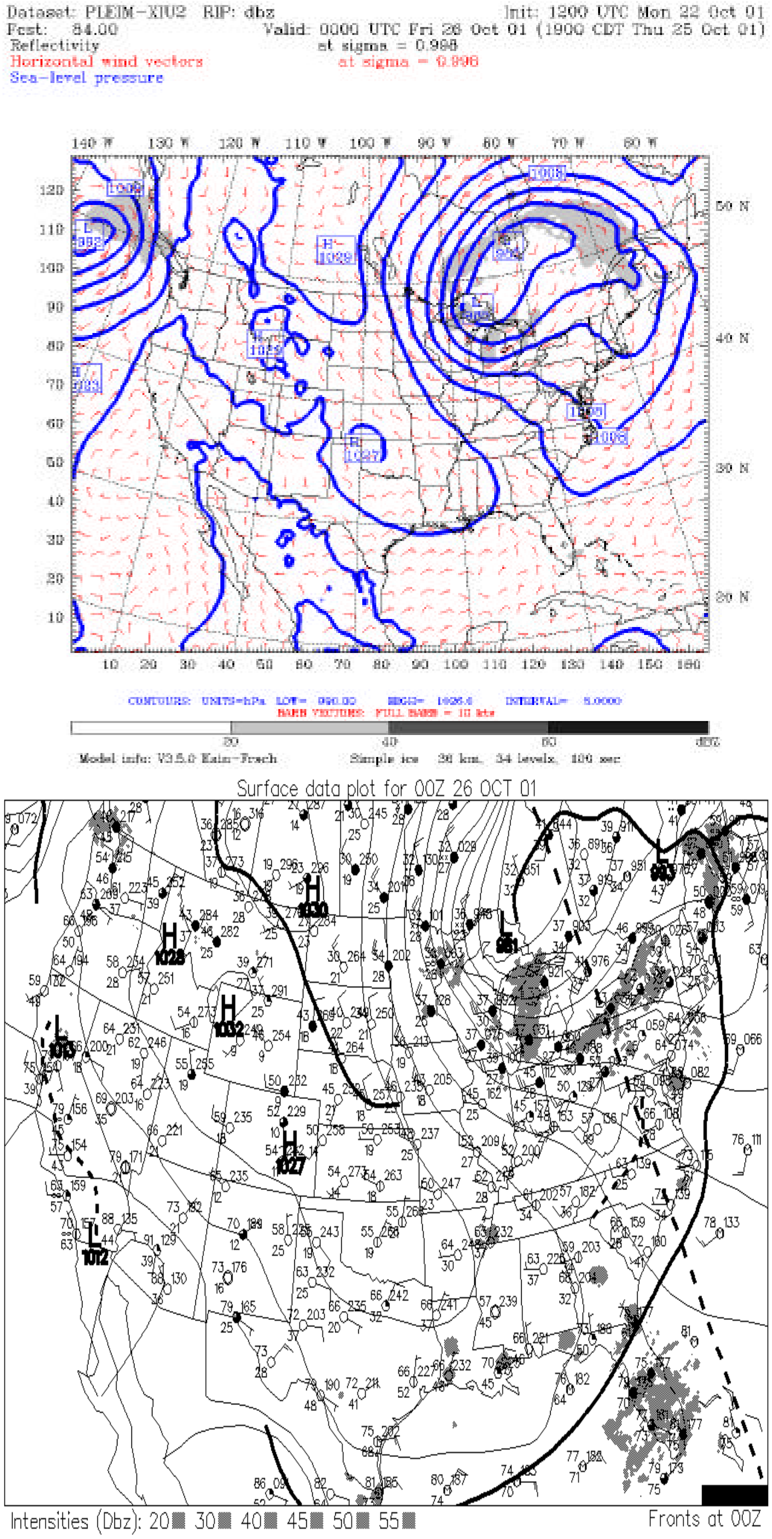
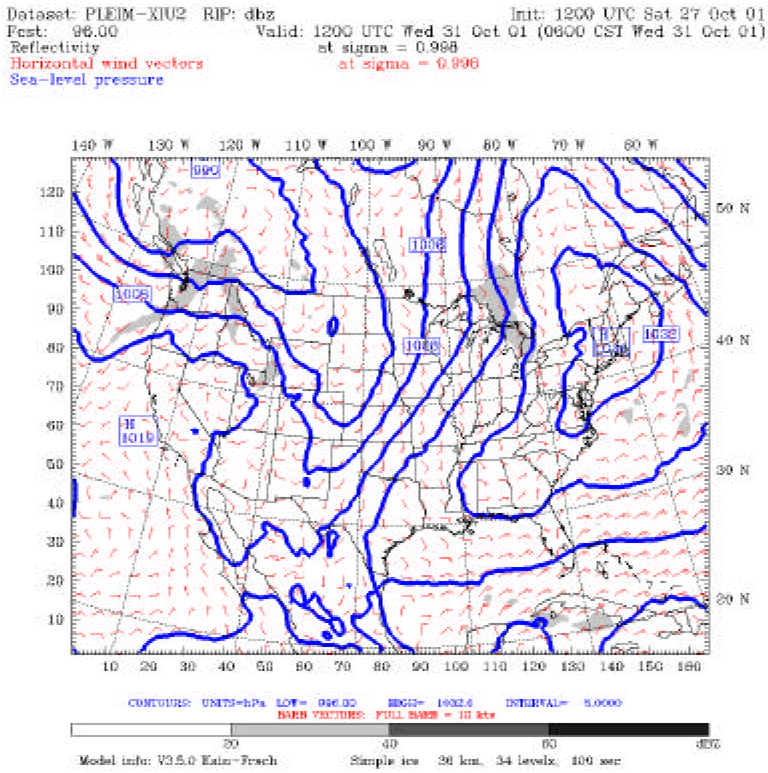


Figure 3-56: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 31 October 2001.



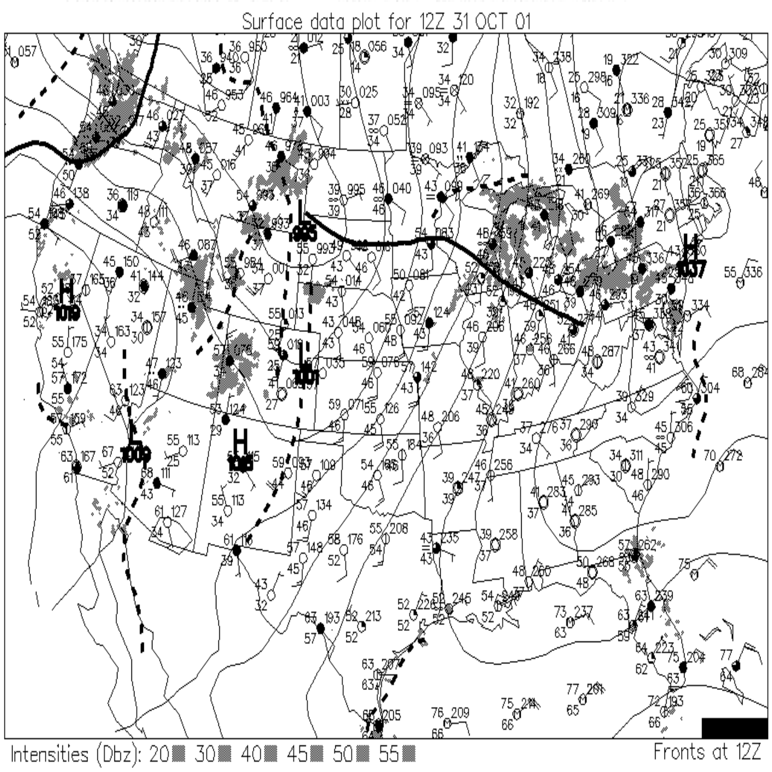


Figure 3-57: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 06 November 2001.

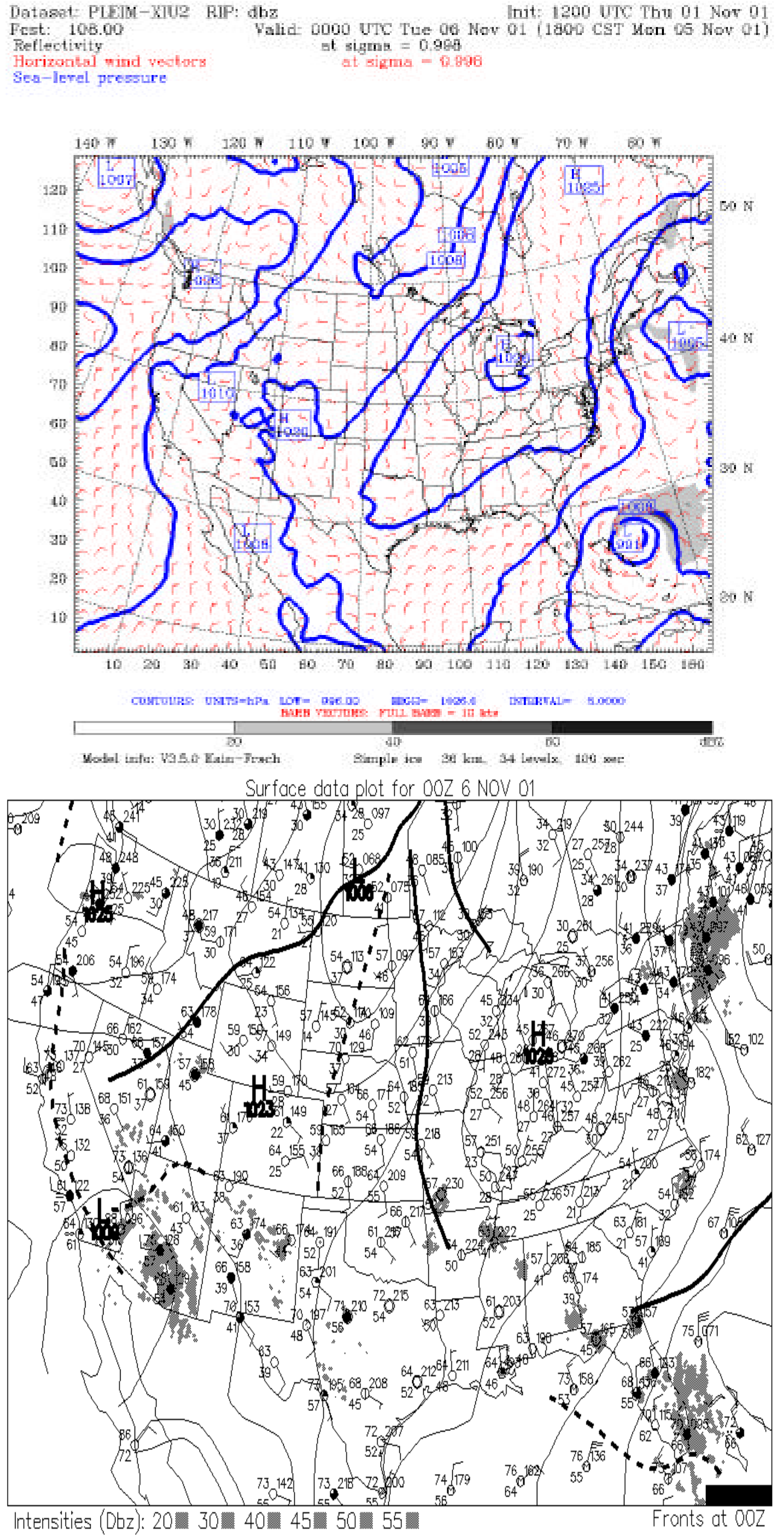


Figure 3-58: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 11November 2001.

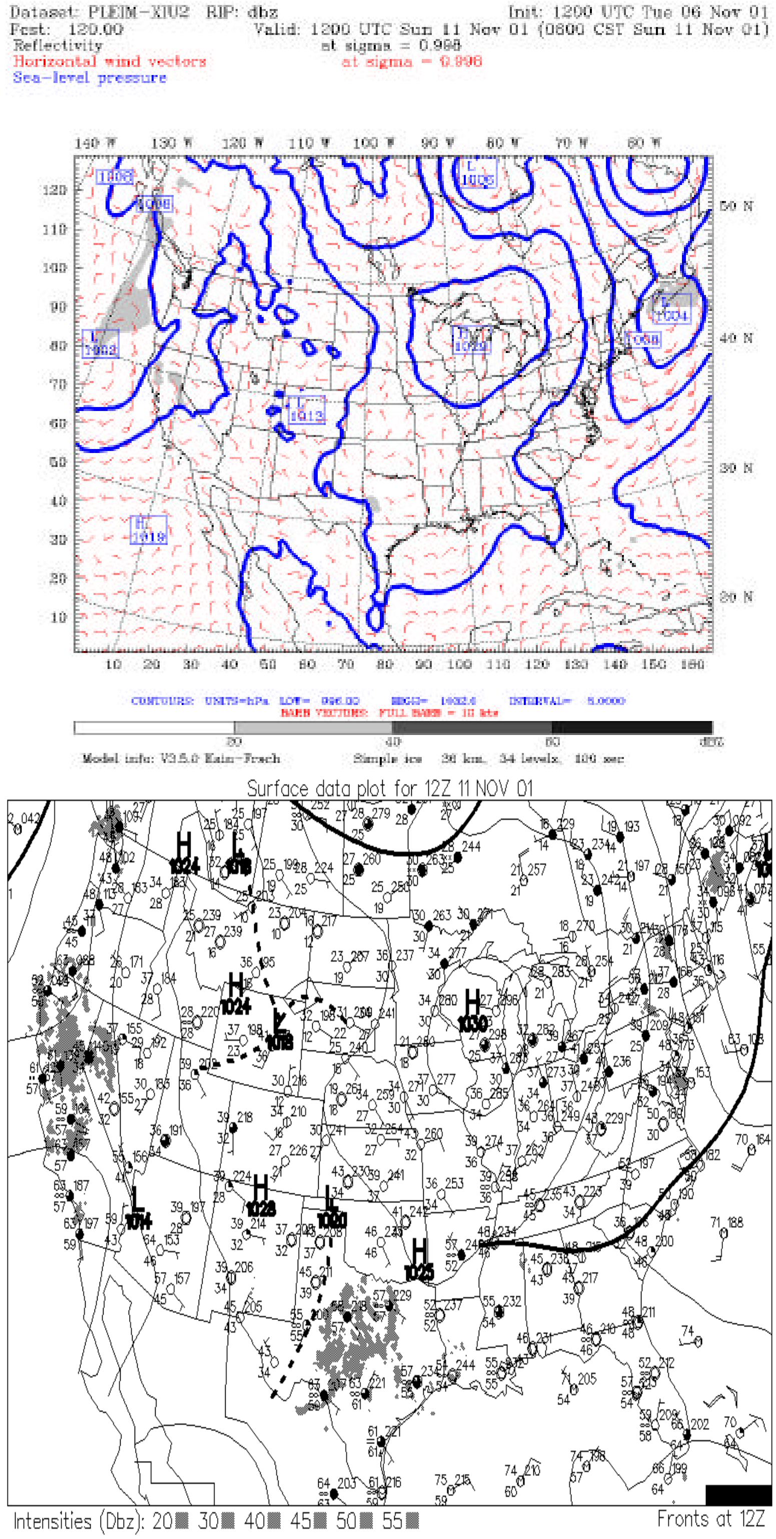


Figure 3-59: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 17 November 2001.

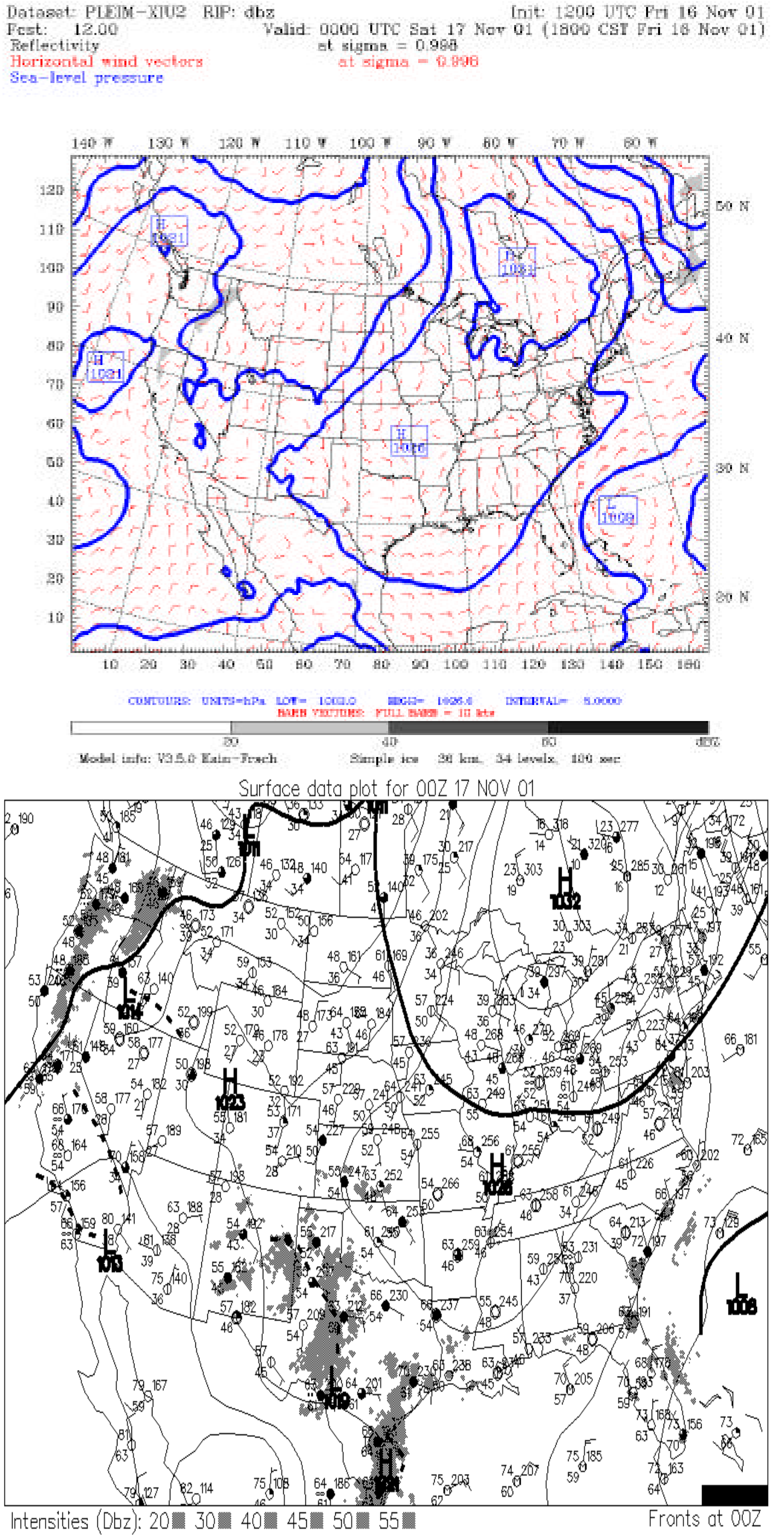


Figure 3-60: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 22 November 2001.

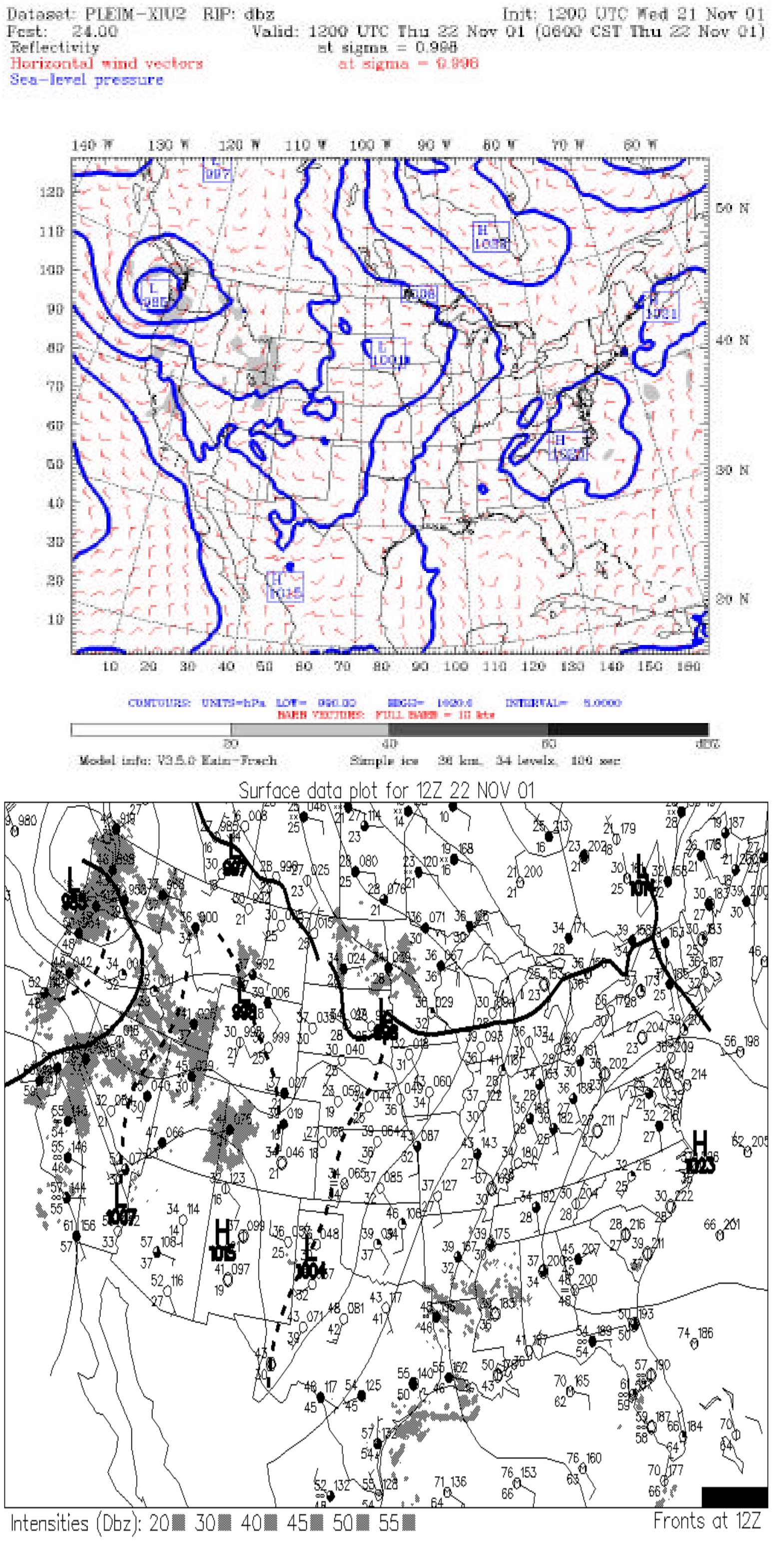


Figure 3-61: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 28 November 2001.

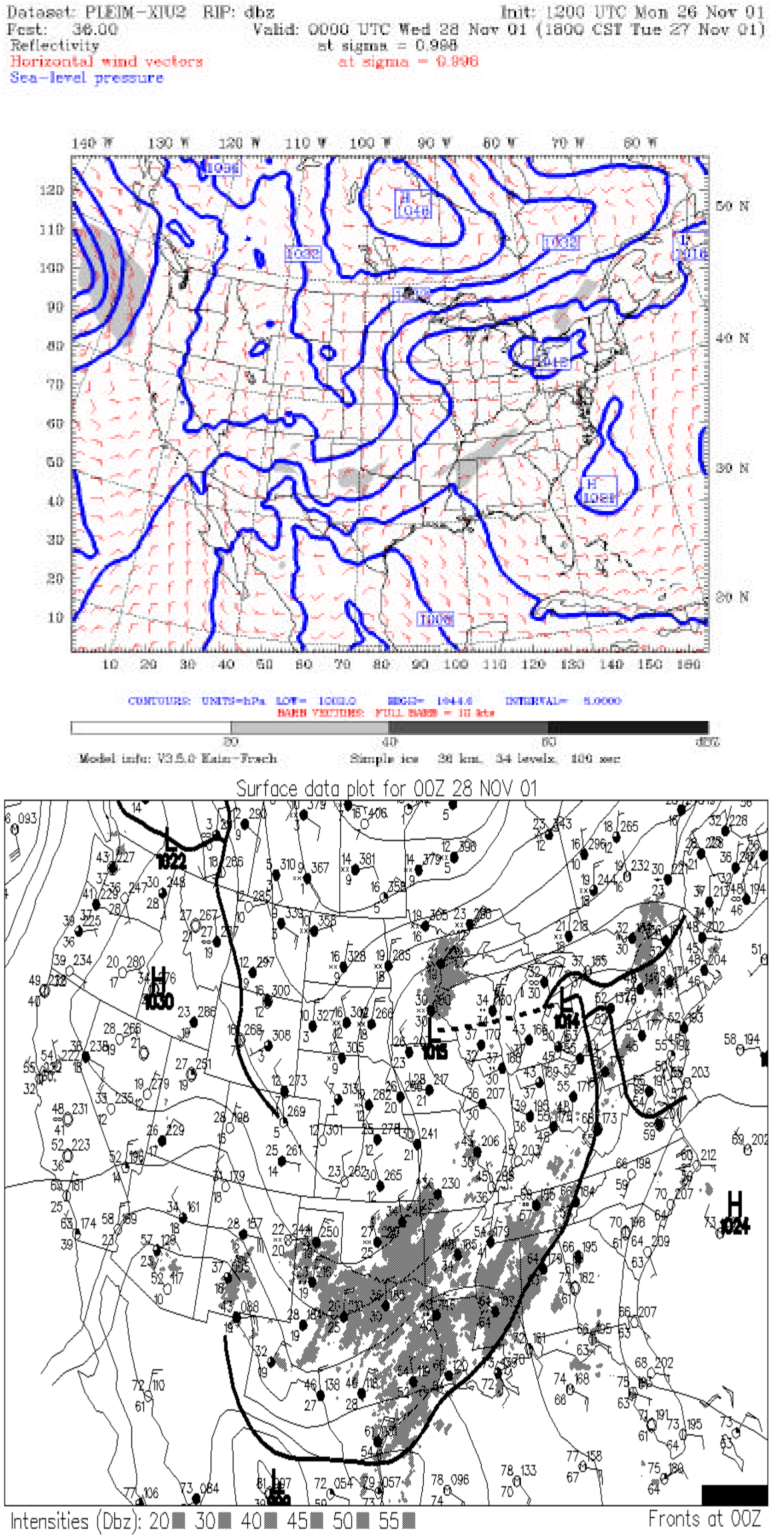


Figure 3-62: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 03 December 2001.

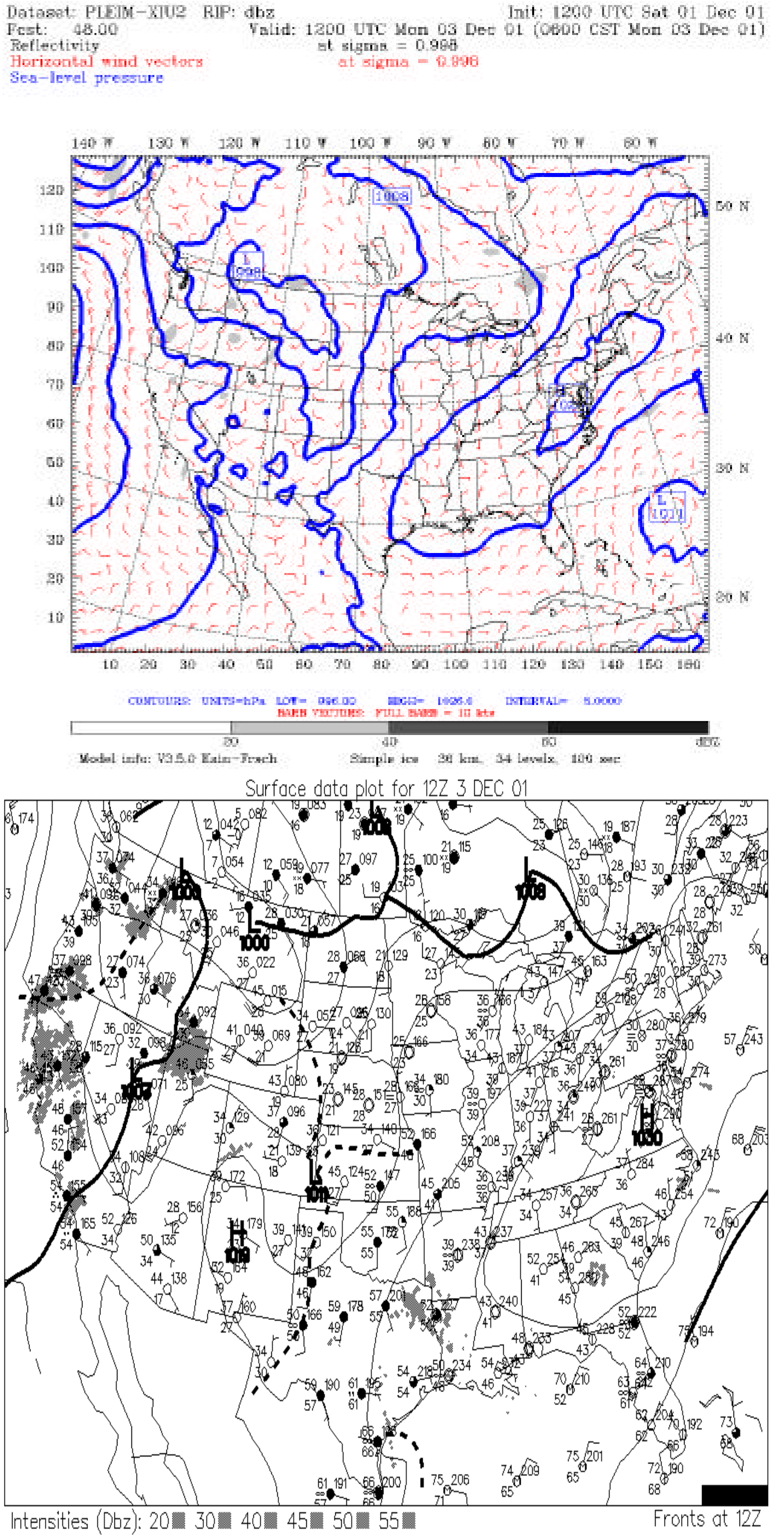


Figure 3-63: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 09 December 2001.

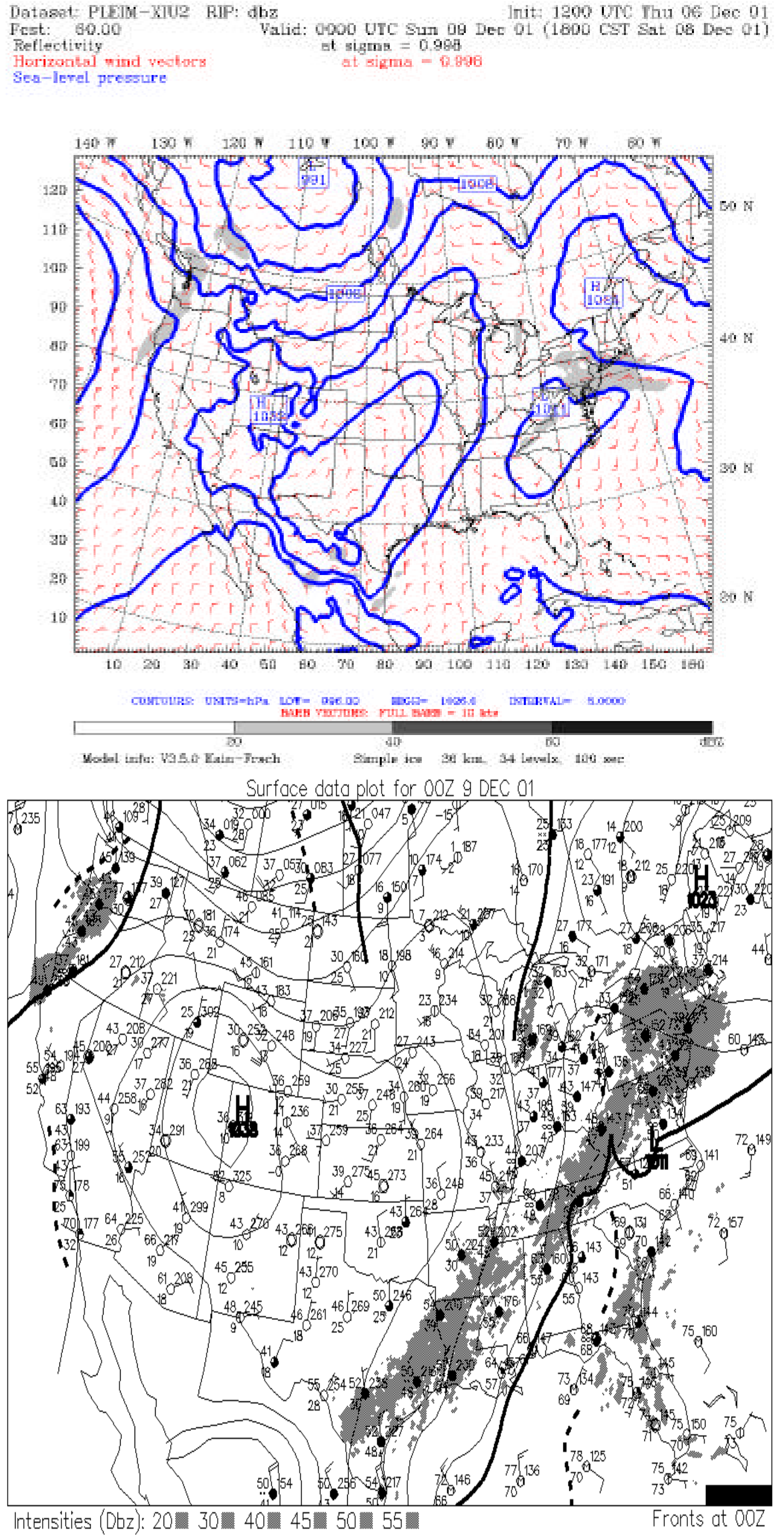


Figure 3-64: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 14 December 2001.

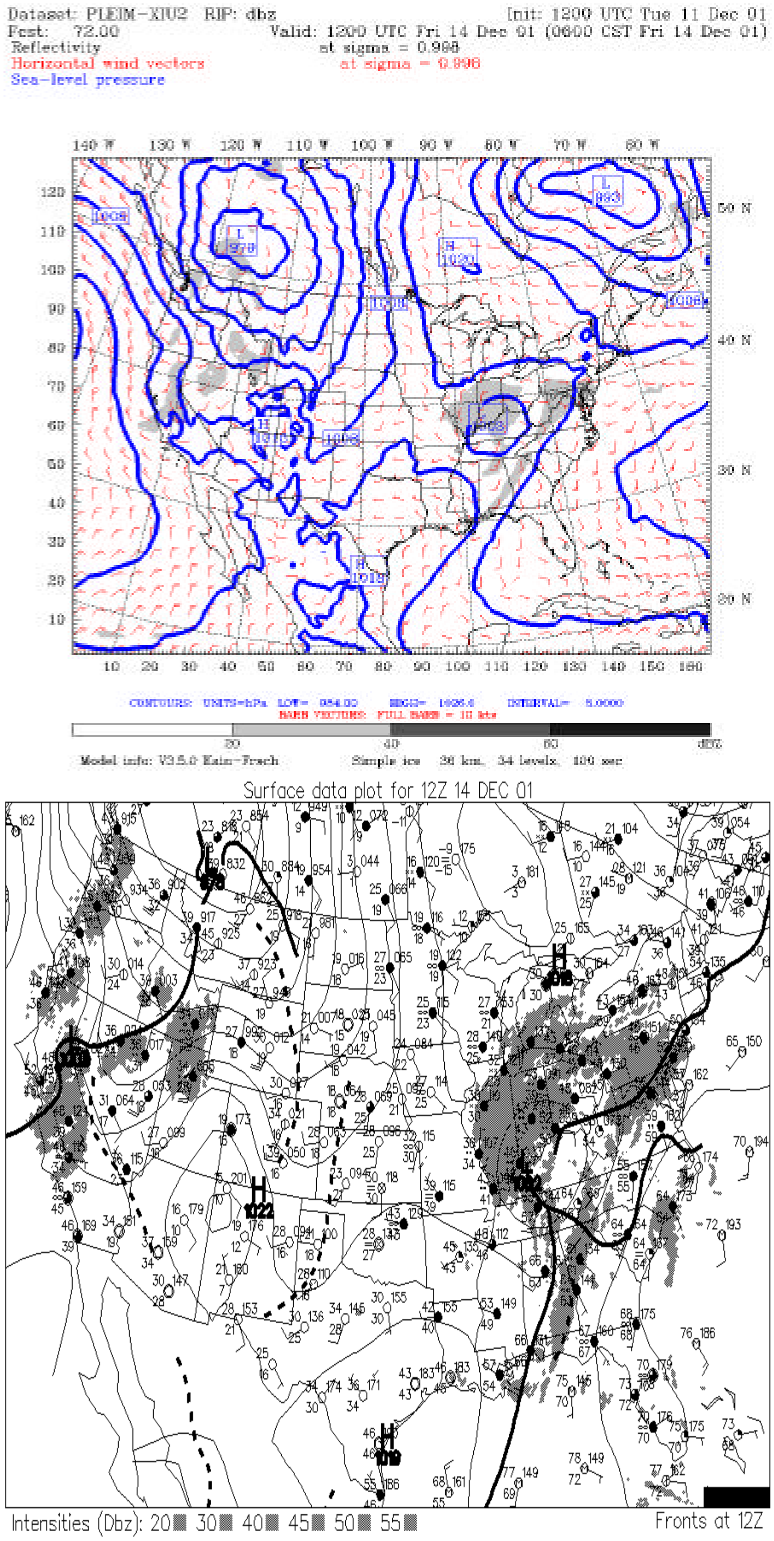


Figure 3-65: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 20 December 2001.

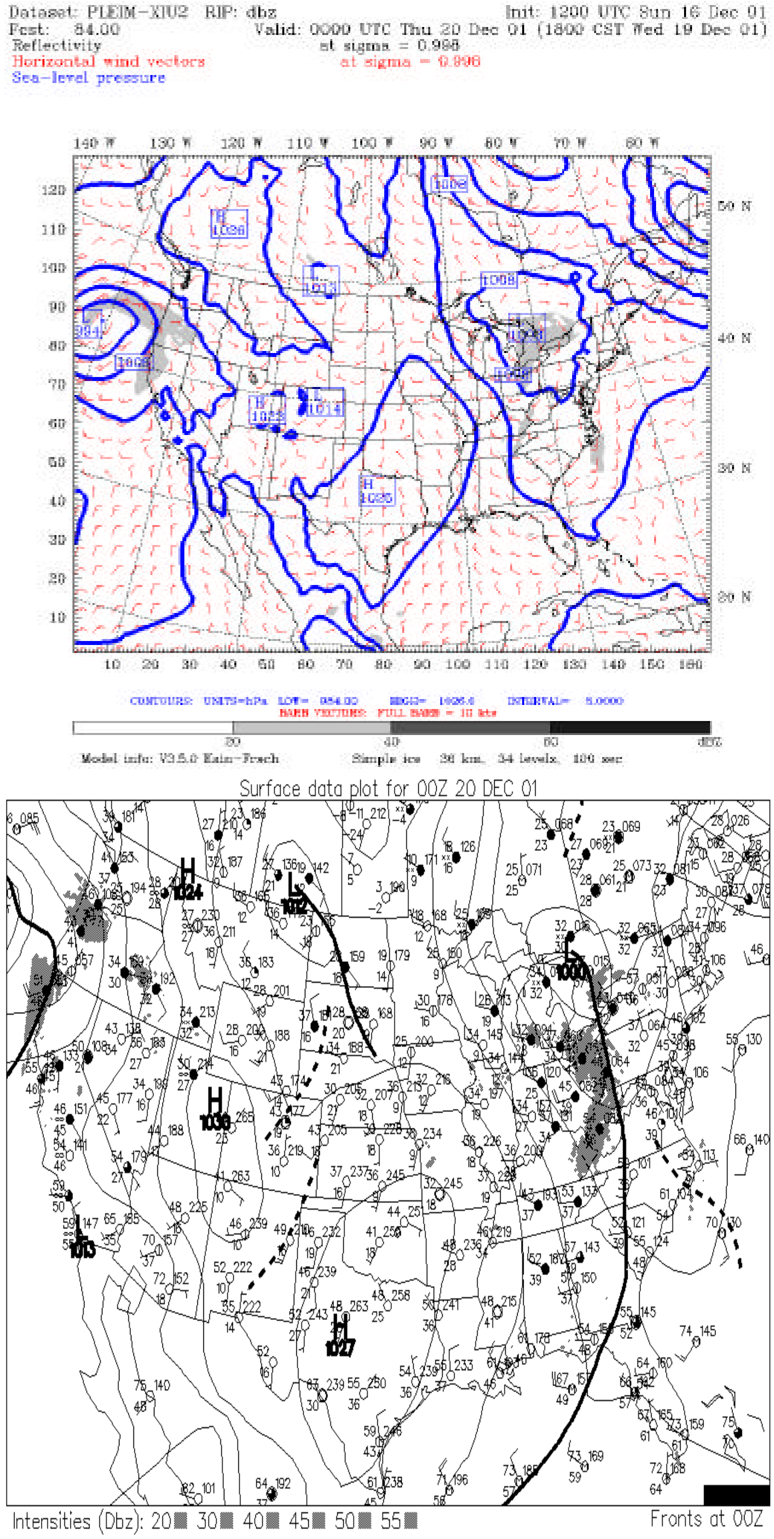


Figure 3-66: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 25 December 2001.

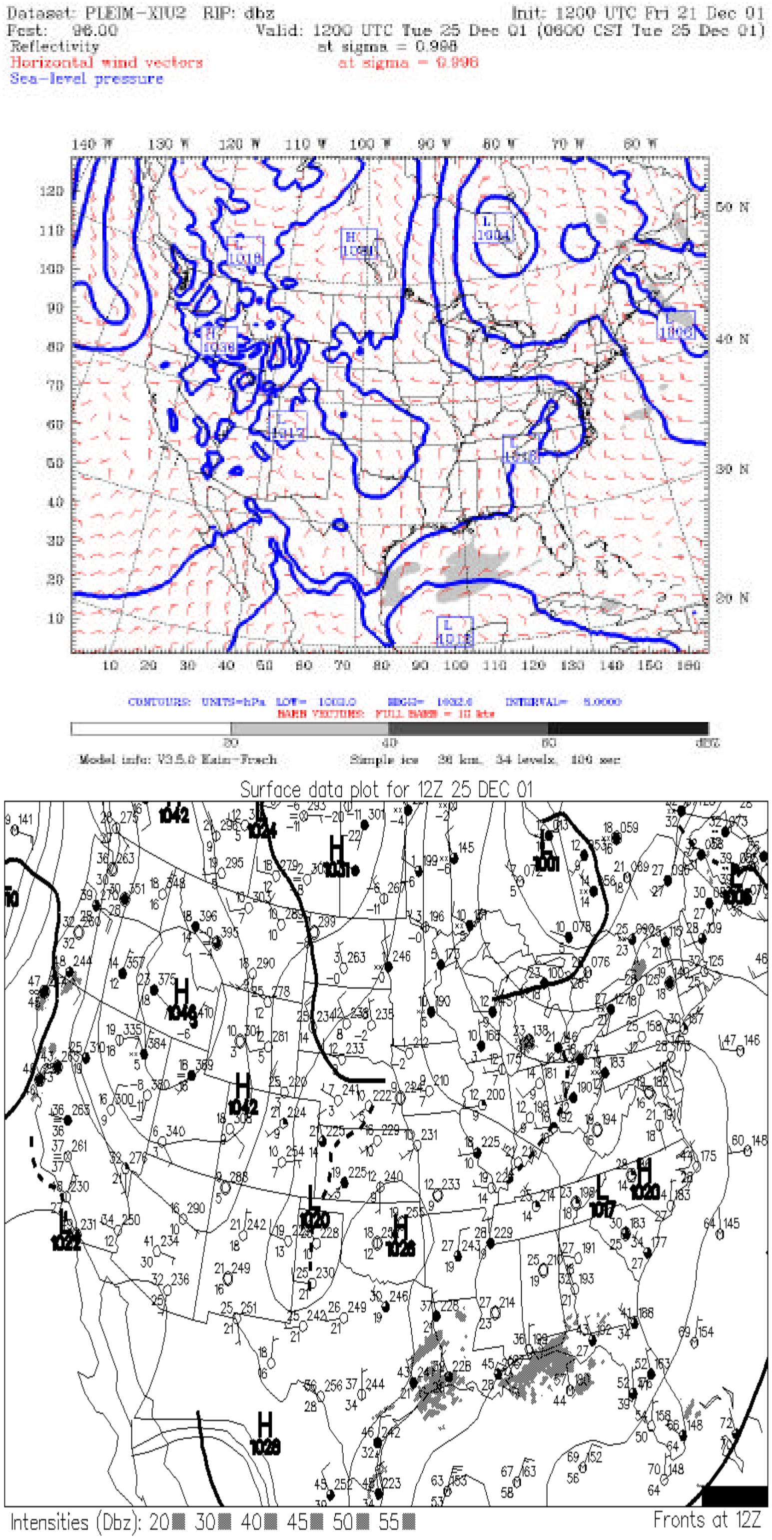


Figure 3-67: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 31 December 2001.

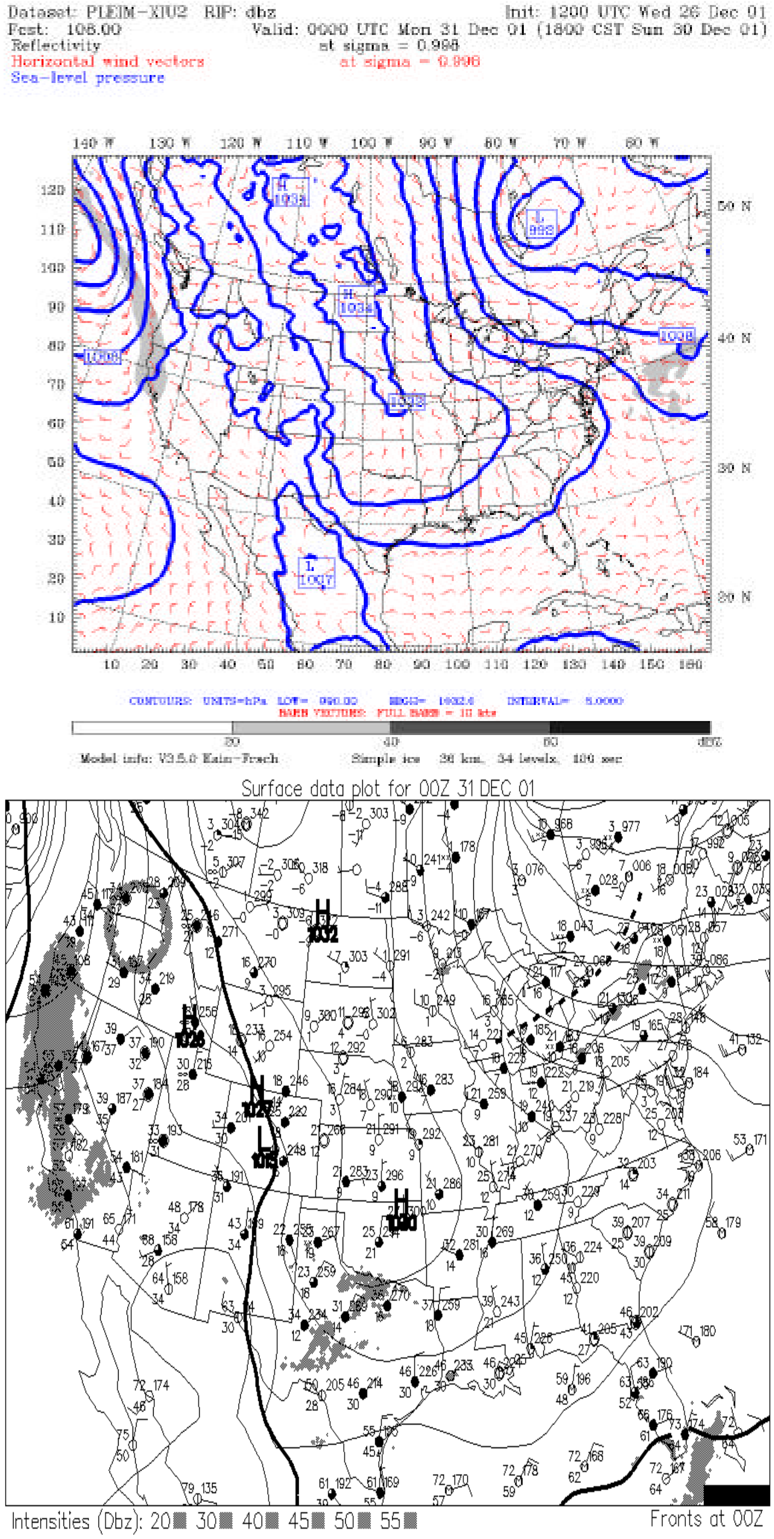


Figure 3-68: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 05 January 2002.

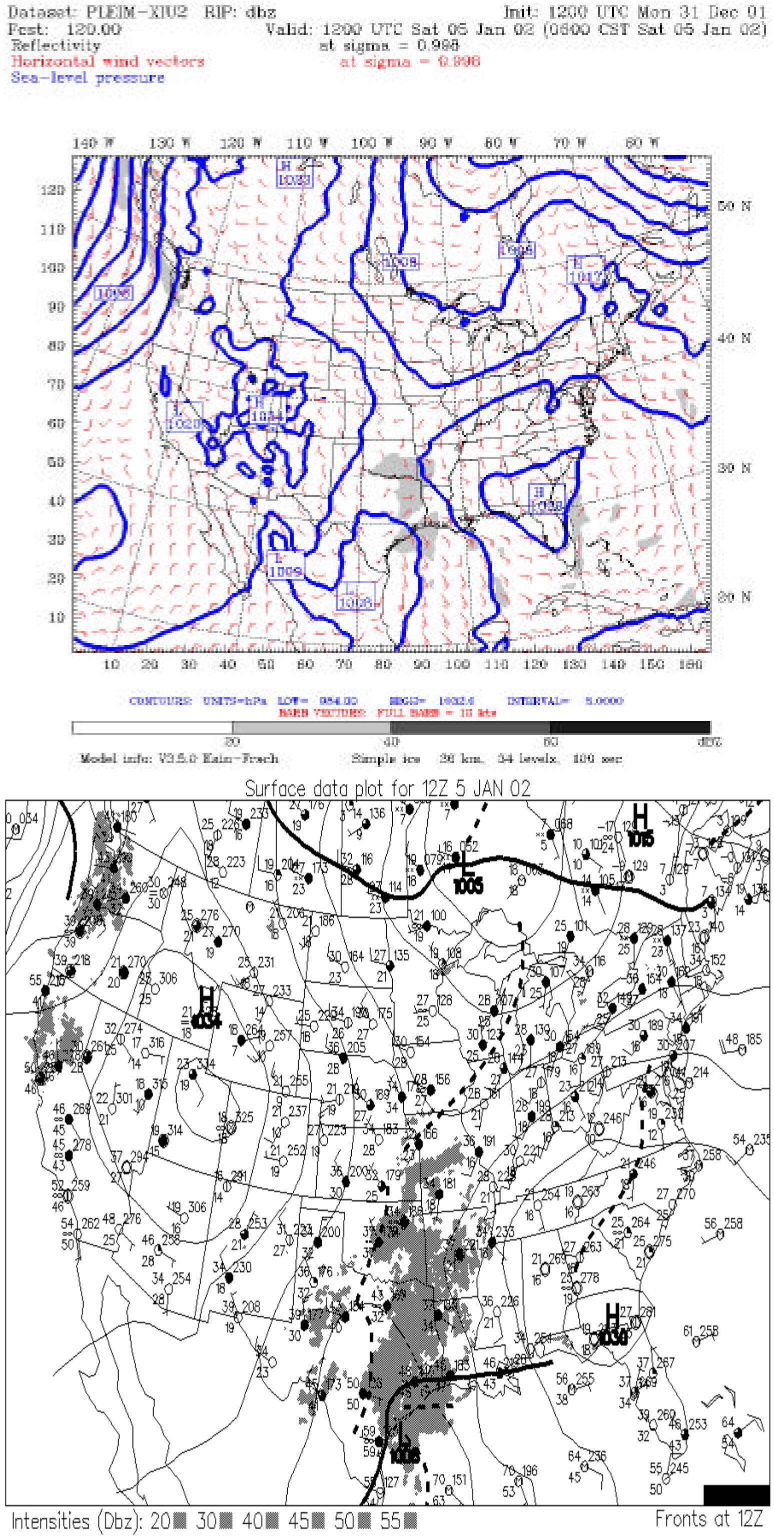


Figure 3-69: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 11 January 2002.

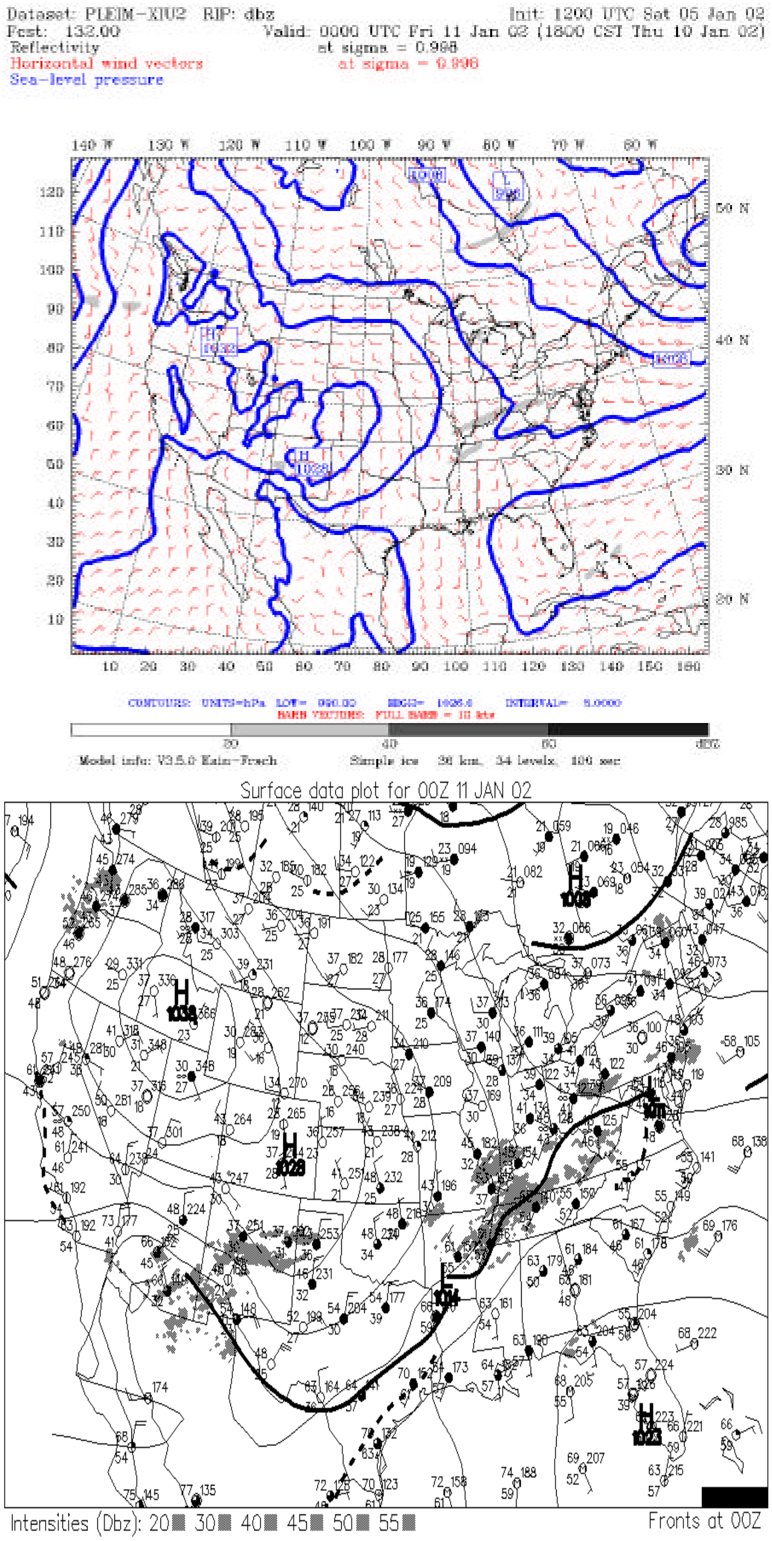


Figure 3-70: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 16 January 2002.

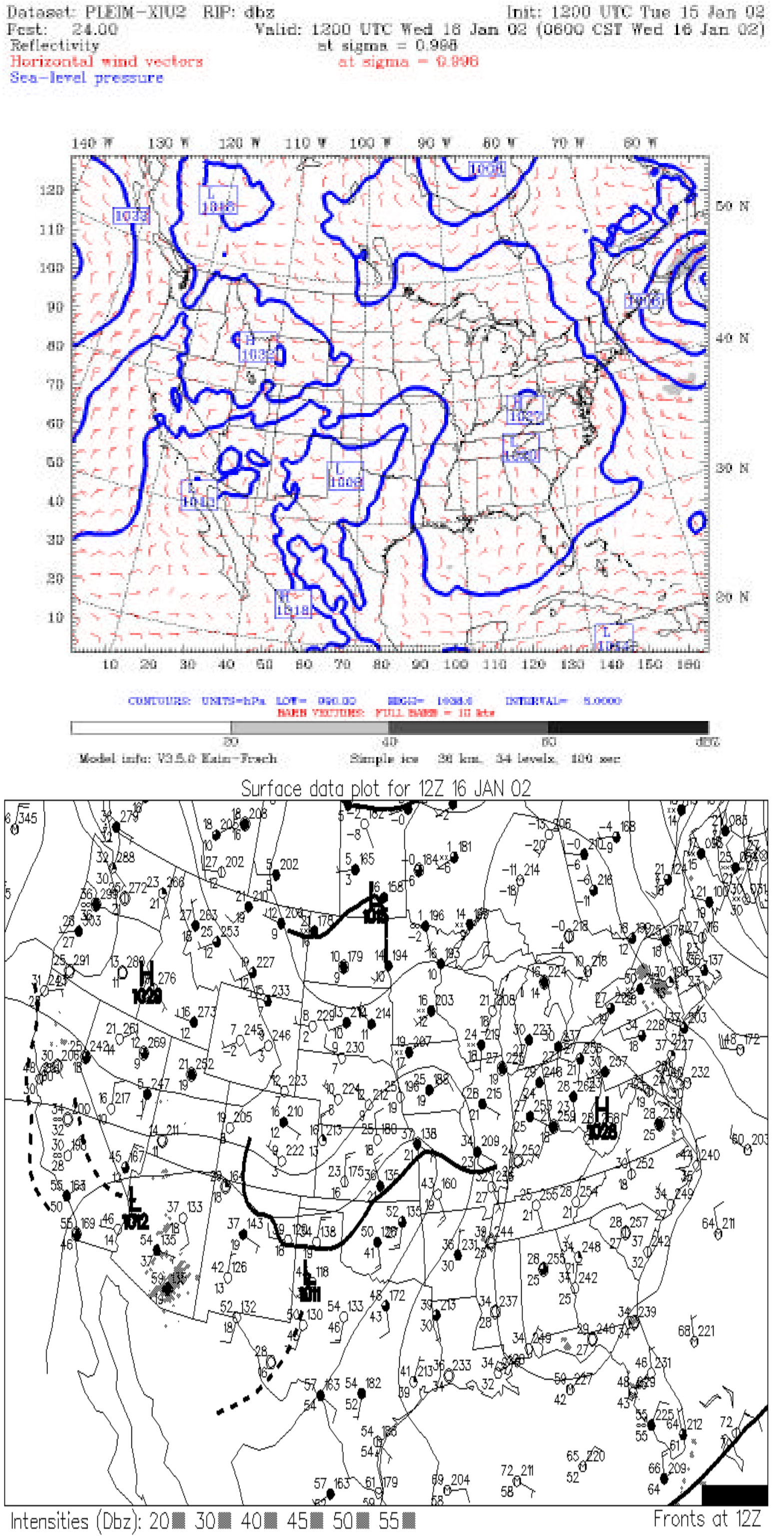


Figure 3-71: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 22 January 2002.

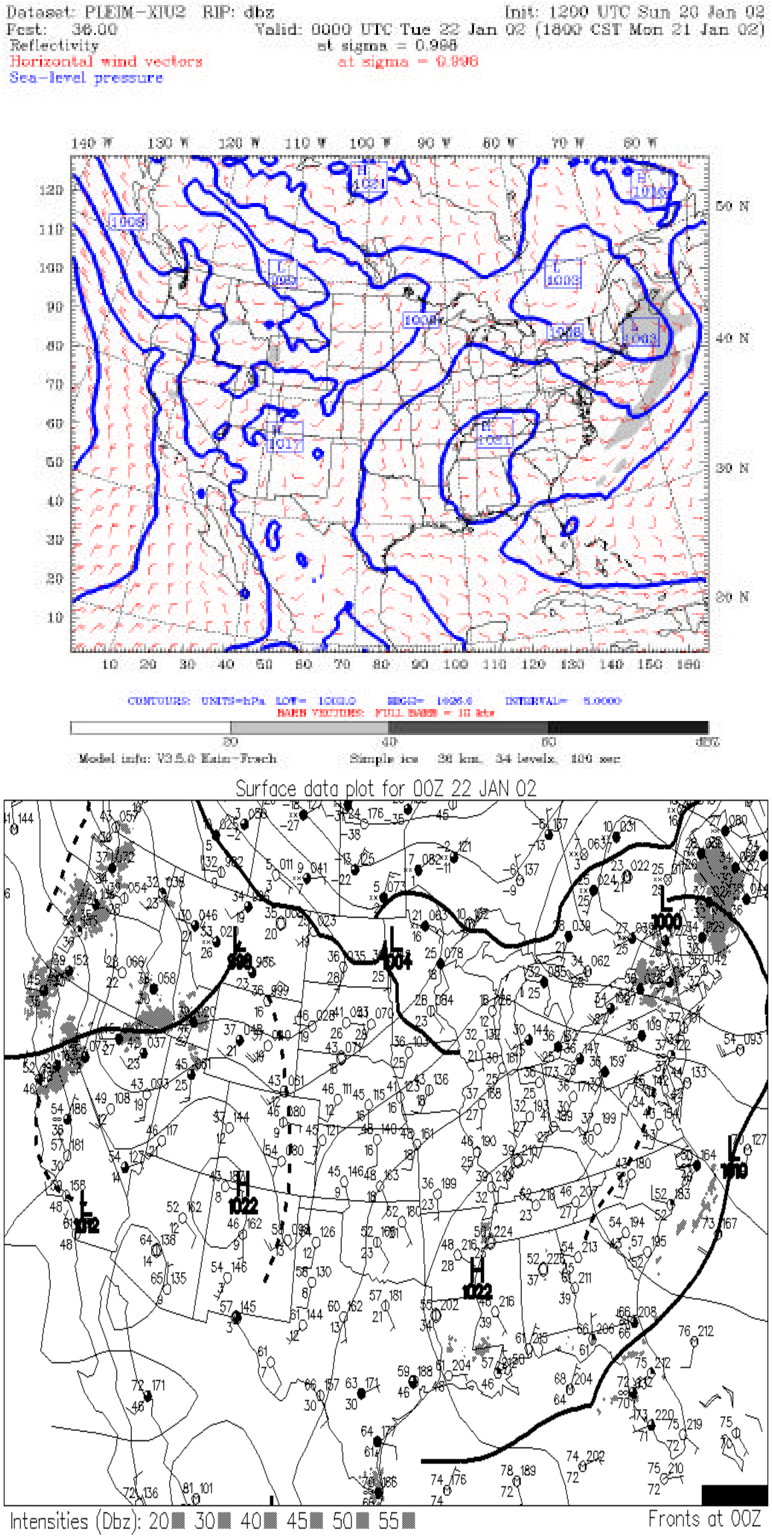


Figure 3-72: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 27 January 2002.

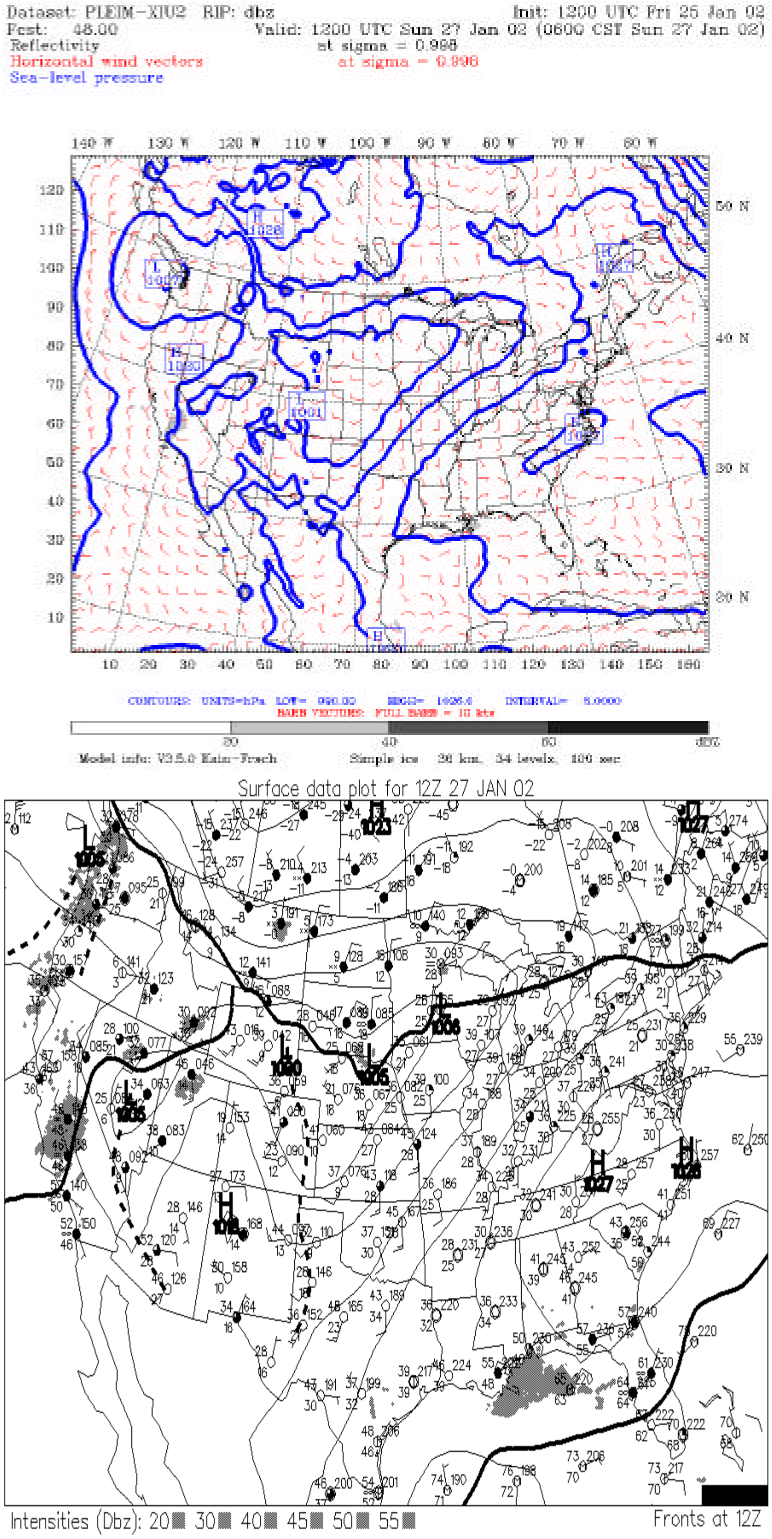
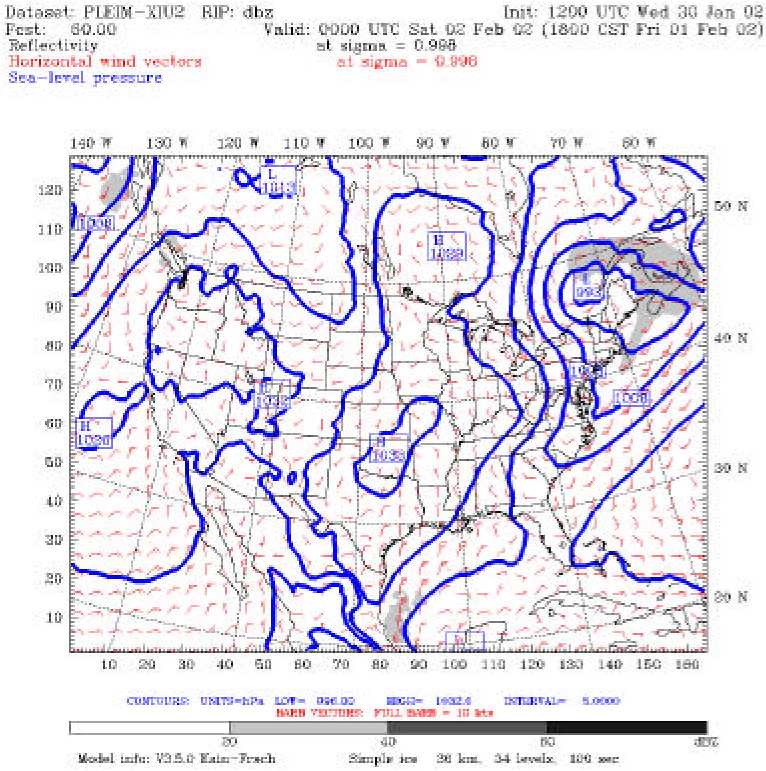


Figure 3-73: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 02 February 2002.



Analysis
Not Available

Figure 3-74: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 07 February 2002.

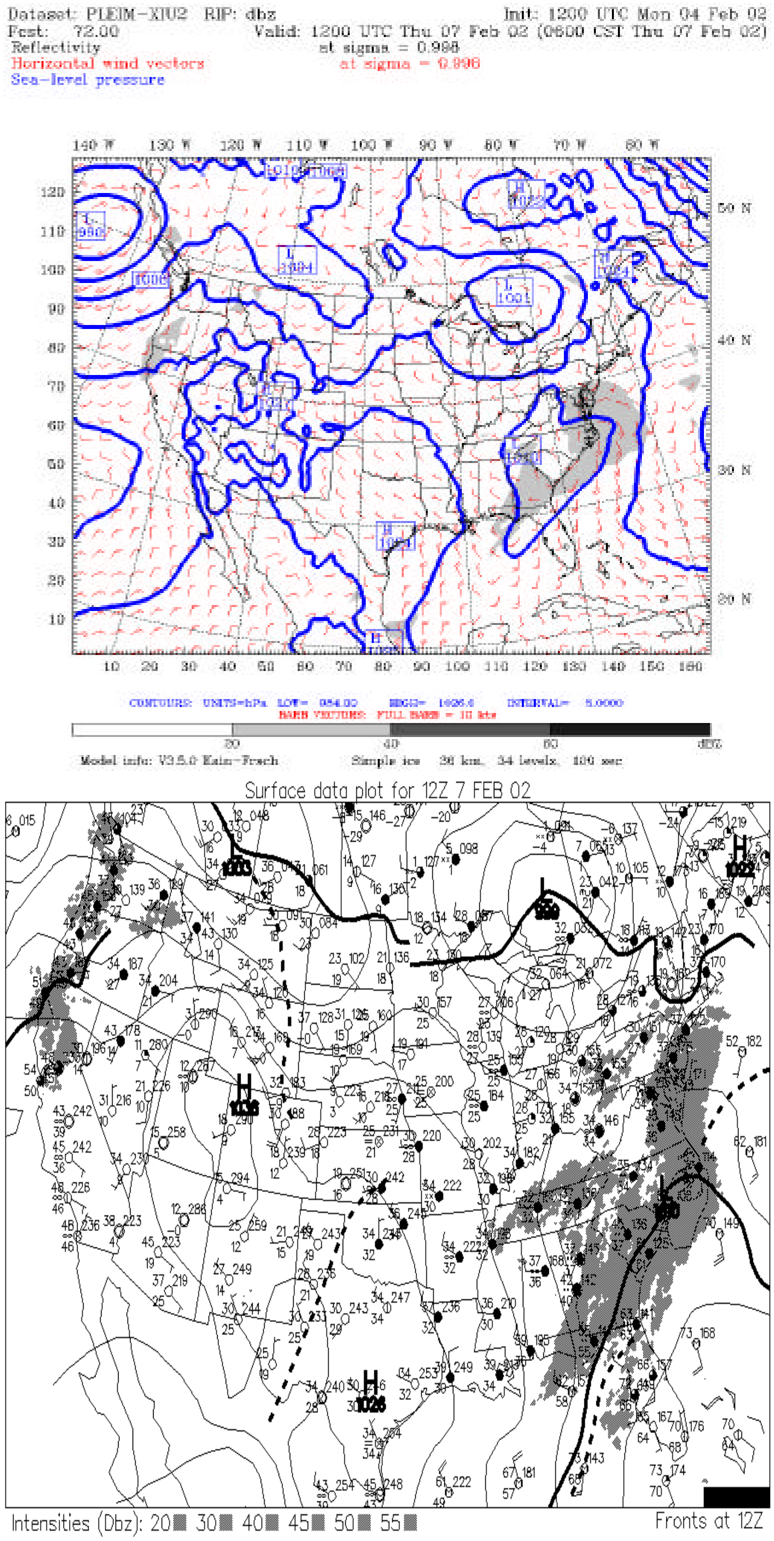


Figure 3-75: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 13 February 2002.

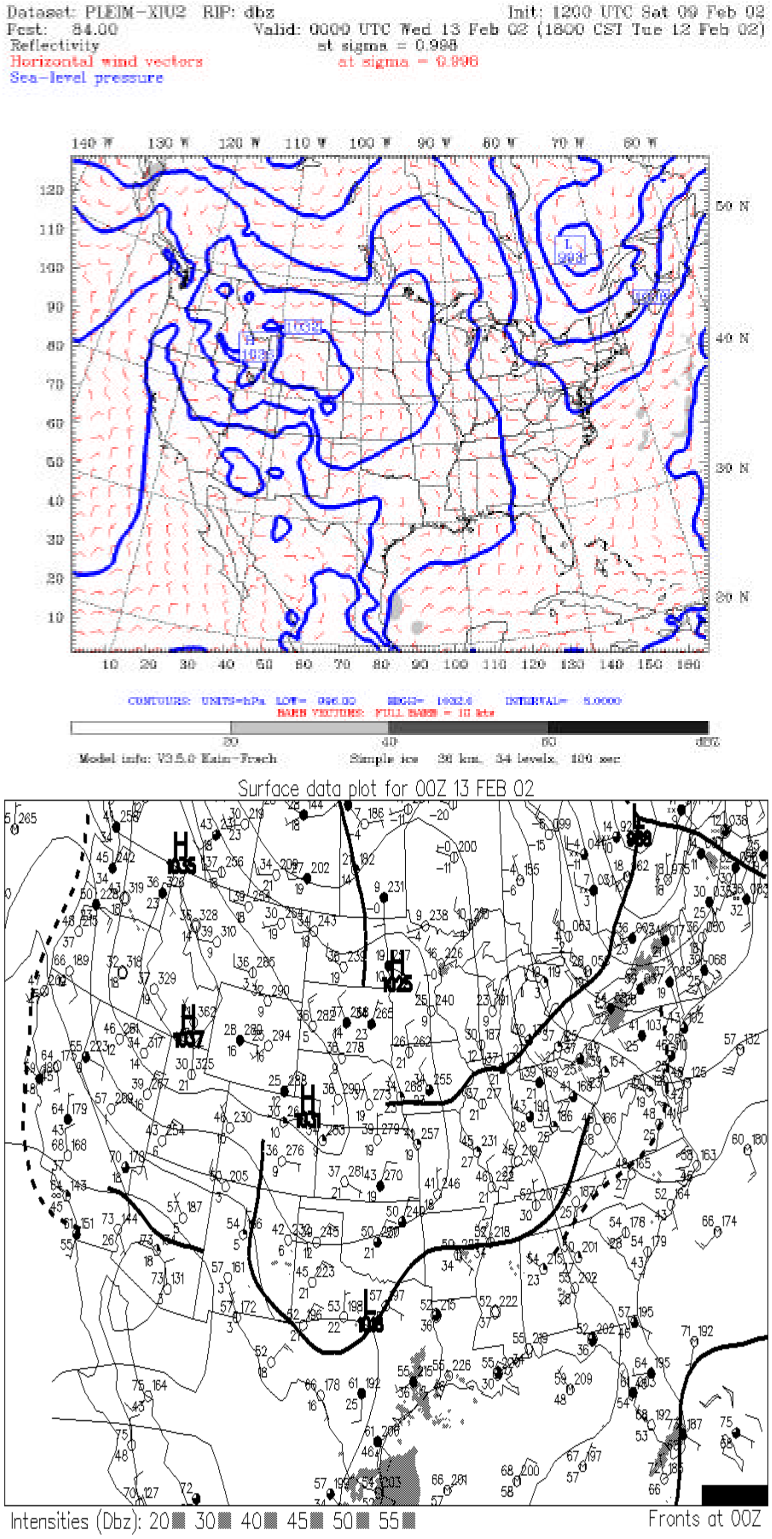


Figure 3-76: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 18 February 2002.

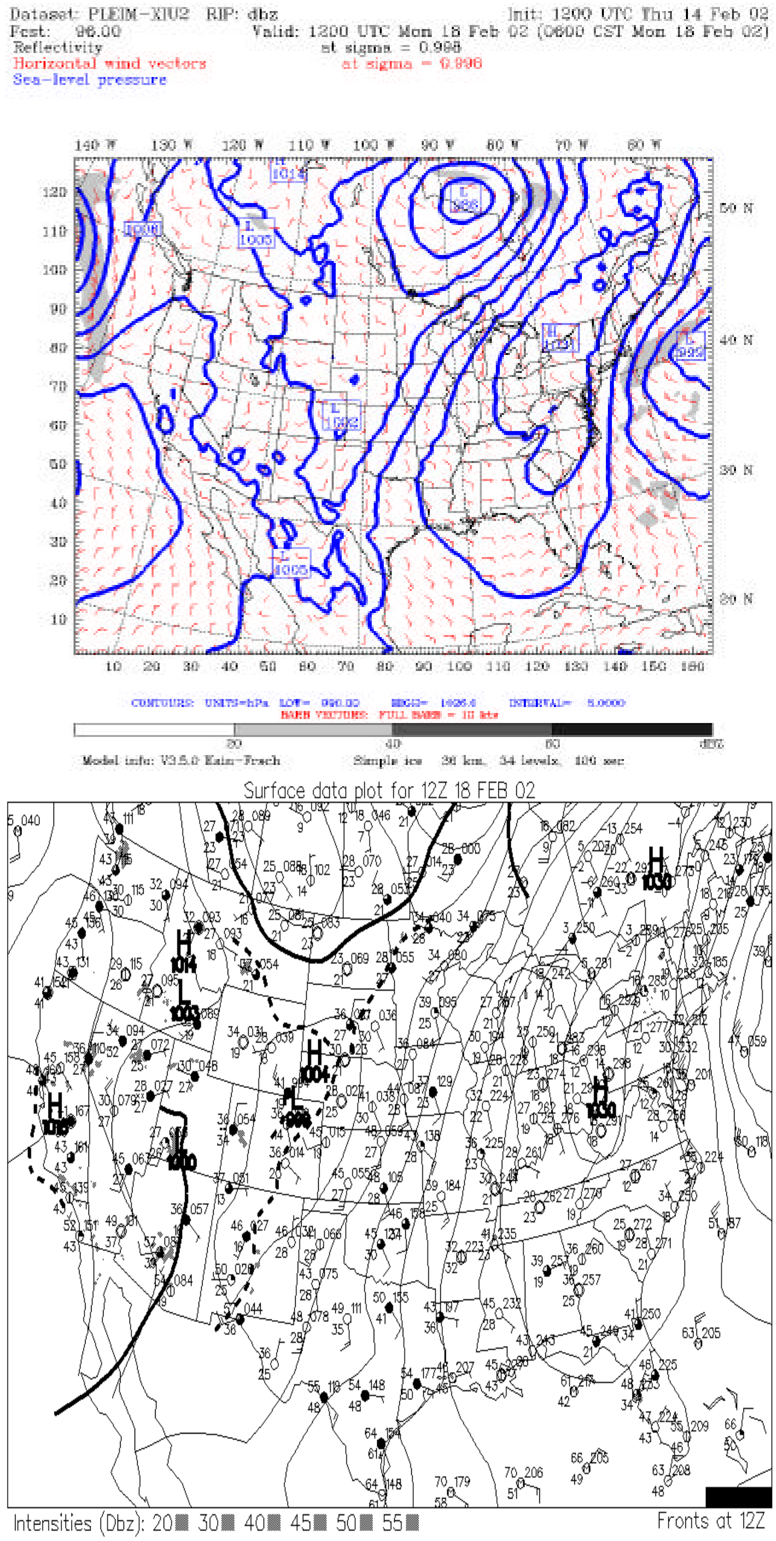


Figure 3-77: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 24 February 2002.

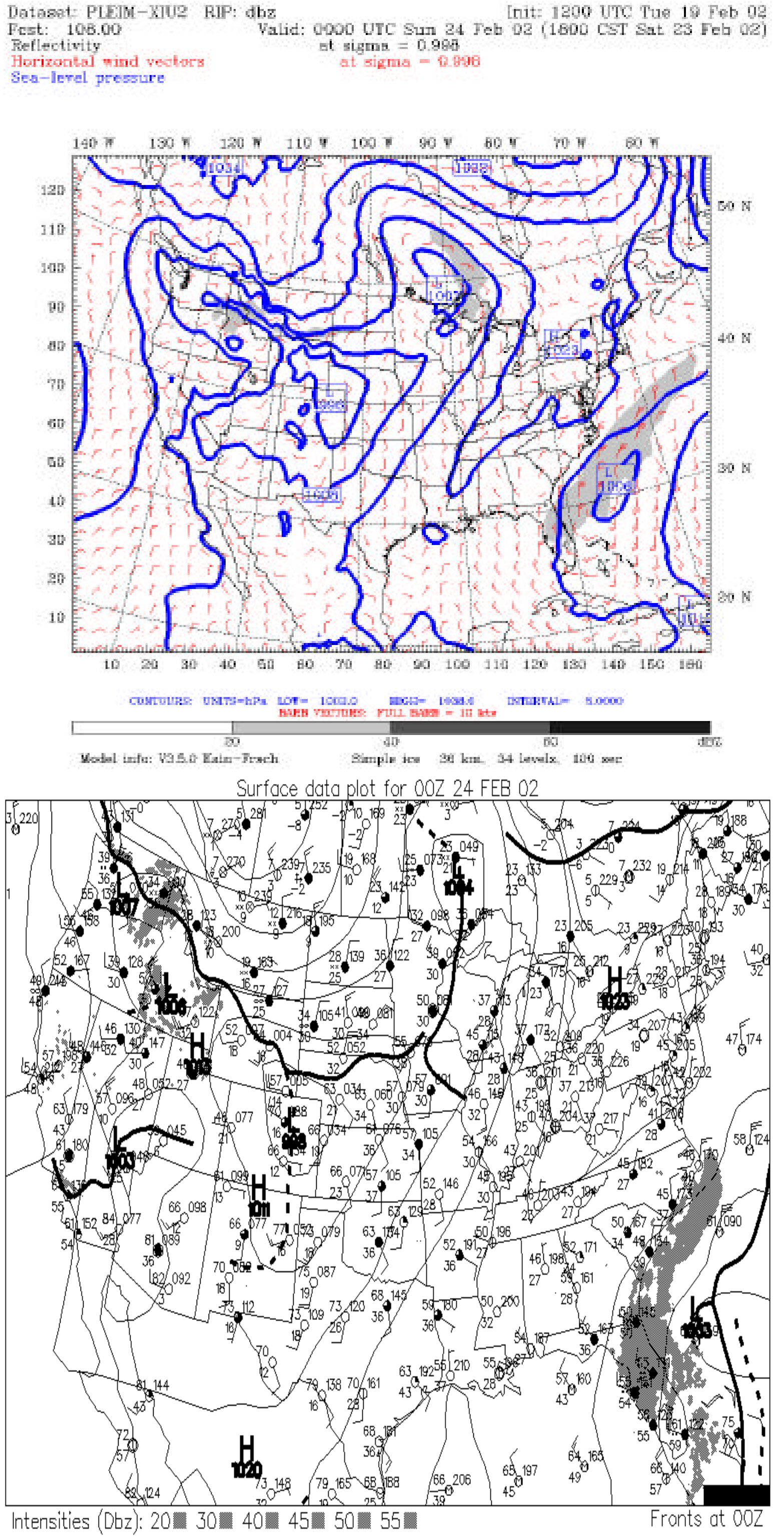


Figure 3-78: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 01 March 2002.

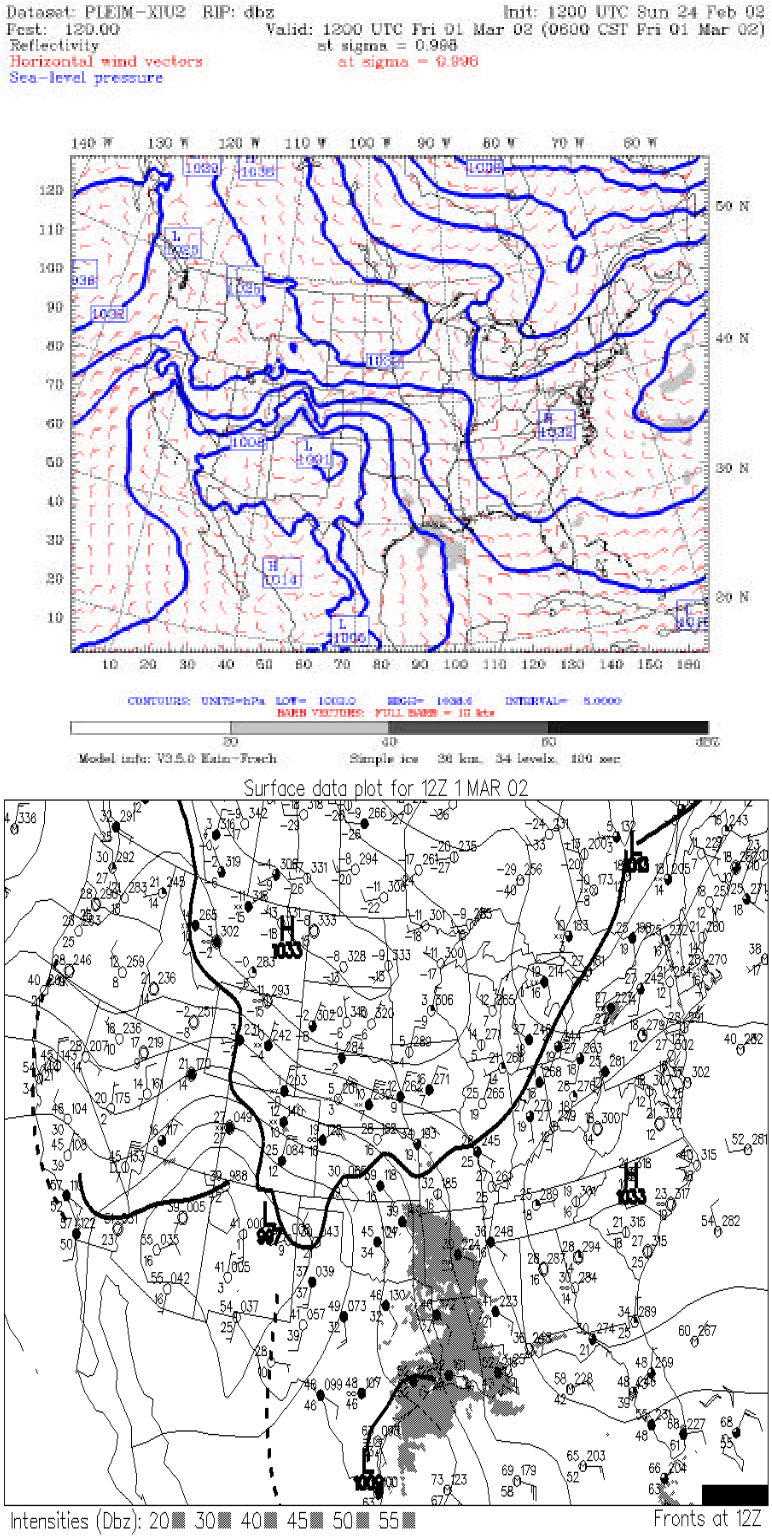


Figure 3-79: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 00Z 07 March 2002.

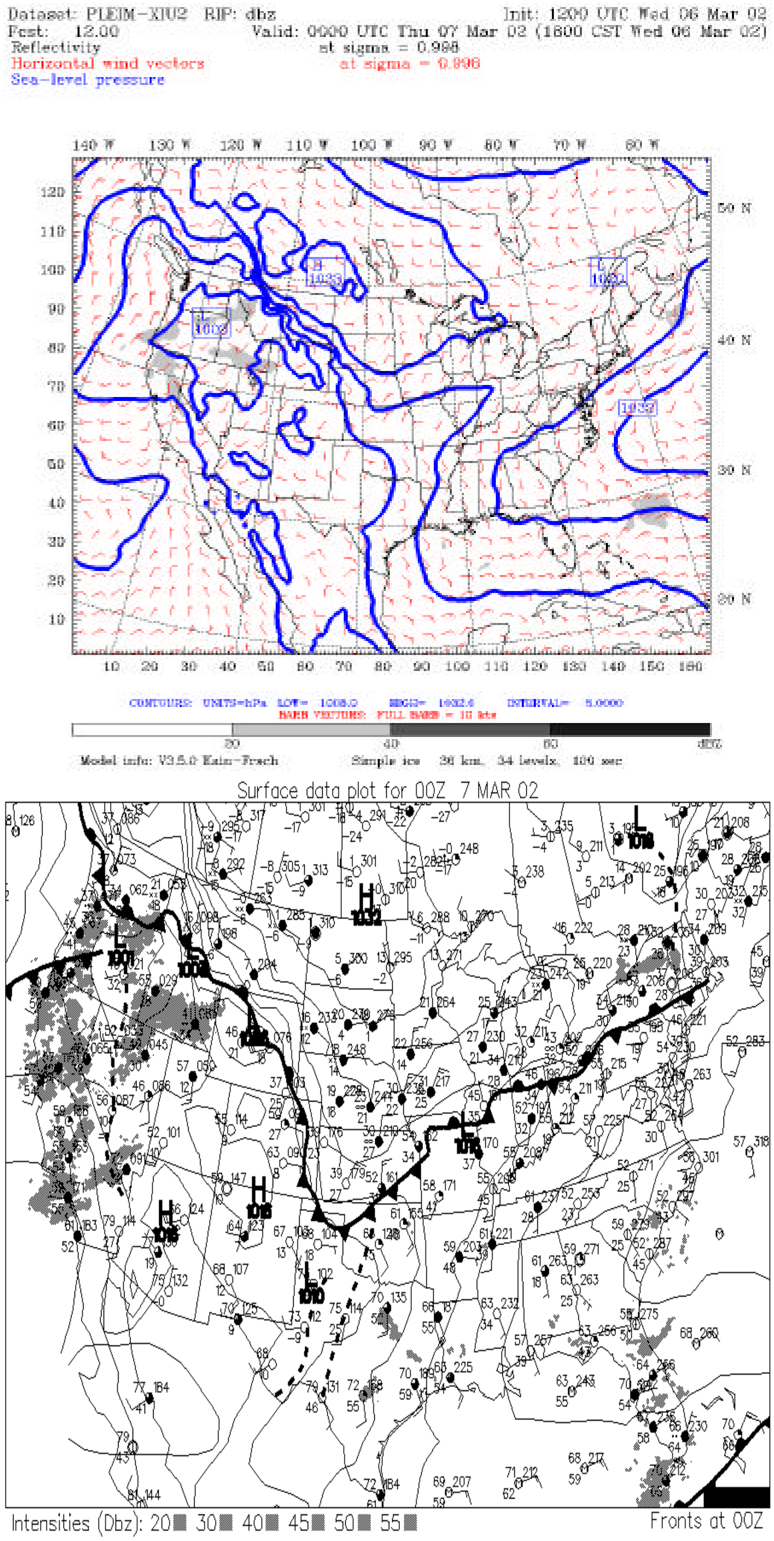


Figure 3-80: Model Predicted (top) and Observed (bottom) 850 Mbar Heights, Surface Wind Vectors and Radar Reflectivity valid 12Z 12 March 2002.

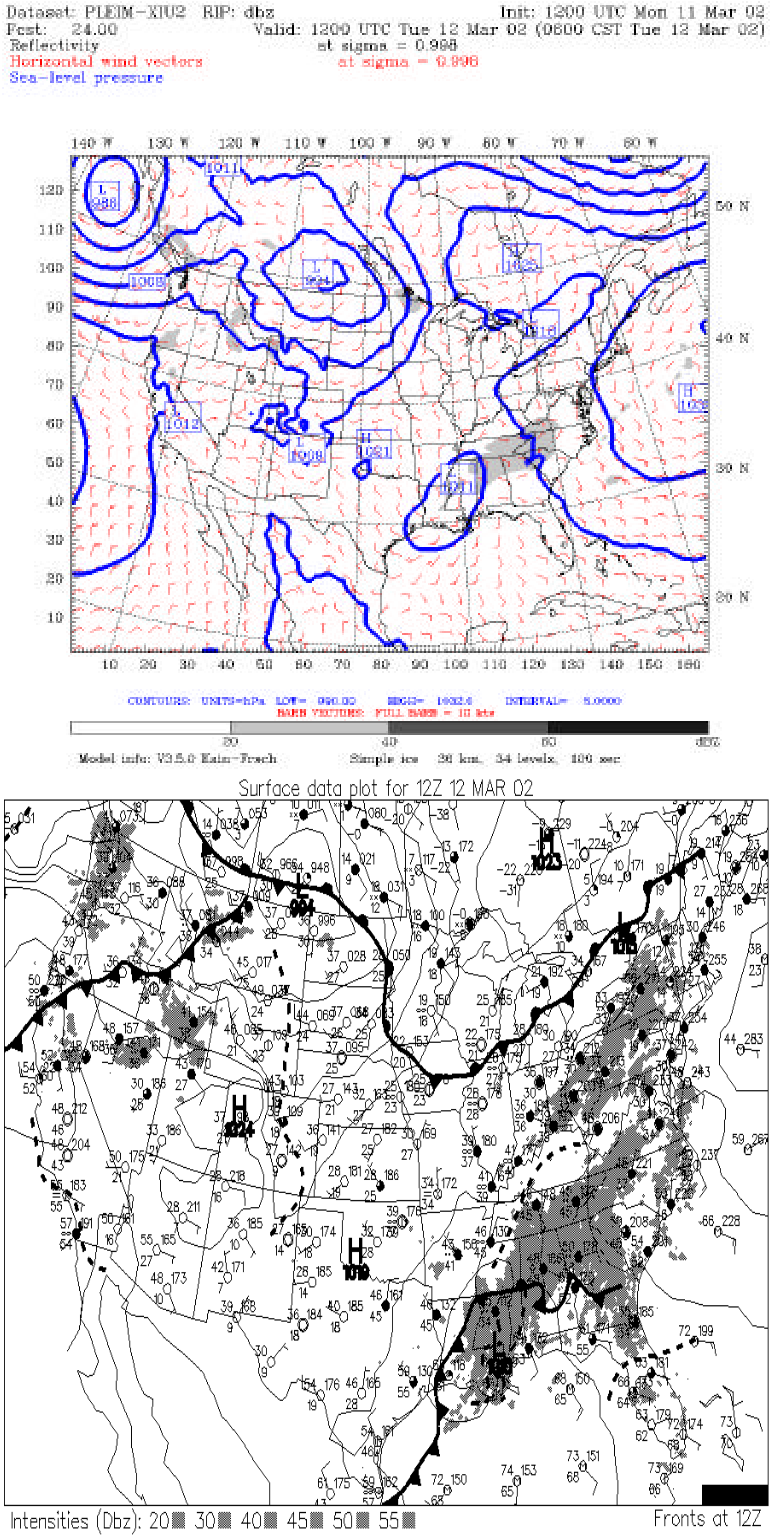


Table 3-1: Temperature Bias (K) by State and Time Period for the 2001 Annual MM5 Simulation.

Region	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb	Mean
ALL	-0.84	-0.93	-0.73	-0.77	-0.19	-0.16	-0.6	-0.6
AL	-0.64	-0.36	-0.27	-0.29	0.19	0.36	0.01	-0.14
AK	-1.27	-0.94	-1.3	-0.96	-0.71	-0.47	-0.04	-0.81
AZ	-1.2	-1.68	-2.32	-2.92	-1.2	-0.17	-0.08	-1.37
AR	-0.77	-0.31	0.29	-0.12	0.36	0.34	-0.24	-0.06
CA	0.08	-1.11	-1.76	-1.69	-0.66	0.16	0.44	-0.65
CO	-1.61	-3.2	-2.62	-2.45	-1.24	-0.79	-1.47	-1.91
CT	-1.51	-1.09	-0.21	-0.16	-0.15	-0.16	-0.67	-0.56
DE	-0.54	-0.31	-0.41	-0.49	0.13	0.32	-0.33	-0.23
DC	-2.04	-1.36	-1.23	-1.23	-1.4	-1.4	-1.39	-1.44
FL	0.28	-0.49	-0.82	-0.66	-0.36	0.2	0.26	-0.23
GA	-0.43	-0.35	-0.18	-0.49	0.21	0.51	0.16	-0.08
ID	-1.12	-2.48	-1.57	-1.44	-0.5	-0.35	-0.8	-1.18
IL	-1.21	-0.48	0.04	0.05	0.19	-0.07	-0.82	-0.33
IN	-1.05	-0.45	-0.08	-0.01	0.07	-0.27	-1.02	-0.4
IA	-1.01	-0.93	-0.19	-0.13	0.18	-0.24	-0.97	-0.47
KS	-0.67	-0.36	-0.55	-0.74	0.07	0	-0.5	-0.39
KY	-1.11	-0.53	-0.17	-0.31	0.05	0.14	-0.68	-0.37
LA	0.03	-0.34	-0.57	-0.51	0.08	0.35	-0.08	-0.15
ME	-0.89	-1.56	-0.03	-0.16	-0.02	-0.58	-0.83	-0.58
MD	-0.54	-0.39	-0.31	-0.29	0.03	0.15	-0.18	-0.22
MA	-1.36	-1.09	-0.36	0.01	-0.06	-0.04	-0.65	-0.51
MI	-1.19	-0.64	-0.34	-0.28	0.1	-0.4	-0.83	-0.51
MN	-0.75	-0.8	0.12	0.34	0.16	-0.58	-1.02	-0.36
MS	-0.25	-0.08	-0.11	-0.15	0.66	0.96	0.33	0.19
MO	-1.13	-0.45	-0.09	-0.22	0.11	0.01	-0.78	-0.36
MT	-1.38	-2.56	-2.11	-2.22	-1.3	-1.04	-1.99	-1.8
NE	-0.88	-0.46	-0.57	-0.29	0.33	0.13	-0.41	-0.31
NV	-1.91	-2.84	-3.16	-3.19	-0.9	-0.79	-0.87	-1.95
NH	-0.9	-0.85	0.63	0.5	0.66	0.25	-0.67	-0.05
NJ	-1.43	-0.88	-0.62	-0.49	0.02	-0.13	-0.78	-0.62
NM	-1.27	-1.32	-2.32	-2.16	-0.83	-0.26	-0.51	-1.24
NY	-1.35	-1.13	-0.52	-0.57	-0.26	-0.48	-1.11	-0.77
NC	-0.62	-0.5	-0.75	-0.58	0.12	0.16	-0.51	-0.38
ND	-0.4	-0.83	-0.05	-0.33	-0.22	-0.39	-0.7	-0.42
OH	-1.33	-0.49	0.02	-0.15	-0.04	-0.14	-0.67	-0.4
OK	-0.51	-0.37	-0.45	-1.09	-0.23	-0.02	-0.4	-0.44
OR	-1.07	-1.61	-1.6	-1.94	-0.65	-0.74	-1.33	-1.28
PA	-1.61	-0.69	-0.24	-0.46	-0.21	-0.38	-1.31	-0.7
RI	-1.27	-0.86	-0.66	0.02	-0.05	-0.14	-0.4	-0.48
SC	-0.4	-0.43	-0.68	-0.74	0.02	0.3	0.01	-0.27
SD	-0.28	-0.57	-0.34	-0.37	-0.07	-0.65	-0.99	-0.47
TN	-1	-0.71	-0.25	-0.69	0.01	0.13	-0.55	-0.44
TX	-0.48	-0.36	-1.05	-1.27	-0.18	0.12	0.11	-0.44
UT	-1.66	-2.54	-2.51	-2.79	-0.85	-0.16	-0.61	-1.59

Region	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb	Mean
VT	-1.87	-1.7	-0.25	-0.46	-0.31	-1.02	-1.73	-1.05
VA	-0.92	-0.68	-0.56	-0.63	-0.27	-0.11	-0.8	-0.57
WA	-0.88	-1.19	-0.96	-0.8	-0.35	-0.47	-1.1	-0.82
WV	-1.16	-0.83	0.21	0.16	0.08	0.11	-0.93	-0.34
WI	-1.56	-1.15	0.22	-0.03	-0.02	-0.61	-1.43	-0.65
WY	-0.72	-2.77	-2.42	-2.78	-1.26	-0.86	-2.1	-1.84
CENRAP	-0.69	-0.54	-0.37	-0.43	0.07	-0.09	-0.51	-0.37
MANE_VU	-1.3	-1.01	-0.29	-0.29	-0.08	-0.28	-0.92	-0.6
MW	-1.3	-0.7	-0.05	-0.12	0.06	-0.35	-0.98	-0.49
VISTAS	-0.48	-0.49	-0.5	-0.51	-0.01	0.24	-0.22	-0.28

Figure 3-81: Episode AverageTemperature Bias (Deg. C).

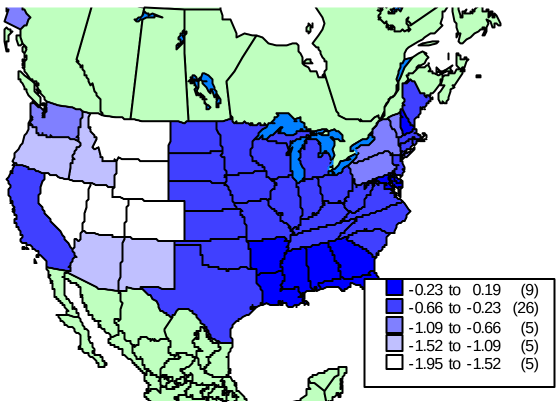


Table 3-2: Temperature Error (K) by State and Time Period for the 2001 Annual MM5 Simulation

Region	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb	Mean
ALL	2.18	2.06	2.06	2.07	2	2.01	2.16	2.08
AL	1.86	1.82	1.75	1.63	1.95	2.19	1.88	1.87
AK	1.79	1.59	1.51	1.33	1.19	1.65	1.69	1.54
AZ	2.46	2.8	3.38	4.05	3.2	2.54	2.54	3
AR	1.72	1.65	1.64	1.6	1.8	1.81	1.85	1.72
CA	2.41	2.34	2.95	2.84	2.67	2.23	2.61	2.58
CO	3.43	3.93	3.48	3.38	3.12	3.12	3.55	3.43
CT	2.23	1.85	1.57	1.53	1.76	1.68	1.81	1.78
DE	1.84	1.78	1.52	1.53	1.44	1.64	1.92	1.67
DC	2.29	1.71	1.49	1.49	1.66	1.58	1.75	1.71
FL	2.18	1.94	2.02	1.87	1.86	1.94	1.93	1.96
GA	1.93	1.81	1.75	1.66	1.92	2.11	1.81	1.86
ID	3.08	3.3	3	3.38	2.9	2.77	2.93	3.05
IL	1.88	1.56	1.59	1.64	1.54	1.47	1.75	1.63
IN	1.75	1.58	1.48	1.47	1.46	1.65	1.83	1.6
IA	2.03	1.76	1.59	1.58	1.69	1.69	2.01	1.76
KS	1.87	1.73	1.73	1.82	1.78	1.93	2	1.84
KY	1.81	1.59	1.61	1.56	1.57	1.8	1.77	1.67
LA	2.01	1.91	1.86	1.75	2.03	2.4	2.34	2.04
ME	2.08	2.31	1.71	1.63	1.67	1.67	1.87	1.85
MD	2.07	1.79	1.68	1.66	1.99	2.04	1.95	1.88
MA	2.27	1.99	1.8	1.63	1.85	1.74	1.94	1.89
MI	1.85	1.73	1.9	1.79	1.55	1.54	1.72	1.73
MN	2.07	2.01	1.76	1.77	1.65	1.8	2.02	1.87
MS	1.91	1.83	1.77	1.63	1.97	2.33	1.91	1.91
MO	1.86	1.58	1.5	1.55	1.72	1.64	1.86	1.67
MT	3.27	3.22	2.88	3.23	2.8	3.21	3.56	3.17
NE	2.14	1.84	1.89	1.85	1.83	2.21	2.33	2.01
NV	3.23	3.37	3.93	4.43	3.53	2.89	2.9	3.47
NH	2.87	2.95	2.55	2.54	2.63	2.3	2.63	2.64
NJ	2.36	1.73	1.67	1.71	1.92	1.83	1.92	1.88
NM	2.55	2.37	3.11	2.99	2.5	2.36	2.53	2.63
NY	2.22	1.92	1.72	1.81	1.84	1.79	2.07	1.91
NC	2.03	1.85	1.84	1.64	1.87	2.09	2.08	1.91
ND	2.03	1.95	1.62	1.8	1.82	2.21	2.33	1.97
OH	1.81	1.54	1.57	1.53	1.51	1.54	1.56	1.58
OK	1.71	1.68	1.66	1.89	1.83	1.87	1.96	1.8
OR	2.41	2.48	2.6	2.95	2.66	2.28	2.34	2.53
PA	2.19	1.69	1.63	1.65	1.66	1.65	2.05	1.79
RI	1.8	1.62	1.52	1.32	1.39	1.34	1.33	1.47
SC	1.83	1.76	1.73	1.56	1.72	1.95	1.84	1.77
SD	2.31	2.02	1.79	2.03	1.89	2.22	2.29	2.08
TN	1.86	1.68	1.69	1.59	1.73	1.98	1.97	1.79
TX	1.74	1.67	1.83	1.83	1.71	1.82	1.91	1.79

Region	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb	Mean
UT	3.15	3.21	3.46	3.93	2.94	2.54	2.89	3.16
VT	2.6	2.36	1.96	1.96	2.1	2.05	2.61	2.23
VA	2.2	2.02	1.9	1.82	2.07	2.24	2.17	2.06
WA	1.99	2.06	2.06	2.26	2.02	1.84	1.98	2.03
WV	2.13	1.91	1.77	1.59	1.86	2.15	2.28	1.96
WI	2.18	2	1.68	1.69	1.54	1.58	1.98	1.81
WY	3.24	3.31	3.17	3.7	2.89	3.18	3.97	3.35
CENRAP	1.91	1.79	1.74	1.75	1.74	1.86	2.01	1.83
MANE_VU	2.25	1.98	1.75	1.74	1.84	1.78	2.03	1.91
MW	1.92	1.73	1.7	1.67	1.53	1.55	1.78	1.7
VISTAS	2.03	1.86	1.84	1.7	1.88	2.08	1.98	1.91

Figure 3-82: Episode AverageTemperature Error (Deg. C).

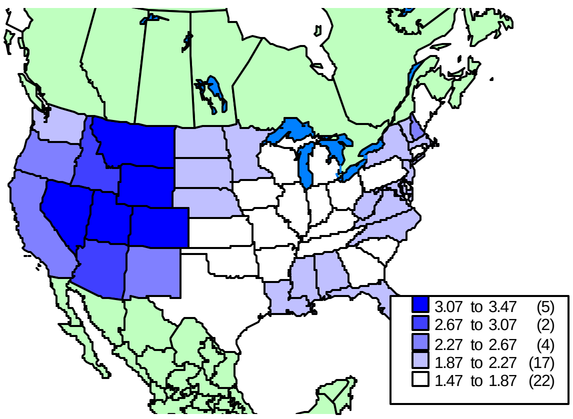


Figure 3-83: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for January-February 2001.

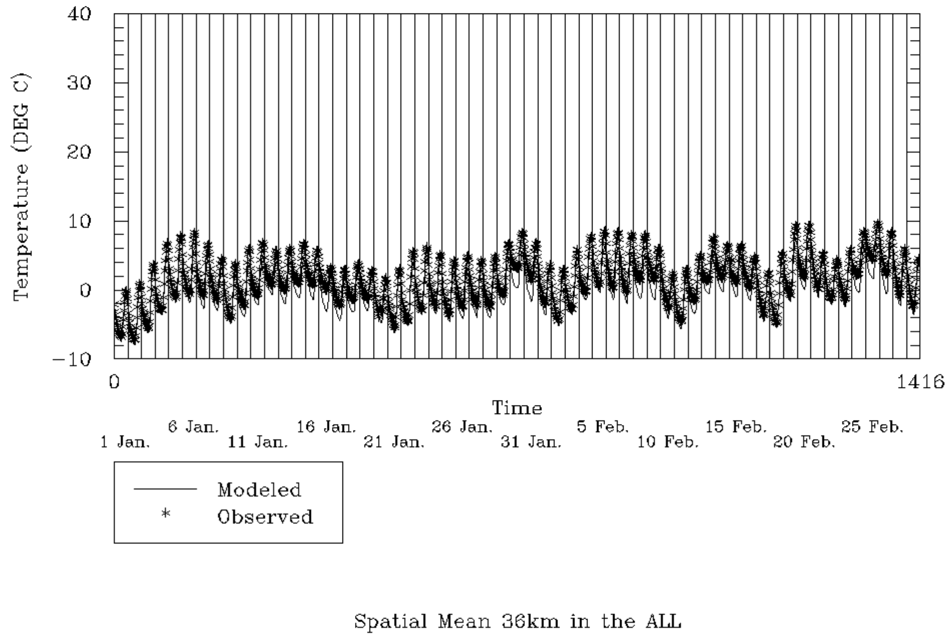


Figure 3-84: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for March-April 2001.

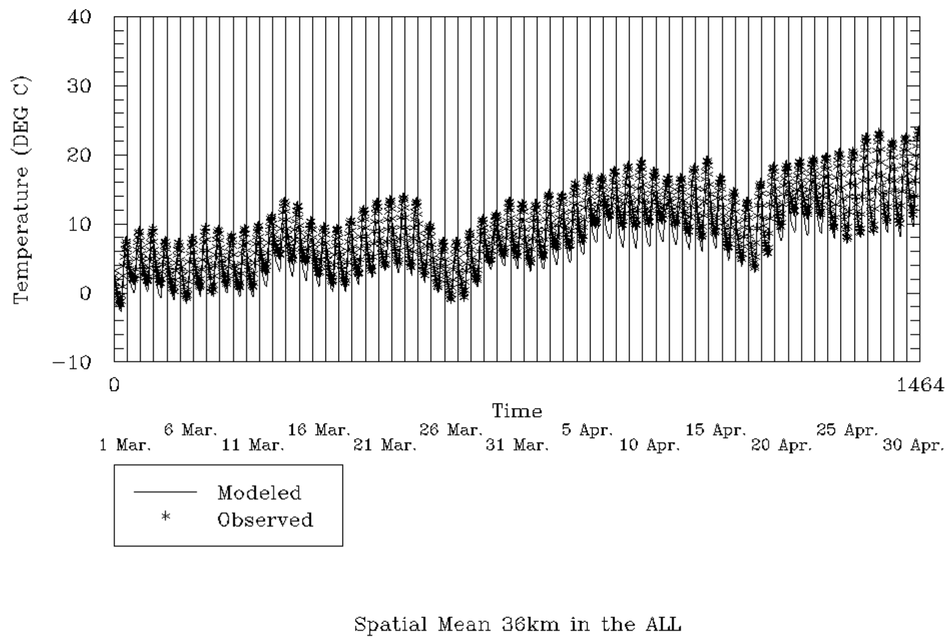


Figure 3-85: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for May-June 2001.

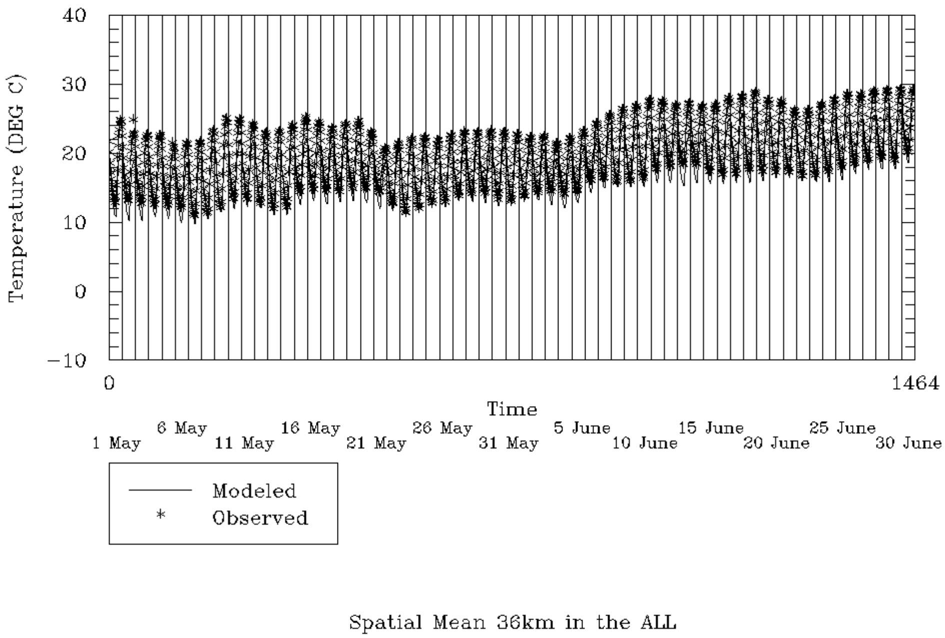


Figure 3-86: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for July-August 2001.

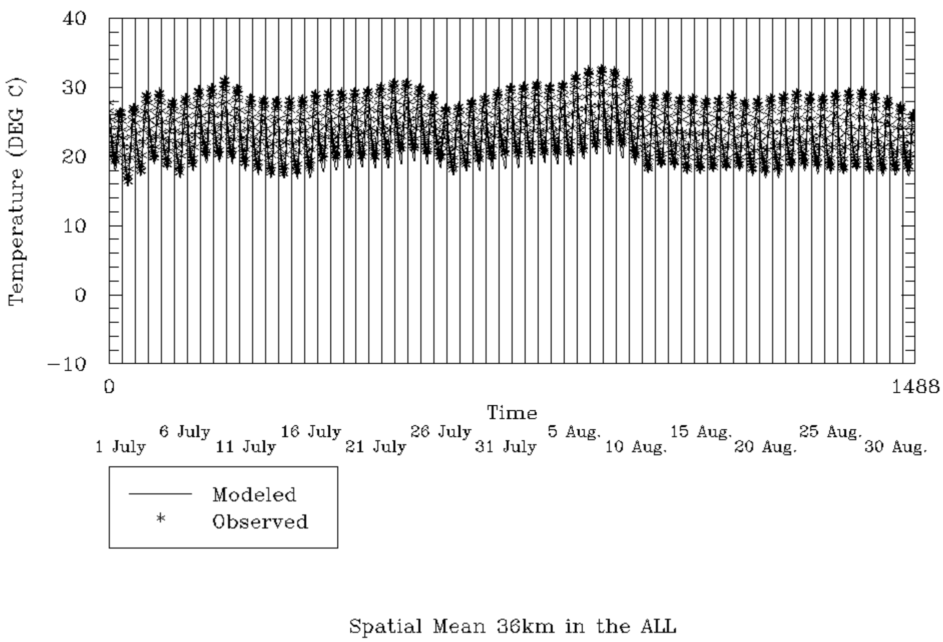


Figure 3-87: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for September-October 2001.

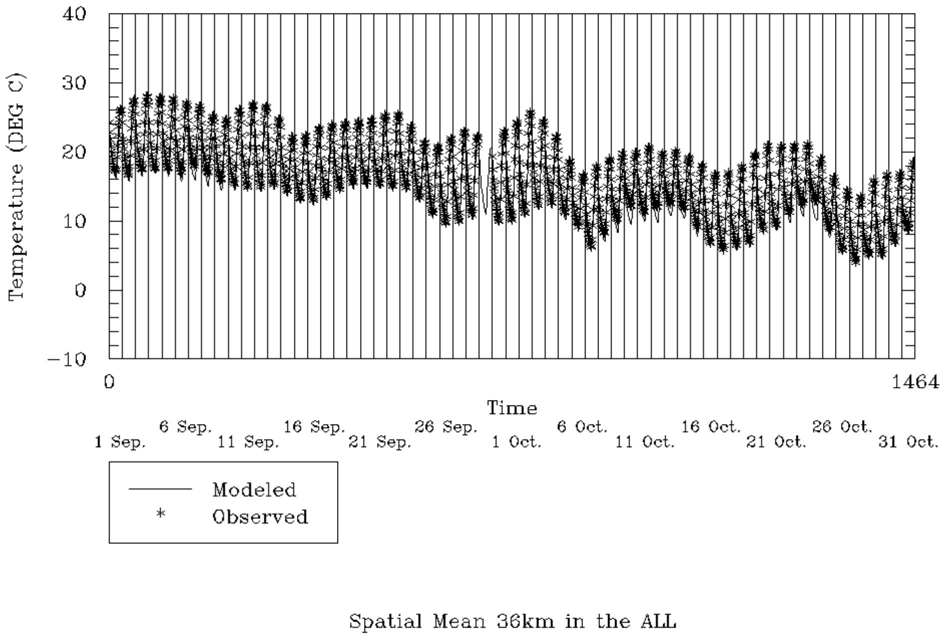


Figure 3-88: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for November-December 2001.

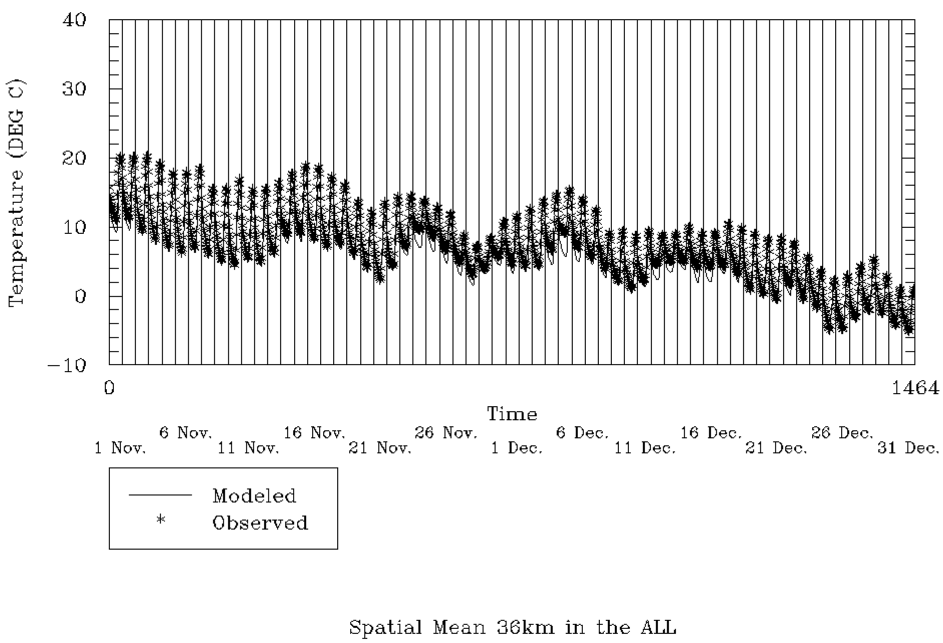


Figure 3-89: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for January-February 2002.

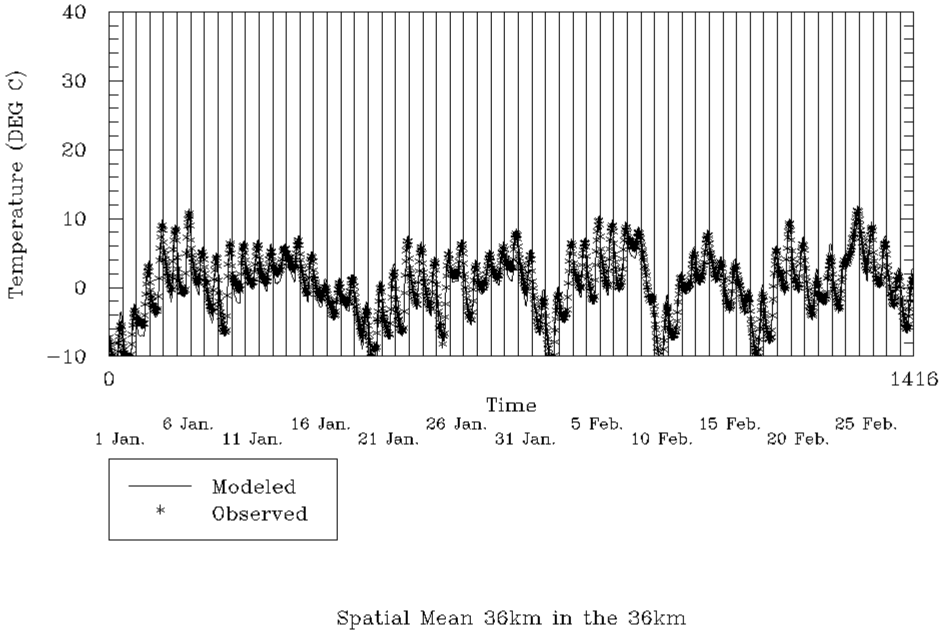


Figure 3-90: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for January-February 2001 for the CENRAP States.

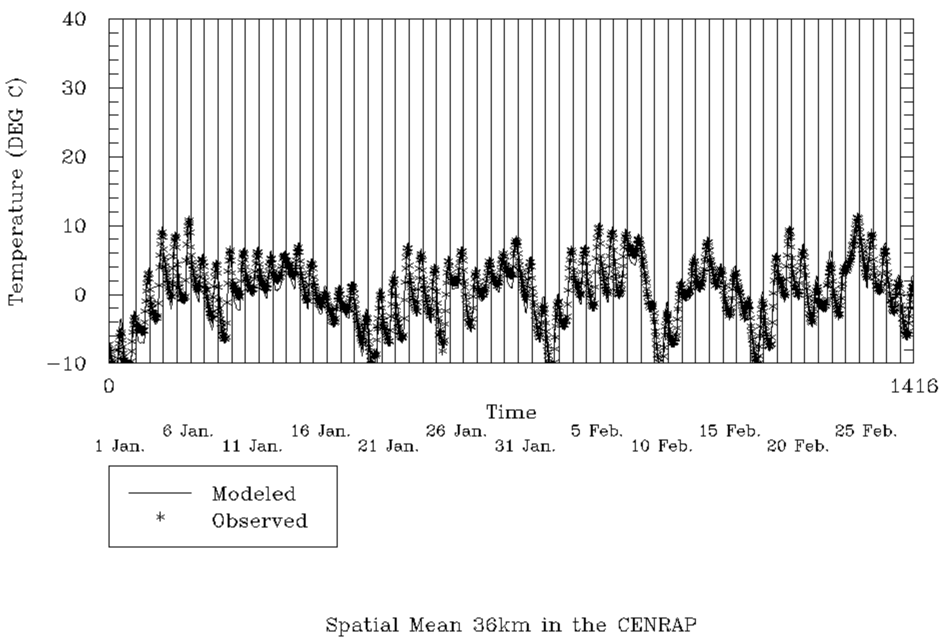


Figure 3-91: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for March-April 2001 for the CENRAP States.

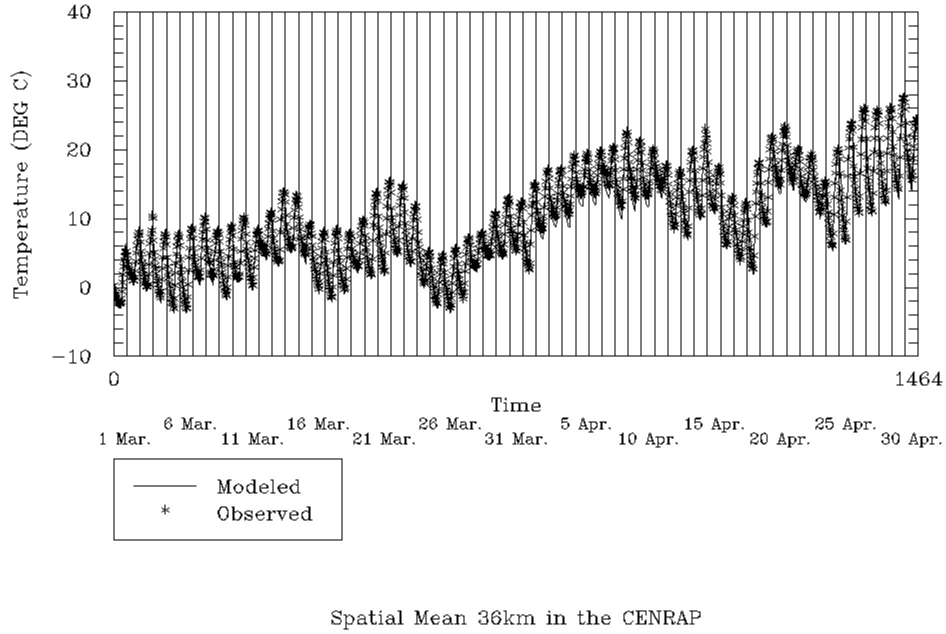


Figure 3-92: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for May-June 2001 for the CENRAP States.

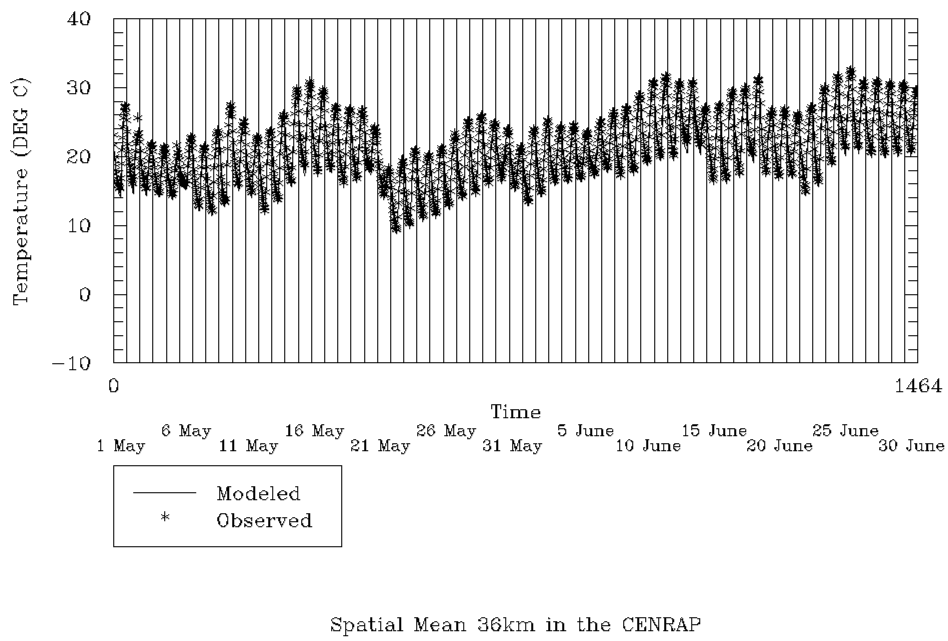


Figure 3-93: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for July-August 2001 for the CENRAP States.

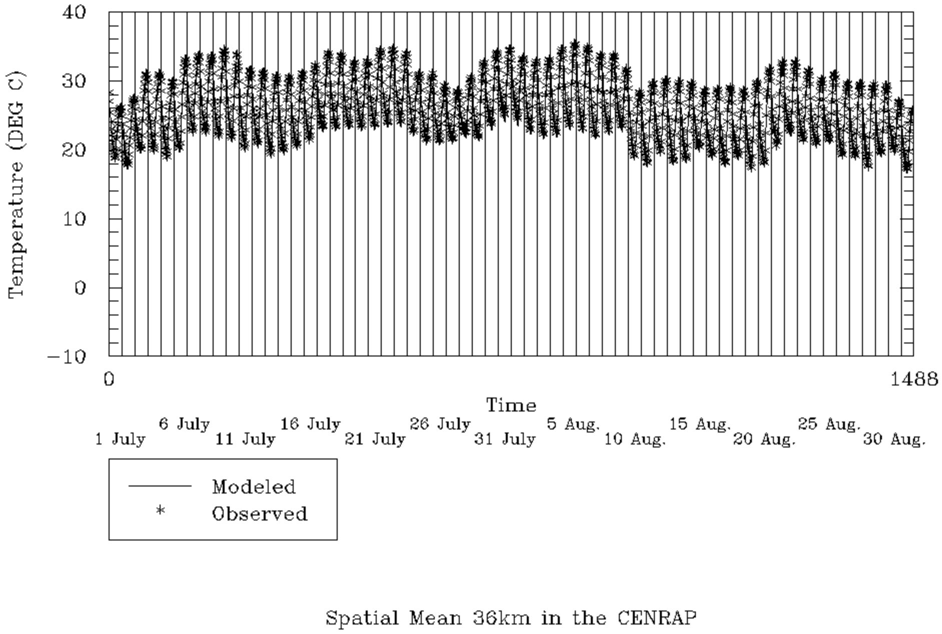


Figure 3-94: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for September-October 2001 for the CENRAP States.

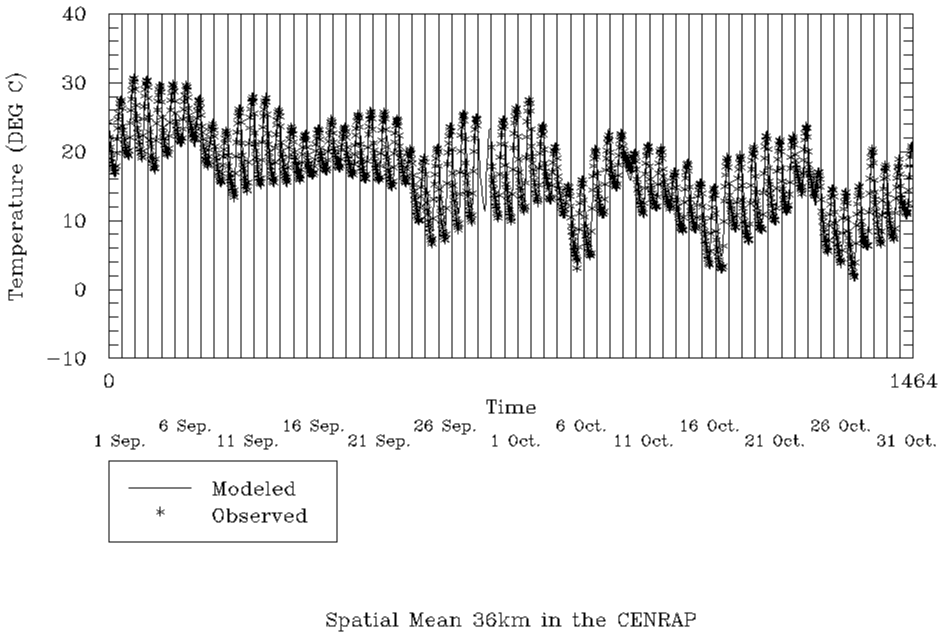


Figure 3-95: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for November-December 2001 for the CENRAP States.

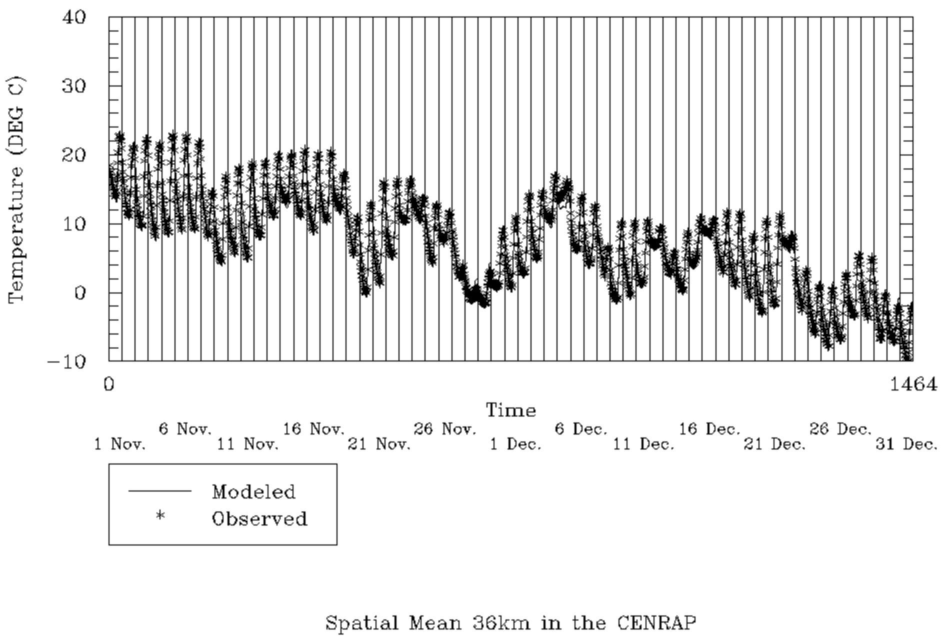


Figure 3-96: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for January-February 2002 for the CENRAP States.

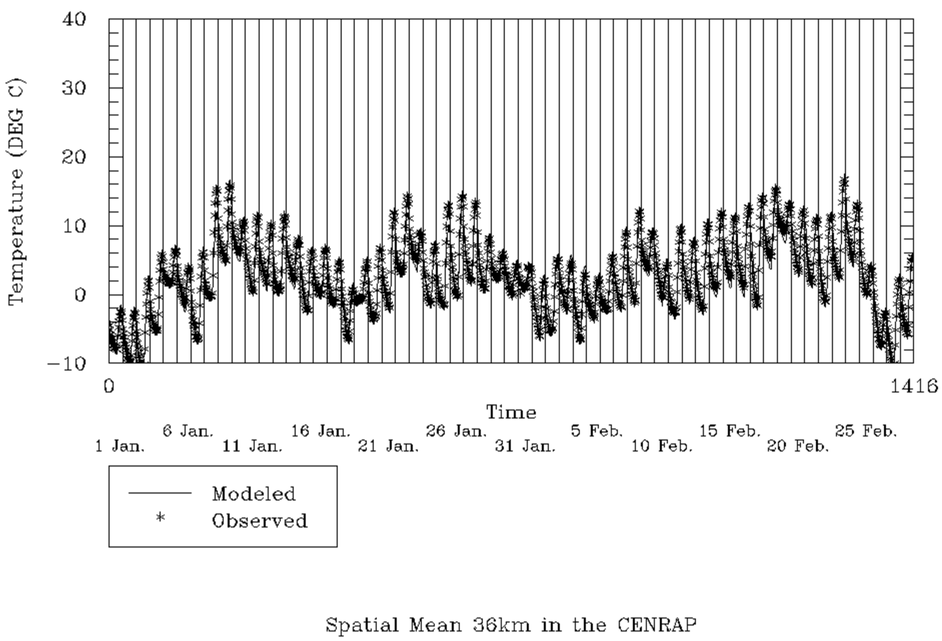


Figure 3-97: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for January-February 2001 for the MANE-VU States.

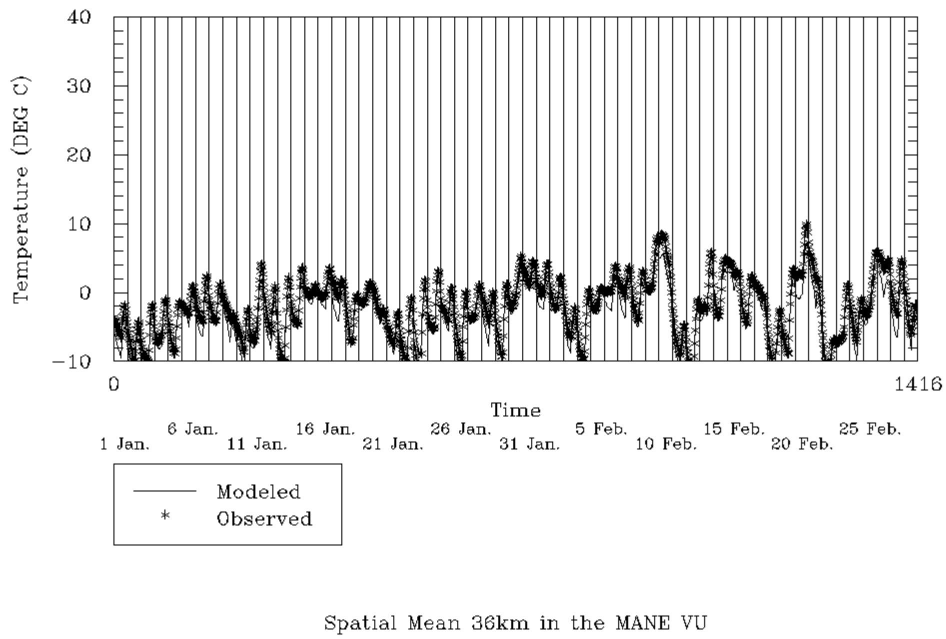


Figure 3-98: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for March-April 2001 for the MANE-VU States.

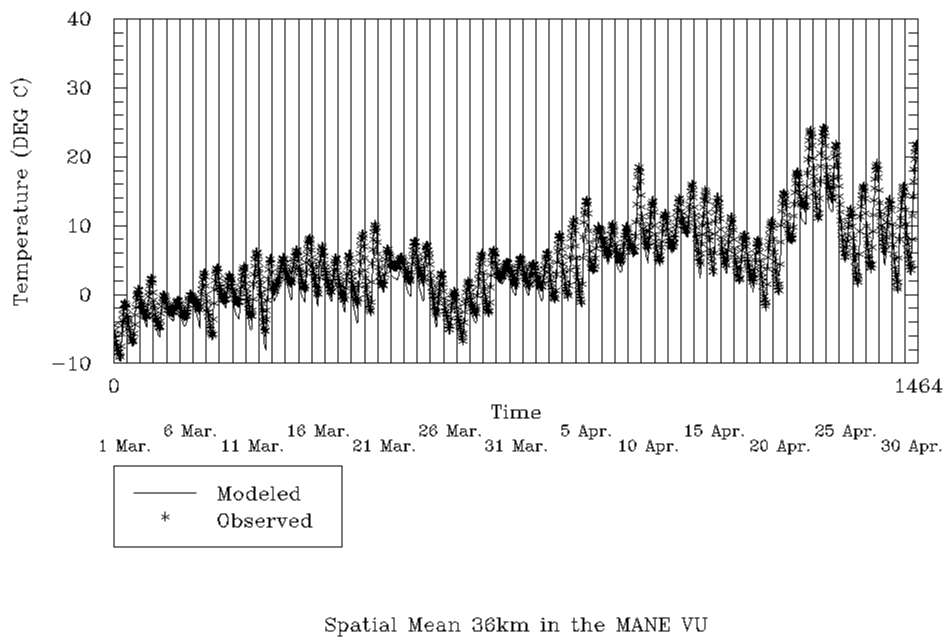


Figure 3-99: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for May-June 2001 for the MANE-VU States.

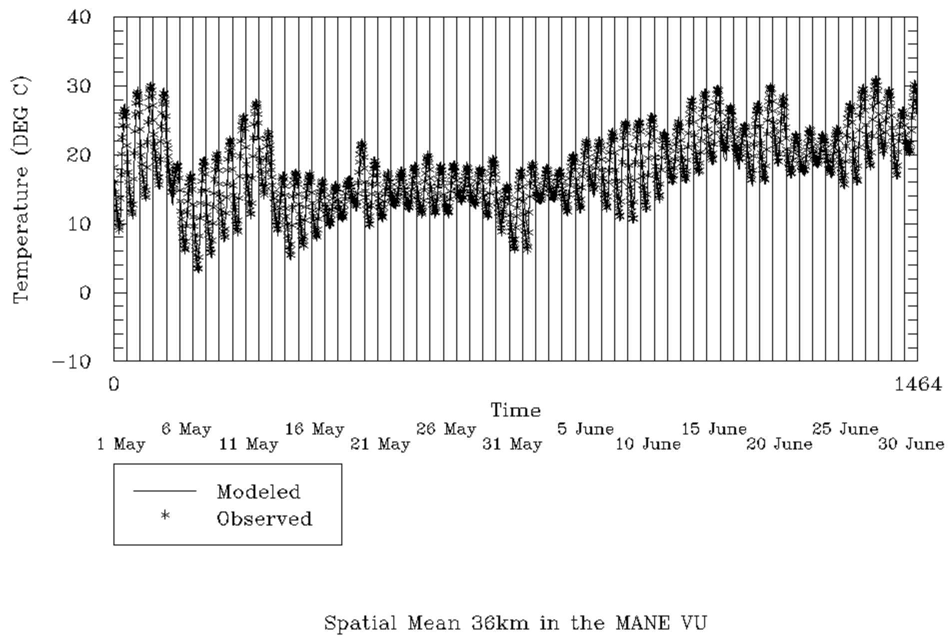


Figure 3-100: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for July-August 2001 for the MANE-VU States.

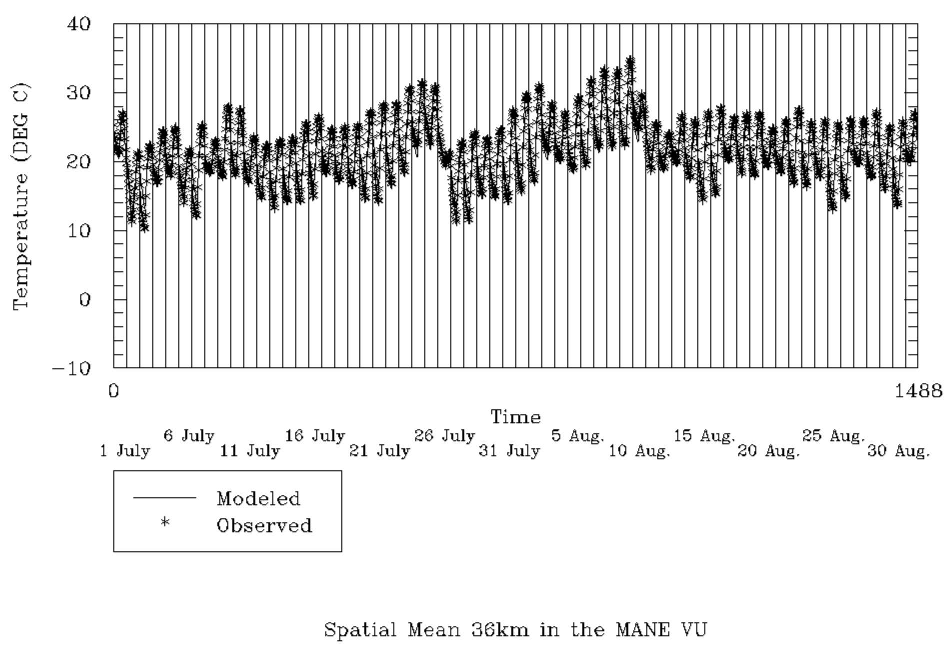


Figure 3-101: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for September-October 2001 for the MANE-VU States.

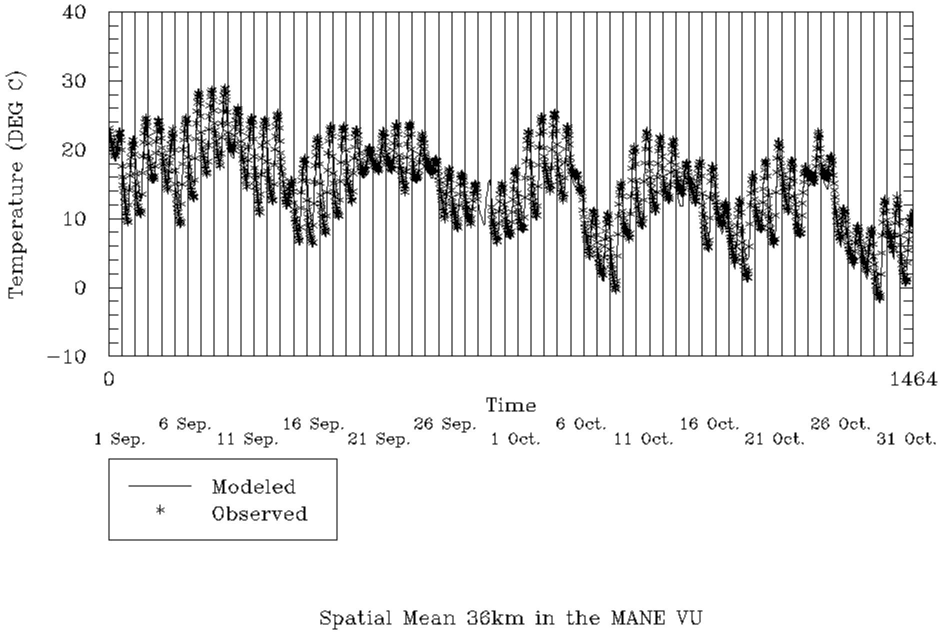


Figure 3-102: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for November-December 2001 for the MANE-VU States.

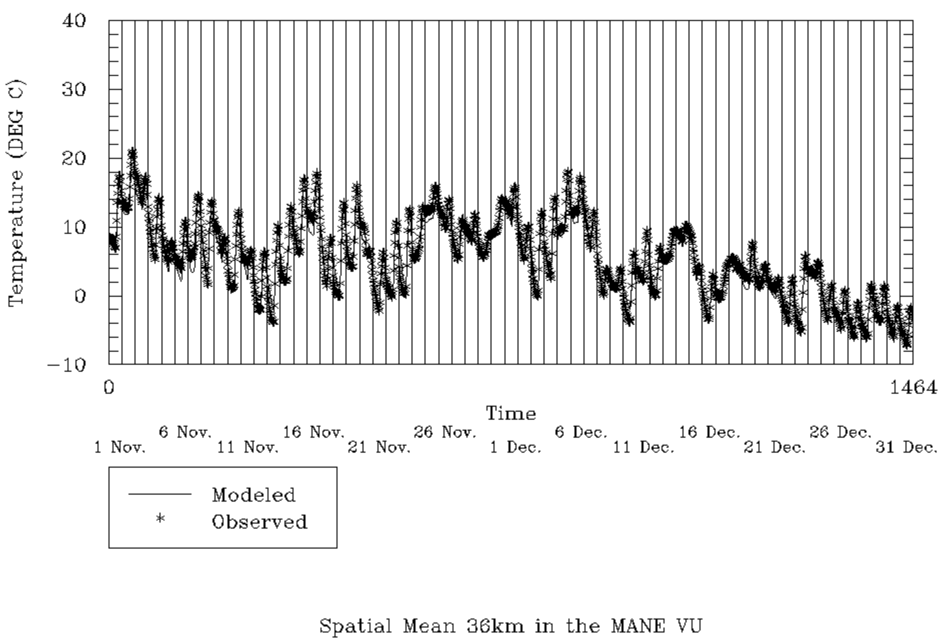


Figure 3-103: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for January-February 2002 for the MANE-VU States.

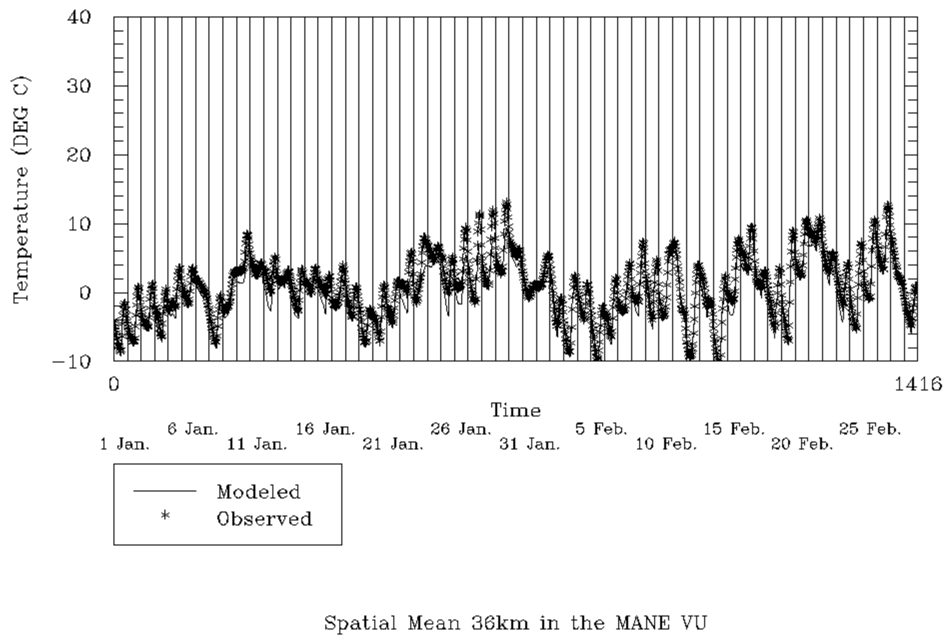


Figure 3-104: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for January-February 2001 for the Midwestern RPO States.

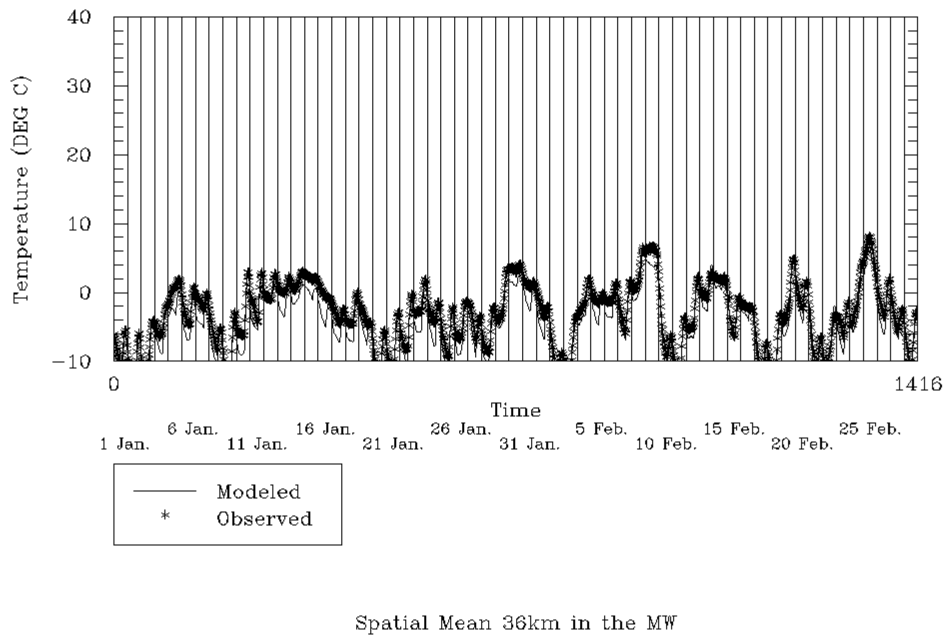


Figure 3-105: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for March-April 2001 for the Midwestern RPO States.

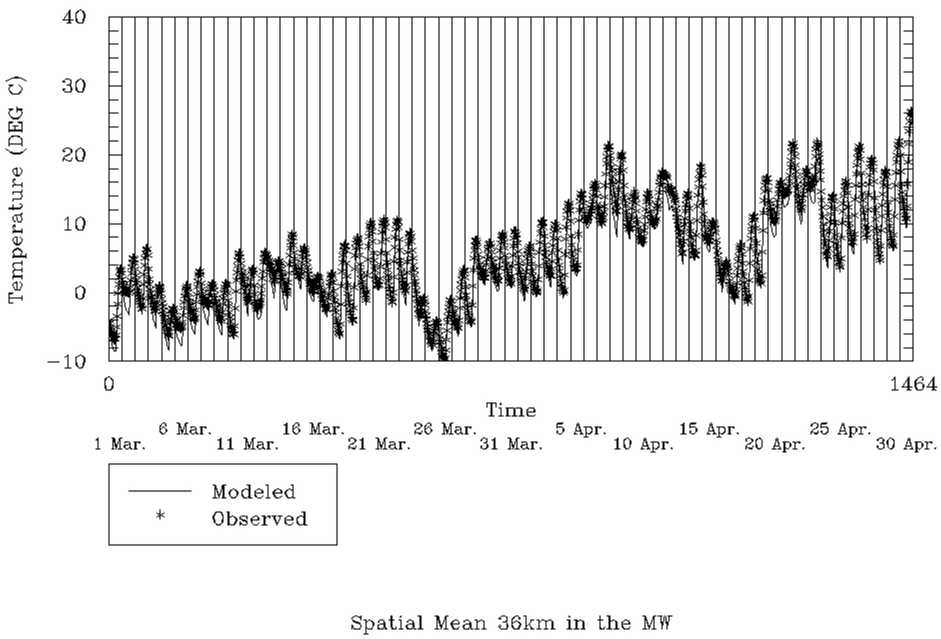


Figure 3-106: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for May-June 2001 for the Midwestern RPO States.

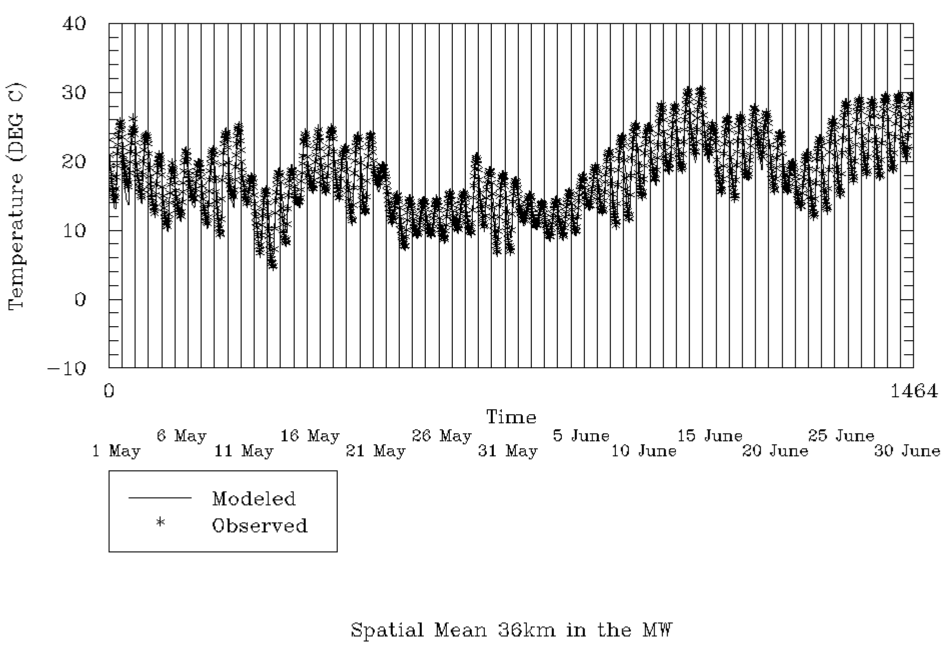


Figure 3-107: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for Ju;y-August 2001 for the Midwestern RPO States.

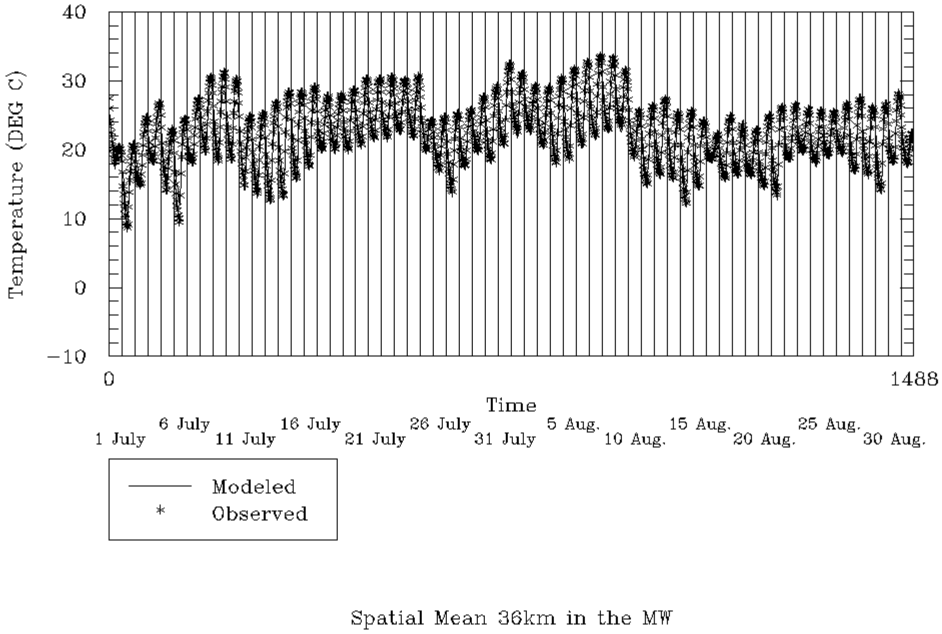


Figure 3-108: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for September-October 2001 for the Midwestern RPO States.

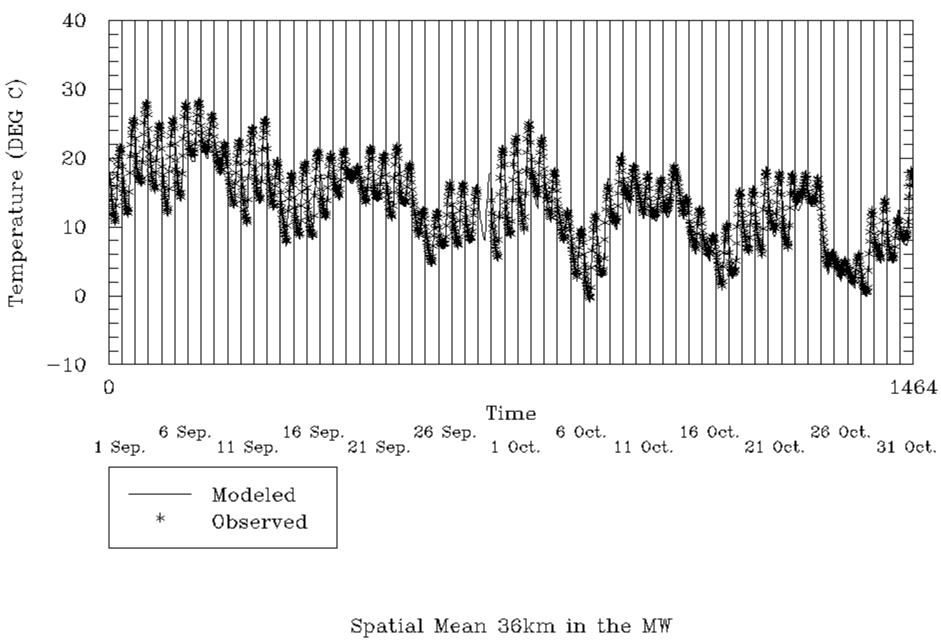
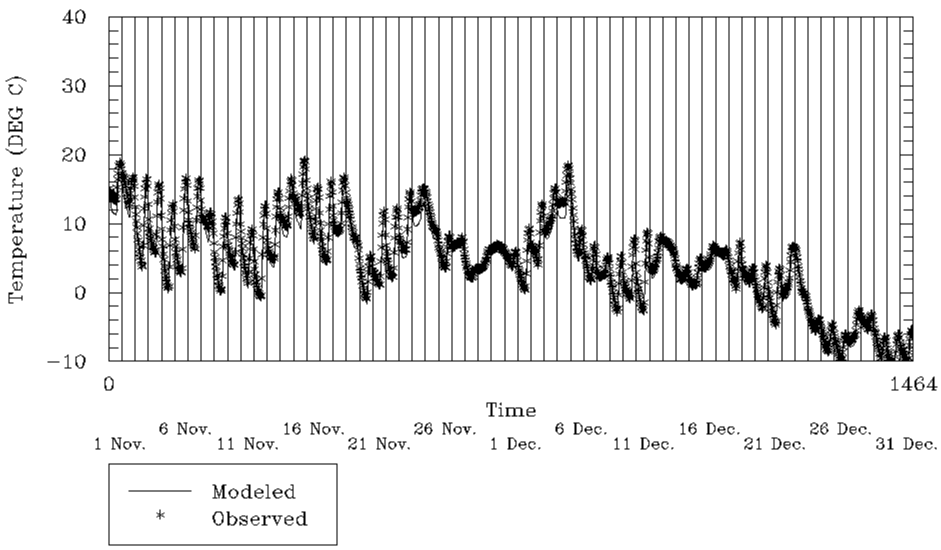
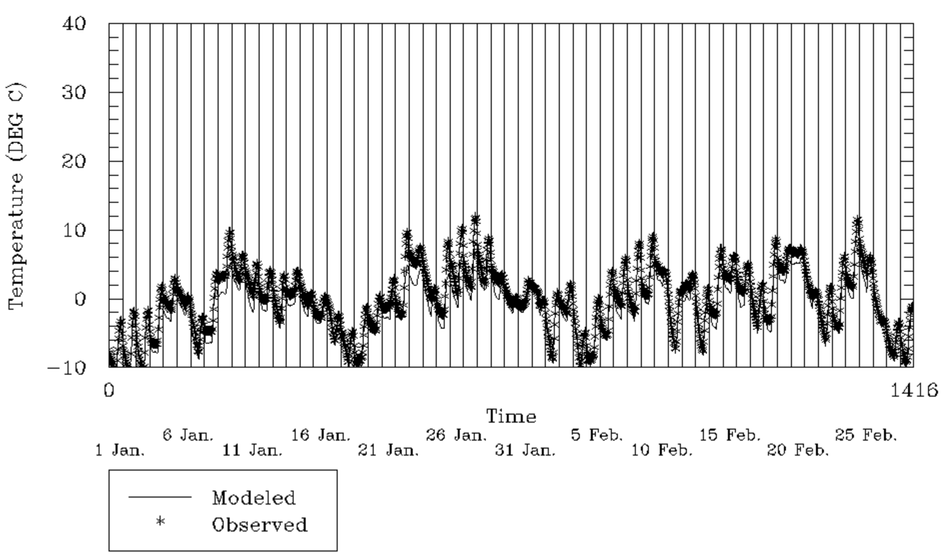


Figure 3-109: Model Estimated and Observe d Spatial Mean Temperatures (Deg. C) for November-December 2001 for the Midwestern RPO States.



Spatial Mean 36km in the MW

Figure 3-110: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for January-February 2002 for the Midwestern RPO States.



Spatial Mean 36km in the MW

Figure 3-111: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for January-February 2001 for the VISTAS States.

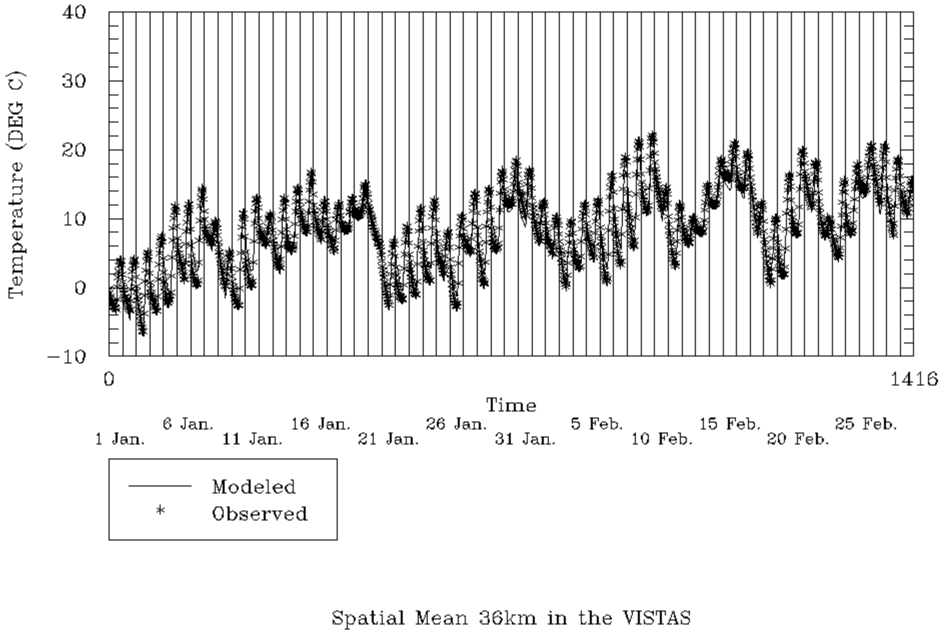


Figure 3-112: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for March-April 2001 for the VISTAS States.

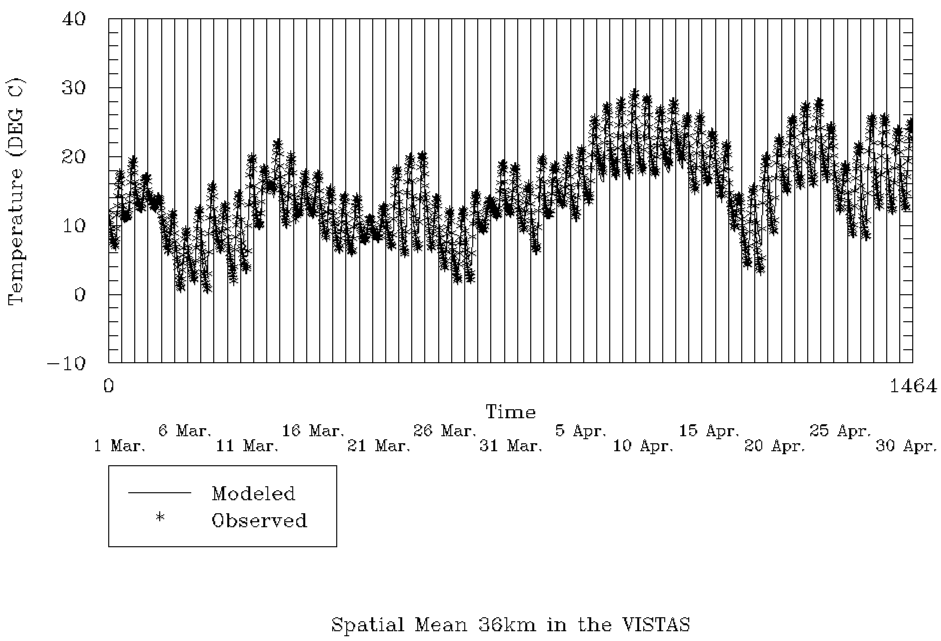


Figure 3-113: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for May-June 2001 for the VISTAS States.

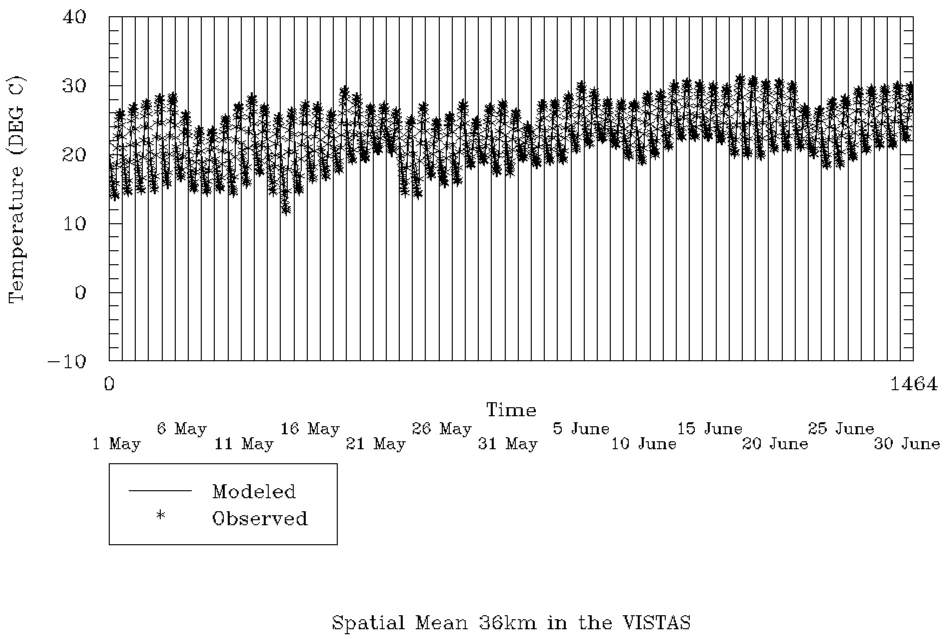


Figure 3-114: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for July-August 2001 for the VISTAS States.

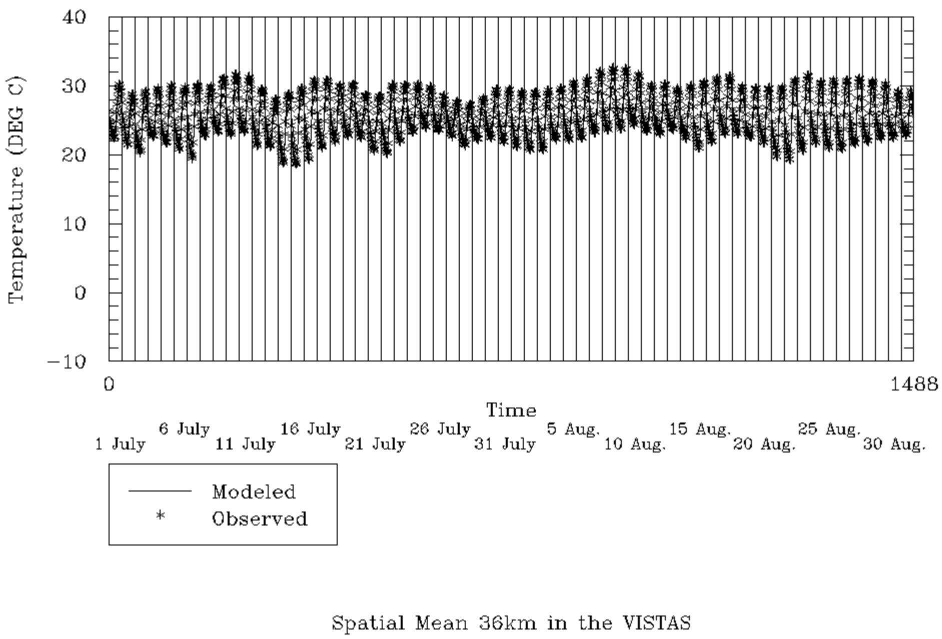


Figure 3-115: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for September-October 2001 for the VISTAS States.

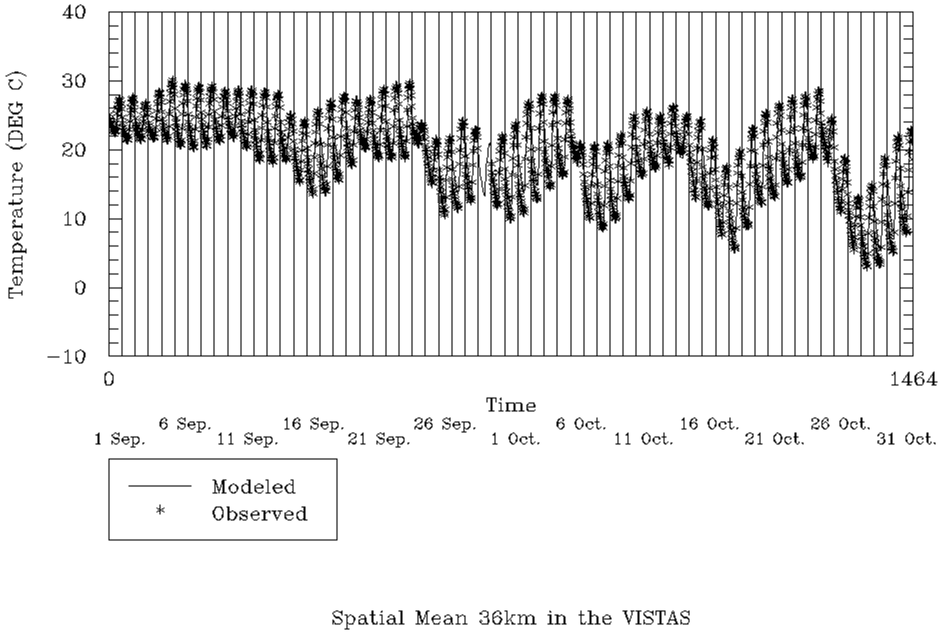


Figure 3-116: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for November-December 2001 for the VISTAS States.

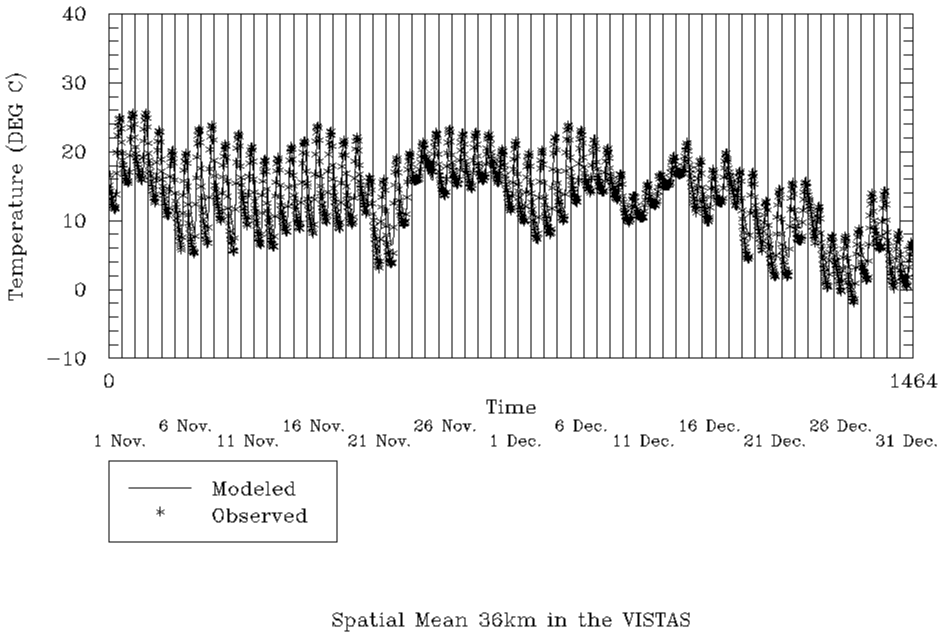


Figure 3-117: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for January-February 2002 for the VISTAS States.

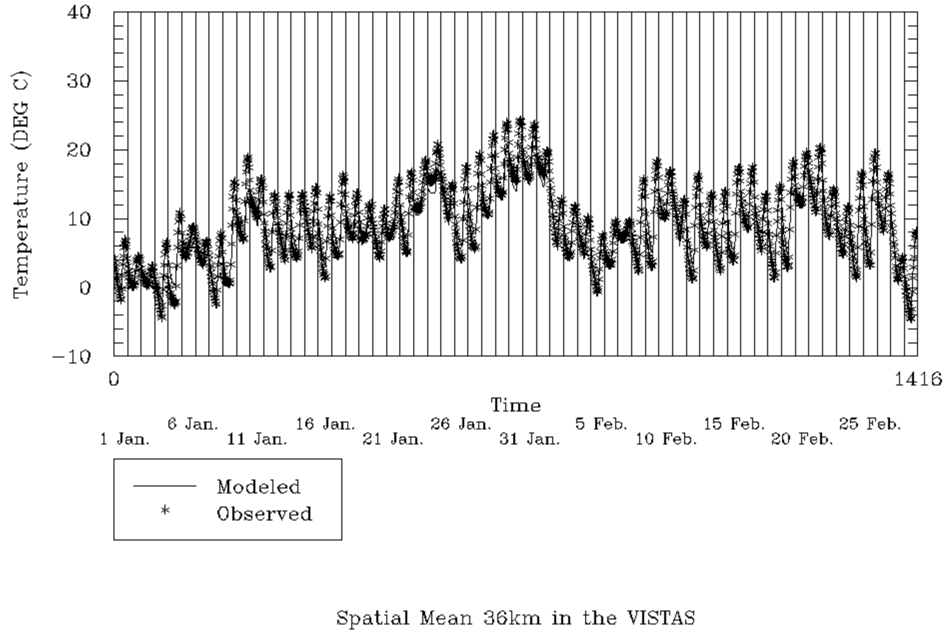


Figure 3-118: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for January-February 2001 for the WRAP States.

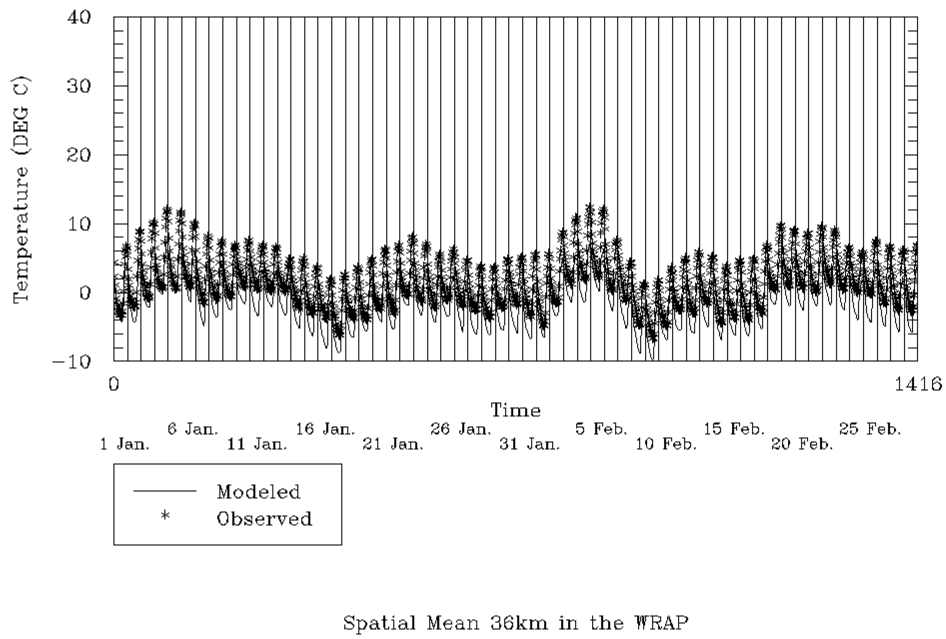


Figure 3-119: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for March-April 2001 for the WRAP States.

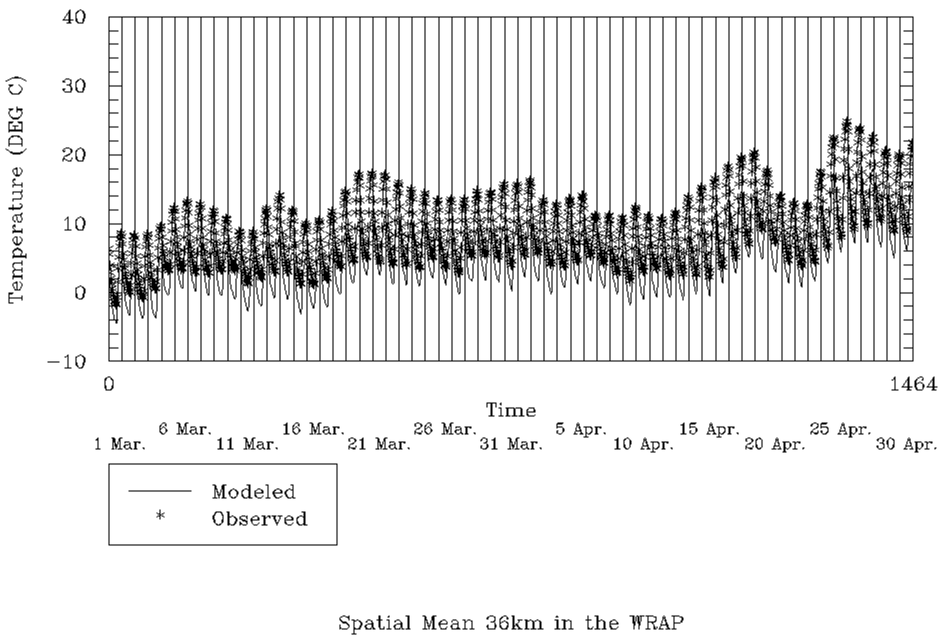


Figure 3-120: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for May-June 2001 for the WRAP States.

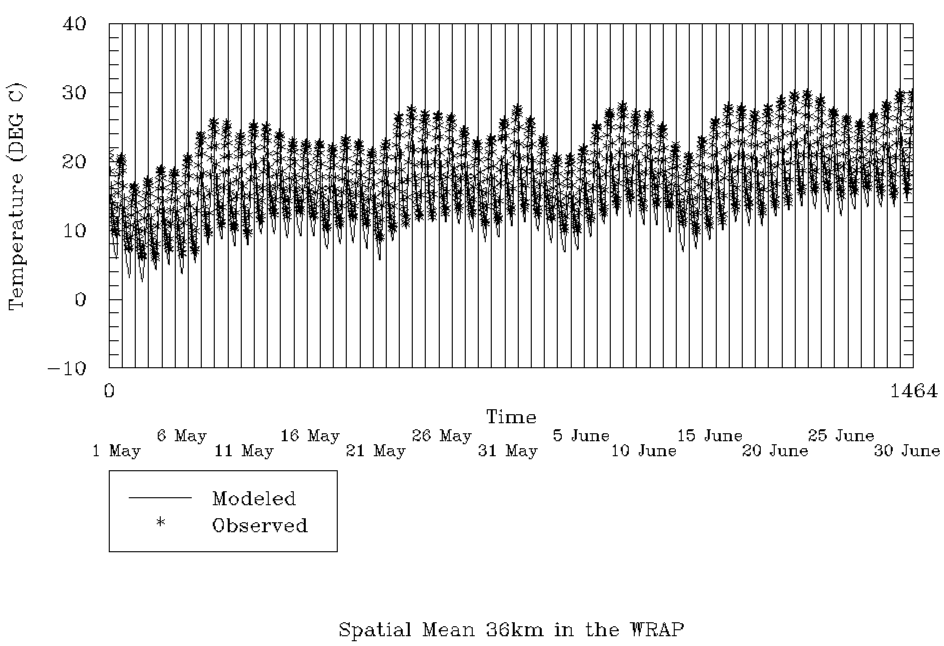


Figure 3-121: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for July-August 2001 for the WRAP States.

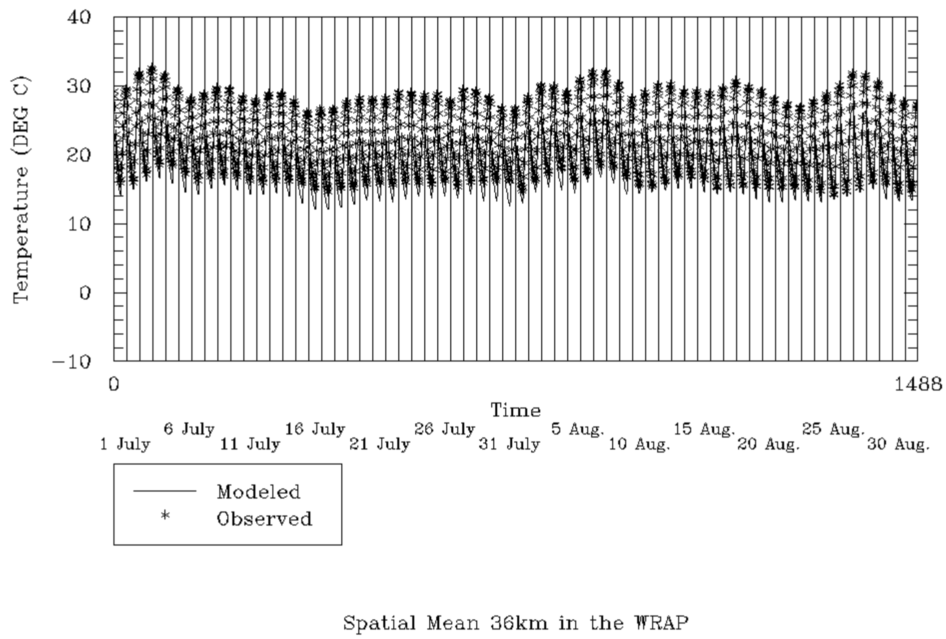


Figure 3-122: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for September-October 2001 for the WRAP States.

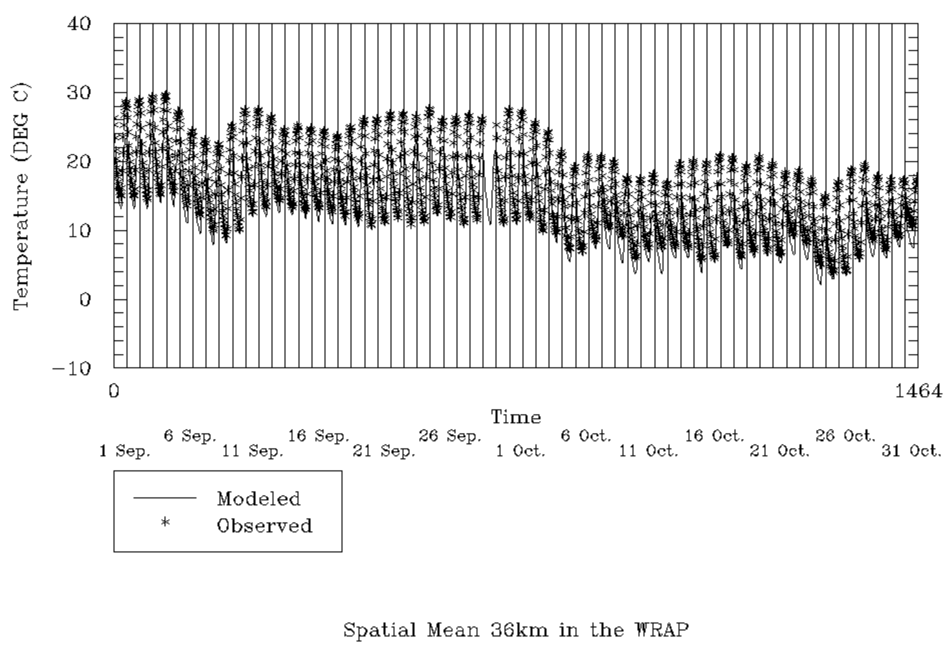


Figure 3-123: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for November-December 2001 for the WRAP States.

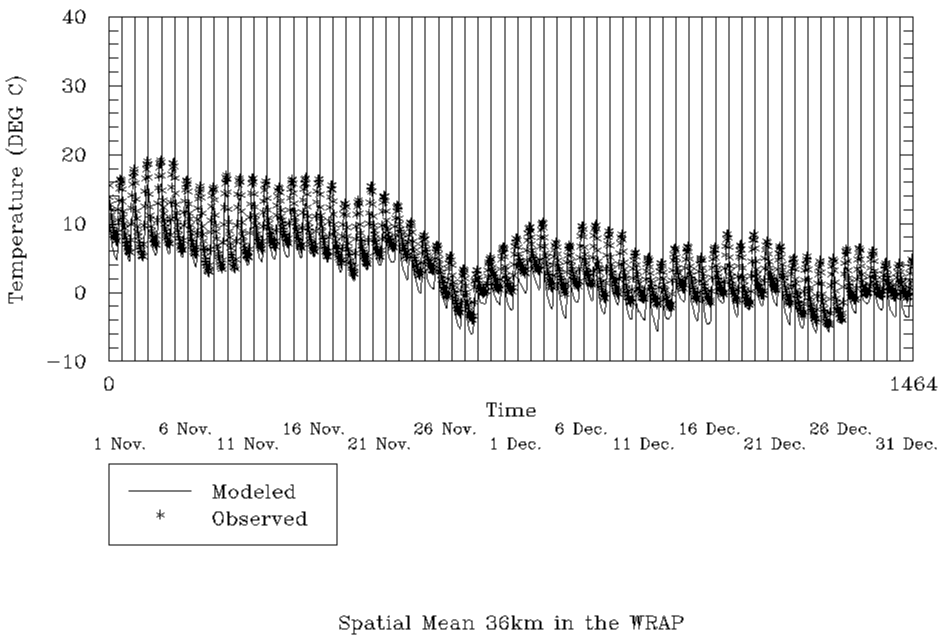


Figure 3-124: Model Estimated and Observed Spatial Mean Temperatures (Deg. C) for January-February 2002 for the WRAP States.

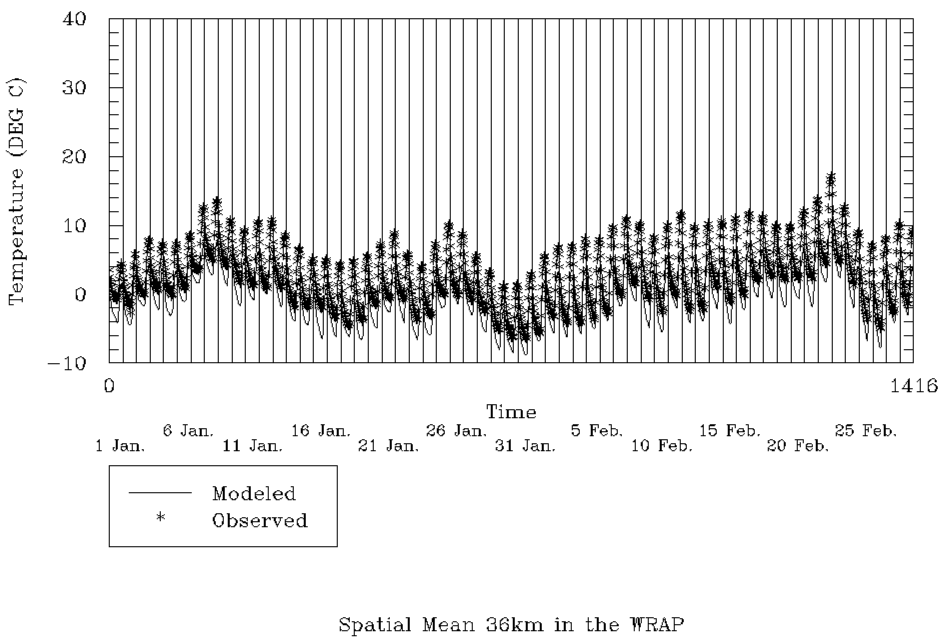


Table 3-3: Mixing Ratio Bias (g/kg) by State and Time Period for the 2001 Annual MM5 Simulation.

Region	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb	Mean
ALL	-0.16	-0.29	-0.37	-0.2	-0.27	0.01	-0.06	-0.19
AL	-0.21	0.2	-0.35	-0.22	-0.29	0.48	0.06	-0.05
AK	-0.05	0.02	0.08	0.11	0.1	0.12	0.11	0.07
AZ	-0.41	0.05	0.72	1.23	0.69	-0.04	-0.17	0.3
AR	-0.34	-0.12	-0.3	-0.42	-0.26	0.34	0.08	-0.15
CA	-0.3	-0.41	-0.6	-0.26	-0.37	-0.24	-0.58	-0.39
CO	-0.22	-0.65	-0.43	-0.35	-0.37	-0.26	0.08	-0.31
CT	0.04	-0.27	-0.68	-0.62	-0.51	-0.02	0.03	-0.29
DE	-0.1	-0.27	-0.68	-0.5	-0.12	0.23	-0.06	-0.21
DC	-0.58	-0.34	-0.77	-0.75	-0.81	-0.07	-0.11	-0.49
FL	0.37	0.28	-0.03	-0.03	-0.06	0.3	0.23	0.15
GA	-0.23	0.34	-0.38	-0.15	-0.18	0.44	0.16	0
ID	-0.24	-0.68	-0.47	0.25	-0.15	-0.05	-0.05	-0.2
IL	-0.22	-0.59	-0.48	-0.43	-0.41	-0.11	-0.16	-0.34
IN	-0.32	-0.76	-0.63	-0.35	-0.14	0.09	-0.09	-0.31
IA	-0.03	-0.57	-0.91	-0.67	-0.52	-0.24	-0.13	-0.44
KS	-0.25	-0.65	-0.26	-0.23	-0.45	-0.13	-0.15	-0.3
KY	-0.26	-0.32	0.08	0.17	0.03	0.52	0	0.03
LA	-0.08	0.01	0.13	0.15	0.07	0.59	0.2	0.15
ME	0.08	0.06	-0.21	0.26	-0.12	0.08	0.1	0.04
MD	-0.11	-0.26	-0.64	-0.26	-0.32	0.26	0.03	-0.19
MA	0.05	-0.05	-0.46	-0.18	0.03	0.19	0.07	-0.05
MI	-0.1	-0.43	-0.62	-0.15	-0.18	0.03	0.04	-0.2
MN	-0.02	-0.33	-0.53	-0.56	-0.47	-0.22	-0.05	-0.31
MS	-0.19	0.14	-0.29	-0.22	-0.37	0.5	0.06	-0.05
MO	-0.3	-0.51	-0.42	-0.47	-0.22	0.08	-0.13	-0.28
MT	0.01	-0.4	-0.24	0.2	0.1	0.1	0.11	-0.02
NE	-0.09	-0.61	-0.06	-0.38	-0.36	-0.18	-0.04	-0.25
NV	-0.22	-0.34	0.14	0.82	0.27	0.02	-0.21	0.07
NH	0.1	-0.02	-0.47	-0.19	-0.13	0.02	0.02	-0.1
NJ	-0.04	-0.29	-0.65	-0.47	-0.28	0.14	0.06	-0.22
NM	-0.31	-0.39	0.34	0.1	-0.24	-0.24	-0.17	-0.13
NY	0	-0.28	-0.61	-0.36	-0.26	0.01	0.06	-0.21
NC	-0.2	0.18	0.48	0.09	-0.18	0.29	0.07	0.1
ND	-0.02	-0.53	-0.62	-0.88	-0.37	-0.17	-0.01	-0.37
OH	-0.23	-0.69	-0.67	-0.26	-0.29	0.05	-0.03	-0.3
OK	-0.46	-0.65	-1.02	-0.64	-0.8	-0.15	-0.32	-0.58
OR	-0.37	-0.47	-0.41	0.27	0.1	-0.05	-0.17	-0.16
PA	-0.05	-0.31	-0.42	-0.18	-0.22	0.09	-0.01	-0.16
RI	0.05	-0.08	-0.53	-0.03	-0.05	-0.01	0.04	-0.09
SC	-0.22	0.33	0.19	0.27	-0.25	0.24	0.13	0.1
SD	0.05	-0.47	-0.36	-0.29	-0.28	-0.1	-0.03	-0.21
TN	-0.29	-0.27	-0.02	-0.14	-0.35	0.47	0.02	-0.08
TX	-0.36	-0.22	-0.46	-0.26	-0.54	-0.14	-0.07	-0.29

Region	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb	Mean
UT	-0.19	-0.56	0.23	0.88	0.12	-0.1	-0.04	0.05
VT	-0.01	-0.12	-0.53	-0.2	-0.19	0.07	0.06	-0.13
VA	-0.29	-0.35	-0.53	-0.78	-0.59	0.05	-0.13	-0.37
WA	-0.42	-0.44	-0.51	-0.1	-0.11	-0.1	-0.22	-0.27
WV	-0.12	-0.31	-0.47	-0.92	-0.49	0.25	0.01	-0.29
WI	-0.08	-0.35	-0.55	-0.48	-0.42	-0.23	-0.04	-0.31
WY	0.04	-0.44	-0.37	0.66	-0.07	0	0.14	-0.01
CENRAP	-0.2	-0.38	-0.48	-0.42	-0.44	-0.08	-0.07	-0.3
MANE_VU	0	-0.19	-0.51	-0.23	-0.2	0.08	0.04	-0.14
MW	-0.16	-0.51	-0.59	-0.32	-0.29	-0.05	-0.04	-0.28
VISTAS	-0.1	0.08	-0.09	-0.18	-0.25	0.31	0.08	-0.02

Figure 3-125: Episode Average Mixing Ratio Bias (g/kg).

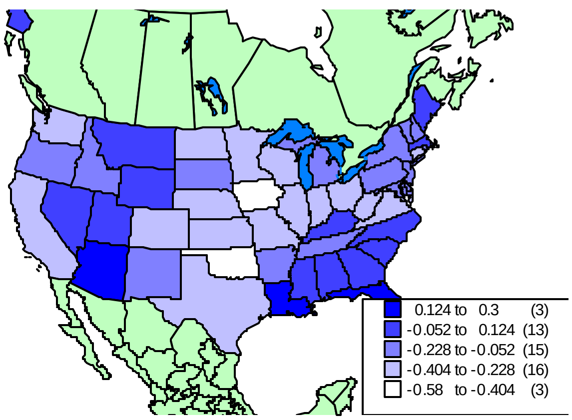


Table 3-4: Mixing Ratio Error (g/kg) by State and Time Period for the 2001 Annual MM5 Simulation.

Region	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb	Mean
ALL	0.59	0.89	1.35	1.52	1.1	0.71	0.62	0.97
AL	0.8	1.05	1.36	1.4	1.14	0.94	0.84	1.08
AK	0.43	0.43	0.49	0.66	0.54	0.41	0.44	0.49
AZ	0.92	1.06	1.71	2.64	1.62	0.9	0.65	1.36
AR	0.7	0.99	1.48	1.6	1.17	0.86	0.86	1.09
CA	0.93	0.98	1.34	1.37	1.32	0.96	1.06	1.14
CO	0.56	1.04	1.64	1.92	1	0.61	0.47	1.03
CT	0.35	0.61	1.16	1.33	1.02	0.57	0.46	0.79
DE	0.35	0.62	1.05	1.23	0.88	0.6	0.51	0.75
DC	0.66	0.78	1.33	1.42	1.15	0.65	0.58	0.94
FL	1.14	1.21	1.47	1.36	1.25	1.16	1.11	1.24
GA	0.8	1.05	1.46	1.48	1.19	0.96	0.79	1.1
ID	0.54	0.95	1.28	1.64	1.02	0.61	0.48	0.93
IL	0.45	0.94	1.32	1.6	1.07	0.61	0.57	0.94
IN	0.51	1.02	1.28	1.32	0.92	0.68	0.67	0.91
IA	0.35	0.93	1.55	1.7	1.16	0.62	0.44	0.96
KS	0.48	1.02	1.31	1.61	1.01	0.6	0.43	0.92
KY	0.56	0.85	1.22	1.34	1.02	0.83	0.82	0.95
LA	0.96	1.06	1.82	2.04	1.6	1.23	0.99	1.39
ME	0.28	0.45	1	1.11	0.9	0.46	0.31	0.64
MD	0.48	0.77	1.24	1.28	1.11	0.67	0.56	0.87
MA	0.34	0.53	1.07	1.13	0.98	0.59	0.4	0.72
MI	0.33	0.7	1.18	1.2	0.85	0.53	0.4	0.74
MN	0.29	0.69	1.34	1.58	0.97	0.51	0.36	0.82
MS	0.83	1.06	1.4	1.39	1.13	0.95	0.9	1.09
MO	0.52	0.99	1.26	1.47	1.06	0.69	0.61	0.94
MT	0.4	0.67	1.12	1.4	0.85	0.45	0.42	0.76
NE	0.38	0.91	1.23	1.63	0.95	0.54	0.38	0.86
NV	0.57	0.9	1.5	2.18	1.21	0.62	0.56	1.08
NH	0.34	0.52	1.05	1.12	1.08	0.5	0.35	0.71
NJ	0.43	0.71	1.25	1.38	1.01	0.65	0.53	0.85
NM	0.7	1.05	1.97	2.09	1.23	0.67	0.54	1.18
NY	0.34	0.62	1.11	1.25	0.94	0.54	0.43	0.75
NC	0.79	0.99	1.37	1.41	1.21	0.91	0.78	1.07
ND	0.28	0.73	1.24	1.53	0.8	0.44	0.36	0.77
OH	0.45	0.93	1.26	1.21	0.99	0.66	0.61	0.87
OK	0.72	1.07	1.7	2.07	1.37	0.74	0.68	1.19
OR	0.66	0.78	1.1	1.21	0.94	0.57	0.51	0.82
PA	0.42	0.77	1.2	1.33	0.99	0.63	0.55	0.84
RI	0.33	0.55	1.01	1.06	0.82	0.47	0.41	0.66
SC	0.78	0.99	1.29	1.41	1.21	0.92	0.8	1.06
SD	0.33	0.76	1.24	1.58	0.85	0.43	0.34	0.79
TN	0.65	0.91	1.26	1.31	1.05	0.84	0.83	0.98
TX	0.89	1.12	1.62	1.83	1.37	0.9	0.82	1.22

Region	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb	Mean
UT	0.51	0.96	1.47	2.05	1.04	0.61	0.45	1.01
VT	0.32	0.53	1.09	1.11	0.94	0.47	0.35	0.69
VA	0.64	0.88	1.4	1.59	1.21	0.79	0.67	1.03
WA	0.6	0.72	0.95	0.99	0.79	0.54	0.48	0.72
WV	0.49	0.83	1.3	1.62	1.07	0.76	0.64	0.96
WI	0.31	0.7	1.2	1.38	0.94	0.56	0.41	0.79
WY	0.41	0.76	1.4	1.77	0.97	0.49	0.43	0.89
CENRAP	0.57	0.95	1.48	1.72	1.17	0.71	0.59	1.03
MANE_VU	0.37	0.62	1.12	1.23	0.97	0.57	0.45	0.76
MW	0.38	0.8	1.23	1.32	0.94	0.59	0.49	0.82
VISTAS	0.81	1.02	1.39	1.43	1.18	0.94	0.85	1.09

Figure 3-126: Episode Average Mixing Ratio Error (g/kg).

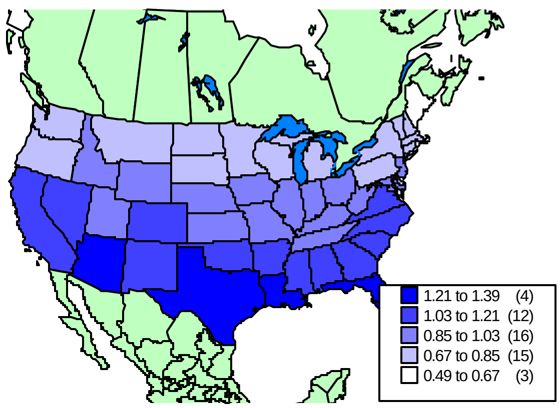


Figure 3-127: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for January-February 2001.

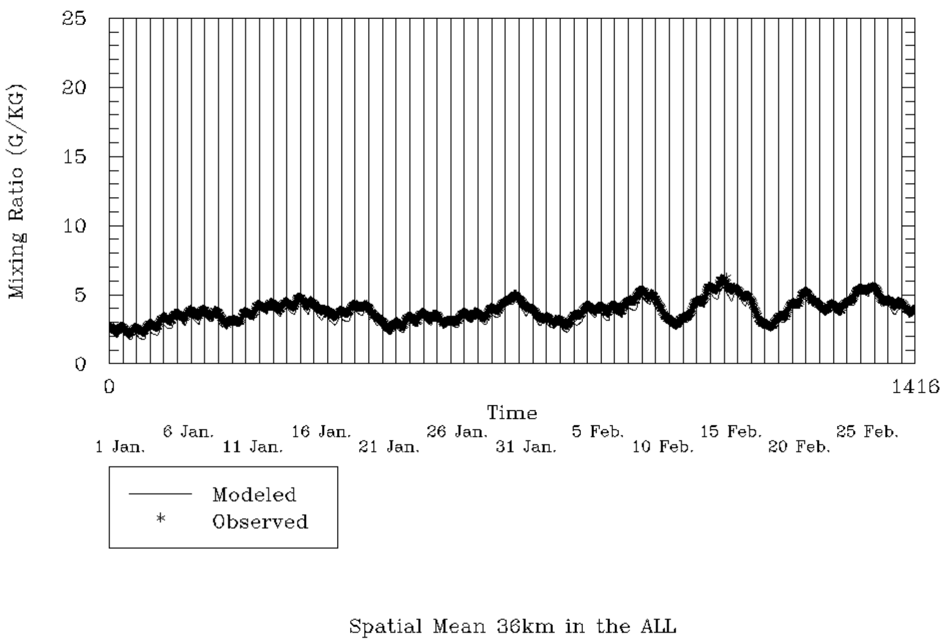


Figure 3-128: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for March-April 2001.

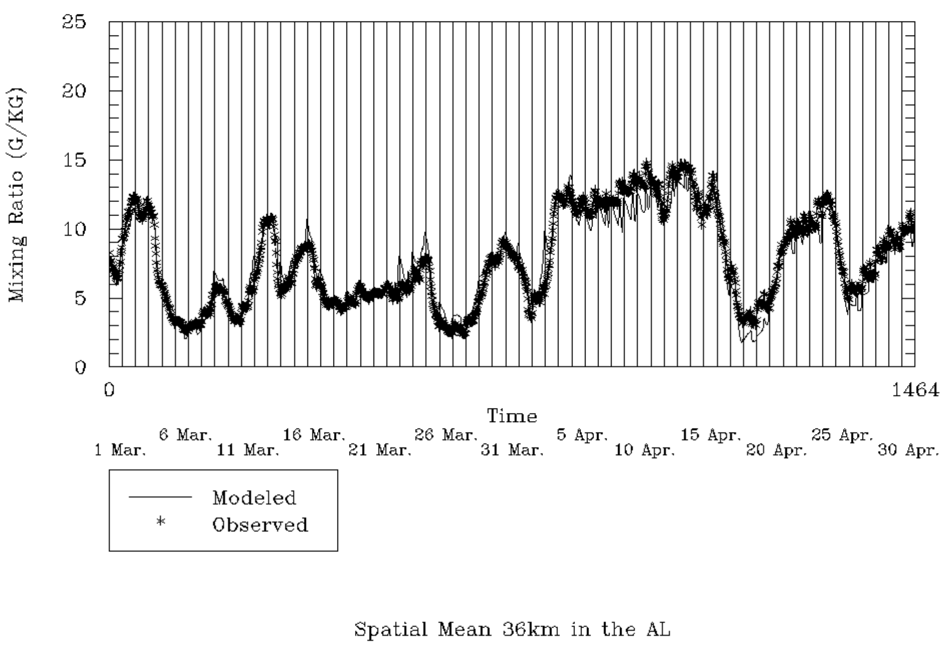


Figure 3-129: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for May-June 2001.

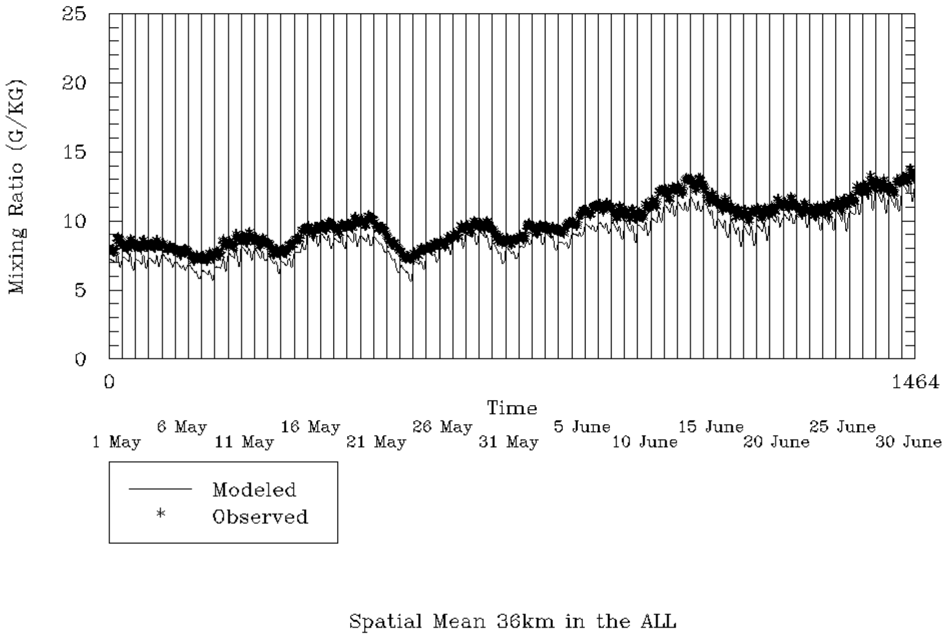


Figure 3-130: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for July-August 2001.

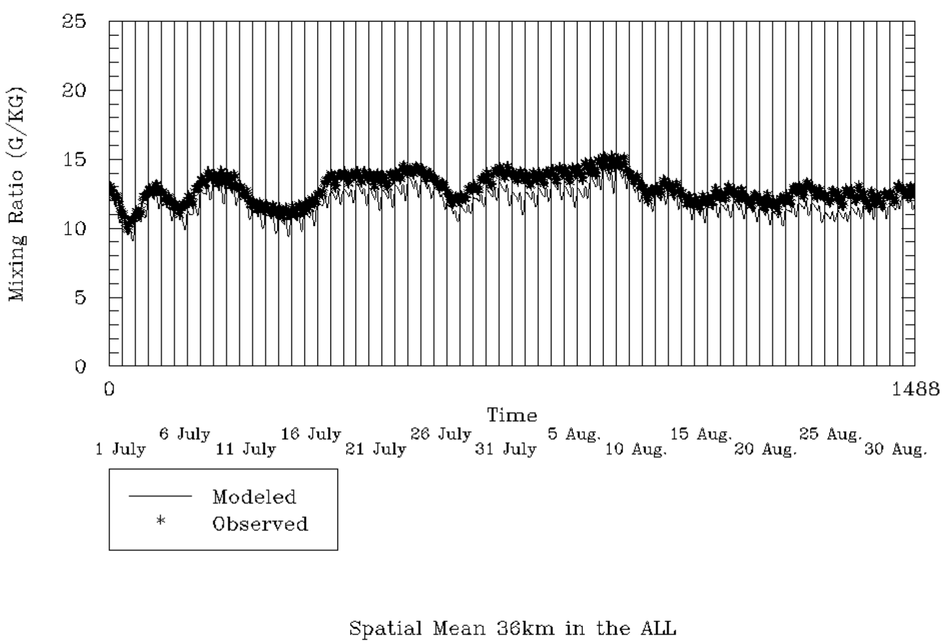


Figure 3-131: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for September-October 2001.

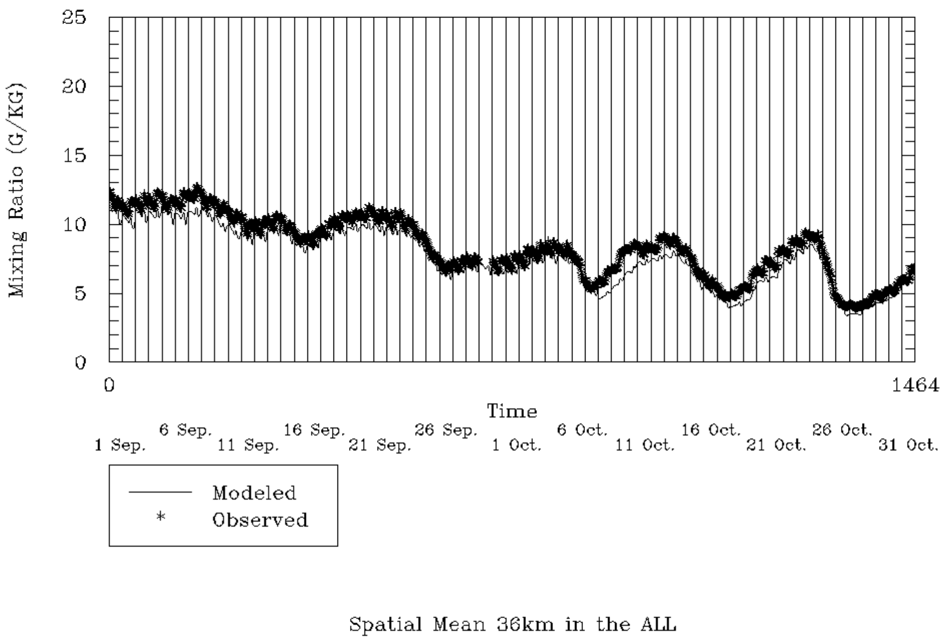


Figure 3-132: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for November-December 2001.

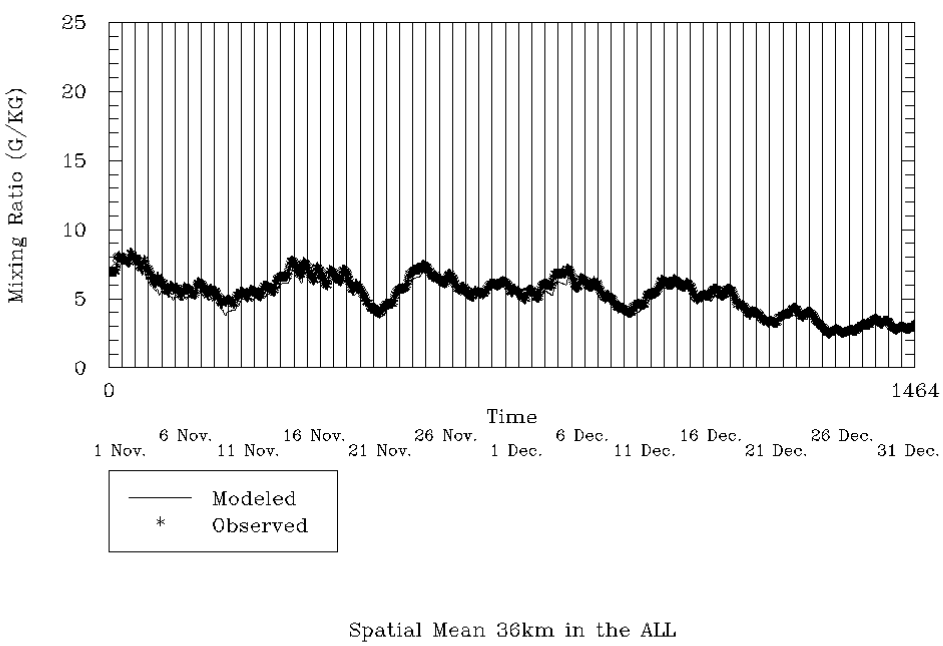


Figure 3-133: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for January-February 2002.

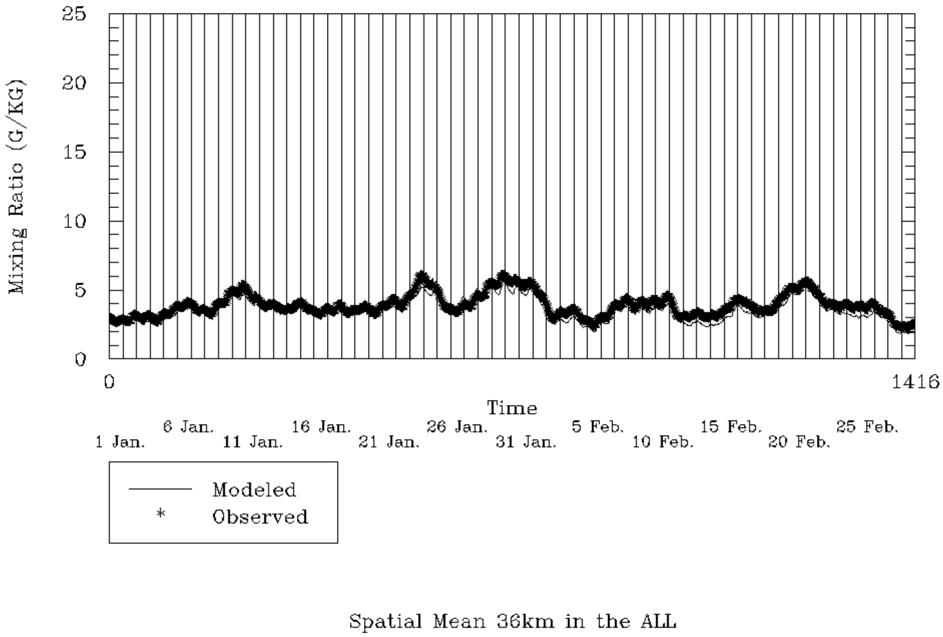


Figure 3-134: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for January-February 2001 in the CENRAP States.

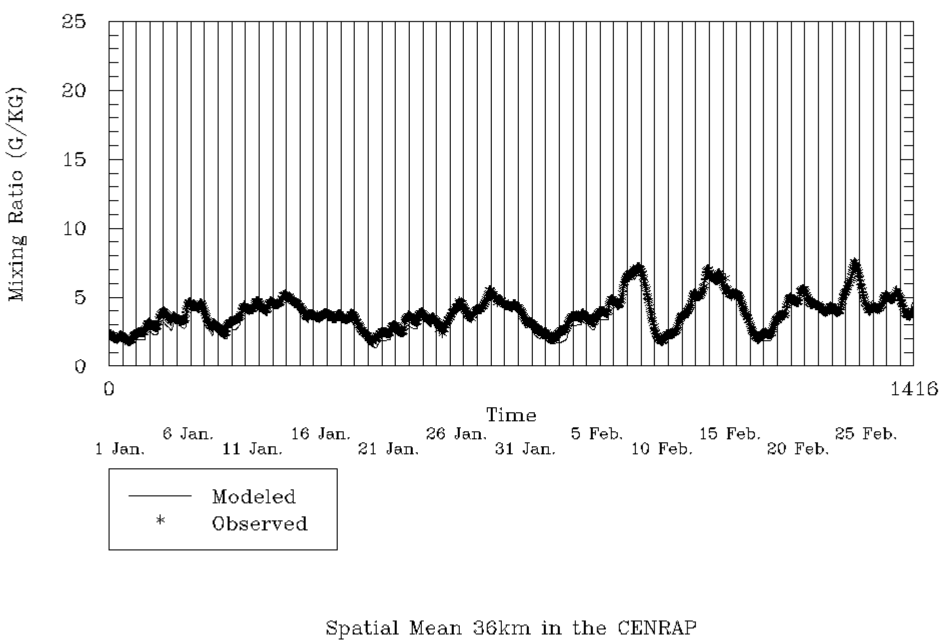
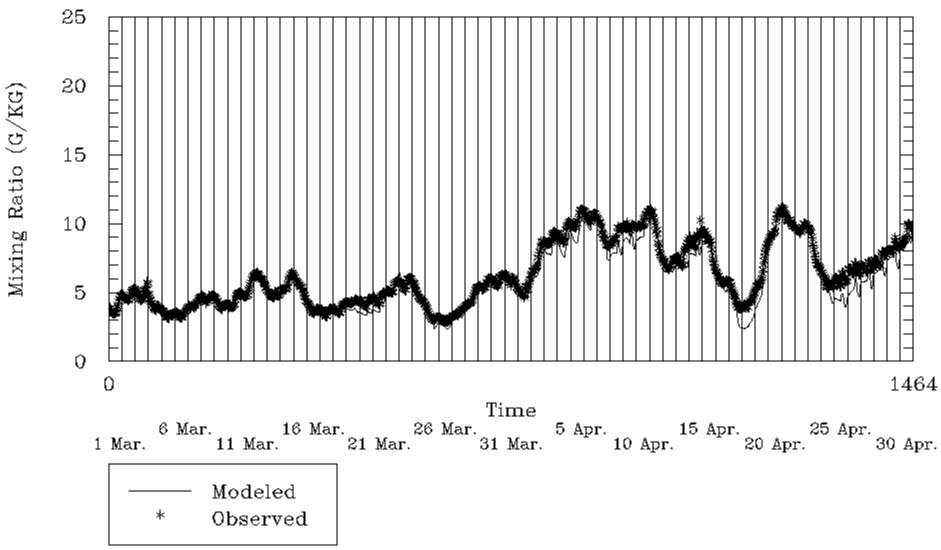
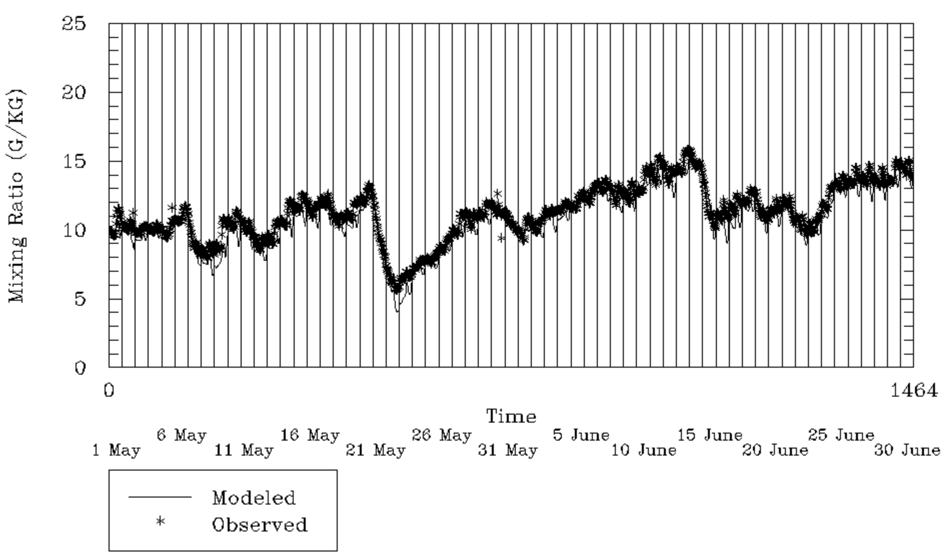


Figure 3-135: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for March-April 2001 in the CENRAP States.



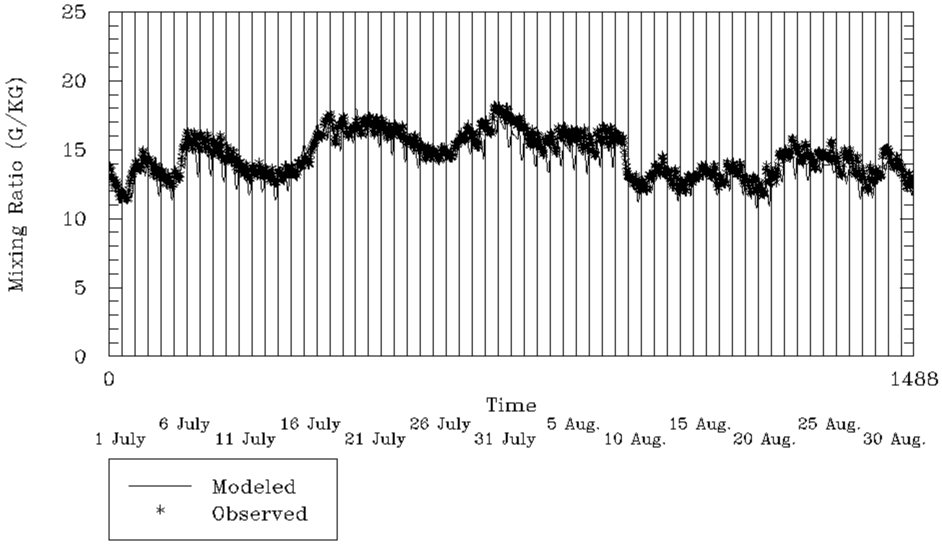
Spatial Mean 36km in the CENRAP

Figure 3-136: Model Estimated and Observed Spatial Me an Mixing Ratio (g/kg) for May-June 2001 in the CENRAP States.



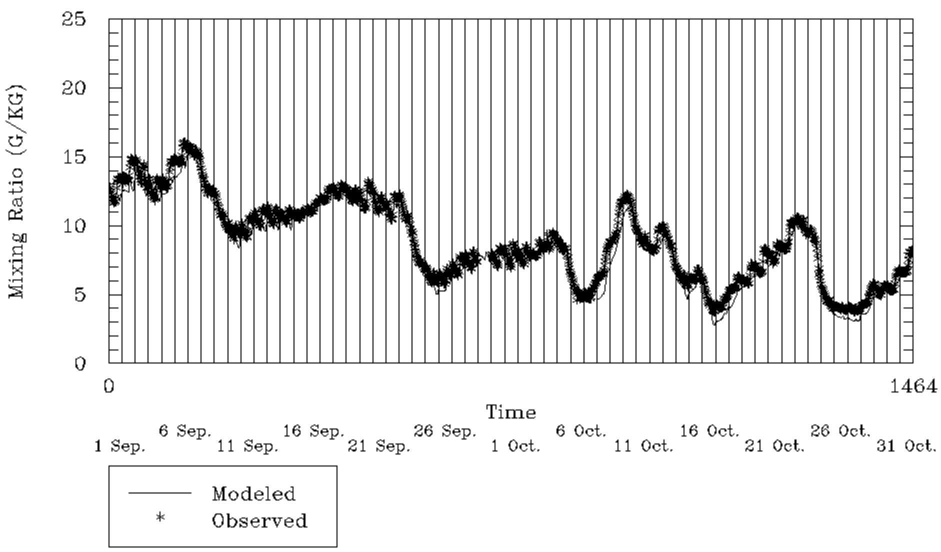
Spatial Mean 36km in the CENRAP

Figure 3-137: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for uly-August 2001 in the CENRAP States.



Spatial Mean 36km in the CENRAP

Figure 3-138: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for September-October 2001 in the CENRAP States.



Spatial Mean 36km in the CENRAP

Figure 3-139: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for November-December 2001 in the CENRAP States.

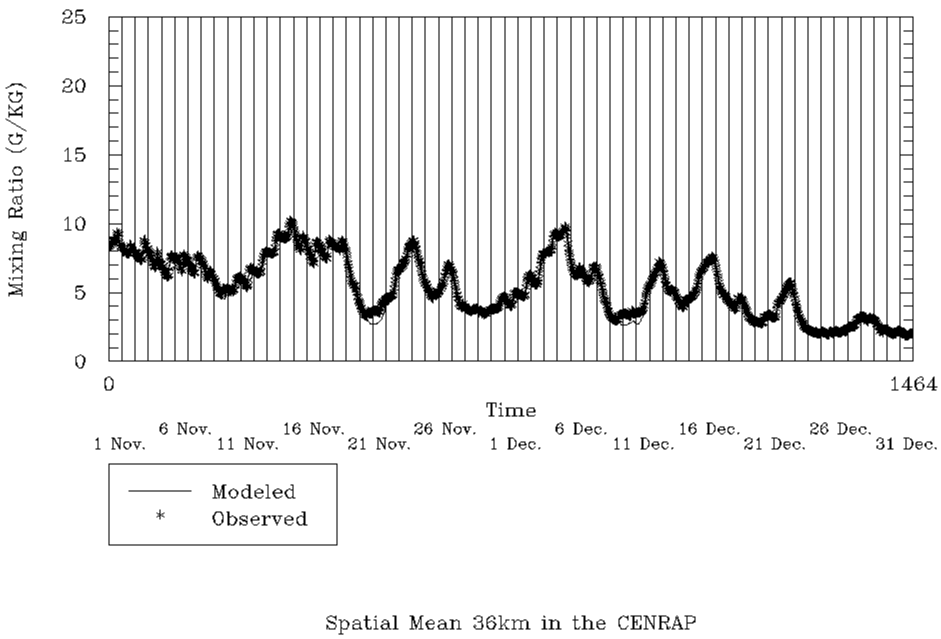


Figure 3-140: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for January-February 2002 in the CENRAP States.

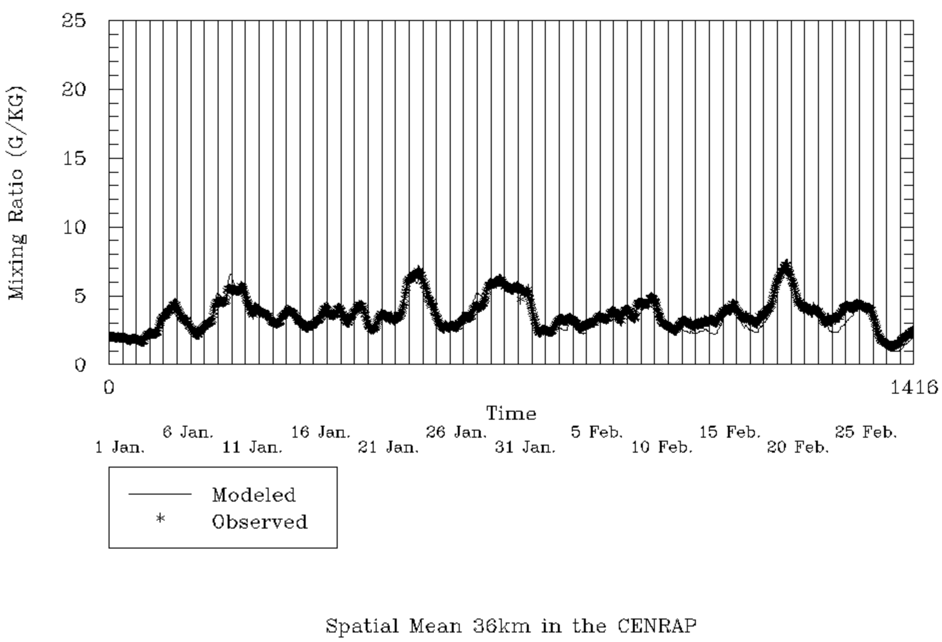


Figure 3-141: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for January-February 2001 in the MANE_VU States.

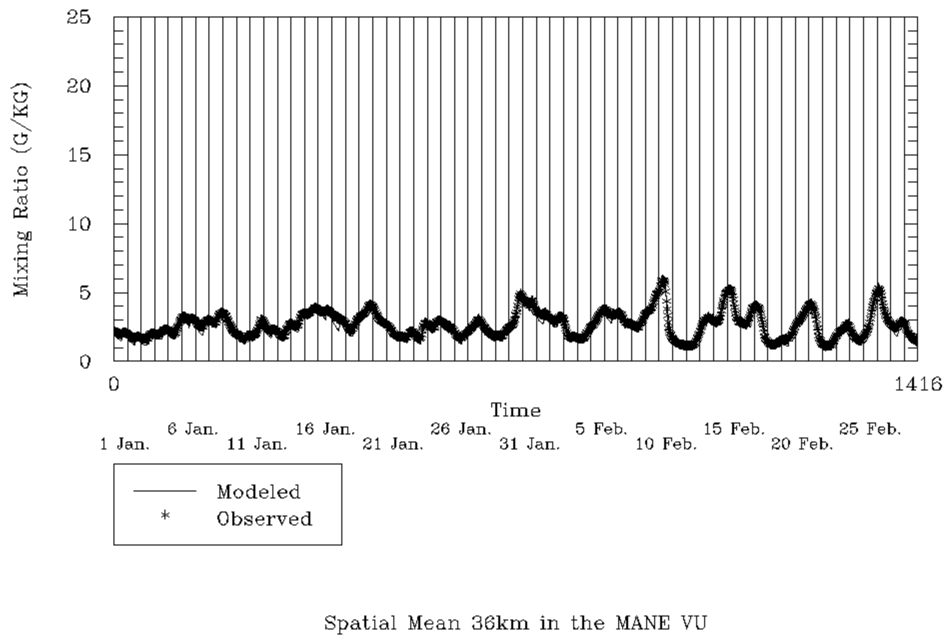


Figure 3-142: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for March-April 2001 in the MANE_VU States.

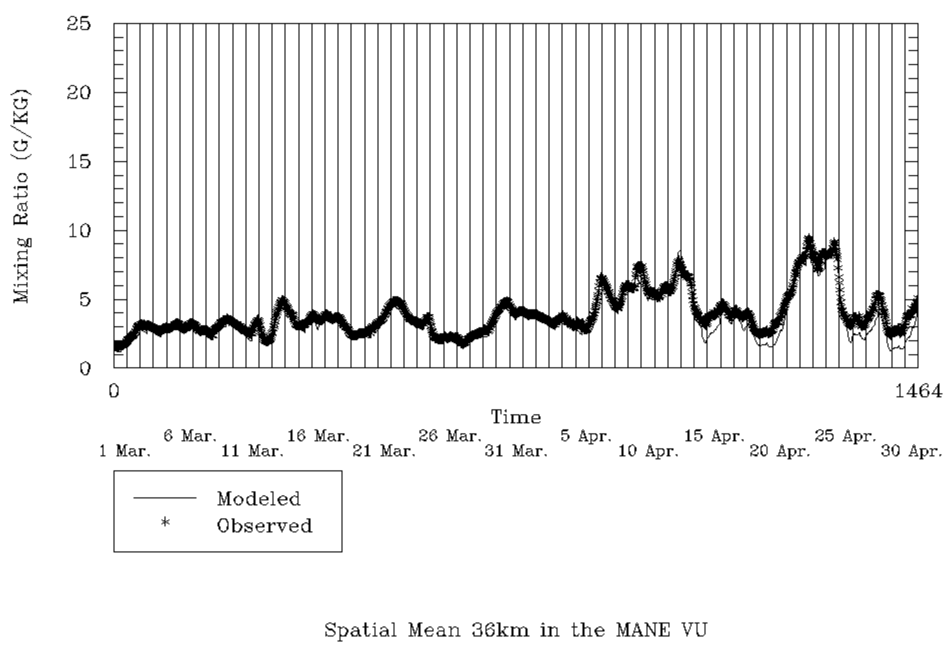


Figure 3-143: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for May-June 2001 in the MANE_VU States.

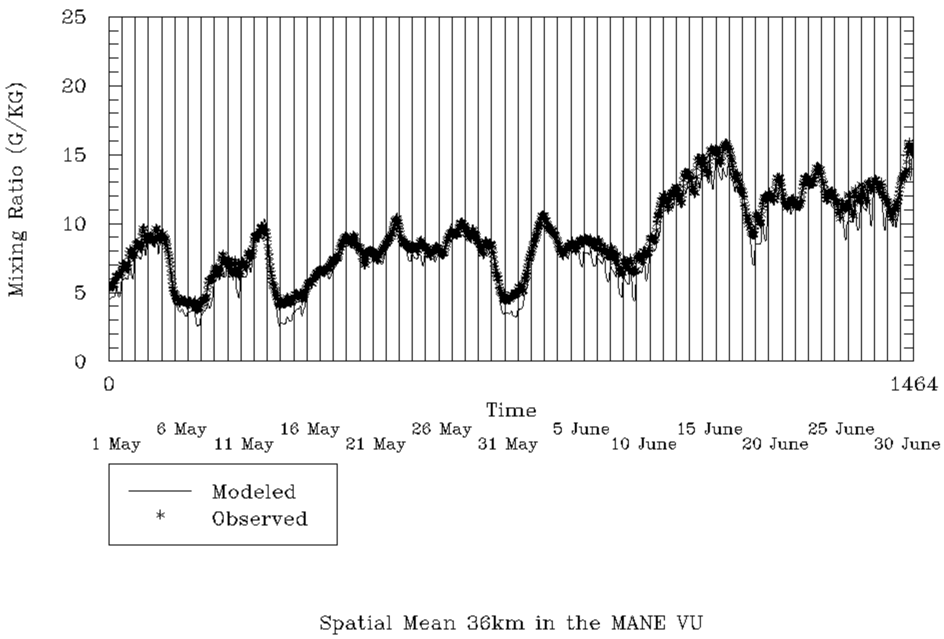


Figure 3-144: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for July-August 2001 in the MANE_VU States.

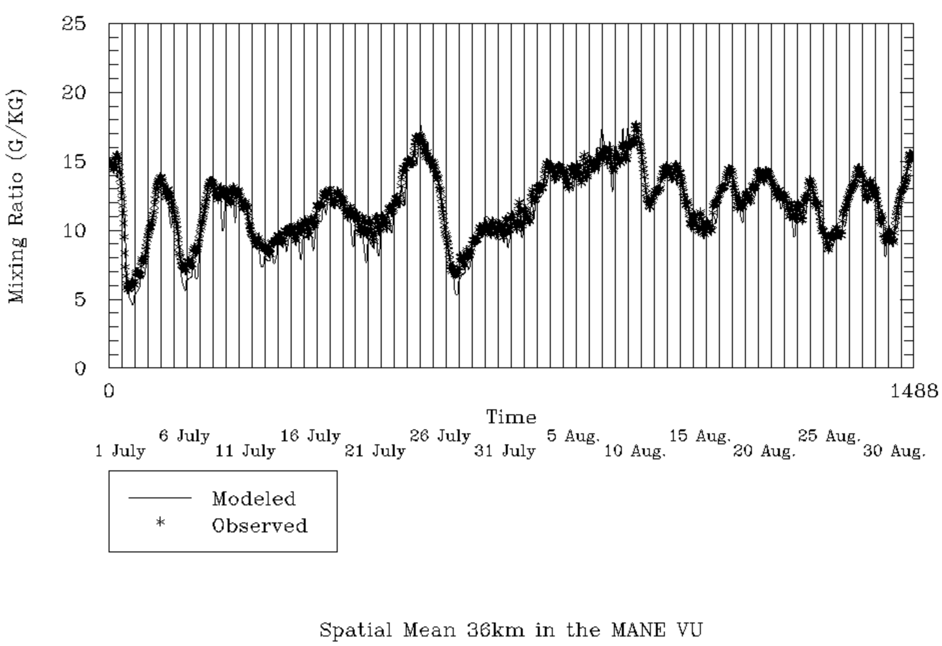


Figure 3-145: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for September-October 2001 in the MANE_VU States.

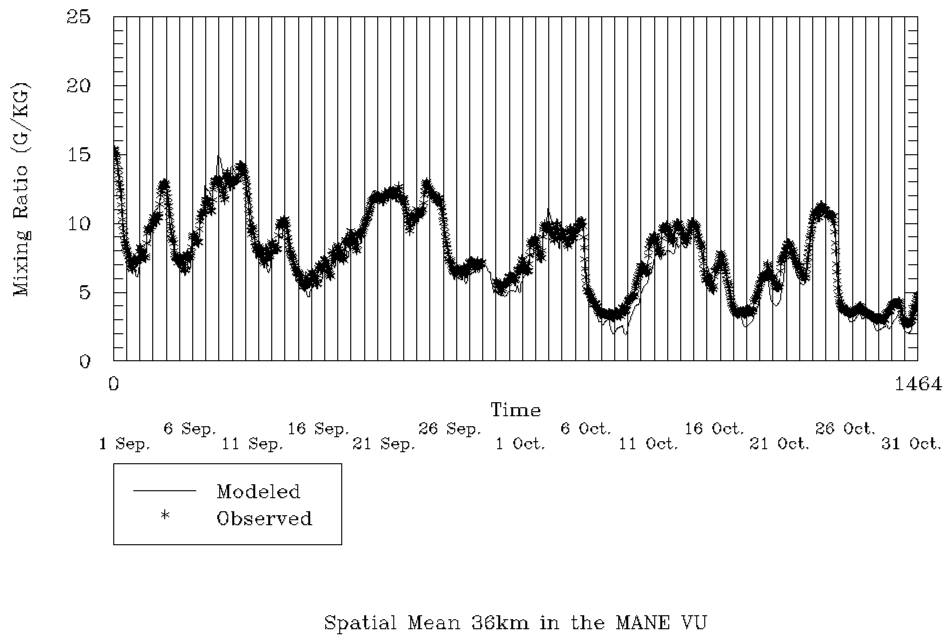


Figure 3-146: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for November-December 2001 in the MANE_VU States.

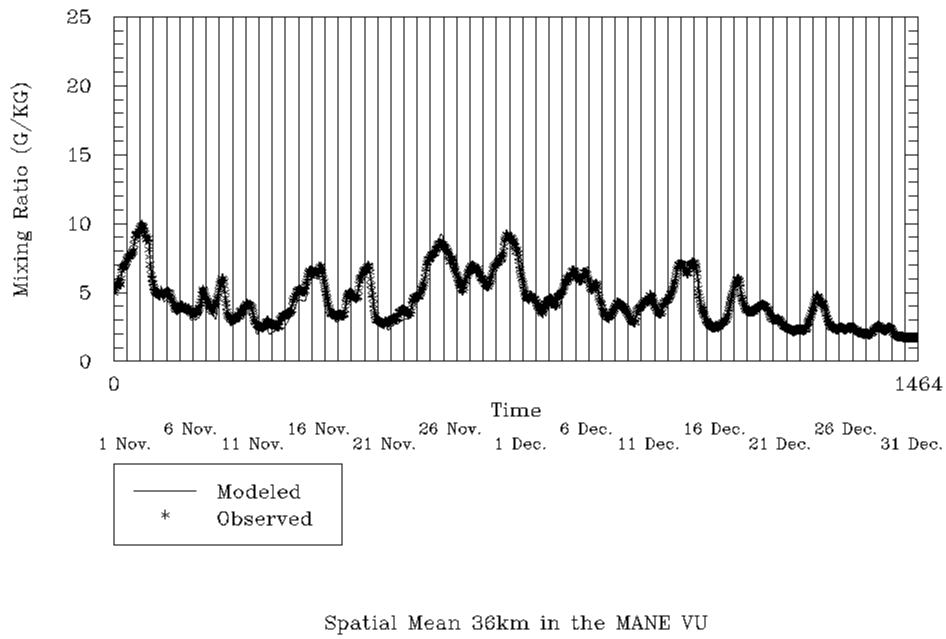


Figure 3-147: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for January-February 2002 in the MANE_VU States.

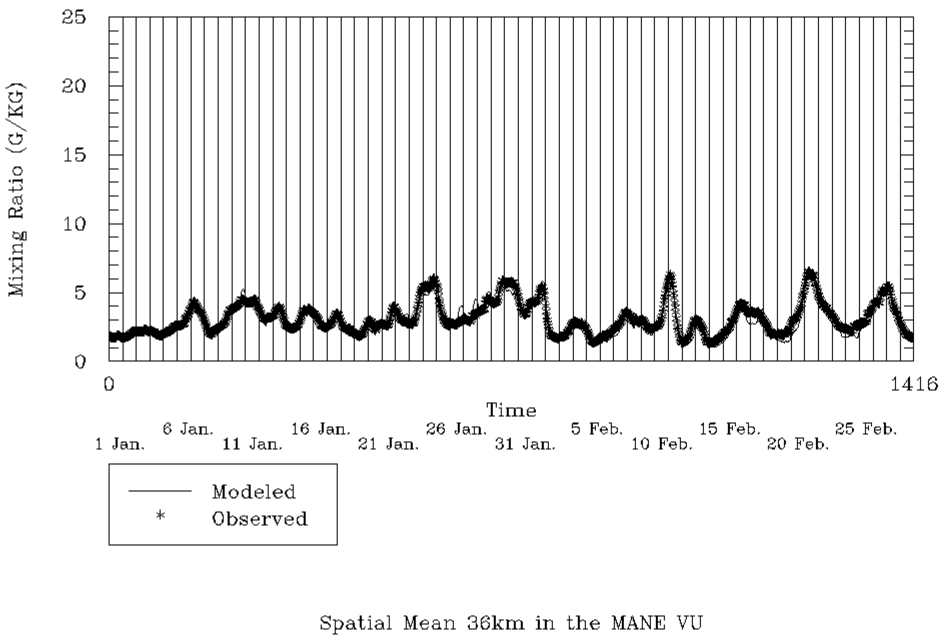


Figure 3-148: Model Es timated and Observed Spatial Mean Mixing Ratio (g/kg) for January-February 2001 in the Midwest RPO States.

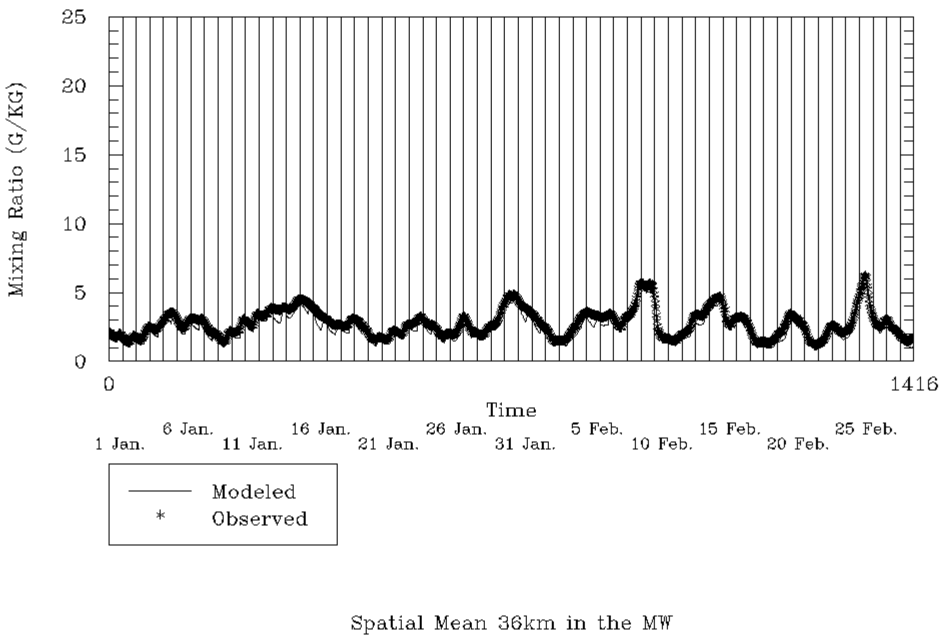


Figure 3-149: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for March-April 2001 in the Midwest RPO States.

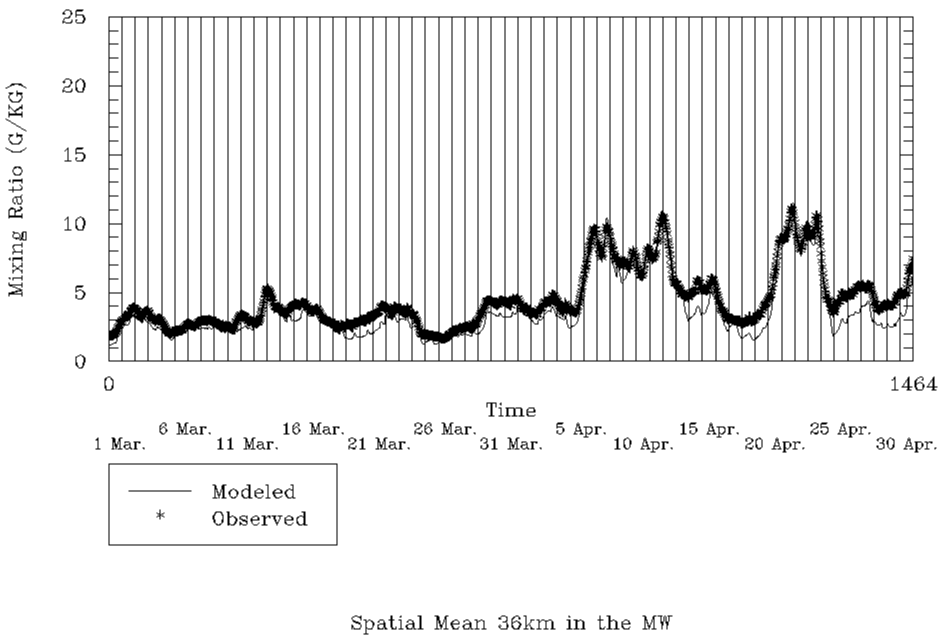


Figure 3-150: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for May-June 2001 in the Midwest RPO States.

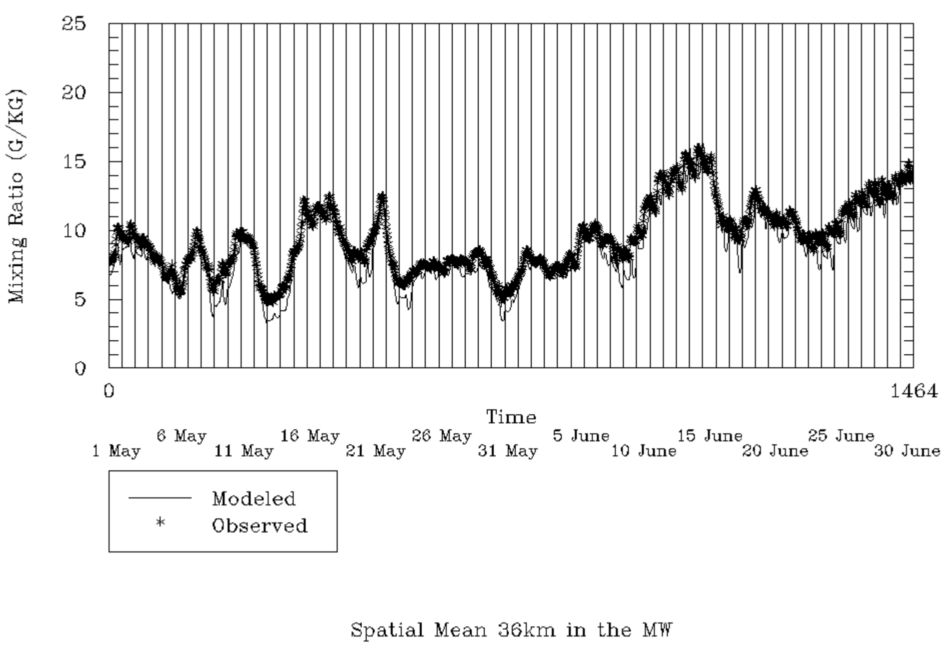


Figure 3-151: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for July-August 2001 in the Midwest RPO States.

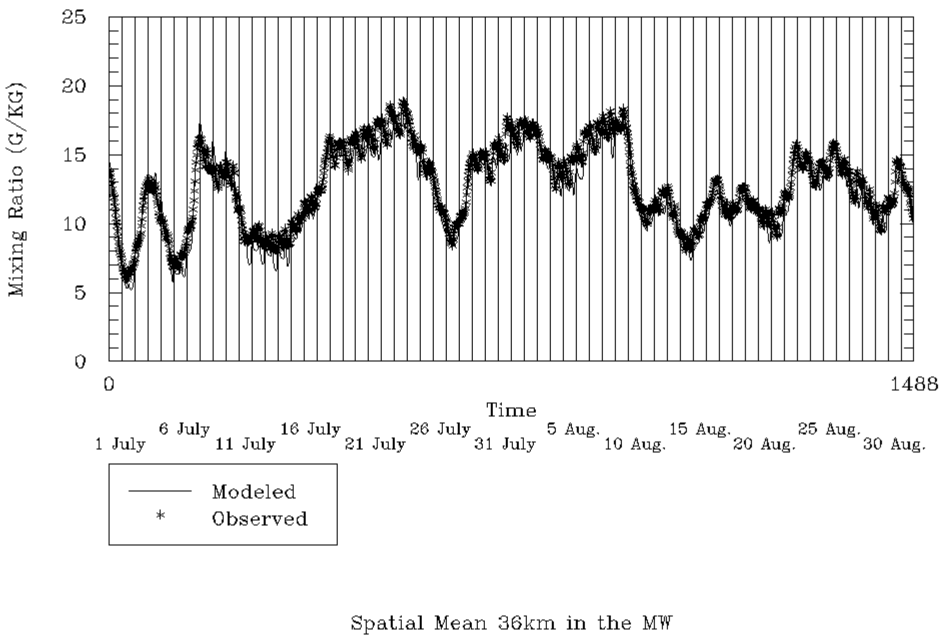


Figure 3-152: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for September-October 2001 in the Midwest RPO States.

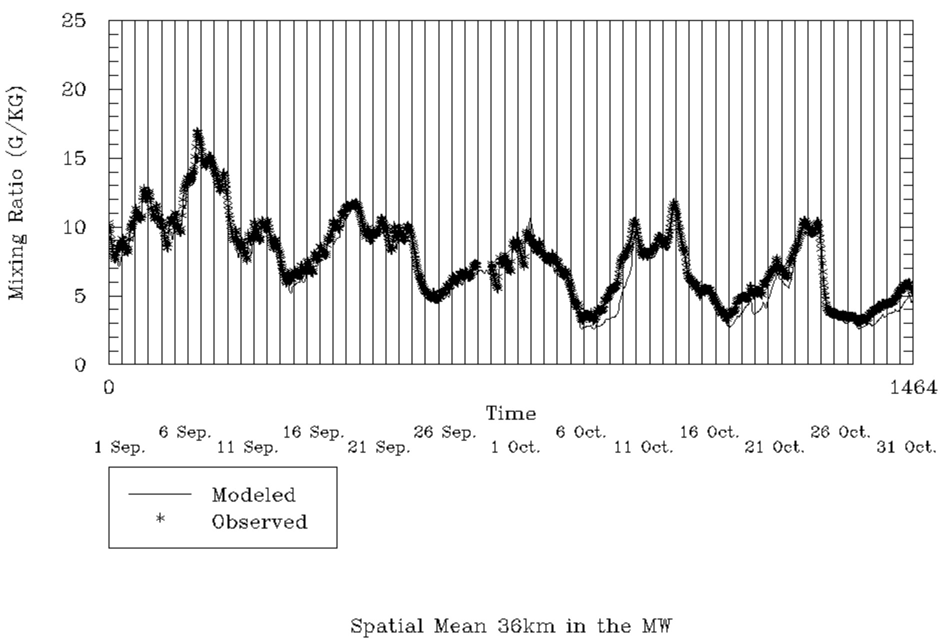


Figure 3-153: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for November-December 2001 in the Midwest RPO States.

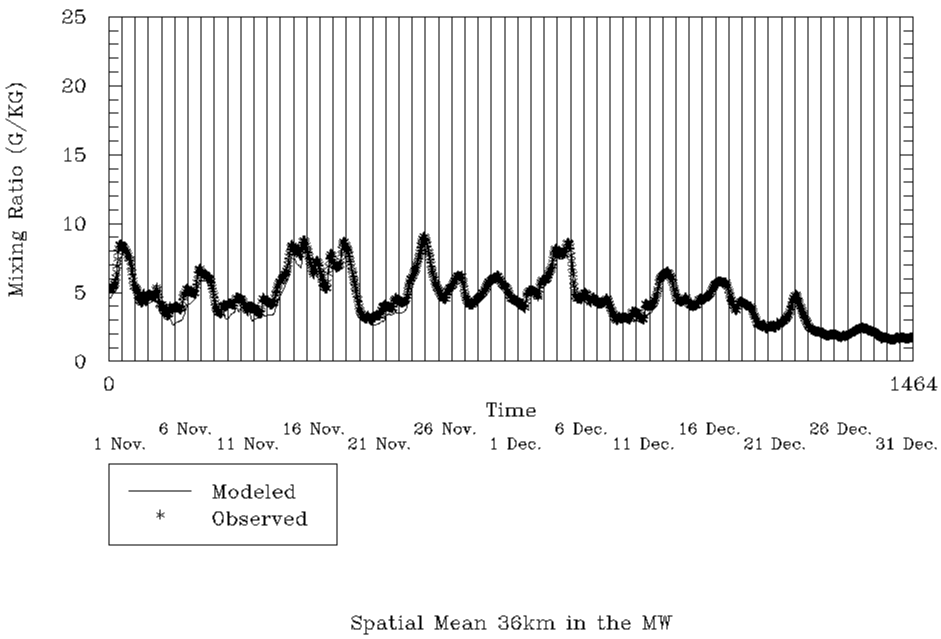


Figure 3-154: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for January-February 2002 in the Midwest RPO States.

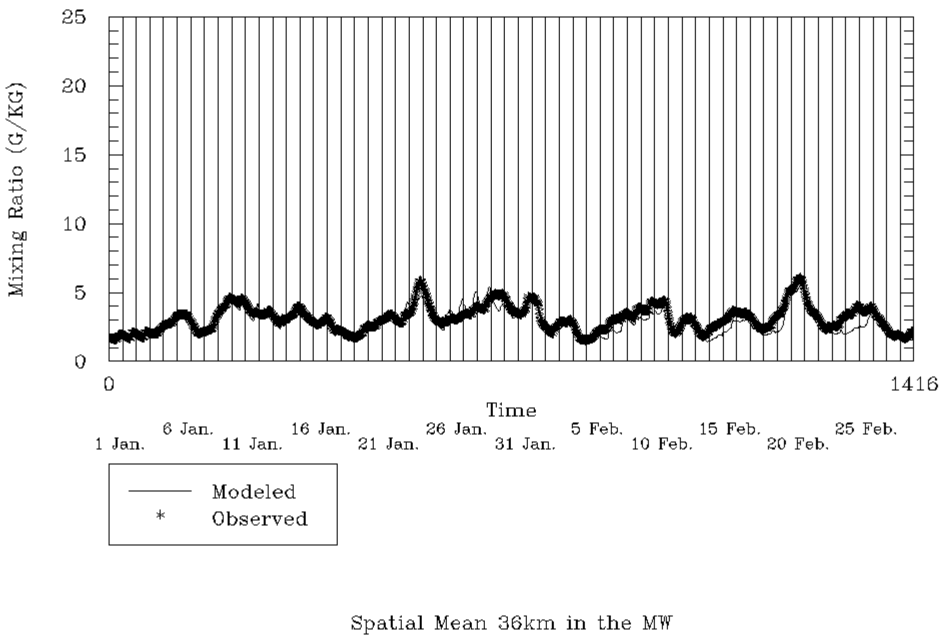


Figure 3-155: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for January-February 2001 in the VISTAS RPO States.

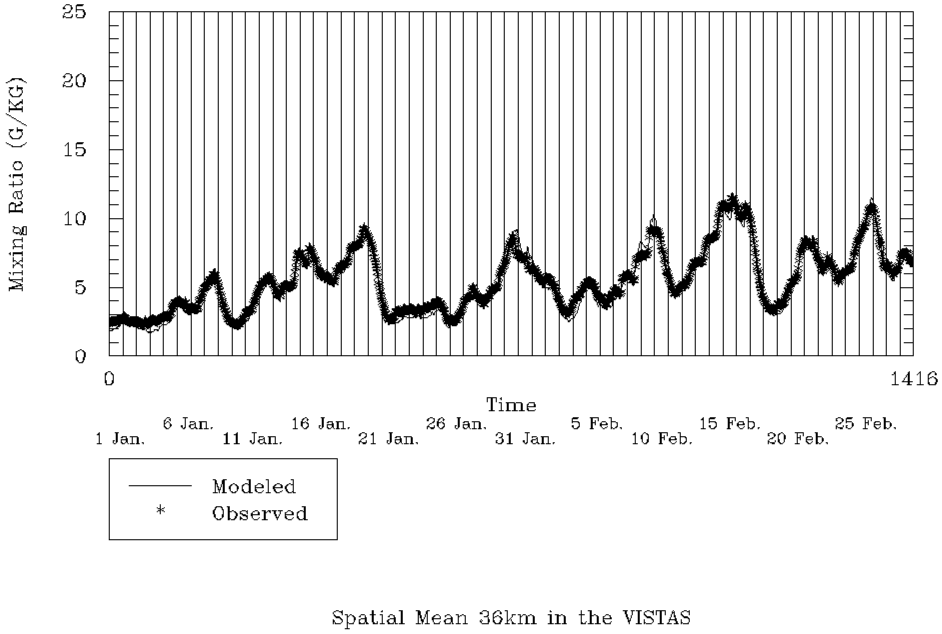


Figure 3-156: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for March-April 2001 in the VISTAS States.

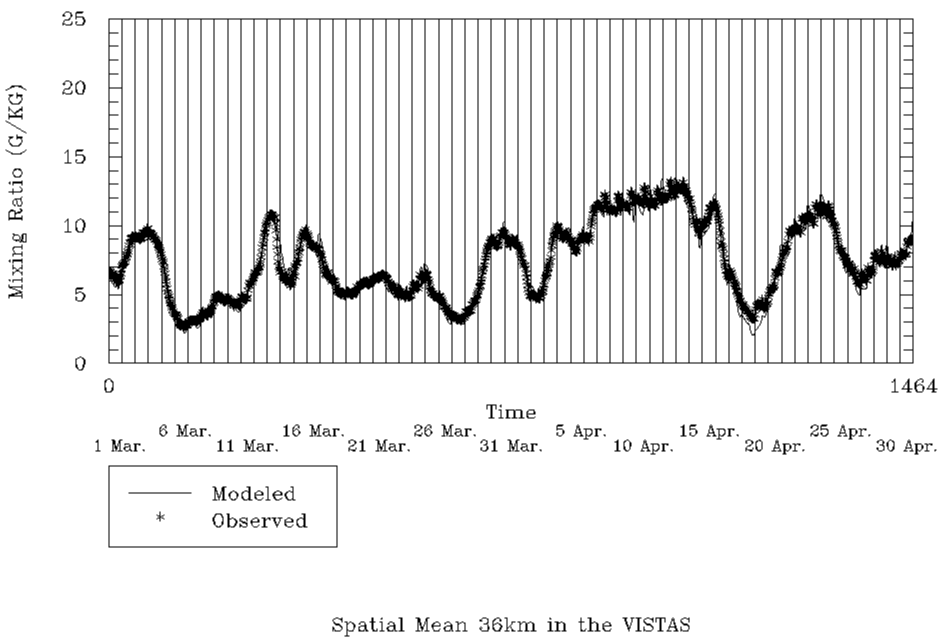


Figure 3-157: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for May-June 2001 in the VISTAS States.

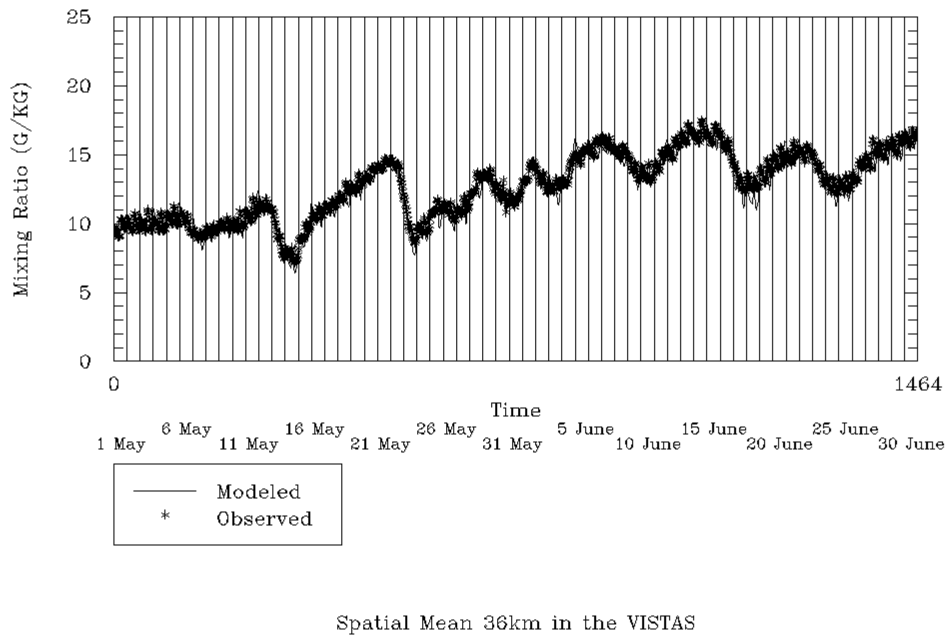


Figure 3-158: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for July-August 2001 in the VISTAS States.

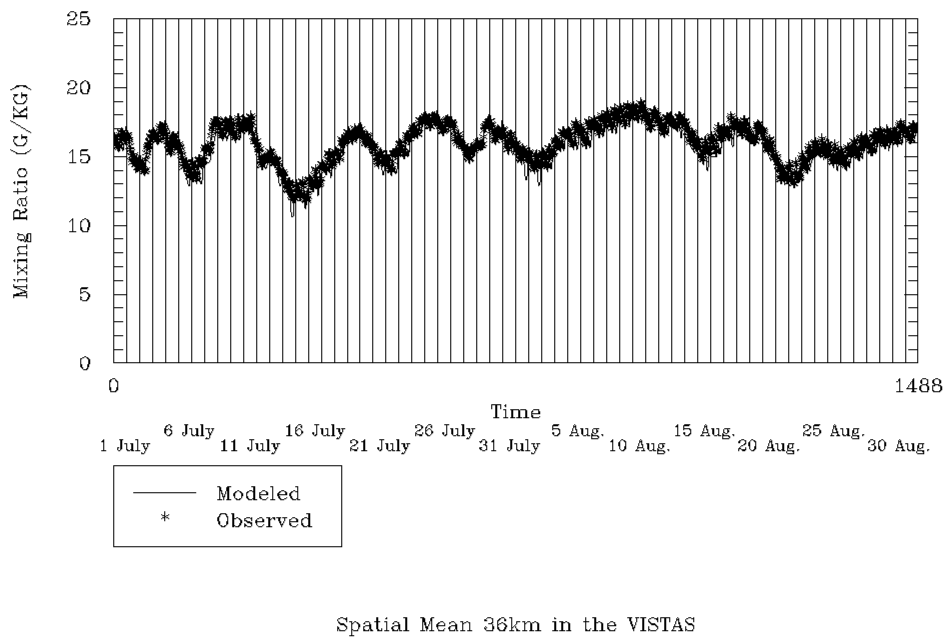


Figure 3-159: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for September-October 2001 in the VISTAS States.

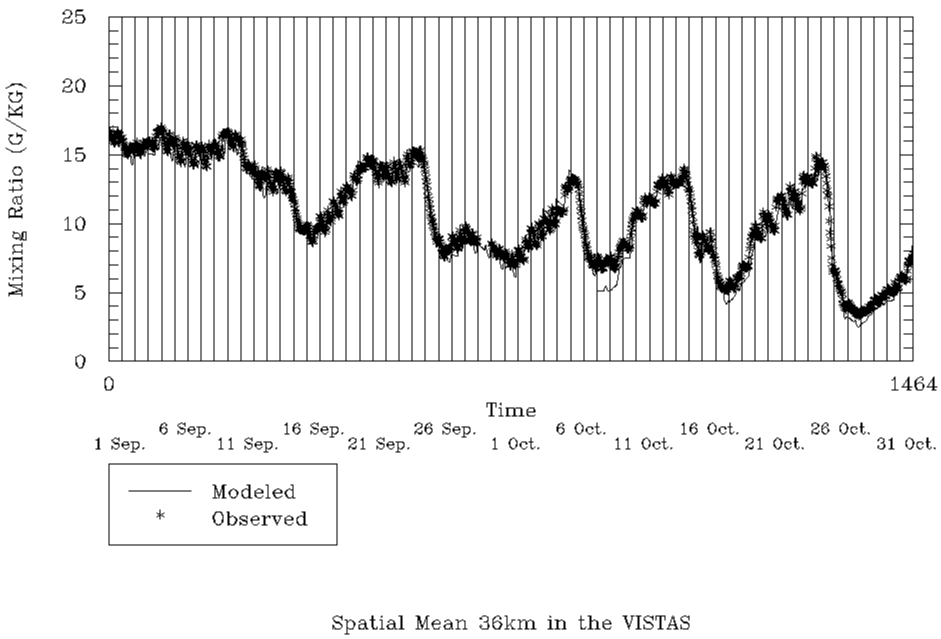


Figure 3-160: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for November-December 2001 in the VISTAS States.

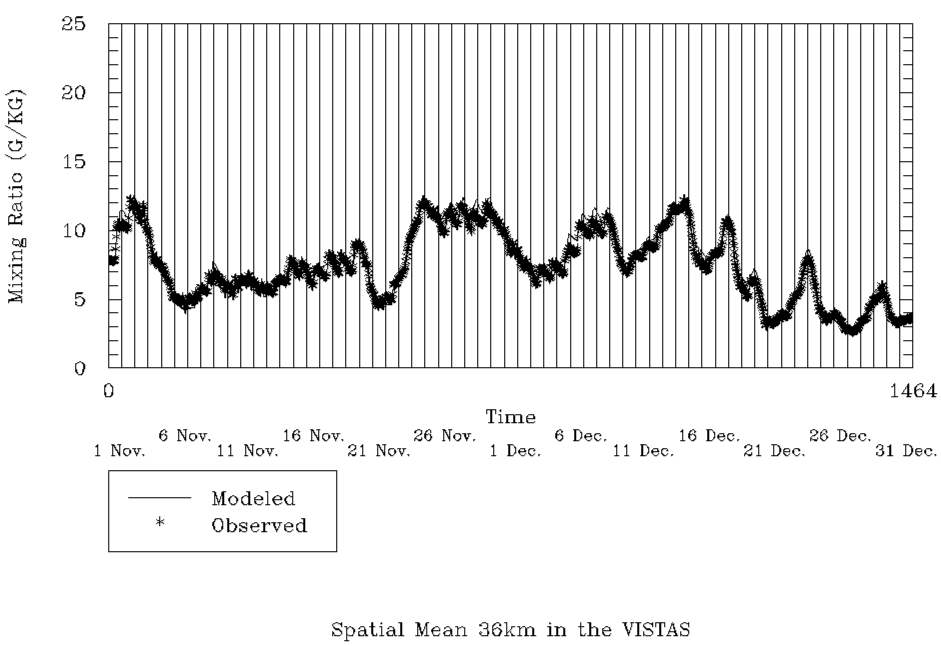


Figure 3-161: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for January-February 2002 in the VISTAS States.

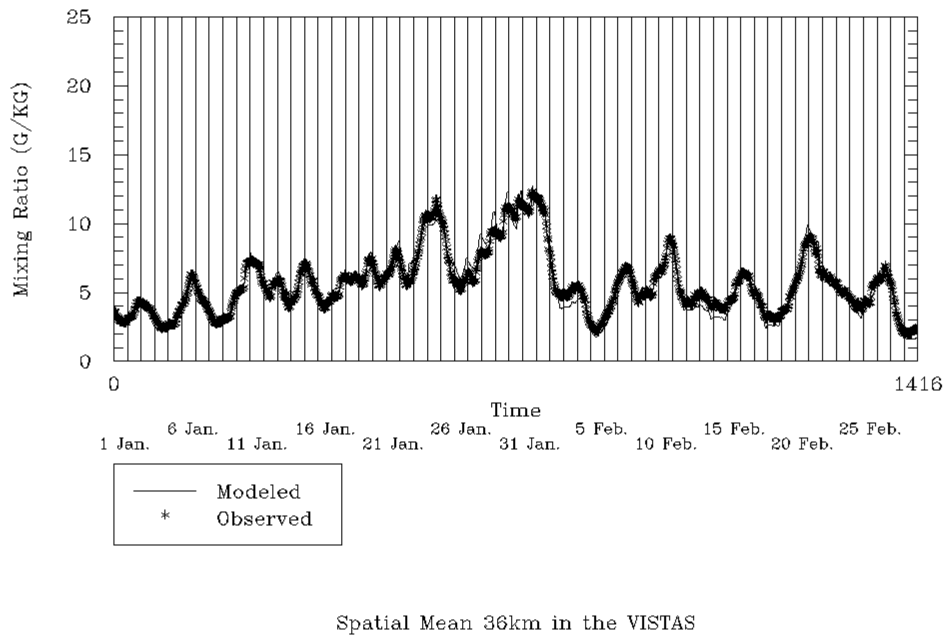


Figure 3-162: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for January-February 2001 in the WRAP States.

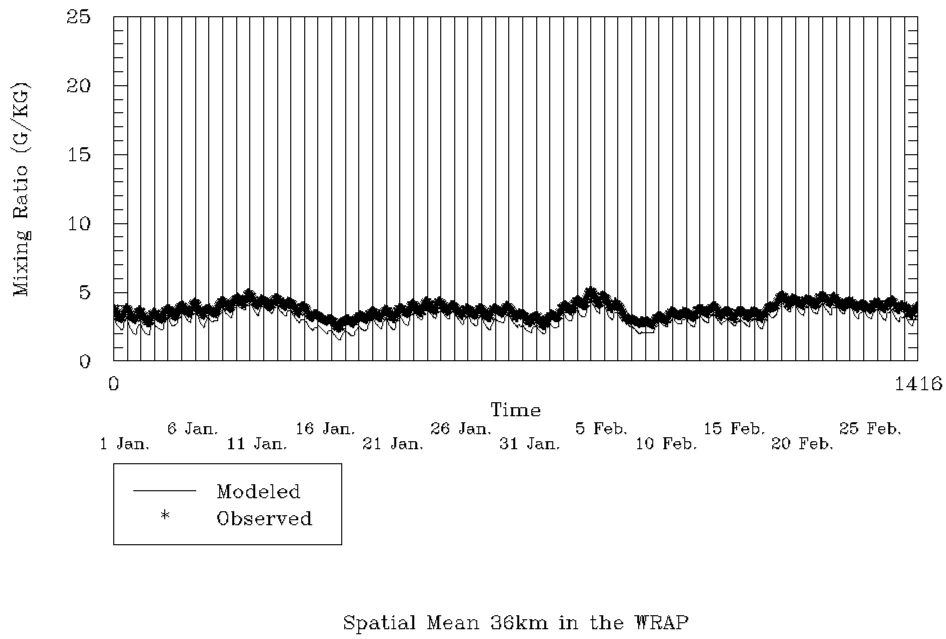


Figure 3-163: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for March-April 2001 in the WRAP States.

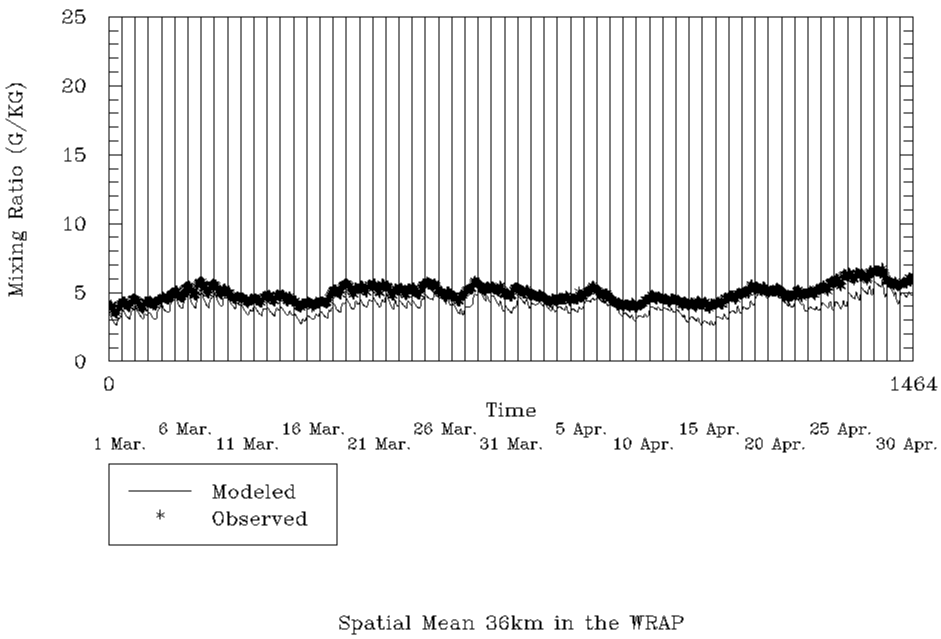


Figure 3-164: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for May-June 2001 in the WRAP States.

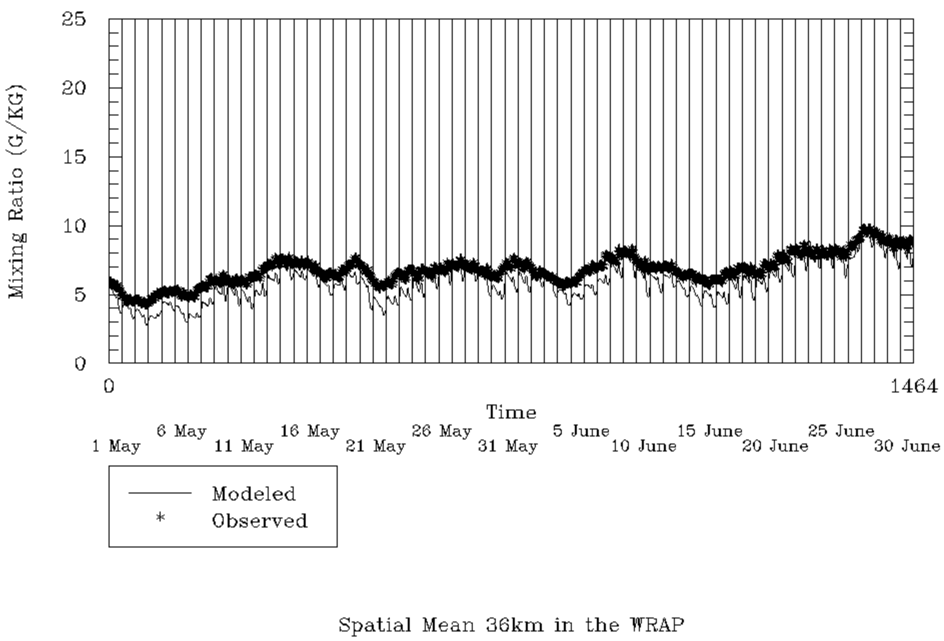


Figure 3-165: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for July-August 2001 in the WRAP States.

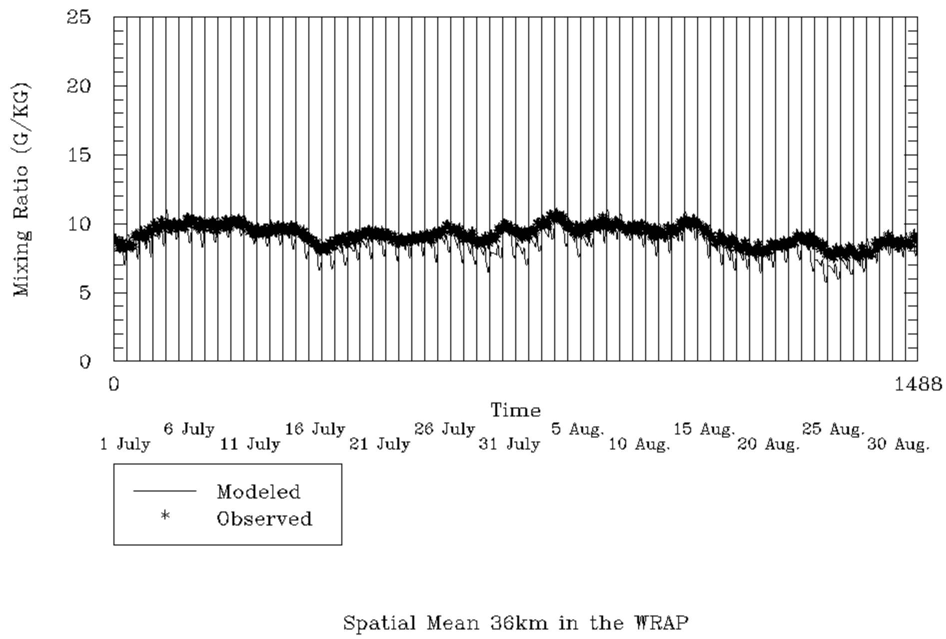


Figure 3-166: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for September-October 2001 in the WRAP States.

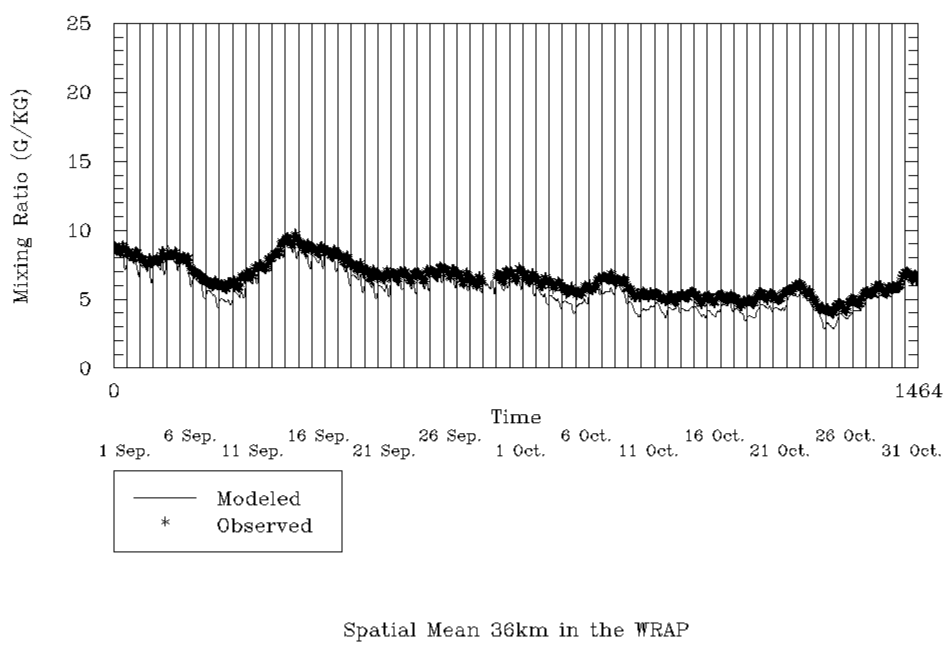


Figure 3-167: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for November-December 2001 in the WRAP States.

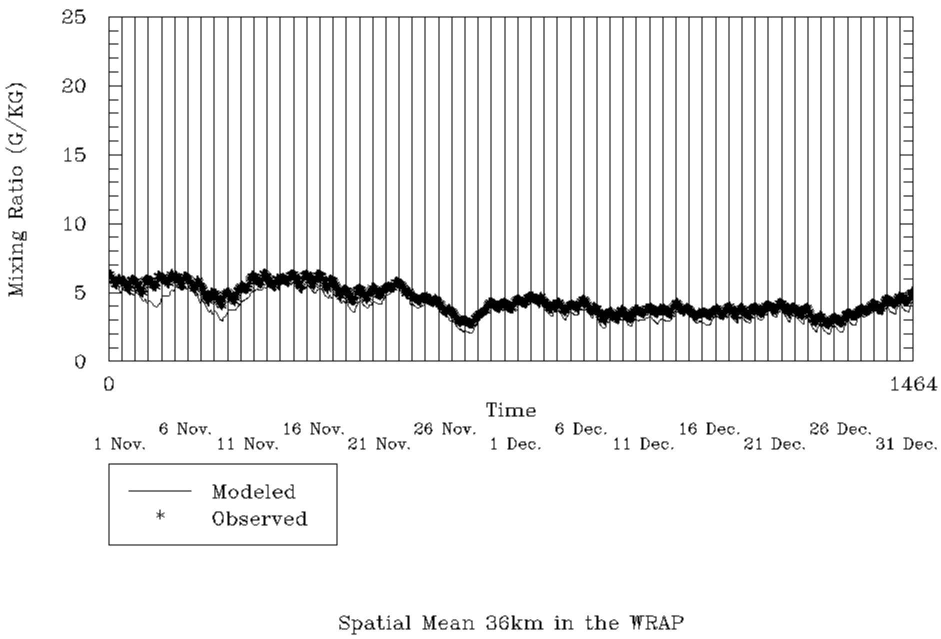


Figure 3-168: Model Estimated and Observed Spatial Mean Mixing Ratio (g/kg) for January-February 2002 in the WRAP States.

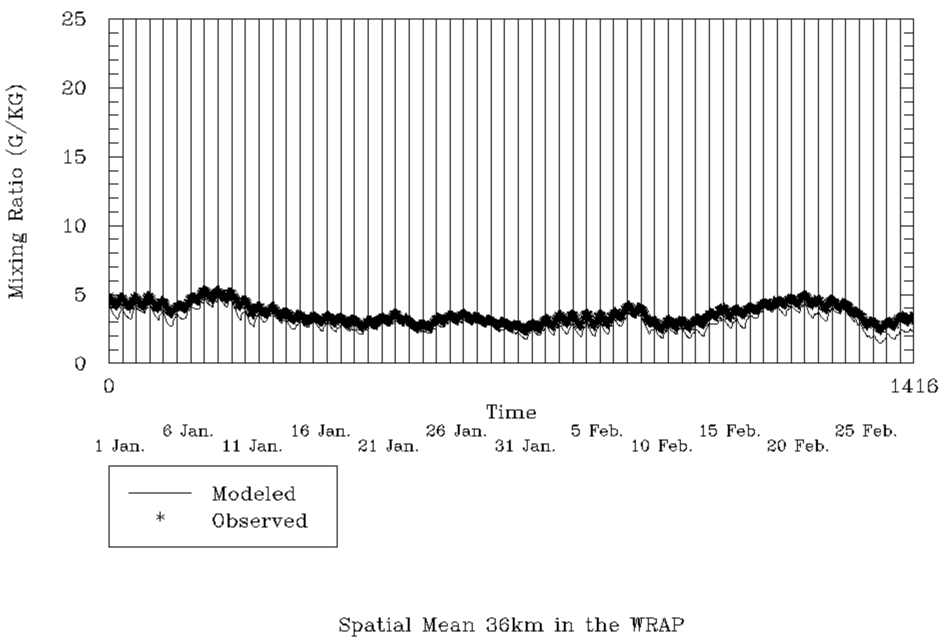


Table 3-5: Accumulated Precipitation Bias (cm) by State and Time Period for the 2001 Annual MM5 Simulation.

Domain	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Mean
ALL	0.16	0.73	2.28	5.15	0.52	0.47	1.55
AL	-1.63	-3.56	1.79	6.47	2.57	-1.55	0.68
AK	-0.73	-0.33	-6.33	-3.15	-1.6	2.31	-1.64
AZ	2.49	2.47	3.18	9.8	2.99	1.15	3.68
AR	-2.91	-0.79	2.15	10.21	-1.26	-1.63	0.96
CA	-2.86	-0.68	0.23	2.11	0	-2.08	-0.55
CO	0.68	0.7	3.25	0.85	0.13	0.47	1.01
CT	0.41	0.56	-1.14	0.78	-0.71	1.41	0.22
DE	0.33	-0.84	-2.28	8.51	-0.35	0.38	0.96
FL	0.55	1.46	7.84	18.73	10.68	1.63	6.82
GA	-0.79	0.61	1.29	9.76	2.71	-0.17	2.23
ID	0.96	1.17	1.67	3.27	0.98	4.01	2.01
IL	0.8	0.83	1.79	6.27	-0.51	1.05	1.71
IN	0.14	2.17	4.97	3.75	-0.56	1.93	2.07
IA	0.99	0.86	0.39	4.88	-1.42	0.83	1.09
KS	0.22	1.17	1.59	6.92	0.65	0.32	1.81
KY	0.3	2.05	10.05	14.59	0.23	1.26	4.75
LA	-1.34	-2.68	0.82	6.67	0.64	-1.31	0.47
ME	0.48	0.9	0.69	2.03	-1.87	0.9	0.52
MD	1.65	1.08	-0.55	0.05	-0.92	0.73	0.34
MA	1.06	2.27	-0.68	0.1	-0.68	0.93	0.5
MI	1.34	0.42	0.52	2.25	-0.36	1.58	0.96
MN	1.42	0.3	1.03	3.05	-0.25	0.72	1.05
MS	-3.55	-2.13	4.26	10.77	2.04	-1.56	1.64
MO	-0.53	1.26	-0.44	8.12	-0.95	-0.12	1.22
MT	1.3	1.85	3.25	3.21	0.91	1.77	2.05
NE	1.08	-0.08	4.11	3.01	-1.52	0.72	1.22
NV	1.07	1.85	1.57	5.41	1.55	1.9	2.22
NH	-0.67	2.08	-0.94	-0.19	-2.97	1.3	-0.23
NJ	0.84	-0.9	-1.58	3.9	1.12	0.95	0.72
NM	1.13	1.9	5.31	6.54	0.76	0.04	2.61
NY	1.21	1.46	-0.41	0.66	-1.16	1.73	0.58
NC	0.3	1.4	9.48	8.95	-0.35	0.19	3.33
ND	0.75	0.75	1.05	2.29	0.75	0.59	1.03
OH	0.54	1.21	3.04	5.08	0.14	2.68	2.12
OK	0.14	0.47	0.39	5.7	0.08	-0.11	1.11
OR	0.14	0.81	0.24	0.81	0.5	0.7	0.53
PA	0.7	0.42	1.97	2.58	-0.74	1.06	1
RI	-0.73	0.13	-3.31	-1.7	-1.49	2.32	-0.8
SC	-0.28	2.35	7.78	15.1	1.02	0.23	4.37
SD	1.61	0.94	1	2.81	0.19	0.97	1.25
TN	-2.68	0.38	4.89	13.01	0.41	-1.98	2.34
TX	1.38	1.53	3.37	6.48	3.27	-0.41	2.6
UT	1.2	0.91	3.1	4.6	1.17	1.56	2.09

Domain	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Mean
VT	0.76	1.11	-1.02	-0.51	-1.99	1.7	0.01
VA	0.85	1.19	4.13	4.5	-0.5	0.93	1.85
WA	0.33	-0.04	0	-0.4	-1.06	1.83	0.11
WV	1.75	3.45	4.75	1.27	-0.01	2.57	2.3
WI	0.49	0.79	-2.35	0.59	-1.2	0.21	-0.25
WY	1.37	1.87	3.37	6.46	1.44	1.3	2.63
CENRAP	0.35	0.65	1.75	6.23	0.51	-0.14	1.56
MANE_VU	0.76	0.99	0.28	1.41	-1.15	1.29	0.6
MW	0.63	1.14	1.86	3.9	-0.45	1.54	1.44
VISTAS	-0.67	0.37	5.34	10.33	2.07	0.03	2.91

Figure 3-169: Annual Accumulated Mean Precipitation Bias (cm).

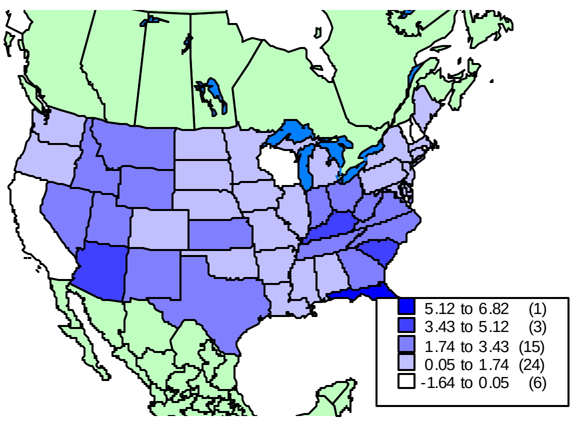


Figure 3-170: Accumulated Precipitation Error (cm) by State and Time Period for the 2001 Annual MM5 Simulation.

Domain	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb
ALL	2.11	2.49	4.42	6.37	2.97	2.79	3.53
AL	2.69	5.77	4.39	7.12	4.1	3.58	4.61
AK	3.31	1.92	6.33	3.15	1.6	2.31	3.1
AZ	2.8	2.73	3.39	10.66	3.44	1.55	4.09
AR	3.82	2.03	5.4	10.75	4.09	3.2	4.88
CA	4.74	2.63	1.04	2.57	0.94	4.76	2.78
CO	0.97	1.88	3.53	2.86	0.85	0.85	1.82
CT	1.52	0.81	4.06	2.95	1.07	1.62	2
DE	1.17	0.84	3.19	8.51	0.45	2.34	2.75
FL	1.87	3.8	9.77	20.6	12.16	2.96	8.53
GA	1.87	2.77	5.24	10.98	3.9	1.53	4.38
ID	1.54	2.04	2.22	3.67	1.77	4.38	2.6
IL	1.58	1.74	4.17	7.05	3.35	2.41	3.38
IN	1.57	2.57	5.8	6.4	2.73	2.77	3.64
IA	1.29	1.94	4.26	6.35	3.2	1.24	3.05
KS	1.25	2.17	4.87	7.48	2.66	0.89	3.22
KY	1.53	2.51	10.22	14.84	3.57	3.63	6.05
LA	2.85	5.26	8.76	8.43	5.1	5.49	5.98
ME	1.35	1.78	2.52	3.05	2.44	1.29	2.07
MD	1.65	2.05	3.08	3.96	1.81	2.6	2.52
MA	1.18	3.24	3.17	2.47	1.63	1.04	2.12
MI	1.79	1.31	3	3.56	2.95	2.22	2.47
MN	1.47	2.52	3.62	4.55	1.84	1.17	2.53
MS	4.68	5.44	6.57	11.48	6.54	4.67	6.56
MO	2.1	2.25	4.76	8.82	3.35	1.53	3.8
MT	1.44	2.16	3.53	3.48	1.51	2	2.35
NE	1.18	2.02	5.26	4.98	2.11	0.86	2.73
NV	1.67	2.2	1.61	5.43	1.77	2.3	2.5
NH	2.15	2.58	2.87	2.47	3.66	2.3	2.67
NJ	1.73	2.28	2.61	4.84	1.81	1.6	2.48
NM	1.39	2.15	5.33	7.31	1.39	0.66	3.04
NY	1.71	2.19	2.77	3.04	2.38	2	2.35
NC	1.22	2.43	9.59	9.35	2.4	1.39	4.4
ND	0.77	1.04	2.4	3.24	1.34	0.68	1.58
OH	0.99	1.66	4.09	5.78	2.61	2.77	2.98
OK	2.37	1.5	5.05	6.52	4.2	1.62	3.54
OR	1.6	3.5	2.04	1.56	2.38	6.83	2.98
PA	1.14	1.79	3.18	4.14	2.09	1.84	2.36
RI	0.84	2.13	7.07	1.7	1.68	2.32	2.62
SC	1.47	3.08	7.94	15.13	4.57	1.3	5.58
SD	1.82	1.68	2.53	3.84	1.06	1.1	2.01
TN	3.56	2.07	6.04	14.32	3.64	3.91	5.59
TX	2.96	2.58	5.8	7.34	5.06	3.18	4.49
UT	1.85	2.1	3.1	5.32	1.69	2.57	2.77

Domain	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb
VT	1.05	2.18	2.34	2.98	3.02	2.07	2.27
VA	1.39	1.99	5.37	5.49	1.56	1.53	2.89
WA	2.62	3.71	2.93	2.19	3.22	7.43	3.68
WV	1.91	3.67	5.18	6.16	1.57	2.8	3.55
WI	0.84	2.06	4.16	3.63	2.84	1.13	2.44
WY	1.4	2.02	3.71	6.5	1.73	1.48	2.81
CENRAP	2.25	2.37	5.25	7.31	3.79	2.22	3.87
MANE_VU	1.45	2.08	2.97	3.45	2.31	1.84	2.35
MW	1.34	1.89	4.3	5.51	2.88	2.31	3.04
VISTAS	2.32	3.5	6.94	11.56	4.58	2.84	5.29

Figure 3-171: Annual Accumulated Mean Precipitation Error (cm).

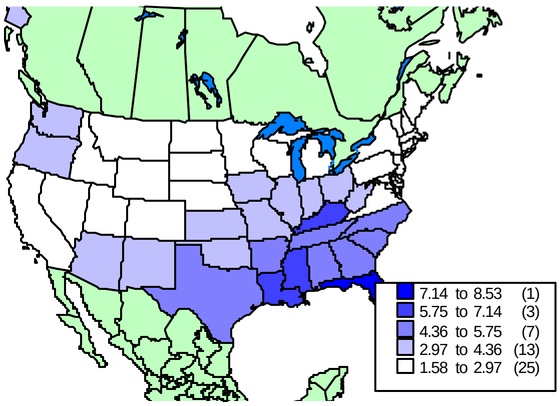


Figure 3-172: Model Estimated and Observed Mean Monthly Total Precipitation for 2001.

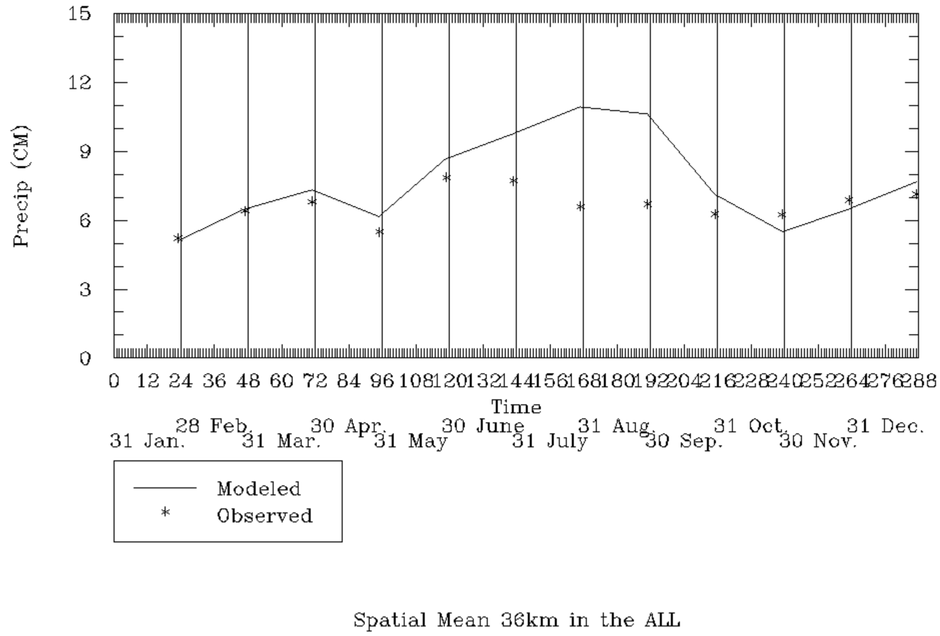


Figure 3-173: Model Estimated and Observed Mean Monthly Total Precipitation for 2001 in the CENRAP States.

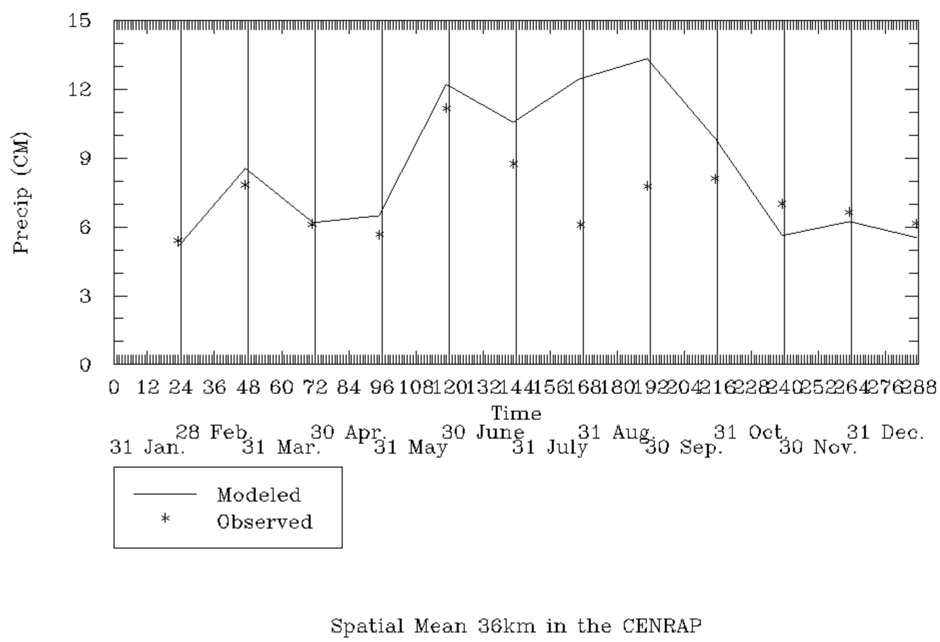


Figure 3-174: Model Estimated and Observed Mean Monthly Total Precipitation for 2001 in the MANE_VU States.

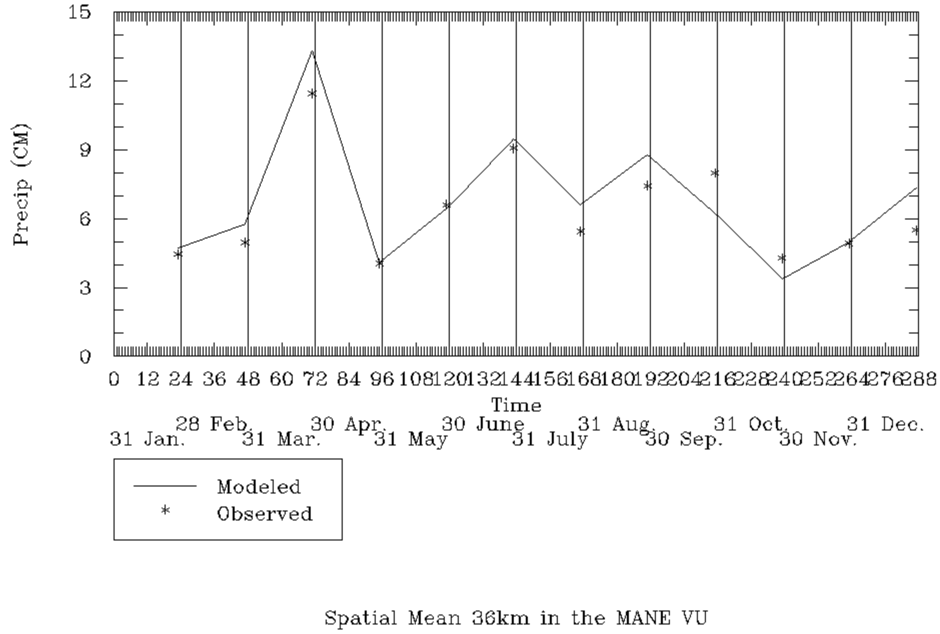


Figure 3-175: Model Estimated and Observed Mean Monthly Total Precipitation for 2001 in the Midwest RPO States.

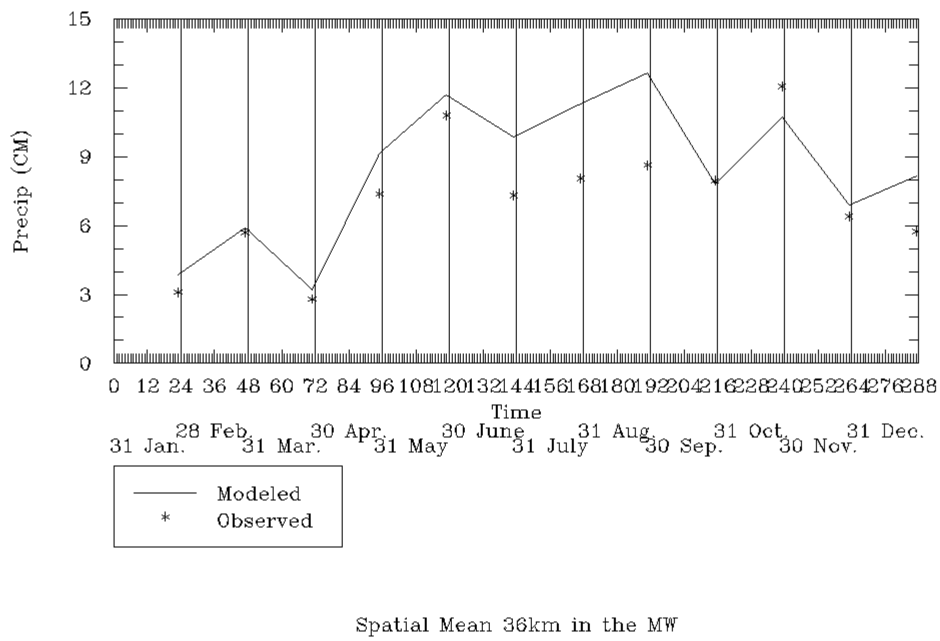


Figure 3-176: Model Estimated and Observed Mean Monthly Total Precipitation for 2001 in the VISTAS States.

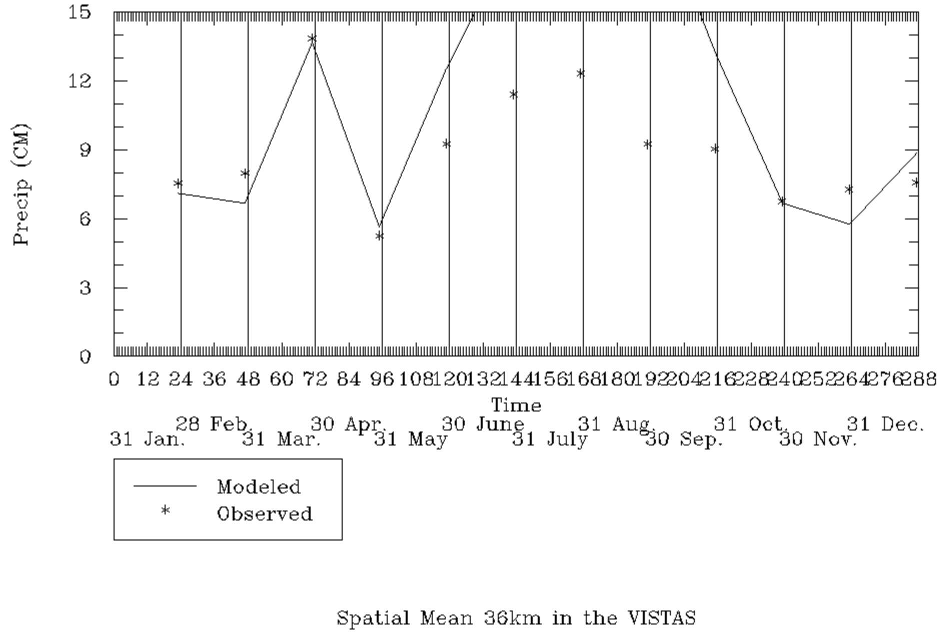


Figure 3-177: Model Estimated and Observed Mean Monthly Total Precipitation for 2001 in the WRAP States.

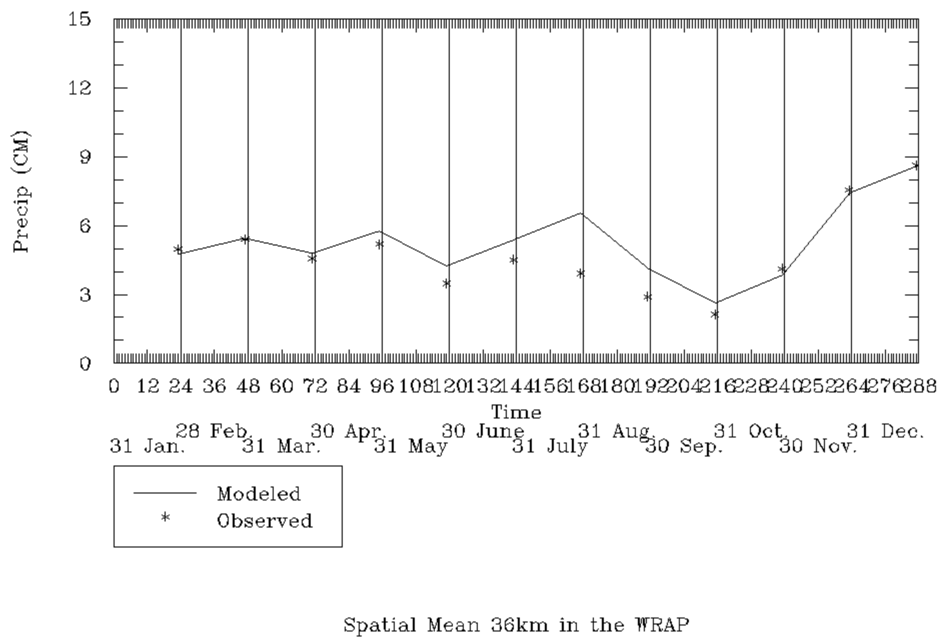


Table 3-6: Wind Index of Agreement by State and Time Period for the 2001 Annual MM5 Simulation.

Region	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb	Mean
ALL	0.88	0.85	0.85	0.88	0.85	0.85	0.88	0.86
AL	0.7	0.72	0.77	0.72	0.61	0.74	0.8	0.72
AK	0.63	0.37	0.46	0.52	0.49	0.6	0.46	0.5
AZ	0.73	0.72	0.65	0.72	0.82	0.68	0.74	0.72
AR	0.73	0.64	0.66	0.74	0.63	0.72	0.82	0.71
CA	0.87	0.77	0.8	0.81	0.82	0.74	0.8	0.8
CO	0.68	0.78	0.71	0.8	0.72	0.72	0.79	0.74
CT	0.53	0.58	0.53	0.58	0.58	0.52	0.46	0.54
DE	0.45	0.77	0.8	0.94	0.84	0.8	0.72	0.76
FL	0.76	0.58	0.57	0.68	0.59	0.66	0.66	0.64
GA	0.65	0.63	0.54	0.54	0.56	0.69	0.6	0.6
ID	0.69	0.74	0.76	0.79	0.61	0.61	0.68	0.7
IL	0.68	0.61	0.65	0.69	0.56	0.58	0.63	0.63
IN	0.69	0.62	0.52	0.68	0.61	0.66	0.58	0.62
IA	0.73	0.63	0.7	0.62	0.52	0.48	0.67	0.62
KS	0.72	0.7	0.71	0.73	0.76	0.67	0.8	0.73
KY	0.69	0.47	0.57	0.5	0.47	0.54	0.56	0.54
LA	0.85	0.64	0.76	0.75	0.64	0.63	0.78	0.72
ME	0.45	0.56	0.5	0.47	0.57	0.46	0.54	0.51
MD	0.56	0.56	0.58	0.47	0.61	0.52	0.35	0.52
MA	0.53	0.63	0.59	0.32	0.54	0.45	0.51	0.51
MI	0.64	0.64	0.58	0.72	0.62	0.69	0.64	0.65
MN	0.62	0.72	0.73	0.64	0.76	0.59	0.69	0.68
MS	0.75	0.67	0.65	0.7	0.51	0.53	0.75	0.65
MO	0.7	0.67	0.63	0.76	0.71	0.64	0.63	0.68
MT	0.75	0.73	0.73	0.83	0.82	0.6	0.78	0.75
NE	0.81	0.8	0.73	0.84	0.77	0.74	0.8	0.78
NV	0.63	0.74	0.76	0.66	0.74	0.74	0.76	0.72
NH	0.23	0.37	0.28	0.24	0.39	0.12	0.27	
NJ	0.41	0.53	0.56	0.55	0.54	0.48	0.56	0.52
NM	0.84	0.77	0.71	0.75	0.76	0.81	0.87	0.79
NY	0.64	0.74	0.64	0.6	0.69	0.55	0.65	0.64
NC	0.61	0.61	0.59	0.57	0.56	0.66	0.66	0.61
ND	0.57	0.66	0.68	0.84	0.71	0.61	0.79	0.69
OH	0.62	0.55	0.49	0.58	0.61	0.73	0.69	0.61
OK	0.53	0.69	0.56	0.6	0.7	0.66	0.67	0.63
OR	0.73	0.73	0.74	0.84	0.7	0.78	0.73	0.75
PA	0.52	0.72	0.56	0.61	0.66	0.65	0.67	0.63
RI	0.47	0.65	0.67	0.52	0.66	0.6	0.57	0.59
SC	0.6	0.72	0.49	0.59	0.46	0.55	0.56	0.57
SD	0.71	0.84	0.66	0.83	0.71	0.71	0.77	0.75
TN	0.66	0.6	0.59	0.59	0.44	0.59	0.69	0.59
TX	0.86	0.7	0.73	0.76	0.72	0.79	0.85	0.77
UT	0.69	0.73	0.77	0.68	0.71	0.6	0.75	0.7
VT	0.63	0.51	0.51	0.51	0.51	0.37	0.38	0.49

Region	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb	Mean
VA	0.74	0.57	0.62	0.6	0.63	0.63	0.64	0.63
WA	0.68	0.66	0.78	0.79	0.7	0.75	0.75	0.73
WV	0.54	0.57	0.56	0.52	0.58	0.56	0.48	0.54
WI	0.56	0.54	0.6	0.56	0.66	0.55	0.64	0.59
WY	0.77	0.63	0.84	0.76	0.64	0.65	0.7	0.71
CENRAP	0.93	0.82	0.87	0.88	0.82	0.85	0.92	0.87
MANE_VU	0.5	0.68	0.57	0.62	0.7	0.49	0.6	0.59
MW	0.75	0.73	0.63	0.8	0.69	0.68	0.72	0.71
VISTAS	0.83	0.8	0.76	0.73	0.73	0.78	0.82	0.78

Figure 3-178: 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.

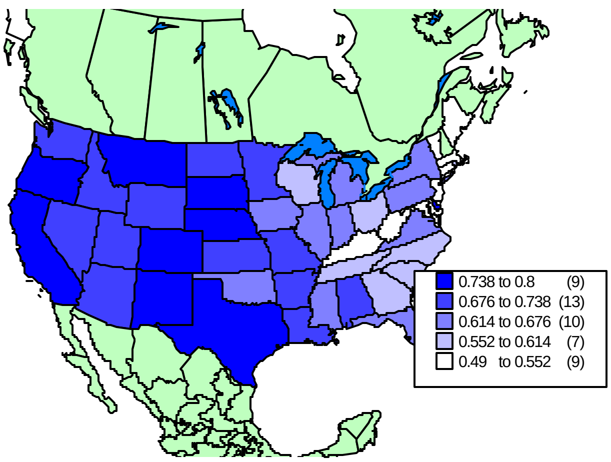


Figure 3-179: Wind Speed Index of Agreement for January-February 2001.

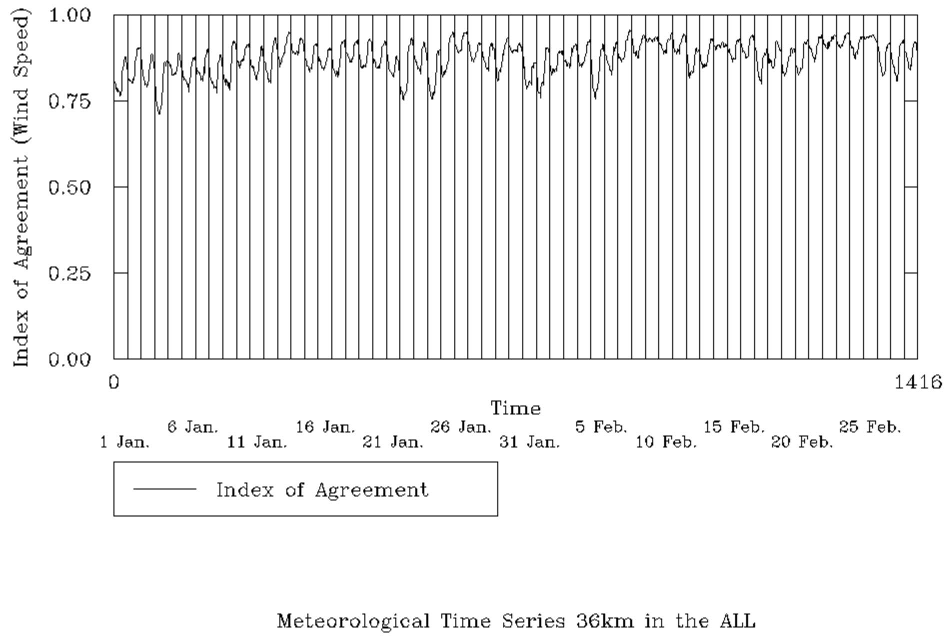


Figure 3-180: Wind Speed Index of Agreement for March-April 2001.

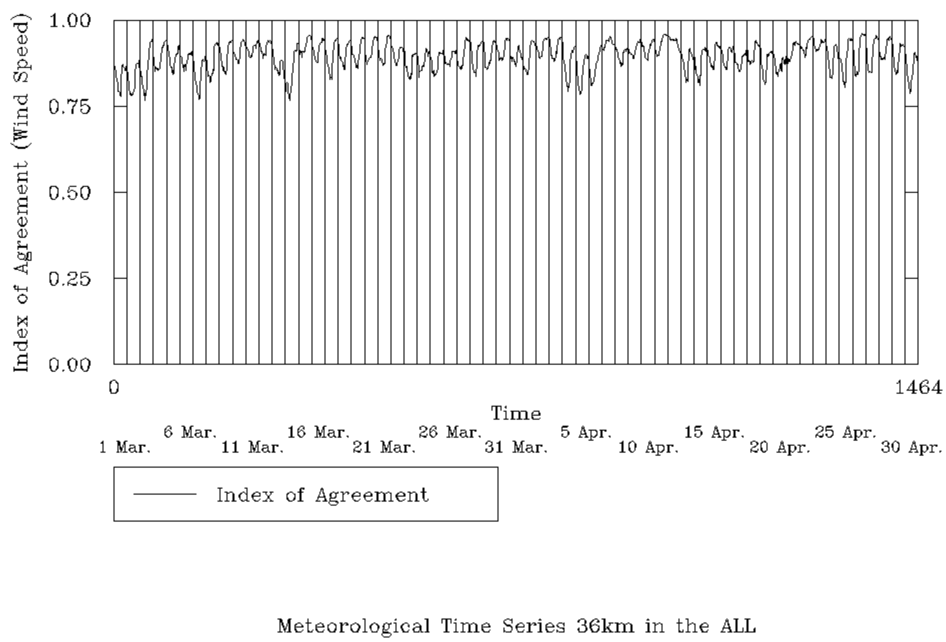


Figure 3-181: Wind Speed Index of Agreement for May-June 2001.

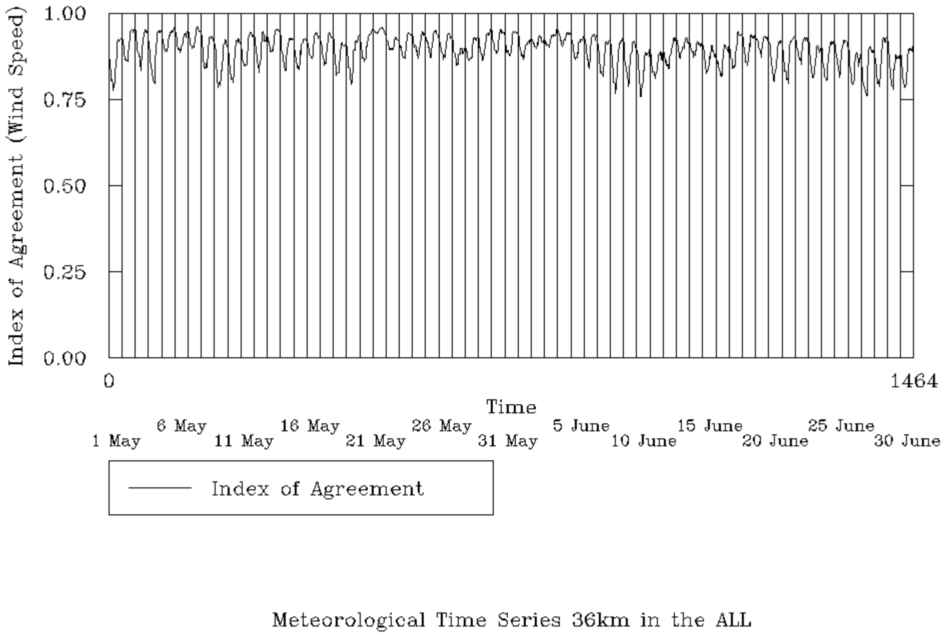


Figure 3-182: Wind Speed Index of Agreement for July-August 2001.

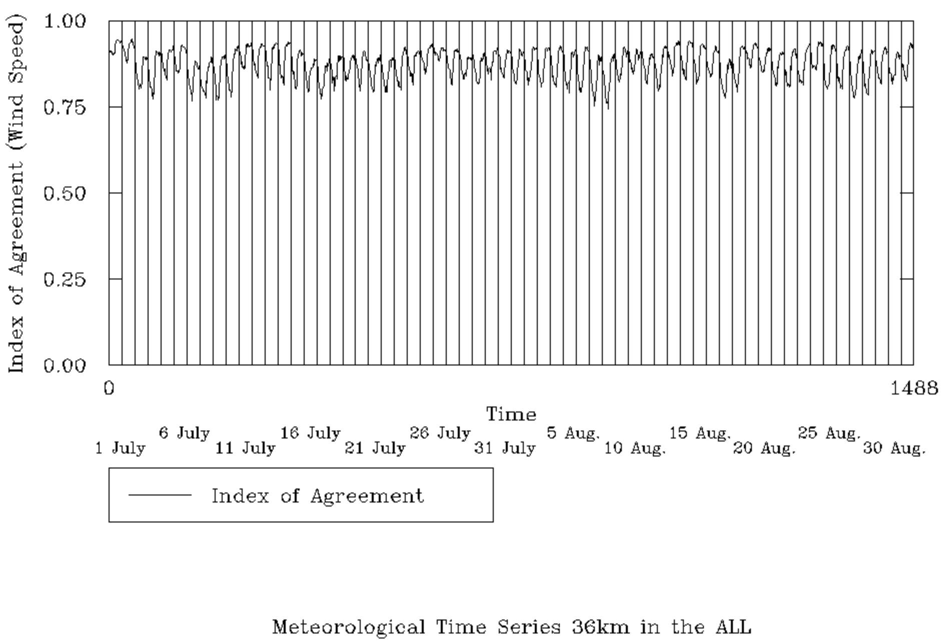


Figure 3-183: Wind Speed Index of Agreement for September-October 2001.

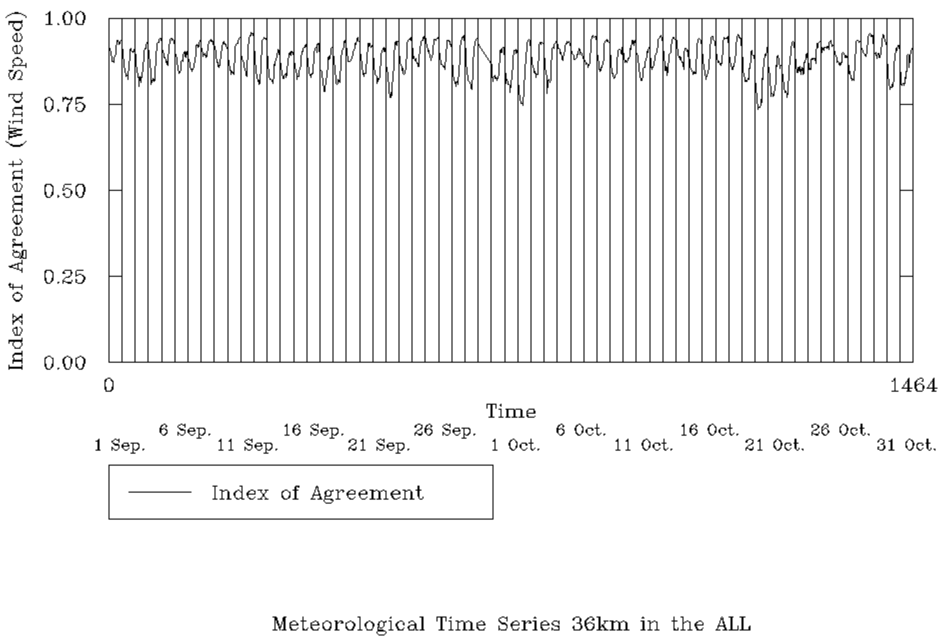


Figure 3-184: Wind Speed Index of Agreement for November-December 2001.

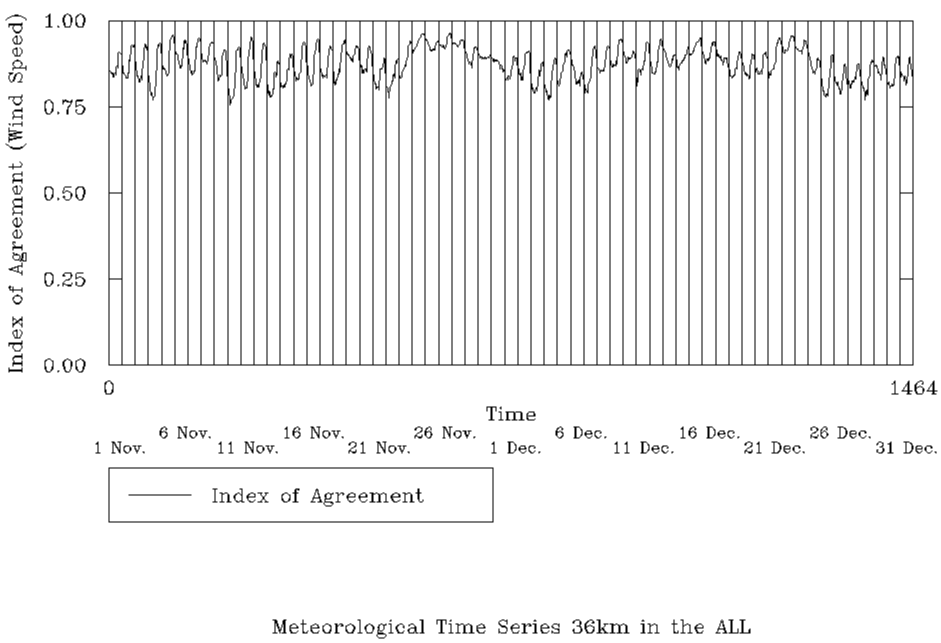


Figure 3-185: **Wind Speed Index of Agreement for January-February 2002.**

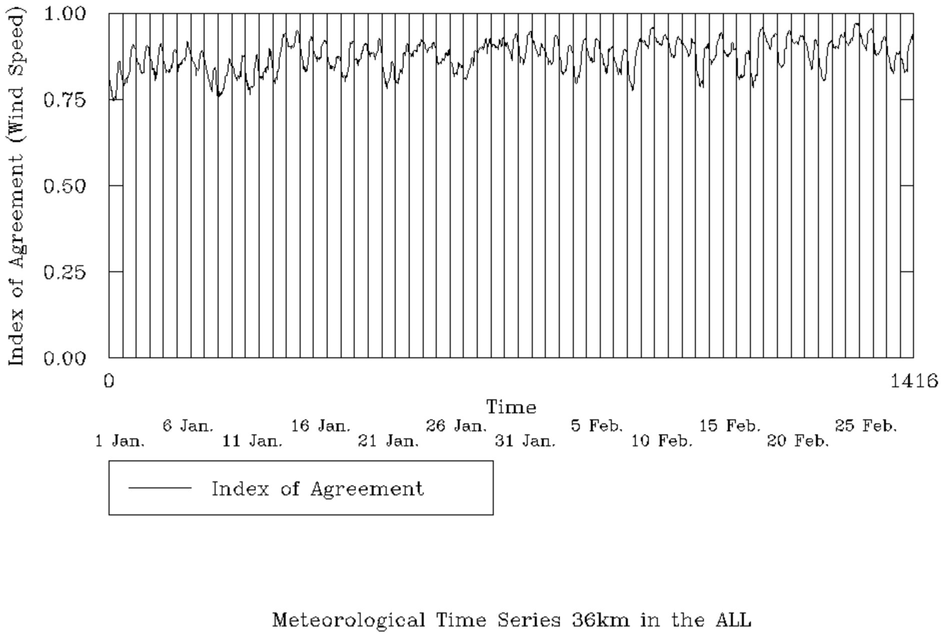


Figure 3-186: Wind Speed Index of Agreement for January-February 2001 in the CENRAP States.

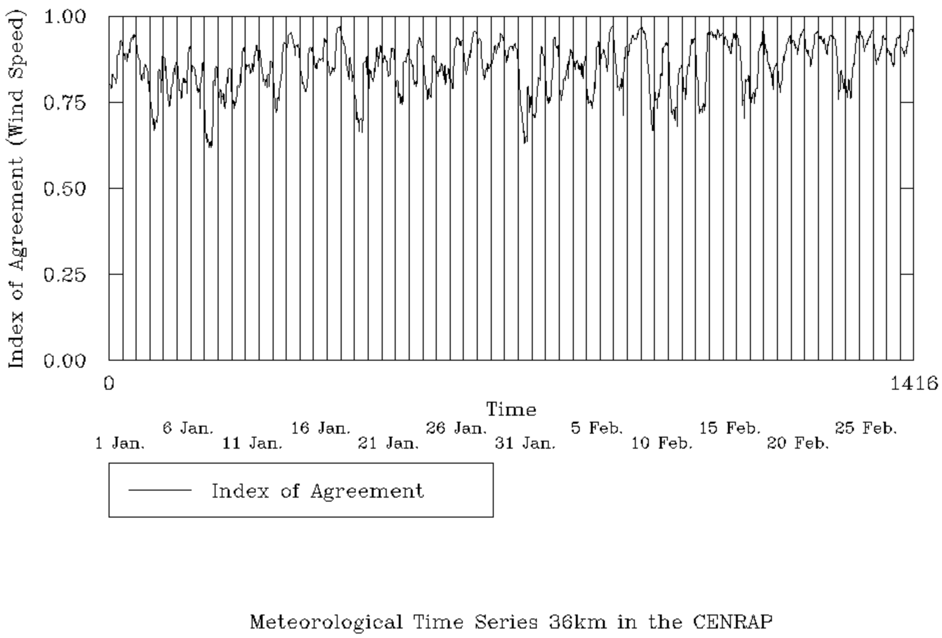


Figure 3-187: Wind Speed Index of Agreement for March-April 2001 in the CENRAP States.

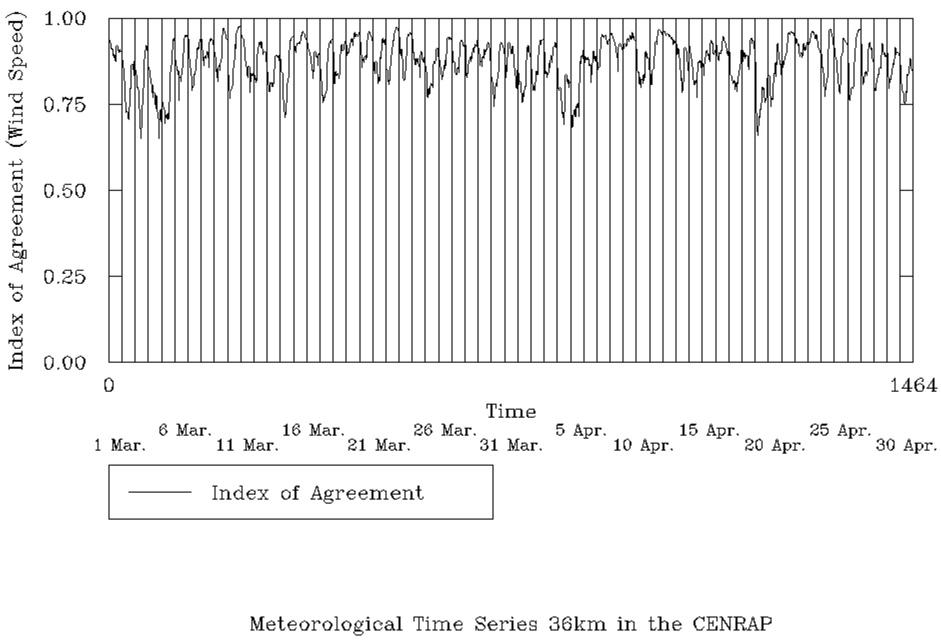


Figure 3-188: Wind Speed Index of Agreement for May-June 2001 in the CENRAP States.

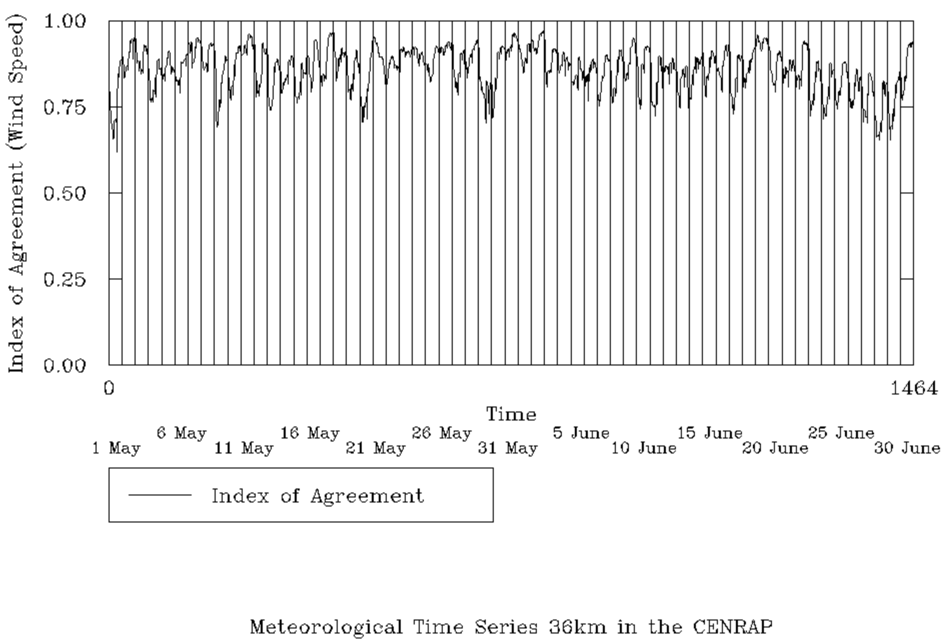


Figure 3-189: Wind Speed Index of Agreement for July-August 2001 in the CENRAP States.

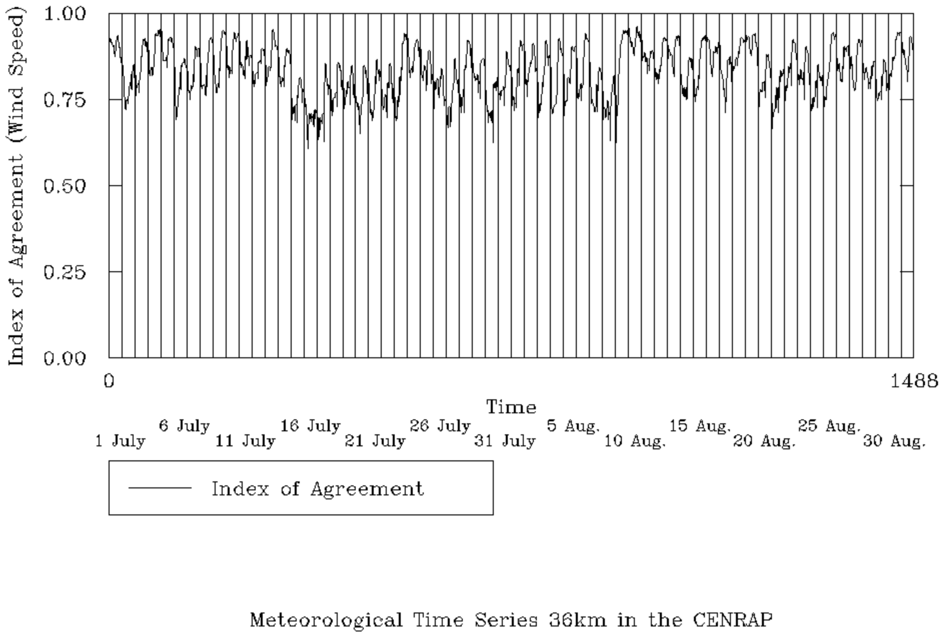


Figure 3-190: Wind Speed Index of Agreement for September-October 2001 in the CENRAP States.

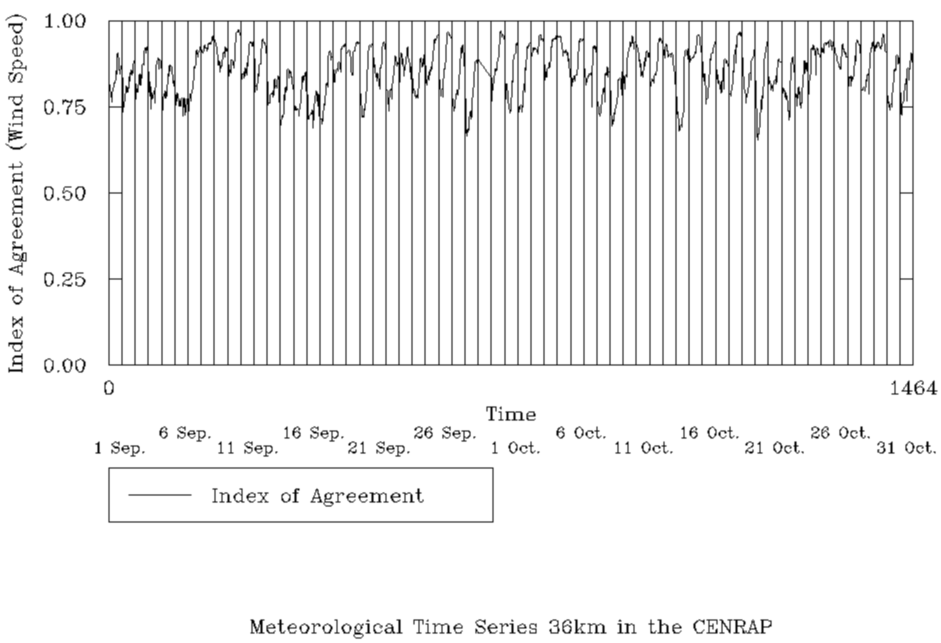


Figure 3-191: Wind Speed Index of Agreement for November-December 2001 in the CENRAP States.

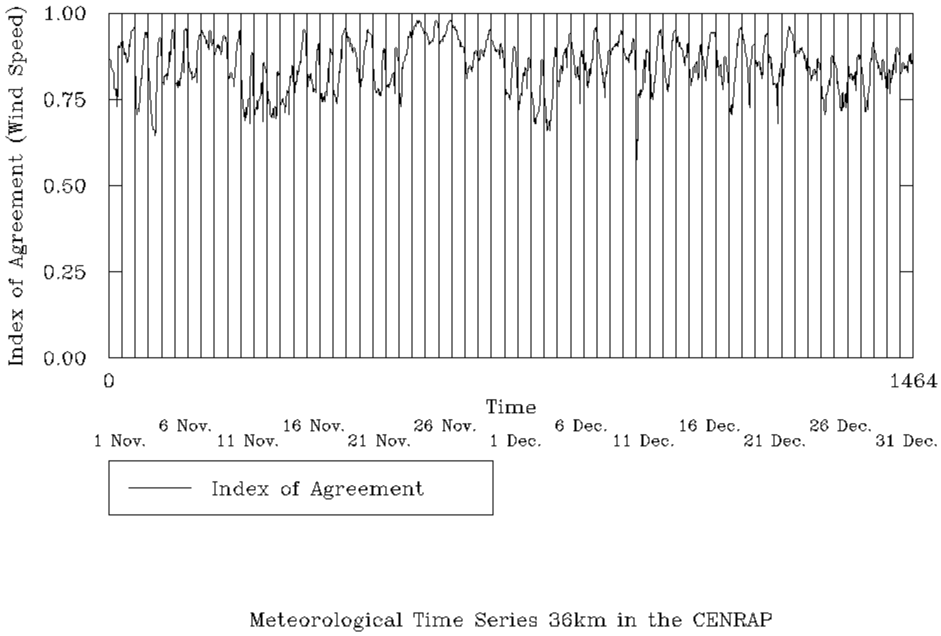


Figure 3-192: Wind Speed Index of Agreement for January-February 2002 in the CENRAP States.

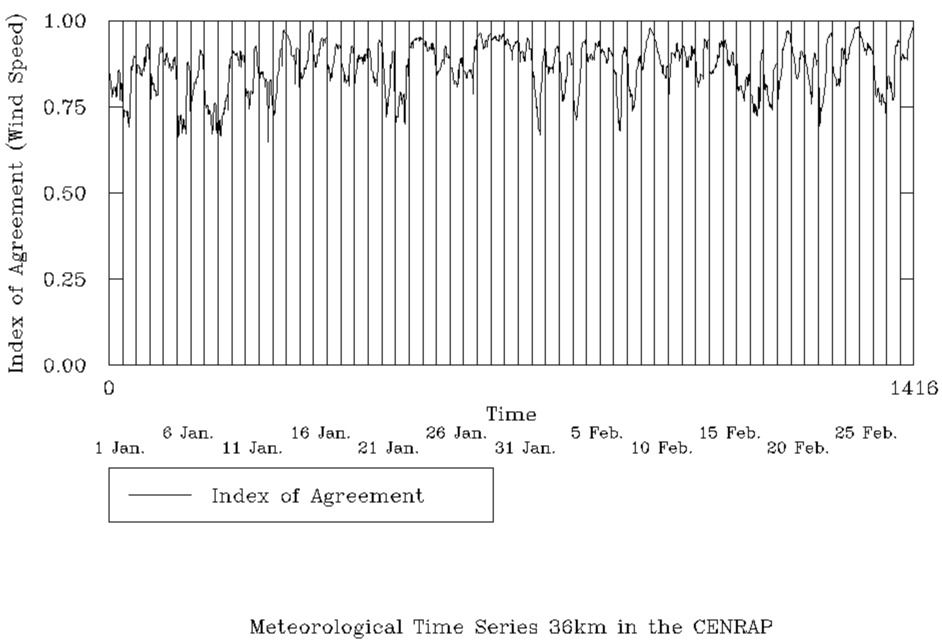


Figure 3-193: Wind Speed Index of Agreement for January-February 2001 in the MANE_VU States.

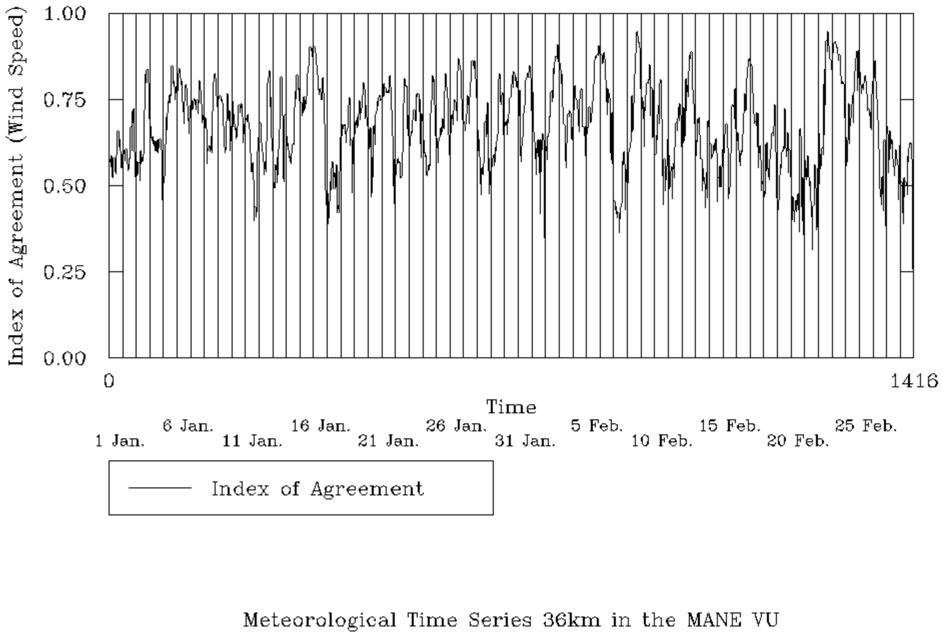


Figure 3-194: Wind Speed Index of Agreement for March-April 2001 in the MANE_VU States.

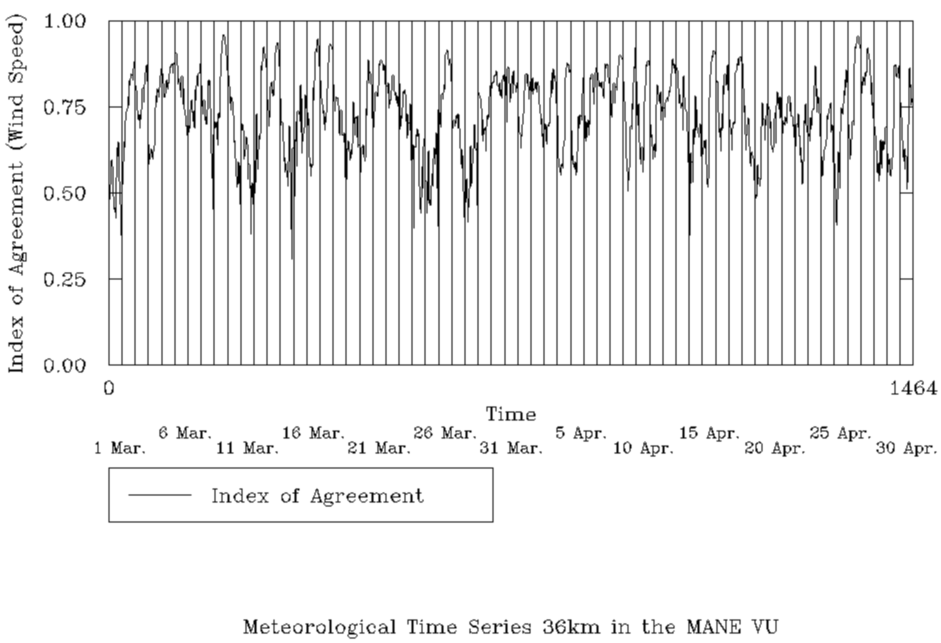


Figure 3-195: Wind Speed Index of Agreement for May-June 2001 in the MANE_VU States.

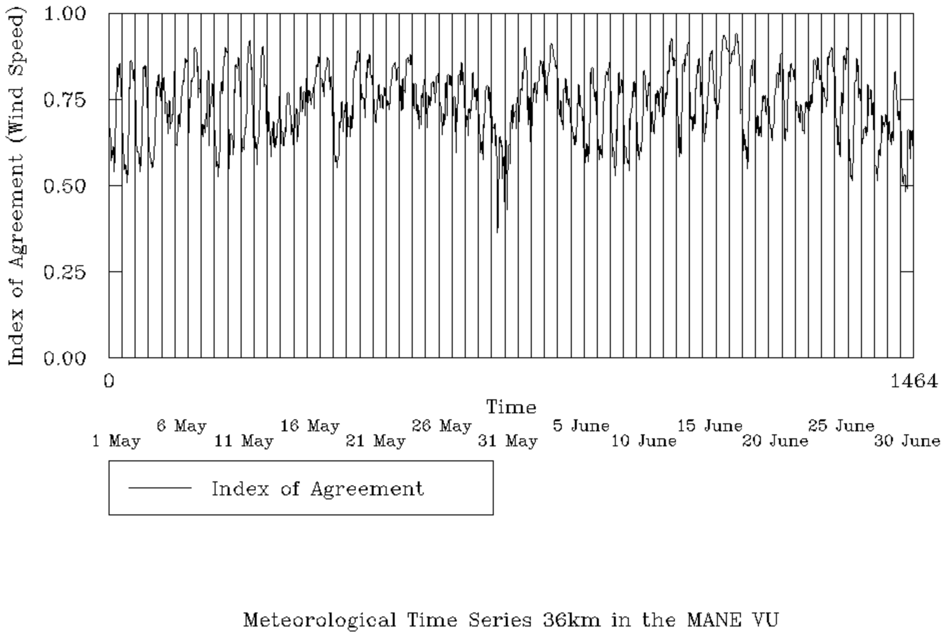


Figure 3-196: Wind Speed Index of Agreement for July-August 2001 in the MANE_VU States.

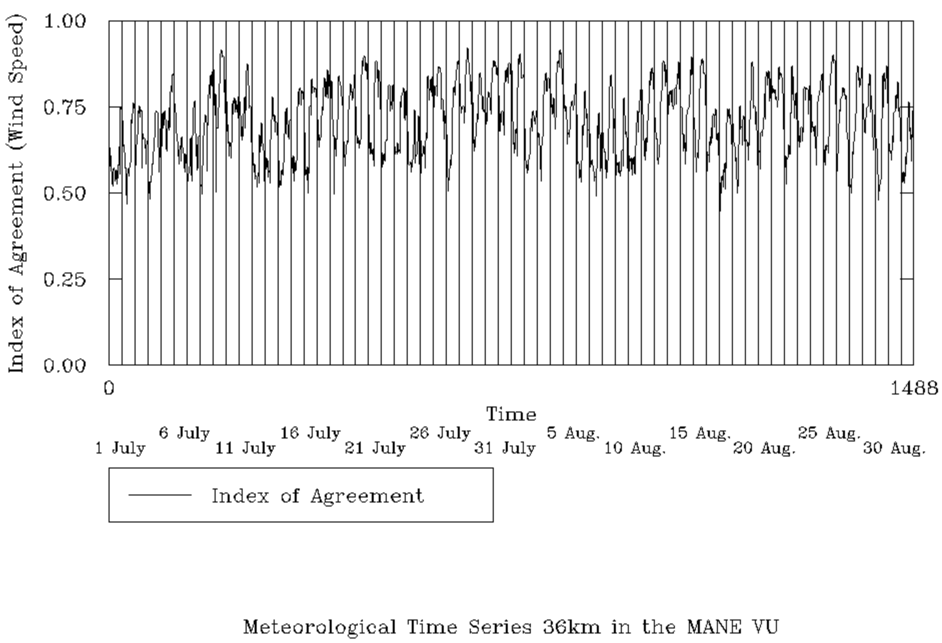


Figure 3-197: Wind Speed Index of Agreement for September-October 2001 in the MANE_VU States.

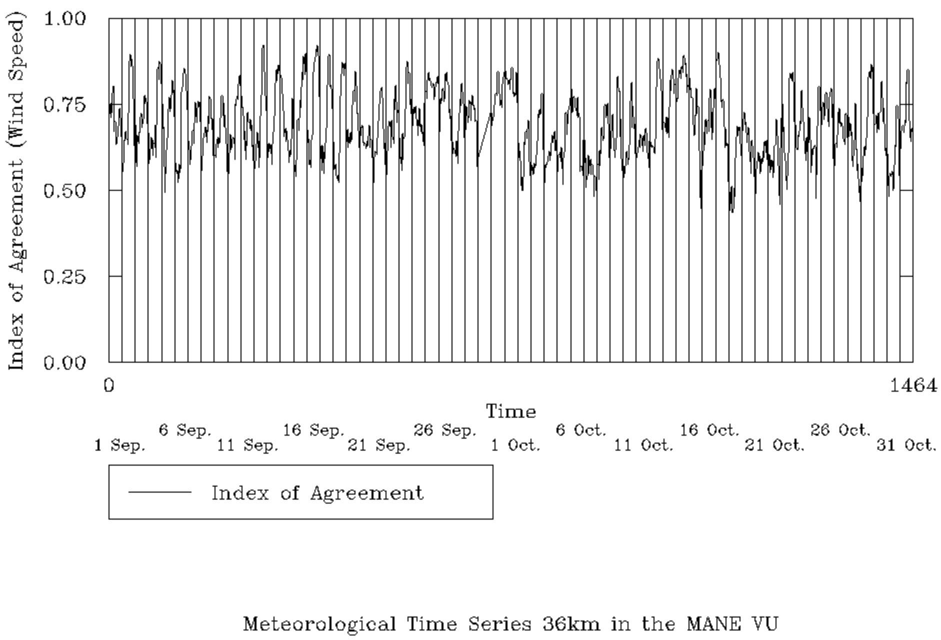


Figure 3-198: Wind Speed Index of Agreement for November-December 2001 in the MANE_VU States.

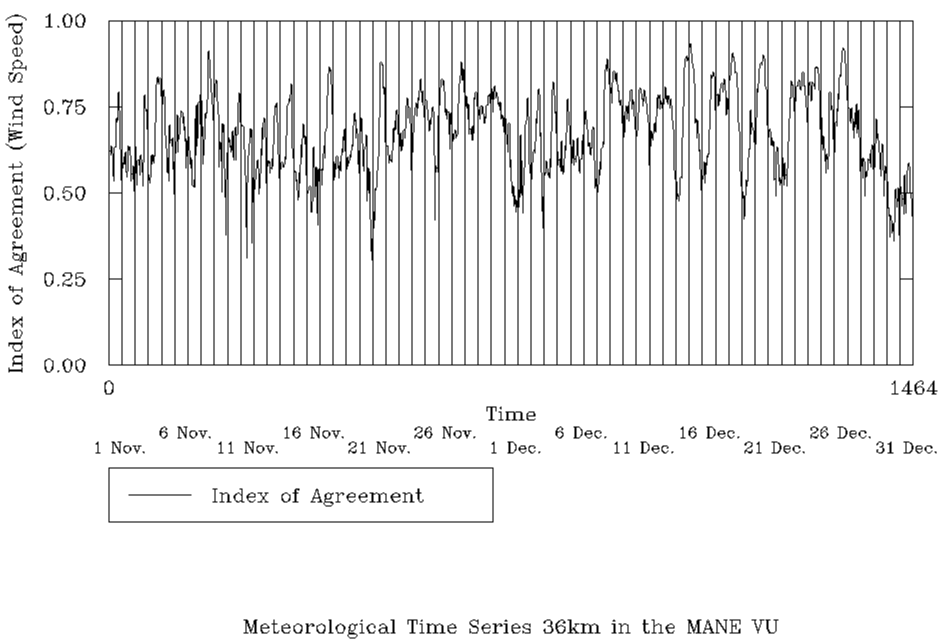


Figure 3-199: Wind Speed Index of Agreement for January-February 2002 in the MANE_VU States.

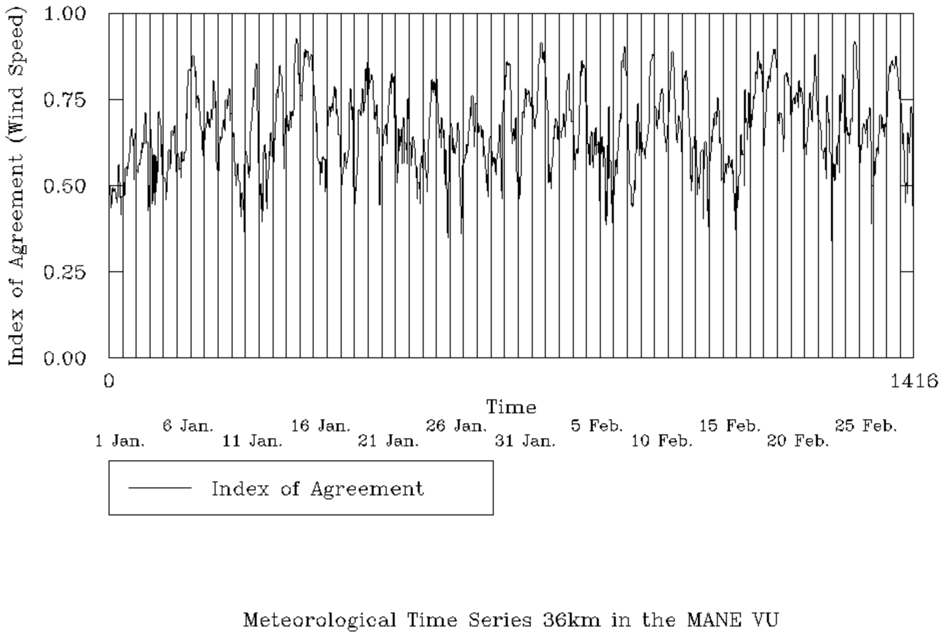


Figure 3-200: Wind Speed Index of Agreement for January-February 2001 in the Midwest RPO States.

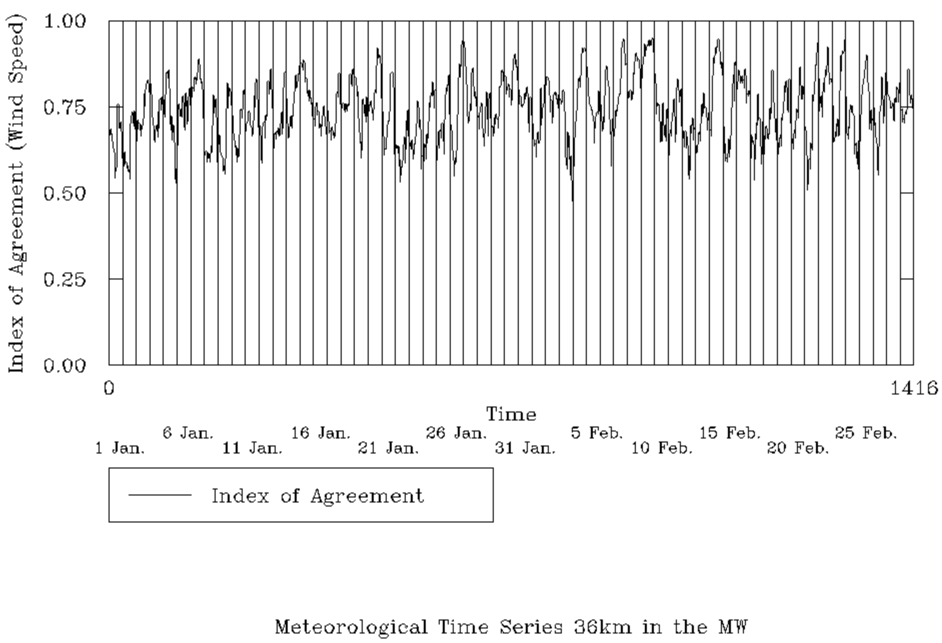


Figure 3-201: Wind Speed Index of Agreement for March-April 2001 in the Midwest RPO States.

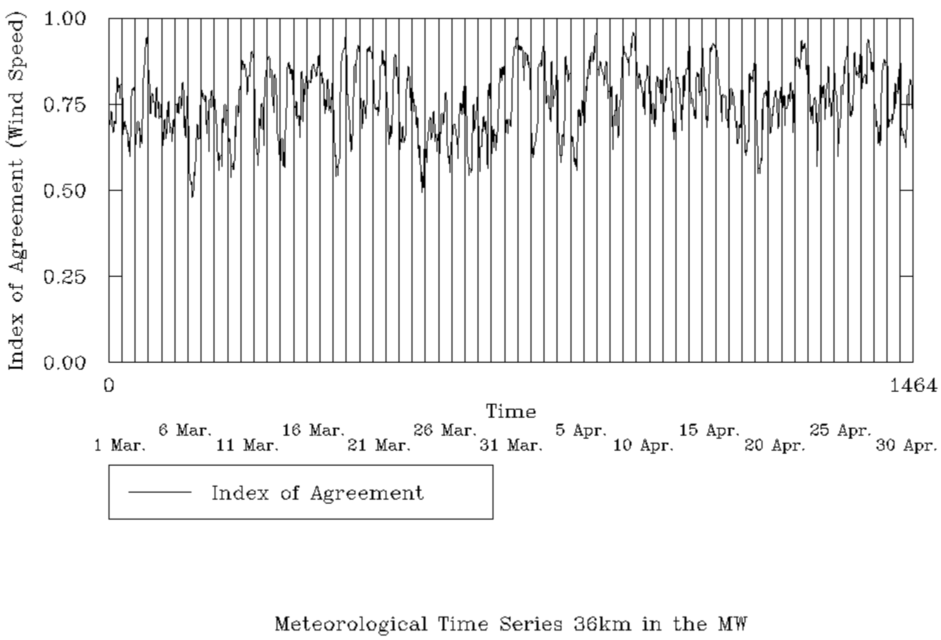


Figure 3-202: Wind Speed Index of Agreement for May-June 2001 in the Midwest RPO States.

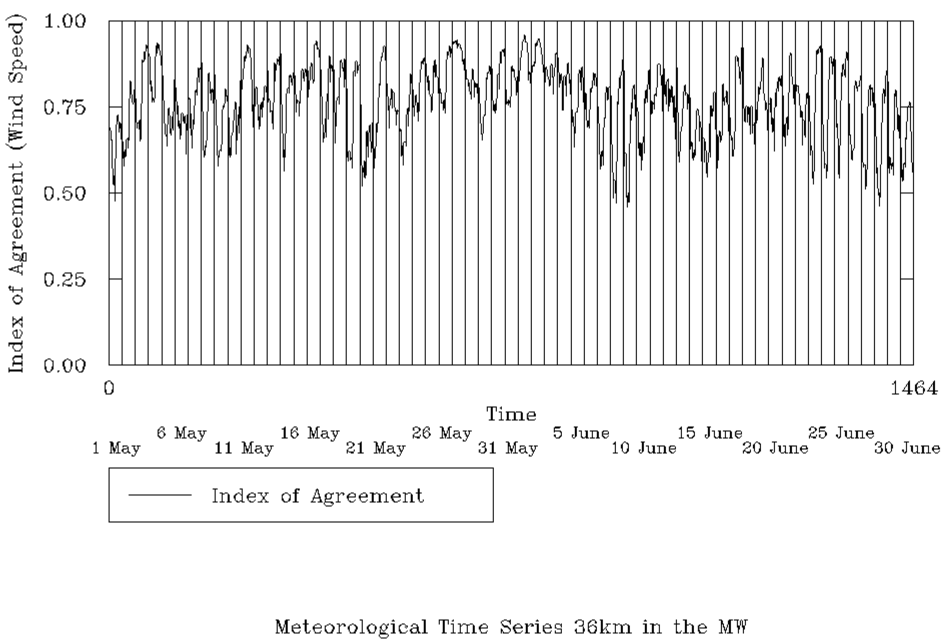


Figure 3-203: Wind Speed Index of Agreement for July-August 2001 in the Midwest RPO States.

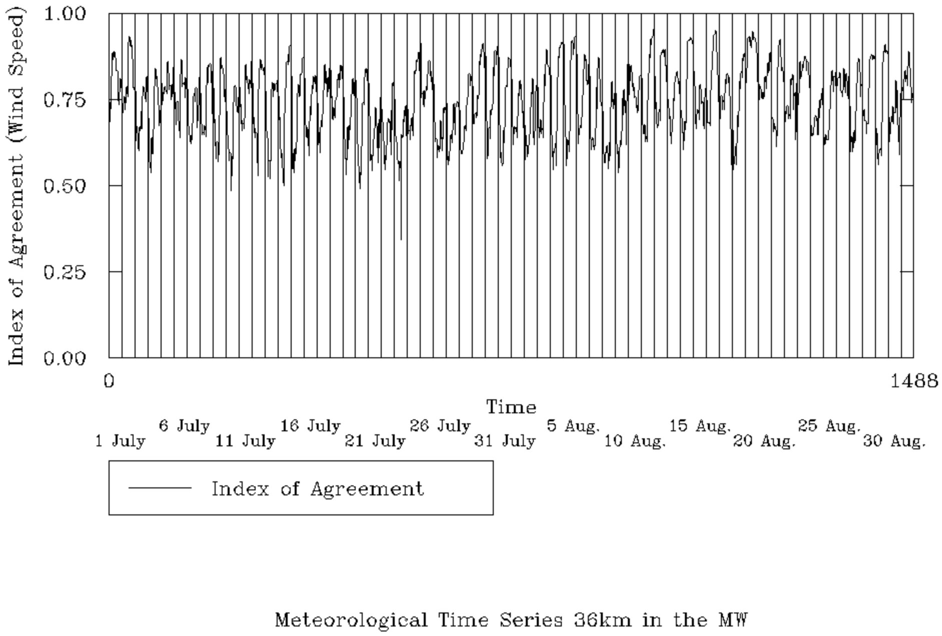


Figure 3-204: Wind Speed Index of Agreement for September-October 2001 in the Midwest RPO States.

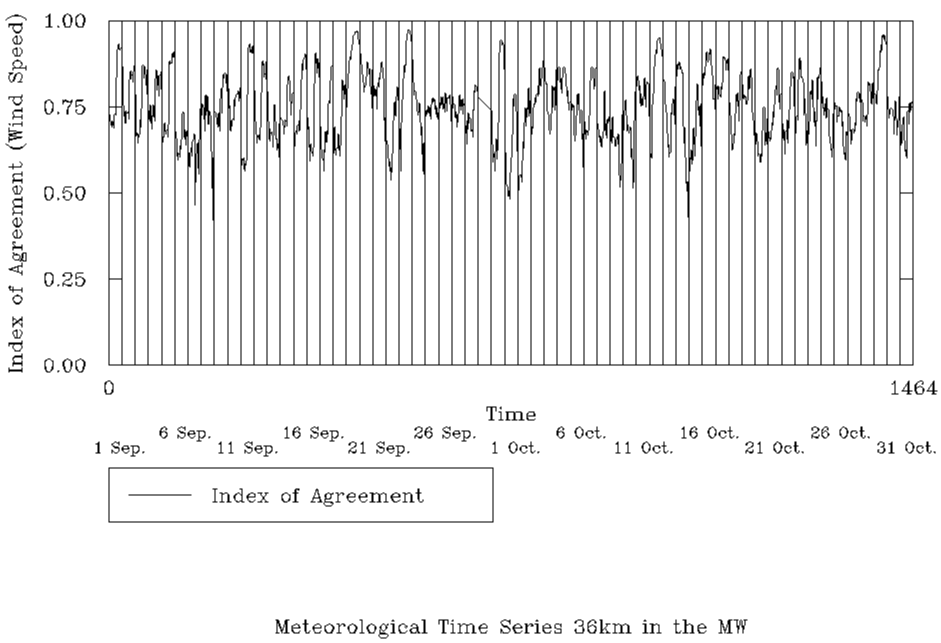


Figure 3-205: Wind Speed Index of Agreement for November-December 2001 in the Midwest RPO States.

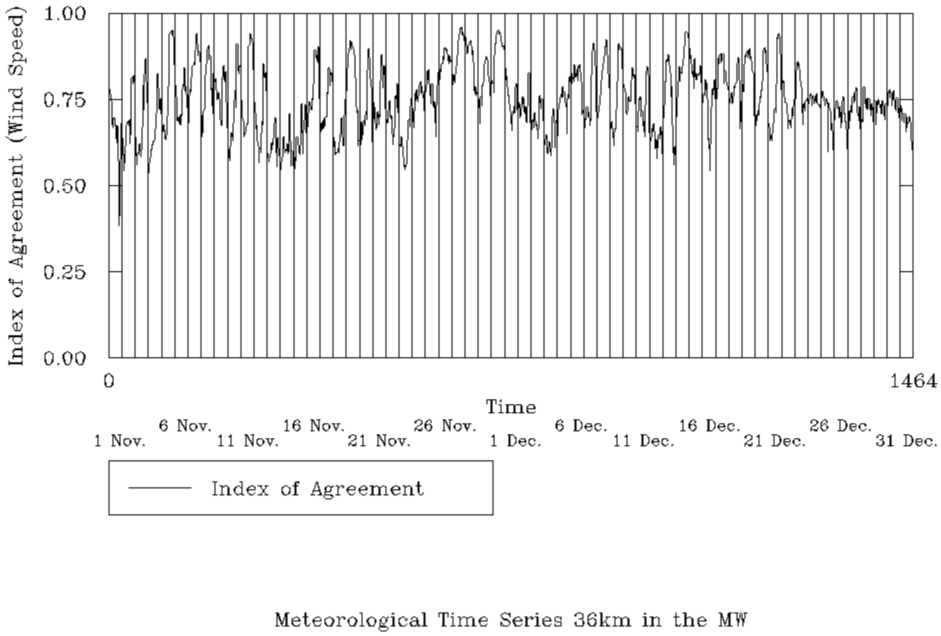


Figure 3-206: Wind Speed Index of Agreement for January-February 2002 in the Midwest RPO States.

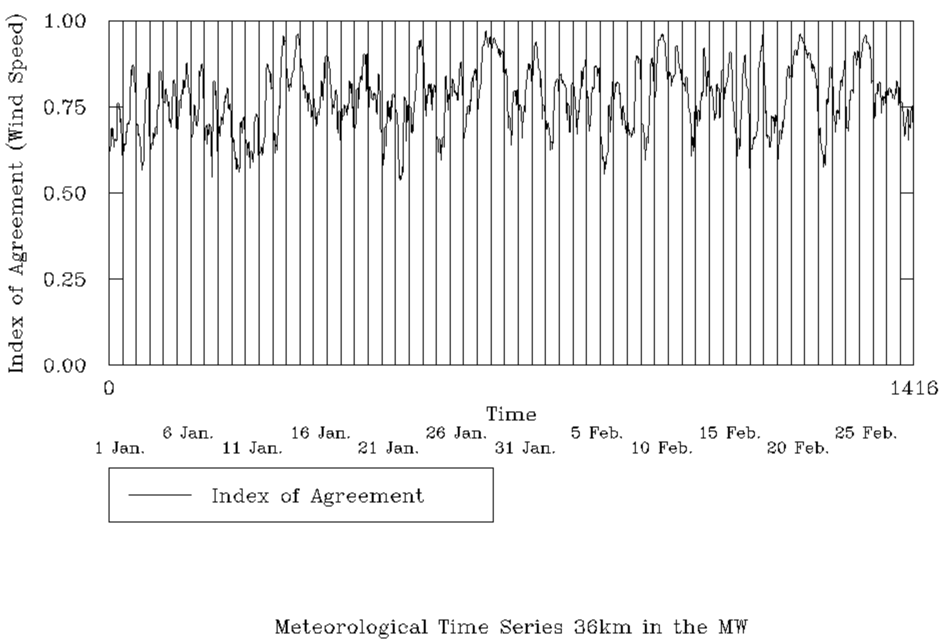


Figure 3-207: Wind Speed Index of Agreement for January-February 2001 in the VISTAS States.

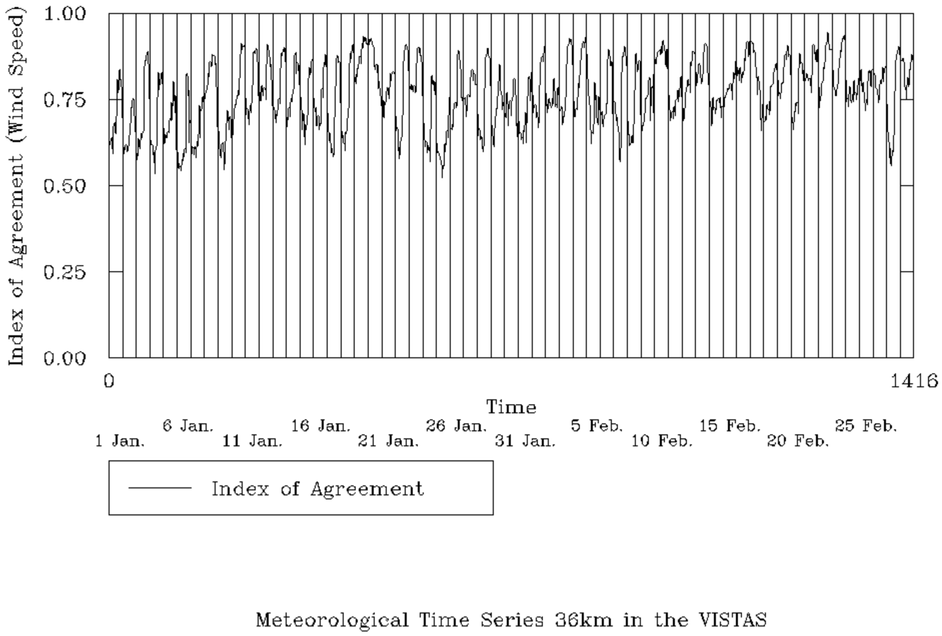


Figure 3-208: Wind Speed Index of Agreement for March-April 2001 in the VISTAS States.

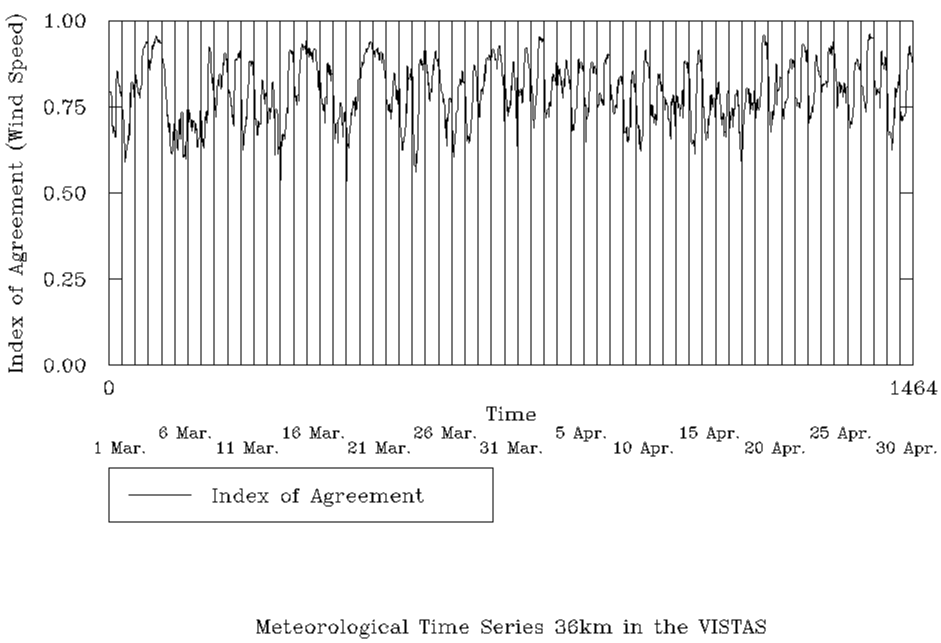


Figure 3-209: Wind Speed Index of Agreement for May-June 2001 in the VISTAS States.

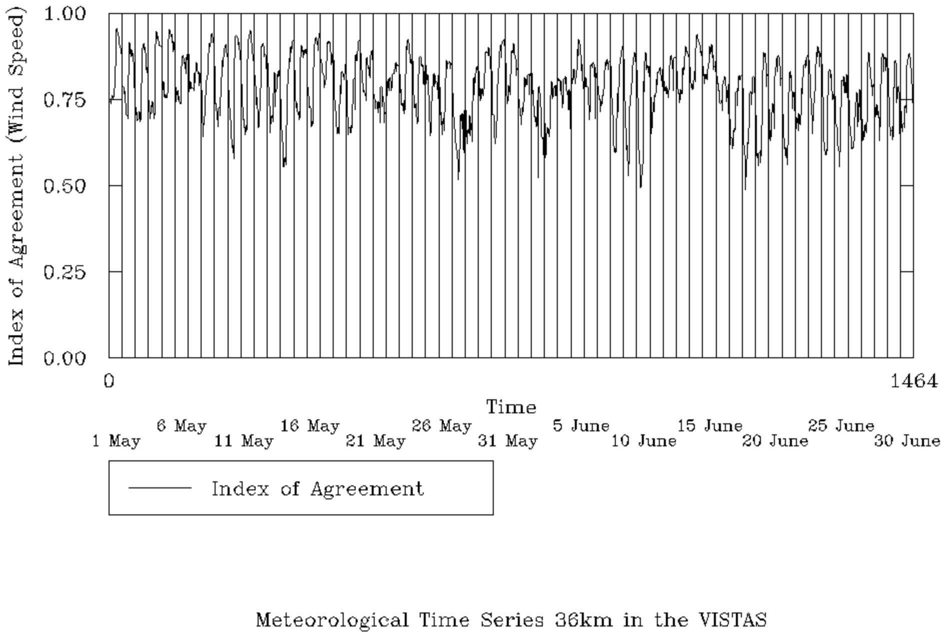


Figure 3-210: Wind Speed Index of Agreement for July-August 2001 in the VISTAS States.

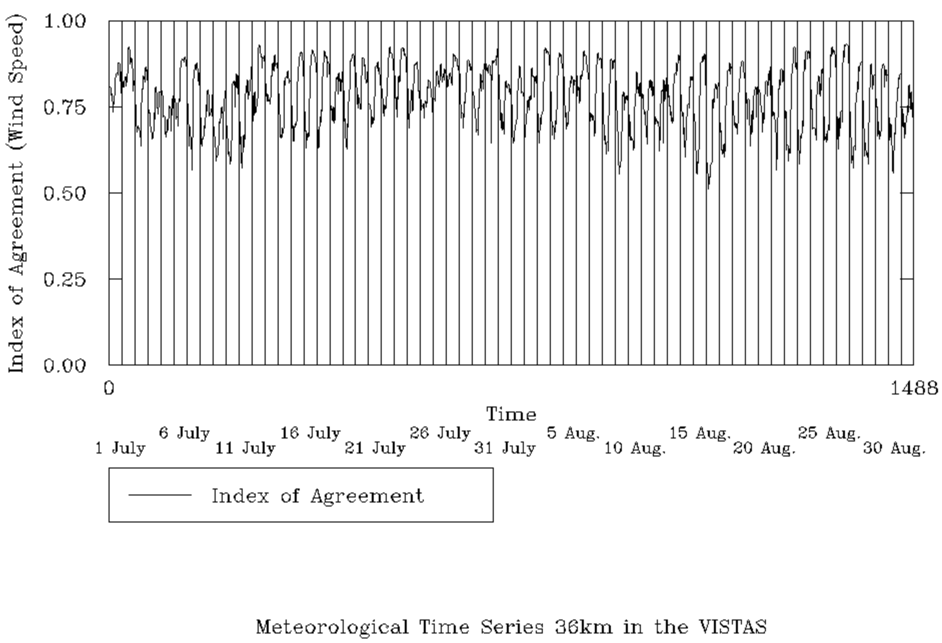
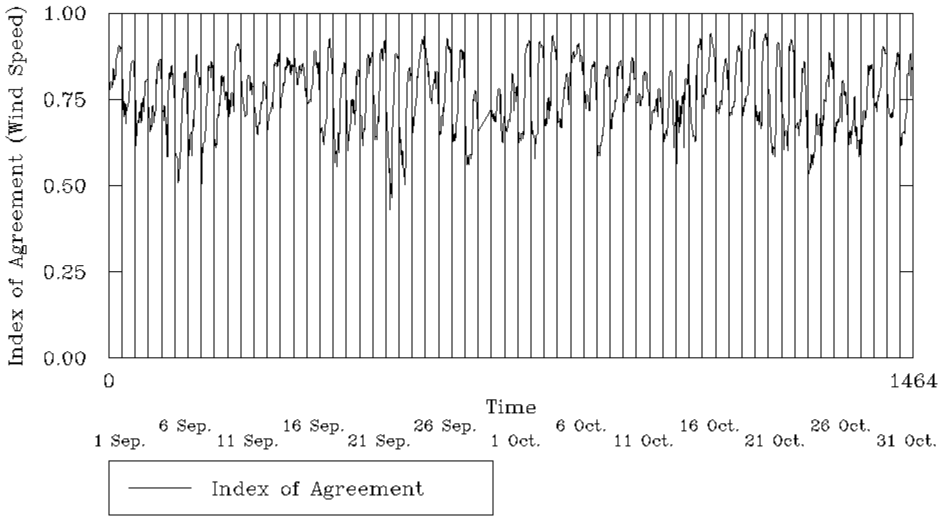
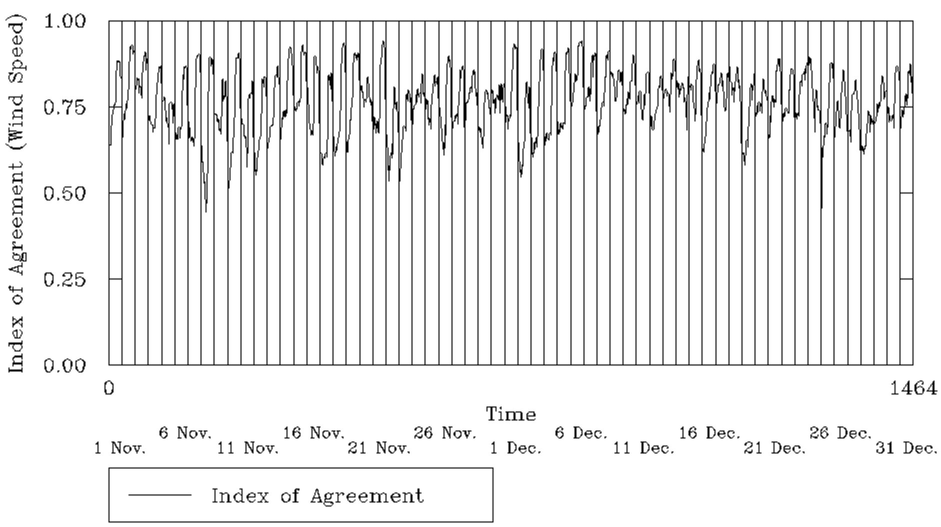


Figure 3-211: Wind Speed Index of Agreement for September-October 2001 in the VISTAS States.



Meteorological Time Series 36km in the VISTAS

Figure 3-212: Wind Speed Index of Agreement for November-December 2001 in the VISTAS States.



Meteorological Time Series 36km in the VISTAS

Figure 3-213: Wind Speed Index of Agreement for January-February 2002 in the VISTAS States.

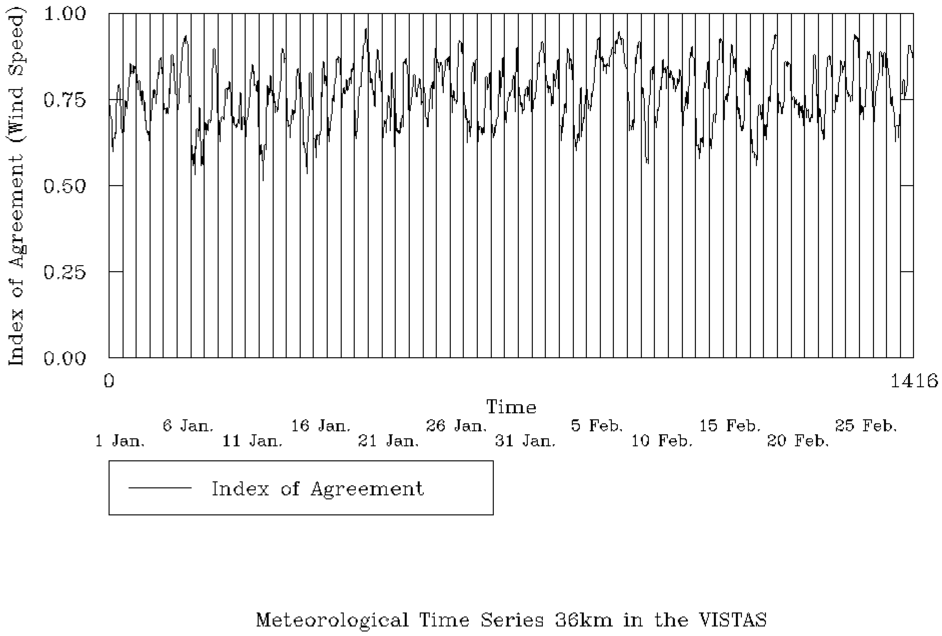


Figure 3-214: Wind Speed Index of Agreement for January-February 2001 in the WRAP States.

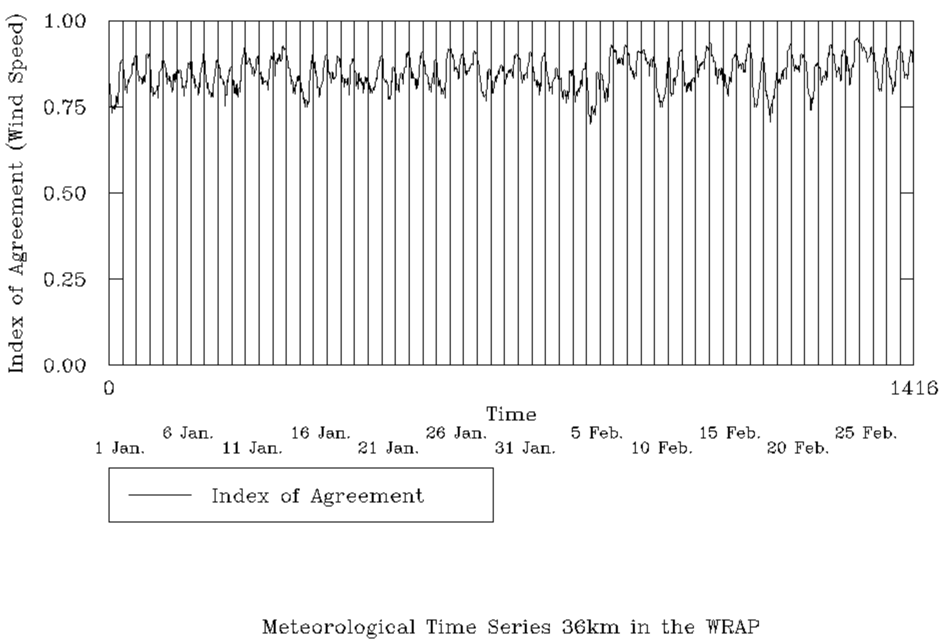


Figure 3-215: Wind Speed Index of Agreement for March-April 2001 in the WRAP States.

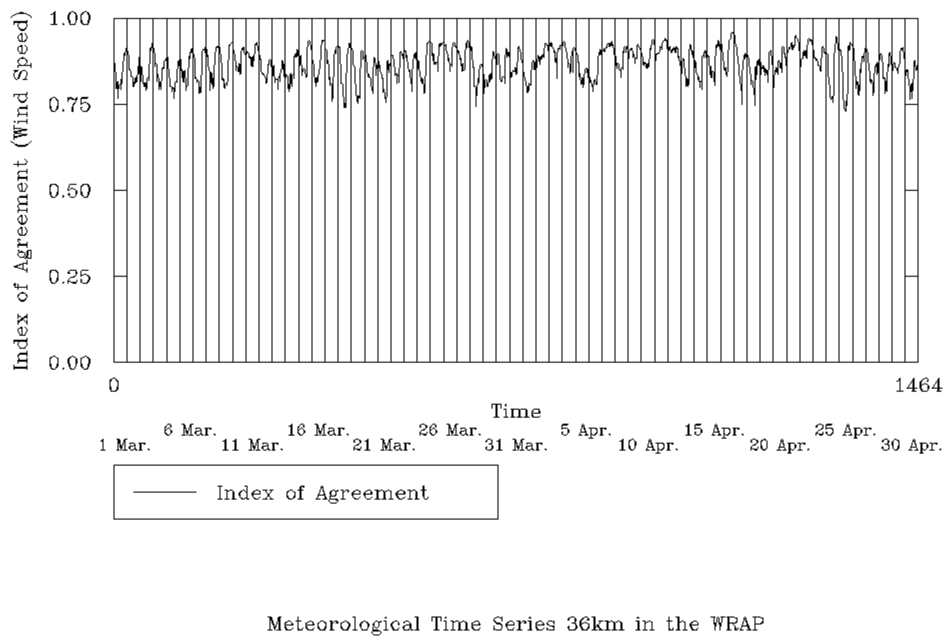


Figure 3-216: Wind Speed Index of Agreement for May-June 2001 in the WRAP States.

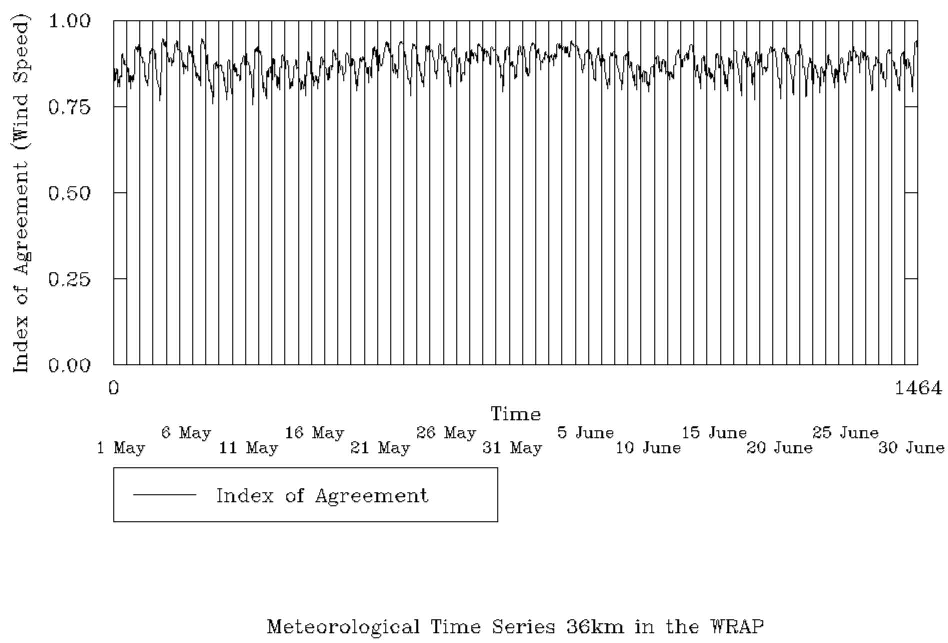


Figure 3-217: Wind Speed Index of Agreement for July-August 2001 in the WRAP States.

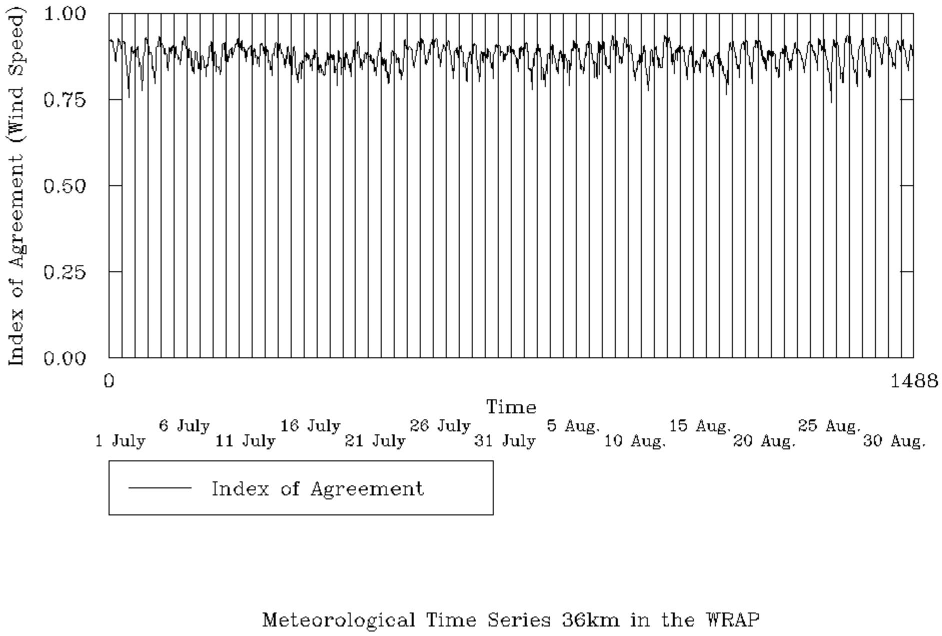


Figure 3-218: Wind Speed Index of Agreement for September-October 2001 in the WRAP States.

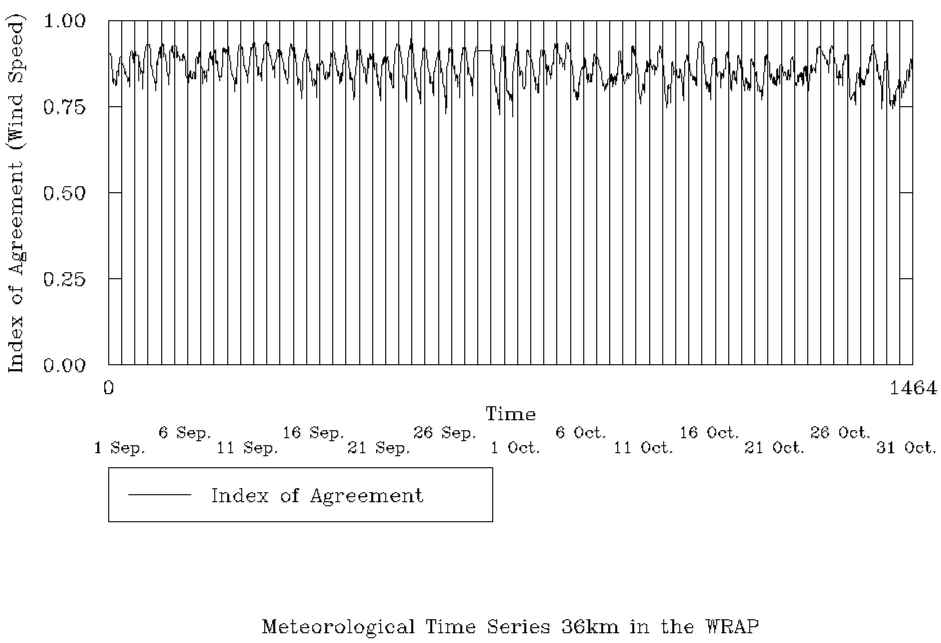
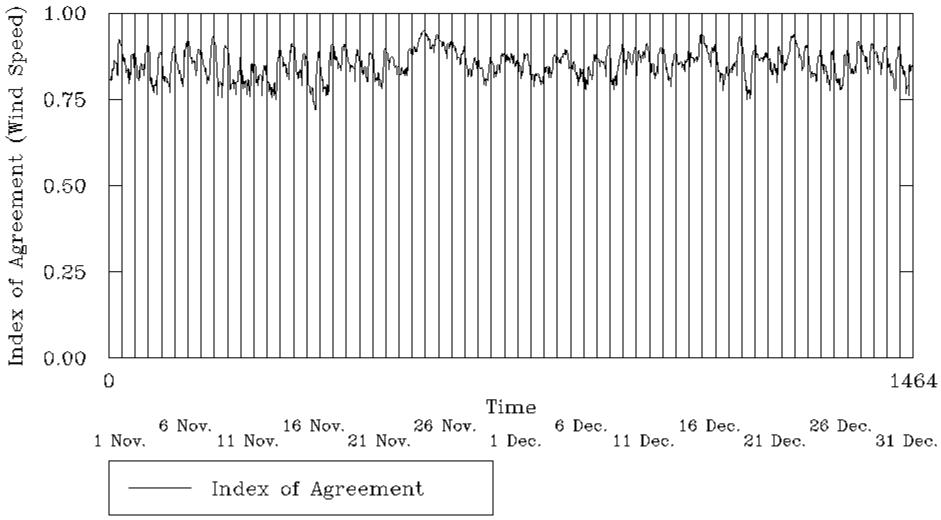
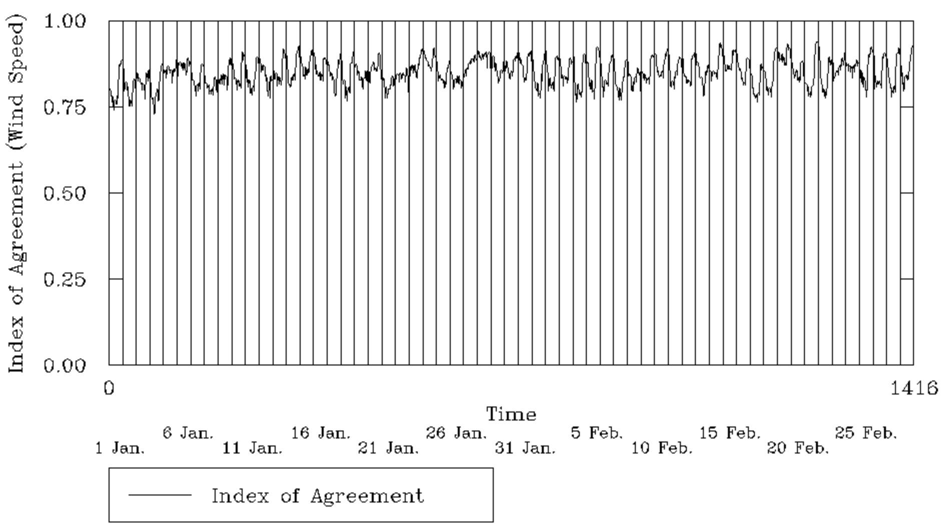


Figure 3-219: Wind Speed Index of Agreement for November-December 2001 in the WRAP States.



Meteorological Time Series 36km in the WRAP

Figure 3-220: Wind Speed Index of Agreement for January-February 2002 in the WRAP States.



Meteorological Time Series 36km in the WRAP

4 DISCUSSION

Analysis of the results of a model simulation of 14 months in duration over the entire Continental United States is a daunting task. To fully distill these results into a single conclusion is nearly impossible. The range of uses to which these modeling results may be applied further complicates this analysis

The synoptic evaluation has shown the model is generally replicating synoptic patterns. The statistical evaluation for temperature has shown that the model is performing reasonably well with bias scores of around 1 K and error scores around 2 K. Mixing ratio analysis show biases of less than 0.5 g/kg and errors around 1 g/kg. Precipitation results show that the model generally replicates the observation, but is overestimating precipitation in the summer months. Wind speed index of agreement shows typical values of around 0.75, consistent with what has historically been found in MM5 modeling studies.