Further comparison of MM5 simulations for the July 11 to 15, 1997 period

The MCNC Environmental group using MM5 has simulated the July 1997 high ozone episode. The results of their analysis were posted at http://www.emc.mcnc.org/projects/NCDAQ/Met/97e. The design and exercising of the MM5 model by this group differs from that of UMD (see ftp://www.dec.state.ny.us/dar/air_research/htdocs/mm5-umd-setup.htm) even though the definition of the projection of the grid is the same between the two simulations.

Some of the salient differences are: vertical grid structure; areal extent of the grids ; and the shorter period of simulation [July 10 (12Z) to July 16 (12Z) 1997 of MCNC compared to July 5 (12Z) to July 21(00Z), 1997 by UMD]. Details of the setup can be found at the above referenced URLs. In this analysis, we focus on the relative response of the two simulations over the common region of the 12km grid to the TDL and CASTNet measurements. To this end, we obtained the gridded data for the MCNC run identified as Case E. The 12 km grid, identified as D02, covers portions of VA, WV, KY, TN, GA, SC besides NC and is shown in Figure 1, adapted from the MCNC web site. Briefly, the UMD simulation consists of 2-way nested 36/12 km grid, while the MCNC utilized 3grids at 36/12/4 km one-way nesting. The comparison is made between D02, the area shown in Figure 1of the MCNC domain to the corresponding portion of the UMD domain (see Figure2). The statistical measures were developed using the METSTAT from Environ (see ftp://camx.pass4camx@ftp.environ.org/processors/metstat.24jan02tar.z).

TDL data comparison

Figure 3 and 4 display the comparison of the MM5 predictions to measured wind speed, that were part of the TDL data utilized in the nudging for MCNC and UMD simulations, respectively. The MCNC estimates of wind speed exhibit both over and under prediction, while the UMD estimate shows under prediction of the measured wind speeds. While the under prediction in both cases is associated with the peak wind speed, the MCNC data shows over prediction for the hours with minimum wind speed as well unlike the UMD data. The wind direction on the other hand shows very good agreement with both models and bias that is generally near the zero line.

Figures 5 and 6 display the comparison of the predicted temperatures from MCNC and UMD to that measured under TDL, respectively. Both models show good agreement to the TDL data, with the UMD data exhibiting slightly lower bias than the MCNC simulation. The bias range for UMD is from 0.5 to –2.5 C, while for MCNC it ranges from 1.5 to –4 C.

Figures 7 and 8 display the comparison of the predicted and measured mixing ratio based on MCNC and UMD simulations, respectively. In general, both simulations tend to under predict with the UMD estimates showing an occasional agreement with the measured data. However, the diurnal variation appears to show a better match visually with observations for the MCNC simulation.

CASTNet data comparison

Figures 9 and 10 display the average observed and predicted wind speed and direction for MCNC and UMD simulations, respectively for the common 12 km domain. The average wind speeds measured at the CASTNet sites are in the 1 to 2m/s range compared to the TDL sites which range from 1 to 4 m/s. The MCNC simulation exhibits generally a positive bias, while the UMD shows a negative bias, in both cases as high as 1m/s.

Figure 11 and 12 display the average observed and predicted temperatures based on MCNC and UMD simulations, respectively. While the MCNC simulation shows under prediction of the maximum temperature, the UMD simulation tends to over predict the maximum. On the other hand, the minimum temperature shows slight under prediction in the case of UMD simulation while the MCNC simulation shows over prediction. Examination of the bias shows that the UMD excursions are higher in magnitude than the over- or under- prediction of MCNC, although the magnitude of the under predictions are about the same.

Spatial correlation

We also examined the correlation of meteorological parameters between model simulated and measured (TDL and CASTNet) data for each of the monitors. The total number of locations considered in this analysis, are 98 and 14 for the TDL and CASTNet, respectively.

Figures 13, 14, and 15 display spatial distribution of correlation for wind speed, temperature, and mixing ratio, respectively, between TDL based-data and MCNC's MM5 simulation. Similarly, Figures 16,17, and 18 display the correlation for wind speed, temperature and mixing ratio, respectively for the UMD's MM5 simualtion. In the case of temperature (see Figures 14 and 17) the UMD simulation appears to yield higher correlation than the MCNC simulation, while for wind speed (see Figure 13 and 16) both simulations exhibit similar level of correlation. In the case of mixing ratio (See Figures 15 and 18) there appears to be slightly higher level of correlation for the MCNC simulation than UMD.

Figures 19 through 22 display the spatial distribution of correlation for wind speed and temperature between CASTNet and the two MM5 simulations. As noted above the sample of stations is much smaller compared to the TDL data. Interestingly, both simulations exhibit lower level of correlation for temperature (see Figures 20 and 22) and for the wind speed (see Figures 19 and 21) when compared to the TDL data.

Discussion and Summary

Both MM5 simulations utilized observational nudging which was based upon TDL data, but not on the measurements from CASTNet. Thus in a way CASTNet provides for an independent assessment, although the number of stations is quite limited in the present assessment.

The agreement between the MM5 simulations is quite good, even though both simulations were conducted independently with differing vertical gird structure. For example, the layer-1 heights are 38m and 20m for MCNC and UMD simulations, respectively. Also, no adjustments were made to the model estimates for monitor height which in the case of temperature probe is about 2m and wind speed and direction at 10m for TDL and for CASTNet at 9m for temperature and 10m for wind speed and direction.

The lack of a better agreement between the model estimated and measured mixing ratio suggests that there is a need for further examination of the methods used for the estimation of the parameter.

Figure 1 **MM5 Modeling Domain used in MCNC Simulation**

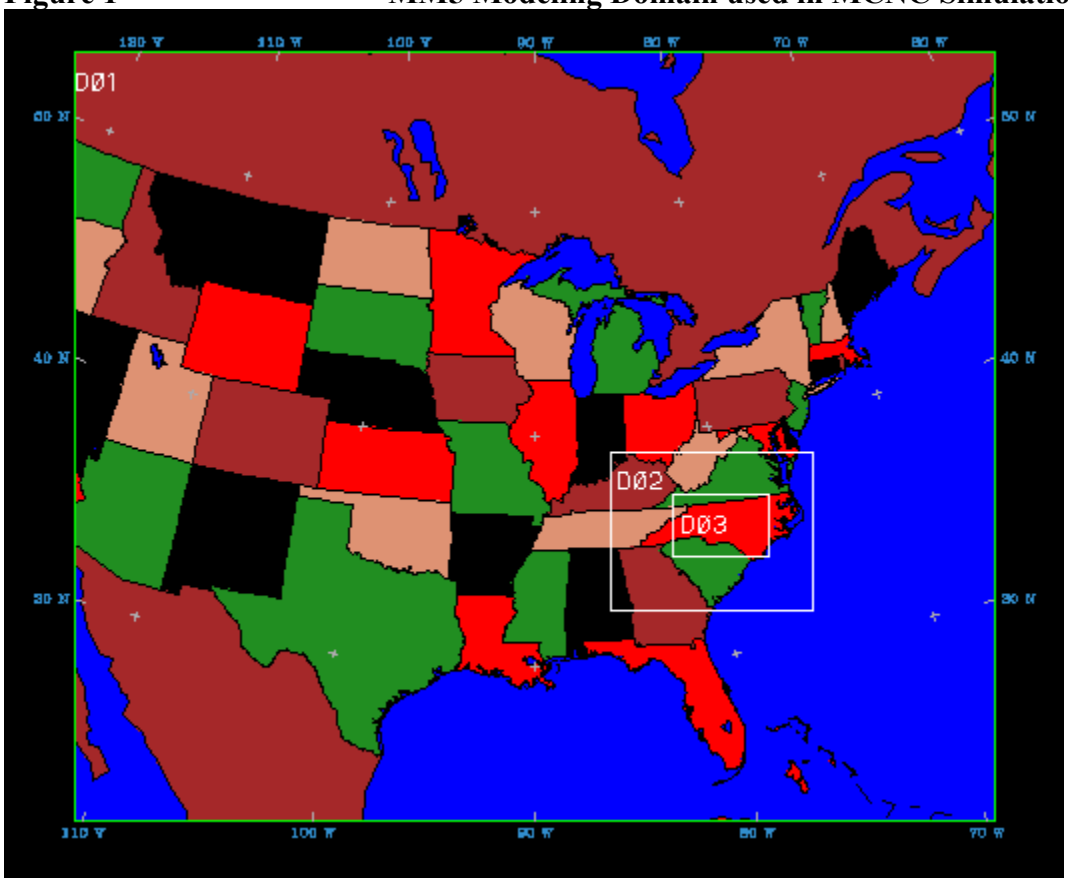

Figure 2 MM5 Modeling Domain used in UMD Simulation

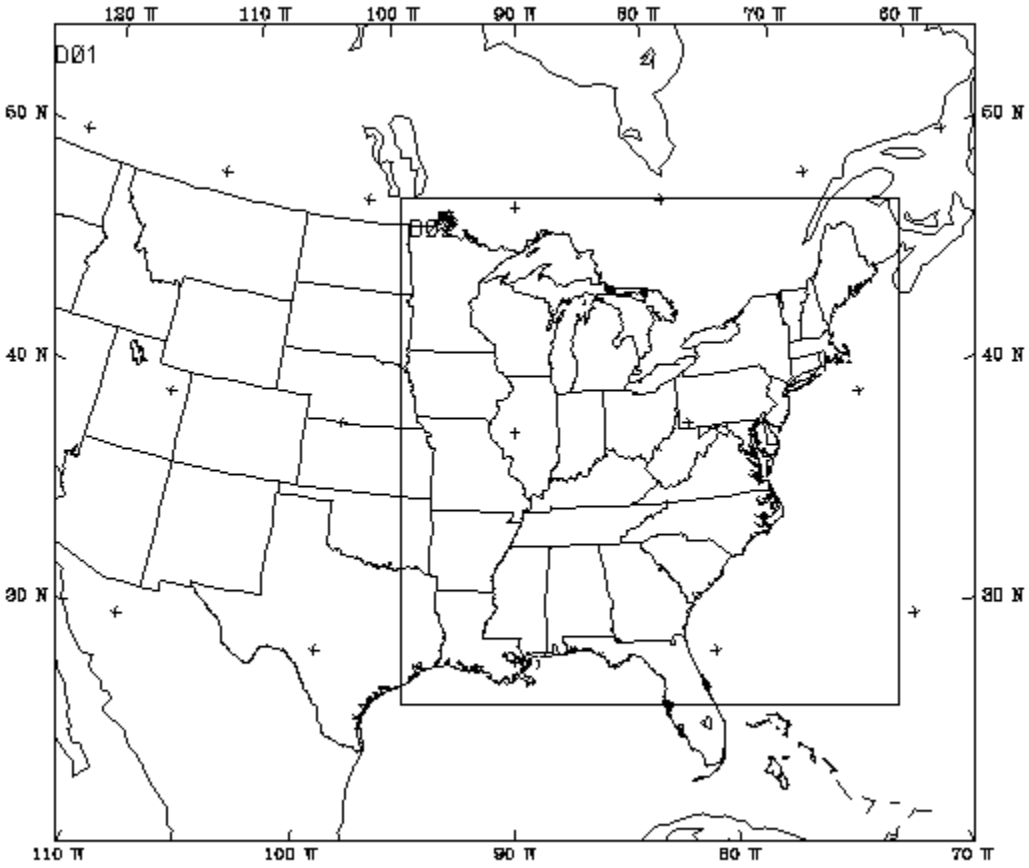

Figure 3 MM5 by MCNC domain2e July 11 to July 15 1997 vs TDL

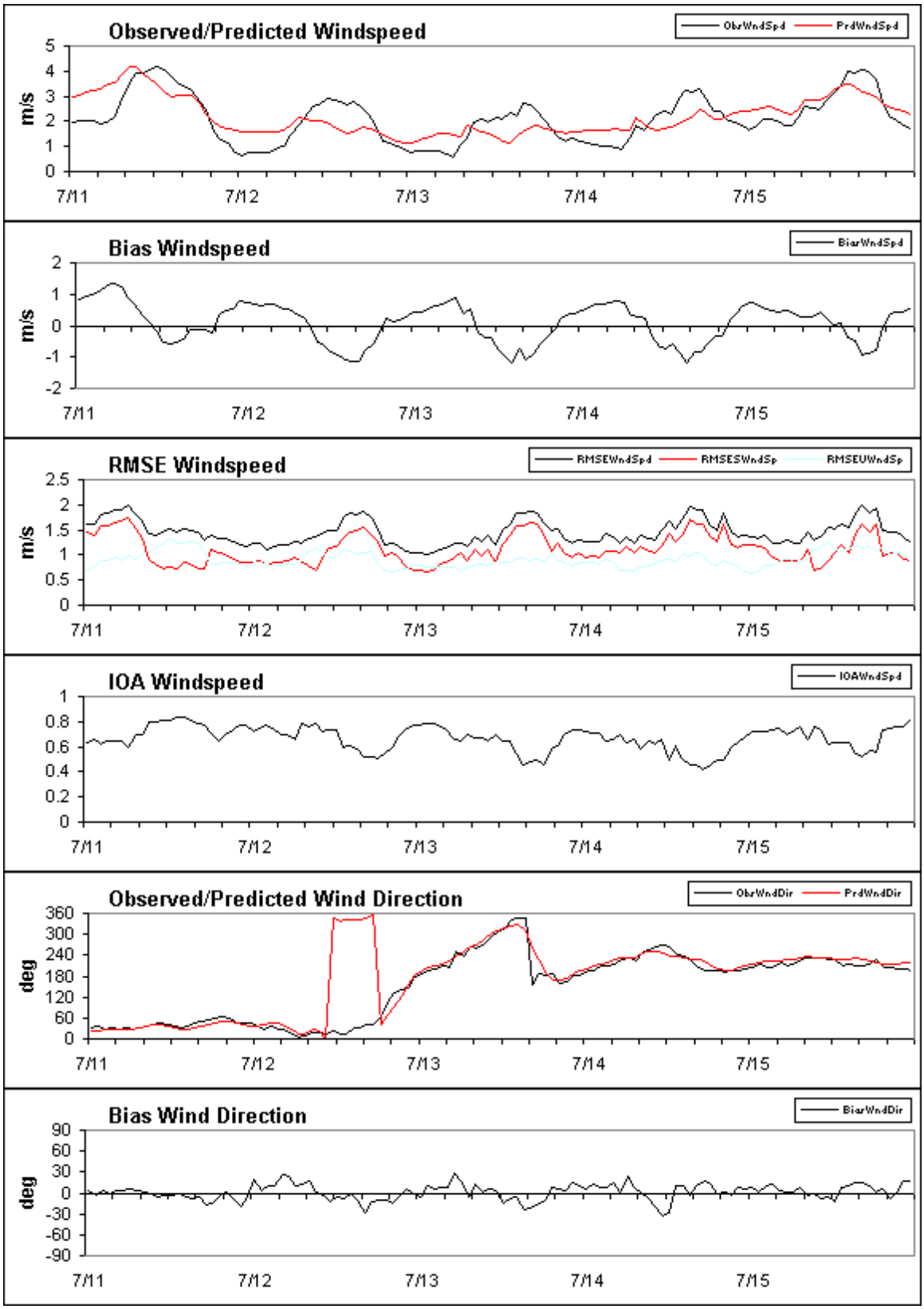

Figure 4 **MM5 by UMD domain2e July 11 to July 15 1997 vs TDL**

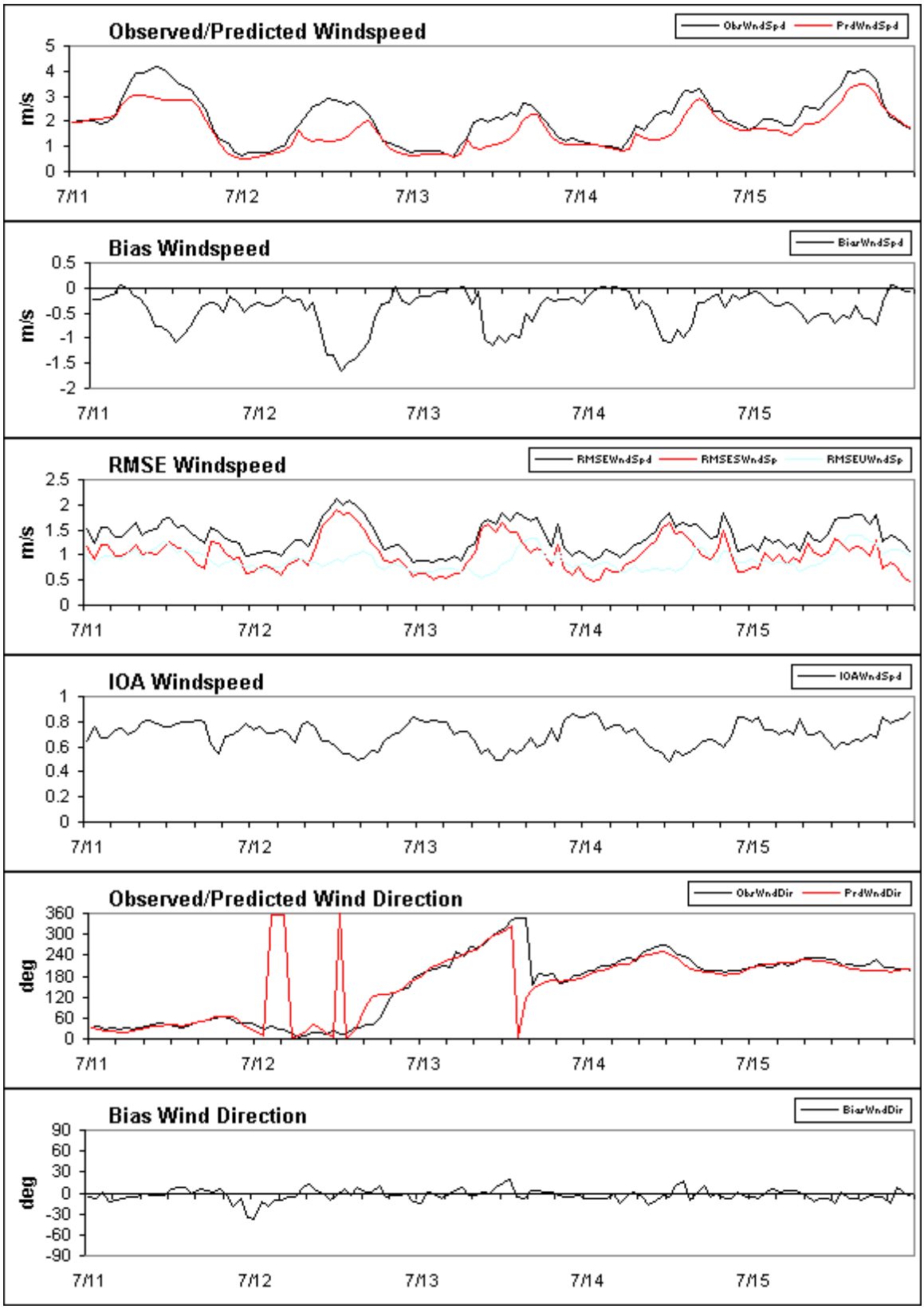

Figure 5 MM5 by MCNC domain2e July 11 to July 15 1997 vs TDL

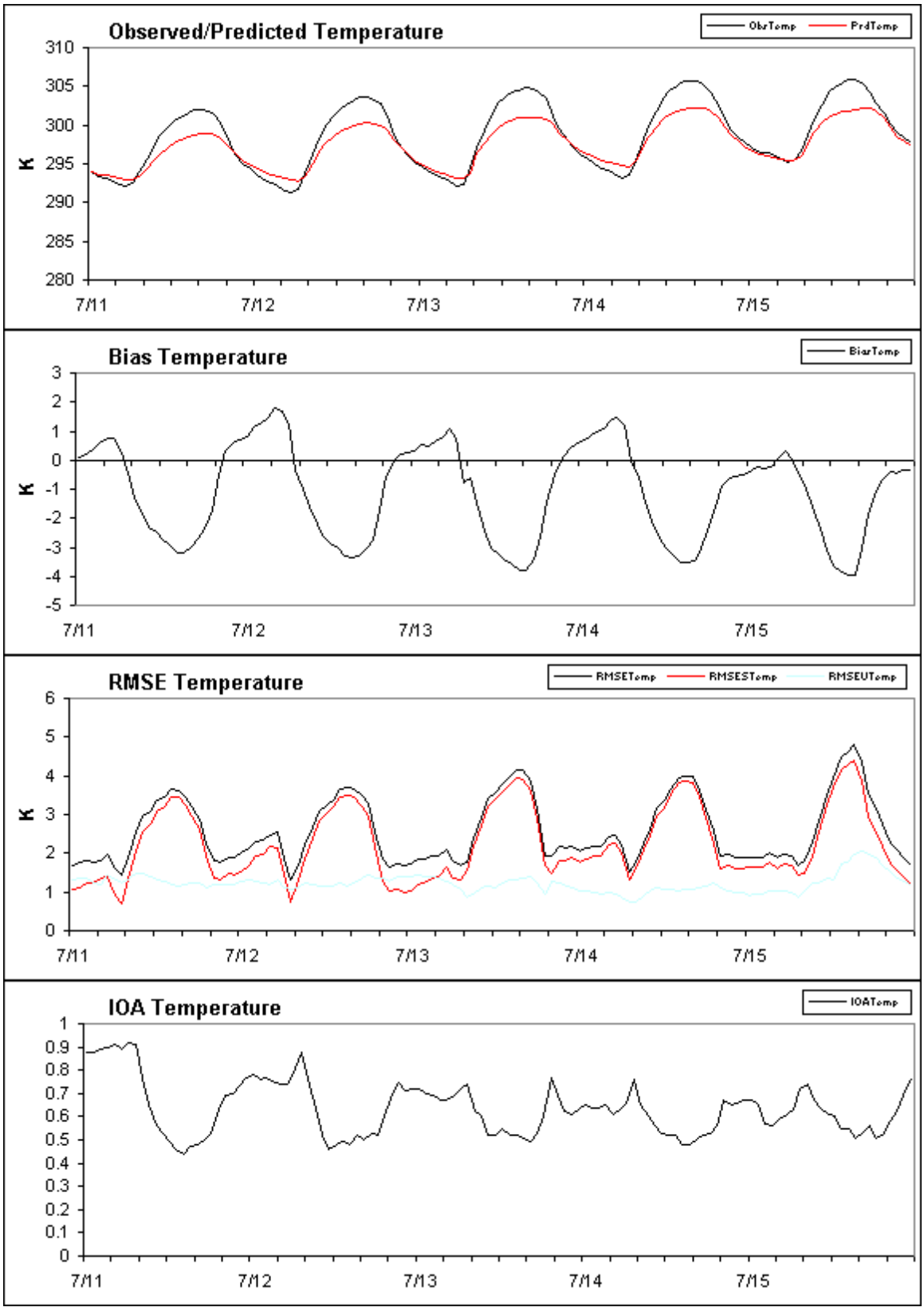

Figure 6 MM5 by UMD domain2e July 11 to July 15 1997 vs TDL

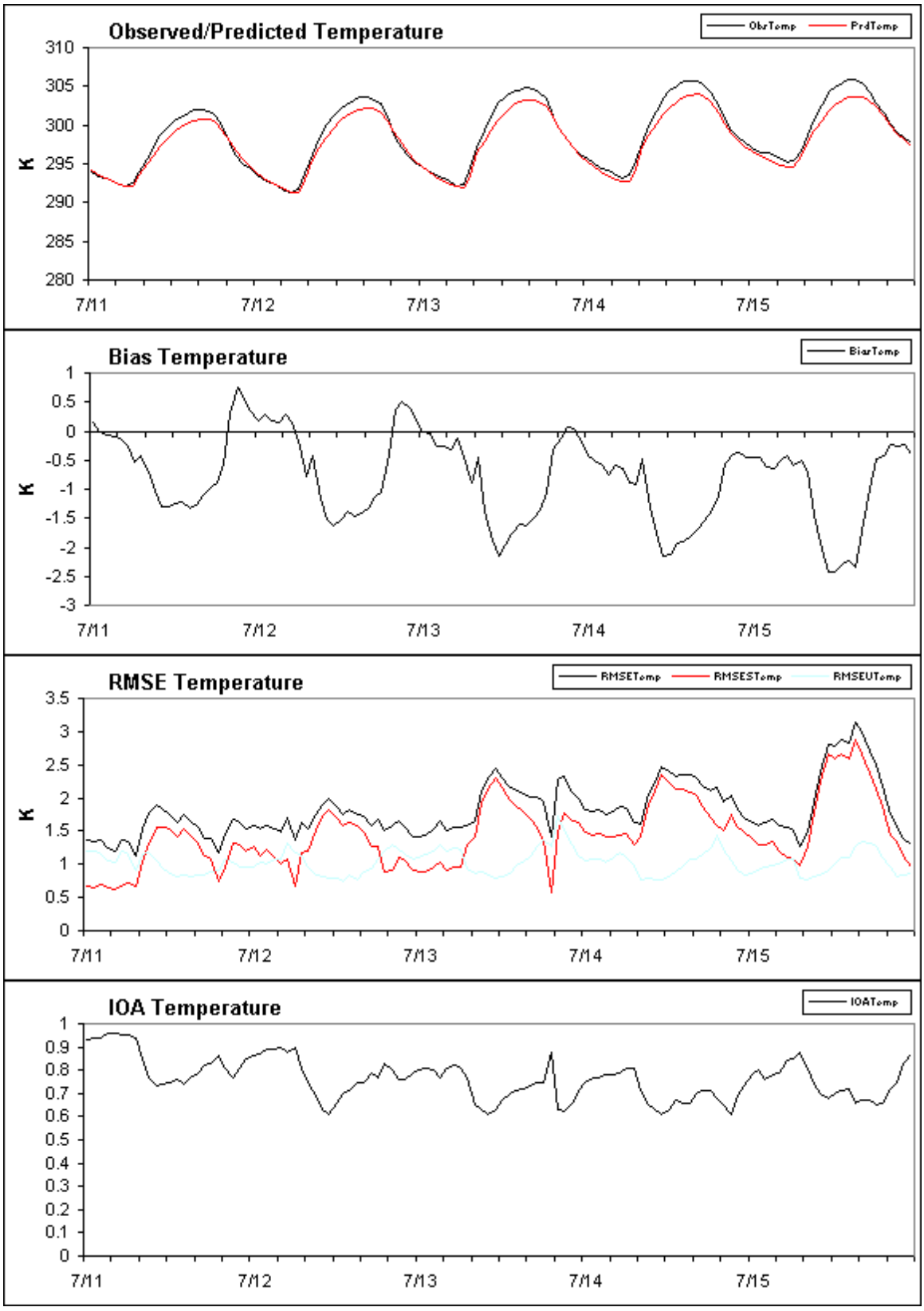

Figure 7 MM5 by MCNC domain2e July 11 to July 15 1997 vs TDL

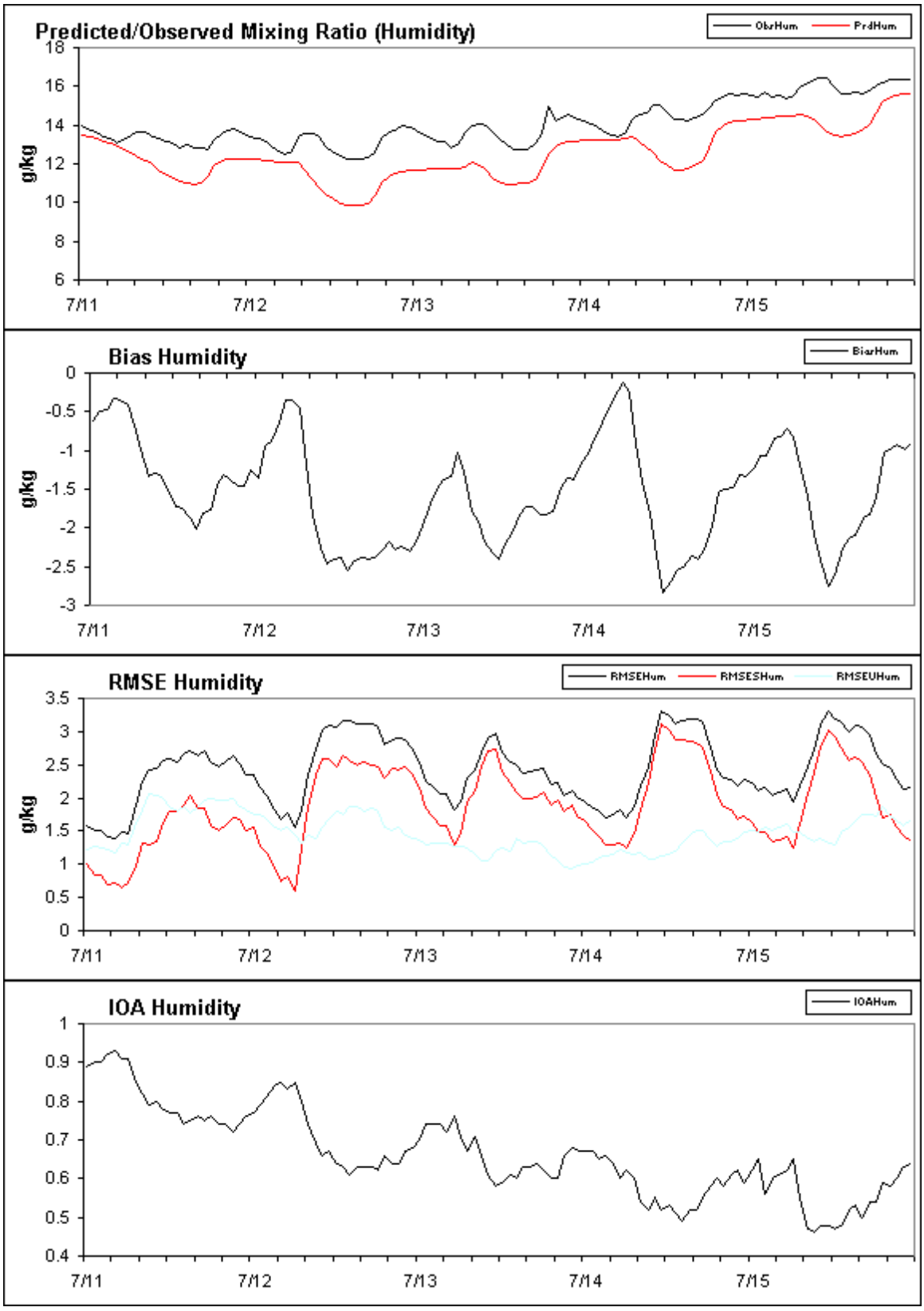

Figure 8 MM5 by UMD domain2e July 11 to July 15 1997 vs TDL

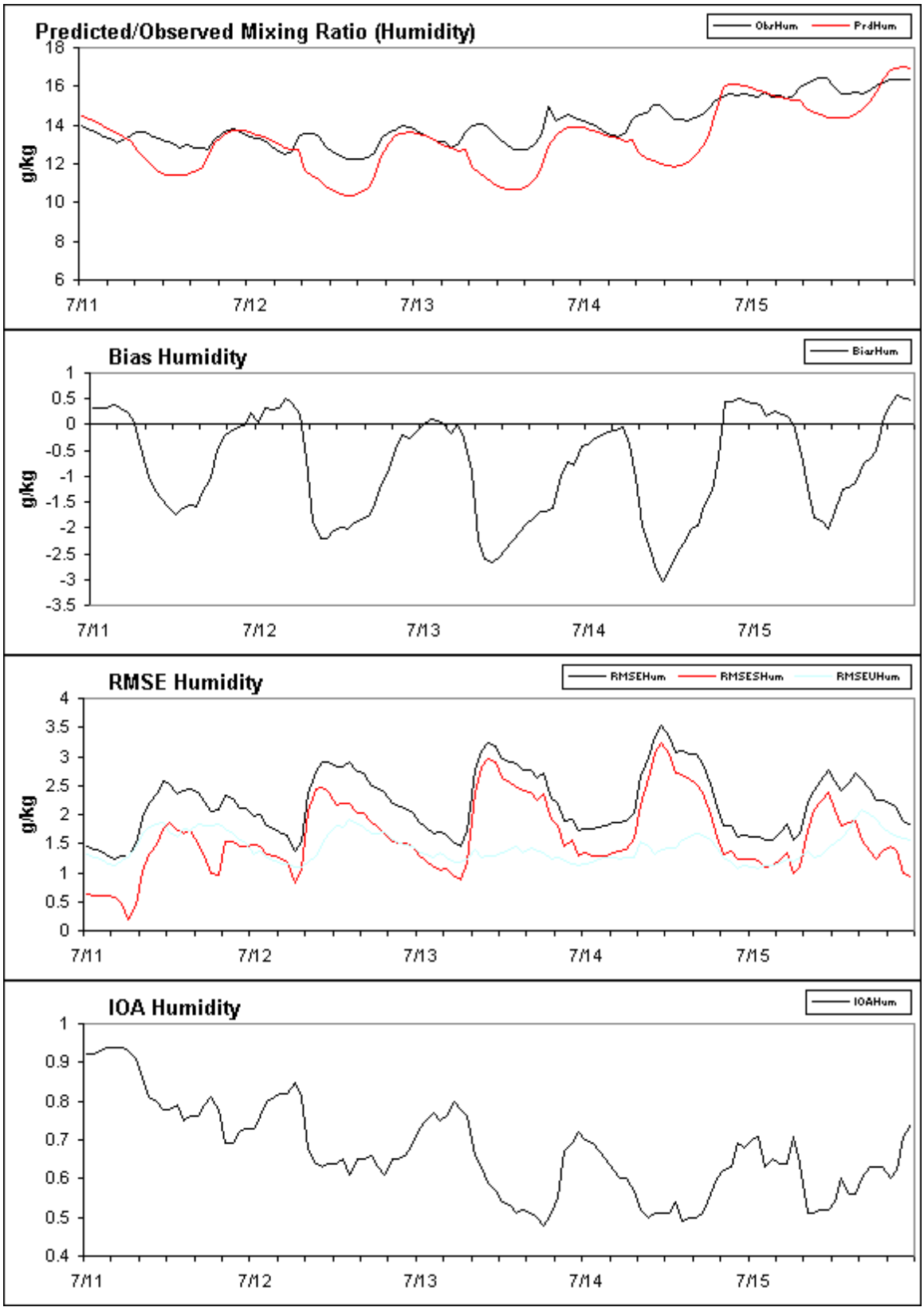

Figure 9 MM5 by MCNC domain2e July 11 to July 15 1997 vs CASTNet

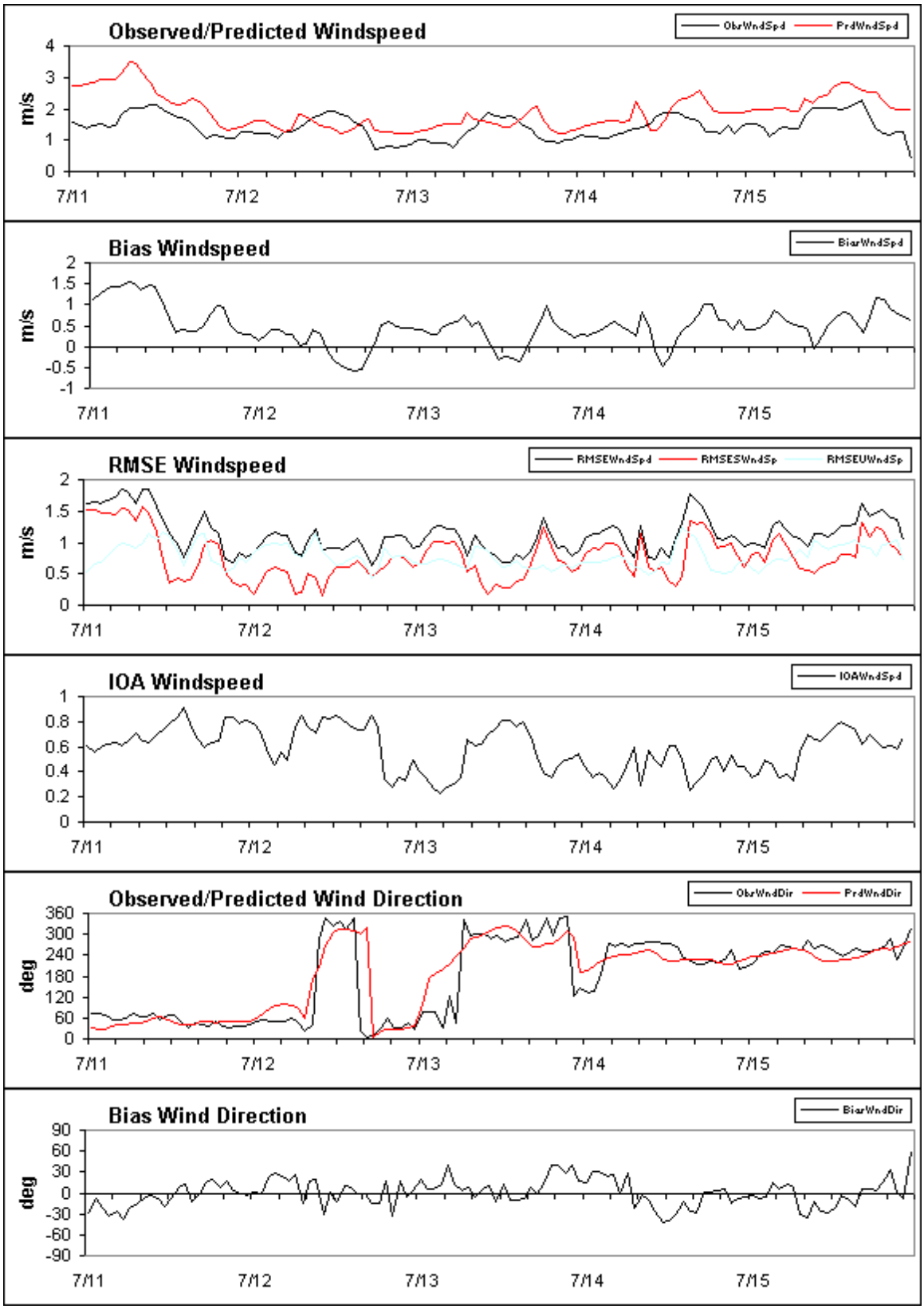

Figure 10 MM5 by UMD domain2e July 11 to July 15 1997 vs CASTNet

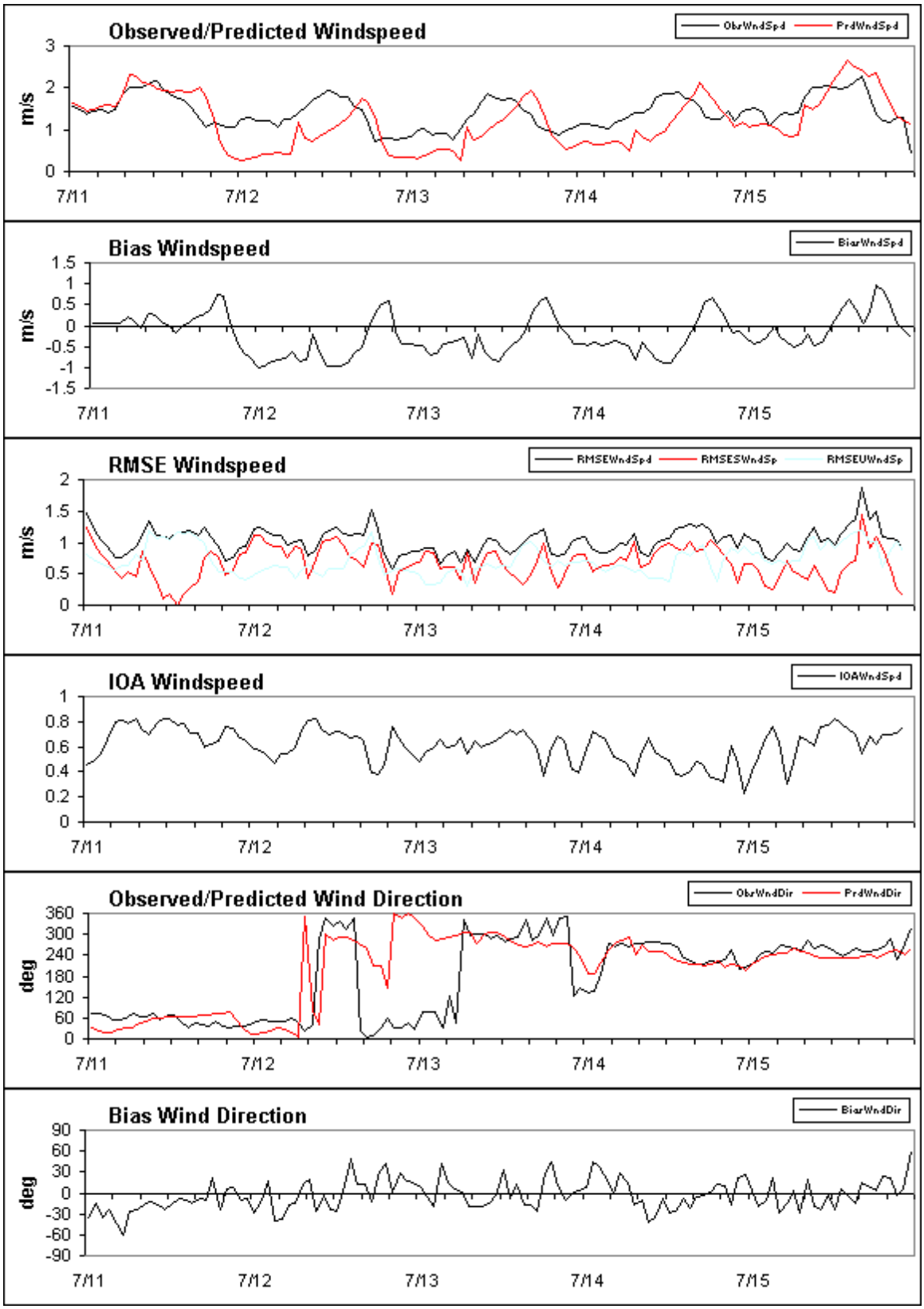

Figure 11 MM5 by MCNC domain2e July 11 to July 15 1997 vs CASTNet

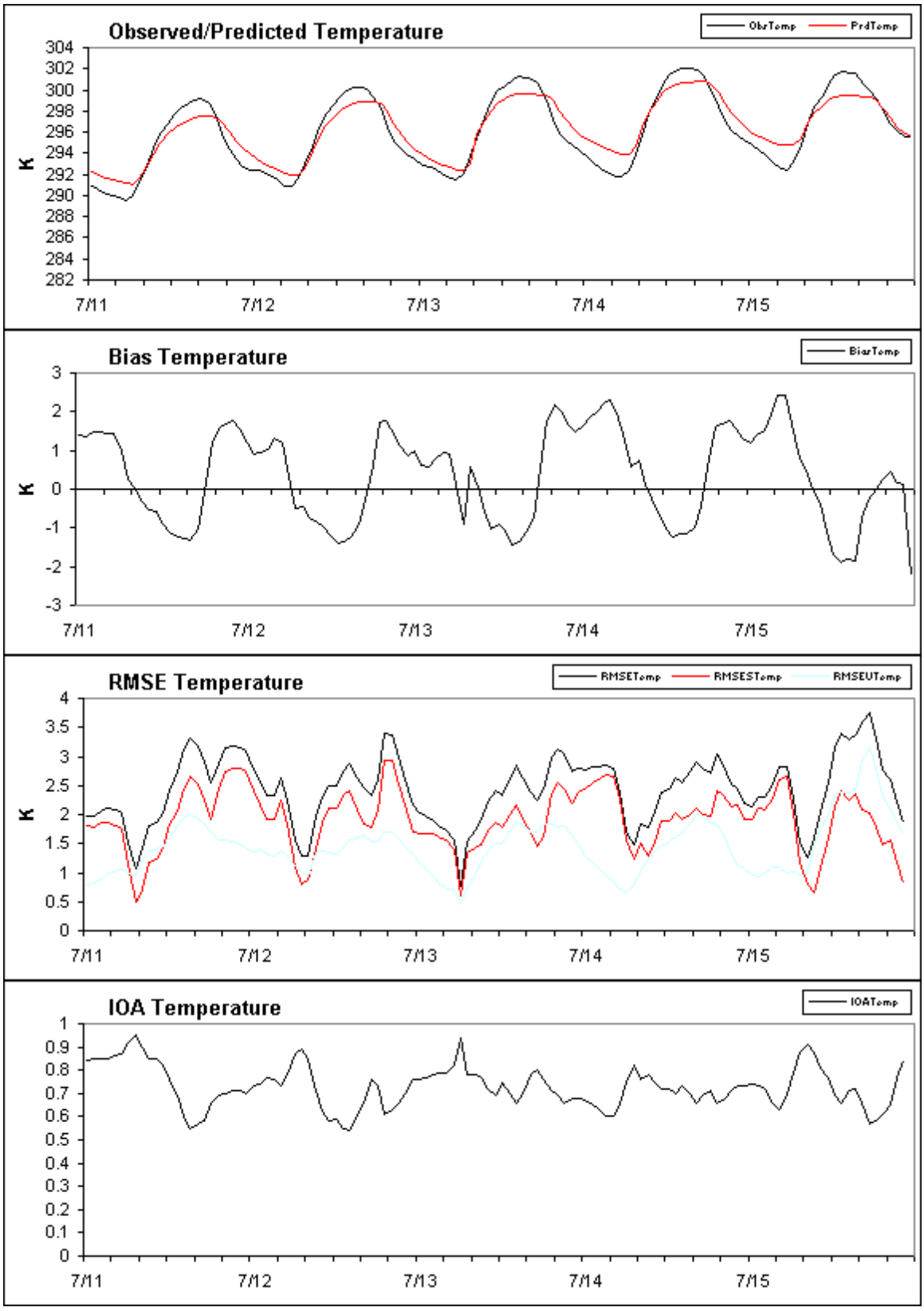

Figure 12 MM5 by UMD domain2e July 11 to July 15 1997 vs CASTNet

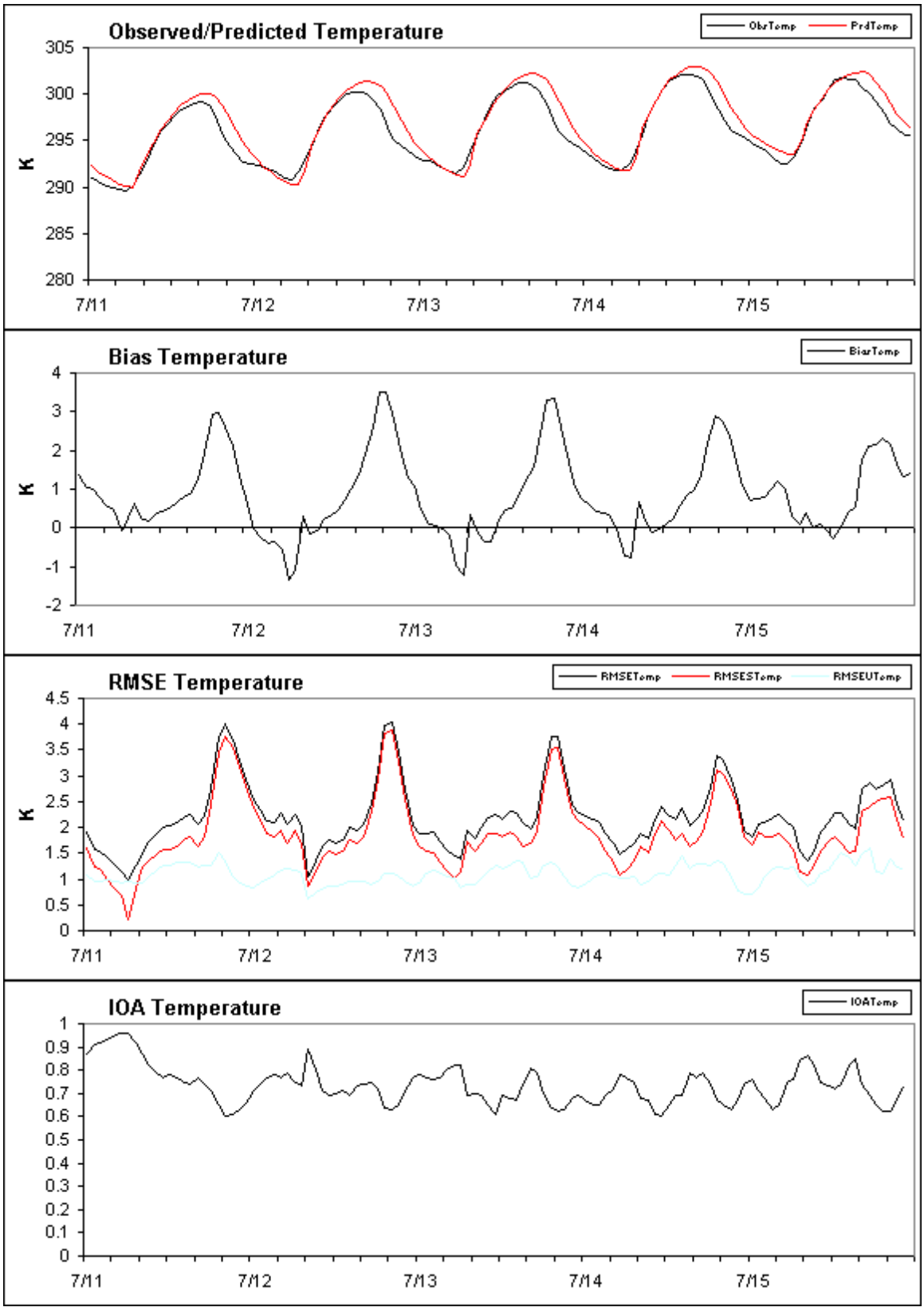

Figure 13 **Spatial distribution of correlation for wind speed between TDL and MCNC's MM5 prediction**

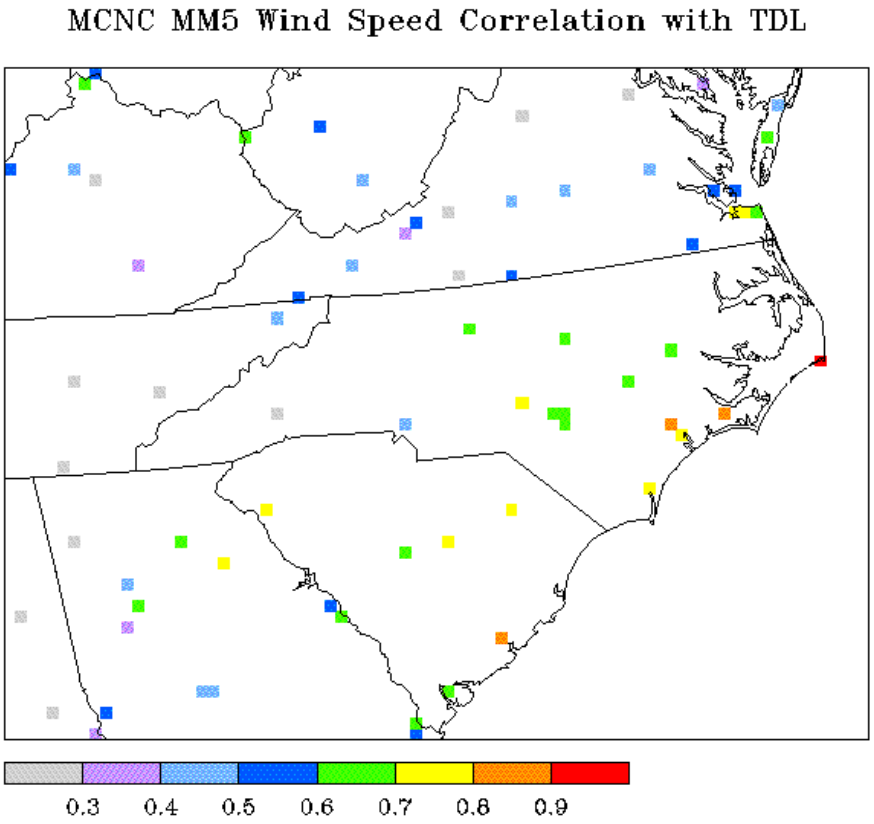

Figure 14 **Spatial distribution of correlation for temperature between TDL and MCNC's MM5 prediction**

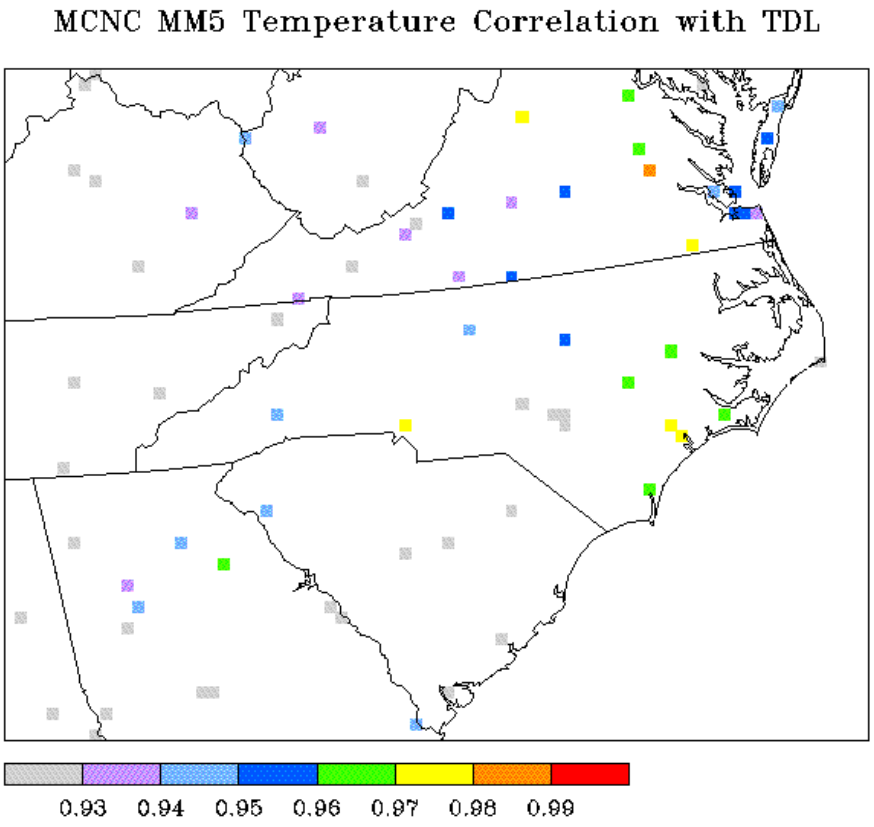

Figure 15 **Spatial distribution of correlation for mixing ratio (humidity) between TDL and MCNC's MM5 prediction**

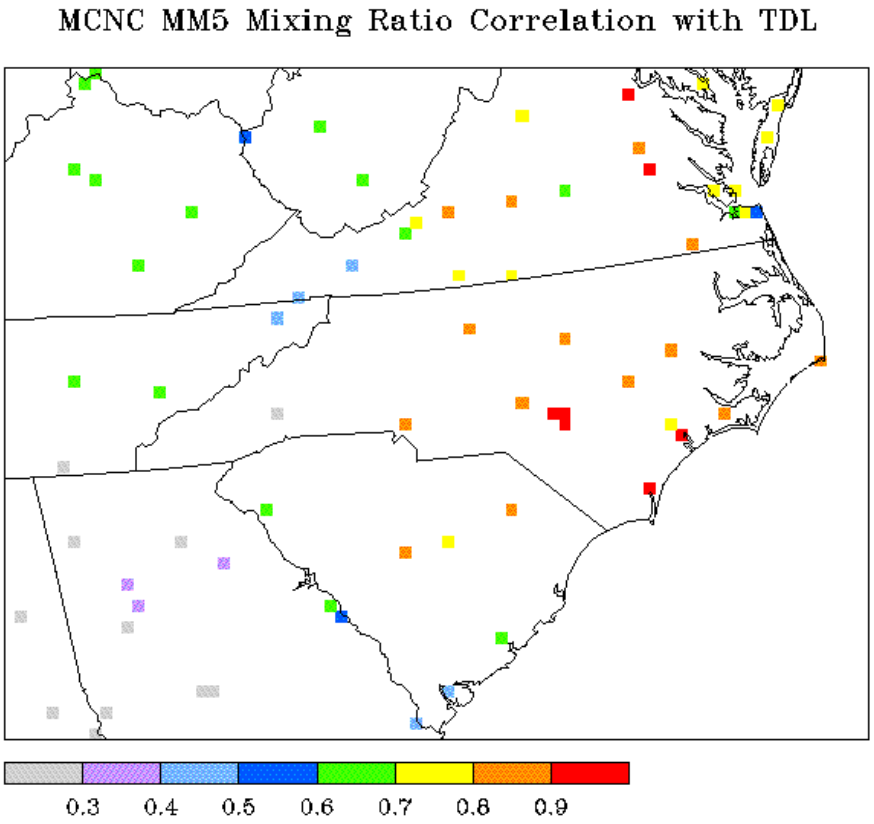

Figure 16 **Spatial distribution of correlation for wind speed between TDL and UMD's MM5 prediction**

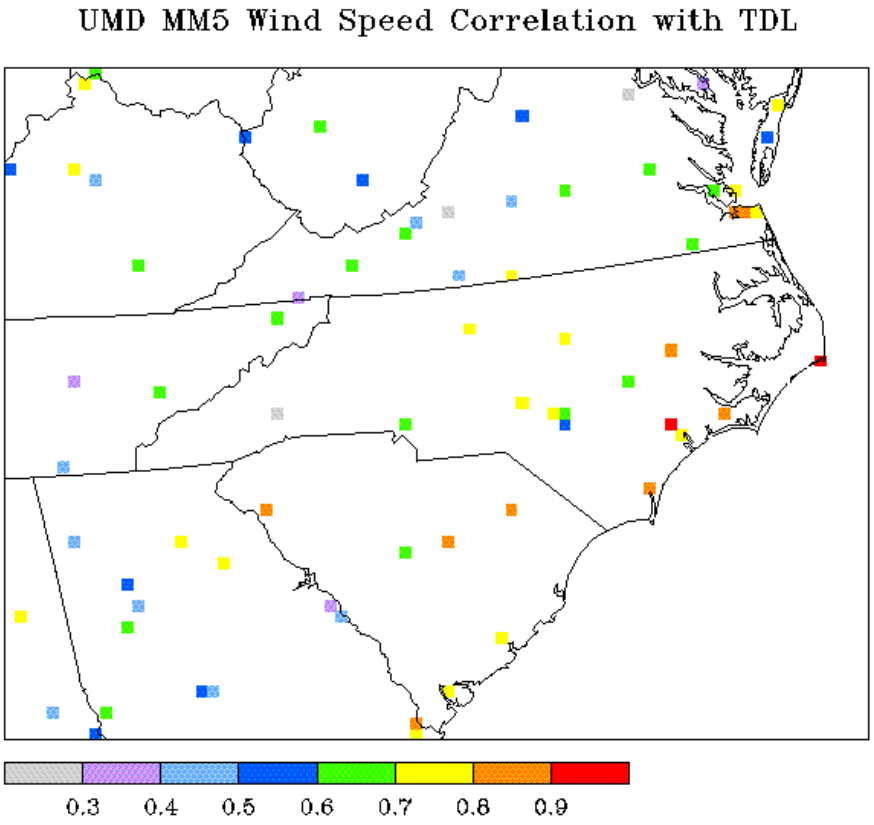

Figure 17 **Spatial distribution of correlation for temperature between TDL and UMD's MM5 prediction**

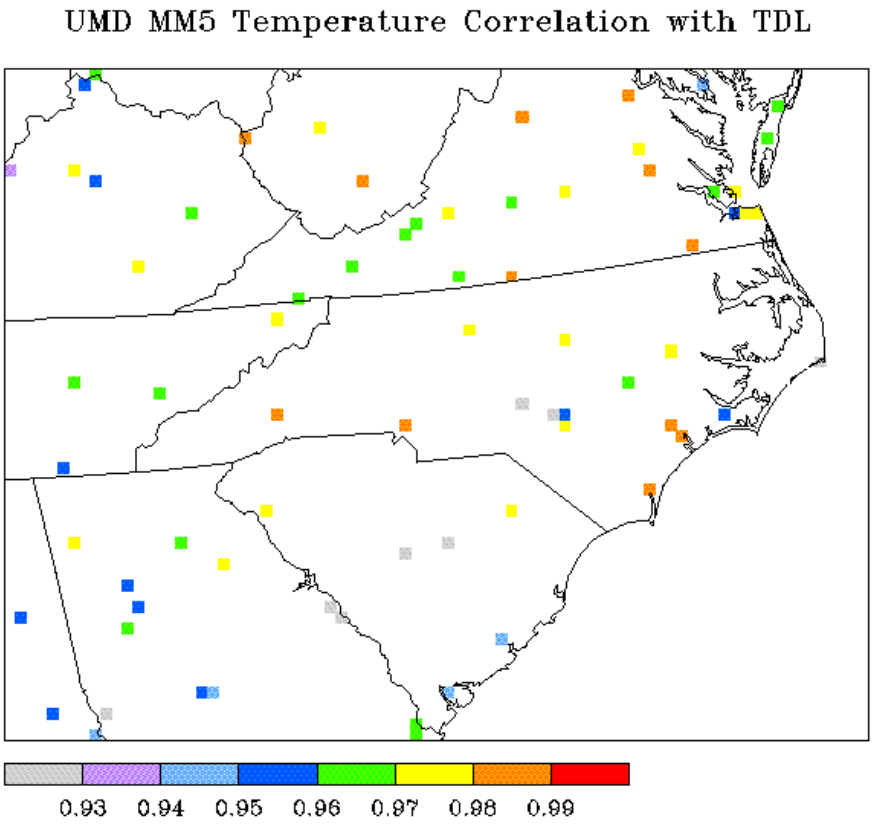

Figure 18 **Spatial distribution of correlation for mixing ratio (humidity) between TDL and UMD's MM5 prediction**

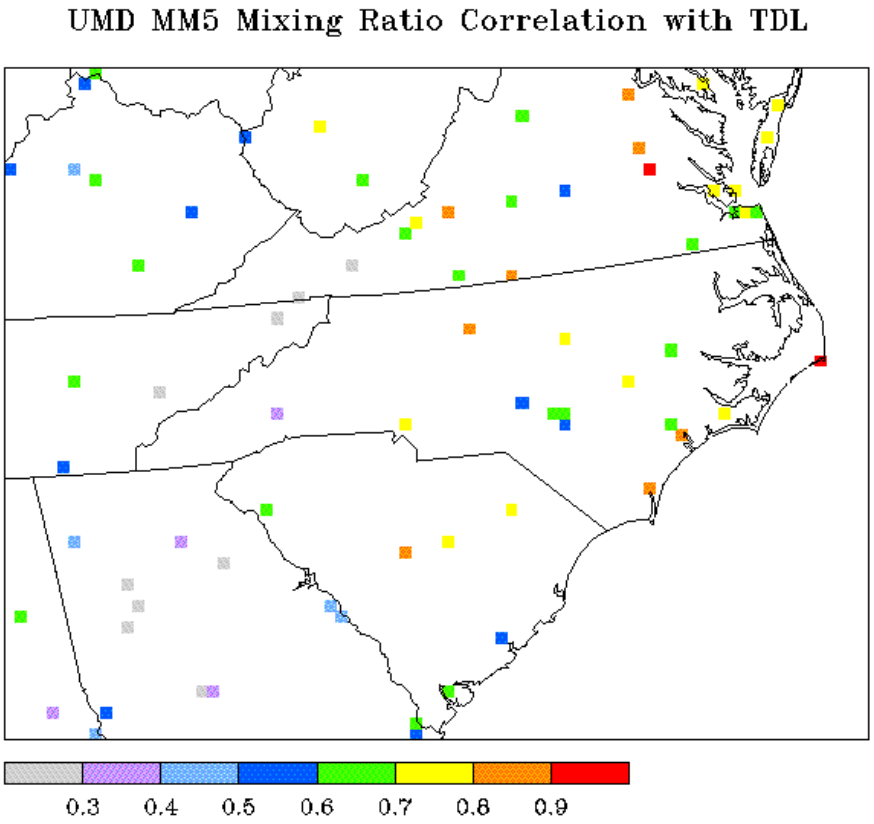

Figure 19 **Spatial distribution of correlation for wind speed between CASTNet and MCNC's MM5 prediction**

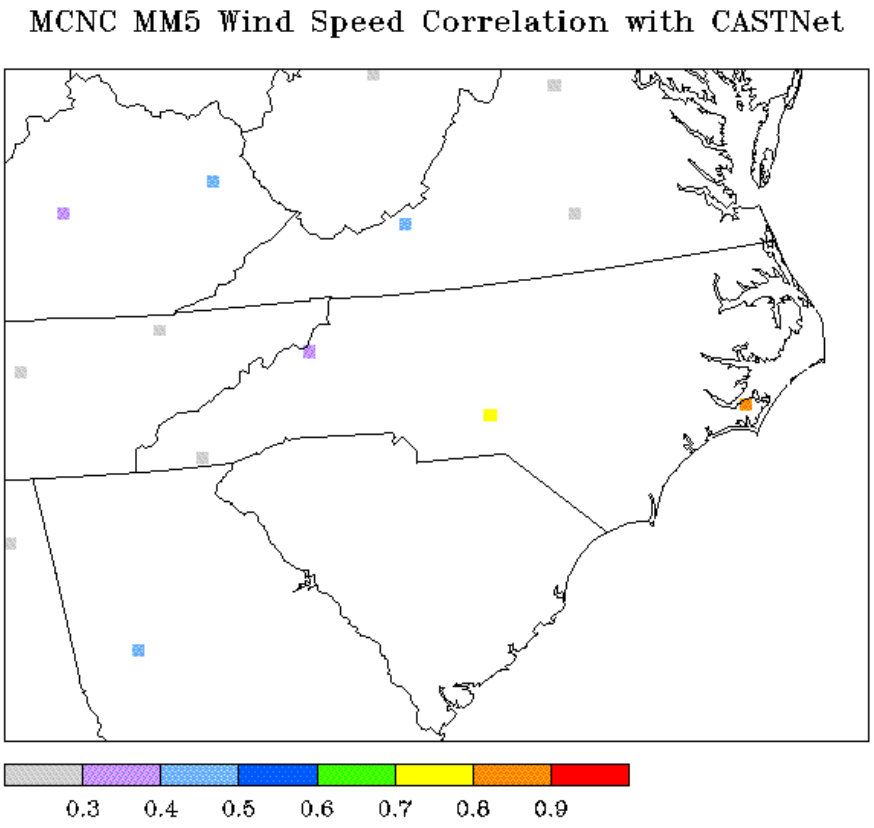

Figure 20 **Spatial distribution of correlation for temperature between CASTNet and MCNC's MM5 prediction**

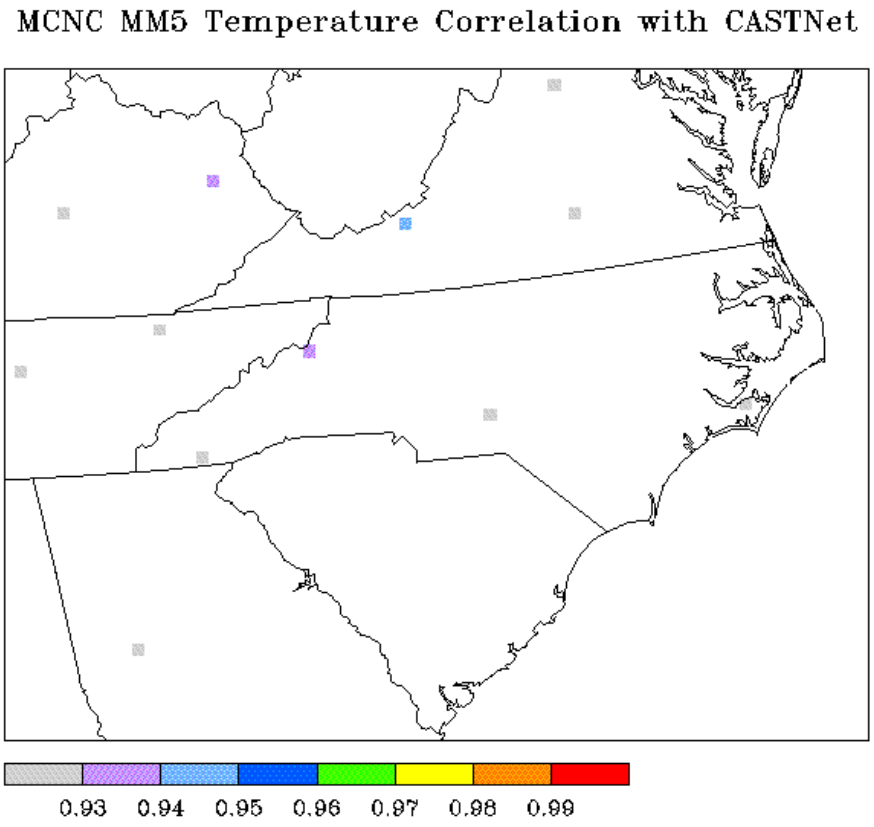

Figure 21 **Spatial distribution of correlation for wind speed between CASTNet and UMD's MM5 prediction**

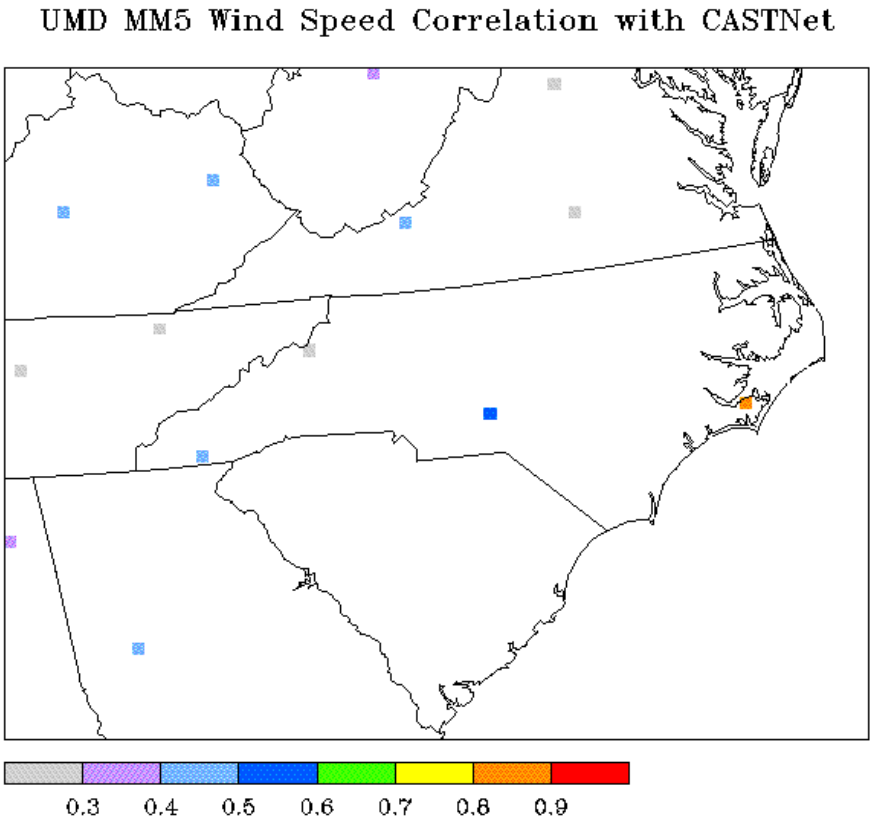

Figure 22 **Spatial distribution of correlation for temperature between CASTNet and UMD's MM5 prediction**