Poor GFS Model MOS Performance…Is it Predictable?

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Introduction

One of the main types of guidance available to forecasters in preparing temperature forecasts is the GFS Model Output Statistics (MAV MOS). Very often the GFS MOS guidance is difficult to improve upon. However, there are periods when the GFS MOS forecasts exhibit significant error. Preliminary data suggests that the spring of 2004 was a period in which the MAV forecasts performed poorly. In an attempt to see if there was some predictability to this poor performance, a study was conducted using GFS MOS forecasts from 2004. This research project is far from complete. The preliminary results are outlined in this paper, but a more thorough treatment will take place in the coming months. To begin with, we compared the performance of the MAV 24 hour maximum temperature forecasts to the actual high temperature for Medford, Oregon.

After reviewing data for 2004, a total of nine cases stood out in which the MAV was significantly too cool or too warm (+ or – 6 degrees or more) in forecasting the 24 hour maximum temperature.

Case Studies

Our first case illustrates a small issue associated with GFS MOS guidance in general. GFS MOS max temperature regression equations use 5 years of data, and the predictors have many more cases averaged into the equation around the normal daily values than at the climatological extremes. Hence at the extremes, there is less data tuned into the regression equation, and the result may be marginally worse. Still, the GFS MOS equation uses most of its input from the model to produce its result, and issues such as air mass timing, moisture and rainfall durations, and inexact low and mid level temperature forecasts may work to hamper the output. Such was the case of May 9, 2004. On the afternoon of May 9th reanalysis data showed an unseasonably cold closed low along the Oregon coast. The 500mb height over Medford was 5620m and the 850mb temperature was only 4 degrees C. The actual high that day was 60 degrees which was 11 degrees below the 24 hour MAV forecast. The afternoon sounding was very moist from the surface up to 400mb and was likely the main contributor to the chilly max. By the morning of the 10th, 500mb heights had fallen to 5540m and the 850mb temperature to 1 degree C as the closed low moved over the Medford area. This 850 mb temperature was 6 degrees C colder than forecast by the GFS 24 hours earlier. This was certainly a good case where advecting in the offshore airmass would have clued the forecaster into predicting that the MAV temperature guidance was too warm for this synoptic situation.

Below are two other cases that were chosen to show when the MAV guidance predictably performs poorly.

The first of these cases was from the period February 10 through February 12, 2004. A strong 500mb ridge was located just off the coast on the 10th. It then moved slowly inland over the region by the 12th (figures 1 and 2). The MAV 24 hour forecast high was 9 degrees too cool on the 10th, 11 degrees too cool on the 11th and 6 degrees too cool on the 12th. The MAV guidance appeared to underestimate the effect of the upper level ridge and one other important factor, which was the development of a strong low level offshore flow (figures 3 and 4). The offshore flow promoted low level drying resulting in lowering dewpoints and clear skies. The absence of low clouds and fog, so common this time of year allowed the maximum amount of solar radiation to be received at the surface. This combined with the factors mentioned above (downslope warming), produced high temperatures significantly warmer than guidance.

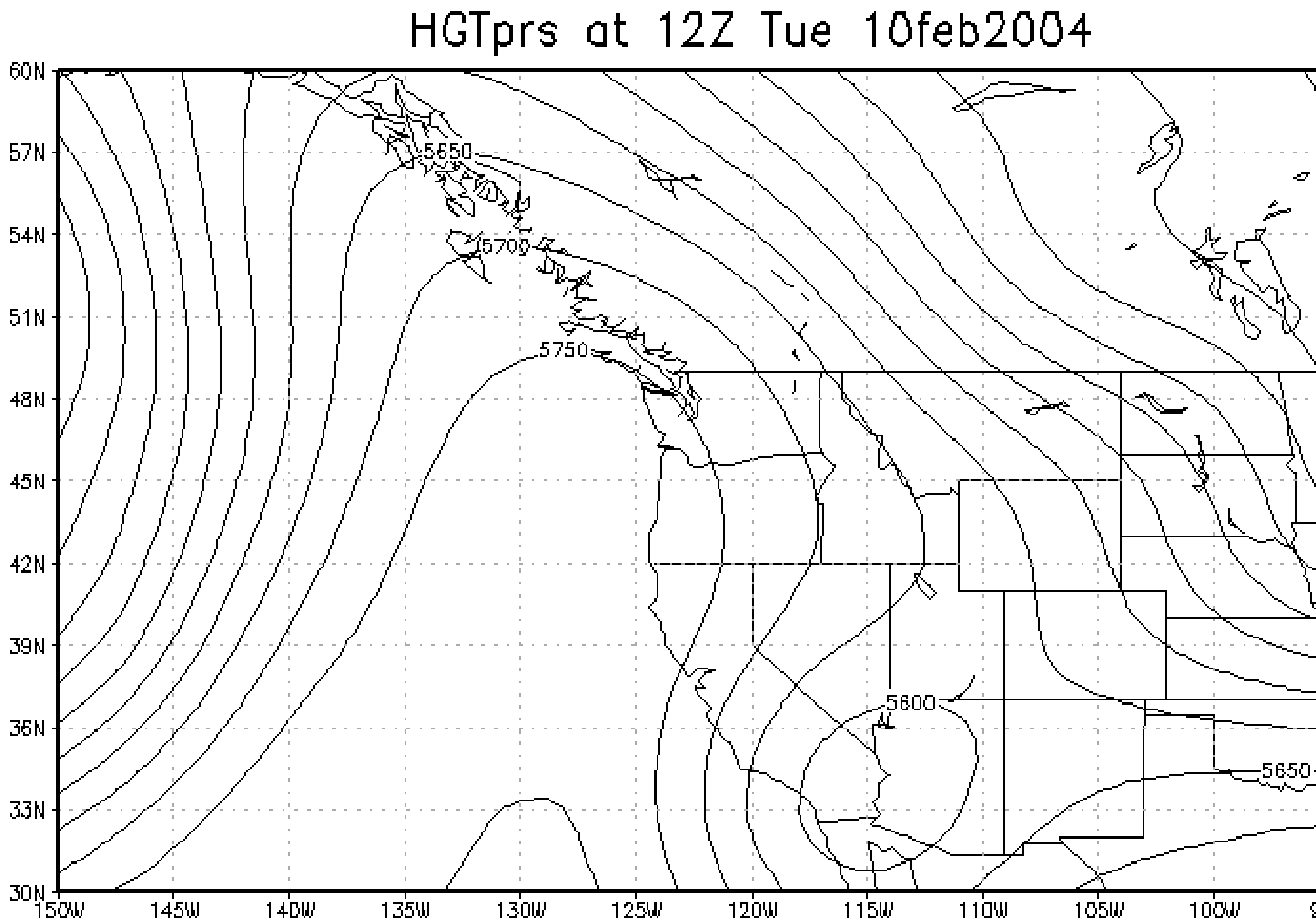

Figure 1.

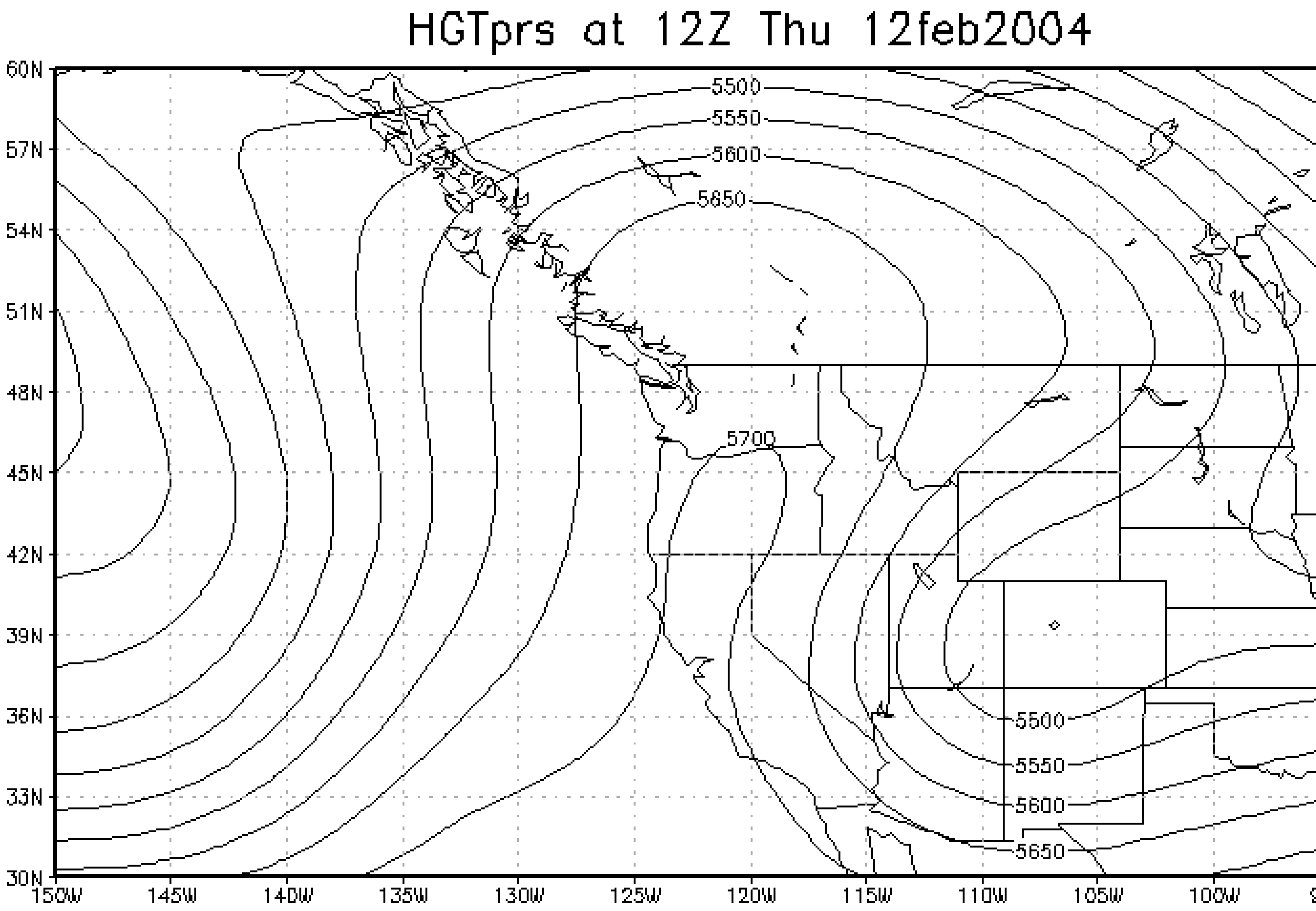
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Figure 2

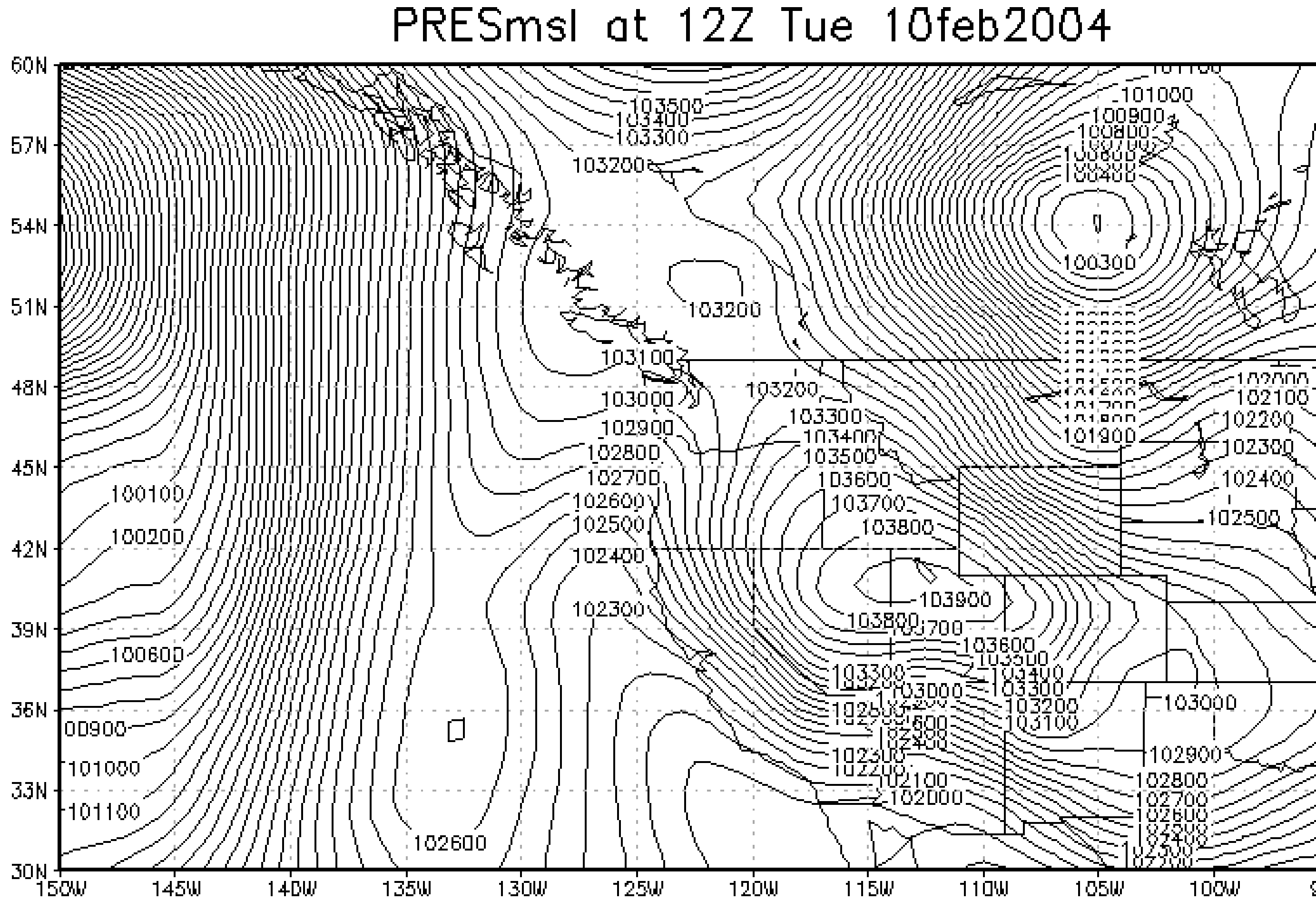
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Figure 3

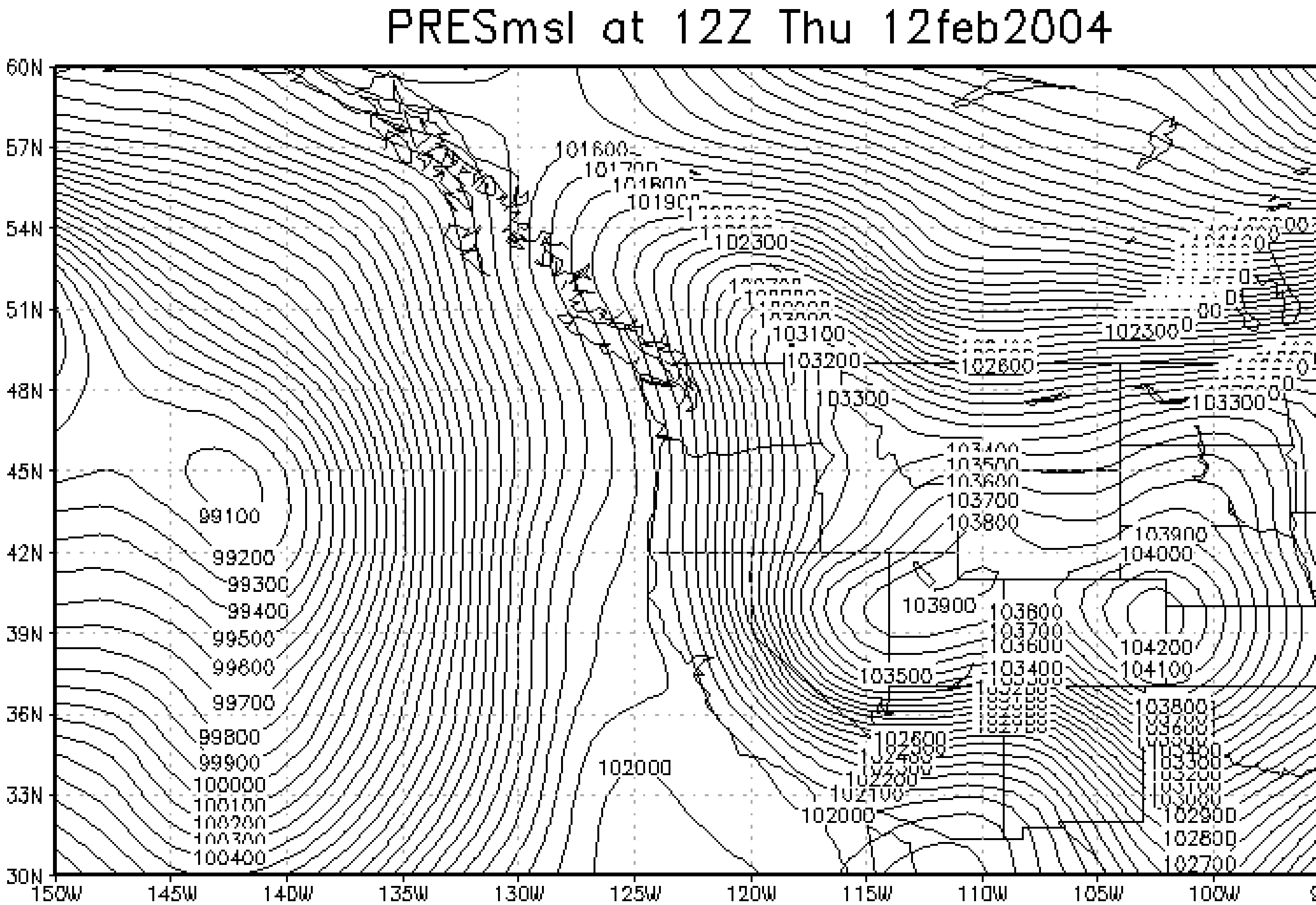
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Figure 4.

Case #2 was from March 19 and 20, 2004. A strong 500mb high developed over the four corners region of the United States. It subsequently built northward into southern Oregon (figures 5-7). The MAV forecast was 8 degrees too warm on the 19th and 7 degrees too warm on the 20th. Surface observations from both days showed clear skies and light winds under a weak offshore low level flow regime (figures 8 and 9). Upper air soundings from Medford showed that a fairly strong surface inversion was present both days and never completely dissipated. It appears that the MAV guidance was keying on the significant warming at 850mb. During the early spring, in the absence of significant downslope offshore flows, surface based inversions in the Rogue Valley can be difficult to break. It’s worth noting that during this time of year, instead of looking too intently at the 850mb temperature, a local station aid was used that predicts the high temperature based on the 1000-700mb thickness and total daily solar radiation under clear skies. Under this type of pattern, this method did a much better job forecasting the high temperature, taking into account more than just extrapolating the 850mb temperature dry adiabatically to the surface.

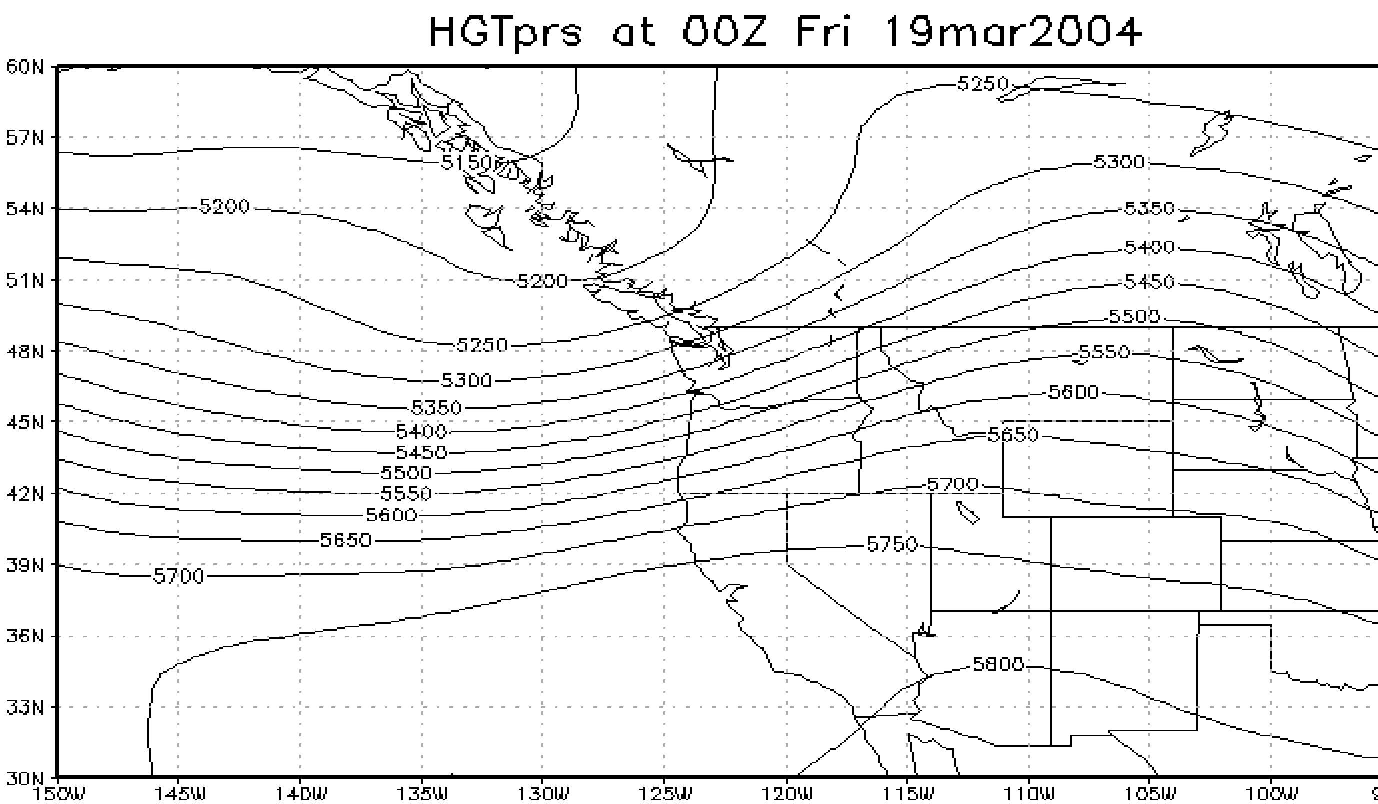

Figure 5.

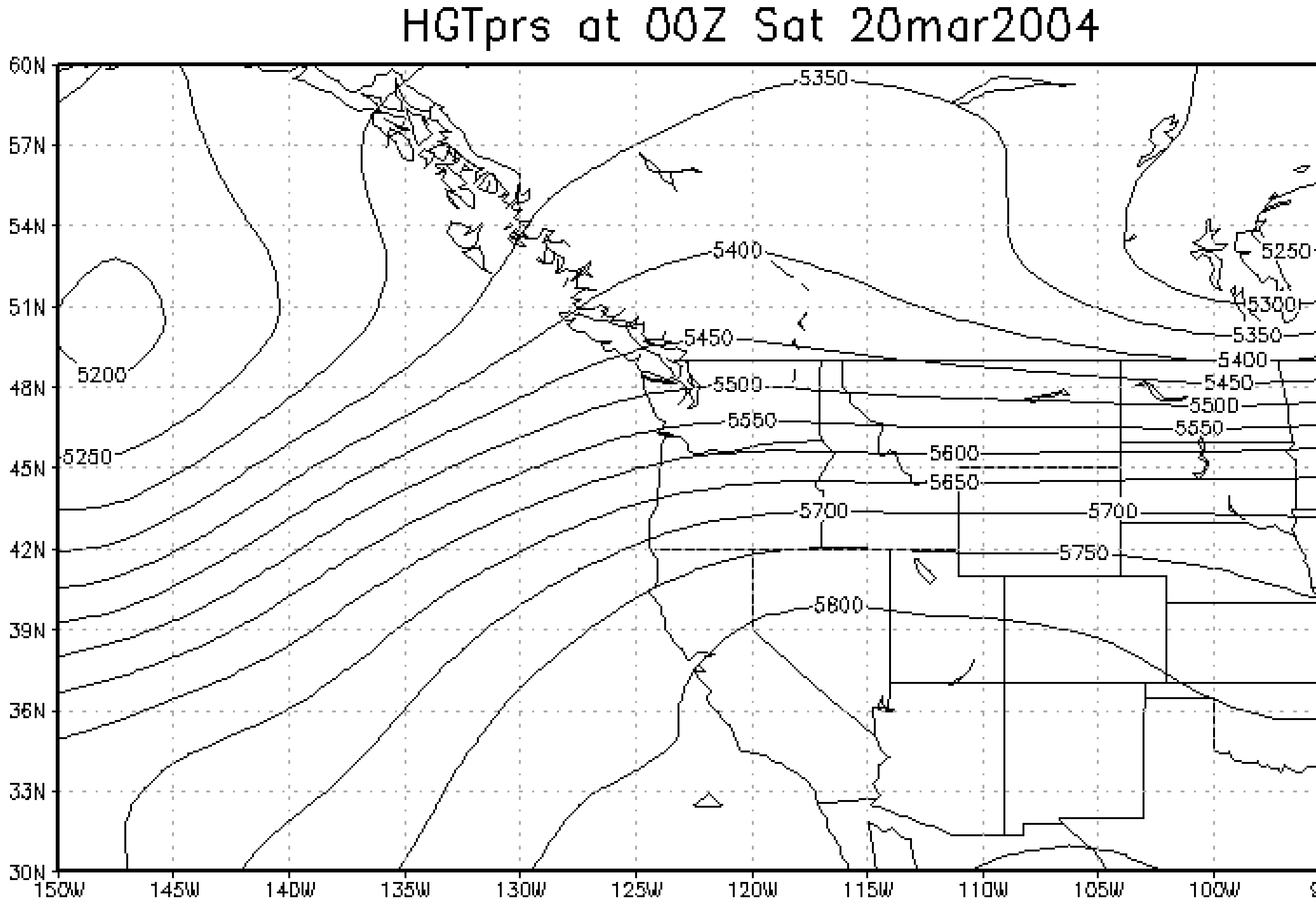
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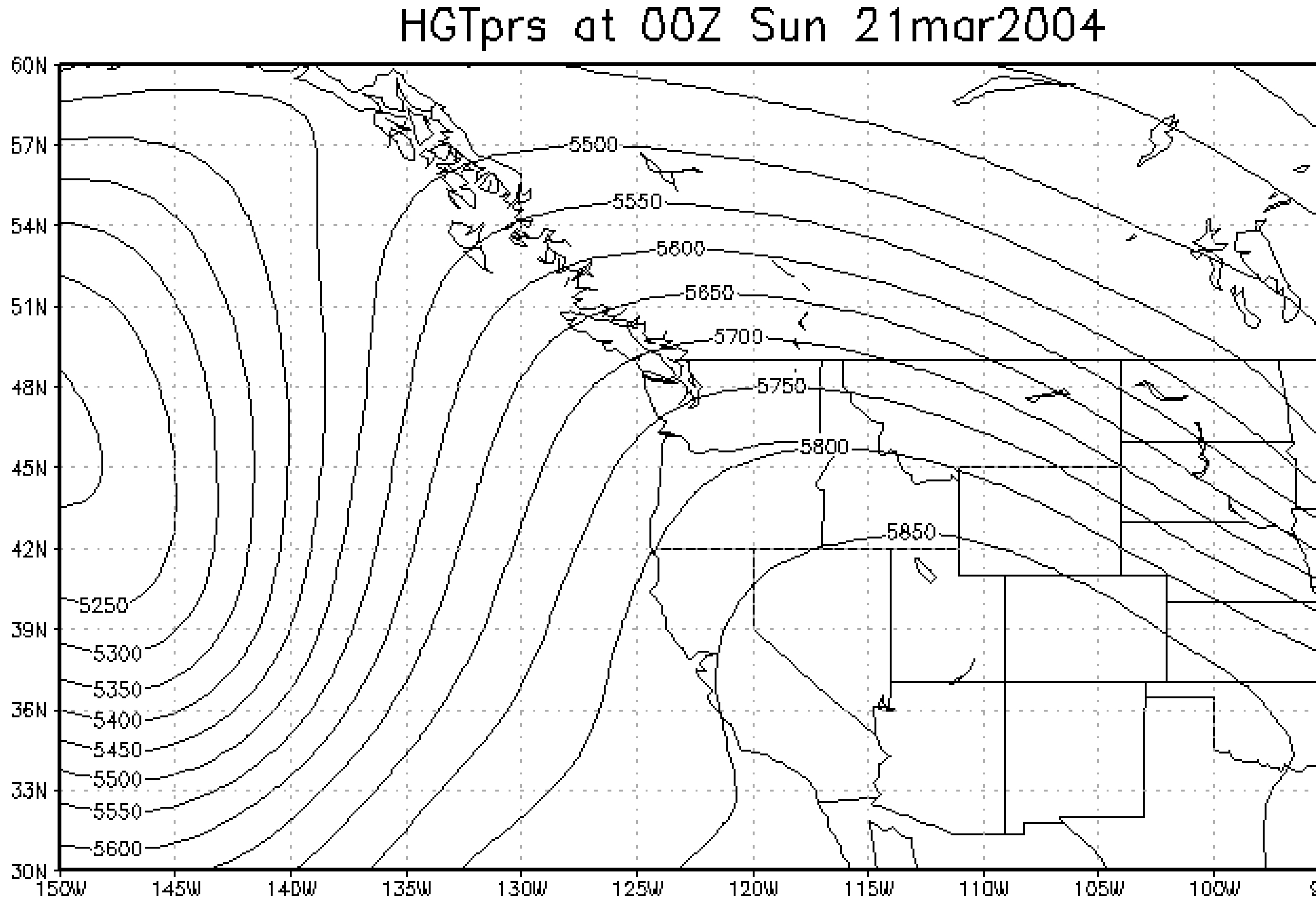
Figure 6.



HGTprs at 00Z Sun 21mar2004
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Figure 7.

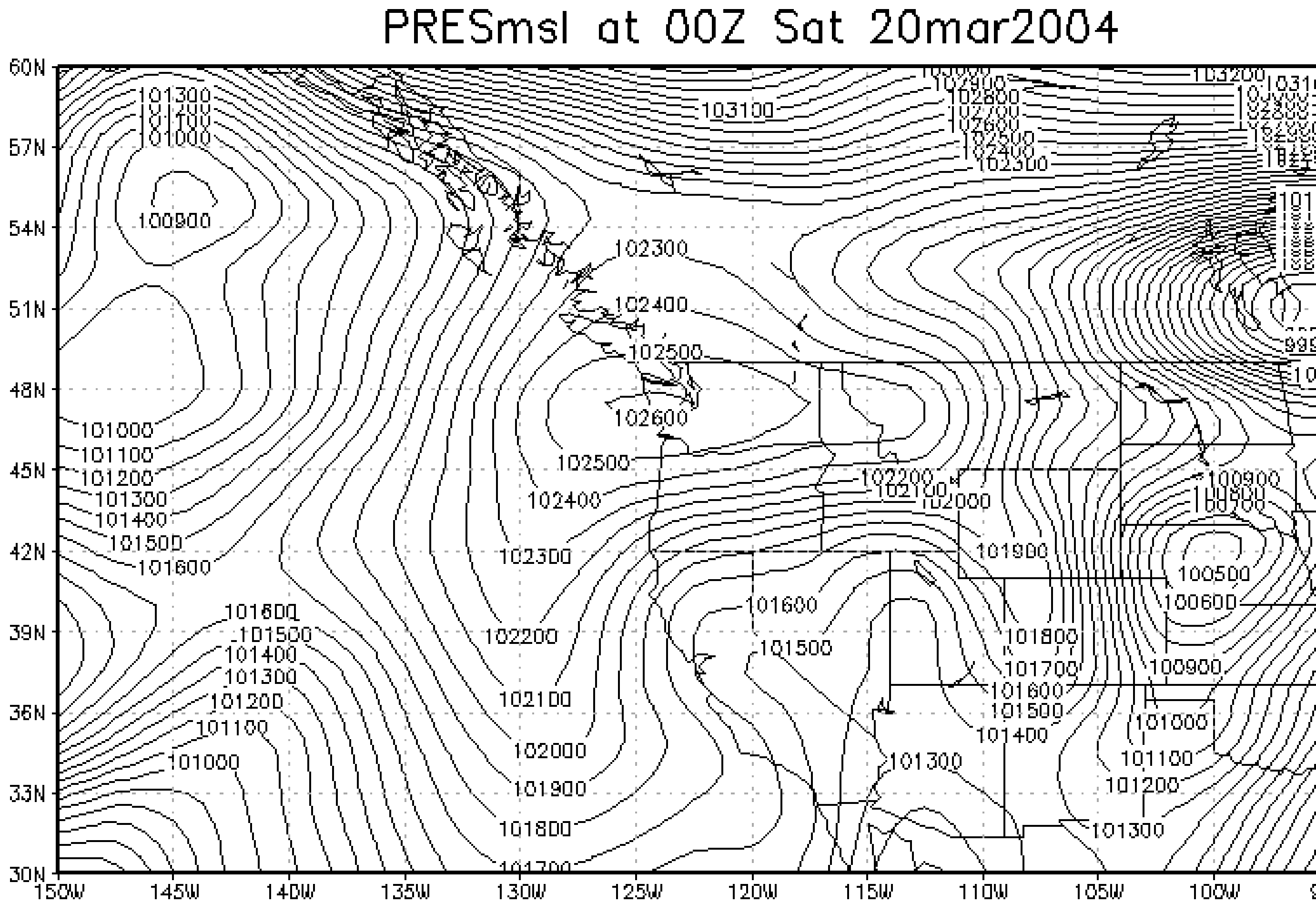
PRESmsl at 00Z Sat 20mar2004
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Figure 8.

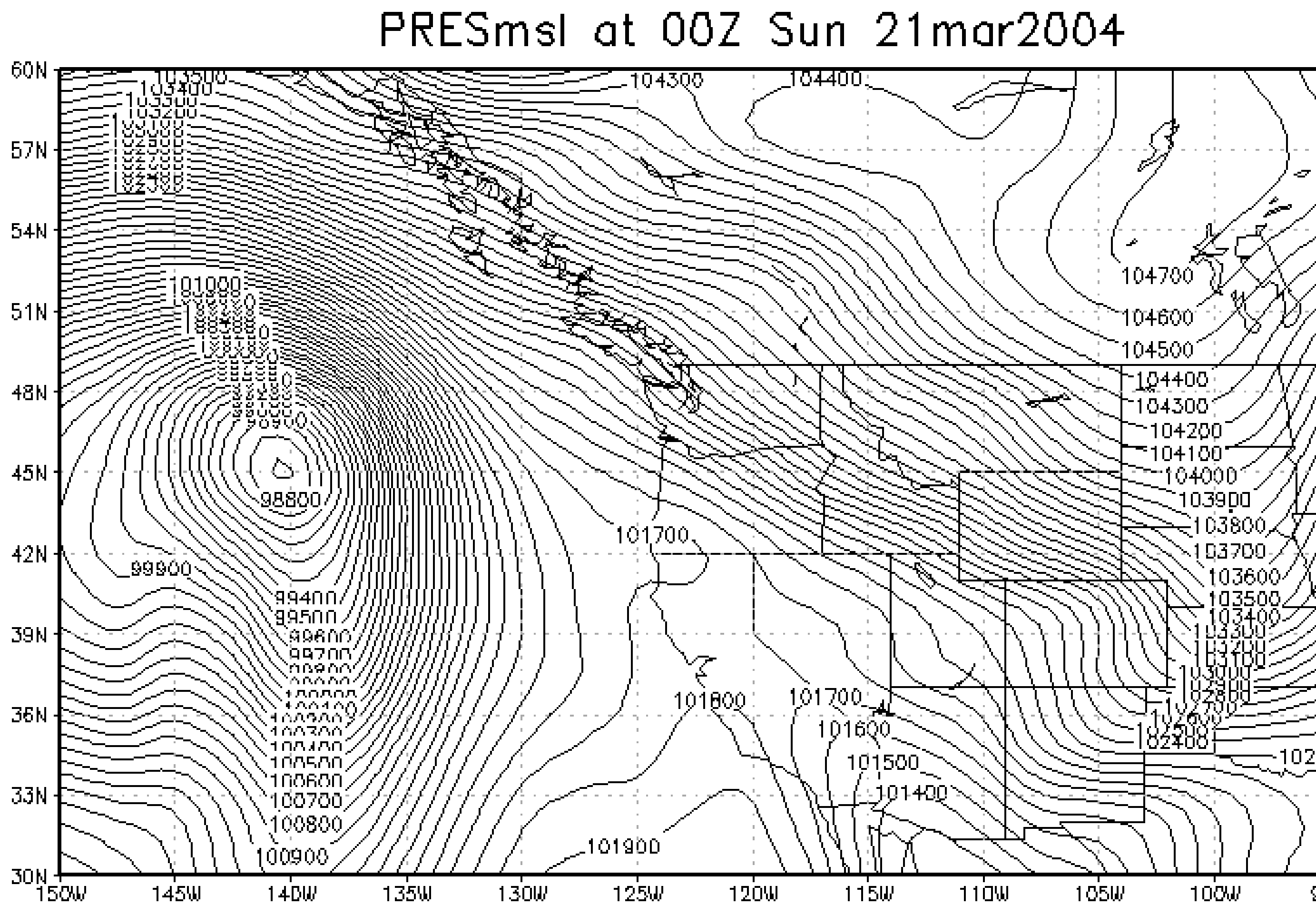

Figure 9.

Summary

Three cases were presented which illustrated a poor performance of the GFS MOS guidance in predicting the 24 hour max temperature at Medford OR. The cases pointed out the need to consider local effects and examine the ambient and upstream air masses in adjusting MOS guidance to produce a value added temperature forecast. During big air mass changes, as in the May 9, 2004 case, often times advecting in the 850 mb and 700 mb temperatures and bringing them to the surface using dry adiabatic or standard atmospheric lapse rates, and further adjusting for clouds and precipitation, will produce a better max temperature forecast.

As mentioned at the outset, this is a work in progress. I have shown three examples of which there are many more. I hope to add more cases where it can be shown that MOS guidance is predictably bad, and differentiate to our staff when to follow MOS guidance and when opportunities exist to significantly improve upon MOS guidance.