Use of MatchGuidance – Examples of the Impact of Model Background Choices and MOS Inputs on Wind Forecasts

Greg Martin
NWS WFO San Diego, CA

Introduction

National Weather Service (NWS) forecast offices produce high resolution forecast grids out through seven days using the Graphical Forecast Editor (GFE) component of the Interactive Forecast Preparation System (IFPS). Among the common tools for producing such grids in complex terrain is the MatchGuidance tool (Barker 2005a). This program takes a background model grid and then applies Tim Barker's and Les Colin's Serp tool (Barker 2005b) to fit the grid to a set of values in selected MOS bulletins using a three-dimensional serpentine curve. After the adjustment, grid values at the MOS points exactly match the values in the MOS bulletins. Adjustments at those points also influence values for the surrounding areas. The goal of this paper is to show that the MOS adjustments chosen, and especially the model forecast field chosen, can make a big difference in the resulting field, especially for portions of the domain.

Overview

The following are some examples of the impact of the initial background field when using MatchGuidance and some of the options for adjusting this background field using MOS. The forecast time for all graphics is 18Z on February 15th, 2006. Model forecasts from the GFS80 and Eta12 were from the 12Z cycle of February 15th, 2006. Both of these models used the baseline SmartInit for Wind. Forecasts for the Workstation Eta (WsEta) were from the 00Z cycle on February 15th, 2006. The WsEta uses an alternate SmartInit for Wind that uses the basic input of wind at the pressure level nearest a given elevation. For stronger wind situations with increasing winds aloft, this would tend to yield stronger winds at higher elevations. The weather pattern on this day was a strong onshore pattern with increasing winds aloft.

In MatchGuidance, there's both terrain and distance weighting in the analysis. This is adjusted using a setting within the MatchGuidance tool known as the "Elevation Factor". Setting the "Elevation Factor" to *higher* values places greater emphasis on distance and less on terrain. Setting the "Elevation Factor" to *lower* values places greater emphasis on terrain and less on distance. When emphasizing terrain (lower values of "Elevation Factor"), locations on the forecast grid with elevations similar to the MOS points will receive the greatest modification. As one moves to elevations higher or lower than the elevations of the MOS points along the forecast grid, the modification will be less.

“Raw” Model Forecasts

Figures 1 through 4 show four different model forecasts of wind. Wind forecasts are shown for the GFS80 (Figure 1), Eta12 (Figure 2), WsEta (Figure 3), and a 50/50 blend of the Eta12 and WsEta (Figure 4). In examining these “raw” model forecasts, one notices that the GFS80 wind field (Figure 1) is very smooth with little variation and little terrain detail. The GFS80 has highest winds over the *model’s* highest terrain. However, because the GFS80 model terrain (Figure 6) is smoothed and displaced from the actual terrain (Figure 5), the location of the strongest winds (Figure 1) is displaced from the actual location of the stronger winds over the mountains. The NAM (Eta12) terrain (Figure 7) and the GFE terrain (Figure 5) are also provided for comparison. Note that the GFS80 terrain is very smooth with poor placement of key mountain and valley locations and greatly reduced amplitude of the these features and the slope between them. Note also that the Eta12 terrain is much better with location of key mountain and valley locations, but with somewhat less amplitude than the actual terrain and somewhat less slope than the actual slope between these mountains and valleys.

Both the Eta12 (Figure 2) and WsEta (Figure 3), as well as the 50/50 blend of these two (Figure 4), have much more directional and speed detail in their wind field. Note the stronger winds in the mountains, the upper deserts, and outer coastal waters with weaker winds in coastal and valley areas and in the lower deserts. Please see Figure 5 for references to these locations.

MOS Adjustments to Model Forecasts

A series of examples will show the impact of different MOS adjustments on a given model forecast field. MOS options included the MAV (GFS shorter range), MET (NAM) and MMG (GFS marine MOS for a point over the outer coastal waters). When adjusting to MOS values using MatchGuidance, values at the MOS points are adjusted to the values in the MOS bulletins. Values away from the MOS points are modified using a serpentine analysis with terrain/distance weighting specified by the “Elevation Factor” in MatchGuidance. With MOS locations for wind limited to lower elevation locations, values in the mountains after running MatchGuidance are more heavily dependent on the initial model forecast than are locations in lower elevations with greater MOS coverage. In general for this day, values in the NAM (MET) MOS were a little stronger than for the GFS (MAV) MOS. In the sections that follow for each model, the first example is for an adjustment to the MET and MMG (marine) MOS; the second is for an adjustment of the MAV and MMG; and the third uses a blend of the MET and MAV in addition to the MMG.

MOS Adjustments to the GFS80 Forecast

The first set of examples (Figures 1 and 8 through 10) is for the GFS80. Figure 1 shows the initial *unmodified* GFS80 wind field. This initial wind field had stronger winds over higher terrain displaced away from the actual mountains toward the higher *model* terrain. Figure 8 shows the GFS80 “adjusted” to the MET and MMG MOS. Figure 9 shows the

GFS80 "adjusted" to the MAV and MMG MOS. Figure 10 shows the GFS80 "adjusted" to the MAV, MET, and MMG MOS. The resulting MOS adjusted fields are strongly biased by the initial model forecast field. While adjusting to MOS will "correct" some of the speed and directional shortcomings at lower elevations where MOS guidance is available, shortcomings remain at the higher elevations. Even after the MOS adjustment, highest wind speeds are still not located over the mountains, but remain closer to where the model erroneously placed the strongest speeds. Due to the coarseness of the GFS80 grids, use of the GFS80 is strongly discouraged as an initial forecast input when preparing operational wind grids, especially in complex terrain.

MOS Adjustments to the Eta12 Forecast

The next set of examples is for the Eta12 (Figures 11 through 14). This set of displays is similar to that for the GFS80. Figure 11 shows the initial *unmodified* Eta12 wind field. This initial wind field had stronger winds over the actual mountains, with secondary maxima over the upper deserts and outer coastal waters. Figure 12 shows the Eta12 "adjusted" to the MET and MMG MOS. Figure 13 shows the Eta12 "adjusted" to the MAV and MMG MOS. Figure 14 shows the Eta12 "adjusted" to the MAV, MET, and MMG MOS. Note the impact on the resulting MOS adjusted grids based on the greater detail in the initial model forecast. The stronger winds in the mountains provided by the Eta12 forecast are preserved in the MOS adjusted grids.

MOS Adjustments to the WsEta Forecast

The next set of examples is for the WsEta (Figures 15 through 18). This set of displays is similar to those for the GFS80 and Eta12. Figure 15 shows the initial *unmodified* WsEta wind field. This initial wind field had stronger winds over the actual mountains, with secondary maxima over the upper deserts and over the coastal waters. Figure 16 shows the WsEta "adjusted" to the MET and MMG MOS. Figure 17 shows the WsEta "adjusted" to the MAV and MMG MOS. Figure 18 shows the WsEta "adjusted" to the MAV, MET, and MMG MOS. Note the impact on the resulting MOS adjusted grids based on the greater detail in the initial model forecast. The stronger winds in the mountains provided by the WsEta forecast are preserved in the MOS adjusted grids.

Concluding Comments

The purpose of these forecast examples is not to impose a particular methodology when preparing wind grids, but to show the impacts and advantages or disadvantages of different approaches. In complex terrain, there are clear advantages to using a model forecast field with greater initial detail. This strongly favors using higher-resolution models such as the Eta12 or WsEta in the shorter term and DGEX in the extended. However, since the resulting surface wind field for higher-resolution models is often dependent on that model's synoptic solution, for the extended one might need to use an earlier version of DGEX other than the most recent version, if the latest version of DGEX does not have the preferred synoptic solution.

Through careful selection of an appropriate model forecast field and through careful selection of MOS inputs for adjustment of this forecast field, one can more easily prepare wind grids that reflect the variation in complex terrain with little additional modification. This is especially advantageous in preparing wind grids due to the complexity of these grids and especially due to the difficulty of editing vector fields in GFE.

References

Barker, T., 2005a: MatchGuidance Ver. 2.3 Documentation. [Available online at http://www.mdl.nws.noaa.gov/~applications/STR/siteappinfoout.php3?appnum=954&LAD=].

Barker, T., 2005b: MatchObsAll Ver. 0.98 Documentation. [Available online at http://www.mdl.nws.noaa.gov/~applications/STR/siteappinfoout.php3?appnum=877&LAD=].

Barker, T., 2005c: Model_Blend Ver. 2.0 Documentation. [http://www.mdl.nws.noaa.gov/~applications/STR/siteappinfoout.php3?appnum=915&LAD=].

Barker, T., 2004: Serp Ver. 1.12 Documentation. [Available online at http://www.mdl.nws.noaa.gov/~applications/STR/siteappinfoout.php3?appnum=755&LAD=].

Figures

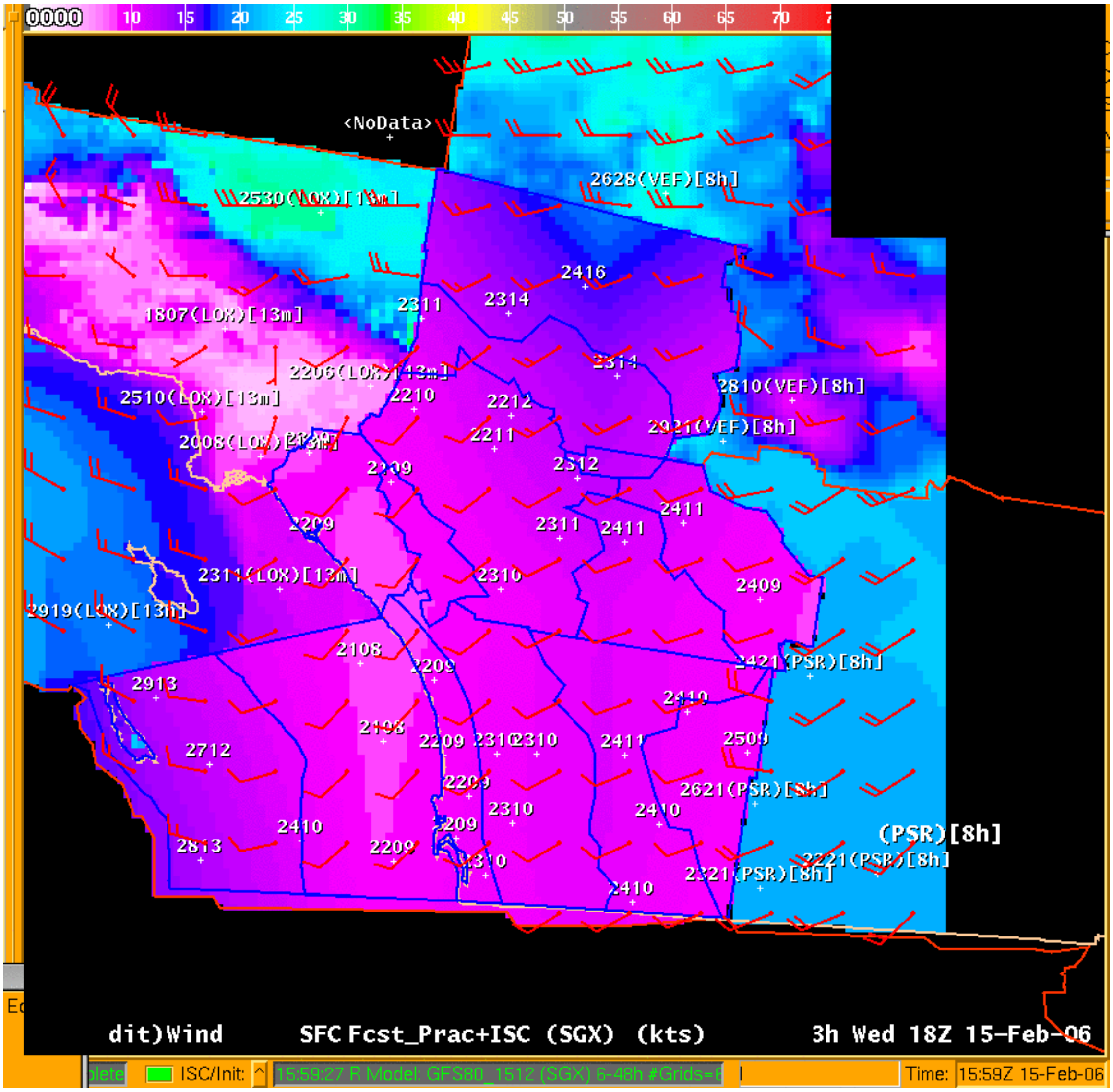

Figure 1 – GFS80 Wind

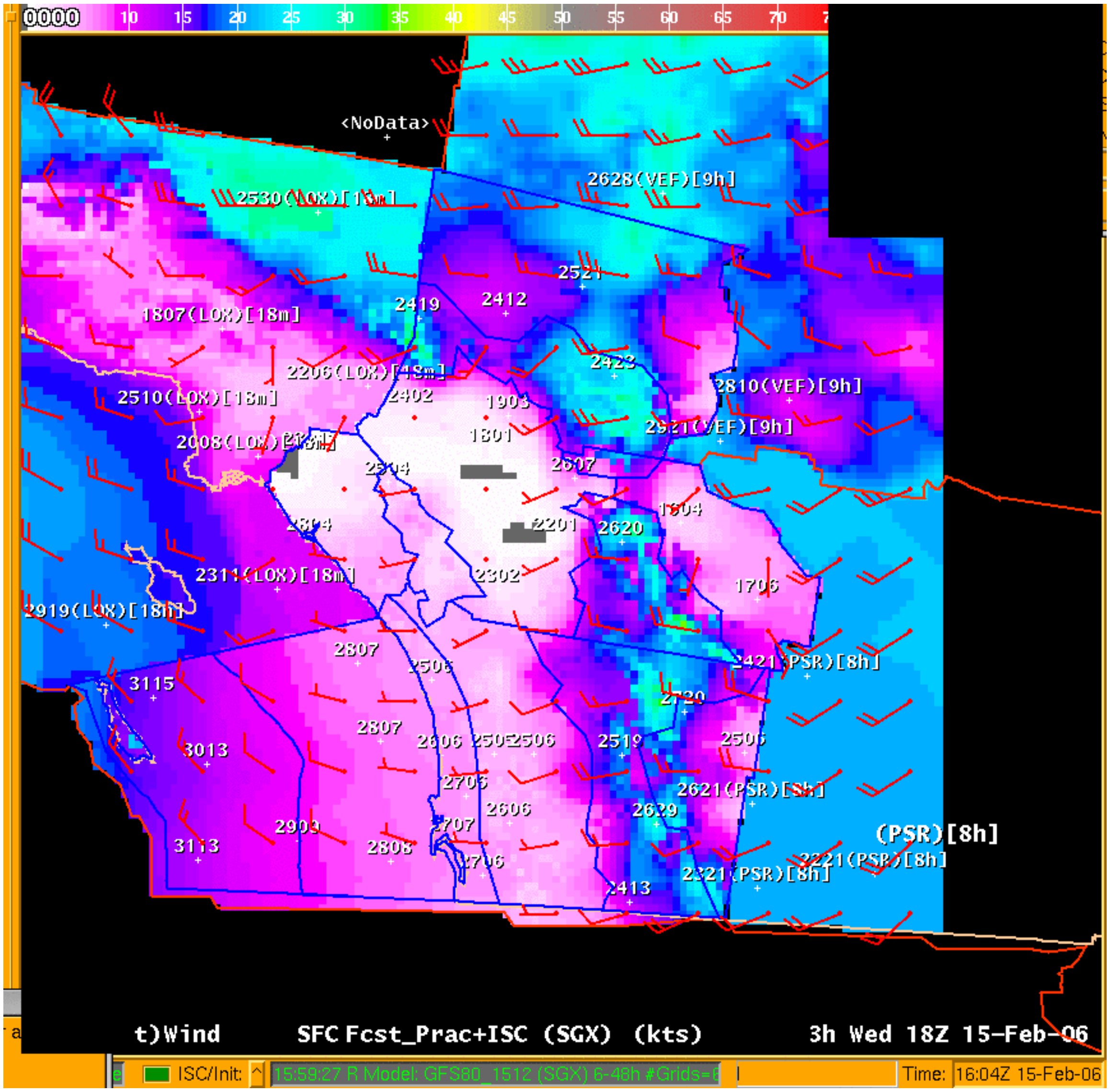

Figure 2 – Eta12 Wind

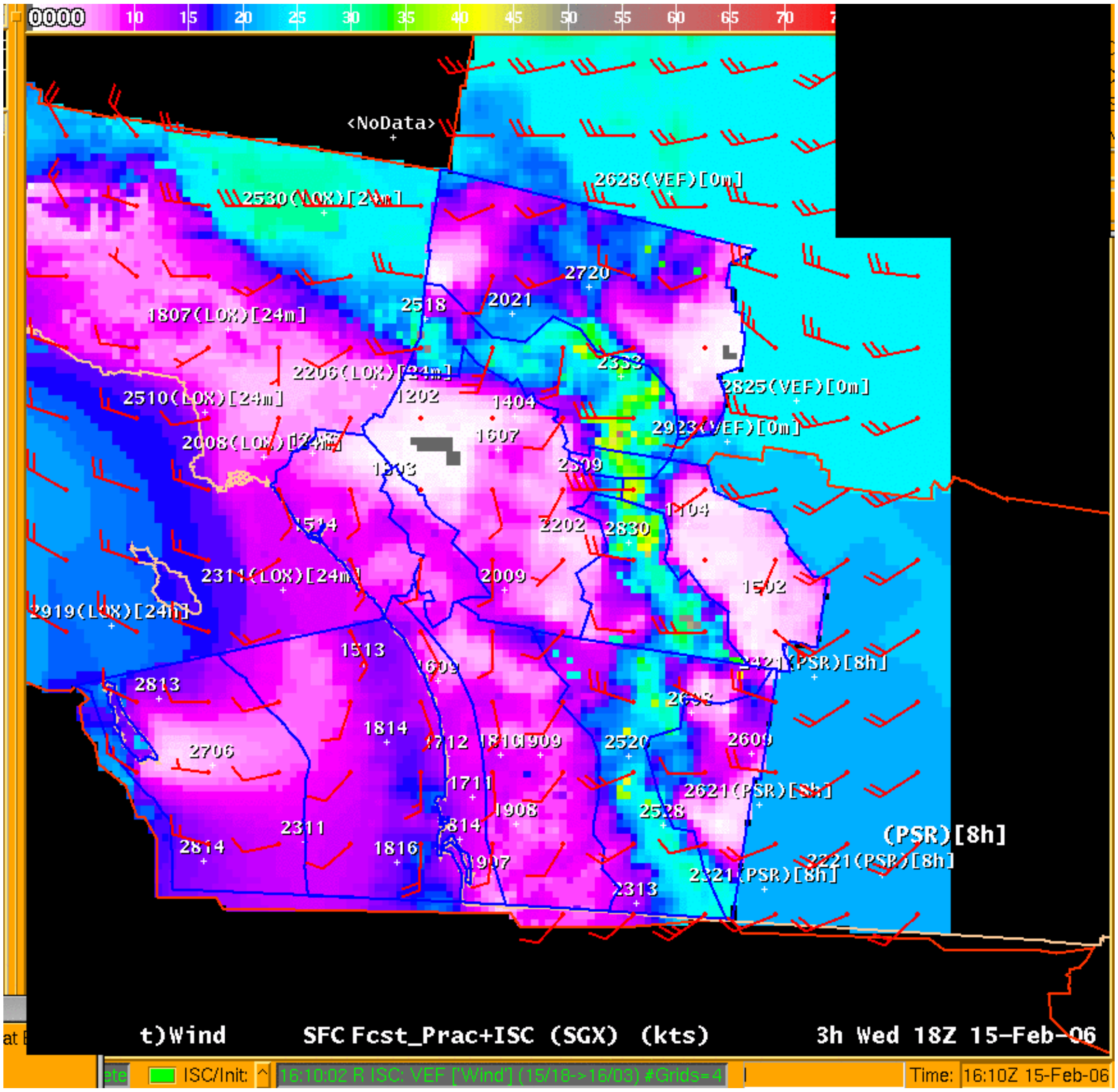

Figure 3 – WsEta Wind

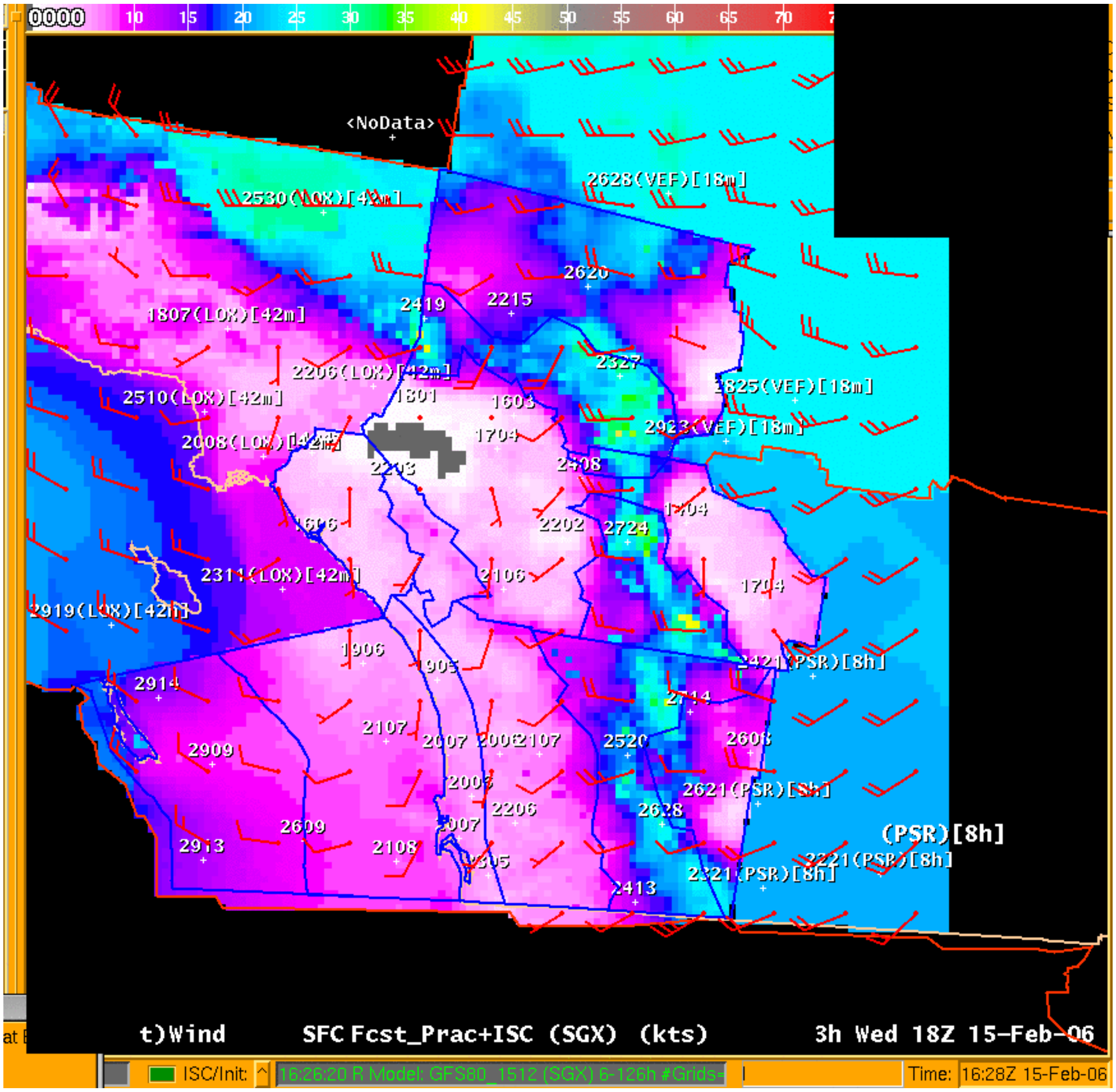

Figure 4 – Equal blend of Eta12 and WsEta Wind (Eta12 02/15 12Z and WsEta 02/15 00Z)

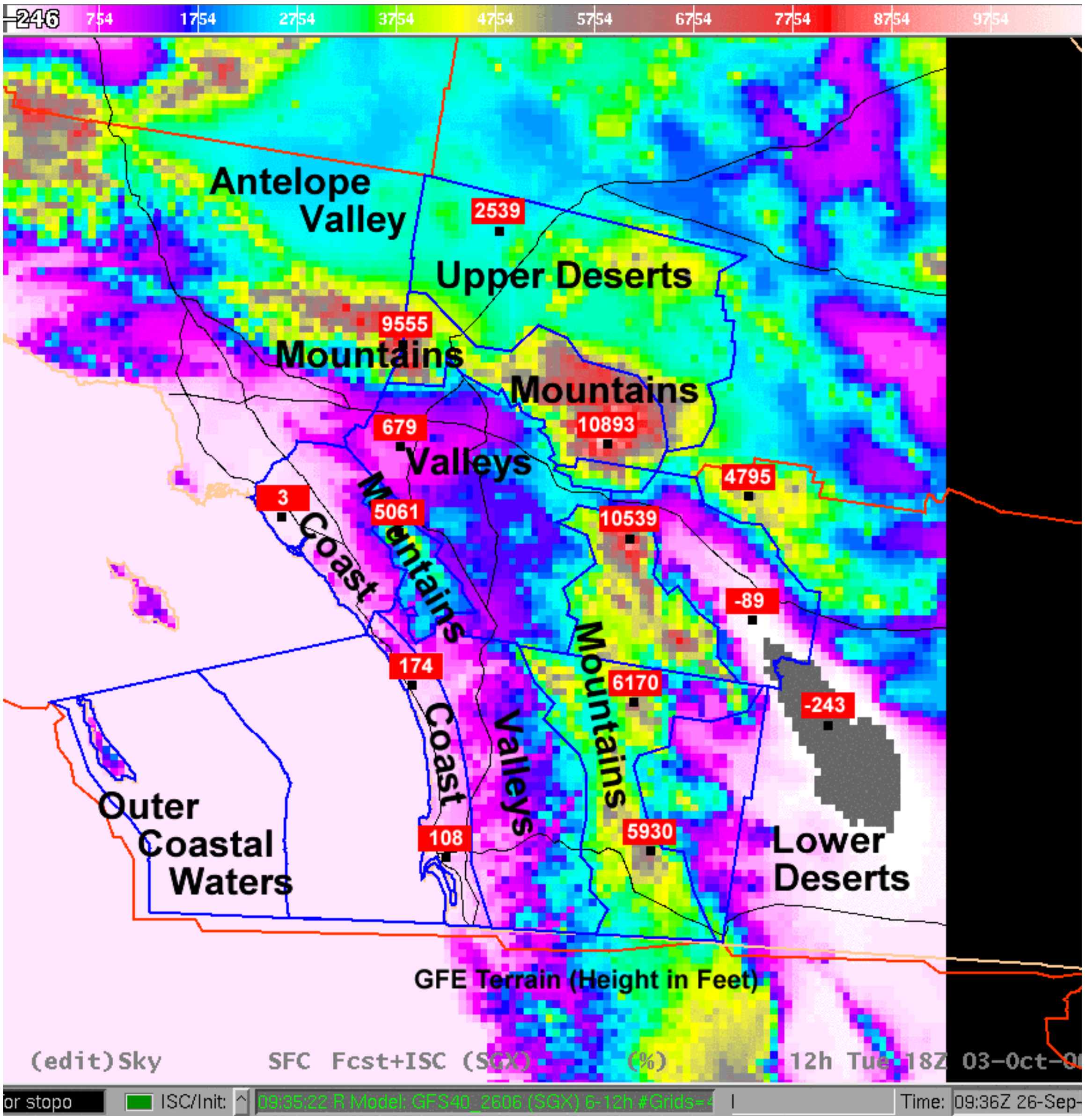

Figure 5 – GFE Terrain (2.5 km resolution, heights in feet)

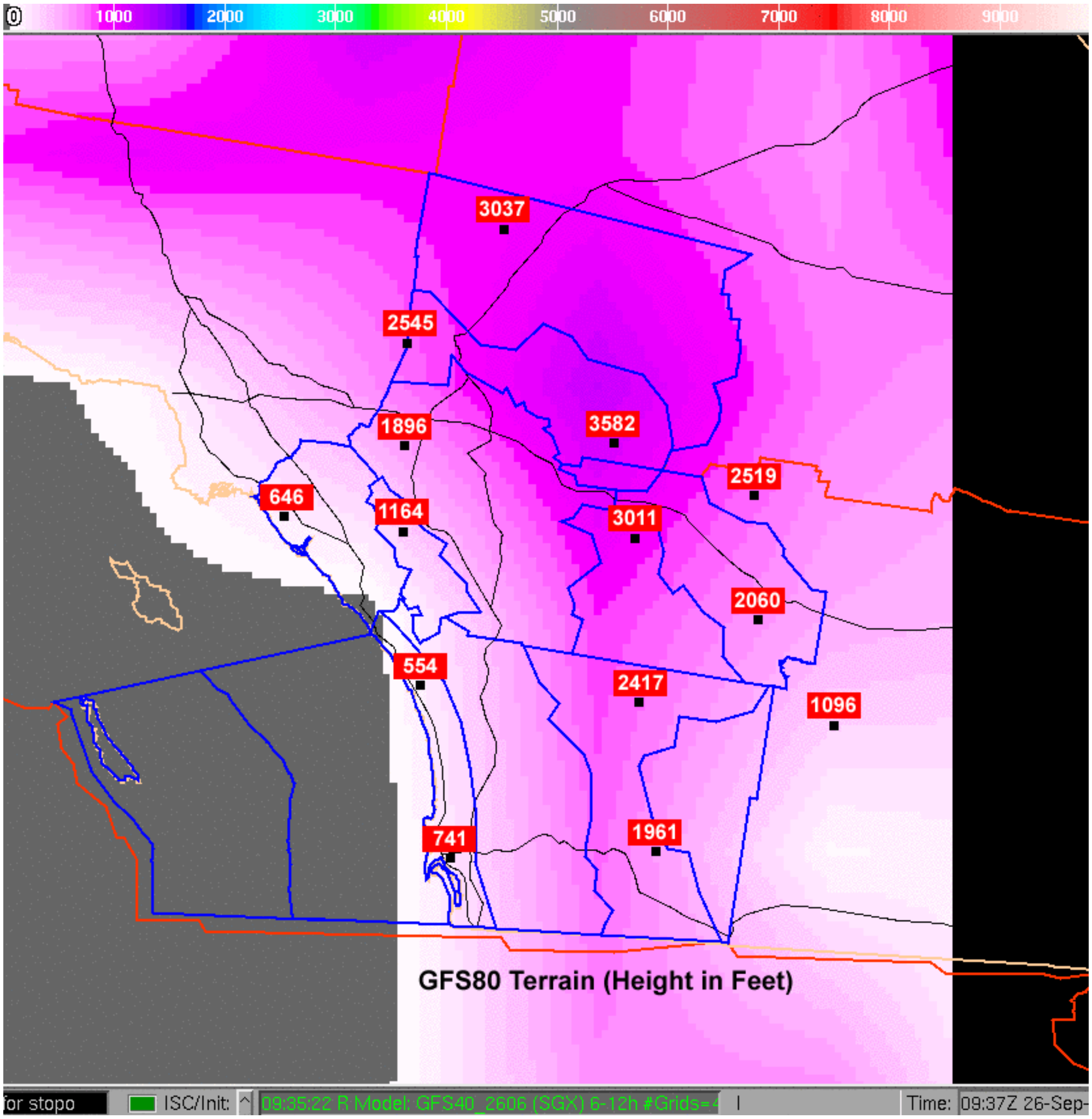

Figure 6 – GFS80 Terrain (height in feet)

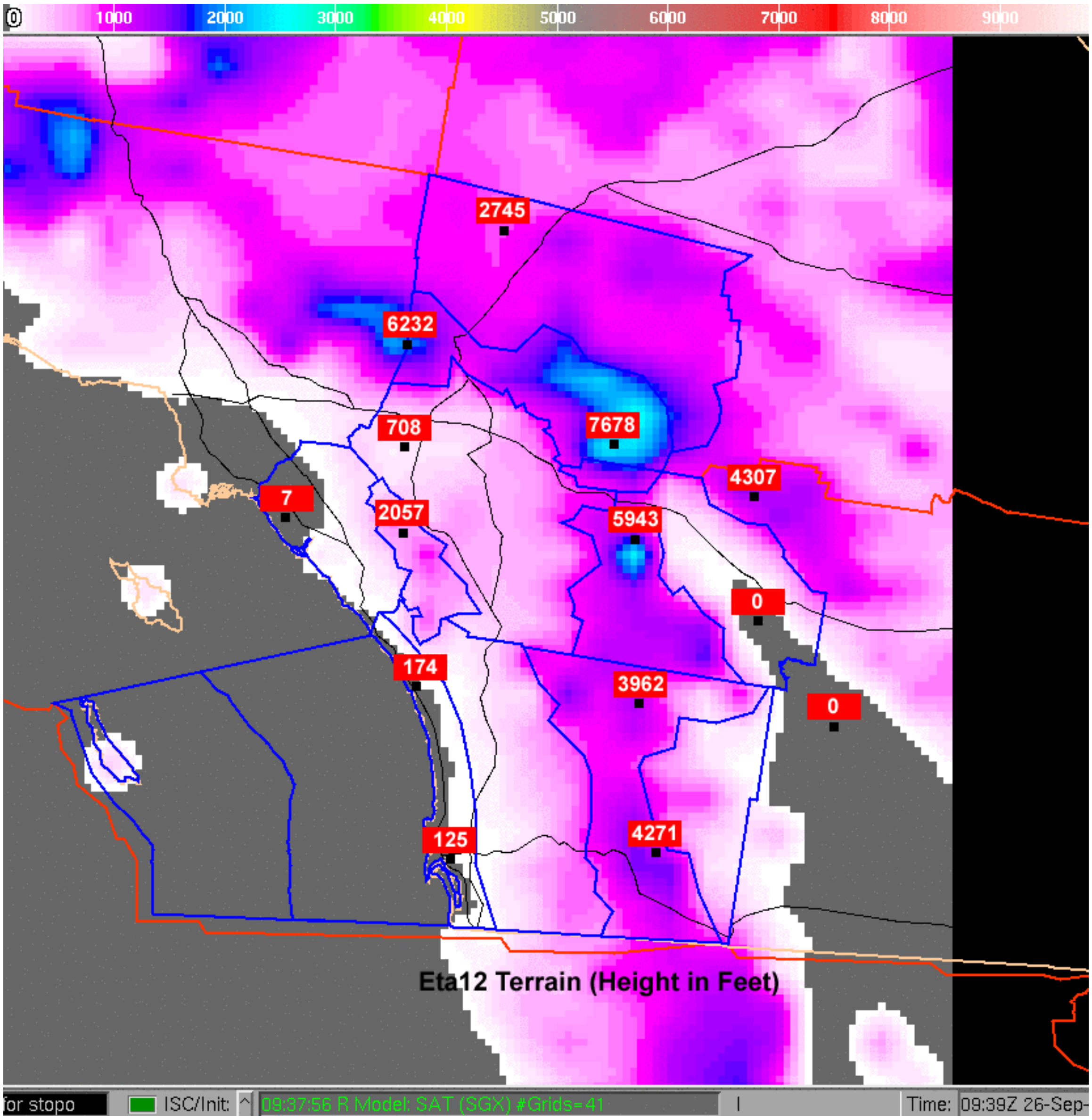

Figure 7 – NAM (Eta12) Terrain (height in feet)

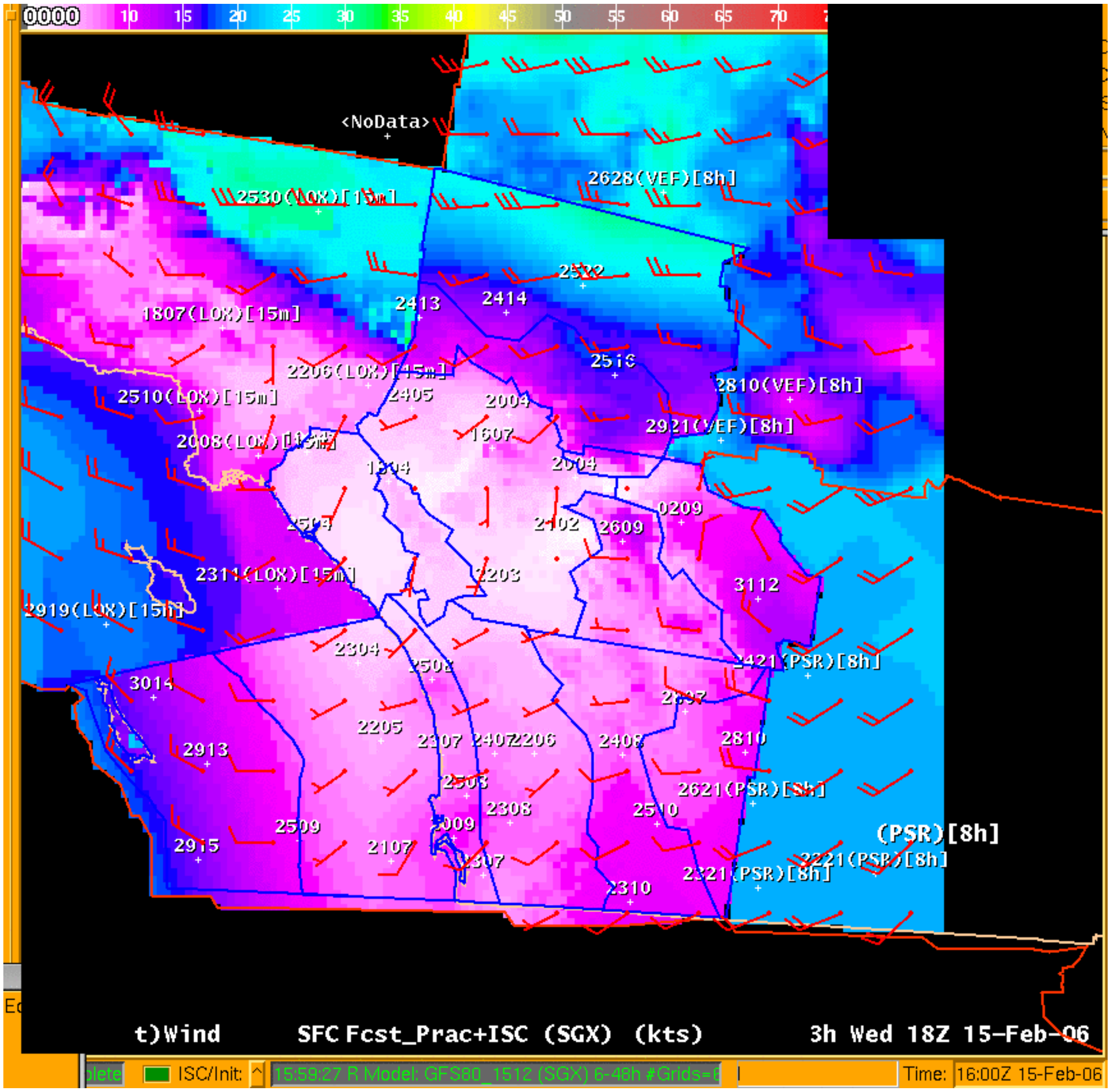

Figure 8 – GFS80 Wind – Adjusted to MET / MMG MOS

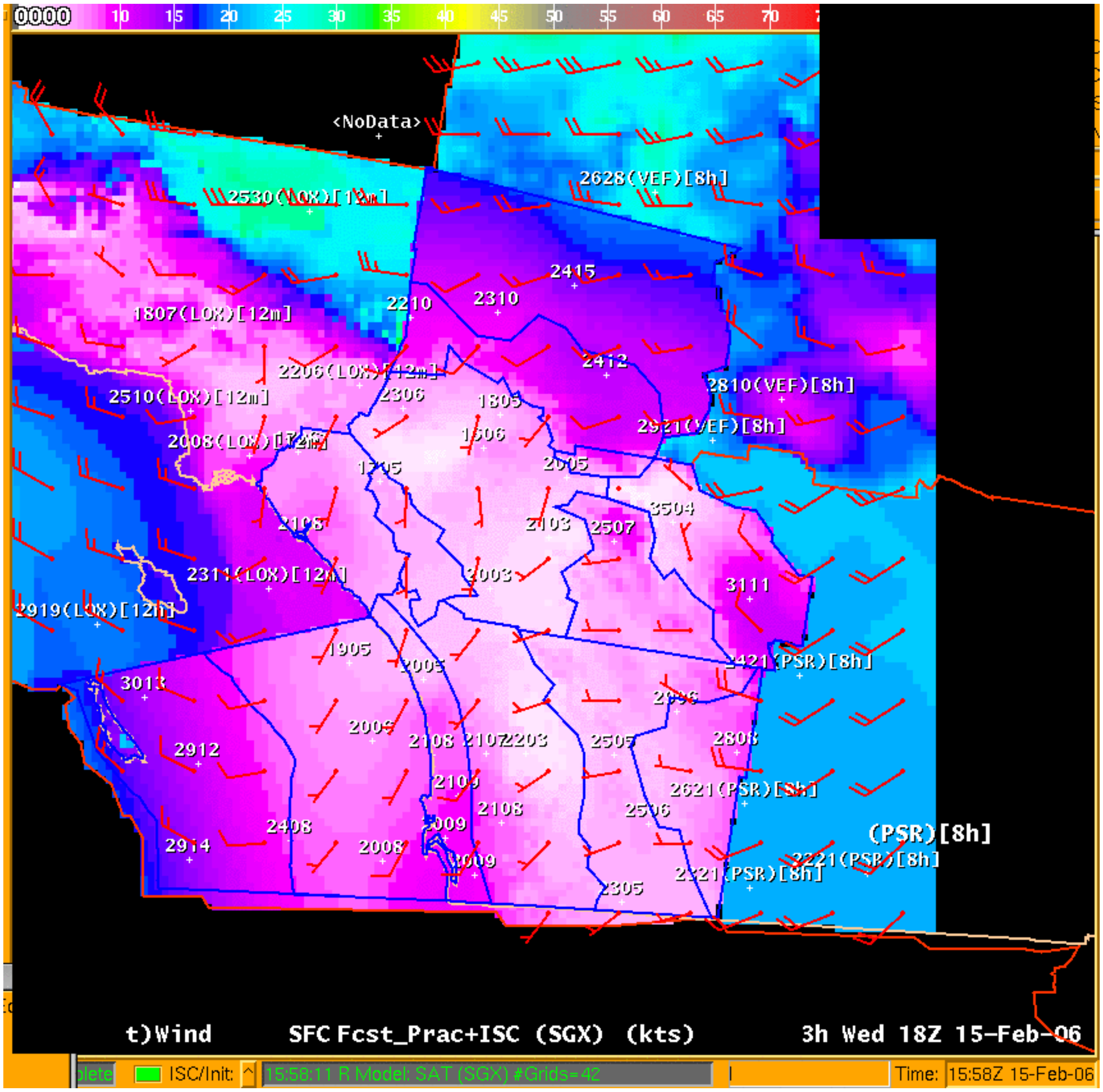

Figure 9 – GFS80 Wind – Adjusted to MAV / MMG MOS

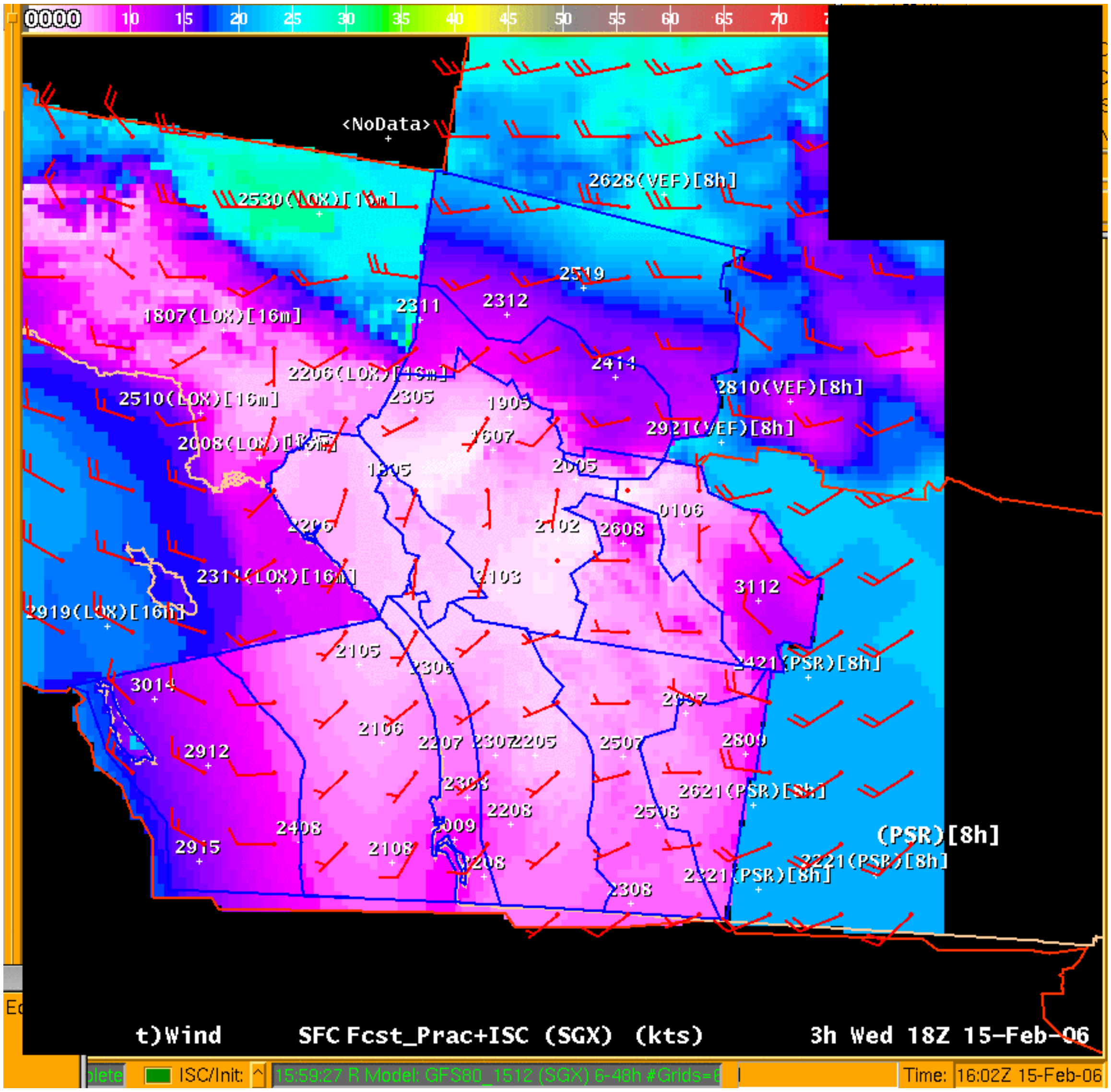

Figure 10 – GFS80 Wind – Adjusted to MET / MAV / MMG MOS

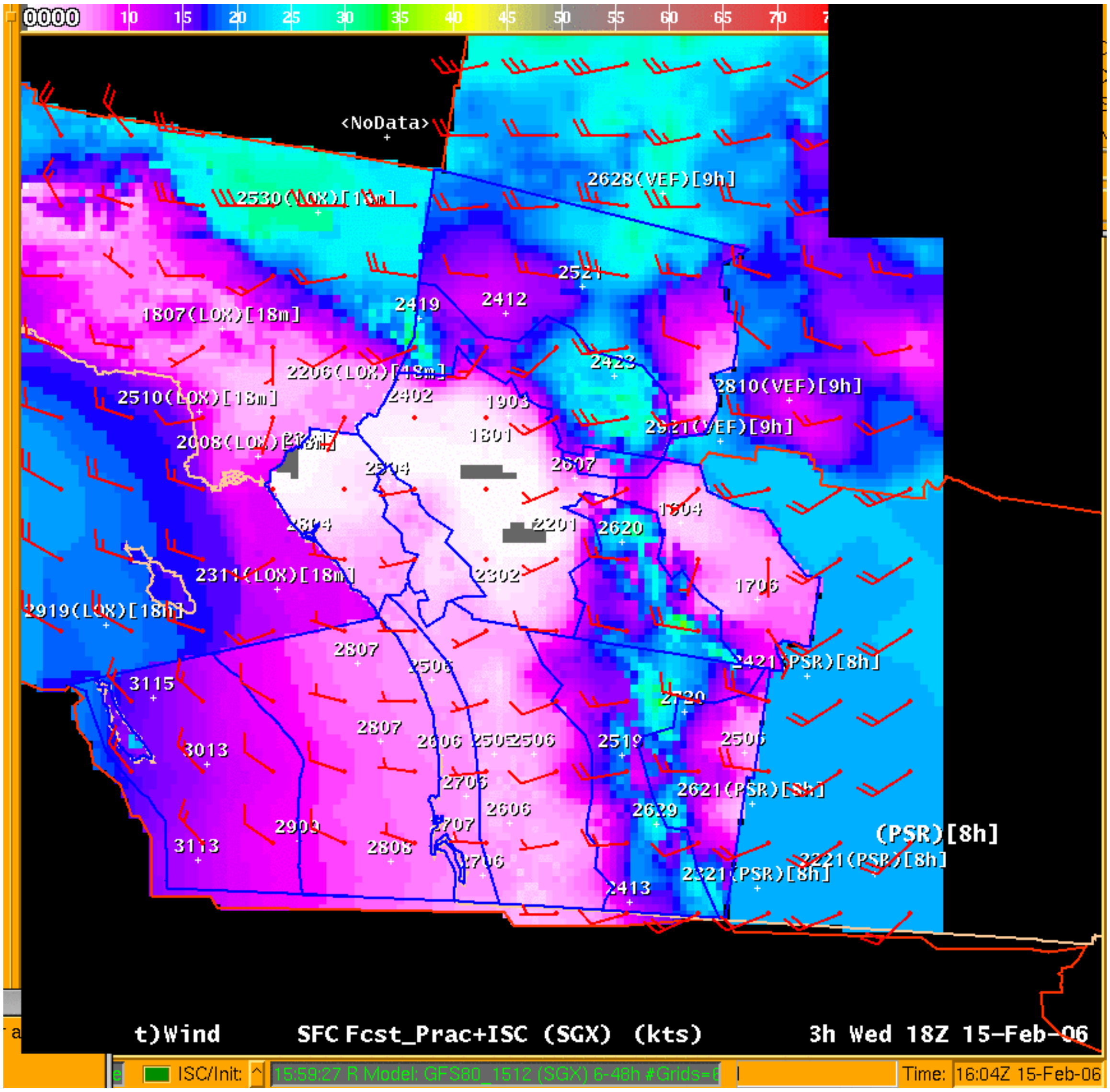

Figure 11 – Eta12 Wind (same as figure 2)

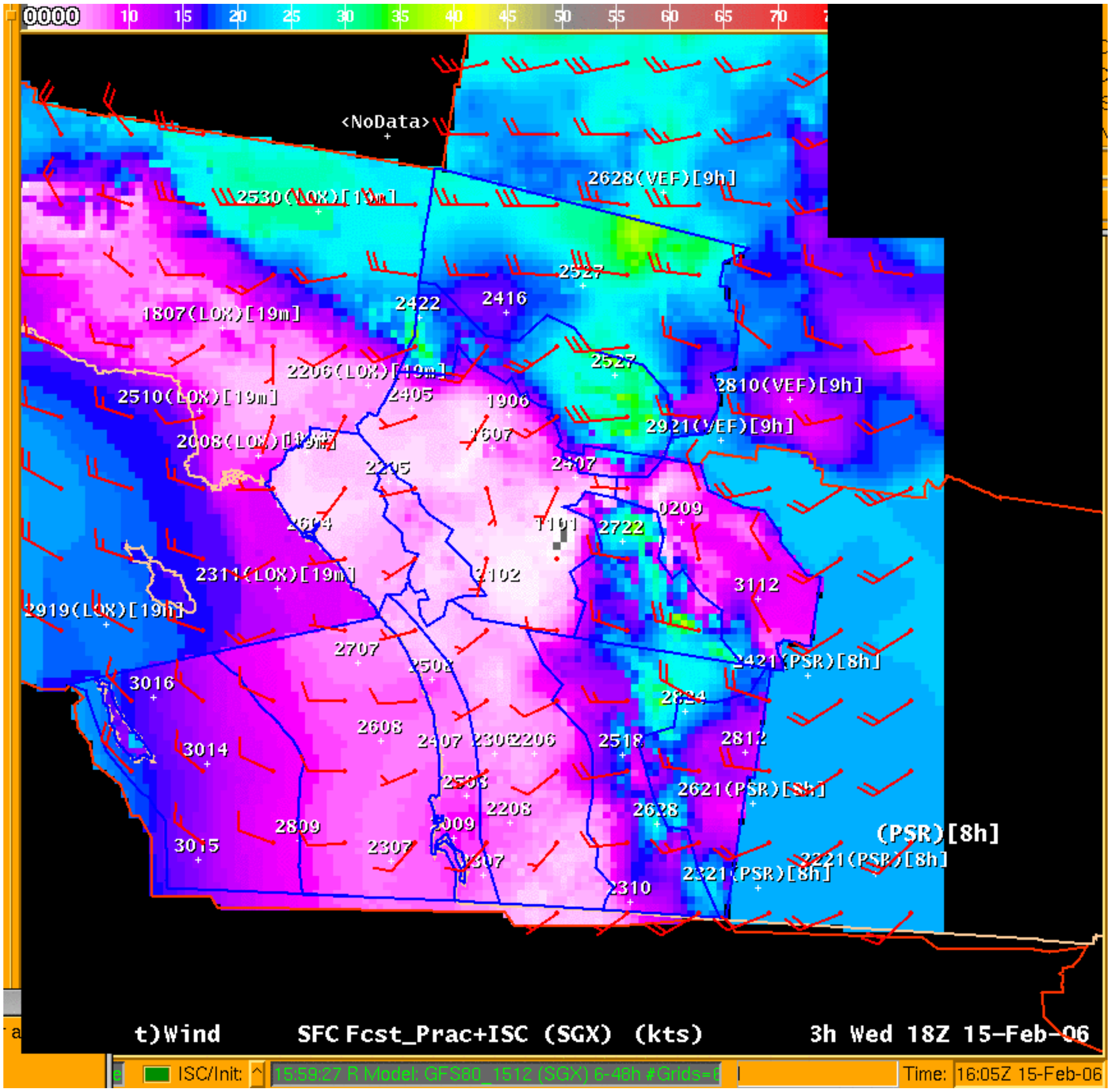

Figure 12 – Eta12 Wind – Adjusted to MET / MMG MOS

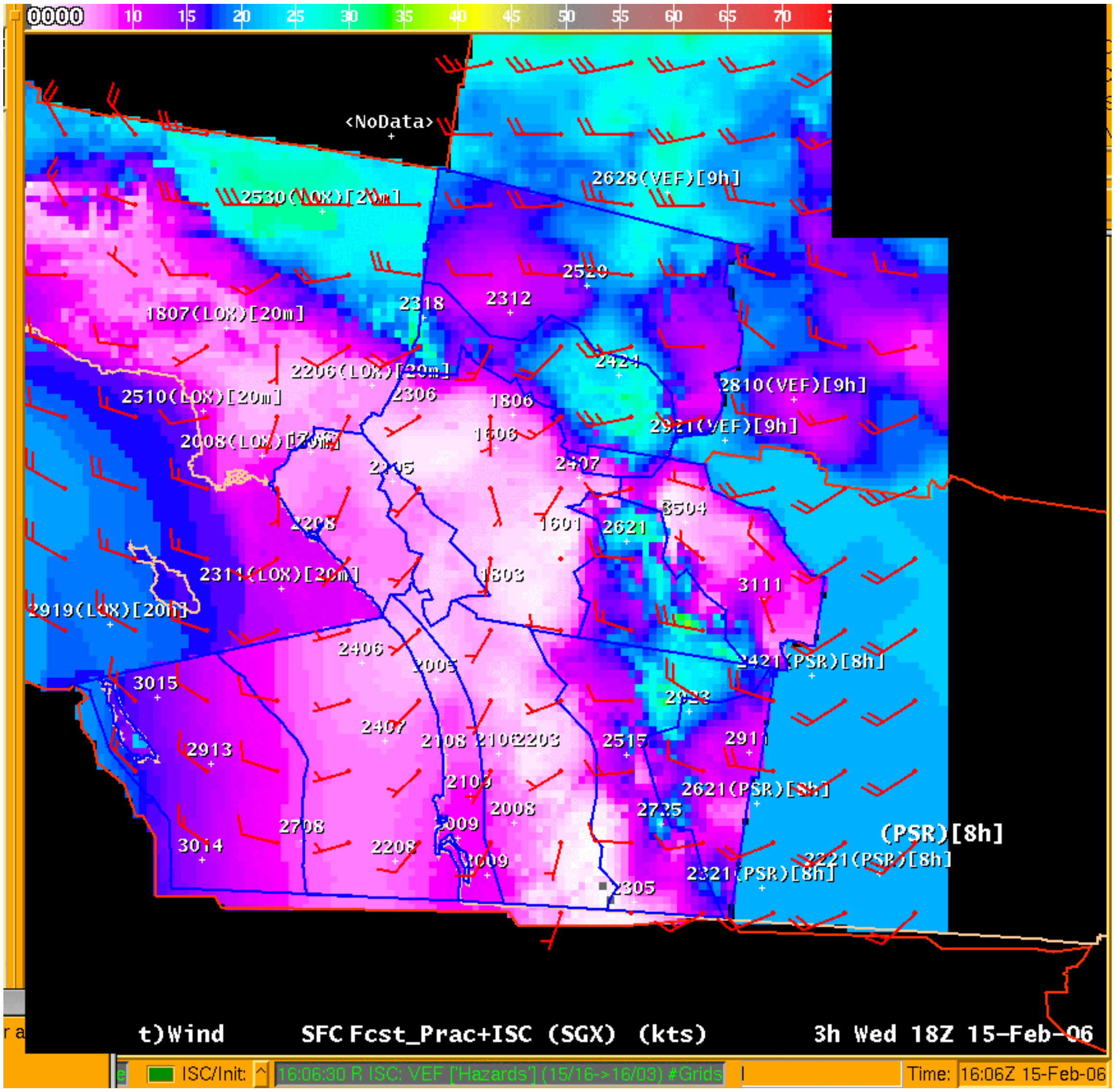

Figure 13 – Eta12 Wind – Adjusted to MAV / MMG MOS

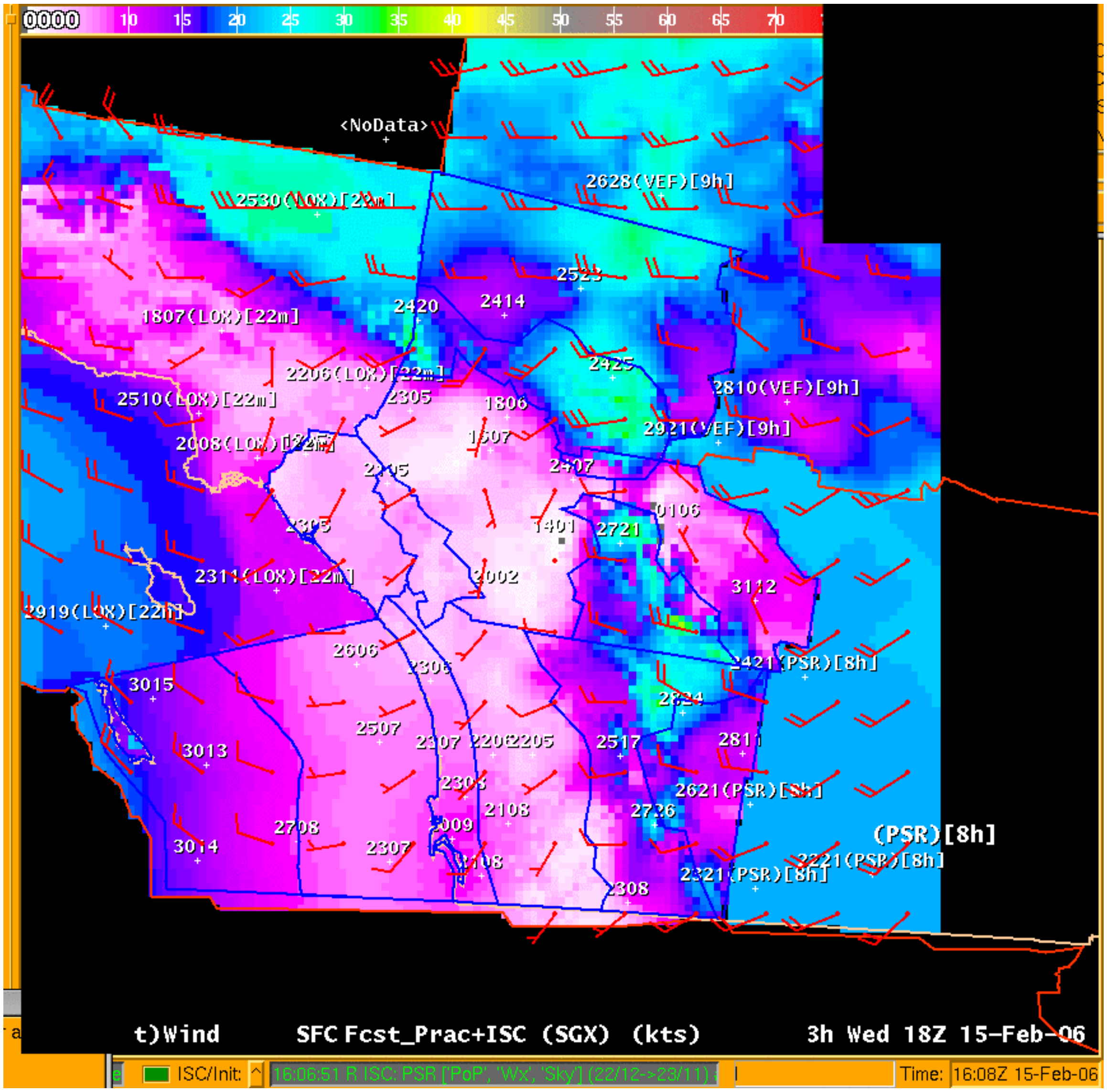

Figure 14 – Eta12 Wind – Adjusted to MET / MAV / MMG MOS

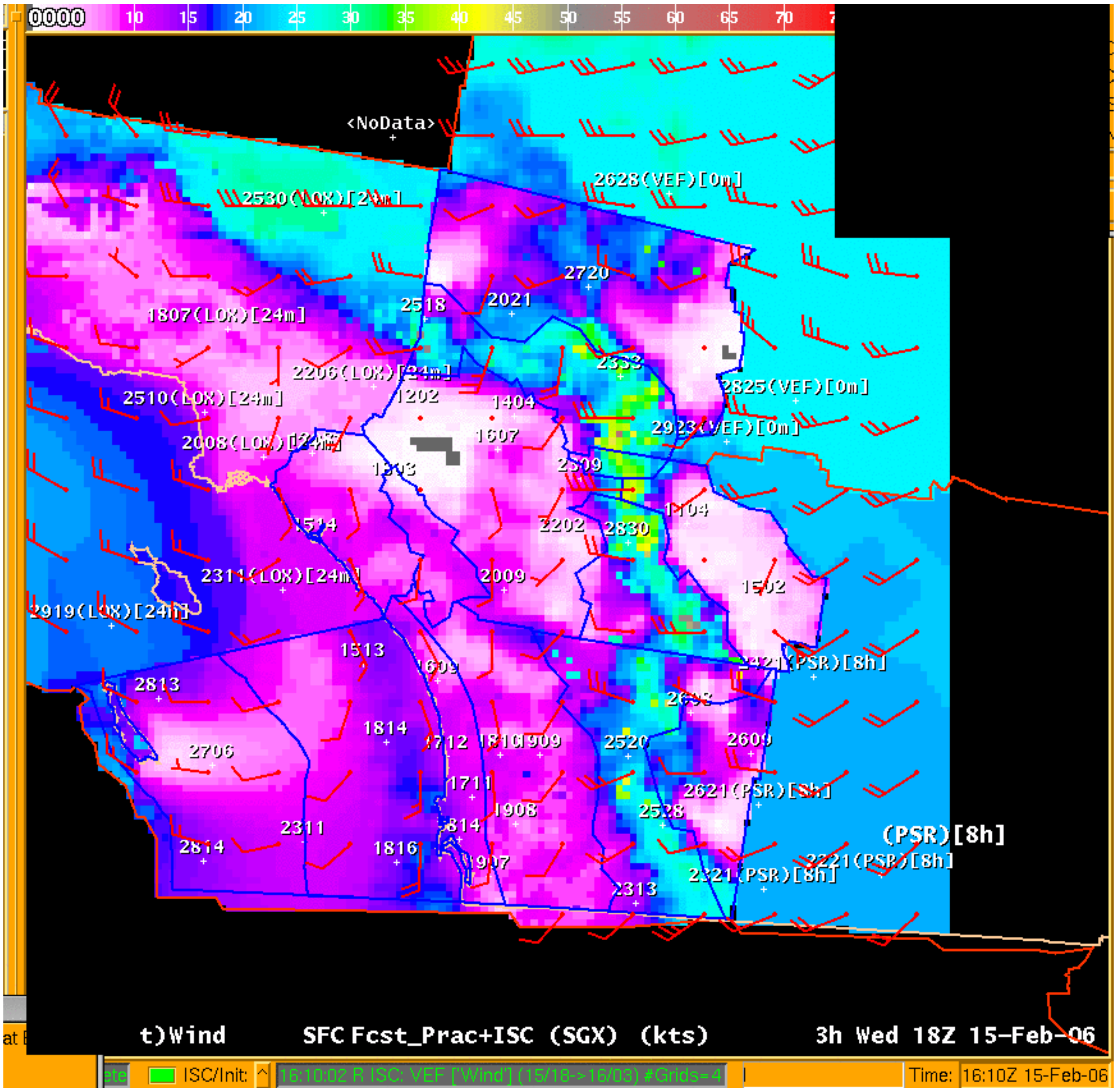

Figure 15 – WsEta Wind (same as figure 3)

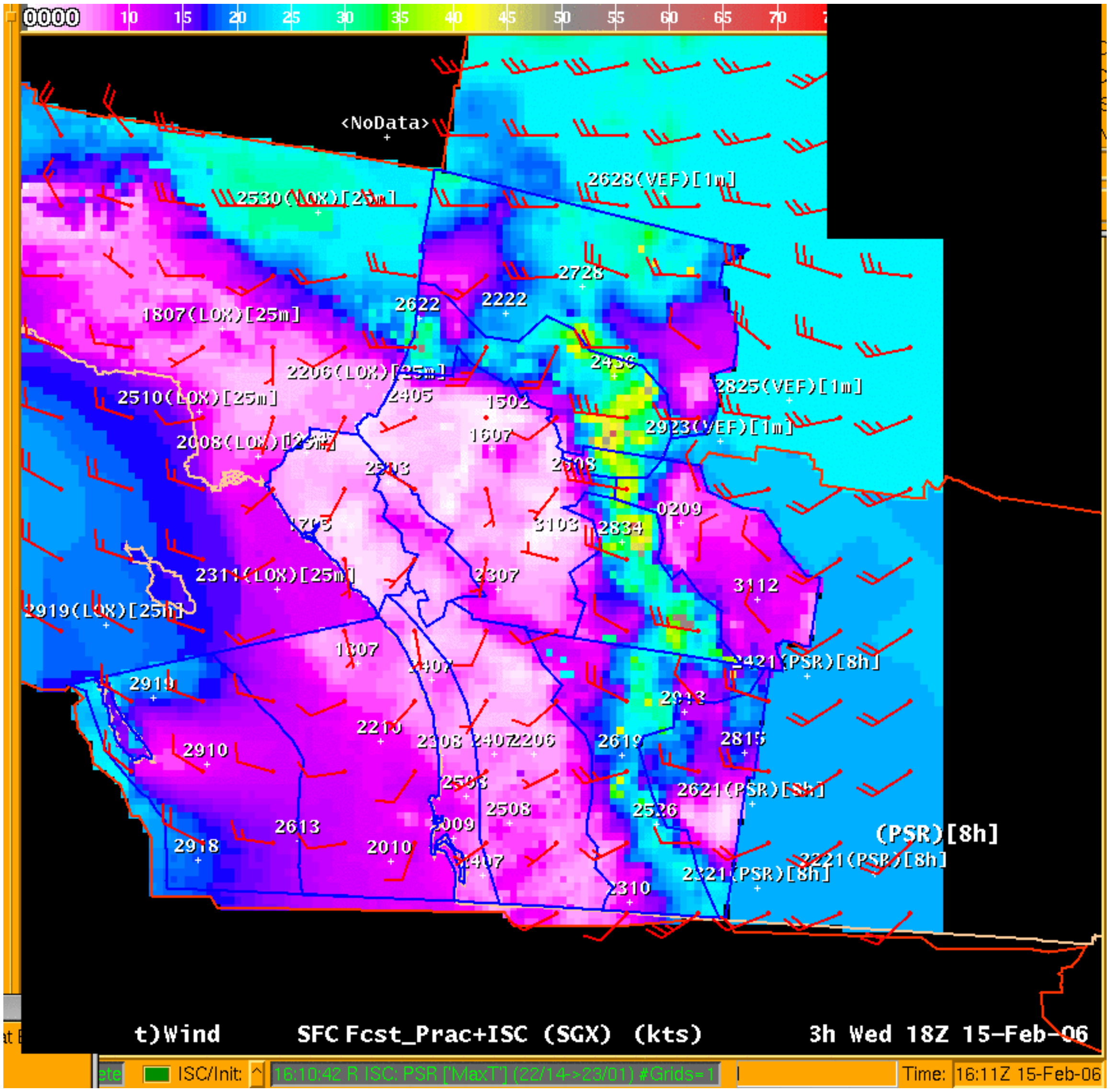

Figure 16 – WsEta Wind – Adjusted to MET / MMG MOS

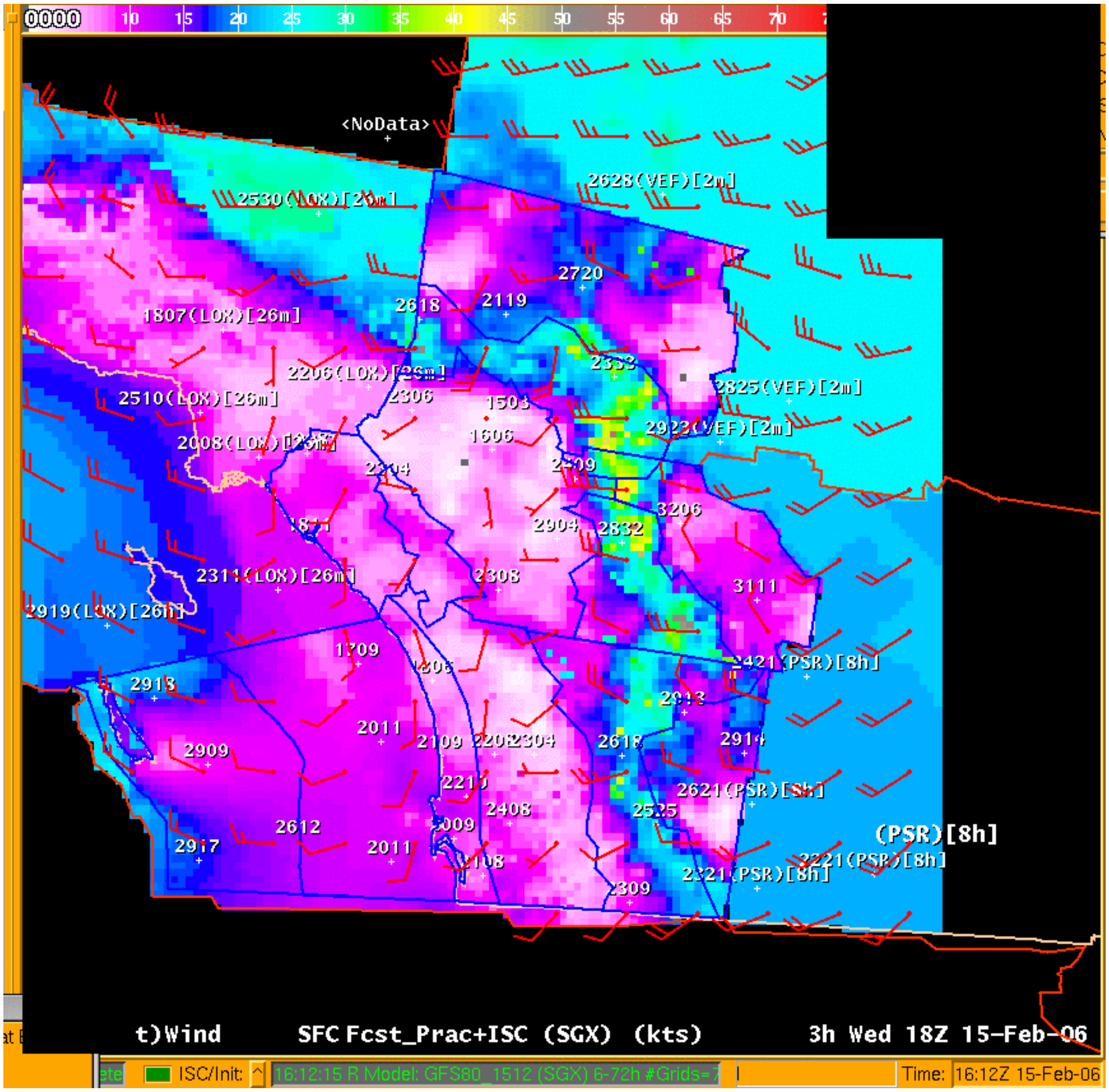

Figure 17 – WsEta Wind – Adjusted to MAV / MMG MOS

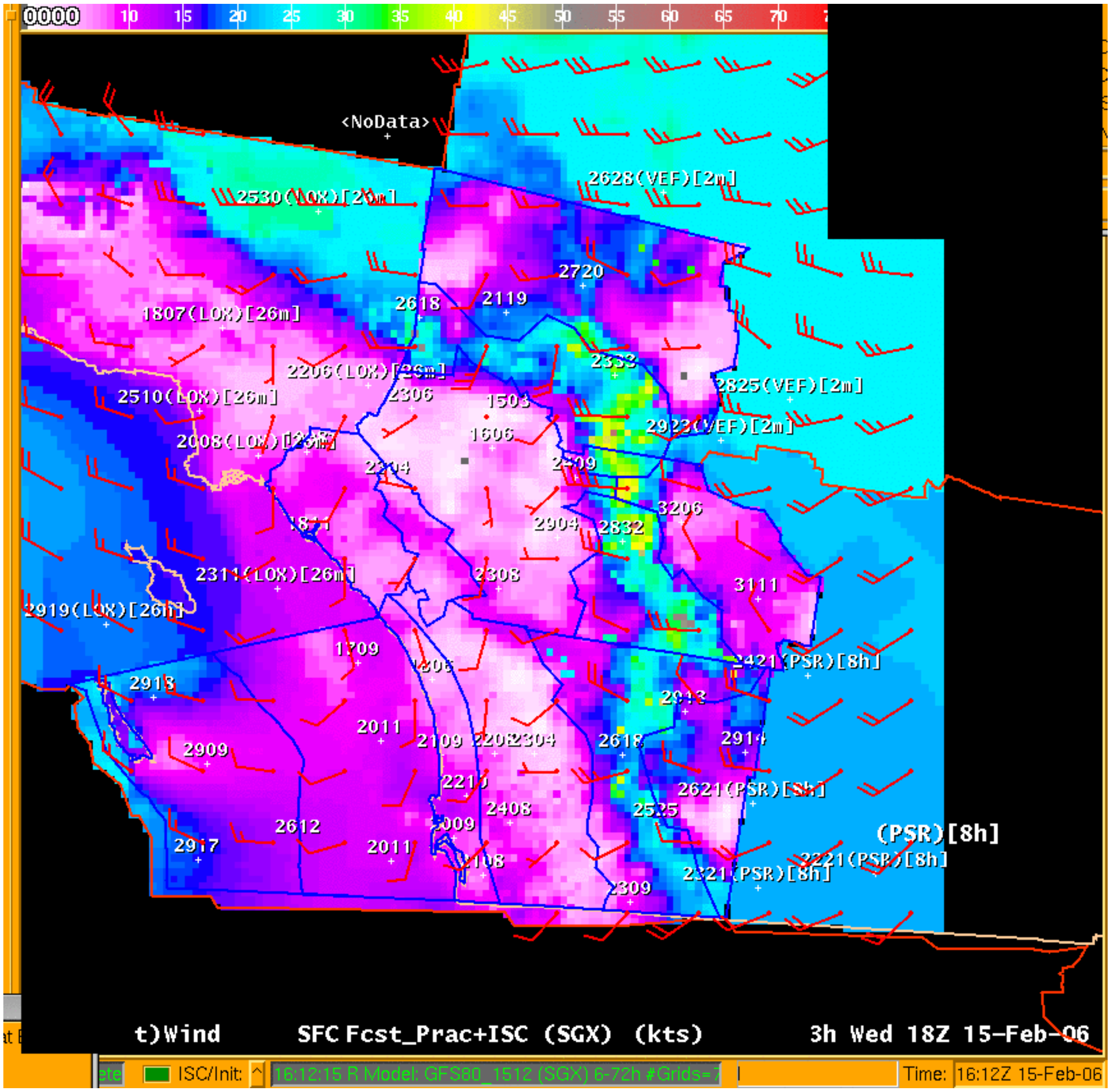

Figure 18 – WsEta Wind – Adjusted to MET / MAV / MMG MOS