WFO Portland, Oregon Sustained Wind Speed Forecast Biases: An Examination of Two Significant Events

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1. Introduction

Winds in the Portland Oregon Forecast office County Warning Area (CWA) are largely pattern driven and are somewhat predictable, given the effects of complex terrain (Fig. 1). In the winter, onshore flow events often consist of strong land falling fronts that result in brisk winds over the coastal waters and along the coastal lowlands of Oregon and Washington, and a general southerly flow throughout the Willamette Valley. In contrast, offshore flow regimes are often dominated by tranquil weather and blustery east winds through the Columbia River Gorge. Sometimes strong east winds also occur over higher terrain in the Cascades and Coast Range mountains.

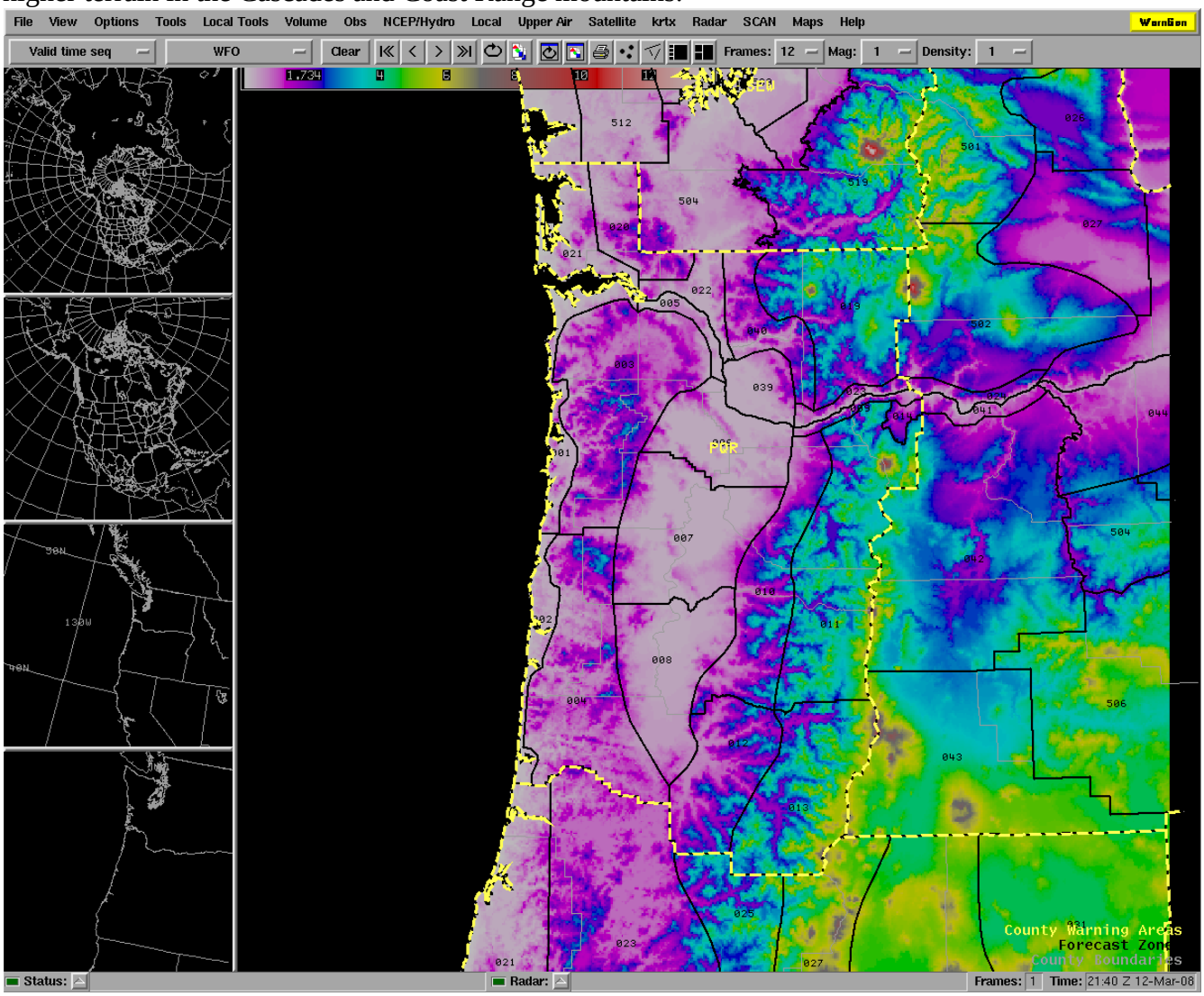

Figure 1. Hi-res topo map with Portland CWA and Zones highlighted in yellow and black respectively

This paper examines the accuracy of sustained wind speed forecasts issued by WFO Portland. Using output from BOIVerify in two separate significant wind events, biases and error in model and official forecasts are identified with the intent of giving forecasters information to produce more accurate wind forecasts.

2. January 23, 2008: An East Wind Event

Synoptic Setup:

On January 17th, 2008, a strong 500 mb ridge was centered along approximately 135W, and extended to the British Columbia/Alaska border region. An approaching system from the west would move across the top of this ridge on the 19th, eventually forming a cutoff low that was centered just off the coast of California west of San Francisco by the morning of January 23rd. An inverted trough that extended from northern California to the central Washington coastline, was present from 850 mb down to the surface. The combination of a thermally induced trough along the Oregon coast, and the existence of a roughly 1040 mb surface high rooted in central Idaho, caused significant offshore flow to develop over the forecast area.

Upper air analysis from 12Z on January 23rd revealed an almost 8°C cross-Cascade temperature gradient at 850 mb (from around the Oregon coast, to just east of The Dalles, OR), along with an easterly component to the 850 mb wind. The 12Z KSLE sounding showed the top of an inversion around 800 mb. While the atmosphere was not primed for strong downslope winds, there were enough elements in place to provide both strong gap winds through the Columbia River Gorge, and at least some easterly downslope wind in the Cascades and Cascade foothills. Notice the wind speed bulls-eye of 29 kt at KTTD, which is located at the western edge of the Columbia River Gorge. Hourly wind speed observations from KTTD on 1/23/08 never fell below 27 kt, with a peak gust of 40 kt occurring at 11z. Meanwhile, notice that much of the Cascades, Cascade foothills, and even the west slopes of the central Oregon Coast Range were experiencing 10-20 kt of easterly winds. Figure 2 shows the observed wind at 12Z on January 23rd, which showed the best mix of easterly gap winds, and downslope winds across the higher terrain.

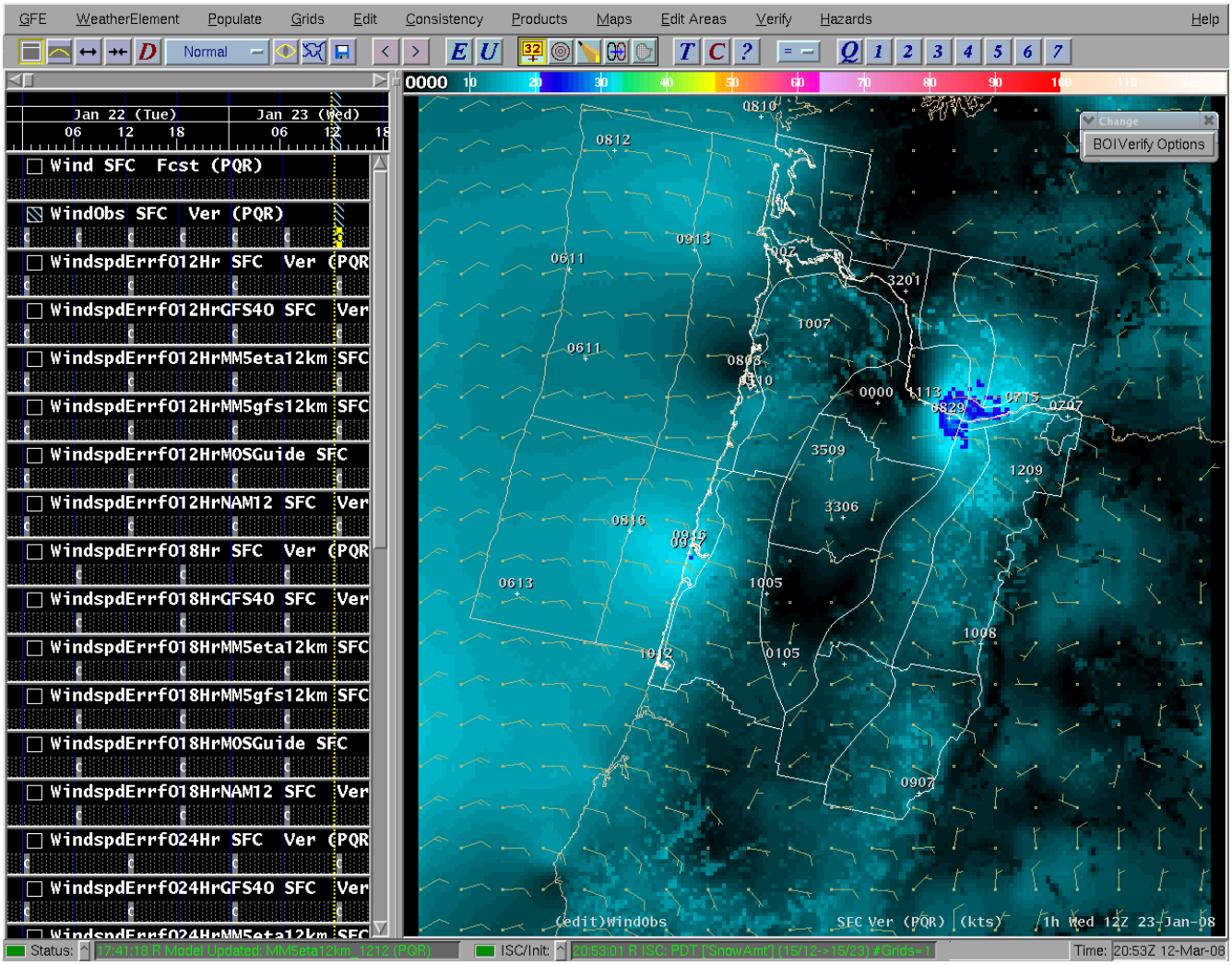

Figure 2. Observed wind at 12Z on 1/23/08. This date, and time, showed the best mix of easterly gap winds in the Columbia River Gorge and downslope winds across the higher terrain of the Coast Range and the Cascades.

Verification:

Winds over the marine forecast zones were not considered in this case because buoys 46029, and 46050 were not operational at the time. The 12hr official forecast, verifying at 12Z on January 23rd (Fig. 3) shows that forecast wind speeds across much of the forecast area were up to 10 mph too high. This was especially true for areas in the Cascades and Cascade foothills, south Willamette valley, and the north Oregon coast range, where errors were upwards of 5 mph too high. Forecasts for areas prone to gap winds such as Troutdale, Oregon (KTTD), near the mouth of the Columbia River Gorge, and Newport, Oregon (KONP) on the Oregon coast, were under-forecast by the same magnitude.

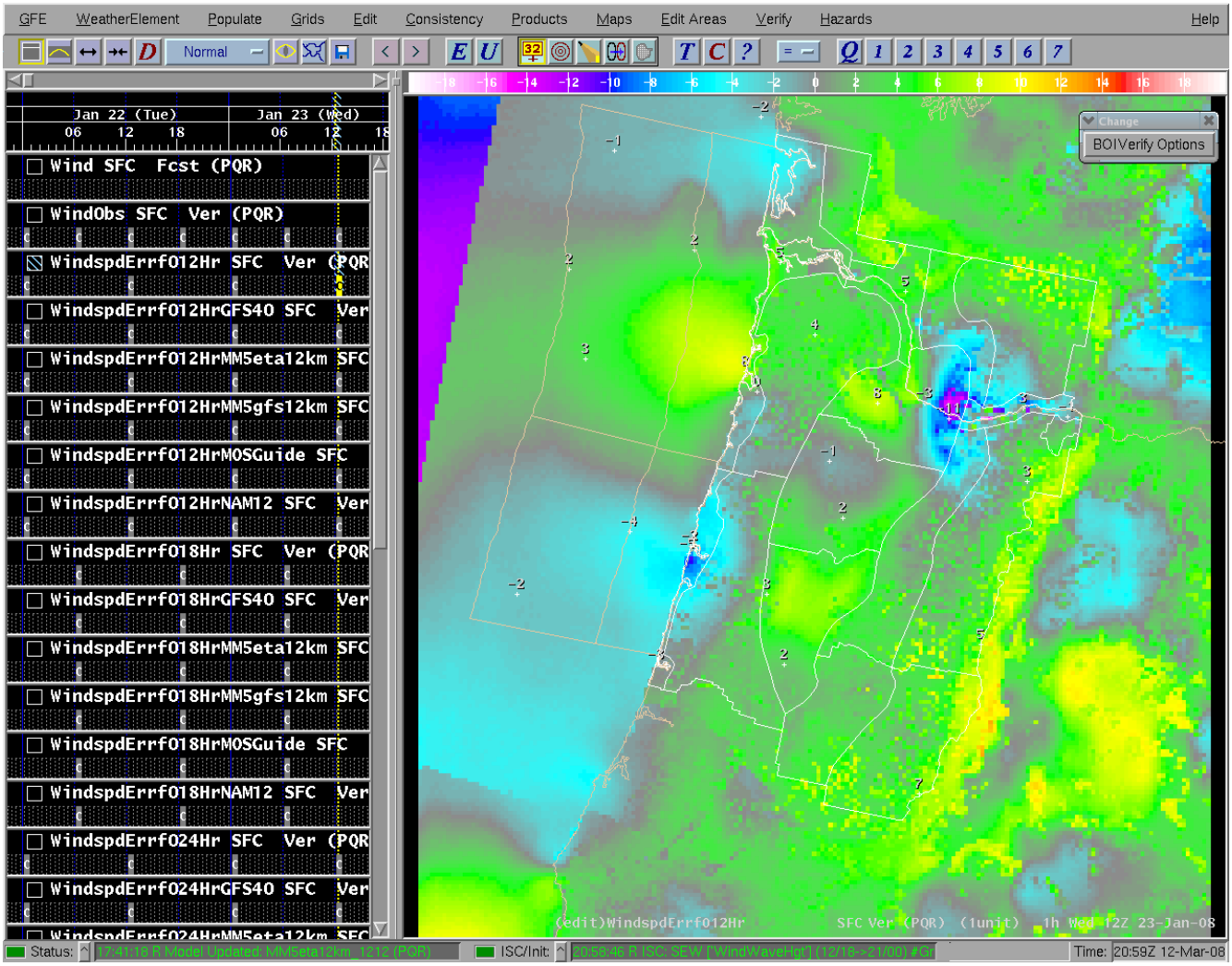

Figure 3. Errors in the official forecast, verifying at 12z on 1/23/08. Notice the overestimation of wind speeds across much of the forecast area, while gap wind areas were underestimated.

For a one day period, histograms produced by BOIVerify showed that the Mean Absolute Error (MAE) for the official 12 and 24 hr forecasts, verifying on the 23rd, were 2.44 and 2.19 kt respectively. Looking at a two day period ending on the 23rd, MAE for the 12 and 24hr forecasts jumped to 5.64, and 5.65 kt respectively. While WFO Portland forecasters produce high biased wind speed forecasts, they are not alone. For this offshore flow case, the official forecasts were compared to those produced by the GFS40, Gridded MOS guidance, the 12km NAM, and the "12km ETA" (actually the 12 km NAM) and GFS versions of the MM5. All guidance produced a high bias, save the MOSguide product which had a near-neutral, or slightly negative bias. Bias values for the 12-36 hr official forecasts and all guidance except MOSGuide ranged from +1.68 kt to +6 kt. MOSGuide had a -2.43 bias.

3. March 10, 2008

Synoptic Setup:

On March 10th, 2008, gale force winds spread across the Oregon coastal waters accompanying a front associated with a strong surface low over the northeast Pacific. This front was well advertised, and guidance had a relatively good forecast of winds that would affect the coastal waters and the Oregon coast. A 500 mb upper level low was associated with this system and centered near 45N, 140W as of

12Z on March 10th. A downstream 500 mb ridge axis was over eastern Washington and Oregon. The front made landfall between 21Z March 10th and 00Z March 11th, and moved east of the Cascades by 03Z on March 11th.

Data:

For this particular case the winds over WFO Portland's marine forecast area were included in the BOIVerify statistics. Buoys 46029 and 46050 returned to a fully functional state several days before; after being sent adrift by an intense and prolonged storm in early December 2007. Examination of the verification data shows the trend to over-forecast seen in the east wind case is similar in this case. In figure 4 (21Z observations from 3/10/08) notice that the buoys located just offshore from the mouth of the Columbia River, and west of Newport Oregon show sustained wind meeting low-end small craft advisory criteria. Gale force winds show up farther offshore. Inland the darkest colors, which encompass a large portion of the inland forecast area, represent sustained winds that are less than 5 kt. MAE values for the 24 and 36 hr wind speed forecasts verifying on March 10th were quite large for this event, especially with regard to the official forecasts that were issued (Figure 5). In fact the mean absolute error for the official 24 hr forecast for the inland portion of the CWA was 9.55 kt. When both inland and coastal water areas are included the error rises to almost 14 kt.

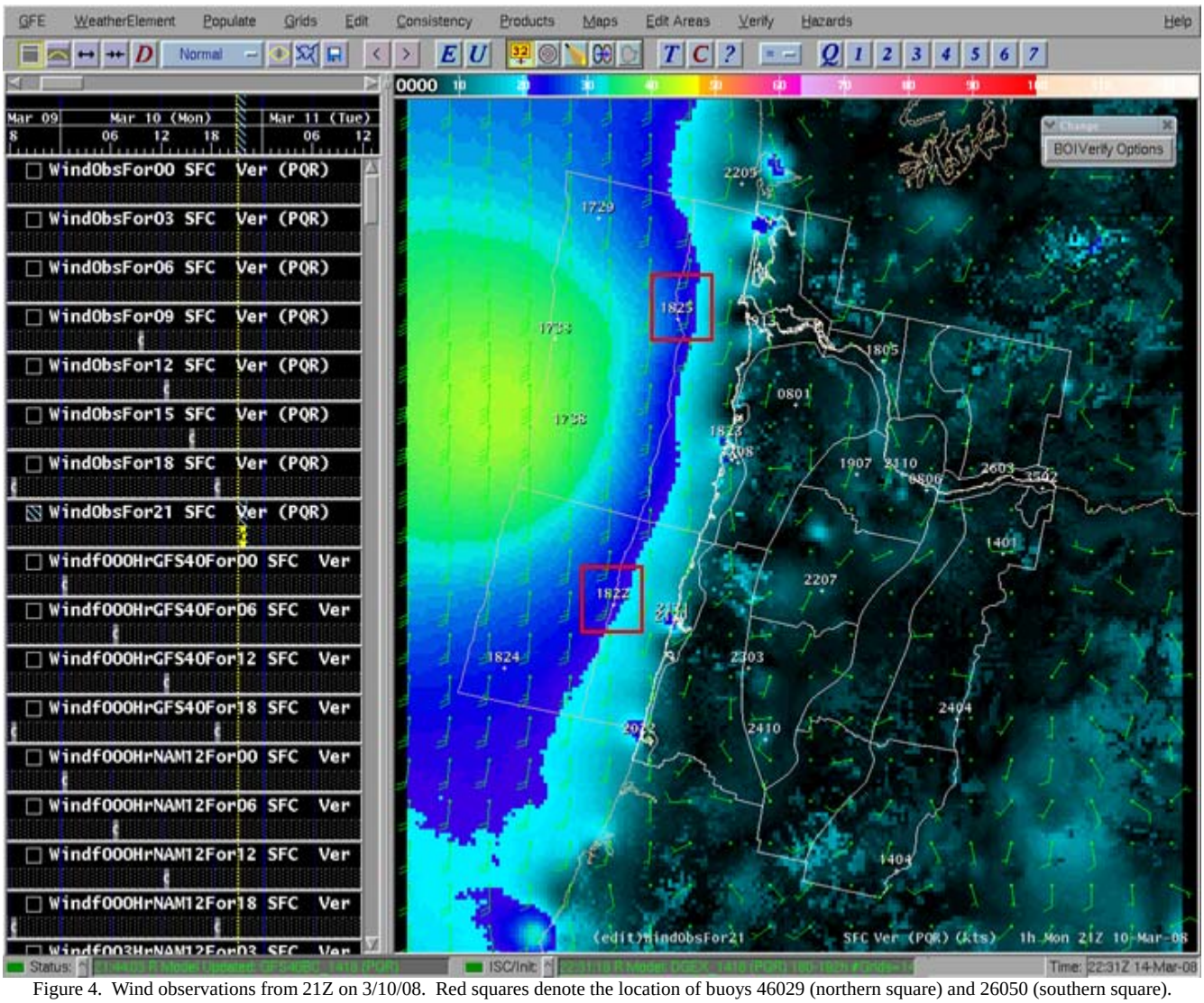

Figure 4. Wind observations from 21Z on 3/10/08. Red squares denote the location of buoys 46029 (northern square) and 26050 (southern square).

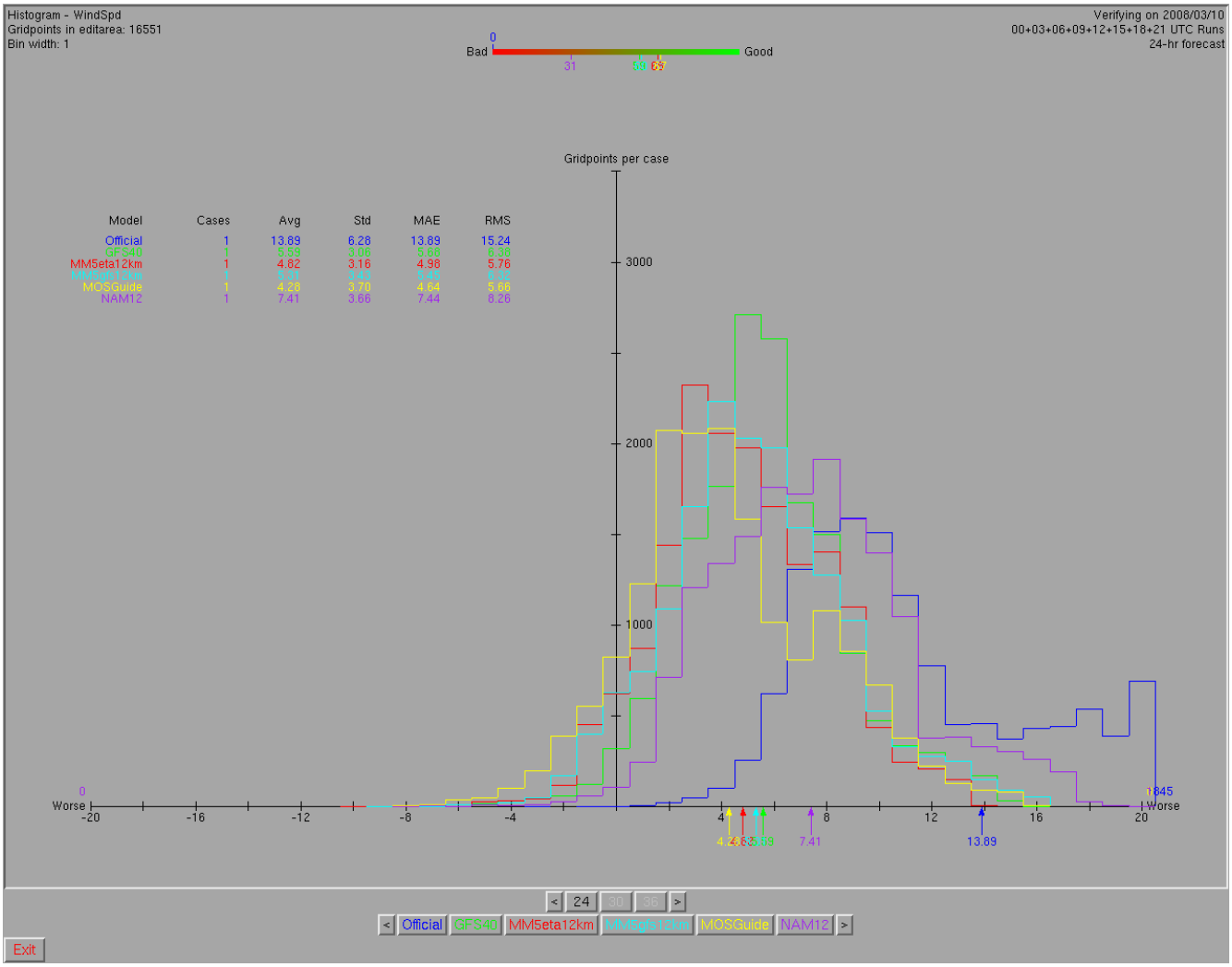

Figure 5. Error histogram showing MAE and bias values for both the land and marine grids, for various 24hr model forecasts verifying on 3/10/08.

4. Summary

The overall trend in official sustained wind forecasts issued by WFO Portland is to overestimate wind speeds in forecasts that are issued within 24 hours of a particular event, as well as those that are issued 36 hours, 48 hours, and beyond. A glimpse of this bias has been shown in the two cases examined. With regard to performance, MOSGuide generally had the lowest MAE values and biases for the two cases illustrated. MOSGuide was followed by the GFS40, which was followed in performance by the 12km GFS and ETA versions of the MM5. Official wind speed forecasts issued by WFO Portland occupied "last place," and showed the most consistent high bias of the group.

5. Conclusion

It is possible that the less than optimal observation network across the high terrain of the Cascades, and over the coastal waters, has slightly skewed the numbers that BOIVerify has produced. While this is true to some extent, a definitive trend to over-forecast sustained winds is still evident when only sampling edit areas that contain more dense observation networks such as the Willamette River valley.

Forecasters should be aware of their tendency to over-forecast sustained winds, as well as take in to account the high bias that most guidance appears to have, when creating their forecasts. While local studies, long-standing rules of thumb, and forecaster experience can certainly produce reasonable wind forecasts, there is still room for improvement. No singular approach to the creation of official wind grids will work for every event. Perhaps using the MOSGuide sustained winds as a starting point and making adjustments based on forecaster knowledge of the influence of the local terrain will produce more accurate wind speed forecasts in the future.