

Catching Up To a Big Temperature Change

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A very potent late-season cold front passed through the Boise forecast area late in the afternoon of April 14th 2008. This storm did not produce much precipitation, but the change in temperature between April 14th and April 15th was very dramatic. Warm temperatures over the previous few days meant that many sensitive plants were blooming, and there was much concern about the impact of cold temperatures on fruit trees, sprinkler systems, etc. The Official forecasts were particularly good during the last two days leading up to the event. However, all the models and forecasts made before that point had difficulty forecasting this large change. This study will look closely at the guidance available during these periods, to see if there were any signals that might have helped us 'catch on' to the large temperature change earlier.

Observations:

The observed Max Temperature grids from Monday, April 14th and Tuesday April 15th show the huge drop in temperatures experienced nearly everywhere across the forecast area (Figure 1):

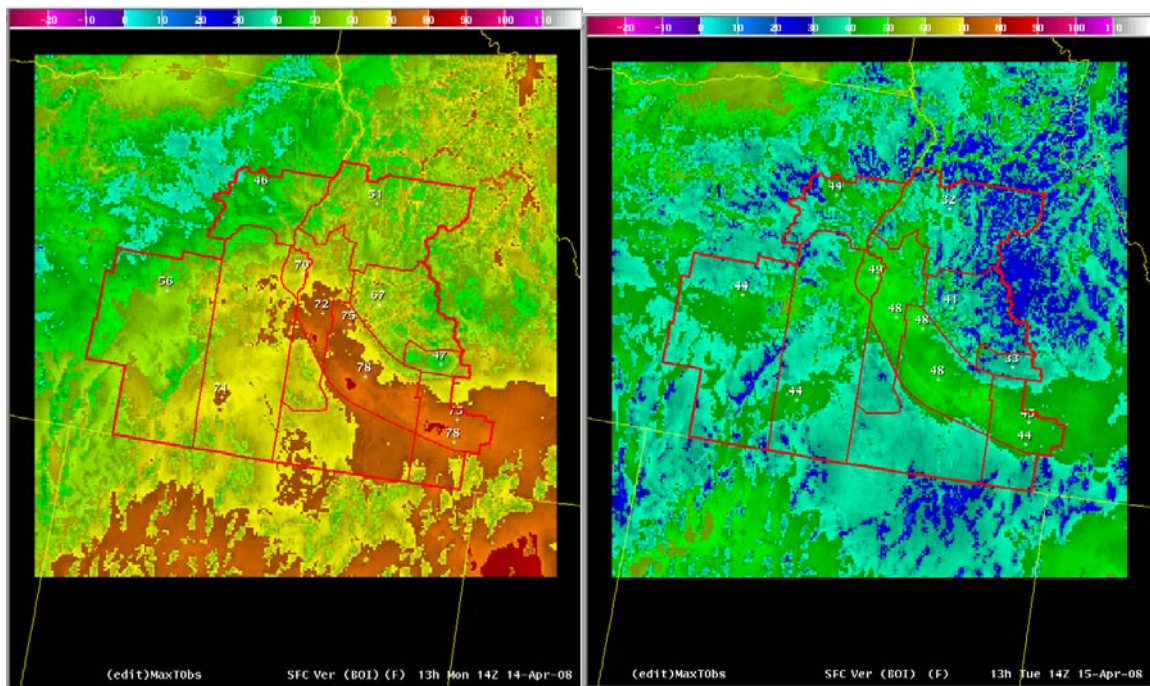


Figure 1. Observed Max Temperature grids on April 14th and April 15th, 2008.

The BOIVerify gridded verification summary highlights the magnitude of the change (Figure 2):

MaxT Verification Summary for Tue, Apr 15:

Grid Time: start: Tue, Apr 15 14Z end: Wed, Apr 16 03Z

Edit Area: Populated_Areas (6249 gridpoints)

Measures of Difficulty:

Avg Anomaly: -17.33 Avg |anomaly|: 17.33 Rank: 1 out of last 30
 Avg 24hr Chg: -22.45 Avg |24hr Chg|: 22.45 Rank: 1 out of last 30
 Standard Deviation: 4.06 Rank: 23 out of last 30

Figure 2. MaxT Verification Summary for Tuesday, April 15th, 2008.

This summary is only calculated over 6249 gridpoints that we consider “populated areas” where the observed temperature grids are deemed ‘reasonable’. Note that for the 15th, the average anomaly was more than 17 degrees below normal, and that the average 24 hour change was more than 22 degrees! This was, indeed, a very significant change.

The BOIVerify gridded verification summary also highlights how the Boise forecasts verified, as well as the model forecasts leading up to the event (Figure 3).

Period	Forecast Made	MAE	Bias	Official		Official Rank among Guidance	Best Guidance	2nd Best Guidance	Worst Guidance
				Official >10° Err	Official <3° Err				
1	14-hr Tue 4/15 mid	1.07	-0.54	0.0%	97.0%	2 out of 19	GFS40BC 97.1%	ADJMETBC 96.4%	SREF 5.6%
2	26-hr Mon 4/14 day	1.50	-1.05	0.0%	89.5%	6 out of 19	ADJMETBC 97.3%	SREFBC 95.4%	SREF 5.0%
3	38-hr Mon 4/14 mid	1.07	0.42	0.0%	97.5%	2 out of 19	SREFBC 98.1%	NGM80BC 96.5%	NGM80 0.7%
4	50-hr Sun 4/13 day	1.15	0.74	0.0%	97.2%	2 out of 17	ADJMETBC 97.9%	MOSGuideBC 91.5%	SREF 8.4%
5	62-hr Sun 4/13 mid	3.84	3.84	0.0%	32.4%	10 out of 15	ADJMEXBC 86.3%	ADJMAVBC 86.2%	SREF 8.7%
6	74-hr Sat 4/12 day	6.31	6.31	3.4%	2.9%	17 out of 17	NAM12BC 93.5%	ADJDGXBC 83.7%	ADJMAV 6.2%
7	86-hr Sat 4/12 mid	7.59	7.59	6.9%	0.4%	13 out of 13	GFS40 85.1%	ADJMEXBC 77.4%	ADJDGX 3.1%
8	98-hr Fri 4/11 day	13.07	13.07	90.5%	0.0%	11 out of 11	GFS40 47.1%	ADJMEXBC 24.2%	MOSGuide 0.0%
9	110-hr Fri 4/11 mid	18.04	18.04	100.0%	0.0%	10 out of 11	DGEXBC 22.8%	DGEX 18.0%	ADJMEX 0.0%
10	122-hr Thu 4/10 day	18.04	18.04	100.0%	0.0%	10 out of 11	DGEX 34.4%	DGEXBC 26.3%	ADJMEX 0.0%
11	134-hr Thu 4/10 mid	18.12	18.12	100.0%	0.0%	11 out of 11	GFS40 40.2%	GFS40BC 24.5%	DGEX 0.0%
12	146-hr Wed 4/9 day	18.12	18.12	100.0%	0.0%	9 out of 11	ADJDGXBC 0.7%	DGEXBC 0.0%	ADJMEX 0.0%
13	158-hr Wed 4/9 mid	15.12	15.12	99.0%	0.0%	9 out of 11	DGEX 12.7%	DGEXBC 9.6%	ADJMEX 0.0%
14	170-hr Tue 4/8 day	15.12	15.12	99.0%	0.0%	10 out of 11	GFS40 16.8%	DGEXBC 12.6%	ADJMEX 0.0%

Figure 3. MaxT Verification Summary for Tuesday, April 15th, 2008. Percentages next to model names are percent of forecasts with errors less than 3 degrees F.

During the last four forecast packages (from the April 13th dayshift through the April 15th midshift), the Official forecasts were particularly accurate with nearly 90% of the populated areas gridpoints having errors of less than 3 degrees. Given such a massive 24-hour change, this is quite astounding. Note also that for these last four packages, the average bias over these gridpoints is nearly zero (and in some cases a little on the cold side). This is quite impressive with a big temperature drop. The normal forecast tendency is to be “too conservative”, forecasting a less drastic drop than actually occurs, which usually leads to positive biases. The official forecasts within the last 2 days before the event were a great success!

However, before these last 4 periods, the official forecasts struggled. Almost all the forecasts made from the April 8th dayshift through the April 12th dayshift, were worse than nearly all the guidance grids available at the respective times (at least in terms of the percentage of gridpoints with errors less than 3 degrees). Since this turned out to be such a huge temperature change, it is not surprising that the forecasts struggled. However, it is interesting that, starting with the midnight shift on April 10th, there WERE some guidance sources that had significant number of gridpoints with errors less than 3 degrees,

while the official forecasts did not. Thus, we wanted to investigate these forecasts more closely, to see if there were clues that these guidance sources would turn out to be correct.

April 9th dayshift

At this time, the model forecasts were essentially 'all over the map'. For example, Figure 4 shows the grids associated with the highest and lowest ensemble MOS guidance values from the 00Z run on the April 9th (this is the last run of the Ensemble MOS Guidance available during the April 9th dayshift):

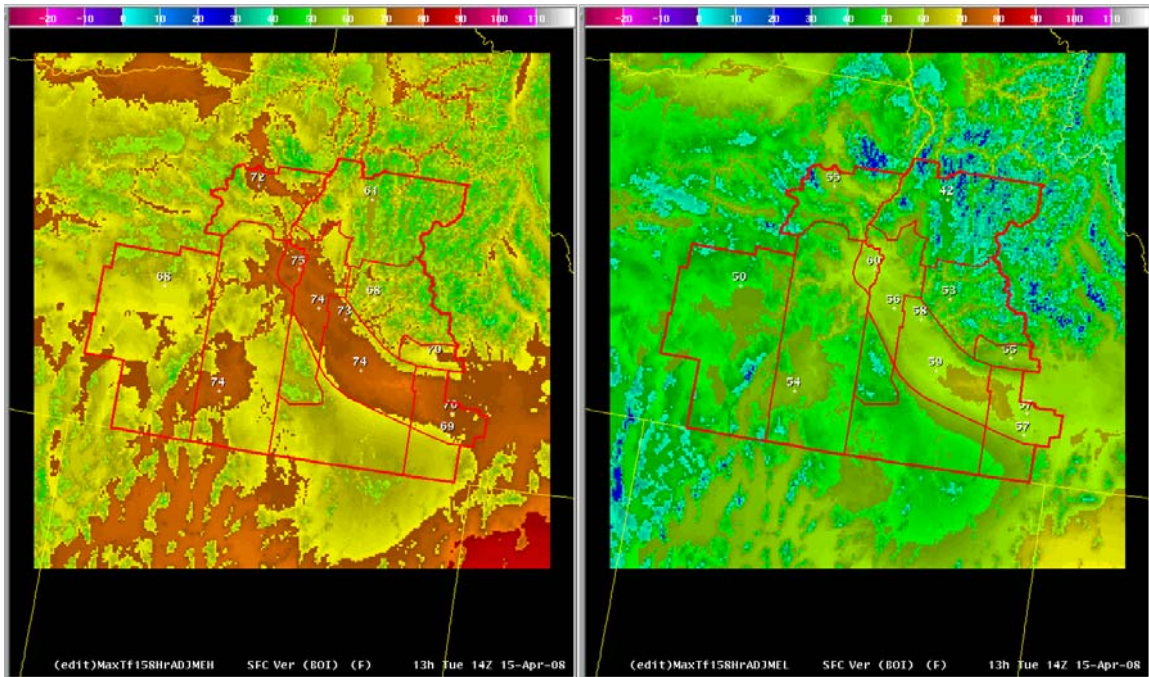


Figure 4. Highest and Lowest Ensemble MOS guidance from April 9th, 00Z run.

This is an unusually large range among the Ensemble MOS values. The Boise gridpoint, the MaxT forecast for April 15th ranged from 73 to 58. The ensemble mean grid showed a value of 67 degrees at Boise (Figure 5):

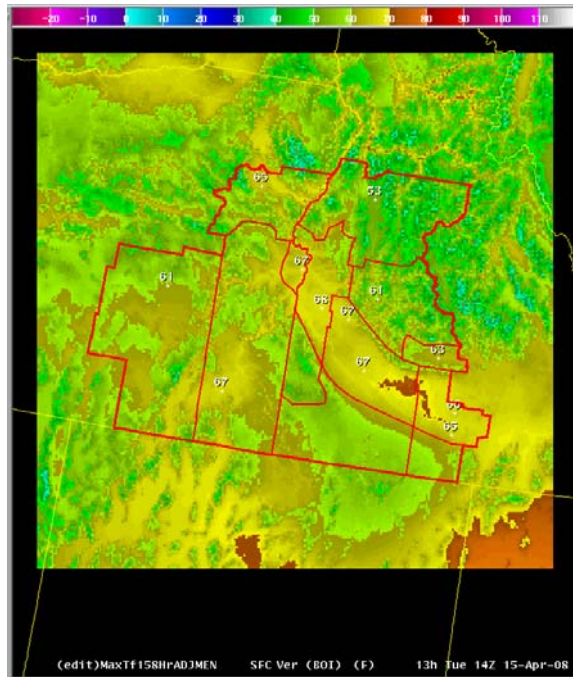


Figure 5. Mean Ensemble MOS Guidance from April 9th 00Z run.

Give this large uncertainty, it is not unreasonable that the official forecast would tend to be near the Ensemble Mean, and indeed it was (Figure 6):

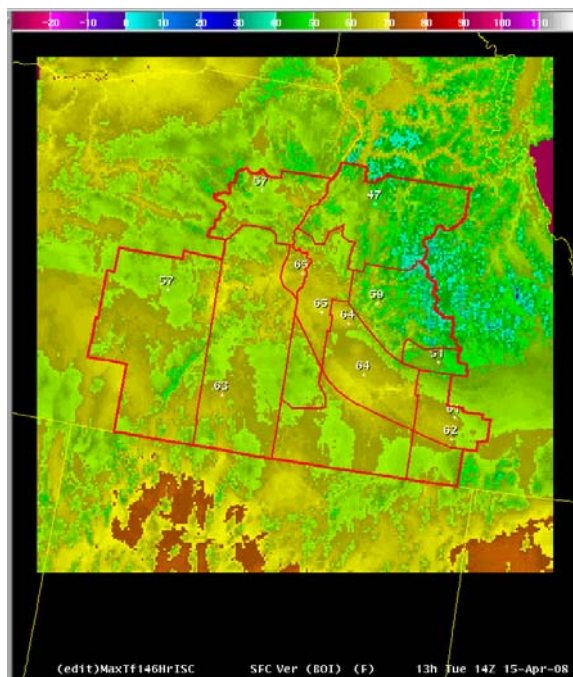


Figure 6. Official and ISC forecast for April 15th MaxT made on April 9th dayshift.

The coordination among neighboring offices is outstanding here, and the official forecasts is slightly on the 'cool side' of the ensemble mean. While the forecasts don't indicate the huge change that will occur, they are trending toward a cooler solution than that proposed by the Ensemble MOS mean.

April 10th dayshift

Once again, the Ensemble MOS guidance from the 00Z run on the 10th had a large range of values (Figure 7):

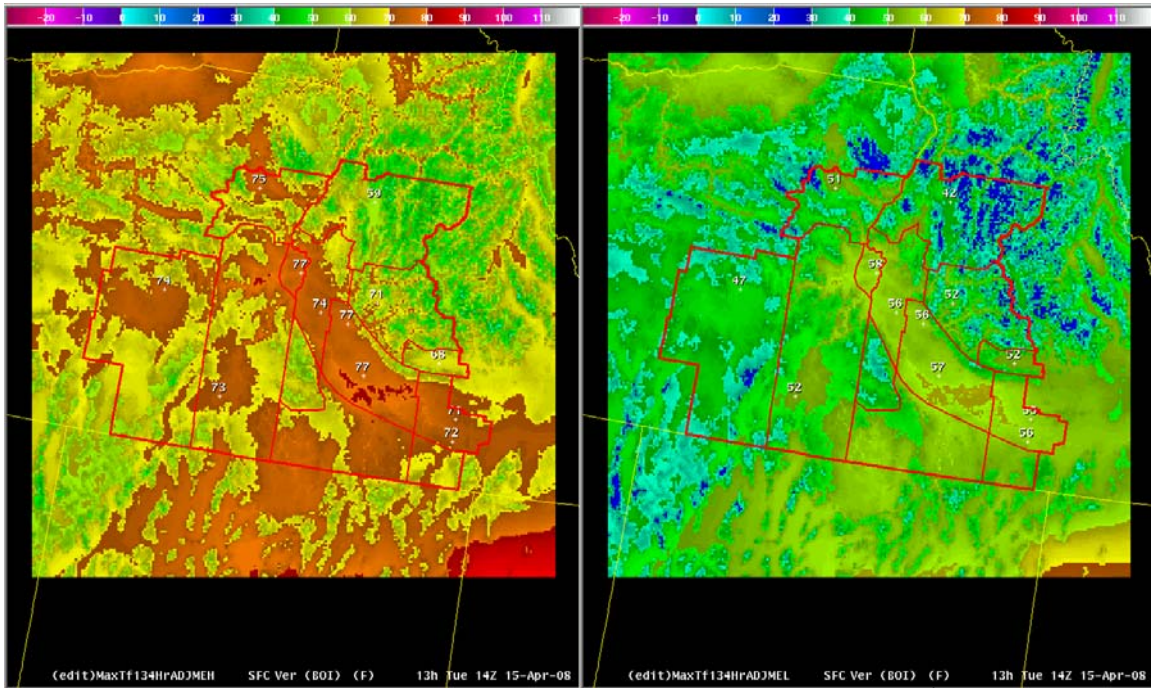


Figure 7. Highest and Lowest Ensemble MOS guidance from April 10th, 00Z run.

The range at the Boise gridpoint still ranges from 77 to 56. This is even a larger range than Ensemble MOS had on the previous day, and the highest value has INCREASED from 73 to 77! The Ensemble Mean grid stayed nearly the same as the previous day; increasing a little along the eastern portions of the forecast area, and decreasing a little along the western portions of the forecast area (Figure 8):

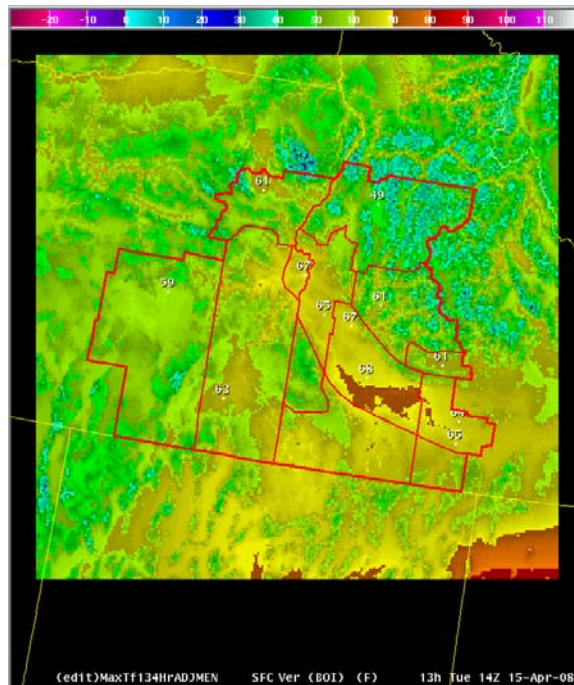


Figure 8. Mean Ensemble MOS Guidance from April 10th 00Z run.

The GFS runs were still bouncing around between a solution where a trough would have moved through our forecast area, and a solution where the trough would still be to the west of our forecast area. It turns out that the 12Z run on the 10th had a splitting trough just slightly west of the forecast area (Figure 9):

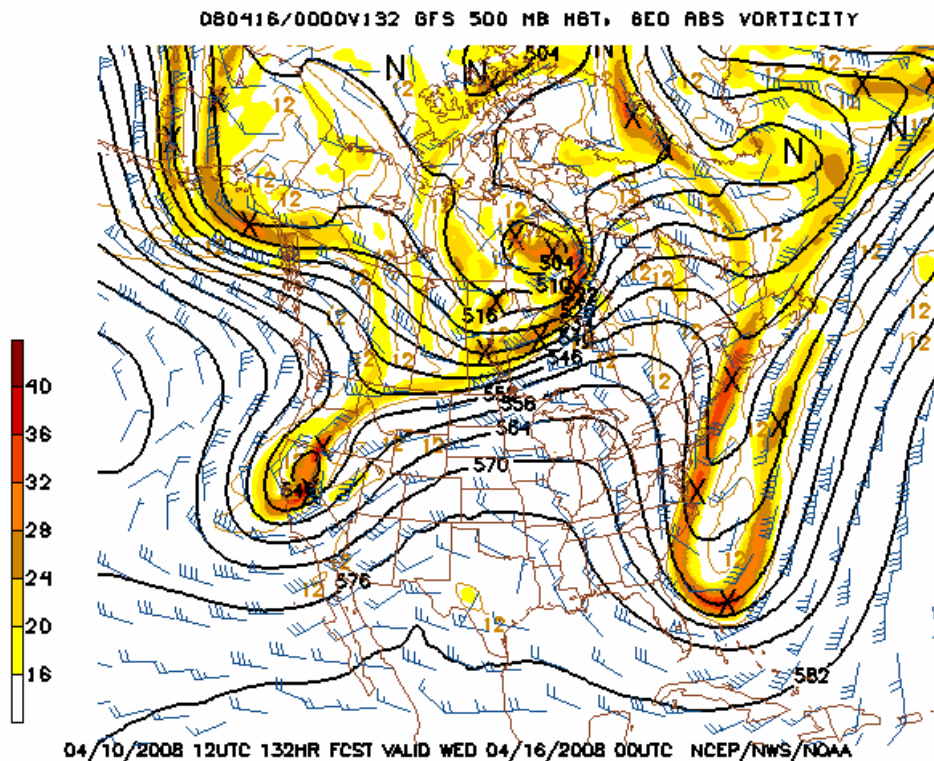


Figure 9. April 10th 12Z GFS forecast of 500mb heights and vorticity for the afternoon of April 15th.

With this upper-level solution, the GFE smartInit came up with rather cool temperatures over the Boise Forecast area, with only upper 50s around Boise, and temperatures in the 40s along the western border of the forecast area (Figure 10):

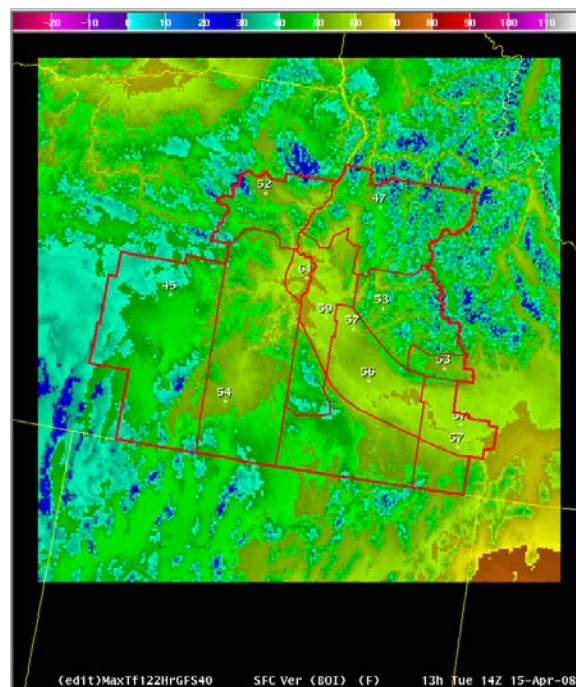


Figure 10. April 10th 12Z GFS40 MaxT forecast for April 15th.

Other guidance, such as the MOSGuide grids, and the various Bias Corrected grids also had much cooler temperatures than the ensemble mean available from the 00Z runs. However, the 12Z MEX guidance was still quite warm, with the max temperature at Boise forecast to be 63 degrees.

Given all this uncertainty, the forecasters in Boise decided to modify the MaxT grid only very slightly (Figure 11):

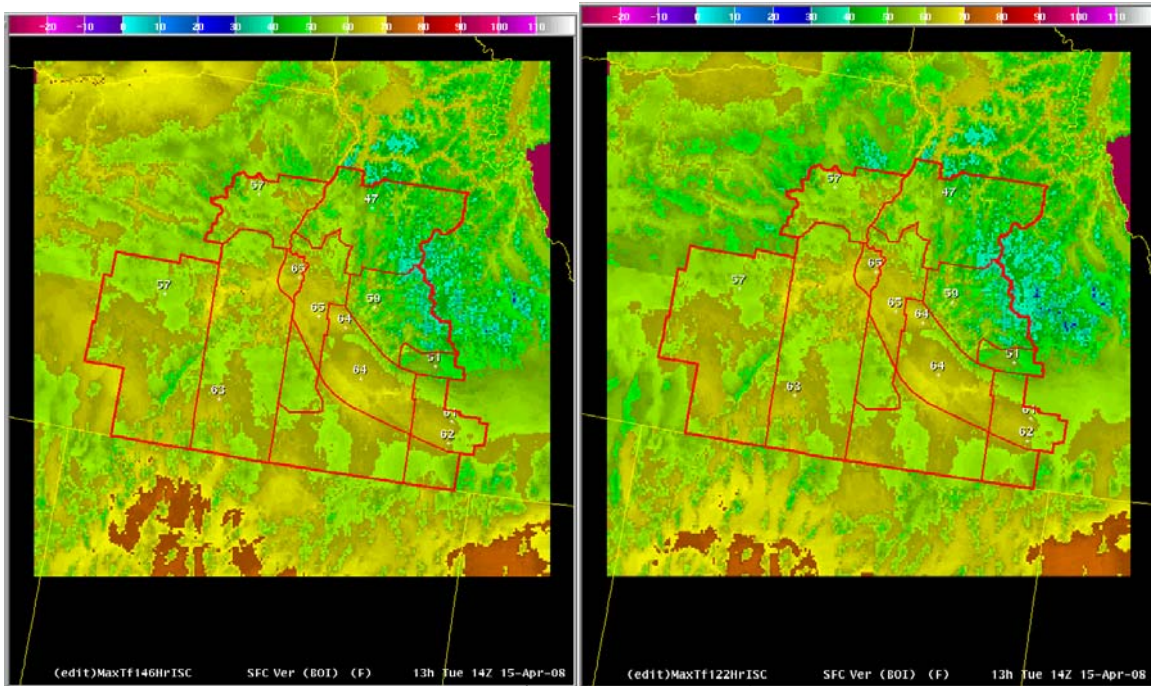


Figure 11. ISC forecast of MaxT for April 15th made on April 10th midshift (left) and dayshift (right).

Note that forecasters at Pendleton and Medford dropped the temperature forecast somewhat for this period, whereas offices to the east did not. However, even with this drop, the values over Pendleton's and Medford's forecast area are ABOVE the guidance available from the 12Z run.

All of this seems quite reasonable. We know from what finally occurs, that the 12Z runs on the 10th turned out to be much closer to the final observations – but it was difficult for forecasters to commit to that solution at this time – given the large range among the ensembles and the way that the GFS solution has flipped back and forth over the past few runs.

April 11th dayshift

The 00Z Ensemble MOS from 00Z on the 11th continued to show a very large range (note that at Boise, it ranged from 72 to 52, which is the largest range from the last 3 days). However, note that both the highest ensemble member, and lowest ensemble member, have both cooled (Figure 12):

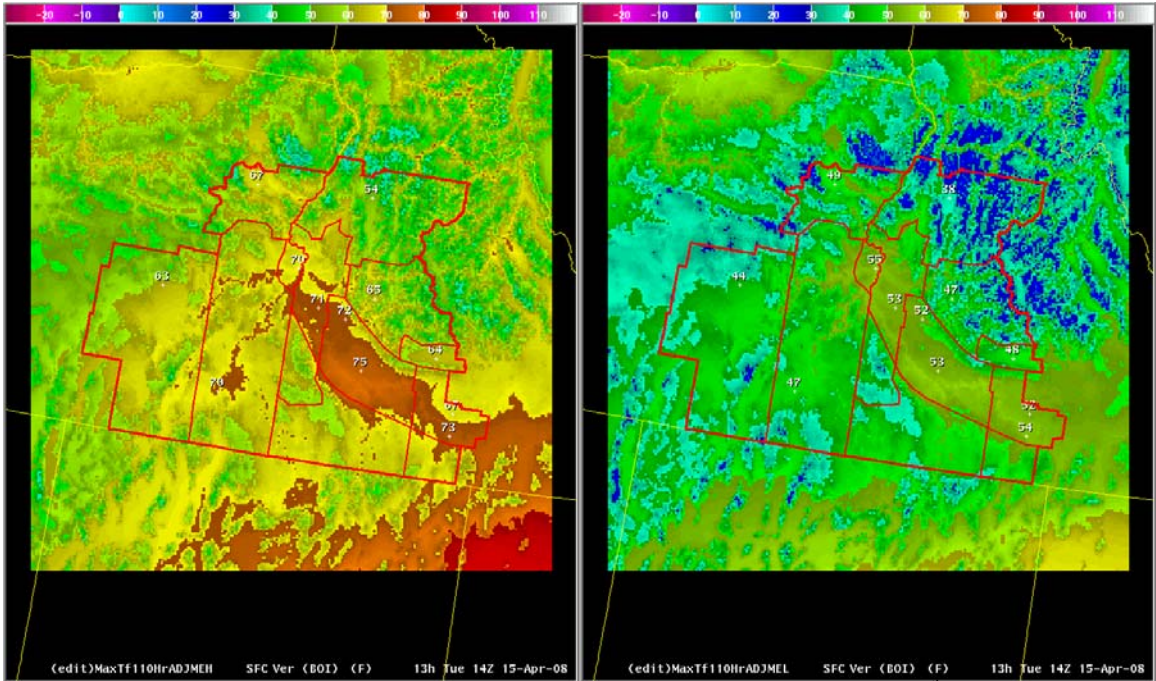


Figure 12. Highest and Lowest Ensemble MOS guidance from April 11th, 00Z run.

In addition, the Ensemble mean has cooled as well, with the forecast value for Boise dropping from a 67 in the 00Z run on the 10th, to a 61 in the 00Z run on the 11th (Figure 13):

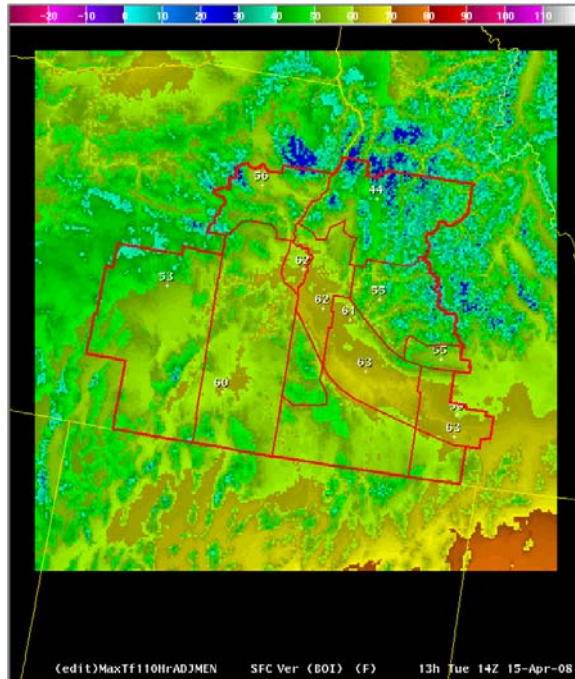


Figure 13. Mean Ensemble MOS Guidance from April 11th 00Z run.

In addition, the 12Z operational run of the GFS showed the trough line well to the east of the Boise forecast area (Figure 14):

080416/0000V10B GFS 500 MB HGT, 6ED ABS VORTICITY

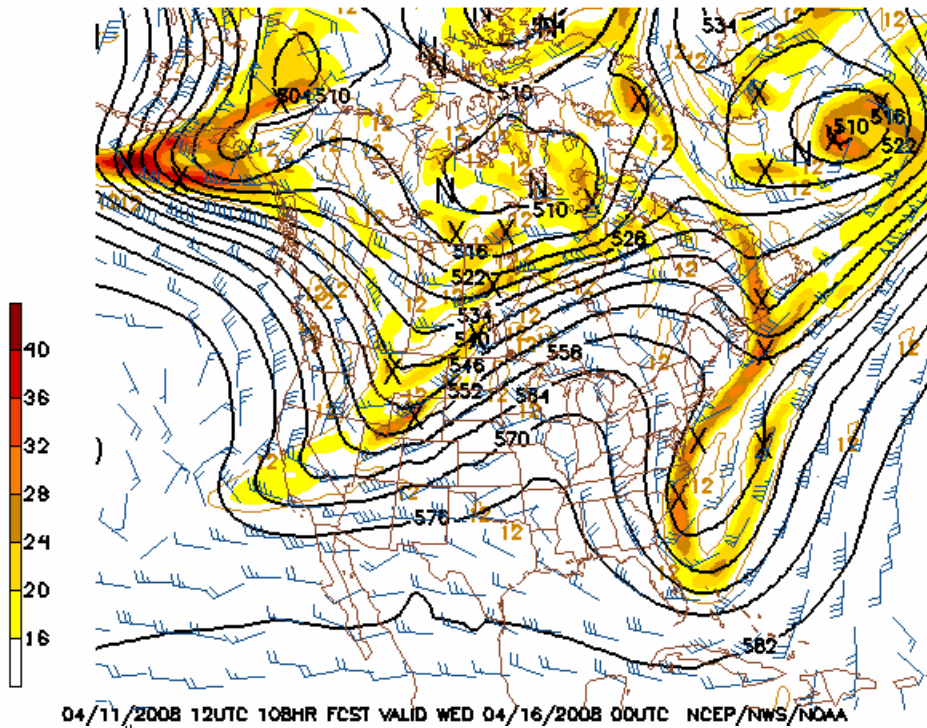


Figure 14. April 11th 12Z GFS forecast of 500mb height and vorticity for the afternoon of April 15th.

As we should expect with this trough line east of the area, the guidance grids from the 12Z run were quite cool. Figure 15 shows the GFS40BC and the MOSGuideBC grids from this run:

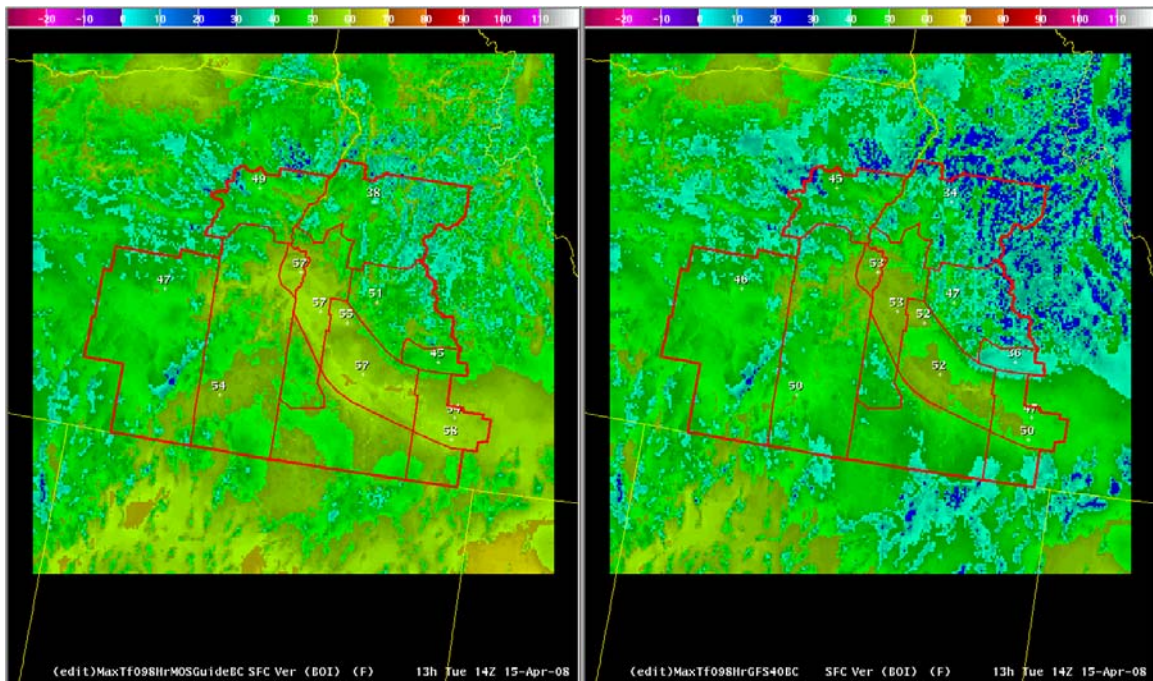


Figure 15. April 11th 12Z forecasts of MaxT for April 15th from GFS40BC (left) and MOSGuide (right).

Other guidance grids were similarly near the low end indicated by the 00Z Ensemble MOS grids. With evidence increasing that a cooler forecast was needed, the Boise forecasters dropped the forecast significantly (Figure 16):

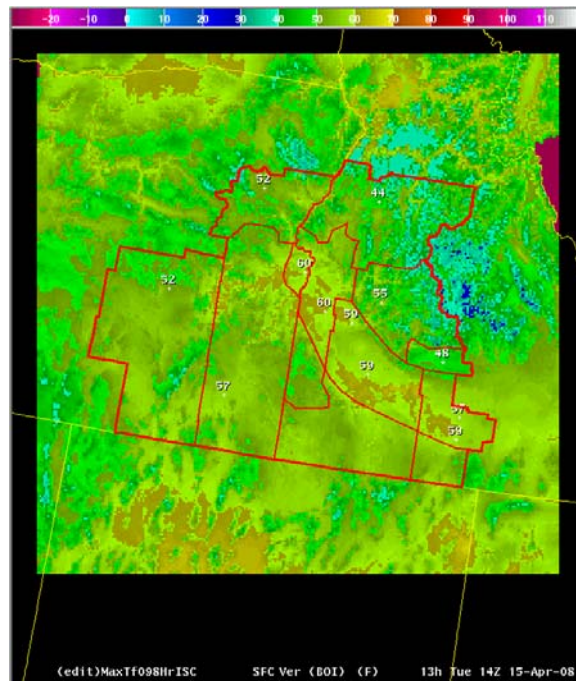


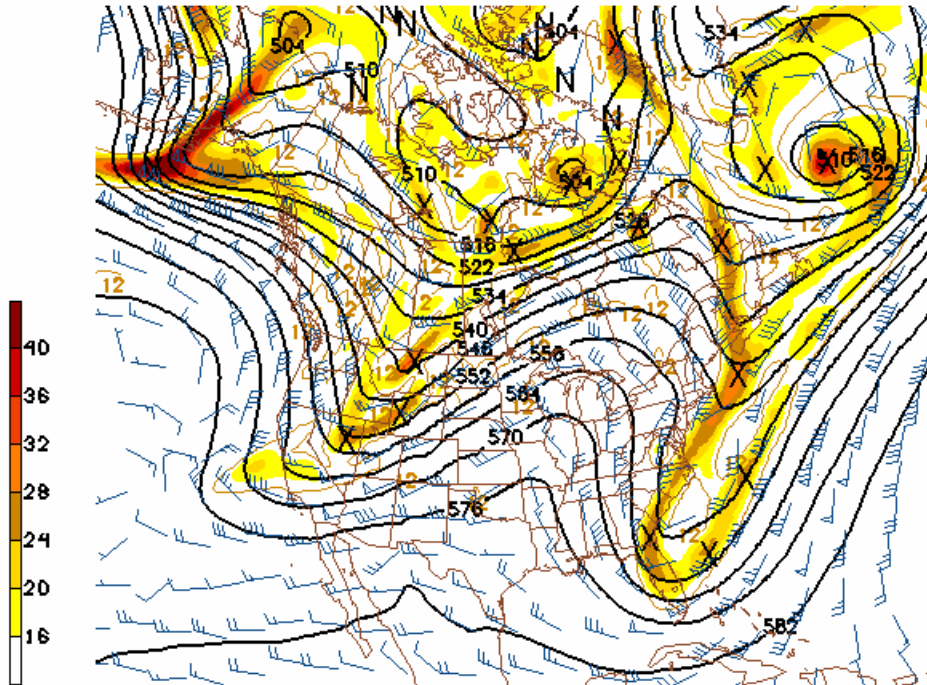
Figure 16. ISC forecast of MaxT for April 15th from the April 11th dayshift.

The forecast value at Boise dropped 5 degrees from 64 to 59, which is similar to the drop indicated by the 00Z Ensemble MOS runs. However, note that this grid is above almost all the guidance available from the 12Z runs. The models seem to be zeroing in on a cooler solution. The 00Z ensembles moved that direction, and the 12Z model runs are going even further, but consensus among the forecasters appears to be that we should come down only as far as the 00Z runs would indicate. This isn't unreasonable. Though the direction the models is heading is clear, we may not want to jump on the extremely cold solution now offered by the 12Z runs.

April 12th midshift

By the midshift on April 12th, two more runs of the operational GFS show the trough to the east of the Boise forecast area (Figures 17 and 18):

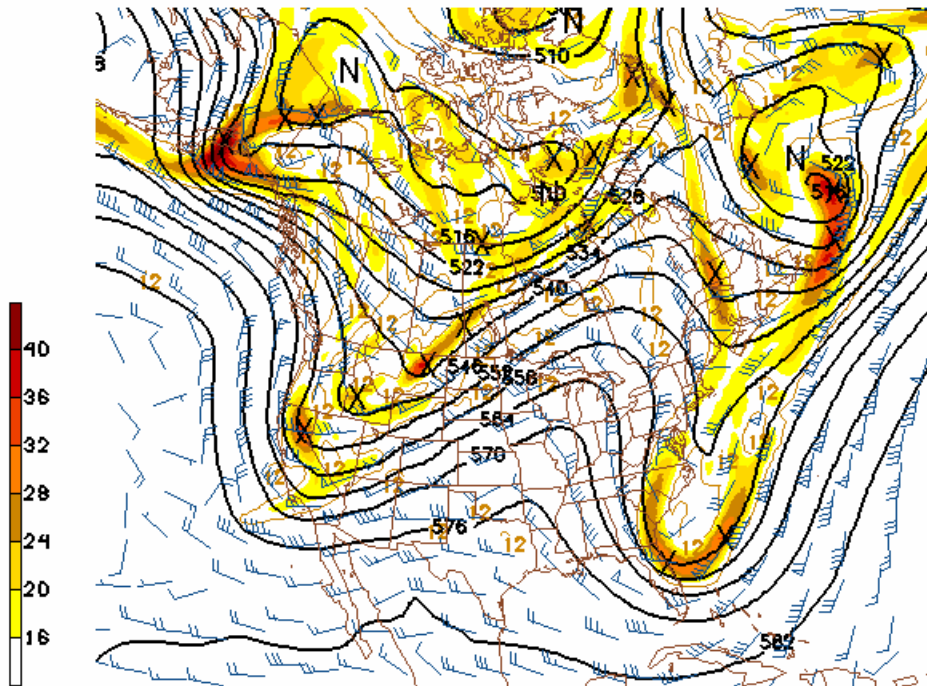
080416/0000V102 GFS 500 MB HGT, 6ED ABS VORTICITY



04/11/2008 18UTC 102HR FCST VALID WED 04/16/2008 00UTC NCEP/NWS/NOAA

Figure 17. April 11th 18Z GFS forecast of 500mb height and vorticity for the afternoon of April 15th.

080416/0000V096 GFS 500 MB HGT, 6ED ABS VORTICITY



04/12/2008 00UTC 096HR FCST VALID WED 04/16/2008 00UTC NCEP/NWS/NOAA

Figure 18. April 12th 00Z GFS forecast of 500mb height and vorticity for the afternoon of April 15th.

The guidance grids from the 00Z run show temperatures even cooler than indicated by the previous 12Z runs (Figure 19):

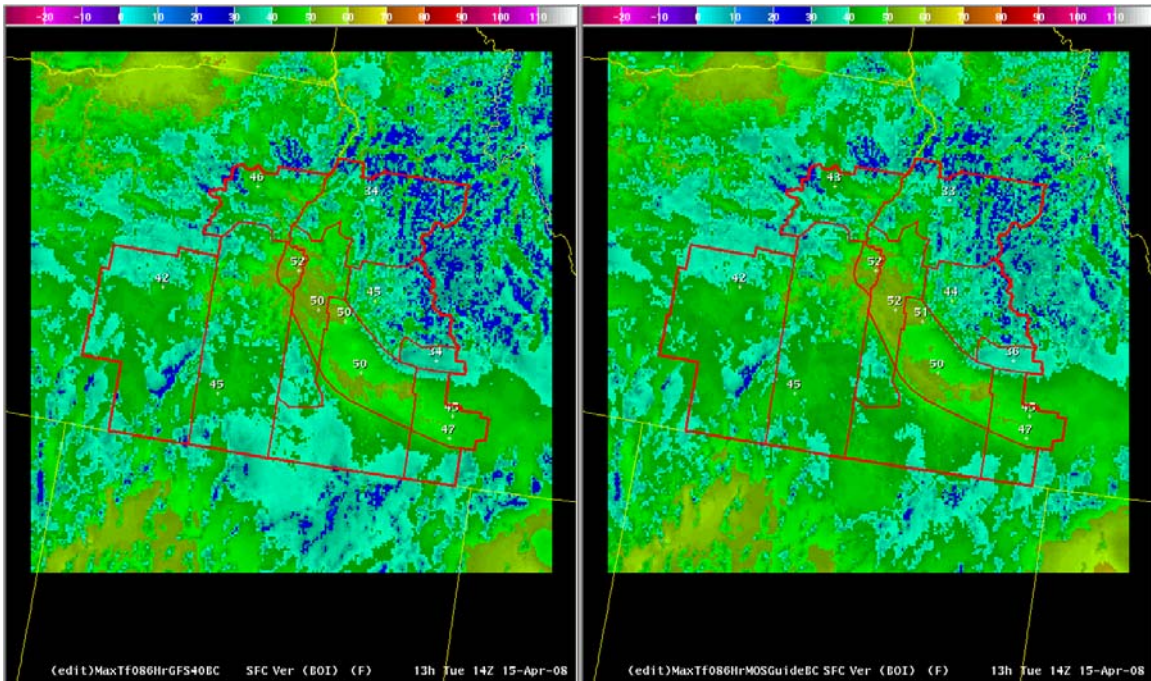


Figure 19. April 12th 00Z forecasts of MaxT for April 15th from GFS40BC (left) and MOSGuide (right).

The models have now been showing a colder solution for several runs. In fact, each successive run is showing a colder and colder solution. The Official MaxT forecast issued on the midshift was lowered an average of 5 more degrees (Figure 20):

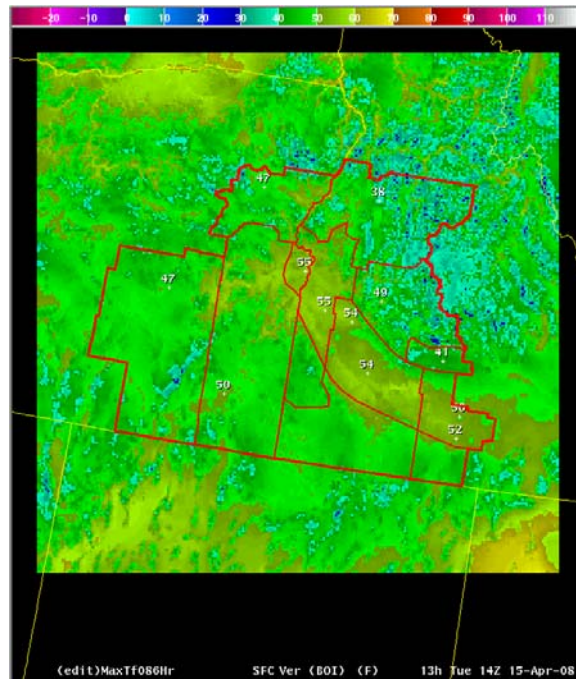


Figure 20. ISC forecast of MaxT for April 15th from the April 12th midshift.

Note that even though models continue to lower the forecast with each run, this forecast still does not come down to the values shown by the latest forecasts. It appears that forecasters are continuing to 'nudge' toward the colder model solutions, but since the model solutions are also continuing to go down, the Official forecast has not yet 'caught up to' what the models are showing.

April 12th dayshift

By the dayshift on the 12th, the output from the 00Z Ensemble MOS runs are available, and FINALLY the models show a much smaller range (Figure 21):

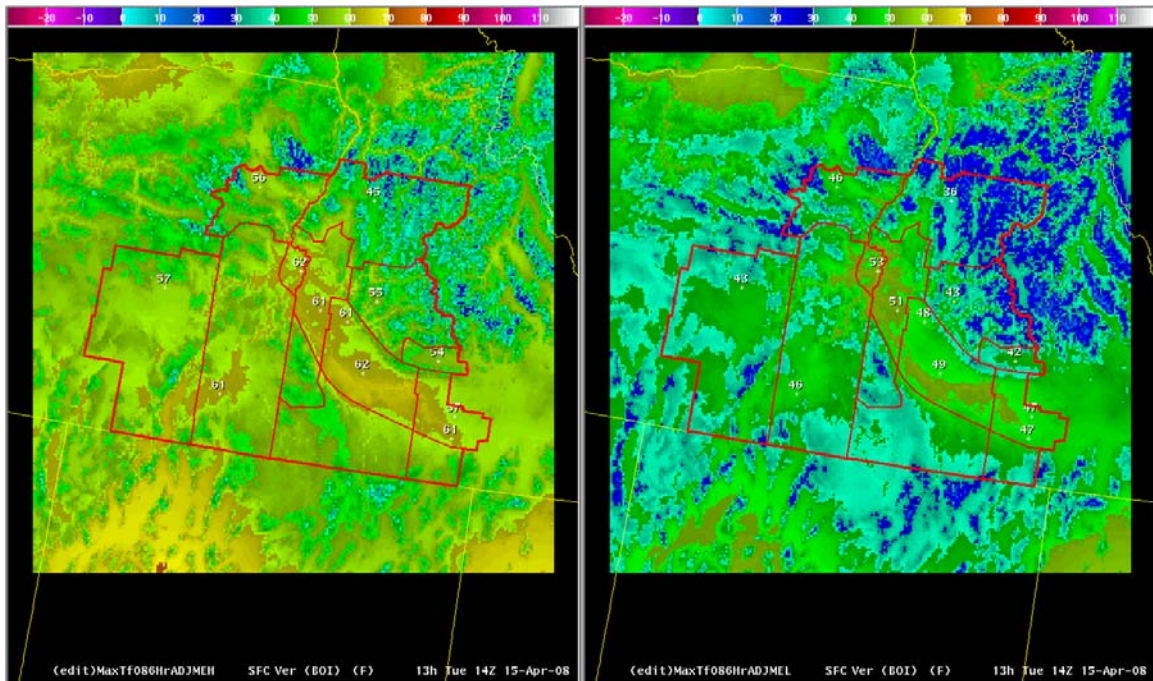


Figure 21. Highest and Lowest Ensemble MOS guidance from April 12th, 00Z run.

And the guidance grids from the 12Z runs show values toward the low end of the range shown by the ensembles:

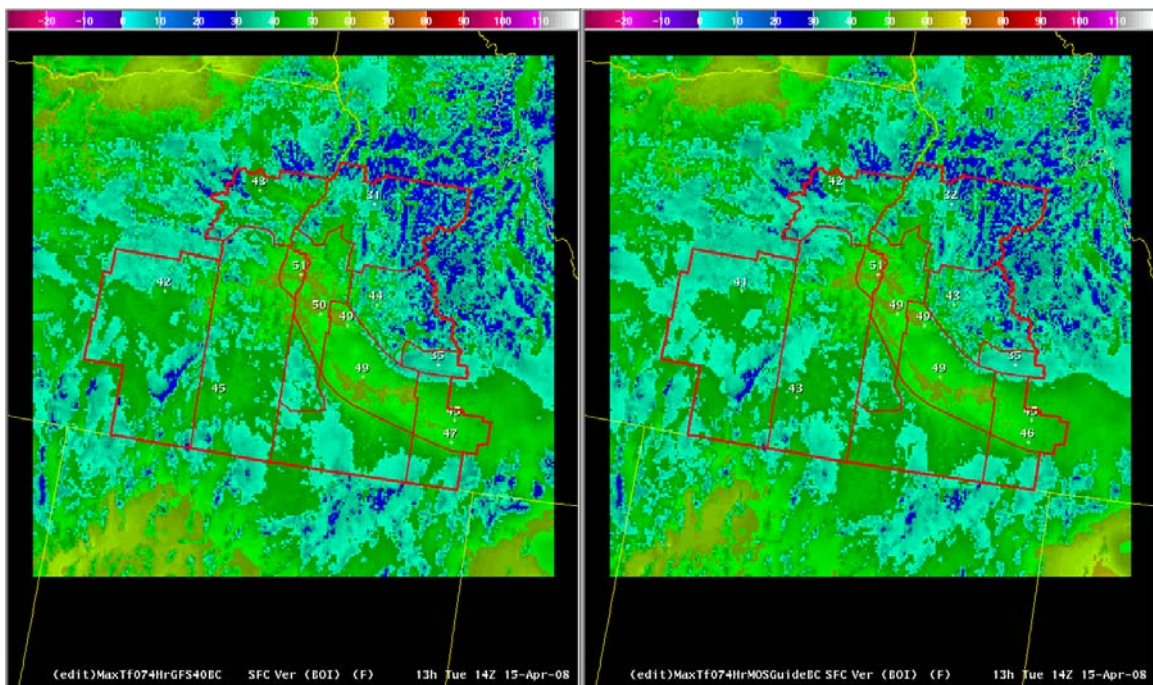


Figure 22. April 12th 12Z forecasts of MaxT for April 15th from GFS40BC (left) and MOSGuide (right).

So, once again, the 12Z model guidance is continuing a trend toward a cooler forecast.

The official forecast issued by the dayshift lowered the temperatures across the forecast area by about another 1 to 2 degrees (Figure 23):

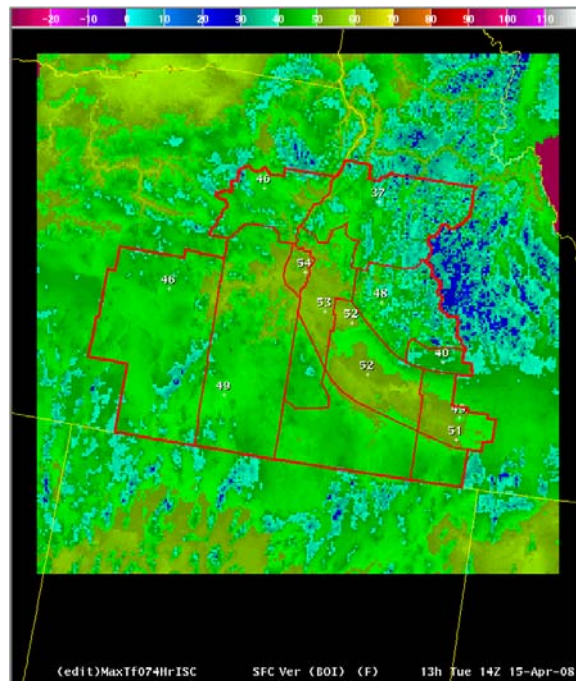


Figure 23. ISC forecast of MaxT for April 15th from the April 12th dayshift.

But once again, even though the forecasts has been lowered, it still remains above the guidance provided by the latest runs.

April 13th midshift

Finally, on the April 13th midnight shift, the Official forecast is lowered a few more degrees, and is finally in line with what the guidance is showing (Figure 24):

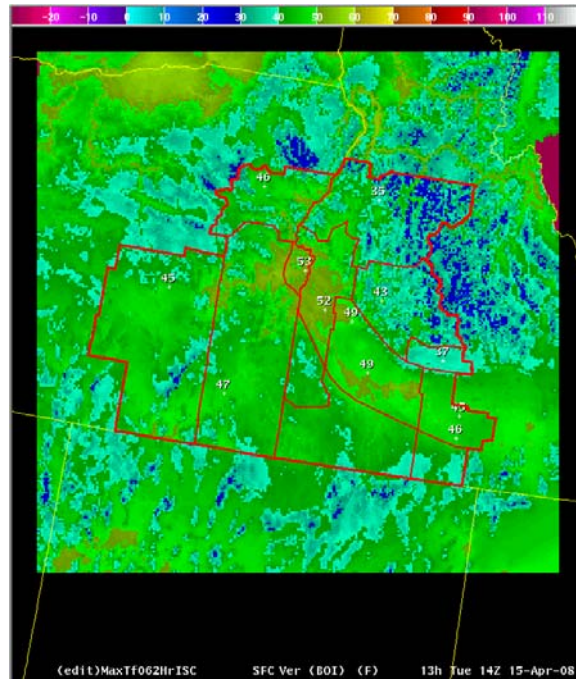


Figure 24. ISC forecast of MaxT for April 15th from the April 13th midshift.

The Boise forecasters dropped the forecast 1 to 3 degrees in most areas, with the biggest changes made in the Magic Valley, where it was lowered by 6 degrees in some areas. The average change was around 2.5 degrees (see the verification summary). With these changes, the forecast grid is finally brought back 'inside the envelope of what the guidance grids are showing' from the latest run. It is interesting that for numerous runs, the model forecasts continued to fall, and the Official forecasts also continued to fall, but that the Official forecast was ABOVE all available guidance for quite some time.

Conclusions

This case was a VERY difficult forecast for a very anomalous event. Model guidance was not great to begin with, had a lot of variability early on, and slowly trended toward the correct solution over many model runs. However, it is interesting that as the model solutions continued to trend toward colder and colder solutions, the Official forecasts seemed to 'lag behind'. Certainly some cautiousness is warranted when the model solutions are bouncing back and forth. However, when the model solutions are continuing in a clear and decisive trend, this case shows that it might be more advantageous to 'jump on board' with the model solution, rather than continue to lag behind for run after run.

Usually the decision not to adjust the forecast completely toward a new model solution is to keep the forecast from bouncing back and forth (or yo-yo-ing) as new model solutions potentially flip back and forth. That is generally a good thing. However, being too slow to react to forecast changes is NOT a good thing. Hopefully, looking at more cases similar to this one will help us find the correct happy medium between cautiousness to abrupt new solutions, and quick adaptation to correct new solutions.