The Strange Case of 282.4E and 10S in NCEP Various Reanalyses

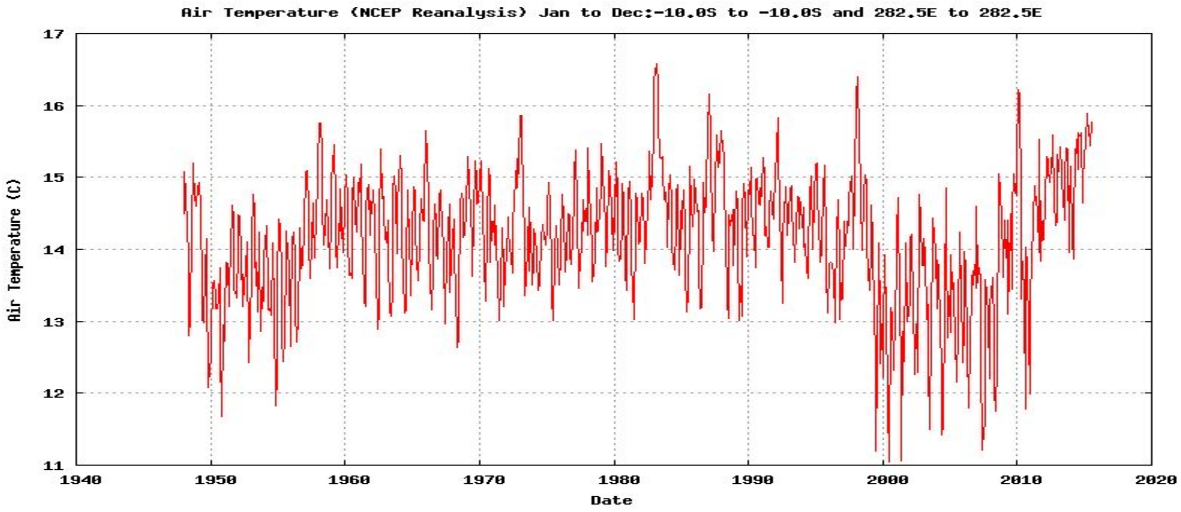
On September 3, 2015, I received this email from Mario Rohrer

Dear Wesley

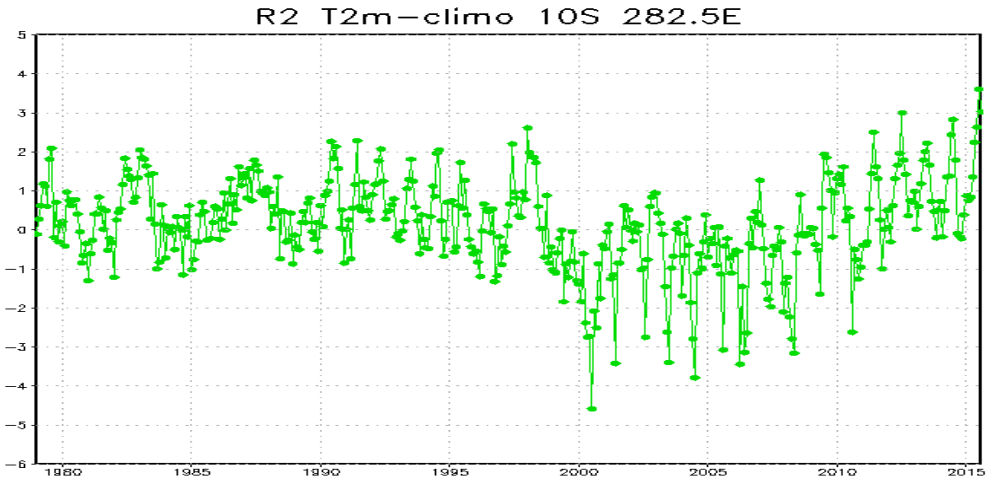
may I disturb you with some important error in the NCEP/NCAR Reanalysis I.

For the 2m air temperature the point -10S,282.5°E seems quite wrong between about the years 2000 and 2010.

I have the impression that this is in context with the synop station 84542 Anta - Huaraz.



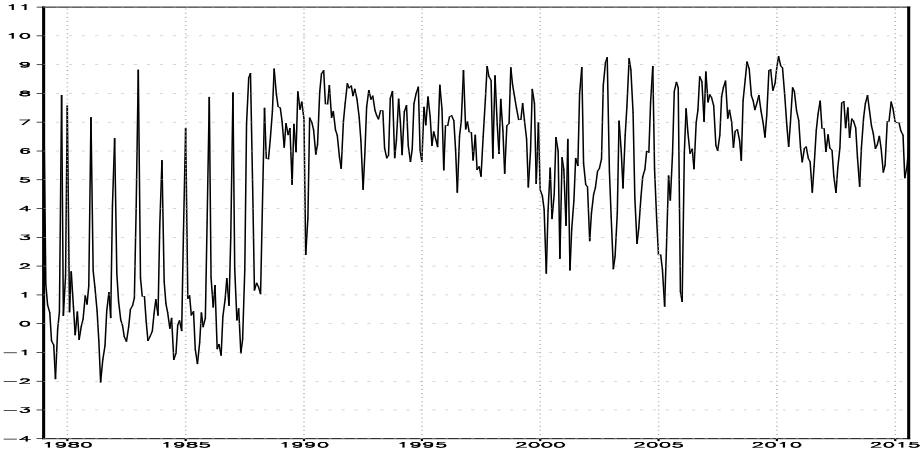
Yes, the near surface temperature looks bad and observations are usually the cause. In order to see whether this case is unique or not, we plotted the T2m anomaly from R2 (NCEP/DOE Reanalysis) at the same location



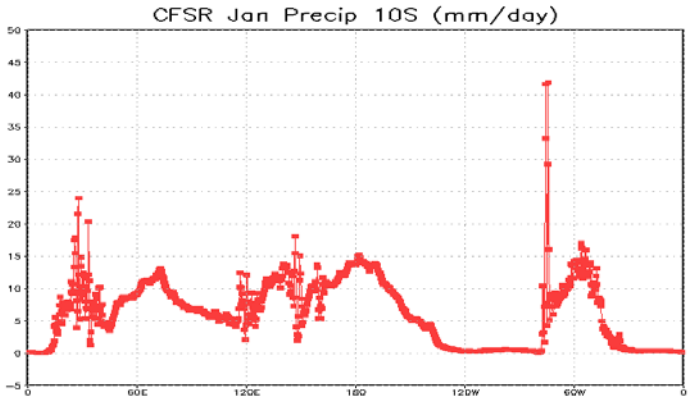
The R2 T2m plot shows the same features as in R1. You can see the seasonal cycle in the temperature

anomaly, with little anomaly in the NH winter and a large negative anomaly in the NH summer.

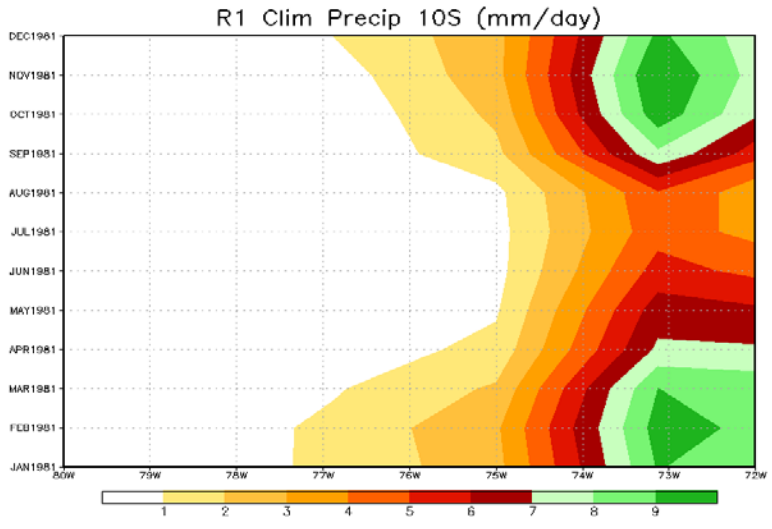
We also made the plot for the most recent NCEP reanalysis, CFSR, T2m at the same location using monthly mean data, which also shows a problematic feature that is different from R1. Data after Dec 2010 will be treated differently because of the large precipitation increase caused by the increasing of the horizontal resolution of the CFSR.

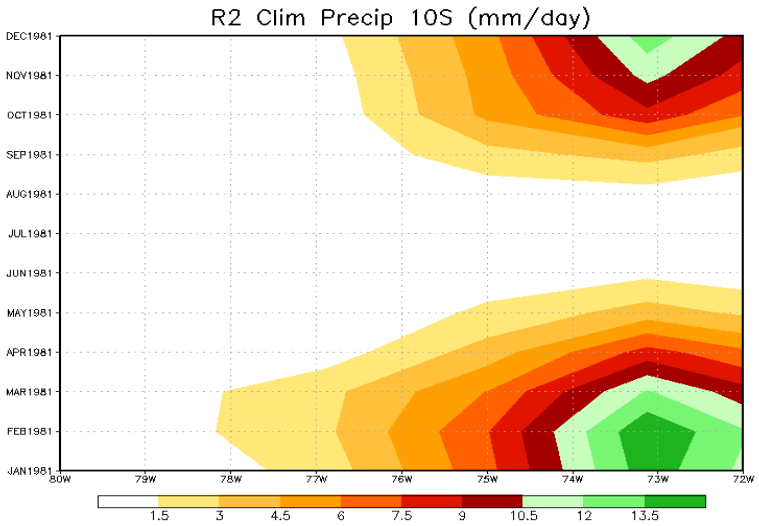


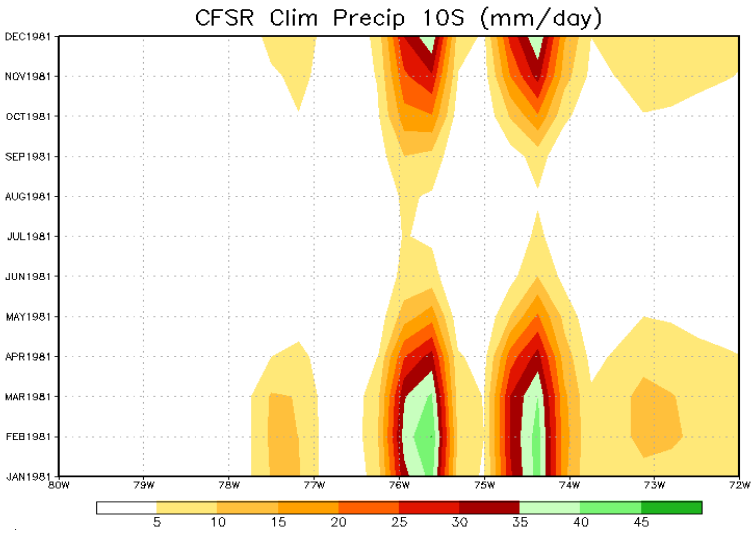
The key to the puzzle is the CFSR precipitation. The January climatological precipitation, averaged over the period of 1981 to 2010 at 10S, shows the point in question is associated with a point with extremely large orographic precipitation of 42 mm/day.



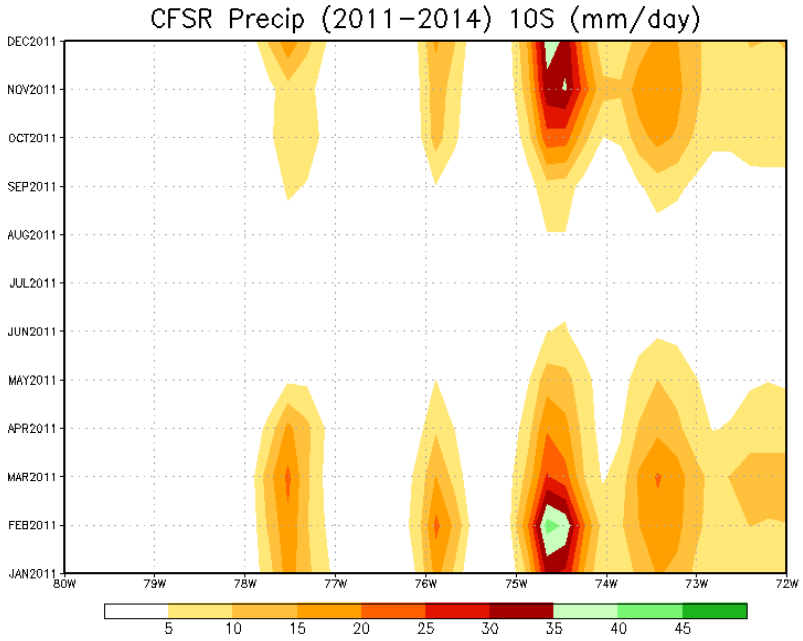
The next three plots show the 10S climatological precipitation 80W-72W (the scale is different).





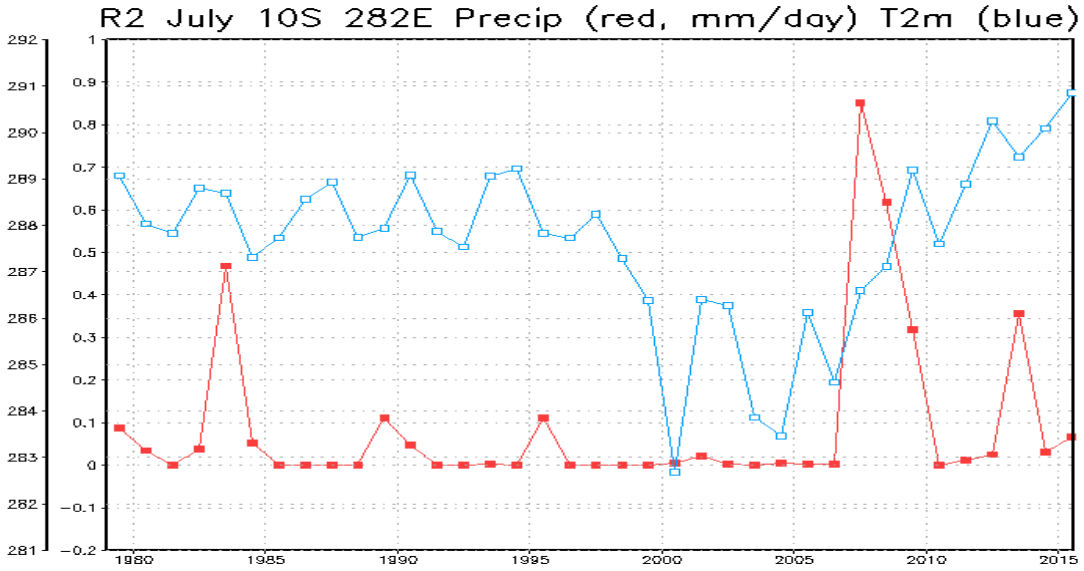


The R1 shows that the orographic precipitation peaks at 9-10 mm/day at 73W. The R2 shows a larger peak value of 13.5-15 mm/day, and the NH summer precipitation is gone. The CFSR precipitation has 4 distinct longitudinal peaks. The precipitation pattern has shifted westward with a peak of 45-50 mm/day vs the 9-10 mm/day for R1. The NH summer precipitation is smaller in CFSR (relative to the winter maximum) than R1 but larger than R2. To make things more interesting, the 2011-2014 CFSR precipitation is plotted next. This uses a higher horizontal resolution.

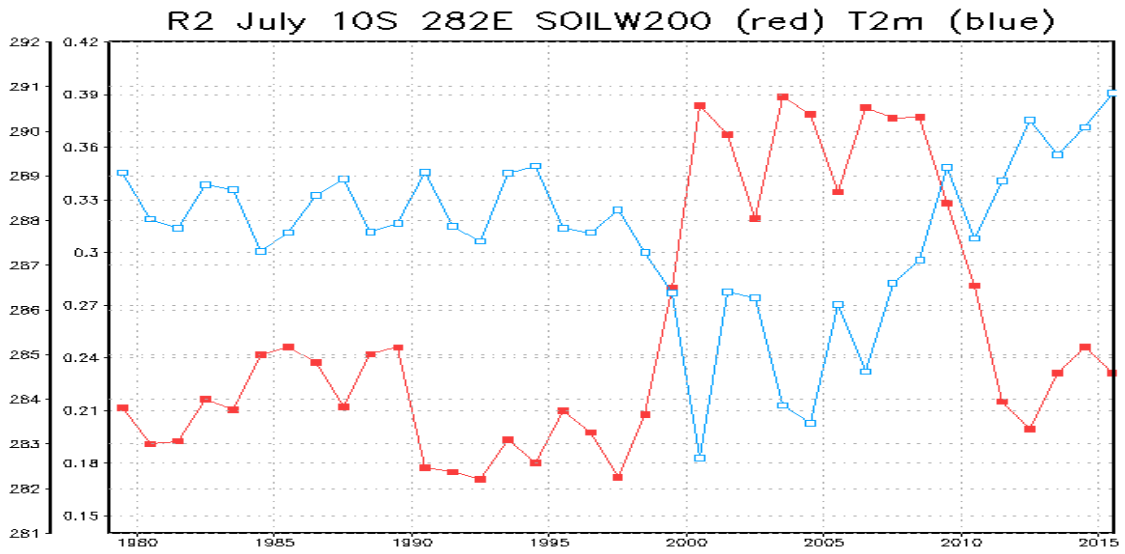


The above figure is only an average of four years and is only an approximation of the climatology. However, increasing the resolution of the CFSR from T382 to T572 seems to have significantly changed precipitation pattern.

The orographic precipitation will have strong contemporaneous effects on the temperature. However the July R2 precipitation at 10S 282.5E has a different signature from the R2 T2m.



Normally the lagged effects of the precipitation on the temperature are small. However, orographic precipitation is, in this case, much stronger than normal non-orographic precipitation, so the effect is expected to be much larger than normal. The plots of the July 10-200cm soil moisture are suggestive that the July temperature is being affected by the soil moisture and the precipitation during the rainy season.



The orographic precipitation is sensitive to the resolution. R2 used smoothed orography and the peak orographic precipitation was larger than R1 using a same-generation model as R2. (One would have expected a smoothed orography to have weaker slopes and weaker orographic precipitation.) Horizontal resolution also appears to be very important. The single latitudinal peak in the precipitation became four peaks in the CFSR (prior to 2011). In 2011, the CFSR went to a higher resolution (T382 → T572), and in the 2011-2014 analyses, the precipitation shows 5 latitudinal peaks.

Summary

One would expect the orographic precipitation to be determined by many factors besides the horizontal resolution. The angle of the wind will play key factor. One would expect atmospheric dynamical factors to be important too. R1 shows an artifact in the surface temperature and precipitation. CFSR also shows artifacts in the surface temperature and precipitation. The only problem is that artifacts in R1 and CFSR are different. So this is the situation

- T and P are sensitive to model resolution and physical parameterization
- One wonders whether the slope assumption is being violated
- P is not accurate (CFSR vs observation at Anta Huarez, not shown)
- P will be sensitive to wind direction
- P will be sensitive to vertical structure
- P may be sensitive to other factors
- T is expected to be sensitive to soil moisture/land model

So this point is not well done by the models. The point is probably very sensitive to the observations. Consequence, avoid using this point in analyses.

Wesley Ebisuzaki, Leigh Zhang 9/2015