

NARR update (April 2009-January 2015)

This update does not affect model, data assimilation scheme or any of the "guts" of the NARR system. The update fixes how observed precipitation is prepared for data assimilation. The update consists of

(1) April 2009, a new source of Mexican precipitation replaced an older source which ceased production. The old data set had units of mm/day and the newer one had 0.1 mm/hour and unfortunately the old code assumed that the units hadn't changed. The update fixes the units.

(2) The observed precipitation needs to be interpolated to the model grid. Around 2012, it was observed that the precipitation and soil moisture in SW Ontario (around London, Ontario) was too wet. The 2004+ NARR was configured not to use observed precipitation but there was abnormally high observed precipitation in SW Ontario where there should have an undefined amount. This problem persisted in WCOSS testing until an update to the interpolation library which gave the desired undefined observed precipitation in Canada. There is no explanation why the interpolation library would start misbehaving in 2012.

(3) In the conversion of NARR from the CCS (AIX) to WCOSS (linux), a bug was introduced. One Fortran95 loop didn't compile as expected. Consequently NARR used the NDAS (NAM predicted precipitation) instead of the observed precipitation over the CONUS. This was noticed in the Mid-West where the NDAS precipitation has a dry bias.

(4) All the observed precipitation processing code was examined line by line. When the radar shows precip and the gauge analysis doesn't, the code needs to estimate a daily accumulation. In one case, the code was difficult to prove correct and was rewritten to use a box average instead of nearest neighbor. In another case, the nearest neighbor code was rewritten.

Comments: (1)-(4) all affect how the observed precipitation is processed. The direct effects of these changes will be in the precipitation and in the soil moisture.

(5) When the period April 2009-January 2015 was reprocessed, the input files had to be obtained from the original sources.

BUFR (meteorological observations): same as original run except for a small possibility of missing data because of time constraints.

Radar precip estimates: same as original run except for a possibility of missing data because of time constraints.

Other precipitation analyses: same producer but current product. Possibility that original analyses had periods where the primary observed precipitation was not used (secondary source used or perhaps none) because of time constraints.

SST, snow, sea-ice: same as original run except when original source was late, unavailable or bad.

The original NARR was run in real time, so late-arriving data would not be used (time constraints). The update used the original files if possible. In case the original files were not available, alternatives were used.

Comments: the problems were not noticed because CPC only used the CONUS analyses. These problem had their strongest impact in Canada and Mexico. In recent years, CPC has not been using NARR in its operations.

Transition Details #1: NCEP Operations (NCO) ran the original system and transitioned to the new system in mid-January 2015. The update continued to the end of the month to make the user transition easier.

Transition Details #2: The NARR data was being distributed by

`emc-ls-nomad7.ncep.noaa.gov`

which was turned off in September 2014. For a temporary fix, I started writing NARR data to

`ftp://ftp.cpc.ncep.noaa.gov/wd51we/NARR_archive/`

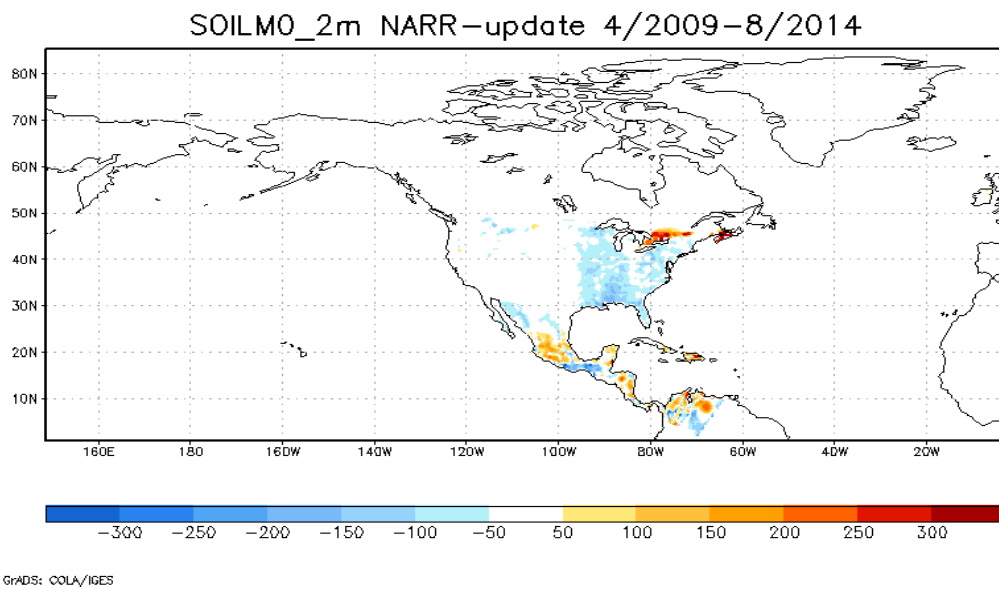
The only problem was that I was pressed for time and I didn't have a copy of the operational NARR data. However, I had a copy of

an experimental NARR analyses. These analyses were created using the new system but started in June 2013. I decided to post this run because it was created using the final version of the new system and was producing a better analyses than the operational version. In the earlier documentation, this was called "rerun2". "Rerun3" started in April 2009 but was terminated after finding that some input files were compressed differently than expected. Rerun4 became the "update".

Soil Moisture Analysis

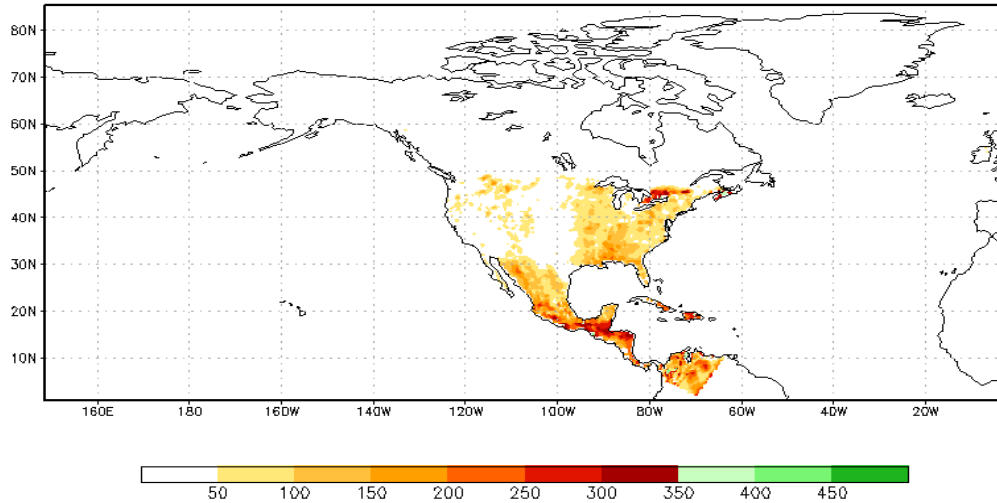
Hot Spots

The following plot contains the NARR-update (bias) for SOILM (0-2 m soil moisture, kg/m/m) for the period April 2009-August 2014. This plot of the bias between these two runs is one indicator where the analyses differ. The NARR is very wet over SW Ontario and Nova Scotia. NARR is slightly dry over the eastern CONUS and larger anomalies of both signs in the countries south of CONUS.



Another map of the "hot spots" is the RMS of the differences in the monthly mean SOILM. In Canada, the RMS is very small except for the previously mentioned regions of SW Ontario and Nova Scotia. This is good as it indicates the interpolation problem in Canada was more or less limited to these two regions. The RMS shows that Mexico and countries further south were also hot spots. Eastern CONUS had a more modest RMS values. Some of this RMS was from the dry bias in the NARR run.

SOILMO_2m rms(NARR-update) 4/2009-8/2014

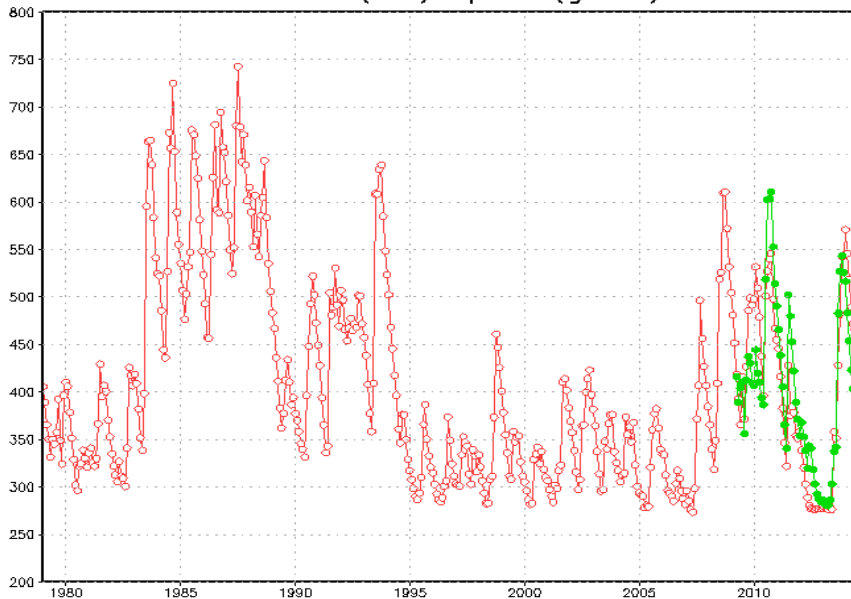


GRADS: COLA/IGES

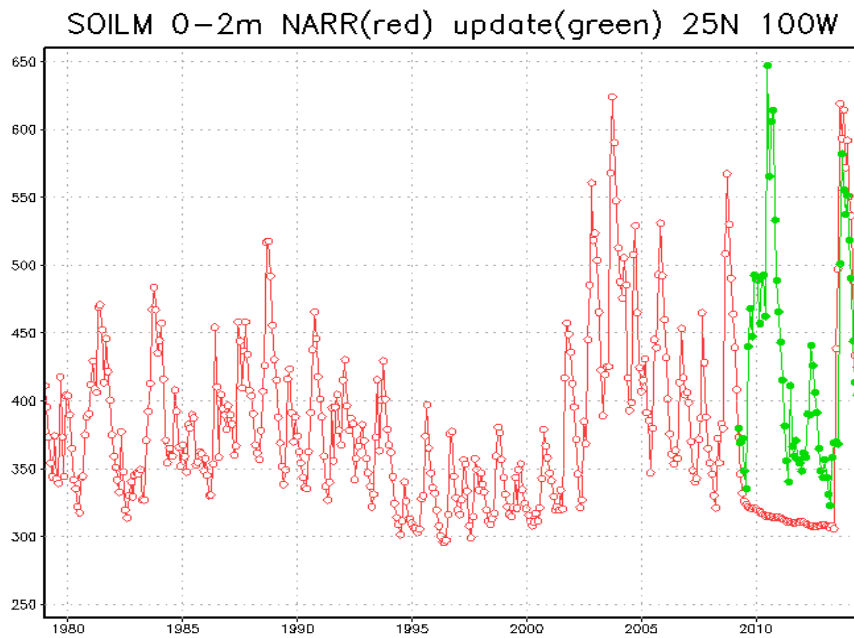
Mexico

One purpose of the update is to improve the Mexican precipitation/soil moisture. The previous plots showed that the update is different. By plotting some time series, I want to show some details on the changes. Plots of the SOILM (monthly 0-2m soil moisture) were plotted for 3 points A (22N, 100W), B(25N, 100W) and C (27N, 100W). In this plot, the time series for point A show that the update was very close to the original.

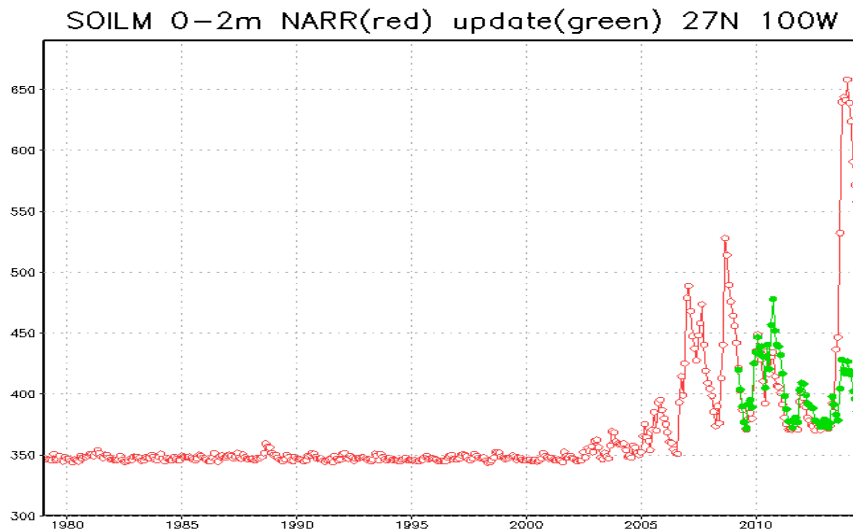
SOILM 0-2m NARR(red) update(green) 22N 100W



In plot for point B, the original NARR data is obviously bad in 2009-2013. After the WCOSS conversion, the soil moisture started being consistent with the 2003-2009 period. The update fixes the original flawed time series.



In plot for the time series for point C, shows the soil was extremely dry prior to 2005 and had a new climatology from 2007 onwards. Obvious there the observed precipitation analyses left something to be desired. The original NARR data was extremely wet after the WCOSS conversion. The update fixes the problem.

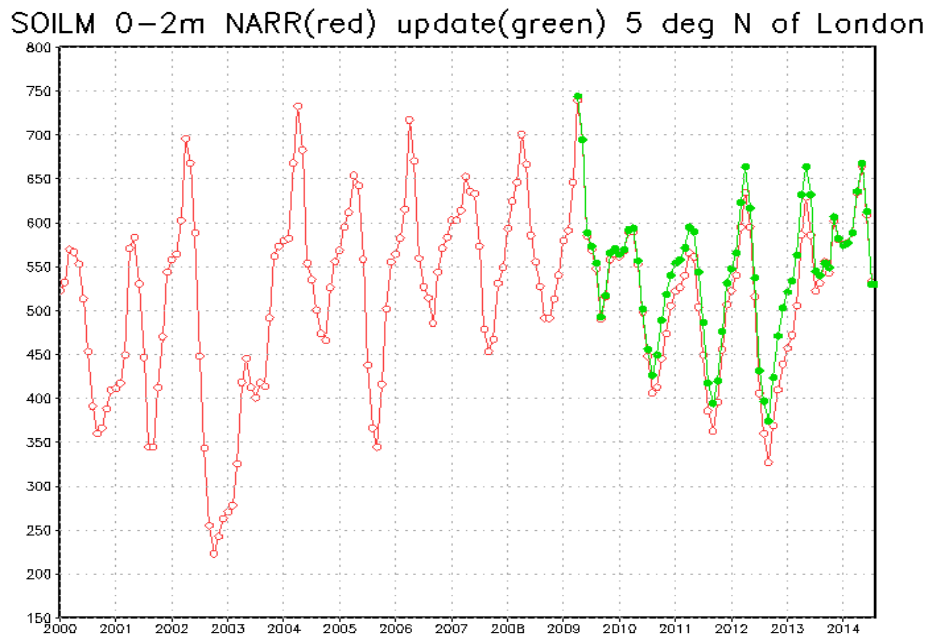
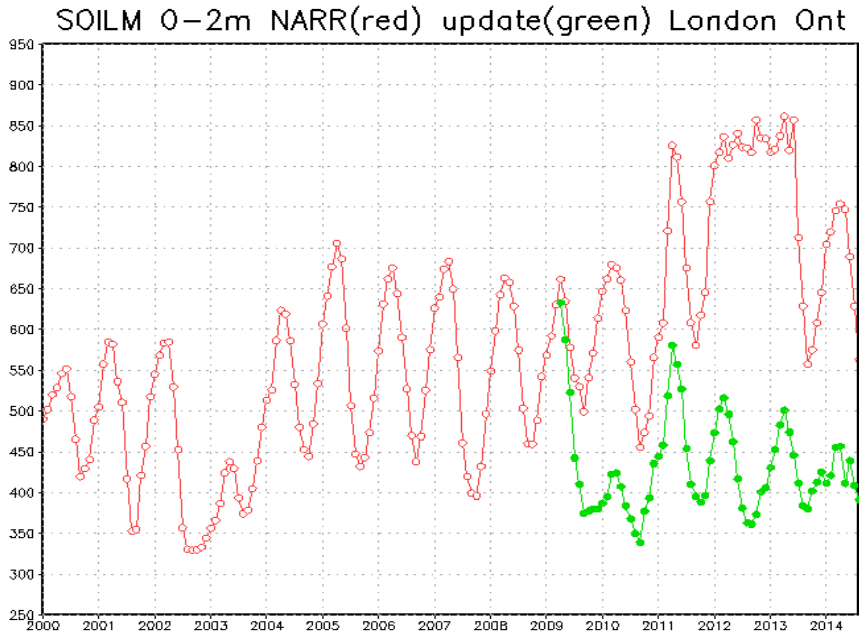


The Mexican soil moisture appears to be better (more consistent with its climatology) after the update. The transitions to the new observed precipitation data set and the WCOSS transition are better handled. The handling of observed precipitation changed when NARR went from a reanalysis to a real-time system in 2004. This may explain the changes in the 25N 100W time series. Perhaps the long spin-up time and the transition to the real-time system had some influence on the 27N 100W time series.

Canada

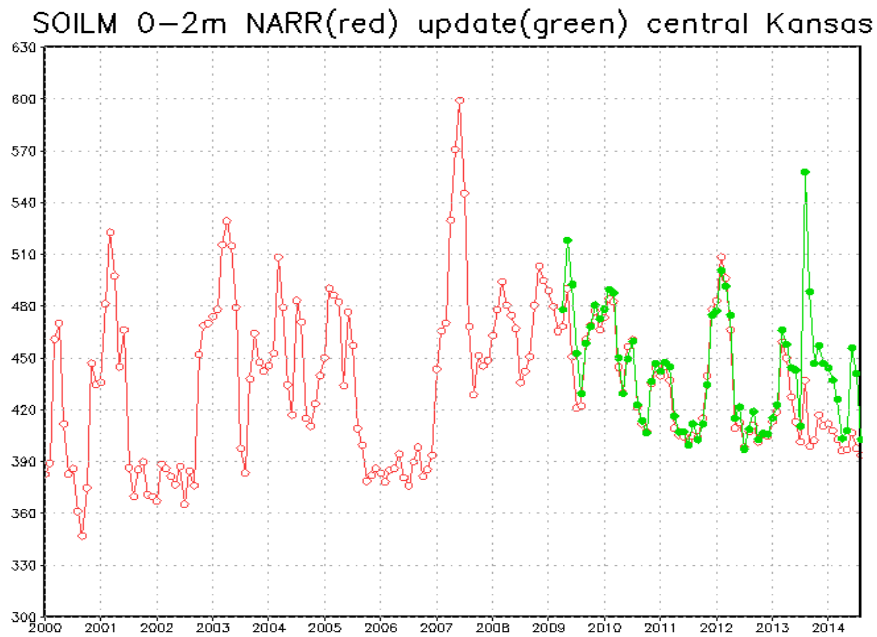
London, Ontario soil moisture/precipitation was identified as a problem starting in mid-2012. The SOILM for London shows the annual cycle of the soil moisture disappeared for 2012 at or near saturation levels. Clearly this NARR is wrong for 2012. The annual cycle returned after the WCOSS transition; however, the spring 2014 soil moisture as abnormally high. This was probably caused by the

saturated conditions prior to the WCOSS transition. The soilm diverged immediately (April 2009) suggesting that the interpolation was always a problem but the problem became more severe in 2012 producing unrealistic soil moisture. A plot of the soilm 5 degrees north of London shows that the update had a minor effect there.

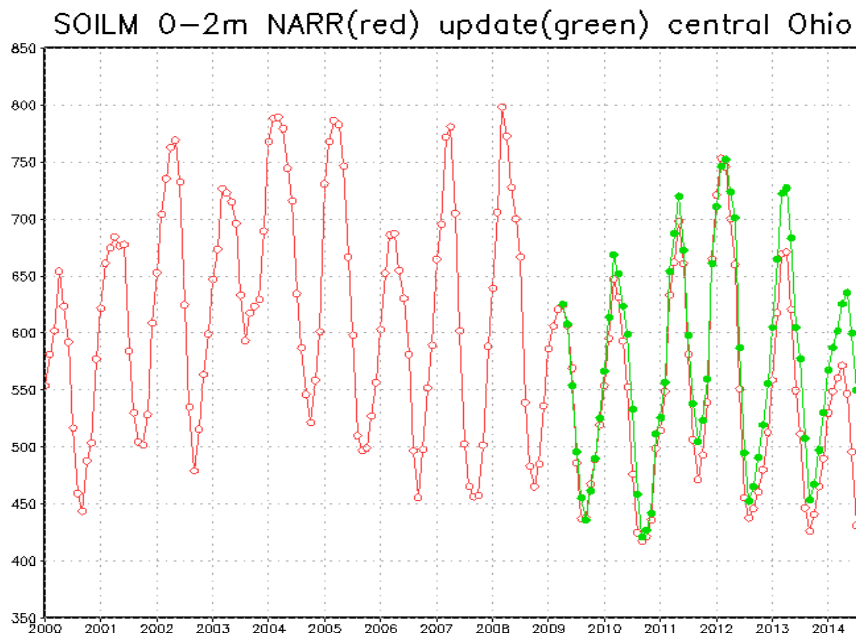


USA

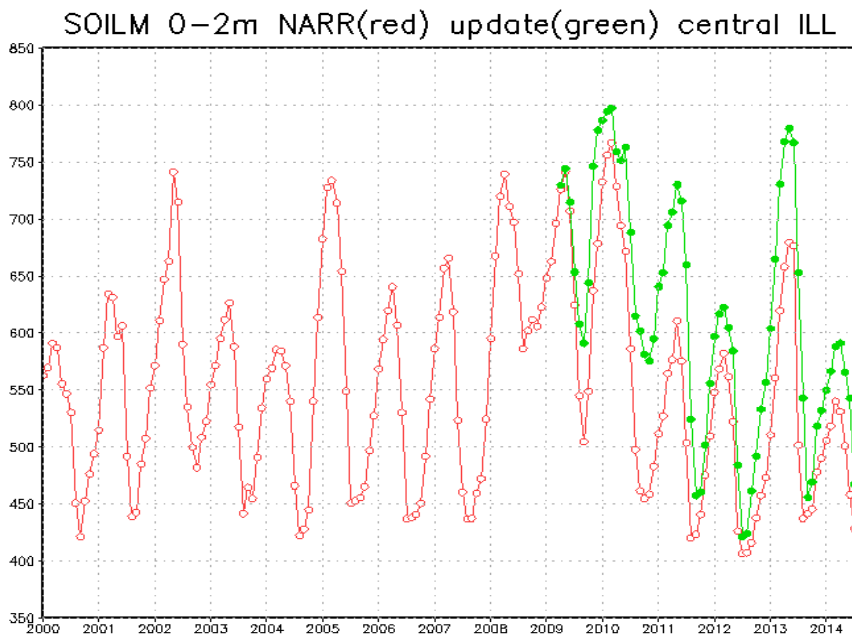
The soil moisture in the USA can be affected by both the interpolation bug and the WCOSS transition. Kansas is far from where the interpolation had its problems and following plot shows the soil moisture for central Kansas (38N, 98W). The plot show the differences were after WCOSS transition.



The next plot shows the soil moisture for central Ohio (40N, 83W). The updated soil moisture is wetter in 2012 and after the WCOSS transition showing some effect of the WCOSS and interpolation problems and the 2012 interpolation problems.

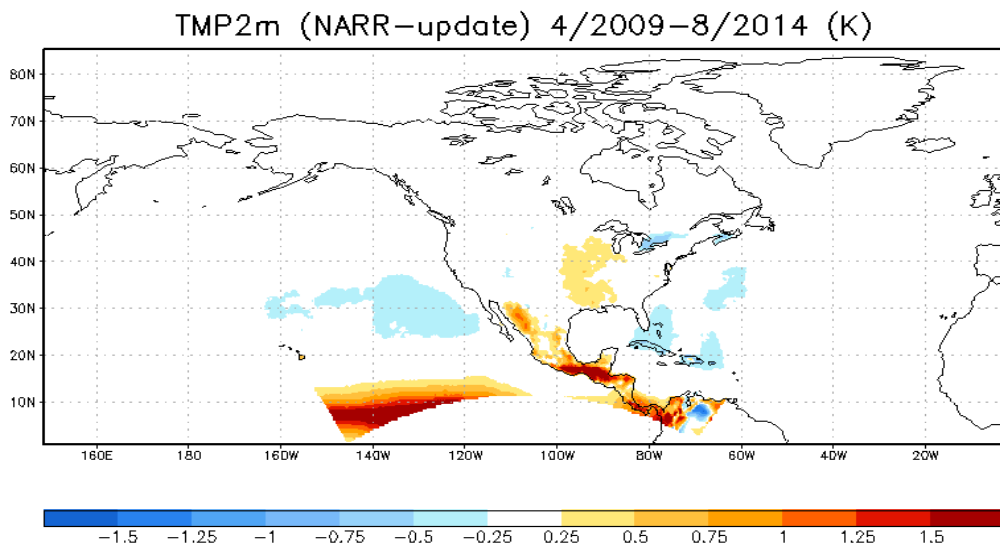


The final SOILM time series shows the soil moisture for central Illinois (40N, 90W). Apparently Illinois was more affected by the interpolation bug and you see the effect prior to 2012.

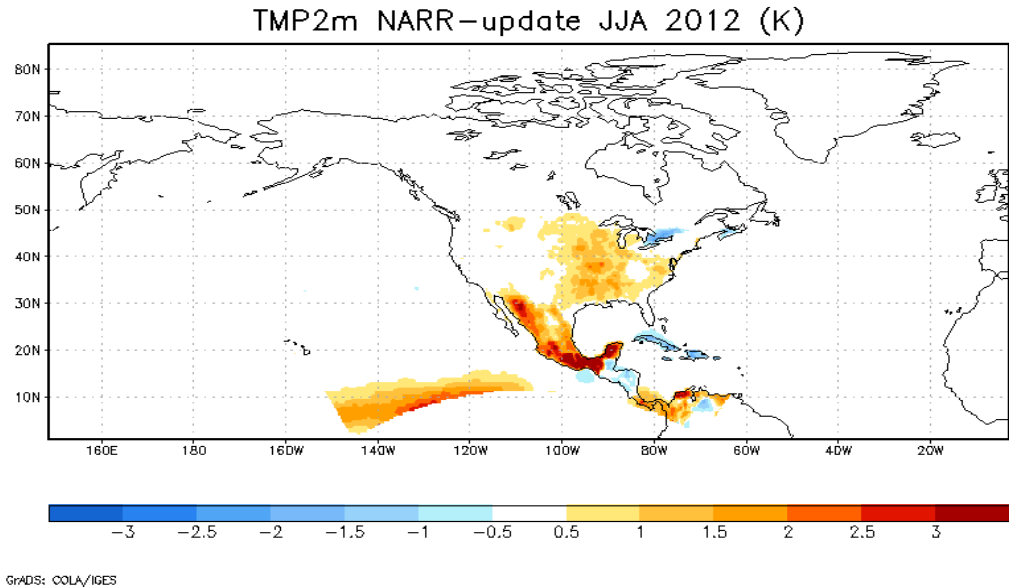


2 meter Temperature

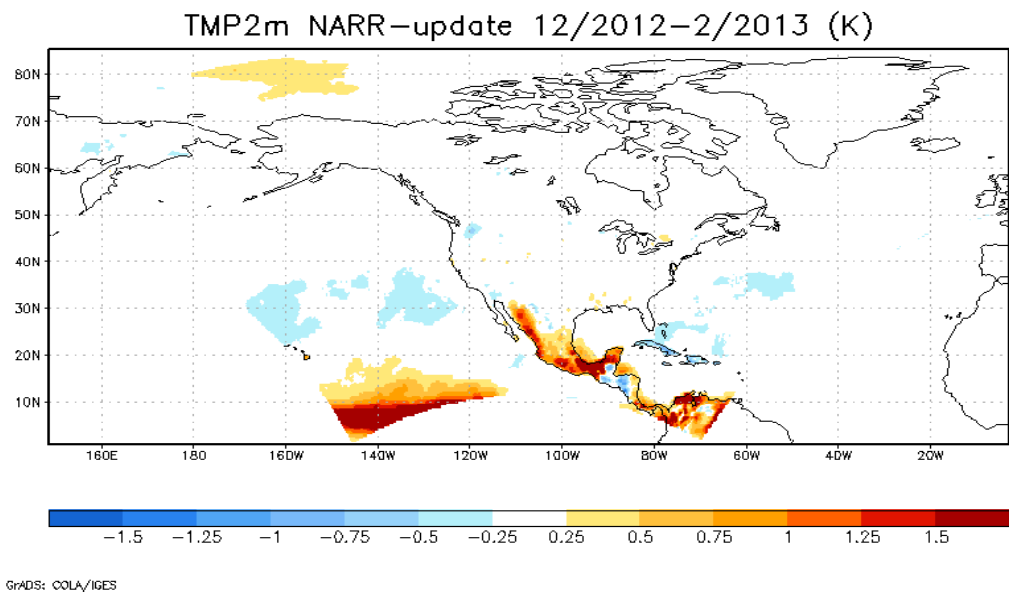
The changes to the NARR system were limited to fixing the processing of the observed precipitation. The observed precipitation is usually a daily accumulation and is converted to an hourly values by using Stage IV (radar) precipitation estimates in the CONUS and CMORPH elsewhere to estimate the hourly variability. The hourly precipitation is interpolated to the model grid and the assimilation system tries to reproduce these values by making minimal adjustments to the temperature and humidity. So the only direct effect of the fixes is in the precipitation field. The precipitation has a strong effect on the soil moisture and the clouds. Most other fields are less directly impacted. A commonly used field is the 2 meter temperature (TMP2m). The plot below shows the bias between the original and updated NARR. Over the CONUS, the update is 0.25-0.5 C colder on average. SW Ontario shows a warming and Mexico an Central America a stronger cooling in the update. The RMS plot (not shown) is consistent with the bias plot.



The bias and RMS for 2009-2014 may understate the problem. For some locations, the problems during 2012 were much worse than other years. The bias was examined for May-June-July 2012 and Dec2012-Jan2012-Feb2012. The bias for May-June-July 2012 shows that the update had a much bigger impact.



The winter (December 2012 through February 2013) is expected to have a smaller change because soil moisture processes are less active during the winter in the northern CONUS and Canada.



Summary

The April 2009-January2015 NARR update was done to fix the processing errors that had been found: (1) WCOSS conversion, (2) 2012 interpolation problems that were found in SW Ontario and (3) Mexican soil moisture. Examination of the run suggests that the update looks better than the original. However, there is evidence that the interpolation problem existed in 2009 and probably to the start of the NARR project. The changes in the 2 meter temperatures are consistent with the changes in the soil moisture. The largest changes in the 2 meter temperature were in Mexico and countries further south. The update warms SW Ontario and cools the US mid-west with a larger effect during summer than in the winter.

April 24, 2015
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