Evaluation of GOES-12 Sounder single field of view and 3x3 retrievals of total precipitable water over the ARM SGP site

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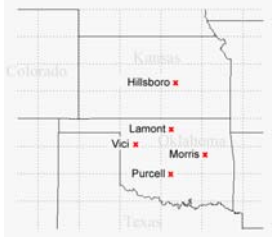
Introduction

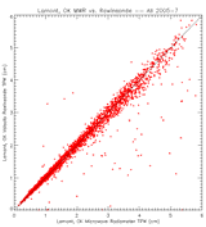
Total Precipitable Water (TPW) is a very useful value for forecasters to determine atmospheric stability and the probability of convection and severe weather. The current GOES Sounder provides the capability to retrieve water vapor profiles and TPW hourly over CONUS at approximately 10 km resolution. Historically, at Cooperative Institute for Meteorological Satellite Studies (CIMSS), retrievals have been performed on 3x3 field of view (FOV) areas. However, the desire to improve product spatial resolution as well as assimilating derived water vapor into numerical models has led to single FOV (SFOV) retrievals. These SFOV retrievals may also provide insight into what differences may be observed with the future, increased-resolution GOES instruments, especially with respect to discriminating spatial gradients of water vapor.

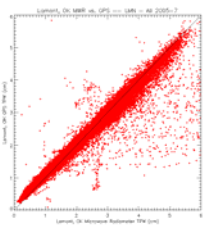
The purpose of this study is to compare the retrievals of TPW from the GOES-12 Sounder with those retrieved from ground-based instruments such as the Microwave Radiometer (MWR), GPS, and rawinsonde. Both SFOV and 3x3 retrievals from 2005- 2007 are included. Results are examined for the ARM-SGP central facility, as well as several boundary facilities.

ARM-SGP Site Details

The U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) program Southern Great Plains (SGP) site is centrally located in Lamont, OK. Rawinsonde launches are performed at this site regularly, and a MWR and GPS are located on-site. Water vapor profiles from these instruments are used to derive TPW. In addition to the central facility, MWR instruments are located at 4 boundary facilities (Hillsboro KS, Morris OK, Purcell OK, and Vici OK). No rawinsonde or GPS profiles are available from these sites.

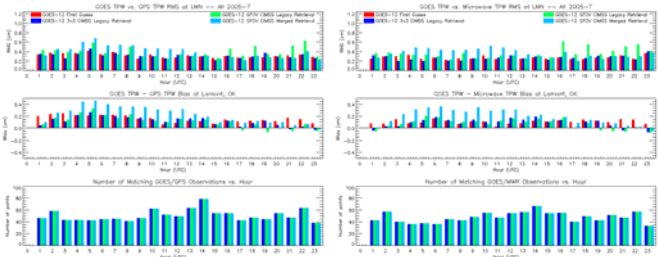






Because rawinsonde and GPS data are not available for all 5 SGP sites, this study will focus on MWR comparisons. Note, however, that TPW values derived from the MWR and rawinsonde are generally in agreement for Lamont. The GPS and MWR also show a similar trend. However, a number of outliers exist where the MWR TPW is significantly larger than that derived from the GPS.

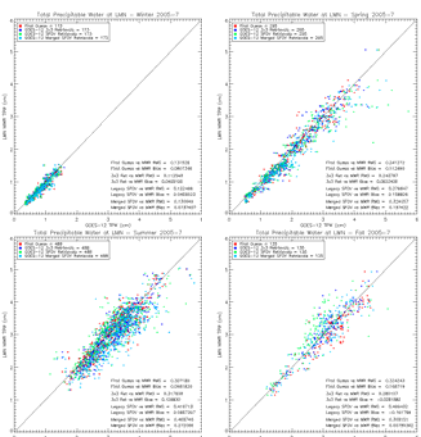
Seasonal and Diurnal Trends



Hourly Statistics vs. GPS | Hourly Statistics vs. MWR

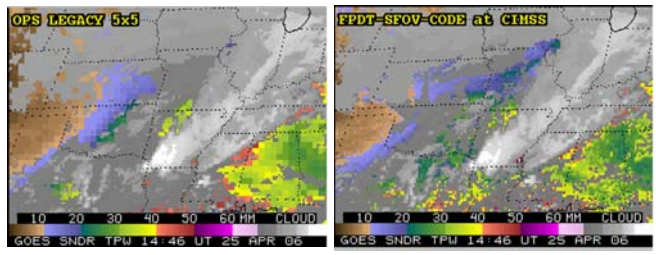
Hourly statistics of RMS/Bias suggest that the different retrievals have difficulties at different times of the day. The merged SFOV product has a higher RMS and bias in the early morning hours, while the Legacy SFOV product has a high RMS (but little bias) in the afternoon. The 3x3 FOV product shows the least improvement over the first guess in the afternoon.

- Higher errors are associated with summertime retrievals at all sites (Lamont is shown).
- All retrievals (SFOV and 3x3 FOV) show improvement over the first guess in the wintertime (DJF).
- None of the retrievals show improvement over the first guess in the summertime (JJA).
- Spring and fall show mixed results, with only the 3x3 retrievals providing a slight improvement over the first guess.



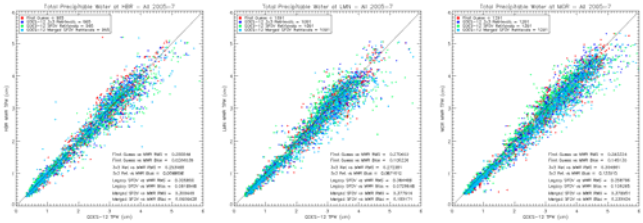
GOES-12 Sounder SFOV and 3x3 Retrievals

GOES-12 Sounder first guess, 3x3 retrieval, and two different SFOV retrievals of TPW are included in this comparison. All retrievals are run at the CIMSS, in Madison, WI. The first guess for the 3x3 retrieval is derived from the GFS numerical weather prediction model short-term forecast. The SFOV products are divided into the CIMSS Legacy product, and the Merged SFOV product. The CIMSS Legacy product is an experimental product that was developed at CIMSS. Both the CIMSS Legacy SFOV and the 3x3 FOV retrievals use a separate cloud mask that is based on the same fundamentals as the NESDIS operational cloud mask. The Merged SFOV algorithm is identical to that being operationally run by NESDIS, and uses a cloud mask that is similar but not identical to the one used by the CIMSS Legacy SFOV product.



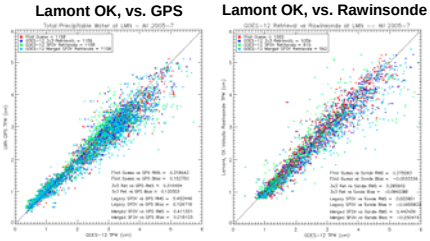
SFOV products tend to be spatially less smooth than larger FOV products (shown is 5x5 FOV; 3x3 would be similar but with slightly better resolution), especially near and adjacent to clouds. Retrievals of TPW are heavily dependent on the accuracy of the underlying cloud mask.

Hillsboro, KS | Lamont, OK | Morris, OK



Data from May 2005-July 2007 are included in these plots. Note that large periods of MWR data were not available from both Purcell and Vici, and thus these comparisons are not shown. MWR data were missing from Hillsboro and Morris from about September 2006 through June 2007, and data were available from Lamont throughout the entire time range. The 3x3 FOV retrievals have an RMS that is very similar to the first guess at all 3 sites, but show little, if any, improvement over the first guess. The SFOV retrievals (especially the merged SFOV) show a significantly greater RMS and Bias than the 3x3 retrievals, which suggests that cloud contamination could be an issue.

Lamont OK, vs. GPS | Lamont OK, vs. Rawinsonde



RMS and Bias values were universally higher when the satellite retrievals were compared against the GPS, which is consistent with the GPS being slightly biased against the MWR. All of the satellite retrievals show a negative bias when compared against the rawinsondes.

Conclusions

Results from this comparison show that the GOES-12 3x3 FOV retrievals show the most skill in retrieving TPW in agreement with the ARM-SGP MWR, GPS, and rawinsonde. However, over 2005-2007, the 3x3 FOV retrieval showed a lower RMS than the first guess for only 1 of the 3 sites examined. The 3x3 retrieval showed a lower RMS and Bias than either of the SFOV products at all sites. The merged SFOV product had a consistently higher Bias than any other product, which was most pronounced in the summer. This suggests that cloud contamination may be an issue for this algorithm. Collectively, over 2005-2007, neither SFOV retrieval showed improvement in accuracy over the first guess. However, an improvement was seen in the wintertime data only. One issue with SFOV retrievals is noise and time-continuity. Recently an improved GOES SFOV sounding algorithm (Li et al. 2007, GRL) has been implemented into the CIMSS merged processing, the improved sounding product will be evaluated using MWR and GPS data

Acknowledgements and Web Links of Interest

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CIMSS GOES realtime product homepage: http://cimss.ssec.wisc.edu/goes/realtime/
CIMSS realtime ARM-SGP TPW comparison: http://bora1.ssec.wisc.edu/~saraht/goes_tpw

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