Improving the Accuracy of Satellite Moisture Measurements

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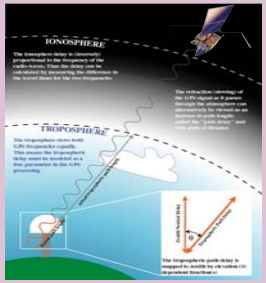
Introduction: **Calibration and validation (Cal/Val) of GOES-R and current GOES moisture can be achieved using an independent data system such as ground–based global positioning (GPS) dual channel measurements. Addresses NOAA mission: satellite product improvement, model improvement, climate research.**

Recommendations:

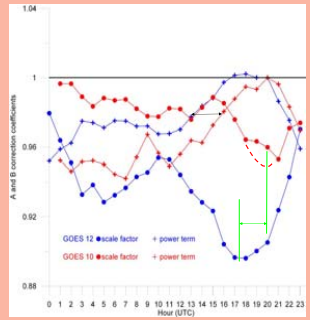
1. ***Modify and test new satellite algorithms using GPS***
2. ***Investigate the impact of assimilating GPS data for improving model forecasts, thus improving the climate record, general circulation models (GCMs), satellite science, and climate science***

Why Use GPS for Cal/Val?



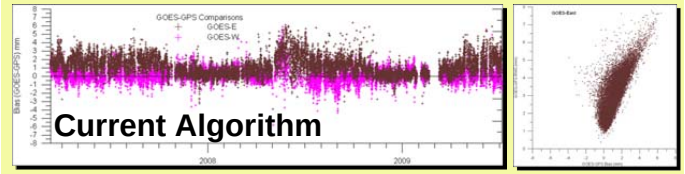
- Independent from other satellite data
- Dense in spatial distribution (~300 stations over CONUS)
- High temporal frequency (30min)
- Reliable
- Immune to clouds and rain

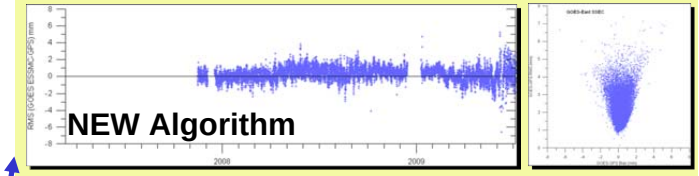
Daylight Effect on the Correction Algorithm Coefficients



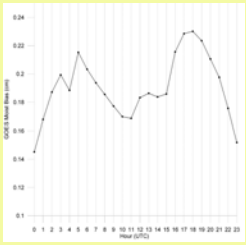
- **Dramatic change from night to day**
- **Daylight hours shows phase shift**
- **Phase correlates to satellite position**
- **Result indicates problems with satellite radiance calculation**
- **OR model problems**

Evaluation of GOES-GPS TPW Differences

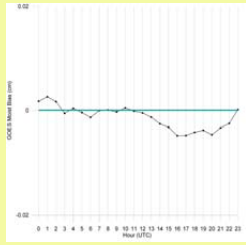




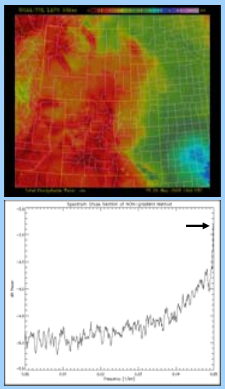
Plots of GOES-12 TPW showing the initial comparison (left) and after applying the correction algorithm (right)



BEFORE

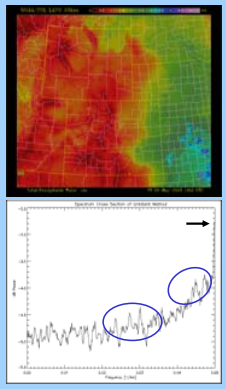


AFTER



Before Gradient Assimilation

- Lower power spectra
- Less detail in image
- Moist biased



After Gradient Assimilation

- Higher spectral signal amplitude
- More structural signal at higher frequencies
- Better image detail

Product Utilization Improvements
1. correction and bias avoidance
2. gradient assimilation

Correction coefficents reveal new information

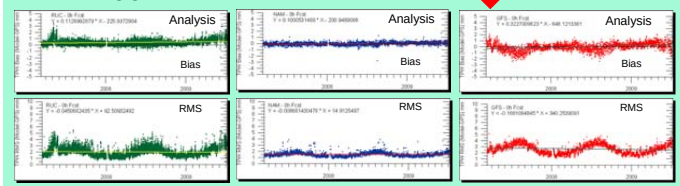
Ultimate Benefits to the NOAA Mission
1. better product algorithms
2. better model accuracy

Synergy in Research Application

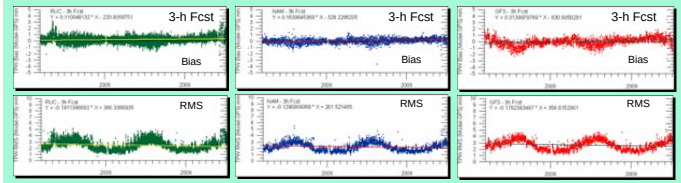
NWP Model Analyses and Forecast Comparisons

- **RUC assimilates GPS (constant bias likely due to other factors)**
- **NAM assimilates GPS (NO BIAS) better RMS at 00h**
- **GFS no GPS assimilation, unrealistic increase in moisture bias, used in climate research, and satellite work**
- **Recommend incorporating GPS in GFS!**

RUC NAM GFS



Above: RUC TPW analysis minus GPS IPW | Above: NAM TPW analysis minus GPS IPW | Above: GFS TPW analysis minus GPS IPW



Above: RUC 3-h TPW prediction minus GPS IPW | Above: NAM 3-h TPW prediction minus GPS IPW | Above: GFS 3-h TPW prediction minus GPS IPW