How the changing passive microwave observing system challenges the development of water cycle climate data records

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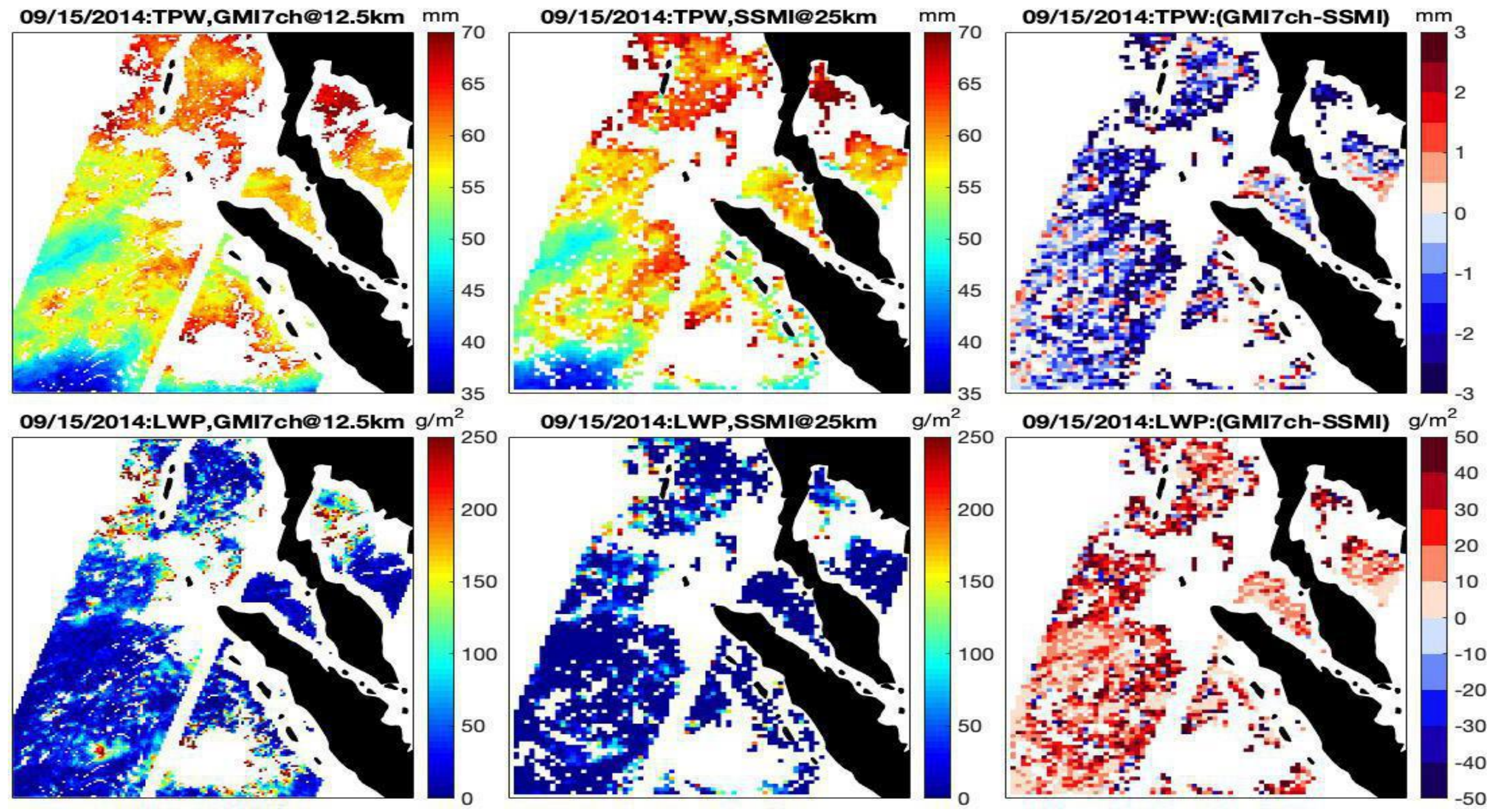
Microwave Imager Observing System:

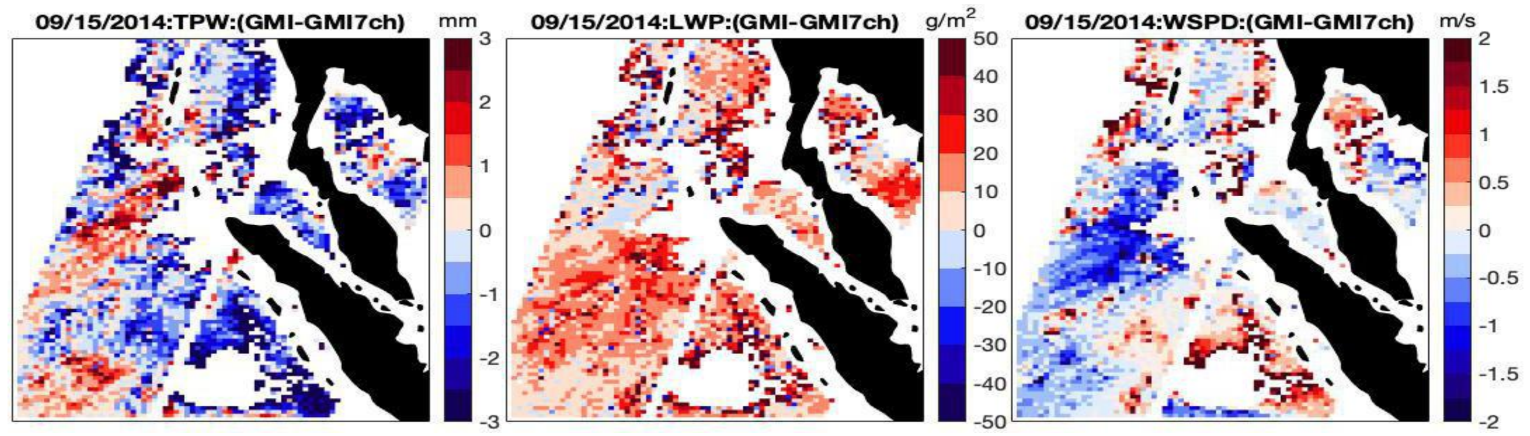
1. Resolution Changes

- ***Problem:*** Resolution of the microwave imager channels has changed significantly over time
- ***Impact:*** Sampling resolution impacts the ability to resolve smaller, often more extreme, features and leads to changes in the distribution of estimated state parameters resulting in climatological offsets of state parameters between sensors.



2. Frequency Changes

- ***Problem:*** Observing frequencies have changed with time. Some include 10GHz channels that provide information on surface temperature and some include water vapor sounding channels
- ***Impact:*** Atmospheric retrievals depend on the information content inherent to the suite of observing frequencies. Lack of and changes to sensitivity of state parameters result in offsets between instruments.



Research Motivation and Objectives

- Observations from passive microwave imagers have been an essential component of the global water cycle observing system including total columnar water vapor (TPW), cloud liquid water path (LWP), and surface wind speeds (WSPD) used for ocean evaporation estimates.
- However, this observing system has evolved in time as more advanced sensors with differing resolutions and frequencies have been implemented. This has the potential to impact the stability of water cycle climate data records.
- Here, we use Global Precipitation Measurement (GPM) mission microwave imager (GMI) observations together with a variational retrieval system to test the sensitivity of water cycle parameter estimates to observing system variations.

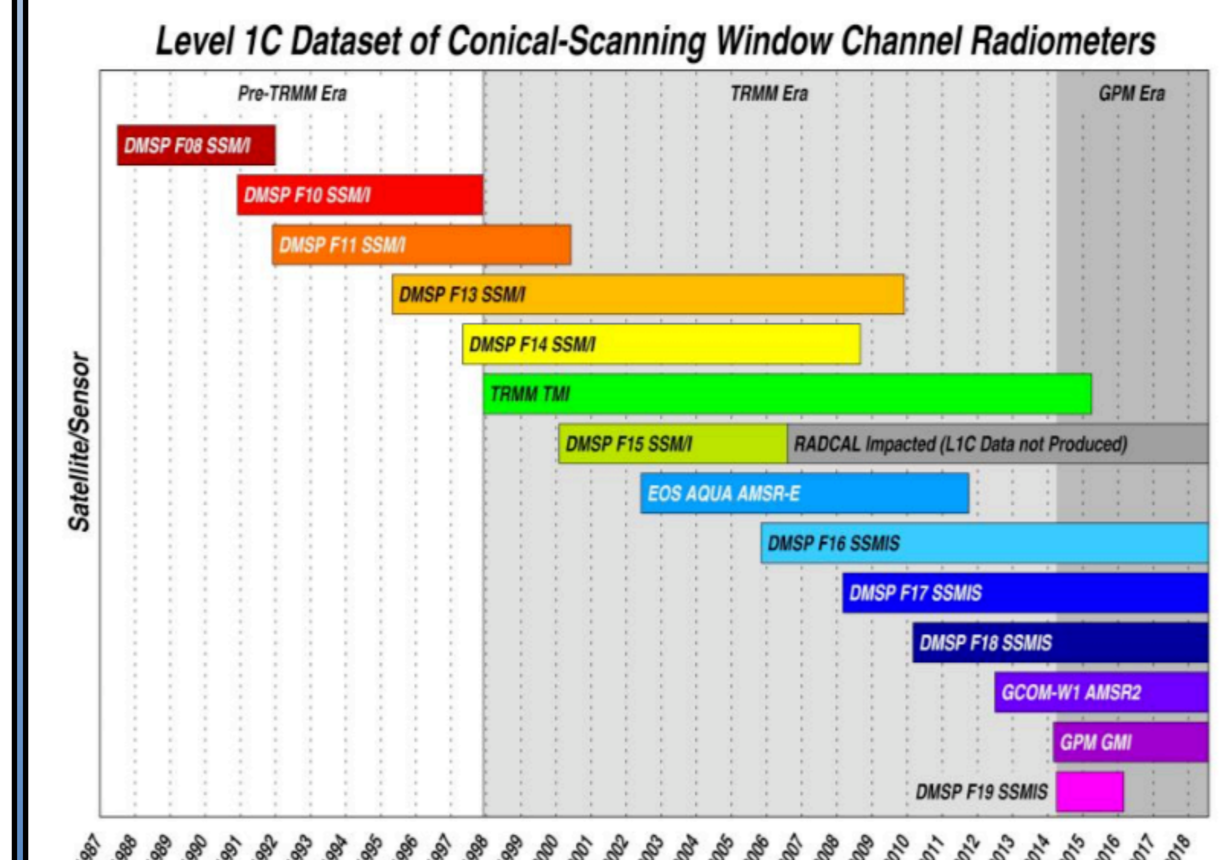
Summary

- Estimates of water vapor, liquid water path, and surface wind speed were made for one month of GMI observations, a 7-channel SSM/I-like subset of those observations, and a Backus-Gilbert resampled (to SSM/I resolution) version.
- The strongest impacts were found with respect to reduction in spatial resolution for heritage SSM/I sensors. In particular, they are unable to resolve small clouds resulting in the variational retrieval increasing the water vapor and winds. Strong regional signatures are found.
- Removing the water vapor sounding and surface-temperature channels from GMI results in more modest global changes to the water cycle parameters. Yet, they remain significant in regions of strong convergence and the warm pool.

GPM Intercalibrated Microwave Brightness Temperatures

- Distributed using NASA Precipitation Processing System (PPS)
- 14 sensors from 1988 through NRT
- Applies intercalibration using GMI as reference sensor

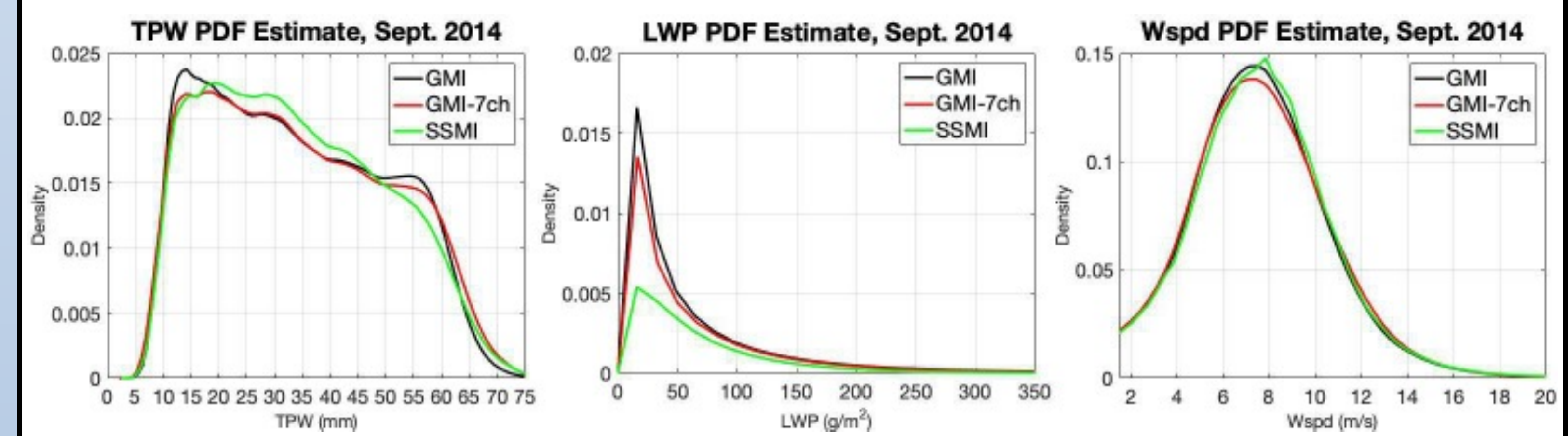
Berg et al. (2018), Fundamental Climate Data Records of Microwave Brightness Temperatures, Remote Sens., 10(8), 1306, doi:10.3390/rs10081306.



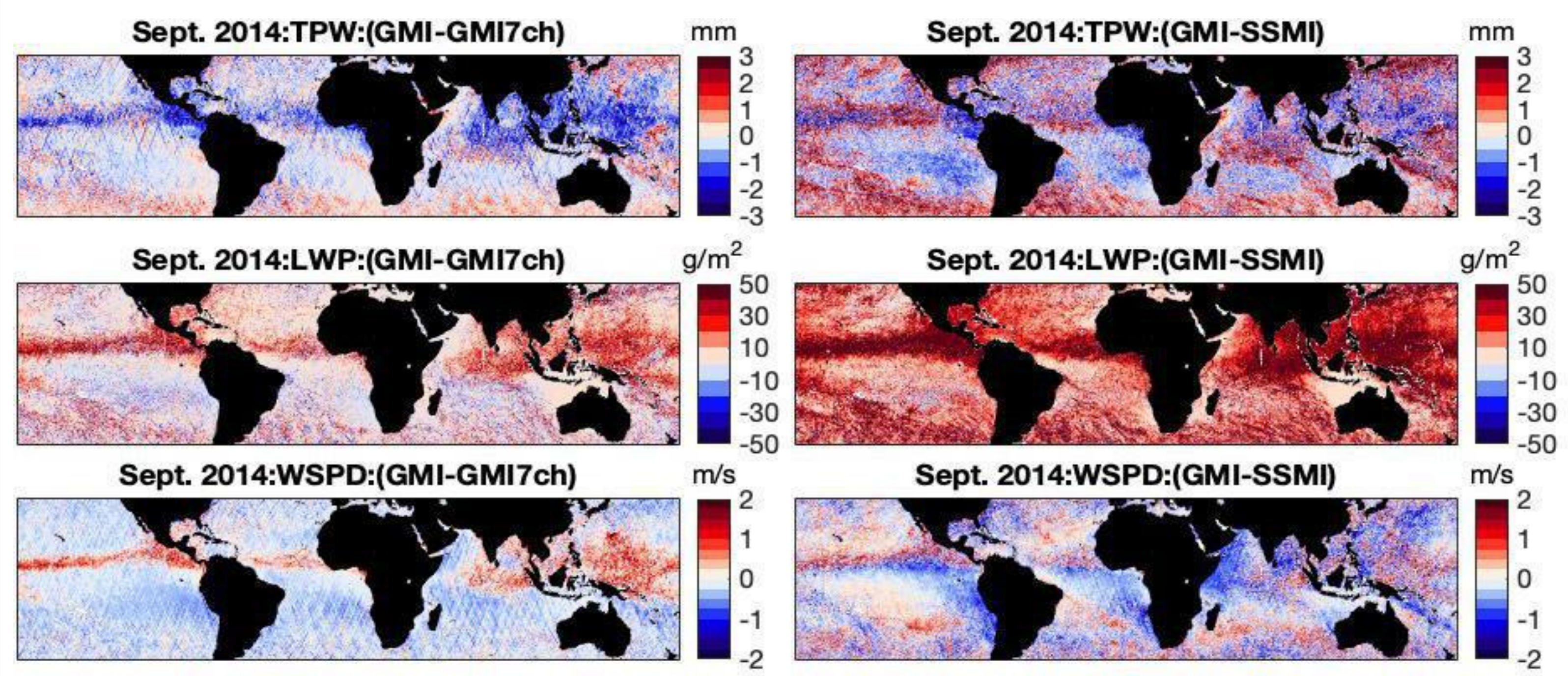
3. Using GPM GMI as a Testbed

- GMI observations are resampled using Backus-Gilbert to simulate resolution of different sensors.
- Different channel combinations are subset from the GMI set to test channel sensitivity.
- Using the Colorado State University 1D Variational Retrieval (CSU 1DVAR) algorithm, estimates are made of water vapor, cloud liquid water, and surface winds for 1-month of data.

4. Results



- Probability density estimates of TPW, LWP, and WSPD illustrate marked differences in the state estimate distributions. SSM/I-resolution estimates are unable to resolve small LWP.



- Mean differences between the 13- and 7-channel GMI illustrate crosstalk between state parameters with higher winds and LWP and lower TPW in GMI.
- Resolution impacts the mean difference in a more complex manner with strong regional signatures likely related to predominant cloud features.