Assimilating Satellite Observations of Clouds and Precipitation in Numerical Weather Prediction Models

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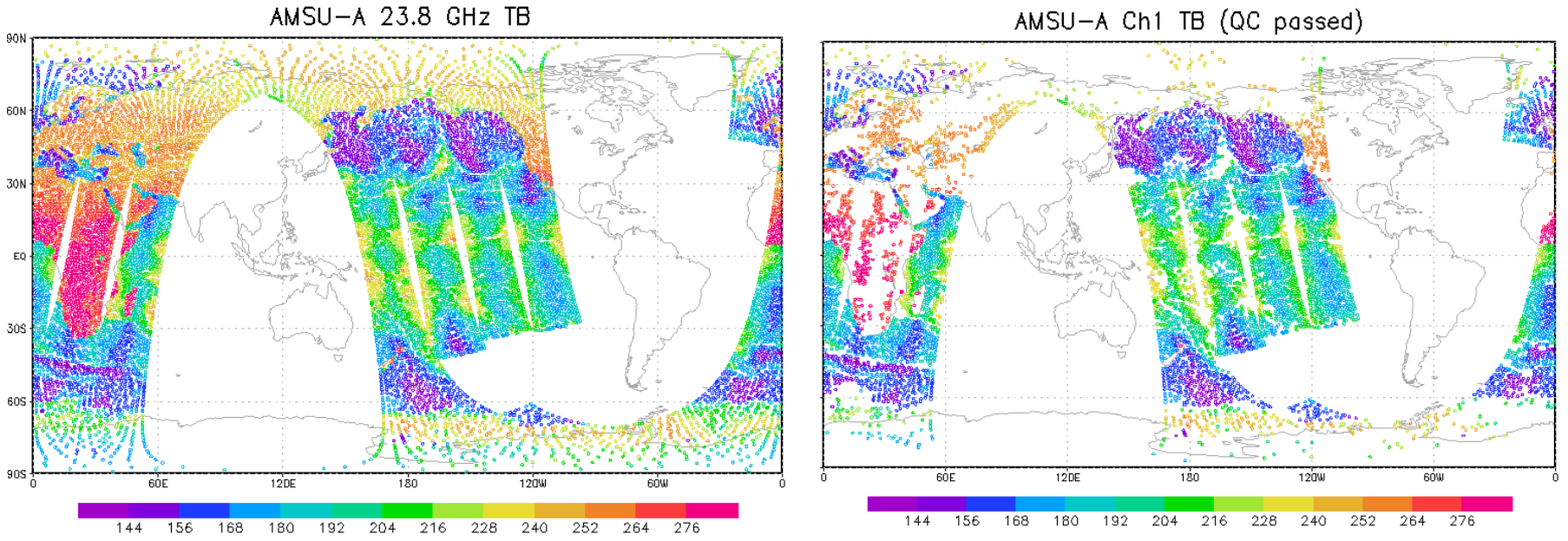
Why important?



- Numerous satellite observations and conventional data are assimilated to generate NCEP analysis.

- Currently radiance data only in the clear sky condition are being assimilated.

- Cloud or precipitation indicates that some dynamically important weather is occurring. Subsequent forecasts are often sensitive to initial conditions in regions with cloud and precipitation occurrence.

Current project

(1) Objective:

- Currently operational NCEP GDAS assimilates conventional, GPS RO refractivity data, SBUV ozone data, *clear radiances* measured from many space-borne radiometers such as AMSU-A/ MHS, HIRS, IASI, AIRS, and GOES Sounder.
- We are trying to improve NOAA NCEP analysis (i.e. 3D atmospheric field) by assimilating cloud and precipitation affected microwave radiances into numerical weather forecast models
- AMSU-A and AMSR-E cloudy radiances are being tested for cloudy radiance assimilation. SSM/I, SSMI/S, and TMI will be tested.

(2) Methodology:

- Three major components of GDAS : Global Forecast System (GFS) model, Global Statistical Interpolation (GSI) System, Community Radiative Transfer Model (CRTM)
- For cloudy radiance assimilation, we are currently working
  - to include moisture physics parameterizations of GFS model in the GSI analysis system
  - to construct QC algorithms, observation error and background error covariance matrices in GSI system appropriate for cloudy radiance assimilation
- Impacts on global weather forecasts will be examined.

Future plans within GPM-era (2013 and beyond)

(1) Assimilation of Cloud and Precipitation Affected Microwave Radiances in NOAA NCEP Global Data Assimilation System

- GMI radiances will be tested in the GDAS to examine the benefit and synergy with other numerous observation data currently being assimilated - if available in real time.
- Performance of the GFS cloud microphysics model in forecasting ice cloud and frozen precipitation will be examined and tested in GDAS to assimilate high frequency microwave radiances.

(2) Assimilation of Space-borne Precipitation Radar Reflectivity in NOAA NCEP Global Data Assimilation System

- JCSDA is currently developing components to assimilate ground-based and aircraft based radar observations in GDAS. The use of these resources will be extended to test the assimilation of space-borne precipitation radar measured reflectivity - if they are available in real time and development resources are available.

Requirements

Observation Requirement	T/O	Geographic Coverage	Vertical Resolution	Horizontal Resolution	Measurement Accuracy	Measurement Precision	Sampling Interval	Data Latency	
Microwave Radiances	T	Global		raw	A few tenth degree	A few tenth degree		120	min
	O	Global		raw	A few tenth degree	A few tenth degree	Once per hour	28	min
Radar Reflectivity	T	Global	raw		TBD	TBD		120	min
	O	Global	raw		TBD	TBD	Once per hour	28	min

Gaps in Current Satellite Data Suite

- **Spatial (coverage) gaps:** Too early to address this issue?
- **Temporal gaps:** Moisture processes related to cloud and precipitation evolve rapidly. More frequent data will definitely help to improve analysis in the region with cloud and precipitation.
- **Latency gaps:** If operational use of the GPM data is desired, it is critical to get the data in real time.
- **Accuracy shortcomings:** TBD
- **How GPM era products might help (if it's possible to speculate):** GMI will fill up the temporal gap in cloud and precipitation observation and can help to improve the analysis through assimilating cloudy radiances. DPR will help to evaluate and improve the performance of moisture physics models. In addition, it will be interesting to see the impact of DPR reflectivity data assimilation in GDAS.

Next Steps for GPM-era data & products

- Clouds and precip is one of the six scientific priority areas for the Joint Center; however, “clouds” has historically attracted more funding than “precip”; in order to change this, we need
  - Competitive proposals
  - Partnerships with other relevant NASA and NOAA activities; GOES-R and HFIP could serve as a models

- NASA is a full JCSDA partner and contributes several elements, e.g.
  - Data
  - Computing
  - Data assimilation system development