Cloud and Precipitation Affected Radiance Data Assimilation in NCEP NWP Forecast Models

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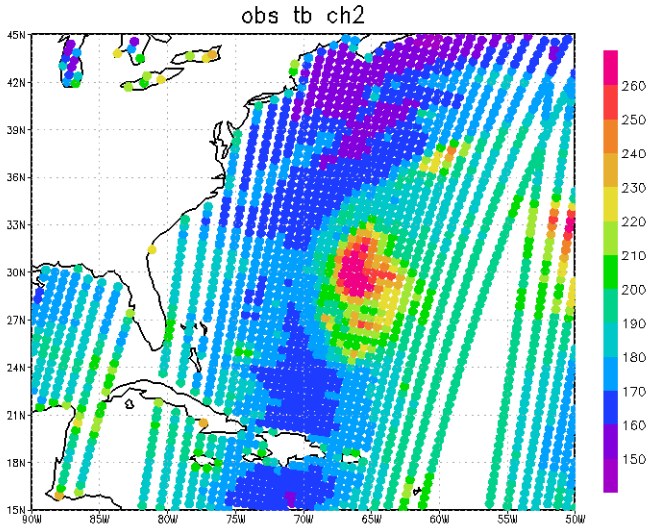
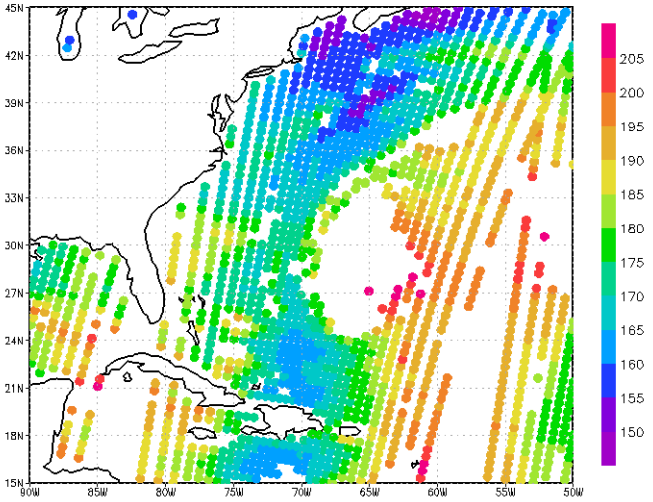
Motivation



(QC passed in GSI)



Hurricane Igor (09/19/2010)

- **Numerous satellite observations and conventional data are assimilated to generate NCEP global and regional analysis.**
- **The majority of satellite data affected by clouds and precipitation are discarded in the NCEP operational data assimilation system which has been geared toward utilization of observations in the clear sky condition.**
- **However, as clouds or precipitation often occur in regions with high forecast sensitivity, improvements in the analysis of this region are likely to contribute to significant gains in NWP accuracy.**

Implementation of Cloud Affected Microwave Radiance Data Assimilation in NCEP Analysis

- **Efforts to utilize cloud affected radiance data in the NCEP data assimilation system has been progressing continuously under JCSDA support**

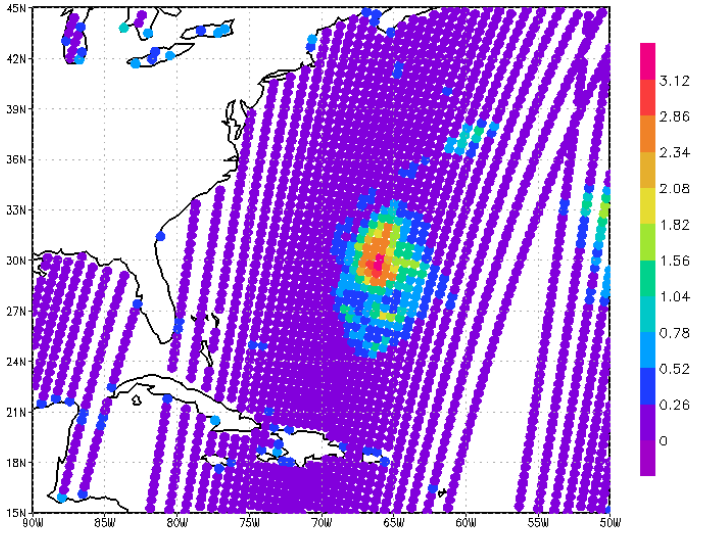
- **NCEP plans to implement cloud affected microwave radiance data assimilation in GDAS *in operational mode by early 2013*.**

- **AMSU-A cloudy radiances are currently being tested. ATMS and SSMI/S will be tested in near future. We hope to test GMI if data can be provided in real time and development resources are available.**

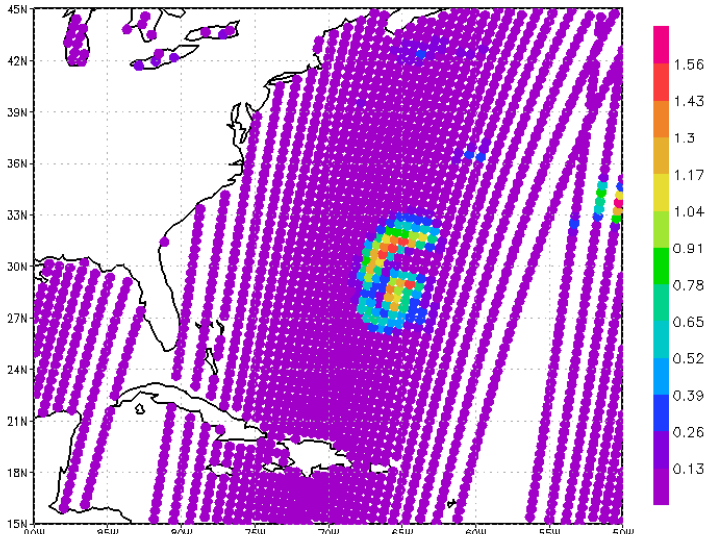
- **Cloudy and precipitating assimilation problem represents one of the most important and difficult problems in modern data assimilation. Large collaborative effort in assimilation of satellite observed cloud and precipitation is underway between NOAA, NASA, and NCAR. (e.g. JCSDA Cloud and Precipitation Data Assimilation WG)**

Cloud Analysis Increments

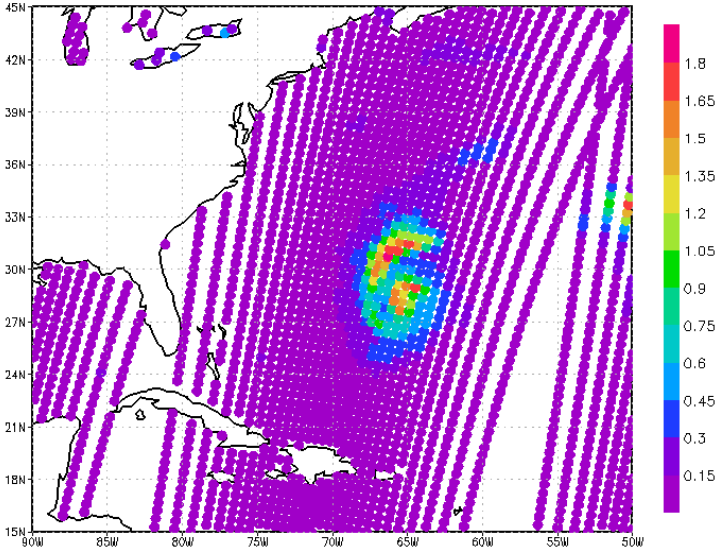
Retrieved CLWP (observations)



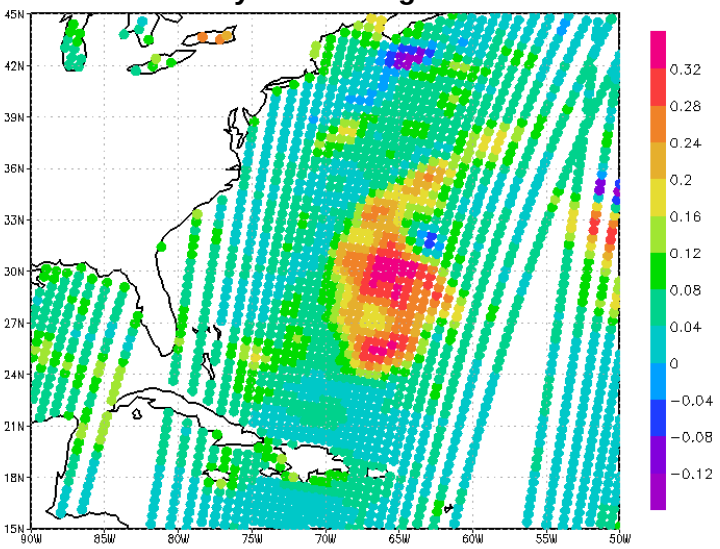
First-guess CLWP



Analysis CLWP



Analysis – First-guess



- **Clouds have been actively assimilated.**
- **Cloud analysis fields got improved and closer to the observations (retrieved clouds).**

Future plans within GPM-era (2013 and beyond)

(1) Assimilation of cloud and precipitation affected microwave radiances in NOAA NCEP Global Data Assimilation System

- If data are available in real time and development resources are available, we hope to test GMI radiance in the GDAS to examine the benefit and synergy with other numerous observations such as observations from NOAA Metop, and NPP satellites.

(2) GMI will be useful to examine the performance of the GFS cloud microphysics model in forecasting ice cloud and frozen precipitation.

- GMI cloud and precipitation product can be useful for validation of cloud and precipitation analysis results and vice versa.

(3) Assimilation of space-borne precipitation radar reflectivity in NOAA NCEP Global Data Assimilation System

- DPR data will be very useful for validation of cloud and precipitation analysis and forecasts
- EMC is currently developing components to assimilate ground-based and aircraft based radar observations in GDAS. The use of these resources can 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	Geographic Coverage	Vertical Resolution	Horizontal Resolution	Measurement Accuracy	Measurement Precision	Sampling Interval	Data Latency
Microwave Radiance	Global		Raw	A few tenth degree	A few tenth degree	Once per hour	28 min
Radar Reflectivity	Global	Raw	Raw	TBD	TBD	Once per hour	28 min

- 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.
- If operational use of the GPM data is desired, it is critical to get the data in real time.
- 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 and to validate cloud and precipitation analysis and forecasts.

BACK-UP SLIDE

Progress Made to Date

	Operational GSI (Clear Sky radiance DA)	New GSI (All-sky radiance DA)
(1) Forward operator & First guess fields	Do not include cloud	Include clouds for Tb and jacobians
(2) AMSU-A radiance Observations	Clear sky over land and ocean	Clear sky over land and ocean + Cloudy sky over the ocean
(3) Observation error	Statistics based in clear sky conditions	Statistics based in clear and cloudy sky conditions
(4) Control variable	T, q, ozone profiles, sfc P, u, v Not including cloud water	T, q, ozone profiles, sfc P, u, v + Cloud water profile
(5) Background error covariance	T, q, ozone profiles, sfc P, u, v Using NMC method	T, q, ozone profiles, sfc P, u, v + cloud water Using NMC method
(6) Quality control	• Screen out cloudy data • Gross check:	• Keep cloudy data unless cloud liquid water path > 0.5kg/m^2 • Gross check: