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Impact of GPM Rainrate Data Assimilation on Simulation of Hurricane Harvey (2017)

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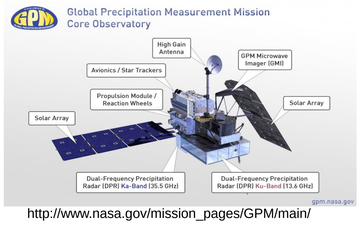
Introduction

Global Precipitation Measurement (GPM):

Built upon Tropical Rainfall Measuring Mission (TRMM) legacy for next-generation global observation of rain and snow. The GPM was launched in February 2014 with Dual-frequency Precipitation Radar (DPR) and GPM Microwave Imager (GMI) onboard.



http://www.nasa.gov/mission_pages/GPM/main/

The GPM has a broad global coverage ~70°S – 70°N with a swath of 245/125-km for the Ka (35.5 GHz)/Ku (13.6 GHz) band radar, and 850-km for the 13-channel GMI. GPM also features better retrievals for heavy, moderate, and light rain and snowfall.

Project Goals:

- To develop methodology to assimilate GPM surface precipitation data with Gridpoint Statistical Interpolation (GSI) data assimilation system and WRF ARW model.
- To investigate the potential and the value of utilizing GPM observation into NWP for operational environment.

Methodology and Experiments

Model and Data Assimilation System:

WRF ARW V3.8

Community GSI v3.5

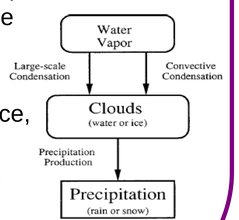
Experiments:

- 9-km resolution, 00 UTC 27 – 00 UTC 29 August 2017
- Observations: IMERG final gauge calibrated rain rate & GMI GPROF rain rate
- Observational error: 2 mm/hr
- DA cycles: 12 UTC and 21 UTC 08/27/2017

Experiments	Data Assimilation
CTRL	No
DA_imerg	IMERG rain rate at 1200–1230 UTC and 2100–2130 UTC 08/27/2017
DA_gprof	GMI GPROF rain rate at 1108–1240 UTC and 2023–2156 UTC 08/27/2017

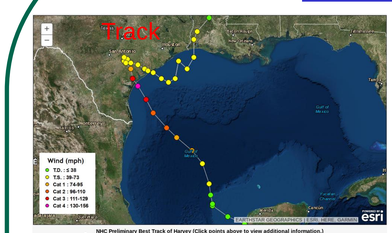
GSI Physics Forward Model for Rain Assimilation:

- Convective Precipitation: Pan and Wu (1995) simplified Arakawa and Schubert scheme
- Grid-scale Condensation and Precipitation: Zhao and Carr (1997)
  - ❖ Hydrometeors: cloud water, rain, cloud ice, and snow
  - ❖ Microphysical processes: condensation, evaporation, accretion, autoconversion, melting/freezing, aggregation of ice crystals

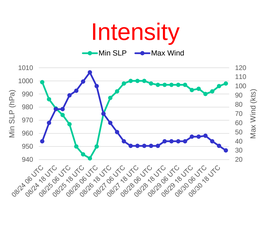


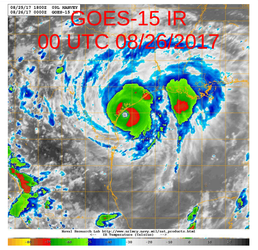
Result

Hurrican Harvey (2017)

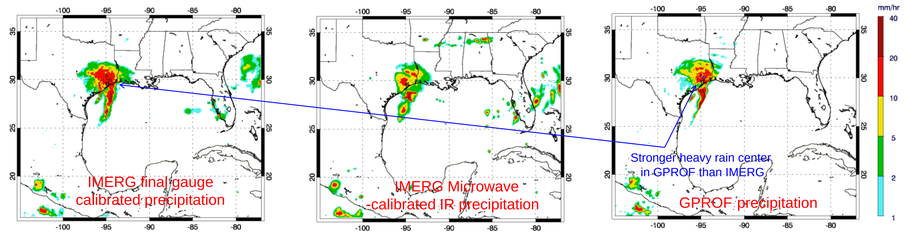


NHC Preliminary Best Track of Harvey (Click points above to view additional information.)
http://www.weather.gov/crp/hurricane_harvey

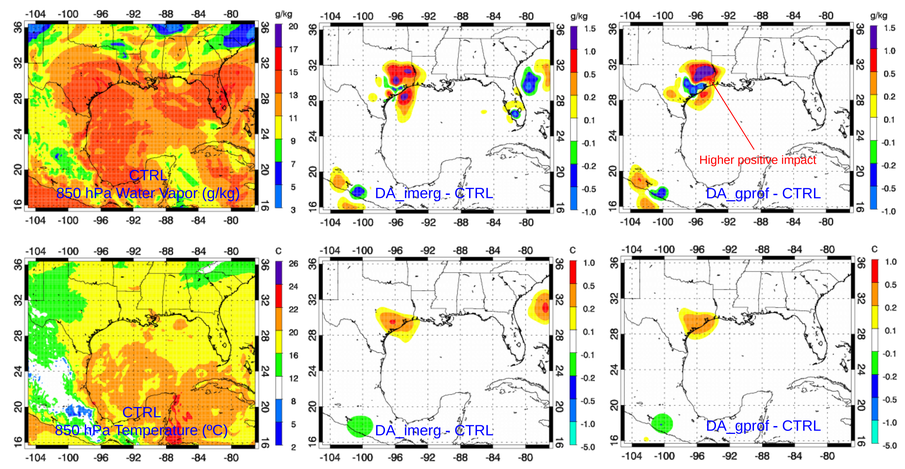




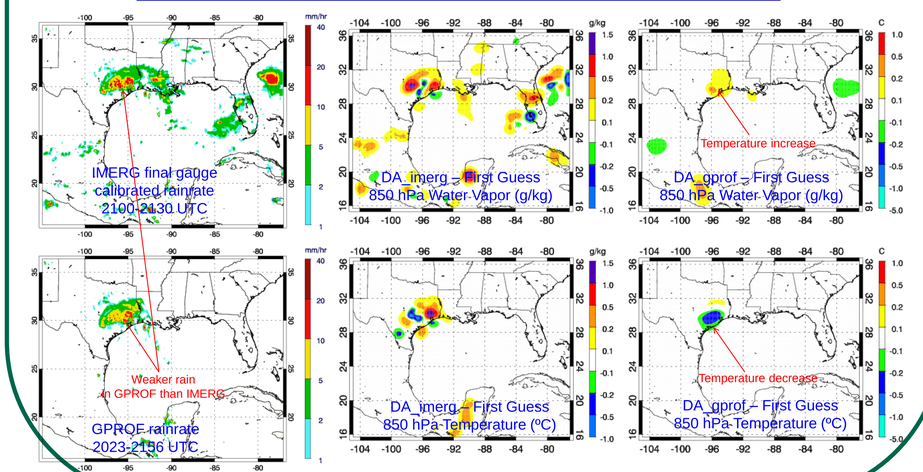
GPM Rainrate Observations at 12 UTC 08/27/2017



Increment from the 1st Data Assimilation Cycle at 12 UTC 08/27/2017

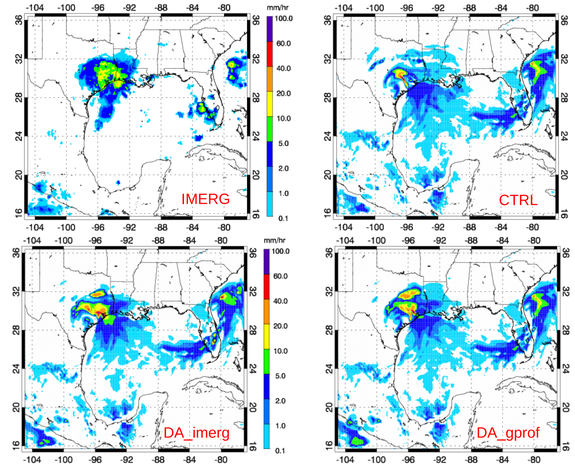


2nd Data Assimilation Cycle at 21 UTC 08/27/2017

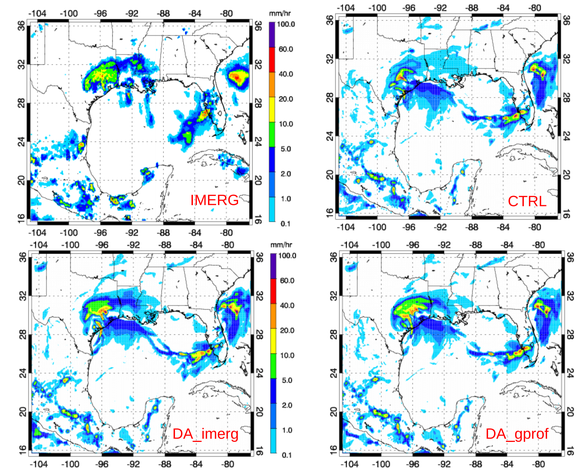


Data Impact on Precipitation Forecast

1-hr Rainfall at 15-16 UTC 08/27/2017



1-hr Rainfall at 00-01 UTC 08/28/2017



Threat Scores (threshold=2mm/hr) Against IMERG Rainrate

Time	CTRL	DA_imerg	DA_gprof
00 UTC 8/28/2018	0.21	0.32	0.32
06 UTC 8/28/2018	0.17	0.28	0.25
12 UTC 8/28/2018	0.20	0.23	0.22
18 UTC 8/28/2018	0.19	0.22	0.24

Conclusion and Discussion

1. The GPM rainrate data has been successfully assimilated using the GSI rain data assimilation package. Impacts of rainrate data have been found in temperature and moisture fields of initial conditions.
2. Assimilation of either GPM IMERG or GPROF rain product produces significant improvement in precipitation amount and structure for Hurricane Harvey (2017) forecast. Since IMERG data is available half-hourly, further forecast improvement is expected with continuous assimilation of IMERG data.

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