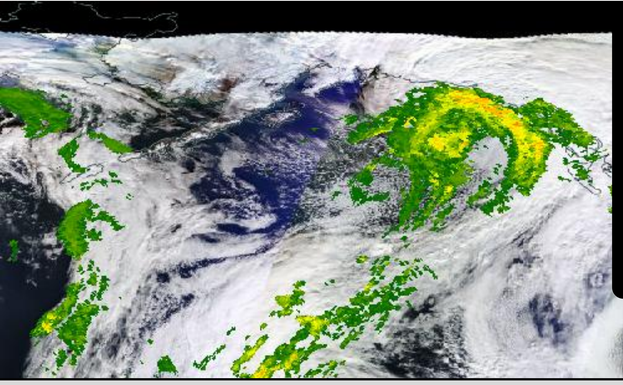
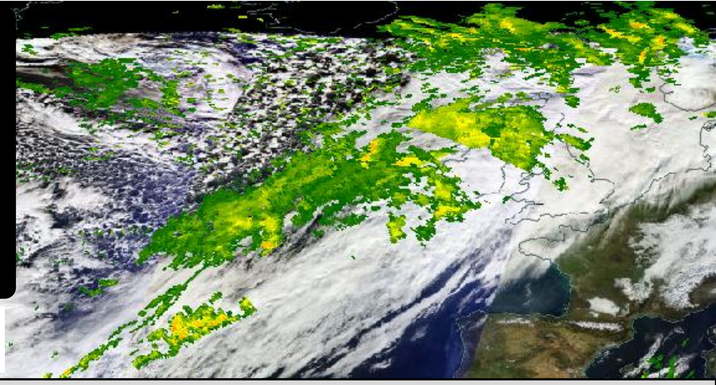


GPM Precipitation In Extratropical Cyclones

Catherine Naud (Columbia Univ./NASA-GISS) & James Booth (CUNY-CCNY)



PMM award *NNX16AD82G* - Contact: **cn2140@columbia.edu**

INTRODUCTION

Extratropical cyclones (ETC) = important purveyor of precipitation in mid-latitudes but no consensus on evolution in a warming climate, i.e. more or less precipitation?
Most GCMs predict rain too frequently with rates when occurring that are too small. Problem found also within ETCs.
=> model representation of precipitation processes in ETCs in question

GOALS

⇒ Create GPM-ETC database = GPM precipitation retrievals associated with ETCs with both CMB and IMERG
⇒ Use database to evaluate midlatitude precipitation in GCMs and MERRA-2; determine MERRA-2 skill in representation of ETC, and contribution of ETC to total precip.
⇒ Use database to explore specific processes associated with precipitation in ETCs; examine impact of local evaporation, moisture advection and vertical velocities.

Part I: GPM-ETC database

Method and content:

- ETC locations and tracks: identified by tracking central pressure minima using MCMS (Bauer et al., 2016), based on ERA-interim 6-hourly SLPs
- Keep ETCs with center within 30-60N/S, land and ocean, from March 2014-present
- For each 6-hr cyclone location, collect **L2 CMB DPR+GMI** files that are within ±3 hours and 25° from cyclone center
  => includes ~ 2/3 of all cyclones per month
- Save one file per cyclone with following information:
  - Description of storm center (lat., lon., SLP, surface)
  - ETC *track* information (i.e. info for all 6-hrly positions during ETC life)
  - Name of all CMB files coincident in time and space
  - For all these CMB files: arrays of latitude, longitude, precipitation rate, type, and liquid fractions and surface type along orbit
- When IMERG v4 ready, database will be updated

For data contact cn2140@columbia.edu or jbooth@ccny.cuny.edu

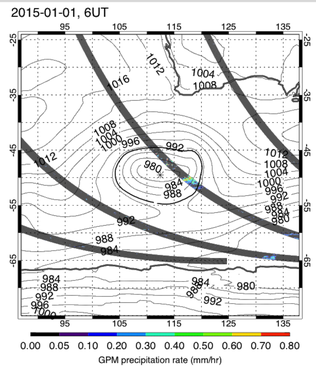


Figure 1: Southern Ocean cyclone on 2015-01-01, 06 UT
Latitude= 49.53°S
Longitude=112.43°E
Contours= MERRA-2 SLP
Dark bands: 4 GPM orbits
Colored pixels: Ka+Ku+GMI precipitation rate
Orbits start time: 03:02UT, 04:34UT, 06:07UT and 07:39UT
Note -65°S limit for orbits

Part II: Groundwork for model evaluation – construction of composites

1. Resolution considerations

Irregular spatial sampling :

- Need equal area grid cells
- Test: 5 km vs. 50 km resolution
  5 km close to GPM resolution
  50 km close to MERRA-2 resolution
  250 km close to GCM resolution
- Project data points into cyclone centered rectangular grid (Fig 2: example for one cyclone)
- Average multiple cyclones for a given region and/or period (Fig. 3: composites for 2015-01 NH ocean cyclones for 3 resolutions)

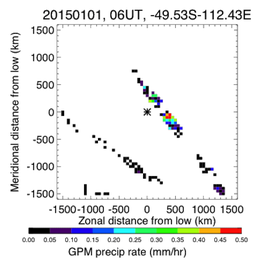


Figure 2: CMB precipitation rate projected in equal area 50 km x 50 km cells for same cyclone as Figure 1

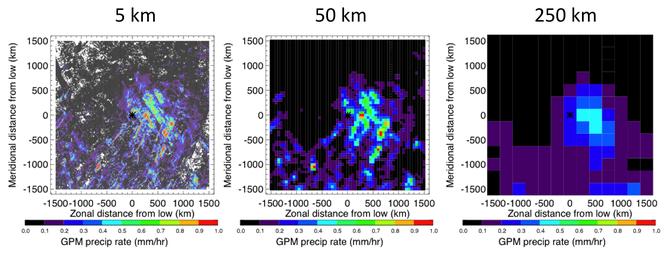


Figure 3: Average CMB precipitation for 2015-01 NH ocean ETCs in 5 km (left), 50 km (middle) and 250 km (right) grids

⇒ As resolution decreases, so does the maximum precipitation rate
⇒ Also need to know the minimum measurable GPM precipitation rate at each resolution – At 50 km, minimum GPM precipitation rate = 10^{-4} mm/hr

2. Impact of ETC number – GPM composites

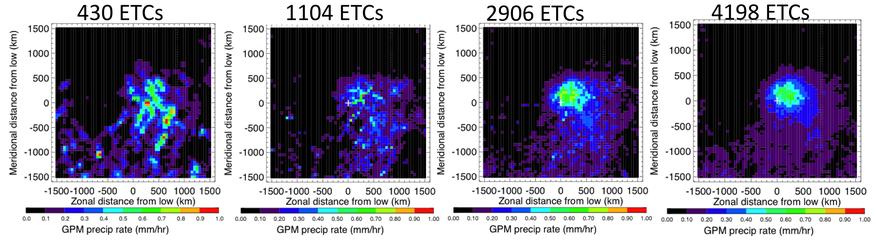


Figure 4: Mean GPM precipitation rate for one month (201501), five months (201403-201408), 10 months (201403-201412) and 22 months (201403-201512).

3. Impact of irregular sampling – MERRA-2 composites

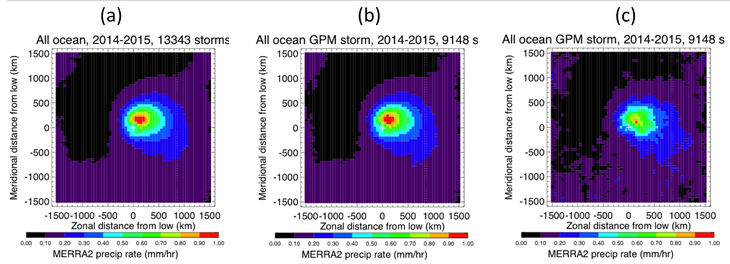


Figure 5: 2014-2015 NH ocean ETCs MERRA-2 mean precipitation: (a) for all NH ocean cyclones and all grid cells, (b) for only cyclones seen by GPM but all grid cells, and (c) for only GPM cyclones and GPM collocated grid cells.

Using MERRA-2: 13343 similar to 4198 ETCs observed by GPM (a vs. b) but irregular sampling within cyclones still has visible impact on composites (c vs. b)

4. Impact of precision: MERRA-2 Frequency of occurrence of precipitation

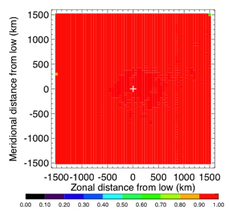


Figure 6: Frequency of occurrence of MERRA-2 precipitation > 0 (min = 10^{-34} mm/hr). Yes, all values are greater than 90%.

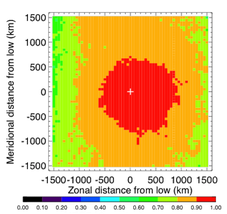


Figure 7: same as Fig. 6 but for MERRA-2 precipitation rate > 10^{-4} mm/hr (GPM min rate)