Growth and Decay of Organized Convection during CPEX 2017: Insights from IMERG and DC-8 data

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Motivation

IMERG[1], with its superior spatial and temporal resolution (vs. 3B42) provides an opportunity for an objective assessment of the growth and decay of convective rainfall events anywhere between 65°N/S. Upscale growth of deep convection into "organized" mesoscale convective systems (MCS) is an important yet poorly understood process.

Here, we explore IMERG as a measuring tool for the area and rain volume of convective systems during the Convective Processes Experiment (CPEX) of 2017, where we can compare IMERG Precipitation Features (IPF) with radar and photographic data from the NASA DC-8. **Our goal** is to learn when to trust the IMERG estimates, when to be more skeptical, and to work together with Dr. Huffman to pinpoint specific issues, and work toward improvement of IMERG.

Cases Studied Thus Far

- **Small (~100 x 100 km) MCS of 10th June:** Aircraft reached MCS just after formation and strengthening, which was well-captured by IMERG. But IMERG incorrectly showed sudden expansion of light precipitation between 1930 - 2000 Z, while correctly showing no major change in rain volume.

- **Large MCS (~ 150 X 500 km) of 06th June:** Aircraft penetrated MCS during period of strong, active convection at 1900 Z, with IMERG in excellent agreement with visual and radar images. Thereafter, IMERG showed continued growth in area and rain volume, but showed unreasonable time series of rainfall rate maxima, at times of passive microwave overpasses only

Data

- IMERG Final run – Half Hourly , 0.1° X 0.1° precipitation product.

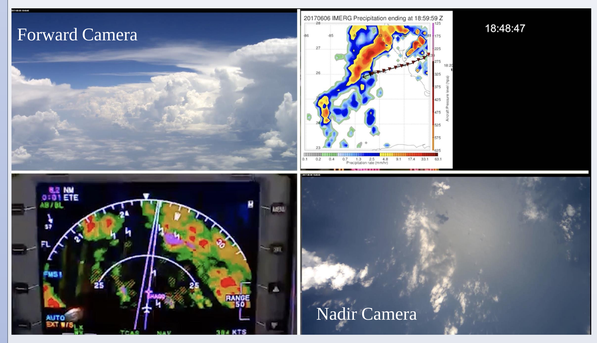
- DC-8 Aircraft - Forward Camera, Nadir Camera, and Pilot Radar scope.

[1]Integrated Multi-satellitE Retrievals for GPM (IMERG), Huffman, G.J., D.T. Bolvin, D. Braithwaite, K. Hsu, R. Joyce, C. Kidd, E.J. Nelkin, S. Sorooshian, J. Tan,P. Xie, 2018: Algorithm Theoretical Basis Document (ATBD) Version 5.2 for the NASA Global Precipitation Measurement (GPM) Integrated Multi-satellitE Retrievals for GPM (I-MERG). GPM Project, Greenbelt,MD.

Results

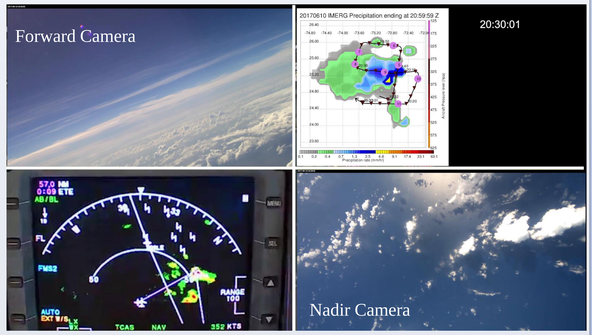
CPEX Flight - June 06th 2017

In the image below, IMERG precipitation overlaid with DC-8 aircraft track, captures the precipitation location, area and intensity very well. The forward camera, and pilot radar shows that the system is oriented north-east to south-west with deep convective cores. There was a passive microwave (PMV) overpass close to this time at 18:53 Z.



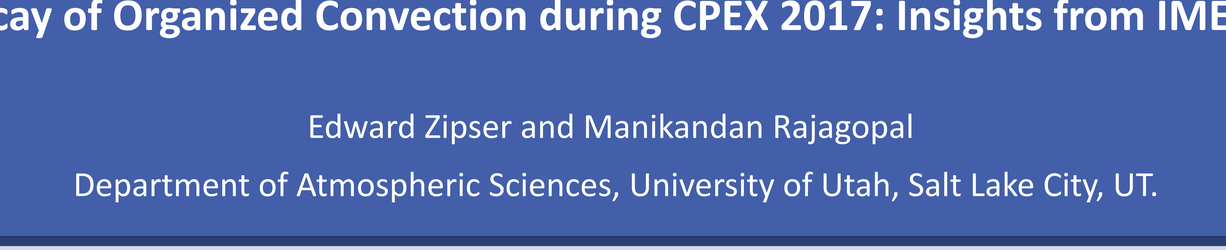
CPEX Flight – June 10th 2017

In the image below, IMERG shows a precipitation rate of 0.5 mm/hr for a large area on the west side of the convective system. The forward camera and pilot radar looking in that direction shows only scattered shallow cumulus which is inconsistent with the IMERG indication.

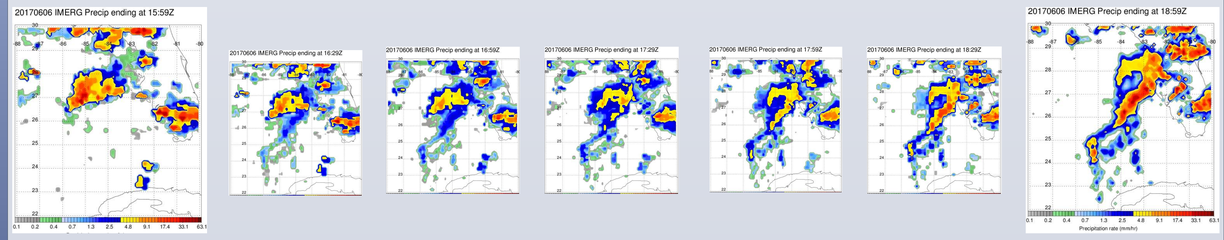


Time Interpolation of Precipitation

IMERG uses CMORPH-KF algorithm to interpolate PMV precipitation forward and backward in time with decreasing weights (IMERG Algorithm Theoretical Basis document). The following sequence of images shows the time interpolation of precipitation between two passive microwave overpasses – For June 10th at 19: 50 Z & 23:02 Z, and For June 06th at 15:36 Z & 18:53 Z.



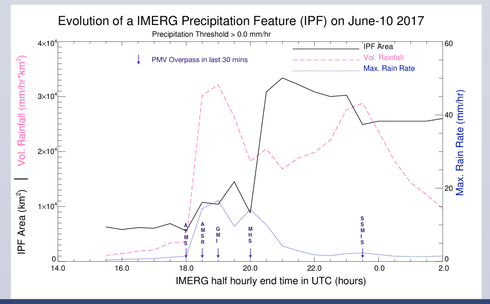
Precipitation Interpolated between PMV Overpass



On June 10th, IMERG precipitation feature underwent a rapid growth in precipitation area at 20:29 Z, The increase in the precipitation area comes from the time interpolation of future passive microwave overpass at 23:00 Z.. Though there was a recent PMV overpass at 19:50 Z, the precipitation from future PMV overpass nearly 2.5 hours later, has contributed to the area and the rapid growth. On June 6th, the upscale growth of area and rain volume shown by IMERG appears reasonable, although peak rain rates suffer between microwave overpasses.

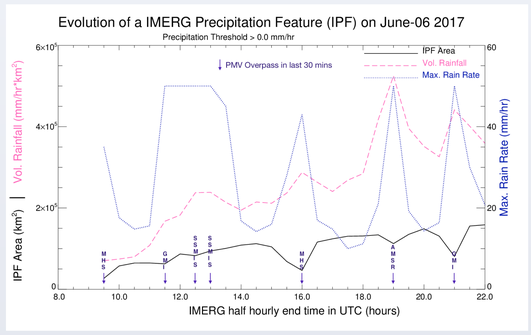
Defining Upscale Growth using IMERG PF:

To define the growth of a convective system, using precipitation area may be misleading at times, as for the CPEX – June 10th case where the rapid growth in precipitation area is not real. However, the evolution of rain volume (summation of product of area x rainfall rate) is not as unreasonable.



Results

The evolution of precipitation feature observed on June 06th flight, shows that the maximum rain rate and volumetric rainfall increases during passive microwave overpass and decreasing away from the overpass time. In this case, despite the unrealistic peaks in maximum rain rate, the evolution of IPF area and IPF rain volume appear to be more reasonable.



Provisional Findings

- IMERG precipitation compares well with the DC-8 aircraft observed features when there is a PMV overpass close in time.

- The interpolation of precipitation forward and backward in time, sometimes create unreal growth/decay of precipitation area.

- Maximum rain rate and volumetric rainfall decreases further away from the PMV overpass in time due to interpolation, which may or may not be true in real MCS.

IMERG time series of the area and rain volume of convective systems over tropical oceans have promise for diagnosing origin and upscale growth of MCSs. However, especially for rainfall rates, the current version of morphing, between passive microwave overpasses, can lead to rapid and perhaps unreasonable changes in rainfall rates. Additional case studies from CPEX are in progress, and we shall work together with Dr. Huffman to assist his team toward improving the morphing procedures.

Acknowledgements

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