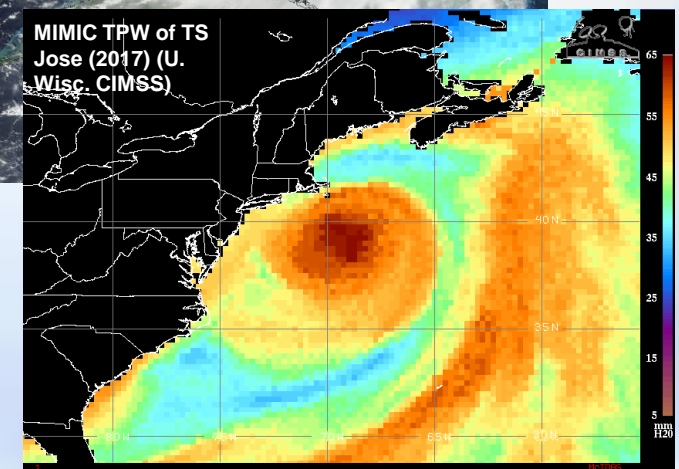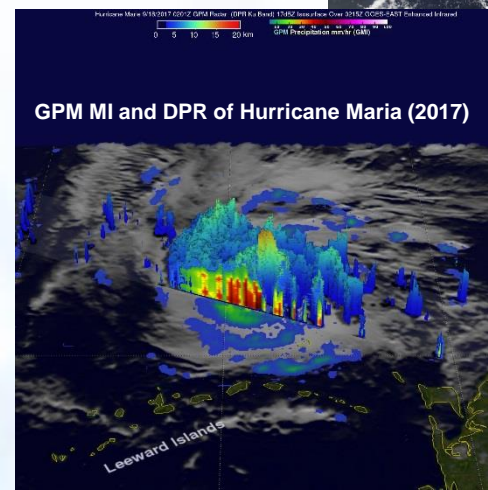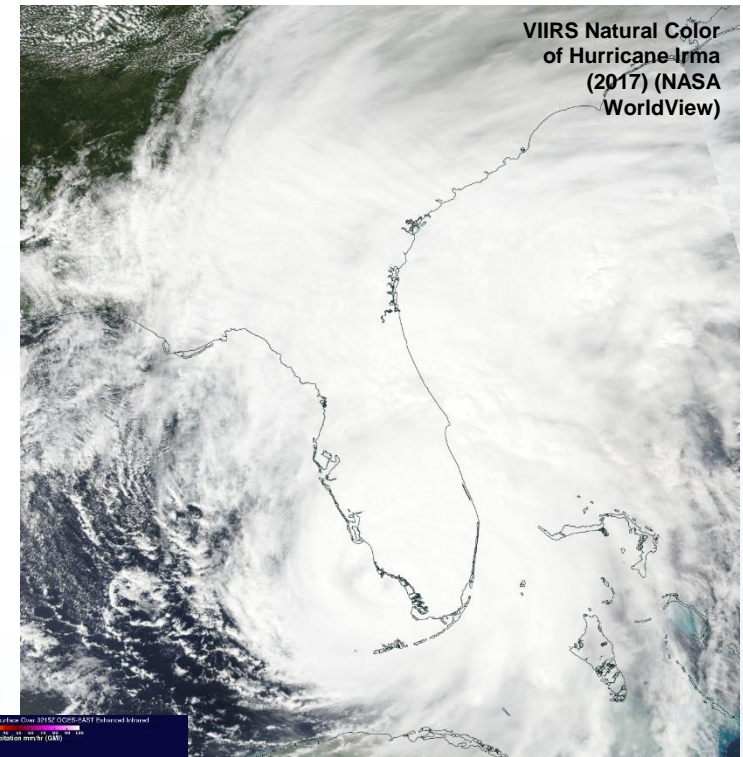# 11D.3: Applications of NASA TROPICS Data for Tropical Cyclone Analysis, Nowcasting, and Impact

Bradley Zavodsky (NASA/MSFC), Jason Dunion (UM/NOAA/AOML), Bill Blackwell (MIT LL), Scott Braun (NASA/GSFC), David Green (NASA/HQ), Chris Velden (UW/CIMSS), Robert Adler (UM/CICS), Joshua Cossuth (NRL), John Murray (NASA/LaRC), and Michael Brennan (NOAA/NHC)

Presentation to the 33rd Conference on Hurricanes and Tropical Meteorology
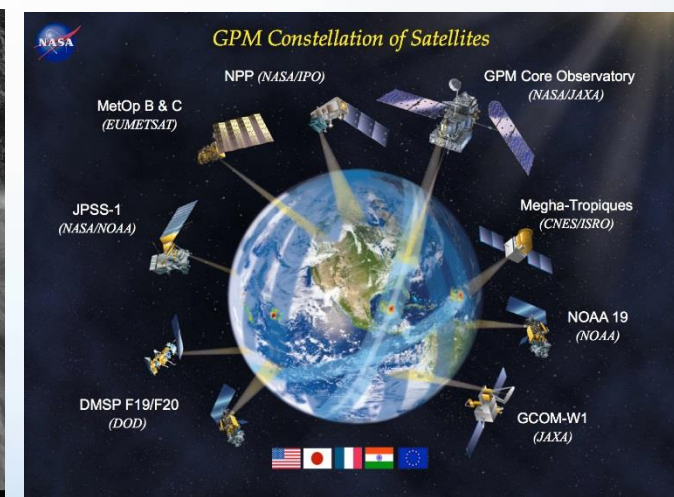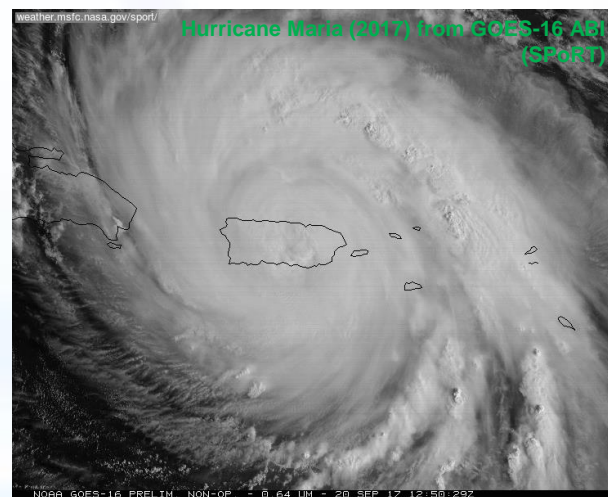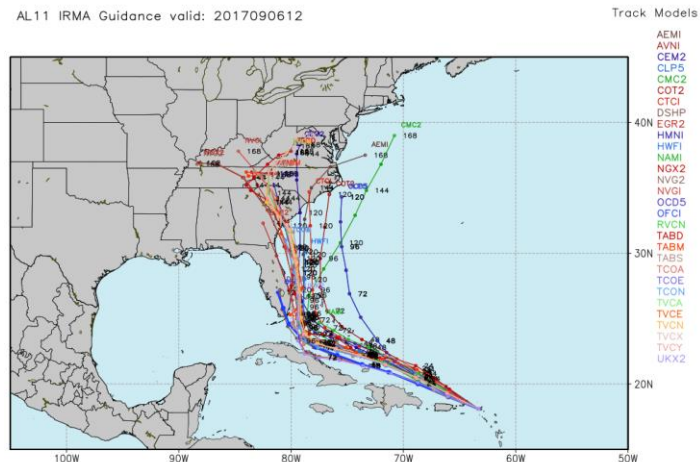
Why does NASA Study Hurricanes?

- **Hurricanes result in large impacts to human population and infrastructure**
  - Hundreds of deaths in 2017
  - $369.6B ($206.6B U.S.) damage in 2017[†]
- **Weather community still has unanswered questions related to hurricane development regarding causes of:**
  - Rapid intensification (RI; all 3 2017 major U.S. landfalling hurricanes underwent RI)
  - Eyewall replacement cycles
  - Diurnal pulsing
- **Mounting evidence that climate change is resulting in conditions that are more favorable for major hurricanes**

VIIRS Natural Color of Hurricane Irma (2017) (NASA WorldView)

GPM MI and DPR of Hurricane Maria (2017)

MIMIC TPW of TS Jose (2017) (U. Wisc. CIMSS)

[†]Source: Charles Watson Jr. of Enki Holdings, LLC and Mark Johnson of JISC, Inc.

- **Numerical models provide information on storm track, capturing environment for steering and strengthening (or weakening)**

- **Intensity is measured using in situ observations, including dropsondes during aircraft missions**

- **Satellites help understand storm structure, which relates to intensity**

  – Geostationary measurements rely on visible and infrared wavelengths that can see shape and motion but lack the ability to see through clouds

  – Passive microwave sensors can see through clouds but are limited to polar-orbiting or high-inclination orbits, reducing ability to study storm evolution


AL11 IRMA Guidance valid: 2017090612 — Track Models

Hurricane Maria (2017) from GOES-16 ABI (SPoRT)

GPM Constellation of Satellites

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- **Earth Venture Instrument proposal selection by NASA with a cost-cap of $30M to measure tropical cyclone structure and demonstrate SmallSat technology**

- **Design**

  - 6 CubeSats with 12-channel passive microwave radiometer (MicroMAS-2)

  - Provide rapid-refresh observations of temperature and moisture soundings and precipitation over the tropics with <60 minute revisit time

  - Meet requirements for temporal refresh needed to study storm evolution with ability to see into clouds

- **SmallSat vehicles to be delivered in 2019 with launch planned for 2020 timeframe**
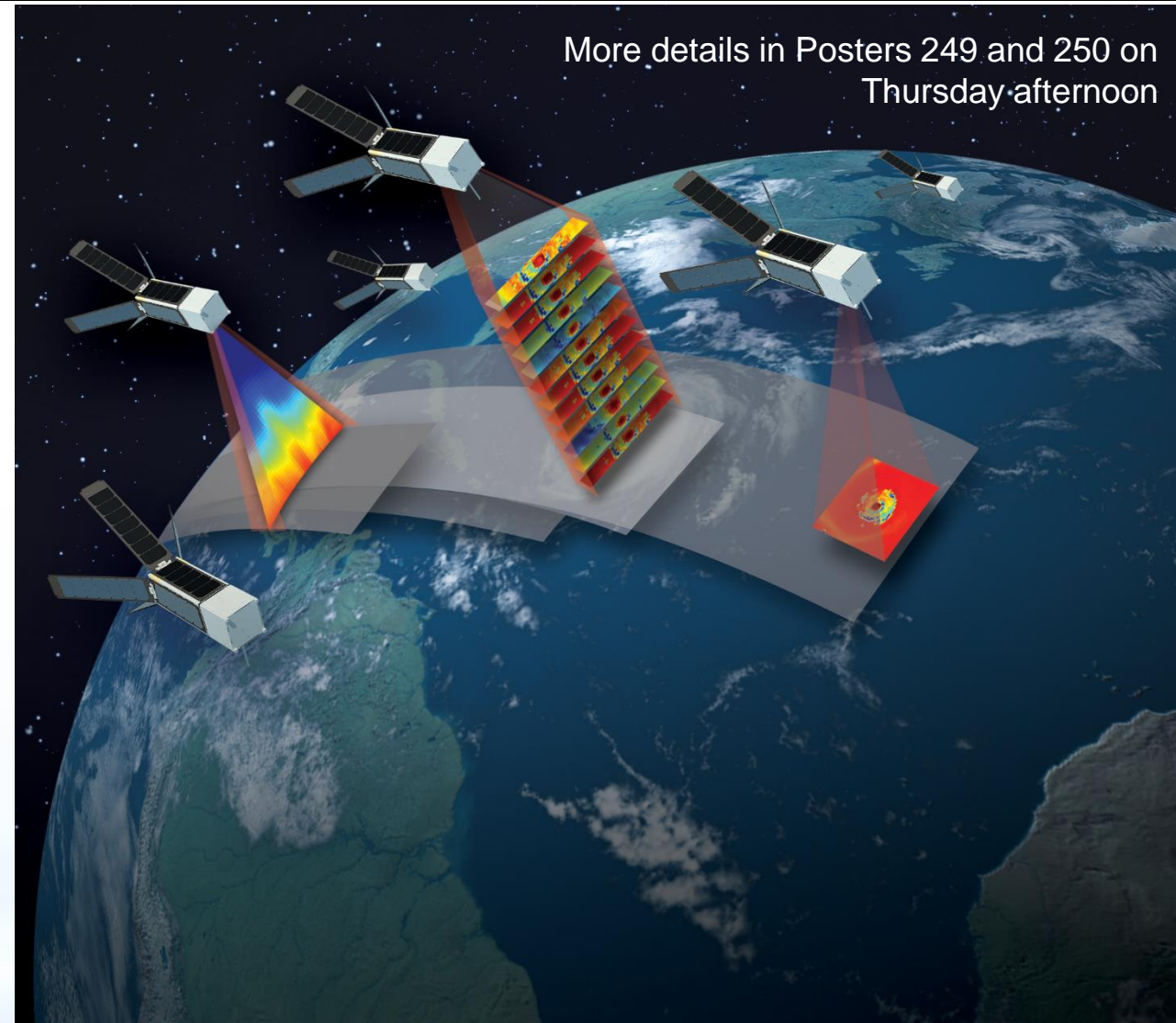
More details in Posters 249 and 250 on Thursday afternoon

TROPICS = Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats

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https://appliedsciences.nasa.gov/

- **NASA's Applied Science program engages with the decision-making community to provide access to and expertise using NASA Earth Science datasets**
- **NASA is continuously looking for opportunities to partner with other private sector, state/local government, disaster responders, university, and other federal agencies to provide value-added observations to support decision makers**
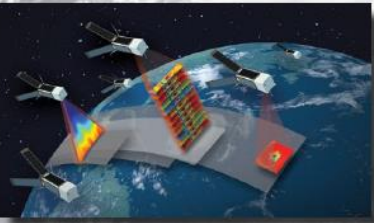
First Time-Resolved Observations
of Precipitation Structure and Storm Intensity
With a Constellation of SmallSats (TROPICS)
Mission Applications Workshop
Summary Report

University of Miami Rosenthal School of Marine
and Atmospheric Studies (RSMAS) Auditorium

Sponsored by
NASA Earth Science Division Applied Science Program

Hosted by the Cooperative Institute for Marine
and Atmospheric Studies (CIMAS),
University of Miami, Miami, Florida

May 8–10, 2017

- **Meeting Objectives**
  - Introduce a broad community of potential end-users to the expected value of TROPICS by reviewing mission specifications and status
  - Review TROPICS data applications through presentations and breakout discussions
  - Provide a forum for applied researchers and operational decision makers to share insight into how observations from TROPICS can be used in their organizations and challenges to their application
  - Begin establishment of a user community that can be used to highlight potential TROPICS applications and accelerate post-launch applications
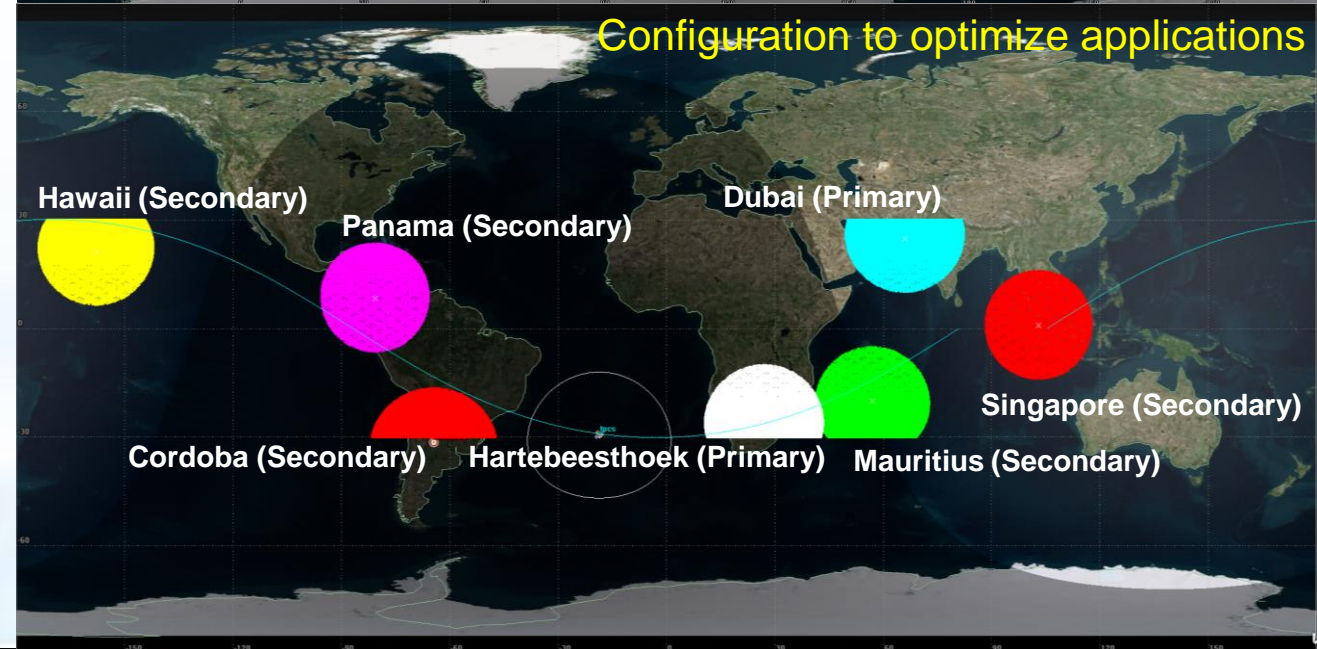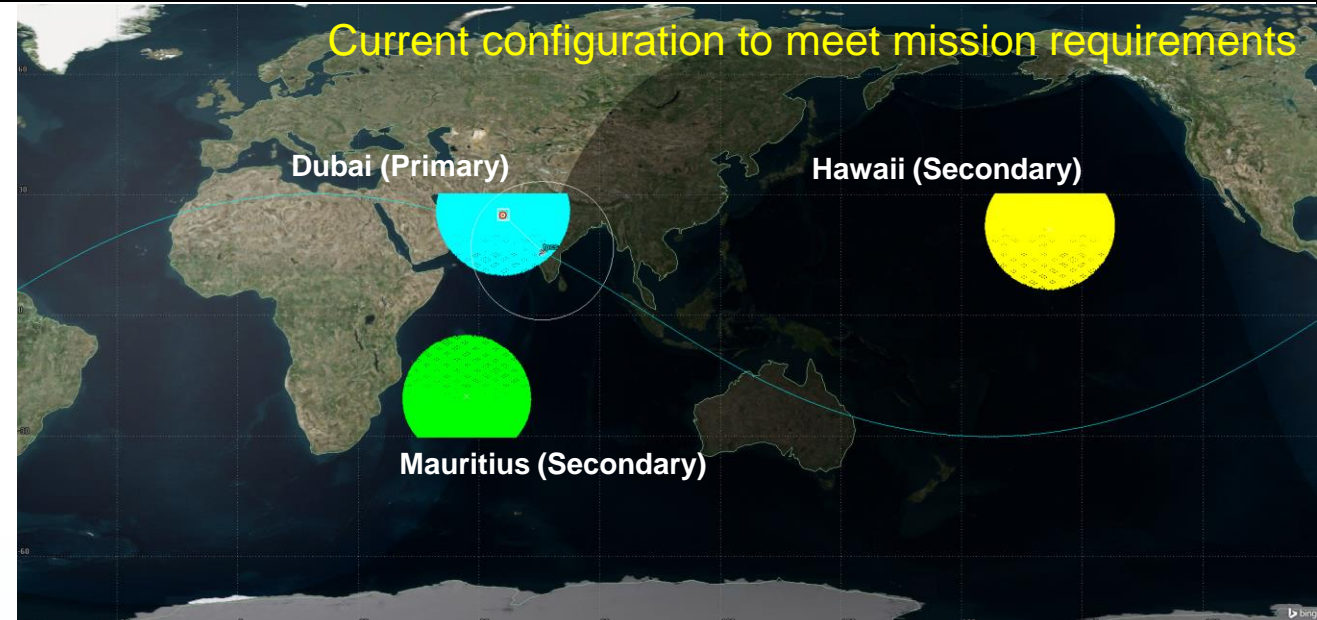 - Hard copy of the report available upon request (see me at the meeting) or go to Workshop website: http://tropics.ccs.miami.edu/workshop-summary/
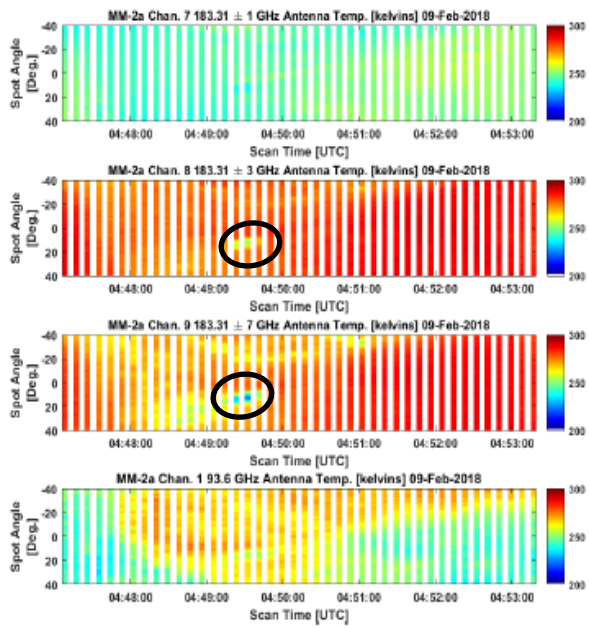
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- **Four application areas were identified and reported on**
  - Terrestrial: high-temporal resolution precipitation data can supplement tropical regions that lack ground-based radar coverage
  - TC Analysis and Nowcasting: providing mission observations and imagery to operational hurricane forecasters who rely on satellite data to diagnose storm structure
  - TC Modeling and Data Assimilation: increased temporal frequency when used with 4DVAR techniques may aid in improving intensity forecasts
  - Tropical Dynamics: applied research to determine convective extremes and trends in precipitation and severe storms not resolved well enough with current temporal frequency of observations
- **End-users want temporal refresh of 30 – 60 minutes to address research and forecasting challenges related to tropical cyclones; more than 3 hours doesn't add to current datasets**
- **Most users want data latency of < 1 hour; > 3 hours makes data difficult to use for operations**
- **Mission data need to be provided in data formats compatible with user modeling and decision support systems**

TROPICS Latency Challenges

- **Data latency: amount of time between observation and data availability**

- **Driver for long data latency is downlink of data from satellites to ground station**

- **Mission has purchased ground services from Kongsberg Satellite Service (KSAT)**

  – Service is "pay to play"

  – TROPICS data will have an average latency of 6 hours to meet mission requirements using 1 station (top)

  – For an additional $500K/yr, latency could be reduced to less than 1 hour (bottom) which would optimize application ability and increase potential use for decision making


Current configuration to meet mission requirements

Dubai (Primary)
Hawaii (Secondary)
Mauritius (Secondary)

Configuration to optimize applications

Hawaii (Secondary)
Panama (Secondary)
Dubai (Primary)
Cordoba (Secondary)
Hartebeesthoek (Primary)
Mauritius (Secondary)
Singapore (Secondary)

Images show some preliminary data going through 6 RPM (full operations is 30 RPM) producing non-"science mode" data Note the convective cell observed in the 183 GHz data (circled)
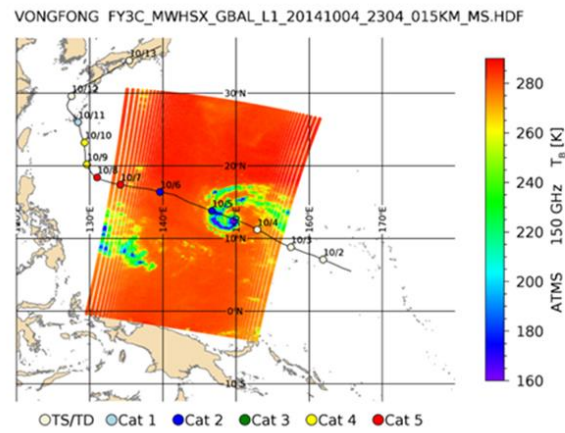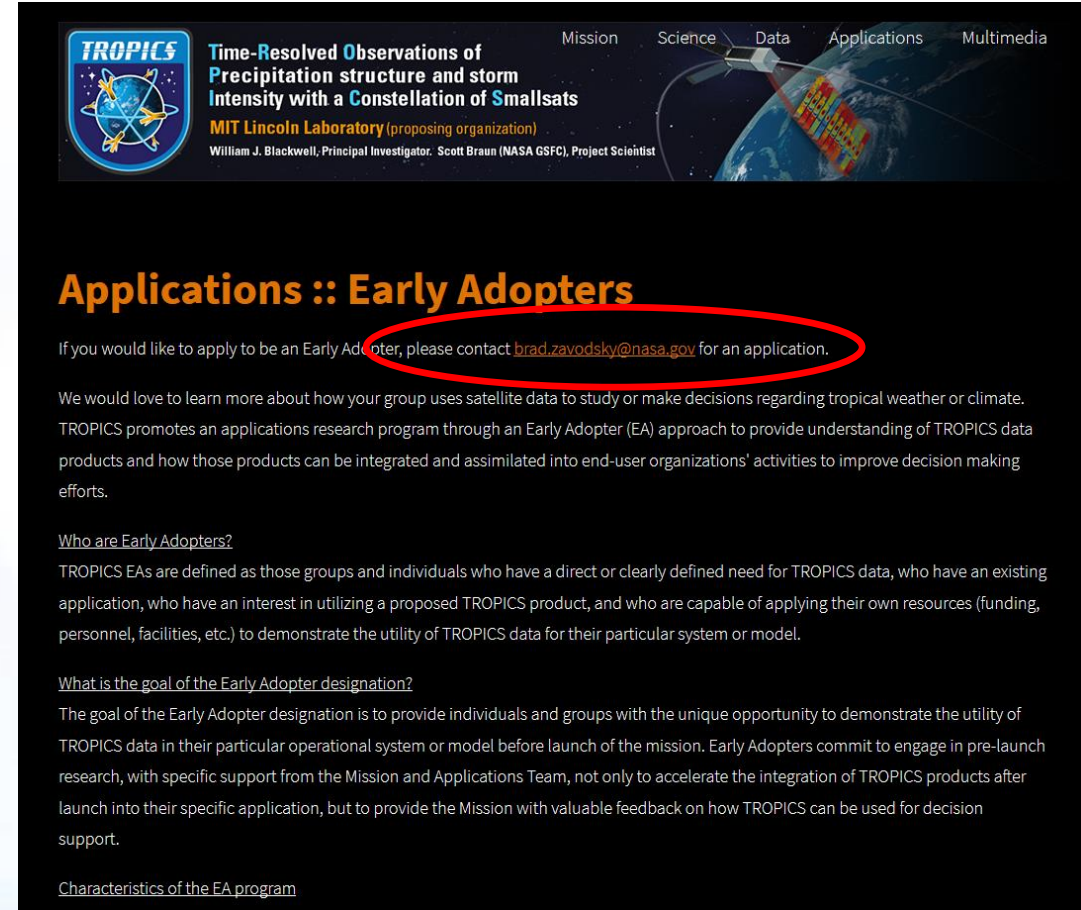

Image from FY-3C MWHS of Typhoon Vongfong
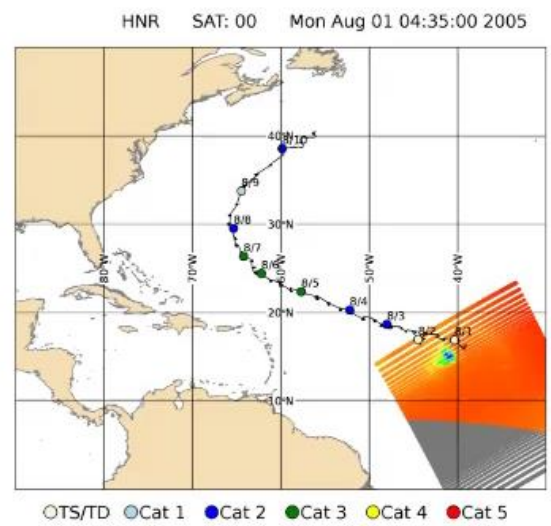
Early-look simulated TROPICS data derived from the Hurricane Nature Run showing temporal resolution of data

- **Goal of proxy data is to accelerate the use of mission data in operational/decision-making environments**

- **Proxy data are being developed using modeled data from a hurricane Nature run, FY-3C, and from recently-launched MicroMAS-2a (see left)**

  - Simulated datasets that match the spatial, temporal, and spectral frequency of planned satellite architecture

  - Plan to make data available in multiple data formats for easier, earlier integration

- **Proxy datasets will first be available to the TROPICS Science Team for evaluation and then once mature will be made available to the Early Adopter community (see next slide)**

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- **Establishment of an Early Adopter (EA) community for TROPICS is underway**

- **Allows formal, albeit *unfunded*, connection to science team for early access to data and ability to ask questions about the data and provide feedback on early products**
  - The EA will receive access to developmental products and interaction with the Applications Team and a relevant member of the Science Team to enable an increased understanding and integration of the new products into their systems
  - The Science Team member will gain a partner who can evaluate products and offer feedback from a functionality perspective as well as potential calibration and validation information

- **Contact Brad Zavodsky (brad.zavodsky@nasa.gov) for a copy of the application form**

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- **We would love to learn more about how your group uses satellite data to study or make decisions regarding tropical weather or climate**
  - Become an EA!
  - Subscribe to our TROPICS Applications Mailing List for mission updates and other opportunities on the applications website: https://www.nsstc.uah.edu/tropics/
  - Participate in quarterly calls—next call will be in June 2018; we are always looking for presenters willing to share their potential use of TROPICS data at a future meeting
- **Contact me at brad.zavodsky@nasa.gov if you have any questions or would like to get involved**