NASA Science Mission Directorate
Earth Science Division
Applied Sciences Program

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

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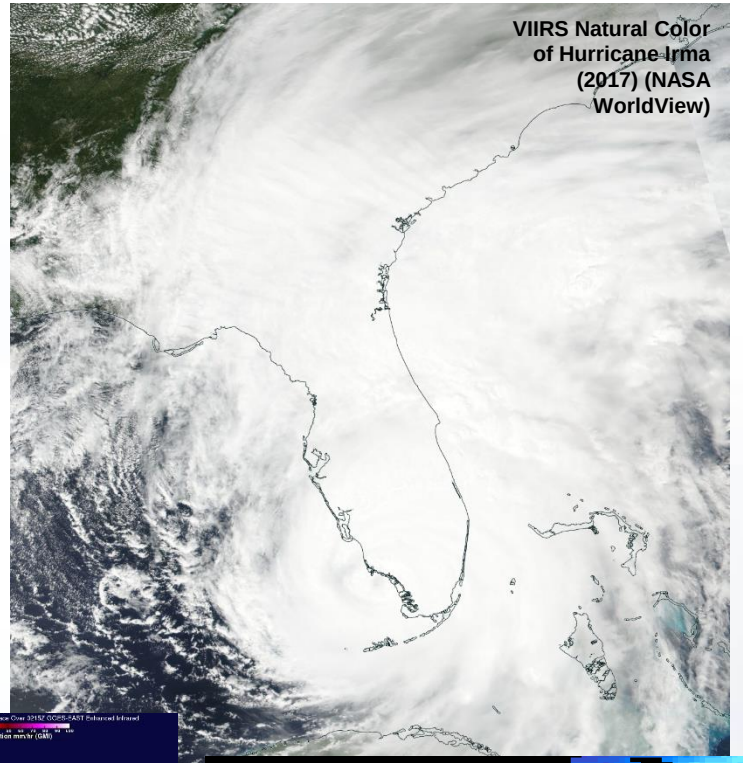
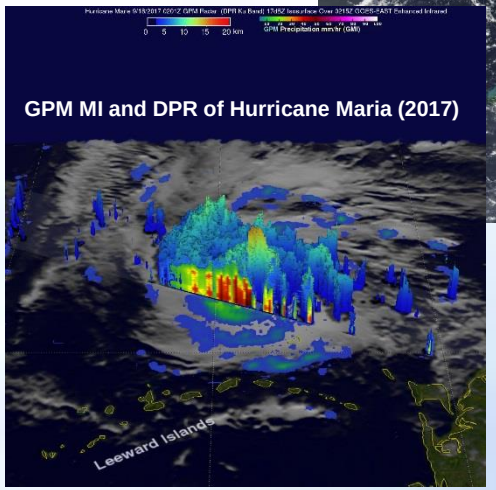
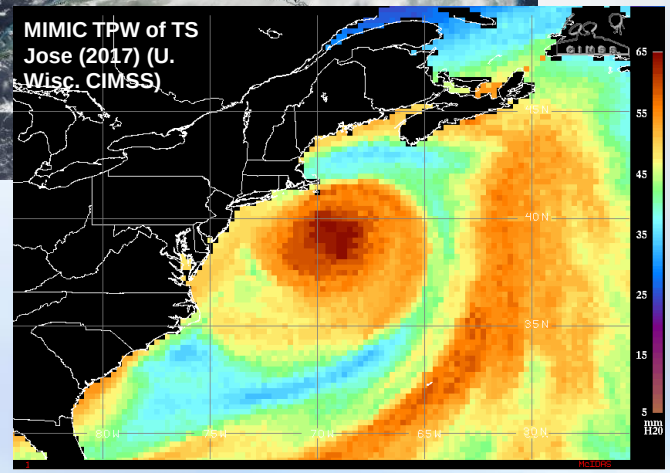
Presentation to the 33rd Conference on Hurricanes and Tropical Meteorology

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**



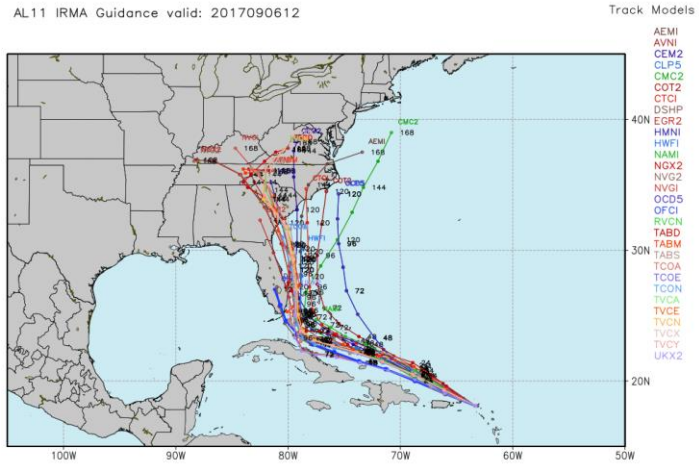


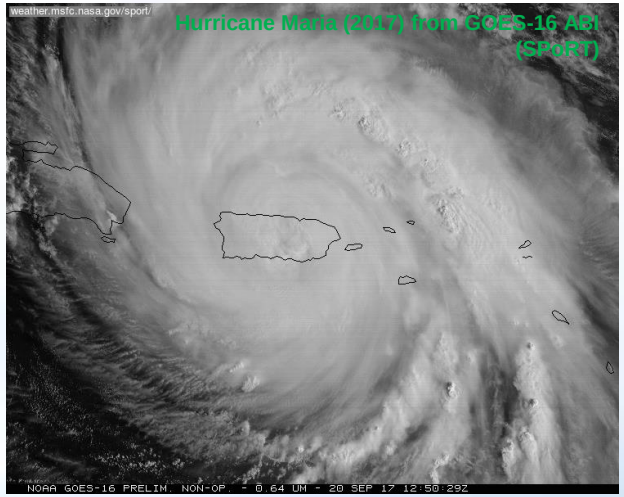


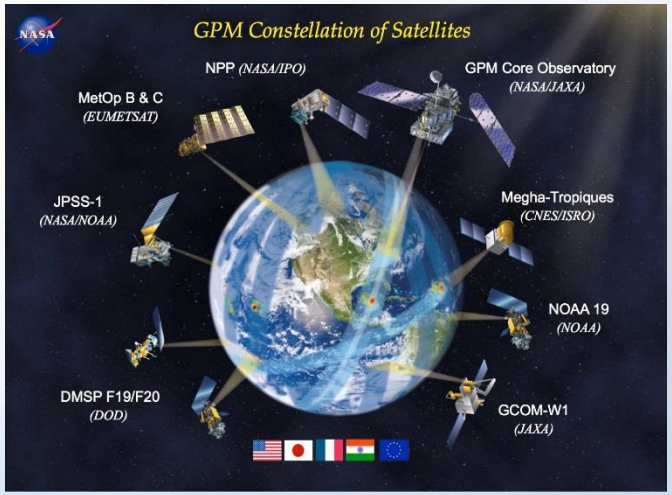
†Source: Charles Watson Jr. of Enki Holdings, LLC and Mark Johnson of JISC, Inc.

Current State of Observation and Forecasting

- **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

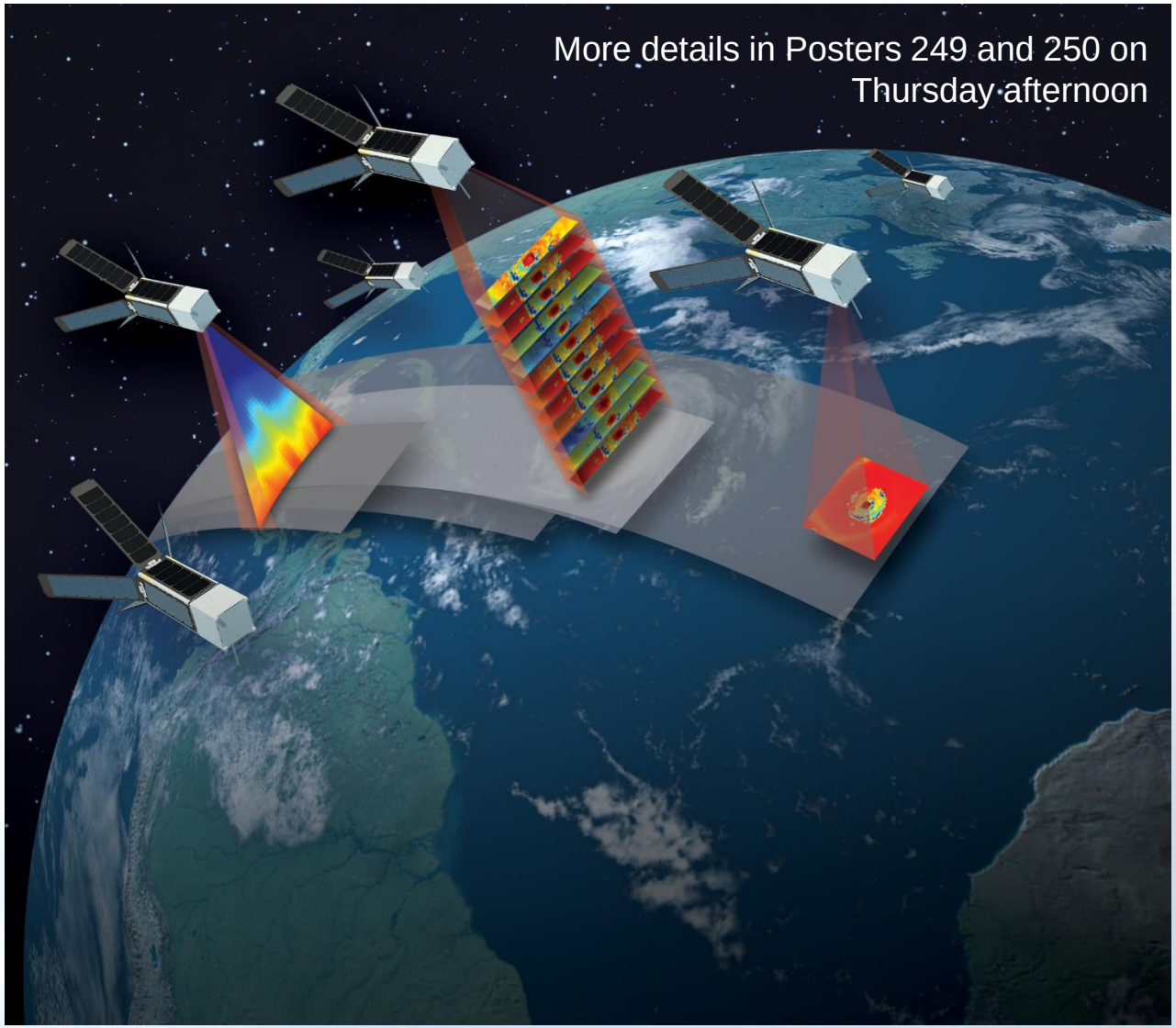






TROPICS Mission Overview

- **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**



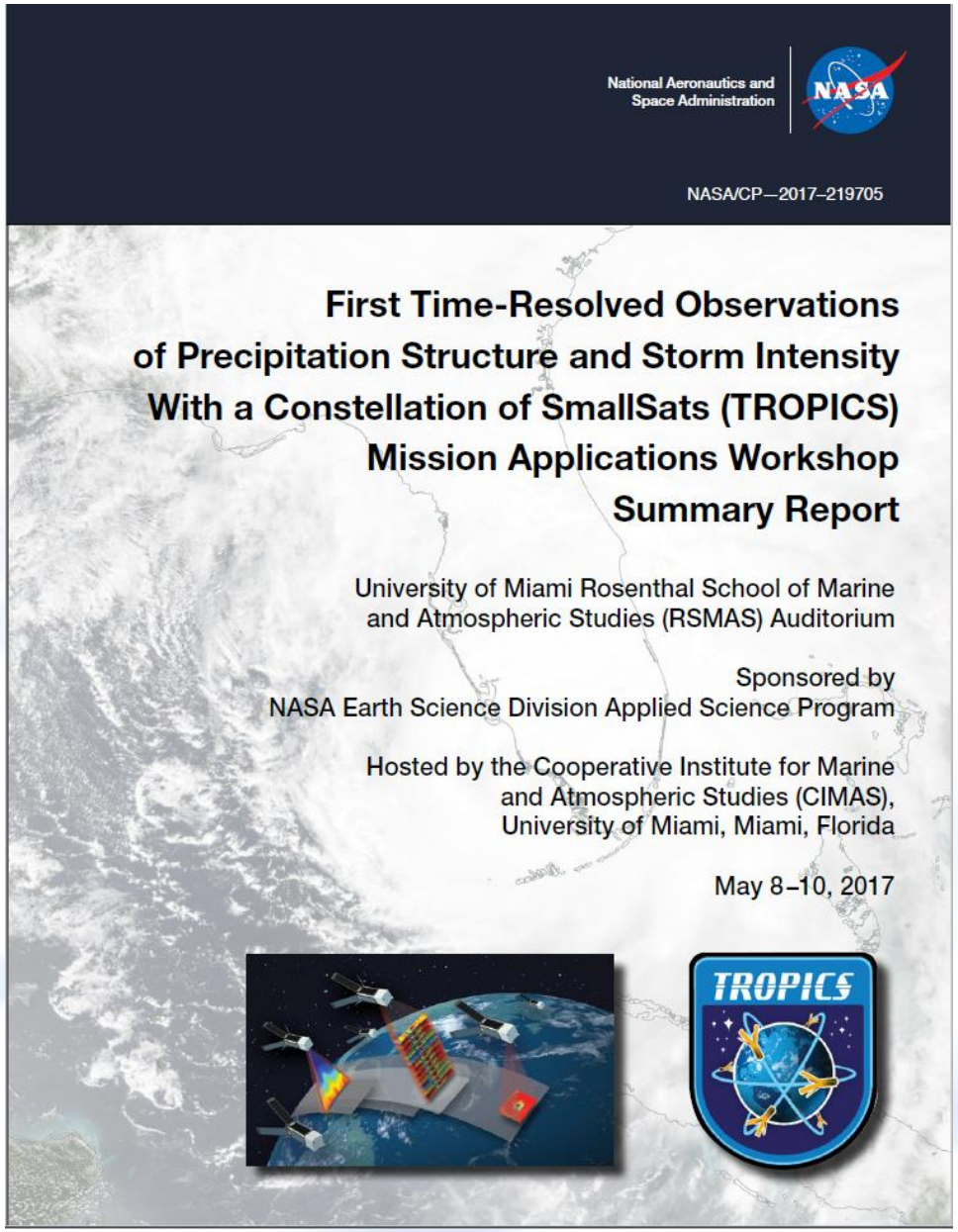
TROPICS = Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats

NASA Earth Science Division Applied Science Program

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 TROPICS Applications Workshop



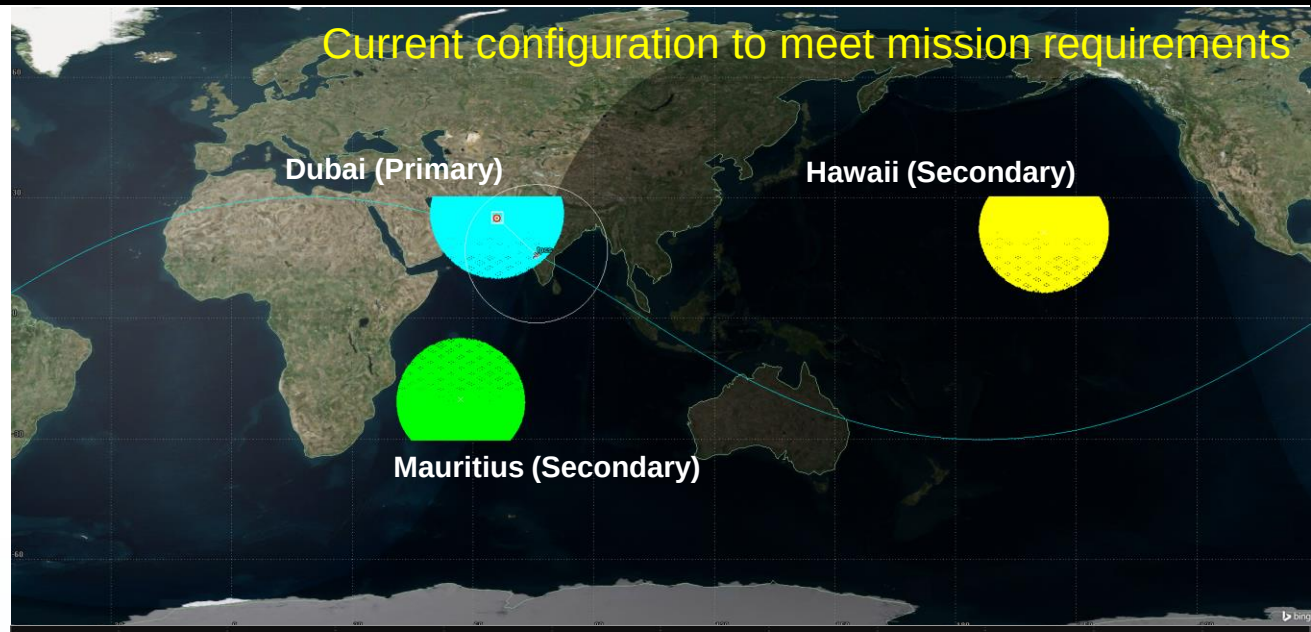
- **Meeting Objectives**
  - Introduce a broad community of potential end-users to the expected value of TROPICS by reviewing mission specifications and status
  - Review TROPICS data applications through presentations and breakout discussions
  - Provide a forum for applied researchers and operational 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/

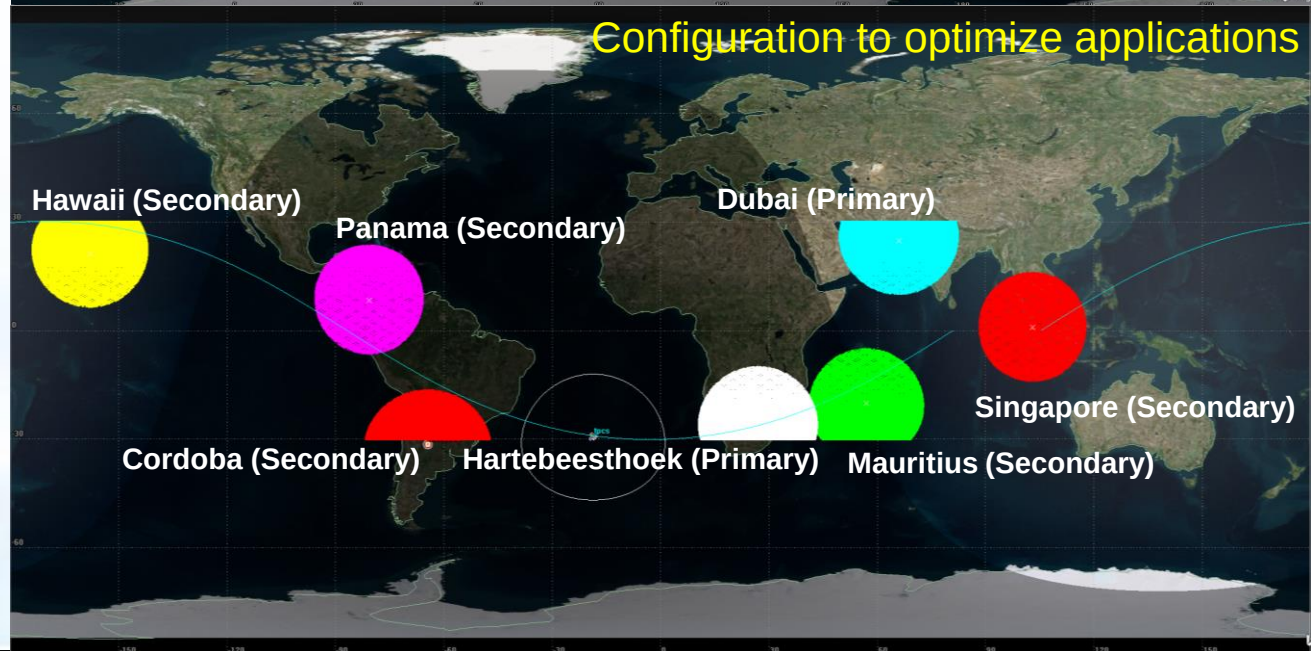
Meeting Take-Aways

- **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**

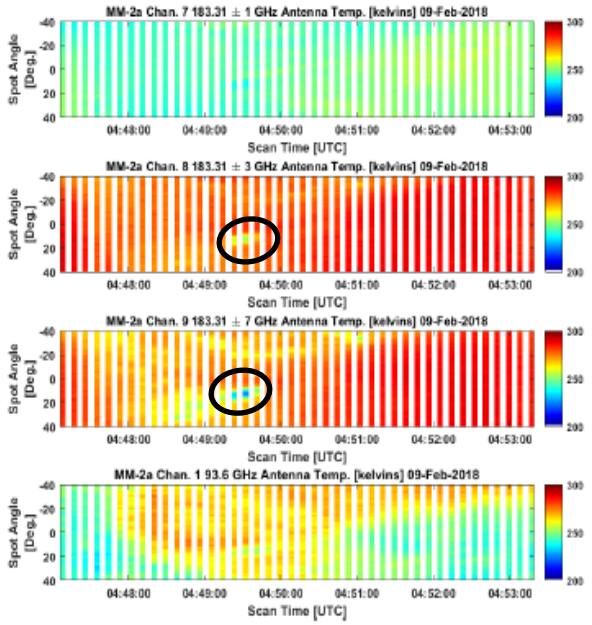
TROPICS Latency Challenges

- **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





Status of Proxy Datasets



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)

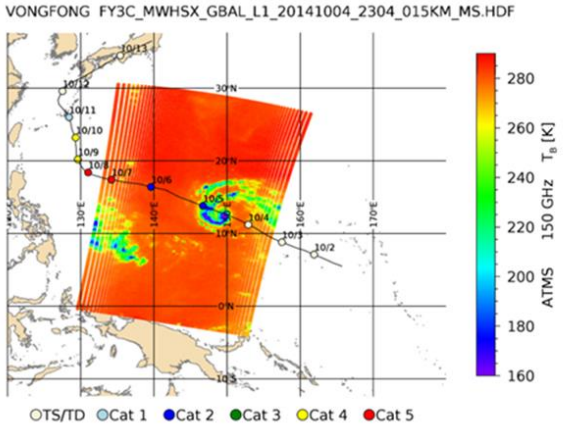
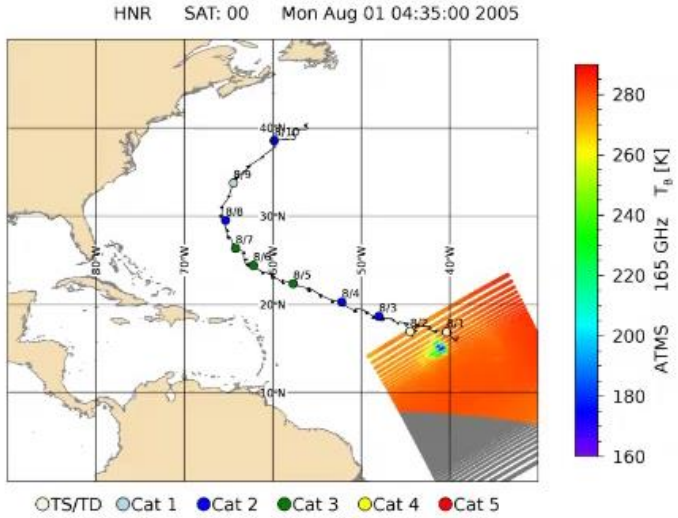


Image from FY-3C MWHS of Typhoon Vongfong

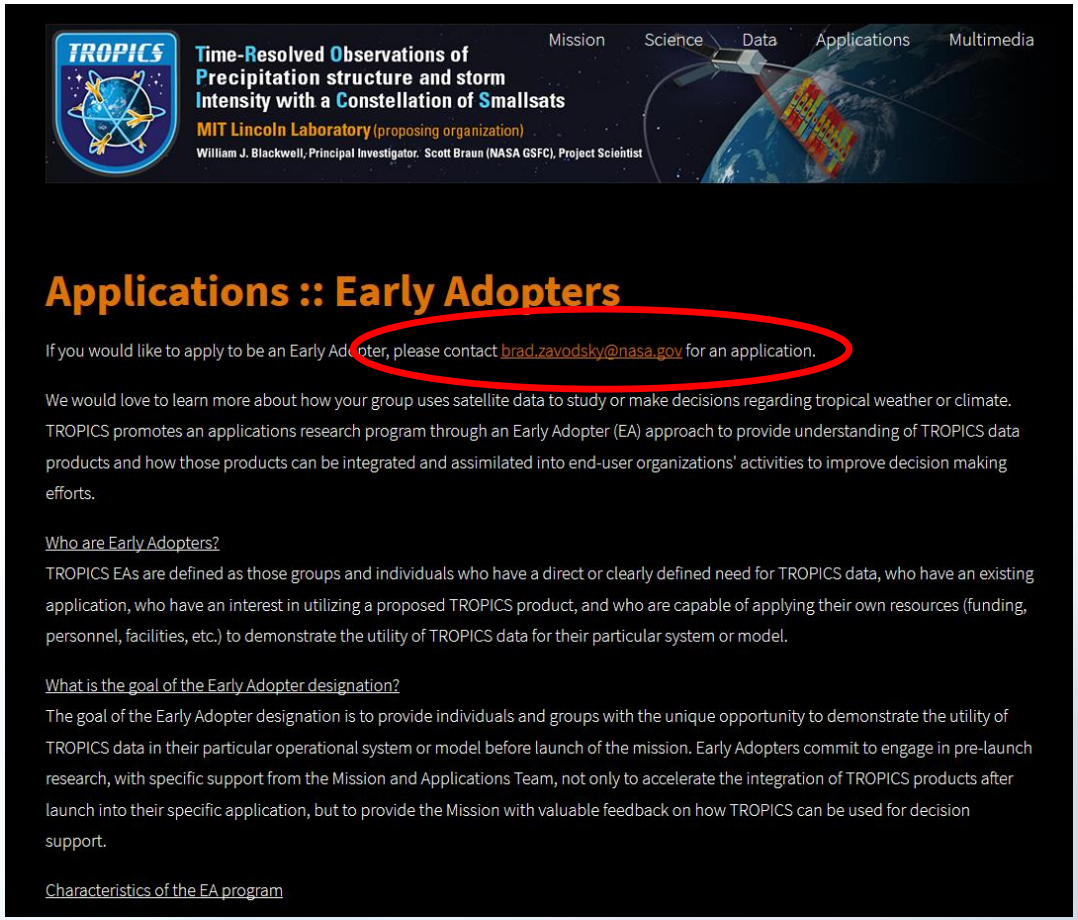


Early-look simulated TROPICS data derived from the Hurricane Nature Run showing temporal resolution of data

- **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)**

Early Adopter Activities

- **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**



Get Involved

- **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**