NASA Satellite and Airborne Data and Applications for Tropical Cyclones

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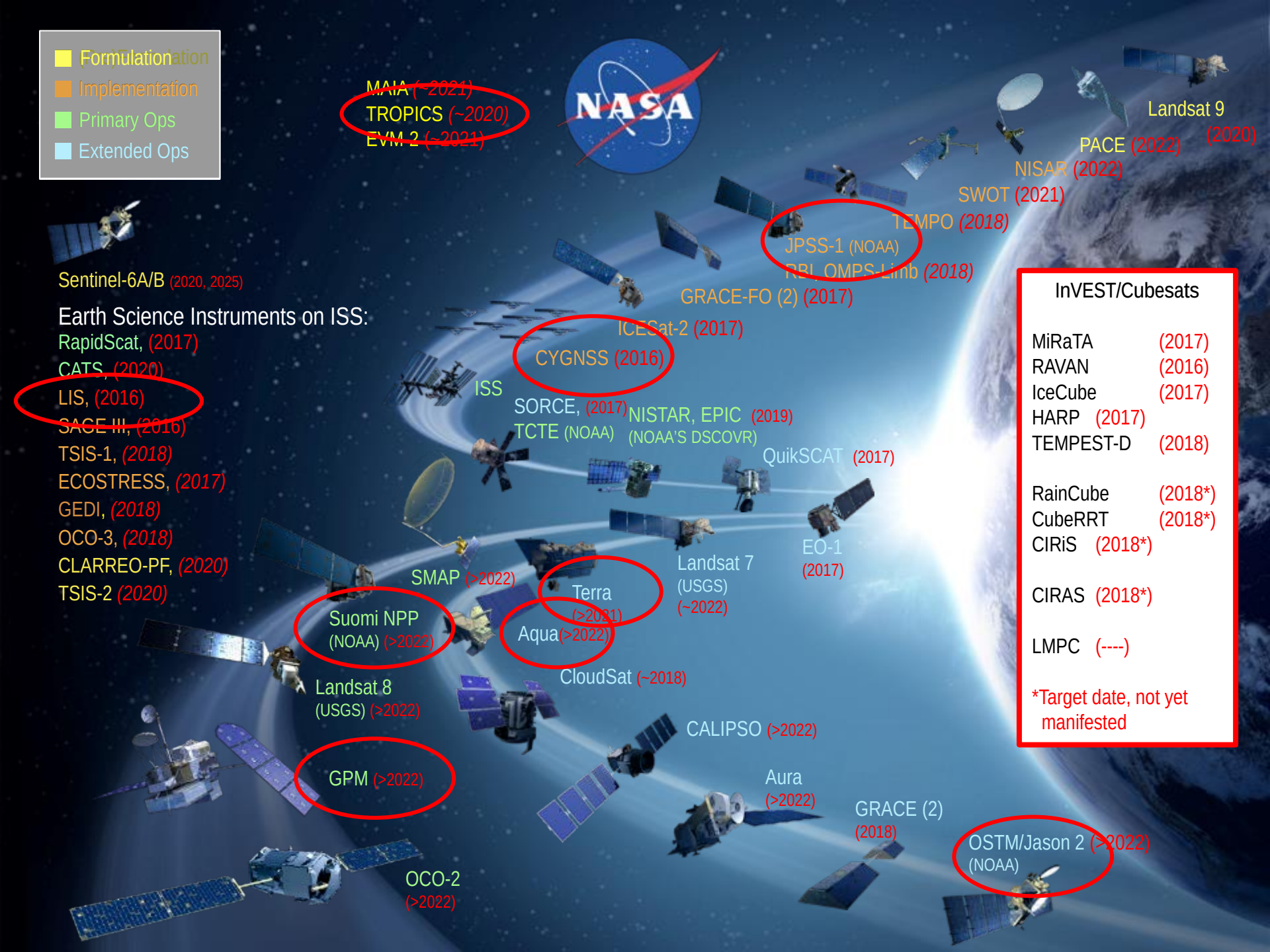
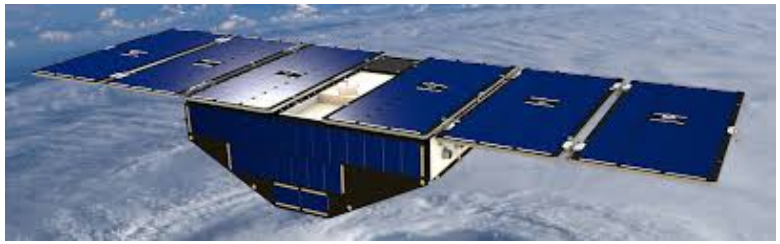
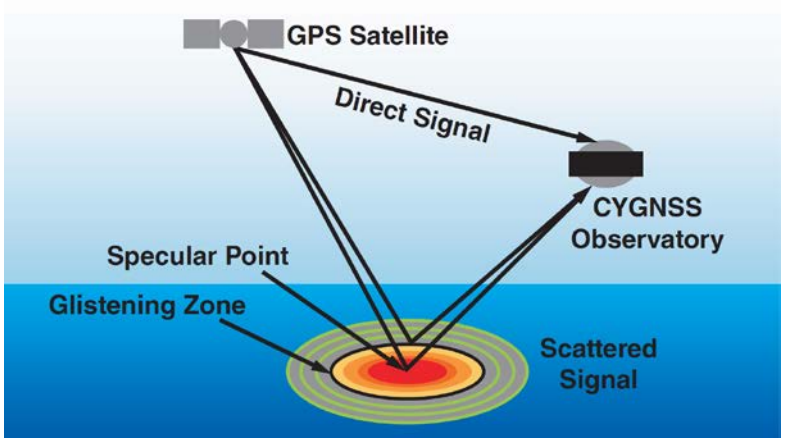
With contributions from Dan Cecil (MSFC), Lisa Callahan (GSFC), and Amber Emory (GSFC)

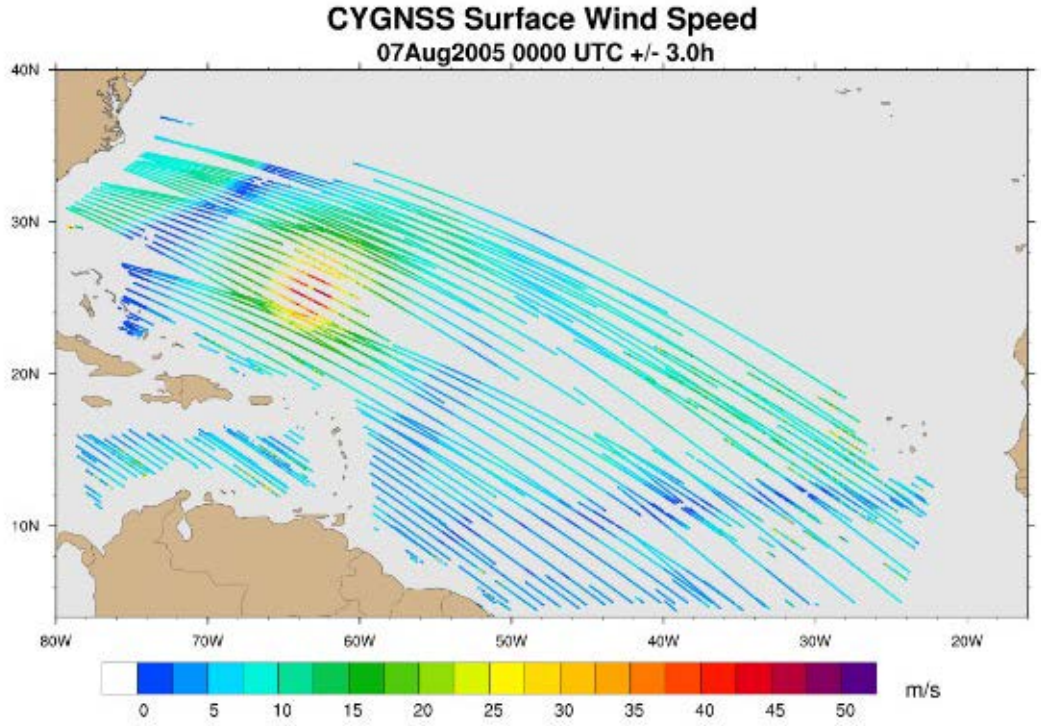

Formulation
Implementation
Primary Ops
Extended Ops
MAIA (~2021)
TROPICS (~2020)
EVM-2 (~2021)
NASA
Landsat 9
(2020)
PACE (2022)
NISAR (2022)
SWOT (2021)
TEMPO (2018)
JPSS-1 (NOAA)
RBI, OMPS-Limb (2018)
GRACE-FO (2) (2017)
ICESat-2 (2017)
CYGNSS (2016)
Sentinel-6A/B (2020, 2025)
Earth Science Instruments on ISS:
RapidScat, (2017)
CATS, (2020)
LIS, (2016)
SAGE III, (2016)
TSIS-1, (2018)
ECOSTRESS, (2017)
GEDI, (2018)
OCO-3, (2018)
CLARREO-PF, (2020)
TSIS-2 (2020)
ISS
SORCE, (2017)
TCTE (NOAA)
NISTAR, EPIC (2019)
(NOAA'S DSCOVR)
QuikSCAT (2017)
EO-1
(2017)
Landsat 7
(USGS)
(~2022)
SMAP (>2022)
Terra
(>2021)
Aqua (>2022)
Suomi NPP
(NOAA) (>2022)
CloudSat (~2018)
Landsat 8
(USGS) (>2022)
CALIPSO (>2022)
GPM (>2022)
Aura
(>2022)
GRACE (2)
(2018)
OSTM/Jason 2 (>2022)
(NOAA)
OCO-2
(>2022)
InVEST/Cubesats
MiRaTA (2017)
RAVAN (2016)
IceCube (2017)
HARP (2017)
TEMPEST-D (2018)
RainCube (2018*)
CubeRRT (2018*)
CIRiS (2018*)
CIRAS (2018*)
LMPC (----)
*Target date, not yet manifested

CYGNSS: A New Approach to Measuring Storm Winds

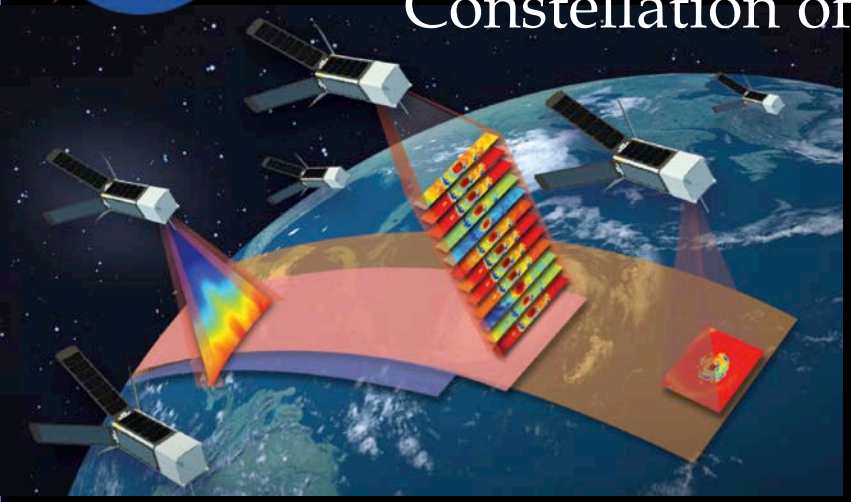
- Launched in December 2016
- Data release expected by May 2017

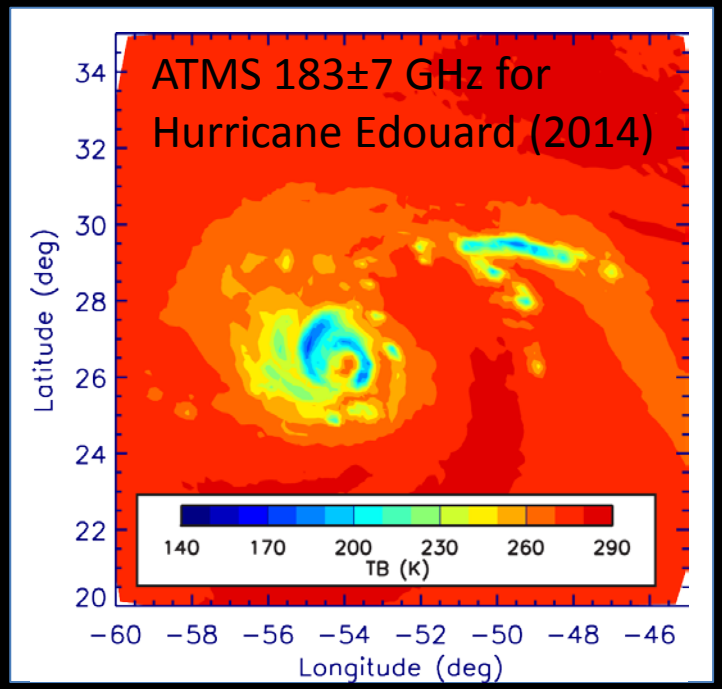






Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS)





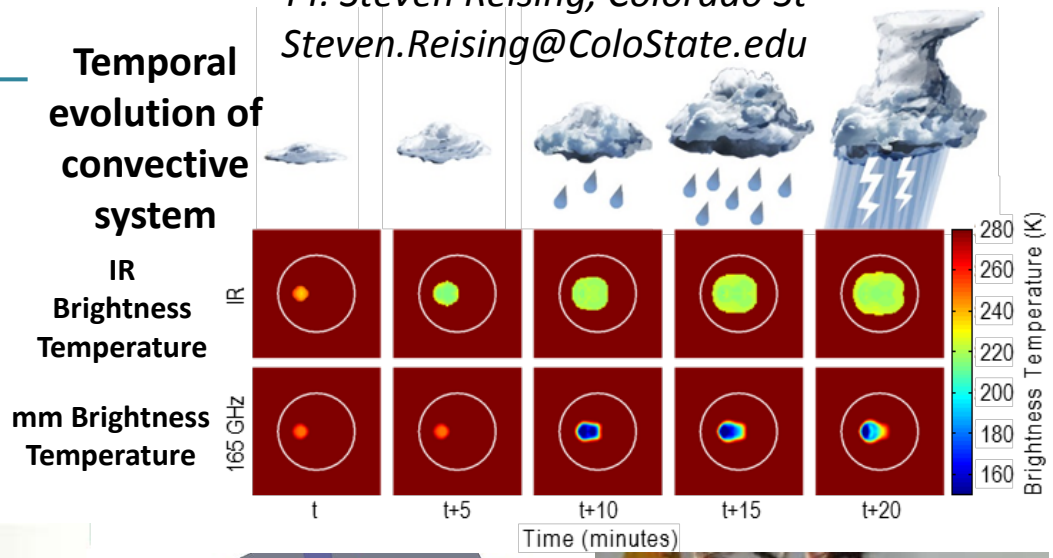
- PI: William Blackwell (MIT/Lincoln Labs)
- 7 temperature channels near 118 GHz, 3 moisture channels near 183 GHz, and imaging at 91 and 205 GHz
- 12 CubeSats, 4 in each of 3 orbital planes
- TROPICS will provide ~30-min median refresh rates between ±40° latitude, horizontal resolution similar to ATMS
- TROPICS will provide rapid-refresh temperature, humidity, and precipitation structure data
- Launch ~ 2019-20 for 1-yr mission

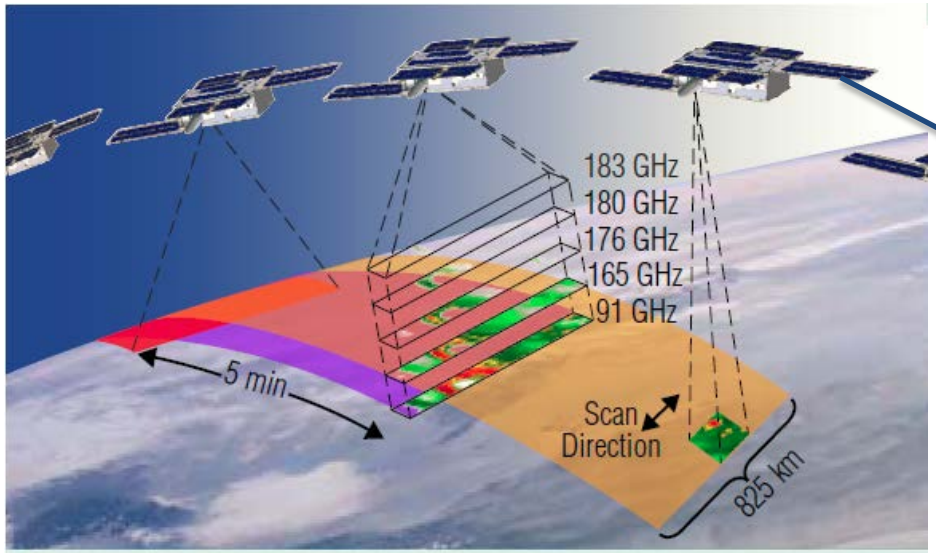
Temporal Experiment for Storms and Tropical Systems (TEMPEST)

PI: Steven Reising, Colorado St
Steven.Reising@ColoState.edu

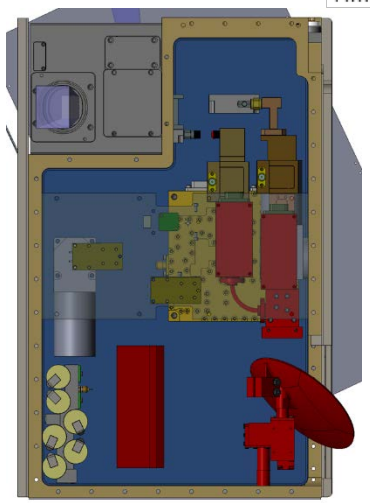
BENEFITS AND STRENGTHS

- Low-cost approach using 6U-Class satellites
- Unique data sets to enable improved weather and climate prediction models
- Significant impacts on agricultural forecasting, forest management and disaster preparedness
- Experienced collaborative team: Colorado State University (CSU), Caltech JPL and BCT





5 identical 6U CubeSats, each with an identical 5-channel radiometer, flying 5 minutes apart

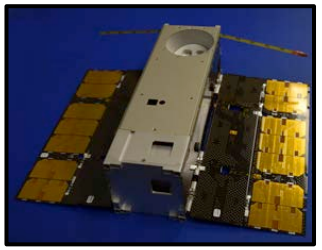


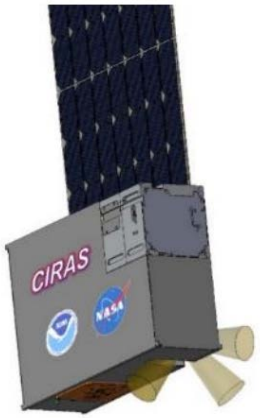
MASC prototype
(S. Padmanabhan)

In-Space Validation of Earth Science Technologies (InVEST)

Not necessarily a complete list:

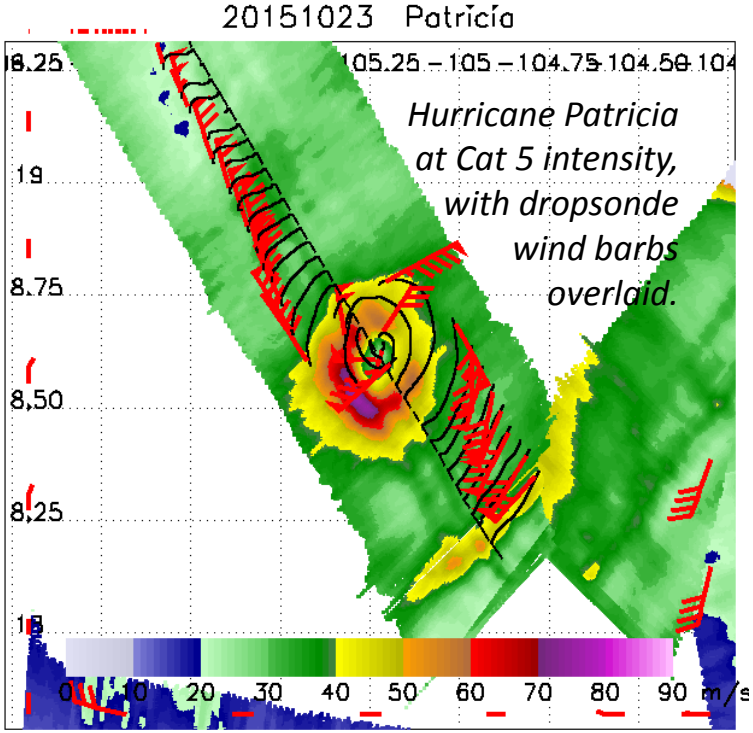
- The Microwave Radiometer Technology Acceleration (MiRaTA, MIT/LL) CubeSat (Jan 2018, JPSS-1) (60, 183, 206 GHz; radio occultation)
- Precipitation Profiling Radar in a CubeSat (RainCube, JPL – launch 2018) (Ka-band radar, nadir pointing)
- CubeSat Infrared Atmospheric Sounder (CIRAS, JPL – launch 2018) (625 channels, 13.5 km resolution, 165 km swath)



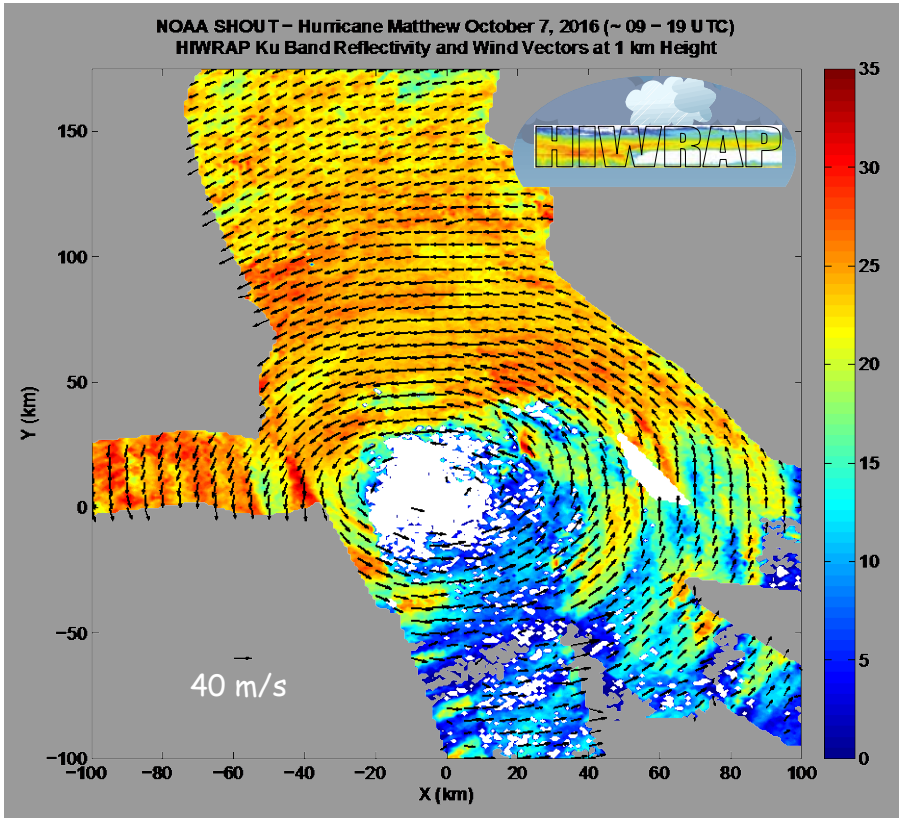


Recent Field Campaign Activities

- **TCI:**
  - HIRAD participated in ONR TCI flights in 2015 to map surface wind speed over wide swath (~50 km, for aircraft > FL600) in hurricanes



- **SHOUT:**
  - HIWRAP and HAMSR participated in the 2015&2016 SHOUT hurricane flights on Global Hawk



East Pacific Origins and Characteristics of Hurricanes (EPOCH)

PI: Amber Emory (GSFC) PM: Alfred Fordan (WFF)

Instrument Co-I's: Matt McLinden (GSFC EXRAD), Mathias Schreier (JPL HAMSR), Gary Wick (NOAA AVAPS)

3 Goals:

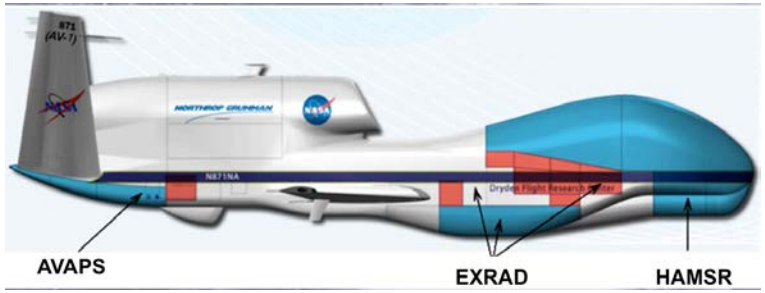
- **First integration of X-band radar for study of intensification processes (NASA)**
- **Assimilation of dropsonde data to improve operational models (NOAA)**
- **Train next generation of airborne science PI's, project managers, engineers as part of Hands On Project Experience (HOPE) Program**

WHO: NASA and NOAA

WHAT: Six Science Flights on the AV-6 Global Hawk to investigate TC genesis and RI

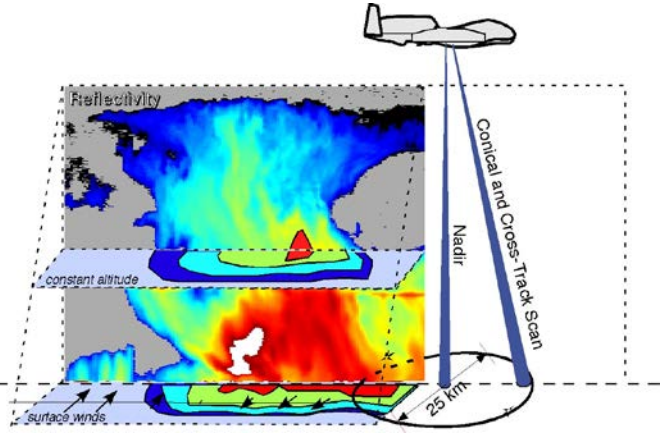
WHERE: Primary focus on the East Pacific but satellite coverage for GoM and East Coast as well

WHEN: 1-30 August 2017



Instrument integration configuration for the AV-6 Global Hawk UAV for the EPOCH science flight

Conceptual diagram of EXRAD instrument deployed on GH overflying a hurricane with conically scanning beam for horizontal wind estimation and nadir-pointing beam to resolve vertical wind



Hurricane Science Research Program

- **K. Corbosierro (SUNY-Albany)**–Investigating Tropical Cyclone Intensity Change Due to Trough-Induced Vertical Wind Shear
- **J. Doyle (NRL)**–Impact of the Environment and Outflow on Tropical Cyclone Intensity Prediction and Predictability
- **G. Heymsfield (GSFC)**–Understanding Hurricane Inner-Core Asymmetries and Their Relationship to Convective Bursts and Storm Intensification Using a Suite of NASA Data
- **S. Hristova-Veleva (JPL)**–Using NASA Observations to Advance the Understanding and Determine the Predictability Limits Regarding Tropical Cyclone Rapid Intensification and Cyclogenesis Processes
- **Haiyan Jiang (FIU)**–The Evolution and Contribution of Different Precipitation Types During the Symmetric Process of Tropical Cyclone Rapid Intensification
- **R. Shi (GSFC)**–Quantifying the Impact of the Saharan Air Layer on the Intensification of Atlantic Hurricanes
- **J. Zawislak (FIU)**–Why Do Tropical Cyclones Evolve Toward Symmetry Before Intensification? An Observational and Modeling Study