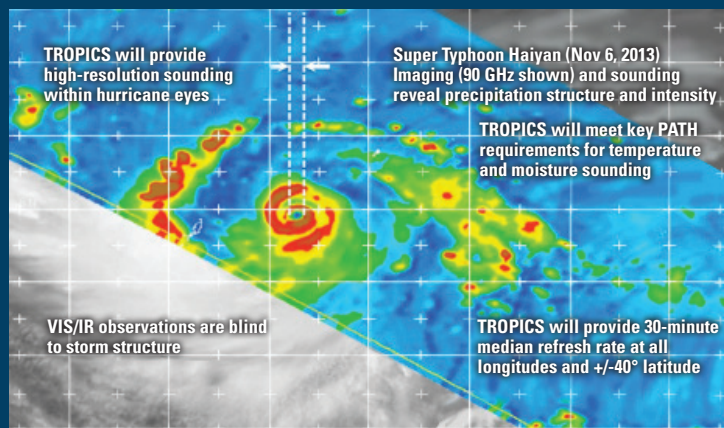




Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats

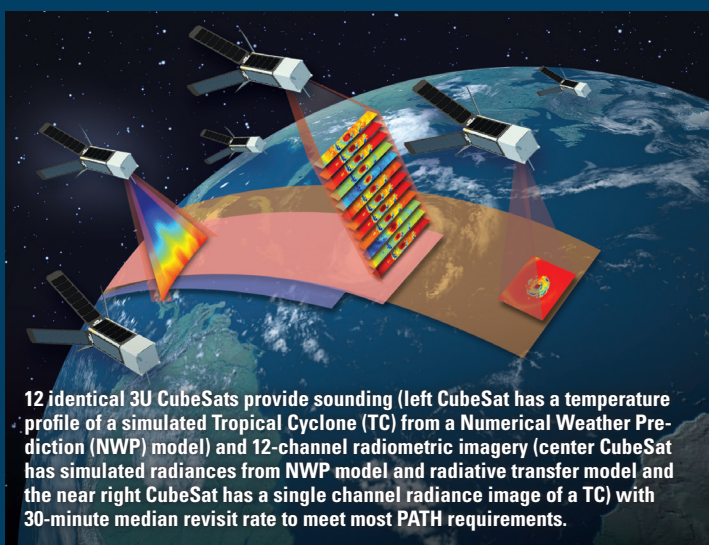
Science Objectives

- Relate precipitation structure evolution, including diurnal cycle, to the evolution of the upper-level warm core and associated intensity changes
- Relate the occurrence of intense precipitation cores (convective bursts) to storm intensity evolution
- Relate retrieved environmental moisture measurements to coincident measures of storm structure (including size) and intensity
- Assimilate microwave radiances and/or retrievals in mesoscale and global numerical weather prediction models to assess impacts on storm track and intensity

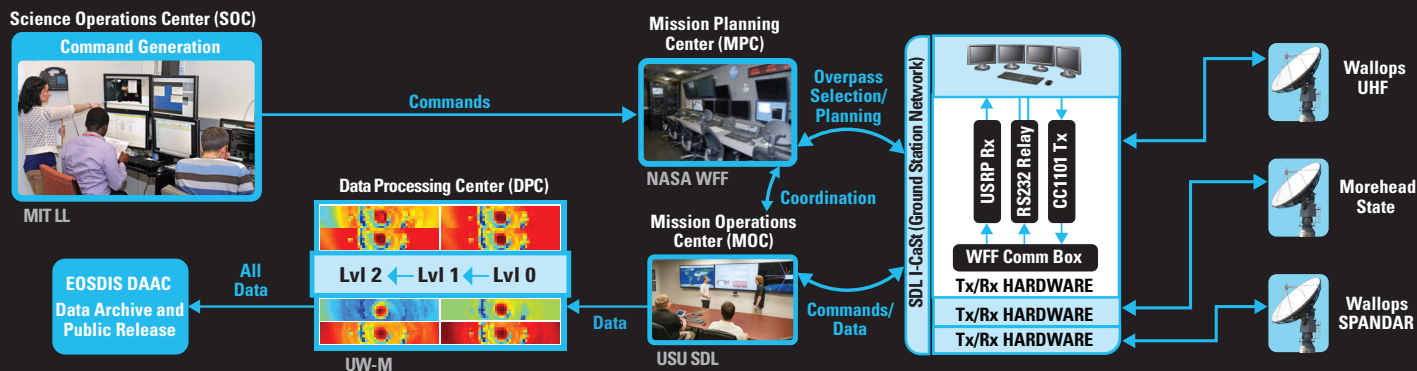


Significance to NASA

- First high-revisit microwave nearly global observations of precipitation, temperature, and humidity
- Fulfills most of PATH Decadal Survey mission objectives using a low-cost, easy-to-launch CubeSat constellation
- Complements GPM, CYGNSS, and GOES-R missions with high refresh, near-all-weather measurements of precipitation and thermodynamic structure
- Increases understanding of critical processes driving significant and rapid changes in storm structure/intensity



Command, Control, Communication and Data Elements for the TROPICS Constellation of 12 CubeSats



Continuous, sustained, high-refresh imaging and sounding observations will profoundly improve our fundamental understanding of the thermodynamic and microphysical processes driving high-impact storms.

Science Team

William Blackwell, PI..... MIT Lincoln Laboratory
 Scott Braun, PS NASA GSFC
 Robert Atlas, Co-I NOAA AOML
 Ralf Bennartz, Co-I University of Wisconsin
 Mark DeMaria, Co-I NOAA NHC
 Jason Dunion, Co-I University of Miami

Ron Errico, Co-I NASA GSFC/GMAO
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 Frank Marks, Co-I NOAA AOML
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 Chris Velden, Co-I University of Wisconsin

For more information please visit <https://tropics.ll.mit.edu/>

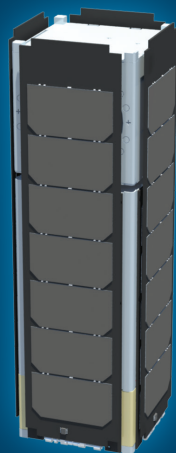


TROPICS CubeSat Key Characteristics

LINCOLN LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

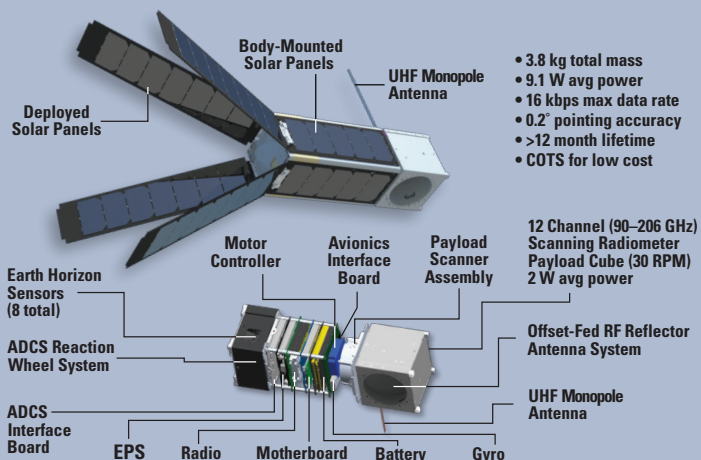


Each **TROPICS** CubeSat is a dual-spinning 3U CubeSat equipped with a 12-channel passive microwave spectrometer providing imagery near 90 and 206 GHz, temperature sounding near 118 GHz, and moisture sounding near 183 GHz. Each CubeSat comprises a 2U spacecraft bus with ADCS, avionics, power, and communications, and a 1U spinning radiometer payload with highly integrated, compact microwave receiver electronics.



Bus with solar panels
in launch position
10 cm × 10 cm × 34 cm

The MicroMAS-2 CubeSat



MicroMAS-2 is a 3U CubeSat with heritage from MicroMAS-2D and MiRaTA flight designs

Investigation Management and Participants

Participating Organizations

MIT Lincoln Laboratory	PI institution, CubeSat development, calibration and testing, Level 1 data product lead, Level 2 algorithm developer, Science Operations Center	NASA Wallops	FM CubeSat assembly and test, ground stations, Mission Planning Center
University of Wisconsin – Madison	Data Processing Center, Level 2 data product lead and algorithm developer, science relating warm-core evolution to storm structure and intensity	USU Space Dynamics Laboratory	Mission Operations Center, Ground Station Network
NASA Goddard Space Flight Facility	PS, data assimilation, study of moisture impacts on structure and intensity	University of Massachusetts Amherst	Receiver front end
NOAA National Weather Service National Hurricane Center	Study precipitation structure evolution and microwave parameters in statistical storm intensity models	NOAA Atlantic Oceanographic Meteorological Laboratory	Regional assimilation leadership; intensity and track forecasting; operations calibration and validation
MIT Space Systems Laboratory	Data validation	Cornell University	Optimize constellation architecture; orbital analysis to maintain constellation revisit rates
CIMAS University of MIAMI (Cooperative Institute of Marine and Atmospheric Studies)	Study relationship between moisture and precipitation to the storm's structure and intensity, diurnal cycle of hurricane structure	Tufts University	Geolocation and calibration

Mission Timeline



Management Structure

William Blackwell	MIT LL, Principal Investigator
Scott Braun	NASA GSFC, Project Scientist
Dennis Burianek	MIT LL, Program Manager
Brenda Dingwall	NASA WFF, Deputy PM
Vince Leslie	MIT LL, Project Systems Engineer
Sue Burzyk	MIT LL, Business Program Manager
Liam Gumley	UW, Data Segment Lead
Tim Neilsen	USU SDL, Mission Ops. Lead

Cost Summary (\$M)

	Phase A/B	Phase C/D	Phase E/F	Total RY\$
PI-MM Cost	9.100	17.203	3.897	30.201
Reserve %	25%	31%	15%	26%
Gap Planning Budget	0.000	1.353	0.000	1.353
Integration with Vehicle	0.000	0.319	0.000	0.319
Contributions	0.104	0.126	0.073	0.304
Total Mission Cost	9.204	19.002	3.970	32.176