Overview of the NASA TROPICS CubeSat Constellation Mission

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Abstract

Recent technology advances in miniature microwave radiometers that can be hosted on very small satellites have made possible a new class of constellation missions that provide very high revisit rates of tropical cyclones and other severe weather. The Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) mission was selected by NASA as part of the Earth Venture–Instrument (EVI-3) program and is now in development with planned launch readiness in late 2019. The overarching goal for TROPICS is to provide nearly all-weather observations of 3-D temperature and humidity, as well as cloud ice and precipitation horizontal structure, at high temporal resolution to conduct high-value science investigations of tropical cyclones (TCs), including: (1) relationships of rapidly evolving precipitation and upper cloud structures to upper-level warm-core intensity and associated storm intensity changes; (2) evolution (including diurnal variability) of precipitation structure and storm intensification in relationship to environmental humidity fields; and (3) the impact of rapid-update observations on numerical and statistical intensity forecasts of tropical cyclones.

TROPICS will provide rapid-refresh microwave measurements (median refresh rate better than 60 minutes for the baseline mission) over the tropics that can be used to observe the thermodynamics of the troposphere and precipitation structure for storm systems at the mesoscale and synoptic scale over the entire storm lifecycle. TROPICS will comprise a constellation of six 3U CubeSats in three low-Earth orbital planes. Each CubeSat will host a high performance scanning radiometer to provide temperature profiles using seven channels near the 118.75 GHz oxygen absorption line, water vapor profiles using three channels near the 183 GHz water vapor absorption line, imagery in a single channel near 90 GHz for precipitation measurements (when combined with higher resolution water vapor channels), and a single channel at 205 GHz that is more sensitive to precipitation-sized ice particles and low-level moisture. This observing system offers an unprecedented combination of horizontal and temporal resolution in the microwave spectrum to measure environmental and inner-core conditions for TCs on a nearly global scale and is a major leap forward in the temporal resolution of several key parameters needed for assimilation into advanced data assimilation systems capable of utilizing rapid-update radiance or retrieval data.

This presentation will provide an overview of the mission and an update on current status, with a focus on recent performance simulations on a range of observables to be provided by the constellation, including temperature, water vapor, rain rate, and TC intensity indicators.

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Bill Blackwell received the B.E.E. degree in electrical engineering from the Georgia Institute of Technology, Atlanta, GA, USA, in 1994, and the S.M. and Sc.D. degrees in electrical engineering and computer science from the Massachusetts Institute of Technology (MIT), Cambridge, MA, USA, in 1995 and 2002, respectively. Since 2002, he has been with the Lincoln Laboratory, MIT, where he is currently an Associate Leader of the Applied Space Systems Group. He serves or has previously served on the NASA Atmospheric Infrared Sounder and NPP science teams, the Joint Polar Satellite System Sounding Operational Algorithm Team, and the National Academy of Sciences Committee on Radio Frequencies. He was the Integrated Program Office Sensor Scientist for the Advanced Technology Microwave Sounder on the Suomi National Polar Partnership launched in 2011 and the Atmospheric Algorithm Development Team Leader for the National Polar-Orbiting Environmental Satellite System Microwave Imager/Sounder. He has served as the Principal Investigator on the MicroMAS-1, MicroMAS-2, and MiRaTA microwave sounding CubeSat missions and is currently PI on the NASA TROPICS Earth Venture mission (tropics.ll.mit.edu). His current research interests include atmospheric remote sensing, including the development and calibration of airborne and spaceborne microwave and hyperspectral infrared sensors, retrieval of geophysical products from remote radiance measurements, and the application of electromagnetic, signal processing, and estimation theory. Dr. Blackwell was the recipient of the 2009 NOAA David Johnson Award for his research in neural network retrievals and microwave calibration and was selected as a 2012 recipient of the IEEE Region 1 Managerial Excellence in Engineering Organization Award for “outstanding leadership of the multidisciplinary technical teams developing innovative future microwave remote sensing systems”.

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