An Overview of the NASA TROPICS Earth Venture Mission

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1. Extended Abstract

The Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) mission was recently selected by NASA as part of the Earth Venture Instrument (EVI-3) program. The overarching goal for TROPICS is to provide nearly all-weather observations of temperature profiles, humidity profiles, instantaneous surface rainfall rate, minimum sea-level pressure, and maximum sustained wind speed; as well as cloud ice and precipitation horizontal structure, at high temporal resolution to conduct high-value science investigations of tropical cyclones, including: (1) relationships of rapidly evolving precipitation and upper cloud structures to upper-level warm-core intensity and associated storm intensity changes; (2) the evolution 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 of 30 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 comprises up to 12 CubeSats in three low-Earth orbital planes. The TROPICS CubeSats will be launched on one or more NASA provided expendable launch vehicles as either the primary or secondary payload to form a multi-plane constellation capable of providing median observation revisit rates necessary to fulfill all science requirements.

The TROPICS core instrument is a cross-track scanning passive microwave spectrometer that provides measurements of upwelling thermal emission and scattering of the earth's atmosphere. The spectrometer provides 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 206 GHz that is more sensitive to precipitation-sized ice particles. This observing system offers an unprecedented combination of horizontal and temporal resolution to measure environmental and inner-core conditions for tropical cyclones 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.

The TROPICS measurements intersect with the 2014 NASA Science Plan, including improving the capability to predict weather and extreme weather events, and furthering the use of Earth system science research to inform decisions and provide benefits to society. Finally, the TROPICS mission directly addresses the need for rapid-update observations with cloud-penetrating capability, cited in the National Research Council (NRC) recommendation to fly the PATH decadal survey mission to improve understanding of fundamental severe storm thermodynamic processes.

2. References

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