SDL/13-503B

SPACE DYNAMICS LABORATORY

HARP

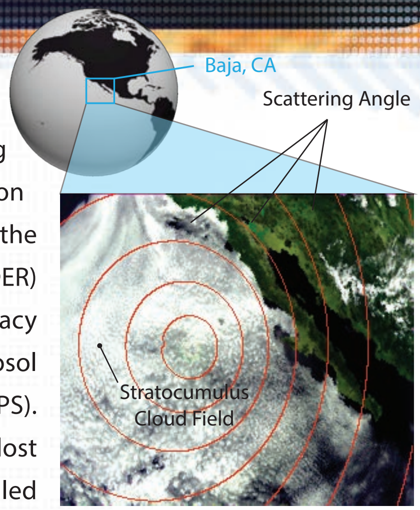
HYPERANGULAR RAINBOW POLARIMETER

The HyperAngular Rainbow Polarimeter (HARP) mission is designed to measure the microphysical properties of cloud water and ice particles. HARP is a precursor for the new generation of imaging polarimeters to be used for the detailed measurements of aerosol and cloud properties. The HARP payload is a wide field-of-view (FOV) imager that splits three spatially identical images into three independent polarizers and detector arrays. This technique achieves simultaneous imagery of three polarization states and is the key innovation to achieve high polarimetric accuracy with no moving parts. The spacecraft consists of a 3U CubeSat with 3-axis stabilization designed to keep the imager pointing nadir during the data acquisition period. The hyper-angular capability is achieved by rapidly acquiring overlapping images.

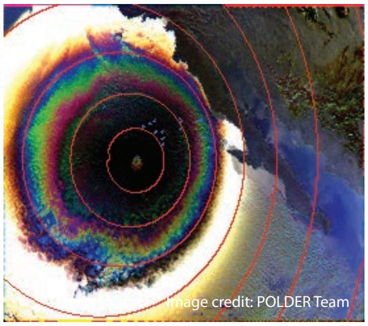
OBJECTIVES

- Space validation of new technology required by the NASA Decadal Survey Aerosol-Cloud-Ecosystem (ACE) mission
- Prove the on-flight capabilities of a highly-accurate, wide FOV hyper-angle imaging polarimeter for characterizing aerosol and cloud properties
- Prove that CubeSat technology can provide science-quality Earth Sciences data

Cloud and aerosol processes influence climate change, which affect our oceans, weather, ecosystems, and society. The largest impediments to estimating climate change revolve around a lack of quantitative information about aerosol forcing, insufficient understanding of aerosol-cloud processes, and cloud feedbacks in the climate system. The climate community requires new observations and a better understanding of aerosol and cloud processes to narrow climate change estimate uncertainties. The aerosol community requires a multi-wavelength, multi-angle imaging polarimeter with the wide FOV imaging heritage of the POLarization and Directionality of the Earth's Reflectances (POLDER) mission and the high accuracy promised by the Aerosol Polarimetry Sensor (APS). Unfortunately, APS was lost when the Glory mission failed to reach orbit.



3-color Composite 443-670-865 nm



Same Scene in Polarized Light

An imaging polarimeter with hyperangular capability can make a strong contribution to characterizing cloud properties, especially ice clouds. Because of their sensitivity to thin cirrus clouds, non-polarized multi-angle measurements can be used to provide climatology. Adding polarization and increasing the number of observation angles provides a much clearer picture of cloud droplet distribution, adding size and width measurements to the currently measured effective radius. The combination of hyperangular polarized measurements and short-wave infrared channels (2.1 μm) should also provide enough constraints to determine important characteristics of cloud ice crystals. In the coming decades, it will be important to have an imaging polarimeter with the capability to characterize both aerosols and clouds. Highly-capable, small, and versatile, HARP is designed to meet the needs of both the aerosol and cloud communities.

Space Dynamics LABORATORY
Utah State University Research Foundation

1695 North Research Park Way • North Logan, Utah 84341 • Phone 435.713.3500 • www.sdl.usu.edu

HARP

HYPERANGULAR RAINBOW POLARIMETER

IN-SPACE VALIDATION OF EARTH SCIENCE TECHNOLOGIES (INVEST)

It is the goal to have HARP become a secondary payload on the International Space Station (ISS) in 2016. The desired mission life consists of three months for technology demonstration and an extended science data period of another seven months, which will total almost a year on orbit. The existing Dynamic Ionosphere CubeSat Experiment (DICE) ground station and mission operations center that includes use of the NASA Wallops Flight Facility UHF dish will be used for uplink and downlink communications on HARP. Magnetometers, sun sensors, 3-axis torque coils, and reaction wheels (BCT ADCS system) will be used to maintain 3-axis spacecraft stability and pointing to < 0.5°. Level zero data will then be sent to the science operation center at the University of Maryland, Baltimore County (UMBC) where it will be calibrated, processed, and converted to final products.

The HARP CubeSat mission will be a joint effort between UMBC, the PI institution, who will provide the instrument and characterization and scientific analysis; the Space Dynamics Laboratory – Utah State University, who will provide the 3U CubeSat spacecraft and mission operations; and the Science and Technology Corporation, who will lead the science algorithm development and science application funded by NOAA. NASA Wallops will support instrument environmental testing, mission operations, and communications. The program is in support of the NASA Earth Science Technology Office (ESTO).

SCIENCE & TECHNOLOGY CORP.

UMBC

Joint Center for Earth Systems Technology (JCET)

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