*Workshop on "Recent advancements in remote sensing and modeling of aerosols, clouds and surfaces",*
*GRASP ACE Summer school,*
*Lille, France, May 22-26, 2023*

# Aerosol and Cloud Observations from Space with HARP CubeSat

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Developed at the Earth and Space Institute of the University of Maryland Baltimore County, HARP (Hyper-Angular Rainbow Polarimeter) is a 3U CubeSat designed for advanced measurements of cloud and aerosol properties from space. HARP boasts hyper-angular imaging capabilities that provide 60 viewing angles at 670 nm, and up to 20 at 440 nm, 550 nm and 870 nm spectral bands, spanning a wide 114° (94°) along-track (cross-track) field-of-view. This allows HARP to measure multi-angular radiance and polarized radiance profiles of Earth targets, providing new and valuable information for atmospheric, land, and ocean property retrievals. Since its deployment into the ISS orbit in February 2020, the HARP CubeSat has captured over 60 observations of aerosols and cloud scenes of interest. The results from on-orbit vicarious radiometric and polarimetric calibration of the HARP CubeSat using collocated observations from NASA and NOAA satellite remote sensing instruments MODIS, VIIRS, and ABI are presented in this work. Furthermore, preliminary retrievals of aerosol properties using GRASP and HARP CubeSat observations are also discussed. These findings build on prior demonstrations of the HARP concept in the field, as reported in the works of Puthukkudy et al. 2020 [1] and McBride et al. 2020 [2]. HARP's advanced capabilities have also earned it a spot on NASA's future Earth-observing mission PACE (Phytoplankton, Aerosol, Cloud and ocean Ecosystem), where an updated version of the instrument, HARP2, will be on board. With its unique multi-angular imaging capabilities, HARP and its successor HARP2 are poised to provide unprecedented insights into cloud and aerosol properties from space, aiding in the understanding of Earth's atmosphere, land, and ocean ecosystems.

**Keywords**: CubeSat, HARP, HARP2, NASA PACE

**References**

[1] Puthukkudy, Anin, et al. "Retrieval of aerosol properties from airborne hyper-angular rainbow polarimeter (AirHARP) observations during ACEPOL 2017." *Atmospheric Measurement Techniques* 13.10 (2020): 5207-5236.

[2] McBride, Brent A., et al. "Spatial distribution of cloud droplet size properties from Airborne Hyper-Angular Rainbow Polarimeter (AirHARP) measurements." *Atmospheric Measurement Techniques* 13.4 (2020): 1777-1796.