

Level 2 aerosol products derived from HARP2-PACE observations using the GRASP algorithm

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The Hyper-angular Rainbow Polarimeter-2 (HARP2), a state-of-the-art multi-angular polarimeter (MAP) deployed on NASA's PACE (Plankton, Aerosol, Cloud, ocean Ecosystem) platform [1], has been acquiring data since March 2024, now providing over two and a half years of top-of-atmosphere (TOA) observations. This work presents a comprehensive validation and in-depth analysis of Level 2 aerosol and surface reflectance products derived from HARP2's unique observational capabilities using the Generalized Retrieval of Aerosol and Surface Properties (GRASP) algorithm [2,3]. HARP2 delivers measurements across a wide range of viewing angles (from -54.5° to $+54.5^\circ$) and four spectral bands (440, 550, 670, and 870 nm), enabling detailed characterization of atmospheric aerosols and surface properties. A central component of this study is the rigorous validation of Aerosol Optical Depth (AOD), a key parameter for quantifying atmospheric aerosol loading, performed against the globally distributed Aerosol Robotic Network (AERONET) of ground-based sun photometers across a multi-year matchup record.

As of May 2026, the standard HARP2 aerosol product distributed through the NASA DAACs is based on the FastMAPOL algorithm [4]; the GRASP-based product presented here is not currently a standard DAAC product. The validation employs advanced methodologies integrated within the GRASP cloud framework. We apply GRASP's multi-pixel retrieval approach, exploiting both spatial and temporal correlations in HARP2's data to enhance retrieval accuracy and robustness, providing improved constraints on aerosol properties even under challenging conditions. Beyond standard AOD validation, we present results from component-based retrievals that decompose the aerosol signal into contributions from distinct aerosol types (e.g., dust, smoke, sea salt), producing physically meaningful outputs directly suitable for assimilation into Earth-System Models (ESMs).

To illustrate HARP2-GRASP aerosol products capabilities and scientific impact, we analyze several case studies drawn from the mission's operational record, including: (1) long-range smoke transport events originating from wildfires in North America, Africa, and Amazonia, demonstrating HARP2's ability to track aerosol plumes and characterize their evolving optical and microphysical properties; and (2) severe air pollution episodes over the Indian subcontinent, highlighting HARP2's contribution to monitoring and understanding anthropogenic aerosol emissions.

In summary, this poster/talk provides a comprehensive overview of HARP2 aerosol product performance and validation after more than two years on orbit, derived using the advanced GRASP retrieval framework. It documents the advancements in aerosol characterization enabled by this next-generation multi-angular polarimeter and underscores HARP2's contribution to the overarching scientific goals of the PACE mission, particularly improving our understanding of aerosol–cloud interactions and their role in the Earth's climate system.

References

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