# Vertical profiling of aerosol microphysics by synergy combination of space lidar and polarimetry in GRASP

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Multiwavelength lidar measurements are unique for studying accurate aerosol vertical profiles. Actually, several approaches based on the regularization technique have been used for obtaining aerosol microphysical properties by using lidar measurements of three aerosol backscattering (β) and two extinction (α) coefficients. However, 3β+2α approach is an underdetermined problem and retrievals need the use of case-dependent optimized-constraints with limitations in coarse mode retrievals [1]. Moreover, the deployment of lidar system that provide 3β+2α in the space is very complex and costly. Here we explore the potentiality of inverting aerosol microphysical properties vertically-resolved by combining in the Generalized Retrieval of Atmosphere and Surface Properties (GRASP – [2]) space lidar and polarimetry measurements.

Extensive simulations have been performed for different mixtures of fine and coarse mode, varying refractive indexes from low to high absorption. The mixtures where also done with aerosol at different heights. GRASP forward simulations permitted to obtain synthetic measurements both for lidars and polarimetry. Particularly, we have simulated HARP-like polarimetry measurements whose multi-wavelength and multi-angular capacity have been widely demonstrated for aerosol column-integrated retrievals. Our results show full capacity of GRASP to retrieve aerosol properties vertically-resolved differentiating between fine and coarse properties. Size distribution is retrieved with the same resolution as in AERONET retrievals. Thus, this synergy of instruments is a step-forward when comparing versus stand-alone polarimetry retrievals. However, we found out that optimized retrieval needs of constraining surface properties, particularly because of the impact of BPDF in coarse mode retrieval. Otherwise, a multi-pixel approach is required. Finally, we present case-study of synergy retrievals from airborne measurements obtained during NASA field campaigns when AirHARP + lidar flew together. The results of the simulations serve as baseline for future space mission that will combine space lidar + polarimetry such as the Atmosphere Observing System (AOS). Future work will consist of studying lidar + polarimetry synergy for other polarimetry configurations.

## References

[1] Perez-Ramirez, D, *et al*., 2019: Retrievals of aerosol single scattering albedo by multiwavelength lidar measurements: Evaluations with NASA Langley HSRL-2 during DISCOVER-AQ field campaigns. *Remote. Sens. Environ., **222**, 144-164.*

[2] Dubovik, O, *et al*., 2021: A comprehensive description of multi-term LSM for applying multiple a priori constraints in problems of atmospheric remote sensing: GRASP algorithm, concept and applications. *Front. Remote. Sens., **2**, 706851.*

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