Retrieval of aerosol and surface properties over land from the Gaofen-5 Directional Polarimetric Camera measurements

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Aerosol properties, including aerosol optical depth (AOD), absorption optical depth (AAOD), single scattering albedo (SSA) and fine mode fraction (FMF), are essential in studying aerosol climate effects. Multi-angle spectral polarimetry (MAP) has been recognized as a promising technique for comprehensive retrievals of global aerosol optical properties from space. As one of the few MAP sensors in space, the Directional Polarimetric Camera (DPC) onboard the GaoFen (GF)-5 satellite has great potential in providing these critical aerosol parameters. However, aerosol retrievals from DPC, especially for SSA and AAOD remain limited. This study introduces a machine-learning algorithm using the XGBoost model to retrieve AOD, AAOD, SSA, FMF, as well as surface albedo (expressed as the directional hemispherical reflectance, DHR) over land from DPC multi-angle radiances and degree of linear polarization, using AERONET retrievals as the training target. Cross validation results indicate high retrieval accuracy, with correlations exceeding 0.75 for all parameters retrieved. Notably, the SSA retrieval accuracies are comparable to the Polarization and Directionality of the Earth's Reflectance (POLDER) products, with 71% and 91% of the independently retrieved 670 nm SSA falling within the ±0.03 and ±0.05 confidence intervals respectively, when 670nm AOD is greater than 0.30, respectively. Gridded products also effectively capture the spatial and seasonal variability of aerosol properties worldwide, such as regions dominated by biomass burning, dust, etc. This study confirms the capability of using DPC for aerosol optical and microphysical property retrievals, which could serve as an important technique and data source for global aerosol and climate monitoring.

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