

Aerosol, cloud and trace gas observations derived from airborne hyperspectral radiance and direct beam measurements in recent field campaigns

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The AERONET (Aerosol RObotic NETwork) ground-based suite of sunphotometers provides measurements of spectral aerosol optical depth (AOD), precipitable water and spectral sky radiance, which can be inverted to retrieve aerosol microphysical properties that are critical to assessments of aerosol-climate interactions. Because of data quality criteria and sampling constraints, there are significant limitations to the temporal and spatial coverage of AERONET data and their representativeness for global aerosol conditions.

The 4STAR (Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research) instrument, jointly developed by NASA Ames and PNNL with NASA Goddard collaboration, combines airborne sun tracking and AERONET-like sky scanning with spectroscopic detection. Being an airborne instrument, 4STAR has the potential to fill gaps in the AERONET data set. Dunagan et al. [2013] present results establishing the performance of the instrument, along with calibration, engineering flight test, and preliminary scientific field data.

The 4STAR instrument operated successfully in the SEAC4RS [Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys] experiment in Aug./Sep. 2013 aboard the NASA DC-8 and in the DoE [Department of Energy]-sponsored TCAP [Two Column Aerosol Project, July 2012 & Feb. 2013] experiment aboard the DoE G-1 aircraft (Shinozuka et al., 2013), and acquired a wealth of data in support of mission objectives on all SEAC4RS and TCAP research flights. 4STAR provided direct beam measurements of hyperspectral AOD, columnar trace gas retrievals (H₂O, O₃, NO₂; Segal-Rosenheimer et al., 2014), and the first ever airborne hyperspectral sky radiance scans, which can be inverted to yield the same products as AERONET ground-based observations. In addition, 4STAR measured zenith radiances underneath cloud decks for retrievals of cloud optical depth and effective diameter.

In this presentation, we provide an overview of the new 4STAR capabilities for airborne field campaigns, with an emphasis on comparisons between 4STAR and AERONET sky radiances, and retrievals of aerosol microphysical properties based on sky radiance measurements, column trace gas amounts from spectral direct beam measurements and cloud property retrievals from zenith mode observations for a few select case studies in the SEAC4RS and TCAP experiments. We summarize the aerosol, trace gas, cloud and air mass characterization studies made possible by the combined 4STAR direct beam, and sky/zenith radiance observations.

References

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