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Aerosol Remote Sensing Applications for Airborne Multiangle, Multispectral Shortwave Radiometers

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Aerosol particles have an important impact on the surface net radiation budget by direct scattering and absorption (direct aerosol effect) of solar radiation, and also by influencing cloud formation processes (semi-direct and indirect aerosol effects). To study the former, a number of multispectral sky- and sunphotometers have been developed at the Institute for Space Sciences of the Free University of Berlin in the past two decades. The latest operational developments were the multispectral aureole- and sunphotometer FUBISS-ASA2, the zenith radiometer FUBISS-ZENITH, and the nadir polarimeter AMSSP-EM, all designed for a flexible use on moving platforms like aircraft or ships. Currently the multiangle, multispectral radiometer URMS/AMSSP (Universal Radiation Measurement System/ Airborne Multispectral Sunphotometer and Polarimeter) is under construction for a Wing-Pod of the high altitude research aircraft HALO operated by DLR. The system is expected to have its first mission on HALO in 2011.

The algorithms for the retrieval of aerosol and trace gas properties from the recorded multidirectional, multispectral radiation measurements allow more than deriving standard products, as for instance the aerosol optical depth and the Angstrom exponent. The radiation measured in the solar aureole contains information about the aerosol phasefunction and therefore allows conclusions about the particle type. Furthermore, airborne instrument operation allows vertically resolved measurements. An inversion algorithm, based on radiative transfer simulations and additionally including measured vertical zenith-radiance profiles, allows conclusions about the aerosol single scattering albedo and the relative soot fraction in aerosol layers. Ozone column retrieval is performed evaluating measurements from pixels in the Chappuis absorption band. A retrieval algorithm to derive the water-vapor column from the sunphotometer measurements is currently under development.

Of the various airborne and ground based operations of the instruments so far, only two exemplary campaigns shall be introduced here. FUBEX in July 2008 was the first airborne campaign with FUBISS-ASA2, FUBISS-ZENITH and AMSSP-EM simultaneously mounted on the Cessna 207T of the Institute for Space Sciences, based in Berlin. Vertical radiation profiles recorded on July 28 in 2008 where used for a first application of the introduced inversion algorithm. In Oktober/November 2009, FUBISS-ASA2 and FUBISS-ZENITH where mounted on the German research icebreaker FS Polarstern, crossing the Atlantic on its cruise from Bremerhaven (Germany) to Punta Arenas (Chile). Measurements where performed throughout the whole cruise on days with a variety of different atmospheric conditions, as a Saharan dust outbreak over Cape Verde, typical marine conditions with salt particles in the marine boundary layer and also pristine conditions in the southern Atlantic. Access to the data of other instruments aboard the ship, as a Raman-Lidar, a cloud camera, weather station, and a microwave radiometer, provided valuable a priori information for processing and calibration of the measurements. The results may be of special interest for the validation of satellite aerosol products.