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Simultaneous retrieval of trace gas and aerosol properties with a compact hyperspectral Sun and aureole photometer

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For aerosol remote sensing, a number of multispectral sky and Sun photometers have been developed at our Institute. The latest operational developments where the multispectral Sun and aureole photometer FUBISS-ASA2, the zenith radiometer FUBISS-ZENITH, and the nadir polarimeter AMSSP-EM, all designed for airborne and ground based operation. Currently the wing pod based hyperspectral scanning radiometer URMS/AMSSP is under construction. It is designed for the use on the high altitude research aircraft HALO.

Our algorithms for the retrieval of aerosol and trace gas properties are so far adapted to the measurements of the combined Sun and aureole photometer FUBISS-ASA2, providing 256 spectral channels between 300nm and 1100nm, and in addition 512 pixels in the NIR between 950nm and 1700nm. The information content of the multidirectional and hyperspectral radiation measurements, regarding aerosol properties, exceeds the basic products derived from Sun photometer measurements, being the aerosol optical depth and Angström exponent. The radiation measured in the solar aureole contains information about the aerosol phase function and therefore allows conclusions about the particle type by a comparison to values computed for model aerosols with a Mie code for spherical particles. A further and newly developed indirect method for the retrieval of aerosol properties, and for atmospheric scene construction, is based on the radiative transfer model MOMO.

The subtraction of significant trace gas contributions from the measured total extinction of Sunlight is necessary to determine the aerosol optical depth at a given wavelength. The high spectral resolution of the measurements enables the identification of the contribution of a trace gas by the spectral shape of its absorption bands, avoiding external measurements or assumptions. The determination of the ozone optical depth, by assuming the Angström law for the spectral dependence of the aerosol optical depth, can be accomplished with measurements within the Chappuis band of ozone continuum absorption, and a comparison to tabled ozone absorption cross section spectra. To determine the concentration of water vapor from spectral bands with line absorption, an absorption model incorporating the spectral sensor response function is necessary, since an exponential dependence of the optical depth on the measured atmospheric transmissivity can not be assumed if the spectral features are small compared to the spectral sensor width. Currently a retrieval algorithm based on the k-binning method and incorporating HITRAN absorption data is under development. It will be tested and calibrated with measurements from a six week ship cruise in the Atlantic Ocean in 2009 and high altitude measurements at Jungfraujoch (CH) in July 2010. Water vapor concentration profiles from a microwave radiometer and radiosondes are available as a reference data set. Preliminary results will be presented. A next step will be to adapt the algorithm for the retrieval of concentrations of trace gases with absorption bands in the spectral region of the NIR spectrometer (e. g. carbon dioxide).