IRS2012-68
International Radiation Symposium 2012
Dahlem Cube, Berlin, Germany, 06 – 10 August 2012

Airborne measurements of surface reflectivity and albedo over a Chinese Megacity

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The spectral surface albedo or surface reflectivity are the lower boundary condition in radiative transfer calculations which are used to retrieve cloud and aerosol properties such as aerosol optical depth, effective radius of cloud droplets or radiative forcing. The upward radiance and irradiance at the top of atmosphere (TOA) or at any level within the atmospheric column is determined by radiation that is scattered by atmospheric components, and reflected by the surface of the Earth. The contribution to the radiation at TOA originating from dark surfaces like ocean water or forest areas is rather small, the contribution of brighter surfaces like desert areas is higher and can cause uncertainties in the retrieval of aerosol or cloud properties. Heterogeneous surfaces like urban structures of megacities may lead additionally to three-dimensional (3D) effects in the radiative transfer especially for high aerosol optical depth, when multiple scattering is increasingly important. Therefore, this paper focuses on urban areas and their impacts on remote sensing and radiative transfer applications. The results of two airborne/ground based field campaigns with different aerosol conditions are presented. The interpretation of the data is supported by 3D radiative transfer simulations. Surface reflectivity and surface albedo of urban surfaces were retrieved by an extrapolation method that combines radiative transfer calculations and airborne measurements of radiance and irradiance to remove the atmospheric masking. Measurements of reflectivity and albedo at three different flight altitudes over the same location and their retrievals of surface reflectivity and surface albedo enable the identification of 3D effects resulting from the heterogeneity of the surface and the aerosol properties. The effect of uncertainties in the retrieval of surface reflectivity of an urban area on the aerosol optical depth obtained from satellite borne instruments will be discussed on basis of a sensitivity study for MODIS.