Geophysical Research Abstracts, Vol. 7, 10556, 2005
SRef-ID: 1607-7962/gra/EGU05-A-10556
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Diurnal variability of validated surface energy flux densities inferred from meteorological satellite data

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The main goal of this paper ist to demonstrate how surface radiant and energy fluxes can be inferred from meteorological satellite data. This can be realized with the modular, complex analysis scheme SESAT. The modules consist of: (A) a detailed cloud classifier - maximum-likelihood - to have first guess information about cloud type, (B) a module to infer geometrical (cloud top height), optical (cloud optical depth) and microphysical (effective cloud droplet radius, effective cloud ice crystal diameter, liquid/ice water content and cloud phase), (C) a module to carry out a narrow-to-broadband conversion including a angular distribution model for top of atmosphere fluxes, (D) a module to determine surface characteristics, like spectral/broadband reflectance, NDVI, roughness length, leaf area index, (E) a module to compute all surface radiant flux densities including the effect of topography and finally (F) a module for the determination of latent, sensible and soil heat flux. Module B and D are based on intensive radiative transfer calculations for the simulation of satellite radiances (inverse remote sensing technique), where geometrical conditions (solar, satellite), cloud properties (cloud type, geometrical, optical and microphysical properties), boundary-layer characteristics (relative humidity, aerosol content) and various spectral surface reflectances are variied within their possible range. The result (more than 1000 cases) are finally validated with surface measurements, in situ at various field sites and path integrated using scintillometer measurements. The intercomparison shows that a very high accuracy could be achieved for all radiant flux components (within a few percent).

Concerning the energy fluxes, the comparison of satellite inferred and at surface measured fluxes shhow that the estimate of latent heat flux is between the measurement itself (based on eddy-cavariance technique, leading to a non-closed energy balance) and the closure of the energy balance, if the sensible and soil heat fluxes are measured. After this detailed validation, time series could be analysed, especially Meteosat-8 data, which allow the determination of the diurnal cylce of validated surface radiant and energy flux densities. Examples of these results will be shown and discussed in detail.