Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 8, 625-636, 2008
www.atmos-chem-phys.net/8/625/2008/

Estimation of the aerosol radiative forcing at ground level, over land, and in cloudless atmosphere, from METEOSAT-7 observation: method and case study

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Abstract. A new method is proposed to estimate the spatial and temporal variability of the solar radiative flux reaching the surface over land (DSSF), as well as the Aerosol Radiative Forcing (ARF), in cloud-free atmosphere. The objective of regional applications of the method is attainable by using the visible broadband of METEOSAT-7 satellite instrument which scans Europe and Africa on a half-hourly basis. The method relies on a selection of best correspondence between METEOSAT-7 radiance and radiative transfer computations.

The validation of DSSF is performed comparing retrievals with ground-based measurements acquired in two contrasted environments: an urban site near Paris and a continental background site located South East of France. The study is concentrated on aerosol episodes occurring around the 2003 summer heat wave, providing 42 cases of comparison for variable solar zenith angle (from 59° to 69°), variable aerosol type (biomass burning emissions and urban pollution), and variable aerosol optical thickness (a factor 6 in magnitude). The method reproduces measurements of DSSF within an accuracy assessment of 20 W m^{-2} (5% in relative) in 70% of the situations, and within 40 W m^{-2} in 90% of the situations, for the two case studies considered here.

Considering aerosol is the main contributor in changing the measured radiance at the top of the atmosphere, DSSF temporal variability is assumed to be caused only by aerosols, and consequently ARF at ground level and over land is also retrieved: ARF is computed as the difference between DSSF and a parameterised aerosol-free reference level. Retrievals are linearly correlated with the ground-based measurements of the aerosol optical thickness (AOT): sensitivity is included between 120 and 160 W m^{-2} per unity of AOT at 440 nm. AOT being an instantaneous measure indicative of the aerosol columnar amount, we prove the feasibility to infer instantaneous aerosol radiative impact at the ground level over land with METEOSAT-7 visible channel.

Final Revised Paper (PDF, 882 KB) Discussion Paper (ACPD)

Citation: Elias, T. and Roujean, J.-L.: Estimation of the aerosol radiative forcing at ground level, over land, and in cloudless atmosphere, from METEOSAT-7 observation: method and case study, Atmos. Chem. Phys., 8,

625-636, 2008. Bibtex EndNote Reference Manager