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Aerosol direct effect on solar radiation over the eastern Mediterranean Sea based on AVHRR satellite measurements

Paraskevi Georgakaki (1,2,3), Christos D. Papadimas (3), Nikos Hatzianastassiou (3), Aggeliki Fotiadi (4), Christos Matsoukas (5), Paul Stackhouse (6), Maria Kanakidou (2), and Ilias M. Vardavas (1)

(1) Department of Physics, University of Crete, 71110 Heraklion, Crete, Greece, (2) Department of Chemistry, University of Crete, Heraklion, Greece, (3) University of Ioannina, Laboratory of Meteorology, Department of Physics, Ioannina, Greece (nhatzian@cc.uoi.gr), (4) Department of Environmental and Natural Resources Management, University of Patras, Greece, (5) Department of Environment, University of the Aegean, 81100 Mytilene, Greece, (6) NASA Langley Research Center, Hampton, VA, USA

Despite the improved scientific understanding of the direct effect of aerosols on solar radiation (direct radiative effect, DRE) improvements are necessary, for example regarding the accuracy of the magnitude of estimated DREs and their spatial and temporal variability. This variability cannot be ensured by in-situ surface and airborne measurements, while it is also relatively difficult to capture through satellite observations. This becomes even more difficult when complete spatial coverage of extended areas is required, especially concerning areas that host various aerosol types with variable physico-chemical and optical aerosol properties. Better assessments of aerosol DREs are necessary, relying on aerosol optical properties with high spatial and temporal variation. The present study aims to provide a refined, along these lines, assessment of aerosol DREs over the eastern Mediterranean (EM) Sea, which is a key area for aerosol studies.

Daily DREs are computed for 1°x1° latitude-longitude grids with the FORTH detailed spectral radiation transfer model (RTM) using input data for various atmospheric and surface parameters, such as clouds, water vapor, ozone and surface albedo, taken from the NASA-Langley Global Earth Observing System (GEOS) database. The model spectral aerosol optical depth (AOD), single scattering albedo and asymmetry parameter are taken from the Global Aerosol Data Set and the NOAA Climate Data Record (CDR) version 2 of Advanced Very High resolution Radiometer (AVHRR) AOD dataset which is available over oceans at 0.63 microns and at 0.1°x0.1°. The aerosol DREs are computed at the surface, the top-of-atmosphere and within the atmosphere, over the period 1985-1995.

Preliminary model results for the period 1990-1993 reveal a significant spatial and temporal variability of DREs over the EM Sea, for example larger values over the Aegean and Black Seas, surrounded by land areas with significant anthropogenic aerosol sources, and over the southernmost parts of EM Sea, affected by frequent Saharan dust export. The mean regional annual AODs range from 0.17±0.05 to 0.23±0.06. The corresponding regional annual DREs at surface range from -14±3 to -18±4 W/m^2 (surface radiative cooling), while in the atmosphere they vary between 7±2 and 10±2 W/m^2 (atmospheric heating), yielding a planetary cooling above the EM Sea between -6±1 and -8±2 W/m^2. However, these AOD and DRE values vary depending on the criteria of data spatial and temporal availability applied in the AOD and DRE calculation, because of the limited availability of retrieved AVHRR AOD over specific areas and in specific days. The DREs reach larger magnitudes at pixel-level; for example the surface DREs slightly exceed -30 W/m^2, whereas they take larger values (magnitudes larger than -50 W/m^2 in summer) when computed on a monthly basis, and even larger values on daily basis. The model results underline the high spatial and temporal variability of aerosol DREs, and the care that must be taken when averaging over space and time. It also points to the need for availability of aerosol data with concurrent high spatial and temporal coverage and resolution, which should be sought in ongoing and future satellite missions.