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Determination of direct aerosol radiative effects in the shortwave and longwave spectral ranges during desert dust events over Valencia (Spain)

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The capacity of the atmospheric aerosols absorbing and scattering the solar radiation cause different effects in the surface radiative budget. These effects are different depending on the aerosol type and the spectral range considered. The effect of aerosols in the shortwave has been extensively studied since the major part of the aerosol properties are measured, directly or indirectly, in the visible and near infrared spectral ranges. In general, the aerosols cause a reduction of the shortwave radiation reaching the surface. Aerosol measurements in the longwave are scarce and consequently the major part of studies devoted to determine its effects in terrestrial spectrum are coming from modelling.

The direct aerosol radiative forcing can be studied from an experimental point of view using the direct method. The main advantage of this method is that is mainly based on measurements of radiative fluxes and aerosol optical properties in the shortwave without any assumption of the aerosol optical properties in the longwave and without using radiative transfer simulations. In that way the aerosol forcing efficiency is determined as the slope of the linear regression between the net radiative flux and the aerosol optical depth. This method is only applicable using a large amount of data displaying a large range of aerosol optical depth. There are some significant differences to accounting for in the way to retrieve the aerosol forcing efficiency depending on the spectral range. That is due to the variables which affect the radiation field in one or another spectral range are different. The shortwave is mainly dependent on the solar zenith angle. Conversely, the longwave spectrum presents several dependencies on temperature and humidity profiles and water vapour content.

The Mediterranean coast of the Iberian Peninsula is frequently affected by desert dust events. That is especially important in the summer months. These events are characterized by moderate-high aerosol optical depth and low Angstrom exponents. Furthermore the Spanish service of Saharan intrusion alert has been use to determine the dust events.

Four years (2008-2011) of aerosol optical properties and radiation measurements in Valencia (Spain) have been analyzed in order to study the radiative perturbation on the Earth surface due to the dust events taken into account the shortwave and longwave spectral ranges.

The instantaneous aerosol forcing efficiency at a solar zenith angle of 40º is -220 W/m2 in the shortwave range. The longwave instantaneous aerosol forcing efficiency is positive and warms the surface by 22.8 W/m2. Therefore, during the dust events the surface cooling due to the shortwave may be partially compensate by the longwave heating by 10%.