Geophysical Research Abstracts
Vol. 12, EGU2010-5697, 2010
EGU General Assembly 2010

Radiative forcing of Mediterranean atmospheric aerosols derived from ground-based and satellite observations: dependence on the aerosol type and single scattering albedo

Claudia Di Biagio (1,2), Alcide di Sarra (1), Daniela Meloni (1), Francesco Monteleone (3), Salvatore Piacentino (3), and Damiano Sferlazzo (4)

(1) ENEA/CLIM-OSS, S. Maria di Galeria (Rome), Italy (claudia.dibiagio@enea.it), (2) Università degli Studi di Siena, Dipartimento di Scienze della Terra, Strada Laterina 8, 53100, Siena, Italy, (3) ENEA/CLIM-OSS, via Catania 2, 90141, Palermo, Italy, (4) ENEA/CLIM-OSS, Contrada Capo Grecale, 92010, Lampedusa (Agrigento), Italy

The Mediterranean region is characterized by a high variability in aerosol origin, composition, optical properties, and radiative effects. Ground-based measurements of aerosol optical properties and surface shortwave irradiance carried out at the island of Lampedusa (35.5˚N, 12.6˚E, central Mediterranean) during 2004-2007 are combined with co-located simultaneous observations of the outgoing shortwave flux at the top of atmosphere (TOA) derived from Clouds and the Earth's Radiant Energy System (CERES) to derive estimates of the aerosol radiative forcing (RF).

The shortwave aerosol RF efficiency, i.e. the forcing produced by aerosols with unit optical depth at 500 nm, τ, at the surface (FE_S), at TOA (FE_{TOA}), and in the atmosphere (FE_{ATM}) are derived by applying the direct method, i.e., by calculating the slope of the linear regression between the net flux and τ over the available large dataset from Lampedusa.

Three different particle classes are discriminated on the basis of their optical properties: desert dust (DD), urban/industrial-biomass burning aerosols (UI-BB), and mixed aerosols (MA). The average value of τ is 0.31 for DD, 0.21 for UI-BB, and 0.14 for MA. The single scattering albedo, ω at 415.6 and 868.7 nm is estimated by combining measurements of radiation fluxes and radiative transfer calculations. Average values of ω at 415.6/868.7 nm are 0.76/0.89 for DD, 0.91/0.81 for UI-BB, and 0.80/0.82 for MA.

The daily mean aerosol forcing efficiency (FE_d) at the equinox at the surface/TOA/atmosphere is -68.9/-45.5/+23.4 Wm^{-2} for DD, -59.0/-19.2/+39.8 Wm^{-2} for UI-BB, and -94.9/-36.2/+58.7 Wm^{-2} for MA. These results indicate that the atmospheric forcing is ∼30-50% of the surface forcing for DD, ∼70% for UI-BB, and ∼60% for MA.

The daily mean aerosol radiative forcing, RF_d, is obtained by multiplying FE_d by the mean τ for each aerosol class. At the equinox RF_d at the surface and TOA is -21 and -14 Wm^{-2} for DD, -12 and -4 Wm^{-2} for UI-BB, and -13 and -5 Wm^{-2} for MA. The forcings at TOA and at the surface are largest for DD due to the high values of both forcing efficiency and τ. The atmospheric RF_d at the equinox is +7 Wm^{-2} for DD, and +8 Wm^{-2} for both UI-BB and MA, suggesting that the mean atmospheric forcing is approximately independent of the aerosol type in the Mediterranean. Estimates of the maximum atmospheric RF are derived by multiplying the atmospheric FE_d at the summer solstice by the largest aerosol optical depth for each aerosol class. The peak atmospheric RF is +35 Wm^{-2} for DD, +23 Wm^{-2} for UI-BB, and +34 Wm^{-2} for MA, indicating the largest role of desert dust and MA, and a large influence on the atmospheric radiative budget.

Cases of MA in the solar zenith angle interval 25˚$\leq \theta \leq$35˚ are grouped in three classes of single scattering albedo (0.7$\leq \omega <$0.8, 0.8$\leq \omega <$0.9, 0.9$\leq \omega \leq$1) at 415.6 and 868.7 nm. The forcing is calculated separately for each class in order to study the influence of aerosol absorption. The forcing efficiency at TOA increases in absolute value for increasing ω: a 0.1 increment in ω at 415.6 and 868.7 nm produces an increase in FE_{TOA} by 10-20 Wm^{-2} for MA (about 25%).

FE_S at θ=60˚ decreases with increasing ω at 868.7 nm for MA. A 0.1 increment in ω at 868.7 nm produces a

reduction in FE_S by 25-30 Wm^{-2} (i.e., about 15%). An increase by 0.1 in ω at 868.7 nm determines a reduction in FE_{ATM} by 40%.