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Modelling the direct effect of aerosols in the solar near-infrared on a planetary scale

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Abstract. We used a spectral radiative transfer model to compute the direct radiative effect (DRE) of natural plus anthropogenic aerosols in the solar near-infrared (IR), between 0.85–10 μm, namely, their effect on the outgoing near-IR radiation at the top of atmosphere (TOA, ΔF_{TOA}), on the atmospheric absorption of near-IR radiation (ΔF_{atmab}) and on the surface downward and absorbed near-IR radiation (ΔF_{surf}, and $\Delta F_{surfnet}$, respectively). The computations were performed on a global scale (over land and ocean) under all-sky conditions, using detailed spectral aerosol optical properties taken from the Global Aerosol Data Set (GADS) supplemented by realistic data for the rest of surface and atmospheric parameters. The computed aerosol DRE, averaged over the 12-year period 1984–1995 for January and July, shows that on a global mean basis aerosols produce a planetary cooling by increasing the scattered near-IR radiation back to space by 0.48 W m^{-2}, they warm the atmosphere by 0.37 W m^{-2} and cool the surface by decreasing the downward and absorbed near-IR radiation at surface by 1.03 and 0.85 W m^{-2}, respectively. The magnitude of the near-IR aerosol DRE is smaller than that of the combined ultraviolet (UV) and visible DRE, but it is still energetically important, since it contributes to the total shortwave (SW) DRE by 22–31%. The aerosol-produced near-IR surface cooling combined with the atmospheric warming, may affect the thermal dynamics of the Earth-atmosphere system, by increasing the atmospheric stability, decreasing thus cloud formation, and precipitation, especially over desertification threatened regions such as the Mediterranean basin. This, together with the fact that the sign of near-IR aerosol DRE is sometimes opposite to that of UV-visible DRE, demonstrates the importance of performing detailed spectral computations to provide estimates of the climatic role of aerosols for the Earth-atmosphere system. This was demonstrated by sensitivity tests revealing very large differences (up to 300%) between aerosol DREs computed using detailed spectral and spectrally-averaged aerosol optical properties. Our model results indicate thus that the aerosol direct radiative effect on the near-IR radiation is very sensitive to the treatment of the spectral dependence of aerosol optical

properties and solar radiation.

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