Nighttime Retrieval of Dust Aerosols: Implications on Long Wave Radiative Forcing

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Mineral dust particles constitute the largest aerosols over land. Large dust particles (i.e. of the order of 1.0 to 10 μm in size) reduce infrared radiance at the top of the atmosphere, due to the combined effects of scattering and absorption. Smaller particles have a much lesser effect on the infrared radiance. Dust aerosols also reduce the surface surface-reaching solar radiation (due to scattering and absorption) while heating the lower atmosphere (due to absorption). This modifies the atmospheric boundary layer characteristics over land and ocean. Over the ocean an increased concentration of dust also contributes to a reduction of surface-reaching solar radiation, which may have an influence on sea surface temperature. Several investigators in the past have used the radiance depression (with respect to clear-sky infrared radiance), resulting from the presence of mineral dust aerosols in the atmosphere, as an index of dust aerosol load in the atmosphere during local noon. Since infrared radiative forcing depends on dust load during both day and night, it is essential to retrieve dust load during night as well. Here, we have used a modified approach to retrieve dust index during night since assessment of diurnal average infrared forcing essentially requires dust load during night. We found that the apparent issue in these circumstances is that the ‘dust index’ algorithm, valid for daytime, will no longer hold during the night (because dust is then hotter than the theoretical dust free reference). Hence we followed a ‘minimum reference’ approach instead of a ‘maximum reference’ approach. A detailed analysis suggests that the maximum dust load occurs during the daytime. The maximum change in dust load is as much as a factor of three between daytime and night, and factor of two variations are commonly observed. We note that this observation has a consequent impact on dust radiative forcing in the long wave bands. During daytime, when surface temperature is maximum, the dust load is also maximum while at night surface temperature decreases, as well as the dust load. Sensitivity studies carried out in this regard have indicated that neglecting the diurnal variation in dust loading results in errors in the estimate of long-wave radiative by forcing as much as 50 to 100%. During the dry season over source regions diurnally averaged long wave radiative forcing at the Earth’s surface was as high as 15 Wm^{-2} to 20 $W\ m^{-2}$.