Persistent, Widespread, and Strongly Absorbing Haze Over the Himalayan Foothills and the Indo-Gangetic Plains

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Abstract

We examine the impact of the Atmospheric Brown Clouds on the direct radiative forcing of the Himalayan foothills and the Indo-Gangetic Plains (IGP) regions, home for over 500 million S. Asians. The NASA-Terra MODIS satellite data reveal an extensive layer of aerosols covering the entire IGP and Himalayan foothills region with seasonal mean AODs of about 0.4 to 0.5 in the visible wavelengths (0.55 micron), which fall among the largest seasonal mean dry season AODs for the tropics. We show new surface data which reveal the presence of strongly absorbing aerosols that lead to a large reduction in solar radiation fluxes at the surface during the October to May period. The three-year mean (2001 to 2003) October to May seasonal and diurnal average reduction in surface solar radiation for the IGP region is about 32 (±5) W m^{-2} (about 10% of TOA insolation or 20% of surface insolation). The forcing efficiency (forcing per unit optical depth) is as large as −27% (note that the forcing is negative) of top-of-atmosphere (TOA) solar insolation, and exceeds the forcing efficiency that has been observed for other polluted regions in America, Africa, East Asia, and Europe. General circulation model sensitivity studies suggest that both the local and remote influence of the aerosol induced radiative forcing is to strengthen the lower atmosphere inversion, stabilize the boundary layer, amplify the climatological tendency for a drier troposphere, and decrease evaporation. These aerosol-induced changes could potentially increase the life times of aerosols, make them more persistent, and decrease their single scattering albedos, thus potentially leading to a detrimental positive feedback between aerosol concentrations, aerosol forcing, and aerosol persistence. In addition, both the model studies and observations of pan evaporation suggest that the reduction in surface solar radiation may have led to a reduction in surface evaporation of moisture. These results suggest the vulnerability of this vital region to air pollution related direct and indirect (through climate changes) impacts on agricultural productivity of the region.

Keywords Aerosol and particles - anthropogenic effects - transmission and scattering of radiation - aerosol radiative forcing efficiency - dimming of the surface - pan evaporation