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The Regional Environmental Impacts of Atmospheric Aerosols over Egypt

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Identifying the origin (natural versus anthropogenic) and the dynamics of aerosols over Egypt at varying temporal and spatial scales provide valuable knowledge on the regional climate impacts of aerosols and their ultimate connections to the Earth's regional climate system at the MENA region. At regional scale, Egypt is exposed to air pollution with levels exceeding typical air-quality standards. This is particularly true for the Nile Delta region, being at the crossroads of different aerosol species originating from local urban-industrial and biomass-burning activities, regional dust sources, and European pollution from the north. The Environmental Climate Model (EnvClimA) is used to investigate both of the biogenic and anthropogenic aerosols over Egypt. The dominant natural aerosols over Egypt are due to the sand and dust storms, which frequently occur during the transitional seasons (spring and autumn). In winter, the maximum frequency reaches 2 to 3 per day in the north, which decreases gradually southward with a frequency of 0.5-1 per day. Monitoring one of the most basic aerosol parameters, the aerosol optical depth (AOD), is a main experimental and modeling task in aerosol studies. We used the aerosol optical depth to quantify the amount and variability of aerosol loading in the atmospheric column over a certain areas. The aerosols optical depth from the model is higher in spring season due to the impacts of dust activity over Egypt as results of the westerly wind, which carries more dust particles from the Libyan Desert. The model result shows that the mass load of fine aerosols has a longer life-time than the coarse aerosols. In autumn season, the modelled aerosol optical depth tends to increase due to the biomass burning in the delta of Egypt. Natural aerosol from the model tends to scatter the solar radiation while most of the anthropogenic aerosols tend to absorb the longwave solar radiation. The overall results indicate that the AOD is lowest in winter due to airborne particles washed out by rain events. Conversely, the AOD increases in summer because particle accumulation is favored by the absence of precipitation during this season. Moreover, in summer, photochemical processes in the atmosphere lead to slight increases in the values of aerosol optical characteristics, despite lower wind speeds [hence less wind-blown dust] relative to other seasons.

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