LONGITUDINAL VARIATIONS IN THE VERTICAL DISTRIBUTION OF ATMOSPHERIC AEROSOLS OVER THE INDIAN REGION

Despite its importance in accurately estimating atmospheric radiative forcing due to aerosols (tiny suspended particles in the atmosphere), the vertical structure and its spatial variation of aerosols remains mostly at large over the south Asian region. Consequently, most of the studies rely upon columnar information inputted to radiative transfer estimation resulting in significant uncertainties in the radiative forcing estimates, especially its vertical structure. However, it is very important to know what heating occurs at different altitudes, because for a given amount of radiation absorbed by the aerosols, the atmospheric heating would be higher at higher altitudes owing to the vertically decreasing air density.

Scientists from the Divecha Centre for Climate Change, have for the first time, made a comprehensive estimate of the vertical structure of aerosol-induced atmospheric heating rate over the South Asian region (Indian mainland and the adjoining oceans) and its seasonality using long-term (2007–2020) satellite observations, assimilated aerosol single scattering albedo, and radiative transfer calculations. The results show strong, seasonally varying zonal gradients in the vertical extent of aerosol extinction over the study region; being rather shallow over the oceans (where the vertical extent of aerosols is confined within 3 km) becoming deeper with the aerosol extinction coefficients extending to considerably higher altitudes over the mainland, reaching as high as 6 km, during pre-monsoon and monsoon seasons over the landmass. This feature is most pronounced over the northern

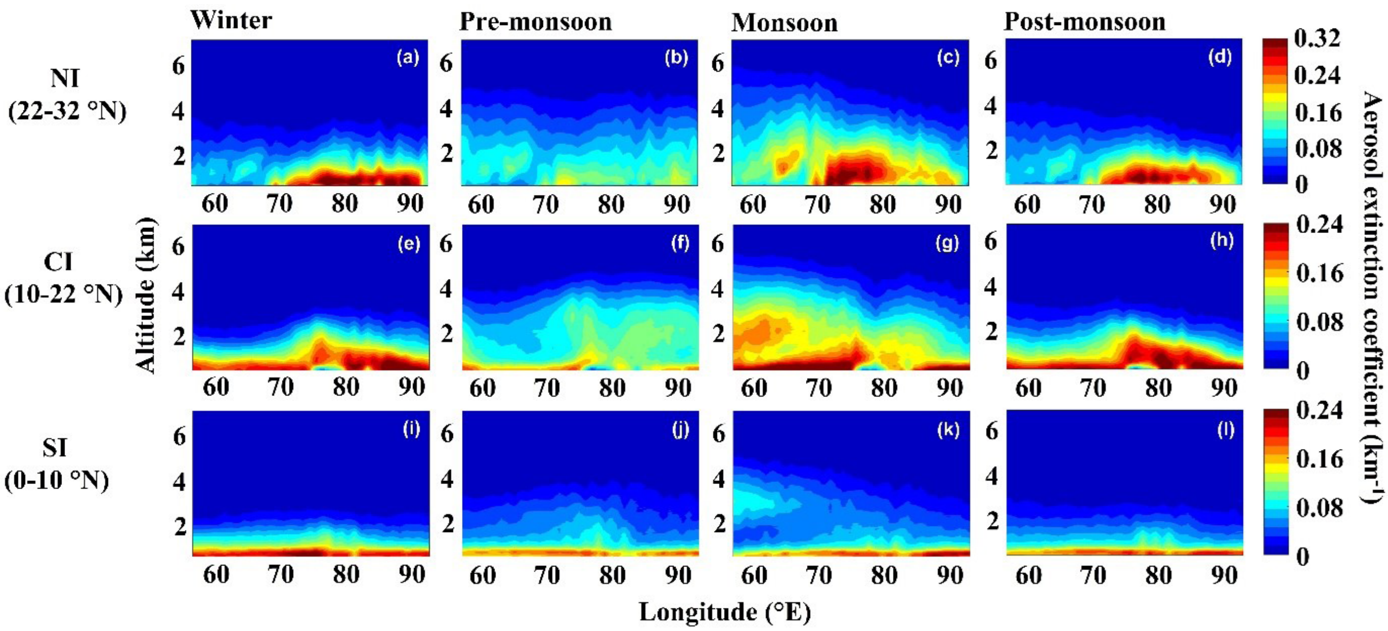

Figure 1: Longitudinal variations in the vertical distribution of aerosols over north (NI; top rows), central (CI; middle rows), and south (SI; bottom rows) India. Each column corresponds to a particular season, as marked above them. The colour scheme marks the magnitude of aerosol extinction coefficient.

Indian mainland compared to the southern parts (Figure 1). Particulate depolarisation ratio profiles identified that the elevated aerosol layers mostly comprise of advected dust.

Using high spatial resolution aerosol extinction profiles and single scattering profiles (generated from measurements and statistical assimilation) as input to radiative transfer calculations, the spatial pattern of vertical structure of aerosol induced heating rate are estimated for different distinct season over the south Asian region and are shown in Figure 2. The results show, for the first time, the influence of incorporation of realistic values of the vertical distribution of aerosol extinction coefficient and the absorption potential of aerosols with high spatial resolution on atmospheric heating rates. Incorporation of these in regional climate models will further demonstrate the implications for the thermal structure and stability of the atmosphere.

Reference: Kala, N. K., Anand, N., Manoj, M. R., Pathak, H. S., Moorthy, K. K., & Satheesh, S. K. (2022). Zonal variations in the vertical distribution of atmospheric aerosols over the Indian region and the consequent radiative effects. Atmospheric Chemistry and Physics, 22(9), 6067-6085, https://doi.org/10.5194/acp-22-6067-2022

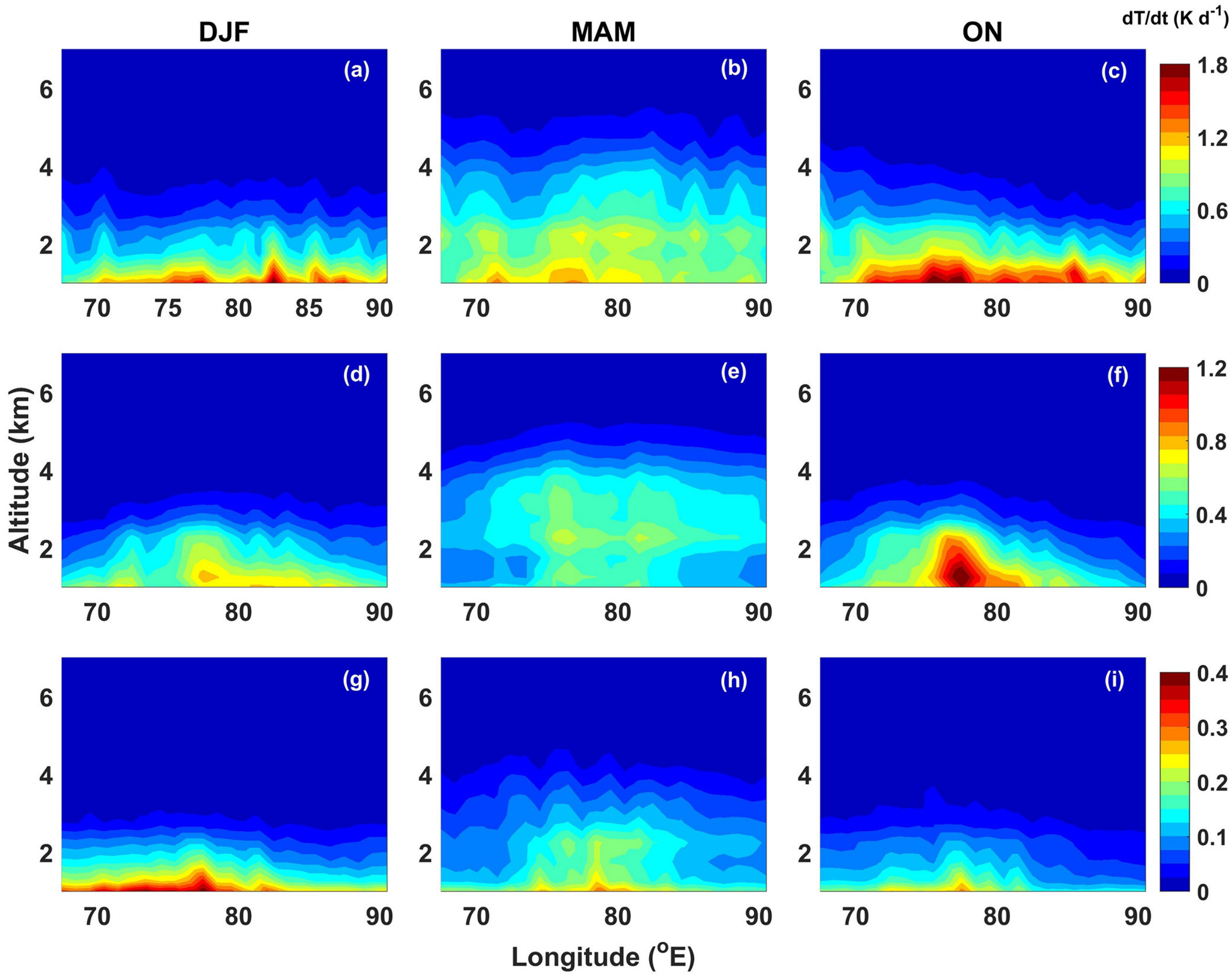

Figure 2: Zonal variation of the vertical structure of aerosol induced atmospheric heating rate over different sub-regions of South Asia clearly depicting the seasonality.