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Impact of atmospheric circulation types on southwest Asian dust and Indian summer monsoon rainfall

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Abstract

This study examines the meteorological feedback on dust aerosols and rainfall over the Arabian Sea and India during the summer monsoon using satellite data, re-analysis and a regional climate model. Based on days with excess aerosol loading over the central Ganges basin during May – September, two distinct atmospheric circulation types (weather clusters) are identified, which are associated with different dust-aerosol and rainfall distributions over south Asia, highlighting the role of meteorology on dust emissions and monsoon rainfall. Each cluster is characterized by different patterns of mean sea level pressure (MSLP), geopotential height at 700 hPa (Z700) and wind fields at 1000 hPa and at 700 hPa, thus modulating changes in dust-aerosol loading over the Arabian Sea. One cluster is associated with deepening of the Indian/Pakistan thermal low leading to (i) increased cyclonicity and thermal convection over northwestern India and Arabian Peninsula, (ii) intensification of the southwest monsoon off the Horn of Africa, iii) increase in dust emissions from Rub-Al-Khali and Somalian deserts, (iv) excess dust accumulation over the Arabian Sea and, (v) strengthening of the convergence of humid air masses and larger precipitation over Indian landmass compared to the other cluster. The RegCM4.4 model simulations for dust-aerosol and precipitation distributions support the meteorological fields and satellite observations, while the precipitation over India is positively correlated with the aerosol loading over the Arabian Sea on daily basis for both weather clusters. This study highlights the key role of meteorology and atmospheric dynamics on dust life cycle and rainfall over the monsoon-influenced south Asia.