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South Asian Climate Response to Local and Remote Aerosol Emissions Perturbations

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The South Asian population's livelihood largely depends on the rainfall brought on by the summer monsoon. Some of the highest emissions of short-lived anthropogenic aerosols can also be found in this region. Understanding how the long-term mean state of the south Asian climate will change in response to both local and remote aerosol emissions is of great importance, since the South Asian monsoon forms a key part of the global climate system. Recent studies suggest that South Asian temperature and precipitation responses to aerosol changes are different depending on the location and type of aerosol. Here, we use the UK Met Office HadGEM3 coupled climate model to investigate the South Asian climate response to removing sulphur dioxide emissions (producing sulphate aerosols) locally and remotely through centennial scale equilibrium simulations. The summer precipitation response to remote emissions (e.g. from Europe, United States, East Asia) and to local emissions (e.g. south Asia) is of opposite sign over land, but of the same sign and pattern over the Indian Ocean. Over land, reductions in rainfall are seen when removing sulphur dioxide from south Asia, while there is an increase in rainfall due to emissions from remote mid-latitudes regions. Remotely emitted aerosols have a greater ability to change the large-scale temperature and circulation patterns compared to locally emitted aerosols. They cause a northward shift of the intertropical convergence zone towards the northern hemisphere and increase the land-sea thermal contrast, which strengthens the monsoon circulation. Local emissions cause a change in composition over the area of interest, which modulates the precipitation response over land and counters the strengthened circulation through local dynamical and land surface changes in the pre-monsoon season. More work is warranted to allow for comparisons with other models, as well as to further our understanding of the processes involved using a similarly holistic approach.