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Earlier onset of the Indian monsoon in the late twentieth century: The role of anthropogenic aerosols

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The impact of the late twentieth century increase of anthropogenic aerosols on the Indian monsoon onset was investigated with a state-of-the-art climate model with fully interactive aerosols and chemistry. We find that aerosols are likely responsible for the observed earlier onset, resulting in enhanced June precipitation over most of India. This shift is preceded by strong aerosol forcing over the Bay of Bengal and Indochina, mostly attributable to the direct effect, resulting in increased atmospheric stability that inhibits the monsoon migration in May. The adjusted atmospheric circulation leads to thermodynamic changes over the northwestern continental region, including increased surface temperature and near-surface moist static energy, which support a stronger June flow and, facilitated by a relative warming of the Indian Ocean, a vigorous northwestward precipitation shift. These findings underscore the importance of dynamical feedbacks and of regional land-surface processes for the aerosol-monsoon link.