Uncertainty in aerosol radiative forcing impacts the simulated global monsoon in the 20th century

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Abstract

Anthropogenic aerosols are dominant drivers of historical monsoon rainfall change. However, large uncertainties in the radiative forcing associated with anthropogenic aerosol emissions, and in the dynamical response to this forcing, lead to uncertainty in the simulated monsoon response. We use historical simulations from the "SMURPHS" project, run using HadGEM3-GC3.1, in which the time-varying aerosol emissions are scaled by factors from 0.2 to 1.5 to explore the monsoon sensitivity to historical aerosol forcing uncertainty (present-day versus preindustrial aerosol forcing in the range –0.38 to –1.50 W m–2). Hemispheric emissions asymmetry generates a strong relationship between scaling factor and both hemispheric temperature contrast and meridional location of tropical rainfall. Averaged over 1950–2014, increasing the scaling factor from 0.2 to 1.5 reduces the hemispheric temperature contrast by 0.9∘C, reduces the tropical summertime land–sea temperature contrast by 0.3∘C and shifts tropical rainfall southwards by 0.28∘ of latitude. The result is reductions in global monsoon area by 3 % and in global monsoon intensity by 2 %. These monsoon properties vary monotonically and roughly linearly across scalings. A switch in the dominant influence on the 1950–1980 monsoon rainfall trend between greenhouse gases and aerosol is identified as the scalings increase. The strongest influence on monsoon area and intensity is found in the Asian sector, where local emissions are greatest.

Keywords: monsoon, aerosol, attribution, uncertainty, CMIP

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