Equilibrium Climate Responses of the East Asian Summer Monsoon to Various Anthropogenic Aerosol Species

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The equilibrium climate responses of the East Asian summer monsoon (EASM) to increases in various types of anthropogenic aerosol emissions, including sulfate, organic carbon (OC), and black carbon (BC), from 1850 to 2000 are studied using an aerosol-climate online model. The results show that various aerosol species have substantially different impacts on the EASM by changing the local sea-land surface thermal difference and atmospheric circulation. The increased sulfate leads to decrease in the surface thermal difference between the land and ocean, the southward shift of the East Asian subtropical jet (EASJ), and significant northerly wind anomalies at 850 hPa over eastern China and the ambient oceans, thus dampening the EASM markedly. Pronounced surface cooling appears and an anomalous anticyclone is formed over the oceans north of 30˚N due to the increase of OC. These cause slight increase in sea-land surface thermal difference and southerly flow anomalies to the west of the anticyclonic center, thereby strengthening the northern East Asian summer monsoon (NEASM). However, the increased OC decreases the sea-land surface thermal contrast over southern China, which weakens the southern East Asian summer monsoon (SEASM). The responses of summer 850 hPa winds and rainfall over the East Asian monsoon region (EAMR) to increase in BC are generally consistent with those to increase in OC. The increased BC leads to the strengthening of the NEASM north of 35˚N and slight weakening of the SEASM south of 35˚N. Also, the simulated responses of the EASM to increase in BC are not changed when BC emission is scaled up by five times its 2000 levels, but the intensities of responses are enhanced. Overall, the increase in sulfate primarily weakens the EASM, while the increases in BC and OC mitigate the weakening of the NEASM to some extent.

Keywords: EASM, various aerosol species, equilibrium climate response

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