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Hydrological sensitivity and global temperature change to greenhouse gases and aerosols in CESM

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We present a set of climate model experiments using the NCAR Community Earth System Model (CESM1.03) to investigate the relationship between precipitation changes and surface temperature change for several forcing mechanisms. The model simulations include forcing mechanisms since preindustrial times causing either warming or cooling, in order to study the energy budget at different levels (surface, atmosphere and top of atmosphere), temperature changes and precipitation change. On a short timescale the precipitation changes are due to atmospheric instability and reduced convection caused by the presence of a forcing mechanism in the atmosphere. On longer timescale it is the adjusted surface temperatures that drive the changes.

In particular we look at the precipitation response from black carbon and study the model sensitivity to absorbing aerosols by introducing black carbon at different altitudes in the model. Our results are similar to earlier studies regarding greenhouse gases and sulphate aerosols, but extend previous results on black carbon aerosols. We introduce BC aerosols in different altitudes and look at how sensitive the precipitation changes are due to the placement of a warming forcing agent in the atmosphere. We find that while the surface temperature response of a column of BC is positive, it is composed of a warming component at low altitudes and a cooling component at higher altitudes. The precipitation response of a change in BC concentration is however always negative.