Geophysical Research Abstracts
Vol. 20, EGU2018-6104-1, 2018
EGU General Assembly 2018

Global flood risk response to stratospheric aerosol geoengineering

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Flood risk would show an increasing pattern under future climate projection due to the enhanced hydrology circulation. Geoengineering is a deliberated method to offset the anthropogenic climate change. However, the impacts of geoengineering on flood risk is rarely studied. Here, we examine the changes of streamflow and flood risk under the representative concentration pathway (RCP) 4.5 and stratospheric aerosol injection (SAI) geoengineering G4 scenarios. The G4 scenario specifies 5Tg sulfate aerosol injection into stratosphere every year aiming to cancel out partial greenhouse gases radiative forcing under RCP4.5. We analyze the streamflow and flood risk calculated with Catchment-based Macro-scale Floodplain Model (CaMa-Flood) driven by six Earth system models (ESMs). Comparing G4 with RCP4.5, the mean streamflow shows a decreasing pattern mainly in high-latitude regions, Southeast Asia, middle Africa and north Europe, while an increasing pattern in west Europe, middle Asia, Middle America and western coast of North America. Meanwhile, the high streamflow increases primarily over Europe and west North America, and decreases primarily over Eastern and Southeast Asia, India and Africa. For the low flow, the increasing trend mainly appears in west Europe, Africa and Middle America, the decreasing pattern shows mainly in Southeast Asia, Indian, middle Africa, middle of North America and some regions in Amazon Basin.
For the flood risk measured by 30-year return period, our results show the flood frequency decreases in Europe, middle Asia, middle Africa and American continent, and increases in Southeastern Asia, India, and high-latitude regions under RCP4.5 scenario. The flood risk under G4 shows a similar spatial pattern as that under RCP4.5 in general, but increases in Europe and North America and decreases in Southeast Asia. The hydrological indicators (i.e. mean, high, low flow and 30-year return period) all show a decreasing trend at Amazon under both RCP4.5 and G4 scenarios, but they further reduce under G4 scenario. Our study suggests that the SAI geoengineering exerts regionally unequal effects on flood risk, which could release the flood pressure in Southeast Asia, but worse it in Europe and North America.