Geophysical Research Abstracts
Vol. 19, EGU2017-4477, 2017
EGU General Assembly 2017

Impact of sulphate geoengineering on rice yield in China

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Sulphate geoengineering is one of the mostly discussed mitigation methods against global warming for its feasibility and inexpensiveness. With SO_2 consistently injected into the stratosphere to balance the radiative force caused by anthropogenic emission, sulphate engineering will significantly influence the climate over the planet and moreover, affect agriculture productivity. In our study, BNU-ESM model was used to simulate the impact of sulphate engineering on climate and ORYZA(v3) model was used to simulate the impact of climate change on rice yield/production in China. Firstly, the ORYZA(v3) model was evaluated and calibrated using daily climate data, management data and county-level yield record during 1981-2010 in 19 provinces in China. Then climate anomalies of sulphate geoengineering simulated by BNU-ESM model was used to perturb the observed climate data over 318 stations evenly distribute in China during 1981–2010. In our study, a 30-year climate record of anomalies were extracted from BNU-ESM model to match the observed climate data, which consisted of a 15-year geoengineering record and a 15-year post-geoengineering record. Lastly, the perturbed climate data was used in calibrated-ORYZA(v3) model to simulate the rice yield over the 318 stations, which were later averaged into corresponding provincial yield. The results showed that (1) geoengineering would balance solar radiation for approximate 140 $W \cdot m^{-2}$ per year (about 0.9 K per year in temperature), which would meet the pre-concerted goal of geoengineering but it would take only about 3 years for temperature to recover after the termination of geoengineering. In spite of this, there would be a declining of vapour pressure for about 0.12 KPa per year during geoengineering period, and it would take about 15 years to recover during post-geoengineering period. The simulation showed that geoengineering would have a little declining impact on average precipitation and would not have much impact on wind speed. (2) rice production in China would decline 7.67% (22.64 Mt) on average during the 15 years of geoengineering, when it comes to the last five years of geoengineering, this number would increase to 16.67% (40.38 Mt). While during the 15 years of post-geoengeering, rice production in China would decline 5.18% when compared with baseline. (3) When geoengineering was turned on, yield of 12 provinces, including all 7 coastal provinces in China, exhibited increasing trend. During this period, inland provinces showed both decreasing and increasing trend, where provinces that are near to the ocean were more likely to decrease in yield and provinces which were close to the interior were more likely to increase in yield.