Geophysical Research Abstracts
Vol. 20, EGU2018-6042-1, 2018
EGU General Assembly 2018

Mitigation of carbon loss in circum-Arctic permafrost region through stratospheric aerosol geoengineering implement

Yating Chen, John C. Moore, and Zhihua Zhang

Beijing Normal University, College of Climate Change and Earth System Science, China (chenyt2016bnu@gmail.com)

Climate warming as a result of human activities causes permafrost region to thaw and release carbon to the atmosphere, representing the permafrost starts to shift from a carbon sink to a carbon source. Geoengineering, the deliberate large-scale manipulation of earth's energy balance in order to mitigate global warming, is an attractive proposition for mitigating carbon losses in circum-Arctic permafrost region. We use soil temperature data from seven earth system models and NCSCD's soil carbon data to predict the spatial-temporal variation of carbon stocks in permafrost region under RCP4.5 scenario and stratospheric aerosol Geoengineering(G4) from the Geoengineering Model Intercomparison Project between 2020-2090. The prediction is based on PInc-Panther approach and we have made some improvements for more detailed analysis. The effect of Geoengineering to mitigate permafrost thaw and reduce carbon loss is evaluated, and the rebound effect after Geoengineering stopped is discussed. We calculate emissions for the period 2020–2070 come from surface soils less than 3 m deep, as a result, a 66$\pm$22 Pg carbon loss in permafrost area under RCP4.5 and a 40$\pm$34 Pg carbon loss under G4 scenario. G4 reduces nearly 40% of carbon loss and 18% of methane emissions relative to the RCP45 scenario between 2020-2070. By 2090, due to the rebound effect, total carbon losses are 91$\pm$27 Pg under RCP4.5 and 82$\pm$32 Pg under G4 scenario. These estimates may be low because the thermokarst and deeper Yedoma deposits hadn't been taken into account and the model we used provides some possible sources of bias. Despite this, Geoengineering has played a role in mitigation of carbon loss in circum-Arctic permafrost region. In addition, by monthly analysis, we find the dominant month of Geoengineering is October and November. At 1-2 m and 2-3 m depths, G4 reduces carbon losses by 16% and 19% relative to RCP45, but in the 0-1m, the role of G4 is not obvious. Thus the major contribution of Geoengineering has been to mitigate the deepening of permafrost degradation. By 2090, we predict a 6%-45% decrease in permafrost area and a 11-78 cm increase in active layer thickness.