EGU2020-10180
https://doi.org/10.5194/egusphere-egu2020-10180
EGU General Assembly 2020

Impacts of wildfire aerosols on global energy budget and climate: The role of climate feedbacks

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Aerosols emitted from wildfires could significantly affect global climate through perturbing global radiation balance. In this study, Community Earth System Model with prescribed daily fire aerosol emissions is used to investigate fire aerosols' impacts on global climate with emphasizing the role of climate feedbacks. The total global fire aerosol radiative effect (RE) is estimated to be -0.78±0.29 W m^{-2}, which is mostly from shortwave RE due to aerosol-cloud interactions (REaci, -0.70±0.20 W m^{-2}). The associated global-annual mean surface air temperature (SAT) change (ΔT) is -0.64±0.16K with the largest reduction in the Arctic regions where the shortwave REaci is strong. Associated with the cooling, the Arctic sea ice is increased, which acts to re-amplify the Arctic cooling through a positive ice-albedo feedback. The fast response (irrelevant to ΔT) tends to decrease surface latent heat flux into atmosphere in the tropics to balance strong atmospheric fire black carbon absorption, which reduces the precipitation in the tropical land regions (southern Africa and South America). The climate feedback processes (associated with ΔT) lead to a significant surface latent heat flux reduction over global ocean areas, which could explain most (~80%) of the global precipitation reduction. The precipitation significantly decreases in deep tropical regions (5°N), but increases in Southern Hemisphere tropical ocean, which is associated with the southward shift of the Inter-Tropical Convergence Zone and the weakening of Southern Hemisphere Hadley cell. Such changes could partly compensate the interhemispheric temperature asymmetry induced by boreal-forest fire aerosol indirect effect, through intensifying the cross-equator atmospheric heat transport.