Droughts, fires and fire emissions of CO_2 and $PM_{2.5}$ in equatorial Asia due to historical and future climate changes

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In 2015, El Niño contributed to severe droughts in equatorial Asia (EA). The severe droughts enhanced fire activities in the dry season (June-November), leading to massive fire emissions of CO_2 and aerosols. Based on large event attribution ensembles of the MIROC5 atmospheric global climate model, we suggest that historical anthropogenic warming increased the chances of meteorological droughts exceeding the 2015 observations in the EA area. We also investigate changes in drought in future climate simulations, in which prescribed sea surface temperature data have the same spatial patterns as the 2015 El Niño with long-term warming trends. Large probability increases in stronger droughts than the 2015 event are projected when events like the 2015 El Niño occur in the 1.5˚C and 2.0˚C warmed climate ensembles according to the Paris Agreement goals. Further drying is projected in the 3.0˚C ensemble according to the current mitigation policies of nations.

We combine these experiments and empirical functions among precipitation, burned area, and fire emissions of CO_2 and fine (<2.5 micrometers) particulate matter ($PM_{2.5}$). Increases in the chances of burned areas and the emissions of CO_2 and $PM_{2.5}$ exceeding the 2015 observations due to past anthropogenic climate change are not significant. In contrast, there are significant increases in the burned area and CO_2 and $PM_{2.5}$ emissions even if the 1.5˚C and 2.0˚C goals are achieved. If global warming reaches 3.0˚C, as is expected from the current mitigation policies of nations, the chances of burned area, CO_2 and $PM_{2.5}$ emissions exceeding the 2015 observed values become approximately 100%, at least in the single model ensembles.

We also compare changes in fire CO_2 emissions due to climate changes and the land-use CO_2 emission scenarios of five shared socioeconomic pathways, where the effects of climate change on fire are not considered. There are two main implications. First, in a national policy context, future EA climate policy will need to consider these climate change effects regarding both mitigation and adaptation aspects. Second, the consideration of fire increases would change global CO_2 emissions and the mitigation strategy, which suggests that future climate change mitigation studies should consider these factors.

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