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

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Wildfire frequently happened in 2019

Fires in the Amazon over the past 48 hours
- Fires detected by satellite in the 48 hours leading up to 23 August, 2019, 11:30 a.m. GMT

The Amazon hasn't stopped burning. There were 19,925 fire outbreaks last month, and 'more fires' are in the future
Two main fire zones

The fire BC to OC ratio (BC/OC) is higher in tropic.
Fire aerosol radiative forcing due to ARI

The direct effect is the largest over tropic.
Fire aerosol effective radiative forcing due to ACI

Fire aerosol indirect effect is the largest in Arctic

Observed Arctic indirect forcing

Why fire aerosol indirect effect in Arctic is the largest during summer?

- Large cloud liquid water path
- Low solar zenith angle
Total fire aerosol forcing is negative (cooling)

Direct forcing

Indirect forcing

Global temperature change

Why the cooling is maximum over Arctic?
Global precipitation change

Fast response
• $\Delta T = 0$
• Without SST change (fast, AMIP)

Slow response
• $\propto \Delta T$
• With SST change (slow, CMIP)

What is the role of fast and slow response respectively?
Precipitation change (fast component)

Drought in tropical land regions
Precipitation change (slow component)

Weakening of Southern Hemisphere Hadley cell
Summary and conclusions

- The fire BC to OC ratio (BC/OC) in the tropical regions is about 3 times higher than that of high latitude of Northern Hemisphere, which results in stronger atmospheric absorption in tropic.

- Strong fire BC atmospheric absorption in tropic should be balance by the turbulent (SH and LH) flux reduction, which leads to the significant precipitation decrease in tropical land regions (fast response).

- Most global precipitation reduction (80%) is associated with the climate feedback processes (slow response).

- Interhemispheric temperature asymmetry induced by boreal-forest fire aerosol indirect effect is balanced by southward shift of ITCZ and weakening of Southern Hemisphere Hadley cell.