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

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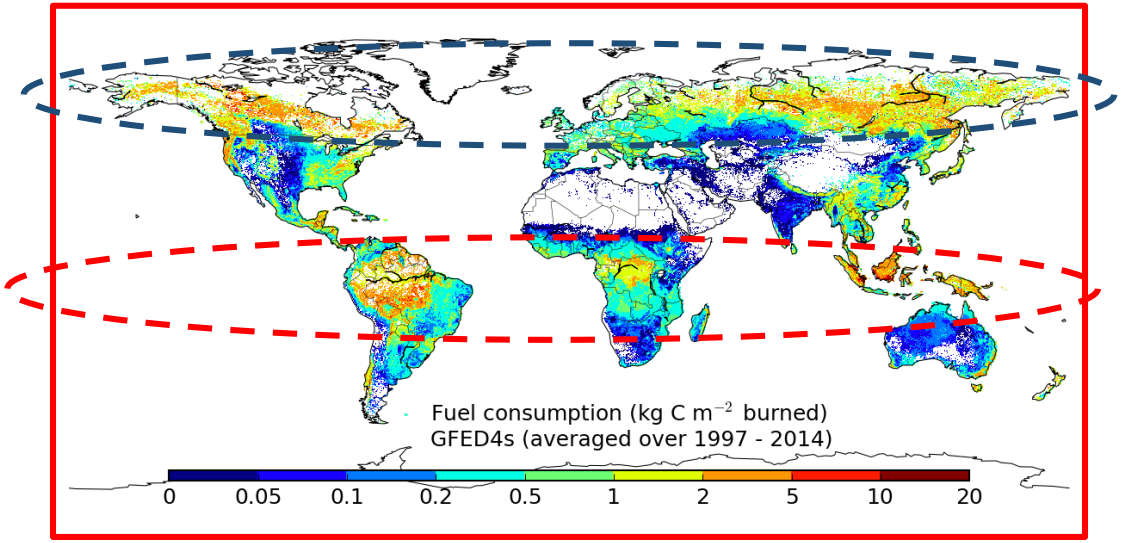
Wildfire frequently happened in 2019

USA TODAY

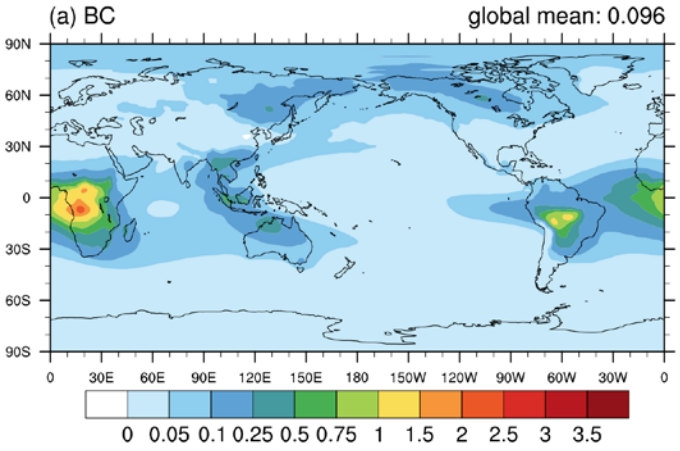
NEWS SPORTS ENTERTAINMENT LIFE MONEY TECH TRAVEL OPINION 54° CROSSWORDS MORE

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

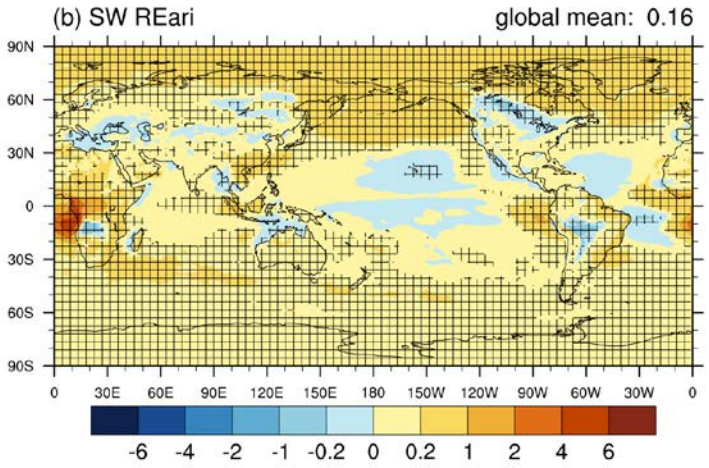


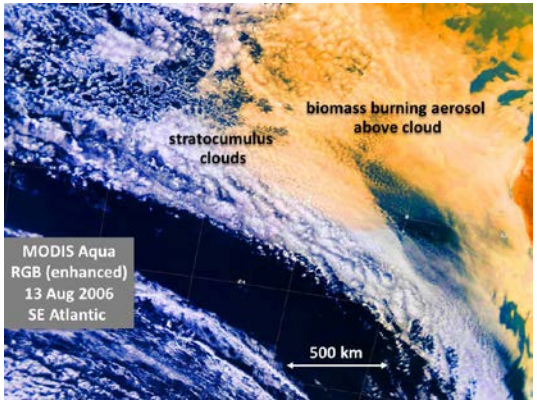
The fire BC to OC ratio (BC/OC) is higher in tropic.

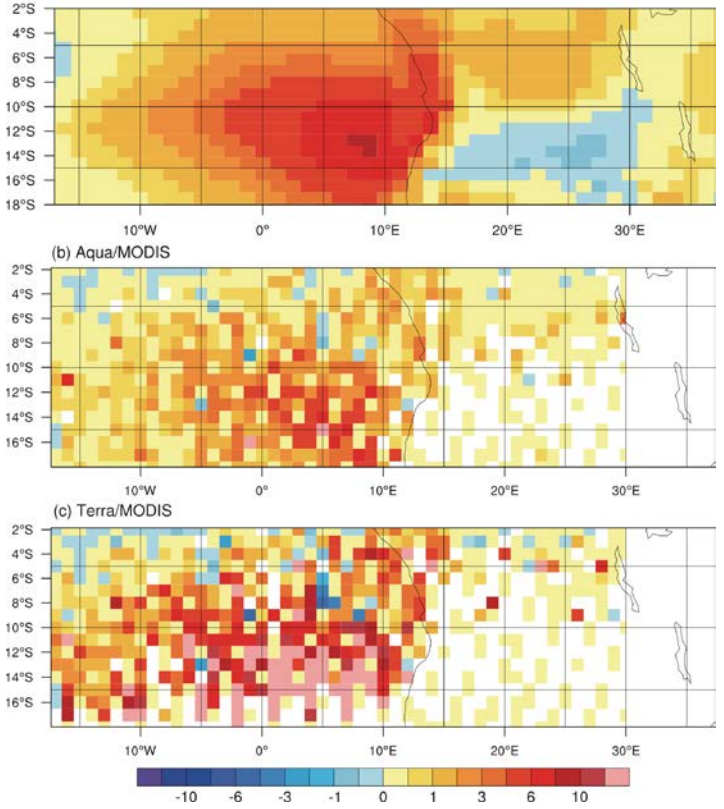


Fire aerosol radiative forcing due to ARI

The direct effect is the largest over tropic

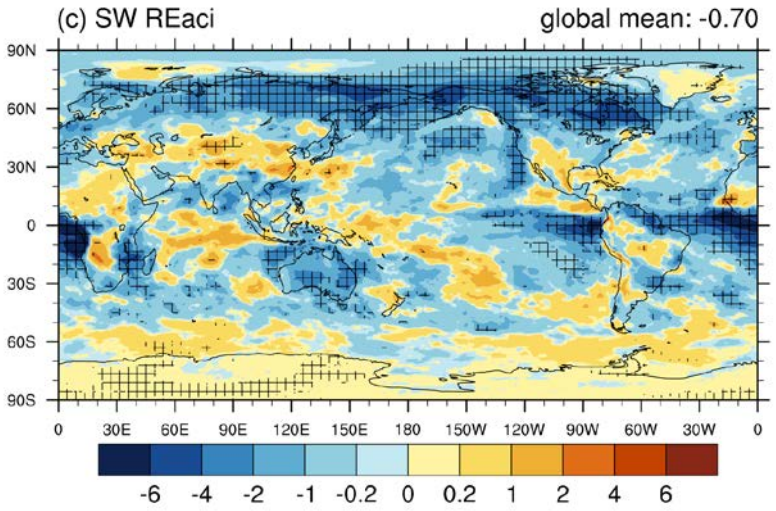




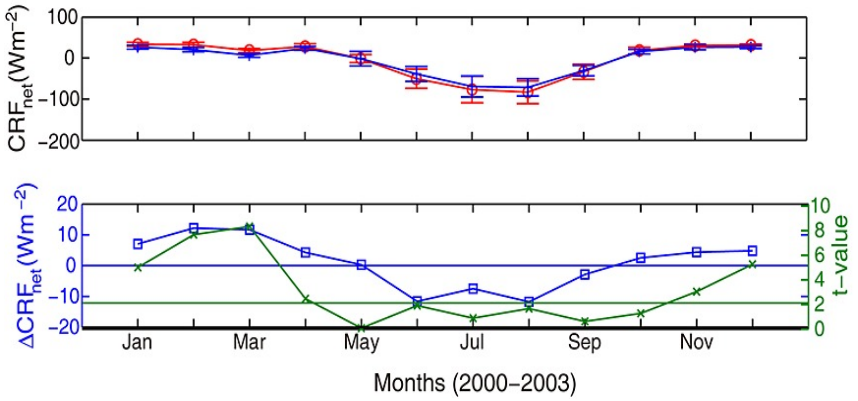


Fire aerosol effective radiative forcing due to ACI

Fire aerosol indirect effect is the largest in Arctic



Observed Arctic indirect forcing

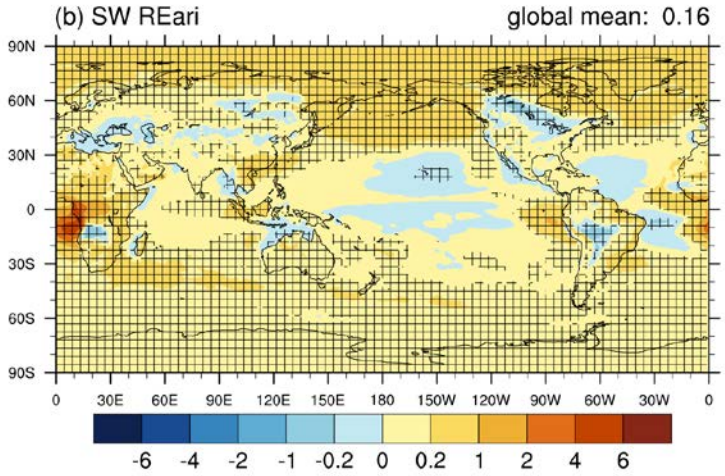


Why fire aerosol indirect effect in Arctic is the largest during summer?

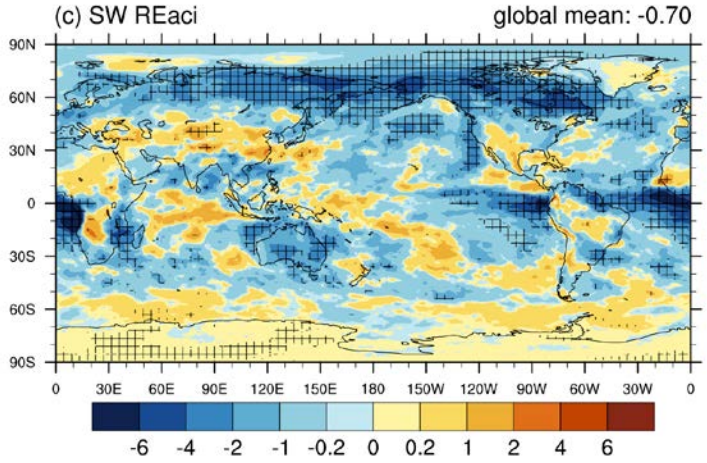
- **Large cloud liquid water path**
- **Low solar zenith angle**

Total fire aerosol forcing is negative (cooling)

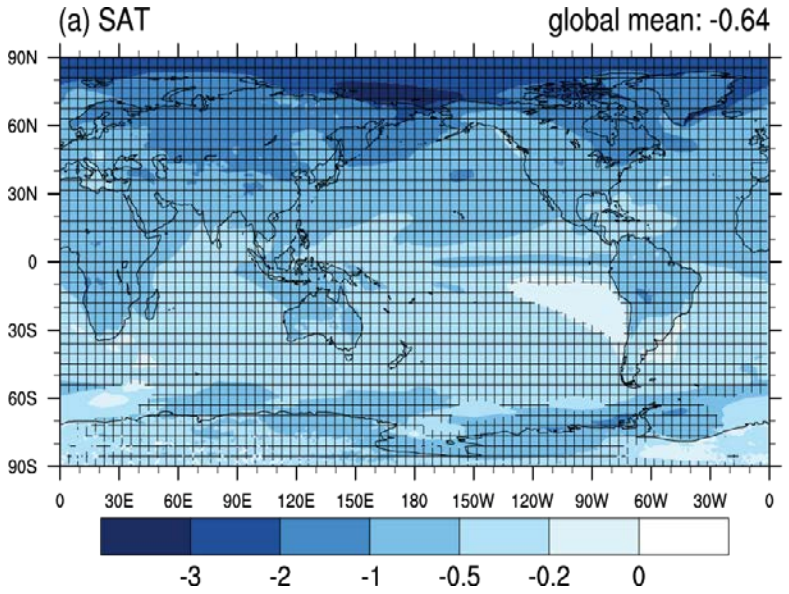
Direct forcing



Indirect forcing

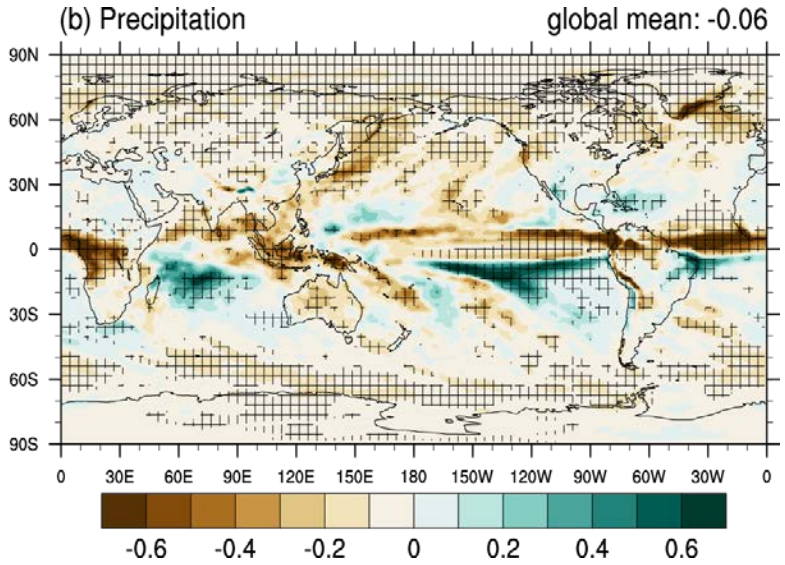


Global temperature change



Why the cooling is maximum over Arctic?

Global precipitation change



Fast response

- $\triangle T = 0$
- Without SST change (fast, AMIP)

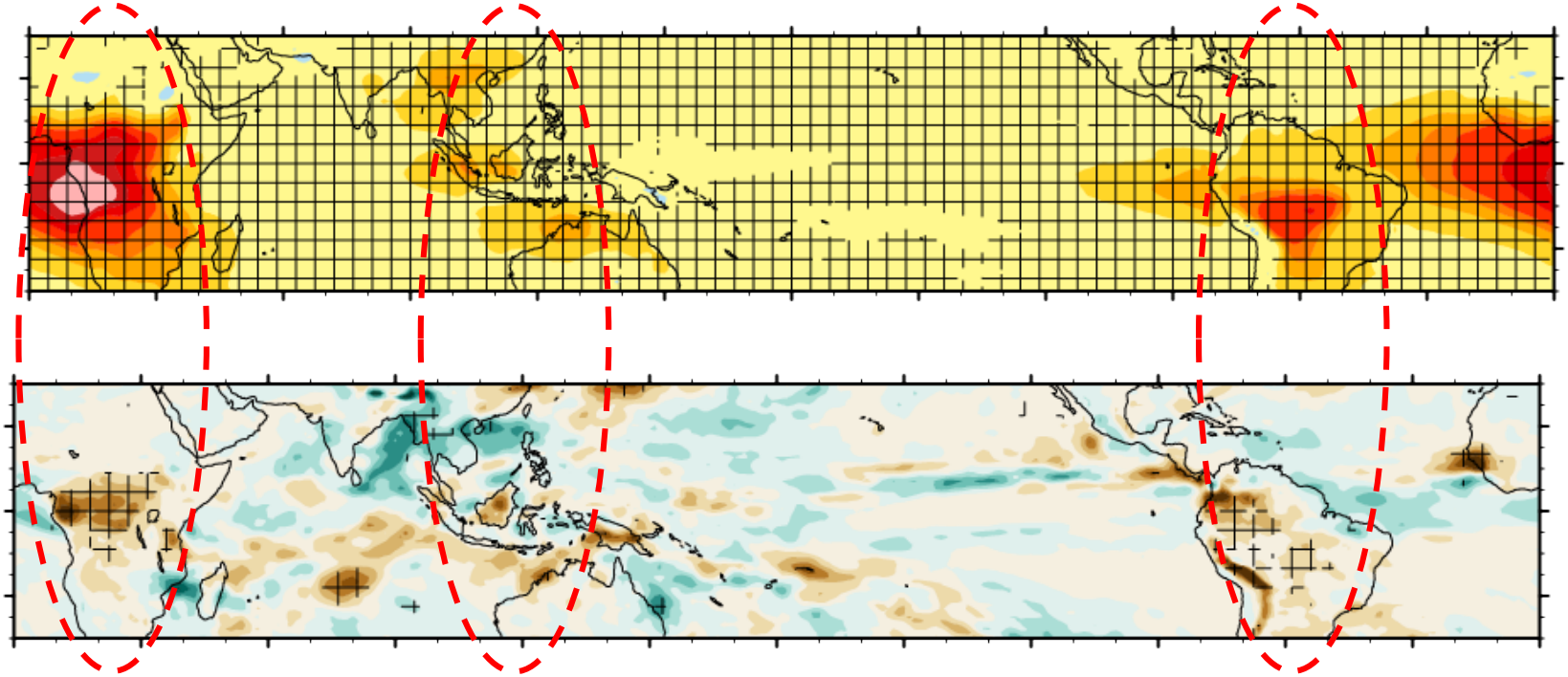
Slow response

- $\propto \triangle T$
- With SST change (slow, CMIP)

What is the role of fast and slow response respectively ?

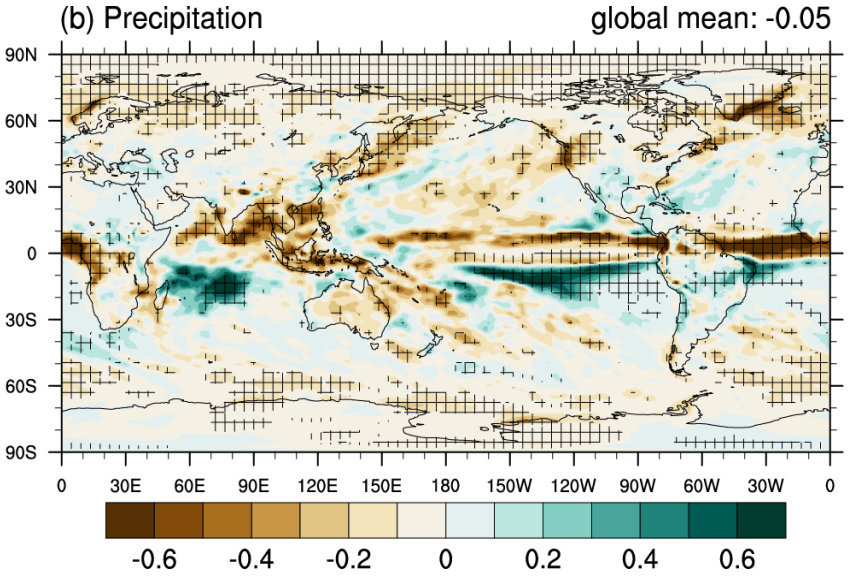
Precipitation change (fast component)

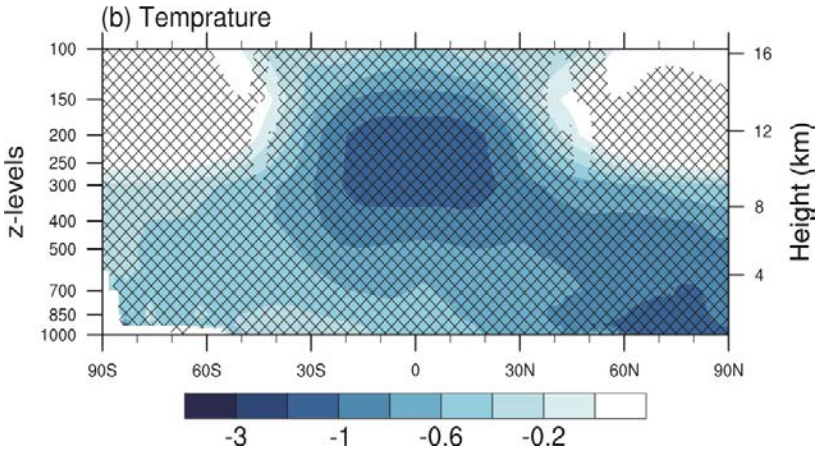
Drought in tropical land regions

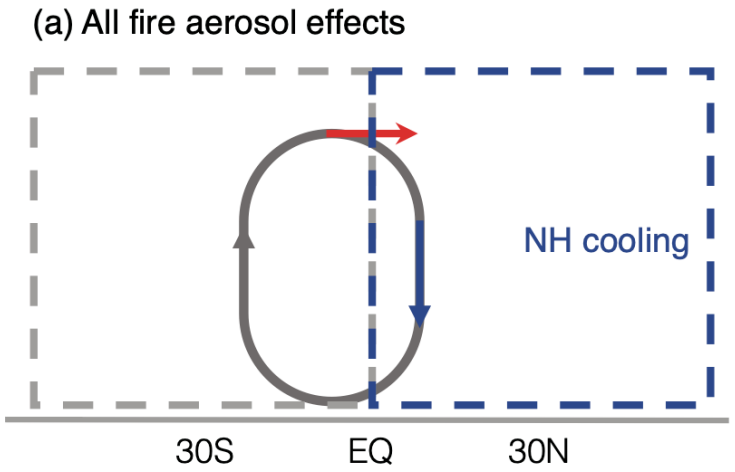


Precipitation change (slow component)

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.**