Climate Change Research Center
Institute of Atmospheric Physics, CAS

Impact of fire air pollution on global ecosystem productivity

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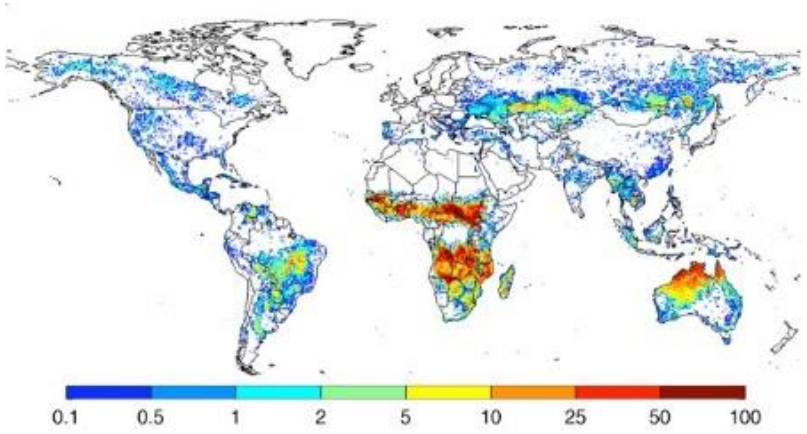
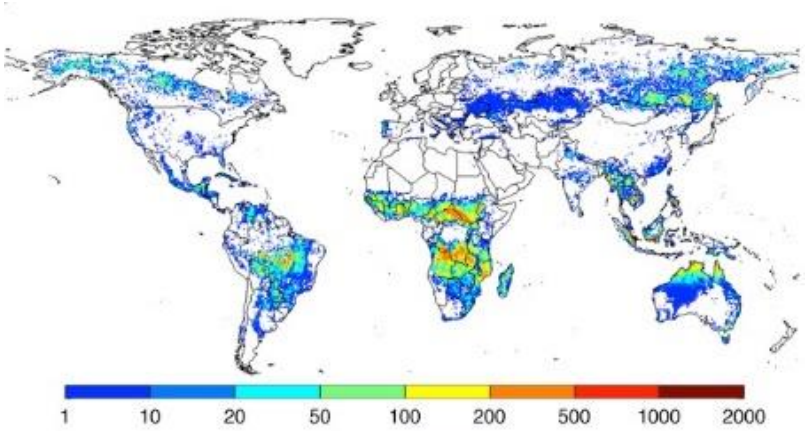
Fire is an important perturbation to global carbon budget

Global area burned



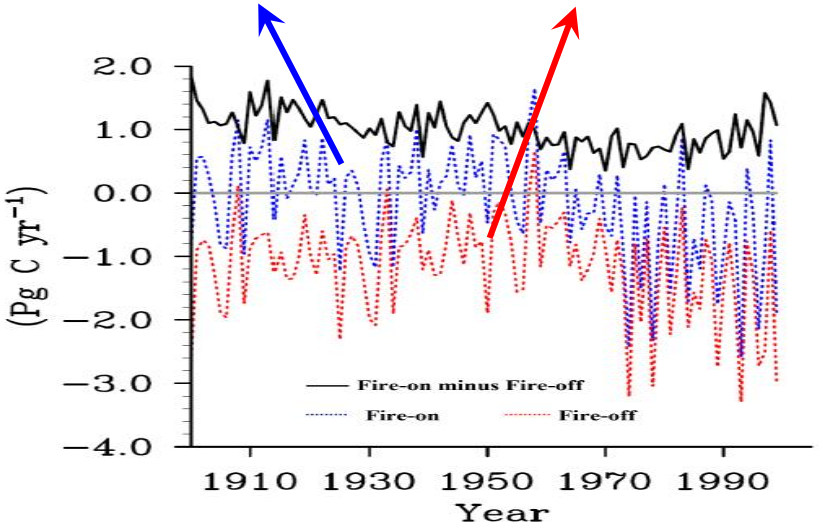
Global fire emissions



(Data source: Global Fire Emissions Database, version 3)

NEE with fires

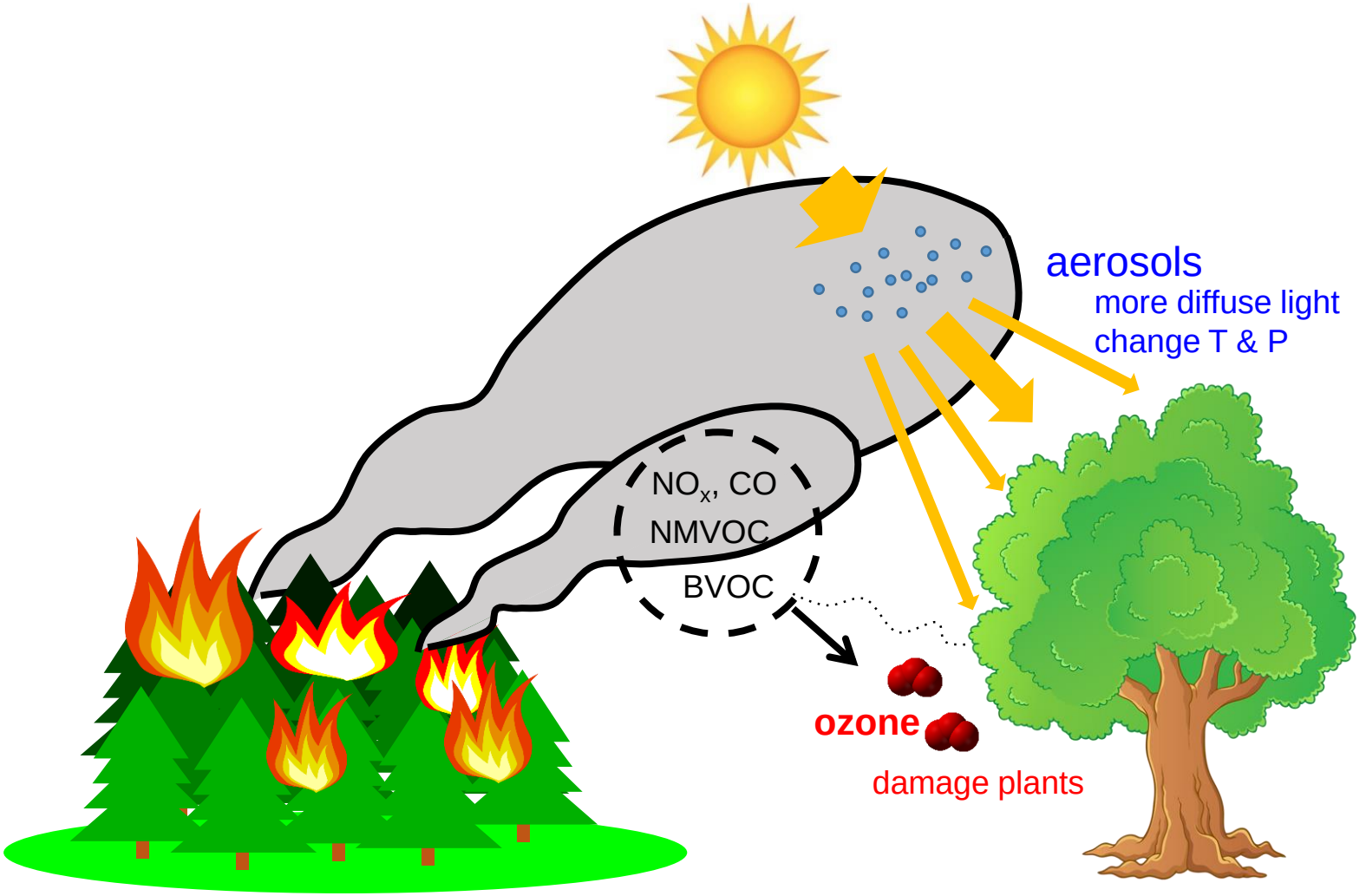
NEE without fires



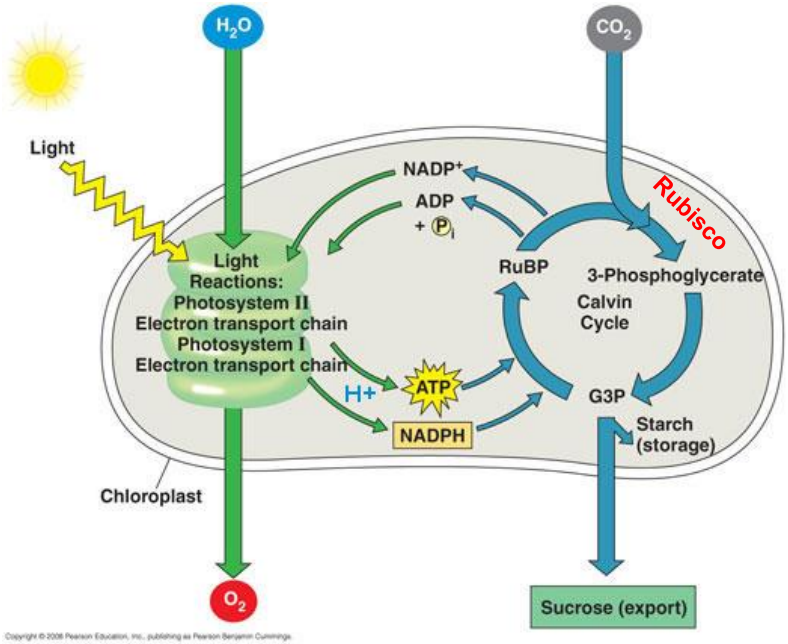
- Globally, fire emits about 2 Pg C every year.
- Land carbon uptake is weakened by fire emissions

(Li et al. 2014)

Fires influences ecosystem productivity indirectly



How ozone affects photosynthesis?

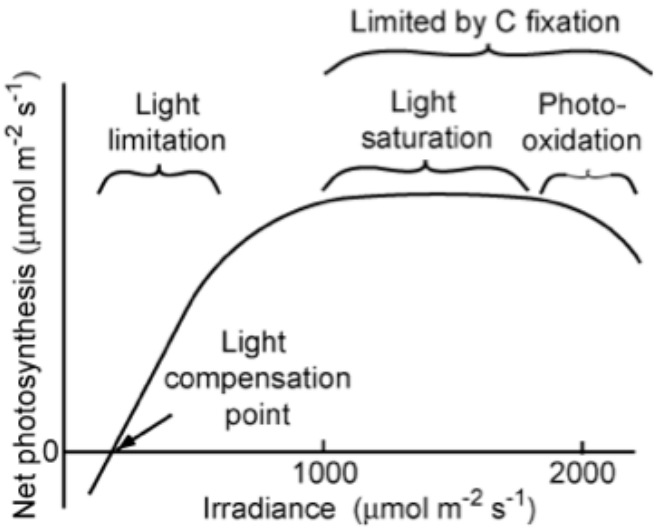


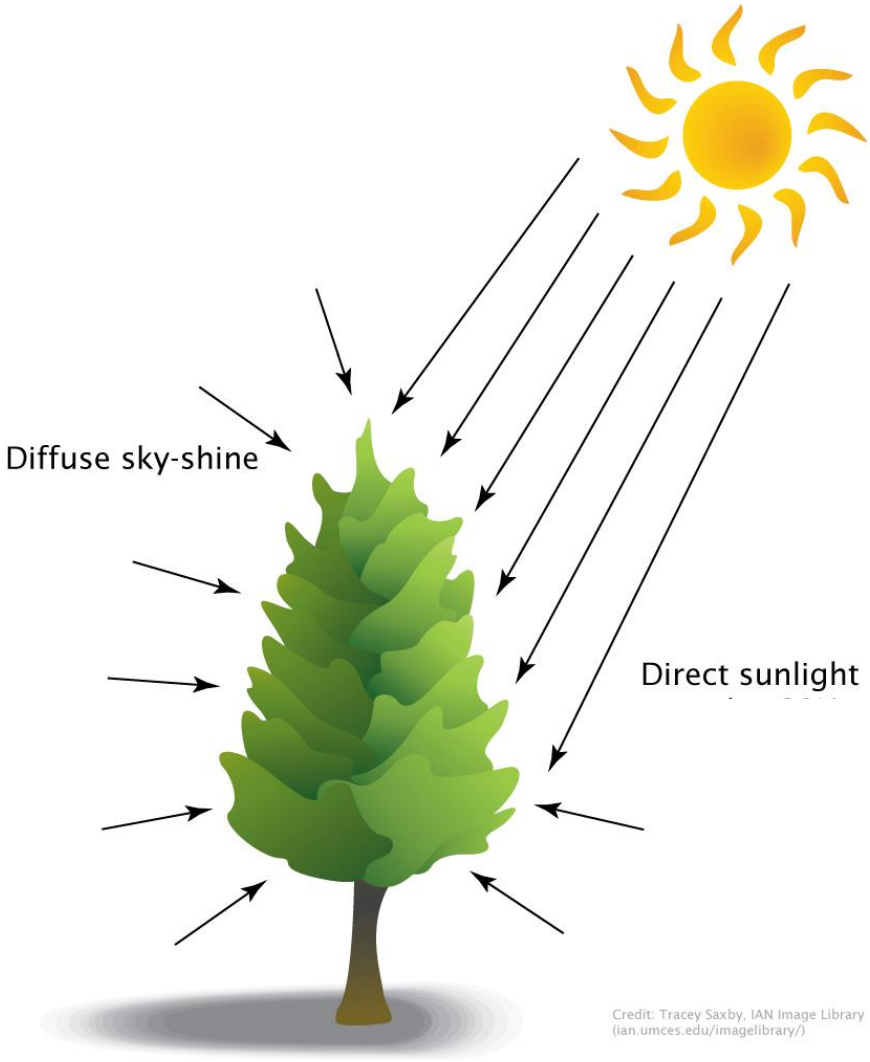
Stoma on apple leaves

Stoma on potato leaves

- Stoma regulate the exchange rate of CO_2 and water vapor between air and plants
- Uptake of ozone damages both photosynthesis and stomatal conductance

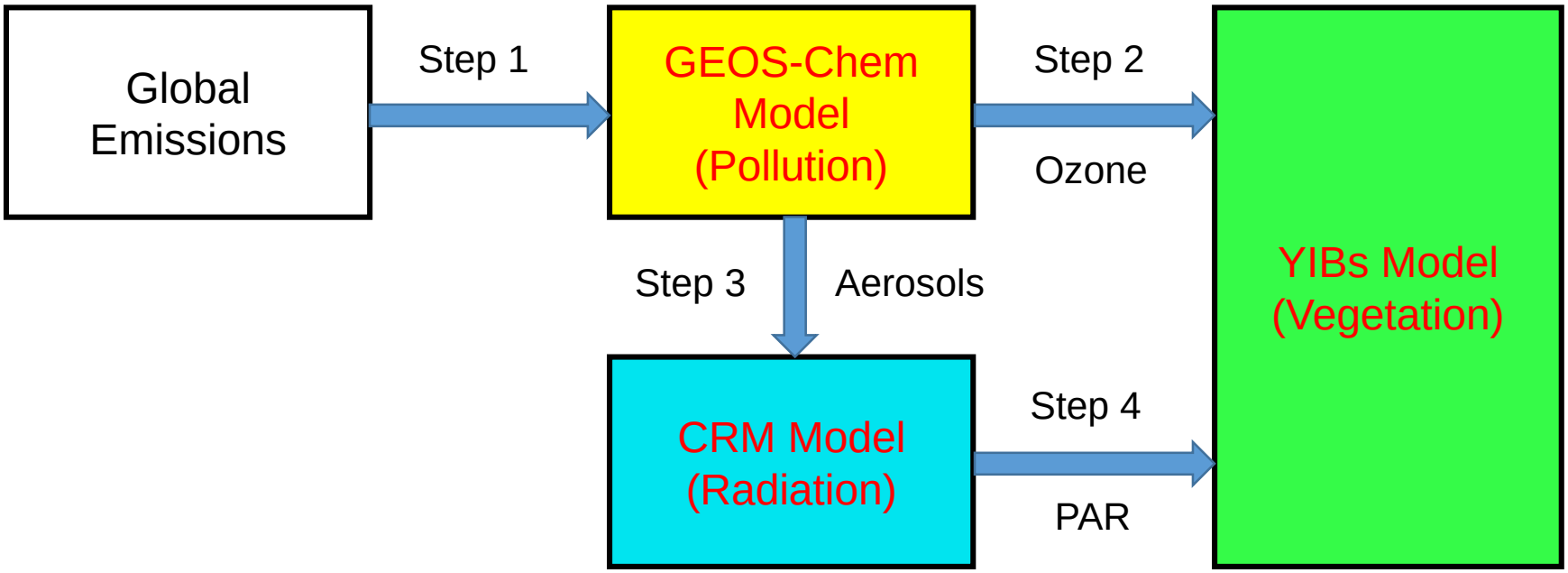
How aerosols affect photosynthesis?





- Moderate reduction of direct light won't decrease photosynthesis
- Aerosol increases diffuse light, promoting photosynthesis for sunshade leaves

Methods and models



Step 1: Simulate global aerosols and ozone using GEOS-Chem Model

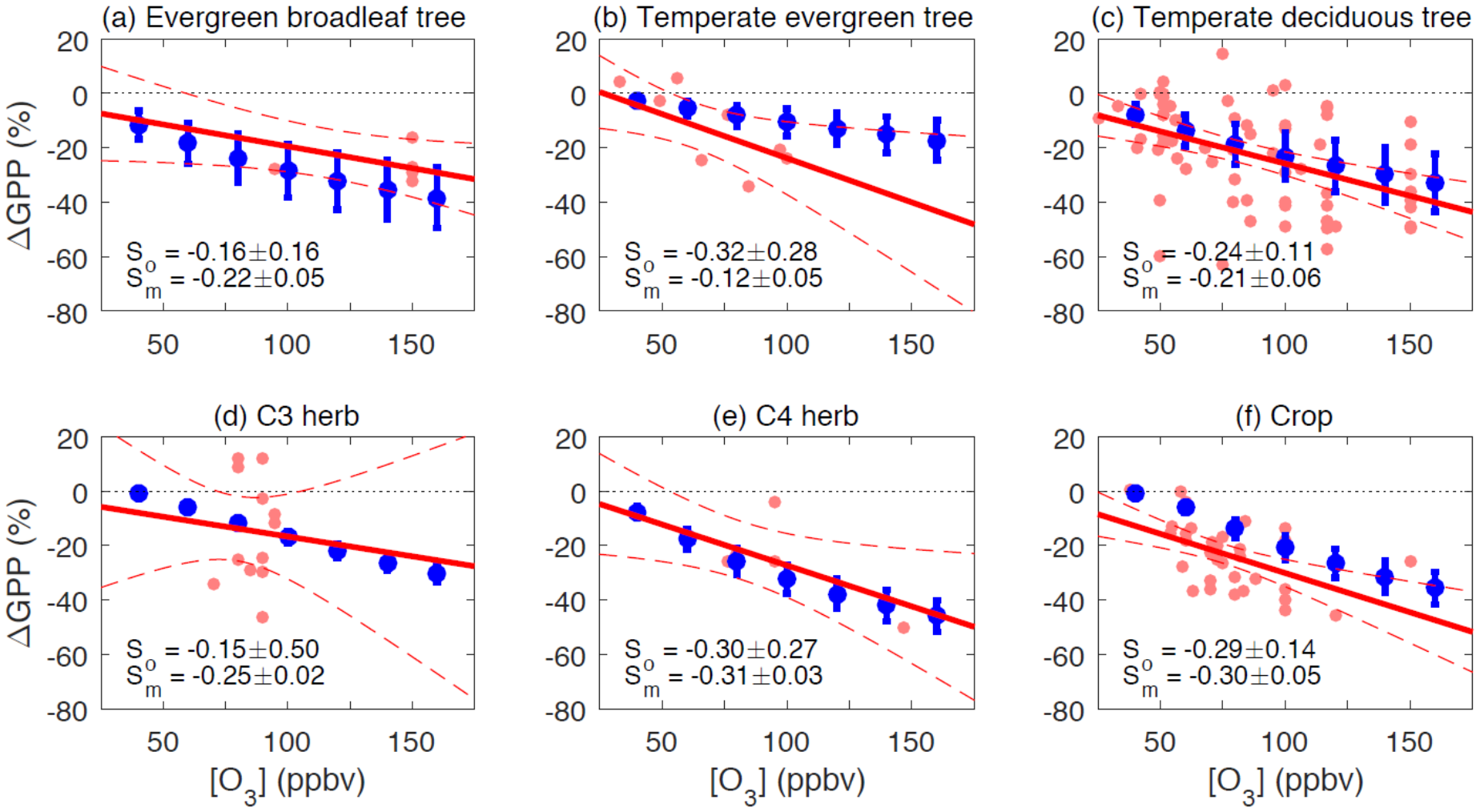
Step 2: Simulate ozone damaging to GPP using YIBs model

Step 3: Simulate aerosol-induced PAR radiation change using CRM model

Step 4: Simulate GPP responses to PAR change using YIBs model

YIBs evaluation: GPP responses to O_3 damage

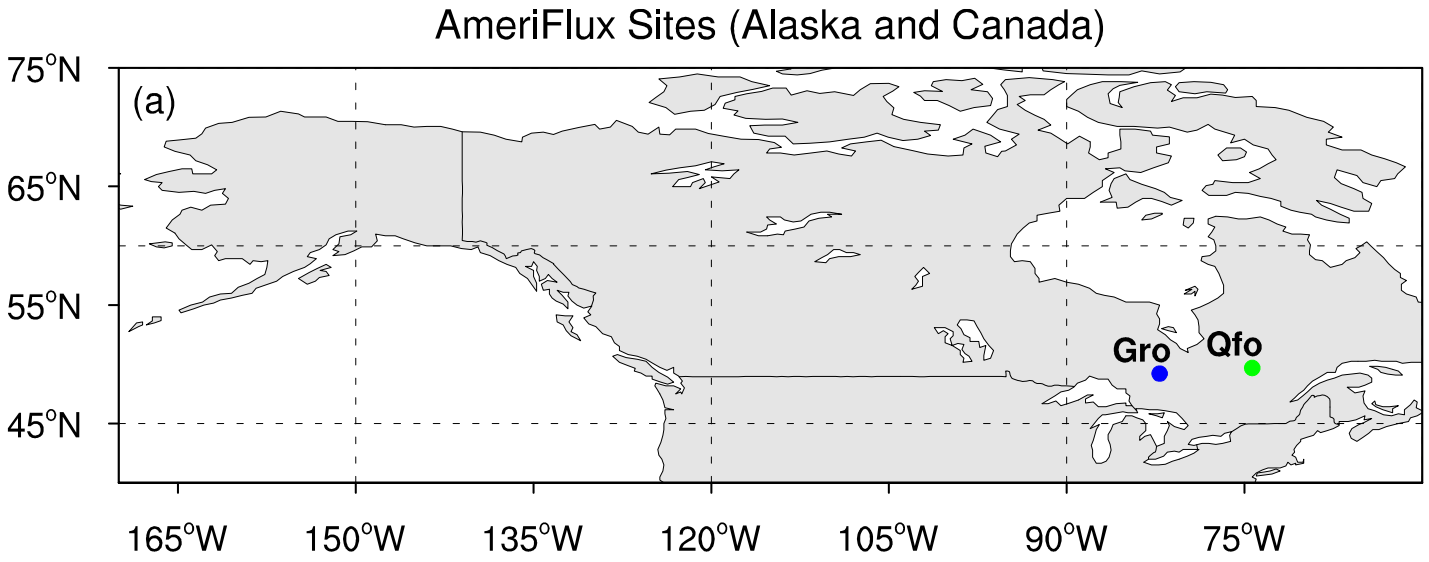
Hundreds of data are collected from >60 literature papers



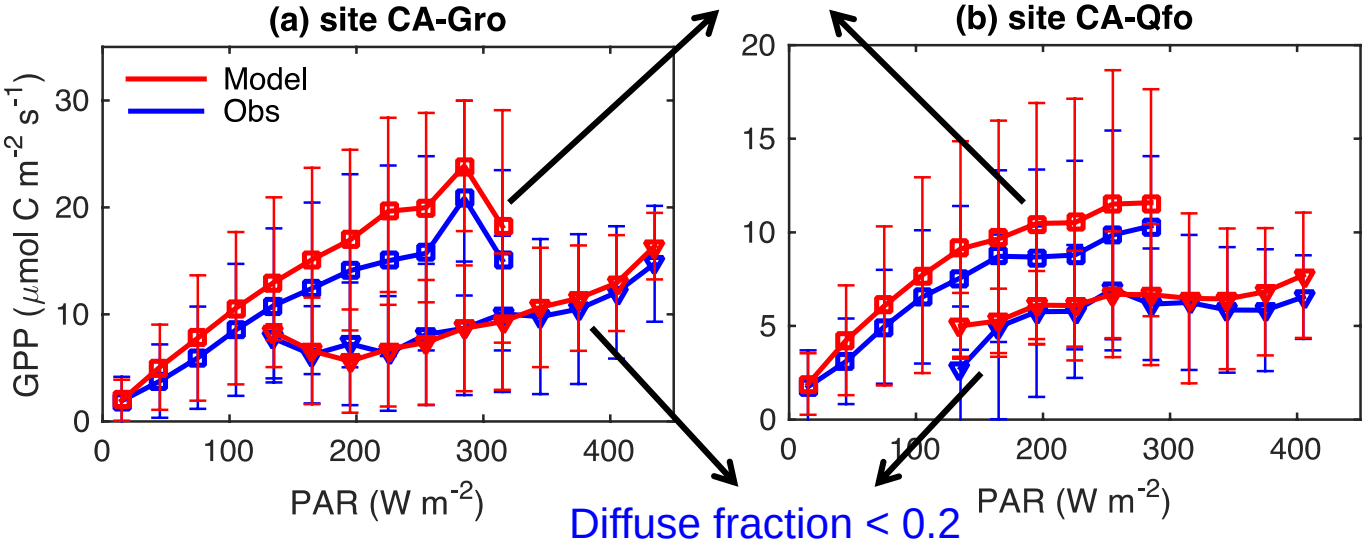
Blue: Model

Red: Measurements

YIBs evaluation: GPP responses to diffuse light



Diffuse fraction > 0.8

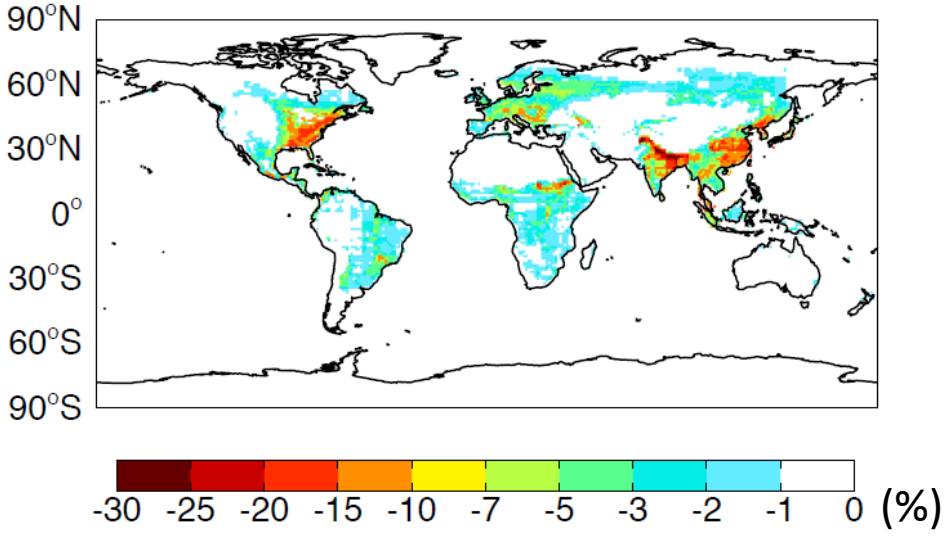


Diffuse fraction < 0.2

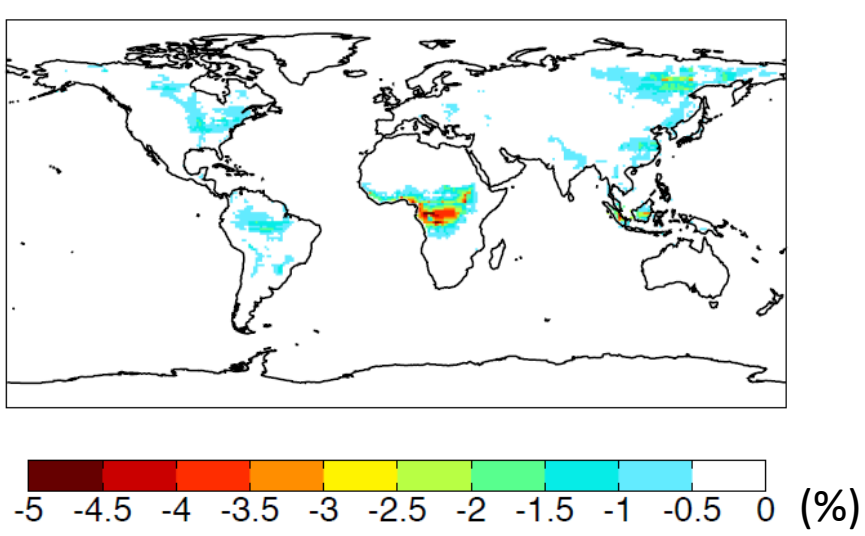
(Yue et al., ACP, 2017)

Model results: ozone damages to GPP

ΔGPP by ozone (no fires)



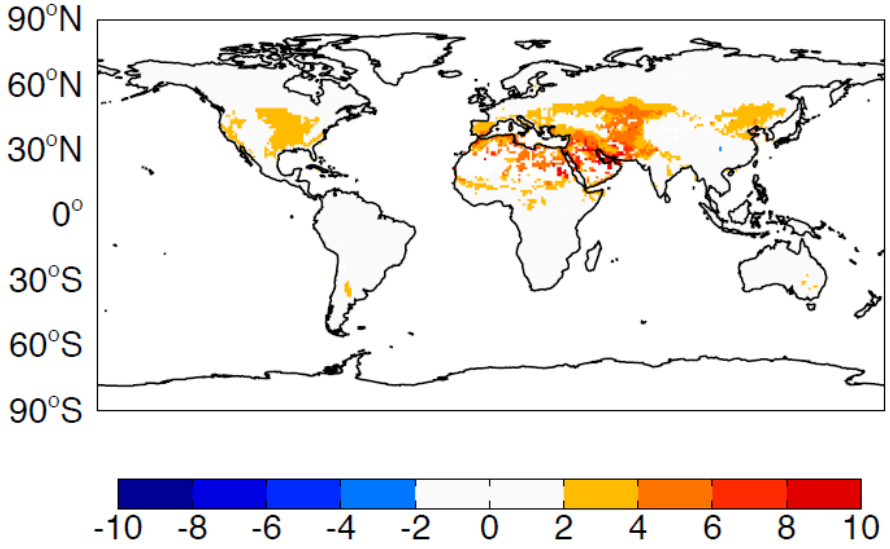
ΔGPP by fire ozone



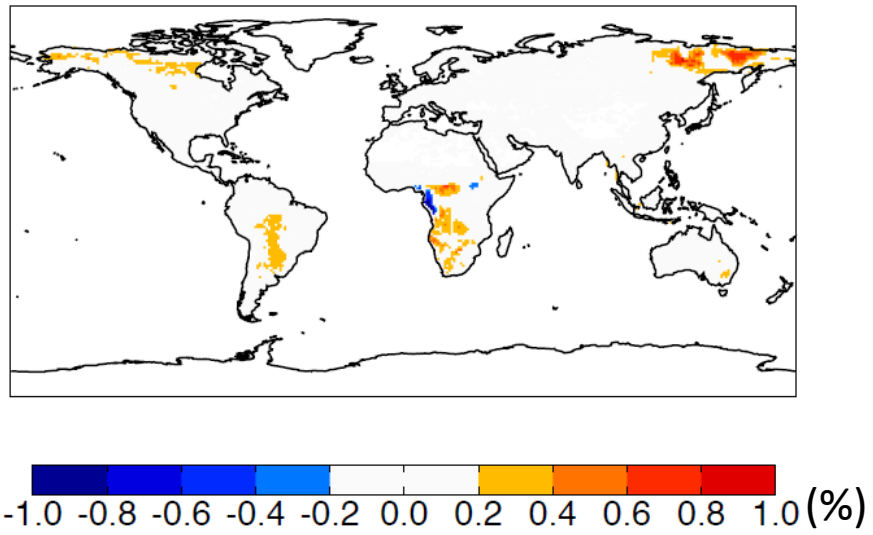
- On the global scale, fire-free ozone reduces GPP by 3% with regional maximum of 8% over eastern U.S. and 7% over eastern China.
- Fire ozone causes additional 0.7% reductions in GPP, with regional maximum of 2% in western central Africa.

Model results: aerosol diffuse fertilization

ΔGPP by aerosols (no fires)



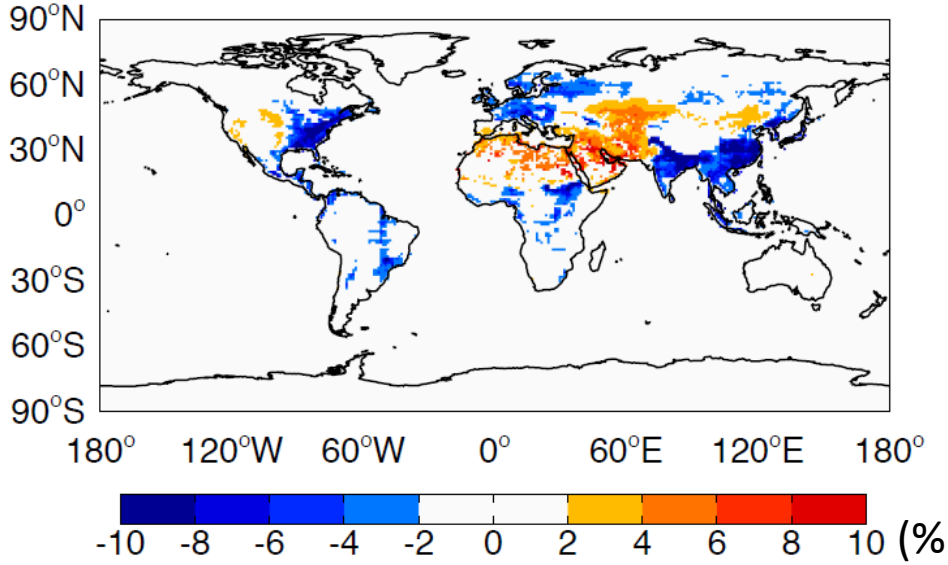
ΔGPP by fire aerosols



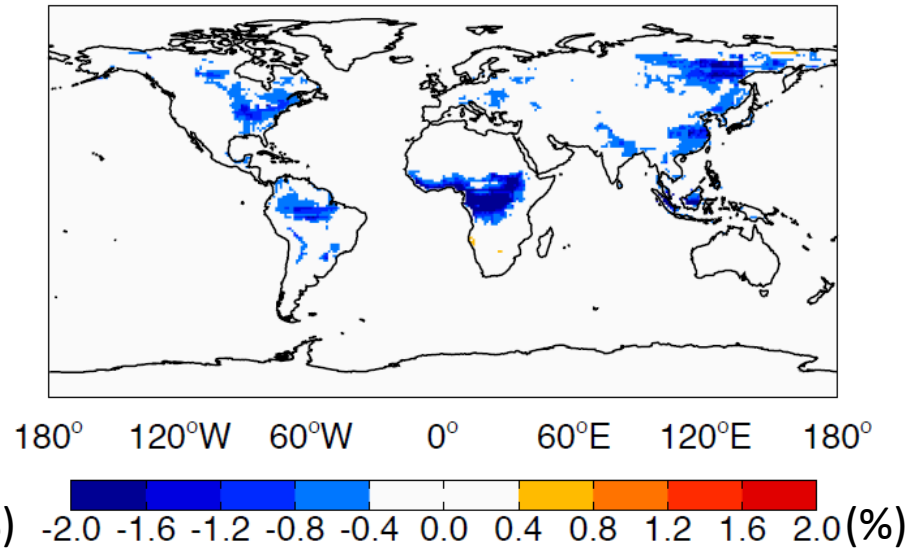
- On the global scale, fire-free aerosol increases GPP by 0.7% with regional maximum of 2.2% over western Asia and 1.4% over northern Africa.
- Fire aerosols cause limited changes in GPP, with the largest GPP increase of 1% in eastern Siberia.

Model results: ozone + aerosol effects

ΔGPP by ozone+aerosol (no fires)



ΔGPP by fire ozone+aerosol



- Ozone damage and aerosol diffuse fertilization show contrast spatial pattern for fire-free pollution. On the global scale, GPP is reduced by 2.1% because ozone effect is dominant.

- Fire pollution causes a net reduction of 0.6% in GPP because damages by ozone is much stronger than the fertilization by fire aerosols.

Thank you and comments?