Estimates of radiative forcing from fires predicted by CLM

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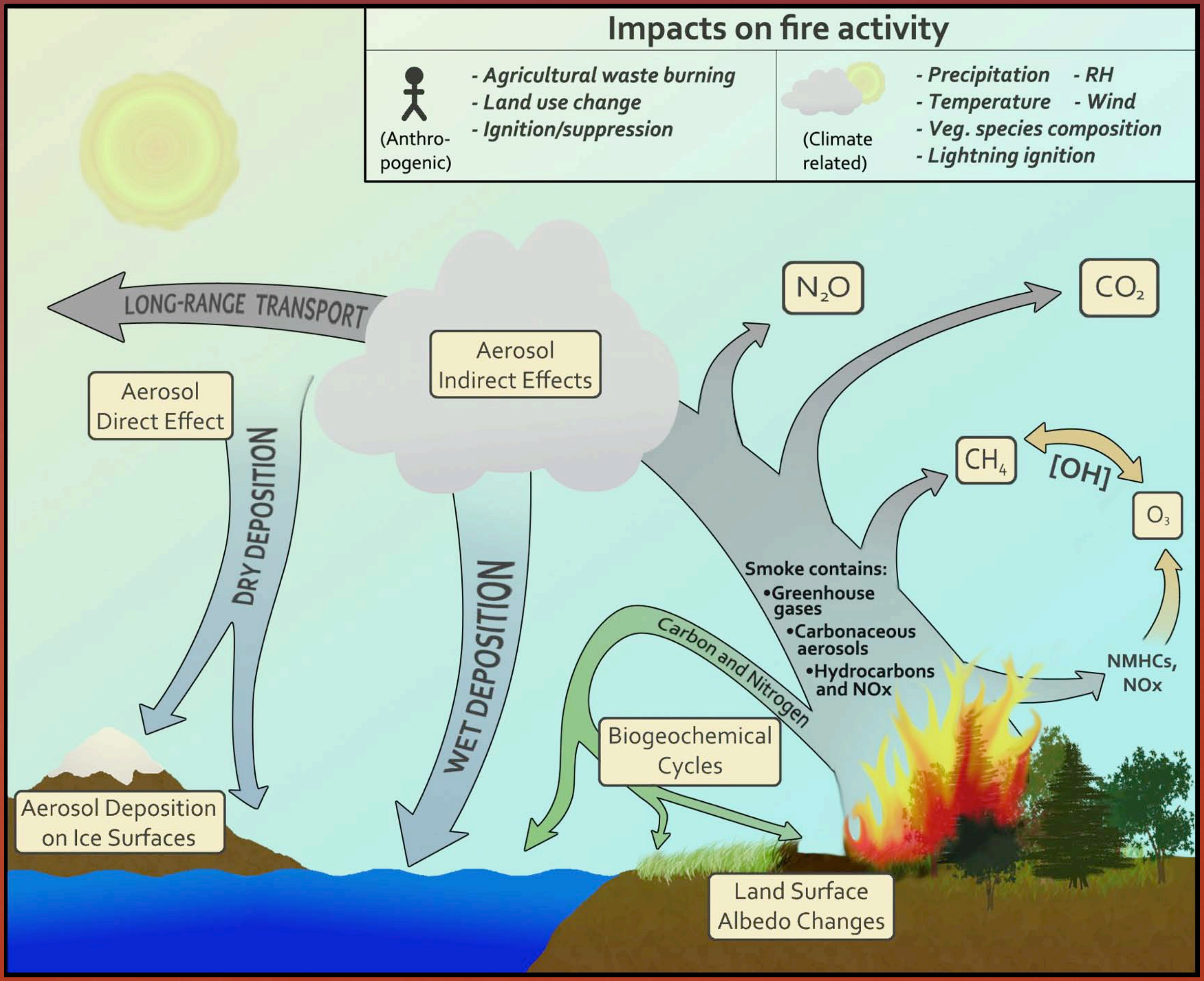


Ward et al., 2012

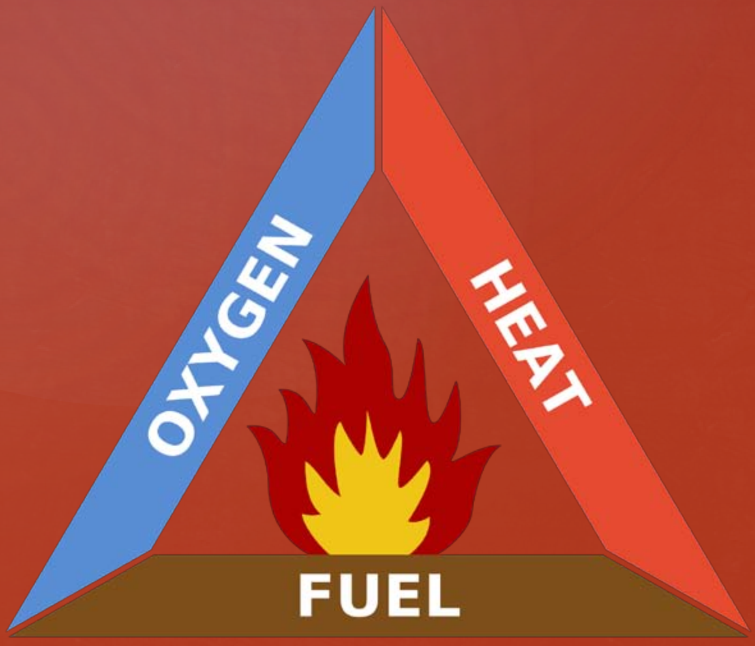
Experiment Overview

- Isolate impacts of fires by running CLM with global fires and without global fires
- Use the change in C stocks from fires to estimate CO2 RF
  - C lost from fires -> fire emissions of other trace gases/aerosols

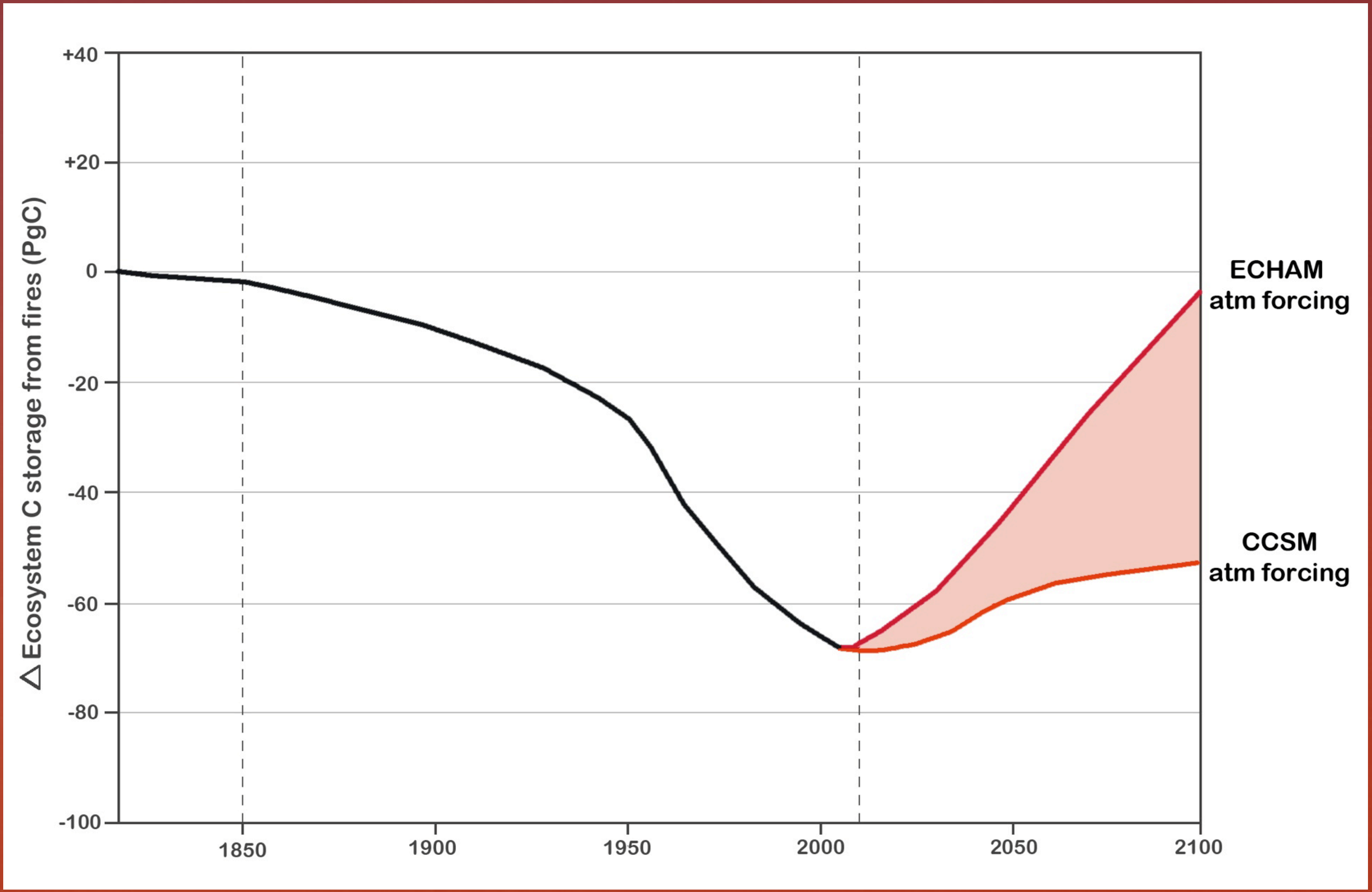
- CLM version 3.5 with the CN extension
- Kloster et al. (2010) fire model
- Preindustrial spinup with and without fires
- Transient CO2 (A1B1) and LULCC (RCP4.5) for 1800-2100
- Future atmospheric forcing = Qian et al. (2006) 1948-1972 reanalysis cycled with CCSM and ECHAM5 climate anomalies applied
- Year 2000 N deposition used for 2000-2100

How do we estimate fire activity/emissions for past and future time periods?

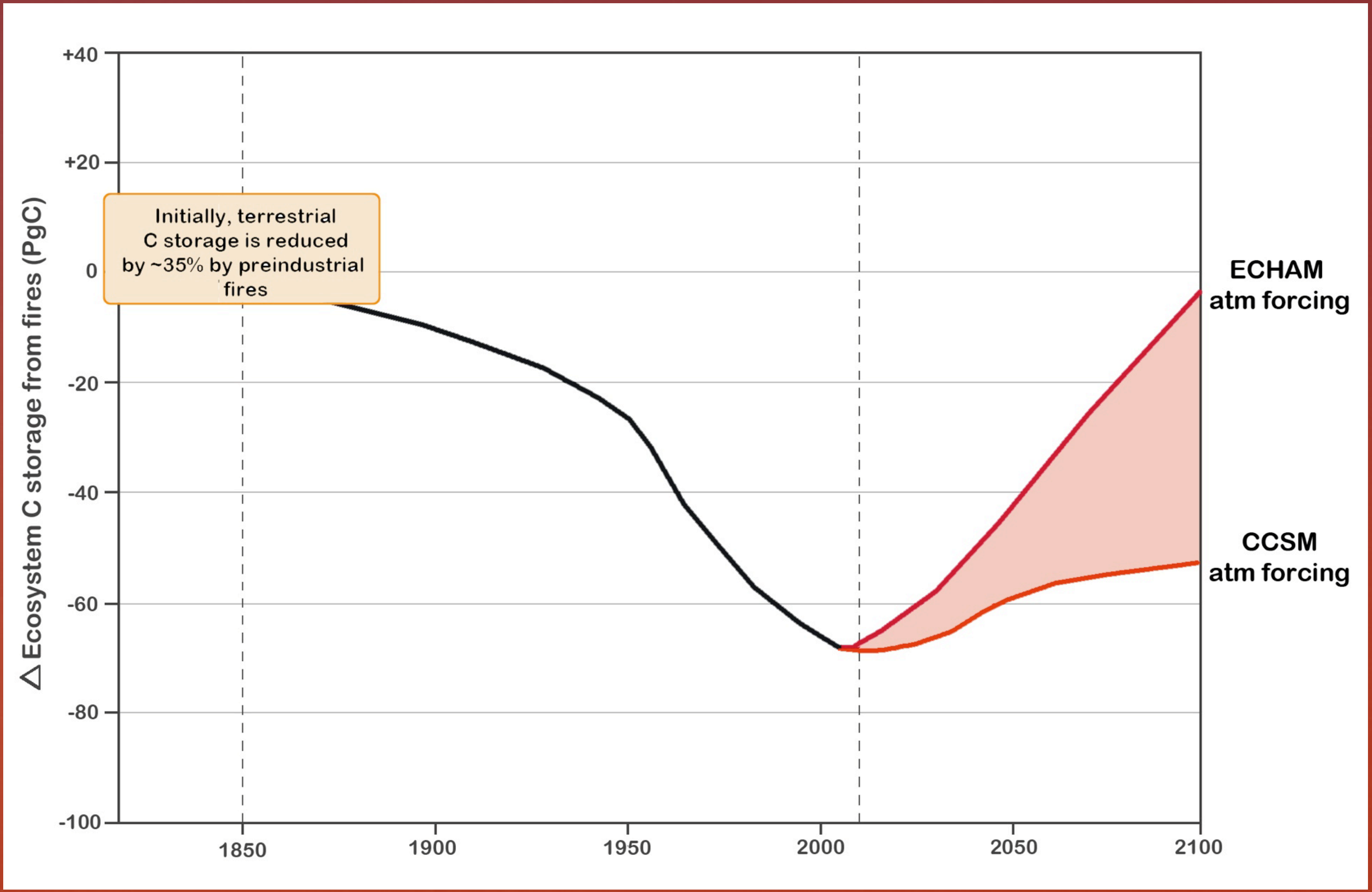
- Kloster et al. (2010, 2012) – fire model in NCAR Community Land Model v3.5 (CLM3)
- Includes PFT-specific combustion completeness and mortality
- But no DGVM
- Probability-based model:
  - Biomass abundance
  - Fuel moisture
  - Ignition source (also suppression)
- Area burned per grid cell is then a function of these probabilities and windspeed



Wikipedia, "Fire triangle"



Change in C stocks caused by removing fires



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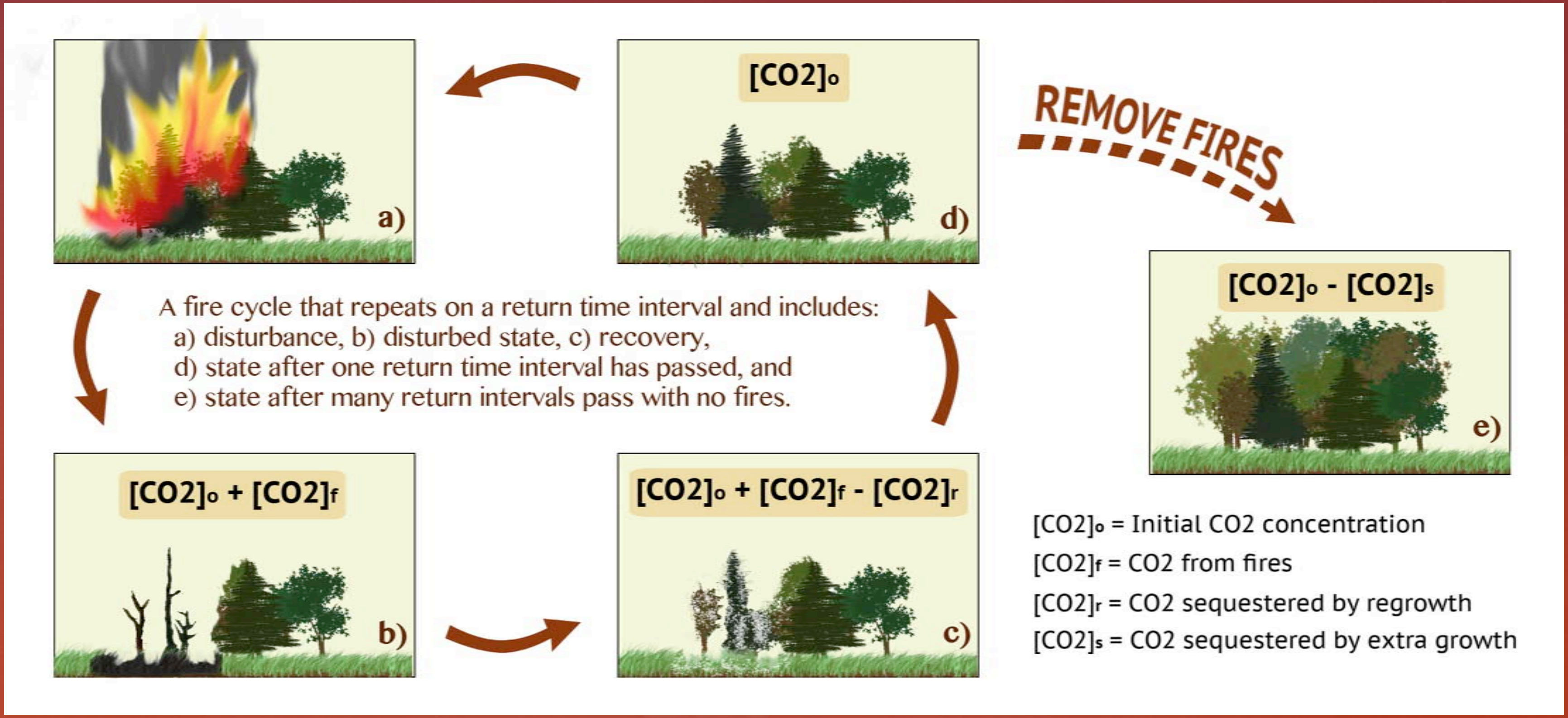
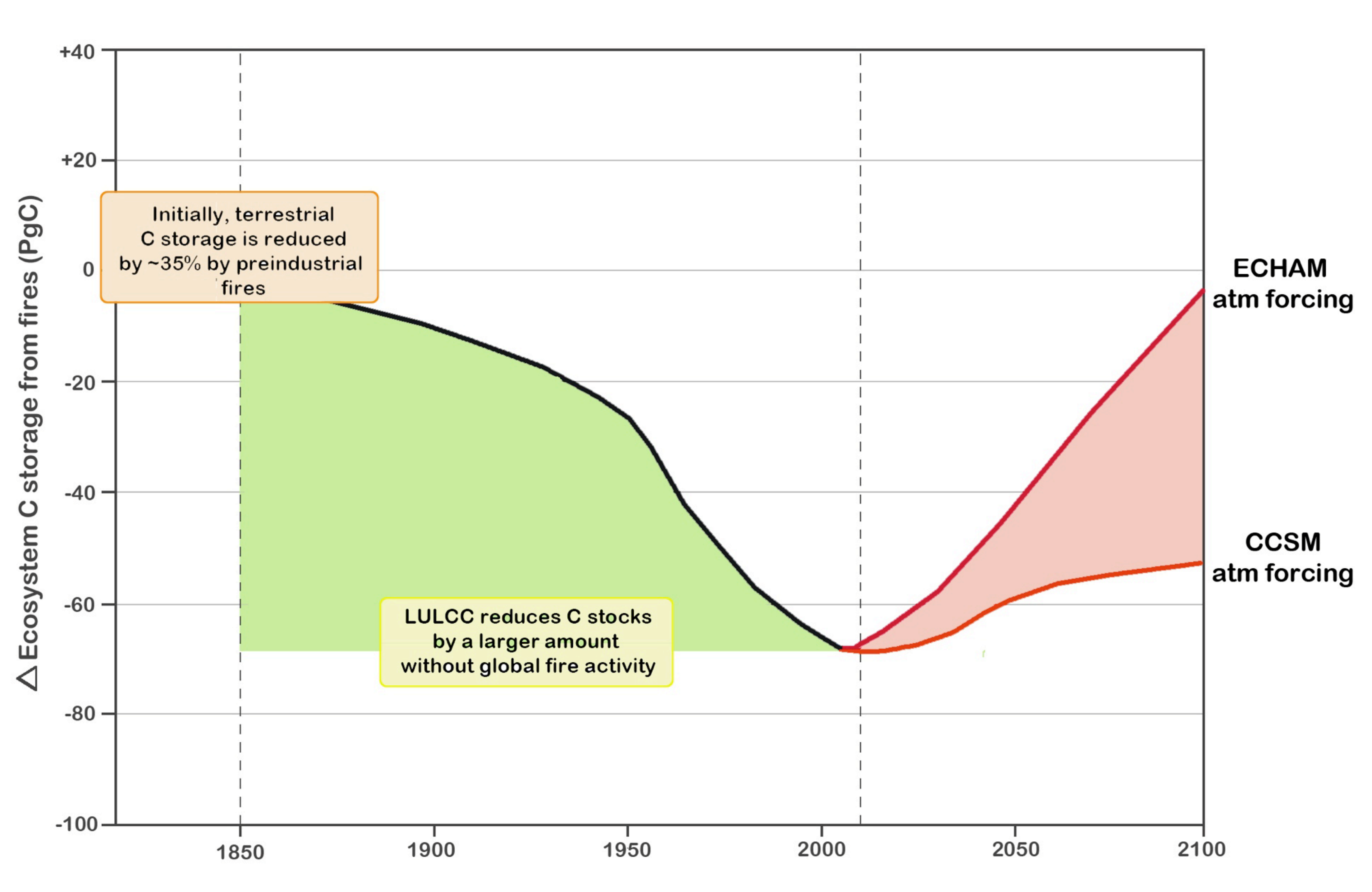


- Compare C stored in land surface –
  - How much CO_2 remains in the atmosphere because of fires?
- RF estimated from calculation of the new partitioning of C between atm/lnd/ocn pools when fires are removed



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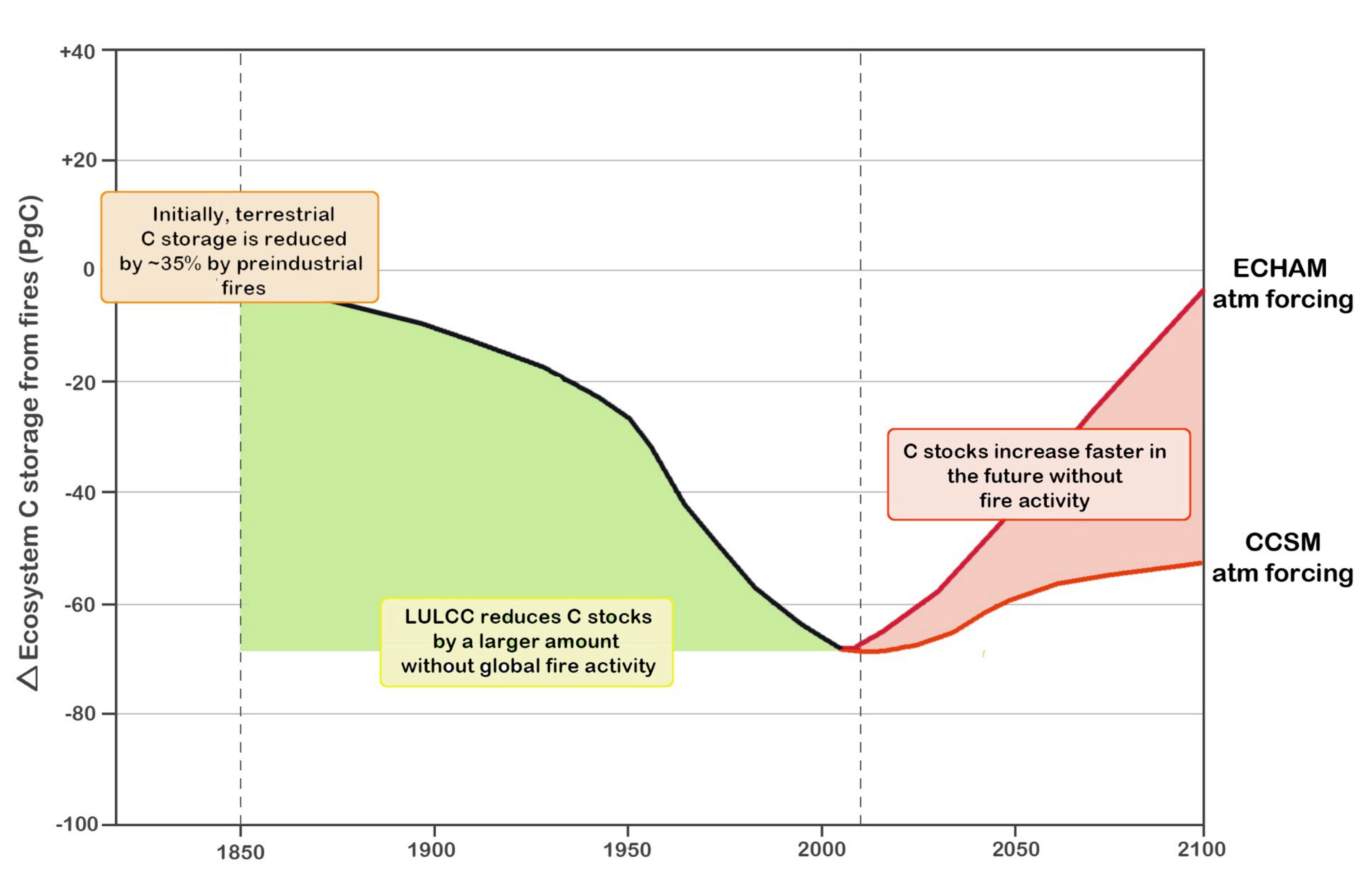
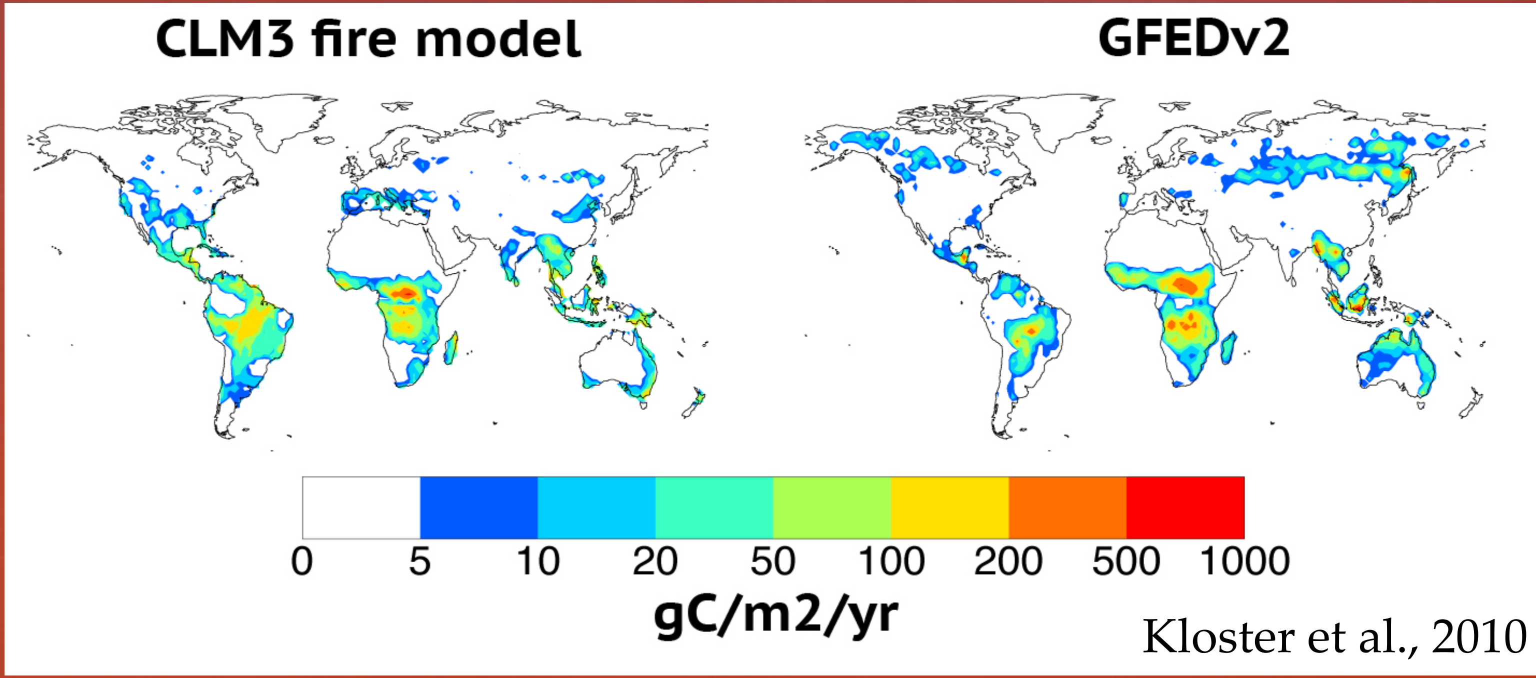


Change in C stocks caused by removing fires

Simulate year 2000 climate using the **Community Atmosphere Model (versions 4 and 5)** with 1850, 2000 and 2100 trace gas and aerosol emissions

One set of simulations with all emissions

One set of simulations without fire emissions



CHEM – MOZART chemistry

(Lamarque et al., GMDD, 2011)

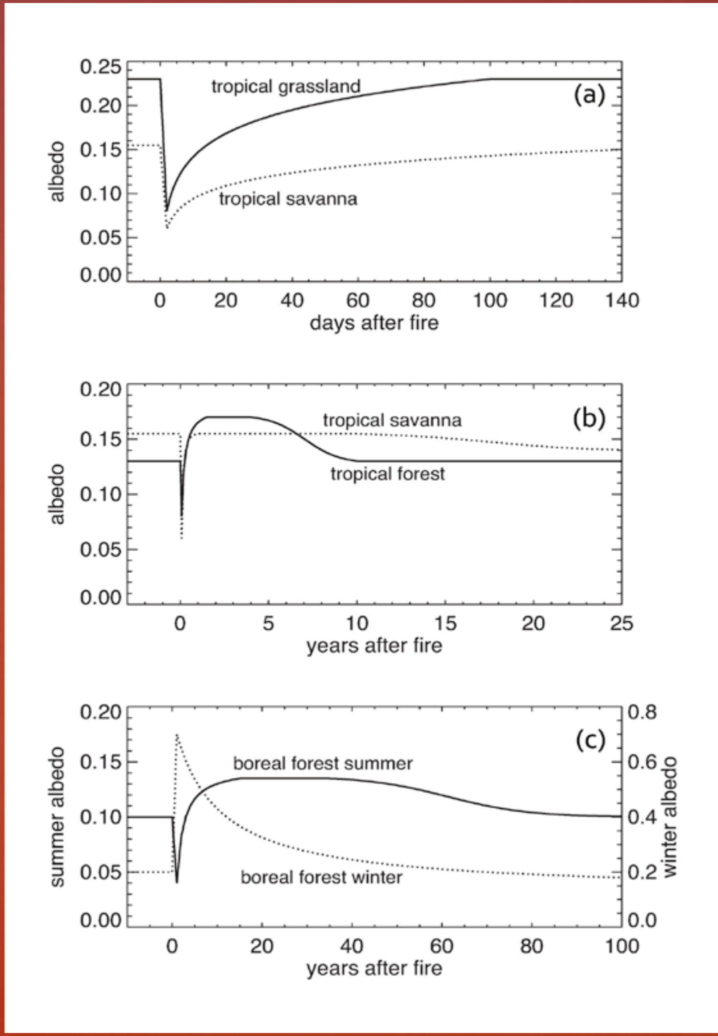
CAM4, 2-deg, 24 months post-spinup

AERO – 3-mode aerosol model

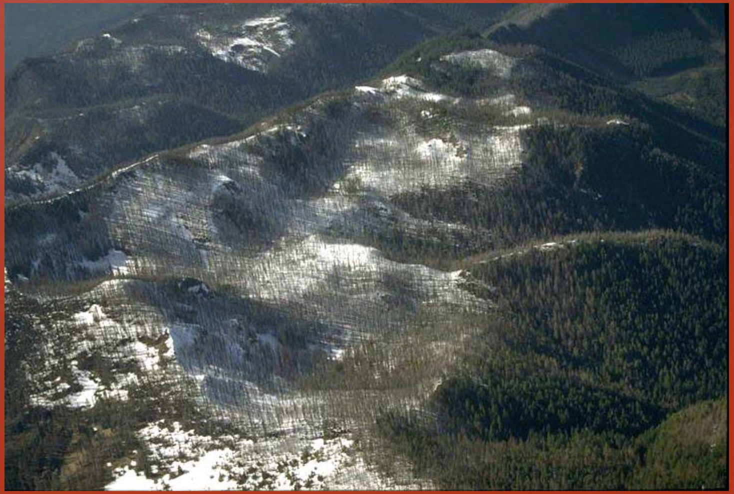
(Liu et al., in prep)

CAM5, 2-deg, 6-years post-spinup

Fire impacts on land surface albedo

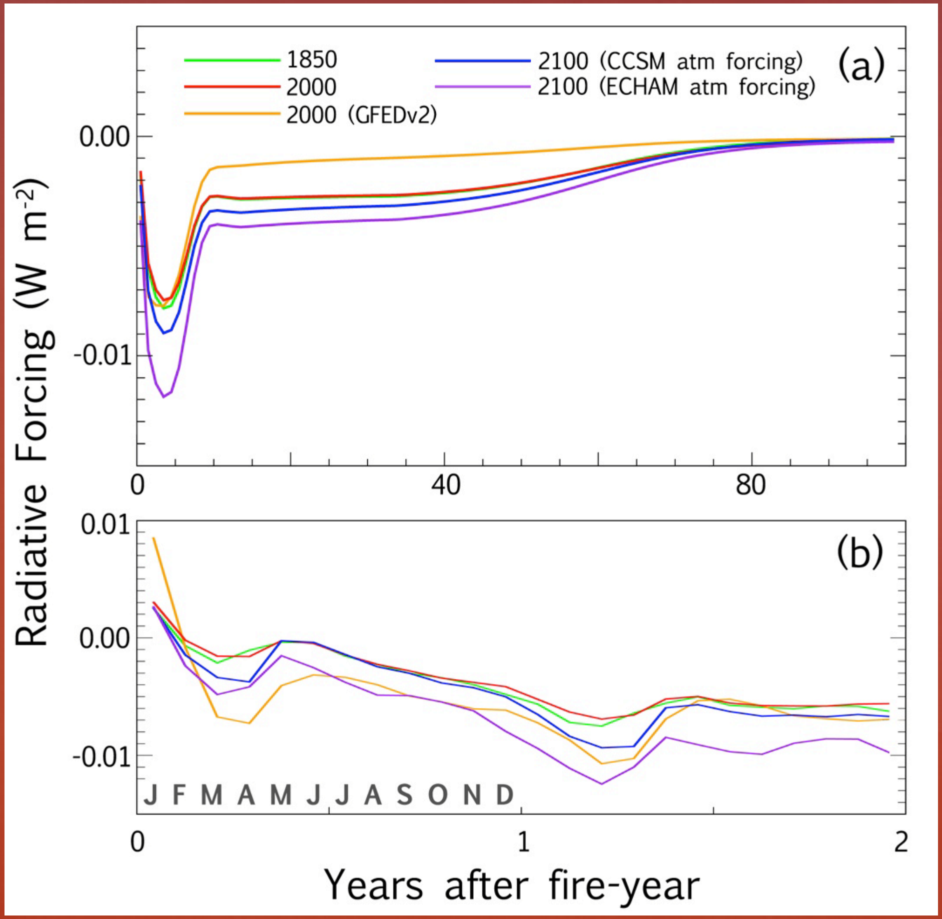


NewWest.net, 2012



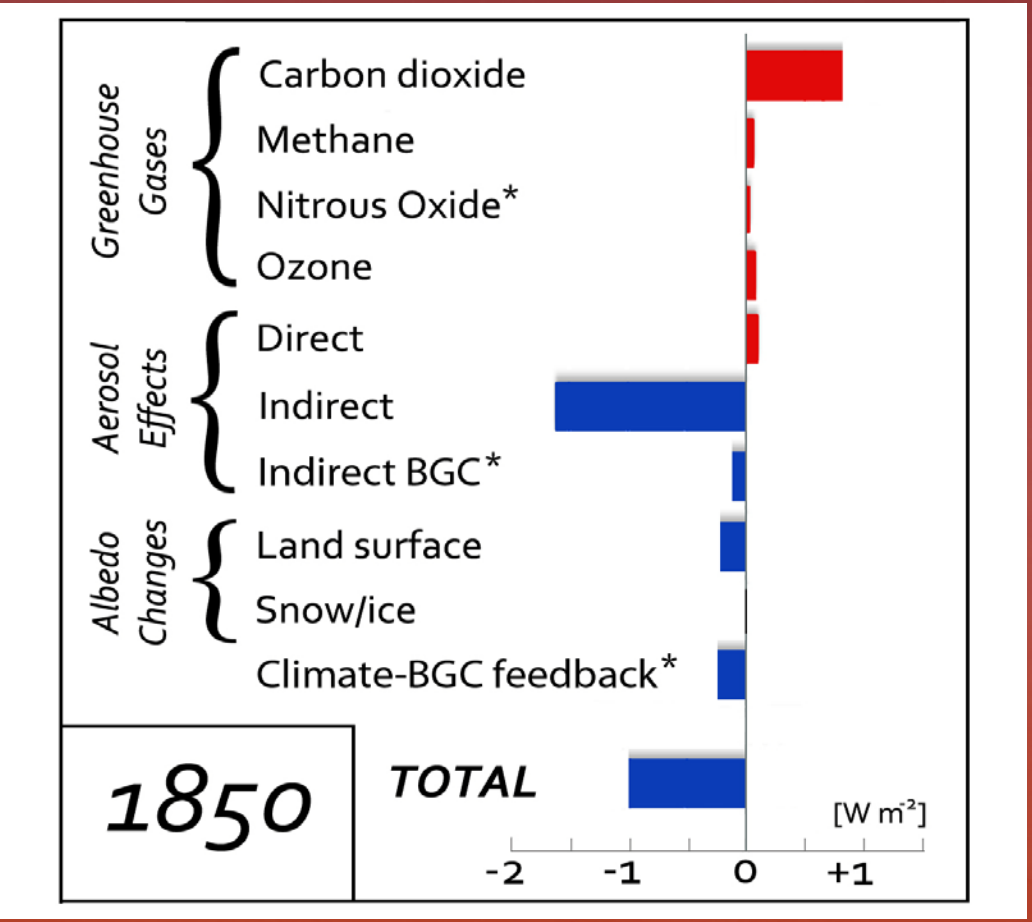
Oregon State University, 2011

Land Surface Albedo



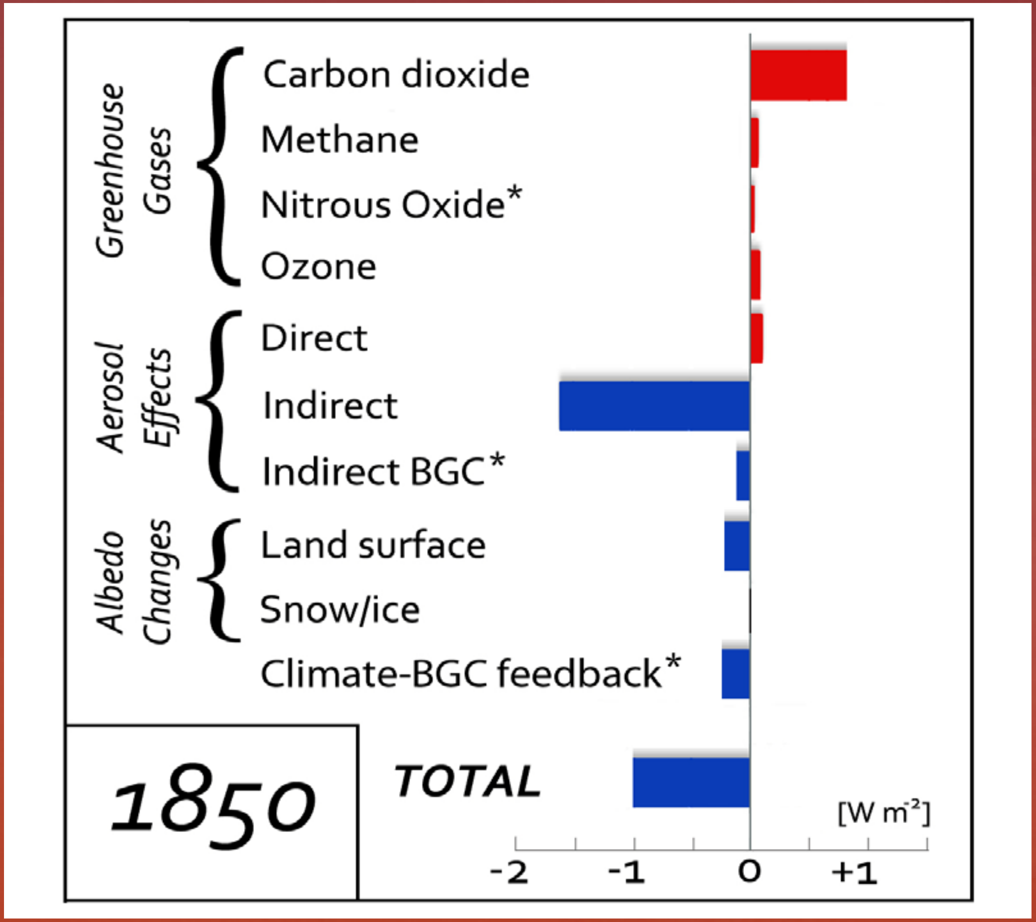
- Fires change albedo by:
  - Charring (-)
  - Secondary vegetation (+)
  - Clearing canopies (+)
  - Clearing canopy above a snow-covered sfc (++)
- Overall, RFs are negative
- Long-term effects tend to increase albedo

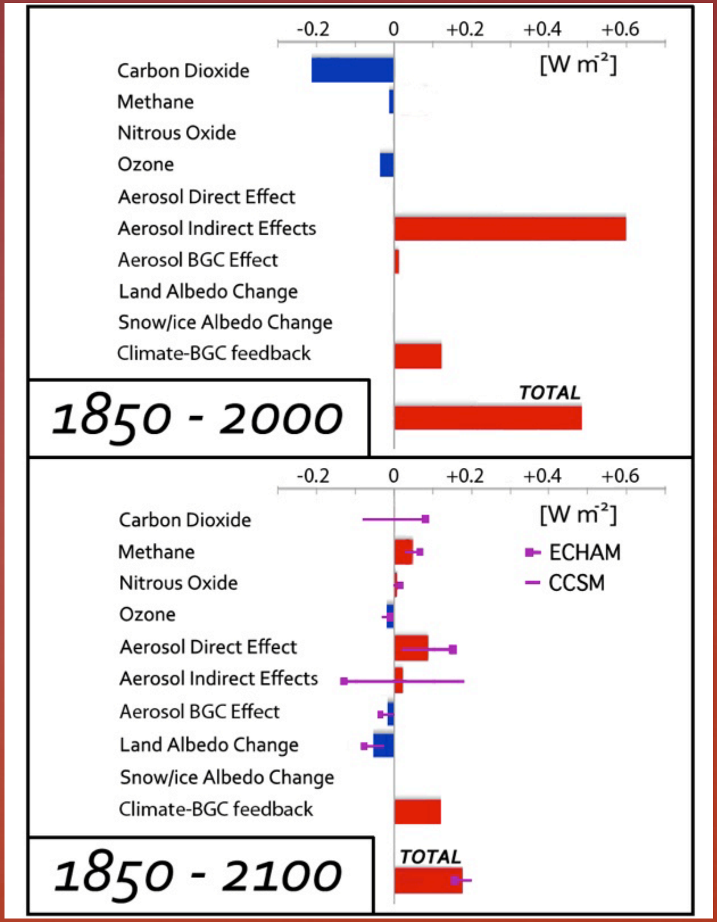
CONCLUSIONS



1. Fires: positive RF that is largely balanced by CO_2 and the Aerosol IEs
2. This RF increases from 1850 -2000 and similarly for 1850-2100
3. Large uncertainties in IEs, land-use trajectories, CO_2 airborne fraction

CONCLUSIONS





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Future direction

1. New fire model from Fang Li and Sam Levis (Li et al., 2012)
2. Interaction with DGVM
3. True coupling of fire emissions to CAM
   - With more realistic emission episodicity (Clark et al., in prep)