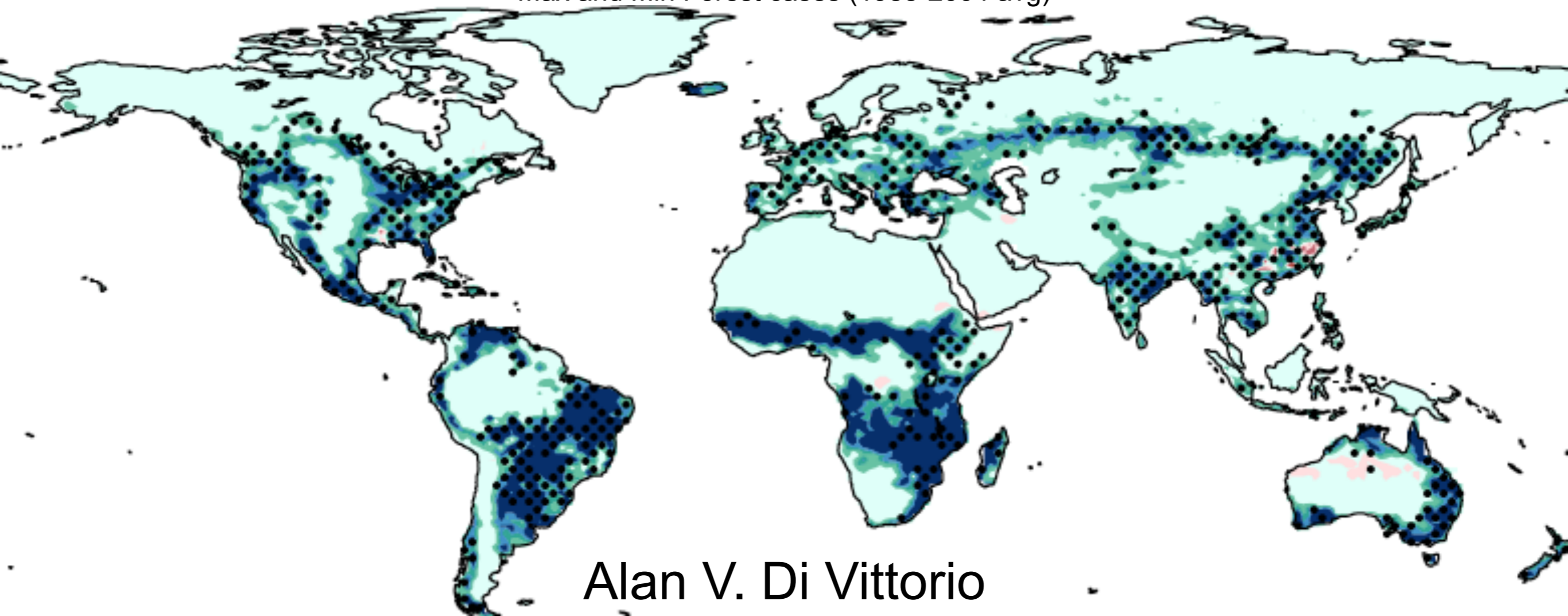


Substantial effects of land cover uncertainty on carbon and climate projections

Difference in forest area between
Max and Min Forest cases (1985-2004 avg)



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Lawrence Berkeley National Laboratory

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LMWG/BGCWG/SDWG Meeting

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With special thanks
to the iESM team

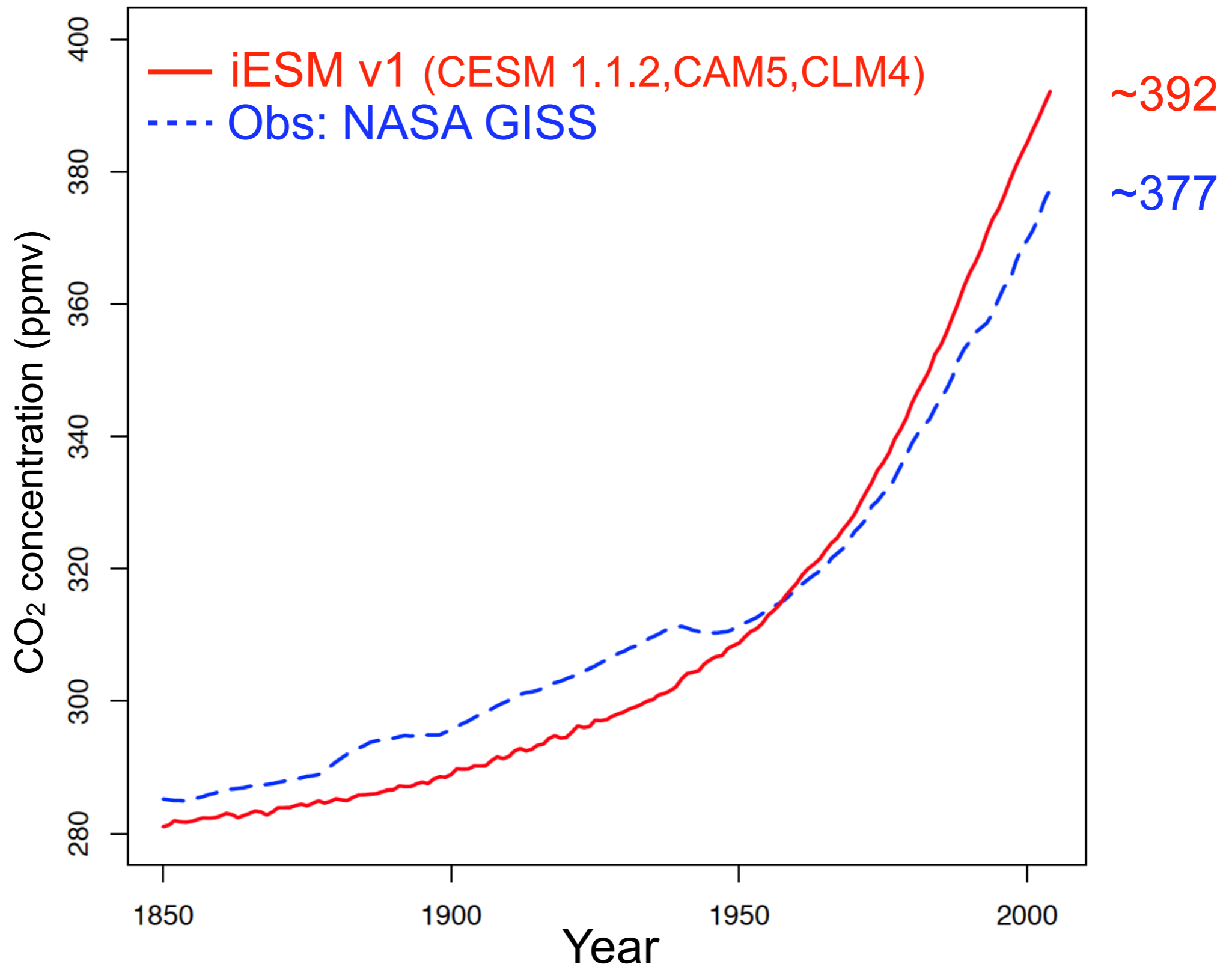


**EARTH &
ENVIRONMENTAL
SCIENCES**

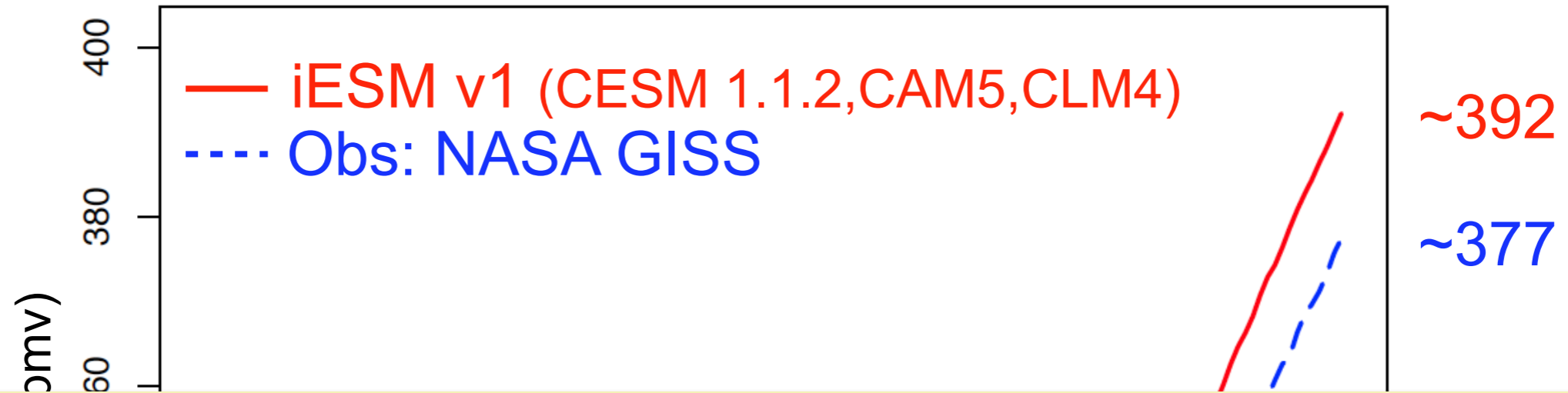
Earth Systems and Society Program



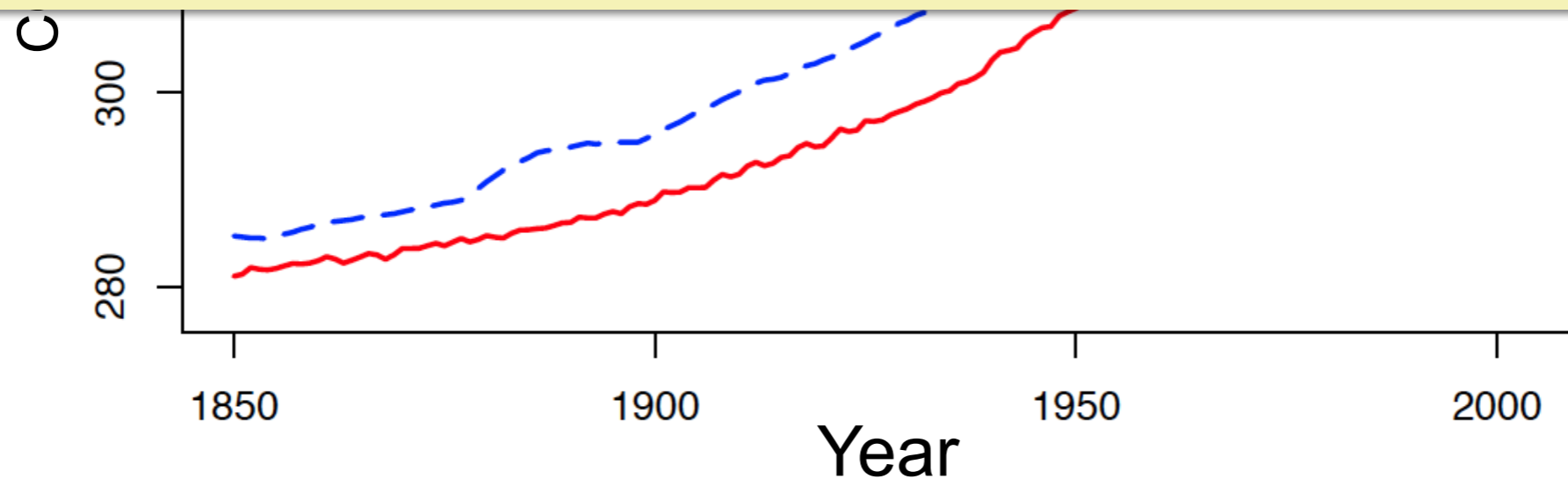
~15 ppmv CO₂ bias in 2004



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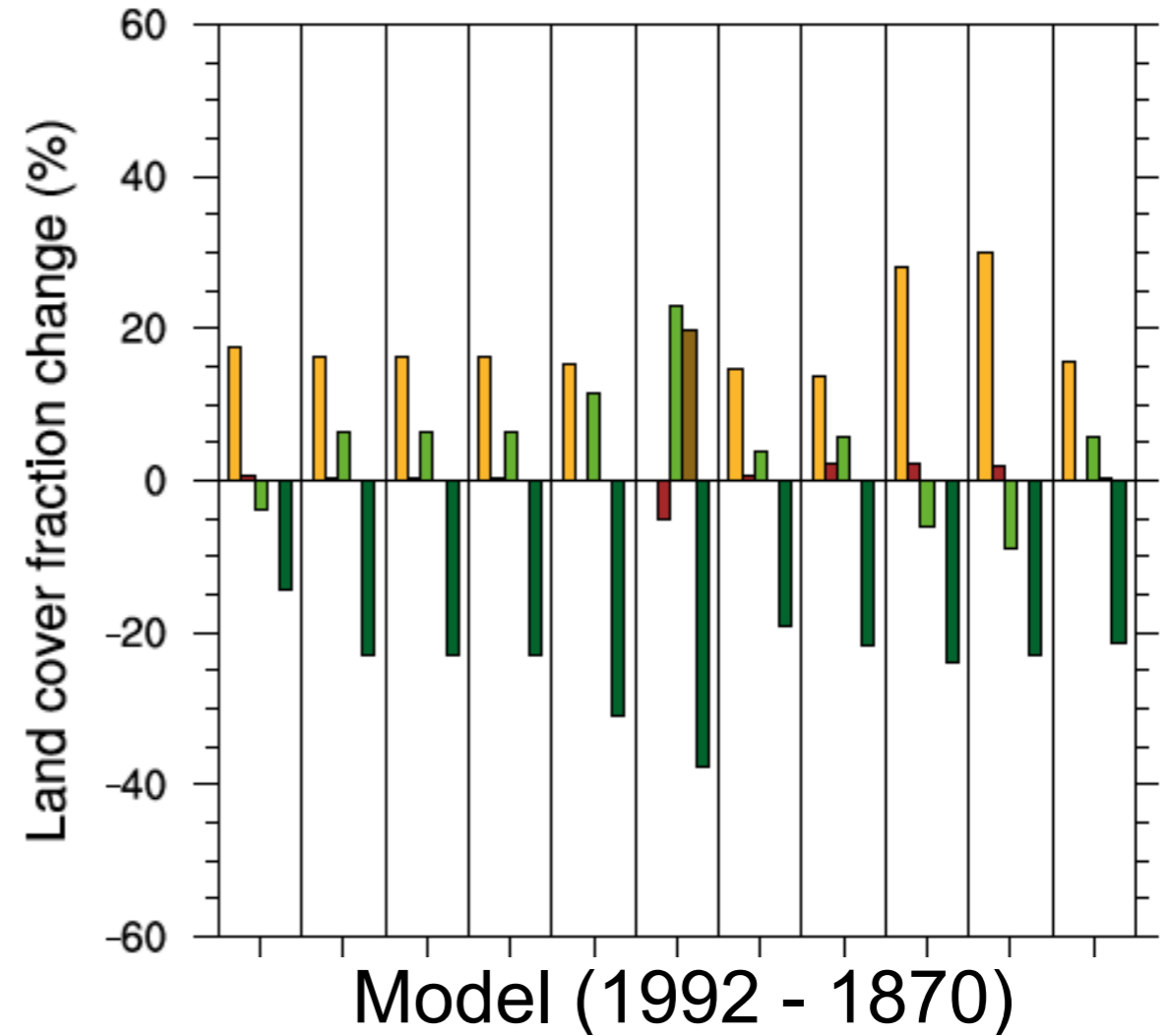
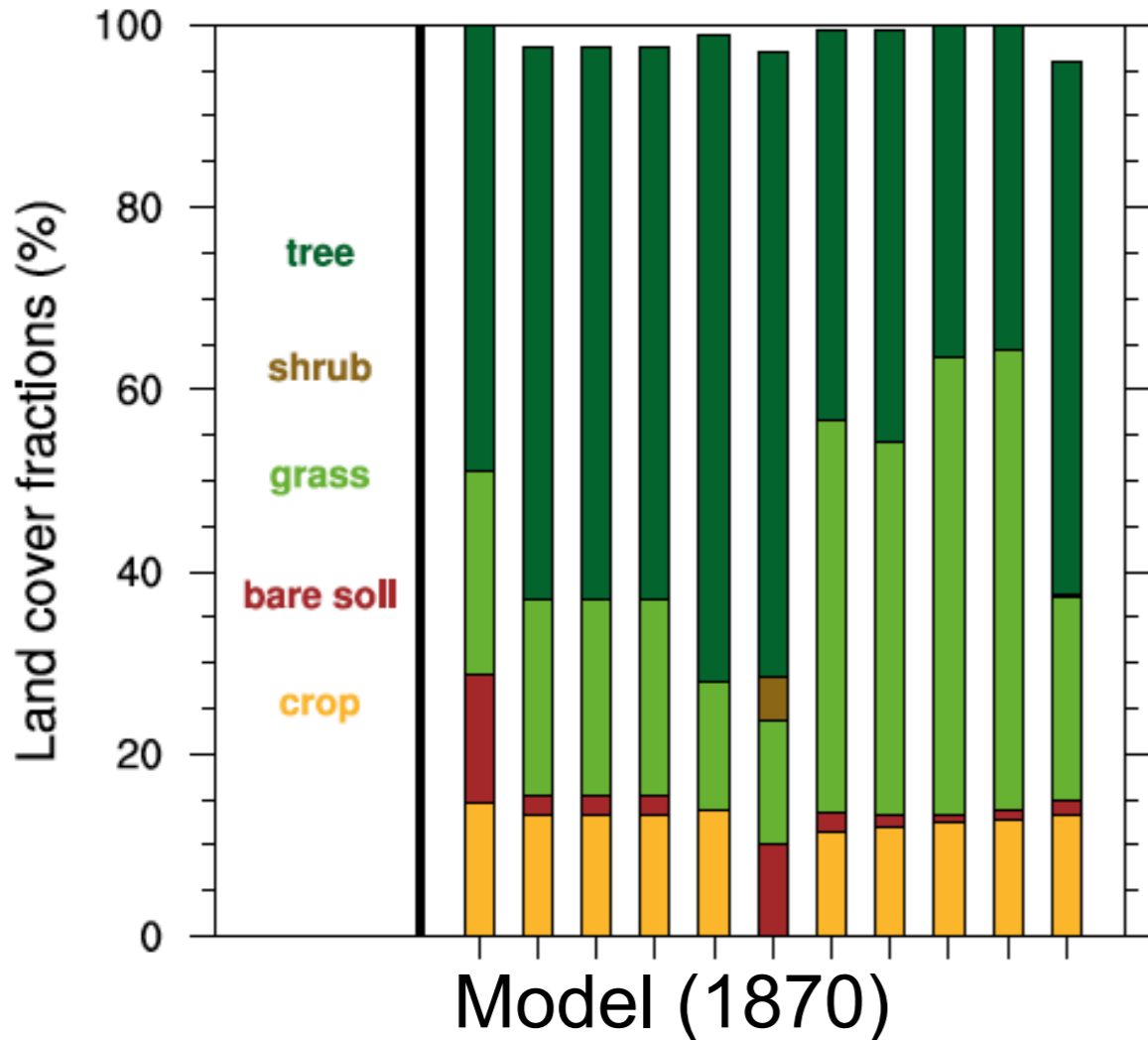


~7M km² more forest
increases veg C gain by ~54 Pg and
decreases CO₂ gain by ~15 ppmv
 over 90 years

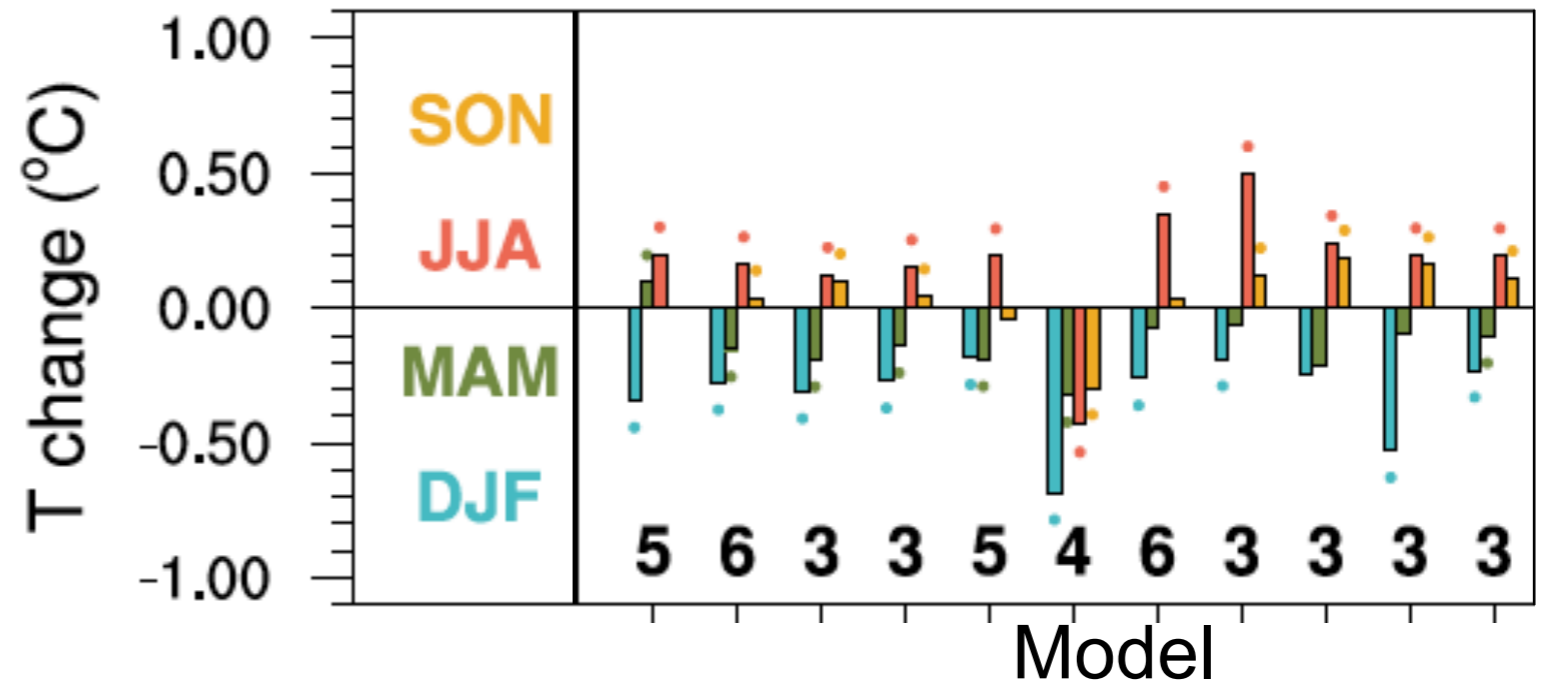


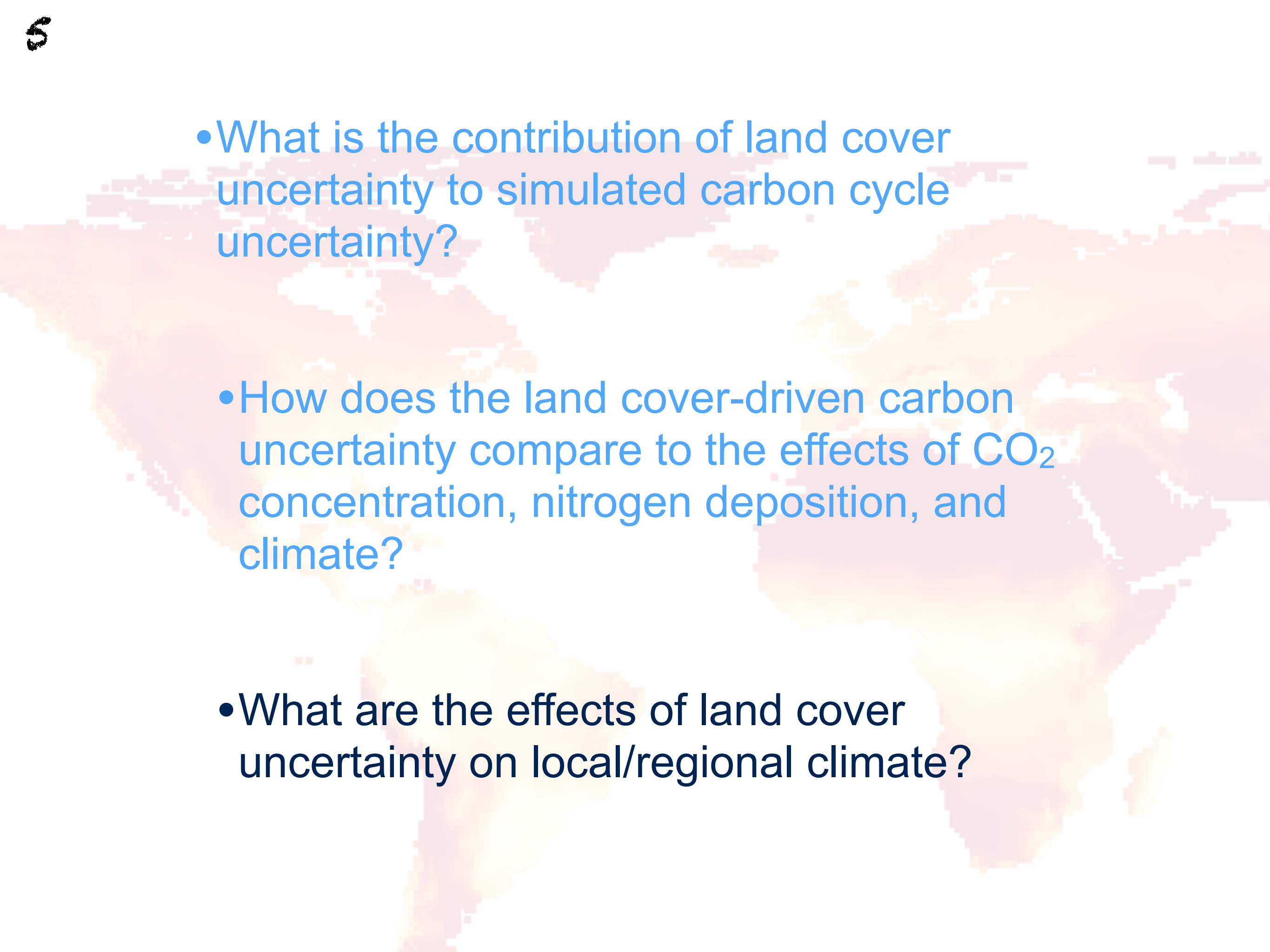
4

Different CMIP5 LULC/C can obscure LULC/C change effects on regional climate



North America
1974-2004 minus 1862-1891
(Lejeune et al., 2017)



- 
- What is the contribution of land cover uncertainty to simulated carbon cycle uncertainty?
 - How does the land cover-driven carbon uncertainty compare to the effects of CO₂ concentration, nitrogen deposition, and climate?
 - What are the effects of land cover uncertainty on local/regional climate?

6

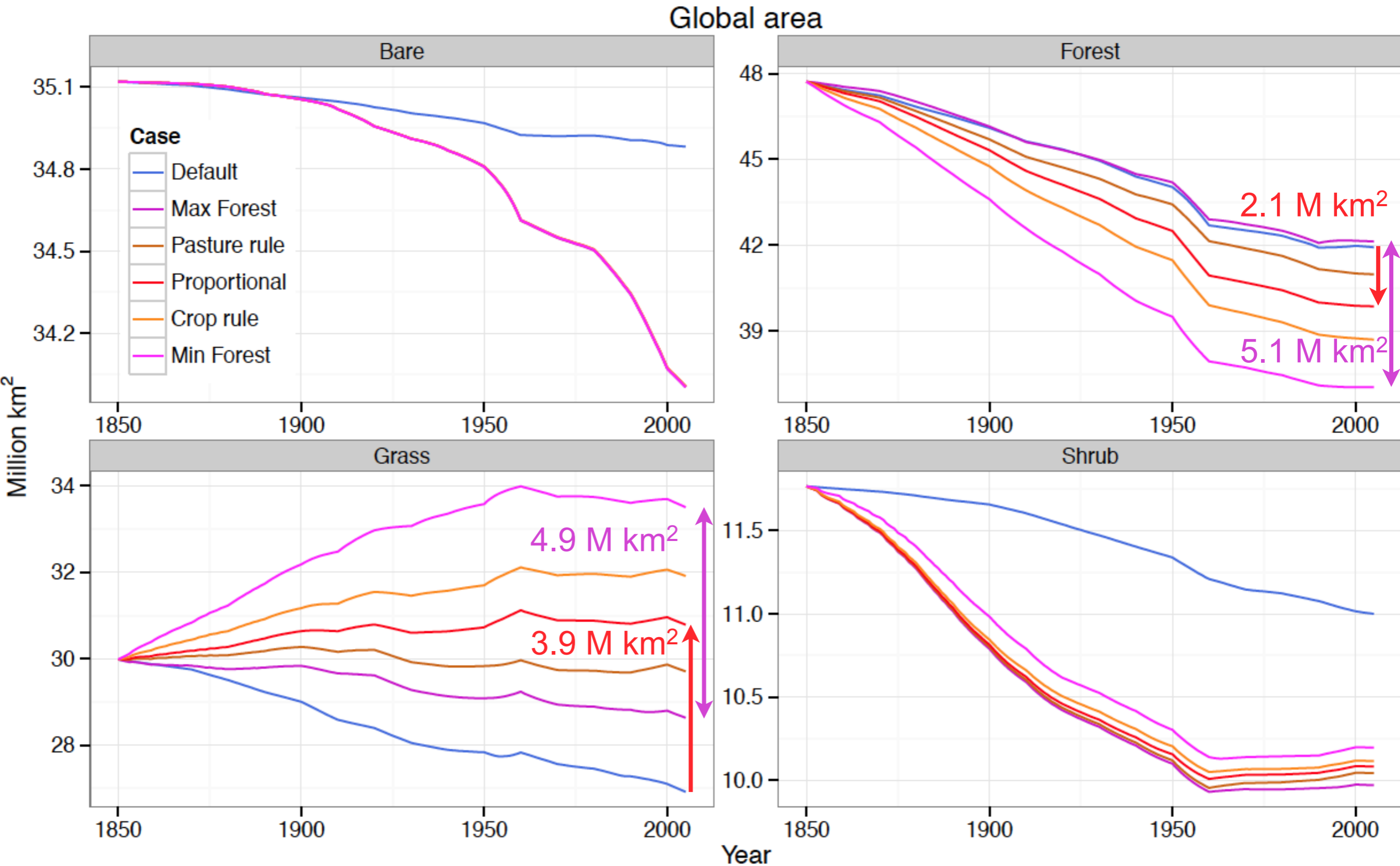
iESM-CLM simulations: 1850 - 2004

- Identical CMIP5 land use inputs (* indicates fully coupled sim)

Case	LULCC Reference	LULCC assumptions
No LULCC	Constant 1850	No conversion
Default*	Year 2000	Proportional to PFTs
Max forest*	Previous year	Δ Pasture/crop maximizes forest area
Pasture rule*	Previous year	+ Pasture replaces grass/shrub PFTs first
Proportional*	Previous year	Proportional to PFTs; accounts for pasture
Crop rule	Previous year	+ Crop replaces tree PFTs first
Min Forest*	Previous year	Δ Pasture/crop minimizes forest area
Prop constant CO ₂	Previous year	Proportional to PFTs (max/min forest also)
Prop const CO ₂ /clim	Previous year	Proportional to PFTs (max/min forest also)
Prop const N dep	Previous year	Proportional to PFTs (max/min forest also)

- Atmosphere: CRU-NCEP, transient CO₂, N deposition, and aerosols

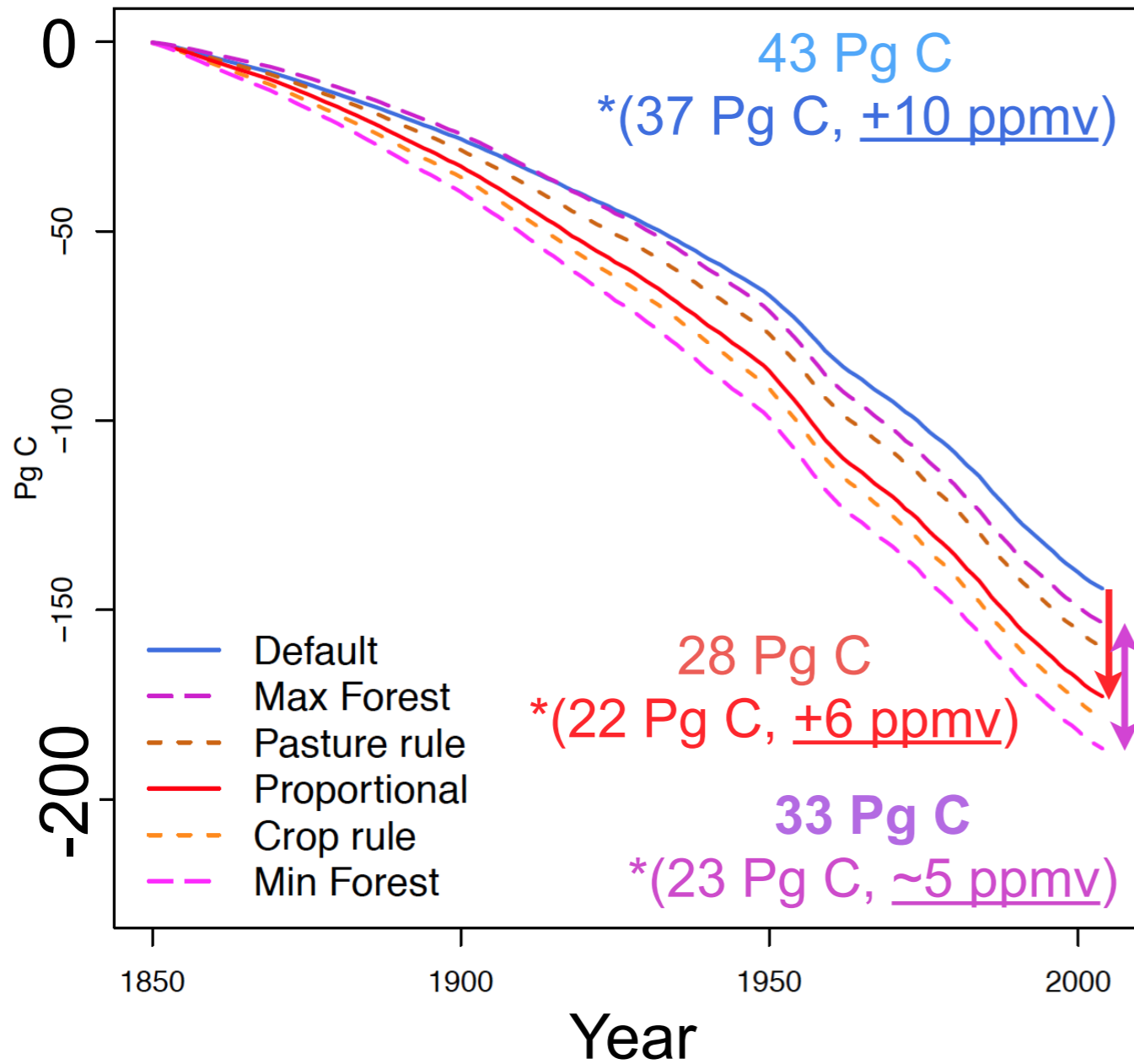
5.1 Million km² range in forest area by 2005



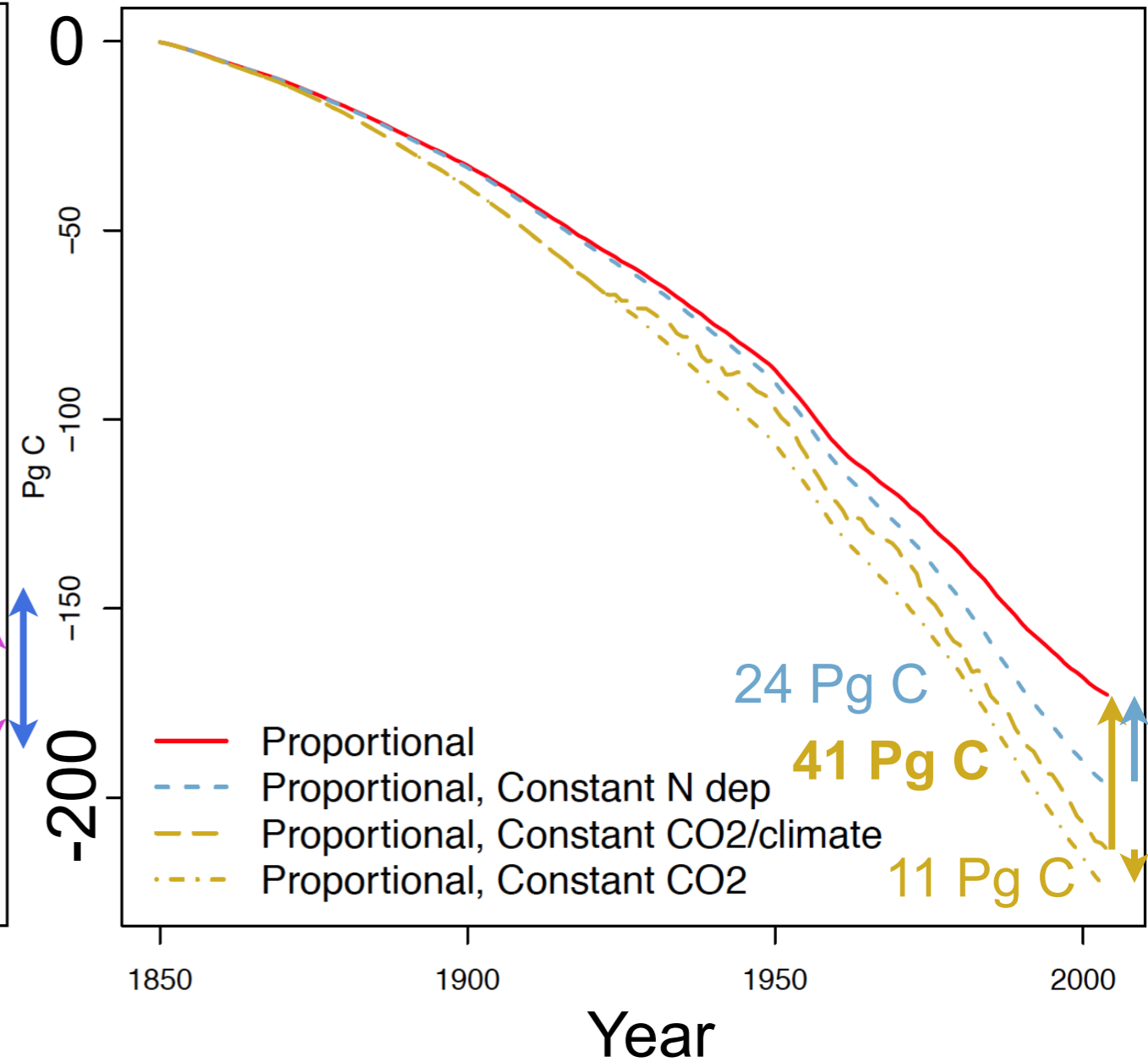


LC uncertainty substantially affects total ecosystem carbon (Pg C)

Change in TOTECOSYSC due to land use

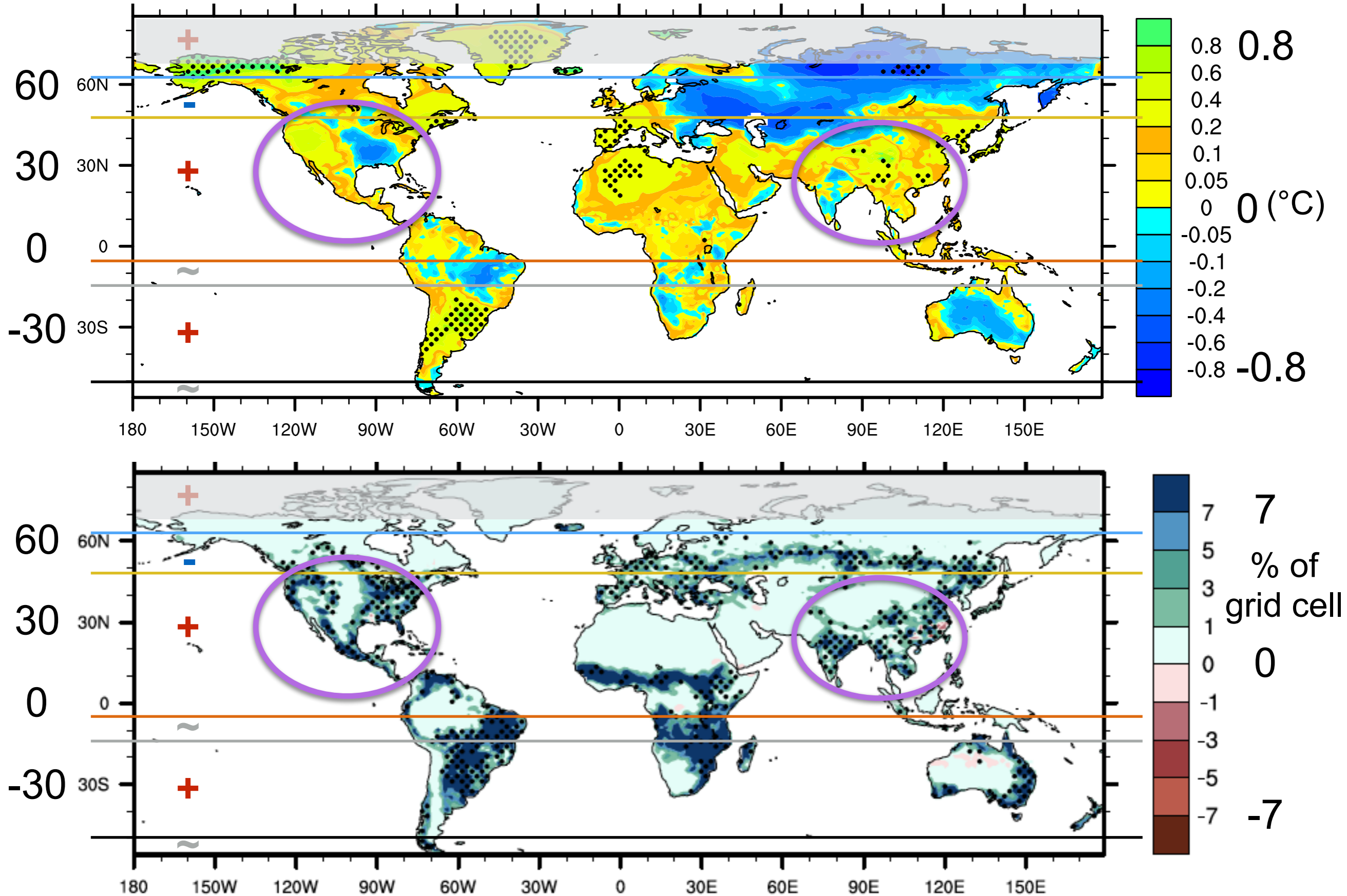


Atmospheric effects on change in TOTECOSYSC due to land use



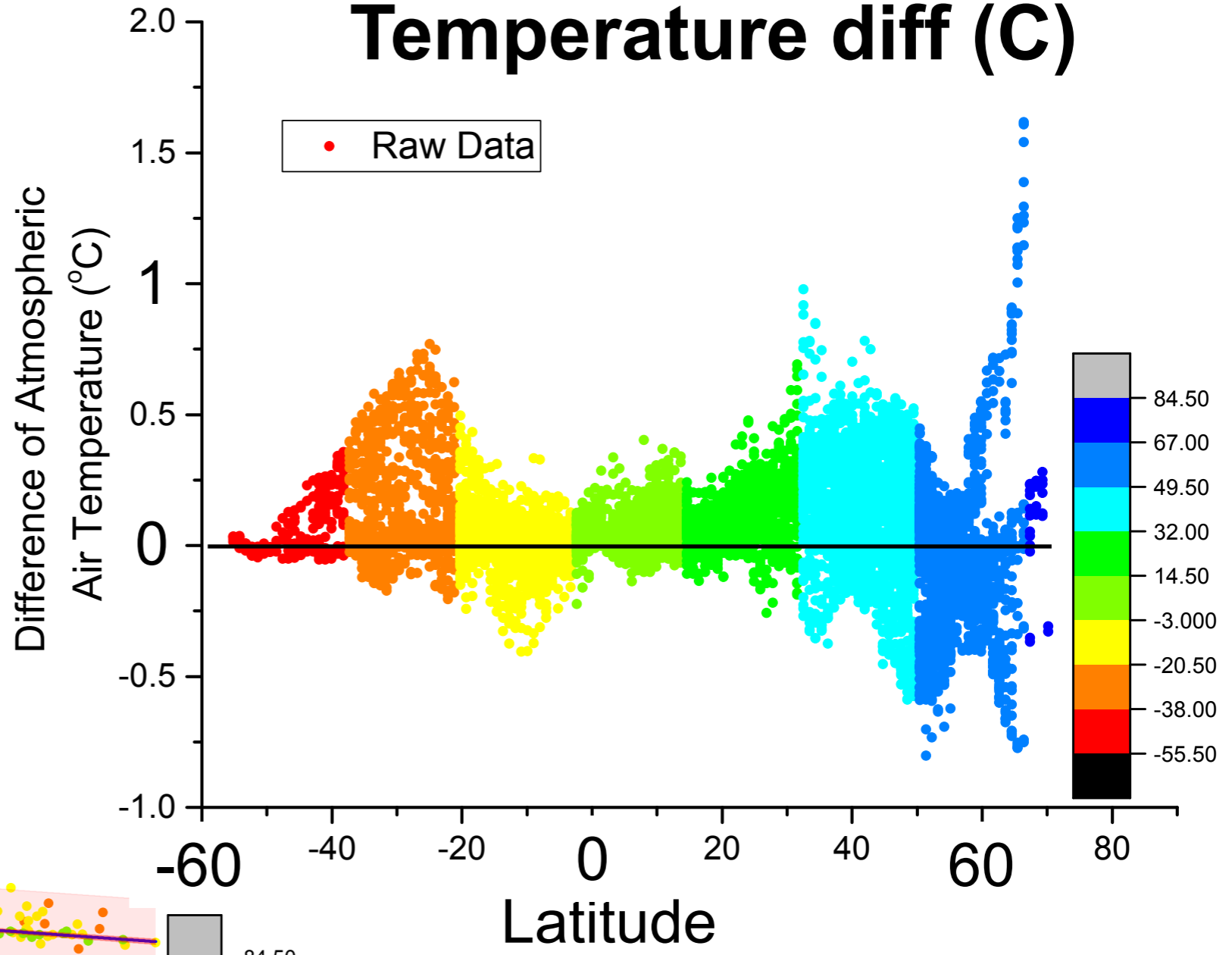
Regional dependence of climate impacts

Max forest minus Min forest (1985-2004 avg)

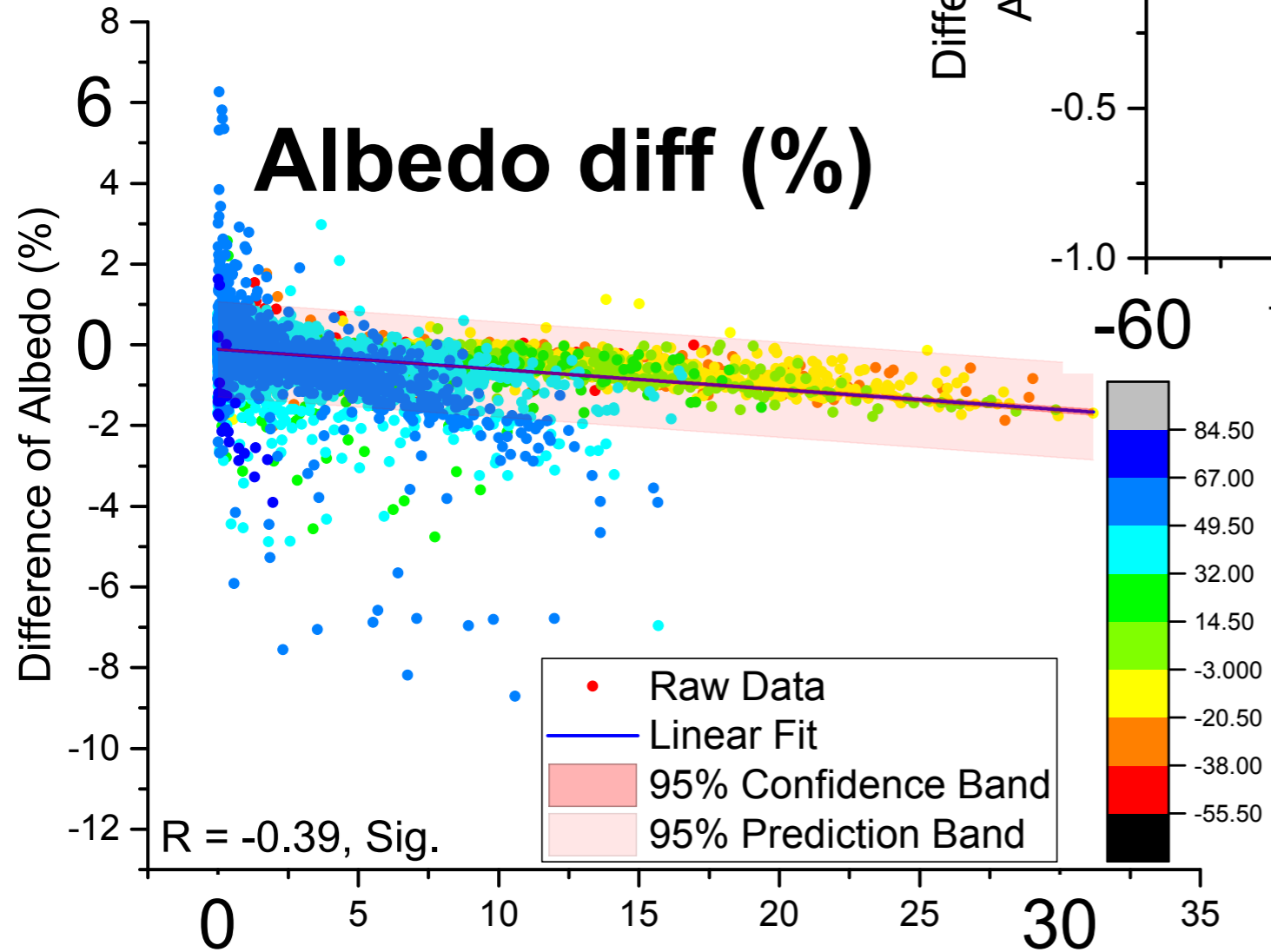


What drives temperature sign?

Temperature diff (C)



Albedo diff (%)

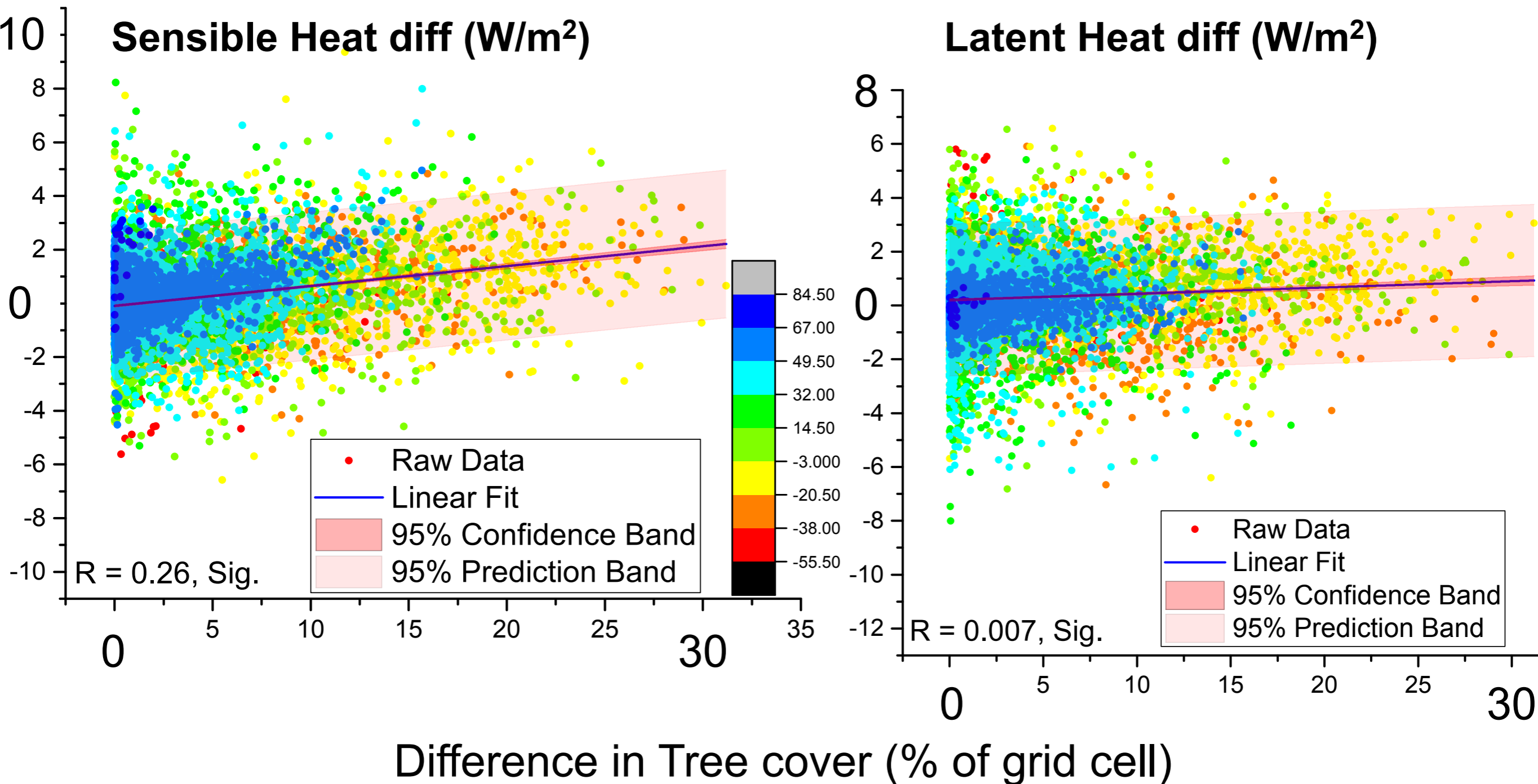


**Max Forest minus Min Forest
(1985-2004 avg)
(tree diff > 0)**

Difference in Tree Cover (% of grid cell)

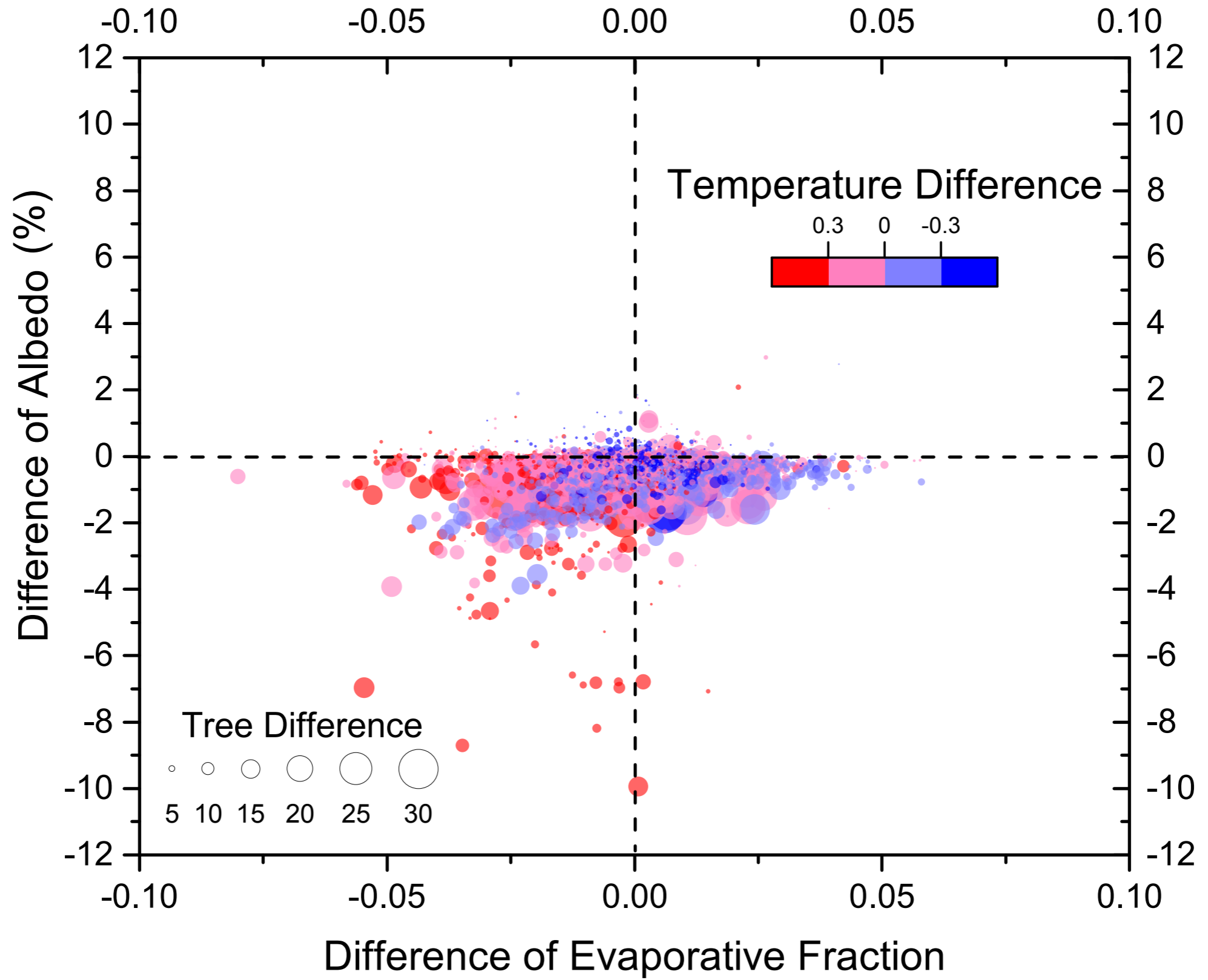
Sensible heat may dominate latent heat

Max Forest minus Min Forest
(1985-2004 avg)
(tree diff > 0)



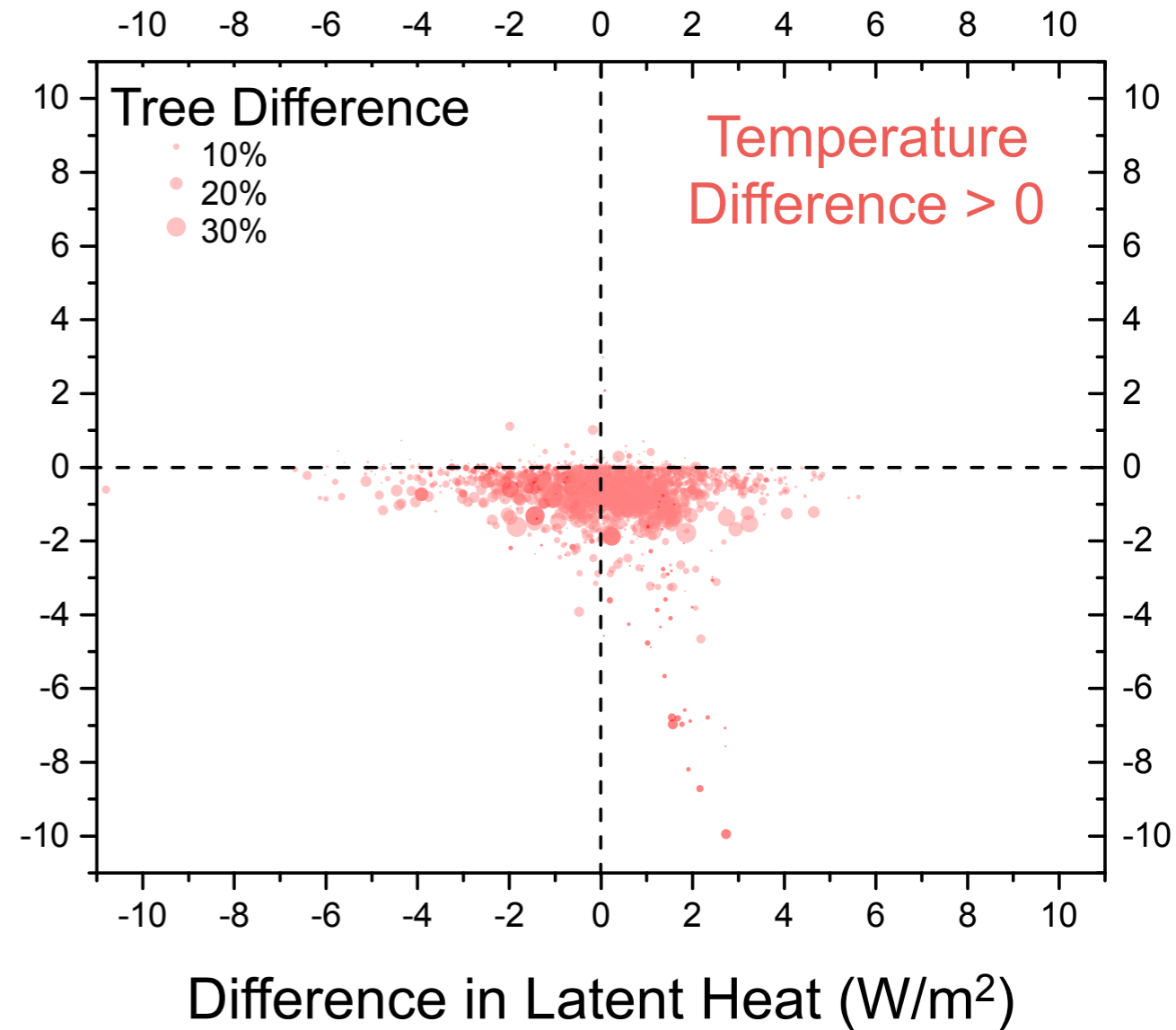
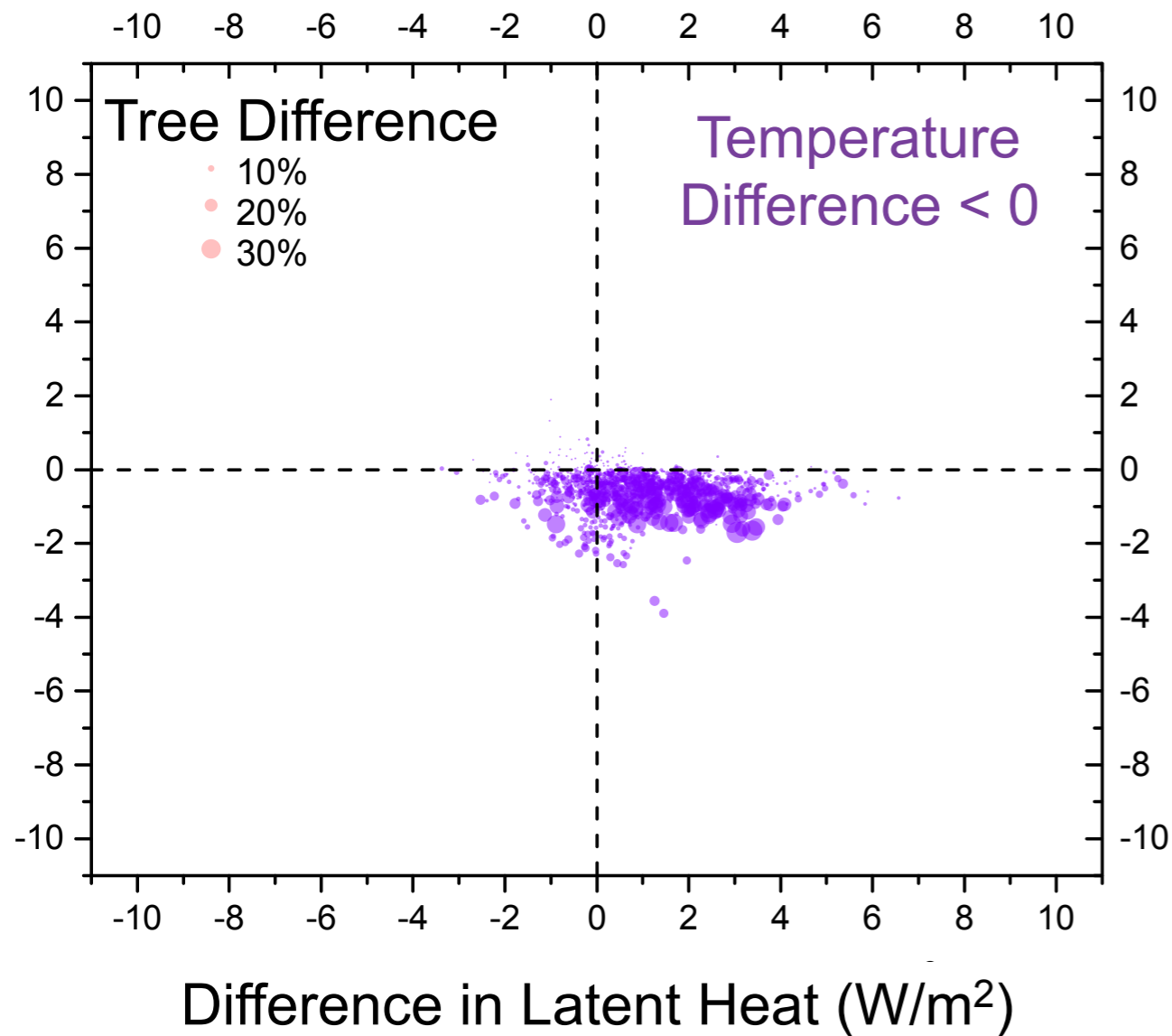
Albedo vs Evaporative Fraction

Max Forest minus Min Forest
(1985-2004 avg, tree diff > 0)



Latent heat and temperature

**Max Forest minus Min Forest
(1985-2004 avg, tree diff > 0)**



Summary

- Land cover uncertainty contributes **~5 ppmv** uncertainty to CO₂ concentration
 - **This is about 1/3 of original bias**
- Land cover uncertainty can contribute on the order of 1 degree to temperature uncertainty
 - This is on the order of LULCC-attributed effects
 - Regional dependence
 - Sensible heat vs albedo vs latent heat?
 - Local vs distributed
- LULCC-driven uncertainty is reducible
 - LULCC is an integrated process

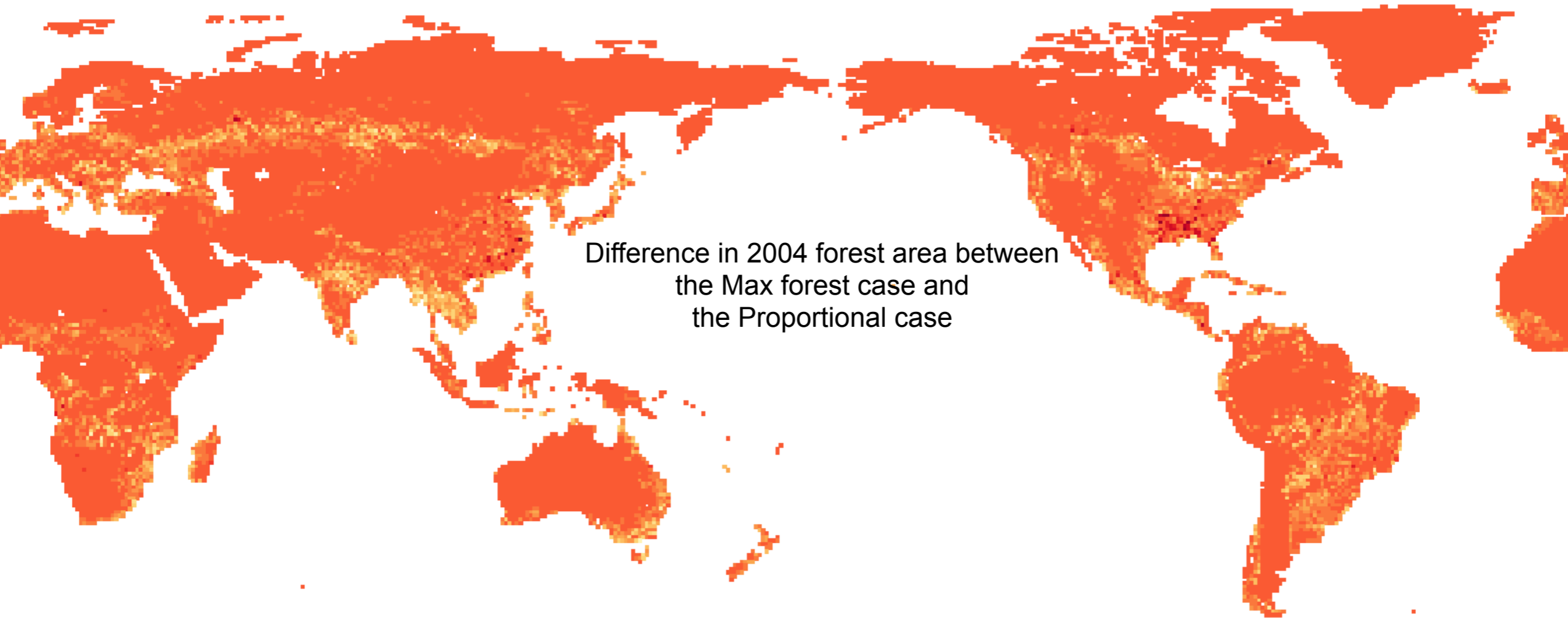
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Questions?

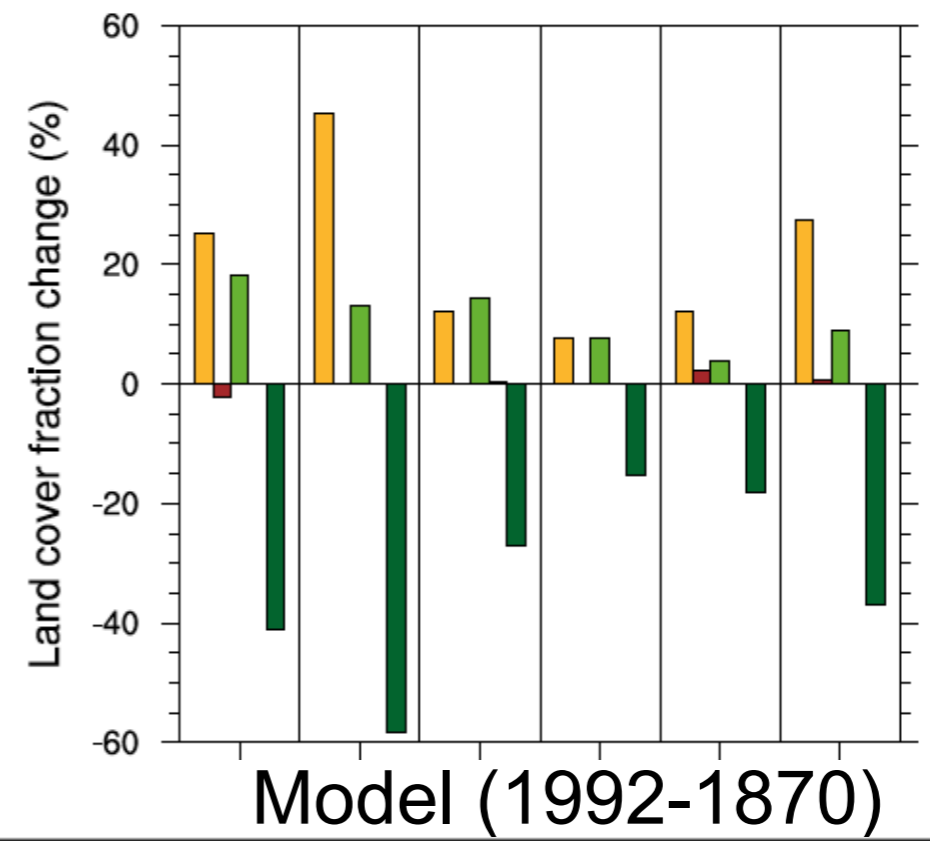
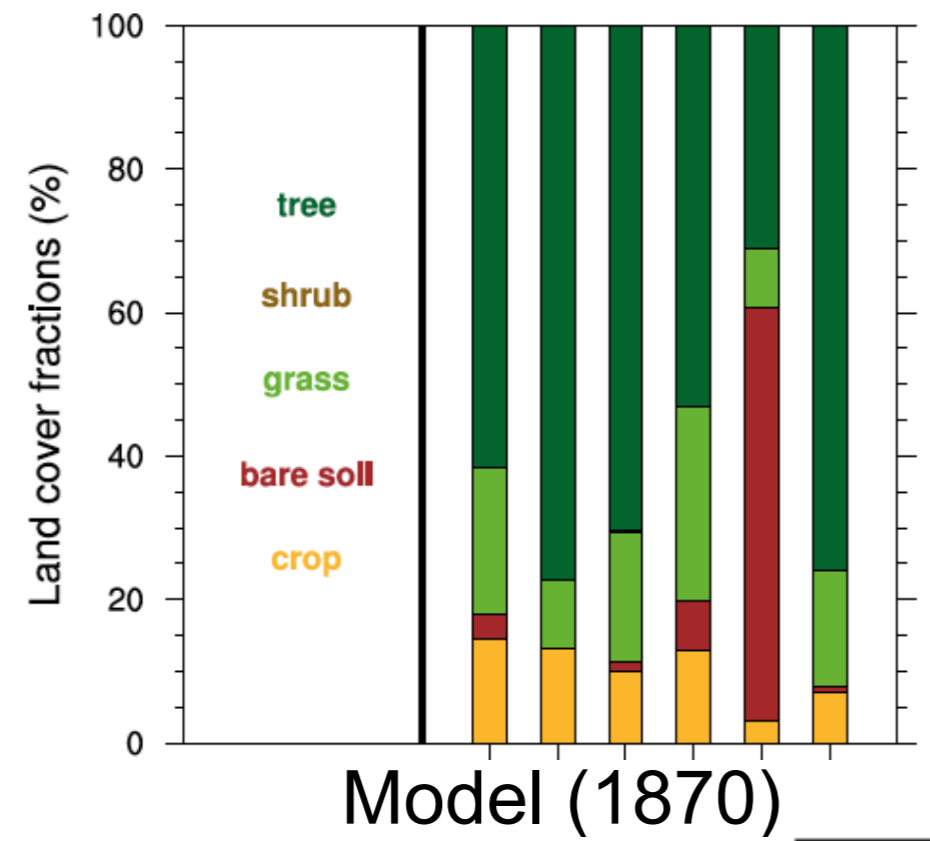


Difference in 2004 forest area between
the Max forest case and
the Proportional case

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Research and Earth System Modeling Programs.

E1

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