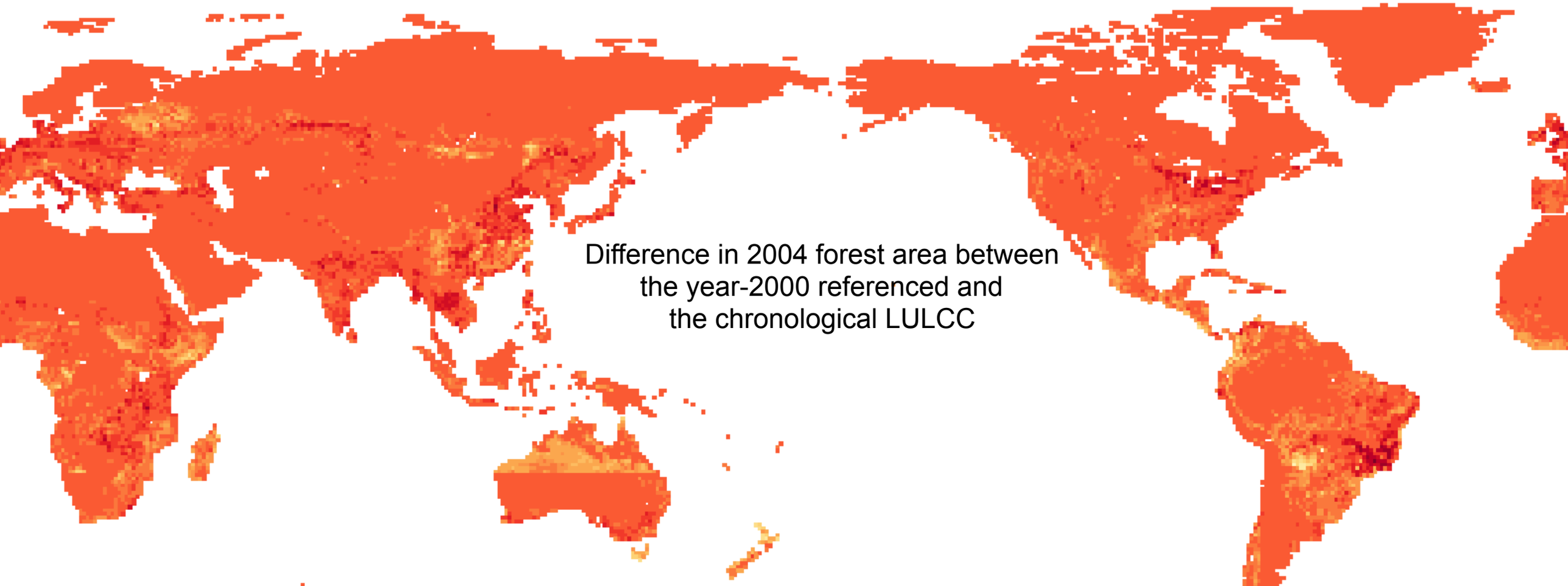
Evaluating the need for integrated Land Use and Land Cover Change (LULCC) analysis



Alan V. Di Vittorio
Lawrence Berkeley National Laboratory

Jiafu Mao and Xiaoying Shi
Oak Ridge National Laboratory

Annual CESM Working Group Meeting
9 February 2016

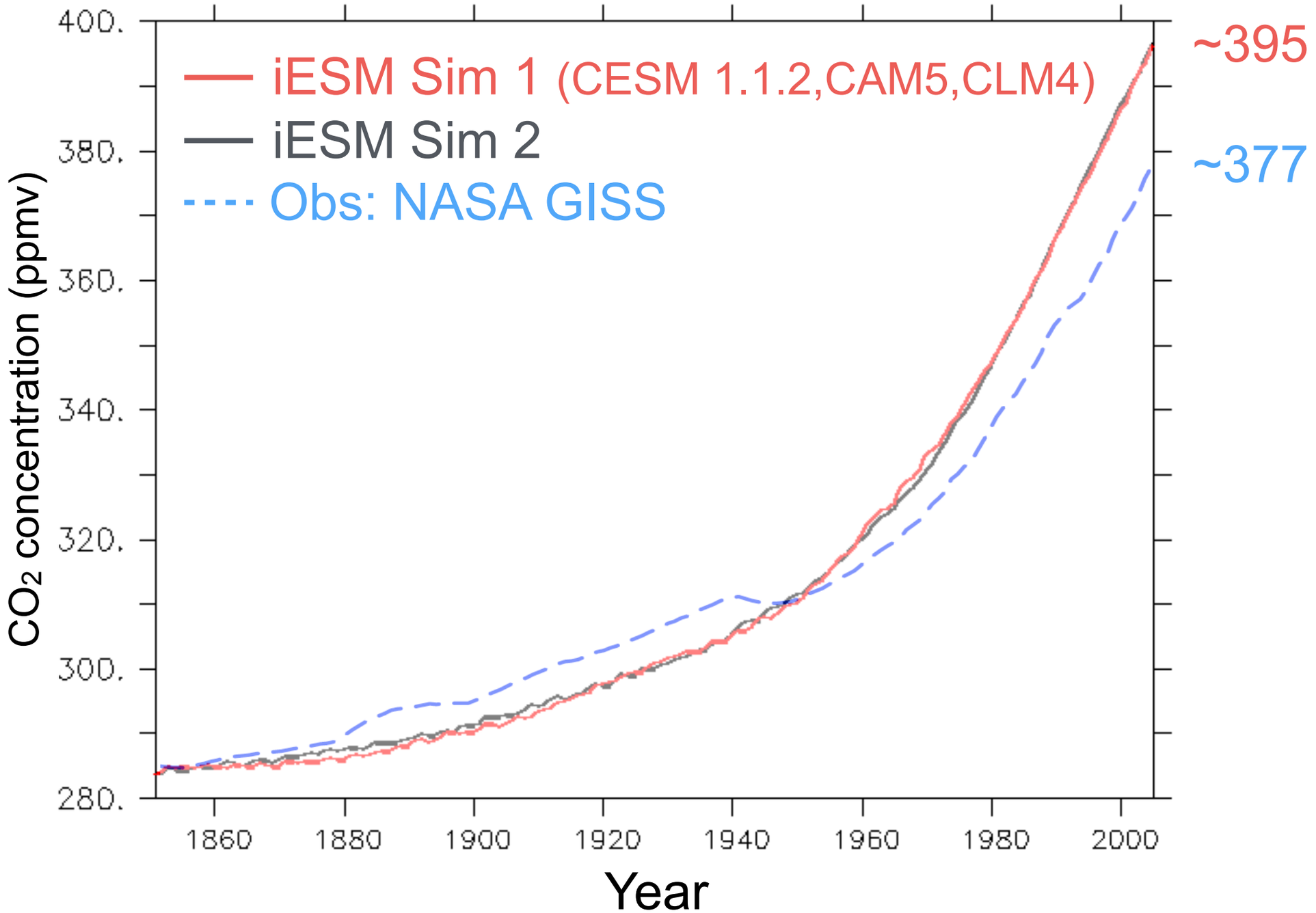
Earth Systems and Society Program

EARTH & ENVIRONMENTAL SCIENCES

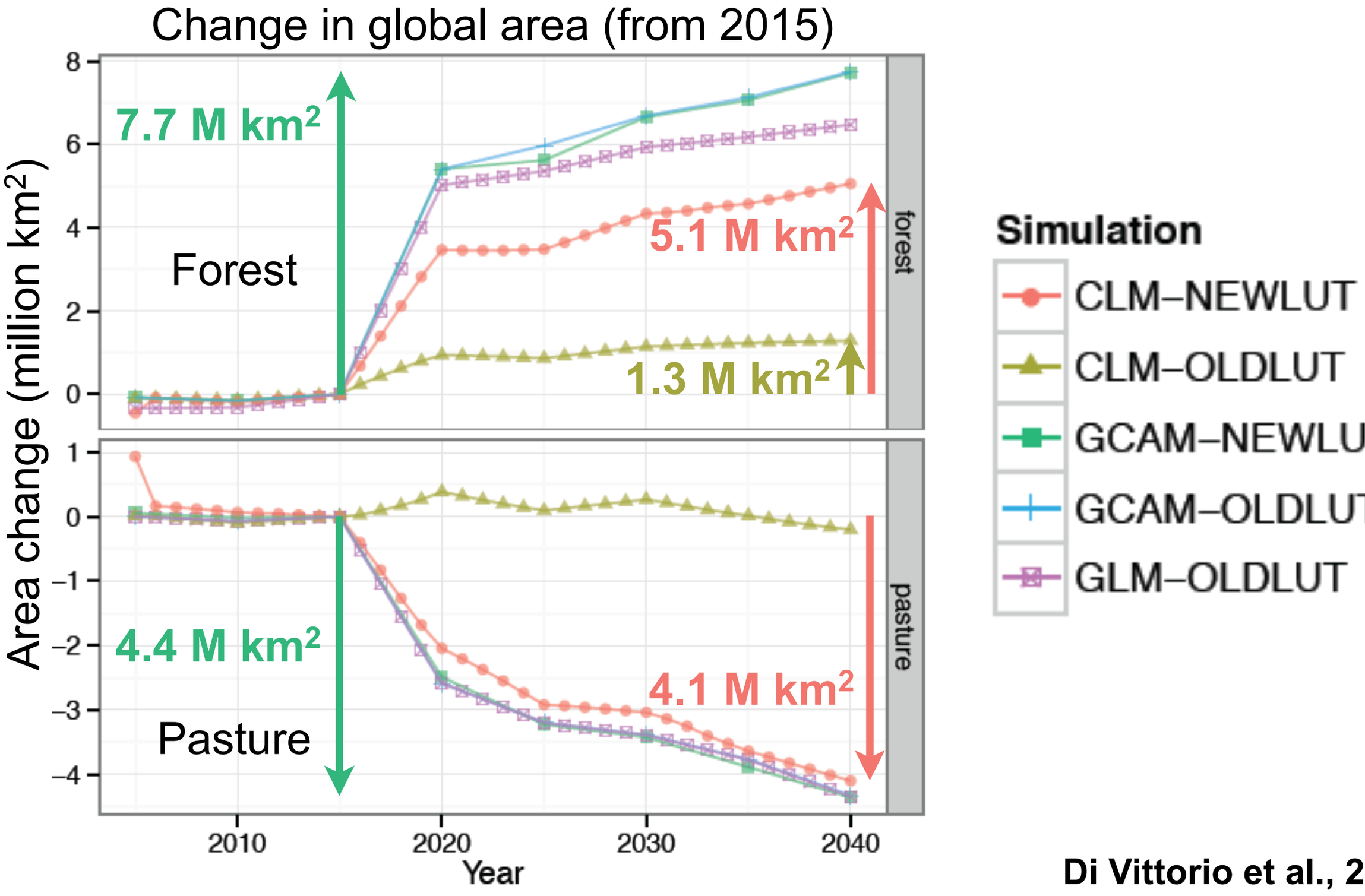
OAK RIDGE National Laboratory

BERKELEY LAB

~18 ppmv CO_2 bias in 2004



More forest increases veg C gain by ~54 Pg and decreases CO_2 gain by ~15 ppmv over 90 years



Di Vittorio et al., 2014

- What is the contribution of LULCC uncertainty to simulated carbon cycle uncertainty?

- How does the LULCC-driven carbon uncertainty compare to the effects of CO_2 concentration, nitrogen deposition, and climate?

- How can we improve LULCC to reduce atmospheric CO_2 bias and improve carbon cycle projections?

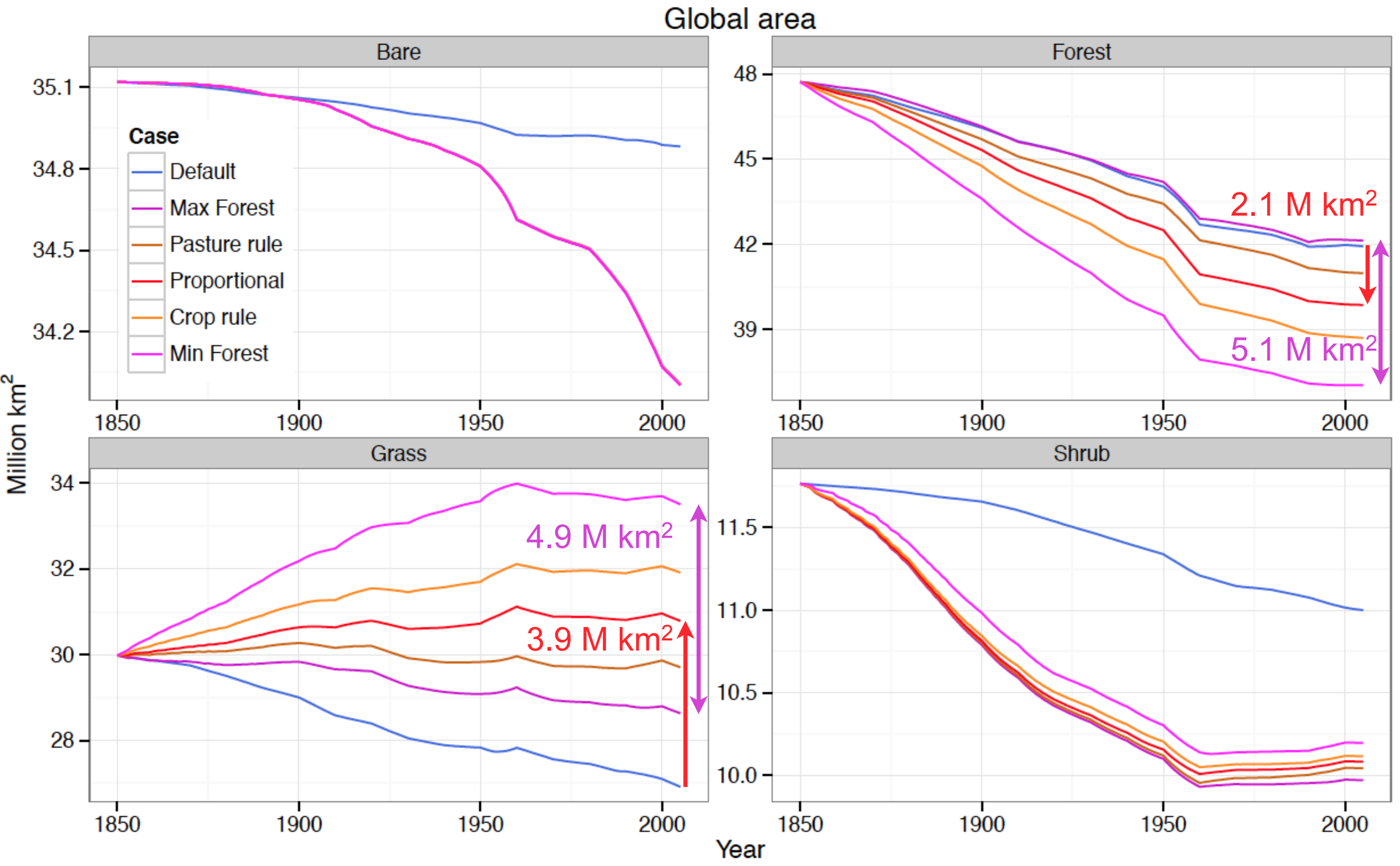
iESM-CLM simulations: 1850 - 2004

- Identical CMIP5 land use inputs

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
Prop const CO_2/clim	Previous year	Proportional to PFTs
Prop const N dep	Previous year	Proportional to PFTs

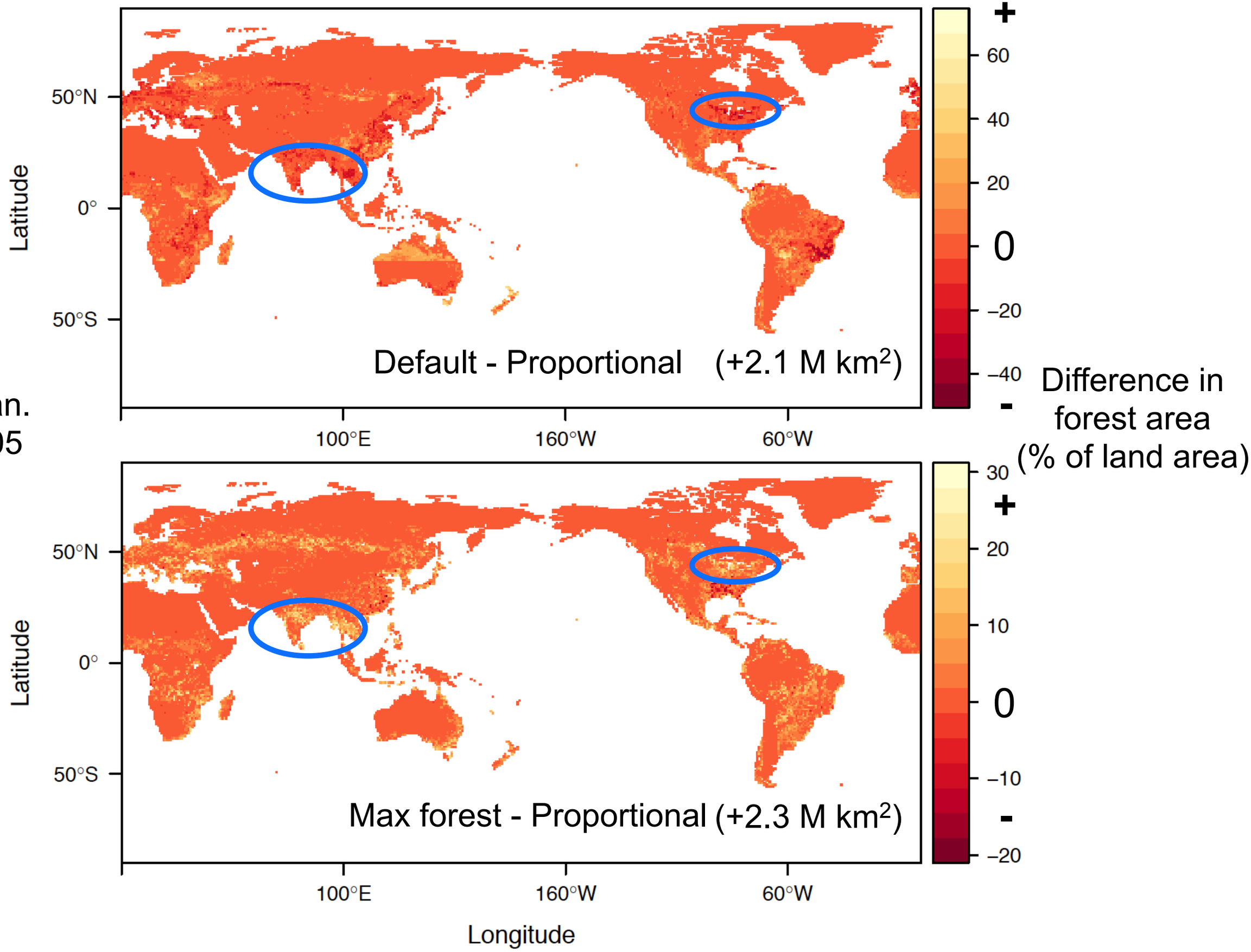
- Atmosphere: CRU-NCEP, transient CO_2, N deposition, and aerosols

5.1 Million km^2 range in forest area by 2005

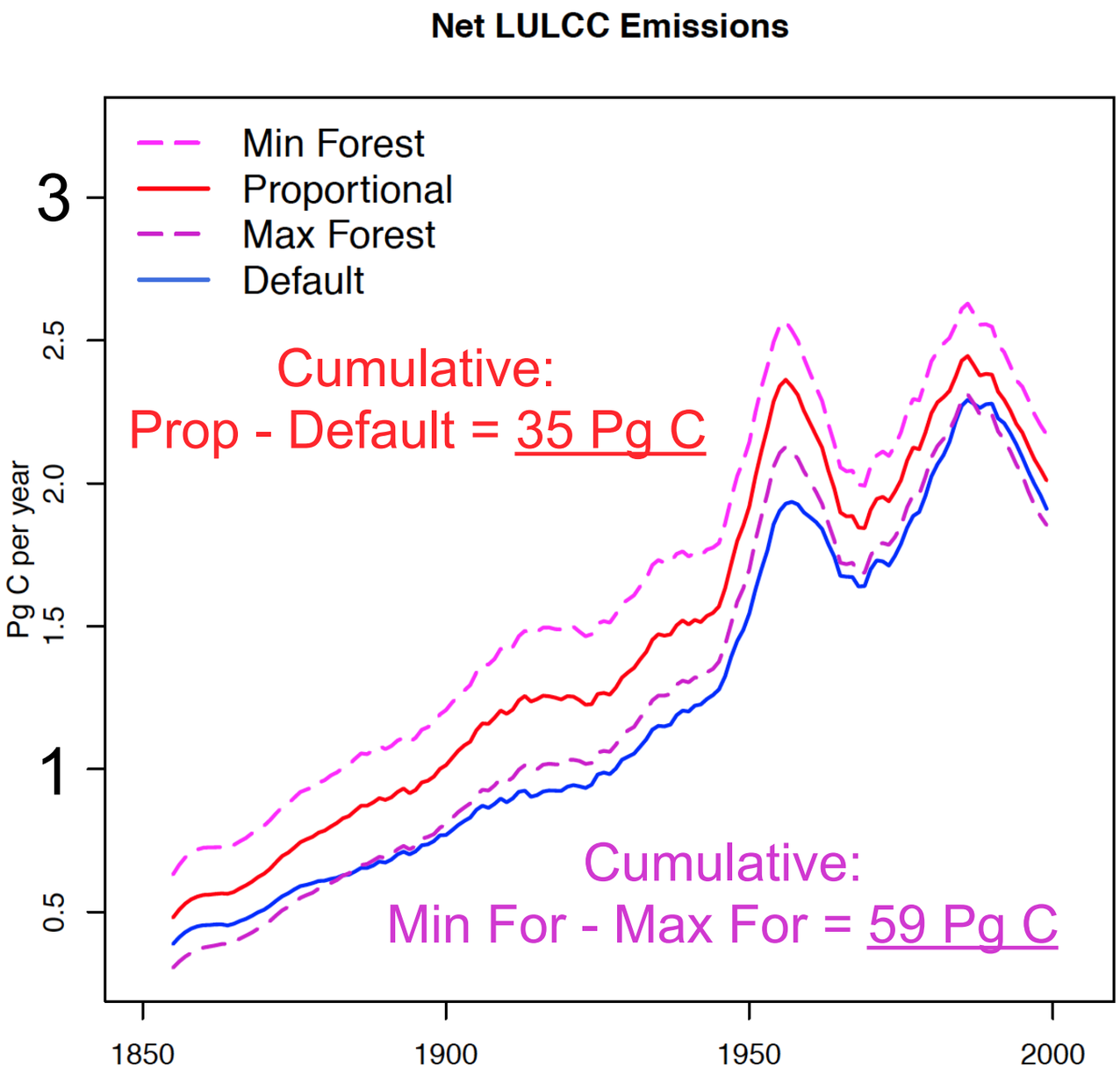


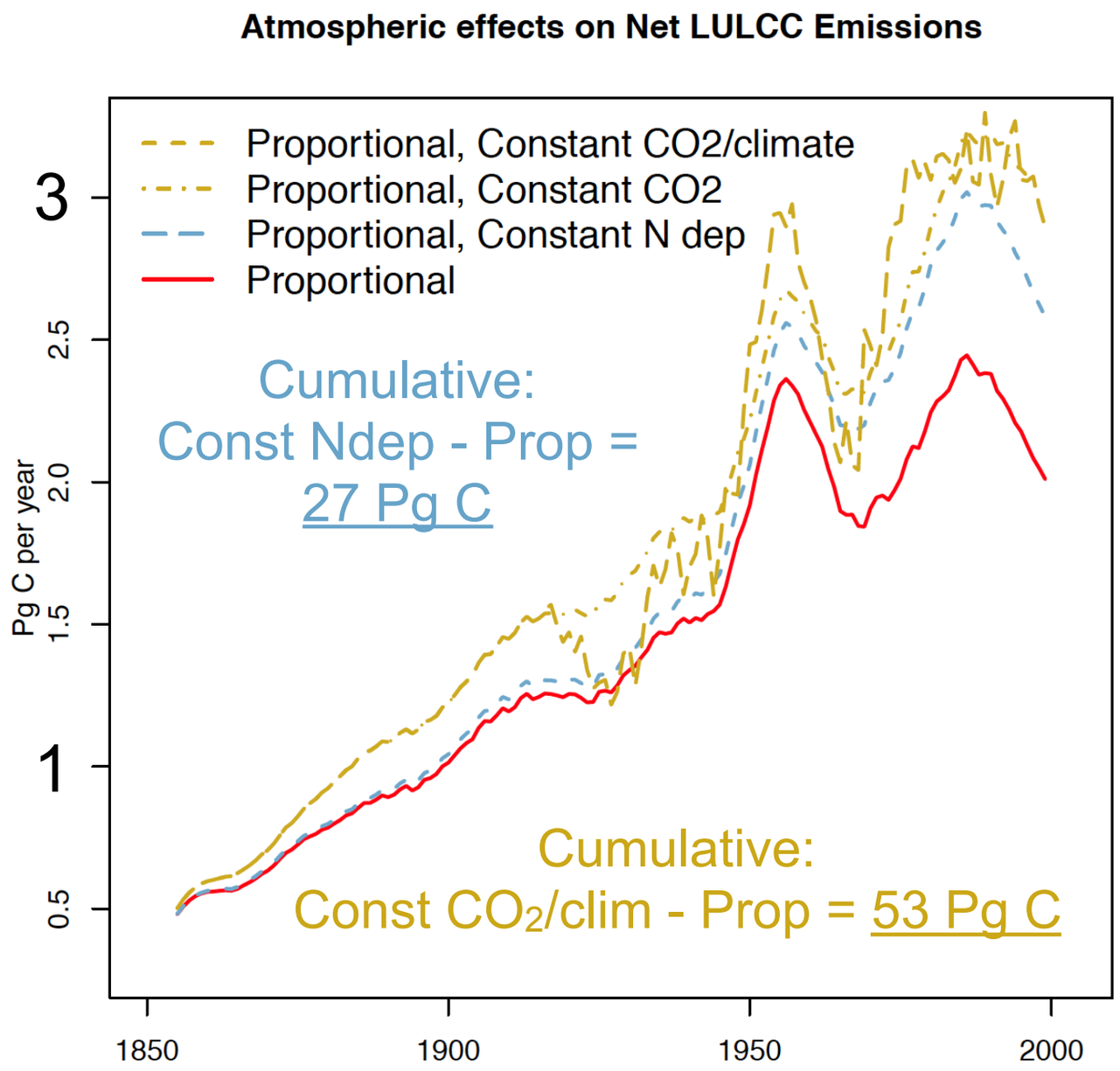
Unique spatial distributions of land cover

1 Jan. 2005

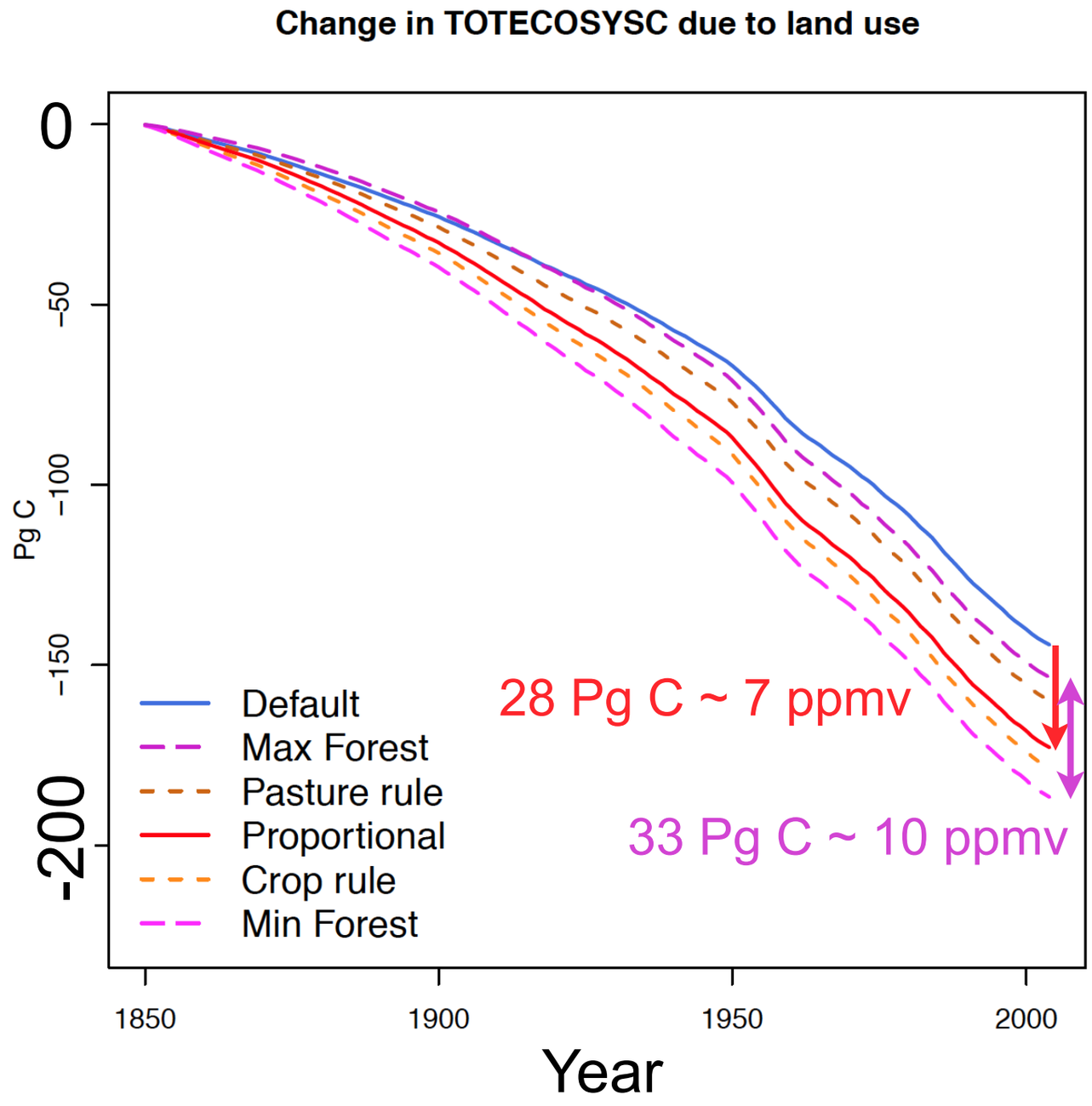


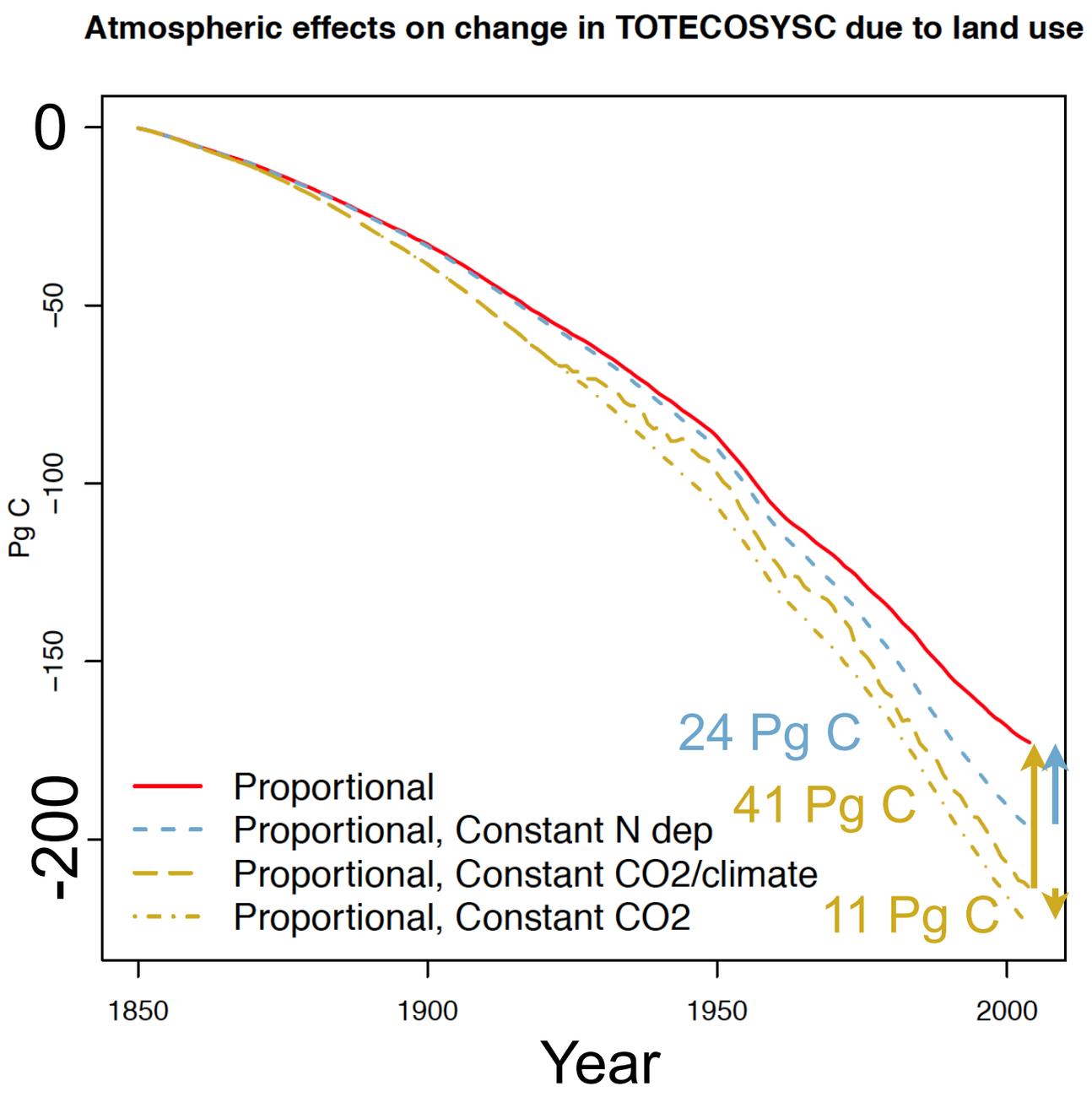
Net LULCC emissions (Pg C per year)





LULCC effects on total ecosystem carbon (Pg C)





Summary

- Chronological LULCC raises CO_2 bias by ~7 ppmv

- Max vs Min forest could span ~10 ppmv CO_2
  - 33 Pg eco C range is 63% of the 52 Pg C CO_2 fertilization effect
  - Eco C range is 80% of the 41 Pg C CO_2+climate effect

- Climate has little effect on LULCC emissions

- Forest PFT area is likely too high

- Potential for integrated LULCC analysis to reduce atmospheric CO_2 bias and improve projections

Summary

- Chronological LULCC raises CO_2 bias by ~7 ppmv

- Max vs Min forest could span ~10 ppmv CO_2
  - 33 Pg eco C range is 63% of the 52 Pg C CO_2 fertilization effect
  - Eco C range is 80% of the 41 Pg C CO_2+climate effect

- Climate has little effect on LULCC emissions

- Forest PFT area is likely too high

- Potential for integrated LULCC analysis to reduce atmospheric CO_2 bias and improve projections

Summary

- Chronological LULCC raises CO_2 bias by ~7 ppmv
- Max vs Min forest could span ~10 ppmv CO_2
  - 33 Pg eco C range is 63% of the 52 Pg C CO_2 fertilization effect
  - Eco C range is 80% of the 41 Pg C CO_2+climate effect
- Climate has little effect on LULCC emissions
- Forest PFT area is likely too high
- Potential for integrated LULCC analysis to reduce atmospheric CO_2 bias and improve projections

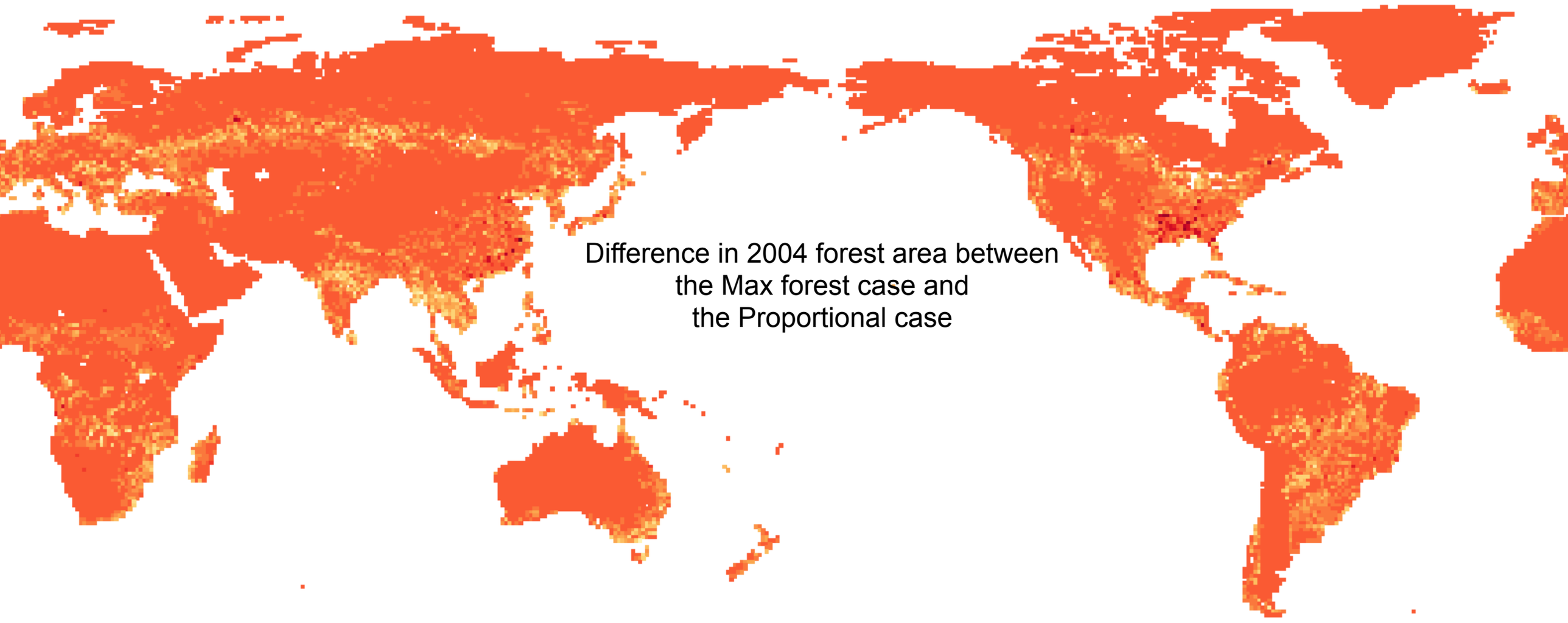
Summary

- Chronological LULCC raises CO_2 bias by ~7 ppmv
- Max vs Min forest could span ~10 ppmv CO_2
  - 33 Pg eco C range is 63% of the 52 Pg C CO_2 fertilization effect
  - Eco C range is 80% of the 41 Pg C CO_2+climate effect
- Climate has little effect on LULCC emissions
- Forest PFT area is likely too high
- Potential for integrated LULCC analysis to reduce atmospheric CO_2 bias and improve projections

Summary

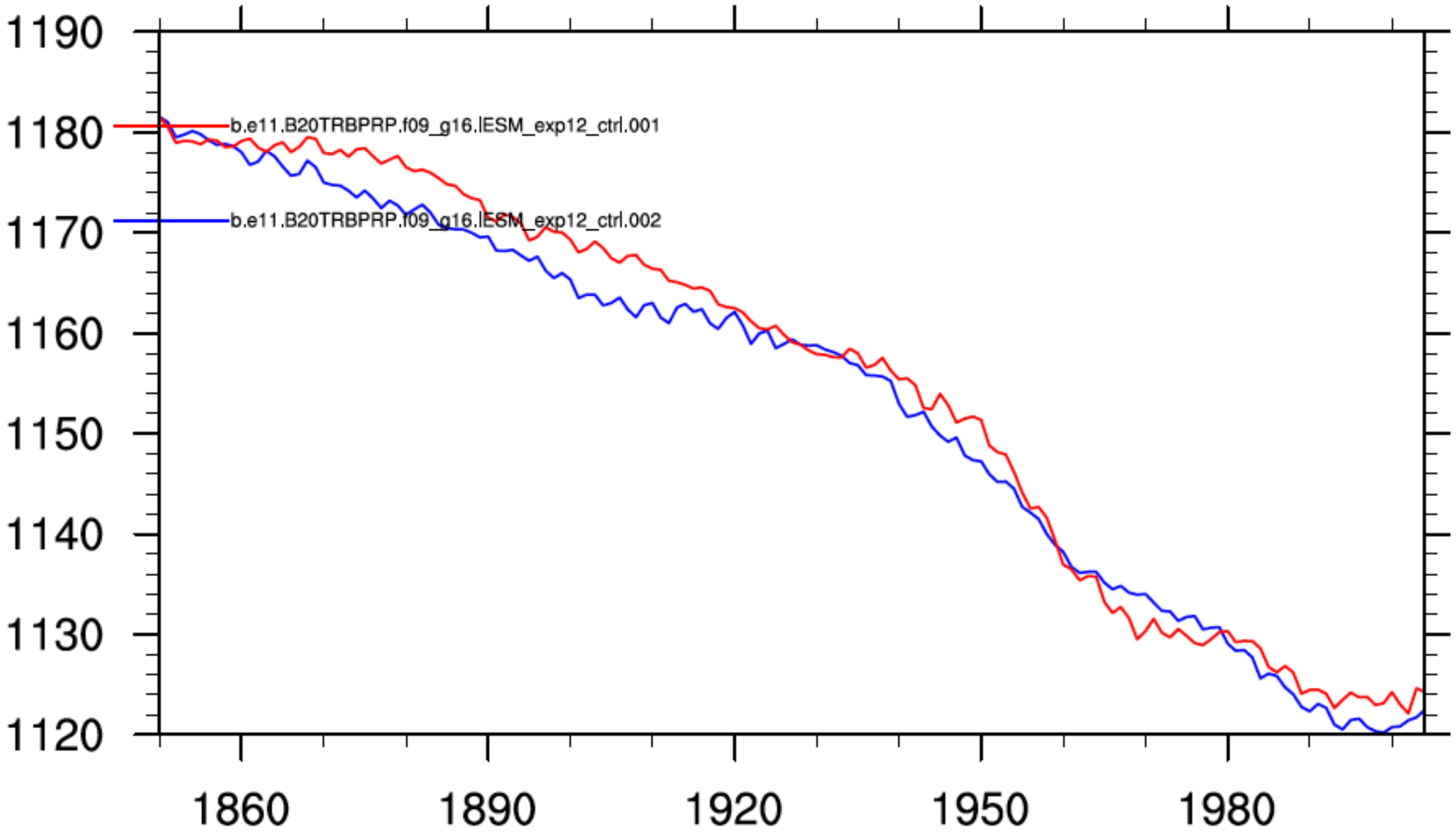
- Chronological LULCC raises CO_2 bias by ~7 ppmv
- Max vs Min forest could span ~10 ppmv CO_2
  - 33 Pg eco C range is 63% of the 52 Pg C CO_2 fertilization effect
  - Eco C range is 80% of the 41 Pg C CO_2+climate effect
- Climate has little effect on LULCC emissions
- Forest PFT area is likely too high
- Potential for integrated LULCC analysis to reduce atmospheric CO_2 bias and improve projections

Questions?



This work is supported by the Director, Office of Science, Office of Biological and Environmental Research of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231 as part of the Integrated Assessment Research Program.

2.5


TOTECOSYSC(PgC) for model year 1850-2004
b.e11.B20TRBPRP.f09_g16.lESM_exp12_ctrl.001
b.e11.B20TRBPRP.f09_g16.lESM_exp12_ctrl.002
1190
1180
1170
1160
1150
1140
1130
1120
1860
1890
1920
1950
1980