

SUMMARY

- The integrated Earth System Model (iESM) is the first fully coupled model capable of examining two-way interactions between human and earth system processes
- Feedbacks of climate on terrestrial carbon are successfully passed from CESM to GCAM
 - Net Primary Productivity (NPP) and Heterotrophic Respiration (HR) are effective proxies
- The forward coupling from GCAM to CESM, which is based on CMIP5, contains dramatic inconsistencies in land cover and land use
 - Only 22% of RCP4.5 afforestation by 2100 was simulated by CESM for CMIP5
- We have significantly improved the iESM land cover consistency through modification of the Land Use Translator (LUT)
 - The iESM simulated RCP4.5 afforestation increased from 17% to 66% of that prescribed by GCAM through 2040
 - This increases vegetation carbon gain by 19 PgC and decreases atmospheric CO₂ gain by 8 ppmv from 2005 to 2040
- Further work is needed to implement consistent land cover and land use representations among IAMs and ESMs
 - This will ensure that ESMs are simulating the scenarios prescribed by IAMs

METHODS

Figure 1. iESM land coupling

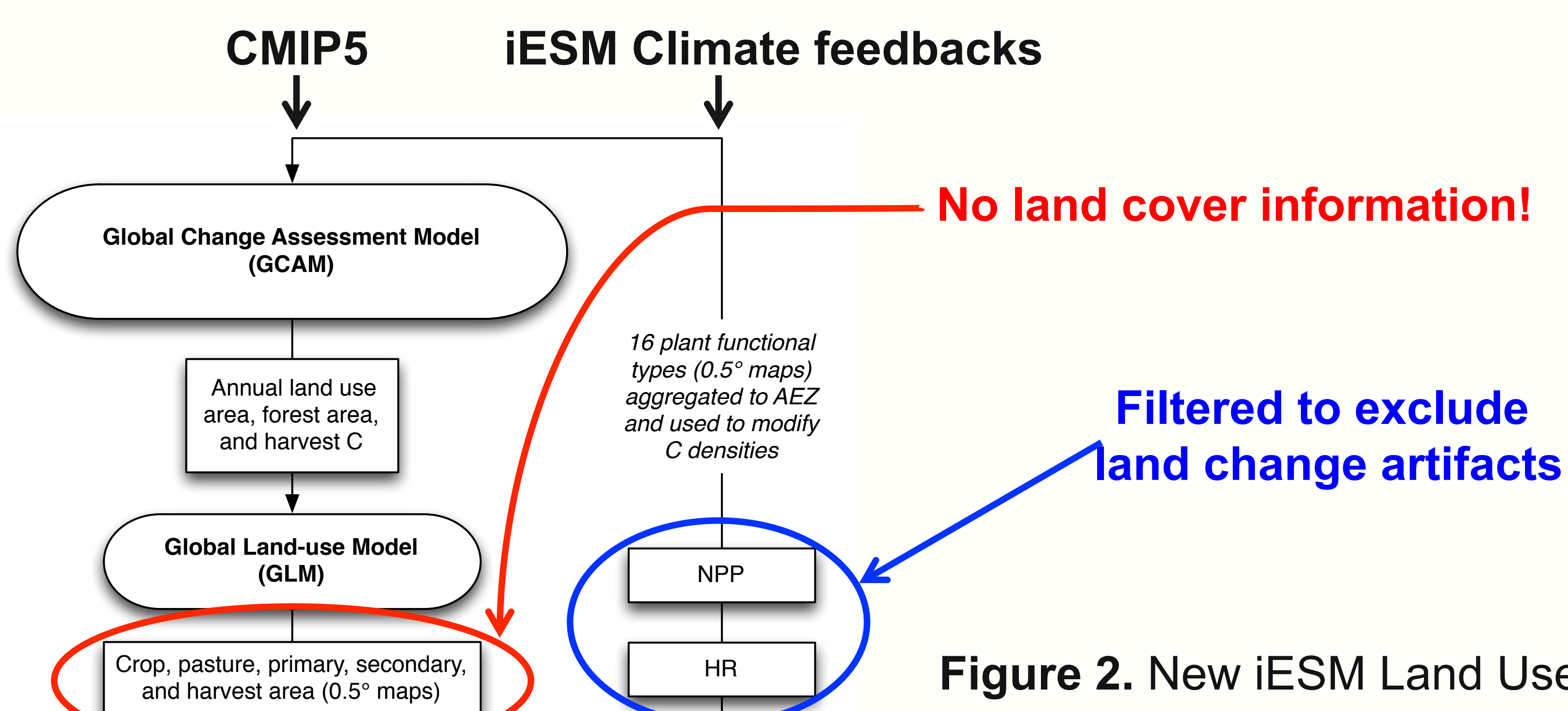
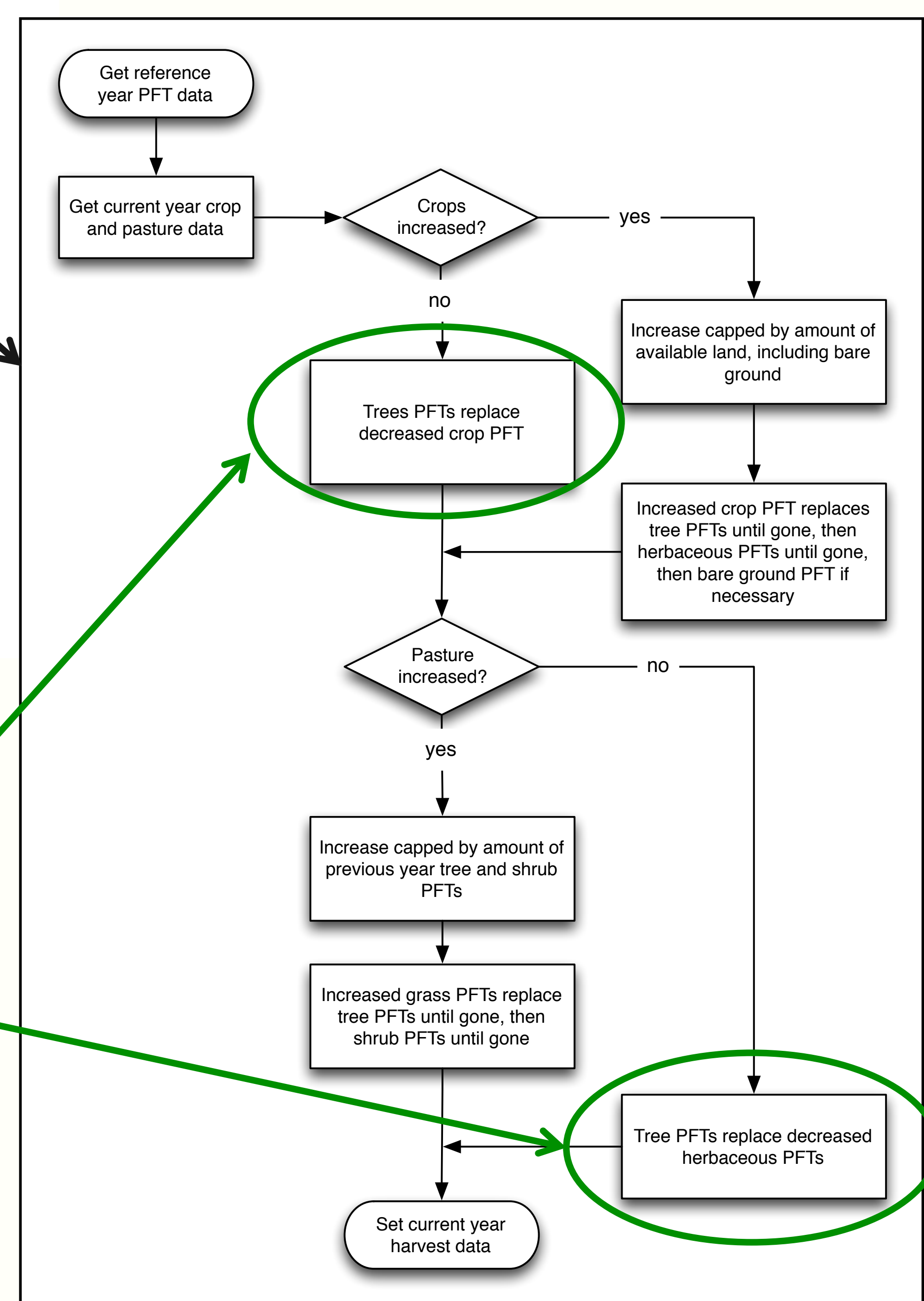


Figure 2. New iESM Land Use Translator (LUT)



Trees replace crops and pasture

RESULTS

Figure 3. NPP is a good proxy for potential carbon stock

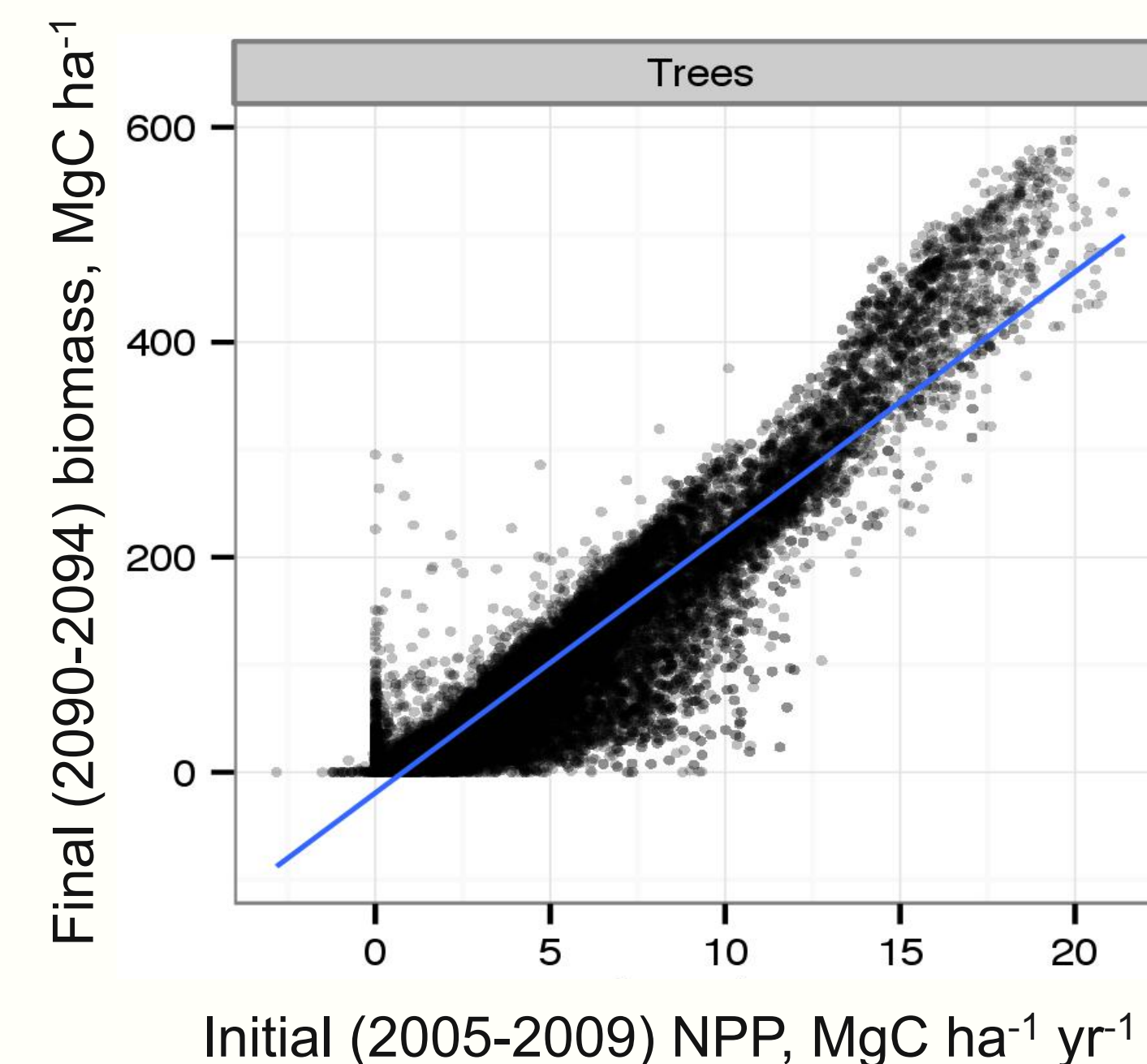


Figure 4. Efficacy of method to filter out land change artifacts from climate feedback signal

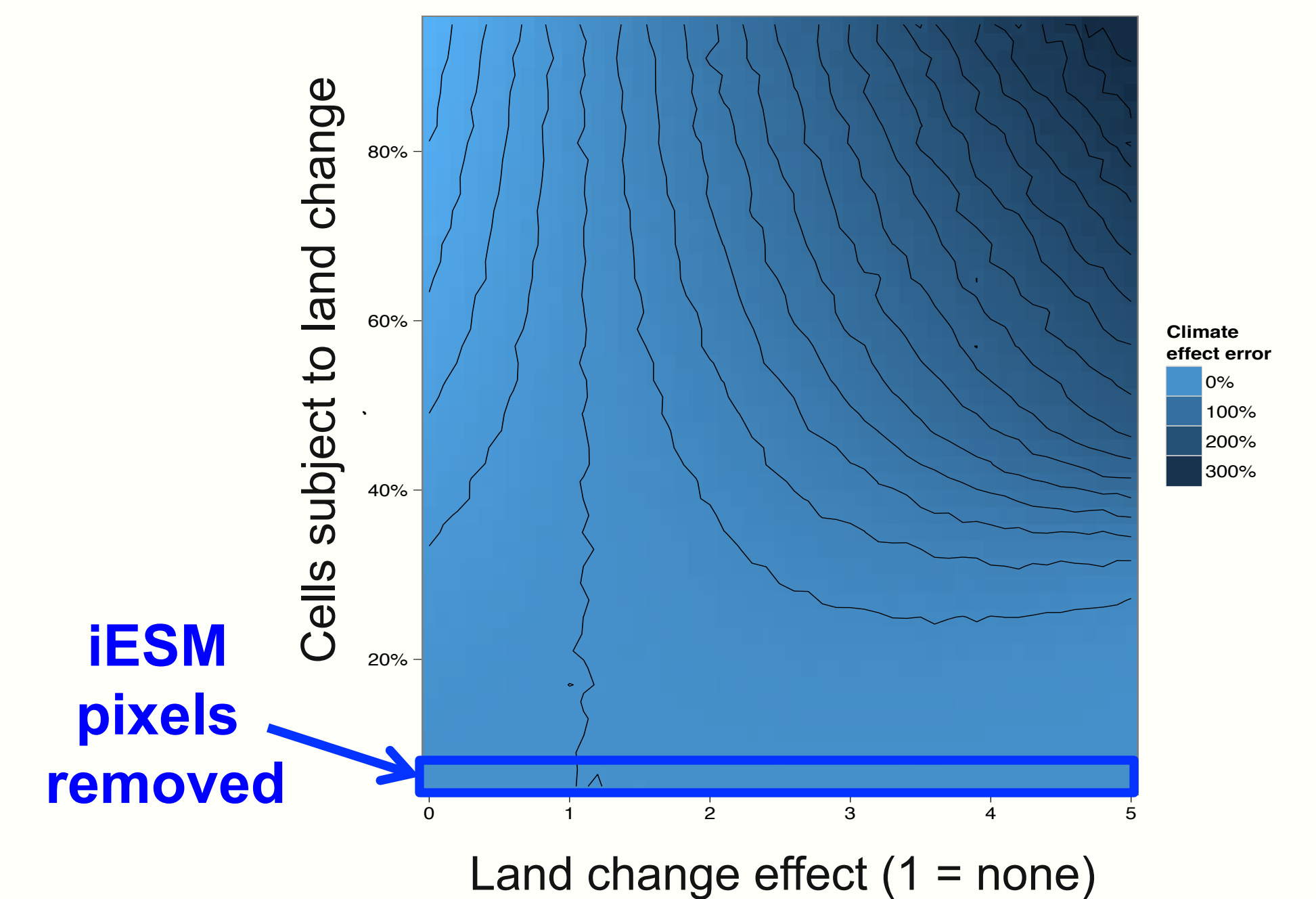


Figure 5. CMIP5

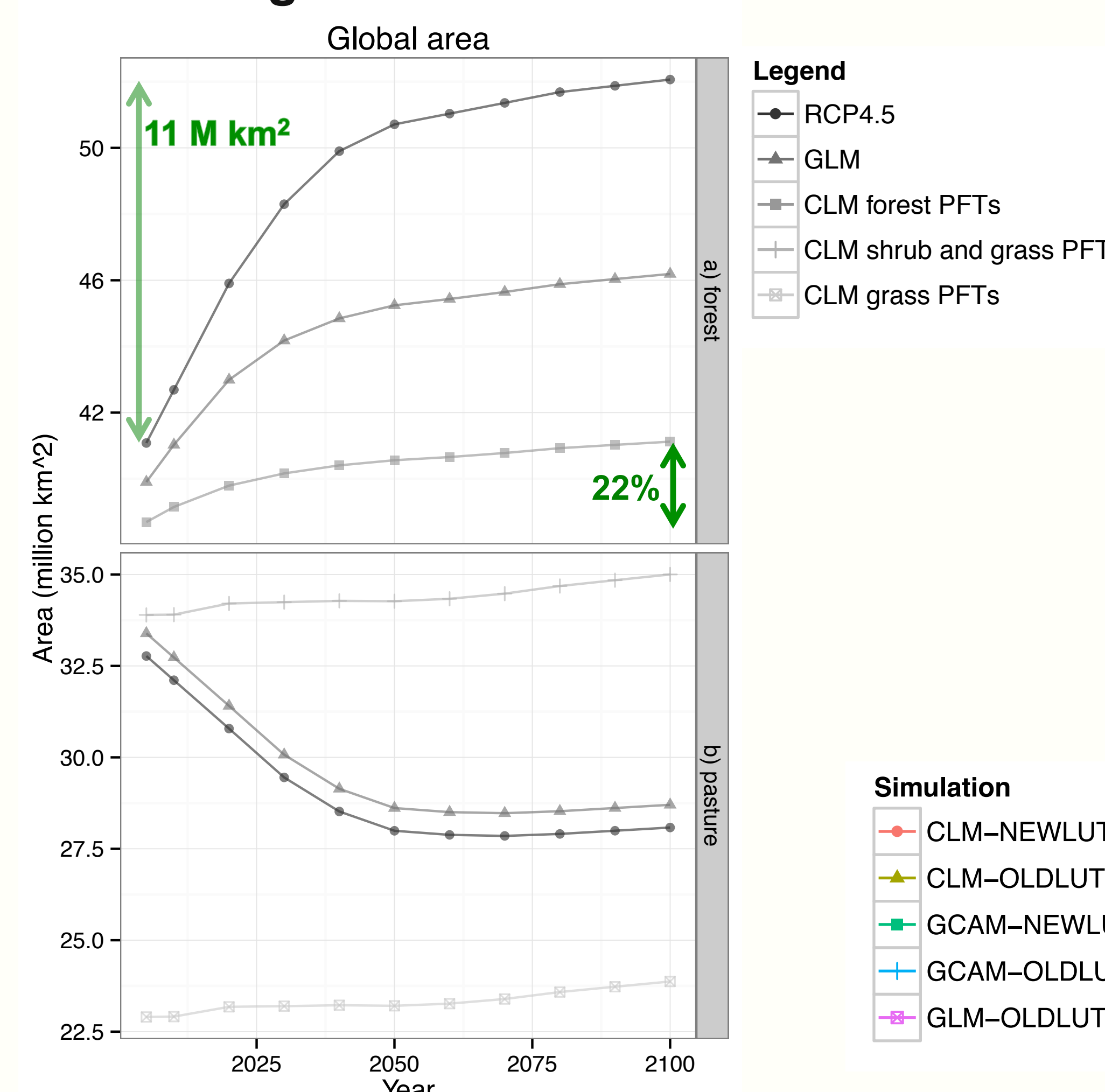


Figure 6. iESM

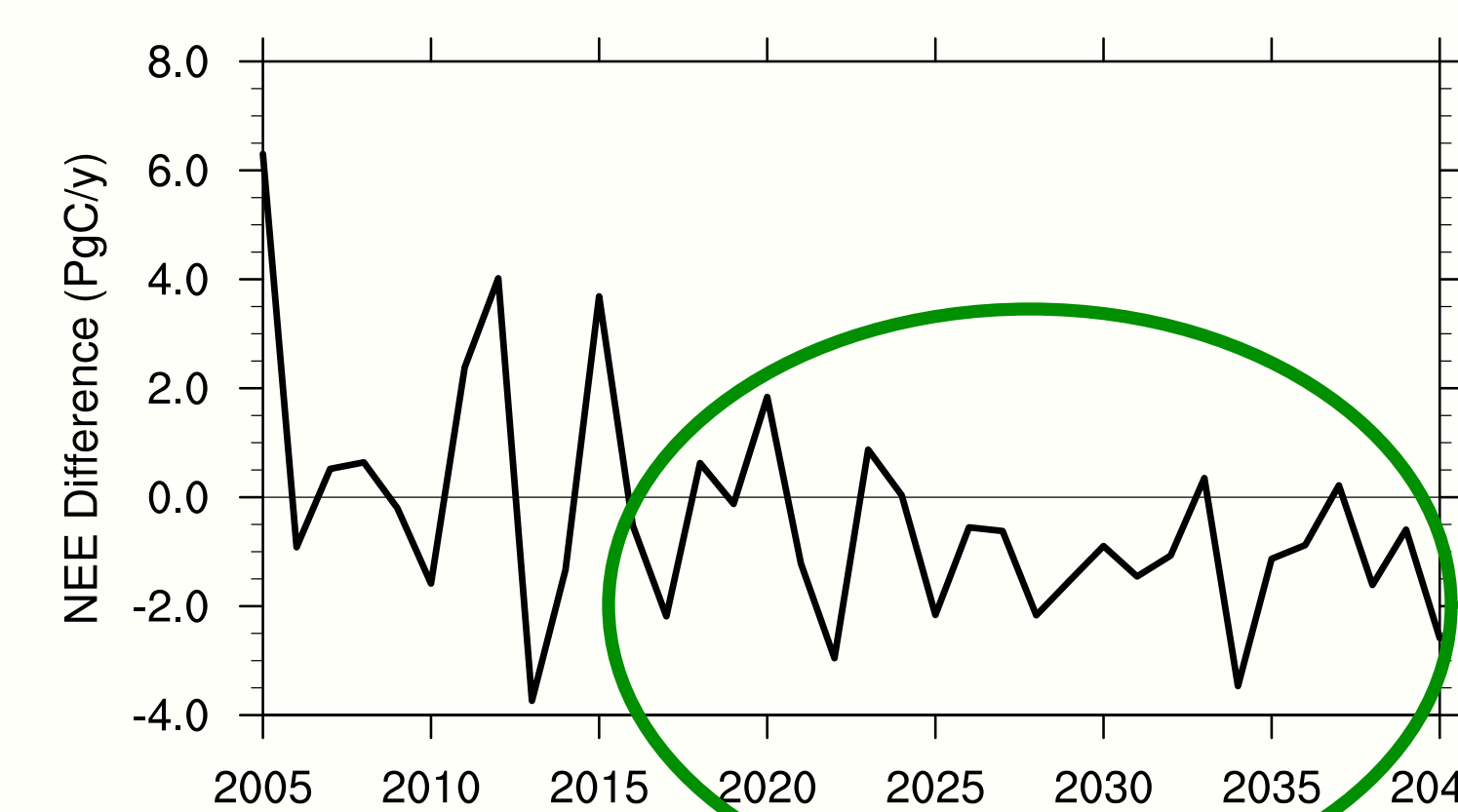
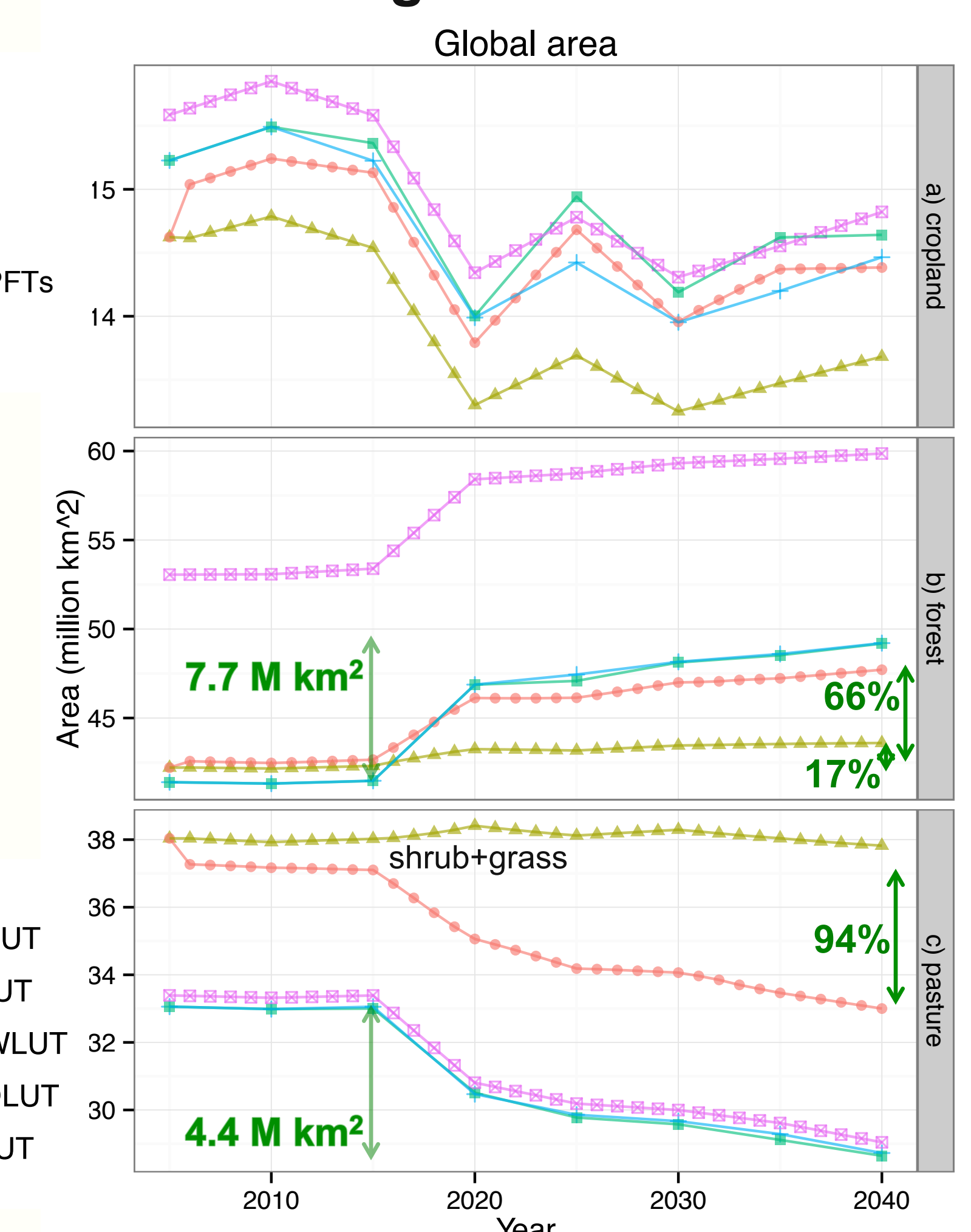


Figure 7. Difference in Net Ecosystem Exchange (NEE) (NEWLUT – OLDLUT)

Increased land carbon uptake due to additional afforestation

DISCUSSION

- Lack of consistency across models/components precludes robust ESM simulations of IAM generated scenarios
 - Afforestation is important for achieving the RCP4.5 climate stabilization target
 - Similar land cover inconsistencies exist in the CMIP5 archive
- Land cover mismatch significantly affects the global carbon cycle for RCP4.5
 - Linear extrapolation to include all prescribed afforestation by 2100 gives increases in vegetation carbon of 100 PgC and decreases in atmospheric CO₂ of 40 ppmv
- Land cover and land use need to be harmonized among ESMs and IAMs to provide robust comparisons and simulations of scenarios
 - IAM to ESM coupling is still incomplete, even after CMIP5 and iESM efforts to develop this coupling
 - ESM to IAM coupling is still limited by inconsistent carbon cycle representations (e.g. potential vs. actual carbon stock) and ESM land change artifacts