



Supplement of

The NASA-GISS ModelE2.1-CC2 ESM: development and evaluation

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Supplemental Material

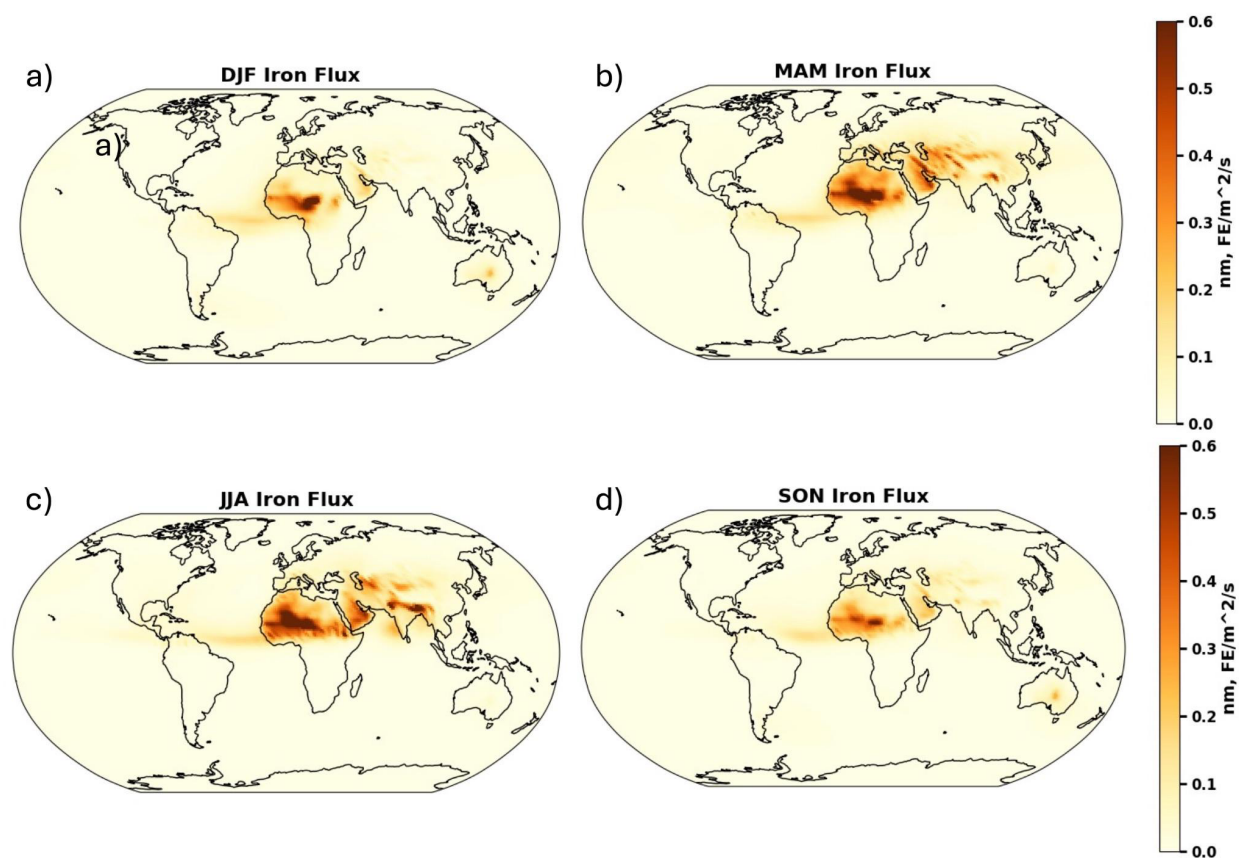


Figure S1. Seasonal averages of dust iron flux emitted over land regions and transported and deposited at the surface of the ocean ($\text{nm, Fe/m}^2/\text{s}$).

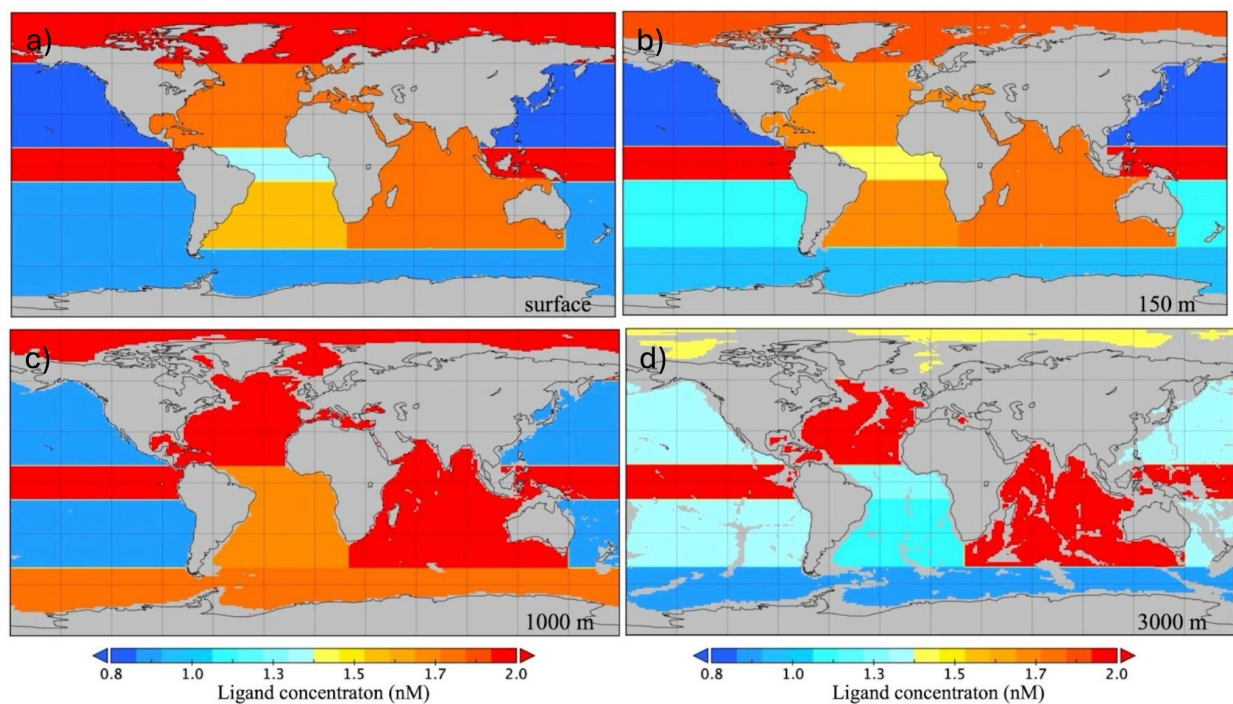


Figure S2. Spatial distribution of total ligand concentration (nM) used to compute iron speciation in the ocean carbon cycle model. Spatial distributions are shown in the ocean at the surface (upper left), 150 m (upper right), 1000 m (bottom left), and 3000 m (bottom right).

Table S1. Iron:Nitrate ratios used to estimate initial conditions for iron concentrations. Ratios taken from Fung et al, 2000.

Region	Antarctic	South Indian Ocean	South Pacific Ocean	South Atlant. Ocean	Equat. Indian Ocean	Equat. Pacific Ocean	Equat. Atlant. Ocean	North. Indian Ocean	North-Cent. Pacific Ocean	North-Centr. Atlant. Ocean	North. Pacific Ocean	North. Atlant. Ocean	Mediterranean Sea
Ratio ($\times 10^{-3}$)	3.5	20	4.5	20	22.5	4	20	25	6	20	6	10	20

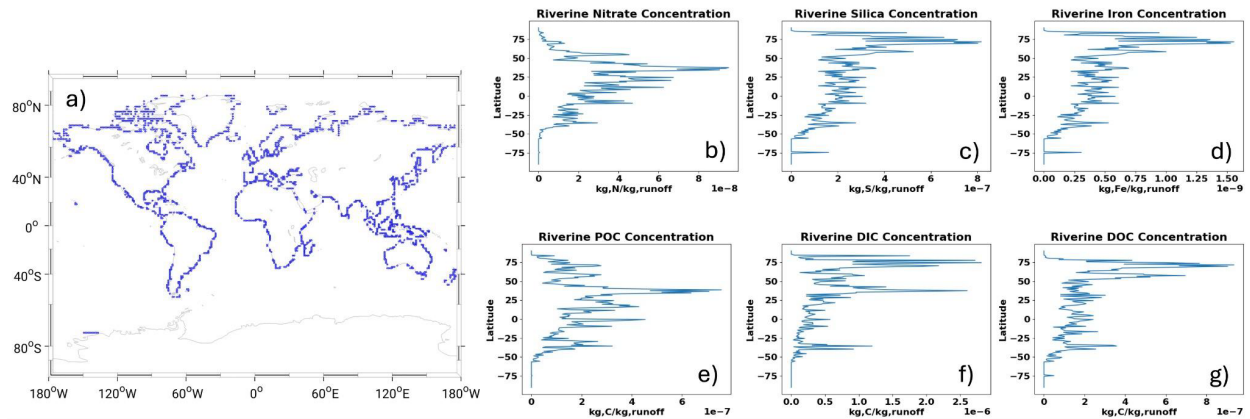


Figure S3. a) Sites of continental runoff release in ModelE. b) Zonally averaged concentrations of nitrate, silica, dissolved iron, POC, DIC and DOC.

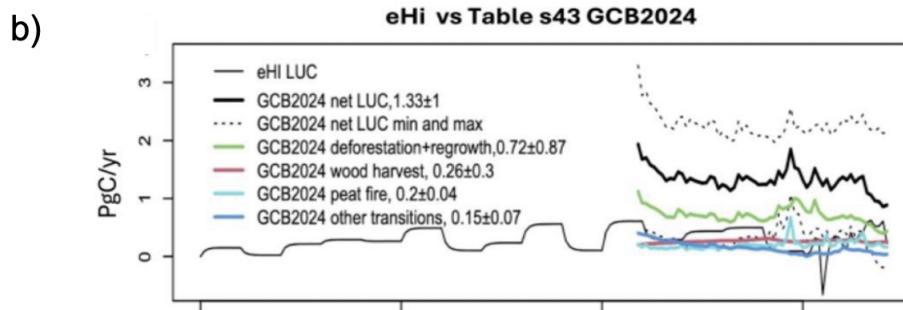
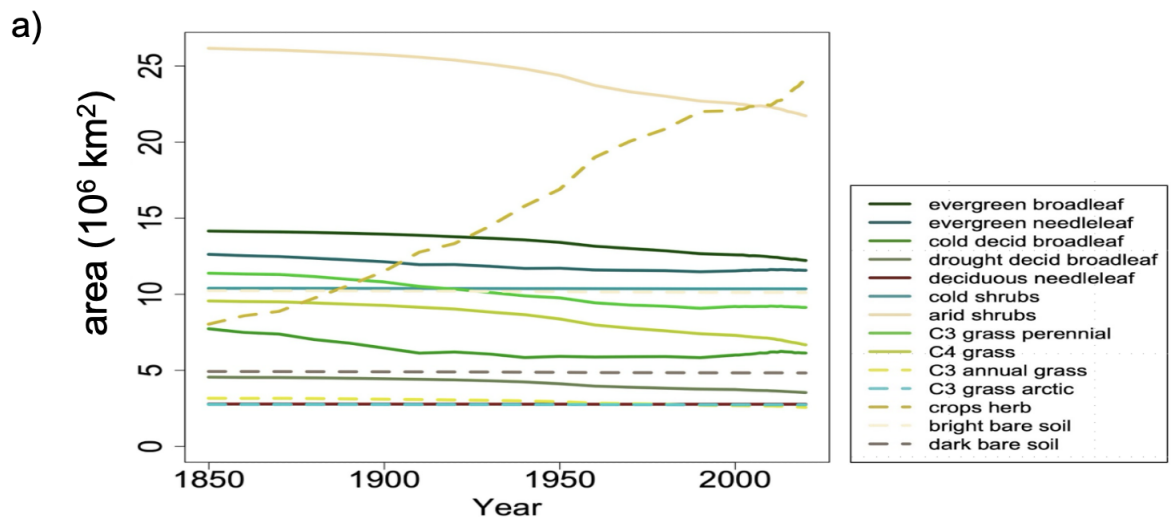


Figure S4. a) Historical global total natural vegetation and crop cover area 1850-2020 prescribed for the simulations in this paper. The natural vegetation cover is derived from MODIS for the year 2004, which is rescaled given historical crop cover. Crop cover is the sum of the LUH2 cropland and pasture cover to capture historical land cover changes. Rangeland in the LUH2 data set is treated as grassland. Individual simulations will vary in cover fractions due to dynamic lakes having complementary subgrid cover to bare soil and vegetation.

b) Components of land carbon fluxes to the atmosphere (positive is flux upward) due to land use change, comparing eHI net emissions to the mean estimates of the Global Carbon Budget 2024 (GCB2024, Friedlingstein et al. 2025). The legend tabulates the GCB2024 means and estimated minimum and maximum bounds around the mean over the period 1959-2021 where the eHI simulation and GCB2024 overlap in time.

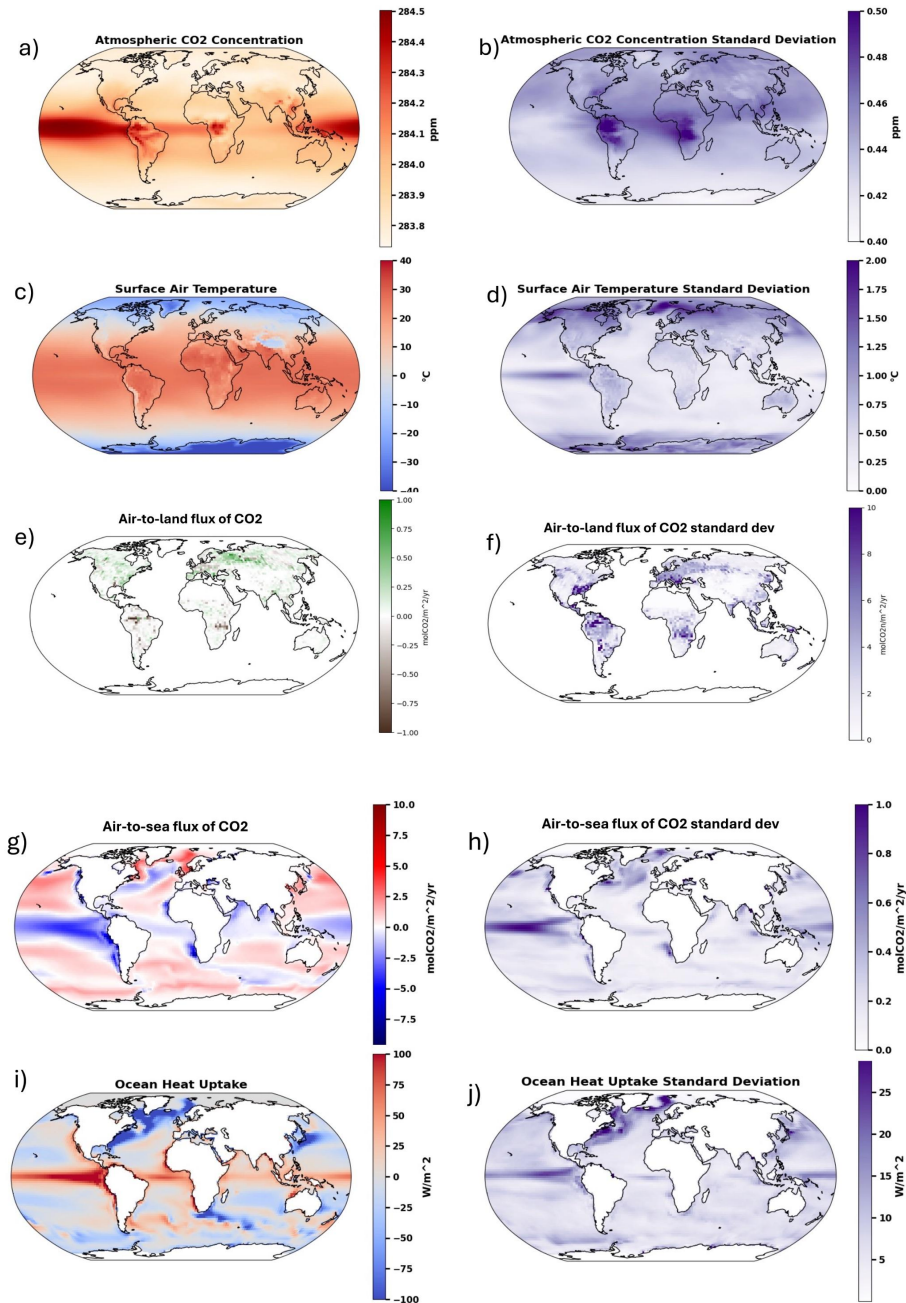


Figure S5. Distributions of time average fields and standard deviation. Averaging is over the last 100 years from the PI simulation. Maps of mean a) atmospheric CO₂ concentration, b) surface air temperature, c) air-land carbon flux, d) air-sea carbon flux, and e) ocean heat uptake.

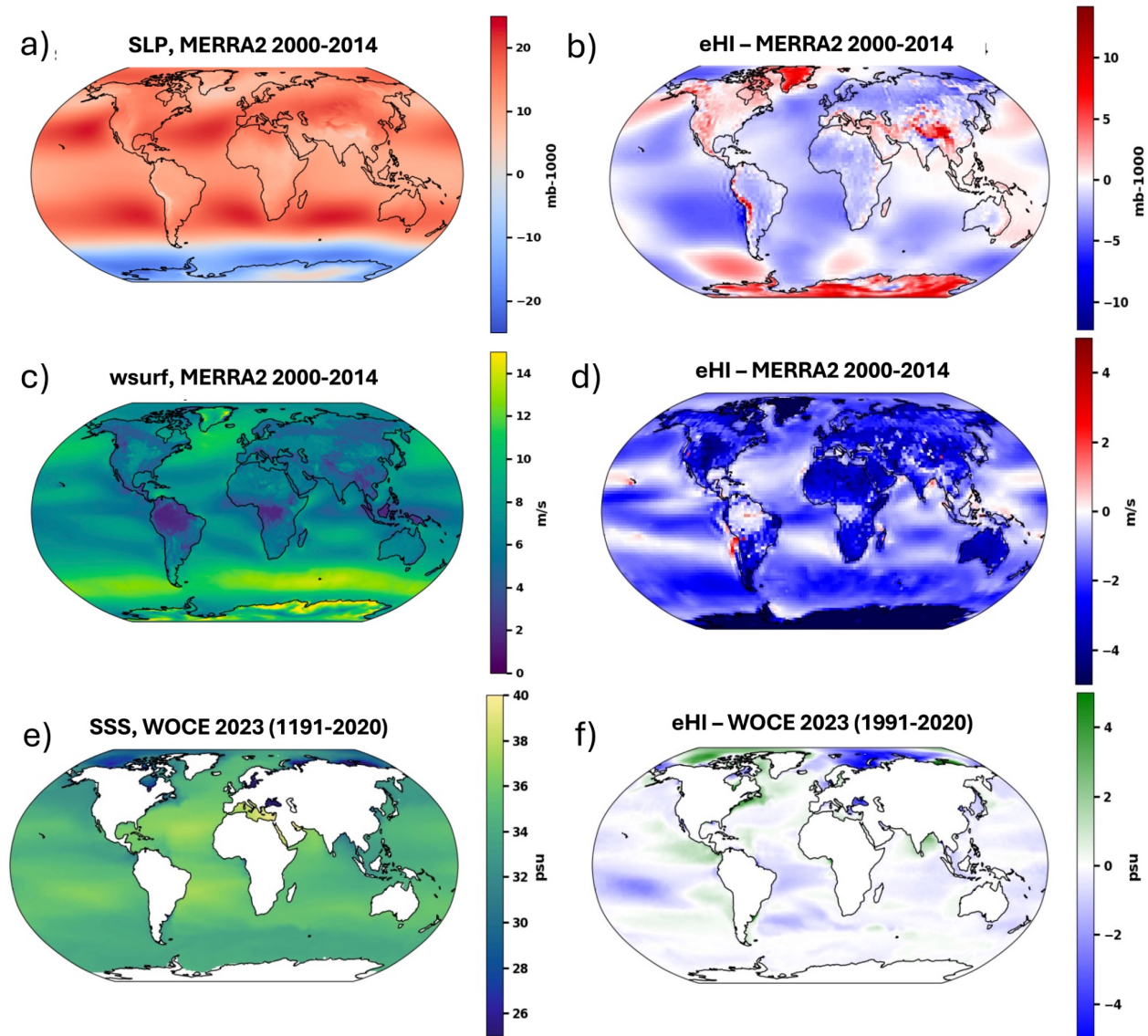


Figure S6: SLP, wsurf and SSS from eHI and observations

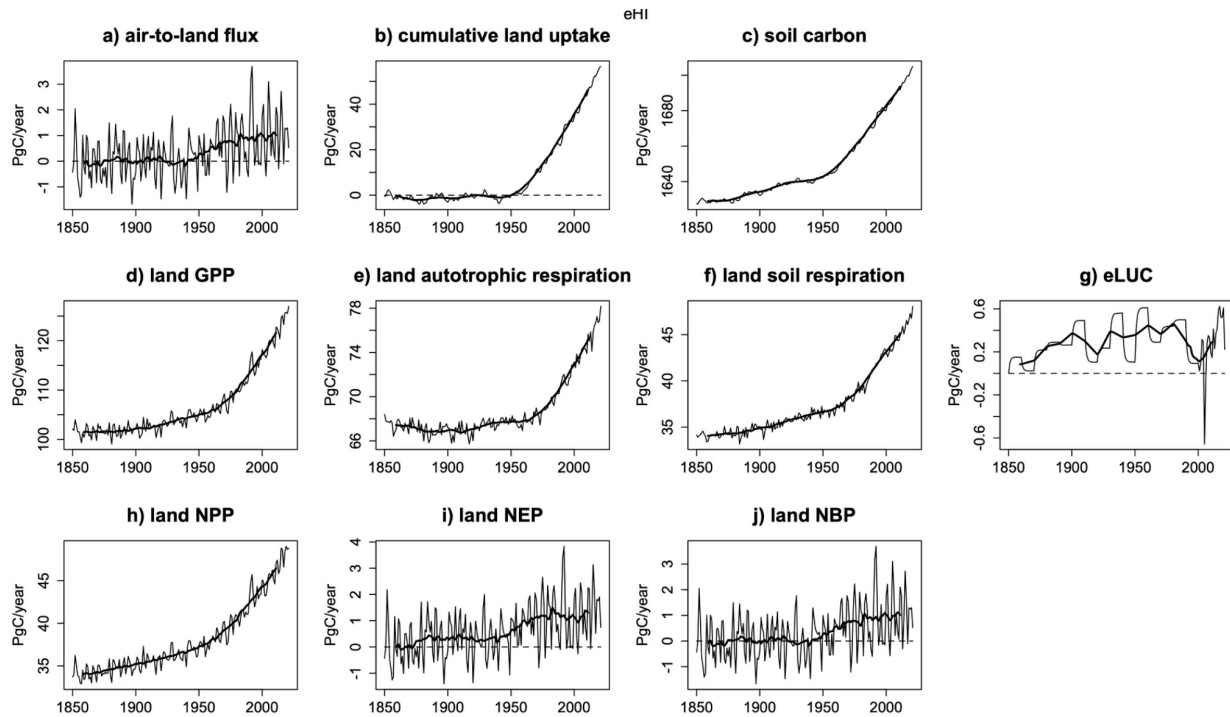


Figure S7: Land fluxes and soil carbon from eHI, with annual (thin line), 20-year moving average (thick line), and zero line (dashed line). a) air-to-land flux, b) cumulative land uptake since 1850, c) soil carbon stocks, d) land gross primary productivity (GPP), e) land autotrophic respiration, f) land soil respiration, g) emissions due to land use change (LUC), h) land net primary productivity (NPP), i) land net ecosystem productivity (NEP), and j) land net biome productivity (NBP).

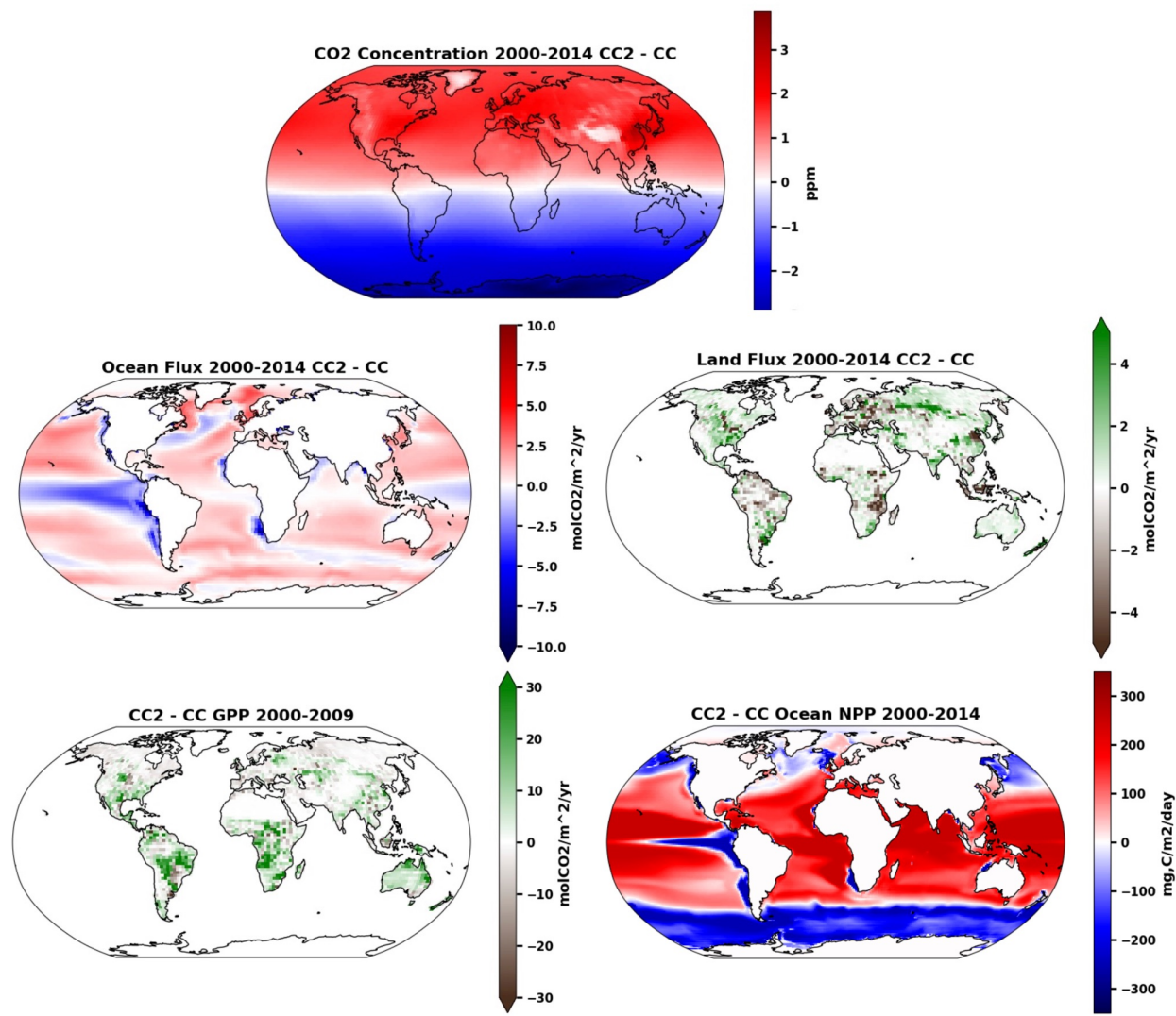


Figure S8: Change between CC (CMIP6) and CC2 (current) versions of the model. a) CO2 concentration; b) Land carbon flux, c) GPP, d) ocean carbon flux, d) ocean NPP. All field are averaged over the 2000-2014 period from the respective simulations CC and CC2.

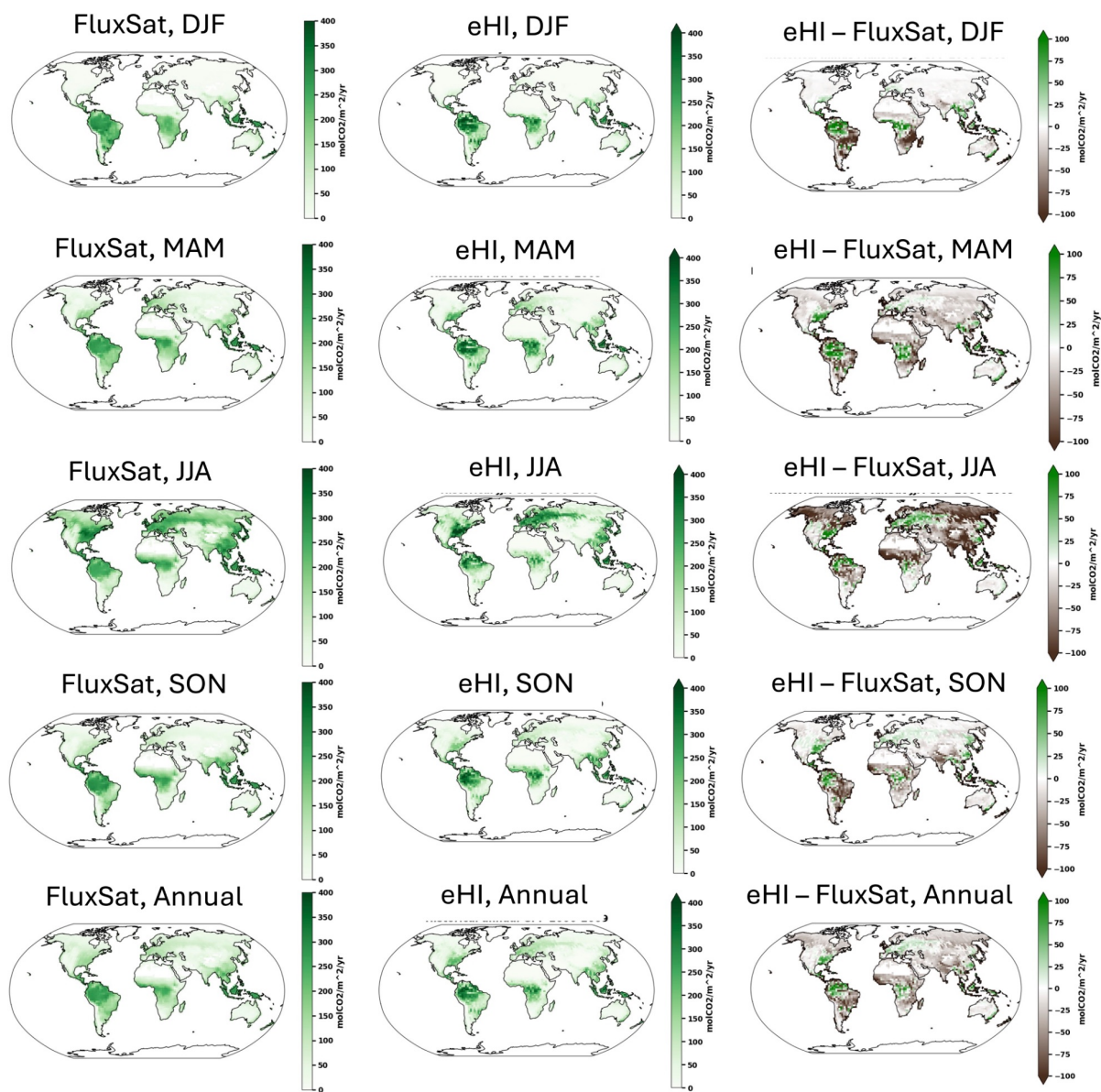


Figure S9: Land carbon seasonality from eHI and FluxSat.