

## Supplemental Material

Table S1: Modeling groups and their contributed models.

<b>Modeling center or group</b>	<b>Model name</b>
Beijing Climate Center, China Meteorological Administration	BCC-CSM1.1
Canadian Centre For Climate Modeling and Analysis	CanESM2
National Center for Atmospheric Research	CCSM4
NOAA Geophysical Fluid Dynamics Laboratory	GFDL-ESM2G
NASA Goddard Institute for Space Sciences	GISS-E2-H, GISS-E2-R
Met Office Hadley Centre	HadGEM2-CC, HadGEM2-ES
Institute for Numerical Mathematics	INM-CM4
Institut Pierre-Simon Laplace	IPSL-CM5A-LR, IPSL-CM5B-LR
Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Sciences	MIROC-ESM, MIROC-ESM-CHEM
Max Planck Institute for Meteorology	MPI-ESM-LR
Norwegian Climate Centre	NorESM1-M, NorESM1-ME

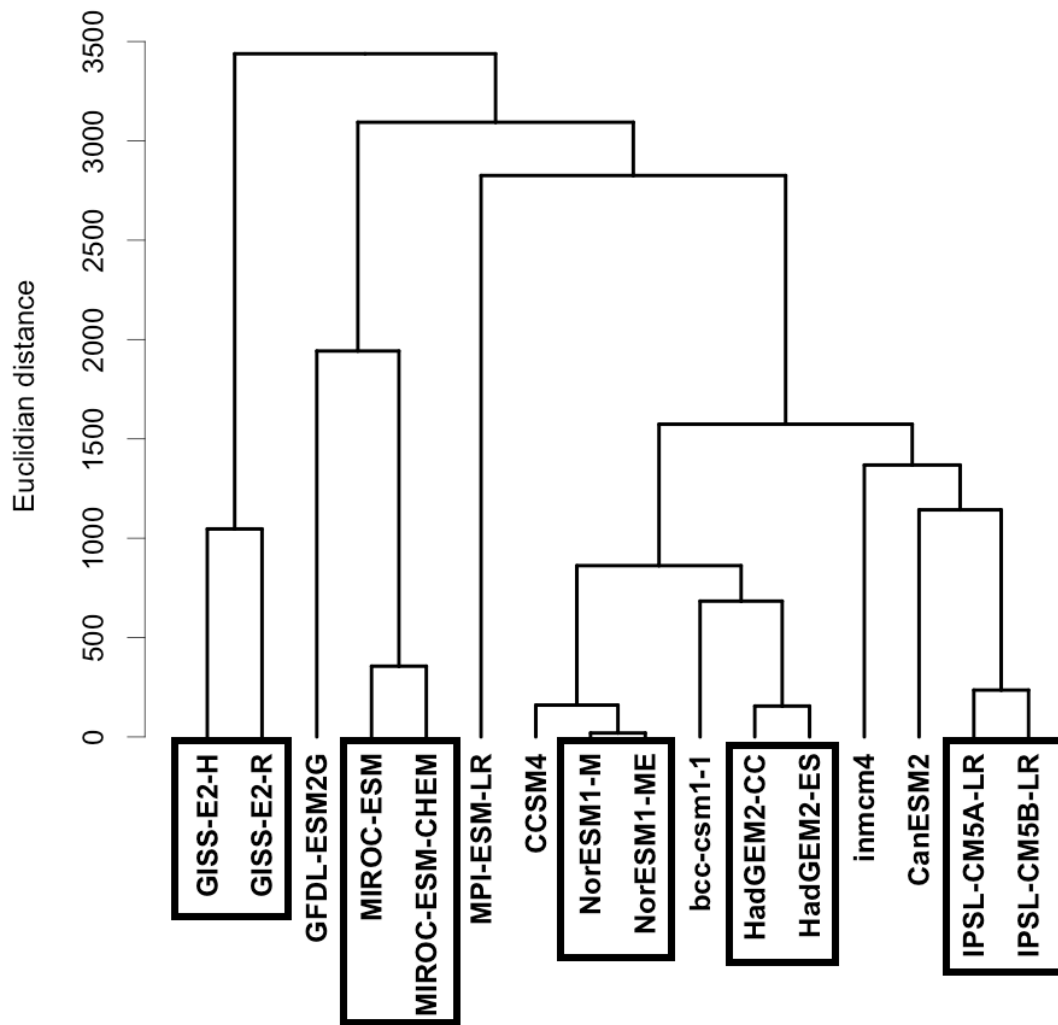


Figure S1: Hierarchical clustering of soil carbon densities (1995-2005 mean) by grid cell for Earth system models. Model outputs from the same climate center always showed >90% relative similarity and were therefore averaged together for analysis (boxes). Relative similarity is defined as  $1 - (\text{branch length in a cluster}) / (\text{total branch length in tree})$ .

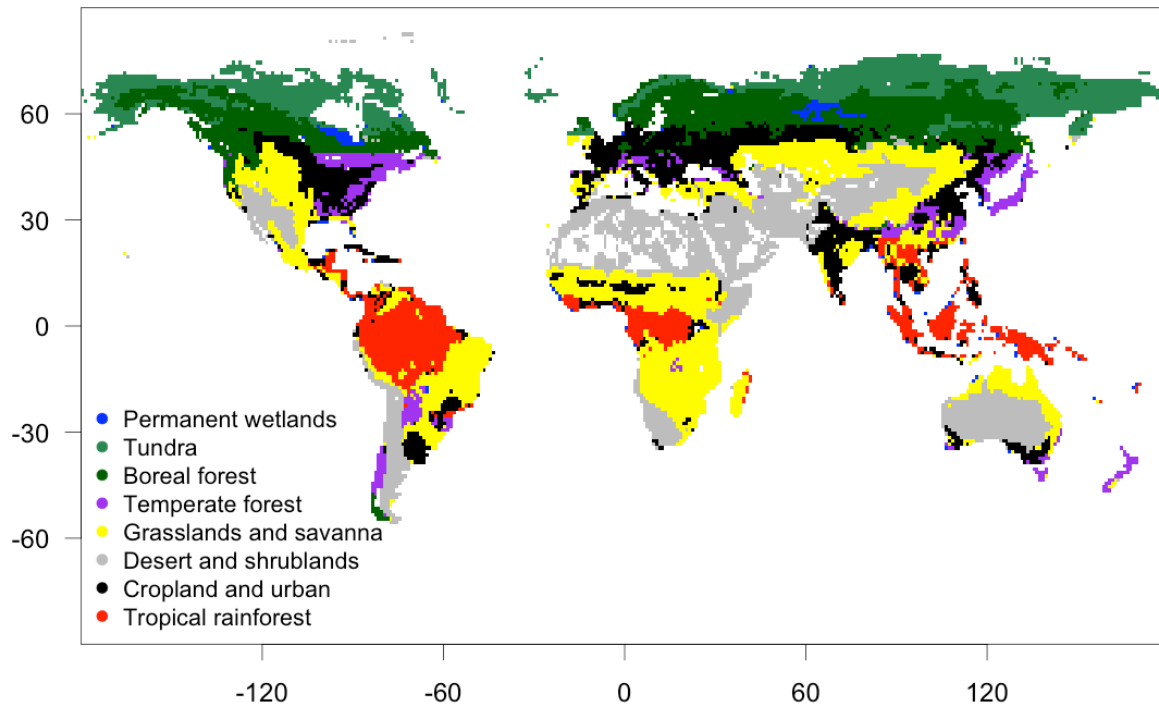


Figure S2: Biome maps constructed from the MODIS/TERRA-AQUA land cover product, where:

1. **Tundra** is a combination of grassland and open shrubland north of 55°N.
2. **Boreal forest** includes evergreen needleleaf forest, deciduous needleleaf forest, woody savanna north of 50°N, mixed forest north of 50°N, and closed shrublands north of 50°N.
3. **Tropical rainforest** includes evergreen broadleaf forest between 25°N and 25°S.
4. **Temperate forest** includes deciduous broadleaf, evergreen broadleaf outside of 25°N-25°S, and mixed forest south of 50°N.
5. **Desert and shrubland** includes barren or sparsely vegetated, open shrubland south of 55°N, and closed shrubland south of 50°N.
6. **Grassland and savanna** includes woody savanna south of 50°N, savanna, and grasslands south of 55°N.
7. **Cropland and urban** includes cropland, urban, and mosaic land cover.
- 8-9. **Permanent wetlands** and **snow and ice** are both preserved unmodified.

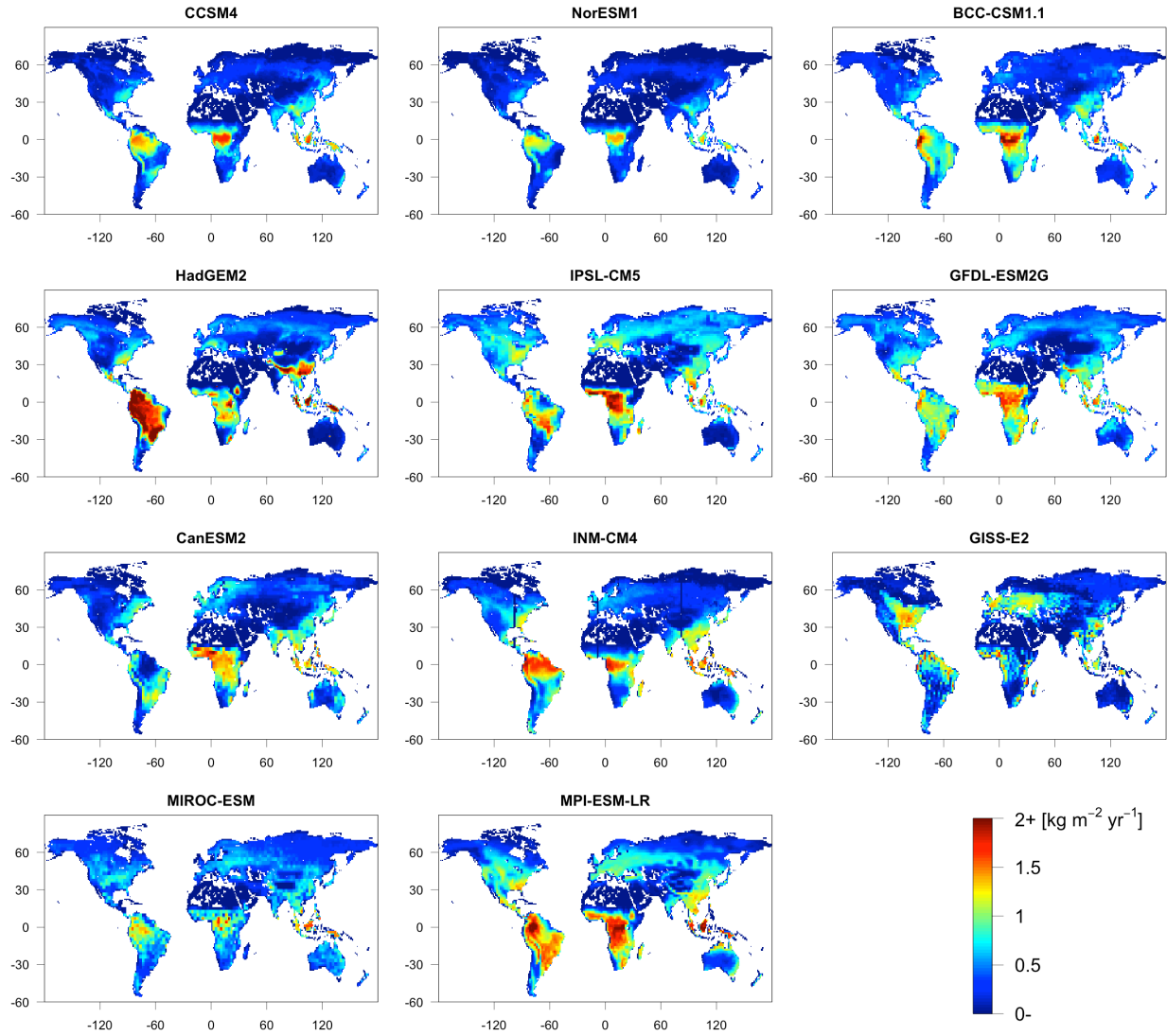


Figure S3: Net primary production map projected onto a  $1^\circ \times 1^\circ$  grid for each Earth system model (1995-2005 mean).

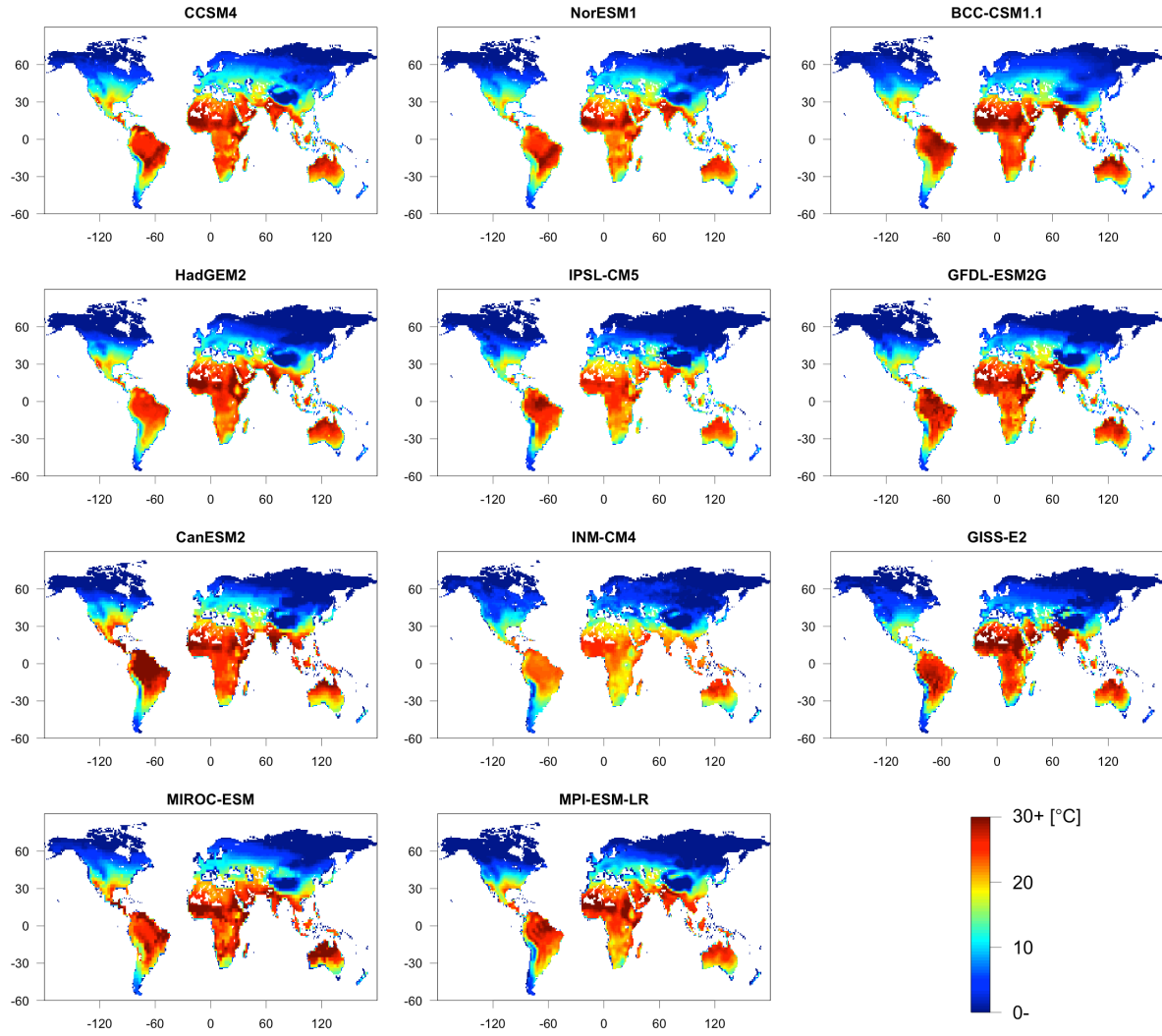


Figure S4: Mean annual soil temperature projected onto a 1° x 1° grid for each Earth system model (top 10 cm mean during 1995-2005).

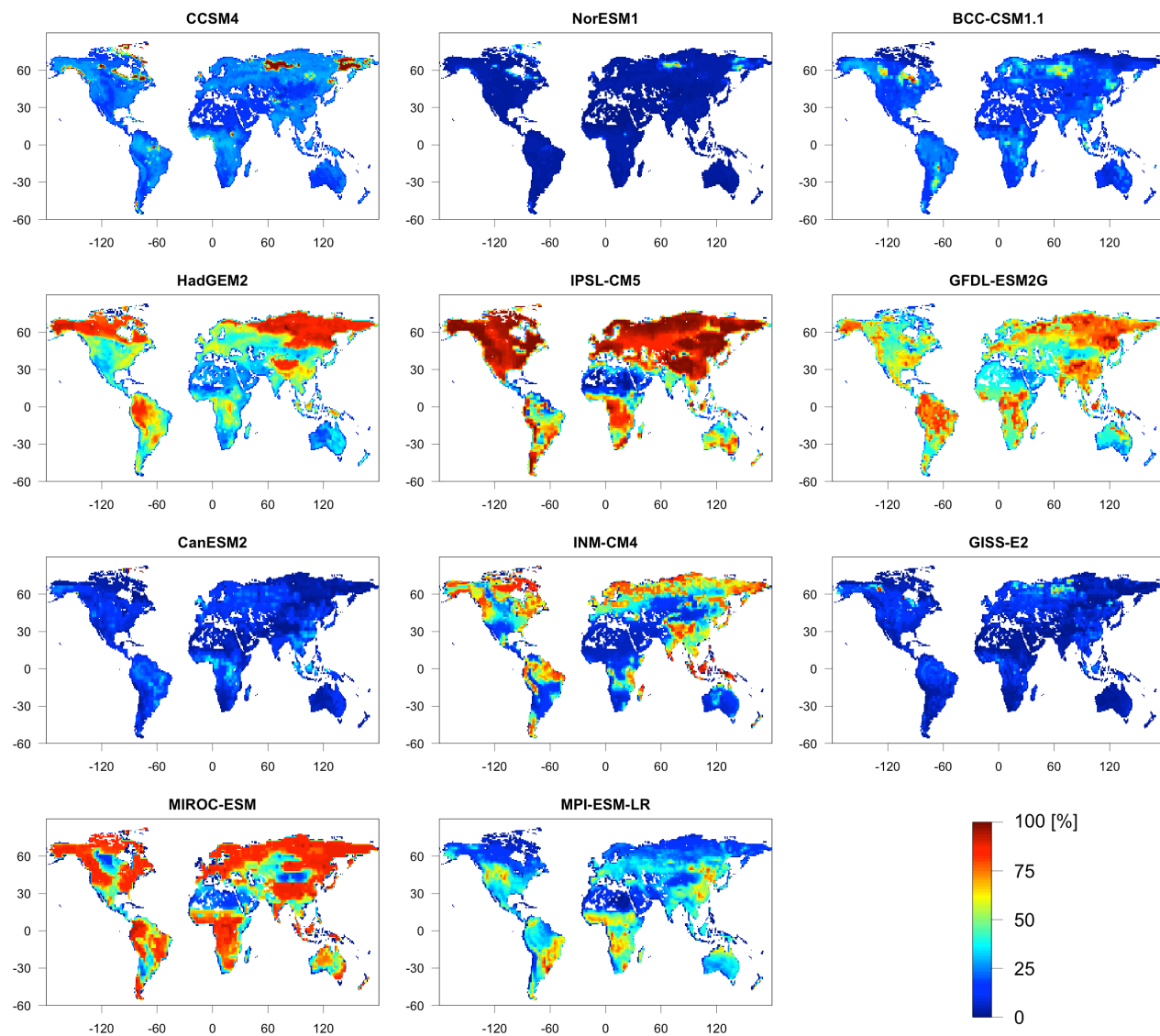


Figure S5: Percent of grid maximal soil water content projected onto a  $1^\circ \times 1^\circ$  grid for each Earth system model (1995-2005 mean). The percentage is calculated from the total soil water content for each grid cell divided by the maximum grid soil water content for each model.

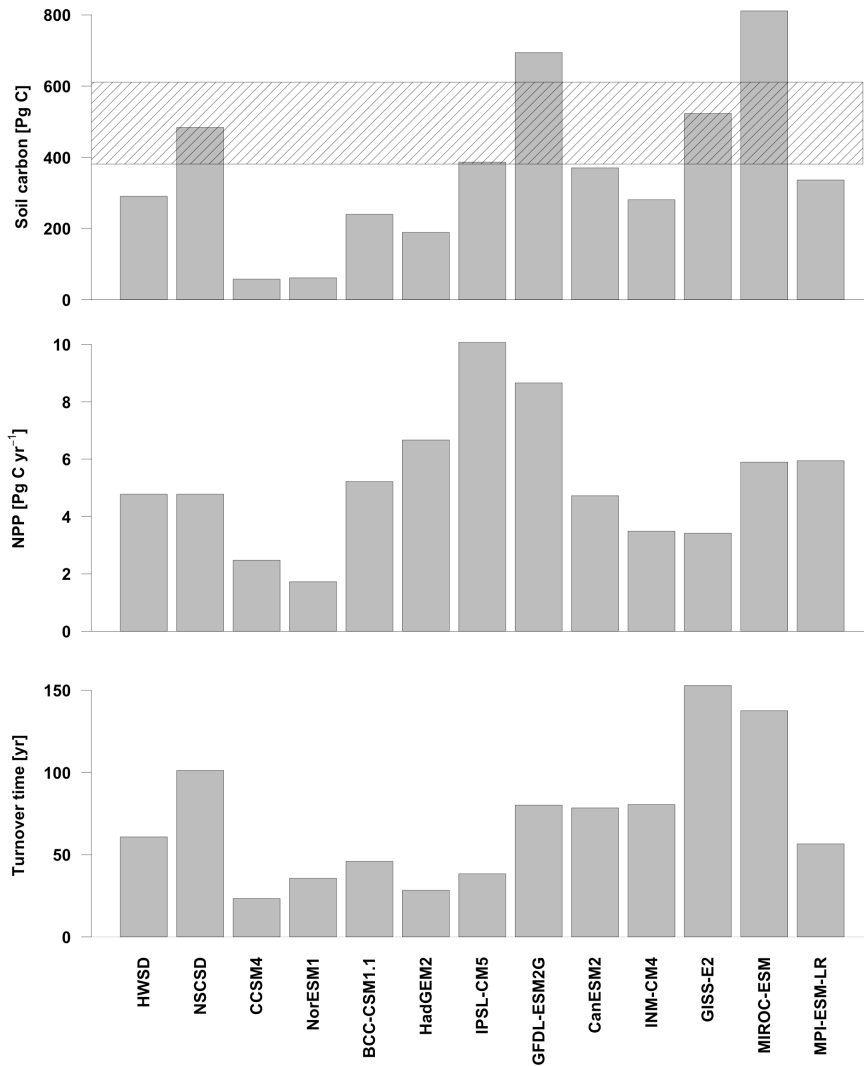


Figure S6: Total soil carbon (top), net primary production (NPP, middle), and turnover times (bottom) for the Harmonized World Soil Database (HWSD), the Northern Circumpolar Soil Carbon Database (NCSCD), and each Earth system model (1995-2005 mean) for grid cells covered by the NCSCD. Turnover times were calculated as total soil carbon divided by MODIS NPP for the HWSD and the NCSCD, and simulated total soil carbon divided by simulated total NPP for Earth system models. The 95% confidence interval for soil carbon indicated by the hashed area is a preliminary estimate based on qualitative uncertainty analysis (see text).

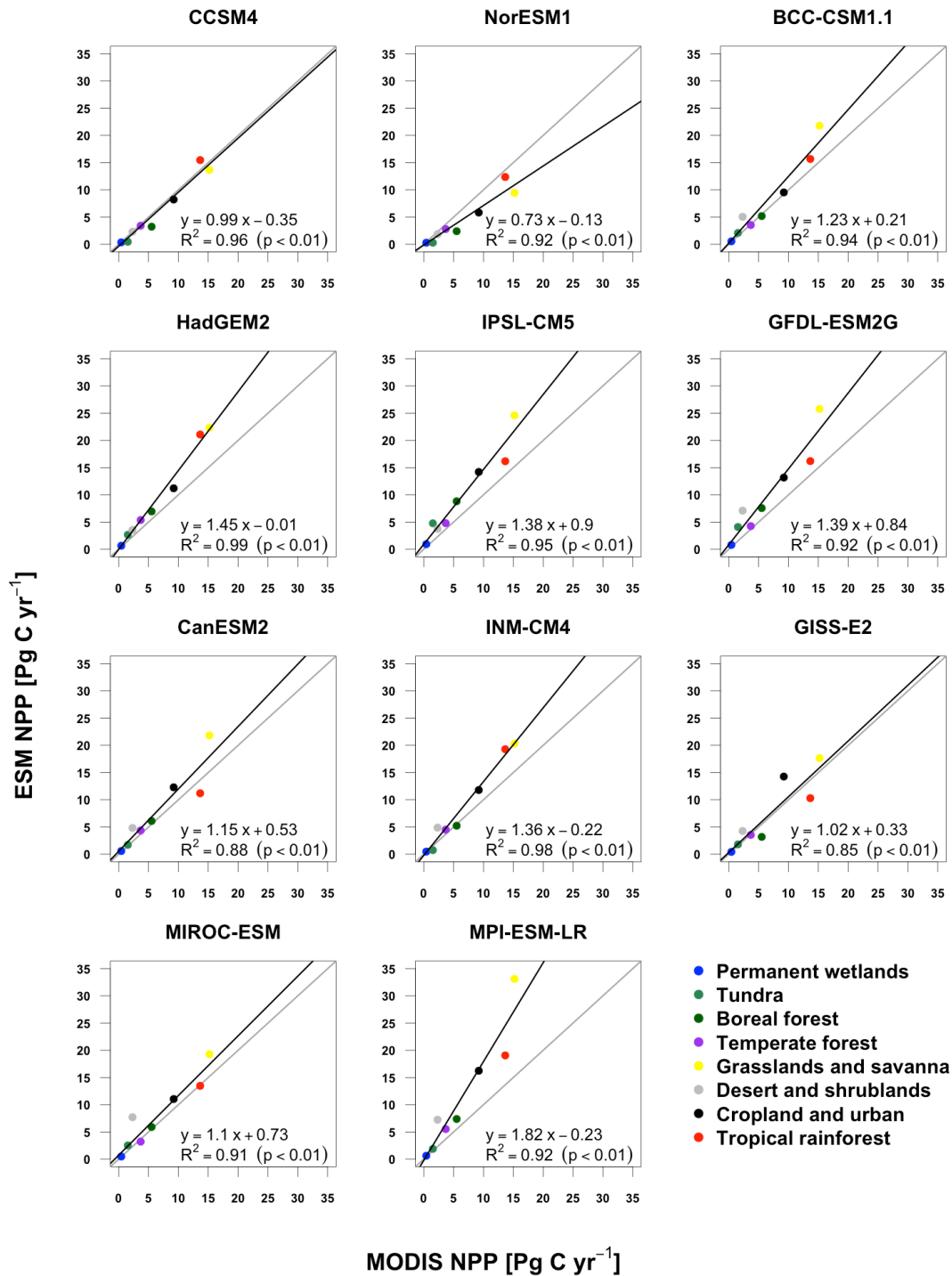


Figure S7: Biome comparison between Earth system model (ESM) net primary productivity (NPP) and MODIS NPP. The grey line indicates a 1:1 relationship and the black line is the linear regression.



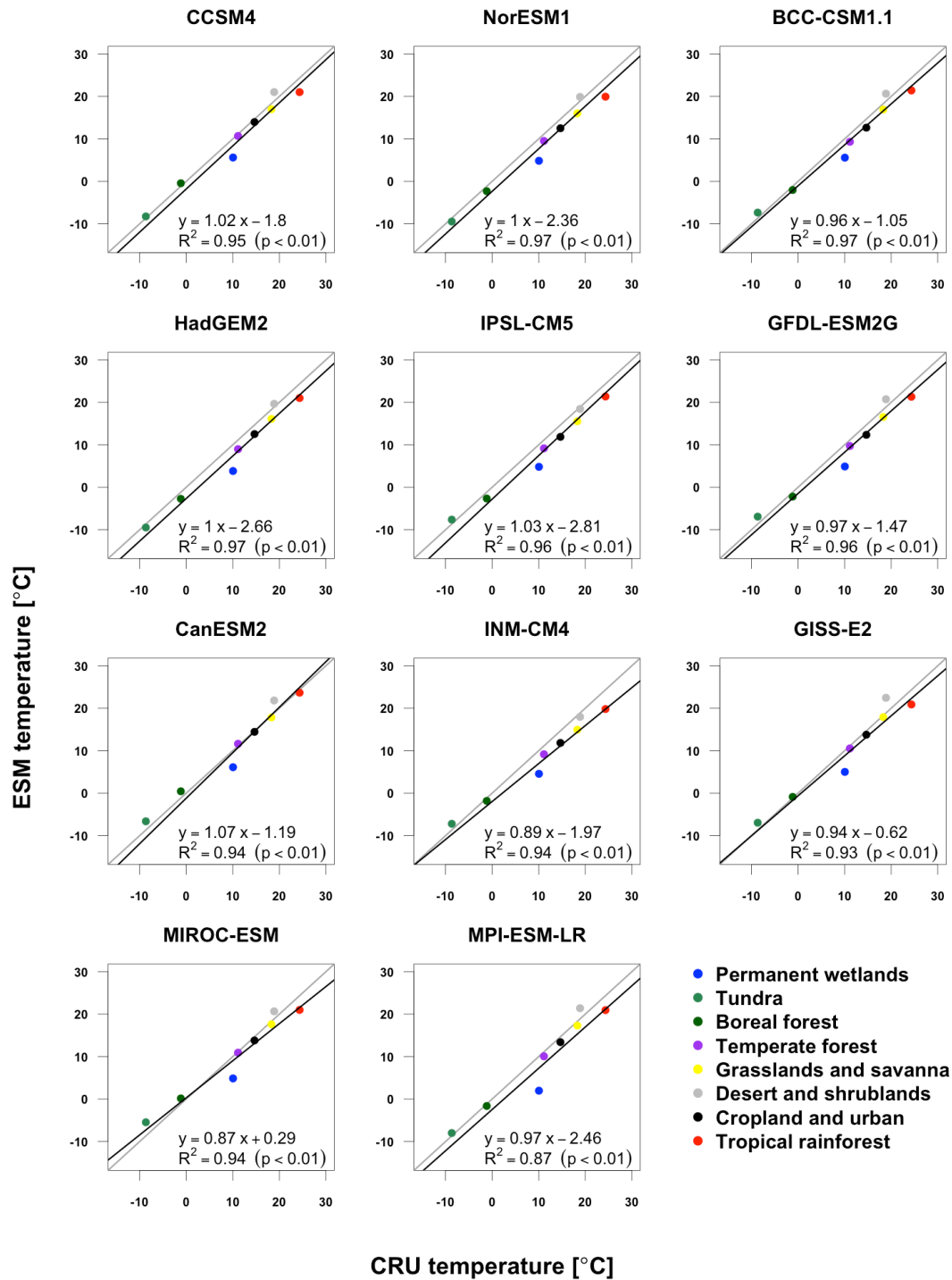


Figure S8: Mean surface air temperature (2 m, 1995-2005 mean), versus mean Climate Research Unit (CRU) temperature (2 m, observed 1995-2005) by biome for each Earth system model (ESM). The grey line indicates a 1:1 relationship and the black line is the linear regression.

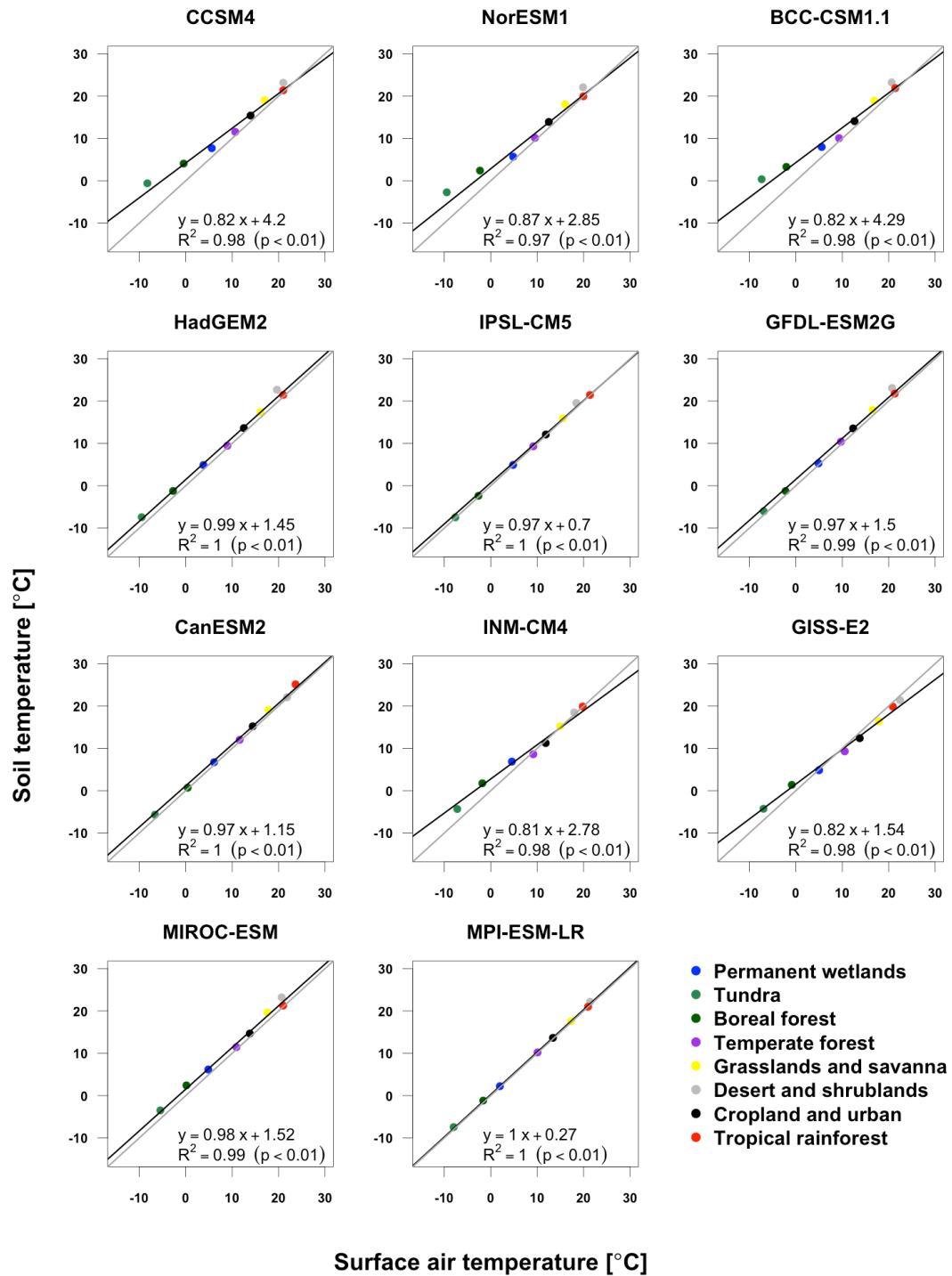


Figure S9: Mean soil temperature (top 10 cm) versus mean surface air temperature (1995-2005 mean) by biome for each Earth system model (ESM). The grey line indicates a 1:1 relationship and the black line is the linear regression.