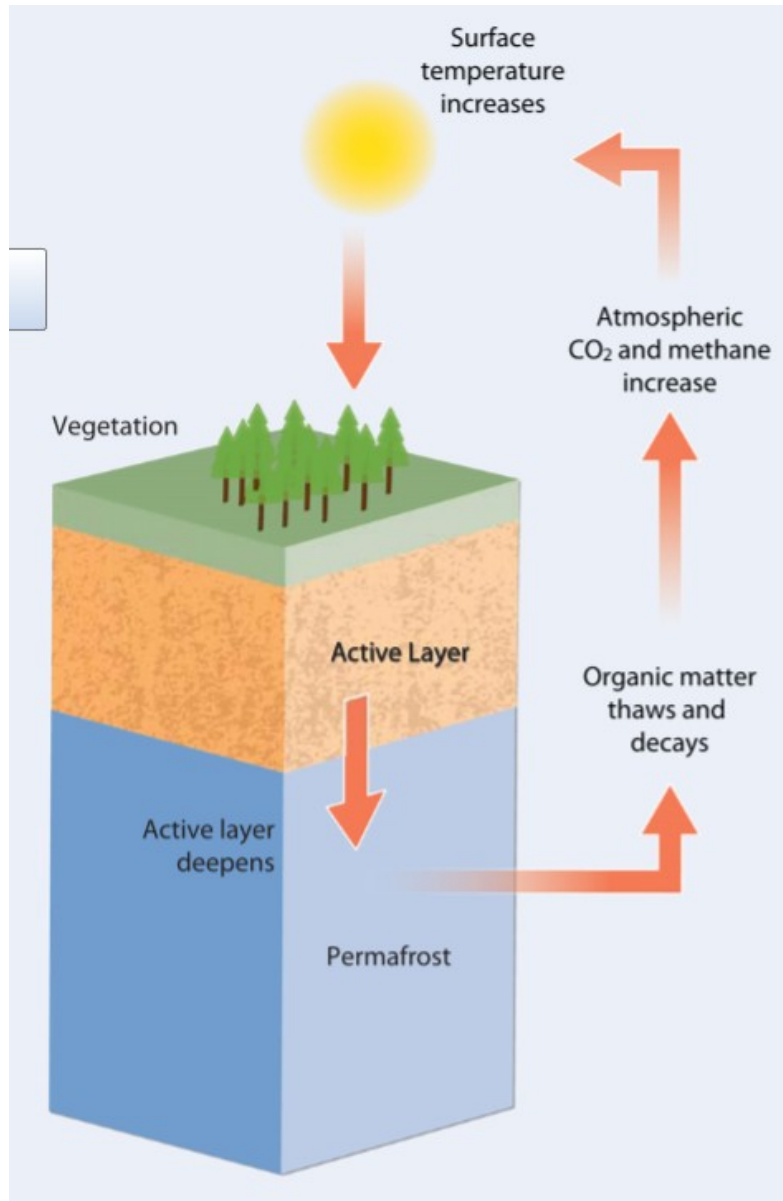


Permafrost climate feedback –
an application of vertically
discretised soil carbon
PRELIMINARY RESULTS

Altug Ekici, Eleanor Burke, Sarah
Chadburn, Chris Huntingford, Pierre
Friedlingstein, Przemyslaw
Zelazowski

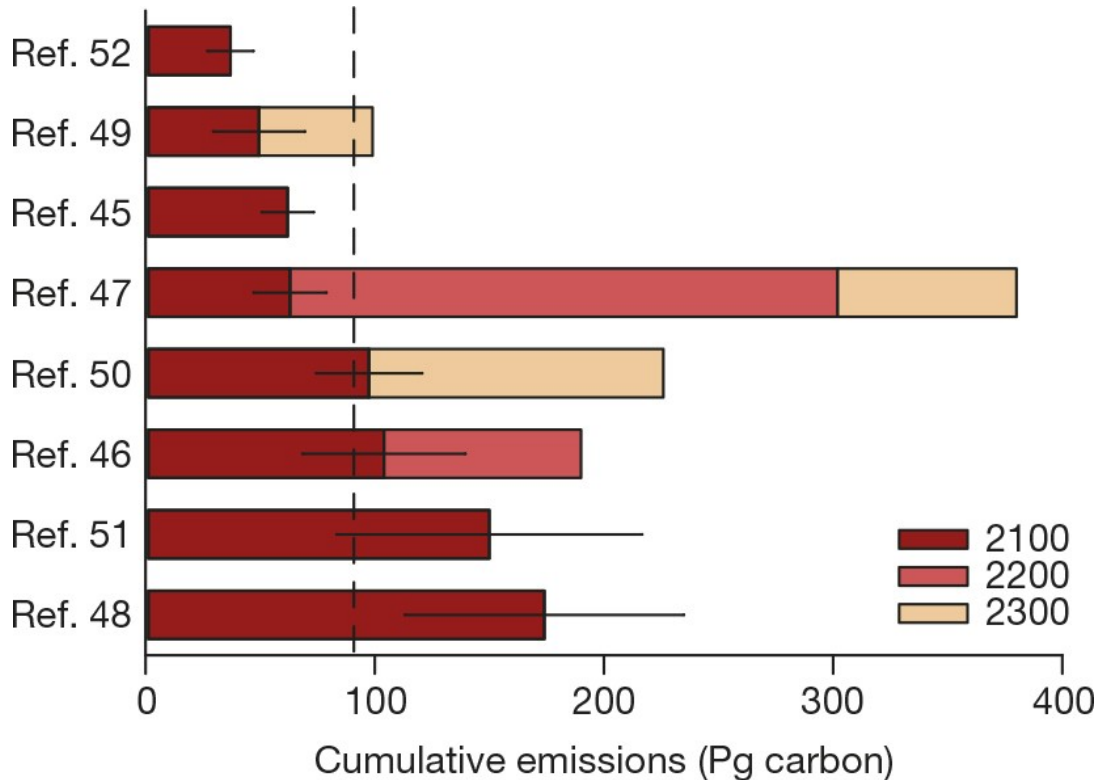
Permafrost climate feedback



Schaefer, Kevin, et al. "The impact of the permafrost carbon feedback on global climate." *Environmental Research Letters*, 9.8 (2014): 085003.

This process is usually not included within Earth System Models

Model estimates of potential cumulative carbon release from thawing permafrost by 2100, 2200, and 2300.



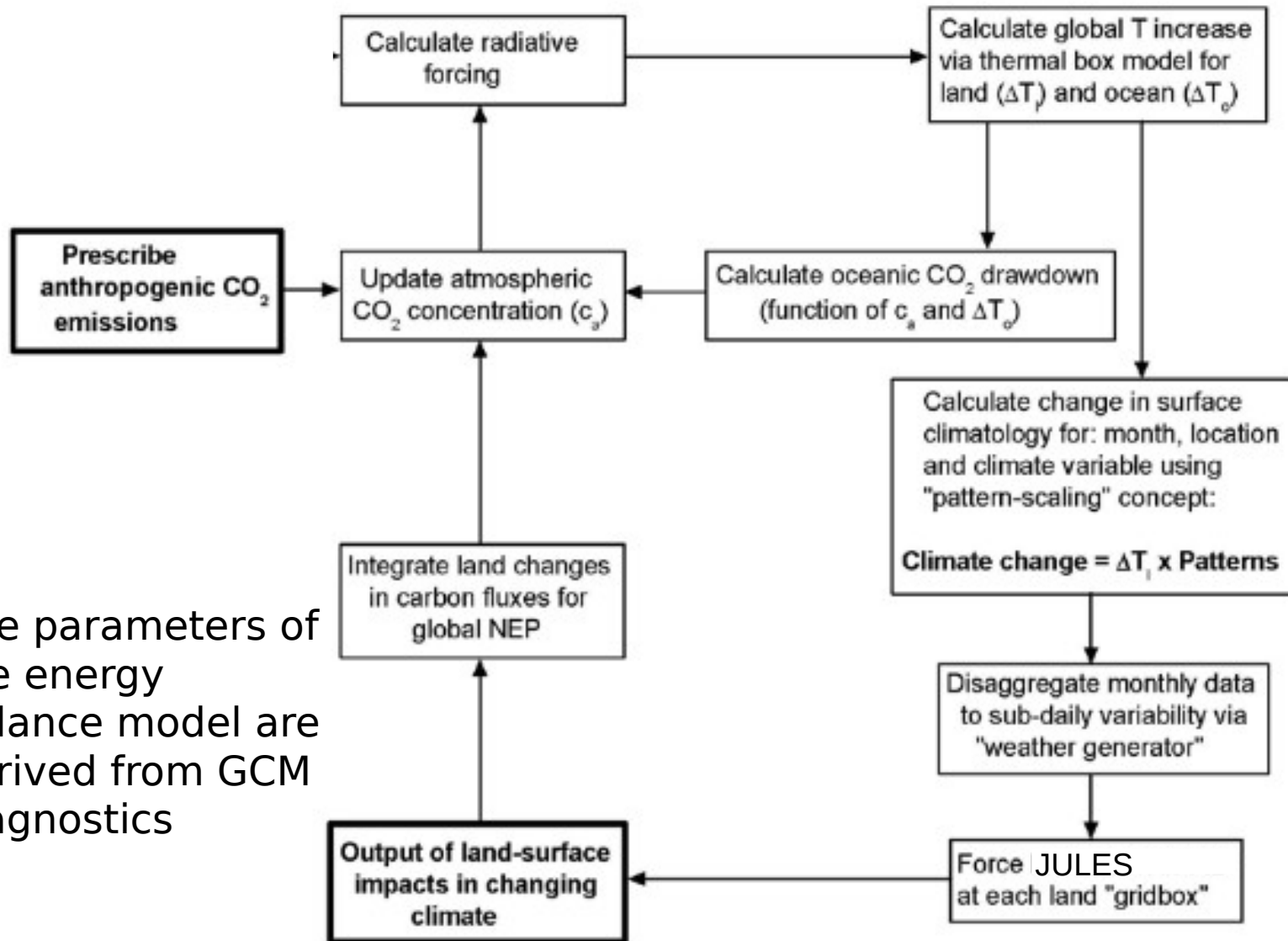
Only Ref. 48 closes the permafrost carbon feedback loop

EAG Schuur et al. Nature 520, 1-9(2015)
doi:10.1038/nature14338

IMOGEN

- An intermediate complexity climate model to evaluate terrestrial impacts of a changing climate
- Used to explore how the inclusion of new terrestrial processes influence projections of climate change
- Computationally efficient so can readily included uncertainties in the processes

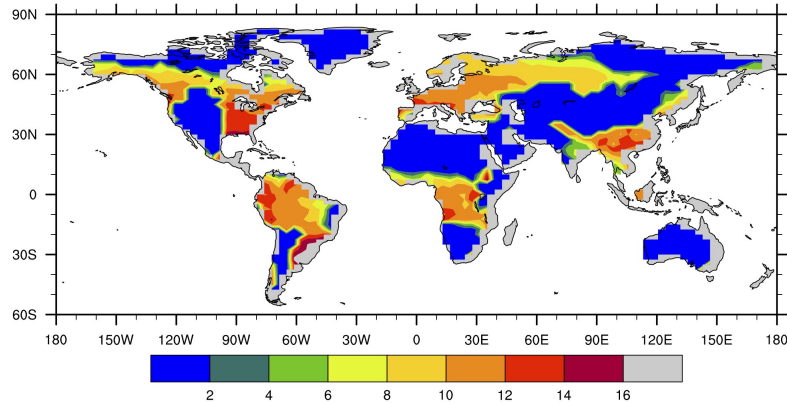
IMOGEN coupled with JULES



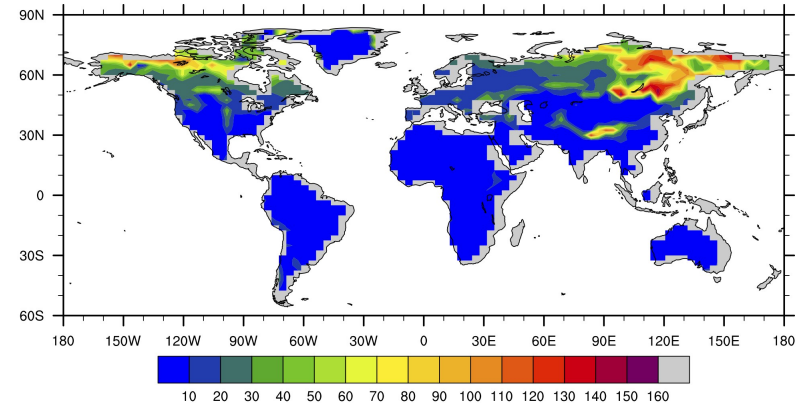
The parameters of the energy balance model are derived from GCM diagnostics

IMOGEN spinup

Vegetation carbon at 1860 [kg/m²]



Soil carbon at 1860 [kg/m²]

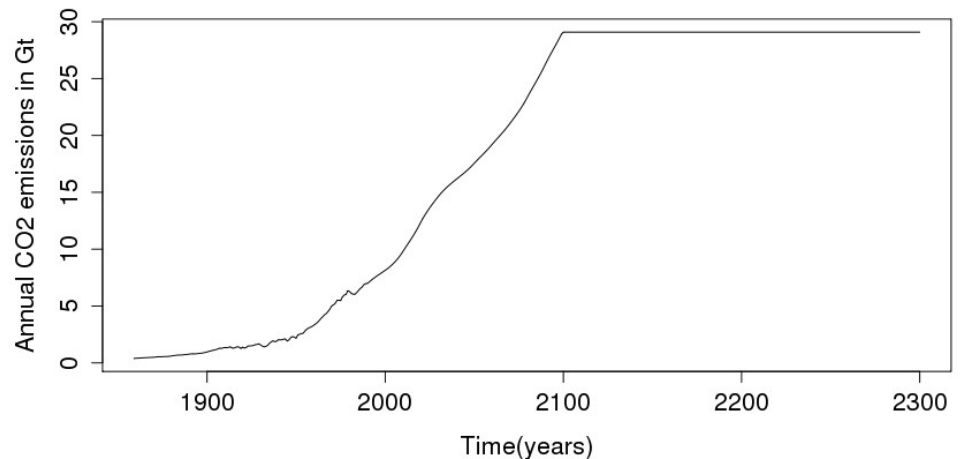


Soil carbon was initialized using the soil carbon equilibrium code

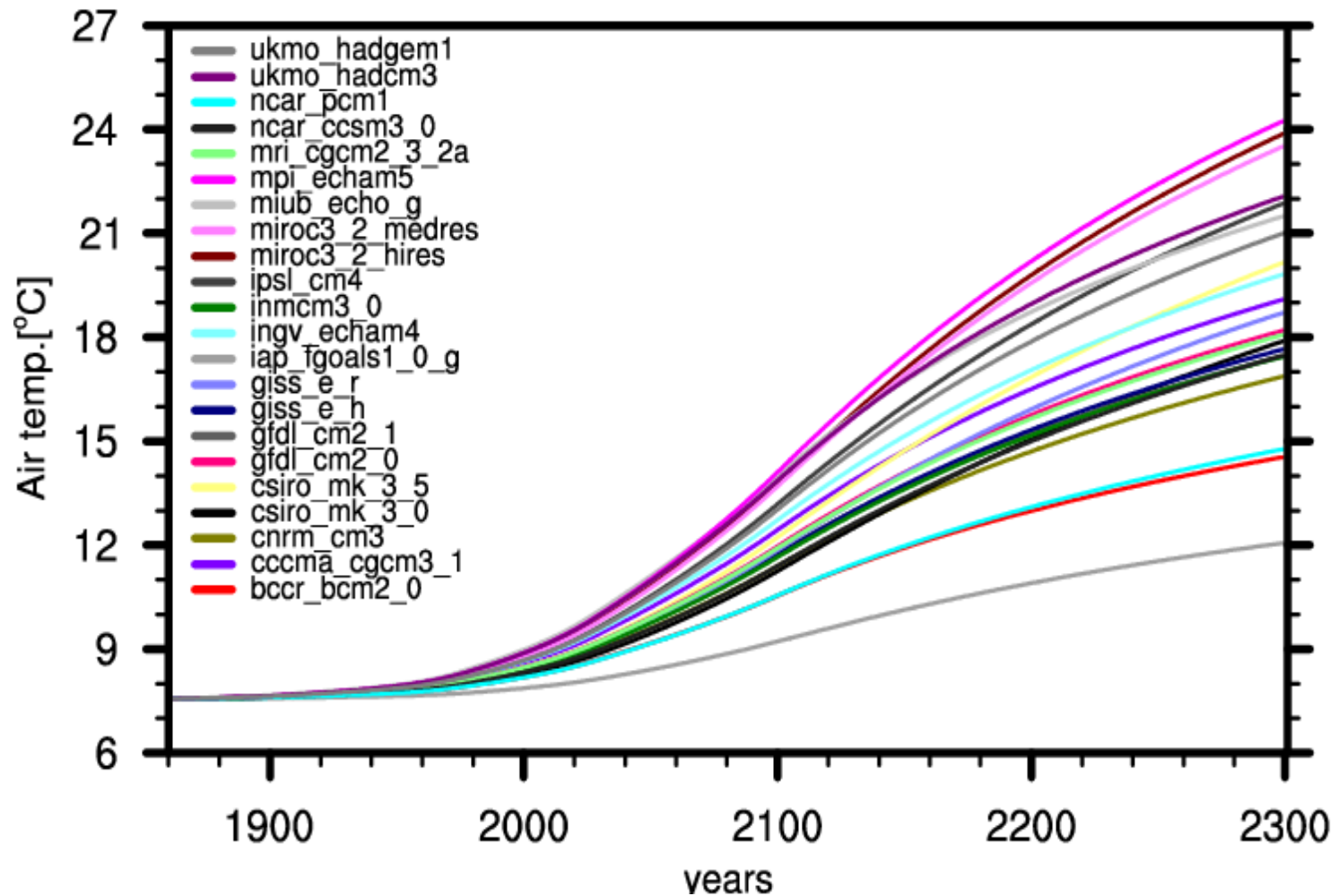
Spin up with the 1961-1990 monthly climate data derived from the WATCH forcing data and the 1860 atmospheric CO₂ concentration.

IMOGEN transient runs

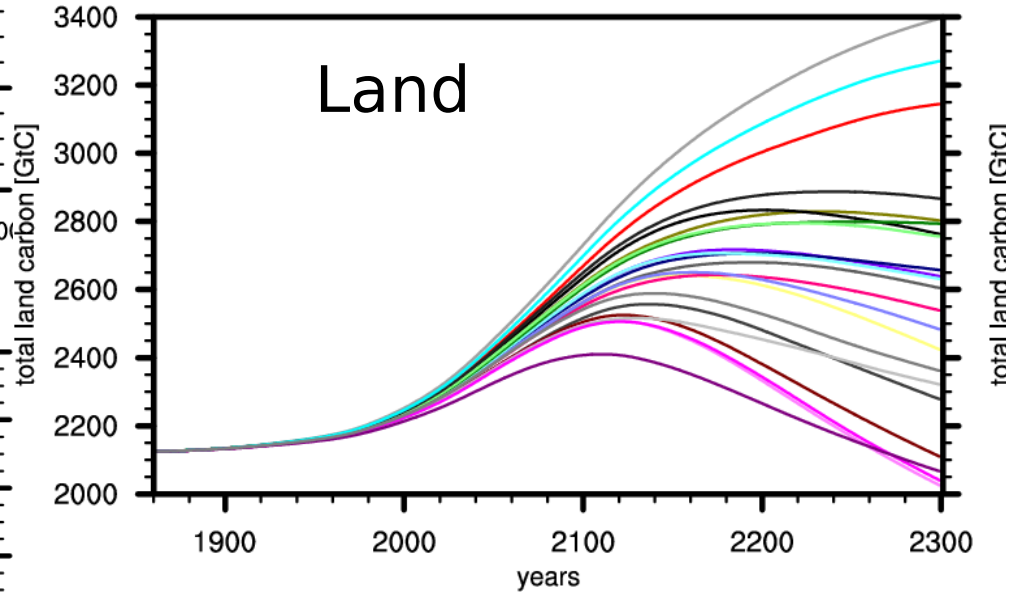
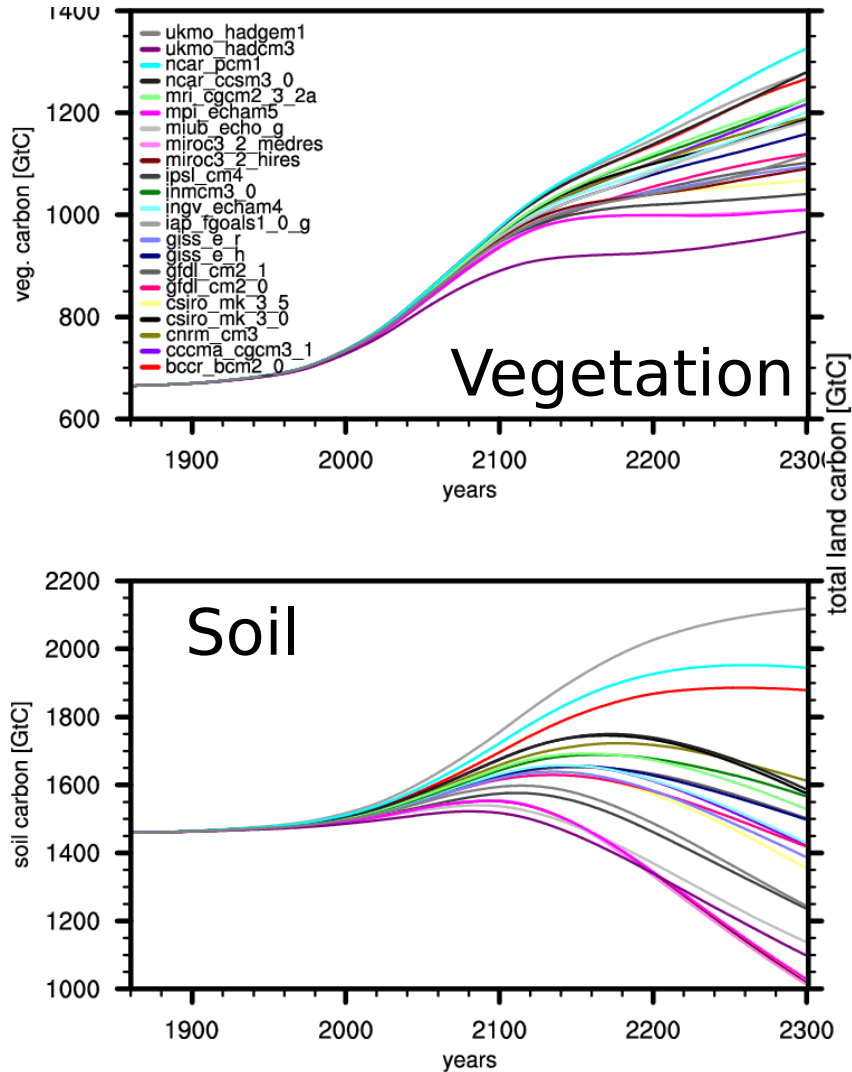
- Relationships between global land temperature and the spatial distribution of the required JULES driving variables are available for 22 different GCMs.
- Model run from 1860-2100 using A2 emissions scenario then constant emissions until 2300.



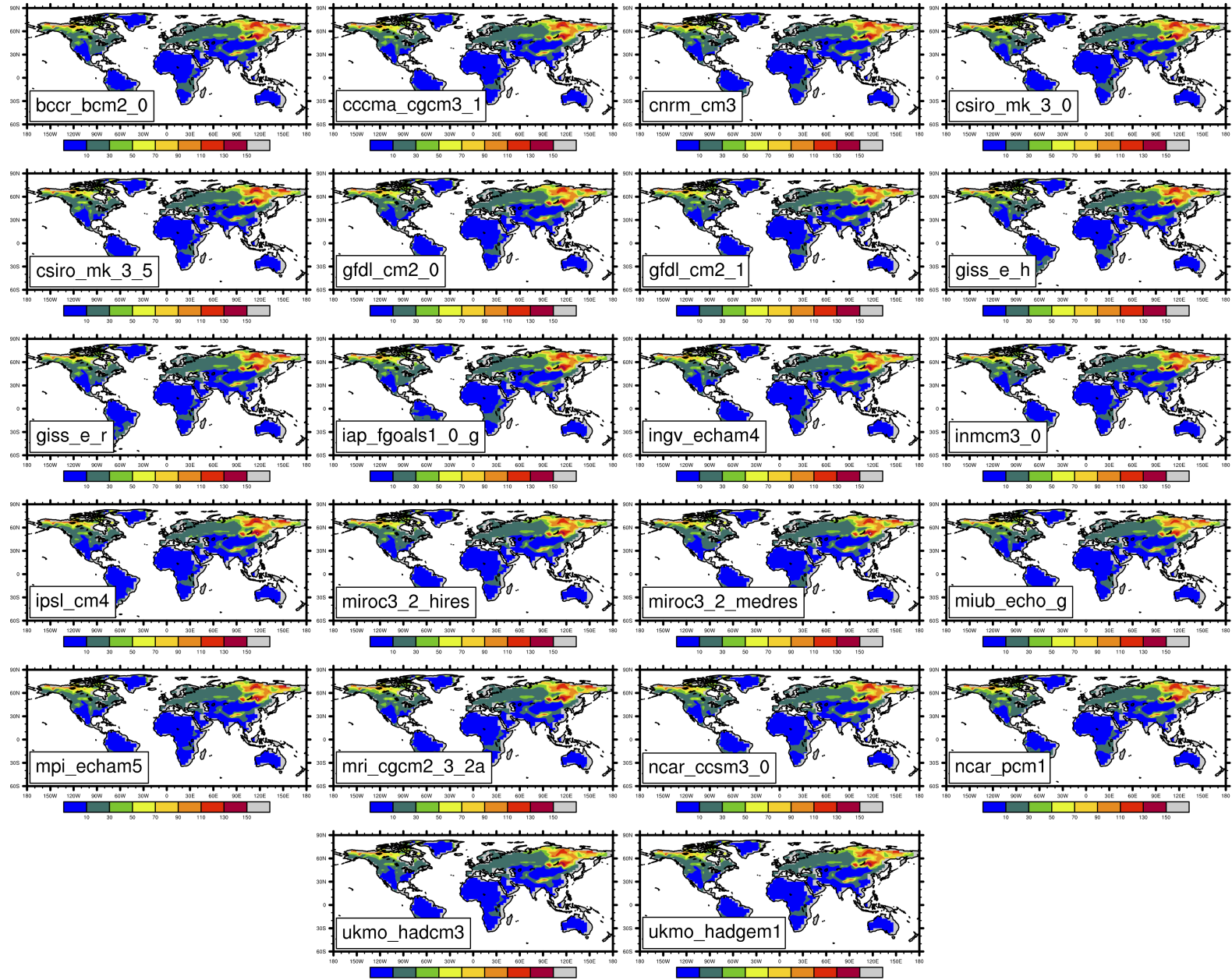
Global mean temperature



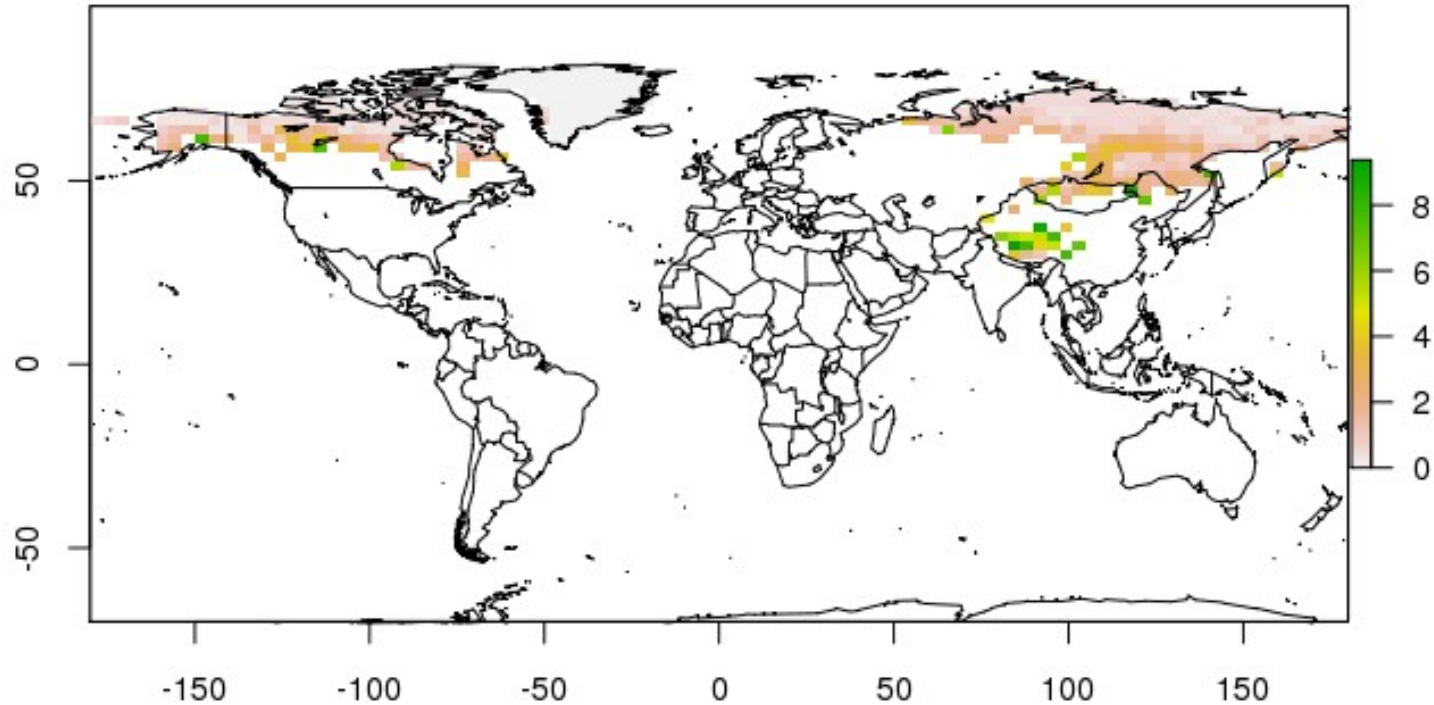
Land carbon



Soil carbon distributions [kg/m²] at 2100

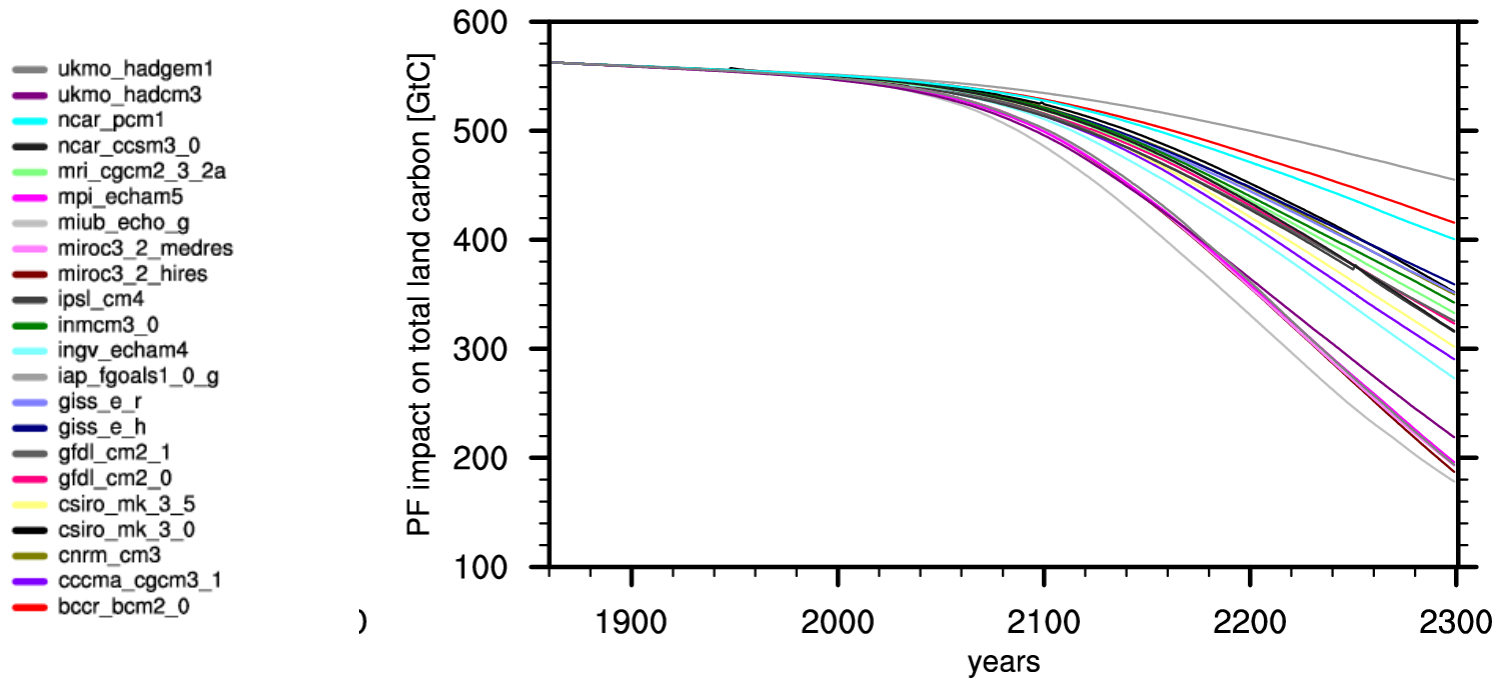


Diagnosing permafrost carbon



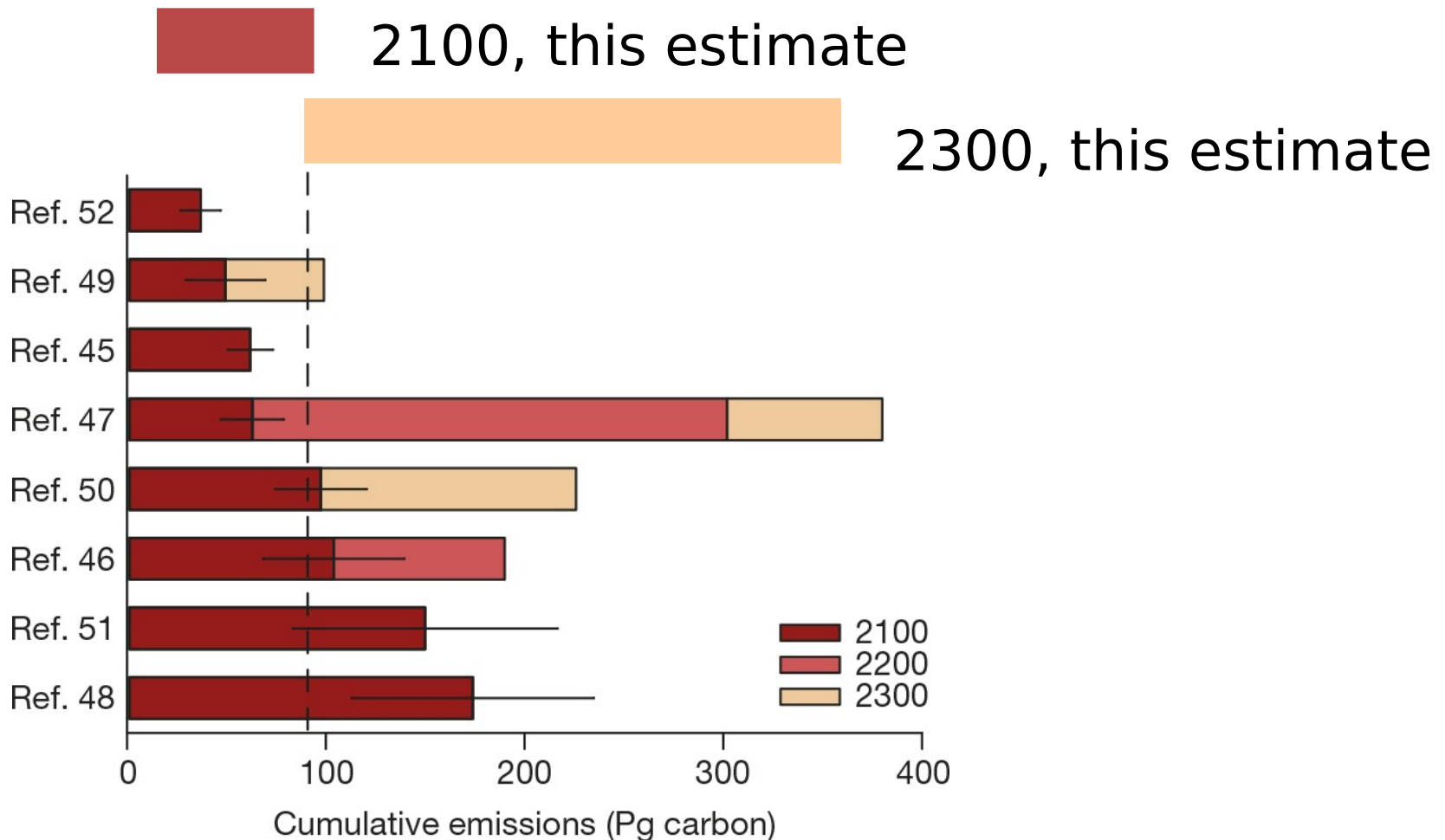
- The simulated permafrost region in 1860.
- Soil carbon within the volume of permafrost is defined as PF carbon
- Soil carbon not contained in the permafrost is defined as NON PF carbon

Permafrost carbon



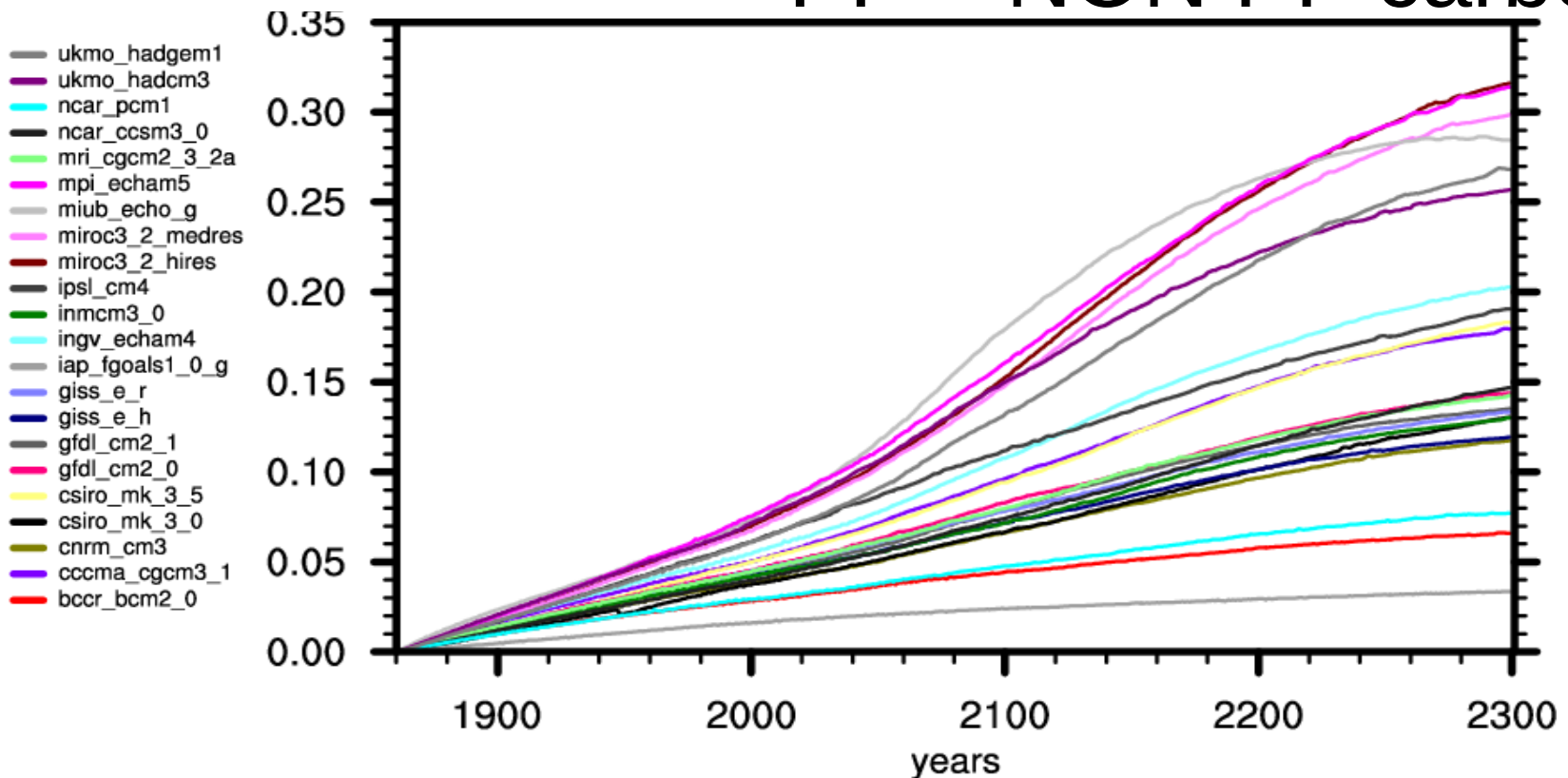
- Approx 560 GtC in the permafrost in 1860
- By 2100 only a small amount of PF carbon is lost ~ 20 to 100 Gt.
- Much more is lost by 2300

Model estimates of potential cumulative carbon release



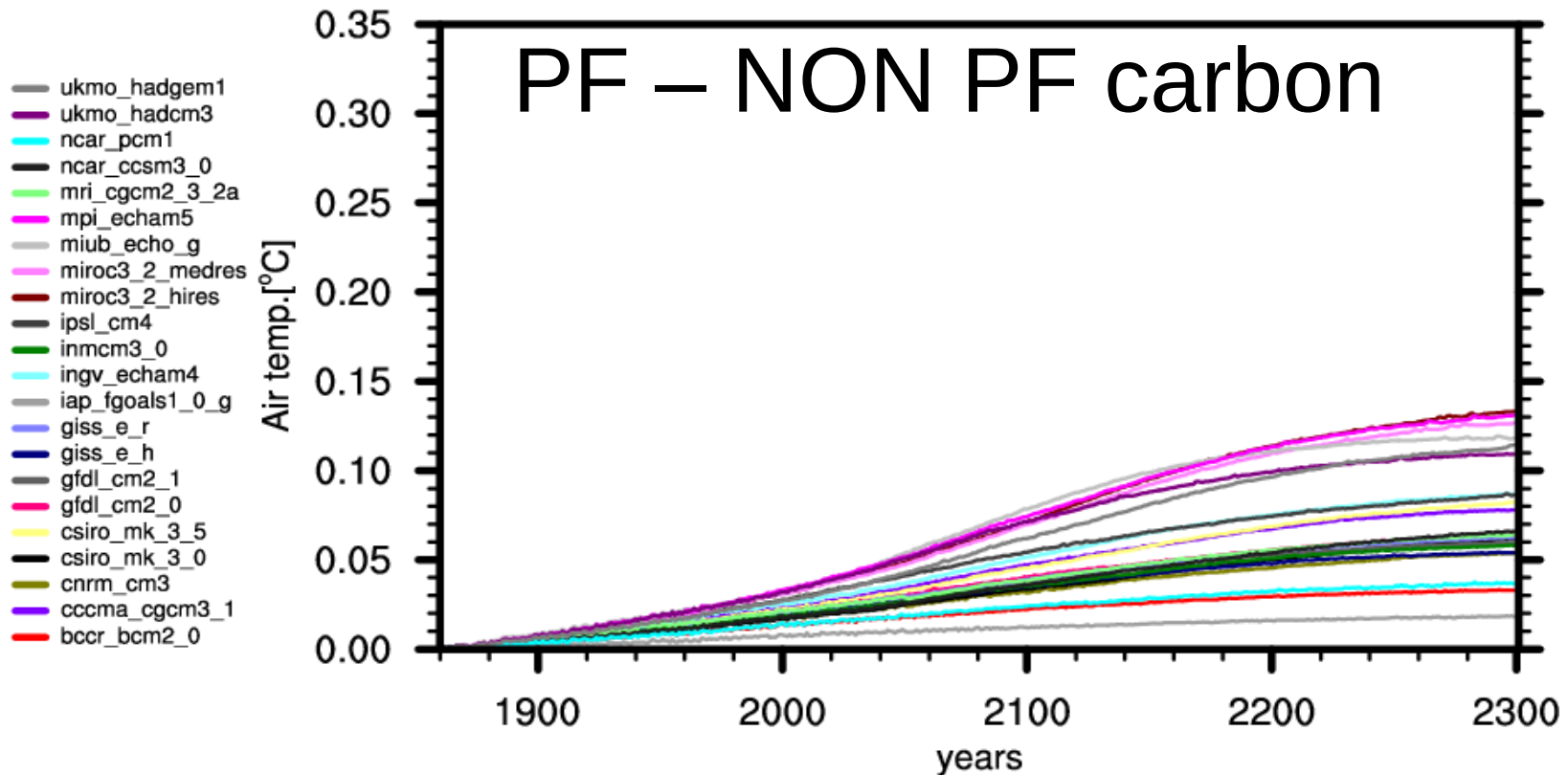
Temperature change caused by including permafrost carbon

PF – NON PF carbon



No decay of respiration with depth

Impact of soil carbon model parameterisation on feedback



Respiration decays with depth
e-folding depth = 50 cm

Conclusions

- IMOGEN is a useful framework for assessing the magnitude of feedbacks from the land carbon cycle
- Modelling uncertainties are readily included.
- Estimates are similar to previous values
- Parameterisation of the soil carbon model has a significant impact on magnitude of feedback.