

High-latitude climate feedbacks and impacts in Hector

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Why care about high-latitudes?

Large organic carbon reserves – 30-50% of global

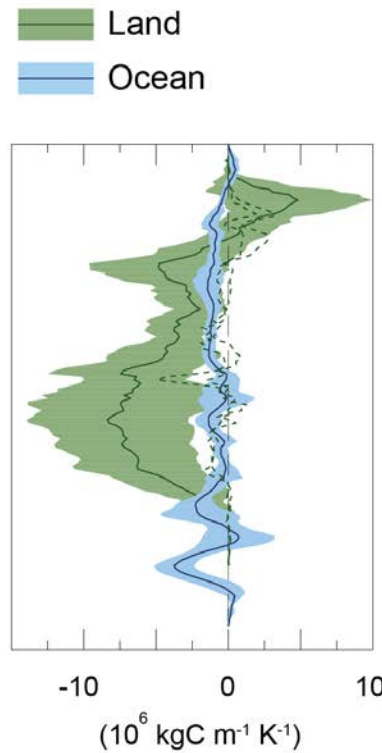
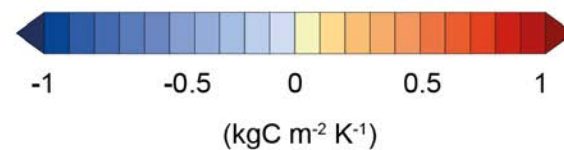
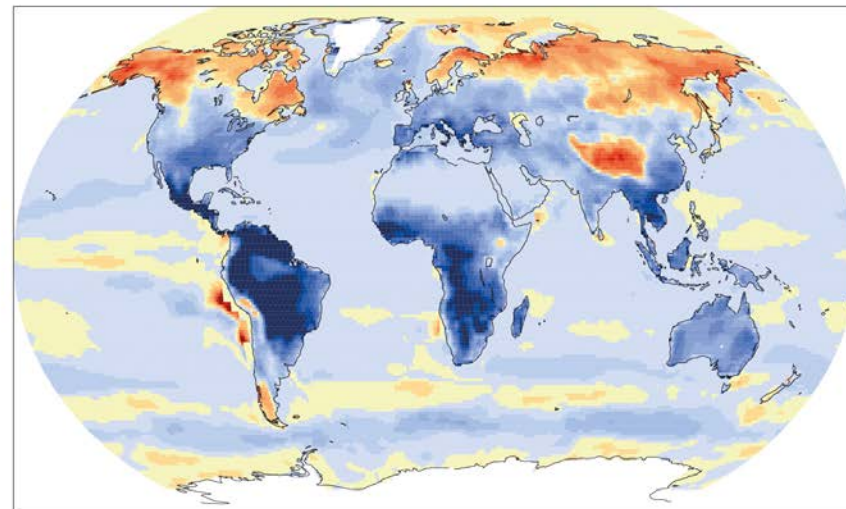


Warming 2-3x faster than global average



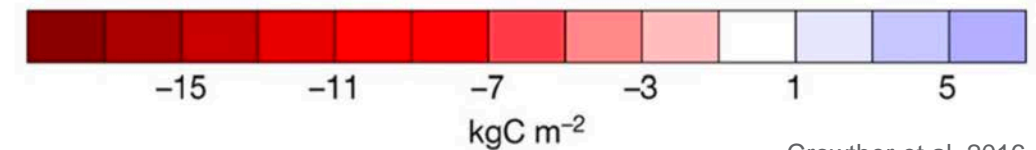
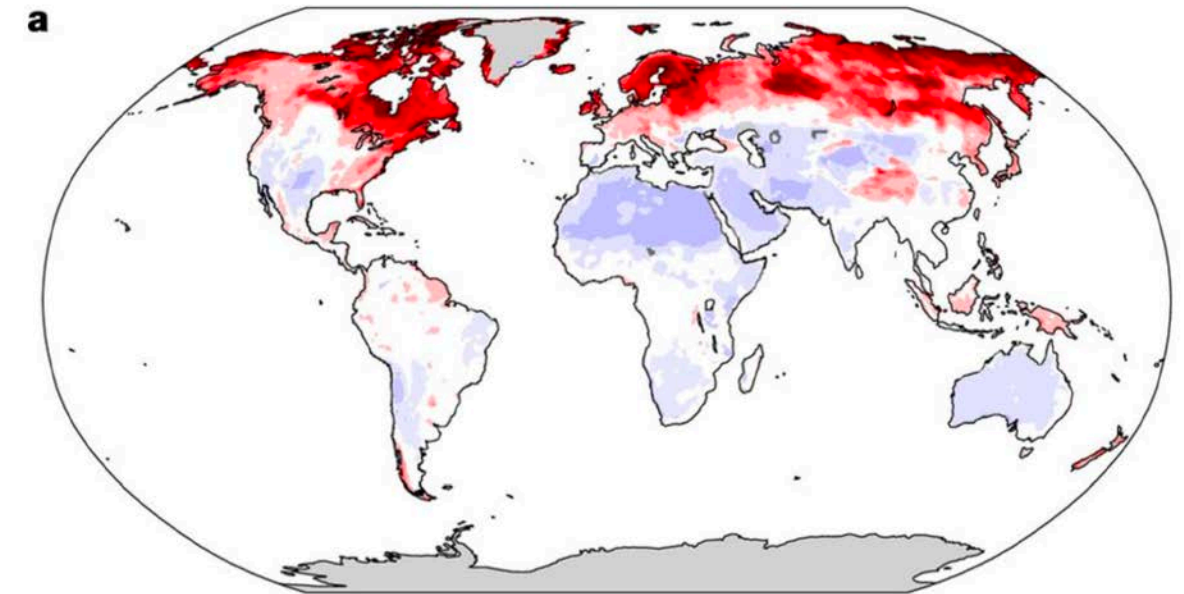
Strong potential for positive feedbacks!

b. Regional carbon-climate feedback



IPCC AR5

Estimated soil carbon losses in 2050 (under RCP 8.5)

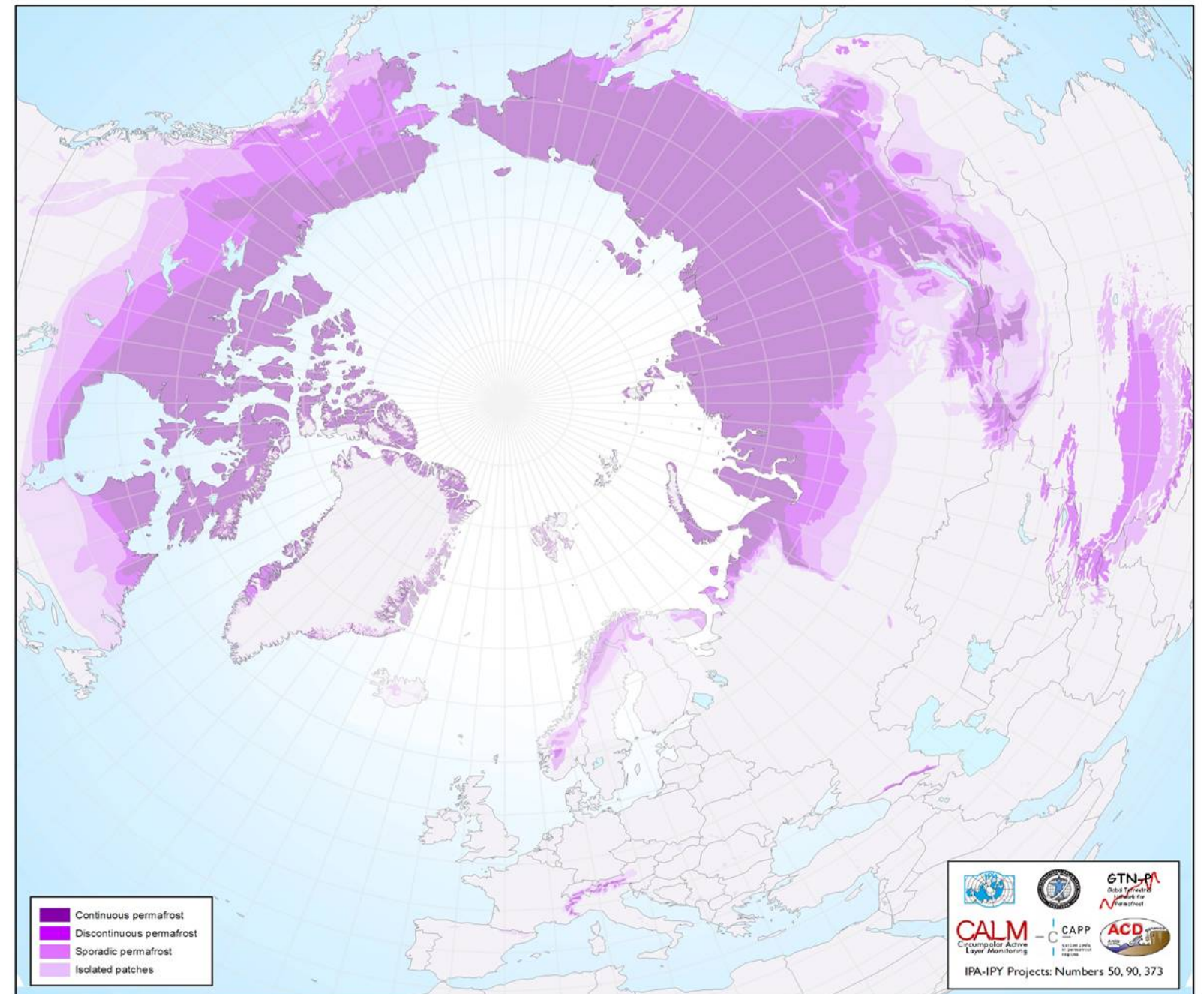


Crowther et al. 2016 *Nature*

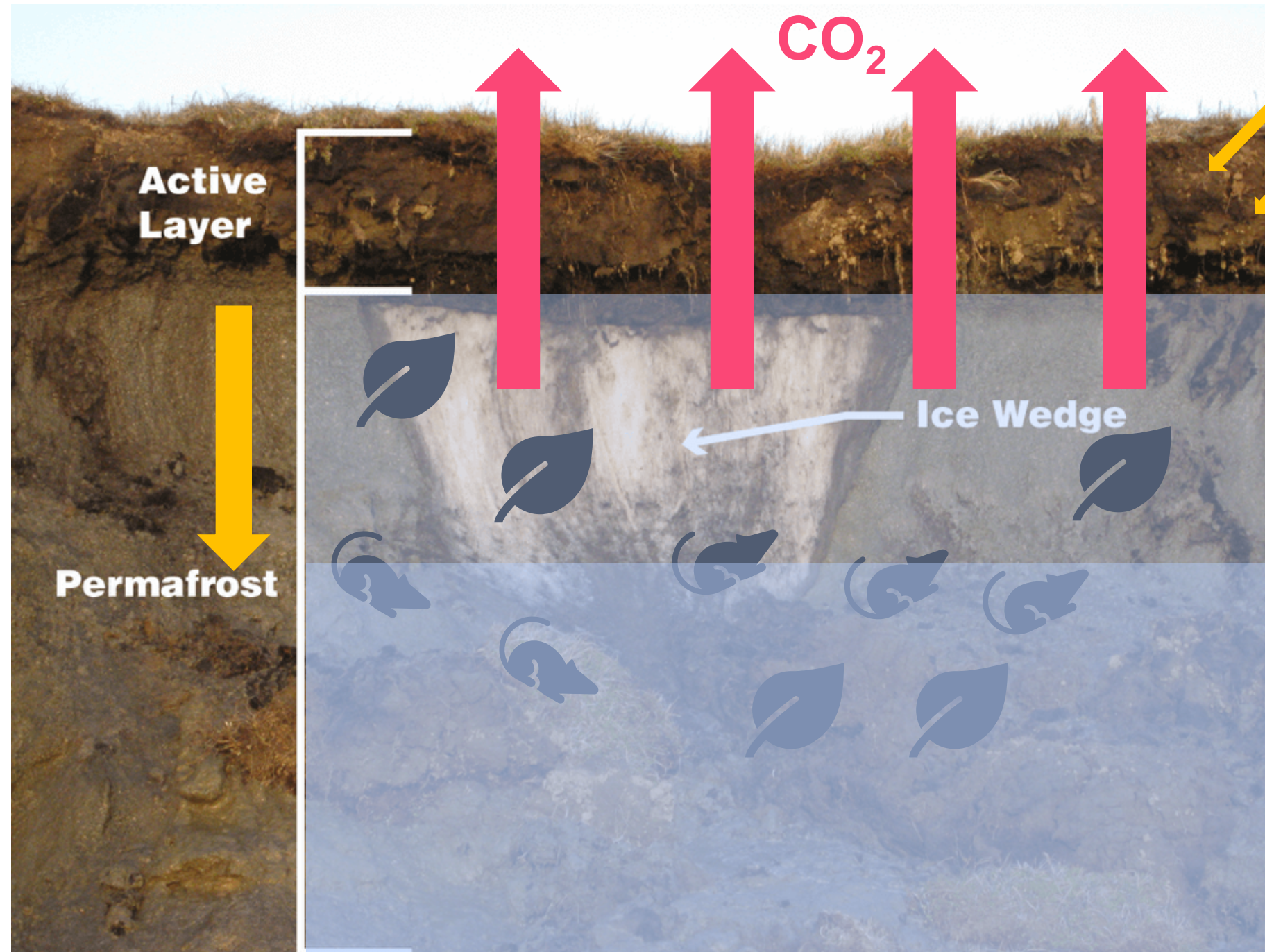
Permafrost

Soil whose temperature remains below 0°C for >2 years.

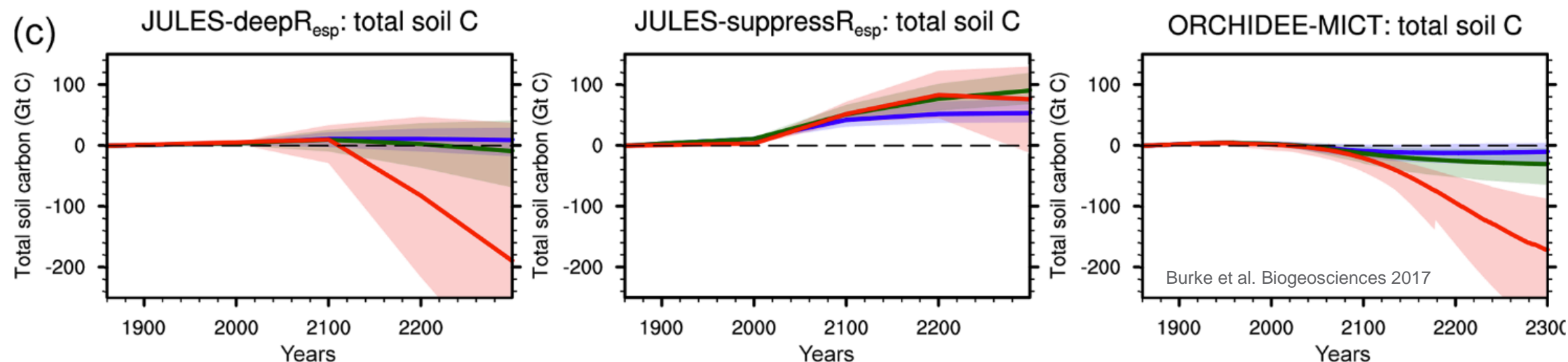
Permafrost 0-3 m deep has **~1/3 of the world's total organic carbon** (1035 +/- 150 Pg C).



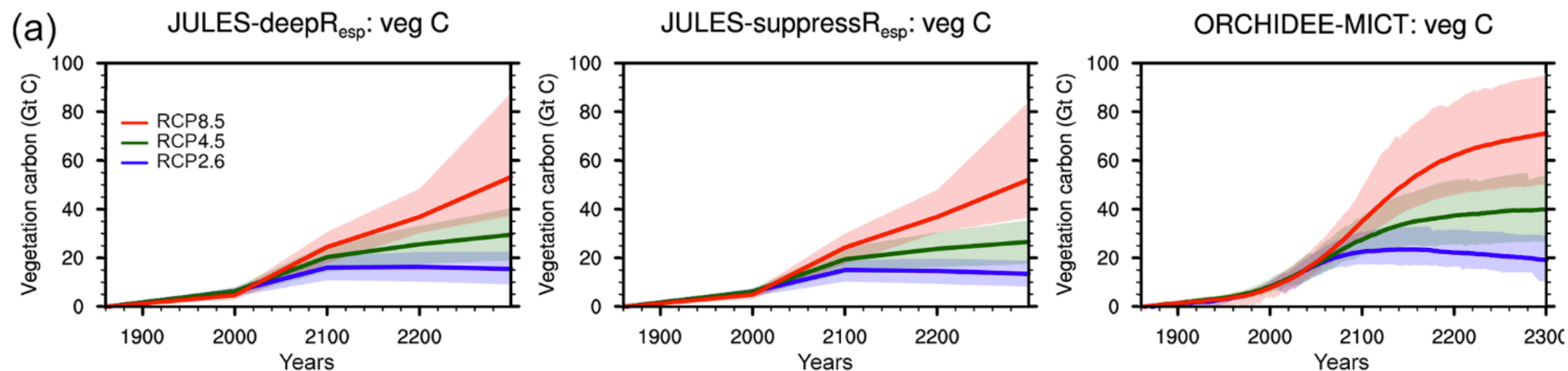
Permafrost and the global carbon cycle



Warming leads to faster carbon loss from soil, especially permafrost...



But, warming and CO₂ fertilization can also boost vegetation productivity...

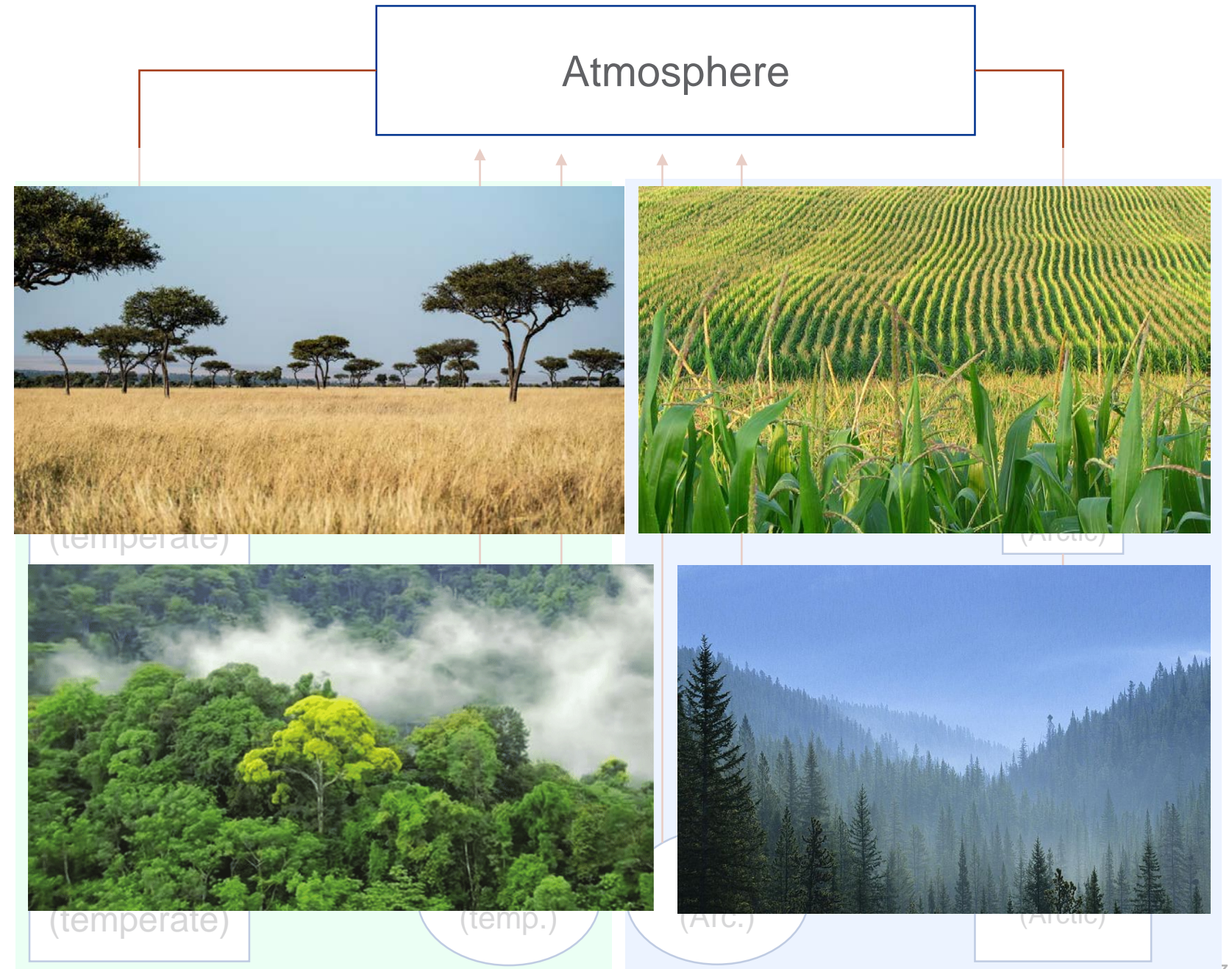
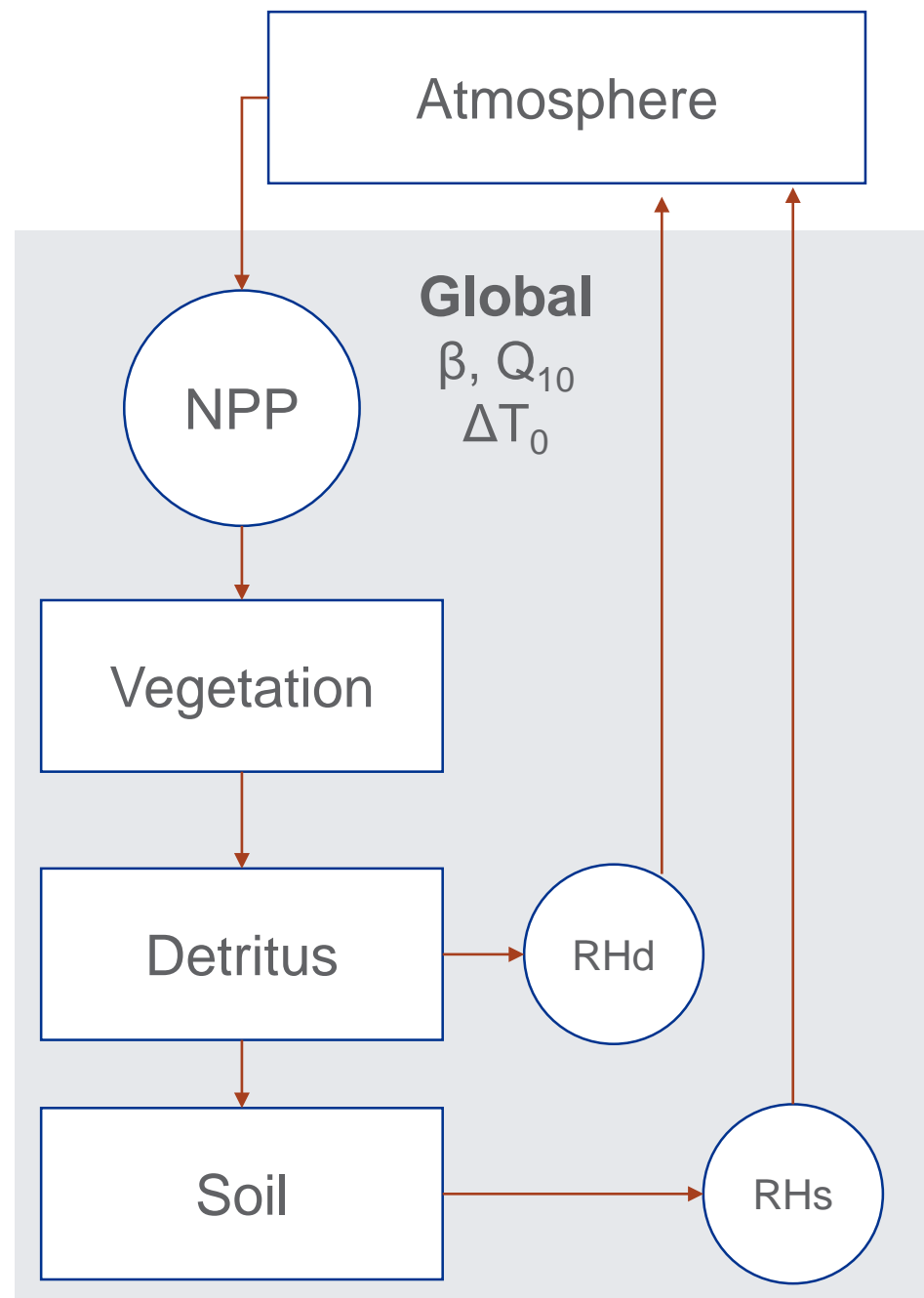


High uncertainty about the net effect, especially in high-emissions scenarios.

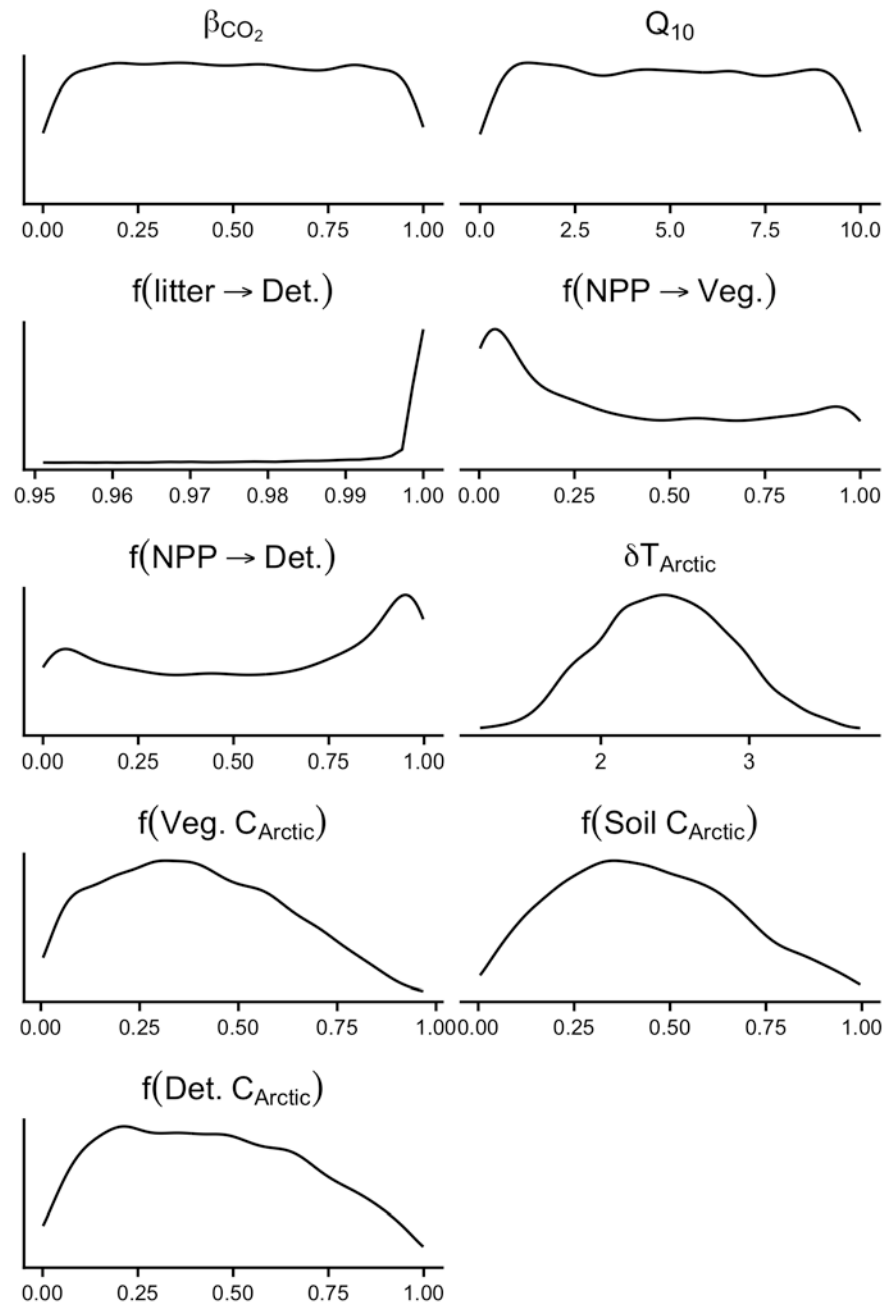
Research questions

- How does accounting for high-latitude carbon-climate feedbacks affect projections of global mean temperature in a simple climate model?
- Which parameters related to the terrestrial carbon cycle contribute the most to uncertainty in projections of global mean temperature?

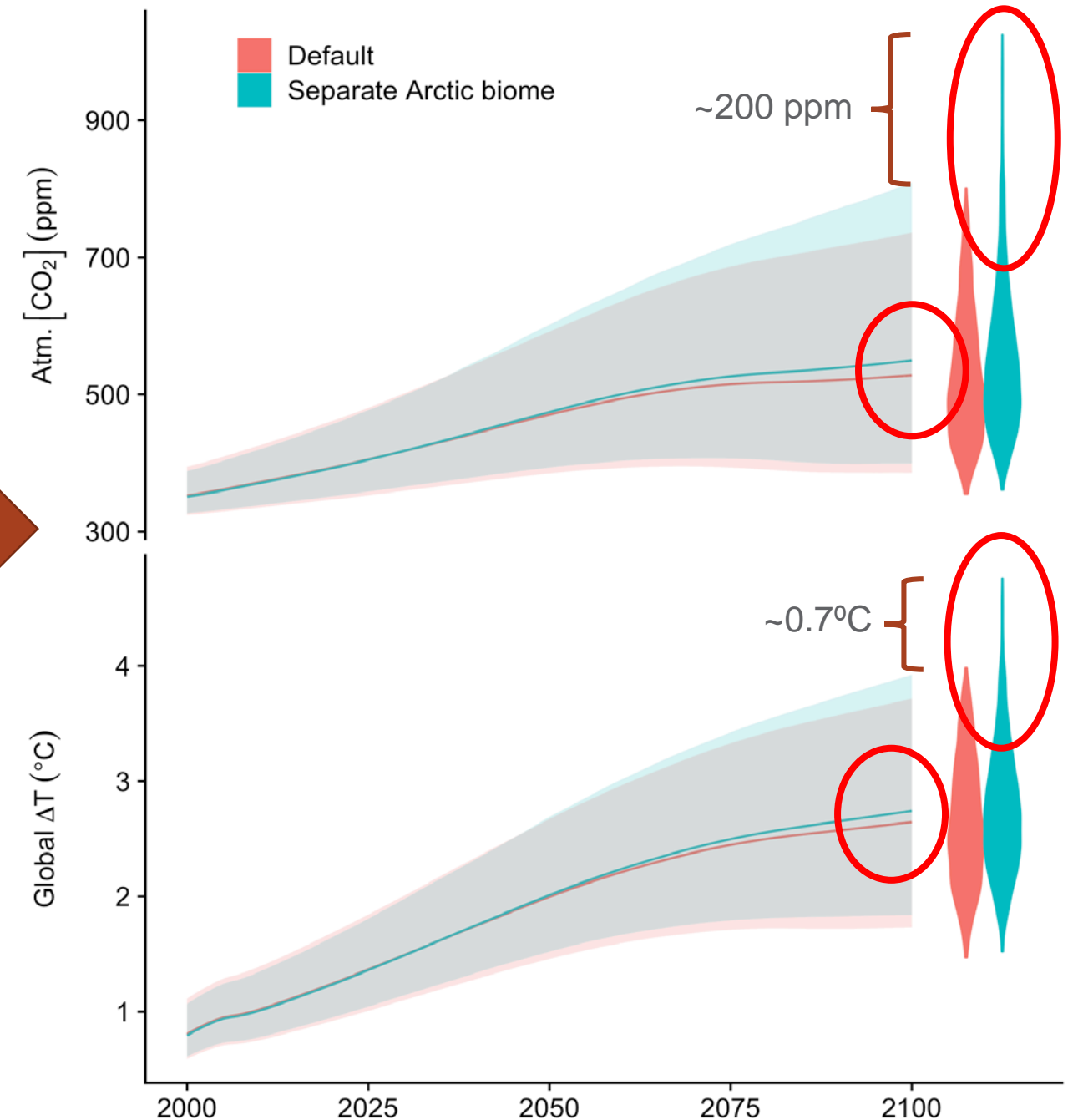
Terrestrial carbon cycle in Hector: Multiple biome edition!



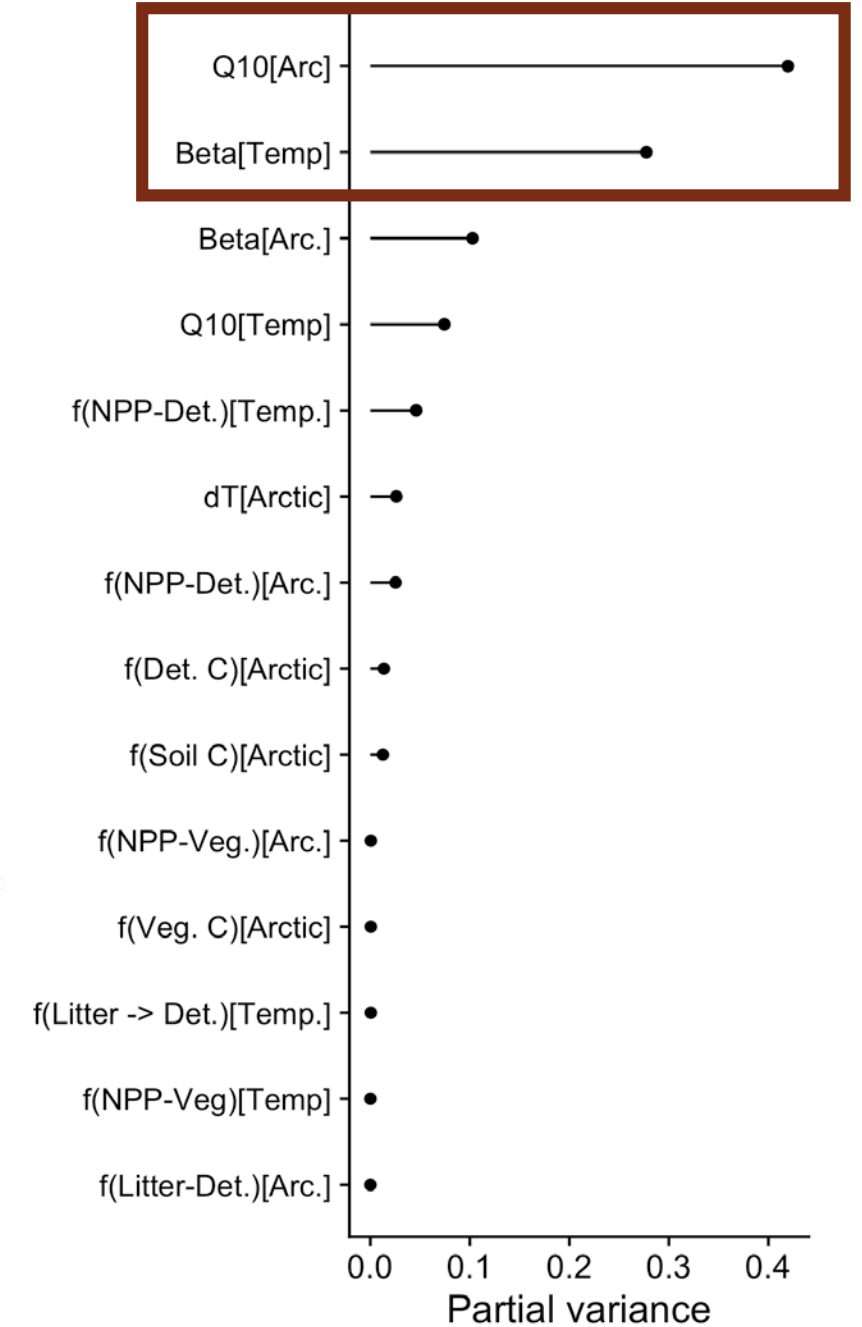
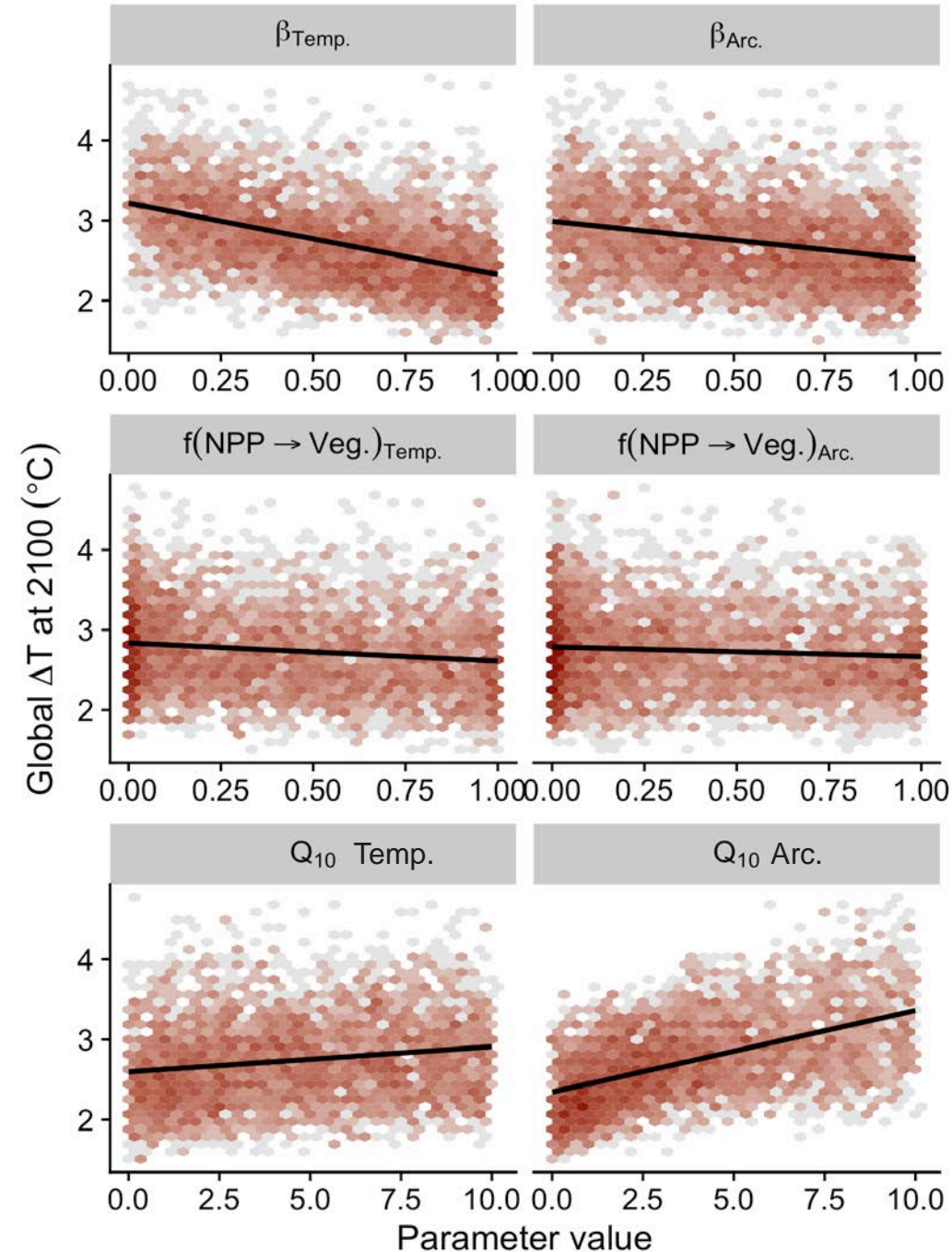
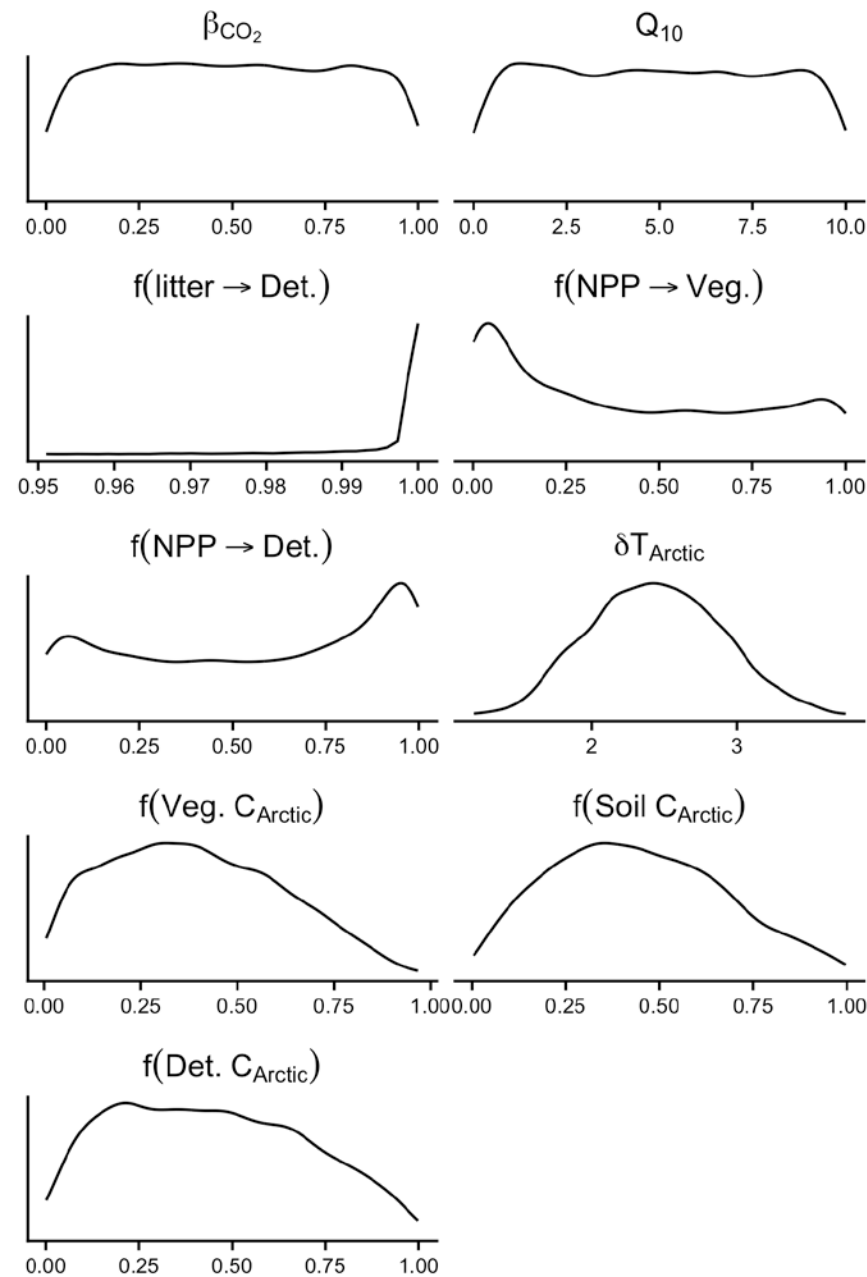
Sensitivity analysis with Hector: Default (global) vs. separate Arctic biome



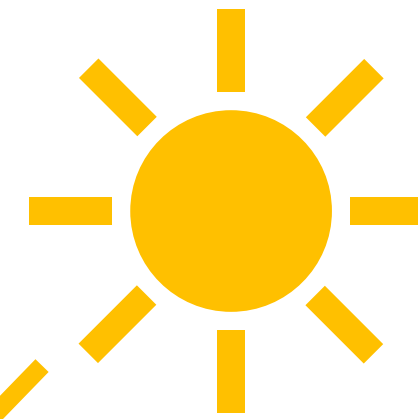
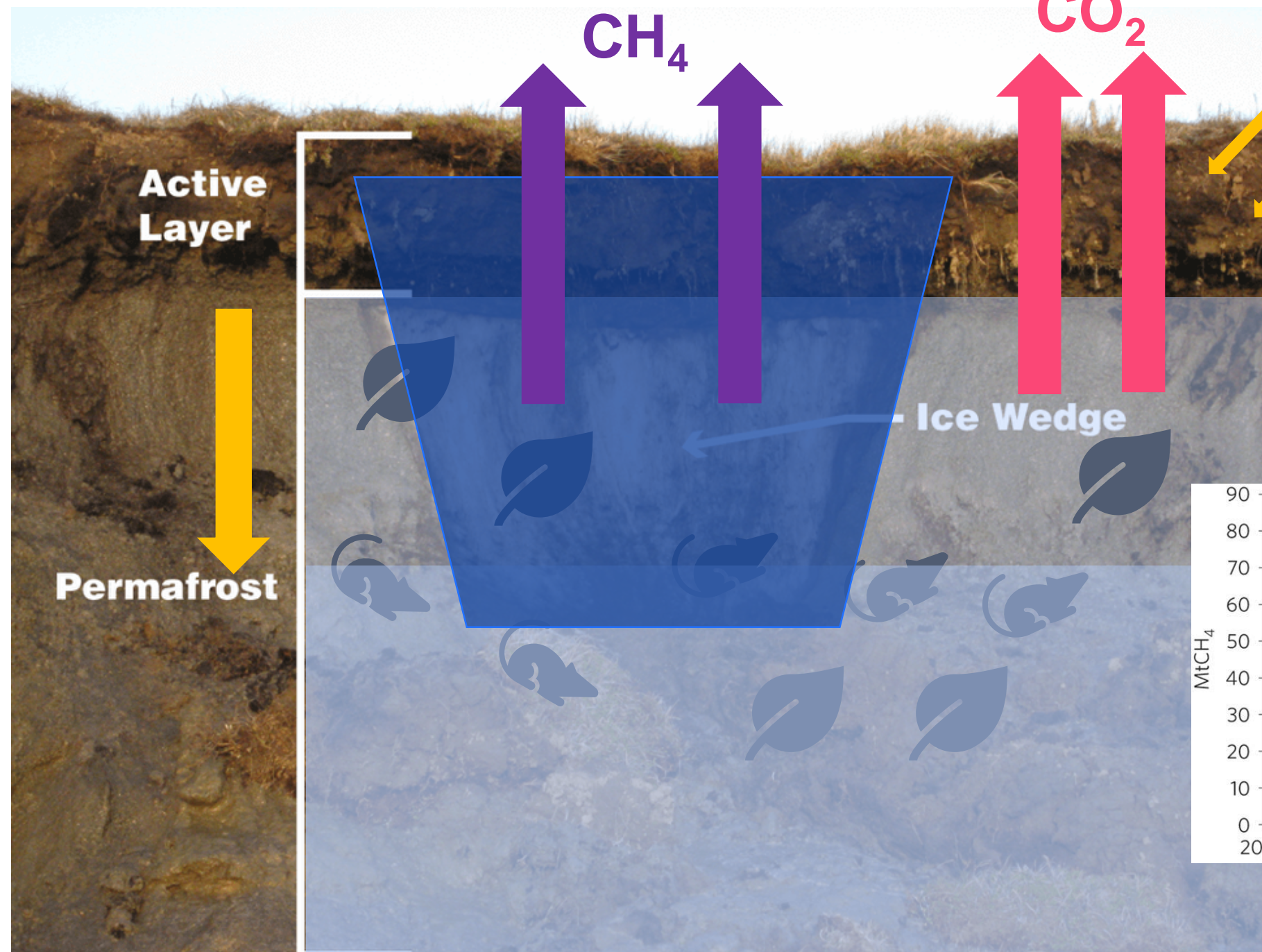
15,000
simulations



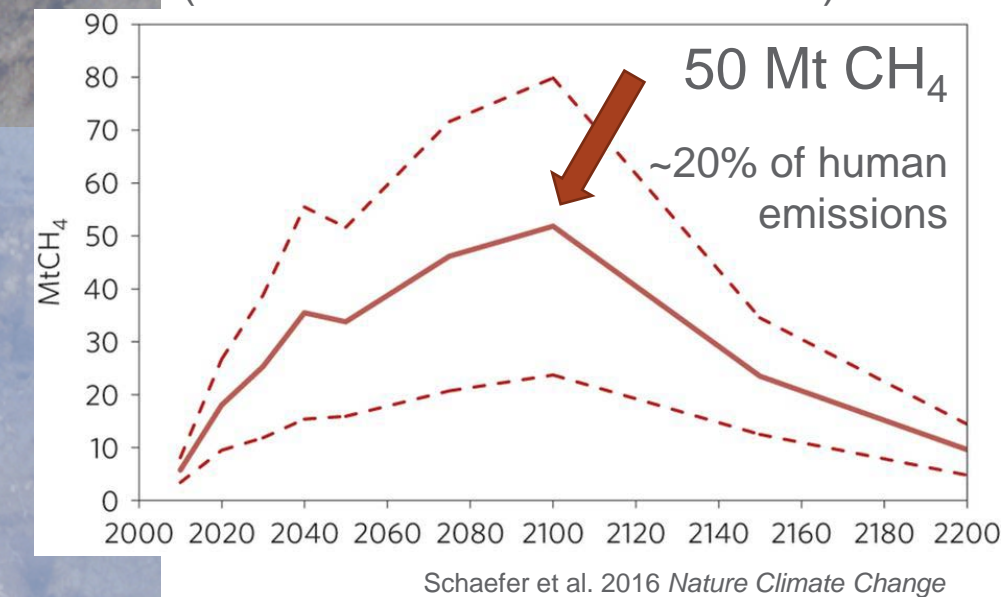
Sensitivity analysis with Hector: Parameter contributions



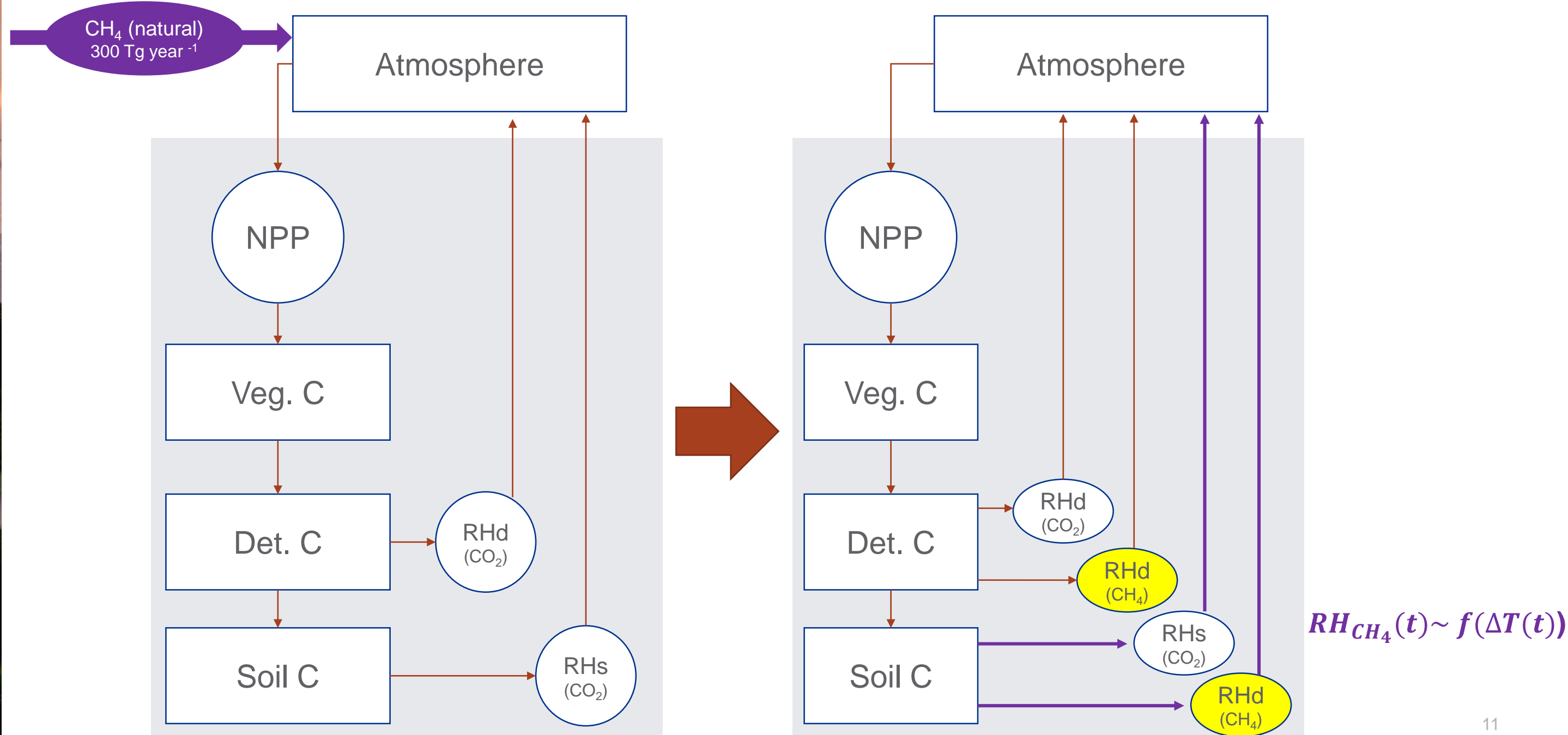
CO₂ is only part of the story...



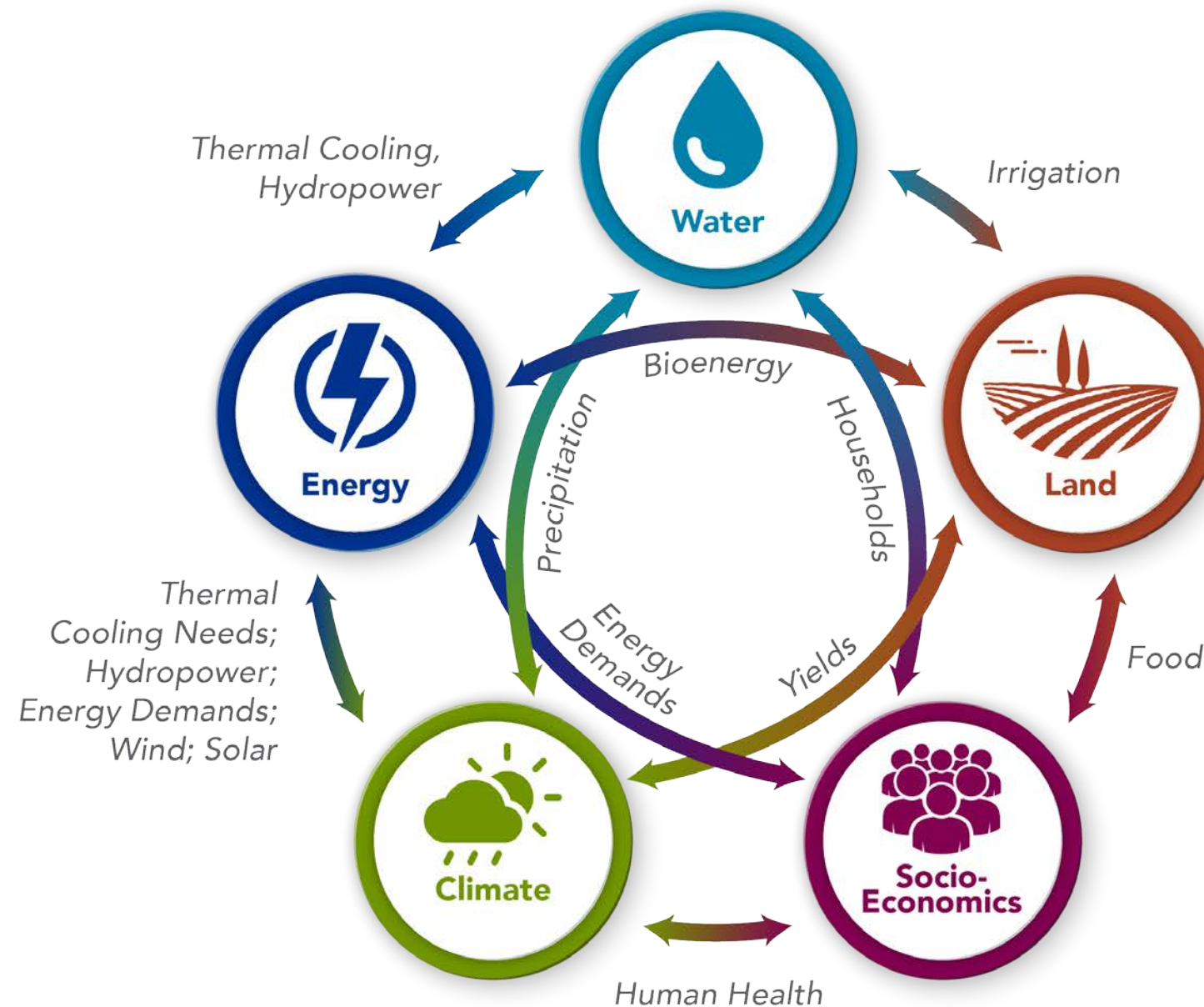
CH₄ emissions from permafrost thaw
(A1B scenario from IPCC AR4)



Next step: Explicit permafrost CH₄ emissions model



Next step: Feedbacks to the human system (with GCAM)





Thank you

