Breakout Group 1
Processes on land

CO_2 fertilization and nutrient limitations

- Beta = most *uncertain*; depends on nutrients availability & disturbance/management
  - Carbon allocation issue (not only NPP and Ra; but also exudates & symbionts)
  - Long-term SOC (de-)stabilization ➔ litter/priming/physical protection/microbial CUE (exudation, foliar vs root & mycorrhizal litter inputs, delta litter quality)

  PROBLEM: global variation of governing processes not fully understood

- Beta and gamma interact
  - nutrient availability response to warming (leakiness of northern ecosystems)

- Models with N (and P) could be tested with already available data:
  - Long term FACE /fertilizer addition/warming experiments
  - Ongoing global experiment: pCO_2 is rising (also during warming hiatus) ➔ compare flux/NDVI/biomass/SOC stock trends in areas with high vs low N deposition or fertile vs infertile soils

Improving the modelling carbon-feedback using estimates of land carbon transit time and age

- Both beta and gamma depend on turnover rate of carbon in vegetation and soil
- Turnover time is related to two quantities: carbon age and transit time
- Atmospheric ^{14}C data, Ocean ^{14}C inventory → land ^{14}C carbon
- GCP residual land sinks
- Vegetation and soil carbon/flux (transit time)
- Soil 14C (age)

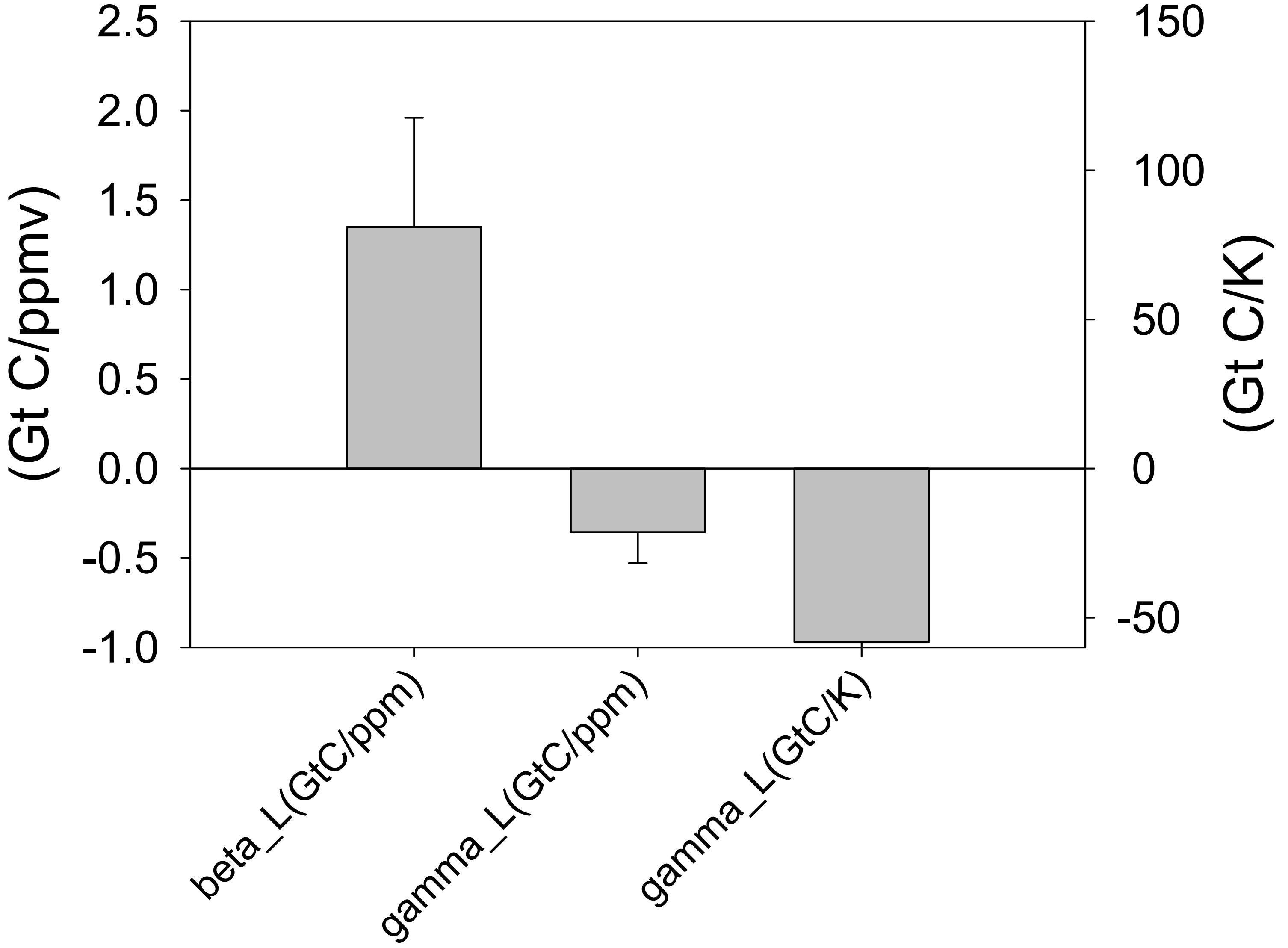
Permafrost carbon

Half of the global soil C pool (ca. 1300 Pg C to 3 m depth) is in soils not represented in CMIP5 generation ESMs. Because of this, their feedbacks are not accounted for in estimates of allowable human emissions for a 2 degree global warming scenario;

An emerging generation of ESMs are able to recreate and project changes in permafrost and wetland extent;

Initializing ESMs with observation-based estimates of vulnerable C pools allows quantification of warming feedbacks from projected changes in permafrost and wetland extent.

Additional slides



$$g = -\alpha(\gamma_L + \gamma_O)/(1 + \beta_L + \beta_O).$$

Carbon-concentration feedback (beta)

Experimental results show that NPP is increased by elevated CO_2, and that increase may vary over time, particularly >10 years, possibly because of the increased limitation by nutrient or other resources; Warming and increased C allocation to rhizosphere may partially alleviate nutrient limitation;

(1) How does nutrient limitation affect beta? = C cost of N acquisition?

(2) Conversion of photosynthetic C into organic matter and the residence time of that organic matter? Such as allocation, plant and microbial CUE

(3) How does residence time vary with CO_2?

Carbon-climate feedback (gamma)

(1) How does NPP vary with warming?

(2) How does Rh vary with warming?

(3) How does the response of NPP or Rh to warming interact with nutrient limitation?

Vulnerability and disturbance

- How do large C pools, such as permafrost, wetlands and forest respond to higher CO_2, warming, and land use change?

Questions

1: How will nutrient availability interact with beta and gamma?

- Does beta increase with nutrient availability? What are observational evidence? If so, how can use those obs to constrain models?
- Does gamma increase with nutrient availability? What are observational evidence? If so, how can use those obs to constrain models?

2: How will ecosystem C turnover time change in the future?

Observations of turnover and change? Can we use these obs to constrain gamma of veg/soil Carbon?

Ecosystem plasticity/acclimation

3: How important is ecosystem plasticity/acclimation to beta/gamma at different scale?

Temperature acclimation

- This happens
- Not of crucial importance for ESMs (Rh: soil C pool depletion dominates = likely covered by ESMs; Ra & photosynthesis acclimate very rapidly = beyond the scope for ESMs)