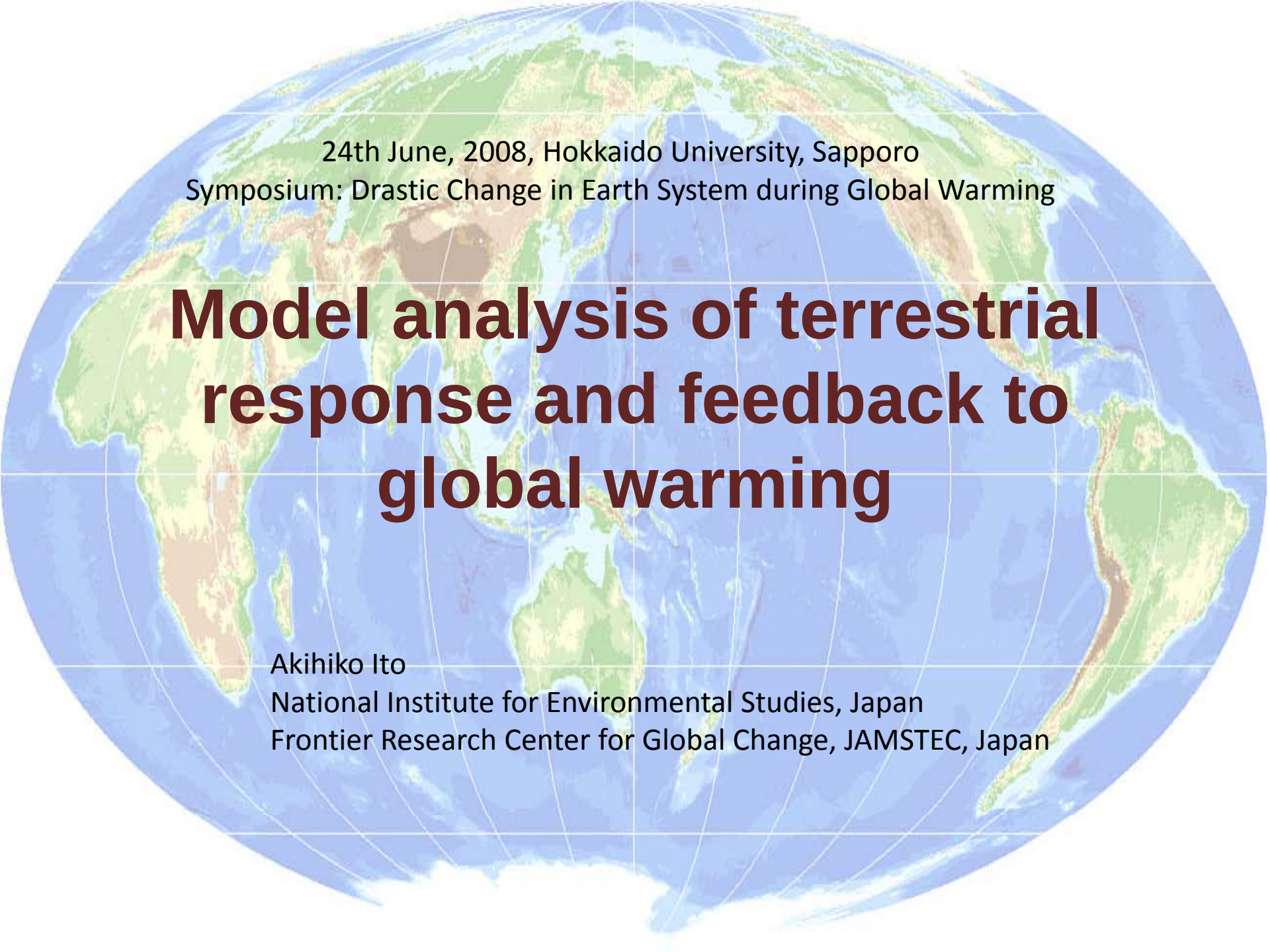




HOKKAIDO UNIVERSITY

Title	Model analysis of terrestrial response and feedback to global warming
Author(s)	Ito, Akihiko
Relation	地球温暖化による劇変を解明する．平成20年6月24日．札幌市
Issue Date	2008-06-24
Doc URL	https://hdl.handle.net/2115/34396
Type	conference presentation
File Information	Ito.pdf





24th June, 2008, Hokkaido University, Sapporo
Symposium: Drastic Change in Earth System during Global Warming

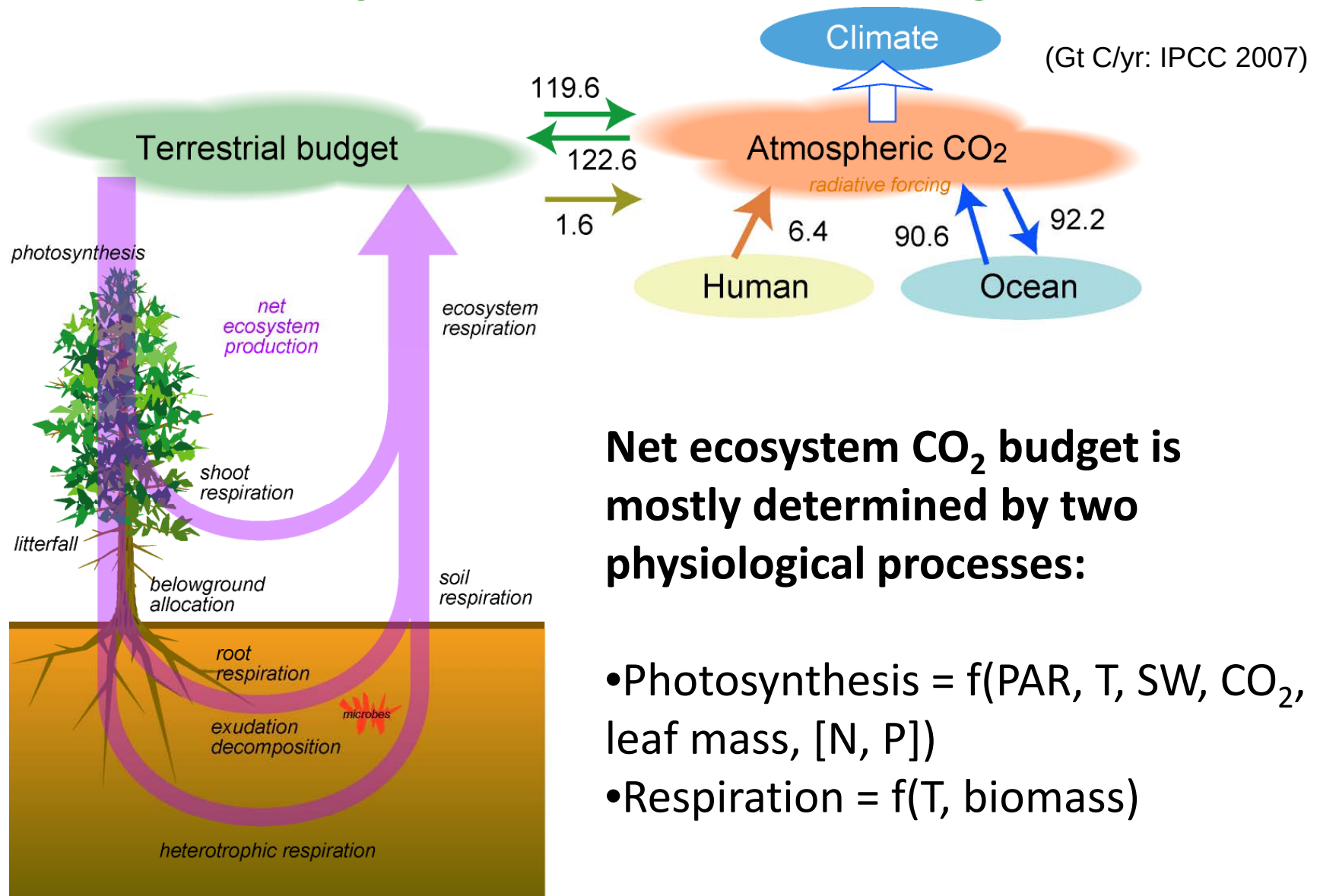
Model analysis of terrestrial response and feedback to global warming

Akihiko Ito

National Institute for Environmental Studies, Japan

Frontier Research Center for Global Change, JAMSTEC, Japan

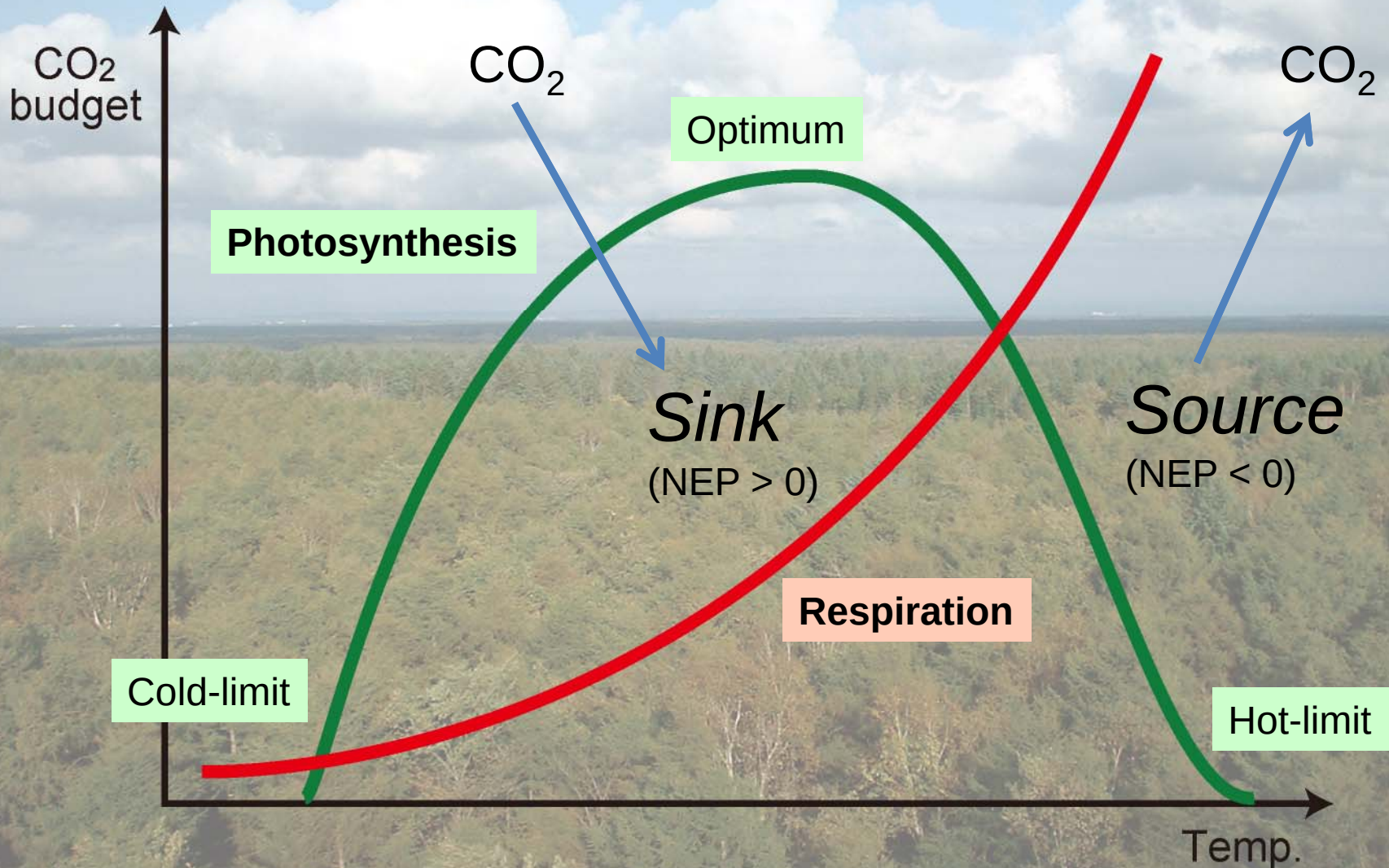
Ecosystem Carbon Budget



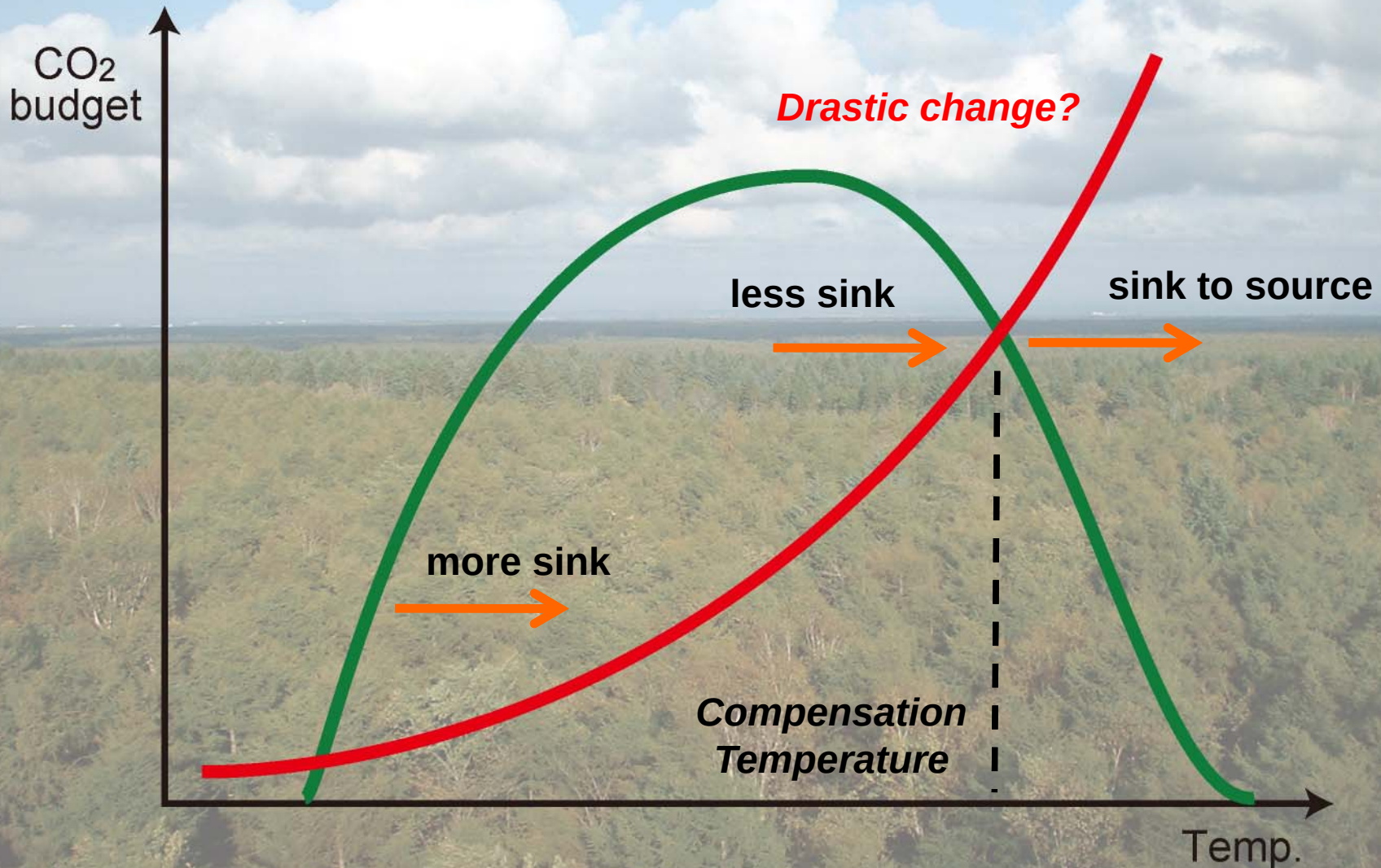
Net ecosystem CO₂ budget is mostly determined by two physiological processes:

- Photosynthesis = $f(\text{PAR}, T, \text{SW}, \text{CO}_2, \text{leaf mass}, [\text{N}, \text{P}])$
- Respiration = $f(T, \text{biomass})$

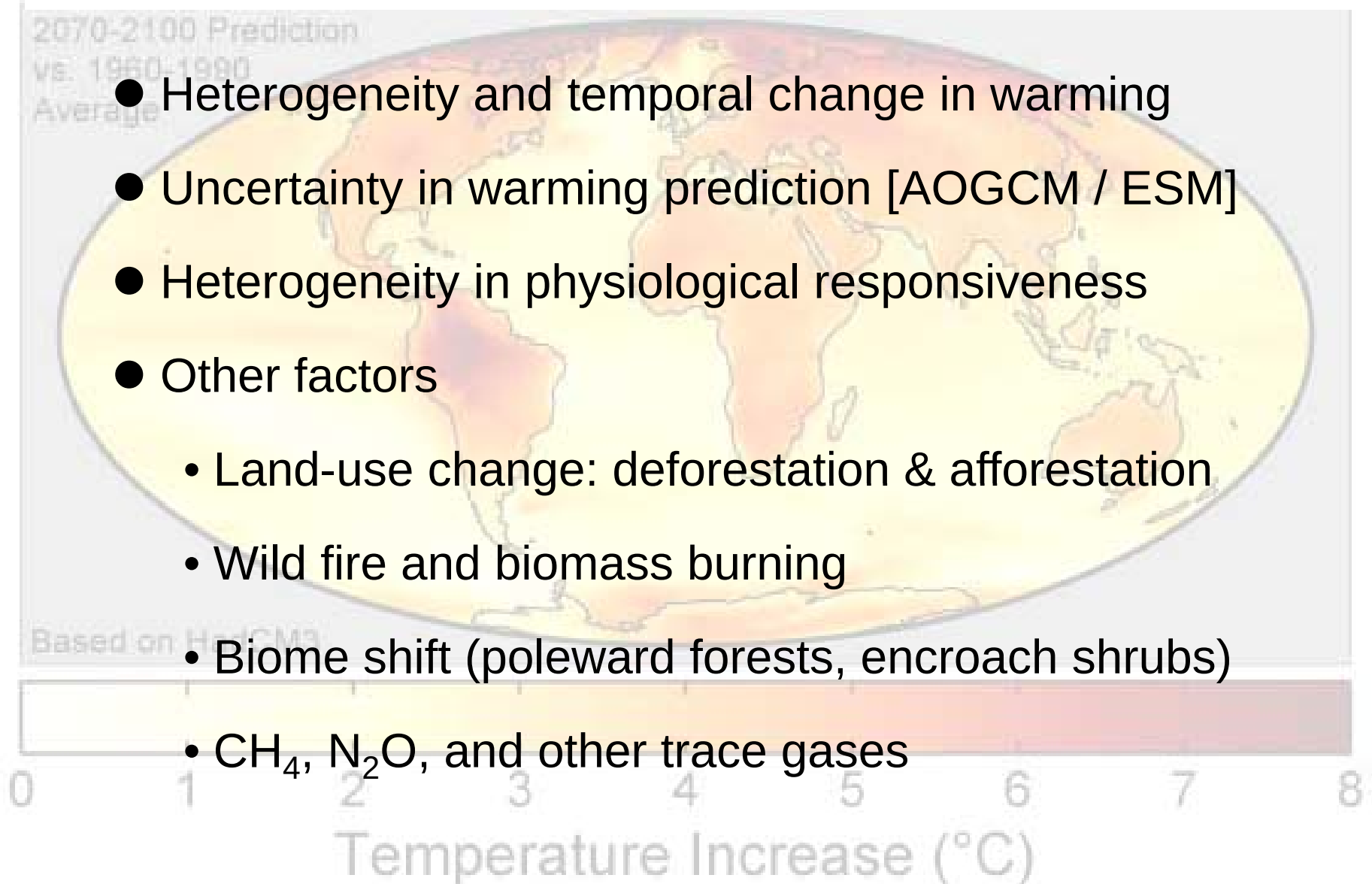
Response to warming: physiology



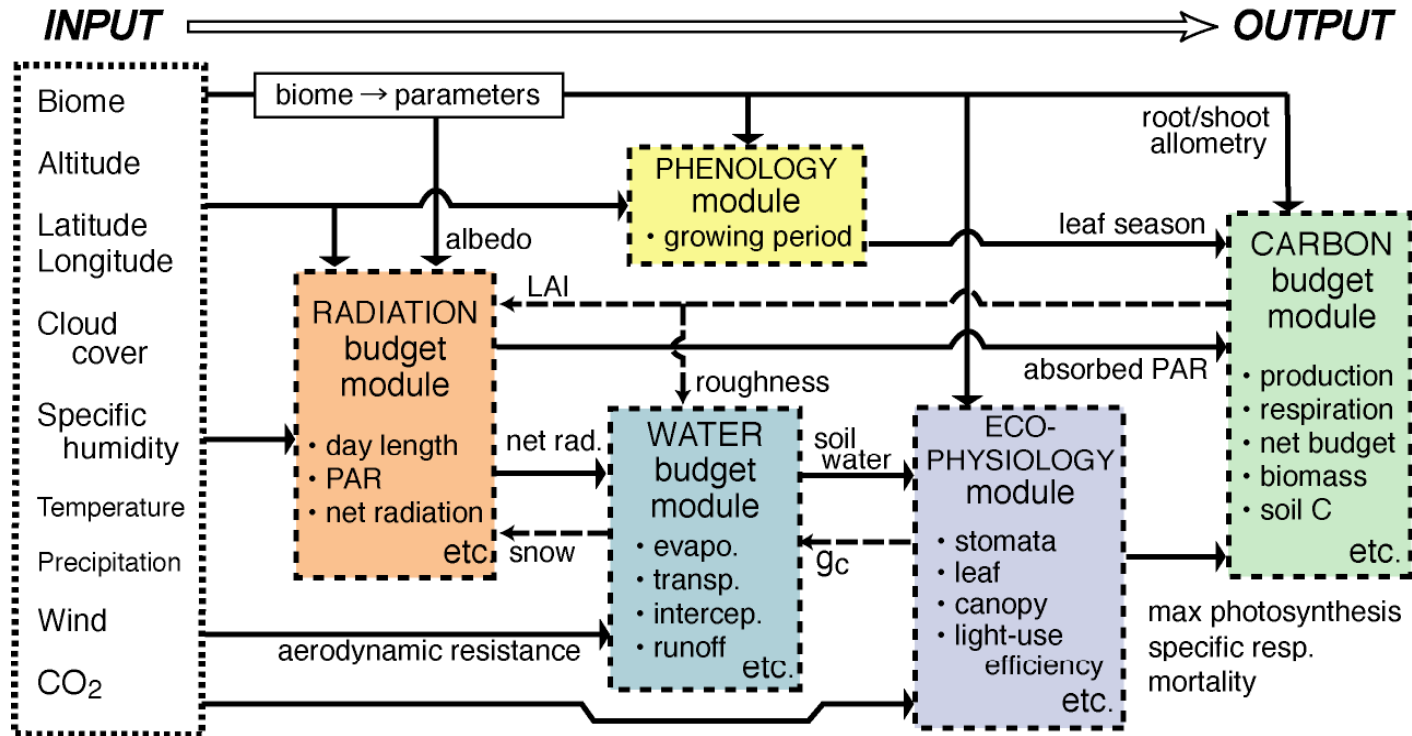
Response to warming: physiology



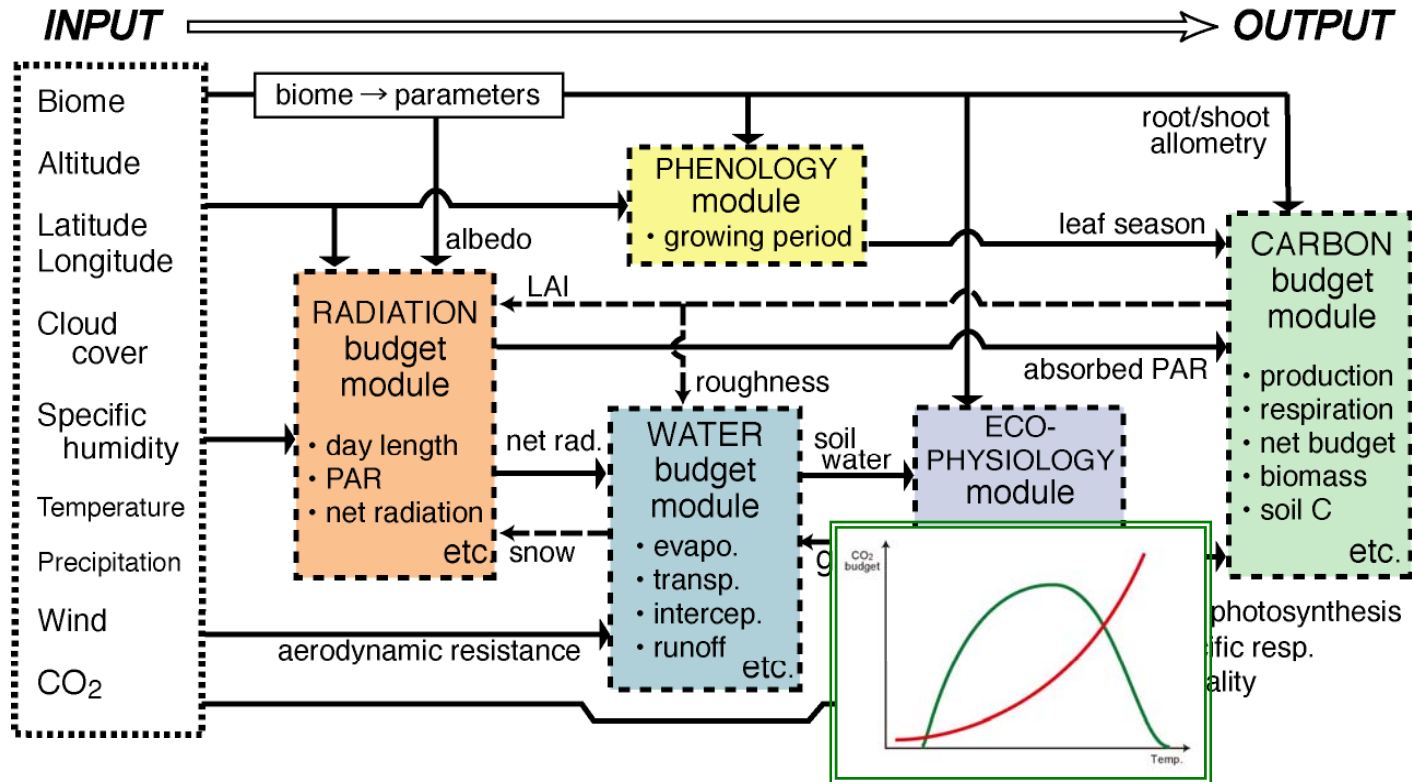
Difficulties



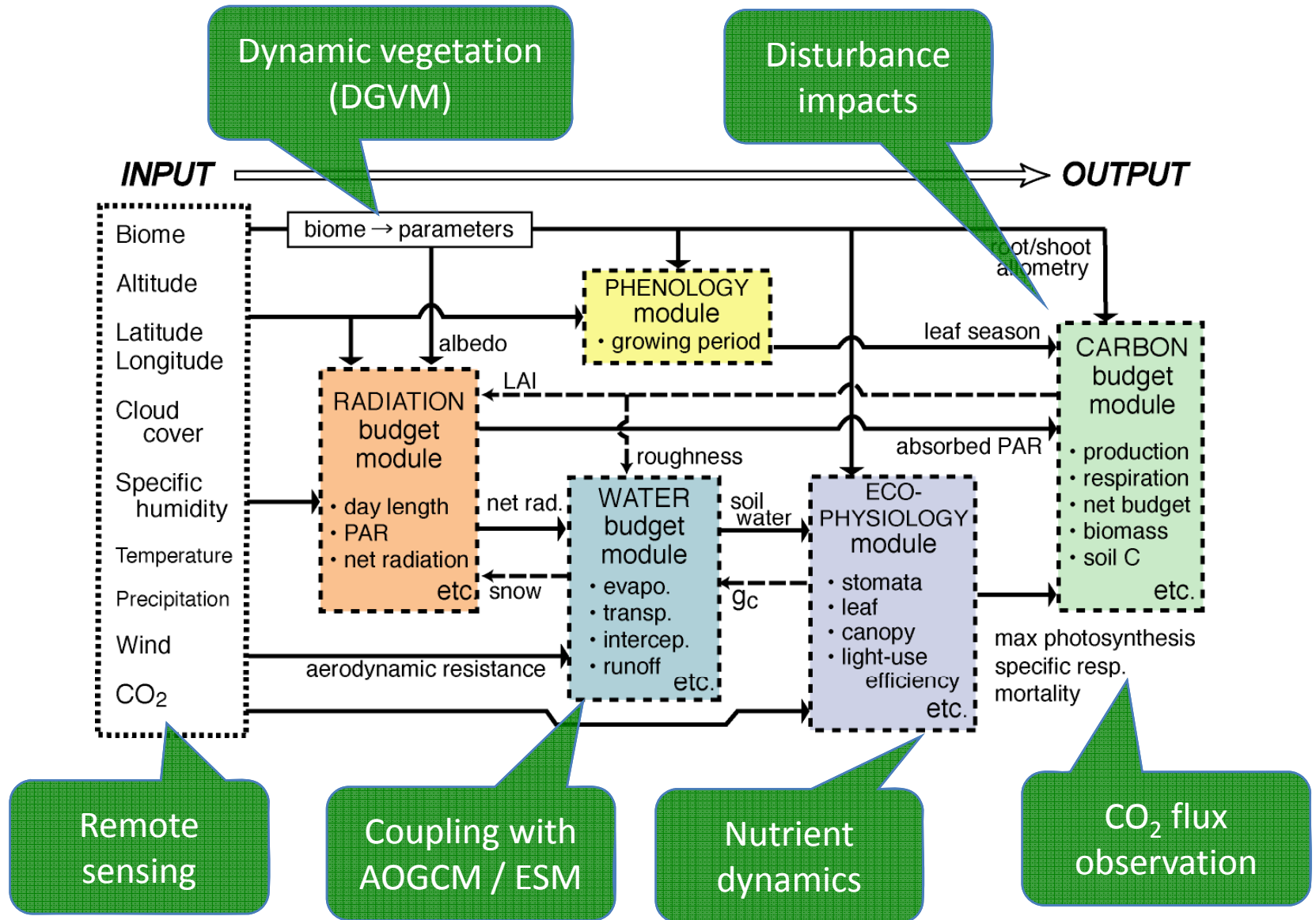
Current Modeling



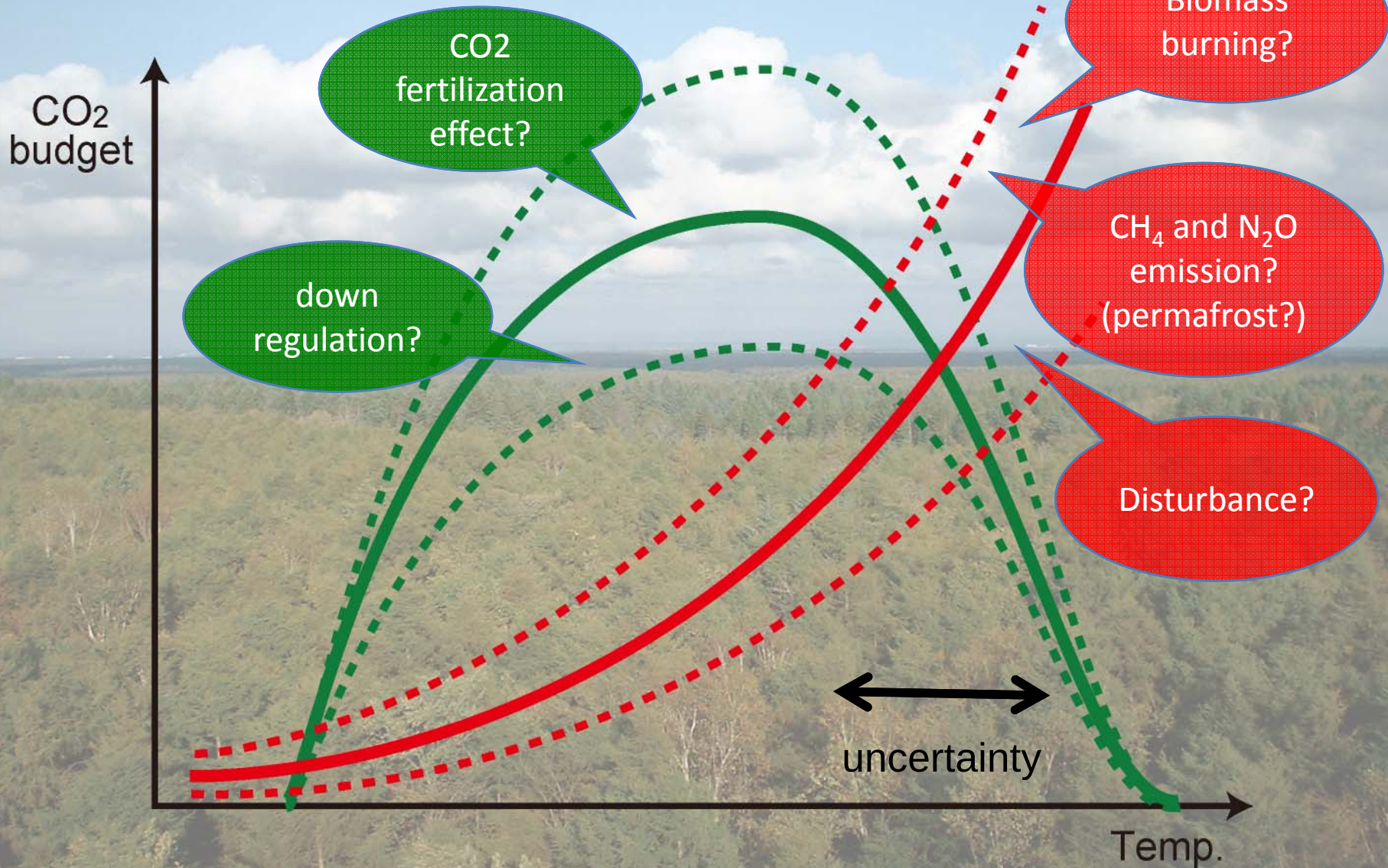
Current Modeling



Current Modeling

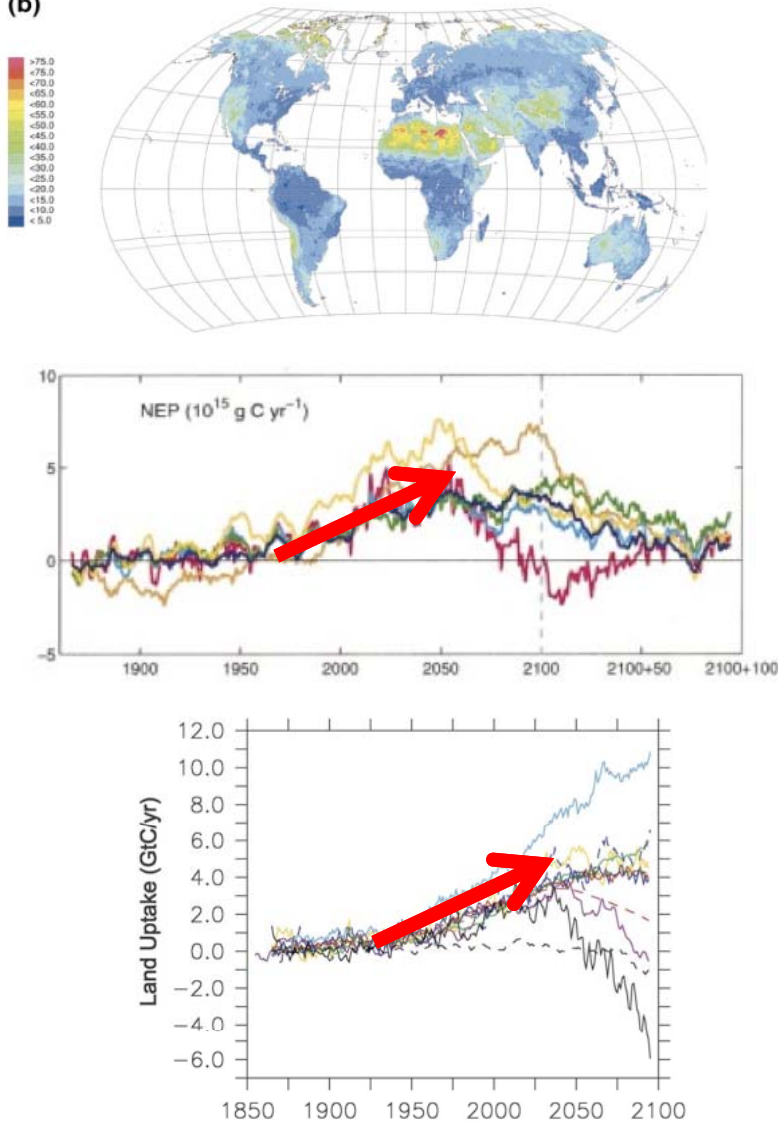


Other factors



Model uncertainty

(b)

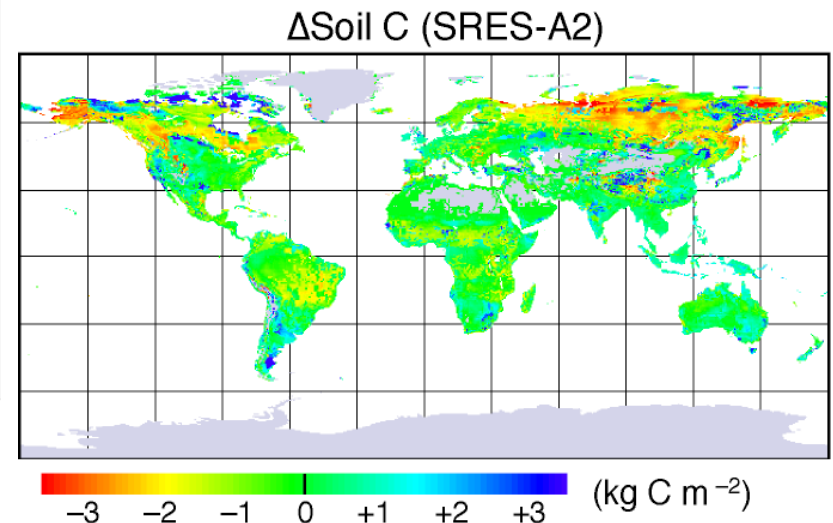
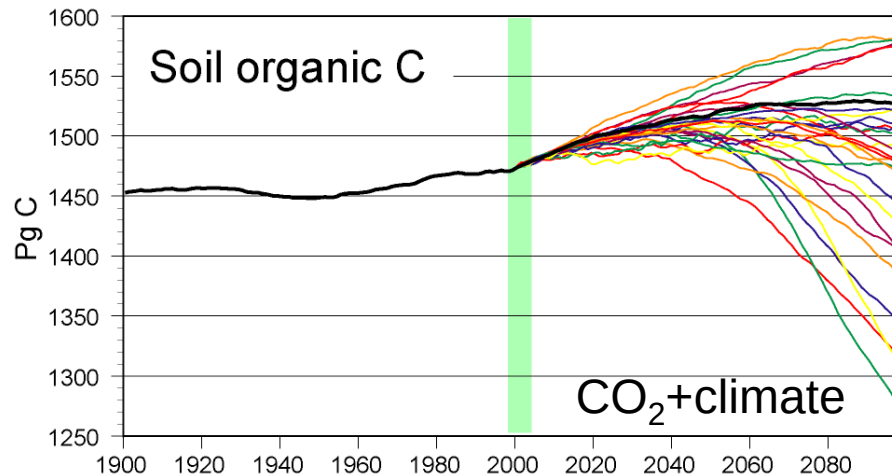
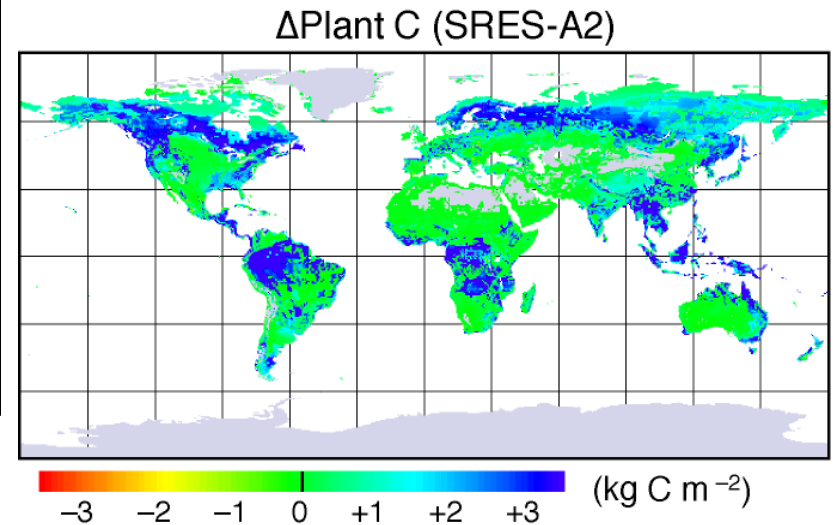
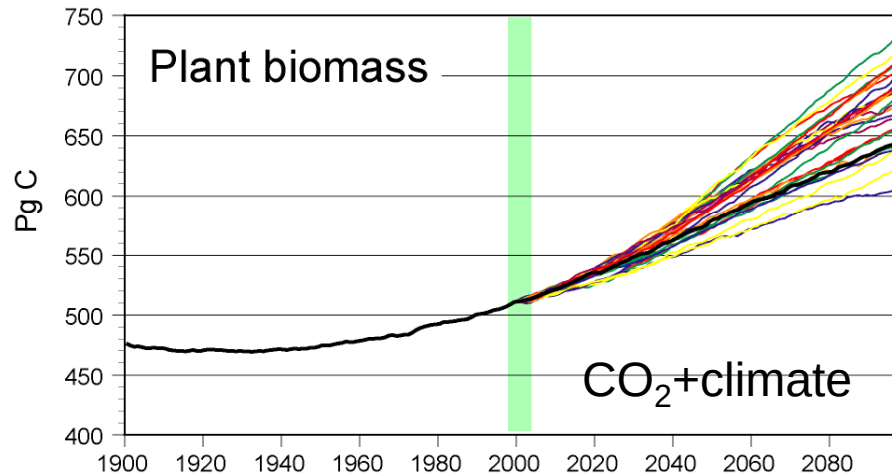


Cramer et al. (1999)
17 model NPP estimations:
30 – 80 Gt C / yr

Cramer et al. (2001)
6 DGVMs:
different NEP & biome shift

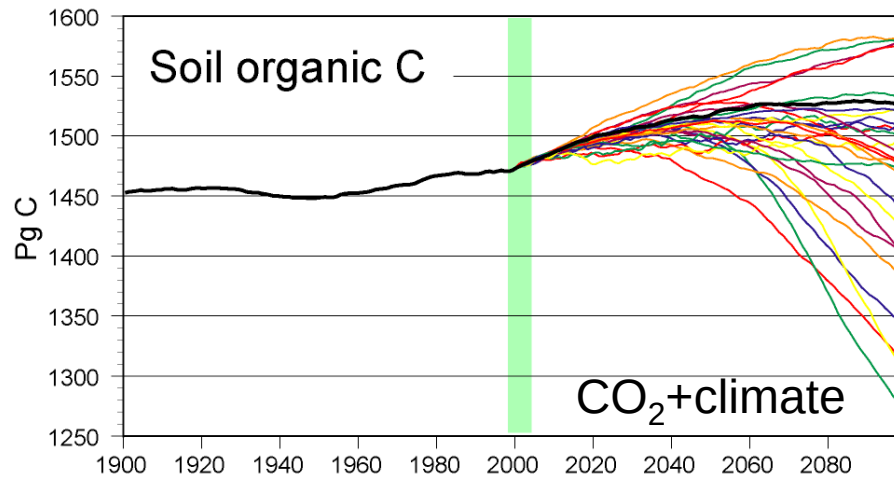
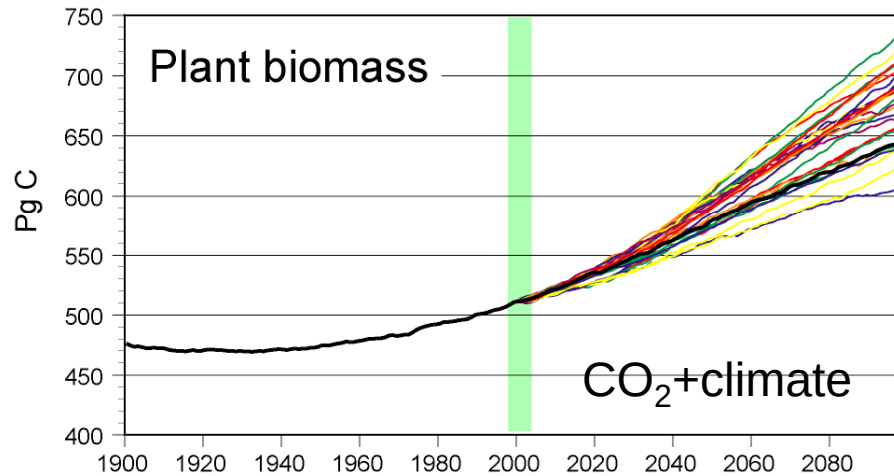
Friedlingstein et al. (2006)
11 climate-carbon cycle models:
different carbon feedbacks

Physiological Response

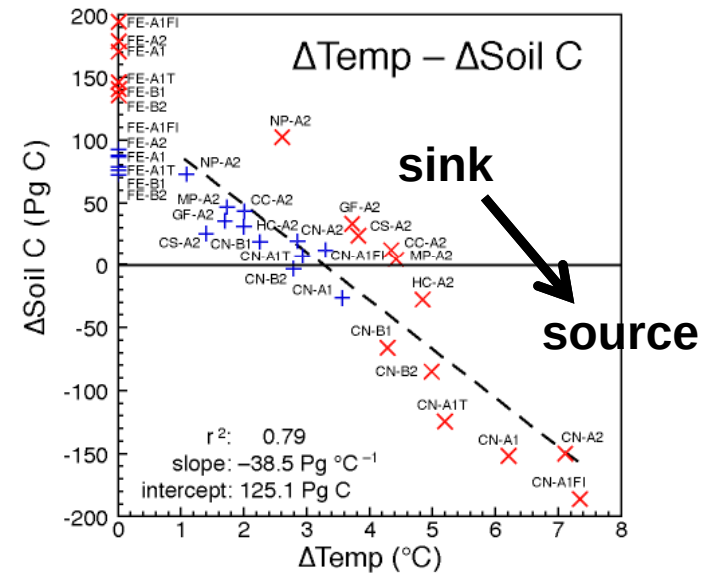
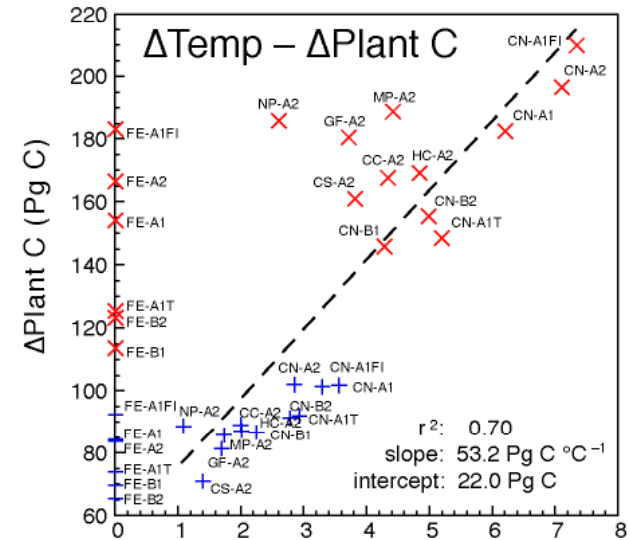


Model: SimCYCLE-VISIT (Ito, 2005)

Physiological Response

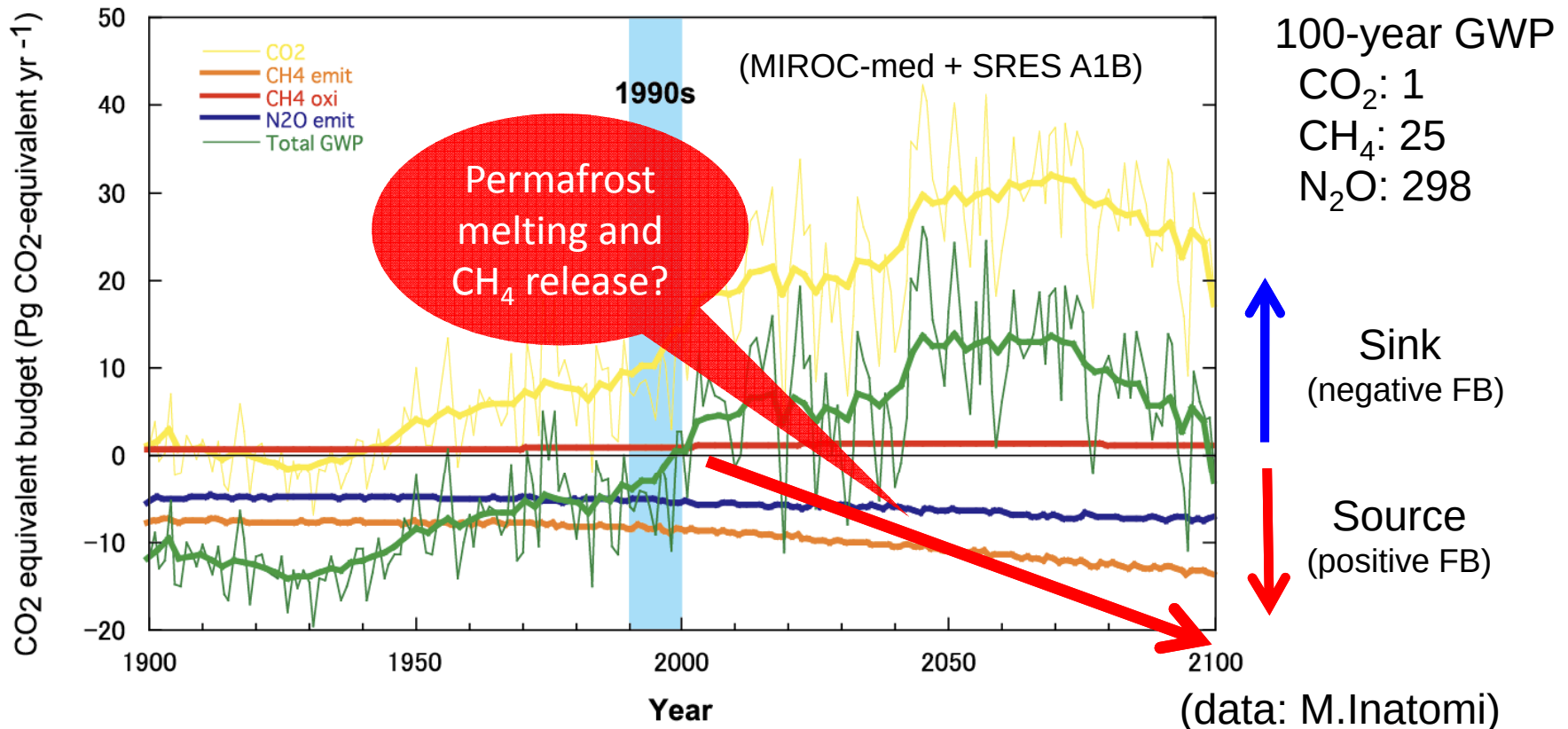


Model: SimCYCLE-VISIT (Ito, 2005)



Effects of CH_4 and N_2O

Biogeochemical exchange of non- CO_2 greenhouse gases (CH_4 and N_2O) is potentially important. The total budget of Global Warming Potential (GWP) can be different from NEP.



Disturbance: local but drastic



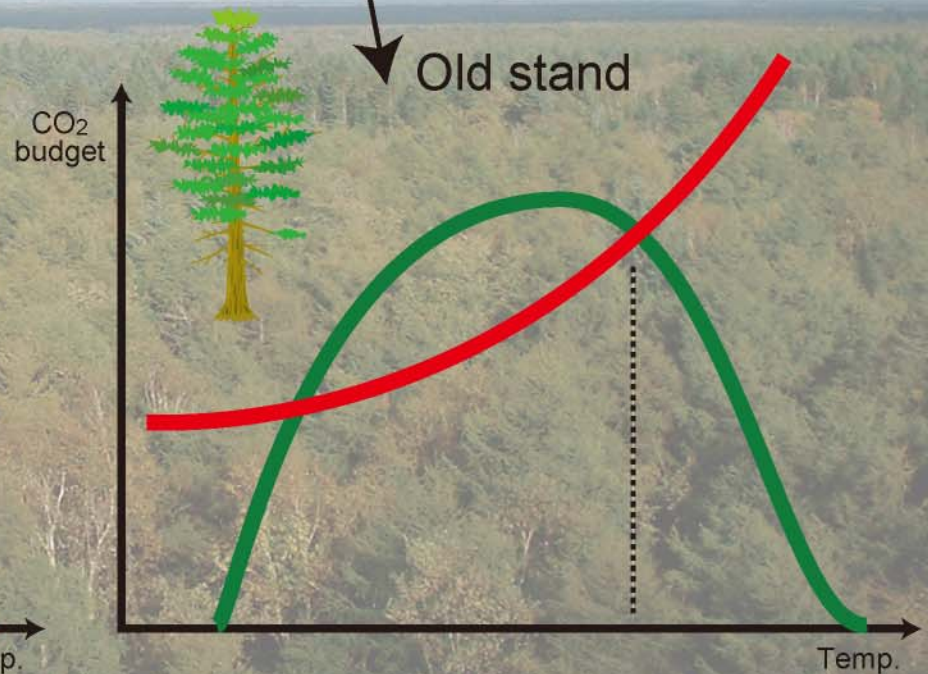
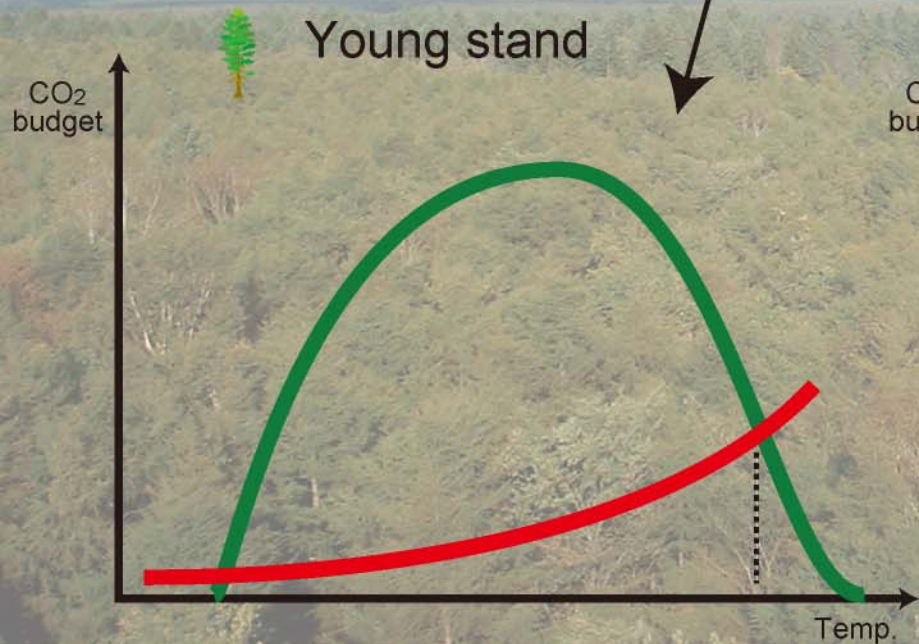
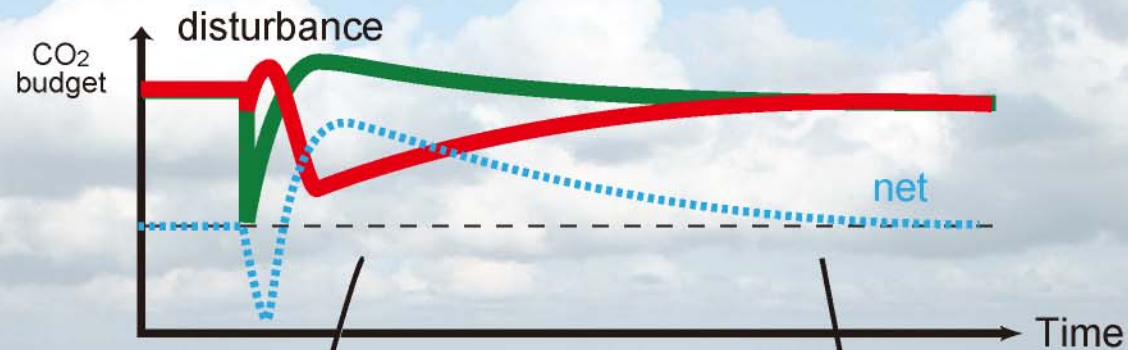
24th June 2008, Sapporo

Disturbance: local but drastic



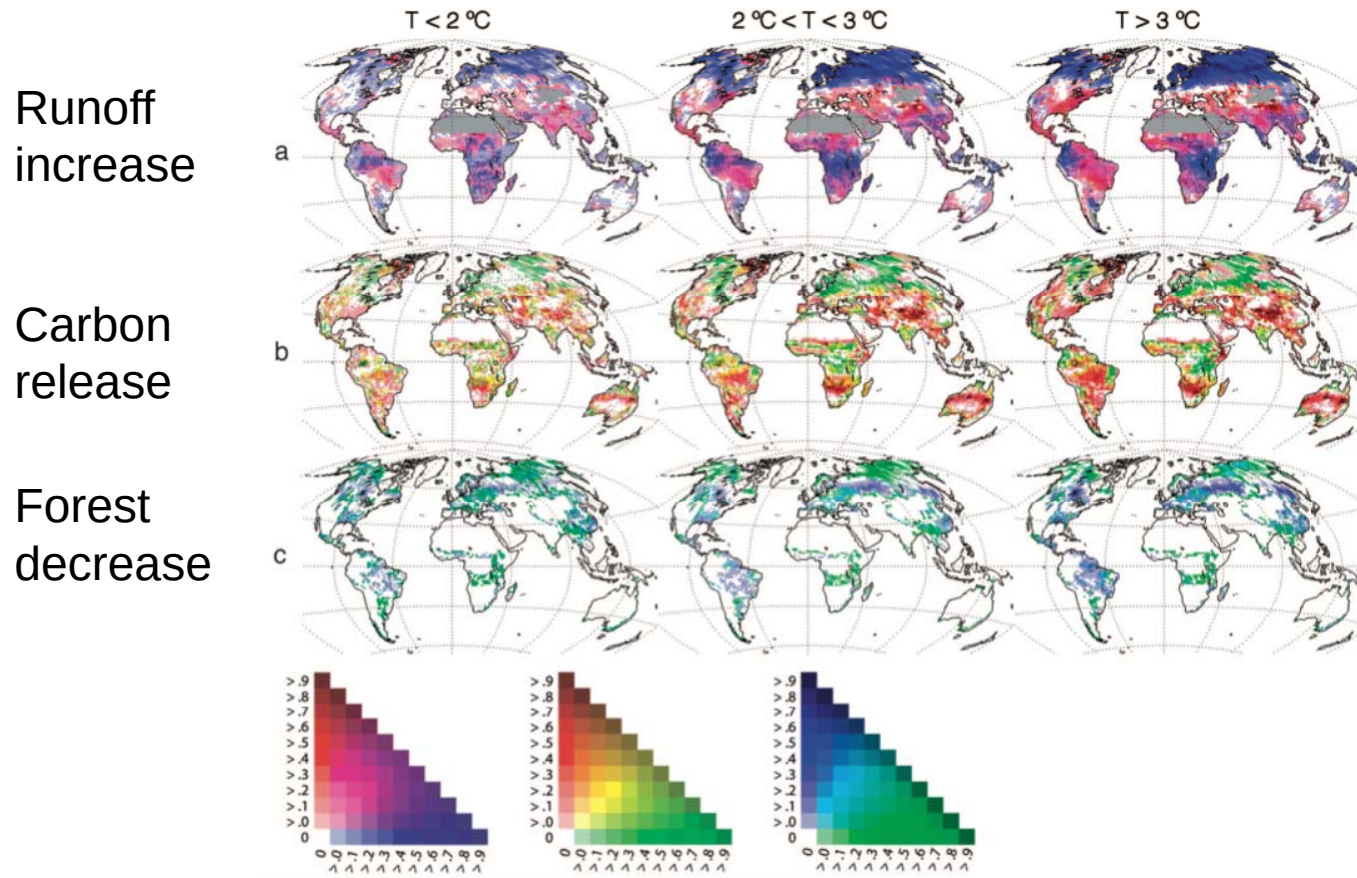
24th June 2008, Sapporo

Disturbance: local but drastic



Ecological Risk Assessment

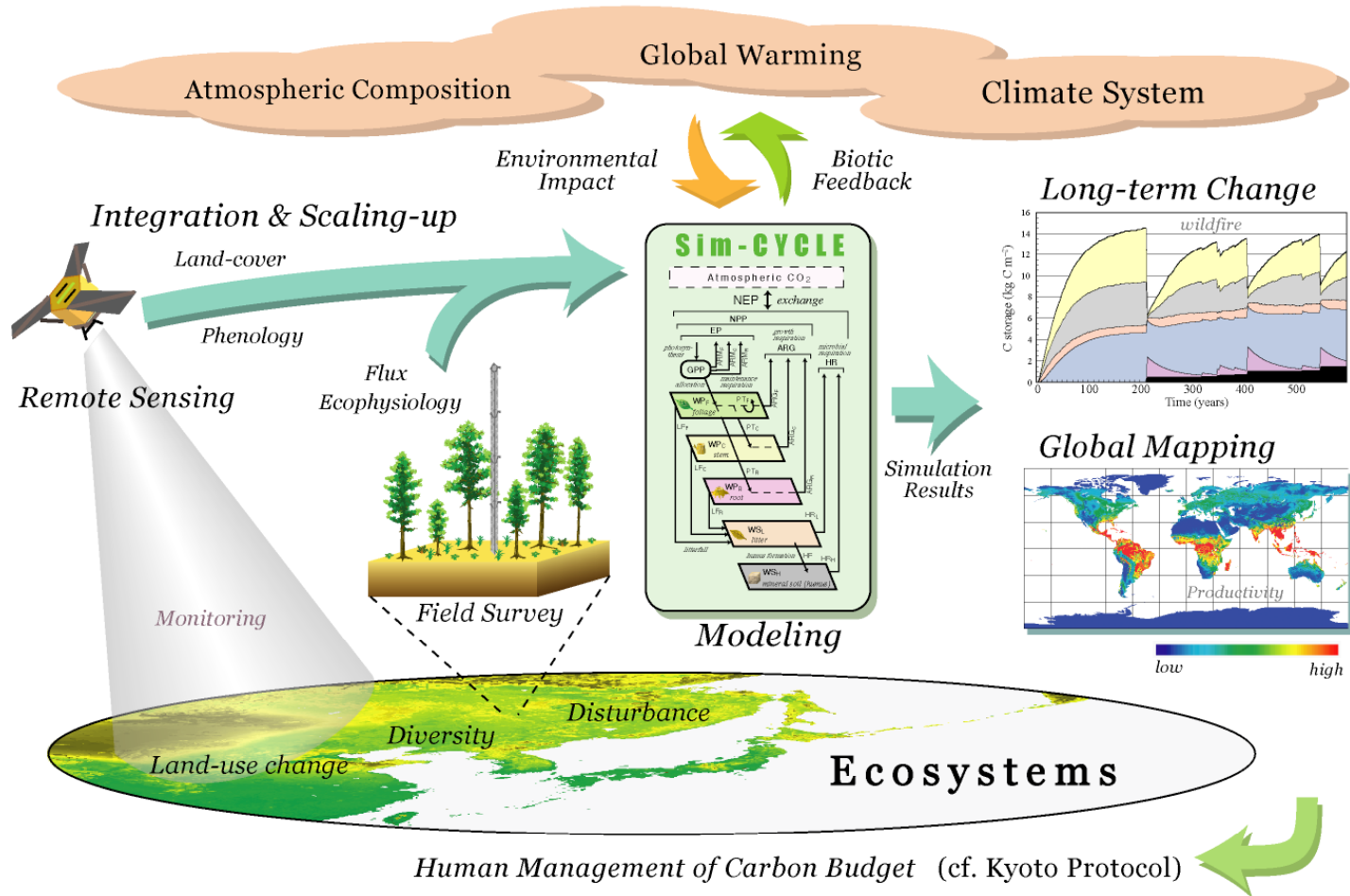
Probabilistic evaluation based on multiple scenarios.



Scholze et al. (2006): Using LPJ model, ecological risks under climate change were investigated: high risk of river floods, carbon source, and biome shift.

Integrated Research

Intimate linkage between observation and modeling



Earth Observations

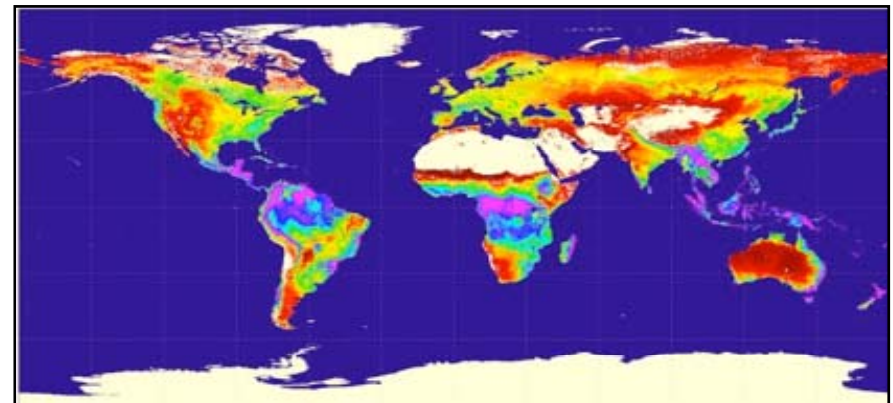
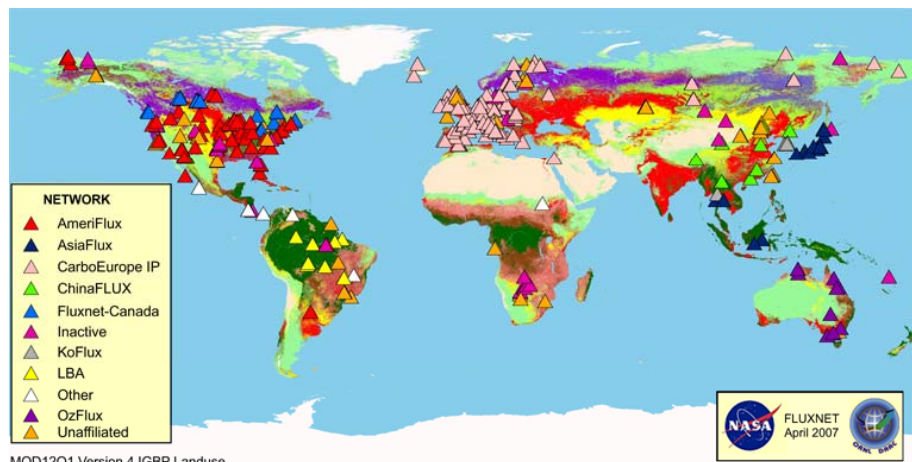
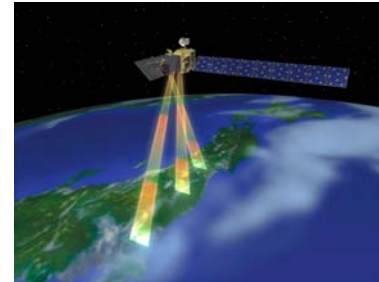
Flux measurement – bottom-up

- global coverage (over 500 sites)
- site scale (km²)
- long-term continuous (max. 15 years)
- NEE (GPP / Re)

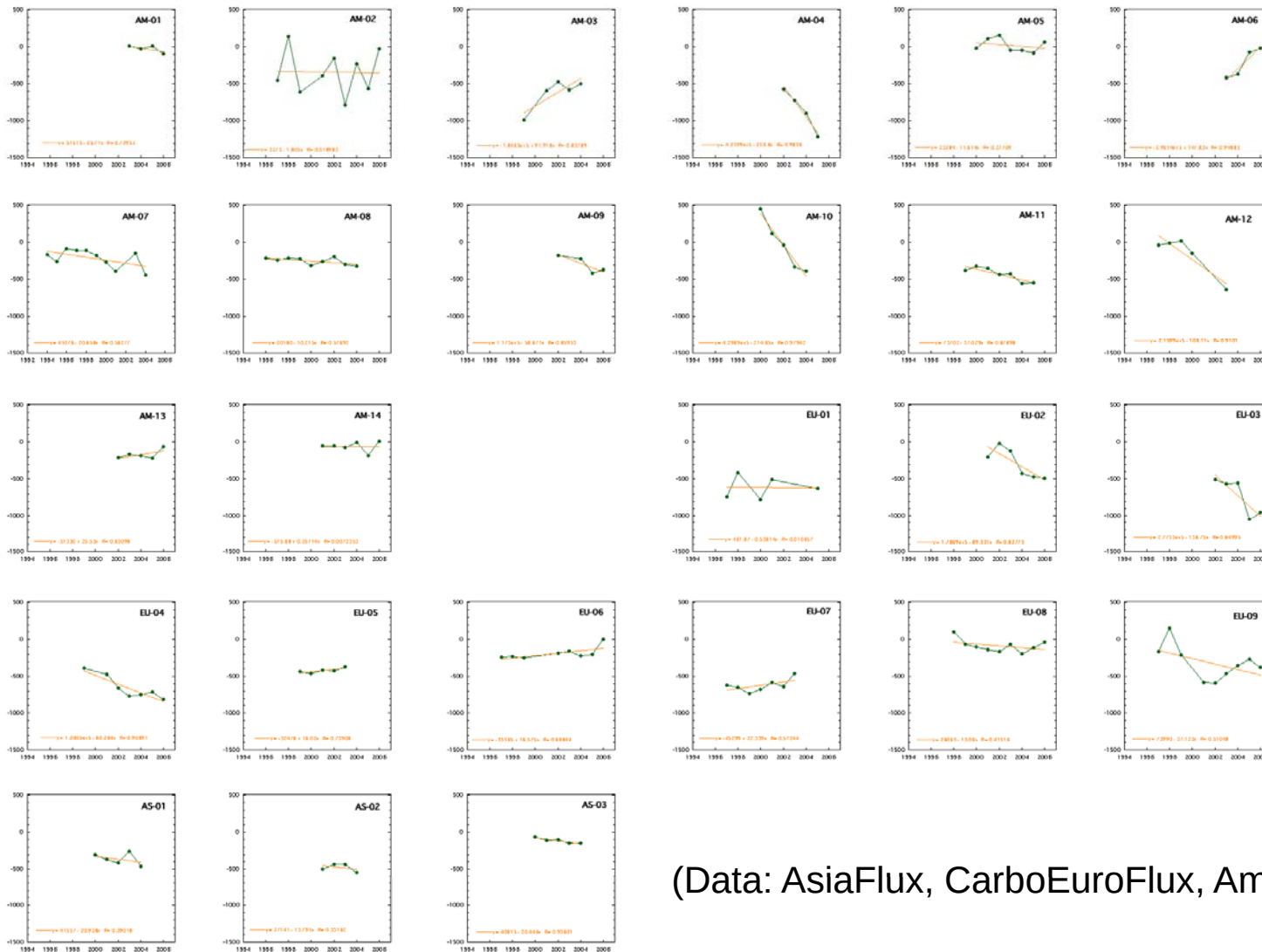


Satellite observation – top-down

- global coverage
- global scale (10⁸ km²)
- long-term continuous (max. 25 years)
- NDVI, LAI, fAPAR, NPP, land cover etc.

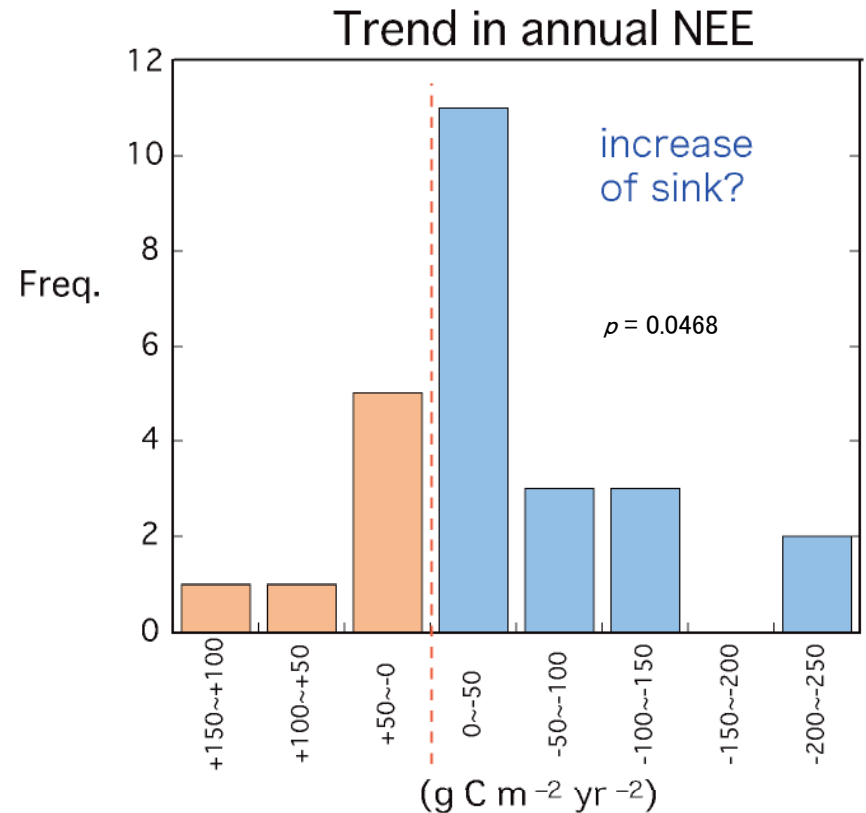
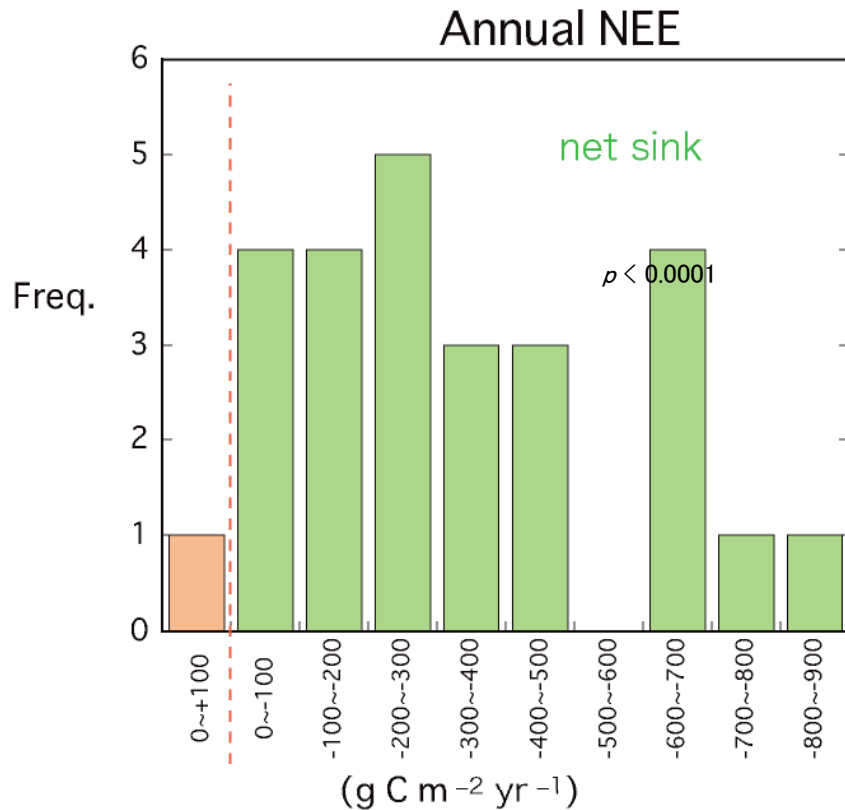


Observed CO₂ Budget

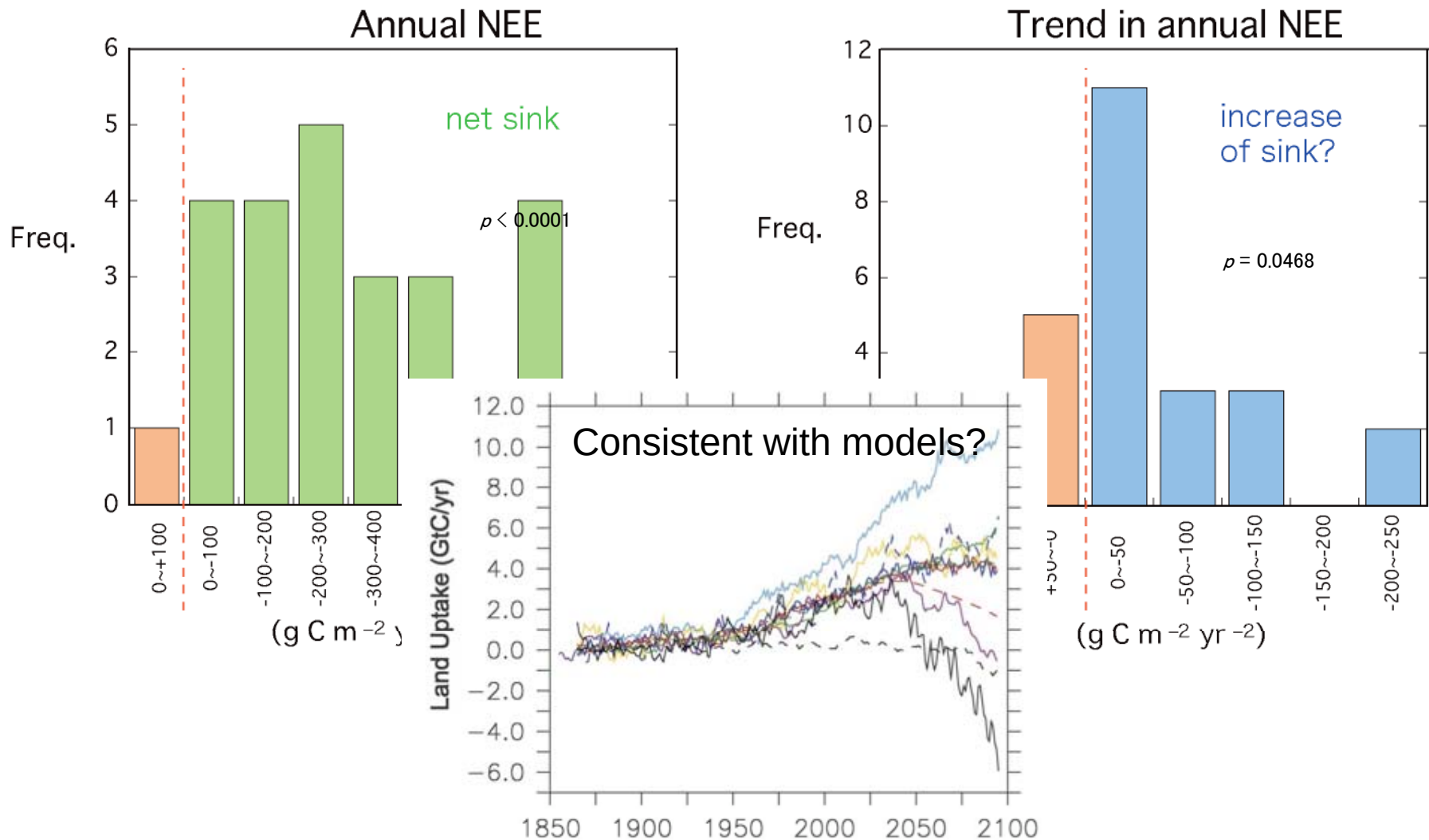


(Data: AsiaFlux, CarboEuroFlux, AmeriFlux)

Observed CO₂ Budget



Observed CO₂ Budget



Concluding Remarks

- Because of CO₂ fertilization and climatic warming, terrestrial ecosystems would act as a net carbon sink (negative feedback) by ca. 2050, but turn to a net source by the end of 21st century.
- There remain large uncertainties in responsiveness to elevated CO₂, temperature, and precipitation change.
- Additional processes such as CH₄ and N₂O exchange, land-use change, and biomass burning may not be negligible but can strongly affect net response (feedback) to global warming.
- Further studies, especially Earth Observations, are required to understand ecosystem dynamics under global change, improve models, and make more reliable predictions.



Thank you