Geophysical Fluid Dynamics Laboratory Review

June 30 - July 2, 2009

Land Ecosystems and Biogeochemical Cycling

Presented by

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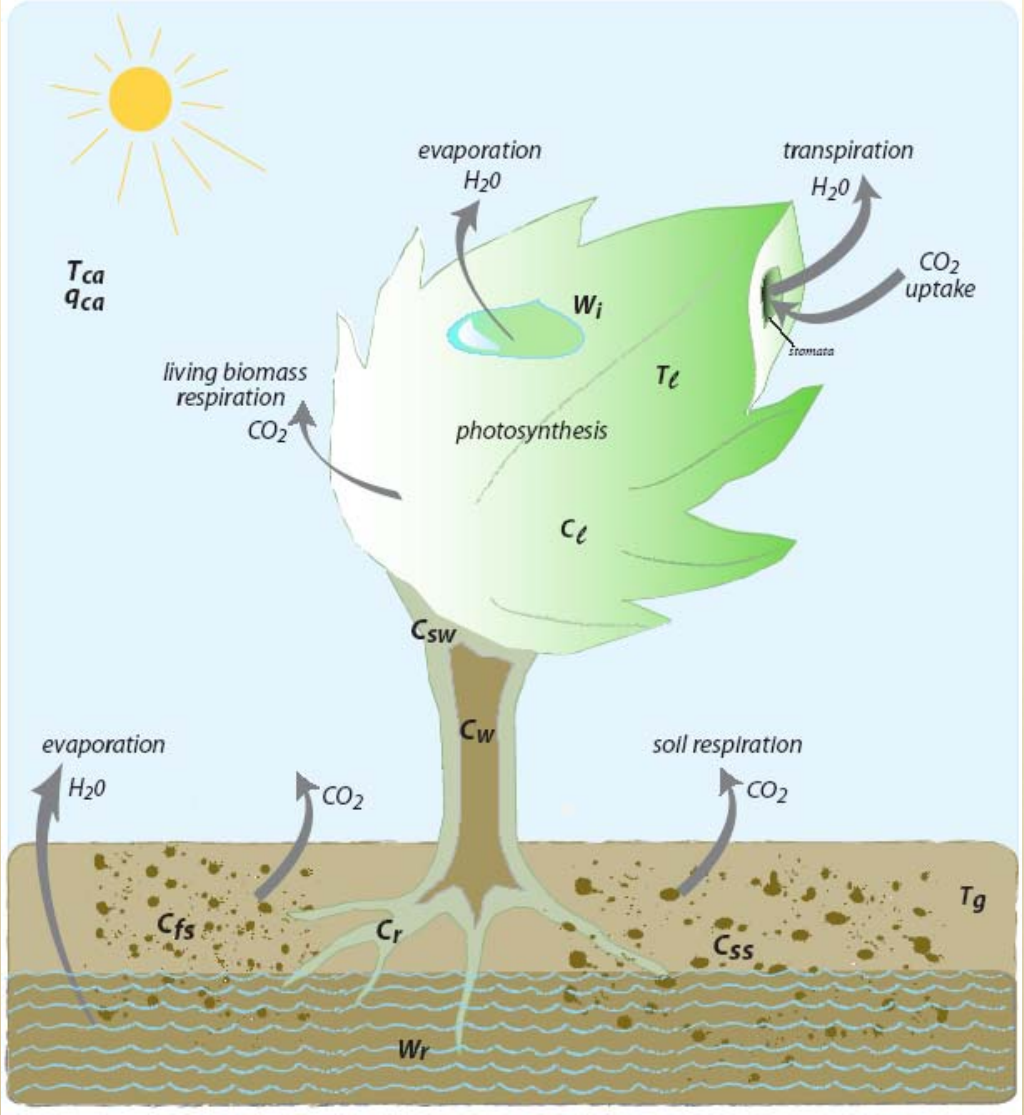
Vegetation structure in the LM3 land model



5 vegetation types

5 vegetation C pools (C_l, C_{sw}, C_w, C_r, C_{lv})

2 soil C pools (C_{fs} *and* C_{ss})

4 land-use types

Up to 15 tiles of different ages per grid-cell

Natural mortality and fire

Shevliakova et al., 2009

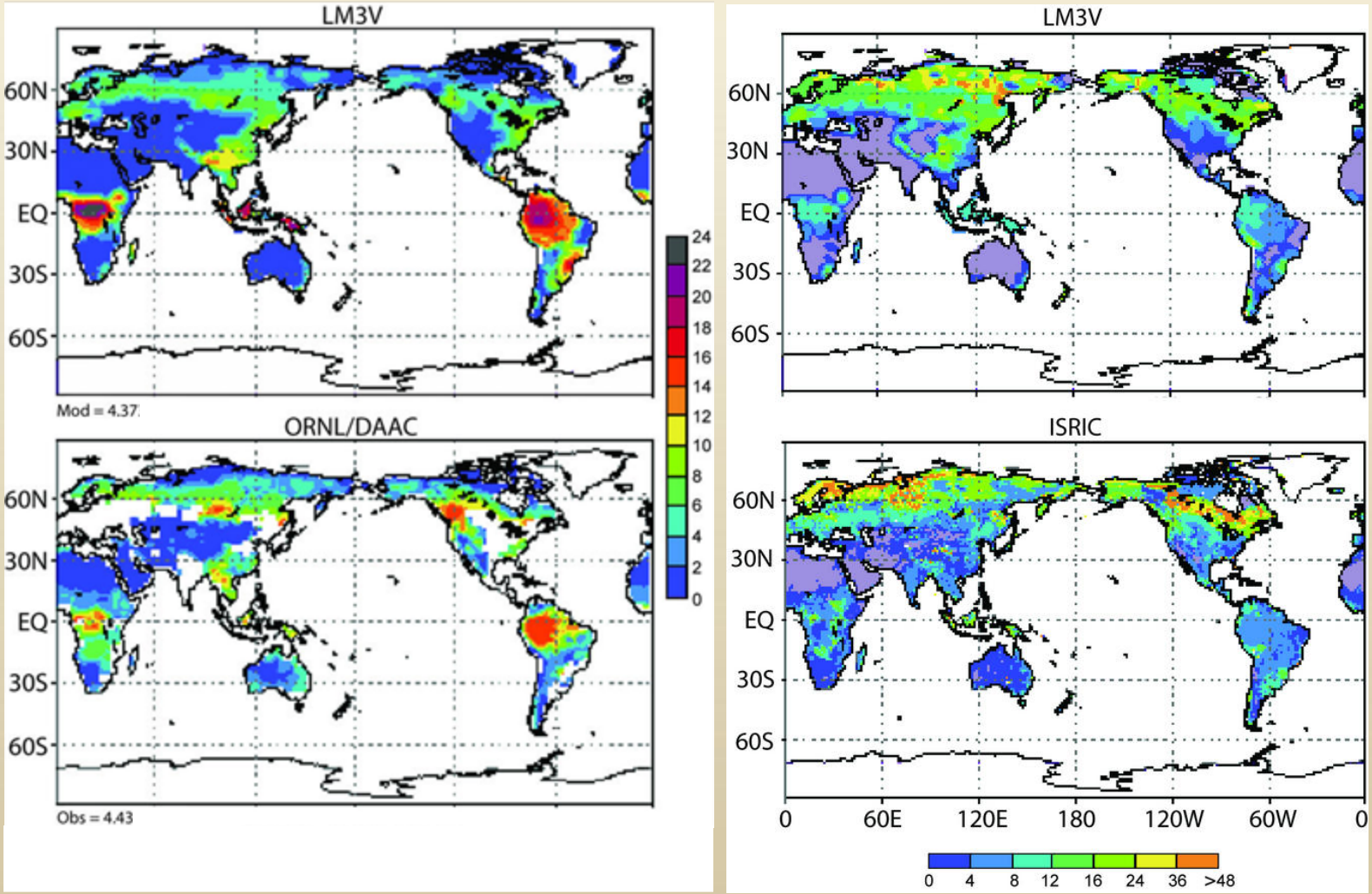
LM3V generates present-day distributions of vegetation and soil C

Vegetation C, Kg/m²

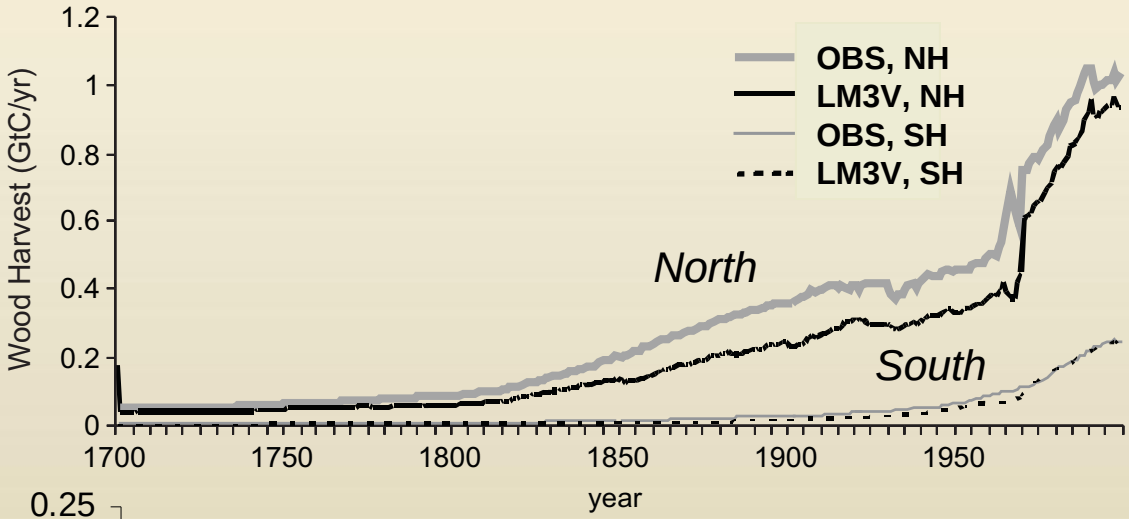
Soil C, Kg/m²

model potential, current climate

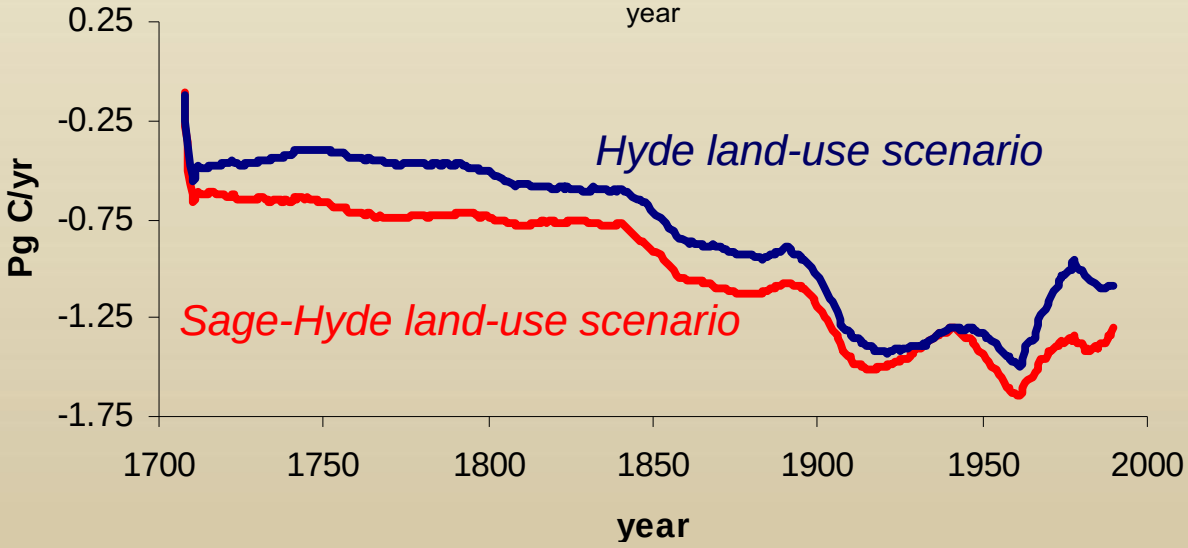
observation-based estimates



LM3V simulates the land-use sinks & sources, including forestry



Simulated historical wood harvests compare well with the FAO-based estimates



The model's estimate of the 90s land use flux, *1.1-1.3 PgC/a*, is about half of previous estimates and implies a smaller "missing sink"

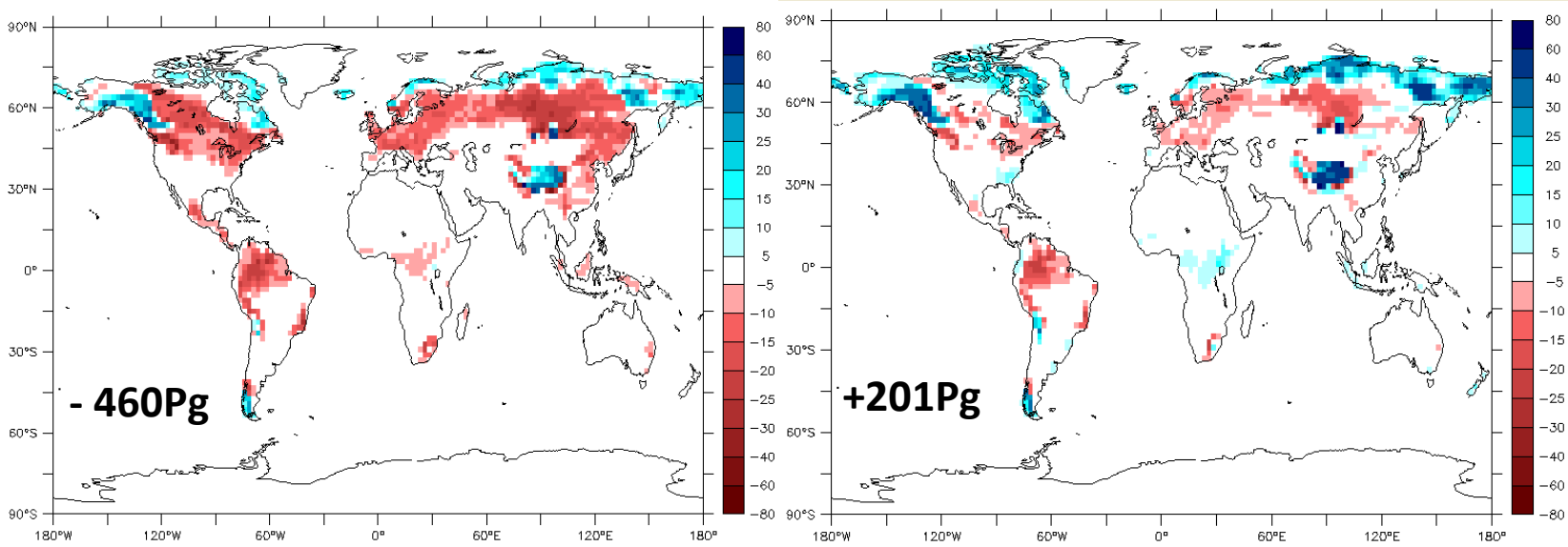
Shevliakova et al., 2009

Uncertainty about CO_2 fertilization is the key factor for future land C uptake

GFDL Slab-Ocean Climate Model (SM2.1-LM3V)

Atmospheric CO_2 concentration: 572 ppm in both experiments

No fertilization, photosynthesis at 286 ppm | **Fertilization, photosynthesis at 572 ppm**

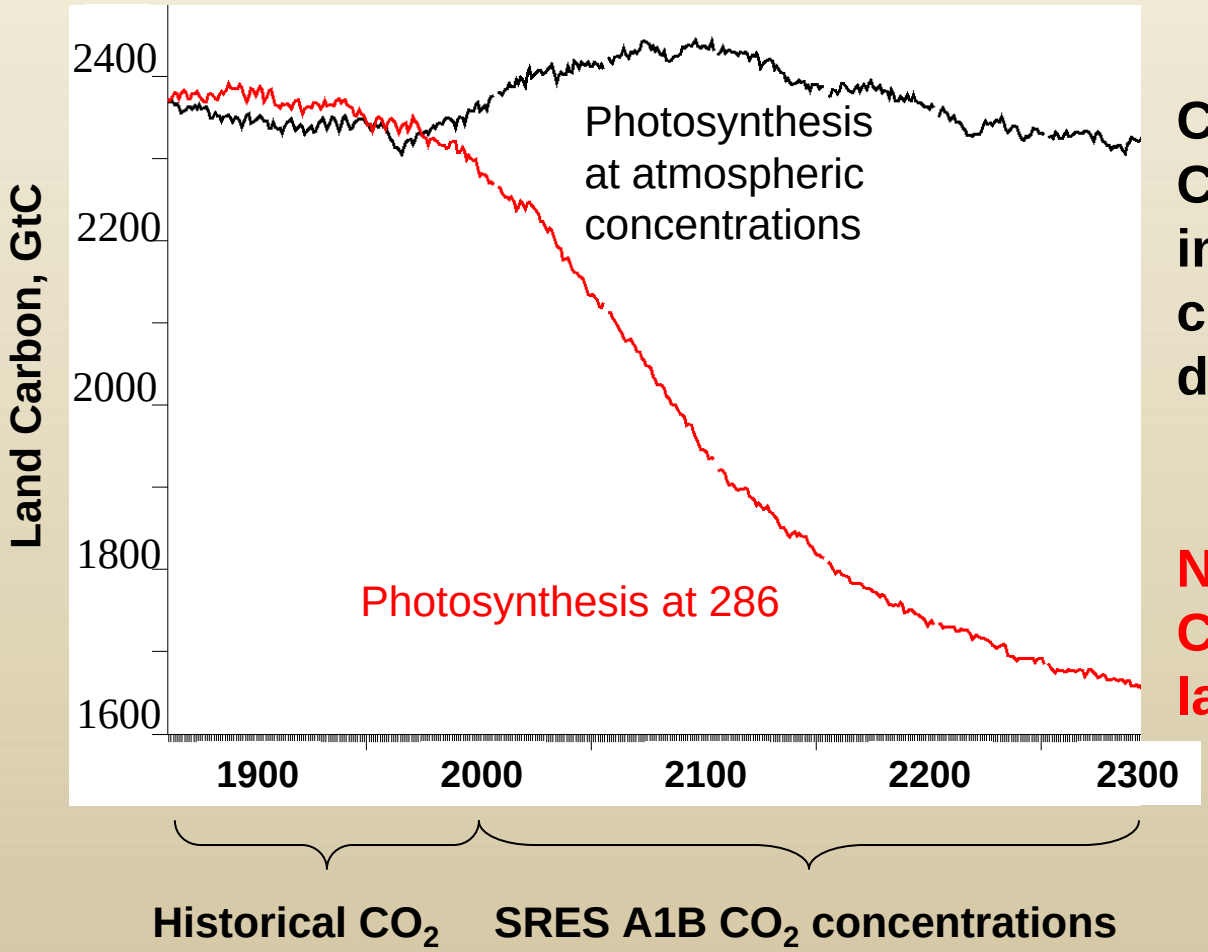


Equilibrium changes in land C from preindustrial levels

The difference in the resulting land carbon storage suggests that the magnitude of the CO_2 fertilization uncertainty can be as large as that associated with clouds or oceanic heat uptake

Shevliakova et al., subm.

Transient changes in land C storage depend on CO_2 fertilization (ESM2.1)



CO_2 fertilization: Carbon storage increases in 21st century and then declines

No CO_2 fertilization: Catastrophic loss of land carbon

Summary

- **The GFDL ESM land component, LM3**
  - represents a range of *biosphere-climate interactions and feedbacks*
  - captures effects of both climate change and land use on *vegetation dynamics and structure*
  - simulates historic and future distribution of *Carbon sources and sinks*
- **A version of LM3 simulates coupled *Carbon-Nitrogen dynamics* in plants and soils**
  - *poster by Gerber, Keel et al.*
- **Considerable uncertainty about the magnitude of climate effects on biosphere and its feedbacks**

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