Assessment of Model Estimates of Land-Atmosphere CO_2 Exchange Across Northern Eurasia

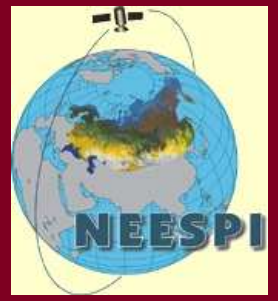
Michael A. Rawlins
University of Massachusetts – Amherst

A. David McGuire
US Geological Survey, Fairbanks, AK

John S. Kimball
University of Montana

Pawlok Dass
University of Massachusetts – Amherst

Members of the Model Integration Team of the Permafrost Carbon Network



OUTLINE

- **Motivation for Study**
- **Models and Region**
- **Results**
- **Conclusions and Recommendations**

Study Motivation

- Magnitude of sink for atmospheric CO_2 uncertain

- Recent studies suggest land models overestimate respiration flux

- Evaluate late 20th century changes in productivity and respiration

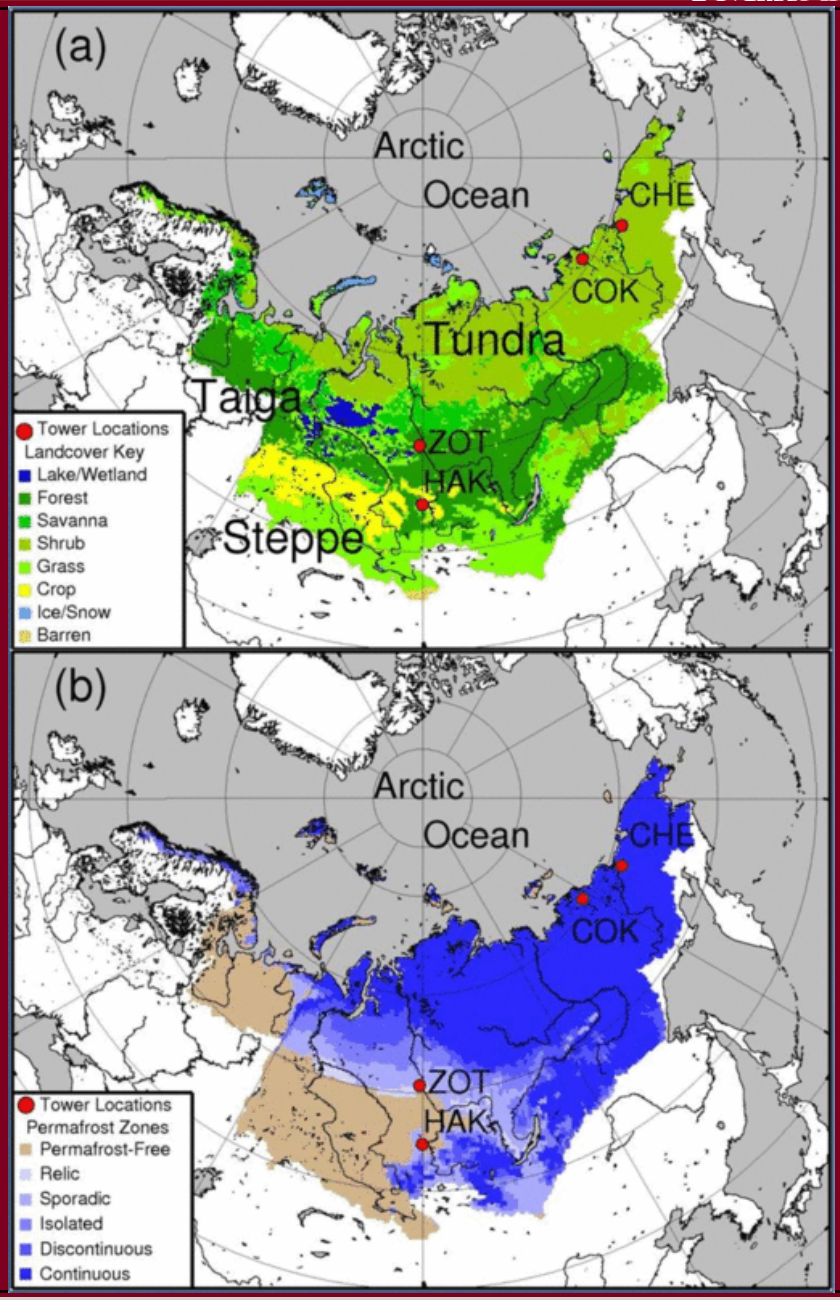
- Model benchmarking

Study Region

Drainage basin of northern Eurasia

Steppe to Tiaga-Forest to Tundra

More than 50% of area underlain by permafrost



Rawlins et al., in prep

Models Participating in the Simulations

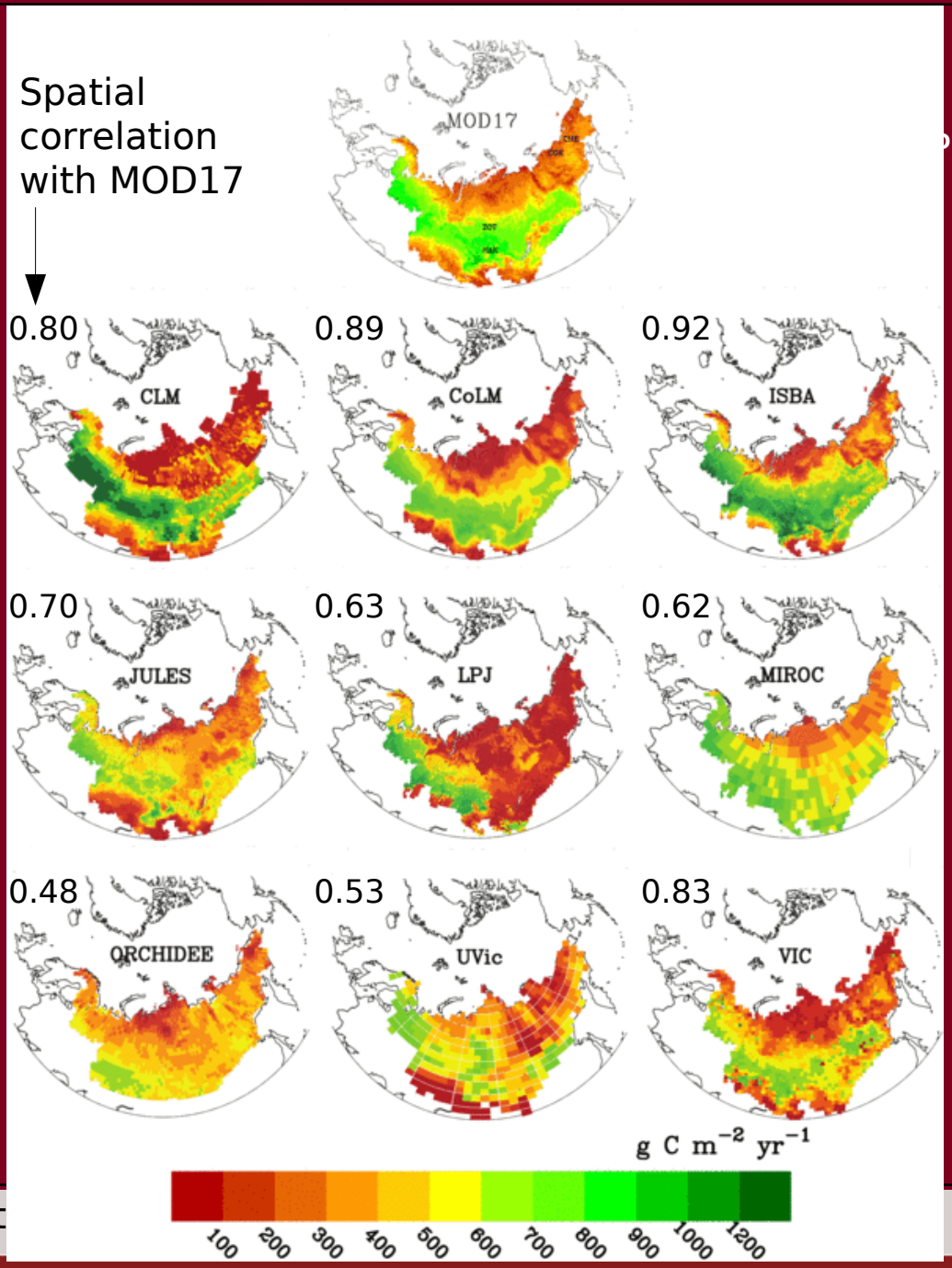
- Simulation period 1960-2009
- Resolution 0.5 degree
- Land area northern hemisphere

Model	Institution
Community Land Model (CLM)	National Center for Atmospheric Research, USA
Common Land Model (CoLM)	Beijing Normal University, China
Interaction Sol-Biosphère-Atmosphere (ISBA)	National Centre for Meteorological Research, France
Joint UK Land Environment Simulator (JULES)	Met Office, United Kingdom
Lund-Potsdam-Jenna General Ecosystem Simulator (LPJ-GUESS)	Max-Planck Institute for Biogeochemistry, Germany
Model for Interdisciplinary Research on Climate (MIROC)	Center for Climate System Research (CCSR), University of Tokyo, Japan
Organising Carbon and Hydrology In Dynamic Ecosystems (ORCHIDEE)	Institute Pierre Simon Laplace (IPSL), France
University of Victoria (UVic)	University of Victoria, Canada
Variable Infiltration Capacity (VIC)	University of Washington, USA

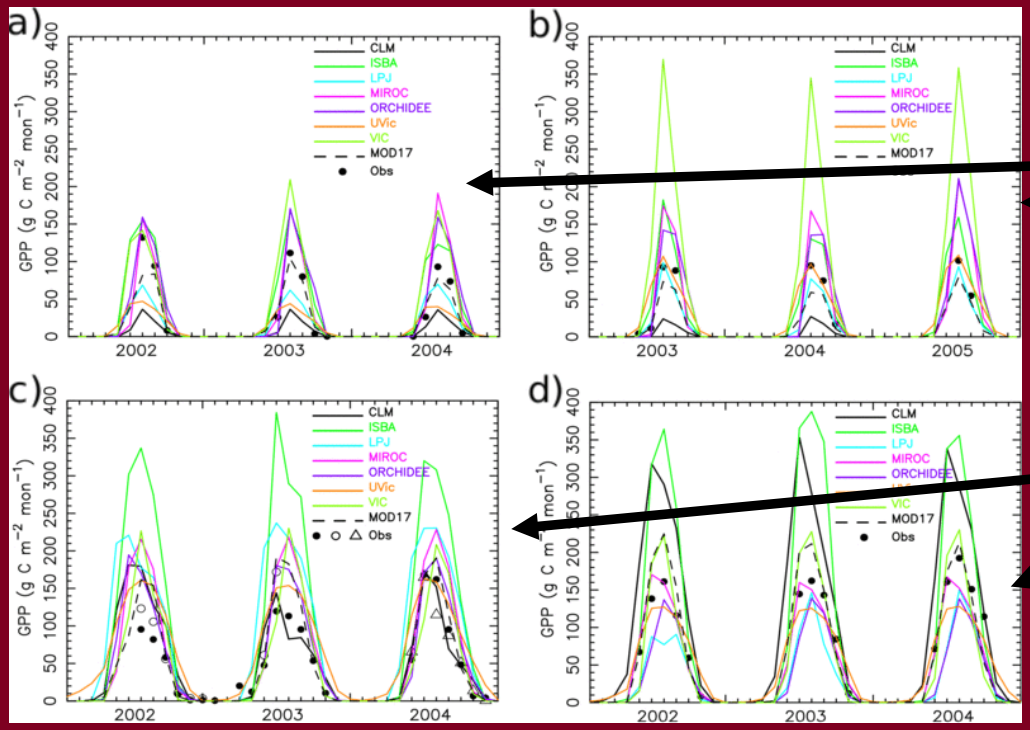
Evaluating Spatial Pattern in GPP

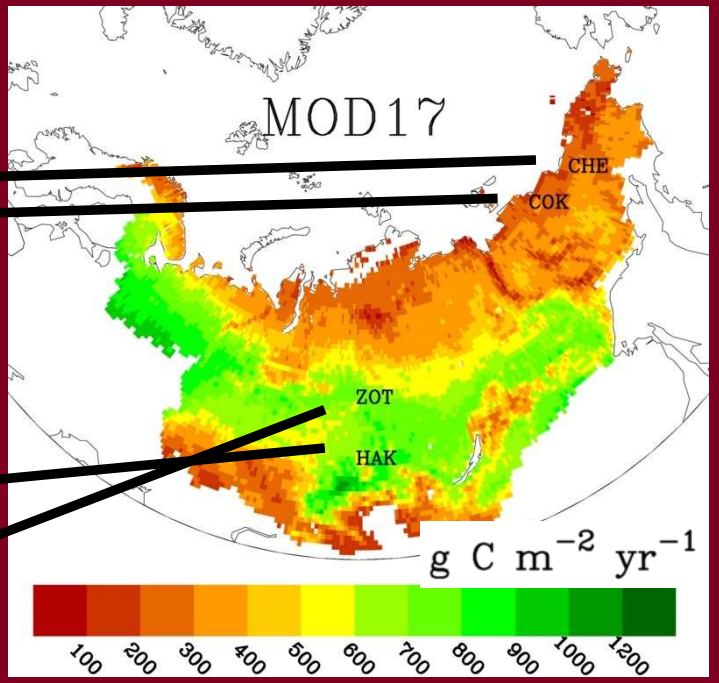
CoLM and ISBA agree well w/ MOD17 GPP

Four models explain less than half of the spatial pattern in MOD17 product GPP



Monthly Gross Primary Productivity

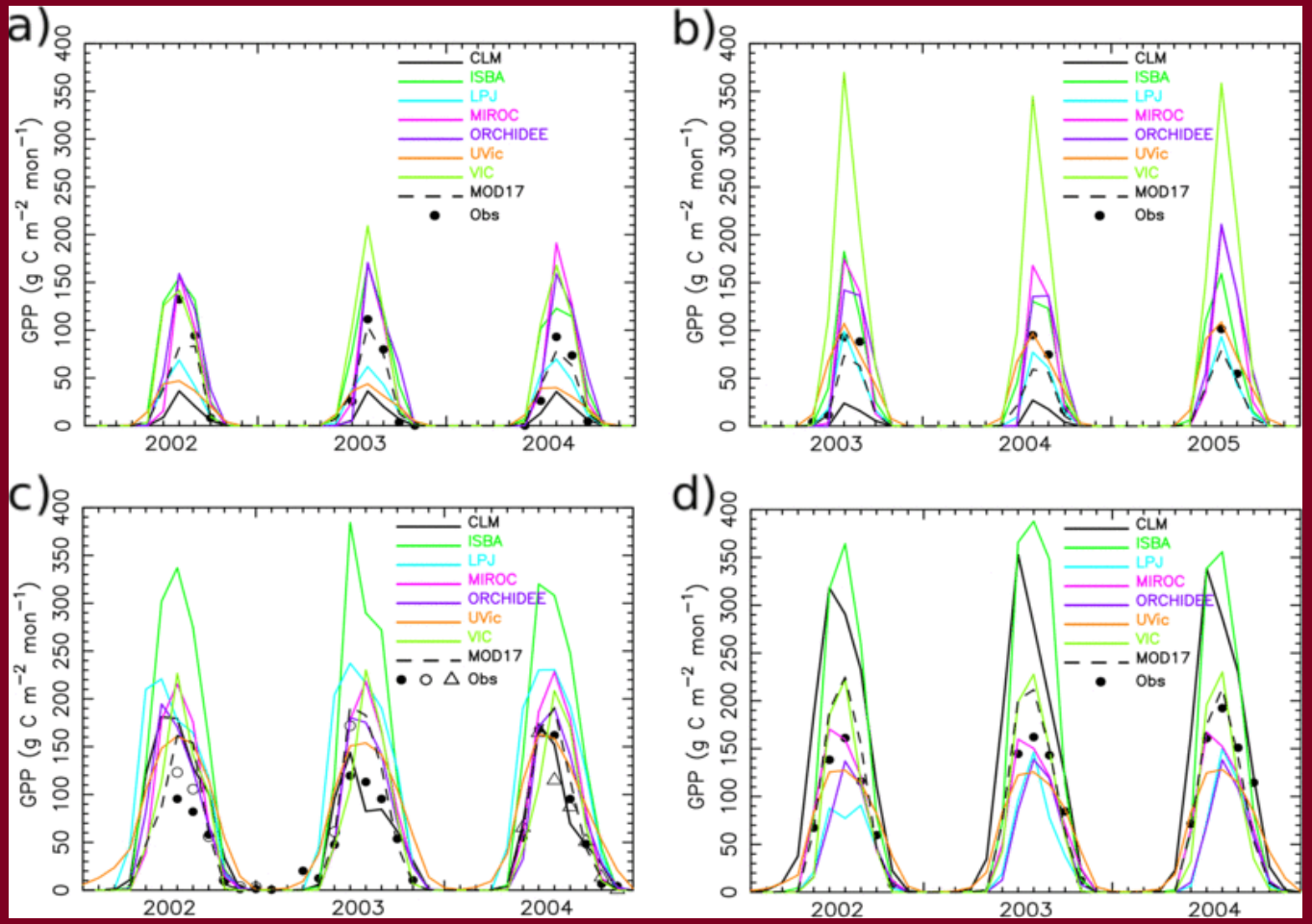




Monthly Gross Primary Productivity

Timing of peak productivity well estimated

Overestimates at forest sites

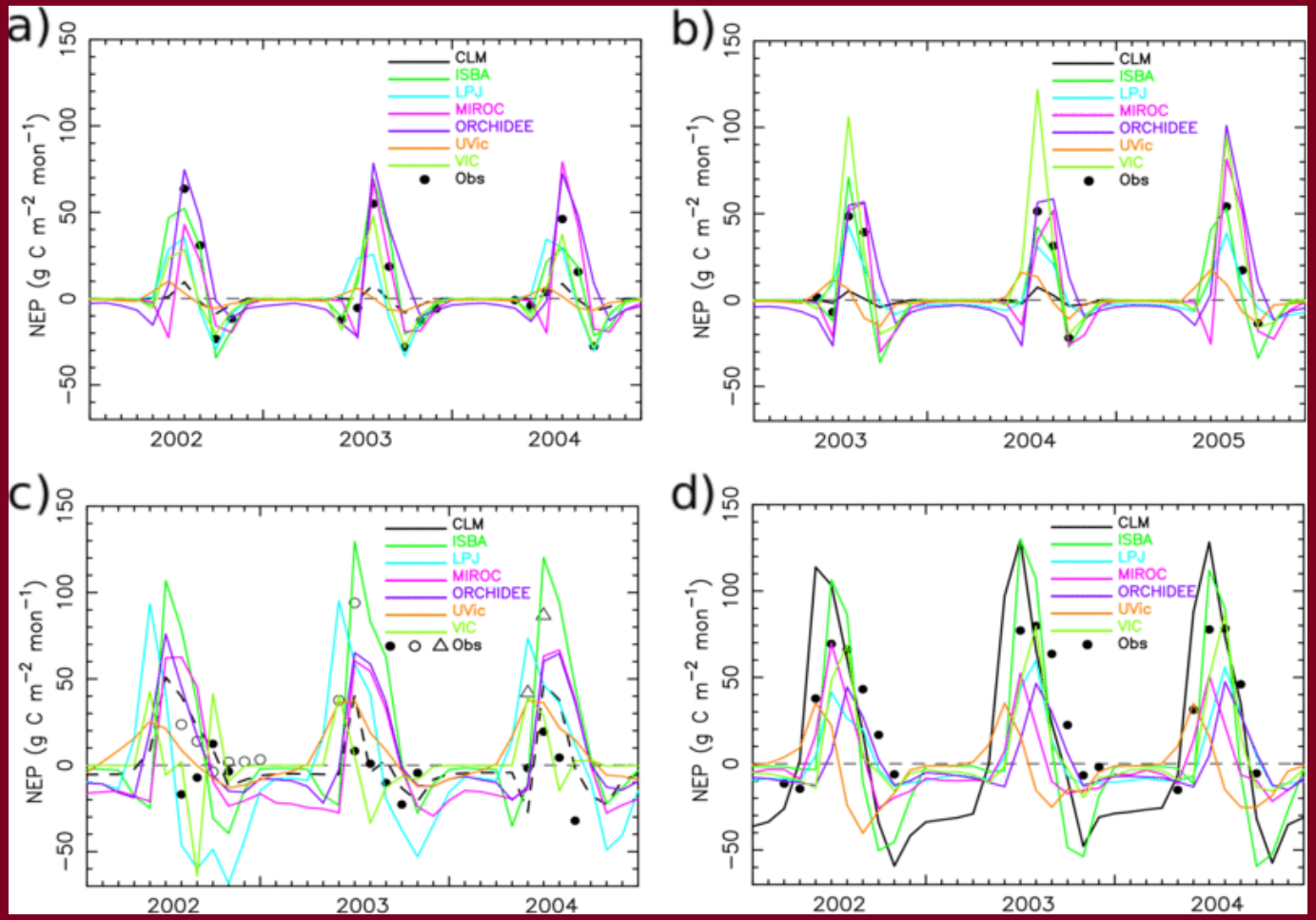


Monthly Net Ecosystem Productivity

Overestimates in CO_2 source in autumn due to high respiration rates

Measured data sporadic in winter

NEP = GPP - ER

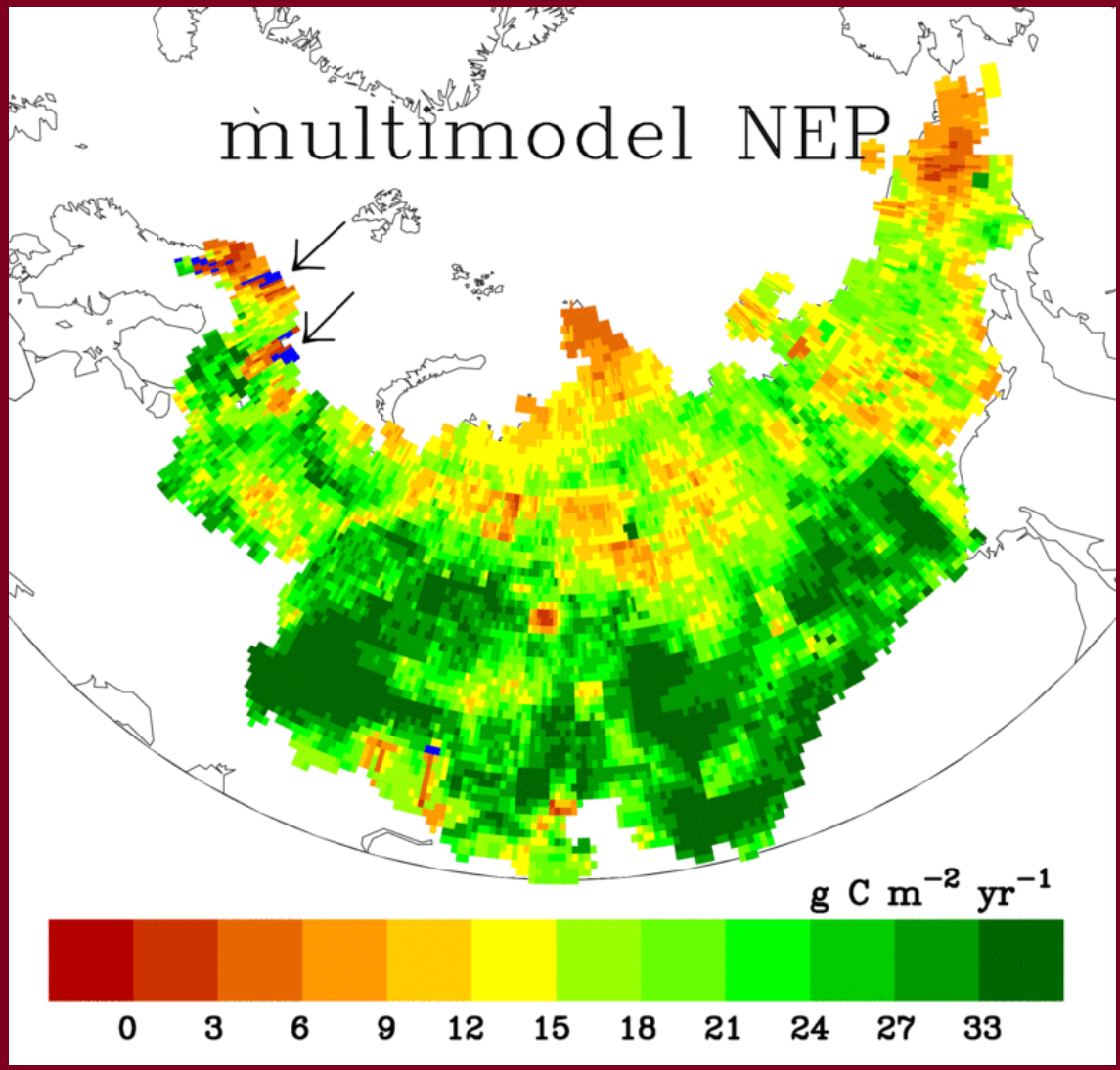


Monthly Net Ecosystem Productivity

Regional NEP varies from a small source to up to ~40 g C m^{-2} yr^{-1} across forest zone.

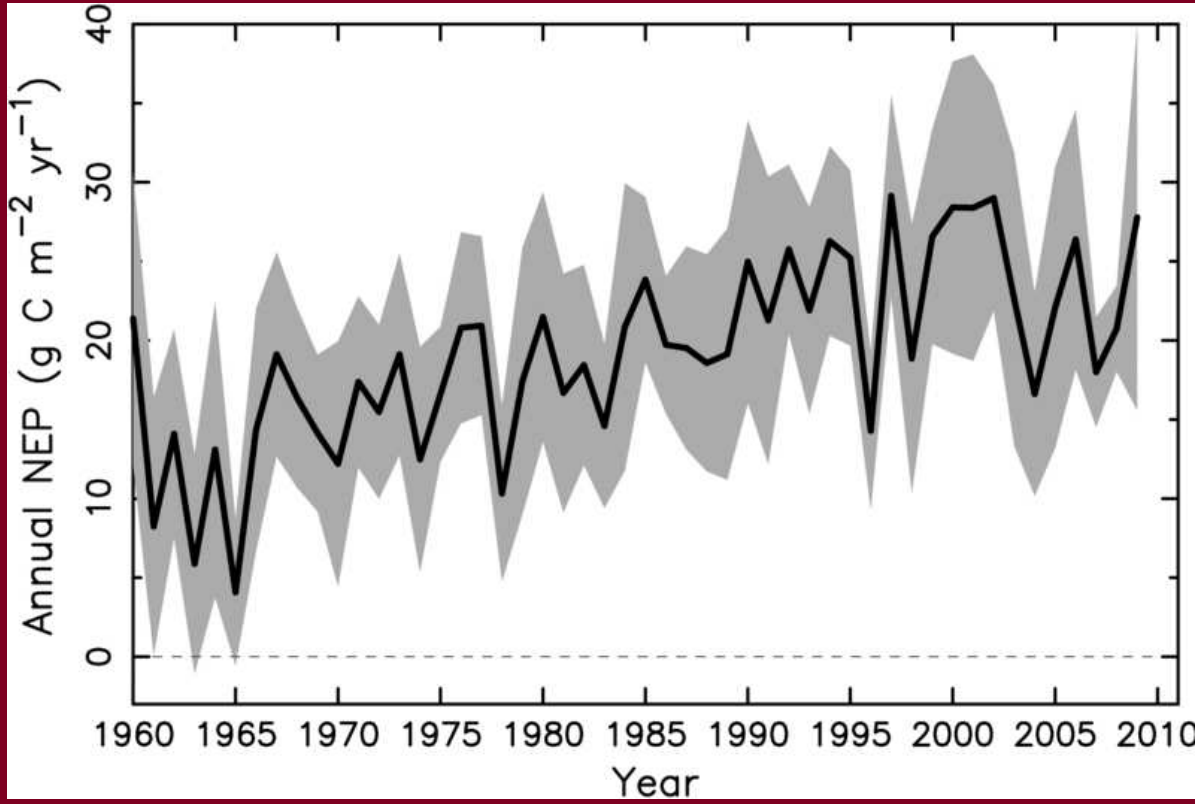
Overestimates in respiration suggest sink may be underestimated.

Must account for disturbances.



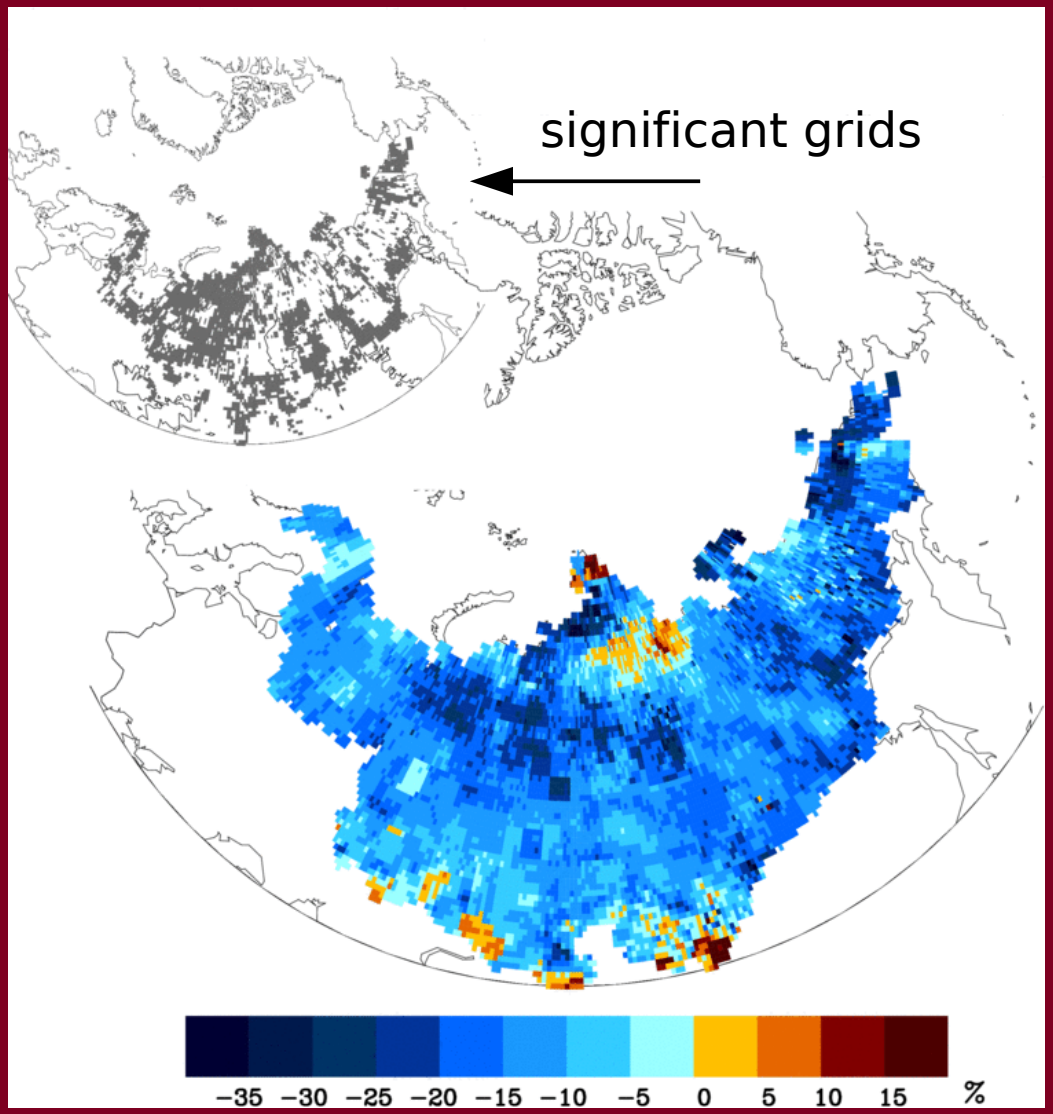
Annual NEP averaged across the models

- Mean NEP positive
- Best agreement during “low sink” years
- End of NEP increase?



standard error range

Change in Soil C Residence Time 1960-2009



- **Residence time decreasing**
- **Soil C storage increase**
- **NPP inputs greater than Rh losses**

Conclusions and Recommendations:

- **Evaluations point to model overestimates in respiration in high productivity region.**
- **GPP, ER, and NEP increasing. CO_2 sink weakening.**
- **Soil C residence time decreasing amid increases in soil C storage.**
- **A priori model forcing and parametrization setup needed.**
- **Investments to better measure and model high arctic carbon cycle.**

Acknowledgements

Study supported by NASA Carbon Cycle program grant: "Synthesis and Integration of Recent Research Characterizing the Carbon Cycle of Northern Eurasia"

MODIS Land Cover Type product data was obtained through the online Data 502 Pool at the NASA Land Processes Distributed Active Archive Center (LP DAAC).

Researchers working at FLUXNET sites for providing the CO2 flux data.