North American Carbon Project (NACP) Regional Model-Model and Model-Data Intercomparison Project

AGU Joint Assembly

Toronto, May 25, 2009

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Participants: *Dozens of modeling teams and data providers, Canada, USA, Mexico, Europe*

Interim Synthesis of Regional and Continental Models and Data

- Initiated by MAST-DC and NACP investigators in 2008
- In-hand model simulations & data
- 2000-2005
- 1° spatial resolution
- Monthly temporal resolution
- 14 forward/ecosystem models
- 24 inversion models

http://nacp.ornl.gov/mast-dc_products.shtml

http://nacp.ornl.gov/int_synth_contreg.shtml

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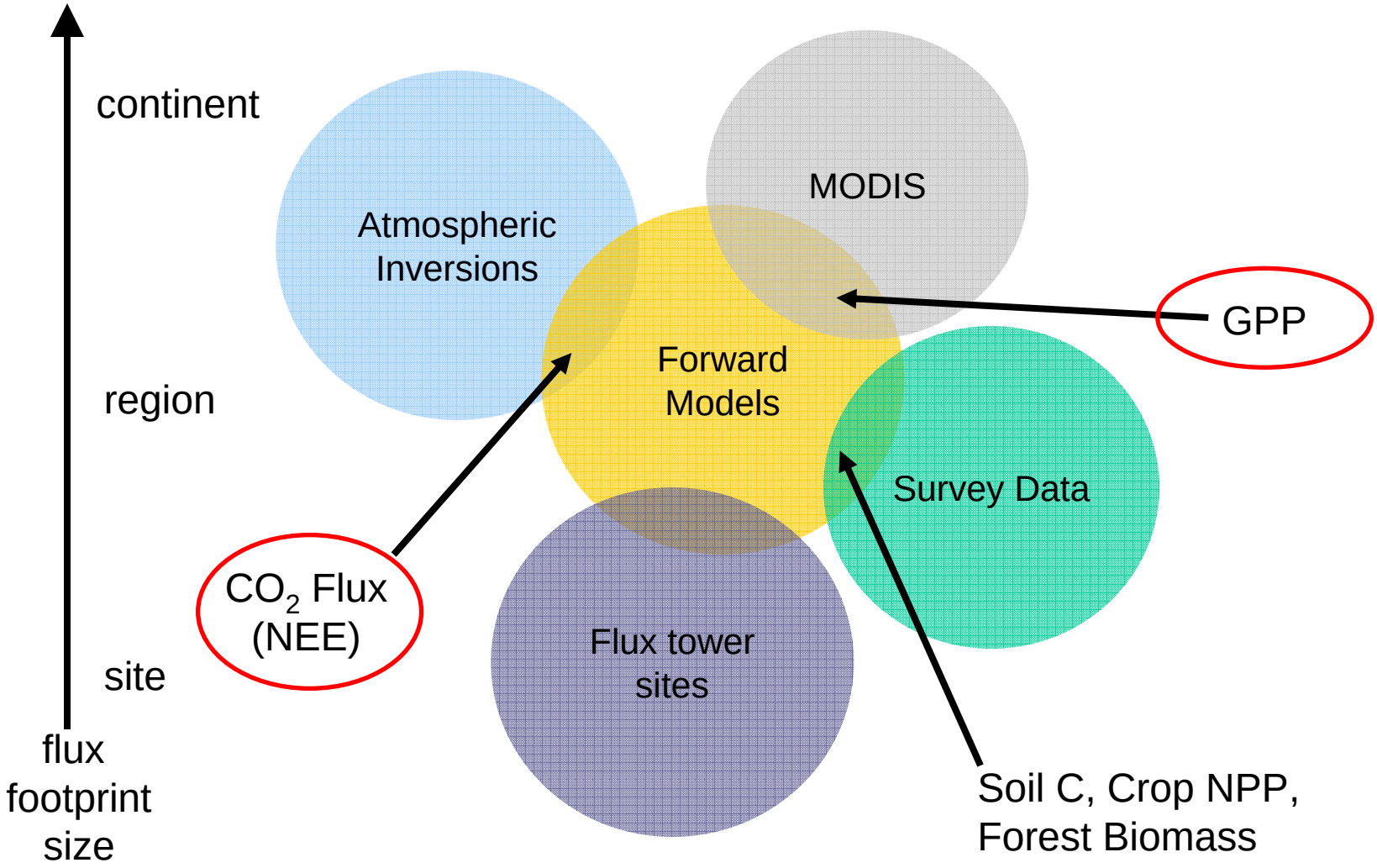
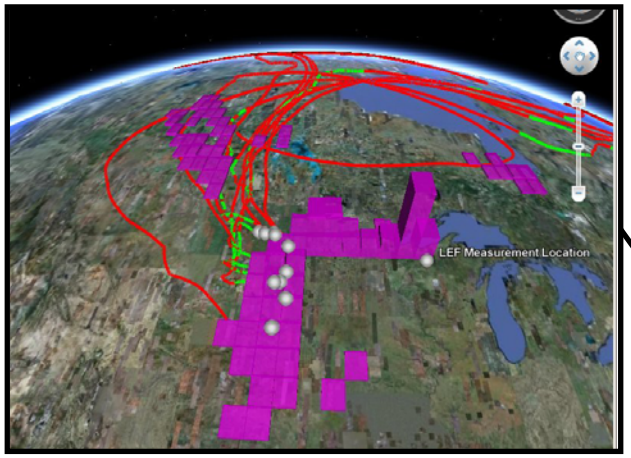
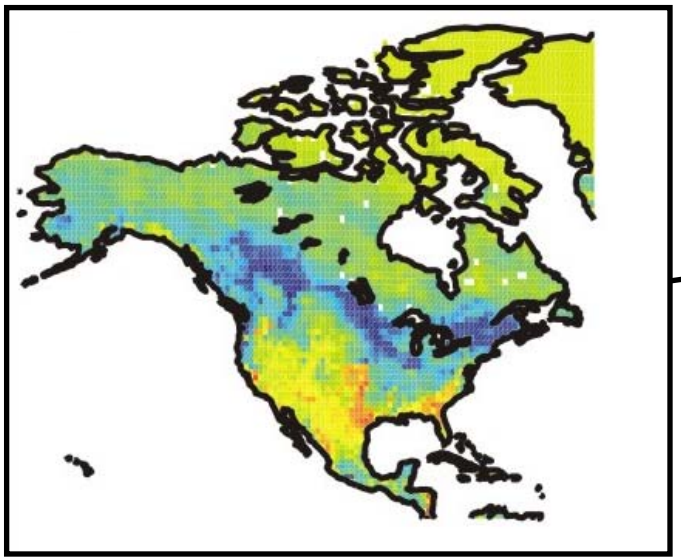
Motivation: Bridge the Gap



Modeling Approaches: Inversions





Inversion

Surface Flux

Ocean fluxes

NEE

Fossil fuel emissions

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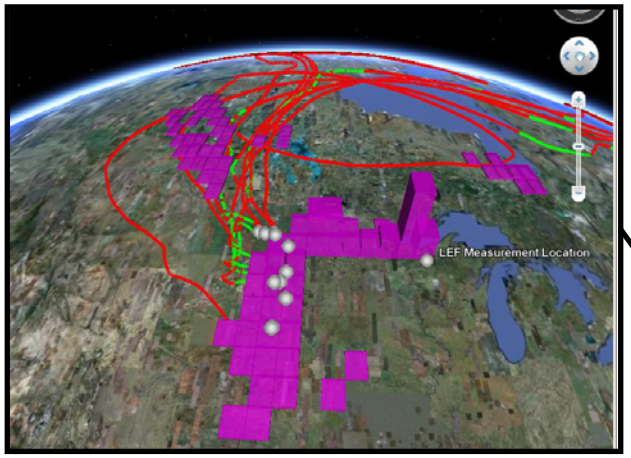

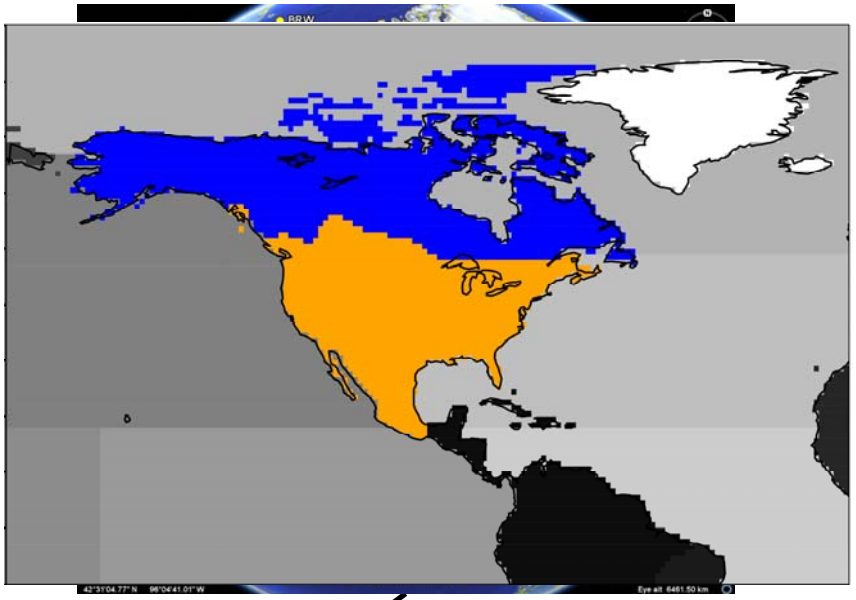

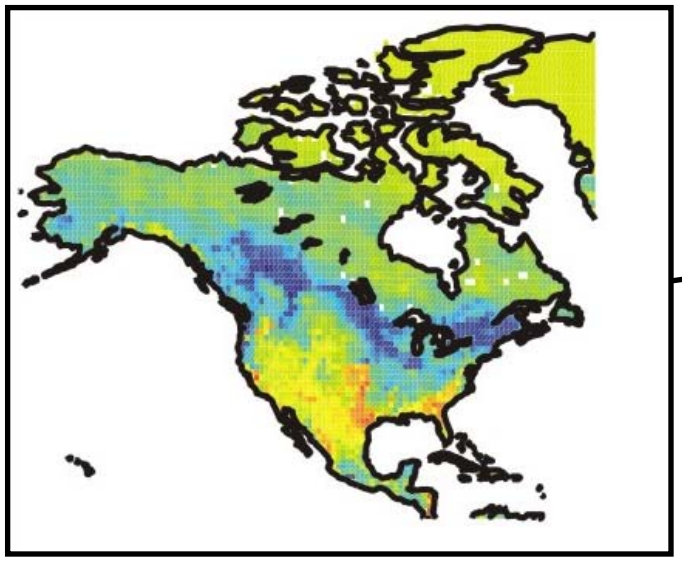

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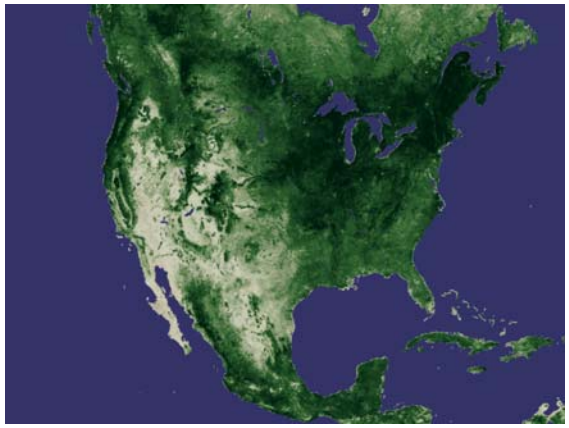
Modeling Approaches: Forward/Ecosystem

- Spatially extrapolate site scale data to model C exchange at regional scales
- Multiple fluxes, including Net ecosystem exchange (NEE) and component fluxes (GPP, R, NPP), etc.
- Test hypotheses and make projections
- Different model formulations/parameterizations
- Different boundary conditions
  - Soil properties
  - Vegetation type
  - Land management
- Different forcing data
  - Weather
  - Nutrient inputs
  - Disturbances
  - Land-use/land cover changes



Overall Science Questions:

- Identification of Sources/Sinks
  - What are the magnitudes and spatial distribution of carbon sources and sinks, and their uncertainties during 2000-2005?
- Interannual Variation
  - What is the spatial pattern and magnitude of interannual variation in carbon fluxes during 2000-2005?
  - What are the components of carbon fluxes and pools that contribute to this variation?
- 2002 Drought
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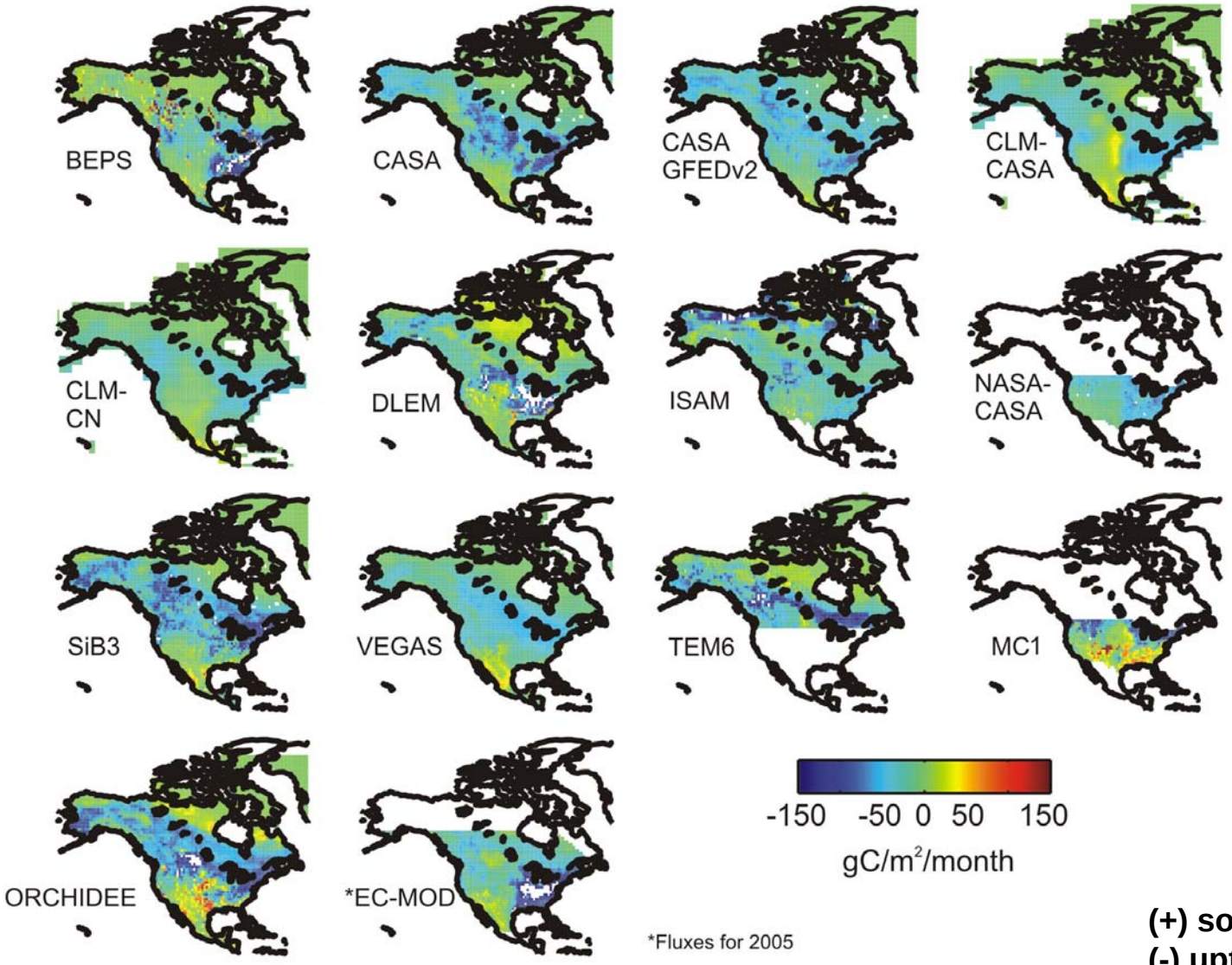
Identify Sources/Sinks: Spatial Patterns



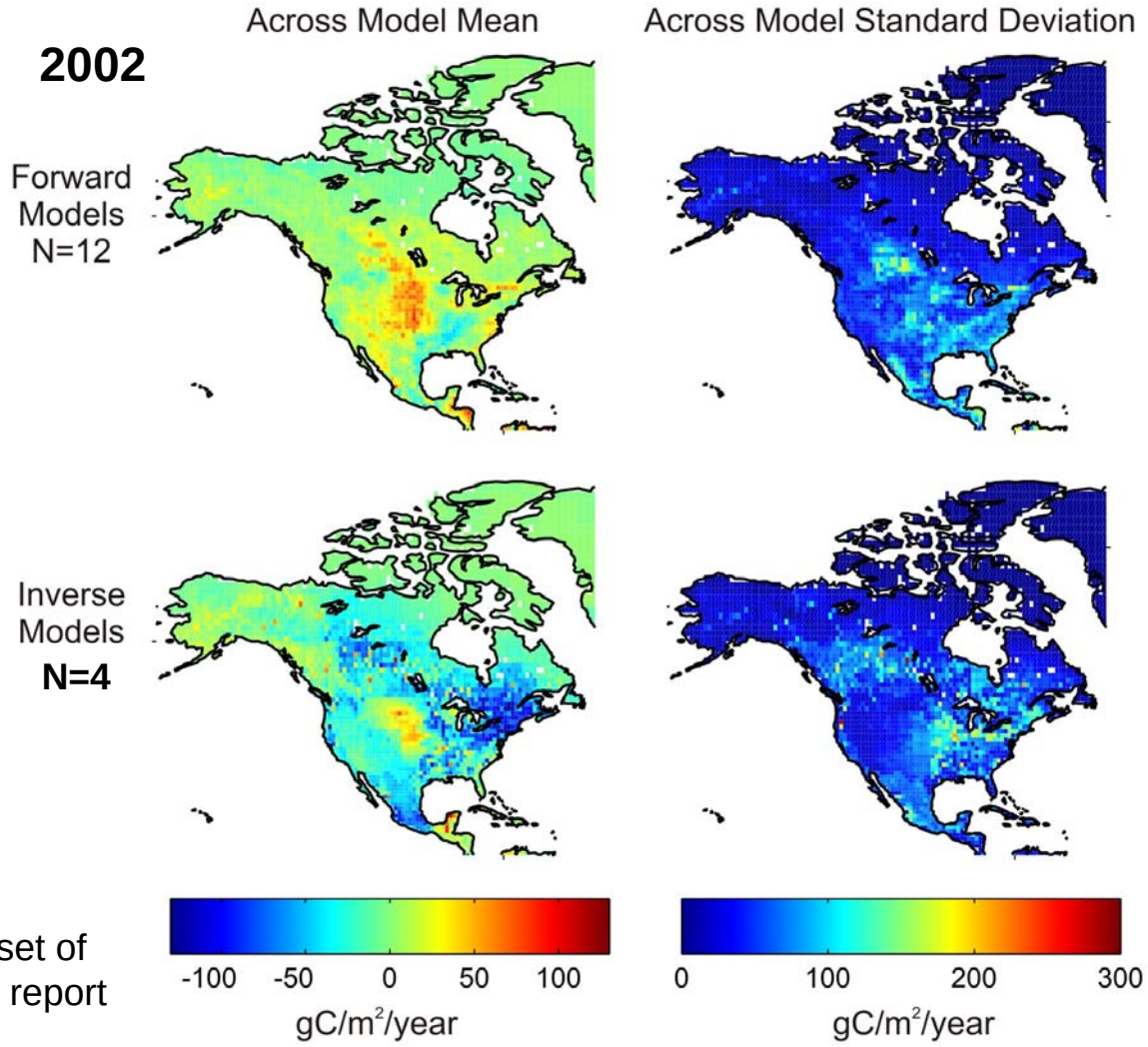
Forward Models

Net C Flux

June 2002

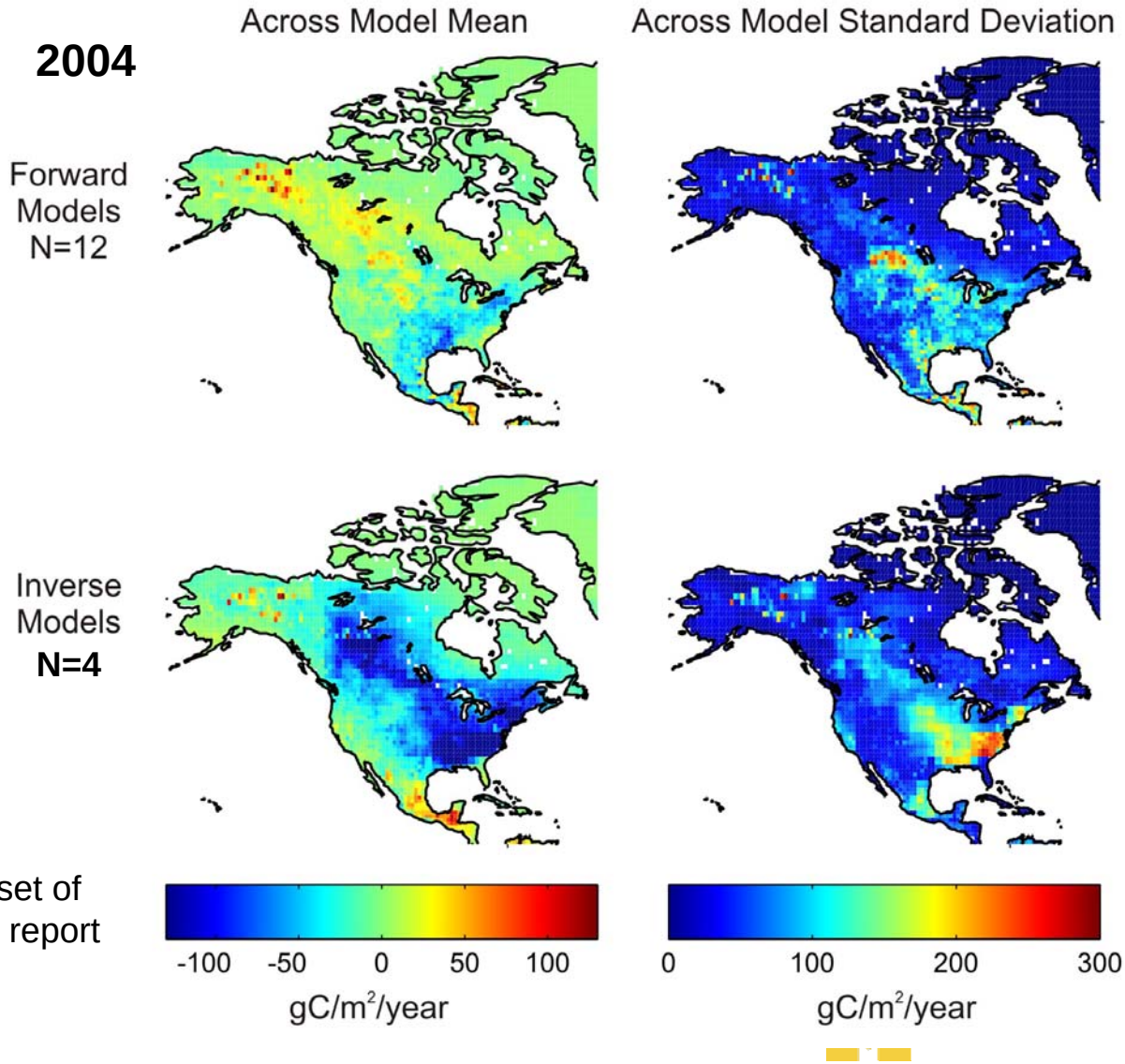
(+) source to atmosphere
(-) uptake from atmosphere

Identify Sources/Sinks: Inter-Model Variability



Note:
Only a small subset of inversion models report 1°x1° fluxes

Identify Sources/Sinks: Inter-Model Variability



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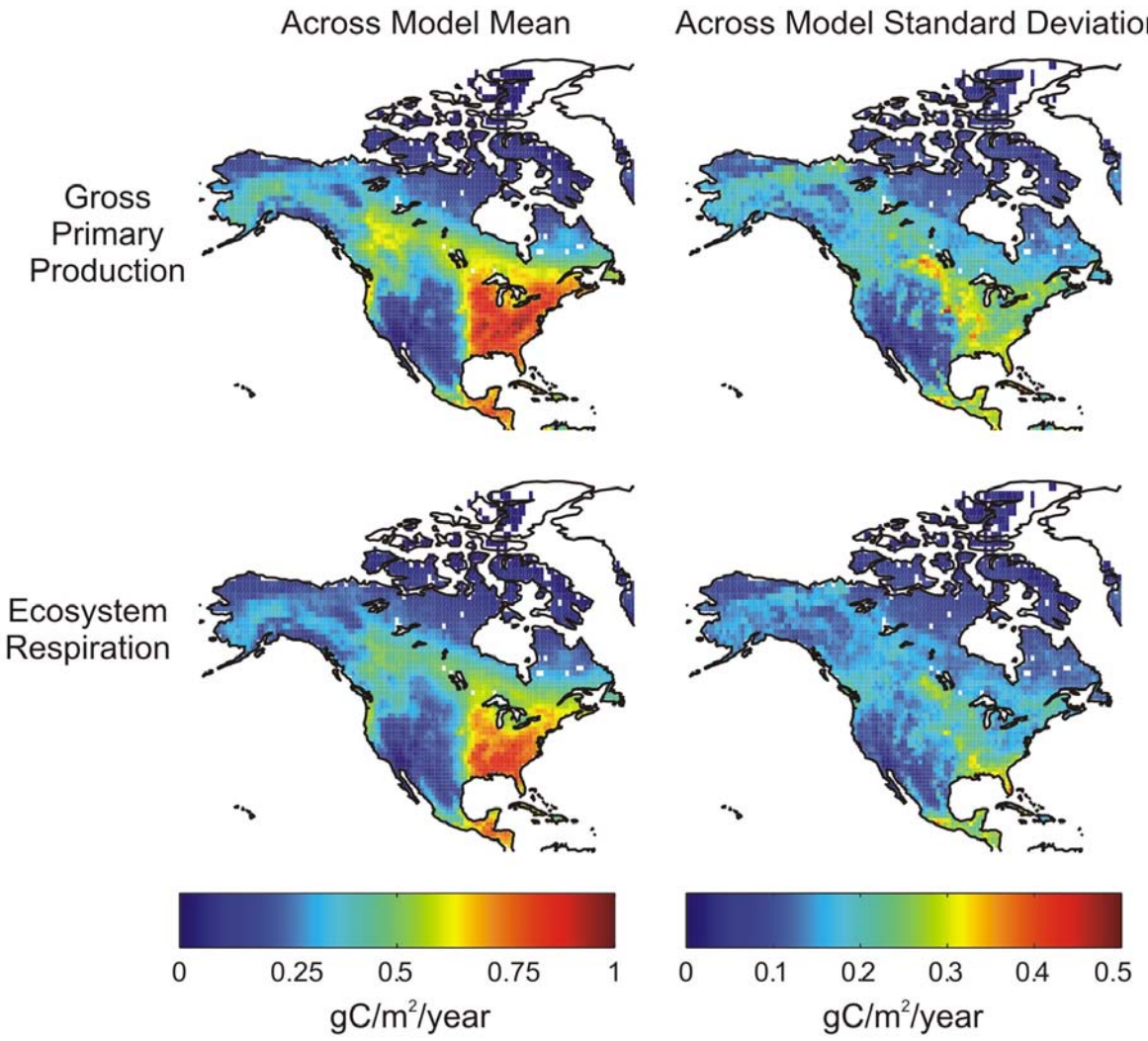
Inter-Model Variability: Component Fluxes

2002

Forward Models



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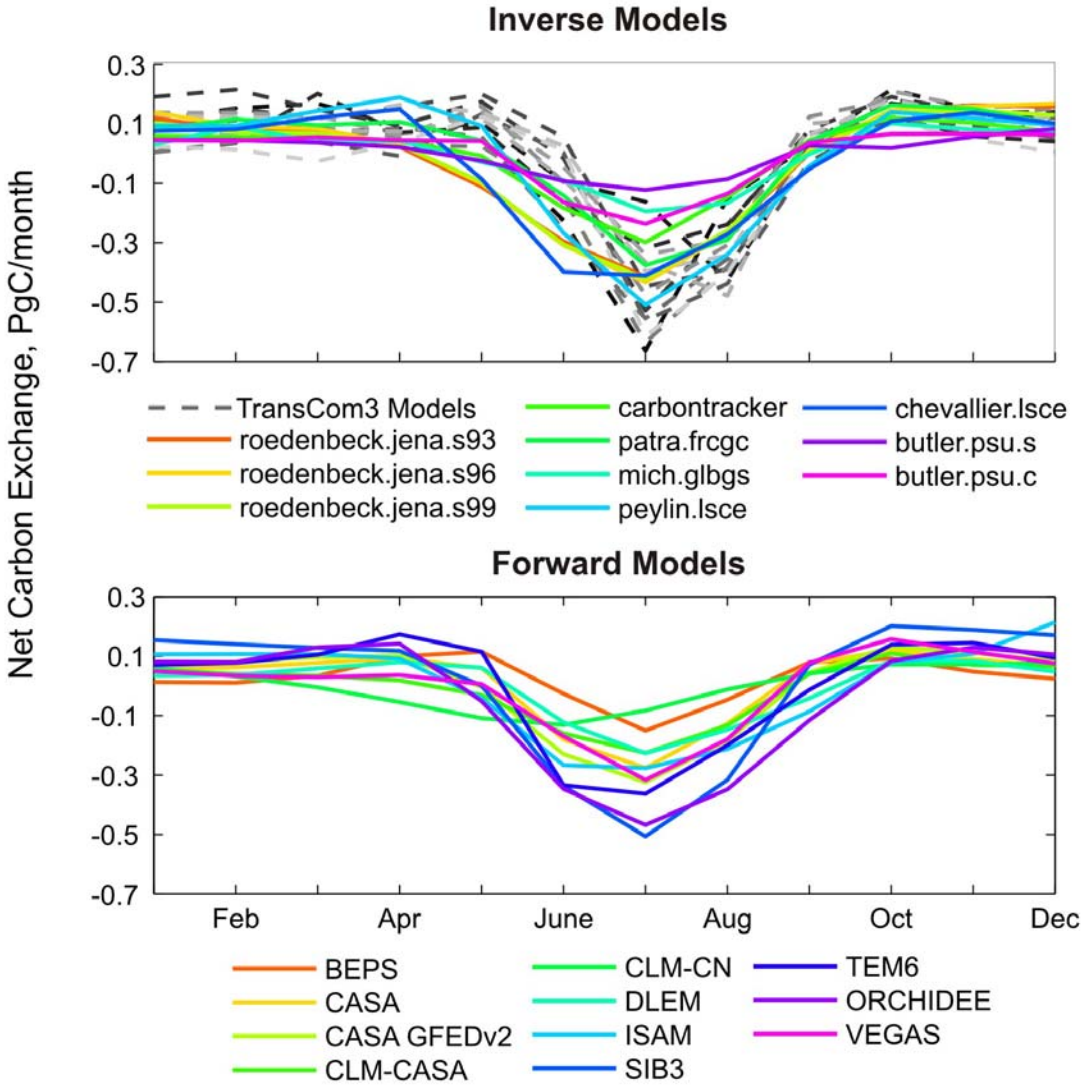
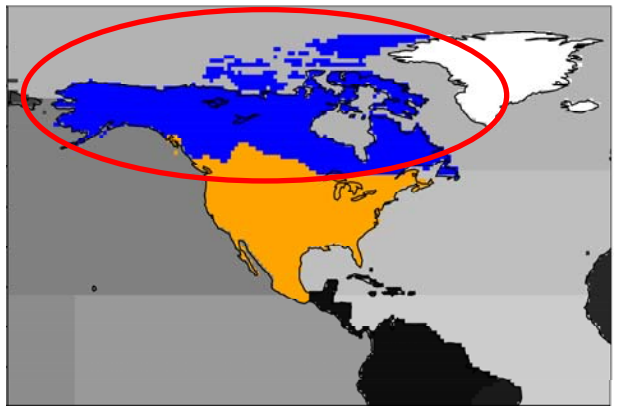
Identify Sources/Sinks: Long-Term Mean



Boreal North America



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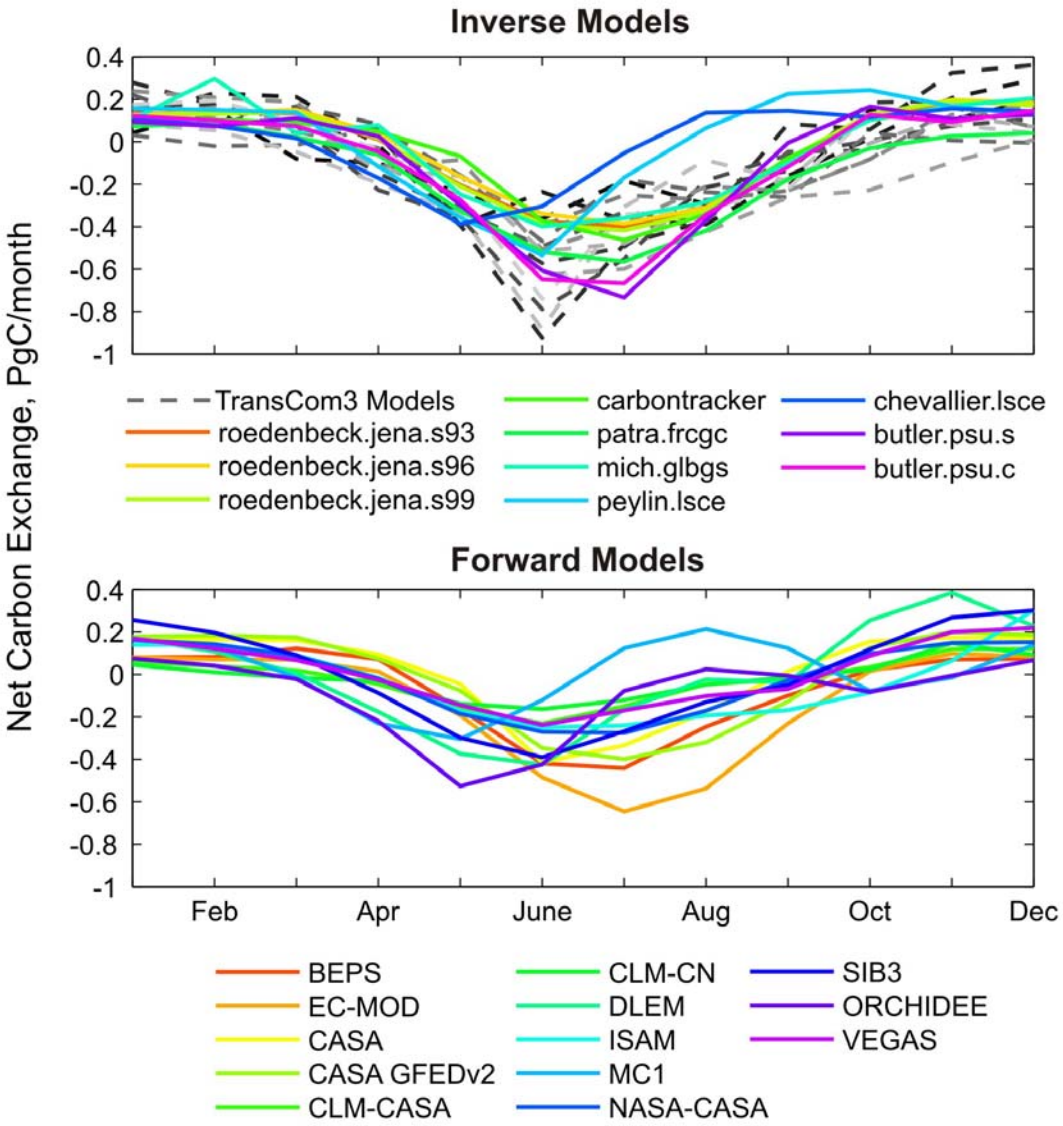
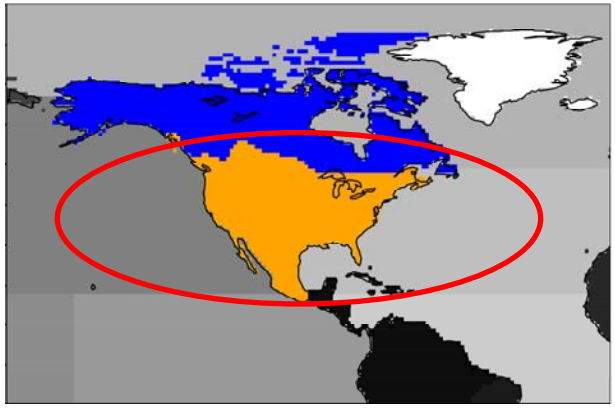


Temperate North America



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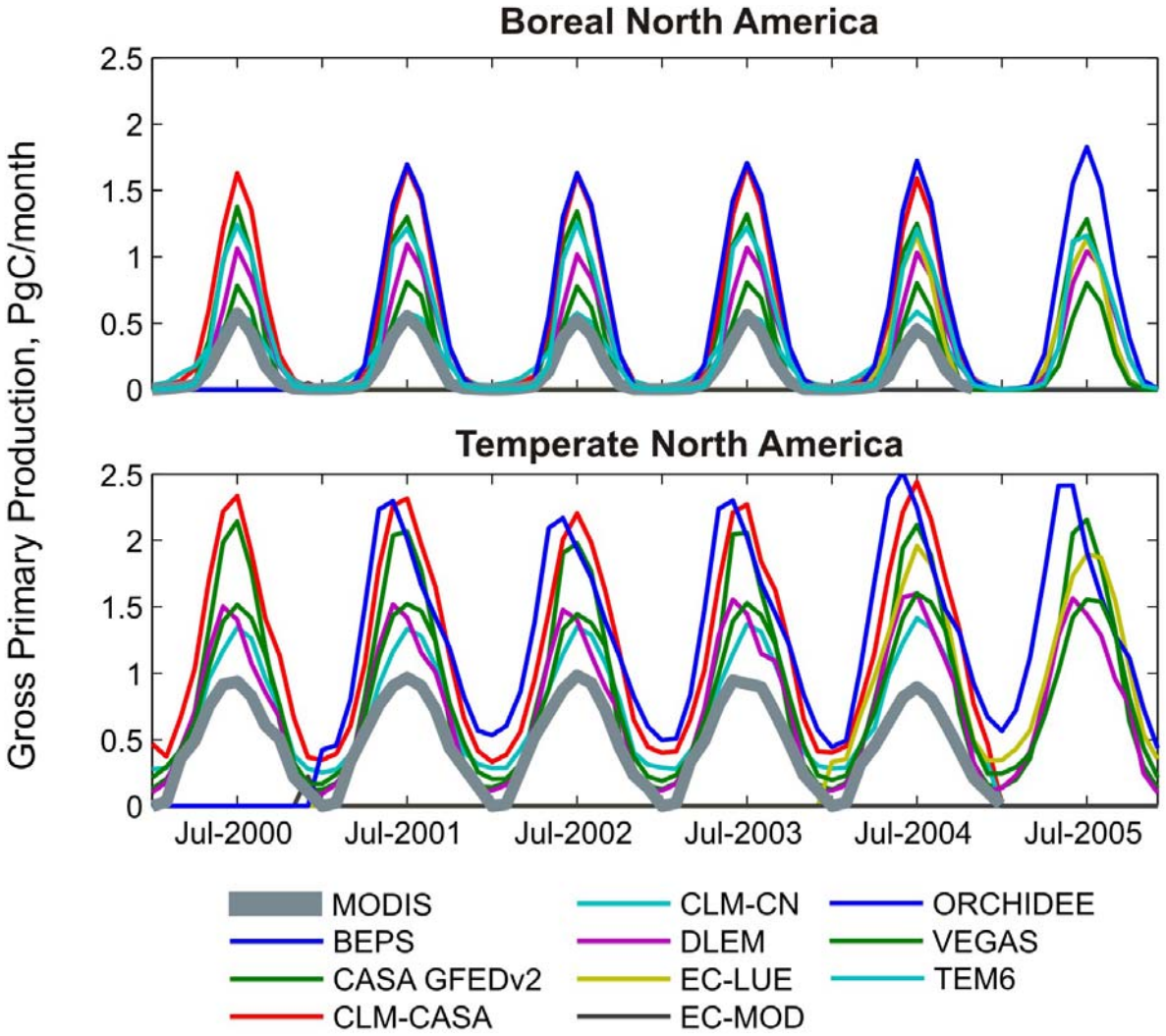
Identify Sources/Sinks: GPP



(6 – 20 PgC/yr)

(12 – 30 PgC/yr)

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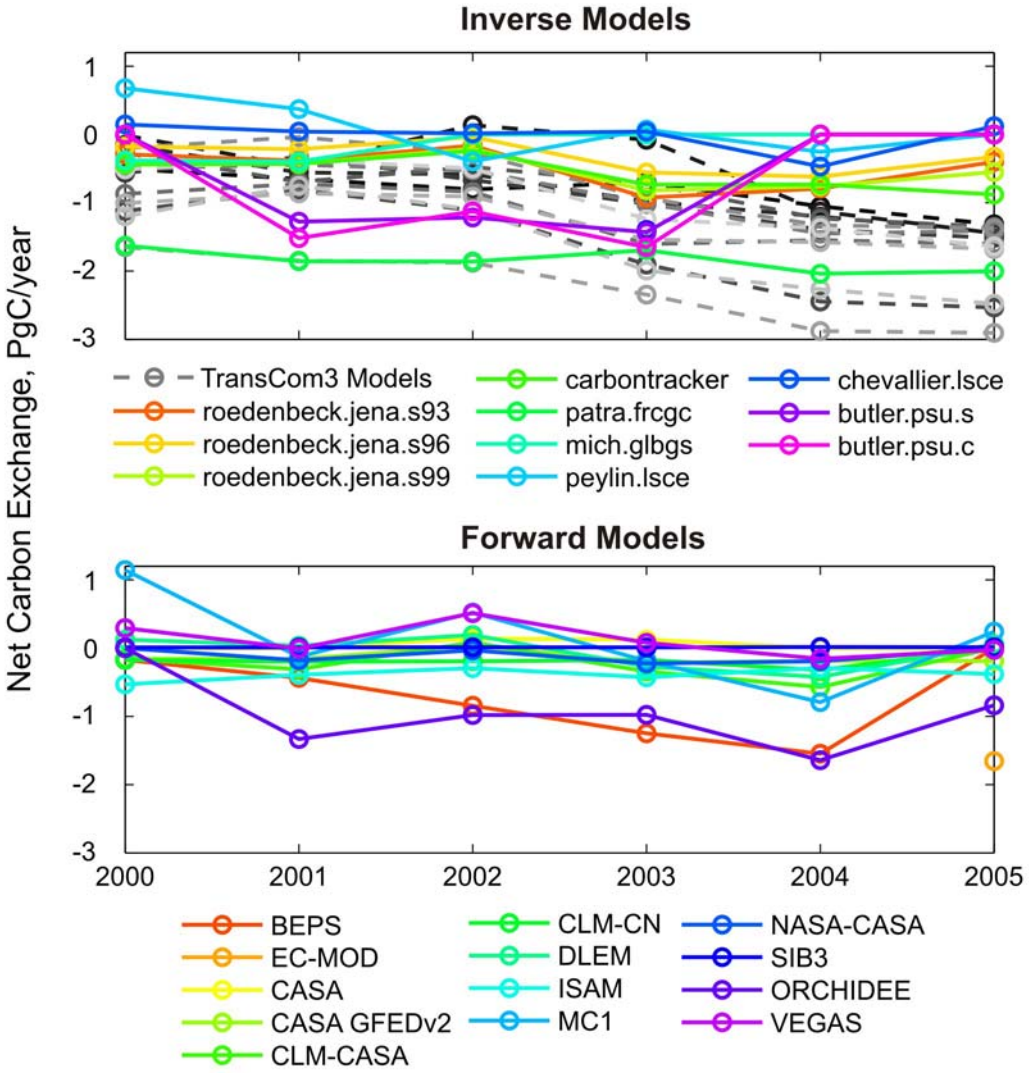
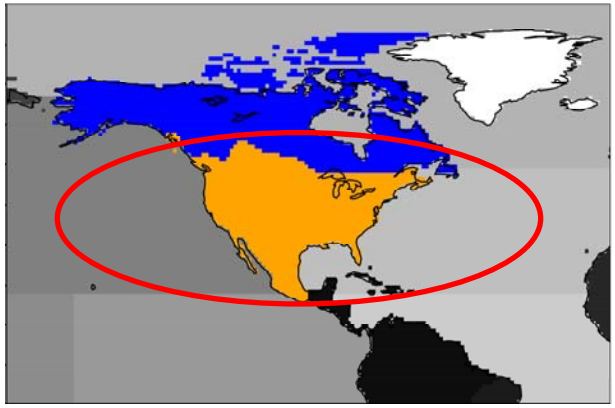
Interannual Variation: Net Annual Flux



Temporal Patterns

Temperate North America



	Inverse	Forward
Boreal	-0.07 (-0.3, 0.2)	-0.05 (-.01, 0.02)
Temperate	-0.9 (-0.4, -1.4)	-0.07 (-0.04, 0.01)

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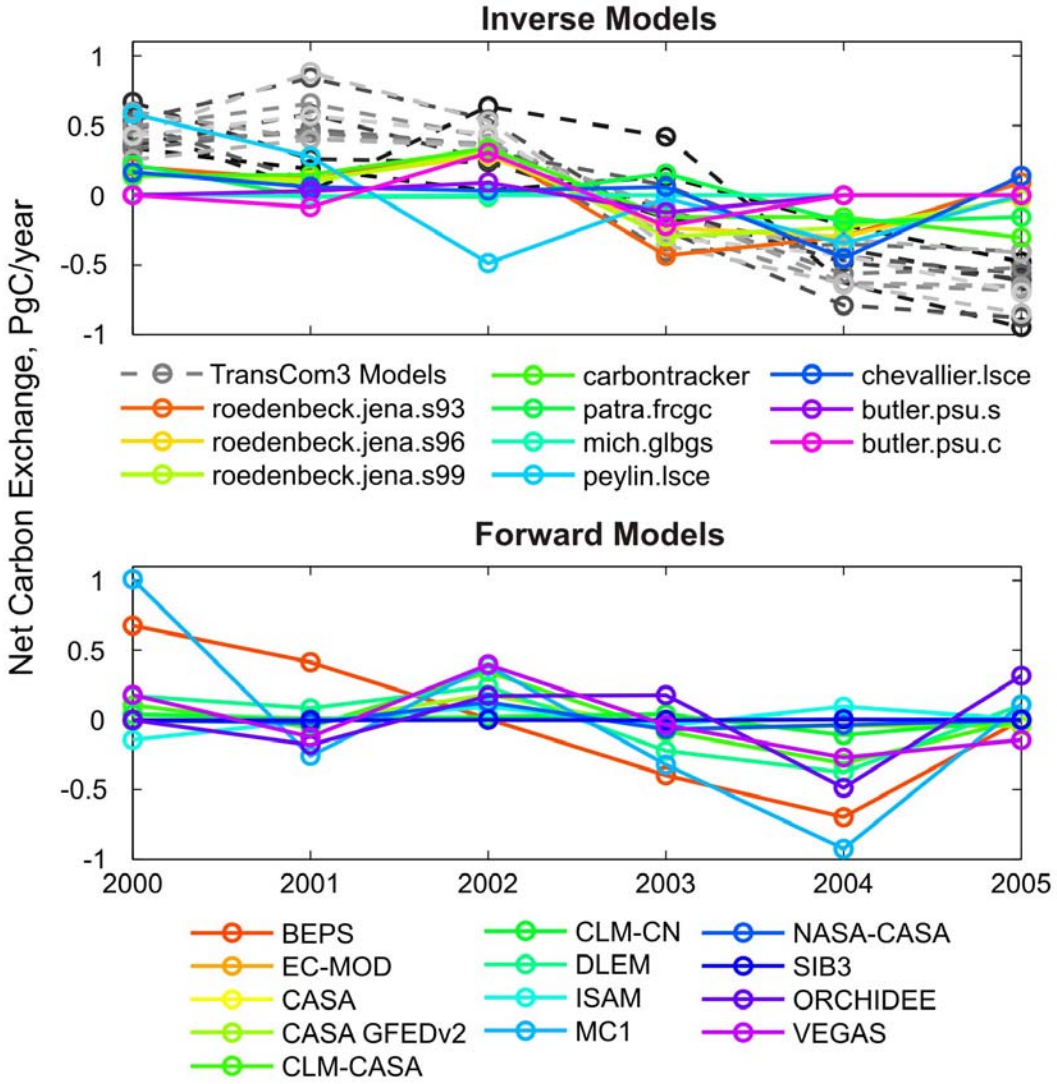
Interannual Variation: Mean Deviated



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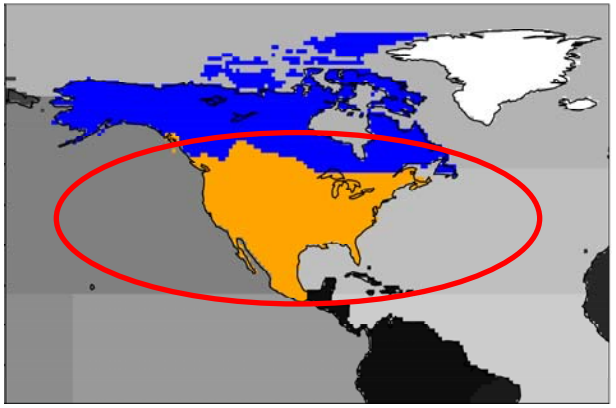

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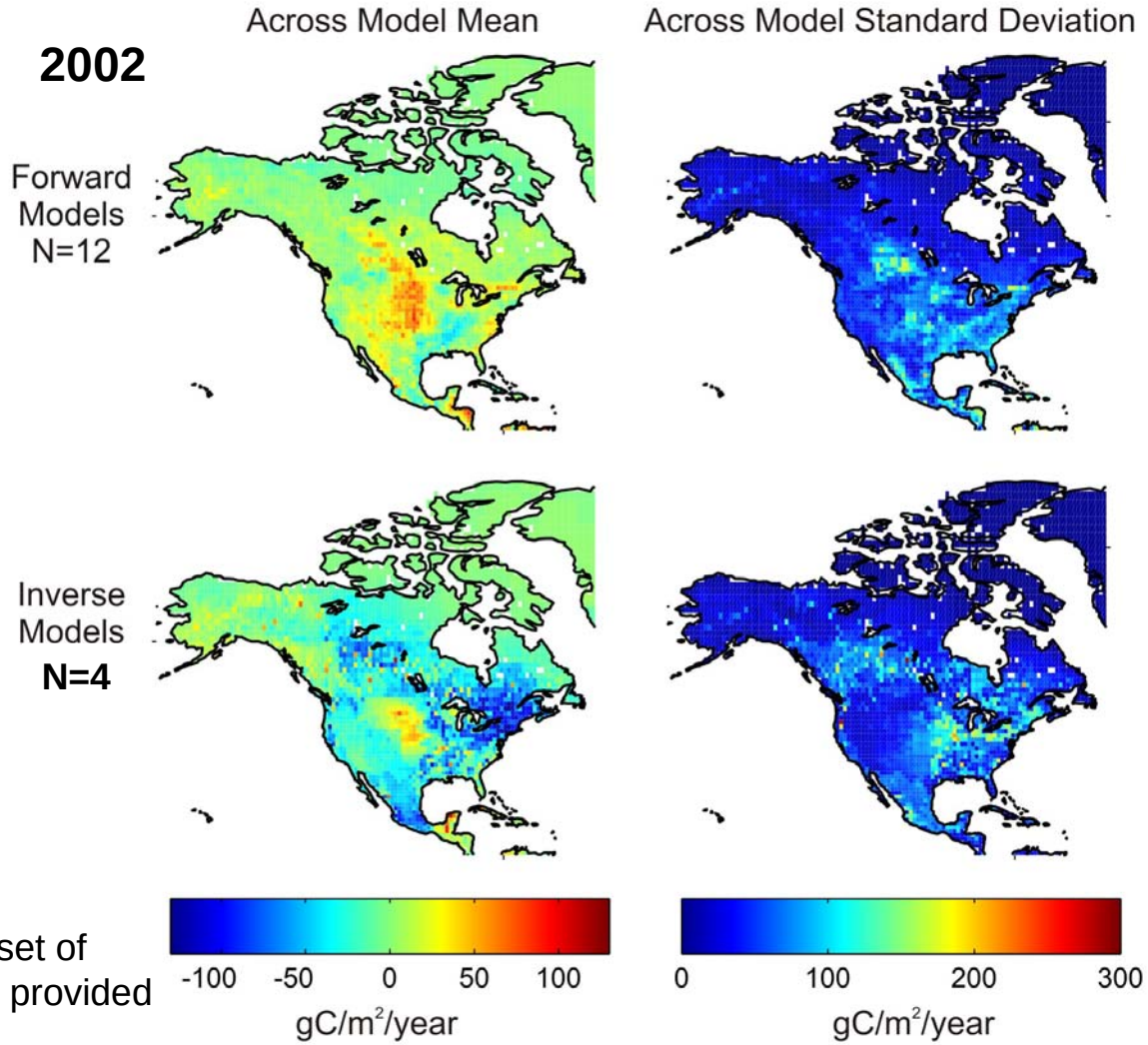
2002 Drought: Inter-Model Variability



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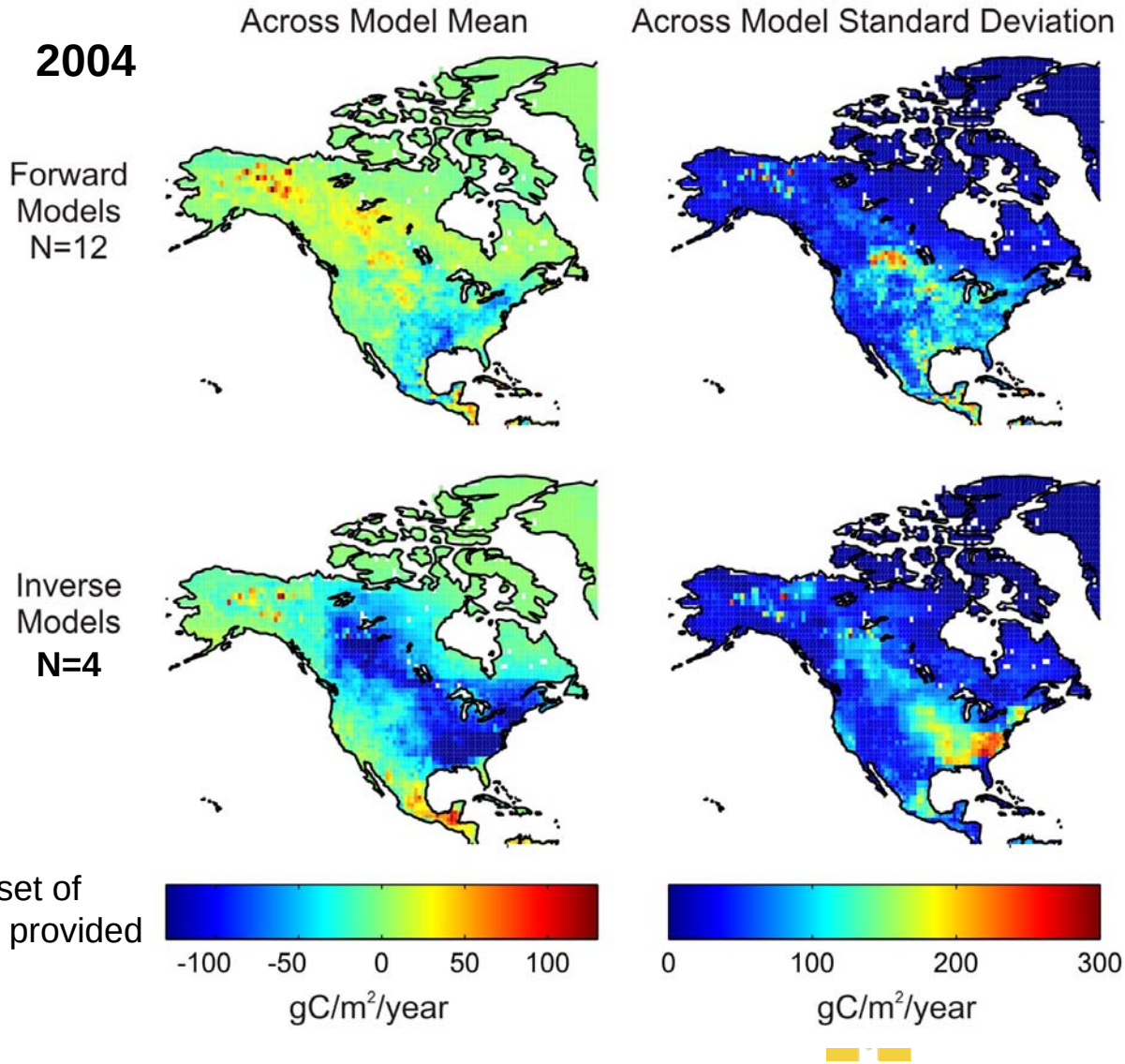

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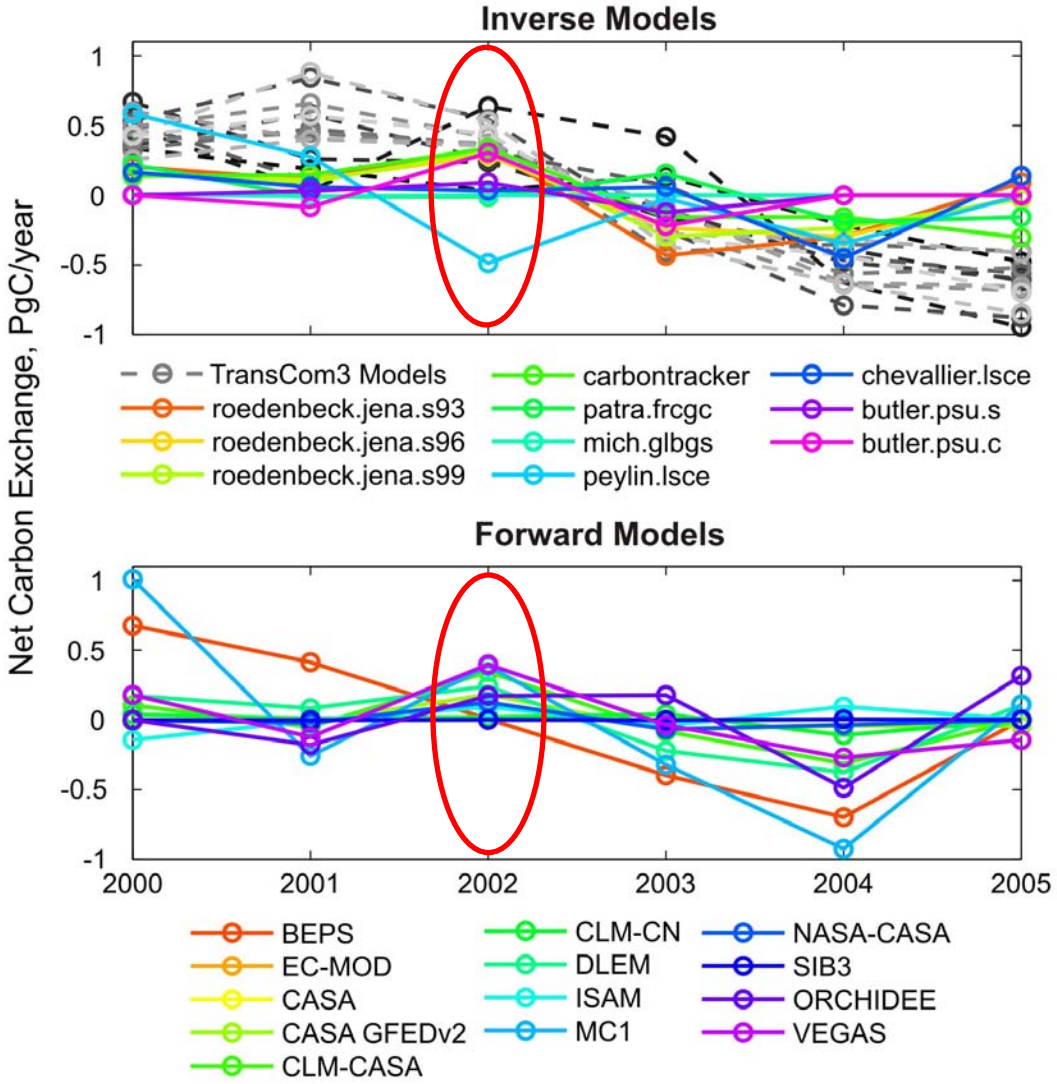

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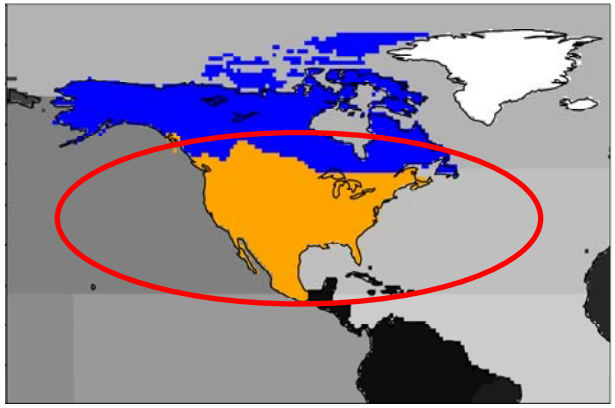

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Conclusions:

- Identification of Sources/Sinks
  - Forward models predict significantly different magnitudes and spatial patterns of flux across NA.
  - Spread in forward model predictions due, *in part*, to differences in model purpose, inputs, and model formulation.
- Interannual Variation
  - Inversions predict more seasonality, **uptake**, and IAV over N. America than forward models.
  - We can make broad statements of agreement among different models/approaches, but cannot identify mechanisms responsible for disagreement.
- 2002 Drought
  - Both forward and inverse models do predict less uptake (greater source) of C during 2002.
  - Cannot make inferences about what processes were affected by the 2002 drought.

Steps Forward

- Continue analysis:
  - Component fluxes (e.g., NPP, Ra, Rh);
  - Satellite indices (e.g., LAI, FPAR, NDVI, EVI); and
  - Inventory data (e.g., Soil C, Biomass, crop NPP) at monthly or annual times
- NACP Multi-Scale Terrestrial Model Intercomparison Project (**MsTMIP**)
  - Site, regional, global scales
  - Detailed protocol
  - Consistent set of model input and driver data
    - Place focus on differences in model formulation and help improve model performance

http://nacp.ornl.gov/int_synth_contreg.shtml

Acknowledgements

Funding/Support:

•Carbon Cycle Interagency Working Group (CCIWG)

•MAST-DC

•NASA NACP (Anna Michalak, Univ. Michigan)

Participants:

Dozens of modeling teams and data providers

Canada, USA, Mexico, Europe

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