Multi-scale Synthesis and Terrestrial Biosphere Model Intercomparison Project (MsTMIP)

<table>
<thead>
<tr>
<th>MsTMIP Team:</th>
<th>Collaborators</th>
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<tbody>
<tr>
<td>Deborah Huntzinger (Science PI)</td>
<td>Peter Thornton, Forrest Hoffman, Rama Nemani, Weile Wang, Josh Fisher, Philippe Ciais, Nicolas Viovy, Philippe Peylin</td>
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<tr>
<td>Anna Michalak (PI)</td>
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<td>Kevin Schaefer</td>
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<td>Andrew Jacobson</td>
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<td>Mac Post; Robert Cook; Yaxing Wei</td>
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</table>
Simulations start May, 2011

- **Global**
  - 0.5° by 0.5°
  - CRU-NCEP with rescaled precipitation

- **Regional (North America)**
  - 0.25° by 0.25°
  - NARR with rescaled precipitation and SW

- **Site level**
  - Site Synthesis towers
  - NARR meteorology
Infrastructure

- Model evaluation: C-LAMP (now iLAMB)
- Model team support (mini-grants)
- Output Subroutine Library
NACP Site Synthesis Analysis Projects

Kevin Schaefer
NACP Site Synthesis Team
Flux Tower PIs
Modeling Teams
General Status

- Now in Analysis phase
- Gap-filled fluxes V2 ready (V3 soon)
- Model Survey V2
<table>
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<tr>
<th>Num</th>
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<td>1</td>
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<td>Writing</td>
<td>Flux Uncertainty Analysis (2 papers)</td>
<td>Alan Barr</td>
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<td>Dan Ricciuto</td>
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<td>Nutrient cycling and Carbon Fluxes</td>
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<td>Maoyi Huang</td>
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<td>Scott Denning</td>
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<td>31</td>
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<td>Weather Events and Carbon Fluxes</td>
<td>Hanqin Tian</td>
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GPP Annual Bias (*Schaefer et al.*)

- Slope of LUE Curve drives Annual bias
- Models need better $V_{\text{max}}$, leaf-to-canopy scaling, ...
Wetland Sites (Desai et al.)

- Residuals correlate to water table depth
- Models should include water table dynamics
NEE Seasonal Cycle (*Schwalm et al.*)

- Add soil layers
- Add vegetation pools
- Improve prognostic phenology

![Graphs showing Taylor Skill over different numbers of soil layers and vegetation pools, with bars indicating skill levels.](image)
Areas For Model Development

- Better Phenology
- More soil layers
- More vegetation pools
- Slopes to LUE curve
- Water table dynamics
- Crop parameterizations
47 Flux Tower Sites

30 Models

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36 AmeriFlux
11 Fluxnet Canada

24 submitted output
10 runs per site
Products Derived from Flux Data

- Gap-filled observed weather (Ricciuto et al.)
- BADM files (everyone)
- Gap-filled fluxes & Uncertainty (Barr et al.)
  - Random
  - U* threshold
  - Gap-filling Algorithm
  - Partitioning Algorithm
Random Uncertainty (Barr et al.)

- Random $\varepsilon_{\text{NEP}} \sim 4\% R_e$
- $U^*_{\text{th}} \varepsilon_{\text{NEP}} \sim 1.3\% R_e$
BADM Files

• Extremely useful to modelers
  - Soil texture
  - Site history
  - Initial pools sizes
  - Leaf Area Index

• We strongly encourage more submissions
Weather Uncertainty (*Ricciuto et al.*)

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<th>Swdown (W m⁻²)</th>
<th>Delta (%)</th>
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<td>Observed</td>
<td>65.38</td>
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• Bias in radiation produces bias in GPP
Agriculture Sites (Lokupitiya et al.)

- Need crop specific parameterizations
Spectral NEE Error (*Dietze et al.*)

- Error peak at diurnal & annual time scales
- Errors at synoptic & monthly time scales
• Models match observations only some of the time
Phenology (*Richardson et al.*)

- Early/late uptake means positive GPP bias
- Models need better phenology
Regional vs. Site (*Raczka et al.*)

- Enzyme kinetic models biased high
- LUE models biased low
Extra Slides
Annual GPP Bias due to Phenology

Deciduous sites
- Spring: 160±145
- Autumn: 75±130

Evergreen sites
- Spring: 40±80
- Autumn: -5±65

Error (g C m$^{-2}$ y$^{-1}$)
Multi-Model wavelet Coherence

Scale (hours)
NEE Seasonal Cycle (Schwalm et al.)

Our 1st published paper!

Perfect Model

Normalized Mean Absolute Error

Chi-squared
U*th vs. Random Uncertainty (Barr et al.)

The graph shows a scatter plot comparing U*th Annual $\varepsilon_{\text{NEP}}$ (g C m$^{-2}$ y$^{-1}$) against Random Annual $\varepsilon_{\text{NEP}}$ (g C m$^{-2}$ y$^{-1}$). The data points are categorized by geographical regions (USA, Canada), ecological types (Needleleaf Forest, Broadleaf Forest, Mixedwood Forest, Juvenile Forest, Wetland, Grassland, Shrubland, Cropland), and their respective annual NEP values. The data suggests a positive correlation between the two variables, indicating that higher U*th values are associated with higher random annual NEP values. The graph also highlights the variability and uncertainty in NEP measurements across different ecosystems.