Multi-scale Synthesis & Terrestrial Model Intercomparison Project: From Cohort to Insight

MsTMIP Phase I Version 1 release available at:
http://nacp.ornl.gov/mstmipdata/mstmip_simulation_results_global_v1.jsp

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MsTMIP Phase I

Constrained protocol
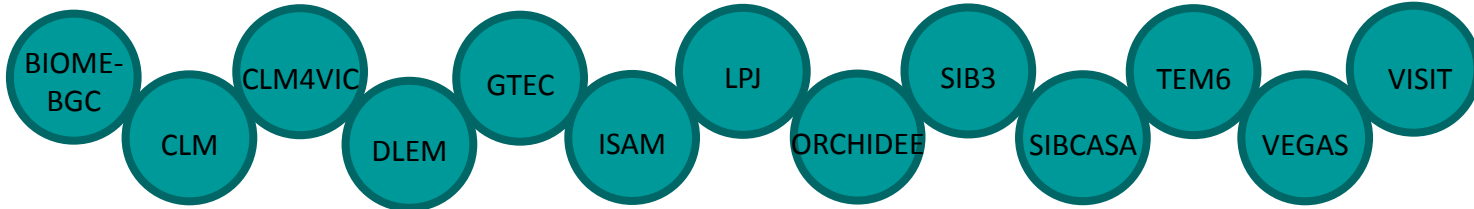Decrease modeler discretion
Skill to structure mapping

Model Output (1901-2010)

Analysis

Benchmarks

Global (0.5° by 0.5°) simulations
Version 1 release contains 15 models

Uncoupled process-based land-surface models

BIOME-BGC · CLM · CLM4VIC · DLEM · GTEC · ISAM · LPJ · ORCHIDEE · SIB3 · SIBCASA · TEM6 · VEGAS · VISIT

Climatology CRU-NCEP

Atmospheric CO_2 & nitrogen deposition

Soil properties

Phenology

Land-use & land-cover change
Hurtt+SYNMAP

C3/C4 grass & major crops

MsTMIP Phase I

Order	Domain	Code	Climate	LULCC	[CO$_2$]	Nitrogen
1	Global	RG1	Constant	Constant	Constant	Constant
2		SG1	Time-varying			
3		SG2		Time-varying		
4		SG3			Time-varying	
5		BG1				Time-varying

MsTMIP Phase I

Reference simulation → spin-up run out to "2010"

Order	Domain	Code	Climate	LULCC	[CO$_2$]	Nitrogen
1		RG1	Constant	Constant	Constant	Constant
2	Global	SG1	Time-varying			
3		SG2		Time-varying		
4		SG3			Time-varying	
5		BG1				Time-varying

MsTMIP Phase I

Order	Domain	Code	Climate	LULCC	[CO_2]	Nitrogen
1		RG1	Constant	Constant	Constant	Constant
2	Global	SG1	Time-varying	Constant	Constant	Constant
3	Global	SG2	Time-varying	Time-varying	Constant	Constant
4		SG3	Time-varying	Time-varying	Time-varying	Constant
5		BG1	Time-varying	Time-varying	Time-varying	Time-varying

Sensitivity simulations → turn one variable component on at a time to systematically test the impact of climate variability, land cover / land-use change, CO_2 fertilization, nitrogen limitation on carbon exchange.

MsTMIP Phase I

Order	Domain	Code	Climate	LULCC	[CO$_2$]	Nitrogen
1	Global	RG1	Constant	Constant	Constant	Constant
2		SG1	Time-varying			
3		SG2		Time-varying		
4		SG3			Time-varying	
5		BG1				Time-varying

Baseline simulation → model's "best estimate" of net land-atmosphere carbon flux (everything turned on)

MsTMIP Phase I

Order	Domain	Code	Climate	LULCC	[CO$_2$]	Nitrogen
1	Global	RG1	Constant	Constant	Constant	Constant
2		SG1	Time-varying	Constant	Constant	Constant
3		SG2	Time-varying	Time-varying	Constant	Constant
4		SG3	Time-varying	Time-varying	Time-varying	Constant
5		BG1	Time-varying	Time-varying	Time-varying	Time-varying

Effect of nitrogen limitation → BG1 – SG3
Effect of CO$_2$ fertilization → SG3 – SG2
Effect of land cover / land-use change → SG2 – SG1
Effect of climate → SG1 – RG1

MsTMIP Phase II

Climatology

Atmospheric CO_2 & nitrogen deposition
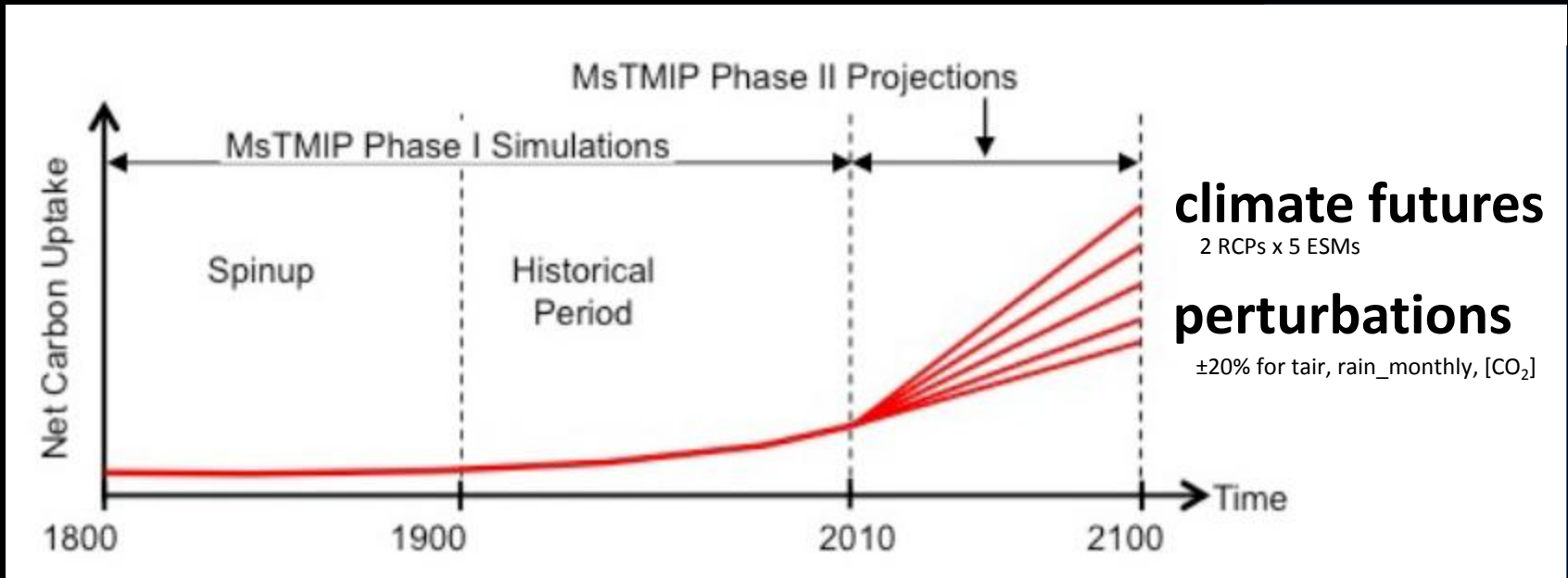
Soil properties

Phenology

Land-use & land-cover change history

C3/C4 grass & major crops

10 sets of future climate driver data
Scenarios: RCP4.5 and RCP8.5
ESMs: CESM1-CAM5, GFDL-CM3, HadGEM2-AO, IPSL-CM5A-MR, & MPI-ESM-MR
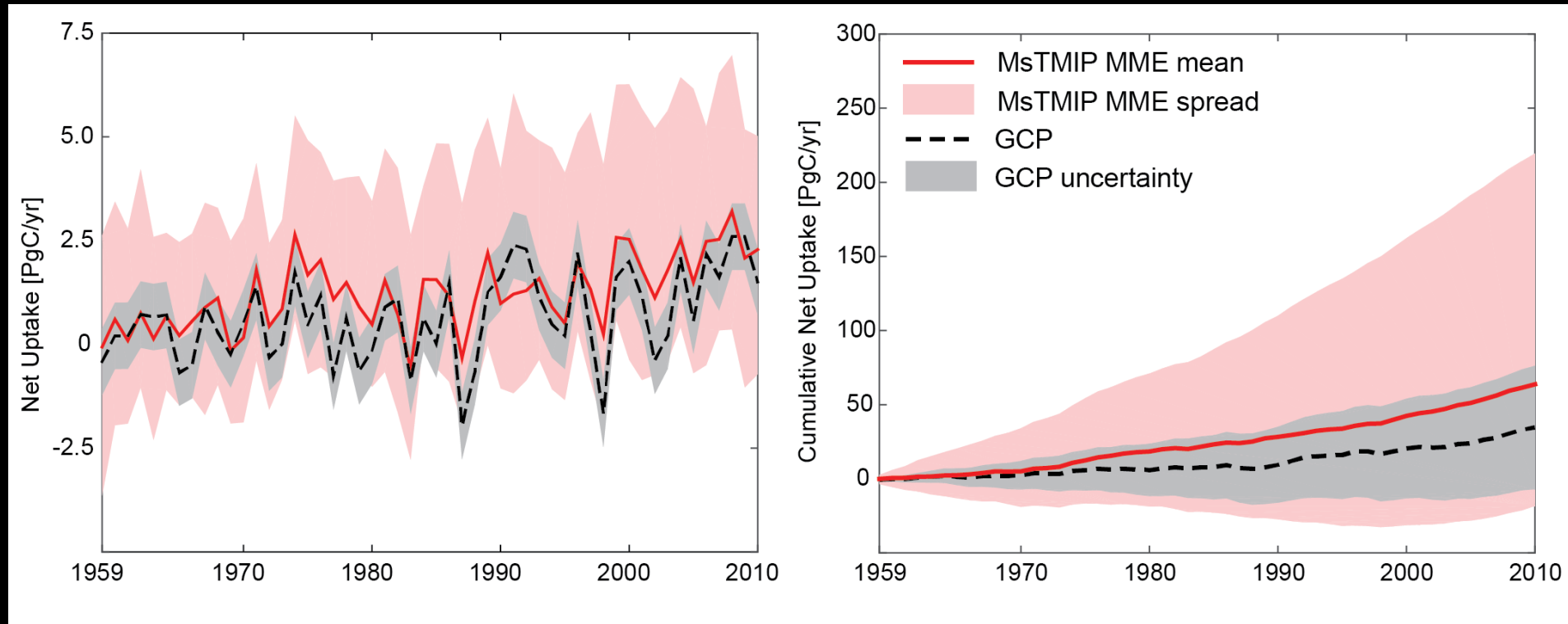Randomized CRUNCEP scaled using ESM trend

Scenarios: RCP4.5 and RCP8.5

MsTMIP Phase I+II

**Segue between MsTMIP Phase I and Phase II
"best estimate" simulations**

Benchmarking

Huntzinger et al. (in prep)
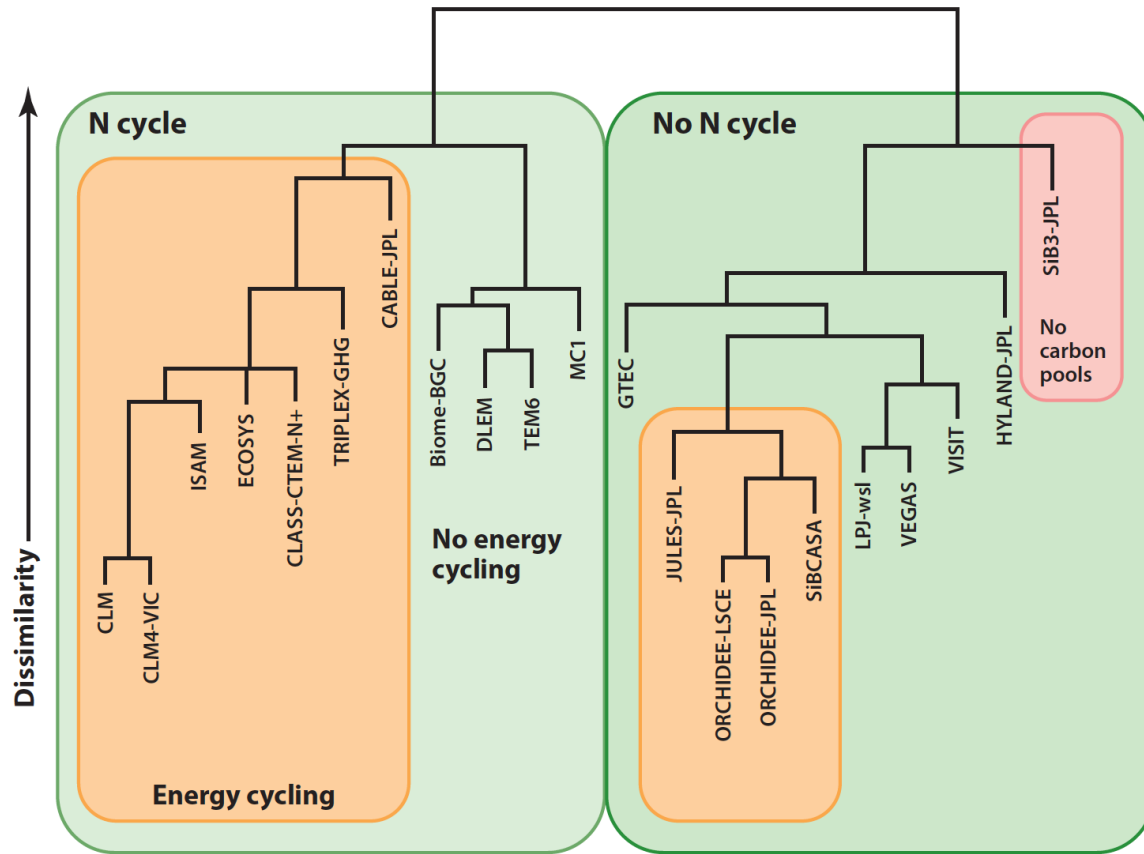
Skill to Structure

Figure 3

Dendrogram showing overall model structural differences, as determined by Hamming distance, for 21 terrestrial biosphere models. Models in the same "tree" share similar structural characteristics. Models to the left include an explicit nitrogen (N) cycle, whereas those to the right do not. Further separation or clustering is by treatment of soil carbon pools and radiation/heat storage. (Adapted with permission from Reference 132.)

Fisher JB, Huntzinger DN, Schwalm CR, Sitch S (2014) Modeling the terrestrial biosphere. *Annual Review of Environment and Resources*, *39*, 91-123.

Insight…?

- Skill to structure (Phase I)
  - Clustering
  - "Inversion"
  - Software visualization
- Inter-model spread (Phase I & II)
  - Sensitivity/perturbation experiments
  - Physical environment (pathways, not just endpoints!)

Questions?

- **Support:** NASA #NNX10AG01A (Phase I), NASA #NNX14AI54Gand (Phase II), MAST-DC #NNH10AN68I

- **Project website:** http://nacp.ornl.gov/MsTMIP.shtml

- **Version 1.0 release:** http://nacp.ornl.gov/mstmipdata/