



U.S. DEPARTMENT OF
ENERGY

Office of
Science

CESD Cyberinfrastructure Working Groups

Community-Based Cyberinfrastructure Town Hall

AGU Fall Meeting, San Francisco, California, USA

December 12, 2016

Model–Data Integration

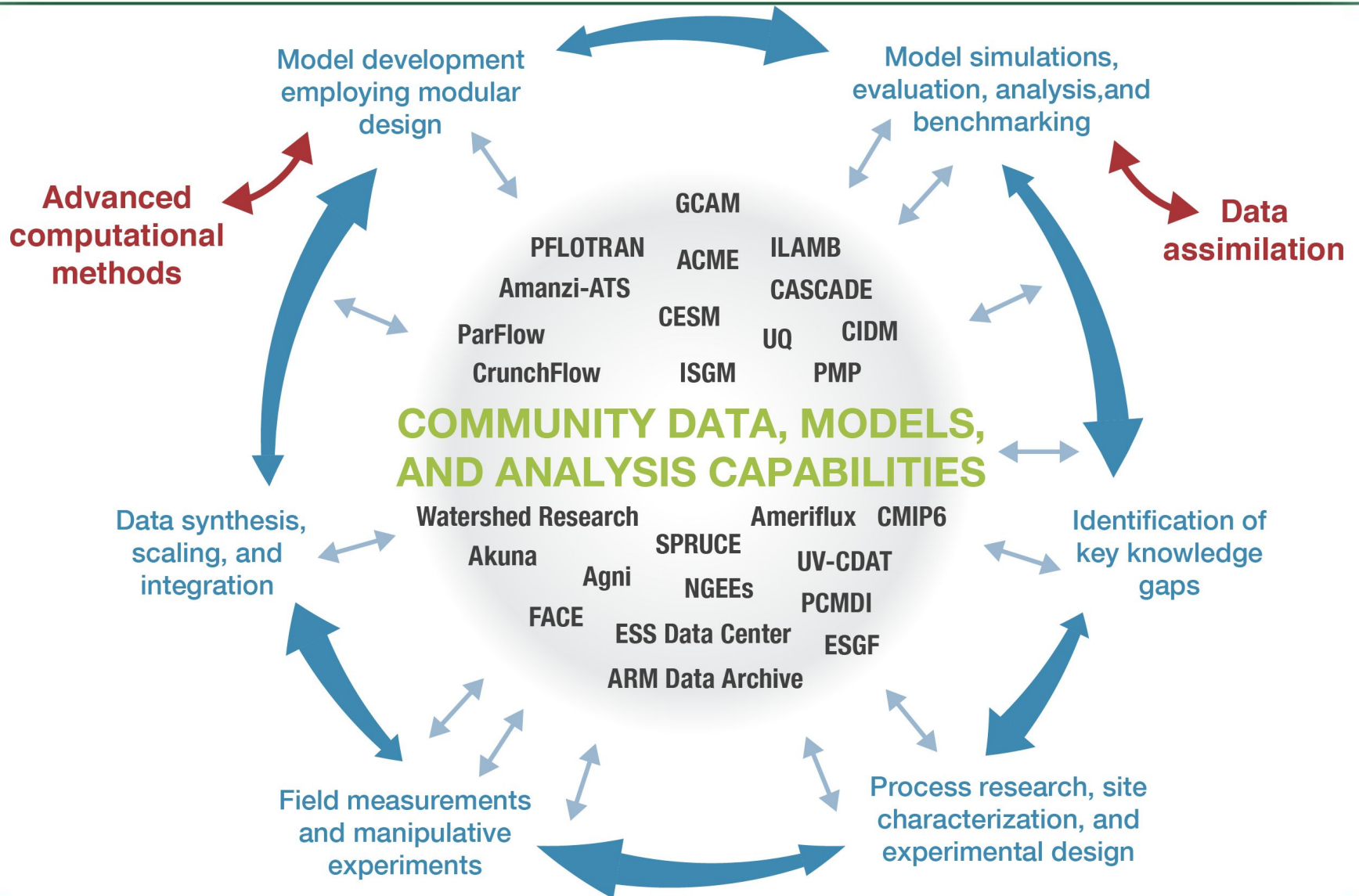
Leads: Forrest M. Hoffman (ORNL) and Xingyuan Chen (PNNL)

**Team Members: Tom Boden, Maoyi Huang, Lara Kueppers,
Umakant Mishra, Peter Thornton, Haruko Wainwright**

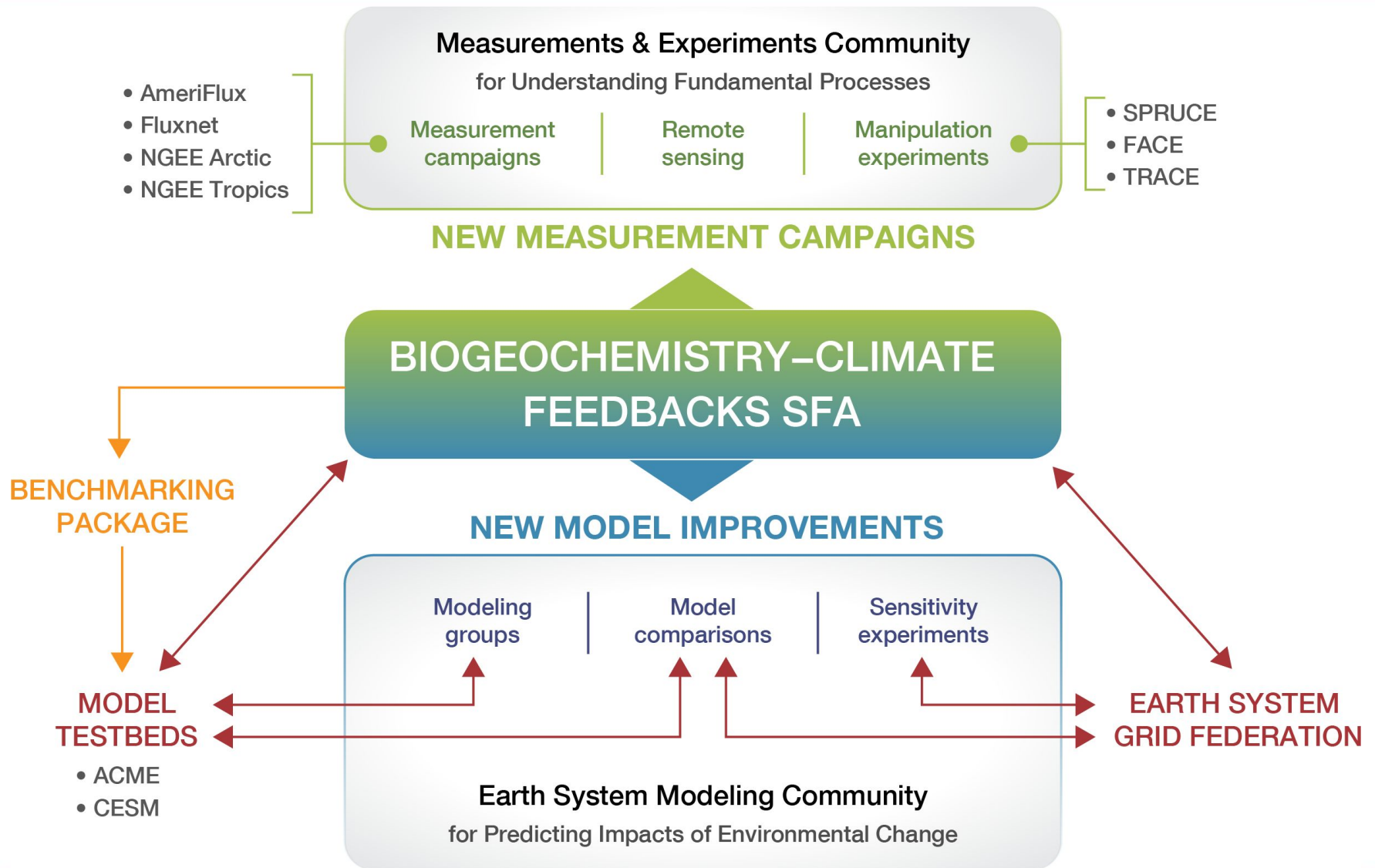
Model–Data Integration Scope

- Model–data comparison
- Data assimilation
- Management of model results and observational data
- Geospatial and remote sensing data analysis
- Model–data fusion
- Formal uncertainty quantification (UQ) approaches
- Data analytics methods and techniques
 - Data mining
 - Neural networks and genetic algorithms
 - Visual analytics

Model–Data–Experimentation Strategy



Example Model–Data Integration Activity



Short-Term Goals

- **Encourage archiving and versioning of publications, data, models, and software tools**
 - Document best practices jointly with other Working Groups
 - Versioning for synthesized & combined data sets (e.g., FLUXNET2015)
 - Digital Object Identifiers (DOIs) for pubs, data, models, and tools
- **Identify available scientific workflows, UQ frameworks, and model–data tools (e.g., ESGF, UV-CDAT, PEcAn, ILAMB)**
 - What workflows are people using and when does one assign a DOI?
 - Develop a user survey to capture initial information
- **Initiate subgroup on geospatial analysis and remote sensing**
 - Google Earth Engine and similar useful tools are rapidly evolving
 - Identify tools and resources for geospatial data analytics
 - Individual community projects have pockets of expertise (e.g., ARM)
- **Advocate for open and standard data formats & conventions**
 - Engage in groups to develop standards and educate users
 - Deploy tools/APIs to transform observational data into model formats
 - Foster API consistency across multi-agency/federated data centers



Short-Term Goals (continued)

- **Support community activities to make observational data quickly and easily available for model evaluation (e.g., ILAMB)**
 - Sponsor working groups focused on individual data sets and corresponding model metrics
 - Make AmeriFlux, NGEE Arctic, NGEE Tropics, SPRUCE, FACE, and similar data sets rapidly available to modelers by creating benchmarks
- **Organize disparate uncertainty quantification (UQ) activities to foster collaboration and establish best practices**
 - Standardize methods and approaches
 - Create workflows for common modeling frameworks



International Land Model Benchmarking (ILAMB)

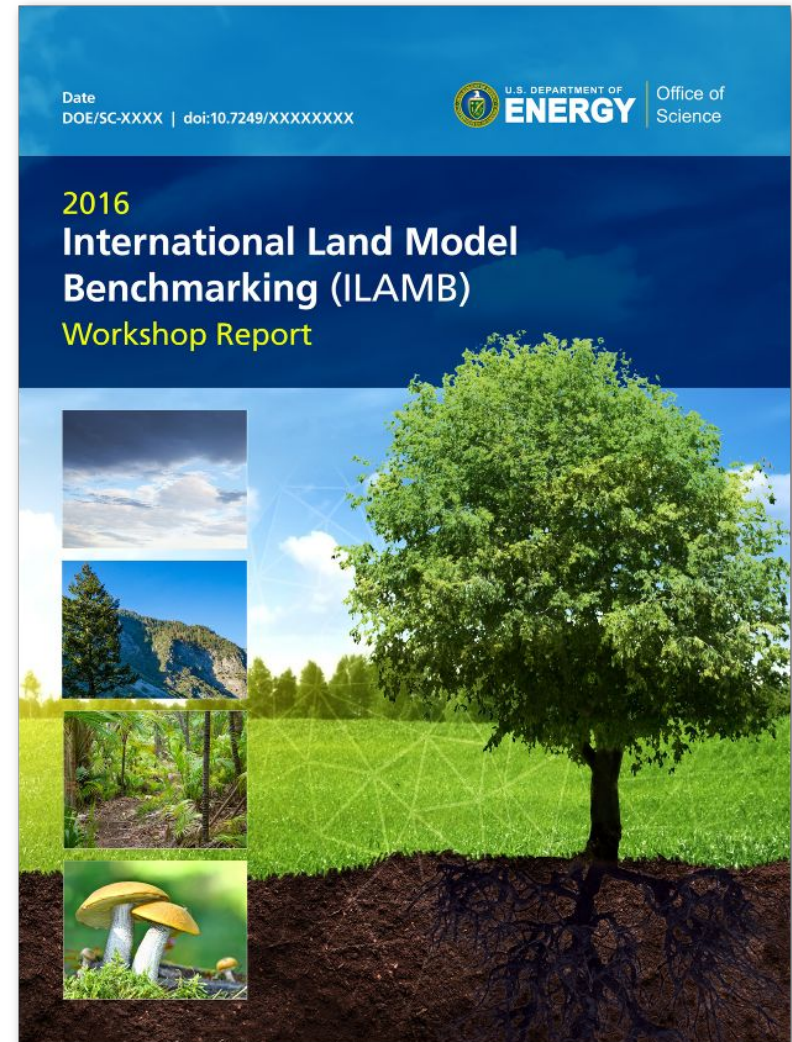
Overarching Workshop Goals

Engage the research community in defining scientific priorities for

- Design of new metrics for model benchmarking
- Model Intercomparison Project (MIP) evaluation needs
- Model development, testbeds, and workflow practices
- Observational data sets and needed measurements

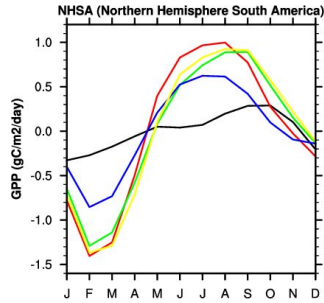
Workshop Attendance

- 60+ participants from Australia, Japan, China, Germany, Sweden, Netherlands, UK, and US
- 10 modeling centers represented
- ~25 online attendees at any time

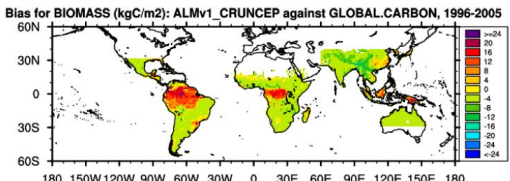
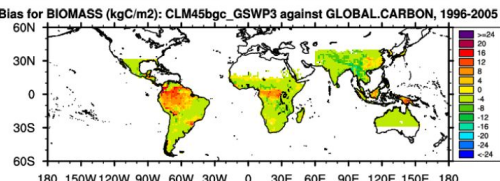
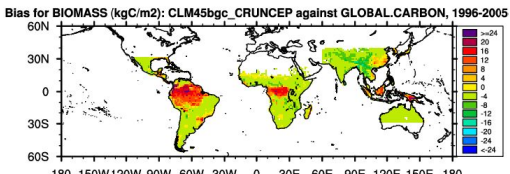
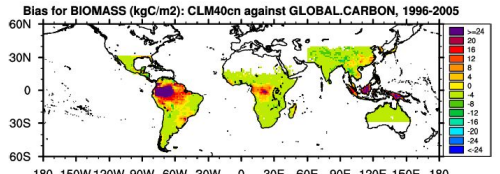
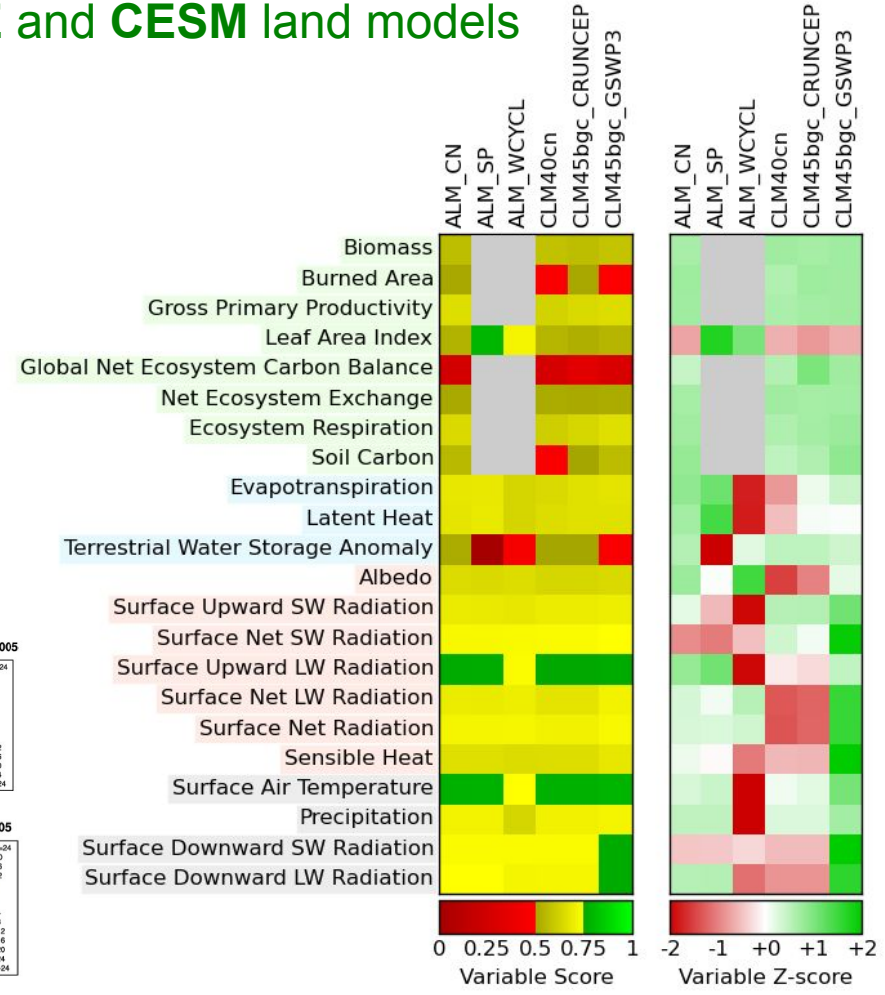
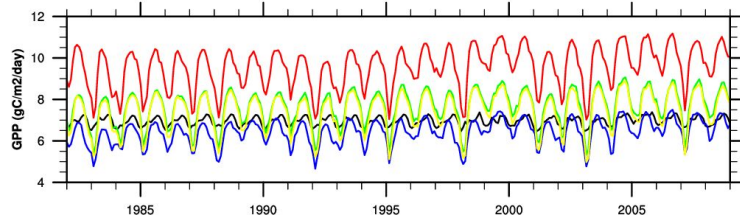


International Land Model Benchmarking (ILAMB)

- **ILAMBv1** released at 2015 AGU Town Hall, doi:[10.18139/ILAMB.v001.00/1251597](https://doi.org/10.18139/ILAMB.v001.00/1251597)
- **ILAMBv2** released at 2016 ILAMB Workshop, doi:[10.18139/ILAMB.v002.00/1251621](https://doi.org/10.18139/ILAMB.v002.00/1251621)
- Being used for system evaluation of **ACME** and **CESM** land models



Model	Annual	Bias	RMSE
FLUXNET-MTE	6.95	-999.00	-999.00
CLM40cn	9.55	2.60	2.73
CLM45bgc_CRUNCEP	7.62	0.67	0.96
CLM45bgc_GSWP3	6.42	-0.53	0.71
ALMv1_CRUNCEP	7.43	0.48	0.89



Next Steps

- Engage with the measurements, modeling, and data communities to foster scientific discoveries
- Organize working groups on key scientific research topics, where multi-disciplinary scientists come together to conduct unique studies and publish results
- Exploit synergies across federal agency and university research activities
- **To get involved, contact:**
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