
U.S. DEPARTMENT OF ENERGY | Office of Science

# CESD Cyberinfrastructure Working Groups

## Environmental System Science (ESS) PI Meeting

Bolger Center, Potomac, Maryland, USA

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# *Model–Data Integration*

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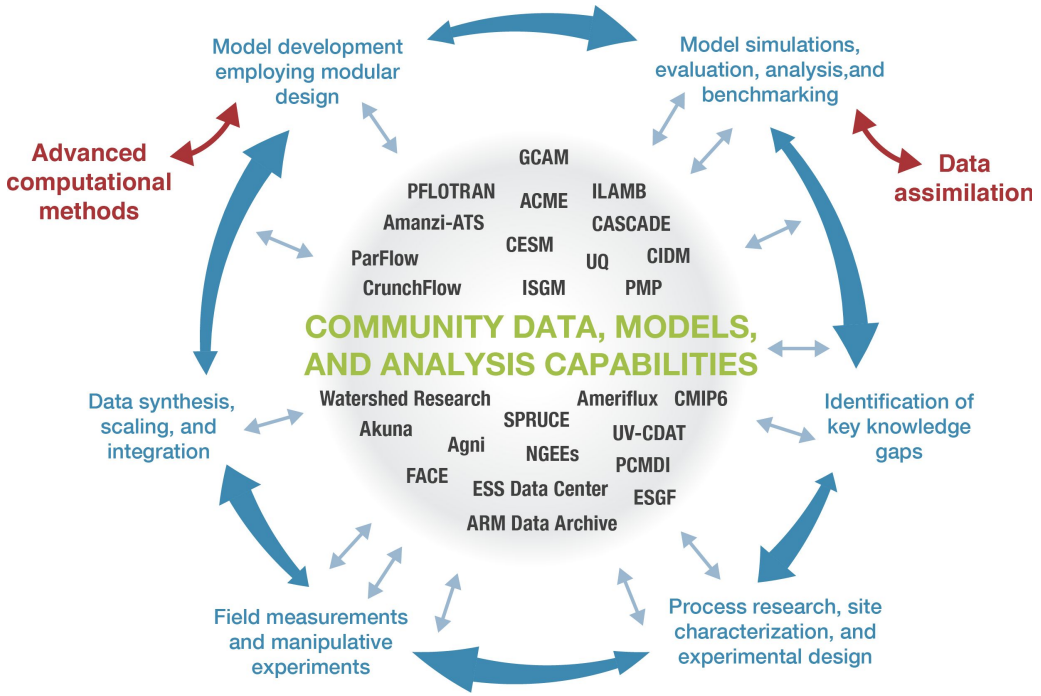
# Model–Data Integration Scope

- Model–data comparison
- Uncertainty quantification (UQ) & data assimilation (DA)
- Management of model results and observational data
- Geospatial and remote sensing data analysis
- Data analytics methods and techniques, e.g.,
  - –Data mining
  - –Neural networks
  - –Genetic algorithms
  - –Other machine learning techniques
  - –Visual analytics
- Model–data fusion



# Short-Term Goals (2016–2018)

- **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 (2016–2018) (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

# Progress Since 2016

- **Geospatial analysis and remote sensing**
  - 2017 whitepaper : **Geospatial Science to Inform Land Surface Models** (Mishra, Serbin, Wainwright, Kumar, Huang, and Chen)
- **Model–data comparison and benchmarking**
  - International Land Model Benchmarking (ILAMB) Workshop and Tools (described by Hoffman later)
- **Archiving of publications, data, models, & software tools and open data standards & conventions**
  - Data management plan plus software productivity and sustainability requirements for CESD projects
  - Work with new ESS-DIVE
  - Draw on work of ESIP, ISMC, CSDMS, EarthCube
- **Uncertainty quantification (UQ) & data assimilation (DA)**
  - Akuna-CLM, DART-PFLOTRAN, PEcAn
- **Scientific workflows and model & data analysis tools**
  - Jupyter notebooks
- **Community outreach**
  - AGU Fall Meeting sessions on “Computational Methods and Tools for Model–Data Integration” and “Big Data in the Geosciences” and “ML”

# Path Forward

- **Community survey on workflows and model–data integration tools being conducted**
  - Please take this survey by the end of the ESS PI Meeting: https://goo.gl/forms/BdLCDpq1IZckhKPI3
- **Preliminary results with 27 responses:**
  - 56% Python
  - 33% MATLAB
  - 30% R
  - 30% Visit
  - 22% NCL
  - 19% C/C++
  - 11% IDL
  - 7% FORTAN
  - 48% Jupyter notebooks
  - 44% ILAMB
  - 15% PEcAn
  - 15% Akuna