



Accelerated Climate Modeling
for Energy



Uncertainty Quantification in Accelerated Climate Model for Energy

Khachik Sargsyan (8351)

CRF Climate Team Celebration
Dec 9, 2015

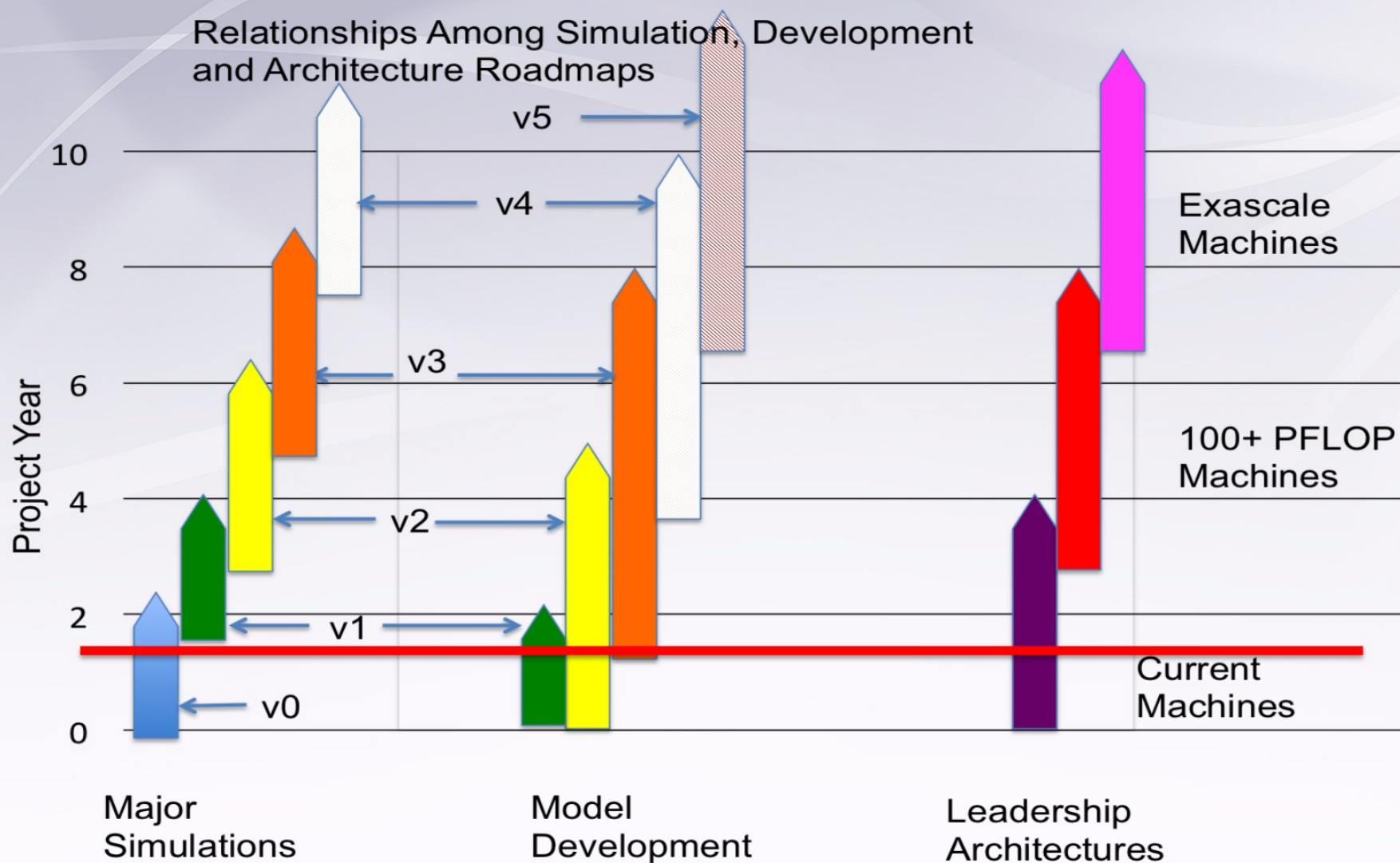
Accelerated Climate Modeling for Energy

A DOE Model on DOE Machines for the DOE mission

The Accelerated Climate Modeling for Energy is an ongoing, state-of-the-science Earth system modeling, simulation and prediction project that optimizes the use of DOE laboratory resources to meet the science needs of the nation and the mission needs of DOE.

- PI: Dave Bader (LLNL), DOE PM: Dorothy Koch
- Started summer of 2014, funded by **DOE BER**
- 8 DOE Labs, NCAR, a few universities and one company
- 100+ people, ~50 FTE effort, ~\$20M per year
- Reformulated effort of existing funding and people
- Branching from existing community models

ACME Roadmap



SNL-CA role in ACME: Uncertainty Quantification (UQ) for Land Model

- Current funding based on previous project (CSSEF) with Habib Najm (8351), Bert Debusschere (8351), Cosmin Safta (8954)
- ACME focus is on science development, but still....
... automated parameter sensitivity, tuning and prediction uncertainty assessment are needed.
- UQ Lead: K. Sargsyan, 0.5 FTE
- Direct collaboration with ORNL and PNNL scientists

Major UQ challenges for climate models

- High dimensionality (too many parameters)
- Expensive models (a single run is a few hours)
- Scarce information
- Inputs are very uncertain, and not independent
- Strongly nonlinear response
- [Elephant in the room] Structural uncertainties!

What we do:

- Developing/enhancing statistics and machine learning tools for UQ in physical models

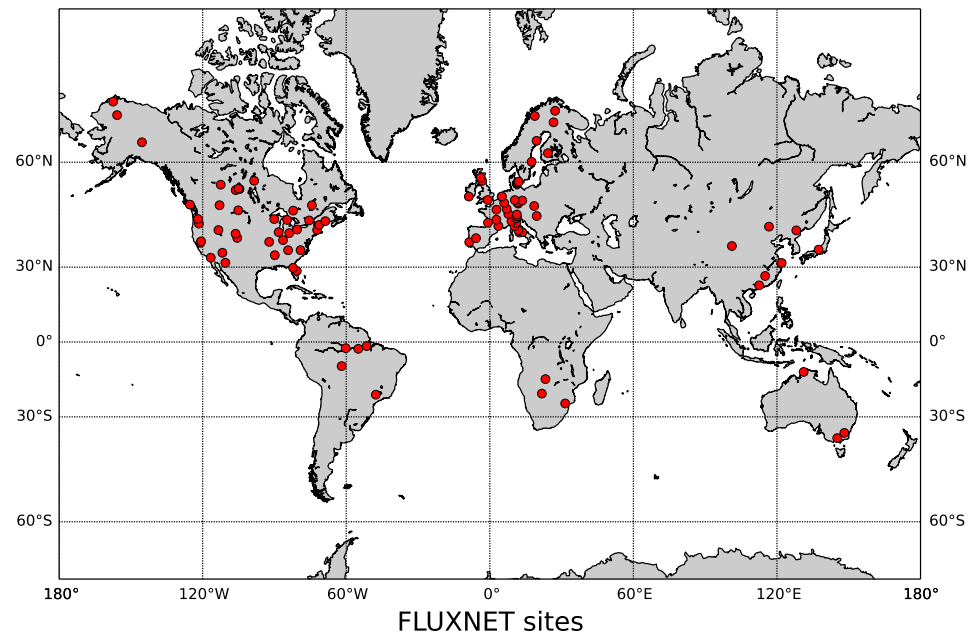
Forward UQ Analysis for Multiple Sites

- 96 FLUXNET sites covering major biomes and plant functional types
- Varying 68 parameters over given ranges
- Ensemble of 3000 ACME Land Model

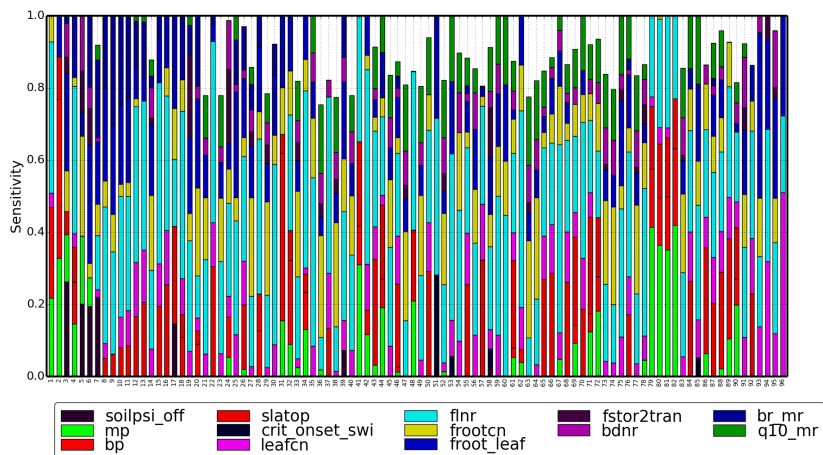
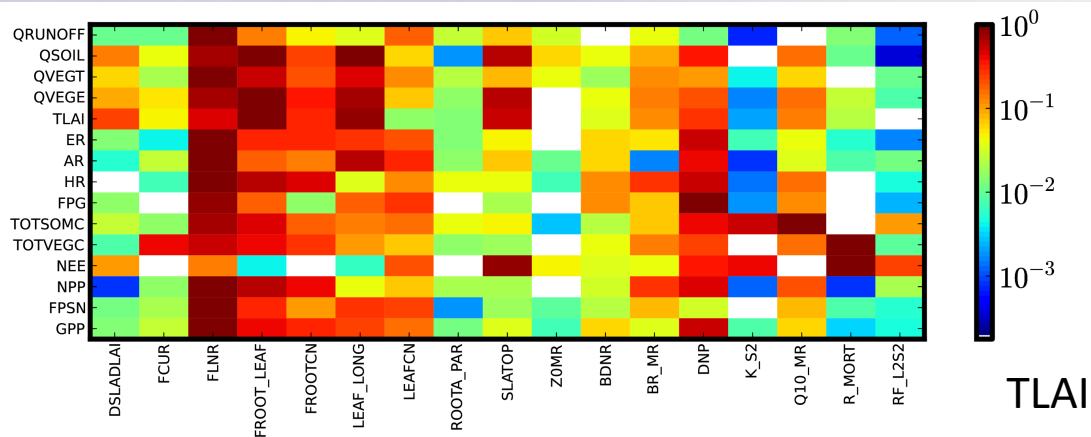
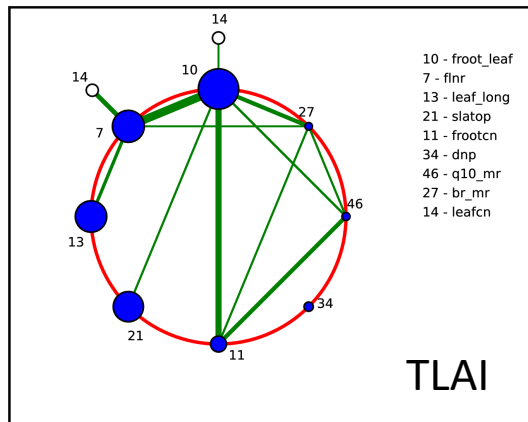
runs on Titan

(ORNL supercomputer)

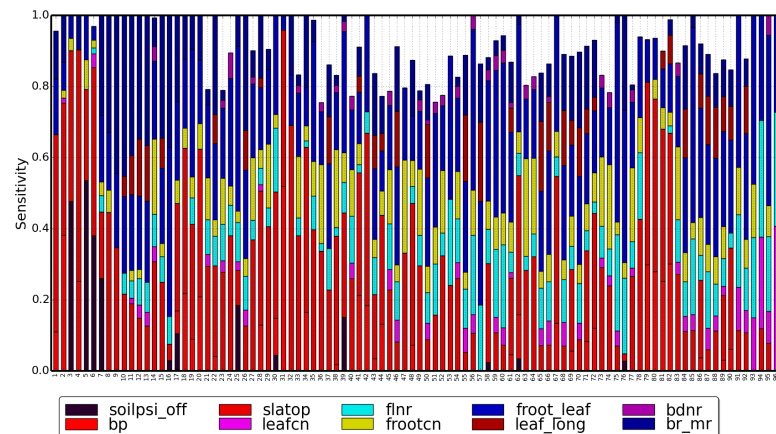
- The goal is to build surrogate models and to perform parametric uncertainty decomposition



Uncertainty Decomposition / Global Sensitivity Analysis



GPP



TLAI

Current / Future

- **Forward UQ** workflow for automatic parameter ranking
 - Interface to UQTK v2.2 (www.sandia.gov/uqtoolkit)
 - Uncertainty decomposition, global sensitivity analysis
 - Dimensionality reduction
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- Create automatic workflow for **Inverse UQ**
 - Calibration: parameter tuning with surrogates
 - More accurate, adaptive surrogates