Revolutionizing large-scale parameter calibration for land surface hydrologic models using deep learning

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RGMA

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Motivation:

1. Parameter estimation has been a pain point for land surface models (LSM) for a long time (hydrologic, ecosystem, etc). For many models, repeated parameter calibration can take a lot of time.
2. Parameters equifinality causes huge uncertainties.
3. Purely data-driven models can only predict observed variables.
4. Coupling physics with ML **may** improve the chance to capture extremes.
5. Multifaceted process-based model outputs build better narratives and explanations to stakeholders.

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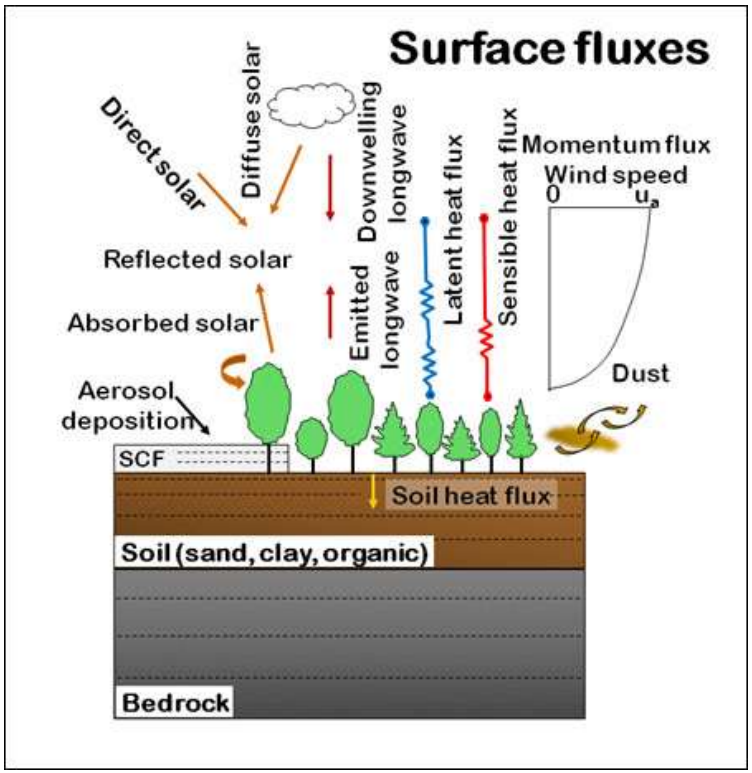
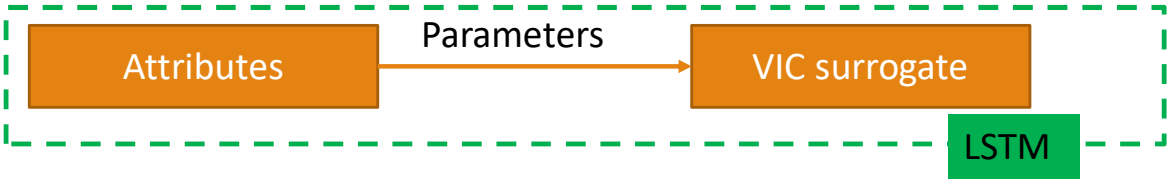
A Framework for Improving Analysis and Modeling of Earth System and Intersectoral Dynamics at Regional Scales

Interactions w/ ecosystem/biogeochemistry



From parameter calibration to →

Forward parameter learning (fPL)



We calibrated VIC model using SMAP data and the LSTM-based fPL scheme.

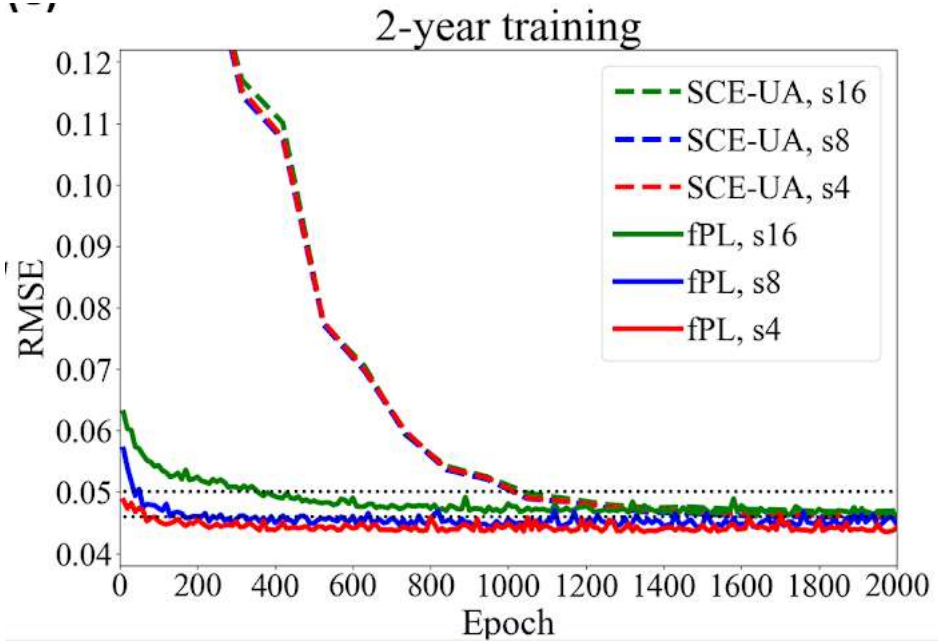
We turned parameter calibration into a pattern recognition problem, but with flexibility for the process-based model.

Parameter learning (*fPL*) -- results

- Equivalent to or slightly stronger than SCE-UA on the main calibration target
- Saves O(10^4) computation

enter the Economy of Scale of big data machine learning

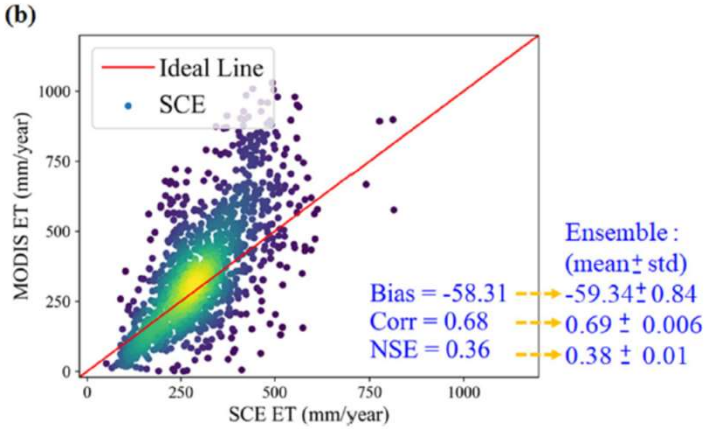
Get right results… for the right reason

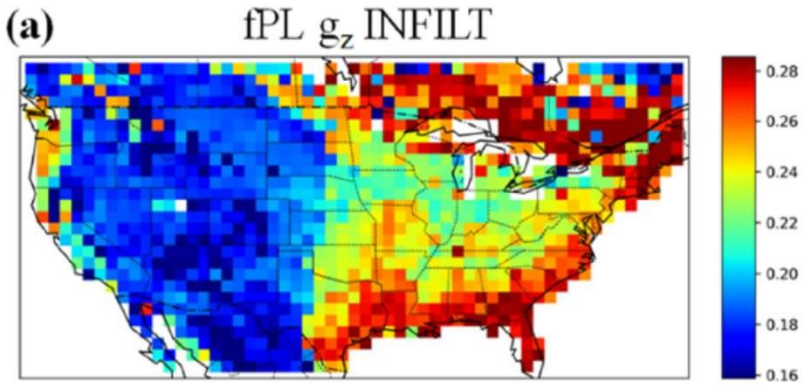


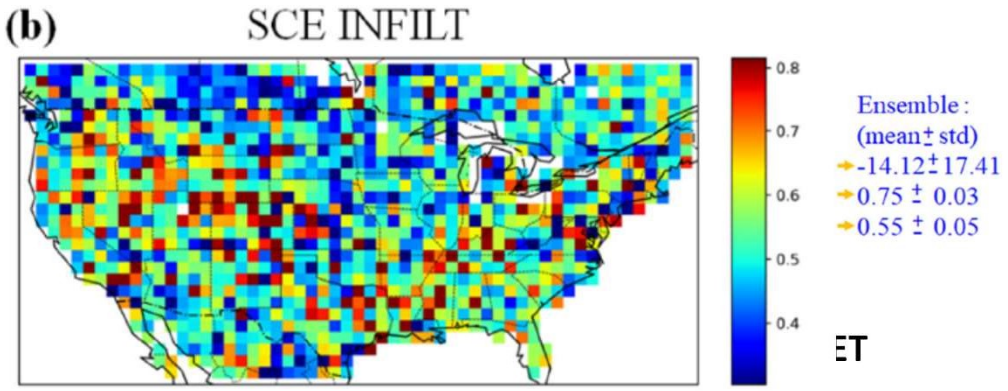
More efficient and scales better with more data!

Parameter learning (*fPL*)

- Stronger than SCE-UA!
- Saves O(10^4) computation!
- Better results at neighboring locations
- Better results for uncalibrated variables







Spatial extrapolation

Tsai et al., under review