Hyper-resolution land surface modeling enables 30-m SMAP-based soil moisture at continental scales

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\[ KGE = 1 - \sqrt{(\rho - 1)^2 + (\beta - 1)^2 + (\gamma - 1)^2} \]

\[ \rho = \text{correlation} \]

\[ \beta = \frac{\mu_{\text{model}}}{\mu_{\text{obs}}} \]

\[ \gamma = \frac{\sigma_{\text{model}}/\mu_{\text{model}}}{\sigma_{\text{obs}}/\mu_{\text{obs}}} \]
CONCLUSIONS

- A physically-based tile-based assimilation framework that combines HydroBlocks LSM, Tau-Omega RTM, and spatial Bayesian Merging to downscale SMAP to an unprecedented 30-m spatial resolution.

- Merging and downscaling improves performance overall, outperforming SMAP-L3 and SMAP-L4.

- HRUs/tiles reduce the dimensionality of the system → Efficient modeling and assimilation.

- The proposed HRU-based assimilation can be applied to:
  - Other land surface or earth system models that use hillslope or tile-based scheme.
  - Assimilating and merging other land variables without the RTM (e.g., LST, ET, SWE, etc.).
  - Multi-scale dynamic assimilation using ensemble models and Ensemble Kalman Filter.

A framework that bridges the gap between coarse-scale satellite retrievals and fine-scale model simulations as we move towards “everywhere and locally relevant” predictions.