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

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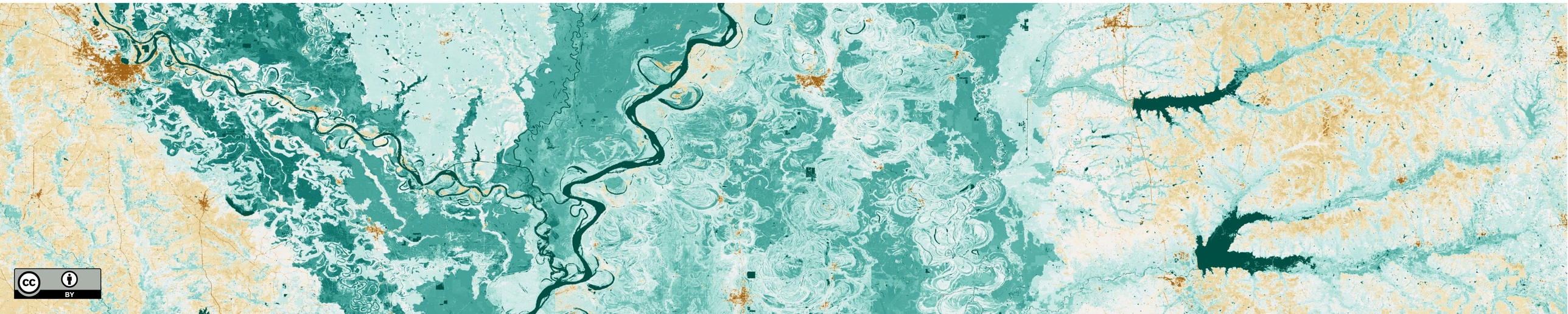
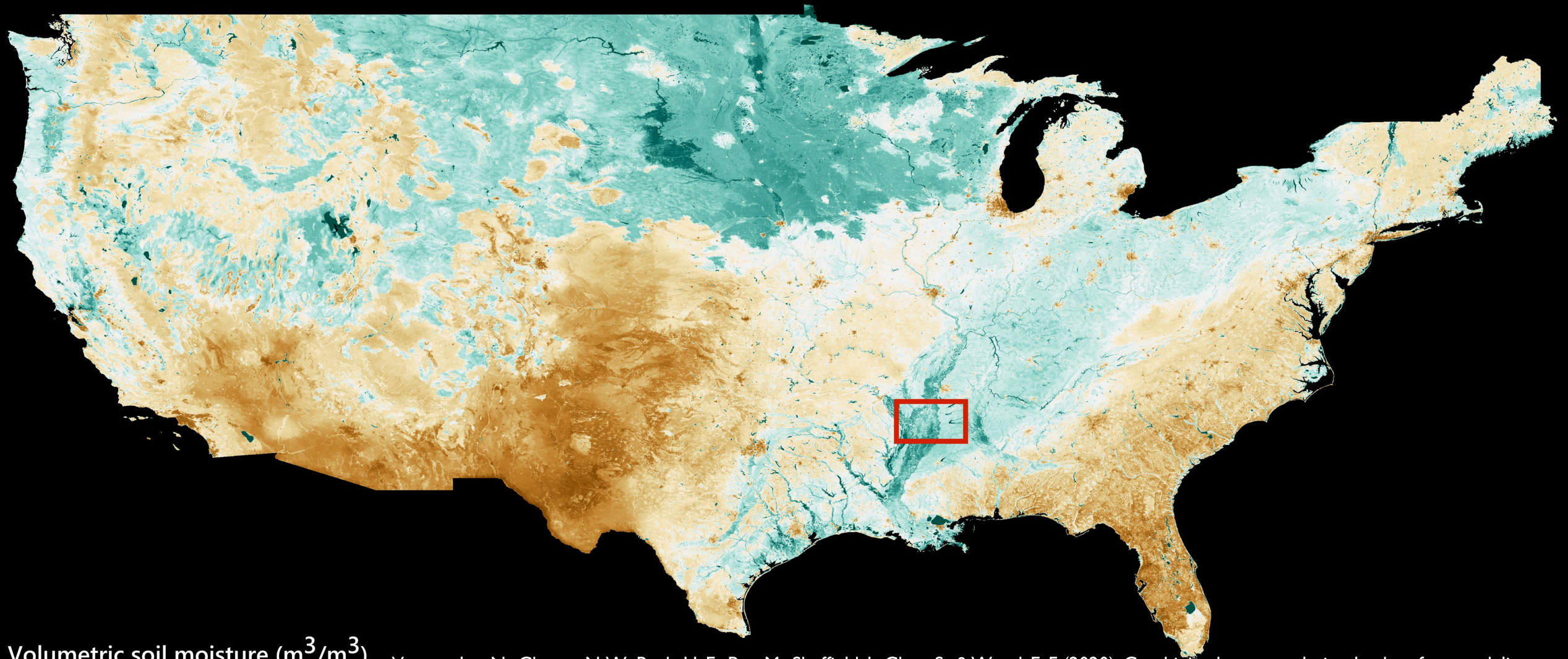


Hyper-resolution land surface modeling of surface soil moisture

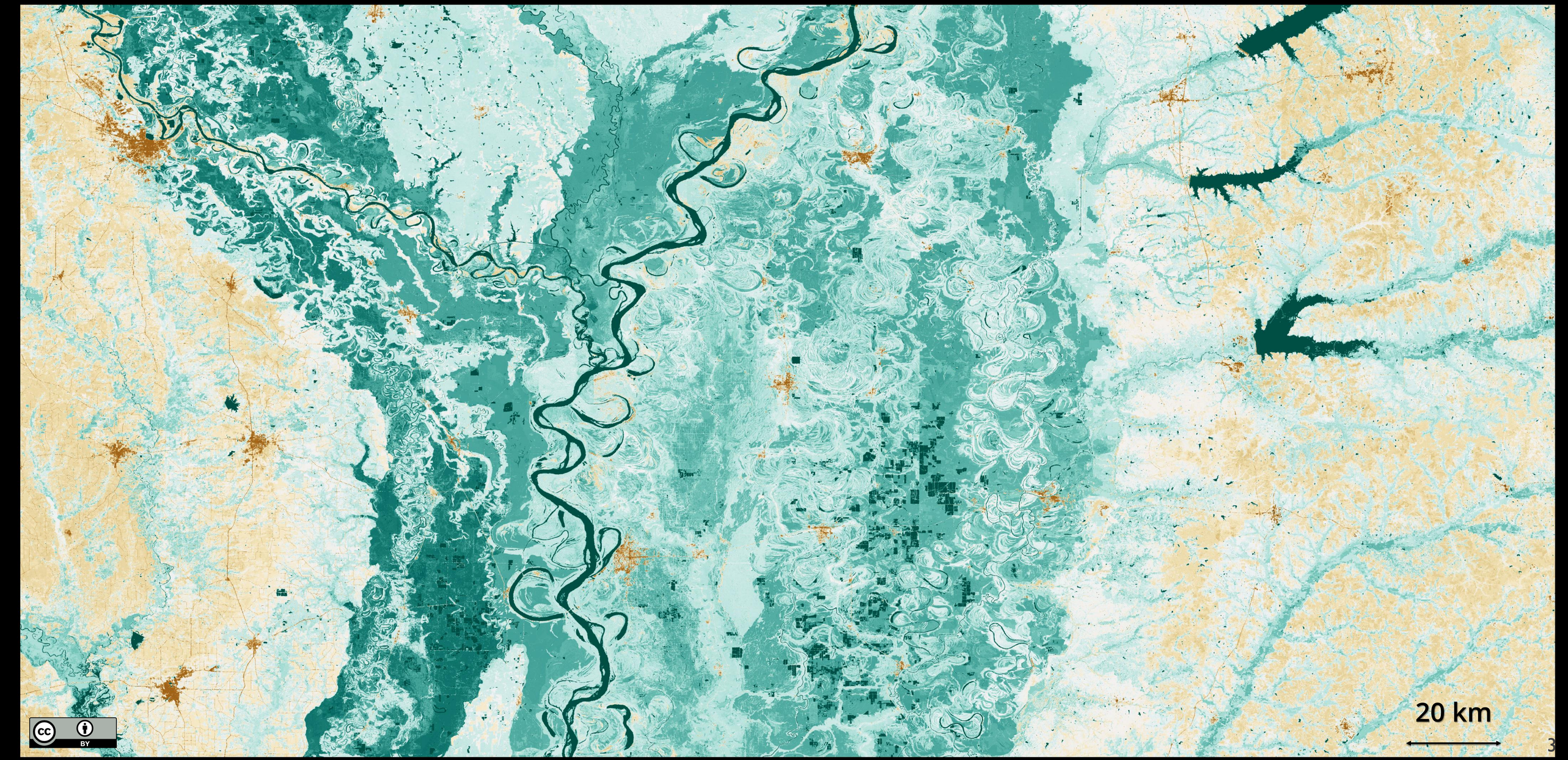


Volumetric soil moisture (m^3/m^3)

0.0 0.25 0.5

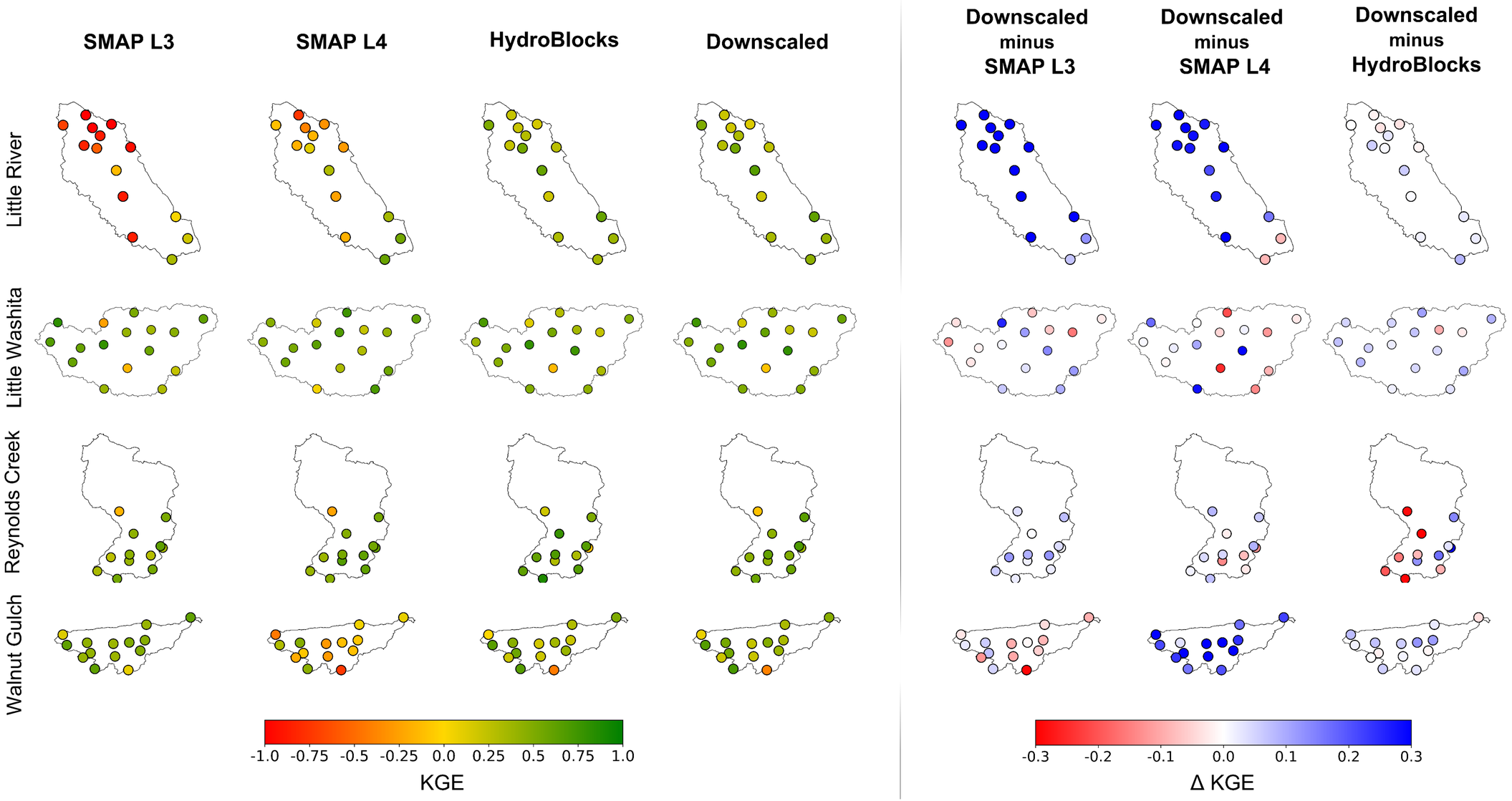
Vergopolan, N., Chaney, N.W., Beck, H. E., Pan, M., Sheffield, J., Chan, S., & Wood, E. F. (2020). Combining hyper-resolution land surface modeling with SMAP brightness temperatures to obtain 30-m soil moisture estimates. Remote Sensing of Environment, 242, 111740. https://doi.org/10.1016/j.rse.2020.111740

Mississippi River / Greenville, April 1st, 2017



KGE Performance

Blue shows improvement



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

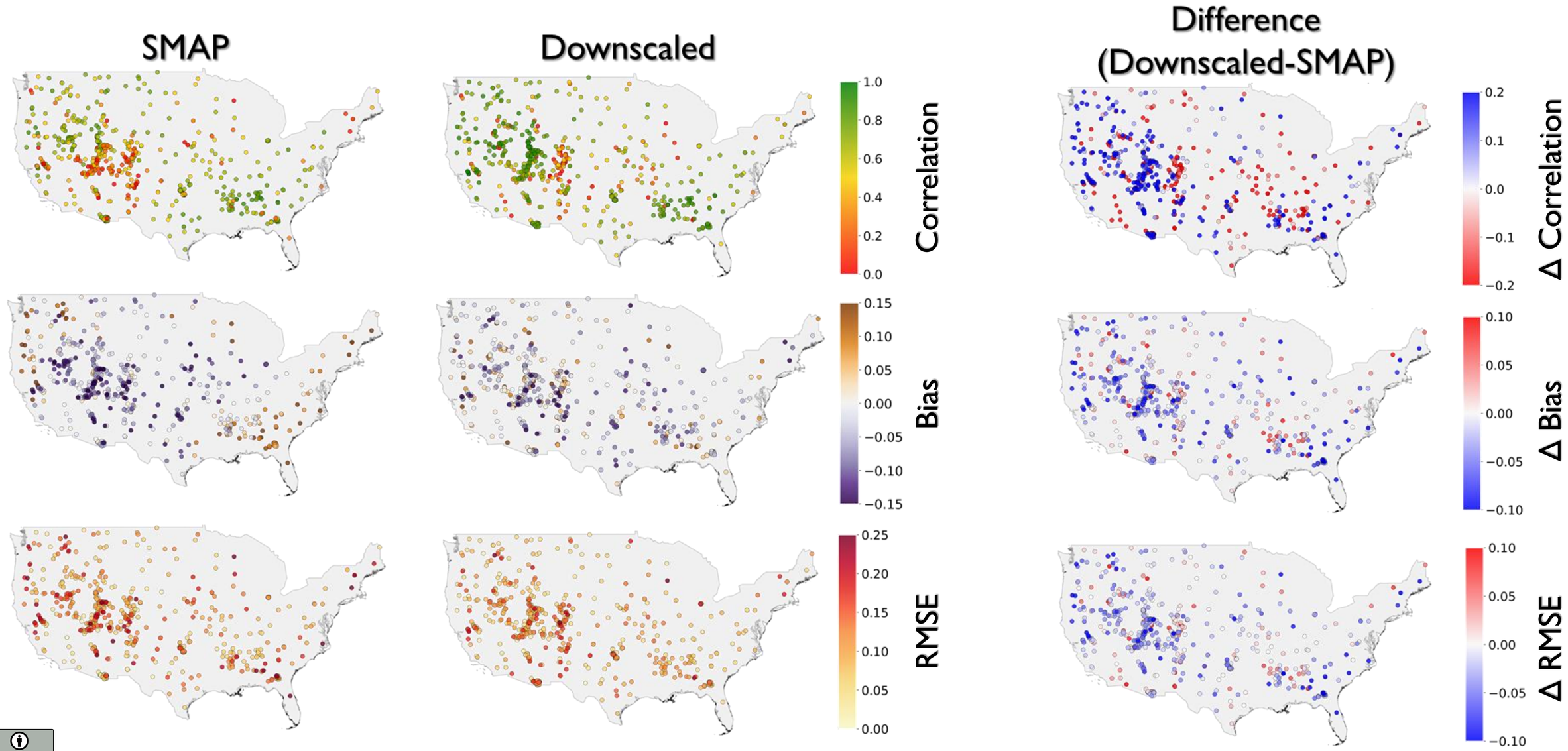
ρ = correlation

$$\beta = \mu_{model}/\mu_{obs}$$

$$\gamma = (\sigma_{model}/\mu_{model})/(\sigma_{obs}/\mu_{obs})$$

Evaluation over CONUS

Blue shows improvement



CONCLUSIONS

- A physically-based tile-based assimilation framework that combines HydroBlocks LSM, Tau-Omega RTM, and spatial Bayesian Merging to downscaled 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