Mapping field-scale soil moisture and its spatial variability across the United States using SMAP-HydroBlocks

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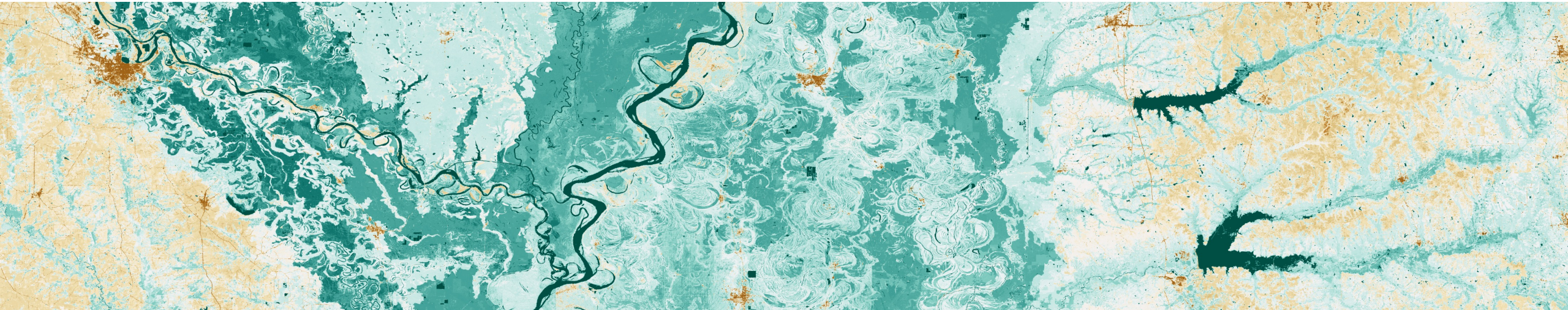


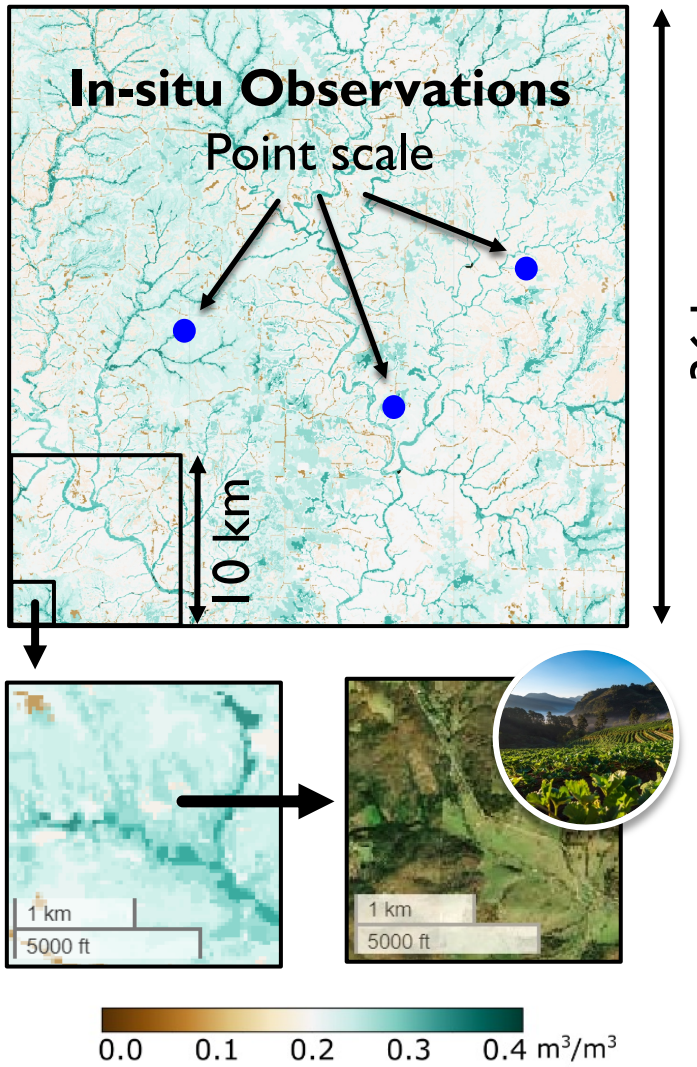
Challenges in Monitoring Soil Moisture

- Soil moisture is **highly heterogeneous** in space and time
- **In-situ** observations are **sparse** and **costly**
  - ~ 1200 for the United States
  - Roughly inexistent in much of the developing world
- **Satellite** microwave-based remote sensing provide **good accuracy** & **global coverage**, but only available at coarse spatial scales (e.g., 9-36 km resolution)

Satellite Observations
36 km resolution

Traditional Hydrological and LSM
10 km resolution

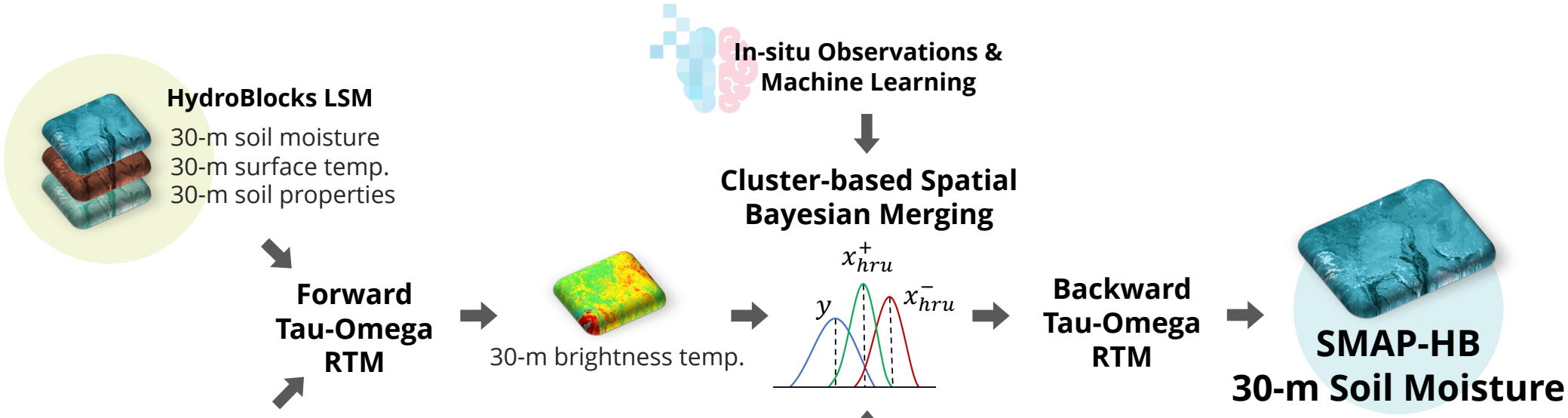
Impacts & Decisions
< 1 km resolution



The spatial scale mismatch between observations and modeling scales hampers data use for local-scale water resources applications

SMAP-HydroBlocks

Combining land surface modeling, satellite remote sensing, and in-situ observations



Modeling and merging satellite observations at the HRU (cluster) space **reduces the dimension of the system by 300-500 times**

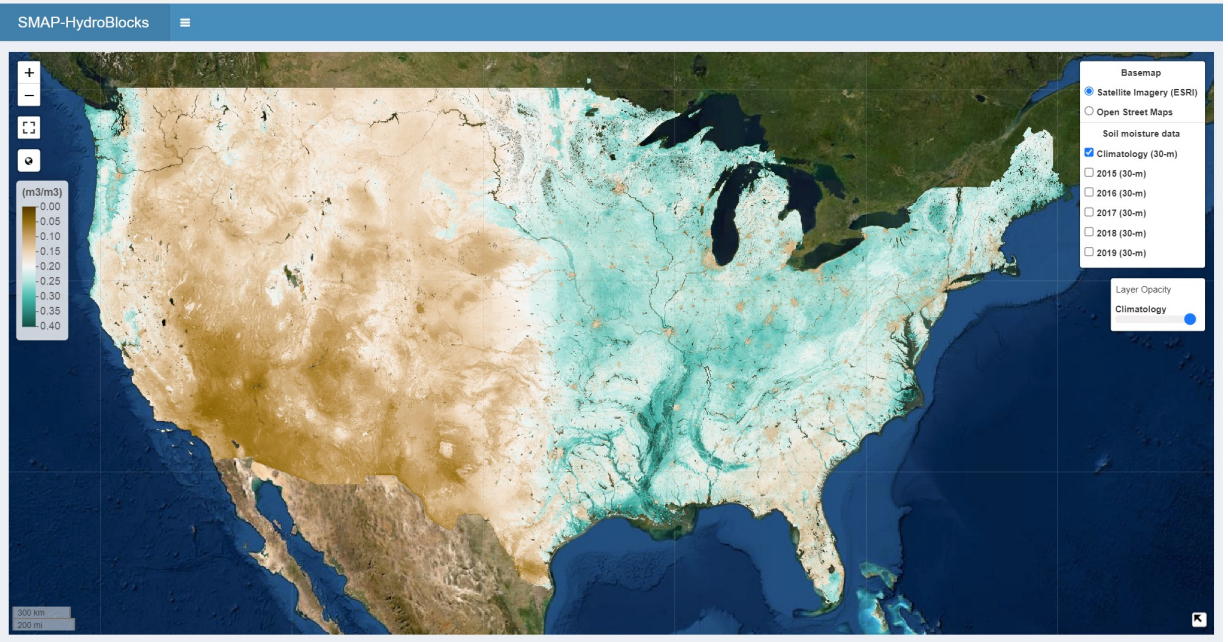
Vergopolan et al. (2020). Combining hyper-resolution land surface modeling with SMAP brightness temperatures to obtain 30-m soil moisture estimates. Remote Sensing of Environment.

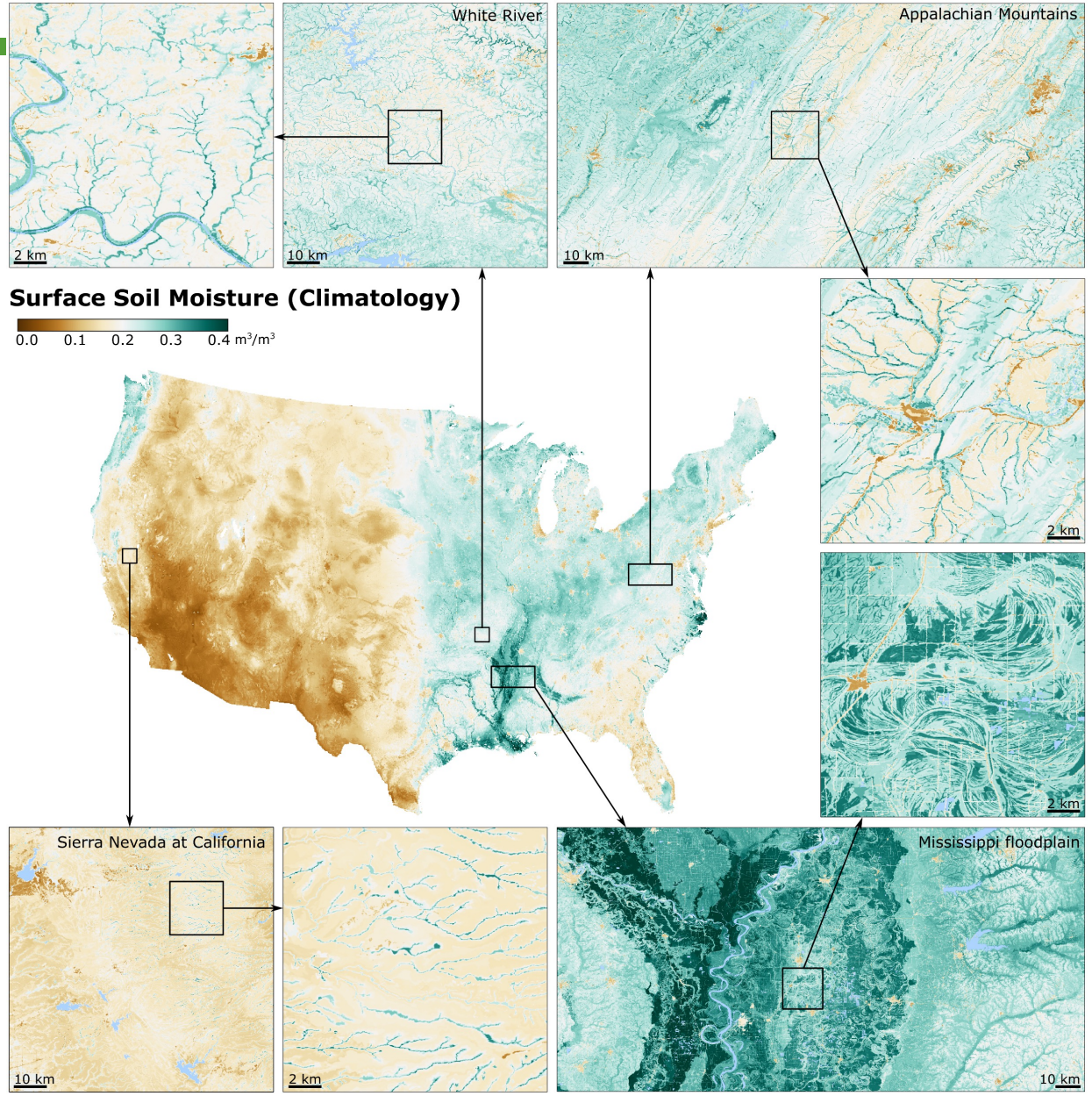
SMAP-HydroBlocks

The first satellite-based hyper-resolution surface soil moisture dataset for the US

- Open Access
- 2015-2019
- 30-m spatial resolution
- 2-3 days revisit time
- 62 TB

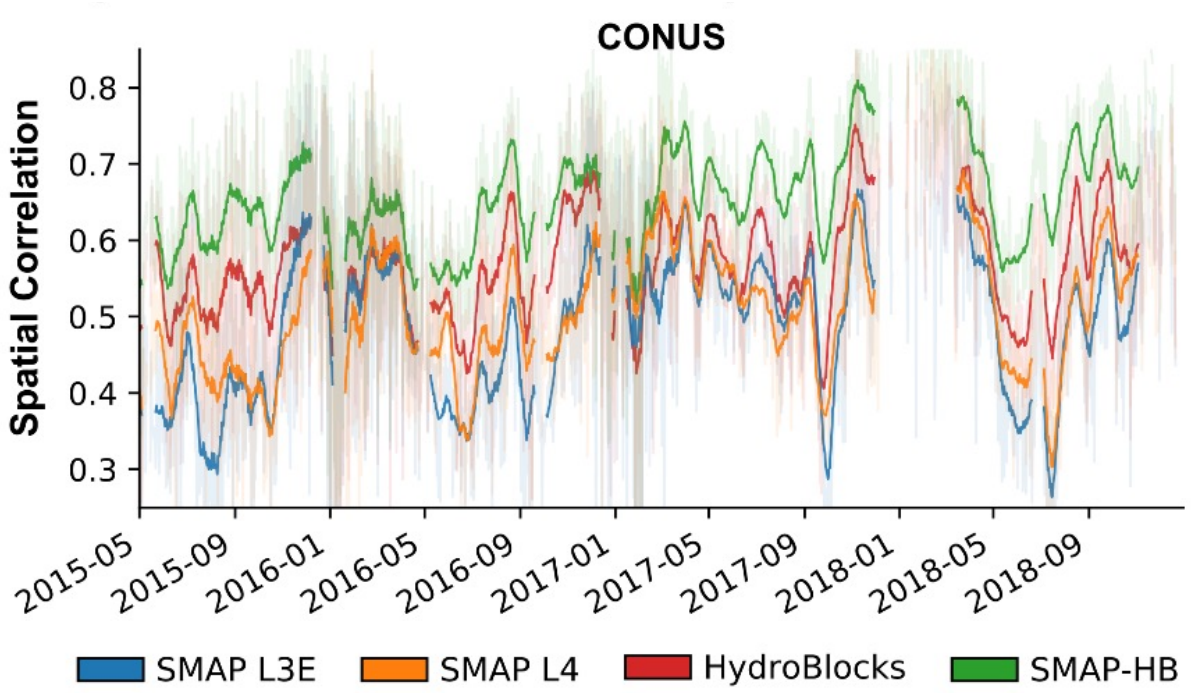
http://waterai.earth/SMAPHB

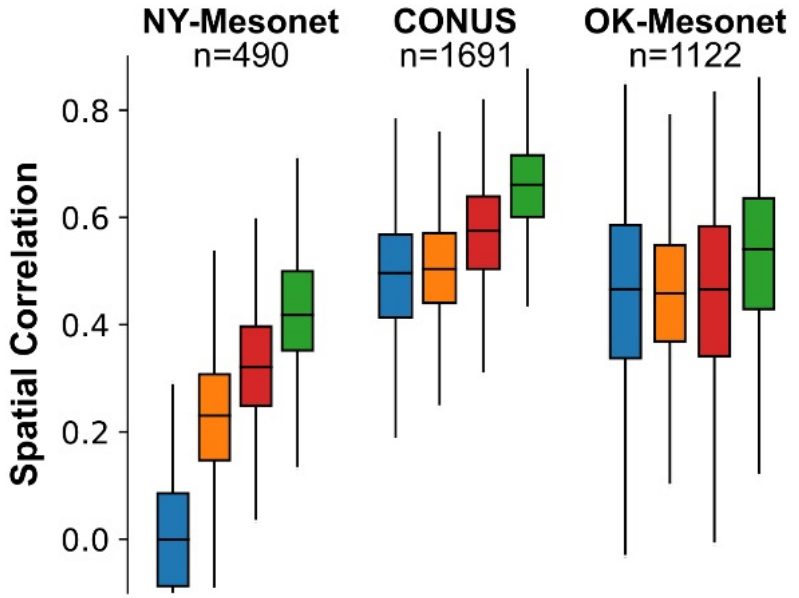




Vergopolan et al. ***SMAP-HydroBlocks, a 30-m satellite-based soil moisture dataset for the conterminous US.*** *Scientific Data. 2021*

SMAP-HydroBlocks:
Largely improves soil moisture spatial representativeness





Spatial correlation:
Correlation calculated between in-situ observation and soil moisture products at each time step when at least 60 in-situ observations are simultaneously available

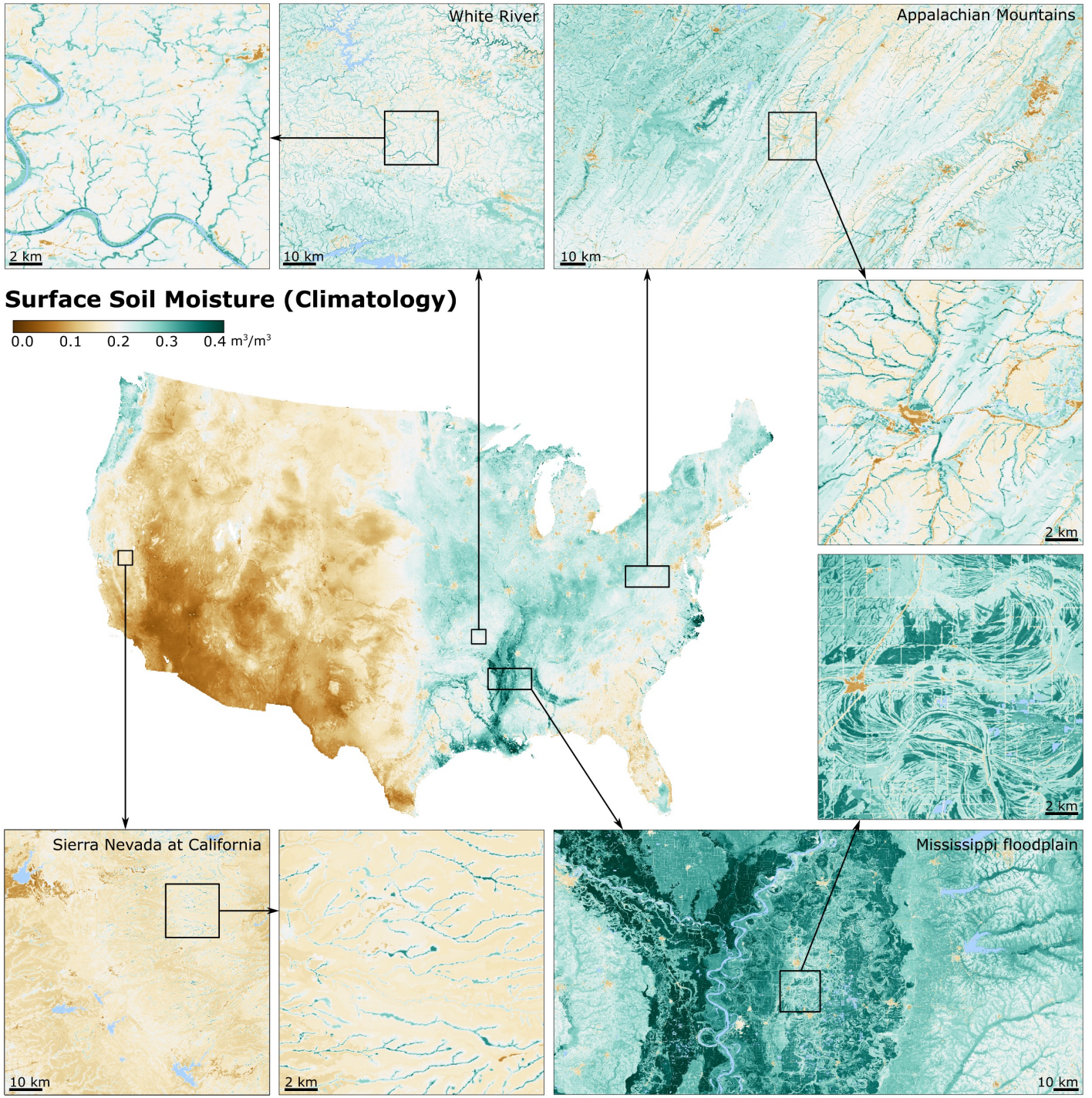
- SMAP L3: 9-km resolution (observation input)
- SMAP L4: 9-km resolution (NASA's state-of-the-art)
- HydroBlocks: 30-m resolution (model input)
- SMAP-HydroBlocks: 30-m resolution (best performance)

*Extensive temporal validation at Vergopolan et al. (2021): SMAP-HydroBlocks, a 30-m satellite-based soil moisture dataset for the conterminous US. Scientific Data

SMAP-HydroBlocks enable us to understand for the first time...

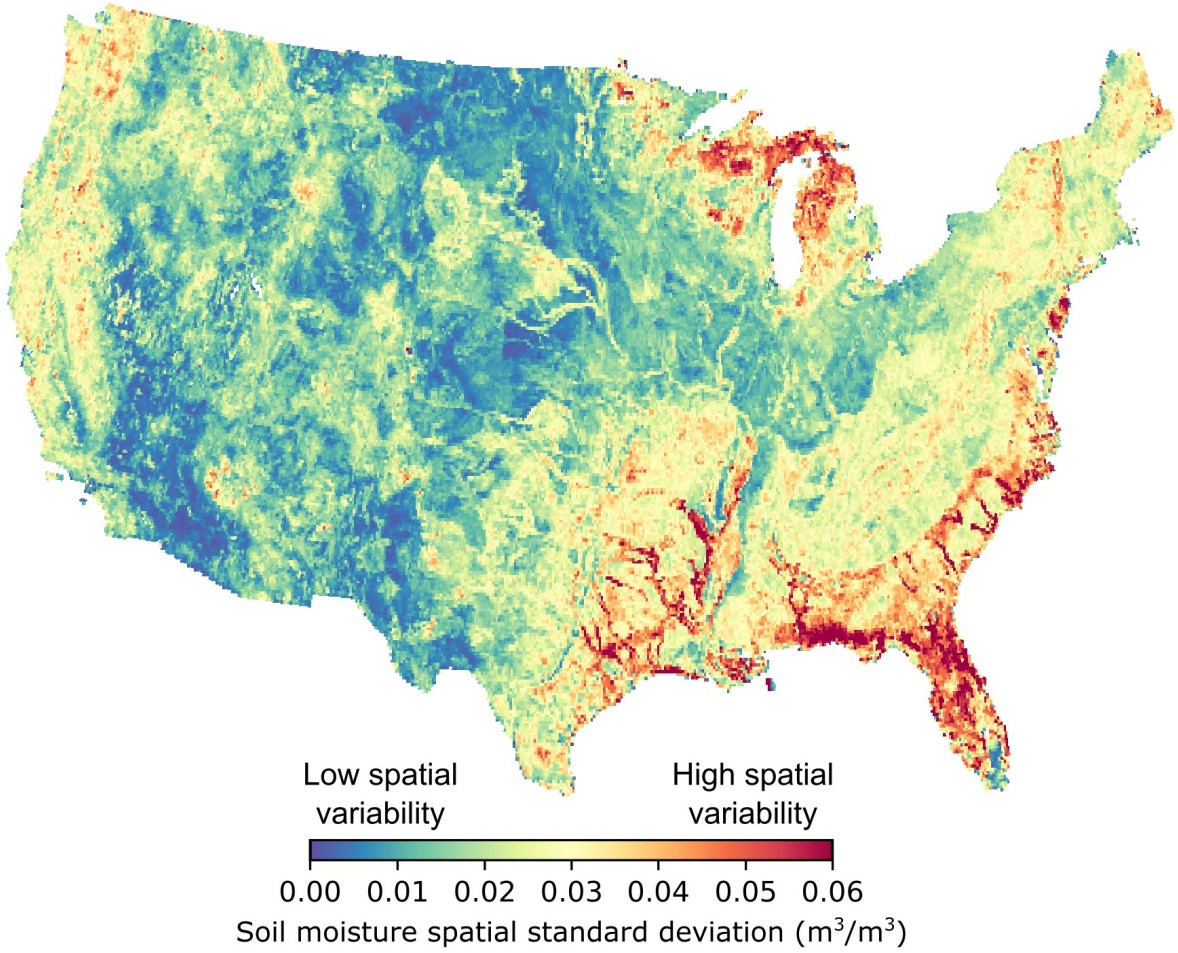
What is the soil moisture variability at local-scale?

How this spatial variability persists across scales?



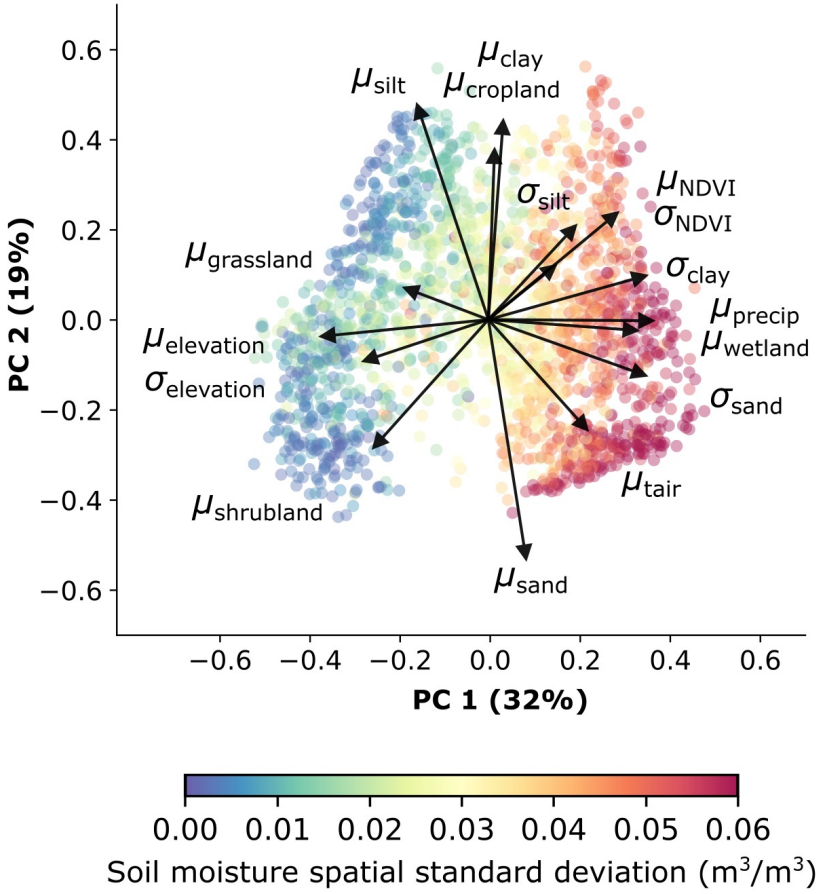
What is the soil moisture spatial variability?

A. Spatial variability of soil moisture (σ_{30m})



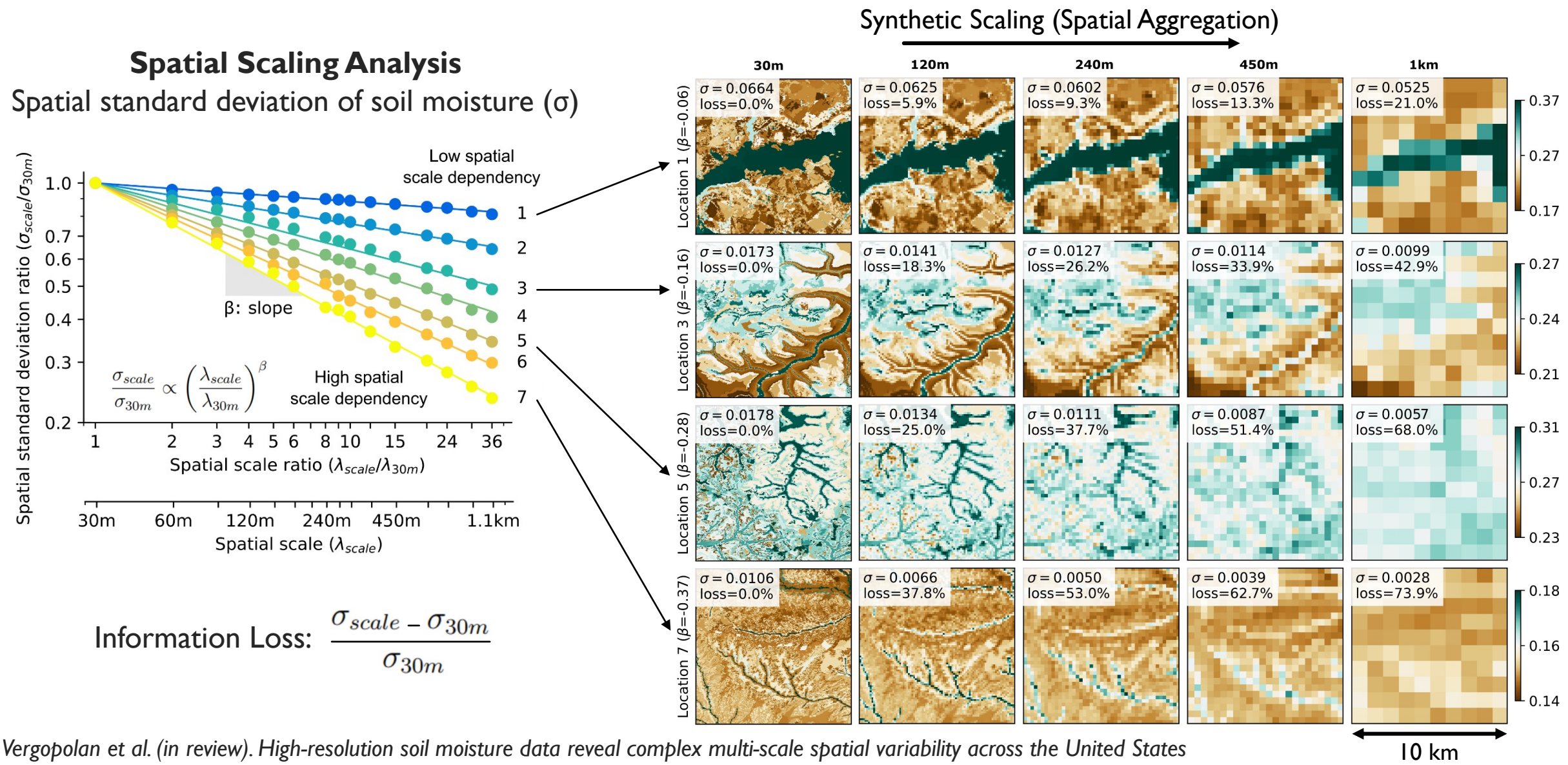
Spatial standard deviation (std) calculated at each 10-km grid cell using the 30-m SMAP-HB climatological soil moisture

B. Physical drivers of the spatial variability



PCA comparing the soil moisture spatial std with the spatial mean and spatial std of the respective physical characteristics

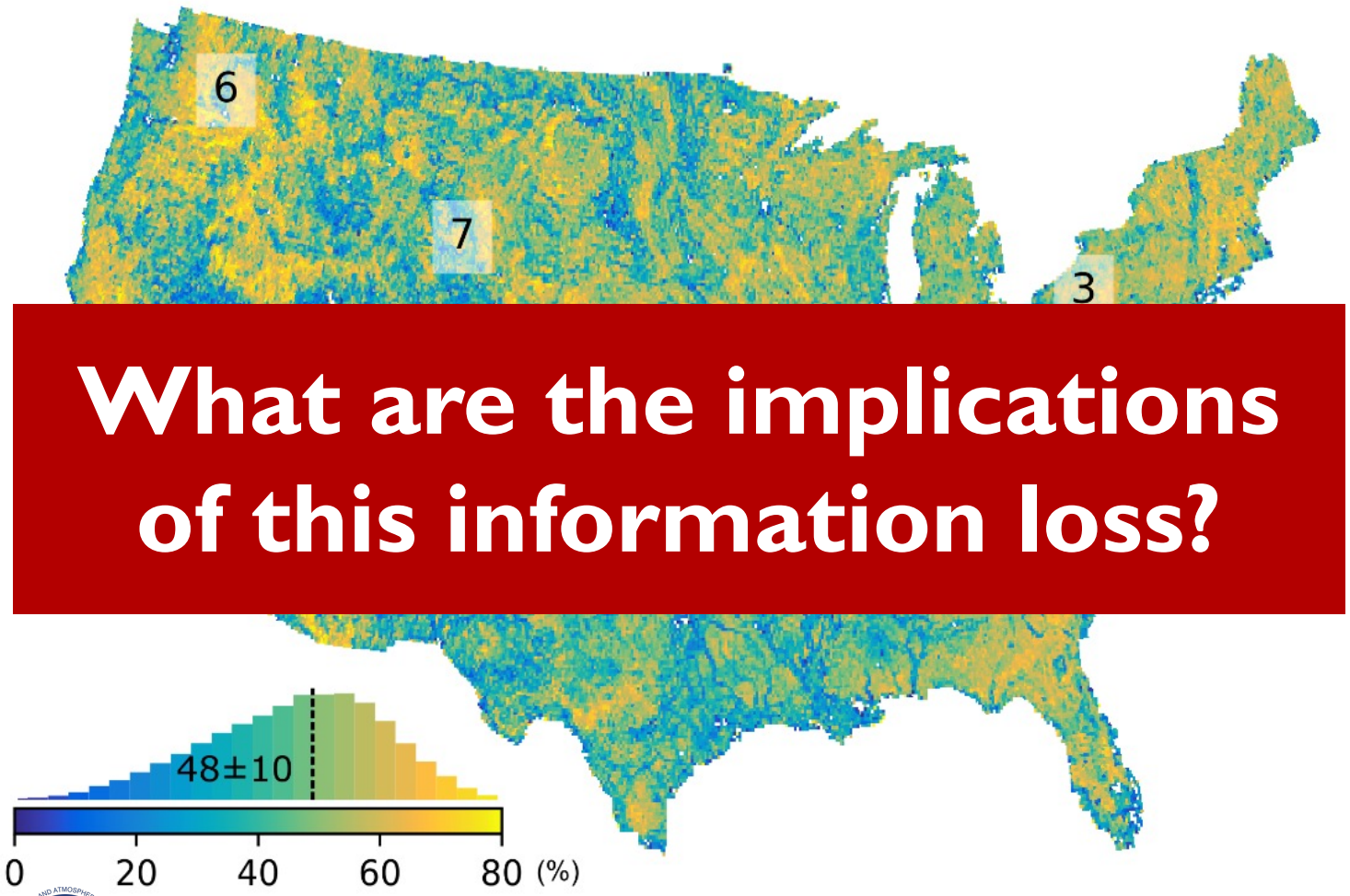
How this variability persists across scales?



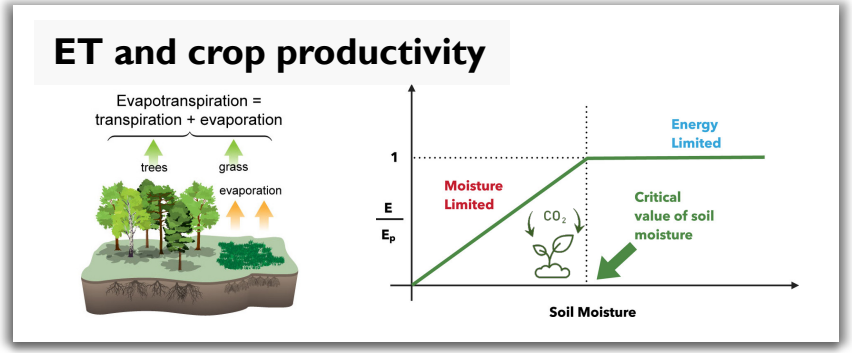
Vergopolan et al. (in review). High-resolution soil moisture data reveal complex multi-scale spatial variability across the United States

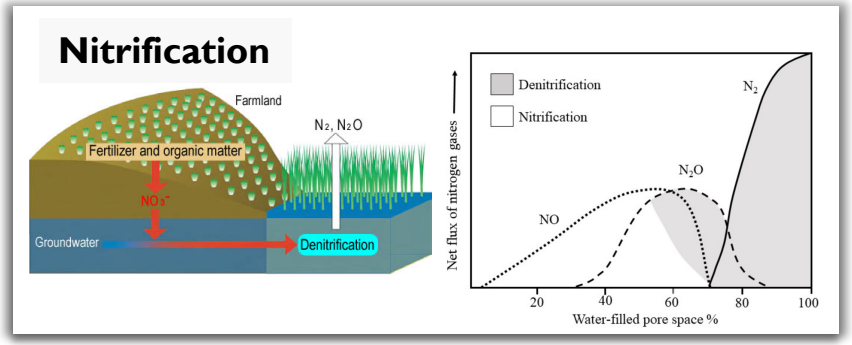
What is the soil moisture information loss across the US?

Information Loss of 1-km Resolution Data (%)



What are the implications of this information loss?





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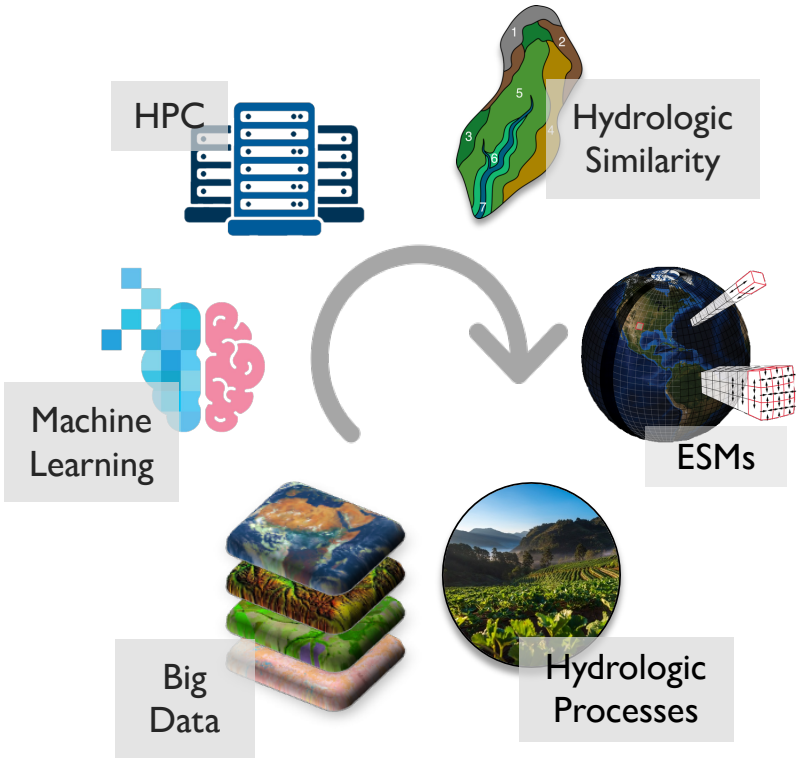

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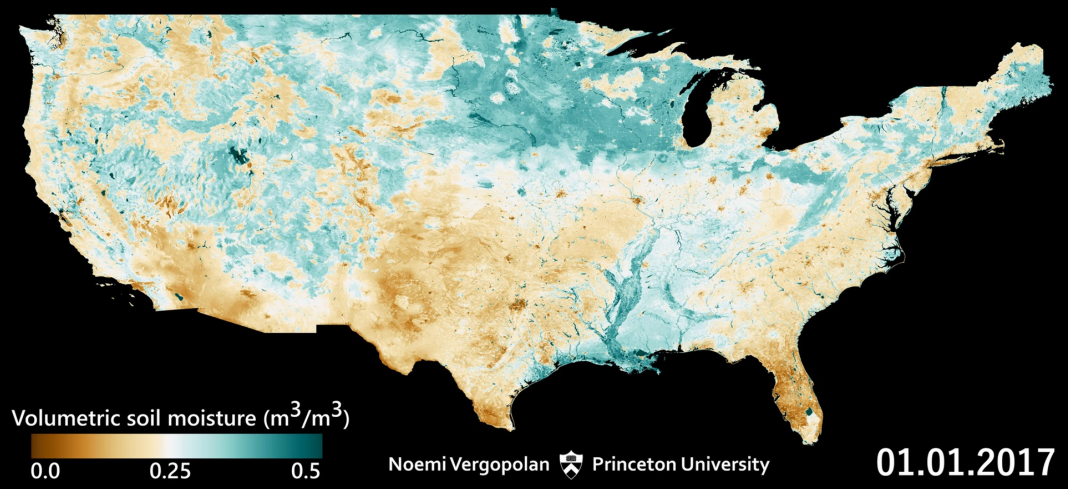

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