Estimates of global erosional sediment, carbon, nitrogen and phosphorus fluxes

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E3SM Energy Exascale Earth System Model

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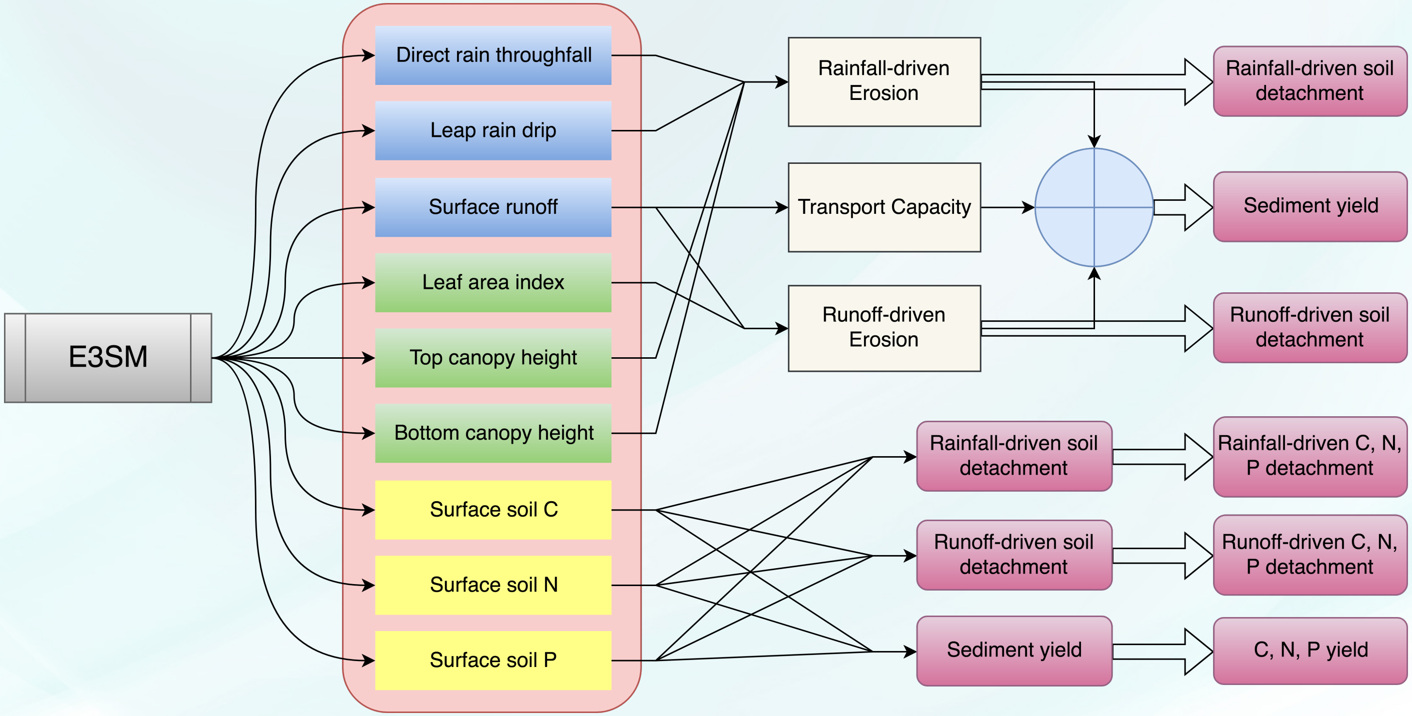
Methods

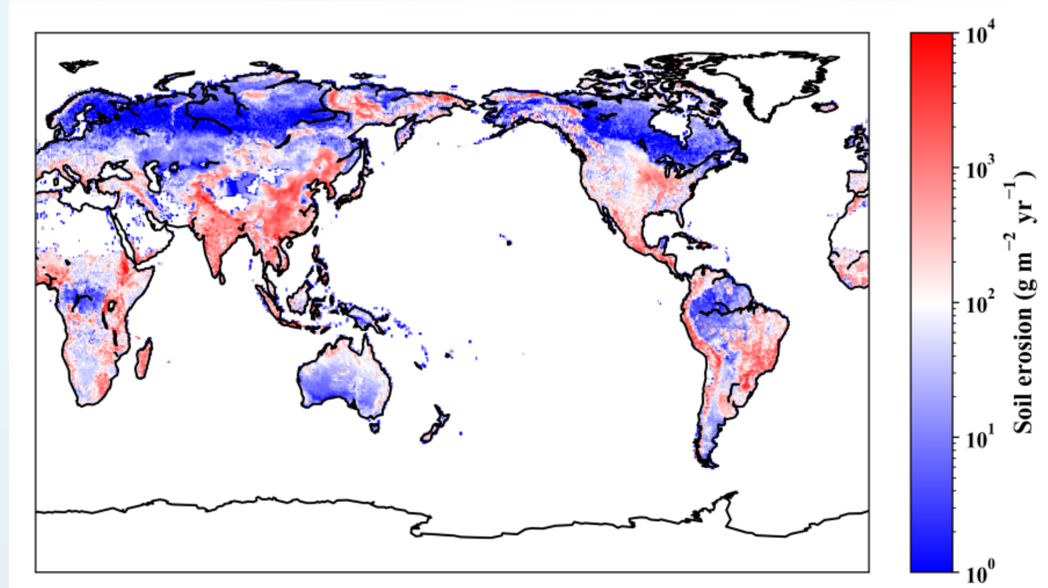
- Realistic representation of soil erosion in E3SM will greatly improve the understanding of global carbon and nutrient cycles in the context of environmental changes.

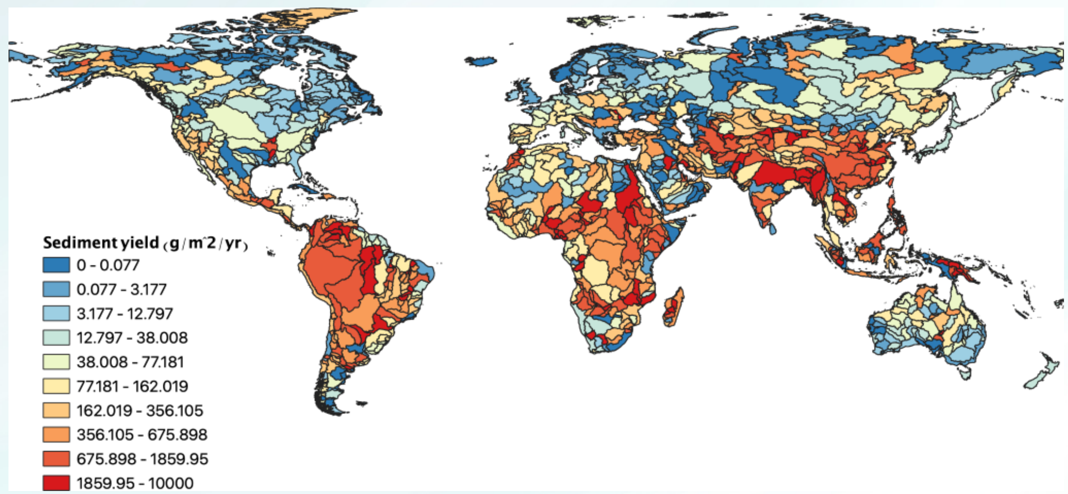


Schematic of the ELM-Erosion model (Tan et al., 2018, 2020)

Benchmark estimates

Widely-used soil erosion and sediment yield estimates are for ELM-Erosion calibration, including a global RUSLE 25-km soil erosion estimate for 2000s (Borrelli et al., 2017), and WBMsed long-term semi-pristine sediment yield estimate on the HydroBASINS Lev04 basins (Cohen et al., 2013).



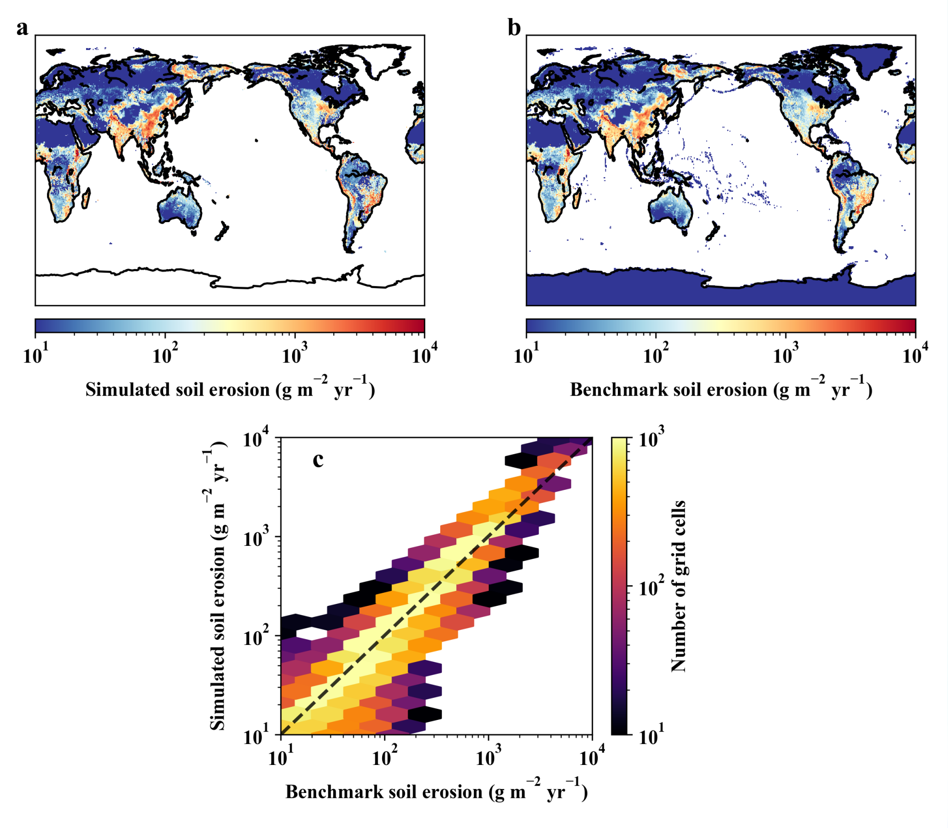


Simulation protocol

- Simulation period: from 1991 to 2010
- Forcing data: 0.5-deg 3-hourly GSWP3 data
- Simulation resolution: 0.5-deg
- Land BGC scheme: ECA
- LULCC scheme: The Land Use Harmonized version 2 (LUH2) transient dataset from 1850 to 2015

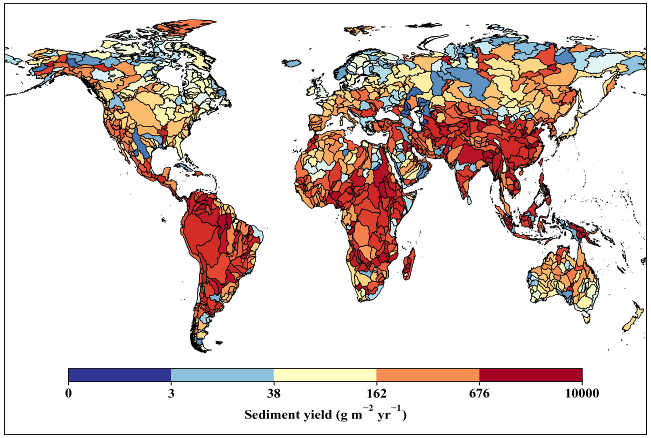
Model calibration

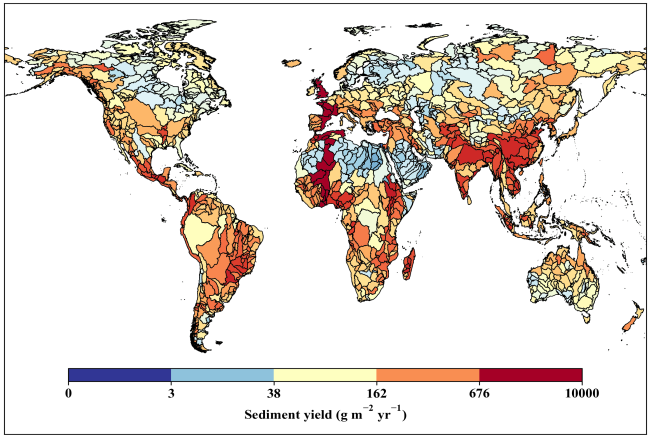
- **Calibrated ELM-Erosion reproduces spatial variability of global soil erosion**

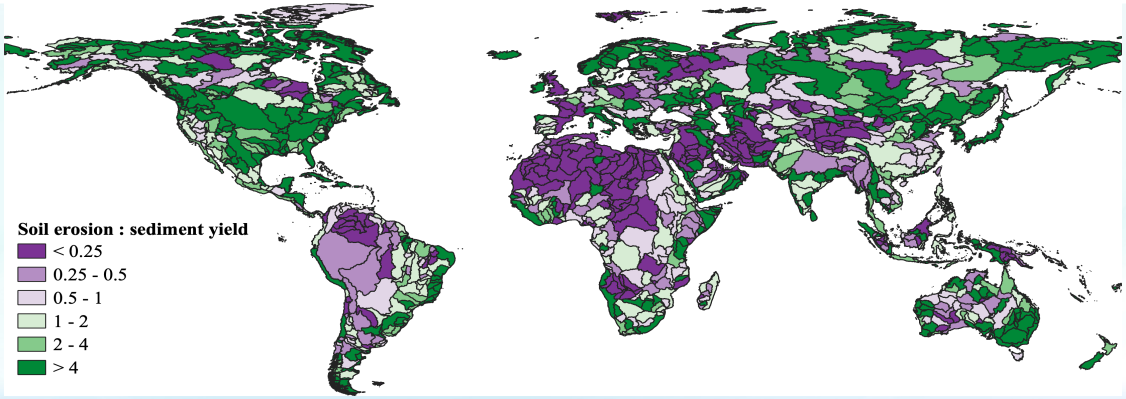


Model calibration (cont.)

- **Calibrated soil erosion is insufficient to support riverine sediment yield**

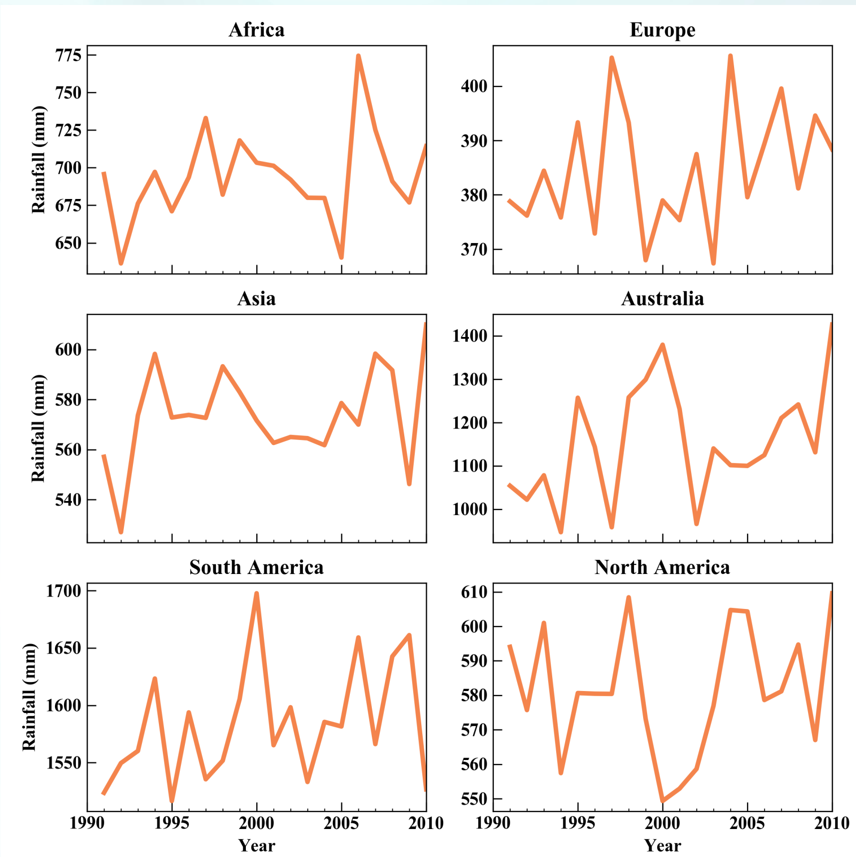


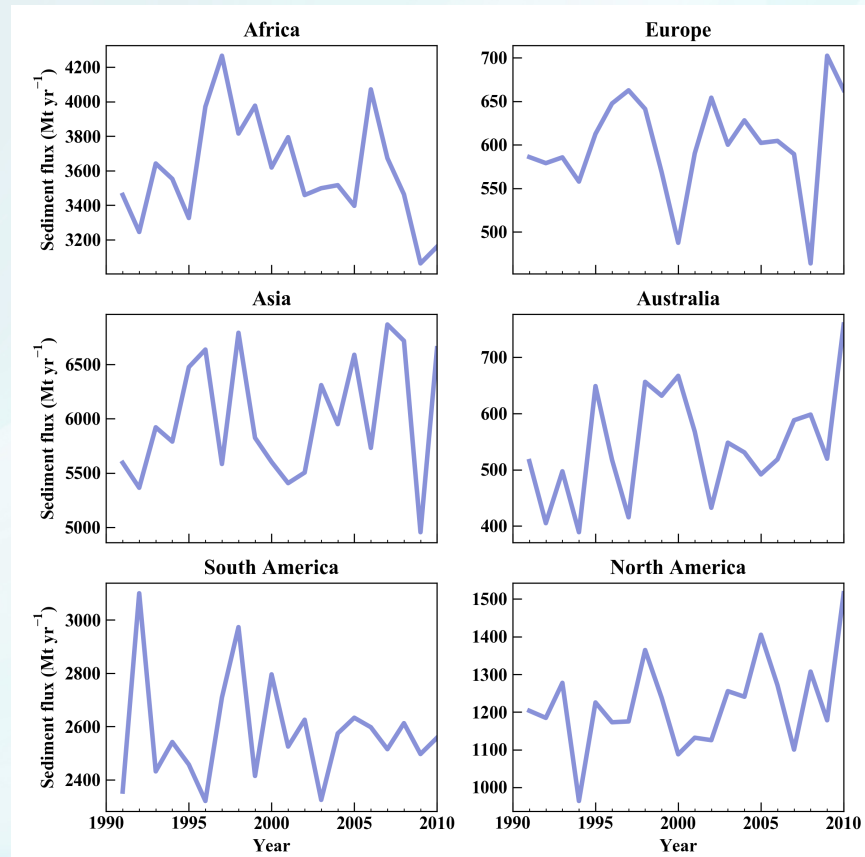




Modeled sediment loads

- Low correlation between the temporal variability of rainfall and sediment loads at the continental scale





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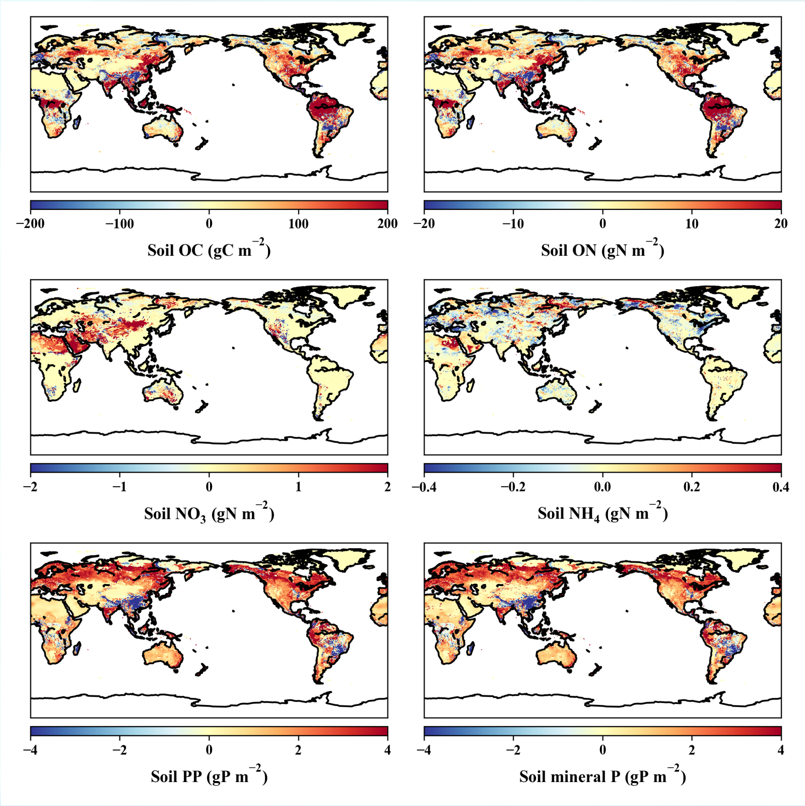
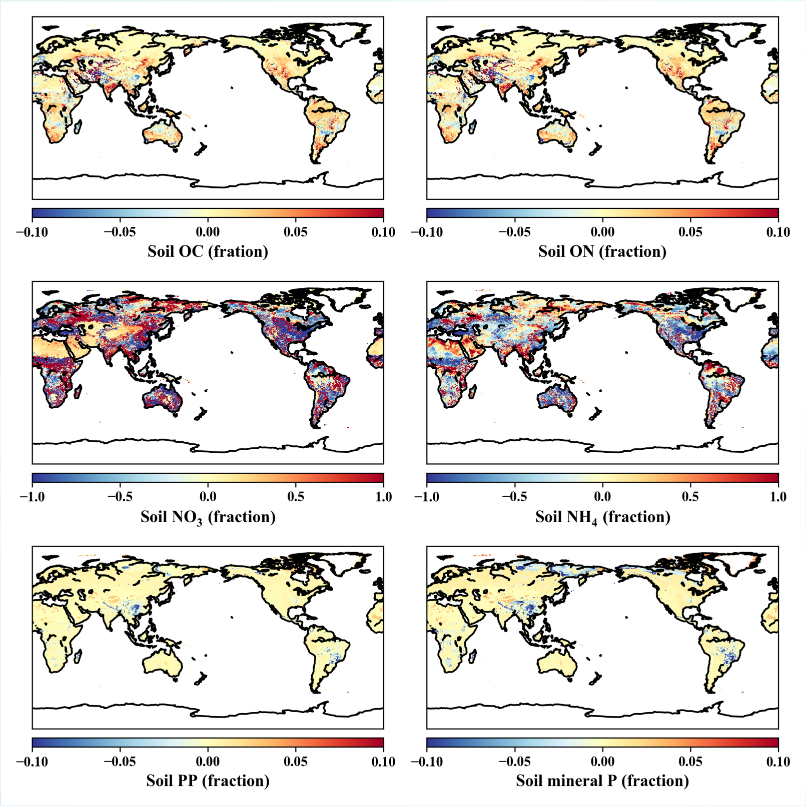
Soil erosion exacerbates nutrient limitation

- Soil erosion reduces phosphorus availability in low latitudes





Summary

- Channel erosion is a dominant sediment production pathway for many large rivers in the world.
- Correlation of water cycle and soil erosion should be considered in the context of spatial heterogeneity.
- Soil erosion has a large negative impact on phosphorus availability in low latitudes with rough topography.