



2026-2027 EOAS Colloquium Series

From Laboratory Observations to Natural Environments: A New Coordinate System for Interpreting Environmental Biogeochemical Rates

Microorganisms drive many of the reactions that regulate carbon and sulfur cycling in soils, sediments, aquifers, and other environments. Yet rates measured in nature span more than six orders of magnitude, raising a basic question: by what criteria should an environmental microbial rate be considered “slow” or “fast”? In this talk, we develop a physiological frame of reference for interpreting environmental methanogenesis and sulfate reduction. Our results suggest that “slow” and “fast” are best interpreted relative to pathway-specific physiological references. We define a lower reference by evaluating microbial kinetic and thermodynamic constraints at experimentally observed substrate thresholds for catabolic activity, and an upper reference from independently compiled maximum-capacity rates. Together, these references define a physiological rate envelope. We then compare these laboratory-derived benchmarks with 217 published cell-specific rate measurements from 43 environmental studies. Rates measured under near-in-situ, unamended conditions cluster near the lower physiological reference, whereas experimentally stimulated rates shift toward maximum capacity. More broadly, this work addresses a long-standing Earth science challenge: how should laboratory-derived microbial traits be applied to natural environments? Rather than asking whether laboratory traits can predict the exact microbial rate at an individual site, we ask whether they can provide a common physiological coordinate system for interpreting rates across diverse environments. Our results suggest that this alternative use of laboratory physiology may help connect microbial traits with environmental observations and provide biologically grounded constraints for process-based biogeochemical models.



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Location: EOA 1044

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