Talk title:
Microbial biosignatures in deep time: physiological implications and evolutionary innovations

Abstract:
Marine microbes drive biogeochemical interactions in the ocean, bridging the link between biological evolution and environmental change. Chemical or isotopic biosignatures left by these microbes allow us to investigate how oceans and their inhabitants have changed through Earth history. Physiology plays a key role how these biosignatures are preserved in the geologic record. Here, I use two examples of important marine organisms, archaea and cyanobacteria, to illustrate how we can use physiology to interpret their preserved biomarkers and carbon isotope signatures.

Membrane lipids that form the cellular envelope of marine archaea are used to reconstruct ocean temperatures on million-year timescales. This molecular proxy, known as TEX$_{86}$, is based on a parameterized response to growth temperature. I use a chemostat approach to show that the growth rate, rather than the habitat temperature, of marine archaea explains TEX$_{86}$ profiles in the modern marine water column.

Carbon isotope ratios in sedimentary organic matter can, in principle, identify the dominant primary producers in the marine environment on billion-year timescales. I have developed Monte Carlo simulations of the Proterozoic carbon isotope record and physiological analogs of ancestral cyanobacteria to place new constraints on metabolic fractionations associated with primary production during this time.

Collectively, microbial biosignatures provide a long-term view of evolutionary innovations that shaped ocean biogeochemistry in the past and may influence its trajectory in the future.