Title: The ocean’s carbon and nutrient biogeochemistry: From greenhouse world into the ice ages

Abstract:
Earth history holds abundant evidence for the coupling of climate, the environment and the global carbon cycle. And yet – despite the secular transition from early Cenozoic greenhouse conditions at high atmospheric CO2 to the ice age cycles with atmospheric CO2 fluctuating in Earth’s orbital beat – marine fertility and a habitable planet were maintained. In a world rapidly changing under human influence it is of high importance to better understand the physical, biological and chemical processes and feedbacks that naturally operate in and stabilize the Earth system. In this talk I will use examples from my work to describe the last 50 million years of environmental change from the perspective of ocean chemistry to draw conclusions for what may await us in the future. For example, Cenozoic changes in the seawater major ion composition have progressively improved ocean buffering against perturbations of its acid/base chemistry. However, the rate of anthropogenic carbon emission is projected to overwhelm seawater buffering and lead to ocean acidification that is unprecedented for at least the last 23 million years unless stringent emission reduction is implemented. Similarly, the emerging consensus that changes in ocean circulation and biological nutrient cycling were the main drivers of the Pleistocene ice age CO2 cycles has important implications for the rate of ocean uptake of anthropogenic carbon, the efficacy of engineered ocean fertilization to sequester carbon, and the dynamics of abrupt climate change and recovery. The reconstructed ice age changes in ocean nutrient cycling also highlight important gaps in our understanding of the modern marine nitrogen cycle, a topic of my ongoing research.