Evolution of the oceans' biological pump

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In the modern ocean, the cycling of carbon within and through the ocean (to ultimate burial in marine sediments) is characterized by a complex interplay of different nutrients and different forms of carbon, both particulate and dissolved, organic and inorganic. Intertwined with these cycles of carbon and nutrients are the biotic actors – microbes and animals – driving elemental and molecular transformations throughout the ocean and down into the sediments. Yet this could not have always been the case, and on the earliest Earth only relatively passive and purely inorganic cycles would have existed to help regulate atmospheric CO_2 and climate. The 'bit in the middle' is clearly of interest and begs the question: how and when did the different pieces of the (modern carbon cycle) puzzle fall into place, and what were the environmental consequences of each (presumably evolutionary) transition?

In this talk, we use an Earth system model coupled to a size-structured representation of marine ecology, to play out, against a background of progressive tectonic and climate evolution of the Earth, possible scenarios for the impact(s) of key evolutionary transitions on the oceans' biological pump and possible feedbacks on large-scale biogeochemistry. I'll consider the marine environmental impacts relevant to the evolution of early eukaryotic and animal ecosystems (e.g. dissolved oxygen) as well as the implications for spatial patterns in, and the interpretation of, key paleoenvironmental proxies (e.g. carbon isotopes). It sounds a mess, but a story will emerge …