Is this a good time to be burning fossil fuels?

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The basic for any sane analysis and discussion of the biotic response to past ocean acidification is, of course, identifying that there has been ocean acidification in the first place. But outside of the relatively recent geological past, the measurement and interpretation of direct proxies for the key parameters involved – pH and carbonate ion concentration (saturation state) becomes increasingly challenging. This is important as only the closely coupled decline in both these parameters together constitutes a future-relevant marine environmental change. One can resort to analysis of the size and duration of carbon isotopic changes and if really desperate … models, in order to make estimates of the magnitude of carbon release and perturbation, but often such thinking takes place in a conceptual framework delineated by observations of how the modern carbon cycle works.

What I would like to explore here is whether the sensitivity of ocean chemsitry to perturbation could have been much greater ealier in the Phanerozoic compared to today. For instance, following the advent and proliferation of planktic (carbonate) biomineralization during the Mesozoic: did the emergent deep sea carbonate 'buffer' preclude ocean acidification driven mass extinction? And what would it take in terms of fossil fuel CO_2 emissions to overwhelm it today?

Evolution of the oceans biological pump

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Earth history is punctuated by a huge variety of transitions and perturbations in climate and global biogeochemical cycling. These may be linked to major extinctions or evolutionary innovations, and may exhibit evidence for greenhouse warming and CO_2 release and hence potentially hold direct future-relevant information. In interpreting the geological record it is common to assume the presence in the ocean of a strong vertical 'pump' of carbon and associated trace elements and isotopic properties. Proxies for past environments and perturbations are duely interpreted on this basis. However, evolutionary innovations have the potential to change the ground rules and give rise to non uniformitarianism behaviors of the global carbon cycle in deeper time. For instance, the cycle and reservoir of dissolved organic in the ocean may have been dominant in the past and has been invoked to explain a number of prominent features of the geological record. But is even this thinking too constrained by our familiary with the modern? Just how radically different might the biological pump have been at different times since the the advent of photosynthesis? When was a biological pump of any sort first developed?

In this talk I'll start by summerizing the known knowns and known unknowns surrounding the marine carbon cycle as it exists today, as we need to be clear at the outset about what key processes are incompletely understood. I will then piece together a potted history of how today's carbon cycle might have arisen in relation to the various evolutionary developments and transitions over the past ~2 Ga and discuss the implications for how we interpret the geological record.

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