A lesson on carbon release and sequestration from the past

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One of the most urgent questions in biogeoechmistry is understanding the natural feedbacks that govern the carbon release and sequestration by ocean, atmosphere, bio- and geosphere. Knowledge of the involved mechanisms critically determines our ability to reconstruct and forecast atmospheric CO_2 concentrations. A powerful approach to the problem is to study past carbon cycle perturbations, thereby providing information on time scales inaccessible to modern observations. The Paleocene-Eocene Thermal Maximum (PETM, ~55 Ma ago) constitutes a case study for natural, massive methane/carbon release and sequestration, potentially comparable to the release and sequestration of anthropogenic carbon within the next centuries. Here we use models of various complexities to simulate the carbon cycle perturbation and recovery phase during the PETM and Anthropocene, including terrestrial carbonate and silicate weathering. Our results indicate remarkable similarities between the PETM and future scenarios. However, there are significant differences to consider if the PETM is to be used as a future analogue. This includes initial baseline steady-state conditions as well as transient behavior during perturbation and recovery phase. One lesson to be learned from the past is that despite strong natural restoring feedback mechanisms, the recovery phase from the anthropogenic carbon release may take tens to hundreds of thousands of years.