Evaporite dynamics and their effects on global climate and oxygen

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Evaporite weathering and deposition are seldom in balance even on million-year time-scales with grand depositional events superimposed against a background of more slowly varying weathering. Despite such imbalance, biogeochemical models generally assume that evaporite weathering and deposition rates are equal on all time scales. Changes in evaporite dynamics through time will likely impact oxidant budgets through the sulfur cycle and we have shown this to have been especially significant during Proterozoic times. Recently, we proposed that imbalances between evaporite weathering and deposition can also affect climate through the process of carbonate sedimentation. Calcium sulfate weathering supplies calcium ions to the ocean unaccompanied by carbonate alkalinity, so that increased carbonate precipitation strengthens greenhouse forcing through transfer of carbon dioxide to the atmosphere. Conversely, calcium sulfate deposition weakens greenhouse forcing, while the high depositional rates of evaporite giants may overwhelm the silicate weathering feedback, causing several degrees of planetary cooling. Non-steady-state evaporite dynamics and related feedbacks have hitherto been overlooked as drivers of long-term carbon cycle change. In this talk, we illustrate the importance of evaporite deposition, in particular, by showing how a series of massive depositional events contributed to global cooling during the mid-late Miocene. Further studies are required to quantify gypsum deposition over time and its possible effects on deoxygenation of the surface environment, especially at times of mass extinction, as well as on climate.