

The role of biogeochemical transients in Earth's habitability - *F.W. Clarke* *Medal Lecture*

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The geologic carbon cycle helps maintain Earth's habitability by regulating the concentration of atmospheric carbon dioxide. Central to our thinking about the geologic C cycle has been a negative climate-weathering feedback that closely links input fluxes of carbon dioxide from degassing and sedimentary recycling to the burial flux of carbonate minerals. Though there is both theoretical and empirical support for a climate-weathering feedback, it is also the case that many non-climatic variables modulate weathering fluxes. In cases where weathering acts as a carbon cycle forcing or the feedback strength is low, it is likely that additional geologic "buffering" mechanisms are necessary to help regulate Earth's climate. Using data from modern catchments and a new model framework, I discuss multiple ways in which transient imbalances in the global biogeochemical cycles of S, Na, and organic carbon can dampen carbon cycle perturbations independently of the canonical climate-weathering feedback. Some role for these types of transient imbalances effectively lowers the required feedback strength for climate regulation and can counterbalance C cycle perturbations driven by enhanced weathering fluxes.