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Modeling global biosphere response to enhanced riverine nutrient delivery during the Late Devonian Kellwasser Event

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The Devonian was a dynamic period in Earth's past, the Late Devonian particularly so. The expansion and radiation of the first land plants, the evolution of significant root systems and the initiation of pseudo-modern soil formation processes drove a host of substantial biogeochemical changes in the terrestrial and likely, marine realms. Several significant marine extinction events coincide with these terrestrial developments, including the Kellwasser Event, one of the big five mass extinctions. While the initiation of the Kellwasser Event has been attributed to large scale volcanic eruptions of the Viluy Traps, extinction events are complex, often with multiple contributing and exacerbating factors. The eruption of the Viluy Traps created a favorable environment for rapid plant growth (i.e., relatively warm, wet, high CO_2 environment). It is possible that this favorable environment accelerated the expansion and radiation of land plants into formally arid regions such as the Devonian Basin in East Greenland, enhancing terrestrial nutrient input into the Panthalassic and Rheic oceans. To test this concept, we utilized an oceanic advection–diffusion–reaction biogeochemical cycle model (*CANOPS*), driven by geochemical records we generated from sedimentary fluvial/lacustrine sequences, to model global terrestrial phosphorus flux to Devonian oceans and the subsequent biosphere response during the Late Frasnian in the Devonian basin in East Greenland. Results show nutrient perturbations detected in East Greenland, when scaled globally, are sufficient to drive eutrophication and significant increases in deoxygenation in Devonian oceans. Model results for inorganic carbon ($\delta^{13}C_{carb}$) show enhanced carbon burial concurrent with the two extinction pulses of the Kellwasser Event, mirroring current marine records. Atmospheric temperature, pCO_2 and pO_2 predicted by the model also compare favorably with marine records. While it is clear land plant expansion is not the sole causal factor in the Kellwasser Event, these results show it is plausible that even the transitory phosphorus input event from land plant expansion that we measured in land-based sections played a contributing role in exacerbating an extinction event already in progress.