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Incorporating plant evolution into a deep time dynamic vegetation model and exploring the rise of O_2 and fall of CO_2 over the Paleozoic

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The evolution and emergence of plants were key events in the Phanerozoic that helped shape Earth's climate and atmospheric composition. Land plants are a major contributor to global biomass and primary productivity, which influences atmospheric oxygen and carbon dioxide levels. Interaction between adaptive plant physiology and the carbon cycle likely exerted some degree of control over Phanerozoic oxygenation and climate via enhanced weathering and carbon burial. The inclusion of spatially-resolved vegetation within models that predict paleo-O_2 and CO_2 levels is essential, but evolution of plant physiology over time and the subsequent interactions with the carbon cycle are yet to be explored within this framework.

Here we build upon the existing deep-time vegetation model FLORA [1] and incorporate a step-wise evolution of simple plant physiology (i.e., roots, woods). By coupling this to the climate-chemical model SCION [2], the model allows us to observe the impact of productivity of rudimentary verses complex plants on weathering and biomass, and therefore the carbon fluxes, atmospheric O_2 and climate. By integrating evolution and competition into the model, we are also able to postulate what may be the influential factor towards long-term Earth system change: geographical spread, productivity or plant complexity.

[1] Gurung et al., (2022), *Nature Communications* 13, 4530
[2] Mills et al., (2019), *Gondwana Research* 67, 172-186