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Exploring the influence of plants on Phanerozoic climate using a deep time dynamic vegetation model

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Land plants are key contributors to global primary production and influence atmospheric CO_2 and O_2 levels, as well as global biogeochemical cycling of nutrients. Terrestrial vegetation and its interaction with atmospheric carbon likely exerted control, to some degree, on Phanerozoic climate. However, representation of the terrestrial biosphere over geological timescales in biogeochemical models is limited and poorly understood, especially due to the difficulty in modelling vegetation on a changing paleogeography.

Here, we couple a new deep-time vegetation model (FLORA) to a spatially-resolved long-term climate-chemical model (SCION [1]). The dynamic feedback created between local climatic conditions and vegetation biomass allows us to explore the impact of vegetation on organic carbon burial and spatial weathering rate amplification, and thus atmospheric CO_2 concentration over the Phanerozoic. We show that continental aridity during the Triassic and Jurassic restricted CO_2 drawdown and created a hotter climate. Conversely, continental dispersal in the Cretaceous allowed the terrestrial biosphere to sequester more carbon, countering high rates of tectonic degassing and mediating climate. By improving the representation of the terrestrial biosphere and its effect on biogeochemical cycling, the new SCION predictions better match available proxy data and highlight the importance of a comprehensive vegetation model within long-term climate-chemical models. Further improvements to the model involve the addition of plant functional types, ecological interactions and terrestrial nutrient cycling. Future work aims to use these models to explore the impact of land colonisation and plant evolution on Phanerozoic climate change.

[1] Mills, B. J. W., Donnadieu, Y. & Goddéris, Y., (2021), *Gondwana Research* 100, 73-86. doi:10.1016/j.gr.2021.02.011