The link between the rise of land plants, cloud-albedo, and carbon cycle perturbation

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The terrestrialization of life is one of the most significant evolutionary events in Earth history, and correlates in time with periods of major palaeo-climatic perturbations and marine extinctions. Terrestrial plants not only play an important role in the carbon cycle, weathering and nutrient cycles, but also influence the cloud albedo. Here we explore the effect of the terrestrialization progress on cloud-albedo: Vegetation emits biogenic volatile organic compounds (BVOCs), such as monoterpenes and isoprene, into the atmosphere. Once emitted, BVOCs oxidise to yield a range of lower volatility oxidation products that can partition into the aerosol phase, forming secondary organic aerosols (SOA). The presence of SOAs, influence the Earth's radiative balance by contributing to the absorption and scattering of radiation and by altering the cloud fraction and -droplet size.

Through compilation of literature and satellite date, we estimate the radiative forcing and climate sensitivity caused by plant induced changes to cloud-albedo. Using a geochemical box-model, we find that the stepwise terrestrialization progress could have resulted in cooling through the control on cloud-albedo. Such a cooling would influence the carbon cycle and decrease silicate weathering, compensating the direct plant induced weathering. Consequently, the result would be a tendency toward a long-term increase in pCO_2. It is intriguing how this scenario fits with evidence of several glacial episodes coinciding with both short- and long term increasing carbon isotope fractionation throughout the Palaeozoic geological record.