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Changes in plant water use efficiency over the recent past reconstructed using palaeo plant records from the boreal forest

M. Gagen (1), W. Finsinger (2), D. McCarroll (1), and F. Wagner ()

(1) Swansea University, United Kingdom (m.h.gagen@swansea.ac.uk), (2) Laboratory of Palaeobotany & Palynology, Utrecht University, The Netherlands

The Boreal forests contains 33% of the earth's forest cover and are located at the latitude where most of the estimated global warming is predicted to occur. Warming as a consequence of rising carbon dioxide will affect evapotranspiration within the biome, with significant consequences given that water vapour is an important greenhouse gas. However, there is also a physiological forcing associated with the effects of rising carbon dioxide on plants. Higher atmospheric carbon dioxide will reduce evapotraspiration because tree stomata tend to close under elevated carbon dioxide. The warming associated with reduced evapotranspiration is known as carbon dioxide physiological forcing and it is not well constrained. Here we suggest that future predictions of evapotranspiration flux within the Boreal forest zone might be more accurately gauged by taking account of palaeo evidence of changing plant water use efficiency and stomatal density in the two most important Boreal plant species: Pinus sylvestris and Betula nana. Stable carbon isotope ratios in tree ring cellulose and stomatal density measurements, from preserved leaves falling on the forest floor, hold a record of the plant physiological changes associated with adjustment to rising carbon dioxide. We present evidence that, rather than plants simply closing their stomatal apertures under recent elevated carbon dioxide, over the last 150 years reduced evapotranspiration in the northern Boreal forest has been associated with a powerful plastic response including reductions in stomatal conductance via changes in stomatal density and pore length. Furthermore we present evidence that trees may be reaching the limits of their ability to respond plastically to rising carbon dioxide by increasing their water use efficiency.