Geophysical Research Abstracts
Vol. 21, EGU2019-15956, 2019
EGU General Assembly 2019

Diurnal variation in mesophyll conductance and its influence on modelled water-use efficiency in a mature boreal Pinus sylvestris stand

Zsofia R. Stangl (1), Lasse Tarvainen (2), Mats Räntfors (2), Göran Wallin (2), Nerea Ubierna (3), and John D. Marshall (1)

(1) Swedish University of Agricultural Sciences, Department of Forest Ecology and Management, Umeå, Sweden, (2) University of Gothenburg, Department of Biological and Environmental Sciences, Gothenburg, Sweden, (3) Research School of Biology, The Australian National University, Canberra, Australian Capital Territory, Australia

Water-use efficiency (WUE) describes the trade-off between the amount of assimilated carbon and transpired water, connecting the plant carbon and water cycles at leaf-level. The carbon isotope composition (δ13C) of plant material can be used to infer WUE, even as a screening tool in large-scale studies or across historical timelines. A critical component of this inference is an accurate estimate of mesophyll conductance (gm), which describes the ability of CO_2 to diffuse across the interior of the leaf. Although gm is similar in magnitude to stomatal conductance (gs), it has been measured less often, especially under field conditions and at high temporal resolution. We mounted an isotopic CO_2 analyser (CRDS) on a field photosynthetic gas-exchange system to make continuous online measurements of gm, gs, net photosynthesis, and WUE in mature Pinus sylvestris trees in June/July, 2017. Mean values for gm were 0.33 (SE = 0.03) mol CO_2 m-2 s-1 bar-1, and for gm / gs, were 2.3 (SE = 0.2). These high-resolution measurements highlighted the asynchronous diurnal behaviour of gm and gs. While gs declined from around 09:00, gm remained near its maximum throughout the morning and midday. We suggest that the high gm played a role in supporting an extended Anet peak throughout the morning, despite stomatal closure. We compared estimates of photosynthetic WUE calculated as Anet/E and from δ13C, based on three frequently assumed patterns of gm: constant gm/gs, constant but finite gm, or infinite gm. We found that considering constant, finite gm or gm/gs yielded similar results on a diurnal scale, while assuming infinite gm led to over-estimation of WUE. Taken together, the results highlight the importance of high-resolution gm measurements on the modelling of net photosynthesis and WUE and show that, even under field conditions, it is now possible to acquire such gm data with a CRDS coupled to a continuous gas-exchange system. Finally, we present a comprehensive model to calculate WUE from δ13C, accounting for ternary effects and the effect of day respiration on the observed discrimination.