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From cellular to stand level: Impact of the internal conductance on GPP in a boreal Scots pine forest

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Photosynthetic models are widely used to estimate photosynthetic rate for leaves and canopies. Canopy-scale measurements have mostly been based on eddy-covariance data, as have model parameterizations. There has been no adequate means of testing the resulting estimates of gross primary production (GPP). It has been noted that it should be possible to estimate tree-level GPP from sapflux and isotopic estimates of water-use efficiency, but implementation produced unreasonable estimates and the idea has not caught on. In part, this is because the internal, or mesophyll, conductance (gi) must be known to avoid upward bias of values of photosynthesis and therefore of gross primary production (GPP). Here we combine δ13C of phloem sugars with sap-flow measurements to estimate GPP for a Scots pine forest in Sweden. We compare the results to PRELES model runs and daily sums of eddy-covariance data. We found that inclusion of a finite internal conductance led to GPP estimates that agreed with the models and data. As well, the comparison highlighted our need to improve model representation of the early and late growing season.