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Comparison of different tree sap flow up-scaling procedures using Monte-Carlo simulations

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An important task in determining forest ecosystem water balance is the estimation of stand transpiration, allowing separating evapotranspiration into transpiration and soil evaporation. This can be based on up-scaling measurements of sap flow in representative trees (SF), which can be done by different mathematical algorithms. The aim of the present study was to evaluate the error associated with different up-scaling algorithms under different conditions. Other types of errors (such as, measurement error, within tree SF variability, choice of sample plot etc.) were not considered here.

A set of simulation experiments using Monte-Carlo technique was carried out and three up-scaling procedures were tested. (1) Multiplying mean stand sap flux density based on unit sapwood cross-section area (SFD) by total sapwood area (Klein et al, 2014); (2) deriving of linear dependence of tree sap flow on tree DBH and calculating SF_{stand} using predicted SF by DBH classes and stand DBH distribution (Cermak et al., 2004); (3) same as method 2 but using non-linear dependency. Simulations were performed under different SFD(DBH) slope (b_s, positive, negative, zero); different DBH and SFD standard deviations (Δ_d and Δ_s, respectively) and DBH class size. It was assumed that all trees in a unit area are measured and the total SF of all trees in the experimental plot was taken as the reference SF_{stand} value.

Under negative b_s all models tend to overestimate SF_{stand} and the error increases exponentially with decreasing b_s. Under $b_s > 0$ all models tend to underestimate SF_{stand}, but the error is much smaller than for $b_s < 0$ and tend to an asymptotic value. In practice, in our experimental stand in Yatir (Northern Negev, Israel) b_s varied within a year from highly negative in summer to zero or slightly positive in winter. Δ_s has only a weak effect on the error. Different up-scaling models gave the best approximation in different cases: Usually for high negative b_s, models (3) and (1) were the best and the worst ones, whereas when b_s is approaching zero from negative side, model (1) becomes the best. Under high positive b_s all models give similar results. Increase of diameter variability (Δ_d) dramatically decreases up-scaling precision under negative b_s, first of all for model (1), whereas under b_s close to 0 or positive it has only a minor effect under any model. The DBH class, d_c, considerably affects the precision of up-scaling models (2) and (3). Lower d_c under the same Δ_d leads to considerable increase of precision. When applying typical values from the Yatir forest (DBH 20±5 cm, SFD around 40 $cm^3 cm^{-2} day^{-1}$, b_s from -5 to 2 day^{-1}, Δ_d = 2 cm) errors for models 1 to 3 ranged from -30 to +5%, -5 to +15%, and -10 to +25%, respectively. However, in summer under negative b_s, model (3) performs best (with error, e, of

$-1.0\% \leq e \leq +9.2\%$ for $-5 \leq b_s \leq -4$), whereas in winter, when SFD does not depend on DBH, model (1) gives the best approximation (with error of $-1.5\% \leq e \leq +2.6\%$ for $-0.5 \leq b_s \leq +0.5$).

The results suggest that the best up-scaling model for stand-scale sap flux estimates should be selected for given conditions based on DBH distribution parameters and b_s value.

References

Čermák J, Kučera J, Nadezhdina N (2004). Trees, 18: 529–546.

Klein T et al. (2014) Ecohydrology 7:409–419.