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Supplementary file S1

Tree distribution parameter (TDP) is an important input parameter for the forest reflectance and transmittance model FRT. It quantifies the spatial structure of the modelled forest stand and is connected to the Fisher's Grouping Index (GI) that is the relative variance of the number of trees on a plot with an area that equals to the vertical projection area of a tree (Nilson 1999). The connection between TDP and GI is given as TDP = –ln(GI) / (1–GI). GI, and thus TDP, indicates whether the tree distribution of a forest stand is regular, random or clumped. A completely random spatial pattern generated by a Poisson process produces GI = 1. In a clumped forest GI > 1, and GI < 1 corresponds to a regular distribution that is typical for a managed boreal forest.

The retrieval of GI, and thus TDP, from field measurements is difficult when only basic forestry variables are collected. However, if measurements of canopy transmittance and leaf area index (LAI) are also available, GI can be quantified by minimising the difference between the measured and estimated canopy transmittance. The calculation to estimate the transmittance of the forest requires as input an initial guess for the GI, LAI, density (m^{-2}), crown radius and length (m), zenith view angle (rad) and measured canopy transmittance for the view angle. Using an optimisation function, the residuals between the measured and estimated transmittance can be minimised and a suitable GI quantified.

We retrieved GI and TDP for Finnish boreal forest using an open dataset of in situ measurements (Majasalmi and Rautiainen 2020), which were accompanied by data on canopy openness (diffuse non-interceptance) and leaf area indices (not available in the forest data of Finnish Forest Centre). We used a range of 0°–11° (0.5 degree interval) for the zenith view angle to obtain a more generic estimate for TDP. The computations required density (m^{-2}) as an input, which was available for 76 plots. In addition, we excluded plots with diameter at breast height (DBH) < 8 cm. At this point, we were left with 32 plots. Next, we optimised GI for each plot per a view angle. Plots that had GI < 0.06 (corresponding to TDP > 3) were excluded, because they were unrealistic. At this point on average 9 plots were left for the entire zenith view angle range. For the remaining plots, we calculated TDP from the optimised GI values, and eventually calculated an average TDP per a view angle. After TDP was solved for the entire zenith view angle range, we obtained an average of 2.0 for TDP (GI = 0.203) to represent the spatial structure of Finnish boreal forests. This was a value close to 2.3 presented by Hase et al. (2022) for German forest using an approach similar to ours.

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