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Quantifying within-canopy heterogeneity in light absorption and photosynthesis with probability density functions

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Within a canopy, heterogeneity exists for many environmental conditions. For simulation of canopy processes on a regional or global scale in earth system models or vegetation models, assumptions with regard to this heterogeneity are often made, but rarely tested.

In this study, the heterogeneity of several of these environmental conditions is quantified with probability density functions. These are treated numerically as a number of class averages with equal probability. These probability density functions, giving variations in e.g. leaf and solar angles, light intensity, and positioning of the leaves within the canopy, are used to force simple models for light absorption and photosynthesis. The resulting distributions of output parameters provide not only a canopy-average or canopy-integrated value for processes in the canopy, but they give a measure of the within-canopy variability of these processes as well.

The outcome of this method that captures the within-canopy heterogeneity in light absorption and photosynthesis is compared with conventional methods for upscaling of leaf-level processes in canopies, which allows for testing the assumptions that are made in these methods.