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# A new model for estimating boreal forest fPAR

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Life on Earth is continuously sustained by the extraterrestrial flux of photosynthetically active radiation (PAR, 400-700 nm) from the sun. This flux is converted to biomass by chloroplasts in green vegetation. Thus, the fraction of absorbed PAR (fPAR) is a key parameter used in carbon balance studies, and is listed as one of the Essential Climate Variables (ECV).

Temporal courses of fPAR for boreal forests are difficult to measure, because of the complex 3D structures. Thus, they are most often estimated based on models which quantify the dependency of absorbed radiation on canopy structure. In this study, we adapted a physically-based canopy radiation model into a fPAR model, and compared modeled and measured fPAR in structurally different boreal forest stands. The model is based on the spectral invariants theory, and uses leaf area index (LAI), canopy gap fractions and spectra of foliage and understory as input data. The model differs from previously developed more detailed fPAR models in that the complex 3D structure of coniferous forests is described using an aggregated canopy parameter – photon recollision probability p. The strength of the model is that all model inputs are measurable or available through other simple models.

First, the model was validated with measurements of instantaneous fPAR obtained with the TRAC instrument in nine Scots pine, Norway spruce and Silver birch stands in a boreal forest in southern Finland. Good agreement was found between modeled and measured fPAR. Next, we applied the model to predict temporal courses of fPAR using data on incoming radiation from a nearby flux tower and sky irradiance models. Application of the model to simulate diurnal and seasonal values of fPAR indicated that the ratio of direct-to-total incident radiation and leaf area index are the key factors behind the magnitude and variation of stand-level fPAR values.