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Measuring overstory leaf area index in eastern Siberia larch forests

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This study presents a new remote sensing method to measure the leaf area index (LAI) developed specifically for eastern Siberia larch forests. It also presents the first evaluation of MODIS MOD15 collection 5, and of CYCLOPES LAI version 3.1 in larch forests.

Reliable monitoring of the leaf area index (LAI) is required to understand and model the exchanges of carbon, water, and energy between forests and the atmosphere. Several remote sensing methods were developed to measure LAI globally, but most of them did not consider the specificities of larch forests despite the huge area such forests cover in East Siberia. We developed a satellite-based method to estimate the LAI of larch forests, separating overstory LAI (LAIo) from the understory LAI (LAIu). This method is based on the seasonal dynamics of a spectral index called NDWI, and it was developed and calibrated using three-dimensional radiative transfer simulations based on forest scenes representative of larch forest structure, with particular consideration of the typical clumped shoot structure of larch. Model-based sensitivity analyses indicated a maximum error of up to 26% under known noise levels.

The method was applied to medium resolution SPOT-VEGETATION data, and was evaluated by comparing its results to global LAI products and to reference data (in situ LAI and LAI derived from high resolution Landsat ETM+ data). Our LAIo slightly underestimated field-obtained LAIo data but reproduced the spatial pattern of LAI better than CYCLOPES and MOD15 LAI products. The main drawbacks of MOD15 were unrealistically strong temporal variability and the fact that LAI began to increase earlier than the overstory leaf appearance date. In contrast, CYCLOPES LAI started increasing at the correct time and displayed smooth temporal evolutions; however, because these data are effective LAI, they may be difficult to use. At the continental scale, our total LAI is close to those from CYCLOPES and MODIS. Overall, our method provides a good alternative to MOD15 and CYCLOPES, especially for studies requiring separate estimates of LAIo and LAIu and true LAI instead of effective LAI.