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Leaf Area Index at a forested ICOS site: a detailed method comparison

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The three-dimensional structure of forest canopies is essential for light use efficiency, photosynthesis and thus carbon sequestration. Therefore, high-quality characterization of canopy structure is critical to improving our carbon cycle estimates by Earth system models and better understanding disturbance impacts on carbon sequestration in forested ecosystems.

In this context, a widely used observable is the Leaf Area Density (LAD) and its integral over the vertical dimension, the Leaf Area Index (LAI). A multitude of methods exists to determine LAD and LAI in a forest stand. In this contribution, we use a mature Norway spruce forest surrounding an ICOS flux tower at Hurdal site (NO-Hur) to investigate LAD and LAI with six different methods: field campaigns using (1) the Plant Canopy Analyzer LAI-2000; (2) the LaiPen LP 110; (3) Digital Hemispheric Photography at a set of plots within the area; (4) a Lidar drone flight covering the footprint area of the tower; (5) an airborne Lidar campaign, and (6) a satellite LAI product (MODIS).

The horizontal spatial structure of LAI values is investigated using marked point process statistics. Intercomparison of the methods focusses not only on biases and root mean squared errors, but also on the spatial patterns observed, quantifying to which extent a simple bias correction between the methods is sufficient to make the different approaches match to each other.