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# Characterization, validation and intercomparison of clumping index maps from POLDER, MODIS, and MISR satellite data over reference sites

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Vegetation foliage clumping significantly alters its radiation environment and therefore affects vegetation growth as well as water and carbon cycles. The clumping index is useful in ecological and meteorological models because it provides new structural information in addition to the effective leaf area index (LAI) retrieved from mono-angle remote sensing and allows accurate separation of sunlit and shaded leaves in the canopy. Not accounting for the foliage clumping in LAI retrieval algorithms leads to substantial underestimation of actual LAI, especially for needleleaf forests. Normalized Difference between Hotspot and Darkspot (NDHD) index has been previously used to retrieve global clumping index maps from POLarization and Directionality of the Earth's Reflectances (POLDER) data at $\sim$6 km resolution, from Moderate Resolution Imaging Spectroradiometer (MODIS) Bidirectional Reflectance Distribution Function (BRDF) product at 500 m resolution. Most recently the algorithm was applied with Multi-angle Imaging SpectroRadiometer (MISR) data at 275 m resolution over selected areas. In this presentation we characterize and intercompare the three products over a set of sites representing diverse biomes and different canopy structures. The products are also directly validated with both in-situ vertical profiles and seasonal trajectories of clumping index. We illustrate that the vertical distribution of foliage and especially the effect of understory needs to be taken into account while validating foliage clumping products from remote sensing products with values measured in the field. Satellite measurements respond to the structural effects near the top of canopies, while ground measurements may be biased by the lower vegetation layers. Additionally, caution should be taken regarding the misclassification in land cover maps as their errors can be propagated into the foliage clumping maps. Our results indicate that MODIS data and MISR data with 275 m in particular can provide good quality clumping index estimates at pertinent scales for modeling local carbon and energy fluxes.