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# On the relation between tree foliage clumping at the branch scale and light and water limitations

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Foliage clumping is known to have a significant effect on the radiative transfer and mass and energy exchanges in forests. It is an important component of canopy structure to consider for the estimation of photosynthesis rates and the interpretation of observed solar induced fluorescence (SIF). Yet, relatively little is known about the drivers of foliage clumping, and few observations of foliage clumping are available at the branch scale. Here, we report on a study using laser light to estimate foliage clumping at the tree branch scale in eight broadleaf species, at different heights above ground, from four sites located in two climatic zones: one water limited, and one light limited. We also integrate our results with published foliage clumping estimates from two sites (one in each climatic zone). We find that foliage arrangement on branches exposed to high solar irradiance tend to be random at the dry sites, but are very clumped at humid sites where competition for light is high. Branches sampled at the top of tall canopies at humid sites showed that foliage clumping increased with tree height, suggesting that higher competition for light results in the production of larger numbers of leaves grouped together which reduces the light interception efficiency on a per leaf area basis. Comparison with landscape clumping values suggests that the spatial availability of a limiting resource is a major driver of foliage clumping in forests.