ICOS ecosystem measurements in support of remote sensing analysis – and vice versa

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Data from eddy covariance (EC) towers are important for supporting remote sensing estimates of seasonal and interannual vegetation dynamics. Several previous studies confirm that seasonal gross primary productivity (GPP) can be modelled with fair accuracy across boreal and sub-arctic ecosystems based on coarse-resolution data from e.g. MODIS. However, in heterogeneous landscapes these estimates be unreliable due to the coarseness of the data. High-resolution remote sensing might be a key to resolving some of these uncertainties and we are now looking into possibilities to utilize higher resolution remotely sensed data from the Sentinel-2 platform for better describing the landscape and to improve the matching with flux tower measurements. We have so far studied data from eight flux tower sites in Scandinavia, spanning a climate gradient across temperate, boreal and sub-arctic areas. Also for phenology, ICOS data are useful for calibrating estimates of phenological parameters. Again, we are studying Sentinel-2 satellite data for improved accuracy in estimation of phenology parameters.

In order to strengthen the link between the flux data and the synoptic observations by satellite we have installed spectral sensors at several of the ICOS Sweden flux tower sites. These sensors are operated in collaboration with SITES Spectral and NordSpec, which are projects focusing on high-resolution data sampling to improve the understanding of vegetation dynamics. The sensors allow for detailed view of the vegetation, unobstructed by cloud or other atmospheric influences, therefore useful for calibrating and checking the satellite measurements and the way they are processed. Multispectral images from drones provide additional detailed data across the footprint areas. The precise matching of the various spectral measurements with ground vegetation provides information regarding which part of the ecosystem contributes to the flux measurements. Thus, there is potential to improve parameterization of models to be used for upscaling of greenhouse gas fluxes.

The spatial footprint of the EC measurements is larger than that of the newest satellites (hundreds of pixels per footprint area). This means that to fully utilize these high-resolution data for flux upscaling, the EC data may need to be disaggregated to smaller areas. Footprint modeling is a way to do this, and our results indicate that footprint-disaggregated parameters differ from those derived from averaging across all pixels. The combination of EC data, high-resolution data from spectral instruments and drones, and the latest satellite data provide an invaluable combination for improved knowledge about flux and vegetation dynamics at the ICOS ecosystems stations.