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Retrieval of seasonal dynamics of forest understory reflectance from semi-arid to boreal forests using MODIS BRDF data

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Ground vegetation (understory) provides an essential contribution to the whole-stand reflectance signal in many boreal, sub-boreal, and temperate forests. Accurate knowledge about forest understory reflectance is urgently needed in various forest reflectance modelling efforts. However, systematic collections of understory reflectance data covering different sites and ecosystems are almost missing.

Measurement of understory reflectance is a real challenge because of an extremely high variability of irradiance at the forest floor, weak signal in some parts of the spectrum, spectral separability issues of over- and understory and its variable nature. Understory can consist of several sub-layers (regenerated tree, shrub, grasses or dwarf shrub, mosses, lichens, litter, bare soil), it has spatially-temporally variable species composition and ground coverage. Additional challenges are introduced by patchiness of ground vegetation, ground surface roughness, and understory-overstory relations. Due to this variability, remote sensing might be the only means to provide consistent data at spatially relevant scales.

In this presentation, we report on retrieving seasonal courses of understory Normalized Difference Vegetation Index (NDVI) from multi-angular MODIS BRDF/Albedo data. We compared satellite-based seasonal courses of understory NDVI against an extended collection of different types of forest sites with available in-situ understory reflectance measurements. These sites are distributed along a wide latitudinal gradient on the Northern hemisphere: a sparse and dense black spruce forests in Alaska and Canada, a northern European boreal forest in Finland, hemiboreal needleleaf and deciduous stands in Estonia, a mixed temperate forest in Switzerland, a cool temperate deciduous broadleaf forest in Korea, and a semi-arid pine plantation in Israel.

Our results indicated the retrieval method performs well particularly over open forests of different types. We also demonstrated the limitations of the method for closed canopies, where the understory signal retrieval is much attenuated. The retrieval of understory signal can be used e.g. to improve the estimates of leaf area index (LAI), fAPAR in sparsely vegetated areas, and also to study the phenology of understory layer. Our results are particularly useful to producing Northern hemisphere maps of seasonal dynamics of forests, allowing to separately retrieve understory variability, being a main contributor to spring emergence and fall senescence uncertainty. The inclusion of understory variability in ecological models will ultimately improve prediction and forecast horizons of vegetation dynamics.