Reflectance of Boreal forests: what new did we learn?

Jouni Peltoniemi (1) **Teemu Hakala** (1) **Juha Suomalainen** (1)

(1) ***Finnish Geodetic Institute***
Box 14, 02431 Masala, Finland

Forest remote sensing is important business and science for Finland and the whole earth. The value of results is quite high, but so are the costs. Also, there are still big demand of much more information. New more productive techniques are thus needed.

We started from the hypothesis that knowing better the reflectance could lead to better analysis methods and support more optimal instrument design. We built field gonio-spectro-polari-radiometer FIGIFIGO, and unmanned flying observation system based on Microdrone md4 200 and 1000 electric quadrocopters with several camera options.

We have measured the bidirectional reflectance factors of over 100 vegetation targets from forest, and over 100 snow samples. We have taken hundreds of colour and spectral aerial photographs, to be calibrated to reflectances. We have measured linear polarisation of many samples in higher spectral and angular detail than ever. The data is to be put to an open web distribution.

We have observed, to name a few:

- The leaf surface type plays big role in the anisotropy: wax surface leaves have much stronger forward scattering than smooth leaves.
- Orientation have small effects: planophile leaves have stronger forward scattering, in rare cases even signs of specular effect, erectophile leaves have smaller bowl shape (sideways scattering), photophile leaves have stronger back scattering.
- Some species can be well identified by the spectrum, e.g. lichen and moss from other understorey vegetation, coniferous from broad leaved trees, but pine and spruce and very many other species are very hard to separate even when pure; variations inside the same class are bigger than between classes. The situation is much harder in real nature that is always a complex mixture of many species, snow, soil, and other dead and living material.
- Wetness in very visible in the spectrum, other features are weaker.
- Polarisation shows many new interesting features, and much new information can be available, more than seen yet. Especially the forward polarisation gives quite clear signatures for many targets, although the data is still too sparse for strong conclusions.

These bring many new challenges to modelling, not all can be easily explained now, although we have proceeded well, e.g. in snow modelling.

The developed instruments have been working excellently. The combination of automatic and robustness of the FIGIFIGO has allowed measurements even in such demanding conditions as Greenland ice sheet. The UAV based observations systems show remarkable promise, and the enthusiasm is now shared by quite many. Now it is possible to take very flexible and cost-effective observations from local targets and test easily many new remote sensing concepts.

In addition to forest remote sensing, the results can be extremely useful also in many of the Remote Sensing Days Highlighted Topics. From the observations, the surface albedo can be derived, even better, if physical models are available. Land surface albedo is one of the most important climate factors, not far behind the greenhouse gases, but much less understood. In arctic and Boreal latitudes the seasonal snow plays especially big role. The new UFOS technique might be suitable for developing countries, because no big investments are needed. They could also be extremely important in natural disasters, when fast data is needed, and harder techniques are too busy, conditions too risky, or visibility low.