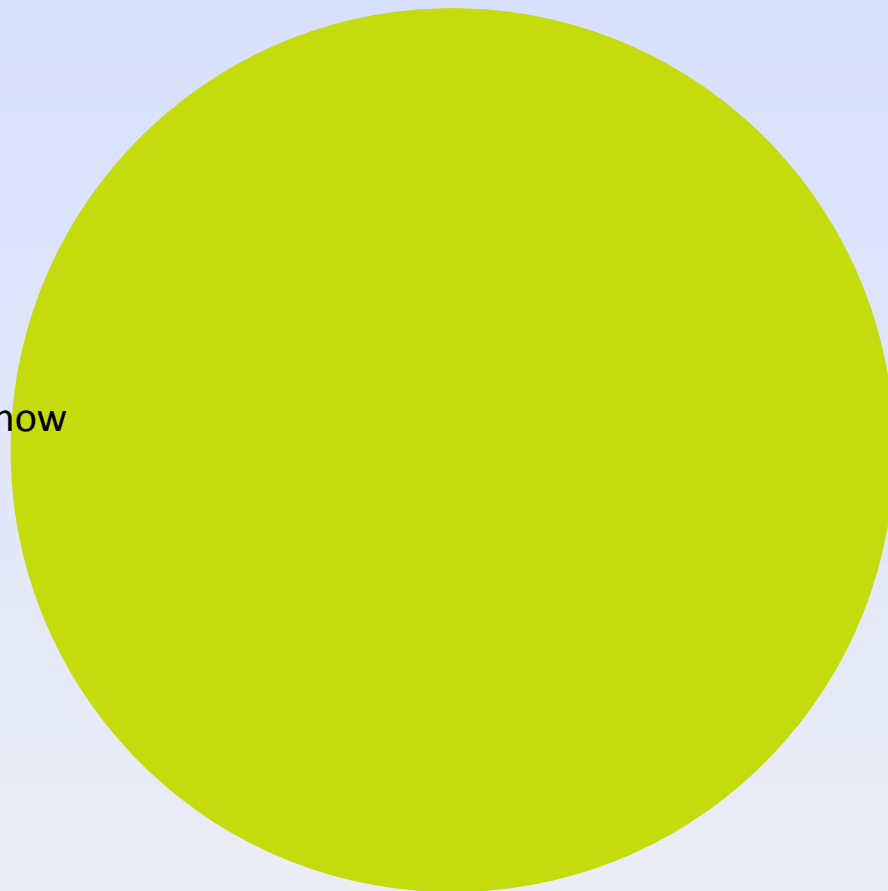# Spectral Reflectance Measurements of a forest and a forest opening form a 30-meter mast

Workshop on is-situ snow albedo measurements: toward a snow albedo intercomparison experiment, 24-25.8.2016, Helsinki

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Contents

- ❖ Introduction of the measurement system

- ❖ Applications

- ❖ Calibration procedures

- ❖ Problems and uncertainties

- ❖ Way further?

FINNISH METEOROLOGICAL INSTITUTE

Measurement system

A

ASD Field Spec Pro Jr

Spectrum	350–2500 nm
Sampling interval	1,4 nm for 350–1000 , 2 nm for 1000–2500
Spectral resolution	3 nm at 700 nm, 6 nm at 1400 nm and 7 nm at 2150 nm
Input	5 m fiber optic with 25° FOV
Number of comprising spectrometers	3 (VNIR, SWIR1, SWIR2)
Detectros / Dispersion elements	512 element silicon photo diode array (350–1000 nm), 2 x InGaAS photo-diode (1000–2500 nm)
Scanning time	Fixed 0,1 s
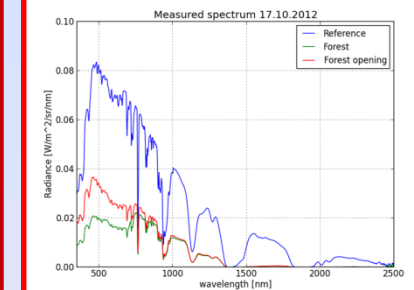
Python script for automatic reference / scene measurements every 30 min

Useful / good data, instrument malfunction etc..
When to measure?

Wind gust < 8 m/s

Temperature > - 20 °C

No rain

Difference in lightning conditions between reference and scene measurement < 10 % ?

B

C

Weather resistant cover box with heating

ASD Fieldspec Pro JR spectrometer

Glass fiber pole for measurement head

Control computer

Measurement head

Steel support for glass fiber pole

Large-view Control camera

Turning machine

Movable reference plate

Glass fiber pole for reference plate

Top of the tower

Measured spectrum 17.10.2012
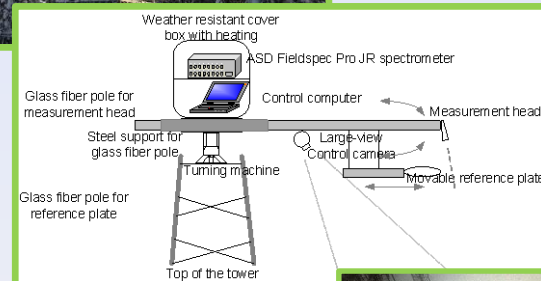
Applications

❖ Characterization of the scene reflectance in different environmental and illumination conditions (snow cover, partial snow cover, snow on tree canopy, sun azimuth & elevation, shadowing etc..) → validation and development of radiative transfer models, snow data products retrieved by remote sensing
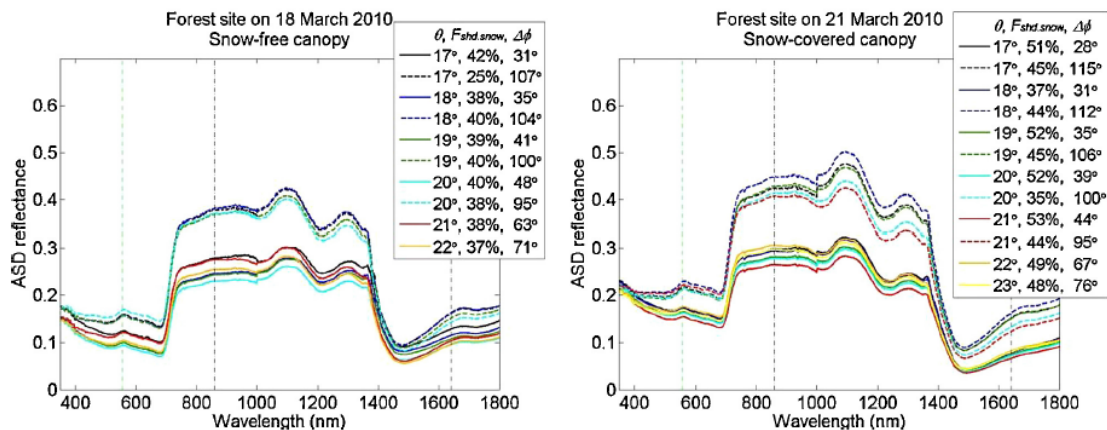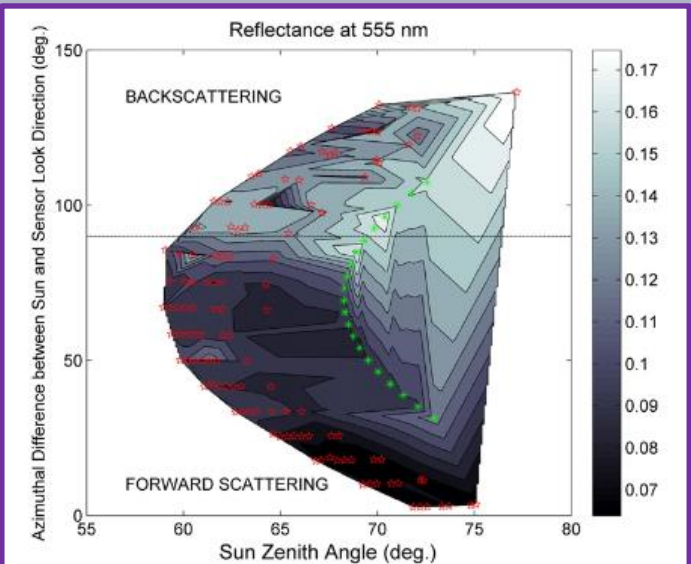

Fig. 8. Bidirectional reflectance of the forest plot of mast-borne spectrometer observations. Red and green symbols show the geometry of actual measurements representing full snow cover condition. The behavior of reflectance (contour plot) is interpolated from measurements at the locations of all the symbols (red pentagrams and green asterisks). Red pentagrams depict observations conducted for 12 days at different hours of day during the year 2013. Measurements from 18 March 2010 coinciding airborne data acquisition are shown by green asterisks.

Pulliainen et al. (2014)

Fig. 11. The effect of solar elevation θ, fraction of shadowed snow $F_{shd.snow}$ and the relative azimuth $\Delta\varphi$ on scene reflectance of forest area in dry snow conditions. The sun is in the direction of instrument view when $\Delta\varphi$ - 0 (case of forward scatter). Dashed curves and solid curves represent backscattered and forward scattered spectra, respectively. Left: Snow-free canopy. Right: Snow-covered canopy.

Heinilä et al. (2014)

Applications..

Forest scene
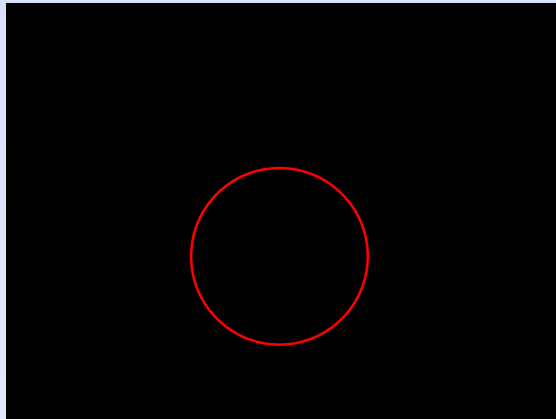
Forest opening scene

Blue = diffuse
Red = direct
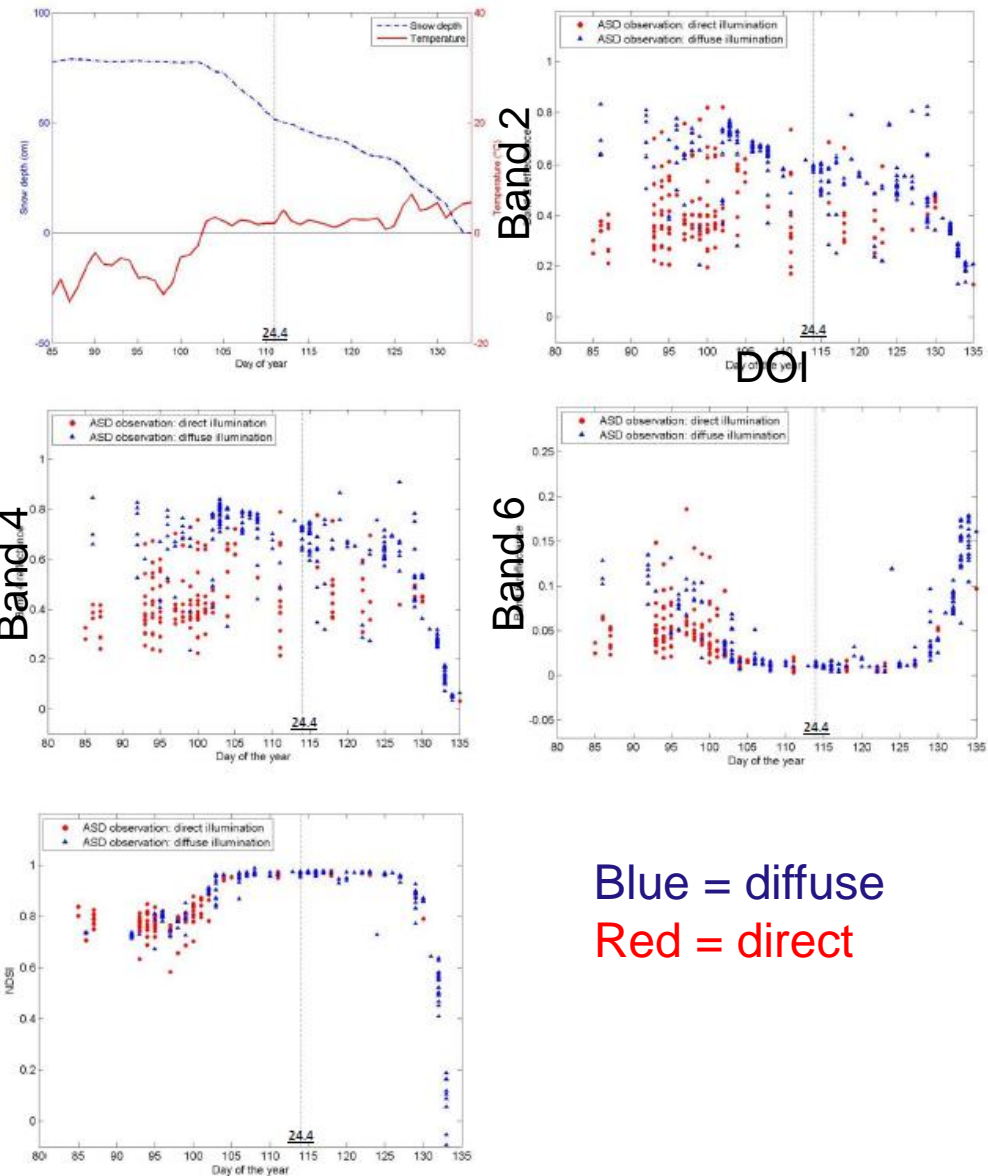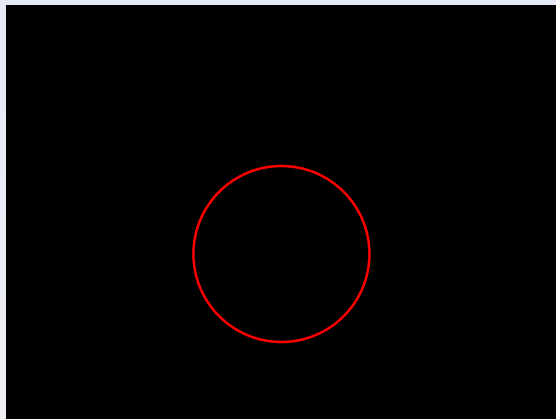
Measurements of forest opening from 26 March 2013 to 14 May 2013 in direct and diffuse illumination. Mast-borne ASD measurements were resampled to correspond MODIS bands using band-specific relative spectral response functions. a) Daily averages of snow depth and air temperature at 2 m, b) Band 2 reflectance, c) band 4 reflectance d) band 6 reflectance e) Normalized difference snow index (NDSI). Dotted vertical line represents the appearance of snow-free patches.
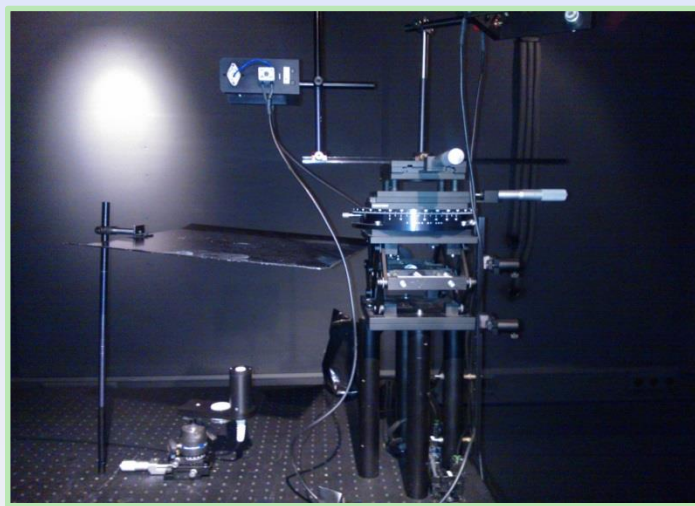
Calibration procedures

Yearly measurements in a dark laboratory

❖ Change in instrument response?

❖ Darkening of the reference panel (Spectralon)?

❖ 1000 W Tungsten halogen lamp, calibrated to 250-2500 nm, used as a light source

- time reseved for the lamp to warm up
- lamp current is controlled

Reflectance measurement to follow the darkening of the reference panel

RCR-measurements to follow possible changes in the instrument behaviour
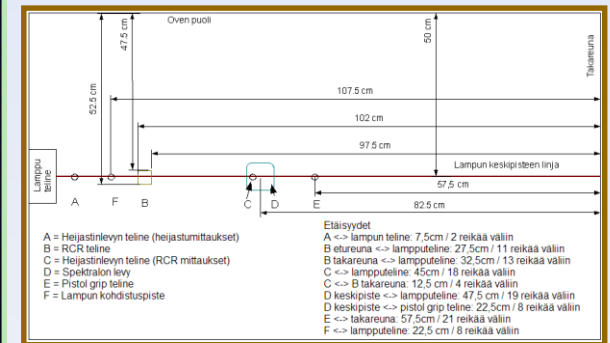
Detailed instructions have been made to enable exactly the same measurement setup each year.

Calibration procedures..
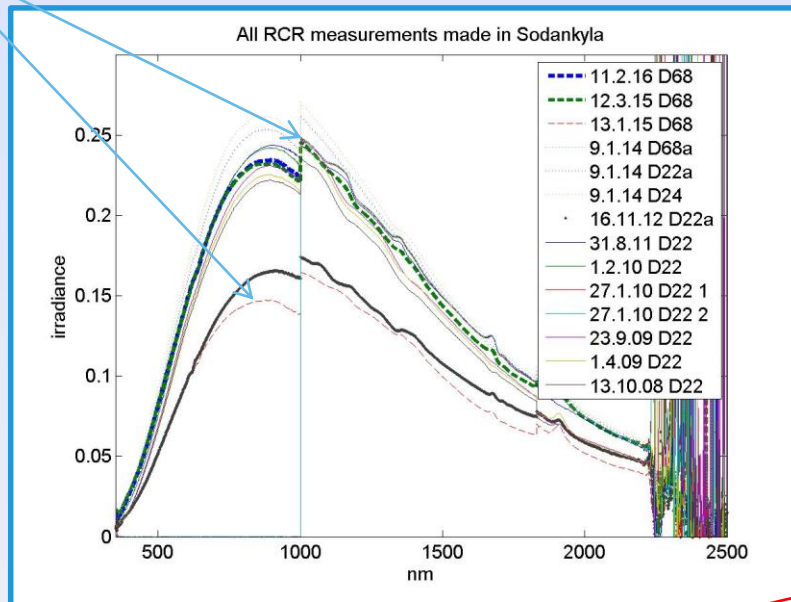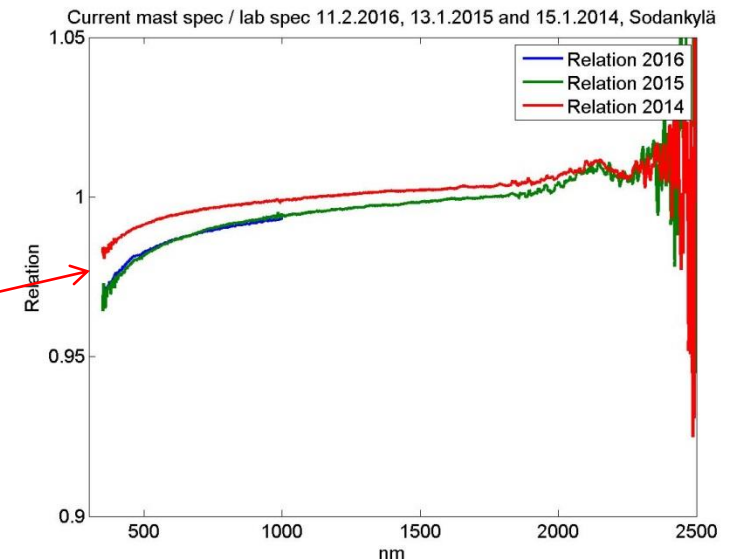
Very low response 13.1.2015,
re-measurement 12.3.2015
→ Measurement head not
properly in its place?

1 Spectralon panel kept in the
laboratory and not used outside
→
Each year "Mast Spectralon" is
compared with this "Lab
Spectralon"

All RCR measurements made in Sodankyla

Legend:
- 11.2.16 D68
- 12.3.15 D68
- 13.1.15 D68
- 9.1.14 D68a
- 9.1.14 D22a
- 9.1.14 D24
- 16.11.12 D22a
- 31.8.11 D22
- 1.2.10 D22
- 27.1.10 D22 1
- 27.1.10 D22 2
- 23.9.09 D22
- 1.4.09 D22
- 13.10.08 D22

Current mast spec / lab spec 11.2.2016, 13.1.2015 and 15.1.2014, Sodankylä
- Relation 2016
- Relation 2015
- Relation 2014

Decrease in mast-spectralon
reflectance during ~ 1 year (no
cleaning before measurement)

Problems and uncertainties

Reference measurement is probably the most essential part to gain good valuable data → we do not know exactly what happens in the mast. Darkening is corrected only once a year although it is gradual and possibly not linear

Usually big problems are easily detectable from the spectrum.

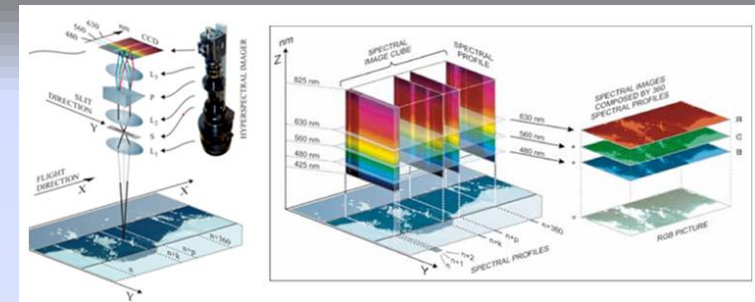What does the instrument actually measure? → apparently also mast itself

Shadow over
The reference
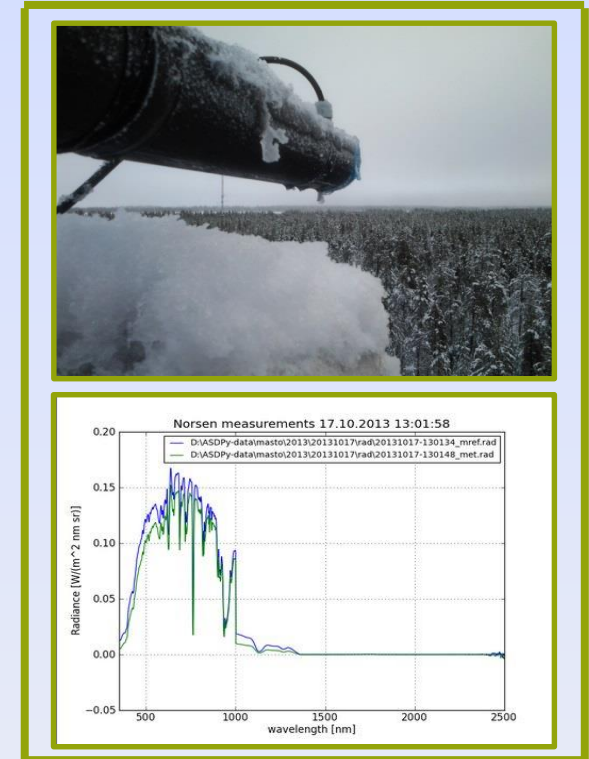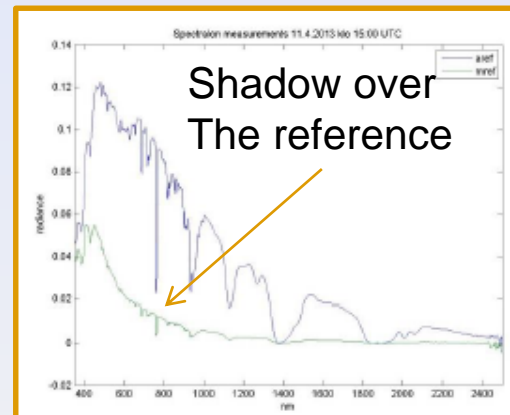
General problem in validation of RS products → how to compare things with footprints of very different sizes (RS pixel size, point measurements, mast measurements)?

Way further?

❖ Static mast measurements have already been seen...

❖ Ability to change measurement angle + measurement height + adding a simultaneous measurement also for spectral irradiance would add valuable information

❖ Exploitation of UAVs with eg. hyperspectral camera would offer most of this information → numerous applications

❖ The current system will be moved to another tower with easier access for maintenance → interesting how different / not different measurements are from different part of the forest and from different height (~ 18 m)

❖ Similar systems / instruments very popular → ability to combine data from different sources / systems would be useful → Detailed documentation of instruments themselves   and measurements (metadata) is needed → maybe a common "reference level" for both the instrument response and the reference measurement would help the comparison of data from different sources?

Thank you. Questions?

References:

Heinilä, K., Salminen, M., Pulliainen, J., Cohen, J., Metsämäki, S., and Pellikka, P. (2014). The effect of boreal forest canopy to reflectance of snow covered terrain based on airborne imaging spectrometer observations. *International Journal of Applied Earth Observation and Geoinformation* 27, 31–41.

Lakkala, K., Suokanerva, H., Karhu, J. M., Aarva, A., Poikonen, A., Karppinen, T., Ahponen, M., Hannula, H.-R., Kontu, A., and Kyrö, E.: Optical laboratory facilities at the Finnish Meteorological Institute – Arctic Research Centre, Geosci. Instrum. Method. Data Syst., 5, 315-320, doi:10.5194/gi-5-315-2016, 2016.

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