ENVISAT/ASAR VV/HH BACKSCATTERING AND THE RADIATION CHARACTERISTICS OF SUBARCTIC BOREAL FOREST

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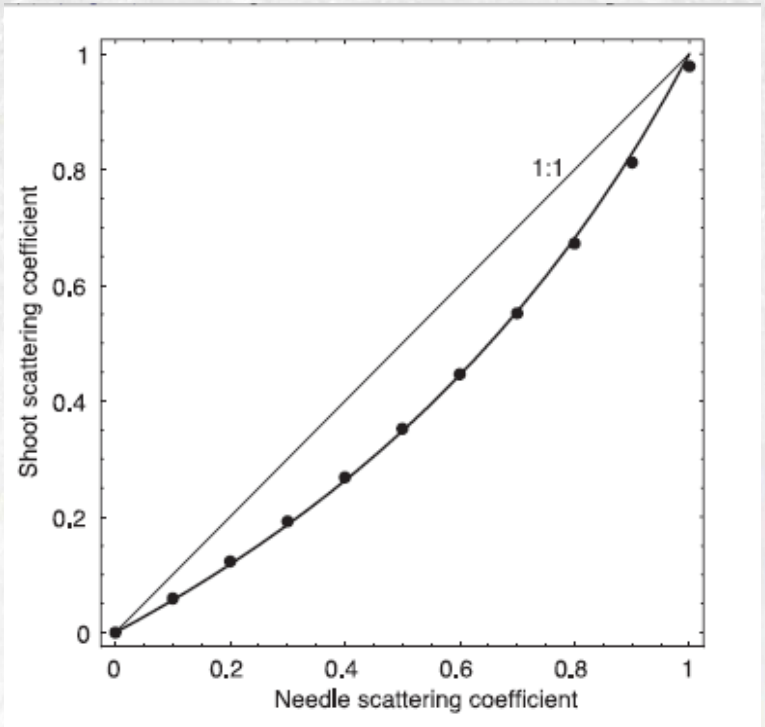
Motivation

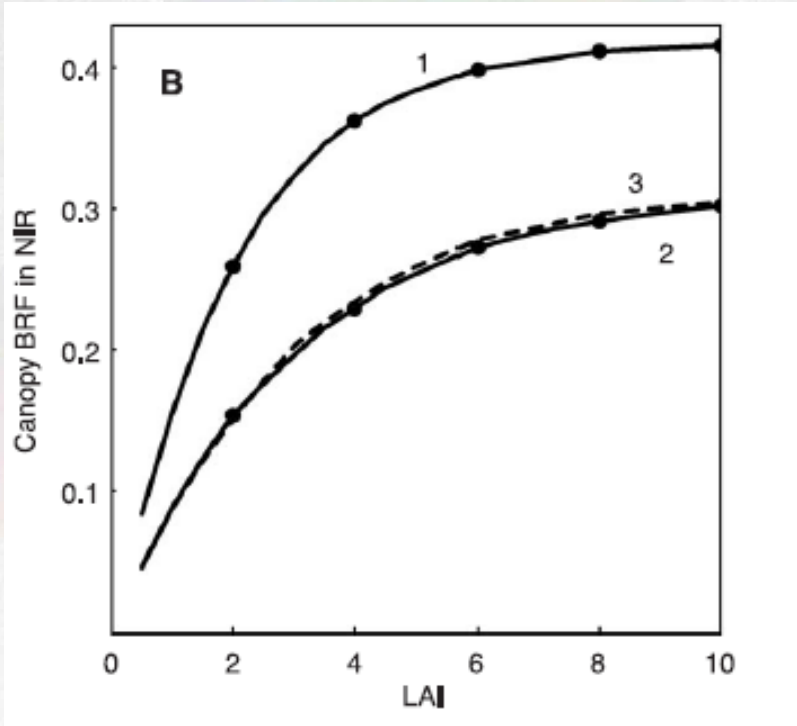
- Boreal forest influences significantly the northern hemisphere albedo and carbon budget.
- Use of optical data is limited by low sun elevation angles and cloud cover
- Optical BRDF estimation for forests is based on NDVI, which is in boreal forests sensitive to phenological changes of the forest floor.
- Independent additional data may improve estimation accuracy

Scattering of Scots pine shoots

- Optical instruments
  - Red band ~700 nm
  - Near infrared band 700 nm – 1 μm
- Microwave instruments
  - C-band 5.6 cm (ASAR)

Shoot vs. needle scattering at NIR band



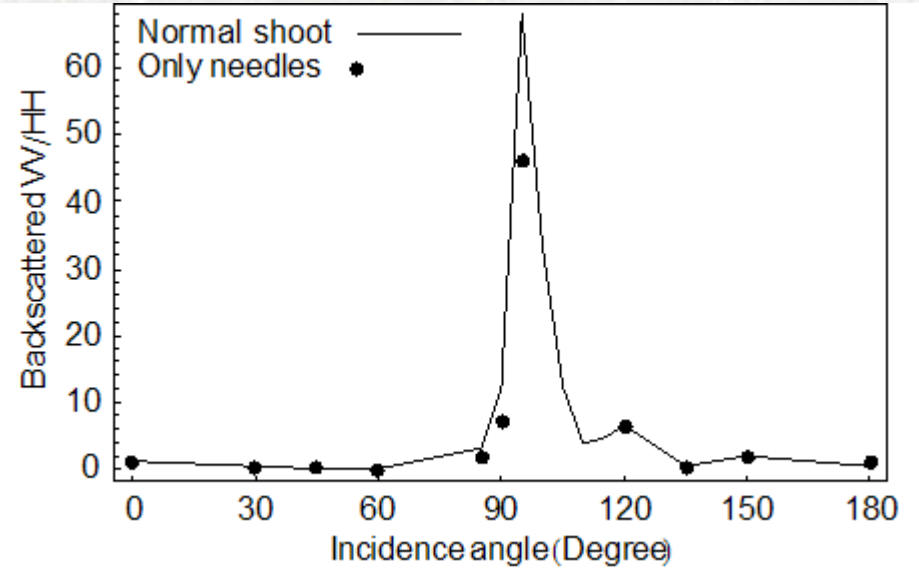


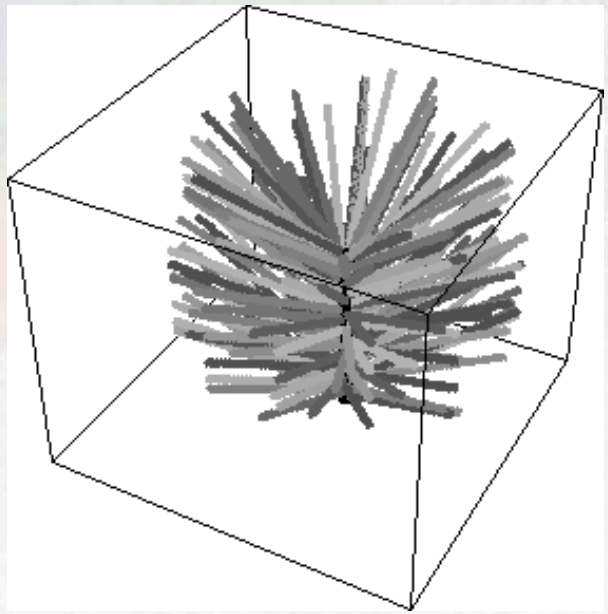
S. Smolander and P. Stenberg,
Remote sensing of Environment 88 (2003) 363-373

1 leaf canopy
2 shoot canopy
3 ”shoot-like leaf” canopy

Directional scattering at C-band

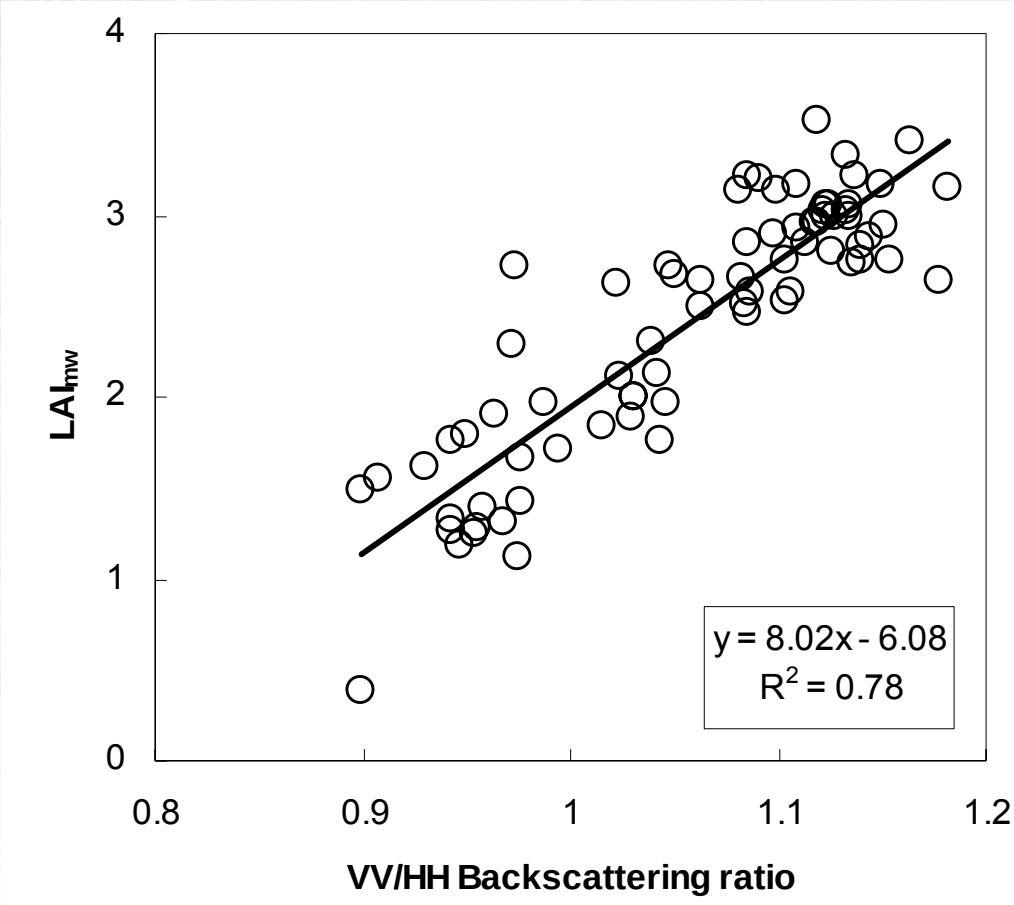
- DDA simulation
  - Needles dominate shoot scattering





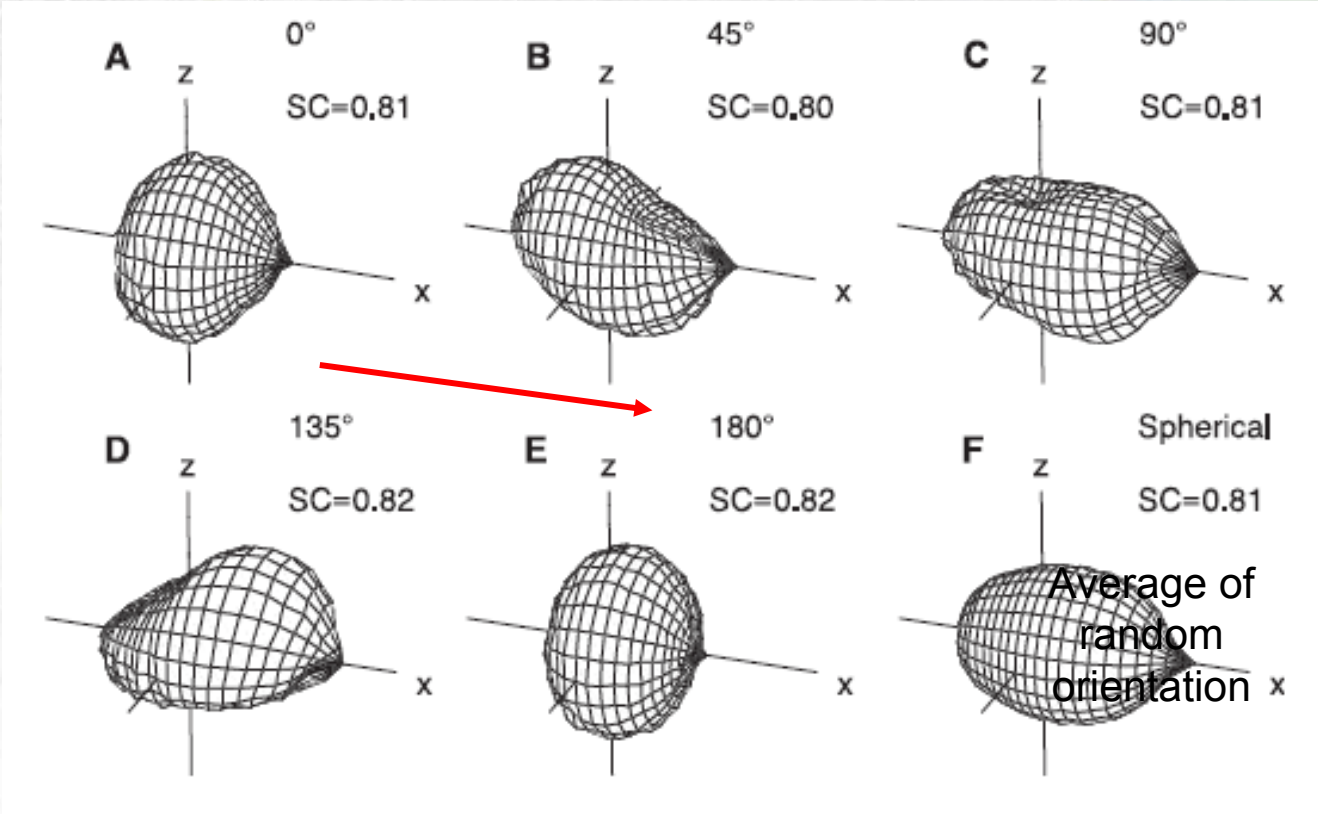
Manninen,T, Penttilä, A. and Lumme, K., 2007,
Waves in Random and Complex Media, Vol. 17, No. 1, pp. 85-98.

C-band polarization and LAI



Manninen, T., P. Stenberg, M. Rautiainen, P. Voipio and H. Smolander, 2005, *IEEE Trans. Geoscience and Remote Sensing* **43**(11), pp. 2627-2635.

Directional distribution of photons scattered by a shoot in NIR wavelength

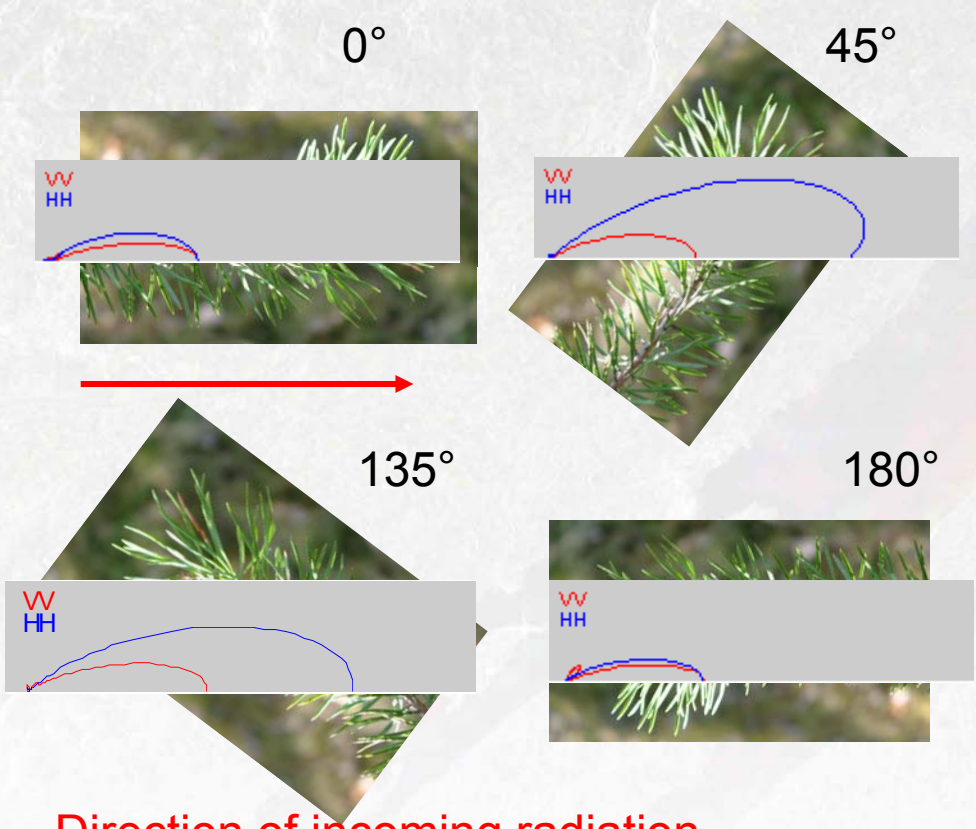


Direction of incoming radiation

$SC_{needle} = 0.9$

S. Smolander and P. Stenberg, 2003, Remote sensing of Environment 88, pp. 363-373

Directional scattering at C-band



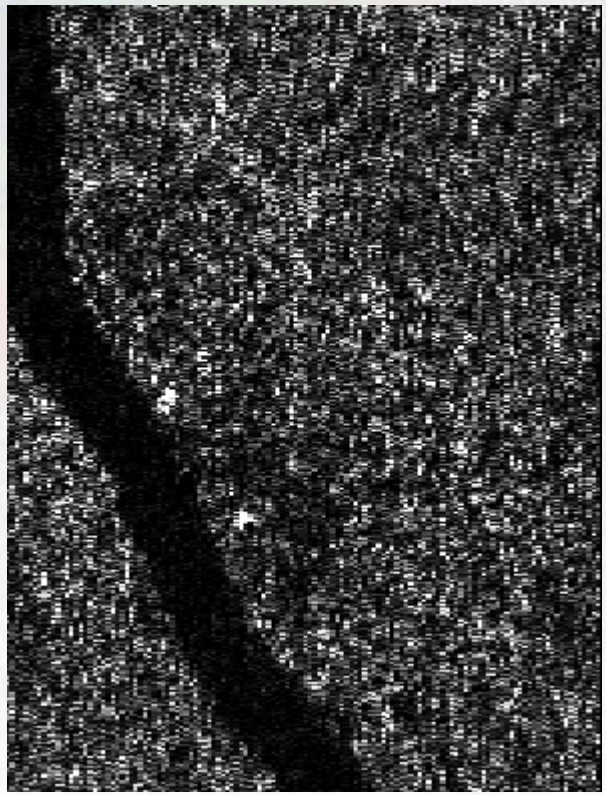
Manninen,T, Penttilä, A. and Lumme, K., 2007, Waves in Random and Complex Media, Vol. 17, No. 1, pp. 85-98.

Test site and ground based measurements

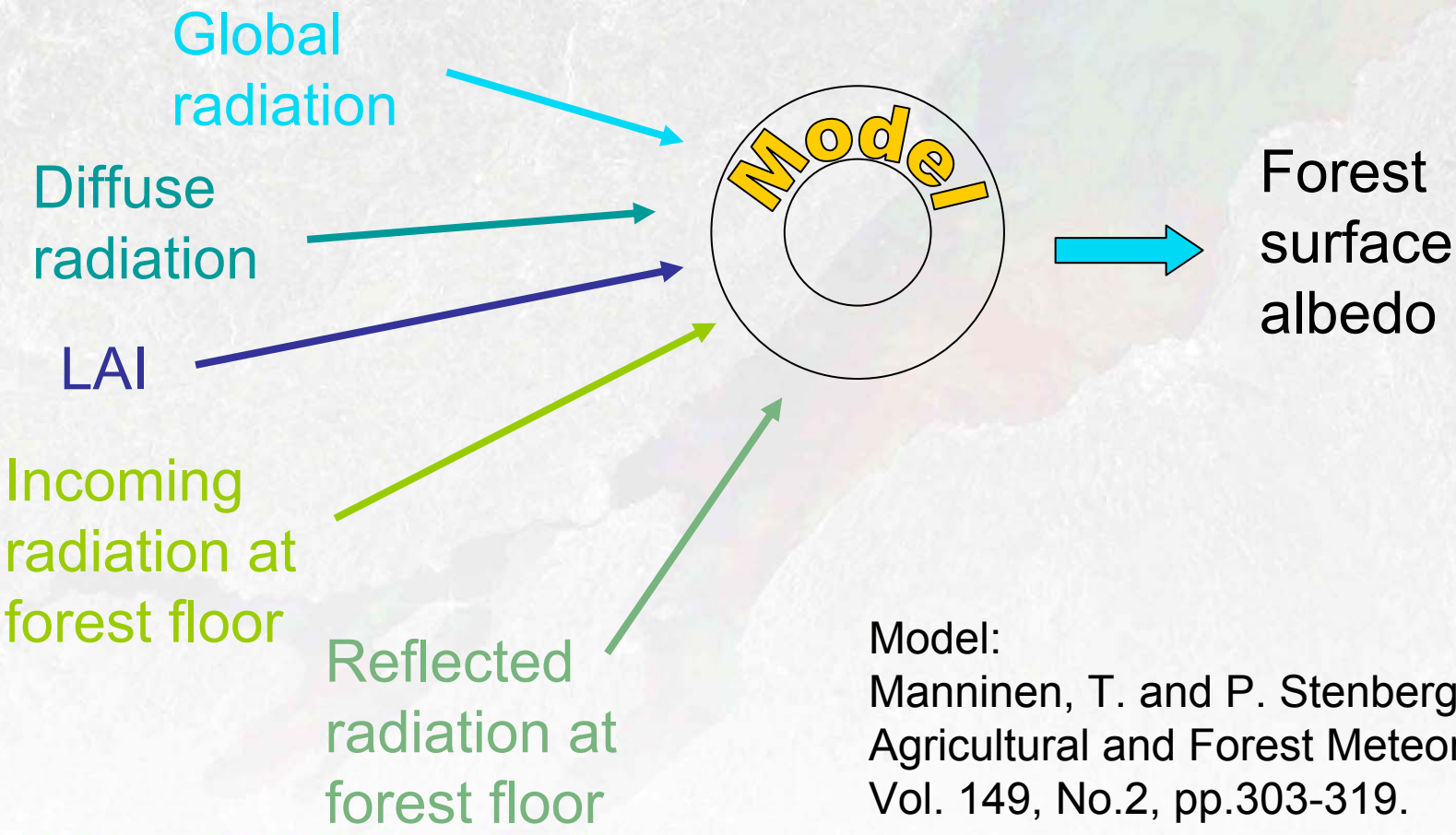
- Arctic Research Centre of FMI
- 67.368˚N, 26.633˚E
- Subarctic boreal forest
- Continuous global and diffuse radiation measurements
- Incoming and reflected radiation measurements at forest floor

Satellite data

- 1 SPOT image of June 7, 2006
- 2 ENVISAT/ASAR SLC images
  - May 26, 2006 VV/HH
  - August 8, 2006 VV/HH

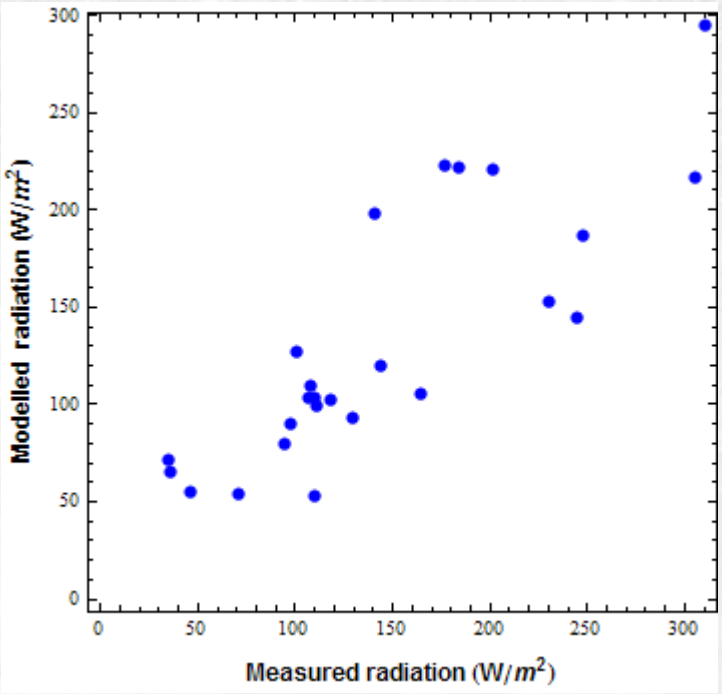


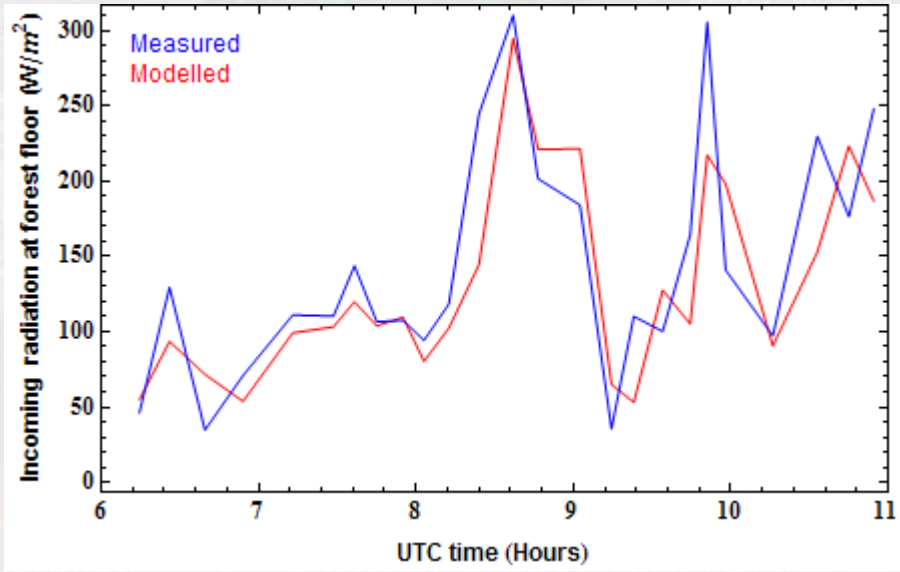
Ground based forest albedo



Model:
Manninen, T. and P. Stenberg, 2009, Agricultural and Forest Meteorology, Vol. 149, No.2, pp.303-319.

Albedo model testing

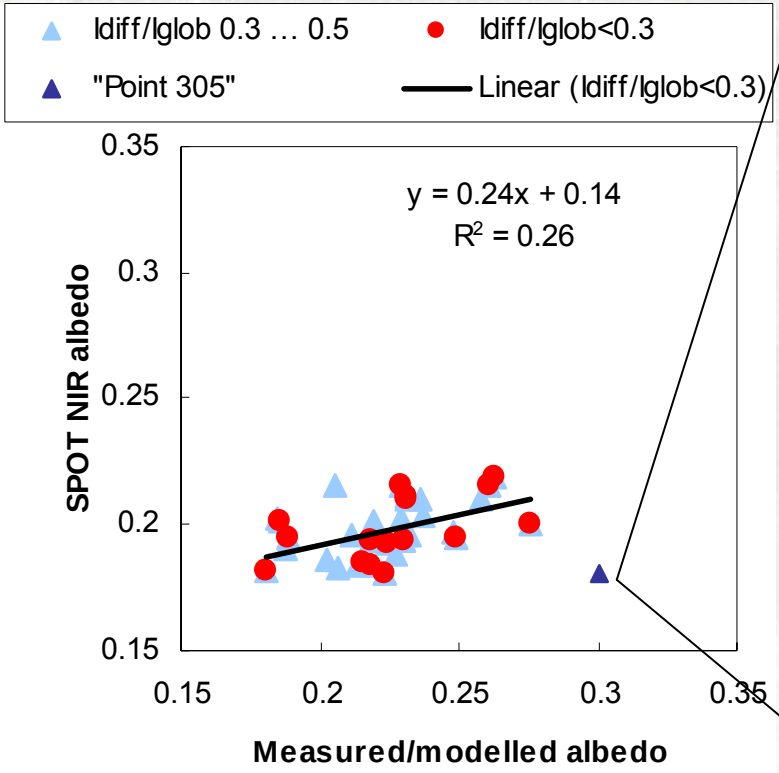




$I_{measured}$ = 28 W/m^2 + 0.71 ·$I_{modelled}$, R^2=0.69

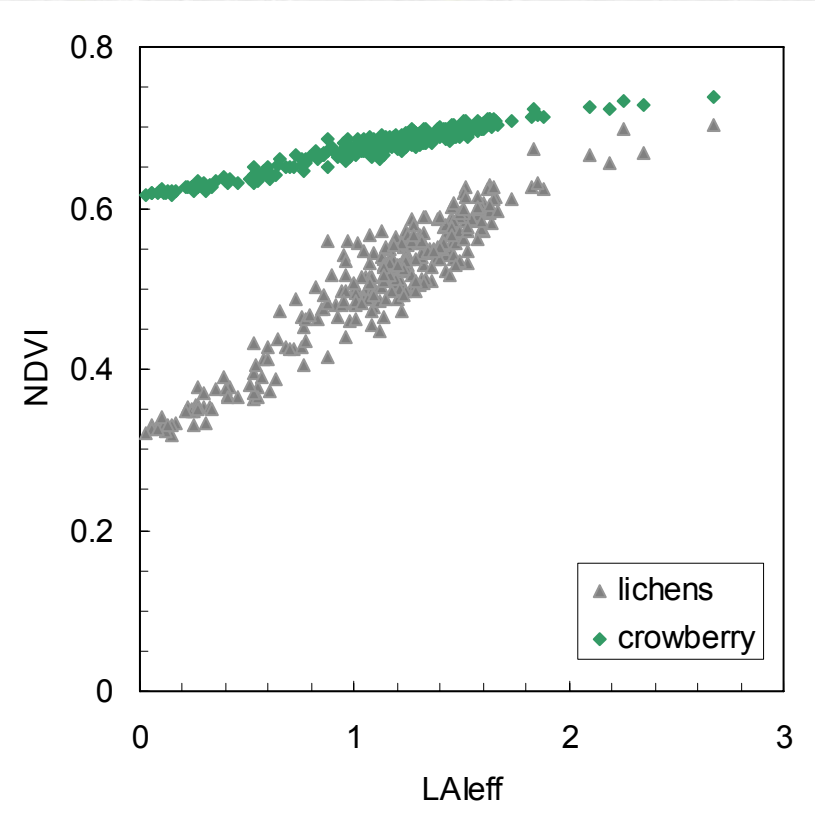
<| *Imeasured* - *Imodelled*|> = 34 W/m^2

Optical satellite based albedo vs. measured/modelled forest albedo



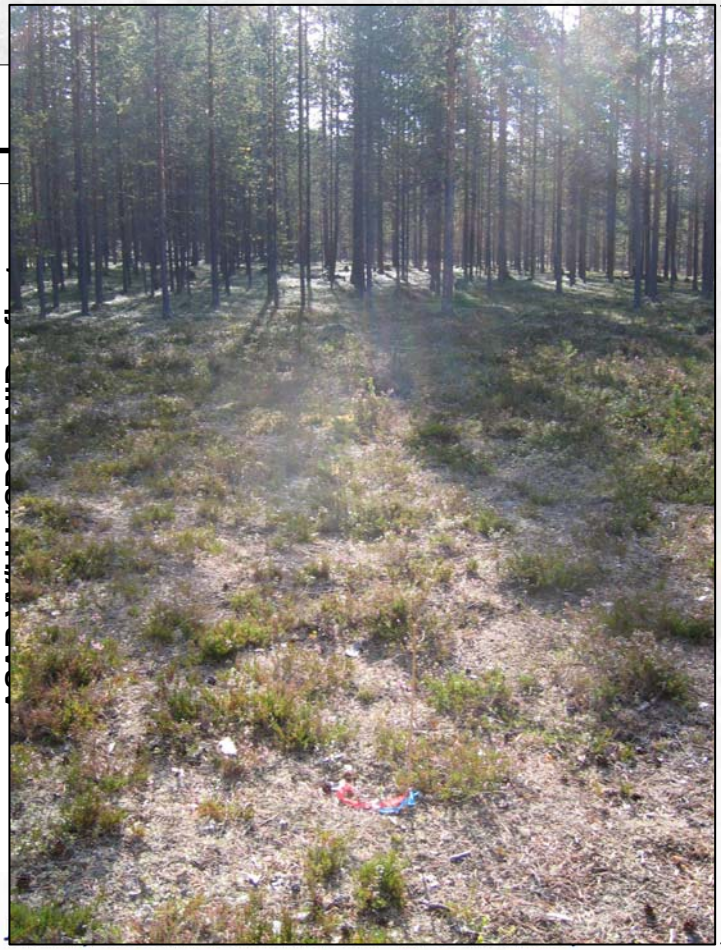
Measured/modelled albedo

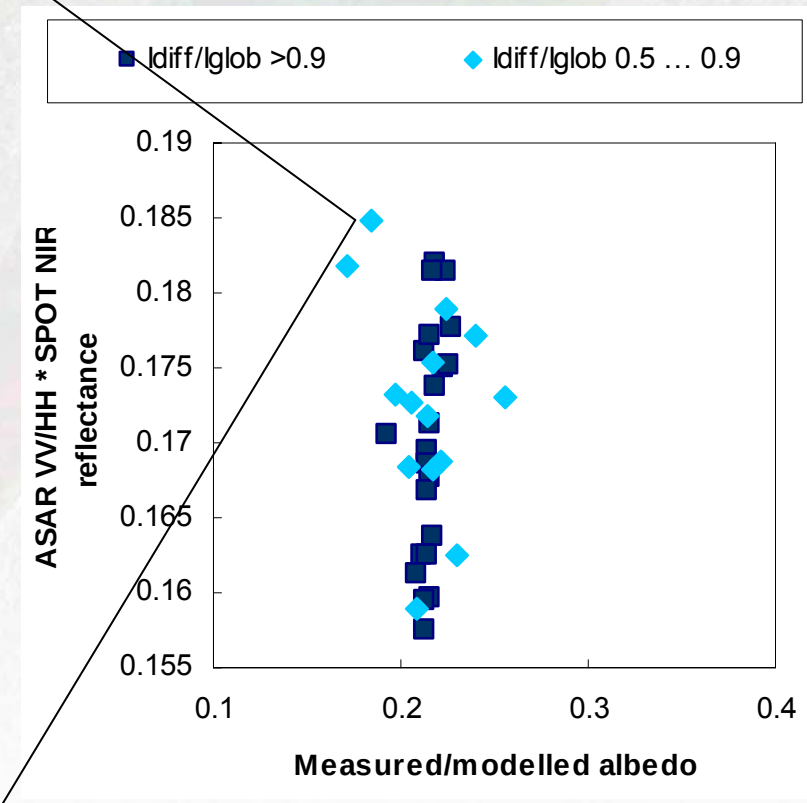
NDVI vs. canopy LAI for various forest understorey species



Rautiainen, M., J. Suomalainen, M. Mõttus, P. Stenberg, P. Voipio, J. Peltoniemi, and T. Manninen, 2007, *Remote Sensing of Environment*, 110:332-343.

Optical/microwave signal vs. measured/modelled forest albedo





Difference of satellite and ground based albedo values

		Mean difference	Relative mean difference
NIR	SPOT	0.038	12%
	SPOT/ASAR	0.017	8%
BB	SPOT	0.015	13%
	SPOT/ASAR	0.011	9%

Conclusions

- Including microwave data improved the boreal forest surface albedo estimation in the NIR band
- Microwave data could be used for improving broad band surface albedo estimation of boreal forest
- Microwave data could be used for improving the BRDF of boreal forest

Thank you for your attention!