WorldView-2 calibration experiment at Järvselja

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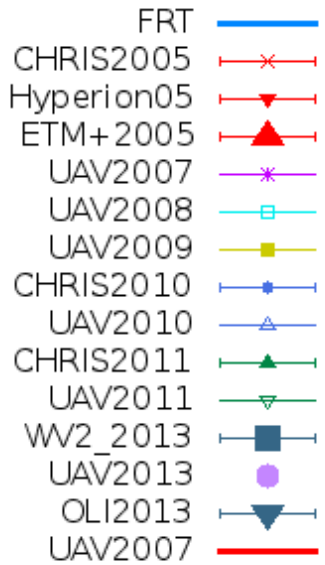
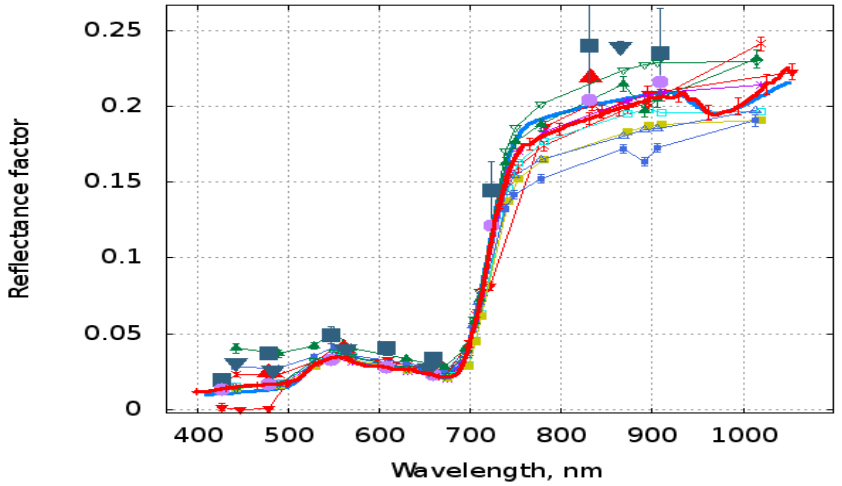
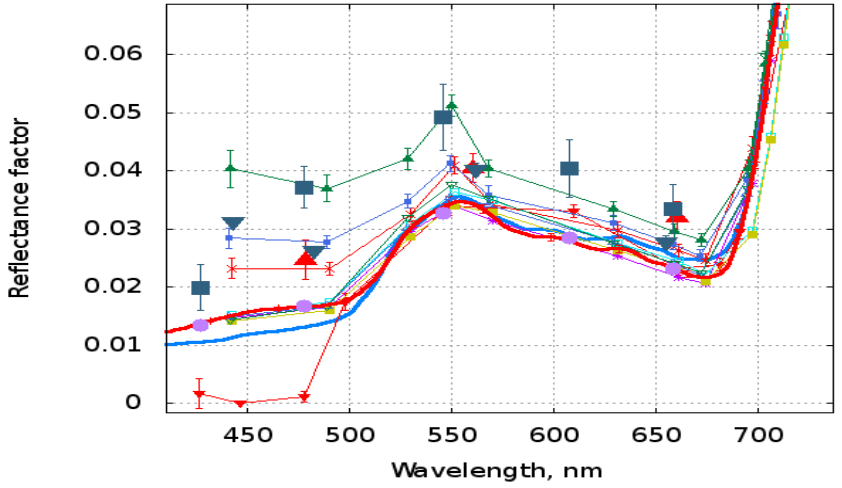
Juhan Ross Legacy Symposium
25 August 2017, Tõravere

BRF of the pine stand





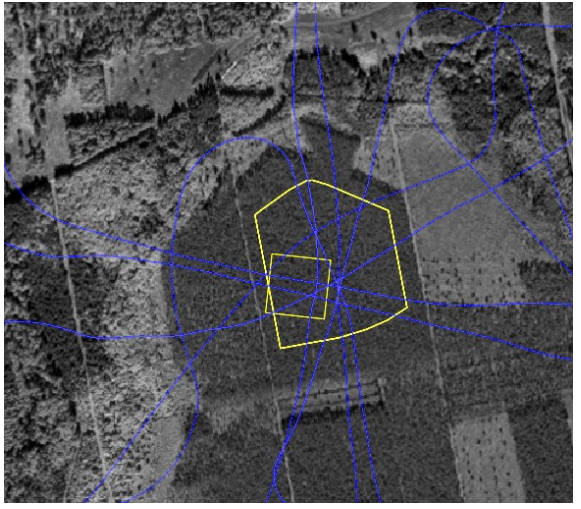


Standard parameters:

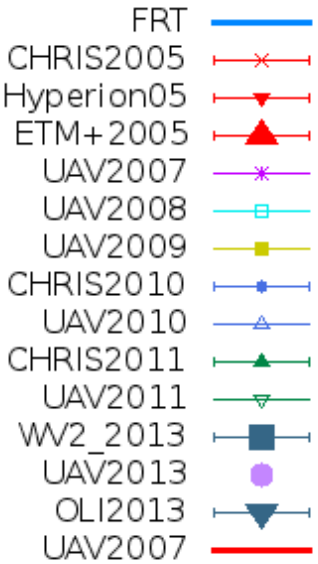
SZA = 40°

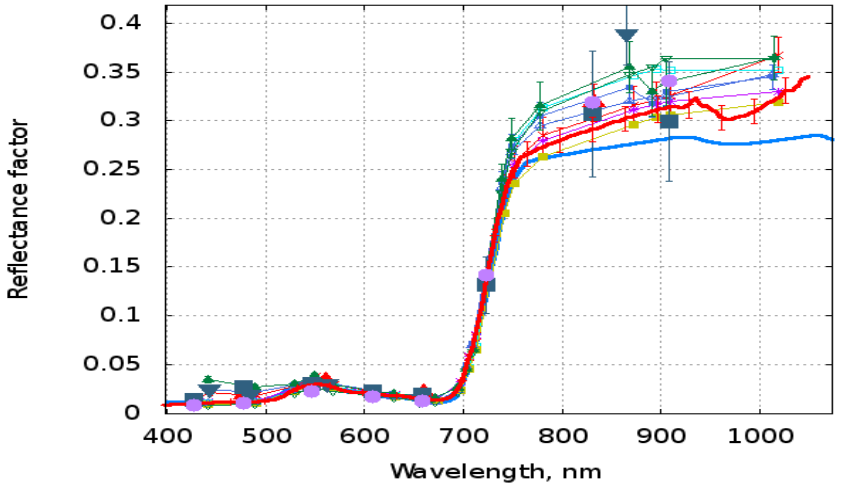
VZA = 0°

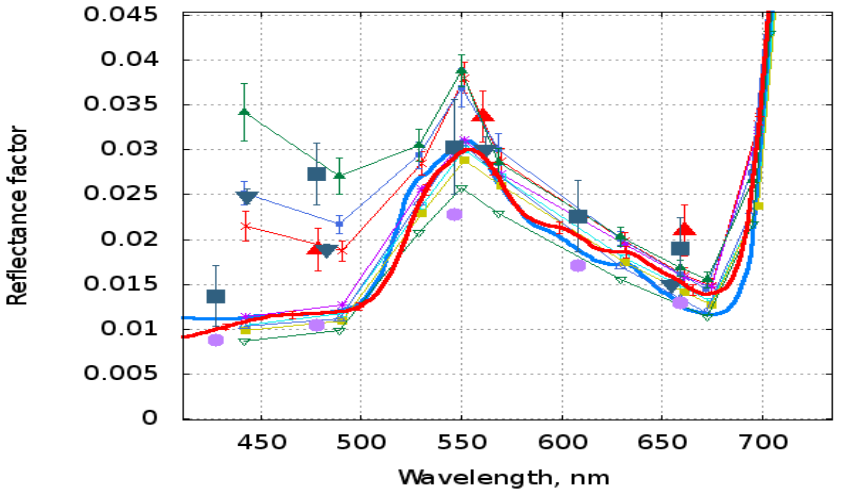
$\tau\_550 = 0.12$



BRF of the birch stand







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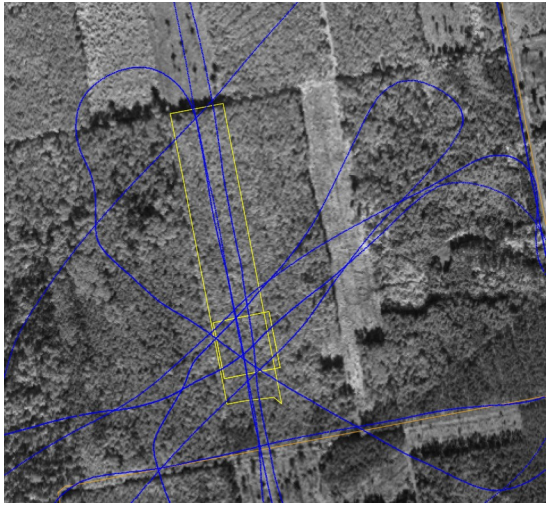

UAVSpec measurements

Standard parameters:

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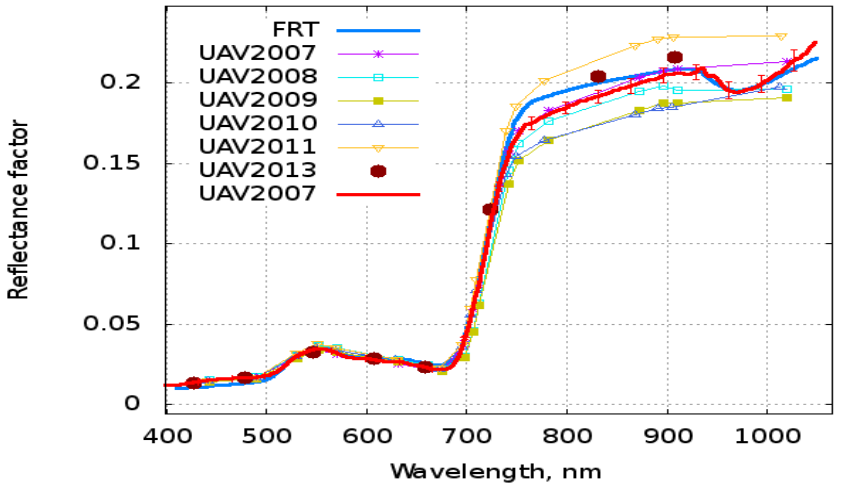
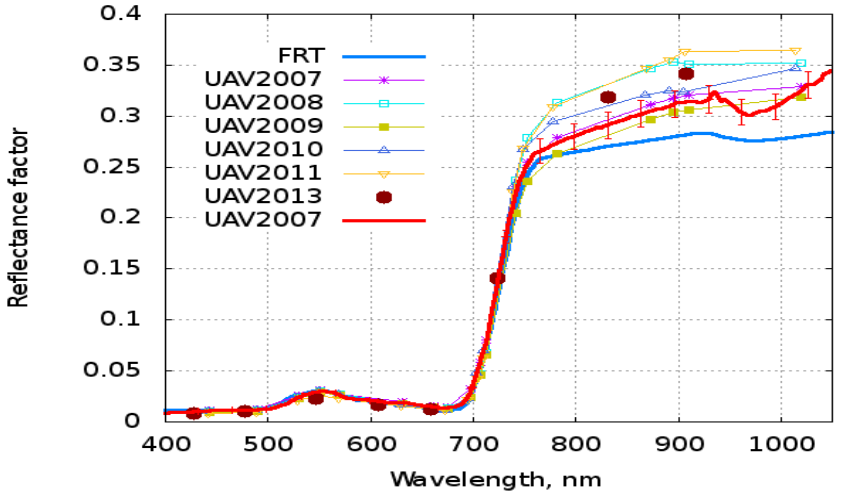


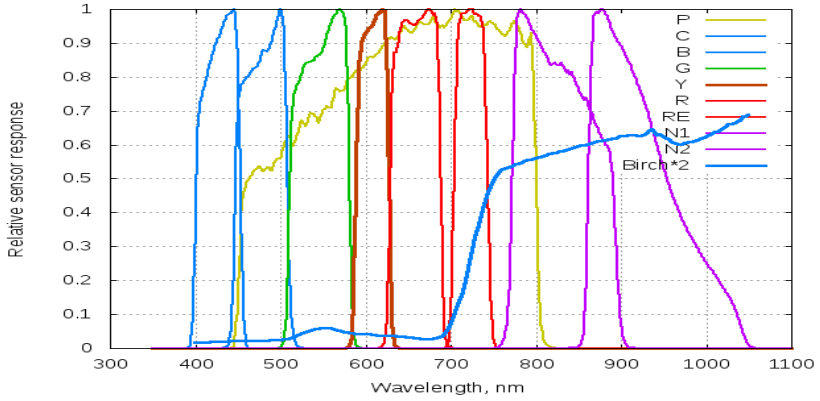
Pine stand



Birch stand

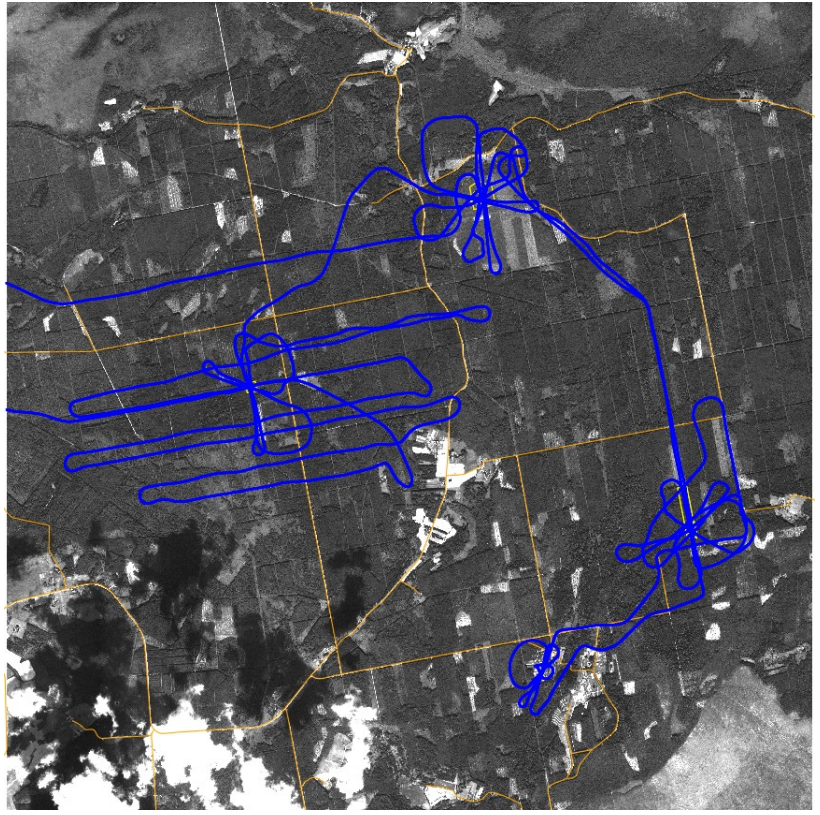
WorldView-2 acquired Järvselja test site on 29 July 2013

Spectral bands		pixel size
Coastal	400–450 nm	2 m
Blue	450–510 nm	
Green	510–580 nm	
Yellow	585–625 nm	
Red	630–690 nm	
Red Edge	705–745 nm	
NIR-1	770–895 nm	
NIR-2	860–1040 nm	
Panchromatic:	450–800 nm	0.5 m

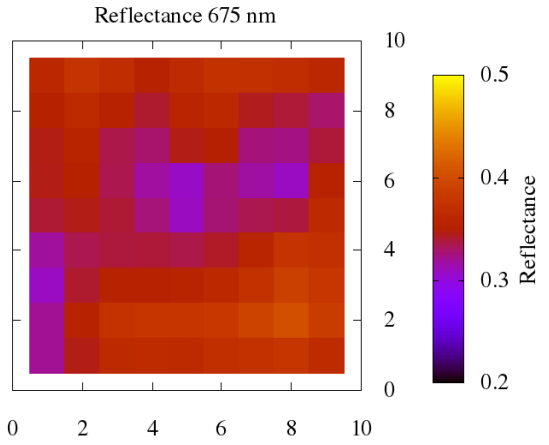


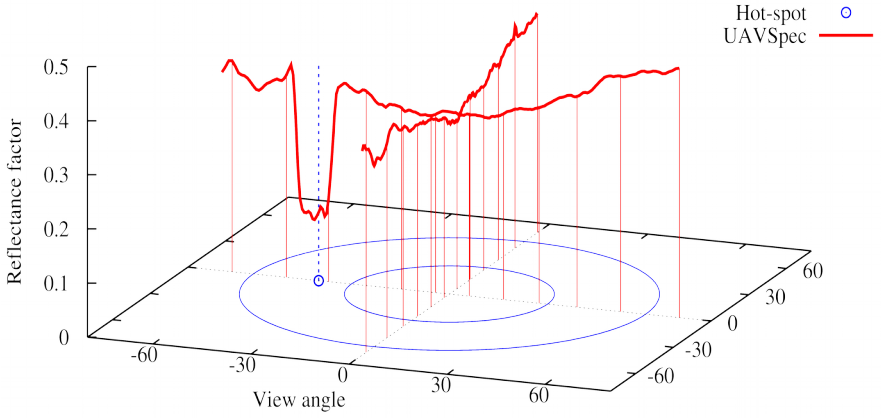
Supporting measurements at Järvselja on 29 July 2013

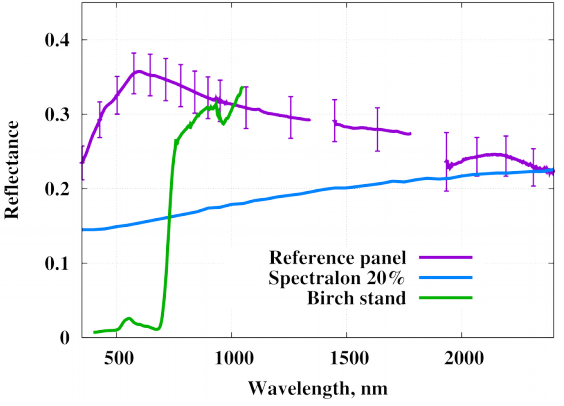
- Cimel – aerosol, H2O, O3
- SpectraVista – vis-NIR Q_λ, D_λ
- hemispherical sky images
- UAVSpec3 – forest reflectance in WV2 bands



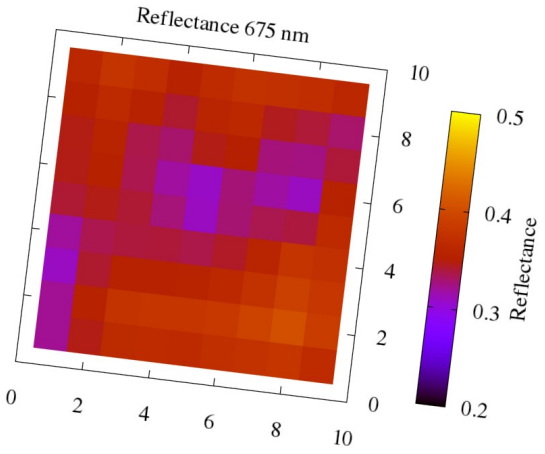
Reference panel at Järvselja, 2013

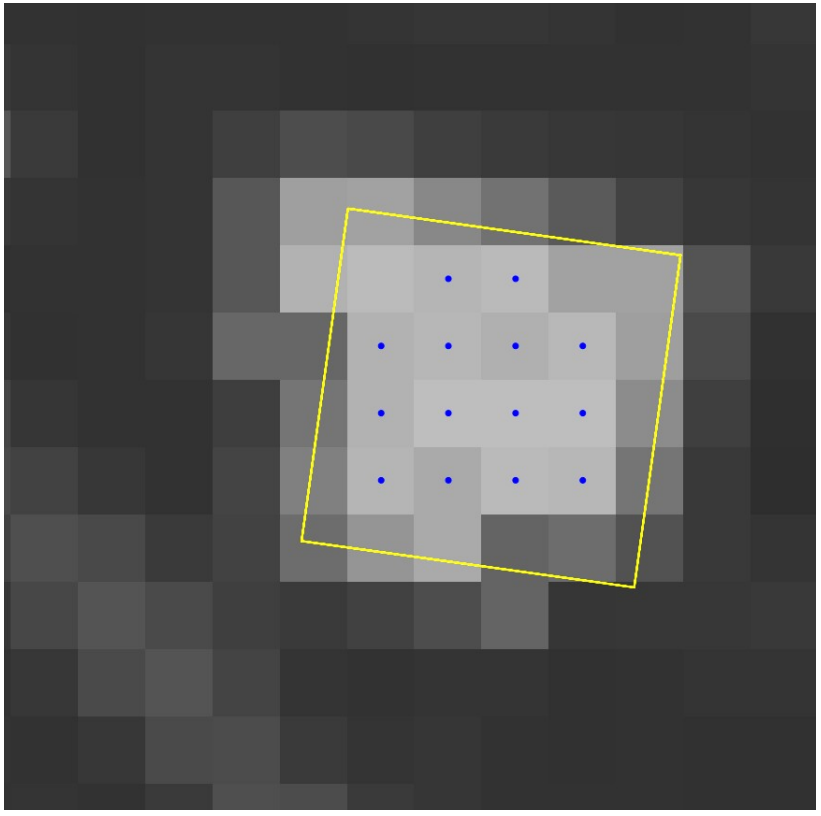






Reference panel in the WV2 image





Atmospheric correction of the WV-2 images using 6S and LUT

SZA = 39.6°

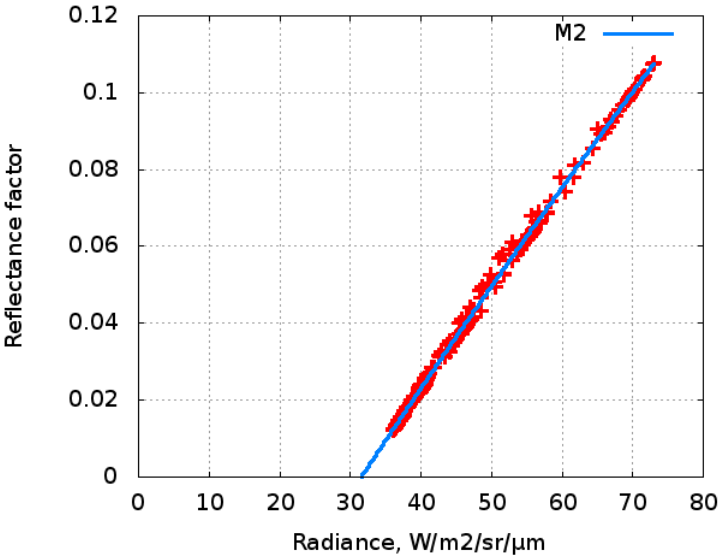
VZA = 19.4°

SZA-VZA = 152.5°

H2O: 1.91 cm

O3: 314 DU

$\tau\_550 = 0.12$



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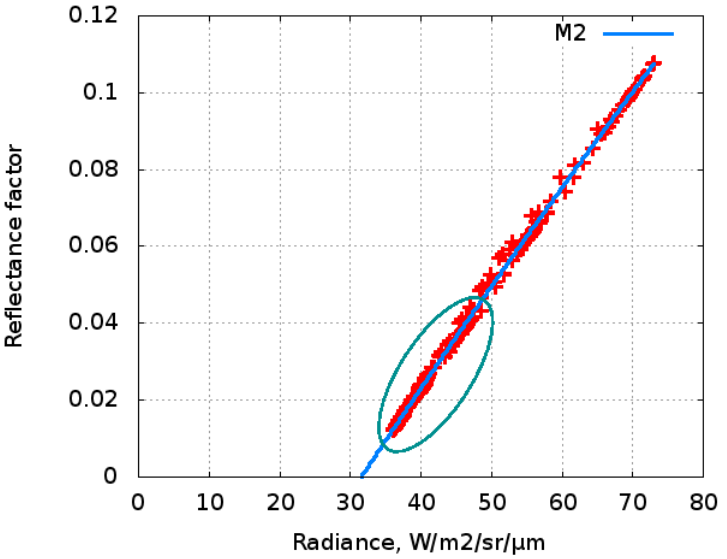
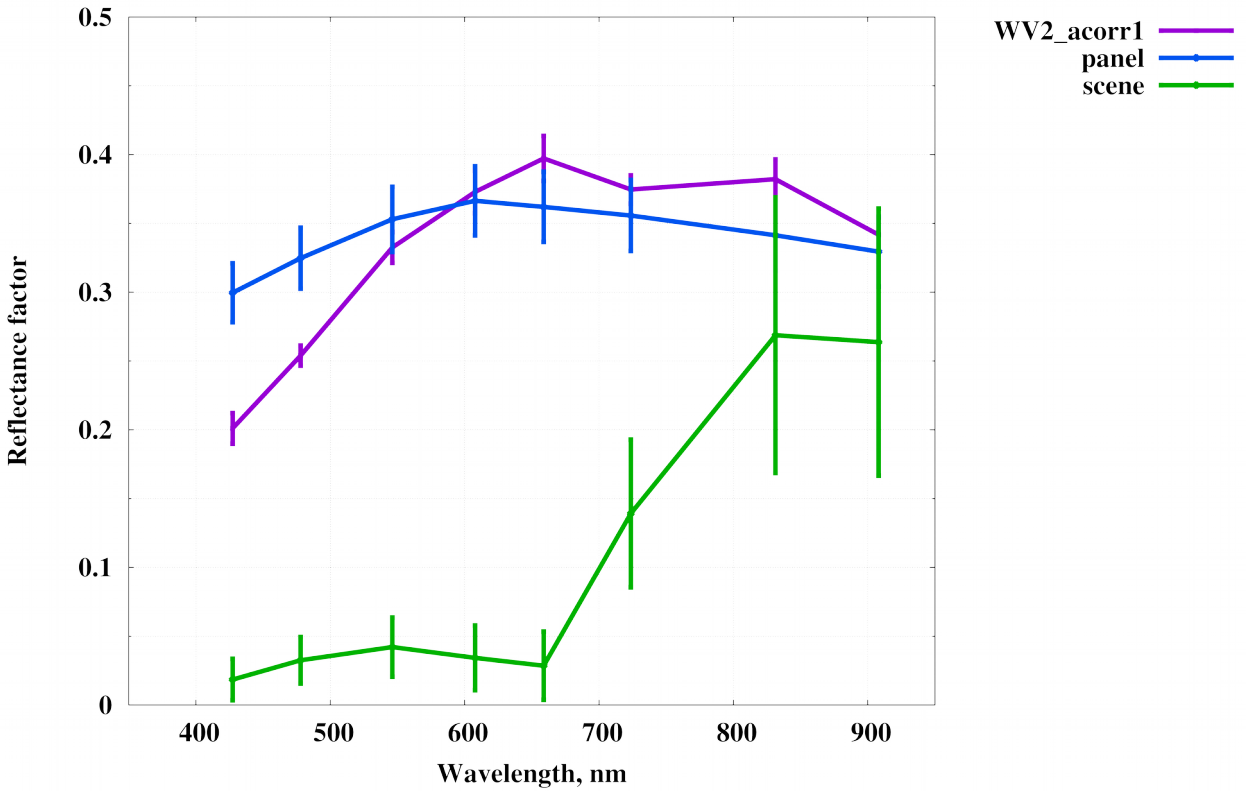
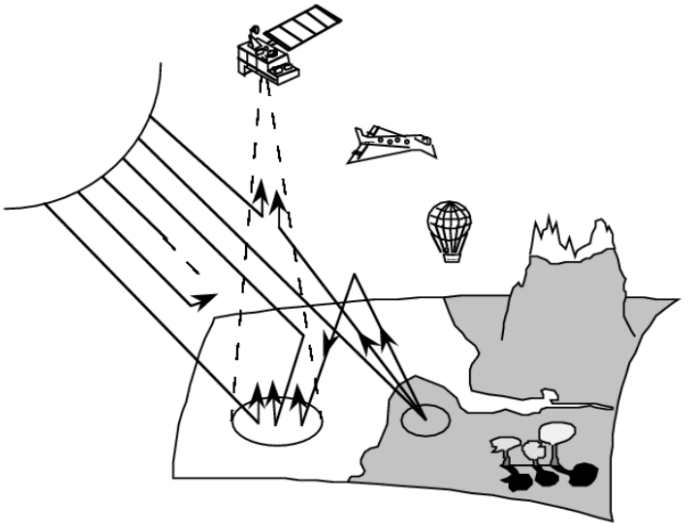


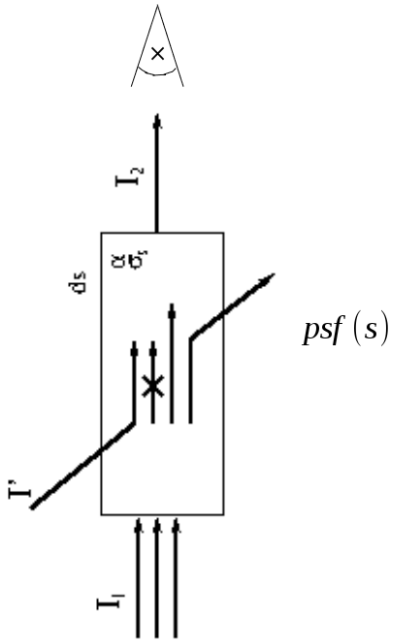
Reference panel in WV2 images



Adjacency effects



(Vermote et al., 1994)



Adjacency effects

Inverse filtering in the 2D Fourier space $g(x,y) = psf(\xi,\eta) \otimes f(u,v)$

Kaufman 1984, 1989, MTF of the atmosphere:

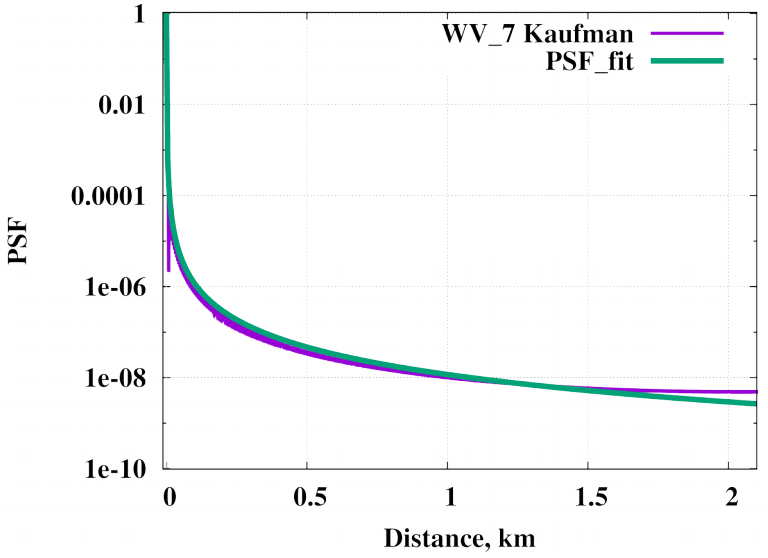
$$mtf(k) = 1 - 0.5\,\tau_r(1 - \exp(-2.5\ k\ H_r)) - 0.7\,\lambda^{-0.2}\tau_a(1 - \exp(-1.3\ k\ H_a))$$

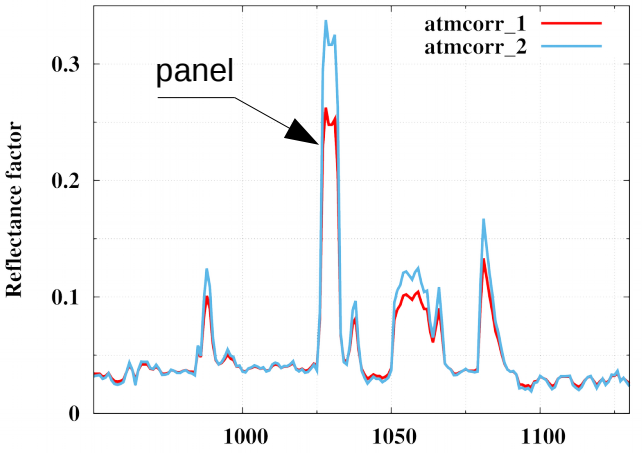
k — *frequency*, $1/km$
λ — *wavelength*
H_r — *the scale height of molecules* ($\approx 8\,km$)
H_a — *the scale height of aerosol* ($\approx 1\,km$)
τ_r — *Rayleigh*
τ_a — *aerosol*

$$mtf(k) \xrightarrow[FFT]{} psf(s)$$

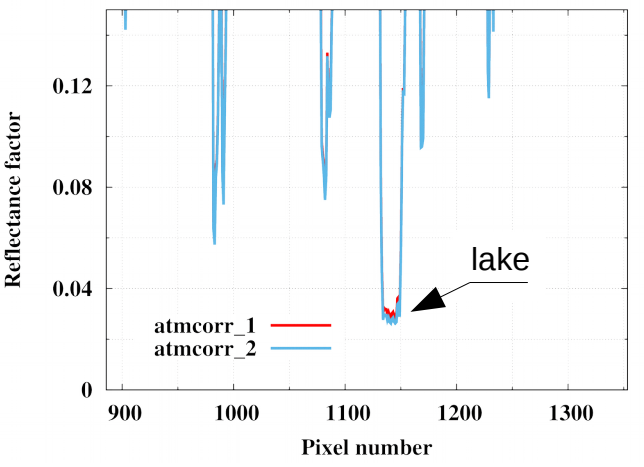
$$psf(s) \approx (a_1 \exp(a_2/(1 + s^{a_3})) + b_1 \exp(b_2\ s))/(1 + s^2)/(a_1 \exp(a_2) + b_1)$$

Adjacency effects, PSF of the atmosphere





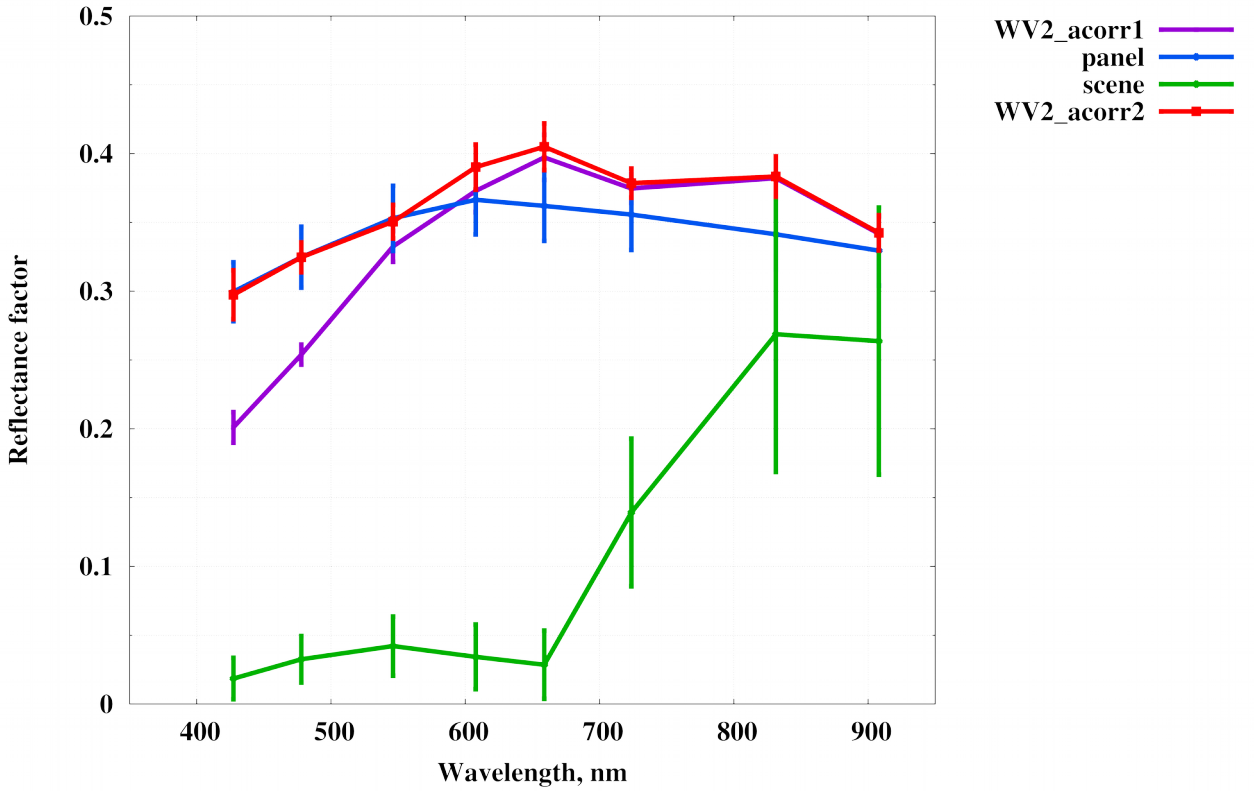
M2, blue



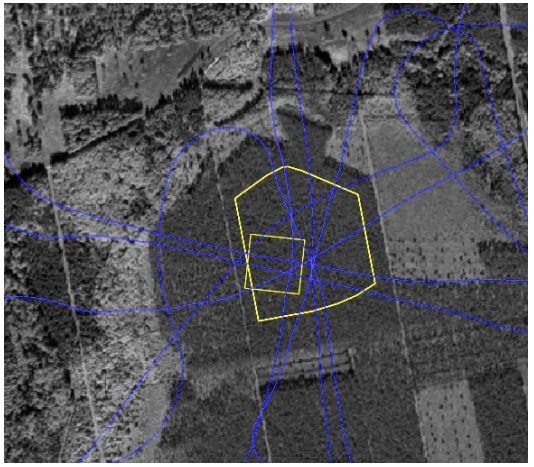
M7, NIR

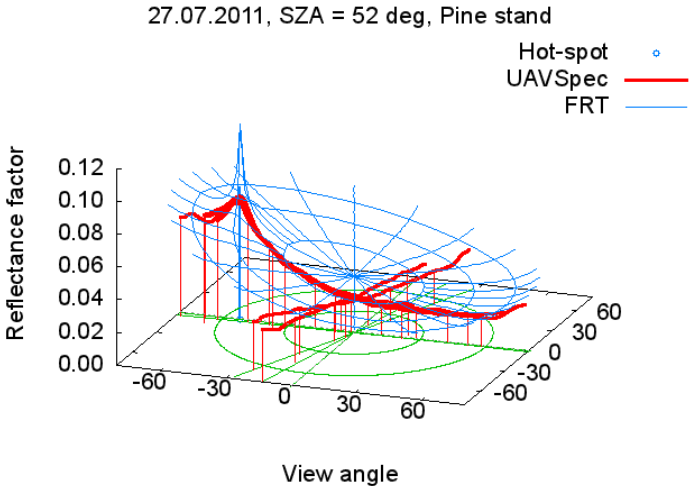
$$psf(s) \approx (a_1 \exp(a_2/(1 + s^{a_3})) + b_1 \exp(b_2\, s))/(1 + s^2)/(a_1 \exp(a_2) + b_1)$$

Adjacency effects, the reference panel

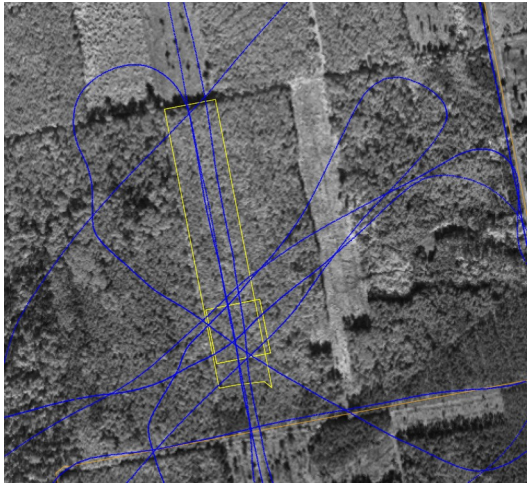


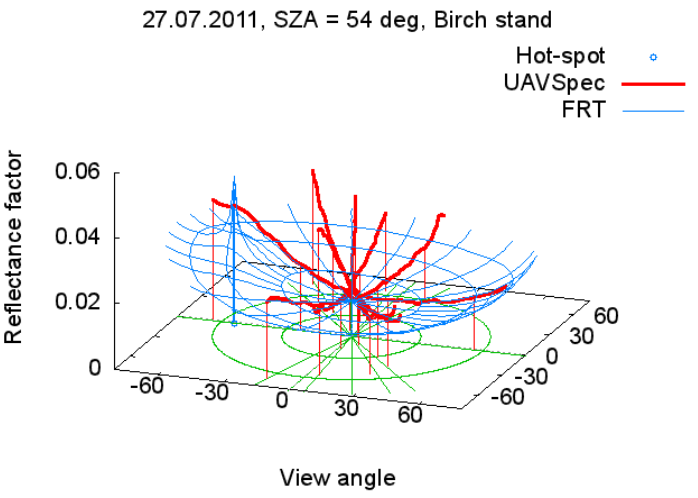
Directional effects, forest stands





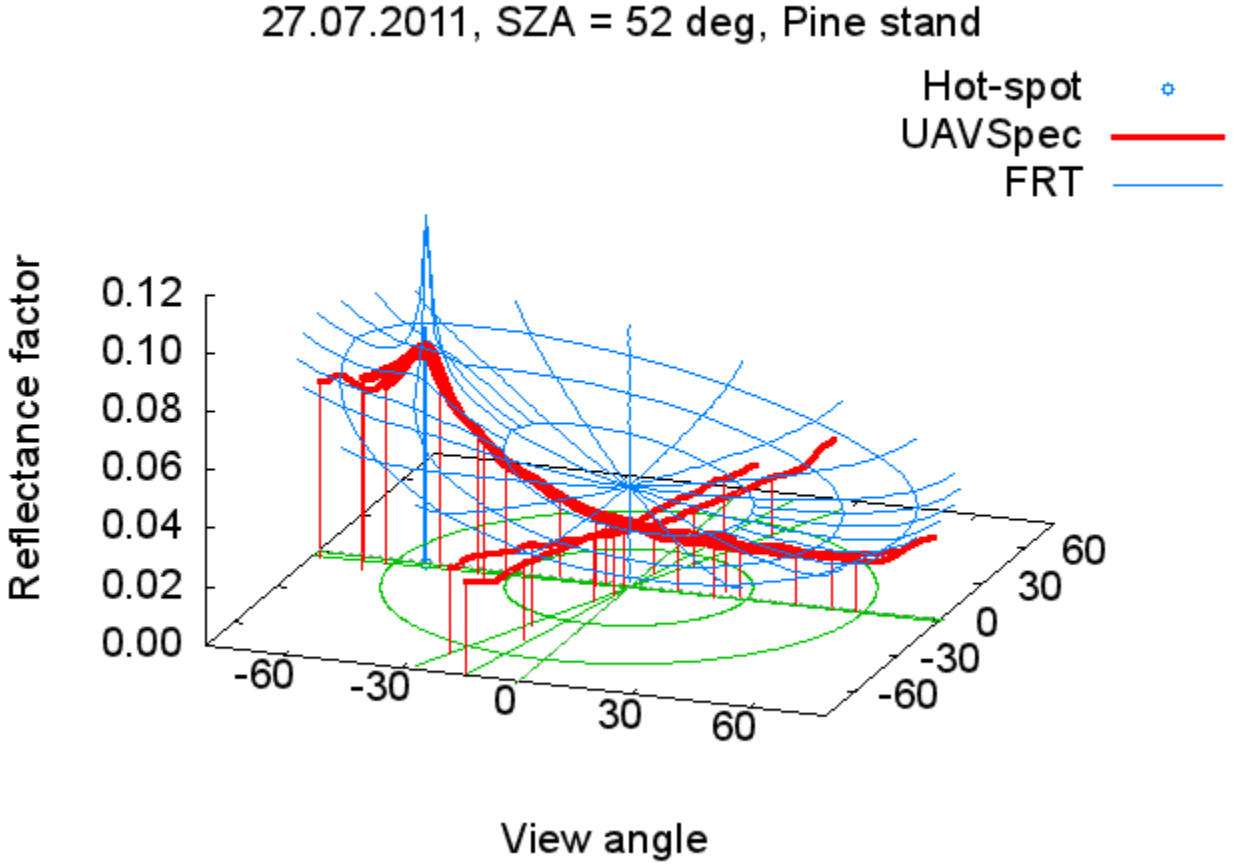
Pine



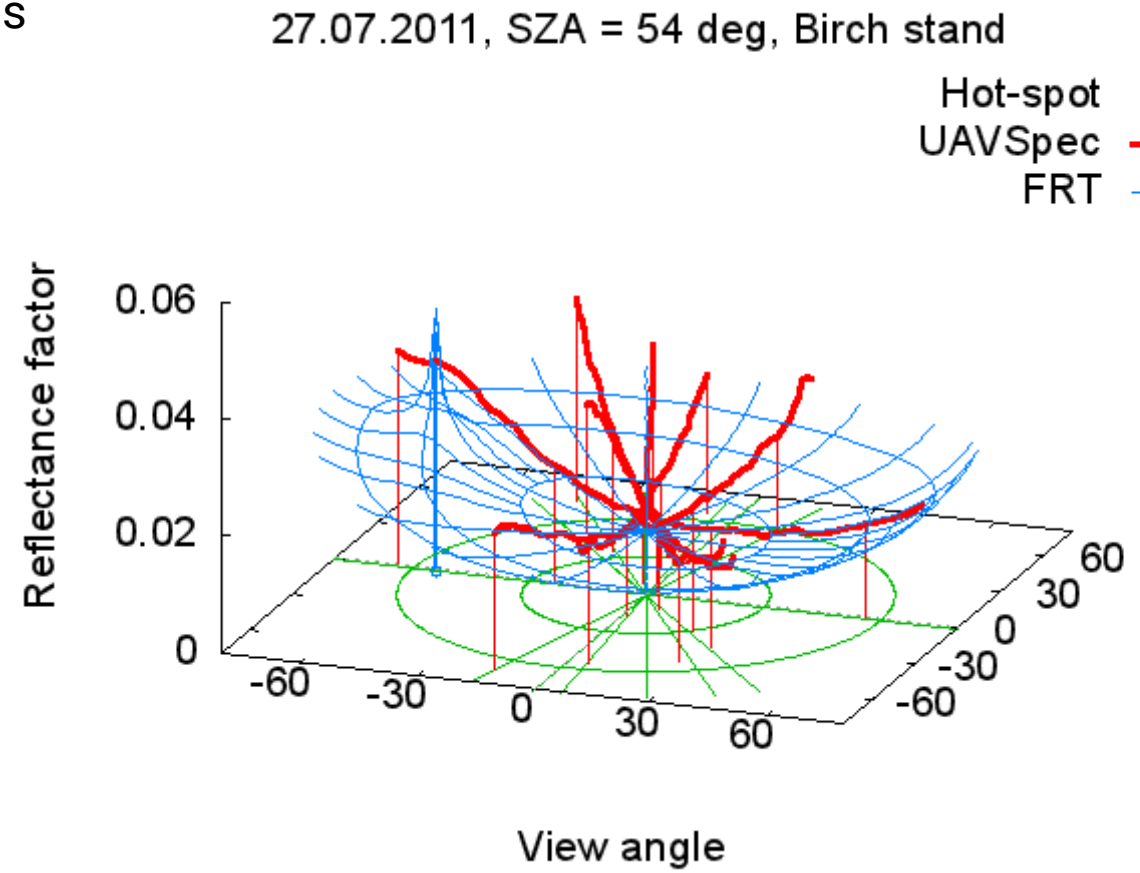


Birch

BRF of forest stands



BRF of forest stands



Summary

Radiometry of satellite remote sensing needs

- reference targets
- detailed optical properties and 3D RT in the atmosphere
  - adjacency correction
  - directional effects

Acknowledgments

- European Space Imaging & DigitalGlobe
- Kaupo Voormansik & AS Regio
- Pakker Avio