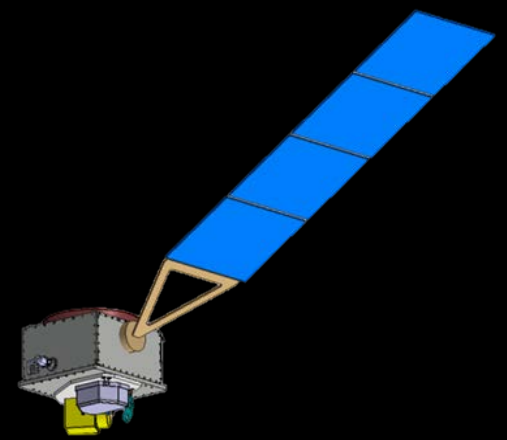
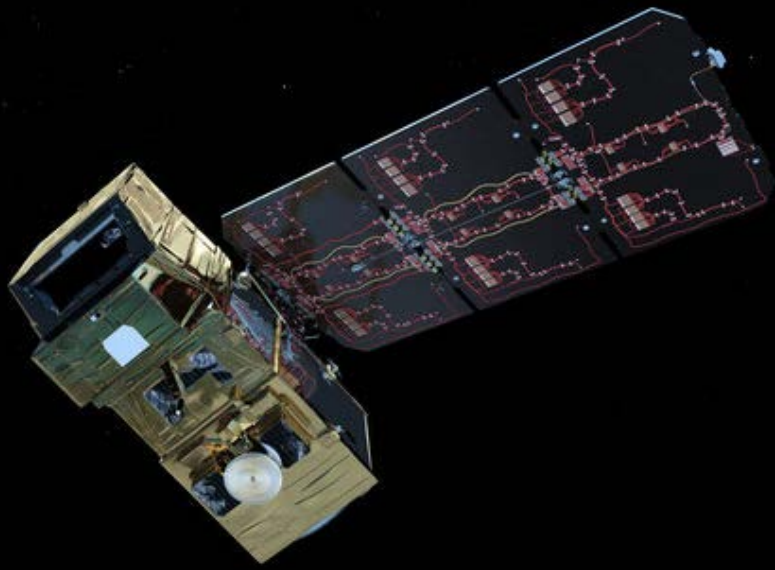


Calibration approaches: Post-launch

Emma Woolliams, Nigel Fox, Javier Gorroño, Lydia Zajiczek, Claire Greenwell, Agnieszka Bialek, Tracy Scanlon, Paul Green (and more)

29th June 2017



- **TRUTHS**

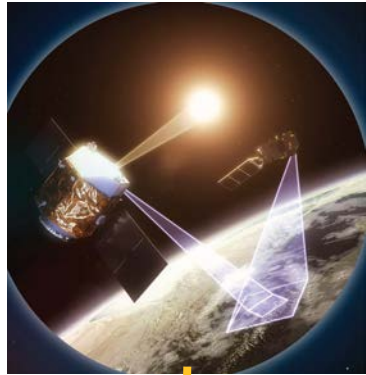
- **Interoperability**
- **Decadal Stability**
- **Absolute radiometric accuracy**

Rigorous uncertainty analysis
Documented traceability
Formal comparisons



- **RadCalNet**
- **PICS**

TRUTHS (Traceable Radiometry Underpinning Terrestrial and Helio- Studies)



Takes terrestrial SI-traceability chain into orbit
(320 nm – 2400 nm)

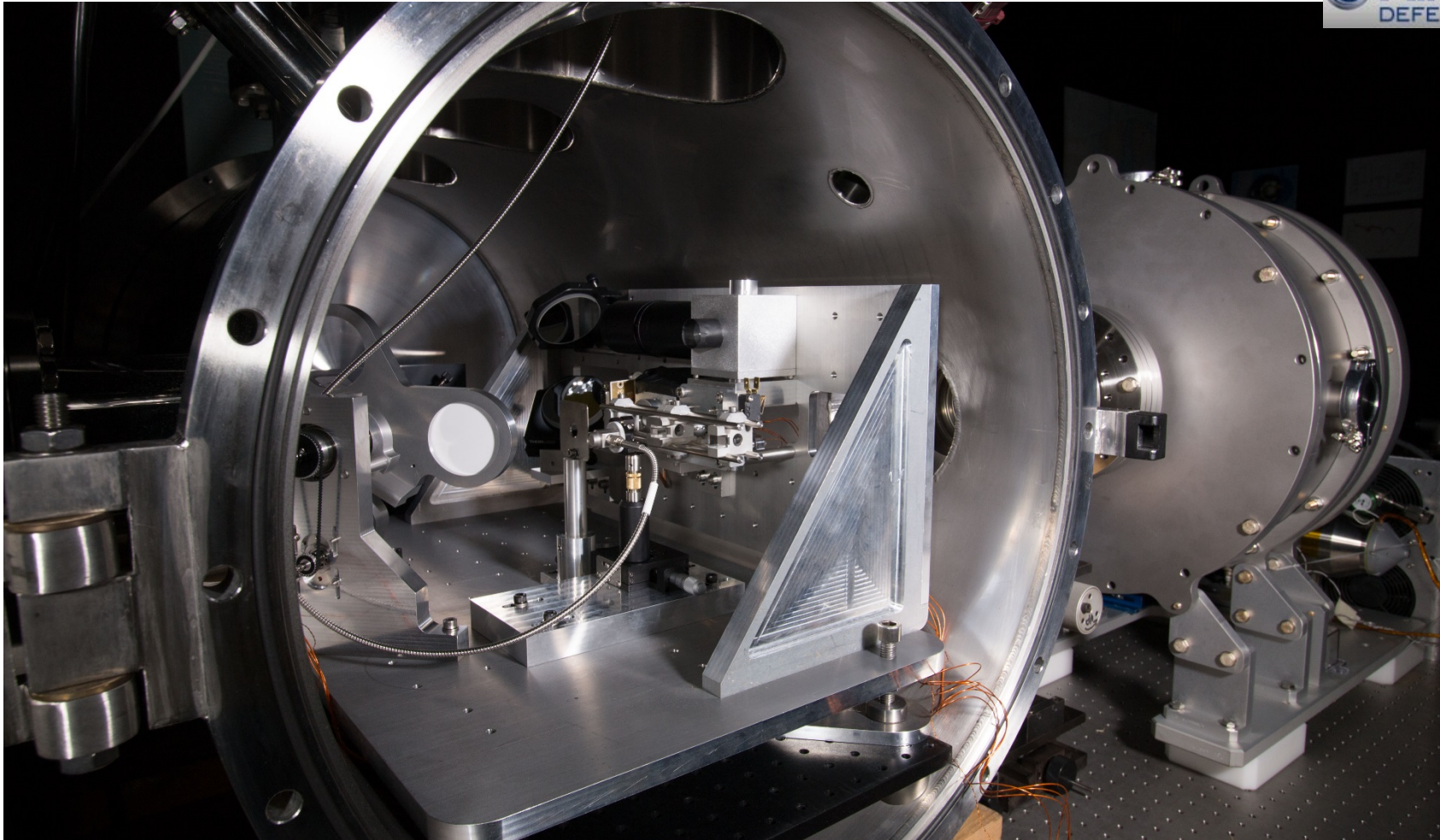
Climate Observatory
(Uncertainties, $k = 2$)

Total Solar Irradiance 0.02 %
Solar Spectral Irradiance 0.3 %
Earth Spectral Radiance 0.3 %

Calibration Laboratory
Calibration of Earth reference sites (0.3 %)
Calibration of Lunar spectral irradiance (0.3 %)

www.npl.co.uk/truths

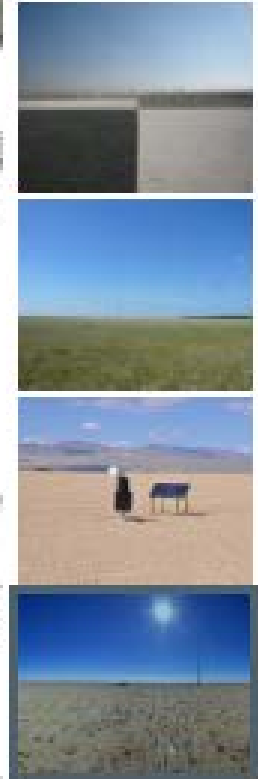
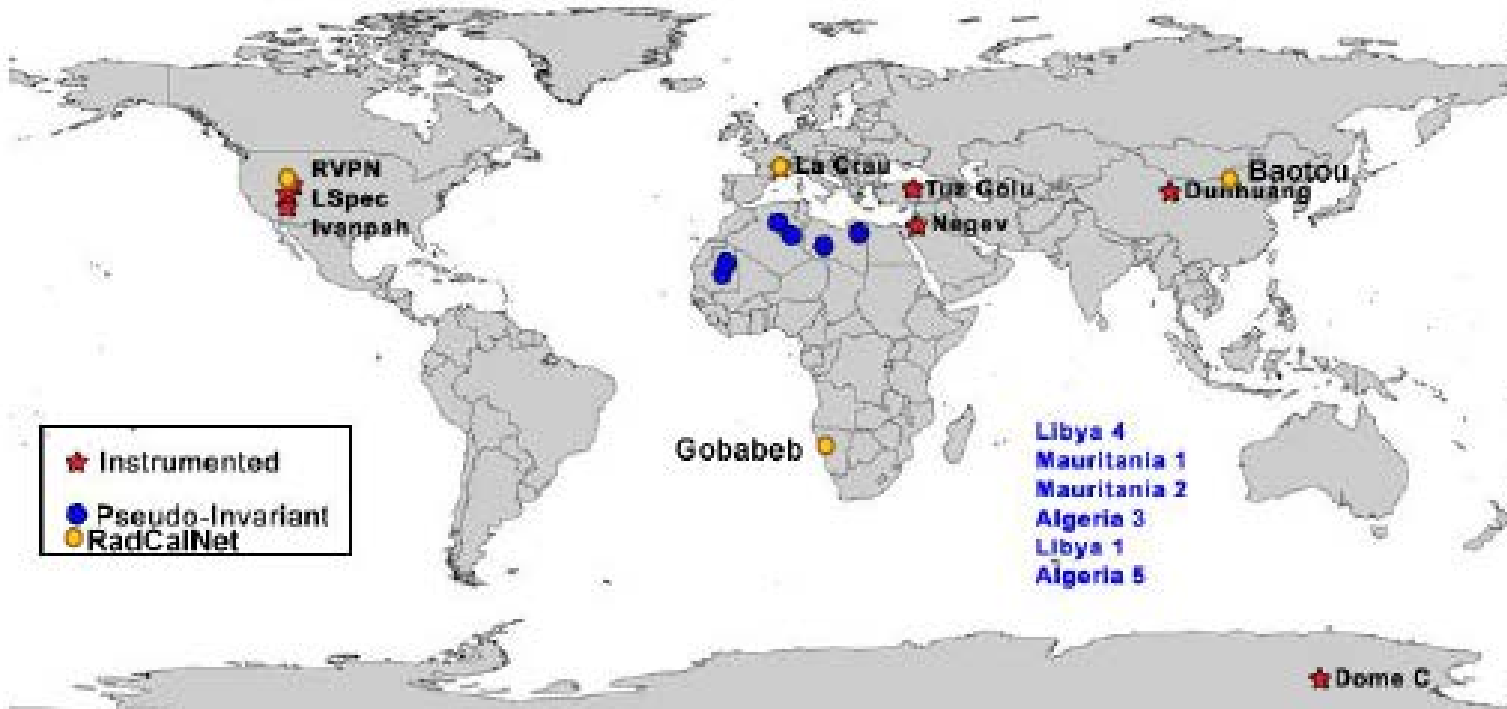
Calibration System Prototype



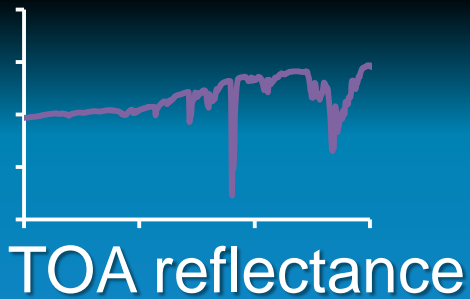
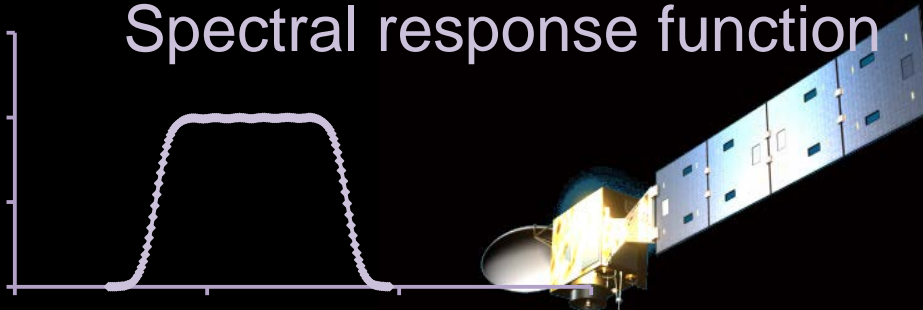
Priority sites for cross-comparison of L1



CEOS Reference Standard Tests Sites



Spectral response function

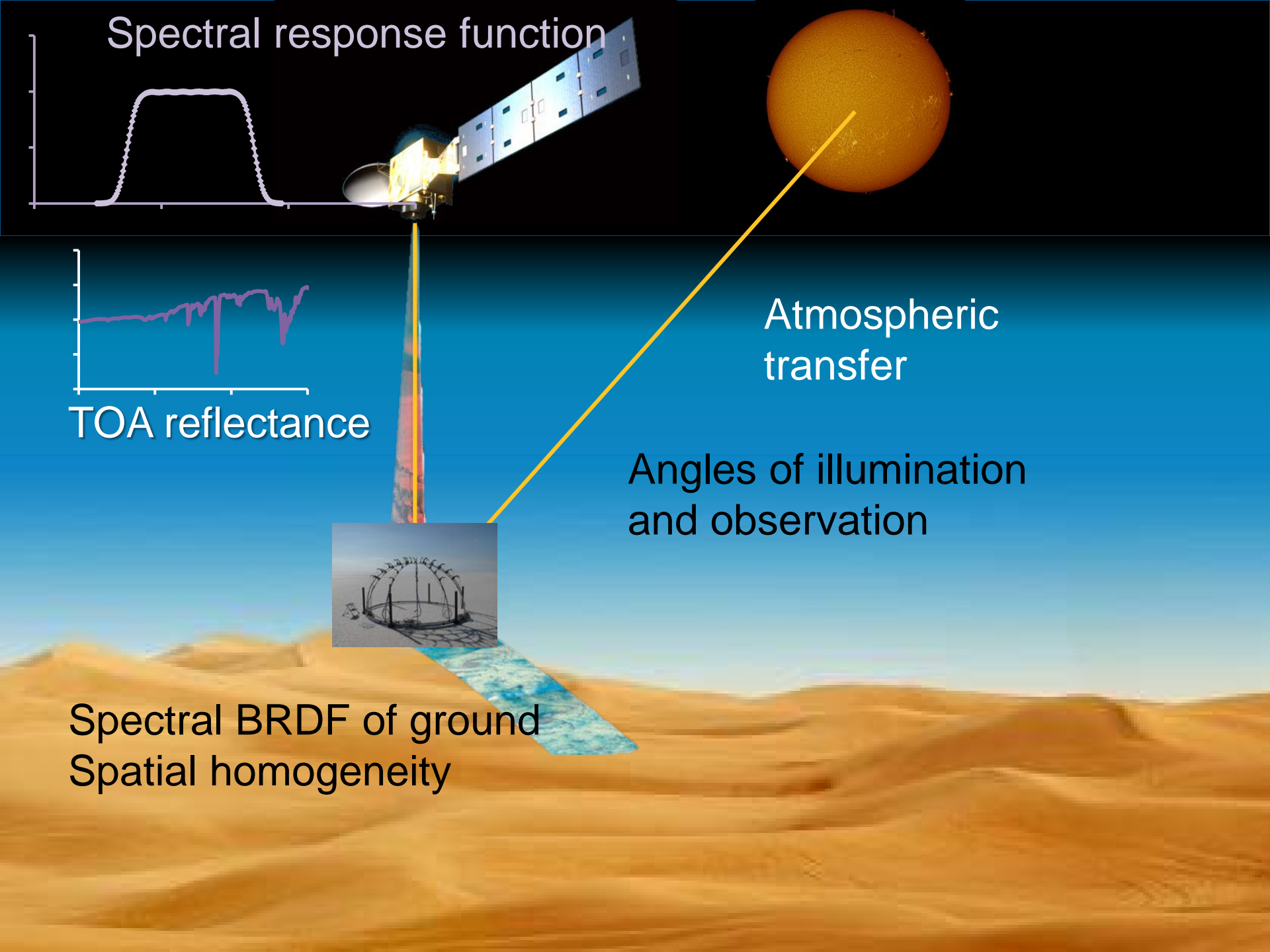


Atmospheric transfer

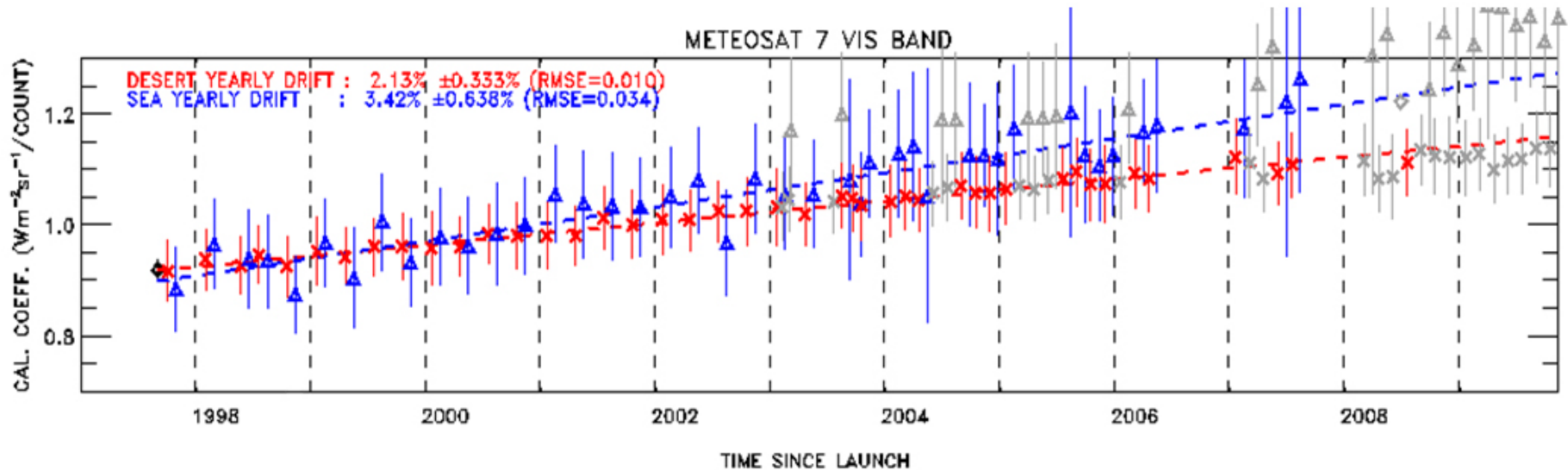
Angles of illumination and observation



Spectral BRDF of ground
Spatial homogeneity



Sensor drift since launch

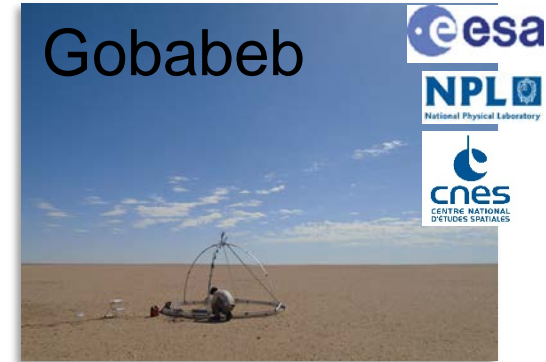


Drift of MVIRI Vis band since launch as determined from desert (red) and ocean (blue) test sites
Figure from:

<https://scienceblog.eumetsat.int/2016/11/improving-climate-data-records-with-fiduceo/>

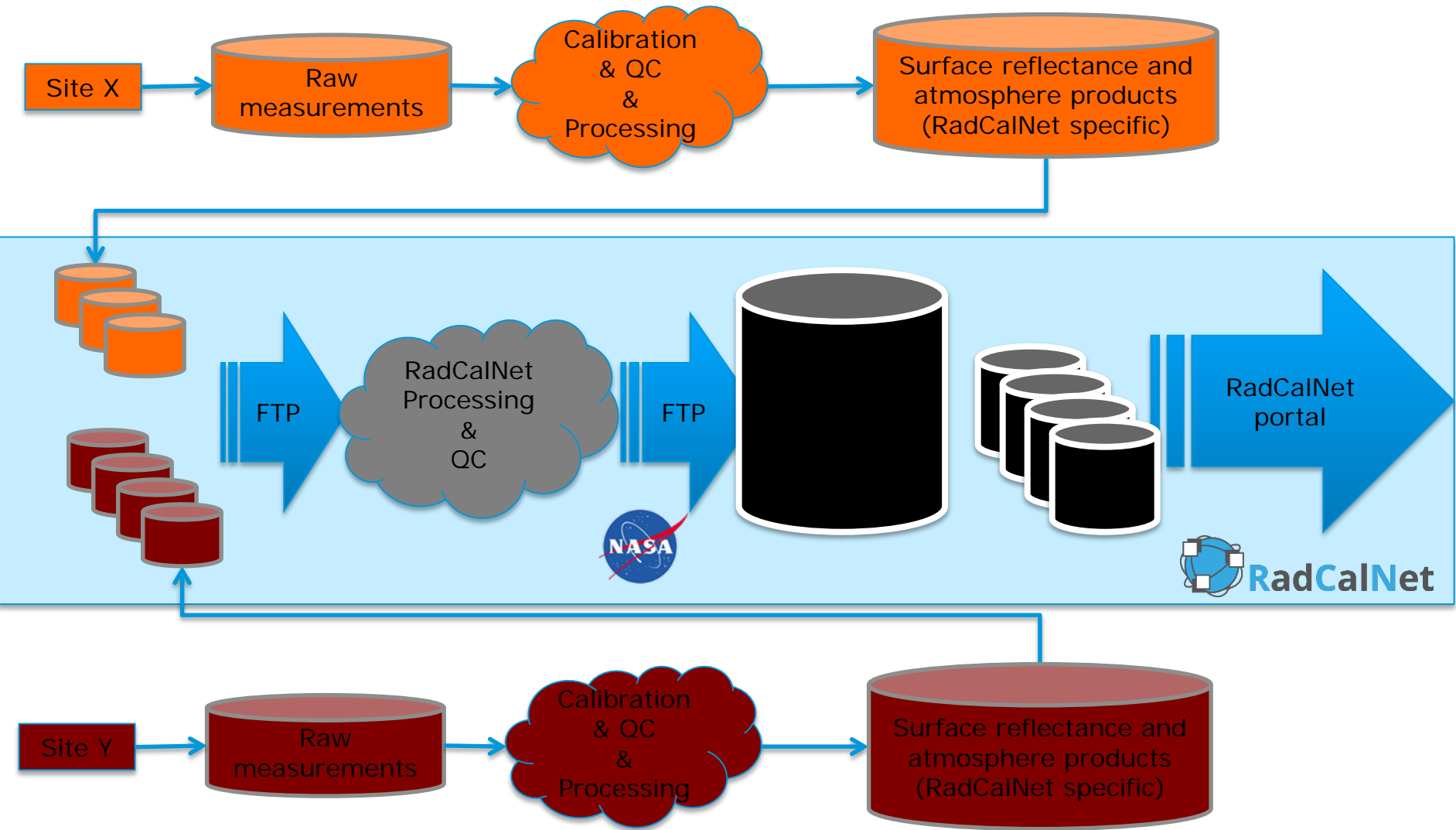
RadCalNet: www.radcalnet.org

RadCalNet
prototype sites

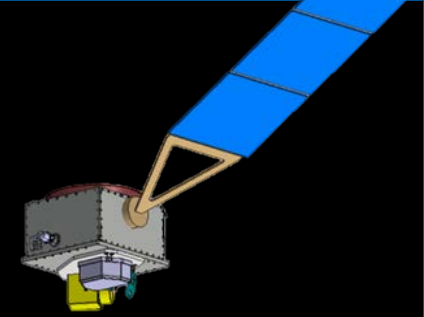
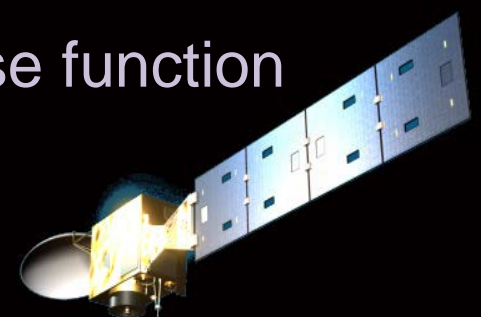
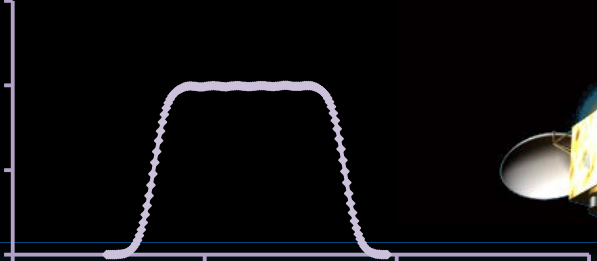




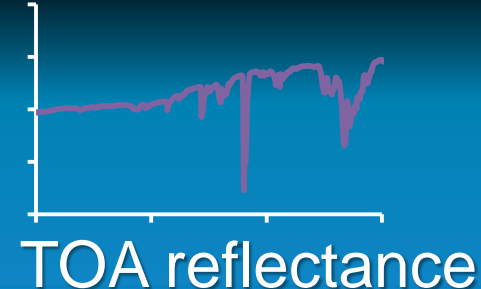
What is RadCalNet: individual sites responsible for QA and processed through common processing chain from NASA



Spectral response function



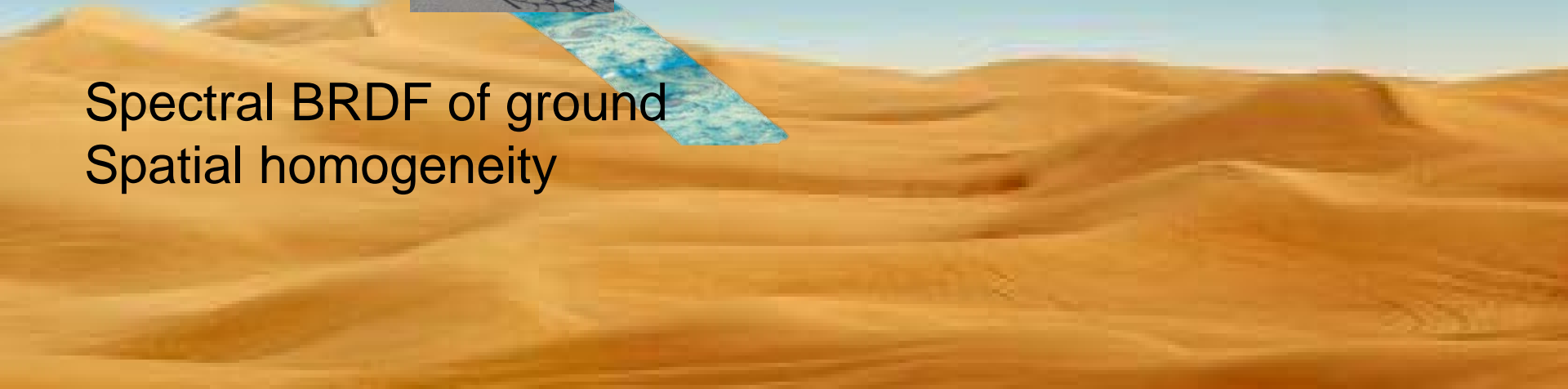
Atmospheric transfer



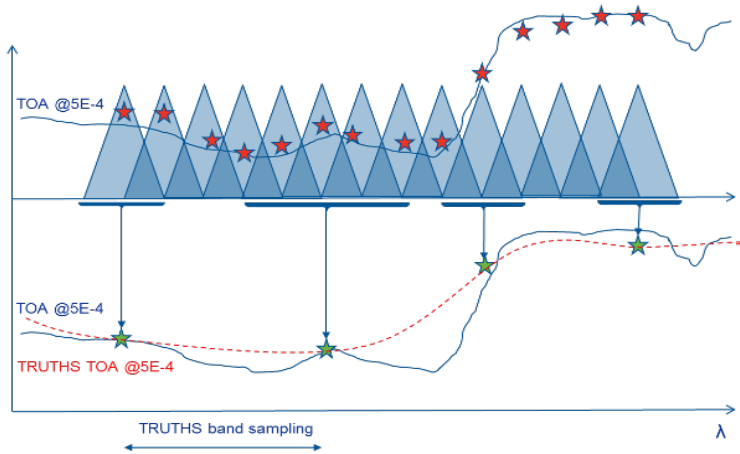
Angles of illumination and observation



Spectral BRDF of ground
Spatial homogeneity

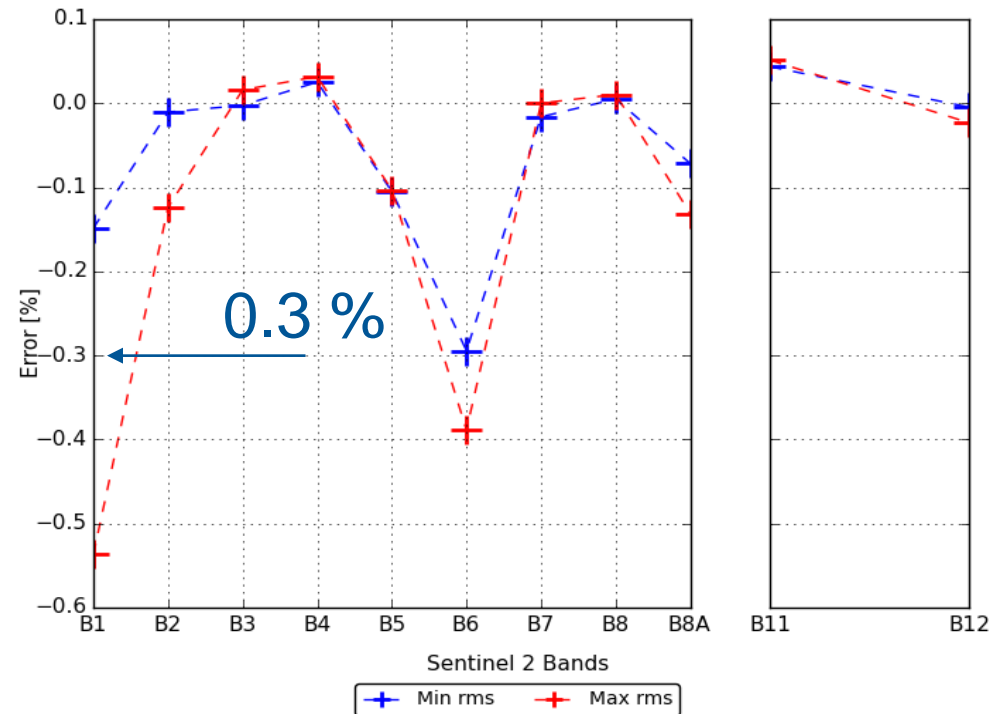


Spectral dimension



Sentinel 2 – TRUTHS comparison

Maximum error introduced by spectral interpolation (red and blue lines depend on starting wavelength)

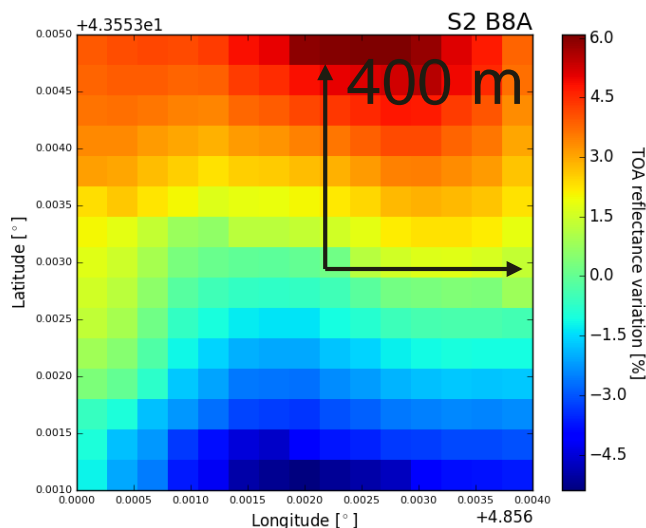
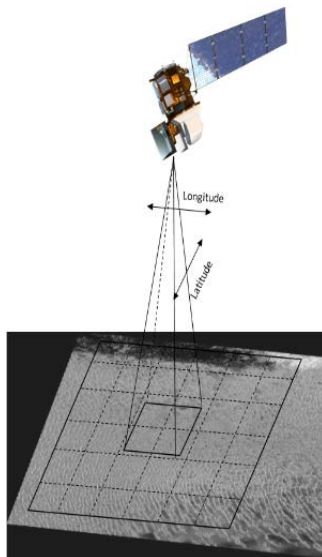


Submitted to ISPRS Journal of Photogrammetry and Remote Sensing
Gorrone et al. 2017
Funded by CEOI



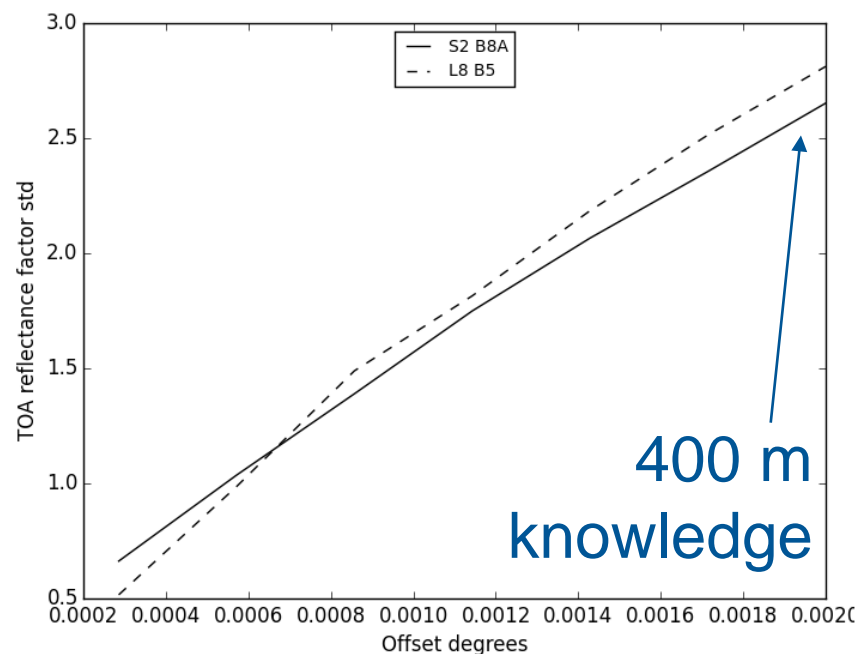
Spatial dimension

How sensitive is comparison to geolocation accuracy?



<0.1 % for Libya 4
0.1 % - 0.5 % for La Crau
(40 m geometric knowledge)

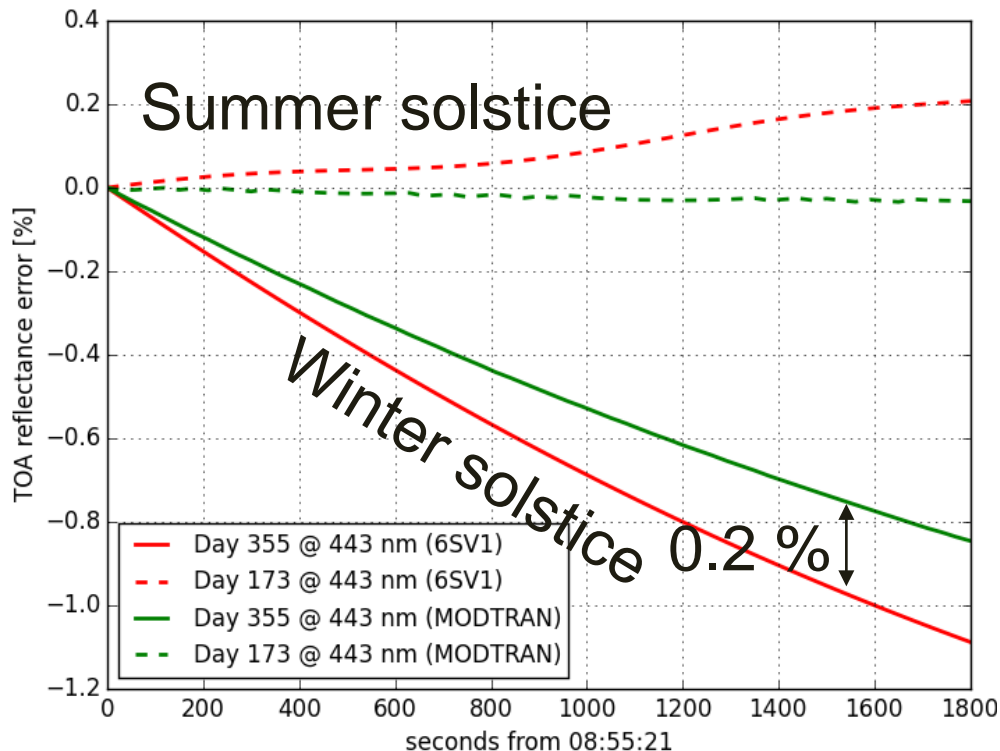
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Photogrammetry and Remote Sensing
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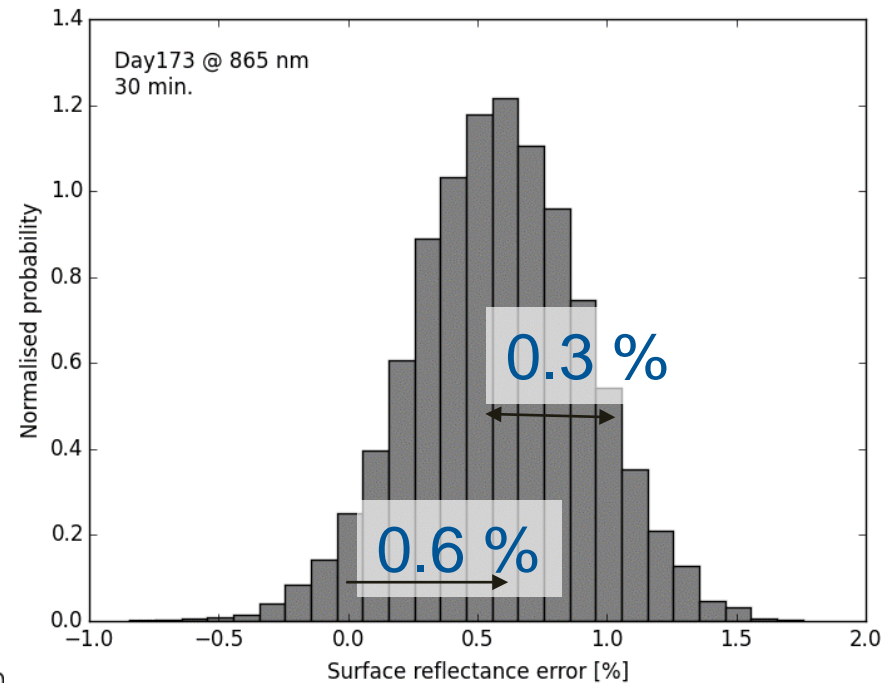
Temporal dimension

Effect of changes in water vapour, aerosols, surface BRF, SZA

Atmosphere dominant (443 nm)



Surface dominant (865 nm)



Submitted to ISPRS Journal of
Photogrammetry and Remote Sensing
Gorrone et al. 2017
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Uncertainty budget for TRUTHS – satellite comparisons

(single overpass – reduces for multiple overpasses)

Uncertainty	Best S2 bands	Worst S2 bands
Spectral resolution TRUTHS	0.1 %	0.6 %
Spectral accuracy TRUTHS	0.1 %	0.2 %
Spatial co-alignment mismatch	0.1 % (Libya) 0.12 % (La Crau)	0.1 % (Libya) 0.5 % (La Crau)
30 minute time difference (atmospheric effects)	0.1 % (if corrected) 0.3 % (if atmosphere not known)	0.1 % (if corrected) 2 % (if atmosphere not known)
30 minute time difference (surface BRF)	0.2 %	0.4 %
Combined with reasonable corrections	0.4 % - 0.5 %	0.7 %

PICS



Thank you



Department for
Business, Energy
& Industrial Strategy



Metrology for Earth
Observation and Climate

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■ Programme of EURAMET



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