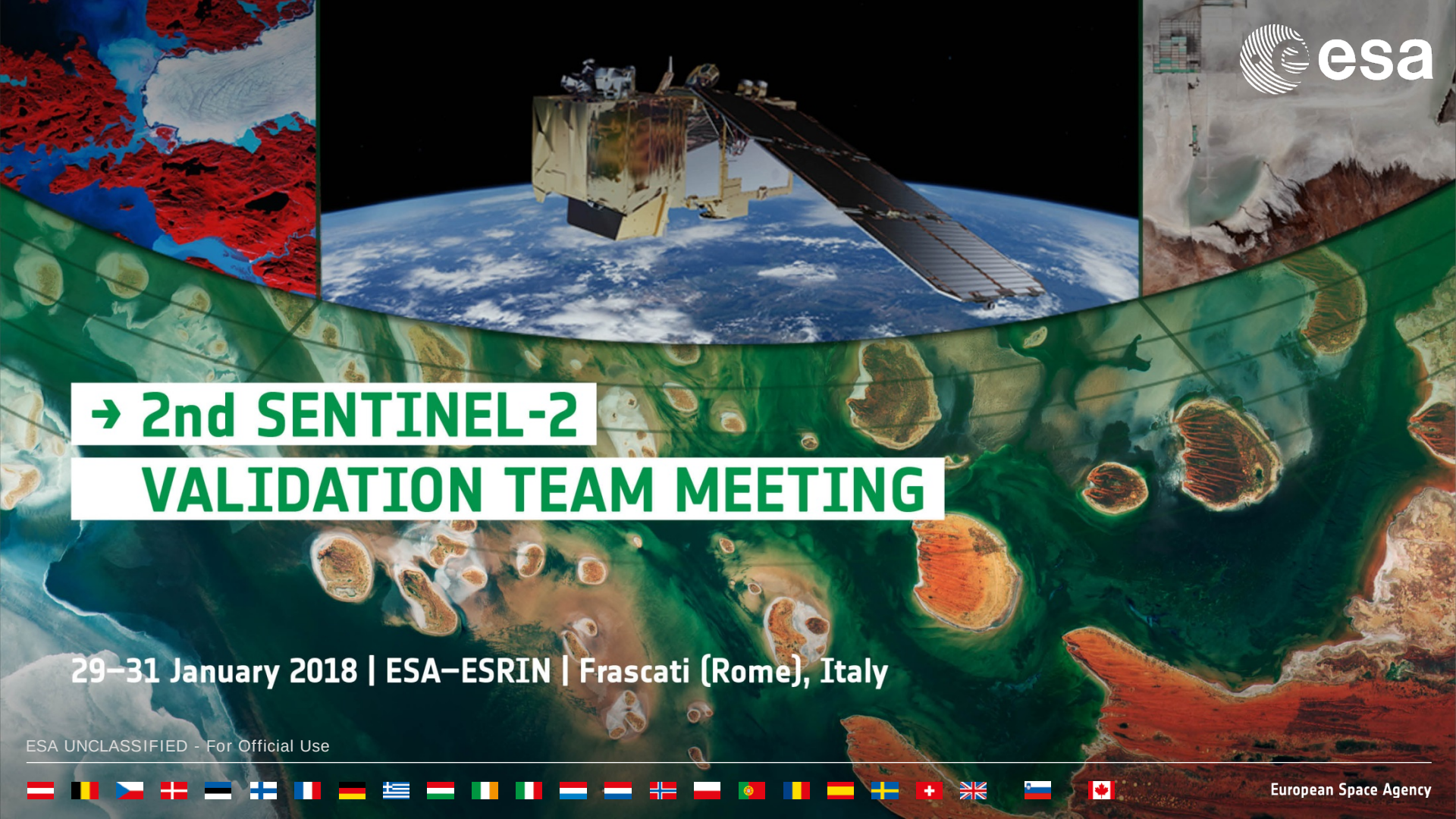
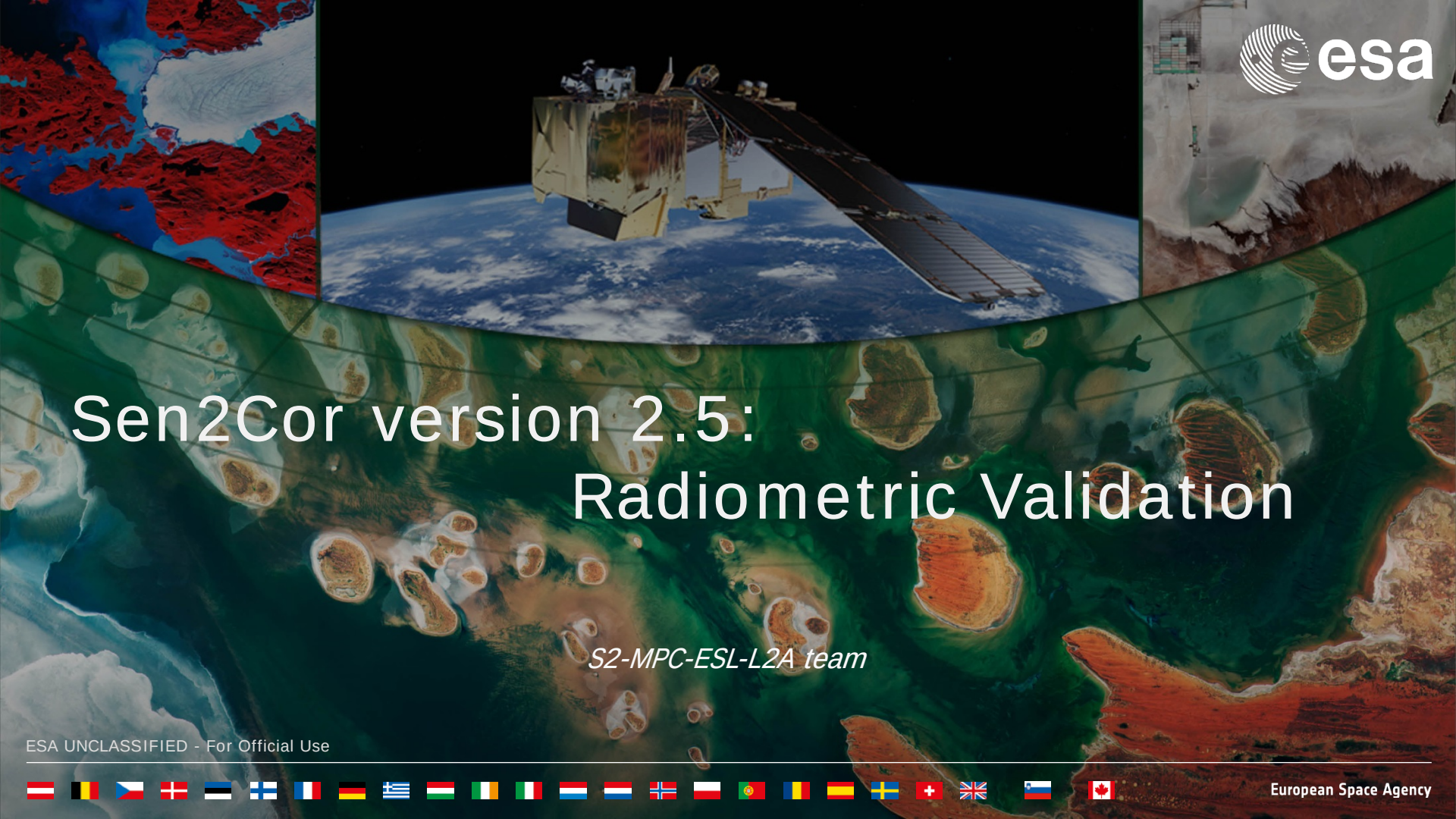


→ 2nd SENTINEL-2 VALIDATION TEAM MEETING

29–31 January 2018 | ESA–ESRIN | Frascati (Rome), Italy

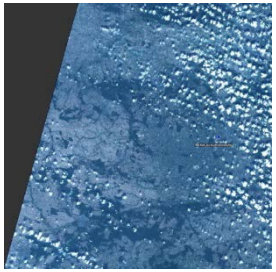


Sen2Cor version 2.5: Radiometric Validation

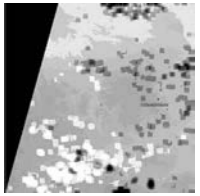
S2-MPC-ESL-L2A team

Outline:

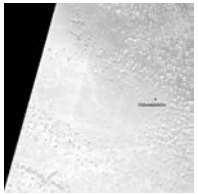
1. Sen2Cor Processor
2. Validation data set
3. Validation procedure
4. Validation results for AOT product (2.5)
5. Validation results for WV product (2.5)
6. Validation results for SR product (2.4)
7. Feed-back/suggestions with respect to S2VT#01 objectives



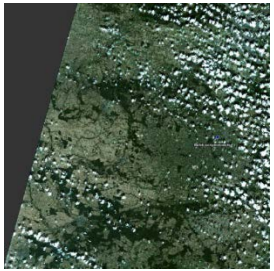
TOA-RGB (L1C-input)



AOT map



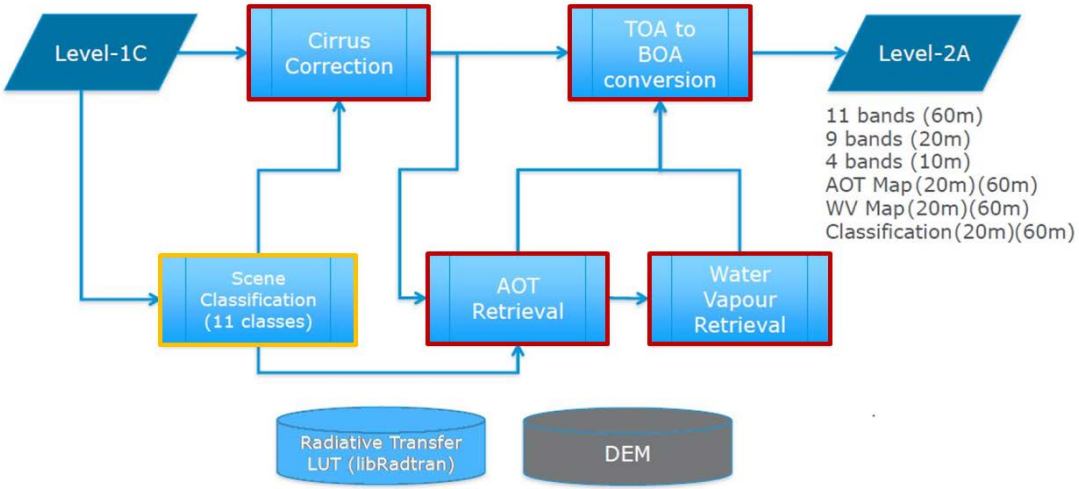
WV map

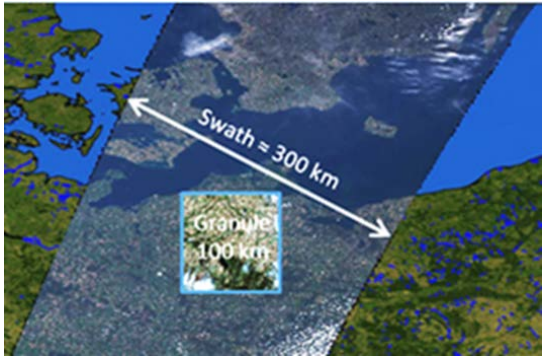


BOA-RGB (L2A-output)

Sen2Cor Processor

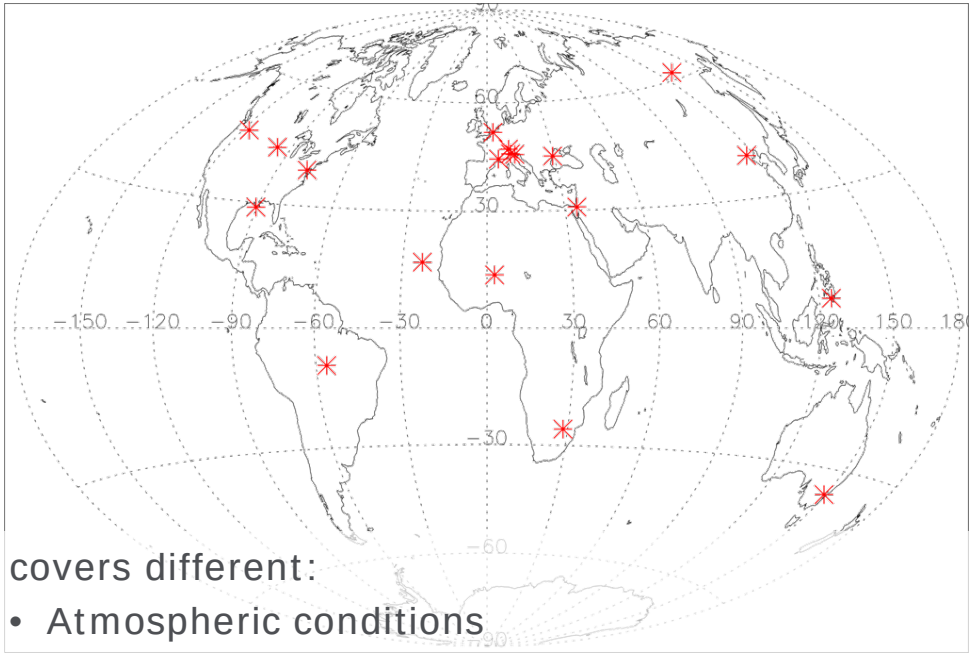
- Atmospheric correction processor for **Sentinel-2 data**
  - Single-Mission tool for Sentinel-2 mission
  - Atmospheric Correction over land surface
  - Processing **mono-temporal** orthorectified **L1C granules**
  - Two main modules : Scene Classification (SCL) and Atm. Correction (AC)





- SCL: series of threshold tests on L1C spectral bands, band ratios and indices
- AOT (550 nm): DDV-algorithm
- Optional cirrus correction preprocessing
- WV retrieval: Atmospheric Pre-corrected Differential Absorption Algorithm (APDA)
- BOA: terrain correction, adjacency corr., empirical Bidirectional Reflectance Distribution Function (BRDF) corrections

Validation data set

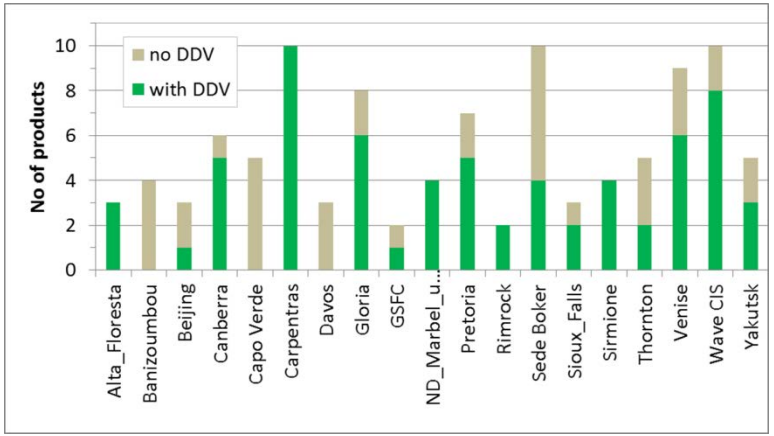


covers different:

- Atmospheric conditions
- Latitudes (various solar angles & seasons)
- Continents
- Topography and land cover types

- based on AERONET sunphotometers

(6 month of products from January to July 2016 used in ACIX)



- Supplemented by RADCALNET site RRV and ad-hoc-campaigns

Validation procedure

Sen2Cor processing:

- rural aerosols
- profile selection automatic
- (ozone content from metadata)
- no cirrus correction
- terrain correction with SRTM-DEM

AOT & WV validation:

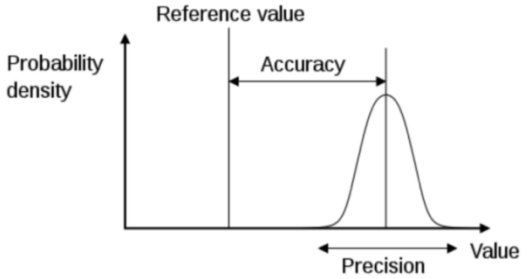
- direct comparison with AERONET
- satellite overpass time ±30 min
- 9km x 9km area around sunphotometer
- all vegetated, non-vegetated (and water pixels)

BOA-validation:

- Pixel-by-pixel comparison with AERONET corrected (surface reflection) data:
- Considered only non-saturated, non-cloudy pixels

statistical metrics:

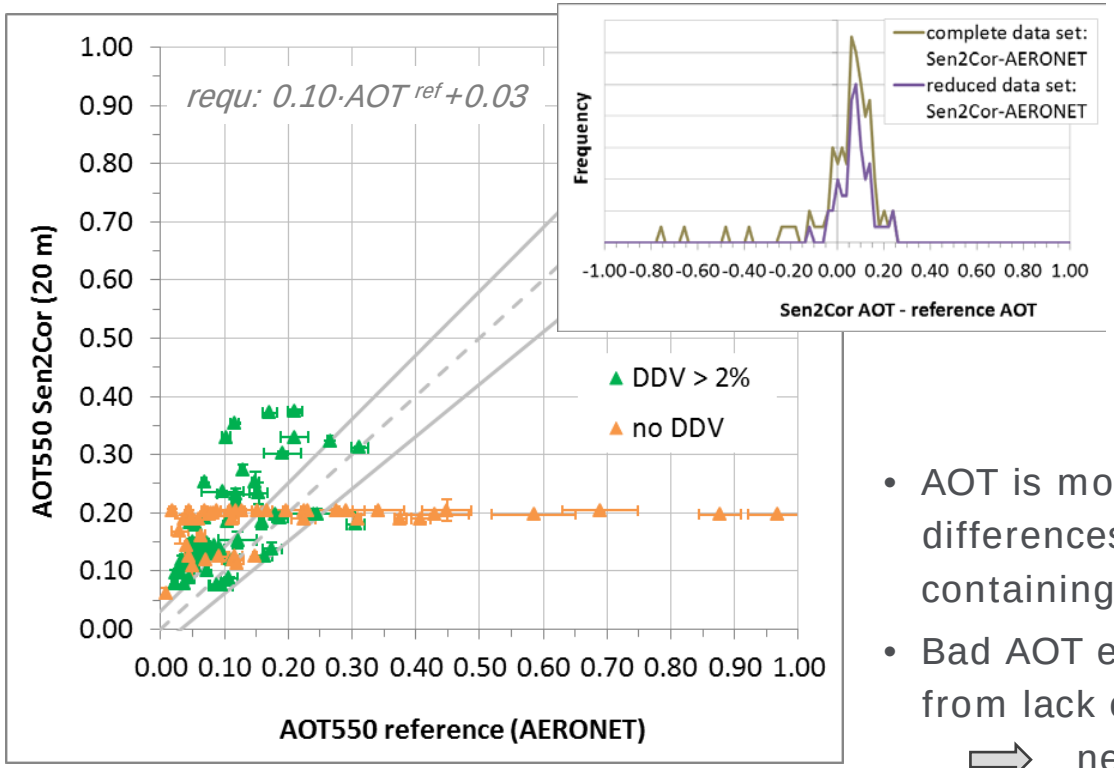
- Accuracy (A): mean difference to reference value
- Precision (P): rms around mean value
- Uncertainty (U): rms around reference value



High accuracy, but low precision

High precision, but low accuracy

AOT validation Sen2Cor 2.5

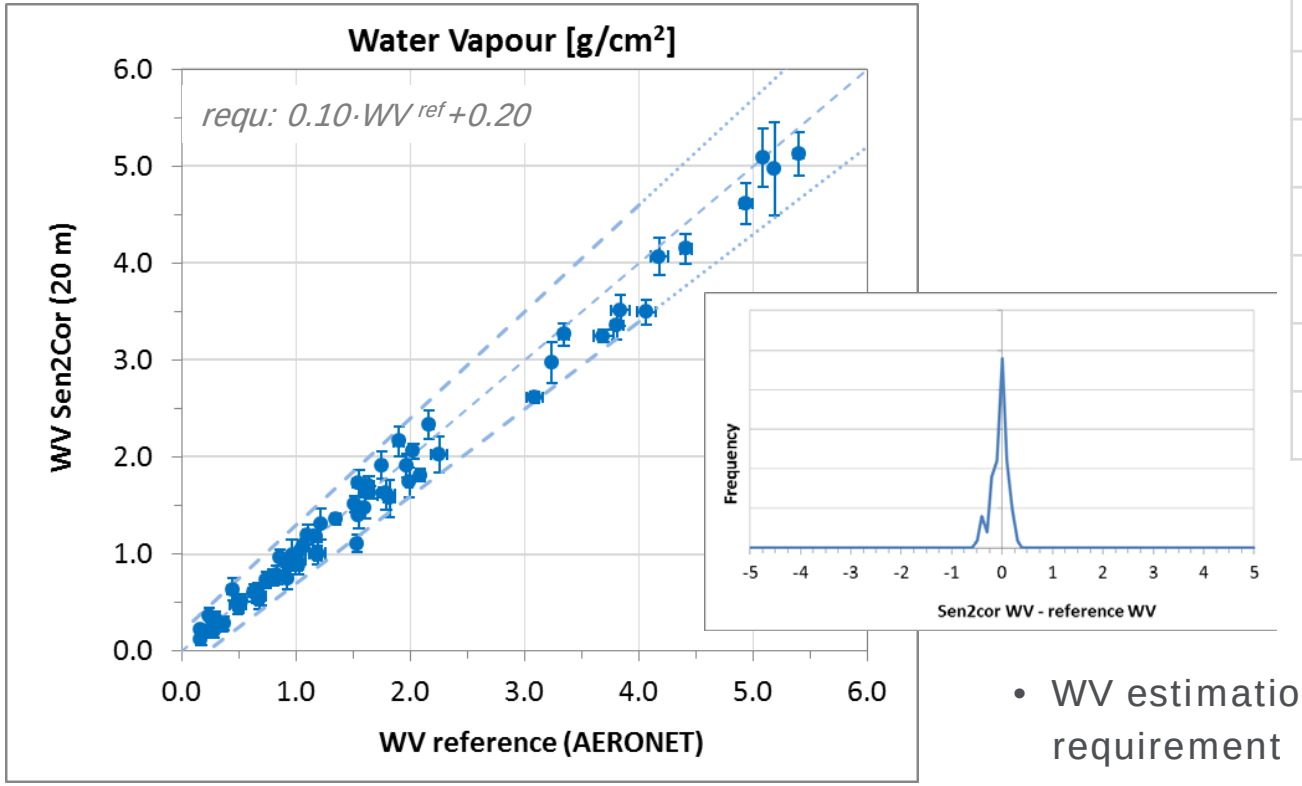


	complete set	Reduced set
No. of products	99	55
within requ.	24	14
R^2	0.09	0.37
Accuracy (A)	0.02	0.07
Precision (P)	0.16	0.07
Uncertainty (U)	0.16	0.10

- AOT is mostly overestimated by Sen2Cor, differences are still to large even for images containing DDV-pixels
- Bad AOT estimation results frequently suffer from lack of DDV-pixels.

  ⇨ new fallback solution

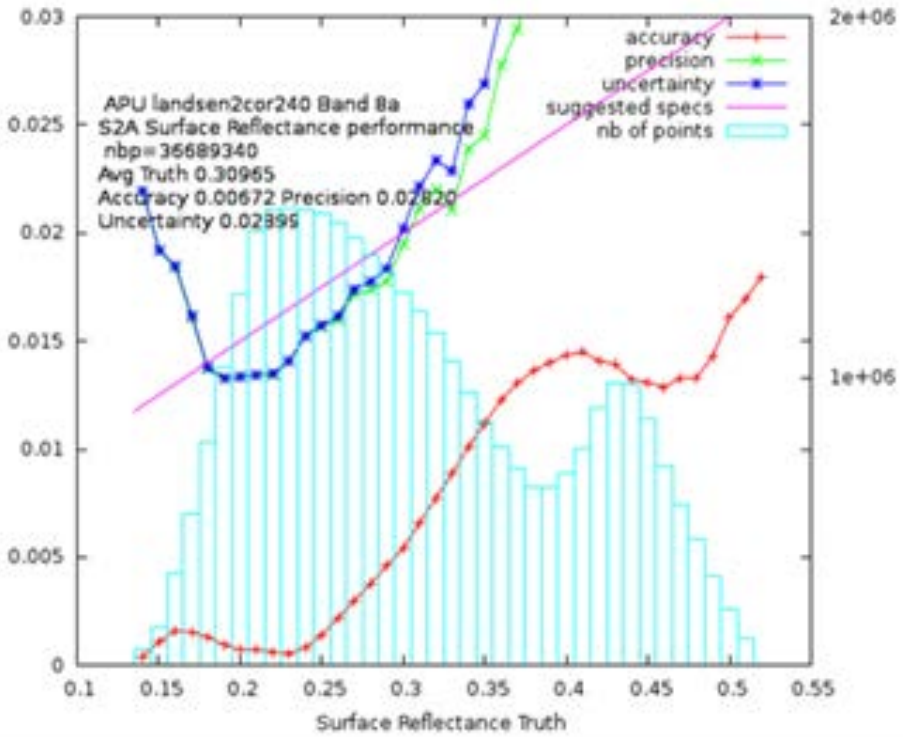
WV validation Sen2Cor 2.5



	complete set
No. of products	68
within requ.	67
R^2	0.99
Accuracy (A)	-0.09 g/cm^2
Precision (P)	0.17 g/cm^2
Uncertainty (U)	0.19 g/cm^2

- WV estimation is very accurate within requirement

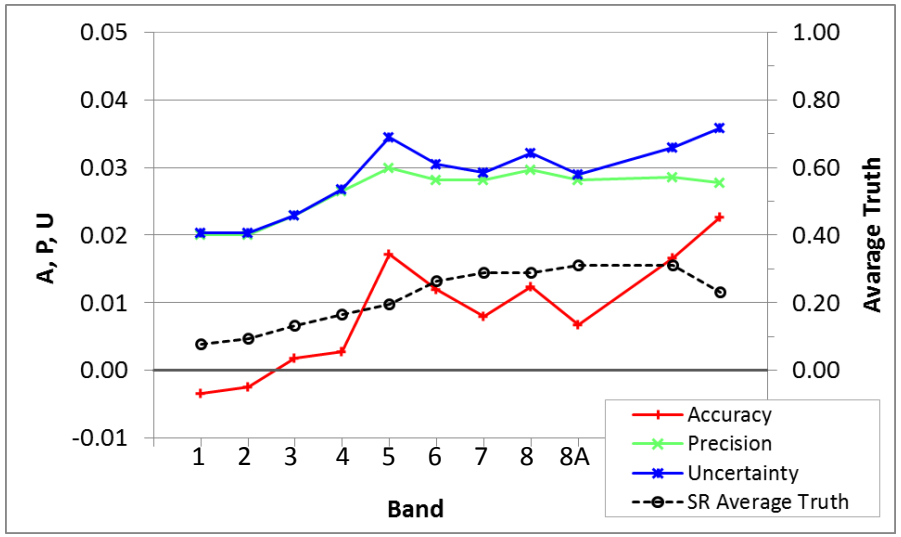
BOA validation Sen2Cor 2.4 (Band 8a)

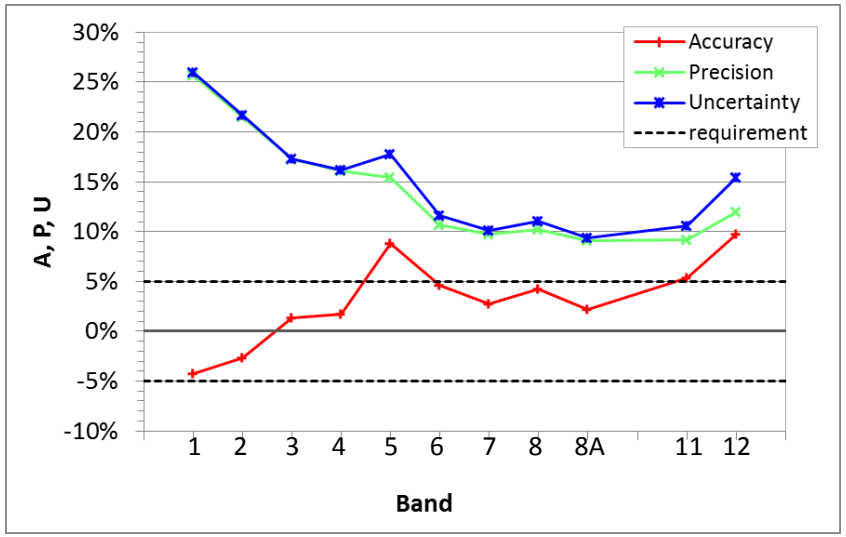


- Pixel-by-pixel comparison with AERONET corrected (surface reflection) data
- Represents average results over 19 test sites including arid locations
- A, P and U are computed per 0.02-bins and overall values for entire range
  (A: 0.007, P: 0.03, U: 0.02, Avg. Truth: 0.31)
- Requirement: $0.05\rho^{ref} + 0.005$
  - ➢ Accuracy well within requirement
  - ➢ Uncertainty (and Precision) within requirement for large amount of pixels

- Analysis: [Eric Vermote]

BOA validation Sen2Cor 2.4 (overall values)





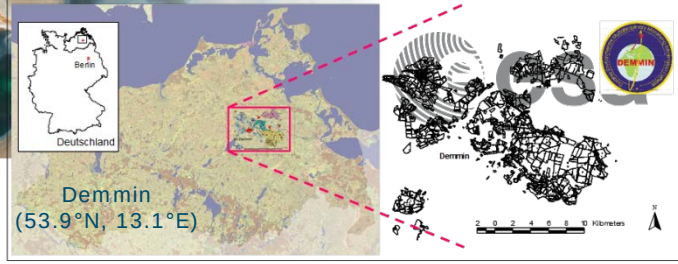
Accuracy:

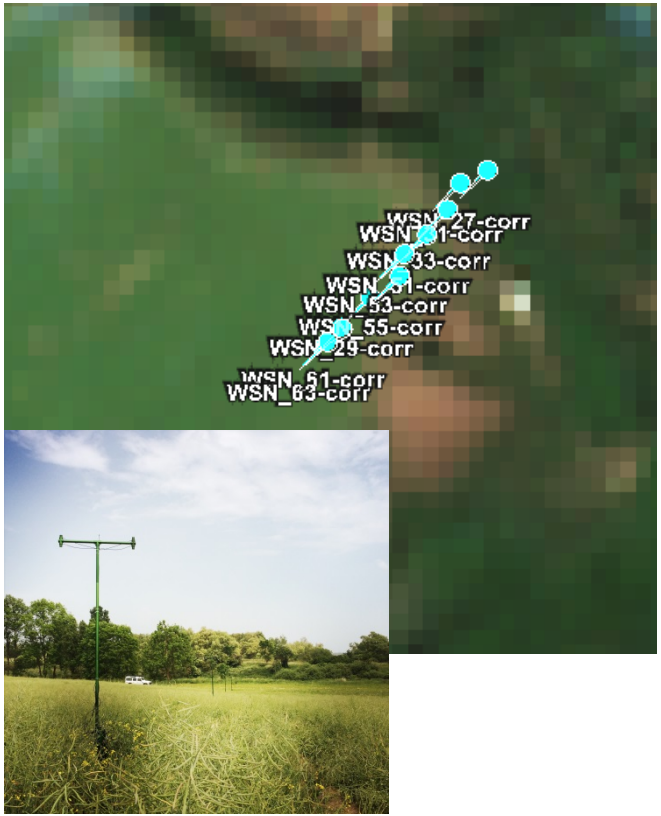
- A increasing with wavelength
- within requirement except band 5, 12, (11)
- red, green and blue bands are more accurate

Uncertainty and Precision:

- absolute P and U increase,
  relative P and U decrease with wavelength
- outside requirement 5% relative

Feed-back/suggestions with respect to S2VT#01 objectives





Suggestion for the **establishment** of operational **test site Demmin®** for Level-2A (and higher) products validation

- 45 environmental measurement stations
  (meteorology, soil moisture and temp., shortwave radiation, …)
- Frequent airplane operations and satellite acquisitions
- Annual field campaigns, agricultural gain data
- Sporadic data: biomass, leaf area, plant height, soil conductivity

<u>Missing:</u>

- Instrumentation for validation of surface reflectance products for land and water surface
  (Cimel sunphotometer, sensors for reflectance measurements)

Feed-back/suggestions with respect to S2VT#01 objectives

Preparation of Validation campaign 2018

Lake Stechlin (NE-Germany)

(53.15°N, 13.03°E)

- Time window: 16.04-28.05

Instrumentation:

- HySpex (VNIR to SWIR) on airplane (low altitude, spatial resolution 2 m)
- Mobile sunphotometers (AOT spectra, WV, ozone)
- SVC spectrometer (land surface reflectance)
- water reflectance spectra over and under water surface
- Permanent water monitoring: T_{water}, O_2-content, pH-value, Visibility-depth, alga

Participants:

- DLR
- Leibnitz Institute of Freshwater Ecology and Inland Fisheries

Summary

- Validation results based on AERONET sunphotometer measurements
- Processor performance continuous improved

- AOT estimation: A < 0.07 , U < 0.16
- WV retrieval: A = -0.1 g/cm^2, U = 0.2 g/cm^2

➢ BOA reflectance: Results still for Sen2Cor 2.4

➢ Accuracy for most bands within requirement

  ➢ red, green and blue bands are the most accurate

➢ Uncertainty and precision still outside requirements

o Validation with AERONET-corrected surface reflectance as reference must be supplemented by measurements

⇨ **establishment of permanent working test sites**, ad-hoc campaigns

ACKNOWLEDGEMENT: The authors thank the PI investigators and their staff for establishing and maintaining the AERONET sites used in this investigation.

Thank you for your attention !

Sen2Cor version 2.5:
Radiometric Validation

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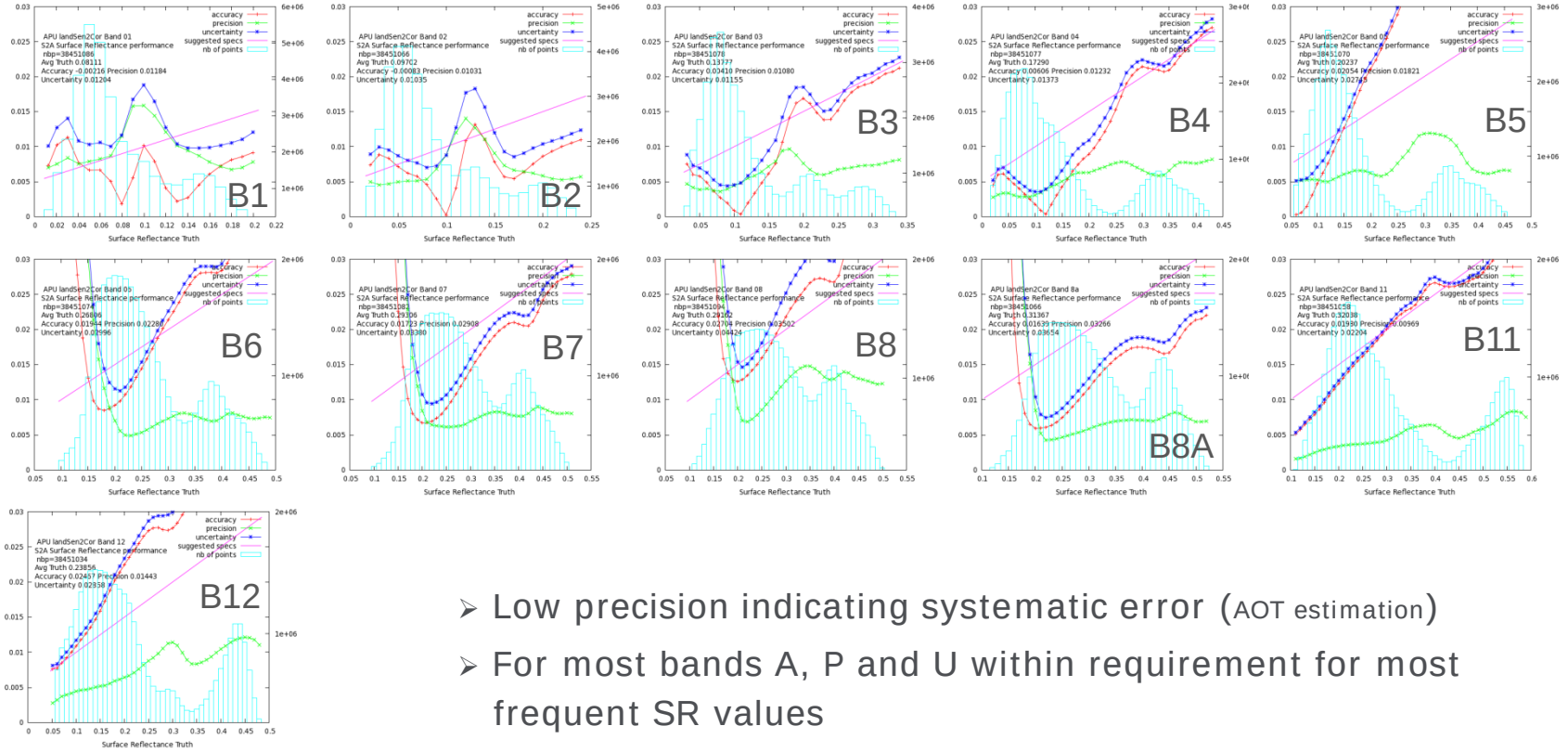
Uwe Müller-Wilm

Ferran Gascon

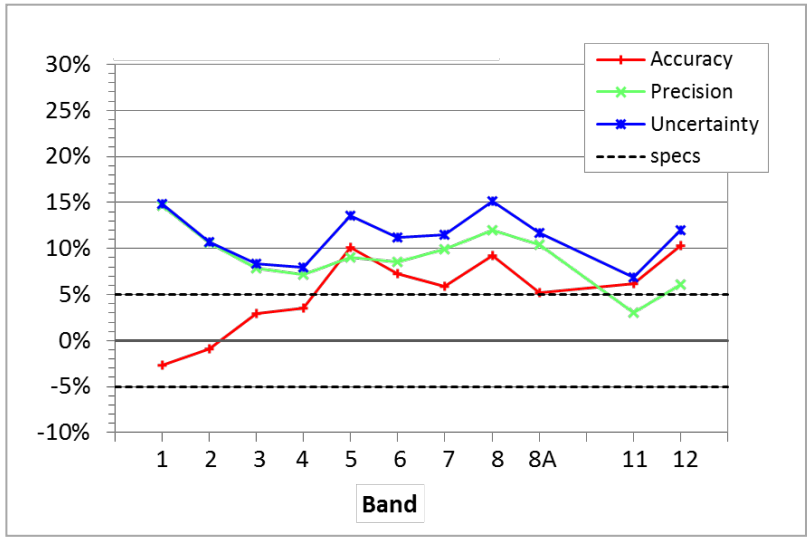
BOA validation Sen2Cor 2.4 (complete data set)



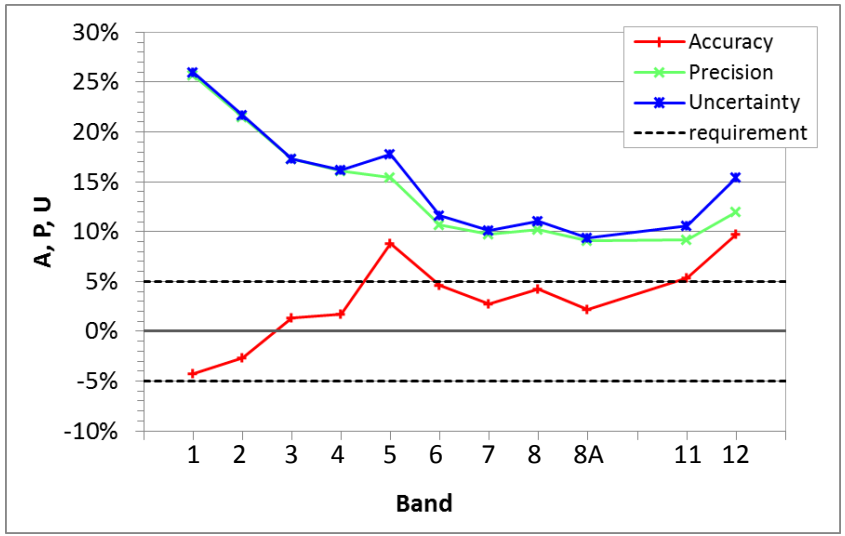
- Low precision indicating systematic error (AOT estimation)
- For most bands A, P and U within requirement for most frequent SR values

BOA validation Sen2Cor 2.4 (overall values)

Sen2Cor 2.2, complete set



Sen2Cor 2.4, complete set



- Improved accuracy, but higher uncertainty