OPT-MPC

Copernicus Sentinel

Optical Mission Performance Cluster

European Union

Initial Validation of Sentinel-2 Collection-1 L2A-Products

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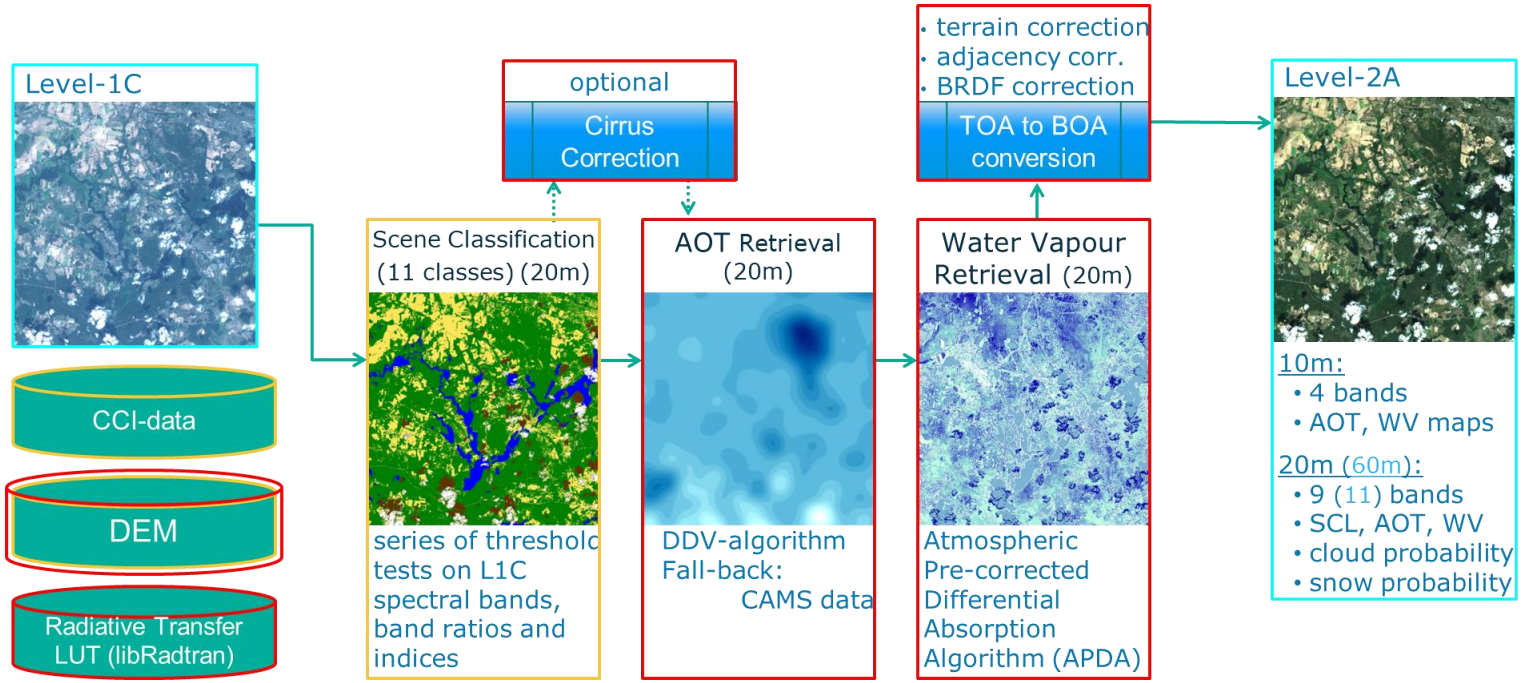
EARSeL Symposium 2023

Bucharest, 06.07.2023

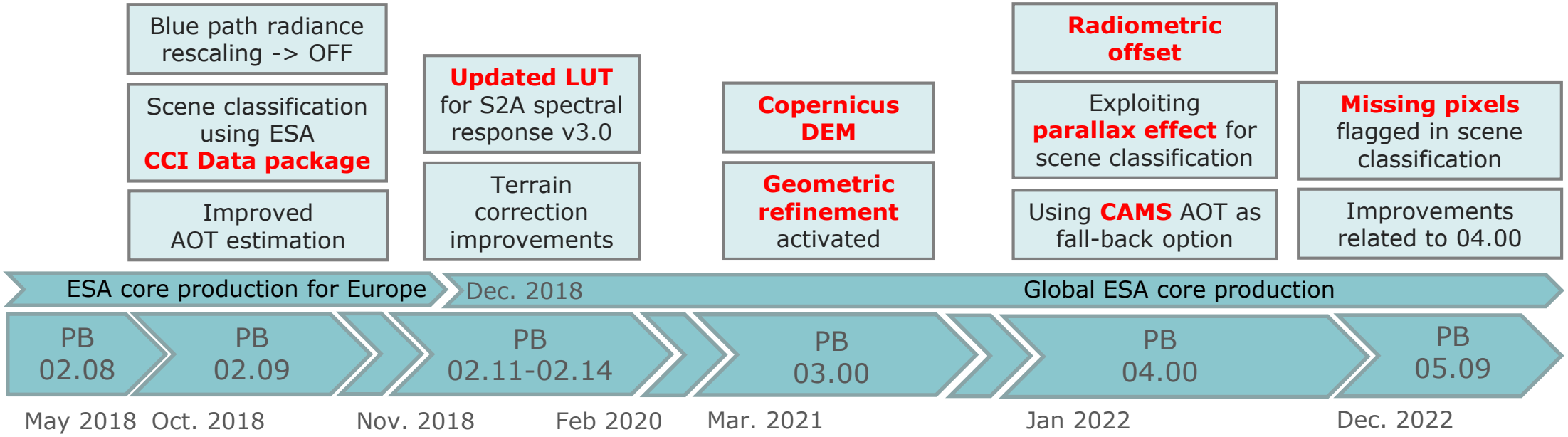
Outline

- What is Collection-1 and why we need it?
- Performance of scene classification and cloud masking
- Performance of AOT retrieval
- Performance of WV retrieval
- Performance of SDR retrieval
- Summary



What is Collection-1 and why we need it?

- **Collection-1 is the Sentinel-2 data archive reprocessed from January 2022 to beginning of mission**
- **Why we need it?**
  - ✓ **Improvements in L1C and L2A products** (like geometric refinement, updated digital elevation model)
  - ✓ **Different operational L2A processing baselines related to Sen2Cor history**



- Source: OMPC.TPZG.SRN.003 - i1r0 - Sen2Cor 2.11.00 Software Release Note.pdf; OMPC.CS.APR.001 - i1r0 - S2 MSI Annual Performance Report 2022.pdf

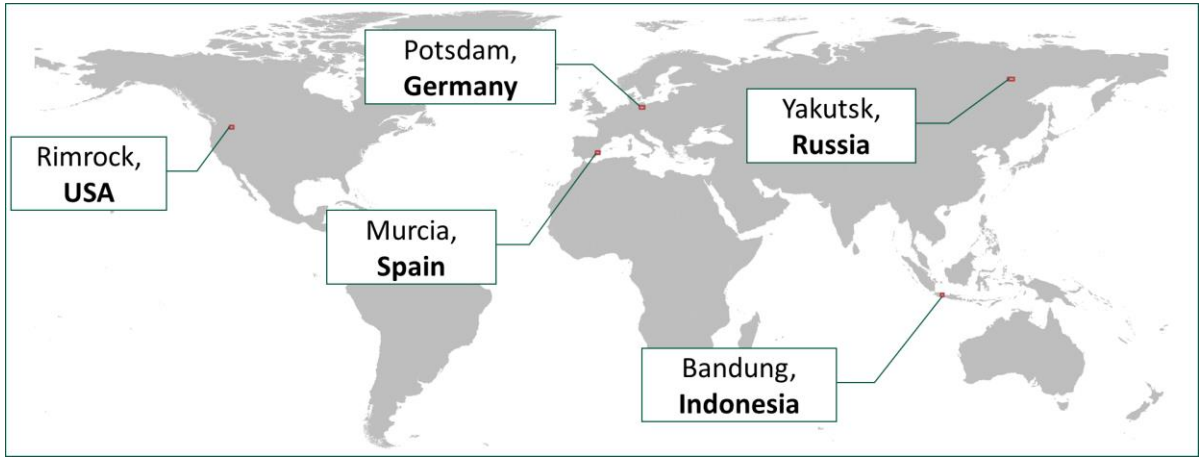
Collection-1 Products Features

- **Geometric refining** based on the use of the Global Reference Image (GRI)
- Harmonized **radiometry** after **alignment of S2B on S2A**
- Most recent product format for L1C and L2A with
  - ✓ radiometric offset,
  - ✓ quality masks in raster format,
  - ✓ L2A quality indicators,
  - ✓ DOI (introduced in PB 04.00)
- Improved L2A processing algorithms for scene classification and surface reflectance
- Compliance with the CEOS Analysis Ready Data for Land (CEOS ARD) standard of the Level-2A product
- Use of the new 30 m Copernicus Digital Elevation Model (DEM)

- Source: https://sentinels.copernicus.eu/ca/web/sentinel/technical-guides/sentinel-2-msi/copernicus-sentinel-2-collection-1-availability-status

Performance of scene classification and cloud masking

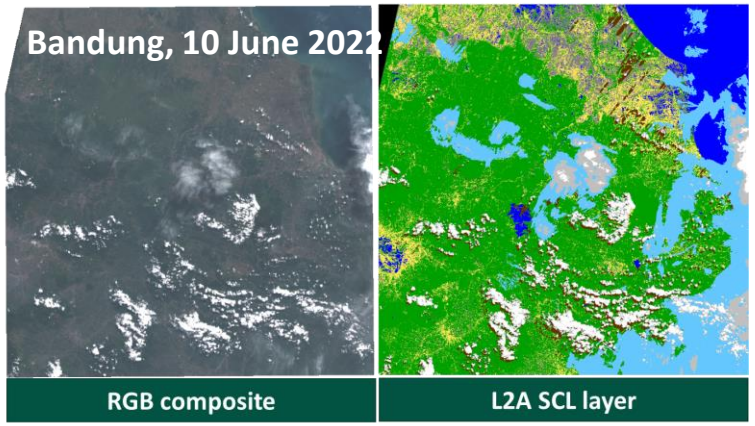
- **Data set: 11 products from 25 January to 30 November 2022** (Processing Baseline (PB) 04.00, Sen2Cor 2.10)
- **Reference masks generated by visual labeling with stratified random subset selection**



Northern latitude season		winter		spring			summer			fall		
Yakutsk	**T52VEP**		Febr.					July				
Potsdam	**T33UUU**			March					August			
Rimrock	**T11TMM**				April					Sept.		
Murcia	**T30SXH**					May					Oct.	
Bandung	**T48MZT**	Jan.					June					Nov.

Performance of scene classification and cloud masking

Products **without** snow cover



SCL classes

- no data
- saturated_or_defective
- topographic shadow
- clouds_shadows
- vegetation
- non_vegetated
- water
- unclassified
- cloud_medium_probability
- cloud_high_probability
- thin_cirrus
- snow

Products **with** snow cover

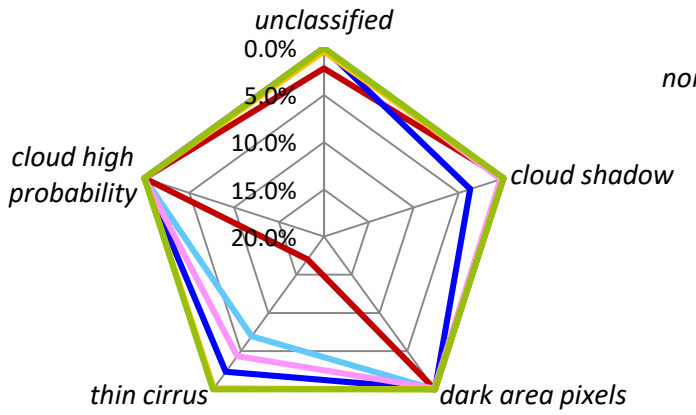
	Clear pixels	Cloud pixels	sum	UA	CE
Clear pixels	54%	2%	56%	97%	**3%**
Cloud pixels	9%	35%	44%	80%	**20%**
sum	63%	37%	100%		
PA	86%	95%			
OE	**13.6%**	**5.1%**			
	OA	90%		**Balanced OA**	92%

	Clear pixels	Cloud pixels	sum	UA	CE
Clear pixels	45%	36%	81%	55%	**45%**
Cloud pixels	1%	18%	19%	95%	**5%**
sum	46%	54%	100%		
PA	98%	33%			
OE	**2%**	**67%**			
	OA	63%	Balanced OA		77%

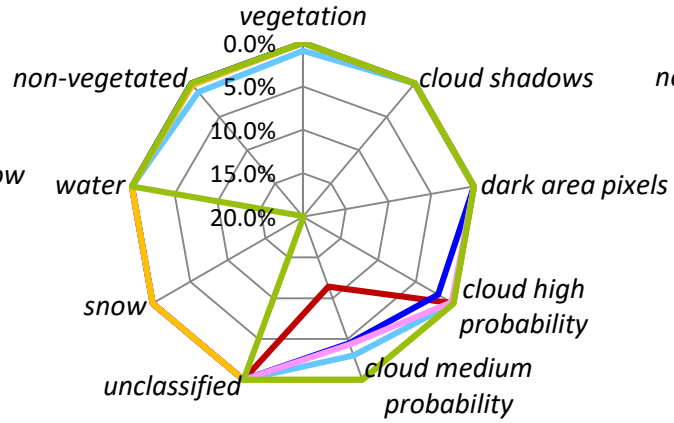
Performance of scene classification and cloud masking

Class omission error

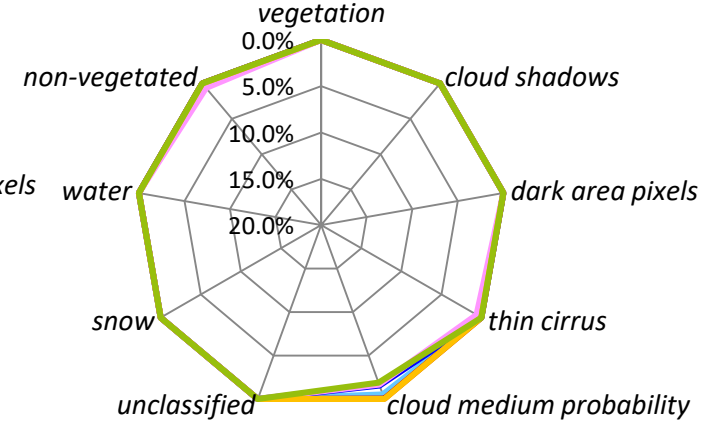
Omitted clear pixels classified as



Omitted thin_cirrus pixels classified as

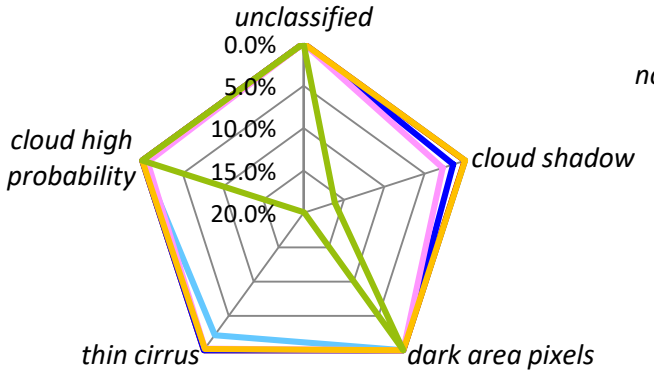


Omitted cloud_high_probability pixels classified as

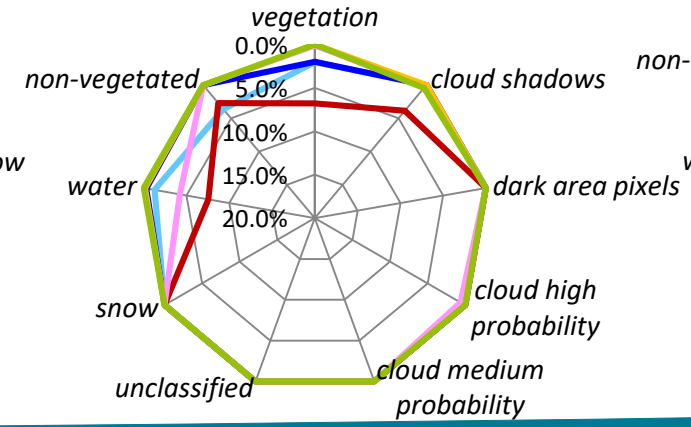


Class commission error

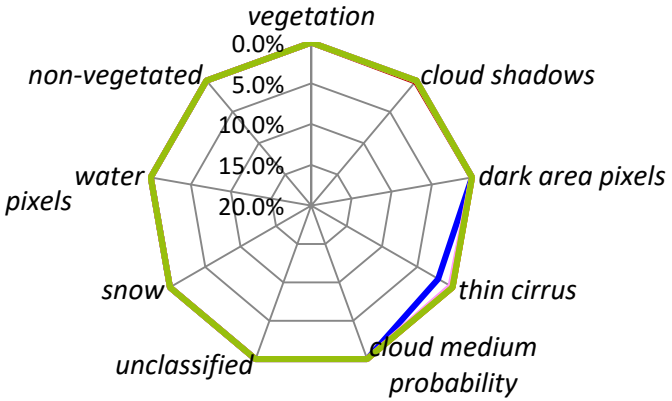
Committed clear pixels are really



Committed thin_cirrus pixels are really



Committed cloud_high_probability pixels are really



- Only little problems with thick clouds
- Thin cirrus pixels are often misclassified as snow
- Cloud shadow pixels on snow are also often misclassified as clear pixels

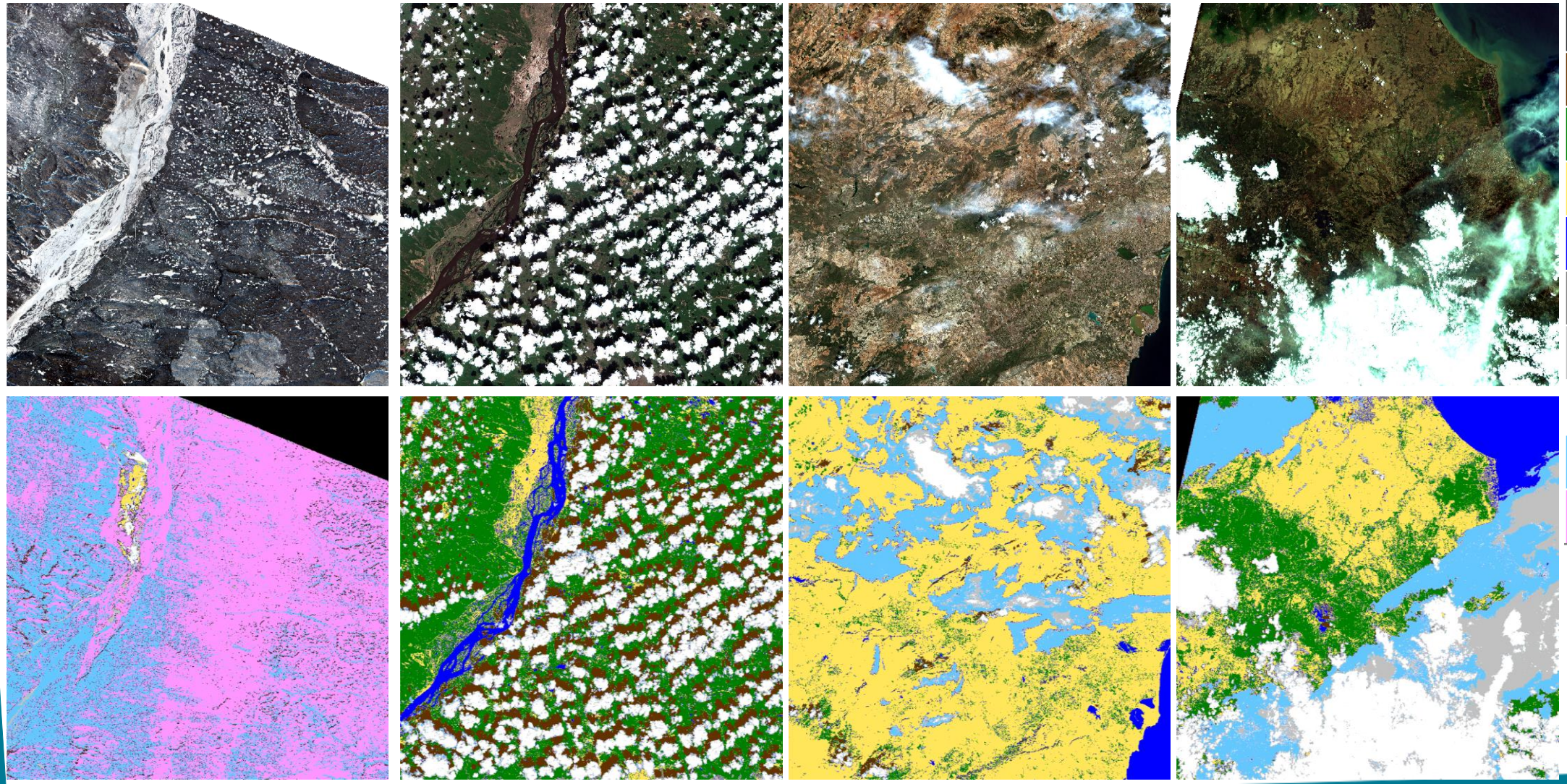
Verification of Collection-1 scene classification

Yakutsk 2020-01-25

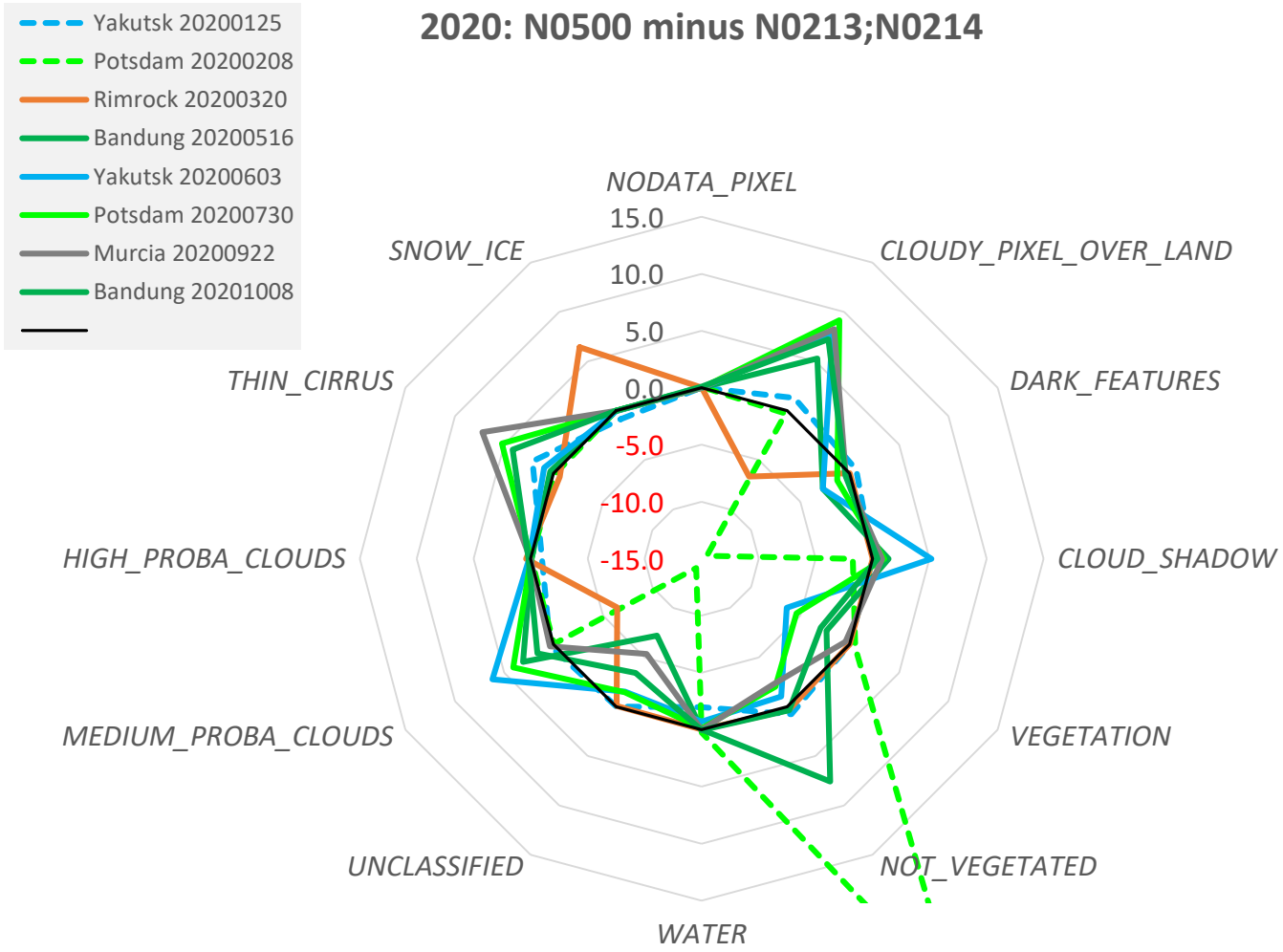
Yakutsk 2020-06-03

Murcia 2020-09-22

Bandung 2020-10-08



Verification of Collection-1 scene classification



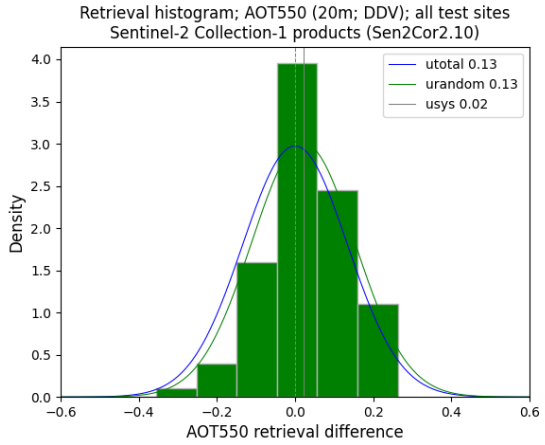
- No problems due to reprocessing chain found in PBL 0500
- More (thin) clouds due to dilation
- Less unclassified
- Less dark features
- Increase of not_vegetated
- Higher OA;
  less clear pixel and cloudy pixel omission and commisson

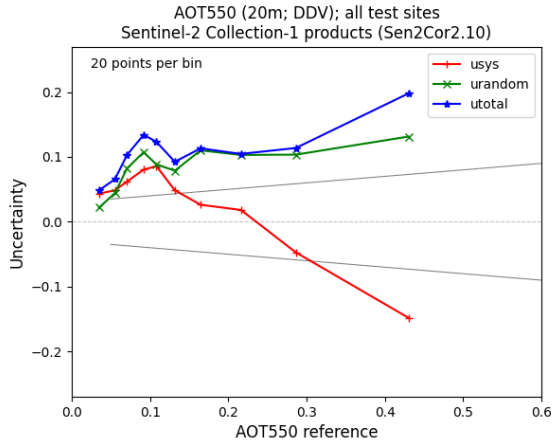
Preliminary

Performance of AOT retrieval

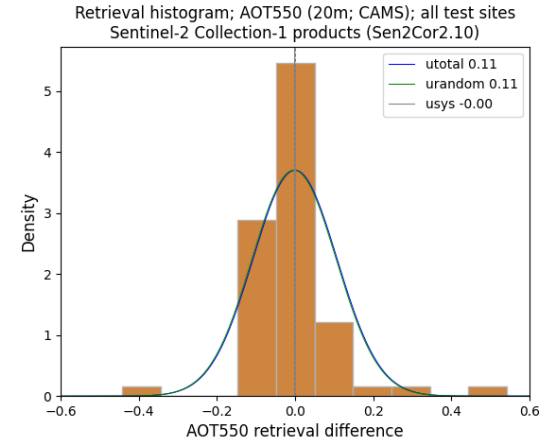
- Collection-1 dataset 2021, cloud cover ≤ 50%
  Reference: AERONET

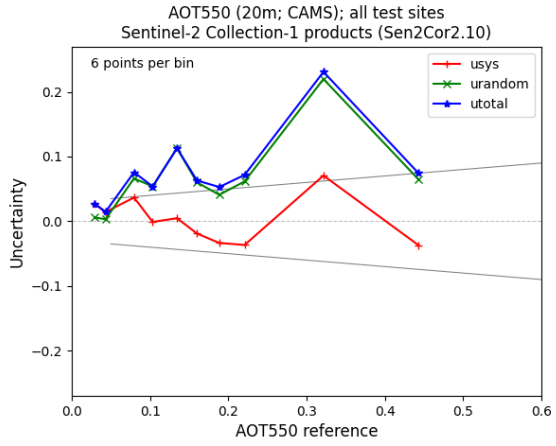
DDV





CAMS





AOT_{DDV}	Sample size	U_{sys} (Bias)	MAE	U (RMSD)	within spec	range
Polar						
Boreal	63	0.00	0.02	0.05	67%	0.01 – 0.41
Midlat. N	162	0.03	0.09	0.14	31%	0.02 – 1.0
Subtrop. N						
Tropical	12	-0.15	0.11	0.21	42%	0.08 – 0.8
All data	238	0.01	0.06	0.13	41%	0.01 – 1.0

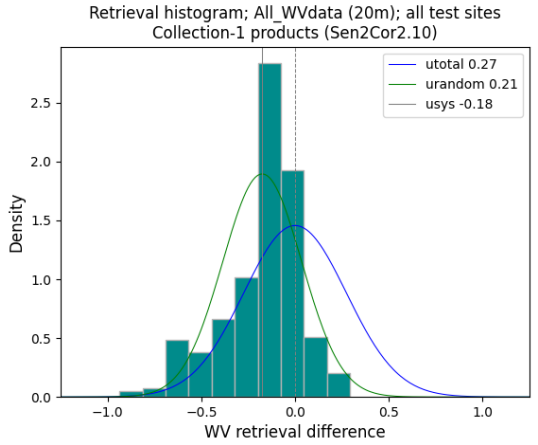
AOT_{CAMS}	Sample size	U_{sys} (Bias)	MAE	U (RMSD)	within spec	range
Polar	5	-0.02	0.02		60%	0.04 – 0.14
Boreal						
Midlat. N	53	-0.02	0.04		57%	0.02 – 3.0
Subtrop. N						
Tropical	22	-0.05	0.06		36%	0.09 – 1.0
All data	83	-0.03	0.05		52%	0.02 – 3.0

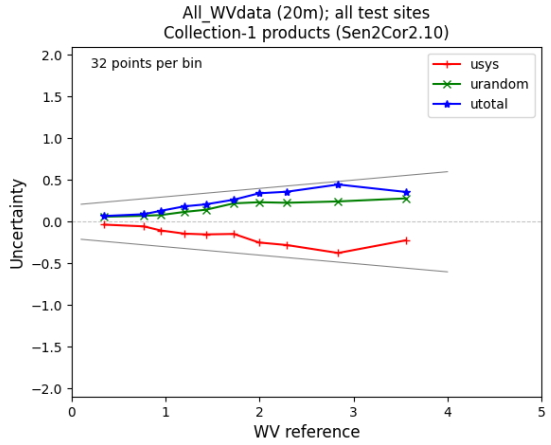
Preliminary

Performance of WV retrieval

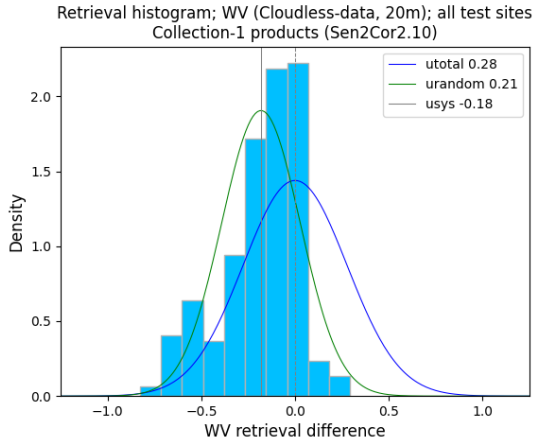
- Collection-1 dataset 2021, cloud cover ≤ 50% ; Reference: AERONET

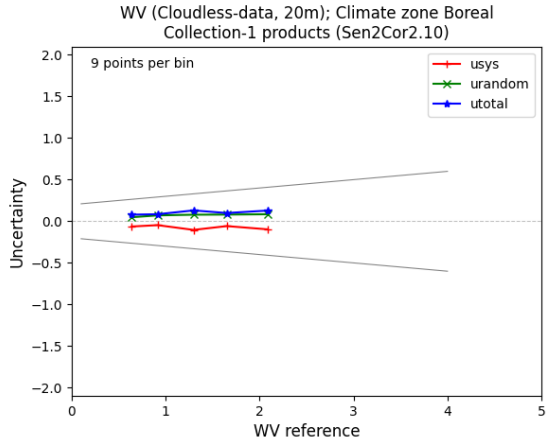
All data





< 5% Clouds

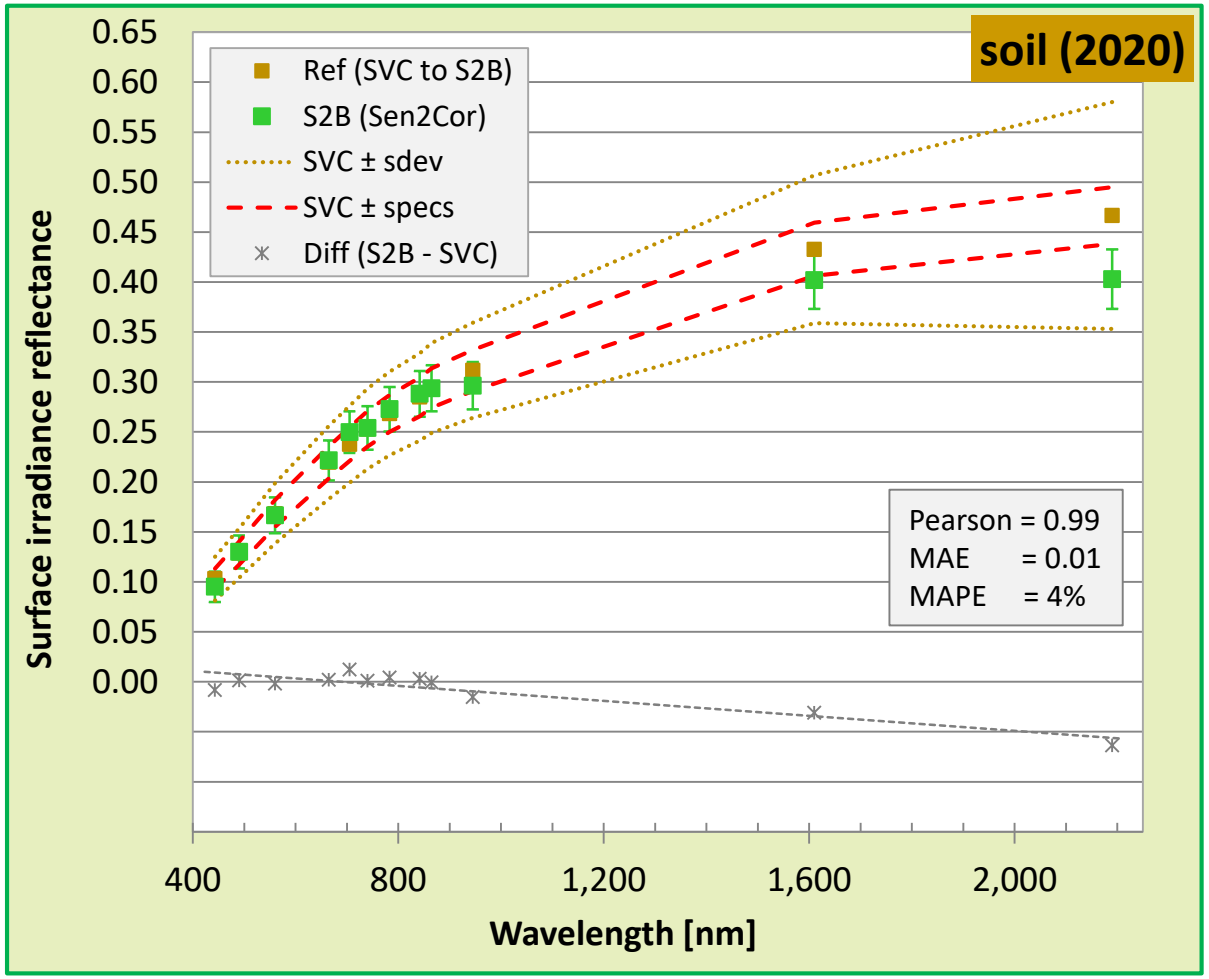


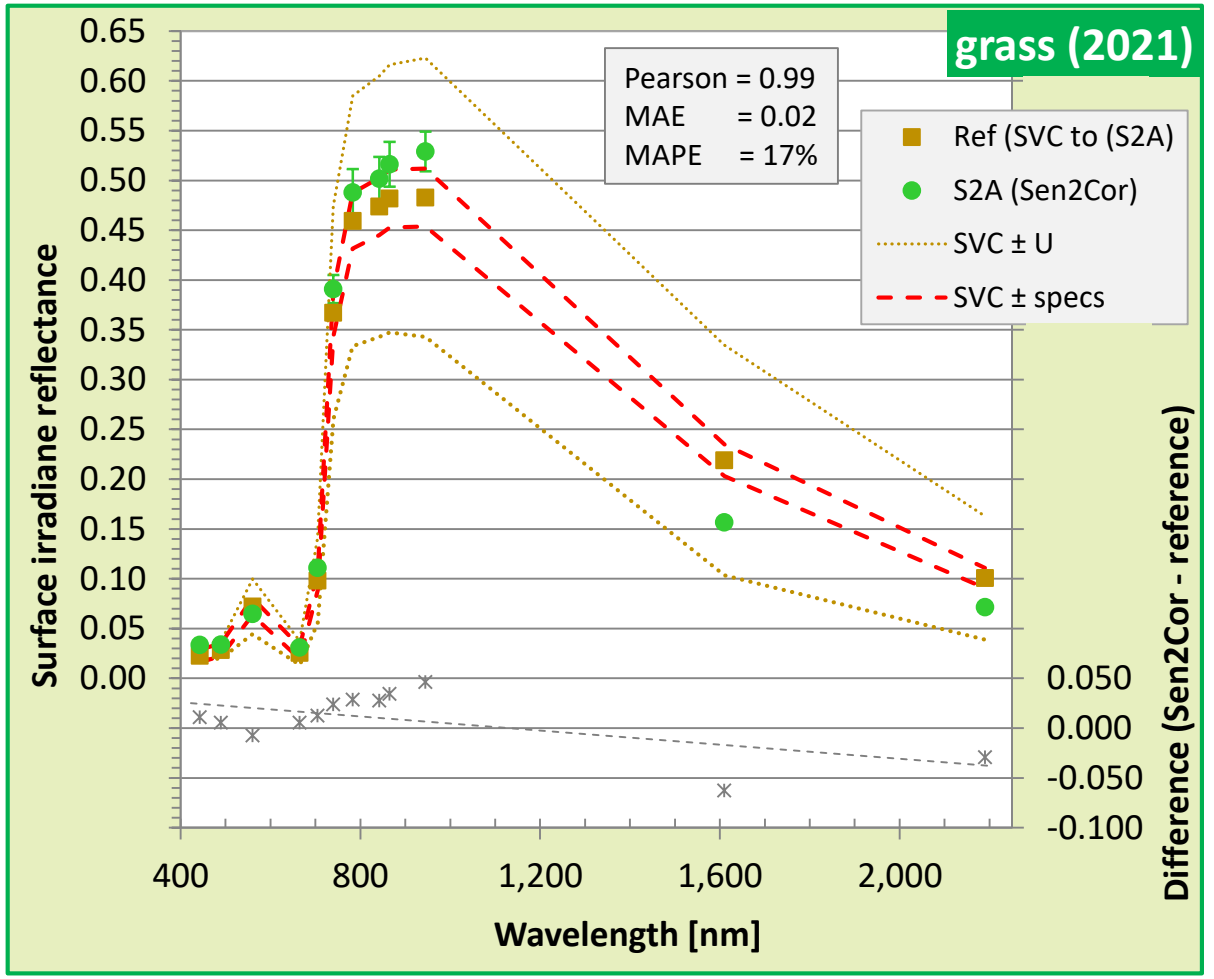


WV [cm]	Sample size	U_{sys} (Bias)	MAE	U (RMSD)	within spec	range
Polar	5	0.04	0.03	0.04	100%	0.19 – 1.2
Boreal	66	-0.07	0.10	0.12	100%	0.44 – 2.9
Midlat. N	215	-0.22	0.18	0.32	77%	0.20 – 4.1
Subtrop. N						
Tropical	34	-0.09	0.13	0.16	100%	0.75 – 4.8
All data	321	-0.18	0.15	0.27	85%	0.19 – 4.8

Performance of SDR retrieval

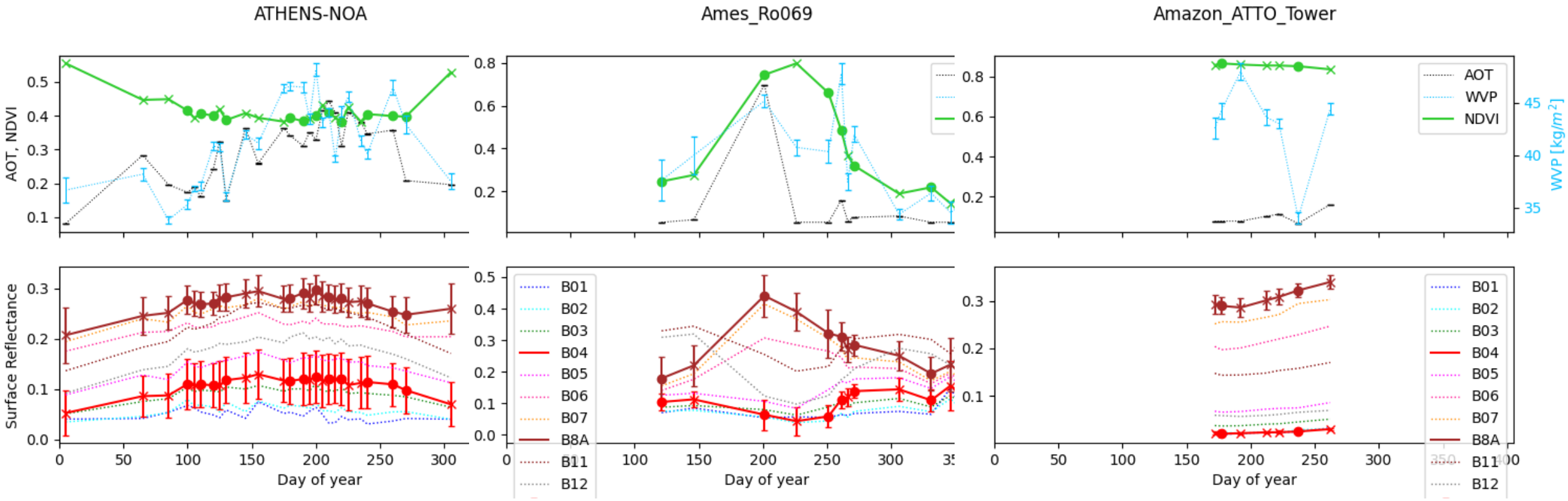
- Collection-1 dataset 2020 + 2021; Reference: Campaigns in Germany





SDR time series

- Collection-1 dataset 2021



Summary

- **Collection-1**
  - ✓ **gives a uniform time series from begin of the mission until now**
  - ✓ **processed with the latest processors**
  - ✓ **Including important updates in data format.**

- **Initial verification and validation of L2A-products**
  - ✓ **Improvements in cloud masking performance**
  - ✓ **Similar performance of AOT, WV, and SDR retrieval as known since Sen2Cor 2.8**
  - ✓ **No artefacts due to reprocessing chain**

This work was partially funded by EU and ESA.
Reference measurements in Germany were funded by DLR-internal project AC2020.

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Thank you!

Sen2Cor processor

ATBD version 2.10

monthly L2A Data Quality Reports:

Bucharest

2023-05-25