Sentinel-2 Level-2 processing Sen2Cor status and outlook of 2022

Authors: **Jérôme Louis**(1), Bringfried Pflug(2), Avi Putri Pertiwi(2), Francesco C. Pignatale(3), Silvia Enache(4), Rosario Quirino Iannone(5), Valentina Boccia(6)

(1) Telespazio France, (2) German Aerospace Centre, 3) Telespazio Germany, (4) CS Group, (5) Rhea spa, (6) European Space Agency

21th September 2022

Torrent, Spain

© ACRI-ST | OPT-MPC – 2021

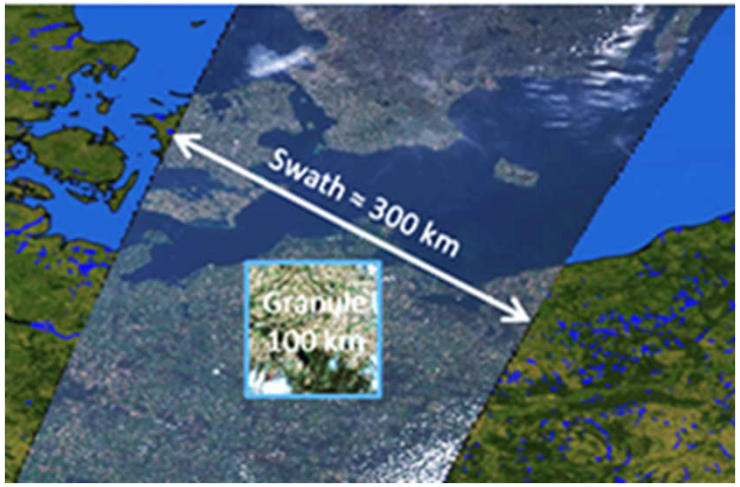
Presentation outlook

- Sen2Cor overview
- L2A product contents
  - Updates since processing baseline 04.00
- Algorithm evolutions
- Data Quality
  - Atmospheric Correction validation

© ACRI-ST | OPT-MPC – 2021

Sen2cor overview

Description of the main characteristics of the processor



Atmospheric Correction-Tool for Sentinel-2 mission

- Processing modes:
  - Operational (ground segment)
  - Toolbox-mode (user)
- Atmospheric Correction over land surface
- Processing mono-temporal orthorectified L1C granules
- Two main modules : Scene Classification (SCL) and Atm. Correction (AC)

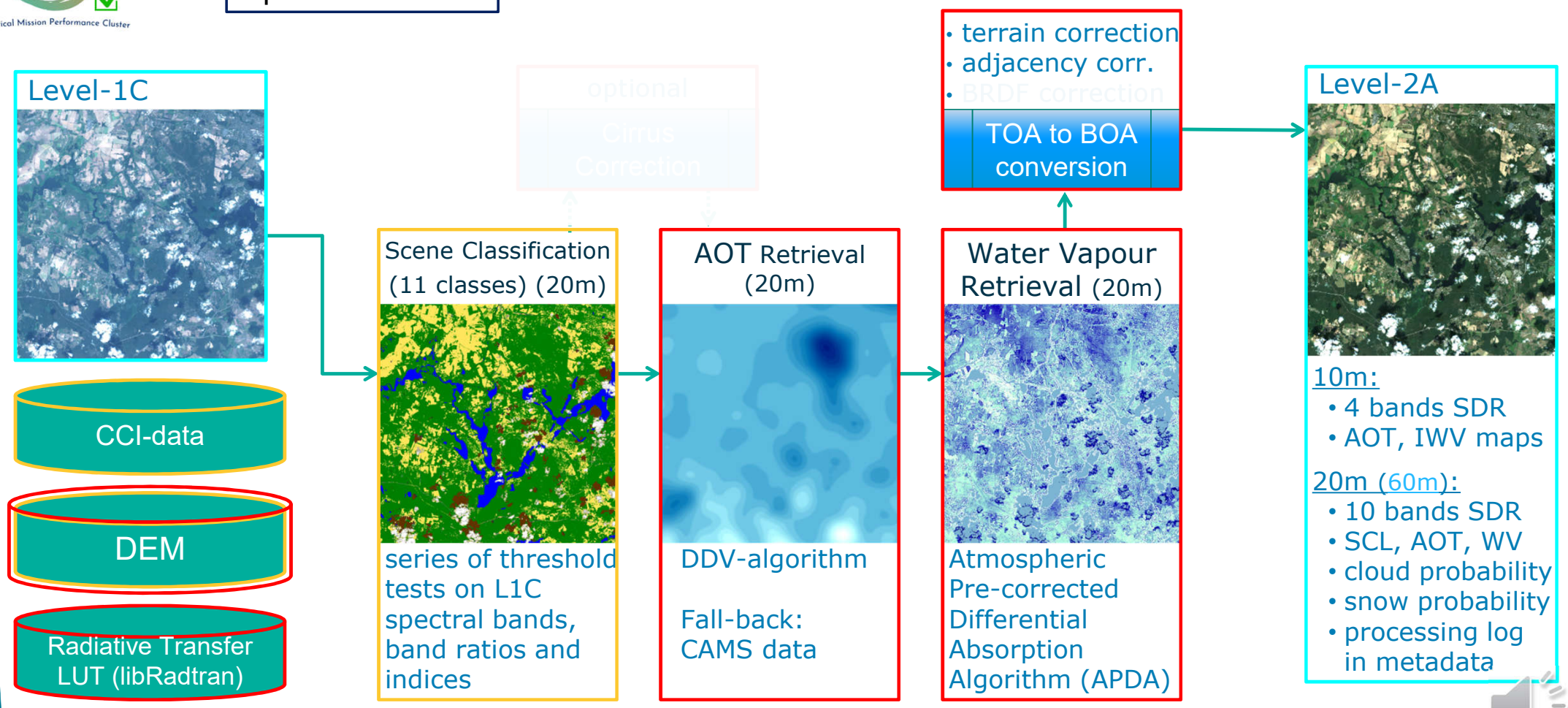
- L2A Products are CARD4L (Surface Reflectance) compliant (https://ceos.org/ard/)

Product	CEOS-ARD Type	PFS Version	Agency	Mission(s)	Threshold Specification	Target Specification	Access (DOI)	Info	Self Assessment	Peer Review	Sample Products
Sentinel-2 Level-2A	Surface Reflectance	v5.0	ESA	Sentinel-2A, 2B	● 100%	Not assessed	Link	Link	PDF	PDF	Link

© ACRI-ST | OPT-MPC – 2021

Sen2Cor processing chain

Operational mode



© ACRI-ST | OPT-MPC – 2021

Sen2cor versions

General User's version (latest):

Version 2.10 released on January 10, 2022 (publicly available)

S2 PDGS version (official L2A)

Version 2.10 in operations since 25 January 2022 >= L2A PB 04.00

S2 Reprocessing Service version:

Version 2.10 + operational fixes

© ACRI-ST | OPT-MPC – 2021

L2A product contents

© ACRI-ST | OPT-MPC – 2021

L2A product format updates

Starting with L2A products with Processing Baseline >=04.00

1. Provision of band **B01** also at 20m resolution
2. Update of L2A Quality Indicators + **L2A_QUALITY.xml** file in QI_DATA folder
3. Addition of a **DOI** (Digital Object Identifier)
4. **OZONE** ECMWF activated & traced in MTD

CEOS Analysis Ready Data (ARD) compliant

5. Flow down of L1C evolutions:
   - "Introduction of a **radiometric offset** in the L2A products";
   - "L1C quality masks in **raster** format in JPEG2000";
   - "Addition of new **ECMWF** auxiliary data in L2A products";
   - "Inclusion of **CAMS** auxiliary data in L2A products";

https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-2-msi/processing-baseline

© ACRI-ST | OPT-MPC – 2021

L2A product format updates : L2A_QUALITY.xml

L2A_QUALITY.xml
Scene_Class_Quality


```xml
<Data_Block type="xml">
  <report gippVersion="2.10.0" globalStatus="PASSED" date="2021-10-12T00:00:00Z">
    <checkList>
      <parentID>L2A_SC</parentID>
      <name>SCENE_CLASS_QUALITY</name>
      <version>2.10</version>
      <item class="http://www.esa.int/s2#pdi_level_2a_tile_container" className="PDI Le
      <check>
        <message contentType="text/plain">"Percentage of classified pixels"</message>
        <extraValues>
          <value name="CLOUDY_PIXEL_PERCENTAGE">5.355208</value>
          <value name="CLOUDY_PIXEL_OVER_LAND_PERCENTAGE">5.359353</value>
          <value name="DEGRADED_MSI_DATA_PERCENTAGE">0.000400</value>
          <value name="NODATA_PIXEL_PERCENTAGE">0.000000</value>
          <value name="SATURATED_DEFECTIVE_PIXEL_PERCENTAGE">0.000000</value>
          <value name="DARK_FEATURES_PERCENTAGE">0.104293</value>
          <value name="CLOUD_SHADOW_PERCENTAGE">1.231675</value>
          <value name="VEGETATION_PERCENTAGE">13.869317</value>
          <value name="NOT_VEGETATED_PERCENTAGE">78.985292</value>
          <value name="WATER_PERCENTAGE">0.165461</value>
          <value name="UNCLASSIFIED_PERCENTAGE">0.288755</value>
          <value name="MEDIUM_PROBA_CLOUDS_PERCENTAGE">1.752390</value>
          <value name="HIGH_PROBA_CLOUDS_PERCENTAGE">1.565237</value>
          <value name="THIN_CIRRUS_PERCENTAGE">2.037581</value>
          <value name="SNOW_ICE_PERCENTAGE">0.000000</value>
```


© ACRI-ST | OPT-MPC – 2021

L2A product format updates : L2A_QUALITY.xml

L2A_QUALITY.xml
Atmospheric_Correction_Quality


```xml
<checkList>
  <parentID>L2A_AC</parentID>
  <name>ATMOSPHERIC_CORRECTION_QUALITY</name>
  <version>2.10</version>
  <item class="http://www.esa.int/s2#pdi_level_2a_tile_container" className="PDI Level
  <check>
    <message contentType="text/plain">Atmospheric correction quality values</message>
    <extraValues>
      <value name="AOT_RETRIEVAL_ACCURACY">0.000000</value>
      <value name="GRANULE_MEAN_AOT">0.169415</value>
      <value name="WV_RETRIEVAL_ACCURACY">0.000000</value>
      <value name="GRANULE_MEAN_WV">1.405101</value>
      <value name="OZONE_VALUE">279.486575</value>
      <value name="START_VISIBILITY_KM">40.000000</value>
      <value name="VISIBILITY_FROM_DDV_KM">40.810000</value>
      <value name="FINAL_VISIBILITY_KM">40.810000</value>
      <value name="AVERAGE_SOLAR_ZENITH_ANGLE">45.794456</value>
      <value name="DDV_PIXEL_PERCENTAGE">2.015425</value>
      <value name="DDV_REFLECTANCE_RANGE">0.050000</value>
      <value name="BLUE_PATH_RADIANCE_RESCALING_FACTOR">1.000000</value>
    </extraValues>
  </check>
  <check>
    <message contentType="text/plain">Atmospheric correction quality control</message>
    <extraValues>
      <!-- WV_RETRIEVAL_METHOD: SEN2COR_APDA -->
      <value name="WV_RETRIEVAL_METHOD">SEN2COR_APDA</value>
      <!-- AOT_RETRIEVAL_METHOD: SEN2COR_DDV | CAMS | DEFAULT -->
      <value name="AOT_RETRIEVAL_METHOD">SEN2COR_DDV</value>
      <value name="VISIBILITY_LESS_THAN_5_KM">False</value>
      <value name="AOT_ABOVE_1">False</value>
      <value name="GRANULE_WV_ABOVE_5_CM">False</value>
    </extraValues>
  </check>
```


© ACRI-ST | OPT-MPC – 2021

L2A product format updates : L2A_QUALITY.xml

L2A_QUALITY.xml
Aux_Data_Quality


```xml
<checkList>
  <parentID>L2A_AUX</parentID>
  <name>AUX_DATA_QUALITY</name>
  <version>2.10</version>
  <item class="http://www.esa.int/s2#pdi_level_2a_tile_container" className="PDI Level 2A Tile Fol
  <check>
    <message contentType="text/plain">AUX related parameters</message>
    <extraValues>
      <!-- DEM_TYPE: SRTM_90 | DTED_90 | COPERNICUS_90 -->
      <value name="DEM_TYPE">DTED_90</value>
      <value name="DEM_MEAN_ALTITUDE_KM">0.990692</value>
      <value name="DEM_MEAN_SLOPE">9.9481</value>
      <value name="GROUND_ELEVATION_ABOVE_3_KM">True</value>
      <value name="SOLAR_ZENITH_ANGLE_ABOVE_70_DEG">False</value>
      <!-- OZONE_SOURCE: AUX_ECMWFT | CONFIG | OTHER -->
      <value name="OZONE_SOURCE">AUX_ECMWFT</value>
    </extraValues>
  </check>
  <check>
    <message contentType="text/plain">AUX data file list</message>
    <extraValues>
      <value name="AUX_DATA_FILES">['w005_n36.dt1', 'w005_n37.dt1', 'w005_n38.dt1', 'w004_n36.dt1'
    </extraValues>
  </check>
</checkList>
```


© ACRI-ST | OPT-MPC – 2021

L2A product format updates : AUX_DATA

Updated Auxiliary data:

Meteorological: **AUX_ECMWFT**

+ 10 m wind speed (u & v) [m/s]
+ relative humidity [%]

Atmospheric : **AUX_CAMSFO**

- aerosol optical depth (5 wavelengths)
- aerosol optical depth (5 aerosol types)
- geopotential [m^2/s^2]

Located in AUX_DATA folder of L2A GRANULE

AUX_CAMS example:
AOD550 [unitless]

© ACRI-ST | OPT-MPC – 2021

Algorithm evolutions

© ACRI-ST | OPT-MPC – 2021

Cloud Screening update (Sen2Cor version 2.10)

Most noticeable improvements:

1. Improved cast shadow algorithm
2. Limit false cloud detection on bright pixels
3. Limit false snow detection in clouds
4. Improved cloud shadow detection
5. Dilation of cloud (80m) / cloud shadow (40m) / snow (20m)

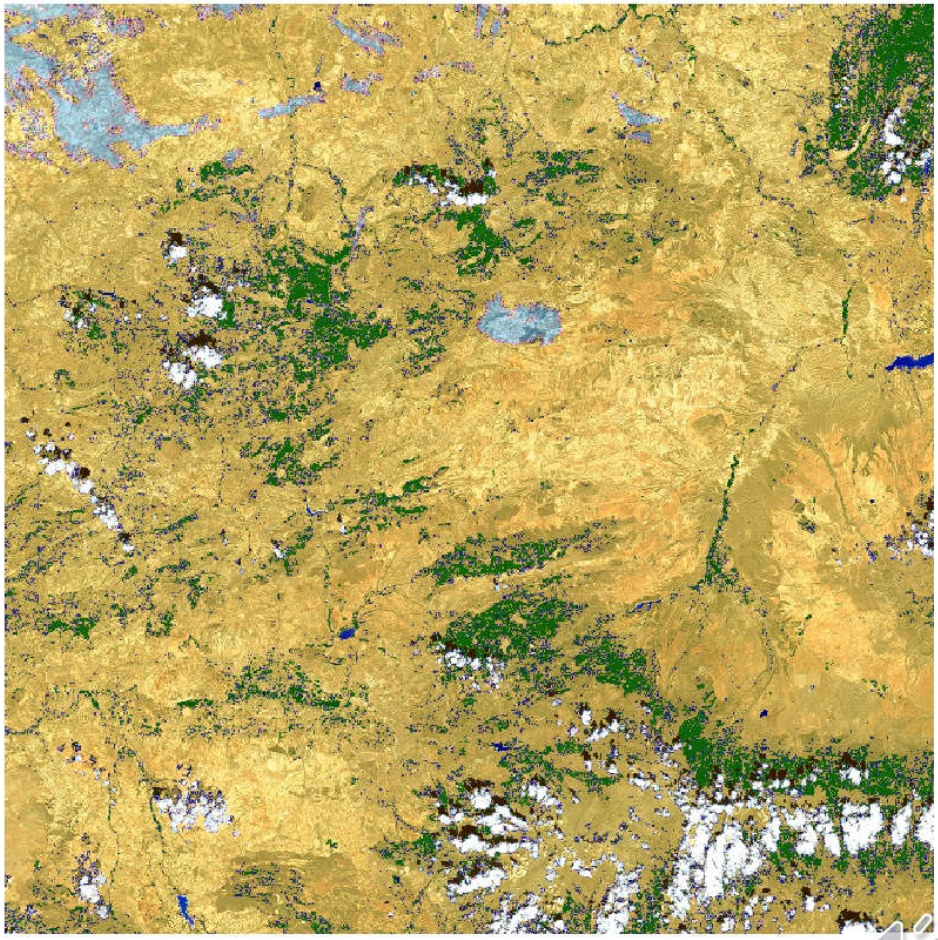
Point of attention:

Risk of omission of low altitude clouds, fog

L2A ATBD (v2.10):
https://step.esa.int/thirdparties/sen2cor/2.10.0/docs/S2-PDGS-MPC-L2A-ATBD-V2.10.0.pdf

© ACRI-ST | OPT-MPC – 2021

Cloud Screening update (Sen2Cor version 2.10)



Most noticeable improvements:

1. Improved cast shadow algorithm
2. Limit false cloud detection on bright pixels
3. Limit false snow detection in clouds
4. Improved cloud shadow detection
5. Dilation of cloud (80m) / cloud shadow (40m) / snow (20m)

Point of attention:

Risk of omission of low altitude clouds, fog

L2A ATBD (v2.10):
https://step.esa.int/thirdparties/sen2cor/2.10.0/docs/S2-PDGS-MPC-L2A-ATBD-V2.10.0.pdf

© ACRI-ST | OPT-MPC – 2021

Cloud Screening update (Sen2Cor version 2.10)

- L2A SCL PB.04.00 vs PB.03.01 on Almeria, Spain:
  - Greenhouses

Photo credit: Edward Burtynsky

13/01/2022

L2A PB 03.01

22/02/2022

L2A PB 04.00

© ACRI-ST | OPT-MPC – 2021

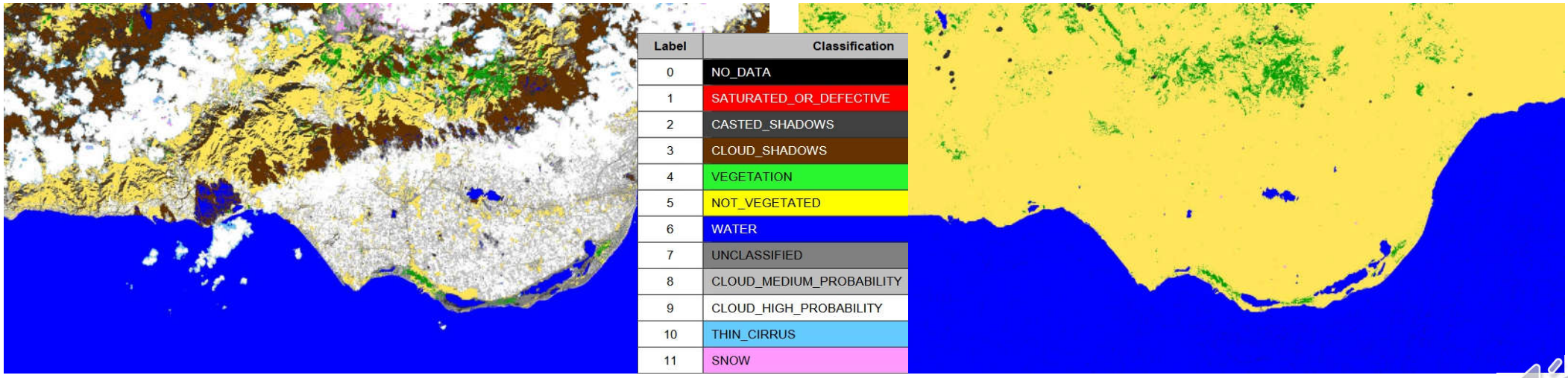
Cloud Screening update (Sen2Cor version 2.10)

- L2A SCL PB.04.00 vs PB.03.01 on Almeria, Spain:
  - Greenhouses

Photo credit: Edward Burtynsky

13/01/2022

22/02/2022



Label	Classification
0	NO_DATA
1	SATURATED_OR_DEFECTIVE
2	CASTED_SHADOWS
3	CLOUD_SHADOWS
4	VEGETATION
5	NOT_VEGETATED
6	WATER
7	UNCLASSIFIED
8	CLOUD_MEDIUM_PROBABILITY
9	CLOUD_HIGH_PROBABILITY
10	THIN_CIRRUS
11	SNOW

L2A PB 03.01

L2A PB 04.00

© ACRI-ST | OPT-MPC – 2021

Cloud Screening update (Sen2Cor version 2.10)

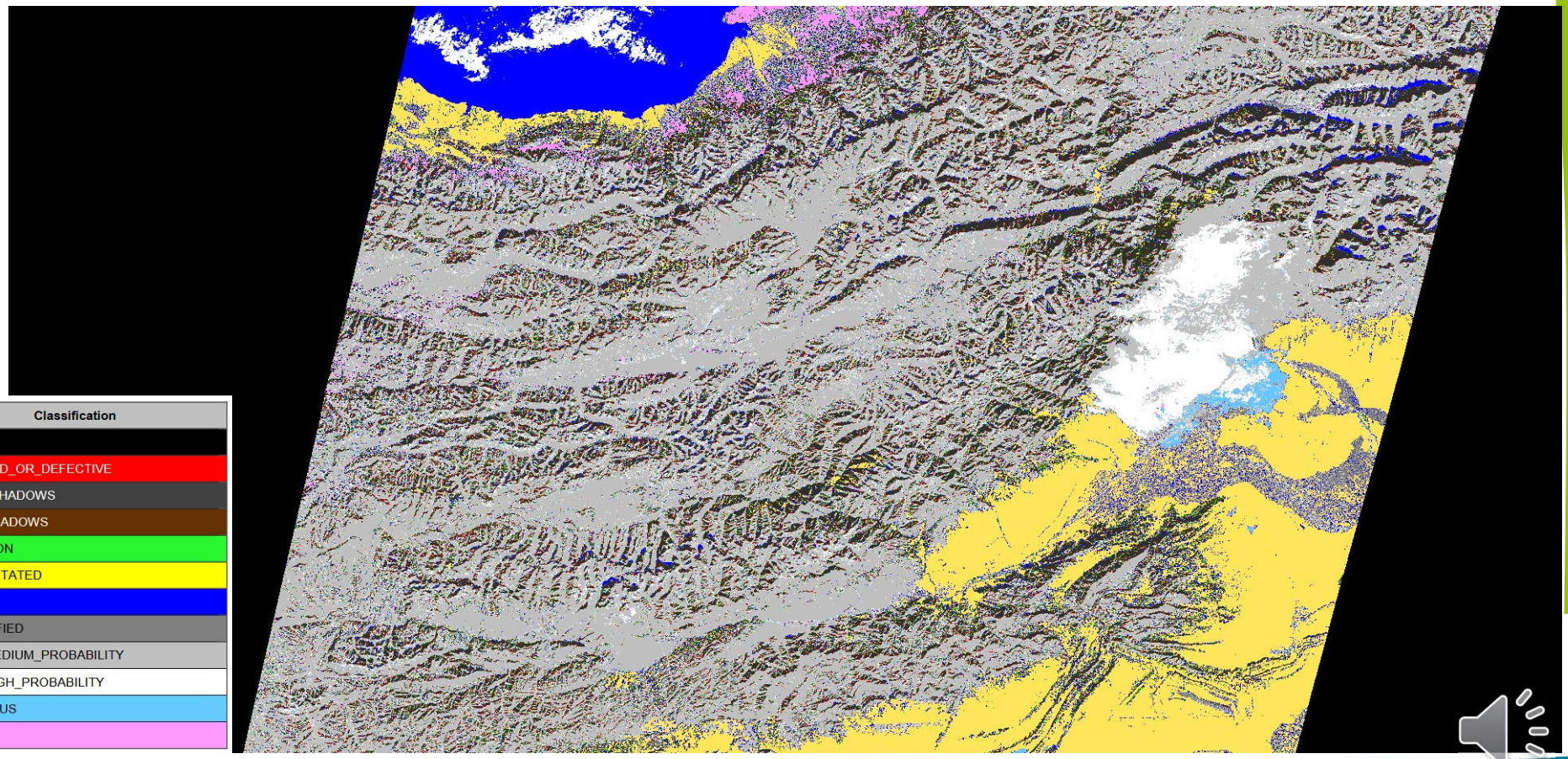
PB:03.01

Region:
Himalaya
Date:
22/01/2022
PB:
03.01
Layer:
RGB-visible

© ACRI-ST | OPT-MPC – 2021

Cloud Screening update (Sen2Cor version 2.10)

Before Sen2Cor 2.10 PB:03.01



Region:
Himalaya
Date:
22/01/2022
PB:
03.01
Layer:
SCL

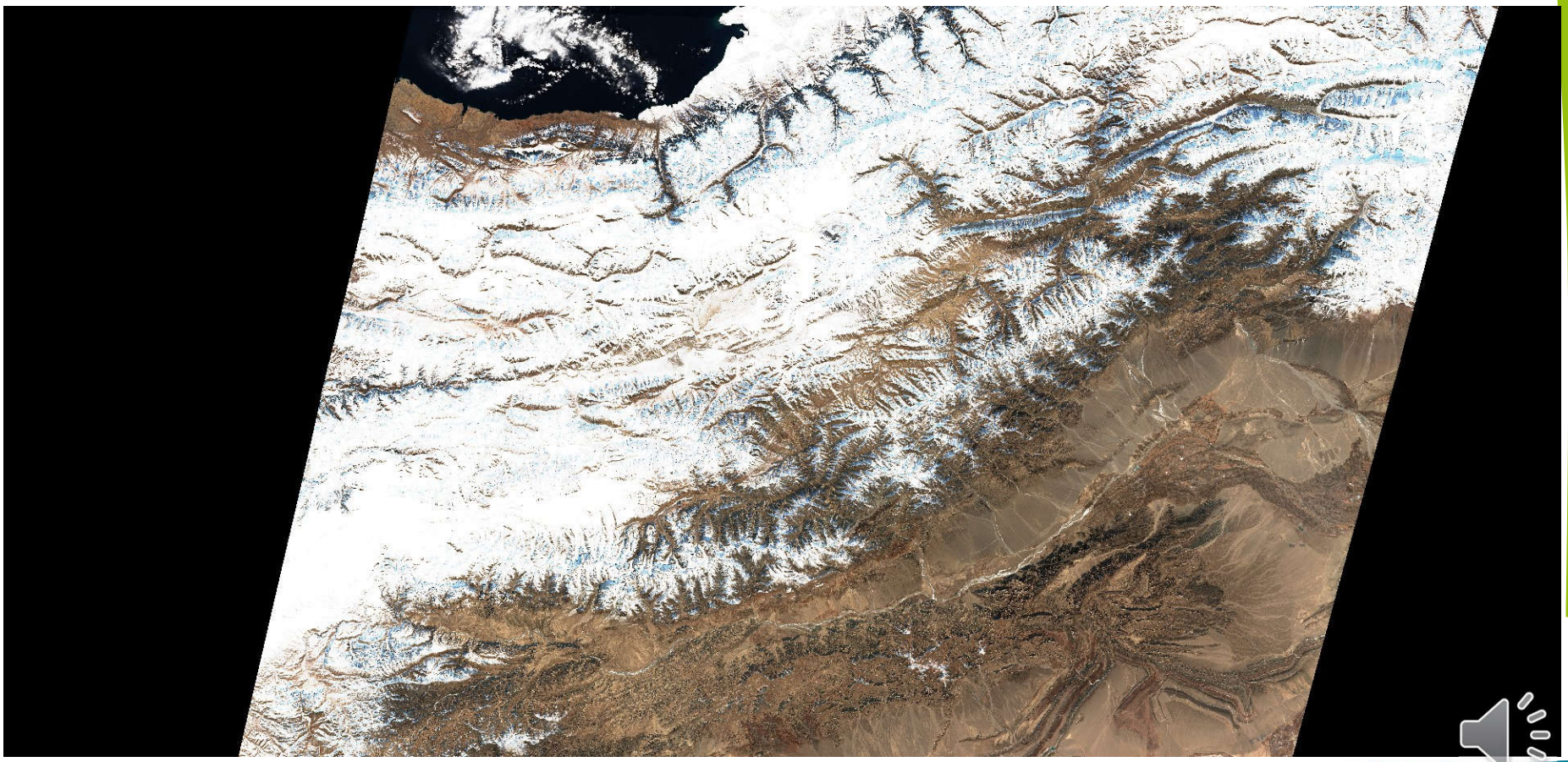
Label	Classification
0	NO_DATA
1	SATURATED_OR_DEFECTIVE
2	CASTED_SHADOWS
3	CLOUD_SHADOWS
4	VEGETATION
5	NOT_VEGETATED
6	WATER
7	UNCLASSIFIED
8	CLOUD_MEDIUM_PROBABILITY
9	CLOUD_HIGH_PROBABILITY
10	THIN_CIRRUS
11	SNOW

© ACRI-ST | OPT-MPC – 2021

Cloud Screening update (Sen2Cor version 2.10)

PB:04.00

Region:
Himalaya
Date:
27/01/2022
PB:
04.00
Layer:
RGB-visible

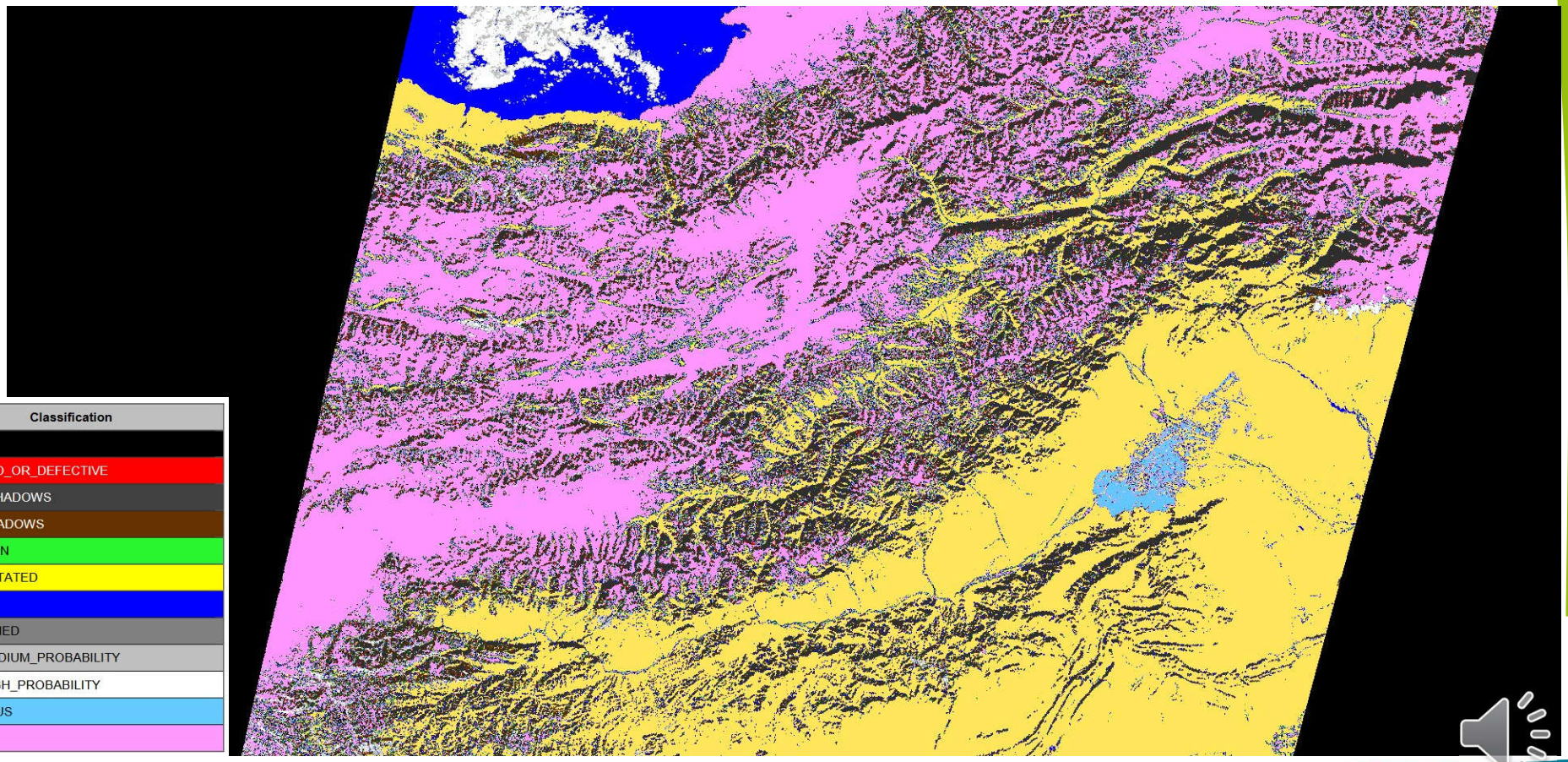


© ACRI-ST | OPT-MPC – 2021

Cloud Screening update (Sen2Cor version 2.10)

PB:04.00

Region:
Himalaya
Date:
27/01/2022
PB:
04.00
Layer:
SCL



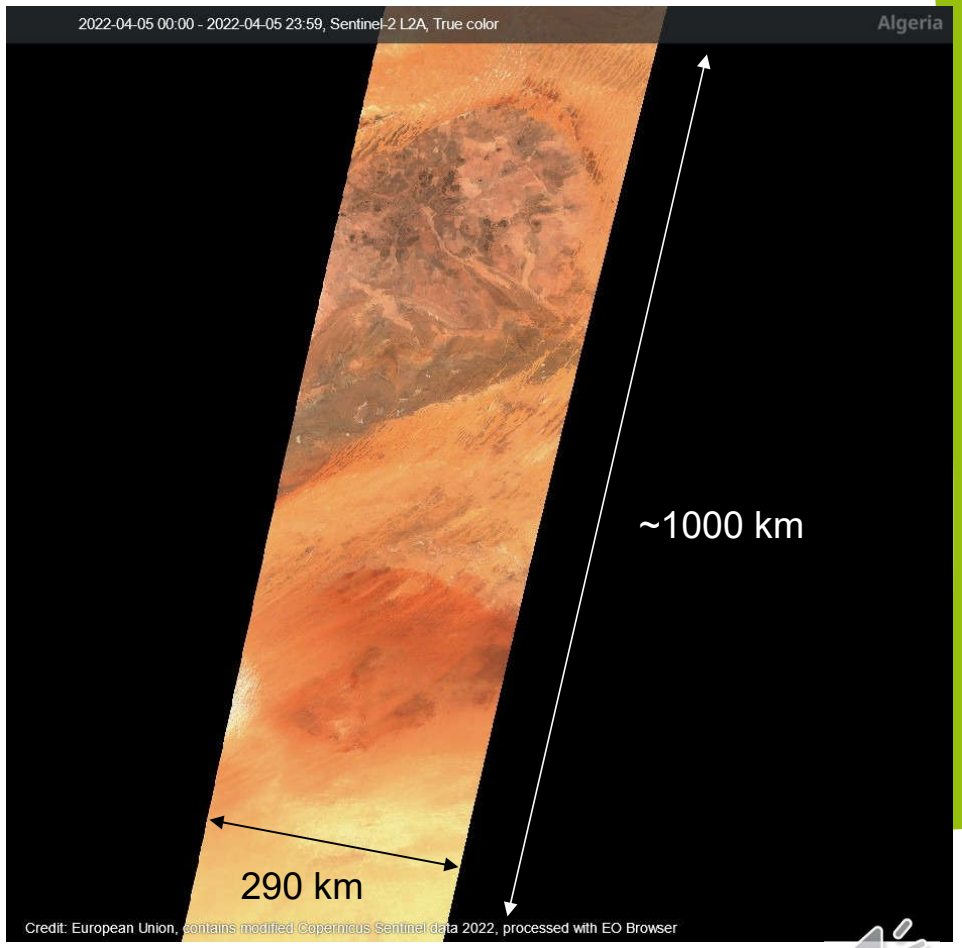
Label	Classification
0	NO_DATA
1	SATURATED_OR_DEFECTIVE
2	CASTED_SHADOWS
3	CLOUD_SHADOWS
4	VEGETATION
5	NOT_VEGETATED
6	WATER
7	UNCLASSIFIED
8	CLOUD_MEDIUM_PROBABILITY
9	CLOUD_HIGH_PROBABILITY
10	THIN_CIRRUS
11	SNOW

© ACRI-ST | OPT-MPC – 2021

Atmospheric correction (Sen2Cor version 2.10)

<u>Most noticeable improvements:</u>

1. Usage of CAMS aerosol data in case of missing DDV pixels
2. Example over desert area:
   L2A surface reflectance TCI

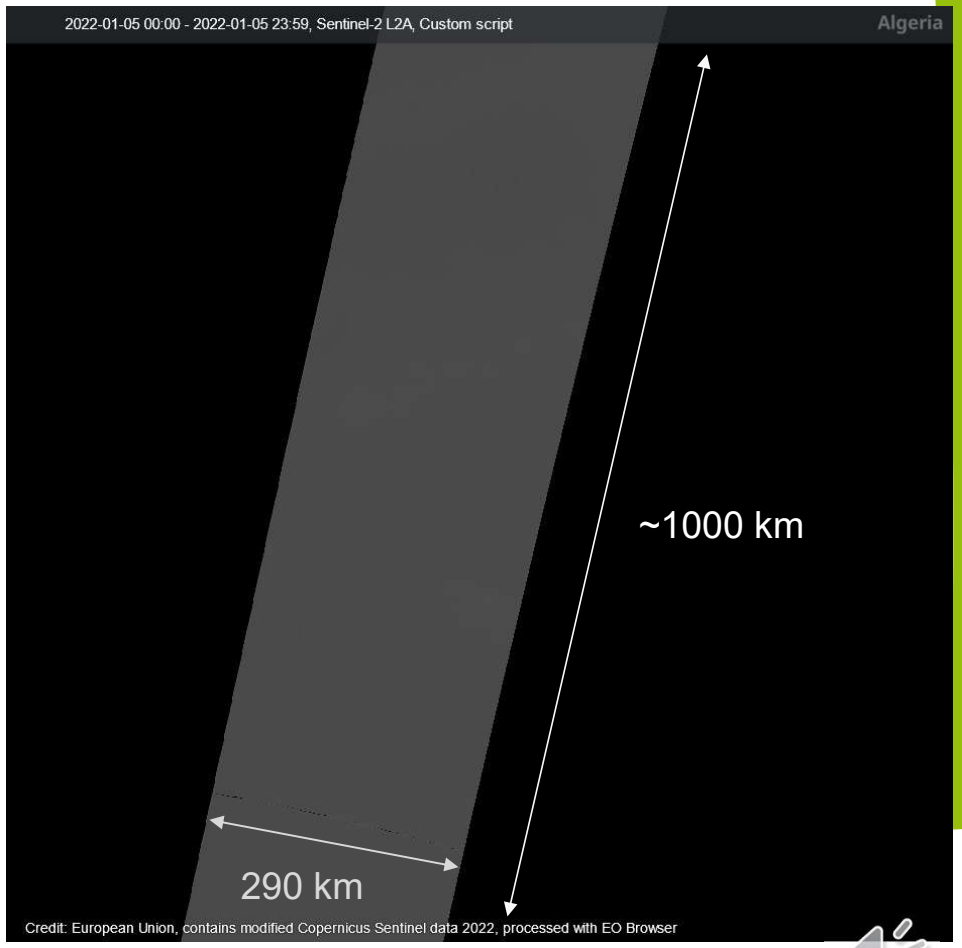


L2A ATBD (v2.10):
https://step.esa.int/thirdparties/sen2cor/2.10.0/docs/S2-PDGS-MPC-L2A-ATBD-V2.10.0.pdf

© ACRI-ST | OPT-MPC – 2021

Atmospheric correction (before Sen2Cor version 2.10)

1. Usage of default aerosol AOT in case of missing DDV pixels
2. Example over desert area
   AOT map along the datastrip
   (up to L2A PB03.01: constant AOT value ~0.2)



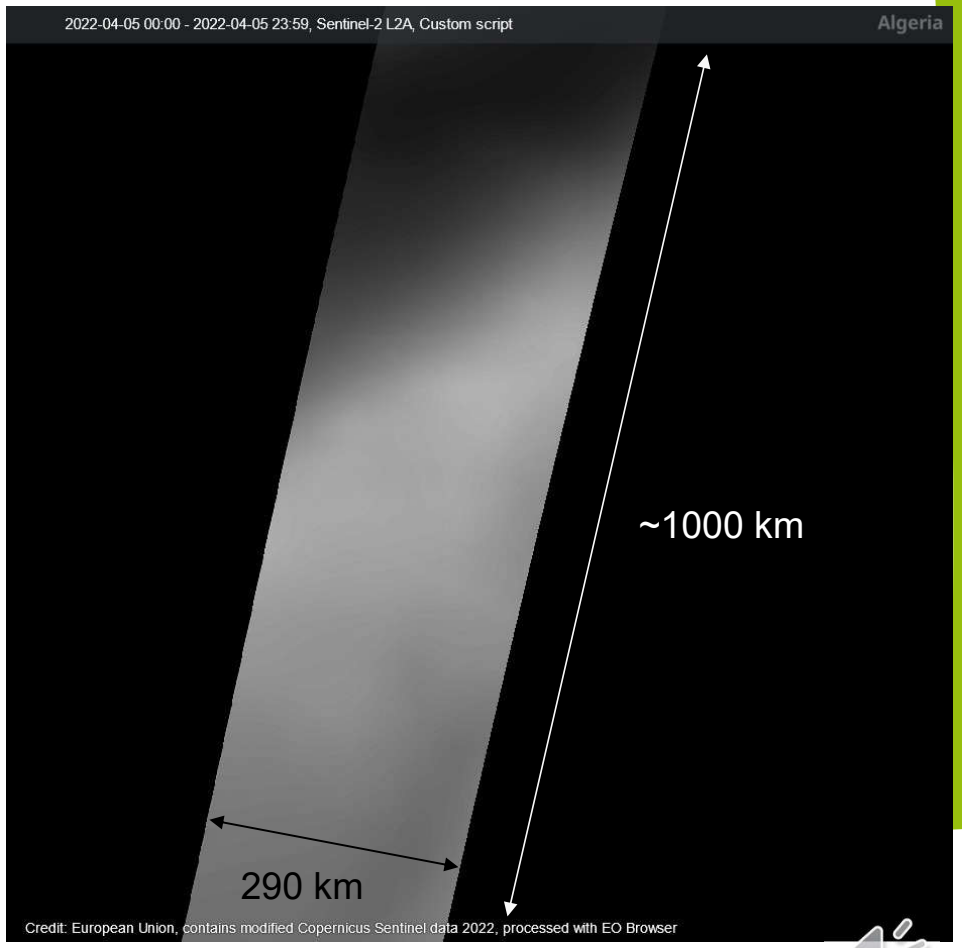
L2A ATBD (v2.10):
https://step.esa.int/thirdparties/sen2cor/2.10.0/docs/S2-PDGS-MPC-L2A-ATBD-V2.10.0.pdf

© ACRI-ST | OPT-MPC – 2021

Atmospheric correction (Sen2Cor version 2.10)

<u>Most noticeable improvements:</u>

1. Usage of CAMS aerosol data in case of missing DDV pixels
2. Example over desert area
   AOT map along the datastrip
   (L2A processing of L1C CAMSFO file)



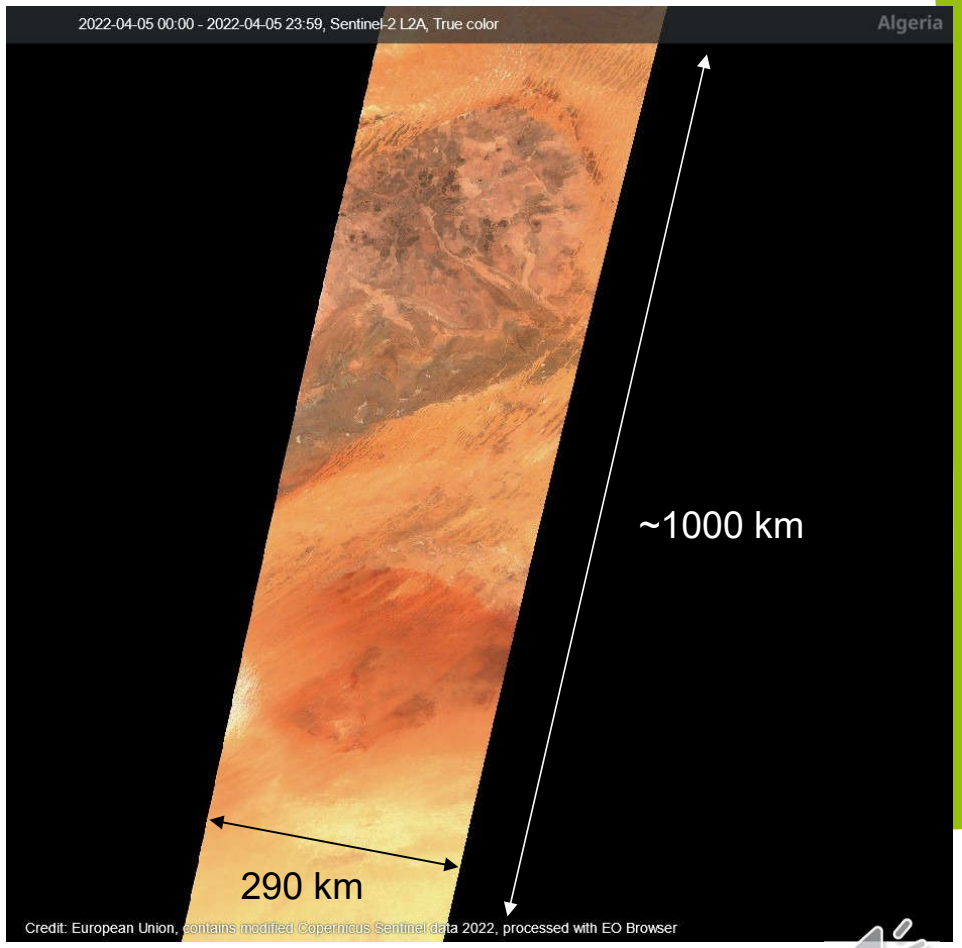
L2A ATBD (v2.10):
https://step.esa.int/thirdparties/sen2cor/2.10.0/docs/S2-PDGS-MPC-L2A-ATBD-V2.10.0.pdf

© ACRI-ST | OPT-MPC – 2021

Atmospheric correction (Sen2Cor version 2.10)

<u>Most noticeable improvements:</u>

1. Usage of CAMS aerosol data in case of missing DDV pixels
2. Example over desert area:
   L2A surface reflectance TCI



L2A ATBD (v2.10):
https://step.esa.int/thirdparties/sen2cor/2.10.0/docs/S2-PDGS-MPC-L2A-ATBD-V2.10.0.pdf

© ACRI-ST | OPT-MPC – 2021

L2A Data Quality

© ACRI-ST | OPT-MPC – 2021

L2A product validation methods

AOT and IWV:

- direct comparison with AERONET
- satellite overpass time ±15 min
- 9km x 9km area around sunphotometer
- all vegetated, non-vegetated and snow pixels

SDR:

- Comparison with reference measurements (5x5 pixel)
- Comparision with computed reference data at AERONET locations (9km x 9km area around sunphotometer; all vegetated, non-vegetated and snow pixels)

Reporting:

- Pearson Correlation of retrieval and reference data
- Percentage of products within specification (goal)
- Spectral correctness of SR retrieval
- APU plots

$$X = \{ \rho_\lambda \; ; AOT_{550} \; ; WV \}$$

$$\Delta X = X_{SEN2COR} - X_{REFERENCE}$$

$$u_{sys} = \frac{1}{(n-1)} \cdot \sum_{i=1}^{n} \Delta X_i \qquad \text{(Accuracy)}$$

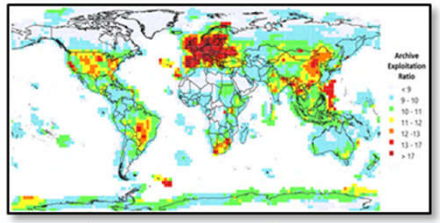
$$u_{random} = \sqrt{\frac{1}{(n-1)} \cdot \sum_{i=1}^{n} \left(\Delta X_i - u_{sys}\right)^2} \qquad \text{(Precision)}$$

$$u_{total} = \sqrt{\frac{1}{(n-1)} \cdot \sum_{i=1}^{n} (\Delta X_i)^2} \qquad \text{(Uncertainty)}$$

$$= \sqrt{{u_{sys}}^2 + {u_{random}}^2}$$

© ACRI-ST | OPT-MPC – 2021

(AERONET) - Test site selection



Site selection: ⅔ area + ⅓ data access +side conditions
AERONET data available (level ≥ 1.5) within ±15 min to overpass

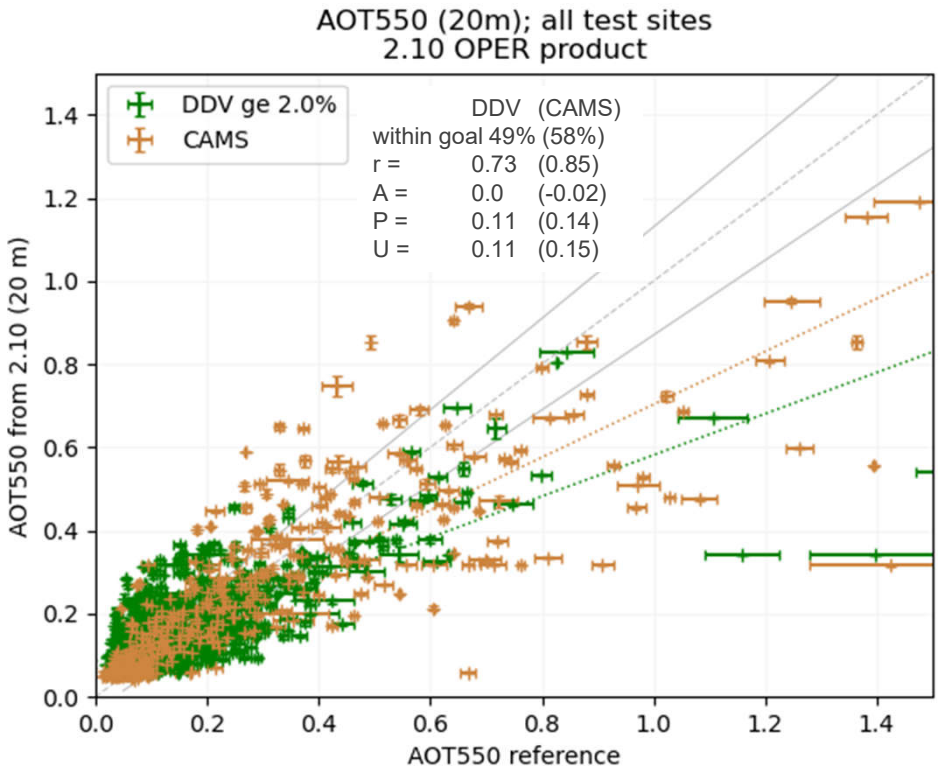
climate zone	N-America	S- America	Europe	Africa	Asia	Australia	Antarctica	No. of tiles	% tiles	No. of sites
Polar	43		113					156	**13%**	6
Boreal	86		159					245	**20%**	14
Midlatitude N	155		113	34	102			404	**33%**	23
Subtropical N	51			78	60			189	**16%**	13
Tropical		33		49	35	9		126	**10%**	13
Subtropical S		21		32		3		56	**5%**	6
Midlatitude S +Austral		15				21		36	**3%**	4
number of tiles	335	69	385	193	197	33	0	**1212**		
% tiles selected	**28%**	**6%**	**32%**	**16%**	**16%**	**3%**	**0%**			
% tiles goal	**18%**	**9%**	**30%**	**15%**	**23%**	**5%**	**0%**	⅔ area +⅓ access +side condition		
number of sites	18	6	20	15	15	5	0			**79**

© ACRI-ST | OPT-MPC – 2021

L2A AOT retrieval

Sen2Cor 2.10 operational production

Goal U(AOT) ≤ 0.1*AOT_{ref} +0.03 for AOT 0.05 - 0.3



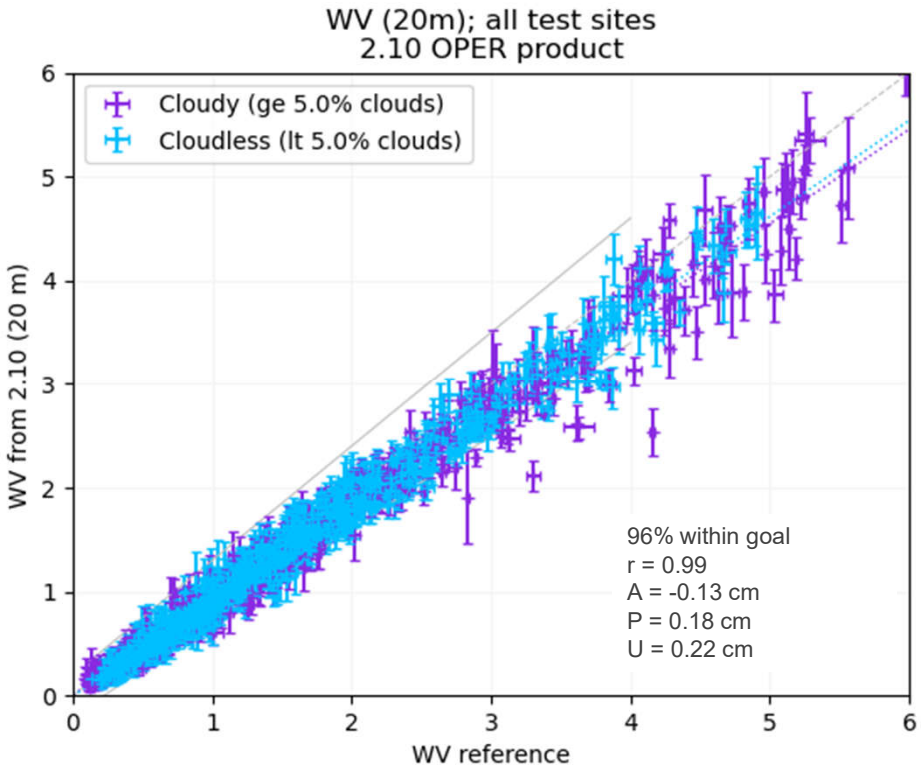
Average Uncertainty	DDV	CAMS	AOT_{DDV}	AOT_{CAMS}
Polar	54	97	0.08	0.08
Boreal	200	44	0.06	0.04
Midlat. N	239	163	0.13	0.10
Subtrop. N	73	113	0.17	0.21
Tropical	70	42	0.08	0.26
Subtrop. S	51	0	0.08	
Midlat. S	7	17	0.04	0.02
Austral	0	10		0.05
All data	694	486	0.11	0.15

© ACRI-ST | OPT-MPC – 2021

L2A IWV retrieval

Sen2Cor 2.10 operational production

Goal U(IWV) ≤ (0.1*WV_{ref} +0.02) g/cm² for IWV 0.1 - 4 g/cm²

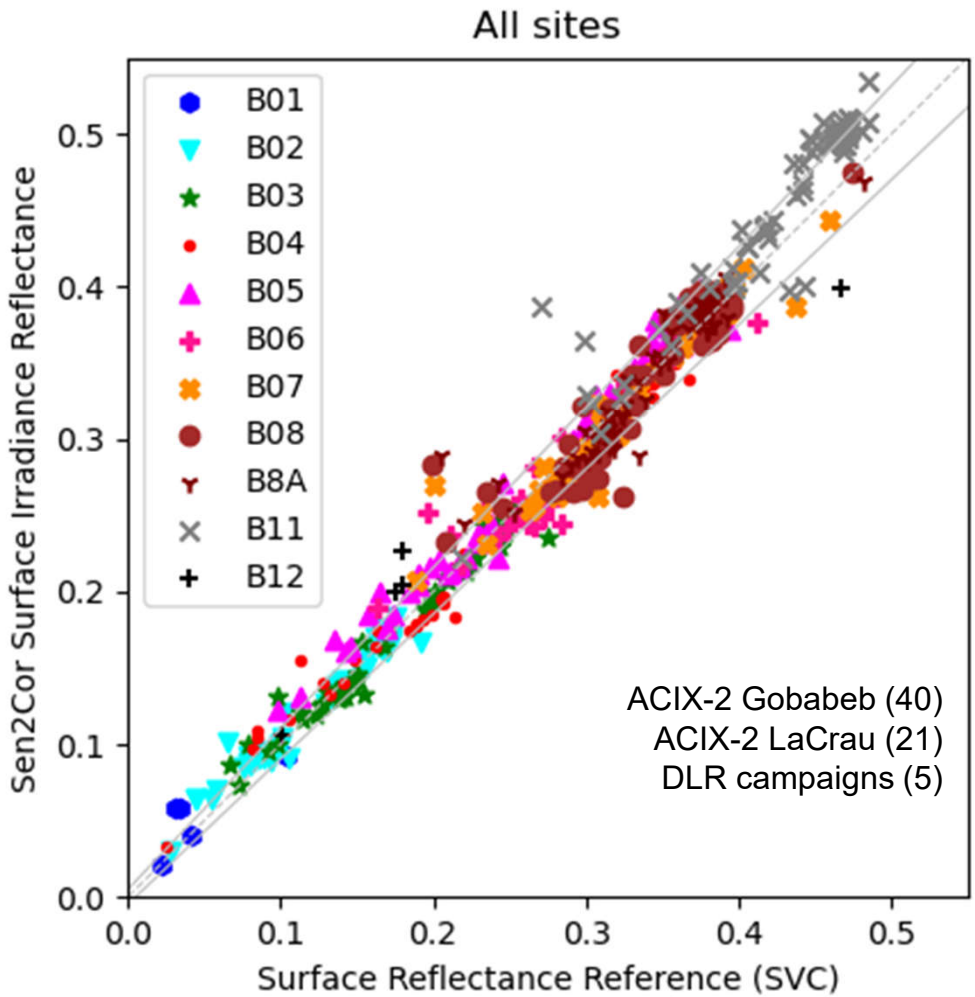


Average Uncertainty	WV
Polar	0.16 g/cm²
Boreal	0.13 g/cm²
Midlat. N	0.18 g/cm²
Subtrop. N	0.30 g/cm²
Tropical	0.40 g/cm²
Subtrop. S	0.29 g/cm²
Midlat. S	0.17 g/cm²
Austral	0.12 g/cm²
All data	0.29 g/cm²

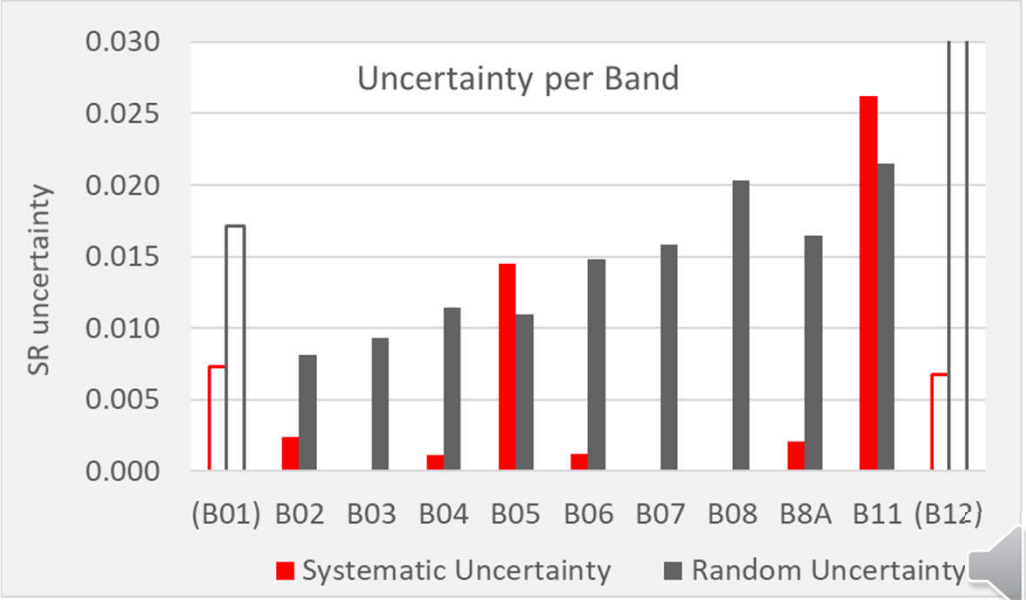
© ACRI-ST | OPT-MPC – 2021

Comparison of SDR retrieval with reference measurements

- Sen2Cor 2.80 user processing with CAMS fall back



- Uncertainty Goal $U(SR) = 0.05 * SR + 0.005$
  - ✓ 79% of 604 values
- Average Total Uncertainty
  - ✓ U = 0.018
  - ✓ relative: 9%
- Systematic Uncertainty
  - ✓ $U_{sys}(SR) = (0.02 \pm 0.007) * SR + (0.0 \pm 0.002)$



© ACRI-ST | OPT-MPC – 2021

Conclusions

- L2A product CARD4L compliant
  - https://ceos.org/ard/
  - https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-2-msi/processing-baseline

- Algorithm evolutions
  - https://step.esa.int/thirdparties/sen2cor/2.10.0/docs/S2-PDGS-MPC-L2A-ATBD-V2.10.0.pdf

- Data Quality
  - L2A Product Performance reported in the monthly L2A Data Quality Reports https://sentinels.copernicus.eu/web/sentinel/data-product-quality-reports

© ACRI-ST | OPT-MPC – 2021

OPT-MPC

Copernicus Sentinel

Optical Mission Performance Cluster

Thank you

21th September 2022

Torrent, Spain

© ACRI-ST | OPT-MPC – 2021

Additional slides

21th September 2022

Torrent, Spain

© ACRI-ST | OPT-MPC – 2021

OPT-MPC

Copernicus Sentinel

Optical Mission Performance Cluster

Surface Reflectance Conversion

$$SR = (DN - 1000) / 10\,000$$

Scope: possibility to encode « negative » reflectance values
in order to preserve the spectral shape of the surface reflectance

DN below 1000 are « negative » reflectance values.

© ACRI-ST | OPT-MPC – 2021

The link to download the ESA CCI package compatible with Sen2Cor version 2.10:
https://earth.esa.int/eogateway/ftp/Sentinel-2/ESACCI-LC-L4-ALL-FOR-SEN2COR-2.10.tar.gz

The link is available in section 3.1.1 of SUM: (hyperlink location)
http://step.esa.int/thirdparties/sen2cor/2.10.0/docs/S2-PDGS-MPC-L2A-SUM-V2.10.0.pdf
"Users of Sen2Cor version 2.10 should download the new monthly snow condition files derived from ESACCI from this location."

© ACRI-ST | OPT-MPC – 2021

La Palma 9 December 2021:

S2A_MSIL1C_20211209T120321_N0301_R023_T28RBS_20211209T133933.SAFE

L2A_QUALITY.xml

Scene_Class_Quality: Cloudy_pixel_over_land_percentage

What about Cloudy_pixel_over_water_percentage ?

Not implemented in PB 04.00

How to implement?

- using the same land/sea mask (ESA CCI Water Bodies @ 150 m)
- using the “land ratio” of the Sentinel-2 tile of interest

- with landratio != 100%: $$\text{cloud\%overwater} = \frac{\text{cloud\%} - (\text{cloud\%overland} \cdot \text{landratio})}{(1 - \text{landratio})}$$

© ACRI-ST | OPT-MPC – 2021

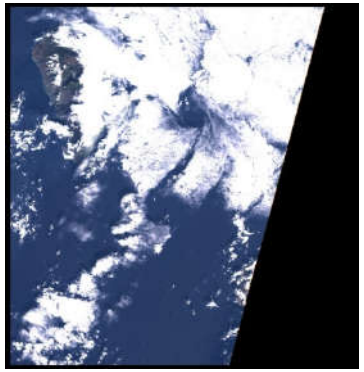
La Palma 9 December 2021:

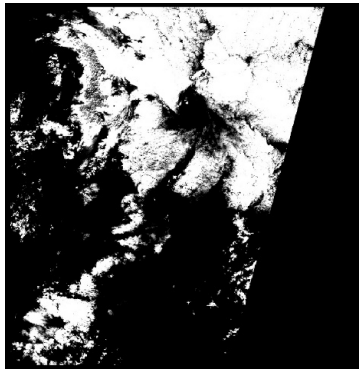
S2A_MSIL1C_20211209T120321_N0301_R023_T28RBS_20211209T133933.SAFE

L2A_QUALITY.xml

Scene_Class_Quality: Cloudy_pixel_over_land_percentage

CLOUDY_PIXEL_PERCENTAGE = 47.365642
CLOUDY_PIXEL_OVER_LAND_PERCENTAGE = 59.753519





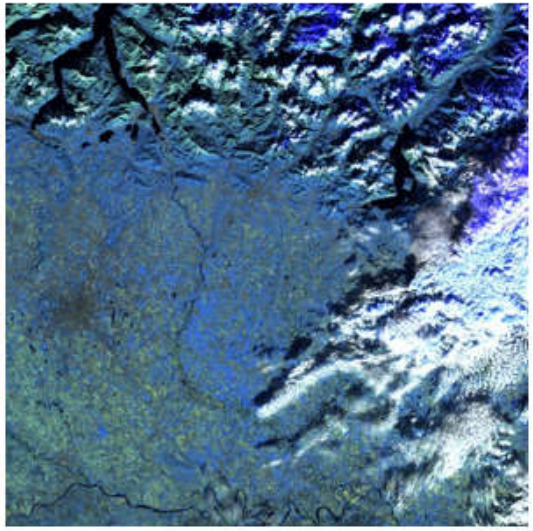
land_count
1852890
total_count
22490323
water_count
20637433
landratio
0.08239

$$\text{cloud\%overwater} = \frac{47.365642 - (59.753519 \cdot 0.08239)}{(1 - 0.08239)} = 46.253364\ \%$$

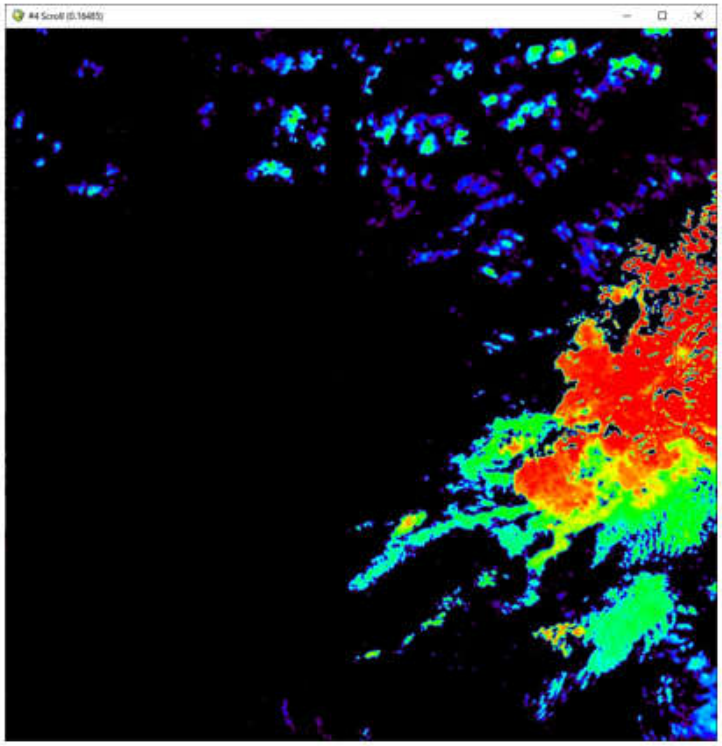
© ACRI-ST | OPT-MPC – 2021

➔1) Sen2Cor Scene Classification Evolution

› Update of cloud shadow algorithm with cloud top height estimation



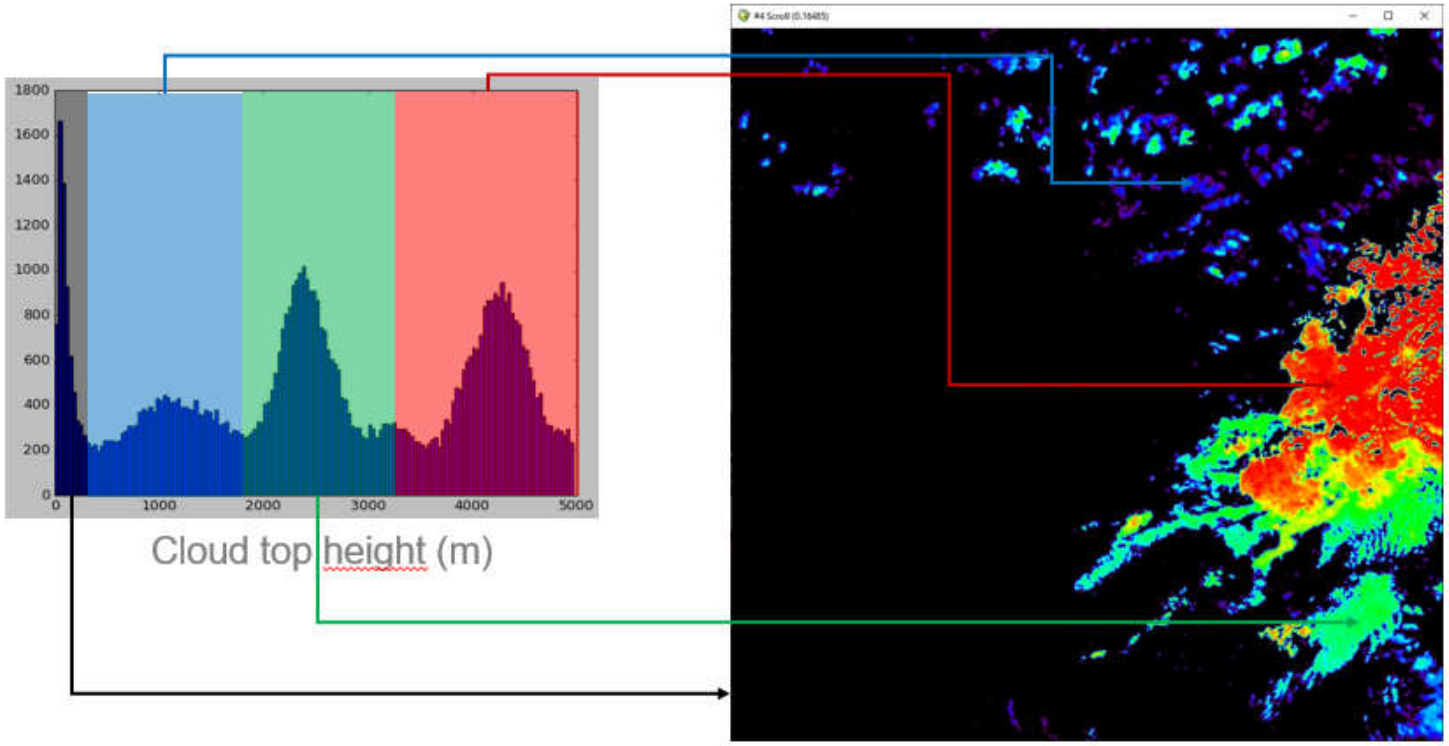
RGB
(B12, B11, B8A)



© ACRI-ST | OPT-MPC – 2021

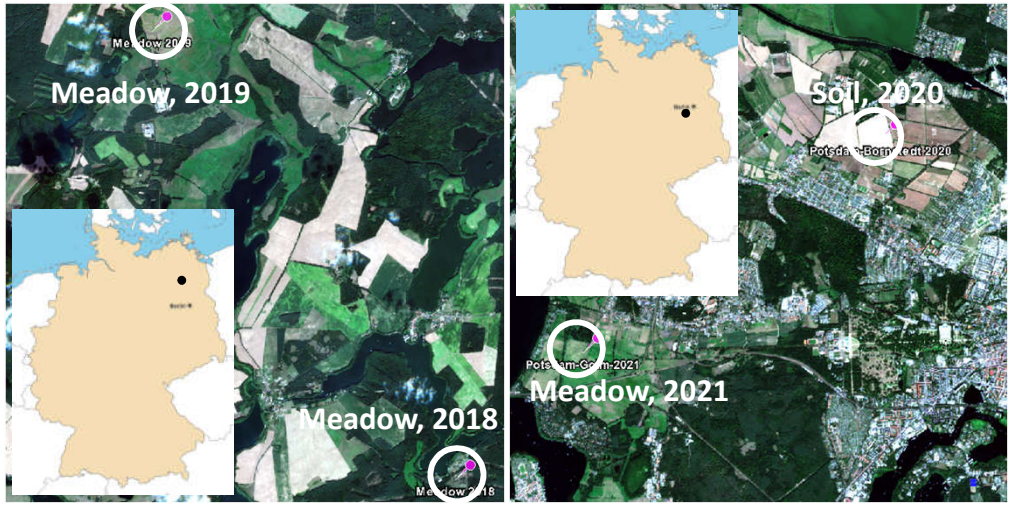
➔1) Sen2Cor Scene Classification Evolution

› Update of cloud shadow algorithm with cloud top height estimation



© ACRI-ST | OPT-MPC – 2021

Reference measurements and test sites



- Copernicus Sentinel-2:
  Sen2Cor 2.80 user processing with CAMS fall back

- Measured reference data:

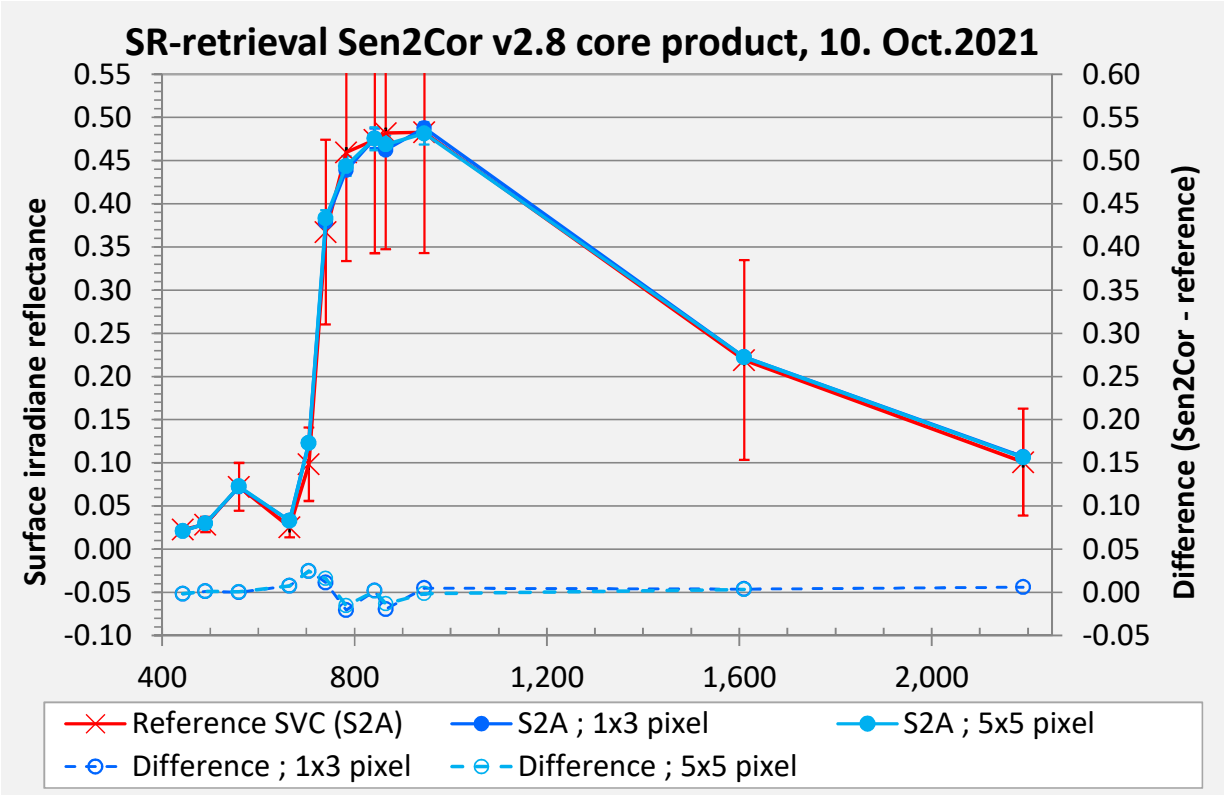
	Site	No.		Granule	RO	VZA	RAA
ACIX-2 ground* data set	Gobabeb, Namibia	40	Oct. 2017 – May 2018	T33KWP	107	8°	190°-260°
ACIX-2 ground* data set	La Crau, France	11	Jan. 2018 – Sept. 2018	T31TFJ	8	9°	110°
ACIX-2 land data set	La Crau, France	10	Jan. 2018 – Sept. 2018	T31TFJ	108	7°	51°
DLR-campaigns	Mecklenburg, Germany	3	5/2018, 8/2019	T32UQE	22	11°	49°
DLR-campaigns	Potsdam, Germany	2	8/2020, 10/2021	T33UUU	22	9.1°	59°

(*) E. Vermote, G. Doxani, F. Gascon, and J. C. Roger, "ACIX – Atmospheric Correction Inter-comparison eXercise," presented at the IGARSS 2019 - 2019 IEEE International Geoscience and Remote Sensing Symposium, 2019

© ACRI-ST | OPT-MPC – 2021

DLR campaigns

- SVC HR-1024i Spectroradiometer
  - ✓ Spectral range: 350 – 2500 nm
  - ✓ Reflectance relative to white panel
- Microtops Ozonometer + sunphotometer

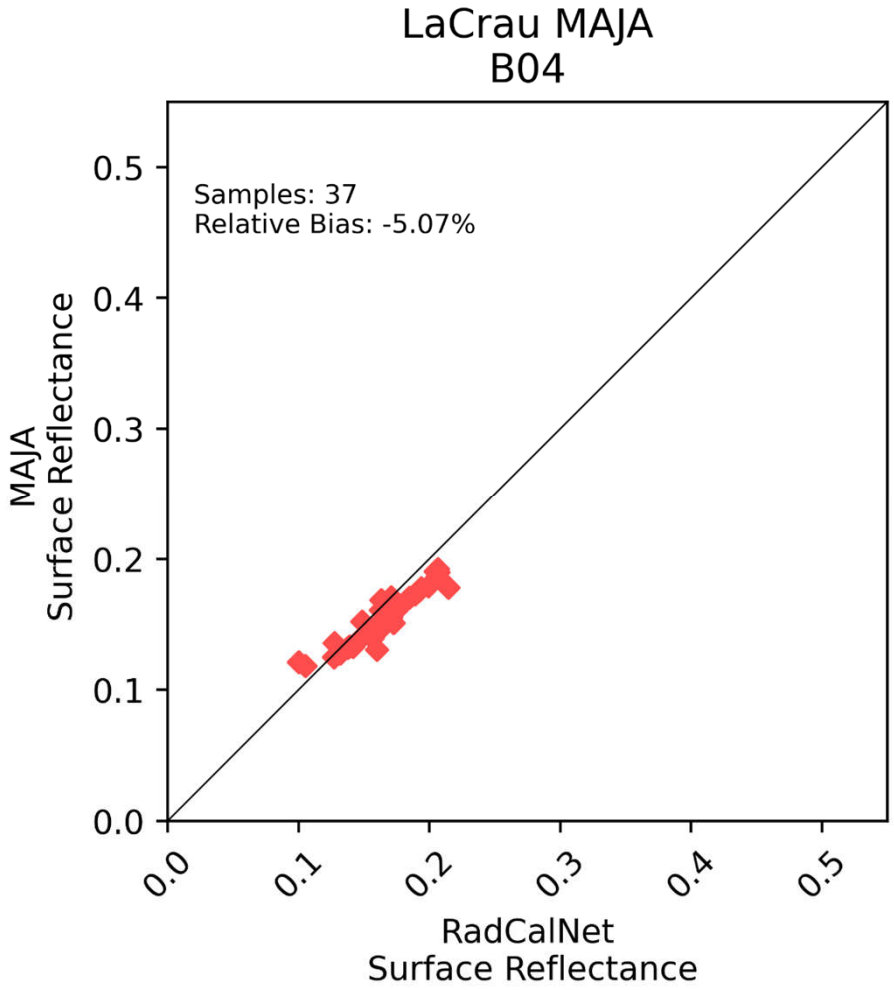


- High spectral correctness of retrieval
  - ✓ 0.99 Pearson correlation (S2, SVC)
  - ✓ 0.01 RMSD (retrieval, SVC)

	B01	B02	B03	B04	B05	B06	B07	B08	B08A	B11	B12
(S2 – SVC)	-0.002	0.001	0.001	0.007	0.024	0.016	-0.016	0.001	-0.013	0.003	0.005
|(S2 – SVC) / SVC|	7%	4%	1%	29%	25%	4%	3%	0%	3%	2%	5%

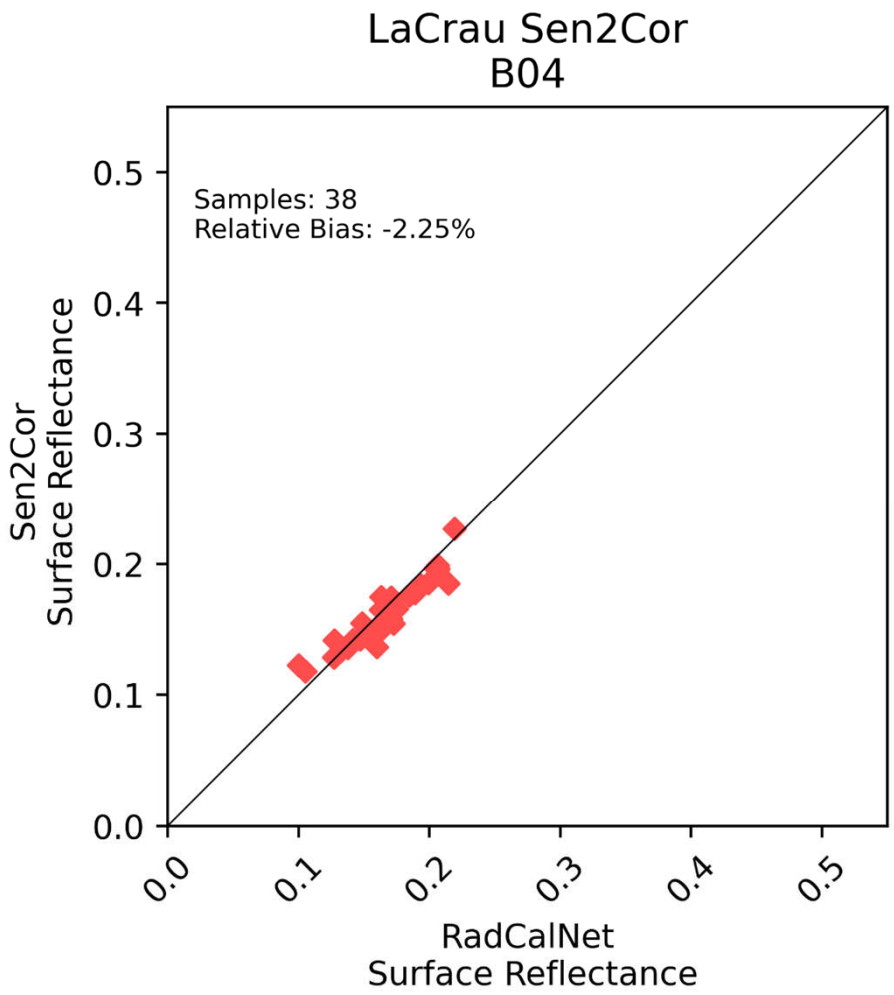
© ACRI-ST | OPT-MPC – 2021

ACIX-2 Radcalnet / ROSAS



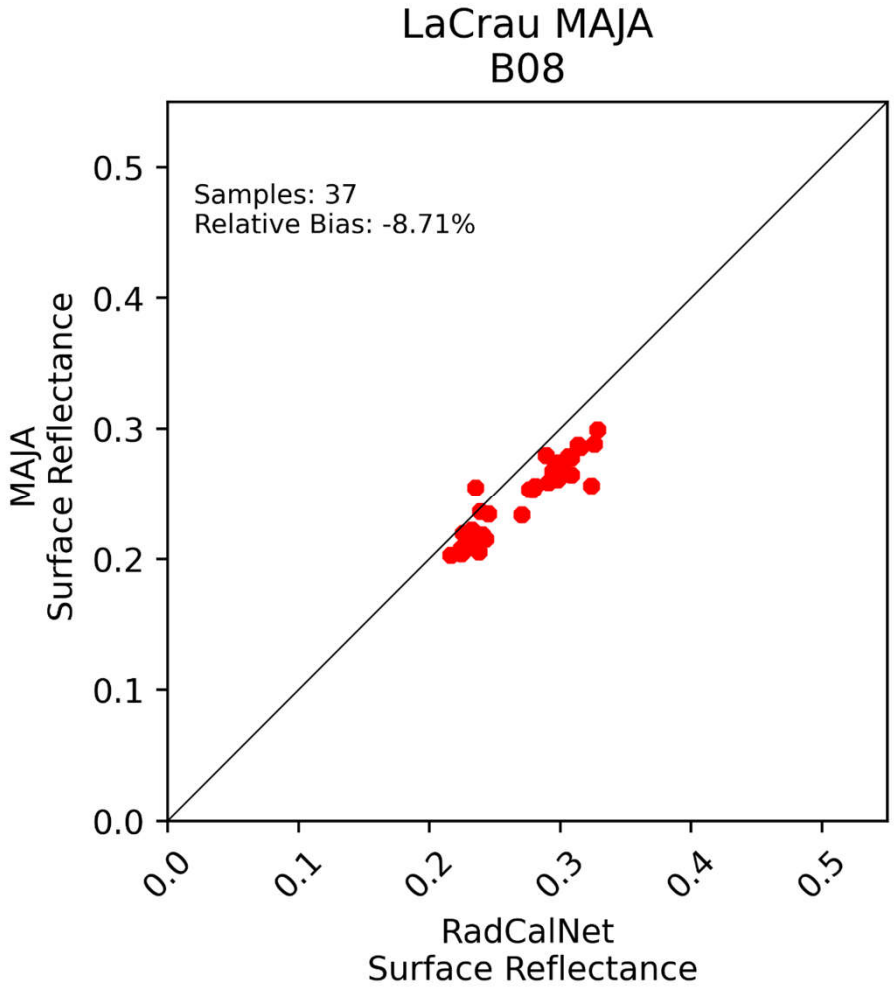
© ACRI-ST | OPT-MPC – 2021

ACIX-2 Radcalnet / ROSAS



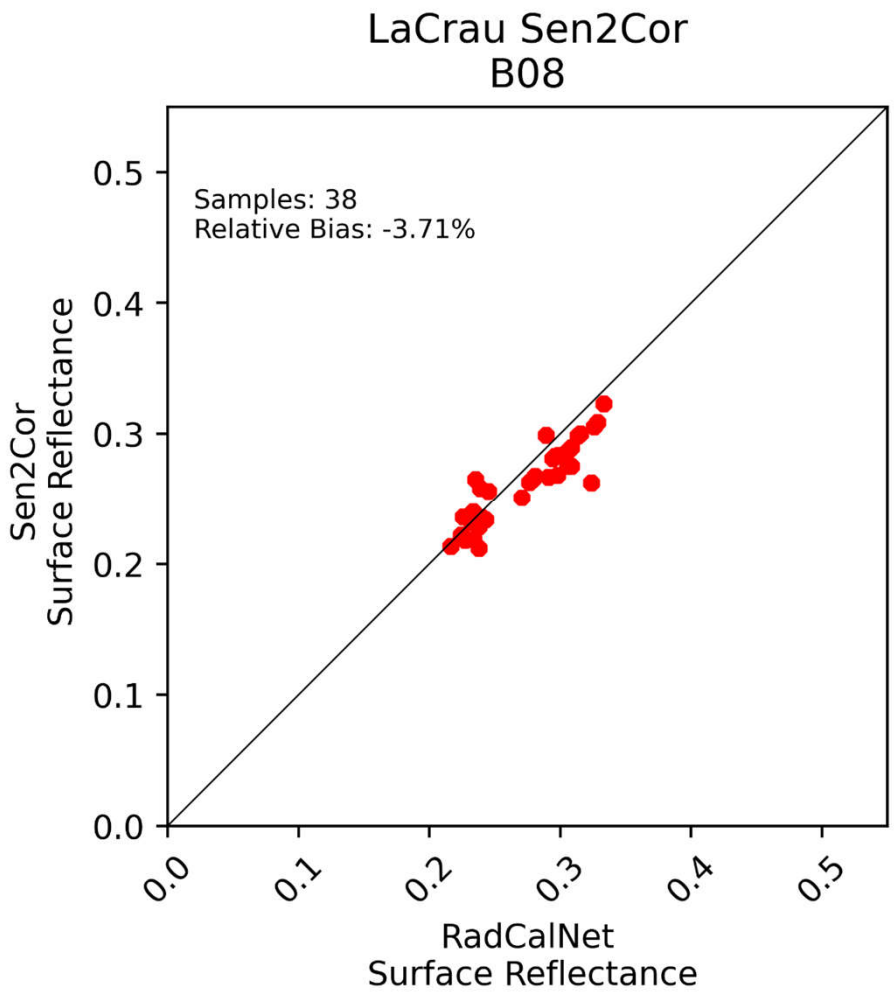
© ACRI-ST | OPT-MPC – 2021

ACIX-2 Radcalnet / ROSAS



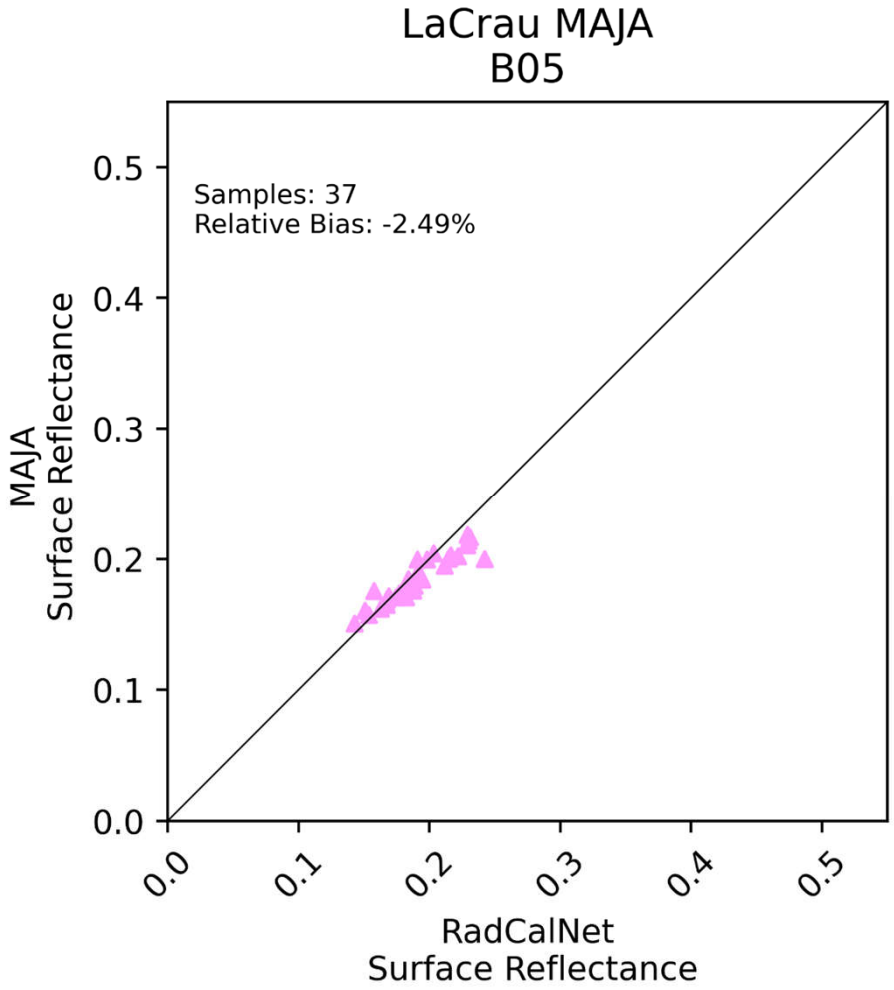
© ACRI-ST | OPT-MPC – 2021

ACIX-2 Radcalnet / ROSAS



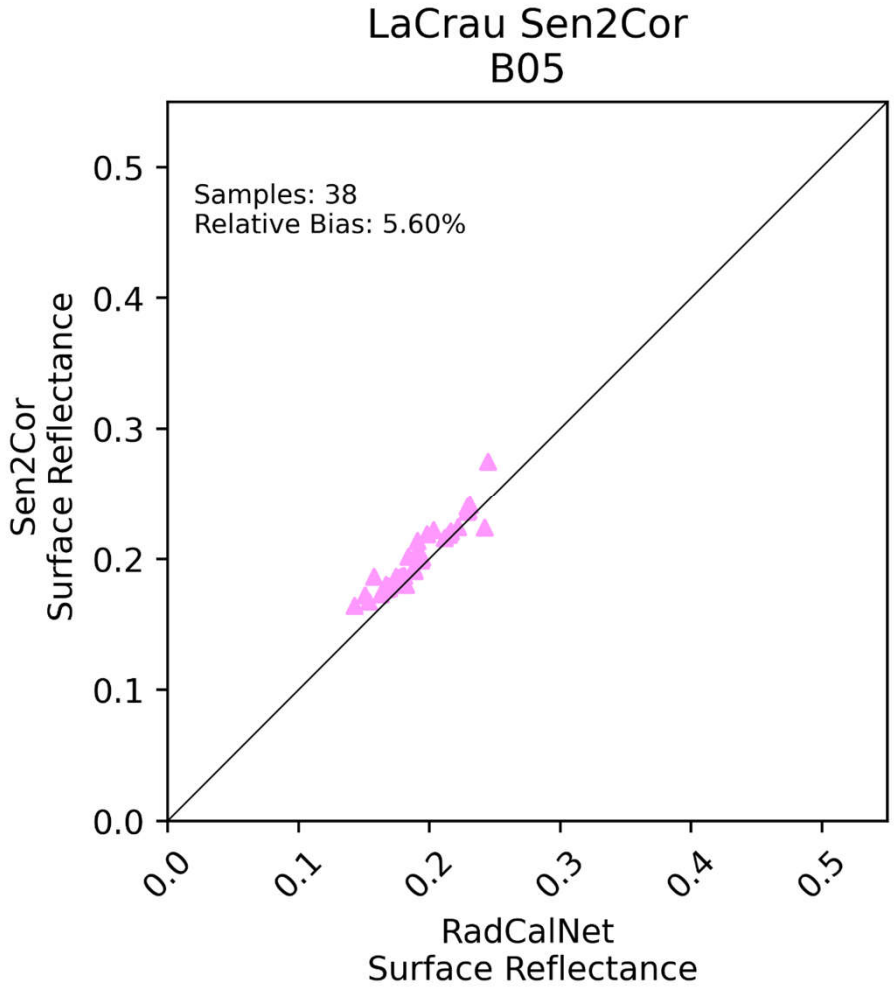
© ACRI-ST | OPT-MPC – 2021

ACIX-2 Radcalnet / ROSAS



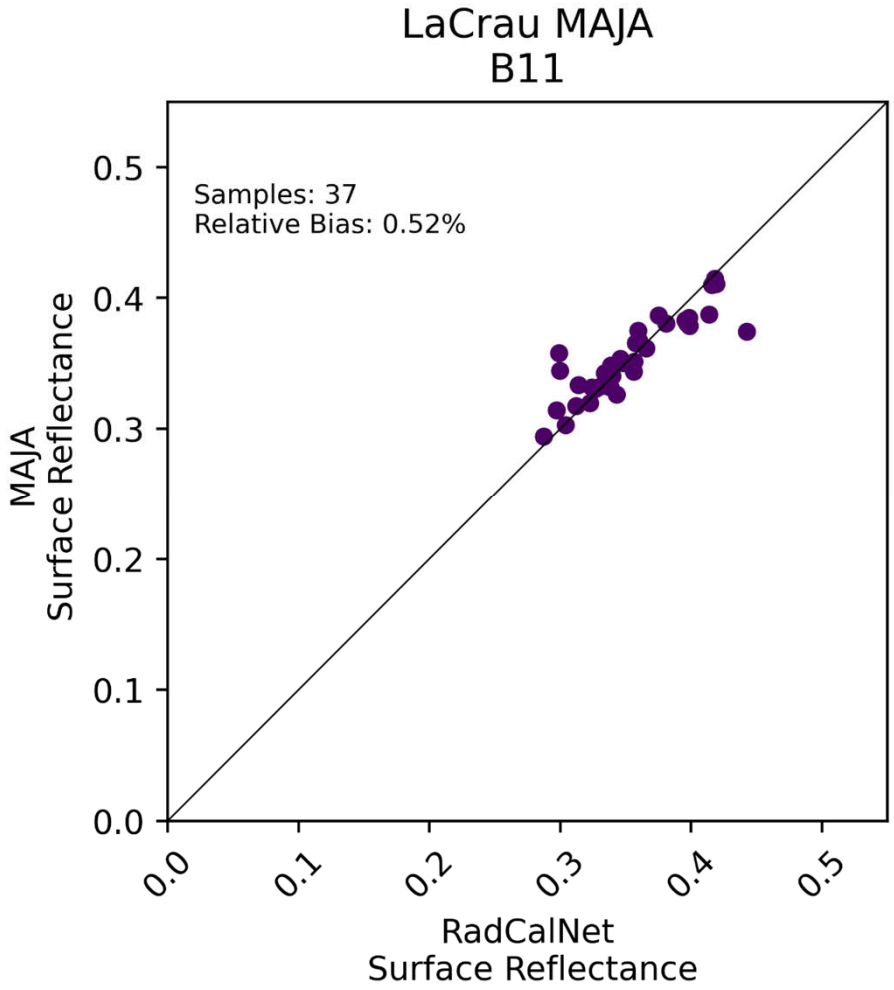
© ACRI-ST | OPT-MPC – 2021

ACIX-2 Radcalnet / ROSAS



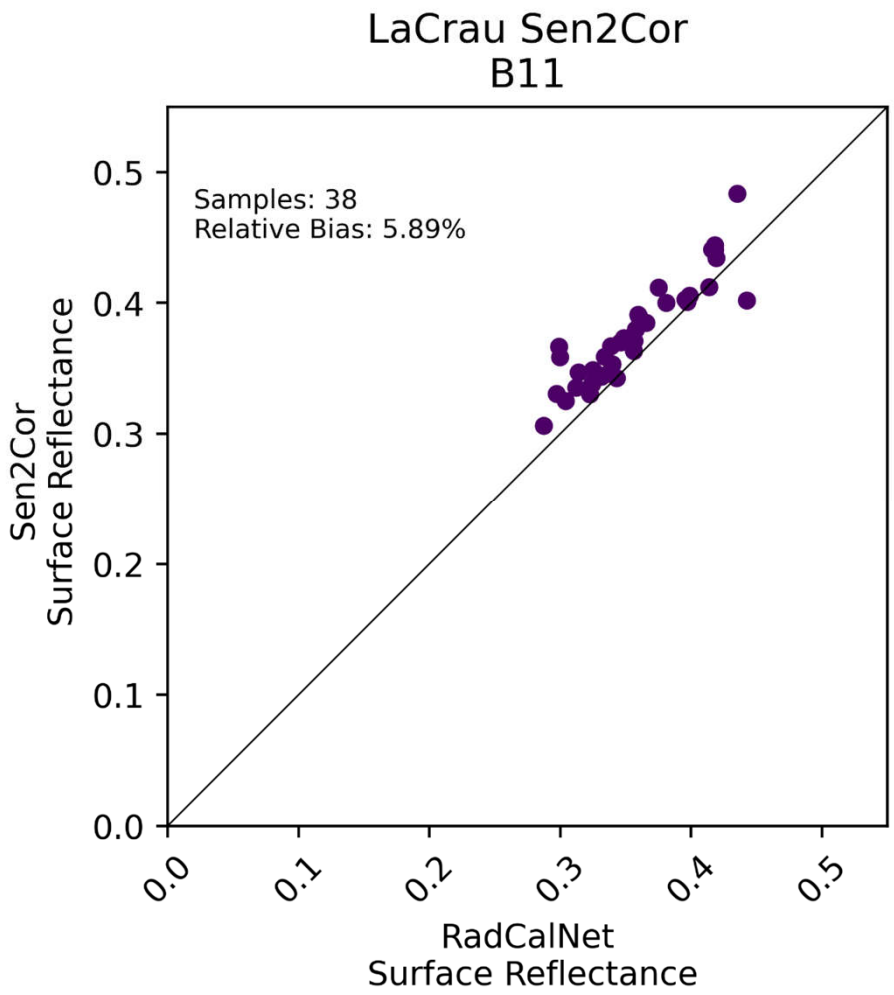
© ACRI-ST | OPT-MPC – 2021

ACIX-2 Radcalnet / ROSAS



© ACRI-ST | OPT-MPC – 2021

ACIX-2 Radcalnet / ROSAS



© ACRI-ST | OPT-MPC – 2021