# Sen2Cor version 2.10: Last evolutions &

# Focus on the update of Cloud Screening and Scene Classification algorithm

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European Union

**Sentinel-2** is a polar orbiting satellite constellation of two units carrying each one an optical imaging sensor called MSI (Multi-Spectral Instrument). Sentinel-2A was launched on June 23, 2015 and Sentinel-2B was launched on March 7, 2017.

Sentinel-2 **Level-2A processor Sen2Cor** is applied to Top-Of-Atmosphere (TOA) Level 1C ortho-image reflectance products. Sen2Cor Level-2A outputs are a scene classification image, aerosol and water vapor maps and a surface reflectance product.

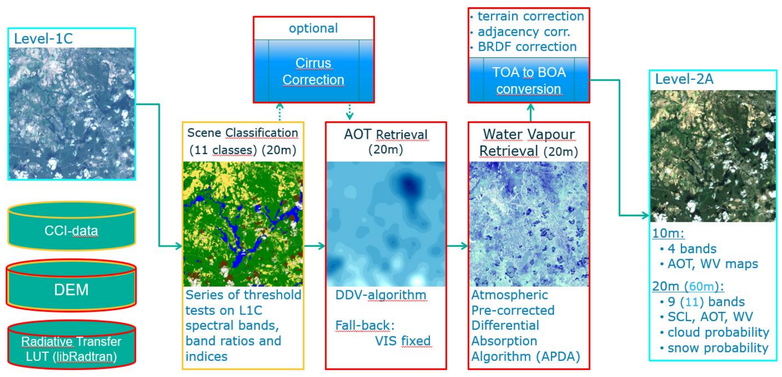
This poster presents the latest evolutions of Sen2Cor v.2.10 in terms of Product Format evolution, Cloud Screening, Atmospheric Correction and updated Quality Information. Sen2Cor v.2.10 is used to generate L2A Processing Baseline 4.0 products and for the future Collection-1 reprocessing. The poster presents also the latest updates of version 2.10 that makes use of the parallax properties of the Sentinel-2 MSI instrument to limit the false detection of clouds above urban and bright targets.

## Sen2Cor Processor Overview

Two main modules :
- Scene Classification (SCL)
- Atmospheric Correction (AC)

Radiative Transfer Model:
- **libRadtran**

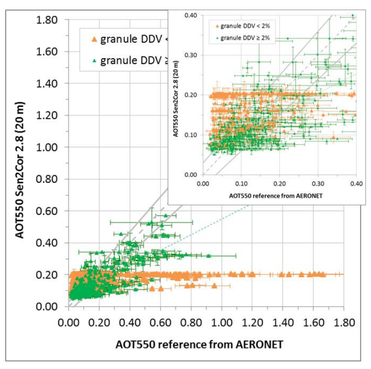
Sen2Cor can be run from:
- ➔ Command line
- ➔ Plugin of the Sentinel-2 Toolbox (**SNAP-S2TBX**).



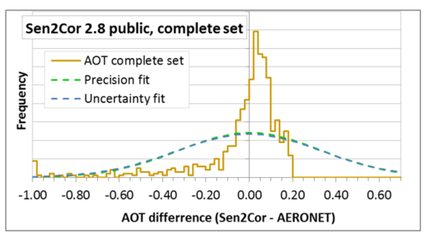

Sen2Cor processor can be downloaded from:
http://step.esa.int/main/third-party-plugins-2/sen2cor/

## L2A Product Quality Overview

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




› **solid lines**: Accuracy requirement
|ΔAOT550| ≤0.1*AOT550$_{ref}$+0.03
› **Dashed line**: Sen2Cor_output = Reference
› **Green triangles**: Results for **DDV**-algorithm
› **Orange triangles**: **fall-back** processing
› Linear trend line for DDV processing

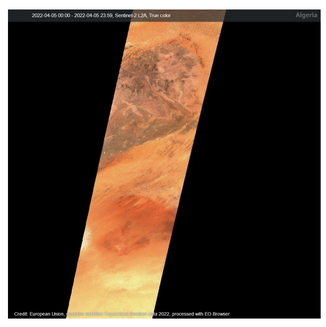



**Aeronet data is used as absolute reference in the L2A validation**
The authors thank the PI investigators and their staff for establishing and maintaining the AERONET sites used in this investigation.

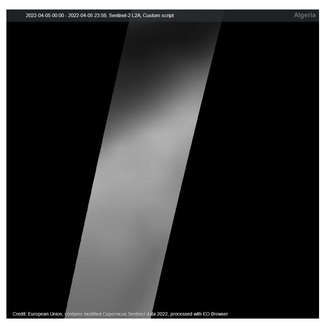
## Latest Evolutions

**Atmospheric Correction updates:**

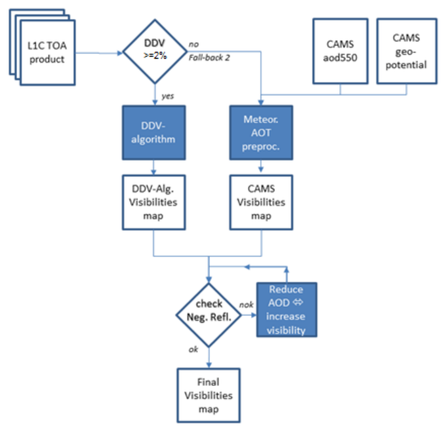
- CAMS aerosol data when DDV pixels are missing in the image



L2A True Colour Image



L2A AOT map derived from L1C CAMSFO




**Scene Classification updates:**

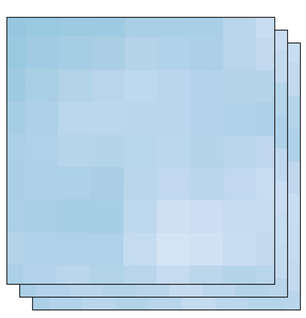
- SCL == 2 class limited to shadows: topographic shadows, tree shadows, building shadows
- Improved cast shadow algorithm + support of Copernicus DEM
- Limit false cloud detection on bright pixels
- Limit false snow detection in clouds
- Improve cloud shadow detection
- Dilation of cloud (80m) / cloud shadow (40m) / snow (20m)

**L2A product format updates:**

- Provision of band B01 also at 20m resolution
- Update of L2A Quality Indicators + **L2A_QUALITY.xml** file in QI_DATA folder
- Addition of a DOI (Digital Object Identifier)
- OZONE ECMWF activated & traced in MTD
- 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" -> AUX_**ECMWFT** (GRIB);
  - "Inclusion of CAMS auxiliary data" -> AUX_**CAMSFO** (GRIB); ;

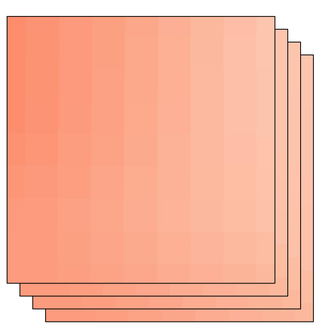
Updated Surface Reflectance Conversion:
SR = (DN – 1000) / 10 000

AUX_**ECMWFT**



Precipitable water content, mean sea level pressure, total column ozone, 10 m wind speeds, relative humidity

AUX_**CAMSFO**



Aerosol Optical Depth [unitless]
Total at different wavelengths, per aerosol types

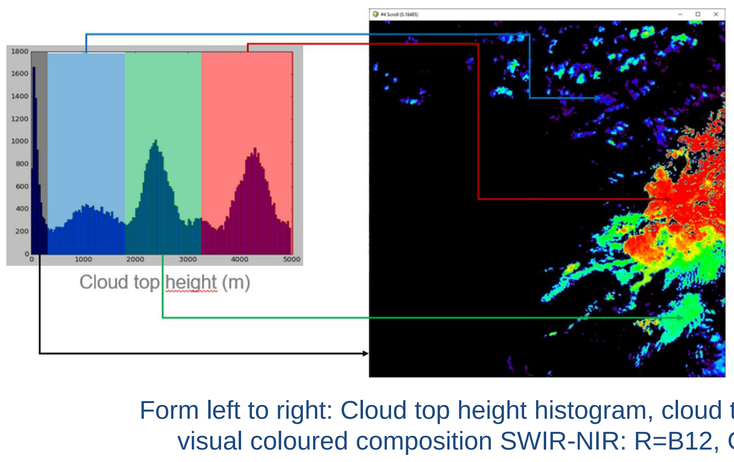
## S2 MSI parallax algorithm

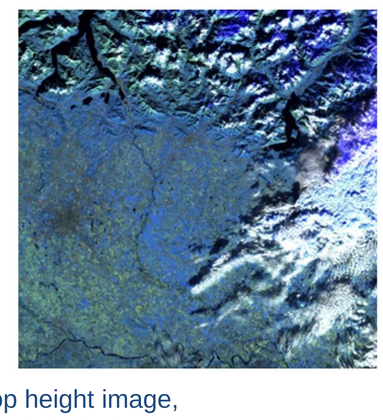
Level-2A Algorithm Theoretical Baseline Document (ATBD) version 2.10
https://step.esa.int/thirdparties/sen2cor/2.10.0/docs/S2-PDGS-MPC-L2A-ATBD-V2.10.0.pdf

**Algorithm overview:**

- Estimation using Sentinel-2 MSI instrumental parallax between: Band B08 (resampled at 20 m) and B8A
- The pixel displacement is computed for all pixels of the image (Telespazio algorithm using OpenCV library)
- Displacement is converted in cloud top height estimation (m) using B08/B8A parallax information and pixel resolution
  *Remark: height above DEM not altitude*
- Statistics on the cloud height distribution are computed and used to identify the regions of potential cloud shadow in the image (using sun angles).
- This information is then "crossed check" with potential cloud shadow pixel based on pixel radiometry (as in Sen2Cor v2.9)
- Clouds with cloud top height below 250 m are discarded from cloud mask for cloud shadow computation

- This algorithm is also used to:
  1) remove some of the bright surfaces/buildings detected as false clouds from final cloud mask.
  -> identified by very low pixel displacement
  2) Pixel displacement on snow pixels is used to check that snow pixels are located on ground and not in altitude (false snow in sky) -> identified by medium/high displacement



Form left to right: Cloud top height histogram, cloud top height image, visual coloured composition SWIR-NIR: R=B12, G=B11, B=B*A

## Recommendations

**Recommendations**:
- Use of a Digital Elevation Model (DEM) in Sen2Cor to improve scene classification
- Download and install ESA CCI auxiliary data package specific for version 2.10
- Use the default configuration shipped with Sen2Cor v.02.10.00
- Be cautious with L2A products acquired with Sun Zenith Angle (SZA) higher than 70°

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