Sentinel-2 Level-2 processing: Sen2Cor status and outlook for 2021
Outline

1. Sen2Cor processor overview
2. Sen2Cor versions (TOOLBOX) – L2A processing baselines (PDGS)
3. L2A product quality references
4. Future evolutions in 2021
5. Recommendations / Discussion
Sen2Cor processor overview

- **Level-1C**
  - Cirrus Correction
  - TOA to BOA conversion

- **CCI-data**
  - Scene Classification (11 classes) (20m)
  - Series of threshold tests on L1C spectral bands, band ratios and indices

- **DEM**
  - AOT Retrieval (20m)
  - DDV-algorithm
  - Fall-back: VIS fixed

- **Radiative Transfer LUT (libRadtran)**
  - Water Vapour Retrieval (20m)
  - Atmospheric Pre-corrected Differential Absorption Algorithm (APDA)

- **Level-2A**
  - 10m:
    - 4 bands
    - AOT, WV maps
  - 20m (60m):
    - 9 (11) bands
    - SCL, AOT, WV
    - cloud probability
    - snow probability

**4th SENTINEL-2 VALIDATION TEAM MEETING**
15–17 March 2021 | Virtual Event
Sen2Cor versions

General User’s versions:
Version 2.5 released on March 19, 2018 (publicly available)
Version 2.8 released on May 10, 2019 (publicly available)
Version 2.9 to be soon released

S2 PDGS versions:
Version 2.8 in operations since May 2019 >= L2A PB 02.12
Version 2.9 to be soon transferred to operations: L2A PB 02.15
(supports L1C refined products)
Level-2A processing baselines

- RAM consumption less than 4GB
- L2A OLIQC reports included

Level-1C evolutions (L1C PB 02.07)
- OpenJPEG 2.3 faster reading time
- Topographic correction extended

PB 02.08 (Sen2Cor v.02.06.03) 23 May 2018
PB 02.09 (Sen2Cor v.02.06.06) 8 Oct 2018
PB 02.10 (Sen2Cor v.02.06.06) 6 Nov 2018
PB 02.11 (Sen2Cor v.02.07.01) 21 Nov 2018
PB 02.12 (Sen2Cor v.02.08.00) 6 May 2019
PB 02.13 (Sen2Cor v.02.08.00) 8 July 2019
PB 02.14 (Sen2Cor v.02.08.00) 4 February 2020

- Single retrieval of atmospheric parameters (AOD & WVP) at 20 m
- Resampling of 20 m to 60 m
- Scene Classification using ESA CCI Data package
- Spatial homogeneity improved: blue path radiance rescaling -> OFF
  
- Topographic correction under clouds disabled
- PDGS Optimizations (dual databases)

Worldwide L2A production since 14 December 2018

L2A data quality consistent since PB 02.12
L2A product quality references

L2A Product Performance reported in the monthly L2A Data Quality Reports:


Next presentation:

Comparison of the Copernicus Sentinel-2 L2A Core Product distributed by ESA and the Sen2Cor Toolbox ‘user-generated’ product
Future evolutions

1. Compatibility with the Copernicus DEM @90m (PDGS format)
2. Support of PSD 14.6 (PSD updated for L1C refined products)
3. Sen2Cor supporting CAMS atmospheric data
4. Sen2Cor Scene Classification Evolution
5. Addition of L2A Quality Indicators
6. Provision of band B01 also at 20m resolution
7. Addition of a DOI (Digital Object Identifier)
8. Support of Landsat-8 and Python 3 (dedicated presentation)

2.9
2.10
3.0
Future evolution: Sen2Cor CAMS

Example of CAMS aod550 product 0.4 x 0.4 deg lat-lon grid source: Copernicus Atmosphere Monitoring Service (CAMS)

L2A improvements expected on non vegetated areas:

- Bare areas like deserts
- Ice/snow covered areas
- Coastal areas, seas
- Winter products
Future evolution: Sen2Cor CAMS

- Fall back solution when DDV pixels are missing in the image.
- ECMWF-CAMS Total AOD at 550 nm short term forecast (< 24 hours)
- Sen2Cor CAMS developed by TPZ F
- Validation performed by DLR
Future evolution: Scene Classification

- Improved casted shadow algorithm supporting Copernicus DEM 30 m
- Limit false cloud detection on bright pixels
- Limit false snow detection in clouds
- Improved cloud shadow detection
- Dilation of cloud (80m) / cloud shadow (40m) / snow (20m)

Cloud top height estimation derived from S2 MSI instrumental parallax properties used to improved the quality of cloud shadow and cloud / snow mask detection.
Future evolution: Scene Classification

Location: Baltimore, USA
Date: 10/07/2018

Prototype
L1C

v. 2.8
Artificial bright targets
Future evolution: Scene Classification

Location: Atlas, Morocco
Date: 18/12/2017

Natural bright targets: slopes facing sun

Prototype

L1C

v. 2.8
Future evolution: Scene Classification

Location: Arizona, USA
Date: 01/05/2017

Natural bright targets: bright sand/salt desert

Prototype

v. 2.8

L1C
Recommendations / Discussion

- **With Toolbox version:**
  - Use of a Digital Elevation Model (DEM) in Sen2Cor to improve scene classification
  - Download and install ESA CCI auxiliary data package
  - Use the default configuration shipped with Sen2Cor v.02.08.00

- **General comment:**
  - Careful with L2A products acquired with Sun Zenith Angle (SZA) higher than 70°
  - More details in monthly data quality reports
External links and references

- L2A products available on OpenHub
  
  https://scihub.copernicus.eu/dhus/

- Sen2Cor version 2.9 for SNAP Toolbox (soon) available at:
  
  http://step.esa.int/main/third-party-plugins-2/sen2cor/
Thank you for attention!

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Correlation plot of Sen2Cor AOT$_{550}$ retrieval at 20 m resolution versus AOT$_{550}$ reference from AERONET (25 AERONET sites)

Future evolution: Sen2Cor CAMS

Sen2Cor 2.5 public version

Sen2Cor 2.5 CAMS prototype
Future evolution: Scene classification

RGB: (B12, B11, B8A)

Cloud top height estimation
Future evolution: Scene classification

Cloud top height (m)

Cloud top height estimation