SENTINEL 2

S2 MPC

Sen2Cor Software Release Note

Ref. S2-PDGS-MPC-L2A-SRN-V2.8.0

The power of innovation

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Change Log

Issue	Date	Reason for change	Section(s)
1.0.1	June 2014	Initial Delivery	N/A
2.0.3	May 2015	First Maintenance Patch	3.2
2.0.4	Oct. 2015	Urgent fix for correcting the scaling problem on the Level 2A output files	3.1.19
2.0.5	Nov. 2015	Fix for calibration problem between 60/20 and 10 m resolutions	3.1.18
2.0.6	Dez. 2015	Fix corrupted version of windows openjp2.dll Added correction parameter for sun-earth distance	3.1.17
2.1.0	Feb. 2016	Parallel processing on tile base	3.1.16
2.2.1	Apr. 2016	Integration of Look Up Tables for Summer / Winter /Rural / Water atmospheric conditions, automated ozone determination, automated aerosol / atmosphere detection, improved up- and down sampling routines, new scene classification, selection of planet DEM	3.1.15
2.3.0	Nov. 2016	Support of PSD 14.2 in parallel to PSD 13.1 and corrective maintenance fixes as specified	3.1.14
2.3.1	Feb. 2017	Maintenance fixes as specified	3.1.13.1
2.3.1	Feb. 2017	Added list of known issues	3.3
2.3.1	Feb. 2017	Added list of planned evolutionary upgrades	3.4
2.4.0	Jun. 2017	Upgrade of Configuration Parameters according to CCN.1	3.1.12
2.4.0	Jun. 2017	Maintenance fixes as specified	3.1.12.1
2.4.0	Jun. 2017	Updated list of planned evolutionary upgrades	3.1.12.2
2.4.0	Jun. 2017	Provision of new stand-alone installers (Independent of Anaconda, Beta Release)	4.1
2.5.0	Nov. 2017	New Product Specification 14.3 implemented	4.1

Issue	Date	Reason for change	Section(s)
2.5.0	Nov. 2017	New PSD design for integration into PDGS	3.1.11.1
2.5.0	Nov. 2017	Improvement of Scene Classification	3.1.11.1
2.5.0	Nov. 2017	Improvement of Cirrus Correction	3.1.11.1
2.5.0	Nov. 2017	Evolutionary upgrades as specified	3.1.11.1
2.5.0	Nov. 2017	Maintenance fixes as specified	3.1.11.1
2.6.0	Feb. 2018	Implemented items for Phase II as described for section 3.1.1	3.1.10.2
2.5.5	Feb. 2018	Maintenance fixes as specified	3.1.10.1
2.6.1	Feb. 2018	Evolutionary upgrades as specified	3.1.9
2.6.1	Feb. 2018	Maintenance fixes as specified, merge with 2.5.5	3.1.9
2.6.1	Feb. 2018	Removed sections on Anaconda installation as no longer of relevance	4.1
2.6.1	Feb. 2018	Added comments and changes after review	All Pages
2.6.2	Mar. 2018	Implemented updates and fixes according to Section	3.1.8
2.6.3	Apr. 2018	Implemented updates and fixes according to Section	3.1.7
2.6.4/5	June 2018	Implemented updates and fixes according to Section	3.1.6
2.6.6	Sept 2018	Implemented updates and fixes according to Section	3.1.5
2.7.0	Oct 2018	Implemented updates and fixes according to Section	3.1.4
2.7.1	Nov. 2018	Implemented updates and fixes according to Section	3.1.3
2.7.2	Dec. 2018	New section for Toolbox Users written	3.1.2
2.8.0	Jan. 2019	Added fixes	3.1.1

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Table of contents

1. Introduction

1.1 Purpose of the document

This document is produced in the context of the SENTINEL-2 (S2) Mission Performance Centre (MPC) maintenance and evolution. Its purpose is to document the performed corrective maintenance and evolutionary upgrades applied to the Sentinel 2 Level-2A processor software named Sen2Cor, its installation and environment settings.

1.2 Document structure

Chapter 1 provides the introduction, describing the scope and structure of the document, and a list of applicable reference documents.

Chapter 2 describes in short the scope of the current release and the content of the delivery

Chapter 3 gives an overview on the history of the evolution and applied fixes for each release in a downward order.

Chapter 4 gives an introduction how to install and configure the software and its environment.

Chapter 5 lists the Copyright Notes

1.3 References

The following is a list of documents with a direct bearing on the content of this release note.

Table 1-1: Reference Documents

Document ID	Description	Version
S2-PDGS-MPC-L2A-PFS	Sentinel-2 MSI – Level 2A Product Format Specification	14.5
S2-PDGS-MPC-L2A-IODD	Sentinel-2 MSI – Level 2A Prototype Processor Input Output Data Definition	2.8.0
S2-PDGS-MPC-L2A-SUM	Sentinel-2 MSI – Level 2A Prototype Processor Installation and User Manual	2.8.0
S2-PDGS-MPC-L2A-ATBD	Sentinel-2 MSI - Level 2A Products, Algorithm Theoretical Basis Document	2.1
S2-PDGS-MPC-L2A-DPM	Sentinel-2 MSI – Level 2A Detailed Processing Model	1.0
S2-PDD	GMES Space Component – Sentinel-2 Payload Data Ground Segment (PDGS), Product Definition Document	2.3
S2-PSD	Sentinel-2 Products Specification Document	14.5

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2. Software release overview

Sen2Cor release 2.8.0 is the first official release for users operating Sen2Cor in the stand-alone mode since Version 2.5.5. Many evolutionary upgrades and fixes have been applied to the processor operating in the PDGS environment since then. Now, as the multiple changes and improvement for the operative environment have been consolidated, it is time to make it also available for the user's community.

As the complete evolutional history of all changes and upgrades applied to the PDGS mode since Version 2.5.5 might confuse, section 3.1.1 lists an excerpt of all those relevant changes and fixes which are of importance to the user's community. All further sections below this excerpt up to the release description of version 2.5.5 can be ignored from a Toolbox user's perspective.

Although numerous changes and improvements in terms of speed and size have been implemented since Version 2.5.5, the basic interface with respect to Version 2.5.5 has not changed much for the standard Toolbox user. Details for the new options implemented can be found in section 3.3.2 of the User's Manual. It should be noted, that Sen2Cor could also be configured in the so-called "PDGS mode" as a stand-alone application, driven via command-line. However, this full configuration is quite complex and is only recommended to very experienced users or software integrators. Users, interested to set-up this PDGS mode, should read section 3.3.1 of the User's Manual.

2.1 Delivery List

Delivery number	Description
D1	Processor Software [Sen2Cor-V2.8.0]. Stand-alone installers for Linux, macOS, Windows
D2	This release note [S2-PDGS-MPC-L2A-SRN-V2.8.0]
D3	Software Configuration and User Manual, V.2.8, Issue 1

Details on the applied evolutionary upgrades and fixes are listed in section 3.1.1 (Toolbox changes since release 2.5.5) and 3.1.2 (changes with respect to Sen2Cor 2.7.2).

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3. Status of the software configuration item

3.1 Evolution History

3.1.1 Evolution since release 2.5.5 for Sen2Cor Stand Alone Version (Toolbox Mode)

3.1.1.1 Software Installation

The installation itself is equivalent to the previous Toolbox Version 2.5.5.

3.1.1.2 Evolutionary Updates

This section lists all evolutionary changes since version 2.5.5 in a chronological order:

1. The Usage of Sen2Cor in Toolbox mode supports previous PSD version 14.2 by upgrading the metadata to PSD Version 14.5. Old multiple tile versions (PSD Version 13.1) are no longer supported. A reprocessing of these old 13.1 formats to PSD Version 14.X on the Data Hub Server is however foreseen, so that also very old L1C products can be processed again in the near future.

2. A series of new command line options for the Toolbox mode is present. Users are requested to read section 3.3.2 of the User Manual to get an overview on the new options.

3. Memory and speed optimisations have been performed:
   - Improved RAM consumption is now less than 4 GB;
   - Starting with this version, all bands are only read in once for all resolutions.
   - Since Version 2.8.0, the multithreading features of OpenJPEG 2.3 are supported for speeding up of the reading of the L1C Images.

4. Version 2.8.0 does no longer perform the processing of a 60m resolution by default. If no resolution is specified via command line, only 20m and 10m resolutions are processed. Instead, a down sampling option to 60m resolution can be chosen as a post- processing step for a 20m processing via configuration. This improves the overall performance by about 3 – 5 minutes and leads to equivalent reflectance products for 60 and 20 m resolution (except the resampling effects). The option to perform a 60m down sampling following a 20m processing can be activated via the configuration file L2A_GIPP.xml:

   Option: <Downsample_20_to_60>TRUE</Downsample_20_to_60>

   If "--resolution=60" is specified via the command line, a 60m resolution processing is however still achievable.

5. The Scene Classification of snow/ice has been improved, enabling the detection of snow above frozen lakes and icebergs in Arctic and Antarctic Sea. This has been done relying less on ESA CCI aux data and relaxing one of the snow thresholds.

6. A new option for the output of images in raw format instead of JPEG-2000 has been implemented, as described in SUM and IODD. Export for RAW and GeoTiff and aligning output format to L1C input (Kakadu) has been added.

7. Option to disable the terrain Correction using a DEM: It is now possible to decouple the DEM processing as an option or a configuration of the L2A_GIPP.xml. This has been achieved by using the same routines like in flat terrain calculation (dtm_flat) and disabling the terrain iteration, for the terrain corrections, whereas Scene Classification, AOT (and WVP) are still calculated using the DEM input. There is now a new option <DEM_Terrain_Correction> in the L2A_GIPP configuration file, which can be set to TRUE / FALSE (see also Configuration Changes).

8. The size of the internal image database has been made configurable via the configuration file L2A_GIPP.xml. The following measures have been performed:

   ▪ The size of the used 10m JP2 test Image is: 156.6 MB
   ▪ The size of HDF5 database in uncompressed mode is 241.2 MB for storing the single test image above.
   ▪ The database can effectively be compressed to ~ 160 MB using compression level 1-4 with an average additional time of 4-6 s for the read of each band. All higher compression levels are not recommended. For PDGS operations default configuration is compression mode 1, whereas a compression mode 0 is recommended for standards users, giving priority to a better processing speed.

Table 2: database size and access time dependent for selected compression level

Compression Level	DB Size (%)	Read (s)
0	100	0.3
1	68	4
2	67	5
3	67	7
4	66	6
5	66	9
6	65	15
7	65	20
8	65	57
9	65	102
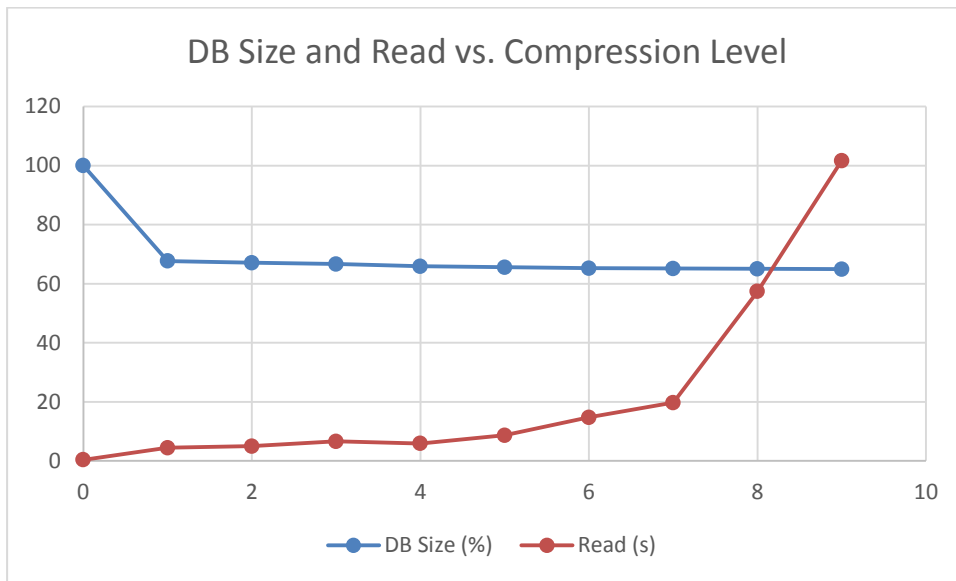
Figure 1: database size and read access time vs. compression level

9. Splitting the internal database into two entities: Initial need for this optimisation was the fact that the internal database could grow up to > 5 GB and thus was impossible to keep in a RAM disk in the PDGS mode. The following changes have been implemented:

- In the first processing stage the image database will load only the bands needed for the 20 m processing (except 10 m Band 8). After the 20m processing is performed, all bands (except the three 10m bands 1-3) are removed and Band 8 will be loaded. Thus, the database will keep a size below 1 GB during the whole processing.

- The temporary database will import all auxiliary data (like the DEMs and ESACCI images). It will additionally store the resampled bands from the image database and the processed products from the 20 m Scene Classification (Classification Map) and Atmospheric correction (AOT/Visibility and Water Vapor). After the 20 m processing is performed, only these products will be up-sampled to 10 m and copied into a new temporary database. The old database with all products no longer needed will be removed.

- In the 10 m processing the temporary database keeps the AOT/Visibility and Water vapor and imports the new resampled auxiliary data, needed for the 10m processing.

- The down-sampling routine to 60 m has also improved in that way that the output products will be directly converted to their final format, so that no further storage of these down-sampled products in the database is required.

- Additionally, all bands which are no longer needed in the processing chain are removed from the temporary database, to free space for other intermediate products.

With this, the following measures have been obtained by operation of a full sized L1C tile with configured DEM, processing for 20 and 10 m and a down-sampling of the 20m product to 60 m.

Resolution	Image DB	Temp DB
20 m processing	739 MB	1.53 GB
Down sampling to 60	No changes in DB size	No changes in DB size
10 m processing	867 MB	1.963 GB

10. ESACCI-LC package for Scene Classification: The ESACCI-LC for Sen2Cor data package is prepared for users of Sen2Cor version ≥ 2.5 who want to benefit from the last improvements of Sen2Cor Cloud Screening and Classification module. This auxiliary data information is used in Sen2Cor to improve the accuracy of Sen2Cor classification over water, urban and bare areas and to have a better handling of false detection of snow pixels.

Please refer to section 3.1.1 of the User's Manual for details concerning the installation of this auxiliary data. Users of Sen2Cor version ≥ 2.5 should download this ESACCI-LC for Sen2Cor data package (ESACCI-LC-L4-ALL-FOR-SEN2COR.zip) from this location: *http://maps.elie.ucl.ac.be/CCI/viewer/download.php*

The two files and the directory contained in this zip file shall be copied at this location of Sen2Cor installation: '*$SEN2COR_BIN/aux_data/.*'

11. Supporting multithreading feature for reading L1C Images with OpenJPEG. OpenJPEG, version 2.3 allows the usage of multithreading to speed up the reading of the L1C input images. The configuration is set by default to AUTO, which detects the amount of usable threads by calling cpu_count(). If the user does not want this feature or want to set the amount of threads individually, the parameter can be changed between a value of 1 (single thread processing) up to 8. See section 3.1.1.4. Figure 2 below shows the speed improvement for reading on a 2 Core Intel I5 platform with 8 GB of RAM between OpenJPEG 2.1 (left) and (new) OpenJPEG 2.3 with one, two and four threads applied.
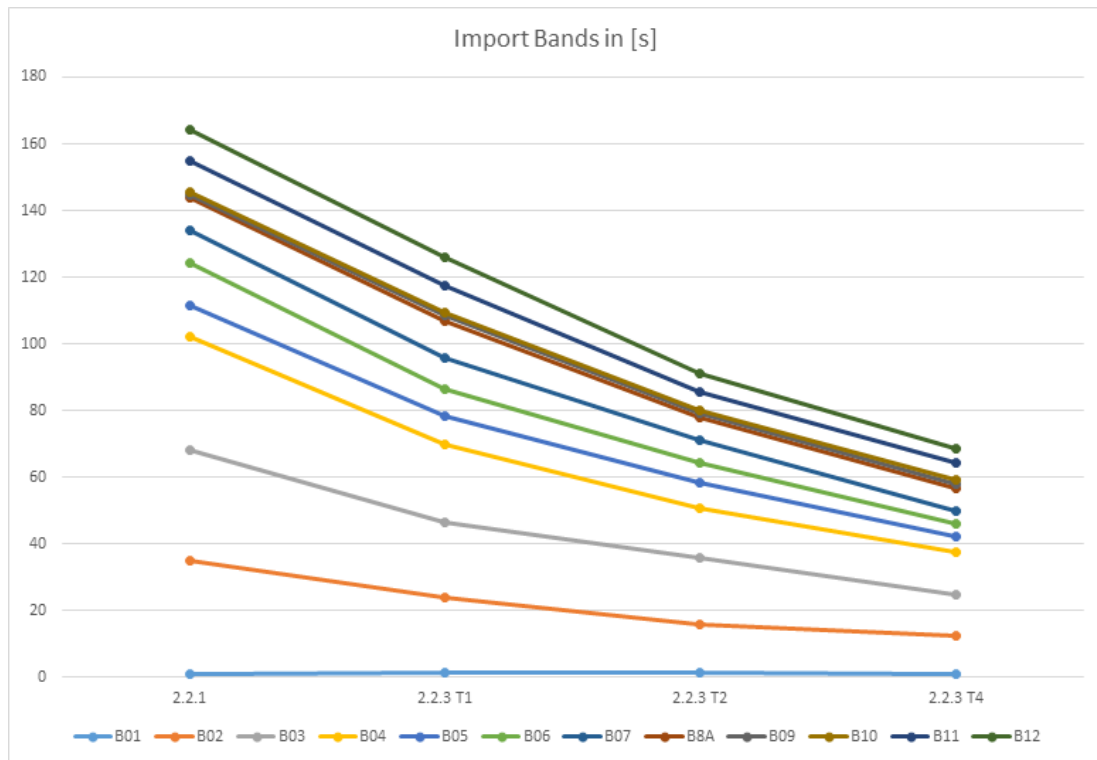
Figure 2: Performance improvement using OpenJPEG 2.3 and multithreading

3.1.1.3 Corrective Maintenance

The following fixes have been applied to Sen2Cor since Release 2.4.2:

- SIIMPC-1241: ZeroDivisionError has been fixed.
- SIIMPC-1245: Mismatches in the surface refelectance between 60, 20 and 10m have been fixed.
- SIIMPC-1241: fixing a zero division error when only background pixels are identified.
- SIIMPC-1255: datastrip shows a wrong satellite ID and version number under certain conditions.
- SIIMPC-1257: If no ESA CCI auxiliary data are installed the following entries in the L2A Datastrip are set to "None":
  <ESACCI_WaterBodies_Map>
  <ESACCI_LandCover_Map>
  <ESACCI_SnowCondition_Map_Dir>
- SIIMPC-1271: Sen2cor fails with higher version of numpy in L2A_SceneClass.py.
- SIIMPC-1272: Correcting the no data mask in the scene classification module as shown below.
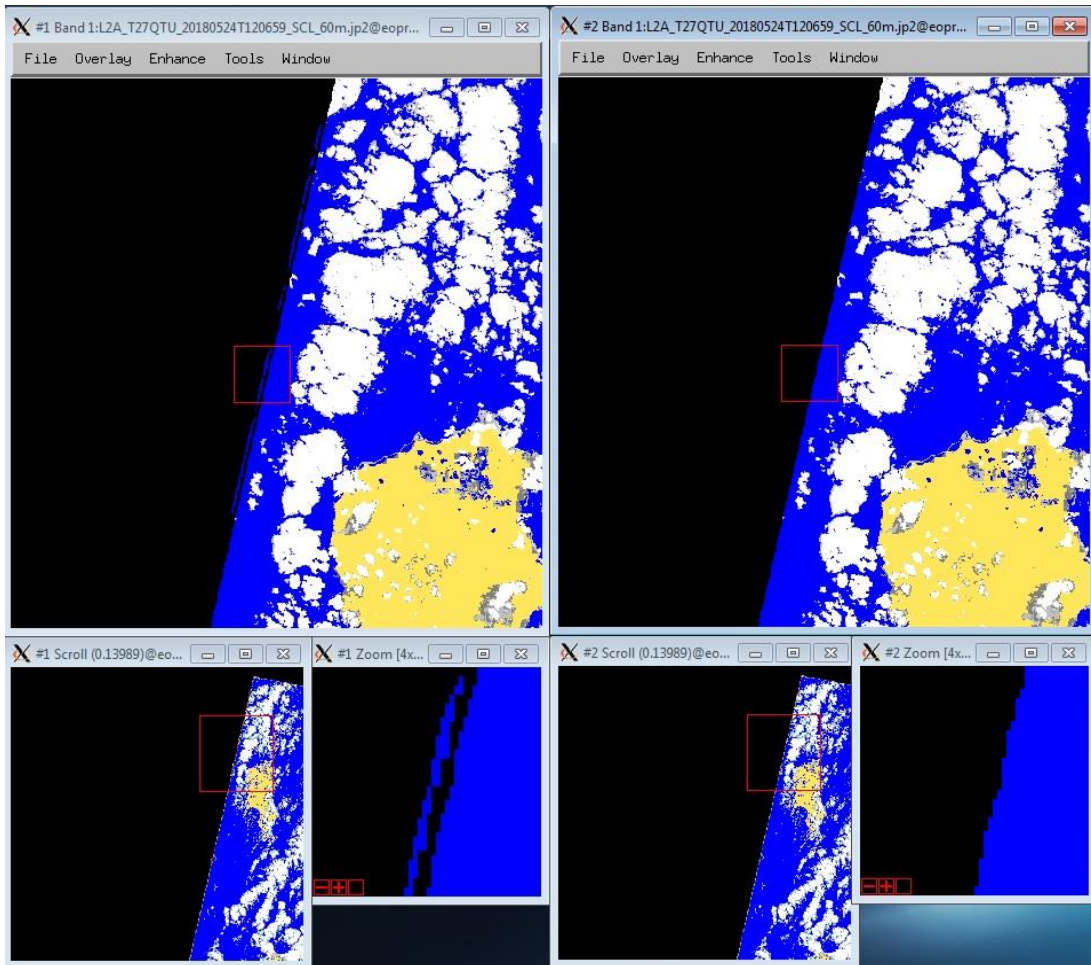
Figure 3 – improvement of no data mask.

- SIIMPC-1286: resampling issue after 60m resampling restart
- SIIMPC-1289: Tile processing failed with error "index 255 is out of bounds"
- SIIMPC-1341 (and SIIMPC-1241): "failure with error "All images contain only background pixels": Instead of stopping with an error message, the processing is now performed excluding the atmospheric correction. A full (but empty) product will be stored instead.
- SIIMPC-1344: The configuration parameter DEM_Unit was removed from the configuration file L2A_GIPP, as [cm] and [dm] are not used in the code. DEM Dimension in the code is always given in [m]. The corresponding code, which led to the error, was removed.
- SIIMPC-1349: move getBand() calls outside of Loops: After moving these calls outside of the loop about 200 – 250 seconds are saved and the database access decreases from 321 calls down to 31.
- SIIMPC-1354: Concurrency problem with configPic.p. The data file configPic will additionally get the filename of the corresponding tile as prefix to avoid concurrency and will be kept in the work directory, to be aligned with all other temporary created files.

- SIIMPC-1019: Pixels under semi-transparent clouds are erroneously "terrain-corrected". This leads to artefacts where the mountain slopes opposed to the sun are artificially "brightened". This has been resolved by applying a mask for non-transparent clouds (and saturated or no data pixels) to exclude them from terrain correction. Figure 6 below shows in clockwise order: L1C, Band4 input. L2A Band4 with artefact. L2A_Band4 after correction, L2A_AOT as a control for avoiding possible side effects.
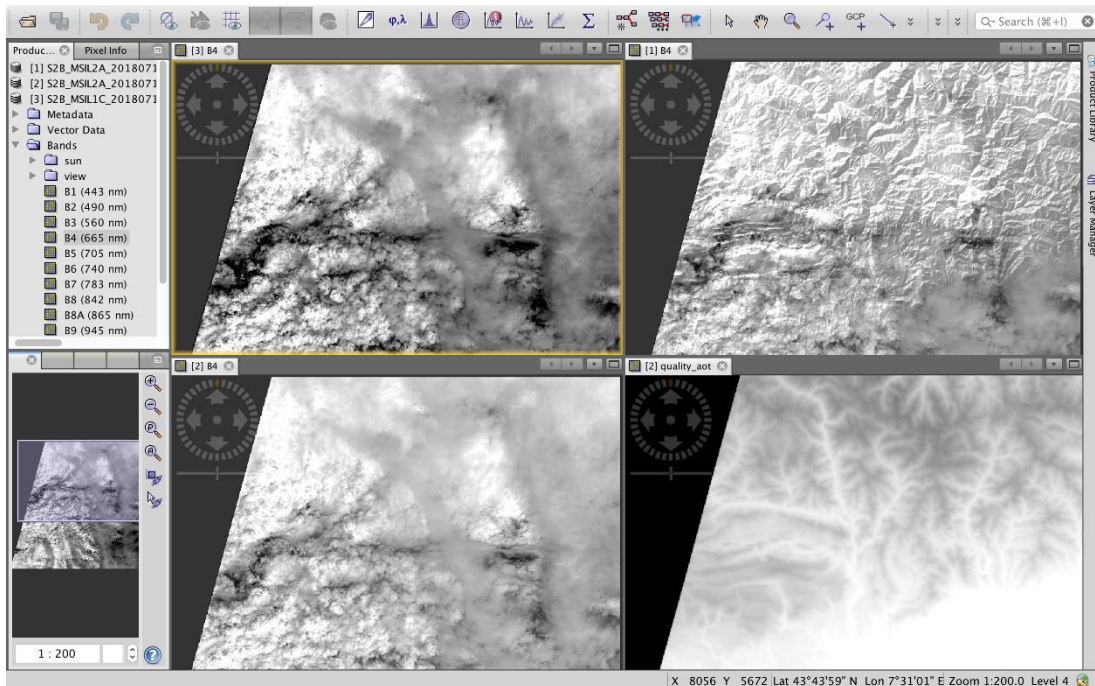
Figure 4: excluding terrain correction for clouds

- SIIMPC-1357: wrong MASK_FILENAME in tile metadata. Metadata now show the correct filenames.
- SIIMPC-1298: disable the insertion of a DEM string in the metadata if no DEM is selected. The user can now alternatively insert a string of individual choice in the DEM_reference field. This string is then shown if the user selects a DEM for usage. If no DEM is selected, 'none' will be inserted in the metadata instead.
- SIIMPC-1366: In Sen2Cor-02.06.05 and Sen2Cor-02.06.06 the files .estimation and .progress are written in folder Sen2Cor-02.06.06-Linux64/lib/python2.7/site-packages/sen2cor/log/ instead they shall be written in the folder working_dir in order to avoid conflicts when several tiles are processed in parallel.
- SIIMPC-1341: Processor now creates empty bands for AOT and Water Vapor, if no reflectance pixels are found in the input files.
- SIIMPC-1376: During IVV, It has been discovered that, when the DEM_Directory is not correctly filled in in the GIP_L2ACFG file and Sen2Cor cannot find it, it still exits with code 0 giving a wrong success message. This has been corrected and will give now a qualified error message.

- <u>SIIMPC-1225:</u> MPC/CC verification of the sample PDGS L2A - NO_DATA values present, patch applied.
- <u>SIIMPC-1226:</u> ozone value 370 added as an allowed value in the L2A_GIPP.xsd schema. Was initially missing.
- <u>SIIMPC-1390</u>: An alignment of the level 2A Metadata between the products available on the SciHUB and the products generated by Sen2Cor in the Toolbox mode has been performed.
- <u>SIIMPC-1427</u>: Discontinuities in topographic correction. It has been noticed over Sahara (see image below) that some L2A tile seems to be terrain-corrected while the other neighbouring tiles are not terrain-corrected. These different processing behaviours are caused by a threshold used in the Atmospheric Correction algorithm, when checking the peak-to-peak height in the tile pixels. For some tile, the peak-to-peak height condition leads to a terrain correction, whereas for some adjacent tiles, the peak-to-peak height condition leads to a flat terrain assumption without terrain correction. The chosen solution was to make the threshold value of this peak-to-peak height condition configurable in the file L2A_CAL_AC_GIPP.xml. Setting a lower value for peak-to-peak height condition allows getting more tiles to be processed with terrain correction, still excluding flat areas like seas. The default value is now set to 50 m instead of 300 m as it was before.
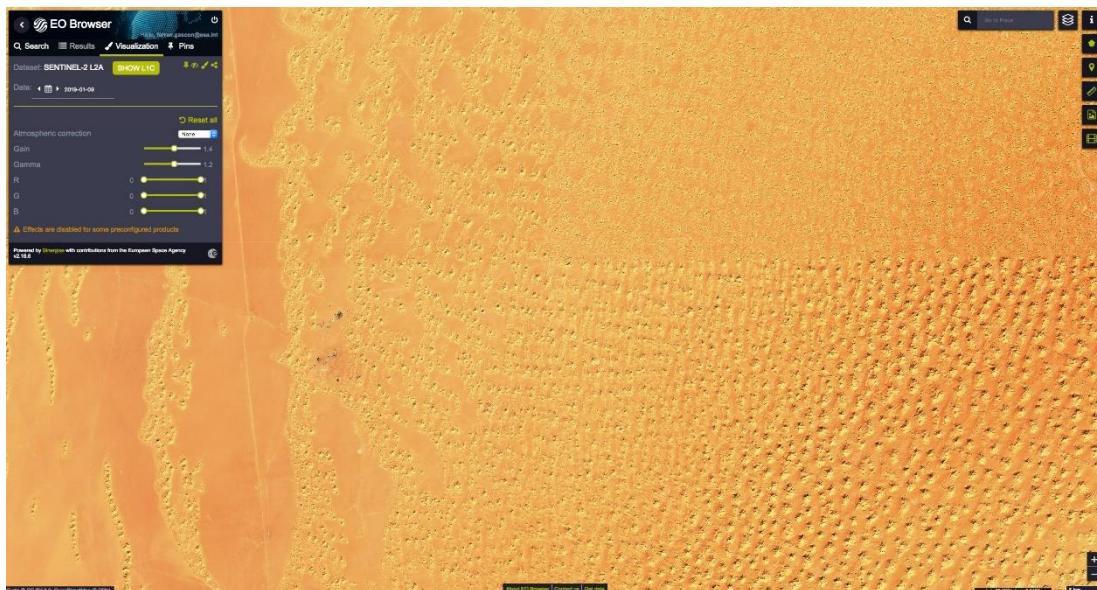

Figure 5: changes in the peak-to-peak values between different tiles

3.1.1.4 Configuration Changes

Configuration as contained in the **L2A_GIPP.xml.** The configuration file has changed considerably. So it is advised to compare the L2A_GIPP.xml from version 2.5.5 with the recent one and to align to the new version, if individual changes have been performed. The following parameters have been changed in detail:

- **Operation_Mode:** TOOLBOX/PDGS: This configuration has been removed. Sen2Cor automatically detects via the command-line settings, which operation mode shall be performed.

- **Target_Directory:** this configuration has been replaced by the command-line option –output_dir, which is equivalent for Toolbox and PDGS mode.

- **DEM_Reference:** no changes to Version 2.5.5 when using SRTM DEMs. If Planet DEMs are used, it is possible to add here the local path where the DEM's are installed. This will then be displayed in the datastrip metadata. Note: this is only an optional string. It has no impact on the configuration itself.

- **Downsample_20_to_60:** TRUE/FALSE: this configuration has been added. If it is set to TRUE a downsampling from 20 to 60 m resolution will take place as a post-processing step @ 20 m processing.

- **PSD_Scheme:** Version 13.1 has been removed, as it is no longer supported, version 14.3 has been removed, as it is unused.

- **DEM_Terrain_Correction:** TRUE/FALSE: this configuration has been added to exclude the terrain correction when using a DEM (see SIIMPC-557 and SIIMPC-1298).

- **DEM_Unit:** this configuration has been removed, as [cm] and [dm] are not used in the code. DEM Dimension in the code is always given in [m].

- **Database_Compression_Level:** this configuration has been added and is by default set to 0 for standard users and 1 for PDGS operations.

- **Nr_Processes:** This parameter has been removed as the processing of multi tile products (until PSD 13.1) is no longer supported. In previous versions of Sen2Cor (up to 2.5.5), it was possible to process multiple tiles in parallel with one single instance of the application. It is however still possible, to run several instances of Sen2Cor in parallel, to process different tiles.

- **Nr_Threads:** this is a new parameter allowing the usage of multithreading to speed up the reading of the L1C input images (see section 3.1.1.2 above). It is set to AUTO by default, which detects the amount of usable threads by calling cpu_count(). If the user does not want this feature or want to set the amount of threads individually, the parameter can be changed between a value of 1 (which is single thread processing, as before) up to 8.

- **AC_Dem_P2p_Val:** this parameter in the expert configuration file L2A_CAL_AC_GIPP is related to SIIMPC-1427 (see section 3.1.1.3 above). It is set by default to 50 instead of a hard coded value of 300 as it was before. It can be changed back up to 300, but it is recommended to keep the default value.

3.1.1.5 Differences between DHUS and Toolbox generated L2A User Product

The HTML folder is not present in the Toolbox generated L2A user product

The manifest is generated differently for L2A products on the Data Hub Server in comparison to the Toolbox generated user product.

Both issues will be aligned in future releases.

At pixel level some differences can be found which are mainly due to the usage of different DEM (e.g. SRTM vs PlanetDEM for L2A DHUS products) and a different JPEG2000 encoding library (OpenJPEG vs Kakadu for L2A DHUS products).

Product Quality data are also different. In Toolbox mode, they are copied from L1C QI_DATA, whereas they are generated with OLQC L2A software for DHUS products.

3.1.2 Evolutions since release 2.7.2

3.1.2.1 Software Installation

The installation is equivalent to the previous version 2.7.2.

3.1.2.2 Evolutionary Updates

SIIMPC-1420 + SIIMPC-1421 : update of the python runtime libraries to support OpenJPEG 2.3.

SIIMPC-1422 : supporting multithreading feature for reading L1C Images with OpenJPEG 2.3. See further descriptions in section 3.1.1.2.

3.1.2.3 Corrective Maintenance

SIIMPC-1419 : remove the full path for MASK_FILENAME in the tile metadata for PDI (PDGS) mode.

SIIMPC-1424 : small clean-ups on Windows had been required due to the long period of evolutions concentrated on the Linux systems only.

SIIMPC-1427 : Discontinuities in topographic correction. It has been noticed over Sahara that some L2A tile seems to be terrain-corrected while the other neighboring tiles are not terrain-corrected. The origin of these different processing behaviors is caused by a threshold used in the Atmospheric Correction algorithm, when checking the peak-to-peak height in the tile pixels.

For some tile, the peak-to-peak height condition leads to a terrain correction, whereas for some adjacent tiles, the peak-to-peak height condition leads to a flat terrain assumption without terrain correction. The chosen solution was to make the threshold value of this peak-to-peak height condition configurable in the file L2A_CAL_AC_GIPP.xml. Setting a lower value for peak-to-peak height condition allows to get more tiles to be processed with terrain correction, still excluding flat areas like seas. De default value is now set to 50 m instead of 300 as it was before.

3.1.3 Evolution since release 2.7.1

3.1.3.1 Software Installation

The installation is equivalent to the previous version 2.7.1.

3.1.3.2 Evolutionary Updates

The Usage of Sen2Cor in Toolbox mode now also supports previous PSD version 14.2 by upgrading the metadata to PSD Version 14.5. Old multiple tile versions (PSD Version 13.1) are no longer supported.

Two new options for the Toolbox mode are present:

--processing_centre: with this option, it is possible to change the code for the processing centre in the metadata. Expected is a four-character code or "_". Examples: "--processing_centre = ABCD" or "SGS_".

--processing_baseline: with this option, it is possible to change the processing baseline in the metadata. Expected is a string in the format "dd.dd". Example: "--processing_baseline = 08.15".

3.1.3.3 Corrective Maintenance

SIIMPC-1225: MPC/CC verification of the sample PDGS L2A - NO_DATA values present

SIIMPC-1390: An alignment of the level 2A Metadata between the products available on the SciHUB and the products generated by Sen2Cor in the Toolbox mode has been performed.

3.1.4 Evolution since release 2.7.0

3.1.4.1 Software Installation

The installation is equivalent to the previous version 2.7.0.

3.1.4.2 Evolutionary Updates

None

3.1.4.3 Corrective Maintenance

The following issues have been resolved together with release 2.7.1:

SIIMPC-1226 : ozone value 370 added as an allowed value in the L2A_GIPP.xsd schema. Was initially missing.

SIIMPC-1378 (SCOR-5): the configuration object stored the path of the databases during the preprocessing step and did not change it afterwards. If the databases is moved and the 10m processing is called at a later point in time, the same path as for 20m processing was used and the processing failed. This is now

corrected by updating the path with the entry from command line at each new processing step.

SIIMPC-1379 : assessment of release 2.7.0 has identified that the PVI size is a lot smaller in the new version. The PVI image was overwritten after the down sampling from 20 to 60m and was thus much smaller. A flag for preventing the overriding was not set.

SIIMPC-1382 (SCOR-6): the gdal software routines handling the crossing of international date lines had not been applied to the new CCI auxiliary inputs.

SIIMPC-1385 (SCOR-7): L2A DS coming from EDRS are produced with a name S2x_OPER_MSI_L2A_DS_EPA instead S2x_OPER_MSI_L2A_DS_EPAE. The archiving_center parameter was used to name the DS instead of the processing_center parameter.

3.1.4.4 Configuration Changes

None

3.1.5 Evolution since release 2.6.6

3.1.5.1 Software Installation

The installation is equivalent to the previous version 2.6.6. As the configuration file L2A_GIPP.xml has changed, be sure to replace the current configuration with the updated file. See also section 3.1.5.4 for configuration changes.

3.1.5.2 Evolutionary Updates

The following fixes have been applied to this release:

SIIMPC-557 : it should be possible to decouple the DEM processing as an option or a configuration of the L2A_GIPP.xml. This has been achieved by using the same routines like in flat terrain calculation (dtm_flat) and disabling the terrain iteration, for the terrain corrections, whereas Scene Classification, AOT (and WVP) are still calculated using the DEM input. There is a new option <DEM_Terrain_Correction> in the L2A_GIPP configuration file, which can be set to TRUE / FALSE.

SIIMPC-1300 : improve the database size needed for storage of the products.
Initial need for this optimisation was the fact that the database could grow up to > 5 GB and thus was impossible to keep in a RAM disk. The following changes have been implemented:

- A command line option allows to specify the two locations of the image and the temporary database. Two different user selectable locations are available in order to select between the separate usage of a ramdisk and a normal disk space.
- There is also a configurable compression factor available in the User configuration file L2A_GIPP.xml (see also [SIIMPC-1300]: it is

recommended to use a compression factor of 1, which allows a reduction of the databases to about 2/3 of their original size in the non-compressed mode.

▪ In the first processing stage the image database will load only the bands needed for the 20 m processing (except 10 m Band 8). After the 20m processing is performed, all bands (except the three 10m bands 1-3) are removed and Band 8 will be loaded. Thus, the database will keep a size below 1 GB during the whole processing.

▪ The temporary database will import all auxiliary data (like the DEMs and ESACCI images). It will additionally store the resampled bands from the image database and the processed products from the 20 m Scene Classification (Classification Map) and Atmospheric correction (AOT/Visibility and Water Vapor). After the 20 m processing is performed, only these products will be up-sampled to 10 m and copied into a new temporary database. The old database with all products no longer needed will be removed.

▪ In the 10 m processing the temporary database keeps the AOT/Visibility and Water vapor and imports the new resampled auxiliary data, needed for the 10m processing.

▪ The down-sampling routine to 60 m has also improved in that way that the output products will be directly converted to their final format, so that no further storage of these down-sampled products in the database is required.

▪ Additionally, all bands which are no longer needed in the processing chain are removed from the temporary database, to free space for other intermediate products.

With this, the following measures have been obtained by operation of a full sized L1C tile with configured DEM, processing for 20 and 10 m and a down-sampling of the 20m product to 60 m.

Resolution	Image DB	Temp DB
20 m processing	739 MB	1.53 GB
Down sampling to 60	No changes in DB size	No changes in DB size
10 m processing	867 MB	1.963 GB

The update of the command line parameters is as follows:

Command Line Parameters for the generation of Datastrip or Tile (PDGS mode)

```
▪
▪      L2A_Process --help
usage: L2A_Process.py [-h] [--mode MODE] [--resolution {10,20,60}]
                      [--datastrip DATASTRIP] [--tile TILE]
                      [--output_dir OUTPUT_DIR] [--work_dir WORK_DIR]
                      [--img_database_dir IMG_DATABASE_DIR]
                      [--res_database_dir RES_DATABASE_DIR]
                      [--processing_centre PROCESSING_CENTRE]
                      [--archiving_centre ARCHIVING_CENTRE] [--raw] [--tif]
                      [--sc_only] [--cr_only] [--debug] [--refresh]
                      [--GIP_L2A GIP_L2A] [--GIP_L2A_SC GIP_L2A_SC]
                      [--GIP_L2A_AC GIP_L2A_AC] [--GIP_L2A_PB GIP_L2A_PB]
                      input_dir

Sentinel-2 Level 2A Processor (Sen2Cor). Version: 2.7.0, created: 2018.21.09, supporting
Level-1C product version <= 14.5.

positional arguments:
  input_dir             Directory of Level-1C input

optional arguments:
  -h, --help            show this help message and exit
  --mode MODE           Mode: generate_datastrip, process_tile
  --resolution {10,20,60}
                        Target resolution, can be 10, 20 or 60m. If omitted,
                        only 20 and 10m resolutions will be processed
  --datastrip DATASTRIP
                        Datastrip folder
  --tile TILE           Tile folder
  --output_dir OUTPUT_DIR
                        Output directory
  --work_dir WORK_DIR   Work directory
  --img_database_dir IMG_DATABASE_DIR
                        Database directory for L1C input images
  --res_database_dir RES_DATABASE_DIR
                        Database directory for results and temporary products
  --processing_centre PROCESSING_CENTRE
                        Processing centre
  --archiving_centre ARCHIVING_CENTRE
                        Archiving centre
  --raw                 Export raw images in rawl format with ENVI hdr
  --tif                 Export raw images in TIFF format instead of JPEG-2000
  --sc_only             Performs only the scene classification at 60 or 20m
                        resolution
  --cr_only             Performs only the creation of the L2A product tree, no
                        processing
  --debug               Performs in debug mode
  --refresh             Performs a refresh of the persistent configuration
                        before start
  --GIP_L2A GIP_L2A     Select the user GIPP
  --GIP_L2A_SC GIP_L2A_SC
                        Select the scene classification GIPP
  --GIP_L2A_AC GIP_L2A_AC
                        Select the atmospheric correction GIPP
  --GIP_L2A_PB GIP_L2A_PB
                        Select the processing baseline GIPP
```

3.1.5.3 Corrective Maintenance

The following issues have been resolved together with this release:

SIIMPC-1019 : Pixels under semi-transparent clouds are erroneously "terrain-corrected". This leads to artefacts where the mountain slopes opposed to the sun are artificially "brightened". This has been resolved by applying a mask for non-transparent clouds (and saturated or no data pixels) to exclude them from terrain correction. Figure 6 below shows in clockwise order: L1C, Band4 input. L2A Band4 with artefact. L2A_Band4 after correction, L2A_AOT as a control for avoiding possible side effects.
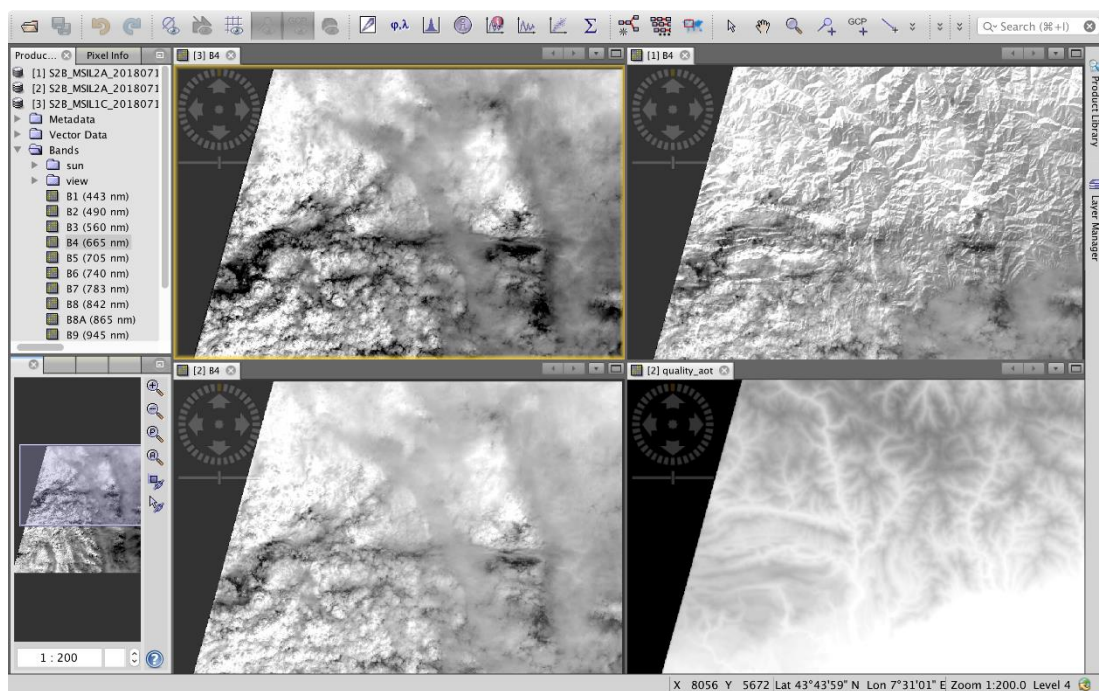
Figure 6: excluding terrain correction for clouds

SIIMPC-1357 : wrong MASK_FILENAME in tile metadata. Metadata now show the correct filenames.

SIIMPC-1298 : disable the insertion of a DEM string in the metadata if no DEM is selected. The user can now alternatively insert a string of individual choice in the DEM_reference field. This string is then shown if the user selects a DEM for usage. If no DEM is selected, 'none' will be inserted in the metadata instead.

SIIMPC-1366 : In Sen2Cor-02.06.05 and Sen2Cor-02.06.06 the files .estimation and .progress are written in folder Sen2Cor-02.06.06-Linux64/lib/python2.7/site-packages/sen2cor/log/ instead they shall be written in the folder working_dir in order to avoid conflicts when several tiles are processed in parallel.

Fixed equivalent to release 2.6.7.

SIIMPC-1341 : Processor now creates empty bands for AOT and Water Vapor, if no reflectance pixels are found in the input files.

SIIMPC-1376 : During IVV, It has been discovered that, when the DEM_Directory is not correctly filled in in the GIP_L2ACFG file and that Sen2Cor can not find it,

Sen2Cor still exits with code 0. Fixed as described in the according ticket. This is a copy from: https://jiraesa.s2pdgs.com/browse/SCOR-3 .

3.1.5.4 Configuration Changes

The following configuration changes have been applied within the context of SIIMPC-557:

Setting of DEM_Terrain Correction:

```
<DEM_Terrain_Correction>TRUE/FALSE</SEM_Terrain_Correction>
True: DEM is used for terrain correction. False DEM is excluded for terrain
correction.
```

Selection of DEM and DEM_Reference:

```
<DEM_Directory>NONE</DEM_Directory>
<!-- should be either a directory in the sen2cor home folder or 'NONE'. If
NONE, no DEM will be used -->
<DEM_Reference>NONE</DEM_Reference>
<!-- DEM_Reference>http://data_public:GDdci@data.cgiar-
csi.org/srtm/tiles/GeoTIFF/</DEM_Reference -->
<!-- disable / enable the upper two rows if you want to use an SRTM DEM -->
<!-- The SRTM DEM will then be downloaded from this reference, if no local
DEM is available -->
<!-- if you use Planet DEM you can optionally add the local path instead,
which then will be inserted in the datastrip metadata -->
```

3.1.6 Evolution since release 2.6.5

3.1.6.1 Software Installation

The installation is equivalent to the previous version 2.6.5. As the configuration file L2A_GIPP.xml has changed, be sure to replace the current configuration with the updated file.

3.1.6.2 Evolutionary Updates

The following fixes have been applied to this release:

SIIMPC-1327 : command line option to specify the hd5 image database path. It will be used by PDGS to store the image database on ramdisk:

Example:

```
L2A_Process --mode=process_tile --datastrip=
/home/inp/S2B_OPER_MSI_L2A_DS_MTI__20180910T085929T103021_N02.06
--tile=/home/inp/L1C_T33VWH_A006855_20180629T103021
--database_dir=/home/tmp
--work_dir=/home/tmp
--output_dir=/home/out
--raw
```

SIIMPC-1300 : Image database size: The size of the image database has been made configurable via the configuration file L2A_GIPP.xml. The following measures have been performed:

- The size of the used 10m JP2 test Image is: 156.6 MB
- The size of HDF5 database in uncompressed mode is 241.2 MB for storing the single test image above.
- The database can effectively be decompressed to ~ 160 MB using compression level2 1-4 with an average additional time of 4-6 s for the read of each band. All higher compression levels are not recommended. Default configuration is: (0) no compression.

Table 3: database size and access time dependent for selected compression level

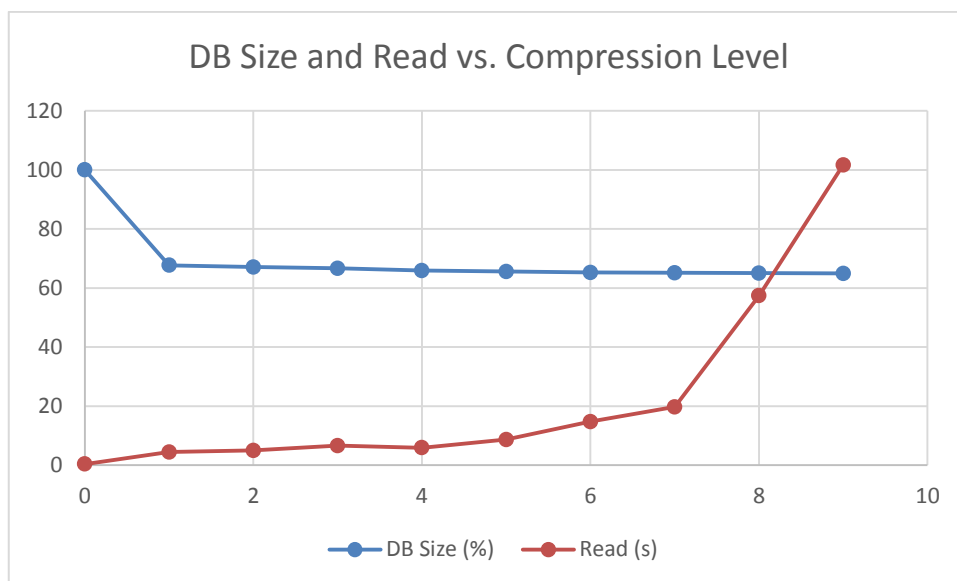| Compression Level	DB Size (%)	Read (s)
0	100	0.3
1	68	4
2	67	5
3	67	7
4	66	6
5	66	9
6	65	15
7	65	20
8	65	57
9	65	102

Figure 7: database size and read access time vs. compression level

3.1.6.3 Corrective Maintenance

The following issues have been resolved together with this release:

SIIMPC-1286: resampling issue after 60m resampling restart

SIIMPC-1289: Tile processing failed with error "index 255 is out of bounds"

SIIMPC-1341: (and SIIMPC-1241) "failure with error "All images contain only background pixels"": Instead of stopping with an error message, the processing is now performed excluding the atmospheric correction. A full (but empty) product will be stored instead. This fix was already delivered as a patch for release 2.6.3.

SIIMPC-1344 : The configuration parameter DEM_Unit was removed from the configuration file L2A_GIPP, as [cm] and [dm] are not used in the code. DEM Dimension in the code is always given in [m]. The corresponding code, which led to the error, was removed. See ticket for further explanation.

SIIMPC-1349

move getBand() calls outside of Loops:

After moving these calls outside of the loop about 200 – 250 seconds are saved and the database access decreases from 321 calls down to 31.

```
   ncalls  tottime  percall  cumtime  percall
filename:lineno(function)
      1    0.515    0.515  864.802  864.802
L2A_AtmCorr.py:2944(process)
      1   80.172   80.172  356.315  356.315
L2A_AtmCorr.py:7645(rho_retrieval_step1)
    321   45.852    0.143  259.000    0.807
L2A_Tables.py:2429(getBand)
```

```
   ncalls  tottime  percall  cumtime  percall
filename:lineno(function)
      1    0.529    0.529  600.237  600.237
L2A_AtmCorr.py:2938(process)
      1   74.095   74.095  130.558  130.558
L2A_AtmCorr.py:7606(rho_retrieval_step1)
     31    9.488    0.306   69.064    2.228
L2A_Tables.py:2528(getBand)
```

SIIMPC-1354 : Concurrency problem with configPic.p. For Sen2Cor 2.6.6 and above, the data file configPic will additionally get the filename of the corresponding tile as prefix to avoid concurrency and will be kept in the work directory, to be aligned with all other temporary created files.

3.1.7 Evolution since release 2.6.3

The installation is equivalent to the previous version 2.6.3.

3.1.7.1 <u>Evolutionary Updates</u>

<u>SIIMPC-1258</u> : a down sampling to 60m resolution has been implemented as a post processing step for a 20m processing. This option can be used alternatively for a 60m processing and improves the performance by about 3 – 5 minutes.

Changes in the configuration:

- This version does no longer perform the processing of a 60m resolution by default. If no resolution is specified via command line, only 20m and 10m resolutions are processed.
- If "--resolution=60" is specified via command line, a 60m resolution processing is still possible.
- There is now a new option to perform a 60m down sampling following a 20m processing, which can be activated via the configuration file L2A_GIPP.xml:

    Option: <Downsample_20_to_60>TRUE</Downsample_20_to_60>

3.1.7.2 <u>Corrective Maintenance</u>

The following issues have been resolved together with this release:

1. <u>SIIMPC-1241</u> : fixing a zero division error when only background pixels are identified.
2. <u>SIIMPC-1255</u> : datastrip shows a wrong satellite ID and version number under certain conditions.
3. <u>SIIMPC-1257</u> : If no ESA CCI auxiliary data are installed the following entries in the L2A Datastrip shall be set to "None":

    <ESACCI_WaterBodies_Map>
    <ESACCI_LandCover_Map>
    <ESACCI_SnowCondition_Map_Dir>
4. <u>SIIMPC-1264</u> : adding export for RAW and GeoTiff and aligning output format to L1C input (Kakadu).
5. <u>SIIMPC-1271</u> : Sen2cor fails with higher version of numpy in L2A_SceneClass.py.
6. <u>SIIMPC-1272</u> : Correcting the no data mask in the scene classification module as shown below.

Reference: S2-PDGS-MPC-L2A-SRN-V2.8.0
Issue: 02
Date: 2019-02-04
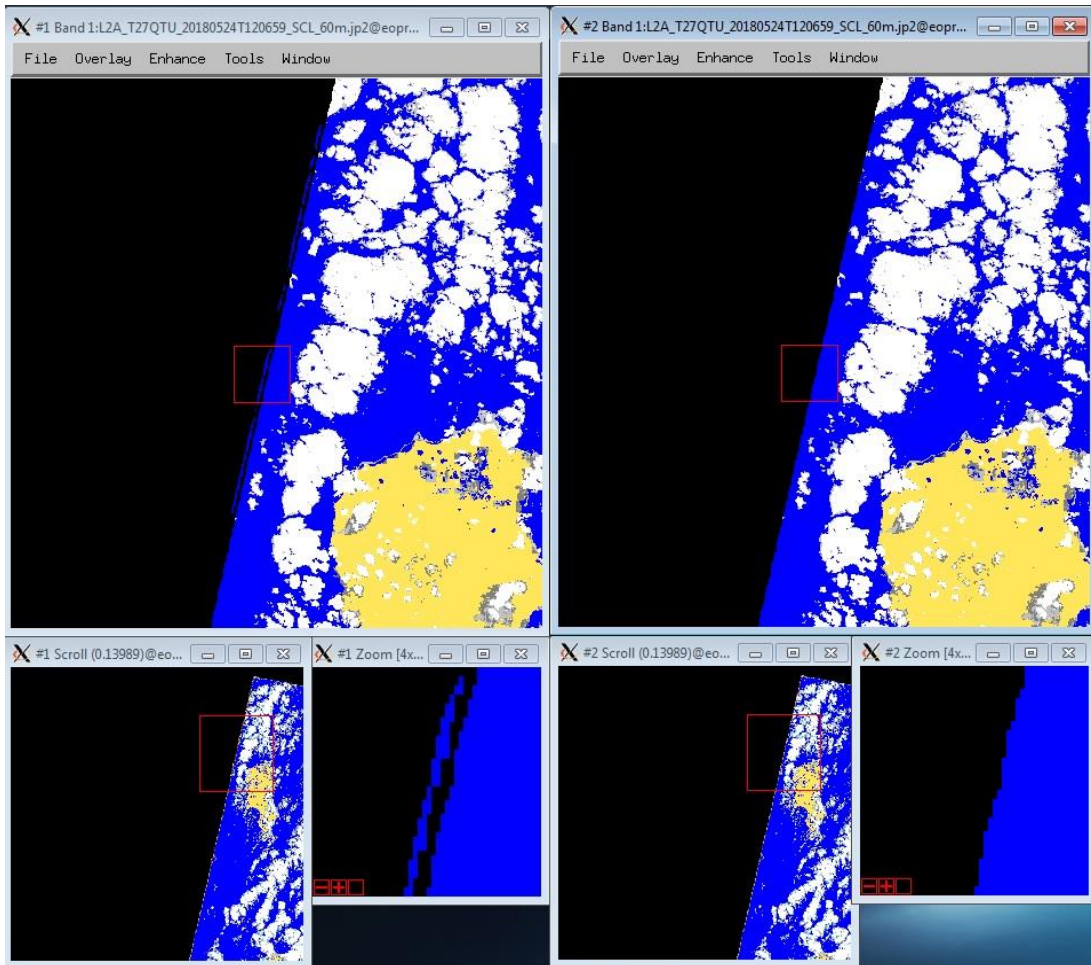
Figure 8 – improvement of no data mask.

3.1.8 Evolution since release 2.6.2

No changes in the user interface have been implemented since the last version 2.6.2. The installation is equivalent to the previous version 2.6.2.

3.1.8.1 Evolutionary Updates

- Improved RAM consumption in version 2.6.3 to less than 4 GB
    - RAM usage below 4GB during the full processing
    - Processing time equivalent to sen2Cor Version 02.05.05
    - L2A surface reflectance (and other AOT, WVP, SCL, TCI, PVI files) values equivalent to Version 02.05.05
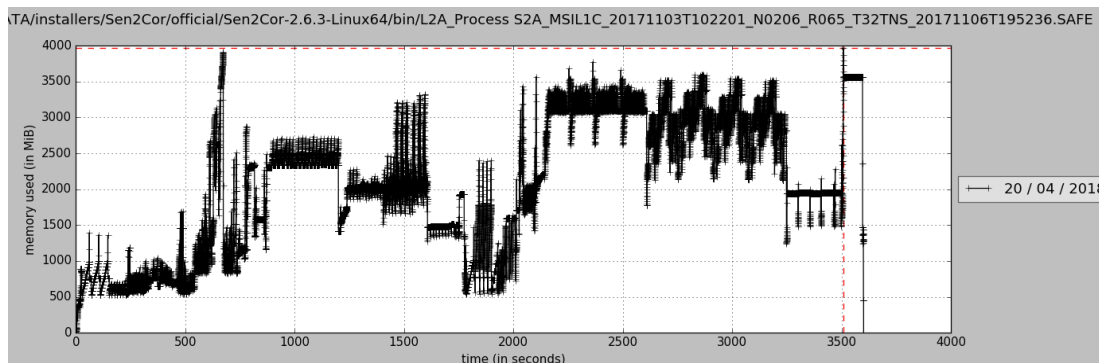
- For Version 2.6.3, all bands are only read in once for all resolutions: improvement in RAM usage as described above led to slight increases in the processing time. This could mostly be compensated by an improvement of the band reader, in which all bands are only read in once and resampled, if necessary.
- In addition, the Scene Classification of snow/ice has been improved, enabling the detection of snow above frozen lakes and icebergs in Arctic and Antarctic Sea. This has been done relying less on ESA CCI aux data and relaxing one of the snow thresholds.

3.1.8.2 Corrective Maintenance

The following issues have been resolved together with this release:

Filenames for masks are still in long format in the metadata:

- SIIMPC-1227

Sen2Cor failure: ZeroDivisionError:

- SIIMPC-1241

Mismatches in the surface refeltance between 60, 20 and 10m:

- SIIMPC-1245

3.1.9 Evolution since release 2.6.1

3.1.9.1 Evolutionary Updates

Upgrade to PSD Version 14.5
Sen2Cor now also supports an End User Product PSD Version 14.3 – 14.5 with Standard SAFE Format as input. The output is converted to SAFE compact.

3.1.9.2 Corrective Maintenance

According to: SIIMPC-1219

[2]: ESA CCI: ERRORS replaced with WARNINGS;

[3]: default installation folder as Sen2Cor-02.06.02 instead of Sen2Cor-2.6.2;

[5]: Corrected the output of the datatake identifier;

[6]: Tile Folder Name, inherits processing baseline from Datastrip;

[6]: MTD_TL.xml: archiving centre is correctly updated from Datastrip;

[6]: MTD_TL.xml: Datastrip and Tile ID get correct baseline from Datastrip;

[6]: Tile Folder Name: processing centre is correctly updated from Datastrip;

[6]: Tile Folder Name: generation time is correctly updated with UTC_DATE_TIME from Datastrip;

[7]: GIP_L2A_USR is not written in Datastrip;

[8]: PRODUCTION_DEM_TYPE in L2A USER MTD: updated from L2A_GIPP;

[9]: FORMAT_CORRECTNESS.xml, GENERAL_QUALITY.xml, GEOMETRIC_QUALITY.xml, SENSOR_QUALITY.xml removed from QA_FOLDER;

[10]: ACCURAY corrected with ACCURACY.

According to: SIIMPC-1217

- Fixed issue due to some leap year affecting only the day of year 61 -> 2nd of March this year (raised with Sen2Cor 2.5.5).

Tests performed with PSD 14.5:

- Mode Datastrip processed with long format as input: output is long format;
- Mode Datastrip processed with short format as input: output is long format;
- Mode Tile processed with long format as input: output is long format;
- Mode Tile processed with short format as input: works, but requires long DS as input, this is in line with processing sequence, where first always a DS is generated in long format;
- Mode EUP processed with long format as input: output is short format as published on OpenHub;
- Mode EUP processed with short format as input: output is short as published on OpenHub.

3.1.10 Evolution since release 2.6.0

3.1.10.1 Evolutionary Updates

New option for output of images in raw format instead of JPEG-2000, as described in SUM and IODD

Evolutionary updates as listed for release 2.5.5 below merged to release 2.6.1

Updated documentation SUM and IODD for release 2.6.1

Memory optimisations as received from ESA for Atmospheric correction module

3.1.10.2 Corrective Maintenance

Fixing the limitations for EUP (Toolbox) mode. User products for PSD 14.3 can now also be generated

Outputs for Datastrip and Tile are now in standard SAFE format

Outputs for User Product are now in compact SAFE format

Fixes as listed for release 2.5.5 below are merged to release 2.6.1

3.1.11 Evolution since release 2.5.5

3.1.11.1 Evolutionary Updates

The following features are implemented new for release 2.6.0:

SIIMPC-1119 Phase 2	Integration into PDGS according to CCN.2 Phase B: • Support of datastrip generation mode from L1C input datastrip; • Support of Tile processing mode from L1C input tile; • L1C Datastrip and tiles can have the standard or compact DIMAP format; • L2A Datastrip and Tile are always formatted in compact DIMAP format. The new added command line parameters for PDGS mode (displayed in **red**) are as follows:

```
L2A_Process --help
usage: L2A_Process.py [-h] [--mode MODE] [--
resolution {10,20,60}]
                                [--datastrip DATASTRIP] [--tile
TILE]
                                [--output_dir OUTPUT_DIR] [--
work_dir WORK_DIR]
                                [--processing_centre
PROCESSING_CENTRE]
                                [--archiving_centre
ARCHIVING_CENTRE] [--sc_only]
                                [--cr_only] [--refresh] [--
GIP_L2A GIP_L2A]
                                [--GIP_L2A_SC GIP_L2A_SC] [--
GIP_L2A_AC GIP_L2A_AC]
                                [--GIP_L2A_PB GIP_L2A_PB]
                                input_dir

Sentinel-2 Level 2A Processor (Sen2Cor). Version:
2.6.2, created: 2018.03.30,
supporting Level-1C product version <= 14.5.

positional arguments:
  input_dir               Directory of Level-1C input

optional arguments:
  -h, --help              show this help message and
exit
  --mode MODE             Mode: generate_datastrip,
process_tile
  --resolution {10,20,60}
                          Target resolution, can be 10,
20 or 60m. If omitted,
                          all resolutions will be
processed
  --datastrip DATASTRIP
```

```
                              Datastrip folder (a full
path)
  --tile TILE           Tile folder (a full path)
  --output_dir OUTPUT_DIR
                        Output directory (a full
path)
  --work_dir WORK_DIR   Work directory (a full path)
  --processing_centre PROCESSING_CENTRE
                        Processing centre
  --archiving_centre ARCHIVING_CENTRE
                        Archiving centre
  --sc_only             Performs only the scene
classification at 60 or 20m
                        resolution
  --cr_only             Performs only the creation of
the L2A product tree, no
                        processing
  --refresh             Performs a refresh of the
persistent configuration
                        before start
  --GIP_L2A GIP_L2A     Select the user GIPP
  --GIP_L2A_SC GIP_L2A_SC
                        Select the scene
classification GIPP
  --GIP_L2A_AC GIP_L2A_AC
                        Select the atmospheric
correction GIPP
  --GIP_L2A_PB GIP_L2A_PB
                        Select the processing
baseline GIPP (a filename with full path)
```

- Classical "TOOLBOX" Mode: This mode is to support the user community working on a Level-1C Product as downloaded from the SCI-Hub. No changes of the Interface compared for Sen2Cor 2.4.0 are present[1].

Example for command line:

```
L2A_Process
S2B_MSIL1C_20171004T233419_N0206_R001_T54DWM_20171005
T001811.SAFE --resolution=60
2018-01-29T09:13:13.879


Output:


L2A_Logger : 89  logging for the main process
initialized
L2A_Process : 383  Sentinel-2 Level 2A Processor
(Sen2Cor). created: 2018.03.30, supporting Level-1C
product version <= 14.5.
started ...
L2A_Process : 384  Product version: 14.3
```

---

[1]Due to necessary rearranges of the product formatter the Toolbox Mode is currently not supported in version 2.6.0 and will be fixed with version 2.6.1.

```
L2A_Process : 385 Operation mode: TOOLBOX.
L2A_XmlParse : 109  validating metadata file
MTD_DS.xml against scheme
...
L2A_Process : 461  Progress[%]: 100.00 : Application
terminated successfully.
```

- PDGS mode GENERATE_DATASTRIP:

Example for command line:

```
L2A_Process
   --mode=generate_datastrip
   --datastrip=<directory of users
choice>/DS_MPS__20171005T001811_20171004T233413
   --work_dir=<directory of users choice>
   --output_dir=<directory of users choice>
   --processing_centre=<four digit code, see PSD
14.3>
   --archiving_centre=<four digit code, see PSD 14.3>
   --GIP_L2A_PB=<directory of users
choice>/L2A_PB_GIPP.xml


2018-01-29T09:18:56.395  GVA0323 001173 L2A_Logger:
89 [ INFO] logging for the main process initialized
2018-01-29T09:18:56.395  GVA0323 001173 L2A_Process:
383 [ INFO] Sentinel-2 Level 2A Processor (Sen2Cor).
Version: 2.6.0, created: 2018.01.15, supporting
Level-1C product version <= 14.3 started ...
2018-01-29T09:18:56.396  GVA0323 001173 L2A_Process:
384 [ INFO] Product version: 14.3
2018-01-29T09:18:56.396  GVA0323 001173 L2A_Process:
385 [ INFO] Operation mode: GENERATE_DATASTRIP.
2018-01-29T09:18:56.399  GVA0323 001173 L2A_Process:
398 [ INFO] Processing baseline: 02.06
2018-01-29T09:18:56.400  GVA0323 001173
L2A_ProcessDa: 210 [ INFO] Progress[%]:  0.00 :
Generating datastrip metadata
2018-01-29T09:18:56.476  GVA0323 001173
L2A_XmlParser: 109 [ INFO] validating metadata file
MTD_DS.xml against scheme
2018-01-29T09:18:56.793  GVA0323 001173
L2A_XmlParser: 115 [ INFO] metadata file is valid
2018-01-29T09:18:56.823  GVA0323 001173
L2A_ProcessDa: 255 [ INFO] datastrip directory is:
/Users/umwilm/Testdata/260_example/output/DS_XXXX_201
80129T091856_20171004T233413
2018-01-29T09:18:57.659  GVA0323 001173
L2A_XmlParser: 109 [ INFO] validating metadata file
MTD_DS.xml against scheme
2018-01-29T09:18:57.996  GVA0323 001173
L2A_XmlParser: 115 [ INFO] metadata file is valid
2018-01-29T09:18:58.013  GVA0323 001173
L2A_ProcessDa: 333 [ INFO] L1C datastrip found, L2A
datastrip successfully generated
2018-01-29T09:18:58.099  GVA0323 001173 L2A_Process:
```

```
461 [ INFO] Progress[%]: 100.00 : Application
terminated successfully.


• PDGS mode PROCESS_TILE:

L2A_Process
   --mode=process_tile
   --datastrip=<directory of users
choice>/DS_XXXX_20180126T081048_20171004T233413
   --tile=<directory of users
choice>/L1C_T54DWM_A003030_20171004T233413
   --work_dir=<directory of users choice>
   --output_dir=<directory of users choice>
   --GIP_L2A_PB=<directory of users
choice>/L2A_PB_GIPP.xml
   --resolution=60


2018-01-29T09:05:51.912  GVA0323 001128 L2A_Logger:
89 [ INFO] logging for the main process initialized
2018-01-29T09:05:51.912  GVA0323 001128 L2A_Process:
383 [ INFO] Sentinel-2 Level 2A Processor (Sen2Cor).
Version: 2.6.0, created: 2018.01.15, supporting
Level-1C product version <= 14.3 started ...
2018-01-29T09:05:51.912  GVA0323 001128 L2A_Process:
384 [ INFO] Product version: 14.3
2018-01-29T09:05:51.914  GVA0323 001128 L2A_Process:
385 [ INFO] Operation mode: PROCESS_TILE.
2018-01-29T09:05:52.085  GVA0323 001128
L2A_XmlParser: 109 [ INFO] validating metadata file
MTD_DS.xml against scheme
2018-01-29T09:05:52.855  GVA0323 001128
L2A_XmlParser: 115 [ INFO] metadata file is valid
2018-01-29T09:05:52.906  GVA0323 001128 L2A_Config:
3774 [ INFO] input product origins from: Sentinel-2B
...
2018-01-29T09:10:13.013  GVA0323 001128 L2A_Process:
461 [ INFO] Progress[%]: 100.00 : Application
terminated successfully.
```

3.1.11.2   Corrective Maintenance

N/A

3.1.12   Evolution since release 2.5.0

3.1.12.1   Evolutionary Updates

The following features are implemented new for release 2.5.5:

SIIMPC-1184	Updated L2A_PB_GIPP and L2A_Config.py according to inputs from ESA
SIIMPC-1190	Updated Look Up Tables for S2A MSI in line with S2-SRF v3.0

SIIMPC-1184	Replaced quantification_value element in datastrip metadata by list of quantification values for each type of L2A images.
	Added Auxiliary data info references for LUT, Snow climatology map, ESACCI maps (in L2A datastrip metadata)

3.1.12.2 Corrective Maintenance

The following fixes are applied to release 2.5.5:

SIIMPC-1184	1	Move the tmp folder from /tmp to AUX_DATA/tmp
	2	Remove the Visibility band after 10 m processing
	3	Updated Look Up Tables for S2A MSI in line with S2-SRF v3.0
	4	Fixed the fact that input Processing baseline can be lower than 2.05 for PSD 14.2
	5	Manifest was initialized in UTF-8, not UTF-16, corrected
	6	XML export: UTF-8 with xml declaration
	7	Packager for windows paths if using spaces
	8	Validation errors in dimap2A.xsd for REFERENCE_BAND and GIPP_List
	9	10 m is not processed when all resolution is selected
	10	Decouple version selection from processing baseline
	11	Remove of report file from product output for PDGS mode
	12	Unreferenced variable esacciSnowCondition when using a DEM
	13	HPC_percentage, wrong value was set
	14	Fixed User product ID issue with PSD 13.1 in SAFE STANDARD

3.1.13 Evolution since release 2.4.0

3.1.13.1 Evolutionary Updates

The following features are implemented new for release 2.5.0:

SIIMPC-823	Improvement of cirrus correction: previous cirrus correction tended to an over correction which is now compensated by applying a range of gamma values equivalent to the improvements applied to ATCOR in July 2015.
SIIMPC-892	To relate AC thresholds to an area rather than a fixed number of pixels: The implementation has invented a new configuration parameter self.config.AC_Spr_Refl_Promille, which replaces the current hard coded value of 1000 with a new configuration parameter which is now independent from pixel size: it represents the ratio between the reference

	pixels and the total number of non background pixels in the image, weighted with 1000 to have a suitable dimensioning between 0 and 1 for the configuration (otherwise parameter would be 0.0003). The default value is set to 0.3 which is fairly equivalent to the hardcoded value of 1000 at 60m, but is now also valid for the 20m calibration.
SIIMPC-924	Implementation of an optional DEM output: Gereration of a DEM, TCI and DDV can now be configured via thee new entries in the L2A_GIPP.xml as follows: <Generate_DEM_Output>TRUE</Generate_DEM_Output> <!-- FALSE: no DEM output, TRUE: store DEM in the AUX data directory --> <Generate_TCI_Output>TRUE</Generate_TCI_Output> <!-- FALSE: no TCI output, TRUE: store TCI in the IMAGE data directory --> <Generate_DDV_Output>TRUE</Generate_DDV_Output> <!-- FALSE: no DDV output, TRUE: store DDV in the QI_DATA data directory --> The DDV is no official supported product and is only of interest for testing purposes of the algorithm for Aerosol Optical Thickness.
SIIMPC-934	J2K library update: the code stream parameters of the generated L2A OpenJPEG outputs have been aligned to the L1C input. Codestream 60m: Reference Grid Height, Width: (1830 x 1830) Reference Tile Height, Width: (192 x 192) Progression order: LRCP Code block height, width: (4 x 4) Precinct size: ((64, 64), (64, 64), (64, 64), (64, 64), (64, 64)) Codestream 20m: Reference Grid Height, Width: (5490 x 5490) Reference Tile Height, Width: (640 x 640) Progression order: LRCP Code block height, width: (8 x 8) Precinct size: ((128, 128), (128, 128), (128, 128), (128, 128), (128, 128)) Codestream 10m: Reference Grid Height, Width: (10980 x 10980) Reference Tile Height, Width: (1024 x 1024) Progression order: LRCP Code block height, width: (64 x 64) Precinct size: ((256, 256), (256, 256), (256, 256), (256, 256), (256, 256))
SIIMPC-942	Ozone selection based on value instead of a single character: the input of a letter for selection of an ozone value (plus profile) in the L2A_GIPP.xml input has been replaced with a direct input of an ozone value. The algorithm chooses the ozone column closest to the ozone value as specified as input. Excerpt from L2A_GIPP.xml: <Aerosol_Type>AUTO</Aerosol_Type>

	`<!-- RURAL, MARITIME, AUTO -->`
	`<Mid_Latitude>AUTO</Mid_Latitude>`
	`<!-- SUMMER, WINTER, AUTO -->`
	`<Ozone_Content>331</Ozone_Content>`
	`<!-- The atmospheric temperature profile and ozone content in Dobson Unit (DU)`
	`0: to get the best approximation from metadata`
	`(this is the smallest difference between metadata and column DU),`
	`else select one of:`
	`========================================`
	`For midlatitude summer (MS) atmosphere:`
	`250, 290, 331 (standard MS), 370, 410, 450`
	`========================================`
	`For midlatitude winter (MW) atmosphere:`
	`250, 290, 330, 377 (standard MW), 420, 460`
	`========================================`

SIIMPC-1017	Exclude cloud shadow pixels from Water Vapor retrieval: at cloud borders, not all pixels are correctly classified. In extreme cases this led to water vapor corrected pixels over water. This has been corrected by taking only vegetation + non_vegetated land and snow/ice pixels into account and set all other pixels to the average of water vapour.
SIIMPC-1058	Visibility iteration extended from 80 to 120 KM: this follows an evolutionary upgrade of the ATCOR input to improve the AOT retrieval.
SIIMPC-1107	Support for PDS 14.3: addition of the PSD 14.3 to the sen2cor internal configuration. Implementation of a version check to discriminate V 14.2 and below from Version 14.3 and applying code changes to handle the differences between PSD V.14.2 and 14.3 correctly.
SIIMPC-1119	• Integration into PDGS according to CCN.2 Phase A: Changes of the Interface to align Level 2A product, datastrip tile objects and metadata with the Level 1C input as specified in detail in document: S2-PDGS-MPC-L2A-PFS-V14.3, being part of this delivery. • Implementation of a switch to perform the generation of the L2A output in the "PDGS" mode in order to obtain maximal alignment with the Level-1C input or to generate the L2A Output in the "TOOLBOX" mode in order to warrant a downward compatibility with the previous versions for PSD V.14.2. • A new GIPP 'GIP_PROBA2' GIPP file can be provided as input to Sen2Cor as an additional optional command line argument (together with the list of other GIPPs) in order to define the processing baseline identifier of the generated L2A products. Sen2Cor is able to read this new input and use the corresponding value of the processing baseline filed in the relevant metadata and file/folder names of the L2A output product structure. In case the GIPP is not given as input, Sen2Cor uses the processing baseline identifier from the input Level-1C (in the L1C Datastrip metadata file). The command line parameter is as follows:

	Command: $ L2A_Process --help
	Output:
	usage: L2A_Process [-h] [--resolution {10,20,60}] [--sc_only] [--cr_only]
	[--refresh] [--GIP_L2A GIP_L2A] [--GIP_L2A_SC
	GIP_L2A_SC]
	[--GIP_L2A_AC GIP_L2A_AC] [--GIP_L2A_PB GIP_L2A_PB]
	directory
	--GIP_L2A_PB GIP_L2A_PB
	Select the processing baseline GIPP
SIIMPC-1146	Improvement of Cloud Screening and Scene Classification: upgrades have been performed on the Cloud Screening and Scene Classification module of Sen2Cor for the the overall accuracy of the Cloud Screening and Scene Classification (CSC) module, especially for the areas over coastal/in-land/muddy waters and areas covered by snow. The improvements also focused on cirrus detection in mountainous areas and of the permanent bright targets false (cloud) detection.

3.1.13.2   Corrective Maintenance

The following fixes are applied to release 2.5.0:

SIIMPC-976	Fixes on AOT calculation: a series of fixes has been applied to improve the calculation for the Aerosol Optical Thickness.

3.1.14   Evolution since release 2.3.1

3.1.14.1   Evolutionary Updates

The following features are implemented new during the course of this release:

SIIMPC-828	The algorithm for the automatic selection of the atmosphere profile (between MidLatitude SUMMER and MidLatitude WINTER) has been improved so that it is based on latitude and date information, instead relying on AOT retrieval as it is currently implemented:
	With latitude = latitude of Tile Center:
	for Tropical/Equatorial areas (if latitude ∈ [-30; 30])
	• for all year long: SUMMER
	for Northern Hemisphere (if latitude ∈]30; 90])
	• between 1st of April and 30th of September: SUMMER
	• between 1st of October and 31st of March: WINTER
	for Southern Hemisphere (if latitude ∈ [-90; -30]).
	between 1st of April and 30th of September: WINTER
	• between 1st of October and 31st of March: SUMMER
	Based on this, the default configuration is now AUTO for Mid_Latitude and '0' (auto configuration) for Ozone_Content.
SIIMPC-850	This evolutionary upgrade is of primary interest for expert users of

(CCN.1)	Sen2Cor for the calibration and validation activities in the context of the Mission Performance Centre (MPC):
	The objective was to restructure the Sen2Cor essential calibration parameters into 3 GIPP files:
	• L2A_GIPP.xml for user choices or ground segment default configuration;
	• L2A_CAL_SC_GIPP.xml for Scene Classification Calibration;
	• L2A_CAL_AC_GIPP.xml for Atmospheric Correction Calibration.
	They shall also conform to the file naming convention applicable to S2 PDGS.
	The three files suggested have a clear separation in their functionality. Whereas L2A_GIPP.xml is a pure user configuration file and in this way should be easily available for a standard user these configuration changes should be primarily performed and tested by the members of the Expert Support Laboratory. It is suggested that an option is available to select the GIPPs from command line in a form like:
	Sen2Cor …. –GIP_L2A=" S2A_OPER_GIP_L2A____MPC…..XML" –GIP_ L2A_SC =" S2A_OPER_GIP_L2A_SC_MPC …..XML" –GIP_ L2A_AC =" S2A_OPER_GIP_L2A_AC_MPC…..XML"
	This allows the expert user e.g. to prepare a set of GIPP file to test the processor and to select the needed GIPP to construct Sen2Cor sensitivity curve to a particular parameter.
SIIMPC-879, 889	Sen2Cor supports Sentinel-2B products in the same way as Sentinel-2A products. Implementation of a "switch" for look up table (LUT) selection ("S2A", "S2B", "AUTO"), in order to perform the Atmospheric Correction using the LUTs adapted to the MSI instruments spectral responses (i.e. S2A or S2B).
SIIMPC-963	Class names in the Sceme Classification module have been changed from "cloud_low_probability" to "unclassified", and from "bare_soil" to "not_vegetated" according to Documentation Change Request.
SIIMPC-1026	Sentinel 2B related Look up Tables for the atmospheric models have been generated and added.

3.1.14.2 Corrective Maintenance

The following fixes are applied to release 2.4.0:

Issue	Description
SIIMPC-793	Sen2Cor does not find a corresponding Look up Table for processing and stops the execution with an error message. This is due to a wrong initial configuration and is resolved by implementing SIIMPC-828.
SIIMPC-802	Due to an error of non-excluding the background pixels in some cases a wrong classification was performed and a terrain correction sometimes was also performed for flat terrains.
SIIMPC-816	If a product has 'NaN's for the Viewing_Incidence_Angles in the granule metadata, this led the atmospheric correction to fail. The fix sets the angular Values to 0 in the configuration and places a warning in the report,

	that these values have been reset.
SIIMPC-897	Atmospheric correction terminates erroneously with: IndexError: index 274031 is out of bounds for axis 1 with size 1: This issue does occur under very special conditions. These conditions have been identified and fixed.
SIIMPC-944, 955	Artefacts on L2A products crossing different UTM zones and international date lines: DEM mosaicking was wrong in these situations and led to artefacts.
SIIMPC-952	Path radiance rescaling: an index error in the routine for the surface reflectance calculation led to slight differences in the results between 20 and 10 m resolution for the blue and red band.
SIIMPC-957, 1015	Visibility update should be cancelled if scene contains pure water pixels, as in these conditions no valid DDV algorithm can be performed. This issue led to two different crashes in the Atmospheric correction module which had been identified and fixed.
SIIMPC-998	Fixed a problem occurred in the adjacency correction for tiles with a huge amount of noData pixels.
SIIMPC-1030, 1033,1034	For PSD Version 14.2 the L2A Manifest had not been properly updated and no checksums have been displayed.

3.1.15 Evolution since release 2.3.0

Sen2Cor release 2.3.1 is a corrective maintenance upgrade based on release 2.3.0 and includes the fixes as described next. Section 3.3 lists the known open issues which will be fixed in the upcoming release 2.4.0, which is currently under preparation to be released during spring of this year.

3.1.15.1 Corrective Maintenance

The following fixes have been applied to release 2.3.1:

Issue	Description
SIIMPC-550	SRTM DEM artefacts in coastal areas: in the previous algorithm for the preparation of SRTM DEMs artefacts in coastal areas could appear. This has been improved by rearranging the processing steps.

SIIMPC-792	Error in SRTM contour lines: the problem happend for terrain with gentle slopes. Contour lines are visible because the slopes had been computed after a resampling of original DEM (90m) to 10m resolution. The elevation information was stored as integer with 1m vertical resolution which leads to some steps for gentle slopes. These steps are them interpreted as steep slopes (1 m altitude difference in 10 meter pixel ~ terrain slope of 10%) and the consequence is an artificial terrain correction due to these DEM slopes processing artefacts. The implemented solution performs a cubic spline resampling in data type float before performing the slope calculation to overcome this issue.

SIIMPC-805	Quality Indicators for cloud coverage percentage have not been properly updated in the metadata at the product level. The quality indicators on product level metadata shall give an average on all processed tiles. The calculation was incorrect due to a copy and paste error. This has been fixed.
SIIMPC-822	Under some conditions multiple entries for the B08 BAND_NAME in the metadata at 10 m resolution occur, which lead to a validation error. This has been fixed.
SIIMPC-880	If a tile contains a huge amount of water and only few parts of land, an overcorrection (black water in RGB Image) is observable (e.g.: tile S2A_MSIL1C_20170108T113441_N0204_R080_T29TNJ_20170108T113754). This deviation has been improved. A full resolution of this issue requires a redesign of the AOT calculation and is planned for upcoming releases and is listed in section 3.3.
SIIMPC-887	Program terminates abnormally if an SRTM DEM is not available for a selected tile (e.g.: srtm_34_04.tif). This has been corrected by continuing the

	execution with a flat surface instead.
SIIMPC-888	Cirrus correction was activated in the default configuration. This has been deactivated as issues with cirrus correction have been observed. These issued will be fixed in a later release as listed in section 3.3.
SIIMPC-890	Processor terminated erroneously with AttributeError: 'L2A_AtmCorr' object has no attribute '_dn_blu_scene_av' when processing at 20 m resolution, whereas 60 m tiles are processed successfully.
	Edge distortion in tiles with background pixels could lead to the execution of the DDV algorithm, although (in principle) only water and cirrus pixels had been present, as the quotient of (false classified) reference pixels vs. scene pixels (without water) was sufficient to pass the test for running the DDV. During scaling of path radiance in the 60 m case, the number of reference pixels was too small so that the algorithm terminated without changing the path radiance. In the 20 m case in contrast, the number of reference pixels was sufficient, so that the algorithm continued. However, then a condition for the initialisation of the average values for the red and blue scenes was not fulfilled, which finally led to the observed crash for 20 m. This has been solved by exiting the DDV algorithm at this stage, which leads to the same results as for the 60 m case.

3.1.16   Evolution since release 2.2.1

Sen2Cor release 2.3 is an evolutionary update on top of release 2.2.1 and implements the support of PSD 14.2 in parallel to PSD 13.1 and the corrective maintenance fixes as described below for section 3.1.16.2.

3.1.16.1   Evolutionary Updates

The following features have been implemented new during the course of this release:

Issue	Description
SIIMPC-677	Implementation of PSD V14.2 in parallel to V13.1 with following additional features: 1. The product naming (including the naming of folders and files inside the product structure) has been compacted to overcome the 256 characters limitation on pathnames imposed by the Windows platforms. 2. The products distributed on the Sentinels Data Hub will embed one single tile of the tiling grid (as opposed to a set of tiles). 3. A full resolution True-Colour Image (TCI) will be included in every product as a separate RGB composite image (in JPEG2000 format) and will be placed inside the Tile folder together with the original spectral band images. These features will only be active if a product with PSD V14 and above is found. The software is downward compatible to PSD V:13.1.
SIIMPC-805	A new Quality Indicator for cloud coverage percentage which is the sum of the percentages of "Cloud medium probability", "Cloud High

probability" and "Thin cirrus" is available if PSD Version is 14 and above.

Additionally a reference to the origin of the L1C input is added under L2A_Product_Info in the User Product metadata. This will only be displayed if PSD is Version 14 and above.

3.1.16.2   Corrective Maintenance

The following fixes have been applied:

Issue	Description
SIIMPC-768	S2Toolbox showed NAN for DN Values of 0. This occurs when negative reflectance values are clipped. Clipping has been set to 1 instead to avoid this false labelling.
SIIMPC-734	New type of files in L1C products: some of the recent L1C products contained .gfs files which are geolocation header files for the masks. These files are unexpected by Sen2Cor and lead to an error at the end of the processing when creating the manifest.safe file. A patch was applied to avoid this issue.
SIIMPC-733	Empty date in log file and "<>" characters: the display of an empty acquisition date and unwanted characters in the xml reports has been fixed.
SIIMPC-702	Processor hangs after creating the DEM files: problems occurred during the creation of DEM files when concurrent access from different processes on the same file generated by gdalwarp occurred. This has been fixed by using the subprocess.Popen.wait() command until the gdal call which created the according file returned.
SIIMPC-687	Different tilesize in converted L2A JPEG-2000 data: the tilesize for the generation of the Jp2K output files has been adapted to the parameters given for the L1C input data.
SIIMPC-686	In section 3.2.1 of the SUM 2.2 still the old convention for processing is stated, which contrasts to the interface changes described for section 2.4.2. This has been aligned.
SIIMPC-672	Handling of AUTO setting for Atmosphere configuration: in some cases, when no Dark Dense Vegetation reference pixels have been found in the input data, the automated aerosol determination failed. This has been fixed in the way that the default values for SUMMER RURAL atmospheric conditions are selected, if this case occurs.
SIIMPC-611	Wrong ids of srtm files for products between 60 and 65° of latitude: there was a rounding error for calculation of the latitude and longitude values for these ranges, which has been fixed.
SIIMPC-599	Rewriting of L1C tiles metadata: the xml parser used a prettifier which failed when L1C data are blocked for writing or write protected. This has been removed so that L1C data can be read only without affecting the execution.
SIIMPC-598	Fails when user does not have write permission on the L1C: as the L2A

	data are copied from the L1C data, these new data are also write protected which led to an error when updating these files. L2A files properties are now recursively set to be writable for the user to avoid this error.
SIIMPC-577	SRTM georeferencing issue: Sen2Cor uses 5x5° SRTM tiles provided by CGIAR as geotiff and 1x1° PlanetDEM tiles as dted, and resamples them on the L2A product tile grid with gdalwarp. Then the DEM and the product bands are superimposed pixel to pixel. When checking the DEMs that outputs Sen2Cor on a same product, between the two different input DEMs, a half-pixel shift was discovered. This ends to a bad resampling when using SRTM DEMs. SRTM geotiff files do apparently not respect the GDAL convention that the origin should be the upper left corner of the upper left pixel. A solution was implemented in the way to rewrite the geoinformation of the geotiff file, via shifting the origin of a half pixel in the South West direction. This improved the output considerable when using the SRTM dem which is now comparable to the Planet one.
SIIMPC-573	Wrong name of dted files: Digital elevation maps for dted files have been labelled wrong as srtm due to a copy and paste error. This has been fixed.
SIIMPC-564	PlanetDEM, stripes on final products: Mosaicking and resampling routine for the treatment and generation of PlanetDems has been separated in order to avoid artefacts on generated products, which have also been observed in the surface reflectance bands.
SIIMPC-563	GdalDEM errors for planet DEM in Sen2Cor 2.2.1: the treatment of the handling of intermediate products have been corrected in order to avoid errors in the generation of the planet DEM output files.
SIIMPC-561	Problems with concurrent access on L2A GIPP Files in root installation directories: same issue as for SIIMPC-599: the xml parser used a prettifier which failed when the GIPP files are blocked for writing or write protected. This has been removed so that GIPP data can be read only without affecting the execution.
SIIMPC-558	Geo-Location + Projection information embedded in JPEG2000 file: this is a major fix which was possible due to an upgrade of Glymur to 0.8.7 at the state of this release: this allows now to place the Geo-Location + Projection information in the same format as is used by GDAL, so that the L2A outputs are now in line with the L1C input data concerning geo referencing.
SIIMPC-557	Option to set the terrain correction ON/OFF: DEMs generated by sen2cor are used for 3 different purposes: • the scene classification • the retrieval of AOT and WV • the terrain correction As the DEMs in generally improve the quality of the output, it is in some cases desirable to deactivate the third option of terrain correction. A configuration parameter named 'Rho_Retrieval_Step2 has been added, with the two options true and false. This has for the moment only experimental status and is only available for expert users in the calibration

	file L2A_CAL_AC_GIPP.
SIIMPC-556	User DEM directory with read_only rights: as DTED DEMs are a commercial product, it is possible that these DEMs are located on a file server and are write protected. Thus a temporary directory was introduced for storing the intermediate products needed for creating the user DEMs, so that the source directory can be write protected. For SRTM DEMs this feature was not implemented, as here these products shall be able to be downloaded, so that the directory should not be write protected.
SIIMPC-555	Logging: Adding a timestamp to the log report filename: it is possible to generate the product multiple times for different tiles and resolutions. Thus the report file which is labelled with the product identifier was overwritten. A timestamp has been added to the report file at the time of creation. The log file will then be copied into the L2A product directory after successful processing.
SIIMPC-554	Logging: duplicated lines: duplicated lines have been observed in the report file. This has been fixed.
SIIMPC-552	Blue Path radiance rescaling routine update: Last L2A processing have shown that sometimes the Blue Path radiance rescaling routine leads to an overestimation of the blue surface reflectance (by underestimating the blue path radiance based on blue/red ratio from reference dark pixels). The implemented solution computes the mean value of the digital numbers for the whole granule in the red channel. Then all pixels are excluded as very bright surfaces which are more than 5 times larger than this mean value. This relative measure was selected because the problem was caused by adjacency correction. Adjacency correction is stronger for larger brightness differences in the image and the variable threshold adapts to the actual image.
SIIMPC-551	DEM data format in L2A AUX_DATA folder: DEMs can have negative values for land below the sea level. The problem is, that the current OpenJPEG library does not support signed integer values (Whereas Kakadu does). A selection of writing GeoTIFF instead of JPEG2000 is no alternative in terms of filesize for the 10 m resolution DEM. A long term solution would be to get 16-bit signed support from OpenJPEG and Glymur. The Short term solution we implemented here is adding an offset of 10.000 in order to be sure that no confusion can be made. Highest elevation value on Earth: ~8,848 m and lowest elevation value on dry land: ~ -418m, which would result in coding as 18848 and 9582 DN. This offset will also be stated in the User Manual.
SIIMPC-550	Handling of SRTM NoData values: when the SRTM CGIAR V4.0 (default dem of Sen2Cor) data is imported in Sen2Cor, the NoData pixels are read with a value of (-32768). In this SRTM dataset, the sea pixels are set to NoData. There are several problems been identified with these -32768 values: The main problem is that there is a dem quality check in L2A_AtmCorr that checks the peak to peak (max –min) value of the data. The resulting peak to peak value is negative and therefore the dem is judged unnecessary and not used for the Atmospheric Correction (AC). For a correct AC on coastal areas, the dem sea pixels should be set at

	zero. For this a land/sea mask is used.
	The implementation which was finally selected use the GDAL tools by replacing the nodata values on coastal regions with 0 before the other dem related bands are imported. So the fix occurs already on the level of the tiff input and corrects thus also the derived products for slope, aspect and shade.

3.1.16.3   Configuration Changes

The following five changes in the configuration have been applied:

Configuration Item	Description	Value
Scaling_Limiter	limits the scaling of the path radiance for the blue channel to +/-10%.	True / false (default)
Scaling_Disabler	Disables the scaling of the path radiance for the blue channel.	True / false (default)
Rho_Retrieval_Step2	Disables the execution of step 2 of the	true (default) / false

As these configuration items are of experimental character they are located in the expert configuration file L2A_CAL_AC_GIPP.xml and should not be changed by standard users.

In the user configuration file L2A_GIPP.xml (located in the cfg subdirectory of the Sen2Cor home directory referenced by the $SEN2COR_HOME environment variable) the two following changes have been applied:

Configuration Item	**Description**	**Value**
Visibility	Sets the visibility default value	40.0 (default)
Cirrus_Correction	Cirrus correction has been activated as a default value	Yes

3.1.17   Evolution since release 2.1.0

3.1.17.1   Evolutionary Upgrades

3.1.17.1.1   Integration of Look Up Tables for Summer / Winter / Rural and Water atmosphere

A set of 24 (LUTs) have been integrated to cover most of atmospheric conditions on Earth for the Sentinel-2 mission. In the SEN2COR context, a set of LUTs is composed by 6 or 4 LUT files depending on the total water vapor columns content of the atmosphere. Different LUTs are calculated for the mid-latitude summer and mid-latitude winter atmospheres, with 6 different (sea level) ozone contents, a rural and a maritime aerosol, 6 or 4 different sea level water vapor columns. For each supported water vapor level, the ground-to- space water vapor column depends on elevation according to the atmosphere temperature /

humidity vertical profile provided. Details can be found in the user manual for SEN2COR 2.2.1.

SEN2COR LUTs are calculated for:

- 2 different types of aerosols (rural and maritime)
- 2 different types of atmospheres (Mid_Latitude SUMMER and Mid_Latitude WINTER)
- 6 different types of ozone concentrations (depending on summer or winter case)
- 6 or 4 different amounts of water vapor column (depending on summer or winter)

3.1.17.1.2   User Configuration

The LUT selection is configurable via the three entries: Aerosol_Type, Mid_Latitude and Ozone_Content in the Look_UP_Tables selection of the User Configuration file (L2A_GIPP.xml) located in the cfg directory specified by the SEN2COR_HOME environment variable. The water vapor columns are set internally.

3.1.17.1.3   Implementation of automated ozone determination

If the Ozone_Content is set to '0' by the user, it will be determined automatically by the processor. In that case, the measured ozone concentration is read from the L1C metadata and the LUT with the best fit for the measured ozone concentration is used.

3.1.17.1.4   Implementation of automated aerosol / atmosphere detection

If the Aerosol_Type and / or Mid_Latitude are set to 'AUTO' by the user, it will be determined automatically by the processor. In that case the processor will process two (aerosol only) or four test trials before the final processing of the atmospheric correction takes place. After calculation of the scene path radiance in the blue and red region (as total minus reflected radiance, using the average values obtained for the dark reference pixels) the ratio of Lp(blue, scene) to Lp(red, scene) can be compared to the corresponding ratio for the existing libRadtran aerosols (RURAL, MARITIME) or atmospheres (SUMMER, WINTER). The aerosol type for which the double ratio (dp) is closest to 1 is the best approximation for the scene and will be selected.

3.1.17.1.5   Improvement of the up- and down sampling routines

During the scientific evaluation campaign it has been shown, that using the previous selected methods for up and down sampling the different resolutions of the images (scipy.ndimage.interpolation.zoom), distortions of the colocation for equivalent pixels occurred. These routines have thus been replaced by the two routines skimage.measure.block_reduce for down- and skimage.transform.resize for up-sampling. These changes have the drawback of reducing the speed of reading of the JP2 input slightly, but improved the quality of the image data considerably.

3.1.17.1.6 Improvement of Scene Classification based on automated DEM selection

Previous releases of the processor had a tendency of false classification of water pixels inside of cloud borders and the correct discrimination between topographic and cloud shadow pixels. This has now been improved by taking the height information of an (optional) digital elevation map (DEM) as an additional input. To use this feature it is necessary to activate the reading of an appropriate DEM as is described in the User Manual.

3.1.17.2 Corrective Maintenance

3.1.17.2.1 Correction of setup routines

Upgrade to Anaconda 4.0.0 and cleanup of the dependencies to fix the issue described in: http://forum.step.esa.int/t/sen2or-install-error/1690/12

3.1.17.2.2 Correction of problems with the openjpeg2 drivers on Windows

The openjpeg DLL shipped with the previous releases of sen2cor was compiled with VC++. The DLL needs msvcr120.dll and msvcp120.dll to load properly. These two libraries are in most cases part of the windows installation under Windows\System32, but in some cases and some systems, they are apparently not present. The new library provides with this release was built with mingw, and has no longer any dependency to the VC++ 120 runtime dll.

3.1.18 Evolution since release 2.0.6

3.1.18.1 New Features

3.1.18.1.1 Implementation of parallelisation on tile base

SEN2COR supports now a parallel processing on tile base.

The maximum of processes can be determined via the L2A_GIPP.xml input configuration:

<Nr_Processes>AUTO</Nr_Processes>

Nr_Processes can be an unsigned integer value specifying the number or processes intended to operate in parallel or: AUTO. If AUTO is chosen, the processor determines the number of processes automatically, using the CPU info of the given architecture.

If L2A_Process is started with a L1C User product as the given directory argument, a series of tiles will be processed in parallel, according to the given Nr. of Processes in the L2A_GIPP above. If the Nr of Processes is 1, only a sequential processing will take place as it was implemented in previous releases.

Memory requirements: the atmospheric correction processing for 10m resolutions uses a huge amount of memory due to the 10.000 x 10.000 pixel for each image. Multiple images must be kept at certain intervals completely in memory for performing correlations. Thus, for each processing at 10m resolution, as a general rule of thumb, a resource of at least 4 GB of memory per

process should be available. Thus, unless you have a machine with sufficient memory, leave the Nr. of processes to single processing (1), otherwise memory overflow errors will occur during processing. On a 2 Core MAC / Linux workstation with 8 GB RAM, 2,8 GHz Intel i5 and 500 GB SSD, a 4 tiles parallel processing for 10m resolution images has been successfully performed. In systems which are equipped with hard disks, however more physical memory might be needed, due to swapping effects on the hard disk.

3.1.18.1.2   Implementation of the Manifest generation for L2A User Product

Sen2cor now replaces the L1C manifest with its own L2A manifest on the User product level

3.1.18.1.3   Implementation of single tile generation

A new feature for the processing of single tiles has been added. The pathname can now either point to a L1C user product or to a single tile of the user product.

If the argument points to a user product, all tiles of the user product will be processed subsequently. If the argument points to a single tile, only that tile will be processed. In the latter case, the configuration settings for parallel processing will be ignored.

3.1.18.1.4   Relative pathname for products and single tiles

The <directory> argument of the command line can now be either a relative or an absolute pathname.

If a relative pathname is given, it is expected that the user is calling sen2cor from inside a parent directory. Sen2cor will expand the absolute pathname for that directory.

Sen2cor will use the L1C user product identifier for generating a subsequent L2A product. For this purpose, the L1C source directory must start with an identifier like 'S2A_????_???_???L1C*' which is the standard, if you download a L1C user product from the Sentinel 2 data hub. The generated product will get the identifier 'S2A_????_???_???L2A*', everything else will be inherited from the L1C source.

3.1.18.1.5   Upgrade of the PSD to version 13.1

Support of the Metadata Format has been upgraded from version 12.0 to version 13.1

3.1.18.1.6   Improvements in the generation of L2A user products

The routines for generating user products of different resolutions have been decoupled and generally improved:

- SEN2COR will now also work on existing L2A user products. This allows the generation of different resolutions in subsequent steps.
- If the user is specifying no resolution at all on the command line, all resolutions will be generated in three subsequent steps. This is the

default. The selection of a 60 m resolution or 20m resolution via command line will only generate the resolution specified.

- If a resolution has already been processed for a given L2A product, sen2cor will not start a regeneration but will inform the user that this product already exists.
- The selection of a 10 m resolution requires the generation of a 20 m product. If a 20m product already exists from a previous processing, this will be taken as input, otherwise it will be generated in a first step, before the 10 m resolution product is processed. If the user wants to start from scratch, he must move, delete or rename the existing product.
- It is also possible to remove only single tiles of an existing product. These tiles will then be regenerated; the other existing tiles will be left untouched.

3.1.18.1.7 Implementation of PlanetDEM usage in parallel to CGIAR SRTM

See the section on Terrain Correction in the User Manual

3.1.18.2 Corrective Maintenance

3.1.18.2.1 L2A Processor exit conventions

In previous releases SEN2COR terminated with "TRUE", after a successful processing. This has been changed now to return "0" for a successful processing and a value above 0 if processing errors occurred. The reasons for an unsuccessful termination can be found usually in the log file, except if a fatal error occurred which immediately killed the logging process.

3.1.18.2.2 L2A generation error if input L1C includes only 1 band

It has been observed that the processor terminated with an error when a corrupt tile with incomplete band series was found. This has been fixed in the way that the processor will terminate the generation of this specific tile, but will continue with the generation of subsequent tiles.

3.1.18.2.3 Metadata file did not pass validation

The validation of the metadata has been adapted to version PSD V 13.1 and will no longer generate errors during validation, if the input data have the correct format. A warning will only occur on the processor output, if the validation fails. If validation is successful, no output will be generated on the standard output, but only in the logfile.

3.1.18.2.4 Issue in handling consolidated tiles

It has been observed that the processor terminated with an error when a consolidated tile was found. This has been fixed. The processing of a consolidated tile however might generate a validation warning, as consolidated tiles do not follow the metadata conventions for valid tile names.

3.1.18.2.5 Processor unable to process two (or more) data strips in one product

This has been corrected. Multiple data strips will now processed and the metadata will be updated accordingly.

3.1.18.2.6 L2A generation error in case of black image

It has been observed that the processor terminated with an error when Imaged did not contain any data. The atmospheric correction cannot work on completely empty tiles. The processor will now stop the processing for the tile in question, shows a corresponding warning message and will continue with the processing of the subsequent tiles.

3.1.18.2.7 Issue of DEM import when DEM support is activated

In previous releases, it occurred that a DEM was not correctly generated after download. The routines for reading a DEM have been improved with respect to parallelisation.

3.1.18.2.8 Issues reprocessing L1C product when L2A product is already present

The routines for generating user products of different resolutions have been decoupled and generally improved:

- SEN2COR will now also work on existing L2A user products. This allows the generation of different resolutions in subsequent steps.
- If the user is specifying no resolution at all on the command line, all resolutions will be generated in three subsequent steps. This is the default. The selection of a 60 m resolution or 20m resolution via command line will only generate the resolution specified.
- If a resolution has already been processed for a given L2A product, sen2cor will not start regeneration but will inform the user that this product already exists.
- The selection of a 10 m resolution requires the generation of a 20 m product. If a 20m product already exists from a previous processing, this will be taken as input, otherwise it will be generated in a first step, before the 10 m resolution product is processed. If the user wants to start from scratch, he must move, delete or rename the existing product.
- It is also possible to remove only single tiles of an existing product. These tiles will then be regenerated, the other existing tiles will be left untouched.

3.1.18.2.9 Problems with long pathnames on Windows

Windows had a path length limitation of 260 characters in the past. Unfortunately, Windows Explorer on Windows 7 x64 is still subject to this path limit. As a consequence, the very long pathnames of a typical Level-1C or Level-2A user product can sometimes not be handled correctly.

Since this release sen2cor is adapted to handle long path names on windows correctly. However there might still be problems that generated Level 2A User

products (as well as the L1C input folders) cannot be removed entirely using the Windows explorer. If this is the case, the path names must be manually shortened to a length below 260 characters before removing can take place. **Please note - this is a windows limitation and not in any case related to sen2cor.**

3.1.18.2.10 Problem with file deletion / creation at 10 m resolution

Previous releases had a problem on Windows with a file deletion at 10 m resolution if a file already existed. This has been fixed.

The fixes described above correspond to the following entries in the JIRA database:

L2A SPR Ref.	Title
SIIMPC-334	Update of PSD XSDs to version 13.1 for Sen2Cor 2.1.0
SIIMPC-287	L2A processor Exit Codes convention
SIIMPC-275	L2A generation error if input L1C include only 1 band
SIIMPC-271	[Meeting action] 20151130-DQM-12: Change request on L2A product format
SIIMPC-126	[Sen2Cor] Metadata file did not pass validation running Sen2Cor
SIIMPC-319	Issue on Sen2Cor in handling Consolidated Tiles
SIIMPC-220	Sen2Cor is not able to process a User Product containing two (or more) datastrips
SIIMPC-274	L2A generation error in case of black image
SIIMPC-297	Sen2Cor: Issue of DEM import when DEM support is activated
SIIMPC-199	Sen2Cor: Issue when reprocessing an L1C and L2A product is already present
SEN2COR-39	Problems with long pathnames on Windows
SEN2COR-40	Problem with file deletion / creation at 10 m resolution

3.1.19   Evolution since release 2.0.5

Corrupted library for openjp2.dll on windows corrected.

Calibration factor for earth-sun-distance in reflectance to radiance conversion corrected. Radiances are computed for a fixed Earth-Sun distance of 1.0 astronomical units. This corresponds to the radiances values as stored in Sen2Cor look up tables used by the Atmospheric Correction module.

3.1.20   Evolution since release 2.0.4

A scaling problem and additionally a mismatch between the 10m resolution output and the 20 / 60 m resolution and a strong distortion in the 10 m processing has been observed in the Level 2A output images for previous releases as reported by several beta test users. This has been identified and fixed:

1. increasing the input sensitivity according to a new reflectance to radiance routine to be aligned with the current inputs. This also works for the new planned 10000 scaling (instead of 1000).

2. improving the Dark Dense Vegetation classification, as the algorithm erroneously classified some water as dark pixels which then contributed to the observed distortions.

For the 60 and 20 m case, a re-scaling of the path radiance was performed if scaled path radiance for the blue band differs more than 3 % from the path radiance of the standard aerosol. This routine was only called when a visibility calculation is performed as is only the case for 60 and 20 m processing.

In the 10 m case this routine was not executed, as the visibility is resampled from 20 m. Thus, for 10 m bands the scaled path radiance for the blue band (sc_lp_blue) always remained to 1.0 due to the different treatment of the visibility calculation (see above).

These findings explain:

1. why the observed differences only occur in some of the images: - only if sc_lp_blue differs more than 3% from the default 0f 1.0, or if sufficient amount of water pixels are found, a rescaling takes place.

2. why the effect is stronger in some of the images: - the weight of the sc_lp_blue goes into the correction.

3. why the differences also occur between 60 and 20m, when the 20 m visibility was resampled from the 60 m bands instead of being calculated new.

The fixes listed above had been applied and the modified scaling for the blue channel path radiance for 20 and 60 m is stored in the configuration and is then reused for rescaling also during the 10 m processing. With this modification the results for the 10 m bands as for the 20 and 60 m are in the same range as to be expected.

New LibRadtran Look up Tables generated with the 2015 spectral response are integrated in the processor and replace the previous one.

The reflectance to radiance conversion has been updated according to a review with R. Richter. It now reflects the proper scaling of the radiance values with respect to the extra-terrestrial solar irradiance (Es). The earth sun distance factor has been removed from the conversion formula, as the TOA radiance is already aligned.

3.1.21   Evolution since release 2.0.3

The three following issues have been fixed for release 2.0.4:

L2A SPR Ref.	TITLE	COMMENT
SIIMPC-126	Metadata file did not pass validation running Sen2Cor	the warnings concerning the metadata are now redirected in the log files and do no longer occur at the command line irritating the user. The warnings itself result from an evaluation of the L1C metadata against their templates and must be fixed on the L1C metadata level.
SIITBX-113 SIIMPC-189	Sen2Cor has a different scaling on the L2A Output	Scaling of L2A outputs is now equivalent to L1C input and is read from the metadata instead from the L2A_GIPP file.
SIIMPC-189	Size of the L2A preview file does not correspond to L1C	Is now in JP2 format and equivalent in size to the L1C input.

3.2 Evolution since release 1.0.1

1. The reading and writing of the metadata have been updated in order to support PFS V12.

2. A syntax checker has been implemented which test the compliance of the product metadata before and after processing.

3. The following items have been implemented according to the SPR list provided by TAS: [S2-PDGS-TS-TR-027, issue: 01, date: 19/12/2014]:

L2A SPR Ref.	TITLE	COMMENT
L2A-001	Hosted Processor installation procedure	SUM chapter 3 to be updated with comments in the present report section

		2.3 Re: Complete rework of the installation procedure. See chapter 3.
L2A-002	Gdal	Delivery and version compatibility with other user software shall be clarified Re: GDAL will be installed as a conda package under the umbrella of Anaconda. No dependency to any GDAL installation outside of anaconda exists, providing that the PATH variable points to '~/anaconda/bin'. These settings can be placed locally, in order not to interfere with any global python setup.
L2A-003	Anaconda	Clarification on use and installation of the tools to be provided. Re: See chapter 3.
L2A-004	Pythonpath and bashrc	Definition and setting procedure to be described. Launch by shell is mandatory. Re see chapter 3.
L2A-005	User and rights	Procedure related to user (sometimes root) and rights for L1c data to be confirmed Re: no administration rights are required, if a local installation is selected as is advised in chapter 3.
L2A-006	Output directory	Procedure to set output directory (different from input directory) to be enhanced and described. Re has been implemented and can be selected in the L2A_GIPP.xml processor configuration file.
L2A-007	Launch parameters	Procedure to set parameters at launch to be enhanced and described. Ree see section 3.2 Operation.
L2A-008	Source shell is necessary in order to set environment variable for the L2A processor	This is necessary in order to not modify centre user installation. This shell is updated with predefined variable during the L2A processor installation. See L2A_Bashrc in the sen2cor user directory.
L2A-009	Execution shell is needed to start L2A processor	This shell a source environment shell and launch the real L2A processor (../bin/L2A_Process) This is a special requirement for the PDGS. For this Purpose a Script named L2A_Process.bash has been generated in the sen2cor user directory. For operations under the S2Toolbox this script is not

		required.
L2A-010	No dependencies must be defined for the L2A installation except for already installed IPF/DPC dependencies	Fortunately, there is no problem with the delivered version because the dependencies are equal to those installed
L2A-011	It is needed to change or comment the ProductionRequestParameters.xsd interface	This is necessary to improve the launch of predefined version, type and options for the correct execution of the L2A processor Re: This information is provided by the L2A_Process.bash script. This does also contain the version number, if multiple versions of the sen2cor should be launched.
L2A-012	Test data rights must be correct	It is necessary to change owner and rights after installation. It is also possible to indicate the command in the L2A SUM. Test data are provided as a zipped tar file. Unpacking is described in the SUM. Installation in the correct environments is in the responsibility of the user.
L2A-013	L2A SUM must indicate how to uninstall the L2A processor if needed (including Anaconda)	See chapter 3.0.
L2A-014	Correct Anaconda version must be delivered with the L2A processor	Delivered Anaconda version is different from the one downloaded on internet and cannot be installed. There are no direct requirements on the anaconda version to be used. It is suggested to install the most recent anaconda release, see section 3.1
L2A-015	Python installation 2.7 is needed but environment variable must be setting whit the 2.6 version	There is no need for any python environment setting, provided that the PATH includes a reference to anaconda/bin
L2A-016	Update of delivery note	Minor corrections to be done in the L2A-RPDN document, regarding the version of L2A-SRN and the FTP server.

3.3 List of Known Issues

Issue	Description

3.4 List of Evolutionary Upgrades

The following issues are foreseen to be part of evolutionary upgrades and are currently under planning. The specific release dates and versions are to be determined.

Issue	Description
SIIMPC-559	For regions with very low aerosol content, e.g. Antarctica, it should be possible to correct only for Rayleigh diffusion (AOT negligible) and water vapour (usually also very low).
SIIMPC-560	One of the issues causing chessboard effect on L2A surface reflectance between adjacent tiles is due to the failure of AOT retrieval when not enough DDV pixels are found on the L1C image. A default aerosol value (currently corresponding to a 40 km or 23 km visibility) is then applied leading to differences in surface reflectance for adjacent tiles. To overcome this problem and to minimize the chessboard effect, it is planned to use the ECMWF meteorological information from short forecast model (AOT at 550 nm) as a fall-back for AOT estimation. Even when AOT is calculated via the DDV algorithm the meteorological data could be used to verify the retrieval or smooth the AOT retrieved over adjacent tiles.
SIIMPC-791	As the usage of the default SRTM DEMs sometimes show poor results (e.g. over Namibia) it is planned to extend the DEM input to other providers or higher resolutions.
SIIMPC-819	Cirrus correction is currently limited to 60 and 20 m resolution. It shall be extended to 10 m.

4. Installation and Setup

This Application will support the three following Operating Systems:
Linux, macOS and Windows (64 bit is mandatory).

4.1 New stand-alone installers (since release 2.4.0)

Due to the numerous installation problems reported which are mostly related to evolutionary shifts between the different Sen2Cor releases and the Anaconda runtime environment and/or its associated tools, we have developed stand-alone installers for the three operating systems specified above. These packages will work fully autonomously and isolated and do not need any further installation of Anaconda, GDAL, OpenJPEG or any other python packages.

Separate installers for the three Operating Systems Windows, Linux and macOS are available:

The installation procedure is as follows:

Download the packages:

- Sen2Cor-02.08.00-win64.zip

- Sen2Cor-02.08.00-Linux64.run

- Sen2Cor-02.08.00-Darwin64.run

    From the ESA STEP website:

    http://step.esa.int/main/third-party-plugins-2/sen2cor

On Windows: extract the zipped archive with an unzip tool. This will create a folder named: Sen2Cor-02.08.00-win64.

You can place the extracted folder in your user account at your choice. Then, change into the directory Sen2Cor-02.08.00-win64 using the windows command line interpreter and call the command "L2A_Process.bat --help". It shall show:

```
L2A_Process.bat --help
usage: L2A_Process.py [-h] [--mode MODE] [--resolution {10,20,60}]
                      [--datastrip DATASTRIP] [--tile TILE]
                      [--output_dir OUTPUT_DIR] [--work_dir WORK_DIR]
                      [--img_database_dir IMG_DATABASE_DIR]
                      [--res_database_dir RES_DATABASE_DIR]
                      [--processing_centre PROCESSING_CENTRE]
                      [--archiving_centre ARCHIVING_CENTRE]
                      [--processing_baseline PROCESSING_BASELINE] [--raw]
                      [--tif] [--sc_only] [--cr_only] [--debug]
                      [--GIP_L2A GIP_L2A] [--GIP_L2A_SC GIP_L2A_SC]
                      [--GIP_L2A_AC GIP_L2A_AC] [--GIP_L2A_PB GIP_L2A_PB]
                      input_dir
```

```
Sentinel-2 Level 2A Processor (Sen2Cor). Version: 2.8.0, created:
2019.01.20,
supporting Level-1C product version 14.2 - 14.5.


positional arguments:
  input_dir             Directory of Level-1C input

optional arguments:
  -h, --help            show this help message and exit
  --mode MODE           Mode: generate_datastrip, process_tile
  --resolution {10,20,60}
                        Target resolution, can be 10, 20 or 60m. If omitted,
                        only 20 and 10m resolutions will be processed
  --datastrip DATASTRIP
                        Datastrip folder
  --tile TILE           Tile folder
  --output_dir OUTPUT_DIR
                        Output directory
  --work_dir WORK_DIR   Work directory
  --img_database_dir IMG_DATABASE_DIR
                        Database directory for L1C input images
  --res_database_dir RES_DATABASE_DIR
                        Database directory for results and temporary products
  --processing_centre PROCESSING_CENTRE
                        Processing centre as regex: ^[A-Z_]{4}$, e.g "SGS_"
  --archiving_centre ARCHIVING_CENTRE
                        Archiving centre as regex: ^[A-Z_]{4}$, e.g. "SGS_"
  --processing_baseline PROCESSING_BASELINE
                        Processing baseline in the format: "dd.dd", where
                        d=[0:9]
  --raw                 Export raw images in rawl format with ENVI hdr
  --tif                 Export raw images in TIFF format instead of JPEG-2000
  --sc_only             Performs only the scene classification at 60 or 20m
                        resolution
  --cr_only             Performs only the creation of the L2A product tree, no
                        processing
  --debug               Performs in debug mode
  --GIP_L2A GIP_L2A     Select the user GIPP
  --GIP_L2A_SC GIP_L2A_SC
                        Select the scene classification GIPP
  --GIP_L2A_AC GIP_L2A_AC
                        Select the atmospheric correction GIPP
  --GIP_L2A_PB GIP_L2A_PB
                        Select the processing baseline GIPP
```

If the processor replies as shown above without any error, you are ready to process. If you add the directory containing the L2A_Process.bat file to your path, then you can call the processor directly from the directory where you host the Level-1C user products.

The configuration data of the processor are by default copied into the folder "sen2cor" inside the Document directory of your home folder.

On Linux and macOS: extract the compressed archive with the system command: "sh Sen2Cor-02.08.00-Linux64.run", respective "sh Sen2Cor-02.08.00-Darwin64.run". It will then create the folder: Sen2Cor-02.08.00-Linux64, respective Sen2Cor-02.08.00-Darwin64 under the current directory.

There is also an option to specify the target folder during installation time, and to give an appropriate name for the installation directory:

Example (for Linux, Mac follows the same principle): To use a different installation directory use the --target option:

./Sen2Cor-02.08.00-Linux64.run --target /tmp/sen2cor280

Then, change into the directory Sen2Cor-02.08.00-Linux64 using the Linux bash shell. Confirm that Sen2Cor is correctly installed with the following command:

example_user@gedapvl07:/home/user/bin/Sen2Cor-02.08.00-Linux64> bin/
L2A_Process --help

It shall show:

```
usage: L2A_Process.py [-h] [--mode MODE] [--resolution {10,20,60}]
                      [--datastrip DATASTRIP] [--tile TILE]
                      [--output_dir OUTPUT_DIR] [--work_dir WORK_DIR]
                      [--img_database_dir IMG_DATABASE_DIR]
                      [--res_database_dir RES_DATABASE_DIR]
                      [--processing_centre PROCESSING_CENTRE]
                      [--archiving_centre ARCHIVING_CENTRE]
                      [--processing_baseline PROCESSING_BASELINE] [--raw]
                      [--tif] [--sc_only] [--cr_only] [--debug]
                      [--GIP_L2A GIP_L2A] [--GIP_L2A_SC GIP_L2A_SC]
                      [--GIP_L2A_AC GIP_L2A_AC] [--GIP_L2A_PB GIP_L2A_PB]
                      input_dir

Sentinel-2 Level 2A Processor (Sen2Cor). Version: 2.8.0, created: 2019.01.20,
supporting Level-1C product version 14.2 - 14.5.

positional arguments:
  input_dir             Directory of Level-1C input

optional arguments:
  -h, --help            show this help message and exit
  --mode MODE           Mode: generate_datastrip, process_tile
  --resolution {10,20,60}
                        Target resolution, can be 10, 20 or 60m. If omitted,
                        only 20 and 10m resolutions will be processed
  --datastrip DATASTRIP
                        Datastrip folder
  --tile TILE           Tile folder
  --output_dir OUTPUT_DIR
                        Output directory
  --work_dir WORK_DIR   Work directory
  --img_database_dir IMG_DATABASE_DIR
```

```
                        Database directory for L1C input images
--res_database_dir RES_DATABASE_DIR
                        Database directory for results and temporary
                        products
--processing_centre PROCESSING_CENTRE
                        Processing centre as regex: ^[A-Z_]{4}$, e.g "SGS_"
--archiving_centre ARCHIVING_CENTRE
                        Archiving centre as regex: ^[A-Z_]{4}$, e.g. "SGS_"
--processing_baseline PROCESSING_BASELINE
                        Processing baseline in the format: "dd.dd", where
                        d=[0:9]
--raw                   Export raw images in rawl format with ENVI hdr
--tif                   Export raw images in TIFF format instead of JPEG-2000
--sc_only               Performs only the scene classification at 60 or 20m
                        resolution
--cr_only               Performs only the creation of the L2A product tree,
                        no processing
--debug                 Performs in debug mode
--GIP_L2A GIP_L2A       Select the user GIPP
--GIP_L2A_SC GIP_L2A_SC
                        Select the scene classification GIPP
--GIP_L2A_AC GIP_L2A_AC
                        Select the atmospheric correction GIPP
--GIP_L2A_PB GIP_L2A_PB
                        Select the processing baseline GIPP
```

If the processor replies as shown above, you are ready to process. Optionally you can source the script L2A_Bashrc automatically from your .bashrc or .profile, then you can call the processor directly from the directory where you host the Level-1C user products.

The configuration data of the processor are by default copied into the folder "sen2cor" inside of your home folder.

We strongly recommend testing these simplified installation first, as it will prominently reduce the installation overhead in contrast to a full Anaconda installation, especially as changes in the interfaces of anaconda packages might occur after the release of a Sen2Cor version (see also section 4.2).

The uninstallation of the packages is simply done by removing the folder. There are no further leftovers except the sen2cor configuration in your home folder which can also simply be removed.

5. Copyright Notes

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