S5P Mission Performance Centre
NPP Cloud [L2__NP_BDx] Readme

document number	S5P-MPC-RAL-PRF-NPP	
issue	1.1	
date	2018-12-04	
product version	V01.00.02	
status	Released	
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1 Summary

This is the Product Readme File (PRF) for the Copernicus Sentinel 5 Precursor Tropospheric Monitoring Instrument (S5P/TROPOMI) NPP-Cloud auxiliary/support data product and is applicable for the Offline (OFFL) timeliness data product (there are no Near Real Time products).

Product Identifier: **L2__NP_BDx** (Where **x** indicates a specific TROPOMI band)

Example filename:

S5P_OFFL_L2__NP_BD3_20180704T133421_20180704T151550_03748_01_010000_20180710T125313.nc

The Readme file describes the current processing baseline, product and quality limitations, and product availability status. More information on this data product is available from the Sentinel product webpage:

https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-5p/products-algorithms,

and from the TROPOMI product webpage http://www.tropomi.eu/data-products.

The S5p NPP Cloud product contains information on cloud and scene homogeneity for TROPOMI scenes, derived from operational products from the Visible Infrared Imaging Radiometer Suite (VIIRS) on board the Suomi NPP platform. S5p operates in loose formation orbit with NPP, so that measurements from VIIRS are well co-located with TROPOMI, with a time difference of about 3.5 minutes. There is no specific validation of auxiliary products within the S5p Mission Performance Centre.

2 Processing baseline description

Table 1 contains the history of the S5p S-NPP Cloud processor versions.

Processor Version	In operation from	In operation until
01.00.00	OFFL: orbit 3661, 2018-06-28	Initial version
01.00.02	OFFL: orbit 5236, 2018-10-17	Current version

Table 1: History of S5p S-NPP Cloud processor versions

3 Product Quality

3.1 Recommendations for data usage

The product contains statistics of the VIIRS measured radiances and cloud mask, aggregated over the S5p footprints. Included in the data are counts of the number of valid VIIRS observations in a given S5p scene and these should be used to confirm that VIIRS data is actually present and valid for a given S5p scene.

The product does not give cloud fraction directly, but reports the number of VIIRS pixels within an S5p scene which are flagged in four classes: confidently cloudy, probably cloudy, probably clear and confidently clear. The user can compute fraction from these by (a) summing the number of pixels in the class(es) of interest (e.g. confidently + probably cloudy) and (b) normalizing by the total number of VIIRS cloud flag value, obtained by summing the counts for all four classes.

For further details, data users are encouraged to read the Product User Manual (PUM) and Algorithm Theoretical Basis Document (ATBD) associated with this data product, available on the ESA S5p Document library (https://sentinel.esa.int/web/sentinel/user-guides/sentinel-5p-tropomi/document-library).

3.2 Validation results

The NPP product is essentially a re-gridding of the operational VIIRS L1 and cloud mask products from NOAA. The fidelity of the re-gridding algorithm was confirmed during the development of the S5P-NPP product and S5p commissioning by (a) comparing results between the prototype and operational versions of the processor; (b) comparing the re-gridded VIIRS radiances to S5p measurements in comparable spectral bands.

The quality of the geophysical quantities which are re-gridded (cloud mask and Level 1 radiances) is covered by documentation and other resources from NASA and NOAA, including the references given in section 8 below.

4 Known Data Quality Issues

To date there are no known major issues with the S5P-NPP product. The algorithm appears to reliably re-grid the input products. Availability and quality of information is limited by that of input VIIRS data and timeliness/completeness of transfer to the S5p ground segment. This has not led to significant gaps of coverage so far, though the NPP product can only be generated with several days delay from real time, due to the need to wait for all required input product to be acquired from NOAA.

It should be noted, however, that for version 01.00.00 (in operations from 2018-06-28 to 2018-10-17) the `max_value` attribute assigned to the cloud flag counts (e.g. `vcm_confidently_cloudy` is set to a value which is too low (the value can be exceeded towards the edge of the TROPOMI swath). Users should ignore the `max_value` attribute and treat all values in the cloud counts as valid. **This problem is solved in version 01.00.02, in operations since 17 October 2018**.

The assumptions made about the S5p spatial response may limit the validity of the S5p data for quantitative use (beyond e.g. simply flagging cloud presence). E.g. the product provides most information for quadrilateral areas which are related to the S5p spatial response. Radiances are also reported as averages weighted by the spatial response, however variations in spatial response as a function of spectral pixel within band are not accounted for. The S5p L1 geolocation information is also assumed to be correct. Details related to these assumptions are provided in the ATBD.

The user should also be aware of the few minutes difference between S5p and VIIRS measurements. In extreme circumstances (very high winds), cloud motion could introduce some error into the NPP derived cloud fraction for TROPOMI. The sensing time difference is reported in the NPP files, and cloud information is reported for scenes (“scaled fields of view”) which are larger than the S5p footprint. This enables scenes which might be affected by cloud motion or small errors in geolocation to be identified.

5 Algorithm Change Record

For a detailed description of the L2__NP_BDx algorithms, please refer to the ATBD [RD01].

There are no algorithm changes to report respect to the previous version of this PRF.

6 Data Format

The product is stored as NetCDF4 file. The NetCDF4 file contains both the data and the metadata for the product.

Details of the data format are provided in the Product User Manual (PUM) [RD02].

6.1 Data format changes

There are no data format changes to report respect to the previous version of this PRF.

7 Product Availability

The S5p NPP-Cloud data are available at https://scihub.copernicus.eu.

More information on this data product and data handling tools are available from the product web page under heading 'Tools': http://www.tropomi.eu/data-products.

For further questions regarding S5P/TROPOMI data products please contact EOSupport@Copernicus.esa.int.

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https://sentinels.copernicus.eu/documents/247904/690755/Sentinel_Data_Legal_Notice.

Auxiliary data are available respecting the terms of the source data including the S5p VIIRS (value-added) auxiliary cloud products. This data provided in line with NASA's data policy that ensures that all NASA data are available fully, openly, and without restrictions https://earthdata.nasa.gov/nasa-data-policy.

8 References

[RD01] S5P-NPP Cloud Processor ATBD: source: RAL **ref:** S5P-RAL-ATBD-001; url: http://www.tropomi.eu/documents/atbd/

[RD02] Sentinel-5 precursor/TROPOMI Level 2 Product User Manual, NPP Cloud **source:** RAL; **ref:** S5P-RAL-PUM-001; **url:** http://www.tropomi.eu/documents/pum/

[RD03] Joint Polar Satellite System (JPSS) VIIRS Cloud Mask (VCM) ATBD **source:** NASA; **ref:** 474-00033 revision E; **date:** 2014-08-05; **url**: https://www.star.nesdis.noaa.gov/jpss/documents/ATBD/D0001-M01-S01-011_JPSS_ATBD_VIIRS-Cloud-Mask_E.pdf

[RD04] VIIRS Cloud Mask IP Release, Validation Stage 2 Data Quality. Read-me for Data Users, http://www.class.ngdc.noaa.gov/notification/pdfs/ReadMe_VCM_CLASS_validated_maturity_stage2.pdf

[RD05] VIIRS SDR Release: Validated Data Quality, March 1, 2014; **url** : http://www.class.ngdc.noaa.gov/notification/pdfs/VIIRS_SDR_Validated_Release_README_CLASS_cc_rev1_SDR_rm.pdf

[RD06] Keith D. Hutchison, Andrew K. Heidinger, Thomas J. Kopp, Barbara D. Iisager & Richard A. Frey (2014) Comparisons between VIIRS cloud mask performance results from manually generated cloud masks of VIIRS imagery and CALIOP-VIIRS match-ups, International Journal of Remote Sensing, 35:13, 4905-4922, DOI: 10.1080/01431161.2014.932465

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https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-5p/products-algorithms,

and from the corresponding TROPOMI product webpage http://www.tropomi.eu/data-products.

The NPP VIIRS official website is https://jointmission.gsfc.nasa.gov/viirs.html

Abbreviations and acronyms

ATBD	Algorithm Theoretical Basis Document
BIRA-IASB	Royal Belgian Institute for Space Aeronomy
DLR	German Aerospace Center / Deutsches Zentrum für Luft- und Raumfahrt
ESA	European Space Agency
ESL	Expert Support Laboratory
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
JPSS	Joint Polar Satellite System
KNMI	Koninklijk Netherlands Meteorologisch Instituut – Royal Dutch Meteorological Institute
MPC	Mission Performance Centre
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NRTI	Near Real TIme
OFFL	OFFLine
PRF	Product Readme File
PUM	Product User Manual
RAL	Rutherford Appleton Laboratory
S5P	Sentinel-5 Precursor
S5PVT	Sentinel-5 Precursor Validation Team
SRON	Netherlands Institute for Space Research
Suomi NPP	Suomi National Polar-orbiting Partnership
TROPOMI	Tropospheric Monitoring Instrument
VIIRS	Visible Infrared Imaging Radiometer Suite