Sentinel-3 SLSTR Uncertainties in Level-1 Products Python Tool User Manual

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CHANGE LOG

Date	Issue	Revision	Pages	Reason for change
28-Oct-2019	2	0		Changes made according to the RIDs. - Section 2: "MapnoiS3 tool's requirements" - Two possibilities included for the output directory name - Output file name changed to: <band>_uncertainty_<g><v>.nc
30-Nov-2021	3			Modified to account for external SLSTR Level-1 combined uncertainties file.

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1 Scope of Document / Introduction

MapnoiS3 is a Python code developed to allow the addition of per-pixel noise NE∆T and NE∆L, and radiometric uncertainty information to the SLSTR Level-1 products. The tool can deal with several SLSTR Level-1 products in one go, and with as many channels and scan views as the user requires. This work was performed under the European Union's Copernicus Programme, and managed by EUMETSAT through the contract EUM/CO/18/4600002122/AOC. The document has been updated to include Level-1 external uncertainty files as part of EUM/CO/21/4600002574/AOC - Order 450021556.

2 MapnoiS3 tool's requirements

The *MapnoiS3* code was written in Python 3.7. and it works in any operating system, Mac OS X, Linux, and Windows.

The simplest way to start *MapnoiS3* is to install Python3 and pip3 package installer for Python3. Then pip3 can be used to install the modules that MapnoiS3 needs. The required modules are: sys, time, os, pathlib, xml.dom, numpy, and netCDF4.

The modules sys, time, os, and pathlib are contained in the Python's standard library. The other modules can be installed with the following command:

```
pip3 install <module>
```

or

```
sudo pip3 install <module>
```

3 Obtaining the MapnoiS3 code

MapnoiS3 is provided as a tarball file which can be opened as:

```
tar -zxvf mapnoiS3.tar.gz
```

This will create a folder called *mapnoiS3* in the user's directory. It contains the *code* archive with the python scripts, and the *input* folder, which contains the input xml file, and the Level-1 and Level-2 ADFs products required by the algorithm.

4 MapnoiS3 Input Files

The MapnoiS3 code consists of two folders: *input* and *code*

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4.1 The INPUT folder

The input folder contains:

4.1.1 *Config_file.xml*

"*config_file.xml*" is the input file where the user should write the paths to the input datasets and the necessary channels and scan views. The user should fill the *config_file.xml* file as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<mapnoiS3_config>
  <path_slstr      value="/data/" description="Path to SLSTR L1 input products" type="STRING" />
  <path_adfL1      value="/mapnoiS3/input/ADFs/Level1/" description="Path to SLSTR ADF L1 input products" type="STRING" />
  <path_adfL2      value="/mapnoiS3/input/ADFs/Level2/" description="Path to SLSTR ADF L2 input products" type="STRING" />
  <channels        value="s1,s3,s5,s6,s7,s9,f1" description="List of channels to process, separated by commas" type="STRING"  />
  <scan            value="nadir,oblique" description="Scan view to process (nadir and/or oblique, separated by comma)" type="STRING" />
  <select_uncert   value="/orbit" description="Select the radiometric uncertainties LUT: 'orbit' (for the L1 combined uncertainties), or 'ground' (for
                   quality products)" type="STRING" />
  <path_tir_uncerts  value="/tir_incerts/" description="Path to SLSTR L1 TIR Uncertainty products" type="STRING" />
  <path_out        value="/output/" description="Path to output products" type="STRING" />
</mapnoiS3_config>
```

- <path_slstr value should contain the path to the directory containing the SLSTR Level-1 products that the user wants to analyse. The code deals with products of both instruments, SLSTR-A and SLSTR-B, separately. The L1 products from different instruments should be placed in different folders, and the code should be run independently, for each instrument using the correspondent ADF products.

- <path_adfL1 value should contain the path to the ADF Level-1 products. Currently, the code contains by default only the ADFs Level-1 products of SLSTR-A.

- <path_adfL2 value should contain the path to the ADF Level-2 products. The code provides by default the ADFs Level-2 products of SLSTR-A.

- <channels value contains the channels. The user can select one channel or as many channels as wanted separated by commas.

- <scan value indicates the scan view, nadir and/or oblique separated by a comma.

- In <select_uncert the user can select to compute the radiometric uncertainties LUT measured during the pre-launch calibration provided in the Level-1 quality products, or to compute the radiometric uncertainties by using the Level-1 combined uncertainties per orbit.

- <path_tir_uncerts value should contain the path to the SLSTR L1 tir uncertainties LUT. If the path is not provided or it is not found, the code will use the LUT contained in the SLSTR quality data products.

- <path_out value should contain the output directory in which the code's output files will be stored. If the parameter is left blank or empty, then the output uncertainty netcdf files will be stored inside the corresponding Level-1 SLSTR product.

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4.1.2 ADF folder

The ADF folder contains by default the ADF Level-1 and Level-2 products corresponding to SLSTR-A.

4.1.3 External file of Level-1 Uncertainties

The tool has been updated to ingest the Level-1 external uncertainty files, so the user can select the data source to map the radiometric uncertainties to the Level-1 data. The external uncertainty file name is:

<MMM>_SL_1_UNCOAX_<START_ORBIT>_<STOP_ORBIT>_<CREATION DATE>_EUM_O_AL_001

It contains a LUT of radiometric uncertainties combined for the full orbit as a function of scene temperature. This is an input optional file. If the file is not provided, the algorithm will use the pre-launch radiometric uncertainty estimates available in the Level-1 quality products.

At the moment, these external files are only applicable to the TIR channels.

4.2 The CODE folder

The code consists of four python scripts: *mapnoiS3.py*, *input_reader.py*, *calc_uncert.py*, and *output_writer.py.*

- *mapnoiS3.py* is the main executable script. It calls at several modules:
- *input_reader.py which* reads the parameters from the file *config_file.xml*

- *calc_uncert.py* which calculates the radiometric uncertainty, NEDL, NEDT and dL/dT at the pixel level, for every SLSTR product, channel and scan view requested by the user
- *output_writer.py* contains the functions necessary to create the output netcdf files

5 Quick Start

To get the code running in Linux or MacOS, the user needs to change the main script *mapnoiS3.py*, and the code folder to executable as follows:

```
chmod +x path/mapnoiS3/code/mapnoiS3.py
```

The path environment variable has to be appended in the .bash_profile file:

```
export PATH="path/mapnoiS3/code:$PATH"
```

The code can be run from a Linux command line as follows:

```
mapnoiS3.py "/path/mapnoiS3/input/config_file.xml"
```

Once the code is executing, the tool will write the following output:

> MapNoiS3 v2.0 starts at: <start time>

The radiometric uncertainties from the SLSTR Level-1 quality products have been selected.

Change the value <select_uncerts> in the config_file.xml if you prefer to use the SLSTR Level-1 combined

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1) Processing Product: <SLSTR Level-1 product>

Writing Uncertainty Datasets to: <path_output

S1_uncertainty_an.nc..... Done
S2_uncertainty_an.nc..... Done

> MapNoiS3 v2.0 finishes at: <end time>

However, if an external uncertainty file is selected (<select_uncert value= “orbit”) which doesn’t correspond to the same orbit of the SLSTR Level-1 product, then a warning message will appear on the screen:

*** Warning! The L1 combined uncertainty file closest to the L1 product observation date (<SLSTR L1 data start >) is:

<MMM>_SL_1_UNCOAX_<START_ORBIT>_<STOP_ORBIT>_<CREATION DATE>_EUM_O_AL_001

Do you want to use it? [Y/N] (If no, the on-ground measured radiometric uncertainties from the Level-1 quality product will be used.)

If the user types <Y> then the external uncertainty file provided in <path_tir_uncerts will be used. If <N>, the uncertainties form the Level-1 quality product will be used.

6 MapnoiS3 Output Files

For each SLSTR Level-1 product analysed:

<MMM>_SL_1_RBT___<data_start>_<data_stop>_<creation_time>_....SEN3

where <MMM> is S3A or S3B, the code will create an output directory per product, named as:

<MMM>_SL_1_UNC___<data_start>_<data_stop>.SEN3

at the output path indicated in the “*config_file.xml*” file. If the output path is left empty then the output products will be located in the level-1 SLSTR product directory:

<MMM>_SL_1_RBT___<data_start>_<data_stop>_<creation_time>_....SEN3/

The output directory contains a netcdf file per each channel and each scan view selected. The netcdf file contains the NEDL and the radiometric uncertainties at the pixel level for the VIS/SWIR channels, and the NEDT, the radiometric uncertainties and the slope dL/dT for the infrared and the fire channels.

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