The EUMETSAT Network of Satellite Application Facilities

NWC SAF
Support to Nowcasting and Very Short Range Forecasting

User Manual of the GEO-L1SD tool

NWC/CDOP3/GEO/AEMET/SW/UM/L1SD, Issue 1, Rev. 0

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Applicable to GEO-L1SD v1.0

for SAFNWC/GEO version 2016

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REPORT SIGNATURE TABLE

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DOCUMENT CHANGE RECORD

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1.0	25 May 2017	15	First version, applicable to GEO-L1SD v1.0

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1 INTRODUCTION

1.1 PURPOSE

In the frame of the NWC SAF project, a simple tool (GEO-L1SD) has been developed in charge of reading Satellite Data (used as input by the NWC/GEO application) and generating binary and/or netCDF output files containing the radiances, reflectance and brightness temperatures in a NWC/GEO-defined processing region

The present document details the functionality of the GEO-L1SD tool, and the procedure to install and operate it.

1.2 REFERENCES

1.2.1 Applicable documents

The following documents, of the exact issue shown, form part of this document to the extent specified herein. Applicable documents are those referenced in the Contract or approved by the Approval Authority. They are referenced in this document in the form [AD.X].

For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the current edition of the document referred applies.

Current documentation can be found at the NWC SAF Helpdesk web: http://www.nwcsaf.org

Ref	Title	Code	Vers	Date
[AD.1]	Proposal for the Third Continuous Development and Operations Phase (CDOP3) March 2017 – February 2022	NWC SAF: CDOP-3 proposal	1.0	11/04/16
[AD.2]	Interface Control Document for Internal and External Interfaces of the NWC/GEO	NWC/CDOP2/GEO/AEMET/SW/ICD/1	1.2	15/10/16
[AD.3]	Data Output Format of the NWC/GEO	NWC/CDOP/GEO/AEMET/SW/DOF	1.2	15/10/16

Table 1: List of Applicable Documents

1.2.2 Reference documents

The reference documents contain useful information related to the subject of the project. These reference documents complement the applicable ones, and can be looked up to enhance the information included in this document if it is desired. They are referenced in this document in the form [RD.X].

For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the current edition of the document referred applies.

Current documentation can be found at the NWC SAF Helpdesk web: http://www.nwcsaf.org

Ref	Title	Code	Vers	Date
[RD.1]	The Nowcasting SAF Glossary	NWC/CDOP2/SAF/AEMET/MGT/GLO	2.1	03/02/17

Table 2: List of Referenced Documents

2 FUNCTIONAL DESCRIPTION

The GEO-L1SD tool implements the following high-level requirements

Id	Description
010	The GEO-L1SD application shall be developed as a NWC/GEO PGE, in order to allow an ease integration within the NWC/GEO system
020	The application shall allow the reading of MSG/SEVIRI data in HRIT segmented native format
030	The application shall read the satellite data contained in a geographical region defined in a NWC/GEO Region Configuration File (.cfg)
040	The application shall read the satellite data for a selected set of spectral bands, defined by the user in a NWC/GEO Model Configuration File (.cfm)
050	Output data shall be provided in radiances and/or reflectance (observed or normalised reflectance, for visible bands) and brightness temperature (for thermal bands) according the configuration defined by the user in a NWC/GEO Model Configuration File (.cfm)
060	The reading and calibration of the satellite data shall make use of the existing functionality provided by the NWC/GEO NWCLIB
070	The application shall generate a file containing the satellite data provided in the requested units and the requested region in i) binary format and/or ii) netCDF format, according the configuration defined by the user in a NWC/GEO Model Configuration File (.cfm)
080	The products generated in binary format will use the strategy defined for the intermediate products generated by the SATEXT module of the NWCLIB
090	The products generated in netCDF format will follow the same schema than that used for all NWC/GEO output products

3 GEO-L1SD OUTPUT PRODUCUTS FORMAT

3.1 BINARY FORMAT

The format of the binary files generated by the GEO-L1SD application is the same than that used by the intermediate products generated by the SATEXT module of the NWCLIB:

Format:

- Raw Binary
- float[n_lines][n_cols] (4 bytes/pixel)
- Indexing: f[0][0]; f[0][1]; …; f[0][n_cols-1]; f[1][0]; …; f[n_lines-1][n_cols-1]

Size:

n_lines * n_cols * 4 bytes

File naming criteria:

S_NWC_<band_id>_<sat_id>_<region_id>-<res_id>_YYYY-MM-DDThh:mm:ssZ.<ext>

where

- <band_id> is the band Identifier
- <sat_id> is the Satellite Identifier
- <region_id> is the identifier of the processing region (defined by the user in the configuration)
- <res_id> is the identifier of the resolution
- YYYY-MM-DDThh:mm:ssZ is the nominal time of the satellite data
- <ext>: defines the content:
    - rad: Radiances
    - refl: Observed Reflectances
    - refn: Normalized Observed Reflectances
    - bt: Brightness Temperature

Content:

- rad file: Effective Radiances for each pixel in the region in mW m-2 sr-1 (cm-1)-1

- refl: Reflectance for each pixel in the region in % (>=0)
- refn: Normalized Reflectance for each pixel in the region in % (>=0)
- bt file:: Brightness Temperature for each pixel in the region, in K
- NODATA: if calibrated data (radiance, reflectance or bt) cannot be computed (missing count, error computing the calibrated data or pixel in space).

Location:

- Binary files are stored in the DATABUF of the NWC/GEO: $SAFNWC/tmp directory

3.2 NETCDF FORMAT

The format of the netCDF files generated by the GEO-L1SD application follows the rules and structure defined for all NWC/GEO output products (see [DOF] [AD.3]), with the following specific characteristics:

- Each satellite band and each calibration (RAD, REFL, REFN, BT) is stored in a different netCDF file
- The name of the netCDF variable containing the satellite data in each netCDF file is "`data`"
- The naming criteria for netCDF file is

  S_NWC_<band_id>-<cal_id>_<sat_id>_<region_id>-<res_id>_YYYYMMDDThhmmssZ.nc

  where

  - <band_id> is the band Identifier
  - <cal_id> is the Identifier of the calibration
    - RAD for radiance
    - REFL for observed reflectance
    - REFN for normalized reflectance
    - BT for brightness temperature
  - <sat_id> is the Satellite Identifier
  - <region_id> is the identifier of the processing region (defined by the user in the configuration)
  - <res_id> is the identifier of the resolution
  - YYYYMMDDThhmmssZ is the nominal time of the satellite data
- netCDF output file are stored as NWC/GEO output products, in the $SAFNWC/export/L1SD directory

High-level specification

The high level structure of the GEO-L1SD products in netCDF is shown below:

	Content
Dimensions	
Attributes	
Variables	
float lat(ny, nx)	// Latitudes
float lon(ny,nx)	// Longitudes
float nx(nx)	// X Georeferenced Coordinates for the centre of the pixel
float ny(ny)	// Y Georeferenced Coordinates for the centre of the pixel
float data(ny,nx)	// Satellie data

Variable	Content
data	Satellite data for the band and in the calibrated units as defined in the filename

Detailed specification

Dimensions

	Content
Dimensions	
ny	Number of Lines of the Region
nx	Number of Columns of the Region

Attributes

See [DOF] [AD.3] document for common NWC/GEO attributes and common image-like products attributes.

Variables

See [DOF] [AD.3]document for a detailed description of common variables to all image-like products:

- lat and lon variables
- nx and ny Coordinate variables

Implementation of specific netCDF variables are hereafter presented

	Content
Variables	
unsigned float data(ny,nx)	**// Satellite data**
Dimensions	
ny	
nx	
Attributes	
standard_name	"l1_satellite_data"
long_name	"l1_satellite_data_band_<band>_in_<calibration>" where <band> is the satellite band <calibration> is the identifier of the calibration: "radiance" "reflectance" "normalized_reflectance" "brightness_temperature"
units	Radiance: "mW m-2 sr-1 (cm-1)-1" Reflectance: "%" Brightness Temp: "K"
valid_range	-1.0E10 1.0E10
_FillValue	-9999.0
ancillary_variables	""
coordinates	"lon lat"
comment	

4 INSTALLATION OF GEO-L1SD

4.1 ENVIRONMENT

This section describes HW/SW prerequisites needed to install and execute the GEO-L1SD tool.

GEO-L1SD tool has been tested in a Linux/RHEL5 64 bits environment. Correct execution in other environments cannot be currently guaranteed.

	Intel/Linux	Intel/Linux
O.S	RHEL release 5.1 Tikanga	RHEL release 6.4 Santiago
CPU	2x Intel(R) Xeon(R) CPU E5-2670 v2 @ 2.50GHz	4x Intel(R) Core(TM) CPU i5-4590 @ 3.30GHz
Arch	x86_64	x86_64
Memory(1)	4 GB	8 GB
Disk	500 GB	500 GB
Shell	bash; ksh	bash; ksh
Compilers	GCC compilers 4.1.2; gcc; g++; gfortran	GCC compilers 4.4.7 gcc; g++; gfortran
gzip	gzip 1.3.5	gzip 1.3.12
Java	1.7.0_03	1.7.0_09

Table 3: Minimum configuration

4.2 PREPARATION OF THE ACCOUNT

The GEO-L1SD has been designed and developed for integration within the NWC/GEO application. Therefore it assumed that the NWC/GEO package has been installed and configured properly in the system before the installation of the GEO-L1SD tool.

4.3 INSTALLATION OF THE GEO-L1SD PACKAGE

The GEO-L1SD package is provided in a tar.gz file:

NWC-CDOP3-GEO-AEMET-SW-CODE-L1SD_v1.0.tgz

To install this package,

1. locate in the NWC/GEO home ($SAFNWC) and decompress the tgz distribution:

```
% cd $SAFNWC
% tar xvf <source>/NWC-CDOP3-GEO-AEMET-SW-CODE-L1SD_v1.0.tgz
```

The following files will be created:

$SAFNWC	***Root directory for SAFNWC software***
src	*Application source code*
L1SD	*GEO-L1SD Module*
S_NWC_PRODIO_L1SD.cf	GEO-L1SD Output Product Configuration file
Makefile	Makefile
GEO-L1SD.c	Source code for the GEO-L1SD tool
safnwc_L1SD.cfm	Model Configuration File of the GEO-L1SD tool

2. Compile the tool

```
% cd $SAFNWC/src/L1SD
% make
```

If required, the tool can be uninstalled simply executing

```
% cd $SAFNWC/src/L1SD
% make uninstall
```

5 OPERATION OF GEO-L1SD TOOL

5.1 COMMAND LINE INTERFACE

The GEO-L1SD tool for the reading of satellite data in native format and writing of data in binary and/or netCDF format has been developed as a PGE for integration within the NWC/GEO. Therefore, the command line interface is the same than that used by all other NWC/GEO PGEs:

```
GEO-L1SD YYYY-MM-DDThh:mm:ssZ region_conf_file model_conf_file
```

where

- *YYYY-MM-DDThh:mmZ* is the nominal time of the satellite slot to be processed
- *region_conf_file* is the name of the region configuration file containing the definition of the geographical region to be processed (see[ICD/1] [AD.2], section 5.1.1)
- *model_conf_file* is the name of the model configuration file for the GEO-L1SD, defined in next section

5.2 GEO-L1SD MODEL CONFIGURATION FILE

The NWC/GEO Model Configuration Files (.mcf) contain specific configuration information for the execution of the PGEs (see[ICD/1] [AD.2], section 5.1.2)

Next table present the content of the Model Configuration file for the GEO-L1SD

Keyword	Description	Type	Possible Value(s)
PGE_ID	PGE Identifier	Char	GEO-L1SD
L1SD_BANDS	List of satellite bands to read	Char	List of Satellite bands identifiers as defined in the Annex A of the NWC/GEO ICD/1
L1SD_RAD	Request the generation of satellite data in Radiances	Char	YES | NO
L1SD_REFL_BT	Request the generation of satellite data in Reflectance (visible bands) or Brightness Temperature (thermal bands)	Char	YES | NO
L1SD_REFL_NORM	If Reflectaces are requested (L1SD_REFL_BT = YES), indicates if reflectances must be normalized according the solar zenith angle	Char	YES | NO
L1SD_BINARY	Request the generation of the output products in Binary Format	Char	YES | NO
L1SD_NETCDF	Request the generation of the output products in netCDF Format	Char	YES | NO

Table 4: Content of the GEO-L1SD Model configuration file

5.3 EXAMPLE

Execution of the GEO-L1SD tool using the default configuration for a defined slot in the Spain processing region:

```
GEO-L1SD 2014-01-20T15:00:00Z Spain.cfg safnwc_L1SD.cfm
```

The tool generates the following files for bands HRV, VIS06, WV62 e IR120 in radiance and reflectance/brightness temperature

- Binary files (in $SAFNWC/tmp)
  - S_NWC_HRV_MSG3_Spain-HRVIS_2014-01-20T15:00:00Z.rad
  - S_NWC_HRV_MSG3_Spain-HRVIS_2014-01-20T15:00:00Z.refl
  - S_NWC_IR120_MSG3_Spain-VISIR_2014-01-20T15:00:00Z.bt
  - S_NWC_IR120_MSG3_Spain-VISIR_2014-01-20T15:00:00Z.rad
  - S_NWC_VIS06_MSG3_Spain-VISIR_2014-01-20T15:00:00Z.rad
  - S_NWC_VIS06_MSG3_Spain-VISIR_2014-01-20T15:00:00Z.refl
  - S_NWC_WV62_MSG3_Spain-VISIR_2014-01-20T15:00:00Z.bt
  - S_NWC_WV62_MSG3_Spain-VISIR_2014-01-20T15:00:00Z.rad

- netCDF files (en $SAFNWC/export/L1SD)
  - S_NWC_HRV-RAD_MSG3_Spain-HRVIS_20140120T150000Z.nc
  - S_NWC_HRV-REFL_MSG3_Spain-HRVIS_20140120T150000Z.nc
  - S_NWC_IR120-BT_MSG3_Spain-VISIR_20140120T150000Z.nc
  - S_NWC_IR120-RAD_MSG3_Spain-VISIR_20140120T150000Z.nc
  - S_NWC_VIS06-RAD_MSG3_Spain-VISIR_20140120T150000Z.nc
  - S_NWC_VIS06-REFL_MSG3_Spain-VISIR_20140120T150000Z.nc
  - S_NWC_WV62-BT_MSG3_Spain-VISIR_20140120T150000Z.nc
  - S_NWC_WV62-RAD_MSG3_Spain-VISIR_20140120T150000Z.nc

Next table shows the global attributes of the product VIS06-REFL (in netCDF format). Most significant values have been highlighted.

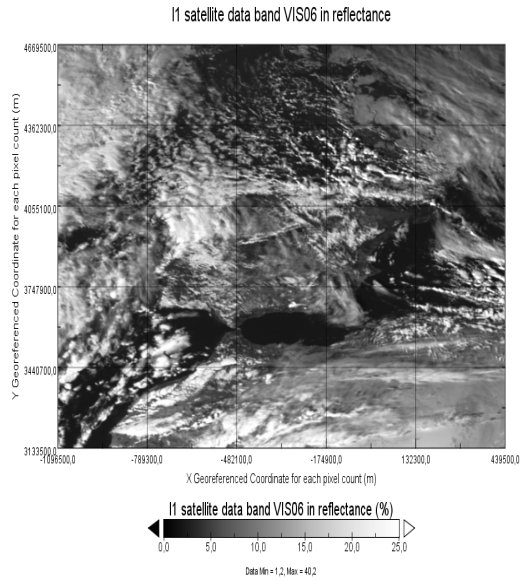
```
// global attributes:
:Conventions = "CF-1.6";
:TITLE = "NWC/GEO LEVEL 1 SATELLITE PRODUCT";
:history = "2016-06-20T17:15:16Z ooal Product Created by NWC/GEO v2016\n2016-06-20T17:15:16Z ooal GEO-
          L1SD 2014-01-20T15:00:00Z Spain.cfg safnwc_L1SD.cfm";
:institution = "Agencia Estatal de Meteorología (AEMET)";
:source = "NWC/GEO version v2016";
:comment = "Copyright 2016, EUMETSAT, All Rights Reserved";
:references = "http://www.nwcsaf.org";
:contact = "safnwchd@aemet.es";
:SUMMARY = "LEVEL 1 SATELLITE DATA";
:KEYWORDS = "SATELLITE DATA";
:keywords_vocabulary = "GCSM Science Keywords";
:id = "S_NWC_L1SD_MSG3_Spain-VISIR_20140120T150000Z.nc";
:naming_authority = "Agencia Estatal de Meteorología (AEMET)";
:cdm_data_type = "Image";
:date_created = "2016-06-20T17:15:16Z";
:creator_name = "Agencia Estatal de Meteorología (AEMET)";
:creator_url = "http://www.aemet.es";
:creator_email = "safnwchd@aemet.es";
:project = "NWC/GEO";
:PROCESSING_LEVEL = "LEVEL 1";
:time_coverage_start = "2014-01-20T15:09:40Z";
:time_coverage_end = "2014-01-20T15:11:22Z";
:license = "EUMETSAT user policy";
:saf = "NWC/GEO";
:product_name = "L1SD";
:product_algorithm_version = "1.0";
:satellite_identifier = "MSG3";
:sub-satellite_longitude = 0.0f; // float
:centre_proyection_longitude = 0.0f; // float
:nominal_product_time = "2014-01-20T15:00:00Z";
:region_id = "Spain";
:region_name = "Spain; CENTRE=40 -4; SIZE=512x512 VISIR pix";
:spatial_resolution = 3.0f; // float
:cgms_projection    =    "+proj=geos    +coff=366.000000    +cfac=13642337.000000    +loff=1557.000000
          +lfac=13642337.000000 +spp=0.000000 +r_eq=6378.137000 +r_pol=6356.752300 +h=42164.000000";
:gdal_projection = "+proj=geos +a=6378.137000 +b=6356.752300 +lon_0=0.000000 +h=35785.863000";
:gdal_geotransform_table = -1096500.0f, 3000.0f, 0.0f, 4669500.0f, 0.0f, -3000.0f; // float
:gdal_xgeo_up_left = -1096500.0f; // float
:gdal_ygeo_up_left = 4669500.0f; // float
:gdal_xgeo_low_right = 439500.0f; // float
:gdal_ygeo_low_right = 3133500.0f; // float
```

```
  :product_quality = 100.0f; // float
  :product_completeness = 100.0f; // float
  :geospatial_lat_max = 52.69991f; // float
  :geospatial_lat_min = 30.525656f; // float
  :geospatial_lon_max = 6.8868937f; // float
  :geospatial_lon_min = -17.702696f; // float
```

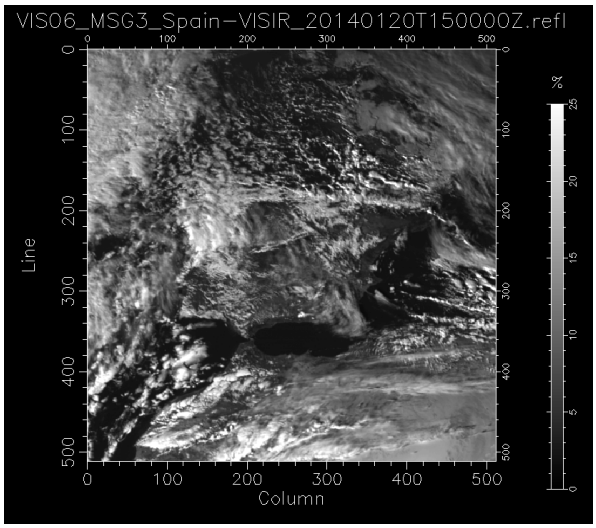
The main characteristics of the `data` variable are hereafter presented:

```
float data(ny=512, nx=512);
      :standard_name = "l1_satellite_data";
      :long_name = "l1_satellite_data_band_VIS06_in_reflectance";
      :units = "%";
      :valid_range = -1.0E10f, 1.0E10f; // float
      :_FillValue = -9999.0f; // float
      :ancillary_variables = "";
      :coordinates = "lon lat";
      :comment = "";
```

Next figures display a graphical representation of the satellite data stored in both netCDF and Binary files:



netCDF format



Binary format