EUMETSAT NWC SAF
SUPPORT TO NOWCASTING AND VERY SHORT RANGE FORECASTING

User Manual of the NWCPY tool for the NWC/GEO

NWC/CDOP3/GEO/AEMET/SW/UM/NWCPY, Issue 3, Rev. 3

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Applicable to NWCPY v3.3

for SAFNWC/GEO version 2018.x, 2021.x and 2025

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REPORT SIGNATURE TABLE

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1.0	2 Oct 2017	16	First version, applicable to NWCPY v1.0
1.1	11 Feb 2018	19	Second version, applicable to NWCPY v1.1 • Pressure interval differentiation and trajectories included in HRW product • ASII product added Image format changed from PNG to GIF
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3.0	24 May 2022	26	Document updated for NWC/GEO vMTG • Automatic representation of the final product • Added optional parameters (help, noplot, otname, quiet) • Restructured the document to include a section for each NWCPY tool with examples for it. • NWCPY migration to python3 and cartopy • Added installation process for users using conda environment • Req 030 includes the management of EXIM product • Code adapted to DOF for NWC/GEO vMTG • Added support for 2021 and MTG versions of the products
3.1	13 Apr 2023	26	New functionality is added: • Plot a subregion of the product given latitude, longitude and size of the region for image-like product.
3.2	22 Jun 2023	26	New functionality is added: • Visualization of the trajectories output for HRW NWCGEO vMTG product • Plot a subregion of the product given latitude, longitude and size of the region for HRW, HRW trajectories vMTG and RDT product • Adapt the installation process to use yml file requirements instead of script
3.3	15 Jun 2025	27	Document updated to v2025 • Added new optional variable that allows to plot the imagen without pixel adjust, plotting only the product without borders, logos or legends. • Update libraries versions • Adapt palette to not show fill value in the color bar.

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1 INTRODUCTION

1.1 PURPOSE

In the frame of the NWC SAF project, an easy-to-use tool (NWCPY) has been developed in charge of reading NWC/GEO output products in native format (netCDF[1] for all products, except ASII, that is generated in BUFR format, see [AD.2]) and generating a graphical representation of a certain variable in a GIF file. The tool read the required information to generate the plot from the NWC/GEO netCDF fields, as for example the colour palette, the valid range of the data, the meaning of the values …

The present document details the functionality of the NWCPY 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:/nwc-saf.eumetsat.int

Ref	Title	Code	Vers	Date
[AD.1]	Proposal for the Third Continuous Development and Operations Phase (CDOP3) March 2017 – February 2022	P-CDOP-3	1.0	11/04/16
[AD.2]	Data Output Format of the NWC/GEO	NWC/CDOP3/GEO/AEMET/SW/DOF (v2018) (v2018.1) (v2021) (v2025)	 1.0 1.1 2.0.1 1.0.4	 21/01/19 01/10/19 28/02/22 31/03/25
[AD.3]	User Manual for the Tools of the NWC/GEO	NWC/CDOP3/GEO/AEMET/SCI/UM/Tools (v2018.x) (v2021) (v2025)	 1.0 2.0 1.2.0	 21/01/19 22/01/22 31/03/25
[AD.4]	User Manual for the Wind product processors of the NWC/GEO: Science Part	NWC/CDOP3/GEO/AEMET/SCI/UM/Wind (v2018) (v2018.1) (v2021) (v2025)	 1.0 1.1 2.0 1.2.0	 21/01/19 18/12/19 10/01/22 31/03/25

Table 1: List of Applicable Documents

[1] The NWC/GEO HRW product is available in netCDF format, just setting `OUTPUT_FORMAT = NET` in the HRW model configuration file.

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:/nwc-saf.eumetsat.int

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

Table 2: List of Referenced Documents

2 FUNCTIONAL DESCRIPTION

The NWCPY tool implements the following high-level requirements:

Id	Description
010	The NWCPY application shall generate a graphical representation of NWC/GEO products in GIF format
020	The NWCPY application shall be developed as a tool apart from the NWC/GEO, so that a user could run it without installing the NWC SAF software
030	The application shall allow the reading of all PGE product files in native netCDF format (including EXIM products) and ASII product in BUFR format (See [AD.2])
040	The application shall also allow the reading of Satellite Data products in netCDF as generated by the NWC/GEO extra tool GEO-L1SD (See [AD.3])
050	Given a netCDF product file, the application shall read the data corresponding to a certain variable, including its attributes and colour palette. In case of HRW product file, the application shall also read trajectory data (See [AD.4])
060	Given a BUFR ASII file, the application shall read the latitude, longitude and variable name contained in each message
070	The plotting shall follow the native geostationary projection, using the gdal parameters included in the netCDF file. In case of HRW, RDT and ASII products, gdal parameters are taken from the corresponding L1SD netCDF file
080	Output image shall be provided in gif format, with the dimensions (width x height) specified by the user as an input parameter
090	No data pixels in iSHAI representation shall be filled using the data of the IR_band variable included in the iSHAI product (See [AD.2])

100	No data pixels in CI product images shall be filled with brightness temperatures data read from the GEO-L1SD IR_120_BT satellite data product for the same slot and region
110	Appropriate GEO-L1SD IR_120_BT satellite data product shall be used as background image for the representation of HRW, ASII and RDT-CW data
120	The image generated in gif format will follow the same nomenclature than the netCDF input file, only adding the parameter being displayed and changing the extension (.gif)

3 INSTALLATION OF NWCPY

3.1 ENVIRONMENT

This section describes HW/SW prerequisites needed to install and execute the NWCPY tool.

NWCPY tool has been tested in the following Linux 64 bits environment. Correct execution in other environments cannot be guaranteed.

	RockyLinux 9	**Ubuntu24**
O.S	Rocky Linux 9.5 (Blue Onyx)	Ubuntu 24.04.2 LTS (Noble Numbat)
CPU	8x Intel(R) Core(TM) i7-9700 CPU @ 3.00GHz	4x Intel(R) Core(TM) i5-4590 CPU @ 3.30GHz
Arch	x86_64	x86_64
Memory	32 GB	8 GB
Disk	512 GB	512 GB
Shell	bash; ksh	bash; ksh
Compilers	GNU 11.5.0	GNU 13.3.0
gzip	gzip 1.12	gzip 1.12
make	GNU Make 4.3	GNU Make 4.3
m4	m4 (GNU M4) 1.4.19	m4 (GNU M4) 1.4.19
CMake	CMake 3.26.5	CMake 3.28.3
Libaec	Libaec v1.0.6	Libaec v1.0.4

3.2 PREVIOUS CONDITIONS AND LICENSES

3.2.1 NWC/GEO

The NWCPY has been designed and developed to be self-dependant. Therefore, the NWC/GEO package is not required to execute this tool.

3.2.2 Python

The NWCPY has been developed in python; python 3 is required to execute the NWCPY tools.

3.2.3 Miniconda

Miniconda is an open and free distribution that is in charge of management and administration of python modules. It is used for install all the modules and its dependencies that are necessary to execute NWCPY software. Please, before install NWCPY, make sure that Miniconda3 is installed in the system.

If Miniconda3 is not installed, if it possible do it with these steps:

1- *curl -O https://repo.anaconda.com/miniconda/Miniconda3-latest-Linux-x86_64.sh*

2- *chmod +x Miniconda3-latest-Linux-x86_64.sh*

3- *./Miniconda3-latest-Linux-x86_64.sh*

In the second command, it is necessary to accept the license terms and set de path installation. Finally, the following question is showed: *"Do you wish the installer to initialize Anaconda3 by running conda init?* As Anaconda documentation recommends, if enter "yes" anaconda modify your shell scripts to execute conda when the session is opened and include bin directory from conda in .bashrc. If is entered "no", to use conda it is necessary to do "cd <*CONDA_PATH/bin*> and execute the commands in this path. For the correct installation and execution of NWCPY packages, it is necessary to enter "yes".

If anaconda is already installed and don't remember if during the installation process entered yes, it must be necessary to check it. Type "conda" in the prompt, and if the commands works displaying an options menu, the variable is set. If it doesn`t works works, it is necessary to go to <anaconda_path>/bin and execute the following:

```
./conda init
```

Relogin the session, and conda is fully available to install the package.

3.2.4 GEO-L1SD

NWCPY requires GEO-L1SD satellite data products as background data for some products. Therefore, the user must assure the availability of GEO-L1SD products if required (CI, HRW, ASII and RDT representation).

The GEO-L1SD tool is integrated in the source code of the NWC/GEO v2018. The generation of L1SD products can be activated by simply adding this tool to the list PS_PGES in the Run Configuration File.

3.2.5 ImageMagick

ImageMagick allows to interact with images from the terminal in a simple manner.

NWCPY requires ImageMagick's `convert` tool that allow to convert images from PNG format into GIF format. NWCPY also uses the `display` tool to represent the final image.

3.3 INSTALLATION OF THE NWCPY PACKAGE

The NWCPY package is provided in a tar.gz file:

NWC-CDOP3-GEO-AEMET-SW-CODE-NWCPY_v3.3.tgz

It is important to note that the NWCPY tool does not require NWC/GEO application to be installed in the system. It can be executed in any machine meeting the requirements from Section 3.2.

To install the NWCPY package, including all required libraries and modules (COTS), follow the next procedure.

1. Define the following environment variables required for the installation of the NWCPY in your .bashrc

   ```
   export NWCPY_PATH=<target_directory> (Directory where NWCPY will be
   installed)
   ```

   and re-login to set this environment variables.

2. Locate in the desired directory for the installation of the tool and decompress the distribution:

   ```
   mkdir $NWCPY_PATH  (if required)
   cd $NWCPY_PATH
   tar xvf <source>/NWC-CDOP3-GEO-AEMET-SW-CODE-NWCPY_v3.3.tgz
   ```

The following directory tree and files will be created:

$NWCPY_PATH		***Decompression directory***
/		
logoNWCSAF.png		NWCSAF logo image
nwcpy_asii.py		Source code for the NWCPY tool, ASII product
nwcpy_hrw.py		Source code for the NWCPY tool, HRW product
nwcpy_hrw_v2021.py		Source code for the NWCPY tool, HRW v2021 product
nwcpy_hrw_vMTG.py		Source code for the NWCPY tool, HRW v2025 product
Nwcpy_hrw_traj.py		Source code for the NWCPY tool, HRW product
nwcpy_hrw_traj_v2021.py		Source code for the NWCPY tool, HRW v2021trajectories
nwcpy_hrw_traj_vMTG.py		Source code for the NWCPY tool, HRW v2025 trajectories
nwcpy.py		Source code for the NWCPY tool, image-like products
nwcpy_rdt.py		Source code for the NWCPY tool, RDT product
CONDA/		
	nwcpy_env.yml	Module version

3. Run the following command to install the conda environment that allow to execute the NWCPY program.

   ```
   cd $NWCPY_PATH/CONDA
   conda env create --file nwcpy_env.yml
   ```

   Disclaimer: This action takes several minutes. To guarantee that the installation is correct, please, don´t stop the process.

   This process creates a conda environment called NWCPY and installs the following C libraries and python packages at user level.

Table 4: C libraries required by NWCPY

Library	Version	Description
pkg_config	0.29.0	Interface to unify libraries and compilations
libpng	1.5.13	To use png format
freetype	2.7	Manage the fonts render
geos-devel	3.3	Library for spatial topology operations in C++
proj	4.9.1	Software to manage geospatial coordinates from CRS to another
HDF5	1.8.17	Format for use with large amounts of hierarchically organised data
netcdf	4.4.1	Binary data format standard for exchanging scientific data

Table 5: Python packages required by NWCPY

h5py	Python interface to the HDF5 binary data format
matplotlib	Python 2D plotting library
cartopy	Provides tools to work with maps in python
netCDF4	Python interface to the netCDF C library.
numpy	Package for scientific computing with Python
pybufrkit	Python toolkit for WMO BUFR messages
dateutil	Manage standard datetime module
setuptools	Package development process library
configparser	For reading and writing configuration files
cython(1)	Optimistic static compiler for python programming
pytz(2)	Provides ASCII names
cycler(2)	Provides composition and iteration logic to matplotlib
pyparsing(2)	Manage the use of regular expressions
six(2)	Provides utility functions to compatibility python versions
shapely(3)	Manipulation of geometric in the cartesian plane
pyshp(3)	Reading and writing ESRI shapefiles
scipy(3)	Provides mathematical tools and algorithms

(1) Required by numpy; (2) Required by matplotlib; (3) Required by cartopy

In case that NWCPY environment has to be uninstall, only is needed to execute the following command:

```
conda remove -n NWCPY --all
```

4 OPERATION OF NWCPY TOOL

4.1 CONDA TIPS

As it is explained previously, NWCPY uses Anaconda to manage all the necessary modules. To do this, Anaconda creates an environment where installed these modules and allows execute programs only inside these environments.

In NWCPY installation, an environment is created with the NWCPY`s dependencies. To execute the program, it is necessary to activate the environment with the following command:

```
conda activate NWCPY
```

If the environment is not activated, the program does not execute. The following command deactivates it: *conda deactivate*.

In the following sections, this process is omitted, and only is presented the command that execute NWCPY. Other command that can execute the program is

```
conda run -n NWCPY <PythonCommand>
```

This avoids the constant activate/deactivate process. If NWCPY is usually executed, it is recommended to define an alias in .bashrc profile with the different scripts that NWCPY contains.

4.2 COMMAND LINE INTERFACE

Once the NWCPY tool is installed on the system, the command line interface is the following:

For **Image-like products** (CMA, CT, CTTH, …):

```
python    $NWCPY_PATH/nwcpy.py <path/file.nc> <variable1> <width> <height>
          [<optional parameters>]
```

For **HRW winds**:

```
python    $NWCPY_PATH/nwcpy_hrw.py <path/file.nc> <width> <height> <type>
          [<pressure_interval>] [<optional parameters>]
```

For **HRW trajectories**:

```
python    $NWCPY_PATH/nwcpy_hrw_traj.py <path/file.nc> <width> <height> <n_slots>
          [<pressure_interval>] [<optional parameters>]
```

For **RDT-CW product**:

```
python    $NWCPY_PATH/nwcpy_rdt.py <path/file.nc> <width> <height>
          [<optional parameters>]
```

NWCPY commands can be executed from any directory, properly indicating the path to the netCDF/BUFR files. However, for CI, HRW, ASII and RDT product, that needs L1SD product as background, it is necessary that product to plot and L1SD data would be in the same level in the folder structure. For example, if we save HRW product in ./HRW/file.nc, to use L1SD, it must be in ./L1SD. The output gif images are generated in the working directory.

4.3 IMAGE-LIKE PRODUCTS

The NWCPY tool `nwcpy.py` represents image-like products. Different variables can be represented for each product

The usage of this code is as follows:

```
python   $NWCPY_PATH/nwcpy.py <path/file.nc> <variable1> <width> <height>
         [<optional parameters>]
```

where

- `<path/file.nc>` is the complete path to the product file in netCDF format.
- `<variable1>` is the name of the variable contained in the netCDF for image-like products.
- `<width> <height>` are the dimensions of the output gif image. Set to "`0 0`" to generate the output file at default size (`1100x800`).

Additional optional parameters can be defined:

- `<help/-h>:` opens the help dialogue, which shows how to operate each code correctly.
- `<noplot>:` by default, after the image is generated, it is opened with linux's display command. This option disables that representation.
- `<waitdisplay>:` if the image is to be represented, holds the console until the display window of the image is closed.
- `<outname>:` writes the output file name with the <outname> value.
- `<quiet>:` reduces the amount of information that is represented in the terminal.
- `<fct>`: the Extrapolated Imagery Products (EXIM) in v2025 contains an additional dimension which stores the result of the extrapolation of the image in multiple timeframes. The code represents the <fct>th [2] timeframe available within the data. (parameter only applicable to EXIM product in v2025)
- `<fctm>`: as with <fct>, <fctm> defines which of the different timeframes are to be represented. The code represents the image which has been extrapolated <fctm> minutes from the original. (parameter only applicable to EXIM product in v2025)
- `<flag>:` In the representation of flag variables, this parameter defines the flag in the variable to be plotted. If this parameter is omitted, the tool presents the list of available flags in the variable to allow the user to select the appropriate one to be displayed
- `<subregion>:` It is possible to zoom the original image given latitude, longitude, and the size of the subregion (number of lines and number of columns). NWCPY recalculates the given points respect the original product and plot the part of the product region.
- `<adjustpixel>:` Allows to plot the imagen only with the product representation, without logos, borders, or legends. Besides, the pixel is not adjusted to represent the imagen in a specific resolution but is show in the size that it is defined in the subregion. This variable optional only works if *subregion* optional variable is in used.

[2] These indexes are zero-based (0 represents the first image of the product)

The images generated by the NWCPY tool are stored in the working directory and follow the naming criteria by default (if <outame> is not used):

```
<file>.<variable1>.gif
```

For the EXIM (only in v2025) product, the naming criteria used by default is

```
<file>.<variable1>.<fctm>.gif
```

4.3.1 Example: NWC/GEO Image-like product (CT)

Execution of the NWCPY tool for `ct` variable contained in the CT (Cloud Type) image-like product, generated for MSG-N region, with the default dimensions:

```
python    $NWCPY_PATH/nwcpy.py
          S_NWC_CT_MTI1_EURMLAND-NR_20250224T105000Z.nc ct 0 0
```

The tool generates the image *S_NWC_CT_MTI1_EURMLAND-NR_20250224T105000Z.ct.gif* shown in Figure 1.

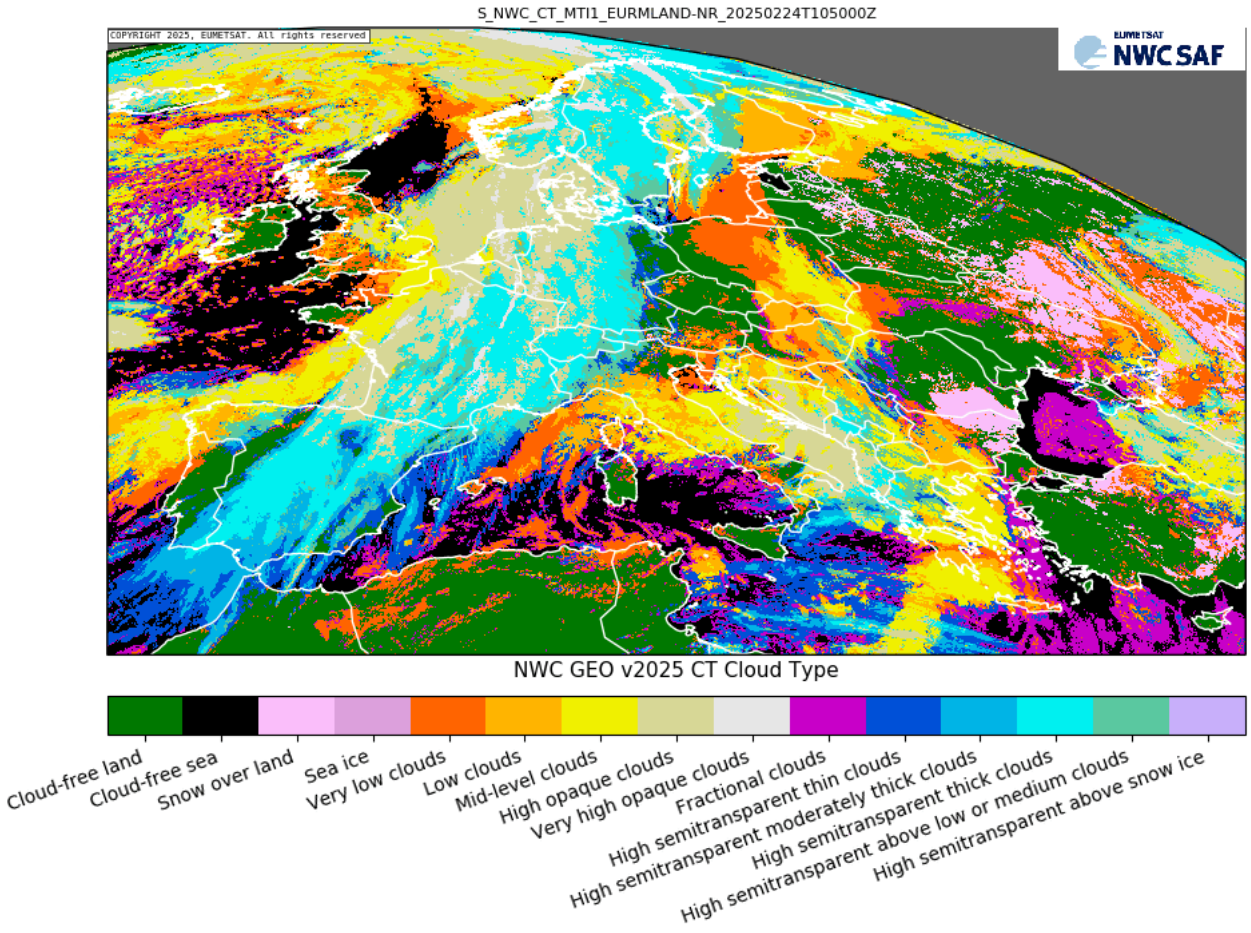

Figure 1: Graphical representation of a NWC/GEO CT product

4.3.2 Example: GEO-L1SD Satellite Data

Execution of the NWCPY tool for `data` variable contained in the L1SD IR120-BT image-like product, generated for Spain region, with dimensions 600x600. It is noted that the single variable in L1SD products is `data` in v2018/v2021, and exists a product for each band. In v2025 a single L1SD product will exists containing one variable for each band in the format `l1sd_<band>`

```
python    $NWCPY_PATH/nwcpy.py
          S_NWC_IR120-BT_MSG3_Spain-VISIR_20151013T150000Z.nc data 600 600
```

```
python    $NWCPY_PATH/nwcpy.py
          S_NWC_L1SD_MTGI1_EURMLAND-NR_20250224T105000Z.nc l1sd_IR120_bt 0 0
```

The tool generates the image *S_NWC_IR120-BT_MSG3_Spain-VISIR_20151013T150000Z.data.gif* shown in Figure 2.

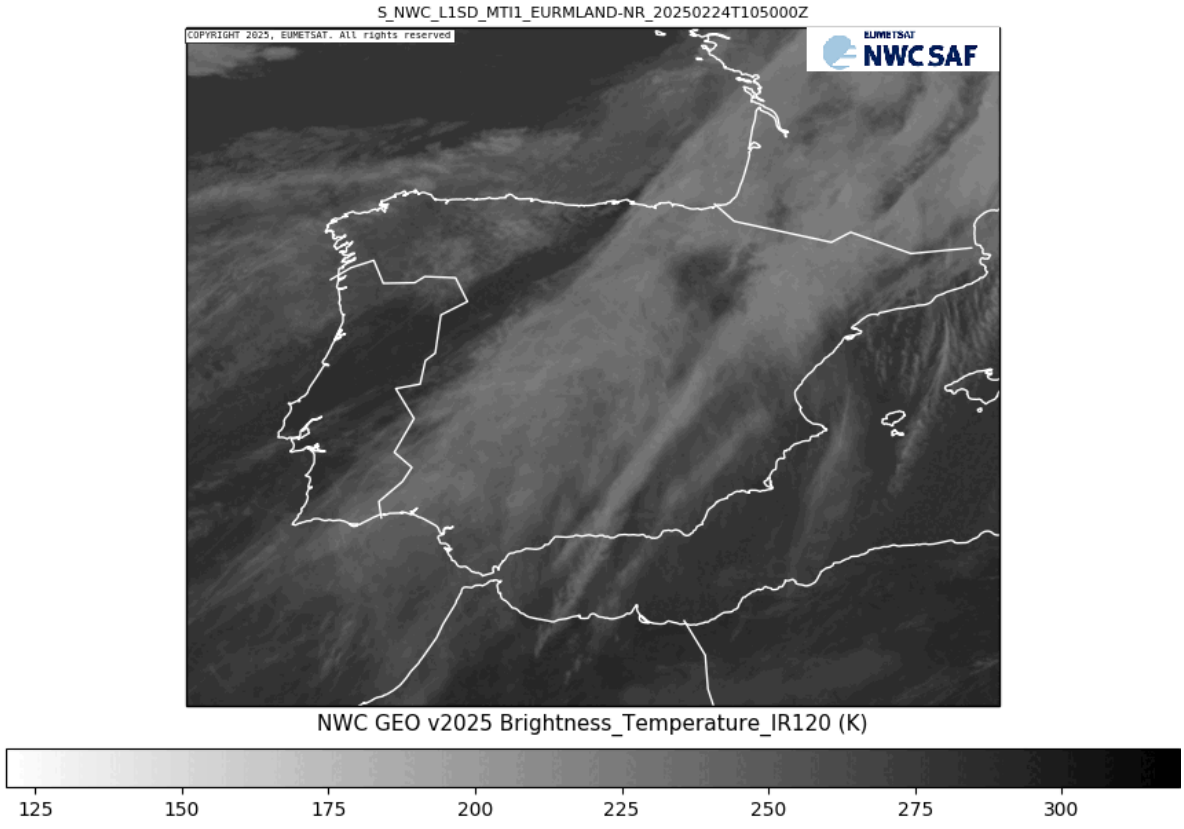

Figure 2: Graphical representation of a NWC/GEO-L1SD product

4.3.3 Example: NWC/GEO Image-like product (iSHAI)

Execution of the NWCPY tool for `ishai_ki` variable contained in the iSHAI image-like product, generated for Spain region, with dimensions 1000x1000:

```
python    $NWCPY_PATH/nwcpy.py
          S_NWC_iSHAI_MSG3_Spain-VISIR_20151013T150000Z.nc ishai_ki 1000 1000
```

The tool generates the image *S_NWC_iSHAI_MSG3_Spain-VISIR_20151013T150000Z.ishai_ki.gif* shown in Figure 3.

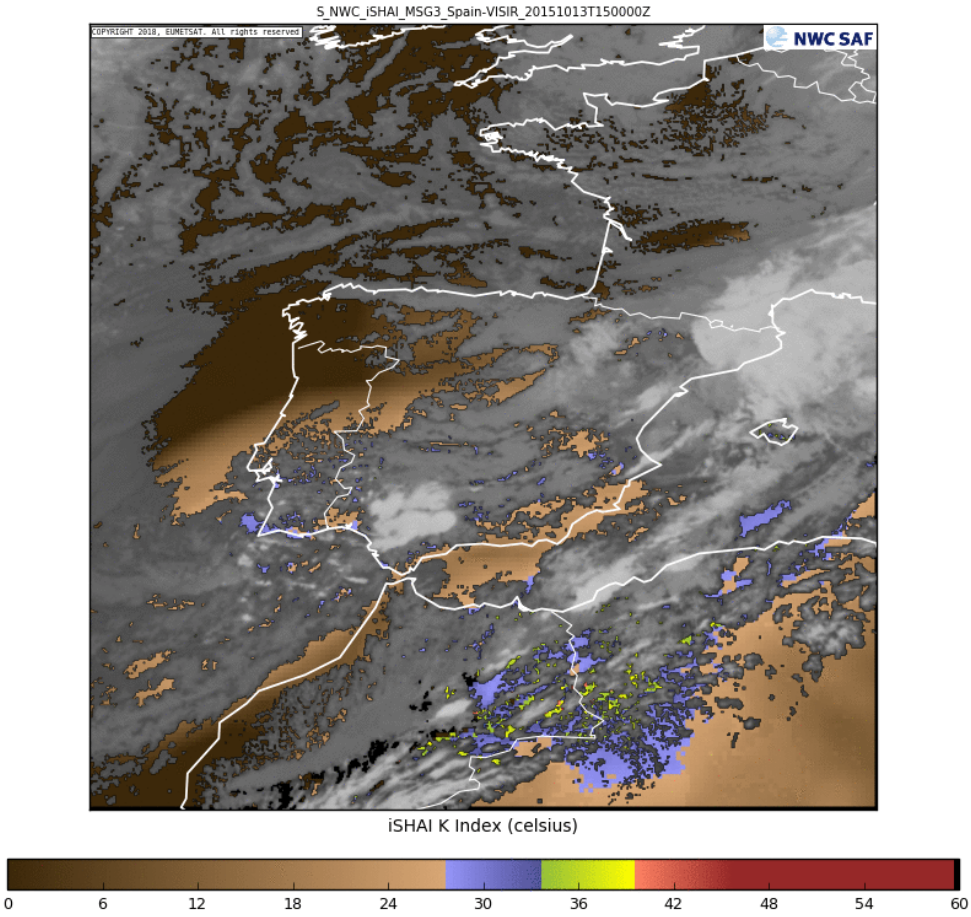

Figure 3: Graphical representation of a NWC/GEO-iSHAI product (K-index parameter)

4.3.4 Example: NWC/GEO Image-like product (EXIM v2025)

Execution of the NWCPY tool allows to draw the different timeframes within the EXIM (Extrapolated Imagery) products. This example uses four executions on the same product that display the different projections. This examples are only valid for v2025.

```
python nwcpy.py S_NWC_EXIM-CMA_MTGI1_EURMLAND-NR_20250224T105000Z.nc cma 0 0
       fct=1
python nwcpy.py S_NWC_EXIM-CMA_MTGI1_EURMLAND-NR_20250224T105000Z.nc cma 0 0
       fctm=30
```

The tool generates the images *S_NWC_EXIM-CMA_MT1_EURMLAND-NR_20250224T105000Z.cma.010.gif*, as shown in Figure 4.

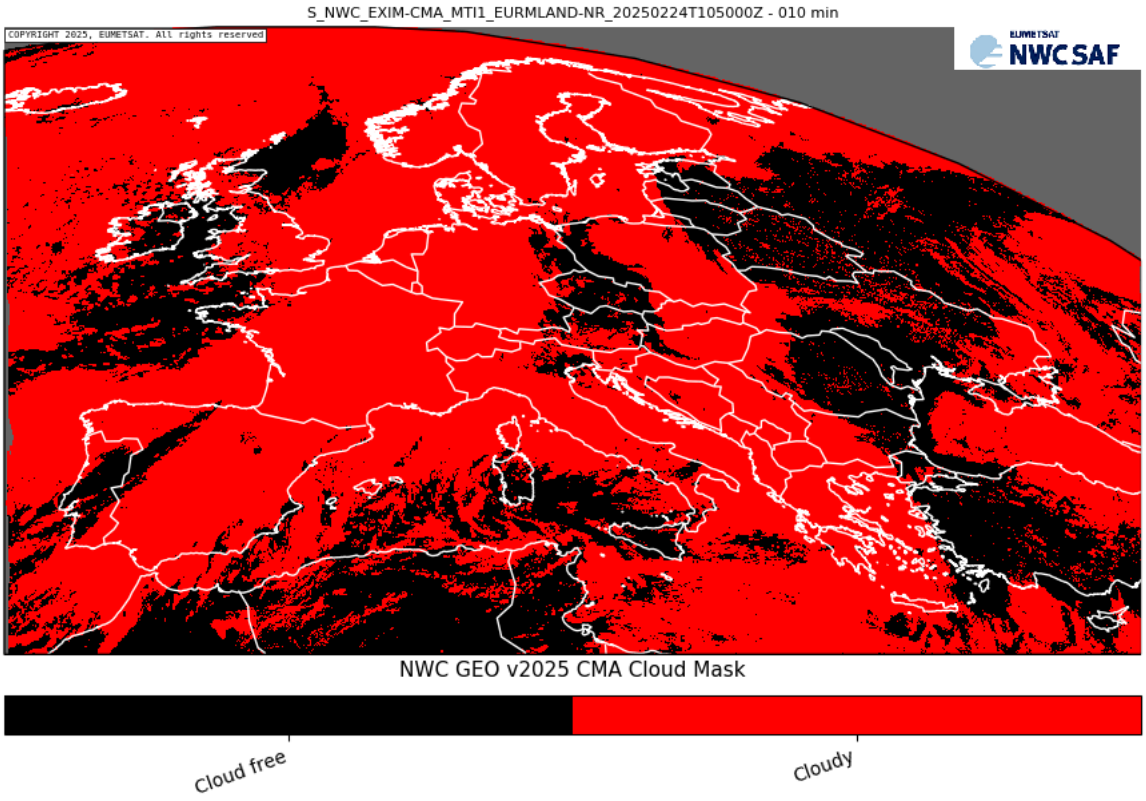

*Figure 4: Graphical representation of a NWC/GEO-EXIM product (*cma *parameter)*

4.3.5 Example: NWCGEO Image Like Product – Flag Variable

Execution of the NWCPY tool for `ct_status_flag` variable contained in the CT image-like product, generated for EURMLAND region, with standard dimensions 0x0, plotting the flag Low_level_thermal_inversion_in_NWP_field.

```
python    $NWCPY_PATH/nwcpy.py
          S_NWC_CT_MTI1_EURMLAND-NR_20250224T105000Z.nc ct_status_flag 0 0
          flag=Low_level_thermal_inversion_in_NWP_field
```

The tool generates the image S_NWC_CT_MTGI1_EURMLAND-NR_20250224T105000Z *.ct_status_flag.gif* shown in Figure 5.

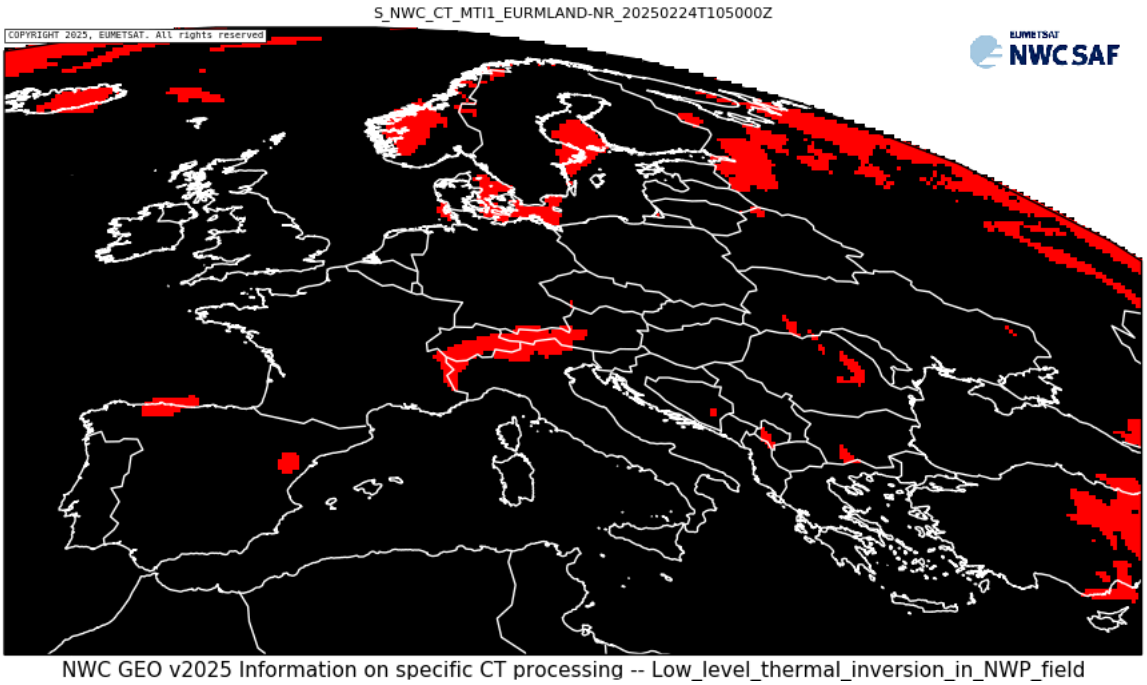

Figure 5: Graphical representation of a NWC/GEO-CT product (flag parameter)

4.3.6 Example: NWCGEO Image Like Product – Subregion

Execution of the NWCPY tool for `ct` variable contained in the CT image-like product, generated for EURMLAND region, with standard dimensions 0x0. Subregion optional variable is used, center the image in Spain (latitude: 40, longitude: -4) and given the size (number of lines: 200 (px), number of columns: 200 (px)).

```
python    $NWCPY_PATH/nwcpy.py
          S_NWC_CT_MTI1_EURMLAND-NR_20250224T105000Z.nc ct 0 0
          subregion=40,-4,500,500
```

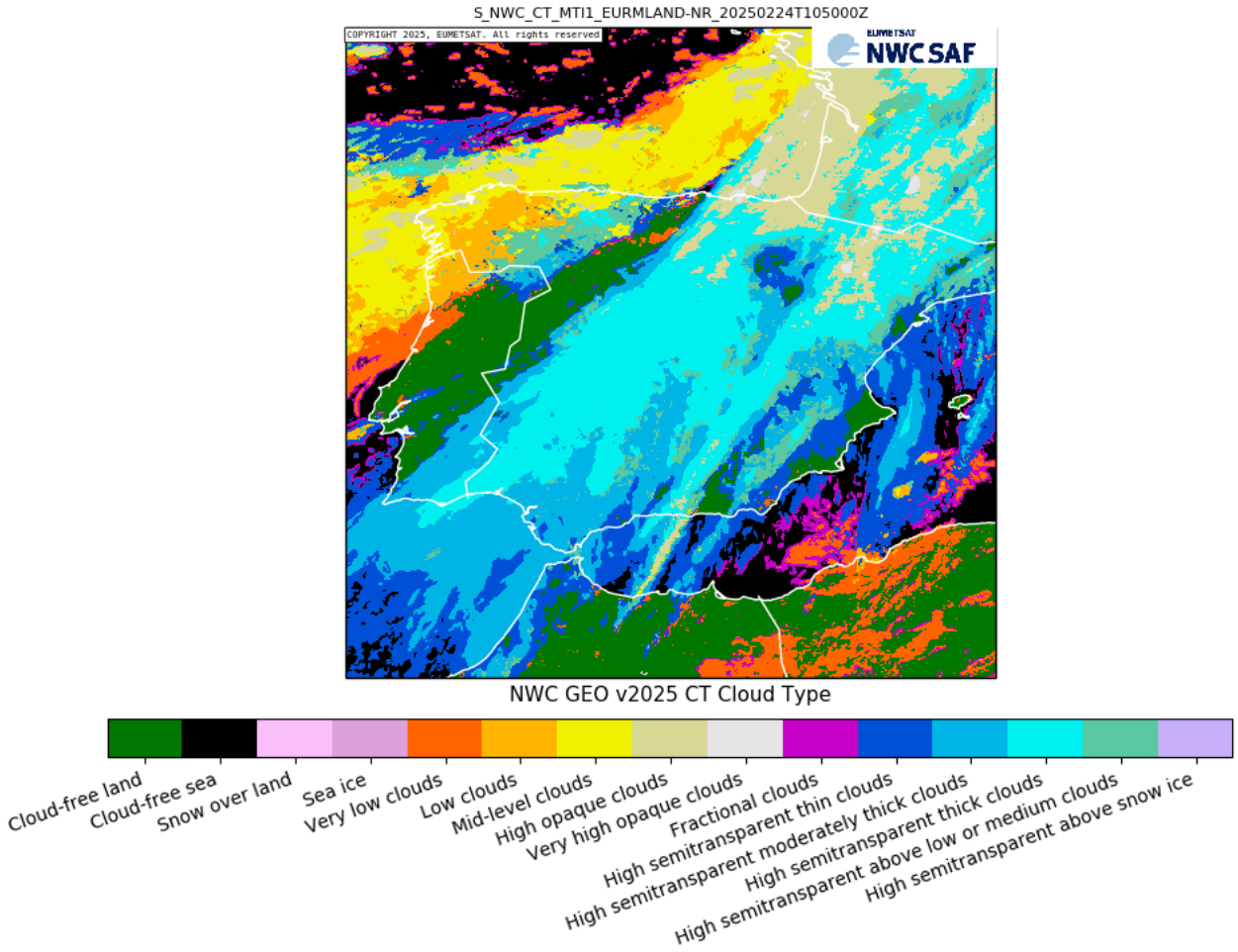

Figure 6: Graphical representation of a NWC/GEO-CT product (subregion parameter)

4.4 NWC/GEO HRW PRODUCT (WINDS)

The execution of the NWCPY tool for the HRW (High Resolution Winds) product represents the pressure levels with regards to the background image. The tool has a second mode, in which it represents the wind speeds. This tool requires the availability of the HRW product as well as the GEO-L1SD products.

The usage of this code is as follows:

```
python   $NWCPY_PATH/nwcpy_hrw.py <path/file.nc> <width> <height> <type>
         [<pressure_interval>] [<optional parameters>]
```

where

- `<path/file.nc>` is the complete path to the product file in netCDF format.
- `<width> <height>` are the dimensions of the output gif image. Set to "`0 0`" to generate the output file at default size (`1100x800`).
- `<type>`: indicates the operation mode. Accepted values are: "`p`" (pressure) or "`ws`" (wind speed)

- `[<pressure_interval>]` is an optional parameter to plot winds and trajectories only for certain pressure levels. Allowed values are 0 (only background), 1 (100-400 hPa), 2 (400-600 hPa), 3 (600-800 hPa), 4 (800-1000 hPa). If no `pressure_interval` is set, winds and trajectories are plotted for ALL pressure levels.

Additional optional parameters can be defined:

- `<help/-h>:` opens the help dialogue, which shows how to operate each code correctly.
- `<noplot>:` by default, after the image is generated it is opened with linux's display command. This option disables that representation.
- `<waitdisplay>:` if the image is to be represented, holds the console until the display window of the image is closed.
- `<outname>:` overwrites the output file name with the <outname> value.
- `<quiet>:` reduces the amount of information that is represented in the terminal.
- `<subregion>:` It is possible to zoom the original image given latitude, longitude, and the size of the subregion (number of lines and number of columns). NWCPY recalculates the given points respect the original product and plot the part of the product region.
- `<adjustpixel>:` Allows to plot the imagen only with the product representation, without logos, borders, or legends. Besides, the pixel is not adjusted to represent the imagen in a specific resolution but is show in the size that it is defined in the subregion. This variable optional only works if *subregion* optional variable is in used.

The images generated by the NWCPY tool are stored in the working directory and follow the naming criteria by default (if <outame> is not used): `<file>.<type>_<pressure_interval_label>.gif`

4.4.1 Example: Considering pressure level

Execution of the NWCPY tool for the HRW product for all pressure levels with the label corresponding to the pressure interval, and generation of the background image. Images are generated for Spain region with dimensions 700x700:

```
python    $NWCPY_PATH/nwcpy_hrw.py
          HRW/S_NWC_HRW_MSG3_Spain-BS_20151013T150000Z.nc 700 700 p
```

```
python    $NWCPY_PATH/nwcpy_hrw.py
          HRW/S_NWC_HRW_MSG3_Spain-BS_20151013T150000Z.nc 700 700 p 0
```

The tool generates the images *S_NWC_HRW_MSG3_Spain-BS_20151013T150000Z.p_all.gif* and *S_NWC_HRW_MSG3_Spain-BS_20151013T150000Z.p_background.gif*, respectively shown in Figure 7.

Note that the generation of the HRW graphical product requires de availability of both

The HRW product: S_NWC_HRW_MSG3_Spain-BS_20151013T150000Z.nc
The GEO-L1SD product: S_NWC_IR120-BT_MSG3_Spain-VISIR_20151013T150000Z.nc

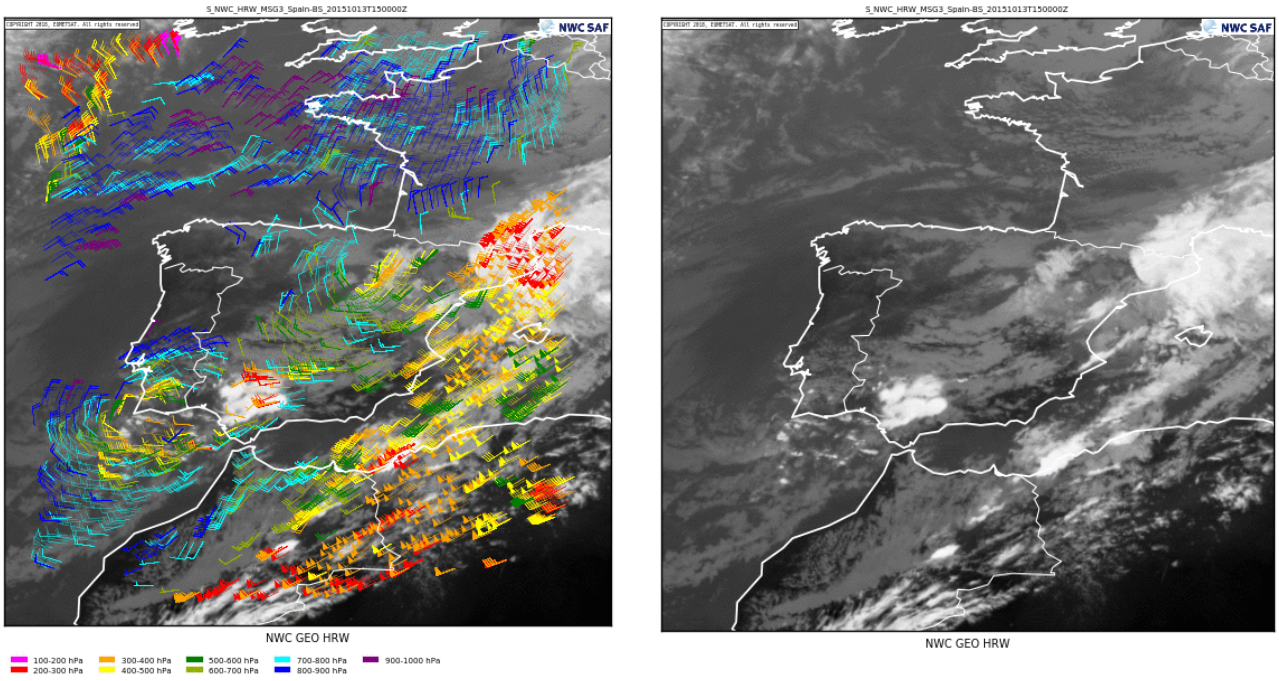

Figure 7: Graphical representation of a NWC/GEO-HRW product in terms of pressure level

4.4.2 Example: Considering wind speed

Execution of the NWCPY tool for the HRW product for 100-400 hPa pressure interval with the label corresponding to the wind speed, and generation of the background image. Images are generated for Spain region with dimensions 700x700:

```
python $NWCPY_PATH/nwcpy_hrw.py HRW/S_NWC_HRW_MSG3_Spain-BS_20151013T150000Z.nc
         700 700 ws 1
```

```
python $NWCPY_PATH/nwcpy_hrw.py HRW/S_NWC_HRW_MSG3_Spain-BS_20151013T150000Z.nc
         700 700 ws 0
```

The tool generates the images
S_NWC_HRW_MSG3_Spain-BS_20151013T150000Z.ws_100-400hPa.gif and
S_NWC_HRW_MSG3_Spain-BS_20151013T150000Z.ws_background.gif, respectively shown in Figure 8.

Note that the generation of the HRW graphical product requires de availability of both

The HRW product: S_NWC_HRW_MSG3_Spain-BS_20151013T150000Z.nc
The GEO-L1SD product: S_NWC_IR120-BT_MSG3_Spain-VISIR_20151013T150000Z.nc

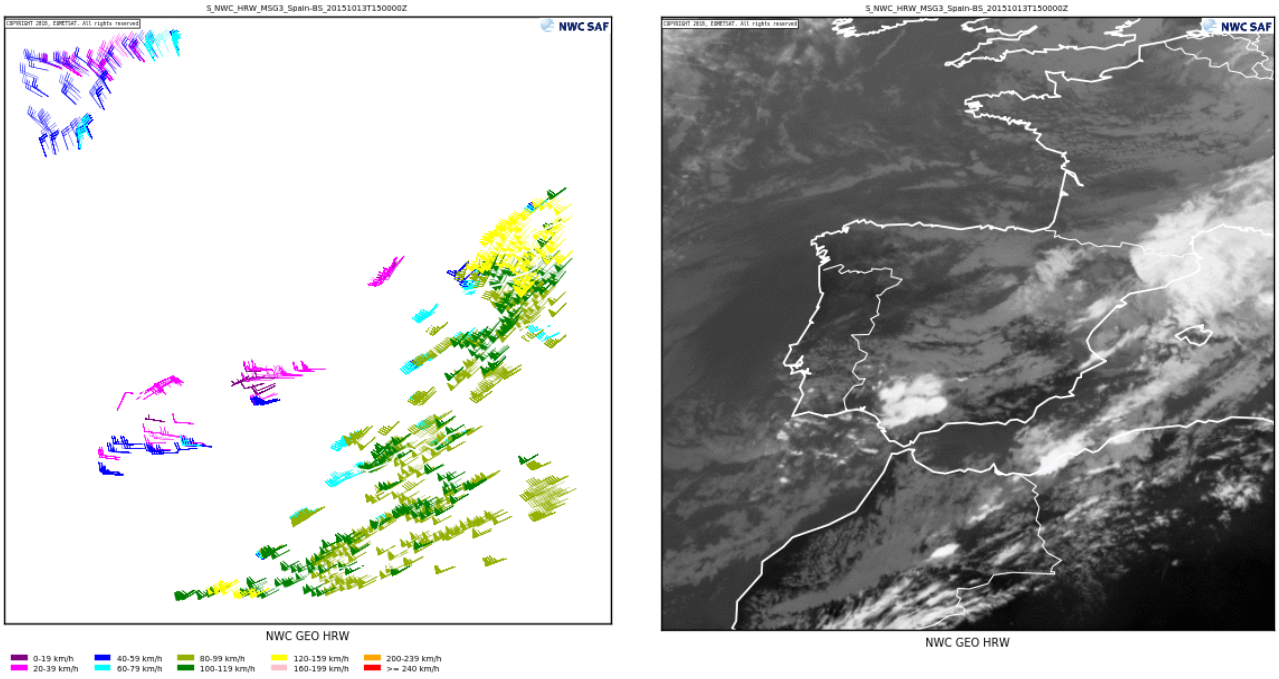

Figure 8: Graphical representation of a NWC/GEO-HRW product in terms of wind speed

4.5 NWC/GEO HRW PRODUCT (TRAJECTORIES)

The execution of the NWCPY tool for the HRW trajectories represents the trajectories for different pressure intervals, considering multiple image slots to plot the displacement. This tool requires the availability of the HRW product as well as the GEO-L1SD products.

The usage is as follows:

```
python   $NWCPY_PATH/nwcpy_hrw_traj.py <path/file.nc> <width> <height> <n_slots>
         [<pressure_interval>] [<optional parameters>]
```

where

- `<path/file.nc>` is the complete path to the product file in netCDF format.
- `<width> <height>` are the dimensions of the output gif image. Set to "`0 0`" to generate the output file at default size (`1100x800`).
- `<n_slots>` is the number of satellite slots to be used to plot trajectories (>=2)
- `[<pressure_interval>]` is an optional parameter to plot winds and trajectories only for certain pressure levels. Allowed values are 0 (only background), 1 (100-400 hPa), 2 (400-600 hPa), 3 (600-800 hPa), 4 (800-1000 hPa). If no `pressure_interval` is set, winds and trajectories are plotted for ALL pressure levels.

Additional parameters can be added:

- `<help/-h>:` opens the help dialogue, which shows how to operate each code correctly.
- `<noplot>:` by default, after the image is generated it is opened with linux's display command. This option disables that representation.
- `<waitdisplay>:` if the image is to be represented, holds the console until the display window of the image is closed.
- `<outname>:` overwrites the output file name with the <outname> value.
- <`quiet`>: reduces the amount of information that is represented in the terminal.
- `<subregion>:` It is possible to zoom the original image given latitude, longitude, and the size of the subregion (number of lines and number of columns). NWCPY recalculates the given points respect the original product and plot the part of the product region.
- `<adjustpixel>:` Allows to plot the imagen only with the product representation, without logos, borders, or legends. Besides, the pixel is not adjusted to represent the imagen in a specific resolution but is show in the size that it is defined in the subregion. This variable optional only works if *subregion* optional variable is in used.
- `<path_netcdf_tools>`: defines the directory where the `ncdump` binary tool is located. By default, `$SAFNWC/COTS/bin/` is used. If you don't have installed SAFNWC, NWCPY used ncdump binary that it is installed in the COTS process installation.

It is important to considering the difference between versions in the trajectories output. This interface allows to use the program with both versions of the product. However, the name of the product is different.

- In v2021 and previous versions, to plot the trajectories, the product to set in the `<path/file.nc>` field is the HRW file. Example: S_NWC_HRW_MSG3_Spain-BS_20151013T154500Z.nc
- In v2025, the `<path/file.nc>` must be the trajectories output. Example: S_NWC_HRW-TRAJ_MSG3_Spain-BS_20221201T124500Z.nc

The images generated by the NWCPY tool are stored in the working directory and follow the naming criteria by default (if <outame> is not used):

```
<file>.traj_<pressure_interval_label>_<n_slots>slots.gif
```

where `<pressure_interval_label>` is the label associated to `<pressure_interval>`: 0-"background", 1-"100-400hPa", 2-"400-600hPa", 3-"600-800hPa", 4-"800-1000hPa" and none-"all".

IMPORTANT NOTE: HRW winds/trajectories image includes IR background (GEO-L1SD IR_120_BT) only in the following cases:

- `<pressure_interval> = 0`
- `<pressure_interval> = ""`

Otherwise, GEO-L1SD satellite data product is used to read gdal projection parameters necessary to navigate wind vectors/trajectories, but these are displayed over a transparent background.

Additionally, the `nwcpy_hrw_traj.py` source code for trajectories v2021 generates the temporary file `trajectories.txt` on each execution, and removes it once the trajectory variables are properly stored. The user shall check there is no file named `trajectories.txt` in the working directory, otherwise it will be overwritten.

4.5.1 Example: NWC/GEO HRW product (trajectories)

Execution of the NWCPY tool for HRW trajectories for 600-800 hPa pressure interval and for all pressure intervals, considering 4 MSG slots (1 hour). The image is generated for Spain region with dimensions 700x700:

```
python $NWCPY_PATH/nwcpy_hrw_traj.py
         ./HRW/S_NWC_HRW_MSG3_Spain-BS_20151013T154500Z.nc 700 700 4 3
```

```
python $NWCPY_PATH/nwcpy_hrw_traj.py
         ./HRW/S_NWC_HRW_MSG3_Spain-BS_20151013T154500Z.nc 700 700 4
```

The tool generates the images
S_NWC_HRW_MSG3_Spain-BS_20151013T154500Z.traj_600-800hPa_4slots.gif and
S_NWC_HRW_MSG3_Spain-BS_20151013T154500Z.traj_all_4slots.gif, respectively shown in Figure 9.

Note that the generation of the HRW graphical product requires de availability of both

The HRW product:	S_NWC_HRW_MSG3_Spain-BS_20151013T154500Z.nc
The GEO-L1SD product:	S_NWC_IR120-BT_MSG3_Spain-VISIR_20151013T154500Z.nc

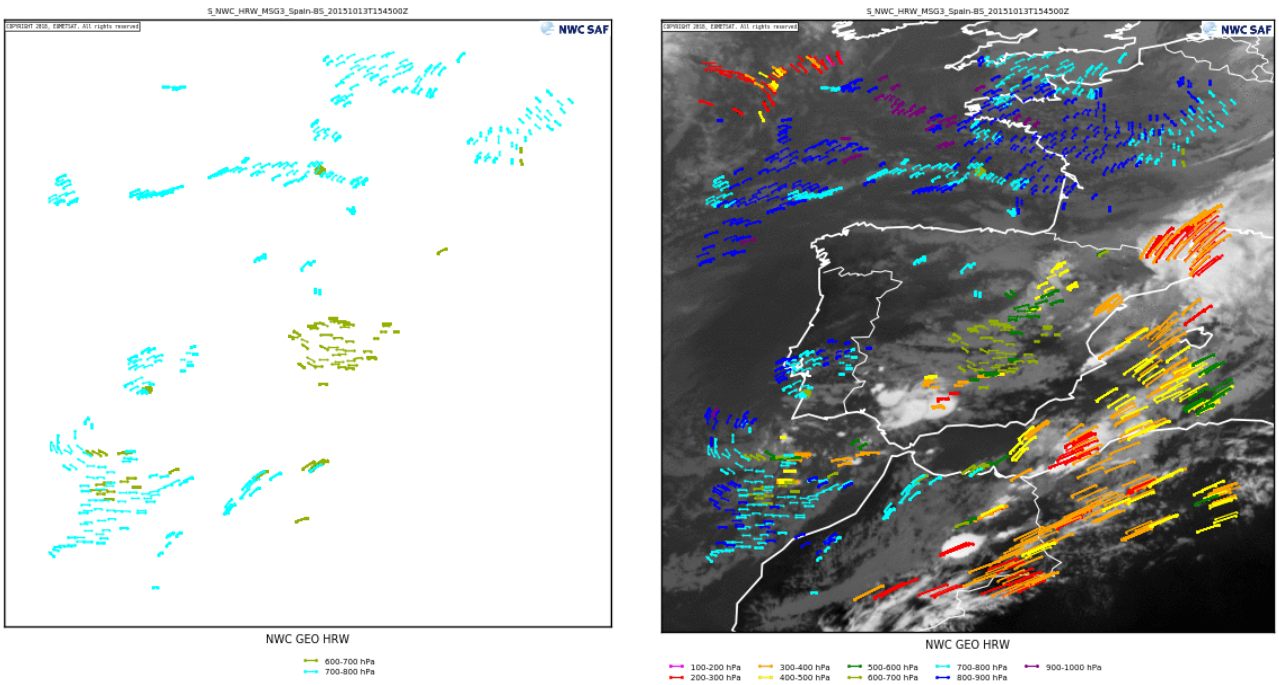

Figure 9: Graphical representation of NWC/GEO-HRW trajectories considering 4 MSG slots

4.6 NWC/GEO ASII PRODUCT

The execution of the NWCPY tool for the ASII products represents the *Automatic Satellite Image Interpretation*. This tool requires the availability of the ASII product as well as the GEO-L1SD products. This product is only available in the v2018 and v2021, not in the v2025.

The usage of this code is as follows:

```
python   $NWCPY_PATH/nwcpy_asii.py <path/file.bufr> <width> <height>
         [<optional parameters>]
```

where

- `<path/file.bufr>` is the complete path to the product file in BUFR format.
- `<width> <height>` are the dimensions of the output gif image. Set to "`0 0`" to generate the output file at default size (`1100x800`).

Additional optional parameters can be defined:

- `<help/-h>:` opens the help dialogue, which shows how to operate each code correctly.
- `<noplot>:` by default, after the image is generated it is opened with linux's display command. This option disables that representation.
- `<waitdisplay>:` if the image is to be represented, holds the console until the display window of the image is closed.

- `<outname>:` overwrites the output file name with the <outname> value.
- `<quiet>:` reduces the amount of information that is represented in the terminal.

The images generated by the NWCPY tool are stored in the working directory and follow the naming criteria by default (if <outame> is not used): `<file>.asii.gif`

4.6.1 Example: NWC/GEO ASII product

Execution of the NWCPY tool for the ASII product, only available in v2018/v2021, not in v2025, generated for Europe region, with dimensions 1000x1000:

```
python    $NWCPY_PATH/nwcpy_asii.py
          ./ASII/S_NWC_ASII-SAT_MSG3_Europe-VISIR_20151013T154500Z.bufr 1000
          1000
```

The tool generates the image *S_NWC_ASII-SAT_MSG3_Europe-VISIR_20151013T154500Z.asii.gif* shown in Figure 10.

Note that the generation of the ASII graphical product requires de availability of both

The ASII product:	S_NWC_ASII-SAT_MSG3_Europe-VISIR_20151013T154500Z.bufr
The GEO-L1SD product:	S_NWC_IR120-RAD_MSG3_Europe-VISIR_20151013T154500Z.nc

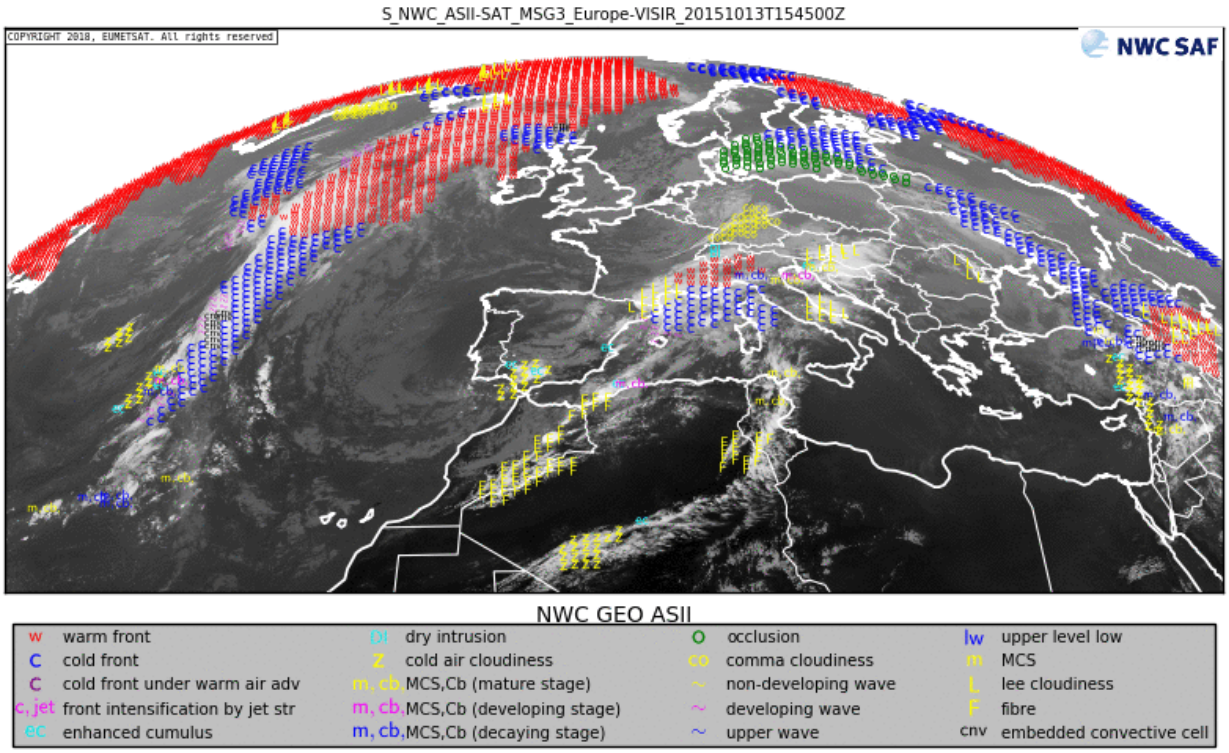

Figure 10: Graphical representation of a NWC/GEO-ASII product

4.7 NWC/GEO RDT-CW PRODUCT

The execution of the NWCPY tool for the RDT-CW (Rapid Developing Thunderstorms) product represents the stages of thunderstorm onto a background L1SD image. The tool has a second mode, in which it represents the wind speeds. This tool requires the availability of the RDT product as well as the GEO-L1SD products.

The usage of this code is as follows:

```
python   $NWCPY_PATH/nwcpy_rdt.py <path/file.nc> <width> <height>
         [<optional parameters>]
```

where

- `<path/file.nc>` is the complete path to the product file in netCDF format.
- `<width> <height>` are the dimensions of the output gif image. Set to "`0 0`" to generate the output file at default size (`1100x800`).

Additional optional parameters can be defined:

- `<help/-h>:` opens the help dialogue, which shows how to operate each code correctly.
- `<noplot>:` by default, after the image is generated it is opened with linux's display command. This option disables that representation.
- `<waitdisplay>:` if the image is to be represented, holds the console until the display window of the image is closed.
- `<outname>:` overwrites the output file name with the <outname> value.
- `<quiet>:` reduces the amount of information that is represented in the terminal.
- `<subregion>:` It is possible to zoom the original image given latitude, longitude, and the size of the subregion (number of lines and number of columns). NWCPY recalculates the given points respect the original product and plot the part of the product region.
- `<adjustpixel>:` Allows to plot the imagen only with the product representation, without logos, borders, or legends. Besides, the pixel is not adjusted to represent the imagen in a specific resolution but is show in the size that it is defined in the subregion. This variable optional only works if *subregion* optional variable is in used.

The images generated by the NWCPY tool are stored in the working directory and follow the naming criteria by default (if <outame> is not used): `<file>.rdt.gif`

4.7.1 Example: NWC/GEO RDT-CW product

Execution of the NWCPY tool for the RDT-CW product, generated for Europe region, with dimensions 1200x1000:

```
python    $NWCPY_PATH/nwcpy_rdt.py
          ./RDT/S_NWC_RDT-CW_MSG3_Europe-VISIR_20151013T150000Z.nc 1200 1000
```

The tool generates the image *S_NWC_RDT-CW_MSG3_Europe-VISIR_20151013T150000Z.rdt.gif* shown in Figure 11.

Note that the generation of the RDT-CW graphical product requires de availability of both

The RDT-CW product: S_NWC_RDT-CW_MSG3_Europe-VISIR_20151013T150000Z.nc
The GEO-L1SD product: S_NWC_IR120-RAD_MSG3_Europe-VISIR_20151013T150000Z.nc

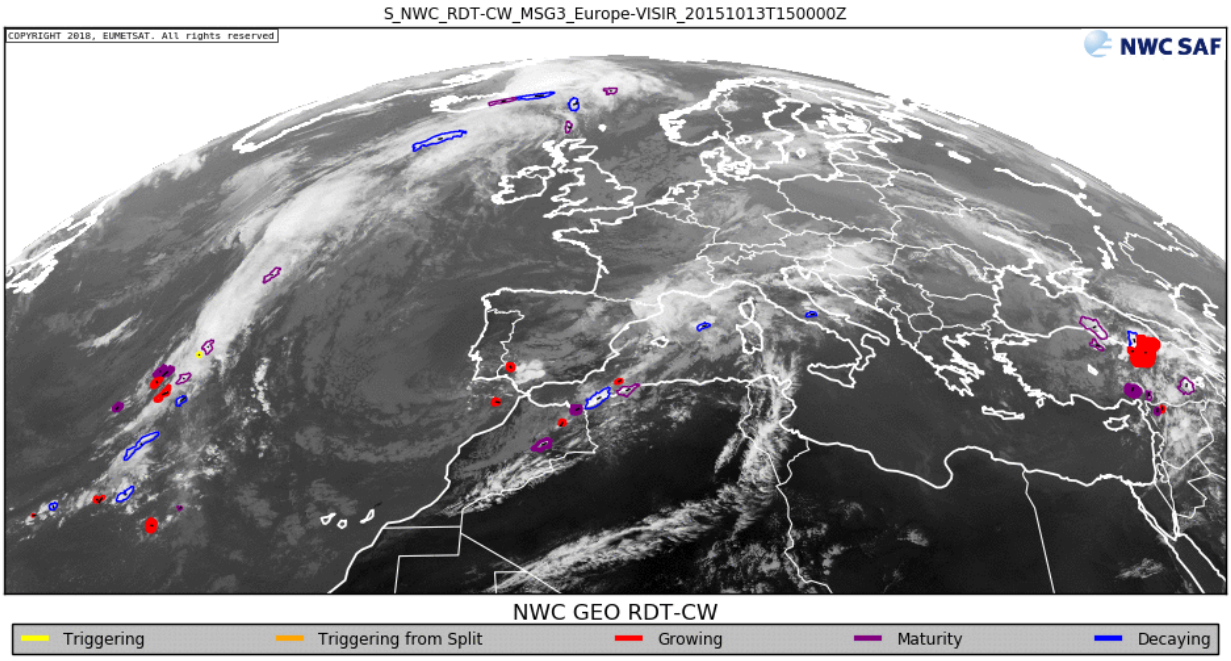

Figure 11: Graphical representation of a NWC/GEO-RDT-CW product