17B.2

USE OF NWCSAF NWC/GEO SOFTWARE PACKAGE WITH MSG, HIMAWARI-8/9 AND GOES-13/16 SATELLITES

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1. INTRODUCTION

The Satellite Application Facility on support to Nowcasting and Very short range forecasting (NWCSAF) belongs to the EUMETSAT SAF Network. Its main objective is the generation of satellite-derived meteorological products with a direct application to Nowcasting. For this purpose, two different software packages for geostationary and polar satellites, NWC/GEO and NWC/PPS, are developed, maintained and delivered to users.

NWC/GEO v2018.1 is the latest operational version of the NWCSAF software package for geostationary satellites, which can process MSG, Himawari-8/9 and GOES-13/16 satellite data. It is going to be available to the NWCSAF users since the autumn 2019.

It calculates 16 different meteorological products related to clouds, precipitation, convection, conceptual models including turbulence, clear air humidity and stability, winds, and extrapolation of images and products. In this paper, examples of these products are presented throughout the world with MSG, MSG/IODC, Himawari-8 and GOES-16 satellites.

Meteorologists and researchers are encouraged to use the NWCSAF NWC/GEO software package with all these satellites, for support in the meteorological analysis and nowcasting. Users are also encouraged to give feedback about the behaviour and usefulness of NWCSAF products in all areas.

2. NWC/GEO v2018.1

NWC/GEO v2018.1 software for geostationary satellites will be available to NWCSAF users since the autumn 2019. It is able to run with MSG satellites (with images every 15 or 5 minutes), Himawari-8/9 satellites (with images every 10 minutes), GOES-13/15 satellites (with images every 30 or 15 minutes) and GOES-16 satellite (with images every 15 or 10 minutes).

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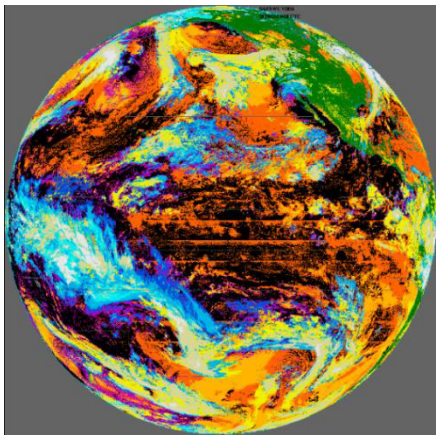
This way, it gives the option to calculate the NWC/GEO products all throughout the world.

The extension to GOES-17 is also in the working plan. However, due to the problems in the cooling system of GOES-17/ABI Imager, the filtering of noisy data using the available quality flags is not efficient for the moment, and significant noise occurs in NWC/GEO products with this satellite.

Considering this, a decision has been taken by the NWCSAF Project Team to wait for the official extension of NWC/GEO software package to GOES-17 satellite.



Example of noise in NWC/GEO Cloud type product with GOES-17 satellite (24 February 2019 10:30 UTC)

This paper is especially dedicated to possible new users of NWC/GEO software in areas covered by Himawari-8/9 and GOES-16 satellites.

Examples of NWC/GEO products are shown in Europe and Africa with MSG, in West Asia with MSG/IODC, in East Asia and the Western Pacific with Himawari-8, and in the Americas with GOES-16.

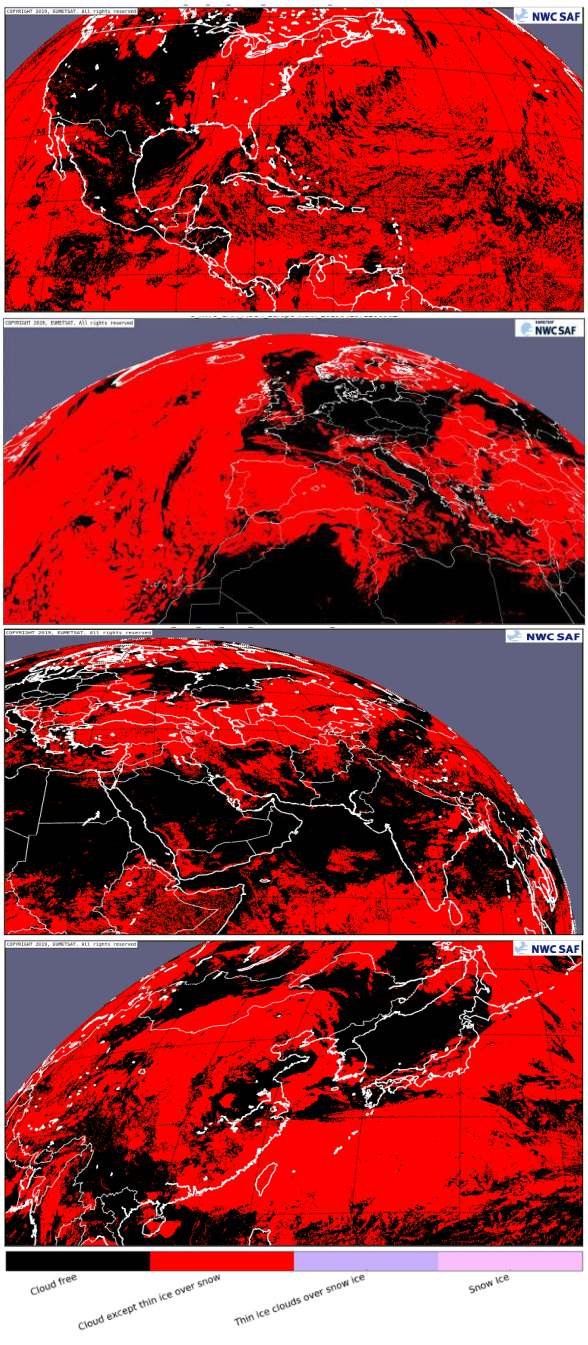
To illustrate the continuity of NWC/GEO outputs with the different satellites, most of these examples are related to the same moment for all satellites: 19 April 2019 at 12:00 UTC.

Although here some of the NWC/GEO outputs are shown for part of the satellites only, it is necessary to remark that all outputs can be calculated for MSG, MSG/IODC, Himawari-8/9 and GOES-16 satellites (not for GOES-13/15 satellites, for which only the NWC/GEO clouds, winds and extrapolation products are available).

2.1 NWC/GEO Cloud products: CMa

"CMa – Cloud Mask" product is used for cloud detection, and also for snow detection during daytime.

It is a complement for visible images during the day. It is more useful during the night, due to the difficulties to identify some low cloud types in infrared images.

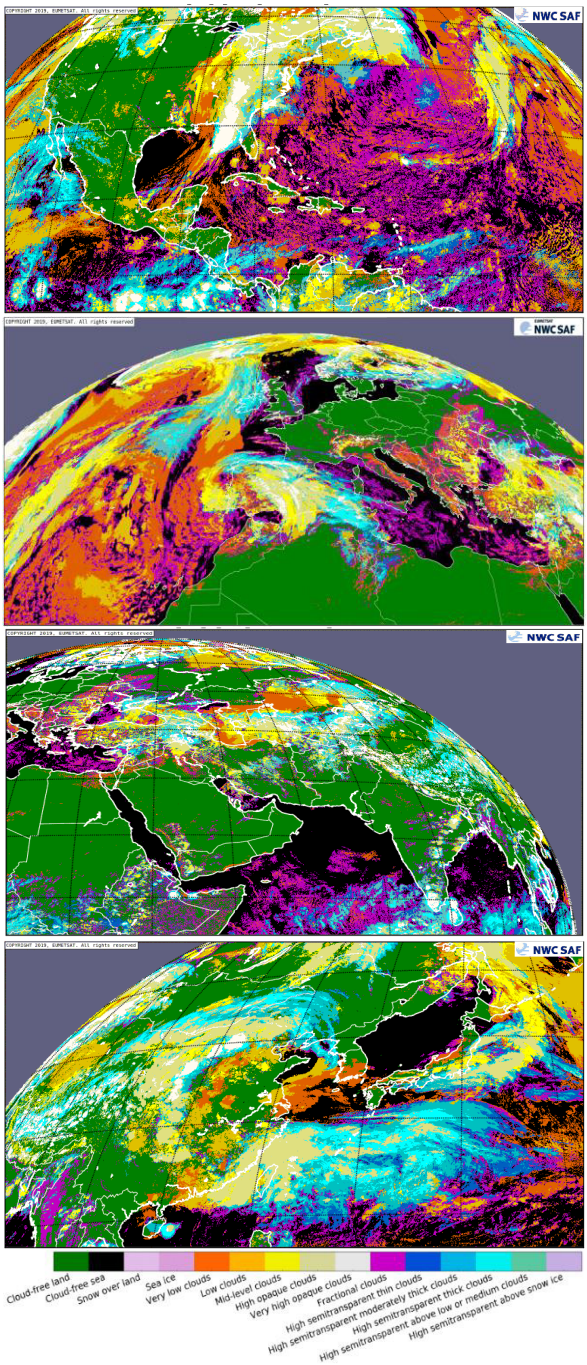


NWC/GEO-CMa Cloud mask
(for GOES-16, MSG, MSG/IODC and Himawari-8)
[19 April 2019 12:00 UTC]

2.2 NWC/GEO Cloud products: CT

"CT – Cloud type" product is used for cloud classification based on the opacity, the transparency and the level of the cloud top.

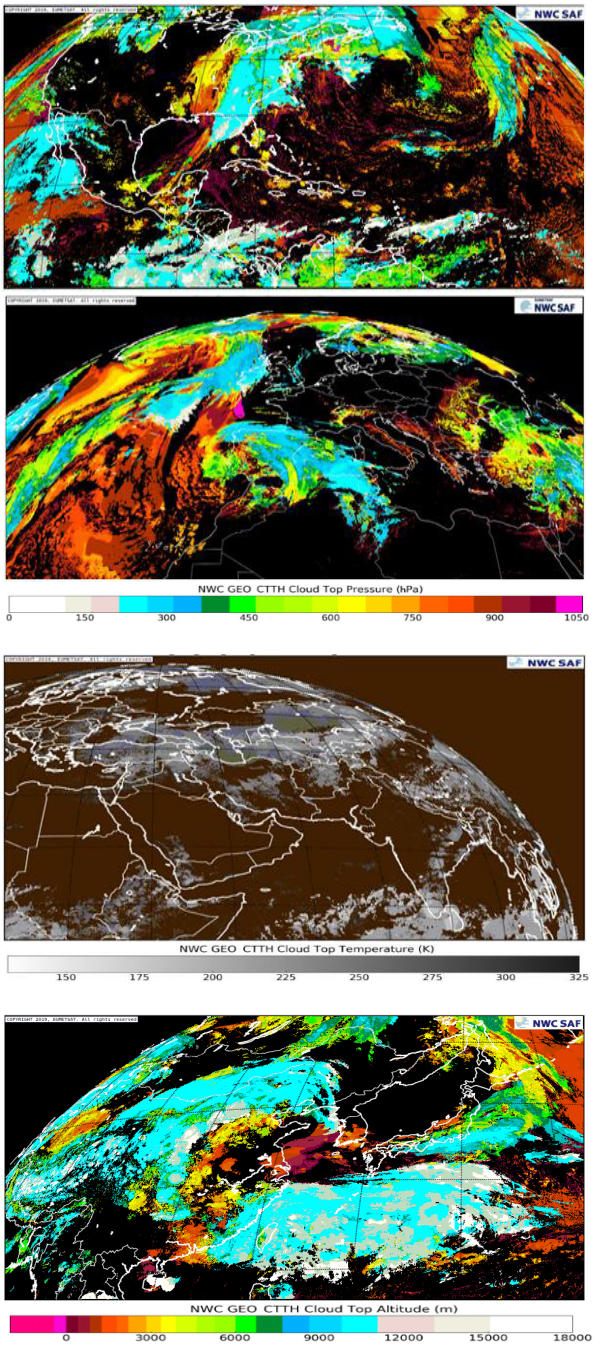
For example, cumulonimbus clouds are classified as "high opaque clouds".



NWC/GEO-CT Cloud type
(for GOES-16, MSG, MSG/IODC and Himawari-8)
[19 April 2019 12:00 UTC]

2.3 NWC/GEO Cloud products: CTTH

"CTTH – Cloud Top Pressure, Cloud Top Temperature and Cloud Top Height" product defines these three outputs for all cloud types except for "fractional clouds", for which no value is defined.

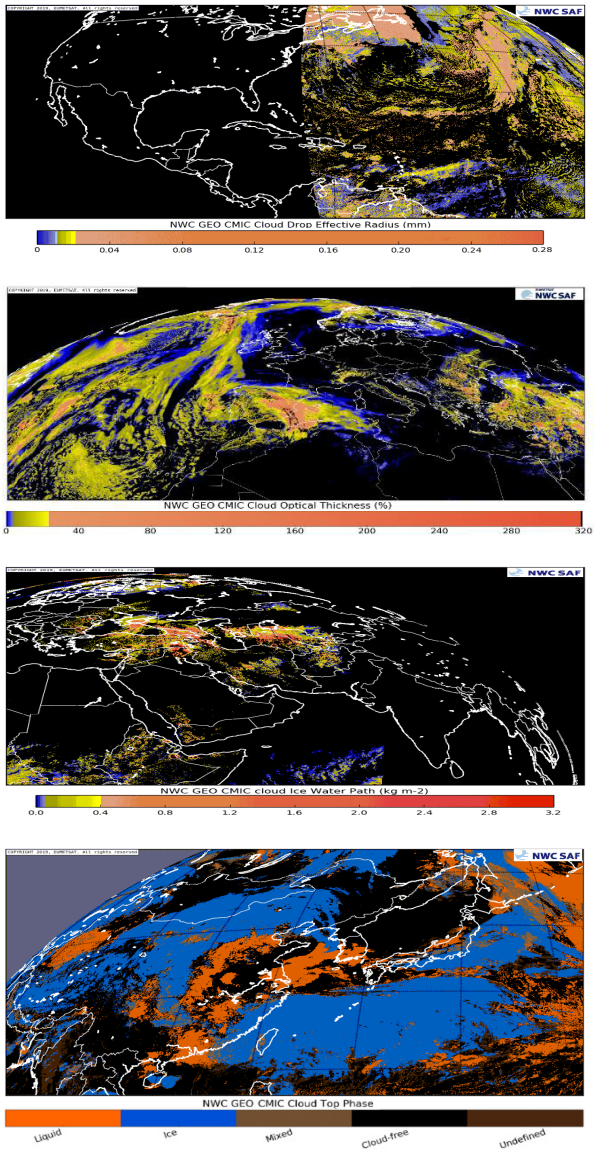


NWC/GEO-CTTH
Cloud top pressure (for GOES-16 and MSG),
Cloud top temperature (for MSG/IODC)
and Cloud top height (for Himawari-8)
[19 April 2019 12:00 UTC]

2.4 NWC/GEO Cloud products: CMIC

"CMIC – Cloud Microphysics" product defines the "cloud drop effective radius", the "cloud optical thickness", the "liquid water path", the "ice water path" and the "cloud top phase" for "cloudy pixels".

From these parameters, only the "cloud top phase" is available for night and twilight conditions, and for mixed and undefined cloud top phase.

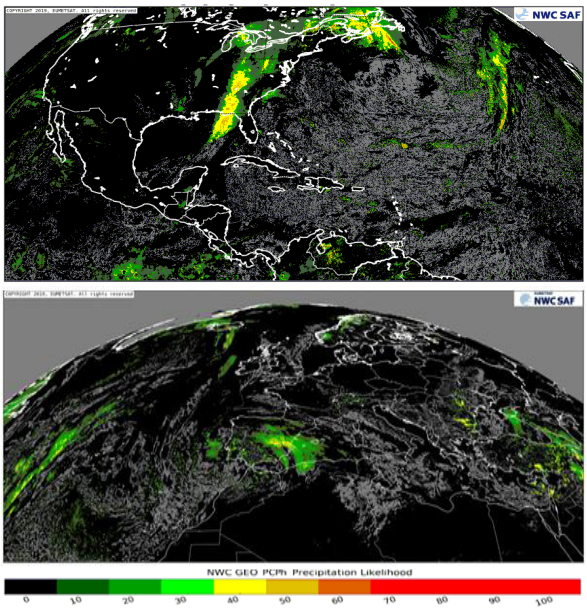


NWC/GEO-CMIC
Cloud drop effective radius (for GOES-16),
Cloud optical thickness (for MSG),
Cloud ice water path (for MSG/IODC),
and Cloud top phase (for Himawari-8)
[19 April 2019 12:00 UTC].
The fact that only the cloud top phase is available during nighttime is to be noticed

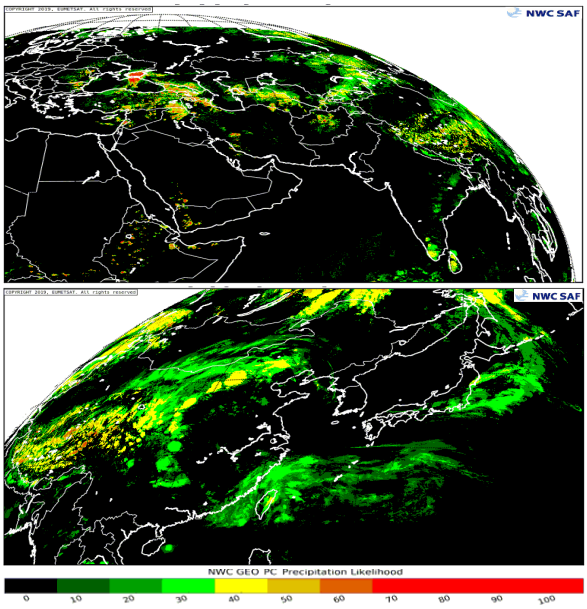
2.5 NWC/GEO Precipitation products: PC, PCPh

Both “PC – Precipitating Clouds” and “PCPh – Precipitating Clouds based on Cloud Microphysics” products define the “probability of precipitation” for all precipitation types, although they work better for convective precipitation.

They are useful when radar data are not available, with preference for PCPh product.



NWC/GEO-PCPh Probability of precipitation based on cloud microphysics (for GOES-16 and MSG) [19 April 2019 12:00 UTC]

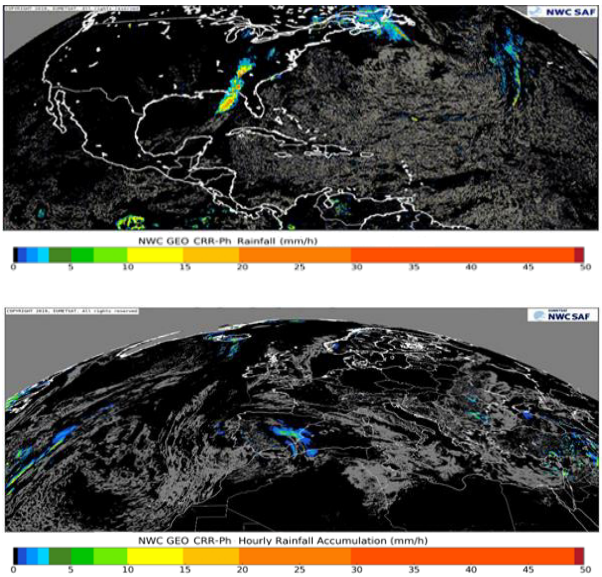


NWC/GEO-PC Probability of precipitation (for MSG/IODC and Himawari-8) [19 April 2019 12:00 UTC]

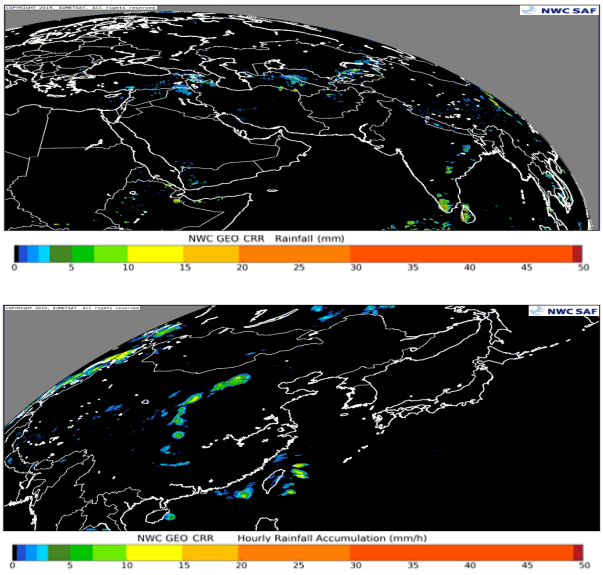
2.6 NWC/GEO Precipitation products: CRR, CRPh

Both “CRR – Convective Rainfall Rate” and “CRPh – Convective Rainfall Rate based on Cloud Microphysics” products define two outputs: “instant value of precipitation” and “hourly accumulation of precipitation”. Again, they work better for convective precipitation.

They are also useful when radar data are not available, with preference for CRPh product.



NWC/GEO-CRPh
Instant value of precipitation (for GOES-16) and Hourly accumulation of precipitation (for MSG) [19 April 2019 12:00 UTC]

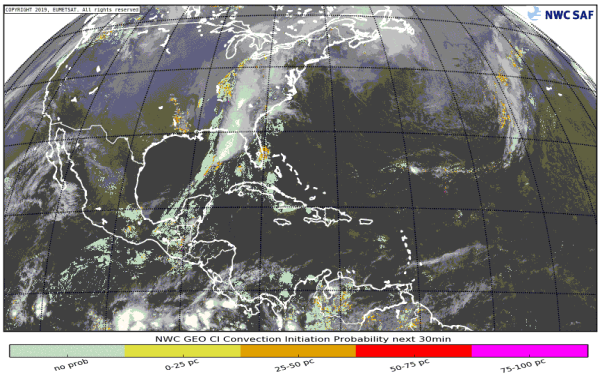


NWC/GEO-CRR
Instant value of precipitation (for MSG/IODC) and Hourly accumulation of precipitation (for Himawari-8) [19 April 2019 12:00 UTC]

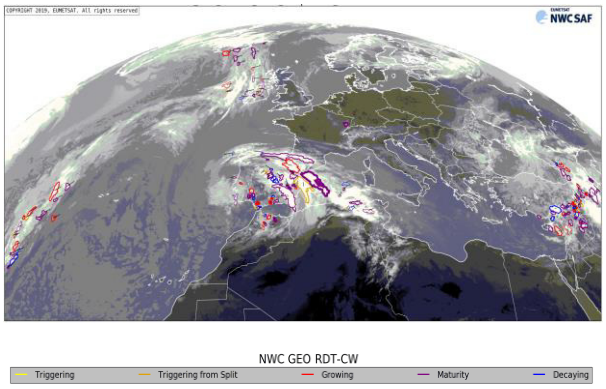
2.7 NWC/GEO Convection products: CI, RDT

"CI – Convection Initiation" product defines the probability of a cloudy pixel to become a thunderstorm in 30 to 90 minutes.

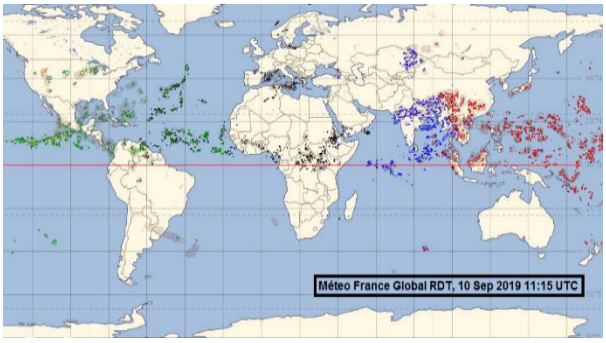
"RDT – Rapid Developing Thunderstorms" product monitors and tracks each convective cell with many properties: trend, displacement, severity, convectivity, rainfall, lightning activity, temperature, pressure…



NWC/GEO-CI Probability of convection initiation in 30 minutes (for GOES-16) [19 April 2019 12:00 UTC]



NWC/GEO-RDT Convective cell status (for MSG) [19 April 2019 12:00 UTC]



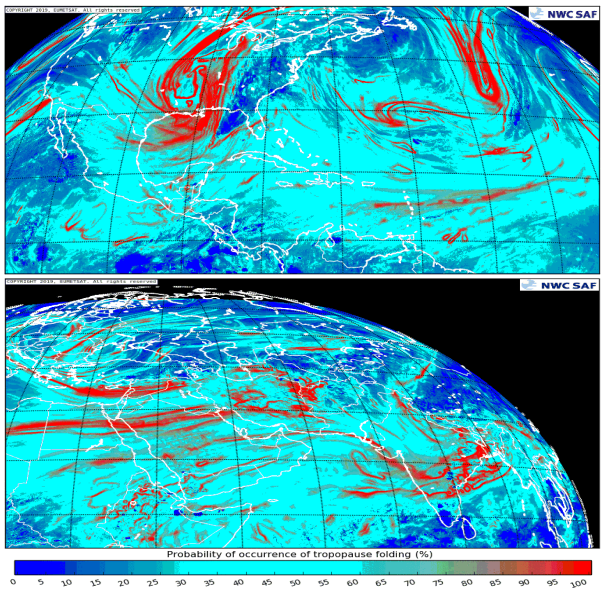
Example of Météo-France Global NWC/GEO-RDT output [10 September 2019 11:15 UTC]

2.8 NWC/GEO Turbulence products:ASII-TF,ASII-GW

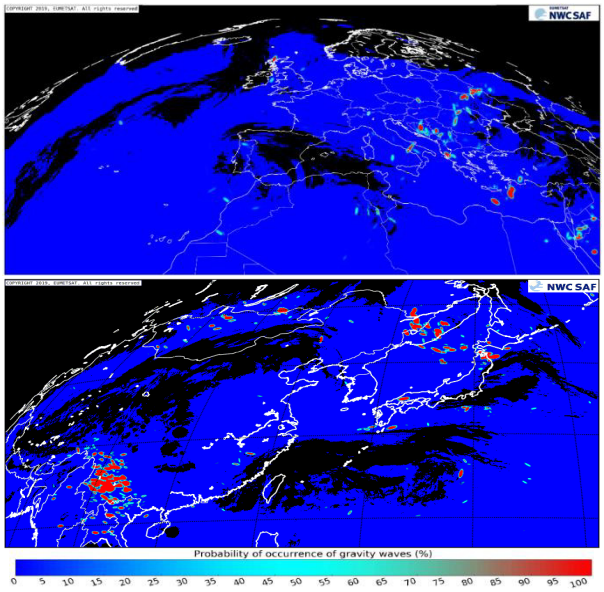
"ASII-TF – Tropopause folding" product detects downward intrusion of stratospheric air in the troposphere.

"ASII-GW – Gravity waves" product detects gravity waves in the troposphere.

Both products are related to "clear air turbulence", and because of this are relevant for aviation users.



NWC/GEO-ASII-TF Probability of tropopause folding (for GOES-16 and MSG/IODC) [19 April 2019 12:00 UTC]

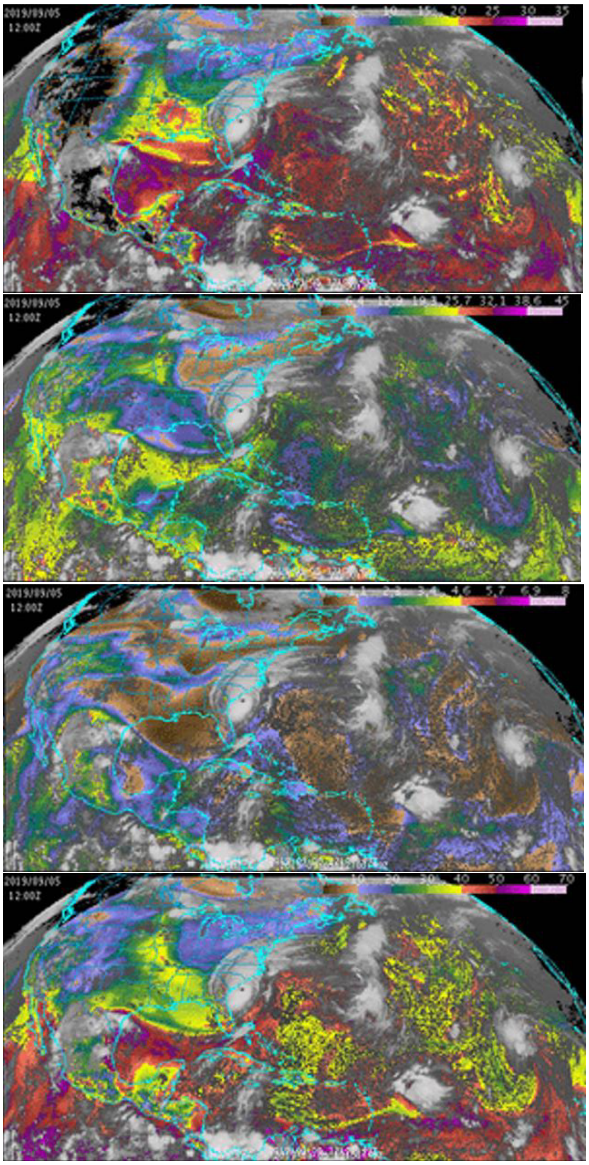


NWC/GEO-ASII-GW Probability of gravity waves (for MSG and Himawari-8) [19 April 2019 12:00 UTC]

2.9 NWC/GEO Clear air product: iSHAI

"iSHAI – imaging Satellite Humidity and Instability" product estimates the precipitable water (in three layers and in the whole atmospheric column), several instability indices, the skin temperature and the total ozone in clear air pixels. It also calculates the differences with the ones defined by the background NWP model.

More information on iSHAI product is available at NWCSAF Helpdesk: www.nwcsaf.org/ishai_description.

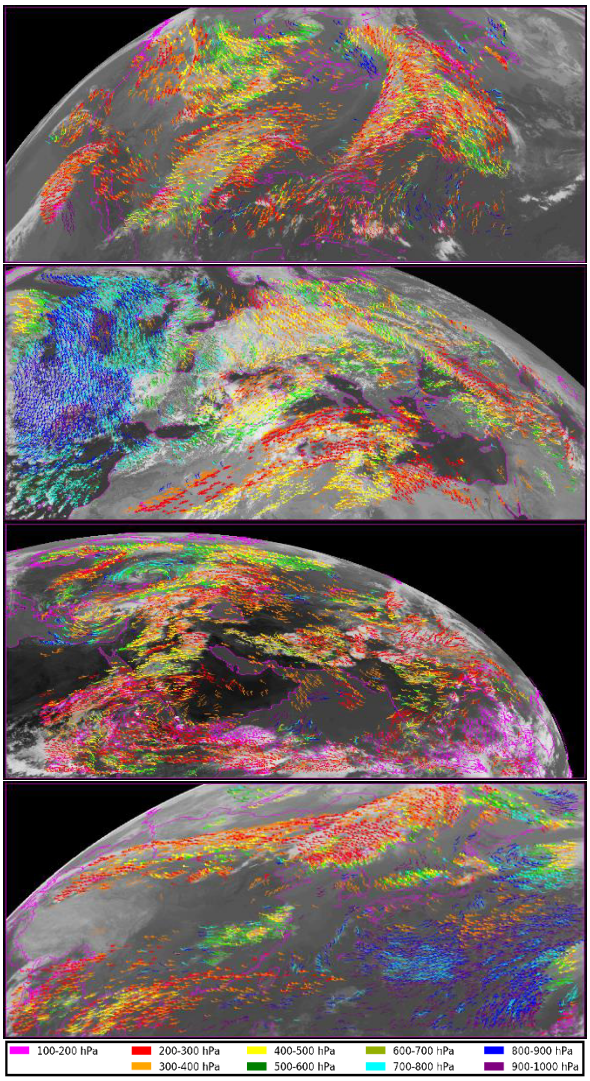


NWC/GEO-iSHAI Humidity in the Boundary layer (Psfc – 850 hPa), the Medium layer (850 – 500 hPa), the High layer (500 – 0.1 hPa) and in the Total column (for GOES-16, 5 September 2019 12:00 UTC, with Hurricane Dorian off the USA East Coast and Tropical Storm Gabrielle on the Atlantic Ocean)

2.10 NWC/GEO Wind product: HRW

"HRW – High Resolution Winds" product calculates Atmospheric Motion Vectors (AMVs) and Trajectories at all tropospheric levels. Its AMVs define wind observations, whose use can be especially important over oceans and remote areas.

These AMVs have been validated for all satellite series (MSG, MSG/IODC, Himawari-8/9, GOES-13/15 and GOES-16) with equivalent results. Additionally, the "2018 AMV Intercomparison Study" showed that NWC/GEO-HRW AMVs are in second position, after Japan Meteorological Agency AMV algorithm only.



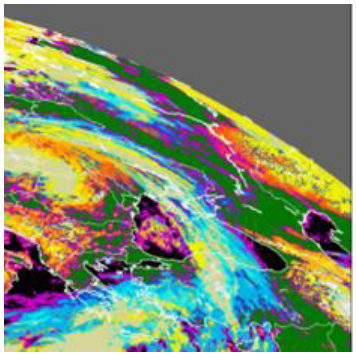
NWC/GEO-HRW AMVs, with colours based on the AMV pressure (for GOES-16 [11 June 2019 12:00 UTC], MSG [14 April 2010 12:00 UTC], MSG/IODC [19 April 2017 12:00 UTC] and Himawari-8 [1 Mar 2018 00:00 UTC]). Cases here defined for different moments, to show the maximum densities of AMVs

2.11 NWC/GEO Extrapolation product: EXIM

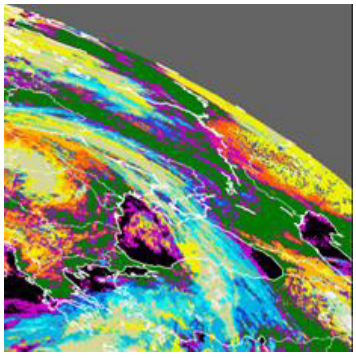
"EXIM – Extrapolated Imagery" product calculates the kinematic extrapolation up to one hour of satellite images, and of NWC/GEO cloud and precipitation products.

Its use is possible for all defined satellites; an example of NWC/GEO-CT cloud type output for MSG satellites, extrapolated with EXIM product, is shown here.

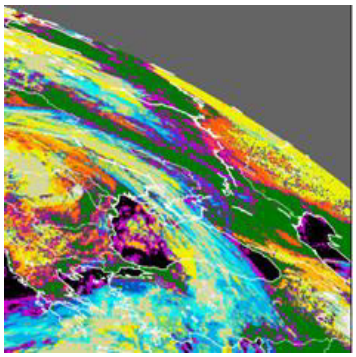
The extrapolated imagery with EXIM product is being used in several operational applications, e.g. in solar radiation forecast in solar power plants.



NWC/GEO-CT Cloud type for MSG [observed for 21 May 2019 09:00 UTC]



NWC/GEO-CT Cloud type for MSG [extrapolated with NWC/GEO-EXIM product for 21 May 2019 10:00 UTC]

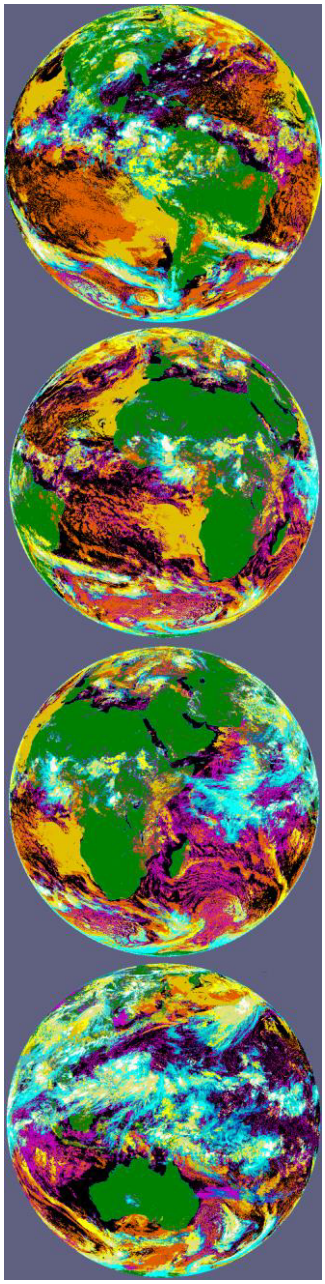


NWC/GEO-CT Cloud type for MSG [observed for 21 May 2019 10:00 UTC]

2.12 Usability of NWC/GEO in all satellite regions

The region where NWC/GEO products are calculated is fully configurable inside the full satellite disk, for MSG, Himawari-8/9 and GOES-16 satellites.

The option is then available to calculate NWC/GEO v2018.1 products globally or in a specific location in the Earth (taking into account the gap existing for the moment with GOES-17 satellite).



NWC/GEO-CT Cloud type for all regions seen by the different geostationary satellites (GOES-16, MSG, MSG/IODC and Himawari-8) [15 July 2019 09:00 UTC]

3. USE OF NWC/GEO SOFTWARE

In case of interest to use NWC/GEO software package, all National Meteorological Services within EUMETSAT member and cooperating states are automatically considered as potential users. Other organizations and individuals may also apply to become users of NWC/GEO software package.

All applicants have become users without restrictions up to now: more than 240 users from all around the world (Europe, Africa, Americas, Asia and Oceania), including all types of institutions: National Meteorological Services, universities, research institutions, public service providers, and public and private companies.

The use of NWC/GEO software is authorized after registration at www.nwcsaf.org/web/guest/register.

After this, access credentials to the "Restricted area" in the "NWCSAF Helpdesk" www.nwcsaf.org are provided, from which NWC/GEO software package can be downloaded.

The installation of NWC/GEO software takes then only two steps, which need less than one hour to be ready: to download and decompress the software files (2 different software tar files + 1 Auxiliary dataset for each satellite used), and to run the installation script.

Nothing else is needed. All software and additional elements to run and visualize NWC/GEO software products are installed and ready to run with this.

The hardware resources needed to run NWC/GEO software package are relatively small:

	Environment used for development and testing	Environment used for testing
Operative System	Linux RHEL release 6.4 (Santiago)	Ubuntu 18.04.1 LTS
CPU	4 x Intel® Core™ CPU i5-4590 @ 3.30 Ghz	8 x Intel® Xeon ® CPU E5-2650 v3 @ 2.30 Ghz
Architecture	x86_64	x86_64
Memory	16 GB	16 GB
Disk	500 GB	500 GB
Shells	bash; ksh	sh; ksh
Compilers	GCC compilers 4.4.7 ecc: e++: efortran	GCC compilers 7.3.0 ecc: e++: efortran
ezip	ezip 1.3.12	ezip 1.6
make	GNU Make 3.81	GNU Make 4.1

Environments used for development and testing of NWC/GEO v2018.1 software package

Although other environments like SUSE and Debian are not officially supported, some NWCSAF users have also tested them successfully.

4. CONCLUSIONS

NWC/GEO software has been extended to geostationary satellites all around the world (MSG, Himawari-8/9 and GOES-13/16).

It can be useful for many meteorological applications in all regions in National Meteorological Services, universities, public and private institutions,… Registering as NWCSAF user and downloading the software is so suggested.

For additional doubts or questions on **N**WCSAF consortium and NWC/GEO software package (how to get it and install it, or how to run and visualize its products), more information can also be obtained through the "NWCSAF Helpdesk" (www.nwcsaf.org) or through the email address safnwchd@aemet.es.

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