



## **EUMETSAT Data and Image Resources: NWC SAF Products for Nowcasting**

**Training event on satellite monitoring and nowcasting  
of high impact weather events for  
National Hydrometeorological Services of CIS countries  
Moscow & Balashikha, Russia - June 2019**

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with contributions by

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- The Satellite Application Facility on support to Nowcasting (NWC SAF) is a **Consortium** between **Eumetsat** and several **Nat. Met. Services**:
  - Agencia Estatal de Meteorología – AEMET (Spain)
  - Météo France
  - Sveriges Meteorologiska och Hydrologiska Institut – SMHI (Sweden)
  - Zentralanstalt für Meteorologie und Geodynamik – ZAMG (Austria)
- Its main objective is:
  - To **provide operational services** to enhance the **Nowcasting and Very short range Weather forecasting**.
  - This is **achieved by**
    - i) **Developing/maintaining two software packages** calculating in real time **Meteorological products** from:
      - \* **Geostationary satellite data (NWC/GEO)**.
      - \* **Polar satellite data (NWC/PPS)**.
    - ii) **Supporting users** on their use.



# NWC/GEO Software installation

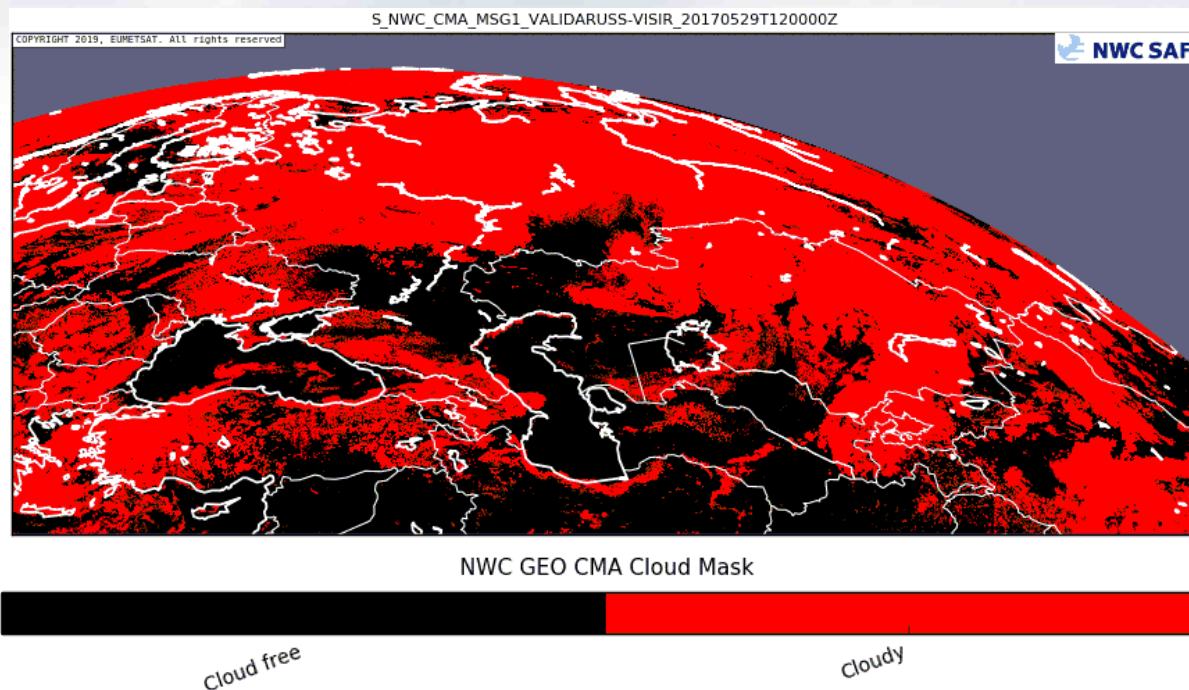


- **Latest version of NWC/GEO software (v2018)** is able to run with MSG + Himawari satellite images, so covering all regions of Russia + other CIS countries.

- Throughout this session, NWC/GEO products will be presented in these regions **with MSG-1 (Indian Ocean) images** (for 29 May 2017 12:00Z) **and Himawari-8 images** (for 19 April 2019 12:00Z) to know what they are able to do and how they can help in the Monitoring & Nowcasting.
- In a practical session tomorrow, we will make use of these NWC/GEO products **in five case studies in Russia.**



# NWC/GEO Clouds: CMa

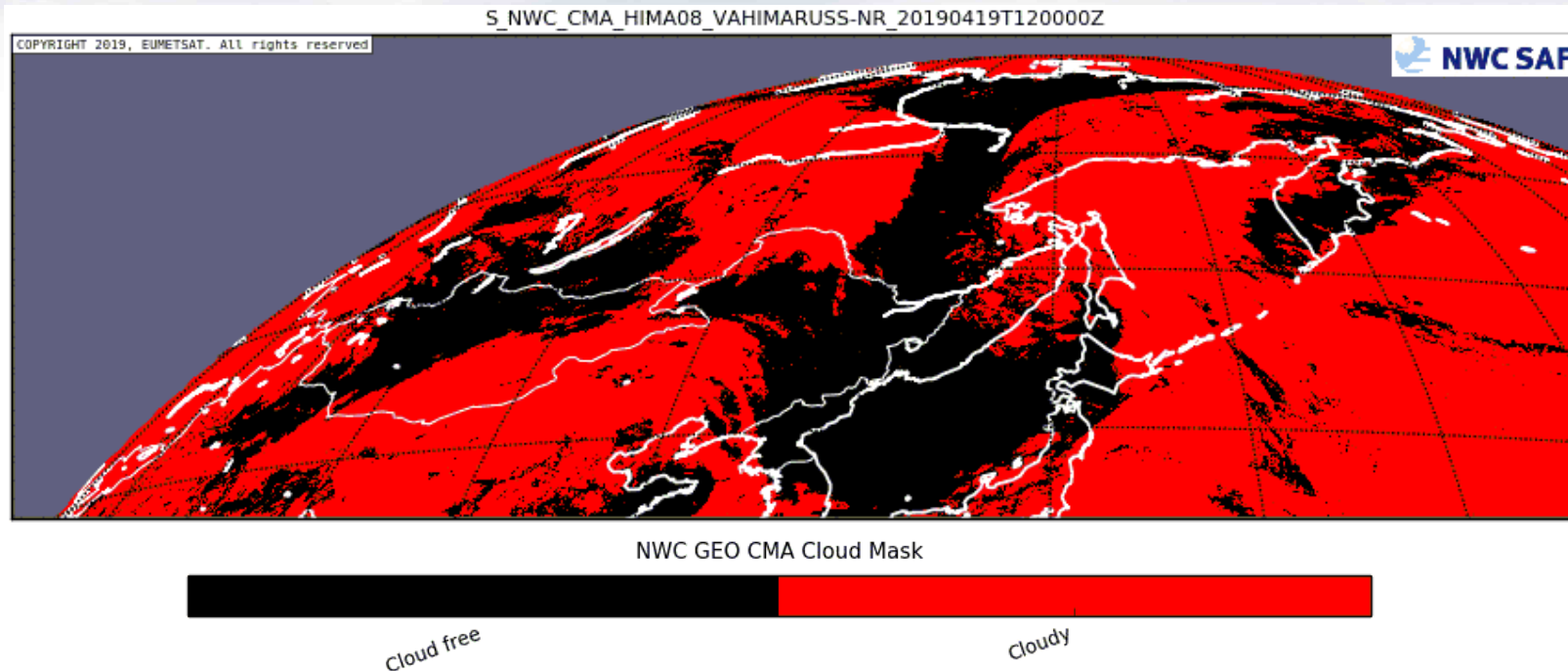


## CMa – Cloud Mask

- **For cloud detection in Nowcasting tasks,**  
CMa product to be used as a complement to Visible images during the day, which generally should provide enough results (especially for opaque clouds).
- CMa product more useful during the night, due to difficulties to identify some low cloud types in Infrared images.



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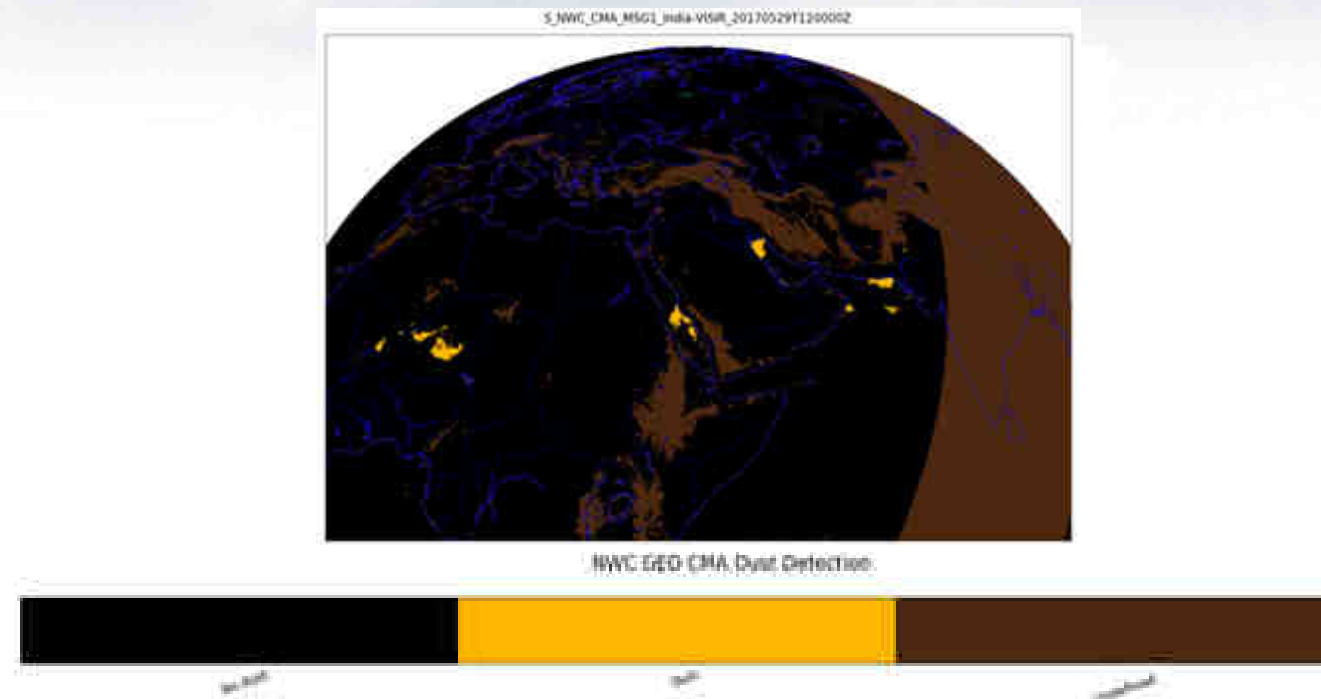
# NWC/GEO Clouds: CMa

## CMa – Cloud Mask

- NWC/GEO Cloud products have day and night algorithms, which can cause output changes in the moment of twilight.
- “Low clouds” sometimes undetected with bad illumination during day, or with high satellite angles during night.
- “Snow” undetected during night.



# NWC/GEO Clouds: CMa

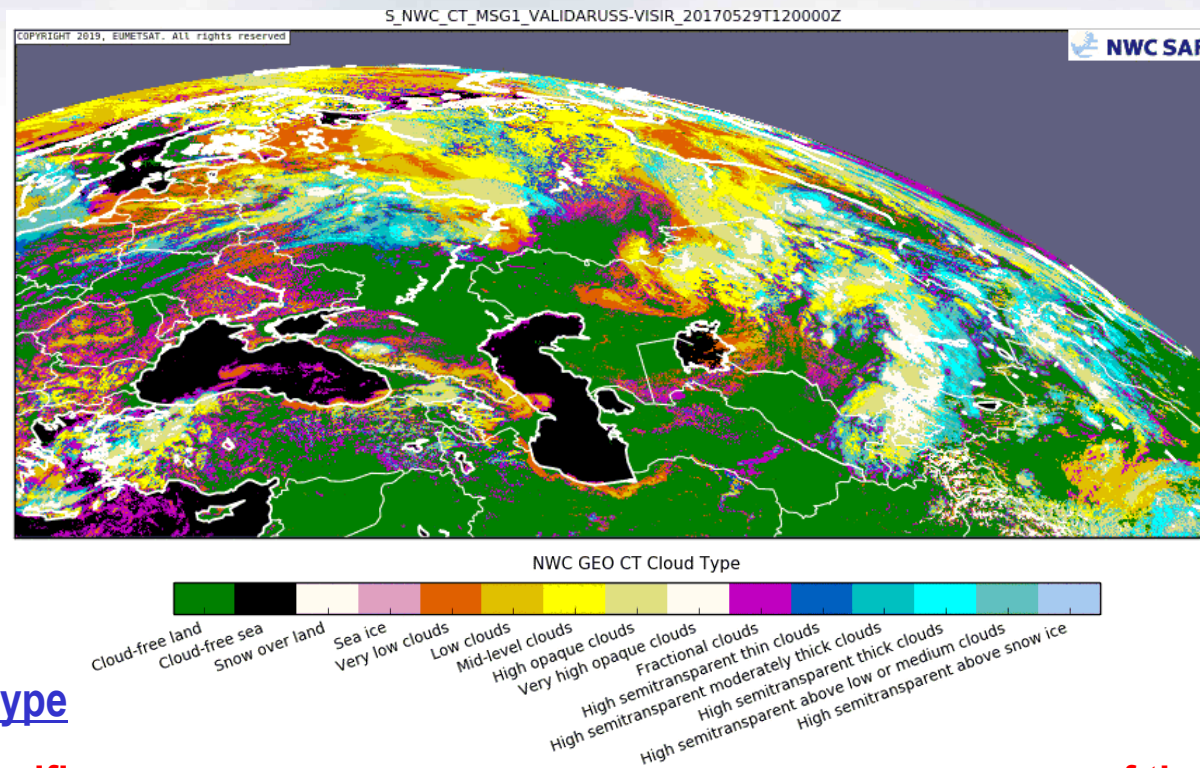


## CMa – Cloud Mask: “Dust cloud” and “Volcanic ash” Flags

- Available except at twilight.
- “Fine dust clouds” and “Volcanic ash over desert or clouds” not detected well.



# NWC/GEO Clouds: CT



## CT – Cloud type

- **Cloud classification based on the “opacity/transparency” and “level of the cloud top”:**  
“Cb” classified as “high opaque cloud”.
- **“Low clouds” with strong inversion** can be identified as “Mid level clouds”.
- **“Semitransparent clouds”** together with “Low clouds” can be identified as “Mid level clouds”.
- **“Very thin semitransparent clouds”** can be identified as “Fractional clouds” frequently.

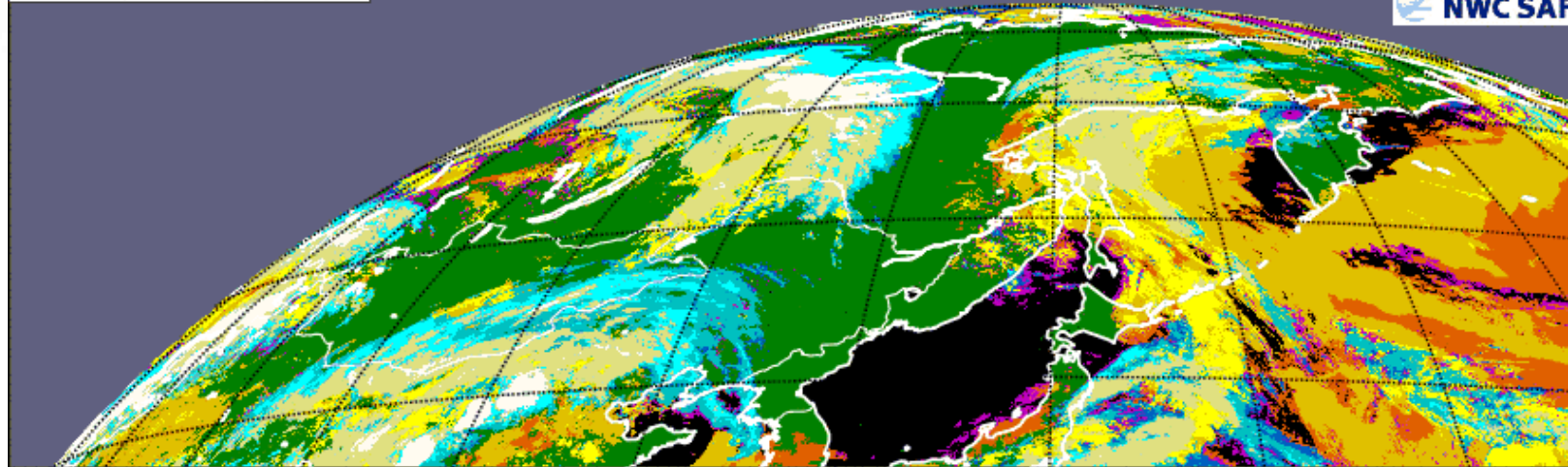


# NWC/GEO Clouds: CT

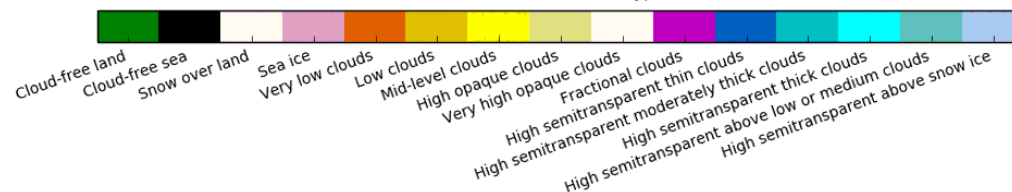
S\_NWC\_CT\_HIMA08\_VAHIMARUSS-NR\_20190419T120000Z

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NWC SAF



NWC GEO CT Cloud Type



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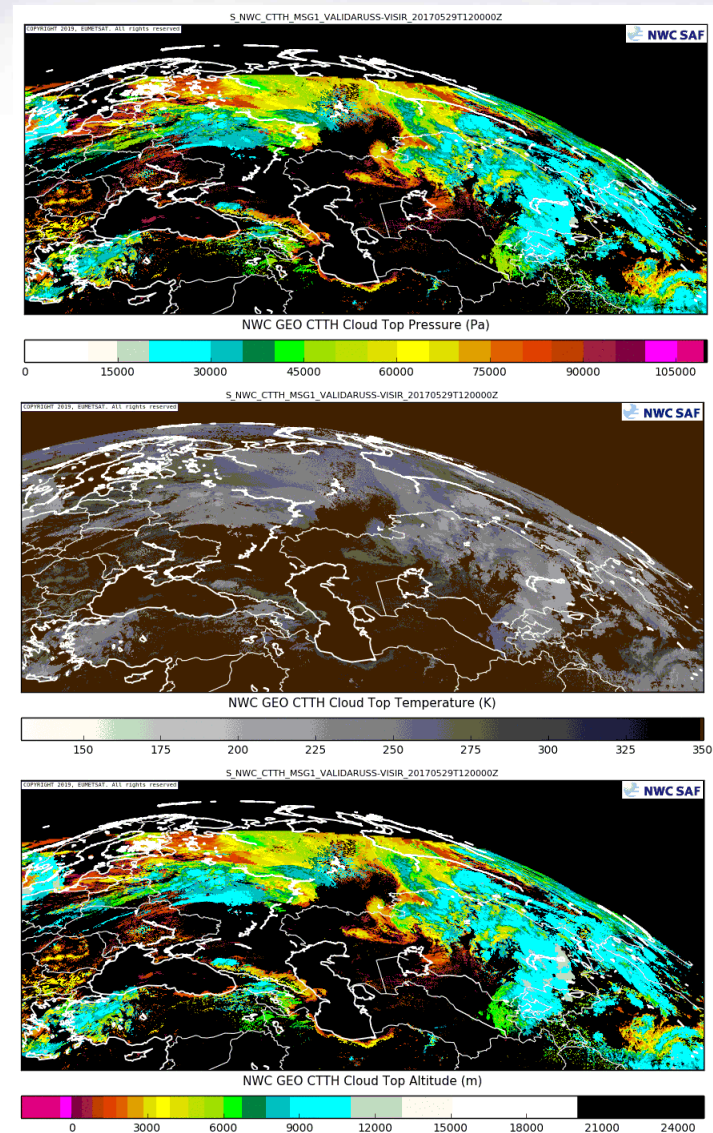


# NWC/GEO Clouds: CTTH

V2013

CTTH - Cloud Top Pressure (up),  
Temperature (centre) and Height (down).

- “Fractional clouds” have no CTTH product outputs.



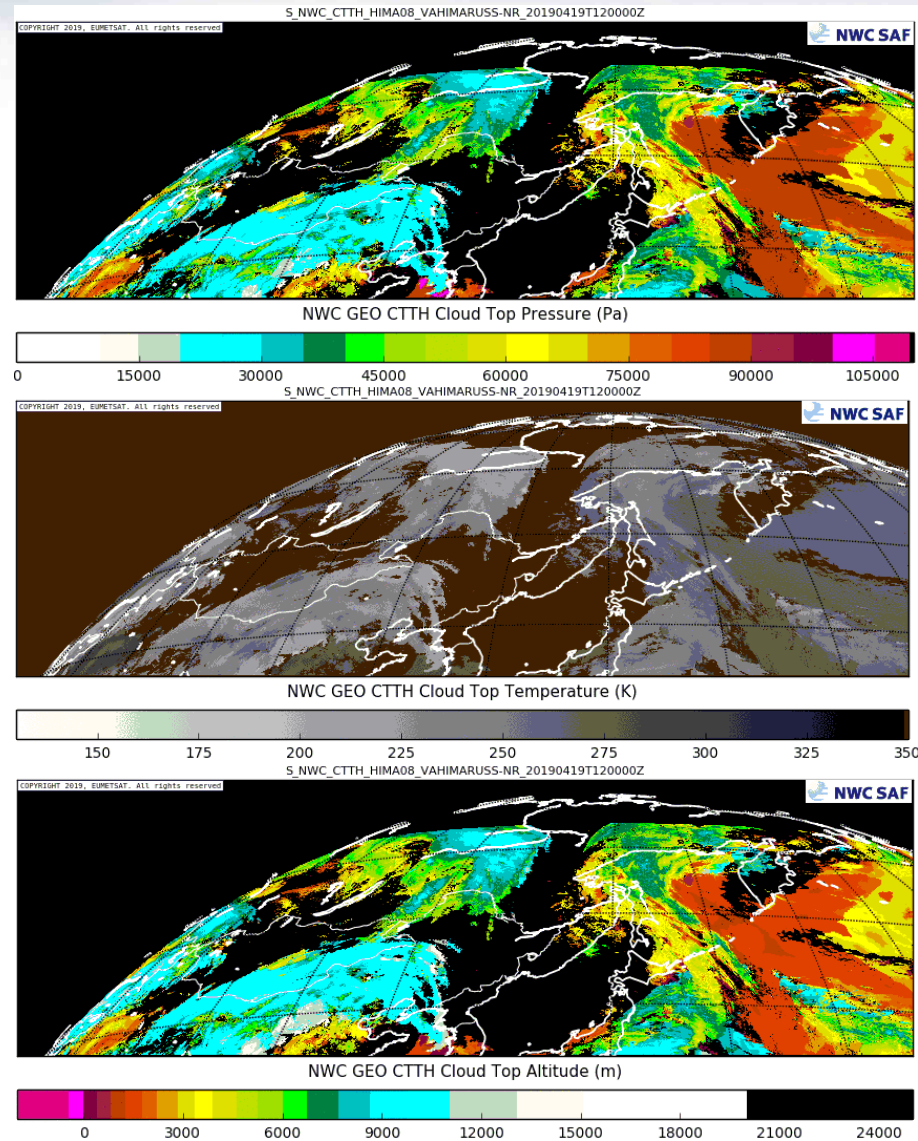


# NWC/GEO Clouds: CTTH

V2013

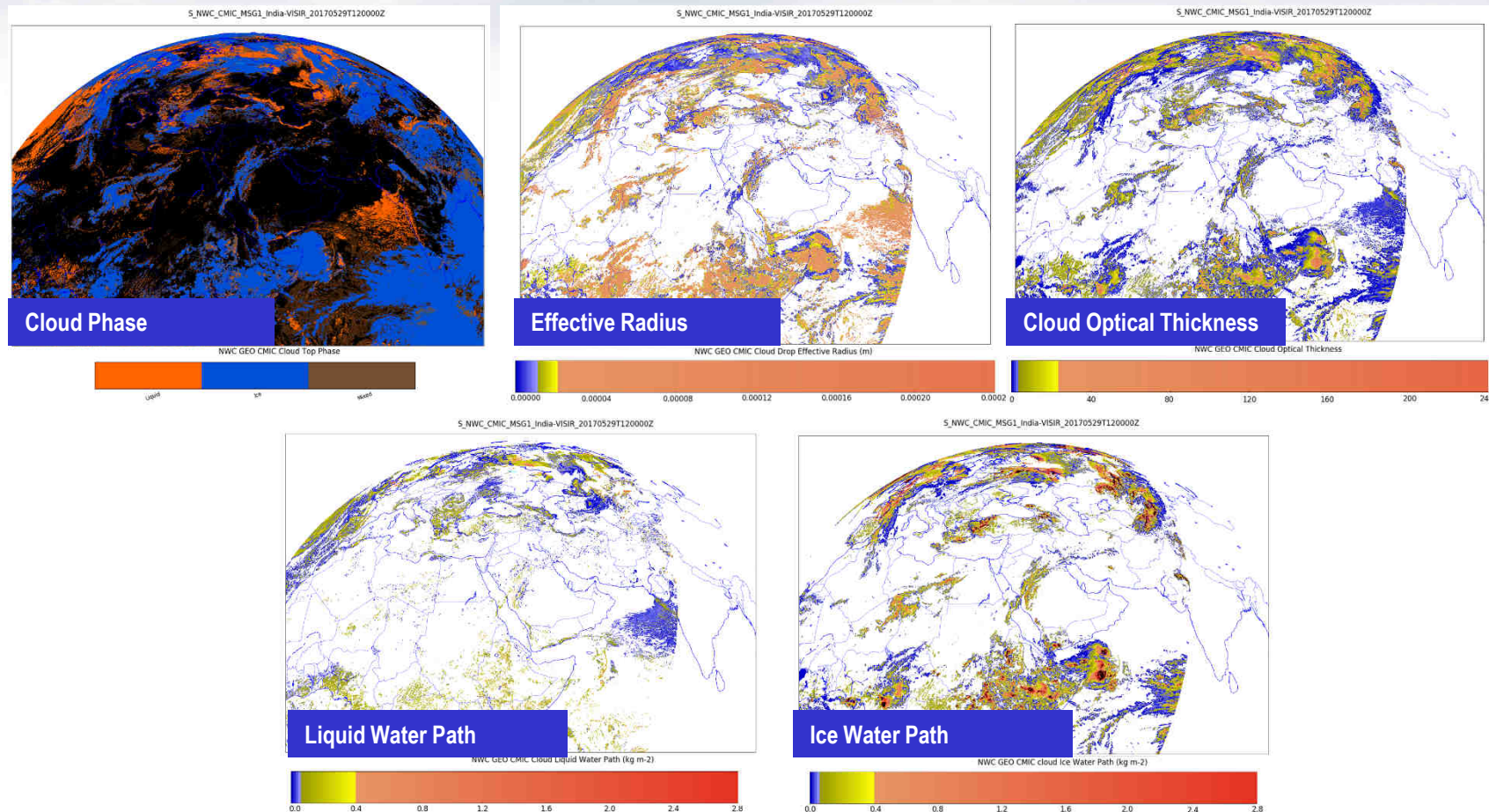
CTTH - Cloud Top Pressure (up),  
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# NWC/GEO Clouds: CMIC



## CMIC - Cloud Microphysics

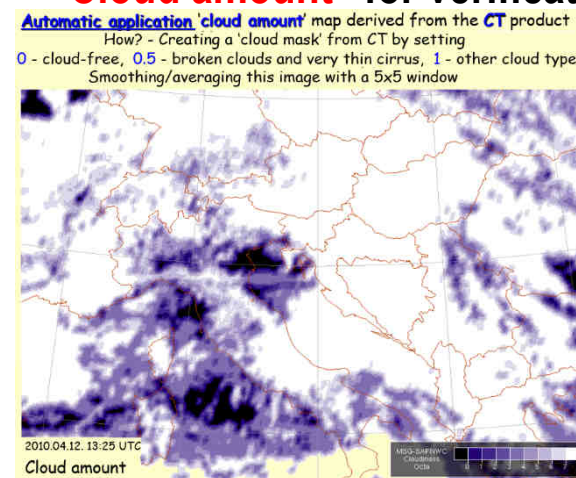
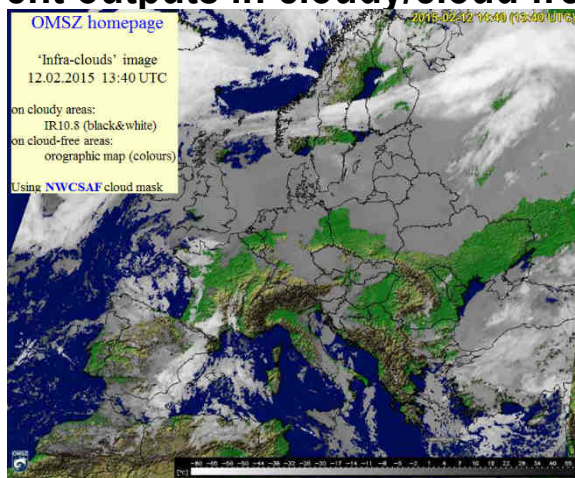
- “Fractional clouds” have no CMIC product outputs.
- Only “Cloud phase” parameter available for night, twilight, and mixed/undefined phase. (Products also available for Himawari, although not shown here).



# NWC/GEO Clouds

Cloud products are in spite of limitations among the most reliable NWC/GEO products, and have been used in NMSs, SAFs, other users for many operational applications:

1. Use of “Cloud mask” for mixed display of different outputs in cloudy/cloud free areas.
2. Use of derived smoothed “Cloud amount” for verification.



3. Use of “Cloud type” for filtering of “precipitation radar noise” in areas which are cloud free or covered by cirrus only.
4. Use of “Cloud top height” and “Cloud phase” in aviation applications, including icing forecast.

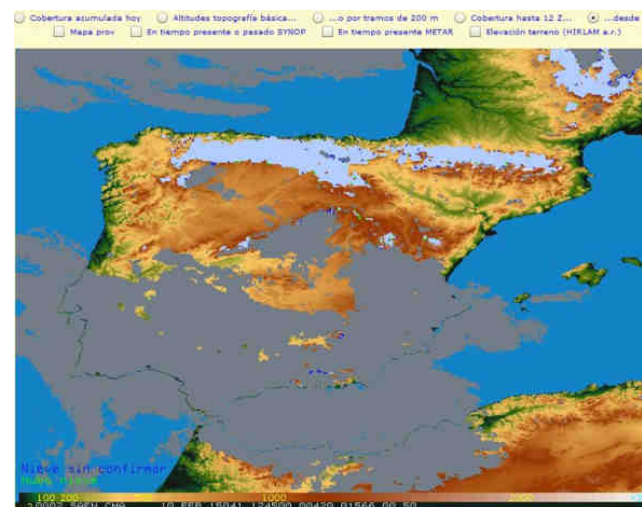
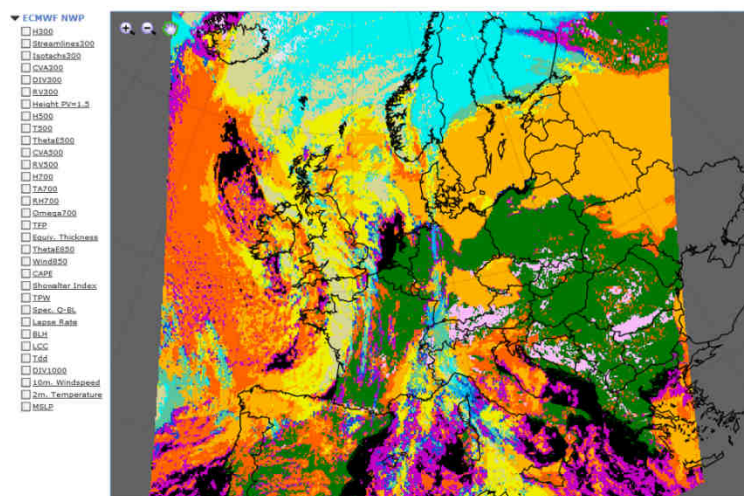


**AEMet**  
Agencia Estatal de Meteorología

**EUMETSAT**  
**NWCSA**  
SUPPORT TO NOWCASTING AND  
VERY SHORT RANGE FORECASTING

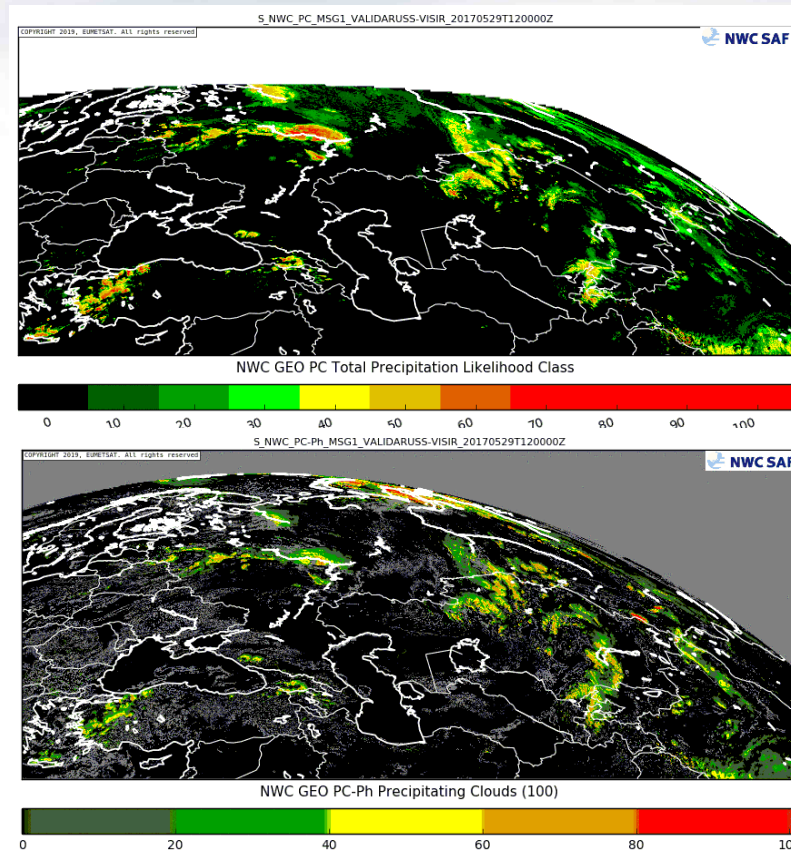
### 5. Use of “Cloud type & CTTH” (with visibility + wind + RH) for “Warning of fog areas”.

## 7. Use of “Cloud mask” for “Snow maps”.





# NWC/GEO Precipitation: PC, PCPh



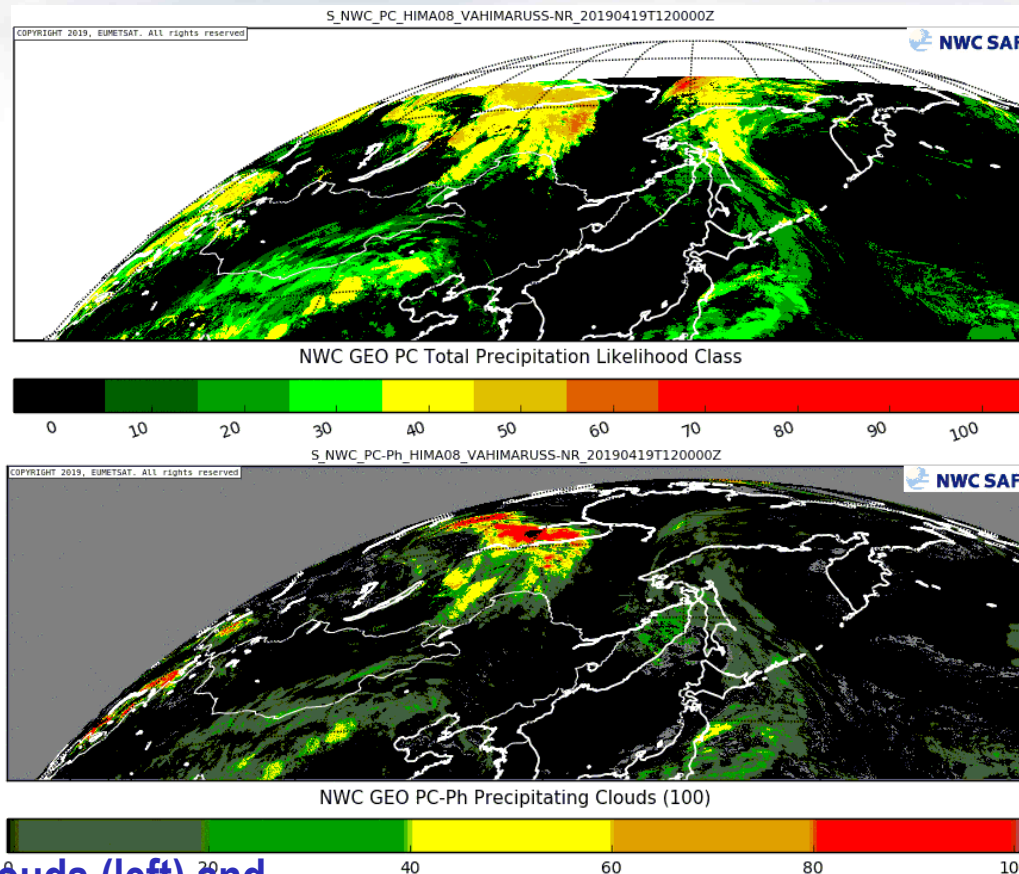
PC – Precipitating Clouds (left) and

PCPh – Precipitating Clouds based on Cloud Microphysics (right)

provide the “Probability of precipitation” for all kinds of precipitation,  
although they work better for convective precipitation



# NWC/GEO Precipitation: PC, PCPh



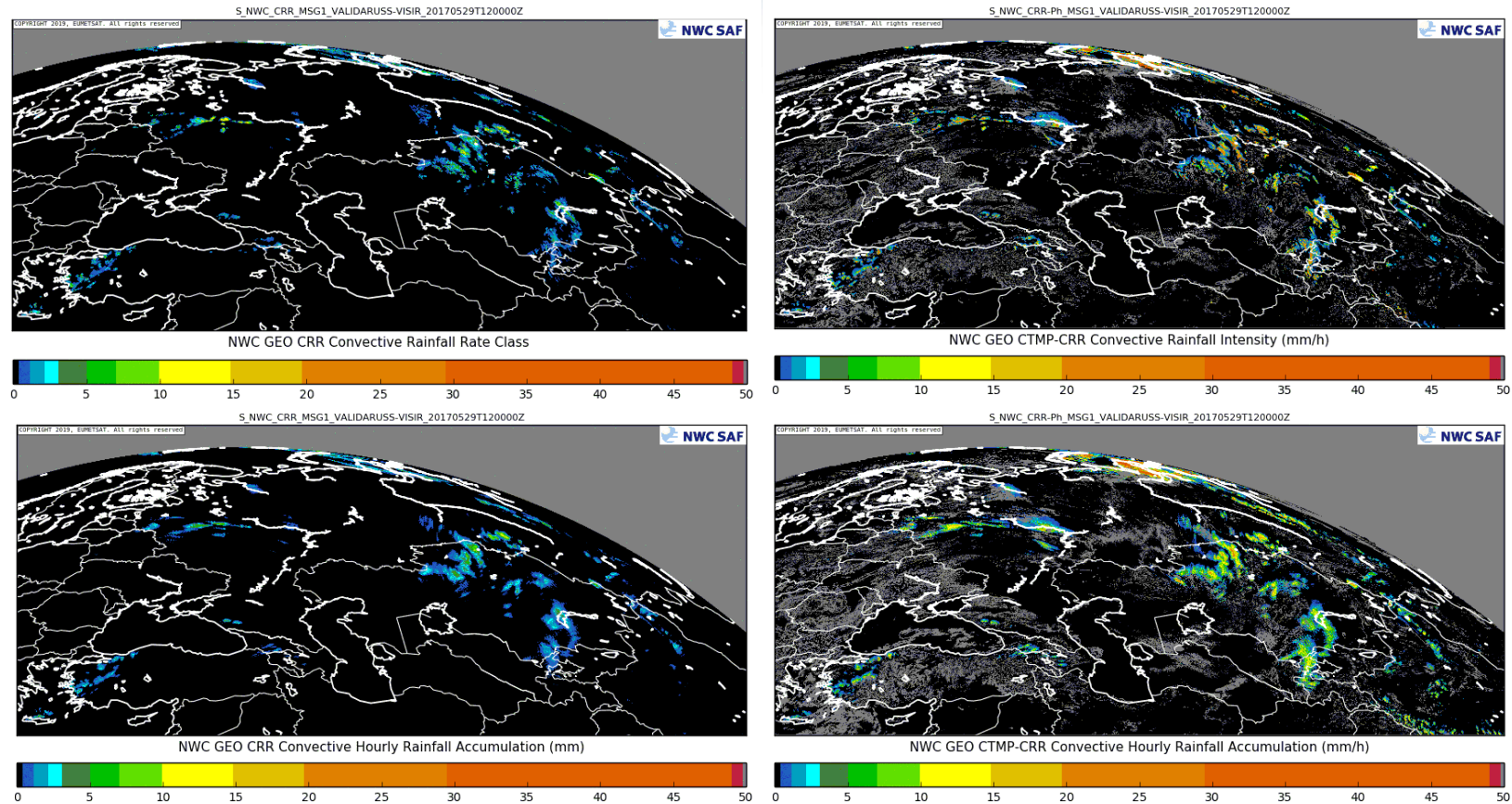
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# NWC/GEO Precipitation: CRR, CRPh



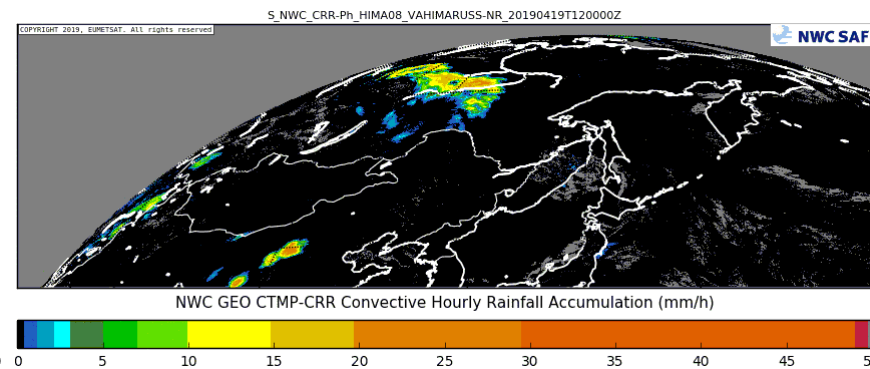
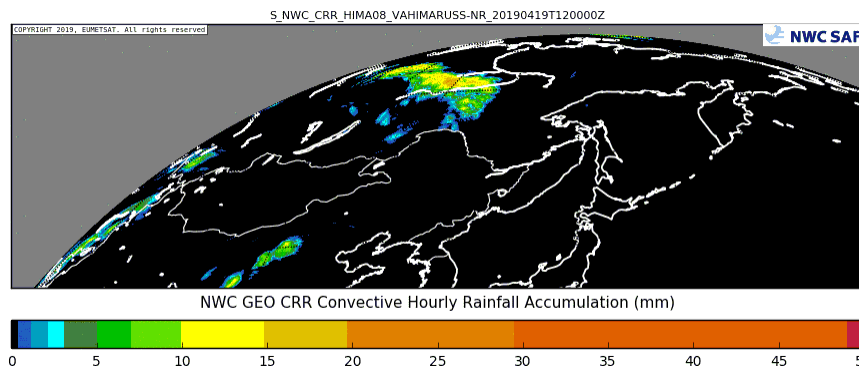
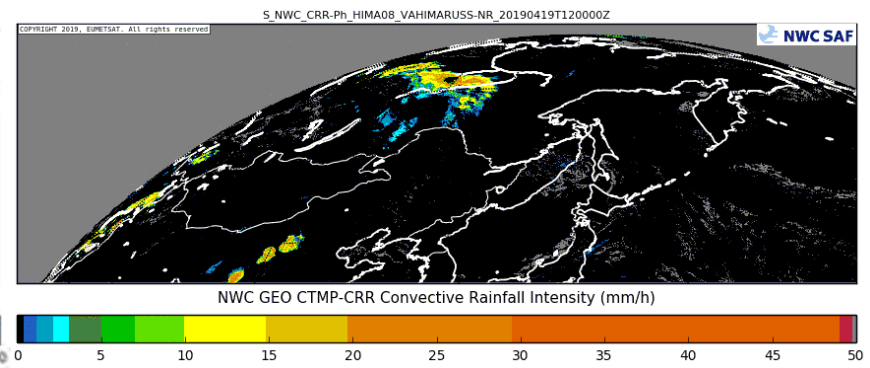
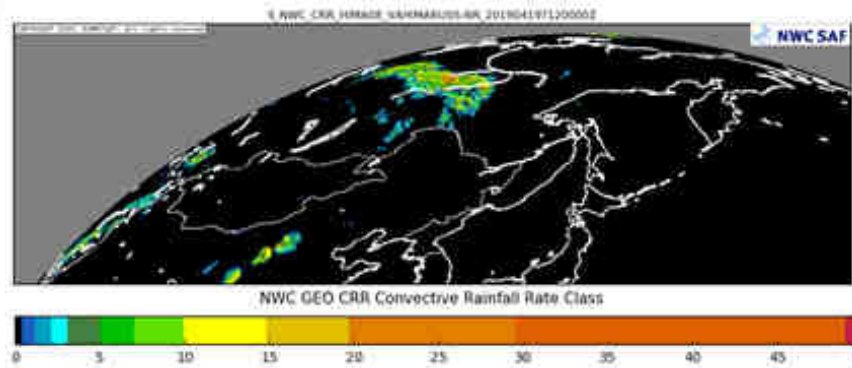
CRR – Convective Rainfall Rate (left) and

CRPh – Convective Rainfall Rate Clouds based on Cloud Microphysics (right)

provide “Instant values of precipitation” (up) and “Hourly values of precipitation” (down)



# NWC/GEO Precipitation: CRR, CRPh



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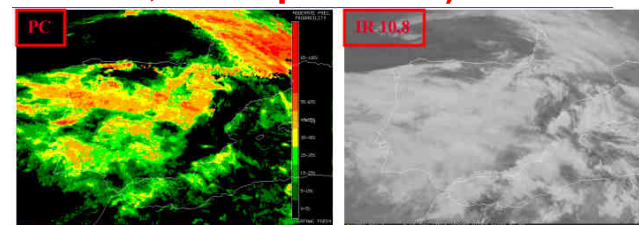
# NWC/GEO Precipitation

Operationally, the procedure with NWC/GEO Precipitation products should always be:

1. **Use always radar data**, if they are available and the quality of radar data is good.
2. If radar data are not available for our forecast/warning area:  
→ **Use of Products with Microphysics (PCPh/CRPh).**

3. **Considering the Products without Microphysics (PC/CRR, older products):**

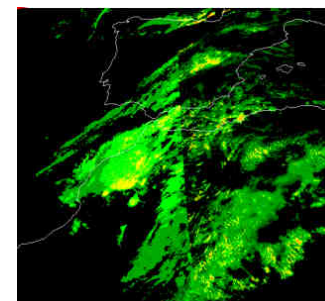
- PC does not detect well precipitation related to low clouds.
- PC/CRR overestimates precipitation area and subestimates precipitation intensity (aspect more similar to “cloud tops” due to dependence on IR temperature).



PC & IR108

16 January 2013 at 10:30Z

4. **Daytime/nighttime algorithm differences** exist for all precipitation products, observable at sunrise/sunset.

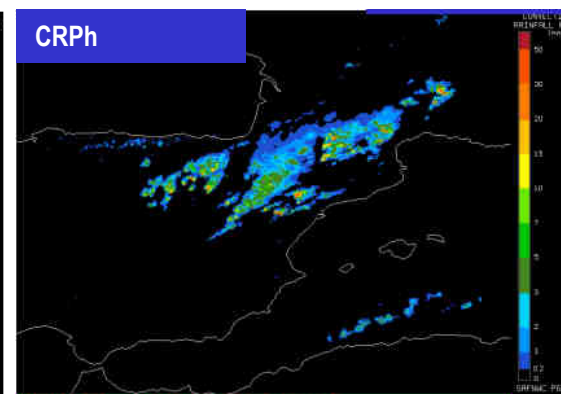
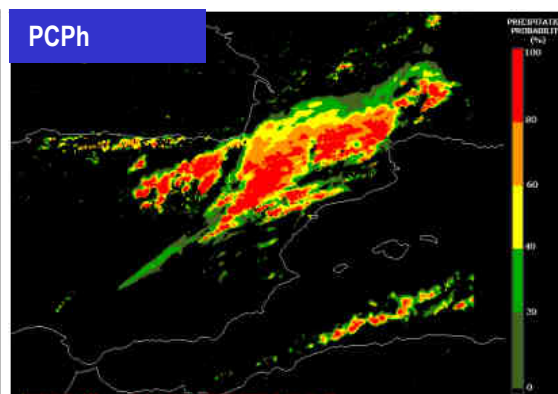
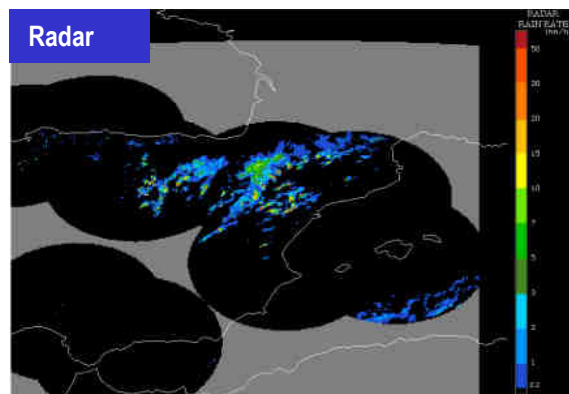
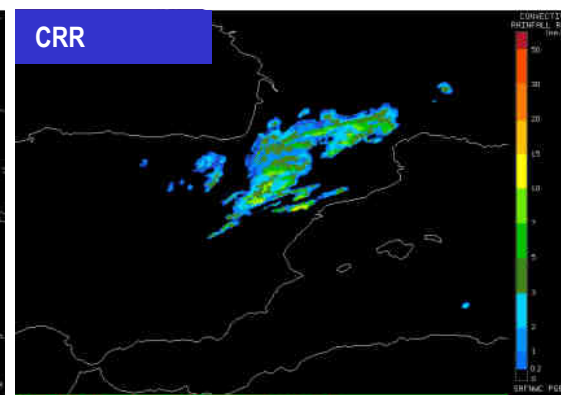
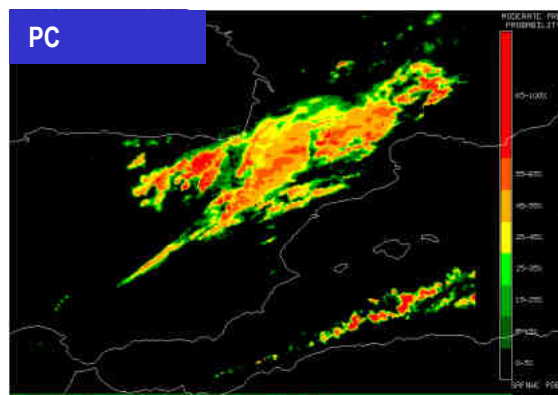


PC, 12 April 2012 at 06:30Z



# NWC/GEO Precipitation

**Microphysics products (PCPh/CRPh) are able to reproduct much better radar patterns:**  
→ Example 1 for 12 July 2008 at 13:00Z  
in the Iberian Peninsula:

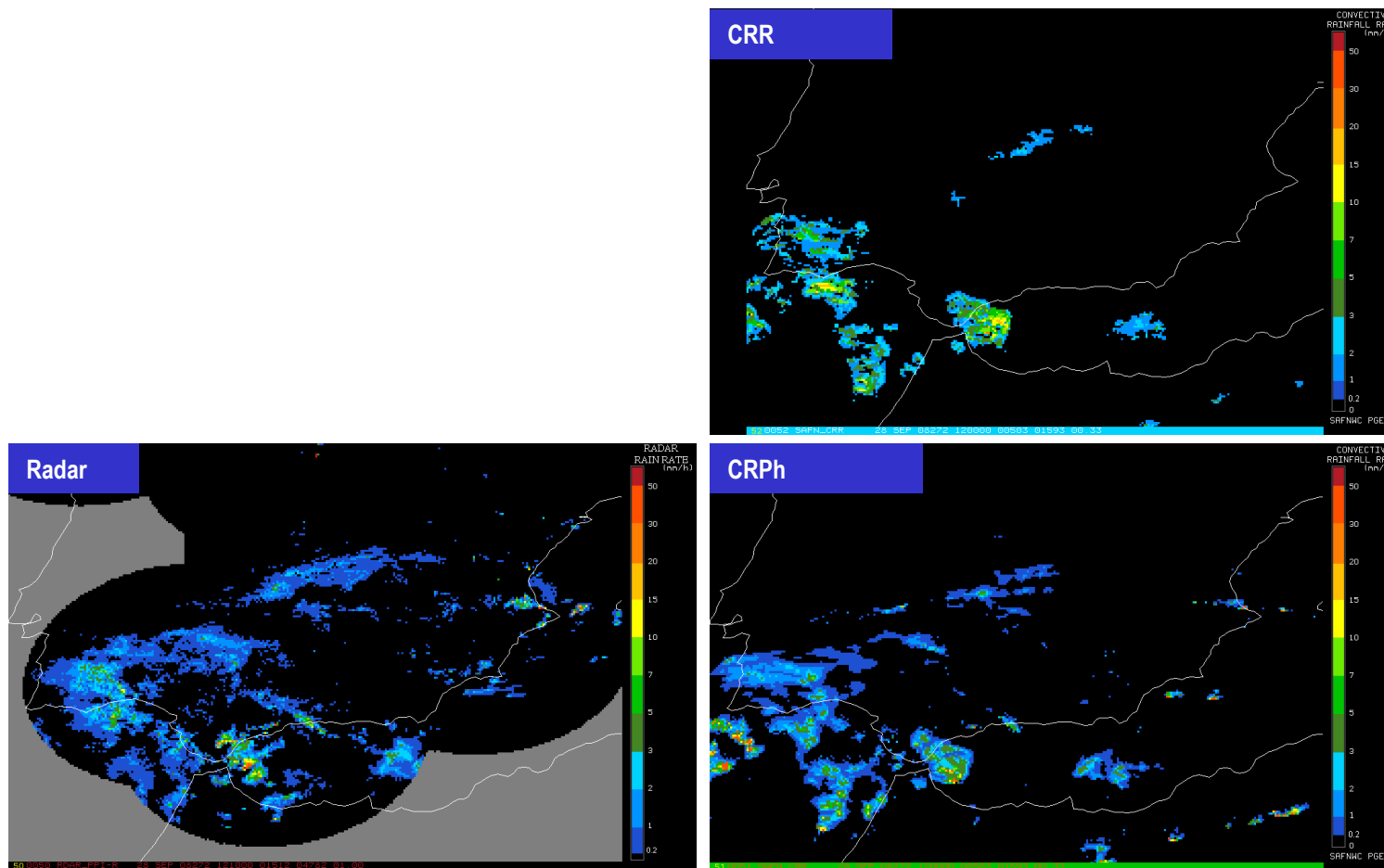




# NWC/GEO Precipitation

**Microphysics products (PCPh/CRPh) are able to reproduct much better radar patterns:**

➔ Example 2 for 28 September 2008 at 12:00Z  
in the Iberian Peninsula:



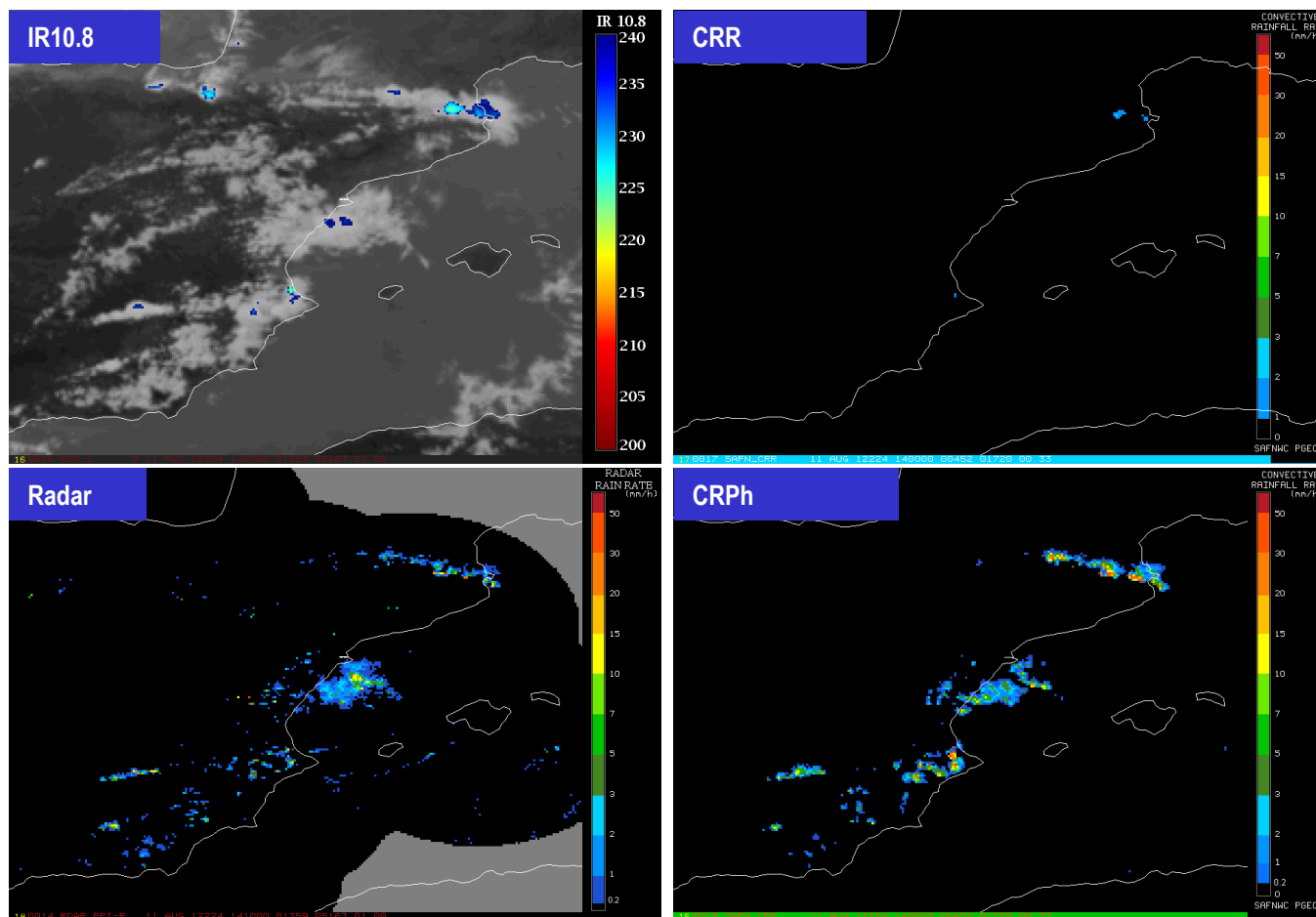


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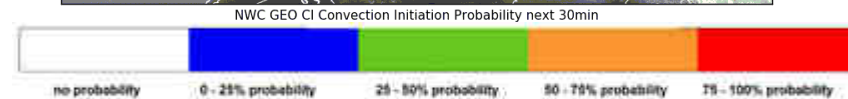
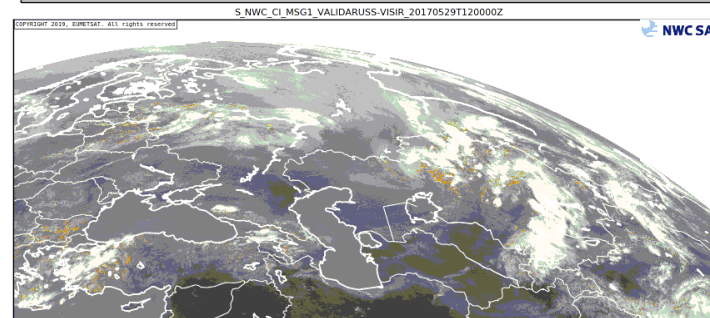
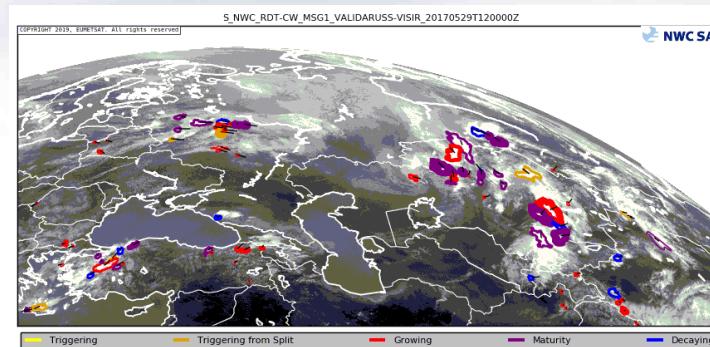
→ Example 3 for 12 August 2012 at 14:00Z in the Iberian Peninsula:

- CRPh works much better than CRR when cloud tops are warm.





# NWC/GEO Convection: RDT, CI



## RDT - Rapid Developing Thunderstorms (up)

identifies, monitors and tracks each “Convective cell” with many characteristics

➔ Trend, displacement, severity, convectivity, rainfall and lightning activity, temperature, pressure,...

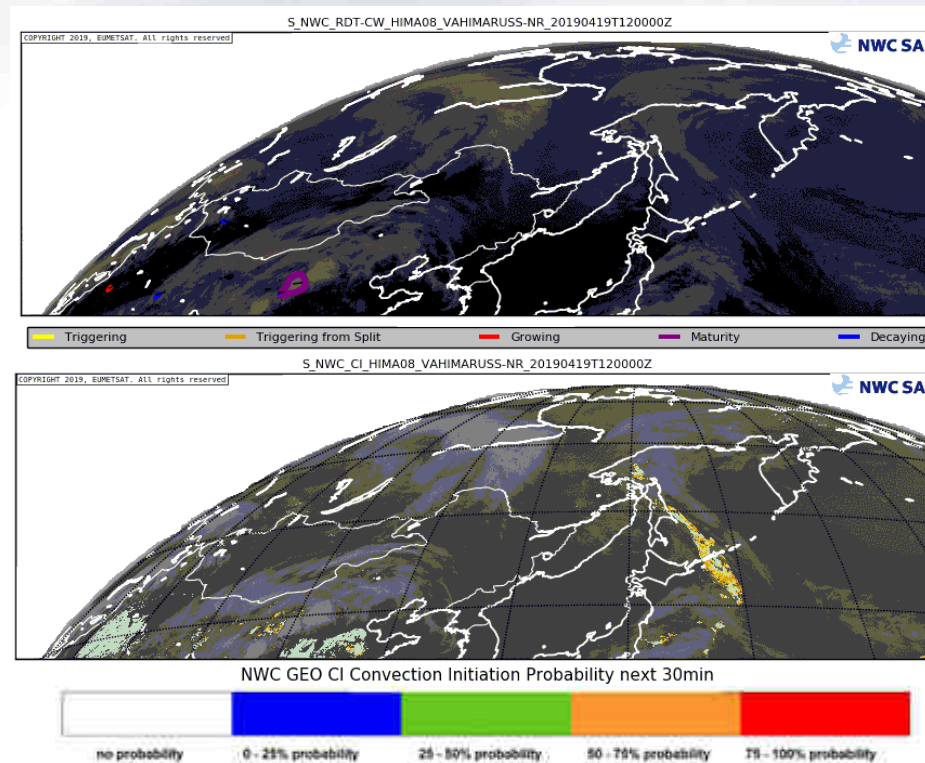
## CI – Convection Initiation (down)

defines the probability of a Cloudy pixel to become a thunderstorm in 30 minutes

➔ Based on 13 height/growth/glaciation thresholds.



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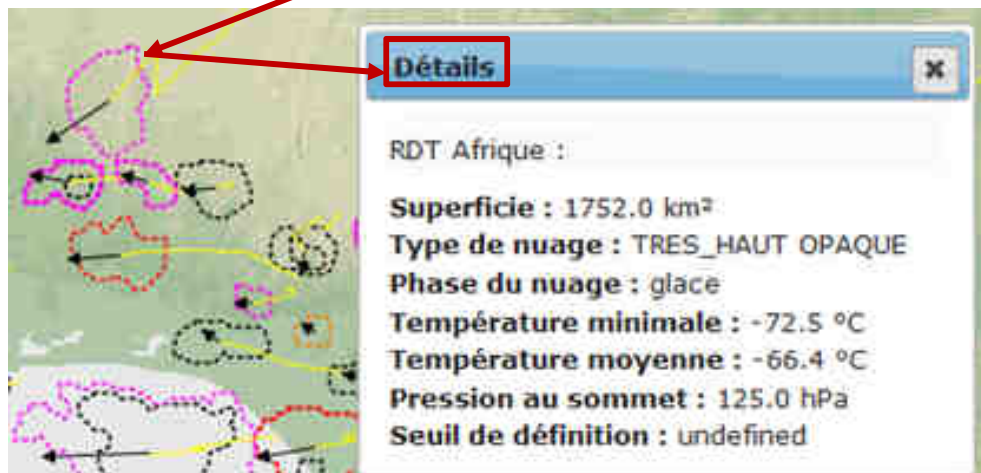
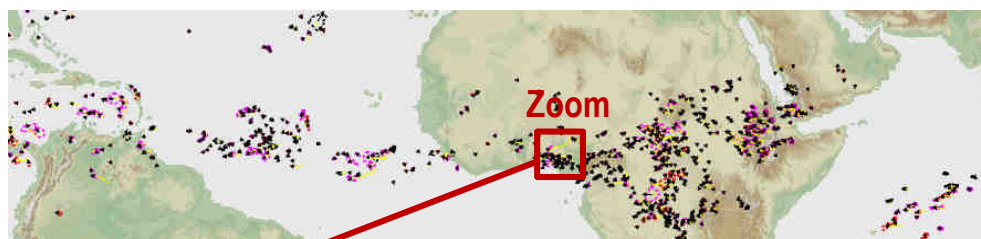
defines the probability of a Cloudy pixel to become a thunderstorm in 30 minutes

→ Based on 13 height/growth/glaciation thresholds.



# NWC/GEO Convection: RDT

→ A visualization data with colours/contouring based on their characteristics improves their use operationally  
(as used by MétéoFrance, globally with GOES-W, GOES-E, 2 MSGs, Himawari-8)



## Base de la tour ( $T^{\circ}$ variable selon morphologie)

Phase de développement	Couleur
Naissance ou développement	Jaune
Croissance	Rouge
Issu d'une Fission	Orange
Maturité	Violet
Décroissance	Bleu

Activité électrique	Style de trait
Impacts ou intra-nuage associés à la cellule	———
Sans activité électrique connue	- - - - -

Refroidissement	Épaisseur de trait
Fort refroidissement < -30°/h	—————
Refroidissement modéré < -20°/h	—————
Refroidissement limité < -10°/h	—————
Refroidissement faible ou pas de refroidissement > -10°/h	—————

**Sommet de la Tour ( $T_{min}+6^{\circ}$ )**  
couleur, épaisseur, style uniques — - - - -

**Trajectoire des centres de gravité des cellules**  
couleur, épaisseur, style uniques ———

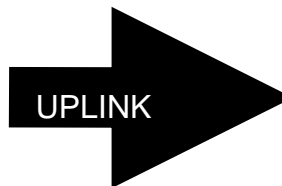
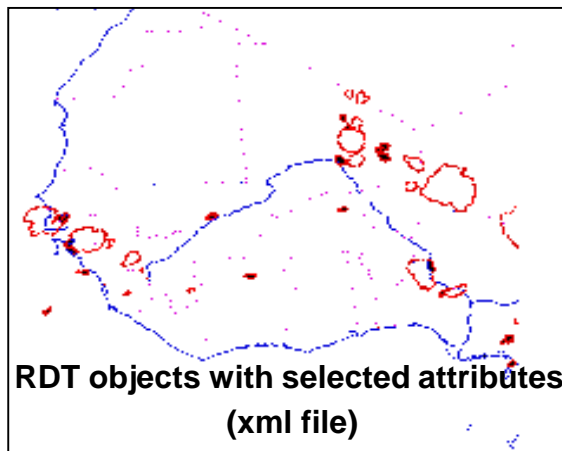
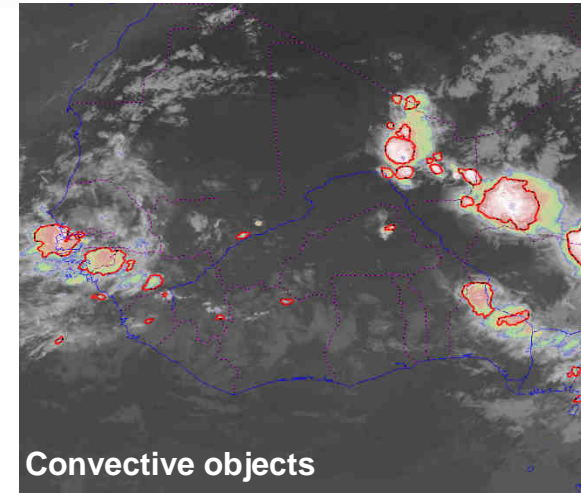
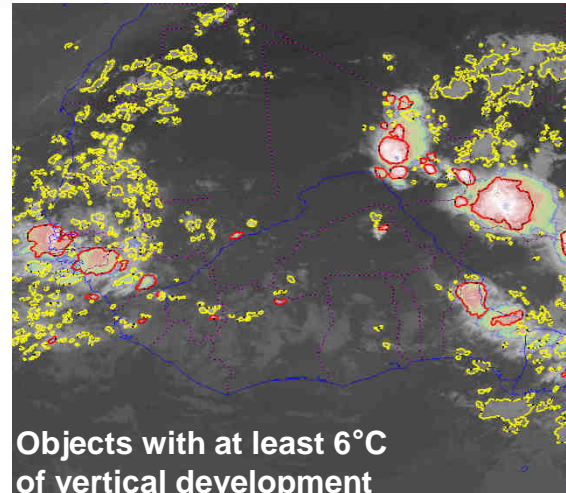
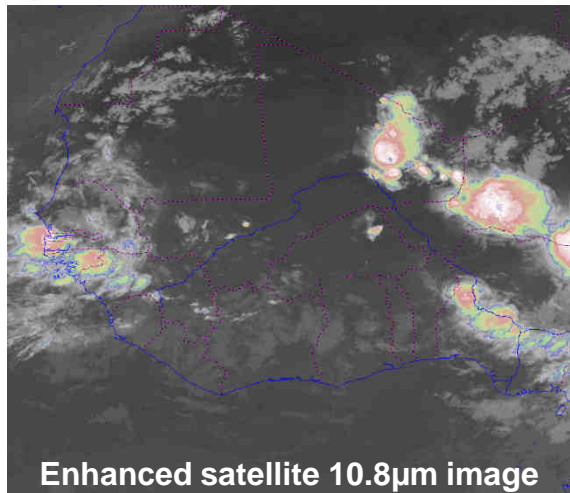
**Déplacement**  
flèche noire ———→  
longueur modulée selon vitesse



# NWC/GEO Convection: RDT

→ Some characteristics can be very useful for some specific users.

Example 1: Aeronautical users.

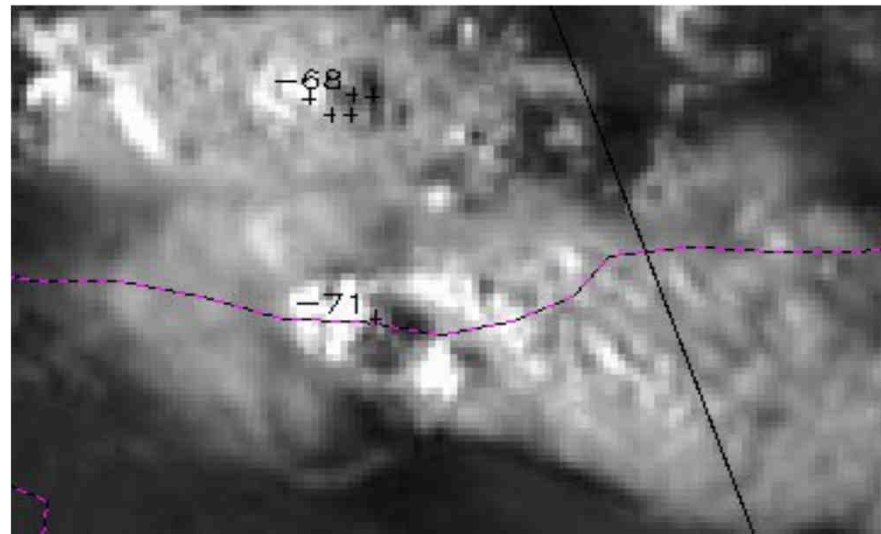
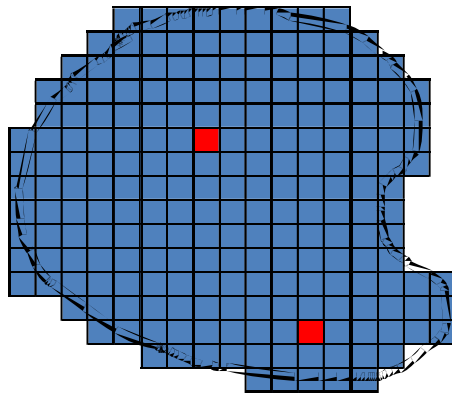




# NWC/GEO Convection: RDT

→ Some characteristics can be very useful for some specific users.

Example 2: Detection of Overshooting Tops (OT) inside each cell.



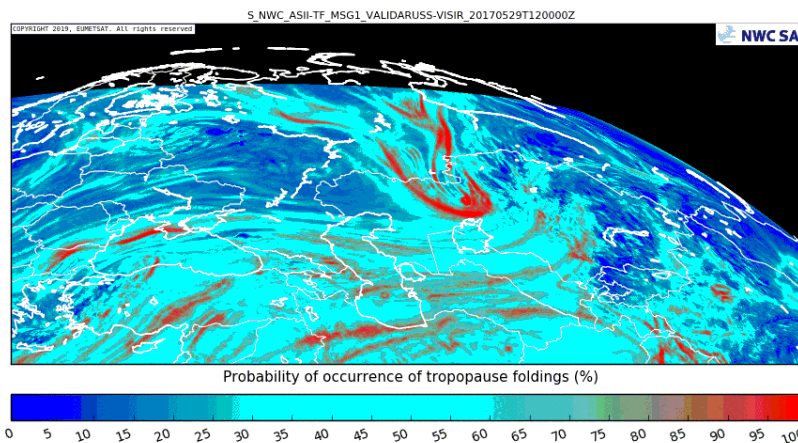


# NWC/GEO Turbulence: ASII-TF,GW

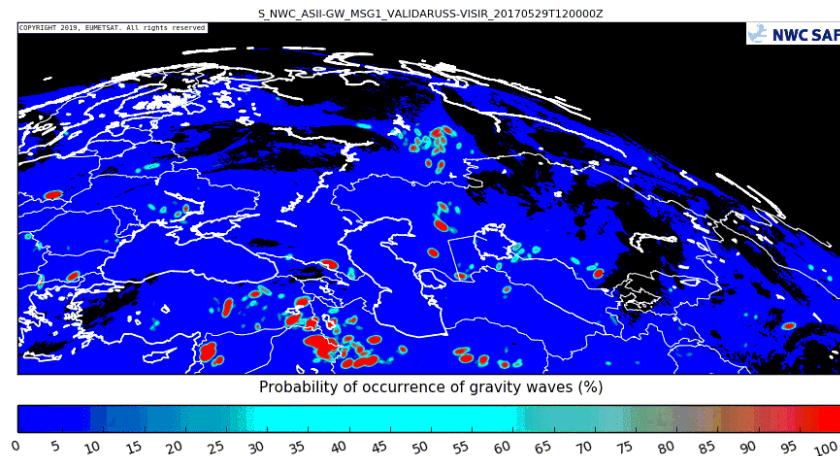
Two NWC/GEO products **related to “Clear Air Turbulence (CAT)”** are available, relevant for “Aviation users”:

- **Tropopause folding (ASII-TF).**

(Downward intrusion of stratospheric air into the troposphere, with a folding of the tropopause).



- **Gravity/Mountain waves (ASII-GW).**



- > CAT involves physical processes with scales usually smaller than the resolution of NWP models.
- > So, “CAT forecast” is difficult with NWP models, and the identification of “CAT risk areas” with satellite observations is useful.

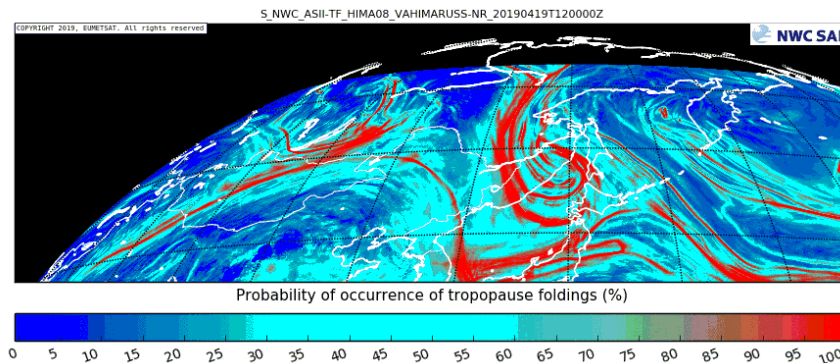


# NWC/GEO Turbulence: ASII-TF,GW

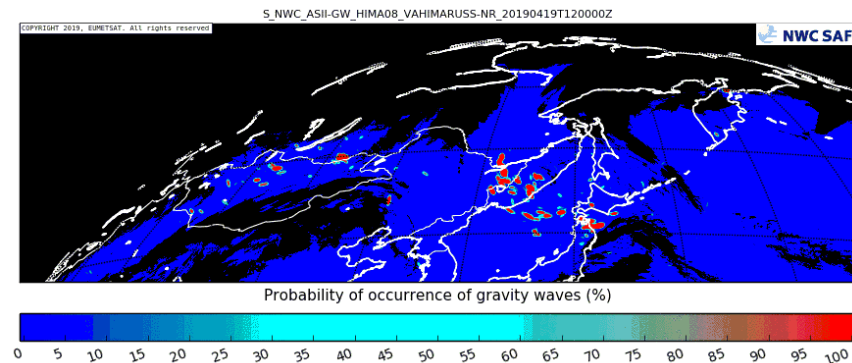
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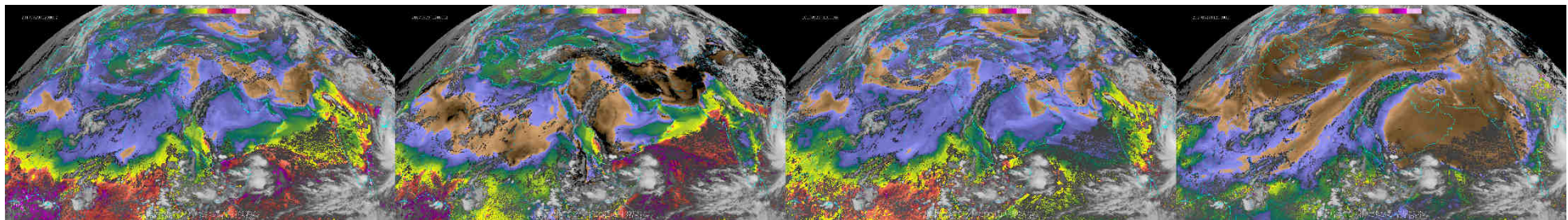
# NWC/GEO Clear Air: iSHAI

iSHAI – **i**maging **S**atellite **H**umidity and **I**nstability product

provides for Clear air pixels:

(products also available for Himawari, although not shown here).

Humidity: Precipitable water for whole column, and for Boundary/Medium/High layer.



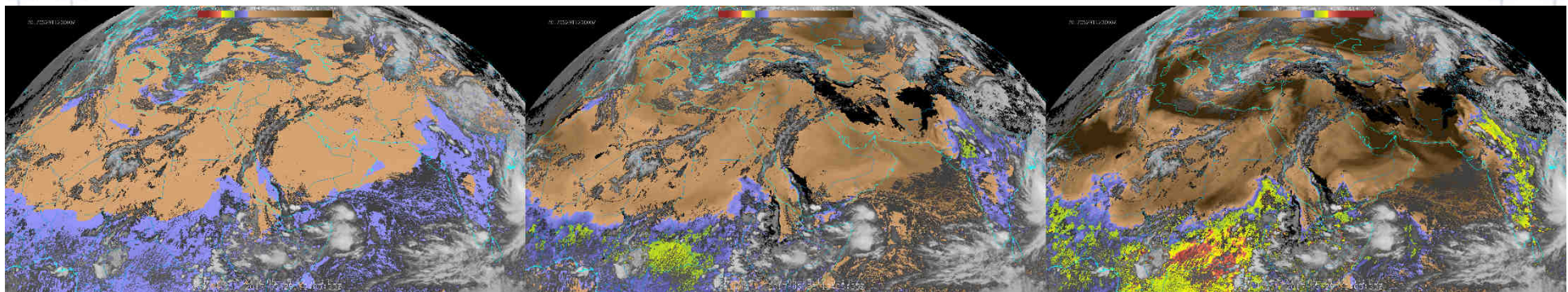
TPW  
Total Precipitable Water

BL  
Boundary Layer ( $P_{sfc} - 850hPa$ )

ML  
Middle Layer (850-500 hPa)

HL  
High Layer (500-0.1 hPa)

Stability indices: LI, Showalter, KI



LI  
Lifted Index

SHW  
Showalter Index

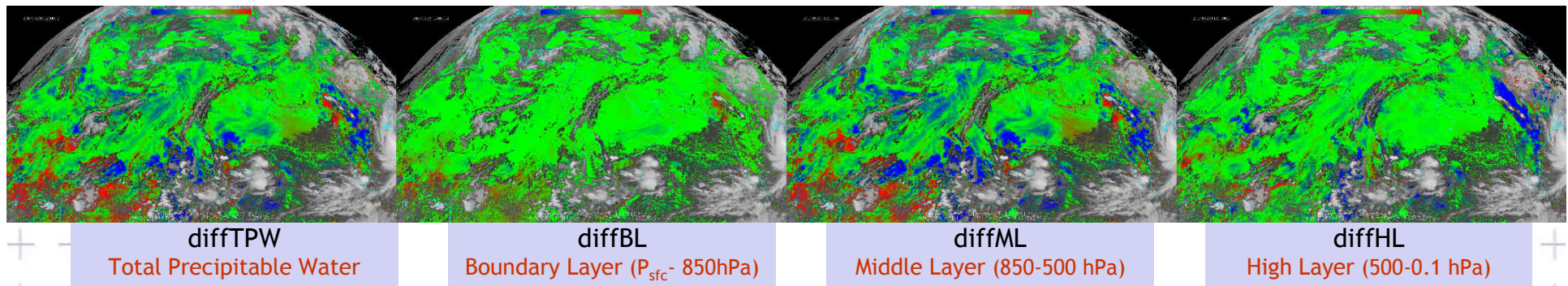
KI  
K-Index



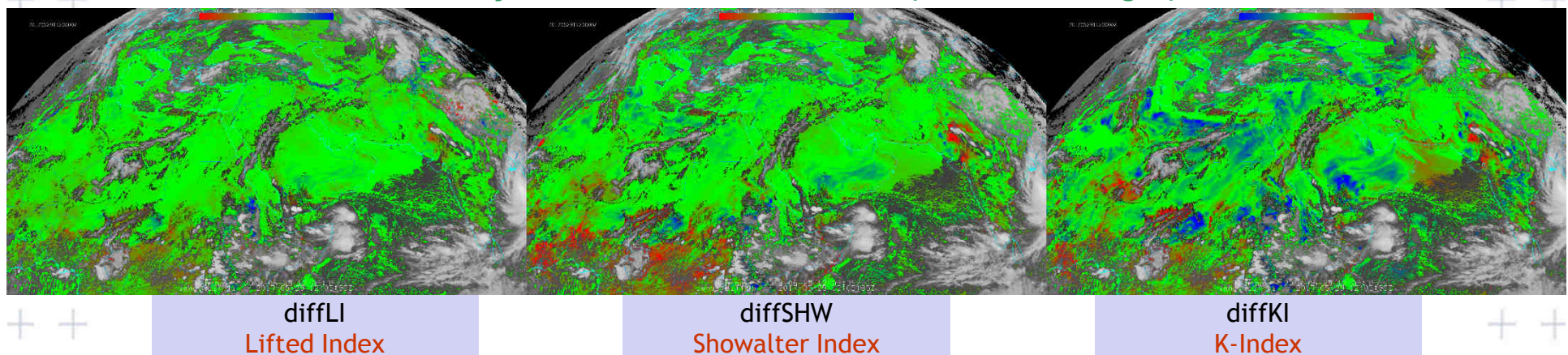
# NWC/GEO Clear Air: iSHAI

Difference fields between iSHAI products and the background NWP model are also provided, and they help very much **for the detection of forecast elements not seen by the NWP model.**

Humidity: Precipitable water for whole column, and for Boundary/Medium/High layer.

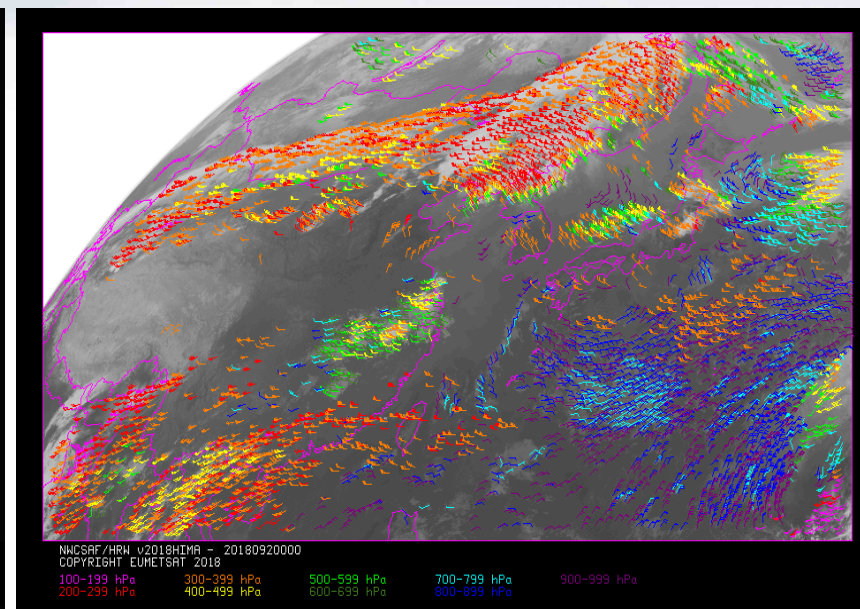
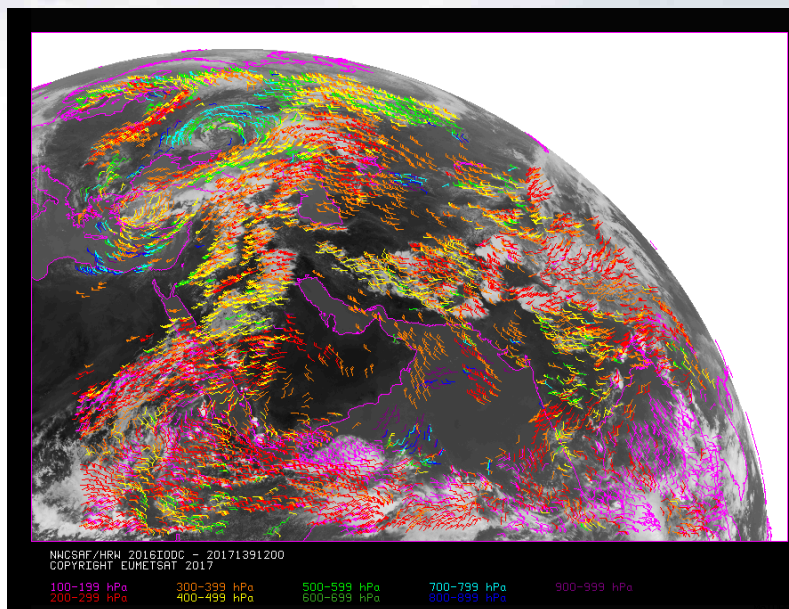


Stability indices: LI, Showalter, KI (left, centre, right)





# NWC/GEO Winds: HRW



## HRW – High Resolution Winds

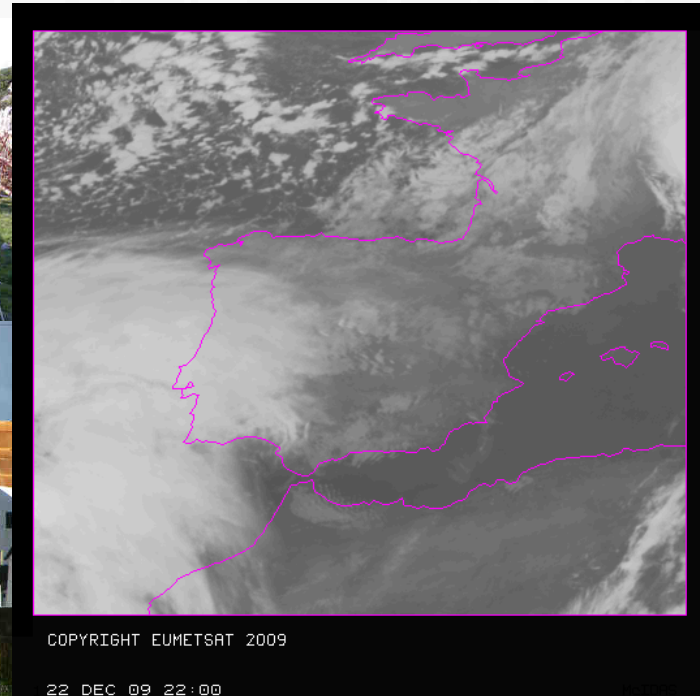
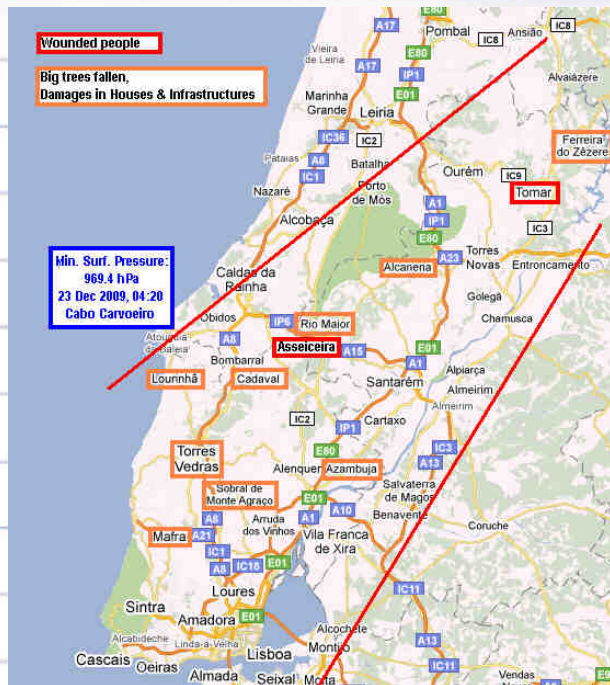
- Calculates “Atmospheric Motion Vectors” and “Trajectories”, used as an **important source of wind observations over oceans and remote areas.**

These data can be used through:

- **Assimilation in Meteorological applications.**
- **Direct use in operational nowcasting:**
  - \* The monitoring and watch of dangerous wind situations.
  - \* The verification of the general circulation, small scale wind and wind singularities.



# NWC/GEO Winds: HRW

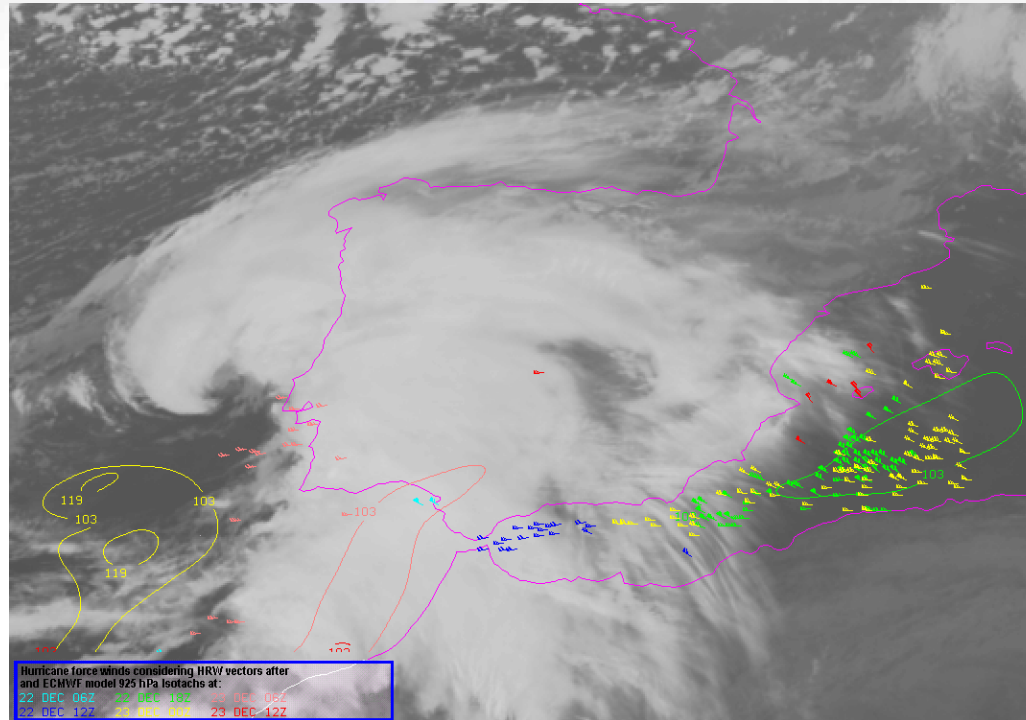


**Example 1, about use in an “extreme” situation:**

**an Explosive Cyclogenesis entering Portugal from the Atlantic Ocean in the night of 22-23 December 2009 (deepening > 20 hPa/24 h), causing important damages in a narrow band from the estuary of Tagus River to the NE inner land.**



# NWC/GEO Winds: HRW

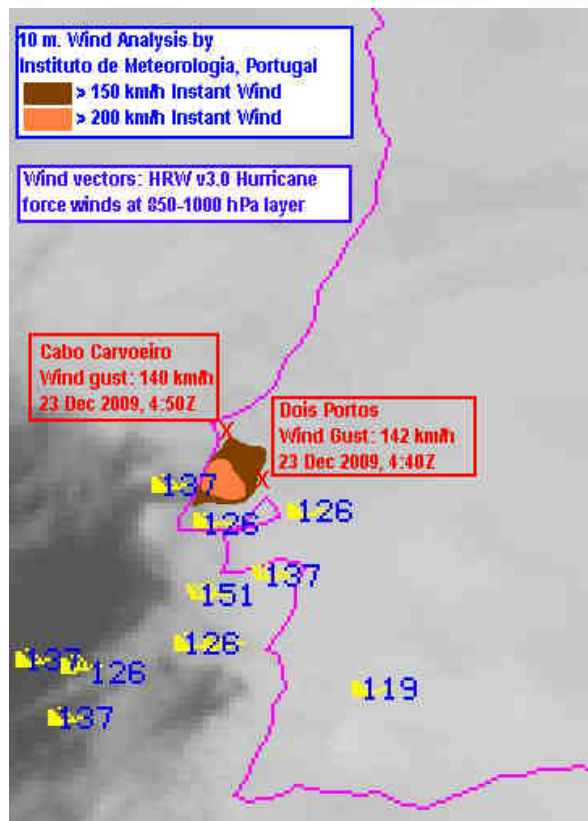


**HRW product** identifies a narrow band of hurricane winds between 850-1000 hPa, which fits very well with the affected area (mean winds in 15 min. of 125-150 km/h)

These winds were not identified by the ECMWF model used for calculation of HRW, and so HRW proves it can provide additional elements useful for the forecasting.



# NWC/GEO Winds: HRW

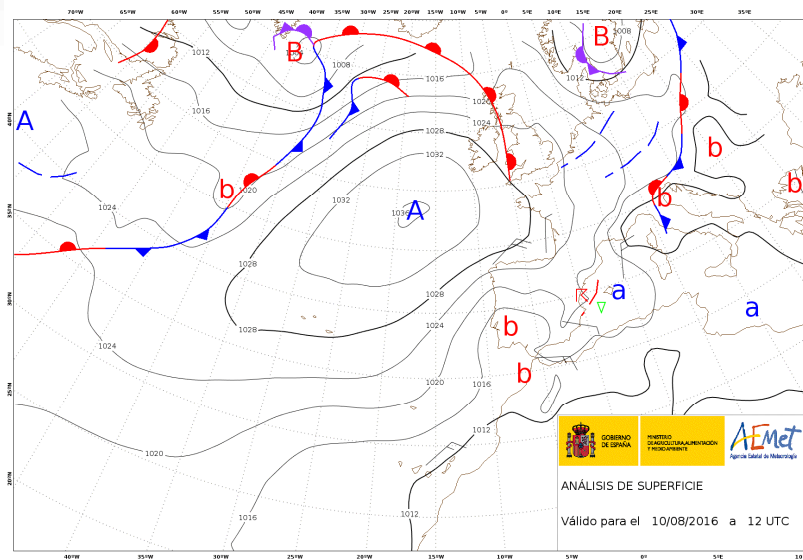


For verification,  
two ground wind observations were detected,  
with wind gusts > 140 km/h.

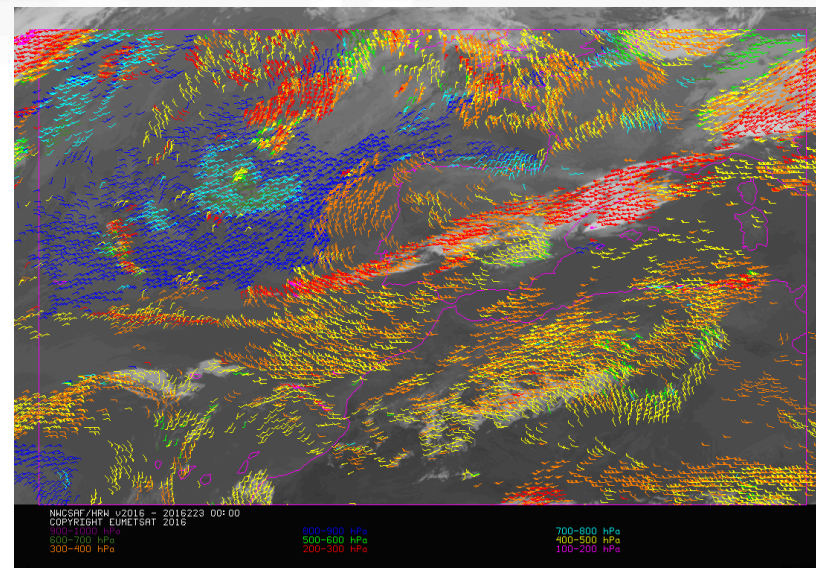
A later analysis using  
Doppler Radar data verified areas with  
winds at 10 m. > 150 km/h and > 200 km/h  
in the affected region at 04:30Z, 23 December



# NWC/GEO Winds: HRW



©AEMET. Autorizado el uso de la información y su reproducción citando a AEMET como autora de la misma



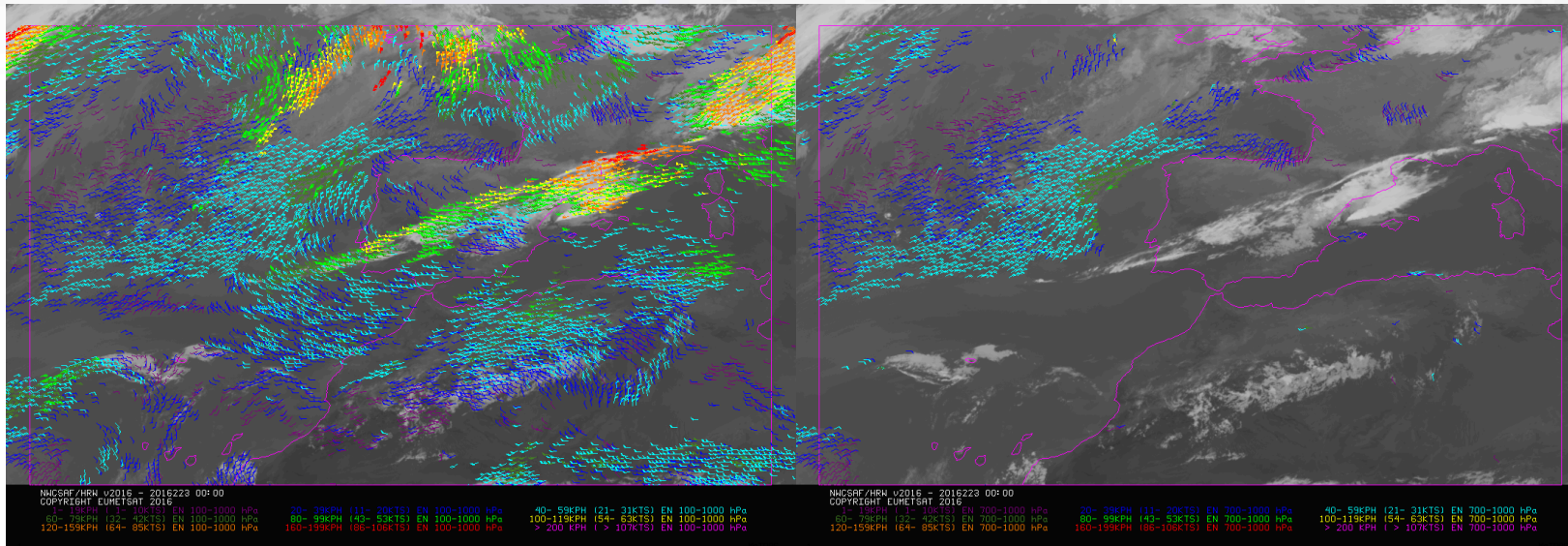
**Example 2, about use in a “normal” situation:**

**10th August 2016, with a High pressure** in the SW of Ireland,  
and **a Termic low** in the SW of Spain.

Considering the wind, a “moderate gale warning” was raised  
in the NW and NE corners of Spain and in the Strait of Gibraltar.



# NWC/GEO Winds: HRW



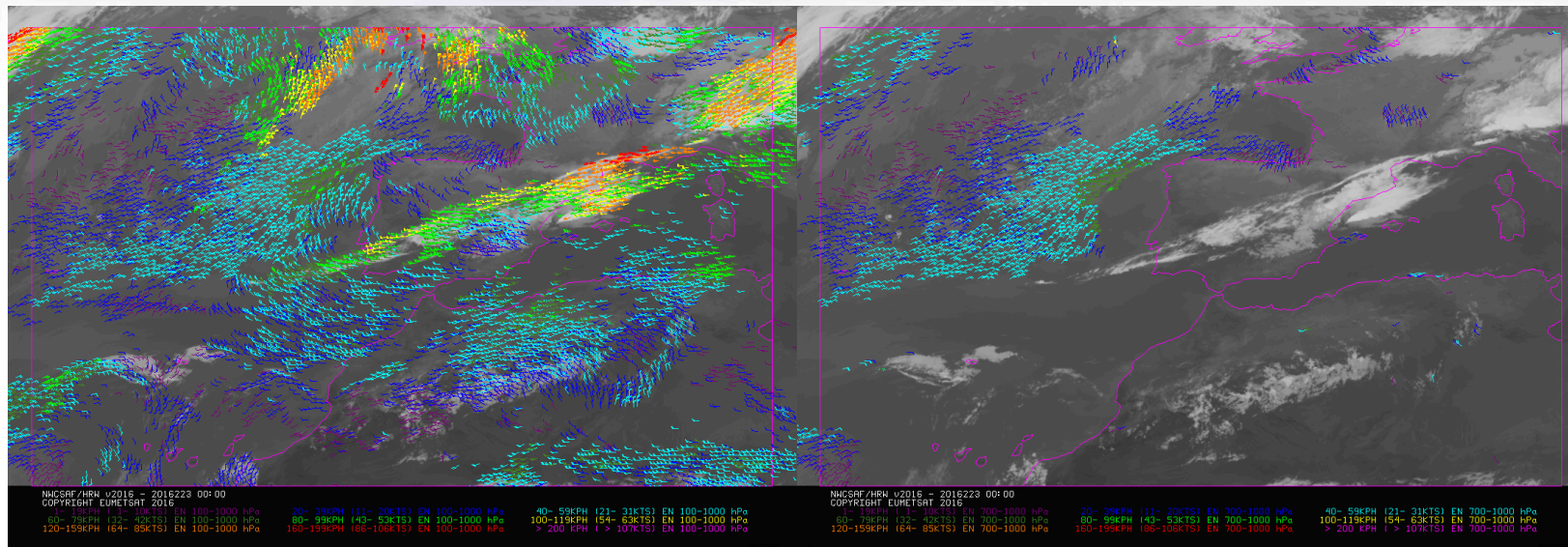
HRW AMVs every hour of 10th August 2016, at all levels (left) and at low levels (right)

**HRW product** is able to identify at low levels:

- “Strong gale” NE winds in the NW coast, extending the need of warning to a longer period and a higher level of warning.
- “Moderate gale” NW winds in the NE coast, extending the need of warning to a wider area.
- Nevertheless, few AMVs in the Strait of Gibraltar avoid the option to confirm the winds there (verified by “gale wind” ground observations in Tangiers).



# NWC/GEO Winds: HRW



HRW AMVs every hour of 10th August 2016, at all levels (left) and at low levels (right)

**HRW product** is also able to identify:

- Some AMVs at low levels in the Mediterranean Sea and the Iberian Peninsula, useful for the forecast of convergencies and convection:
  - > A clear wind shear (low level E winds; medium/high level W winds).
  - > A clear contribution of moisture from the sea in the Mediterranean Coast.
- E/SE winds at all levels from Africa, confirming the high temperature forecast in the Canaries.
  - > Verified by 38°C to 40°C observations between 11Z and 15Z.



# NWC/GEO Extrapolation: EXIM

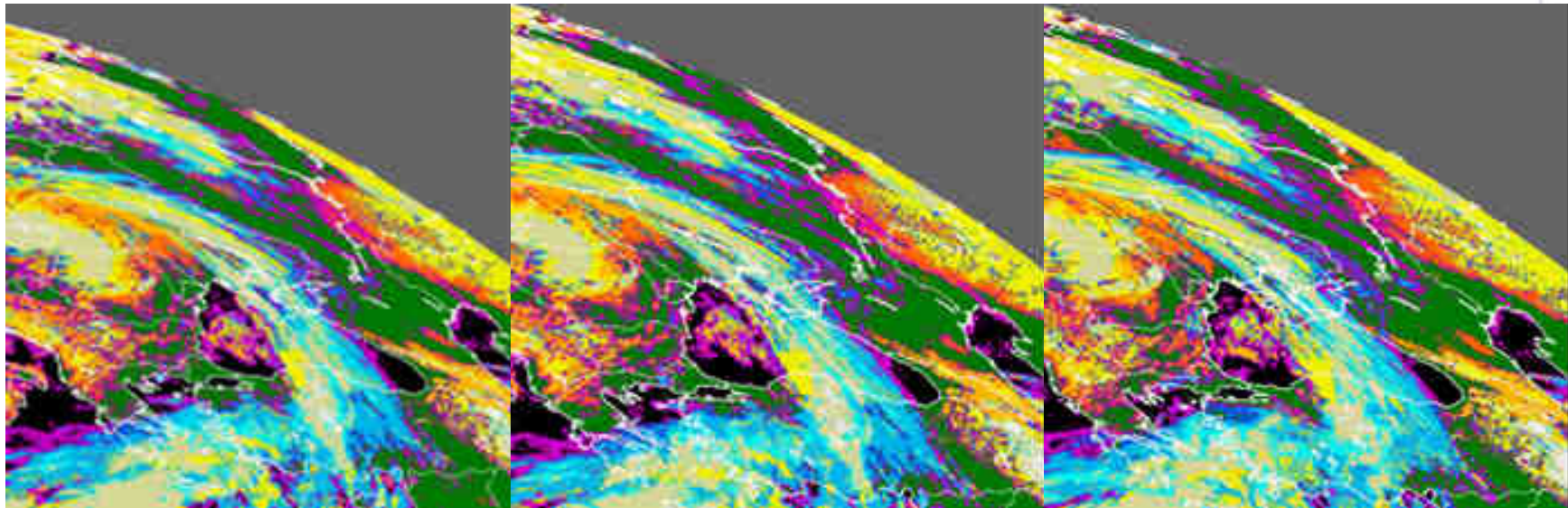
**EXIM – Extrapolated Imagery** provides **kinematic extrapolation up to 1 hour** of satellite images and NWCSAF Cloud & Precipitation products.

Example of NWCSAF/Cloud Type EXIM output with MSG-4 over the Black Sea:

Observation 21/May/2019 09:00Z

Extrapolation for 10:00Z

Observation for 10:00Z





# NWC/GEO Software installation



- In case of interest to use NWC SAF software packages:
  - + All National Meteorological Services within Eumetsat Member/Cooperating States are automatically **considered potential users**.
  - + All other Organisations may also apply to become user of NWC SAF Software.
- All applicants have become NWC SAF users (without restriction up to now!), with:
  - ~ 100 Institutions from all around the world (Europe, Africa, Americas, Asia,...)
  - All types of institutions:
    - National Meteorological Services
    - Research institutions
    - Public and private companies
    - Universities
    - Public service providers



# NWC/GEO Software installation



- **Software Delivery is authorized** to users **through their Licence Agreement**, to be signed by EUMETSAT (represented by AEMET) and the applicant User.
- **Once the Licence Agreement is signed**, **Access Credentials to the NWC SAF Help Desk Restricted Area are provided**, where **the NWC SAF software package can be downloaded**:  

[nwc-saf.eumetsat.int](http://nwc-saf.eumetsat.int)
- **The installation takes then only 3 steps**, which need less than **ONE HOUR** to be ready:
  - + **Download and decompress the software files**  
(2 different software tar files + 1 Auxiliary dataset for each satellite used).
  - + **Define a few variables in the “.profile file” and activate them.**
  - + **Run two installation commands**

**Nothing else is needed. All software/libraries/products/additional elements to run  
NWC SAF GEO software package  
are installed and ready to run with this!**



# NWC/GEO Software installation

- **Hardware resources** needed to run NWC/GEO Software package are **small and relatively easy to obtain, under several possible environments:**

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

	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 gcc; g++; gfortran	GCC compilers 7.3.0 gcc; g++; gfortran
ezio	ezio 1.3.12	ezio 1.6
make	GNU Make 3.81	GNU Make 4.1

- **Other environments like SUSE and Debian** are not officially supported, but **some NWC SAF users have also tested them successfully.**



# NWC/GEO Software installation

- A “Task Manager” tool is defined inside the Software package to run the needed products in real time or under a programmed schedule.
- The user simply has to define in the corresponding configuration files:
  - The products and tasks to be run
  - The satellite and region to be considered
  - The configuration of each productand provide the Satellite and NWP data in the corresponding directories.
- Then the Task Manager is started with a simple command:  
**SAFNWCTM safnwc.cfs**

The “Task Manager” then runs each product for each slot after the reception of the corresponding Satellite image files



# Conclusions

**NWC/GEO software has proved to be useful for many applications**

**(case studies, specific use of the products, etc.)**

**in NMSs, SAFs, public and private institutions,...**

**Registering as NWCSAF users and downloading the software is so suggested.**

**For any additional doubt/question on**

- **NWC SAF and NWC/GEO software package,**
- **How to get it and install it,**
- **How to run and visualize its products,**

**do please contact me today afterwards.**

**More information and feedback is also welcome at:**

- **Through the NWC SAF website:**
- **Through the email address:**

**[nwc-saf.eumetsat.int](http://nwc-saf.eumetsat.int)**  
**[safnwchd@aemet.es](mailto:safnwchd@aemet.es)**