The Nowcasting SAF (NWC SAF): Examples of operational use of its geostationary products in nowcasting tasks

4th May 2017

European Nowcasting Conference 2017

Deutches Wetterdienst, Offenbach, Germany

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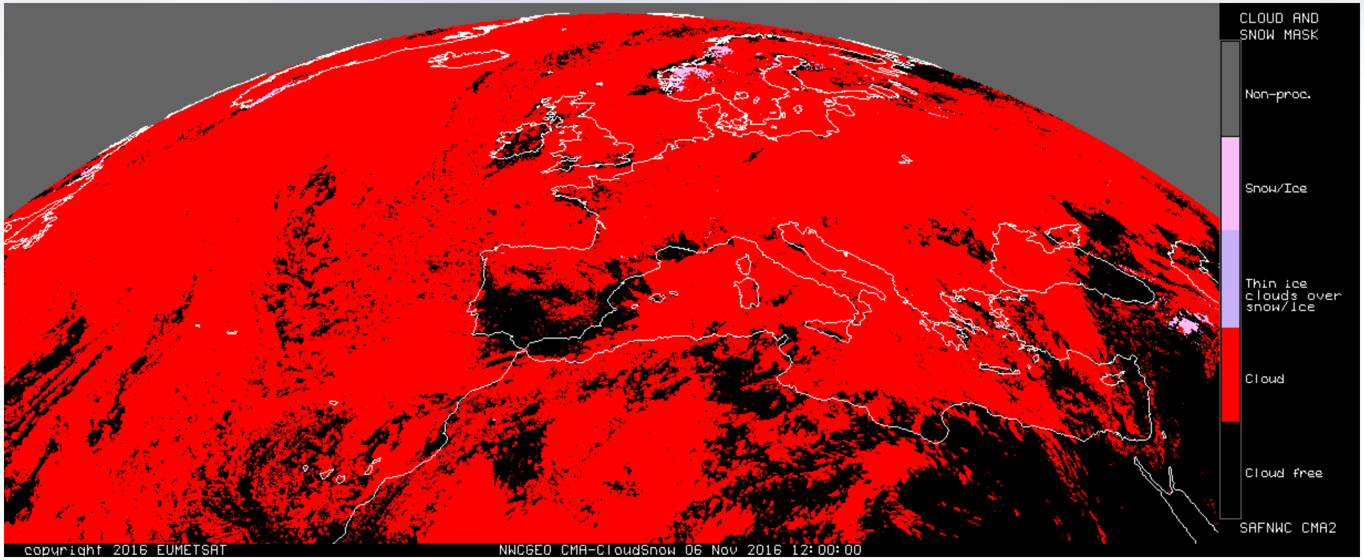
NWC/GEO Clouds: CMa

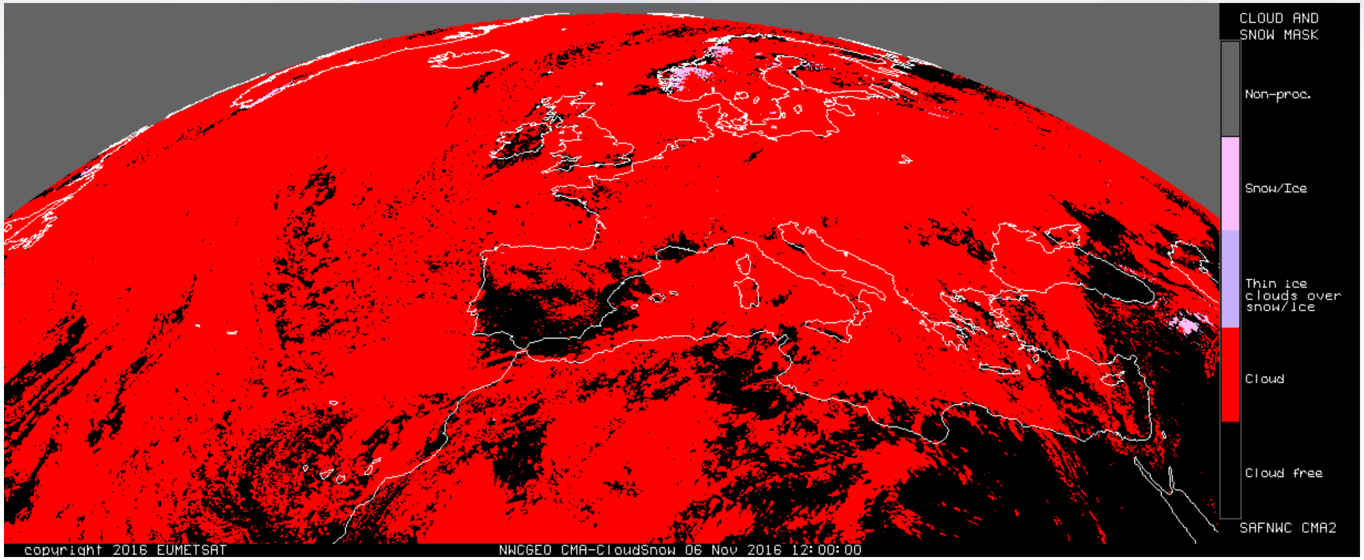


CMa – Cloud Mask

- **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.

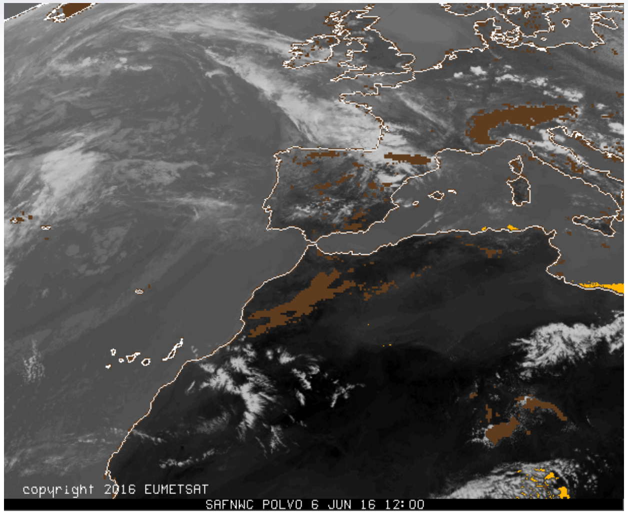
NWC/GEO Clouds: CMa



CMa – Cloud Mask

- CMa (also CT, CTTH) product has day and night algorithms, which can cause significant output changes in the moment of twilight.
- "Low clouds" sometimes undetected during day over land/sea with bad illumination. Also undetected during night over land, in warm sectors or with high satellite angles.
- "Snow" undetected during night.

NWC/GEO Clouds: CMa



"Dust cloud" Flag

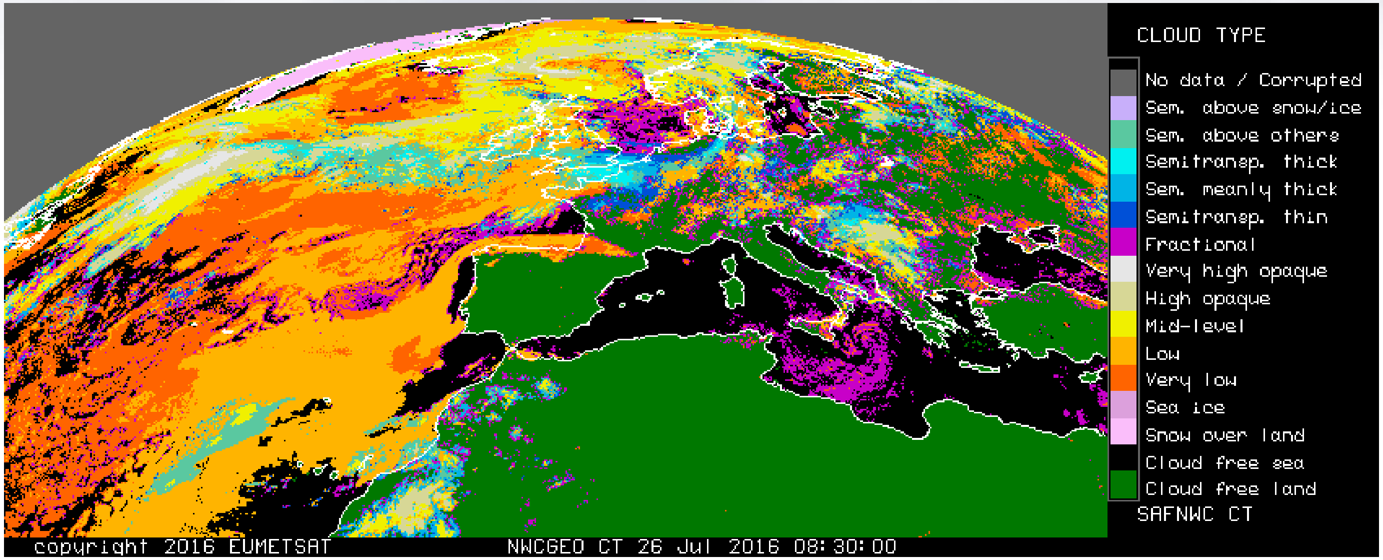
"Volcanic ash" Flag

Undefined Flags

CMa – Cloud Mask: "Dust cloud" and "Volcanic Ash" Flags

- "Dust cloud" and "Volcanic ash" Flags available except at twilight.
- Fine dust clouds not detected well.
- Sometimes wrong detections of Volcanic ash,
  over desert or over low clouds during the day, over cold clouds during night.

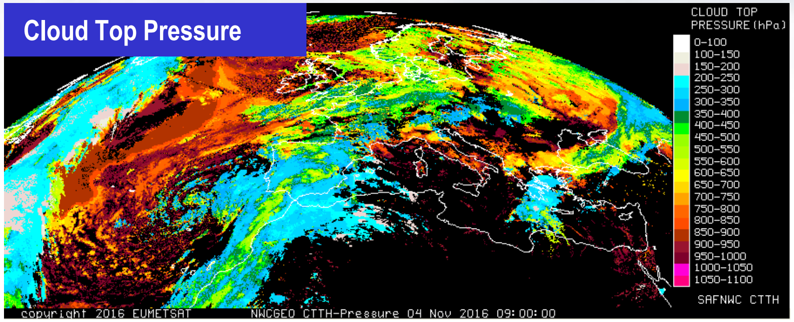
NWC/GEO Clouds: CT

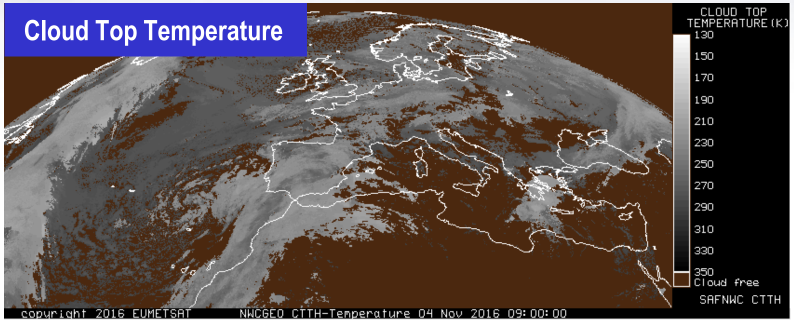


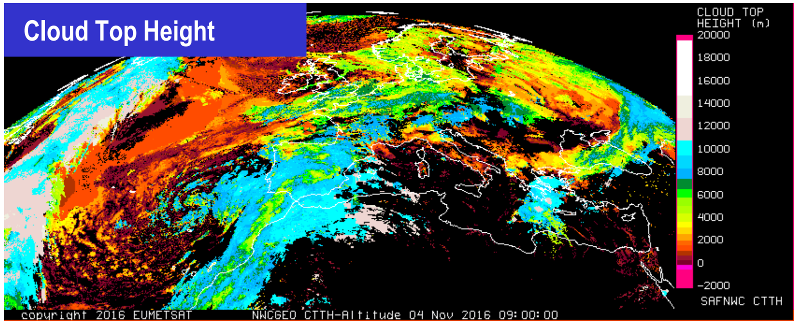
CT – Cloud type

- Cloud classification based on the "cloud top": "Cb" classified as "high opaque cloud".
- "Low clouds" with strong inversion can be wrongly classified as "Mid level clouds".
- "Very thin semitransparent clouds" can be wrongly classified as "Fractional clouds" frequently.
- "Semitransparent clouds" together with "Low clouds" can be wrongly classified as "Mid level clouds".

NWC/GEO Clouds: CTTH



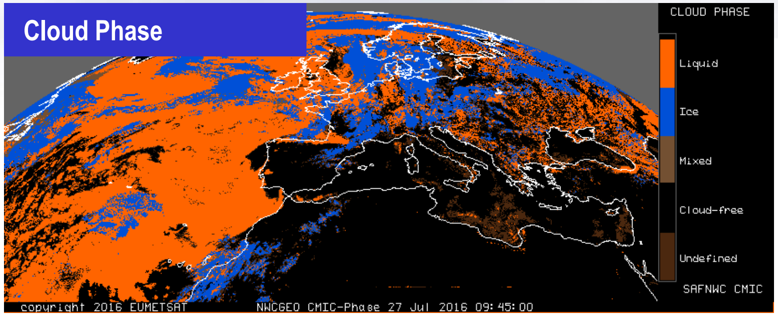


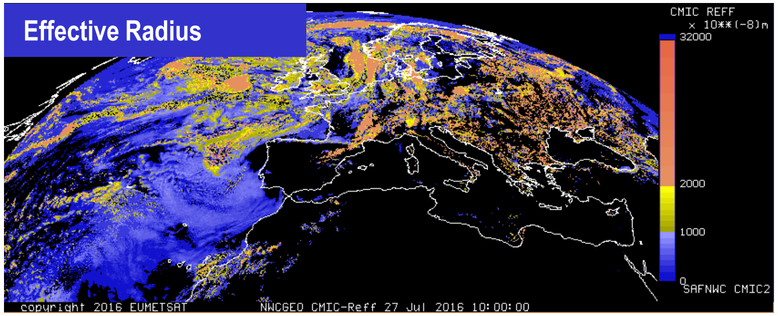


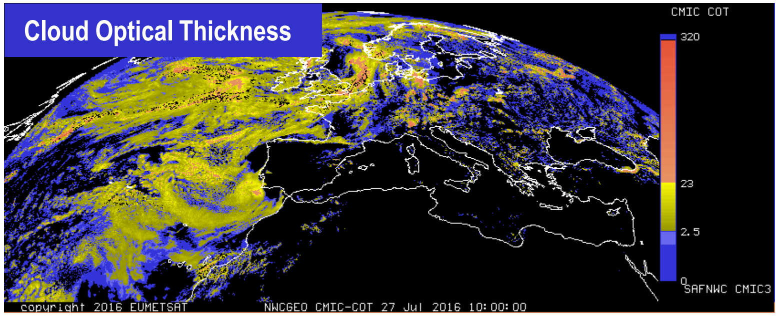
CTTH - Cloud Top Pressure, Temperature and Height

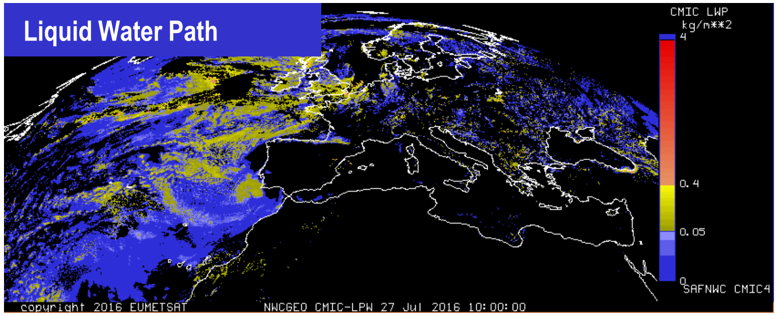
- **“Fractional clouds” have no CTTH product outputs.**

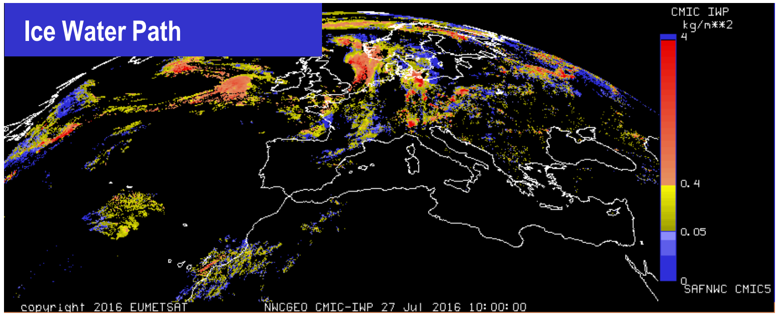
NWC/GEO Clouds: CMIC











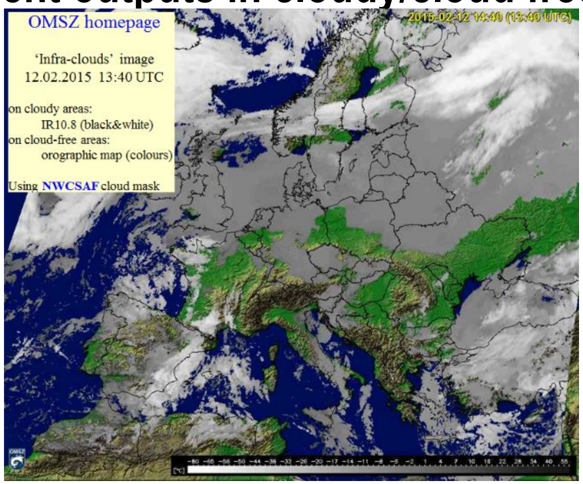
CMIC - Cloud Microphysics

- **"Fractional clouds" have no CMIC product outputs.**
- **Only "Cloud phase" parameter available for night, twilight, and mixed/undefined phase.**

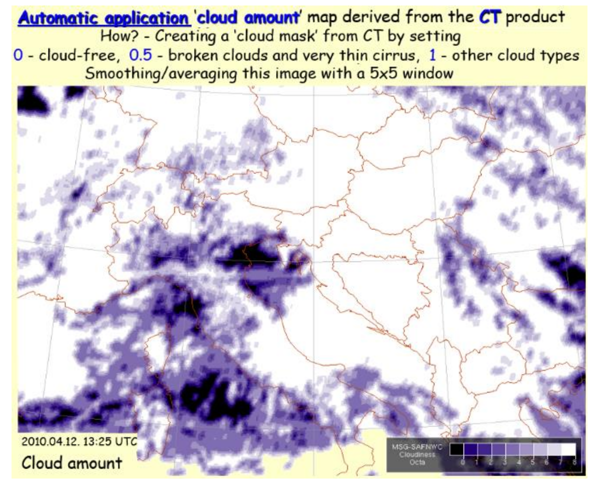
NWC/GEO Clouds

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.

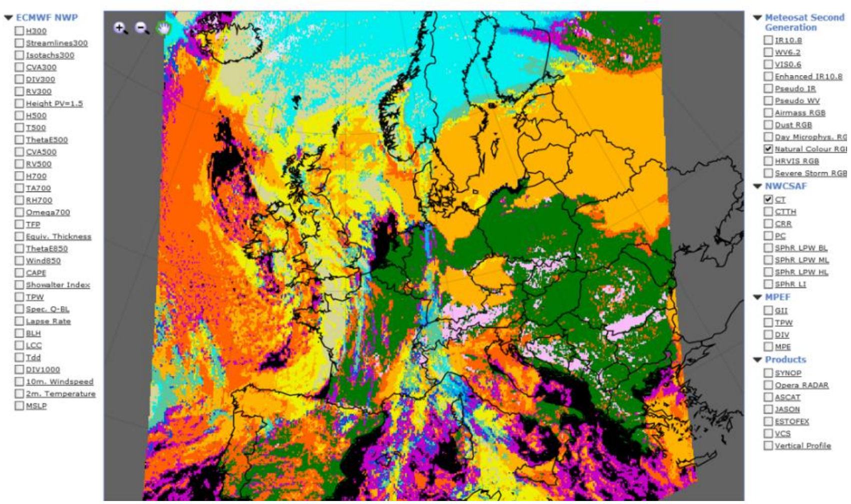
4. **Use of "Cloud top height" and "Cloud phase" in aviation** applications, including <u>icing forecast</u>.

NWC/GEO Clouds

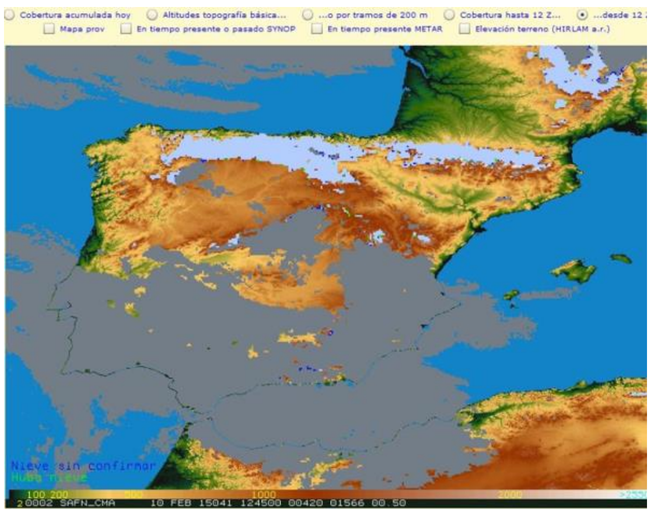
Cloud products are in spite of limitations **among the most reliable NWC/GEO products**, and have been **used in NMSs, SAFs, other users for many operational applications**:

5. Use of **"Cloud type & CTTH" (with visibility + wind + RH)** for "<u>Warning of fog areas</u>".

6. Use in **Eumetrain tool ePort** (http://eumetrain.org/eport.html) together with other Forecasting tools:

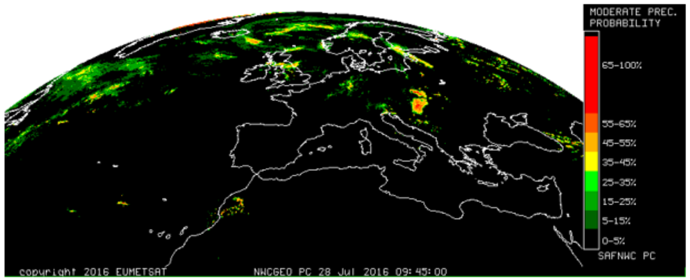


7. Use of **"Cloud mask"** for "<u>Snow maps</u>".

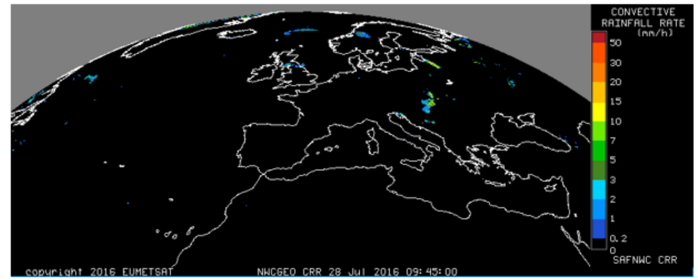


NWC/GEO Precipitation

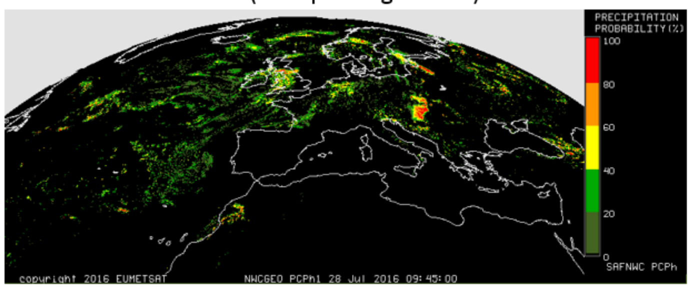
Considering **the four Precipitation products in NWC/GEO software**:



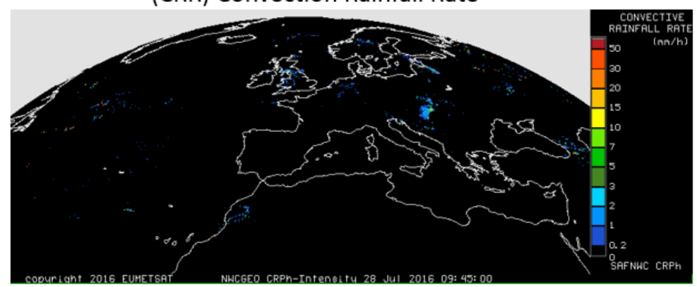
PC (Precipitating Clouds)



(CRR) Convection Rainfall Rate



PCPh (Probability of Precipitation based on Cloud Physical Properties)



CRPh (Convective Rainfall Rate based on Cloud Physical Properties)

PCPh/CRPh based on Cloud Microphysics: better products, but only available during day.

CRR/CRPh provide "instant precipitation values" and "hourly precipitation values", which are only suitable for convective situations.

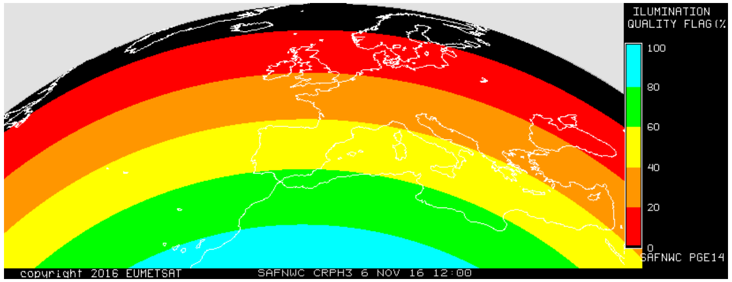
PC/PCPh provide values for all kinds of precipitation, although they also work better for convective precipitation.

NWC/GEO Precipitation

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

1. Use always radar data,
   <u>if they are available</u> 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) during day, taking into account:
   - CRPh would be used to forecast where convection is taking place.
   - The quality of the products reduces:
     * when the pixels are snowy and
     * when the sun/satellite angle is low
       (the "Illumination Quality Flag"
       provides this information).



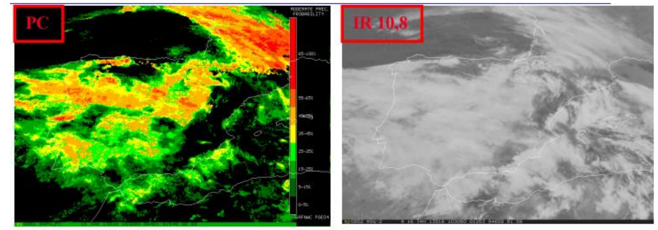
NWC/GEO Precipitation

➔ **When these products are not available (f.ex. night), PC/CRR would be used, taking into account:**

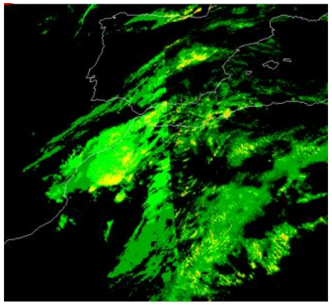
- PC does not detect well precipitation related to low clouds.

- CRR overestimates precipitation area and subestimates precipitation intensity (aspect more similar to “cloud tops” due to dependence on IR temperature).

- A daytime/nighttime algorithm difference exists, observable at sunrise/sunset.



PC & IR108
16 January 2013 at 10:30Z

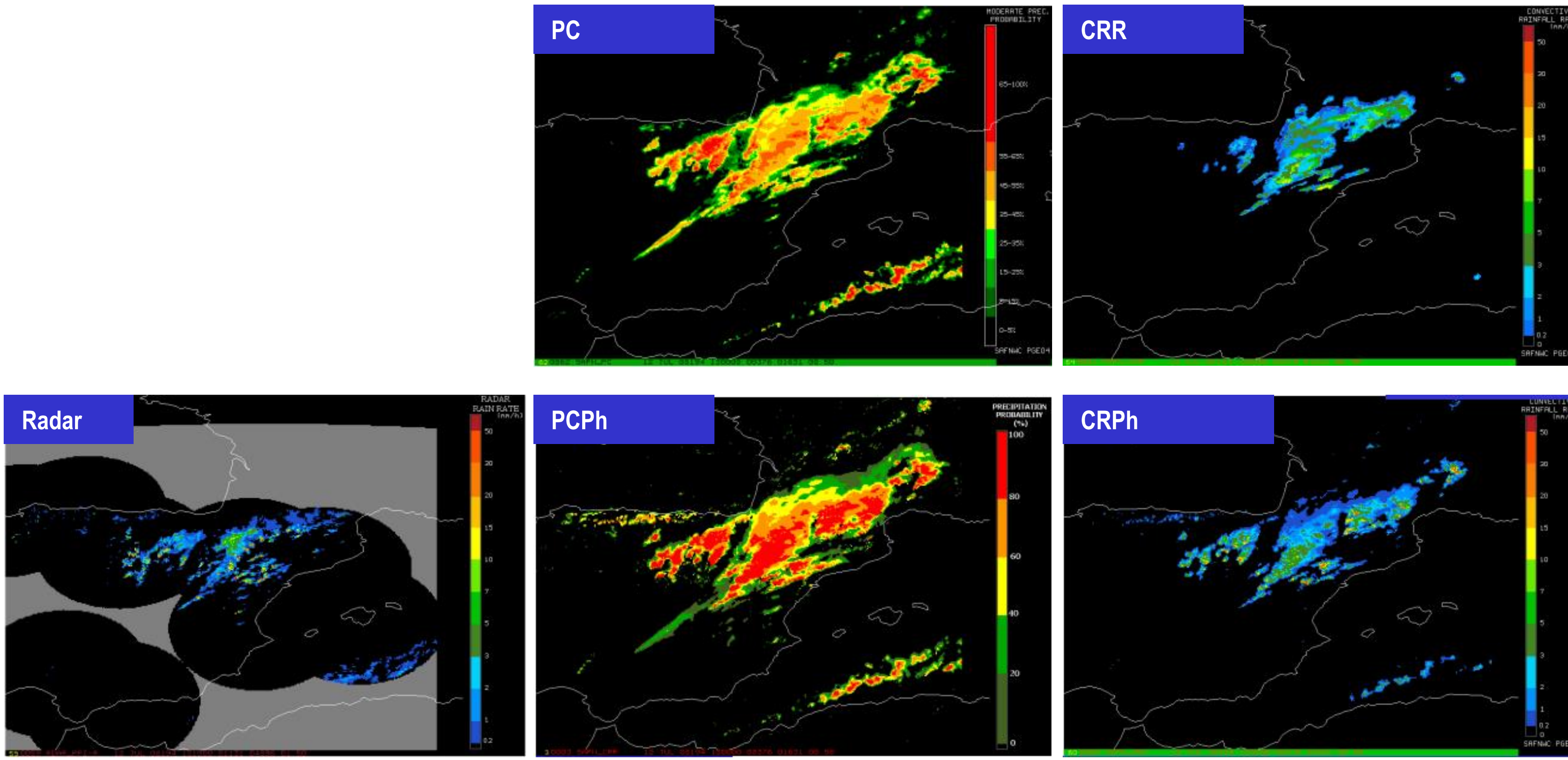


PC, 12 April 2012 at 06:30Z

NWC/GEO Precipitation

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

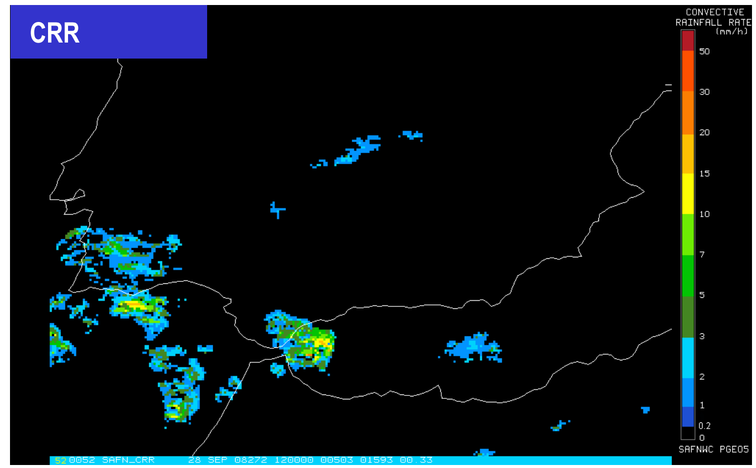
➔ **Example 1 for 12 July 2008 at 13:00Z in the Iberian Peninsula:**

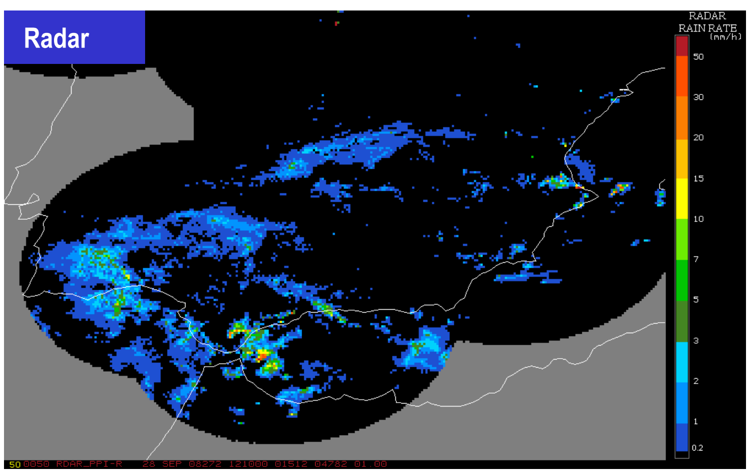


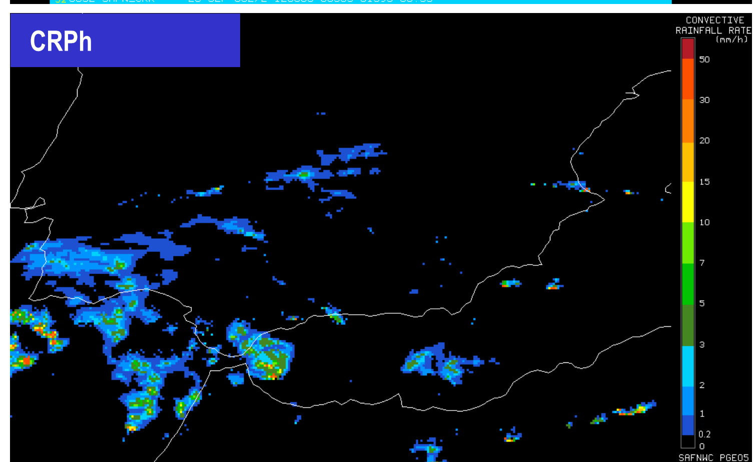
NWC/GEO Precipitation

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:





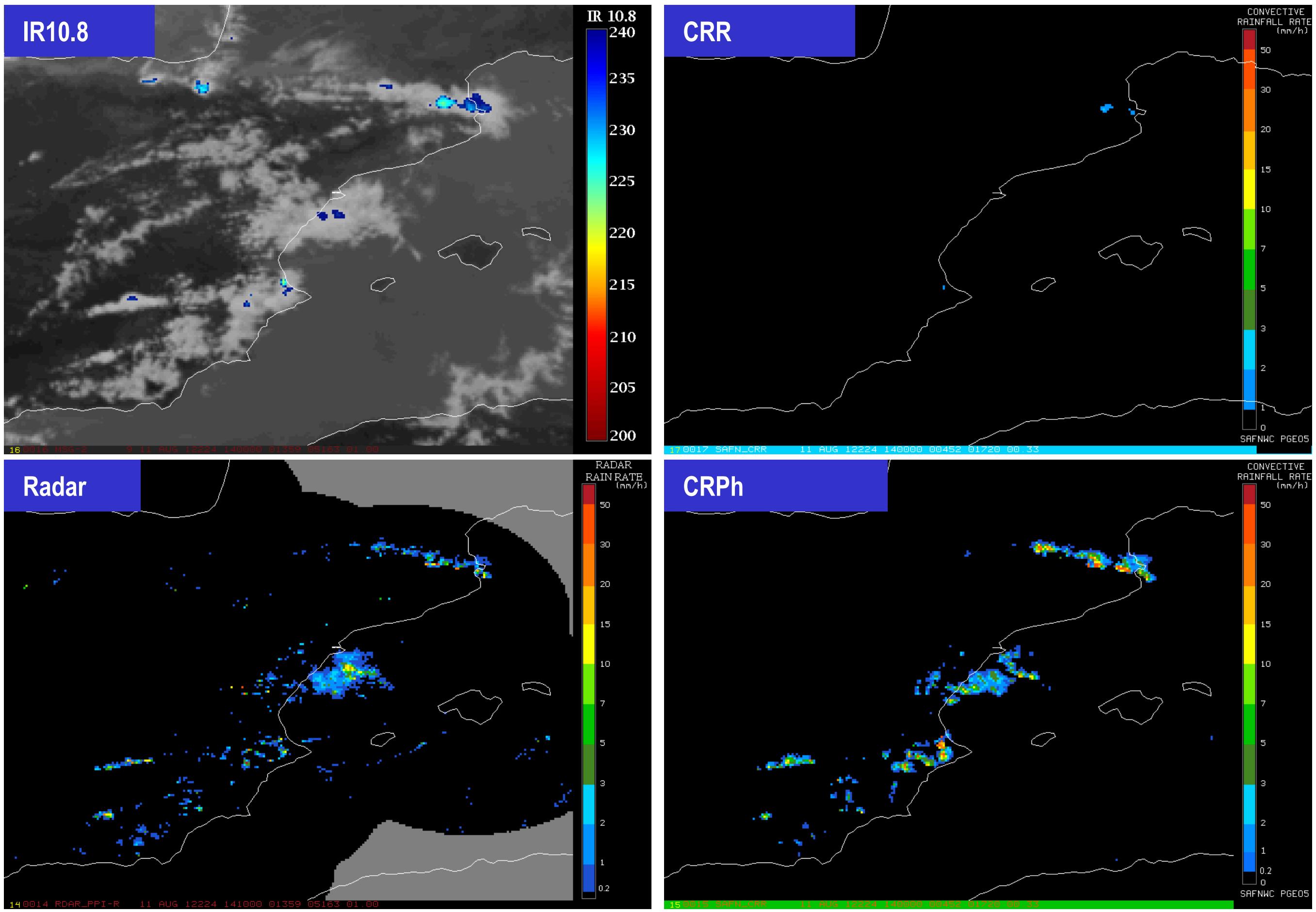


NWC/GEO Precipitation

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

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

- <u>CRPh works much better than CRR when cloud tops are warm</u>.

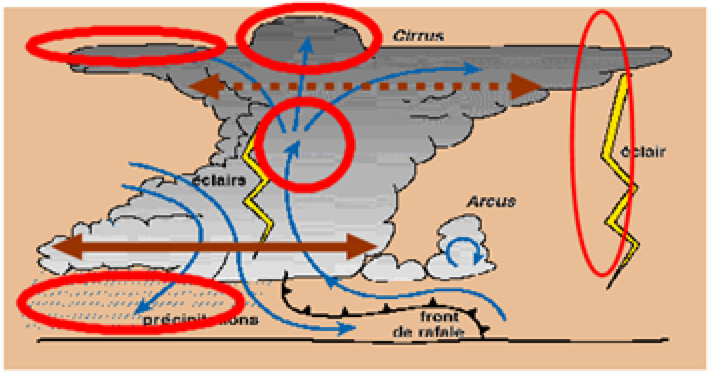


NWC/GEO Convection

Considering RDT - Rapid Developing Thunderstorms:

Each "Convection cell" identified with its specific characteristics:

Multilevel Description Of Convection



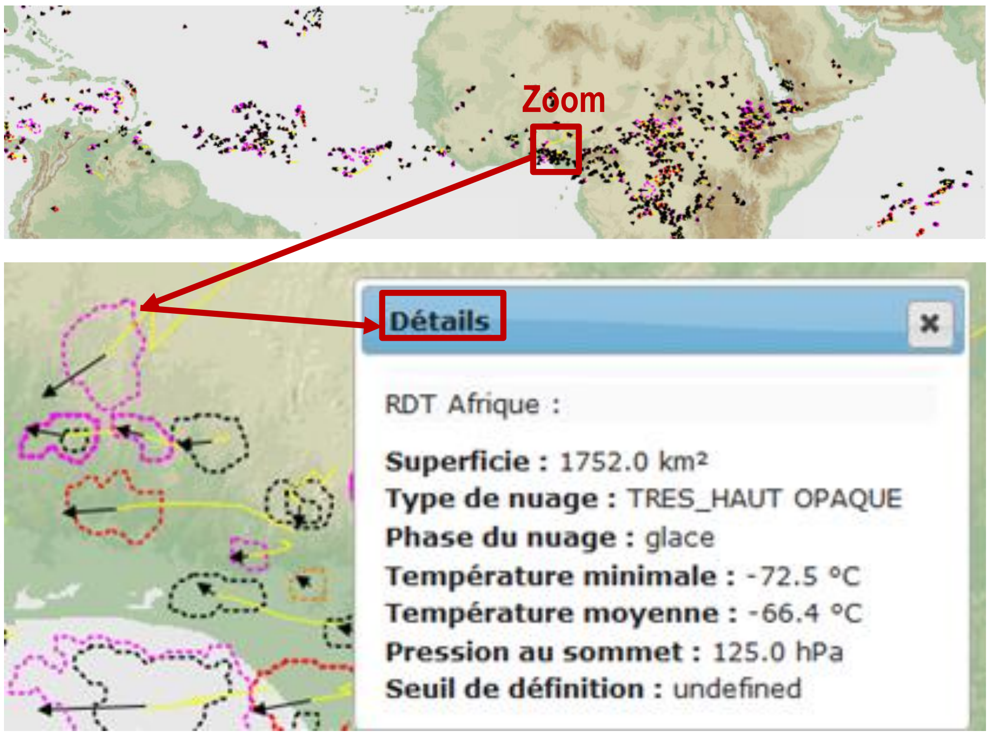
YES/NO Convection + Attributes of cells

- Position
- Surface
- T
- Gap to tropopause
- Cloud type and phase
- Cloud top pressure
- Lightning Activity
- Overshooting Tops
- Rainfall Activity
- Convective Index
- Severity Index
- Displacement
- Relevant trends (T, area)

NWC/GEO Convection

AEMet Agencia Estatal de Meteorología
EUMETSAT NWC SAF SUPPORT TO NOWCASTING AND VERY SHORT RANGE FORECASTING

➔ **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 MSG, Himawari-8)



Base de la tour *(T° variable selon morphologie)*

Phase de développement	*Couleur*
Naissance ou développement	
Croissance	
Issu d'une Fission	
Maturité	
Décroissance	

Activité électrique	*Style de trait*
Impacts ou intra-nuage appariés 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 *(Tmin+6°)*
couleur, épaisseur, style uniques

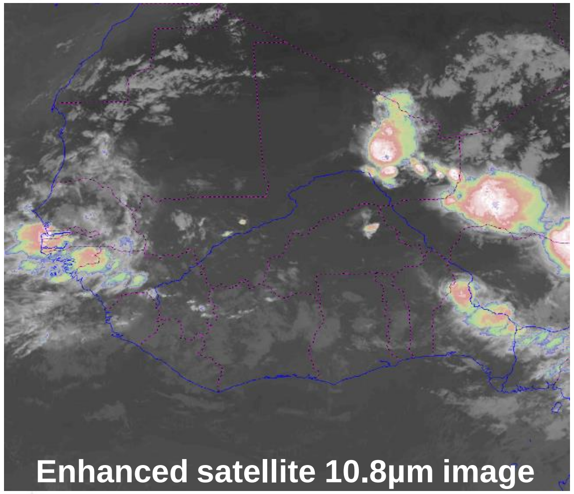
Trajectoire des centres de gravité des cellules
couleur, épaisseur, style uniques

Déplacement
flèche noire
longueur modulée selon vitesse

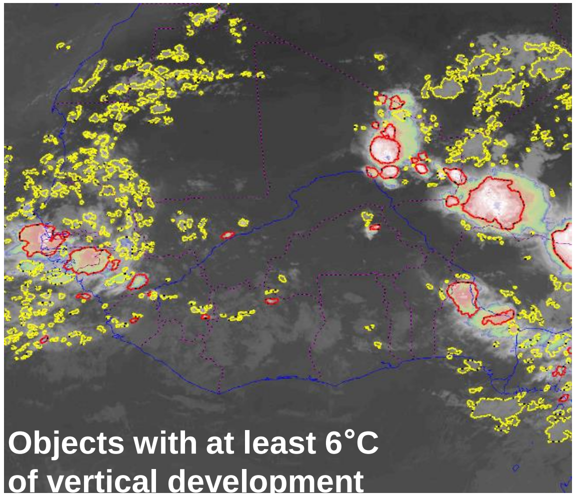
NWC/GEO Convection

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

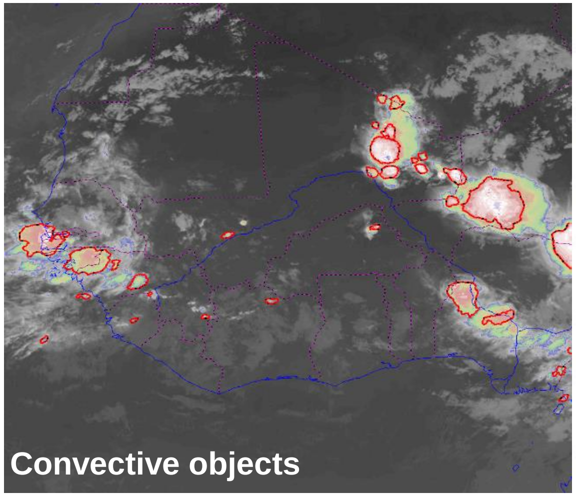
Example 1: Aeronautical users.



Enhanced satellite 10.8µm image

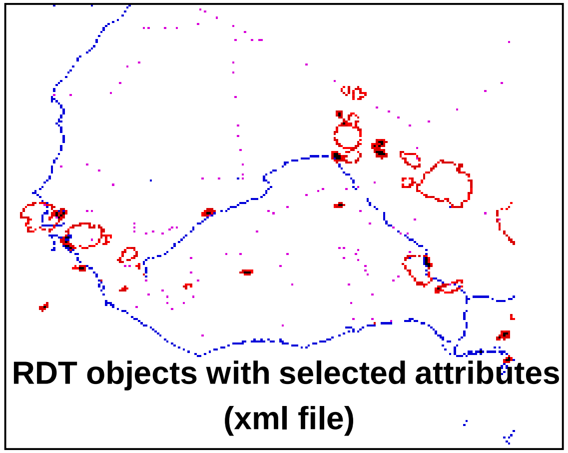


Objects with at least 6°C of vertical development



Convective objects

RDT process



RDT objects with selected attributes (xml file)

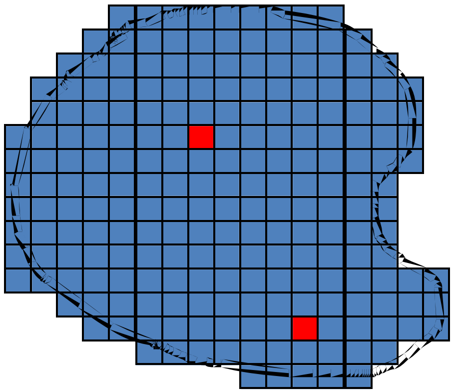
UPLINK

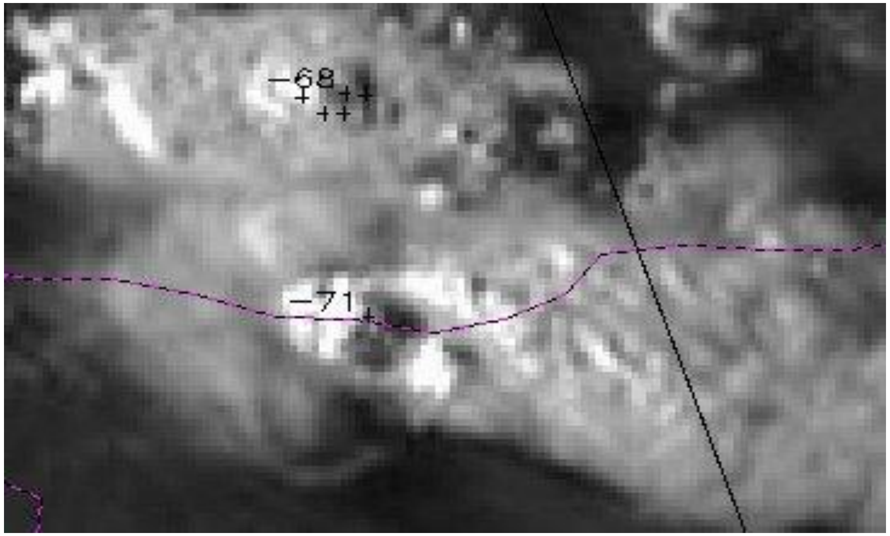
Courtesy Honeywell / Atmosphere

NWC/GEO Convection

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

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

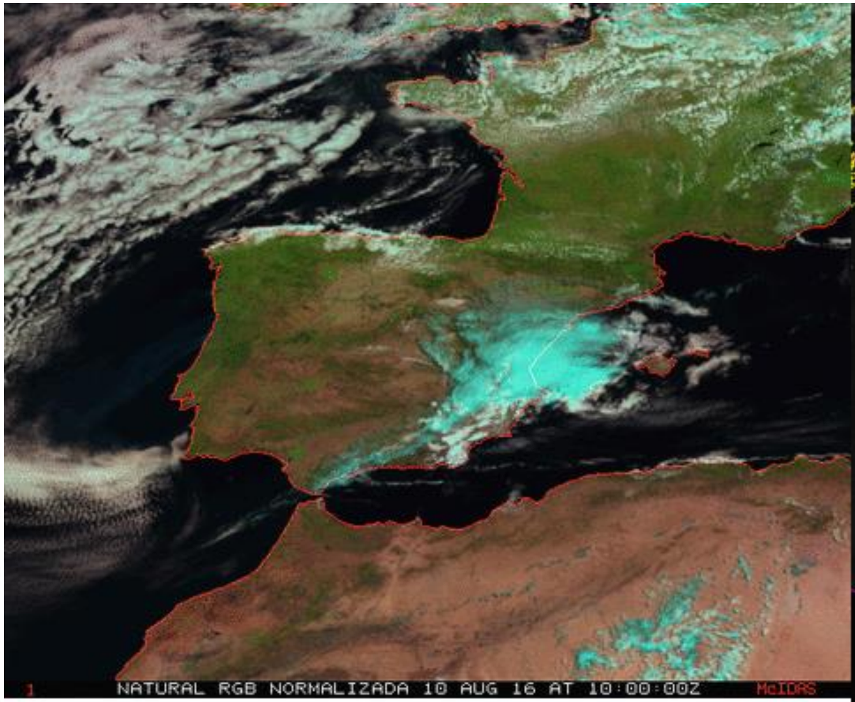




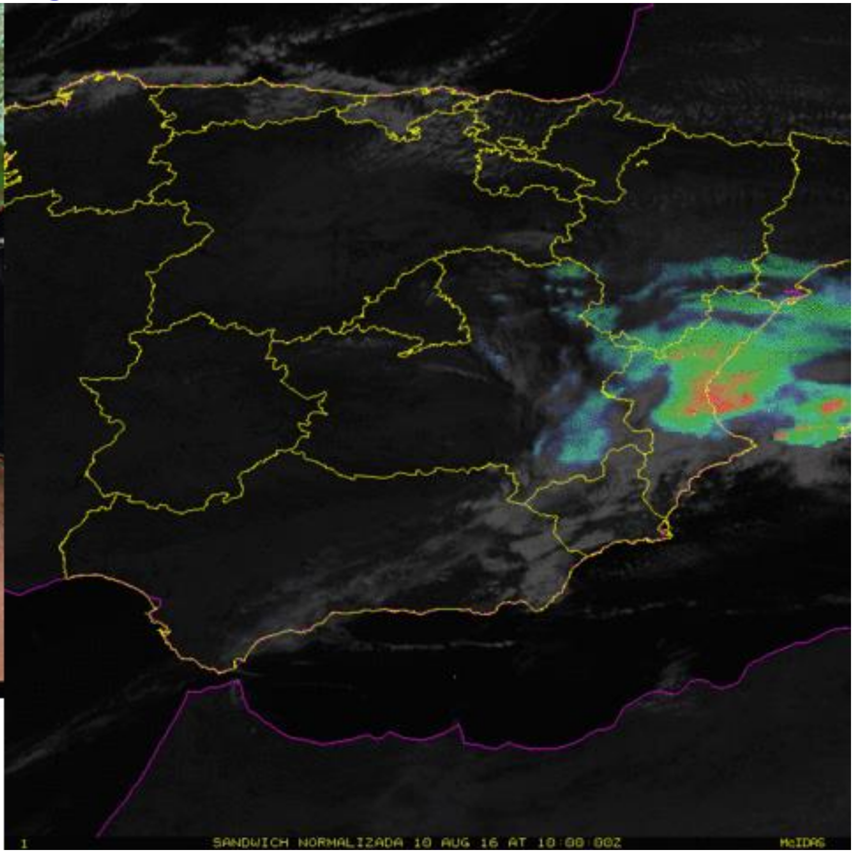
NWC/GEO Clear Air: iSHAI

For the use of iSHAI – Satellite Humidity and Instability product,
an example for 10 August 2016 in the Iberian Peninsula is going to be shown.

"Normalized natural RGB" and "Sandwich image" shown first for introduction



2016/08/10 10:00Z



NWC/GEO Clear Air: iSHAI

All iSHAI product outputs for 10th August 2016:

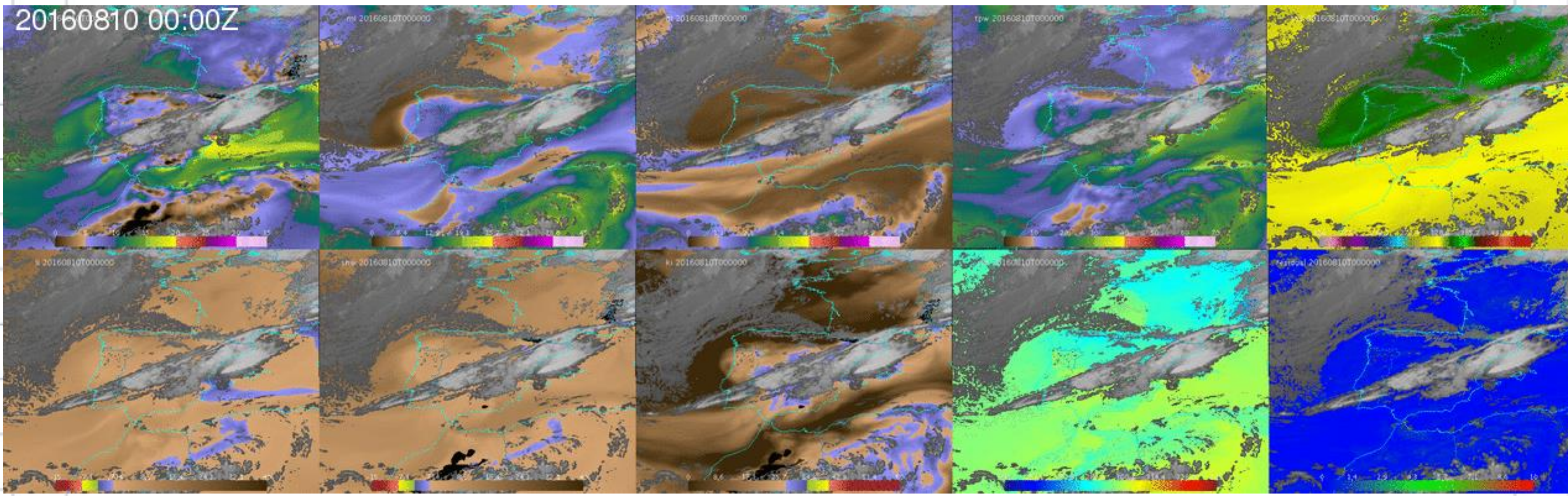
BL
Precipitable Water in Boundary Layer (P_{sfc}- 850hPa)

ML
Precipitable Water in Middle Layer (850-500 hPa)

HL
Precipitable Water in High Layer (500-0.1 hPa)

TPW
Total Precipitable Water in Middle Layer (P_{sfc}- 0.1 hPa)

TOZ
Total Ozone (P_{sfc}-0.0 hPa)



LI
Lifted Index

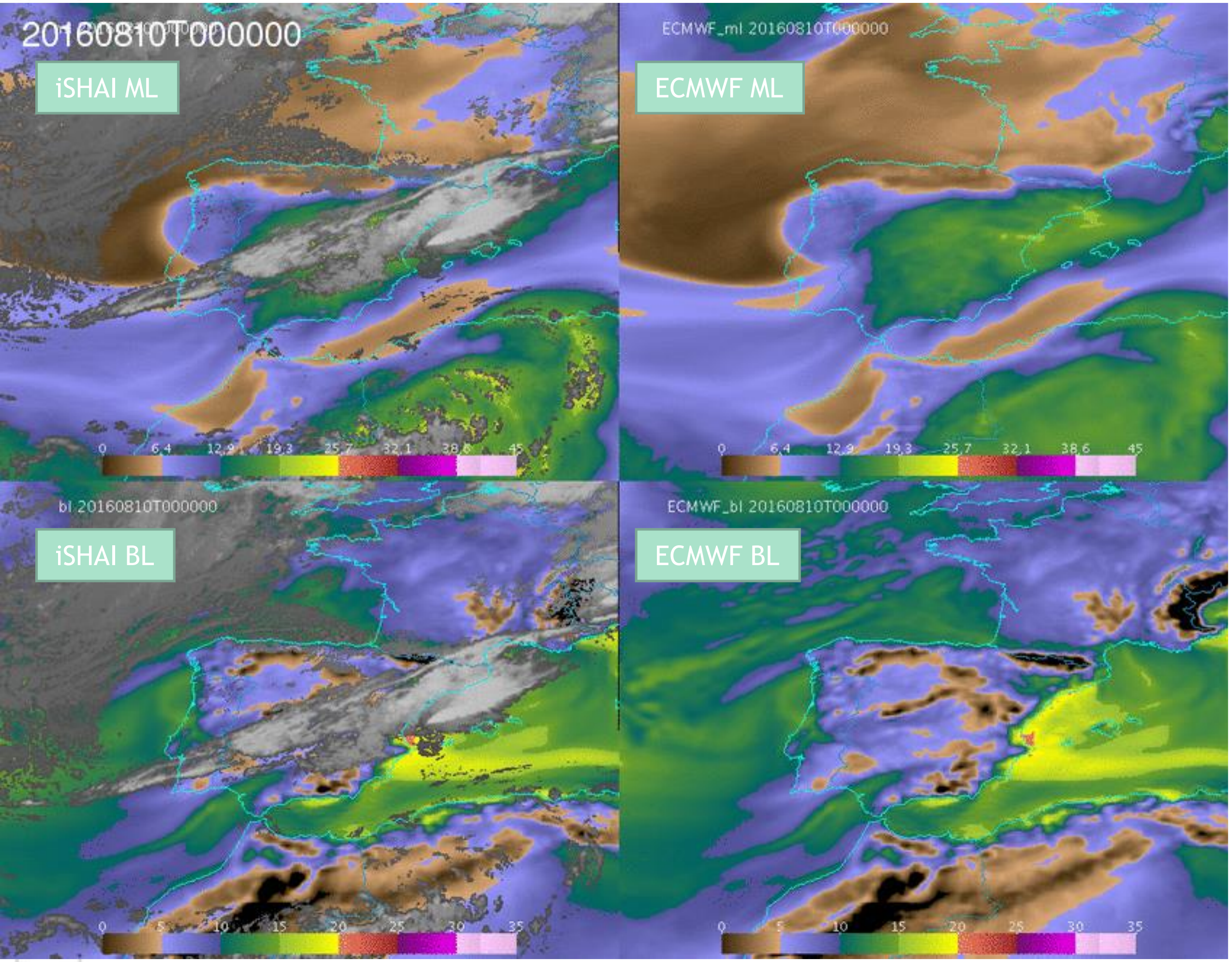
SHW
Showalter Index

KI
K-Index

SKT
Skin Temperature

Residual
Square root of sum (BT_{seviri} -BT_{rttov})

NWC/GEO Clear Air: iSHAI



A **visual comparison between iSHAI and NWP model outputs** can be <u>useful for detection of new elements for the forecast</u> (or for verification of the NWP forecast)

NWC/GEO Clear Air: iSHAI

Difference fields between iSHAI products and the NWP model will normally work much better for visualization of elements for the forecast not detected by the NWP model

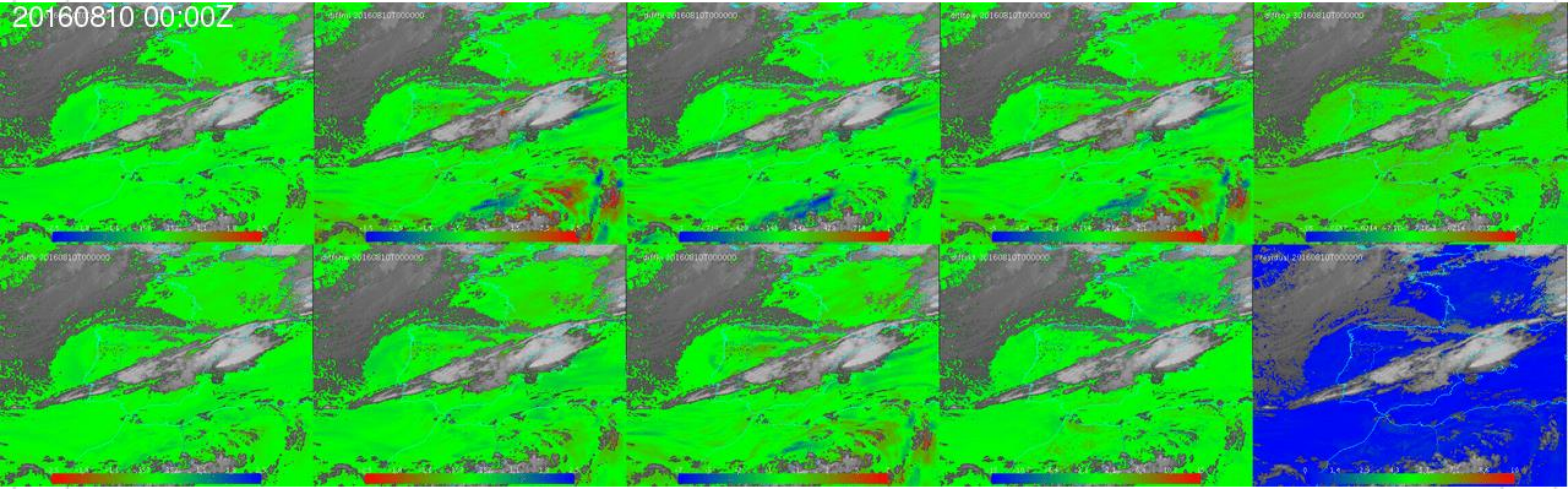
diffBL
Precipitable Water in Boundary Layer (P_{sfc}- 850hPa)

diffML
Precipitable Water in Middle Layer (850-500 hPa)

diffHL
Precipitable Water in High Layer (500-0.1 hPa)

diffTPW
Total Precipitable Water in Middle Layer (P_{sfc}- 0.1 hPa)

diffTOZ
Total Ozone (P_{sfc}-0.0 hPa)



diffLI
Lifted Index

diffSHW
Showalter Index

diffKI
K-Index

diffSKT
Skin Temperature

Residual
Square root of sum (BT_{seviri} -BT_{rttov})

See example of detection of NWP disagreements in Martinez 2013:
http://www.eumetsat.int/website/wcm/idc/idcplg?IdcService=GET_FILE&dDocName=PDF_CONF_P_S3_04_MARTINEZ_V&RevisionSelectionMethod=LatestReleased&Rendition=Web

NWC/GEO Clear Air: iSHAI

As an optional output, the **retrieved temperature and humidity profiles at 54 RTTOV levels can be used as an additional output** (configurable).

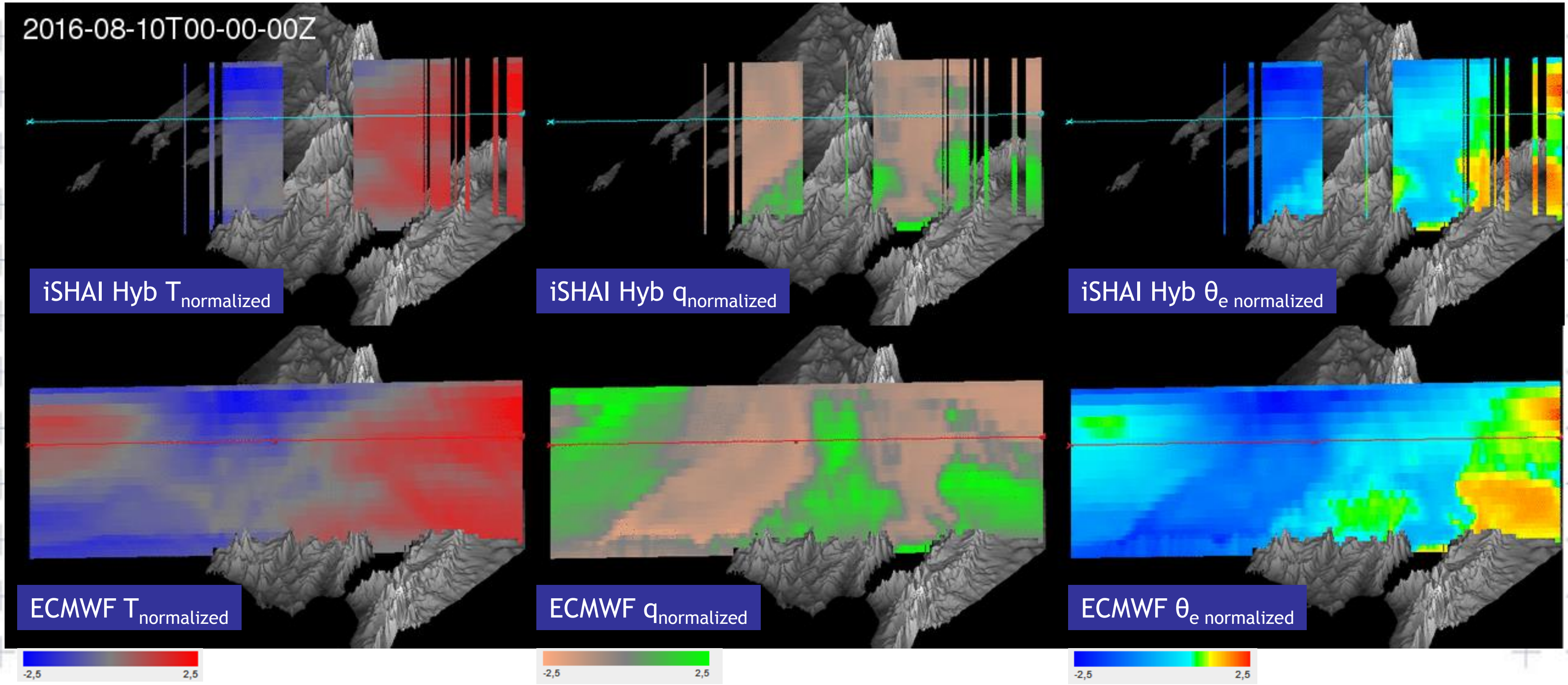
➔ These profiles can be used operationally, using for example IDV or McIDAS-V.

MCIDAS-V	http://www.ssec.wisc.edu/mcidas/software/v/
IDV	http://www.unidata.ucar.edu/software/idv/

➔ This option is supported in a best effort basis. Questions to mmartinezr@aemet.es

NWC/GEO Clear Air: iSHAI

Comparison of Normalized 3D vertical cross sections of iSHAI profiles and NWP model profiles,
can then be very useful for the forecast.



NWC/GEO Winds: HRW

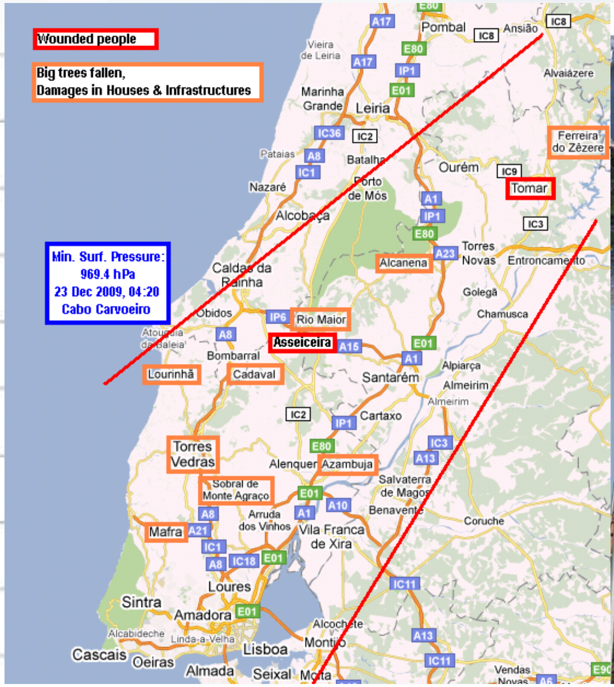
HRW – High Resolution Winds calculates
Atmospheric Motion Vectors & Trajectories,
used as an important source of “mean wind observations”
over oceans and remote areas.

These data can be used:

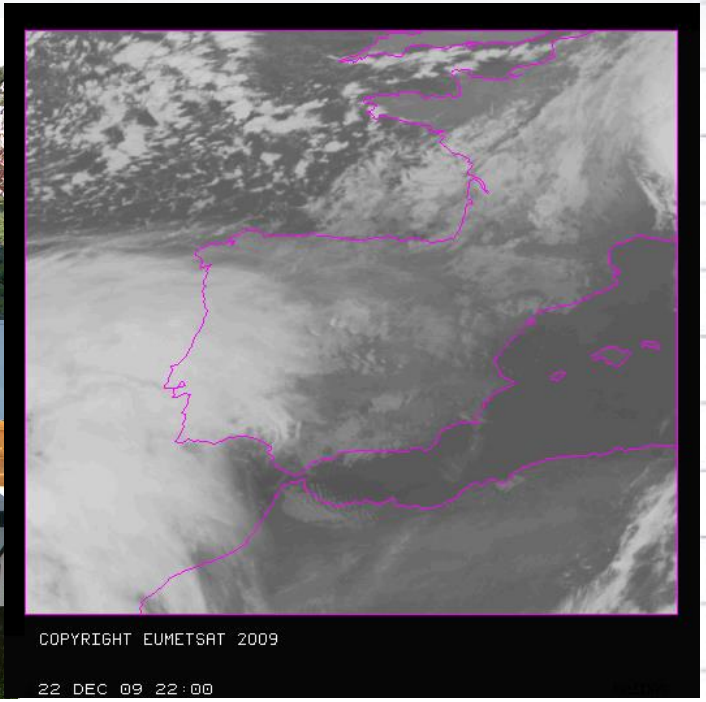
- Through assimilation in Meteorological applications.
- Through the direct use in operational nowcasting:
  * The monitoring and watch of dangerous wind situations.
  * The study of convergence/divergence at low and high levels.
  * The verification of the general circulation of the wind,
    small scale wind, singularities in the wind (and their implications).

To take into account: the lackness/opacity of clouds/humidity features
cause important variations in the density of the HRW data.

NWC/GEO Winds: HRW







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

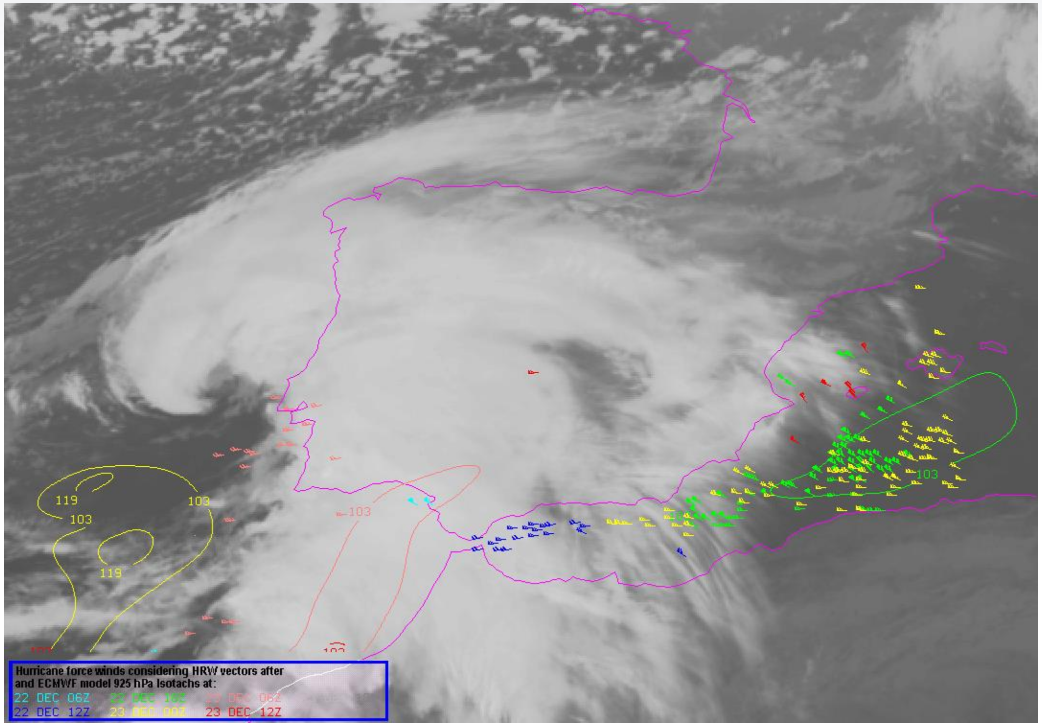
an Explosive Cyclogenesis entering Portugal from the Atlantic Ocean

in the night of 22-23 December 2009 (deepening > 20 hPa/24 h),

<u>causing important damages</u> in a narrow band

from the estuary of Tagus River to the NE inner land.

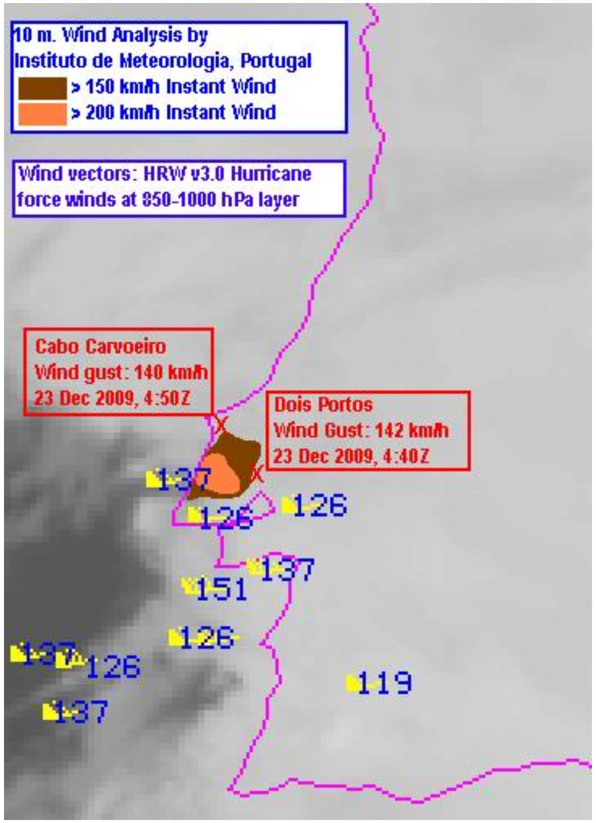
NWC/GEO Winds: HRW



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.

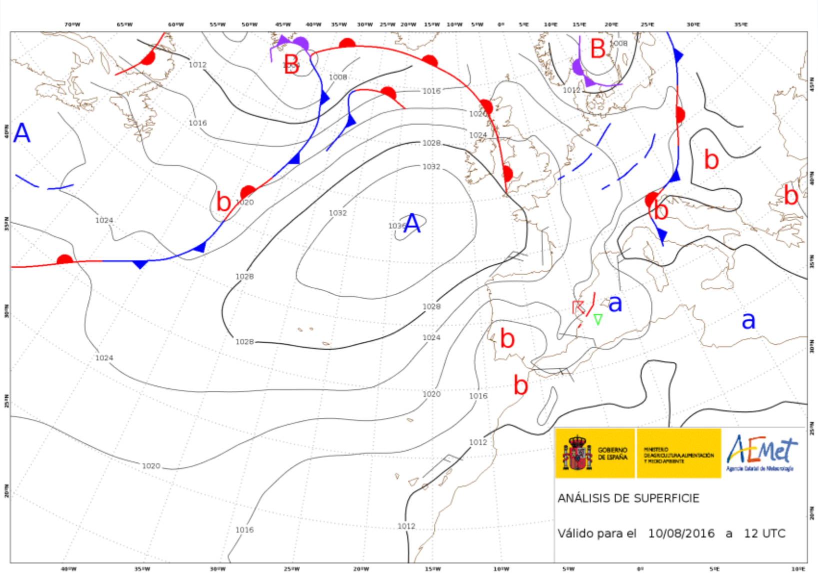
A later analysis using

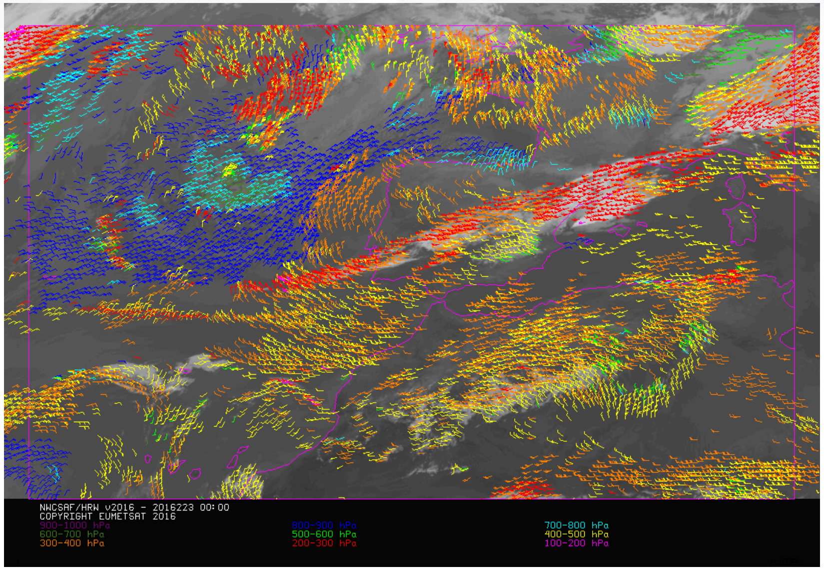
Doppler Radar data verified areas with

winds at 10 m. > 150 km/h and > 200 km/h

in the affected region at 04:30Z, 23 December

NWC/GEO Winds: HRW





Example 2, about use in a "normal" situation:

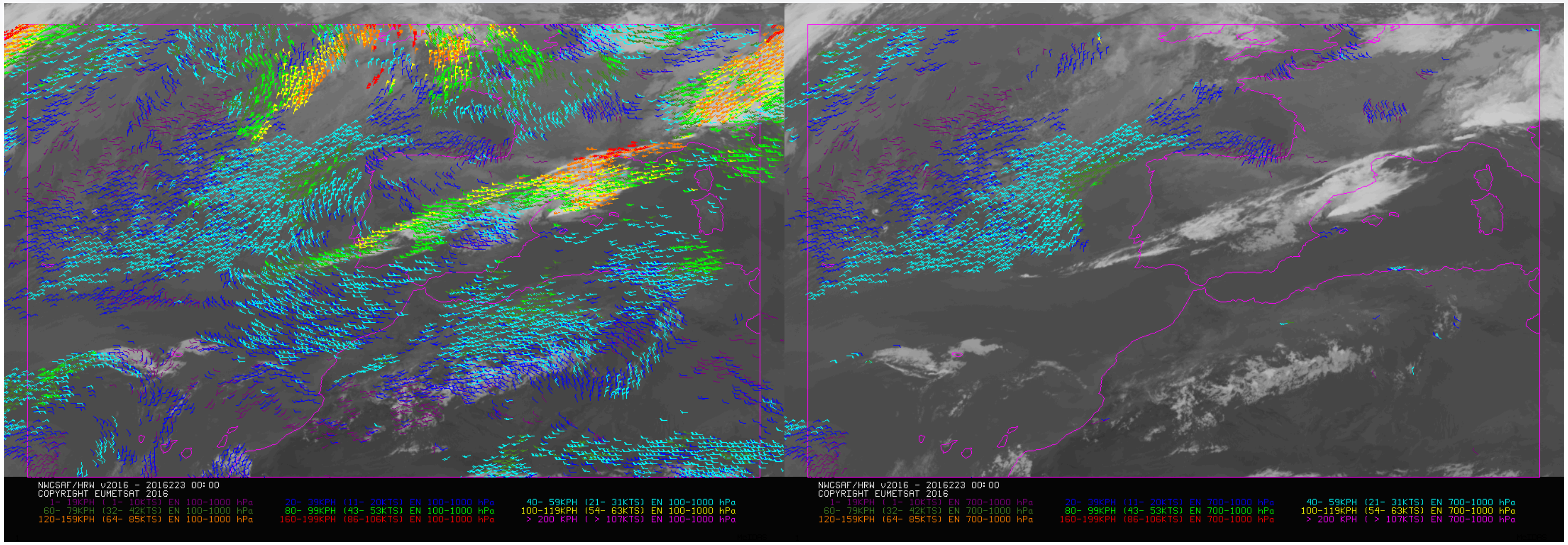
10th August 2016 (same case used previously for iSHAI),

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" (yellow level) was raised

in the NW and NE corners of Spain and in the Strait of Gibraltar.

NWC/GEO Winds: HRW

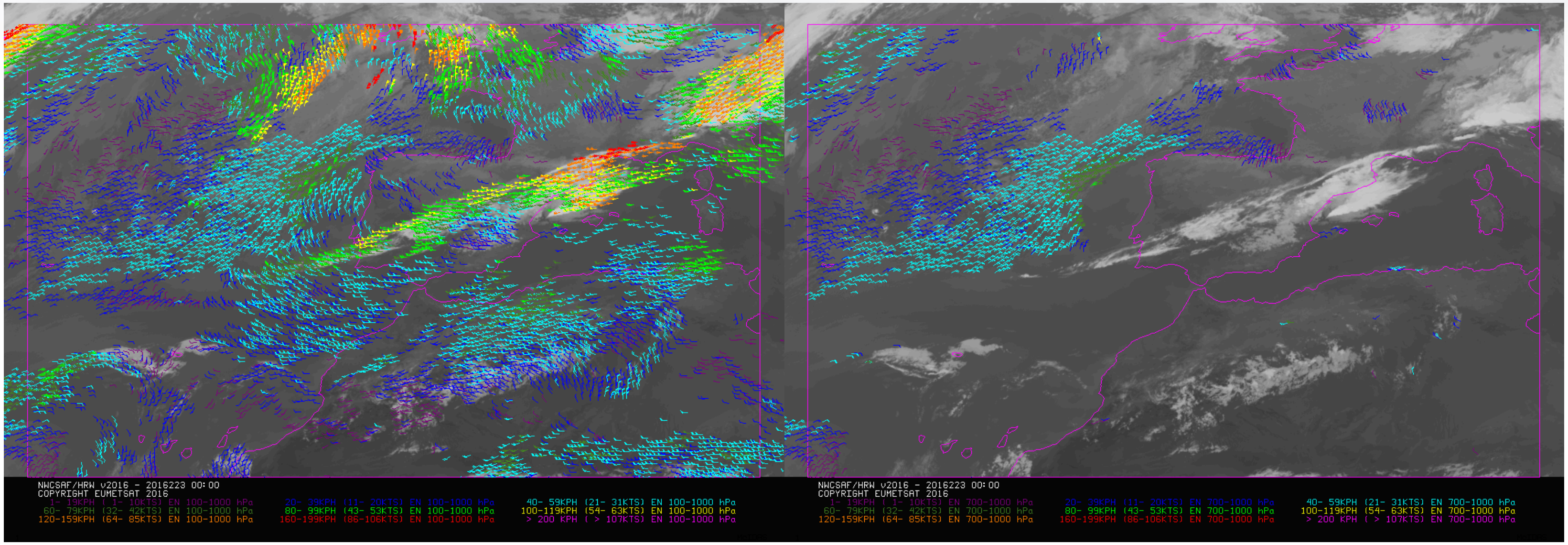


HRW AMVs every hour of 10th August 2016, at all levels (left) and at low levels (right)

HRW product is able to identify:

- Strong NE low level winds at low levels in the NW coast throughout all the day (Maximum 60-80 km, “strong gale”, extending the need of warning to a longer period and a higher level of warning: “orange level”).
- NW low level winds in Catalonia and the Balearic islands 40-60 km/h extending the need of warning to a wider area (verified by gust observations in Minorca > 60 km/h).
- Nevertheless, few low level AMVs in the Strait of Gibraltar avoid the option to confirm the winds in that area (verified by gust observations in Tangiers of 65 km/h).

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 40ºC in Tenerife and 38ºC in Lanzarote between 11Z and 15Z.

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 suggested for those who still do not know it.

Feedback is welcome

- ➔ Through NWCSAF website: nwc-saf.eumetsat.int (➔ new address).
- ➔ Directly through the Product developers:

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jean-marc.moisselin@meteo.fr (Convection)
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