The EUMETSAT Network of Satellite Application Facilities

NWC SAF
Support to Nowcasting and Very Short Range Forecasting

AEMet
Agencia Estatal de Meteorología

EUMETSAT

Nowcasting SAF MSG Precipitation Products

NoWCasting SAF – Event Week 2013
18th – 22nd November 2013

Cecilia Marcos

Overview

PGE04 – Precipitating Clouds (PC)

PGE05 – Convective Rainfall Rate (CRR)

PGE14 - Precipitation products from Cloud Top Physical Properties:

- Precipitating Clouds from cloud top physical properties (PCPh)
- Convective Rainfall Rate from Cloud Top Physical Properties(CRPh)

Comparison of all these products through visual example

Do you know NWCSAF MSG precipitation products?

- No, I don’t know anything about them
- I’ve heard about them but I’ve never used them
- Yes, I’ve used at least one of them

www.nwcsaf.org

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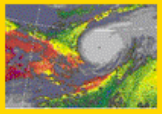

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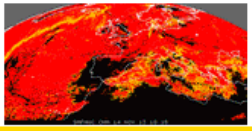
MAIL

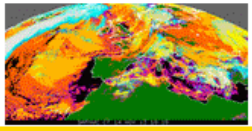
MSG

MSG Cloud Products

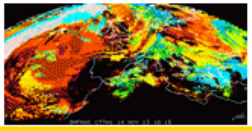
Cloud Mask (Description)



Cloud Type (Description)

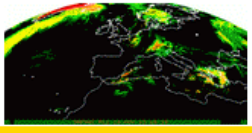


Cloud Top Temperature and Height (Description)



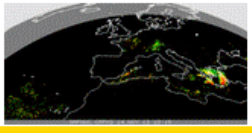
MSG Precipitation Products

Precipitating Clouds (Description)



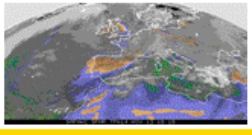
Convective Rainfall Rate (Description)

Prec. Prod. Cloud Physical Properties (Description)

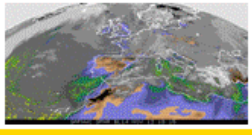


MSG Clear Air Products Physical Retrieval

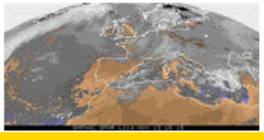
Total Precipitable Water (Description)



Layer Precipitable Water (Description)

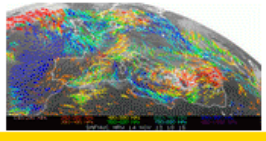


Stability Analysis Imagery (Description)

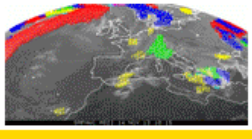


MSG Winds, Conceptual Model and Convection Products

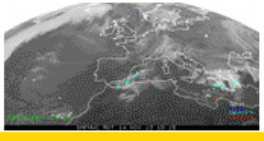
High Resolution Winds (Description)



Automatic Satellite Image Interpretation (Description)

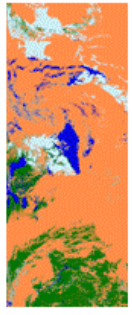


Rapid Development Thunderstorms (Description)



PPS

Cloud Mask (Description)



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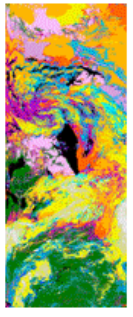
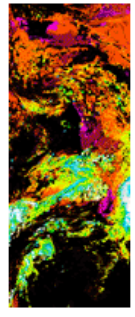
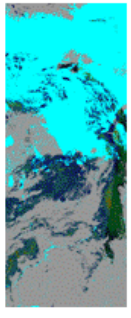


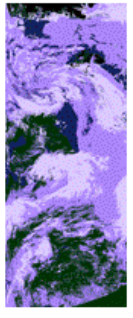
Cloud Top Temperature and Height (Description)



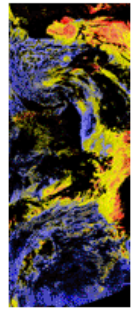
Precipitating Clouds (Description)



Cloud Physical Properties (CPh) (Description)



Cloud Physical Properties (LWP) (Description)



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PC – Precipitating Clouds

CRR – Convective Rainfall Rate

Precipitation Products from Cloud Physical Properties

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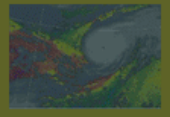

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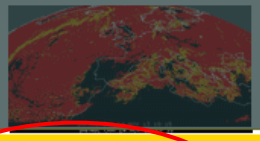
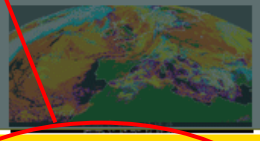
MSG Cloud Products

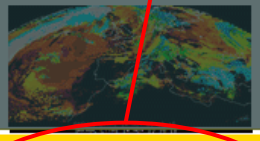
Cloud Mask (Description)



Cloud Type (Description)



Cloud Top Temperature and Height (Description)



MSG Precipitation Products

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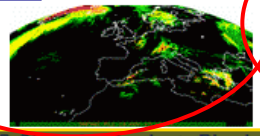
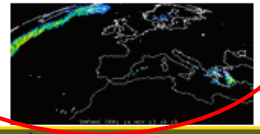
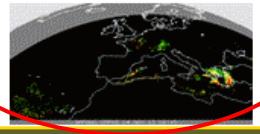


Convective Rainfall Rate (Description)

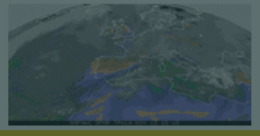


Prec. Prod. Cloud Physical Properties (Description)



MSG Clear Air Products Physical Retrieval

Total Precipitable Water (Description)



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Stability Analysis Imagery (Description)

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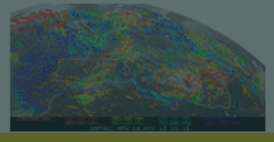

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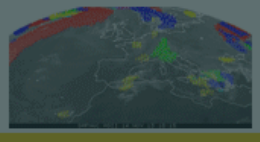

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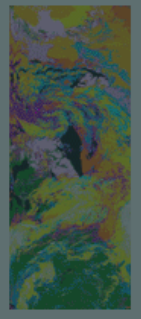
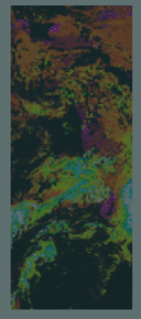
Cloud Mask (Description)

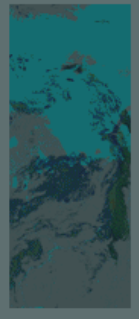
Cloud Type (Description)



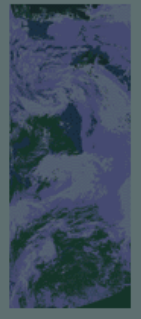
Cloud Top Temperature and Height (Description)



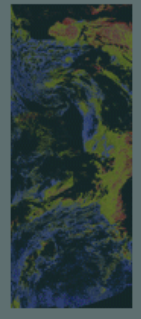
Precipitating Clouds (Description)



Cloud Physical Properties (CPh) (Description)



Cloud Physical Properties (LWP) (Description)



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PC – Precipitating Clouds

CRR – Convective Rainfall Rate

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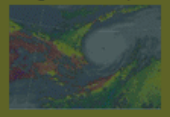

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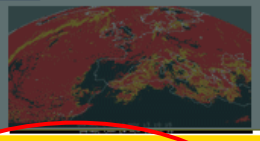

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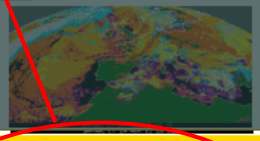
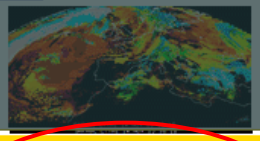


Cloud Top Temperature and Height (Description)



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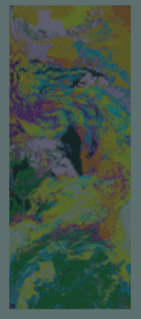

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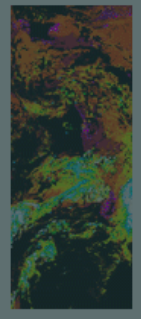
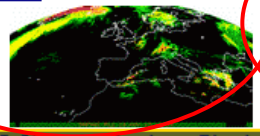
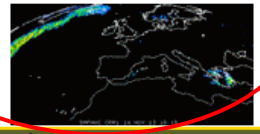


MSG Precipitation Products

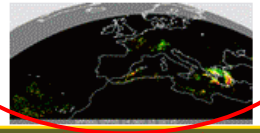
Precipitating Clouds (Description)



Convective Rainfall Rate (Description)



Prec. Prod. Cloud Physical Properties (Description)



MSG Clear Air Products Physical Retrieval

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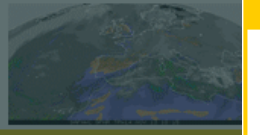


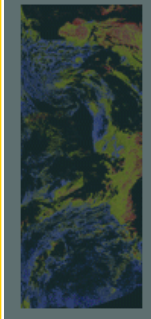
Layer Precipitable Water

Stability Analysis Imagery

Precipitating Clouds

Cloud Physical Properties (CPh)

Cloud Physical Properties (LWP) (Description)



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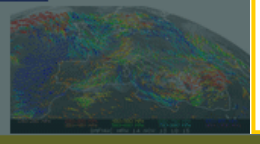
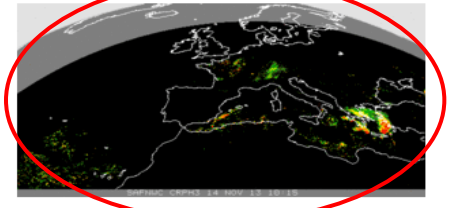


Precipitation Products based on Cloud Physical Properties SEVIRI



PGE14: PCPh (Probability of Precipitation based on Cloud Physical Properties)

PGE14: CRPh (Convective Rainfall Rate based on Cloud Physical Properties)

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  - PPS package:
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PCPh – Precipitating Clouds from Cloud Physical Properties

CRPh – Convective Rainfall Rate from Cloud Physical Properties

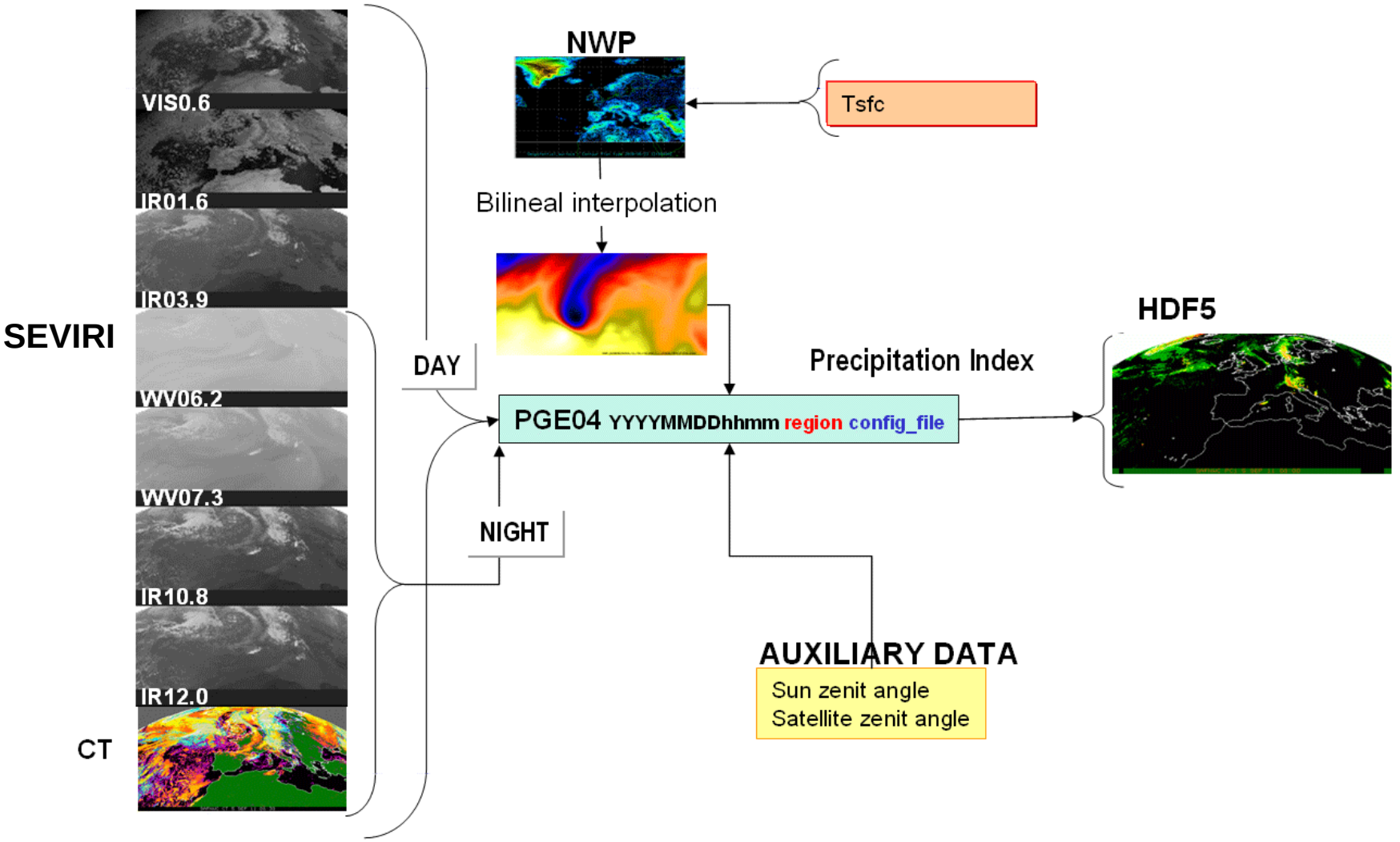
Precipitating Clouds (PC)

INTRODUCTION:

- **The objetive is the delineation of non-precipitating and precipitating clouds.**
- **PC serve as a geneal tool for Nowcasting of precipitation, especially for areas where no surface data is available.**
- **The nature of the input data leads to an overestimation of the precipitating area.**

Precipitating Clouds (PC)

Input and output diagram



Precipitating Clouds (PC)

ALGORITHM DESCRIPTION:

- A Precipitation Index (PI) has been built through a linear combination of those spectral features which have the highest correlation with precipitation:

$$PI=a_0 +a_1*T_{Surf} +a_2*T_{10.8}+a_3*(T_{10.8}-T_{12.0})+a_4*abs(a_5-R_{0.6}/R_{1.6})+ a_6*R_{0.6}+a_7*R_{1.6}+a_8*T_{6.2}+a_9*T_{7.3}+a_{10}*T_{3.9})$$

- Two different calibrations:
  - Precipitation rates from rain gauge over France
  - Synops
- Different algorithms for day and night situations
- Different algorithms for different cloud type groups using the Cloud Type product as input
- The choice of the algorithm to be used is done through the Configuration File

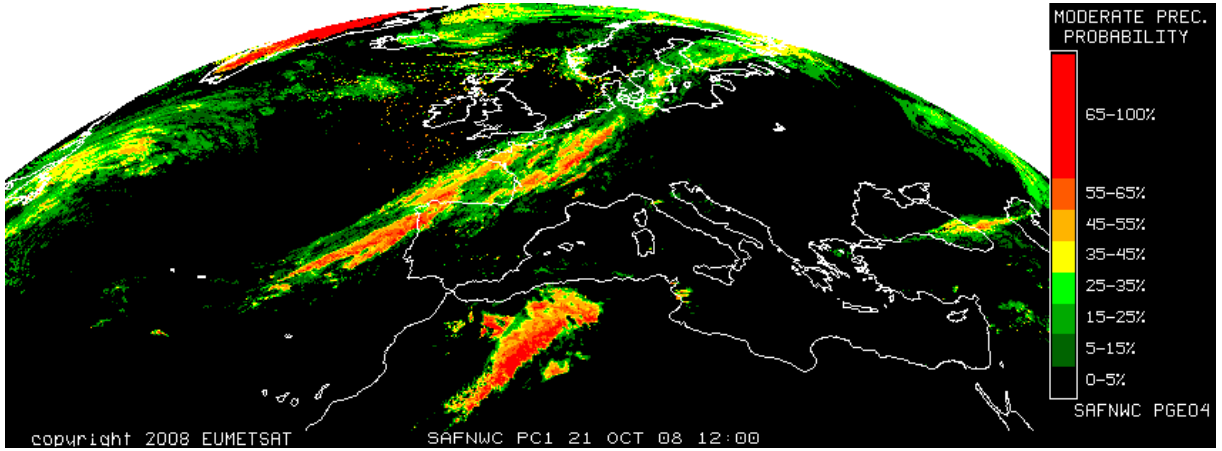
Precipitating Clouds (PC)

OUTPUTS:

The PC product shall consist of a numerical value for the likelihood

The following probability classes will be used:

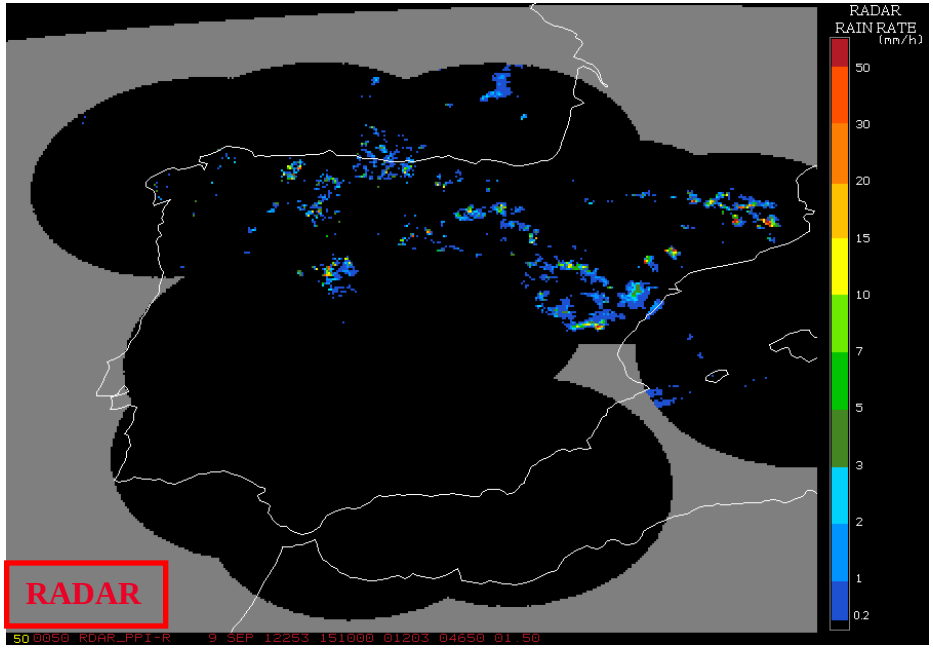
0% (= 0-5%)
10% (= 5-15%)
20% (= 15-25%)
30% (= 25-35%)
40% (= 35-45%)
50% (= 45-55%)
60% (= 55-65%)
70% (= 65-75%)
80% (= 75-85%)
90% (= 85-95%)
100% (= 95-100%)

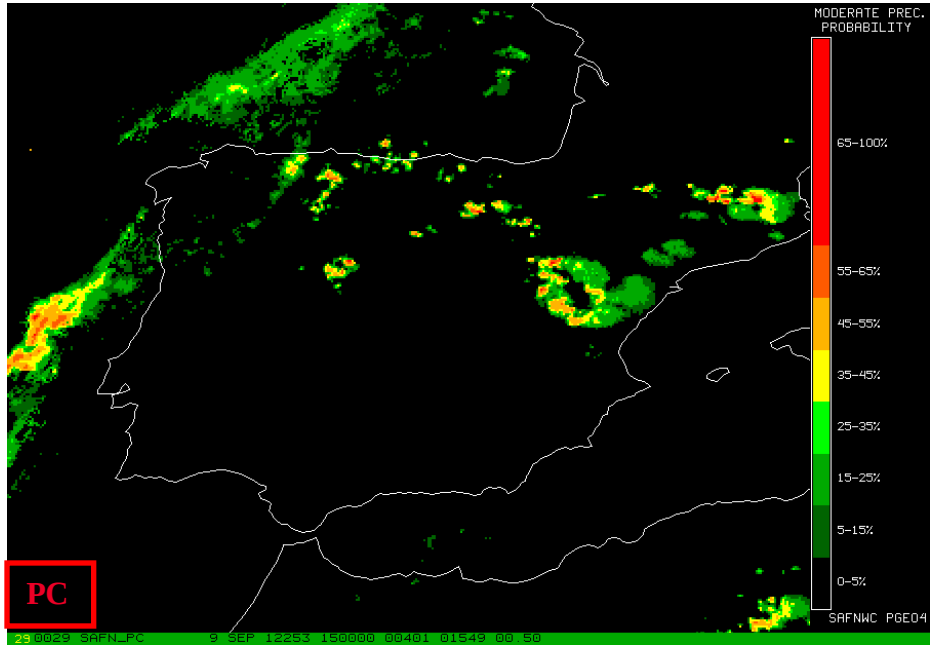


FLAG: information about the processing conditions

Precipitating Clouds (PC)

Applications: Provide information about precipitation ocurrence likelihood over extensive areas, out of the Radar coverage or as a Radar compliment.



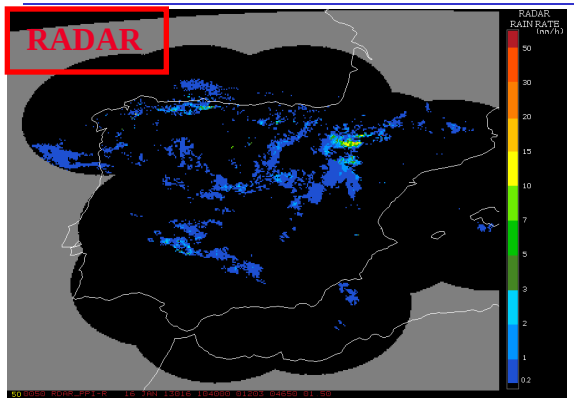


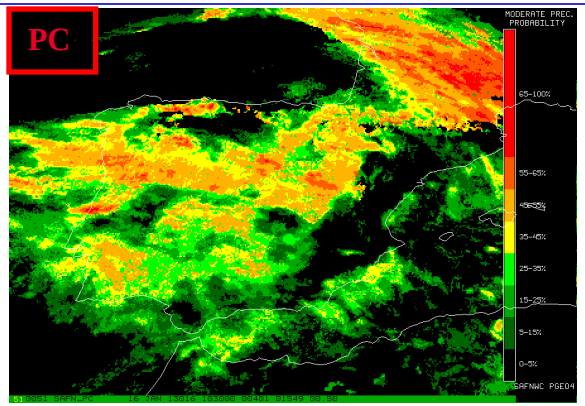
Example: 9th September 2012 at 15:00 UTC

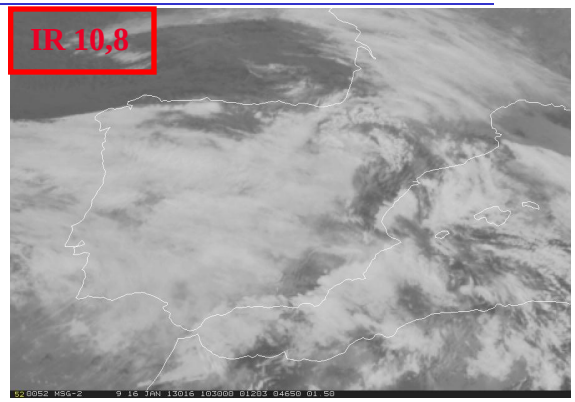
Precipitating Clouds (PC)

Limitations:

16th January 2013 at 10:30 UTC



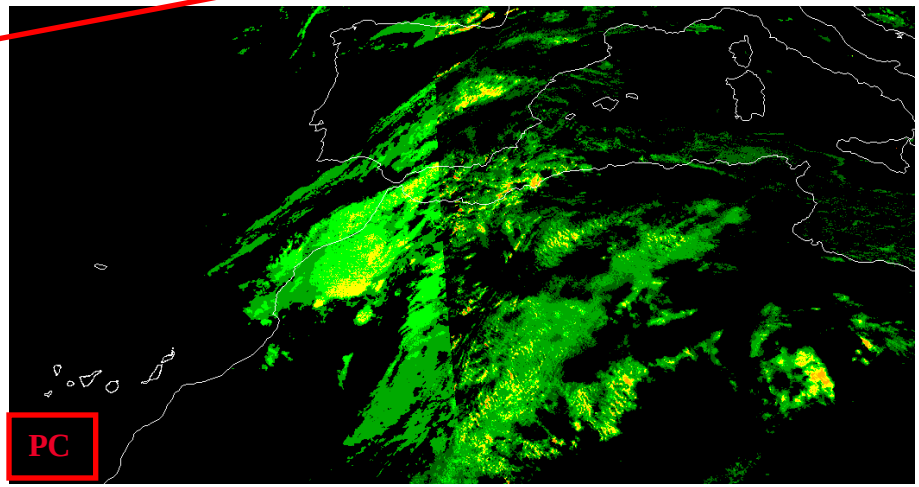




- Similar to the cloud tops
- Too big estimated precipitation area

Different result for day and night

12th April 2012 at 06:30 UTC



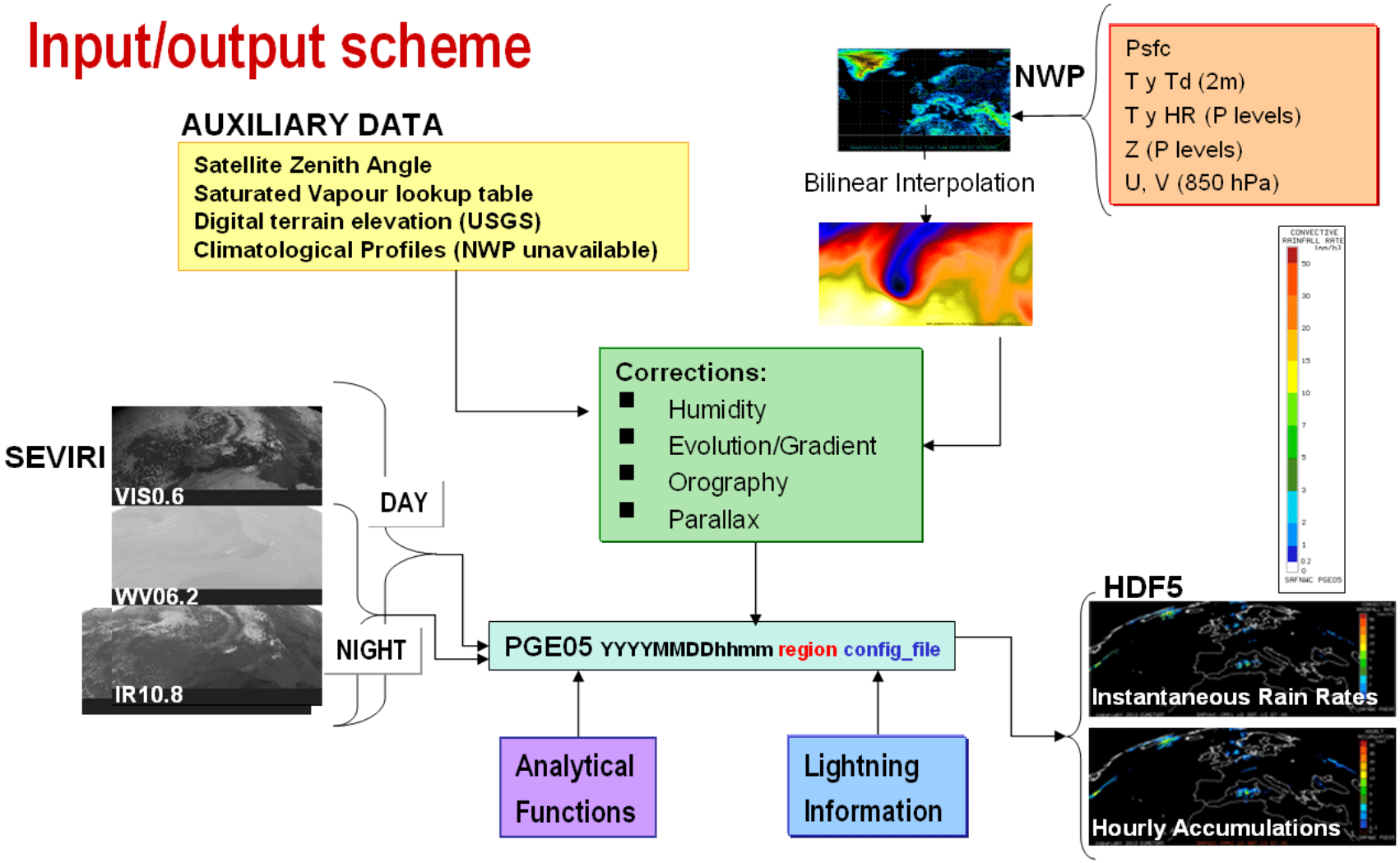
Convective Rainfall Rate (CRR)

INTRODUCTION:

The CRR goal is to estimate rainfall rates from convective systems, using IR, WV and VIS MSG SEVIRI channels and lightning information (as optional input).

Convective Rainfall Rate (CRR)

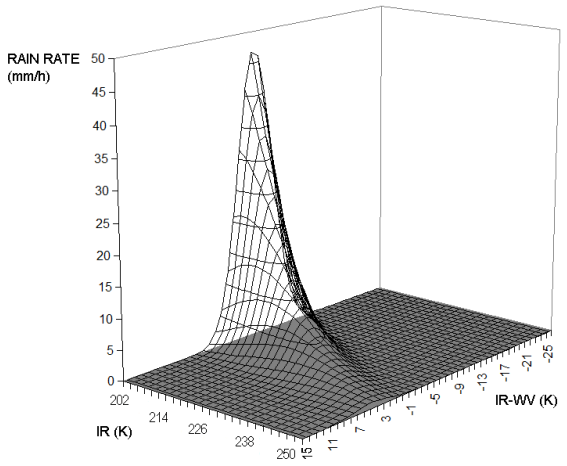
Input/output scheme



Convective Rainfall Rate (CRR)

CALIBRATION FUNCTIONS:

- **Calibration functions have been built through a statistic method using:**
  - **SEVIRI data**
  - **Composite radar data from:**
    - Baltrad network
    - *Hungarian radar network*
    - *Spanish radar network*
- **Two different calibrations:**
  - **R = f (IR, IR-WV, VIS), for 3-V calibration (day time)**
  - **R = f (IR, IR-WV), for 2-V calibration (night time)**



PROCESSING:

- **Basic CRR mm/h value for each pixel obtained from the calibration functions.**
- **Filtering process**
- **Corrections (optional): Moisture Correction, Evolution Correction (Cloud-top Temperature Gradient Correction), Parallax correction and Orographic correction**
- **Lightning algorithm (optional)**

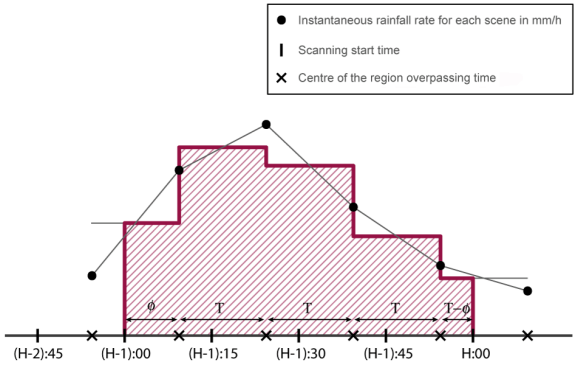
Convective Rainfall Rate (CRR)

OUTPUTS:

- CRR rainfall rates expressed in classes
- CRR rainfall rates expressed in mm/h
- CRR Hourly Accumulations

$$A_6 = \frac{I_1 + I_2}{2}\phi + \frac{I_2}{2}T + I_3 T + I_4 T + \frac{I_5}{2}T + \frac{I_5 + I_6}{2}(T - \phi)$$

Where:
- A_i: hourly accumulation, in mm, corresponding to the time i.
- T: time interval between scenes in hours (T= 0.25)
- Φ: part of T that corresponds to the time that takes the satellite to reach the centre of the region.
- I_i: Instantaneous rainfall rate for each scene in mm/h



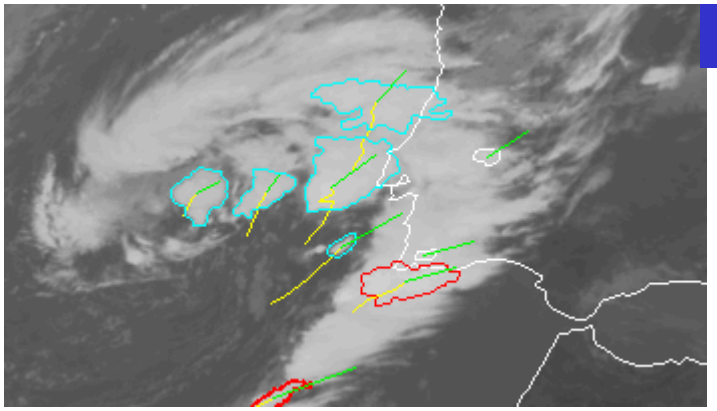
- CRR-QUALITY
- CRR-DATAFLAG

Convective Rainfall Rate (CRR)

Applications:

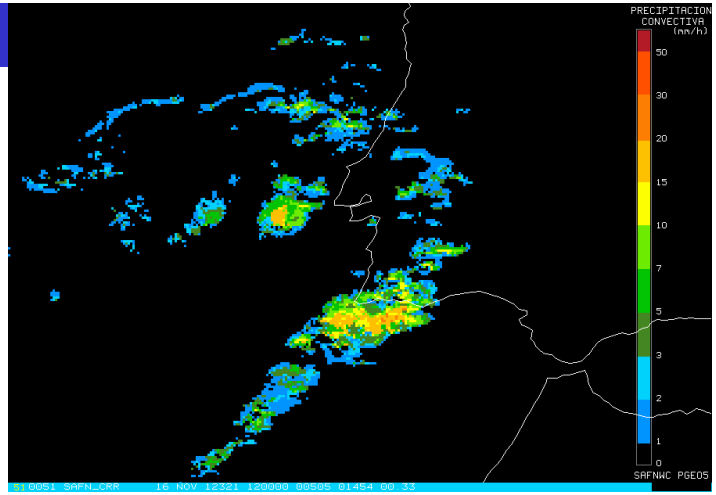
Estimation of rain rates for convective events over extensive areas, out of the radar coverage or as a radar compliment.

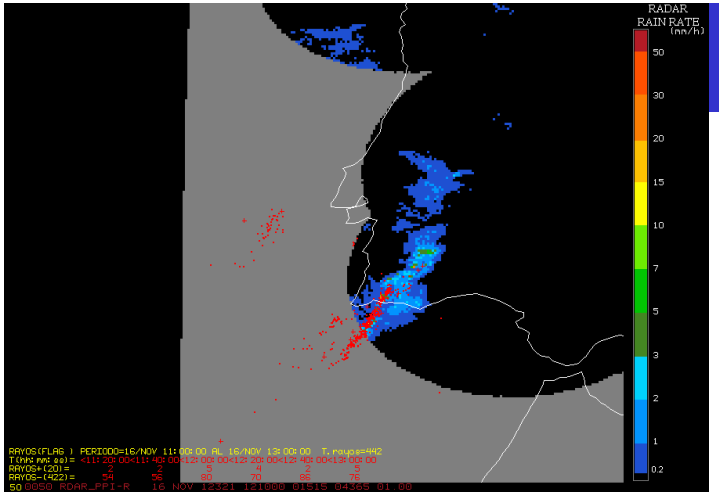
Input of other NWCSAF products (RDT)



RDT

CRR



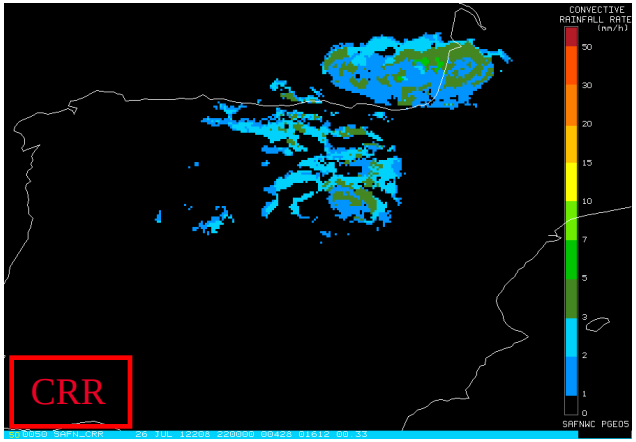


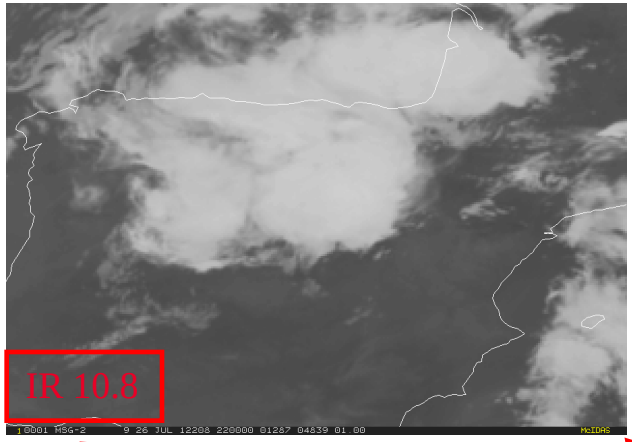
RADAR + Lightning info

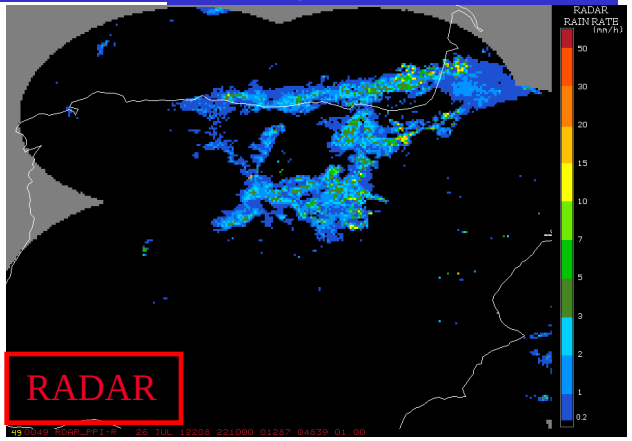
Convective Rainfall Rate (CRR)

Problems:

26th July 2012 - 22:00 UTC

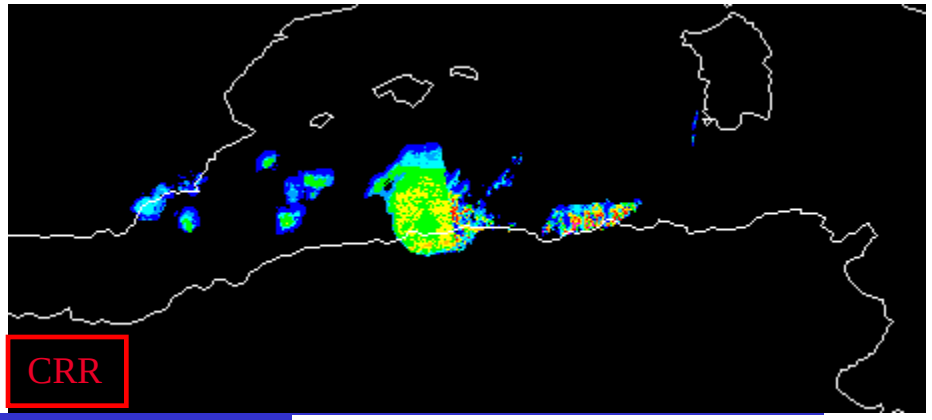






- Similar to the cloud tops
- Too big estimated precipitation area and lower rain rates than Radar

Different result for day and night



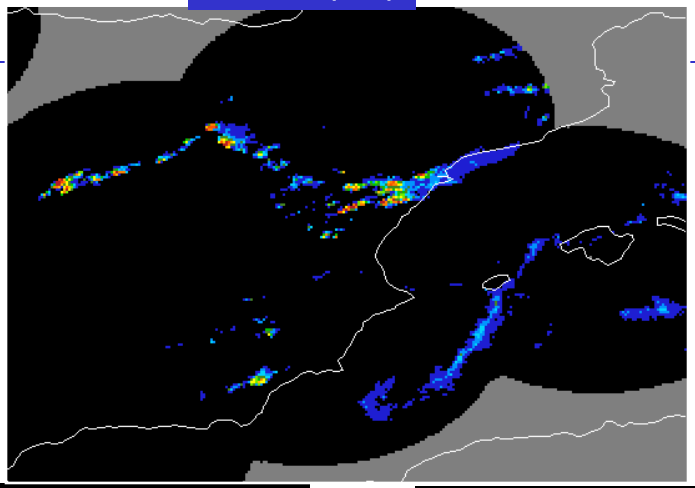
31th August 2012 - 06:00 UTC

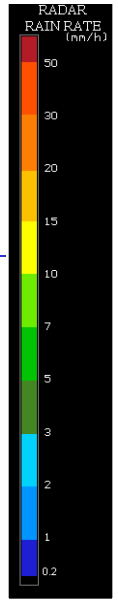
Convective Rainfall Rate (CRR)

Visual example

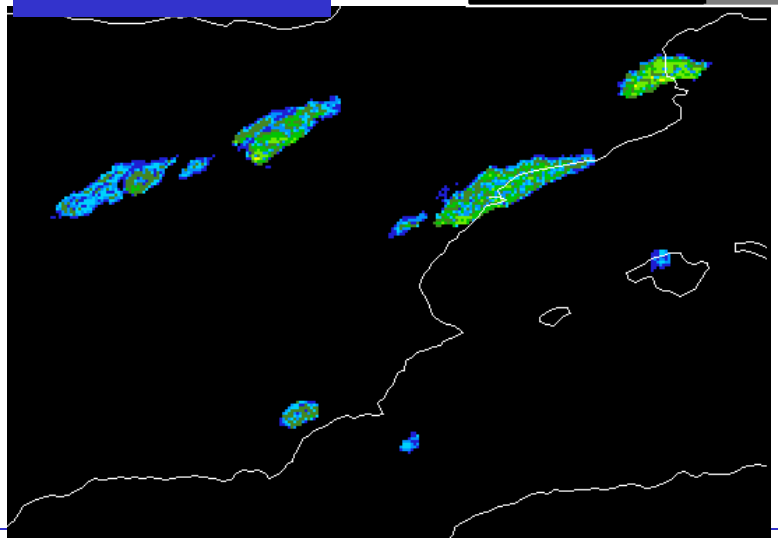
22th August 2008
14:00 UTC

RADAR (PPI)

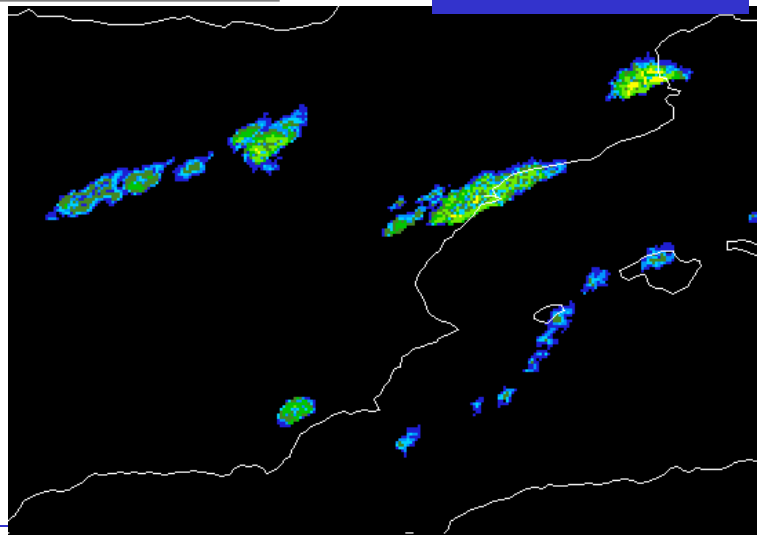




CRR 2V FUNCTION



CRR 3V FUNCTION



Precipitation products from Cloud Physical Properties - PPh

INTRODUCTION:

Two products generated:

- Precipitating Clouds from Cloud Physical Properties – PCPh

  PCPh provides estimation on the probability of precipitation (PoP) occurrence.

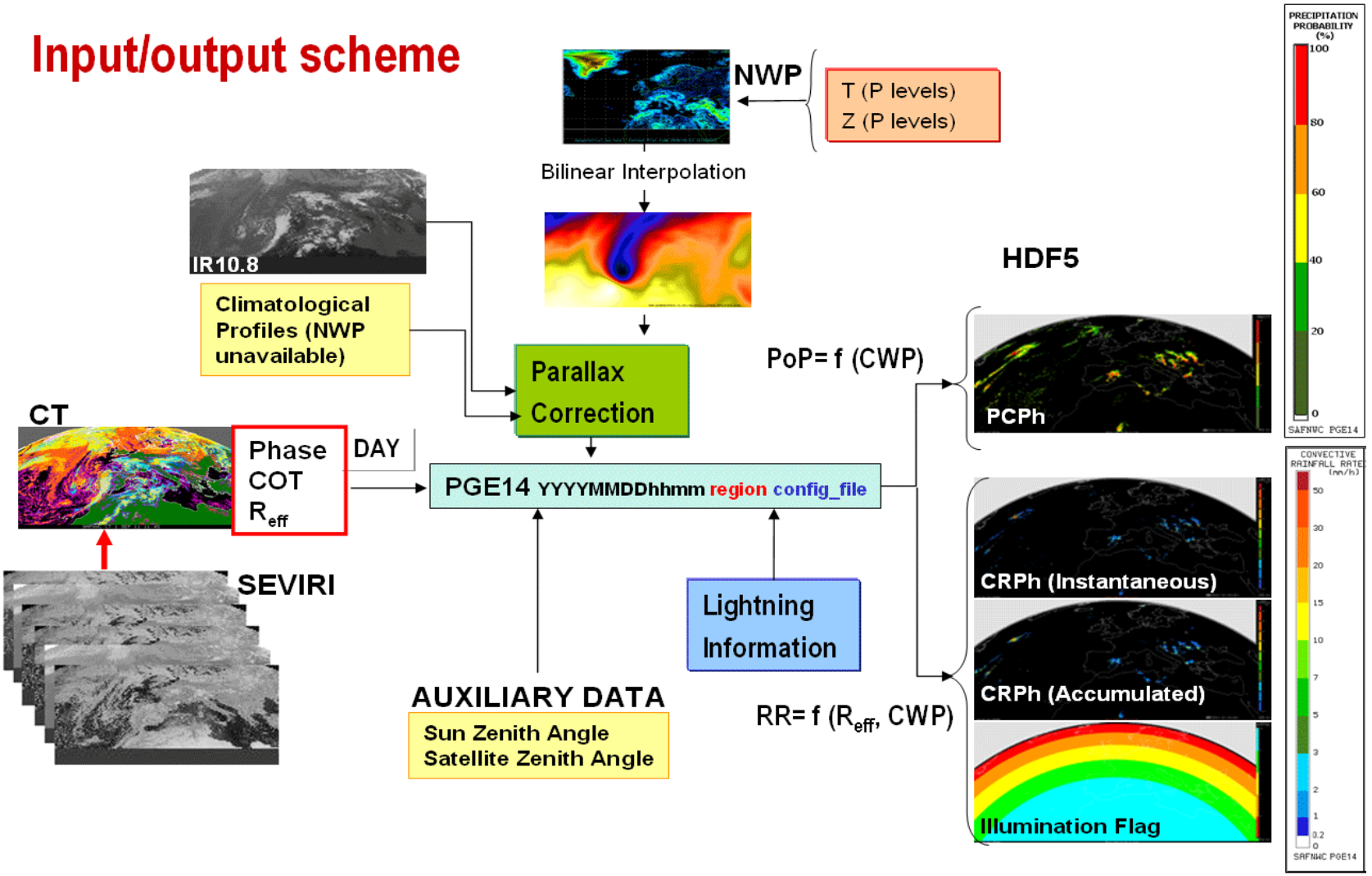
  PoP is defined as the instantaneous probability that a rain rate greater than or equal to 0.2 mm/h occurs at the pixel level.

- Convective Rainfall Rate from Cloud Physical Properties – CRPh

  CRPh provides information on convective, and stratiform associated to convection, instantaneous rain rates and hourly accumulations.

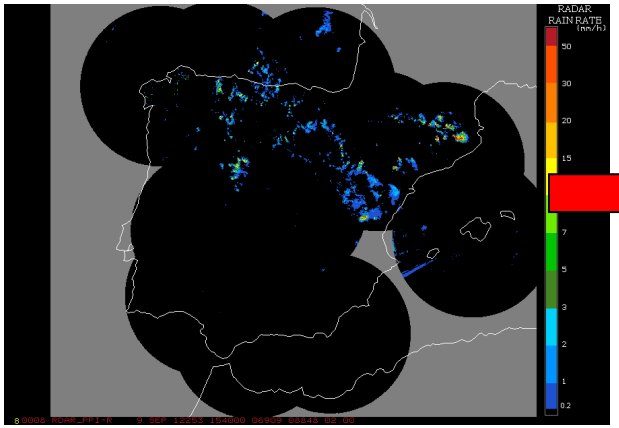
Precipitation products from Cloud Physical Properties - PPh

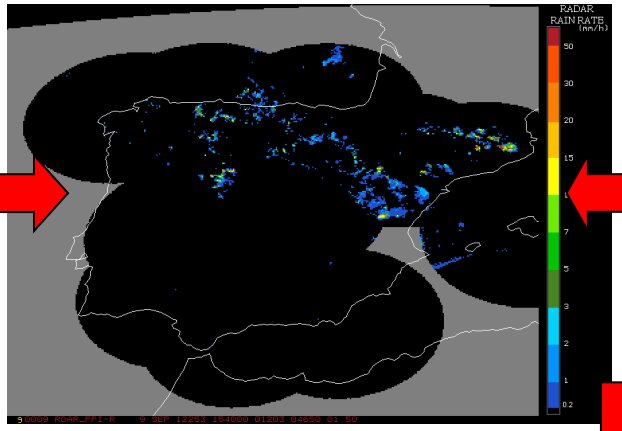
Input/output scheme

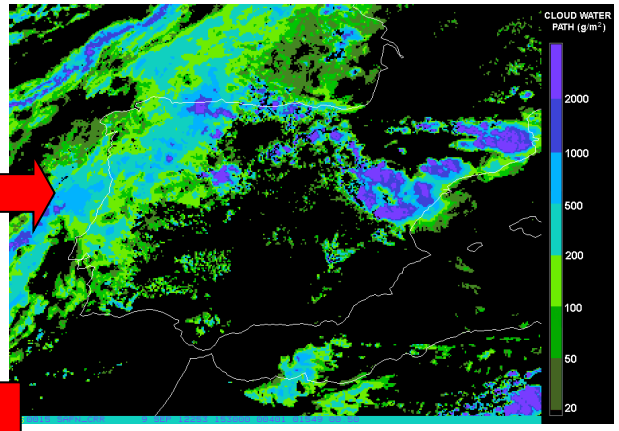


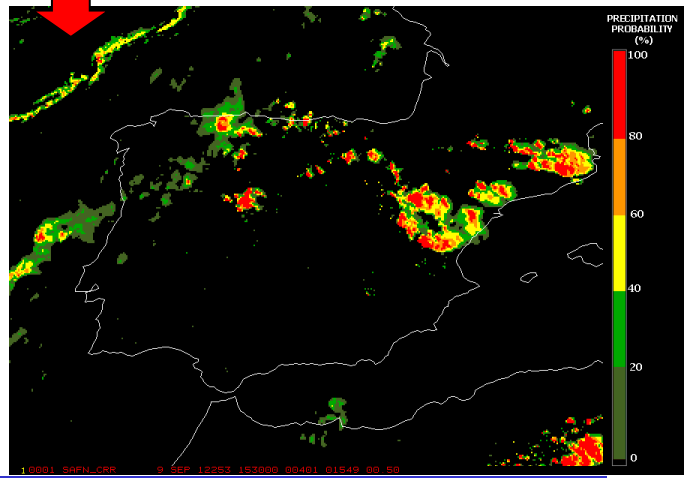
Precipitation products from Cloud Physical Properties - PPh

Algorithm calibration: Probability of precipitation









Comparison: reprojected Radar with CWP

CWP Thresholds ⟷ Precipitation Probability

↓

PoP = f (CWP)

Precipitation products from Cloud Physical Properties - PPh

Limitations:

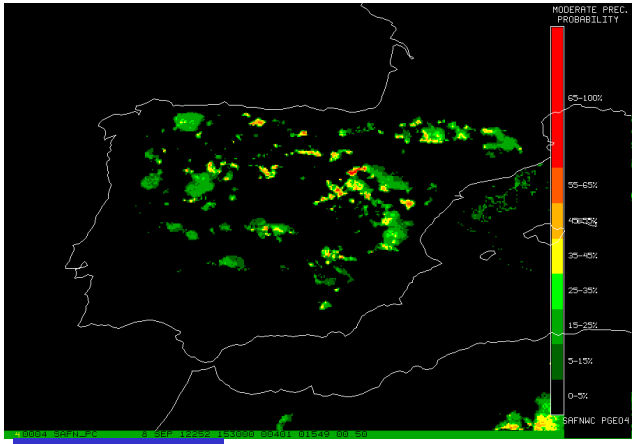
Only day time

Only for estimated phase

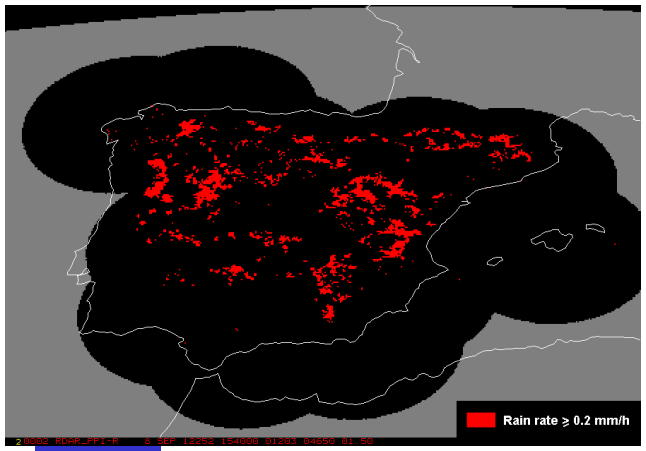
Some dependance on illumination conditions – better VIS normalization needed

Improvements:

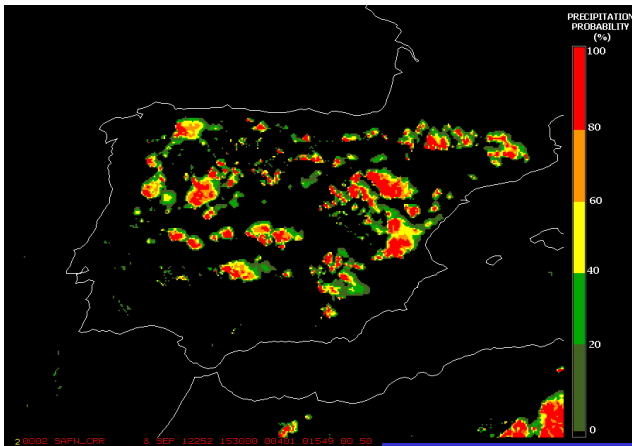
More confidence on the assignment of the precipitation likelihood



PC (PGE04)



Radar



PCPh (PGE14)

NWC SAF

AEMet Agencia Estatal de Meteorología

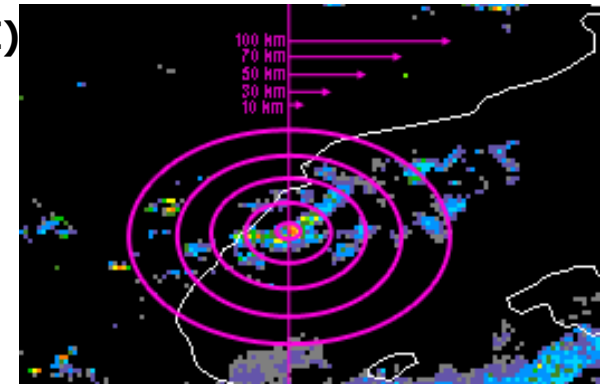
8th September 2012 - 15:30 UTC

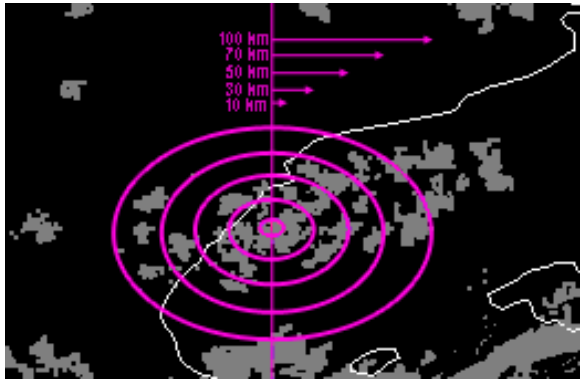
Precipitation products from Cloud Physical Properties - PPh

Datasets:
Spain: 40 storms, May-September 2009, 12:00 UTC
Hungary: 18 storms, May-September 2009, 10:00-12:00 UTC

CRPh Calibration: Precipitation area

Radar (PPI)

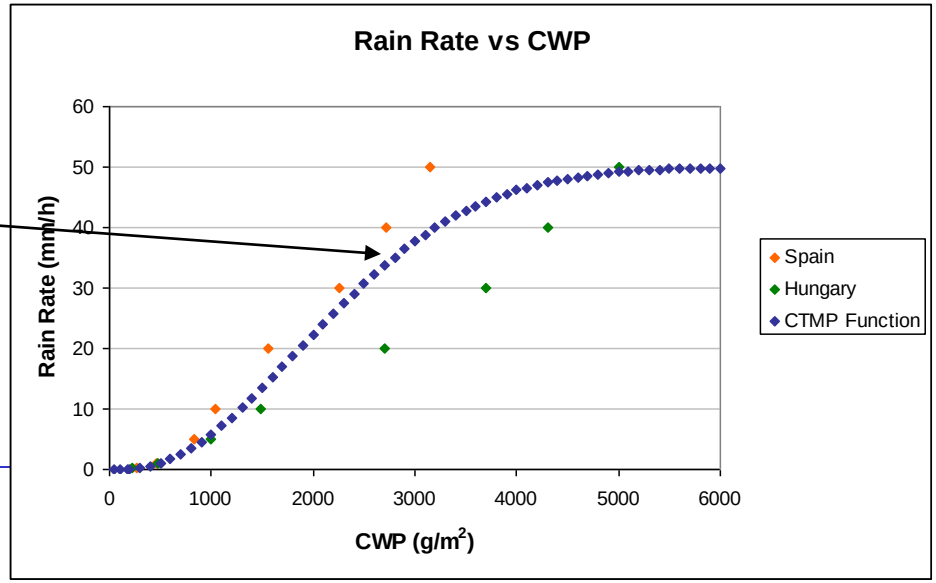




Precipitation area from CWP

CRPh Calibration: Rain Rates

Cloud Top Microphysical Properties Function



NWC SAF
AEMet Agencia Estatal de Meteorología

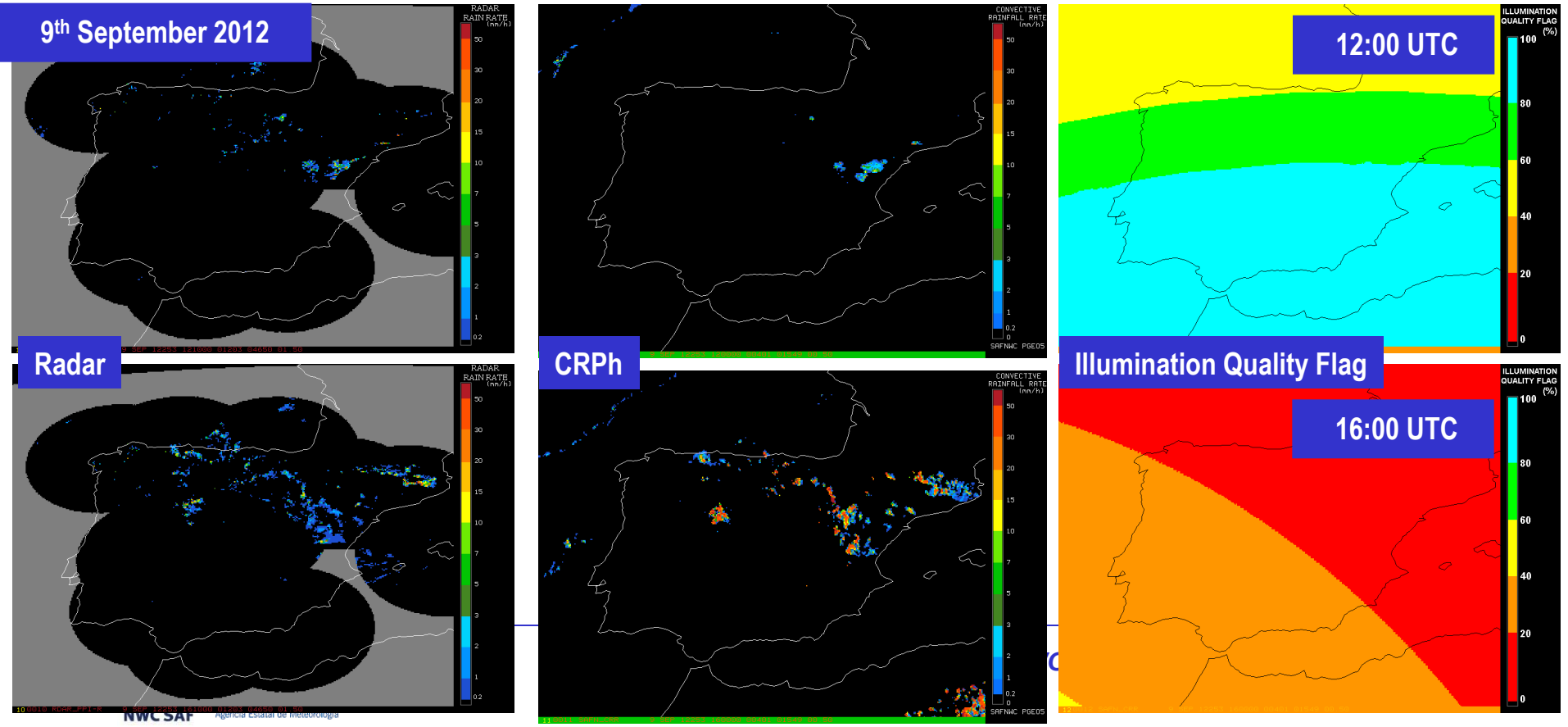
Precipitation products from Cloud Physical Properties - PPh

Limitations:

Only day time

Only for estimated phase

High dependance on illumination conditions → **Illumination Quality flag**

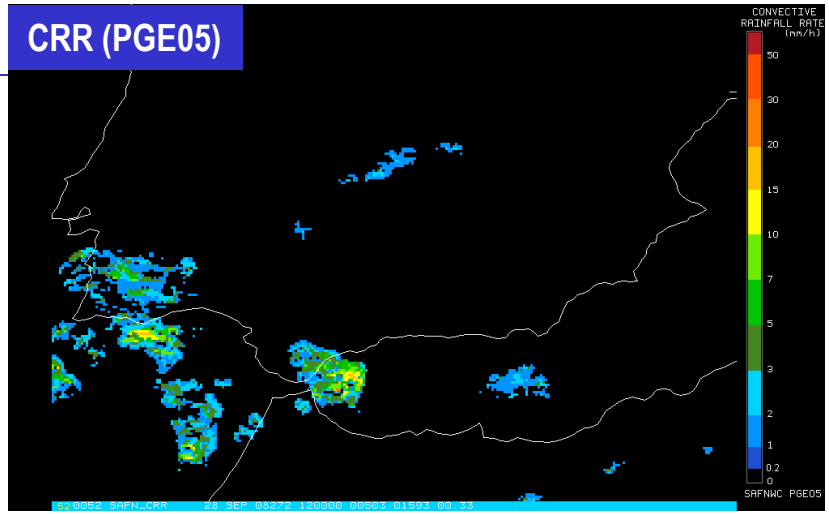


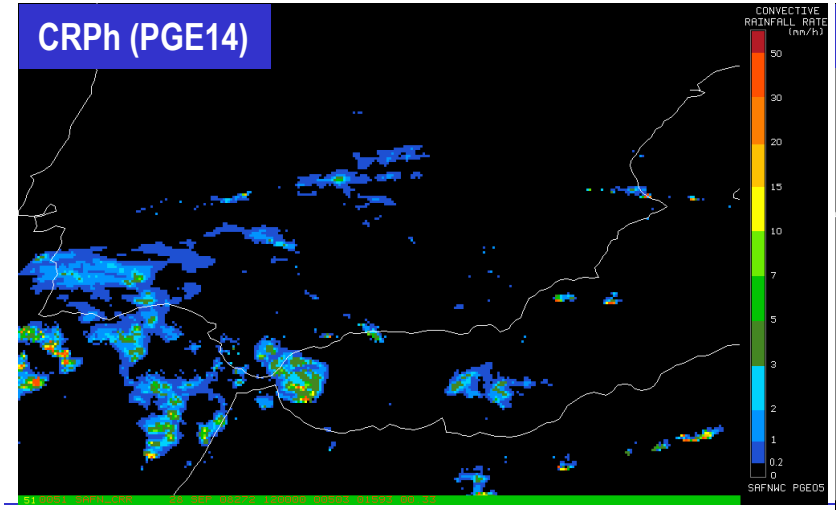
Precipitation products from Cloud Physical Properties - PPh

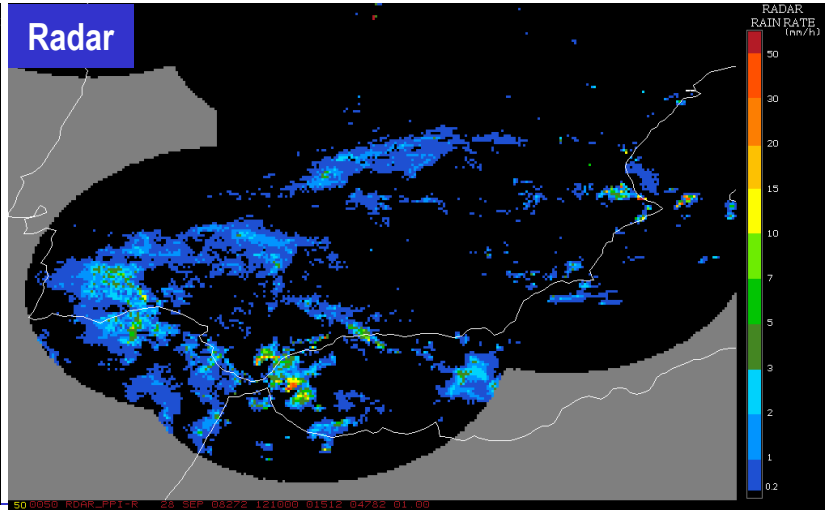
Improvements:

Precipitation areas and intensities closer to the radar ones

28 September 2008
12:00 UTC



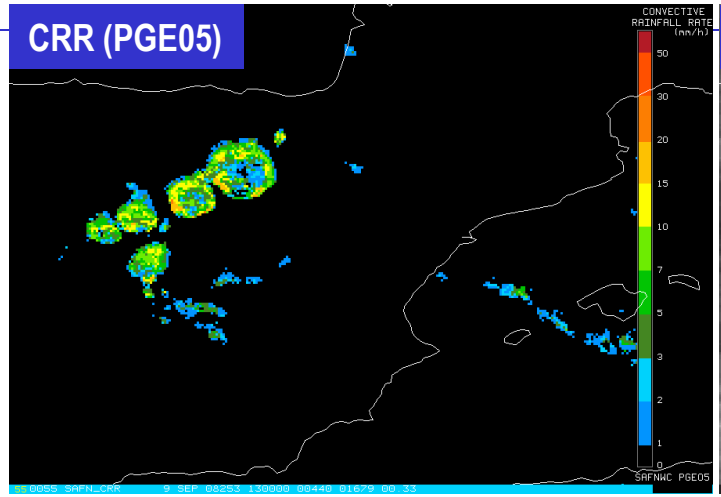


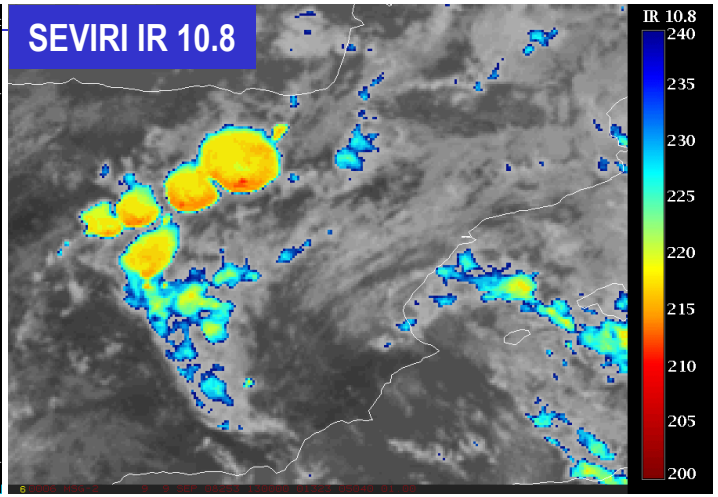


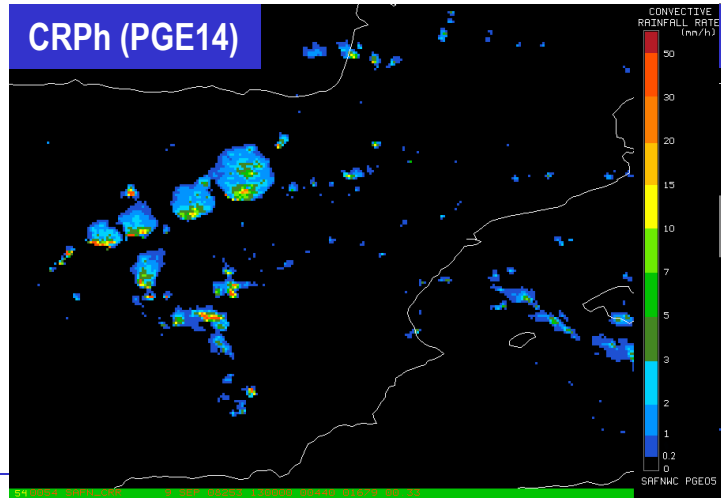
Precipitation products from Cloud Physical Properties - PPh

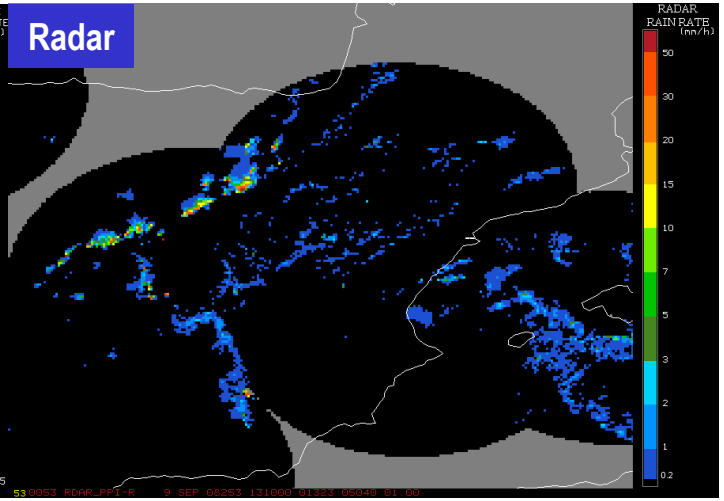
Improvements:

No Cold Rings and detection of smaller precipitation nuclei





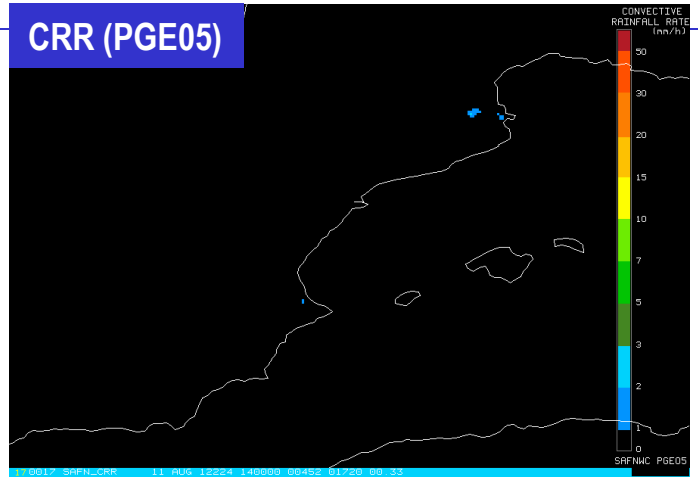


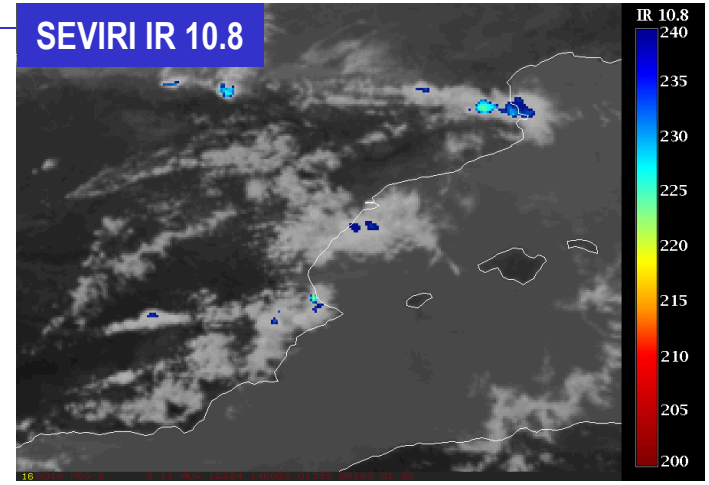


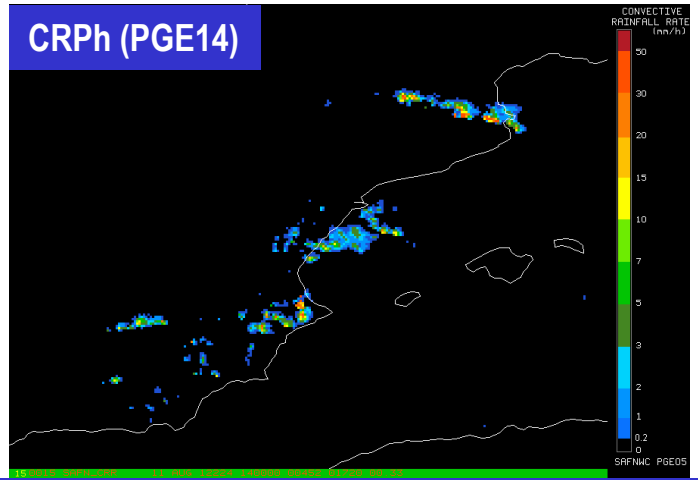
9th September 2008
13:00 UTC

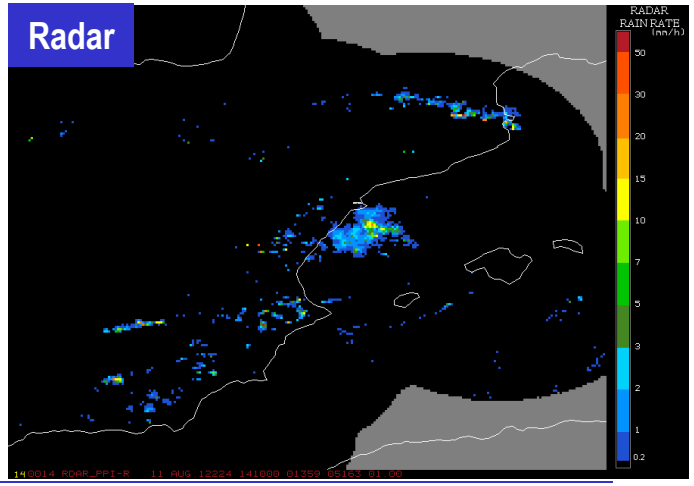
Precipitation products from Cloud Physical Properties - PPh

Improvements:
Detection of precipitation for warm top clouds









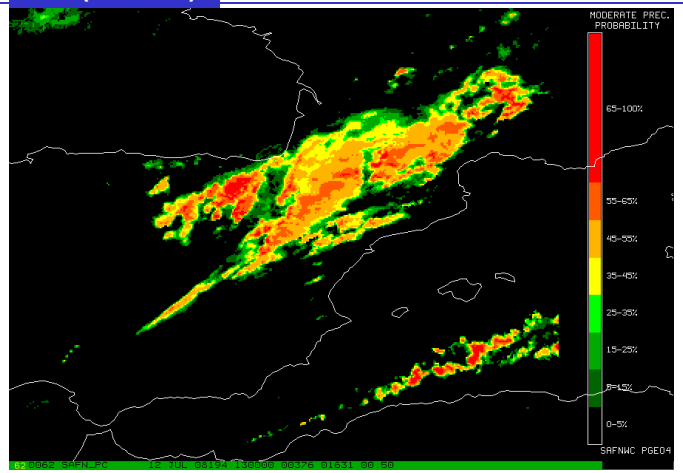
11th August 2012
14:00 UTC

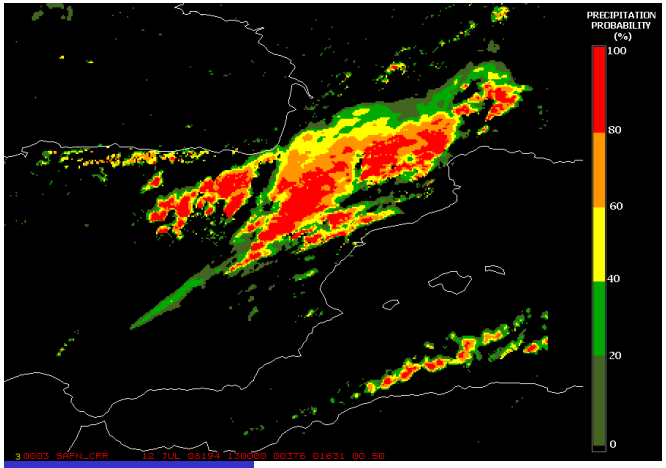
Precipitation products from Cloud Physical Properties - PPh

Visual example

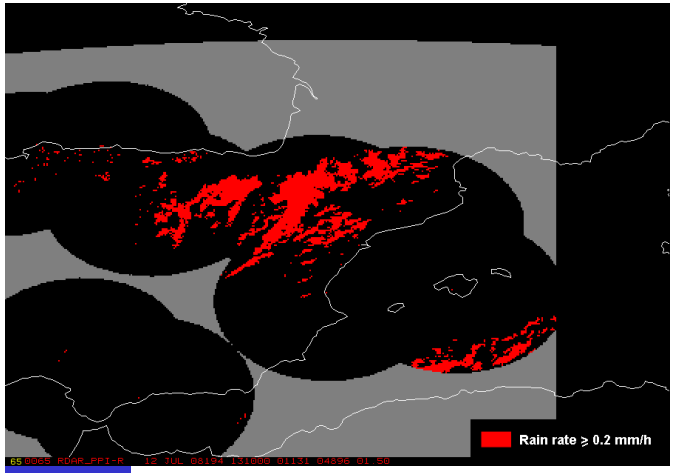
12th July 2008 at 13:00 UTC

PC (PGE04)





PCPh (PGE14)



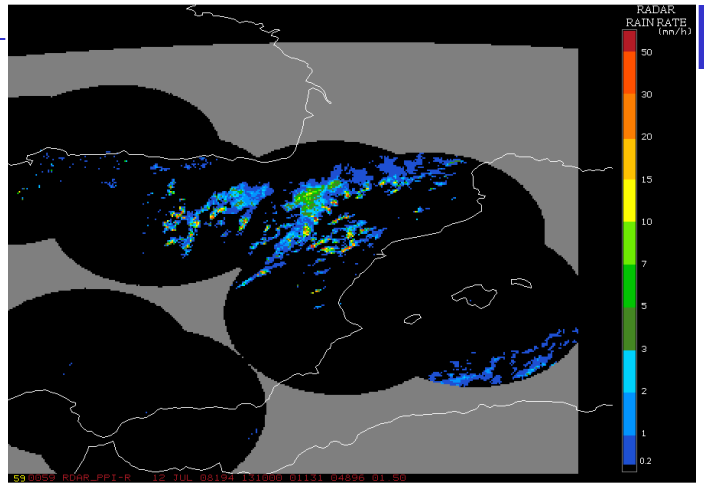
Radar

Precipitation products from Cloud Physical Properties - PPh

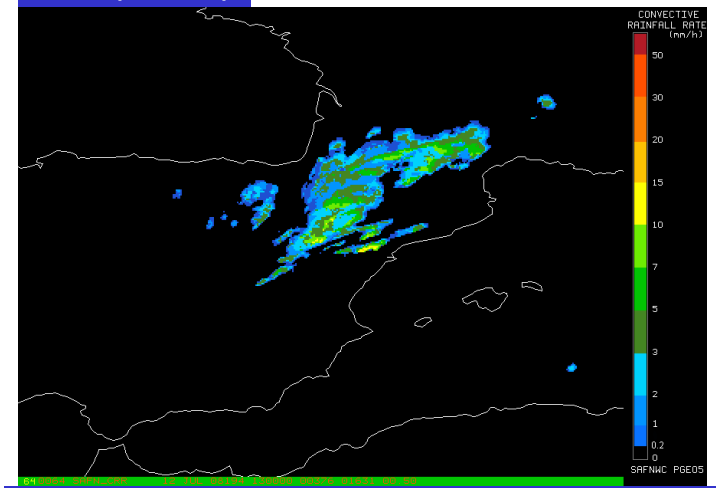
Visual example

12th July 2008
13:00 UTC

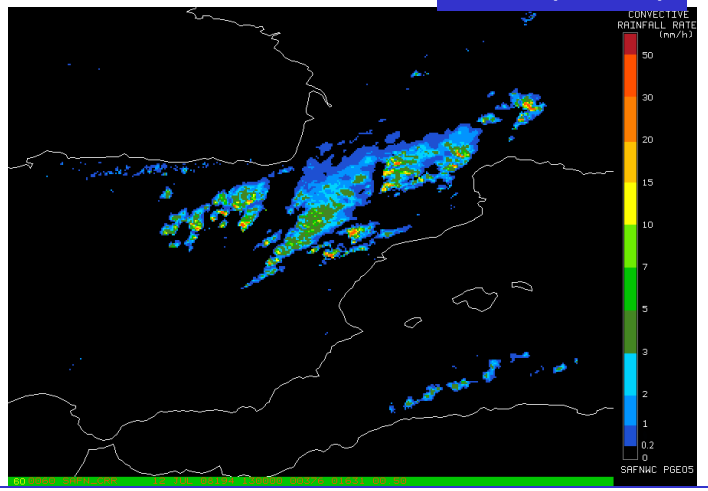
RADAR (PPI)



CRR (PGE05)



CRPh (PGE14)



Thanks for your attention!!