Nowcasting SAF: Convective Rainfall Rate (CRR) and Convective Rainfall Rate from Cloud Physical Properties (CRPh) products

Convection – Event Week 2015
8 – 12 June 2015

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Overview

I. Introduction to EUMETSAT Nowcasting SAF

II. Convective Rainfall Rate (CRR)
   ✓ Algorithm description
   ✓ Applications, limitations and visual examples

III. Convective Rainfall Rate from Cloud Physical Properties (CRPh)
   ✓ Algorithm description
   ✓ Applications, limitations and visual examples

IV. Comparison of Convective Rainfall Rate products (CRR and CRPh): visual examples
The Nowcasting Satellite Application Facility was established in 1996 between Eumetsat and INM (Instituto Nacional de Meteorología).

**Consortium:**

- **AEMet**
- **METEO FRANCE**
- **SMHI**
- **ZAMG**

**Objectives:**

- Development of Nowcasting products derived from both GEO and PPS satellite systems
- To be delivered to users as SW Packages

**Responsible for**

- Development and maintenance of the NWC products
- Development and maintenance of the SW Packages
- User's support tasks made through dedicated Help Desk (training)
Introduction to EUMETSAT NWCSAF

Products are generated in the users’ premises

Features of the products:
  • Near Real Time (NRT)
  • Full resolution
  • Frequency to be selected by the user (default every repeat cycle)
  • Region to be selected by the user

More information on the project is available at Nowcasting SAF Web site:

http://www.nwcsaf.org
Introduction to EUMETSAT NWCSAF

MSG Cloud Products
- Cloud Mask
- Cloud Type
- Cloud Top Temperature and Height

MSG Precipitation Products
- Precipitating Clouds
- Convective Rainfall Rate
- Prec. Prod. Cloud Physical Properties

MSG Clear Air Products Physical Retrieval
- Total Precipitable Water
- Layer Precipitable Water
- Stability Analysis Imagery

MSG Winds, Conceptual Model and Convection Products
- High Resolution Winds
- Automatic Satellite Image Interpretation
- Rapid Development Thunderstorms

PGEs Execution Time
- The general input data for running NWCSAF software are:
  - MSG package: MSG SEVIRI data and NWP (in some of them).
  - PPS package: AVHRR/3 data and NWP (in some of them).
- The user should be aware that using old NWP data might reduce the quality of the product.
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

AUXILIARY DATA
- Satellite Zenith Angle
- Saturated Vapour lookup table
- Digital terrain elevation (USGS)
- Climatological Profiles (NWP unavailable)

Corrections:
- Humidity
- Evolution/Gradient
- Orography
- Parallax

Analytical Functions

Lightning Information

NWP
- Psfc
- T y Td (2m)
- T y HR (P levels)
- Z (P levels)
- U, V (850 hPa)

Bilinear Interpolation

SEVIRI
- VIS0.6
- WV06.2
- IR10.8

DAY

NIGHT

HDF5
- Instantaneous Rain Rates
- Hourly Accumulations

PGE05 YYYYMMDDhhmm region config_file

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8 – 12 June 2015
Convective Rainfall Rate (CRR)

Moisture Correction: (PWRH)
Depends on total precipitable water (surface-500 hPa) and relative humidity

No corrections applied

Only Moisture correction applied
**Convective Rainfall Rate (CRR)**

**Moisture Correction : (PWRH)**

Depends on total precipitable water (surface- 500 hPa) and relative humidity

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**11\textsuperscript{th} Dec 2013 – 03:00 UTC**

**No corrections applied**

**Only Moisture correction applied**
Convective Rainfall Rate (CRR)

Evolution Correction / Gradient Correction:

Evolution Correction:
Rain rate decreases if the analysed pixel becomes warmer in the second image

Cloud-top Temperature
Gradient Correction:
Rain rate decreases if the analysed pixel has a temperature maximum, which indicates that this pixel is warmer than its surroundings

Radar (PPI) - 10th June 2014 – 17:10 UTC

No corrections applied
**Convective Rainfall Rate (CRR)**

**Parallax correction:**
A spatial shift is applied to every pixel with precipitation according the basic CRR value.

- **Only Moisture correction applied**
- **Moisture + Evolution corrections applied**
- **Moisture + Evolution + Parallax corrections applied**

11th Dec 2013 – 03:00 UTC
Orographic correction:
This correction uses the interaction between the wind vector (taken from the 850 hPa. numerical model) and the local terrain height gradient in the wind direction to create a multiplier that enhances or diminishes the previous rainfall estimate, as appropriate.

Convective Rainfall Rate (CRR)

Moisture + Evolution + Parallax corrections applied

Moisture + Evolution + Parallax + Orographic corrections applied

11th Dec 2013 – 03:00 UTC
Convective Rainfall Rate (CRR)

Orographic correction

Moisture + Evolution + Parallax corrections applied

Moisture + Evolution + Parallax + Orographic corrections applied

11th Dec 2013 – 03:00 UTC

Tijarafe-Mirador Time (28.67N, 17.94W)

10 min precipitation accumulation (mm)

Time (UTC)

11th Dec 2013 – 08:30 UTC

Adeje-Caldera B (28.08N, 16.71W)

10 min precipitation accumulation (mm)

Time (UTC)

8 – 12 June 2015
The Lightning algorithm assumes that the higher are the spatial and temporal density of lightning, the higher are the probability and the intensity of convective precipitation.

The rain rates assigned to every lightning takes into account:
- the time distance between the lightning event and scanning time of the processing region centre.
- the location of the lightning.
- the spatial density of lightning in a time interval.

Only Cloud-to-Ground lightning flashes are used by this algorithm.
Convective Rainfall Rate (CRR)

OUTPUTS:

- CRR rainfall rates expressed in classes
- CRR rainfall rates expressed in mm/h
  *(required for hourly accumulations)*
- CRR Hourly Accumulations
- CRR-QUALITY
- CRR-DATAFLAG
Convective Rainfall Rate (CRR)

Problems:

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

Different result for day and night
Applications: Estimation of rain rates for convective events over extensive areas, out of the radar coverage or as a radar compliment.
Links between SAF/NWC products

Use of CRR in RDT (Rapid Development Thunderstorm)—Implemented in v2012

RDT takes advantage of CRR data and different **options** are proposed to the users

- **CRR** can be used to identify maximum **convective rain rate under cloud cell**
- **High CRR values** can help to qualify a cloud cell as **significant** and thus to encode this cell in BUFR output (only for the last BUFR version)
- **Very high CRR values** can be used to set diagnosis of **convection to « YES »** (only for the last BUFR version)

**Convection – Event Week 2015**
8 – 12 June 2015
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.
Convective Rainfall Rate from Cloud Physical Properties (CRPh)

Input/output scheme

- **NWP**
  - T (P levels)
  - Z (P levels)

- **Bilinear Interpolation**

- **Parallax Correction**

- **PGE14 YYYYMMDDhhmm region config_file**

- **PoP = f (CWP)**

- **HDF5**
  - PCPh
  - CRPh (Instantaneous)
  - CRPh (Accumulated)
  - Illumination Flag

- **AUXILIARY DATA**
  - Sun Zenith Angle
  - Satellite Zenith Angle

- **Phase COT Reff**

- **CT**

- **SEVIRI**
Convective Rainfall Rate from Cloud Physical Properties (CRPh)

CRPh OUTPUTS:
- Rainfall rates from 0.0 to 51.0 mm/h with a step of 0.2 mm/h.
- CRPh Hourly Accumulations
- CRPh Illumination Quality Flag
- CRPh _QUALITY
- CRPh_DATAFLAG
Convective Rainfall Rate from Cloud Physical Properties (CRPh)

Limitations:
- Only day time
- Only for estimated phase
- High dependence on illumination conditions
Comparison of Convective Rainfall Rate products (CRR and CRPh)

CRPh cons and pros with respect to CRR:

CONS:
• Only day time
• Only for estimated phase
• High dependance on illumination conditions

PROS:
• Precipitation areas and intensities closer to the radar ones
• Improvement of the Cold Rings problem
• Detection of smaller precipitation nuclei
• Detection of precipitation for warm top clouds
Comparison of Convective Rainfall Rate products (CRR and CRPh)

Precipitation areas and intensities closer to the radar ones

2 July 2014 15:00 UTC
Comparison of Convective Rainfall Rate products (CRR and CRPh)

No Cold Rings and detection of smaller precipitation nuclei

9th September 2008 13:00 UTC
Comparison of Convective Rainfall Rate products (CRR and CRPh)

Detection of precipitation for warm top clouds

11th August 2012 14:00 UTC
Comparison of Convective Rainfall Rate products (CRR and CRPh)

13\textsuperscript{th} June 2014
17:00 UTC
Thanks for your attention!!