SAF on Support to Nowcasting and Very Short Range Forecasting

Xavier Calbet (xcalbeta@aemet.es)

Javier Sanz, Javier García Pereda, Pilar Rípodas

6-9 June 2017

Roshydromet Training Event

CONTENTS

1. Introduction to the NWC SAF

2. NWC SAF Practical Guide with Examples

3. Summary

EUMETSAT SAF Network

- **EUMETSAT European Organization for the Exploitation of Meteorological Satellites**
- **Purpose: to supply weather and climate-related satellite data, images and products to the National Meteorological Services of its Member and Cooperating States in Europe, and other users worldwide.**
- **EUMETSAT HQ in Darmstadt, Germany.**
- **SAFs (Satellite Application Facilities):**
  - **located at Weather Services in EUMETSAT Member and Co-operating States**
  - **complement production of standard meteorological products at EUMETSAT central facility**

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EUMETSAT SAF Network

SAFs are specialized on topics and themes:

- SAF on Climate Monitoring (CM SAF), cm-saf.eumetsat.int
- SAF on Support to Operational Hydrology and Water Management (H SAF), h-saf.eumetsat.int
- SAF on Land Surface Analysis (LSA SAF), lsa-saf.eumetsat.int
- SAF on Numerical Weather Prediction (NWP SAF), nwp-saf.eumetsat.int
- SAF on Atmospheric Chemistry Monitoring (AC SAF), ac-saf.eumetsat.int
- Ocean and Sea Ice (OSI SAF), osi-saf.eumetsat.int
- SAF on Radio Occultation Meteorology, rom-saf.eumetsat.int
- SAF on support to Nowcasting (NWC SAF), nwc-saf.eumetsat.int

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NWC SAF concept: objectives

- ✓ **The general objective of the NWC SAF is to provide operational services to ensure the** optimum use of meteorological satellite data in Nowcasting and Very Short Range Forecasting **by targeted users.**
- ✓ **All products declared operational have been Validated. NWC SAF products for IODC (MSG-1) are not Calibrated/Validated for this region.**
- ✓ **To achieve this goal , the NWC SAF is responsible for the development and maintenance of appropriate** SW Packages (GEO and POLAR Satellites), **as well as of all related tasks for** user's support.

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NWC SAF Software Packages

Geostationary Satellites:

GEO v2016, available since November 2016

Applicable to MSG data, GOES-N (limited to a few products)

Continuous monitoring, space resolution and illumination conditions good for low and middle latitudes

Polar Satelites:

PPS v2014: available to users since October 2014

Process data from the joint polar system (EUMETSAT and NOAA polar satellites)
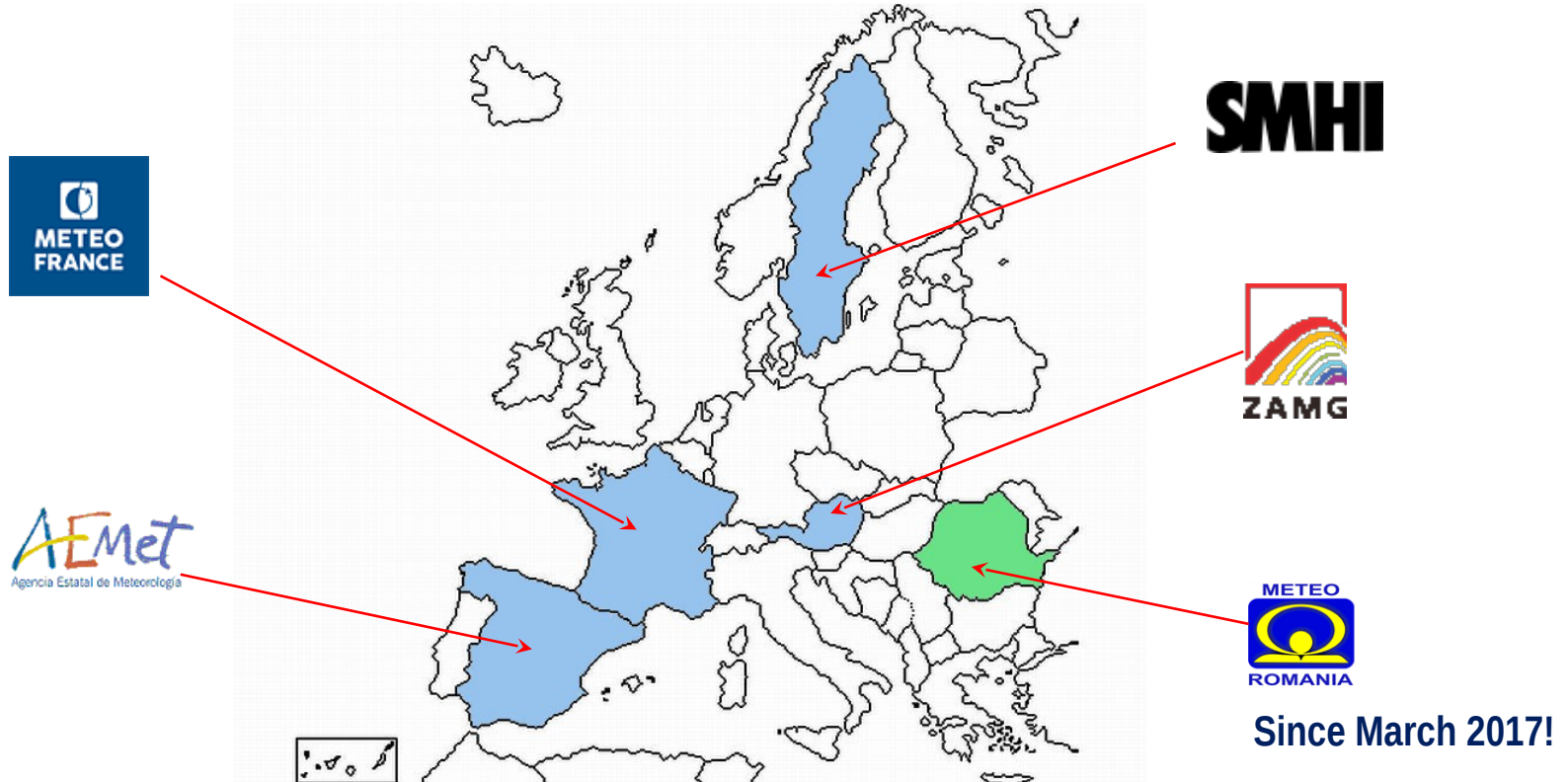
New version planned for 2018

Relatively good coverage for high latitudes

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NWC SAF Software

The software is distributed freely to registered users of the meteorological community and is used for Nowcasting and as a development and research tool

➢ The user runs the SW package and generates the products

➢ Advantage: users can configure the SW to fit their needs (e.g. the   user define the area where the products are generated)

➢ Potential problem: users need access to EUMETSAT satellite images and a NWP model output

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NWC SAF Consortium

Since March 2017!

NWC SAF Consortium Responsabilities

- **AEMET:**
  - Leading Entity
  - GEO High Resolution Winds (HRW), Precipitation products and iSHAI (precipitable water and stability analysis)
- **MétéoFrance in Lannion:** GEO Cloud products
- **MétéoFrance in Toulouse:** GEO Convection products
- **ZAMG:** GEO extrapolation imagery products, automatic recognition of meteorological phenomena
- **SMHI:** Cloud and precipitation products for polar satellites
- **NMA:** some tasks related to quality assessment and prototype products for MTG-LI

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NWC SAF User Services (to registered users)

- **NWC SAF helpdesk (nwc-saf.eumetsat.int):**
  - ✓ SW packages to download
  - ✓ Other tools (provided on a best effort basis)
  - ✓ Documentation (users manuals, products algorithm description, validation reports, ...)
  - ✓ Reference System
  - ✓ Contact to NWC SAF developers sending a "ticket" (formerly mailbox)
- **Training events. Recent and coming events:**
  - ✓ WMO WWRP & CAeM Aviation Research Demonstration Project (AvRDP) Training Workshop, 20-22 July 2016, Hong Kong
  - ✓ EUM-ROSH Training event, Moscow, 6-9 June 2017
  - ✓ Autumn School on the use of satellite data on nowcasting high impact weather , Thessaloniki, Greece, 11-15 September 2017
- **Online Workshops**
  - ✓ PPS v2014
    http://www.eumetrain.org/resources/NWCSAF_tutorial_2015.html
  - ✓ GEO v2016
    http://www.eumetrain.org/resources/msg_geo_engineering_ws_v2016.html

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New SW Package: GEO v2016

- Available since November 2016

- Previous operational version is MSG v2013

- GEO v2016 vs. MSG v2013: main improvements/changes:
  - ✓ Scientific Improvement in some products
  - ✓ New products: (CMIC, CI, ASII-NG,EXIM)
  - ✓ Adaptation of some products to GOES-N satellites
  - ✓ New output format: NetCDF

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NWC SAF Products

- Polar and Geostationary:

  - Clouds → CMA, CT, CTTH, CMIC, CPP (will be CMIC)

  - Precipitation → PC, CRR (only in GEO)

- Geostationary:

  - Instability and Humidity → iSHAI

  - Convection → RDT, CI

  - Winds → HRW

  - Automatic Image Interpretation → ASII, ASII-NG

  - Image Extrapolation → EXIM

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NWC SAF GEO Clouds

- ## CMA: Cloud Mask

  - Mask, Cloud/Snow, Dust, Volcannic Ash

- ## CT: Cloud Type

  - Type, Cumuliform, Multilayer

- ## CTTH: Cloud Top Temperature and Height

  - Altitude, Effective Amount, Pressure, Temperature

- ## CMIC: Cloud Microphysics

  - Optical Thickness, Ice Water Path, Liquid Water Path, Phase, Effective Radius

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NWC SAF GEO Precipitation

- PC: Precipitating Clouds

  - Precipitating probability with and without Physical Properties

- CRR: Convectice Rainfall Rate

  - Rainfall Rate, Accumulated, Intensity with and without Physical Properties

NWC SAF GEO Instability and Humidity

- iSHAI: Imaging Satellite Humidity and Instability

  - Humidity at three levels (boundary layer, mid layer, high layer), Totat Precipitable Water, Instability (Lifted, Showwalter, K index), Skin Temperature, Total Ozone, Differences with NWP

NWC SAF GEO Convection

- RDT Rapid Developing Thunderstorm

  - Convectice cell detection and tracking

- CI: Convective Initiation

  - Detection of Convection before its initiation

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NWC SAF GEO Winds

- HRW: High Resolution Winds
  - Winds at various levels

- ASII: Automatic Image Interpretation
  - Automatic detection of Synoptic features

NWC SAF GEO Automatic Interpretation

- ASII: Automatic Image Interpretation

  - Automatic detection of Synoptic feature

- ASII-NG: Automatic Image Interpretation Next Generation

  - Detection of tropopause tubulence, more to come

- EXIM: Extrapolated Images
  - Extrapolation of satellite images and all some of the other NWC SAF products (cloud mask, cloud type, cloud top temperature and height, precipitating clouds, convective rainfall rate)

NWC SAF Practical Guide

NWC SAF or Other Product

sSHAI, iSHAI: Humidity And Instability

CI: Convective Initiation

RDT: Cell Tracking
EXIM: Extrapolate Images

Radar, CRR: Rain Rate

Lightning, MTG-LI

Time

-6 h   -3 h   -1 h   -30 min   0

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NWC SAF Practical Guide

NWC SAF or Other Product

ASII: Automatic Interpretation
EXIM: Image extrapolation

HRW: Winds
CMA, CT, CTTH: Clouds

Time

-6 h   -3 h   -1 h   -30 min   0

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Product Classification
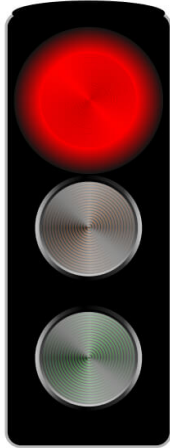
Under Development
Use with great care
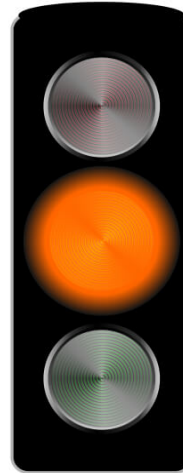
Use with care
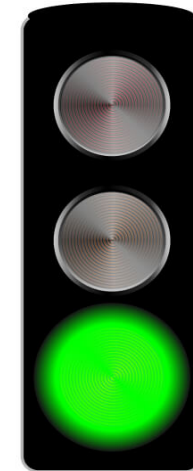
Use with confidence

Practical Guide: iSHAI (1/2)

- SHAI: imager Satellite Humidity And Instability
- Useful to track humidity and instability in clear air scenes
- Normally useful in clear air a few hours (-6 to -1 hr) before convection starts

- Use with Confidence in Clear Sky Scenes

- Use with Care Close to Clouds: Look for Persistence

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Precipitable Water in Middle Layer (850-500 hPa)

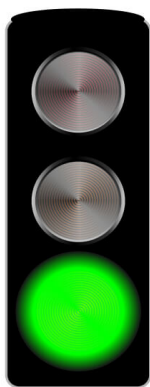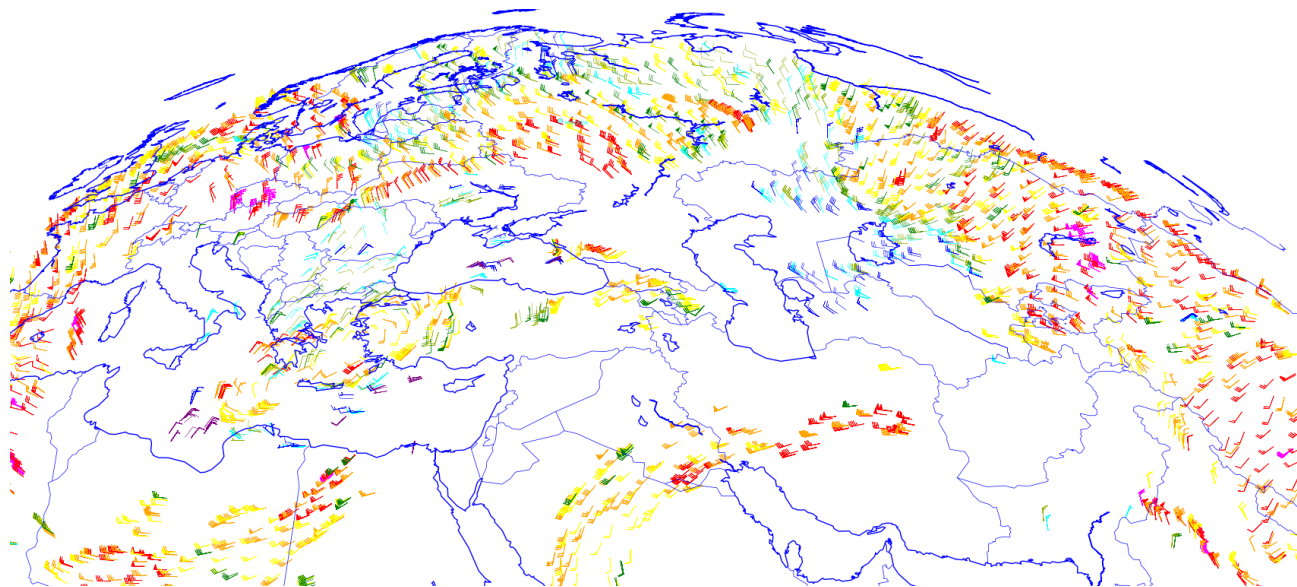S_NWC_iSHAI_MSG1_India-VISIR_20170529T120000Z

iSHAI Precipitable Water in Medium Layer (mm)

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Practical Guide: iSHAI (2/2)

- SHAI: imager Satellite Humidity And Instability
- Useful to track humidity differences with respect to the NWP model at any time there is a clear sky scene
- Regions drier than the model are shown in blue. Regions more humid than the model are shown in red

- Use with Confidence in Clear Sky Scenes

- Use with Care Close to Clouds: Look for Persistence

Precipitable Water Differences in Middle Layer (850-500 hPa) with respect to ECMWF

S_NWC_iSHAI_MSG1_India-VISIR_20170529T120000Z

iSHAI Difference in ML (mm)

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Example iSHAI + HRW → Lead Time: -3 h Date: 23.10.2016

- iSHAI: imager Satellite Humidity And Instability
- HRW: High Resolution Winds
- Obtained with MSG
- Data obtained at 3:00 am
- Moisture river confirmed with NWC SAF

3:00 am iSHAI Boundary Layer Humidity + HRW

- Use with Confidence
- Well Tested Products

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Example iSHAI → Lead Time: -5 h Date: 19.08.2015

- **iSHAI**: imager Satellite Humidity And Instability
- iSHAI showing **big difference with ECMWF**
- Obtained with **MSG**
- Data obtained at **2:00 am**
- It is **persistent in time** at the same location until ~5:00 am
- **RDT** shows cell at **5:15 am**
- **Intense precipitation** at around **07:00 am**

- Use with Confidence in Clear Sky Scenes

- Use with Care Close to Clouds: Look for Persistence

2:00 am iSHAI Boundary Layer Humidity Difference with respect to ECMWF
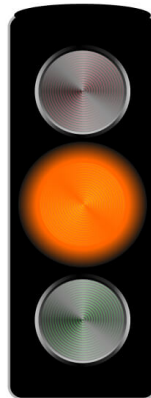
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Practical Guide: HRW

- HRW: High Resolution Winds
- Convergence regions and strong winds at lower levels are sometimes visible
- Very useful products of general purpose (any time)
- Easy to interpret

HRW Winds at different levels (low levels in blue)

- Use with Confidence
- Well Tested Product

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- HRW: High Resolution Winds
- HRW showing convergence in the region of interest
- Very useful products of general purpose (any time)
- Easy to interpret
- Obtained with MSG
- Data obtained at 4:00 am
- RDT shows cell at 5:15 am
- Intense precipitation at around 07:00 am

- Use with Confidence
- Well Tested Product

4:00 am HRW Winds at different levels (low levels in blue)
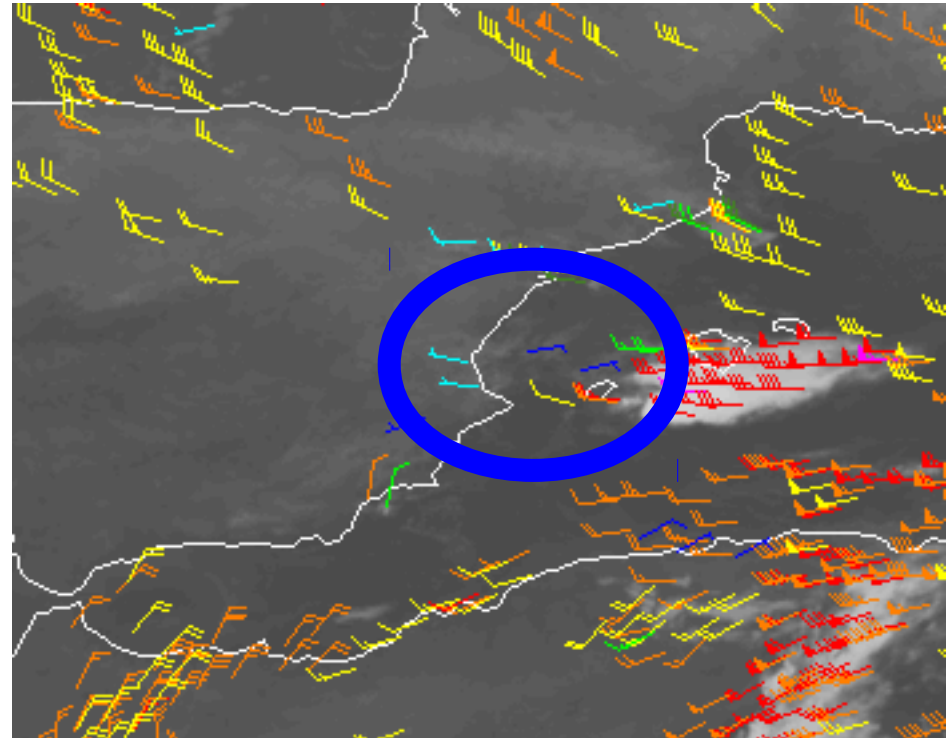
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Example iSHAI + HRW → Lead Time: -3 h Date: 23.10.2016

- iSHAI: imager Satellite Humidity And Instability
- HRW: High Resolution Winds
- Obtained with MSG
- Data obtained at 3:00 am
- Moisture river confirmed with NWC SAF

3:00 am iSHAI Boundary Layer Humidity + HRW

- Use with Confidence
- Well Tested Products

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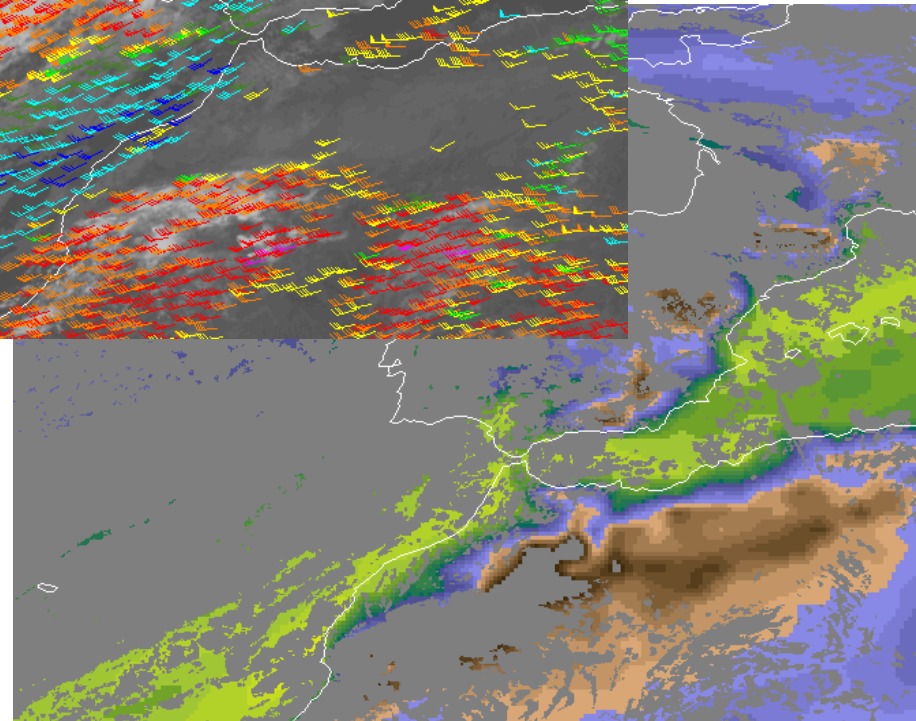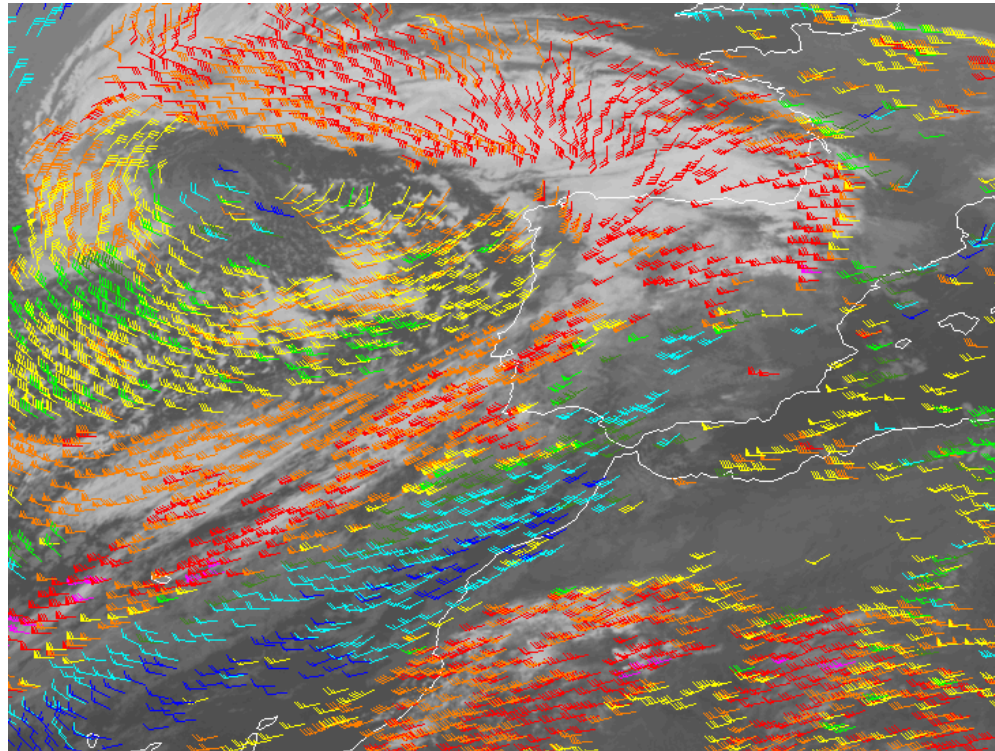
Product Guide: RDT

- RDT: Rapid Developing Thunderstorm
- Very useful product for Cell Tracking, Detection and Evolution
- Cells are shown as polygons
- Color indicate cell evolution stage (red: growing, purple: mature, blue:decaying)
- Thickness of line indicate severity
- Overshooting tops are shown as green circles
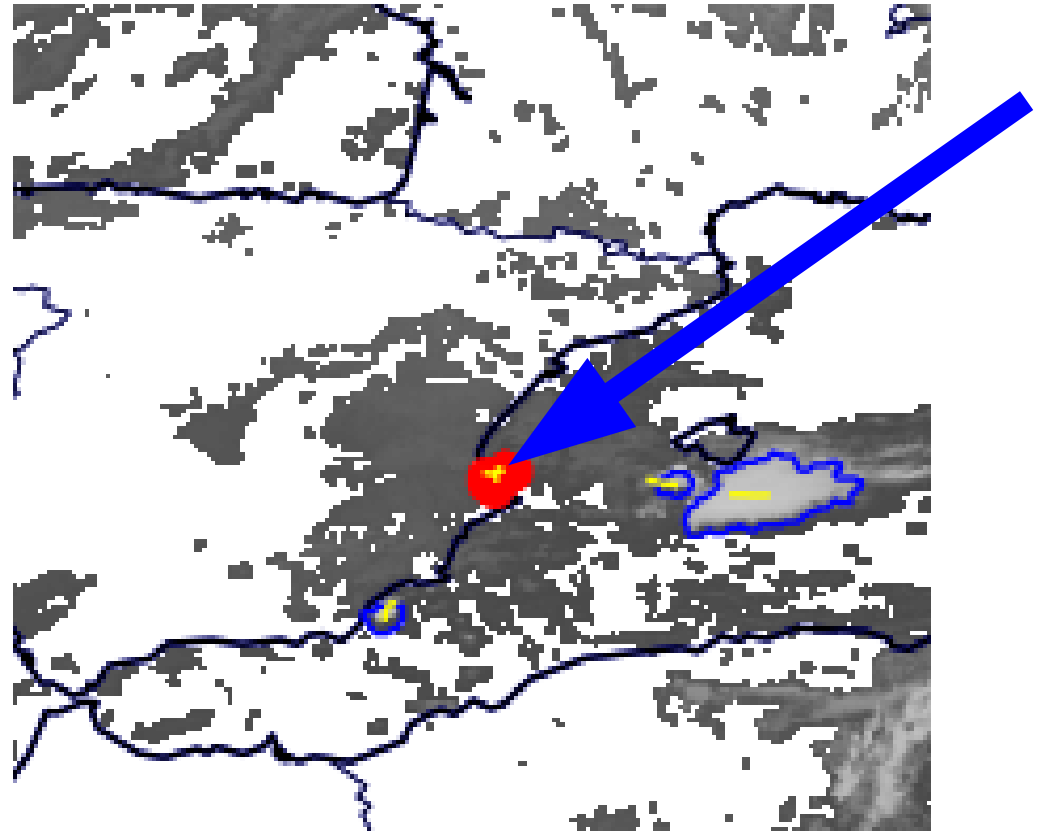- Yellow line: past 1 hour track
-          line: future 1 hour track

RDT

- Use with Confidence
- Well Tested Product

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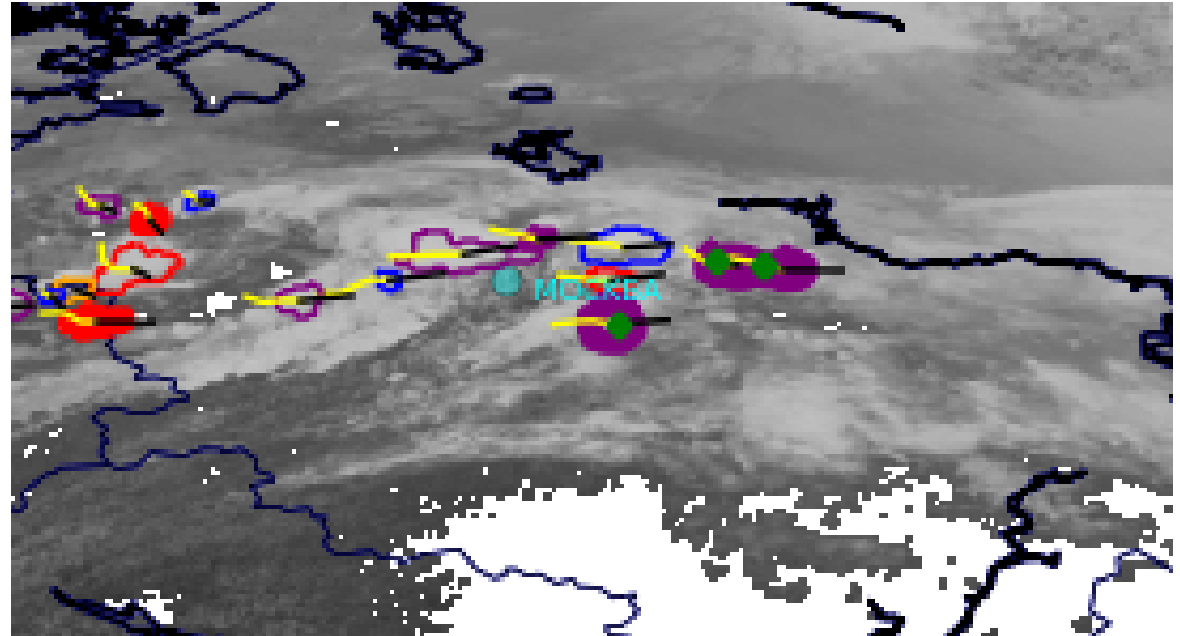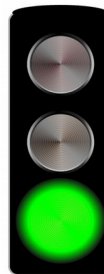
Example RDT → Lead Time: -2 h Date: 19.08.2015

- **RDT**: Rapid Developing Thunderstorm
- Cell Tracking, Detection and Evolution product
- Fast Developing Cell shown
- Cell is shown 15 min before it appears on the Radar
- Obtained with MSG
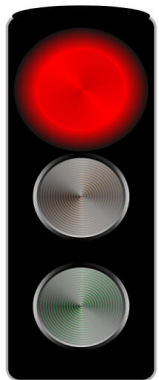- Data obtained at 5:15 am
- Intense precipitation at around 07:00 am

- Use with Confidence
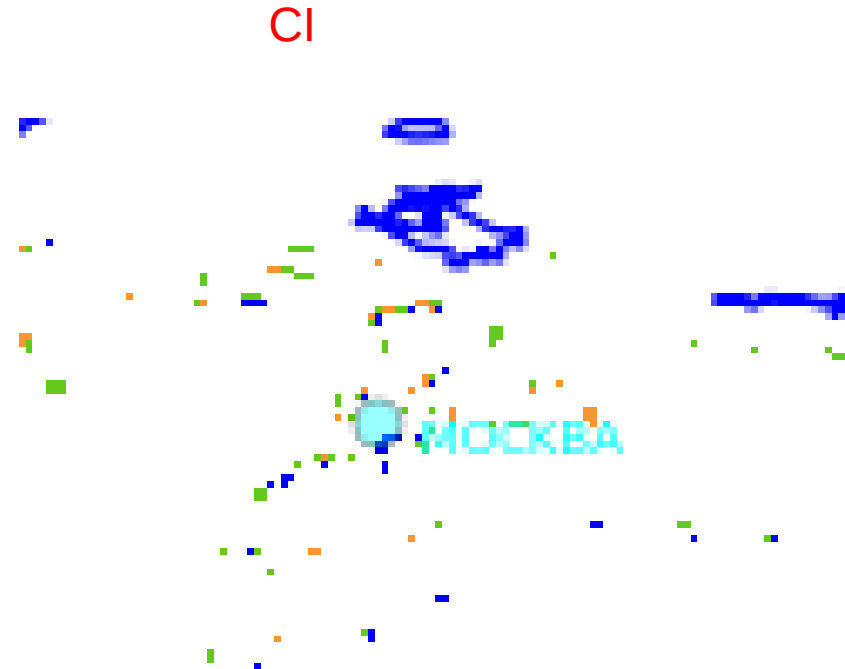- Well Tested Product

5:15 am RDT

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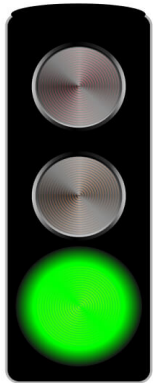
Practical Guide: CI

- CI: Convective Initiation
- Detects Growing Cells which will become Storms
- Detects Cells before Radar
- Still under development

CI

МОСКВА

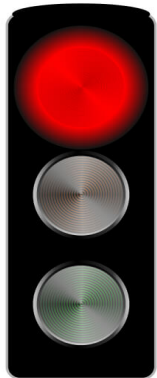- Demonstrational
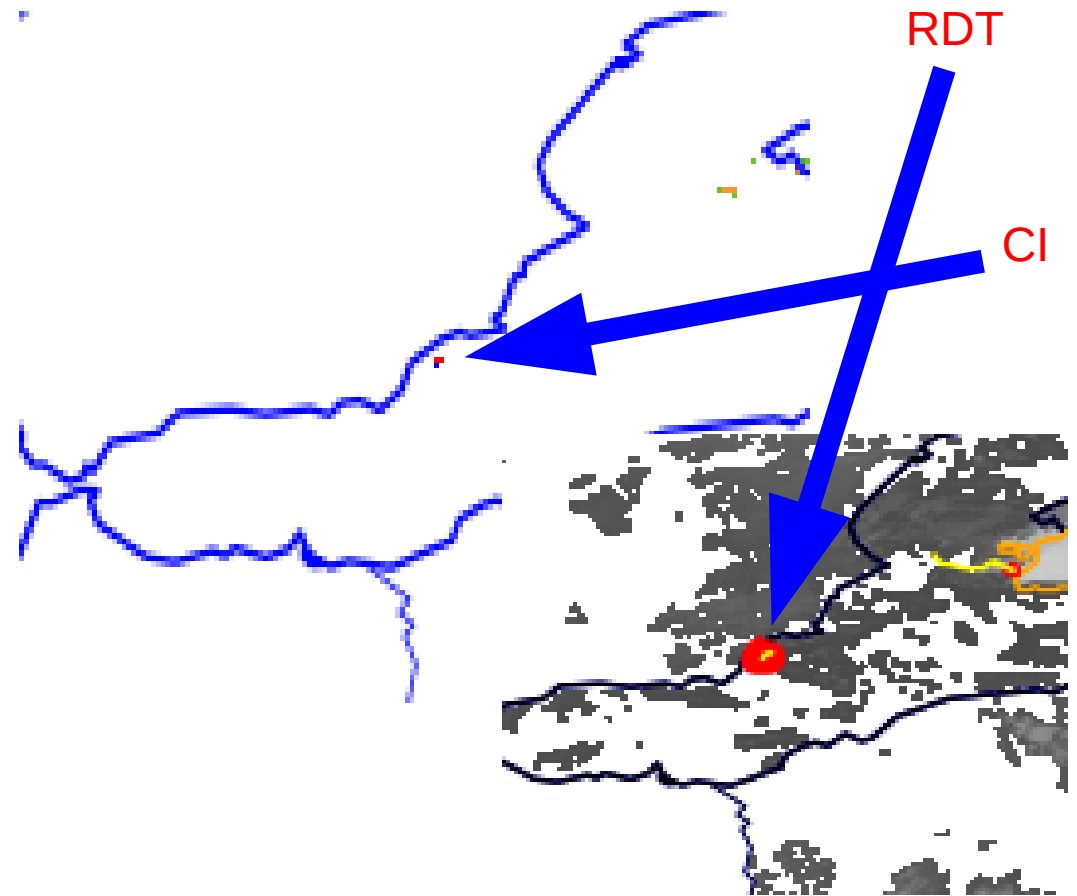- Under Development, but Promising
- Current version with many False Alarms

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Example CI → Lead Time: -1 h Date: 19.08.2015

- CI: Convective Initiation
- Detects Growing Cells which will become Storms
- Detects Cells before Radar
- Fast Developing Cell shown
- Cell is shown 45 min before it appears in RDT
- Obtained with MSG
- Data obtained at 3:45 am (CI) and 4:30 am (RDT)

- Demonstrational
- Under Development, but Promising
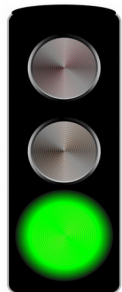- Current version with many False Alarms

3:45 am CI and 4:30 am RDT

RDT

CI

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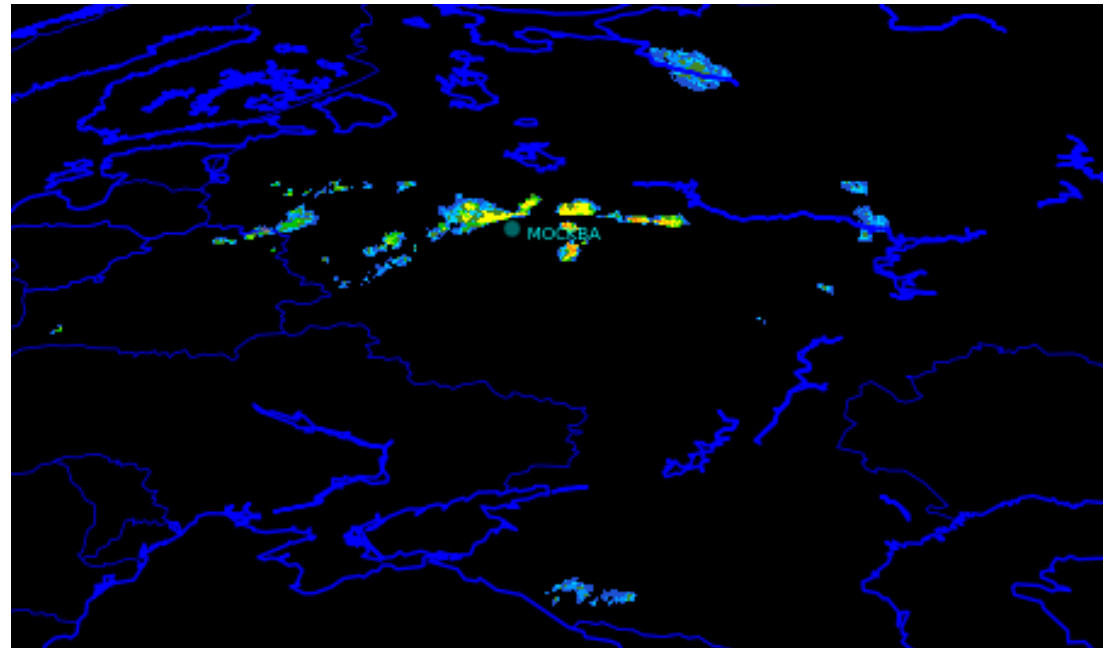
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Practical Guide: CRR

- PC, PCPh, CRPh, CRR: Precipitation Products
- Detects Rain indirectly from Cloud Tops
- Useful when Radar is Off
- Radar is better when available
- Radar and CRR usually do not overlap exactly
- Differences between day and night products

- Use with Confidence
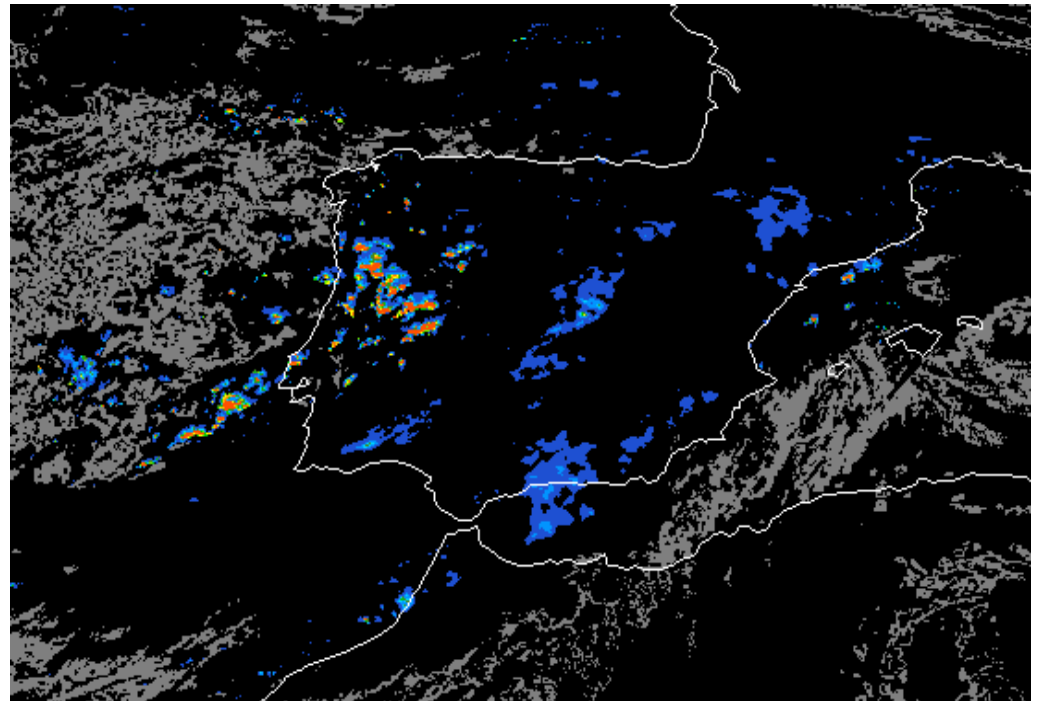- Well Tested Product
- Know its limitations

CRR

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- PC, PCPh, CRPh, CRR: Precipitation Products
- Detects Rain indirectly from Cloud Tops
- Useful when Radar is Off
- Radar is better when available
- Radar and CRR usually do not overlap exactly
- Differences between day and night products
- Obtained with MSG
- Data obtained at 13:15

- Use with Confidence
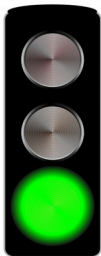- Well Tested Product
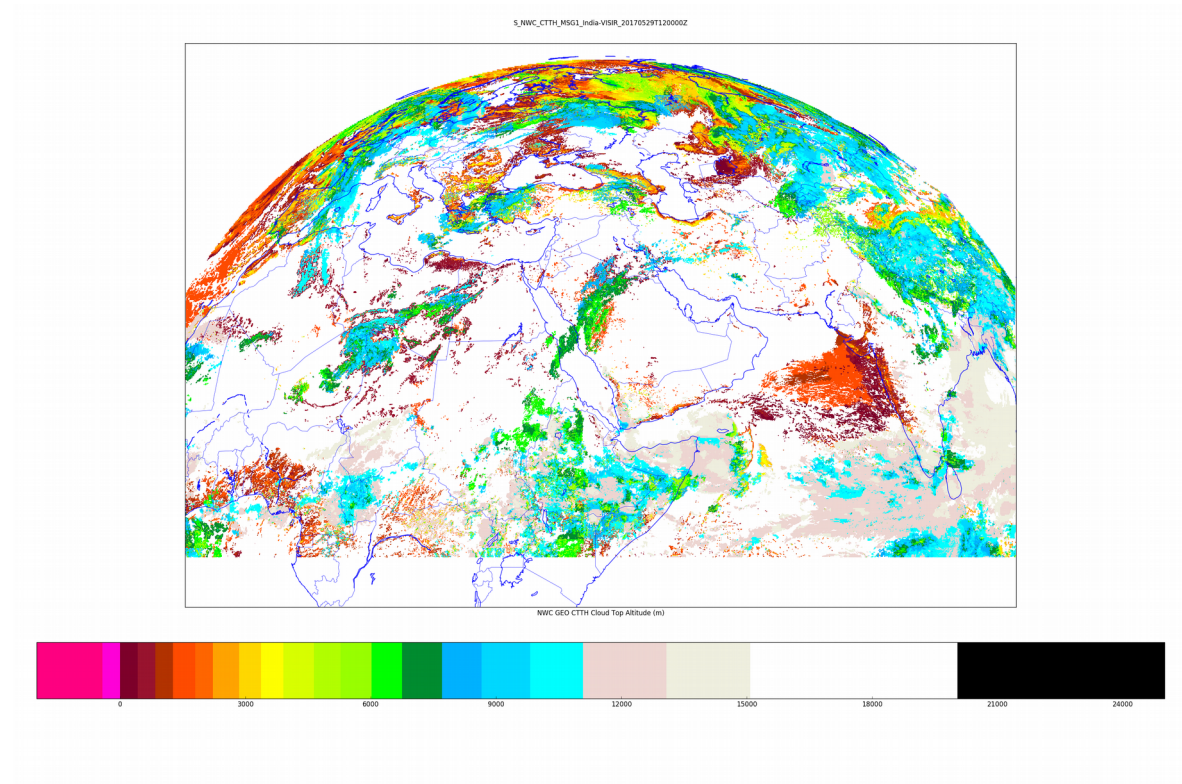- Know its limitations

13:15 CRPh Precipitation Intensity

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Practical Guide: Cloud Products

- **CMa, CT, CTTH, CMIC**: Cloud Mask, Cloud Type, Cloud Top, Cloud Microphysics, etc.
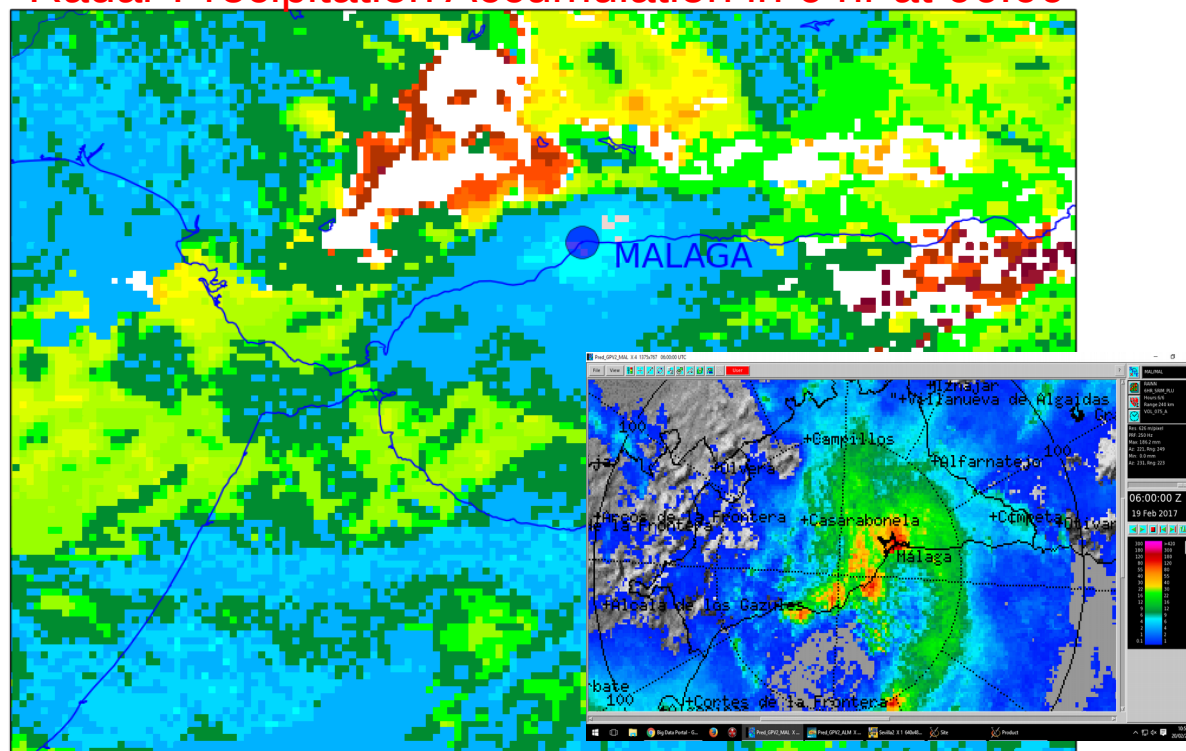- **Very useful** products of **general purpose** (any time)
- **Easy to interpret**

- Use with Confidence
- Well Tested Product

CTTH Cloud Top Height (m)

S_NWC_CTTH_MSG1_India-VISIR_20170529T120000Z

NWC GEO CTTH Cloud Top Altitude (m)

0   3000   6000   9000   12000   15000   18000   21000   24000

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- **CMa, CT, CTTH, CMIC**: Cloud Mask, Cloud Type, Cloud Top, Cloud Microphysics, etc.
- **Very useful** products of **general purpose** (any time)
- **Easy to interpret**
- Obtained with **MSG**
- Data obtained at **3:00 am**
- **Torrential rain** at **3:00 am**
- **Radar** had **Echotops of 8.5 km** giving a **wrong cloud top height** impression
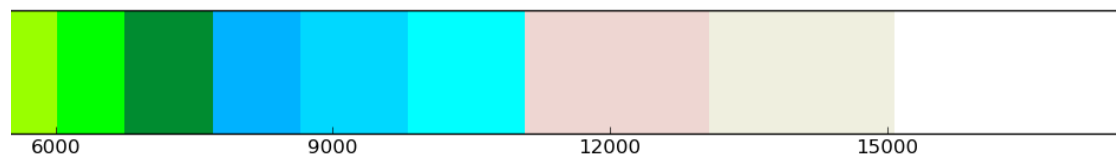- **CTTH** was giving up to **12 km cloud tops**
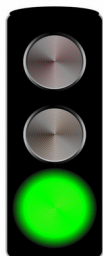
- Use with Confidence
- Well Tested Product

3:00 CTTH Cloud Top Height (m) and Radar Precipitation Accumulation in 6 hr at 06:00
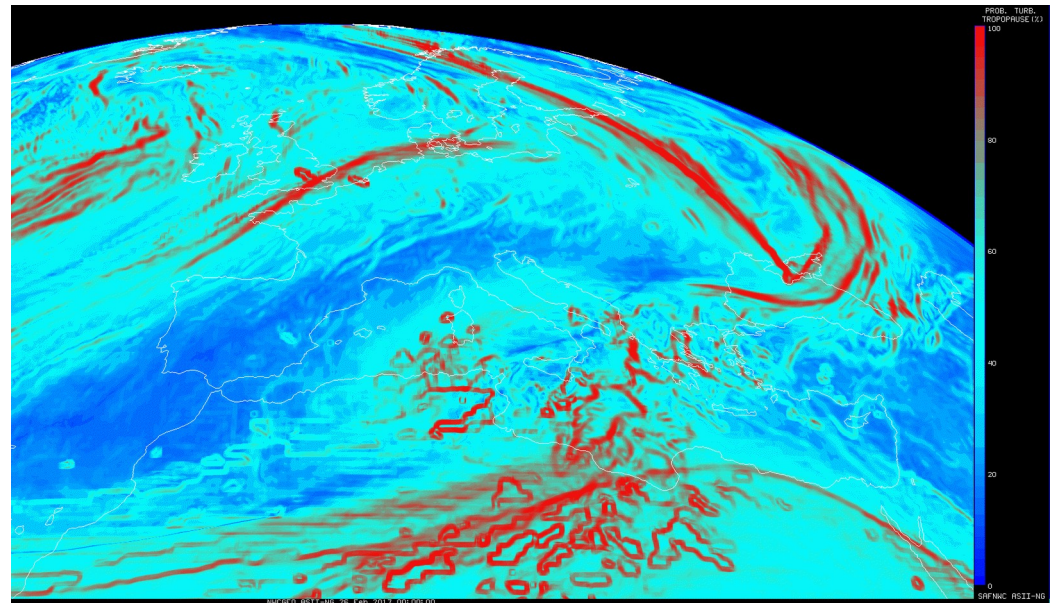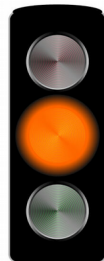

NWC GEO CTTH Cloud Top Altitude (m)

6000   9000   12000   15000

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MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE

AEMet
Agencia Estatal de Meteorología

Practical Guide: ASII-NG

Date 26.02.2017 Time: 00Z

- ASSI-NG: Currently detects tropopause folding
- These are areas where turbulence close at tropopause altitudes is likely to occur
- High turbulence probability regions are shown in red

- Use with care
- Product not fully Validated
- User Feedback is welcome

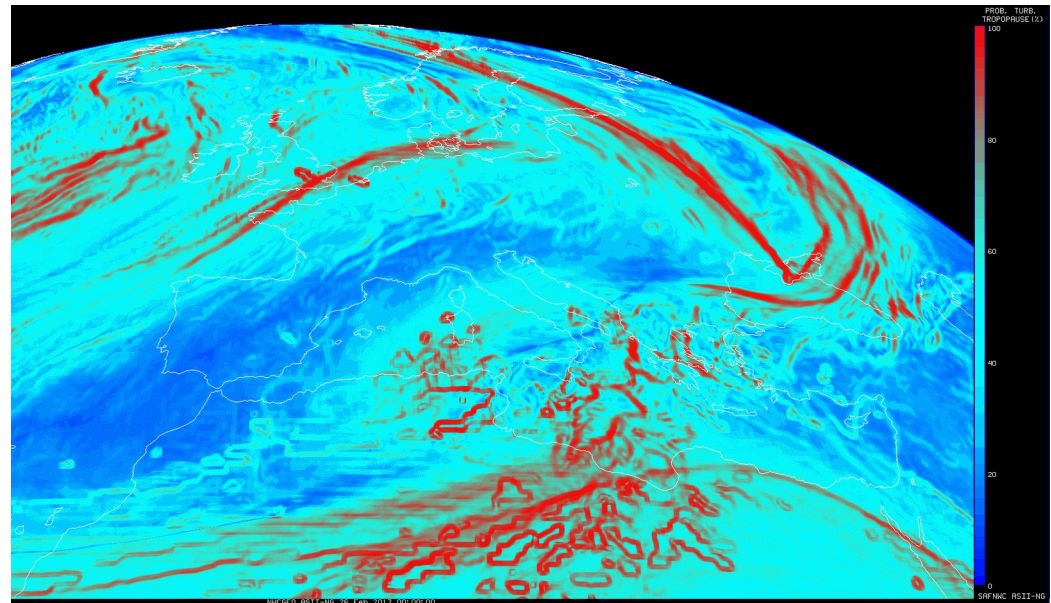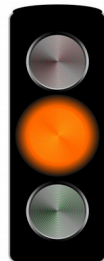**EUMETSAT**

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Example ASII-NG → Tropause Turbulence Detection

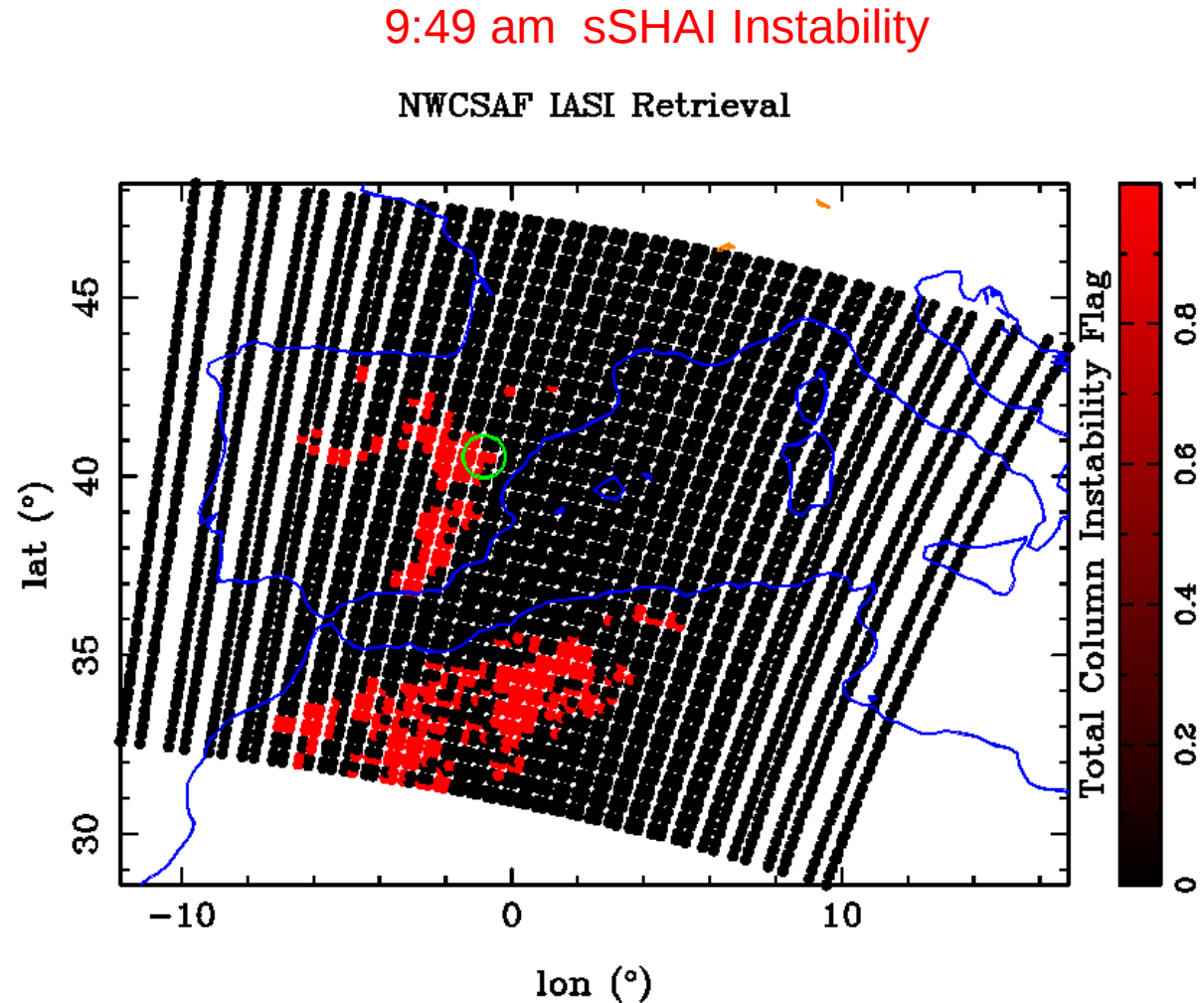Date 26.02.2017 Time: 00Z

- **Turbulence Reported** over **Area of Black Sea** and **Caspian Sea**

- Use with care
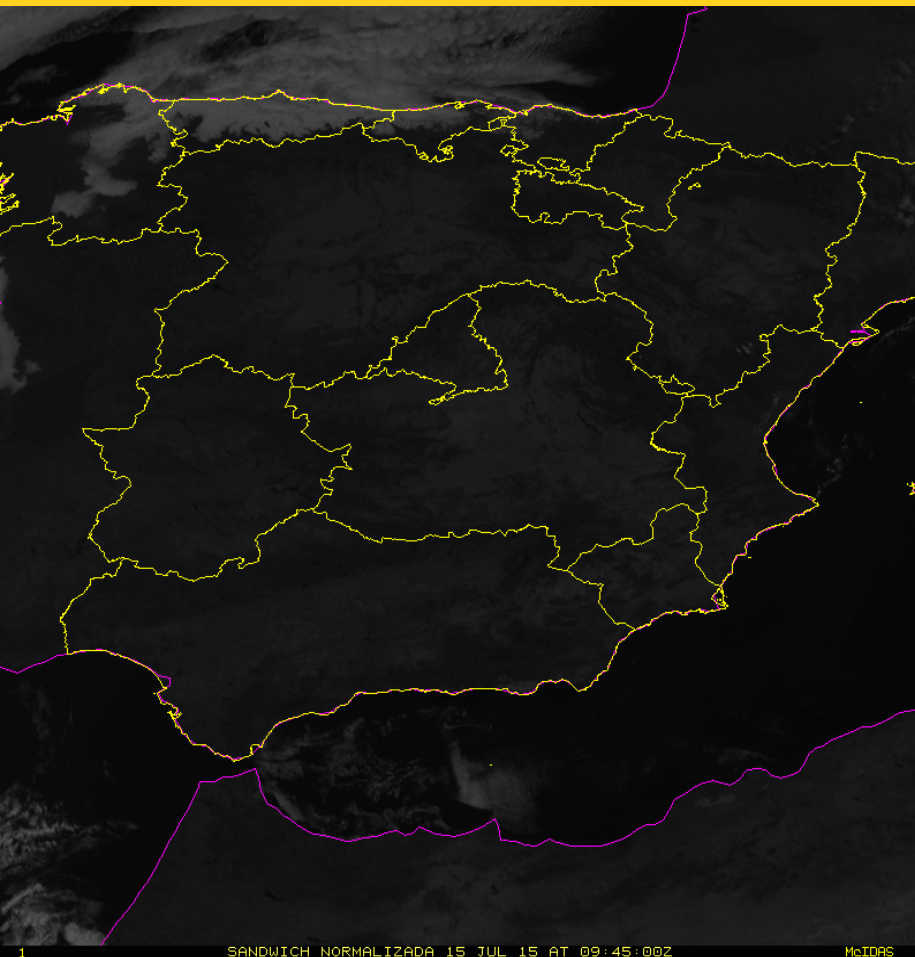- Product not fully Validated
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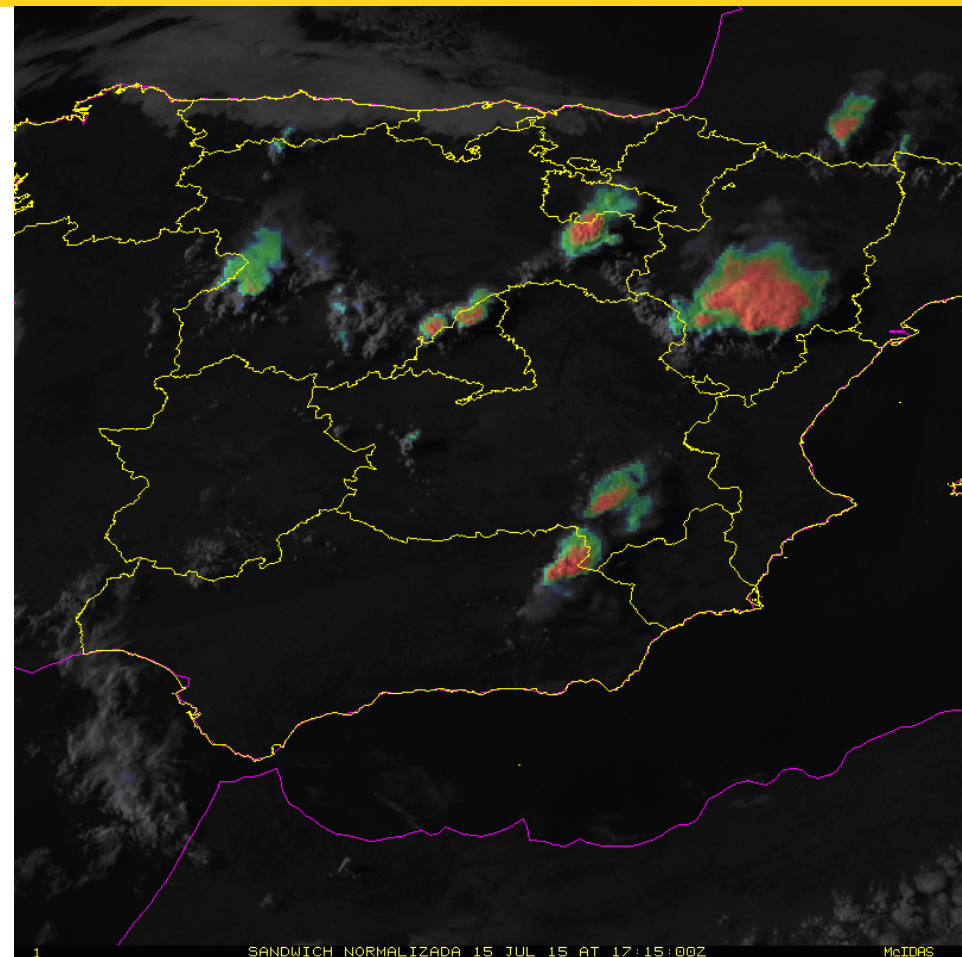AEMet
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- **sSHAI**: sounder Satellite Humidity And Instability
- Obtained with **IASI** as proxy for MTG-IRS
- Data obtained at **9:49 am**
- Useful for days when **synoptic conditions do not change** significantly
- Typically on **solar triggered convection** (summer)

9:49 am sSHAI Instability

NWCSAF IASI Retrieval

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Example sSHAI → Meteosat RGB Images

9:45 Z

17:15 Z

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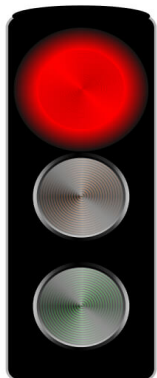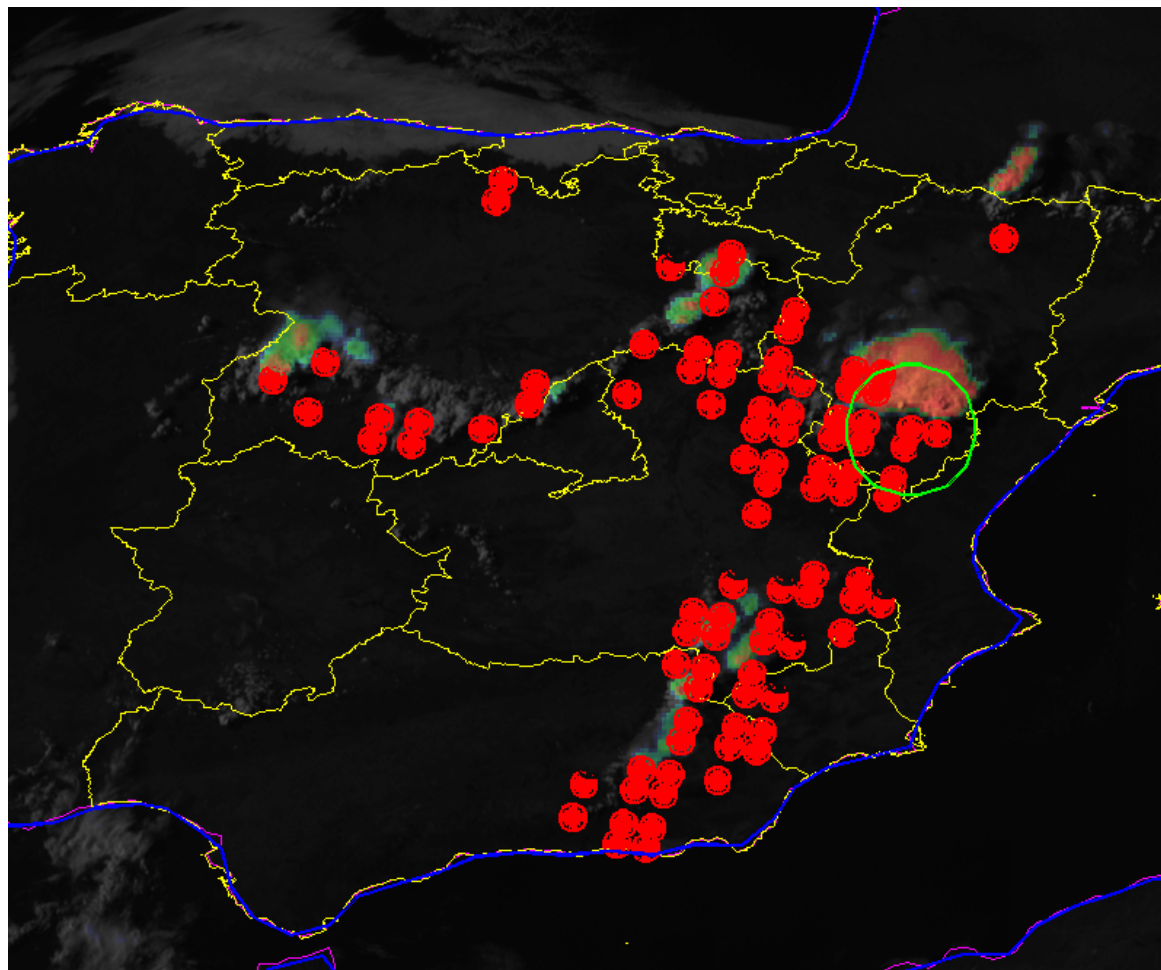
Example sSHAI → Lead Time: -9 h

- **sSHAI**: sounder Satellite Humidity And Instability
- Obtained with IASI as proxy for MTG-IRS
- Data obtained at 9:49 am
- Useful for days when synoptic conditions do not change significantly
- Typically on solar triggered convection (summer)

- Under Development
- Use with great care
- Product NOT Operationally Available

9:49 am sSHAI Instability over 17:15 MSG image

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Summary

- NWC SAF Products are useful for Nowcasting and other applications

- Users can run the software on their computer and taylor it to their needs

- Helpdesk available to users with very quick response time

- More information at nwc-saf.eumetsat.int