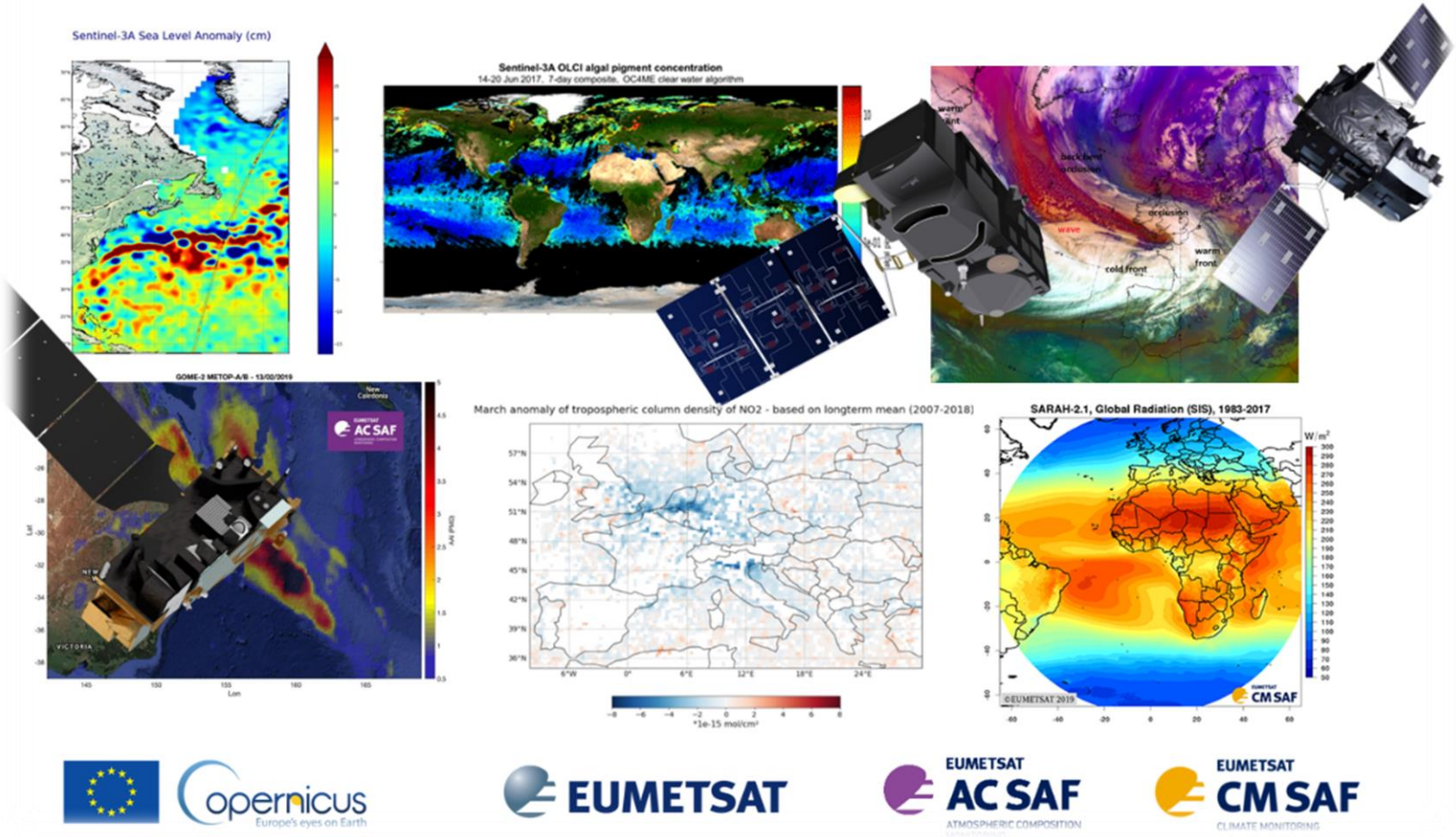
Welcome to the 14th short online course in the series
The session will begin at 12 UTC



Copernicus Europe's eyes on Earth

EUMETSAT

EUMETSAT AC SAF ATMOSPHERIC COMPOSITION

EUMETSAT CM SAF CLIMATE MONITORING

If you have technical issues, please send a message in the chat box to **Support**.

For **Q&A**: go to Slido.com – event code: **#EUMSC14**

Upcoming Short Courses

- **19 May**, 13 UTC - **Exploring the EUMETSAT Land-Surface Temperature Data Records**

Anke Duguay-Teztlaff (MeteoSwiss, CM SAF), Joao Martins (LSA SAF, IPMA) and Christine Traeger Chatterjee (EUMETSAT).

- **31 May**, 11 UTC **- EUMETSAT New Data Services for Data Centre Users - Accessing and Tailoring SEVIRI 1.5 Data**

Pablo Benedicto, Elena Nikolaeva, Sabine Pol Moreno and Harald Rothfuss (EUMETSAT)

- **16 June**, 13 UTC - **A Climate Data Record of Soil moisture in the root zone**

David Fairbairn (ECMWF; H SAF), Christine Traeger Chatterjee (EUMETSAT).

https://training.eumetsat.int/

→Events → Short Courses

Register at:
https://training.eumetsat.int/course/index.php?categoryid=97

EUMETSAT is an intergovernmental Organization

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POLAND
PORTUGAL
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SLOVAK REPUBLIC
SLOVENIA
SPAIN
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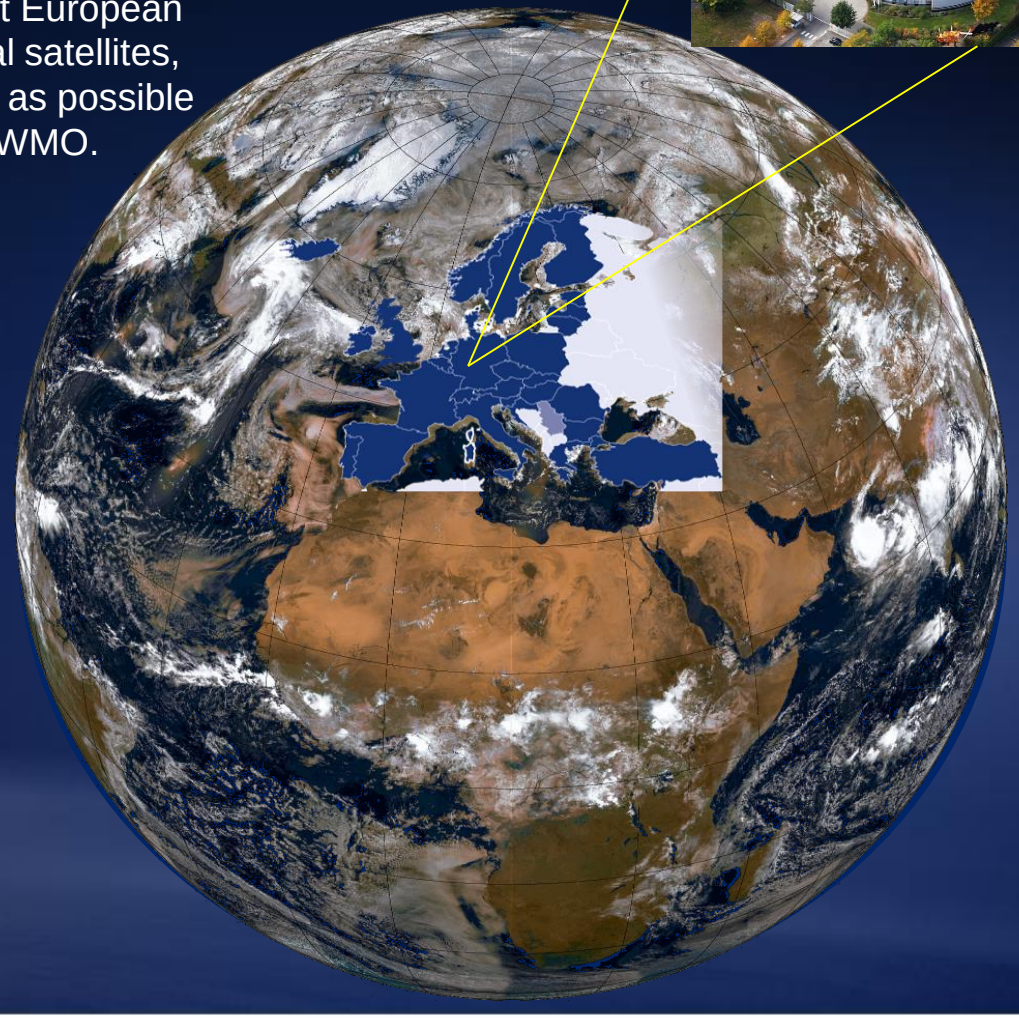
SWITZERLAND
TURKEY
UNITED KINGDOM

Tasks

- Develop, maintain, exploit European systems of meteorological satellites, taking into account as far as possible the recommendations of WMO.
- Contribute to operational climate monitoring and the detection of global climatic changes.



Current EUMETSAT Satellites

METOP-A, -B, & -C

LOW EARTH, SUN-SYNCHRONOUS ORBIT

EUMETSAT POLAR SYSTEM (EPS)

JASON-2 & -3, Sentinel-6

LOW EARTH, NON-SYNCHRONOUS ORBIT

OCEAN SURFACE TOPOGRAPHY MISSION, SHARED WITH CNES/NOAA/EU

SENTINEL-3 A & B

LOW EARTH, SUN-SYNCHRONOUS ORBIT

COPERNICUS SENTINEL-3 MARINE MISSION

METEOSAT-8

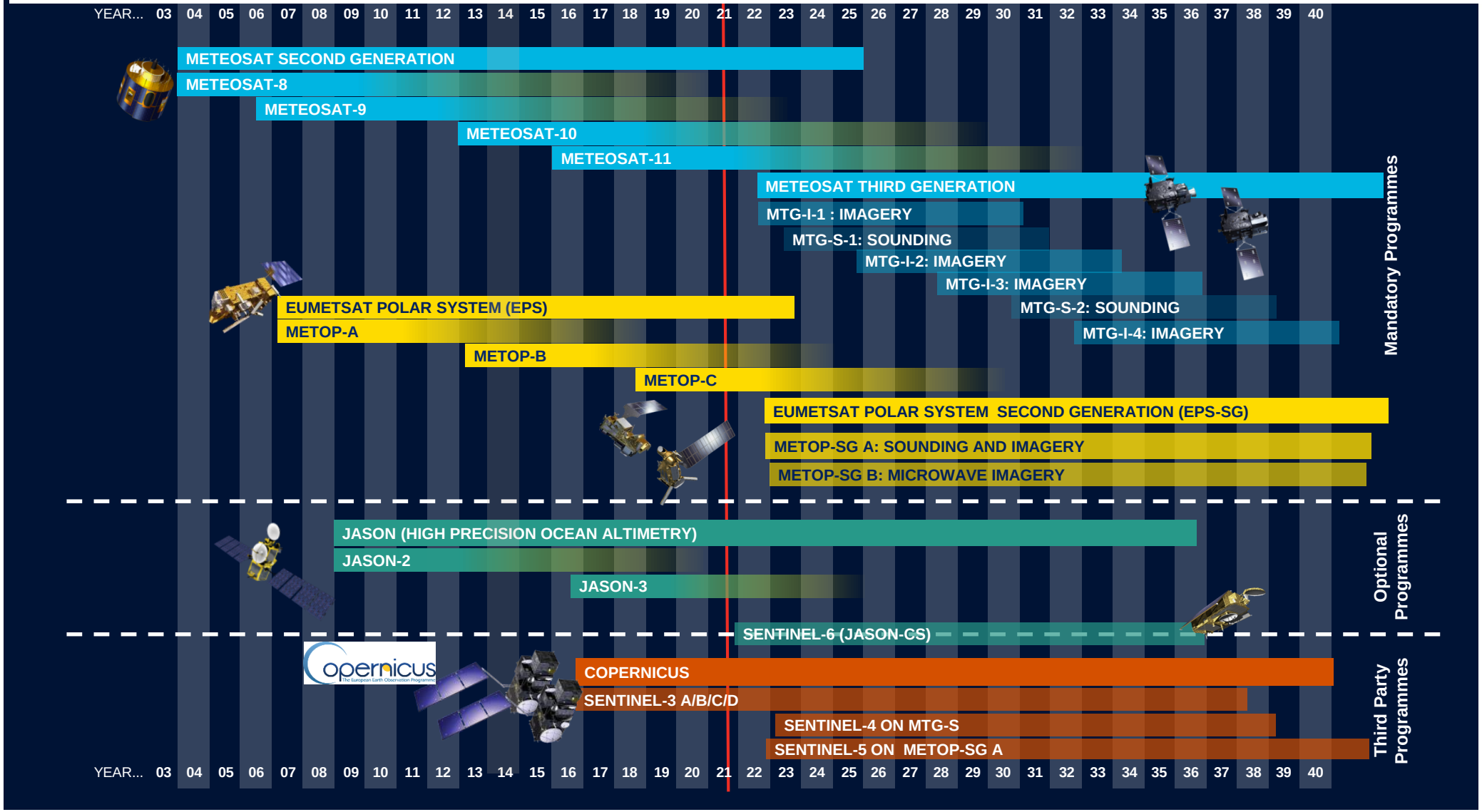
GEOSTATIONARY ORBIT

METEOSAT 2ND GENERATION
IODC SERVICE
UNTILL AT LEAST MID-2020

METEOSAT-9, -10, -11 **METEOSAT Third Generation (MTG), launch 2022**

GEOSTATIONARY ORBIT	TWO-SATELLITE SYSTEM
METEOSAT 2ND GENERATION	FULL DISC IMAGERY SERVICE (15 MINS): METEOSAT-11 (0°)
	RAPID SCAN SERVICE OVER EUROPE (5 MINS): METEOSAT-10 (9.5° E)
	HOT BACK UP TO BOTH SERVICES : METEOSAT-9 (3.5° E)

https://www.eumetsat.int/



Discussion Q&A on: slido.com #EUMSC14

Course Material: https://training.eumetsat.int/course/view.php?id=402

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EUMETSAT Short Courses:
Spot atmospheric convection from satellite
What satellite data is used in convection analysis

12 May 2021

Natasa Strelec Mahovic and Ivan Smiljanic,

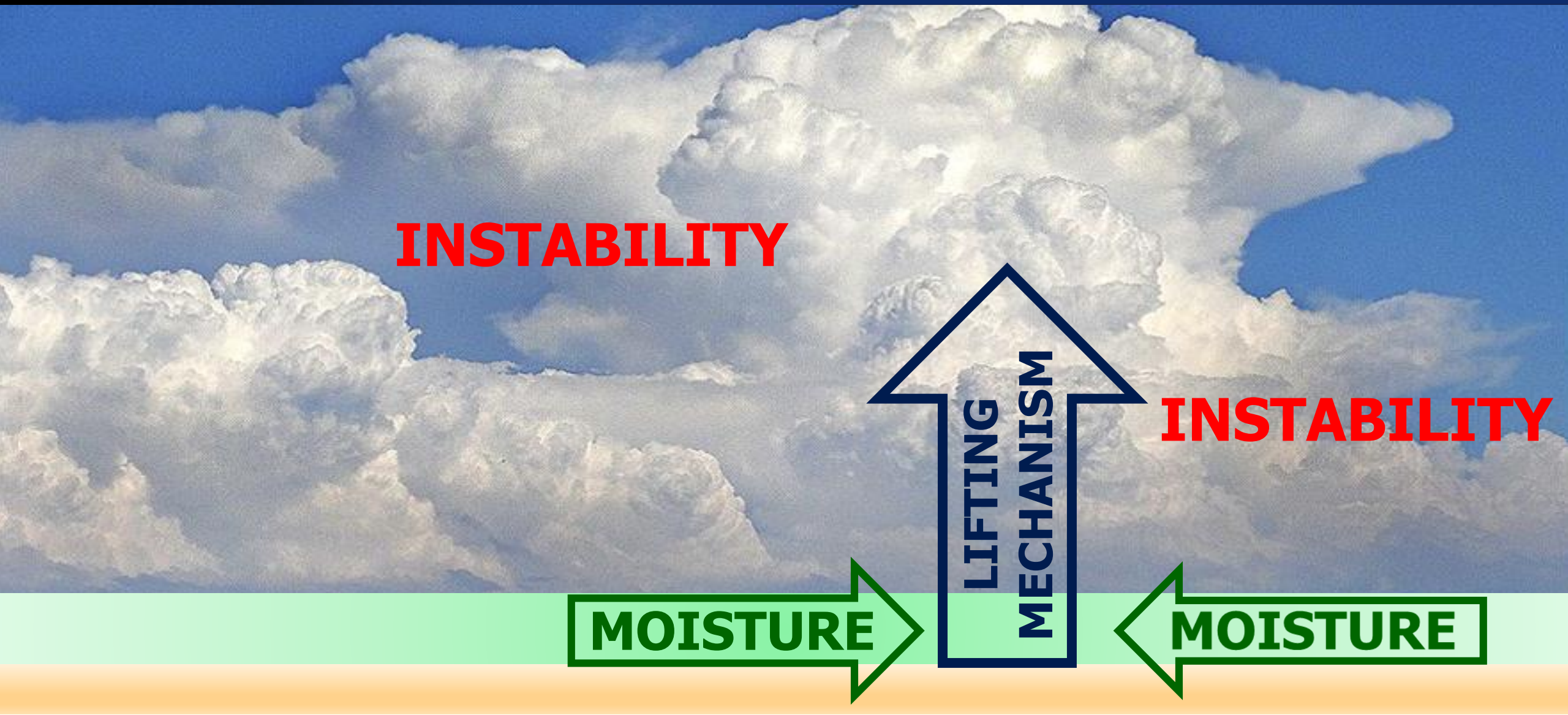
EUMETSAT

Convection

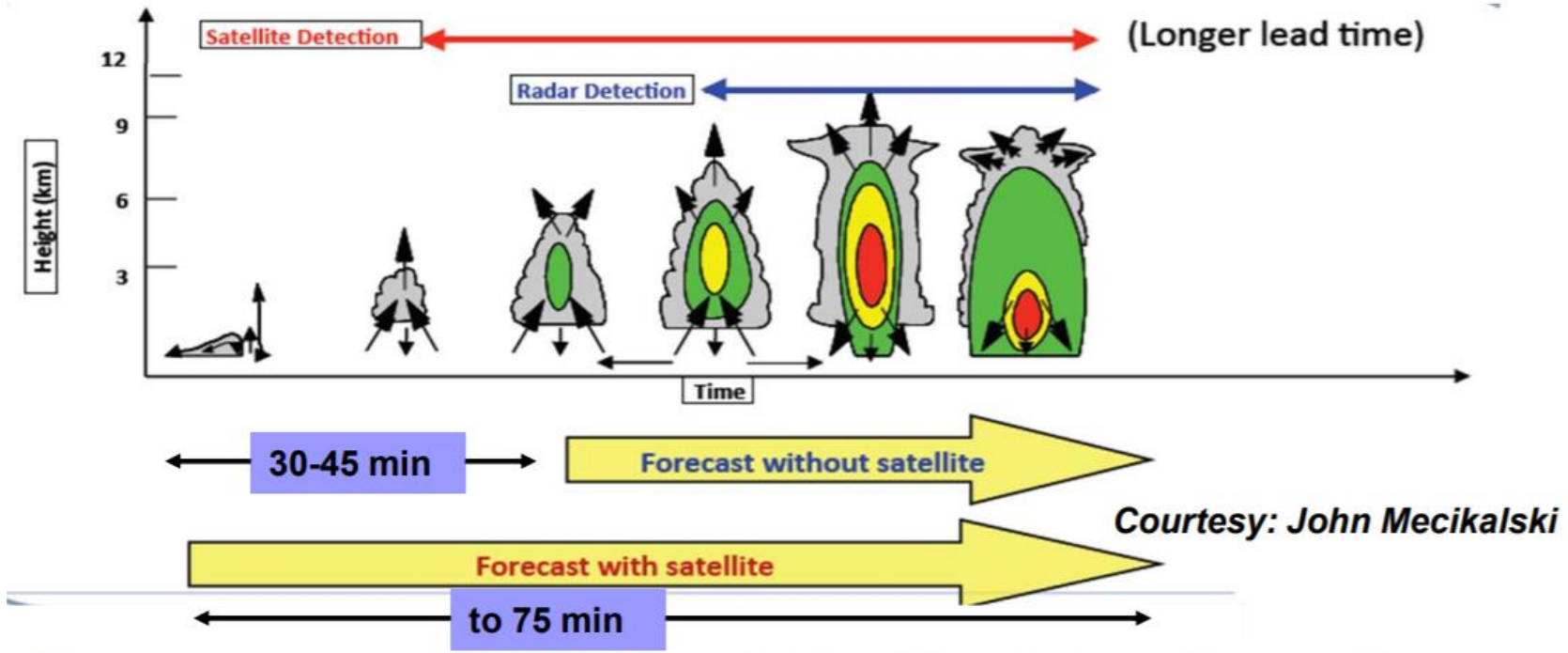
- vertical transport of **heat and moisture** (usually from a warmer area to a cooler one) by **updrafts and downdrafts** in an **unstable** atmosphere
- convection without cloud formation is called "dry" convection
- "moist" convection is the process where the excess water vapor in the rising air condenses and forms a cloud - Cumulus or Cumulonimbus
- deep convection – extending from near the surface to above the 500 hPa level (often stopping at the tropopause at around 200-300 hPa)

(Sli.do Q1) What are the necessary conditions for convection?

Convective ingredients



Benefits of using satellite imagery



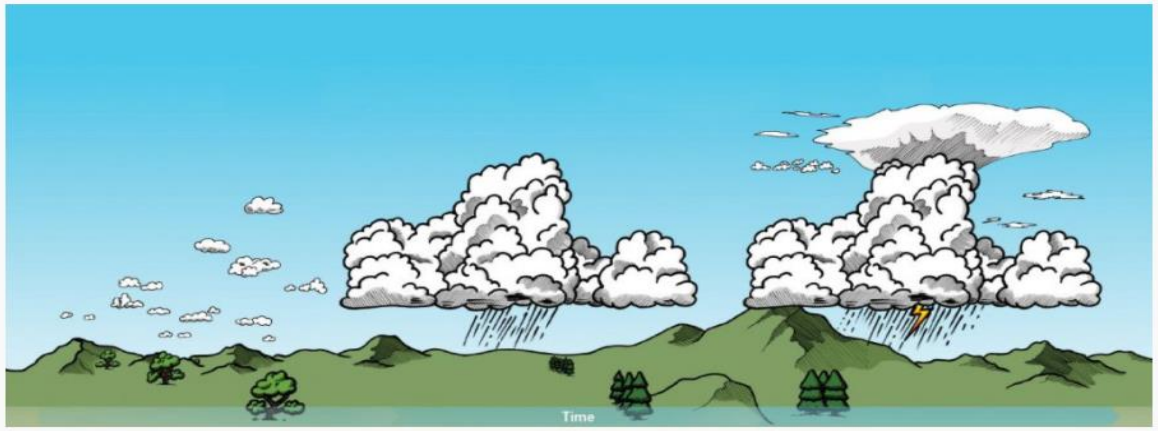
- **Pre-convective environment** ➔ Providing information on the pre-convective envirnment, identify general air mass properties
- **Convective initiation** ➔ Identify the convective initiation phase (before they are seen on radar)
- **Mature convective storms** ➔ Providing information about cloud tops process – useful to estimate storm severity

CWG Recommendations

Convection Working Group

News | Satellite-Guidance | Meetings | Studies / cases | Documentation | About / Contact | Search

STEP BY STEP DEEP CONVECTION NOWCASTING



1. Pre-Convective Environment

Refers to the 4-D thermodynamic and wind field present before the convective initiation occurs.

Useful tools:

NWP data, Radiosonde and aircraft measurements
MSG GII/RII Product – instability & moisture
iSHAI Products – instability & moisture
HRW Product – wind fields
METOP/IASI level2 – temp & moisture vert. profiles

2. Convective Initiation

Refers to the process where an existing cumulus cloud begins rapid vertical growth.

Useful tools:

Radar, lightning data
Cloud Type
Cloud Top Temperature and Height
Cloud Microphysics
Convection Initiation
Optimal Cloud Analysis – demonstrational

3. Mature Convective Storm

Refers to the presence of convective clouds with tops at or above their local equilibrium level.

Useful tools:

Radar, lightning data
RDT Product – storm tracking
Precipitating Clouds
CRR Product – precipitation
NEFODINA
Overshooting Top Detection
MSG Sandwich Product (HRV+IR10.8 enhanced)

CWG Recommendations

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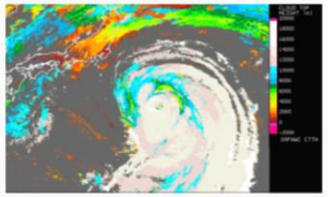
Cloud Top Temperature and Height

Operationally produced by NWC SAF.

Application:

Estimation of the cloud top height (altitude in km or pressure in hPa) and the cloud top temperature.



Advantages:

✓ Available from meteorological geostationary satellites (GOES, Himawari, MSG).

✓ Available during day and night.

✓ Available at the temporal frequency of the satellites.

✓ Useful in estimation of the height of convective clouds .

Limitations:

X CTTH is not retrieved for low broken clouds.

X CTTH may be not retrieved for thin cirrus clouds.

X Retrieved low cloud top height may be overestimated.

Accessibility and Dissemination:

1. Local installation: Product is accessible after registration (signed contract) at NWCSAF and installation of NWCSAF GEO v2018 in the local environment. It can be run every 15 minutes (every 10mn or 20mn for Himawari and Goes) or with the different settings every 5 minutes RSS. Output format is NetCdf.
2. Images for the last 24h, updated every 15 minutes at NWCSAF web site: http://www.nwcsaf.org/ctth2

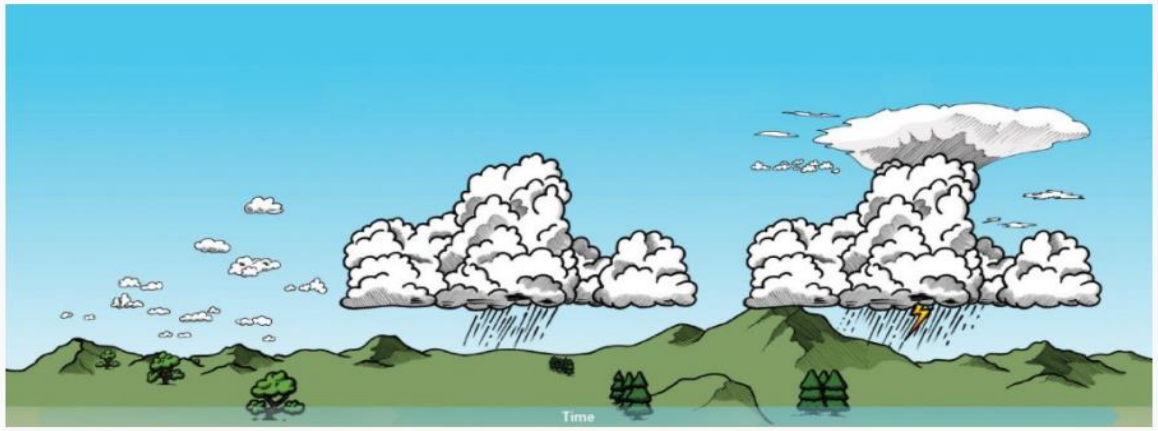
Additional Information:

Web site
Training Module
Practical info and documentation

Convection Working Group

News | Satellite-Guidance | Meetings | Studies / cases | Documentation | About / Contact | Search

STEP BY STEP DEEP CONVECTION NOWCASTING



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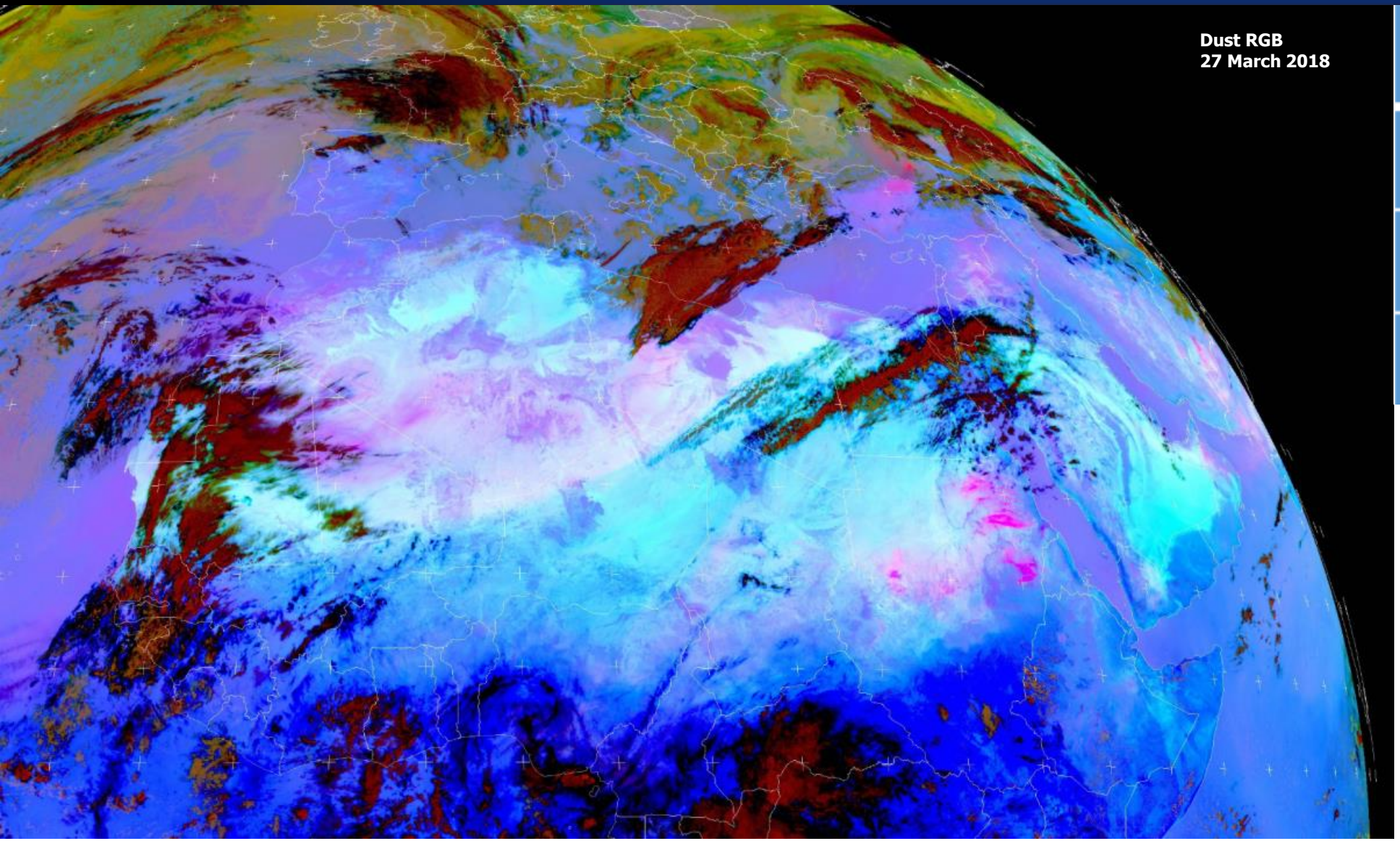
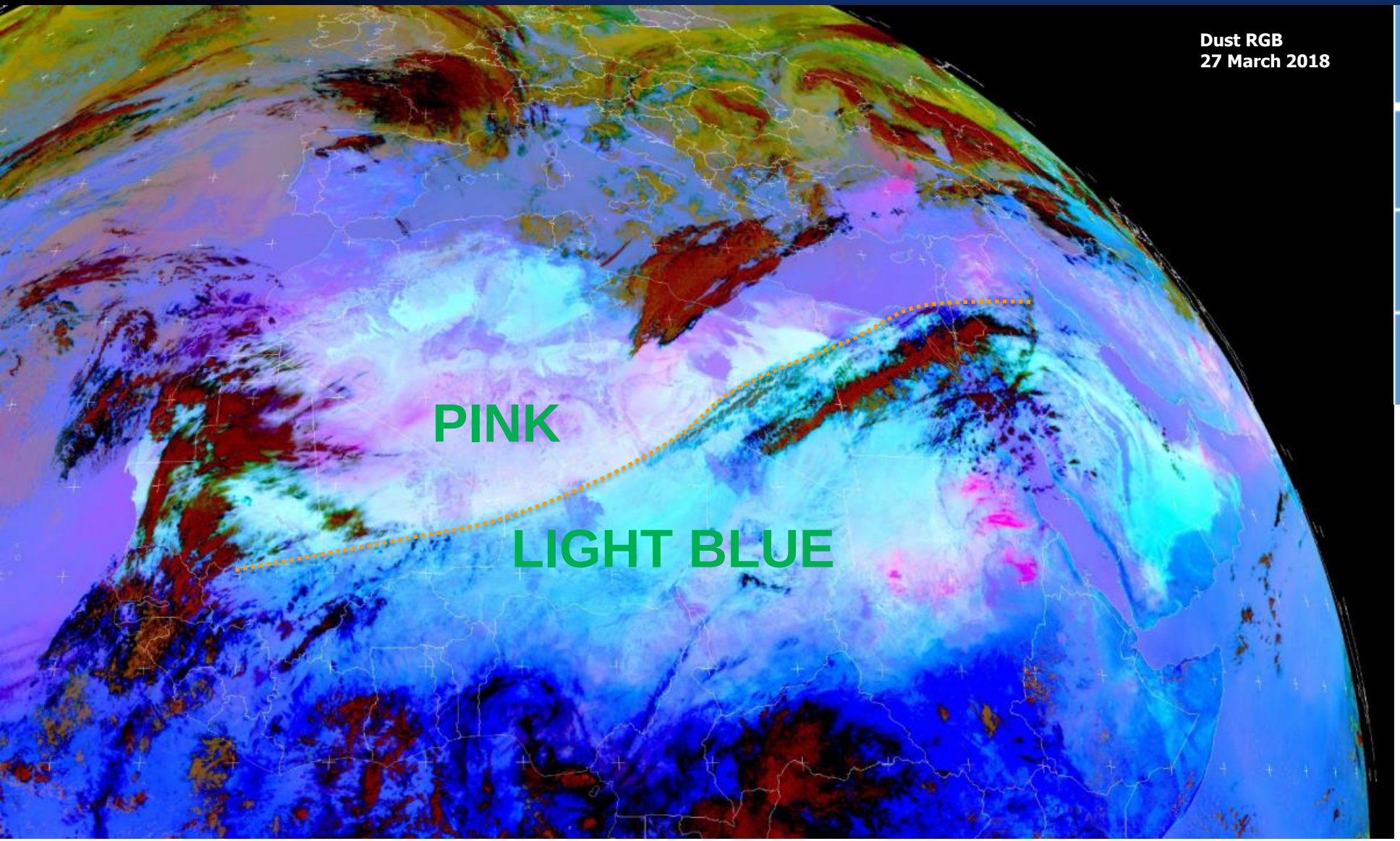
I. Pre-convective environment

I. Preconvective environment - Moisture in DUST RGB



Colour	Channel [µm]
Red	IR12.0–IR10.8
Green	IR10.8–IR8.7
Blue	IR10.8

(Sli.do Q2) MOIST air in the lower levels is in Dust RGB depicted in:



Colour	Channel [µm]
Red	IR12.0–IR10.8
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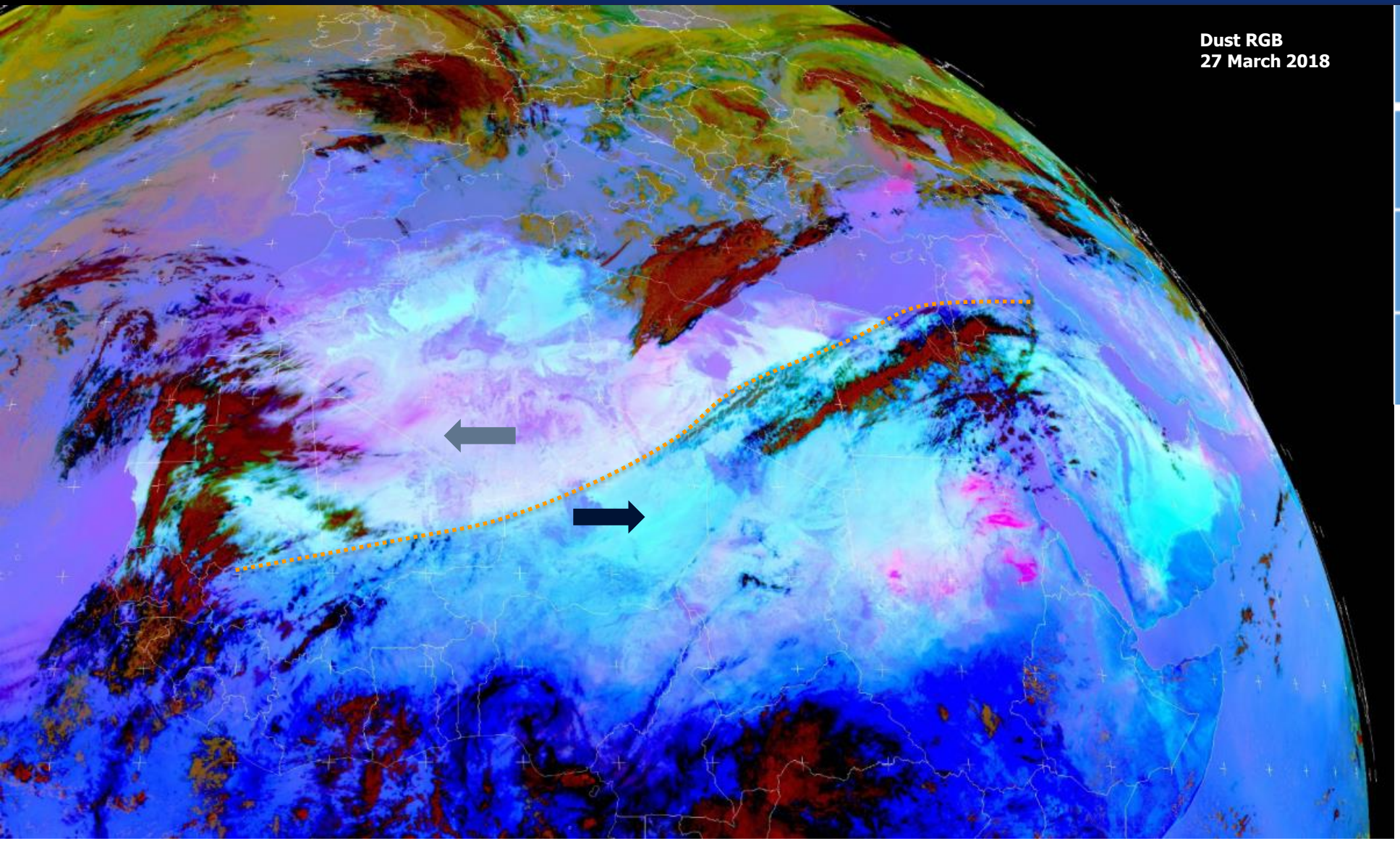
Moisture in DUST RGB



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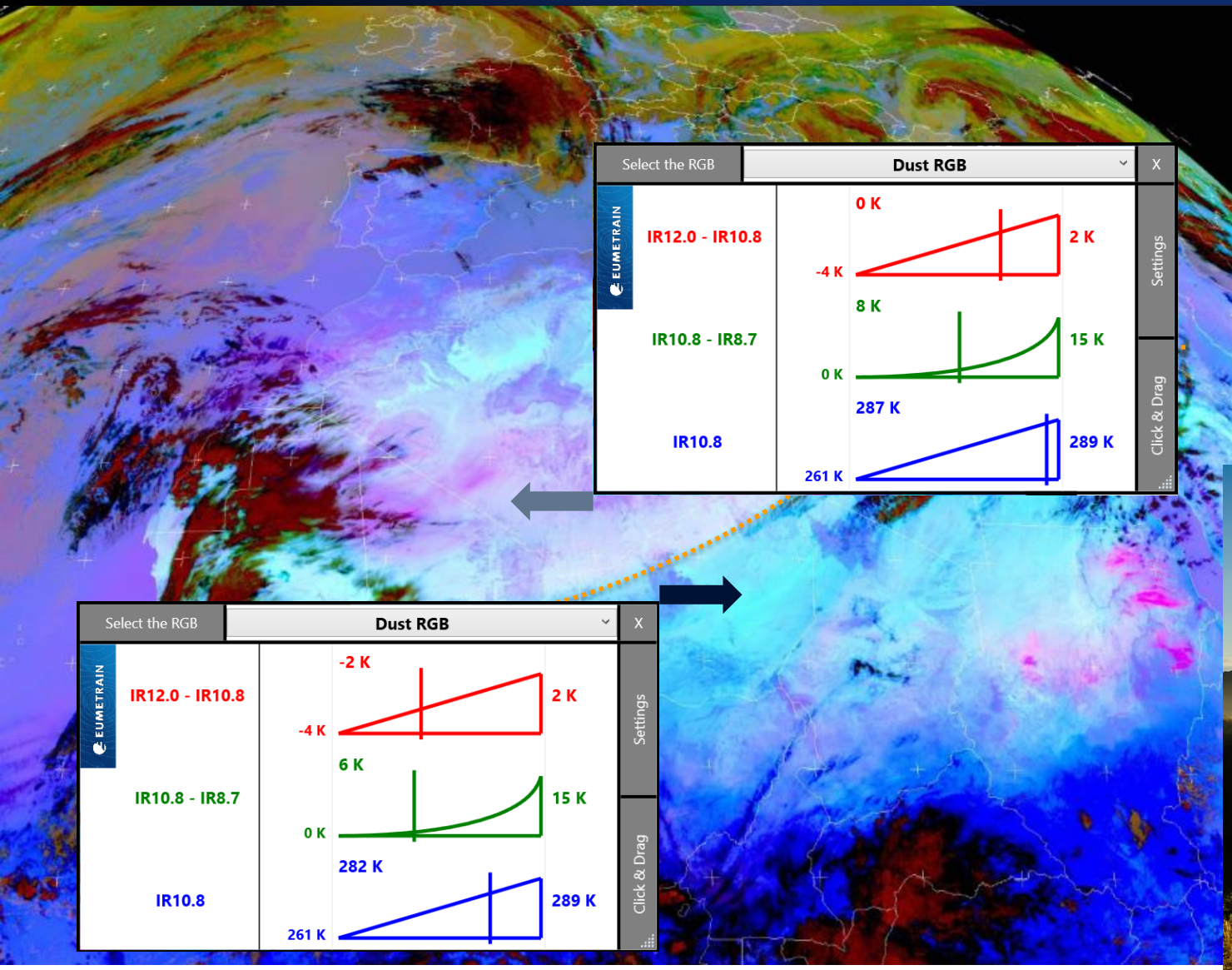
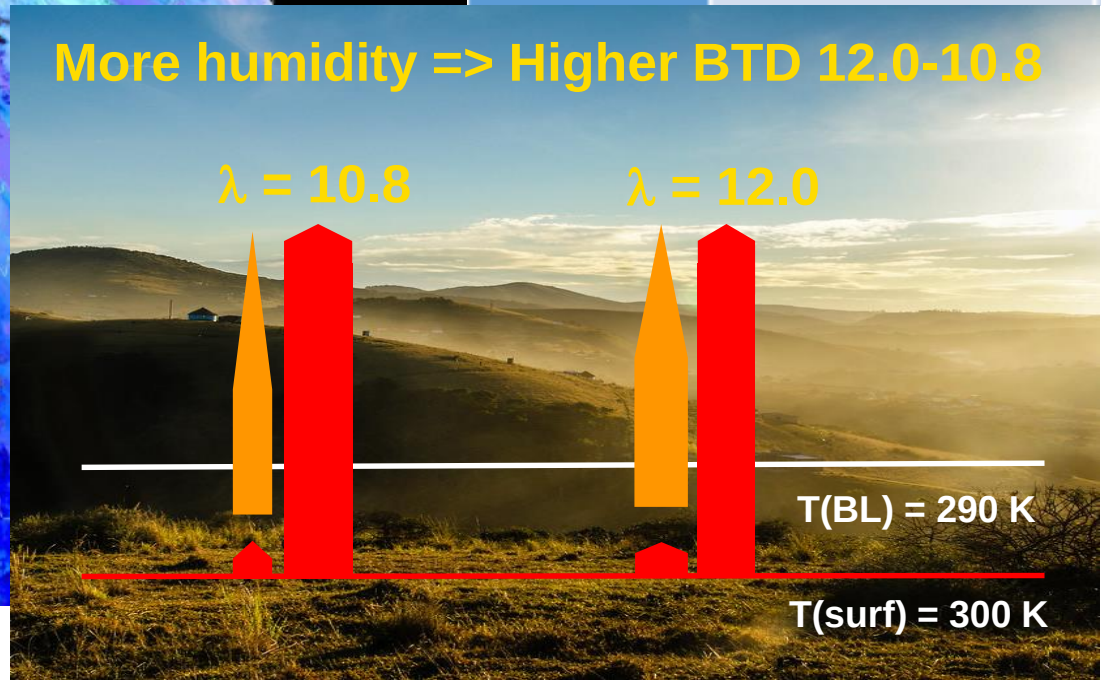
Moisture in DUST RGB

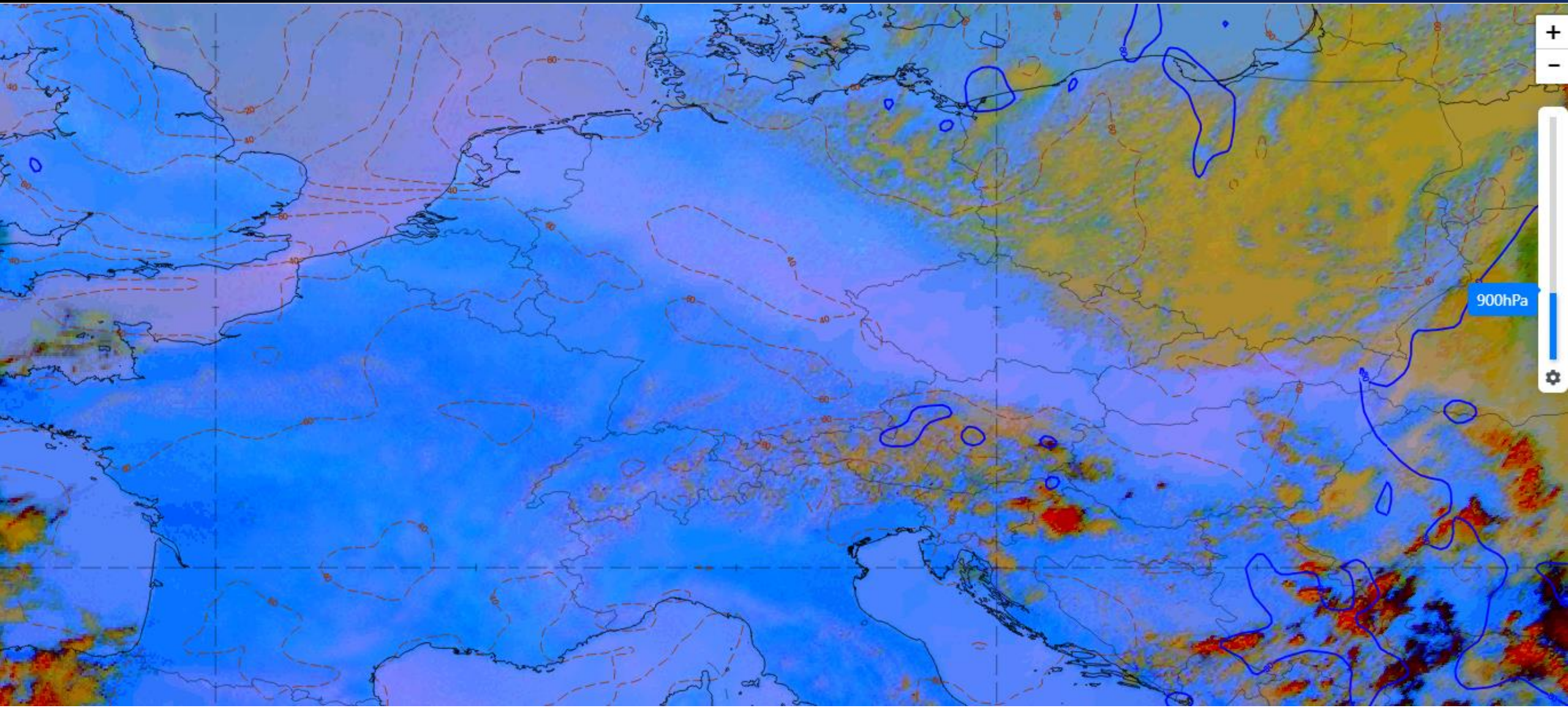


Dust RGB
27 March 2018

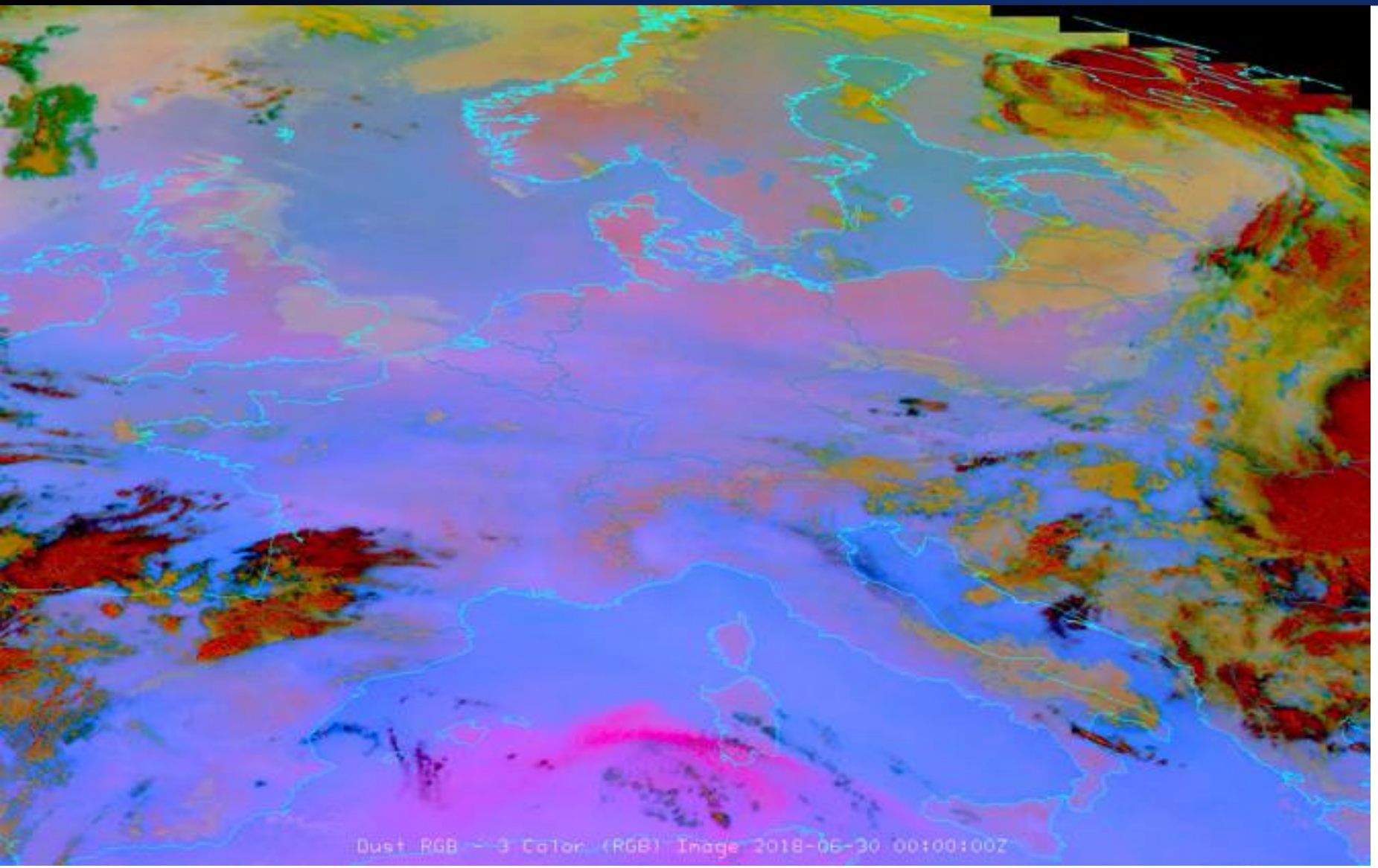
Colour	Channel [µm]
Red	IR12.0–IR10.8
Green	IR10.8–IR8.7
Blue	IR10.8



Moisture in DUST RGB vs. NWP



Moisture in DUST RGB



DUST RGB

30 June 2018

Moisture in the satellite images

Limitations:

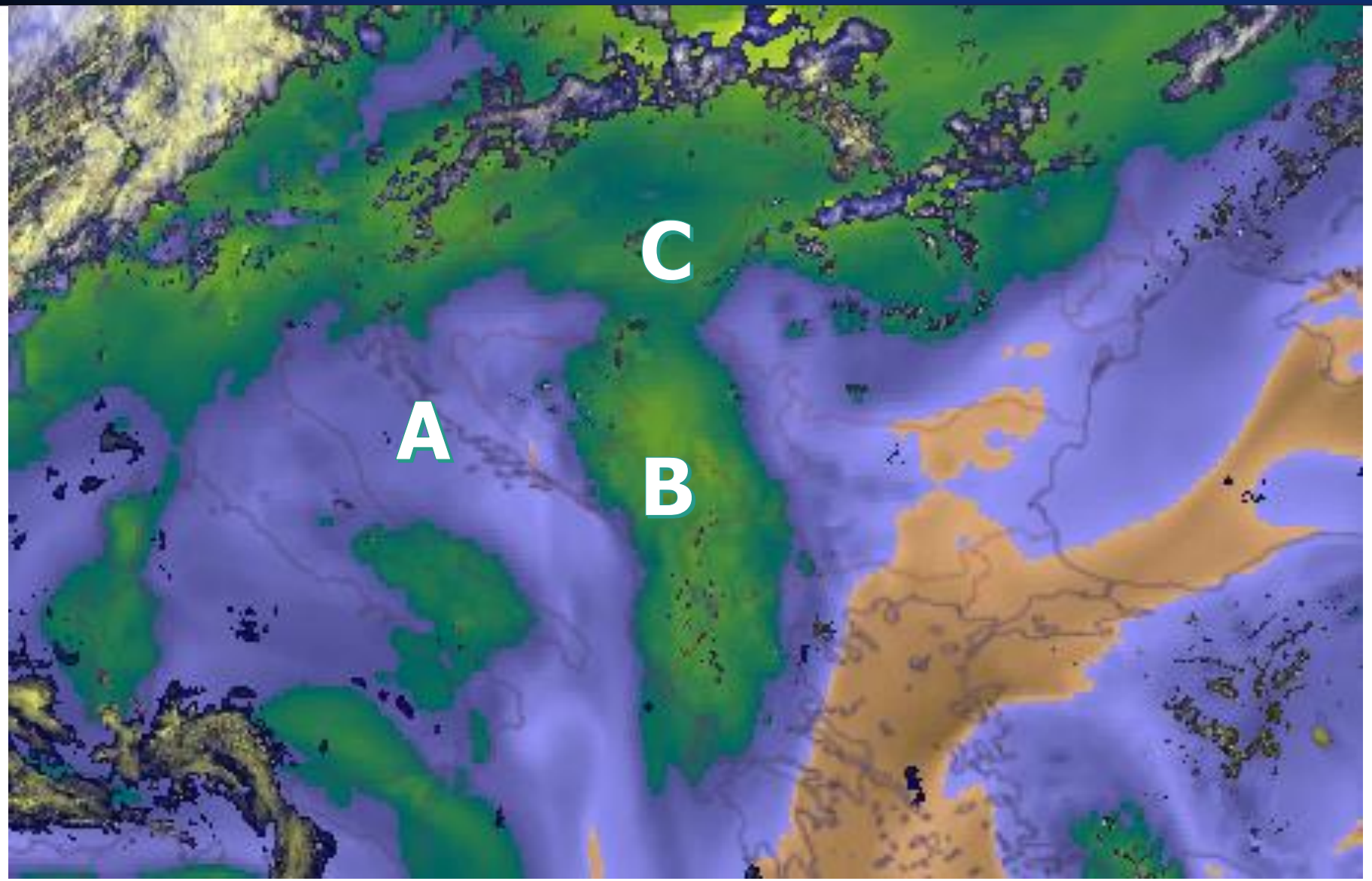
- Must be cloud free (Cirrus clouds disturb)
- Does not work at night (temperature inversion)
- Does not work in high mountain areas
- There is a very strong diurnal cycle
- Difficult to separate the temperature effect from the moisture effect (e.g. low moisture over hot surfaces gives the same signal as high moistures over cooler ground)
- Emissivity effects (sandy surfaces) are also contaminating the BTD product

Pre-convective environment

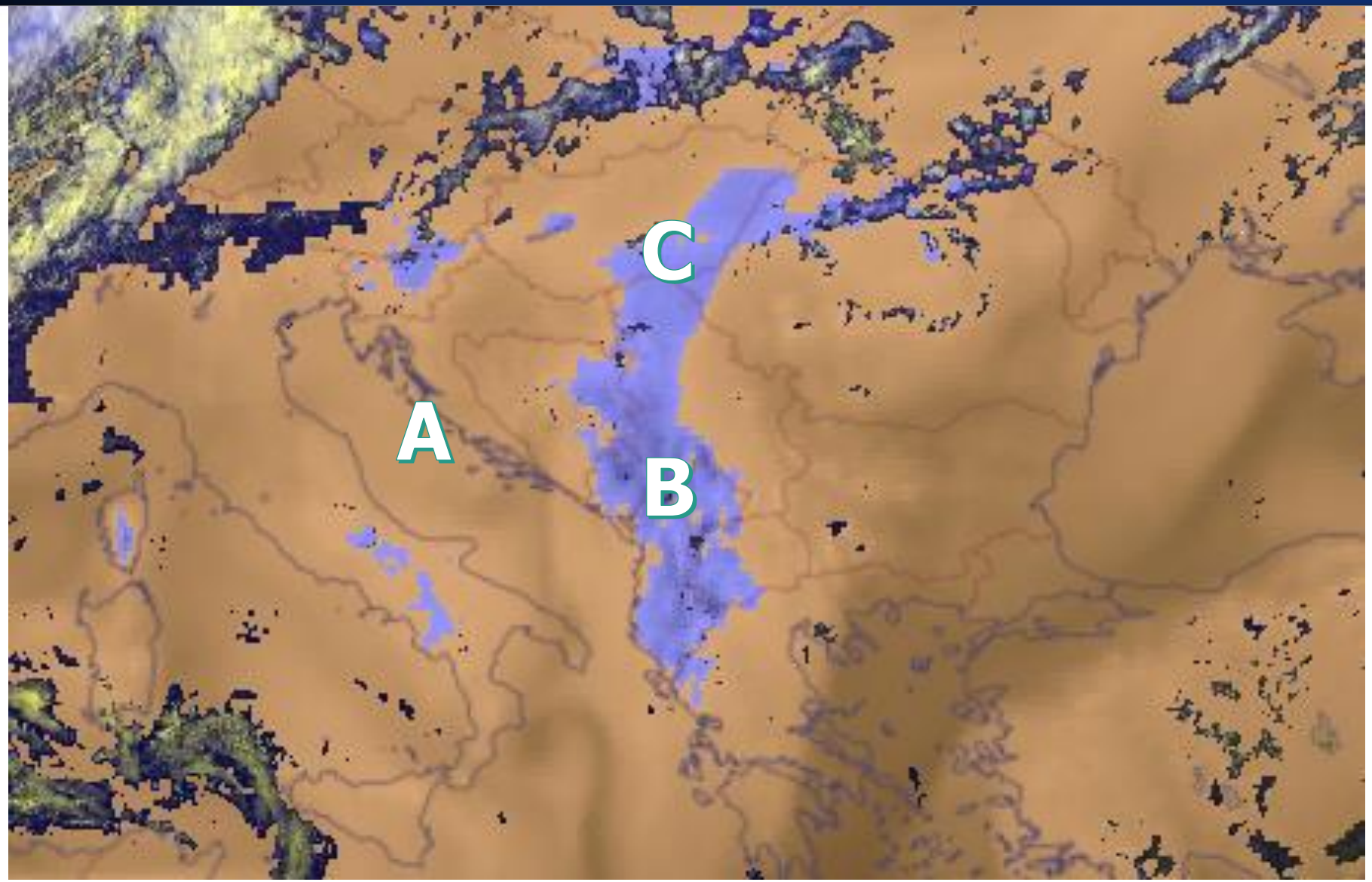
HRV Cloud RGB
28 June 2020, 08 UTC

(Sli.do Q3) Where do you expect convection?

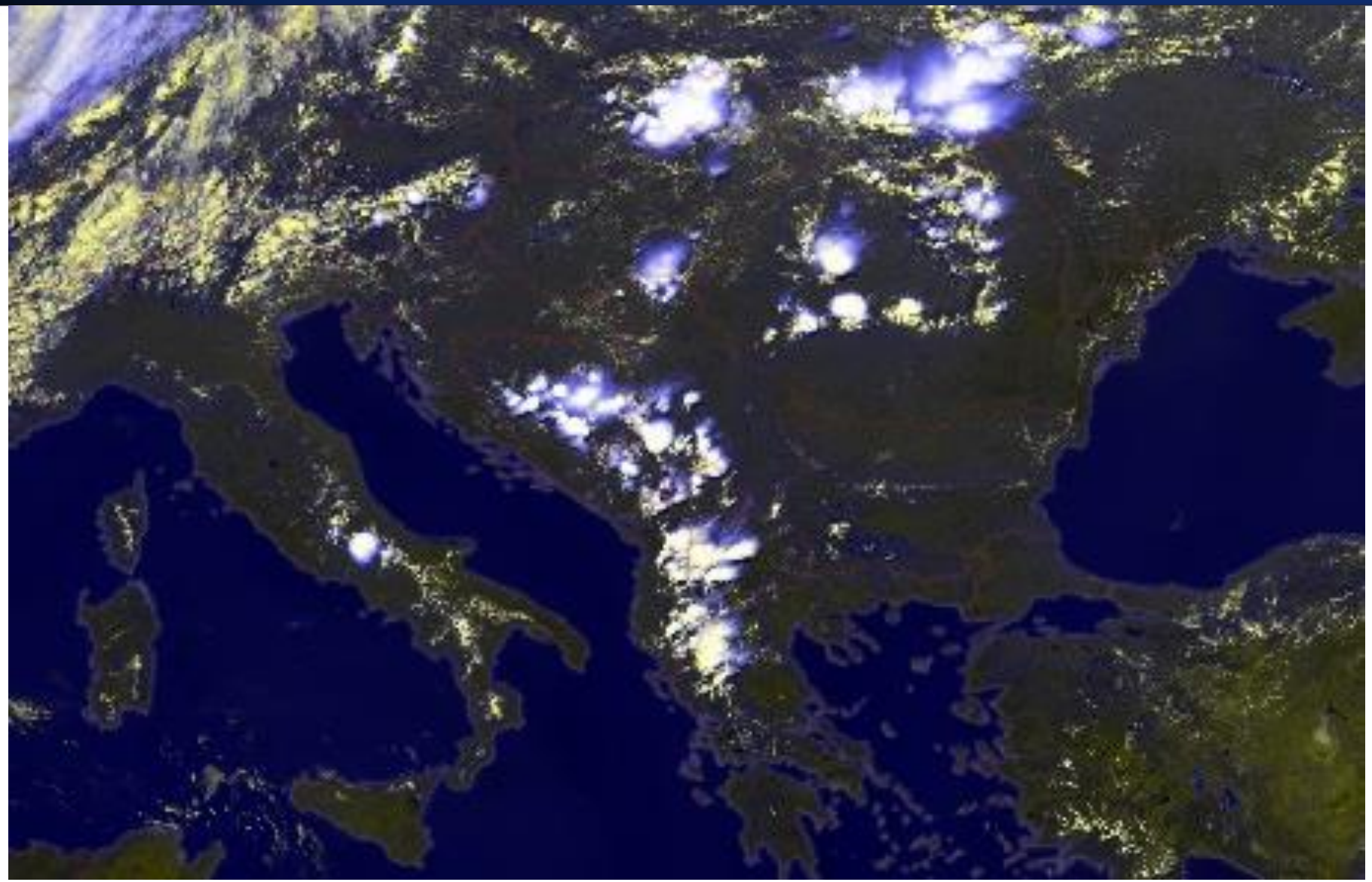
Mid-layer precipitable water
28 June 2020, 08 UTC



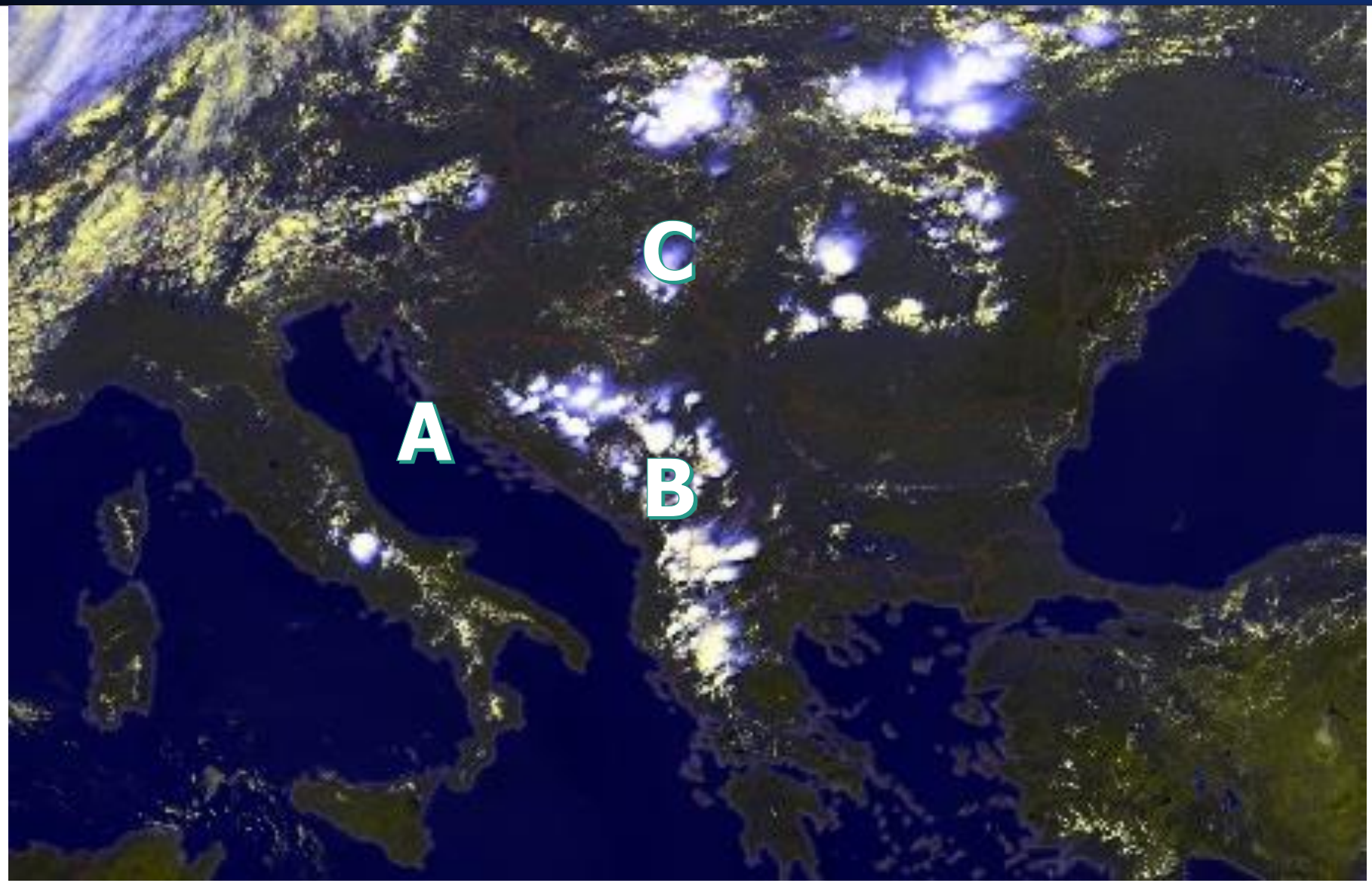
Showalter index
28 June 2020, 08 UTC



HRV Cloud RGB
28 June 2020, 12:30 UTC



HRV Cloud RGB
28 June 2020, 12:30 UTC



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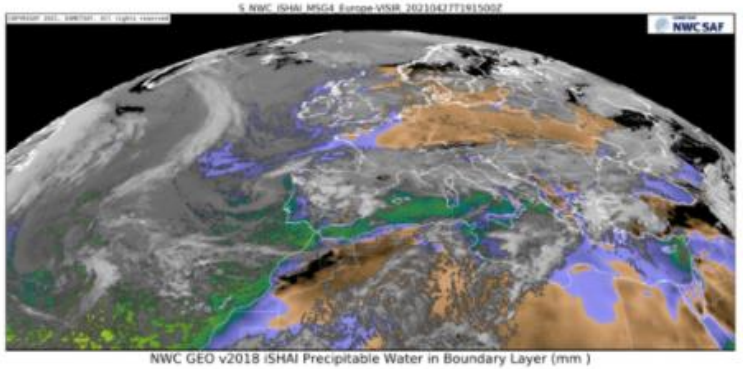
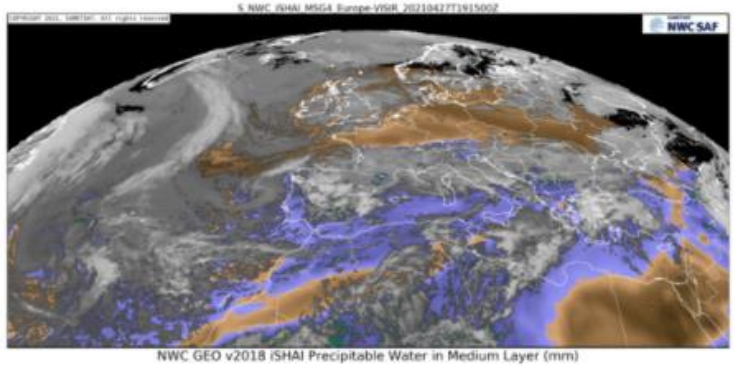
Satellite Humidity And Instability Layer Precipitable Water SEVIRI v2018



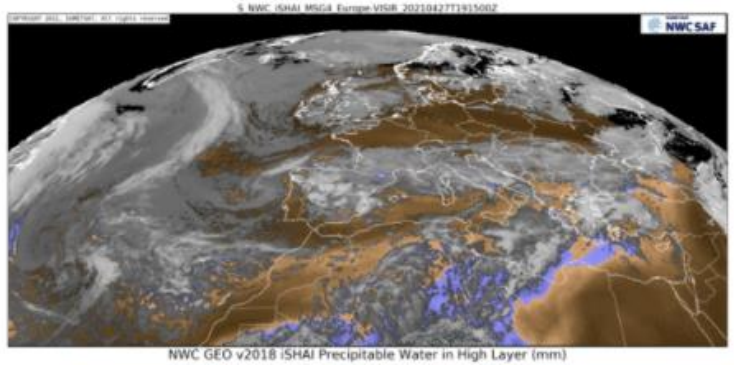
NWC GEO v2018 iSHAI Precipitable Water in Boundary Layer (mm)

BL (Low Layer)



NWC GEO v2018 iSHAI Precipitable Water in Medium Layer (mm)

ML (Medium Layer)



NWC GEO v2018 iSHAI Precipitable Water in High Layer (mm)

HL (High Layer)

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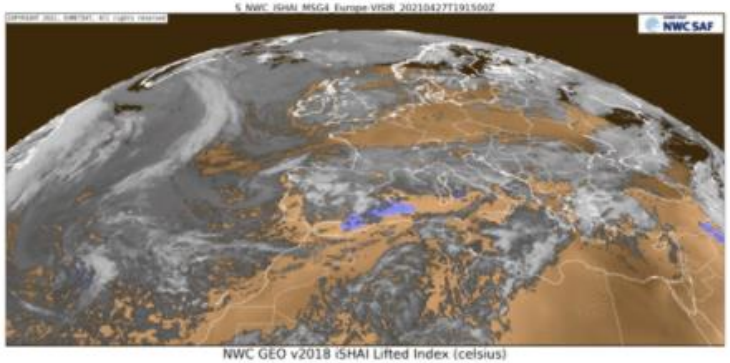
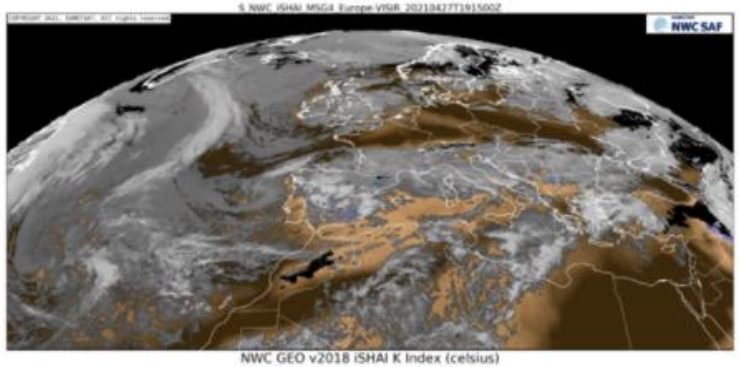
Satellite Humidity And Instability Stability Analysis Imagery SEVIRI v2018



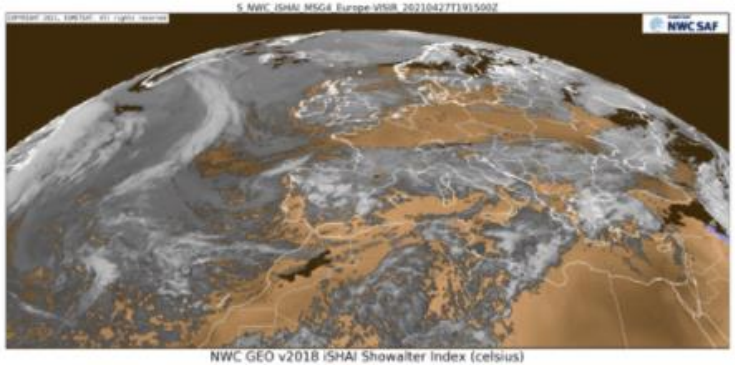
NWC GEO v2018 iSHAI Lifted Index (celsius)

LI (Lifted Index)



NWC GEO v2018 iSHAI K Index (celsius)

KI (K index)

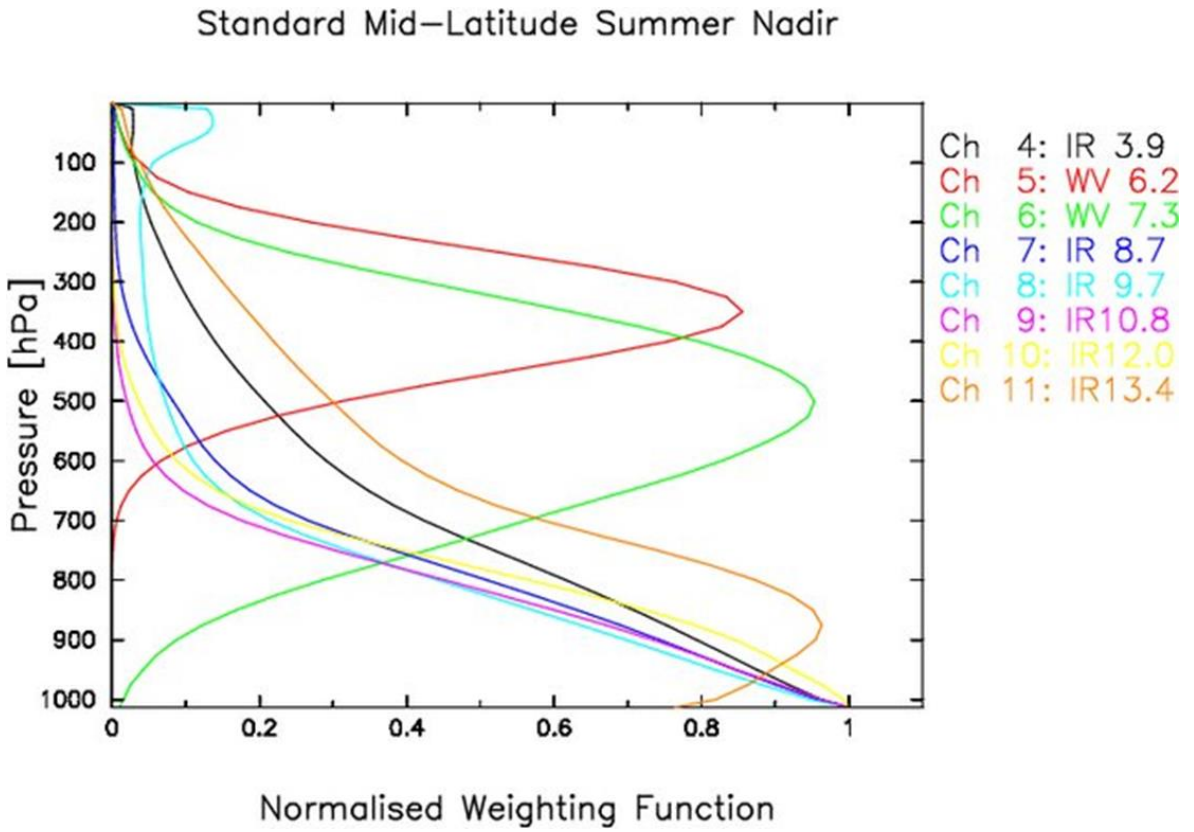


NWC GEO v2018 iSHAI Showalter Index (celsius)

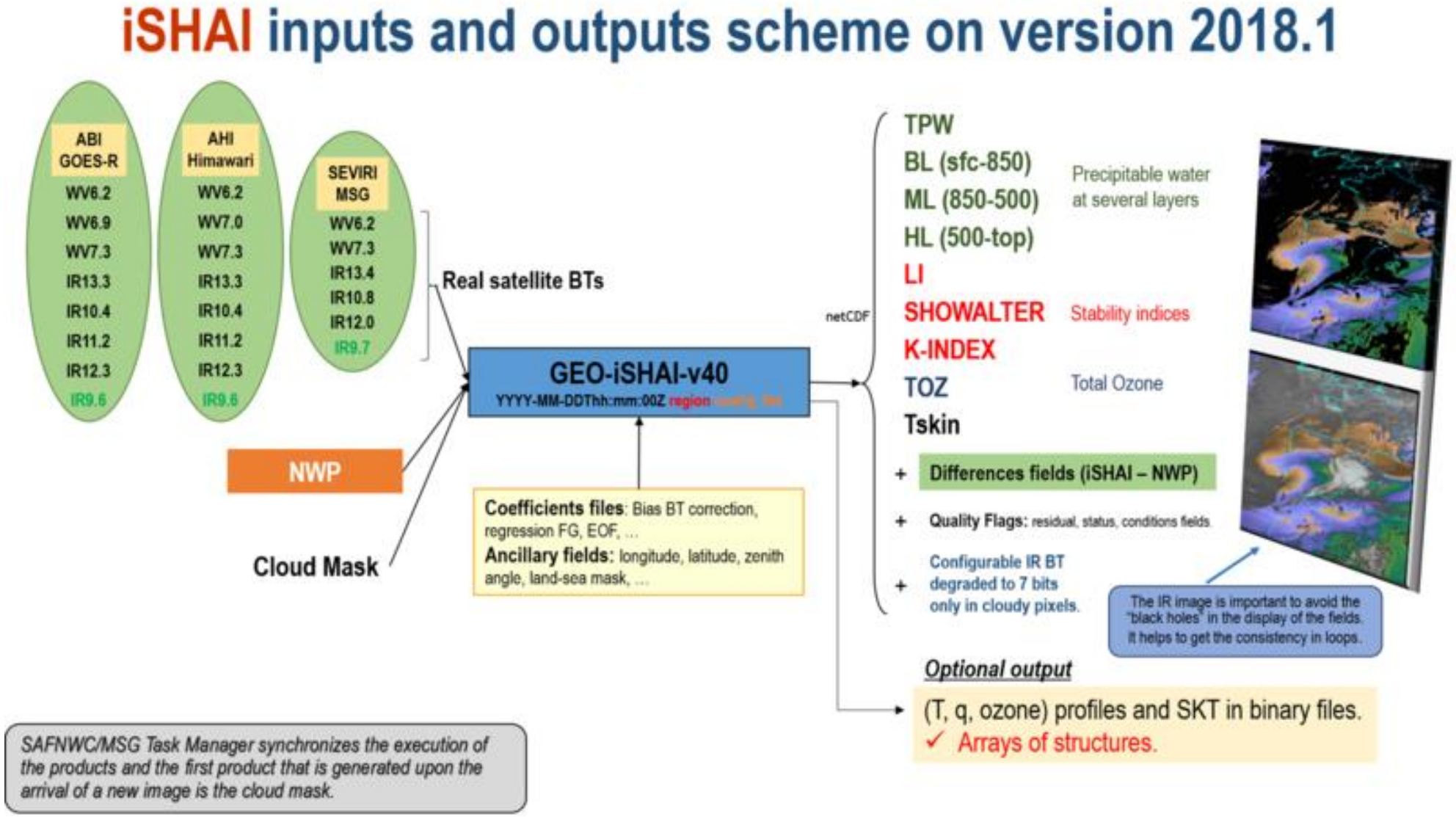
SHW (Showalter)

NWC SAF Satellite Humidity And Instability (iSHAI)

- The main inputs for iSHAI products are real satellite IR brightness temperatures (BTs) and forecast NWP model GRIB files.
- Geostationary satellites provides full resolution images with high spatial resolution (3x3 km in SEVIRI case) and with high temporal resolution (every 15 minutes in operation mode and 5 minute from rapid scan mode) at the satellite nadir for every IR channel.
- The products are useful in the prediction of severe weather due to their ability to measure with high temporal and spatial resolution variations of atmospheric stability and moisture.



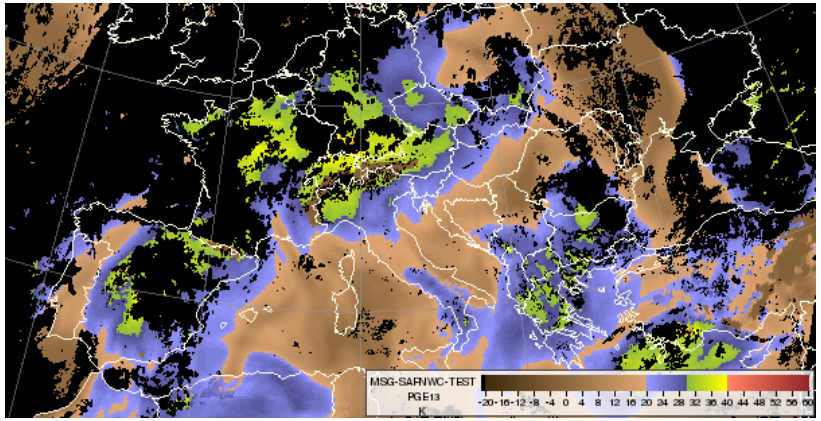
iSHAI algorithm



Pre-convective environment – 2 types of products

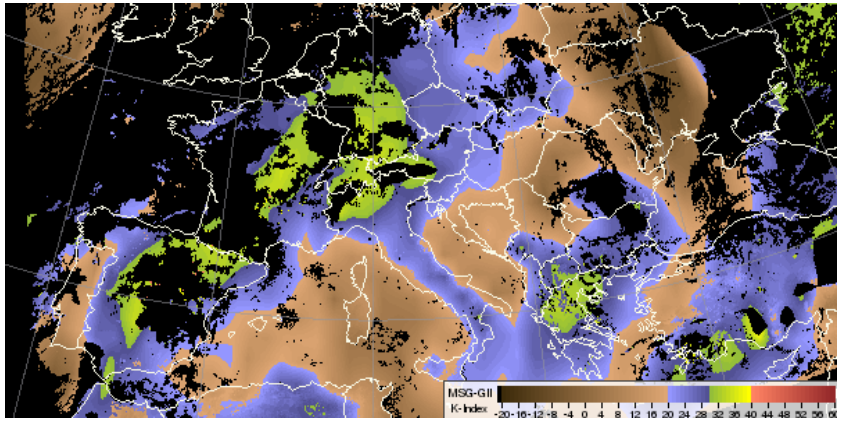
NWC SAF iSHAI product

- K-Index
- Showalter Index
- Lifted Index
- Layer precipitable water content in 3 layers (surface to 850 hPa, 850 hPa to 500 hPa, above 500 hPa)
- Total precipitable water.
- Skin temperature
- Difference fields



MSG GII/RII product

- K-Index
- KO Index
- Lifted Index
- Maximum Buoyancy
- Layer precipitable water content in 3 layers (surface to 850 hPa, 850 hPa to 500 hPa, above 500 hPa)
- Total precipitable water.



Applications of iSHAI products

The main purposes and applications of iSHAI products are:

- help forecasters in the detection and tracking (with high spatial and temporal resolution) of key ingredients in convection to support real time meteorological applications; especially in pre-convective situations.
- enable watch and warning of pre-convective situations through the monitoring of the evolution of several key ingredients in convection.
- enable monitoring of the humid atmospheric flow. This allows the monitoring of the humidity convergence/divergence in clear region on pre-convective situations.
- follow the evolution and regions with instability.
- advice forecasters of the discrepancies between the background NWP model and the retrieved fields.

Limitations of iSHAI products

- not available on cloudy pixels. Once the clouds develop only information from neighborhood is available.
- cloud mask near edge of clouds tends to produce larger differences with the background NWP (perhaps due to cloud contaminated pixels).
- MSG satellites have very few IR and WV channels, not enough information to modify greatly the background NWP profile.
- main errors are related to disagreement between the background NWP model used and the true atmosphere. It is recommend to use profiles with as much spatial, temporal and vertical resolution (use of enough pressure levels) as possible.

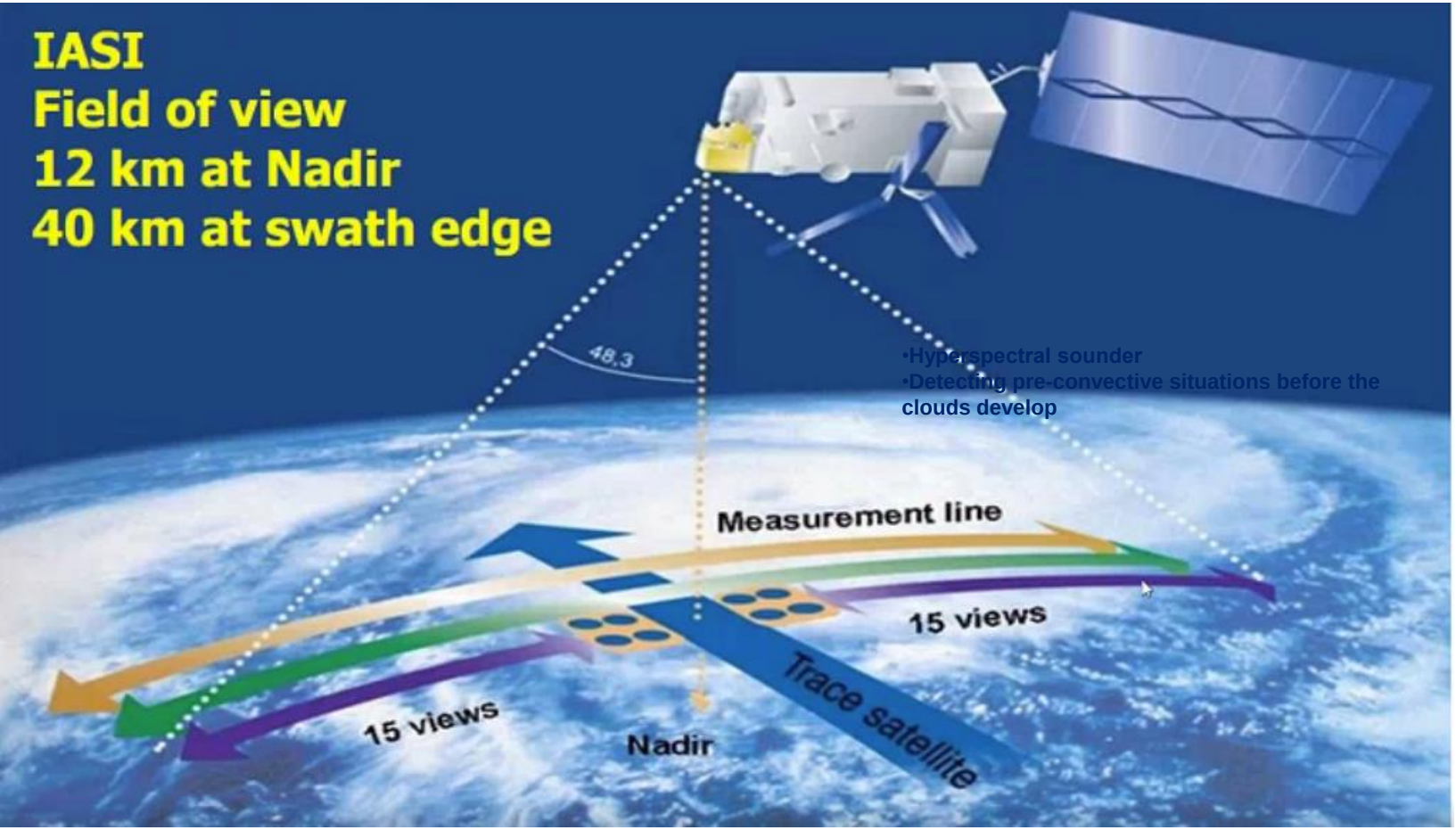
Outlook – iSHAI products with MTG FCI data

- Better spatial and temporal resolution of the products
- New channels - improved products
- Better cloud mask

iSHAI products can be found at: https://www.nwcsaf.org

Display option in ADAGUC (15 days rolling archive):
http://nwcsaf-adaguc-proofs.aemet.es/adaguc-viewer/

IASI – Infrared Atmospheric Sounding Interferometer

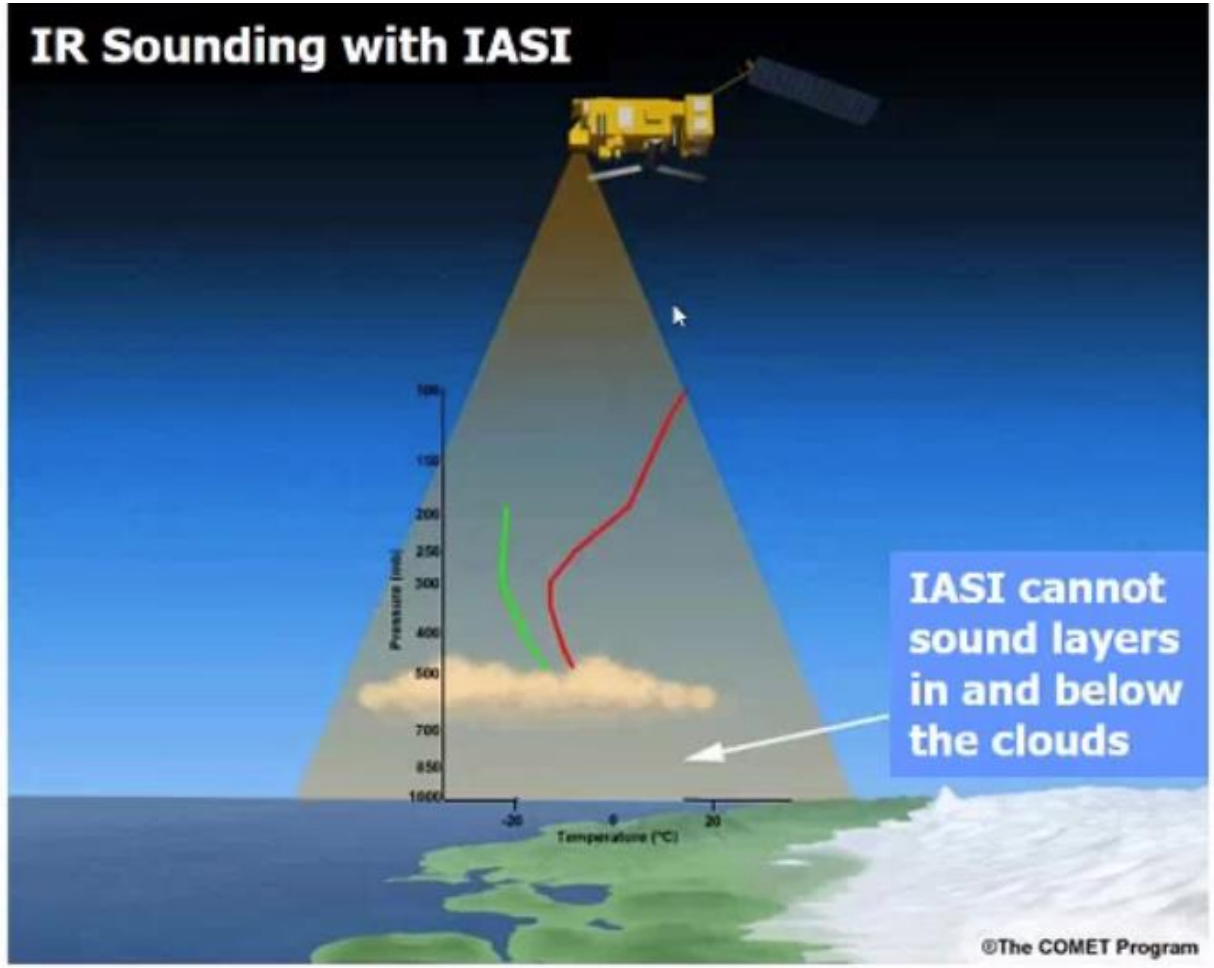


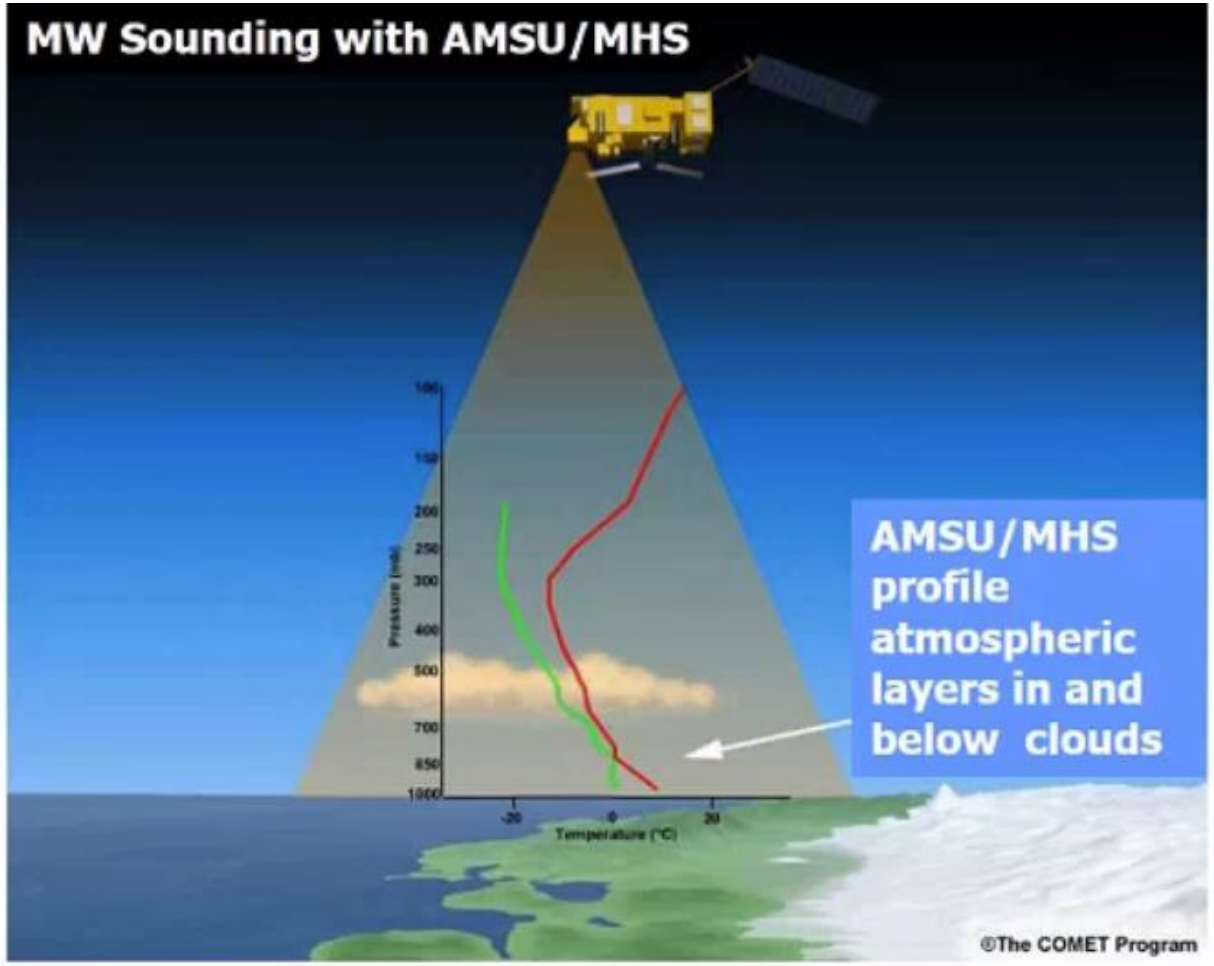
- Hyperspectral sounder
- Flying on Metop A, B and C
- Global coverage 2 times/day

- Swath 2000km
- 4 detectors
- Pixel size: 12 km at Nadir, 40 km at the swath edge

- Detecting pre-convective situations before the clouds develop

Complementarity infrared – microwave sounders

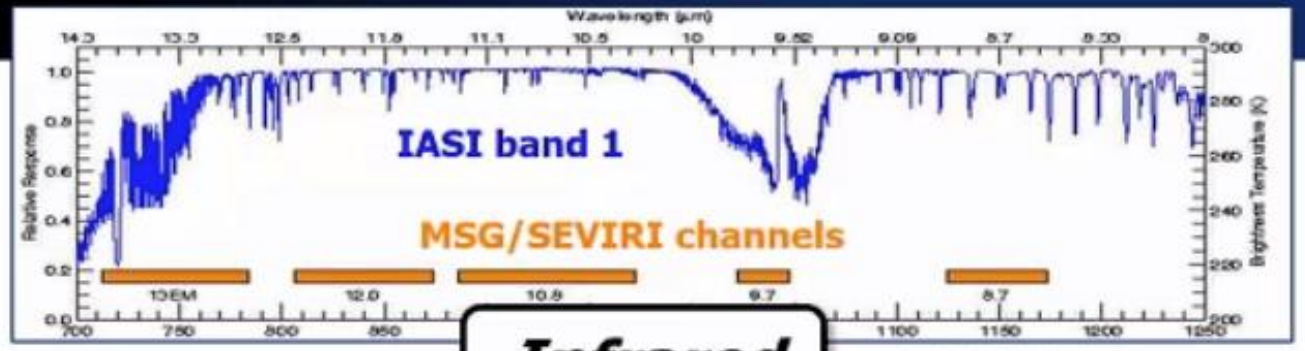




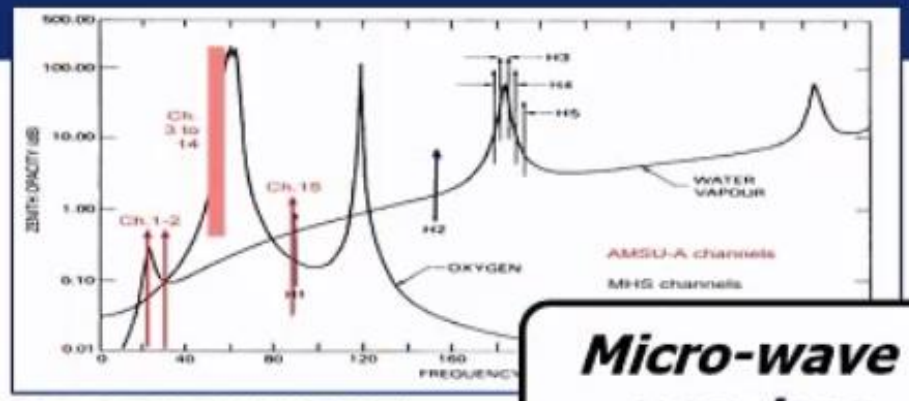
Adapted from MetEd UCAR material

(University Corporation for Atmospheric Research, Boulder CO, US)

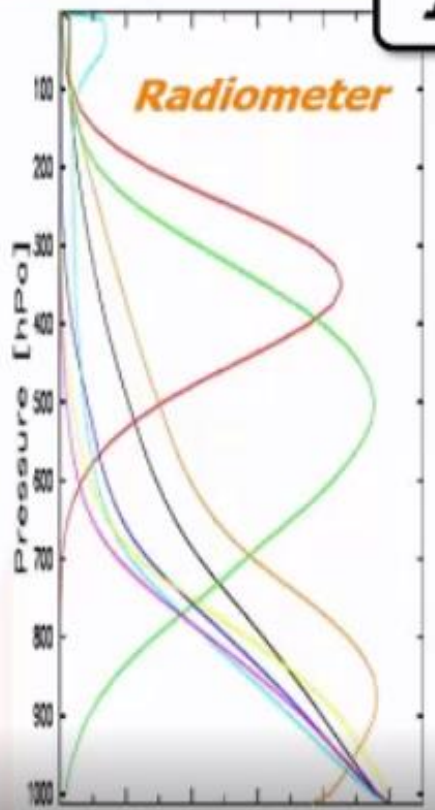
From spectral to vertical resolution

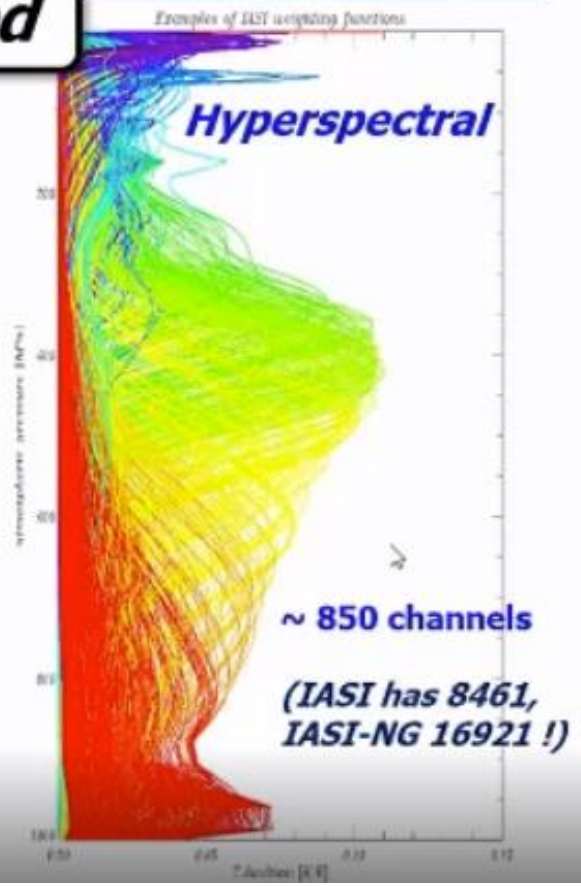


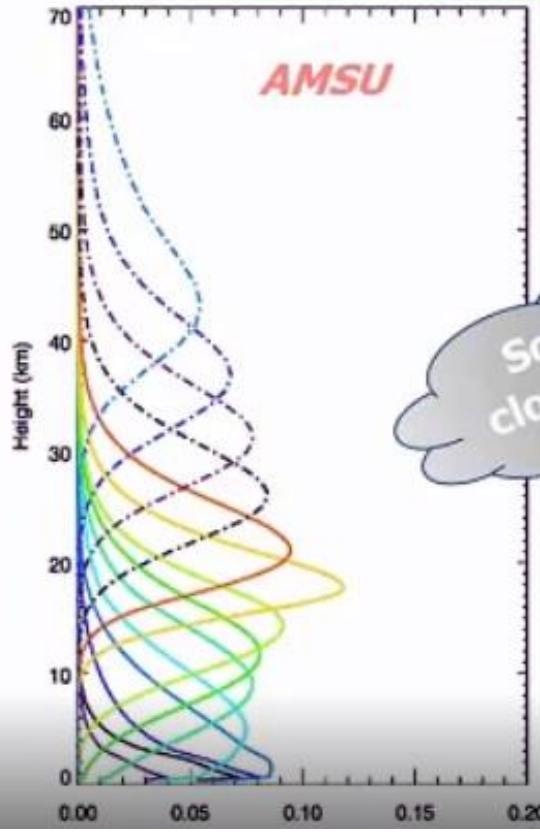
Infrared



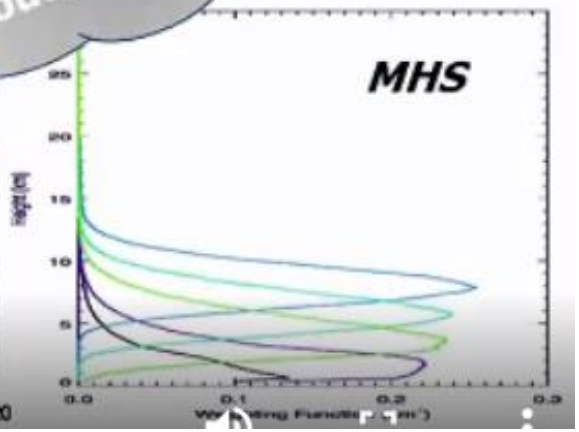
Micro-wave sounders



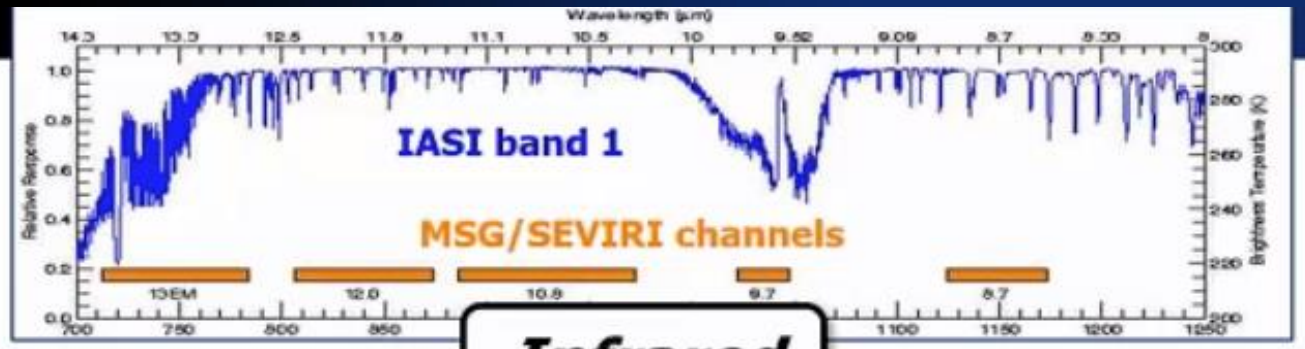




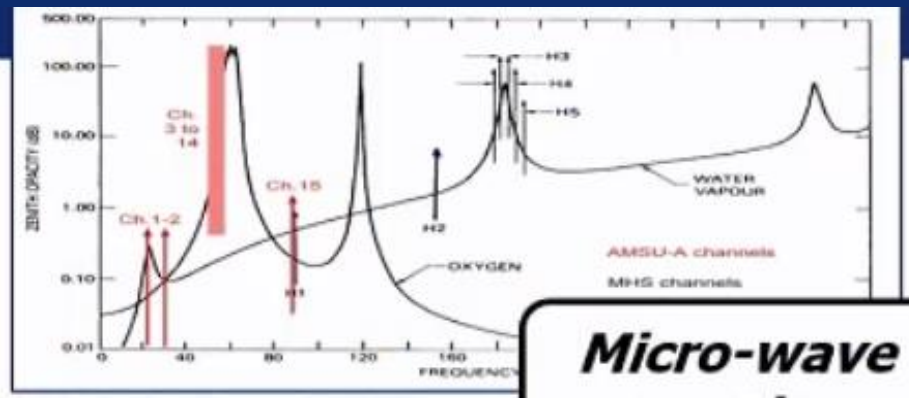
Sounding in clouds possible



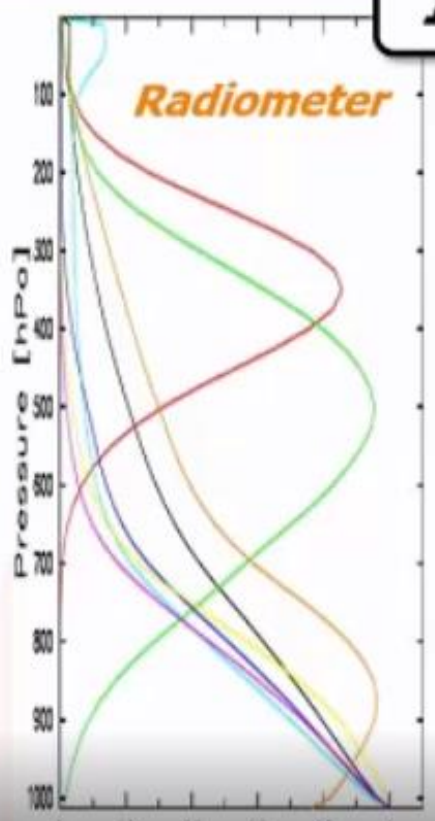
(Sli.do Q4) Have you already used IASI data/profiles?

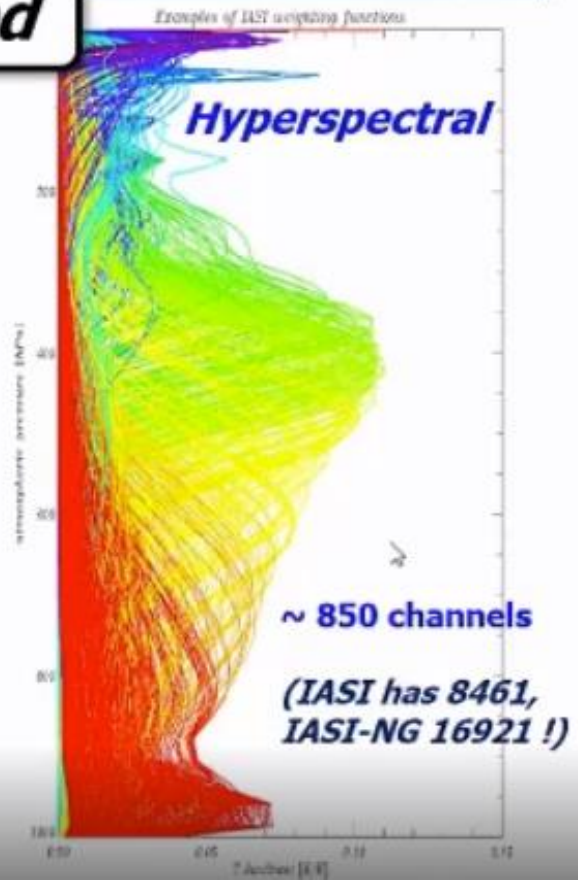


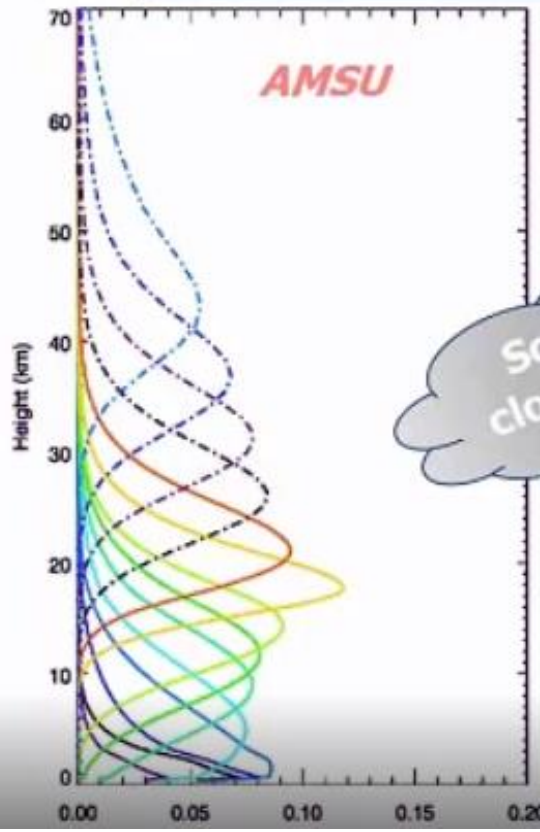
Infrared



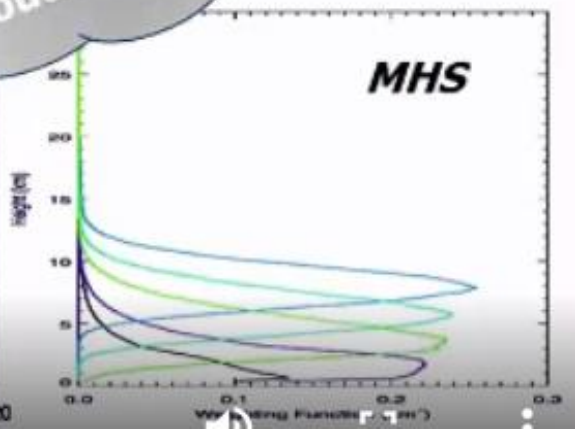
Micro-wave sounders



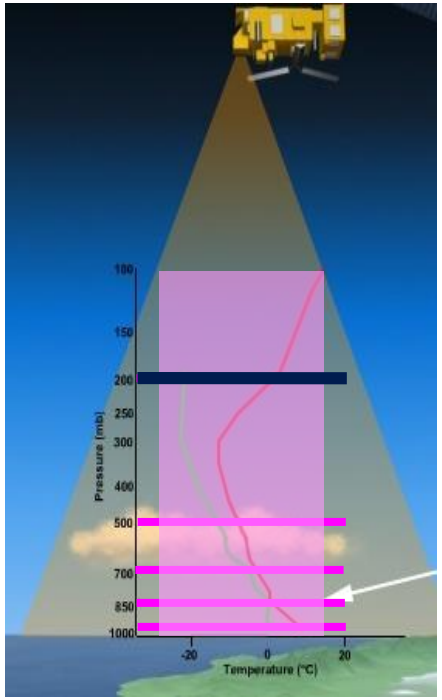


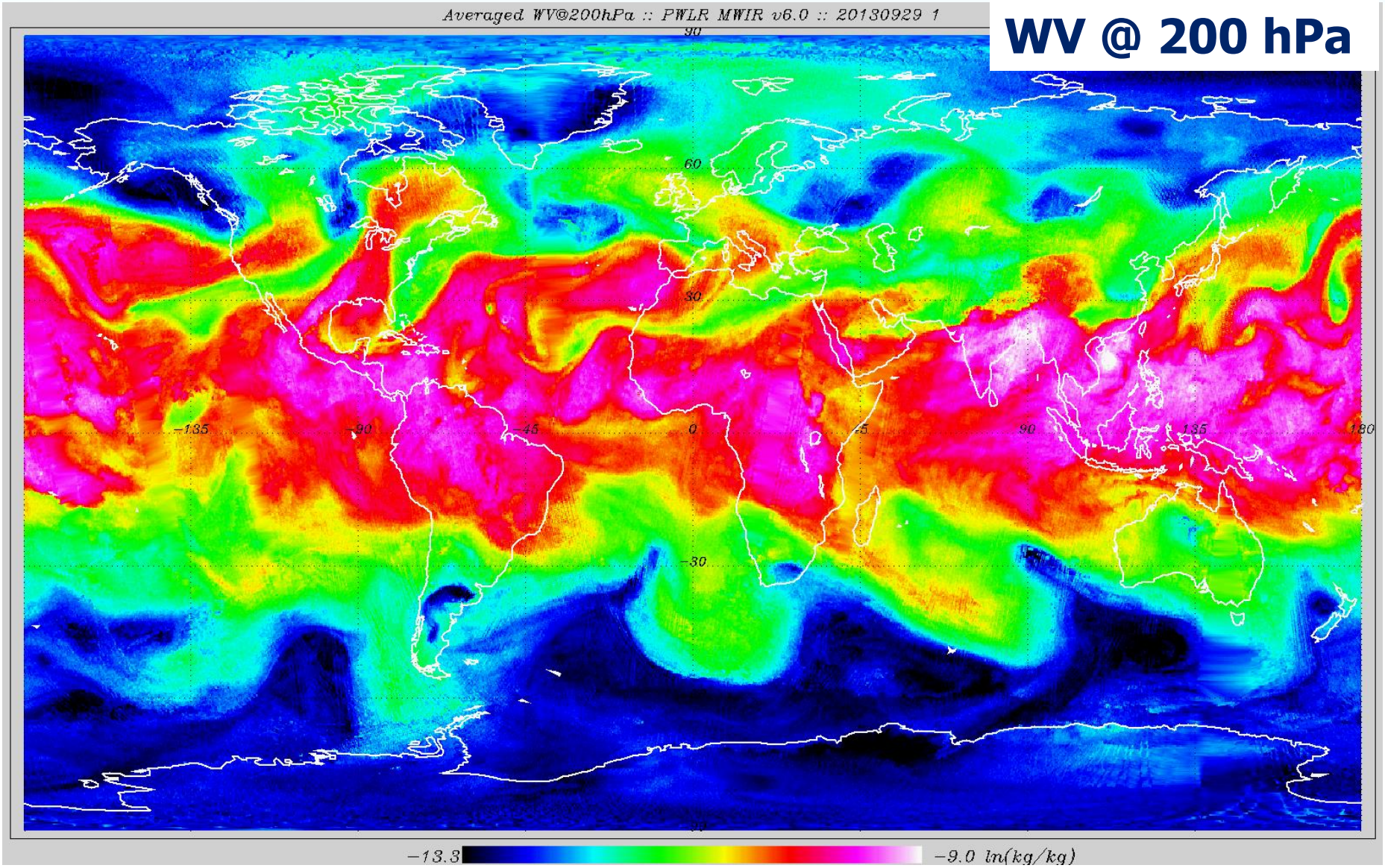


Sounding in clouds possible



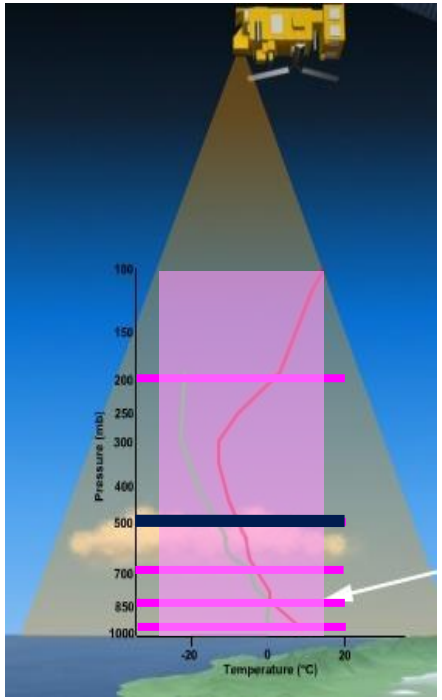
Sounding atmospheric humidity

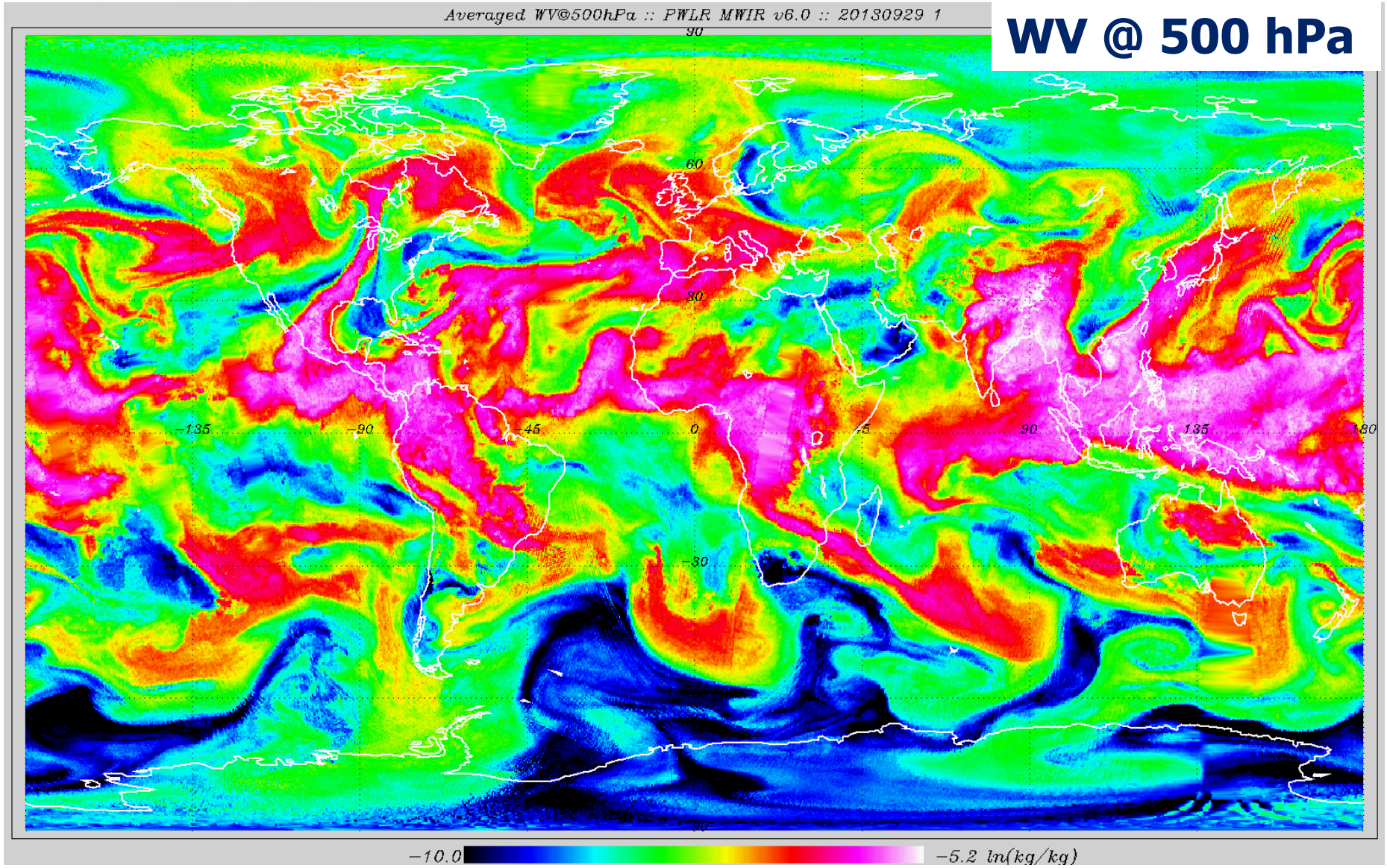




WV @ 200 hPa

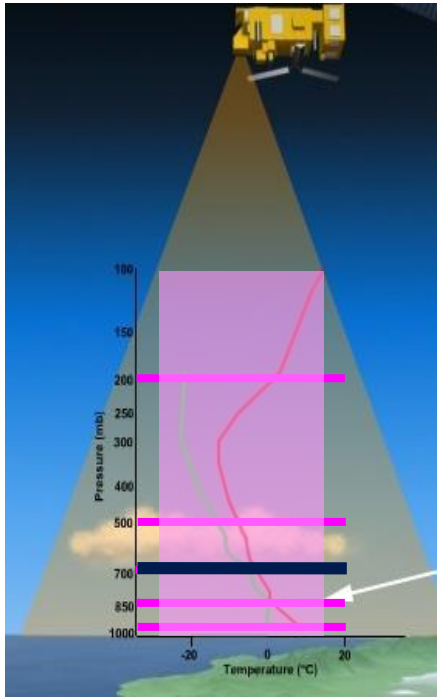
Sounding atmospheric humidity

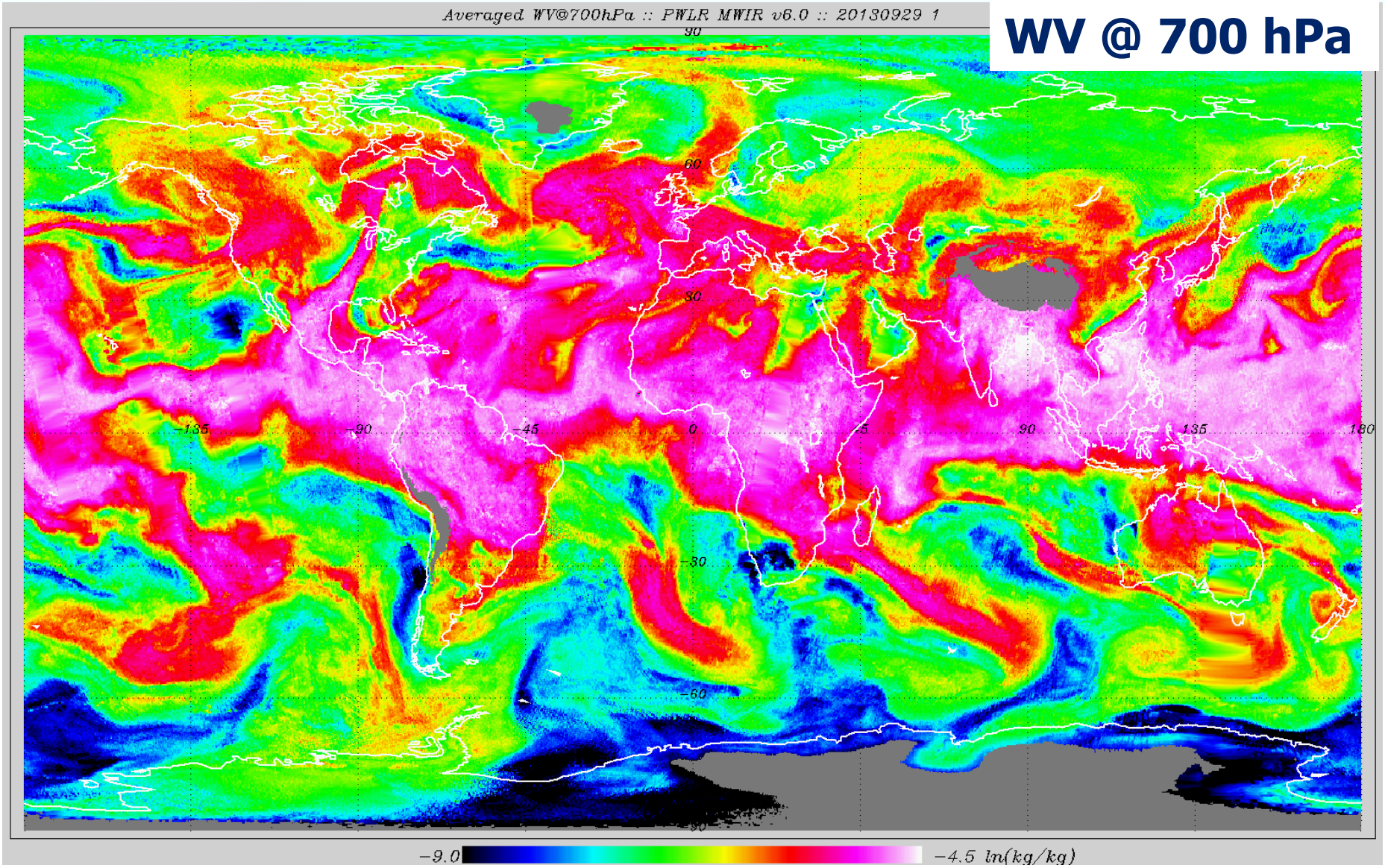




WV @ 500 hPa

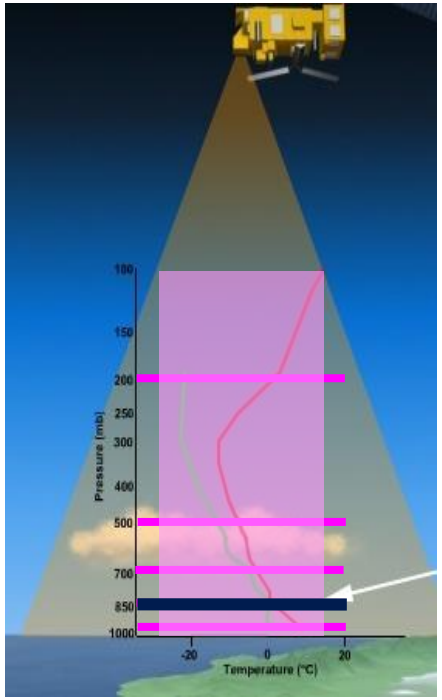
Sounding atmospheric humidity

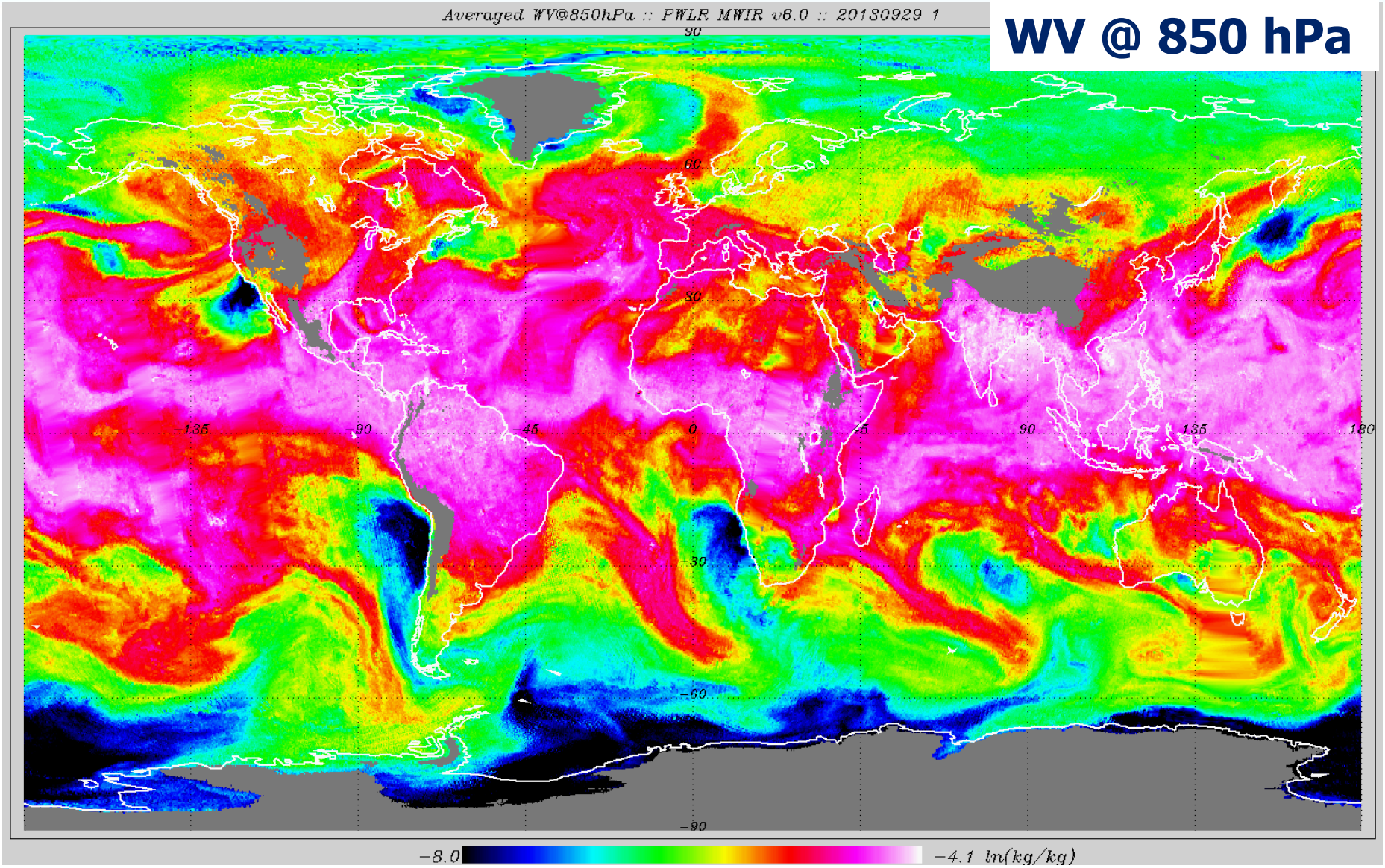




WV @ 700 hPa

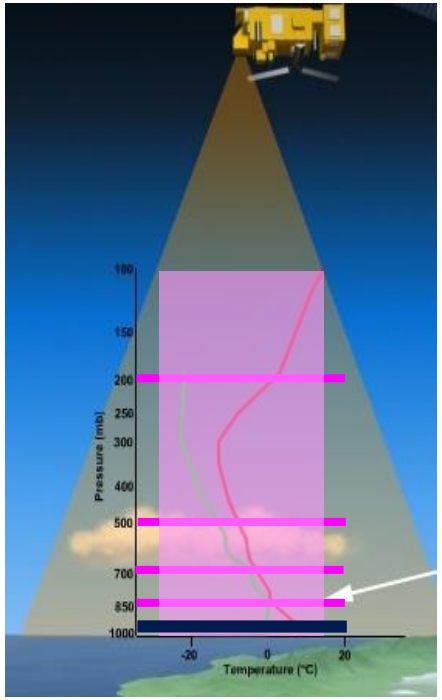
Sounding atmospheric humidity

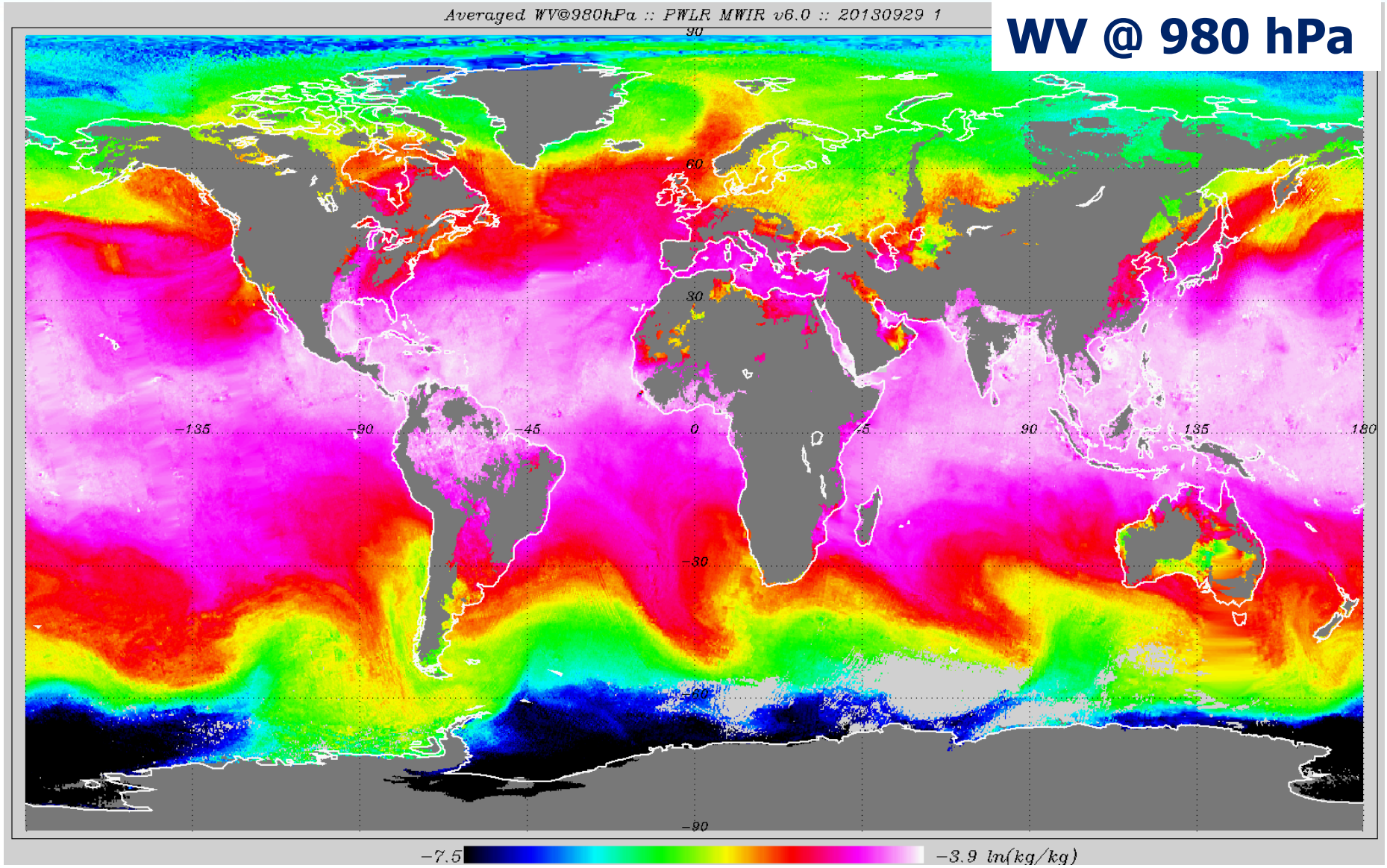




WV @ 850 hPa

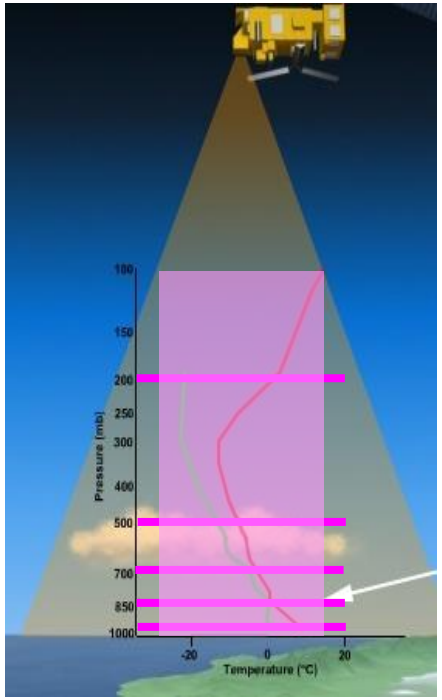
Sounding atmospheric humidity



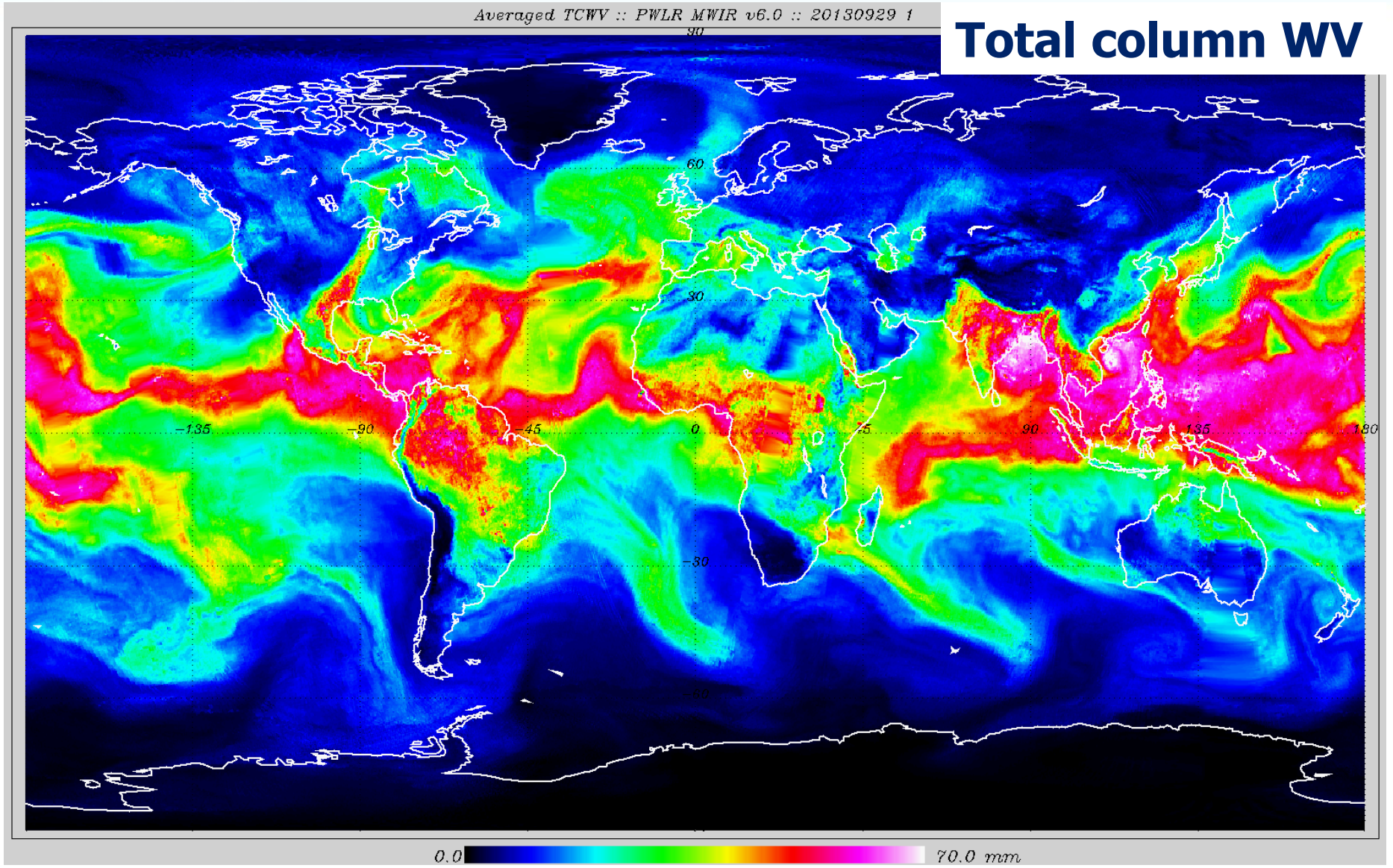


WV @ 980 hPa

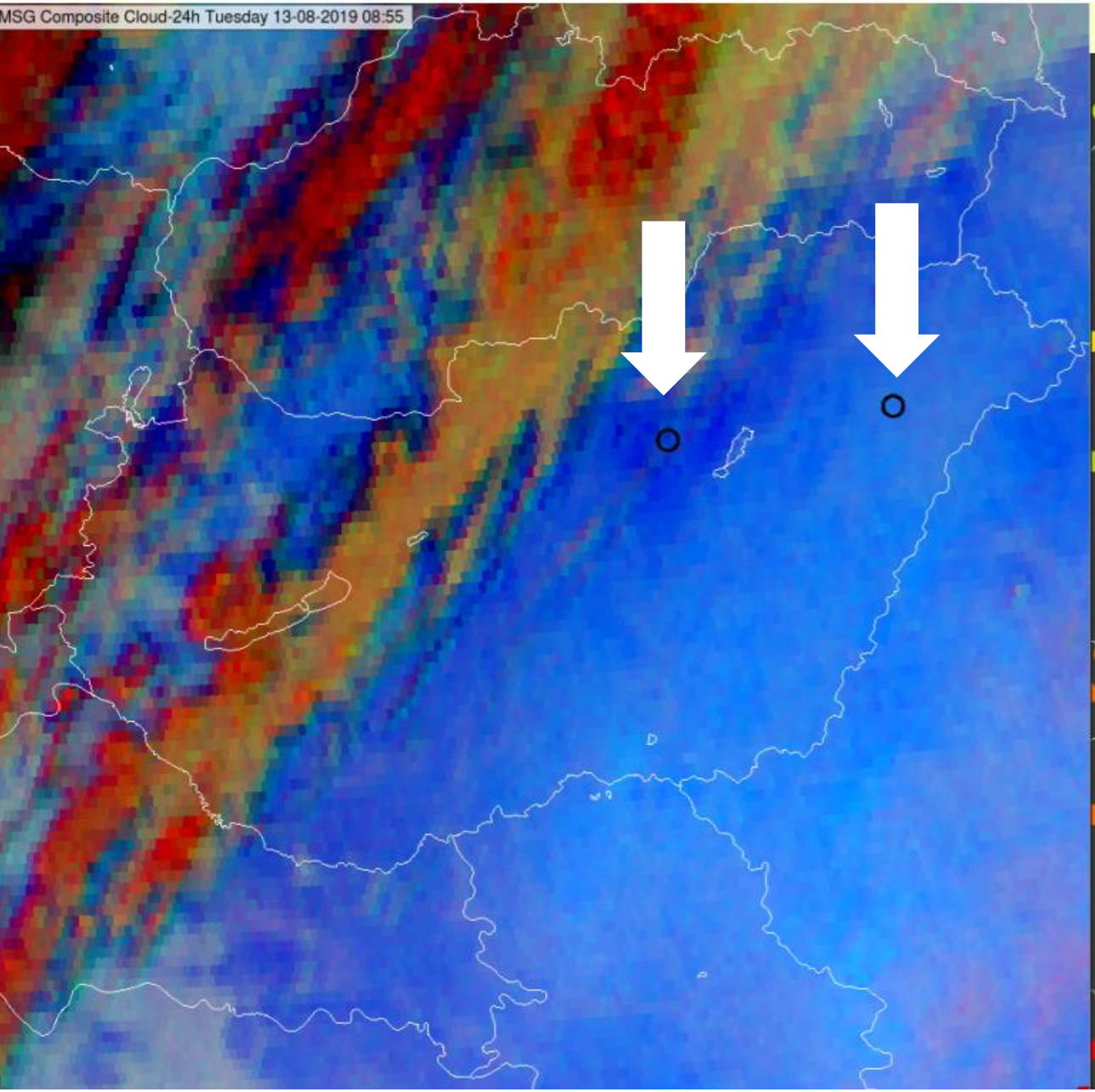
Sounding atmospheric humidity

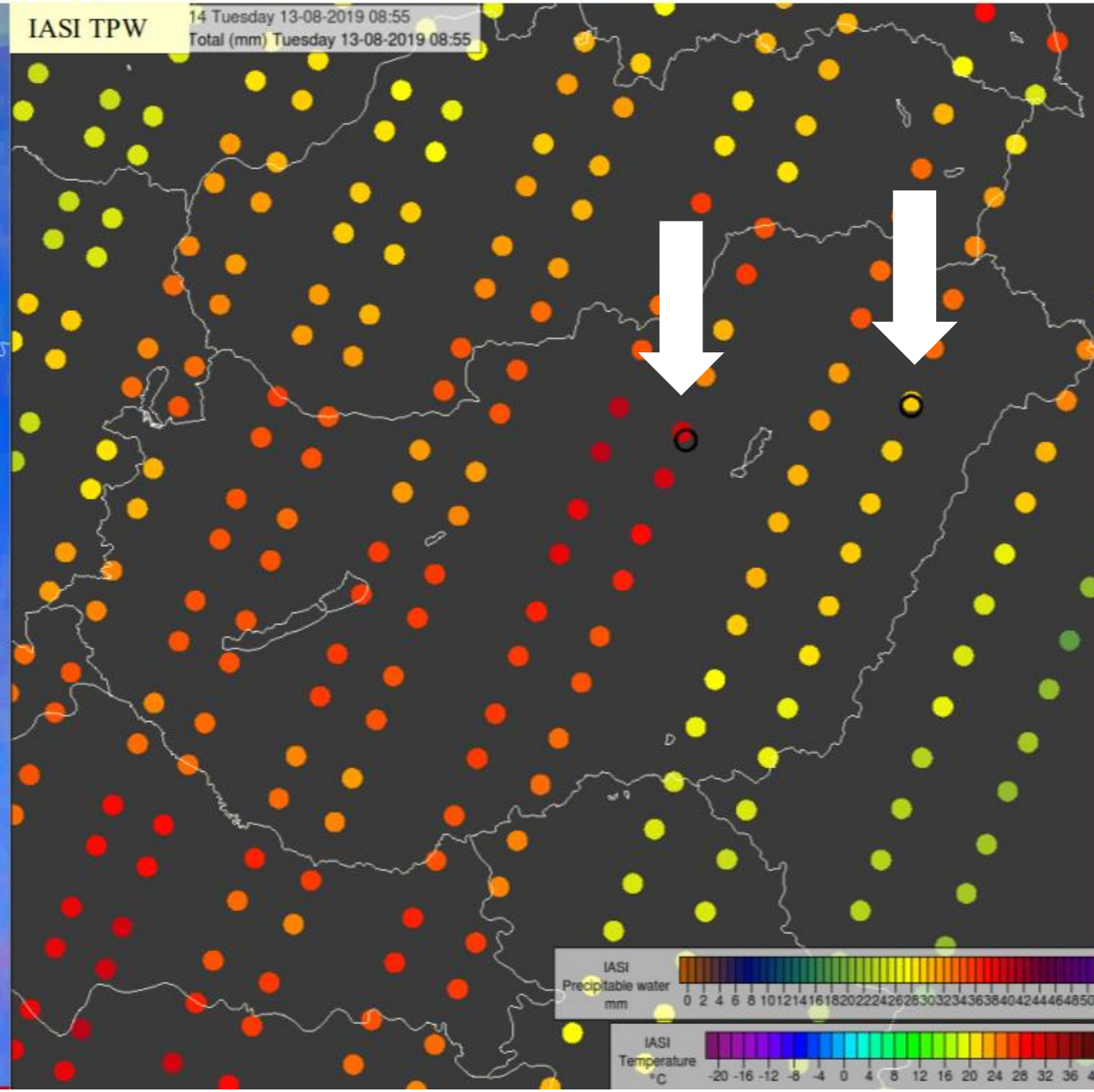


Total column WV

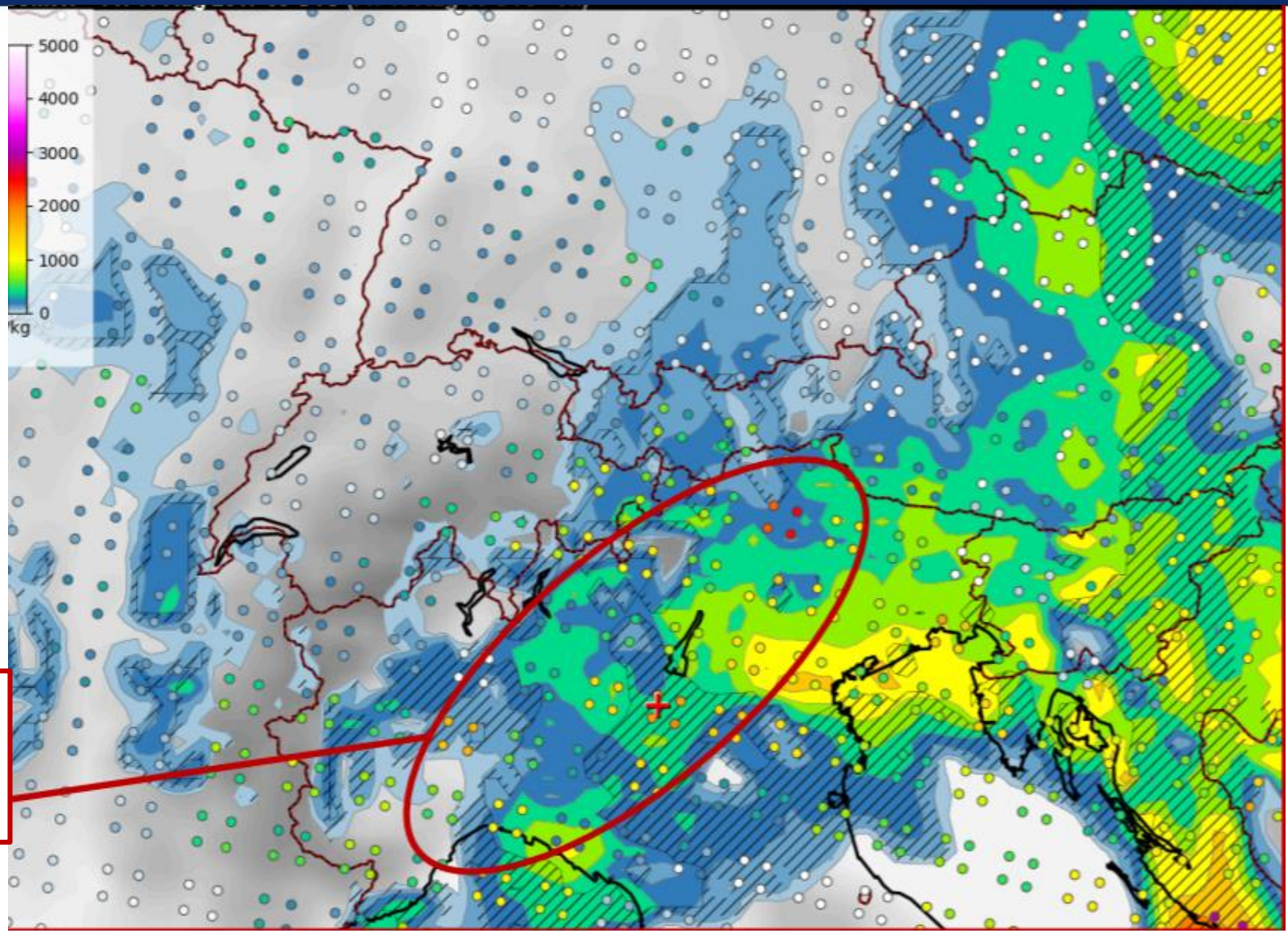


IASI data reflects the moisture content - Moisture boundary - also seen seen in the 24h Microphysics RGB.



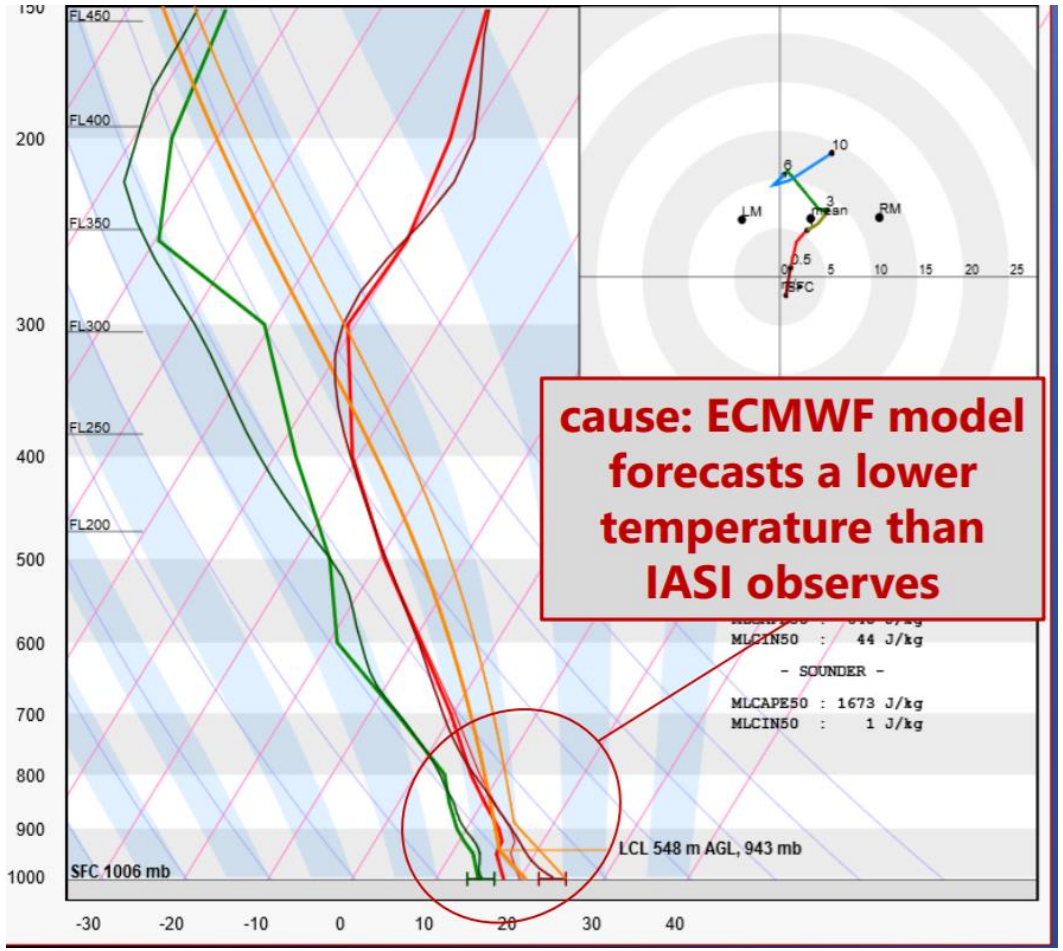


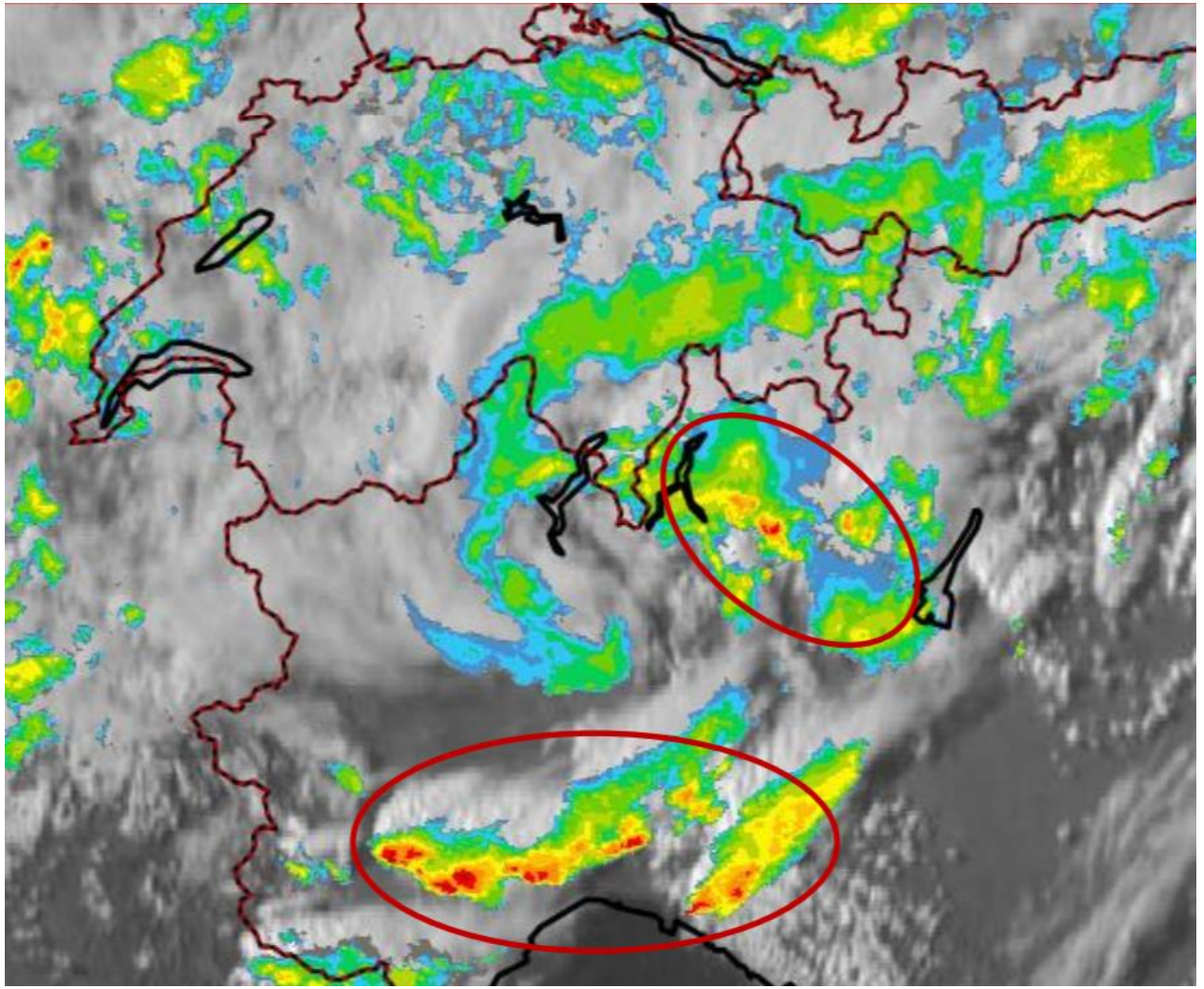
Example 11 August 2017



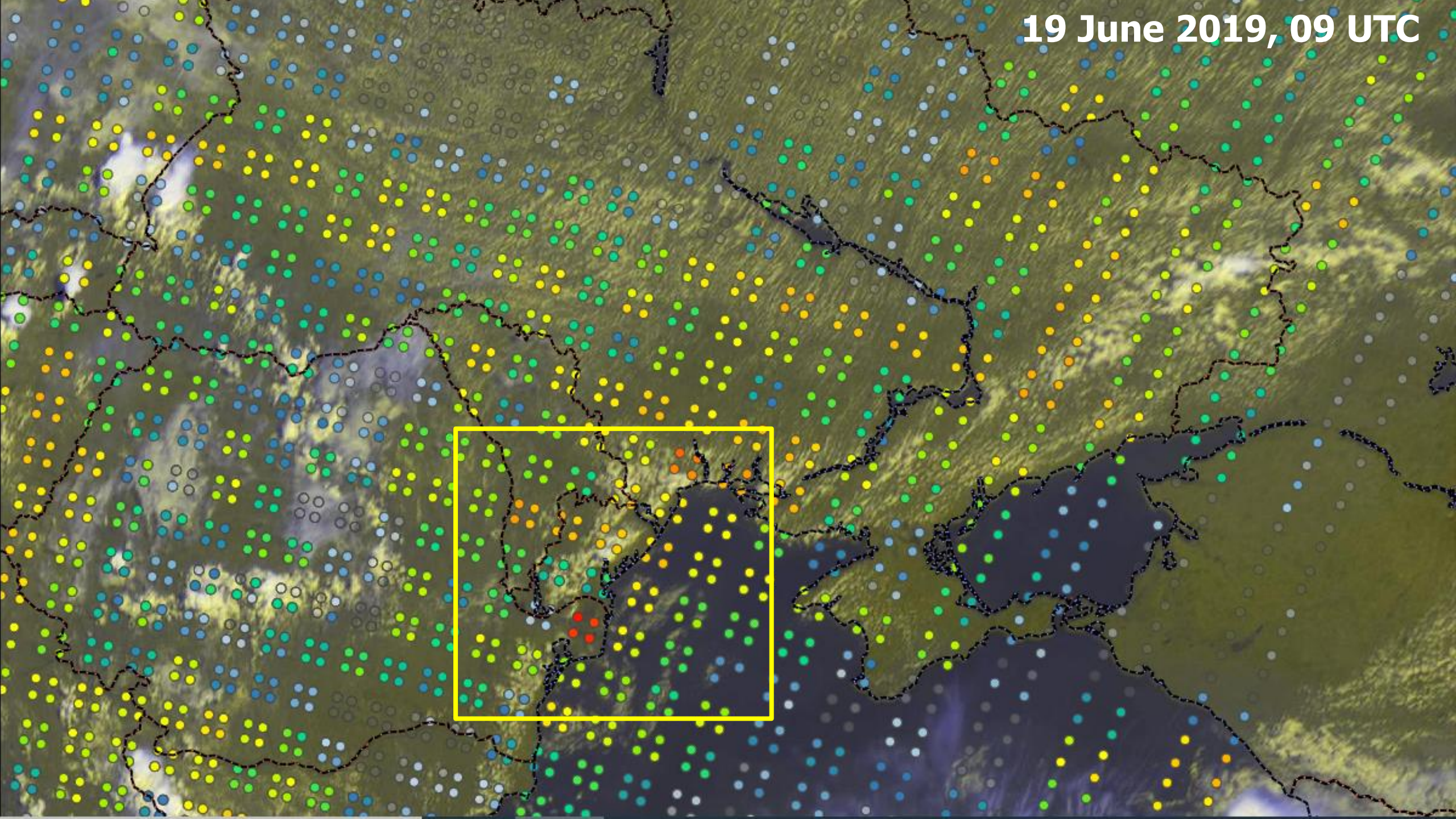
Area where IASI CAPE values are higher than ECMWF CAPE

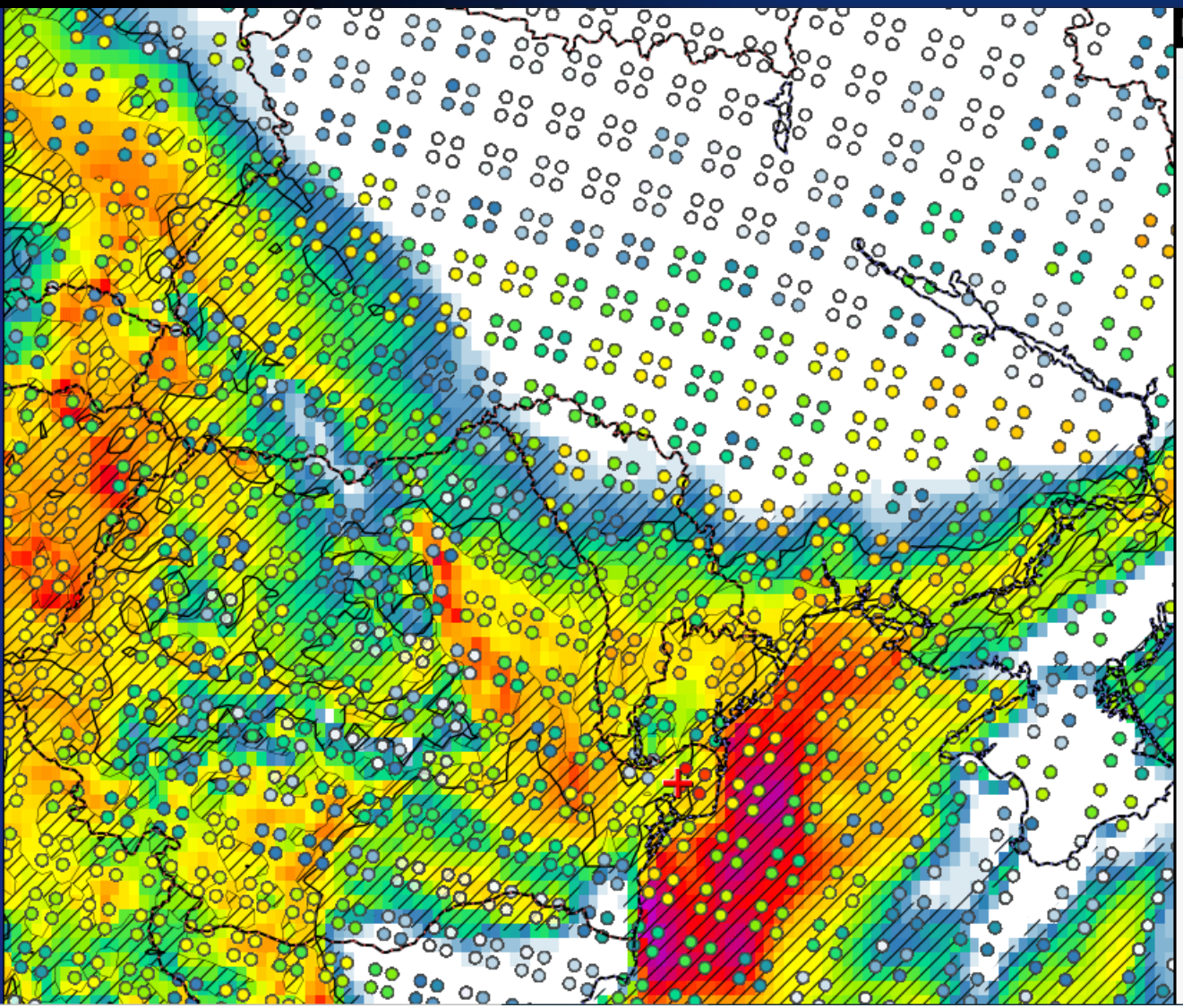
Example 11 August 2017

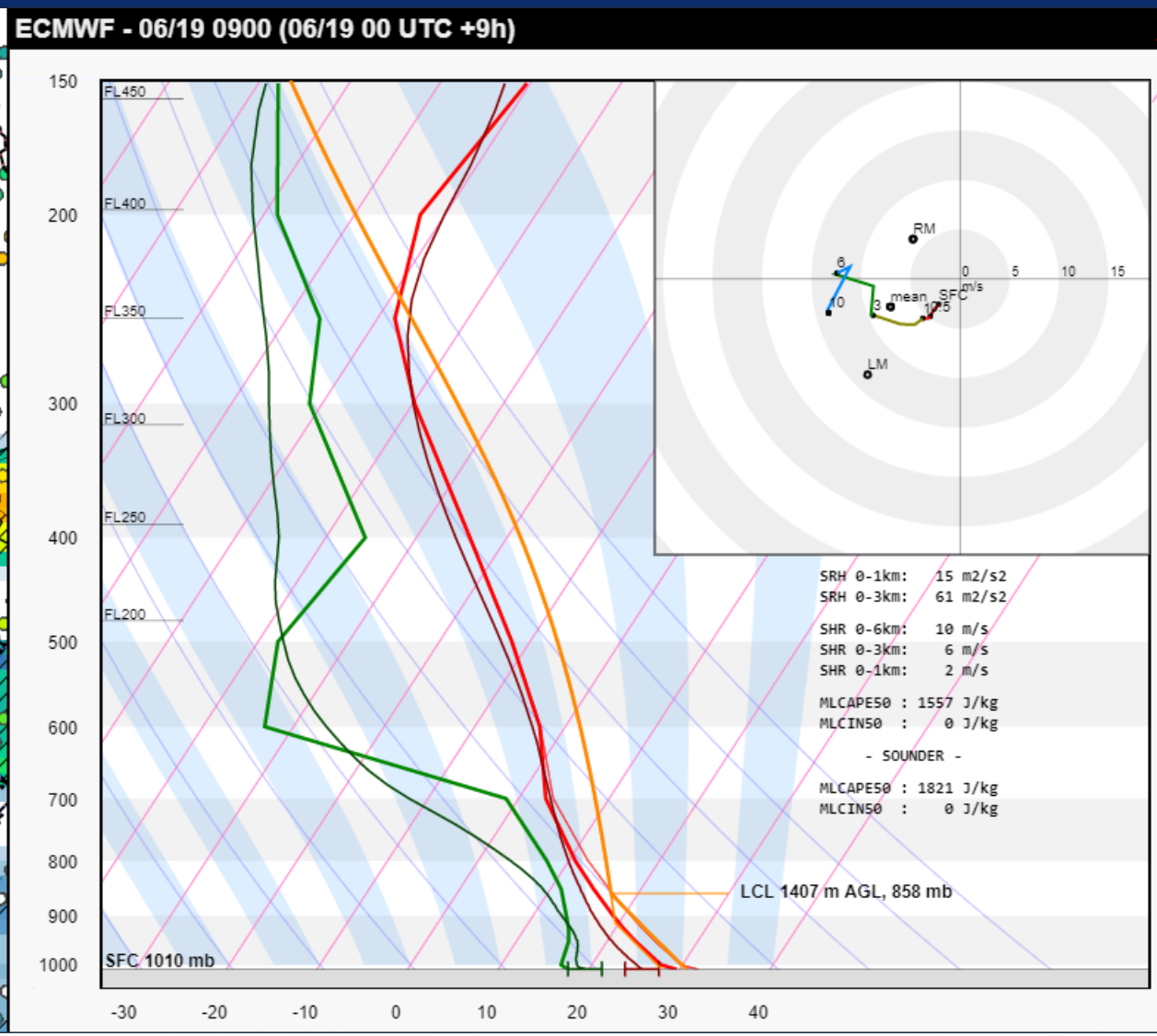


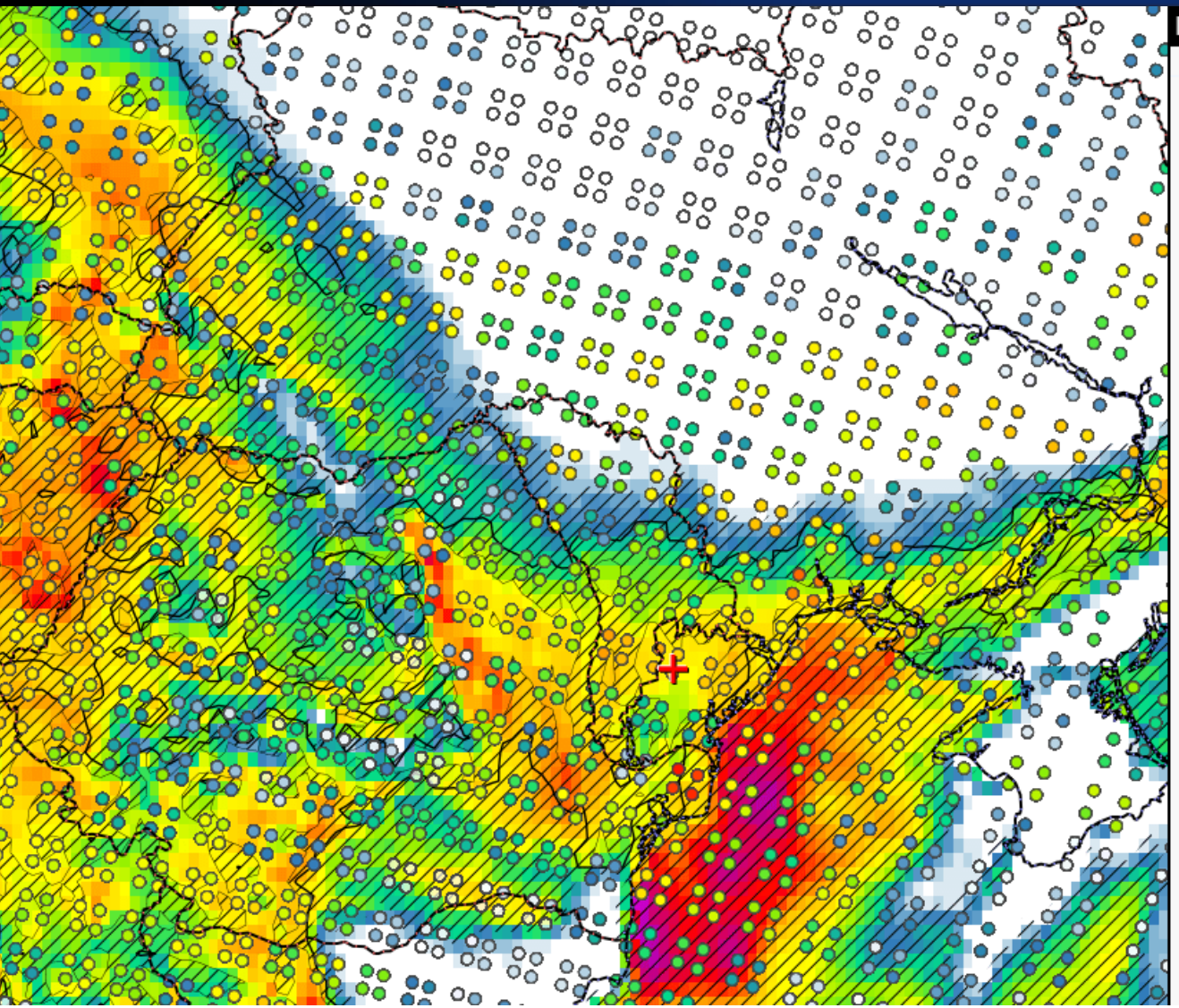


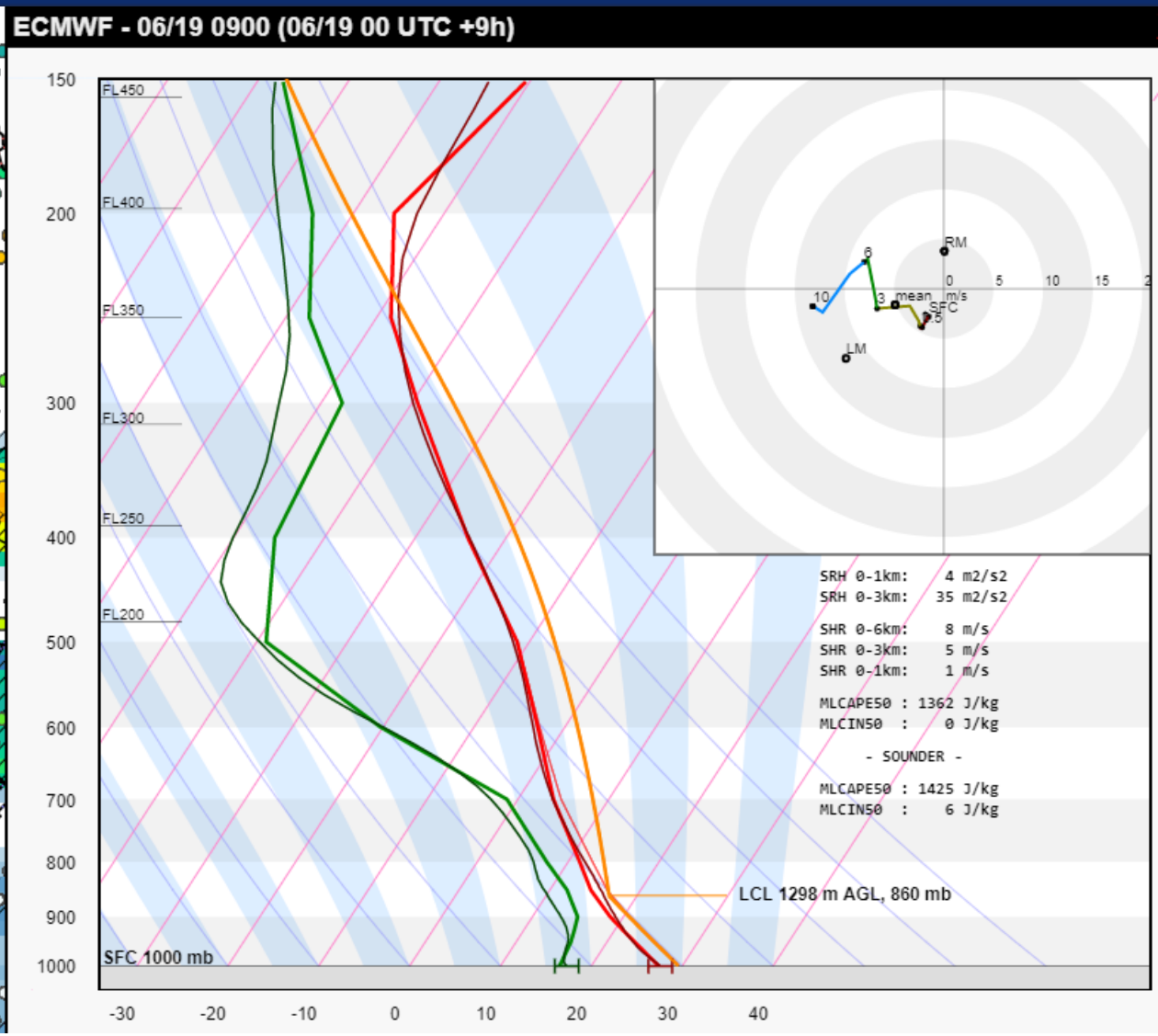
At 15 UTC widespread convection over the area

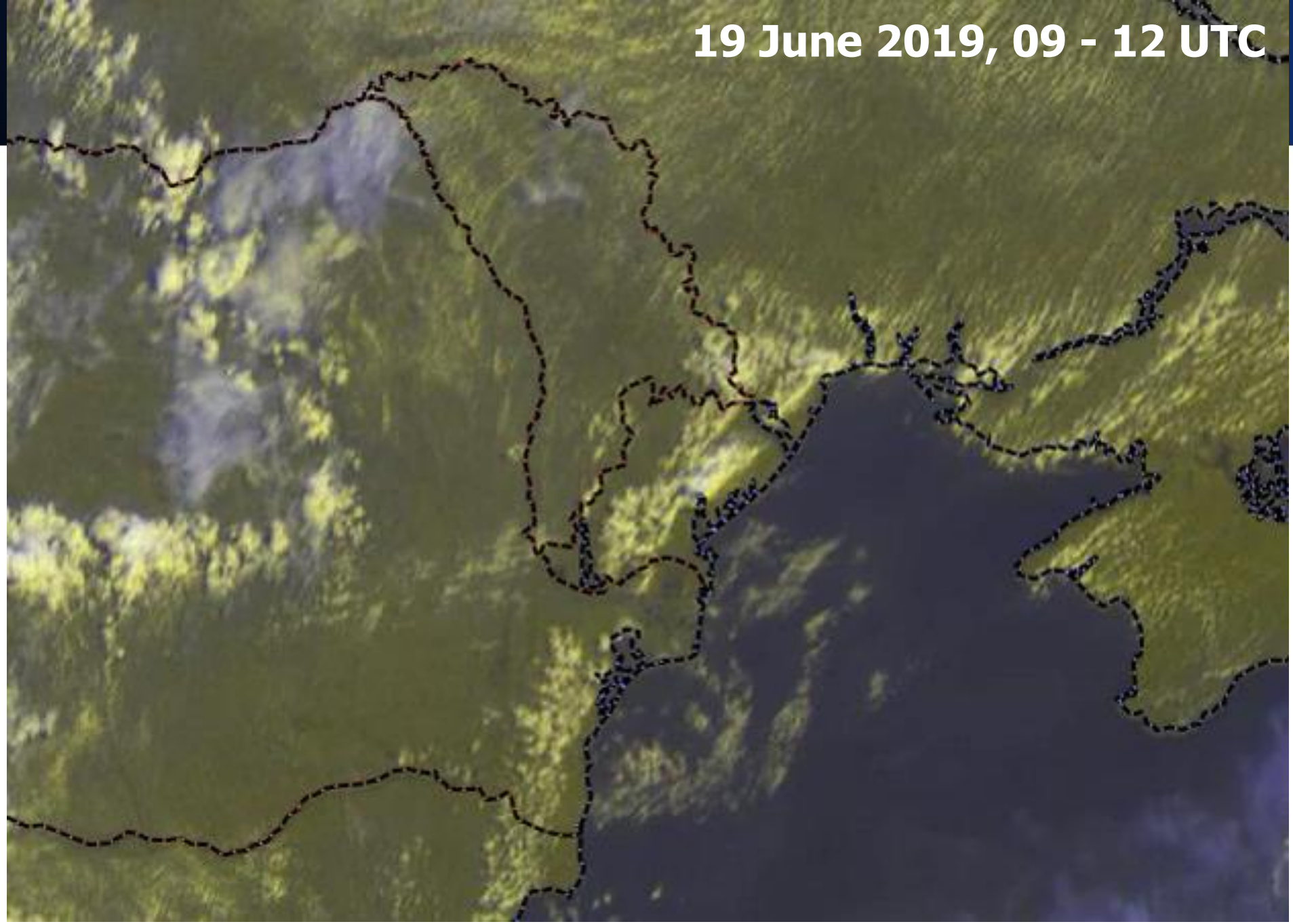

19 June 2019, 09 UTC




ECMWF - 06/19 0900 (06/19 00 UTC +9h)
FL450
FL400
FL350
FL300
FL250
FL200
150
200
300
400
500
600
700
800
900
1000
-30
-20
-10
0
10
20
30
40
RM
LM
mean
SFC
m/s
SRH 0-1km: 15 m2/s2
SRH 0-3km: 61 m2/s2
SHR 0-6km: 10 m/s
SHR 0-3km: 6 m/s
SHR 0-1km: 2 m/s
MLCAPE50 : 1557 J/kg
MLCIN50 : 0 J/kg
- SOUNDER -
MLCAPE50 : 1821 J/kg
MLCIN50 : 0 J/kg
LCL 1407 m AGL, 858 mb
SFC 1010 mb

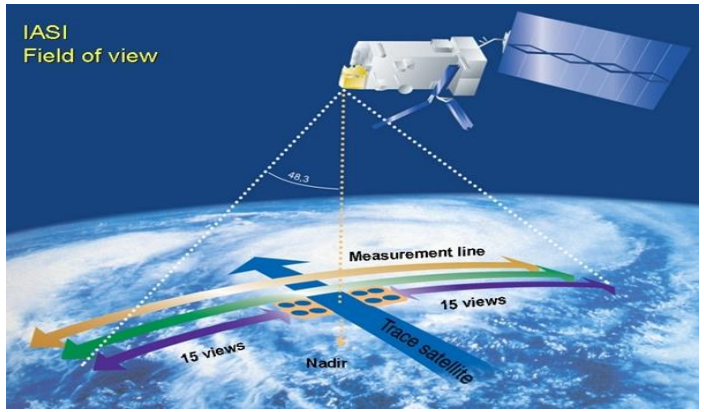


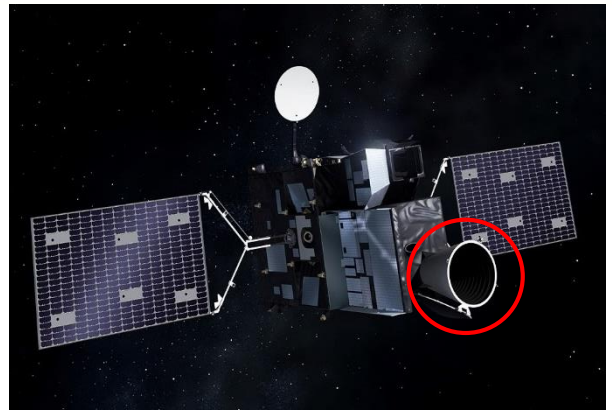

ECMWF - 06/19 0900 (06/19 00 UTC +9h)
FL450
FL400
FL350
FL300
FL250
FL200
150
200
300
400
500
600
700
800
900
1000
-30
-20
-10
0
10
20
30
40
RM
LM
mean m/s
SFC
SRH 0-1km: 4 m2/s2
SRH 0-3km: 35 m2/s2
SHR 0-6km: 8 m/s
SHR 0-3km: 5 m/s
SHR 0-1km: 1 m/s
MLCAPE50 : 1362 J/kg
MLCIN50 : 0 J/kg
- SOUNDER -
MLCAPE50 : 1425 J/kg
MLCIN50 : 6 J/kg
LCL 1298 m AGL, 860 mb
SFC 1000 mb


19 June 2019, 09 - 12 UTC

EUMETSAT hyperspectral sounders

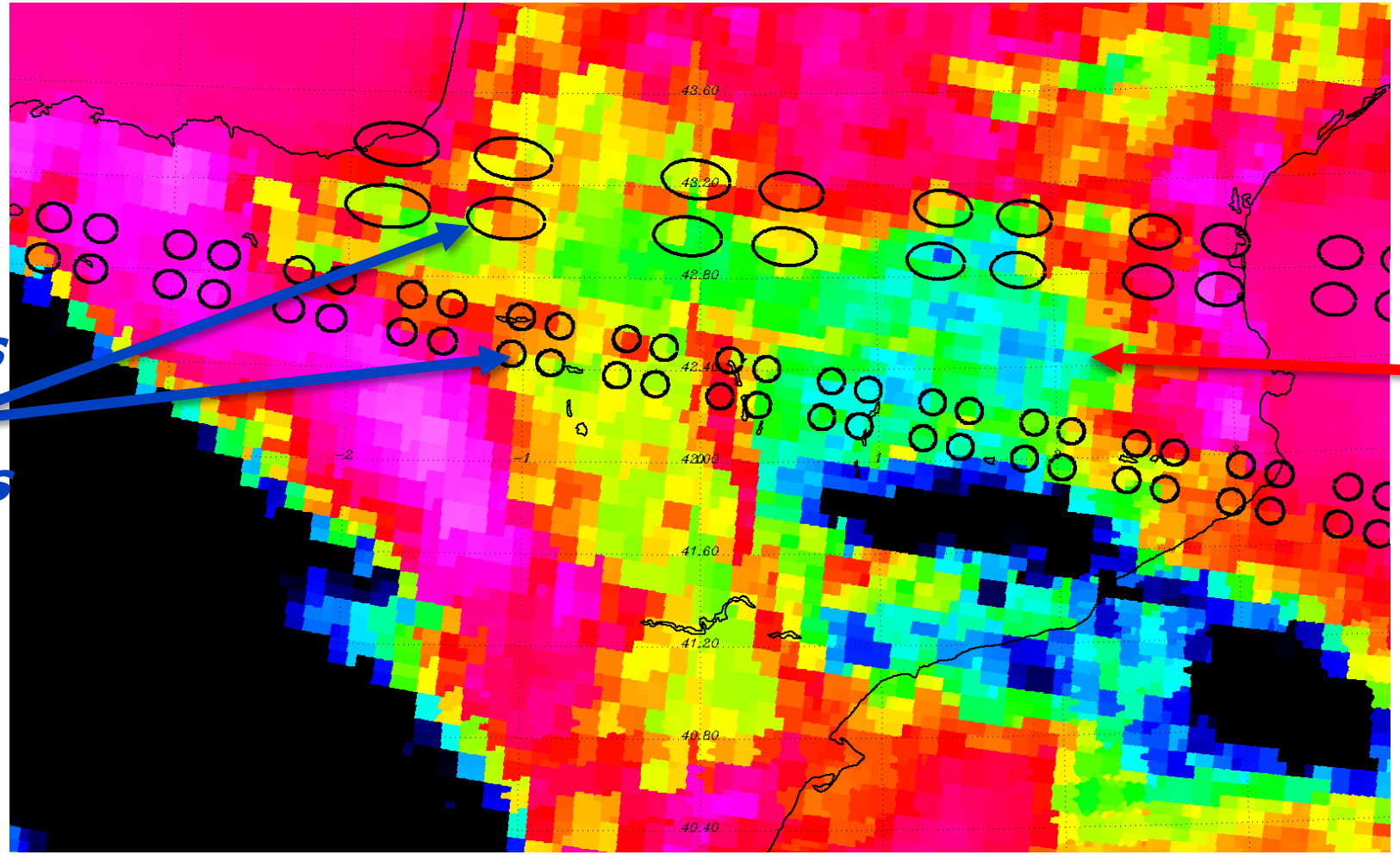
EPS EPS-SG MTG





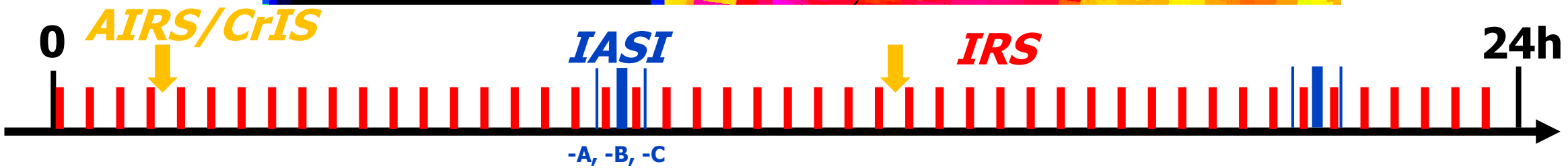
IASI	IASI-NG		MTG-IRS
Polar orbit (LEO)		**Orbit**	**GEO**stationnary
2x2	4x4	**Sensor**	160x160
12 km	12 km	**Spatial (Nadir)**	4 km
0.25 cm^{-1}	0.125 cm^{-1}	**Spectral sampling**	~0.6 cm^{-1}
2x / day	2x /day	**Temporal**	Every 30 min Europe
Metop-A 19 October 2006 Metop-B 17 September 2012 Metop-C 06 November 2018	2023		2023

IRS: unique dynamic 3D observation of the atmosphere



IASI footprints
12-40km
Not-contiguous
2x per day

IRS pixels
~7km
Contiguous
every 30mn



EUMETSAT