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Future NWC SAF products for the Meteosat Third Generation Infrared Sounder (MTG-IRS)

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25 July 2016

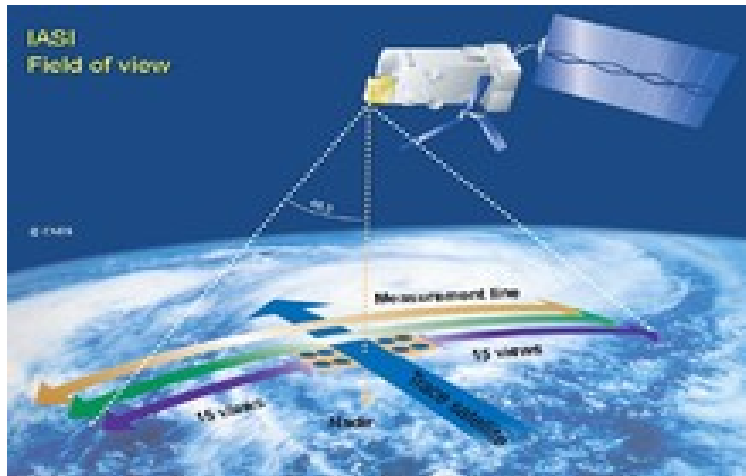
WMO WWRP 4th International Symposium on Nowcasting and Very-
short-range Forecast 2016 (WSN16), 25-29 July 2016

Outline

1. Introduction to Hyperspectral Infrared Sounders
2. Overview of future NWC SAF products for MTG-IRS
3. The qIRS product
4. The sSHAI_ES product
5. The sSHAI product
6. Examples of sSHAI using IASI data as proxy for MTG-IRS

Introduction to Hyperspectral Infrared Sounders (1/2)

IASI



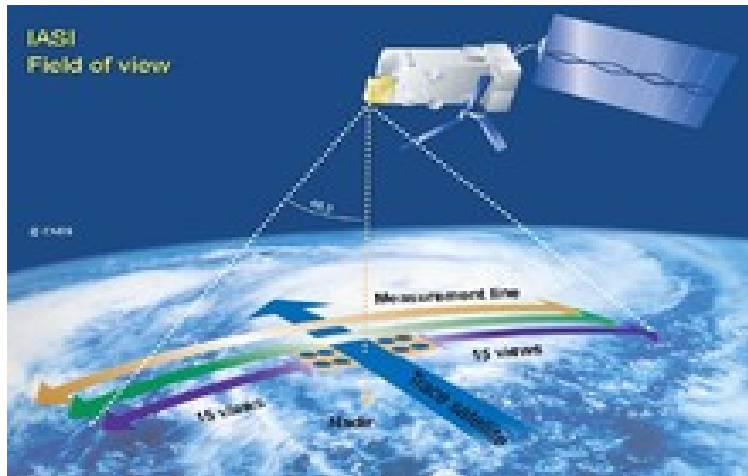
MTG-IRS



1. There are currently several Hyperspectral Infrared Sounders in Polar orbit: AIRS, IASI, CriS. In the future FY-4 and MTG-IRS will be geostationary ones.
2. IASI is a nadir looking across scanning infrared spectrometer with mid/high spectral resolution (0.5 cm^{-1} , 8461 channels) and a spatial resolution of 12 km at sub-satellite point on the polar orbiting satellite Metop.

Introduction to Hyperspectral Infrared Sounders (2/2)

IASI



MTG-IRS



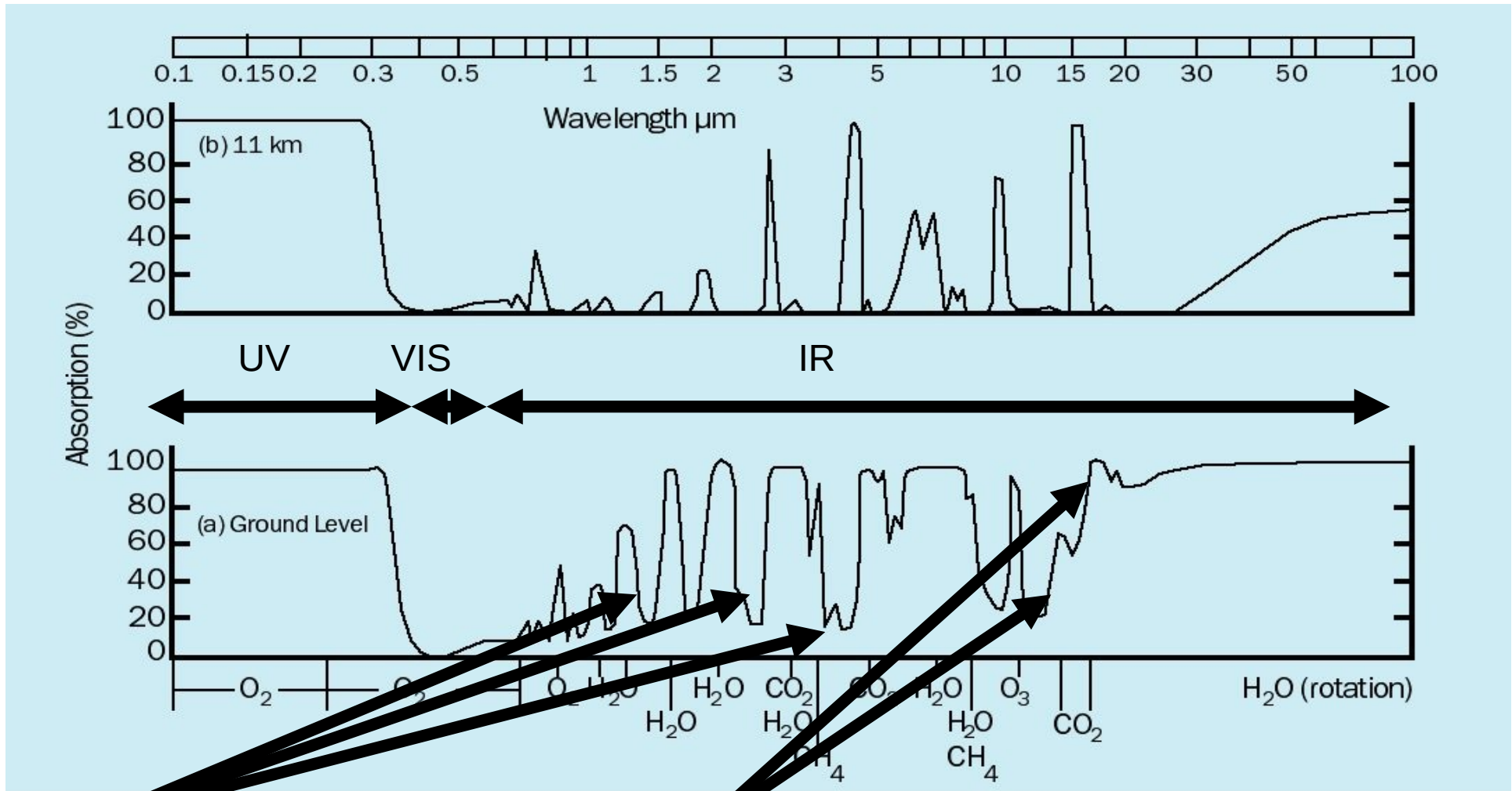
3. The IRS will deliver over the Full Disk in the LWIR (700–1210 cm^{-1} or 14.3–8.3 μm) 800 spectral channels and in the MWIR (1600–2175 cm^{-1} or 6.25–4.6 μm) 920 channels with a basic repeat cycle of 60 min.

4. With an inversion retrieval technique (OE, regression) we can derive T (1 K in 1km layers) and q (15% in 2 km layers) atmospheric profiles. Also ozone.

4 5. Ill-posed problem!! Need extra info!!



Physical Principles (1/2)

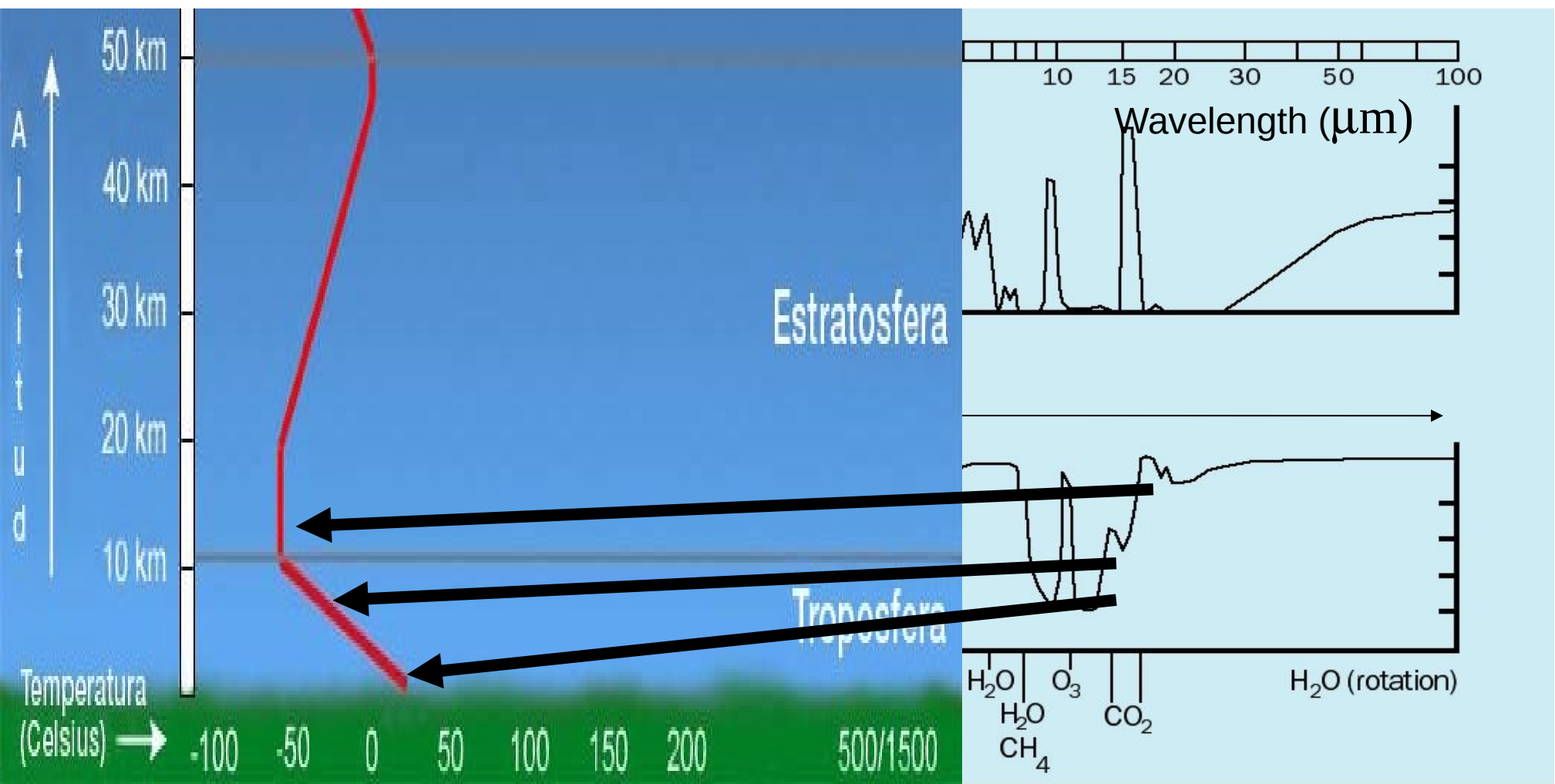


Windows

Absorption Bands



Physical Principles (2/2)



Overview of future NWC SAF products for MTG-IRS

All these products will be available at Day-2

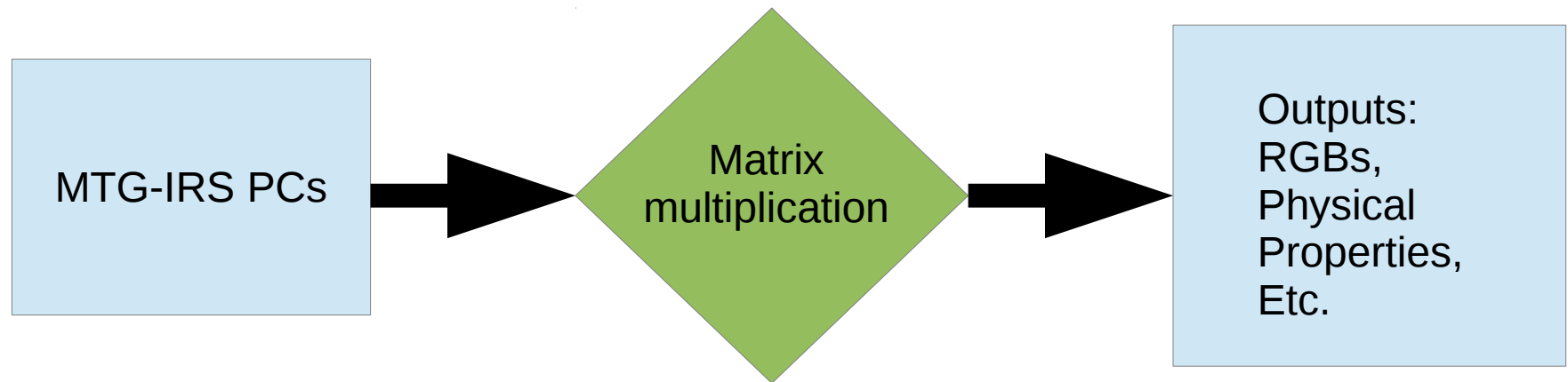
1. qIRS: Quick IRS product
2. sSHAI_ES: sounder Satellite Humidity And Instability from Eumetsat Secretariat
3. sSHAI: sounder Satellite Humidity And Instability from NWC SAF

qIRS: quick IRS product: Motivation

- MTG-IRS will have around 2000 channels
- Only 300 Principal Components of the channels will be distributed via EUMETCast
- The Nowcasters will need something simpler

qIRS: quick IRS product: Description

- The qIRS product will take a user configurable matrix to multiply it by the radiances or brightness temperatures and obtain a product

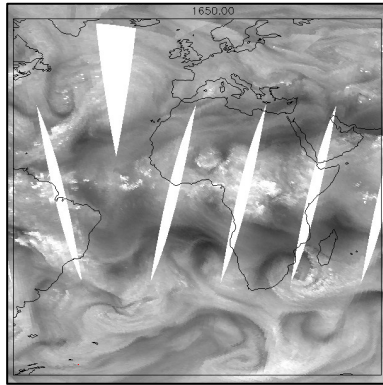


qIRS: quick IRS product: Output

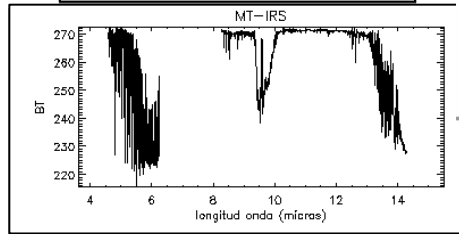
- Potential outputs:
 - Simple physical retrievals: 3 levels of humidity, 3 levels of temperature or 3 levels of ozone
 - Radiances from selected channels
 - RGBs: 3 outputs which are a linear combination of BTs
 - Output highlighting some physical property like a PBL inversion
 - Any other idea...

qIRS: Examples

Top-Down quick looks of Water Vapour (IASI)

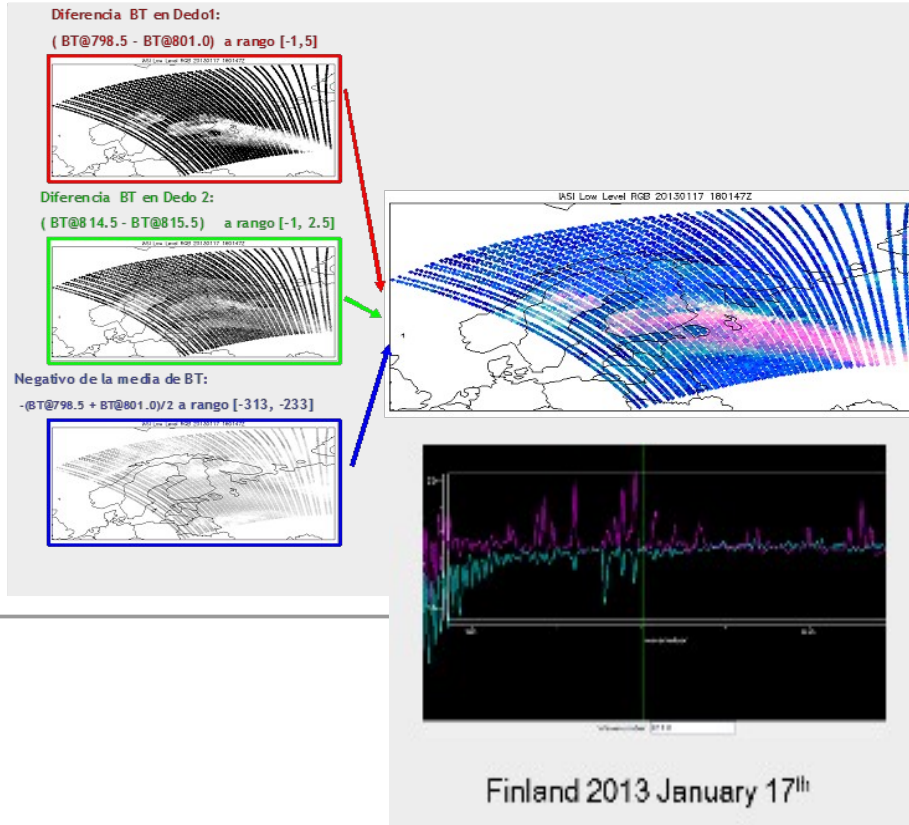


WV absorption peaks on [1650 cm⁻¹, 2143 cm⁻¹)

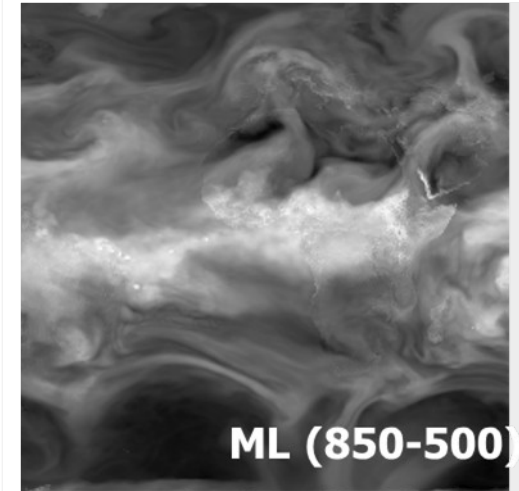


IRS 1738 channels in two bands

Inversion detection (IASI)



Mid layer humidity (synthetic MTG-IRS)

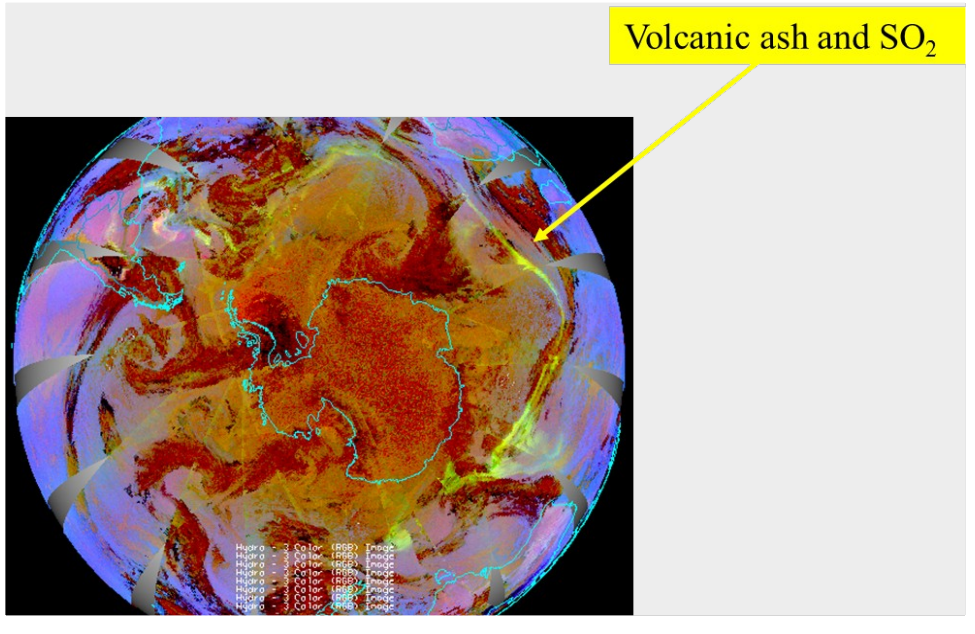


ML (850-500)

ML LPW (850-500 hPa)
C1=1717 (λ = 4.6243)
C2=1539 (λ =4.8751)

qIRS: Examples

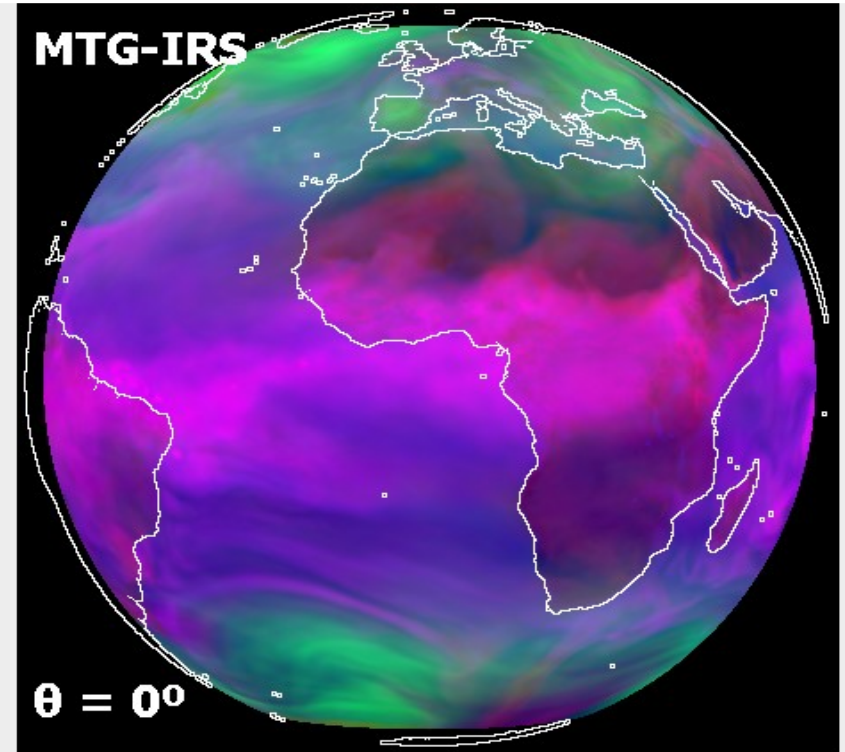
Dust RGB (IASI)



Eruption from the
Puyehue-Cordon
Volcano

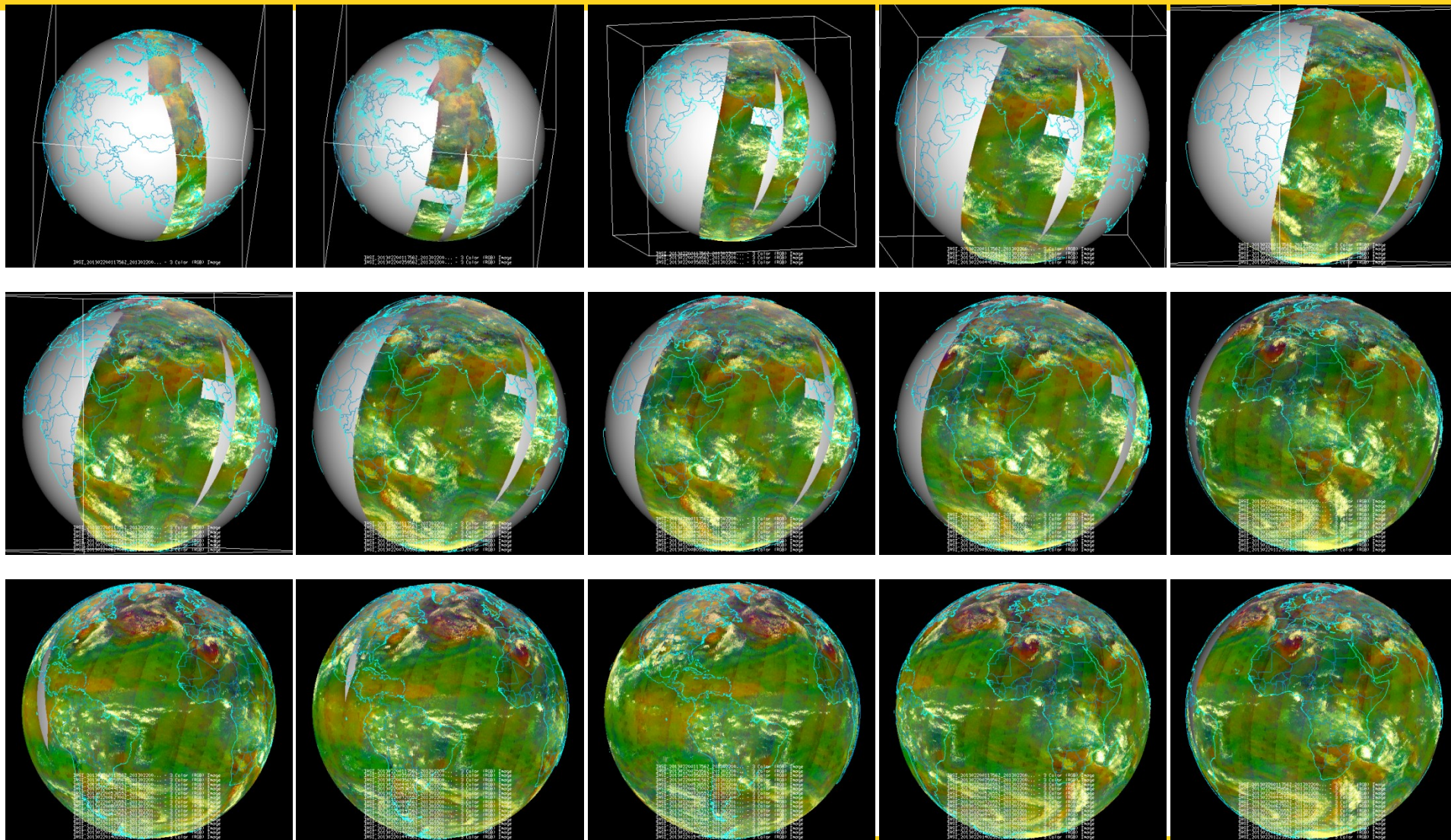
9th June 2011 22:24Z

ML, TOZ, BL RGB (synthetic MTG-IRS)



presented on 2010 EUMETSAT Conference

qIRS: Air Mass RGB (IASI)

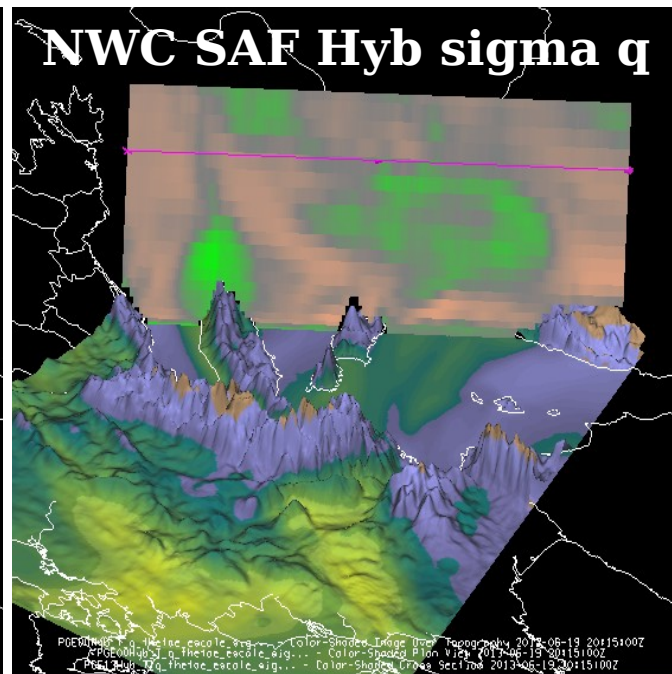
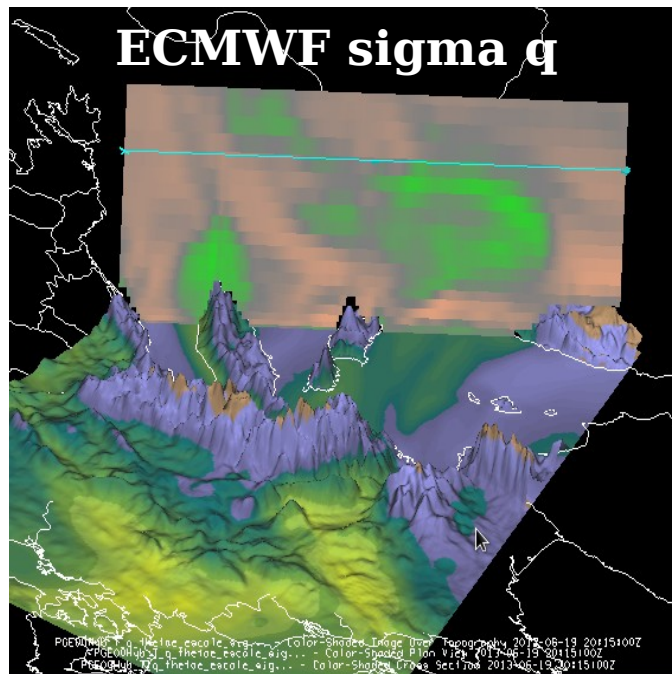
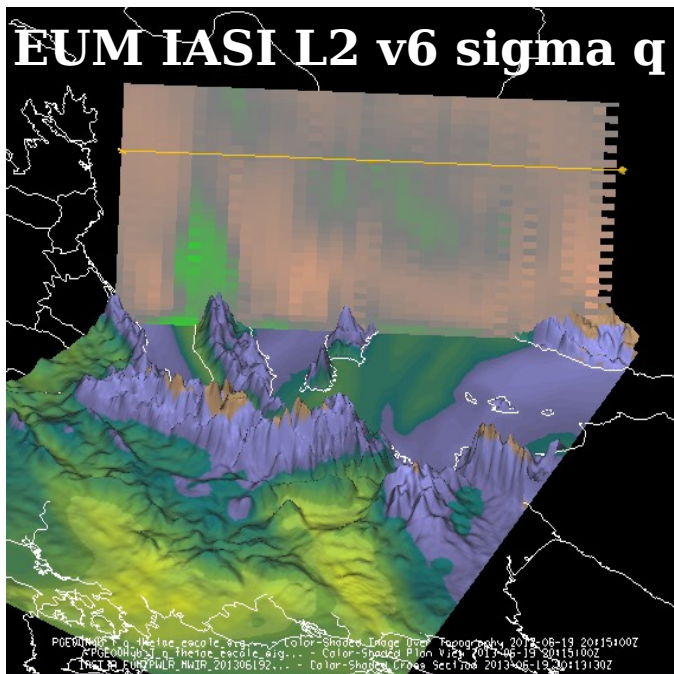


sSHAI_ES: Characteristics

- sSHAI_ES: sounding Satellite Humidity And Instability from Eumetsat Secretariat
 - Retrievals will be based on Optimal Estimation
 - Background will be ECMWF forecasts
 - Retrievals only for clear scenes
 - NWC SAF will derive humidity in layers and instability indices
 - NWC SAF will re-project onto user defined MTG FCI regions

sSHAI_ES: Example

Vertical cross section of “sigma q”



Note: MTG-IRS L2 algorithm will differ from EUM IASI L2

sSHAI: Characteristics

- sSHAI: sounding Satellite Humidity And Instability from NWC SAF
 - Retrievals will be based on a fast non-linear regression method, Kernel Ridge Regression (KRR)
 - Background will be climatology or user provided NWP forecasts
 - Retrievals for clear or partly cloudy scenes
 - Humidity in layers and instability indices will be derived
 - NWC SAF will re-project onto user defined MTG FCI regions

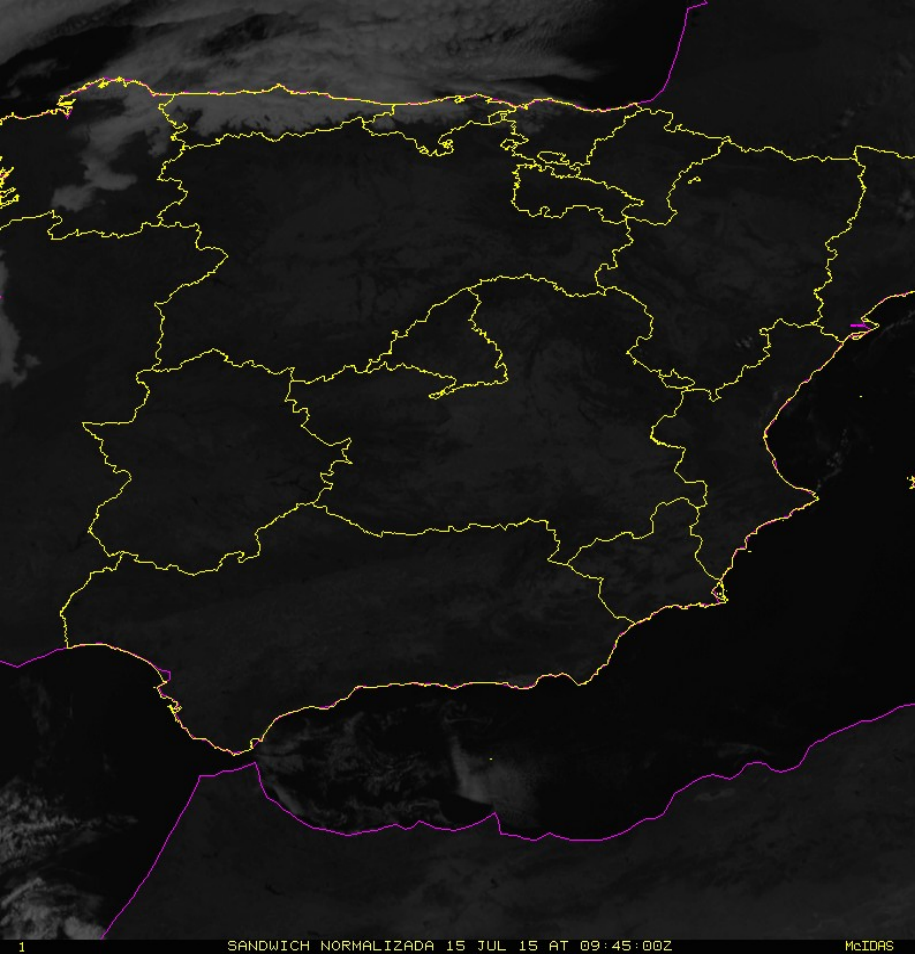
SHAI: Challenges

- SHAI: Satellite Humidity And Instability faces several challenges:
 - Retrievals loose accuracy in lower layers → where it is most critical for instability indices (e.g. CAPE) → possible solution to add ground based data or creating new instability parameters
 - NWP forecast already have a high accuracy and they also assimilate hyperspectral data → difficult to compete with NWP → state of the art retrievals methods are needed

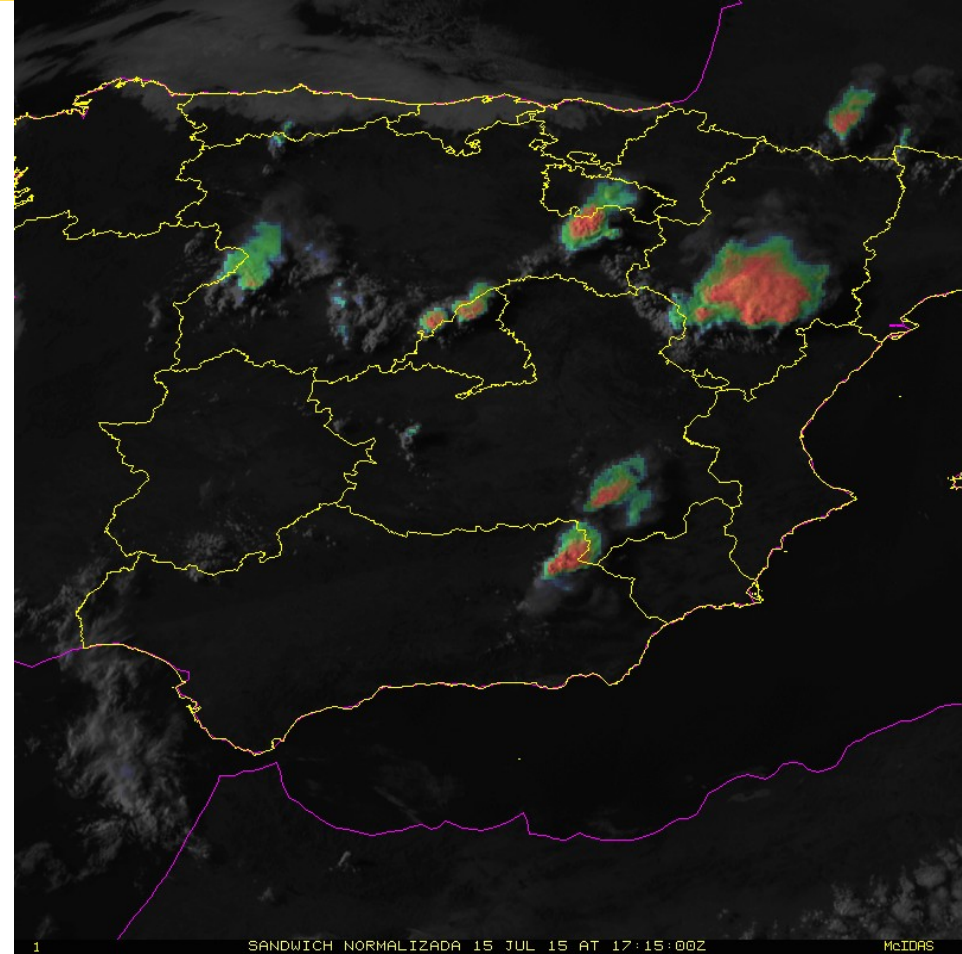
sSHAI: Example

- sSHAI: Example using NWC SAF prototype
 - Non-linear regression retrieval for IASI on clear scenes (Camps-Valls et al., IEEE Trans. Geo. & Rem. Sen., 2012)
 - Based on climatology (no Forecast input!!)
 - Tested on a day suitable for hyperspectral sounders:
 - 2015/07/15 over Spain
 - Clear skies in the morning
 - Convection developing in the afternoon
 - Nearly static synoptic situation → Predictions for the afternoon can be based on morning measurements

sSHAI: Example: Meteosat RGB Images



9:45 Z

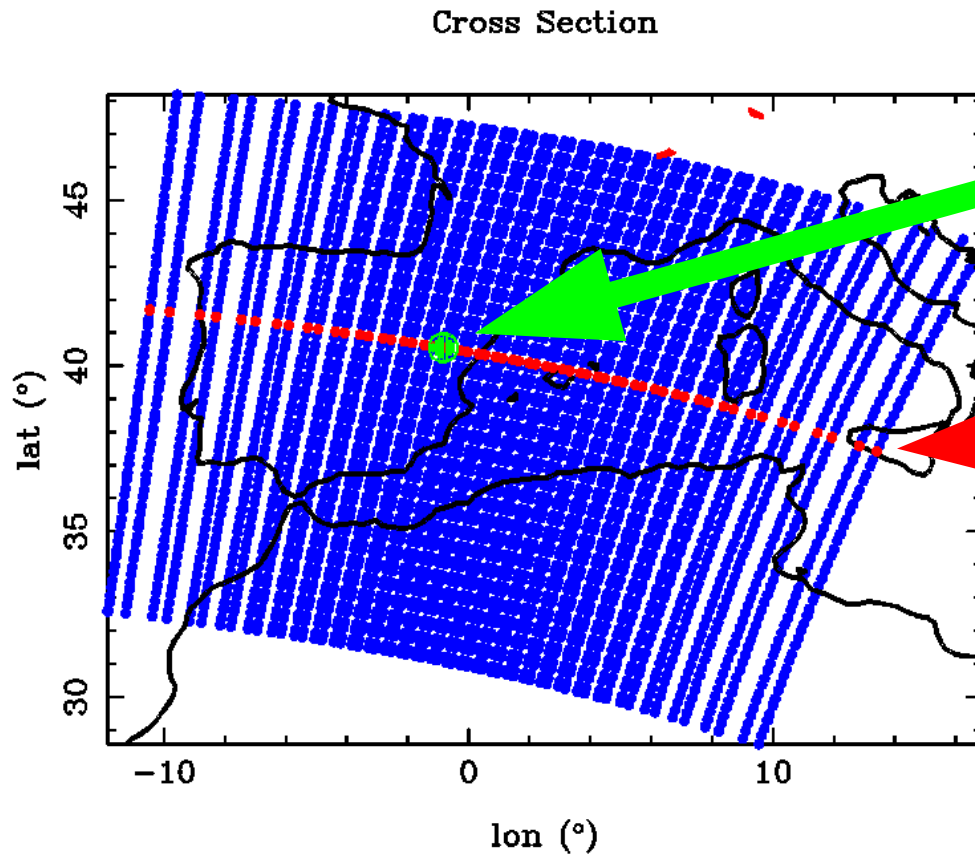


17:15 Z

2015/07/15



sSHAI: Example: IASI retrievals

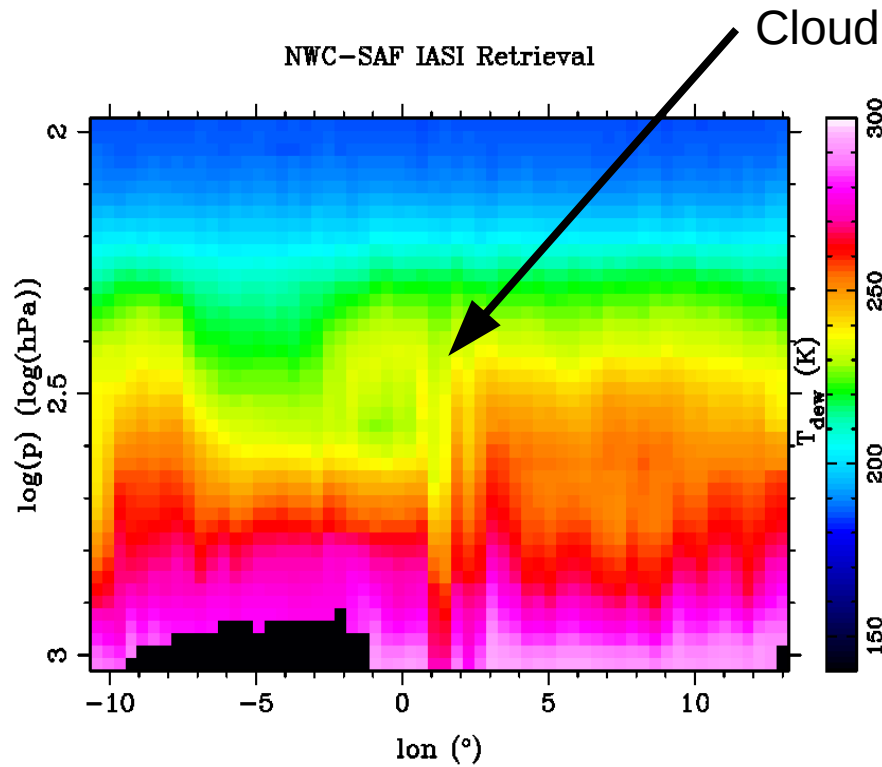


Focus on this storm location

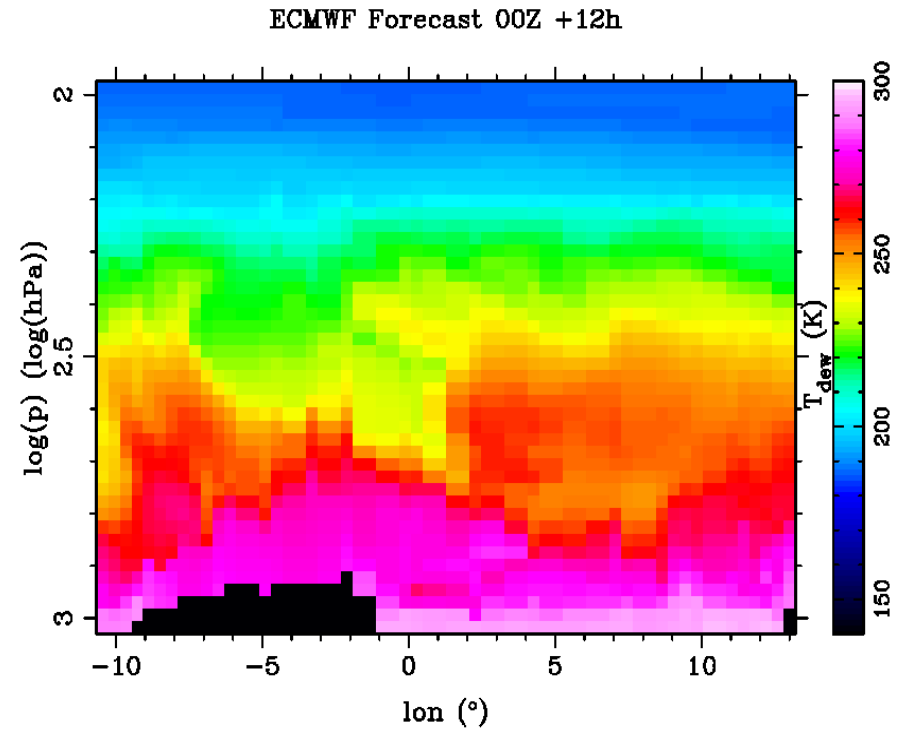
Focus on this cross section

IASI FOVs at 9:49

sSHAI: IASI retrievals: Humidity: Dew Point T

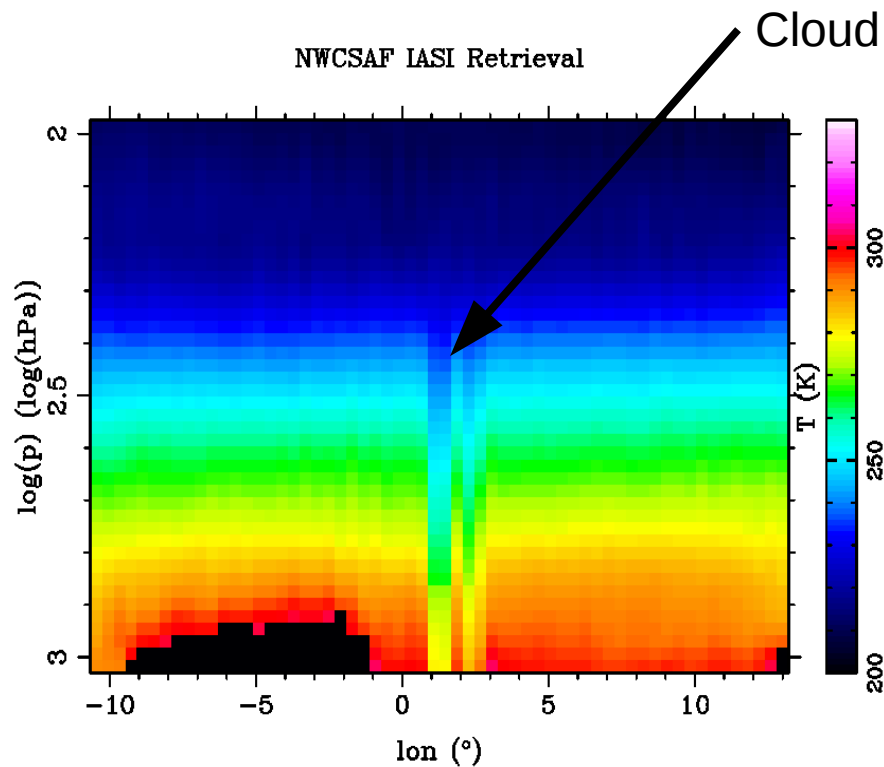


NWC-SAF IASI Retrieval

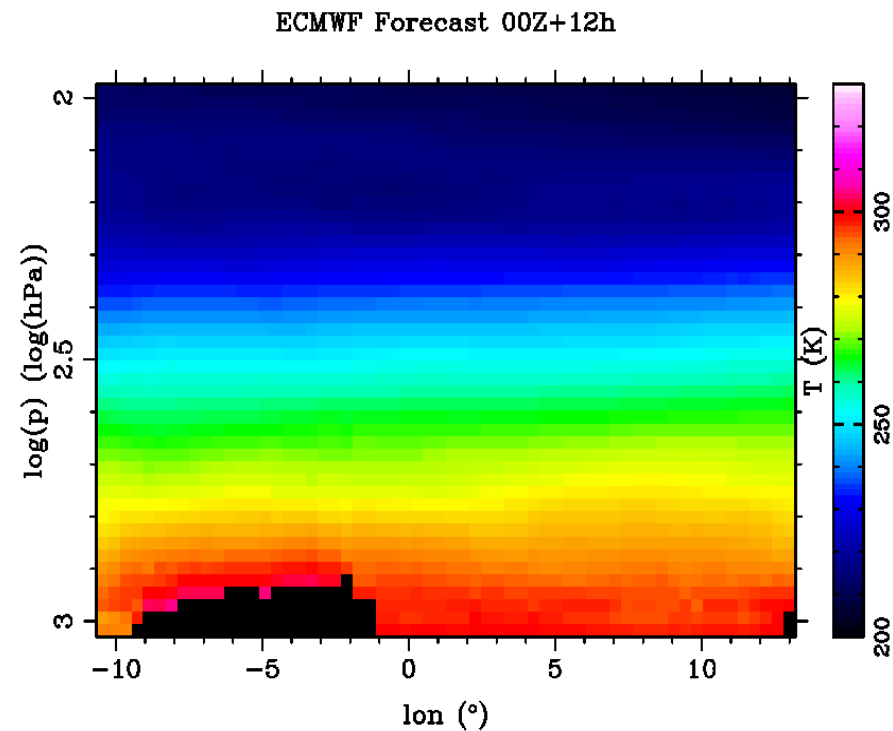


ECMWF Forecast
00Z +12h Step

sSHAI: IASI retrievals: Temperature

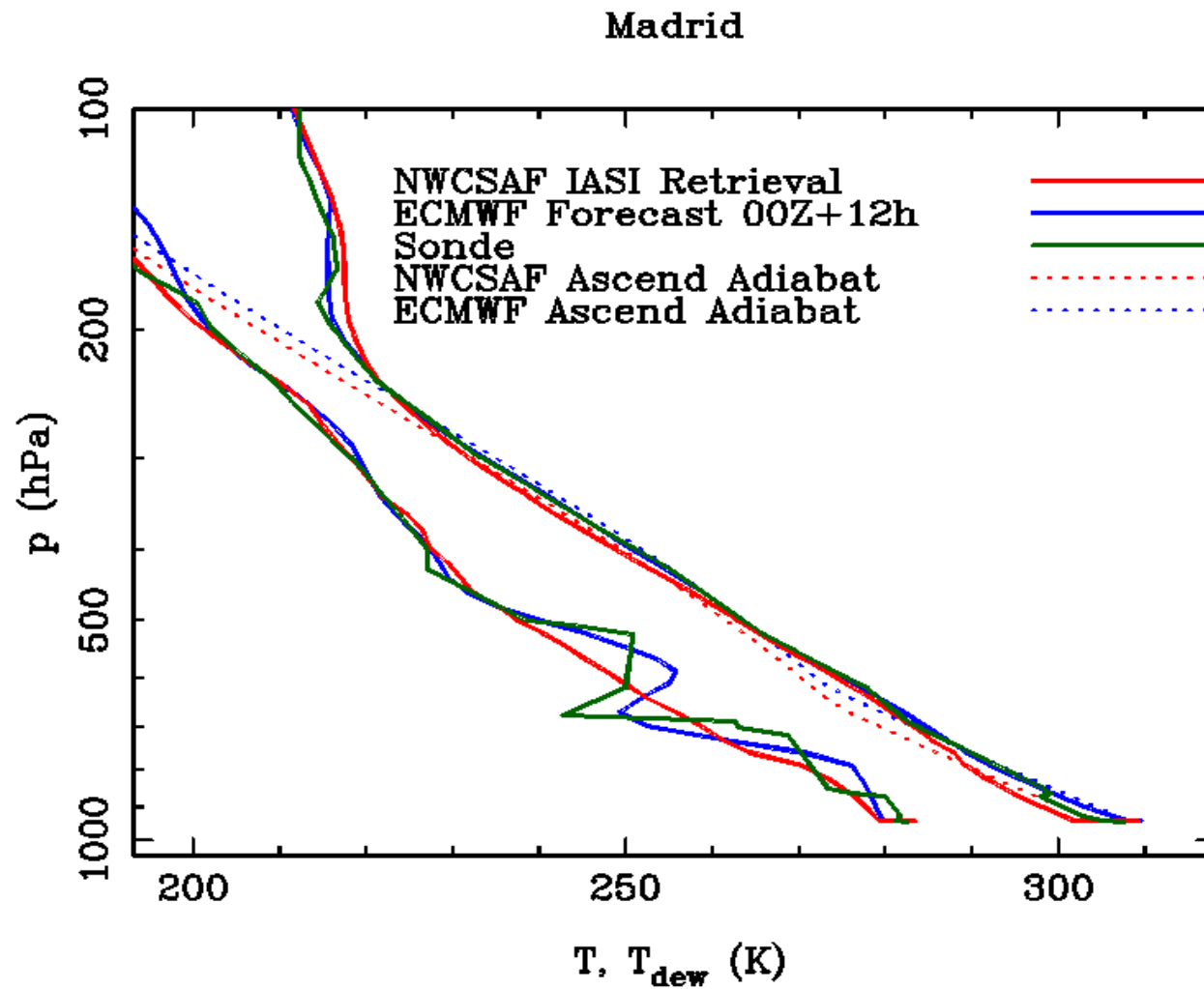


NWC-SAF IASI Retrieval

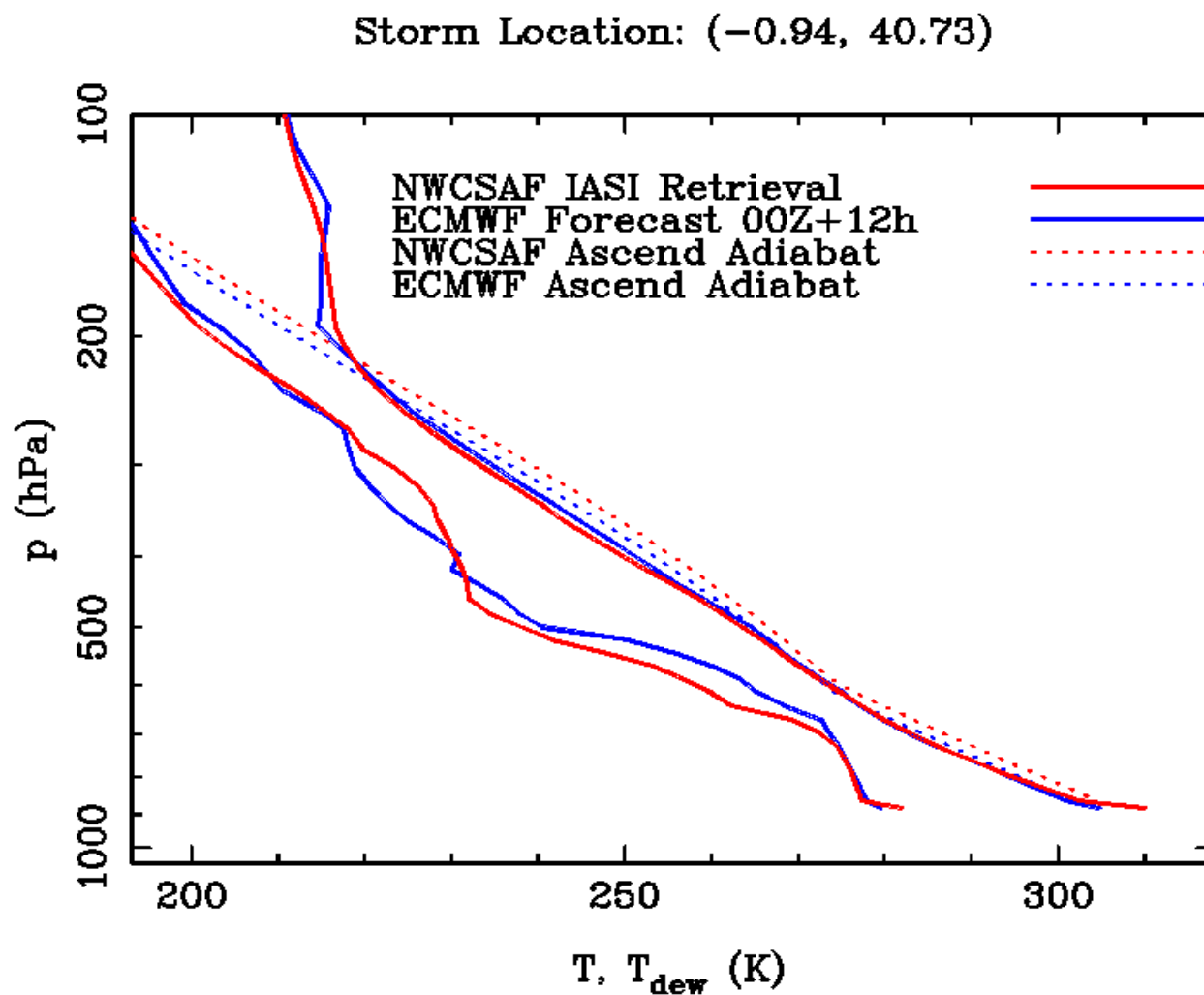


ECMWF Forecast
00Z +12h Step

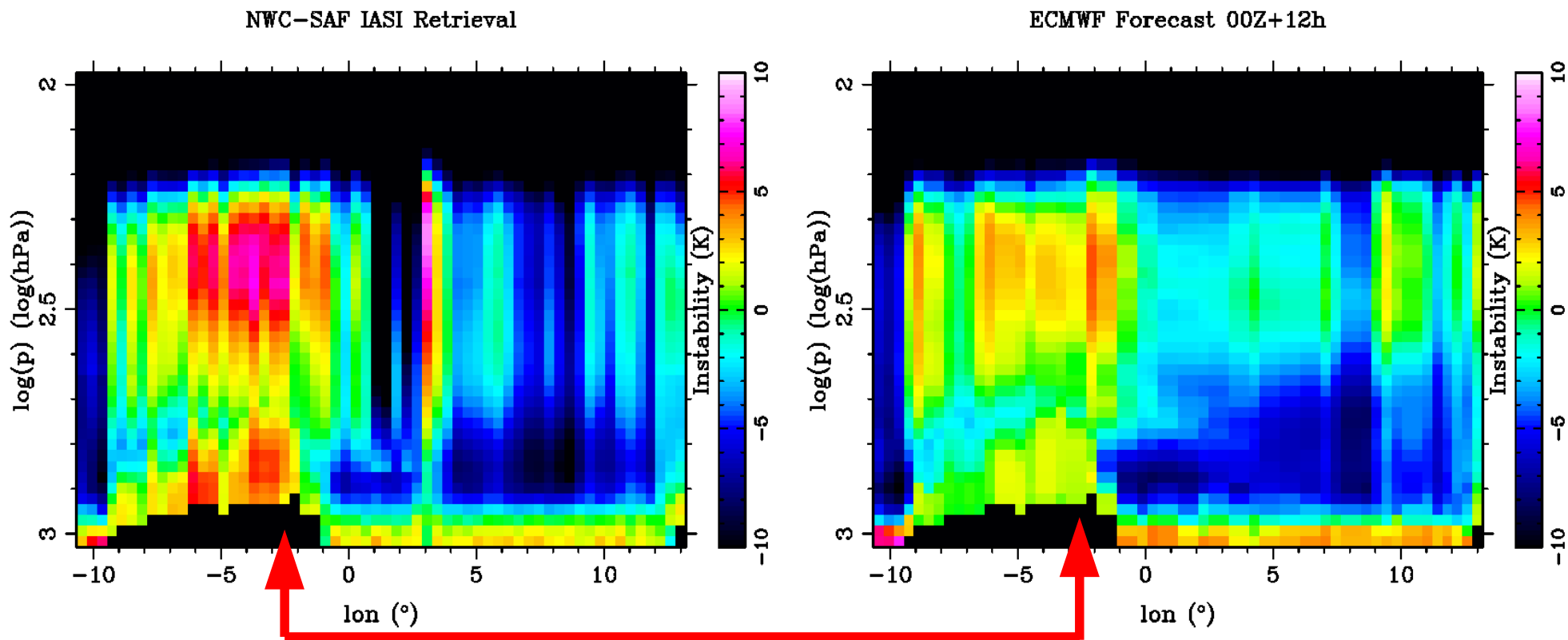
sSHAI: IASI retrievals checking over Madrid



sSHAI: NWC-SAF IASI retrievals over storm location



sSHAI: NWC-SAF IASI Instability



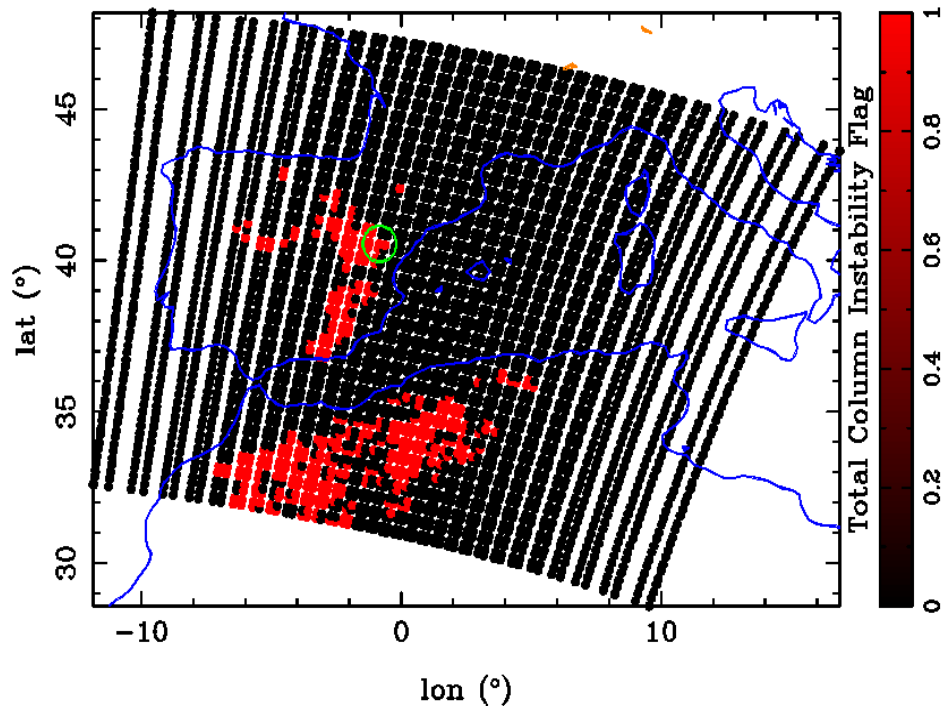
NWC-SAF IASI Retrieval
Instability

Storm
Location

ECMWF Forecast
00Z+12h Step Instability

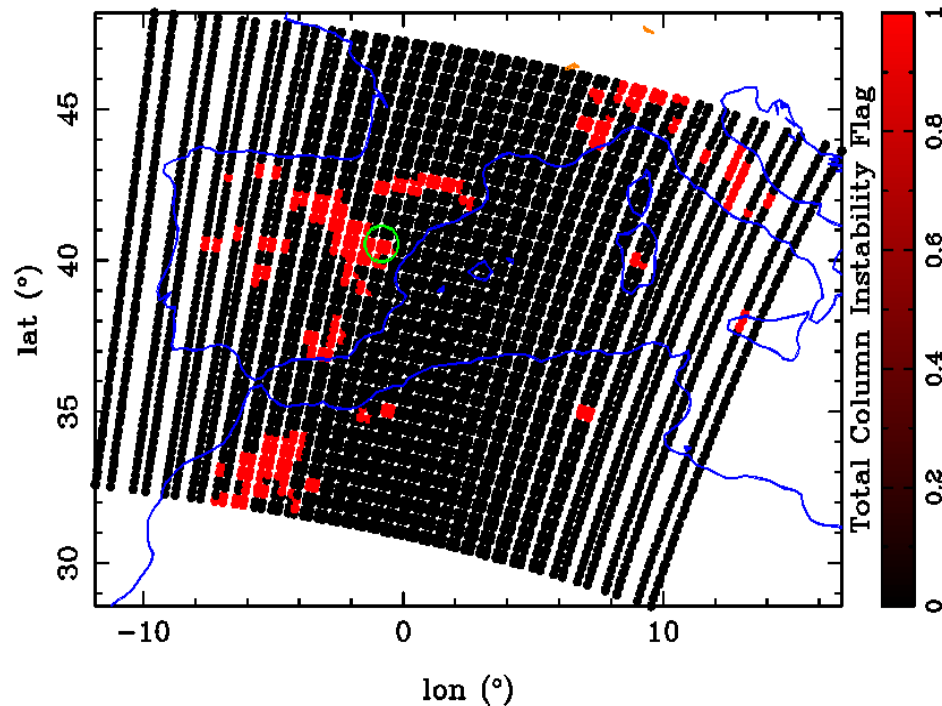
sSHAI: NWC-SAF IASI Instability Map

NWCSAF IASI Retrieval



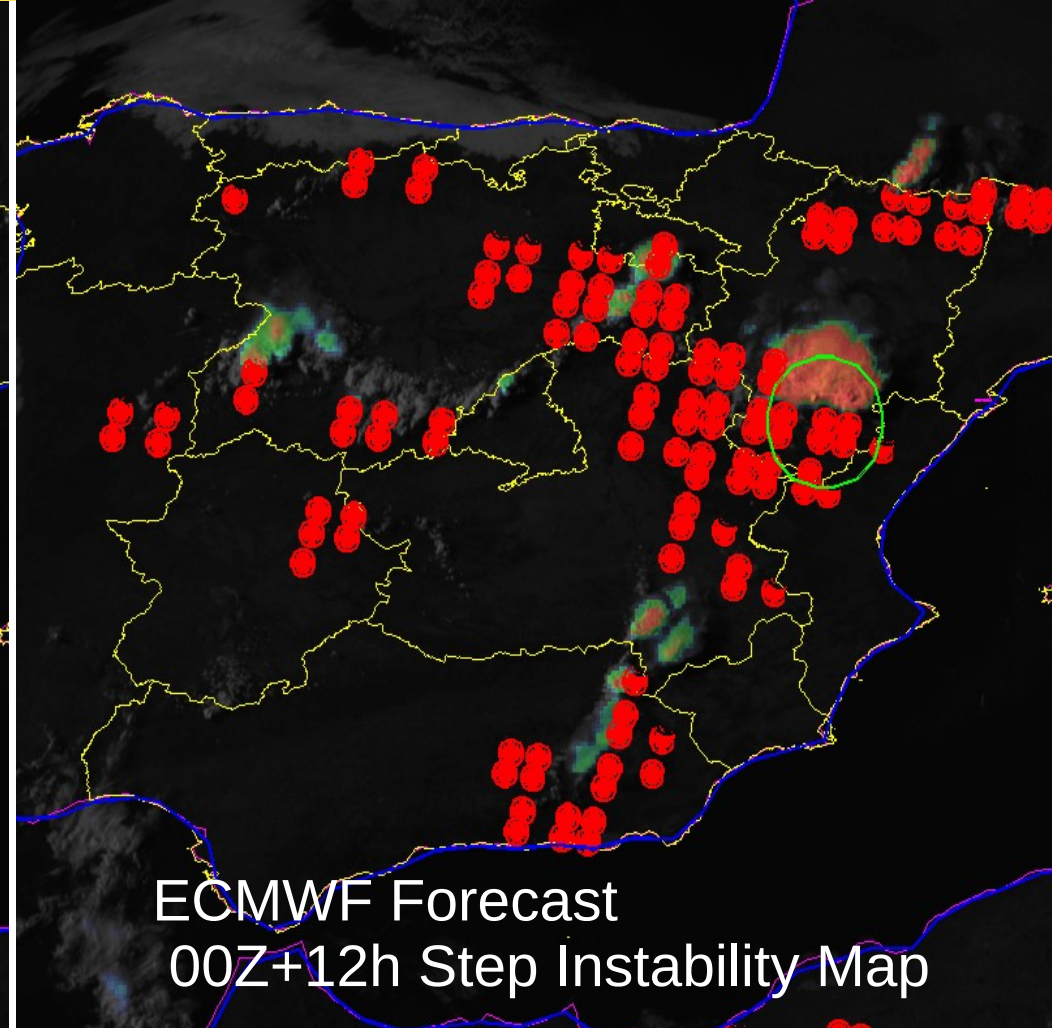
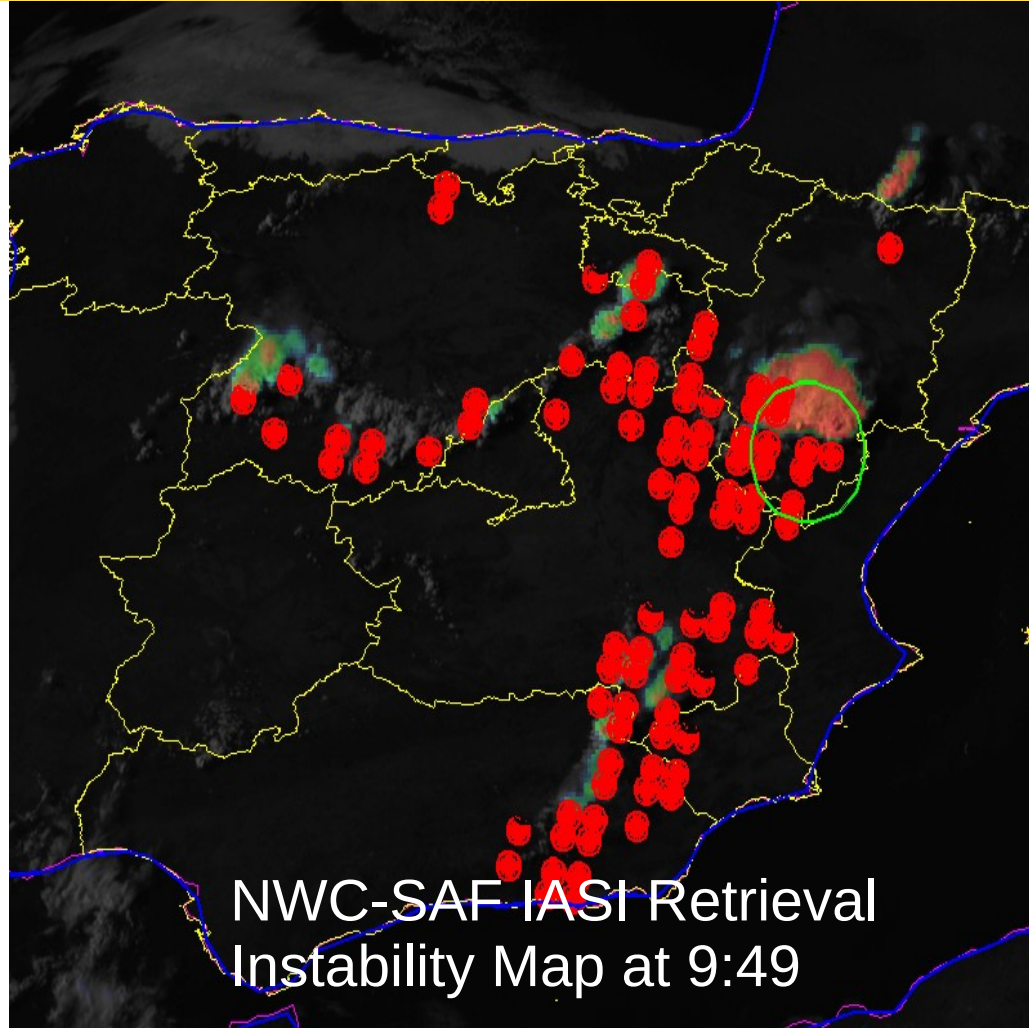
NWC-SAF IASI Retrieval
Instability Map

ECMWF Forecast 00Z+12h



ECMWF Forecast
00Z+12h Step Instability Map

sSHAI: IASI Instability Map (9:49Z) over MSG (16:30Z)



Conclusions

- Fast, state of the art retrievals are necessary
→ There is still room for improvement for MTG-IRS
- More work needed on finding a proper instability index/flag