

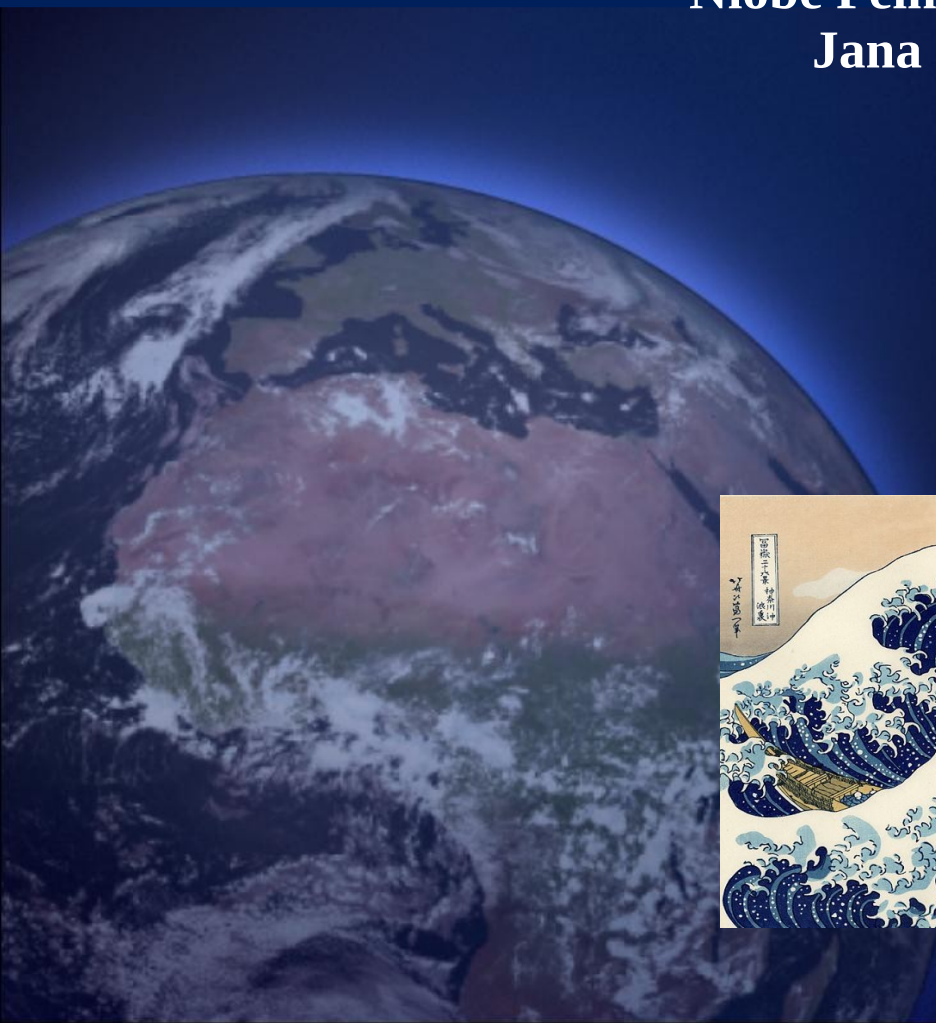
Sounding MTG-IRS products from EUMETSAT's Nowcasting SAF

8 April 2021

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Summary

1. NWC SAF satellite **H**umidity **A**nd **I**nstability (sSHAI) product, infrared hyperspectral retrievals: limitations and results
2. Improving MTG-IRS retrievals
 - i. Using Surface Stations
 - ii. Using MSG 10.8 micron corrections
3. Outlook

Summary

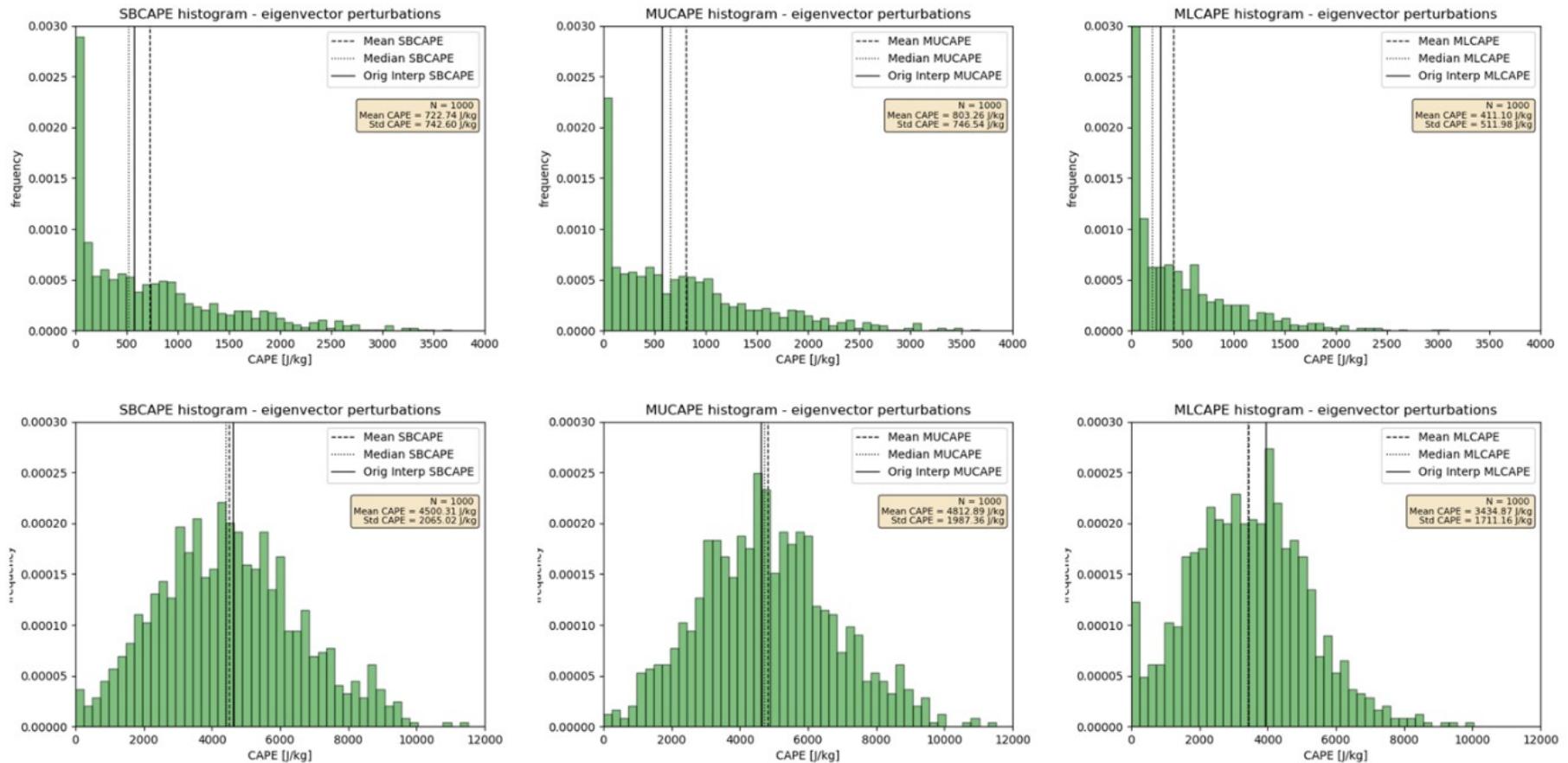
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Introduction

- Infrared Hyperspectral Sounders work with thousands of channels: 8000 (IASI), 2200 (CrIS), ~2500 (MTG-IRS)
- From them a «high» resolution vertical profile of T (1 K accuracy in 1 km layers) and WV (10-15% accuracy in 2 km layers)
- MTG-IRS will have a spatial resolution of 4 km (7 km over Europe) with a sampling of 30 min → many profiles (4D cube)
- Ideally this information should be summarised for particular applications → i.e. CAPE and CIN for Convection
- CAPE and CIN are extremely sensitive to uncertainties that MTG-IRS will have

CAPE Uncertainties

Jana Čampa, 2020: <https://www.nwcsaf.org/aemetRest/downloadAttachment/5821>



CAPE uncertainties of the order of 700 J/kg for CAPEs of 500 J/kg

Introduction

- Priority for MTG-IRS Soundings for Nowcasting → High Accuracy → Best possible instability indices (CAPE, CIN,...) with low latency + spatial and temporal homogeneity
- The NWC SAF MTG-IRS sounding **Satellite Humidity And Instability** product (sSHAI) product is being tailored for this purpose:
 - Low latency: Non-linear Regression Retrieval based on Machine Learning method (Kernel Ridge Regression)
 - High Accuracy: Algorithm will be trained and used within a spatial and temporal domain defined by the user
 - High Accuracy: Additional NWP Forecast input may be used for higher accuracy
 - Increased Accuracy: Needs to be complemented with other observations: surface based, MTG FCI, etc.

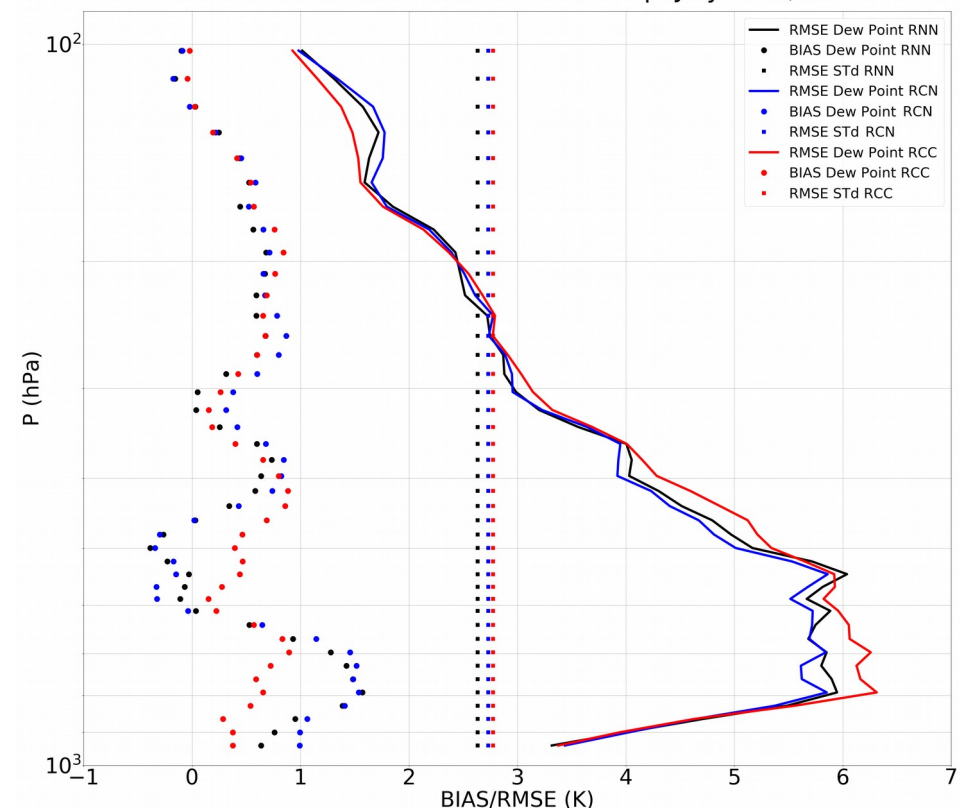
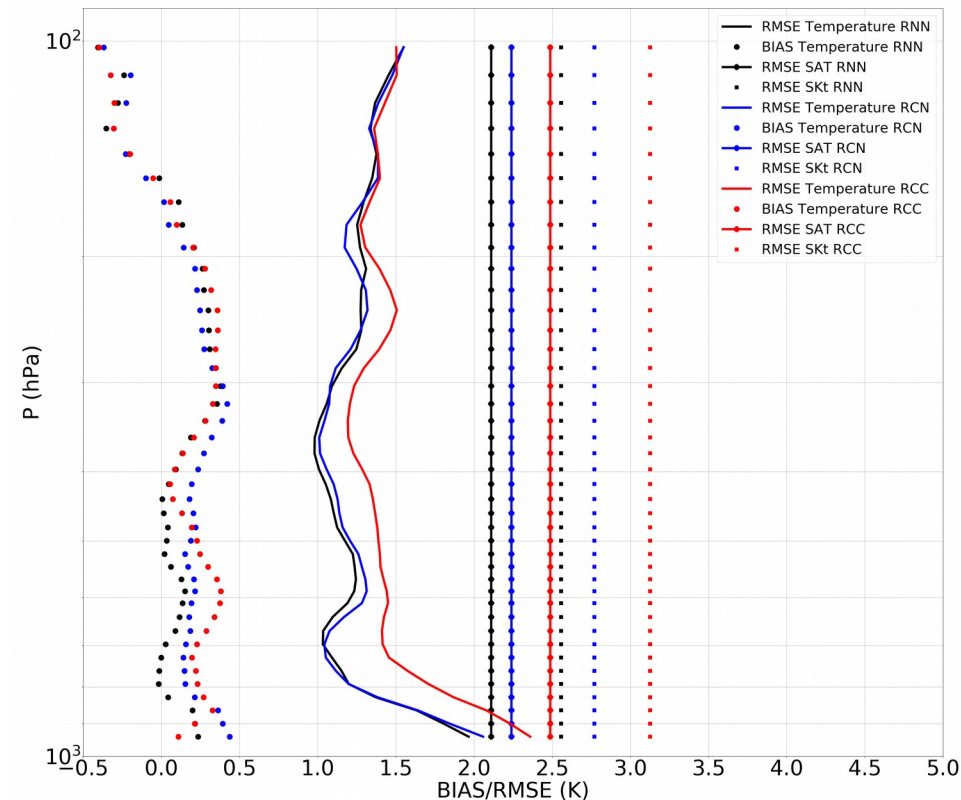
Statistics for the NWC SAF sSHAI Retrievals for IASI as a proxy for MTG-IRS: NO Forecast as input

Comparison with ECMWF Analyses

Níobe Peinado-Galán: <https://www.nwcsaf.org/aemetRest/downloadAttachment/6294>

TEMPERATURE Nonlinear retrievals for IASI-MetOp. July 15th, 2015. 9:45Z

DEW POINT Nonlinear retrievals for IASI-MetOp. July 15th, 2015. 9:45Z



Black: RNN, Retrievals trained with clear scenes and tested on clear scenes

Blue: RCN, Retrievals trained with clouds and tested on clear scenes

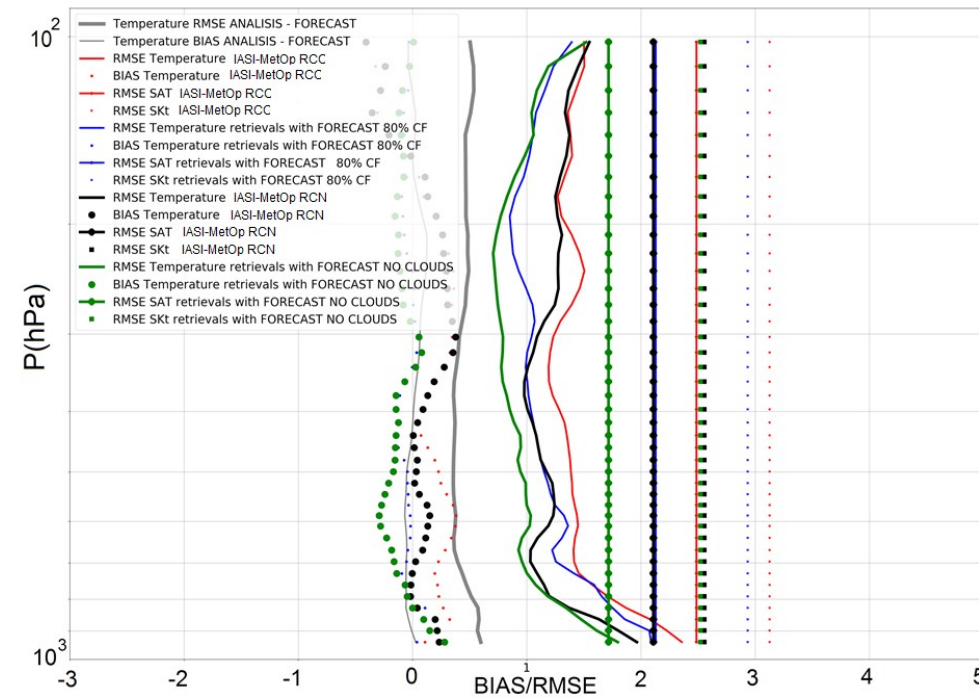
Red: RCC, Retrievals trained with clouds and tested on cloudy scenes

Statistics for the NWC SAF sSHAI Retrievals for IASI as a proxy for MTG-IRS: with Forecast as input

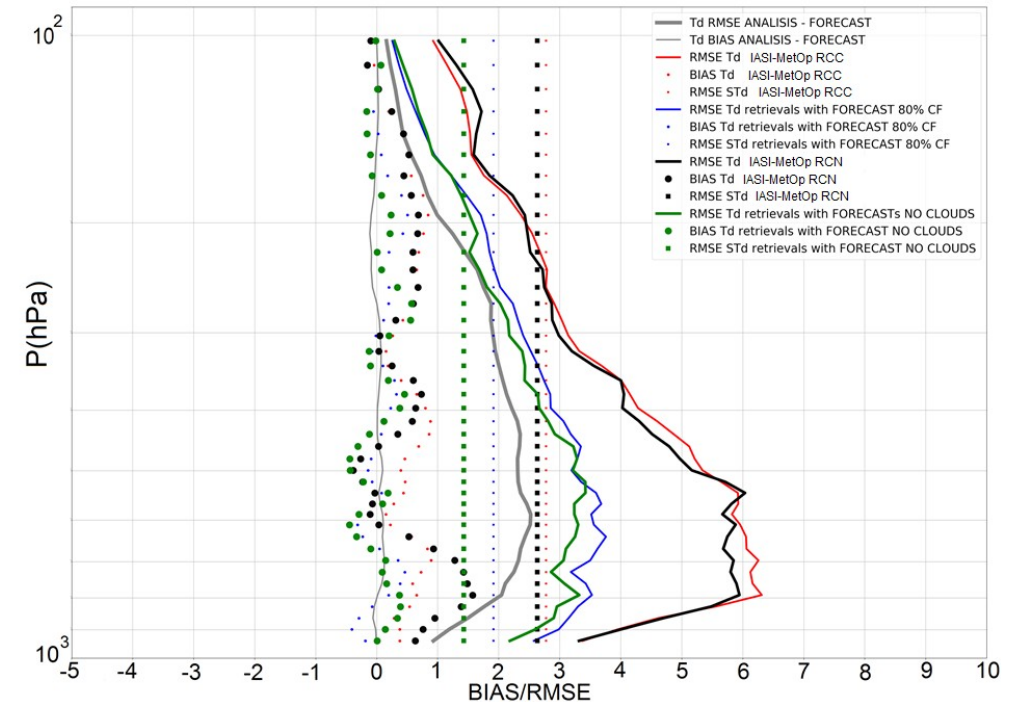
Comparison with ECMWF Analyses

Níobe Peinado-Galán: <https://www.nwcsaf.org/aemetRest/downloadAttachment/6294>

TEMPERATURE PROFILES



DEW POINT PROFILES



Gray: FCT, Forecast

Green: RFCN, Retrievals (+FCT) trained with clouds and tested on clear scenes

Red: RFCC, Retrievals (+FCT) trained with clouds and tested on cloudy scenes

MTG-IRS Retrieval Results

- Best solution for improved accuracy and spatial and temporal homogeneity are RFCC (Retrievals using Forecast as input trained on cloudy scenes and used everywhere)
- Despite this good result for a retrieval, it is still NOT good enough for convection applications

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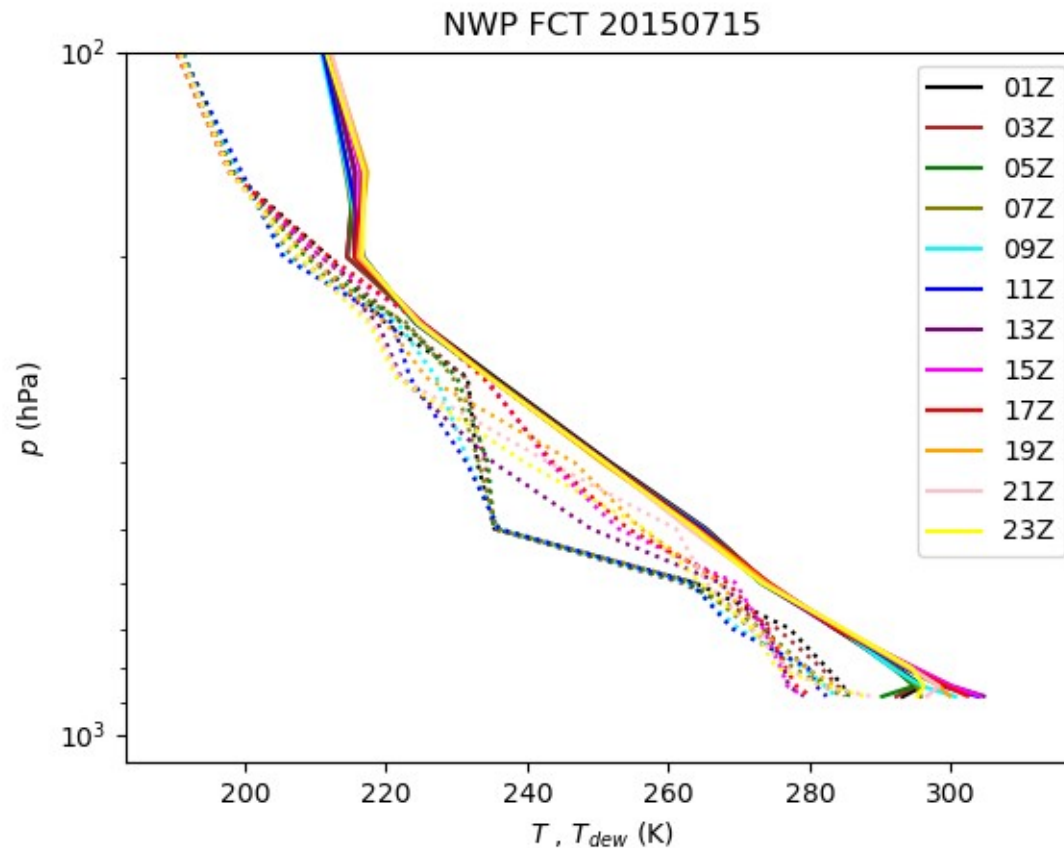
Improving MTG-IRS Retrievals

- Try a few quick concepts in a case study: Spain, 15/07/2015
- Modify surface parameters (T and WV) using measurements from surface stations
- Modify surface parameters (T) using MSG (IR 10.8) images

Case Study: Spain, 15/07/2015

Case Study: Spain, 15/07/2015

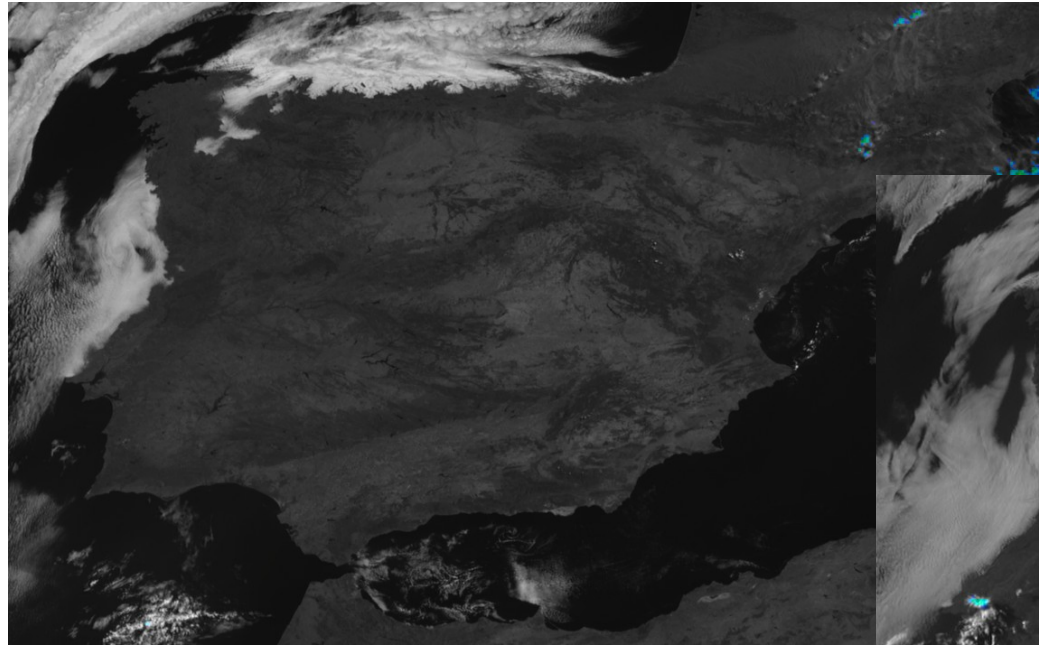
- «Easy» case: synoptic situation is constant → «Poor man's» Nearcast
- Convection triggered by solar heating
- IASI overpass at 9:50Z



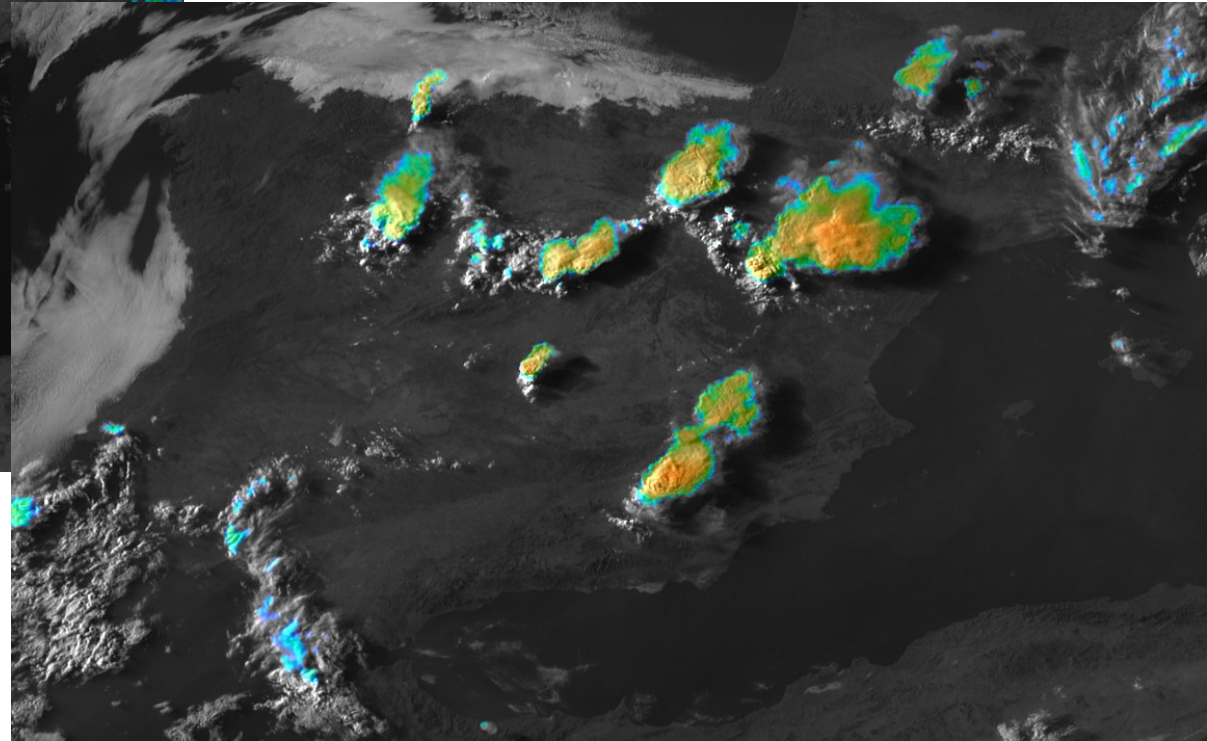
Case Study: Spain, 15/07/2015

- «Easy» case: synoptic situation is constant
- Convection triggered by solar heating

18Z: Convection



10Z: No clouds
IASI overpass



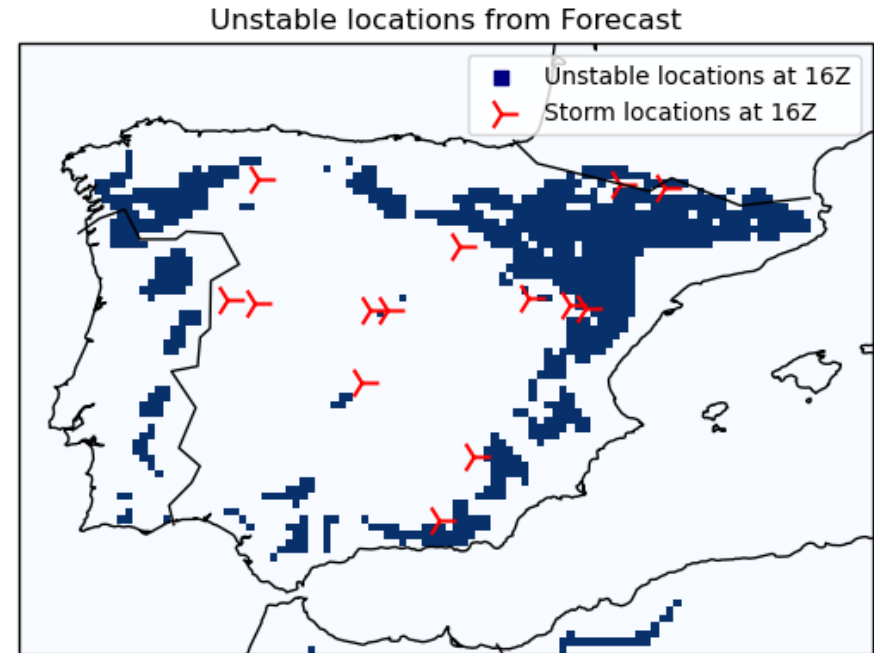
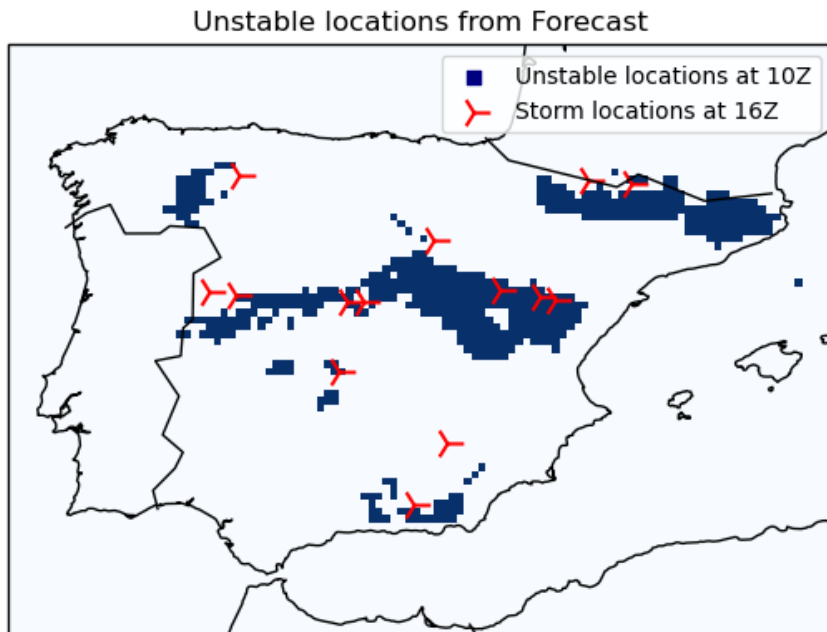
Case Study: Spain, 15/07/2015

- Simplifying plots →
 - Definition for Forecasts and Retrievals:
Unstable Locations = $\text{CAPE} > 500 \text{ J/kg}$ and $\text{CIN} < 50 \text{ J/kg}$

Forecasts

- Forecasts:

10Z: Unstable locations approximately match future (~17Z) storm locations



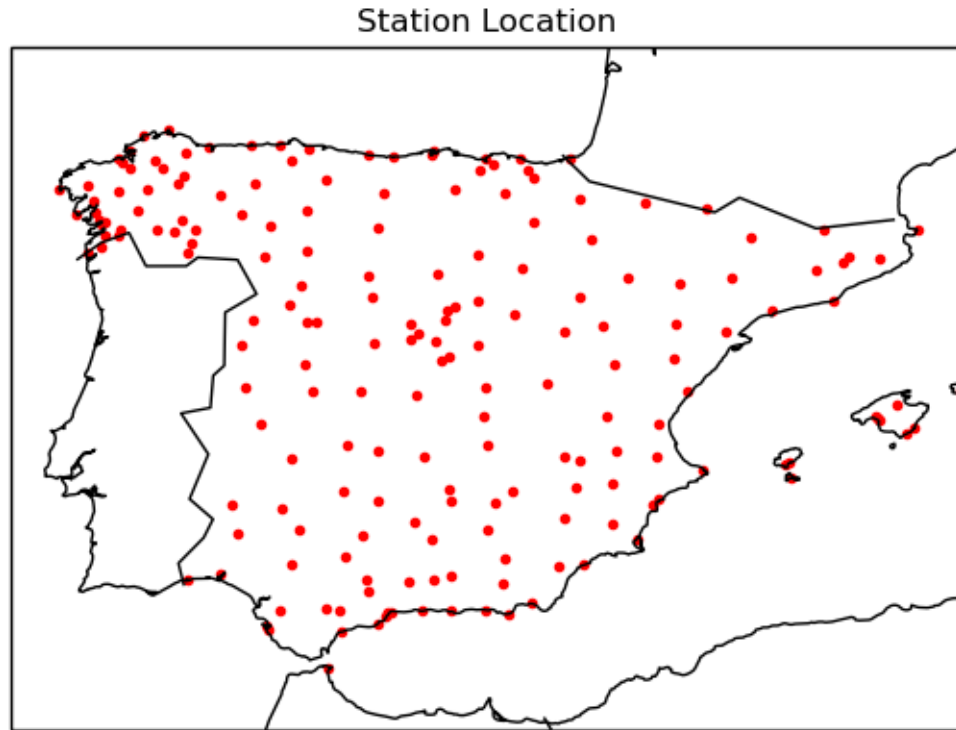
16Z: Unstable locations completely off!! Model generating its «own» convection?
→ We only analyse FCT at 10Z

Summary

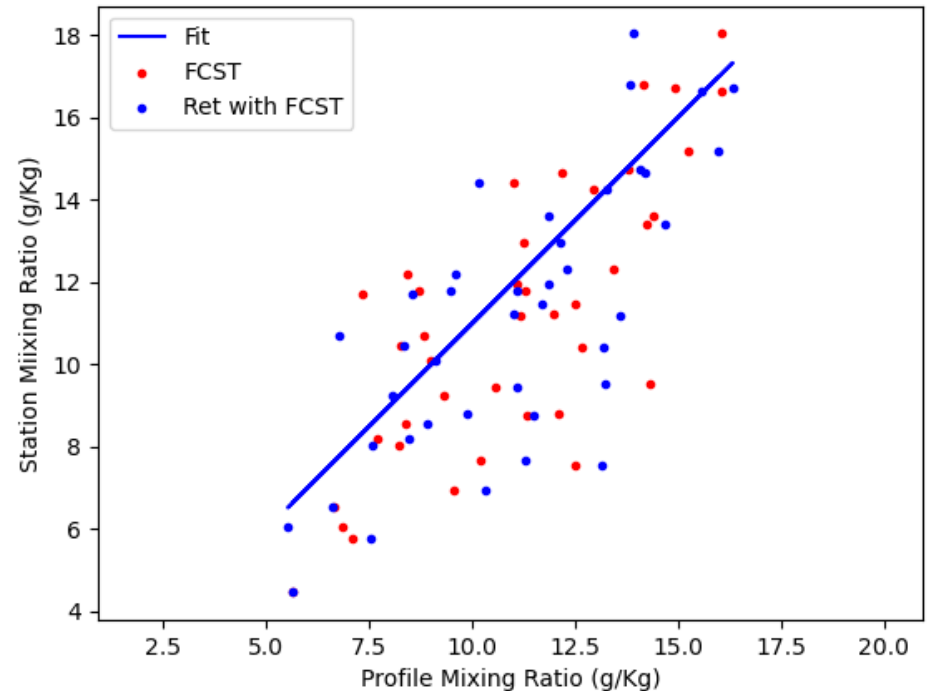
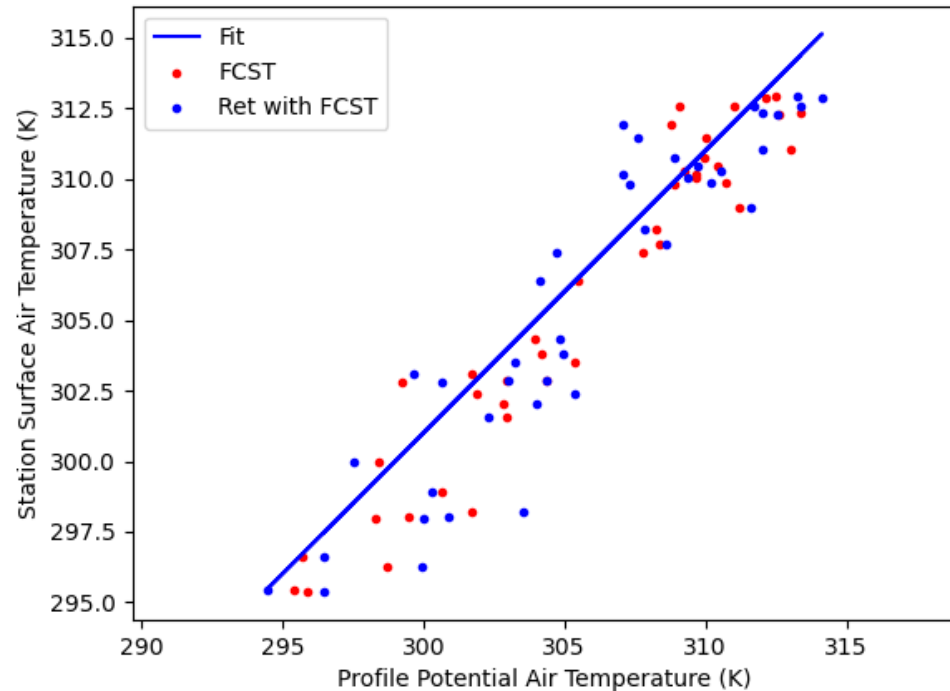
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Surface Stations

- Surface Automatic Station Locations



Fct and Ret versus Surface Stations



- +: There is a correlation!!
- -: Unfortunately, the dispersion is quite high → Not enough accuracy for instability ← Point to area collocation issue? Spanish complex terrain

Regression Kriging

Fct and Ret versus Surface Stations

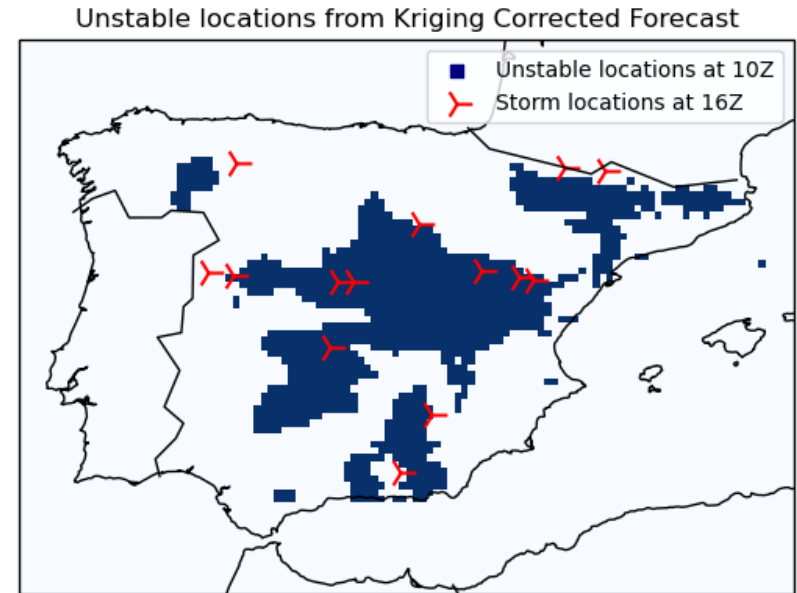
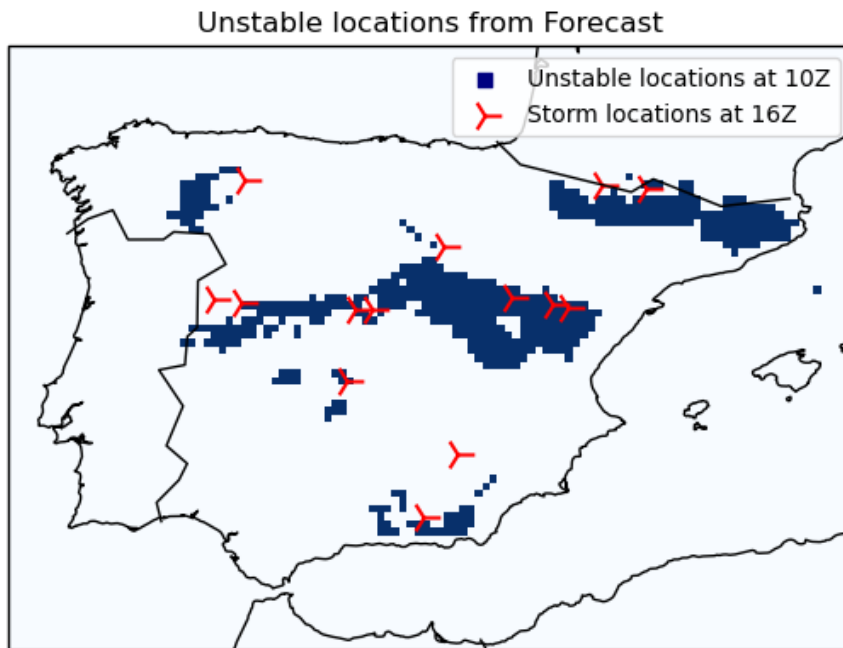
- Regression Kriging of Forecasts and Retrieals versus surface stations

	Forecast	Retrievals NO Forecast	Retrievals + Forecast
Raw Temperature STDV (K)	2.0	2.7	2.4
Kriging Temperature STDV (K)	1.8	2.3	2.3
Raw Mixing Ratio STDV (g/kg)	2.3	2.1	2.1
Kriging Mixing Ratio STDV (g/kg)	2.2	2.0	2.0

Forecasts + Kriging

- Forecasts:

10Z Raw Forecasts



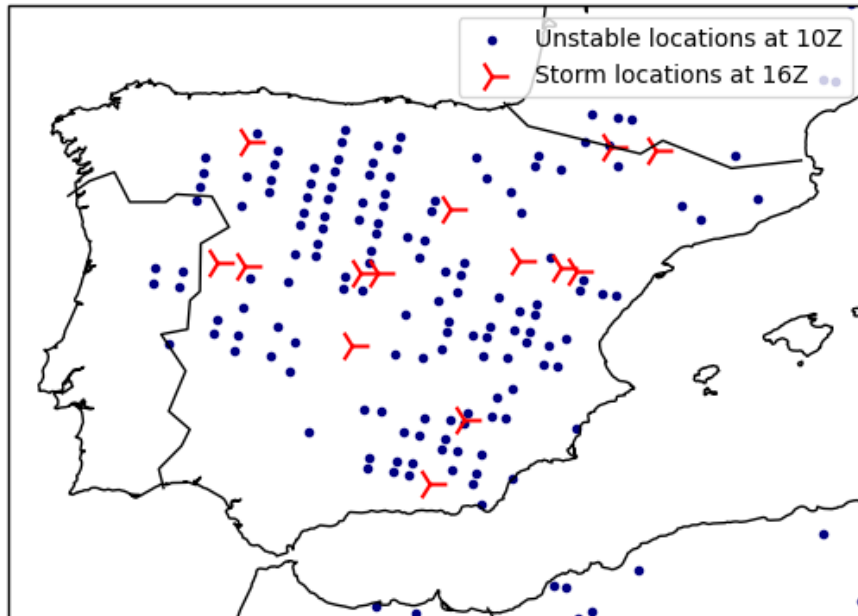
10Z Forecast with Kriging:
extends the unstable region

Retrievals with NO Forecasts + Kriging

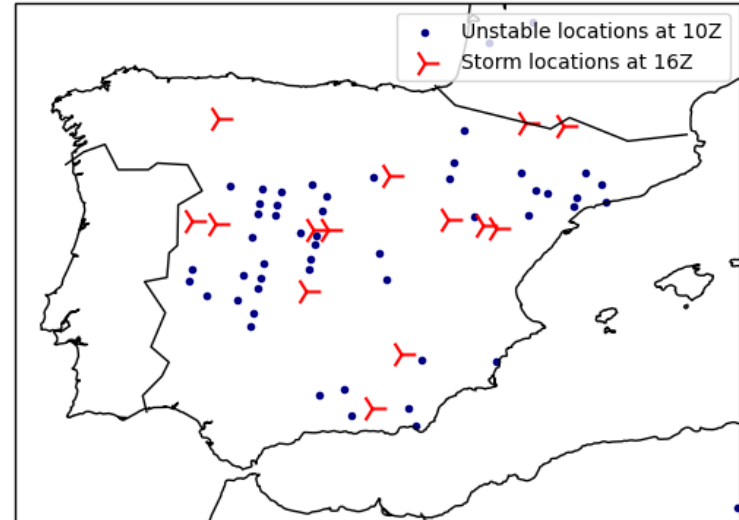
- Retrievals with NO Forecast:

10Z Raw Retrievals

Unstable locations from Retrievals with NO Forecast



Unstable locations from Kriging Corrected Retrievals with NO Forecast

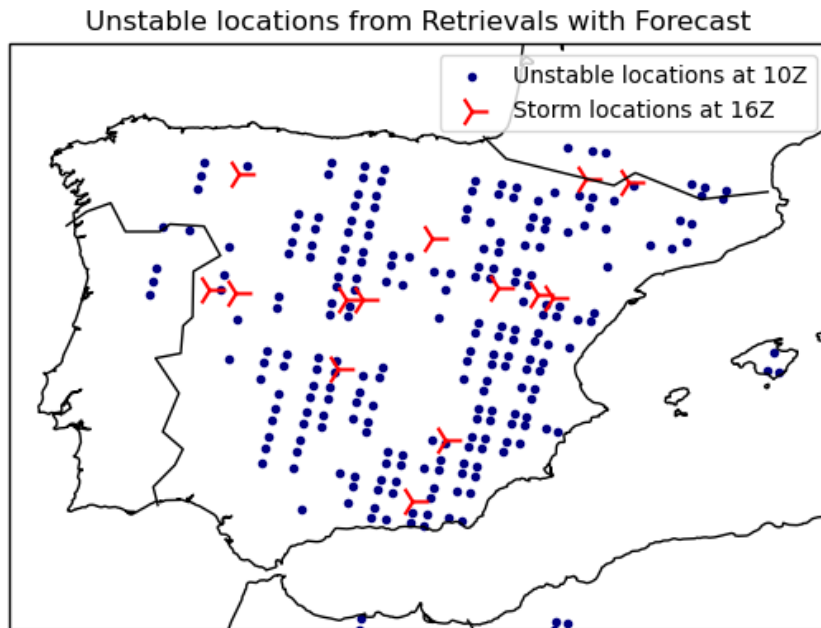


10Z Retrievals with Kriging:
reduces unstable region

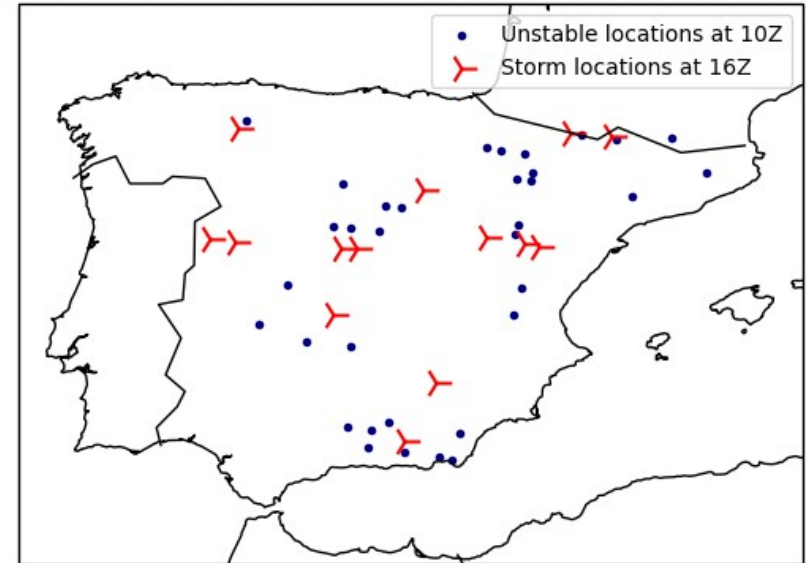
Retrievals with Forecasts + Kriging

- Retrievals with Forecast:

10Z Raw Retrievals



Unstable locations from Kriging Corrected Retrievals with Forecast



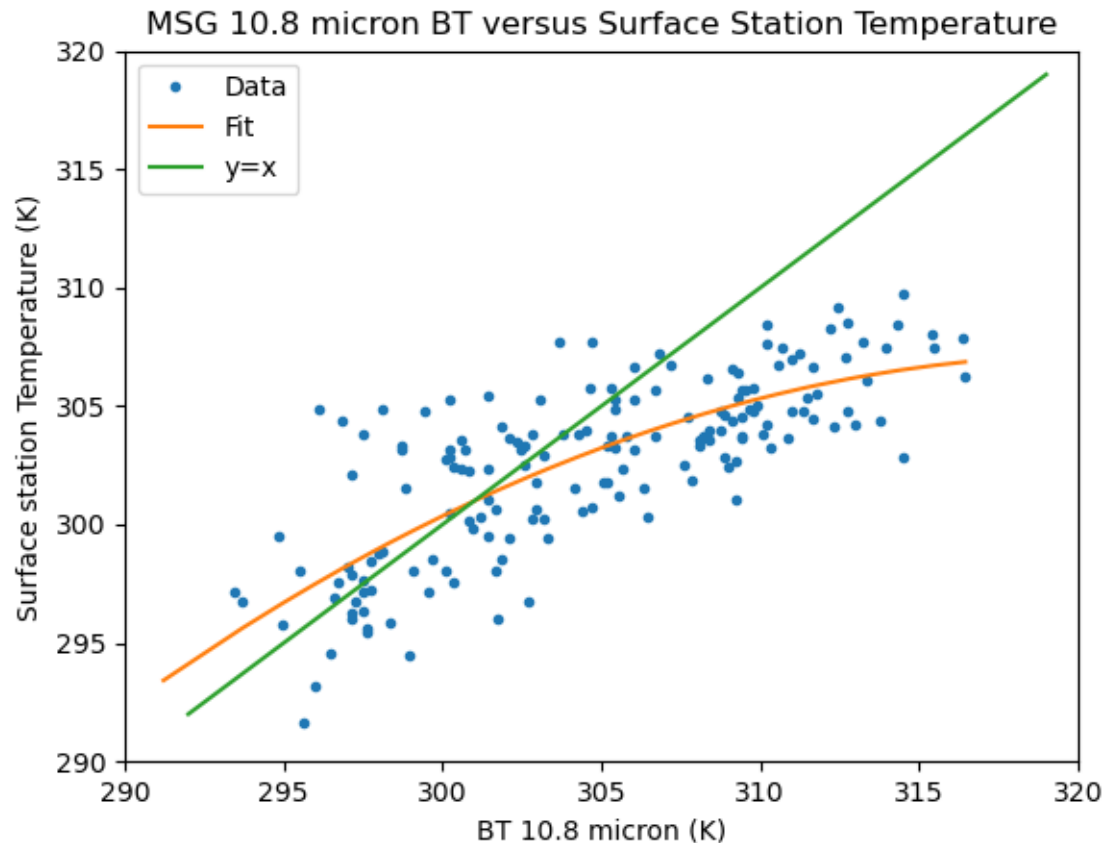
10Z Retrievals with Kriging:
Reduces unstable region

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MSG 10.8 micron channel

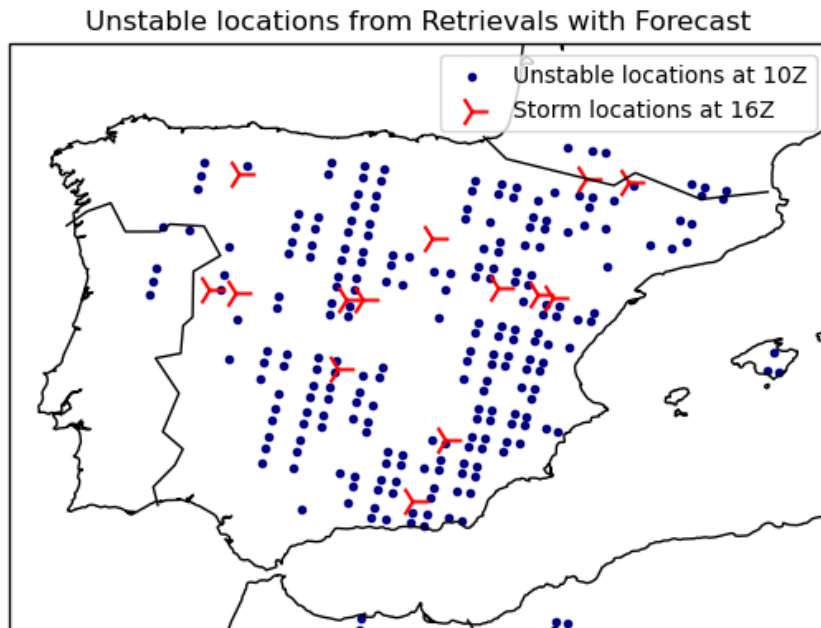
- MSG 10.8 micron channel BT versus surface stations T ← Avoids the point to area collocation issue? → More similar to MTG-IRS
- Based on the strong correlation between Skin Temperature and Surface Air Temperature



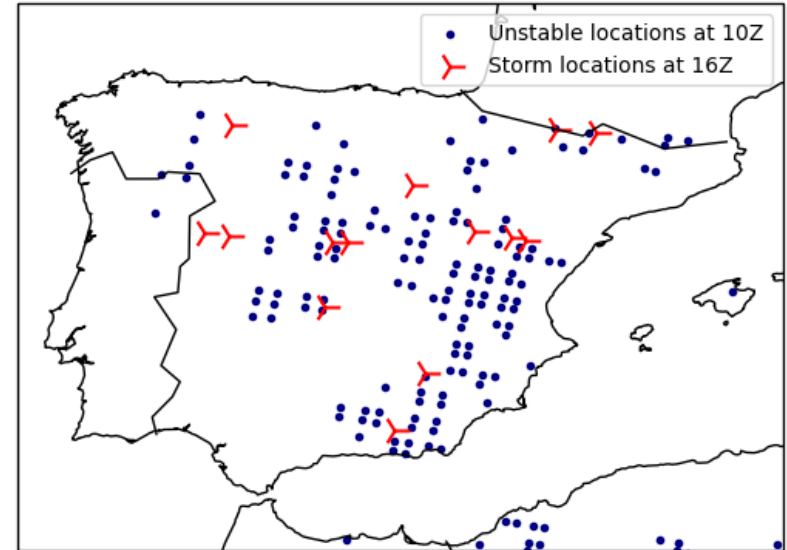
Retrievals with Forecasts + MSG Correction

- Retrievals with Forecast:

10Z Raw Retrievals



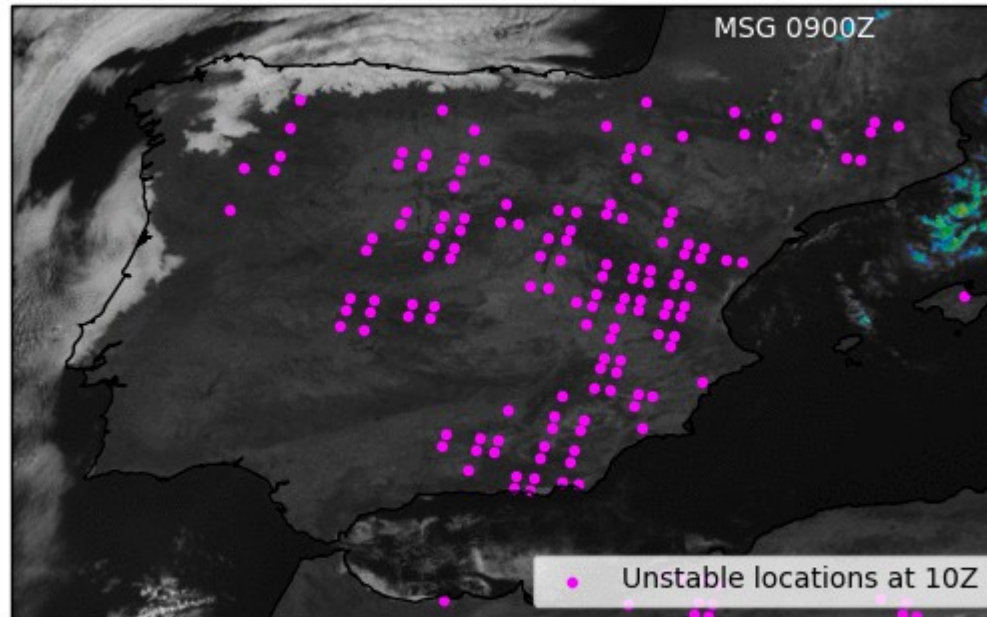
Unstable locations from MSG Corrected Retrievals with Forecast



10Z Retrievals with MSG
10.8 micron temperature
correction: reduces unstable
region slightly

Retrievals with Forecasts + MSG Correction

Unstable locations for Retrievals with FCST corrected with MSG



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Outlook

- Integrating Surface Station data or MSG corrections has its issues
- Still, corrected retrievals or forecasts seem reasonable
- Need to test various algorithms and possibly receive feedback from users → Set up beta processing for continuous supervising → In EWC would be ideal!
- Untested yet: Use of synthetic MTG-IRS data, Nearcasting, EUMETSAT Secretariat IASI L2, ...
- Any ideas or collaboration welcome!
- xcalbeta@aemet.es