Guidance for targeting campaigns

of Mediterranean High-impact weather

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The **Mediterranean region** is frequently affected by **hazardous weather** such as strong winds and heavy rain. Most of Mediterranean HIW is linked to cyclones.

▼

Many efforts are being devoted to improve the prediction of these events.

▼

Two main sources of forecast error:

Imperfections in the models   **Uncertainty in the initial conditions**

▼

Increasing the number and type of observations leads to more accurate inital conditions

▼

To reduce costs and increase efficiency: **Adaptive Observing Strategies**

Sensitivity Analysis: SV, ETKF, Adjoint model, KFS, Ensemble sensitivity
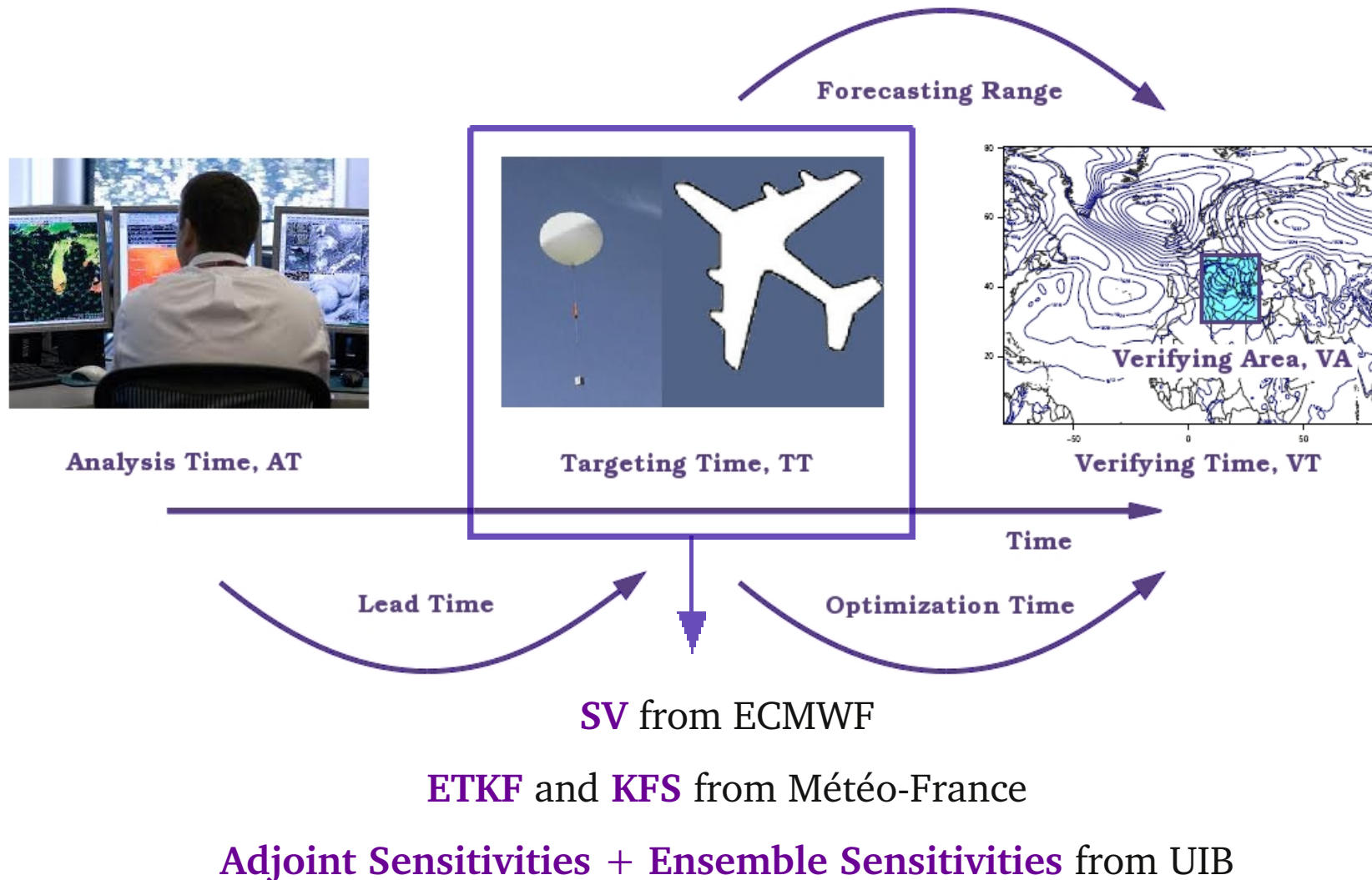
Introduction to DTS-MEDEX-2009

Illustrative example

DTS-MEDEX-2009 is an **observational targeting campaign** focused on **Mediterranean HIW**

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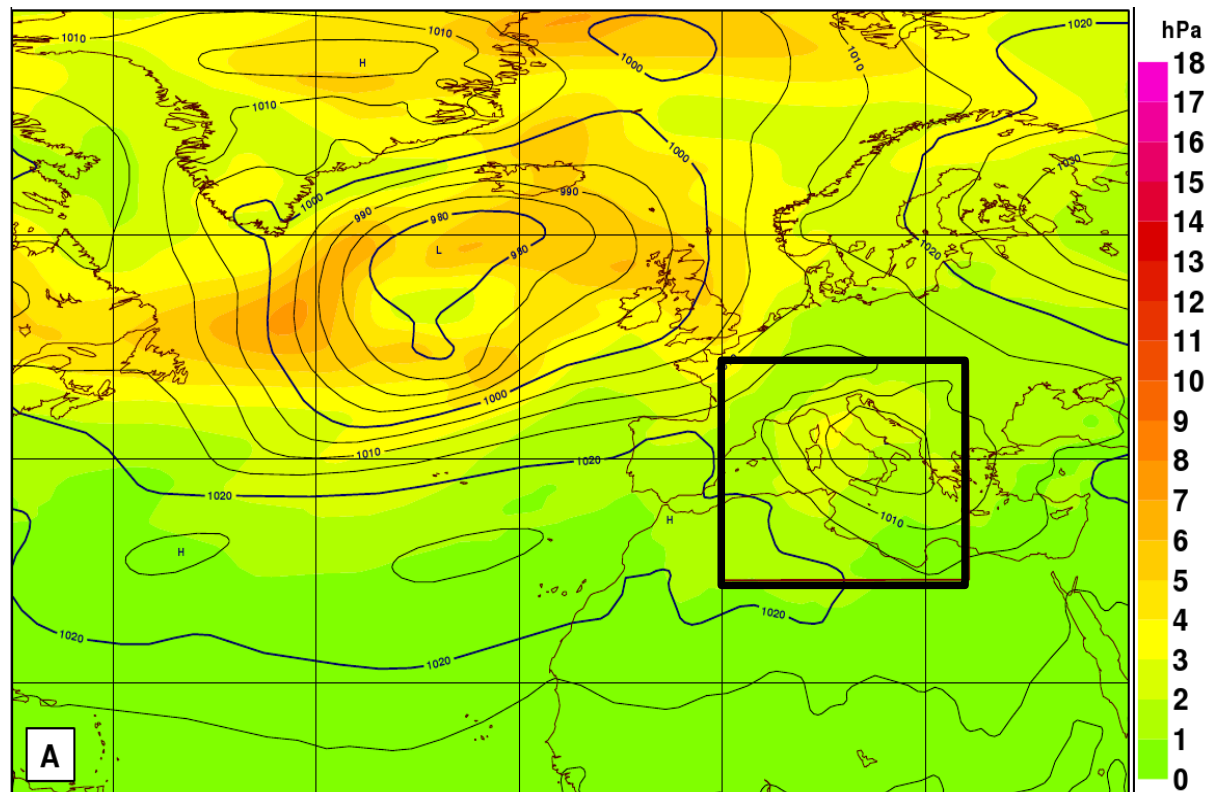**SV** from ECMWF

ETKF and **KFS** from Météo-France

Adjoint Sensitivities + **Ensemble Sensitivities** from UIB
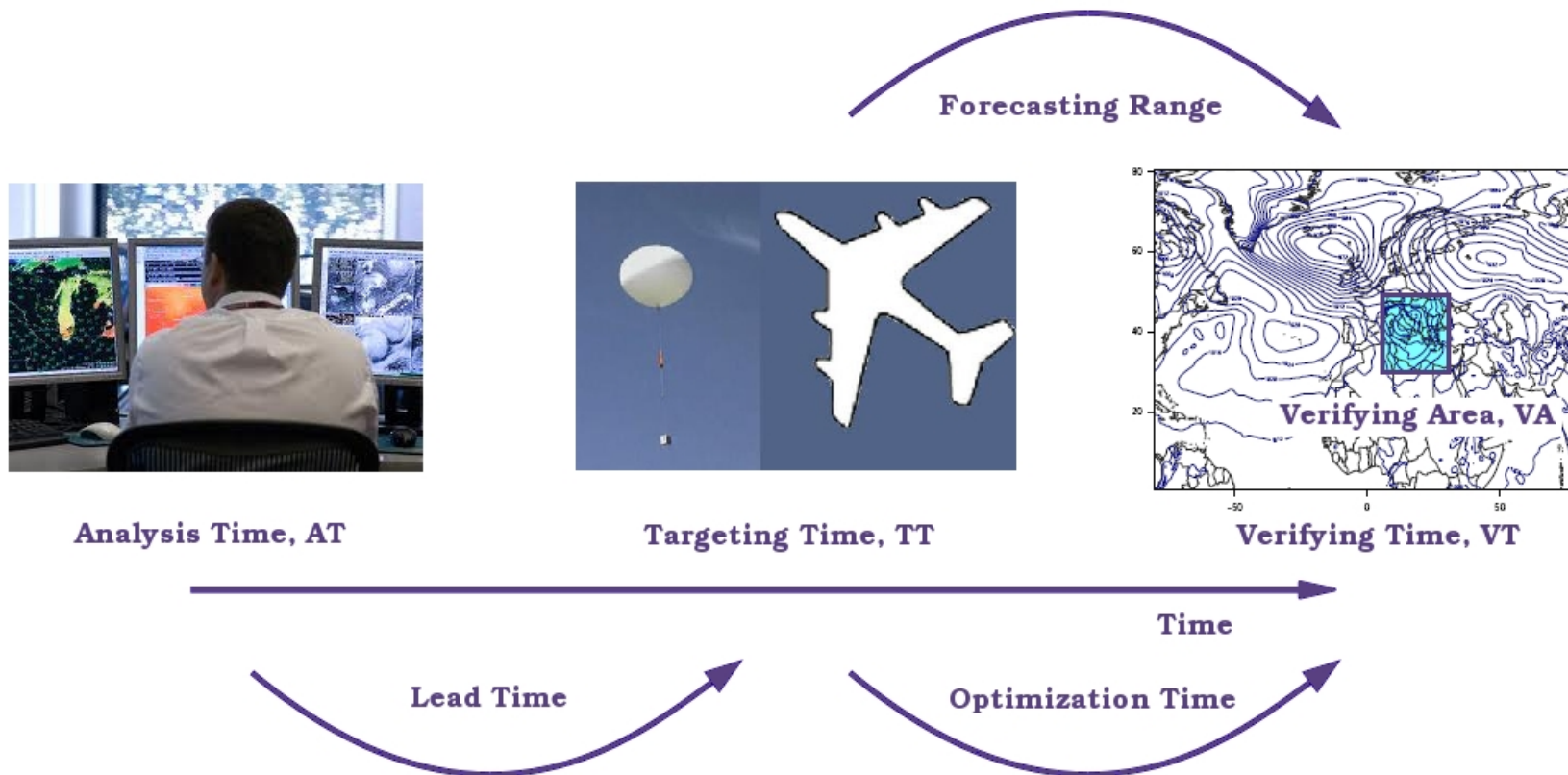
Introduction to DTS-MEDEX-2009

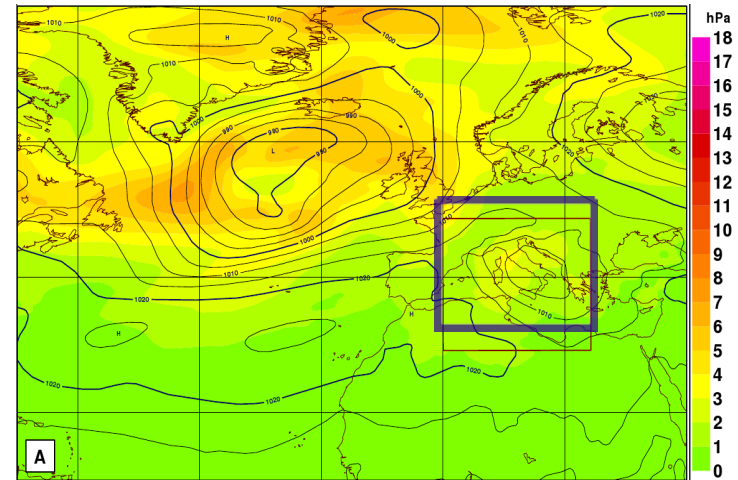**Illustrative example**

Illustrative example

Case evaluated on December 2nd 2009: Intense cyclone, centered in Southern Italy, likely producing heavy rain in the Balkan area and strong winds in the Western Mediterranean and Tyrrhenian Seas.

TT on December 3rd 2009 at 18 UTC. VT on December 5th 2009 at 00 UTC

Illustrative example

- The operational EPS from ECMWF

- Response function:

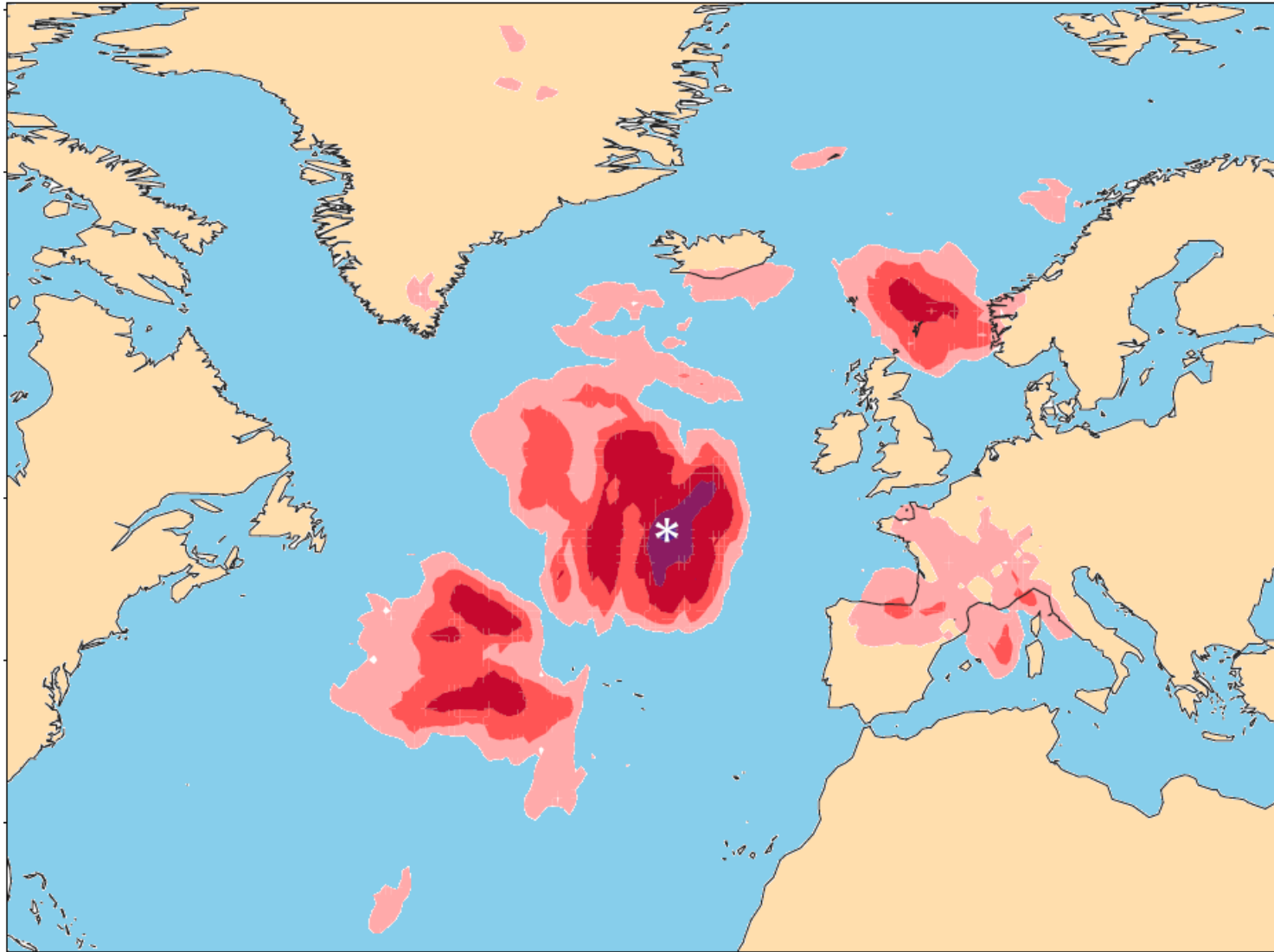 Dry Total Energy (1000, 925 and 850 hPa)

  averaged over the VA

- Statistically corrected normalized raw sensitivity estimate:

$$\mathbb{S} \equiv \frac{cov(\delta\mathbf{J}, \delta\mathbf{x}_0)}{var(\delta\mathbf{x}_0)} \mathcal{R}\sigma_{x_0} \quad \text{where} \quad \mathcal{R} = \begin{cases} 1 & if \quad 0 \notin (\mathcal{S}_{\alpha/2}, \mathcal{S}_{1-\alpha/2}) \\ 0 & if \quad 0 \in (\mathcal{S}_{\alpha/2}, \mathcal{S}_{1-\alpha/2}) \end{cases}$$

where $\delta\mathbf{x}_0$ and $\delta\mathbf{J}$ are $1 \times M$ ensemble estimates of the state variable and forecast metric perturbations.
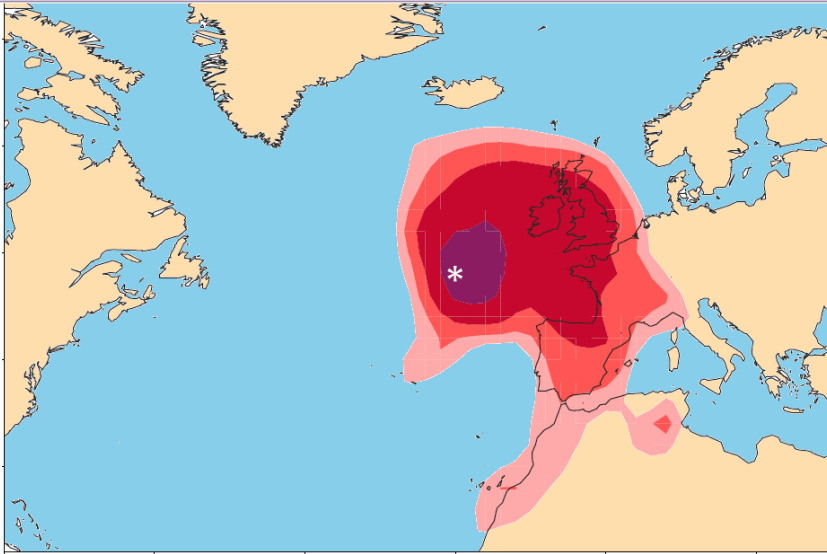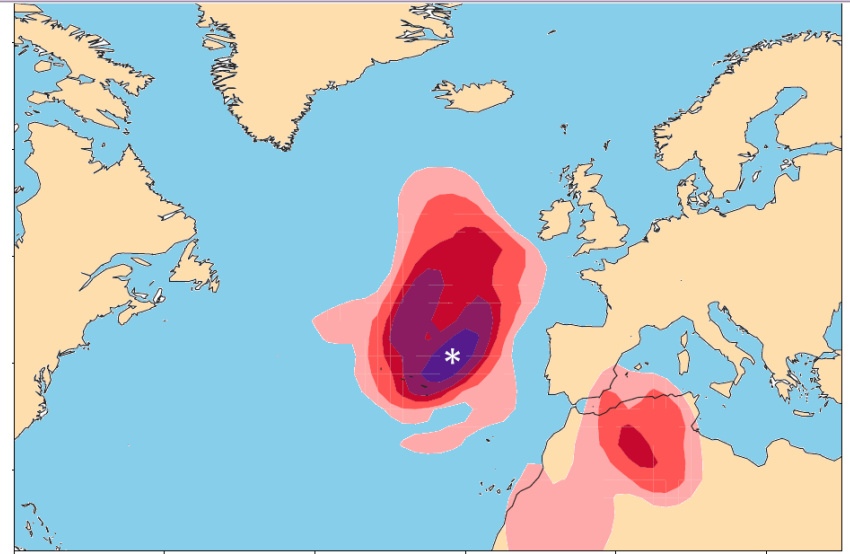
Illustrative example

✔ **Ensemble Sensitivities:**

TT on December 3rd 2009 at 18 UTC. VT on December 5th 2009 at 00 UTC
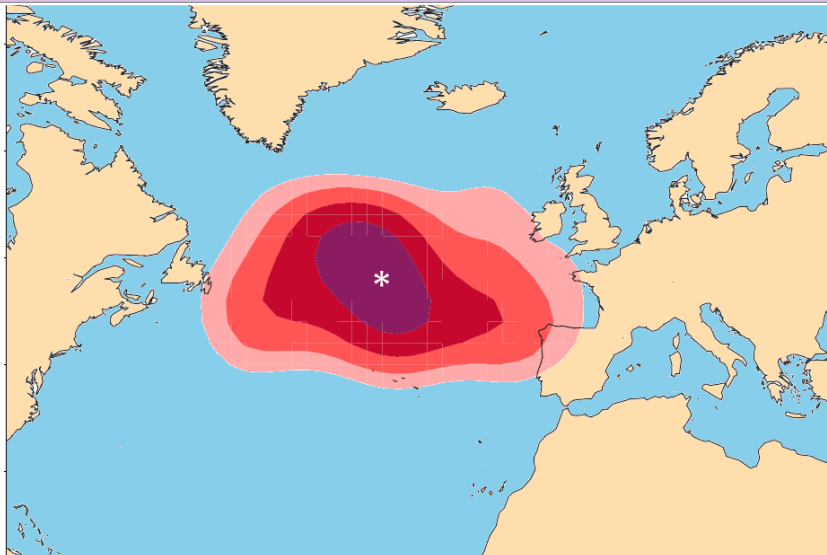
Illustrative example
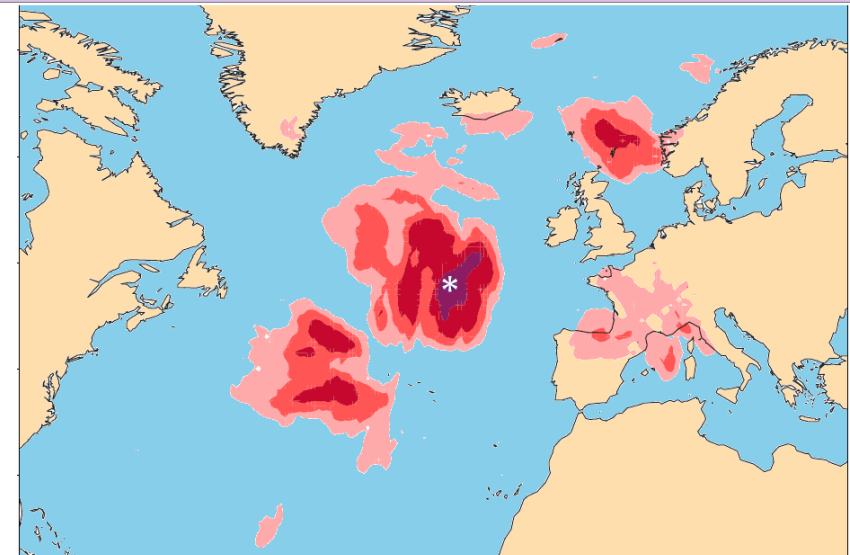

ECMWF: TE-Singular Vectors (SV)

Météo-France: Kalman Filter Sensitivity (KFS)

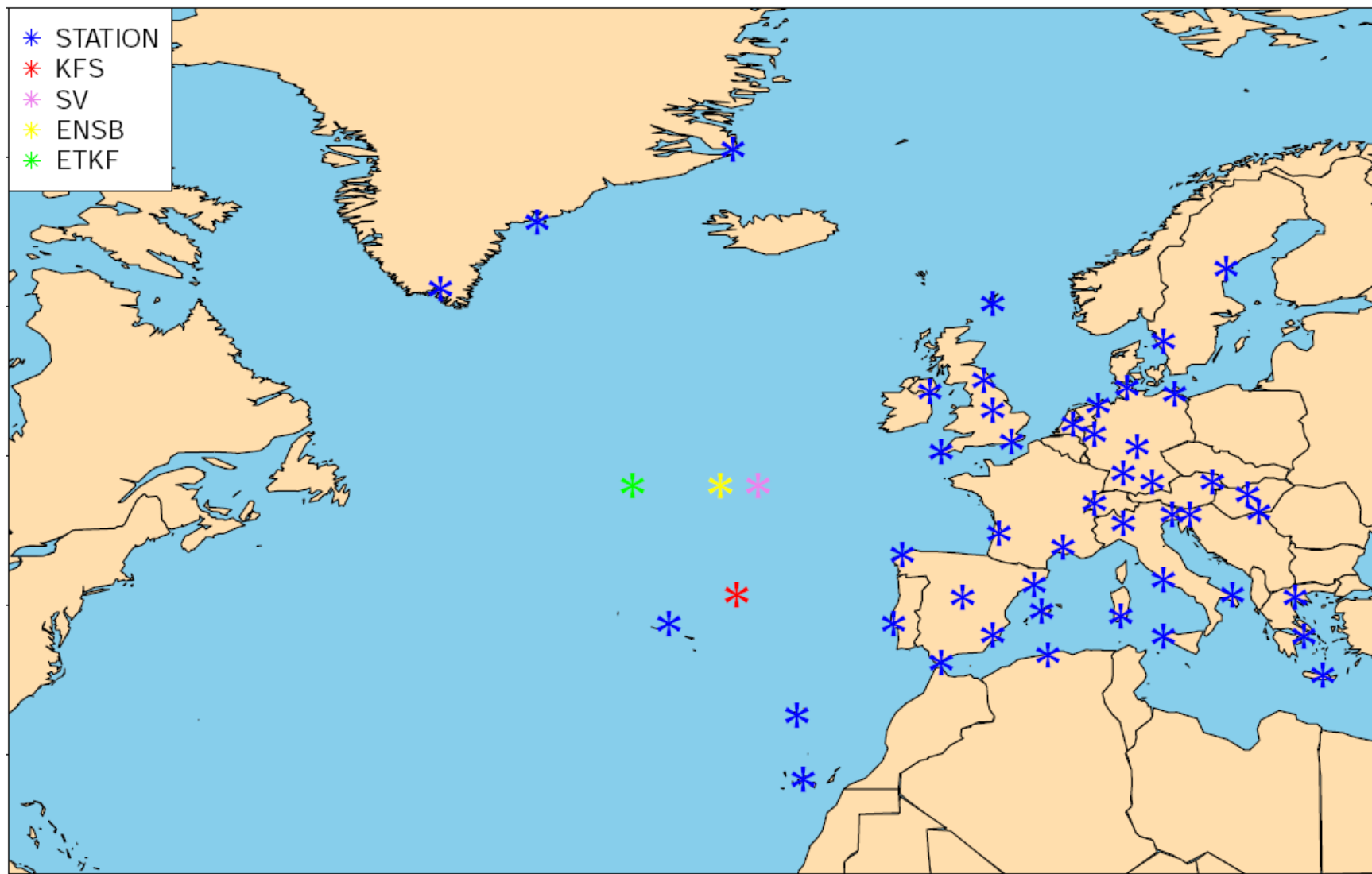## Météo-France: ETKF

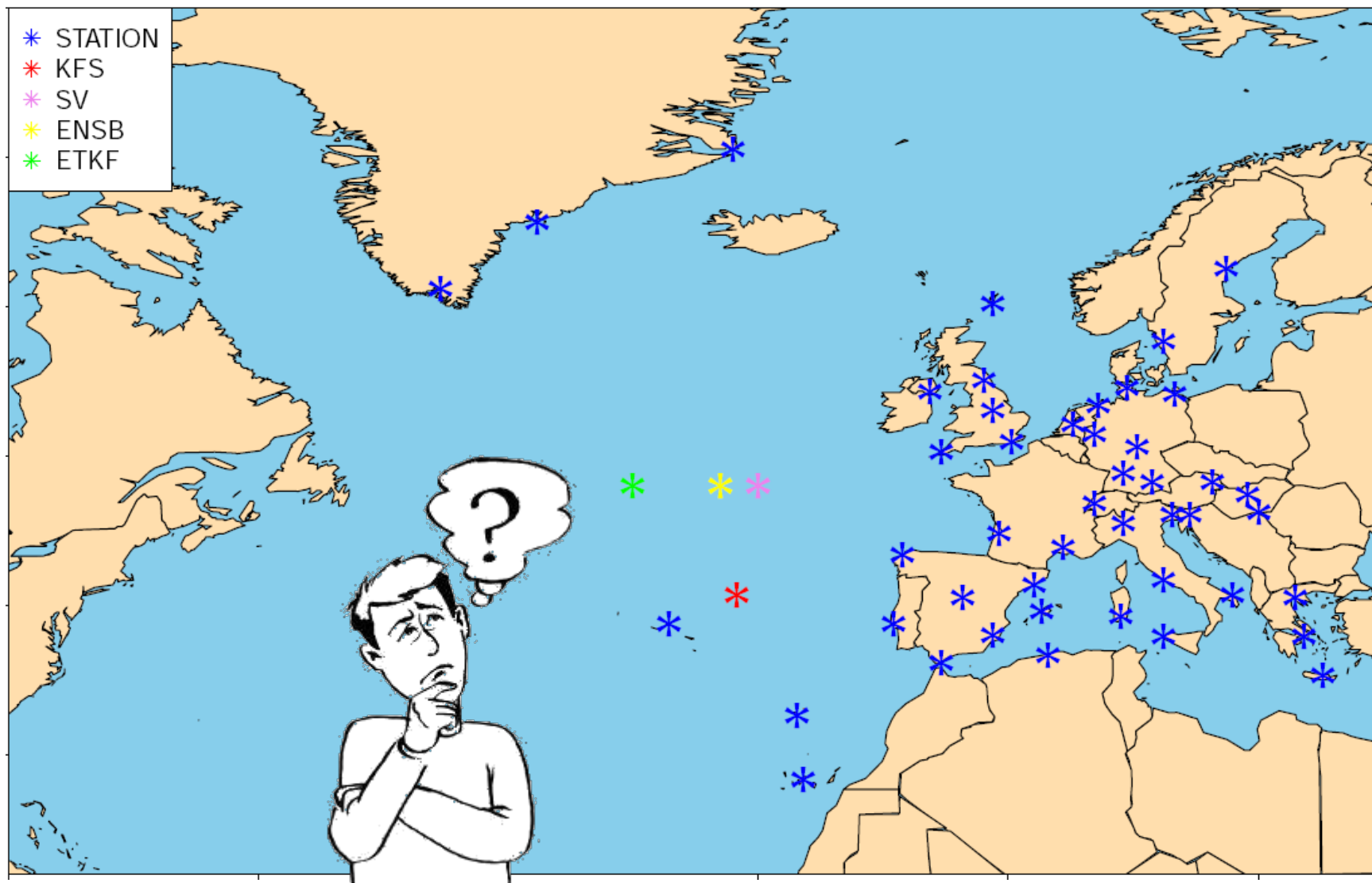## UIB: Ensemble Sensitivities (ENSB)

Framework

Main Results

✔ **Objective:** Test the worth of available sensitivity fields for targeting guidance.

47 Targetable radio-sounding stations and 4 maximum sensitivity locations

✔ **Objective:** Test the worth of available sensitivity fields for targeting guidance.

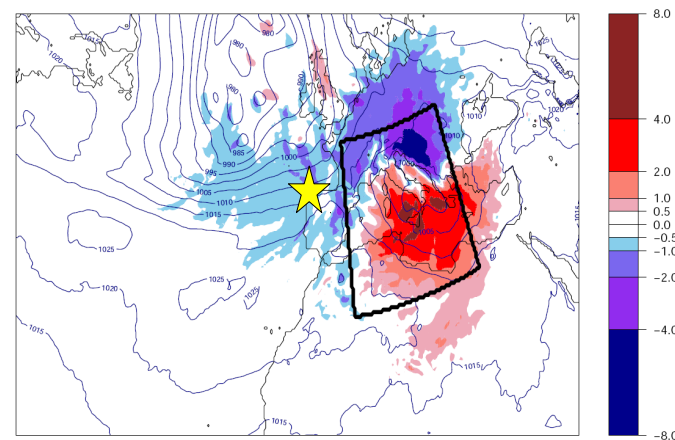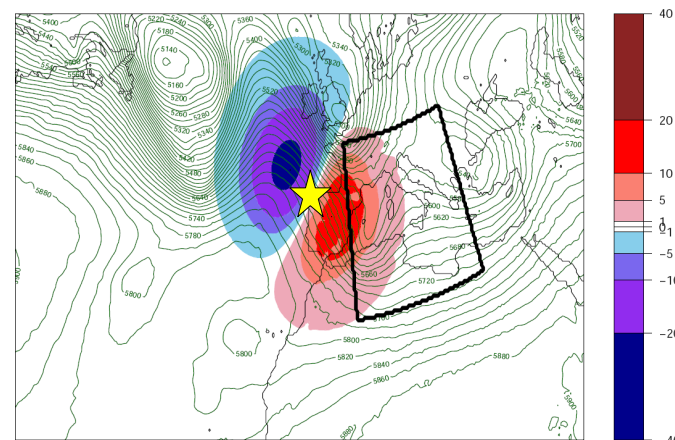**47 Targetable radio-sounding stations and 4 maximum sensitivity locations**

✔ **Objective:** Test the worth of available sensitivity fields for targeting guidance.

✔ **Verification Methodology:**

1. To assimilate a synthetic sounding through WRFDA over each location at the Targeting Time (TT):

2. To evaluate the impact on the prediction (MSLP, Rain, Wind) over the Verifying Area (VA) at the Verifying Time (VT):

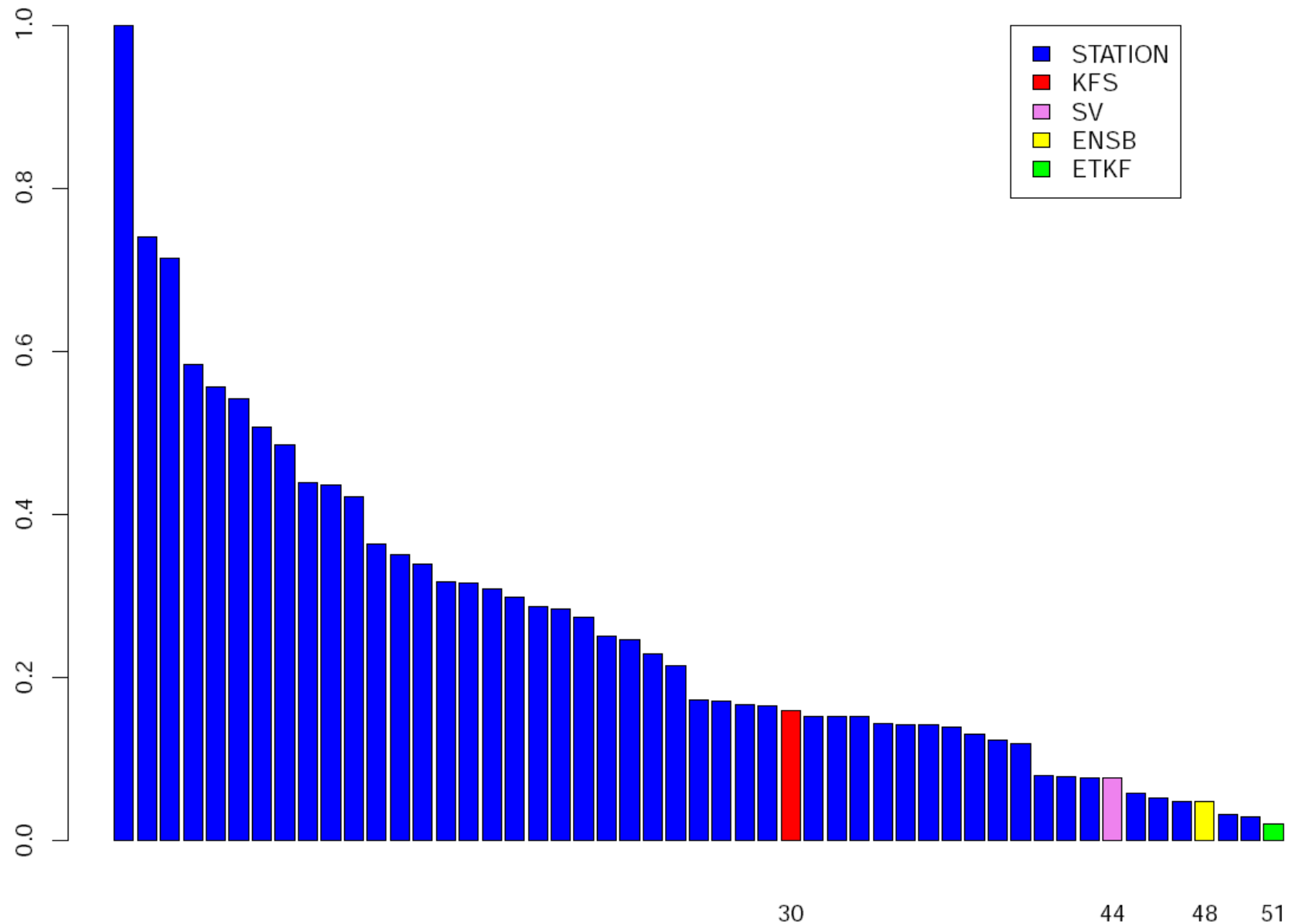✔ 4 sensitivity maximums + 47 radio-soundings locations = **51 Experiments**

Framework

Main Results
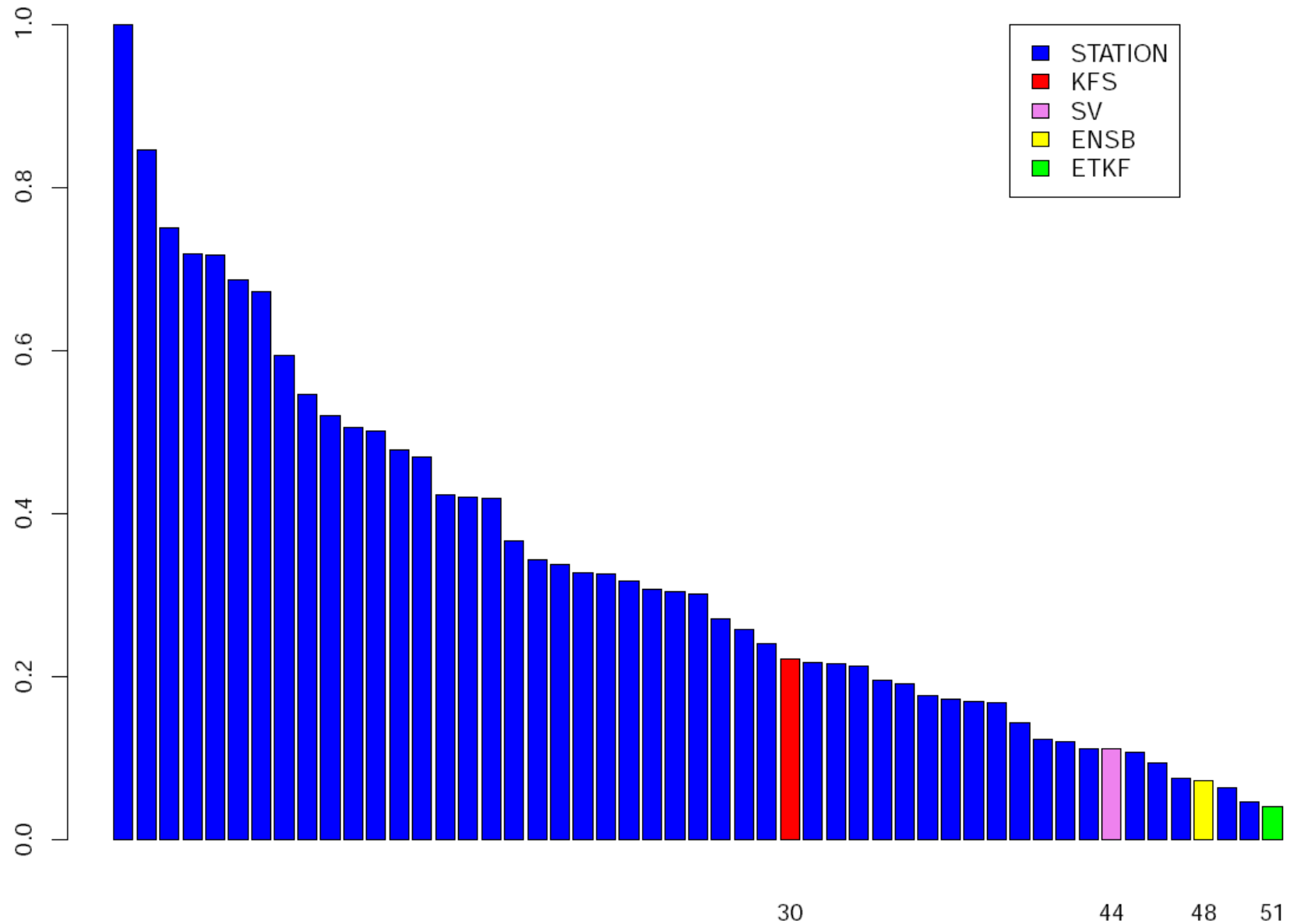
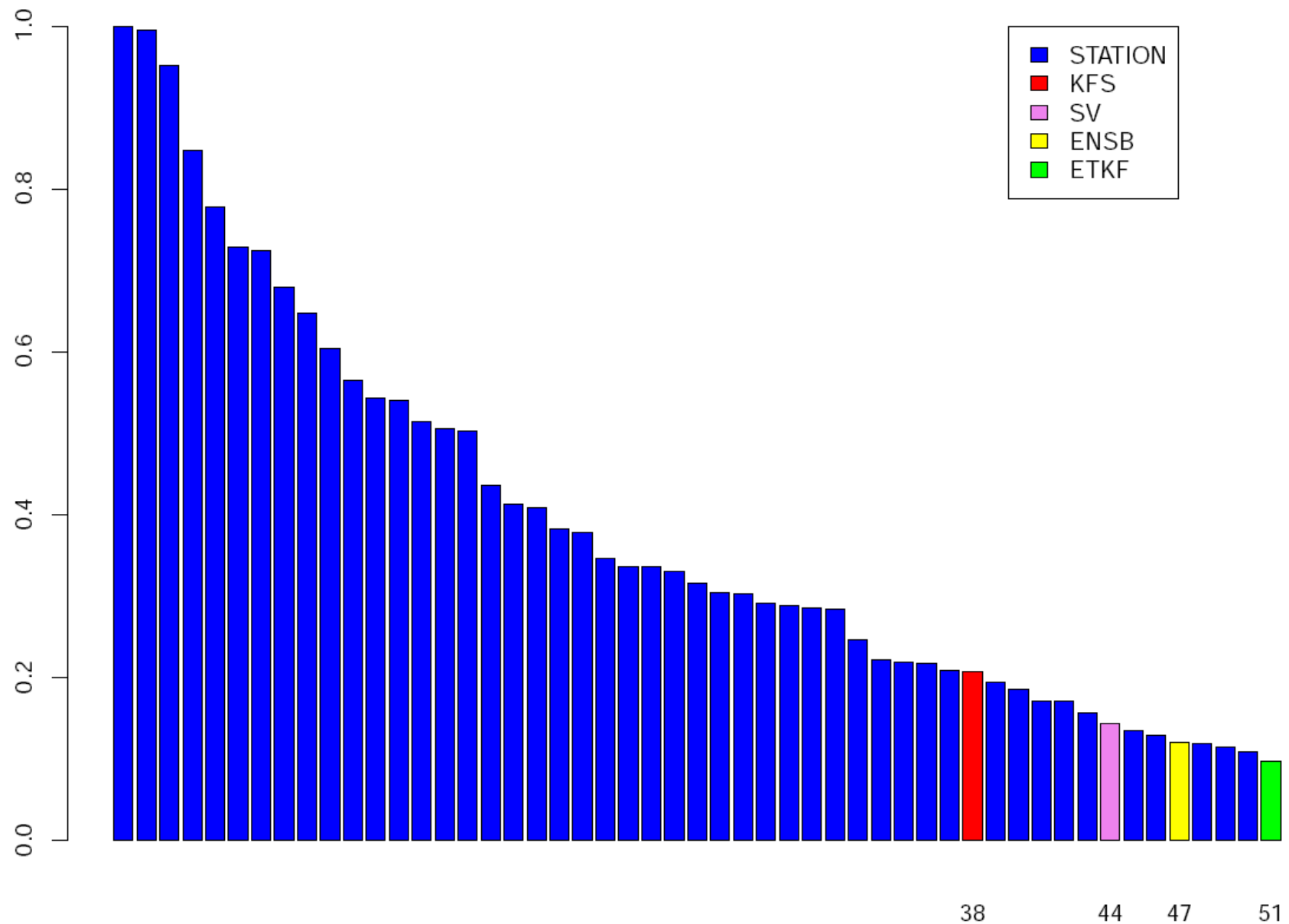# RMSD of MSLP over the VA at the VT

Legend:
- STATION (blue)
- KFS (red)
- SV (pink)
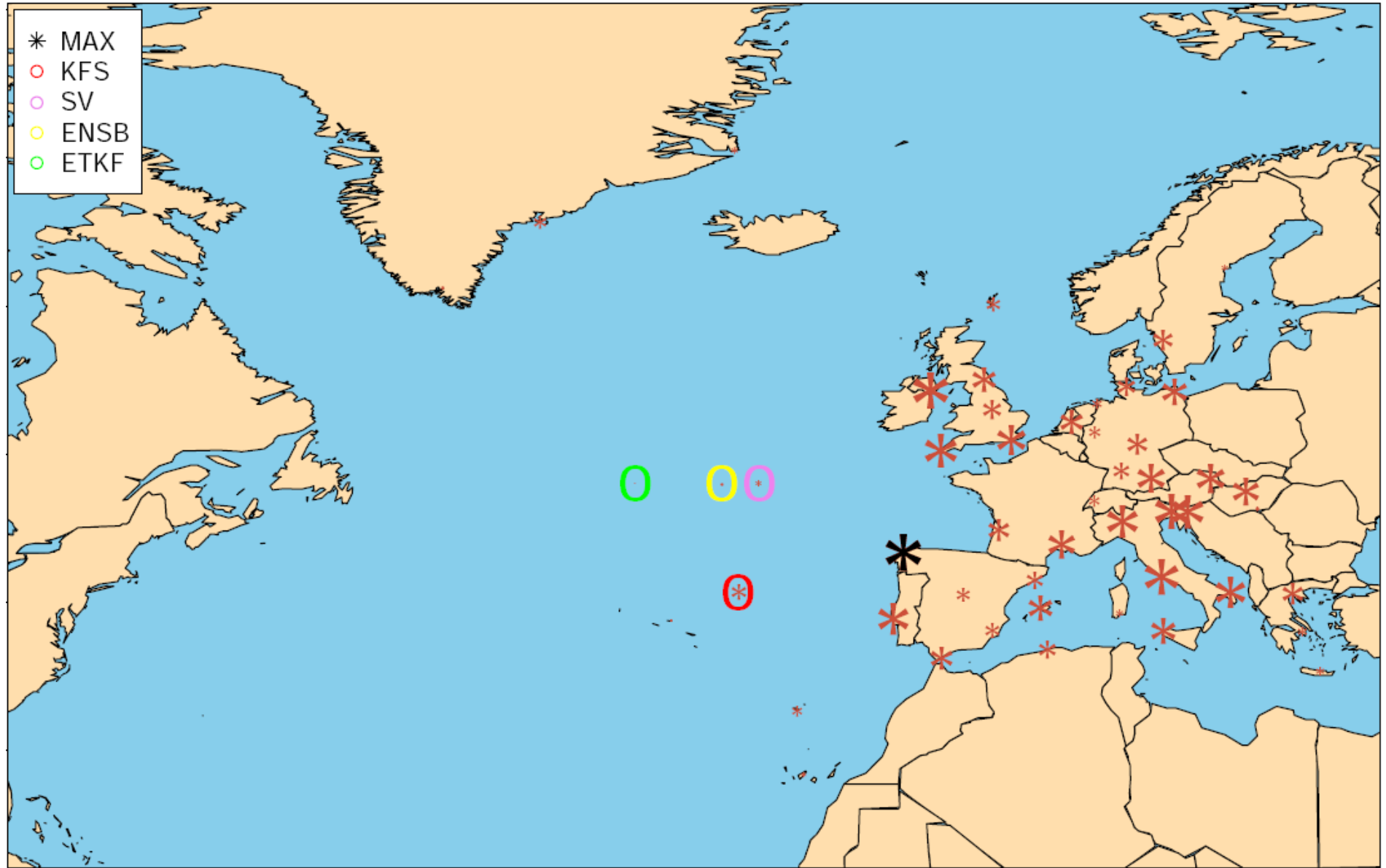- ENSB (yellow)
- ETKF (green)

RMSD of Wind Speed over the VA at the VT

RMSD of Accumulated Rain over the VA at the VT

Spatial distribution: RMSD of MSLP

Legend:
- ✳ MAX
- ○ KFS
- ○ SV
- ○ ENSB
- ○ ETKF

Spatial distribution: RMSD of Wind Speed

Legend:
- ✳ MAX
- ○ KFS
- ○ SV
- ○ ENSB
- ○ ETKF
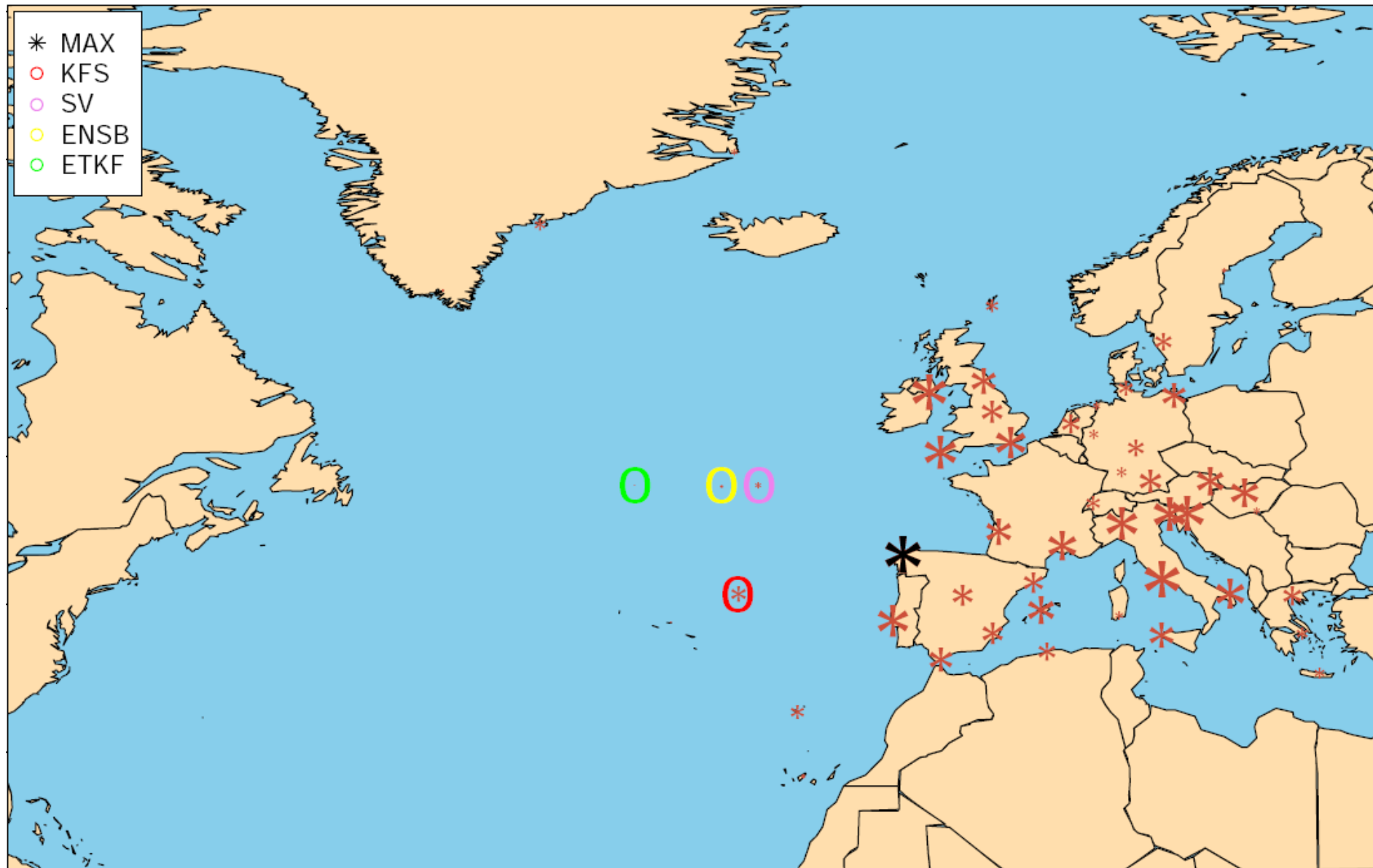
Spatial distribution: RMSD of Accumulated Rain

Legend:
- ✳ MAX
- ○ KFS
- ○ SV
- ○ ENSB
- ○ ETKF
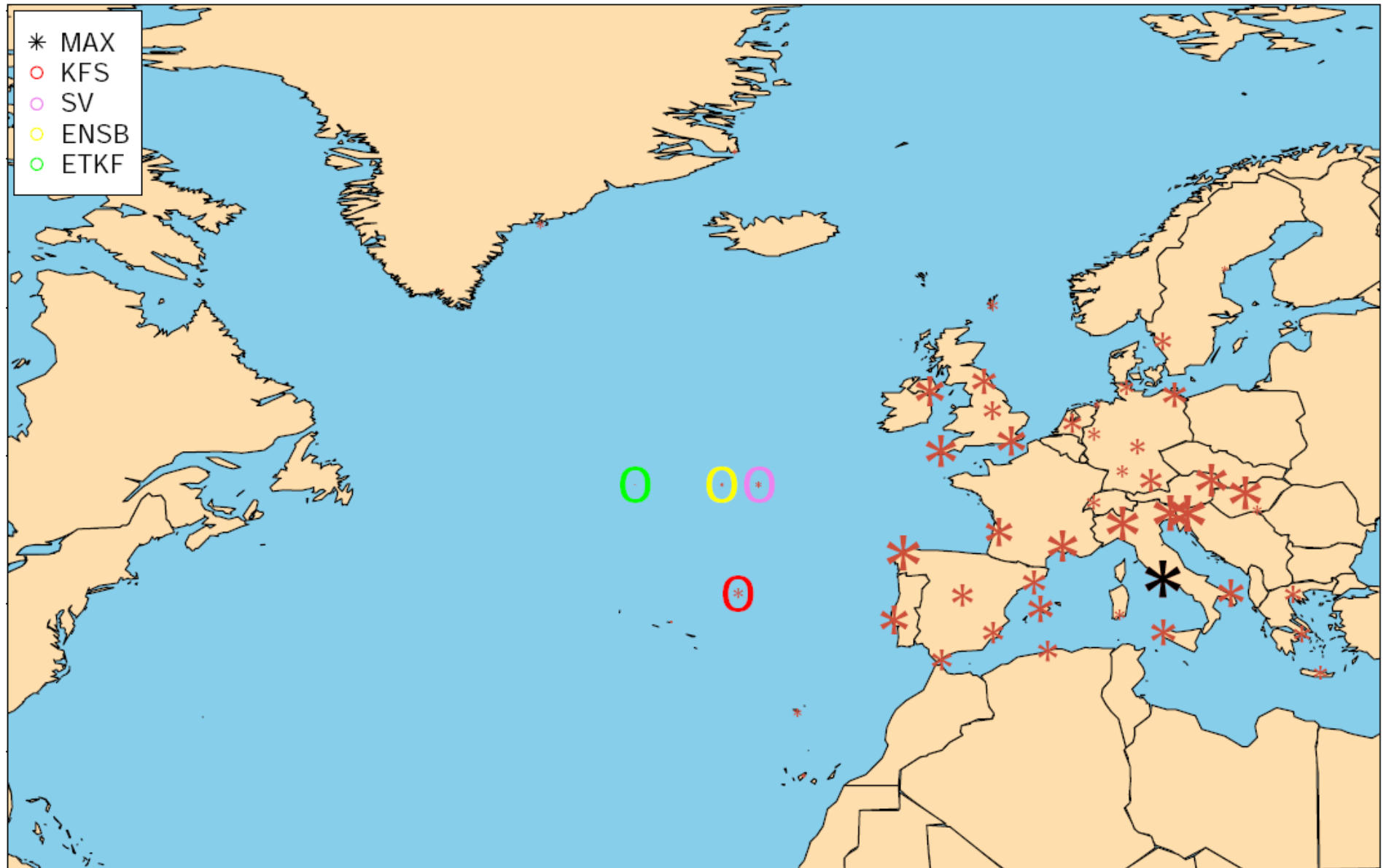
Where additional radio-soundings were deployed?

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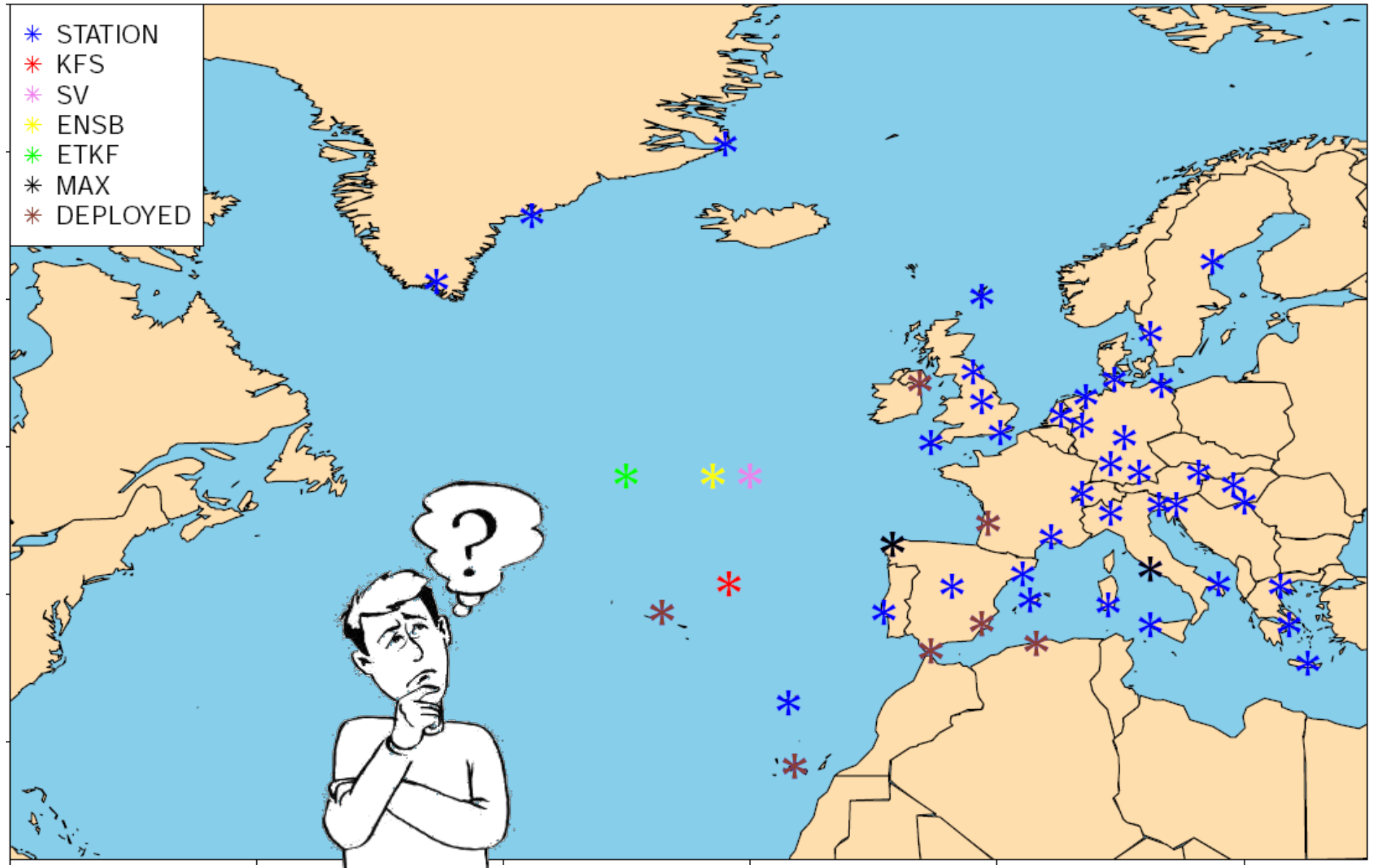
Conclusions and Further Work

- DTS-MEDEX-2009 provides an unique environment to test the performance of sensitivity products in operational targeting for Mediterranean HIW.

- Ensemble sensitivity technique has been applied to DTS-MEDEX-2009 targeting cases contributing to the catalog of sensitivities.

- Available sensitivity fields DO NOT highlight the area where an additional sounding in the initial conditions leads to a greater impact on the forecast of a high-impact weather event.

- STILL REMAINS: To identify the sensitivity products that best guide targeting campaigns in the Mediterranean:
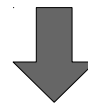
OBSERVATION SENSITIVITY FIELDS (Langland and Baker, 2004 ; Ancell and Hakim, 2007) ???