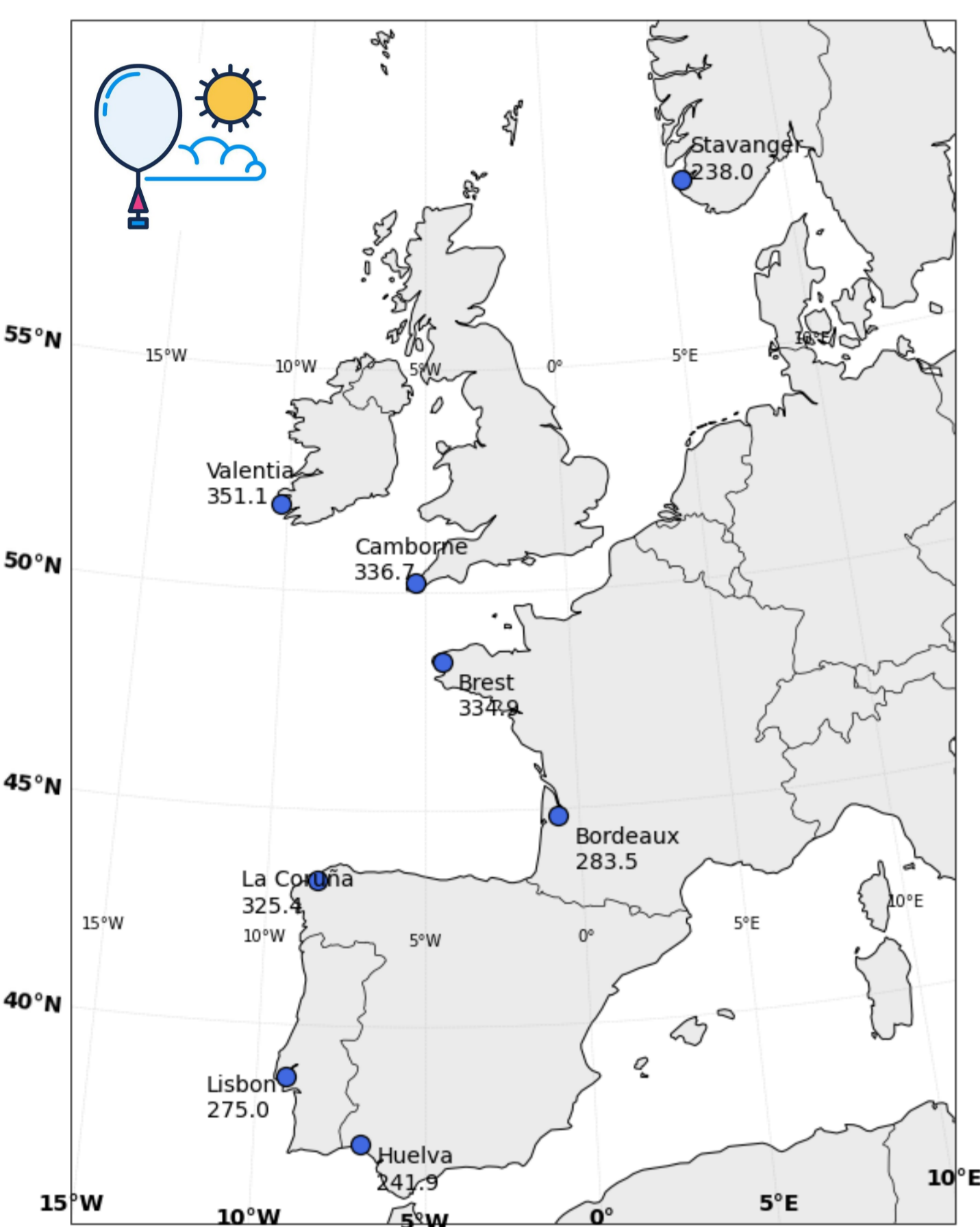


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## 1. Motivation

- **Atmospheric Rivers (ARs)** are responsible for many extreme precipitation and flooding events in Western Europe.
- Accurate prediction of AR intensity and landfall remains challenging.
- This study evaluates the ECMWF Integrated Forecasting System (IFS, Cycle 47r1) using radiosonde observations from eight locations distributed across Western Europe during the extended winter season of 2020/2021 (October to March).

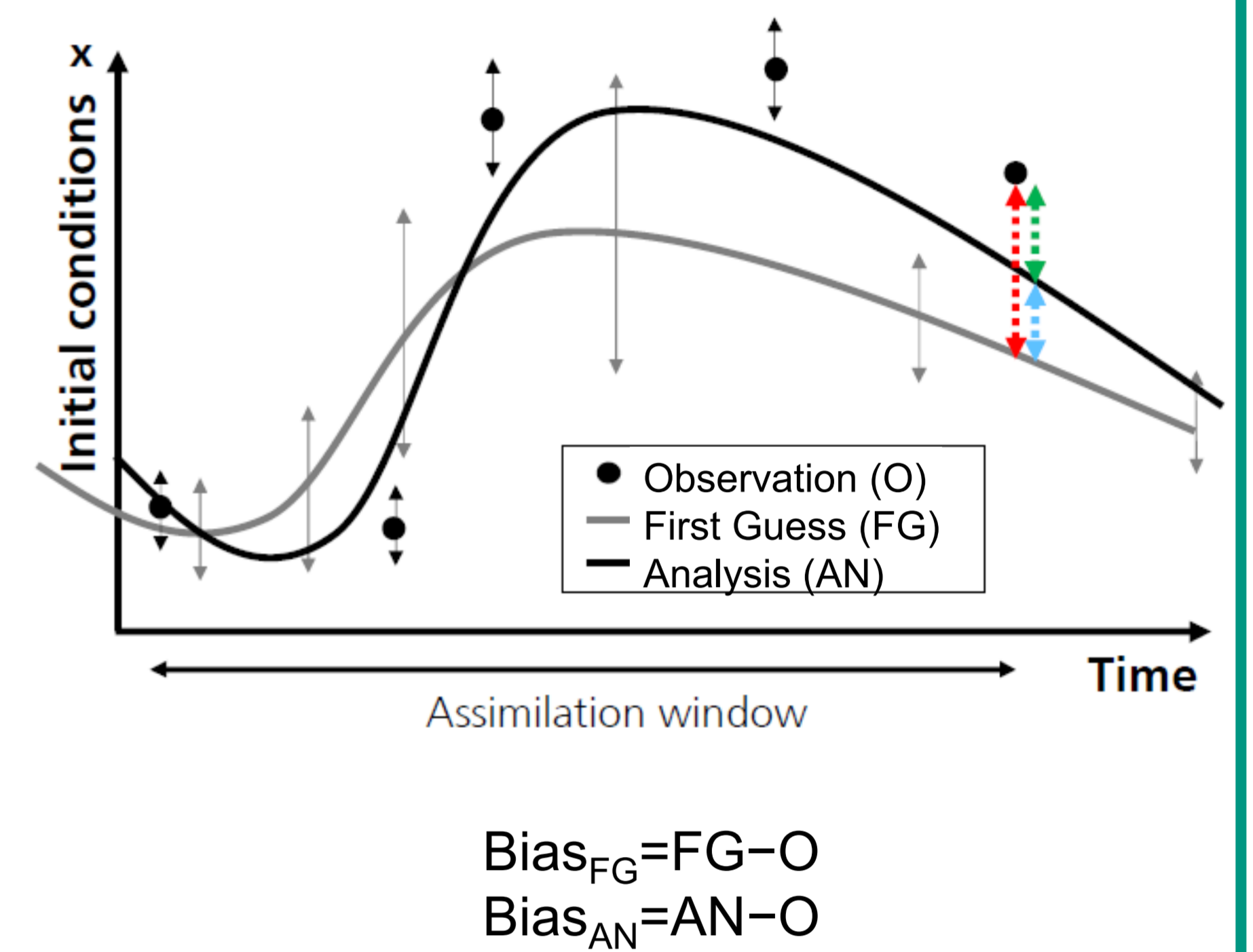
## 2. Study Area and Methodology



**Figure 1.** The eight radiosonde locations used in this study. Numbers indicate the local 85<sup>th</sup> percentile IVT ( $\text{kg m}^{-1} \text{s}^{-1}$ ) threshold employed to identify intense moisture transport events

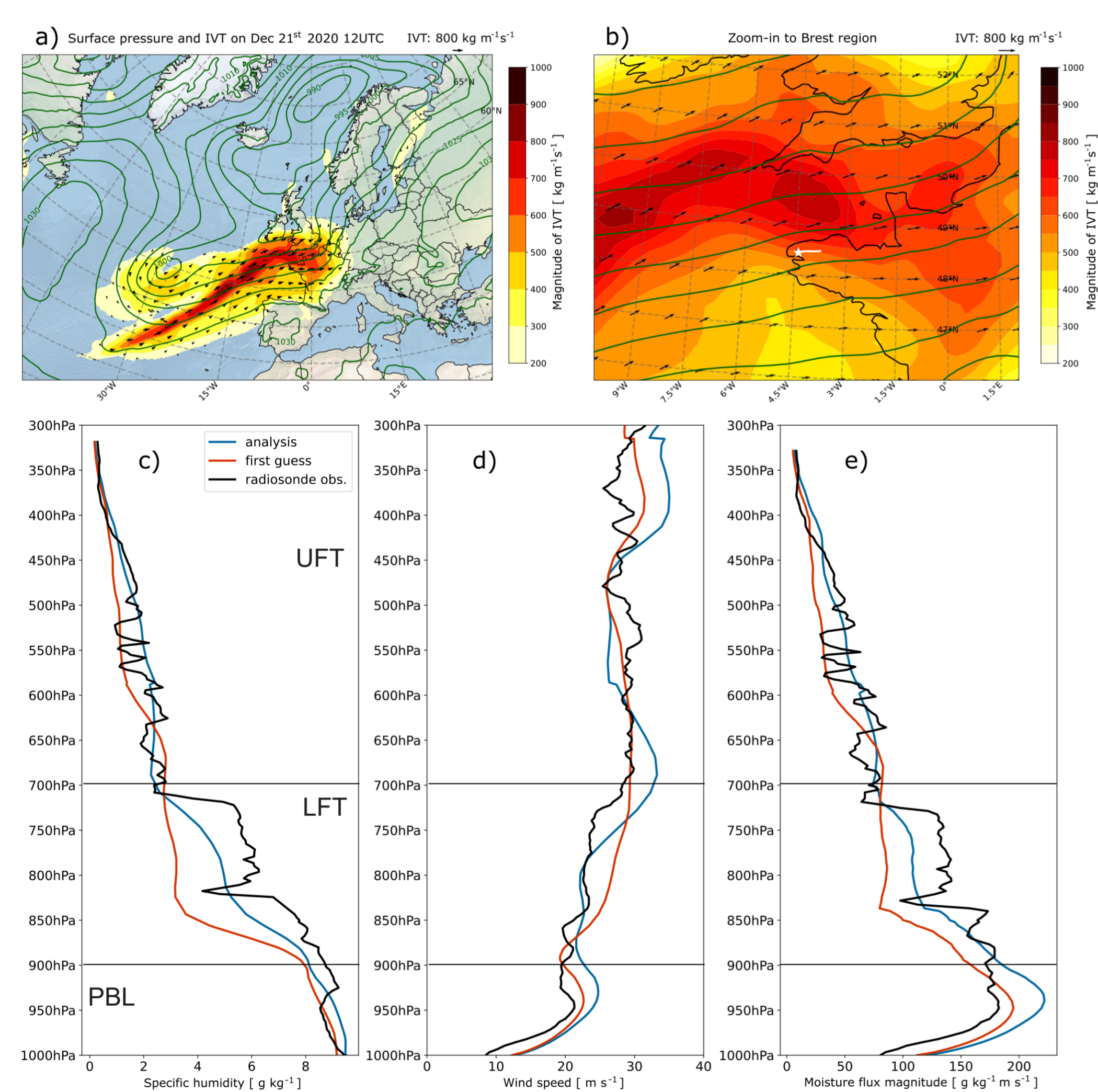


**Figure 2.** Temporal occurrence of intense IVT events during Oct 2020–Mar 2021. Percentages indicate the fraction of intense IVT days.

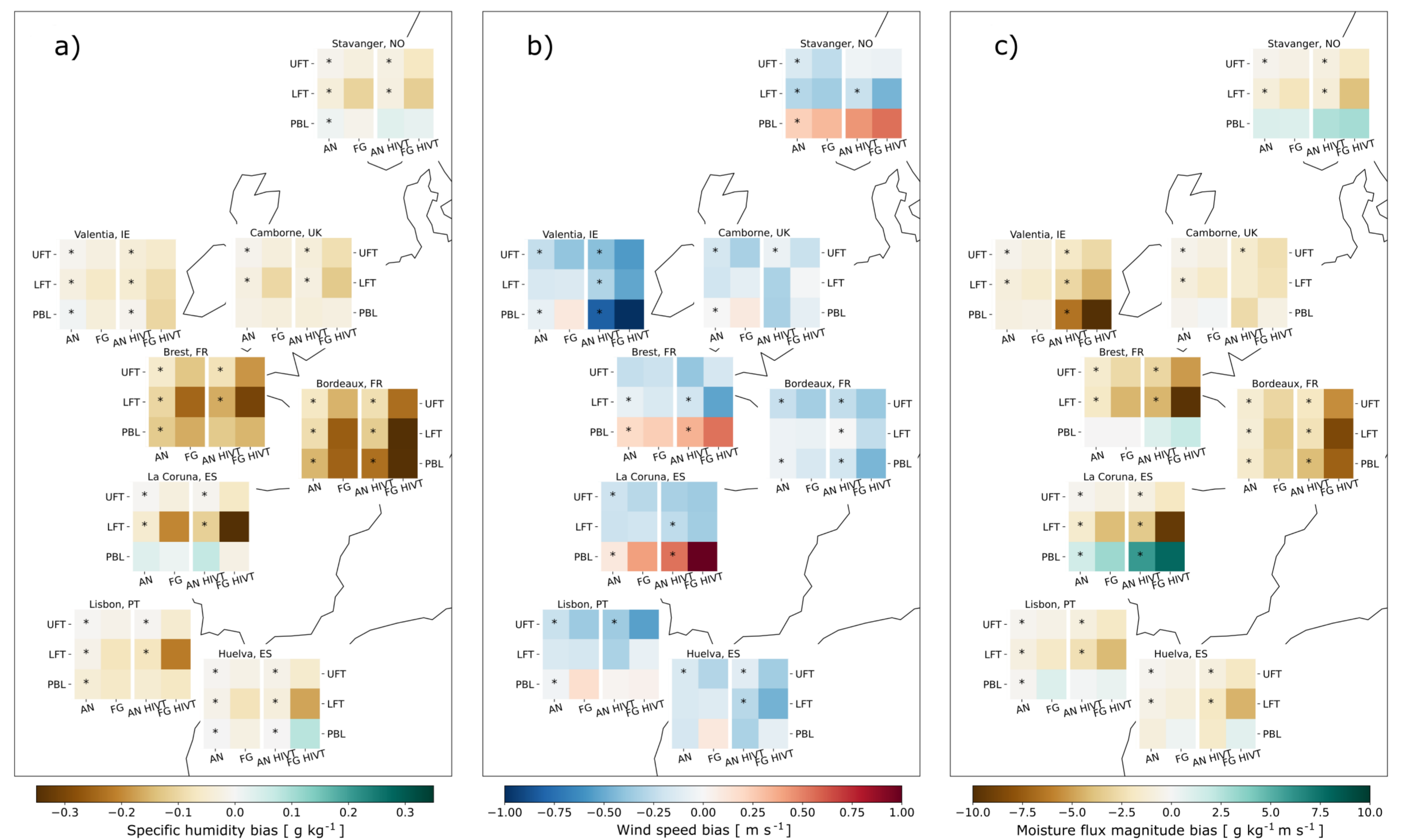


**Figure 3.** Data Assimilation schematic and convection used to compute the Bias of the FG and the AN in regard to observations

## 3. Results



**Figure 4.** Atmospheric River event over Brest on 21 December 2020 (12 UTC). Synoptic conditions from ERA5 are shown in (a–b), while (c–e) compare radiosonde observations with ECMWF IFS first guess (FG) and analysis (AN) profiles of specific humidity, wind speed, and moisture flux.



**Figure 5.** Mean biases of ECMWF analysis (AN) and first guess (FG) for humidity (a), wind speed (b) and moisture flux (c). Results are shown for all conditions and intense IVT events across three atmospheric layers. biases are displayed for the three atmospheric layers planetary boundary layer (PBL, 1000-900hPa), lower free troposphere (LFT; 900-700hPa) and upper free troposphere (UFT; 700-300hPa).

## Key Findings

- IFS exhibits systematic negative biases in the moisture flux, particularly during intense IVT conditions and below 700 hPa;
- Forecast errors are substantially larger during Atmospheric River events than during average winter conditions;
- Radiosonde assimilation significantly improves the representation of moisture and moisture flux across Western Europe.

Full article

