



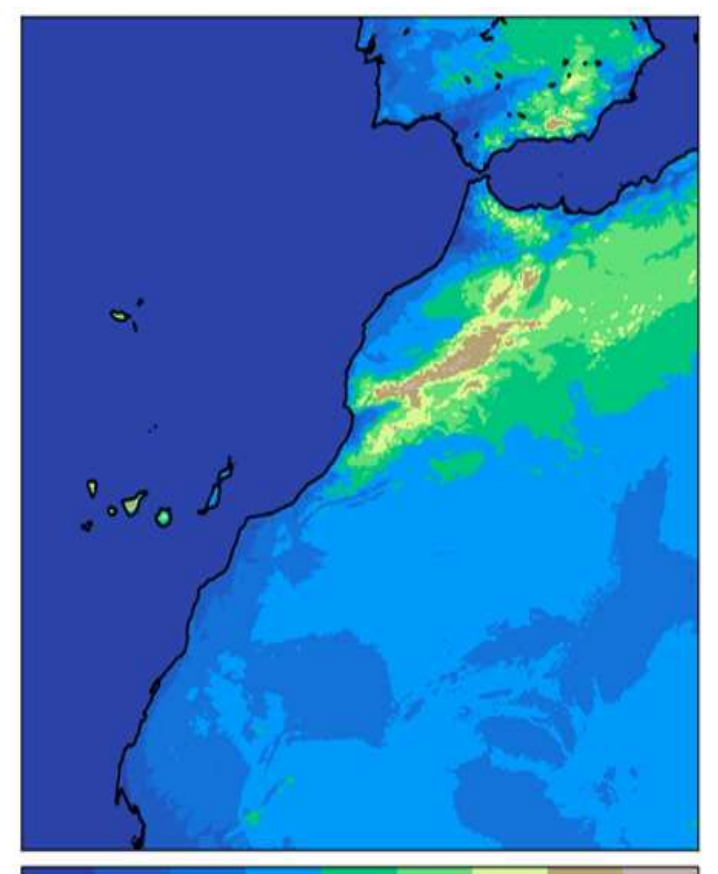
Status of Numerical Weather Prediction in Morocco 2025

NWP Team , Casablanca - Morocco

NWP systems based on AROME

AROME 2.5 km

- 3DVAR for upper air analysis
- OI-MAIN for surface
- Ensemble B matrix
- SYNOP (manual and automatic), TEMP and AMDAR
- Cycle 43t1
- 1h coupling frequency
- LBCs from ARPEGE
- Production at 00 UTC and 12 UTC

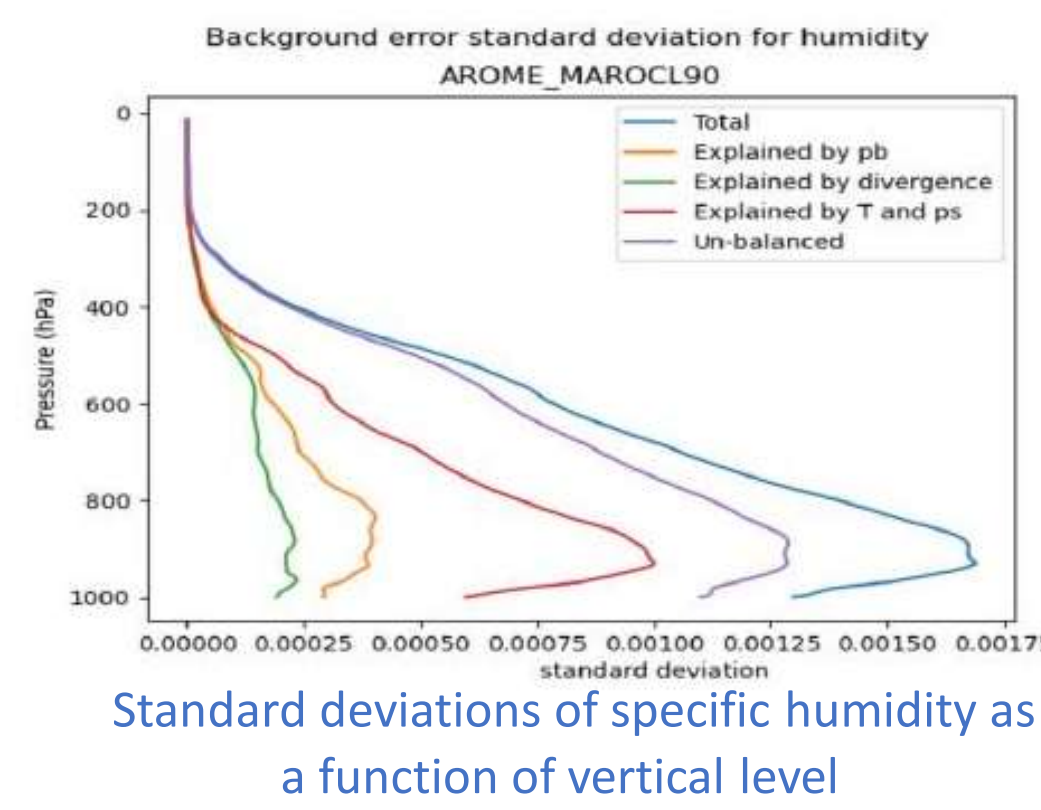


AROME 1.3 km

- Cycle 46t1
- 1h coupling frequency
- LBCs and initial state from ARPEGE/IFS
- Production at 00 UTC and 12 UTC

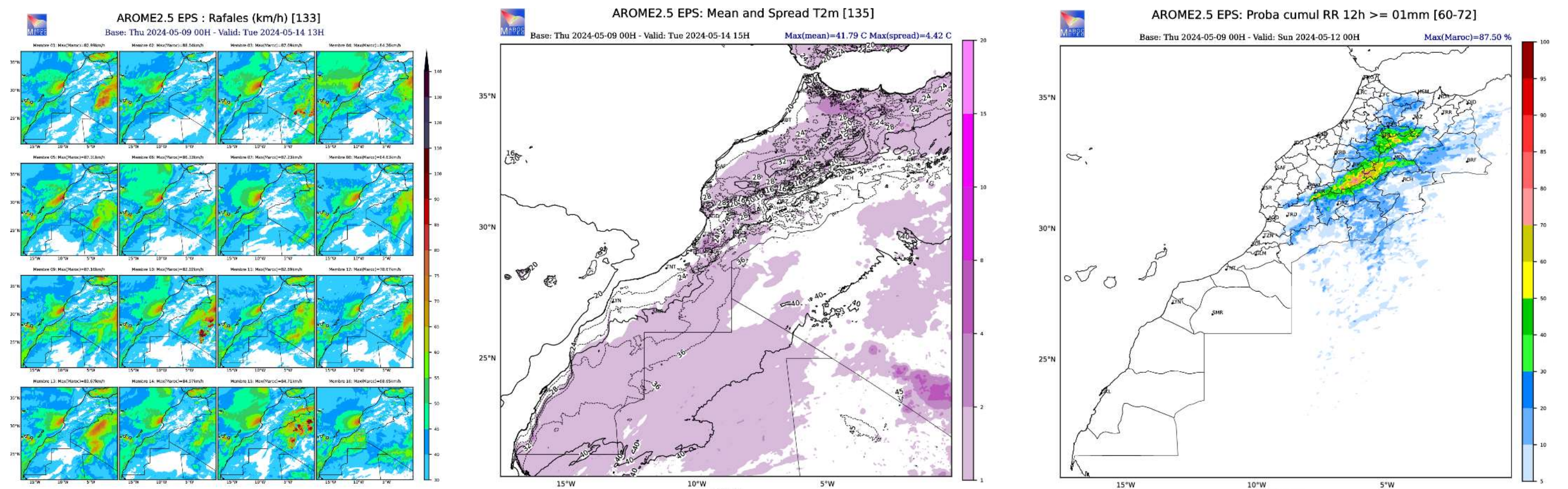
A new Ensemble B-Matrix

- Calculated from PAEARP
- Two periods of 15 days (winter and summer 2025) to capture seasonal variability
- 6 members ensemble
- Diagnostics using "jbdiagnose"



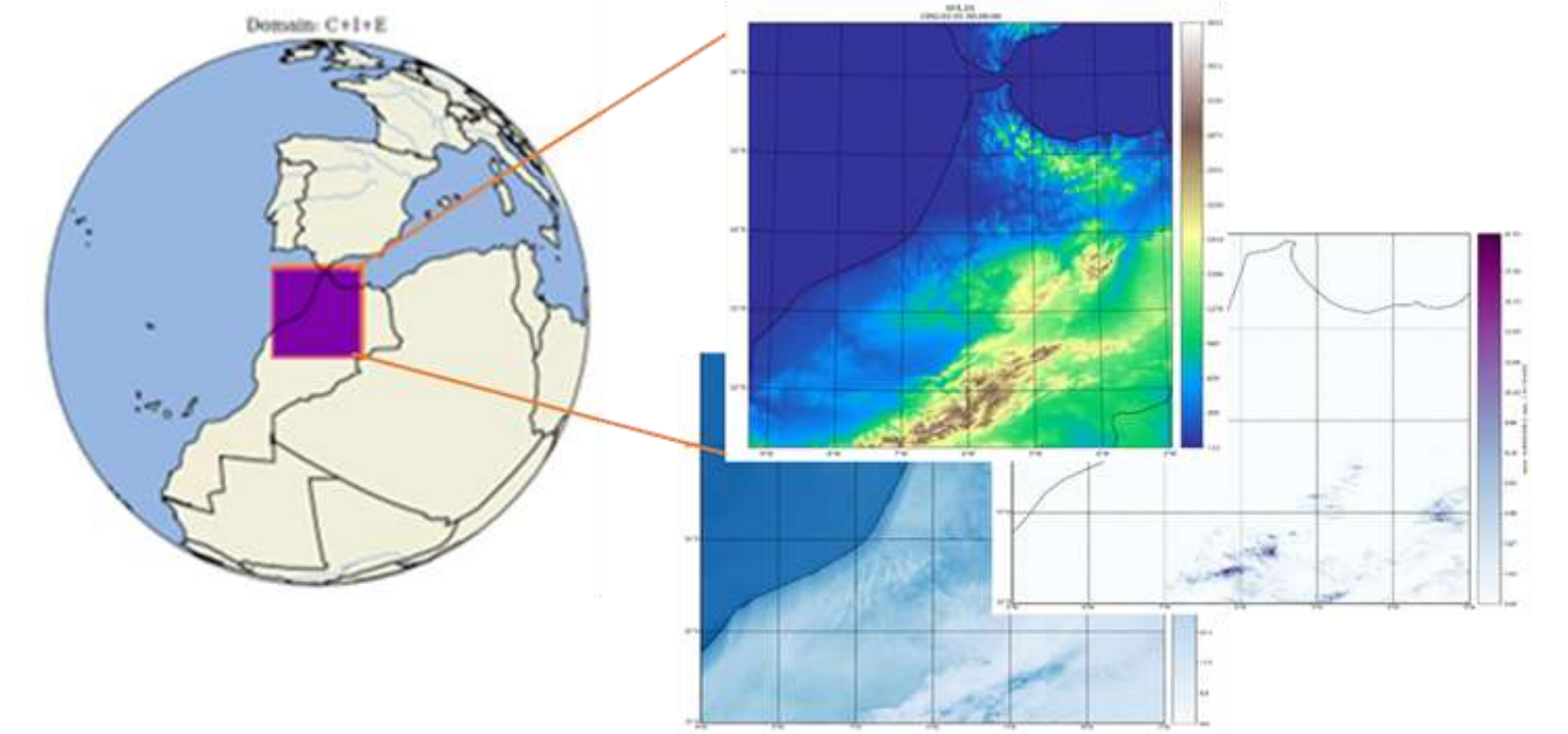
AROME 2.5 km Ensemble Prediction System

- Based on AROME 2.5 km horizontal resolution and 90 vertical levels
- 16 perturbed members
- 1 run/day (00 UTC) up to 144h, post processing every hour
- LBCs : subset of IFS-ENS members, 3h coupling frequency
- Initial states : A mix from AROME 3D-Var analysis and ARPEGE Initial file downscaling
- Perturbation method : SPPT scheme



Prototype of AROME-North of Morocco 500 m

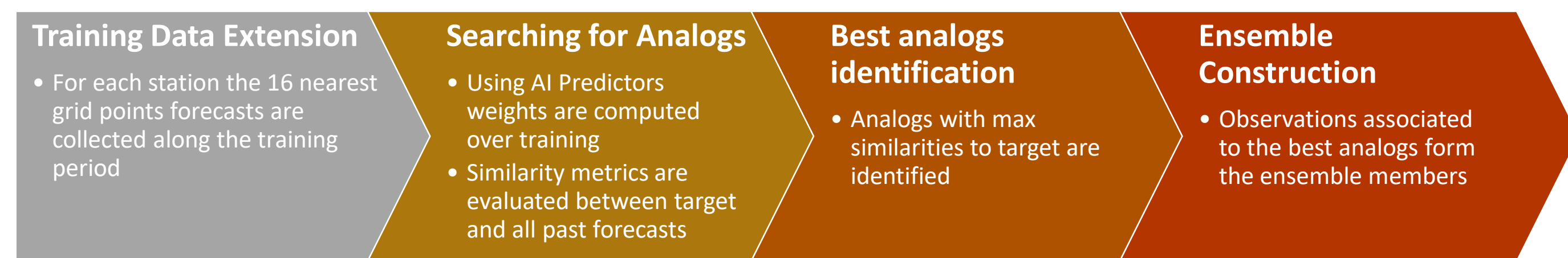
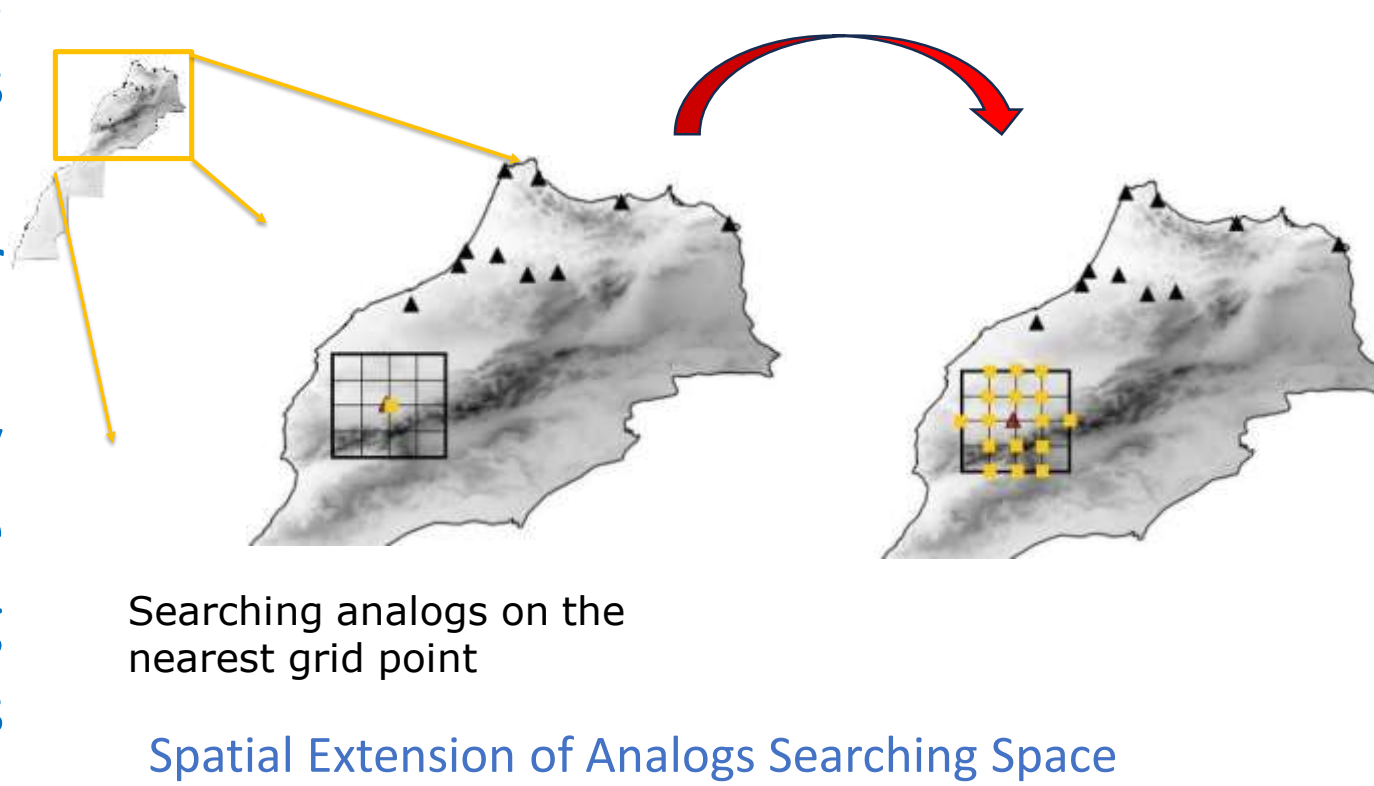
- Cycle 46t1
- LBCs and initial state from AROME 1.3 km
- Tuning of vertical levels (90/120) and TSTEP (30s/60s)



Space Analog's Searching to Improve Deterministic Forecasting Using Analog Ensemble

This study aims to improve surface weather forecasting using an efficient ensemble method called analog ensemble (AnEn) for predicting six surface parameters at 10 airports in Morocco over 24- hour forecasts.

Using a 4-year dataset from the AROME model, in addition to observations. Two innovations are introduced: a machine learning-based weighting strategy for predictors (using linear regression, XGBoost, and random forest) and expanding the analog search area by considering 16 neighboring grid points. These approaches improve forecast accuracy, reducing bias and root mean square error across various lead times and locations. However, performance improvements vary by geography, with topographically complex areas sometimes showing worse results due to local weather variations.

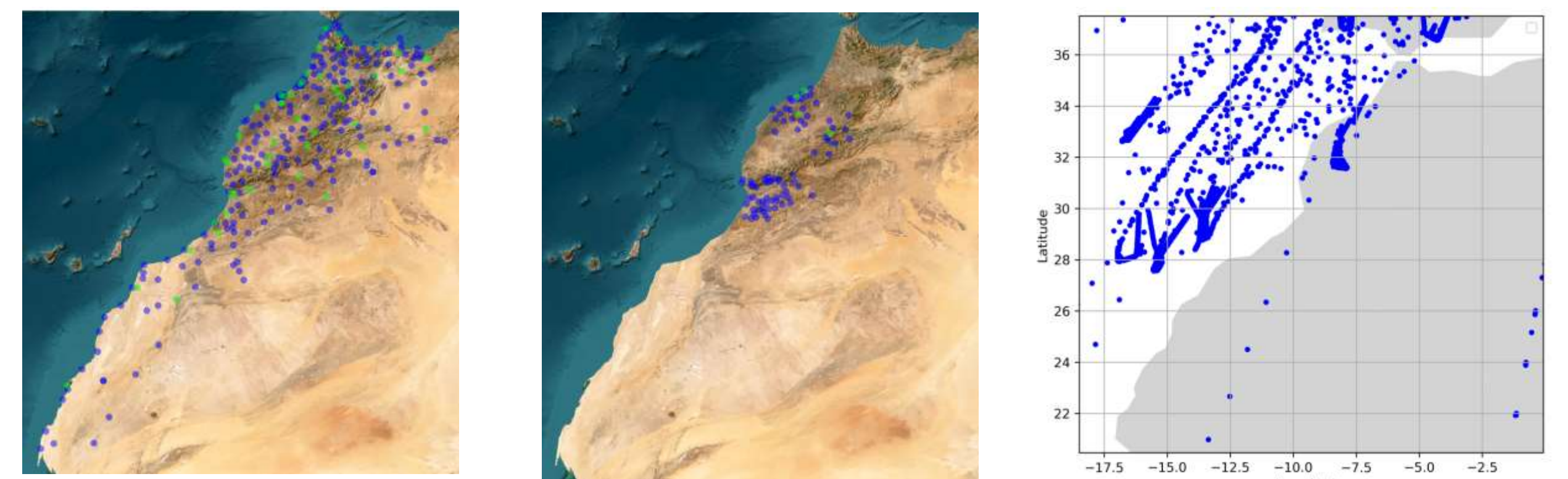


Reference

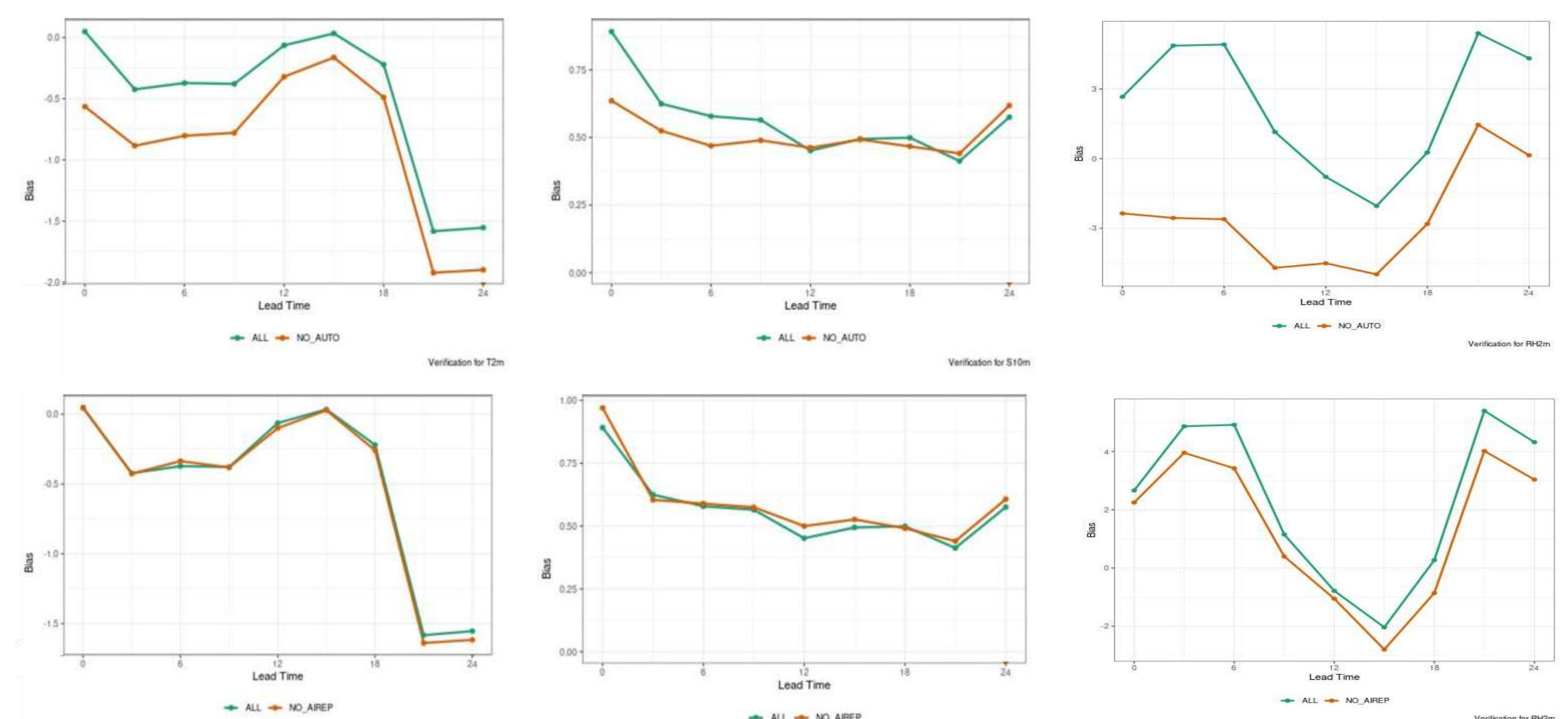
Alaoui, B., Bari, D. & Ghabbar, Y. Space Analog's Searching to Improve Deterministic Forecasting Using Analog Ensemble Method Over Morocco, Recent Advancements from Aquifers to Skies in Hydrogeology, Geoecology, and Atmospheric Sciences 2024. DOI : 10.1007/978-3-031-47079-0

Impact of New AWS and AMDAR in the AROME-2.5 km Morocco Model

The evaluation of the impact of the new AWS network and AMDAR on the quality of AROME 2.5 km model was performed. The study period spans from January 2nd to January 25th, 2024, and 24-hour forecast outputs were compared to observations of three parameters: temperature at 2 meters, humidity at 2 meters, and wind at 10 meters. The results show an overall positive impact of the data from the new automatic stations on temperature and relative humidity. The forecasts improved with the integration of these new observations, reducing the bias. However, there was a degradation in performance for wind at 10 meters. The impact of AMDAR data is more nuanced depending on the parameters and the forecast lead time. The effect of these observations is positive to neutral for temperature and wind speed. On the other hand, the impact is mixed for relative humidity, with a clearly marked diurnal signal.



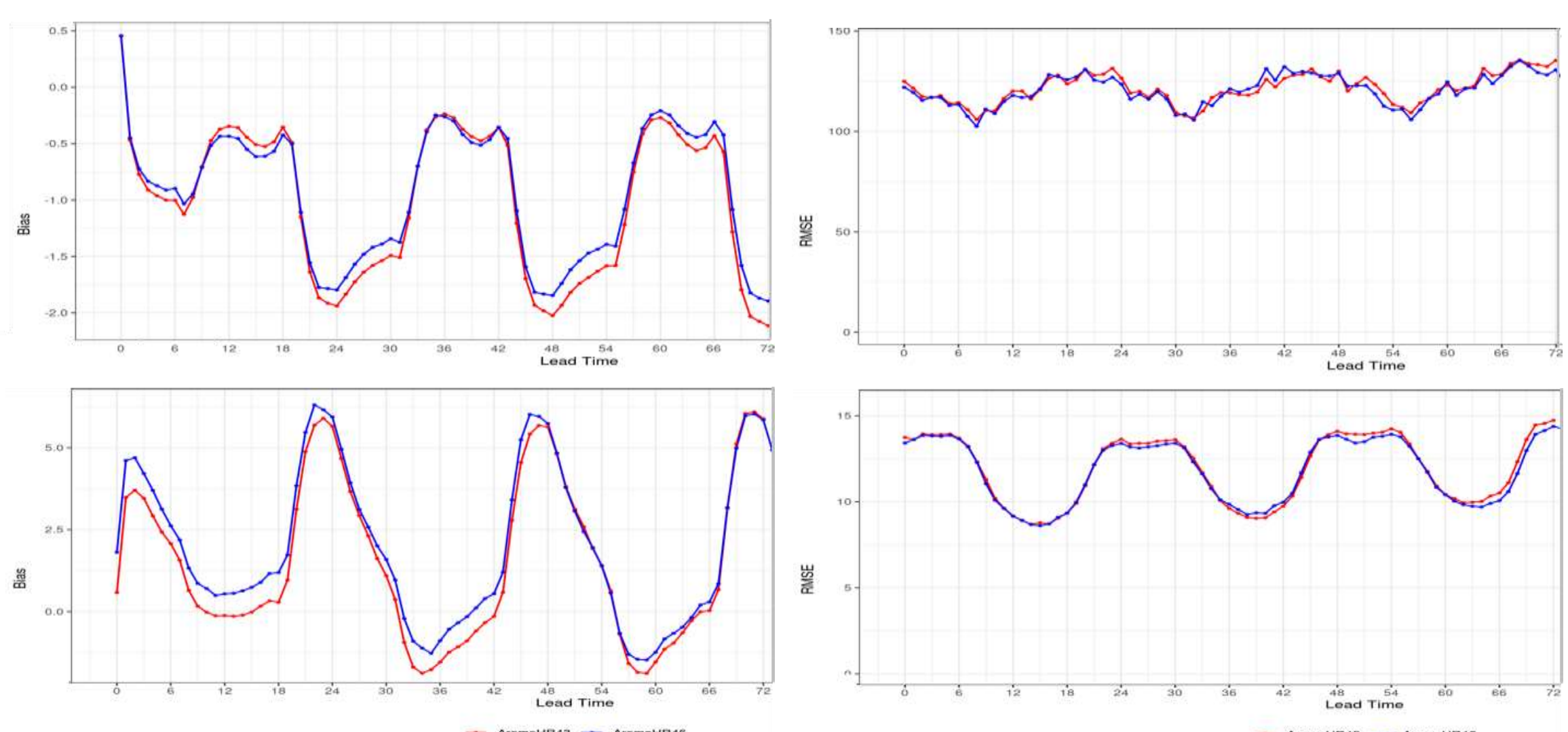
Localisation of the AWS stations (left), the new AWS network (middle), and AMDAR observations (right)



Bias of temperature at 2m (left), wind at 10m (middle), and relative humidity at 2m (right) for the two assimilation cycles with and without the new automatic stations (top) and AIREP (bottom)

Model Quality Assesment: cy43 versus cy46

A comparison is conducted between AROME 1.3 km CY46t1 and CY43t2 without data assimilation. The Bias and RMSE scores for the period from March 1st to June 30th, 2024, are presented. The parameters T2m and RH2m are compared against synoptic observations.



Surface parameter scores (Bias and RMSE) for T2m (top) and RH2m (bottom) for AROME cy43 (in red) and cy46 (in blue) over the period from March 1 to June 30, 2024

Ongoing / Future Work

- Assimilation : 3D-Var for the AROME model (1.3 km)
- Observations: Satellite data
 - Radar observations (the installation of new Moroccan network is in progress)
 - GNSS and GNSS radio occultation
- Ensemble AROME system: Setup of other techniques of perturbations (including AI)
- Hectometric scale: Further tests and tuning of AROME-500m
- AI applications in NWP processes