Status of Numerical Weather Prediction in Morocco

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AROME Configurations

AROME System

Grid points 800 X 800 (resolution 2.5km)
Vertical levels :90
Cycle 43t1
1h coupling frequency
Production at 00 UTC and 12 UTC (48 h range)

Data Assimilation

3DVAR for upper air analysis
OI-MAIN for surface
Ensemble B matrix
SYNOP (manual and automatic), TEMP and AMDAR

Local Data Handling

The following actions are achieved:
1. Getting data from GTS (in BUFR format) for SYNOP, TEMP and AMDAR data
2. Preprocessing observations by **SAPP**
3. Storing these data in a local database
4. Convert GTS data to ODB format (via BATOR).
5. Check the content of the resulting ODB by **OBSMON**

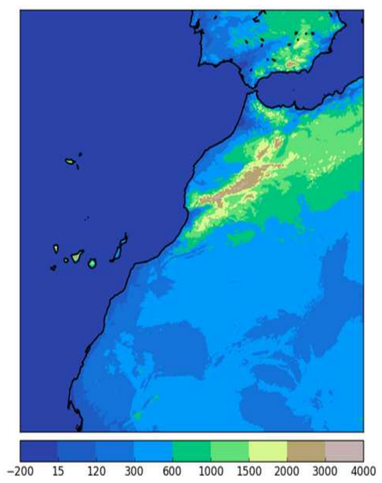


Fig1 : AROME Morocco orography

Cy46 vs cy43 for AROME without data assimilation

Comparison between AROME 2.5km 46t1 vs AROME 2.5km 43t1 without data assimilation is performed. The Bias and RMSE scores calculated over January 2021 are shown for AROME 43t1 (red) and AROME 46t1 (blue). The parameters T2m, RH2m, speed and direction at 10m are compared to synoptic observations. Results show a negative to neutral impact for cy46t1

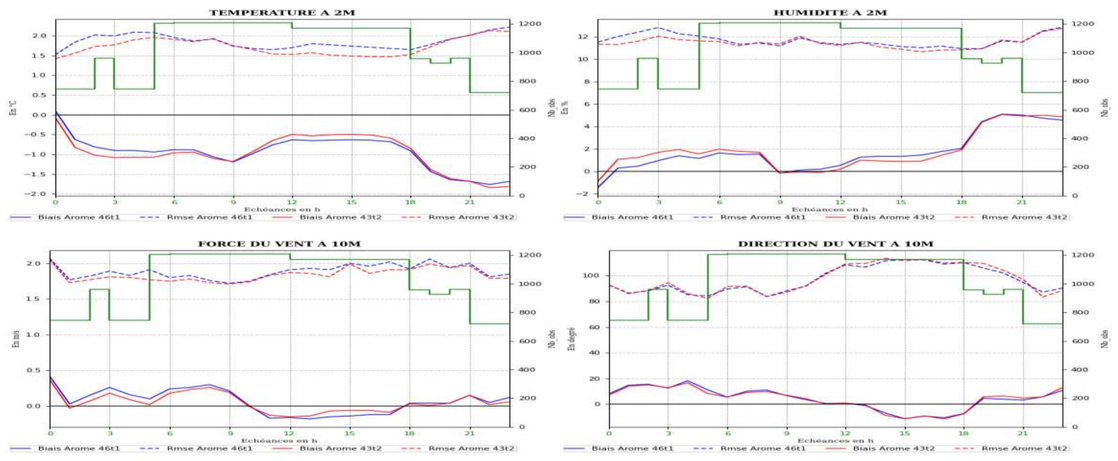


Fig2 : Surface parameters scores (Bias and Rmse) for AROME cy43 (red) and cy46 (blue) over January 2021

Analog Ensemble Forecasting System for Low-Visibility Conditions and Surface Weather Parameters over the Main Airports of Morocco

A recent idea to improve low-cost ensemble forecasting system based on the analog ensemble method (AnEn) was developed. The improved system aims to forecast 8 surface weather parameters in addition to atmospheric visibility over 17 airports of Morocco. The training period extends from 2016 to 2018 and the test period is 2019 where AnEn performances are compared to the operational mesoscale deterministic model (AROME). An analog for a given station and forecast lead time is a past prediction, from the same model that has similar values for selected predictors of the current model forecast. The new version of analog ensemble comes with three scientific contributions: a) new predictors weighting strategy based on machine learning techniques (linear regression, random forest, and XGBoost); b) seasonal restriction where analogs are forced to belong to the same season as the target; c) using wide specter of predictors including 8 surface weather parameters and liquid water content for reduced visibility. For surface weather parameters results analysis shows that AnEn system exhibits a good statistical consistency and it significantly improves the deterministic forecast performance temporally and spatially by up to 50% for Bias (mean error) and 30% for RMSE (root-mean-square error) at most of the airports [1]. For visibility, AnEn visibility forecasts are converted to binary occurrences depending on a set of thresholds from 200 m to 6000 m by a step of 200 m. It is found that the averaged Heidke Skill Score for AnEn is 0.65 for all thresholds. However, AnEn performance generally becomes weaker for fog or mist events prediction [2].

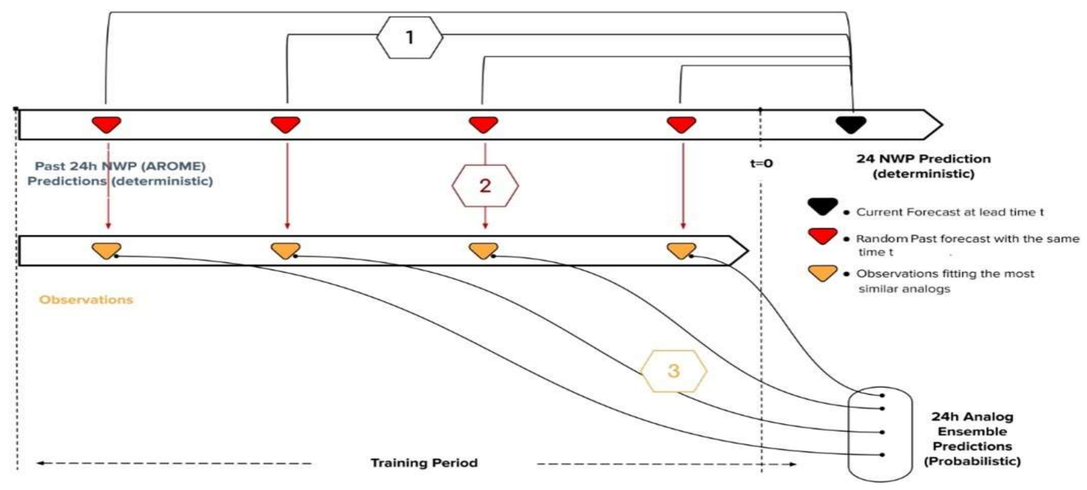
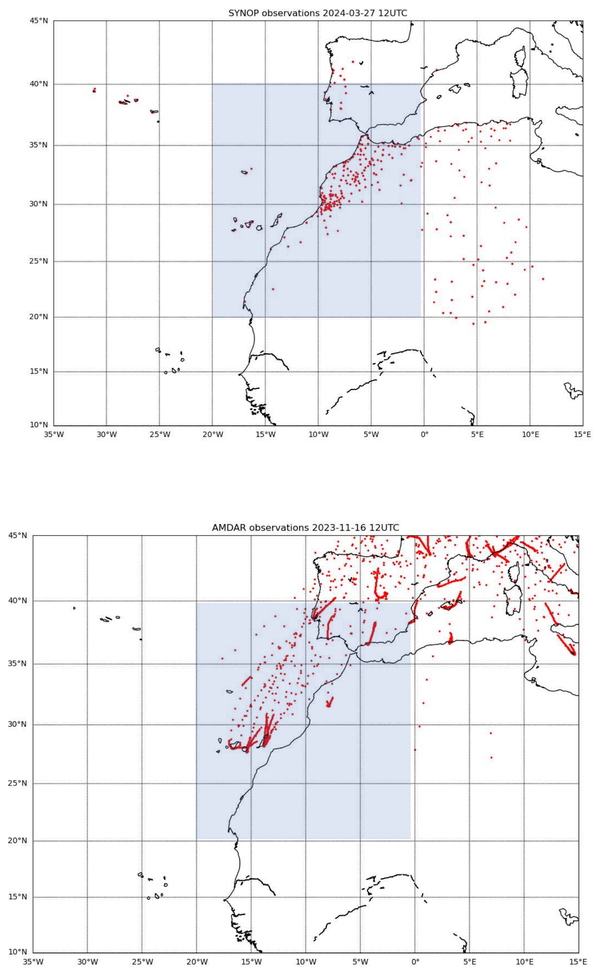


Fig3 : Analog Ensemble Method General Algorithm

SAPP Implementation

- The SAPP (Scalable Acquisition and Pre-Processing) System [3] is a software that performs acquisition, pre-processing and extraction of observational data for use in NWP.
- The first version of SAPP System was provided by ECMWF as a virtual machine and installed locally with the help of IT staff in March 2023
- The ftp service is enabled to allow the dissemination of GTS messages from Maroc-Météo messages switching service (Moving Weather)
- Modifications are introduced to SAPP suite in order to perform observation extraction every three hours
- The observations extracted by SAPP system are: SYNOP, TEMP, AMSUA, MHS, HIRS from NOAAs satellite



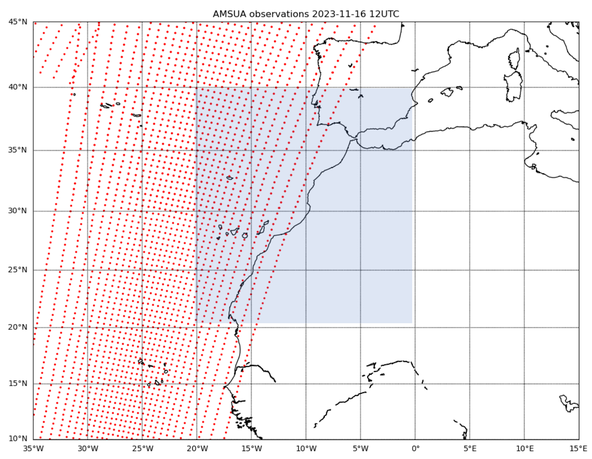


Fig4 : Data coverage of SYNOP, AMDAR and AMSUA (NOAA) produced by SAPP

Observation Monitoring with OBSMON

- Local Installation of OBSMON (OBServation MONitoring): the observation post-processing and the shiny web interface
- Monitoring of observations by analyzing the content of ODB database: ECMA and CCMA produced by screening and minimization
- Operationally used to monitor synoptic and automatic stations and to update the local blacklist file

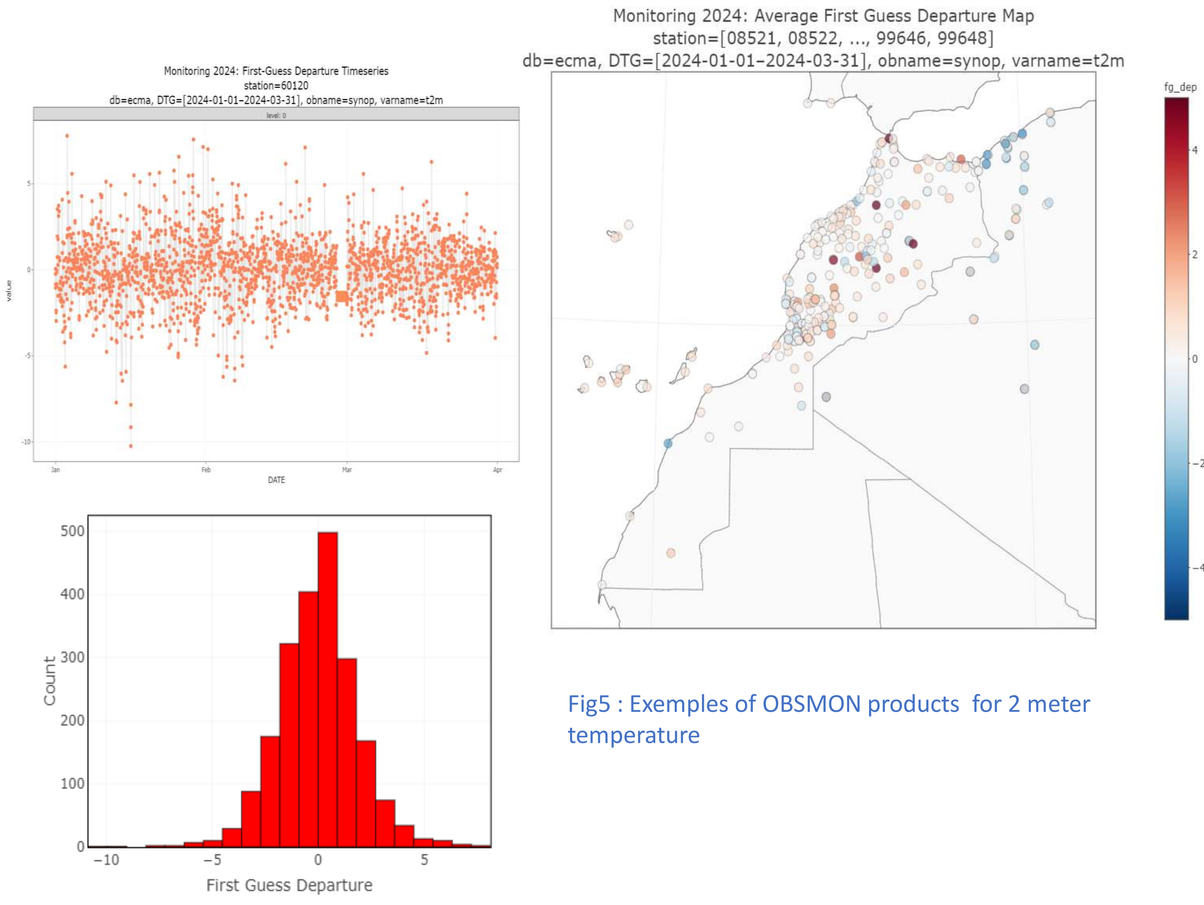


Fig5 : Exemples of OBSMON products for 2 meter temperature

Ongoing / Future Work

- Upgrade of domain resolution (1.3 km) and phasing the assimilation to cycle 46.
- Assimilation of new observations, especially satellite data.
- Setting up an Ensemble AROME system.
- AI applications in NWP.

References

[1] Alaoui, B.; Bari, D.; Bergot, T.; Ghabbar, Y. Analog Ensemble Forecasting System for Low-Visibility Conditions over the Main Airports of Morocco. Atmosphere 2022, 13, 1704. https://doi.org/10.3390/atmos13101704
[2] Alaoui, B., Bari, D. & Ghabbar, Y. Surface Weather Parameters Forecasting Using Analog Ensemble Method over the Main Airports of Morocco. J Meteorol Res 36, 866–881 (2022). https://doi.org/10.1007/s13351-022-2019-0
[3] Fucile, E. et al., 2014: SAPP: a new scalable acquisistion and pre-processing system at ECMWF. ECMWF Newsletter No. 140 – Summer 2014, pp. 37–41. doi: 10.21957/3ylomoa6