ECMWF MS/CS "Green Book" Report 2024

Section 1: Background

*** 1.1 Country**
Türkiye

*** 1.2 Author(s)**

Alper GÜSER

*** 1.3 Organisation**
Turkish State Meteorological Service

* Section 2: Summary of major highlights

Section 3: Forecast Products

3.1. Direct use of ECMWF forecast products

* a) Medium Range (e.g. for high impact weather forecasting)

Performance of precipitation forecast for high impact weather is still lower than other parameters that are operationally used.

* b) Extended Range (monthly)

With introduction of cycle 48, extended range forecasts have been improved and differences (not confirming each other) seen in past consecutive forecasts have been reduced. Temperature and precipitation forecasts are generally more consistent with observations and among consecutive runs. Improvement achieved for temperature is more than precipitation.

* c) Long Range (seasonal)

Similar improvements have been achieved in seasonal forecasts. Additionally, in central Türkiye where convective precipitation occurs during autumn, spring and early summer, the model performance on large-scale precipitation is better than convective precipitation. Seasonal forecast still overestimates temperature. Less improvement seen in overestimation for temperature forecast comparing precipitation.

* d) CAMS and Fire-related output (ecCharts mainly)

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3.2. Cycle 48r1

*** a) <u>Positive</u> impacts of model cycle 48r1**

Higher resolution generally provides improvements for the forecasts issued by Turkish State Met Service.

*** b) <u>Negative</u> impacts of model cycle 48r1**

Low performance in occurrence time and location for extreme precipitation has been monitored in some cases.

c) Systematic changes in forecast output since model cycle 48r1 was implemented

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3.3: Derived Fields

3.4: Artificial Intelligence (AI) / Machine Learning (ML) techniques

In 2021, TSMS has applied Non-Homogeneous Gaussian Regression (NGR) to ENS 00 UTC daily maximum and minimum temperature forecasts up to 15 days. Logistic Regression variants have been tested on ENS total precipitation forecast up to 15 days starting from 4th quarter of 2023. ECMWF re-forecast data (total precipitation and its variance) and corresponding observations have been used to create training dataset. Operational ENS 00 run is used as test dataset. The method provided a clear improvement along 15 days forecast for brier scores. This will give a promising point of view for future automated weather products in medium range.

Figure 1. shows MAE scores of daily ECMWF ENS mean 2 Metre max and min temperature forecast (left and middle panel) against NGR variants that representing same algorithm with different training datasets. In that case, we are able to see performance of different training datasets against Raw ENS model forecast.

On the right panel, it is a comparison of 24 hourly ENS and NGR precipitation forecasts. Brier Scores were computed for total precipitation forecasts greater than 0 mm. In precipitation case, different logistic regression methods with same training dataset were applied. NGR outperforms ECMWF ENS forecast for all parameters and lead times as seen on Figure 1.

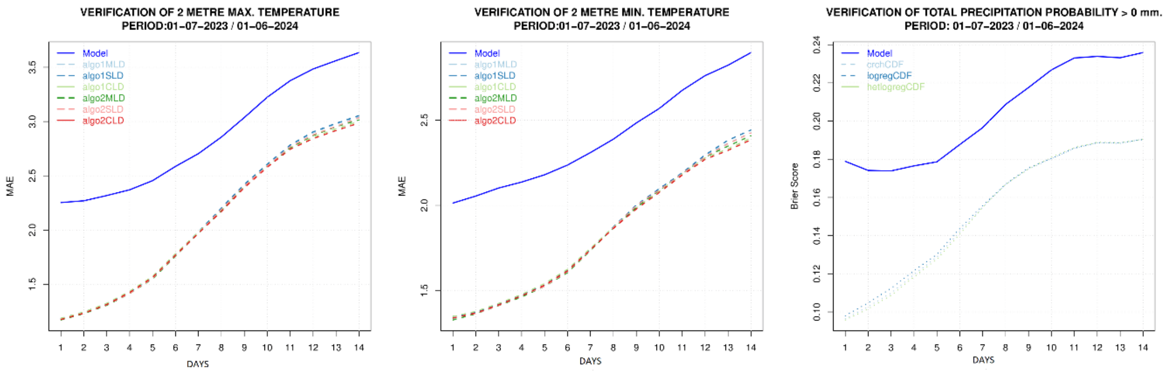

Figure 1. MAE of daily ECMWF ENS mean of 2 Metre max and min temperature forecast (left and middle panel) and Brier Score for 24 hourly total precipitation forecast greater than 0 mm (right panel).

3.5: Dynamical Adaptation

The ENS data is used as boundary and initial conditions for the LAM models namely, C-LAEF, A- LAEF. IFS data is used as boundary condition for AROME with 3d-Var (running in the pre-operational mode).

3.6: Data-driven (AI) models

*** a) ECMWF's real-time AI model initiative**

We are very pleased to see this initiative. Türkiye took part of ECMWF ML pilot project as Tier-2 participant.

*** b) Use of AI forecasts for operational purposes**

None

Section 4: Verification

4.1 Raw model output from ECMWF, and other operational models/ensembles

In sub-sections a and b below please describe your verification activities and show and discuss related scores, in the two lead-time categories. This should include, where possible, comparisons between ECMWF and your own models/ensembles, and other models/ensembles.
Ideally focus on surface weather parameters in your own territory. Inclusion of conditional verification results is also strongly encouraged - e.g. stratification by a weather type - as these can provide very useful insights into model weaker points.

a) Short Range and Medium Range

Basic verification scores are computed on a basis for ECMWF dissemination data and other selected operational models (WRF, ALARO). Model outputs are interpolated to station points then they are verified against corresponding observations. The parameters used for verification and their periods are as follows:

- Daily Maximum and Minimum Temperature: D+1, D+2, D+3;

Scores: ME, MAE, RMSE.

- Mean Sea Level Pressure and 2m. Temperature: from D+1 to D+3;

Scores: ME, MAE, RMSE.

- Total Precipitation occurrence(greater than 0 mm.): D+1, D+2, D+3;

Scores: BIAS, HIT, FAR, TS, POD.

- 1000, 850, 700, 500 and 300mb Geopotential Height and Temperature: from D+1 to D+6;

Scores: ME, MAE, RMSE.
Some objective verification scores from selected parameters and periods are given below:

2-Metre Temperature:

Figure 2. shows 2-metre temperature RMSE and BIAS values for ECMWF HRES, ALARO and WRF in winter and autumn. RMSE values of three models are close to each other and

some lower in autumn than winter. BIAS shows that there are positive values in night time and negative values in daytime.

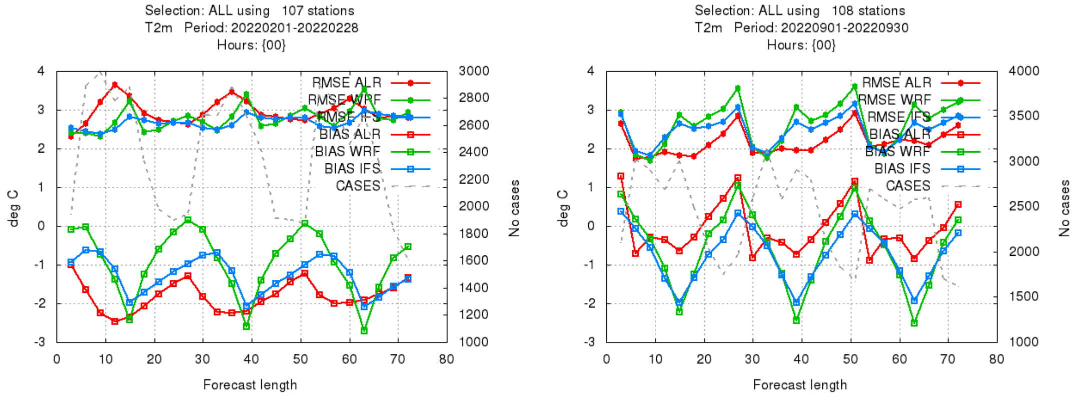

Figure 2. Verification of 2-Metre Temperature.

Mean Sea Level Pressure:
Period for MSLP of two samples were selected with respect to 2 Metre Temperature. In Figure 3 HRES shows best RMSE performance among others in both period while BIAS remains close each other.

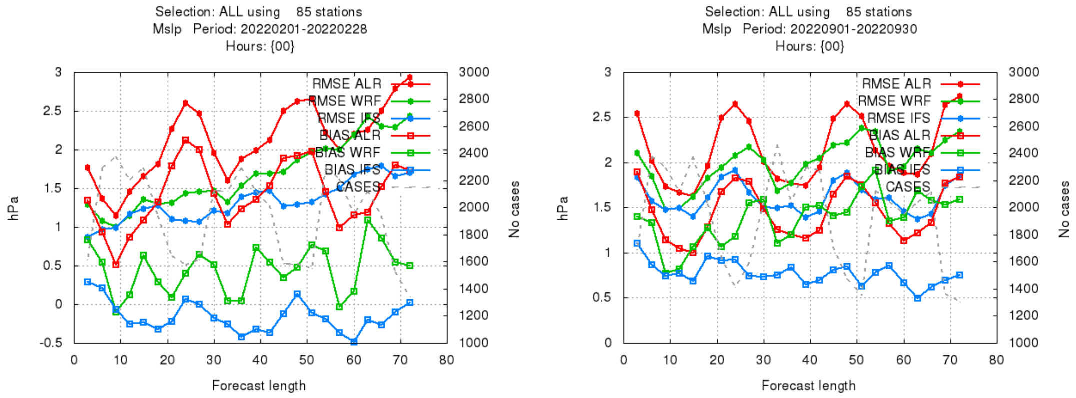

Figure 3. Verification of MSLP

Temperature at Pressure Levels:
Following figures show verification of temperature at pressure levels. Scores are calculated with respect to vertical profile. HRES's performance are clearly better than other models in winter and autumn where BIASs in both figures are close to each other.

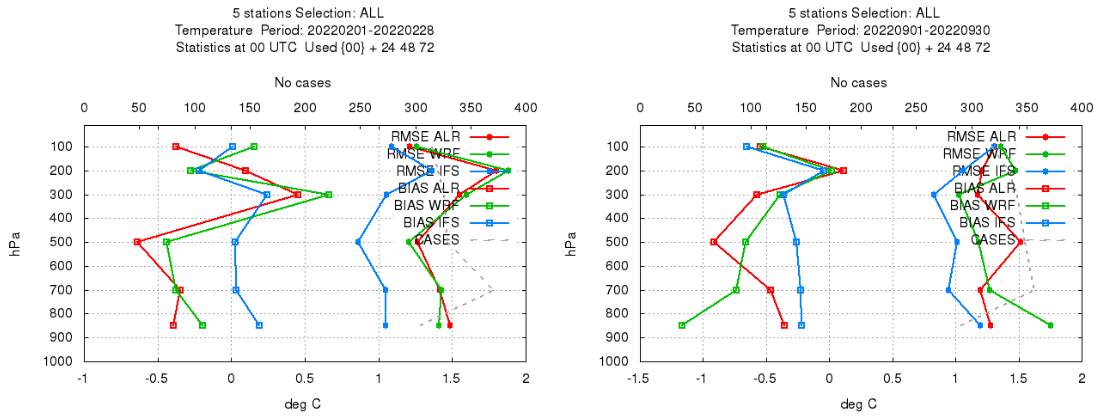

Figure 4. Verification of Temperature at Pressure Levels.

Geopotential Height at Pressure Levels:
Following figures show verification of temperature geopotential height at pressure levels. In all cases, scores are close to each other for all models.

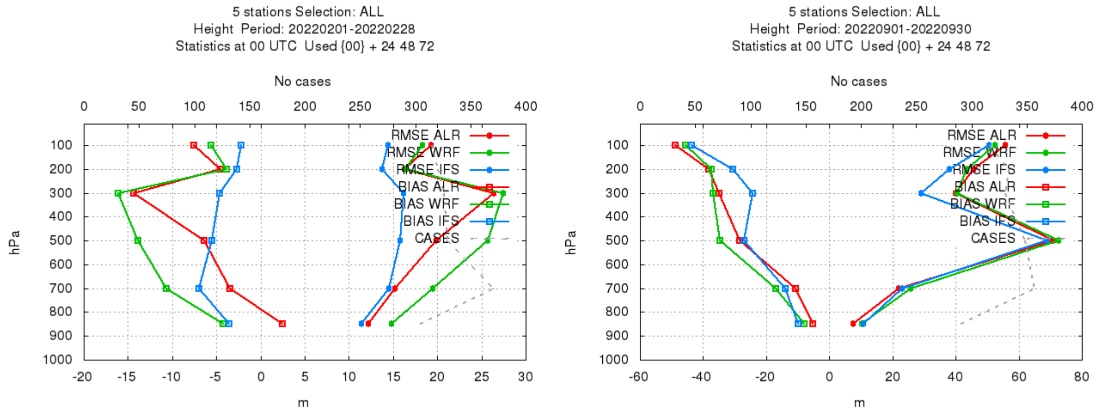

Figure 5. Verification of Geopotential Height at Pressure Levels.

b) Extended Range (Monthly) and Long Range (Seasonal)

4.2 Post-processed products and/or tailored products delivered to users

Kalman Filtering is applied to HRES's daily 2- meter maximum and minimum temperature forecasts from D+1 to D+5 for 960 stations including 42 foreign stations. Kalman Filtering scores have been considered % 5 - 25 better than direct model outputs.

4.3 Subjective verification

Our Weather Analysis and Forecasting Division (WAFD) uses ECMWF outputs for wide range of purposes from short-range forecasts to the special reports. We compared ECMWF forecasts and those of WAFD forecasts (based on bench forecasters' experience) with observed values. The verification results were based on the observed values received from 81 stations, which are indicated above in the figures, for temperature and for precipitation throughout Turkey and ECMWF's D+1, D+2, D+3 and D+4 corresponding forecasts. When "yes-no" type of verification applied for ECMWF precipitation forecasts, little improvements were noted. Most of the figures show a continuing upward trend over the past few years. Based on ECMWF's upward trend, with combining their experiences and ECMWF model outputs, WAFD made better precipitation forecasts than previous years.

4.4 Case Studies

Please describe and illustrate any case study verification you have undertaken. Examples of both good and bad model performance are welcome. Severe weather events (and non-events) are of particular interest to us. Add further sub-sections c, d etc manually if you have more case studies to highlight.

a) Case Study 1

b) Case Study 2

Section 5: Output Requests

Please describe, and illustrate if necessary, any particular requests you may have for new or modified ECMWF products. Add more sub-sections manually (c, d etc.) if you need them.

a) Product request 1: *add a title / short-form summary here in bold*

b) Product request 2: *add a title / short-form summary here in bold*

Section 6: References

Please list here any recent internal or external publications that relate to the questions in this survey, including the respective link(s). For any publication that cannot be readily downloaded via a link please email a copy of that publication to becky.hemingway@ecmwf.int and to tim.hewson@ecmwf.int.

Section 7: Additional comments and Feedback

Please provide here any additional comments on topics that have not been covered in any of the sections above.