Assimilation of 10m wind data in Aladin-HU

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1 Introduction

In the last years, there was given lot of effort to developing numerical weather prediction models. To get better initial conditions and, consecutive, better forecast, there was a lot of work around the assimilation of observations also into the LAM models. At this moment, more and more countries are running assimilation and 3dvar in Europe. And none of them is assimilating 10 m wind data from SYNOP.

Now, only the surface pressure Ps from SYNOP, wind U and V, temperature T, geopotential P and specific humidity Q from TEMP observations and radiance R from ATOVS (AMSU – A) data are assimilated into the Aladin model at Hungarian Meteo Service. One experiment with assimilation of 10m wind from synop observations over land in Arpege was done in Toulouse. There was used a blacklist file, which rejected observations with too high innovation RMSE.

We tried to repeat this experiment on the former ALADIN LACE domain (central and east Europe). The aim of the experiment was to improve weather forecast, specially forecast of wind, including 10m wind data to the assimilation and to determine which stations should be rejected from assimilation. Result should be the blacklist file for stations over ALADIN LACE domain.

2 Note

I would like to note, that our first idea was to use non-envelop orography. It was because non-envelop orography is closer to the real one, so the computation of innovation vector might be more accurate. But concerning the unexpected problems with non-envelop, we realized experiment with envelop orography.

3 Configuration

We ran experiments with al15 cycle on envelop orography. For assimilation and analysis of upper air atmosphere 3dvar analysis was used. The 3dvar analysis was univariate for specific humidity. We assimilated U10, V10 and Ps from SYNOP, U, V, T, P and Q from TEMP and R from ATOVS data.

4 Preparation

Because there was no previous assimilation cycle with assimilation of 10m wind data, we had to prepare all necessary stuff for this.

4.1 Assimilation of 10m wind and blacklisting

Assimilation of 10m wind data from SYNOP and TEMP observations is managed by the namelist switch **LSLRW10**. The default value of the switch was **LSLRW10=.TRUE.** and it provided rejecting of 10m wind data over land. It had to be set to **LSLRW10=.FALSE.,** if we wanted to use 10m wind data. It was located in **NAMOBS** section of **e002_tovs.nml** (screening) and **e131.nml** (3dvar) namelists.

As far as we wanted to investigate only the impact of 10m wind data from SYNOP observations and prepare blacklist for SYNOP stations, simultaneously, we had to switch off using the 10m wind data from TEMP observations. This was done in **NAMJO** section of **e131.nml** (3dvar) namelist by setting **NOTVAR(1,5)** to **-1** on 2.position.

The last thing was to prepare blacklisting file. Blacklisting was done by the file **PATOUCH** during the conversion of data from OBSOUL file to CMA files using **bator**. The blacklist file is one of kind – observation type number, observation type, variable number, station ID, date of blacklisting:

```
1 SYNOP    41 03111   20041112
1 SYNOP    41 06070   20041112
1 SYNOP    41 06680   20041112
…
```

4.2 Single observation experiment

To test correct work of LSLRW10 switch and blacklist file, we prepared single observation experiment. For this, we created OBSOUL file with only 1 observation of 10m wind.

At first, we tested LSLRW10 switch. We set it on LSLRW10=.FALSE. and after first assimilation step (converting data, screening, 3dvar, canari, first guess) we checked the appearance of 10m wind data in NODE files from screening and 3dvar.

Testing of blacklisting was similar – we add the only station, same as in OBSOUL file with 1 observation, into the blacklist file and after assimilation step we checked whether the observation from this station was used or not. We checked also the status of the station (if it is blacklisted, active or passive) in ODB.

When everything was running properly, we could start with the major work.

5 Experiments

After preparations, for the as best as possible investigation of 10m wind data impact, we decided to perform 3 experiments:

1. reference experiment - with no assimilation of 10m wind and with no blacklisting
2. wind experiment - with assimilation of 10m wind and without blacklisting
3. blacklisting experiment - with assimilation of 10m wind and with blacklisting

The reference experiment served as a background for comparisons of the two other experiments. Wind experiment showed us the impact of assimilation of 10m wind data. And also we needed to determine, which stations should be blacklisted in blacklisting experiment. This should be decided from the reference or wind experiment.

5.1 Reference experiment

First, as a background for further comparisons, we ran 3dvar assimilation cycle without 10m wind. We used period from 24.6.2004 to 23.7.2004 – 2 days for “cold start” and 28 days for RMSE statistics necessary for choosing of blacklisting criteria. We ran so big period for assimilation because there was no proper set of data that we could use.

From each assimilation step, we saved **ECMA ODB** database after screening, so we could have all important data about assimilated observations. From these database files, we made an ascii dump containing departures ***observation – first guess*** for each synop observation of 10m wind. For this, we used sql:

```
CREATE VIEW Mandalay AS
SELECT statid, varno, fg_depar, modoro, stalt, lat, lon
FROM hdr, body, update
WHERE ((obstype == 1) && ((varno == 41) || (varno == 42)) && ((obschar.codetype == 11) || (obschar.codetype == 14)) && !(status.blacklisted@body))
SORTBY statid
```

where **statid** is station ID, **varno** is number of variable (41 for **u** component of wind, 42 for **v** component), **obstype** is type of observation (1 for SYNOP), **obschar.codetype** is kind of observation (11 for manual SYNOP and 14 for automatic SYNOP stations), **fg_gepar** is departure ***observation – first guess***, **modoro** is model altitude of station, **stalt** is real altitude and **lat**, **lon** are coordinates of station. **Statid**, **modoro**, **stalt**, **lat**, **lon**, **obstype** and **obschar** are stored in **hdr** table of ODB, **varno** in **body** table and **fg_depar** in **update** table.

From this ascii dump we could calculate RMSE of wind departures and compare it with model orography and station altitude. As we can see from Fig.1, there is no significant relation between RMSE and model orography. For station altitude we can see slight dependence – higher stations have little bit worse RMSE, but it was not enough for our purpose. After that, we made another comparison, and it was RMSE related to the difference ***modoro – stalt***. On Fig.1 we can see, that there is quite big relation. Those stations, for which the difference ***modoro – stalt*** is negative, respectively less than –100m, they have much worse RMSE than the other. Even if this fact was still not very applicable for us, it can be interesting for some other experimenters.

For better and more objective investigation, we also fitted all graphs with polynomial function of degree 5 and 3 (Fig.2).

5.2 Experiment with assimilation of 10m wind

After this, we proceeded experiment with assimilation of 10m wind. Procedure of this experiment was the same as at the reference experiment, only we had to set **LSLRW10** and **NOTVAR(1,5)** switches in namelists as we mentioned above (see chapter 4.1).

We again related RMSE with model orography, station altitude and ***modoro – stalt*** and we have got following results (Fig.3 – Fig.4).

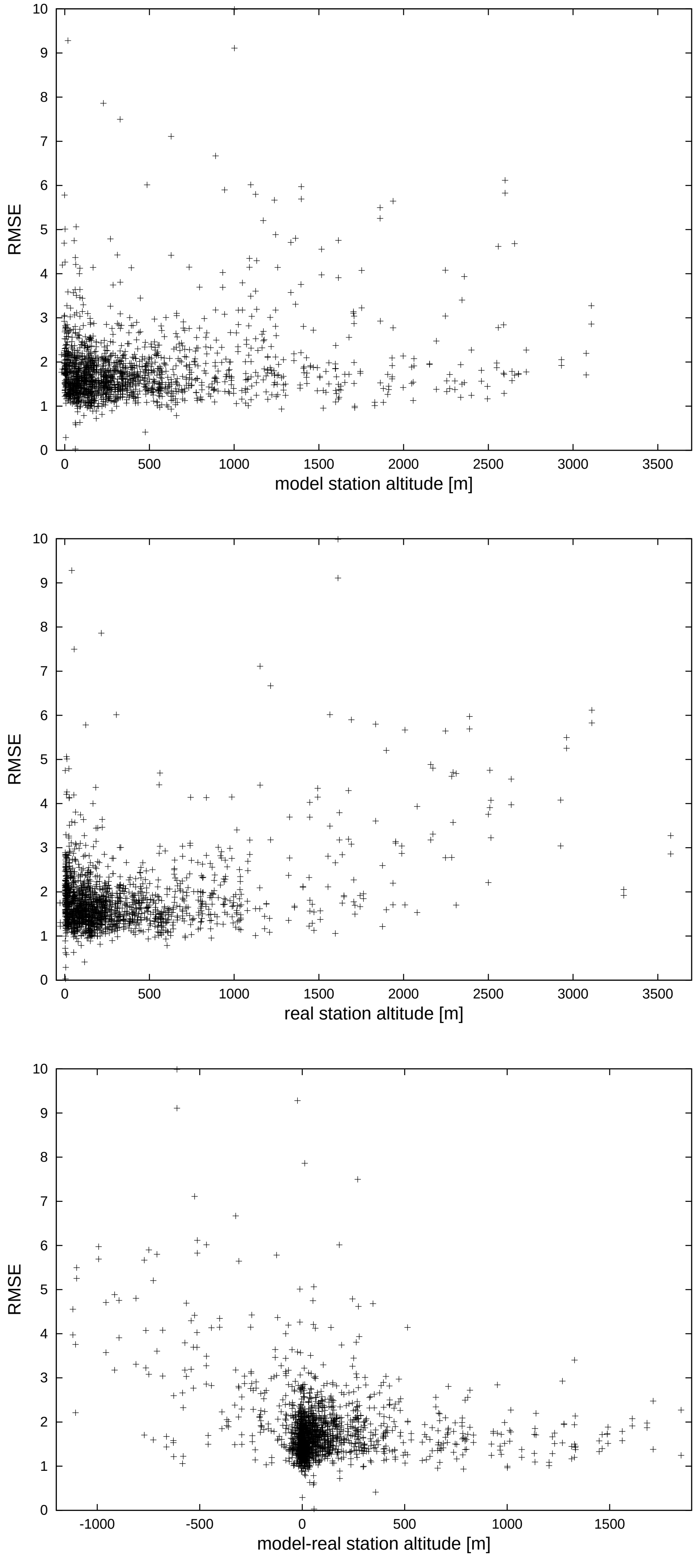

Figure 1: Relation between 10m wind RMSE and model orography, station altitude and **modoro – stalt** in reference experiment.

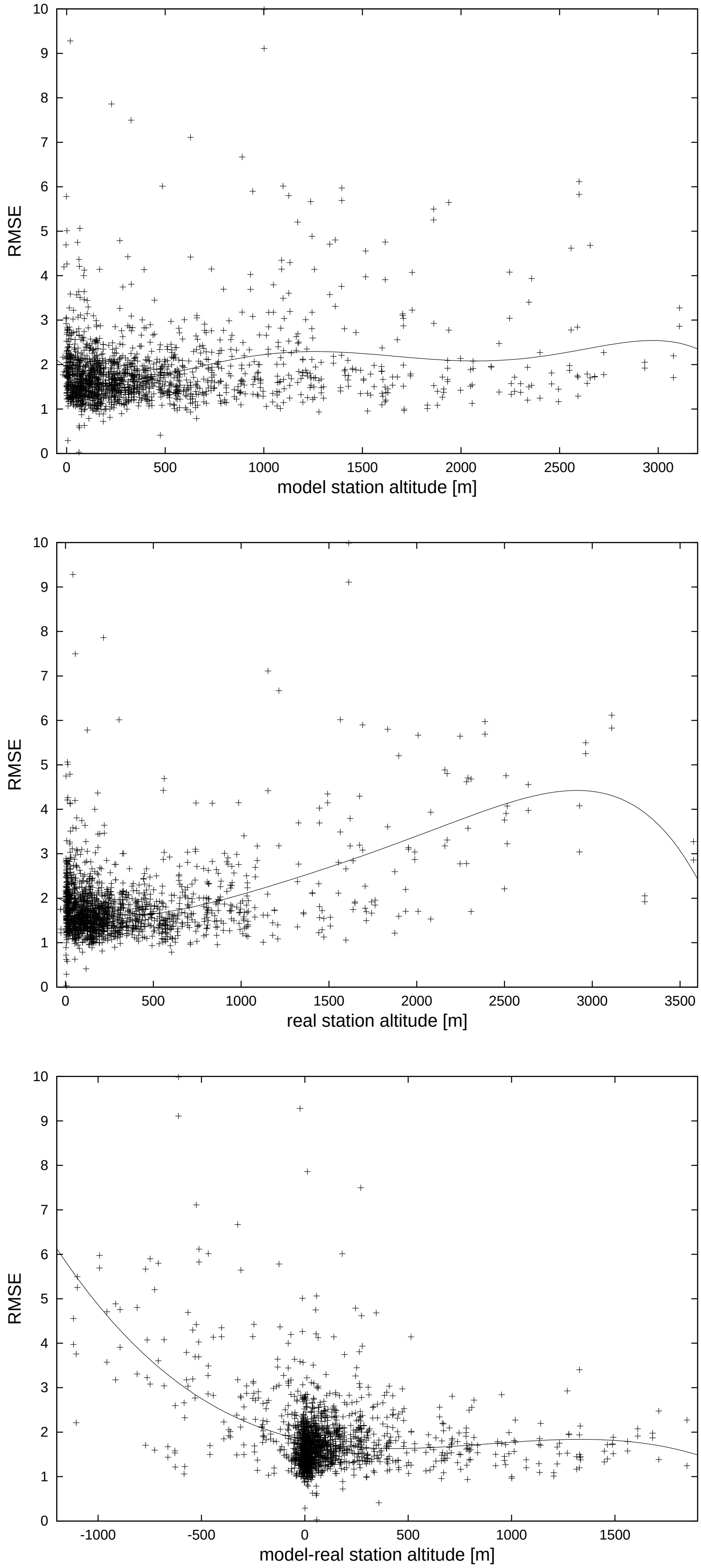

Figure 2: Relation between 10m wind RMSE and model orography, station altitude and **modoro – stalt** fitted by polynomial function of degree 5 and 3 in reference experiment.

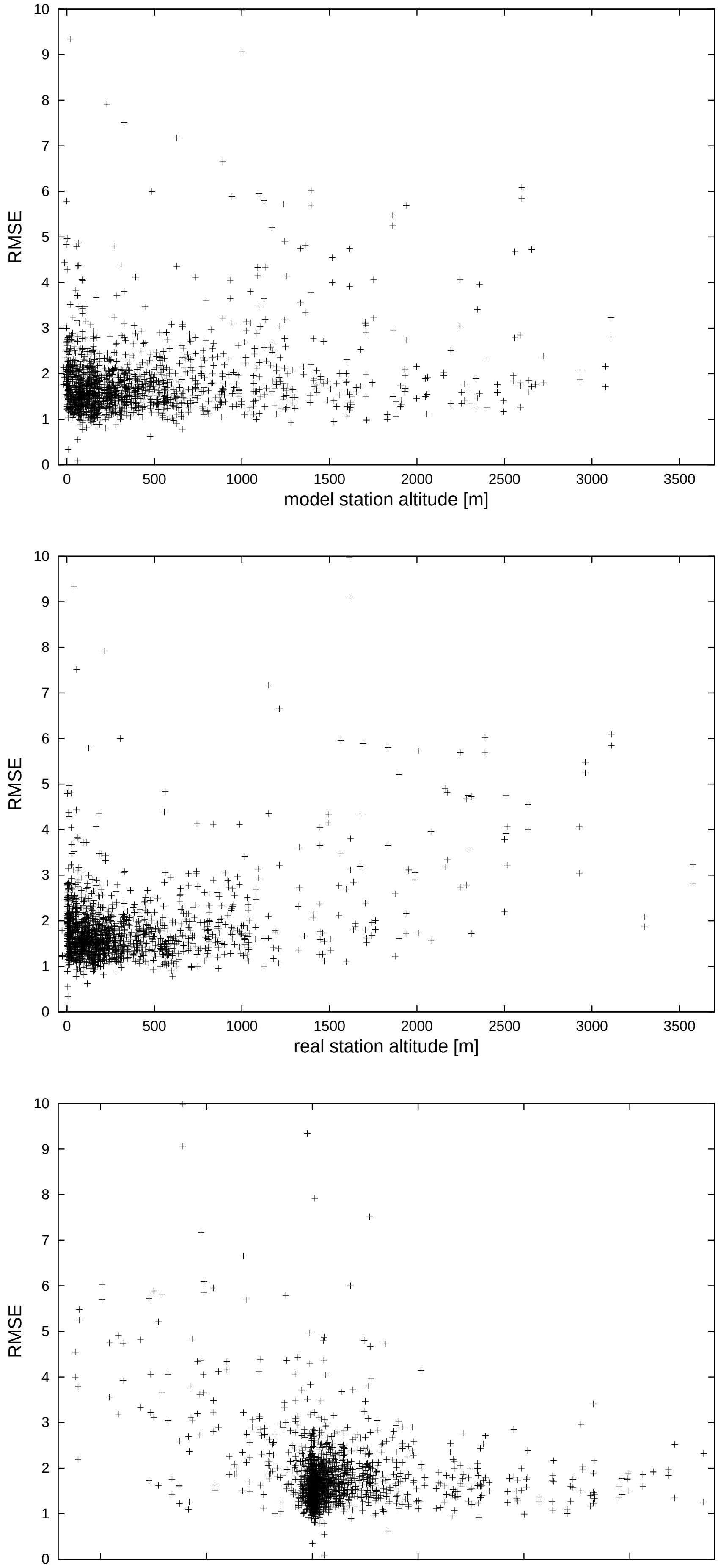

Figure 3: Relation between 10m wind RMSE and model orography, station altitude and **modoro – stalt** in wind experiment.

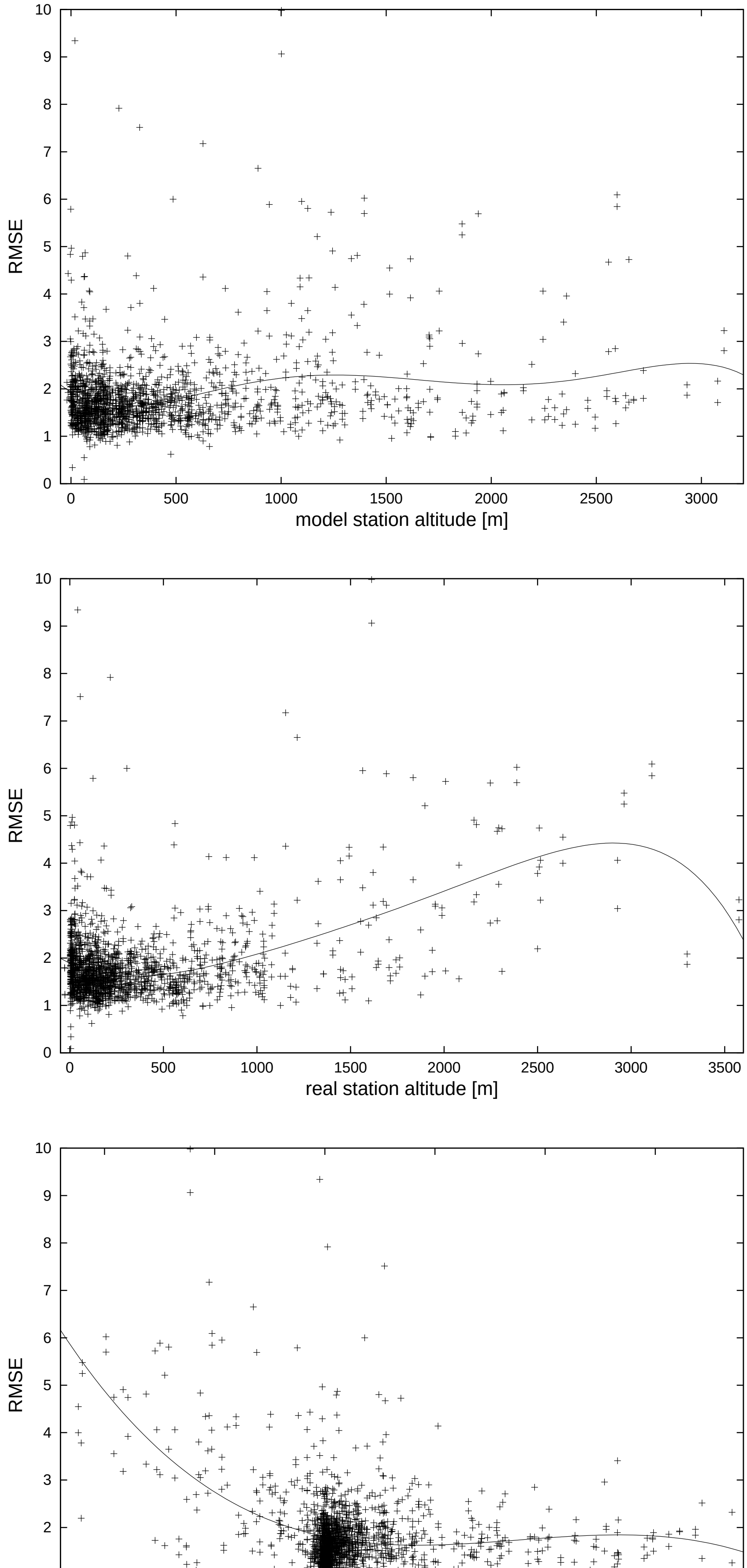

Figure 4: Relation between 10m wind RMSE and model orography, station altitude and **modoro – stalt** fitted by polynomial function of degree 5 and 3 in wind experiment.

Even if the RMSE was almost invisibly better than in the reference experiment, the situation was the same in practical way. We decided to choose criteria for blacklisting from this set of data. And because there was no significant dependence of RMSE, we decided to blacklist all stations, for which RMSE of wind (u or v component) was bigger than 2,5. From 847 stations used in our experiment it was 139 stations, what was 16,4 %.

5.3 Experiment with assimilation of 10m wind and blacklisting

Proceeding of this experiment was exactly the same as the wind experiment, except we added to the blacklist **PATOUCH** all above-mentioned stations.

5.4 Verification

For all experiments we computed 48 hour forecasts started at 00 UTC. We used 14 days period from 26.6.2004 to 9.7.2004. For verification we used Veral. We compared both wind and blacklisting experiments with the reference experiment – we produced scores for individual ranges and individual runs for the whole 14 days period. In Figures 5-26 you can see most important part of the results from this comparison.

6 Results

When we compared wind experiment with reference experiment, we have got mostly neutral impact of 10m wind assimilation. The differences were in the analysis and first guess of 10m wind at surface, where the RMSE was little bit better and BIAS little bit worse than in the reference experiment. Interesting differences were in scores for mean sea level pressure and geopotential. For mean sea level pressure, there could be seen for both BIAS and RMSE little bit negative impact for analysis and first guess and for BIAS also little bit for 12h hour forecast. For geopotential, there could be seen for BIAS little bit negative impact for all pressure levels for analysis and for 850hPa also for first guess. Also some slightly negative impact was in BIAS for analysis of temperature at surface. For the rest the results were rather neutral.

When we compared blacklisting experiment with two others, we found out, that the scores for blacklisting experiment were somewhere between wind and reference experiment, but more close to the wind experiment. So the blacklisting didn’t improve our forecasts much more than 10m wind assimilation without blacklisting.

7 Closure

As it was mentioned above, the impact of assimilation of 10m wind was in general not very significant. Mostly it was neutral, only in some cases it was little bit positive or little bit negative.

For the future experiments, we can recommend to try non-envelop orography, as it can have positive impact because it is closer to the real orography. Also it would be good to use newer cycle of Aladin code.

Maybe also the strategy of blacklisting should be considered to change. Not to take all 10m wind observations and after that blacklist part of them, but to choose, respectively to determine very specific, which 10m wind data should be assimilated. So that the difference will be in the amount of assimilated 10m wind data observations.

It will be also useful to compare, which data are rejected by blacklisting and which by screening, because it can be possible that the most of blacklisted data are rejected by screening anyway.

Anyway, even if our experiment didn't show some big impact of assimilation of 10m wind data on forecasts, it will be useful to deal with this topic also in future.

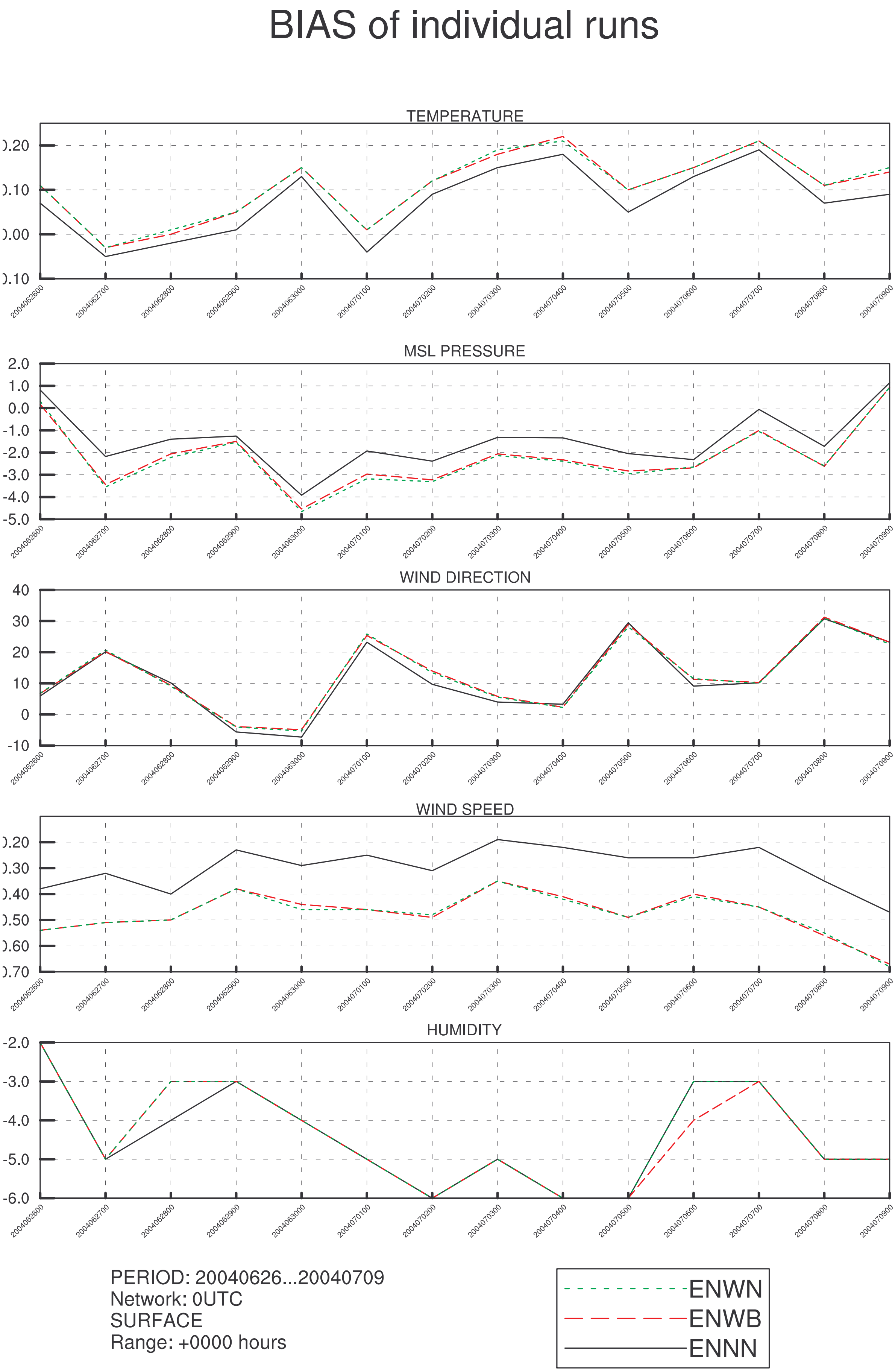

Figure 5: BIAS of analysis for surface level.

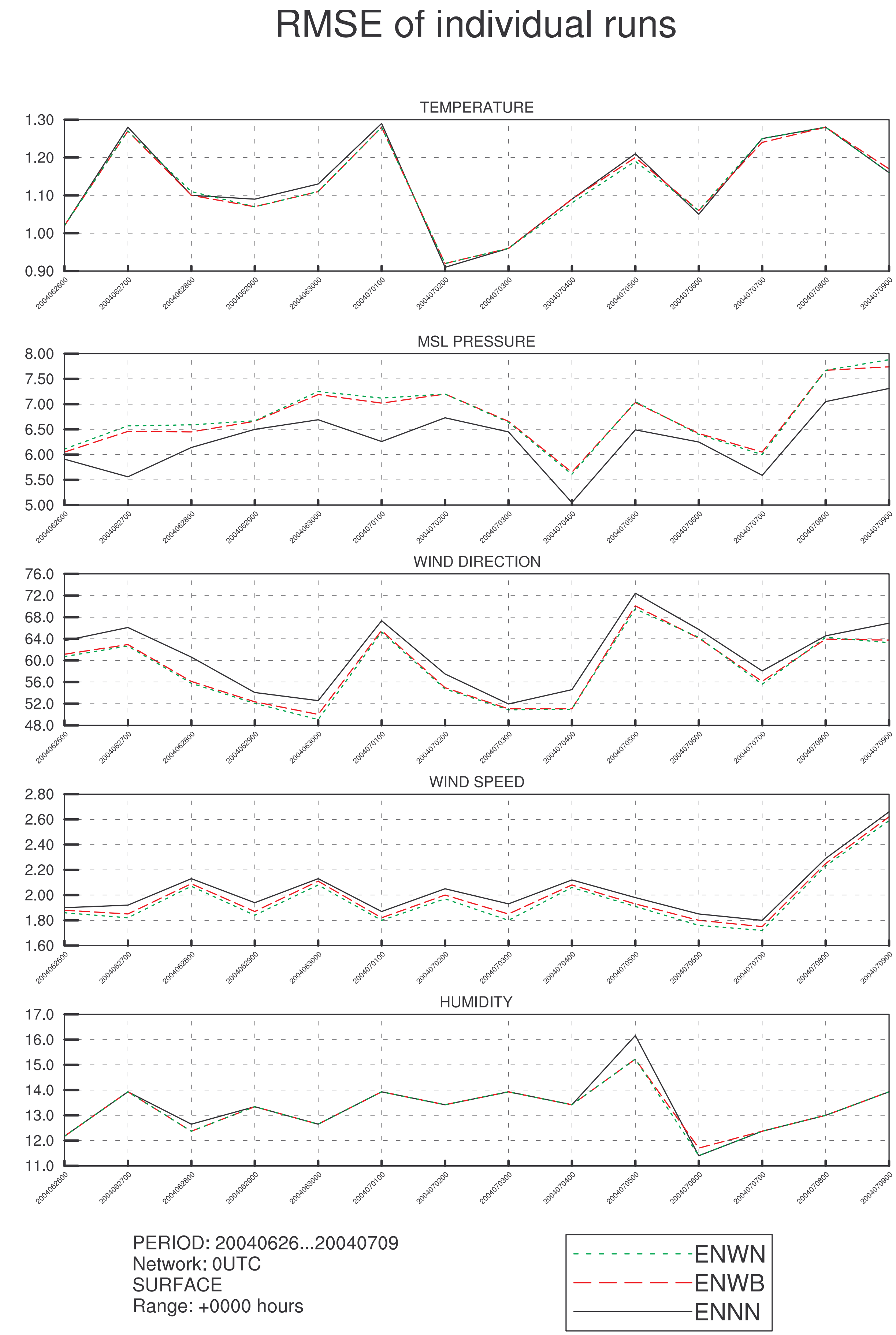

Figure 6: RMSE of analysis for surface level.

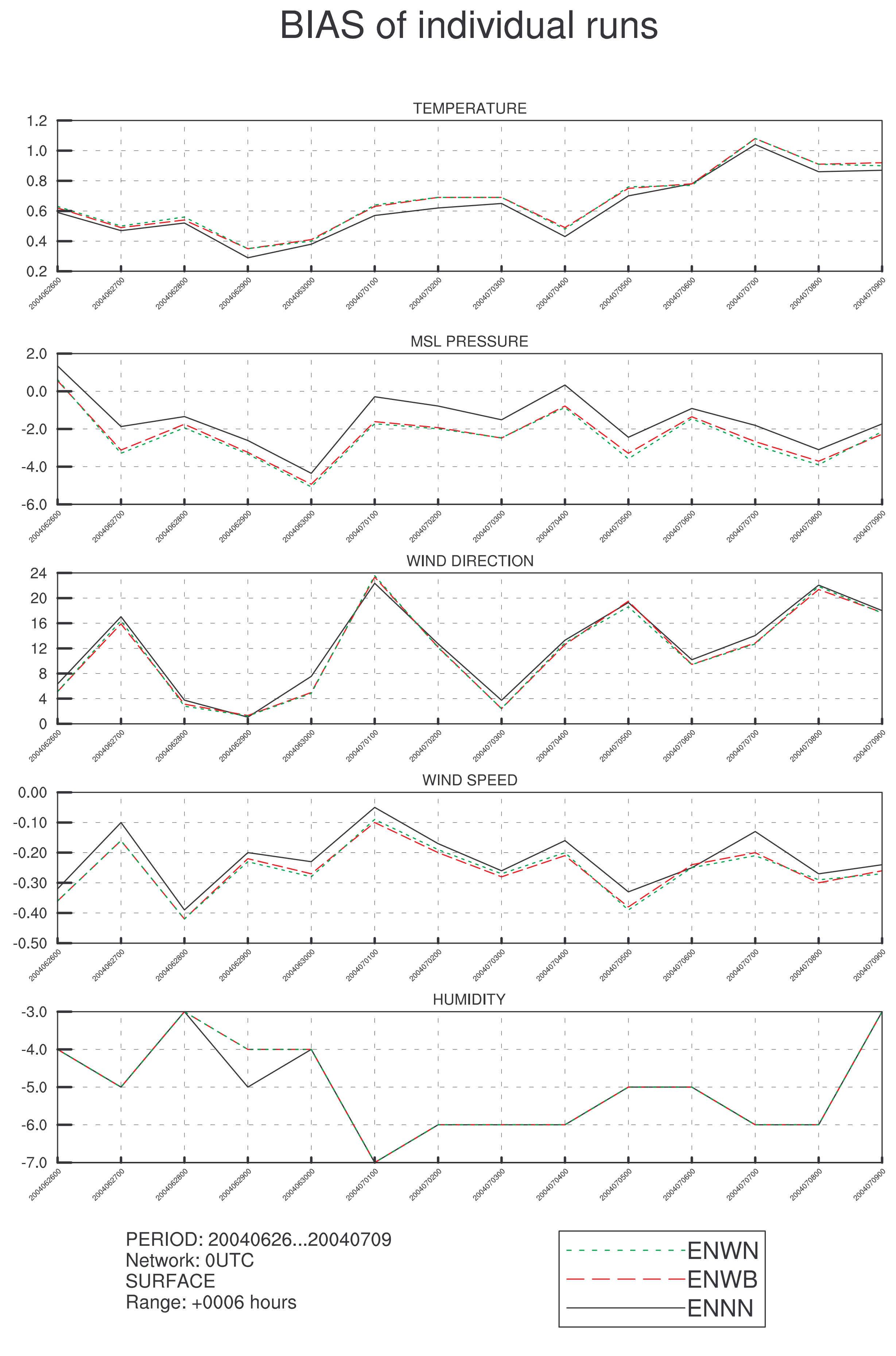

Figure 7: BIAS of 06 hour forecast for surface level.

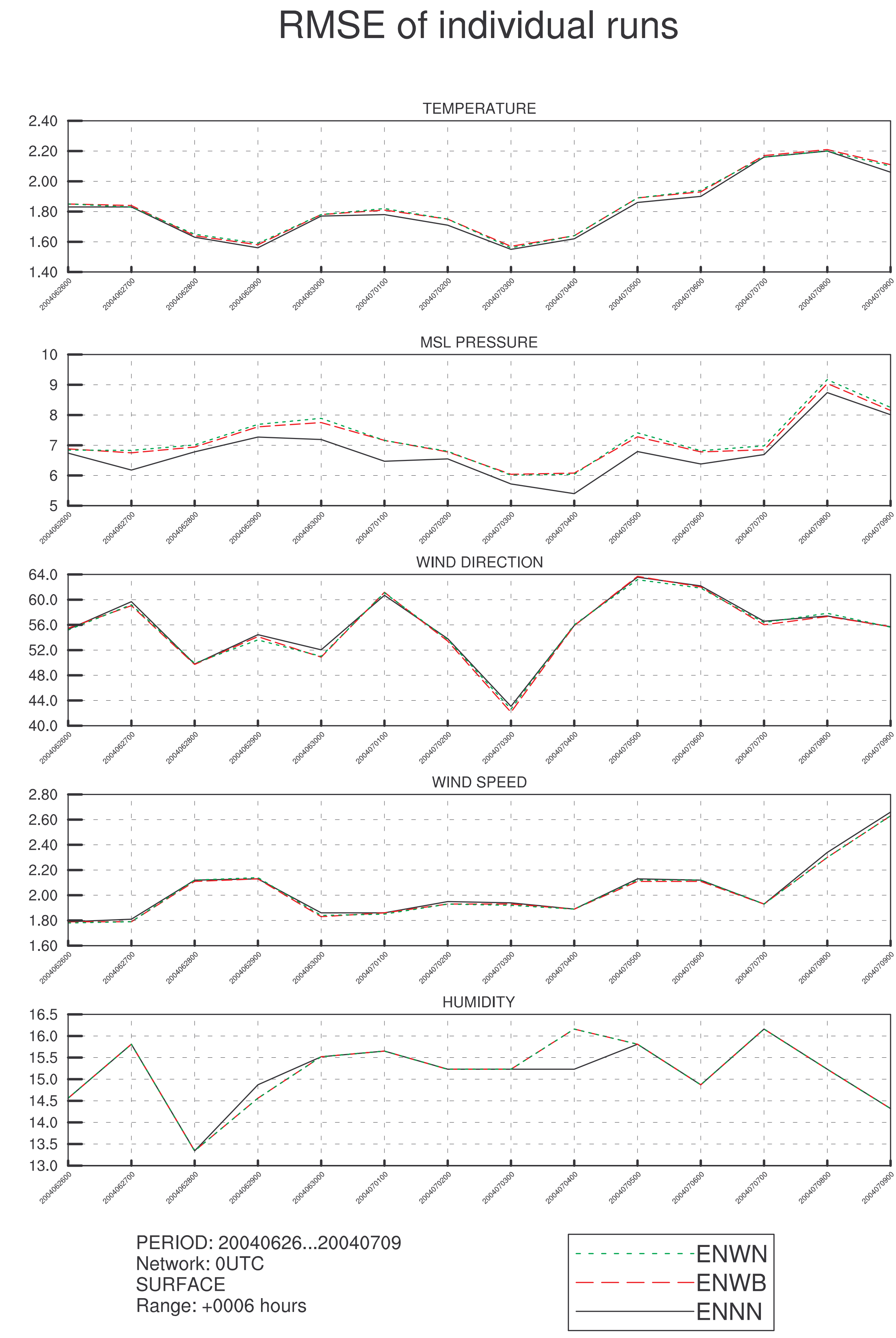

Figure 8: RMSE of 06 hour forecast for surface level.

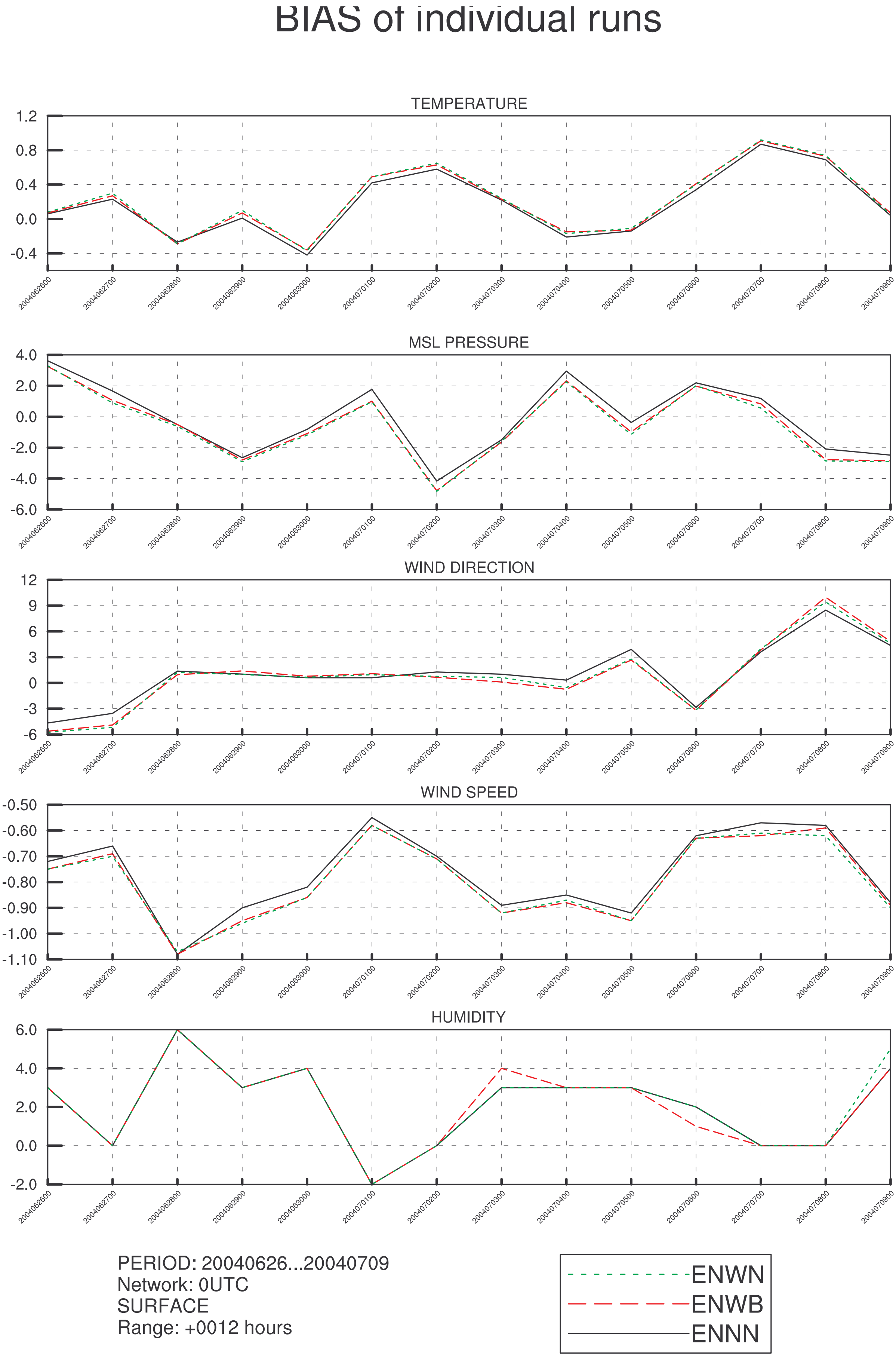

Figure 9: BIAS of 12 hour forecast for surface level.

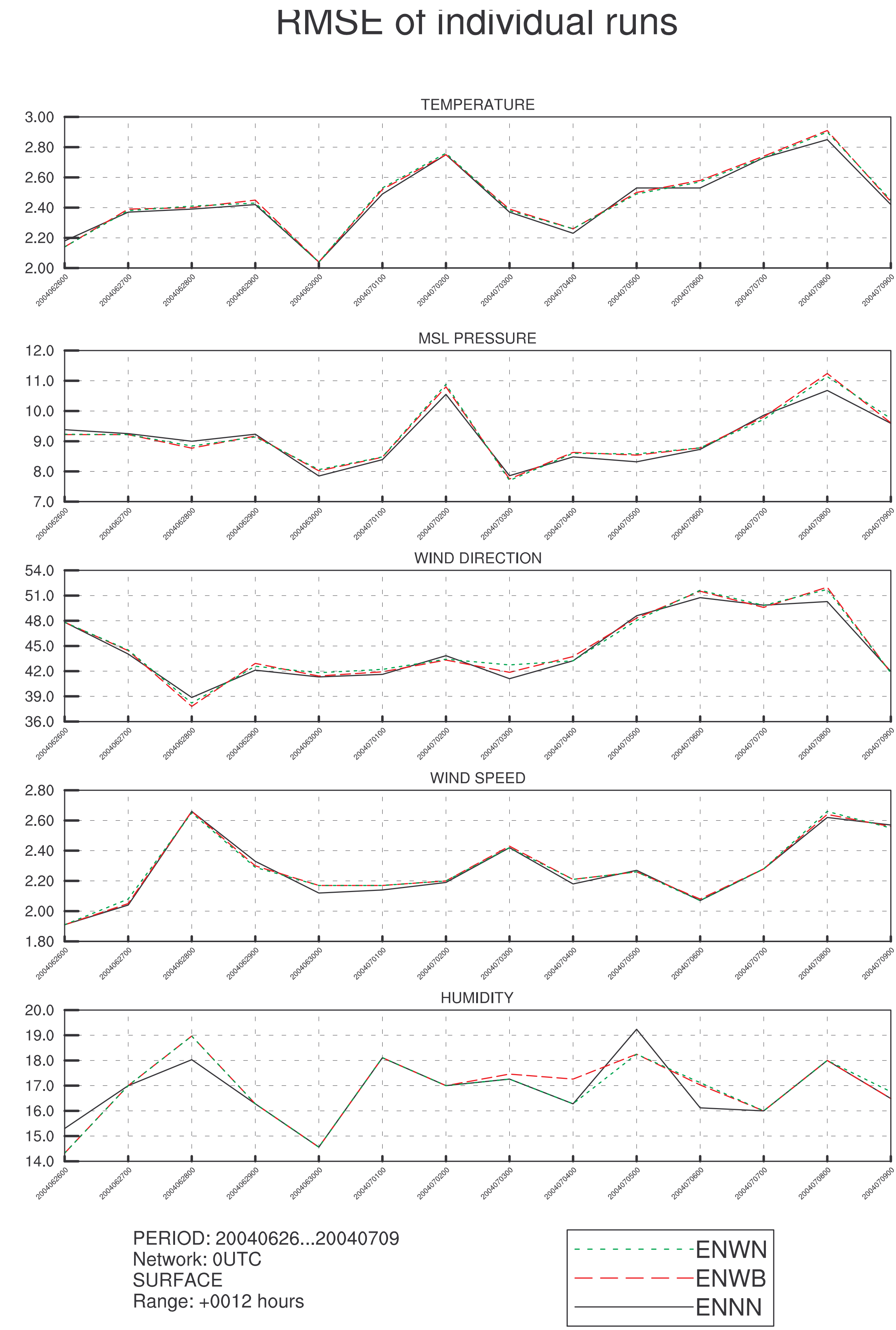

Figure 10: RMSE of 12 hour forecast for surface level.

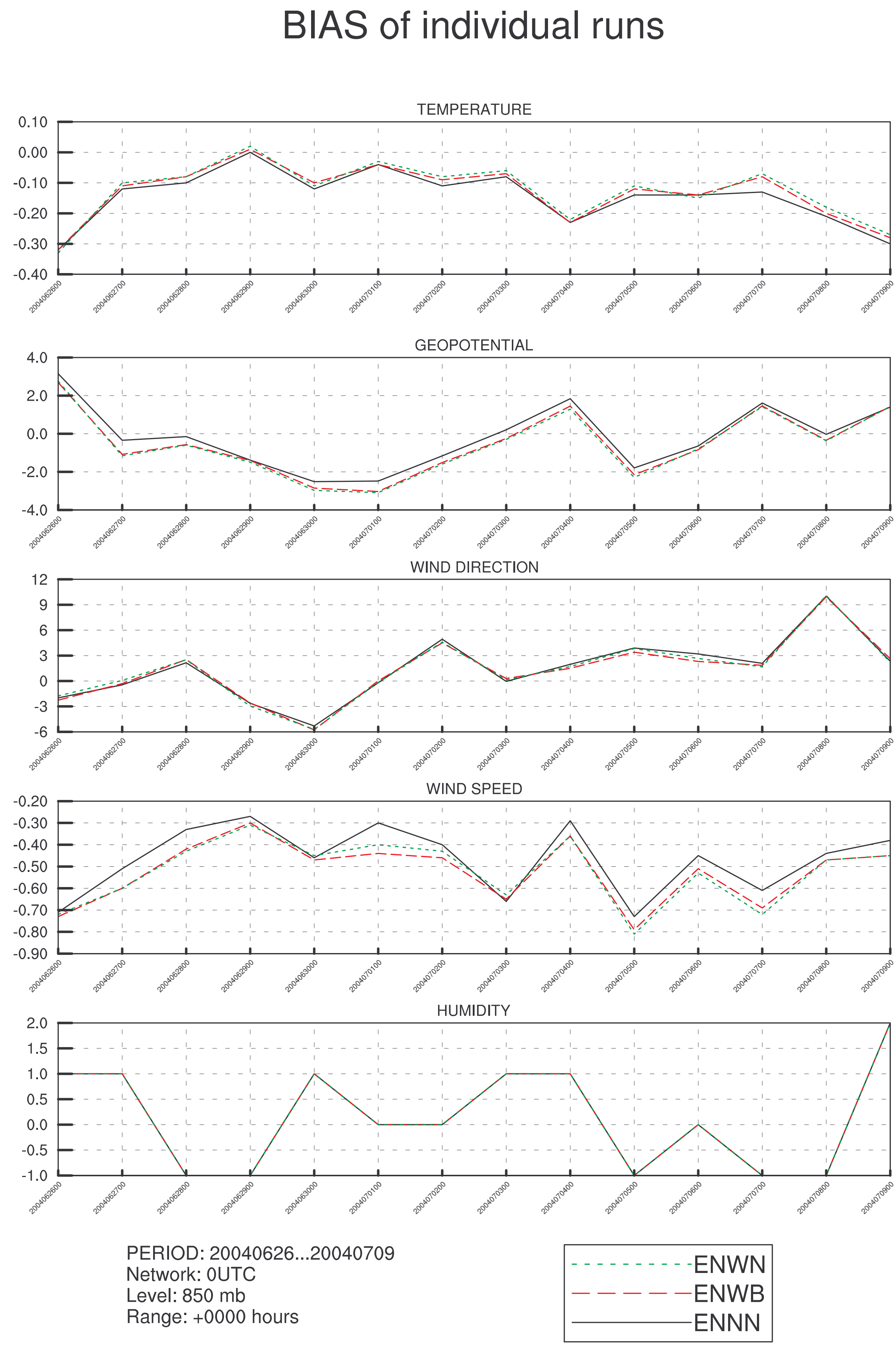

Figure 11: BIAS of analysis for 850hPa level.

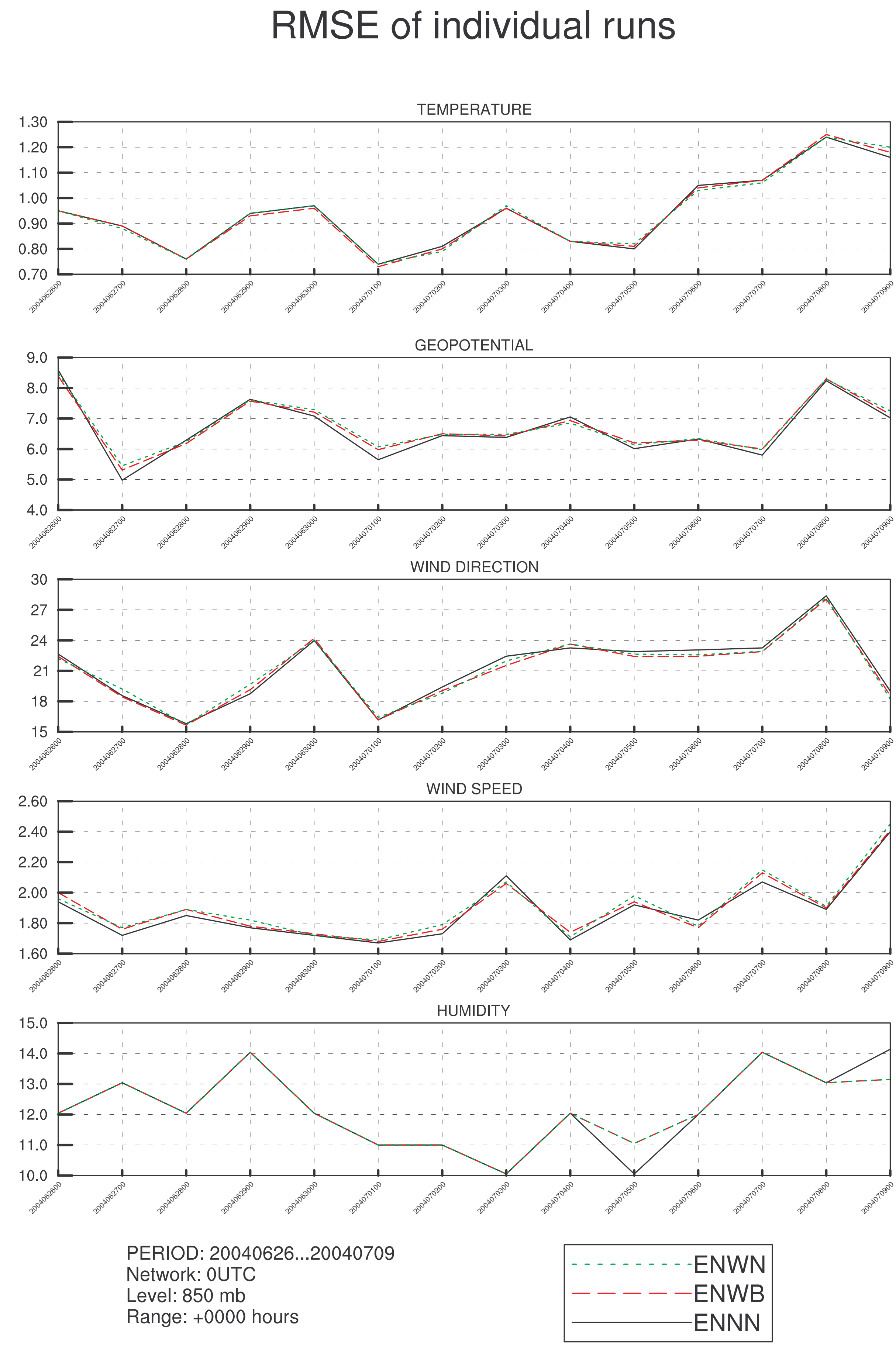

Figure 12: RMSE of analysis for 850hPa level.

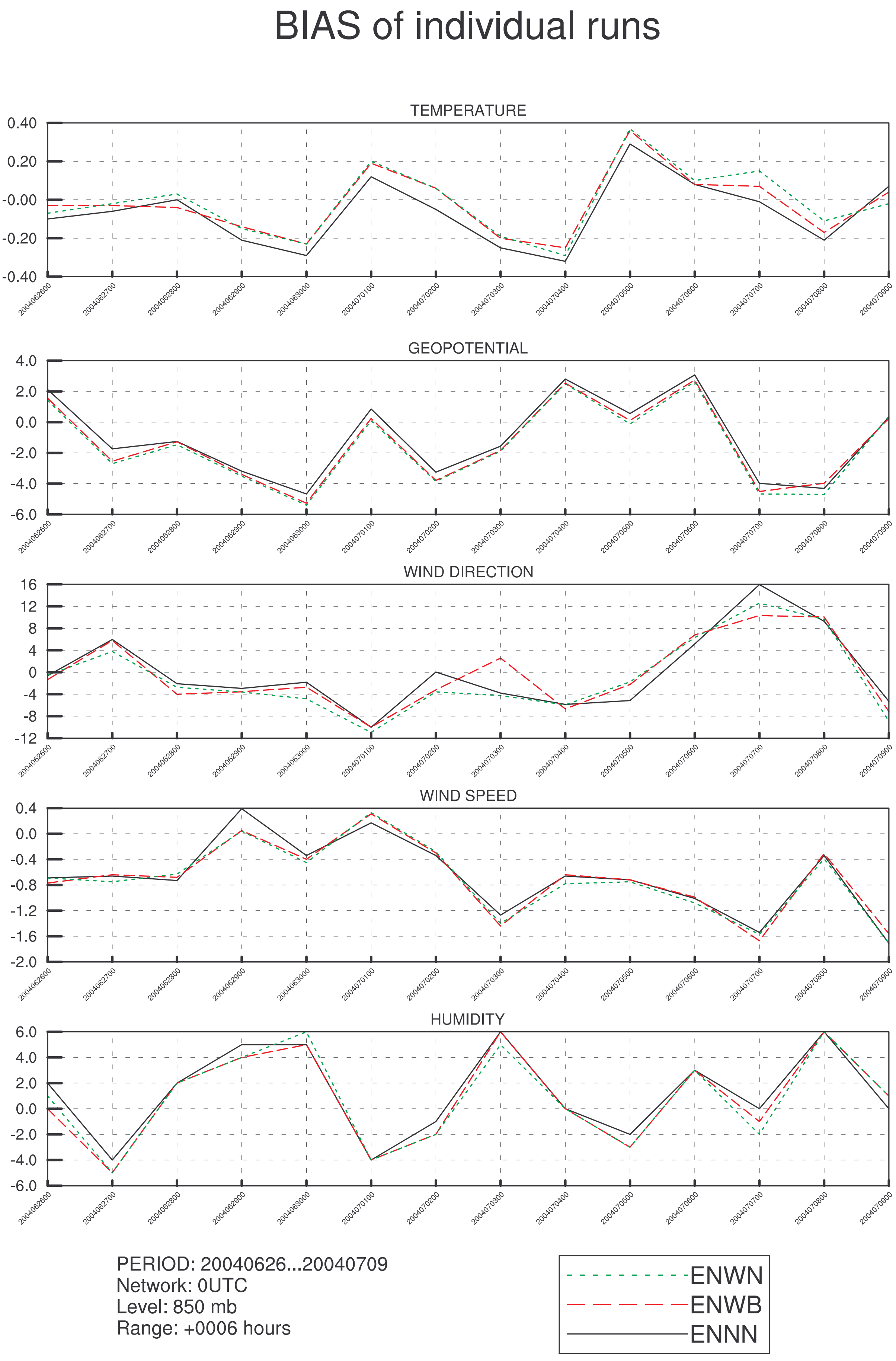

Figure 13: BIAS of 06 hour forecast for 850hPa level.

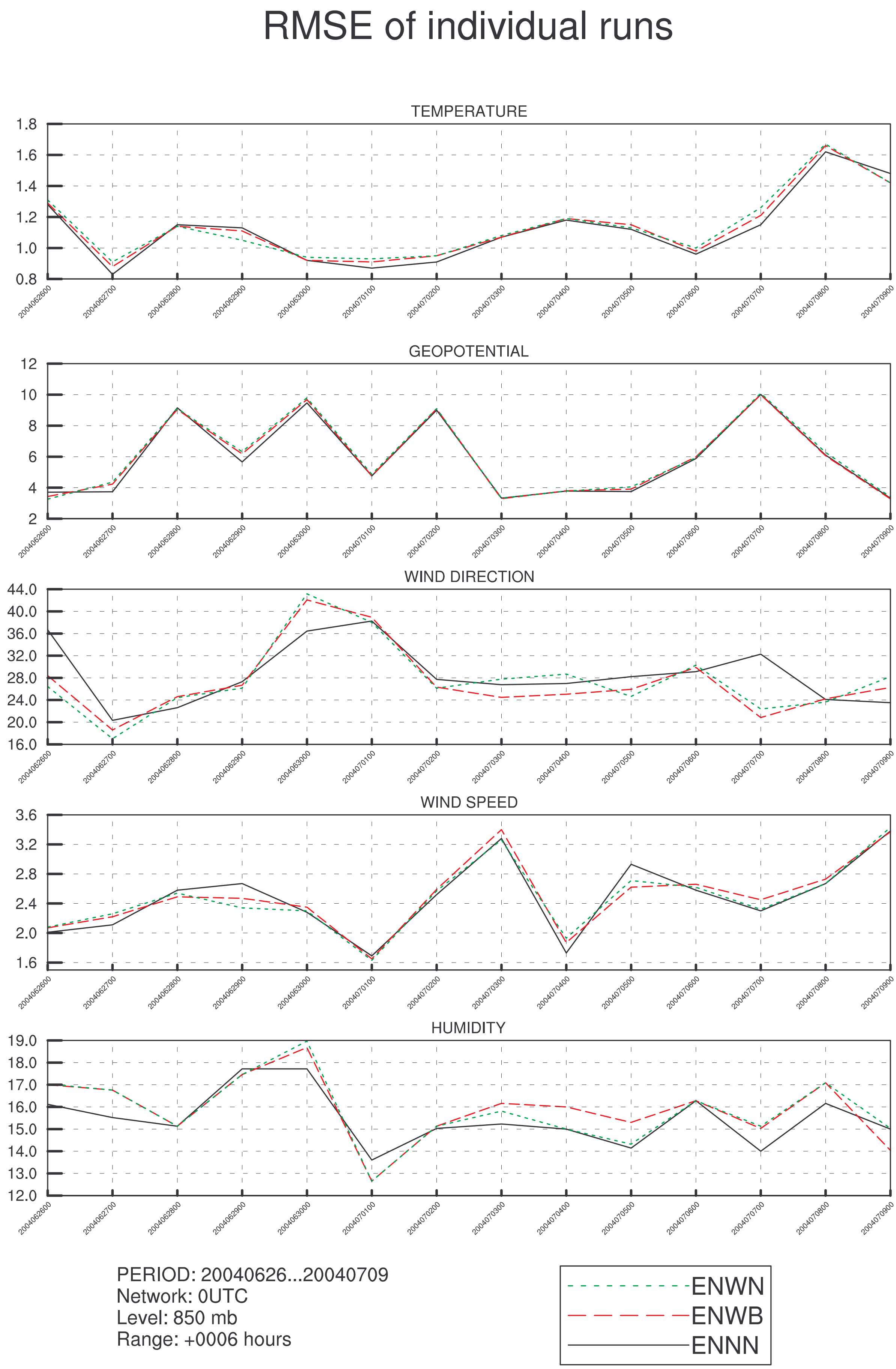

Figure 14: RMSE of 06 hour forecast for 850hPa level.

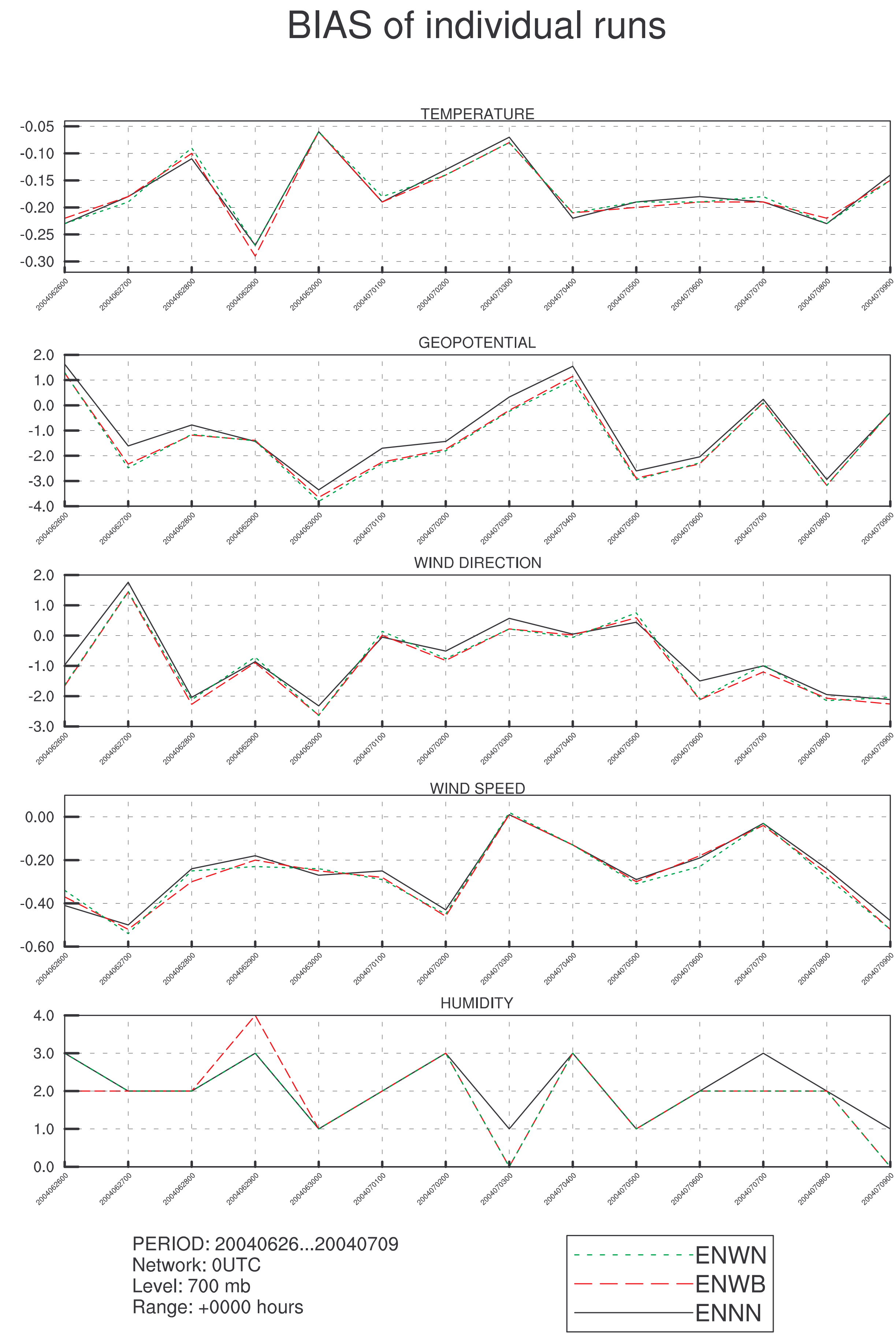

Figure 15: BIAS of analysis for 700hPa level.

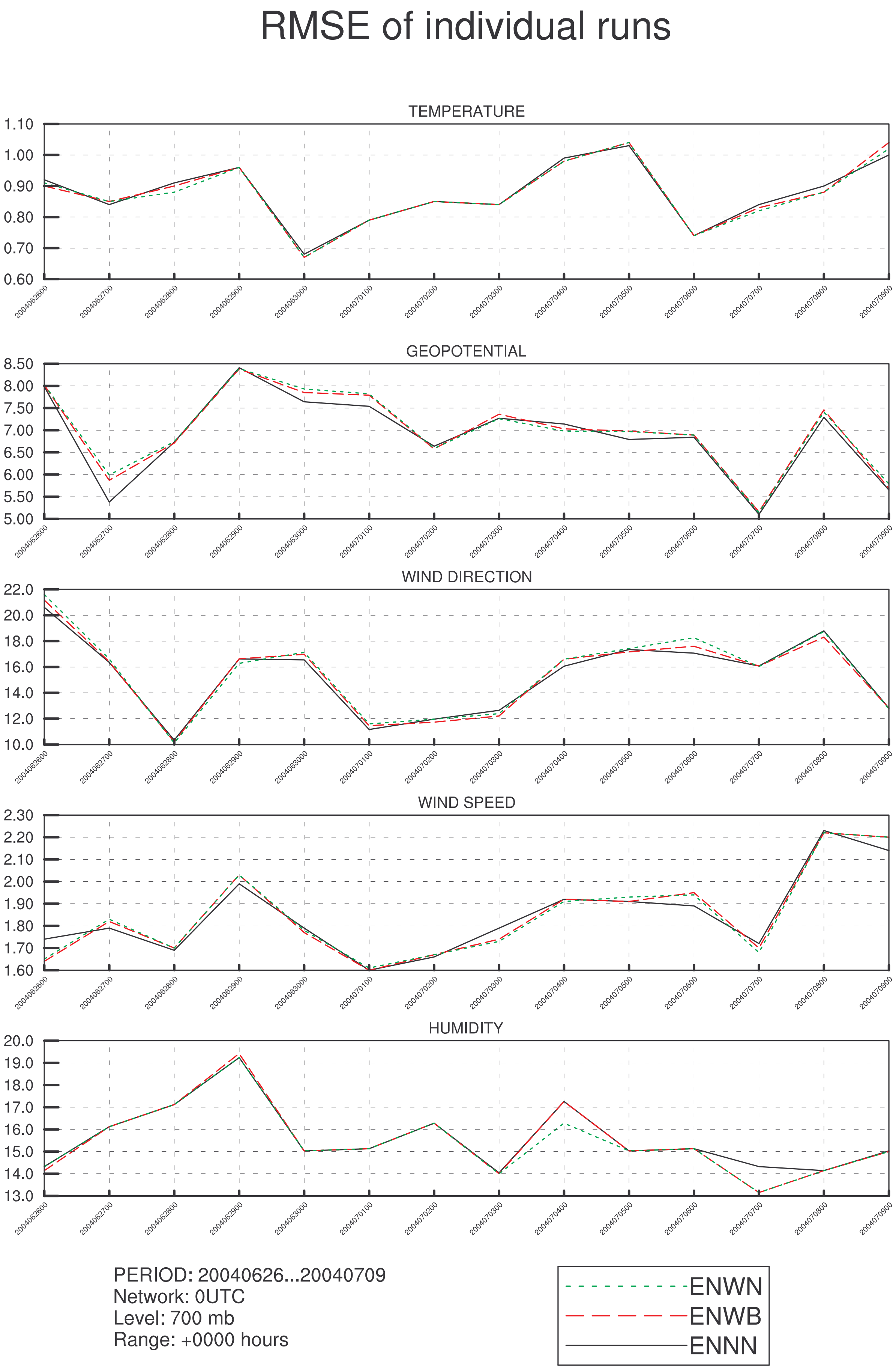

Figure 16: RMSE of analysis for 700hPa level.

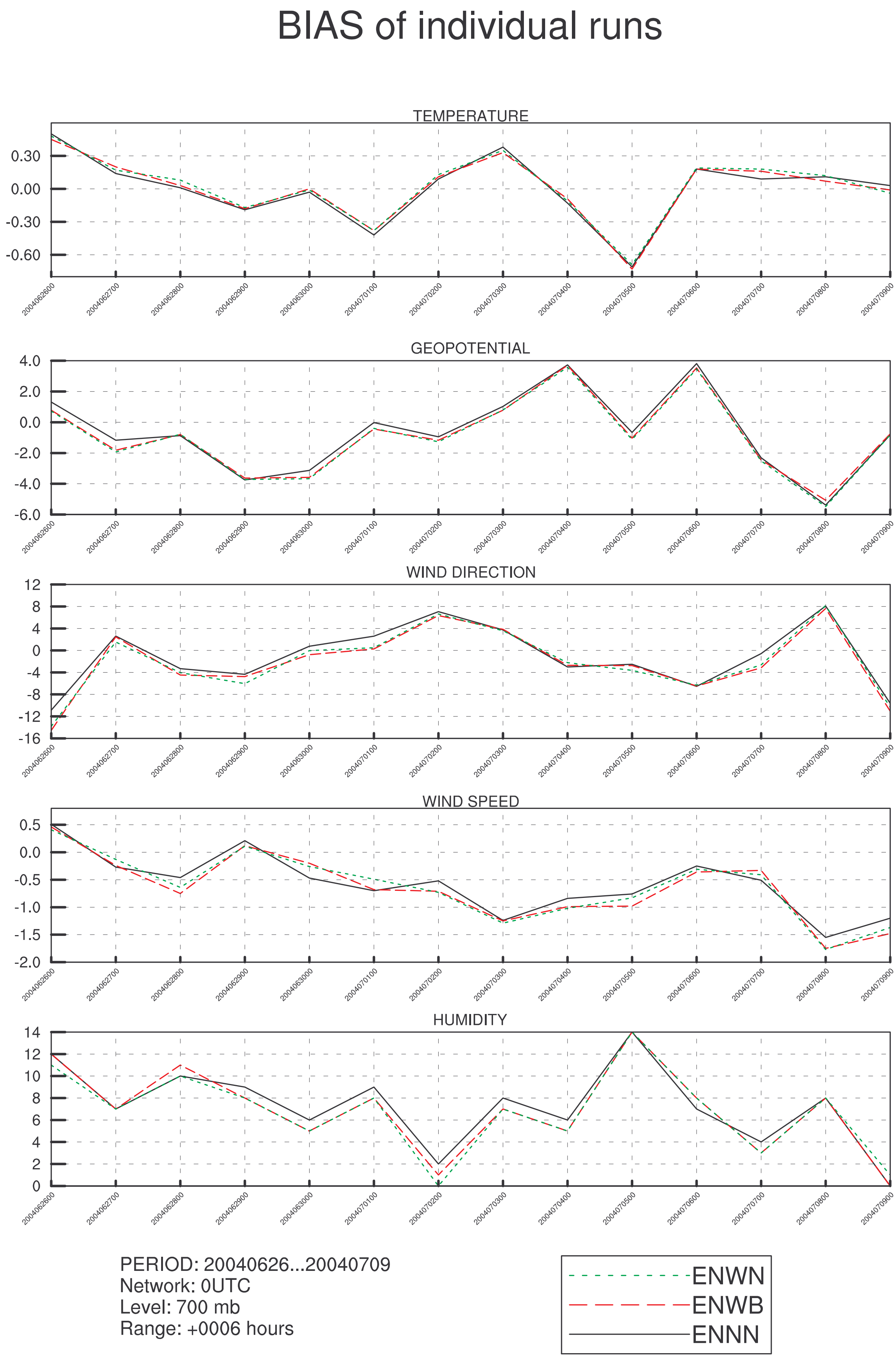

Figure 17: BIAS of 06 hour forecast for 700hPa level.

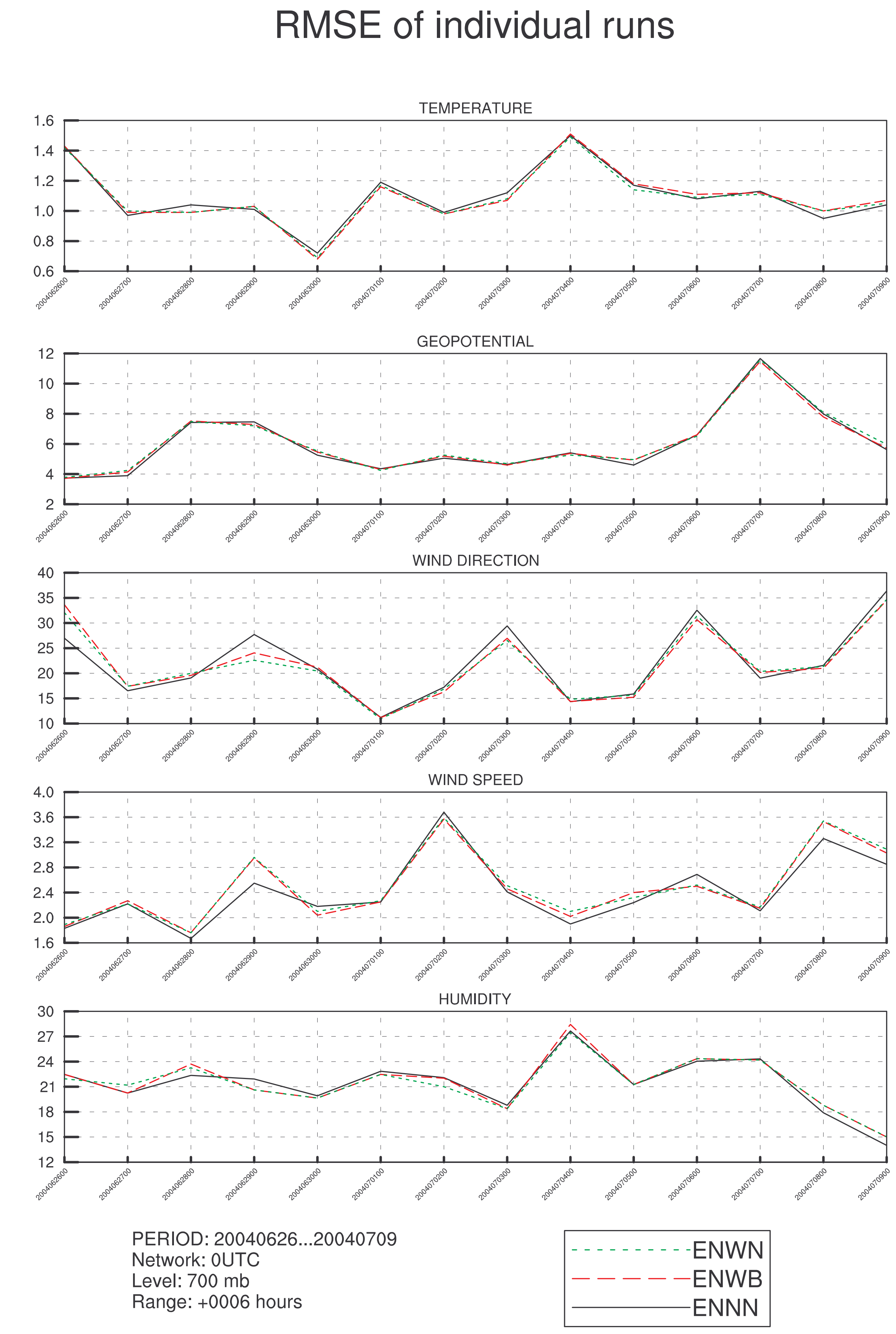

Figure 18: RMSE of 06 hour forecast for 700hPa level.

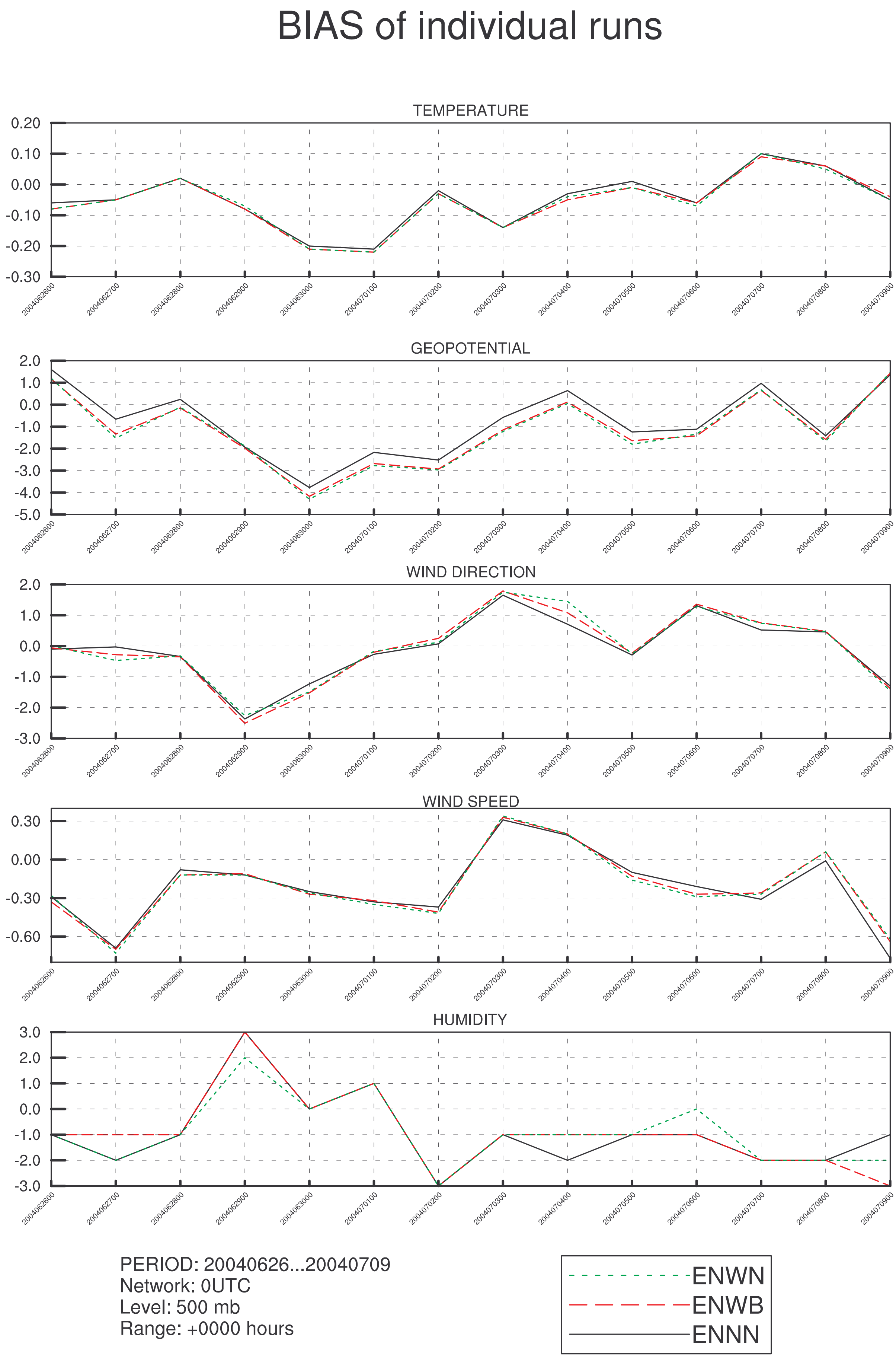

Figure 19: BIAS of analysis for 500hPa level.

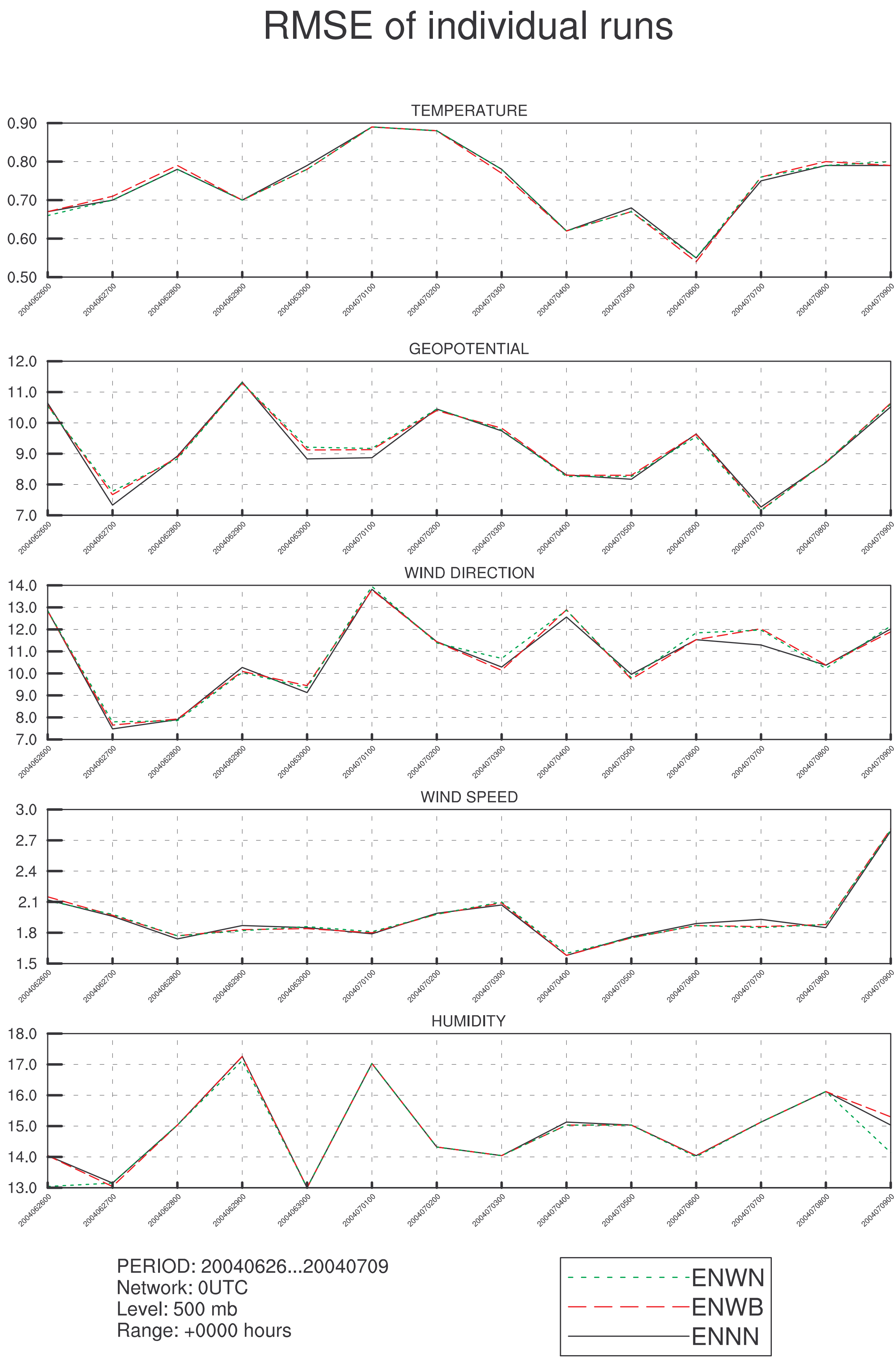

Figure 20: RMSE of analysis for 500hPa level.

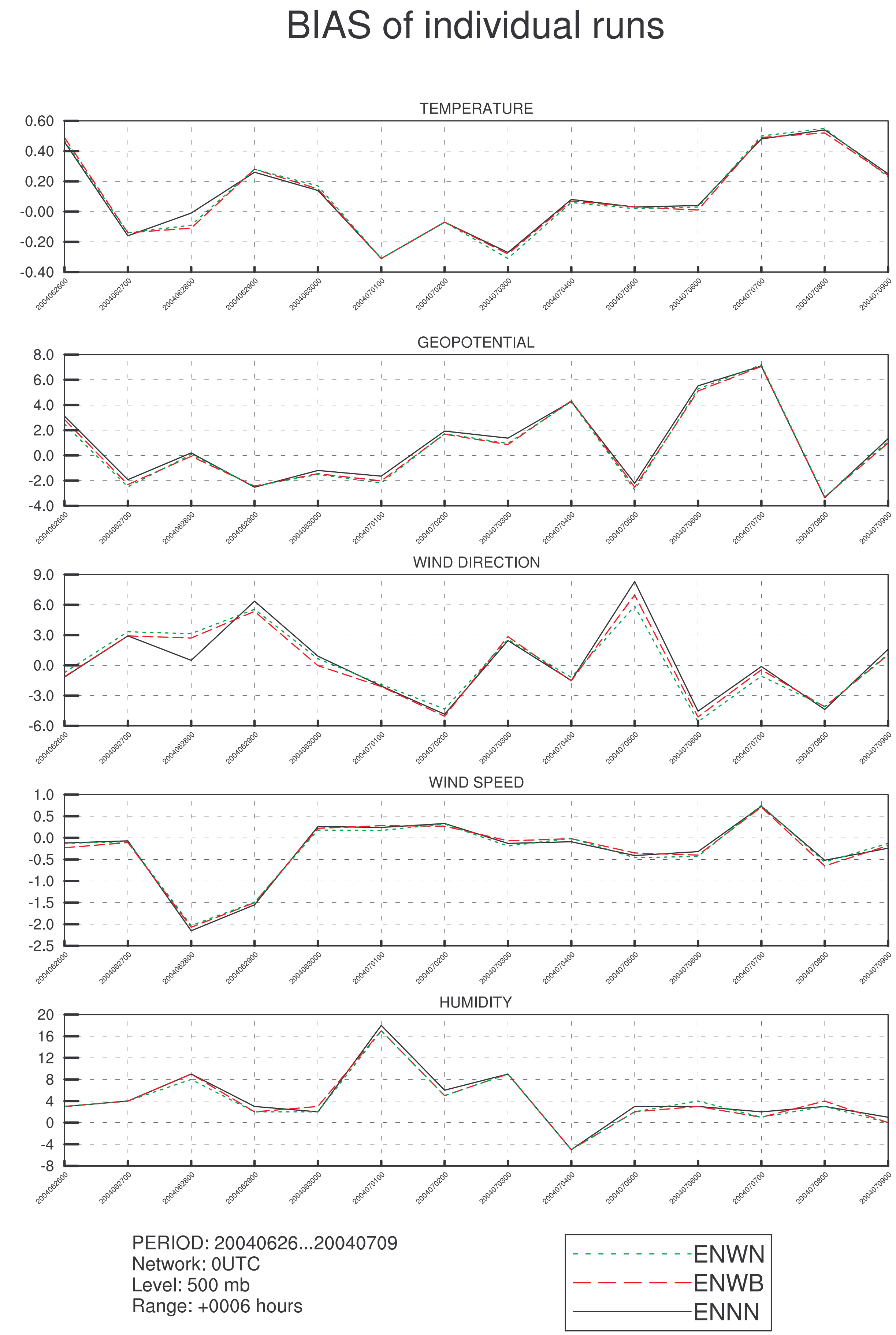

Figure 21: BIAS of 06 hour forecast for 500hPa level.

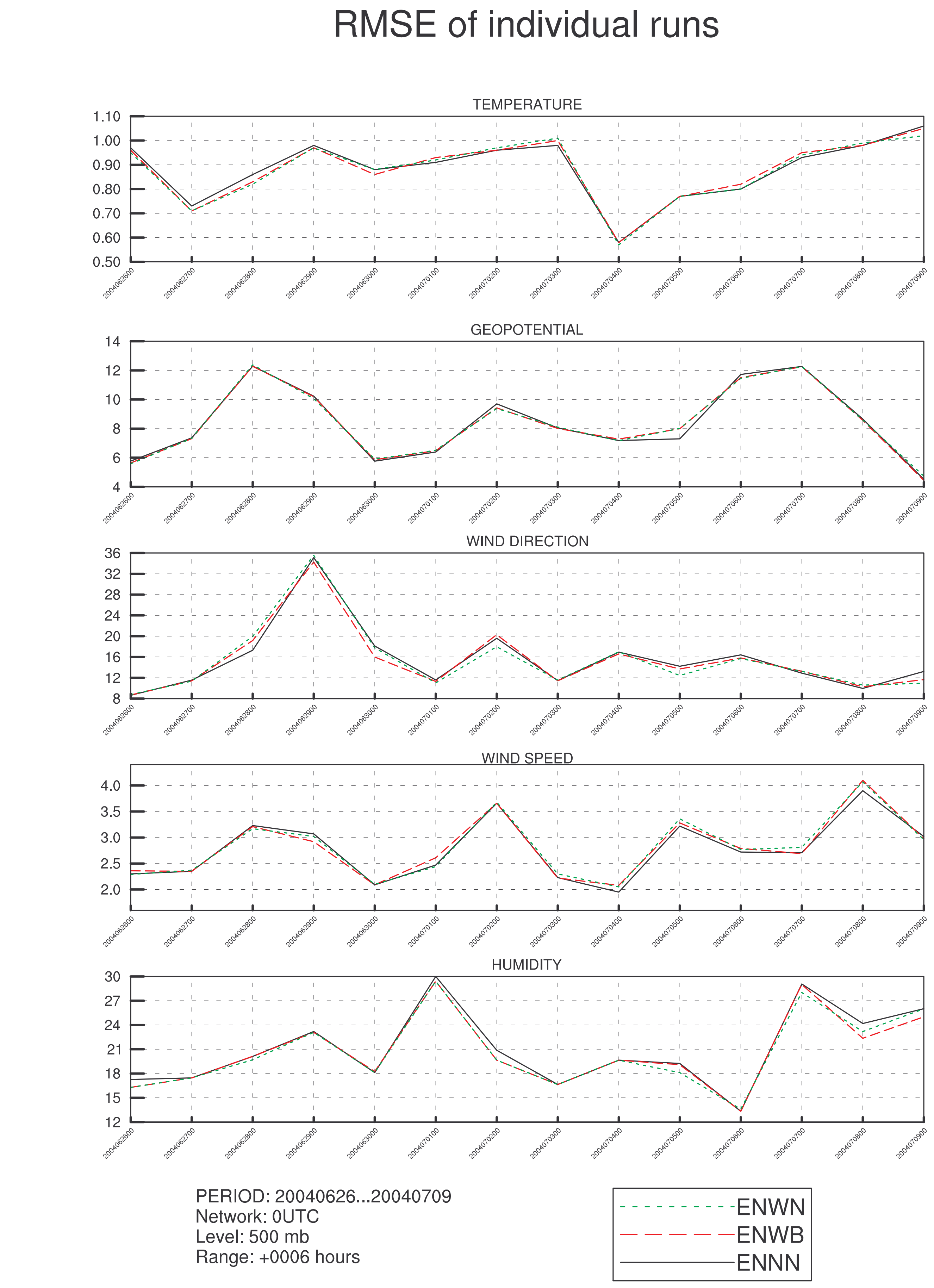

Figure 22: RMSE of 06 hour forecast for 500hPa level.

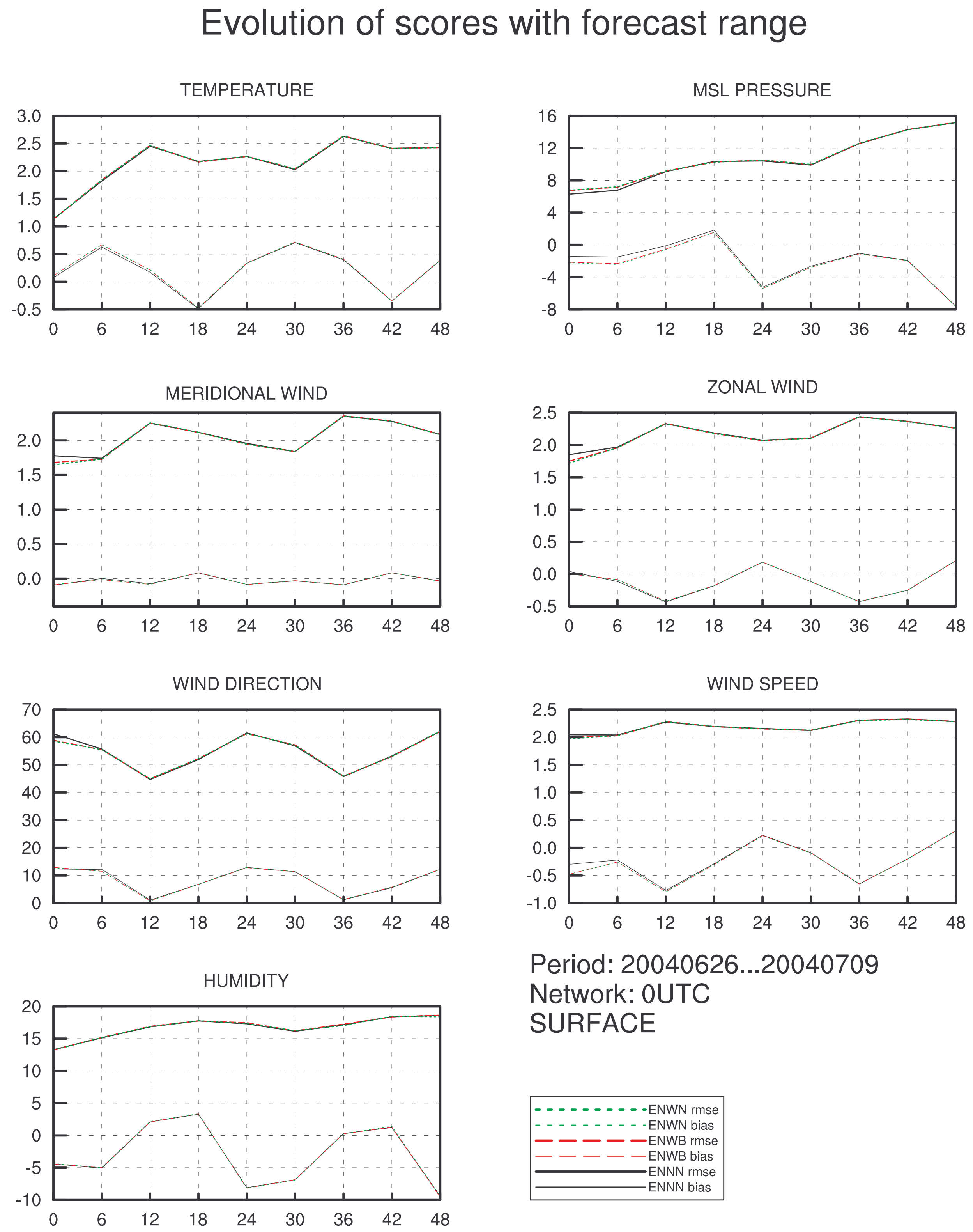

Figure 23: RMSE and BIAS of all ranges for surface level.

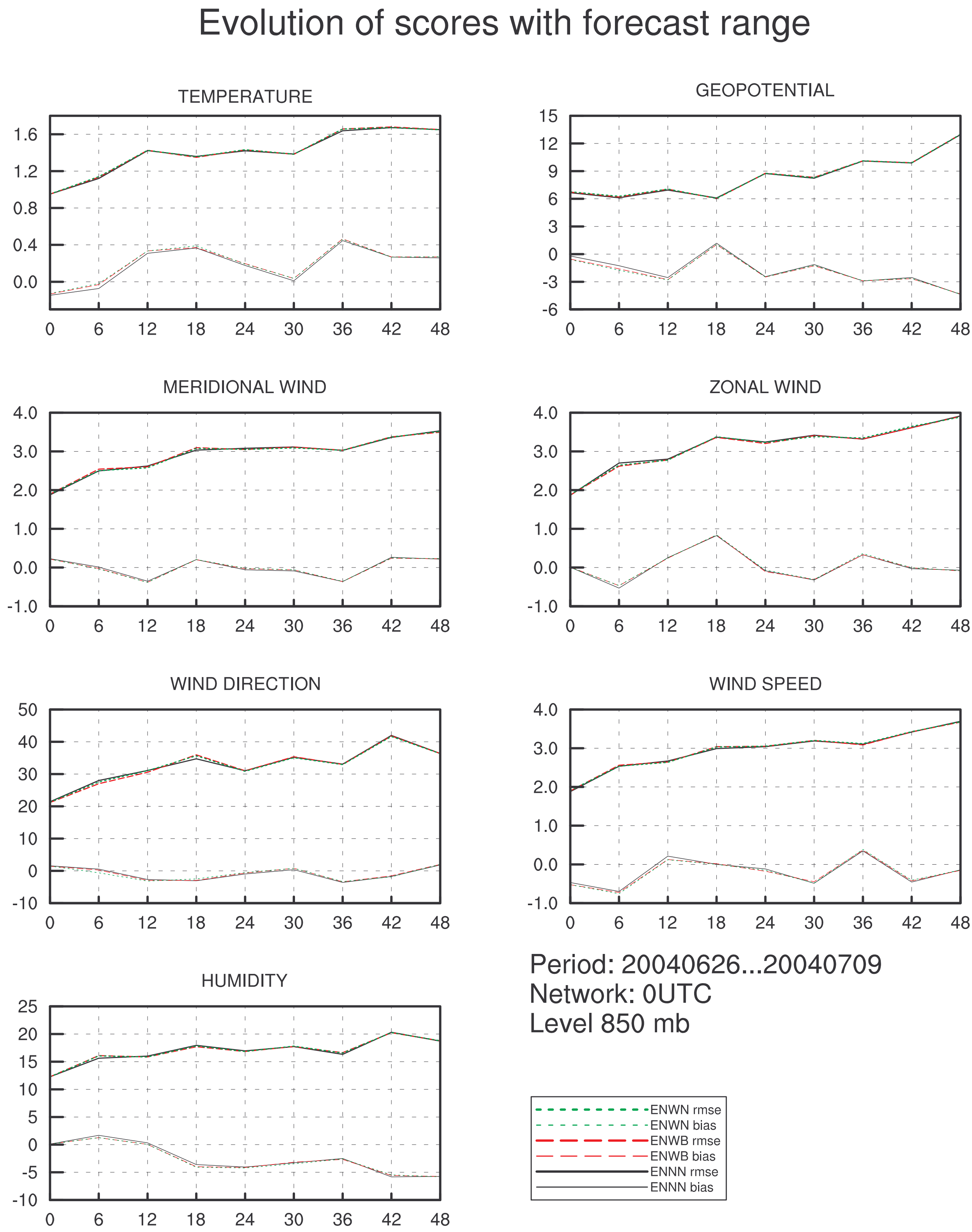

Figure 24: RMSE and BIAS of all ranges for 850hPa level.

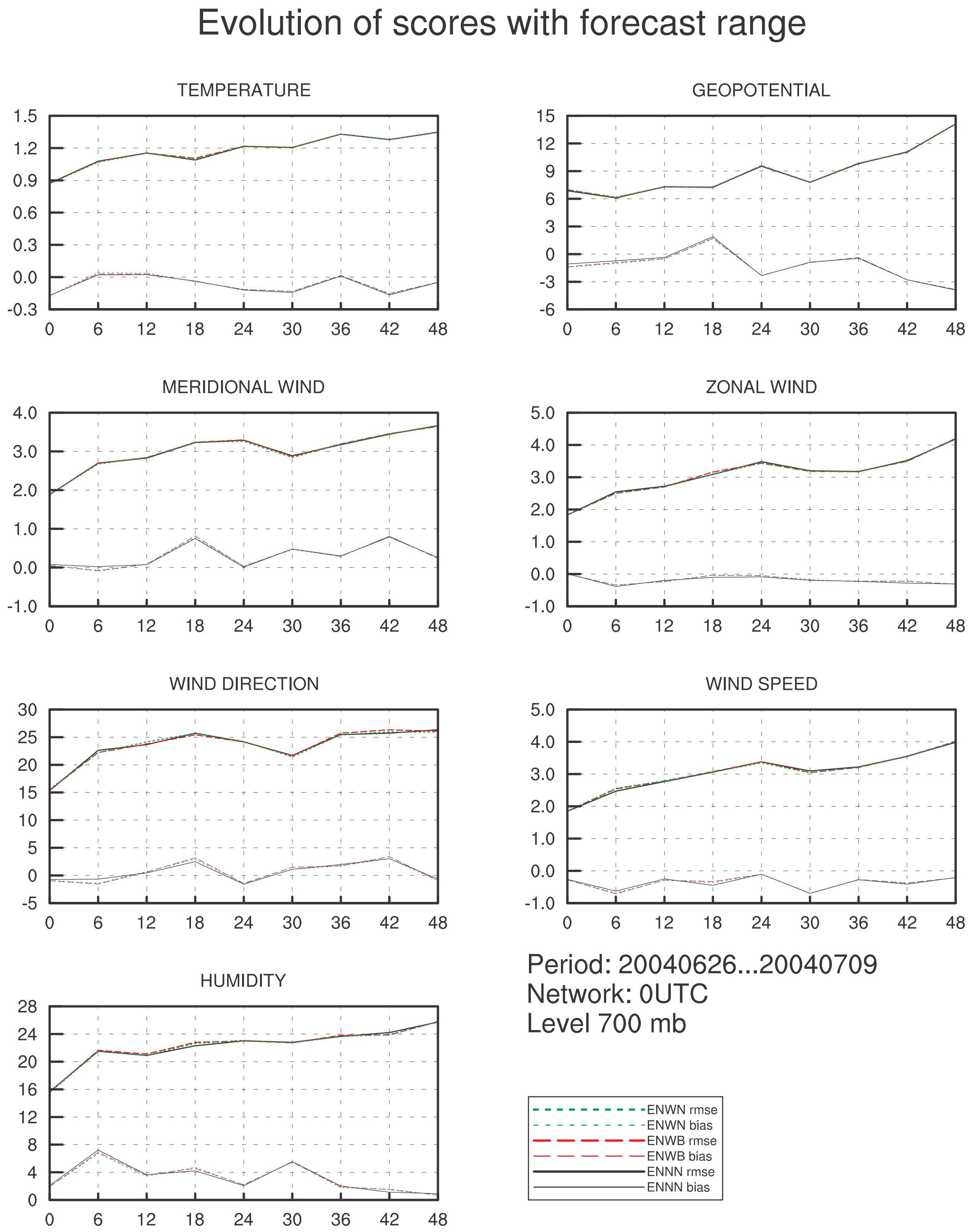

Figure 25: RMSE and BIAS of all ranges for 700hPa level.

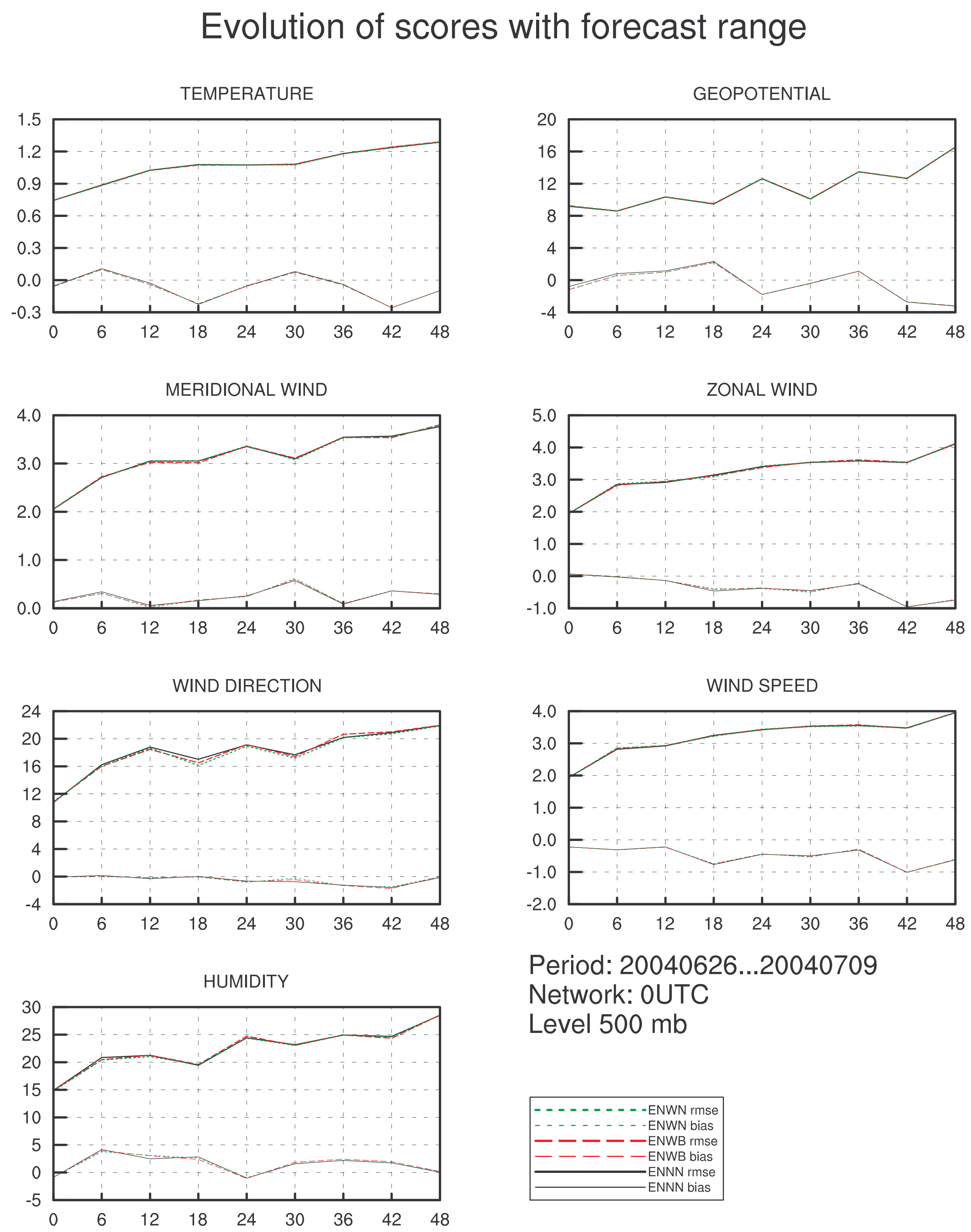

Figure 26: RMSE and BIAS of all ranges for 500hPa level.