Norwegian Meteorological Institute

METinfo

No. 36/2025
ISSN 1894-759X
Meteorology

Verification of Operational Weather Prediction Models March to May 2025

Bjørn Gilje Lillegraven, Gunnar Noer and Lene Østvand

View of downtown Oslo. Photo: Lene Østvand

Contents

Wind gust figures

Precipitation figures

More information...

Verification results are also available on internal web pages

- https://metcoop-comm.smhi.se/ and https://metcoop.smhi.se/ - MetCoOp Web Tools - including verification and observation monitoring
- https://harp.smhi.se/ - MetCoOp verification visualized with harp
- http://verif/vmap/ - timeseries and windroses - on Google map

About this report

This verification report indicates the quality of the main operational weather forecasting models used at the Norwegian Meteorological Institute for the period indicated. Another purpose of the verification report series is to provide a stable source of information suitable for monitoring longer trends in forecasting quality for interested readers. The report complements the verification and monitoring performed on individual models. Each model is monitored and developed according to the scientific method, where changes are only introduced when they can document a better likely prediction skill. Such documentation is available as research papers, consortium news, and presentations at team-, syndicate- and consortium-meetings. The skill of the forecasting service in severe weather situations is also documented with special emphasis on forecast failures, in order to learn from them and improve the system.

The report includes verification results for 3 Numerical Weather Prediction (NWP) models; MetCoOp ensemble prediction system (MEPS) covering Norway, Sweden, Finland, Denmark and the Baltic states, AROME-Arctic covering Svalbard, Novaja Semlja, Frans Josefs land and the Northern part of Scandinavia and the global ECMWF. The models are further described in the Models section. The variables verified are mean sea level pressure, temperature, wind speed and precipitation. The results are grouped by variable. A short summary of the results and cases studies by forecasters are also included.

Verification results are shown for different groups of stations: Norwegian, Svalbard and North Scandinavian. For temperature there are additional groups with Norwegian coastal and Norwegian inland stations, for wind speed Norwegian coastal and Norwegian mountainous stations, and for precipitation coastal stations, stations more than 500 m above sea level, and stations with daily mean precipitation > 4 mm. For MEPSctrl statistics at the observing sites are also visualized on maps with model climatology. The text size of the statistics increases with the value. Time series with observations and available models are included for selected stations. Post processed variables are compared with MEPSctrl.

Models

The following Numerical Weather Prediction (NWP) models are verified in this report. The verification measures are plotted for each model with the colors indicated in the table below.

ECMWF	Global model (IFS) at the European Centre for Medium-Range Weather Forecasts. From 26 January 2010 horizontal resolution approximately 16×16 km^2. From 8 March 2016 cycle 41r2 with horizontal resolution about 9 km. ECMWF is available about 5 hours later than models run at MET.
MetCoOp ensemble prediction system (MEPSctrl)	MEPS has 30 lagged ensemble members, constructed from 5 members updated hourly and run up to 66 hours. Only member 0, the control, is verified in this report. MEPS is based on HARMONIE with AROME physics and non-hydrostatic dynamics, horizontal resolution defined by a 2.5×2.5 km^2 grid. Experimental with cycle 37h1.1 from November 2012, on Yr since 1 October 2013, operational since March 2014, cycle 38h1.2 from December 2014, cycle 40h1.1 since November 2016 and cycle 43h2.1 from 23 March 2021. MEPS is run in cooperation with Swedish Meteorological and Hydrological Institute (SMHI), Finnish Meteorological Institute (FMI) and Estonian Environment Agency (ESTEA).
AROME-Arctic (AA25)	HARMONIE with AROME physics, horizontal resolution defined by a 2.5×2.5 km^2 grid. Experimental with cycle 38h1.2 from 15 October 2015, on Yr from 14 December 2016, cycle 40h1.1 since June 2017, cycle 43h2.1 since 5 May 2021.

Analysis and lead times of forecasts are denoted by e.g. 00+30 UTC which indicates forecast generated at 00 UTC and valid 30 hours later.

A change log for HARMONIE AROME is available on internal webpages
https://metcoop.smhi.se/dokuwiki/nwp/metcoop/changelog/start.

Post processed forecasts

Most of the raw NWP model data are post processed before being published on Yr.

The met nordic temperature forecasts, YrPP in the plots, are post-processed forecasts based on the latest MEPS ensemble runs. The MEPS temperature forecasts are first downscaled to 1 km resolution using the model lapse rate in a neighbourhood. The forecasts are then bias corrected using a fine scale 1 km temperature analysis as reference. The temperature analysis is based on multiple data sources using both conventional and citizen observations.

The MEPS 10 m wind speed forecast is post-processed by downscaling to 1 km resolution to better represent local topography, and called YrPP.

YrPP is plotted with the color below.

The HARMONIE system

HARMONIE is the acronym for HIRLAM's meso-scale forecast system (Hirlam Aladin Regional/Meso-scale Operational NWP In Europe). For documentation see
- *The HARMONIE-AROME Model Configuration in the ALADIN-HIRLAM NWP System* by Bengtsson et al. 2017, available at https://doi.org/10.1175/MWR-D-16-0417.1
- *AROME-MetCoOp: A Nordic Convective-Scale Operational Weather Prediction Model* by Müller et al. 2017, available at https://doi.org/10.1175/WAF-D-16-0099.1

More documentation is also available on hirlam.github.io/HarmonieSystemDocumentation/dev/, www.accord-nwp.org and www.cnrm.meteo.fr/gmapdoc/.

This section presents some of the main components and setups that are used at MET.

AROME physics

AROME (Applications of Research to Operations at MEsoscale) is targeted for horizontal resolution 2.5 km or finer. It uses physical parameterizations based on the French academia model Meso-NH and the external surface model SURFEX. AROME has been operational at Météo-France since 18 December 2008 with a horizontal resolution of 2.5 km and 65 vertical layers, and from April 2015 1.3 km and 90 vertical layers.

SURFEX as surface model

SURFEX (Surface externalisée) is developed at Météo-France and academia for offline experiments and introduced in NWP models to ensure consistent treatment of processes related to surface. Météo-France uses SURFEX in all their configurations. Surface modelling and assimilation benefit from the possibility of running offline experiments. SURFEX is also used for offline applications in e.g. hydrology, vegetation monitoring and snow avalanche forecasts.

SURFEX includes routines to simulate the exchange of energy and water between the atmosphere and 4 surface types (tiles); land, sea (ocean), lake (inland water) and town. The land or nature tile can be divided further into 12 vegetation types (patches). ISBA (Interaction between Soil Biosphere and Atmosphere) is used for modelling the land surface processes. There are 3 ISBA options; 2- and 3-layer force restore and a diffusive approach, where the first one is used in HIRLAM. Towns may be treated by a separate TEB (Town Energy Balance) module. Seas and lakes are also treated separately. The lake model, FLAKE (Freshwater LAKE), has recently been introduced in SURFEX. A global ECOCLIMAP database which combines land cover maps and satellite information gives information about surface properties. The orography is taken from gtopo30.

SURFEX Scientific Documentation and *User's Guide* are available on http://www.cnrm.meteo.fr/surfex/

Data assimilation

NWP models are updated regularly using observations received in real-time from the global observing system. MEPS is updated each third hour; at 00, 03, 06, 09, 12, 15, 18 and 21 UTC.

Surface analysis

Surface analysis is performed by CANARI (Code d'Analyse Nécessaire à ARPEGE pour ses Rejets et son Initialisation) (Taillefer, 2002). The analysis method is Optimal Interpolation and only conventional synoptic observations are used. 2 meter temperature and relative humidity observations are used to update the surface and soil temperature and moisture.

The snow analysis is also performed with CANARI in analogy with the HIRLAM snow analysis. Snow depth observations are used to update Snow Water Equivalent. The snow fields are analysed only at 06 UTC as there are very few snow depth observations at 00, 03, 09, 12, 15, 18 and 21.

The Sea Surface Temperature (SST) and Sea Ice Concentration (SIC) is not analysed, but taken from the boundaries. ECMWF uses the OSTIA (Operational Sea Surface Temperature and Sea Ice Analysis) product, including SST from UK Met Office and SIC from MET. SST and SIC for the Baltic Sea have since 26 November 2015 been taken from ocean models run at SMHI; first HIROMB and since 26 April 2017 NEMO.

The surface temperature over sea ice was taken from the boundary model and remained unchanged through the forecast. A simple thermodynamical sea ice scheme (SICE) giving prognostic sea ice temperatures in 4 fixed layers was introduced 26 November 2015.

Upper air analysis

MEPS runs three dimensional variational (3D VAR) data assimilation using conventional observations from synop stations, ships, radiosondes and aircrafts and AMSU-A and AMSU-B/MHS data from polar orbiting NOAA and METOP satellites. GNSS were introduced 17 February 2015, radar reflectivities 16 June 2015, IASI 26 November 2015 and ASCAT 17 March 2016. Mode-S EHS, AMSU-A and MHS from METOP-C satellite were introduced June 2020, METOP-C IASI (deactivation of METOP-A IASI), June 2021, radar radial wind observations and German radars, June 2022.

Boundary fields

MEPS gets its boundary values (1-hourly) from the ECMWF model at approximately 9 km resolution, and has currently 65 vertical levels. None of the HARMONIE configurations at MET have applied digital filter initialization (DFI).

Verification measures

All model forecasts in this report are verified against observations by interpolating (linear) the grid based forecasts to the observational sites. As a consequence, it should be noted that it is the models' abilities to forecast the observations that is being quantifed and assessed. Thus, there is no attempt in this report to verify area averaged precipitation for example.

Verification is carried out both for raw and categorized forecasts. In the following, let $f_1, ..., f_n$ denote the forecasts and $o_1, ..., o_n$ the corresponding observations.

Forecasts of continuous variables

The verification statistics applied to continuous variables are defined in the table below.

Statistic	Acronym	Formula	Range	Optimal score
Mean Error	ME	$\frac{1}{n} \sum_{i=1}^{n}(f_i - o_i)$	$-\infty$ to ∞	0
Mean Absolute Error	MAE	$\frac{1}{n} \sum_{i=1}^{n} \mid f_i - o_i \mid$	0 to ∞	0
Standard Deviation of Error	SDE	$\left(\frac{1}{n} \sum_{i=1}^{n}(f_i - o_i - \mathrm{ME})^2 \right)^{1/2}$	0 to ∞	0
Root Mean Square Error	RMSE	$\left(\frac{1}{n} \sum_{i=1}^{n}(f_i - o_i)^2 \right)^{1/2}$	0 to ∞	0
Correlation	COR	$\frac{\frac{1}{n}\sum_{i=1}^{n}(f_i - \bar{f})(o_i - \bar{o})}{\mathrm{SD}(f)\mathrm{SD}(o)}$	-1 to 1	1

In the formula for COR the following definitions are used

$$\bar{f} \;=\; \frac{1}{n}\sum_{i=1}^{n} f_i, \qquad \bar{o} \;=\; \frac{1}{n}\sum_{i=1}^{n} o_i$$

$$\mathrm{SD}(f) \;=\; \Big(\frac{1}{n}\sum_{i=1}^{n}(f_i - \bar{f})^2\Big)^{1/2}, \qquad \mathrm{SD}(o) \;=\; \Big(\frac{1}{n}\sum_{i=1}^{n}(o_i - \bar{o})^2\Big)^{1/2}$$

for the means and standard deviations of the forecasts and observations.

For wind direction the probability density function (PDF) is used to show the distribution of observed and forecast wind directions. The PDF used here is a kernel density estimate, which is a smoothed version of the histogram.

Forecasts of categorical variables

All variables in this report are continuous in raw form, but it is possible to categorize them and verify these. For example, wind speed above a given threshold could be of interest which would result in two possible outcomes (yes and no). The verification is then completely summarized by a contingency table as the one shown below

		event observed	
		yes	no
event forecasted	yes	a	b
	no	c	d

Verification statistics for such forecasts are listed in the following table

Statistic	Acronym	Formula	Range	Optimal score
Hit rate	HR	$\frac{a}{a+c}$	0 to 1	1
False alarm rate	F	$\frac{b}{b+d}$	0 to 1	0
False alarm ratio	FAR	$\frac{b}{a+b}$	0 to 1	0
Equitable threat score	ETS	$\frac{a-ar}{a+b+c-ar}$	$-1/3$ to 1	1 (0 = no skill)
Hanssen-Kuipers skill score	KSS	HR - F	-1 to 1	1 (0 = no skill)
Heidke skill score	HSS	$\frac{(a+d)/n-ssf}{1-ssf}$	$-\infty$ to 1	1 (0 = no skill)

In the formula for ETS $ar=(a+b)(a+c)/n$.
In the formula for HSS the score for the standard forecast $ssf=[(a+b)(a+c)+(b+d)(c+d)]/n^2$.

Observations

All observations come from frost.met.no. Only synop stations are used. From June 1 2021, both the model wind speed and the post-processed wind speed are verified against mean wind observations, FF. The model wind gust is verified against the observed wind gust, FG. FF and FG are defined as follows:

- FF: Wind speed (10 meters above ground) - defined as the mean value for the last 10 minutes before the time of the observation.
- FG: Gust wind speed (10 m above ground) - defined as highest gust wind speed (3 second mean) the last 10 minutes before the time of the observation.

Summary of the results

Summarized statistics show that ECMWF in general forecasts sea level pressure better than MEPSctrl/AA25, but the errors are small for both.

Temperature is on average better forecast by MEPSctrl/AA25 than ECMWF. ECMWF underestimates the temperature for all the different groups of stations. MEPSctrl shows a very small underestimation, while AA25 slightly overestimates the temperature for the Svalbard stations and is slightly too cold for the North Norwegian station. However, the standard deviation of the error is about the same for MEPSctrl and ECMWF, although somewhat larger for AA25 for Svalbard stations. Still, the errors are small, indicating that the timing of the temperature changes is generally good. The temperature forecast from MEPSctrl is further improved by post processing, particularly for the shortest lead times. The improvement is larger for inland stations than coastal stations, which have less variation in temperature and smaller errors than inland stations for both MEPSctrl and post processed forecasts.

For wind speed and precipitation, a larger number of verification scores is used to assess model quality, including threshold statistics.

Wind speed is challenging to evaluate. MEPSctrl performs better than ECMWF over land, and particularly in the mountains, where ECMWF underestimates the speed considerably as seen in the monthly mean error and mean absolute error. AA25 performs about as well as ECMWF for the Svalbard stations, with AA25 having a tendency to overforecast the wind speed while ECMWF generally underetimates it. The threshold scores indicate that wind speed is better forecast for lower than for higher wind speeds for all models. The post-processing of wind speed shows a small effect in the mean error and mean absolute error, while the other scores show almost identical results for MEPSctrl and YrPP.

Precipitation also shows varying results, depending on the amount and location. On average ECMWF has more precipitation than MEPSctrl, but the difference is small. Both have more errors for both very small and very high amounts, than for precipitation in the mid range.

For temperature and wind, the monthly scores for the last three years show that the models generally perform better during summer months than during winter. A possible cause is that storm activity is challenging to predict accurately, and that there are often more storms with high wind speeds during fall and winter than during summer. Precipitation does not have clear seasonal patterns. Convective cases that are challenging to predict may occur with different frequency for different months and years. A challenge with verification of precipitation that occurs during winter is the undercatchment of observed snow. This is the case when there is strong wind in combination with snow, which is often the case especially in Northern Norway and in the mountainous areas in Southern Norway. It is suspected that the models are too dry in the coastal and fjord areas, but the undercatchment leads to cases where the observations give an impression that there is better fit in the models with regards to precipitation than what is actually the case. AA25 and MEPSctrl show very similar results, which is expected since both are HARMONIE models with AROME physics and a horizontal resolution defined by a 2.5×2.5 km^2 grid.

Case studies by forecasters

Case 1. Wind gust

On the evening of April 8th a front system was moving over Northern Norway, and behind the cold front a large region of strong winds and wind gusts approached the coast of Troms and Finnmark. MEPSctrl and AA25 both indicated strong gusts, especially in western Finnmark, so strong, in fact, that a severe weather warning was issued (orange level).

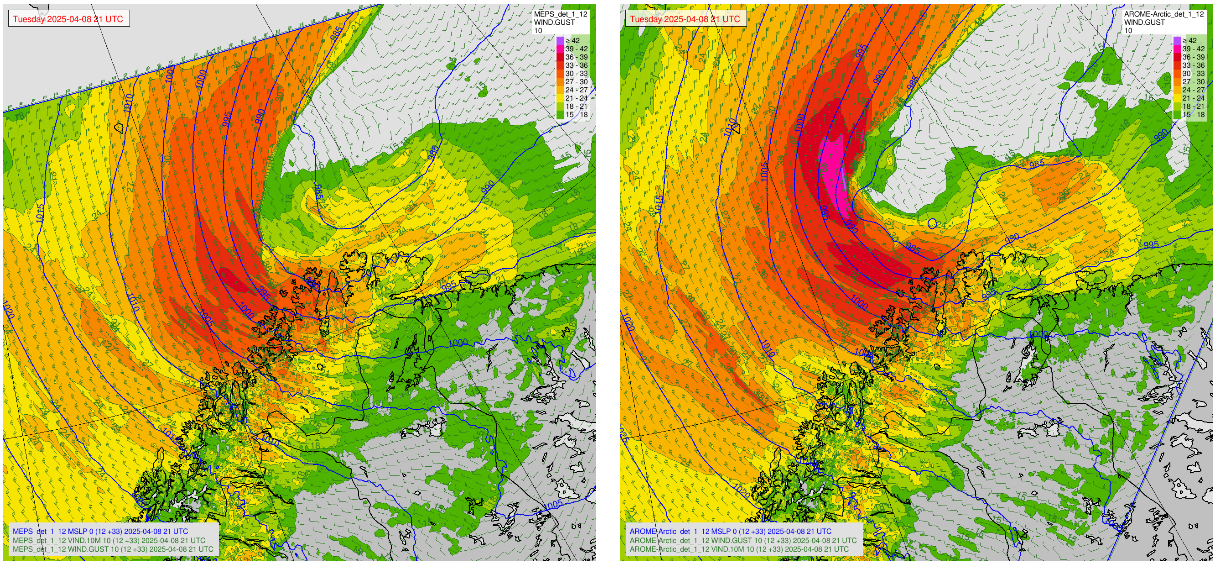


Figure 1: Wind gust (m/s) from MEPSctrl (left) and AA25 (right) at 21 UTC April 8th.

Figure 1 shows the model fields for surface wind gust from MEPSctrl and AA25 at 21 UTC. Looking at Figure 1 it seems that in this situation, AA25 predicted stronger maximum values of gusts than MEPSctrl, which is not uncommon when low pressure systems approach Northern Norway from the north-west, mostly due to the difference in model domain area.

Selected times series from the areas where the models predict most likely to be hit by strong wind gusts are shown in figure 2. It seems that in the period of strongest observed gusts, both models mainly overforecast the values, with AA25 having the highest tendency to do so. Additionally, the timing of the occurrence of strong gusts are inaccurate, such as for Honningsvåg and Mehamn. There are also instances of underforecasting, but this seems to be linked mostly to timing issues. Generally, the models are able to forecast much of the observed wind gust, but they struggle to capture the finer details.

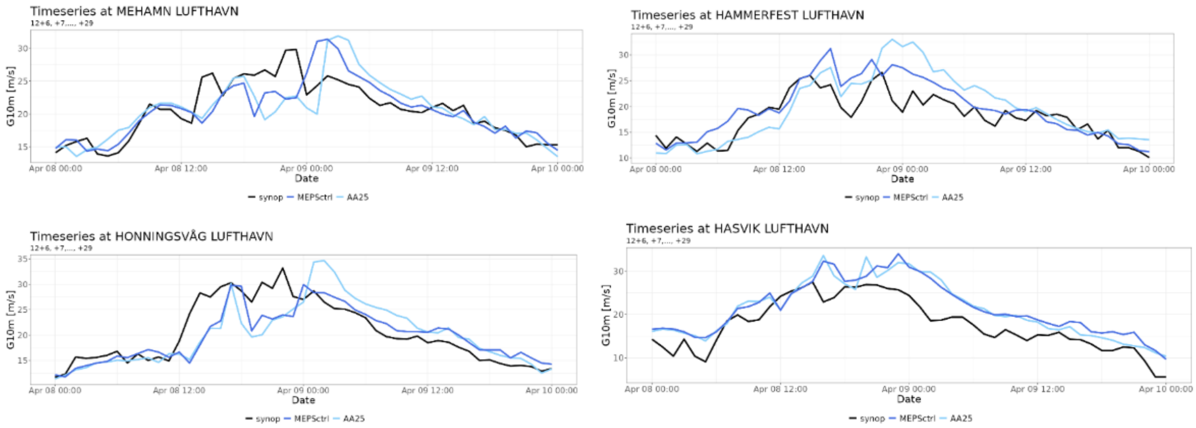


Figure 2: Wind gust observations (black) plotted against MEPSctrl gust (dark blue) and AA25 (light blue).

Case 2. Fog in the North Sea

There are still issues with forecasting fog over the sea in the spring season, as illustrated in this case from the 12th of May, where the problem seems to be mainly related to incorrect values in the model's two-meter temperature (T_{2m}).

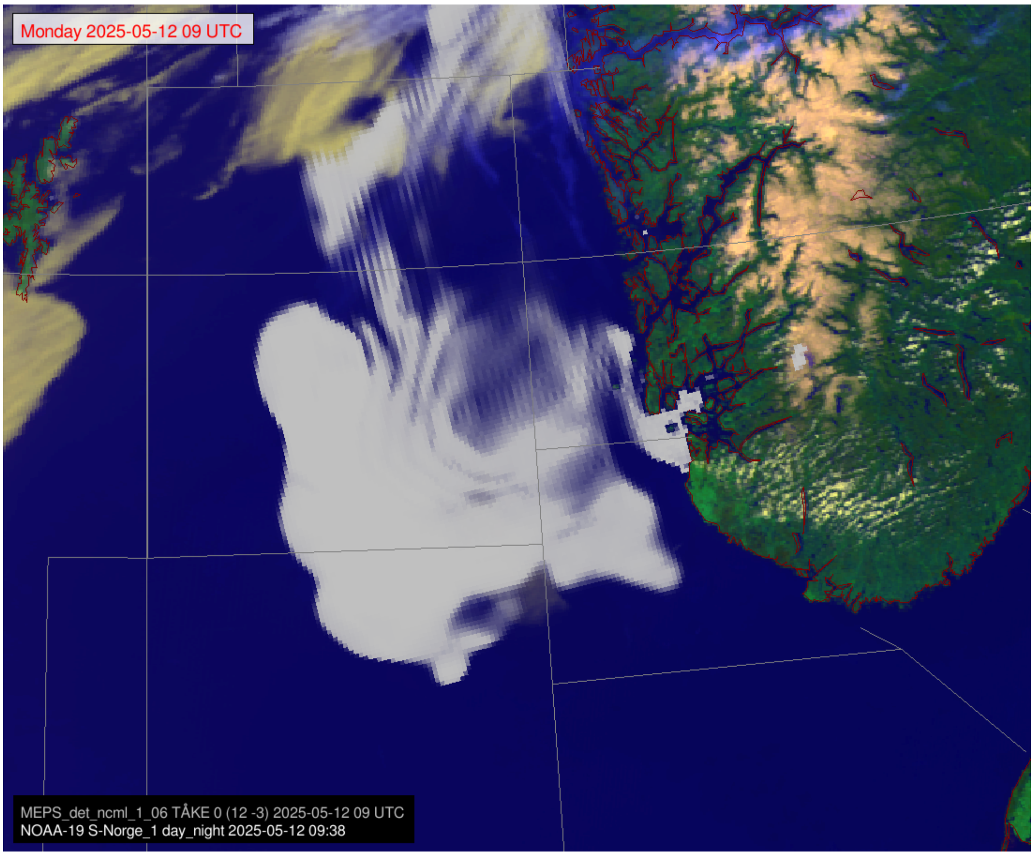


Figure 3: A large area of fog in the MEPSctrl model (grey shading), despite the fact that it is largely cloud free in reality at 09 UTC May 12th. Areas with fog over the ocean appears yellow on the satellite picture.

The extent of the model fog can be seen illustrates with grey shading in figure 3, which also corresponds to an outline of the T_{2m} in figure 4, where the sharp gradient reflects the cooling due to enhanced reflection of short-wave radiation at the cloud top. This gradient is not found in the observed values. In the area near the coast of western Norway where the model has values of 8-10°C, the observed values are in the range 11-14°C. The model T_{2m} is consistently too low compared to observations in all of the North Sea, but especially in the area where the model is forecasting fog.

The model T_{d2m} (two-meter dew point temperature) is slightly too low in the area where MEPSctrl forecasts fog (figure 5), but not more than one to two degrees at most, so the moisture in the lowest levels of the model seems to be well forecasted. Also the difference in T_{2m} and T_{d2m} in the fog layer and in the cloud free area seems to be realistic, so this indicates that the radiation balance is generally well forecast.

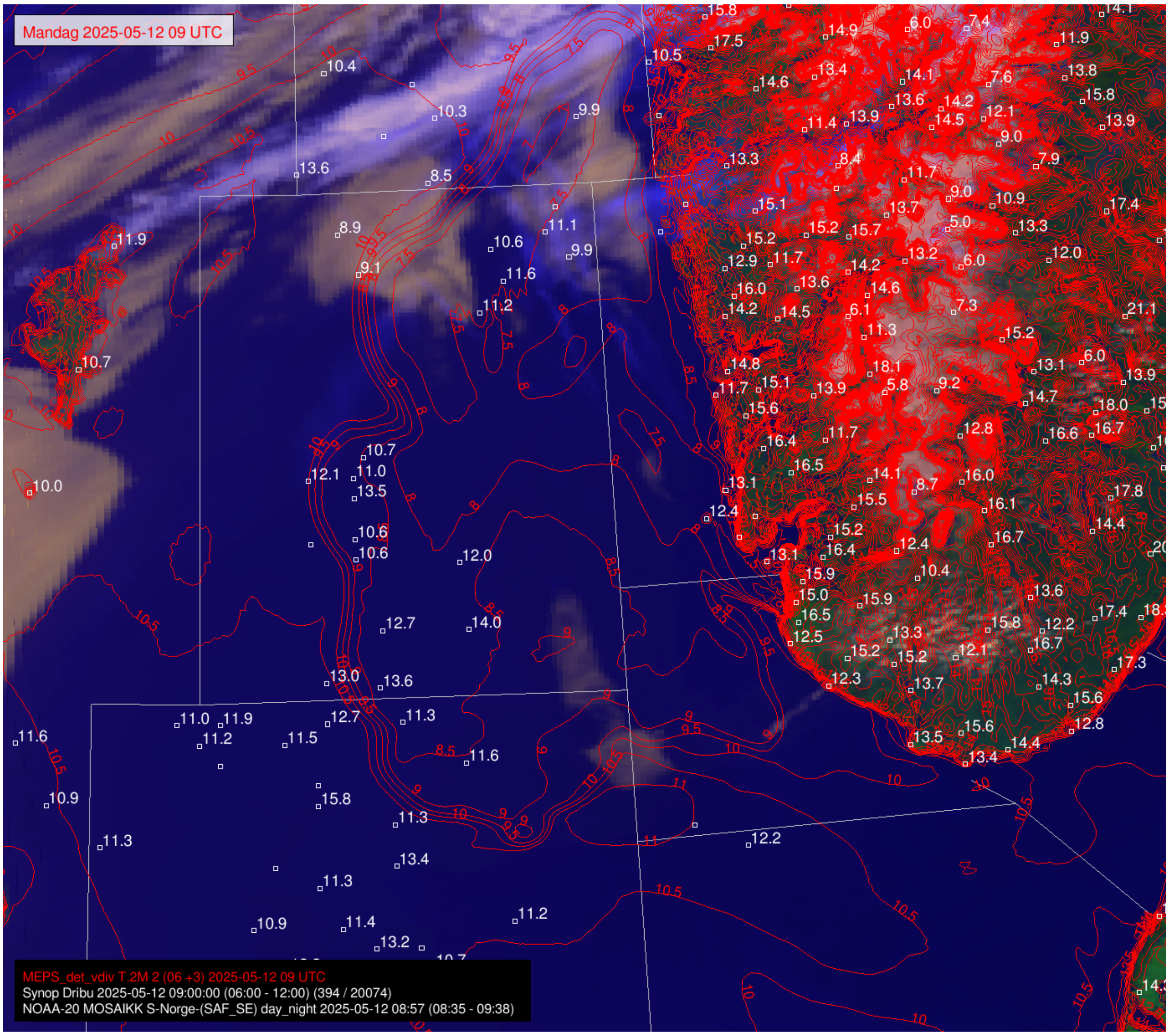


Figure 4: Two-meter temperature from MEPSctrl (red) plotted against observations (white numbers) 09 UTC May 12th.

There are few in-situ observations of sea surface temperature (SST), as can be seen in figure 6. However, based on the few available observations, the model appears to be performing well in the eastern part of the North Sea (station ID 'YME'), indicating an area of slightly higher SST here. In the point further west where the model has fog, it also has a too high SST by about two degrees. This, however, does not seem to have impacted the T_{2m} or the T_{d2m}. Thus, it seems like the most likely source for the excessive fog formation in this case is the T_{2m}, which when forecast too low, causes the air at the sea surface to reach saturation, further causing fog formation and subsequent growth from further cooling of the lowest layers of the atmosphere.

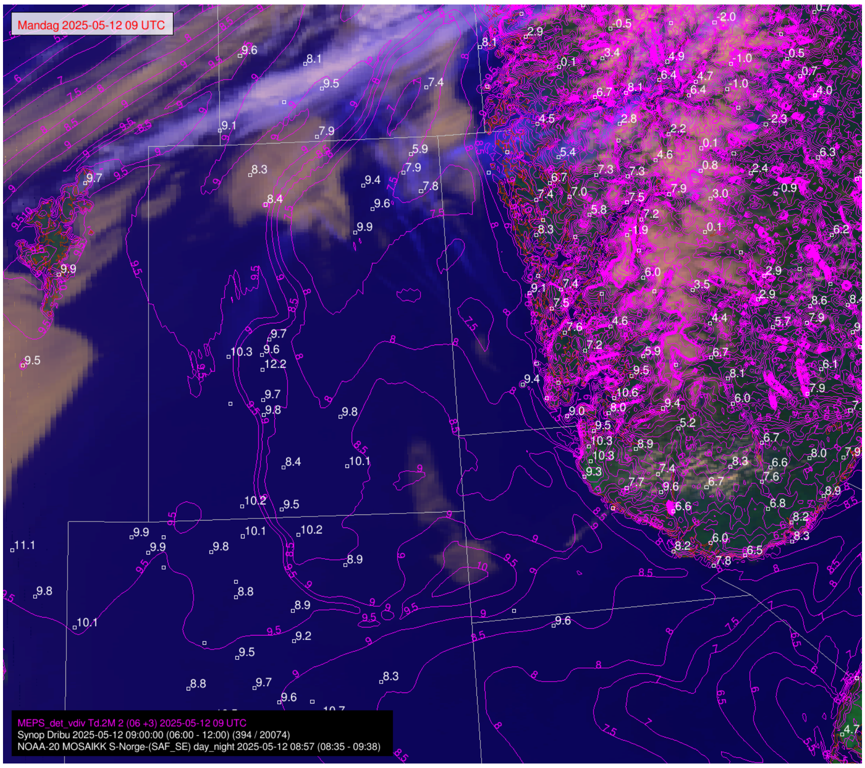


Figure 5: Two-meter dew point temperature from MEPSctrl (pink) plotted against observations (white numbers) at 09 UTC May 12th.

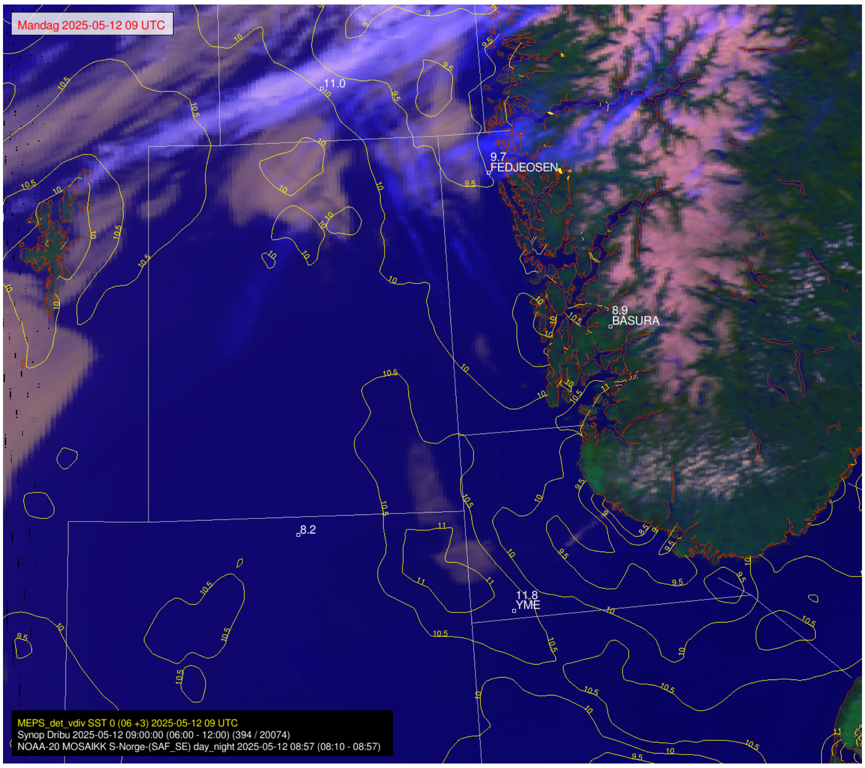


Figure 6: Sea surface temperature from MEPSctrl (yellow lines) plotted against observations (white numbers) at 09 UTC May 12th.

Case 3. Cloud cover

On the 20th of April an occluded front (figure 7) gave precipitation and low clouds over south eastern Norway and in the mountains of southern Norway. While the front moved eastwards during the evening, the cloud layer remained persistent over large parts of southern Norway for nearly 24 hours.

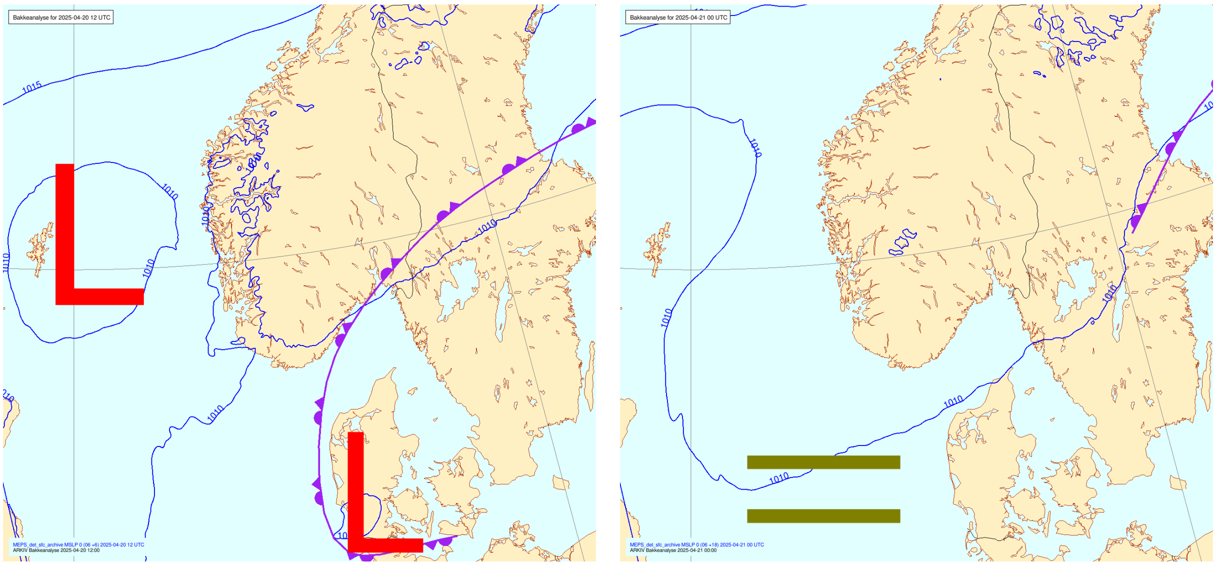


Figure 7: Official surface analysis from MET Norway at 12 UTC April 20th (left) and 00 UTC April 21st.

However, when looking at the MEPSctrl model, there are not nearly enough low clouds and fog in the period from the afternoon of April 20th until around noon on the 21st. Figure 8 shows the model fields for low clouds and fog on top of satellite pictures from 12 and 18 UTC April 20th and 00 and 09 UTC on April 21st. For the satellite pictures at night the low clouds appear as grey/red, while during the day they appear as yellow. It is clear that the cloud cover in the model to a large extent follows the motion of the front system, while in reality the clouds persisted over southern Norway for much longer.

When examining prognostic soundings (not pictured) from the areas where the model underpredicts the cloud cover, it becomes apparent that the model is too dry in the lower part of the atmosphere. There are clear signs of a layer between 1000 and 5000 ft with higher dew point temperatures, but not high enough to generate clouds in the model.

The MEPSctrl model is known to be too dry in certain situations, often not producing enough precipitation or clouds, like in this case. While forecasters are aware of these model weaknesses and can correct their forecasts accordingly when having access to recent observations, the same is not always the case for the forecasts that the public finds on Yr. This is, of course, unfortunate.

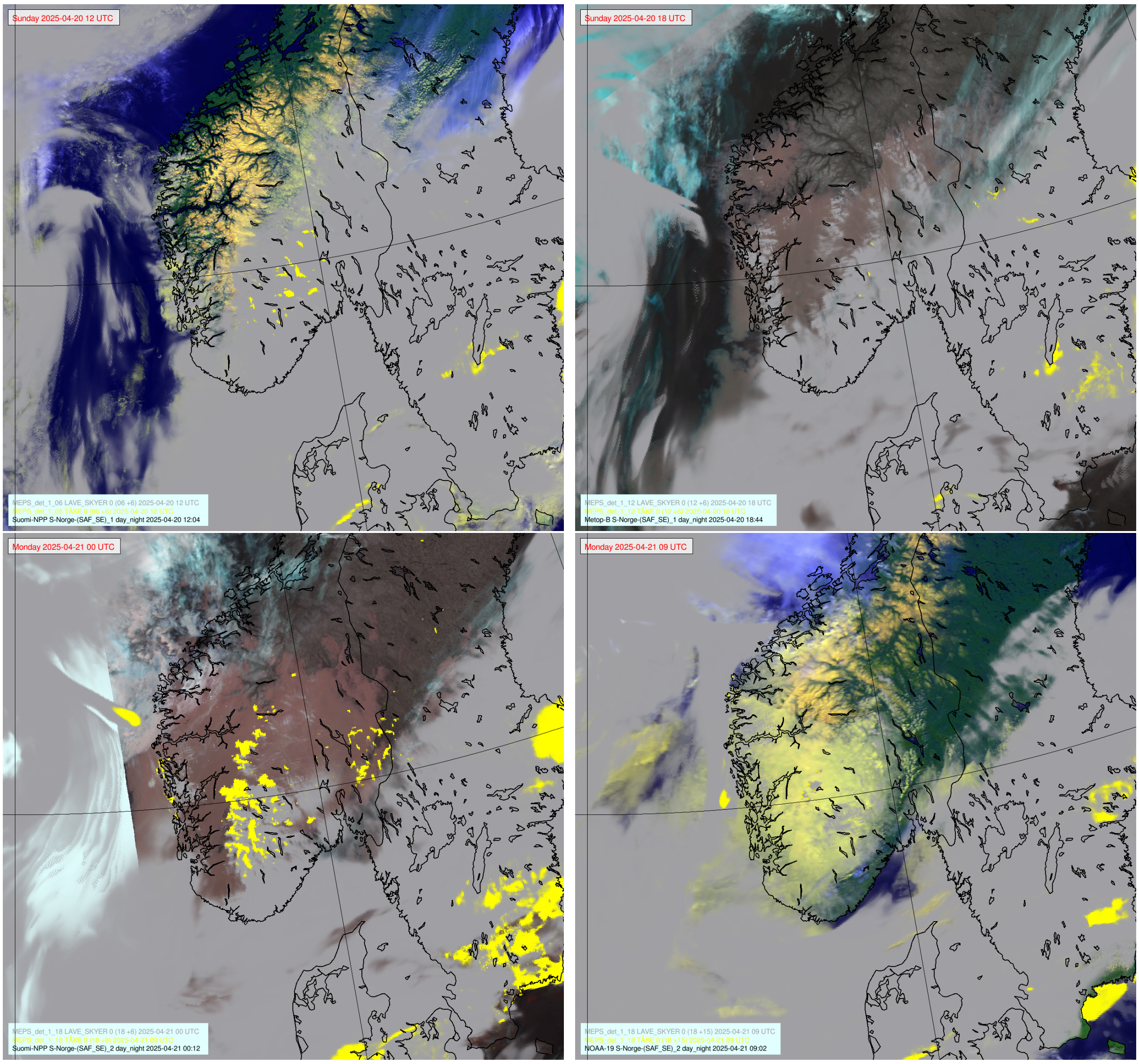
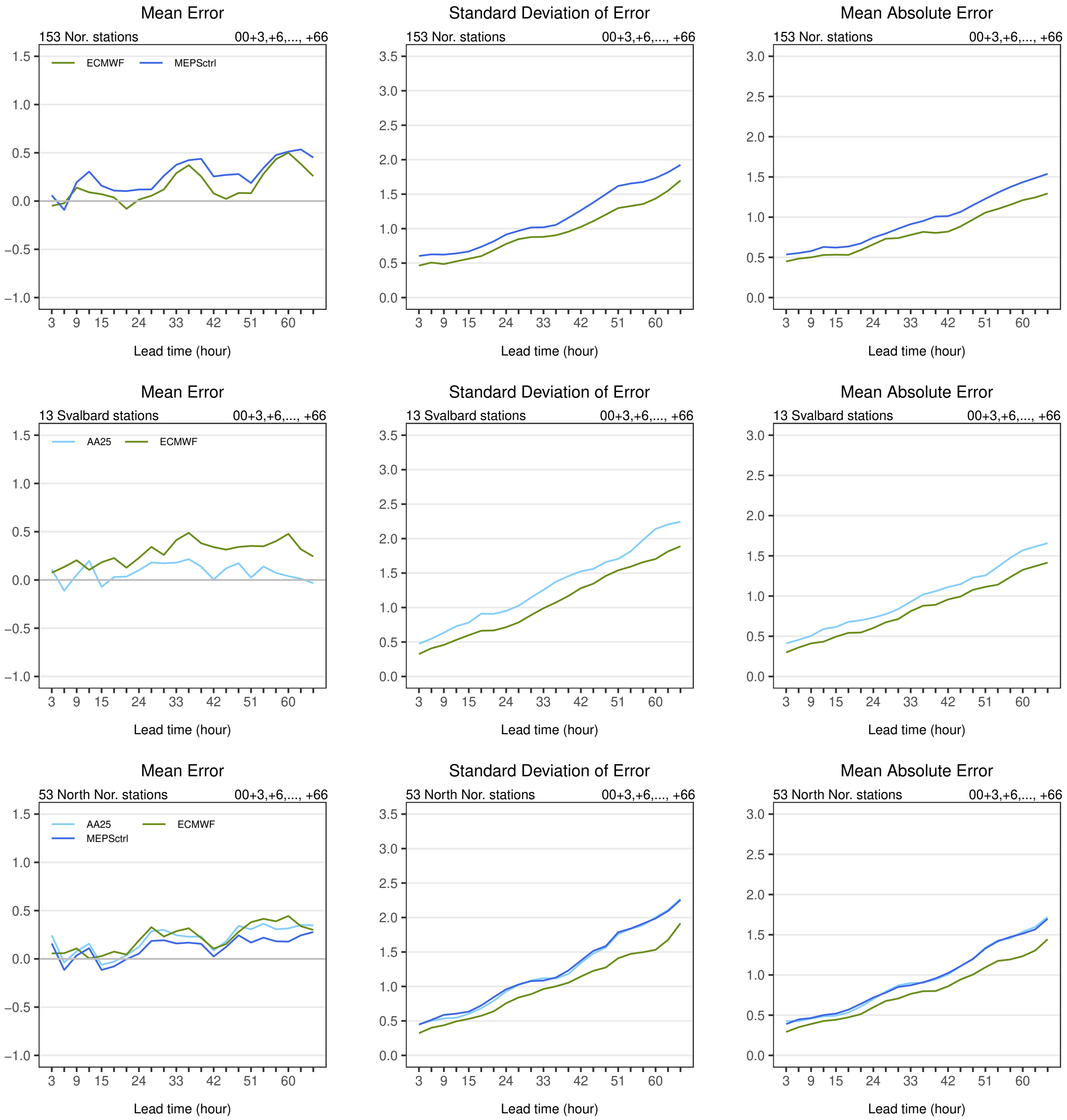
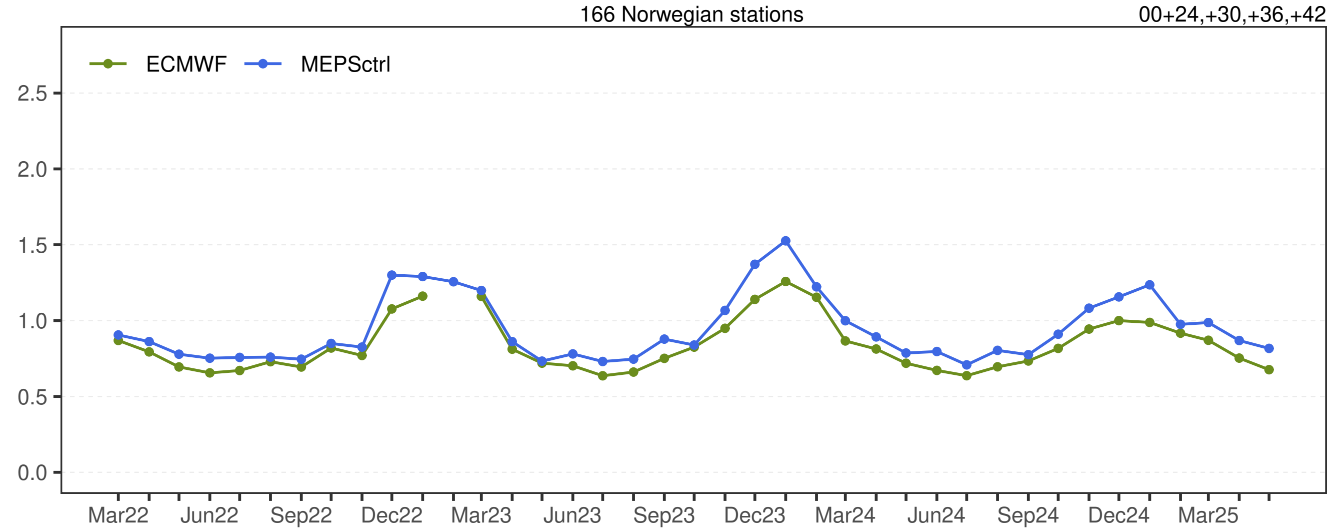


Figure 8: Satellite pictures from 12 and 18 UTC April 20th (top row) and 00 and 09 UTC April 21st (bottom row) with MEPSctrl model fields for low clouds (light grey) and fog (yellow).

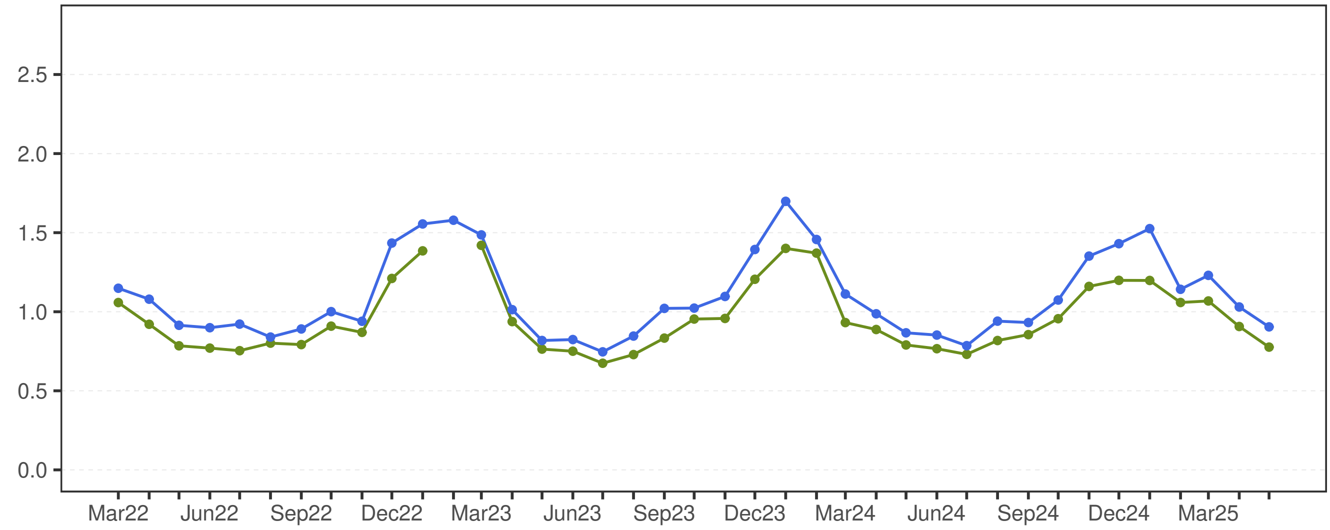
Summarized statistics


Mean Error
153 Nor. stations 00+3,+6,..., +66
ECMWF
MEPSctrl
Lead time (hour)
Standard Deviation of Error
153 Nor. stations 00+3,+6,..., +66
Lead time (hour)
Mean Absolute Error
153 Nor. stations 00+3,+6,..., +66
Lead time (hour)
Mean Error
13 Svalbard stations 00+3,+6,..., +66
AA25
ECMWF
Lead time (hour)
Standard Deviation of Error
13 Svalbard stations 00+3,+6,..., +66
Lead time (hour)
Mean Absolute Error
13 Svalbard stations 00+3,+6,..., +66
Lead time (hour)
Mean Error
53 North Nor. stations 00+3,+6,..., +66
AA25
ECMWF
MEPSctrl
Lead time (hour)
Standard Deviation of Error
53 North Nor. stations 00+3,+6,..., +66
Lead time (hour)
Mean Absolute Error
53 North Nor. stations 00+3,+6,..., +66
Lead time (hour)

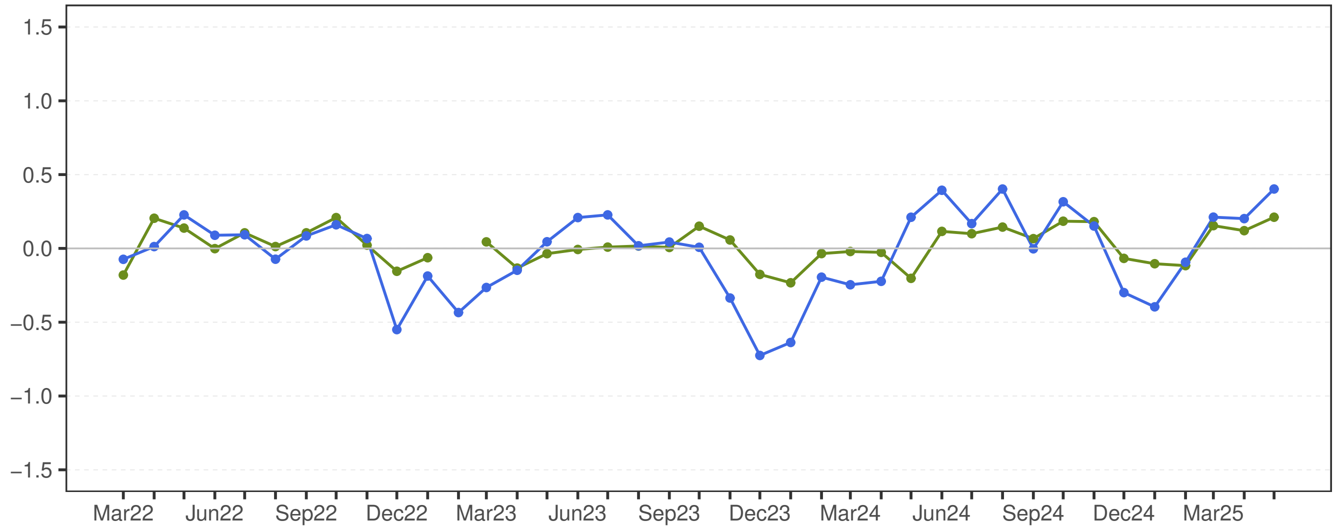
Mean Absolute Error

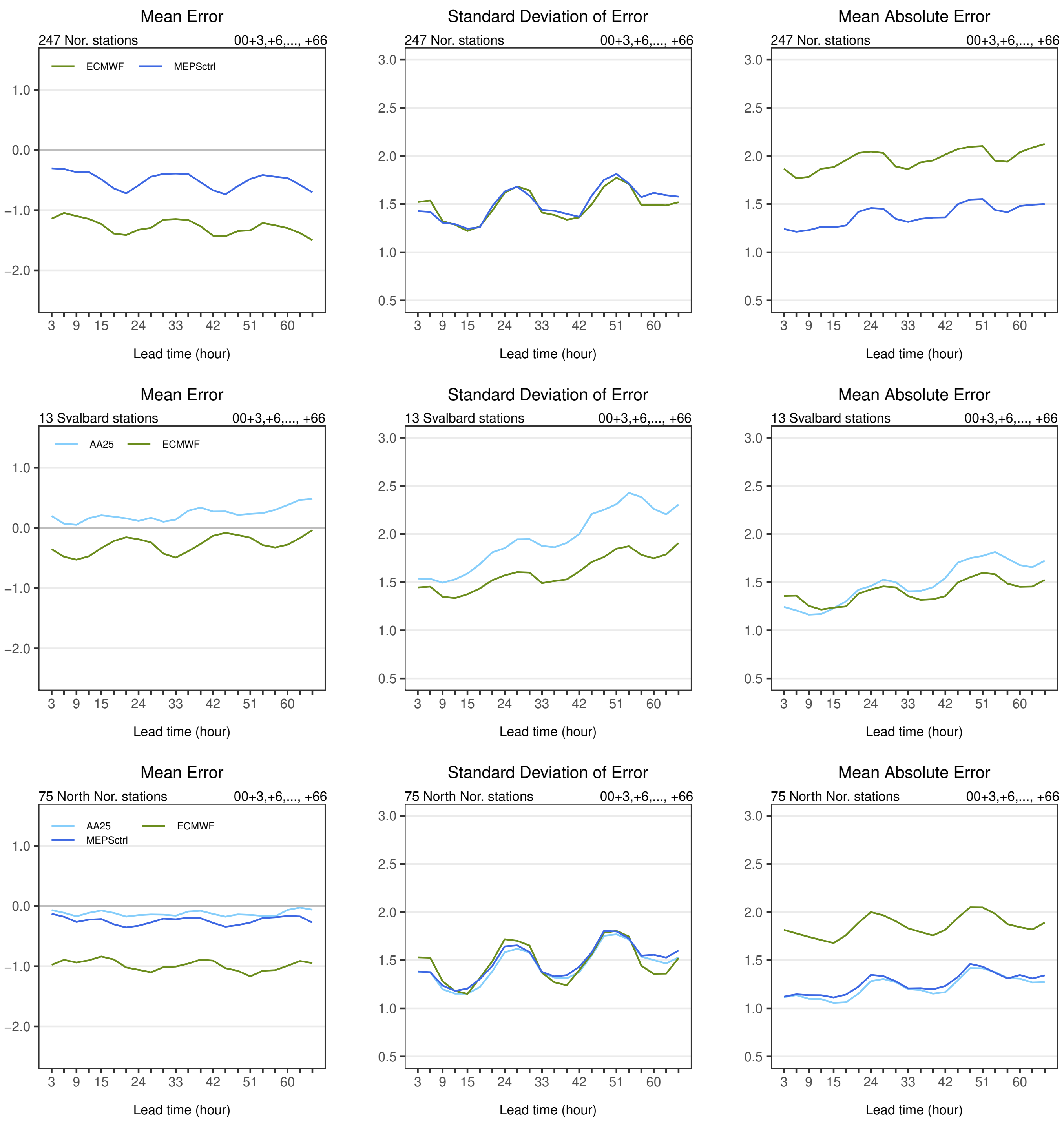


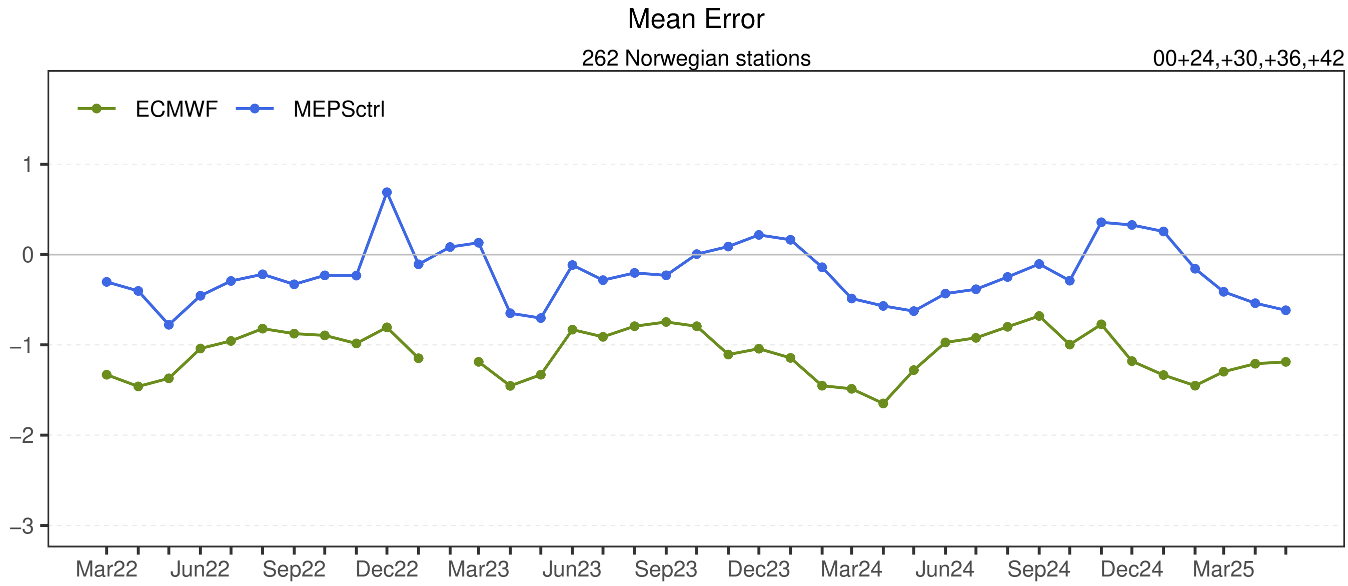
Standard Deviation of Error

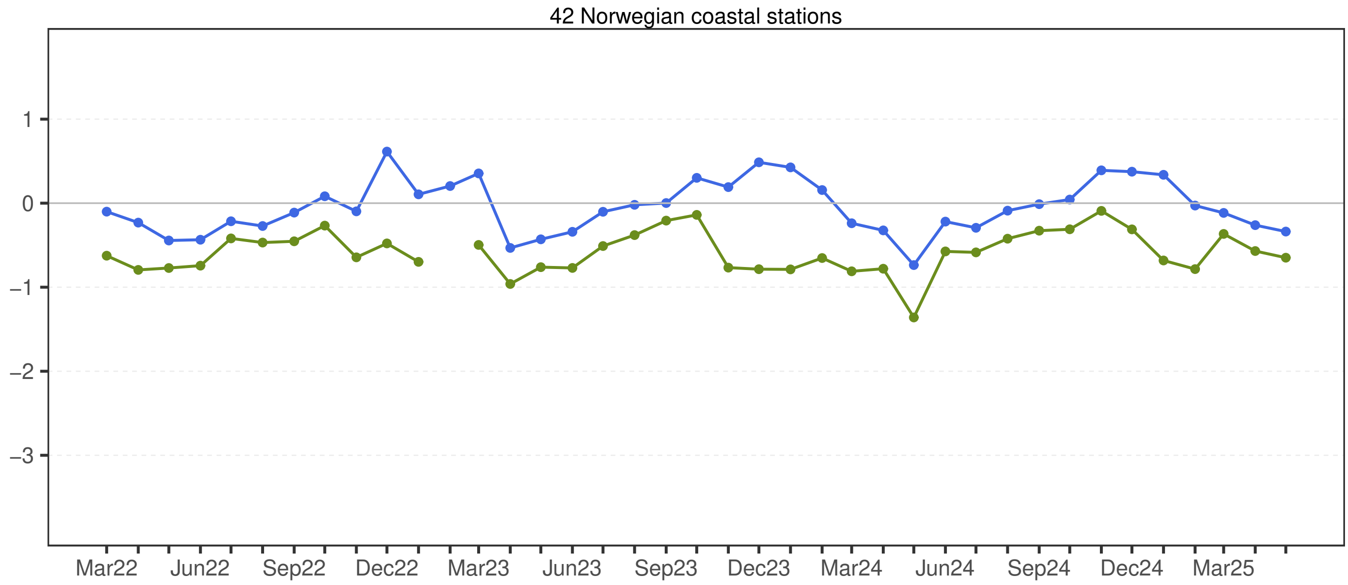


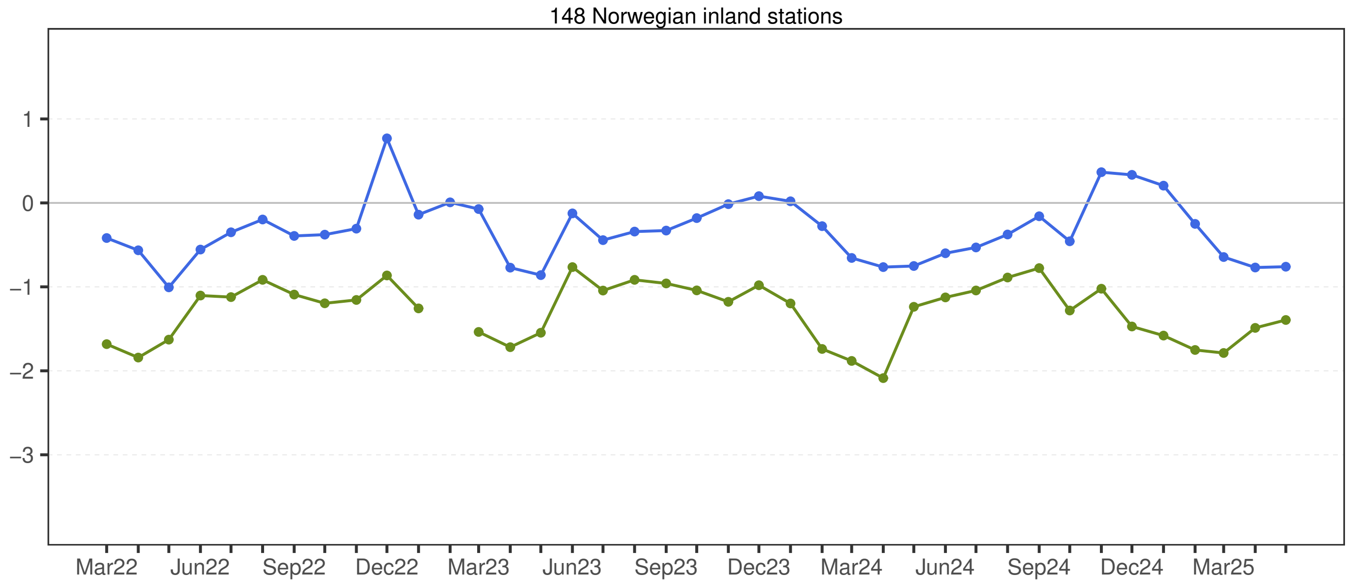
Mean Error

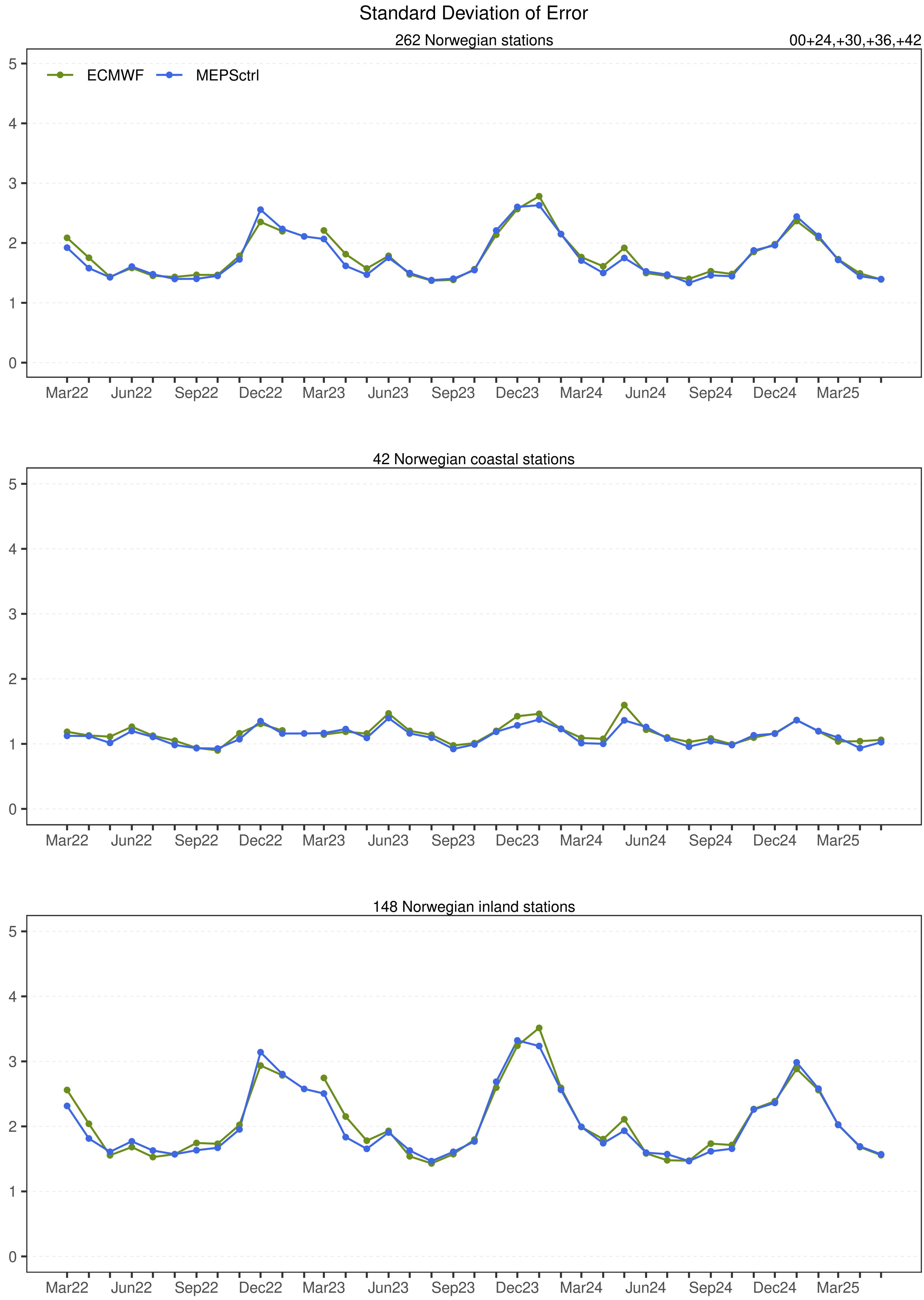


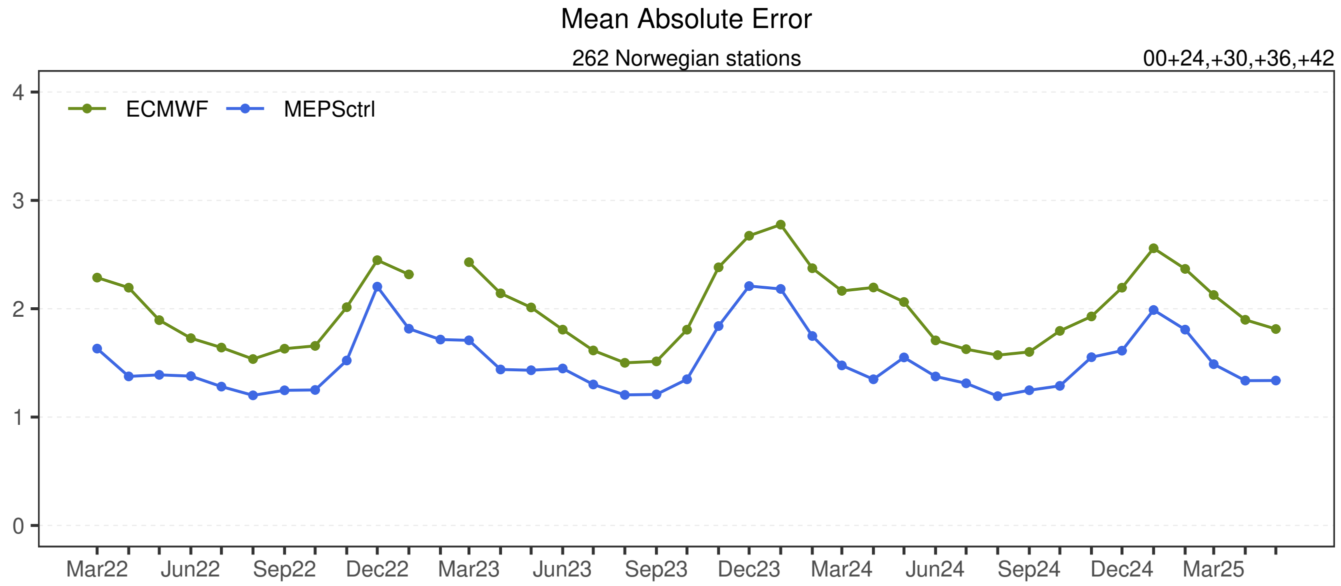

Mean Error
247 Nor. stations 00+3,+6,..., +66
ECMWF
MEPSctrl
Standard Deviation of Error
247 Nor. stations 00+3,+6,..., +66
Mean Absolute Error
247 Nor. stations 00+3,+6,..., +66
Mean Error
13 Svalbard stations 00+3,+6,..., +66
AA25
ECMWF
Standard Deviation of Error
13 Svalbard stations 00+3,+6,..., +66
Mean Absolute Error
13 Svalbard stations 00+3,+6,..., +66
Mean Error
75 North Nor. stations 00+3,+6,..., +66
AA25
ECMWF
MEPSctrl
Standard Deviation of Error
75 North Nor. stations 00+3,+6,..., +66
Mean Absolute Error
75 North Nor. stations 00+3,+6,..., +66
Lead time (hour)

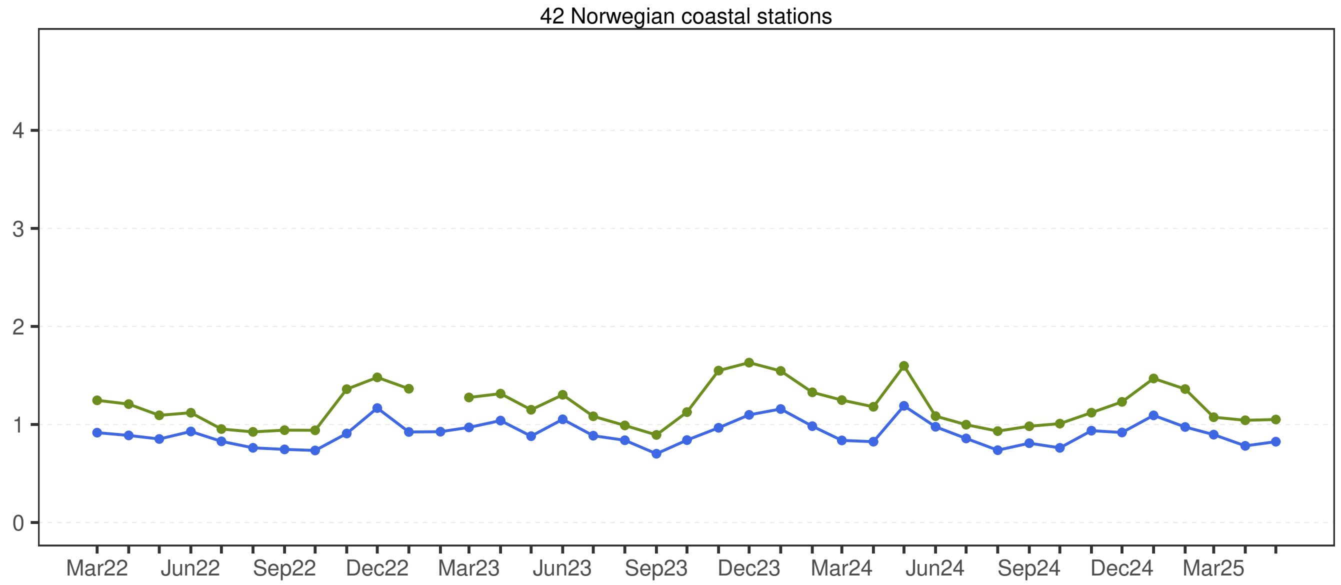

Mean Error
262 Norwegian stations
00+24,+30,+36,+42
ECMWF
MEPSctrl
1
0
−1
−2
−3
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25

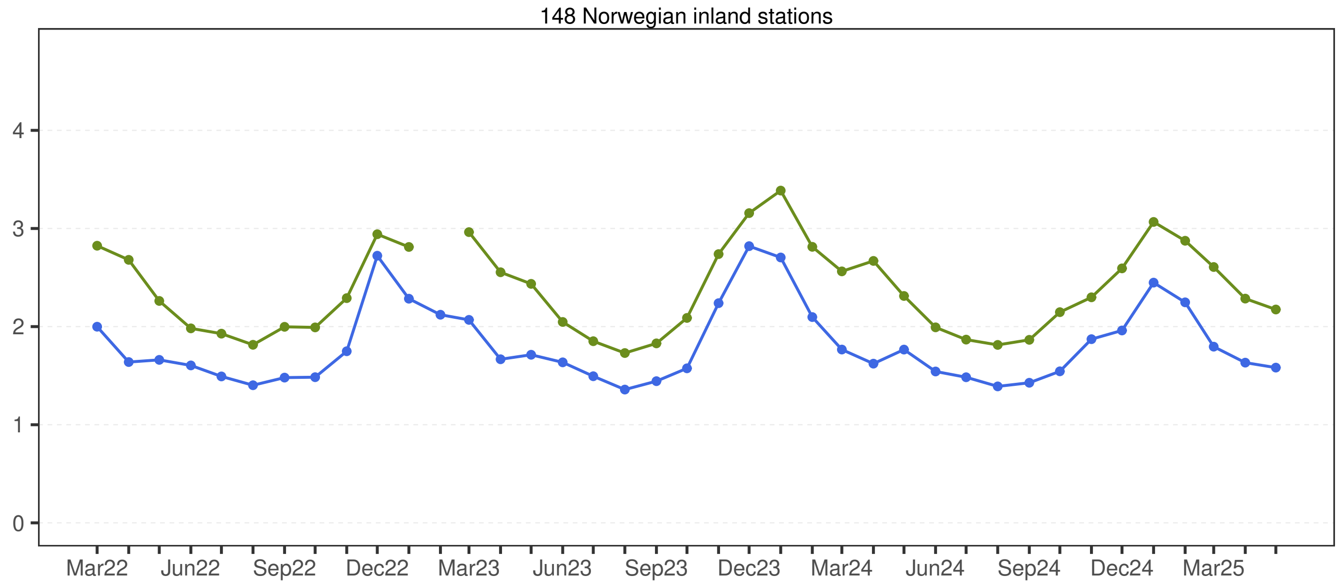

42 Norwegian coastal stations
1
0
−1
−2
−3
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25


148 Norwegian inland stations
1
0
−1
−2
−3
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25


Standard Deviation of Error
262 Norwegian stations
00+24,+30,+36,+42
ECMWF
MEPSctrl
42 Norwegian coastal stations
148 Norwegian inland stations
0
1
2
3
4
5
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25

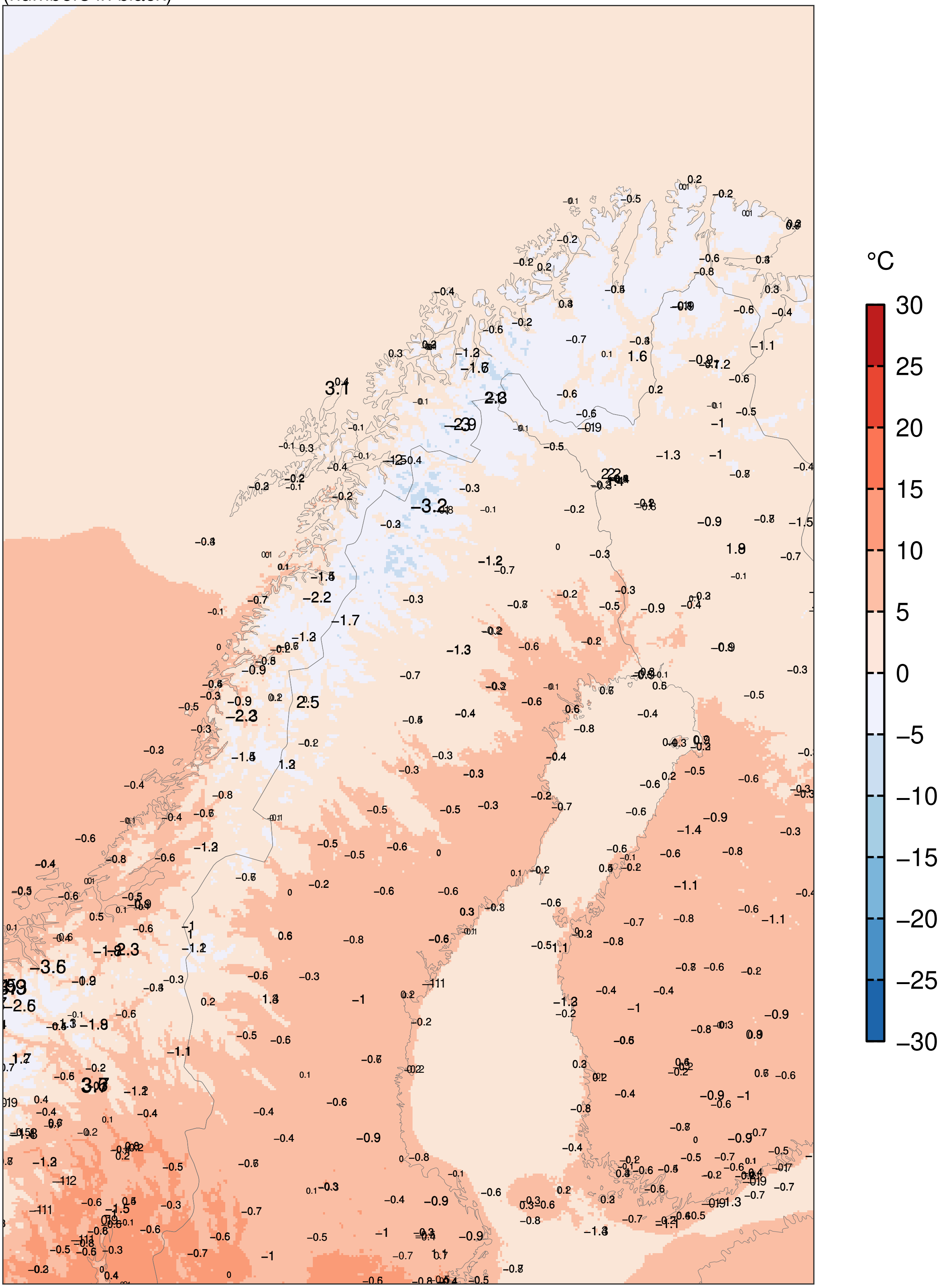

Mean Absolute Error
262 Norwegian stations
00+24,+30,+36,+42
ECMWF
MEPSctrl
0
1
2
3
4
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25


42 Norwegian coastal stations
0
1
2
3
4
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25

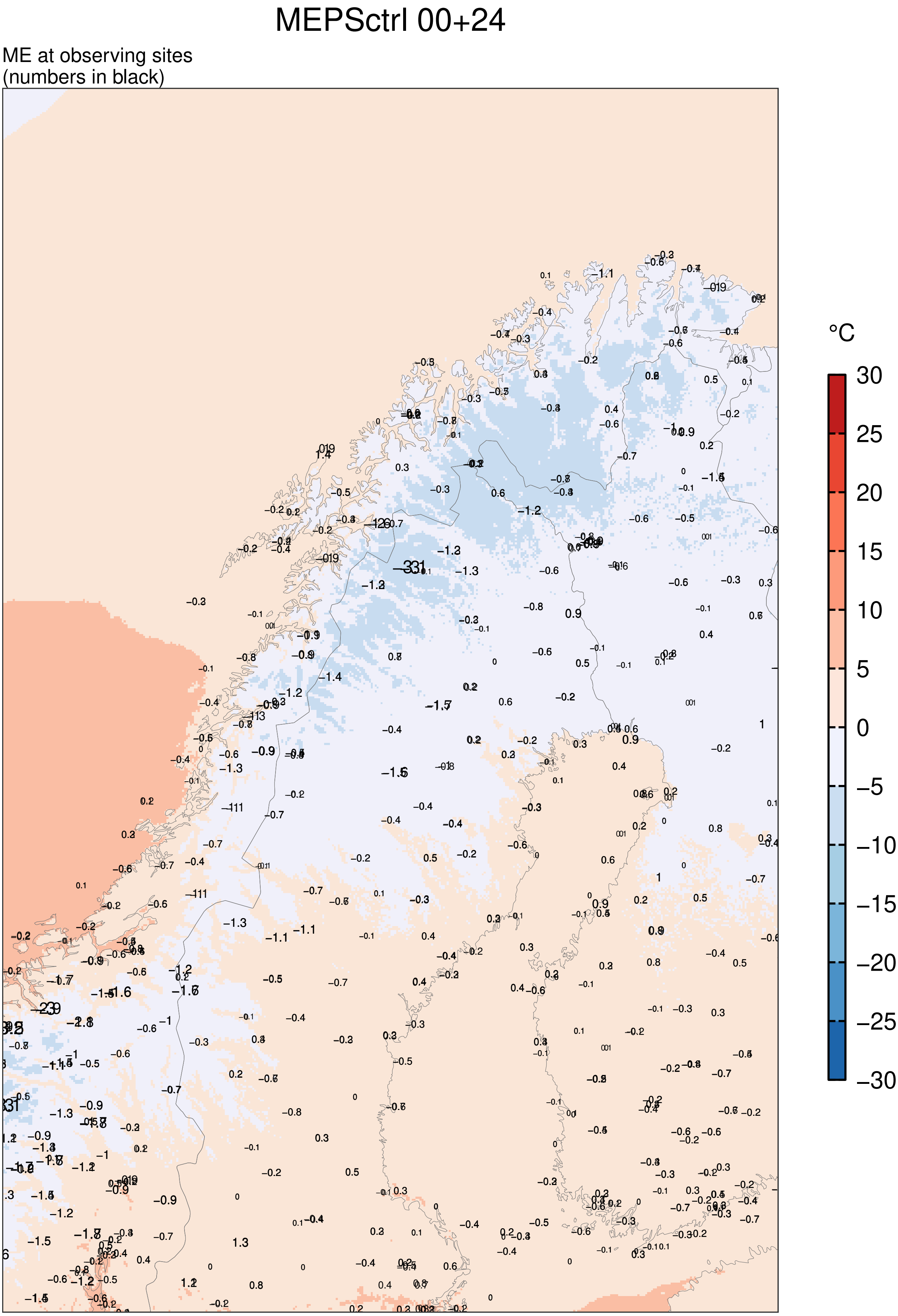

148 Norwegian inland stations
0
1
2
3
4
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25

MEPSctrl 00+12

ME at observing sites
(numbers in black)



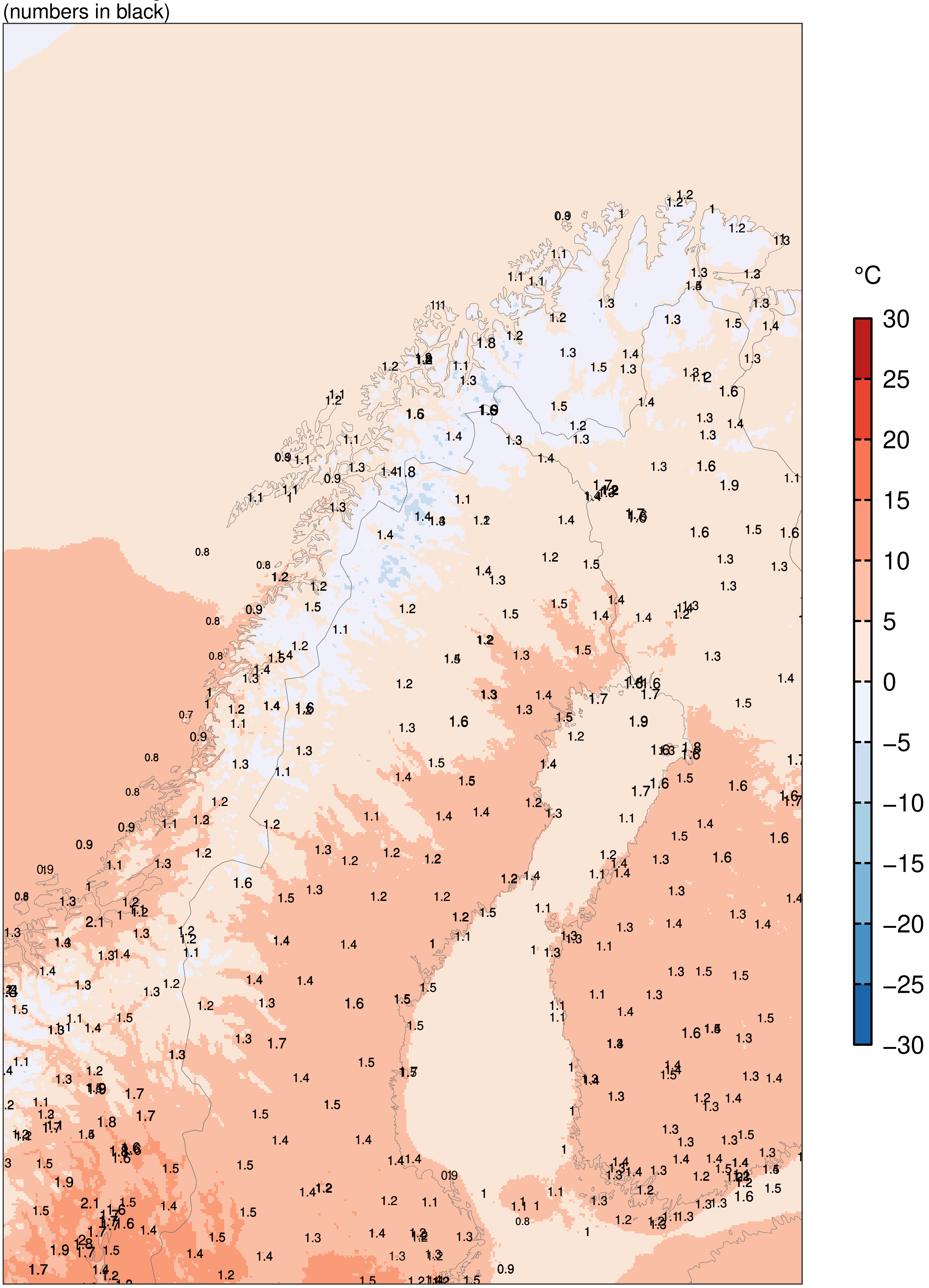
Model "climatology" 01.03.2025–31.05.2025



Model "climatology" 01.03.2025–31.05.2025

MEPSctrl 00+12

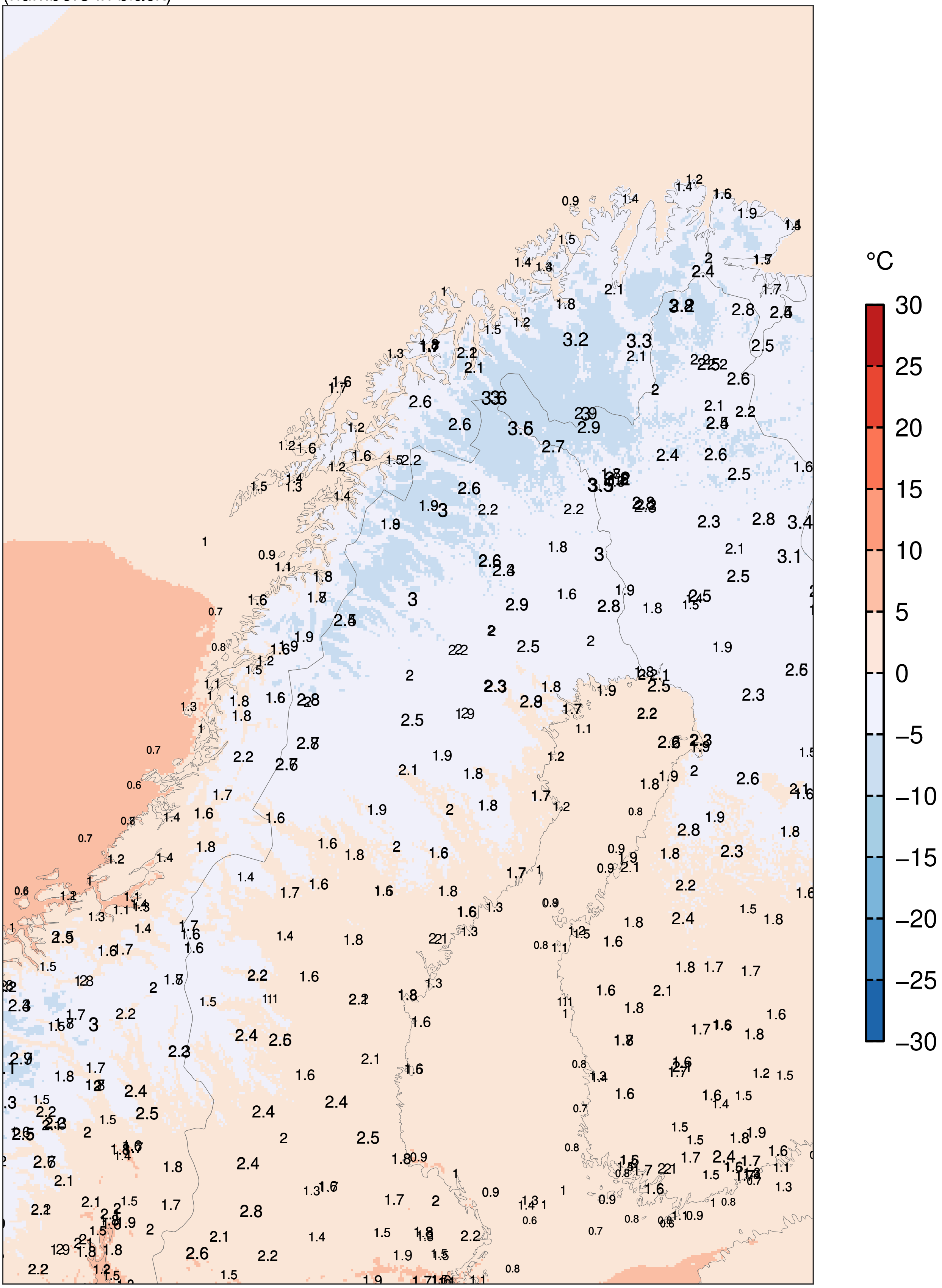
SDE at observing sites
(numbers in black)



Model "climatology" 01.03.2025–31.05.2025

MEPSctrl 00+24

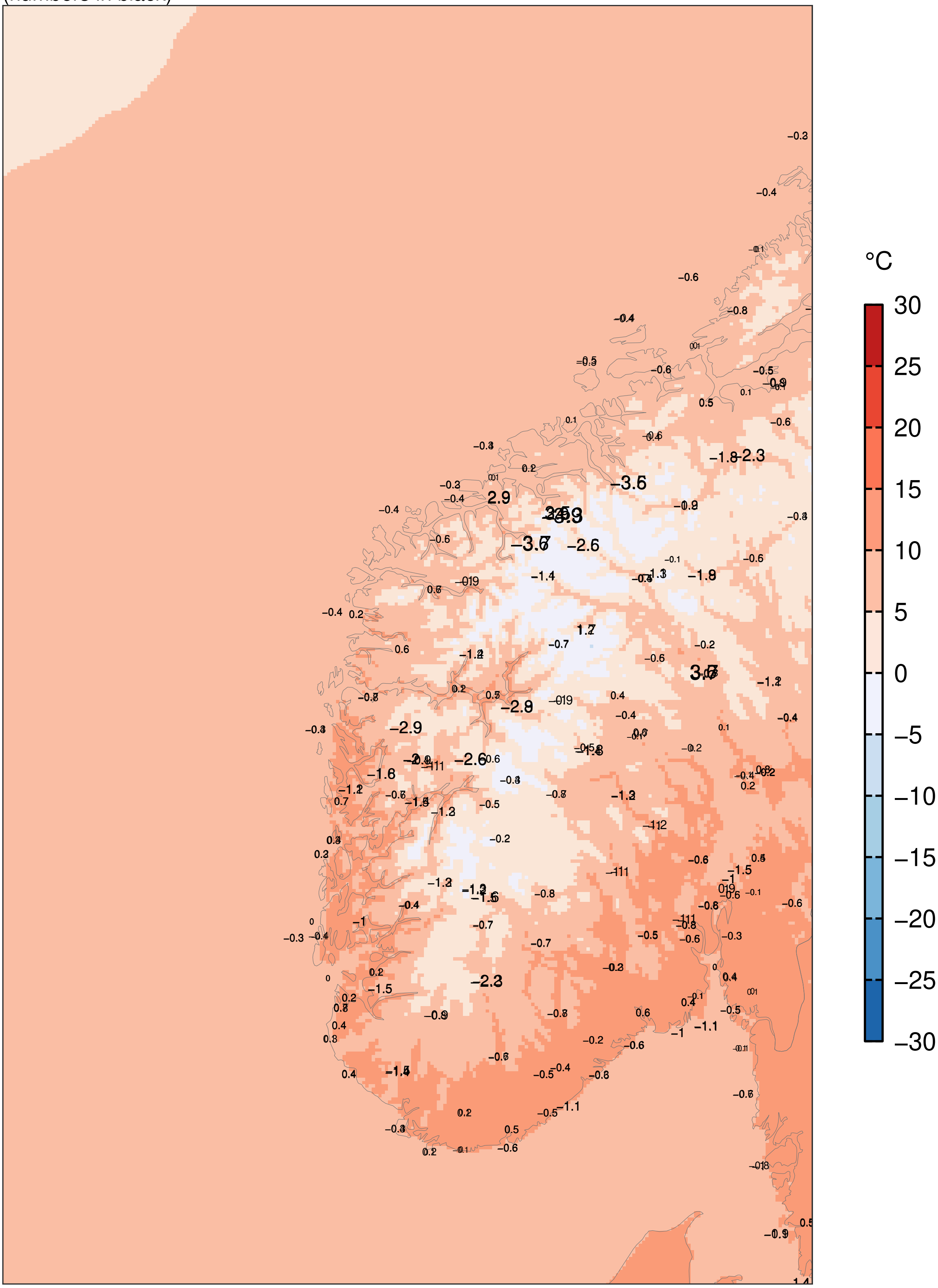
SDE at observing sites
(numbers in black)



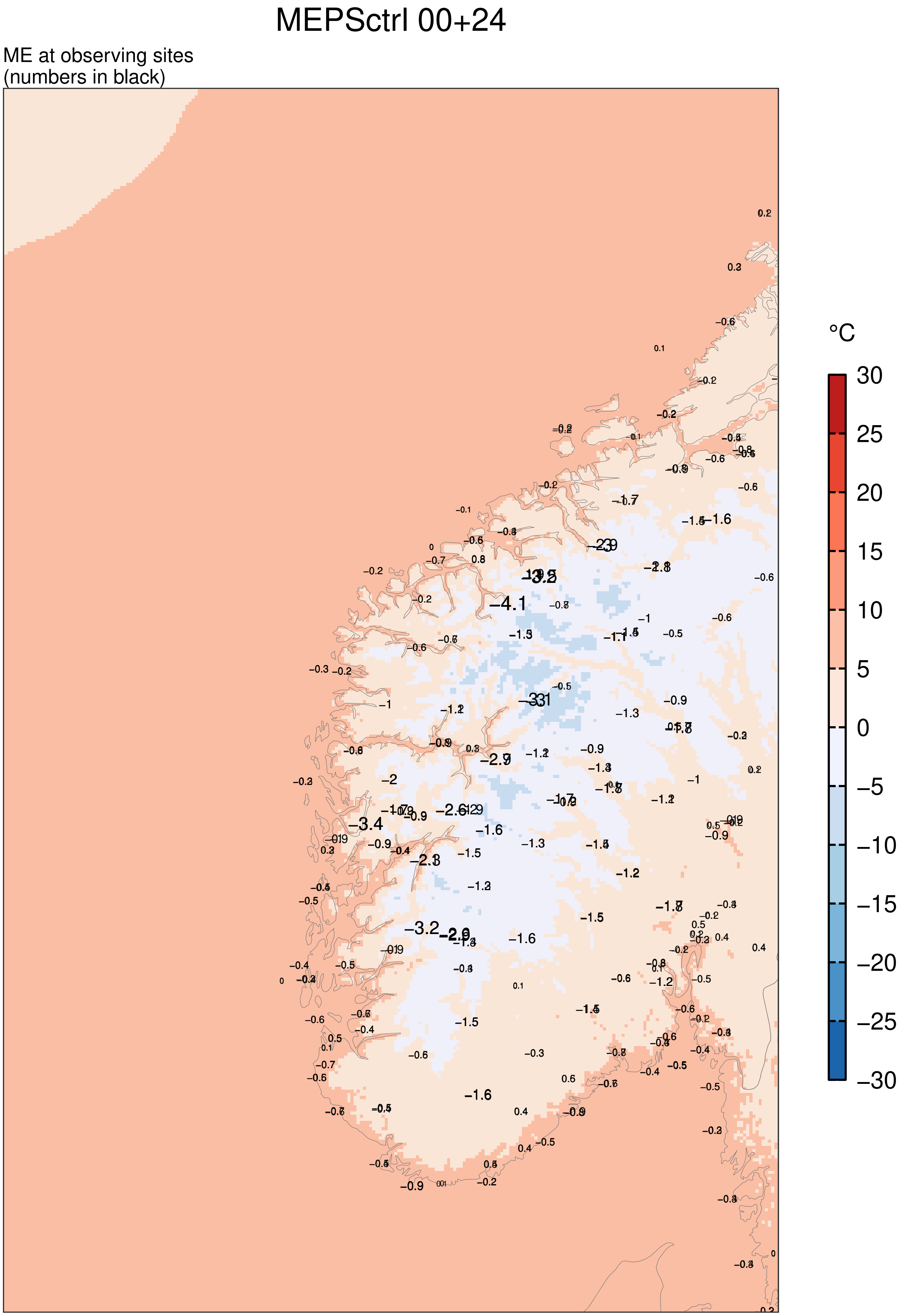
Model "climatology" 01.03.2025–31.05.2025

MEPSctrl 00+12

ME at observing sites
(numbers in black)

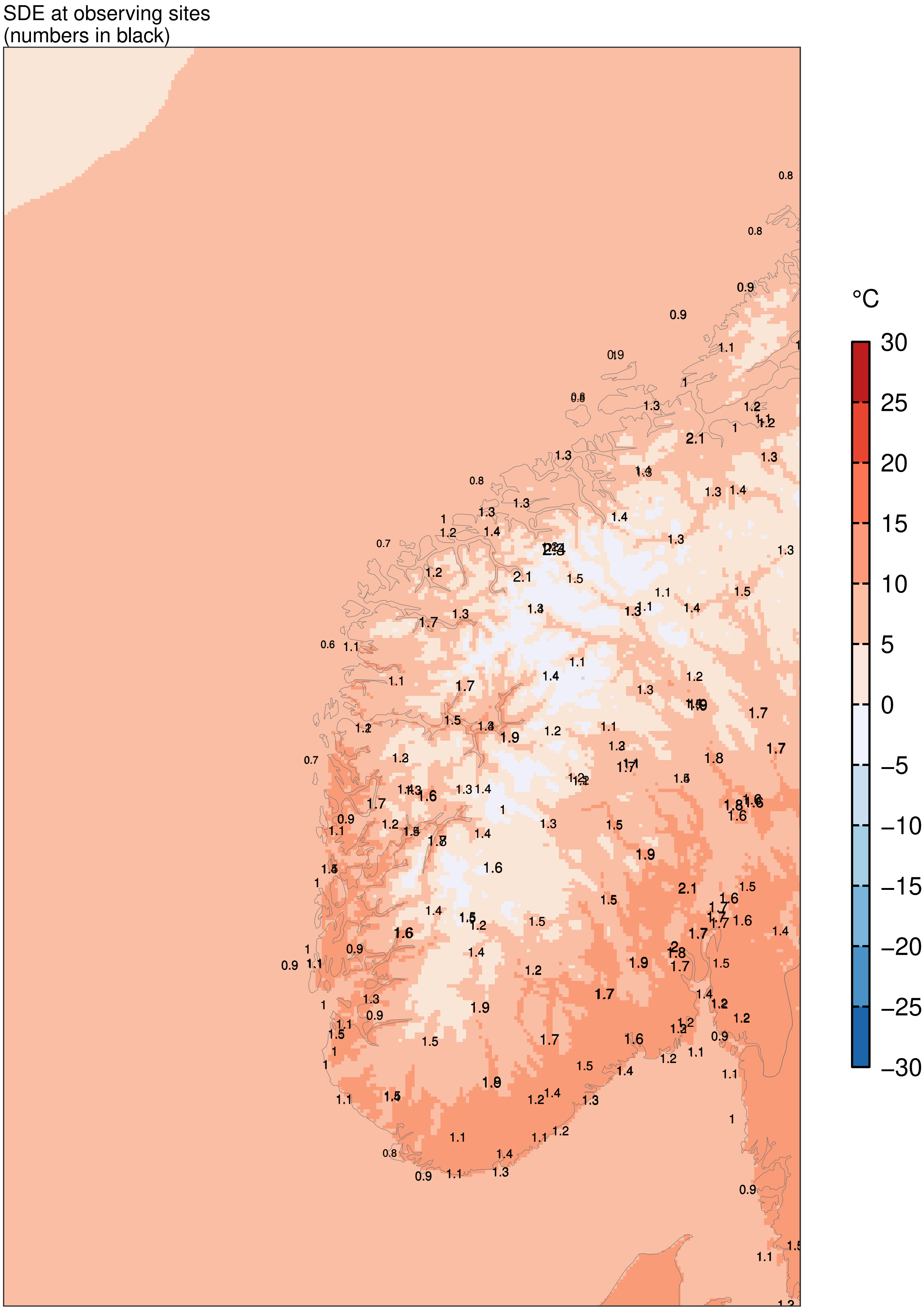


Model "climatology" 01.03.2025–31.05.2025



Model "climatology" 01.03.2025–31.05.2025

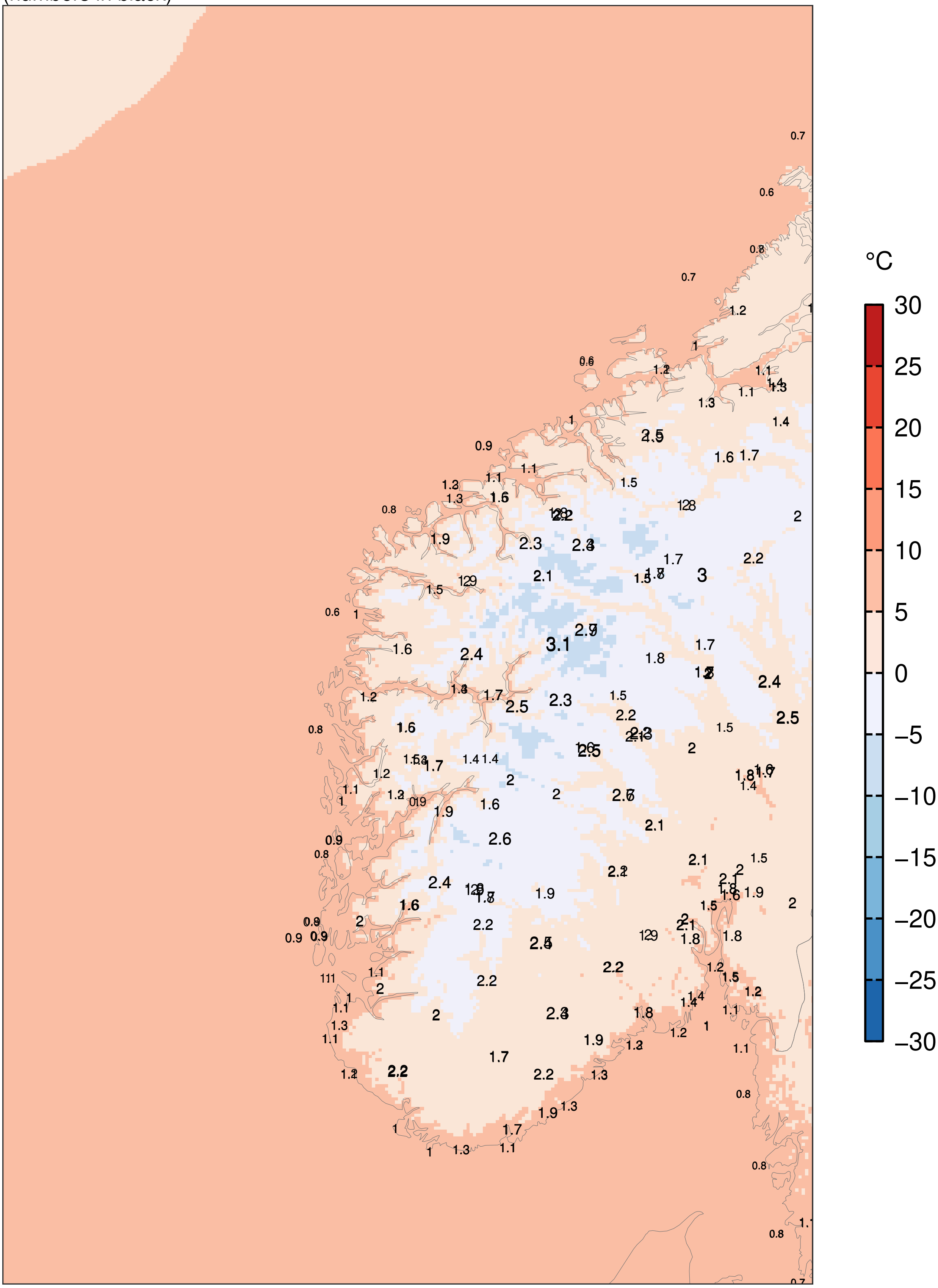
MEPSctrl 00+12



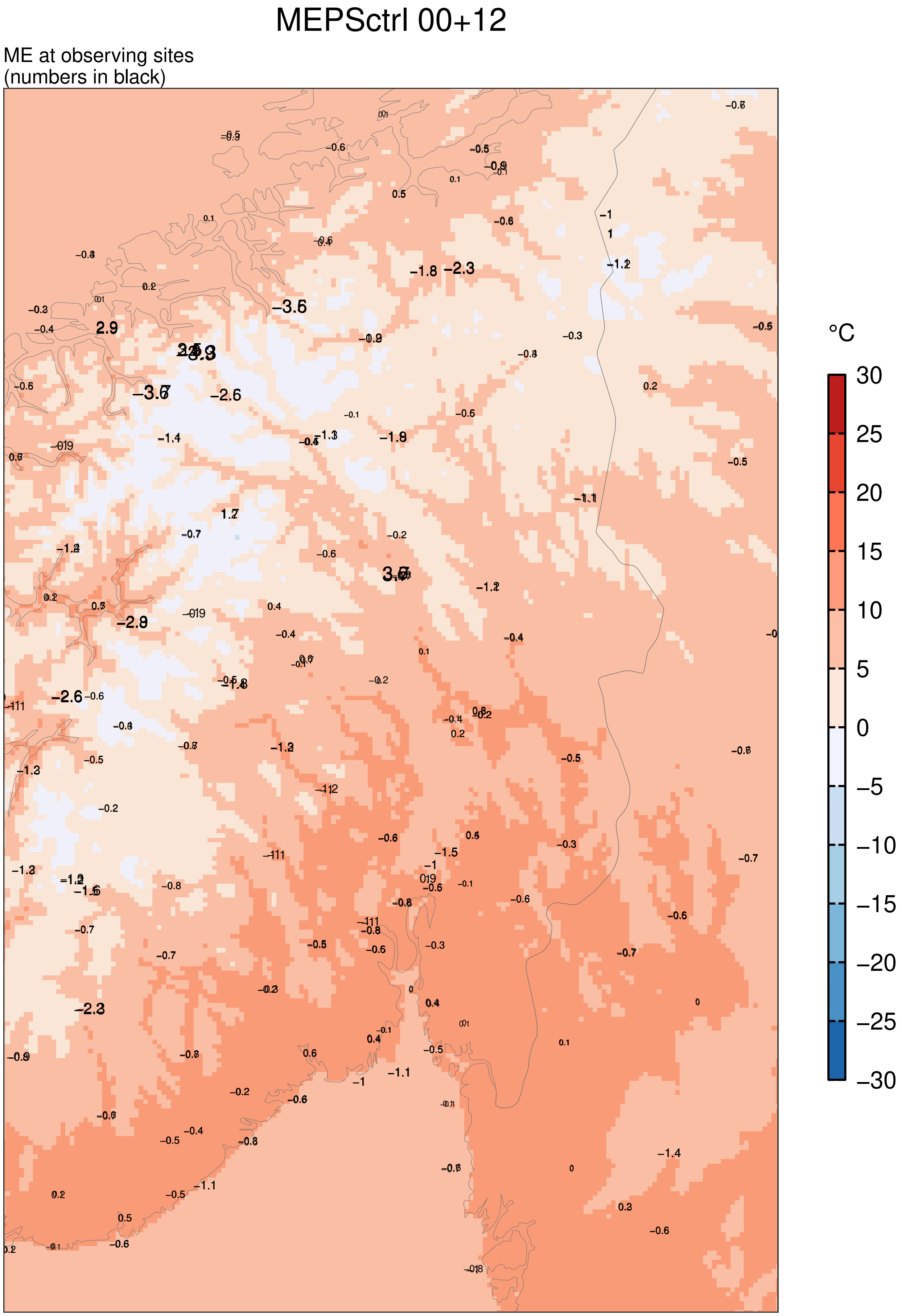
Model "climatology" 01.03.2025–31.05.2025

MEPSctrl 00+24

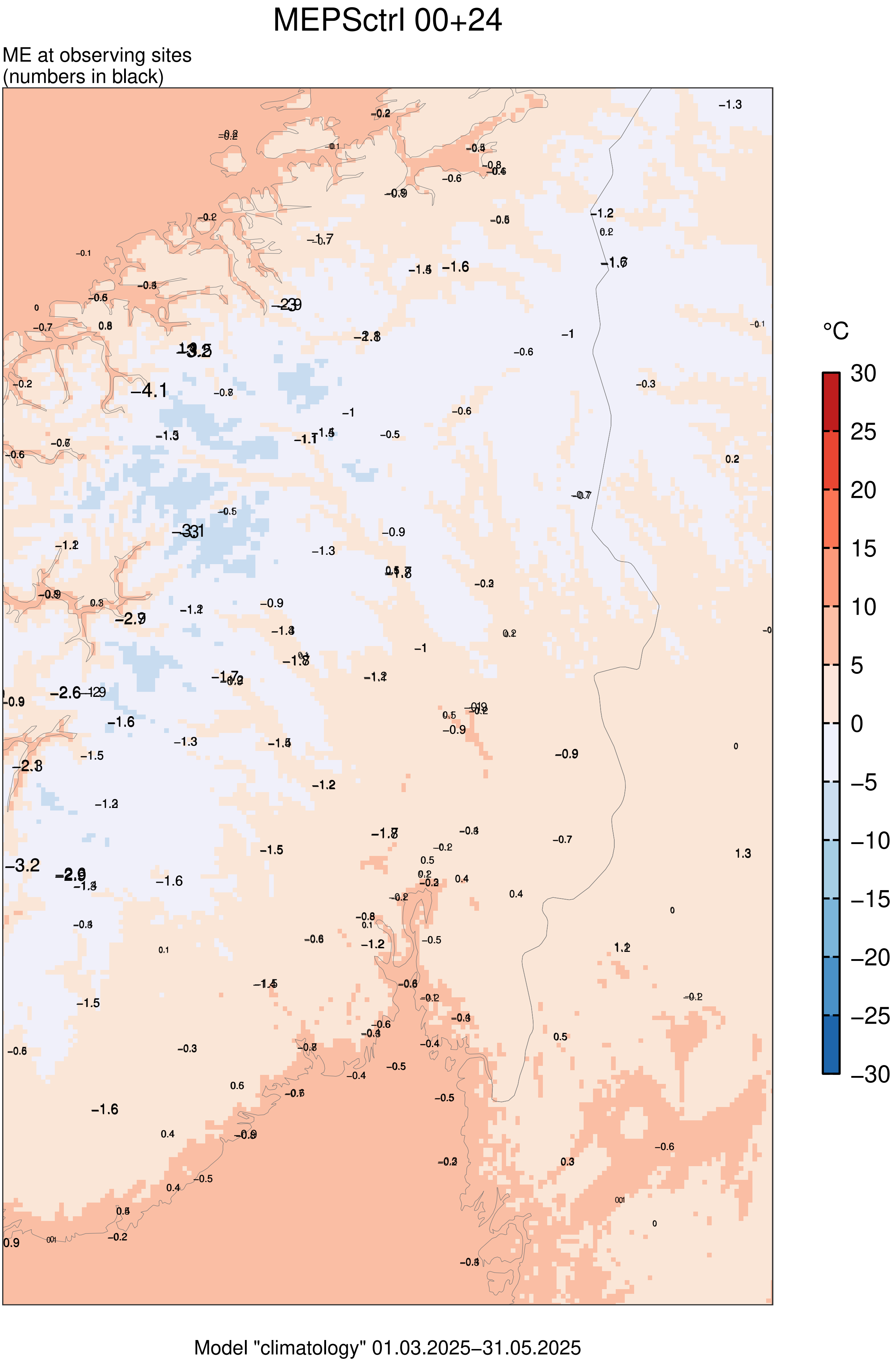
SDE at observing sites
(numbers in black)



Model "climatology" 01.03.2025–31.05.2025

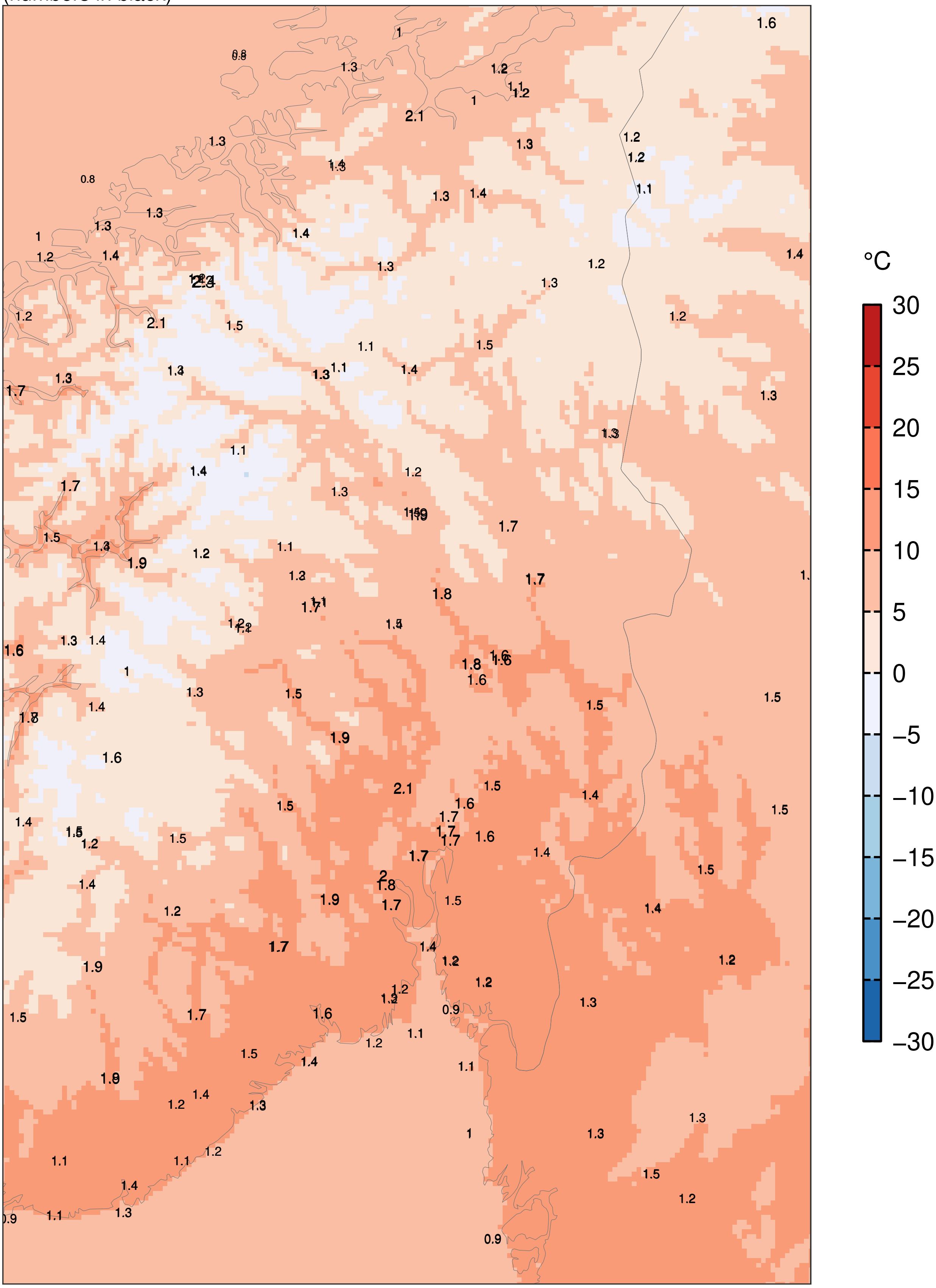


Model "climatology" 01.03.2025–31.05.2025


MEPSctrl 00+24
ME at observing sites
(numbers in black)
°C
30
25
20
15
10
5
0
−5
−10
−15
−20
−25
−30
Model "climatology" 01.03.2025–31.05.2025

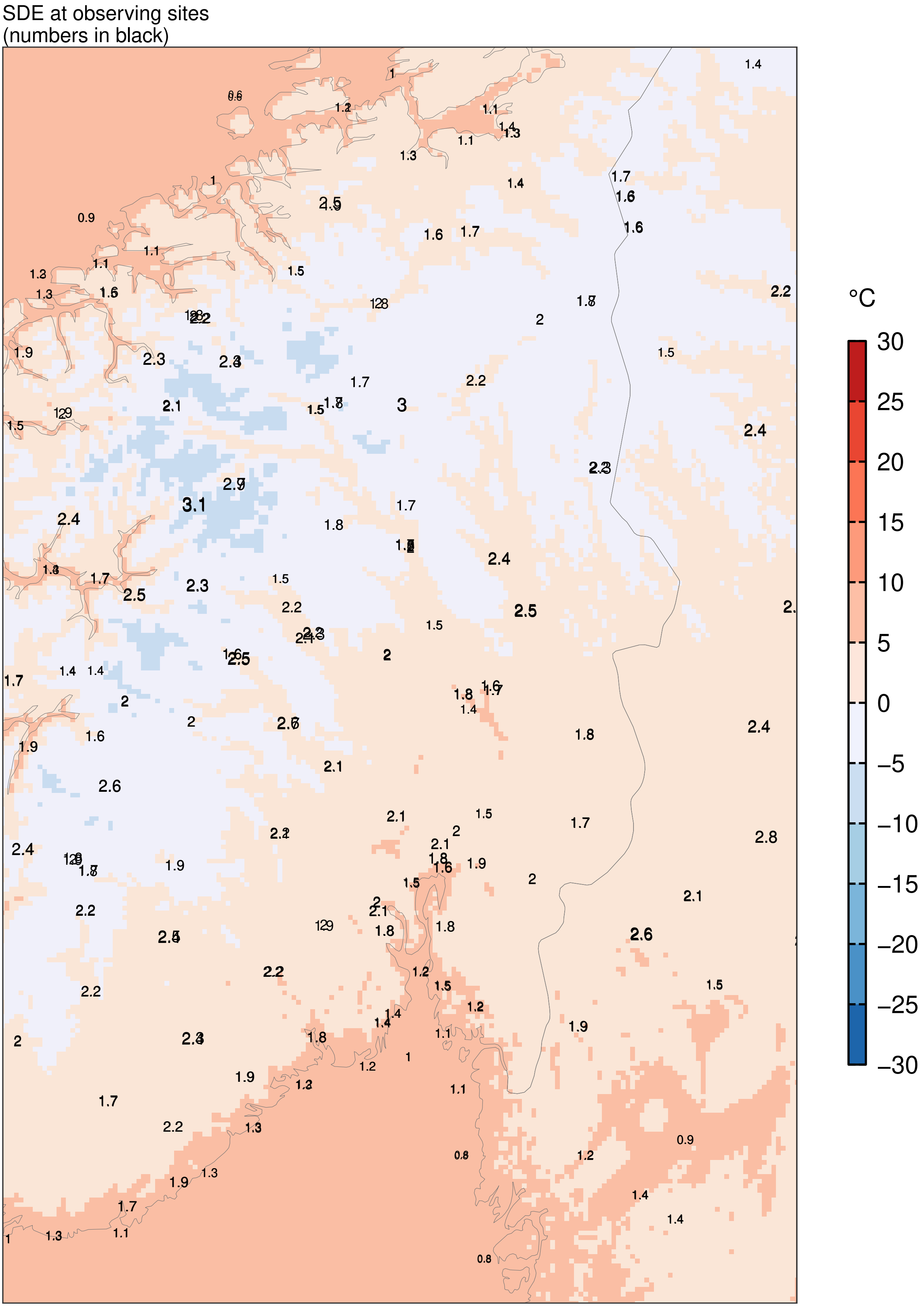
MEPSctrl 00+12

SDE at observing sites
(numbers in black)

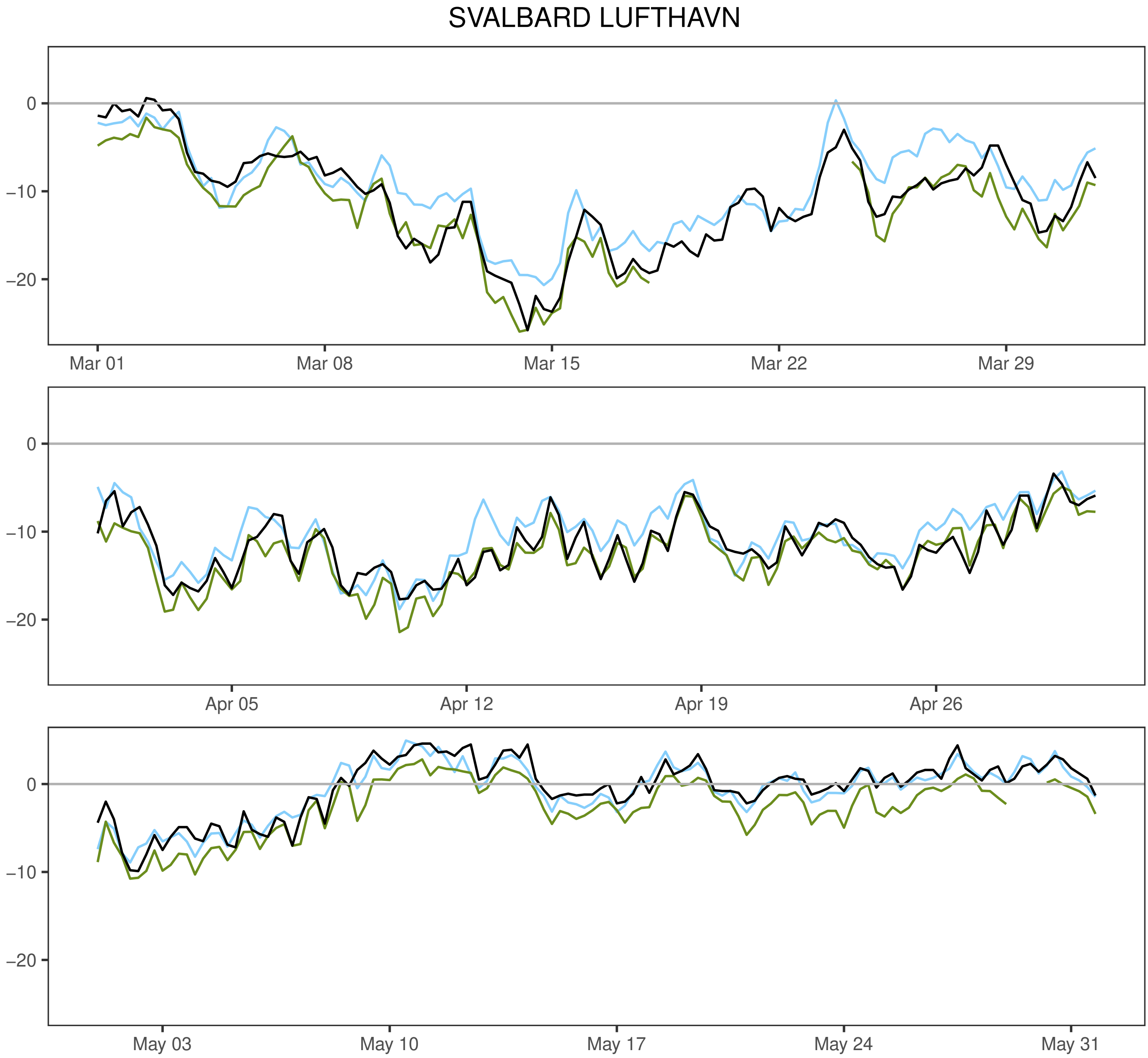


Model "climatology" 01.03.2025–31.05.2025

MEPSctrl 00+24

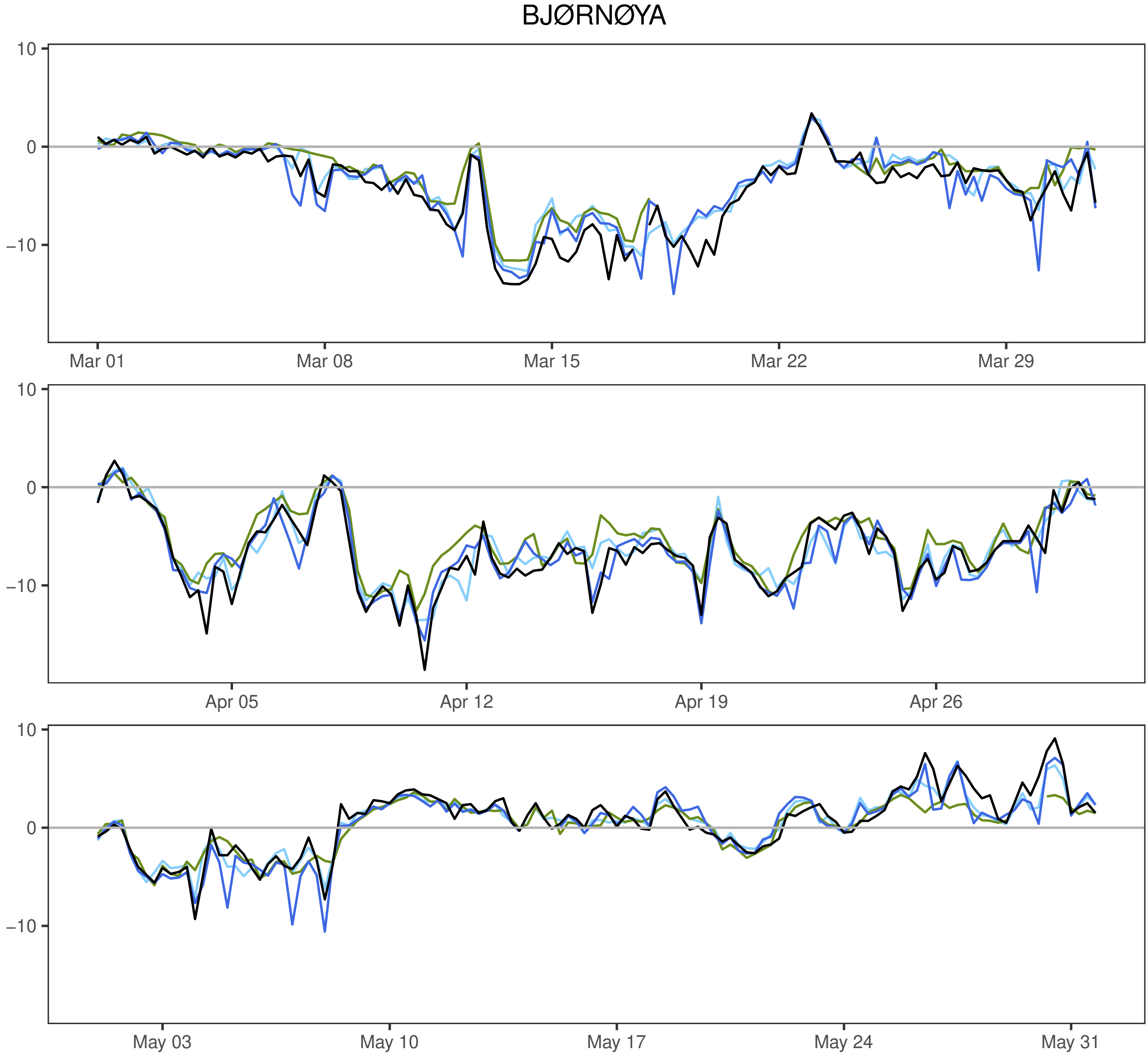


Model "climatology" 01.03.2025–31.05.2025



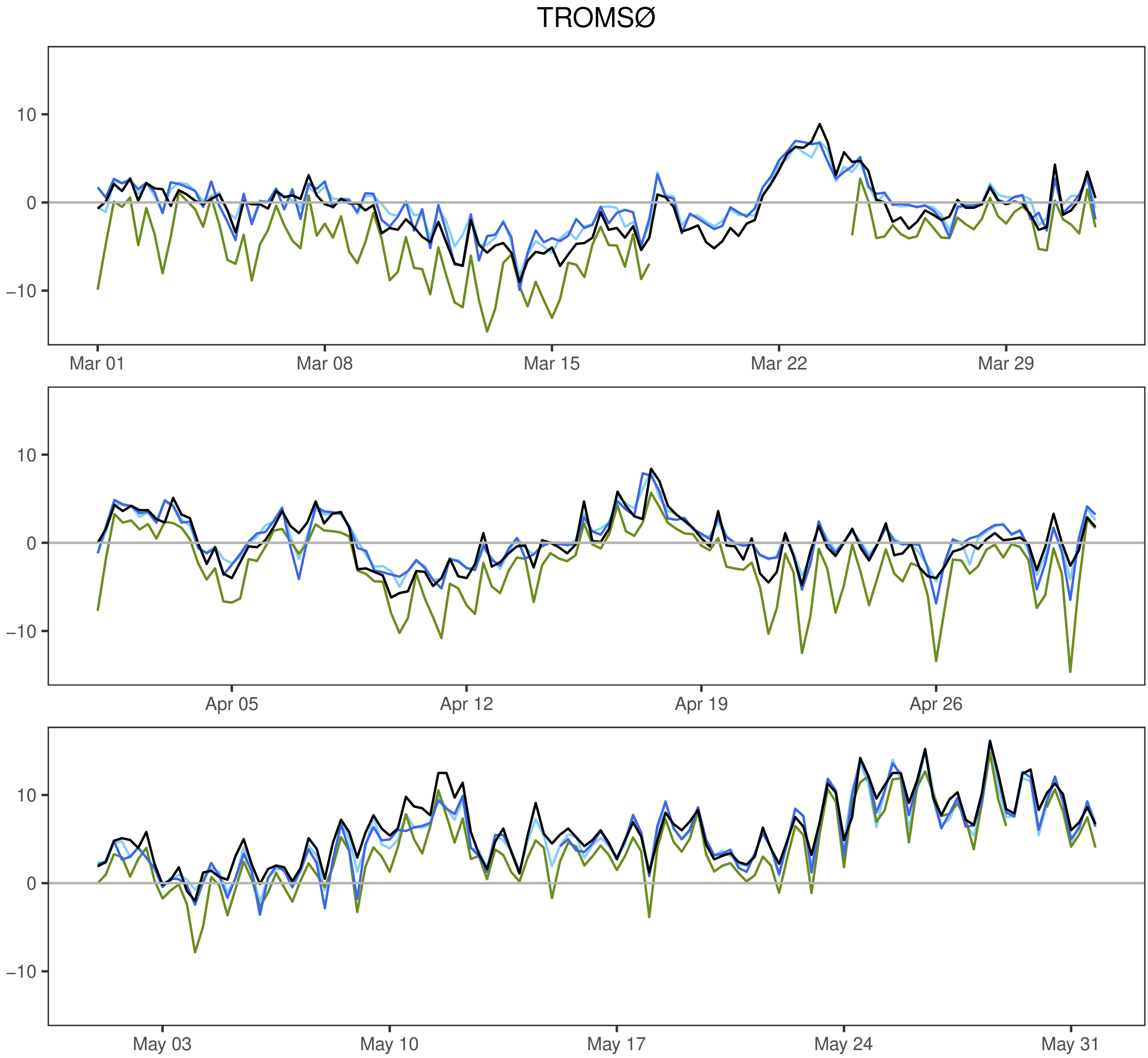
	Min	Mean	Max	Std	N
synop: 00,06,12,18	−25.8	−7.7	4.6	6.7	368
AA25: 12+18,+24,+30,+36	−20.7	−6.8	4.9	5.9	368
ECMWF: 12+18,+24,+30,+36	−26.0	−9.0	2.8	6.3	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
AA25 – synop	0.8	2.1	2.3	1.7	6.9	340
ECMWF – synop	−1.5	1.5	2.2	1.8	5.9	340



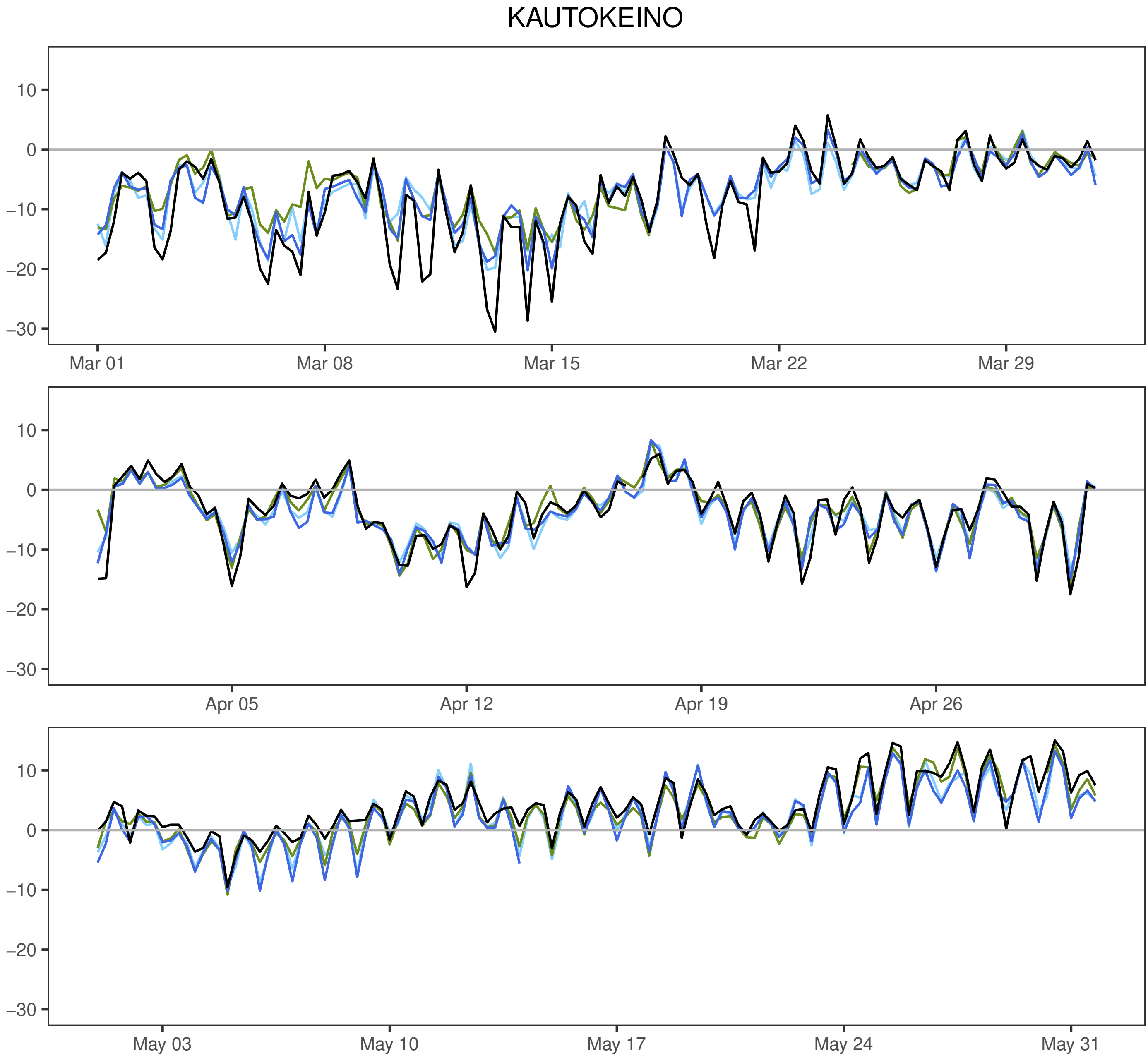
	Min	Mean	Max	Std	N
synop: 00,06,12,18	−18.6	−3.4	9.1	4.8	367
MEPSctrl: 12+18,+24,+30,+36	−15.6	−3.4	7.1	4.6	364
AA25: 12+18,+24,+30,+36	−13.5	−3.0	6.8	4.3	368
ECMWF: 12+18,+24,+30,+36	−12.6	−2.7	3.6	3.8	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	0.0	1.6	1.6	1.1	7.0	335
AA25 – synop	0.4	1.4	1.4	1.0	5.6	335
ECMWF – synop	0.7	1.8	2.0	1.4	7.7	335



	Min	Mean	Max	Std	N
synop: 00,06,12,18	−9.0	1.7	16.1	4.5	368
MEPSctrl: 12+18,+24,+30,+36	−9.9	1.7	16.2	4.1	364
AA25: 12+18,+24,+30,+36	−8.3	1.8	15.8	3.9	368
ECMWF: 12+18,+24,+30,+36	−14.7	−0.9	14.8	5.3	340

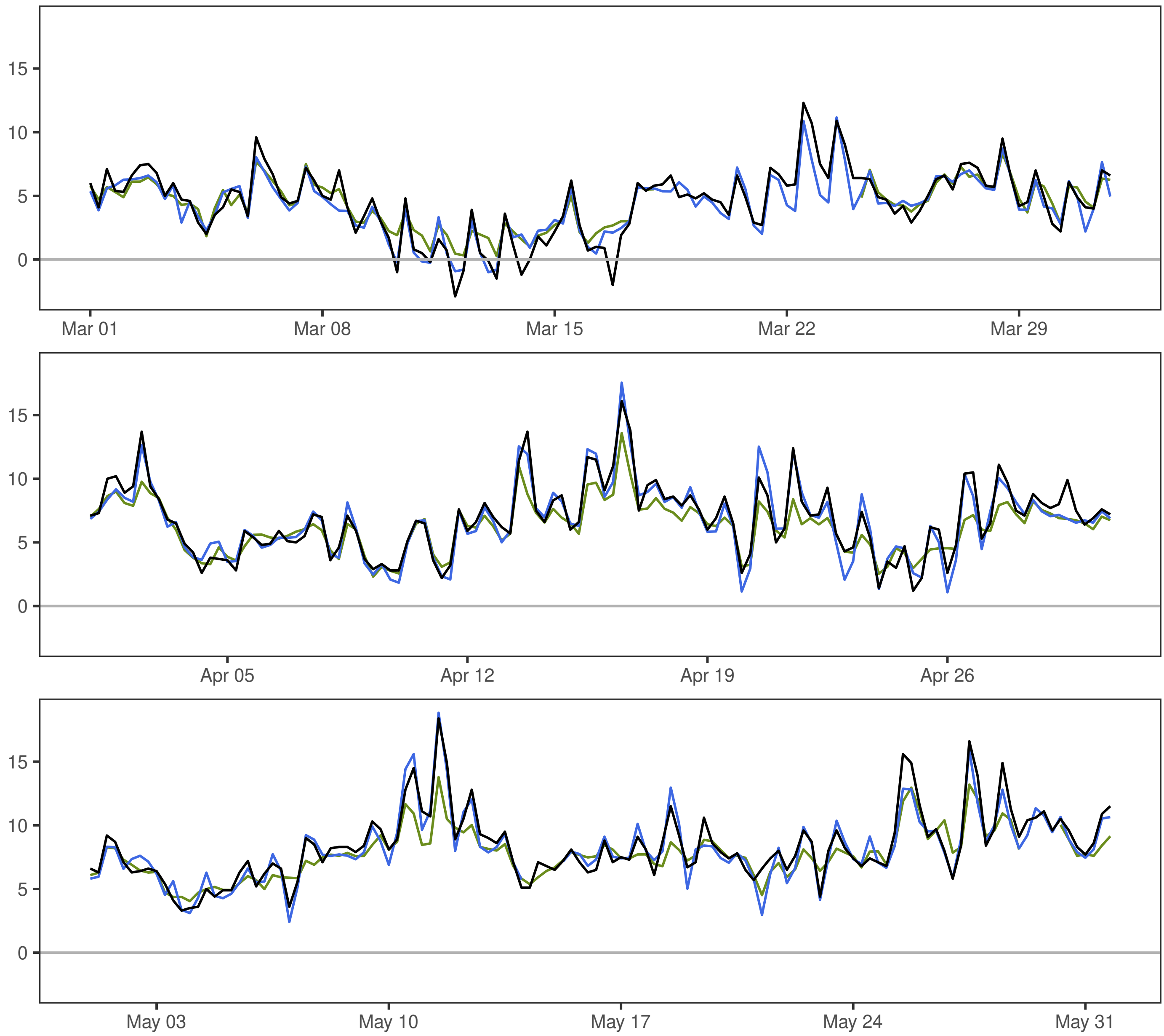
	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	0.0	1.4	1.4	1.1	5.2	336
AA25 – synop	0.1	1.3	1.3	1.0	4.0	336
ECMWF – synop	−2.6	1.9	3.2	2.6	12.1	336



	Min	Mean	Max	Std	N
synop: 00,06,12,18	−30.5	−2.6	15.0	7.8	367
MEPSctrl: 12+18,+24,+30,+36	−20.3	−3.0	13.2	6.3	364
AA25: 12+18,+24,+30,+36	−20.2	−2.8	13.3	6.3	368
ECMWF: 12+18,+24,+30,+36	−17.3	−2.3	14.3	6.2	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	−0.4	2.7	2.7	2.0	12.6	335
AA25 – synop	−0.2	2.8	2.8	2.0	14.1	335
ECMWF – synop	0.3	2.9	2.9	1.9	13.2	335

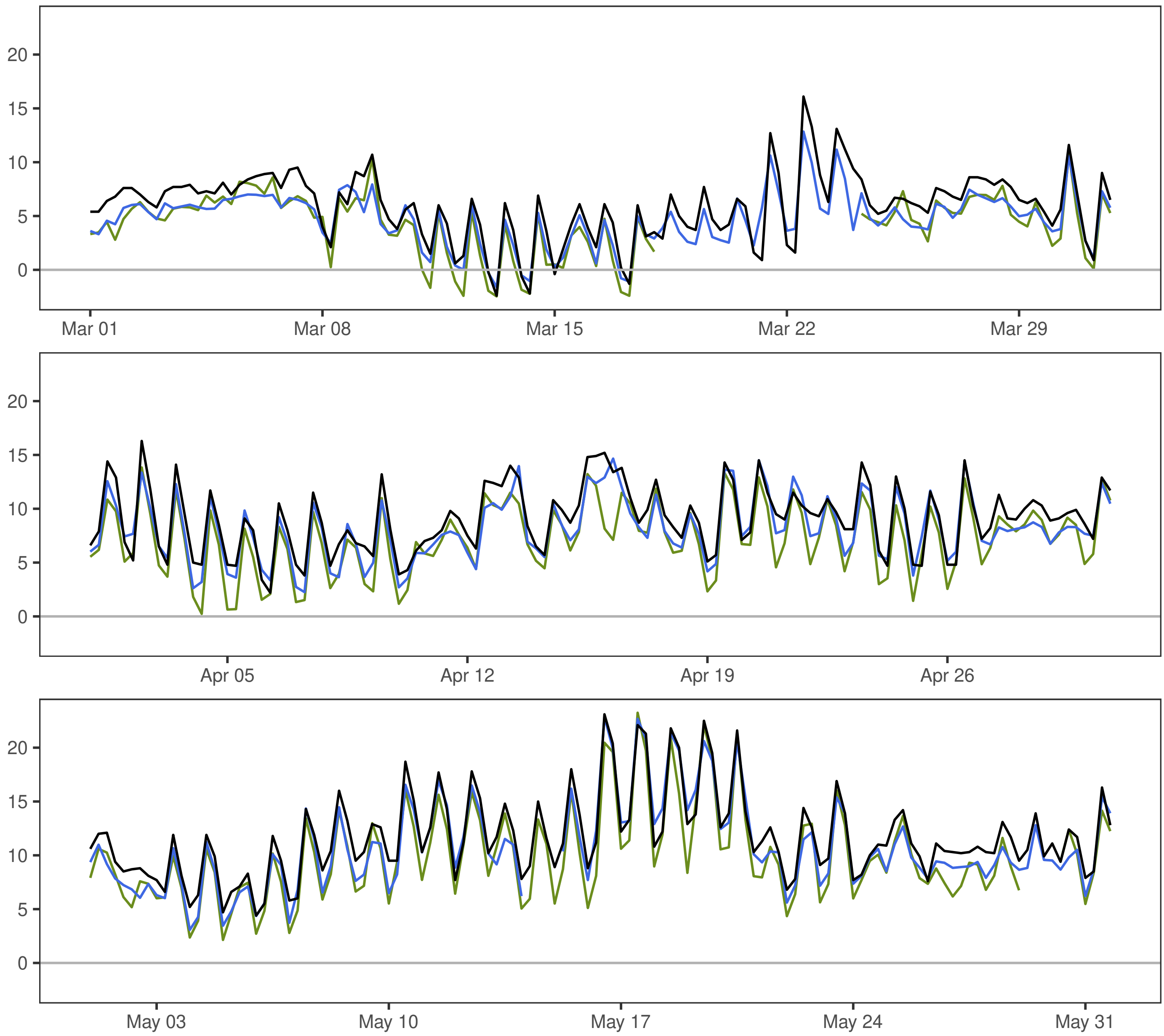
ØRLAND III



	Min	Mean	Max	Std	N
synop: 00,06,12,18	–2.9	6.6	18.4	3.2	368
MEPSctrl: 12+18,+24,+30,+36	–1.0	6.4	18.8	3.1	364
ECMWF: 12+18,+24,+30,+36	0.3	6.2	13.8	2.3	340

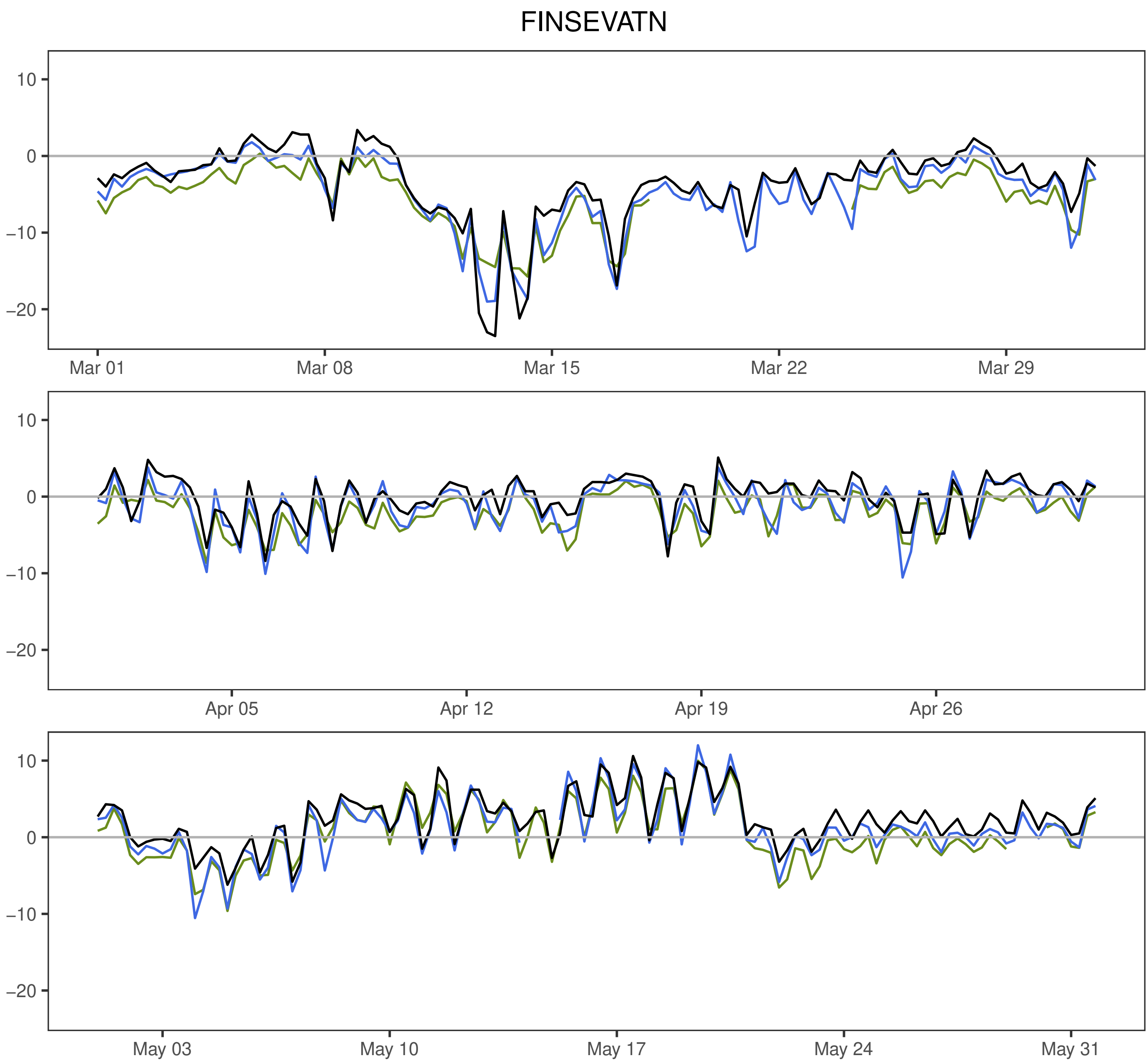
	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	–0.1	0.9	0.9	0.7	4.1	336
ECMWF – synop	–0.4	1.2	1.3	0.9	4.9	336

BERGEN – FLORIDA



	Min	Mean	Max	Std	N
synop: 00,06,12,18	−2.4	8.9	23.1	4.2	368
MEPSctrl: 12+18,+24,+30,+36	−1.6	7.8	22.9	4.1	364
ECMWF: 12+18,+24,+30,+36	−2.5	7.3	23.2	4.3	340

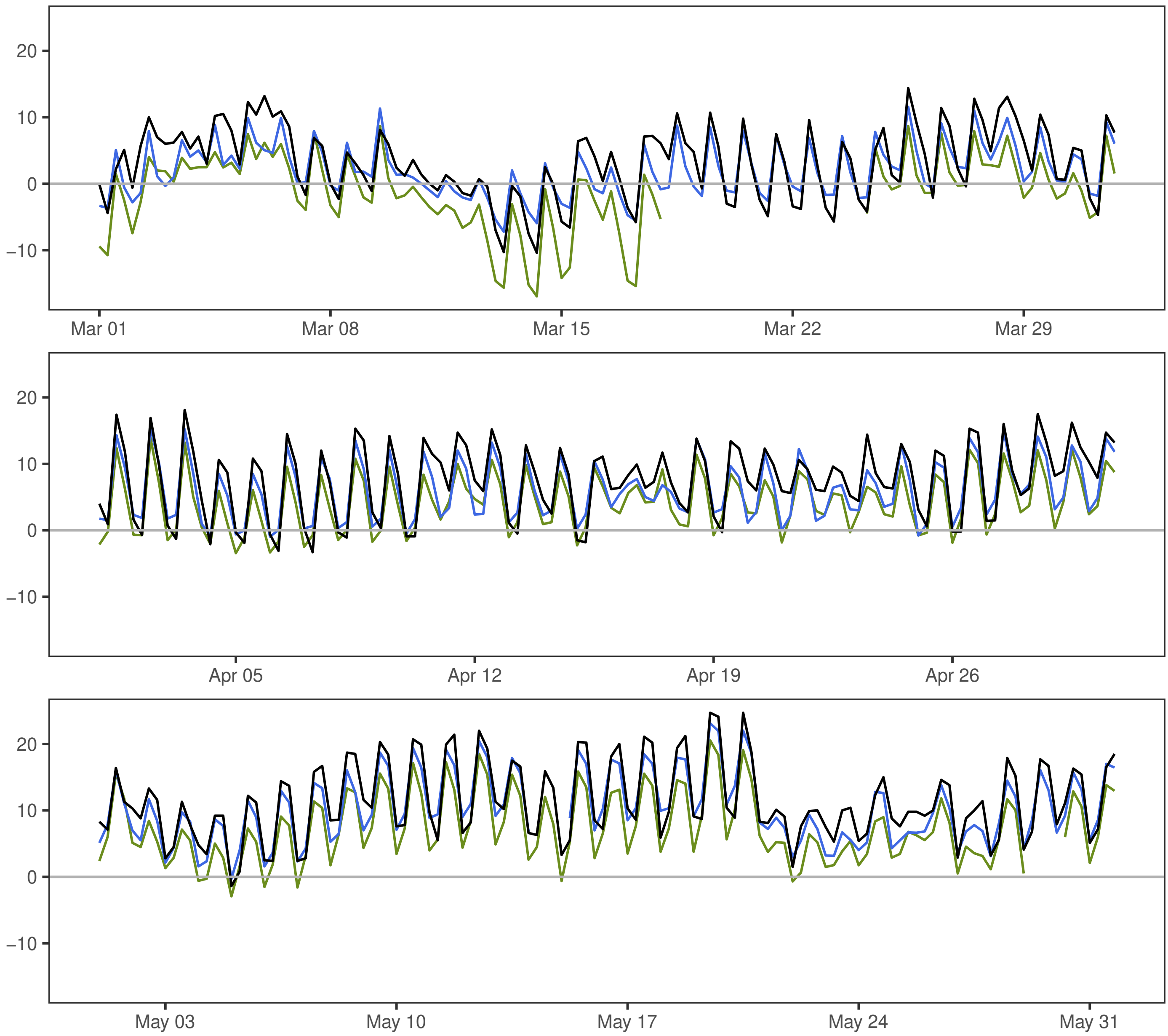
	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	−1.0	1.1	1.5	1.3	3.3	336
ECMWF – synop	−1.7	1.1	2.1	1.8	7.0	336



	Min	Mean	Max	Std	N
synop: 00,06,12,18	−23.5	−0.5	10.6	4.5	368
MEPSctrl: 12+18,+24,+30,+36	−19.0	−1.6	12.0	4.6	364
ECMWF: 12+18,+24,+30,+36	−15.7	−2.1	10.0	4.3	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	−1.1	1.5	1.8	1.4	6.4	336
ECMWF – synop	−1.8	1.8	2.6	2.2	9.1	336

NESBYEN – TODOKK

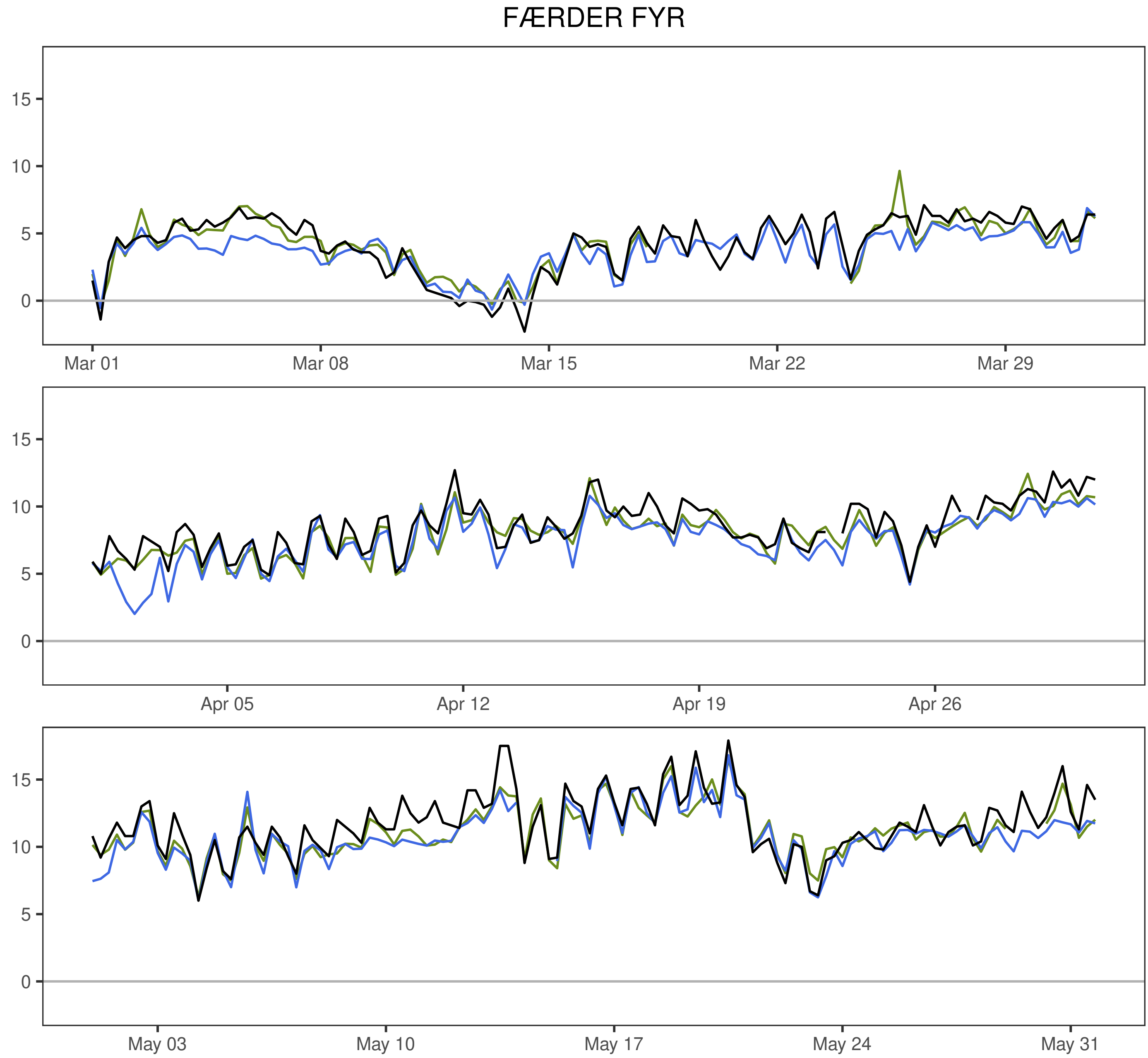


	Min	Mean	Max	Std	N
synop: 00,06,12,18	−10.4	7.4	24.7	6.5	368
MEPSctrl: 12+18,+24,+30,+36	−7.2	6.1	23.1	5.7	364
ECMWF: 12+18,+24,+30,+36	−17.0	3.7	20.5	6.2	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	−1.3	2.4	2.7	2.2	8.2	336
ECMWF – synop	−4.0	2.5	4.7	4.1	11.4	336

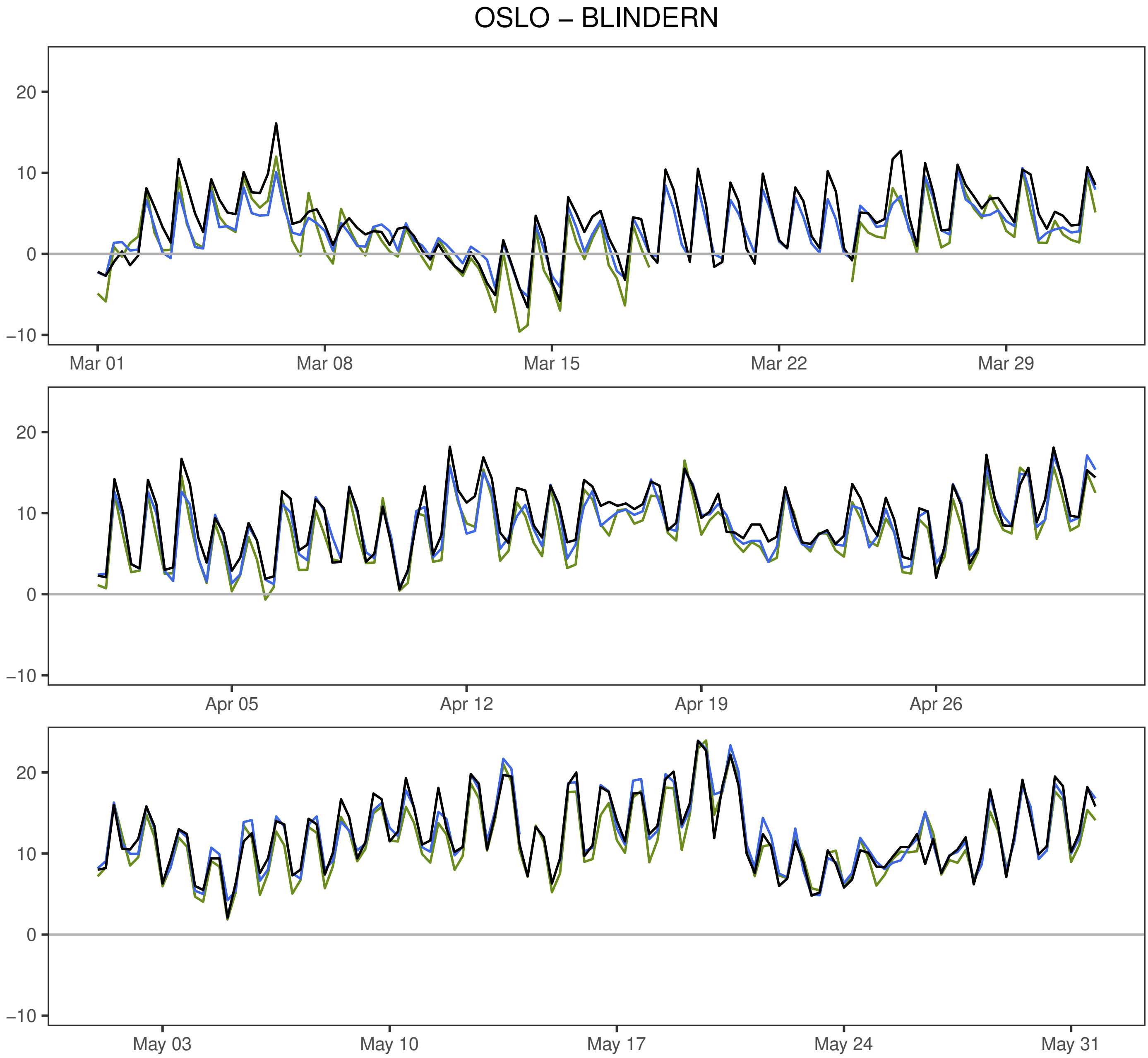
	Min	Mean	Max	Std	N
synop: 00,06,12,18	–3.0	8.3	17.9	3.7	367
MEPSctrl: 12+18,+24,+30,+36	–1.5	8.5	22.8	3.8	364
ECMWF: 12+18,+24,+30,+36	–1.9	7.9	16.6	3.2	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	0.2	1.3	1.3	0.9	6.7	335
ECMWF – synop	–0.4	1.0	1.1	0.9	5.0	335



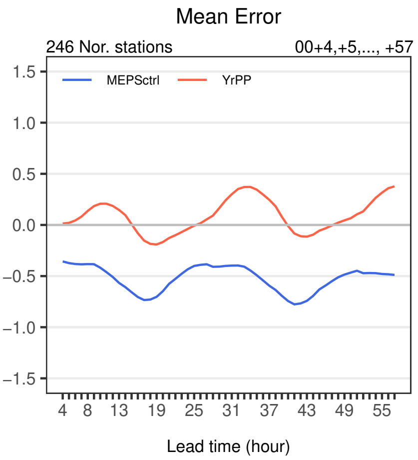
	Min	Mean	Max	Std	N
synop: 00,06,12,18	−2.3	8.1	17.9	3.8	366
MEPSctrl: 12+18,+24,+30,+36	−0.7	7.3	16.8	3.5	364
ECMWF: 12+18,+24,+30,+36	−0.4	8.0	16.5	3.4	340

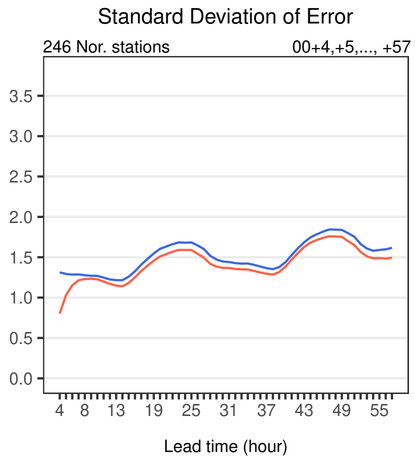
	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	−0.8	1.0	1.3	1.0	5.0	334
ECMWF – synop	−0.4	1.0	1.0	0.8	4.0	334

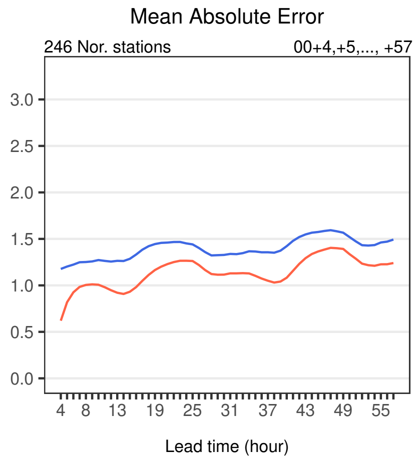


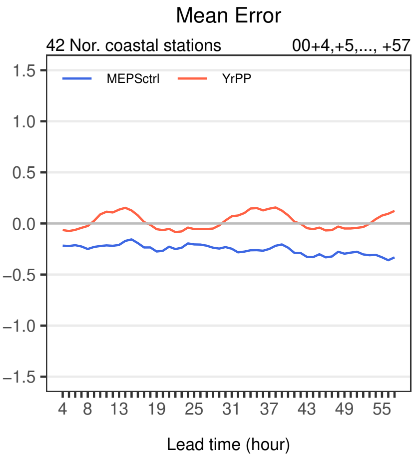
	Min	Mean	Max	Std	N
synop: 00,06,12,18	–6.6	8.5	23.9	5.5	368
MEPSctrl: 12+18,+24,+30,+36	–5.2	7.9	23.9	5.5	364
ECMWF: 12+18,+24,+30,+36	–9.6	7.3	23.9	5.6	340

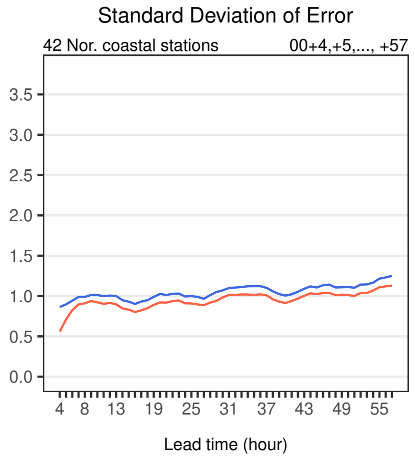
	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	–0.5	1.5	1.6	1.2	6.4	336
ECMWF – synop	–1.4	1.5	2.0	1.7	6.5	336

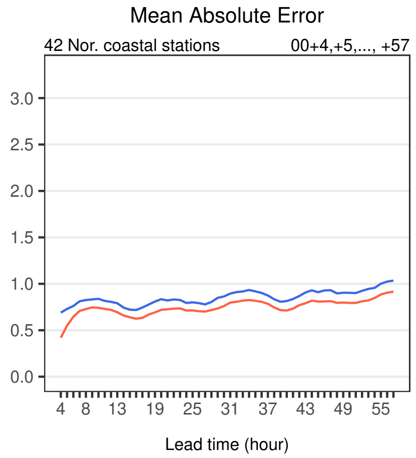

Mean Error
246 Nor. stations
00+4,+5,..., +57
MEPSctrl
YrPP
Lead time (hour)

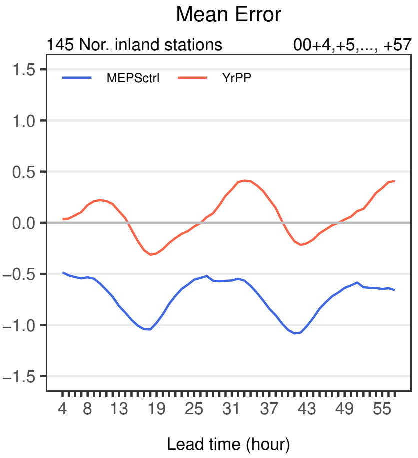

Standard Deviation of Error
246 Nor. stations
00+4,+5,..., +57
Lead time (hour)

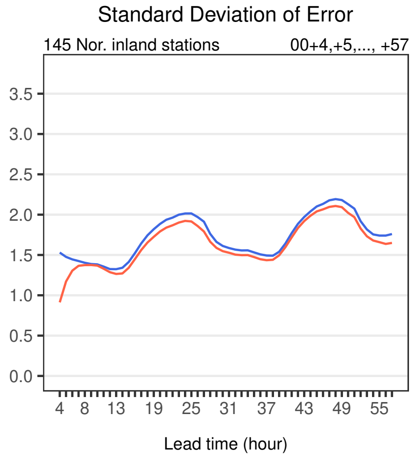

Mean Absolute Error
246 Nor. stations
00+4,+5,..., +57
Lead time (hour)

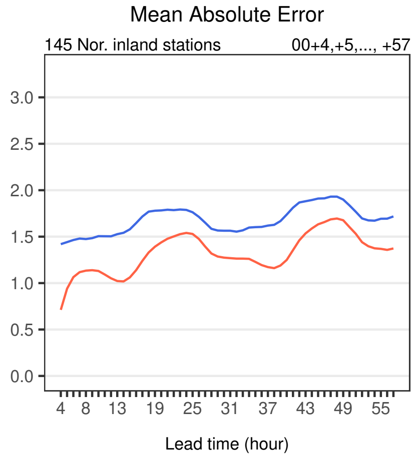

Mean Error
42 Nor. coastal stations
00+4,+5,..., +57
MEPSctrl
YrPP
Lead time (hour)

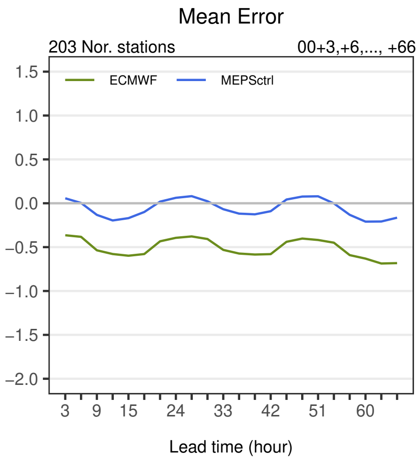

Standard Deviation of Error
42 Nor. coastal stations
00+4,+5,..., +57
Lead time (hour)

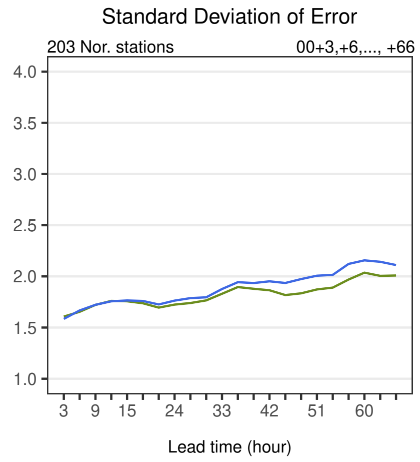

Mean Absolute Error
42 Nor. coastal stations
00+4,+5,..., +57
Lead time (hour)

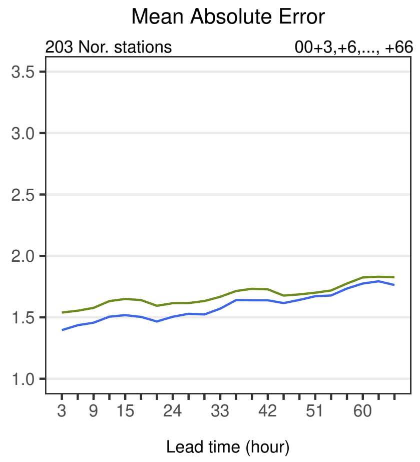

Mean Error
145 Nor. inland stations
00+4,+5,..., +57
MEPSctrl
YrPP
Lead time (hour)

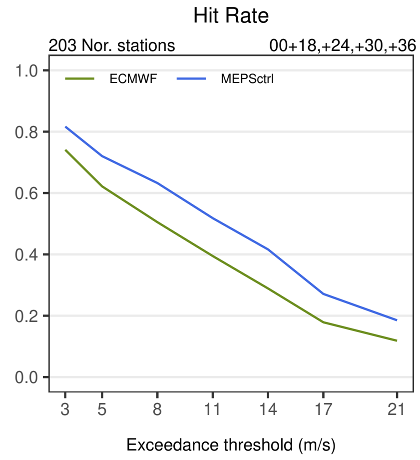

Standard Deviation of Error
145 Nor. inland stations
00+4,+5,..., +57
Lead time (hour)

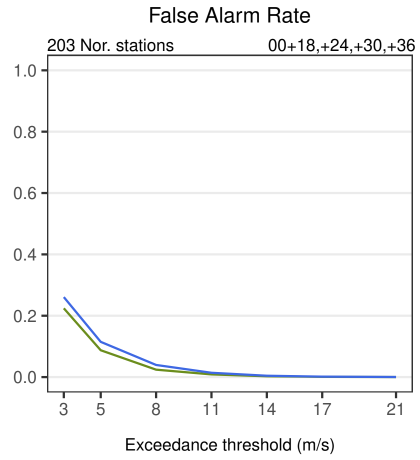

Mean Absolute Error
145 Nor. inland stations
00+4,+5,..., +57
Lead time (hour)

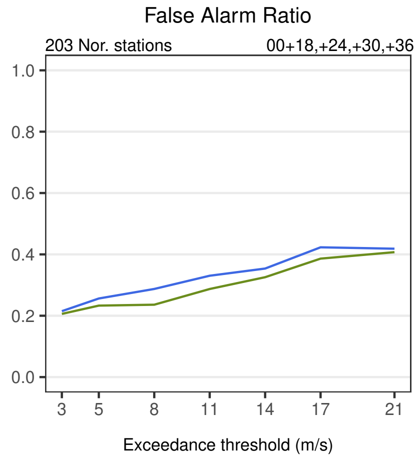

Mean Error
203 Nor. stations
00+3,+6,..., +66
ECMWF
MEPSctrl
Lead time (hour)

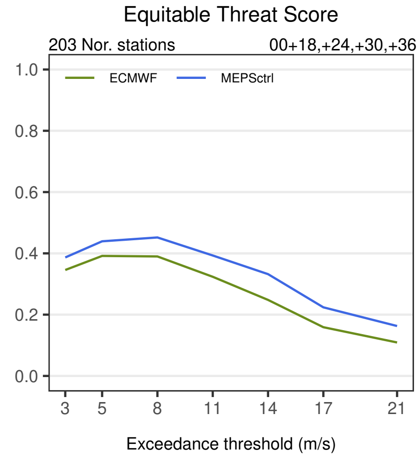

Standard Deviation of Error
203 Nor. stations
00+3,+6,..., +66
Lead time (hour)

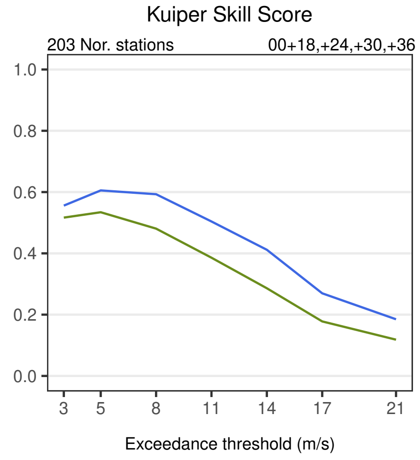

Mean Absolute Error
203 Nor. stations
00+3,+6,..., +66
Lead time (hour)

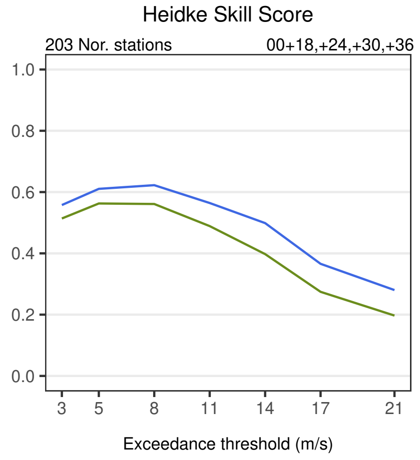

Hit Rate
203 Nor. stations
00+18,+24,+30,+36
ECMWF
MEPSctrl
Exceedance threshold (m/s)

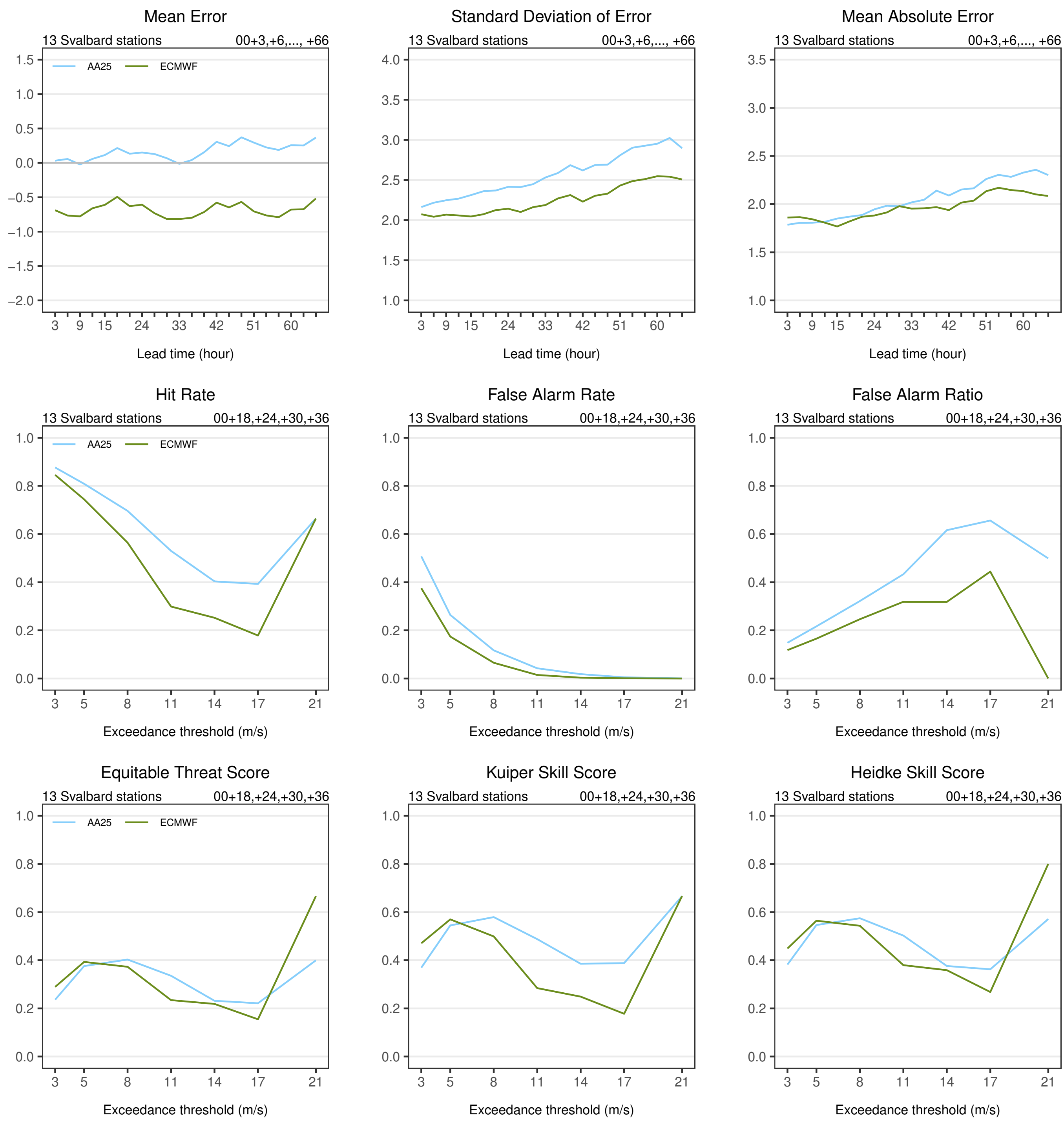

False Alarm Rate
203 Nor. stations
00+18,+24,+30,+36
Exceedance threshold (m/s)

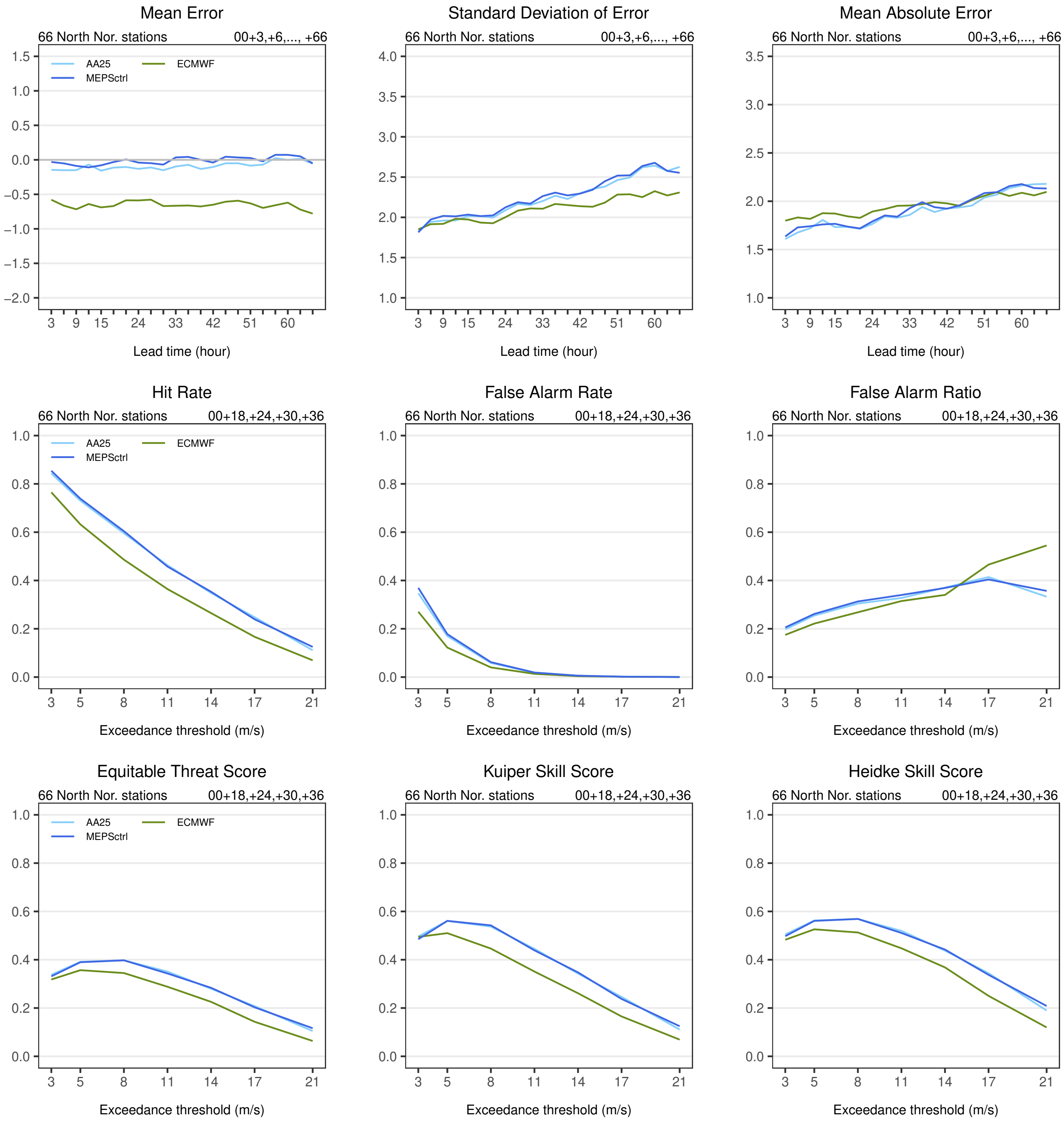

False Alarm Ratio
203 Nor. stations
00+18,+24,+30,+36
Exceedance threshold (m/s)

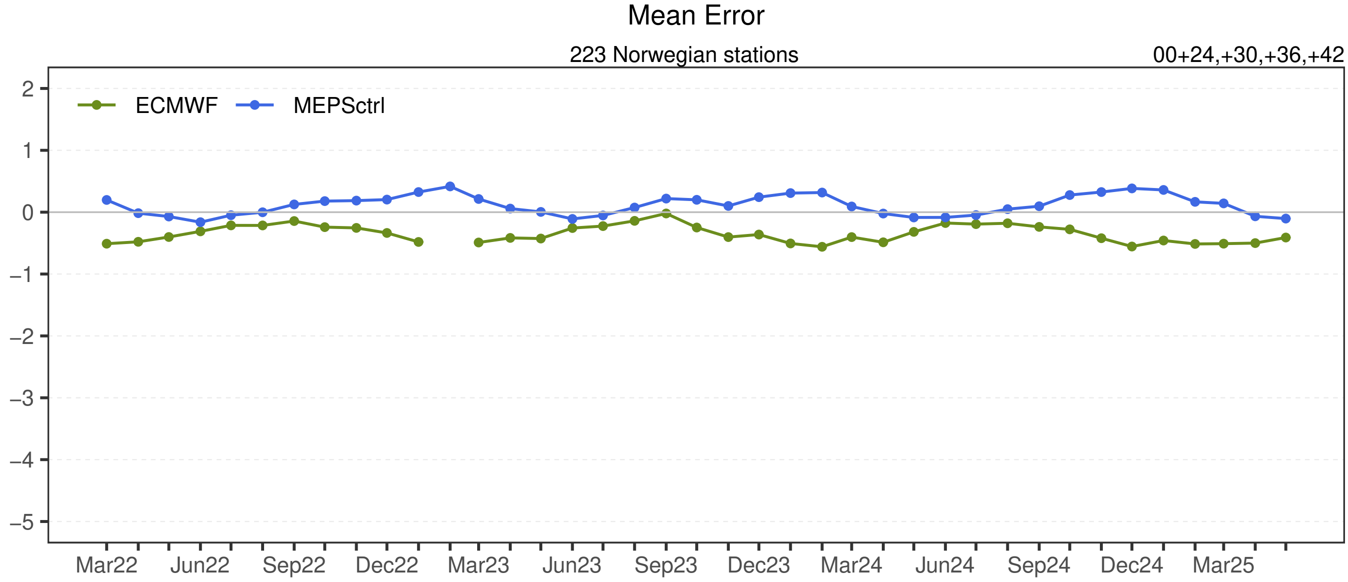

Equitable Threat Score
203 Nor. stations
00+18,+24,+30,+36
ECMWF
MEPSctrl
Exceedance threshold (m/s)


Kuiper Skill Score
203 Nor. stations
00+18,+24,+30,+36
Exceedance threshold (m/s)

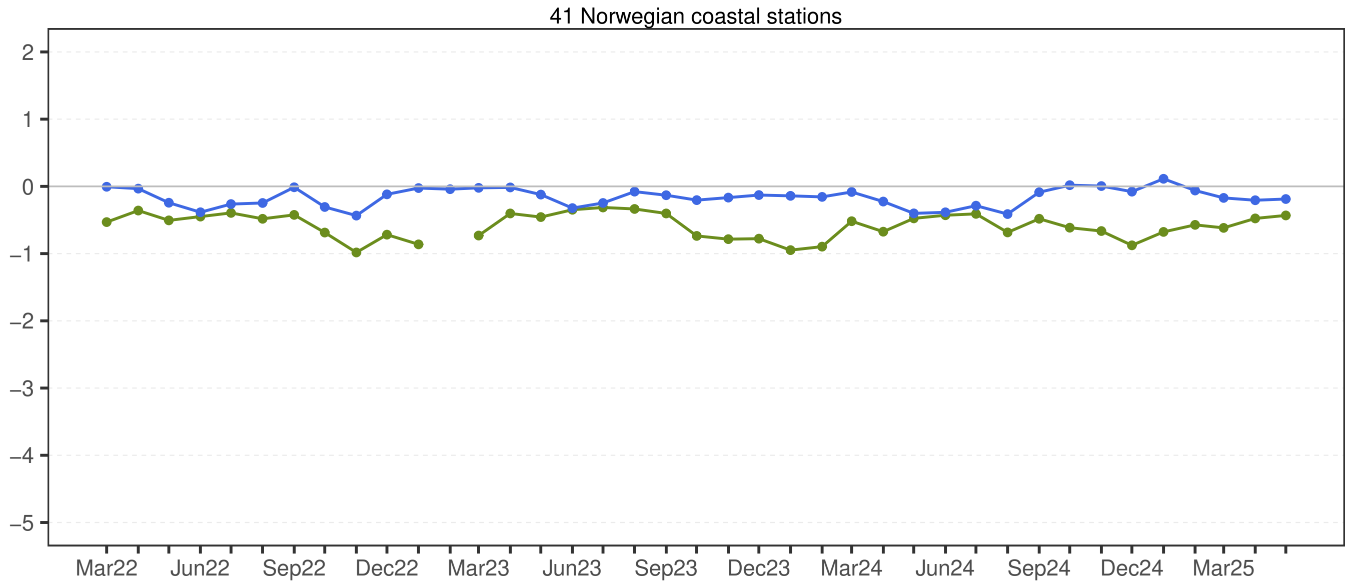

Heidke Skill Score
203 Nor. stations
00+18,+24,+30,+36
Exceedance threshold (m/s)


Mean Error
13 Svalbard stations
00+3,+6,..., +66
AA25
ECMWF
Lead time (hour)
Standard Deviation of Error
13 Svalbard stations
00+3,+6,..., +66
Lead time (hour)
Mean Absolute Error
13 Svalbard stations
00+3,+6,..., +66
Lead time (hour)
Hit Rate
13 Svalbard stations
00+18,+24,+30,+36
AA25
ECMWF
Exceedance threshold (m/s)
False Alarm Rate
13 Svalbard stations
00+18,+24,+30,+36
Exceedance threshold (m/s)
False Alarm Ratio
13 Svalbard stations
00+18,+24,+30,+36
Exceedance threshold (m/s)
Equitable Threat Score
13 Svalbard stations
00+18,+24,+30,+36
AA25
ECMWF
Exceedance threshold (m/s)
Kuiper Skill Score
13 Svalbard stations
00+18,+24,+30,+36
Exceedance threshold (m/s)
Heidke Skill Score
13 Svalbard stations
00+18,+24,+30,+36
Exceedance threshold (m/s)

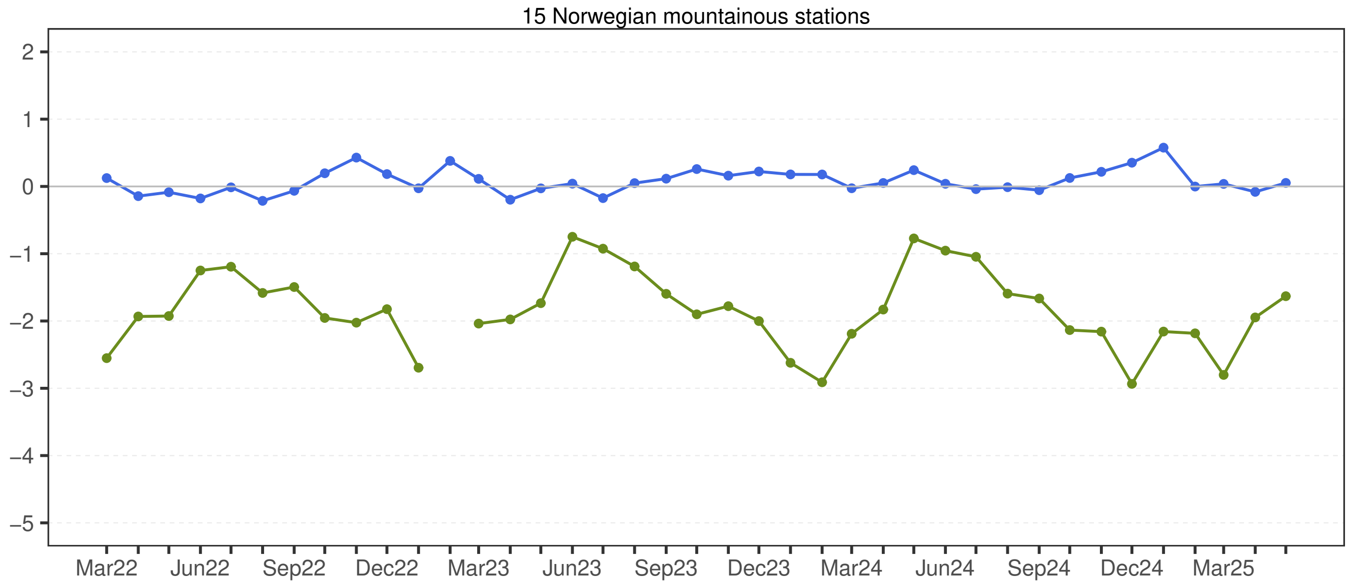

Mean Error
66 North Nor. stations
00+3,+6,..., +66
AA25
MEPSctrl
ECMWF
Lead time (hour)
Standard Deviation of Error
66 North Nor. stations
00+3,+6,..., +66
Lead time (hour)
Mean Absolute Error
66 North Nor. stations
00+3,+6,..., +66
Lead time (hour)
Hit Rate
66 North Nor. stations
00+18,+24,+30,+36
AA25
MEPSctrl
ECMWF
Exceedance threshold (m/s)
False Alarm Rate
66 North Nor. stations
00+18,+24,+30,+36
Exceedance threshold (m/s)
False Alarm Ratio
66 North Nor. stations
00+18,+24,+30,+36
Exceedance threshold (m/s)
Equitable Threat Score
66 North Nor. stations
00+18,+24,+30,+36
AA25
MEPSctrl
ECMWF
Exceedance threshold (m/s)
Kuiper Skill Score
66 North Nor. stations
00+18,+24,+30,+36
Exceedance threshold (m/s)
Heidke Skill Score
66 North Nor. stations
00+18,+24,+30,+36
Exceedance threshold (m/s)



Mean Error
223 Norwegian stations
00+24,+30,+36,+42
ECMWF
MEPSctrl
2
1
0
−1
−2
−3
−4
−5
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25

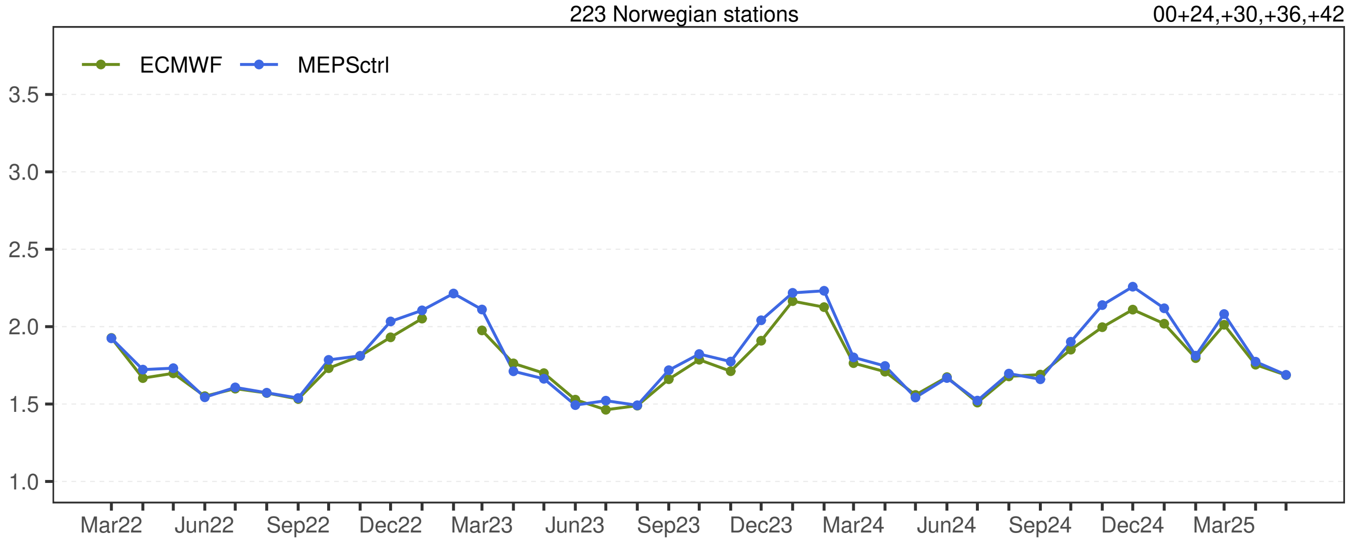


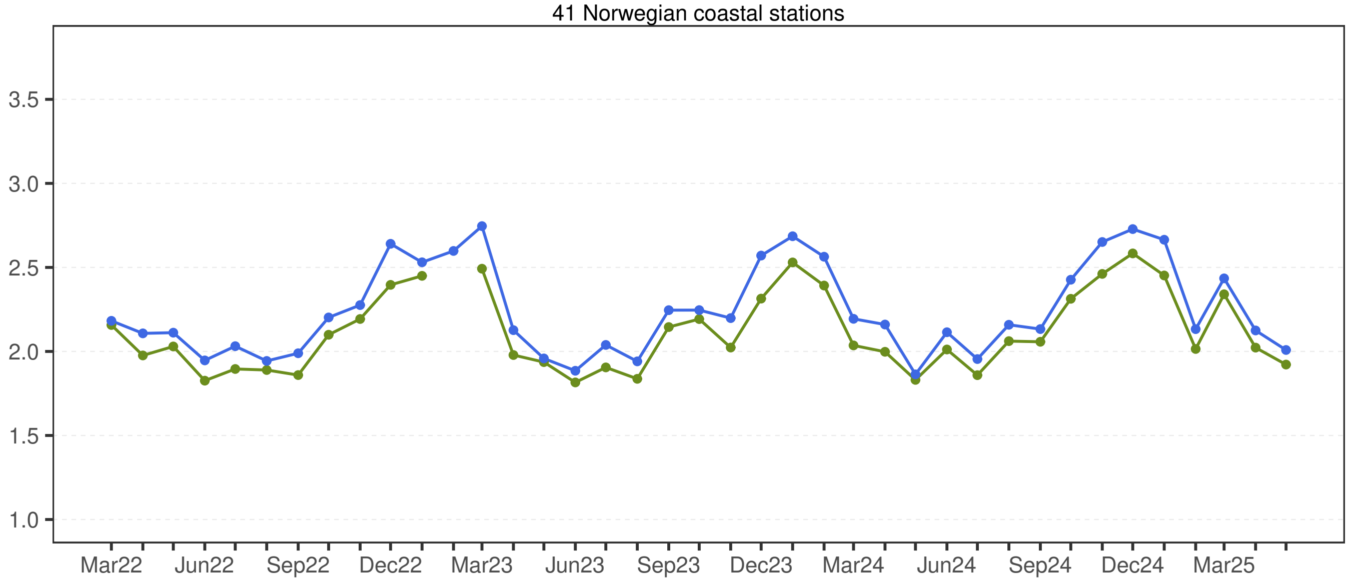
41 Norwegian coastal stations
2
1
0
−1
−2
−3
−4
−5
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25

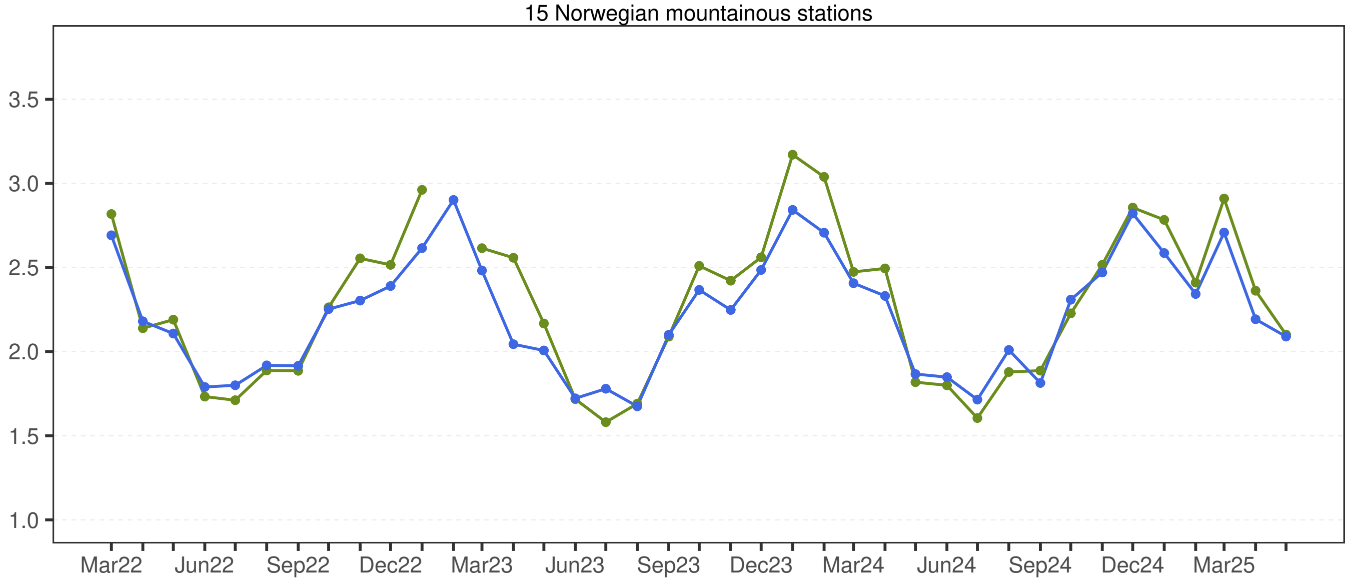


15 Norwegian mountainous stations
2
1
0
−1
−2
−3
−4
−5
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25

Standard Deviation of Error

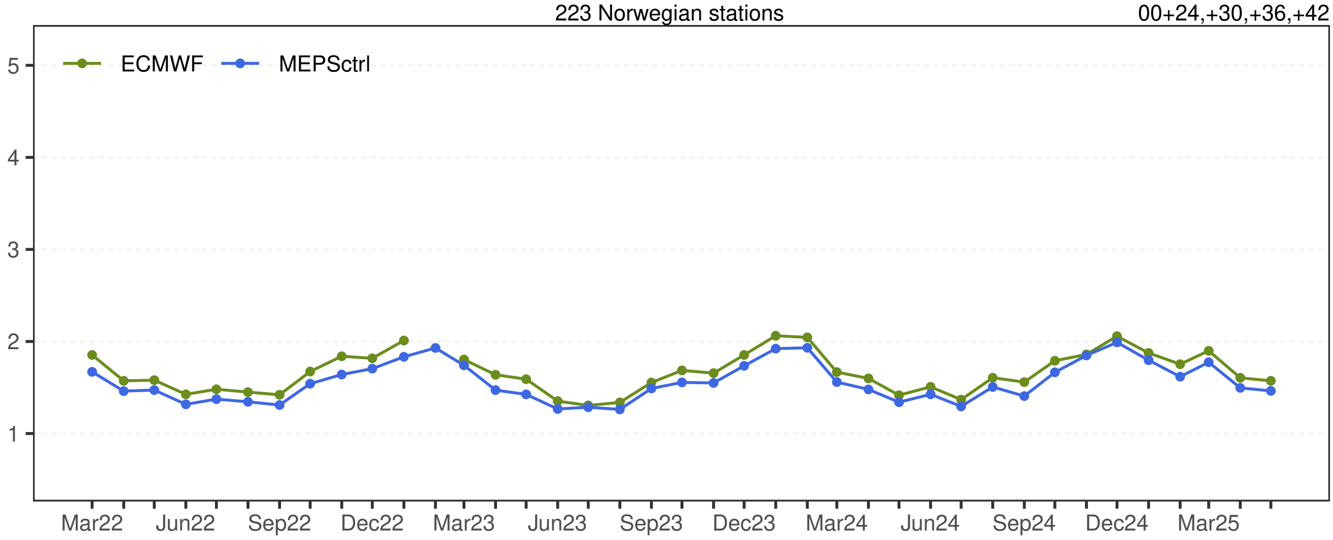




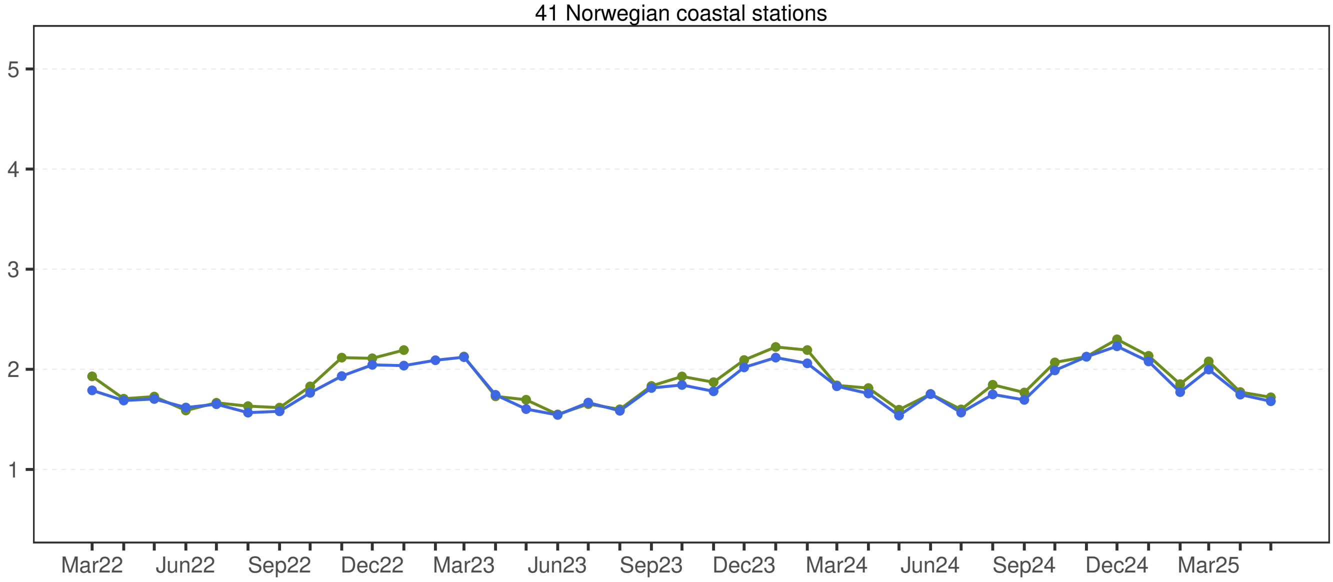


Mean Absolute Error

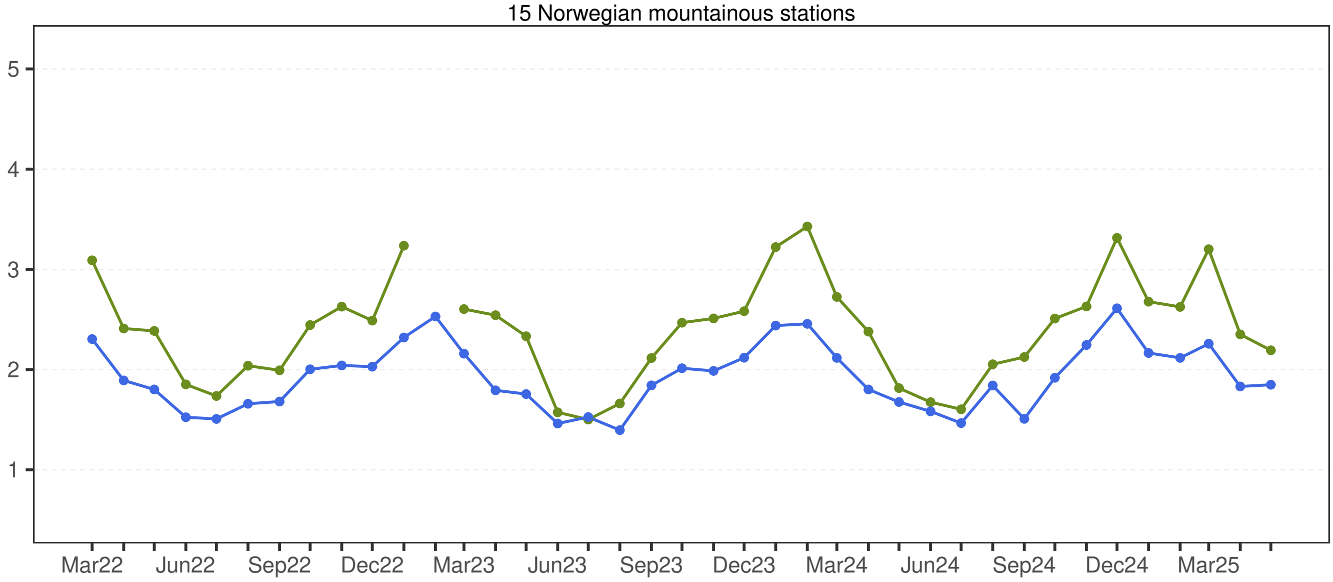
223 Norwegian stations 00+24,+30,+36,+42



41 Norwegian coastal stations

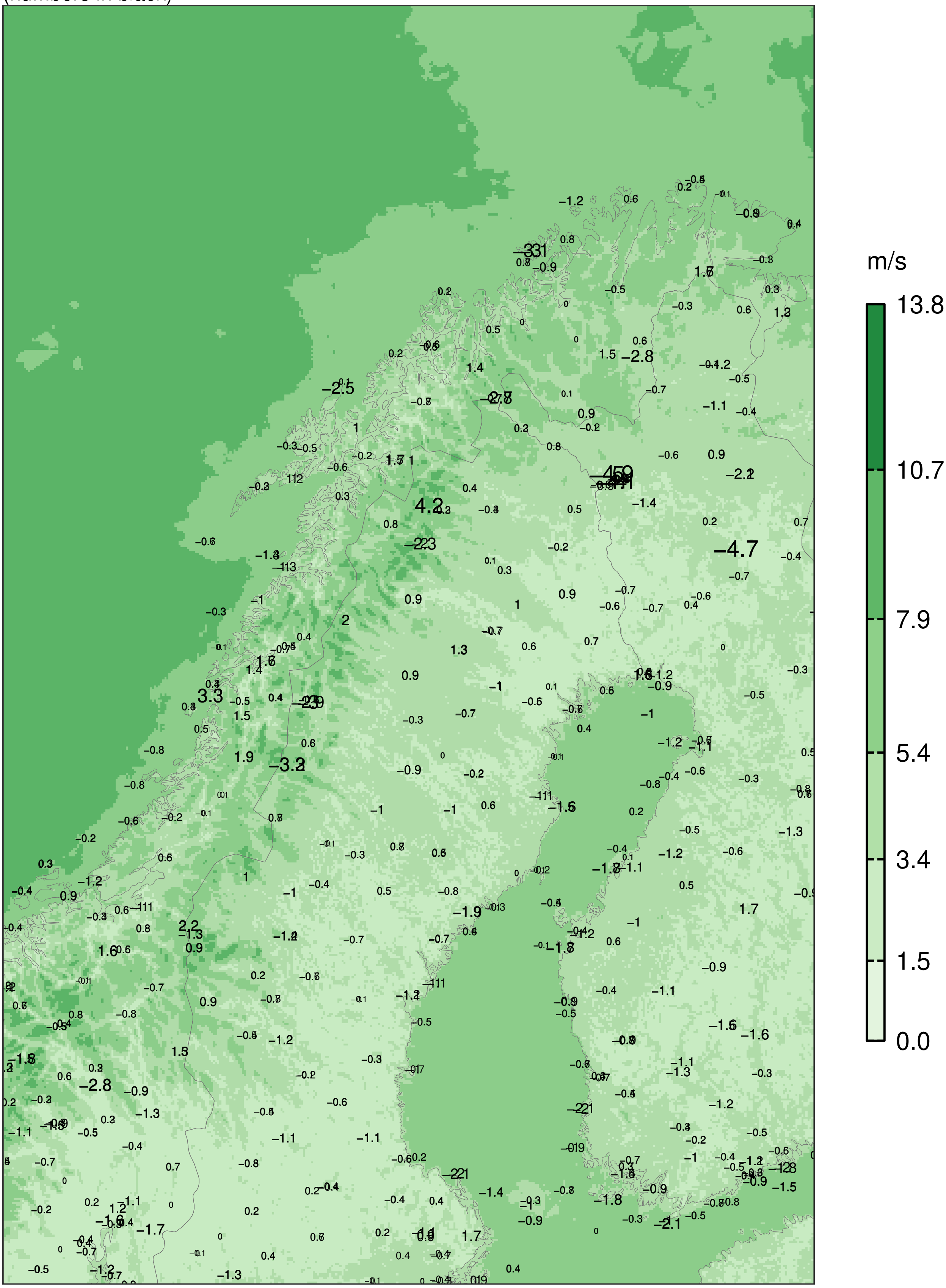


15 Norwegian mountainous stations



MEPSctrl 00+12

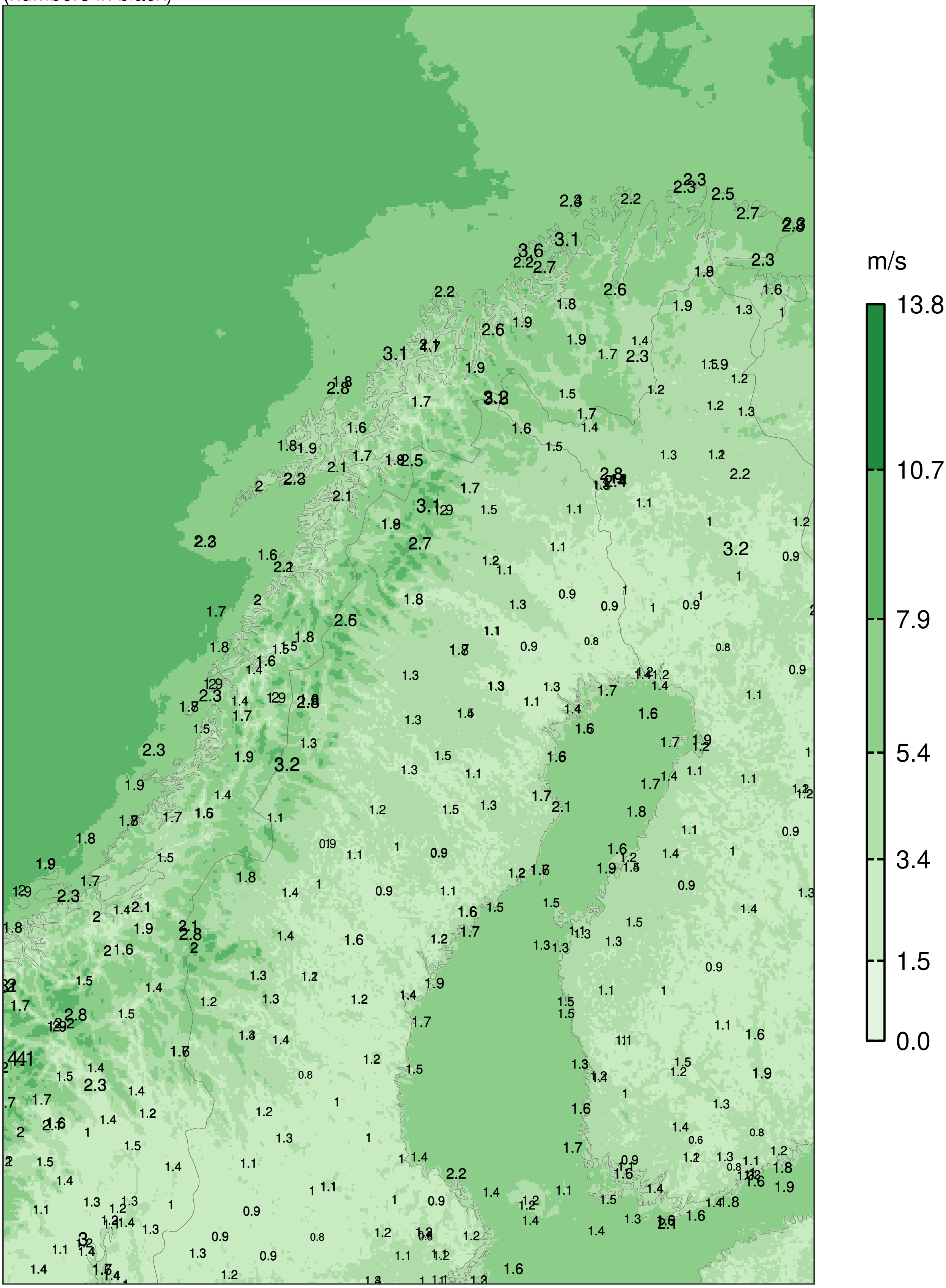
ME at observing sites
(numbers in black)



Model "climatology" 01.03.2025–31.05.2025

MEPSctrl 00+12

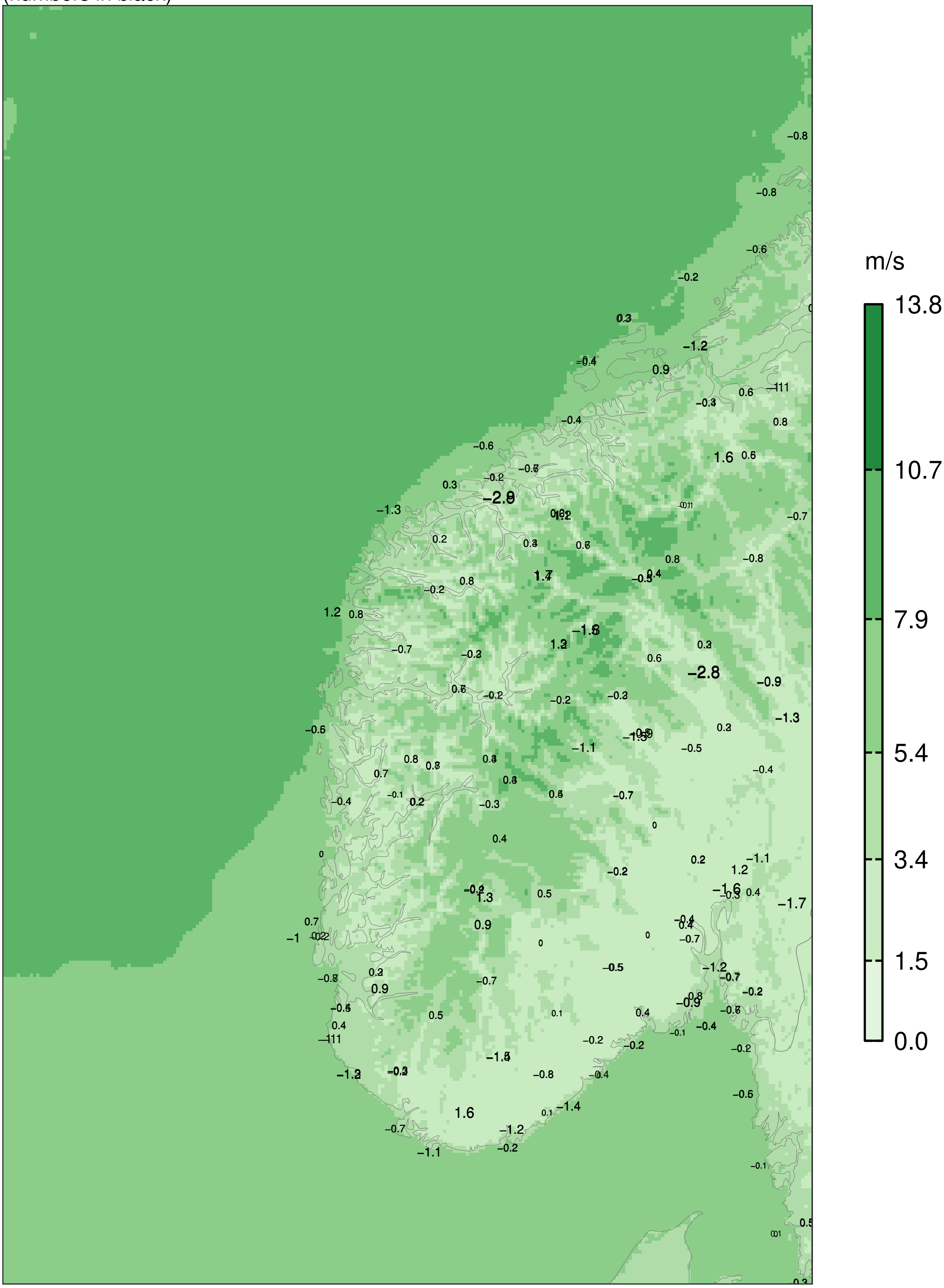
SDE at observing sites
(numbers in black)



Model "climatology" 01.03.2025–31.05.2025

MEPSctrl 00+12

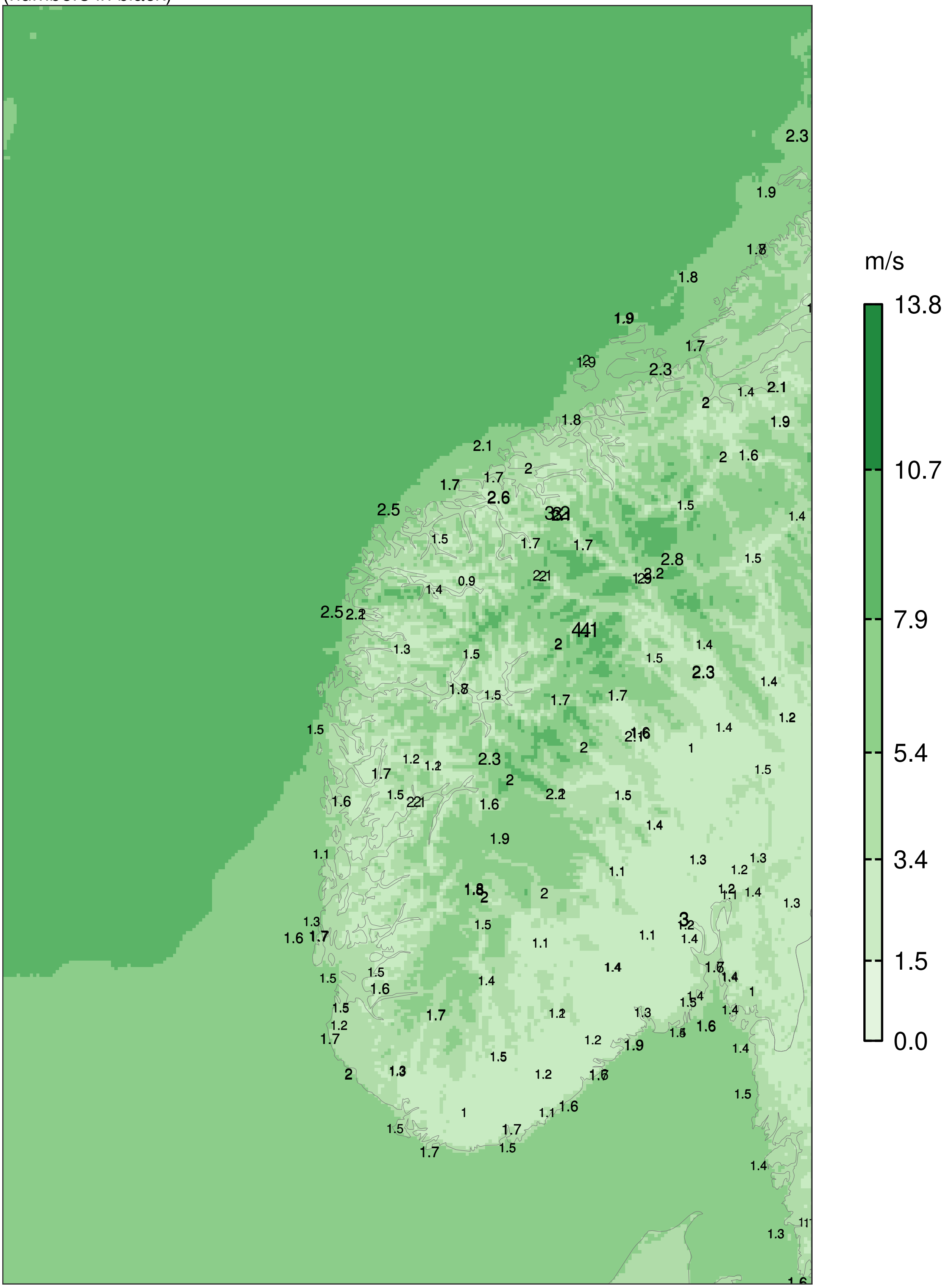
ME at observing sites
(numbers in black)



Model "climatology" 01.03.2025–31.05.2025

MEPSctrl 00+12

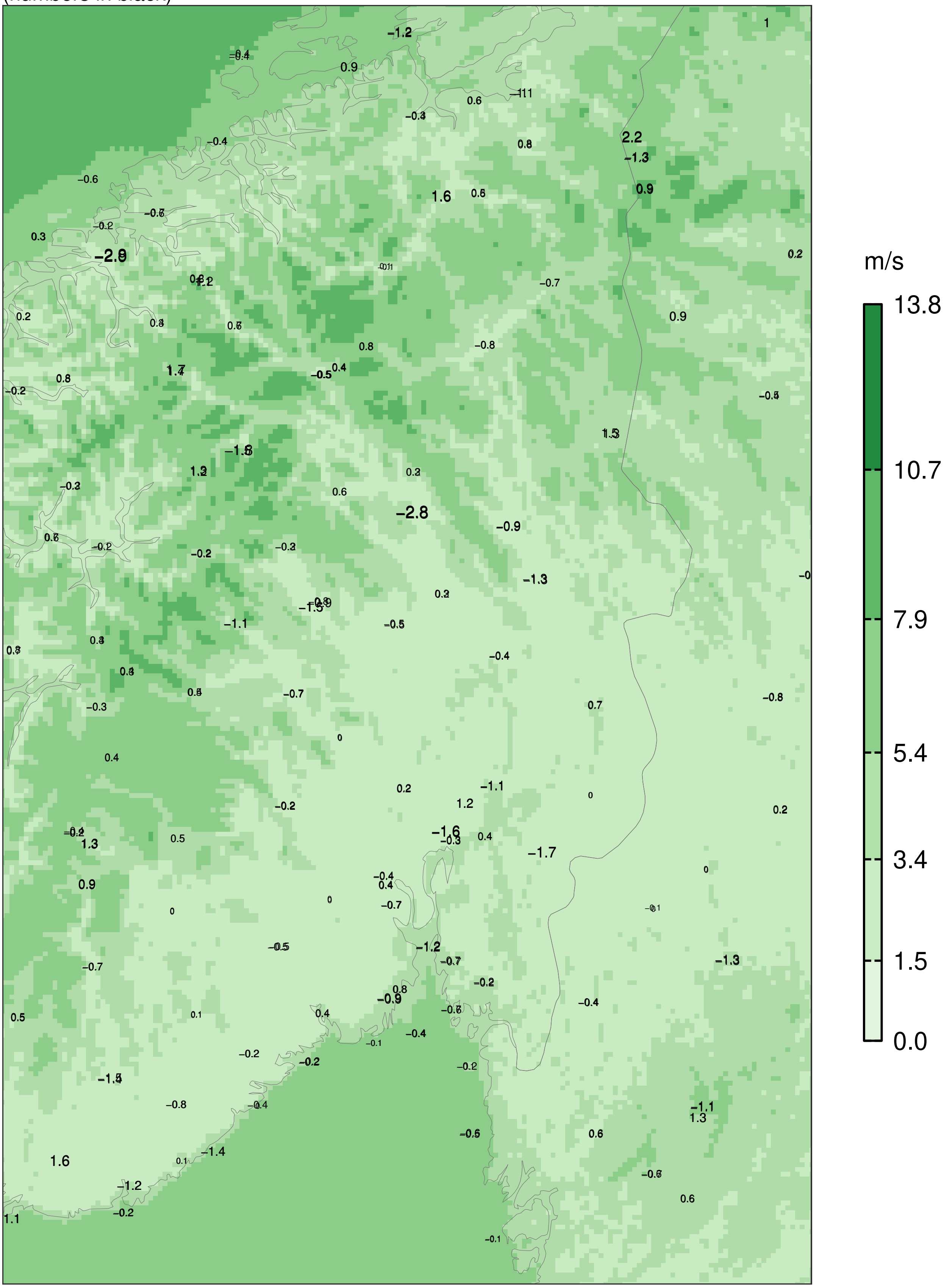
SDE at observing sites
(numbers in black)



Model "climatology" 01.03.2025–31.05.2025

MEPSctrl 00+12

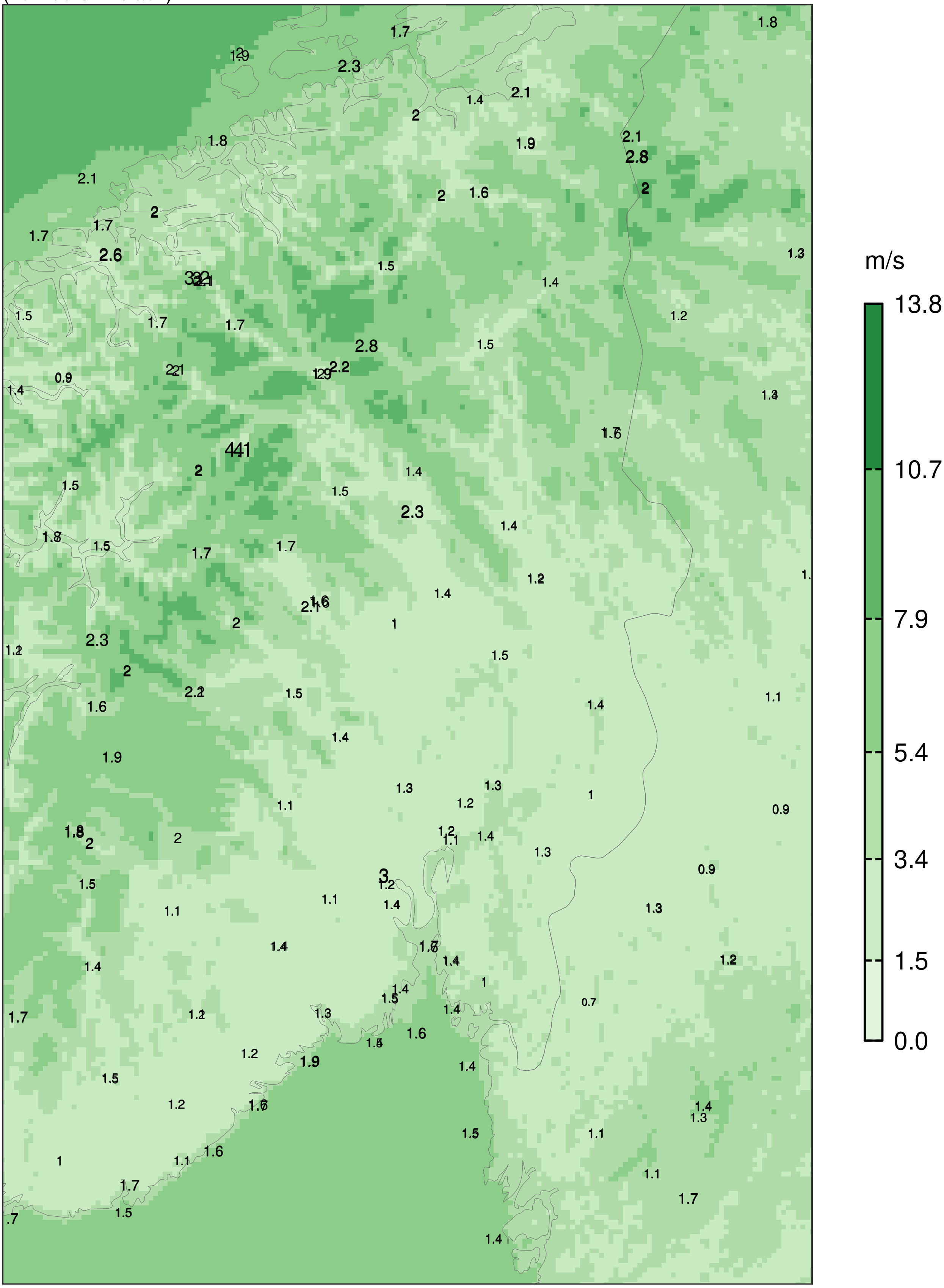
ME at observing sites
(numbers in black)



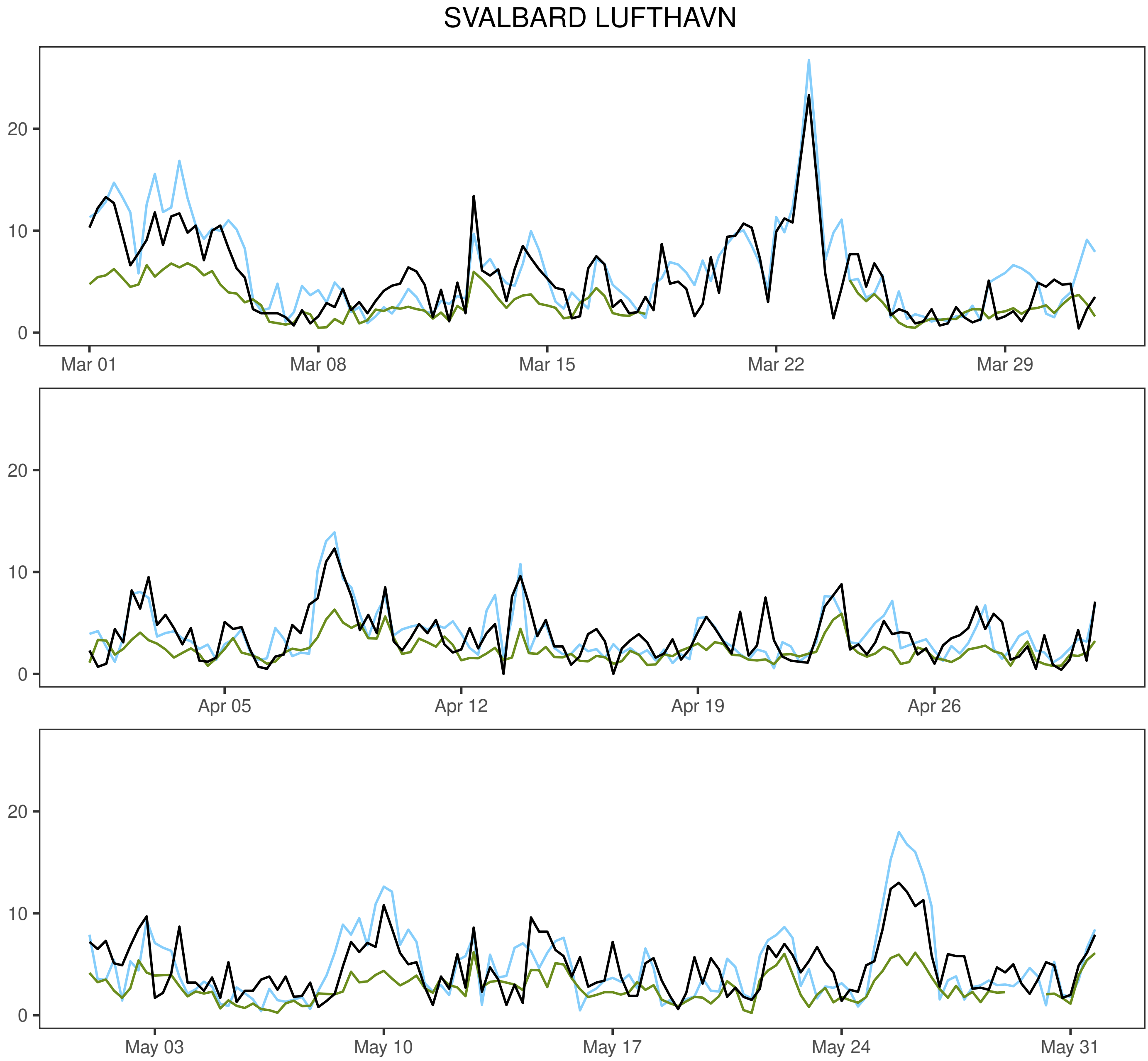
Model "climatology" 01.03.2025–31.05.2025

MEPSctrl 00+12

SDE at observing sites
(numbers in black)

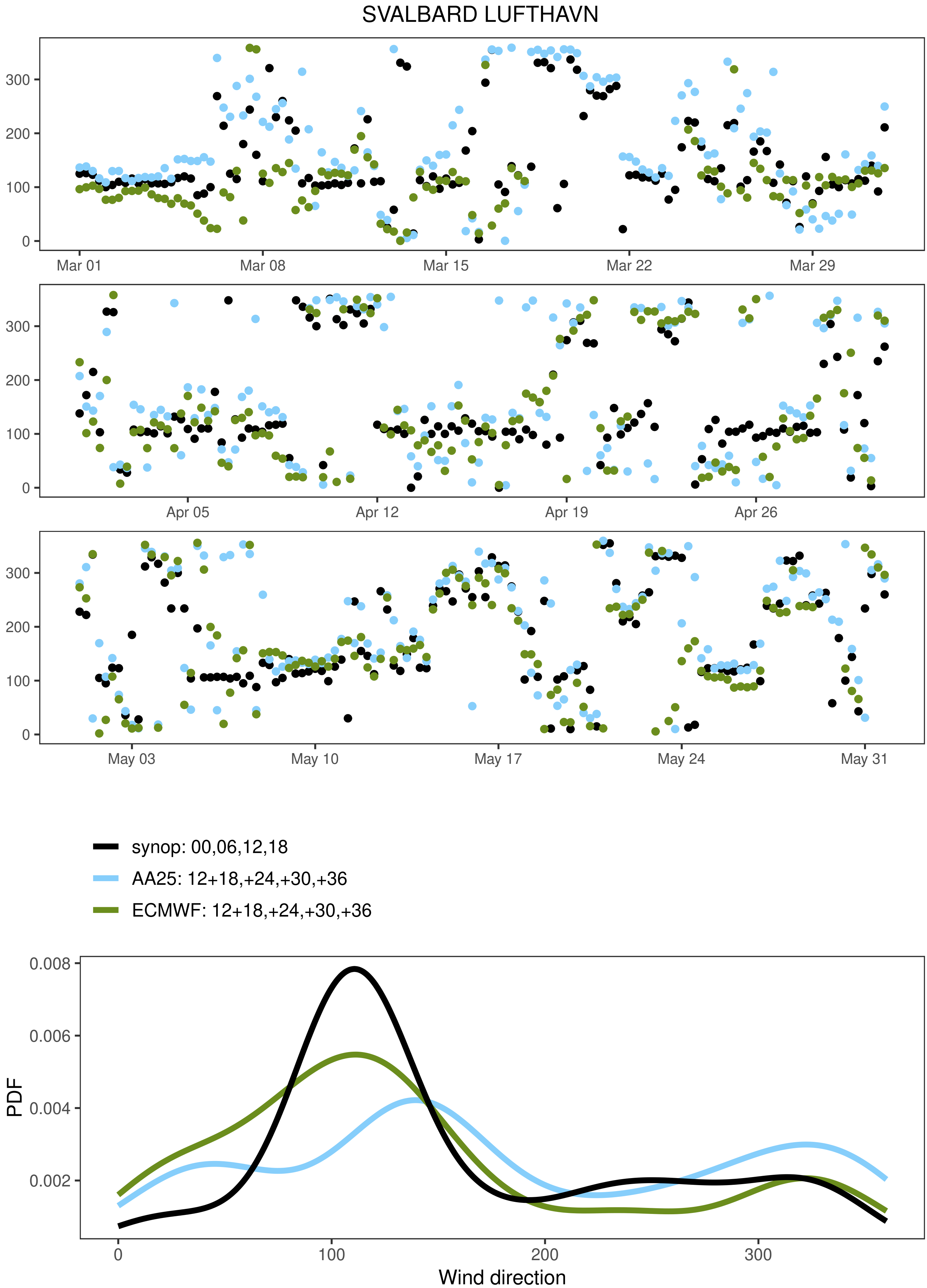


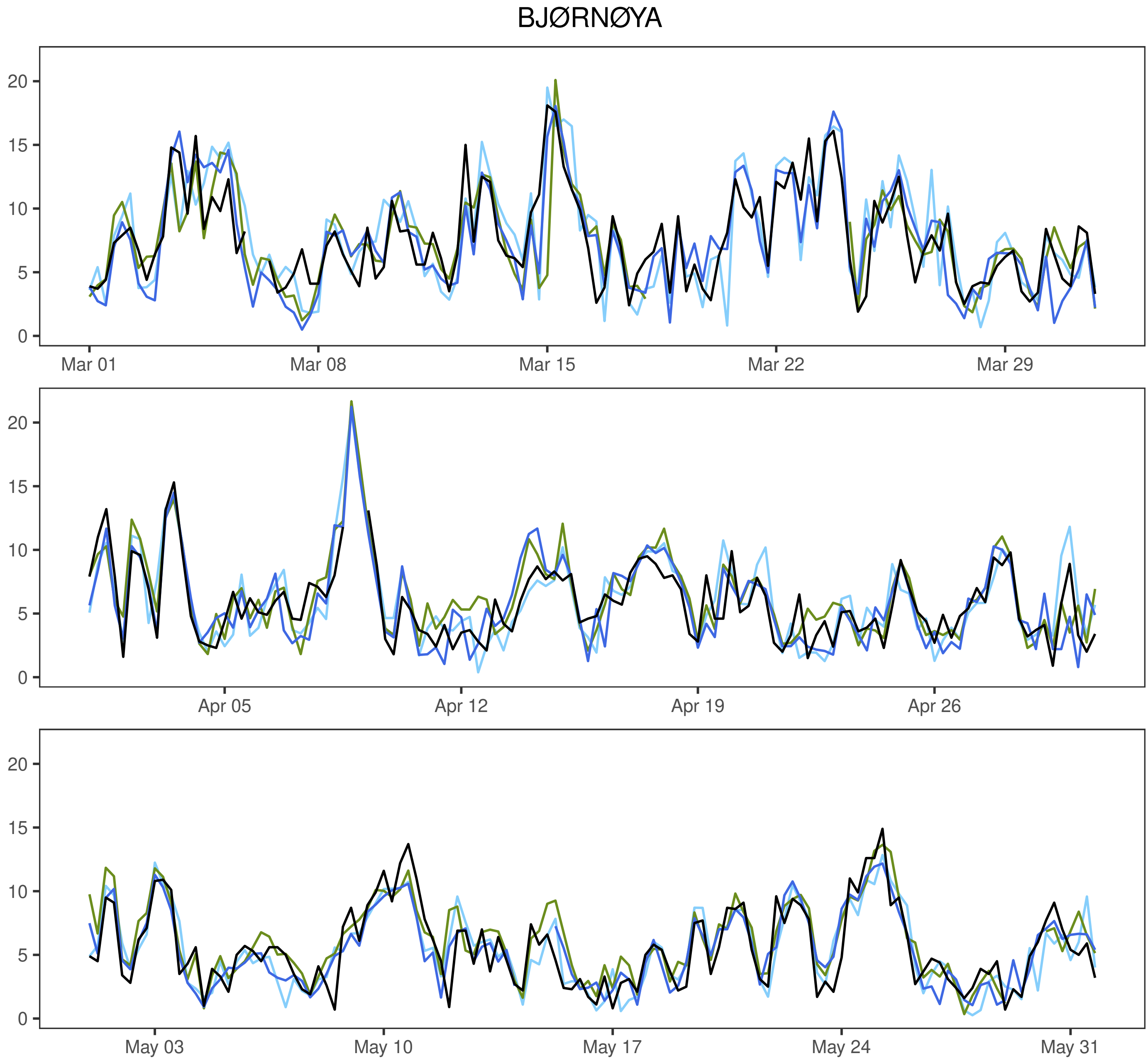
Model "climatology" 01.03.2025–31.05.2025



	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.0	4.6	23.3	3.2	368
AA25: 12+18,+24,+30,+36	0.4	4.9	26.7	3.7	368
ECMWF: 12+18,+24,+30,+36	0.2	2.6	6.8	1.4	340

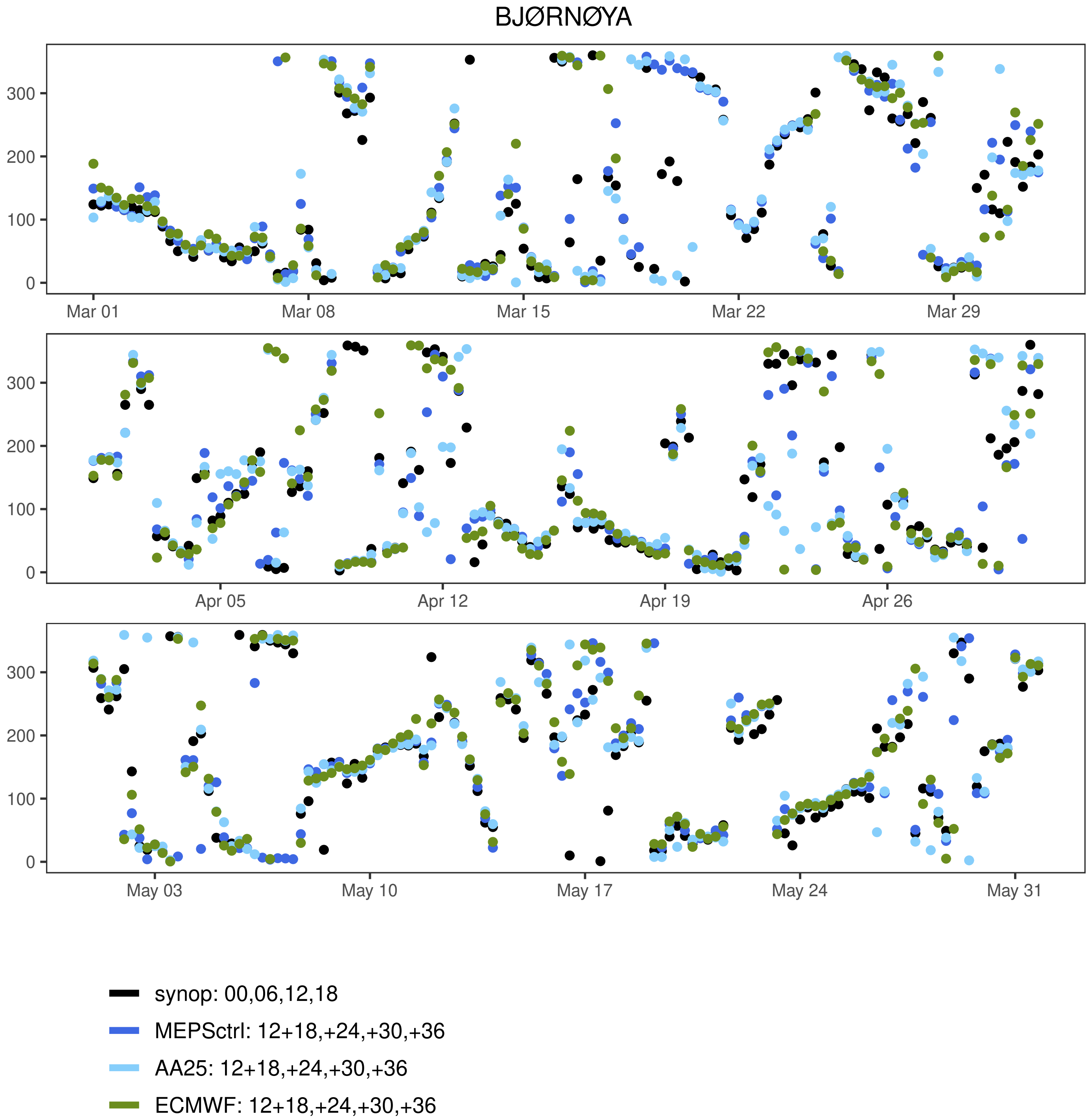
	ME	SDE	RMSE	MAE	Max.abs.err	N
AA25 – synop	0.2	2.2	2.2	1.8	6.8	340
ECMWF – synop	−1.8	2.0	2.7	2.1	7.7	340

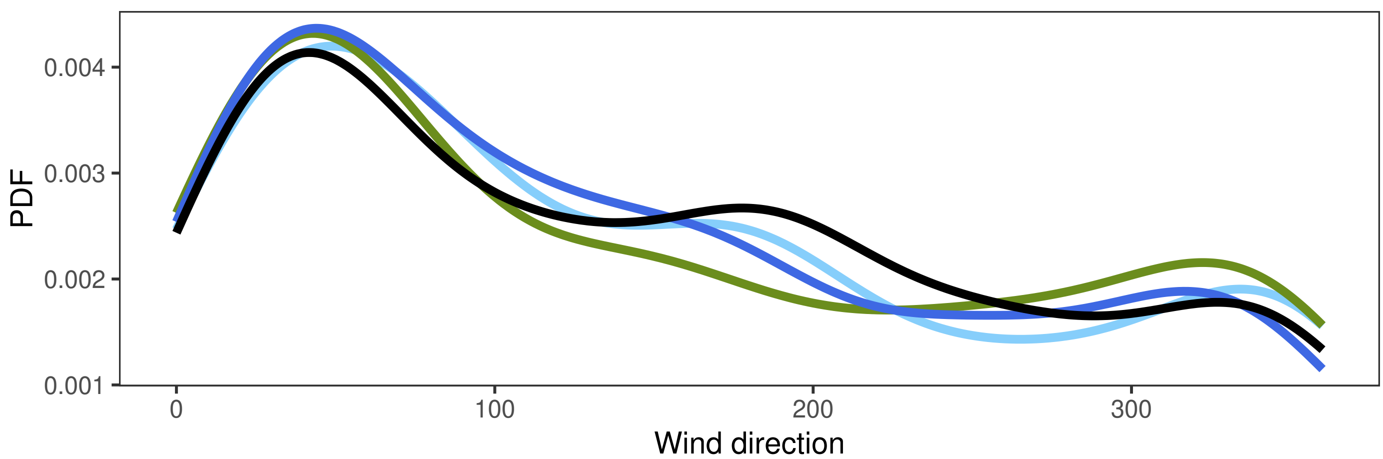

SVALBARD LUFTHAVN
Mar 01
Mar 08
Mar 15
Mar 22
Mar 29
Apr 05
Apr 12
Apr 19
Apr 26
May 03
May 10
May 17
May 24
May 31
synop: 00,06,12,18
AA25: 12+18,+24,+30,+36
ECMWF: 12+18,+24,+30,+36
PDF
Wind direction

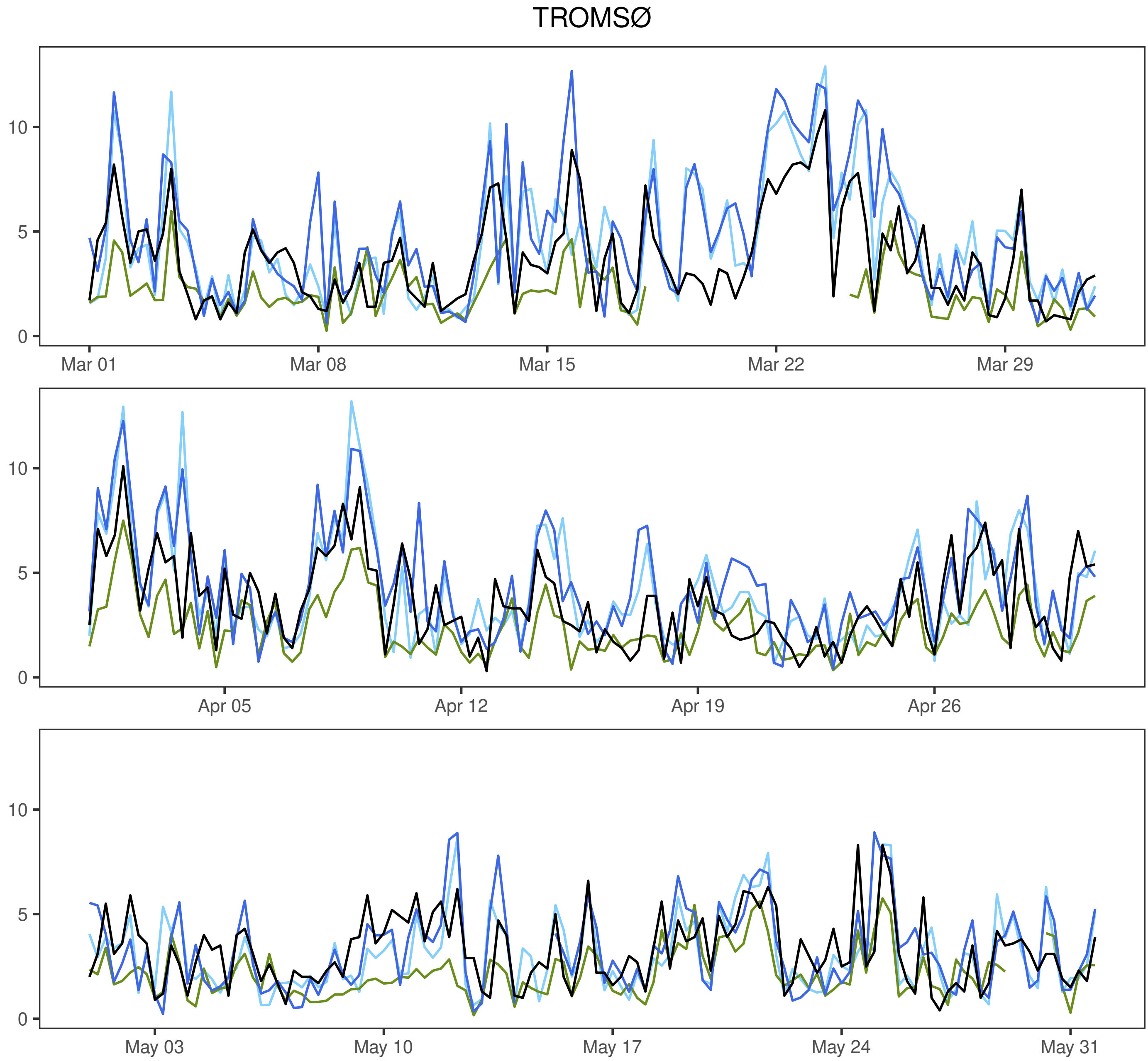


	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.7	6.3	18.1	3.4	364
MEPSctrl: 12+18,+24,+30,+36	0.5	6.3	21.2	3.6	364
AA25: 12+18,+24,+30,+36	0.3	6.5	20.8	3.7	368
ECMWF: 12+18,+24,+30,+36	0.3	6.6	21.7	3.2	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	–0.1	2.0	2.0	1.6	6.4	332
AA25 – synop	0.1	2.2	2.2	1.7	8.2	332
ECMWF – synop	0.4	2.0	2.1	1.5	13.3	332

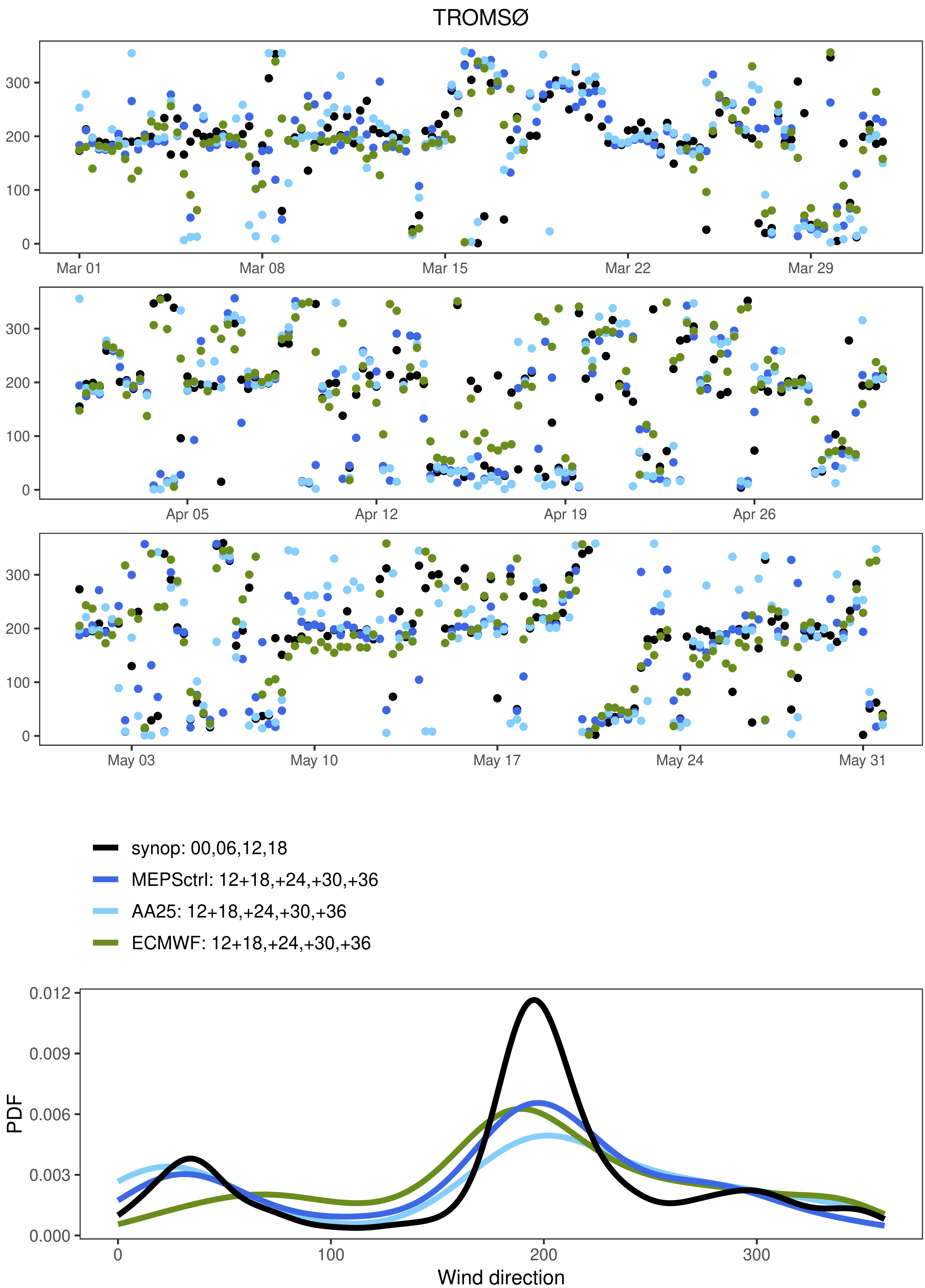

BJØRNØYA
300
200
100
0
Mar 01
Mar 08
Mar 15
Mar 22
Mar 29
Apr 05
Apr 12
Apr 19
Apr 26
May 03
May 10
May 17
May 24
May 31
synop: 00,06,12,18
MEPSctrl: 12+18,+24,+30,+36
AA25: 12+18,+24,+30,+36
ECMWF: 12+18,+24,+30,+36

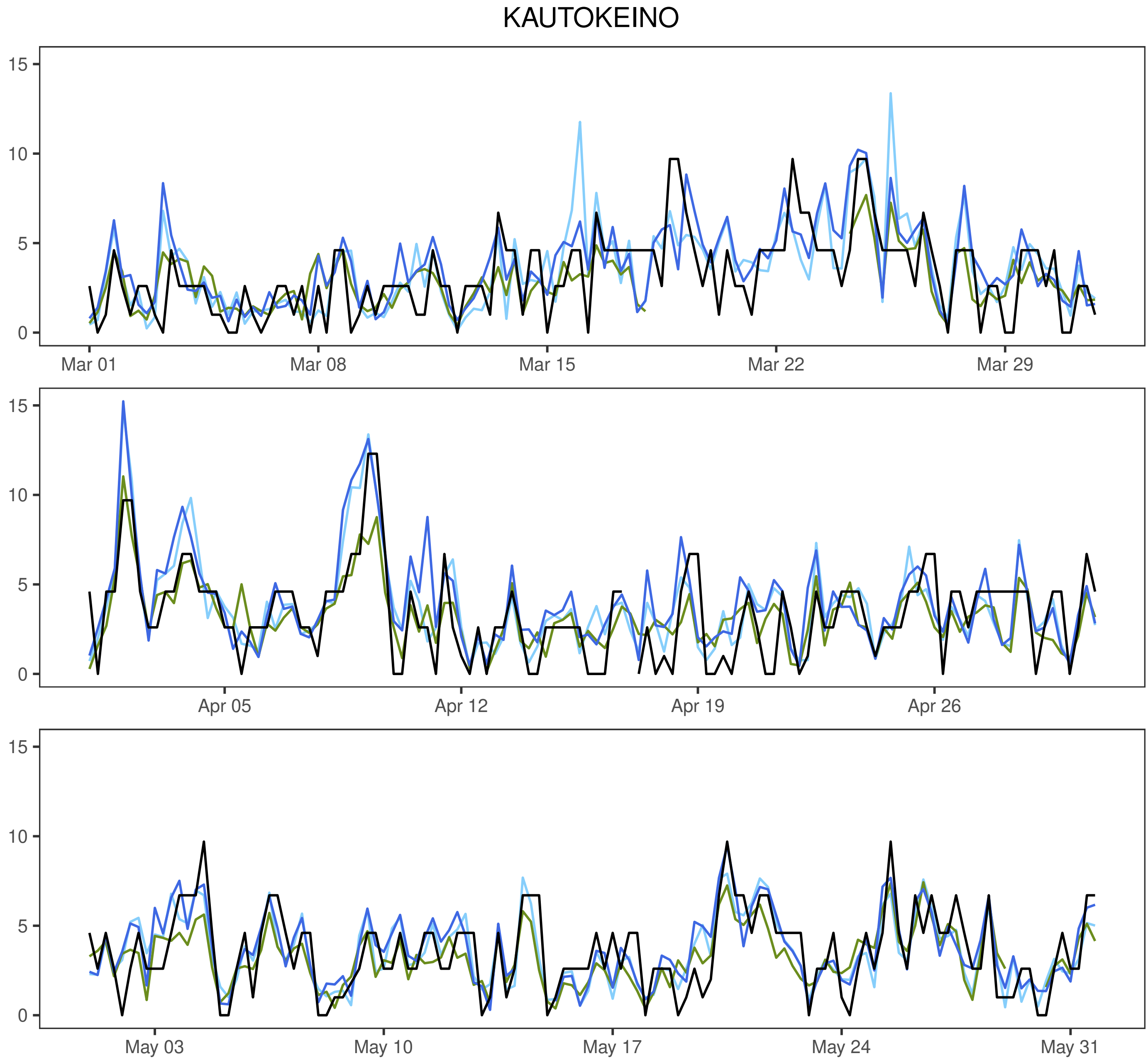

PDF
0.004
0.003
0.002
0.001
0
100
200
300
Wind direction



	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.3	3.5	10.8	2.0	368
MEPSctrl: 12+18,+24,+30,+36	0.2	4.2	12.7	2.6	364
AA25: 12+18,+24,+30,+36	0.7	3.9	13.2	2.5	368
ECMWF: 12+18,+24,+30,+36	0.2	2.2	7.5	1.2	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	0.6	1.9	2.0	1.5	8.1	336
AA25 – synop	0.3	1.9	1.9	1.4	10.8	336
ECMWF – synop	−1.2	1.4	1.9	1.5	6.1	336

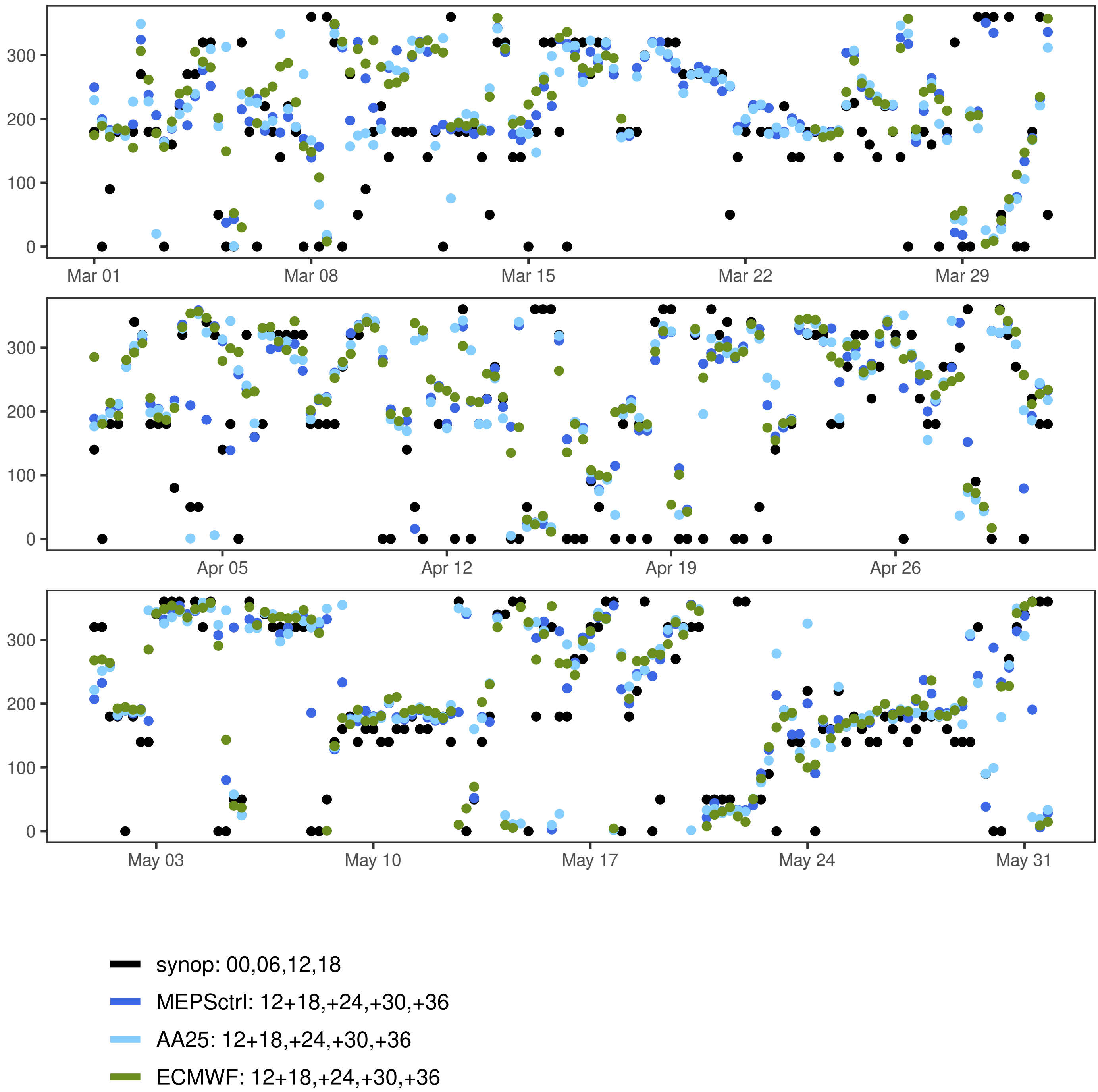

TROMSØ
300
200
100
0
Mar 01
Mar 08
Mar 15
Mar 22
Mar 29
Apr 05
Apr 12
Apr 19
Apr 26
May 03
May 10
May 17
May 24
May 31
synop: 00,06,12,18
MEPSctrl: 12+18,+24,+30,+36
AA25: 12+18,+24,+30,+36
ECMWF: 12+18,+24,+30,+36
PDF
0.012
0.009
0.006
0.003
0.000
Wind direction

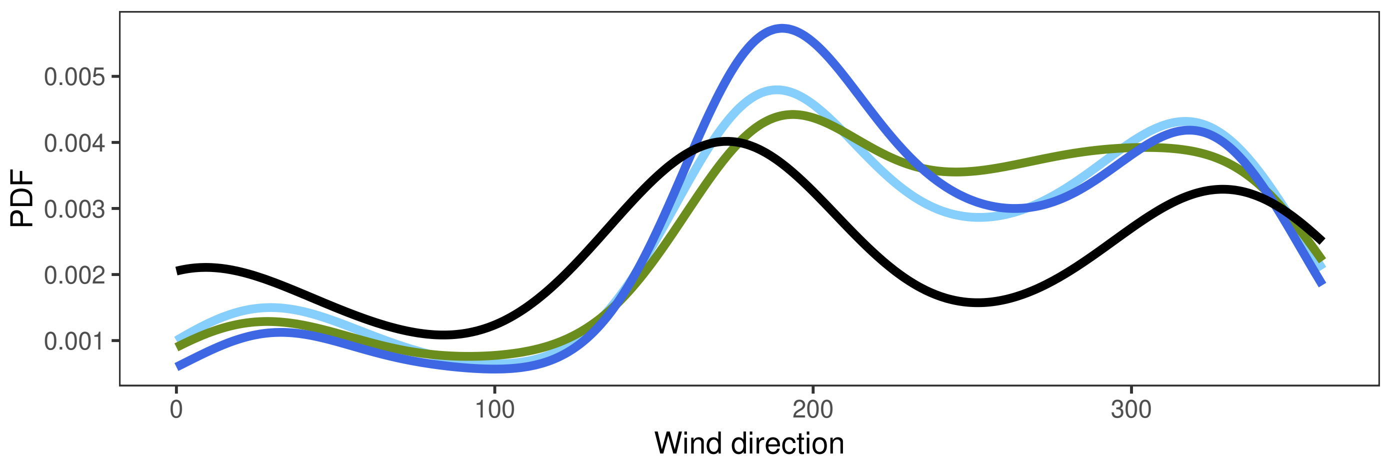


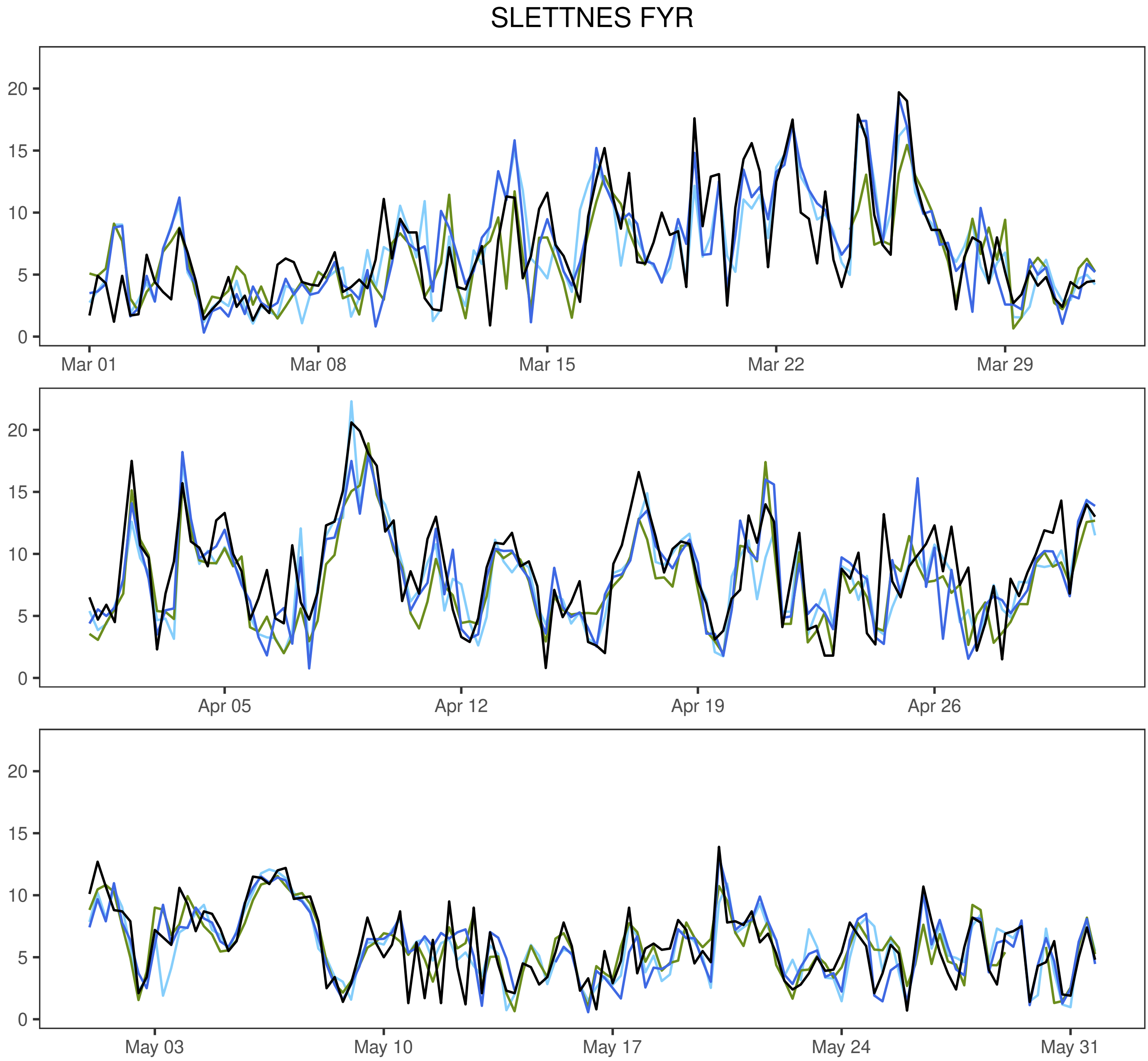
	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.0	3.4	12.3	2.4	367
MEPSctrl: 12+18,+24,+30,+36	0.3	3.9	15.2	2.3	364
AA25: 12+18,+24,+30,+36	0.1	3.6	14.8	2.3	368
ECMWF: 12+18,+24,+30,+36	0.1	3.1	11.0	1.6	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	0.5	1.8	1.8	1.4	8.3	335
AA25 – synop	0.3	1.8	1.9	1.4	8.8	335
ECMWF – synop	−0.2	1.7	1.7	1.4	5.0	335

KAUTOKEINO

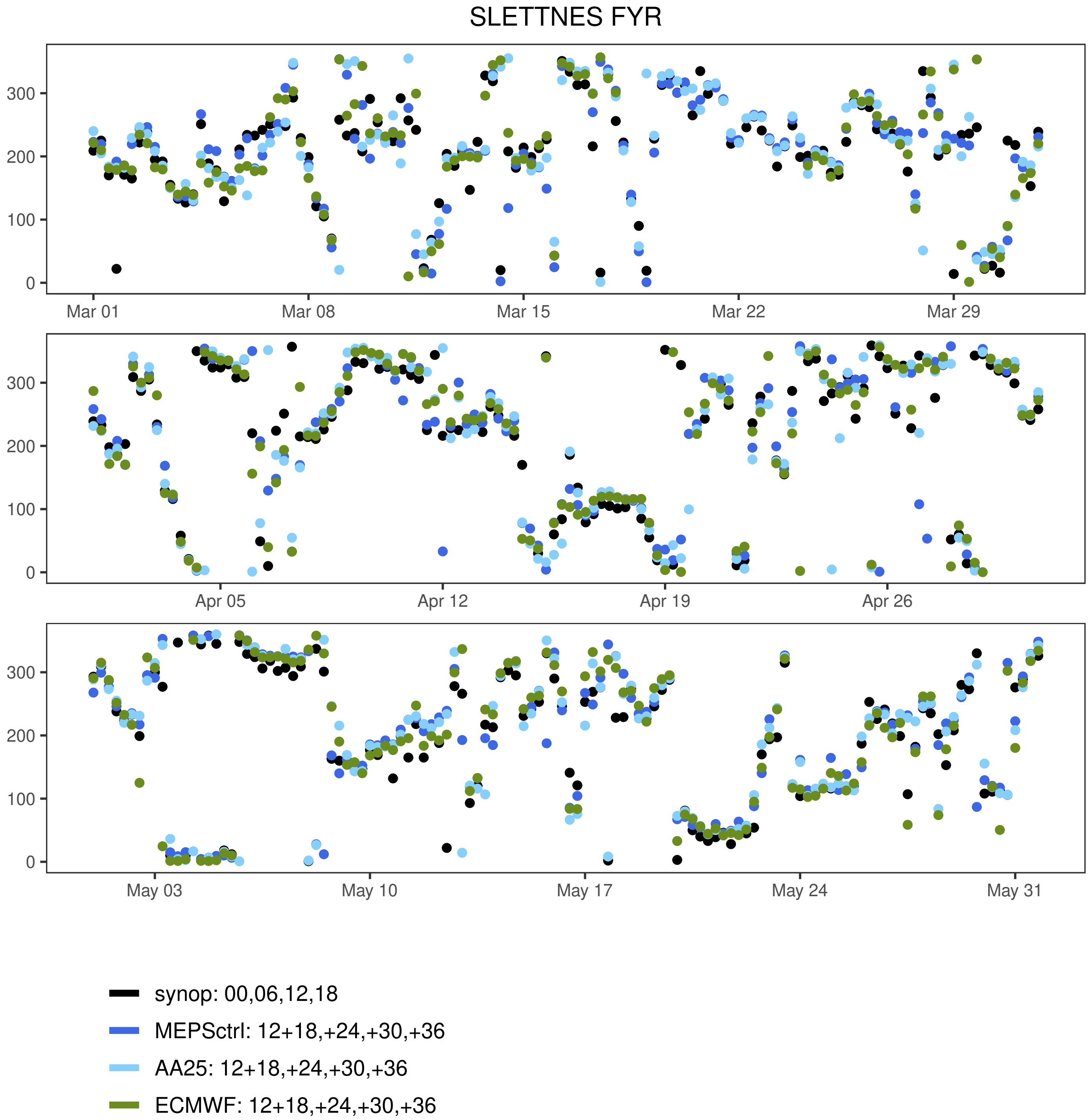

0
100
200
300
Mar 01
Mar 08
Mar 15
Mar 22
Mar 29
Apr 05
Apr 12
Apr 19
Apr 26
May 03
May 10
May 17
May 24
May 31
synop: 00,06,12,18
MEPSctrl: 12+18,+24,+30,+36
AA25: 12+18,+24,+30,+36
ECMWF: 12+18,+24,+30,+36

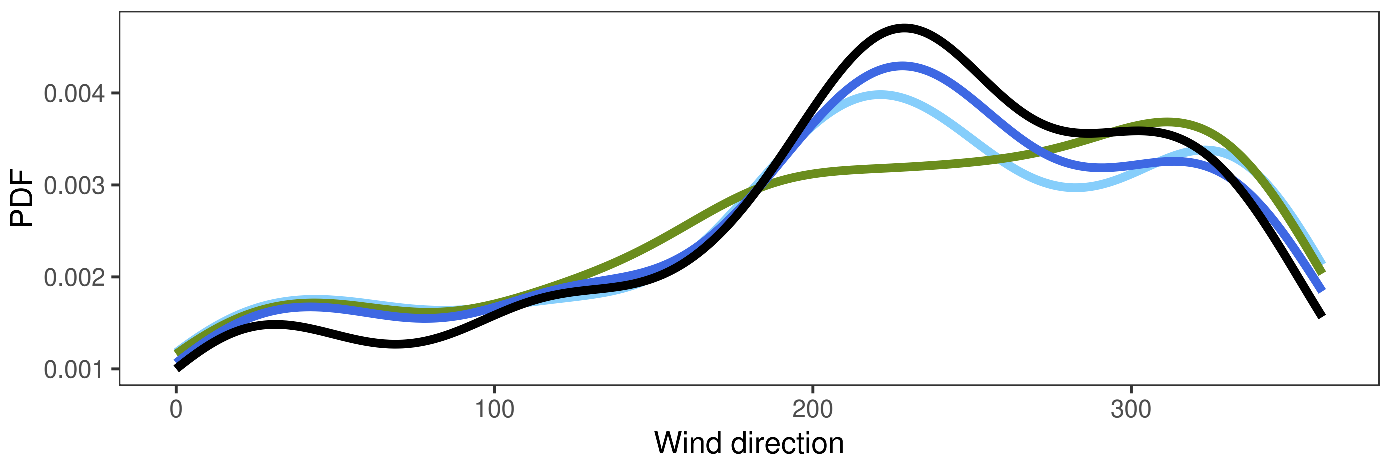

PDF
0.001
0.002
0.003
0.004
0.005
0
100
200
300
Wind direction



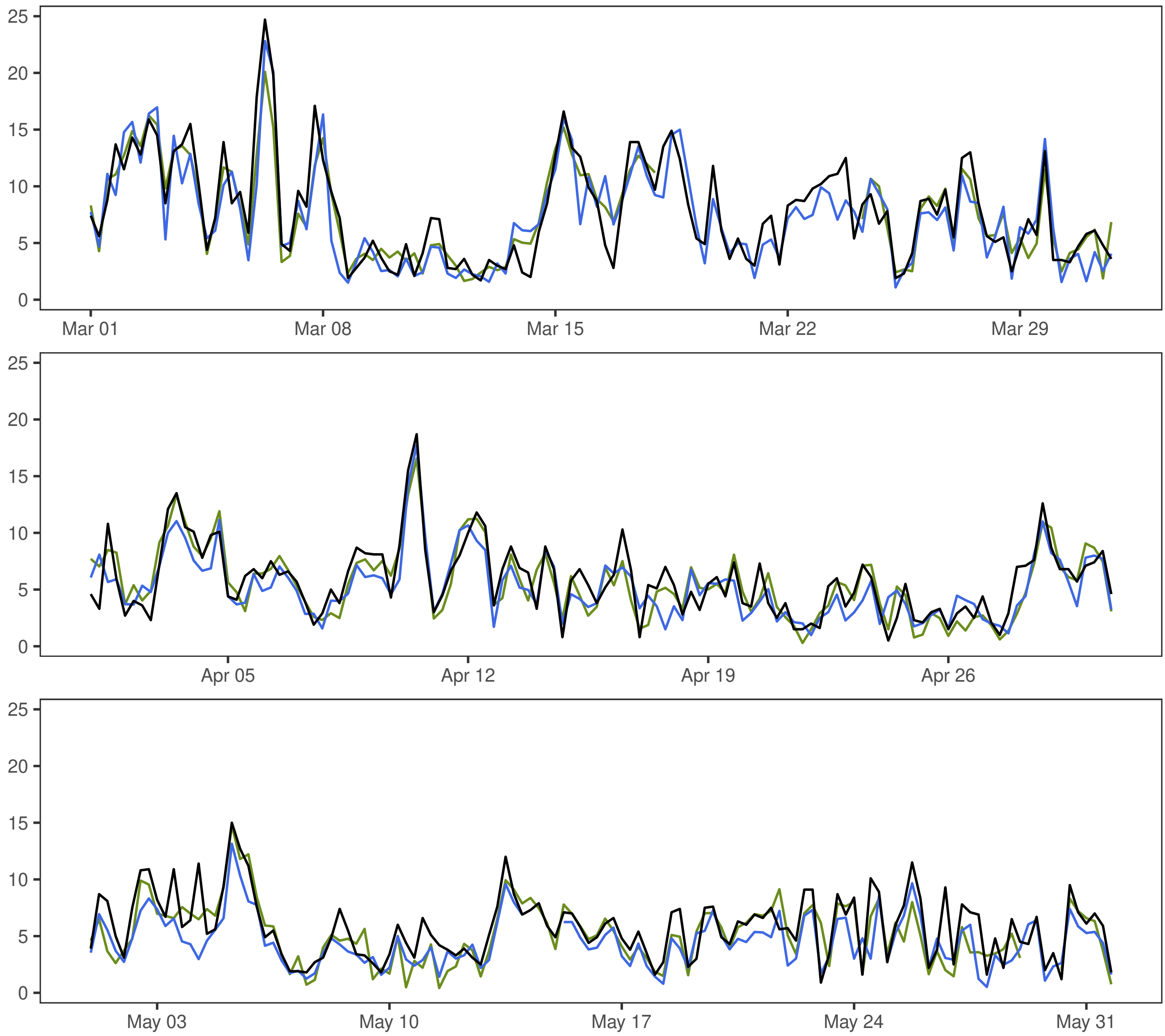
	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.7	7.3	20.6	4.0	368
MEPSctrl: 12+18,+24,+30,+36	0.3	7.1	19.3	3.7	364
AA25: 12+18,+24,+30,+36	0.7	7.0	22.3	3.6	368
ECMWF: 12+18,+24,+30,+36	0.6	6.6	18.9	3.2	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	−0.2	2.5	2.5	1.8	10.5	336
AA25 – synop	−0.3	2.4	2.5	1.8	9.7	336
ECMWF – synop	−0.5	2.4	2.4	1.8	9.4	336


SLETTNES FYR
300
200
100
0
Mar 01
Mar 08
Mar 15
Mar 22
Mar 29
Apr 05
Apr 12
Apr 19
Apr 26
May 03
May 10
May 17
May 24
May 31
synop: 00,06,12,18
MEPSctrl: 12+18,+24,+30,+36
AA25: 12+18,+24,+30,+36
ECMWF: 12+18,+24,+30,+36

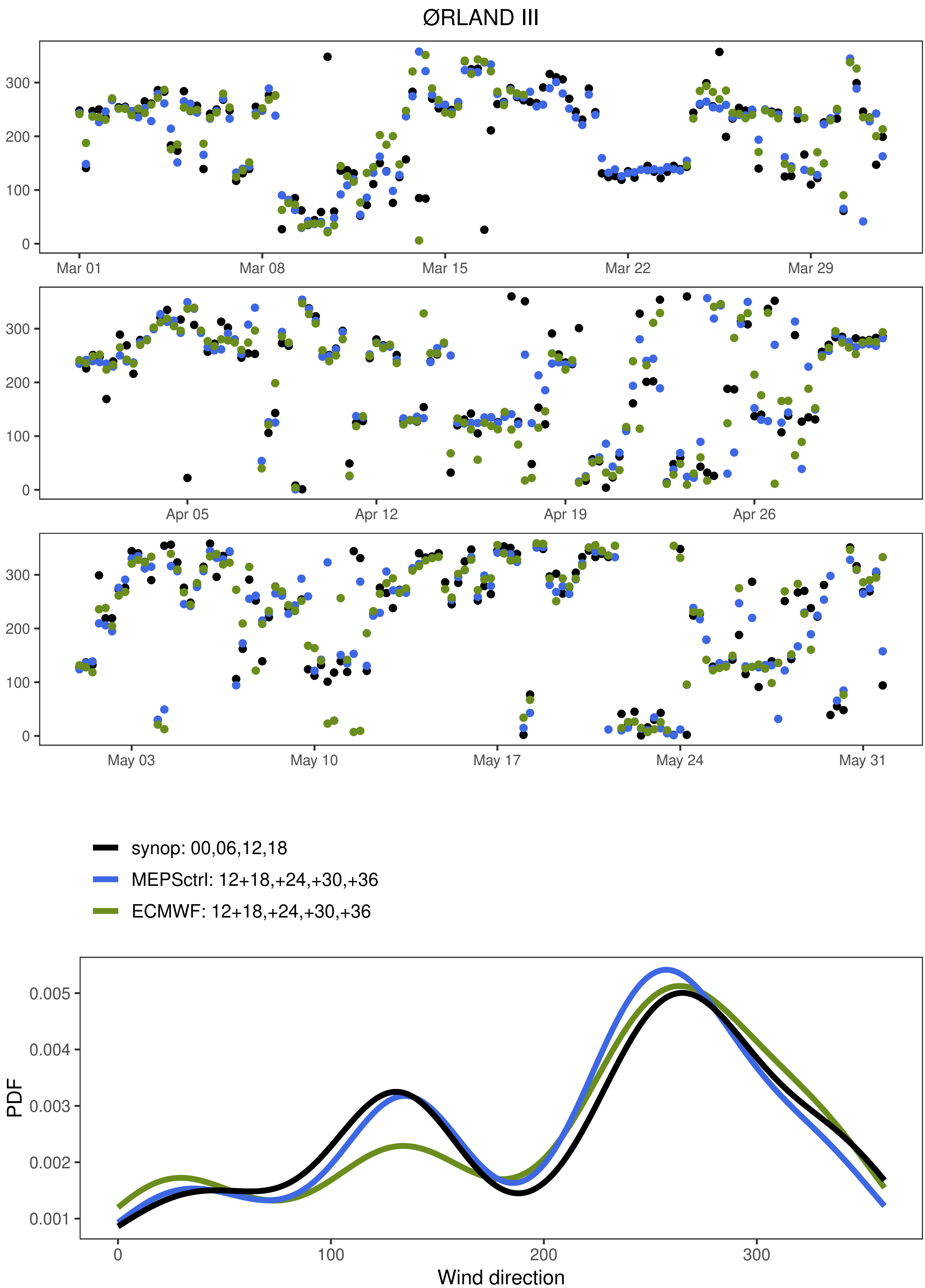

PDF
0.004
0.003
0.002
0.001
0
100
200
300
Wind direction

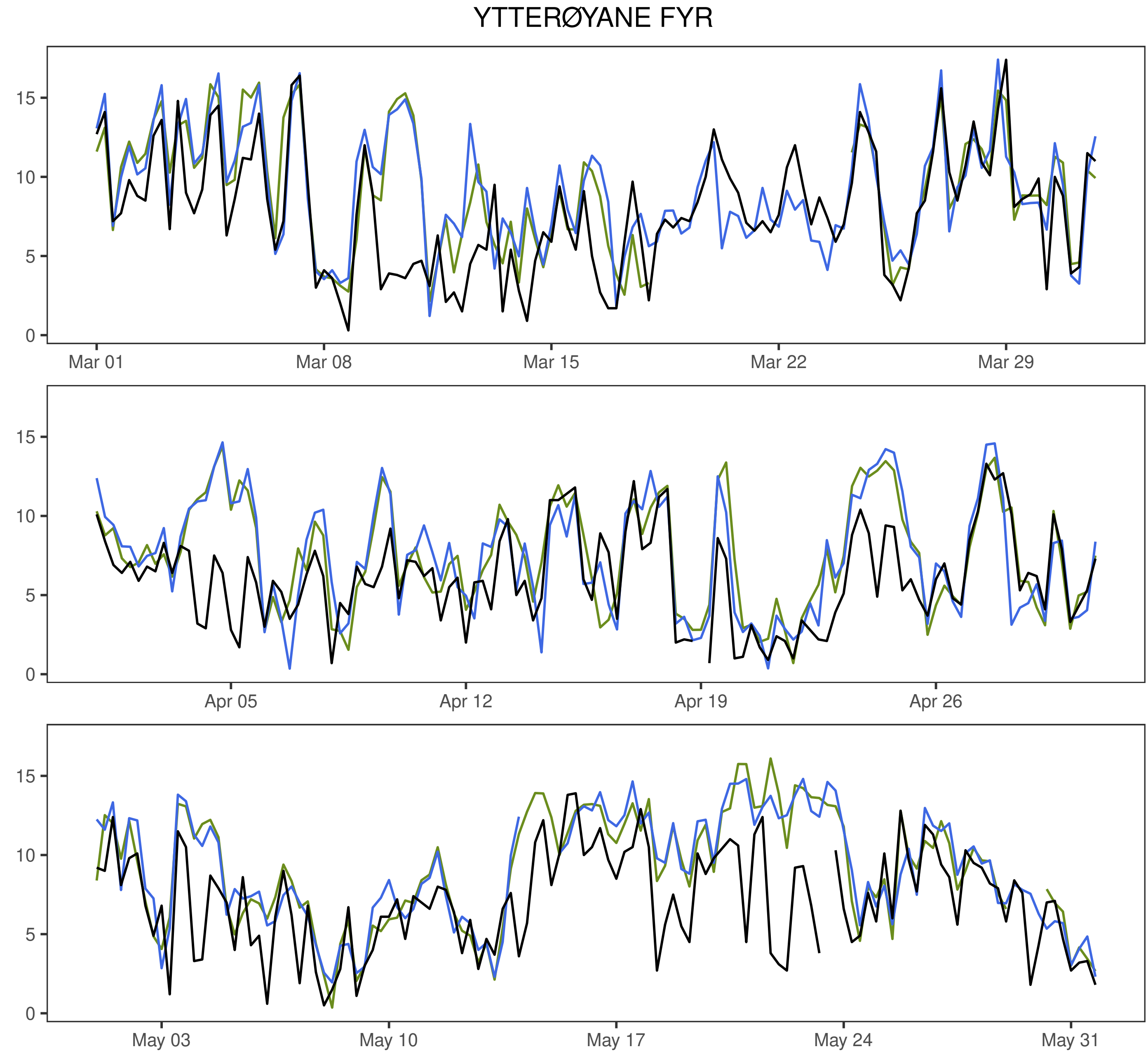
ØRLAND III



	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.5	6.5	24.7	3.7	368
MEPSctrl: 12+18,+24,+30,+36	0.5	5.7	22.8	3.5	364
ECMWF: 12+18,+24,+30,+36	0.3	6.0	20.1	3.4	340

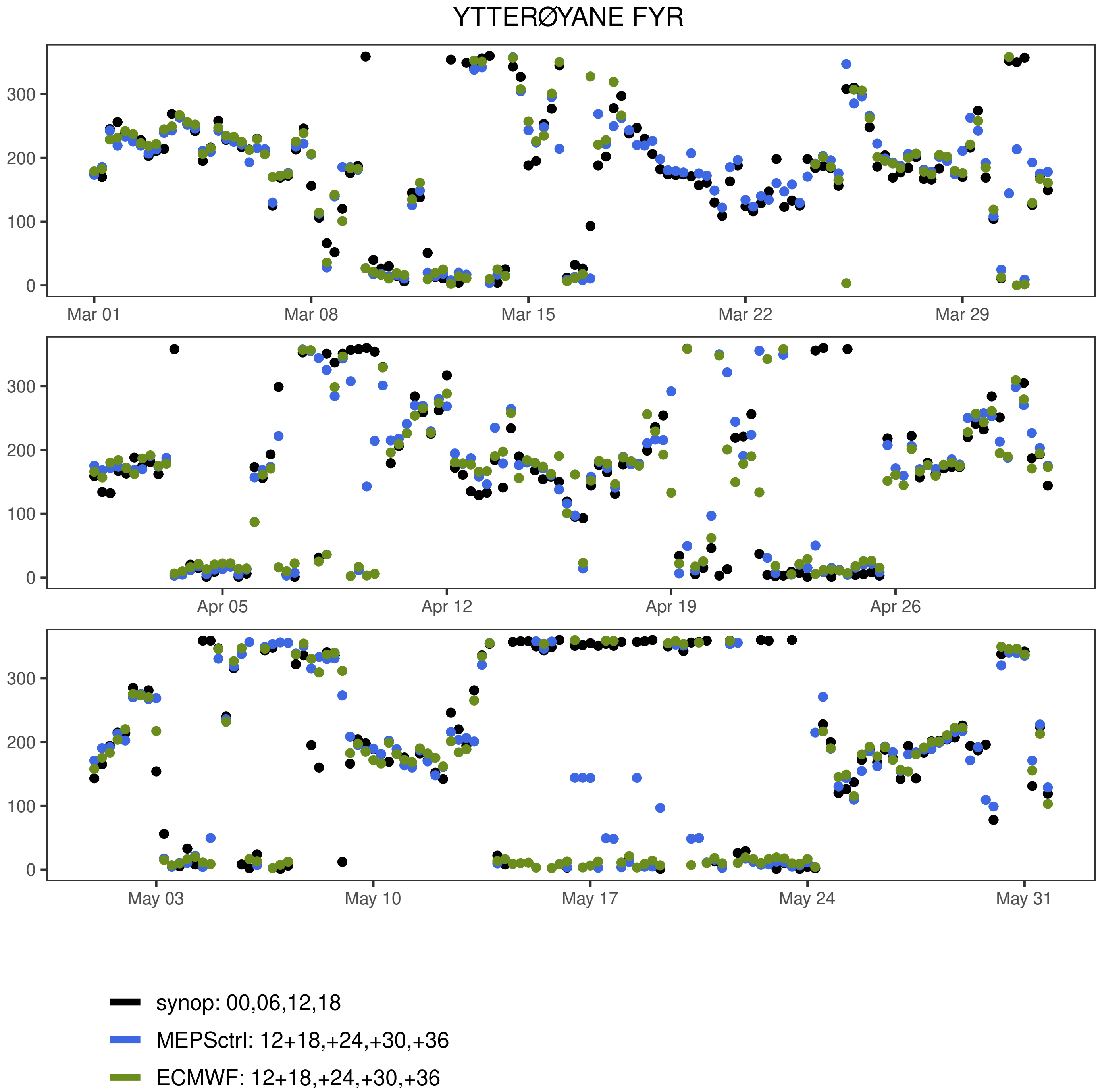
	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	–0.8	1.9	2.1	1.5	8.4	336
ECMWF – synop	–0.4	1.7	1.8	1.3	7.3	336

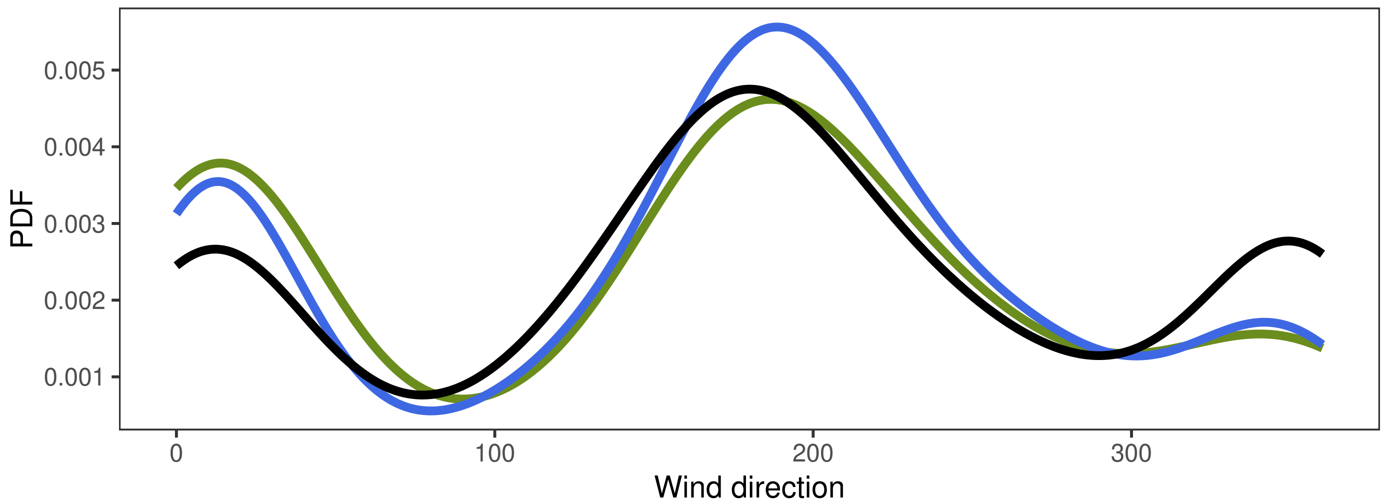

ØRLAND III
300
200
100
0
Mar 01
Mar 08
Mar 15
Mar 22
Mar 29
Apr 05
Apr 12
Apr 19
Apr 26
May 03
May 10
May 17
May 24
May 31
synop: 00,06,12,18
MEPSctrl: 12+18,+24,+30,+36
ECMWF: 12+18,+24,+30,+36
PDF
0.005
0.004
0.003
0.002
0.001
0
100
200
300
Wind direction



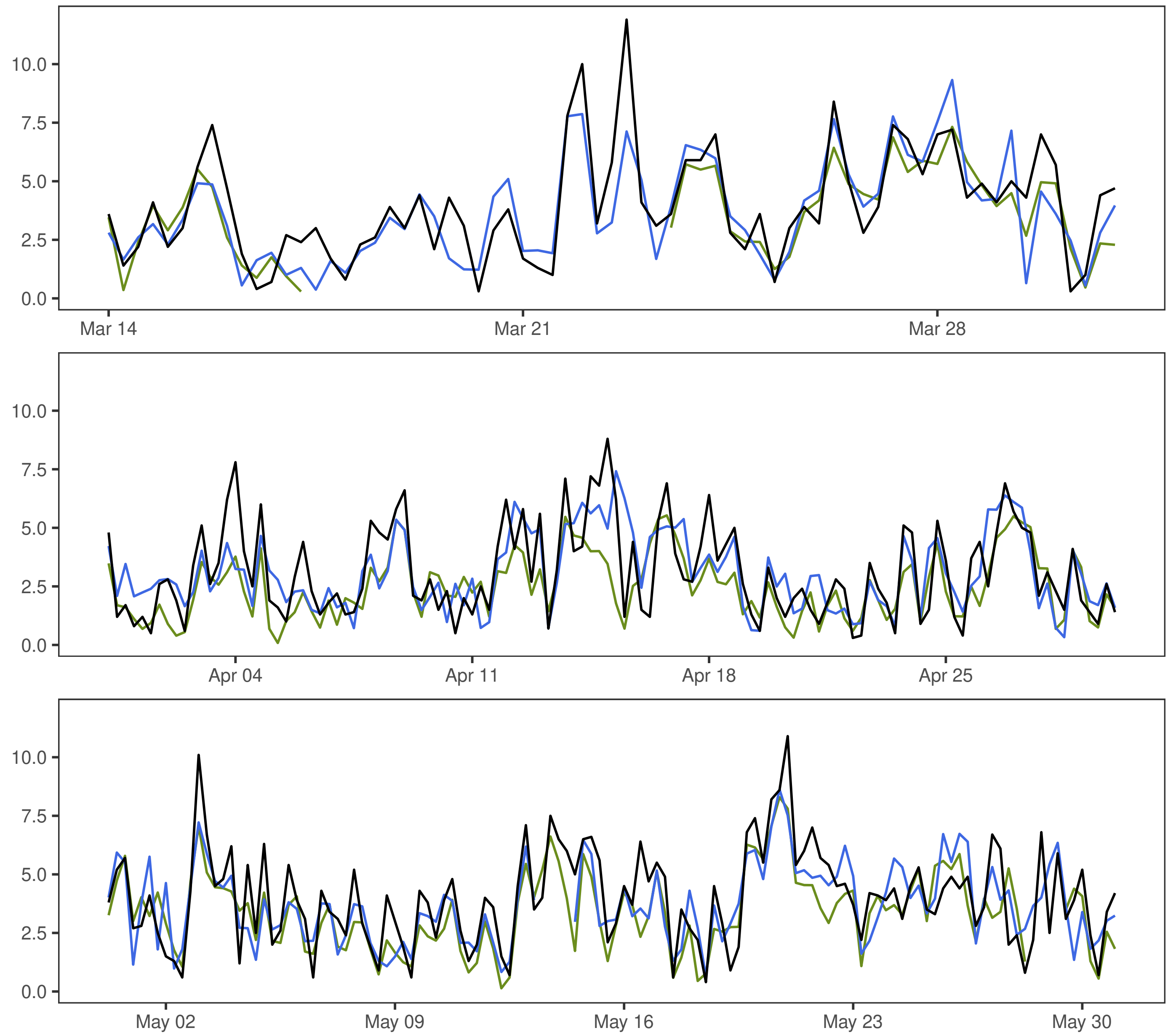
	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.3	7.0	17.4	3.4	366
MEPSctrl: 12+18,+24,+30,+36	0.4	8.5	17.4	3.6	364
ECMWF: 12+18,+24,+30,+36	0.4	8.6	16.1	3.7	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	1.7	2.9	3.4	2.5	11.3	334
ECMWF – synop	1.6	2.8	3.2	2.2	12.3	334


YTTERØYANE FYR
300
200
100
0
Mar 01
Mar 08
Mar 15
Mar 22
Mar 29
Apr 05
Apr 12
Apr 19
Apr 26
May 03
May 10
May 17
May 24
May 31
synop: 00,06,12,18
MEPSctrl: 12+18,+24,+30,+36
ECMWF: 12+18,+24,+30,+36

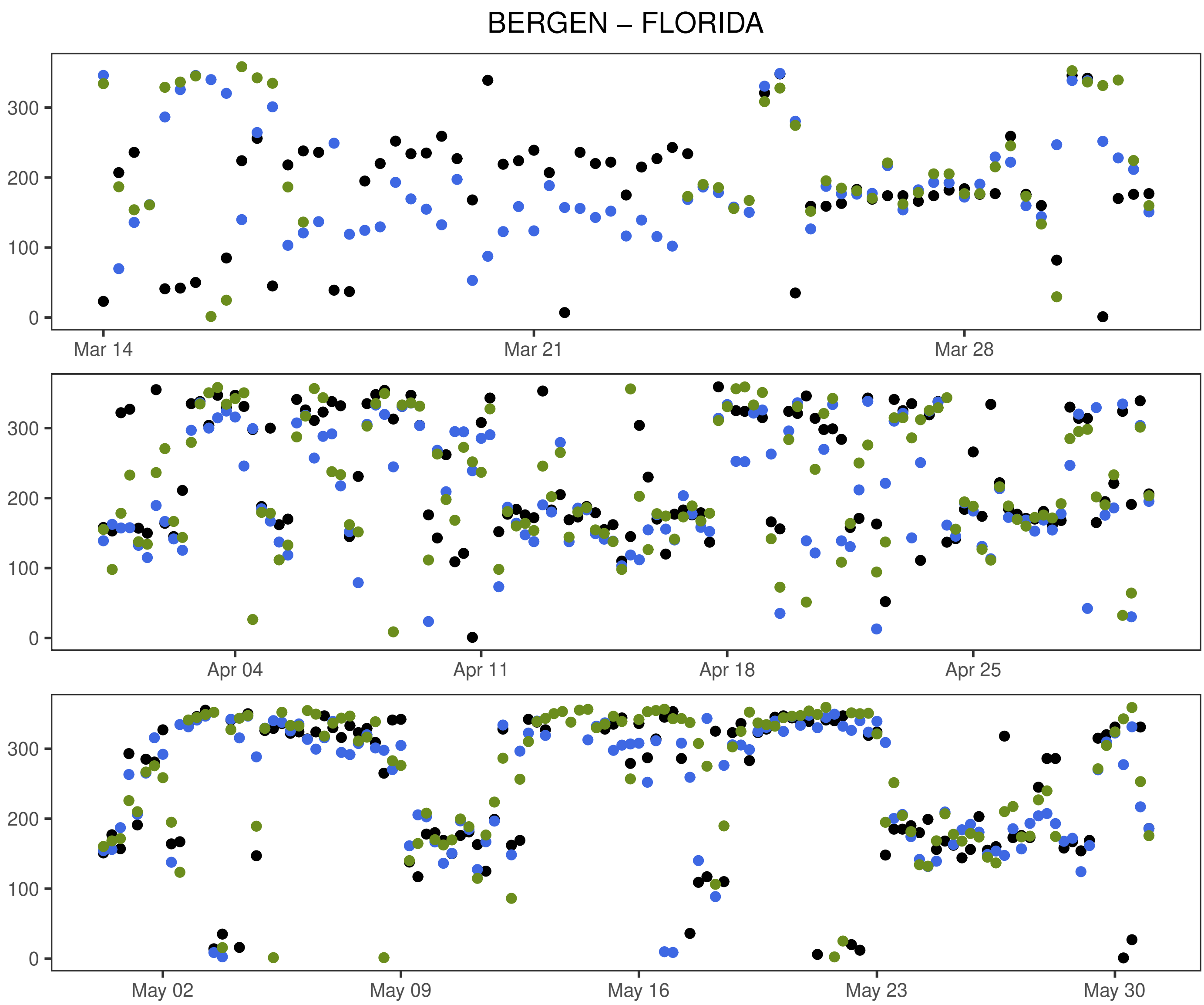

PDF
0.005
0.004
0.003
0.002
0.001
0
100
200
300
Wind direction

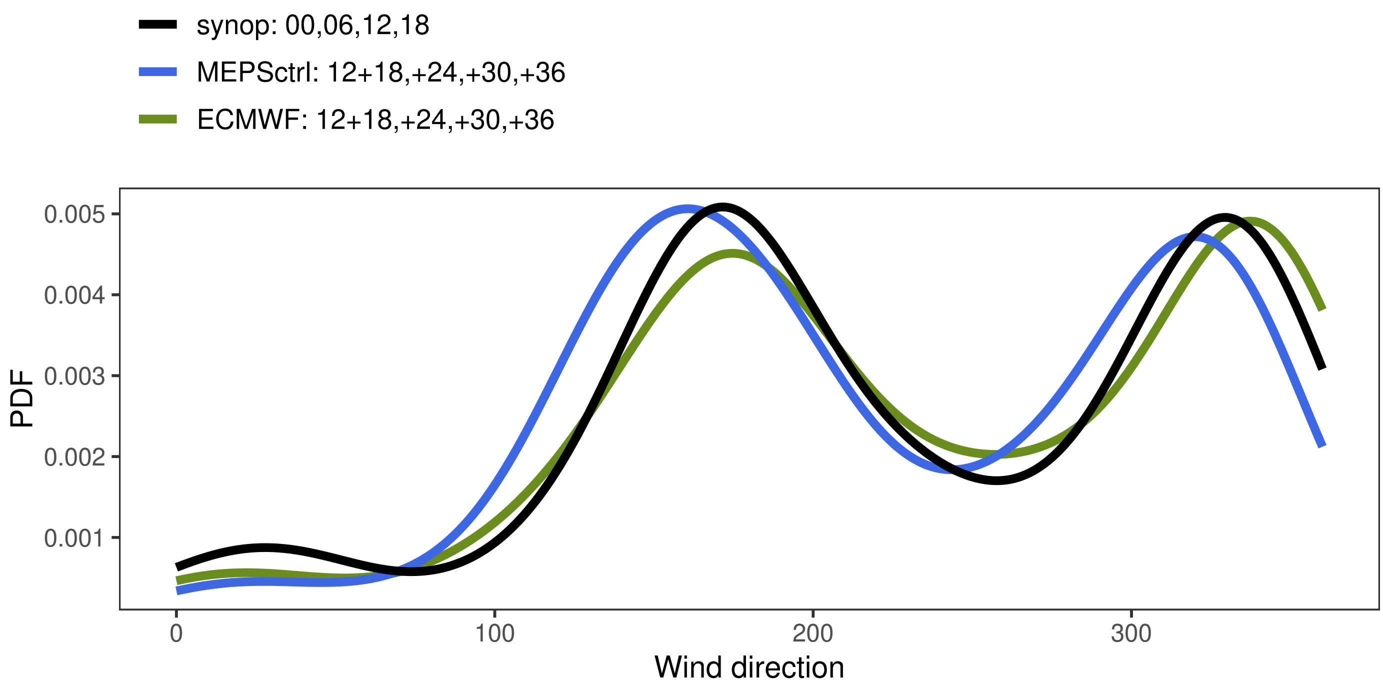
BERGEN – FLORIDA

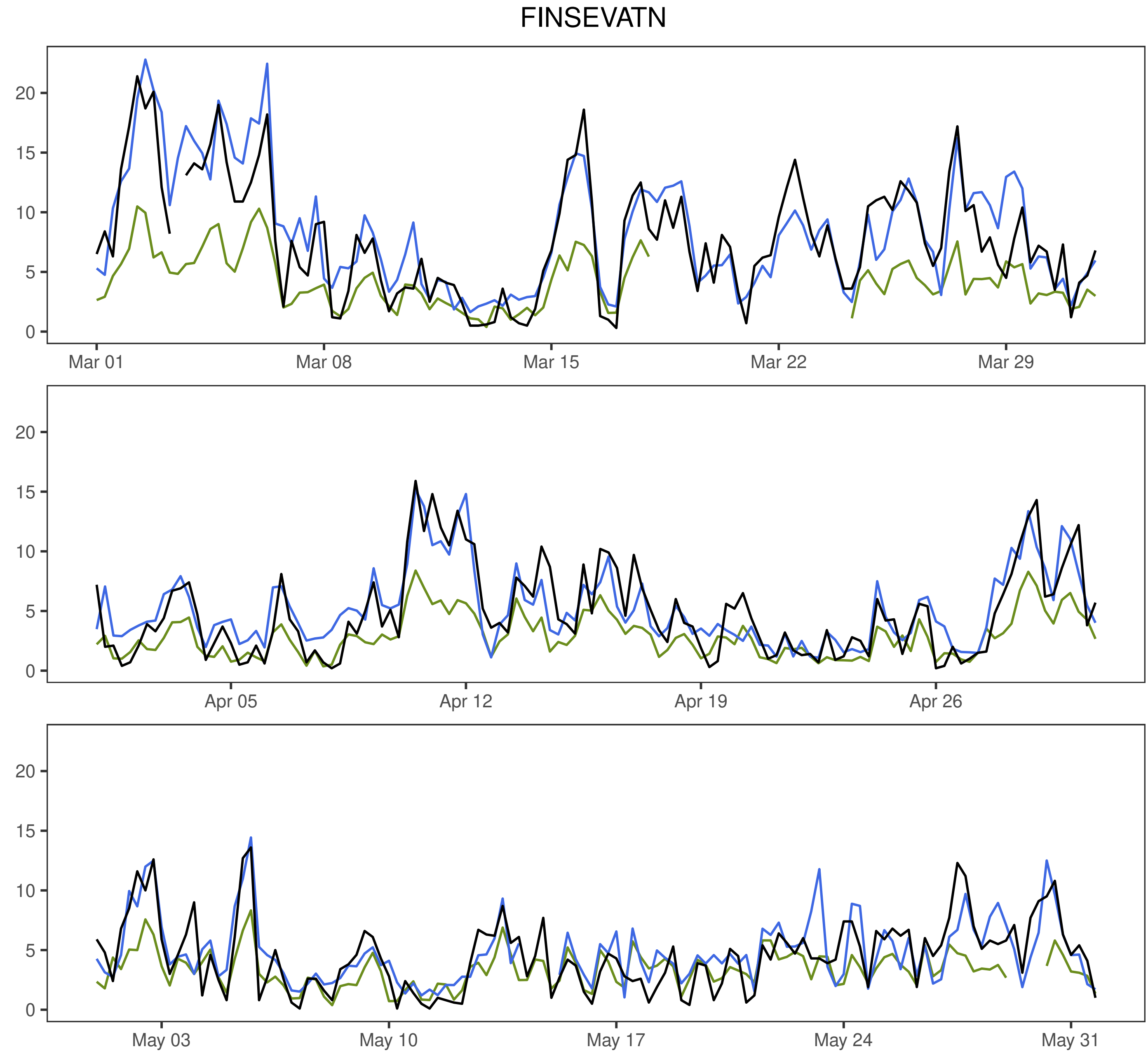


	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.3	3.7	11.9	2.1	313
MEPSctrl: 12+18,+24,+30,+36	0.3	3.4	9.3	1.8	309
ECMWF: 12+18,+24,+30,+36	0.1	3.0	8.3	1.7	285

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	–0.2	1.3	1.4	1.1	5.1	281
ECMWF – synop	–0.6	1.2	1.4	1.1	5.3	281

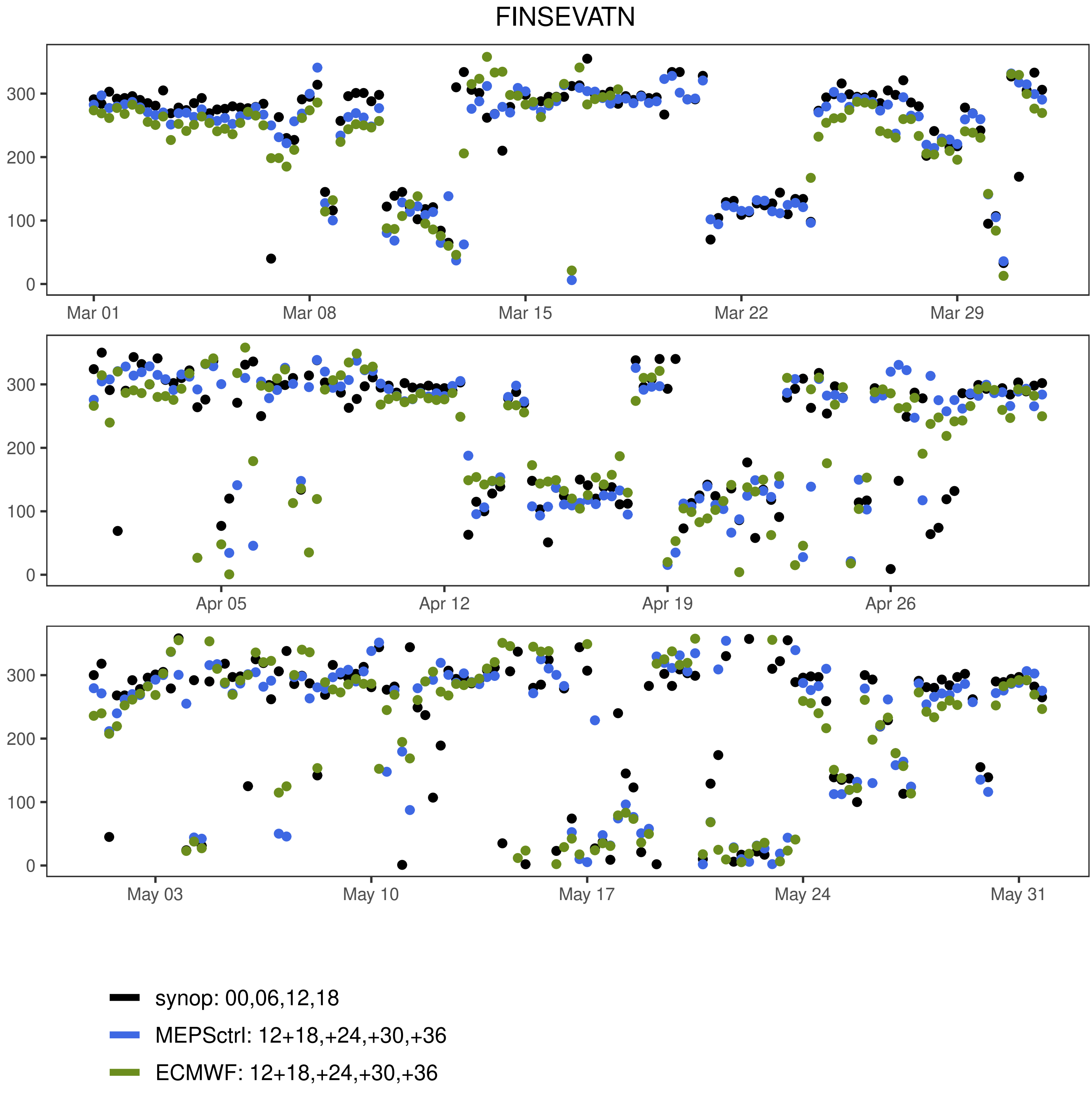

BERGEN – FLORIDA
0
100
200
300
Mar 14
Mar 21
Mar 28
Apr 04
Apr 11
Apr 18
Apr 25
May 02
May 09
May 16
May 23
May 30

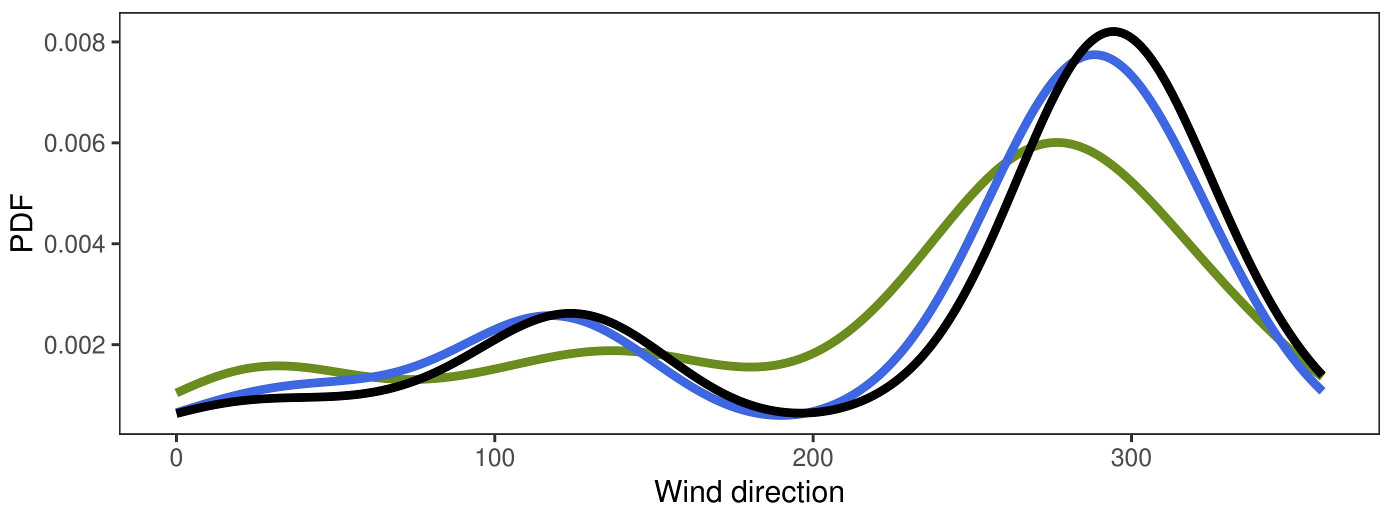

synop: 00,06,12,18
MEPSctrl: 12+18,+24,+30,+36
ECMWF: 12+18,+24,+30,+36
PDF
0.001
0.002
0.003
0.004
0.005
0
100
200
300
Wind direction

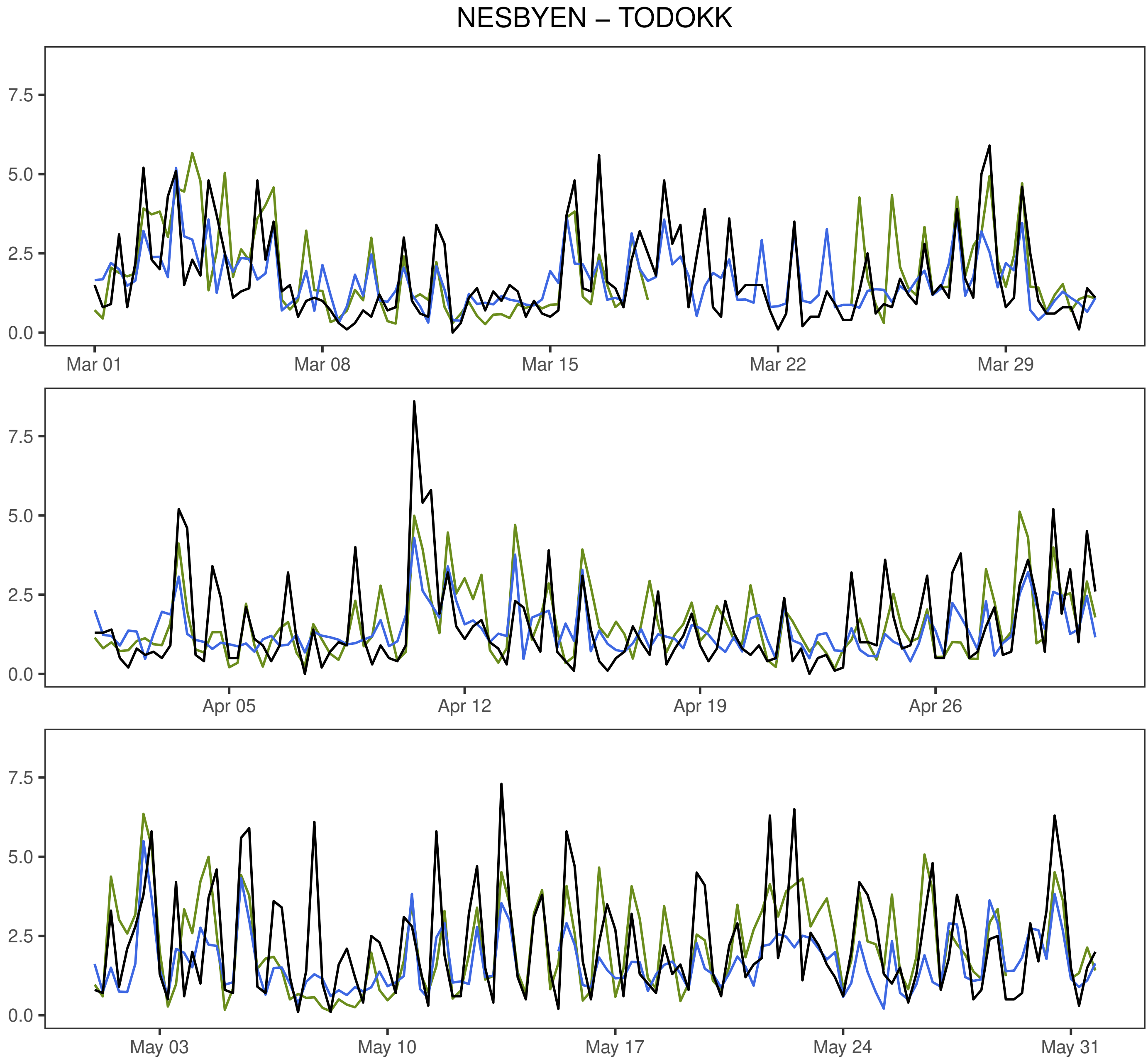


	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.1	5.8	21.4	4.2	367
MEPSctrl: 12+18,+24,+30,+36	1.0	6.2	22.8	4.1	364
ECMWF: 12+18,+24,+30,+36	0.4	3.5	10.5	2.0	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	0.5	2.2	2.2	1.7	8.5	335
ECMWF – synop	–2.2	2.8	3.6	2.6	13.9	335

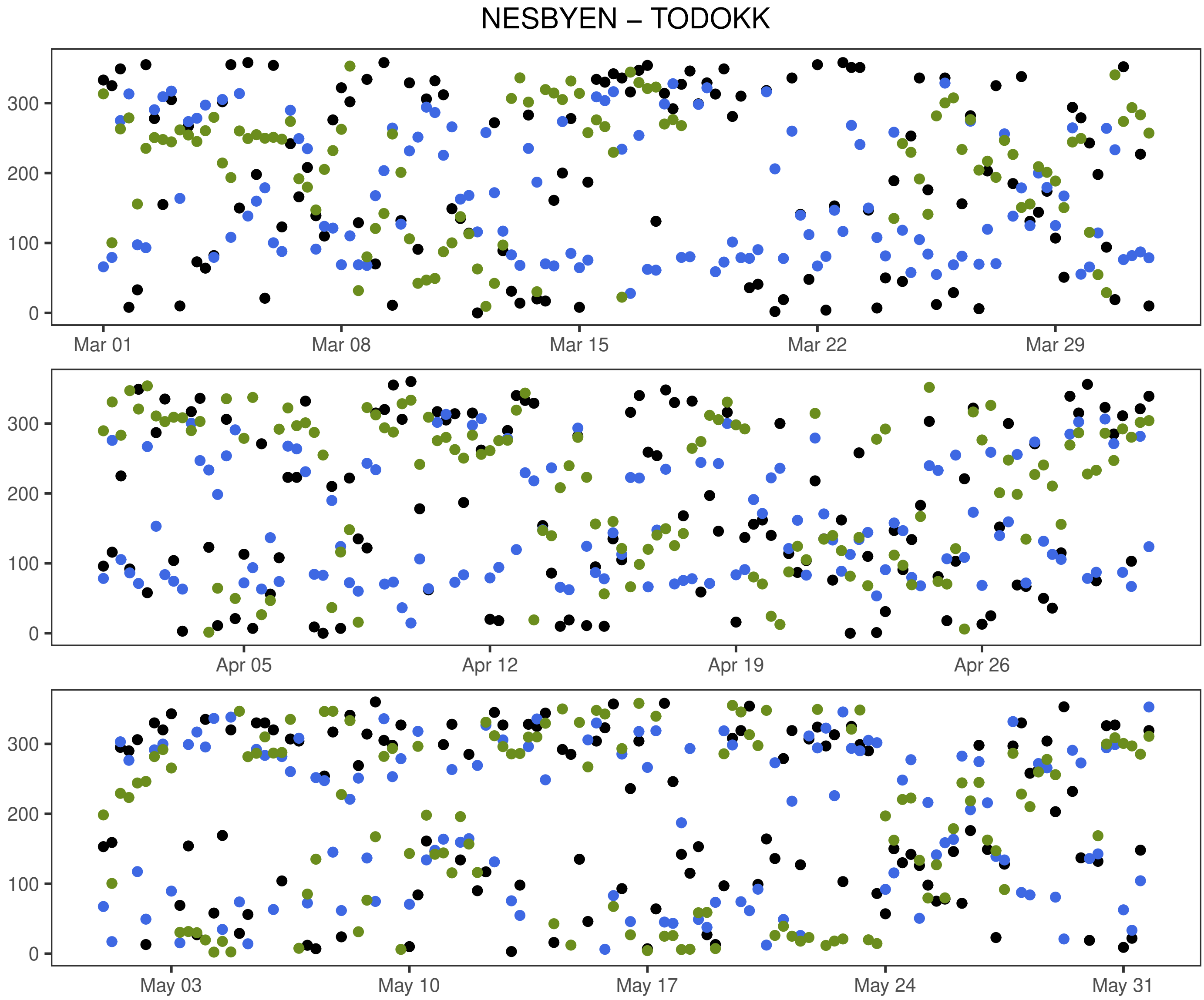

FINSEVATN
300
200
100
0
Mar 01
Mar 08
Mar 15
Mar 22
Mar 29
Apr 05
Apr 12
Apr 19
Apr 26
May 03
May 10
May 17
May 24
May 31
synop: 00,06,12,18
MEPSctrl: 12+18,+24,+30,+36
ECMWF: 12+18,+24,+30,+36

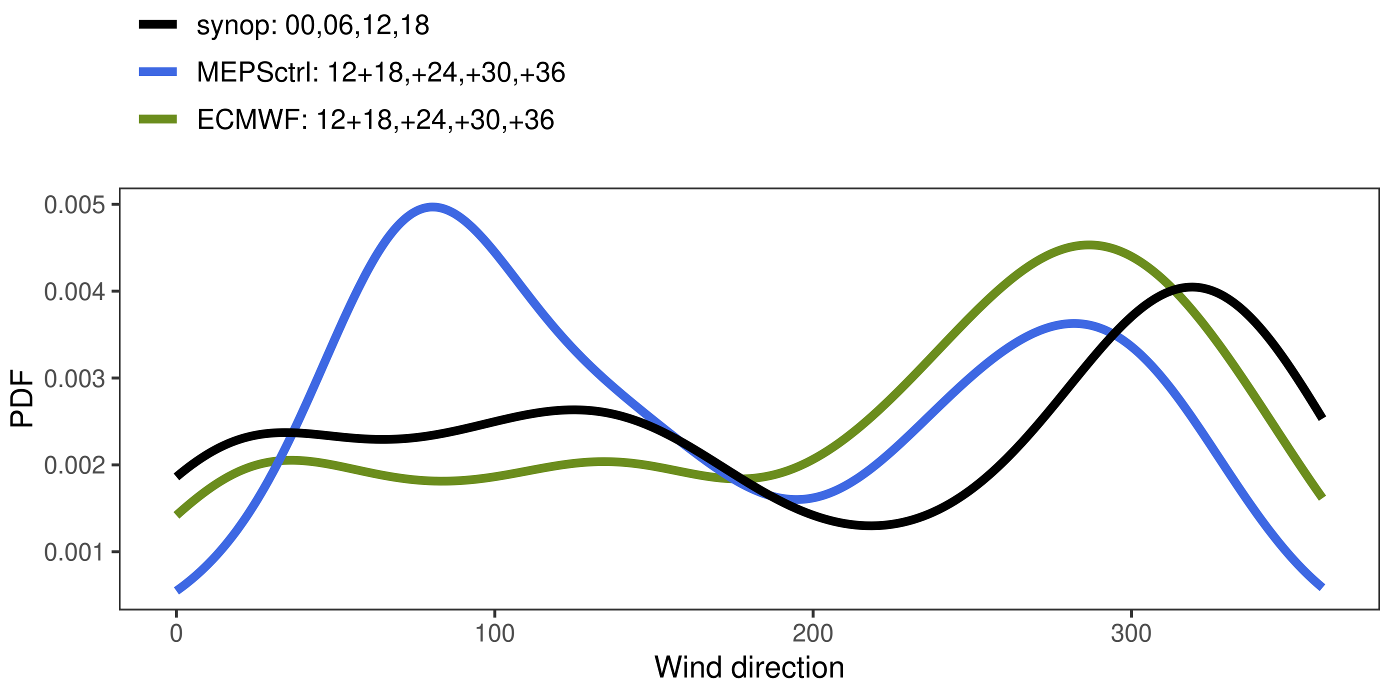

0.008
0.006
0.004
0.002
PDF
0
100
200
300
Wind direction

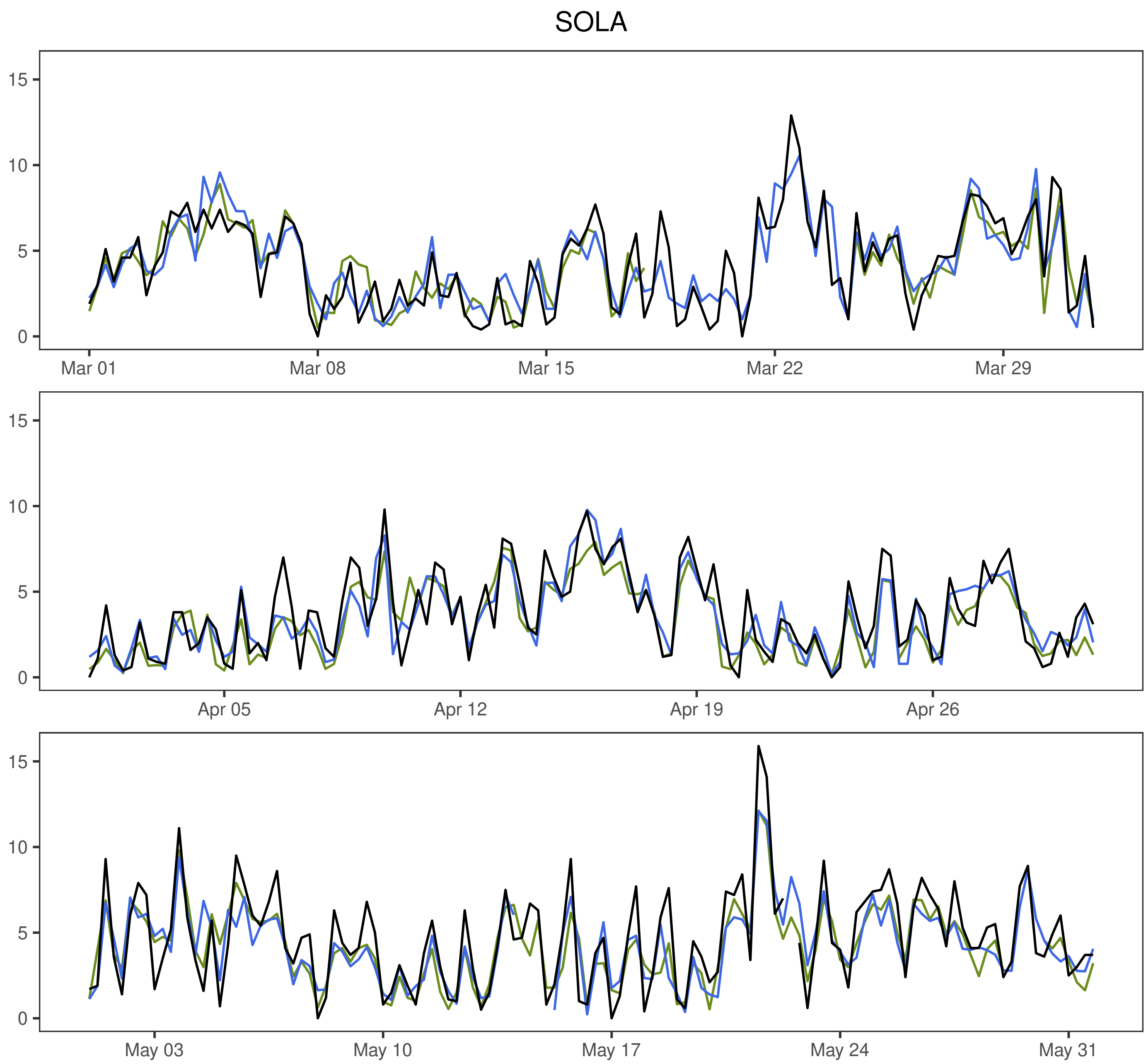


	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.0	1.8	8.6	1.5	368
MEPSctrl: 12+18,+24,+30,+36	0.2	1.6	5.5	0.8	364
ECMWF: 12+18,+24,+30,+36	0.1	1.9	6.4	1.3	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	−0.3	1.2	1.3	0.9	4.8	336
ECMWF – synop	0.0	1.3	1.3	0.9	5.5	336

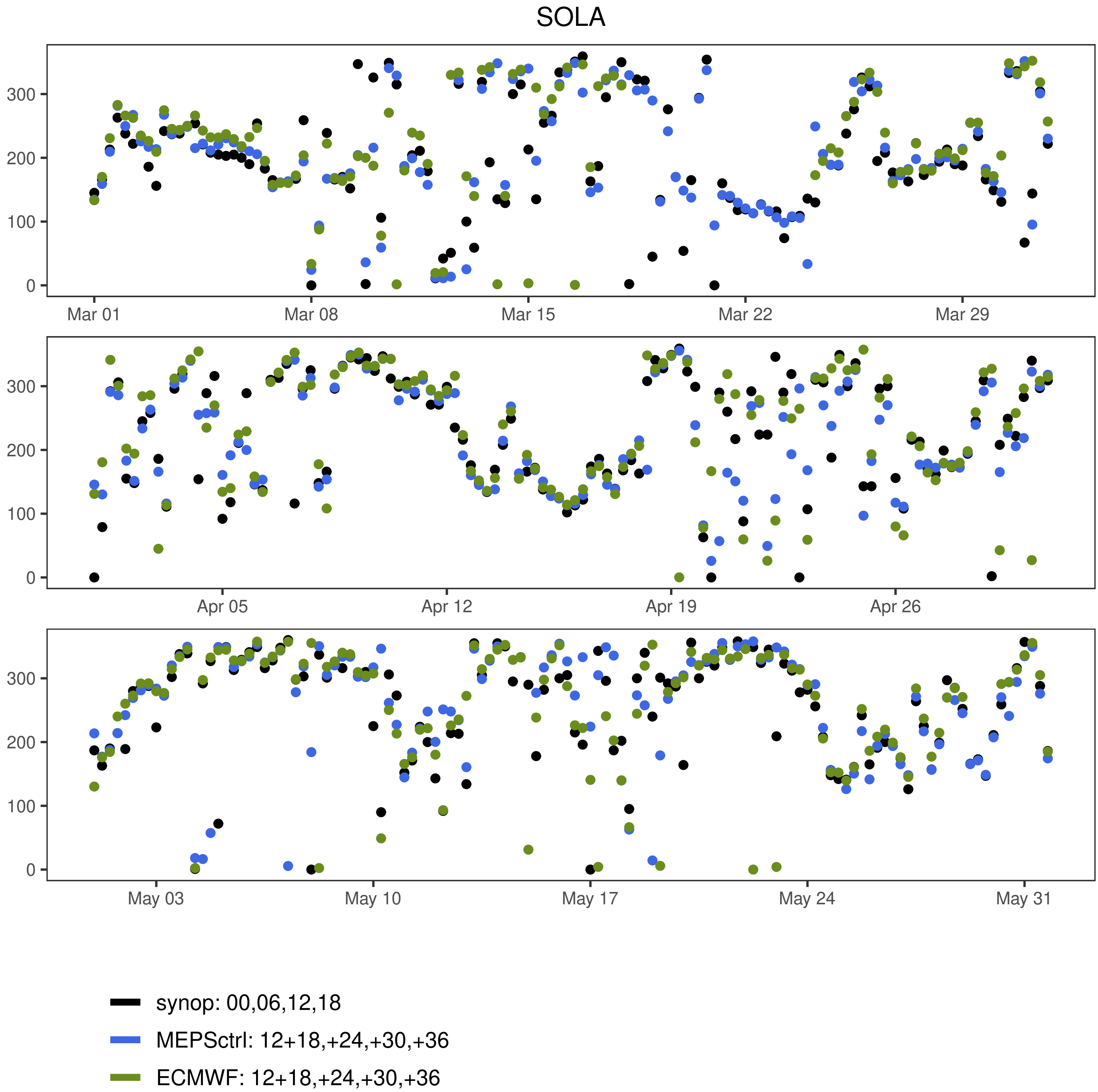

NESBYEN – TODOKK
300
200
100
0
Mar 01
Mar 08
Mar 15
Mar 22
Mar 29
Apr 05
Apr 12
Apr 19
Apr 26
May 03
May 10
May 17
May 24
May 31

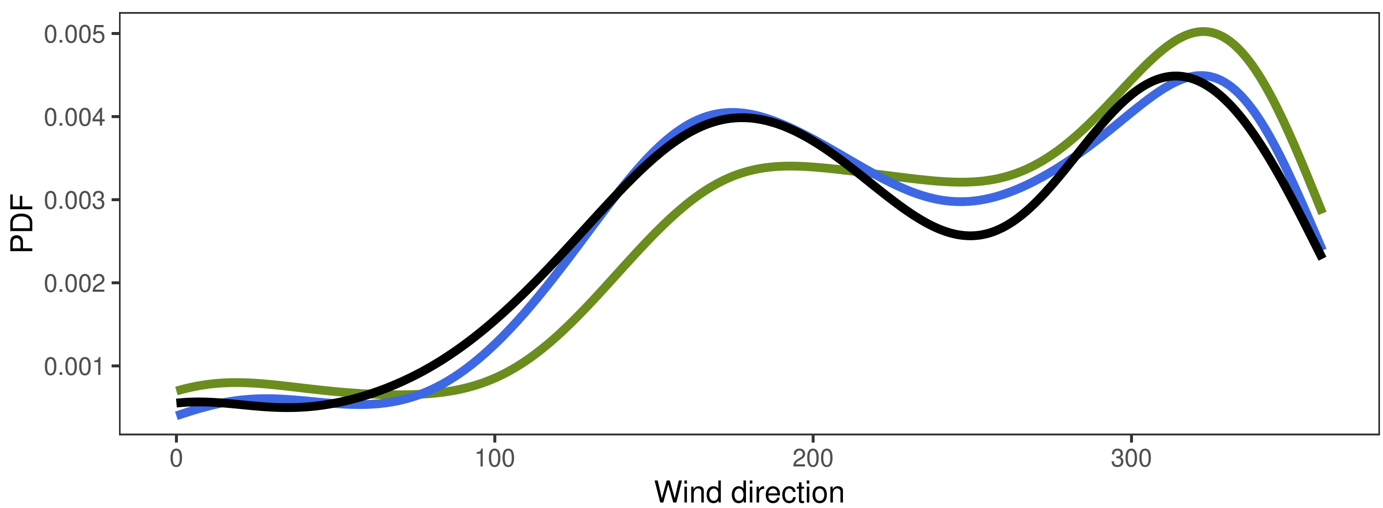

synop: 00,06,12,18
MEPSctrl: 12+18,+24,+30,+36
ECMWF: 12+18,+24,+30,+36
PDF
0.005
0.004
0.003
0.002
0.001
0
100
200
300
Wind direction

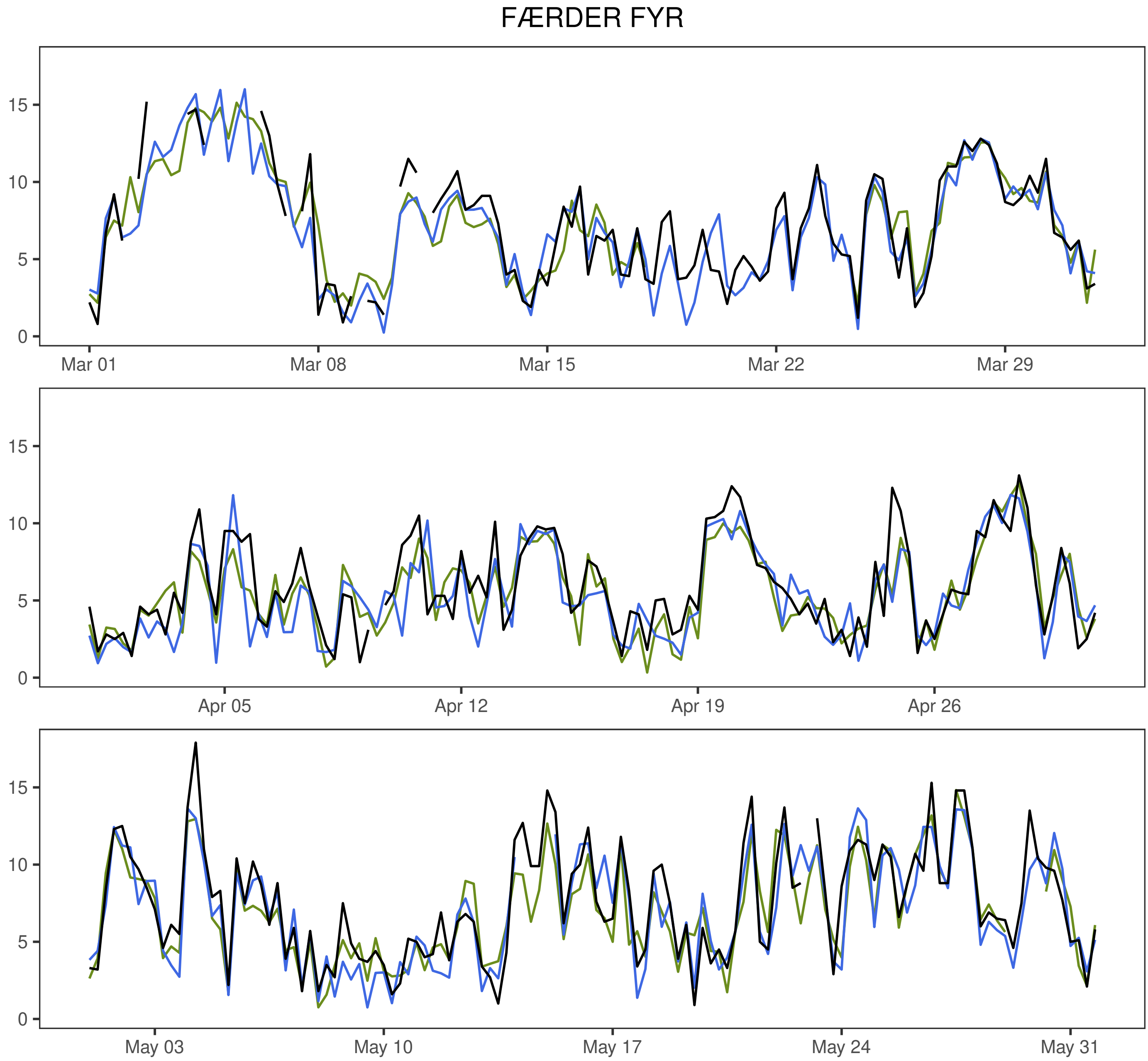


	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.0	4.2	15.9	2.7	367
MEPSctrl: 12+18,+24,+30,+36	0.2	4.0	12.1	2.3	364
ECMWF: 12+18,+24,+30,+36	0.2	3.8	12.1	2.1	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	–0.2	1.4	1.4	1.1	5.3	335
ECMWF – synop	–0.4	1.3	1.4	1.1	3.8	335

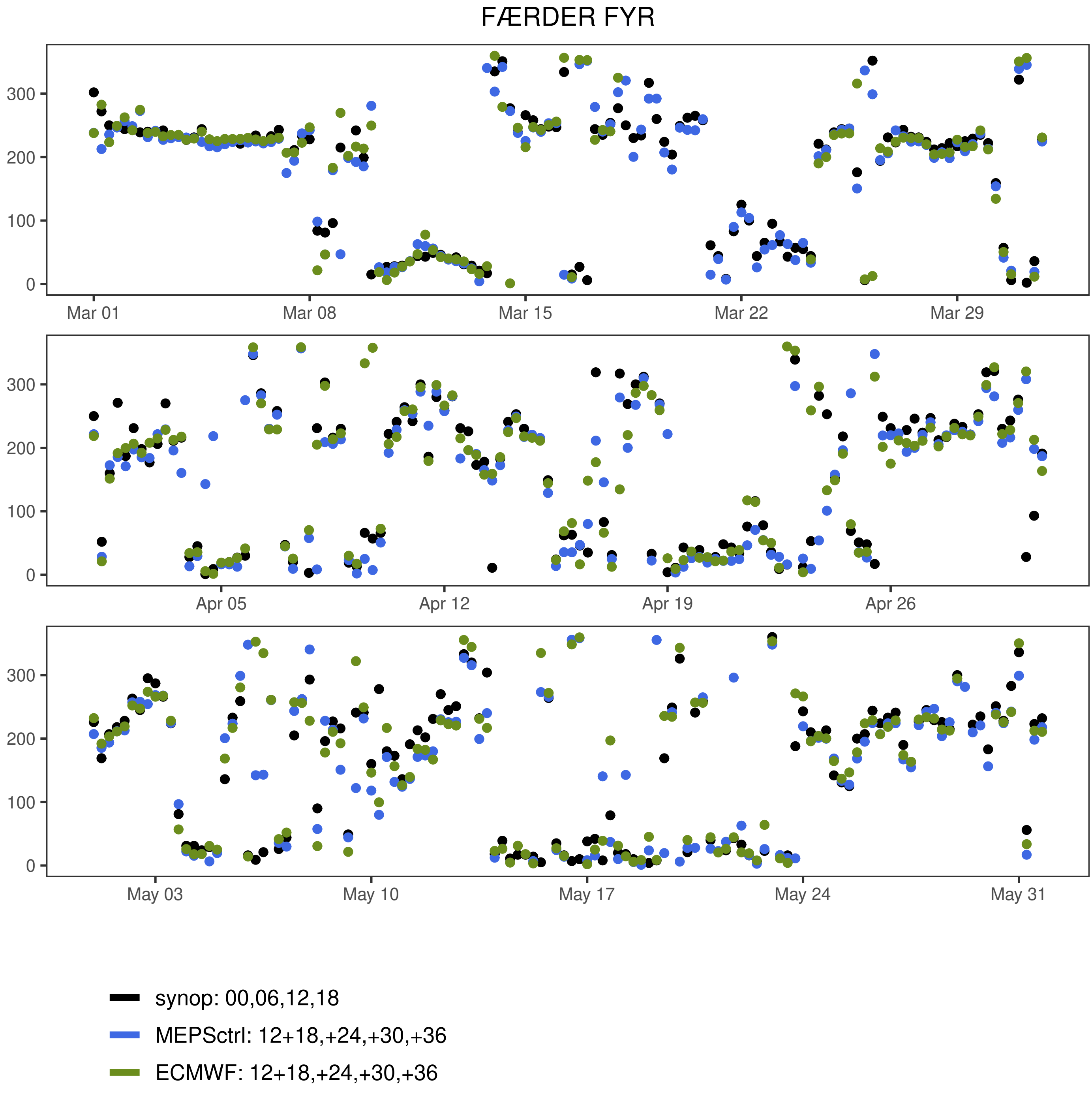

SOLA
300
200
100
0
Mar 01
Mar 08
Mar 15
Mar 22
Mar 29
Apr 05
Apr 12
Apr 19
Apr 26
May 03
May 10
May 17
May 24
May 31
synop: 00,06,12,18
MEPSctrl: 12+18,+24,+30,+36
ECMWF: 12+18,+24,+30,+36

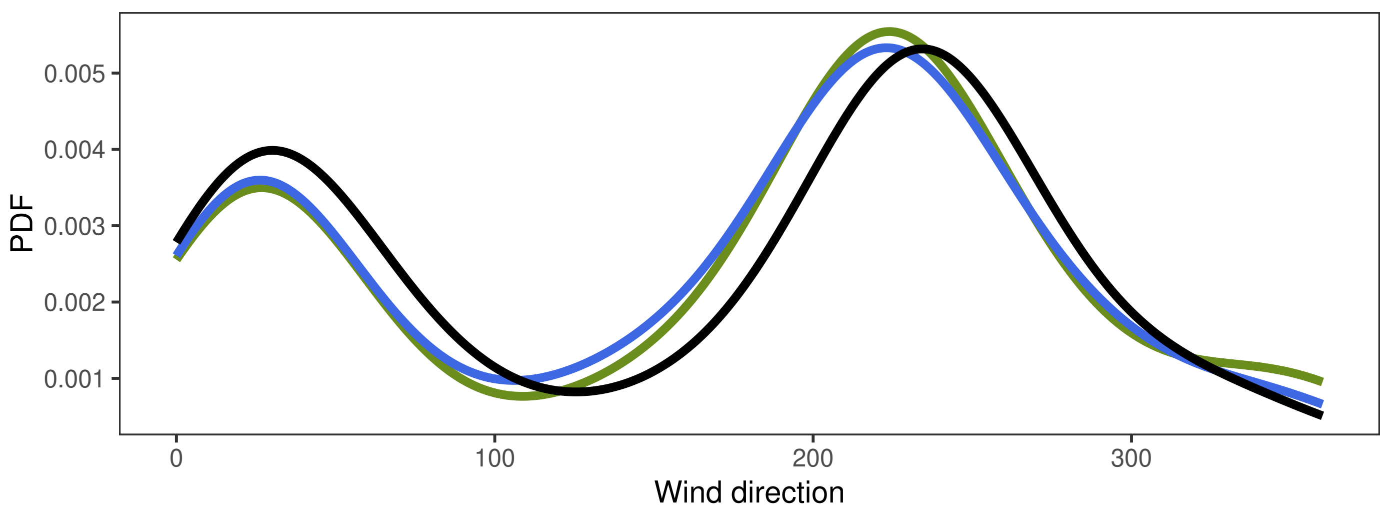

PDF
0.005
0.004
0.003
0.002
0.001
0
100
200
300
Wind direction



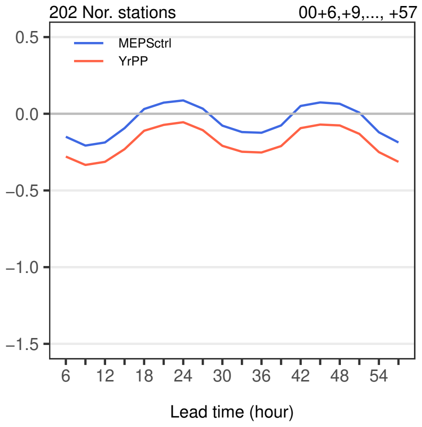
	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.8	6.9	17.9	3.5	354
MEPSctrl: 12+18,+24,+30,+36	0.2	6.5	16.0	3.4	364
ECMWF: 12+18,+24,+30,+36	0.3	6.7	15.1	3.2	340

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	–0.4	1.7	1.8	1.3	7.4	322
ECMWF – synop	–0.4	1.6	1.7	1.3	6.9	322

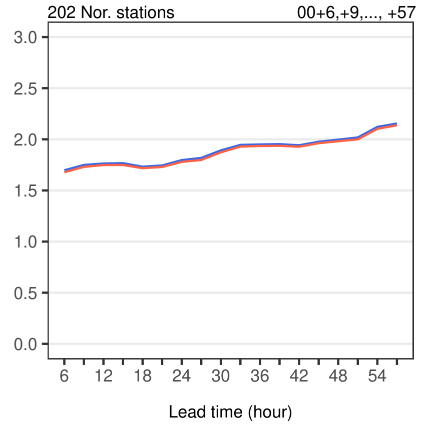

FÆRDER FYR
300
200
100
0
Mar 01
Mar 08
Mar 15
Mar 22
Mar 29
Apr 05
Apr 12
Apr 19
Apr 26
May 03
May 10
May 17
May 24
May 31
synop: 00,06,12,18
MEPSctrl: 12+18,+24,+30,+36
ECMWF: 12+18,+24,+30,+36


PDF
0.005
0.004
0.003
0.002
0.001
0
100
200
300
Wind direction

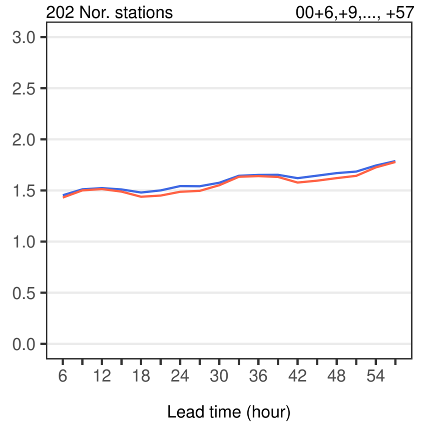
Mean Error



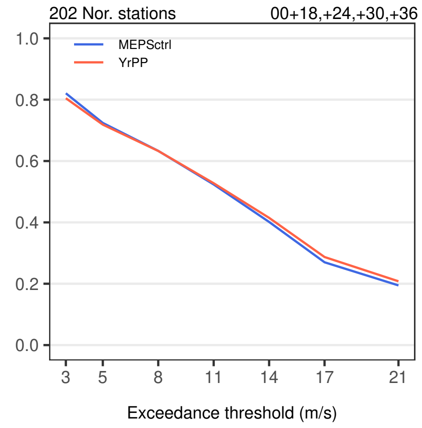
Standard Deviation of Error



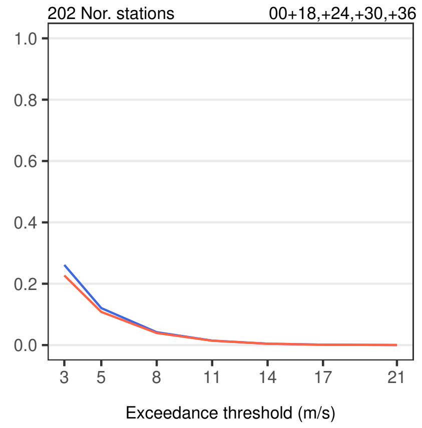
Mean Absolute Error



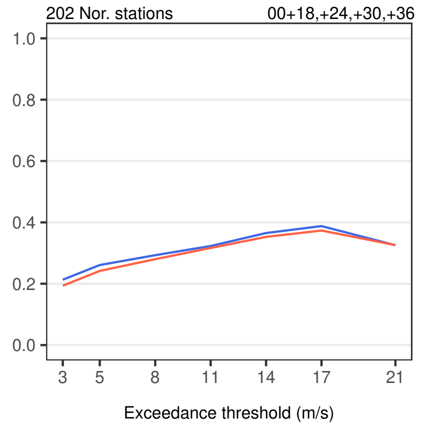
Hit Rate



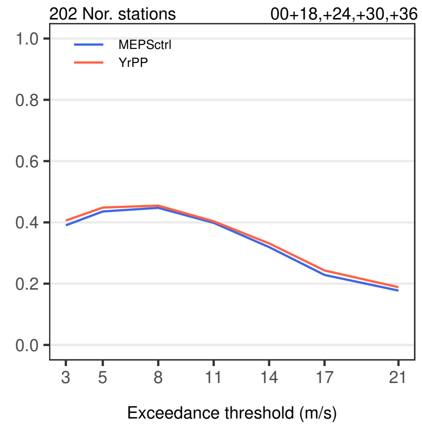
False Alarm Rate



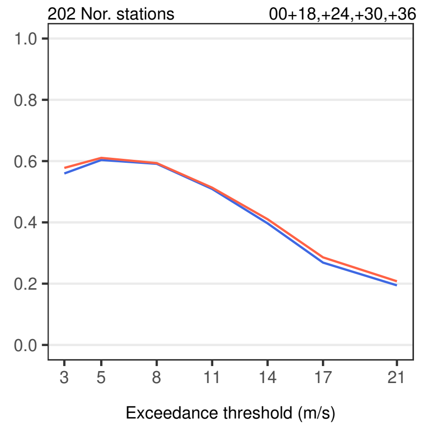
False Alarm Ratio



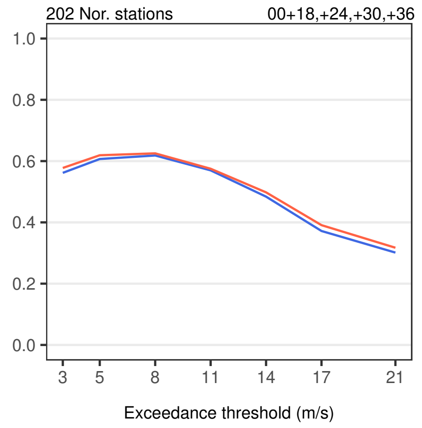
Equitable Threat Score



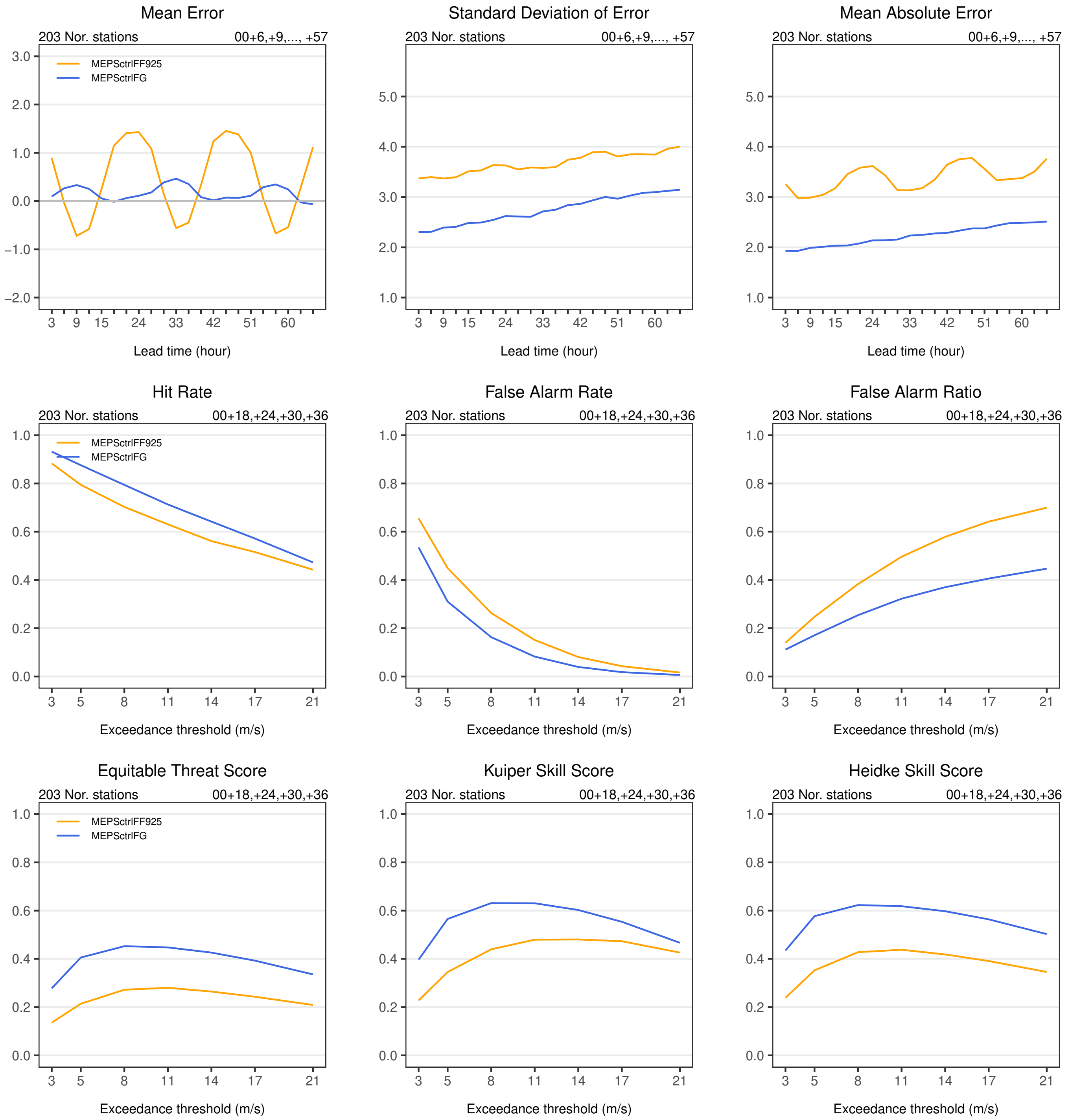
Kuiper Skill Score

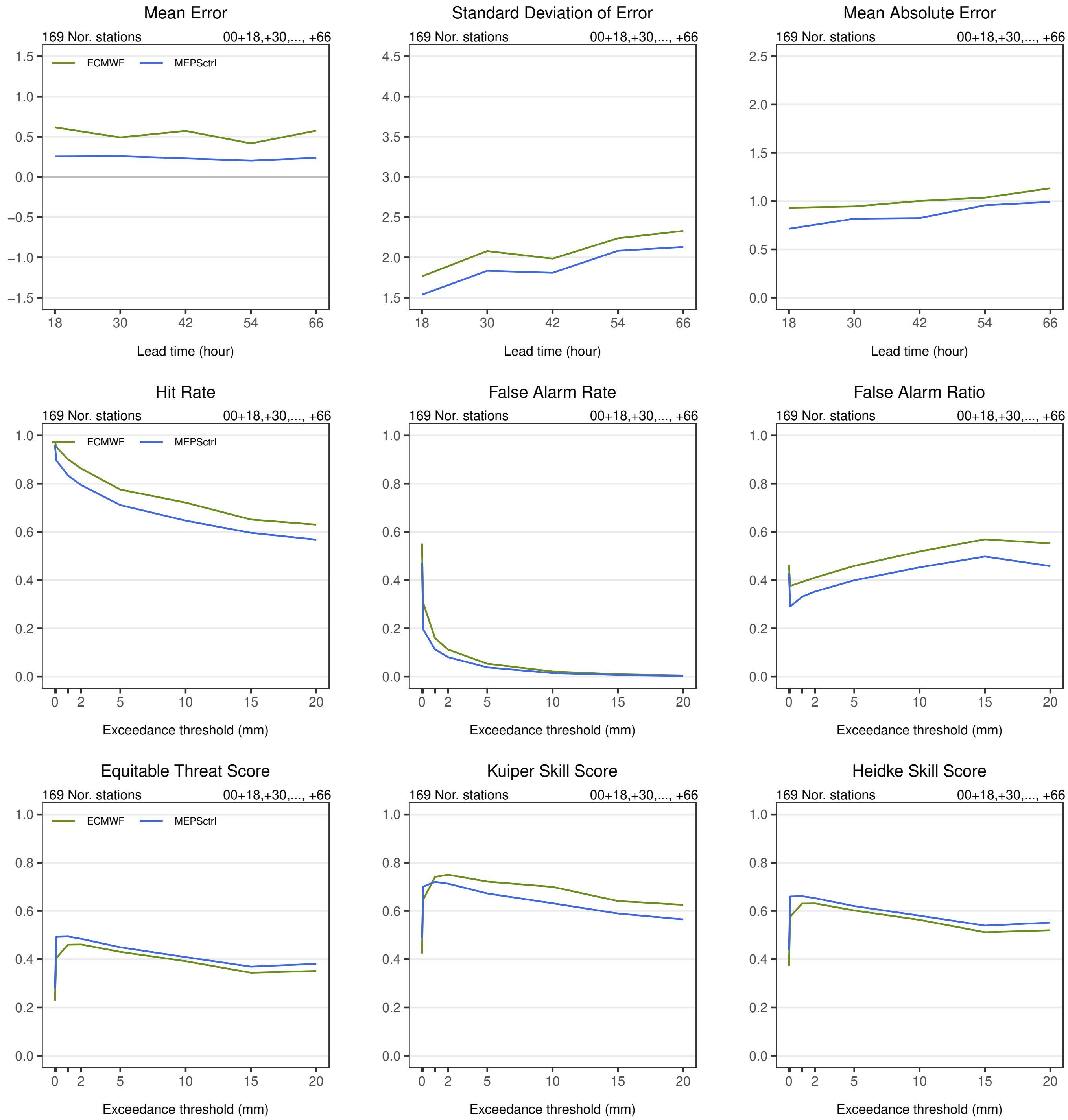


Heidke Skill Score

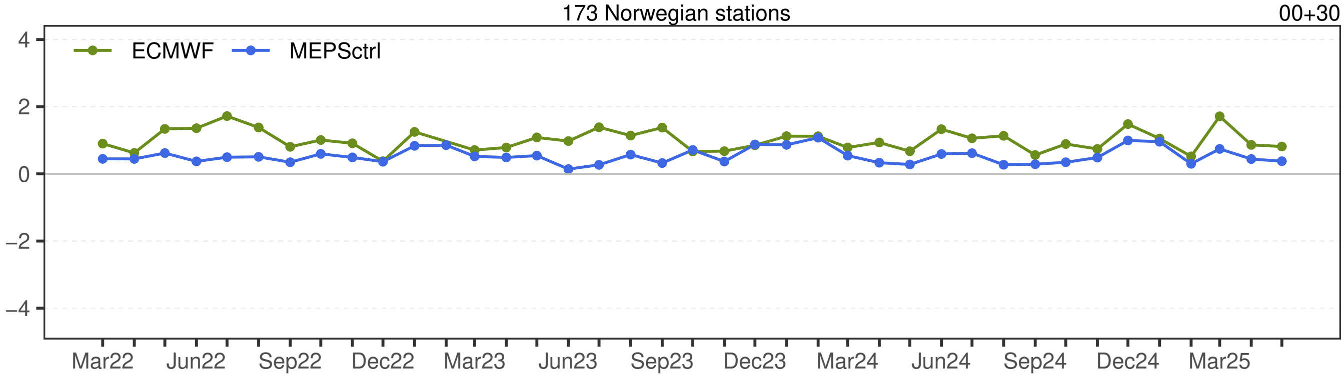


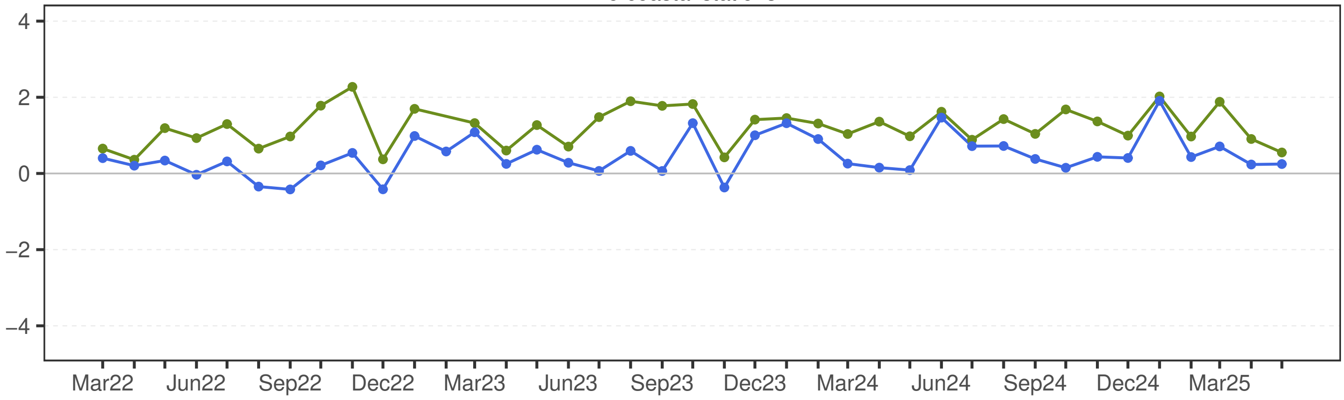
Wind gust (FG) and wind speed in 925 hpa (FF.925)

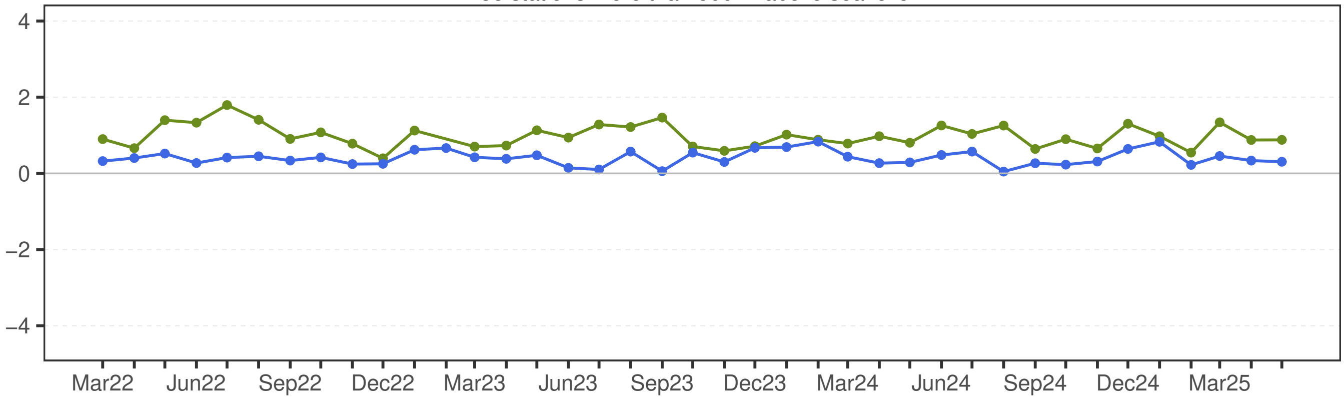


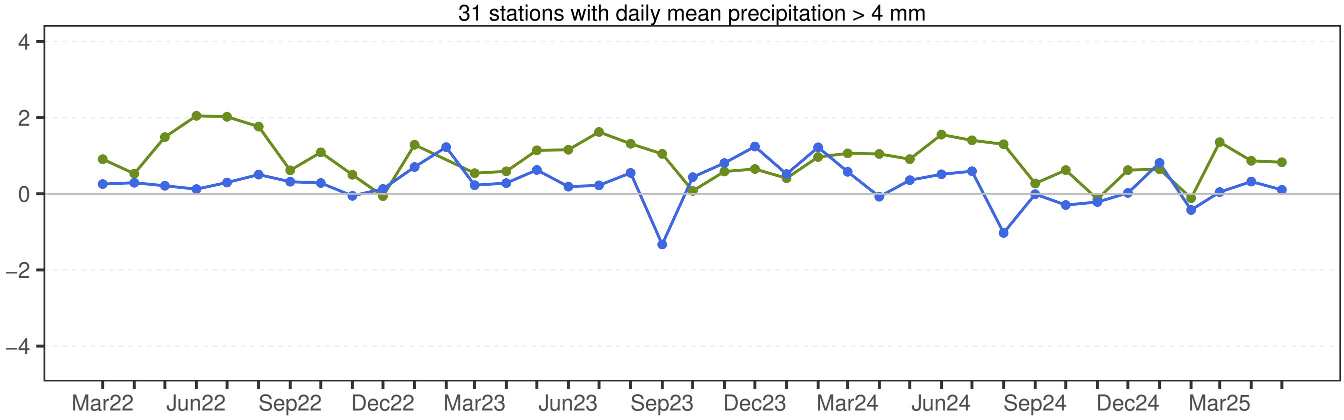

Mean Error
169 Nor. stations
00+18,+30,..., +66
ECMWF
MEPSctrl
Lead time (hour)
Standard Deviation of Error
Mean Absolute Error
Hit Rate
Exceedance threshold (mm)
False Alarm Rate
False Alarm Ratio
Equitable Threat Score
Kuiper Skill Score
Heidke Skill Score

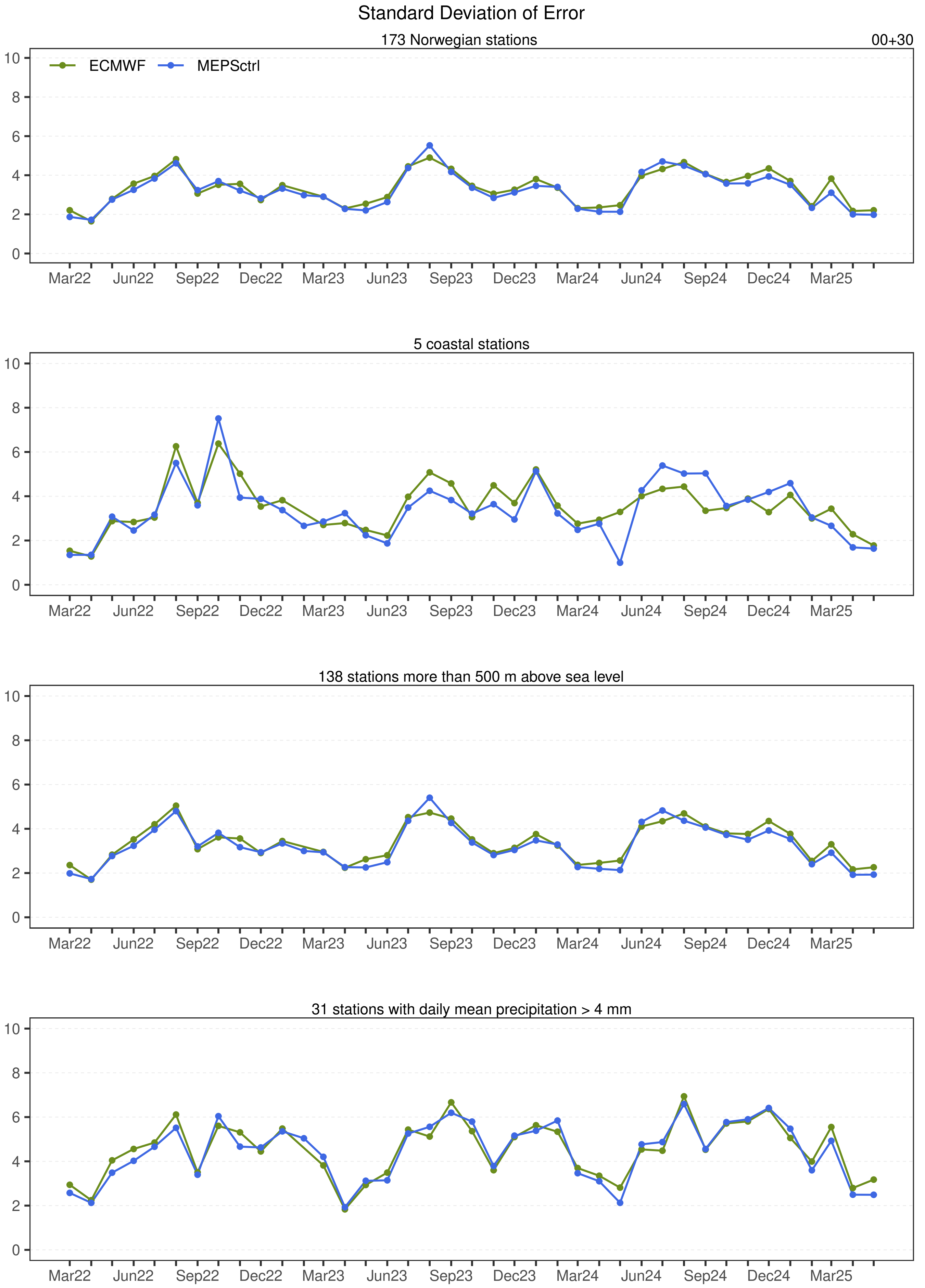
Mean Error

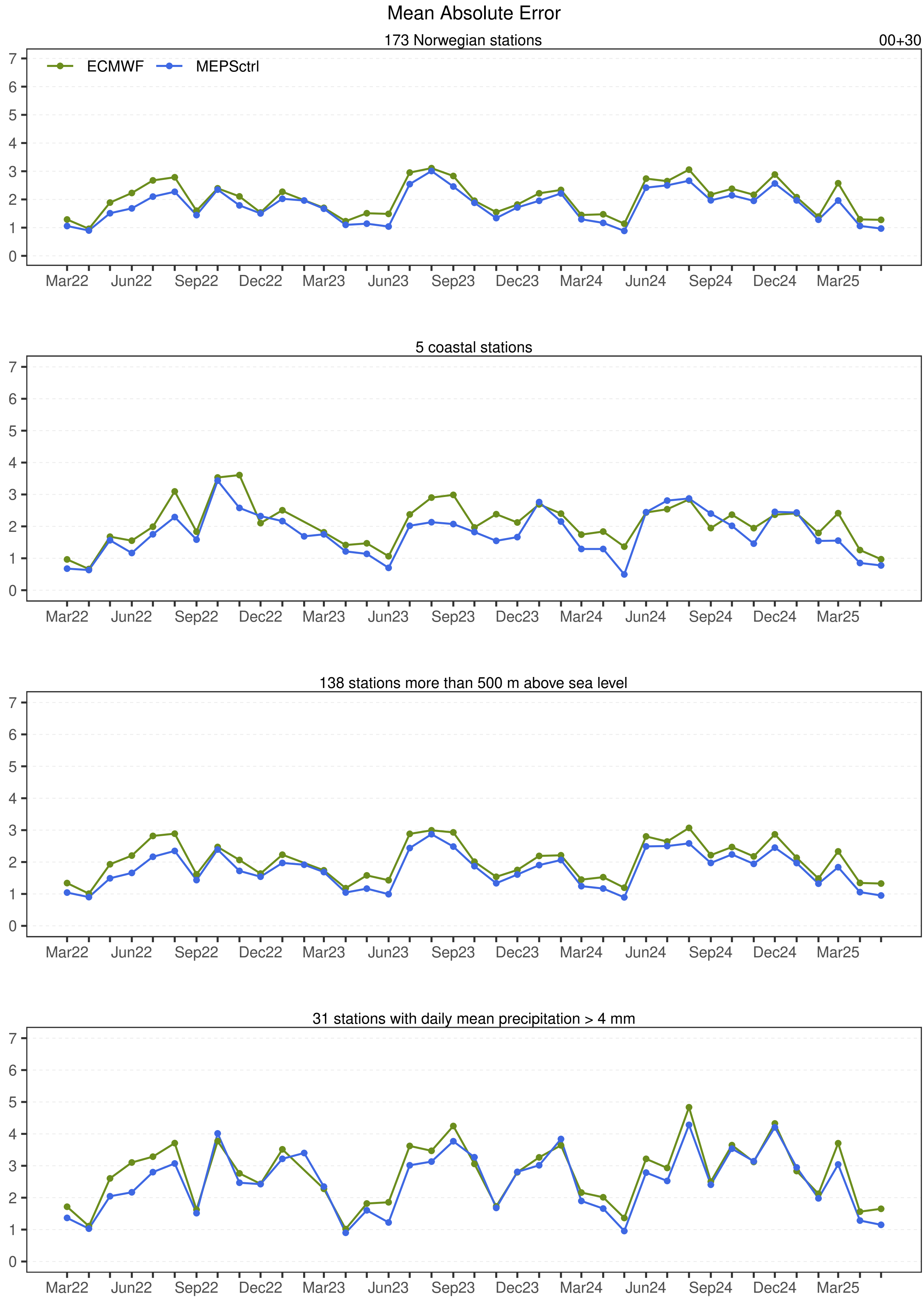

173 Norwegian stations
00+30
ECMWF
MEPSctrl
4
2
0
−2
−4
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25

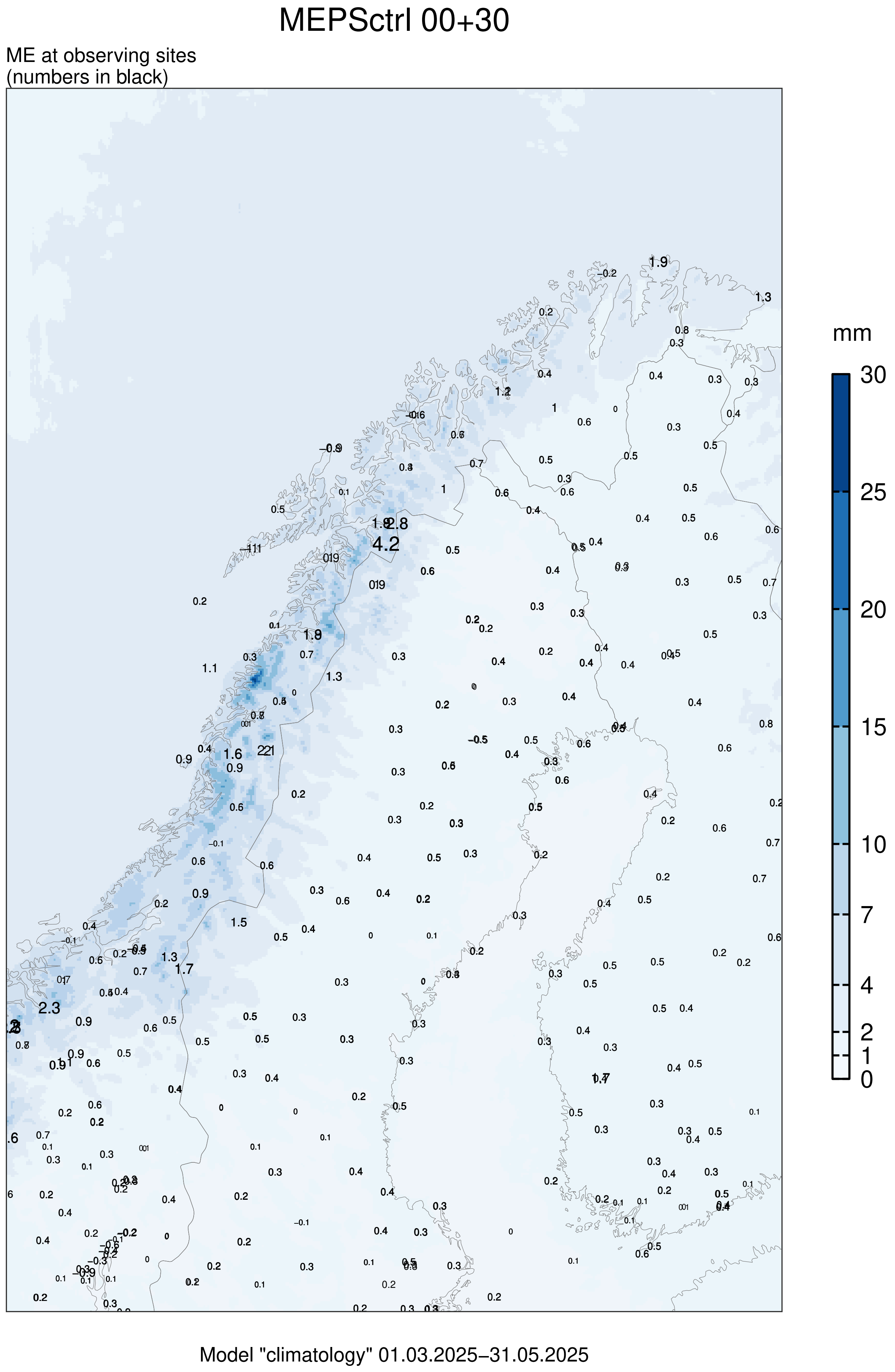

5 coastal stations
4
2
0
−2
−4
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25


138 stations more than 500 m above sea level
4
2
0
−2
−4
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25


31 stations with daily mean precipitation > 4 mm
4
2
0
−2
−4
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25

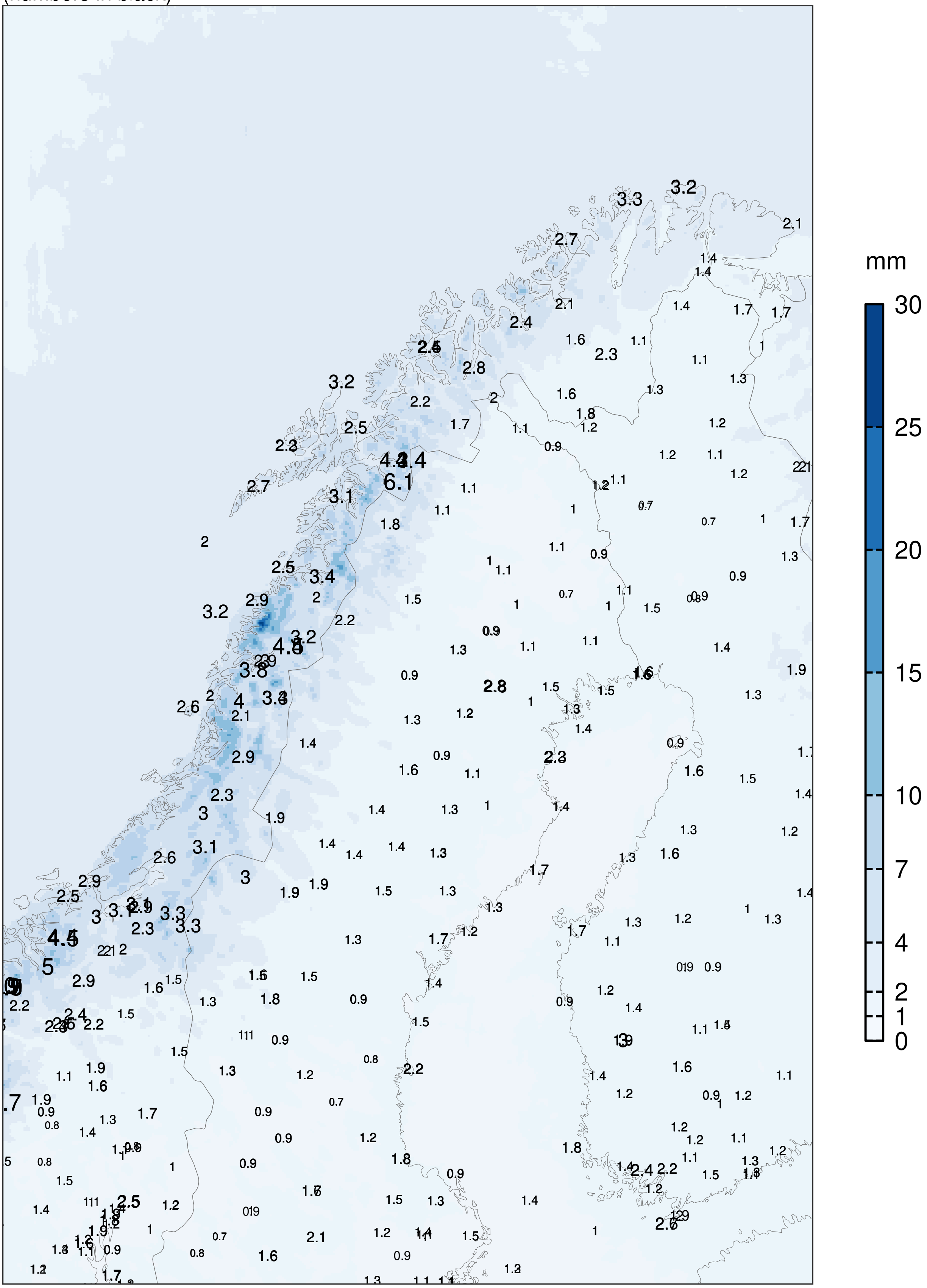

Standard Deviation of Error
173 Norwegian stations
00+30
ECMWF
MEPSctrl
5 coastal stations
138 stations more than 500 m above sea level
31 stations with daily mean precipitation > 4 mm
0
2
4
6
8
10
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25


Mean Absolute Error
173 Norwegian stations
00+30
ECMWF
MEPSctrl
5 coastal stations
138 stations more than 500 m above sea level
31 stations with daily mean precipitation > 4 mm
Mar22
Jun22
Sep22
Dec22
Mar23
Jun23
Sep23
Dec23
Mar24
Jun24
Sep24
Dec24
Mar25

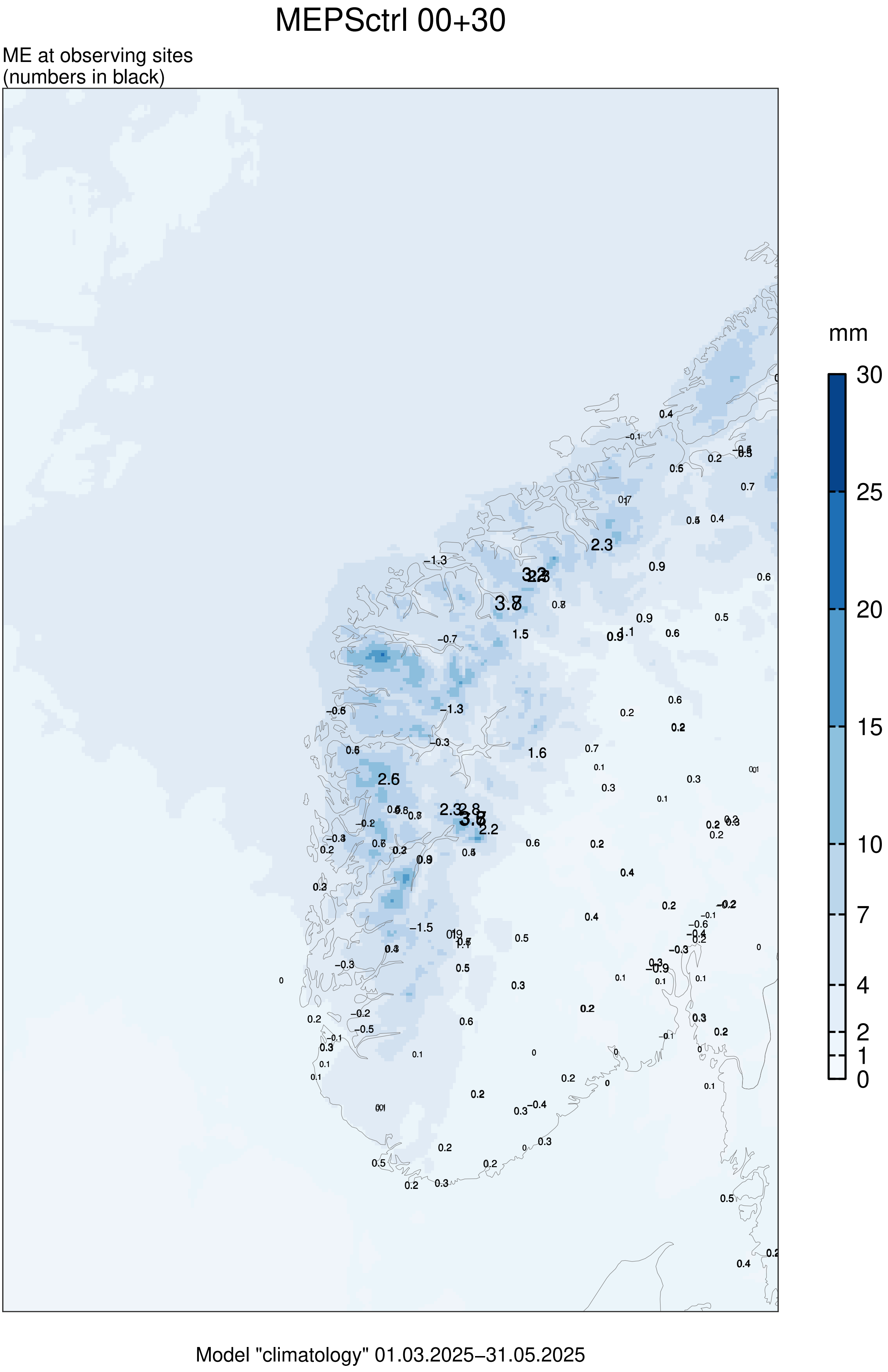

MEPSctrl 00+30
ME at observing sites
(numbers in black)
mm
30
25
20
15
10
7
4
2
1
0
Model "climatology" 01.03.2025–31.05.2025

MEPSctrl 00+30

SDE at observing sites
(numbers in black)

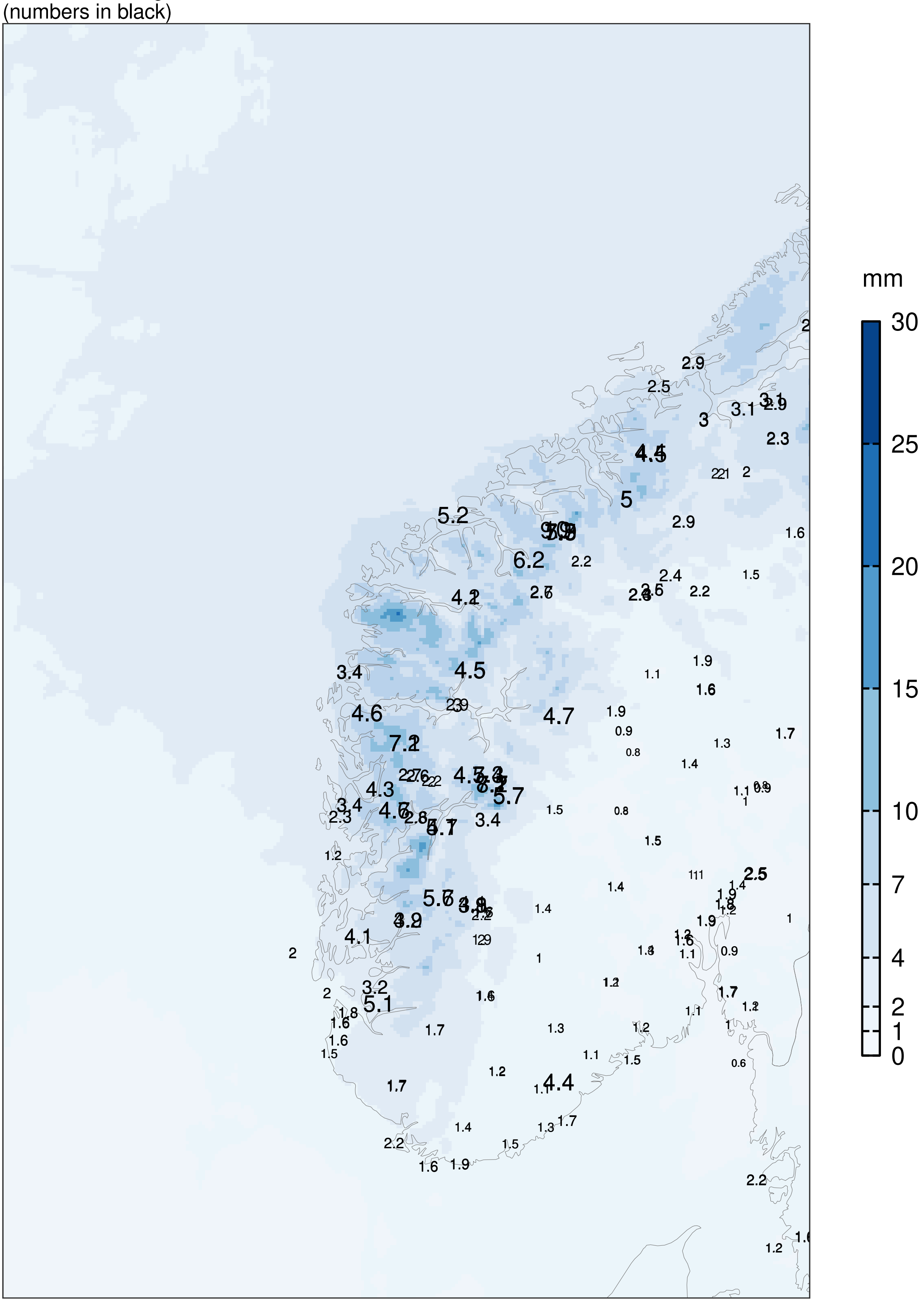


Model "climatology" 01.03.2025–31.05.2025


MEPSctrl 00+30
ME at observing sites
(numbers in black)
mm
30
25
20
15
10
7
4
2
1
0
Model "climatology" 01.03.2025–31.05.2025

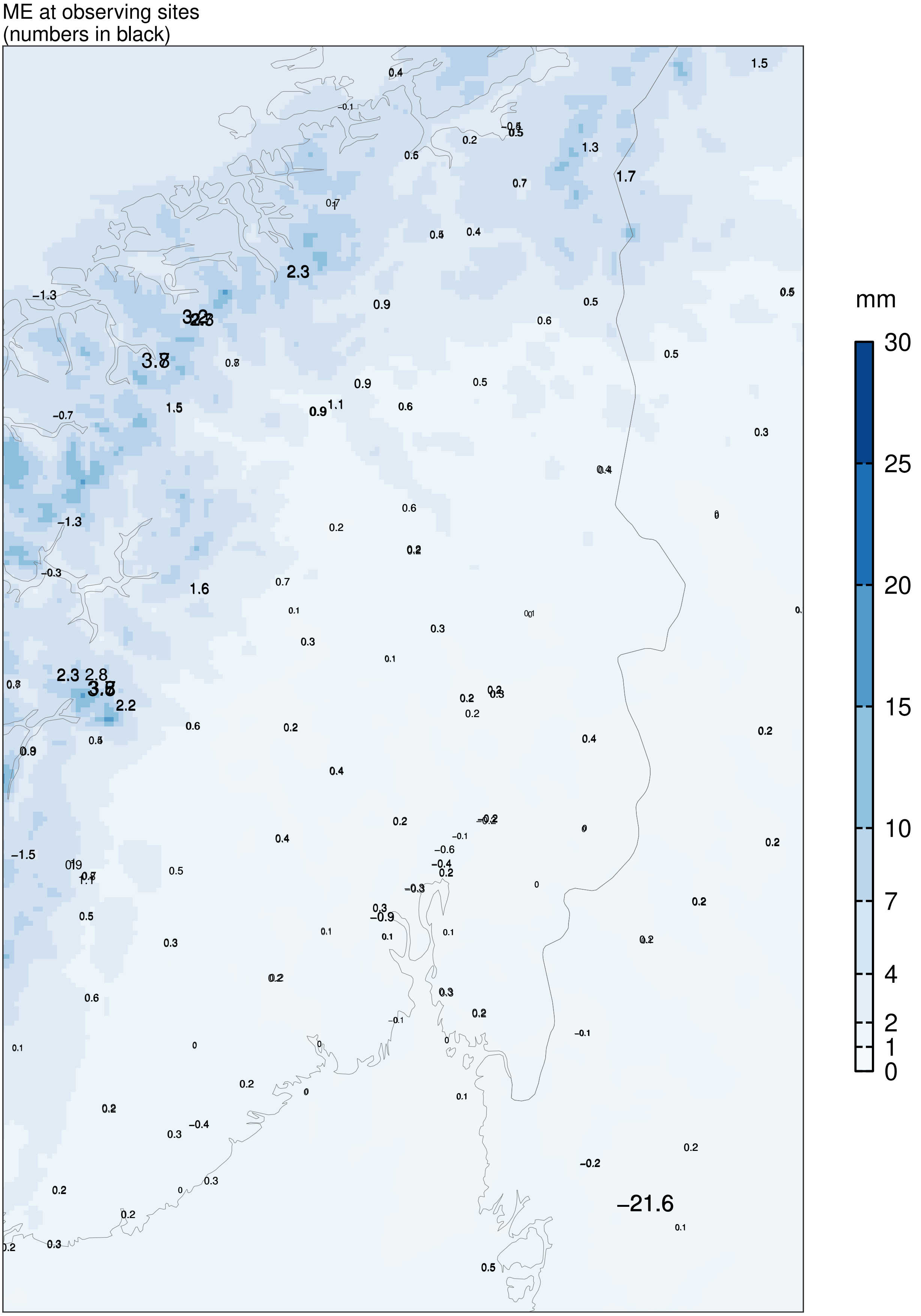
MEPSctrl 00+30

SDE at observing sites
(numbers in black)



Model "climatology" 01.03.2025–31.05.2025

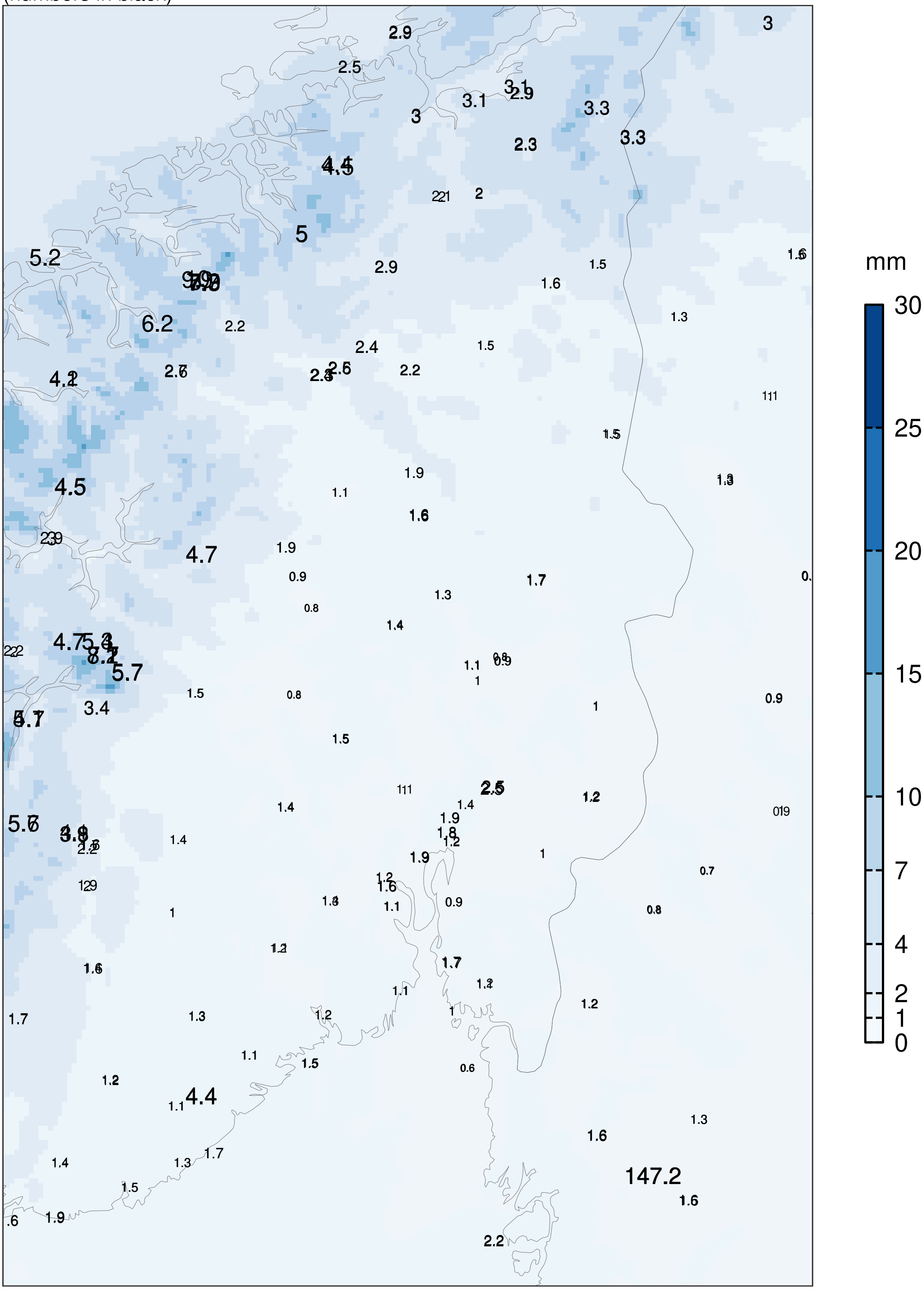
MEPSctrl 00+30



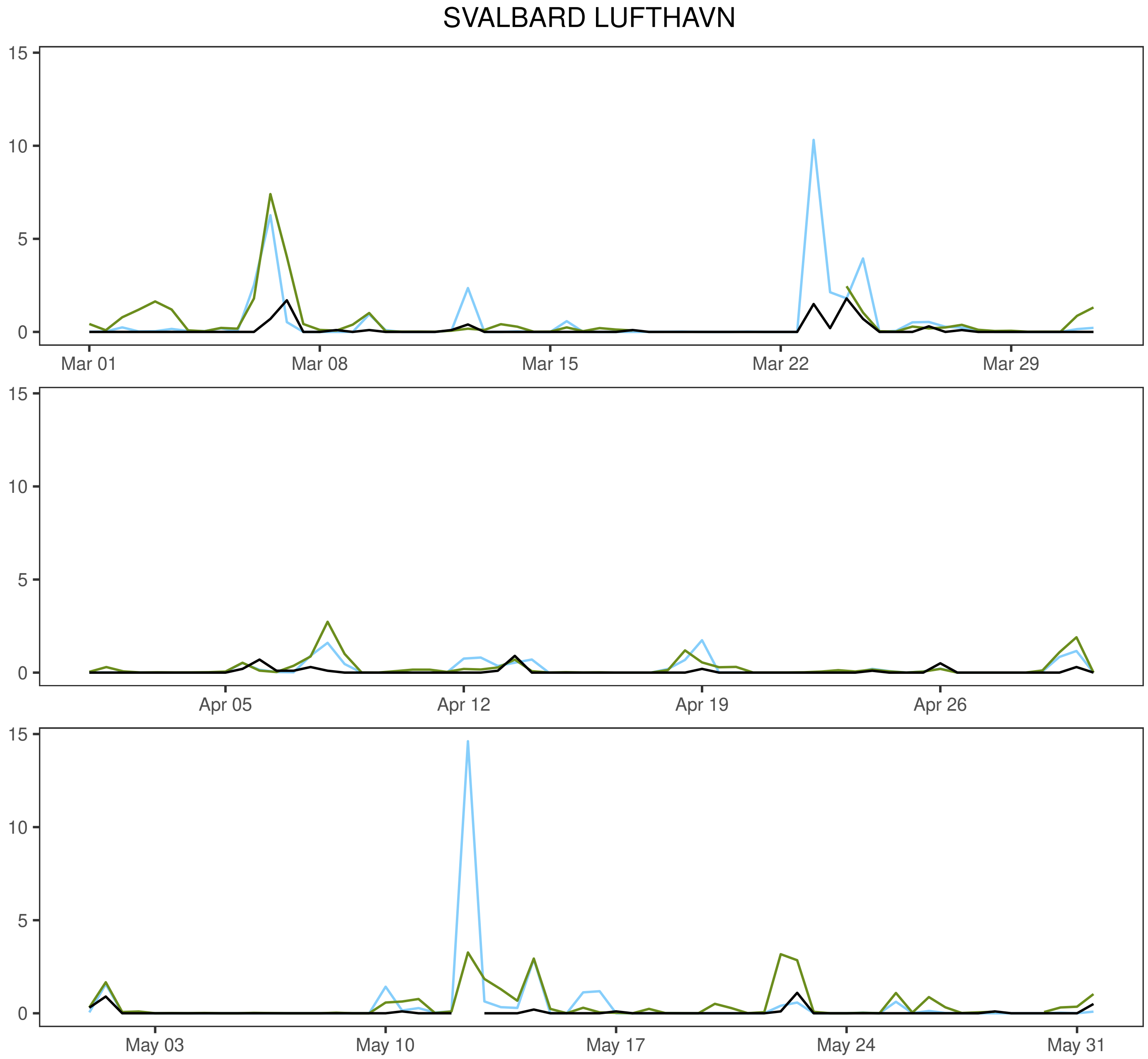
Model "climatology" 01.03.2025–31.05.2025

MEPSctrl 00+30

SDE at observing sites
(numbers in black)

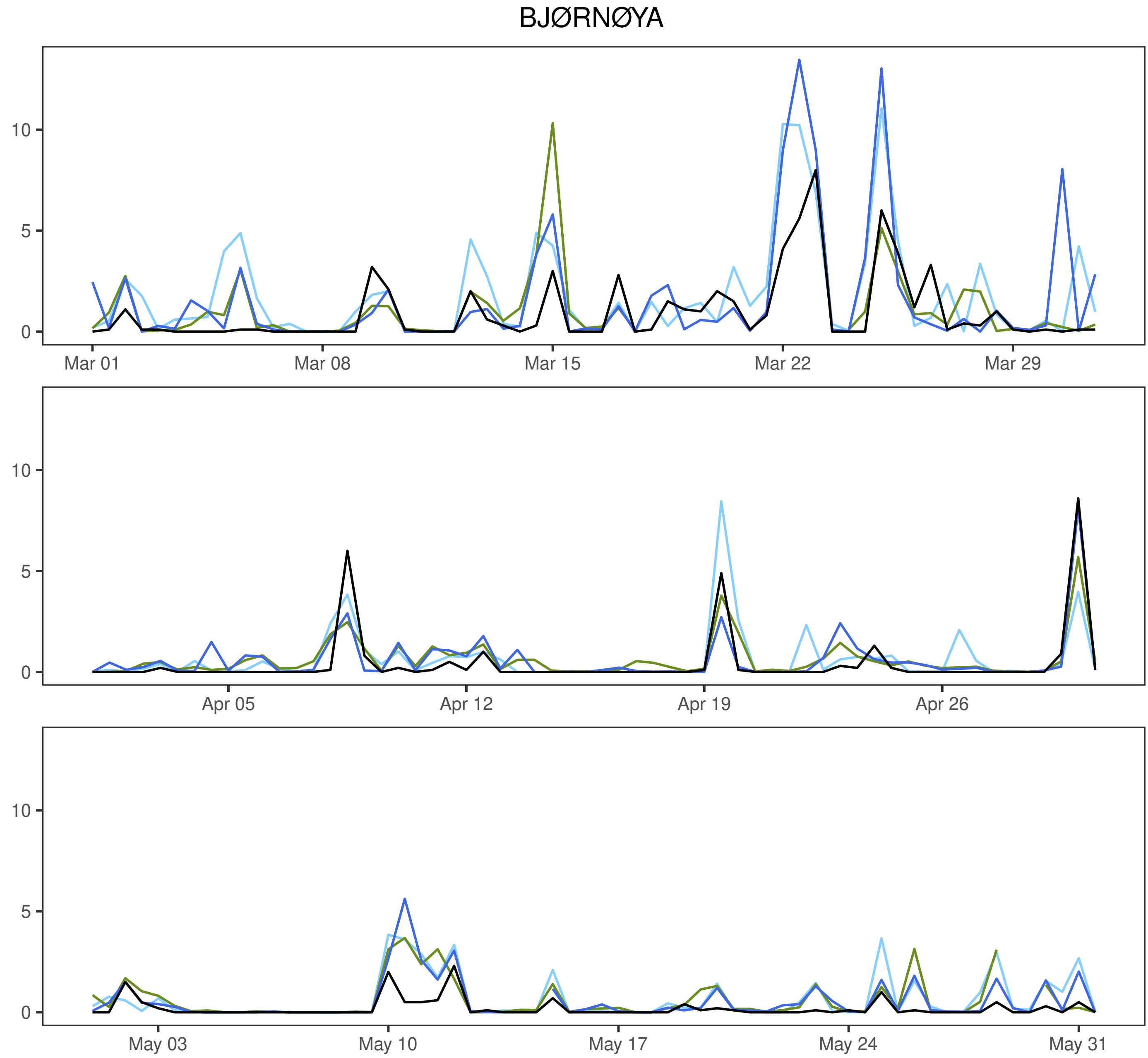


Model "climatology" 01.03.2025–31.05.2025



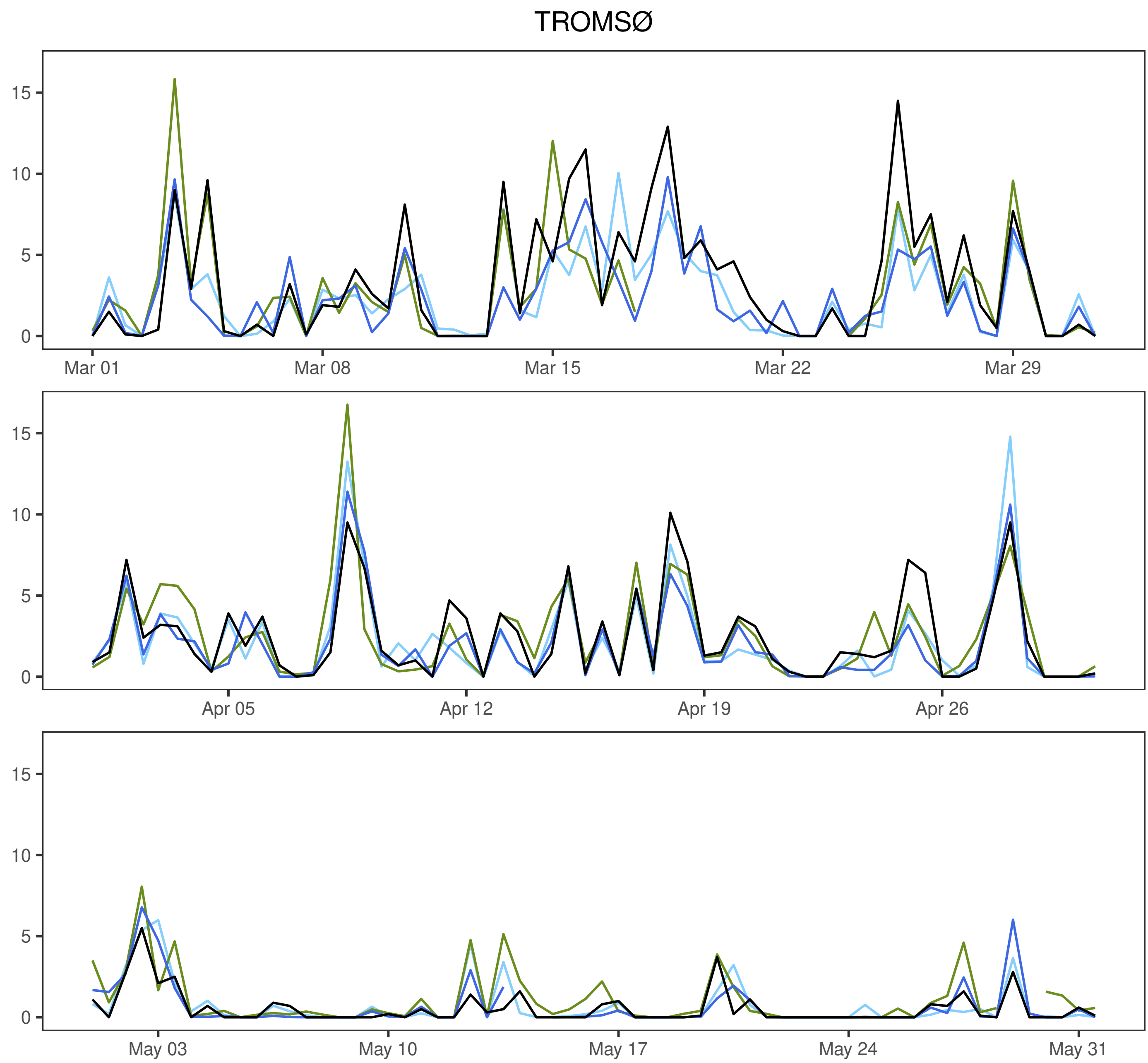
	Min	Mean	Max	Std	N
synop: 06,18	0.0	0.1	1.8	0.3	183
AA25: 12+18,+30	0.0	0.4	14.6	1.5	184
ECMWF: 12+18,+30	0.0	0.4	7.4	0.9	170

	ME	SDE	RMSE	MAE	Max.abs.err	N
AA25 – synop	0.2	0.7	0.7	0.2	5.6	169
ECMWF – synop	0.3	0.7	0.8	0.3	6.7	169



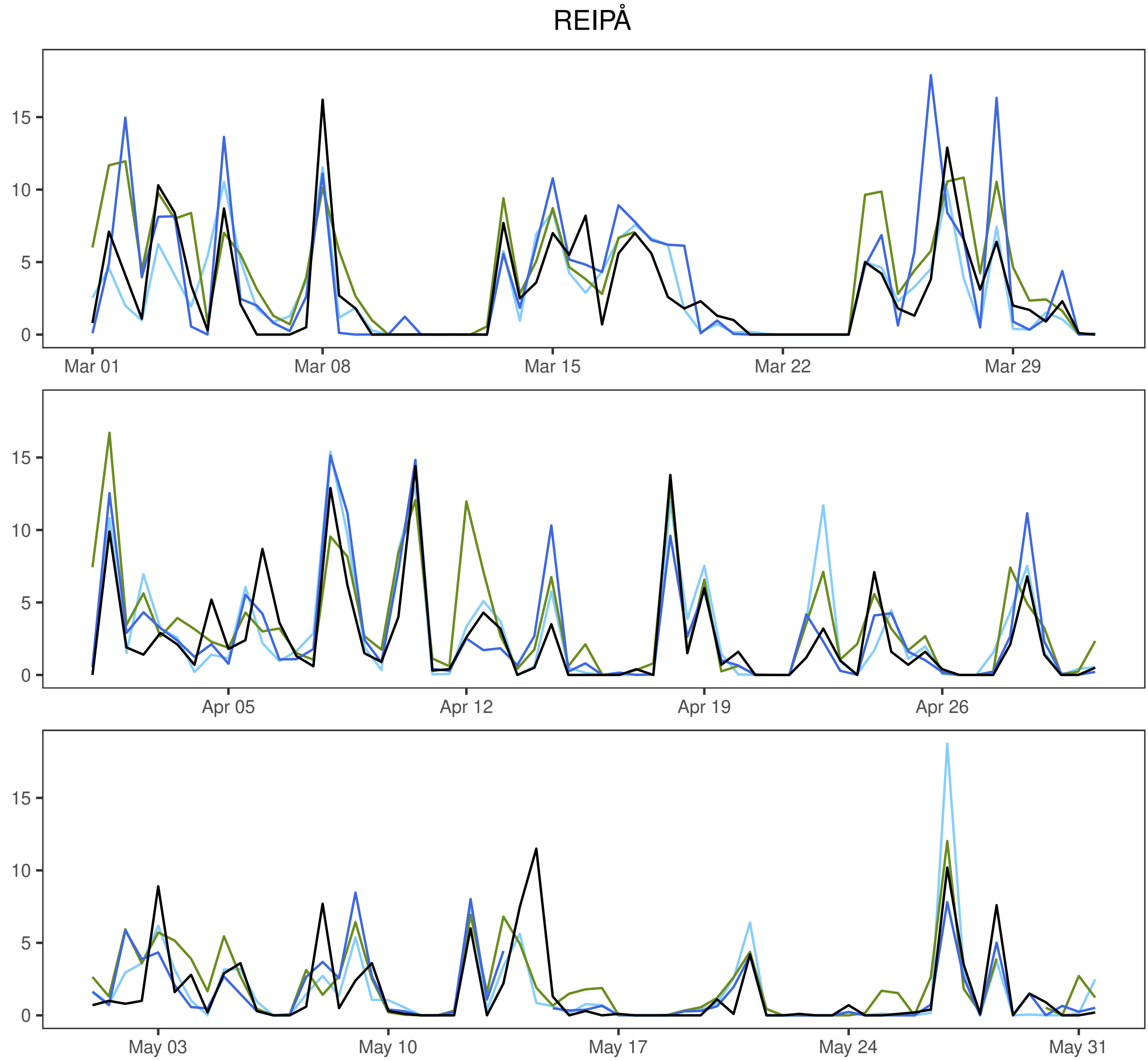
	Min	Mean	Max	Std	N
synop: 06,18	0.0	0.5	8.6	1.3	184
MEPSctrl: 12+18,+30	0.0	0.9	13.5	2.0	182
AA25: 12+18,+30	0.0	1.1	11.1	1.9	184
ECMWF: 12+18,+30	0.0	0.7	10.3	1.2	170

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	0.4	1.2	1.3	0.6	8.1	168
AA25 – synop	0.5	1.2	1.3	0.7	5.1	168
ECMWF – synop	0.3	1.0	1.1	0.6	7.3	168



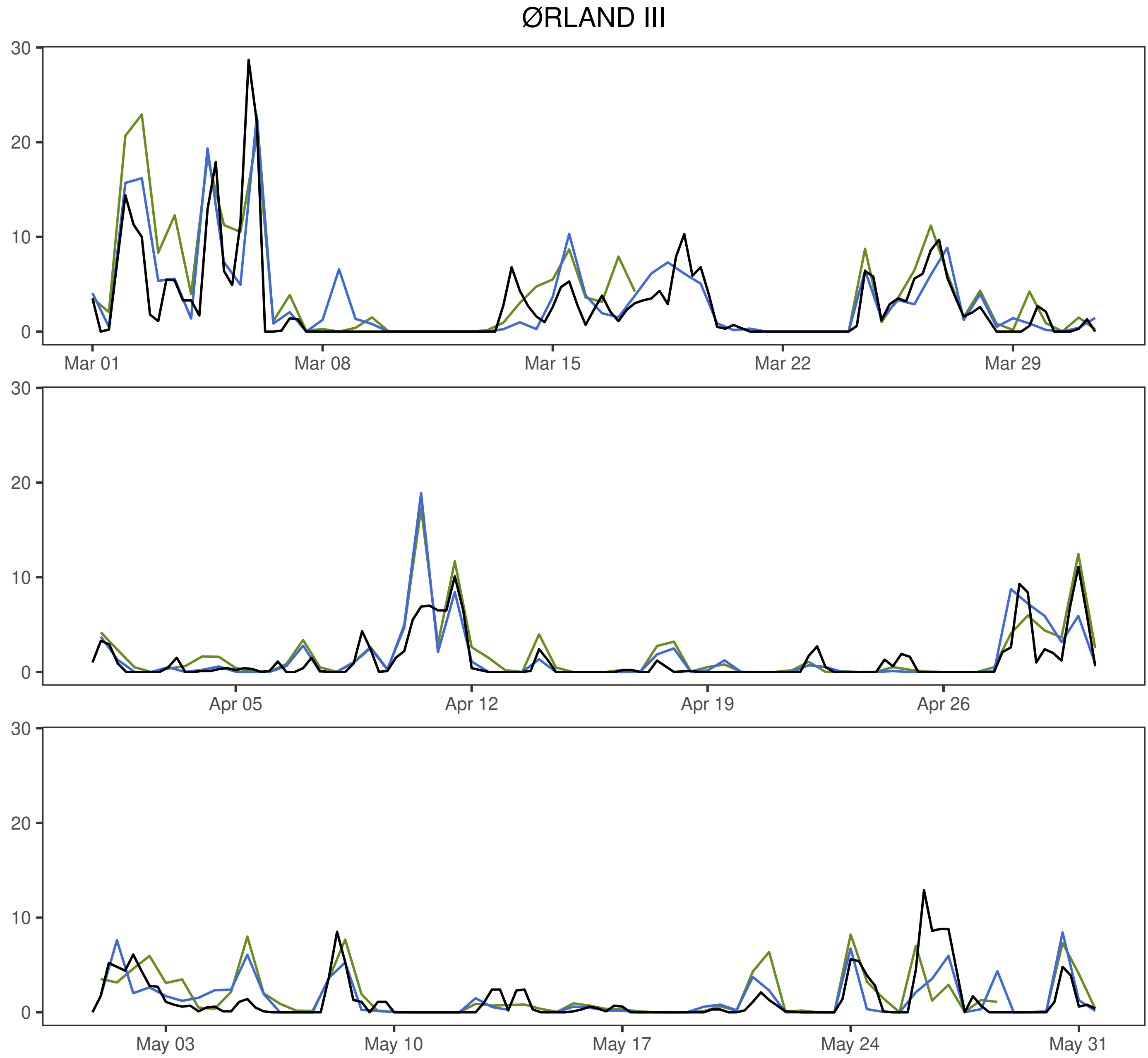
	Min	Mean	Max	Std	N
synop: 06,18	0.0	2.1	14.5	3.0	184
MEPSctrl: 12+18,+30	0.0	1.7	11.4	2.3	182
AA25: 12+18,+30	0.0	1.8	14.8	2.5	184
ECMWF: 12+18,+30	0.0	2.1	16.8	2.8	170

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	–0.4	1.7	1.7	0.9	9.2	168
AA25 – synop	–0.3	1.7	1.7	1.0	6.6	168
ECMWF – synop	0.1	1.8	1.8	1.1	7.4	168



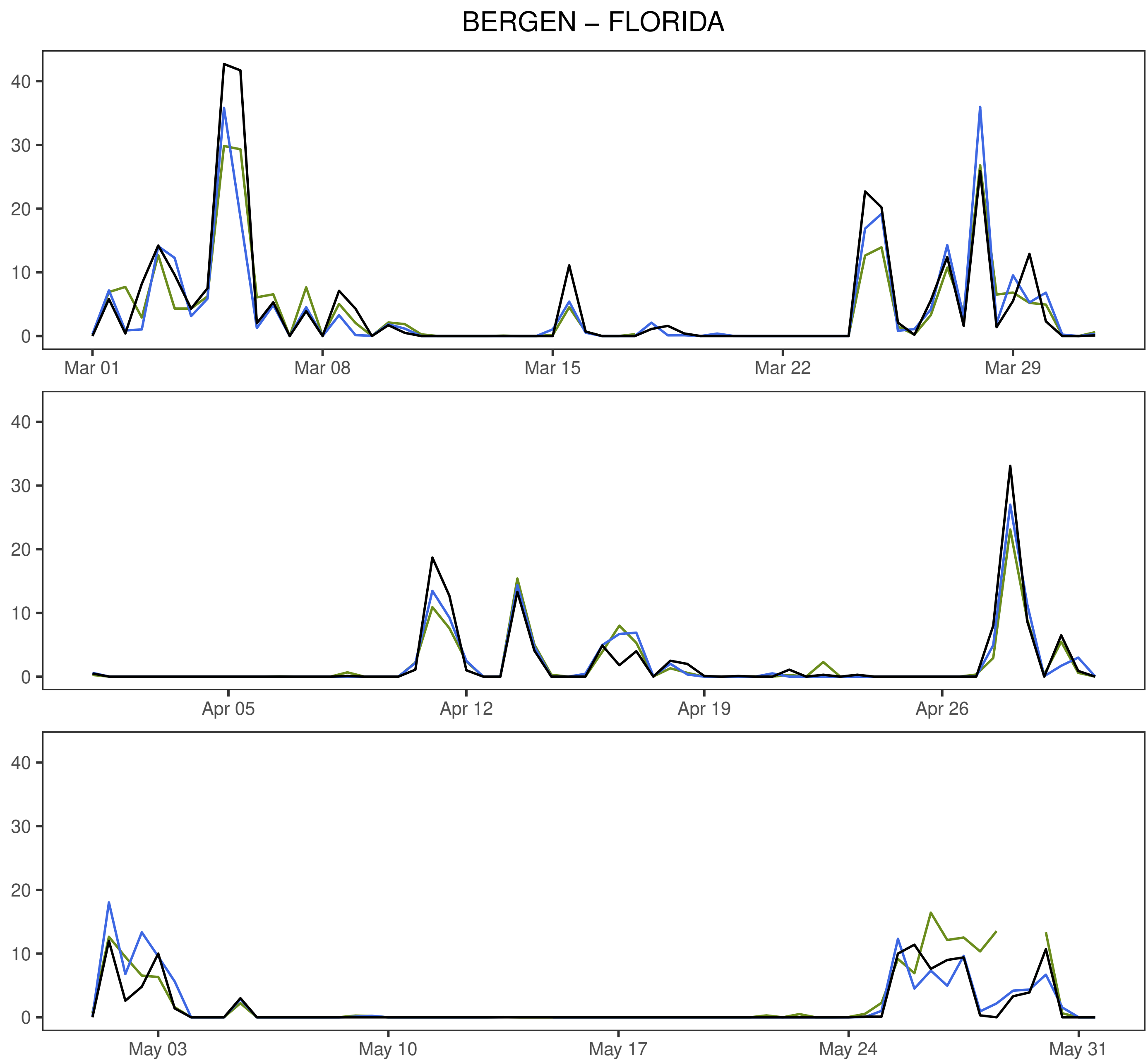
	Min	Mean	Max	Std	N
synop: 06,18	0.0	2.3	16.2	3.3	184
MEPSctrl: 12+18,+30	0.0	2.7	17.9	3.7	182
AA25: 12+18,+30	0.0	2.5	18.8	3.3	184
ECMWF: 12+18,+30	0.0	3.3	16.7	3.5	170

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	0.4	2.5	2.5	1.4	14.1	168
AA25 – synop	0.2	2.1	2.1	1.3	8.6	168
ECMWF – synop	1.0	2.3	2.5	1.6	9.4	168



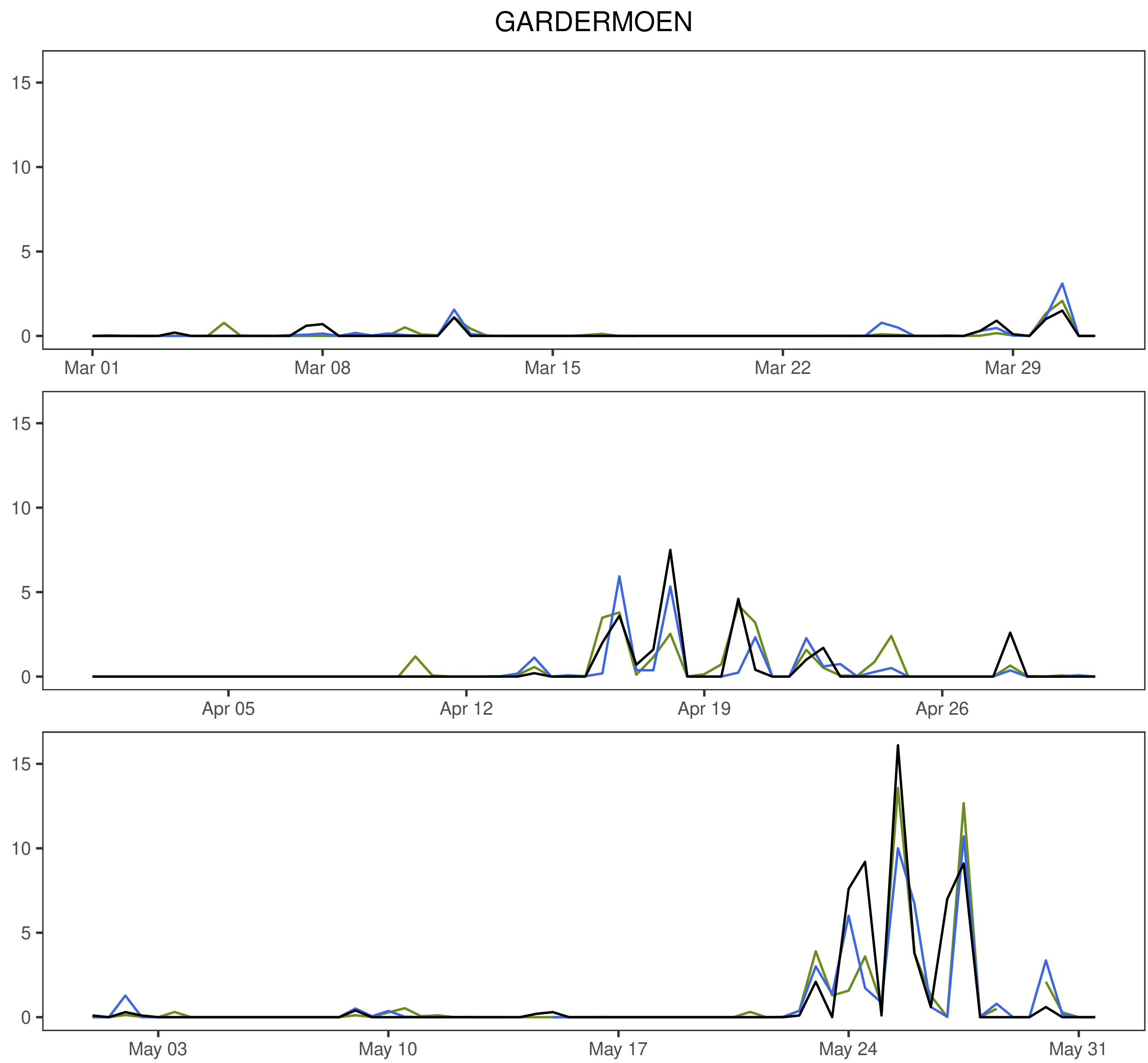
	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.0	1.8	28.7	3.3	355
MEPSctrl: 12+18,+30	0.0	2.1	22.8	3.7	182
ECMWF: 12+18,+30	0.0	2.7	22.9	4.2	170

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	0.3	2.1	2.1	1.1	12.0	168
ECMWF – synop	0.9	2.2	2.4	1.3	12.9	168



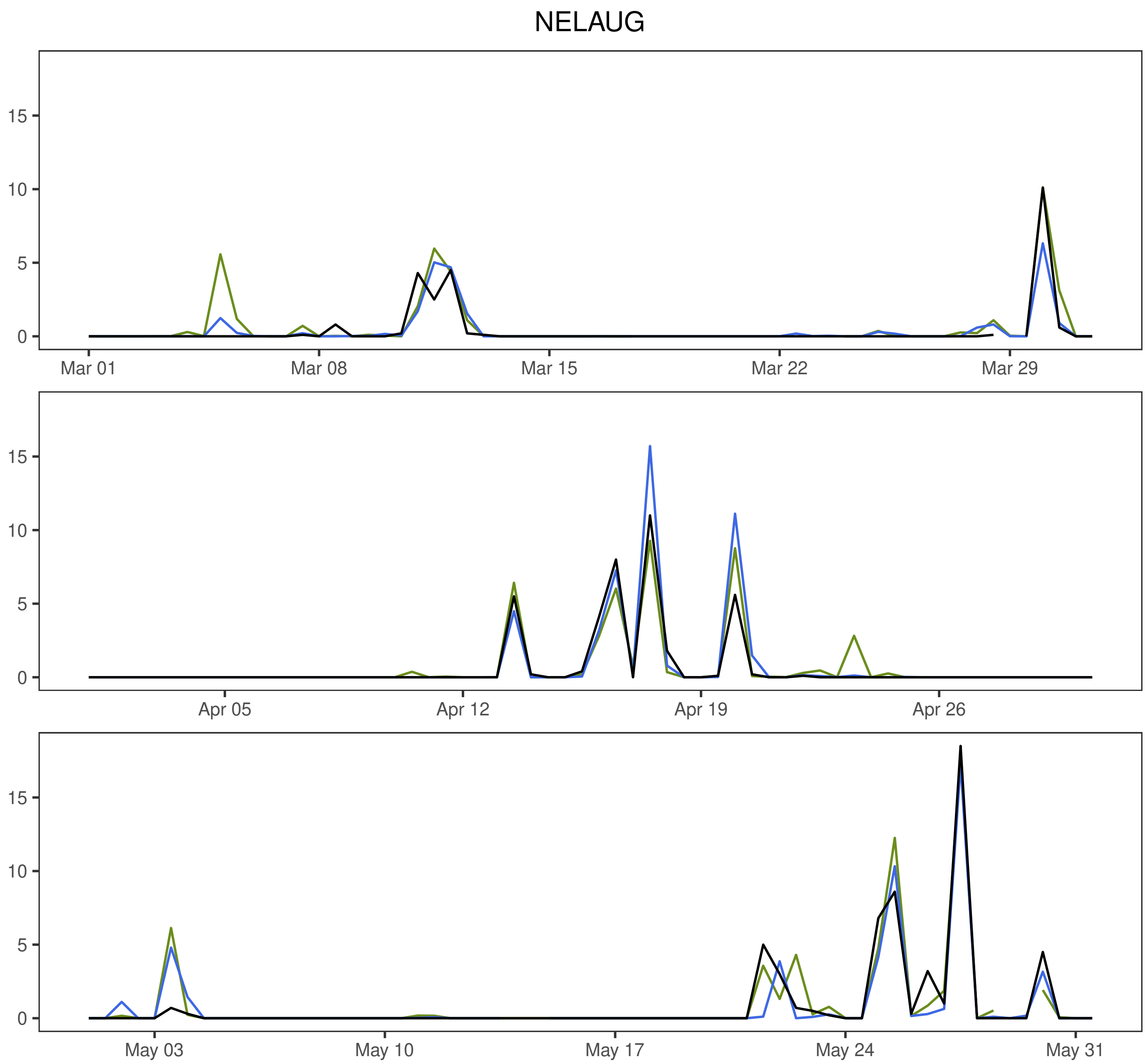
	Min	Mean	Max	Std	N
synop: 06,18	0.0	2.8	42.7	6.5	184
MEPSctrl: 12+18,+30	0.0	2.6	36.0	5.7	182
ECMWF: 12+18,+30	0.0	2.9	29.8	5.4	170

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	–0.2	2.8	2.8	1.2	23.1	168
ECMWF – synop	–0.1	3.0	3.0	1.4	13.5	168



	Min	Mean	Max	Std	N
synop: 06,18	0.0	0.5	16.1	1.8	184
MEPSctrl: 12+18,+30	0.0	0.4	10.7	1.5	182
ECMWF: 12+18,+30	0.0	0.5	13.6	1.6	170

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	–0.1	1.1	1.1	0.4	7.5	168
ECMWF – synop	0.0	1.1	1.1	0.4	7.0	168



	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.0	0.6	18.5	2.2	186
MEPSctrl: 12+18,+30	0.0	0.6	17.3	2.3	182
ECMWF: 12+18,+30	0.0	0.8	17.6	2.3	170

	ME	SDE	RMSE	MAE	Max.abs.err	N
MEPSctrl – synop	0.0	1.0	1.0	0.3	5.5	167
ECMWF – synop	0.1	1.0	1.0	0.4	5.6	167