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Verification of Operational Weather Prediction Models December 2020 to February 2021

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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
- https://hirlam.org/trac/wiki/CommunicationWithUsers - HARMONIE quarterly reports

About this report

The report includes verification results for 3 Numerical Weather Prediction (NWP) models; MetCoOp ensemble 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 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 and cycle 40h1.1 since November 2016. MEPS is run in cooperation with Swedish Meteorological and Hydrological Institute (SMHI), Finnish Meteorological Institue (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.

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 control run. 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. YrPP is plotted with the color below.

10 m wind speed is statistically post processed to represent maximum wind speed 10m last hour, and called YrPP.

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 http://www.cnrm.meteo.fr/gmapdoc/ and http://hirlam.org/.

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.

Boundary fields

MEPS gets its boundary values (1-hourly) from the ECMWF model at approximately 16 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	$\Big(\frac{1}{n}\sum_{i=1}^{n}(f_i - o_i - \mathsf{ME})^2\Big)^{1/2}$	0 to ∞	0
Root Mean Square Error	RMSE	$\Big(\frac{1}{n}\sum_{i=1}^{n}(f_i - o_i)^2\Big)^{1/2}$	0 to ∞	0
Correlation	COR	$\frac{\frac{1}{n}\sum_{i=1}^{n}(f_i - \bar{f})(o_i - \bar{o})}{\mathsf{SD}(f)\mathsf{SD}(o)}$	-1 to 1	1

In the formula for COR the following definitions are used

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

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

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

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 Klimadatavarehuset at MET. Only synop stations are used. The model wind speed is verified against mean wind observations, FF. The post processed wind speed is intended to represent maximum wind speed 10 m last hour, and is verified against FX. The model wind gust is verified against the observed wind gust, FG. FF, FX 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.
- FX: Maximum mean wind speed (10 m above ground) - defined as the highest 10 minutes mean wind speed since the previous observation time.
- 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 forecast sea level pressure better than MEPSctrl/AA25, but the errors are small for both.

While December 2020 was warm in Norway, among the 4 warmest, January and February were cold, 2-3 degrees below the new 1991-2020 temperature normal. Temperature is on average better forecast by MEPSctrl/AA25 than ECMWF. ECMWF tends to underestimate the temperature, particularly in winter. However, standard deviation of the error is about the same for MEPSctrl and ECMWF, and errors are small, indicating that the timing of the temperature changes is generally good. The challenges of forecasting the lowest temperatures are revealed both in time series (e.g. from Kautokeino and Finse), and in large positive ME on inland stations. The temperature forecast is further improved, particularly for the shortest lead times, by post processing. 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 clearly performs better than ECMWF for mountainous stations, although both underestimate the speed here as seen in the monthly mean error and mean absolute error. The maps show that underestimation also applies to coastal stations in strong wind events. Otherwise the results are ambiguous. Post processing yields in general smaller errors, but also has more false alarms.

Precipitation also shows varying results, depending on the amount and location. On average, MEPSctrl performs a little better than ECMWF, but both have more errors for both very small amounts and very high amounts of precipitation than otherwise.

The models generally performs better during summer months than during winter for all variables. AA25 and MEPSctrl show very similar results, which is expected since both are HARMONIE with AROME physics, horizontal resolution defined by a 2.5×2.5 km^2 grid.

Case studies by forecasters

Case 1. Precipitation/snow South and East Norway 27-28 December 2020

Precipitation is shown in figure 1 for 27th to 28th December 2020. This is an example on how the HARMONIE-Arome has a tendency to give too much precipitation in maximum events. Also the maxima from the model is drawn too far inland relative to the observed. In this case the models gave at most 126 mm/24hr, whereas the highest observed was 78.7mm. The spread in the ensemble was in this case not enough to capture the actual uncertainty in the model.

Case 2. Precipitation/snow in Nordland 12 February 2021

Figure 2 shows a similar case from the 12th February in Nordland. While there may be a lot of precipitation in the mountains and glacier areas, these amounts are difficult to verify. Of more interest is the values in the lower lying regions, e.g. the city of Mo i Rana, where there is a more felt impact. In these areas, the model has a tendency to be too dry. Generally, the HARMONIE-AROME has a tendency to give too large contrasts in the precipitation: Too much in the maxima, but elswhere too dry. As before,

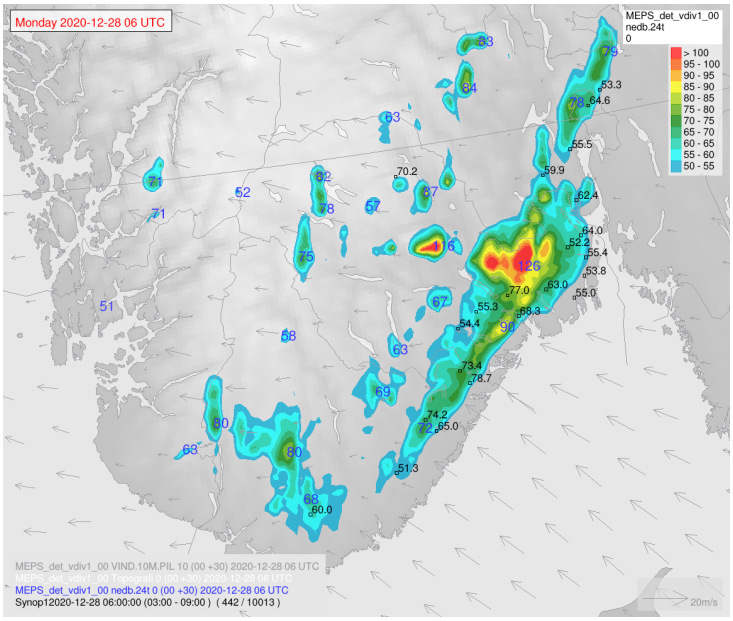


Figure 1: 24hr. precipitation from MEPS-Ctrl 0+30hr from 27th to 28th December 2020. Blue numbers are prognostic maxima. Black numbers are observations above 50 mm/24hr. There is a relatively good resemblance, but the precipitation is drawn too far inland, and the maximum values are generally too high.

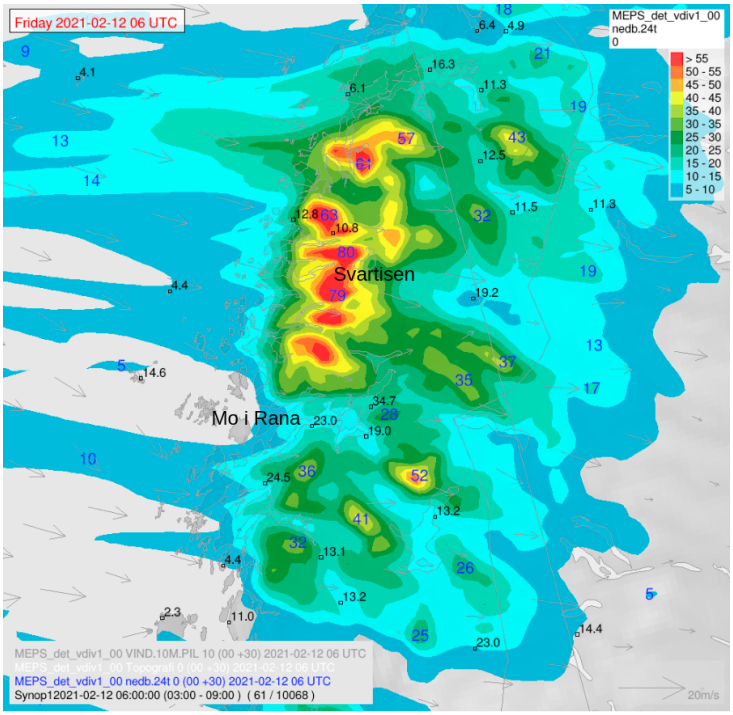


Figure 2: 24hr. precipitation from MEPS-Ctrl 0+30hr for Nordland from 12th February 2021. Blue numbers are model maxima. Black numbers are observed 24hr. precipitation. Note that the palette for precipitation has different steps from that in figure 1.

there is a tendency to too little precipitation at the coast.

Case 3. Wind speed under extreme weather Frank 21 - 22 January 2021

Wind is generally seen as good, but strong winds are often underforecasted at the coast and in the mountains, although better in the MEPS than in the ECMWF. Below are typical examples from Torsvåg and Myken lighthouses from the recent 'Frank' wind storm on the 22nd of January.

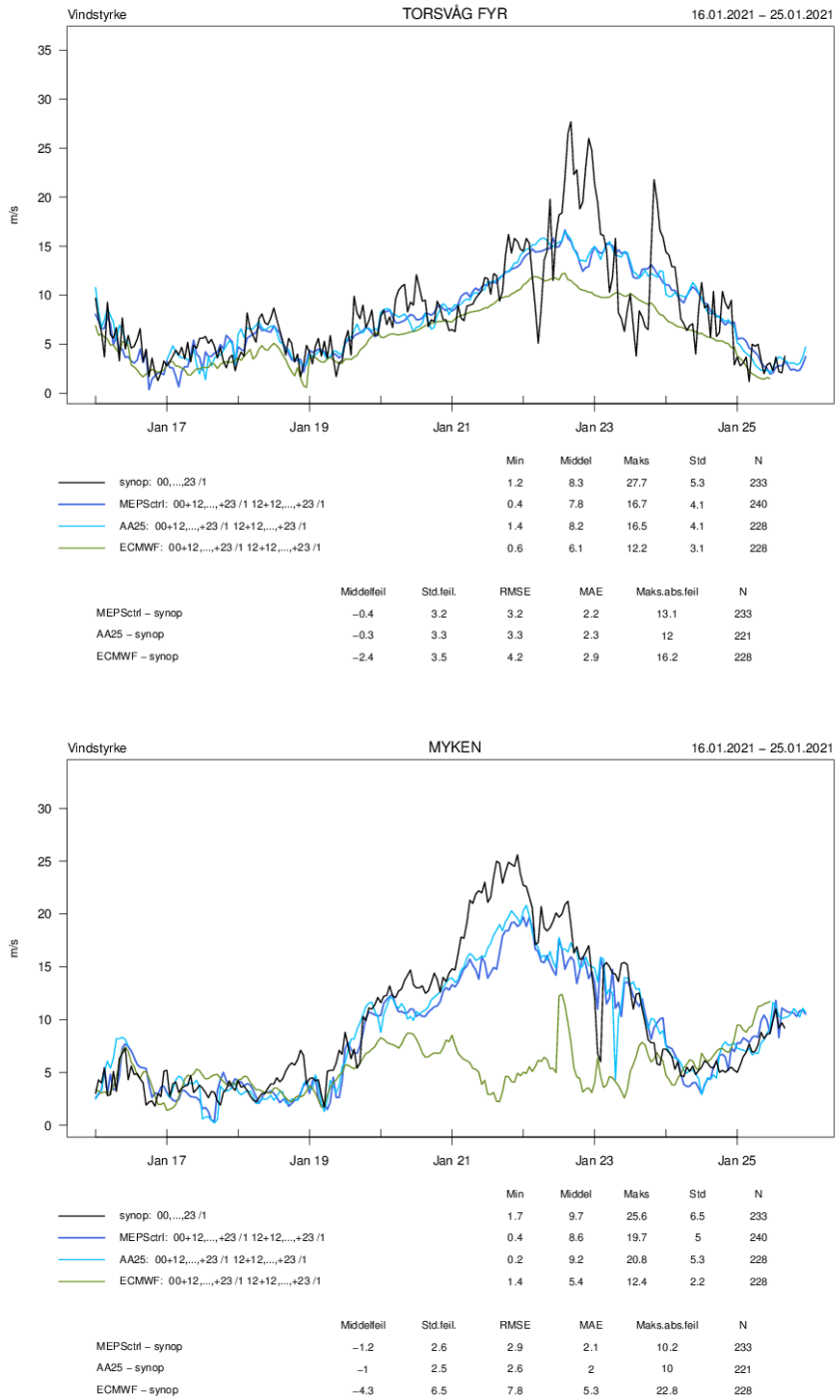
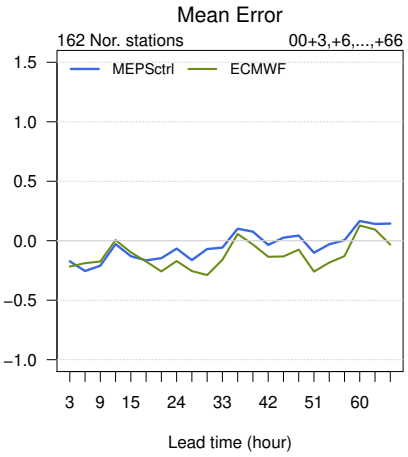
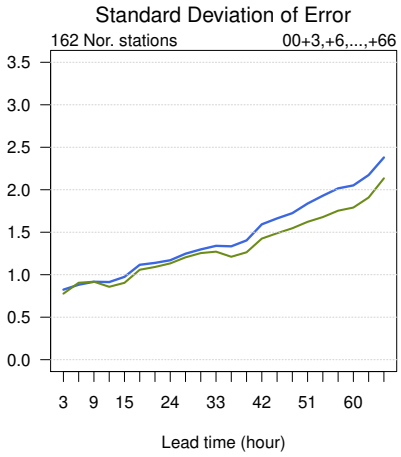


Figure 3: Wind speed at Torsvåg and Myken on the 22nd of January.

Summarized statistics


Mean Error
162 Nor. stations
00+3,+6,...,+66
MEPSctrl
ECMWF
1.5
1.0
0.5
0.0
−0.5
−1.0
3 9 15 24 33 42 51 60
Lead time (hour)


Standard Deviation of Error
162 Nor. stations
00+3,+6,...,+66
3.5
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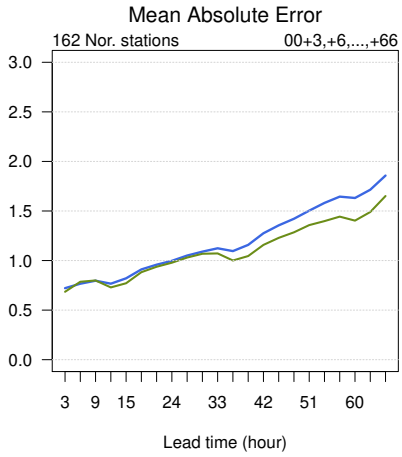
2.5
2.0
1.5
1.0
0.5
0.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Absolute Error
162 Nor. stations
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2.5
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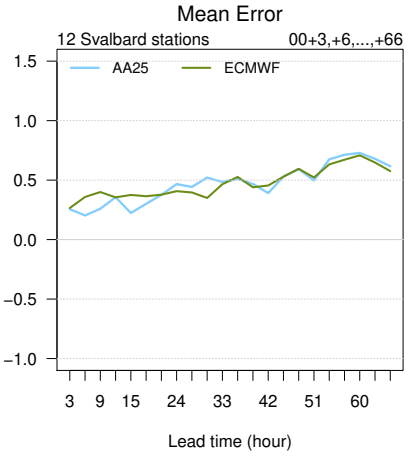
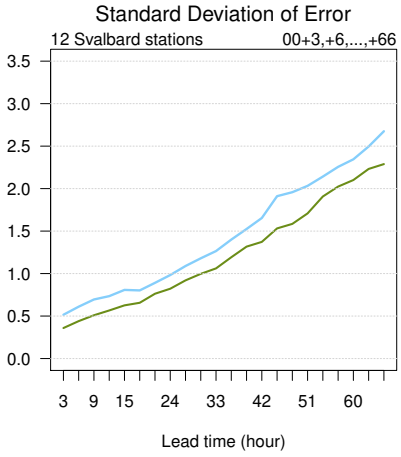
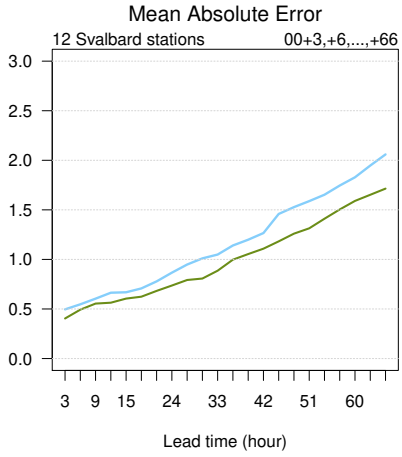
1.5
1.0
0.5
0.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Error
12 Svalbard stations
00+3,+6,...,+66
AA25
ECMWF
1.5
1.0
0.5
0.0
−0.5
−1.0
3 9 15 24 33 42 51 60
Lead time (hour)


Standard Deviation of Error
12 Svalbard stations
00+3,+6,...,+66
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Absolute Error
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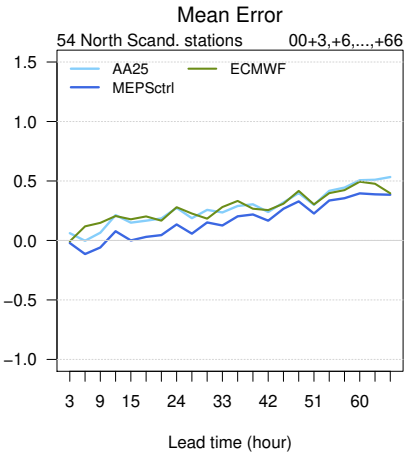
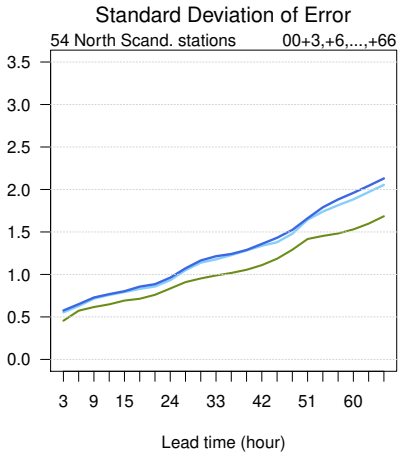
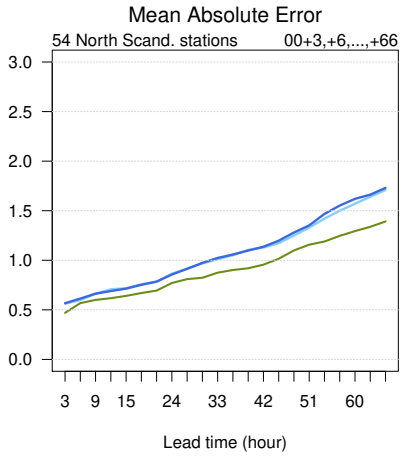
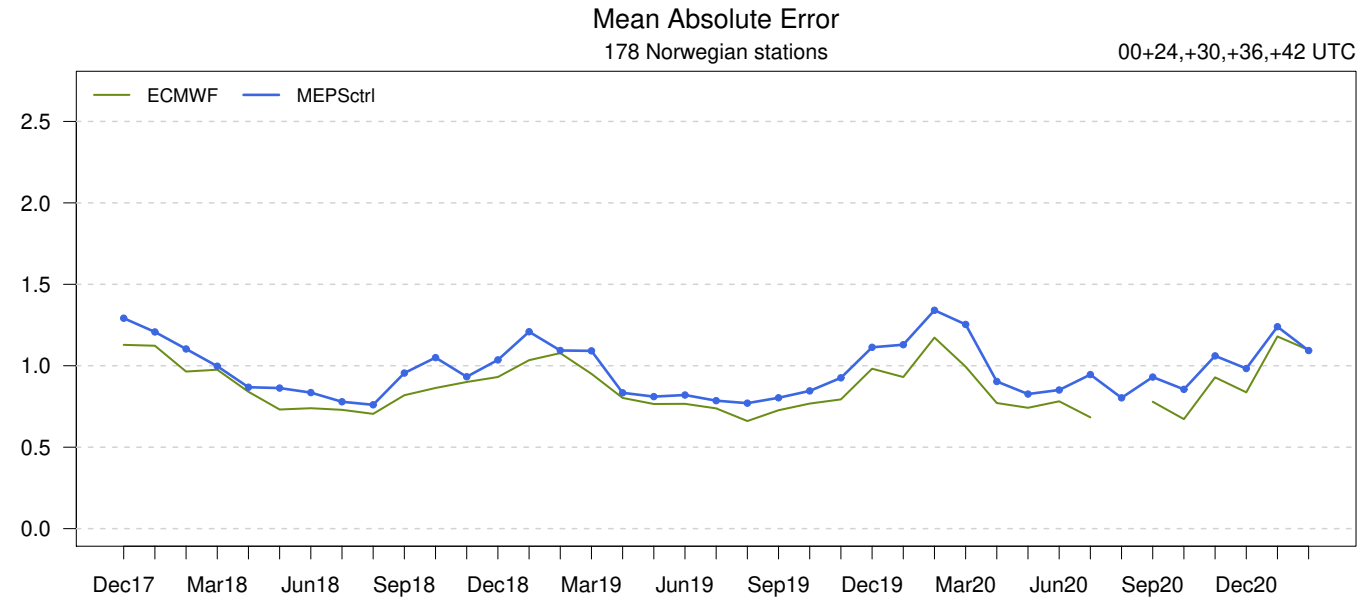
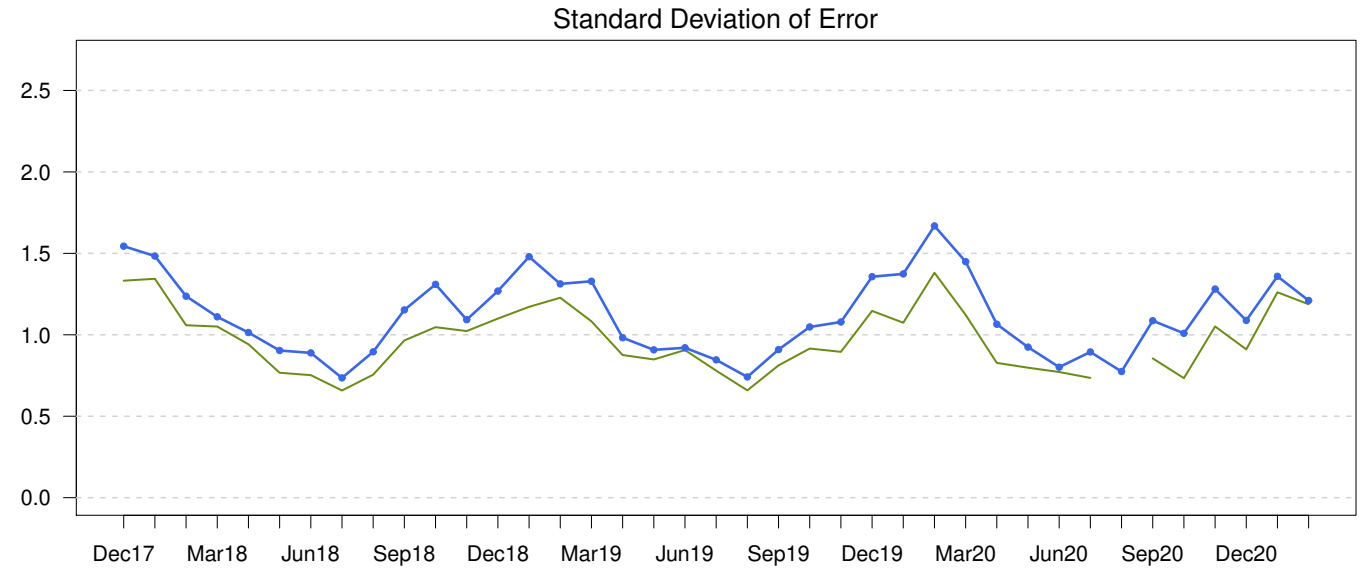
2.5
2.0
1.5
1.0
0.5
0.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Error
54 North Scand. stations
00+3,+6,...,+66
AA25
ECMWF
MEPSctrl
1.5
1.0
0.5
0.0
−0.5
−1.0
3 9 15 24 33 42 51 60
Lead time (hour)


Standard Deviation of Error
54 North Scand. stations
00+3,+6,...,+66
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Absolute Error
54 North Scand. stations
00+3,+6,...,+66
3.0
2.5
2.0
1.5
1.0
0.5
0.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Absolute Error
178 Norwegian stations
00+24,+30,+36,+42 UTC
ECMWF
MEPSctrl
2.5
2.0
1.5
1.0
0.5
0.0
Dec17
Mar18
Jun18
Sep18
Dec18
Mar19
Jun19
Sep19
Dec19
Mar20
Jun20
Sep20
Dec20


Standard Deviation of Error
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2.0
1.5
1.0
0.5
0.0
Dec17
Mar18
Jun18
Sep18
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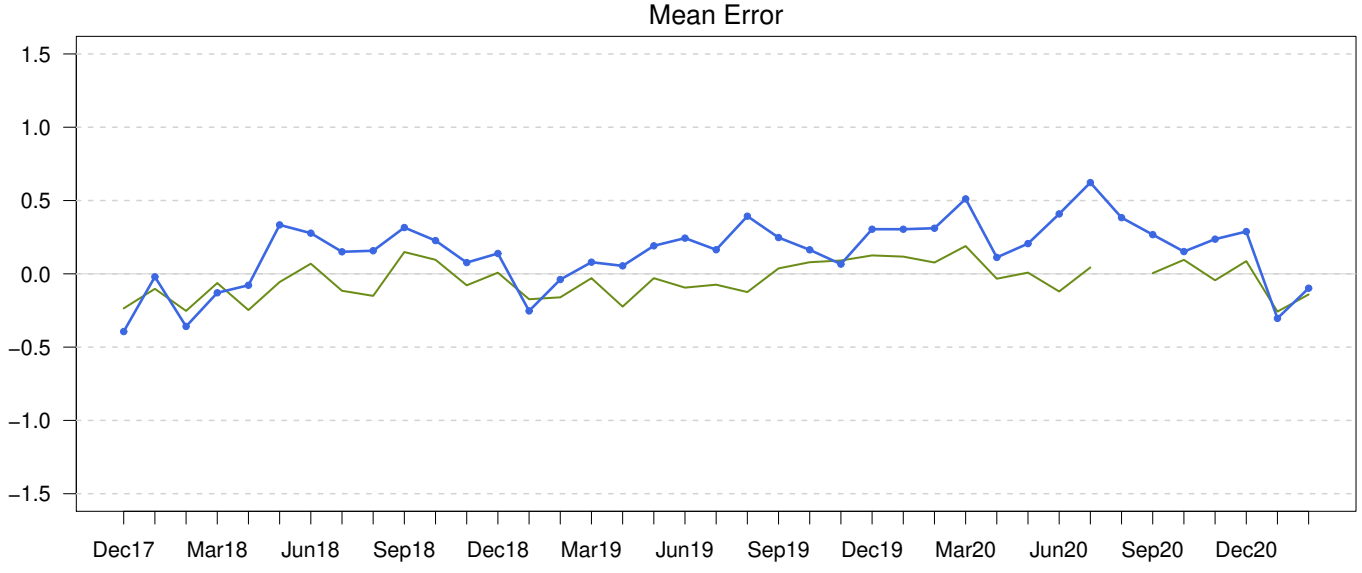
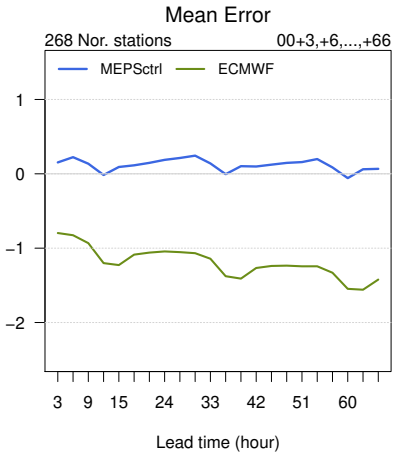
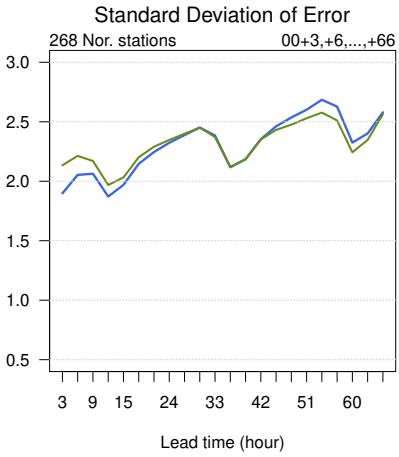
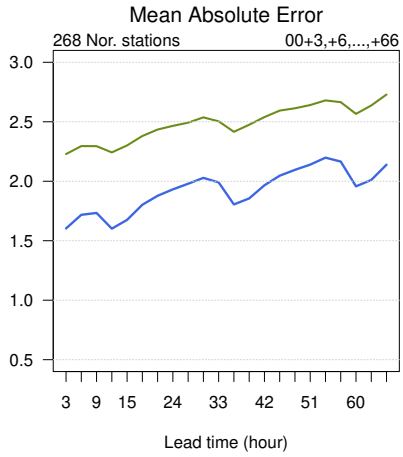
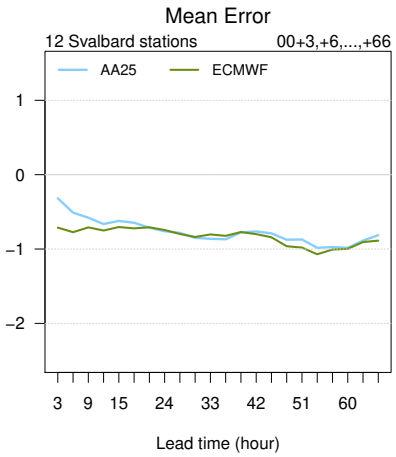
Jun19
Sep19
Dec19
Mar20
Jun20
Sep20
Dec20

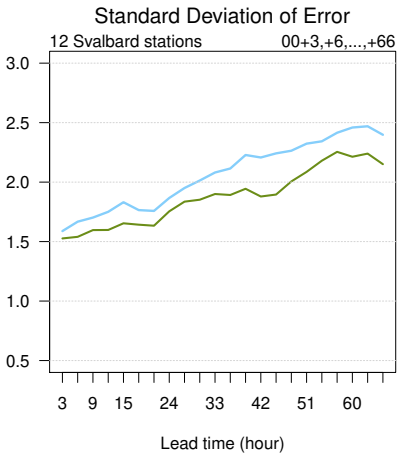

Mean Error
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
Dec17
Mar18
Jun18
Sep18
Dec18
Mar19
Jun19
Sep19
Dec19
Mar20
Jun20
Sep20
Dec20

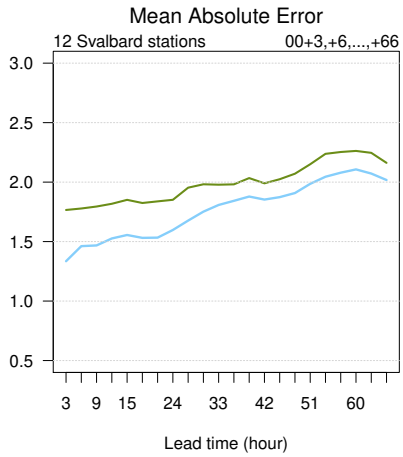

Mean Error
268 Nor. stations
00+3,+6,...,+66
MEPSctrl
ECMWF
1
0
−1
−2
3 9 15 24 33 42 51 60
Lead time (hour)

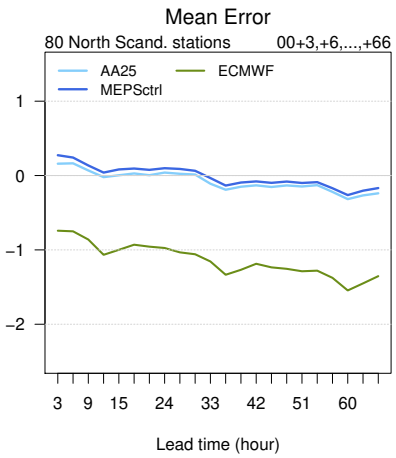

Standard Deviation of Error
268 Nor. stations
00+3,+6,...,+66
3.0
2.5
2.0
1.5
1.0
0.5
3 9 15 24 33 42 51 60
Lead time (hour)

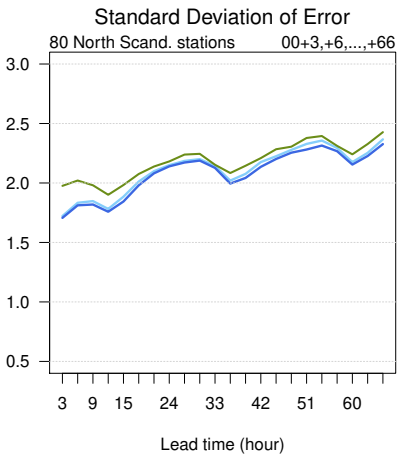

Mean Absolute Error
268 Nor. stations
00+3,+6,...,+66
3.0
2.5
2.0
1.5
1.0
0.5
3 9 15 24 33 42 51 60
Lead time (hour)

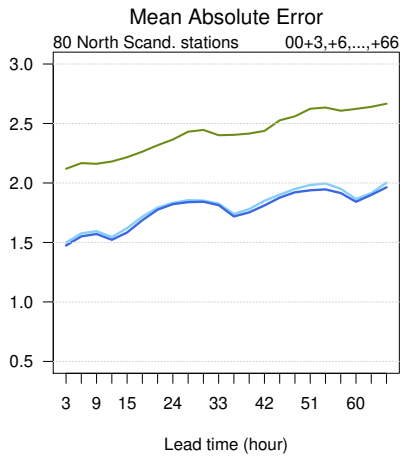

Mean Error
12 Svalbard stations
00+3,+6,...,+66
AA25
ECMWF
1
0
−1
−2
3 9 15 24 33 42 51 60
Lead time (hour)


Standard Deviation of Error
12 Svalbard stations
00+3,+6,...,+66
3.0
2.5
2.0
1.5
1.0
0.5
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Absolute Error
12 Svalbard stations
00+3,+6,...,+66
3.0
2.5
2.0
1.5
1.0
0.5
3 9 15 24 33 42 51 60
Lead time (hour)

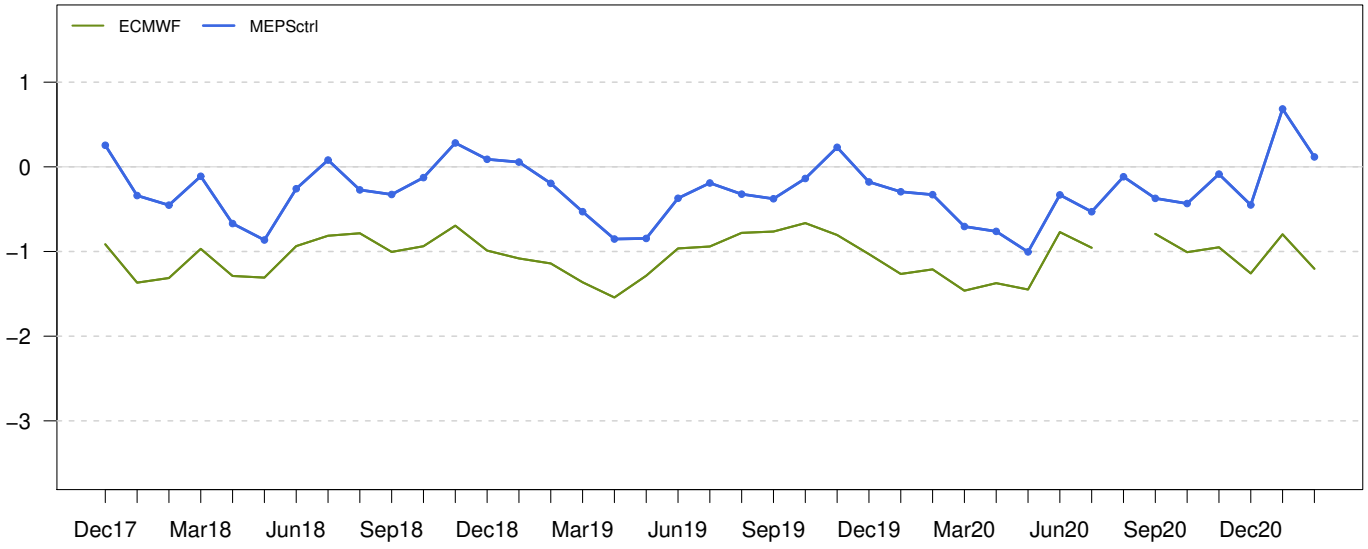

Mean Error
80 North Scand. stations
00+3,+6,...,+66
AA25
ECMWF
MEPSctrl
1
0
−1
−2
3 9 15 24 33 42 51 60
Lead time (hour)


Standard Deviation of Error
80 North Scand. stations
00+3,+6,...,+66
3.0
2.5
2.0
1.5
1.0
0.5
3 9 15 24 33 42 51 60
Lead time (hour)

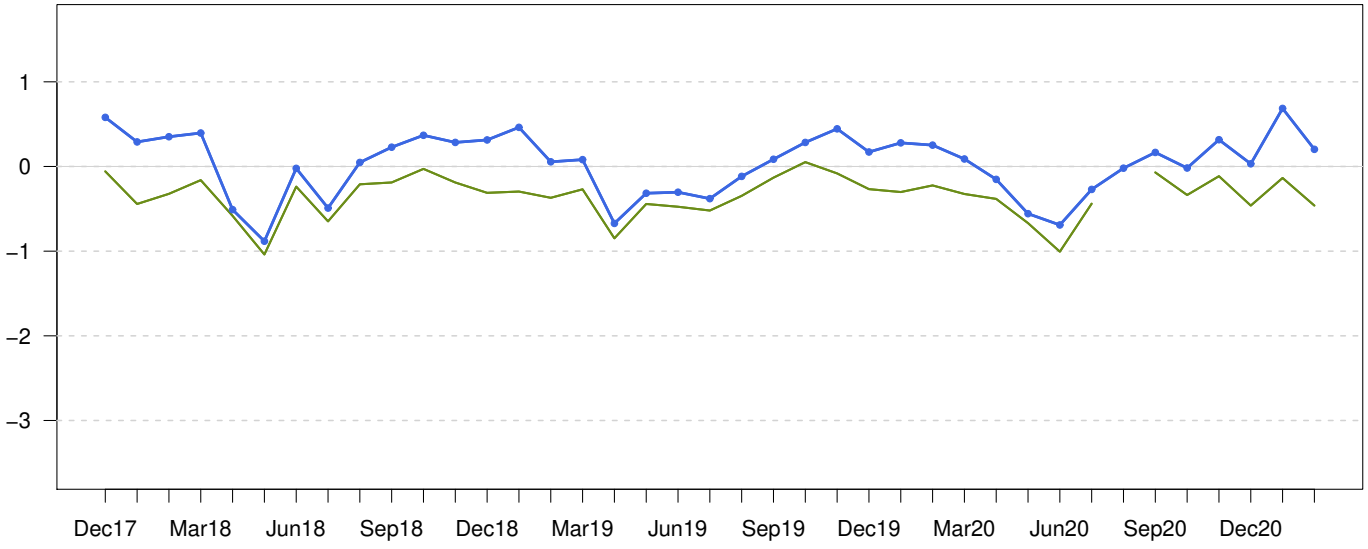

Mean Absolute Error
80 North Scand. stations
00+3,+6,...,+66
3.0
2.5
2.0
1.5
1.0
0.5
3 9 15 24 33 42 51 60
Lead time (hour)

Mean Error

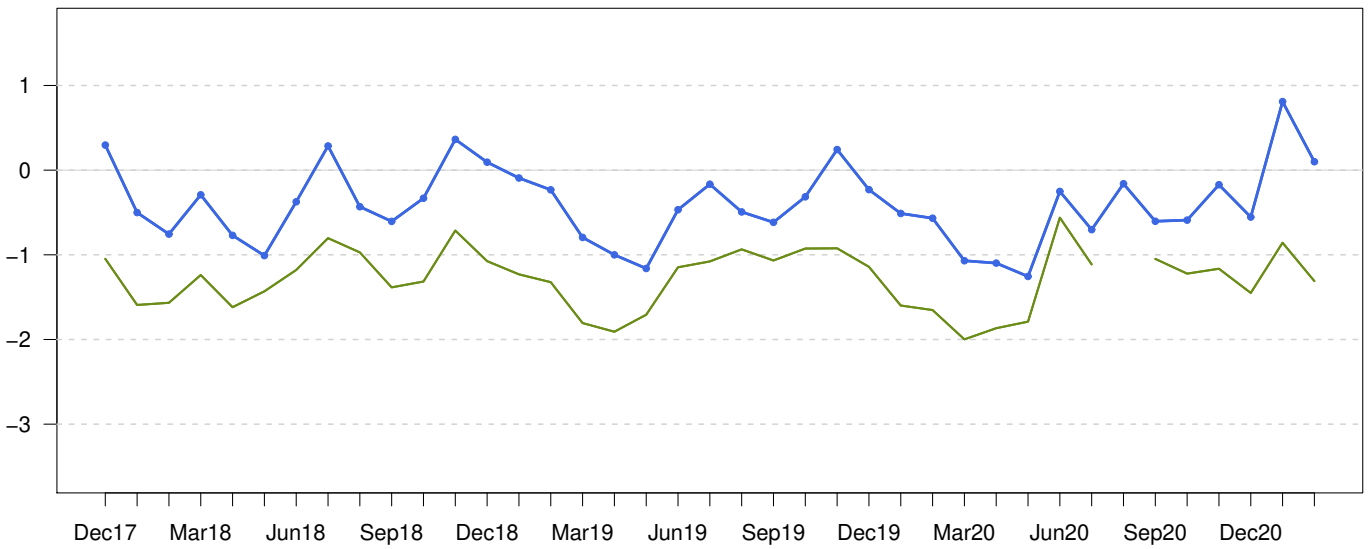
274 Norwegian stations 00+24,+30,+36,+42 UTC



53 Norwegian coastal stations

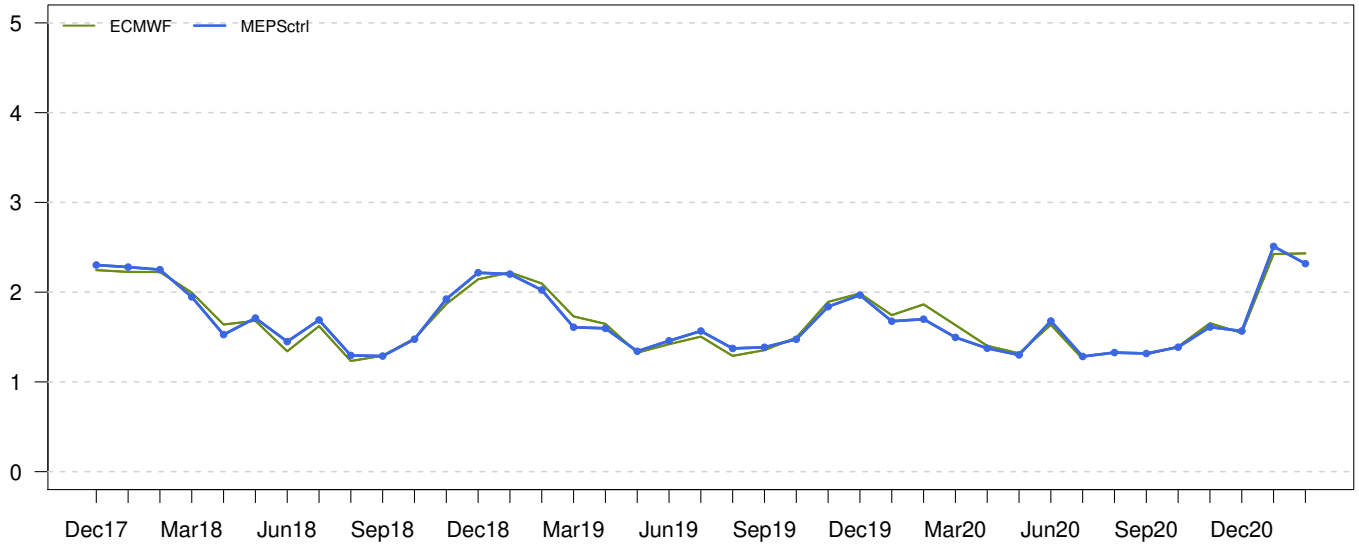


149 Norwegian inland stations

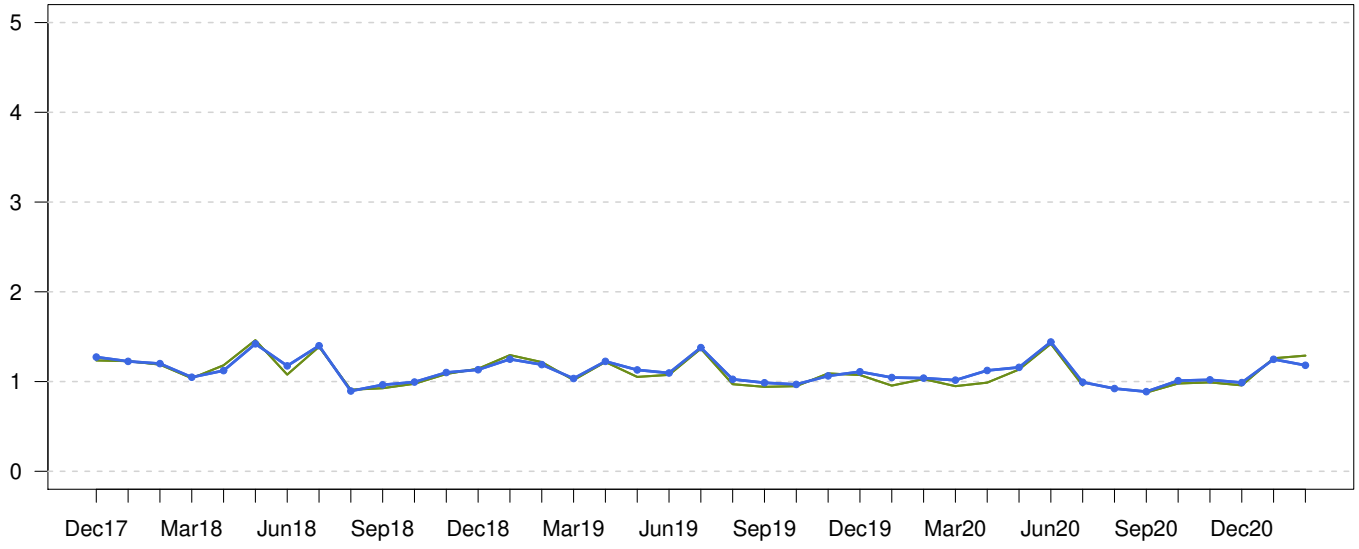


Standard Deviation of Error

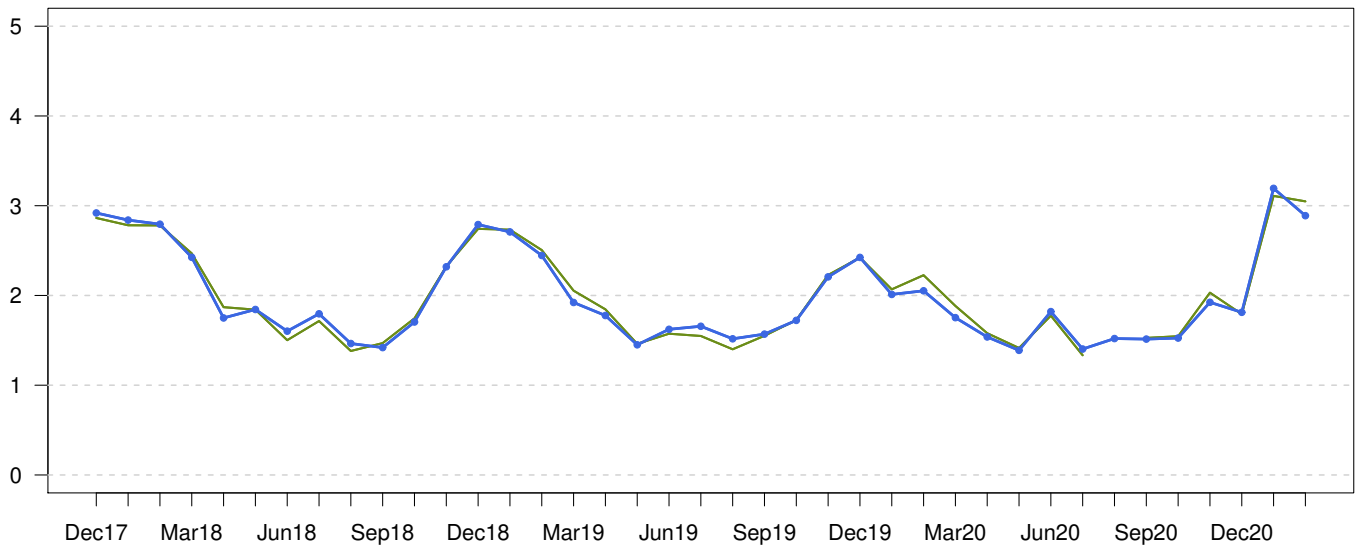
274 Norwegian stations 00+24,+30,+36,+42 UTC



53 Norwegian coastal stations

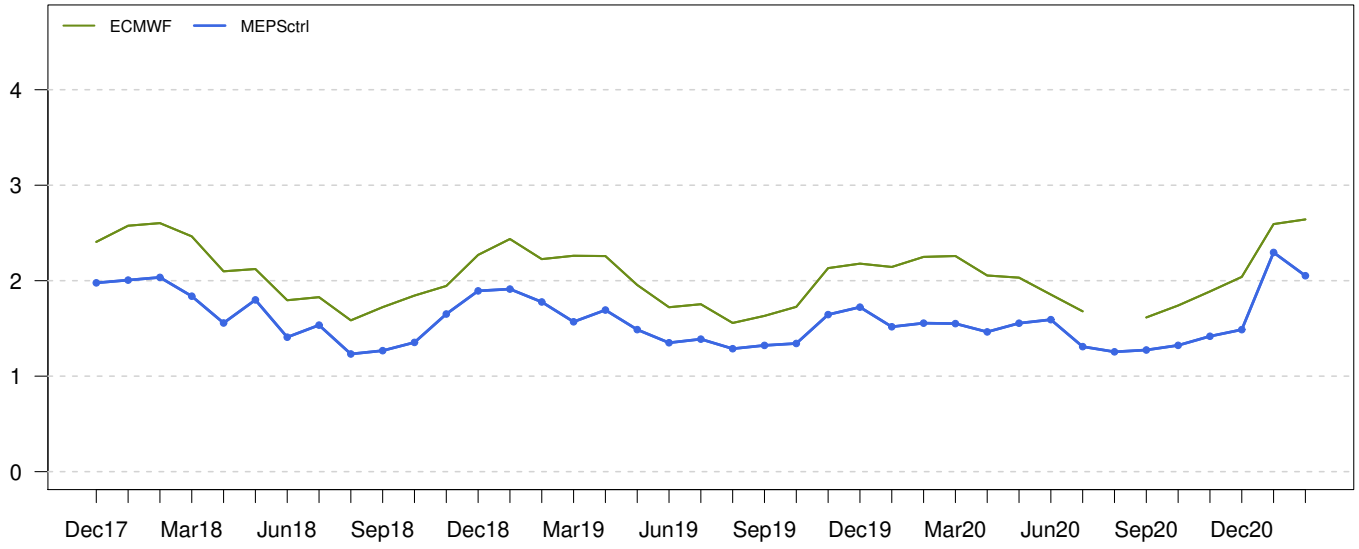


149 Norwegian inland stations

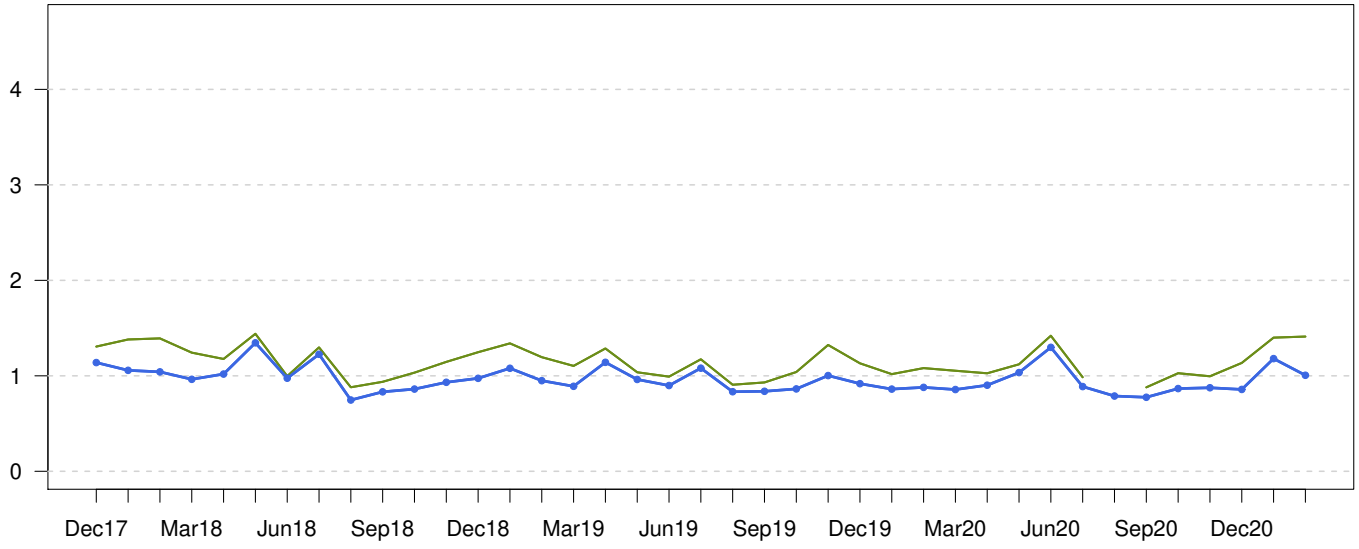


Mean Absolute Error

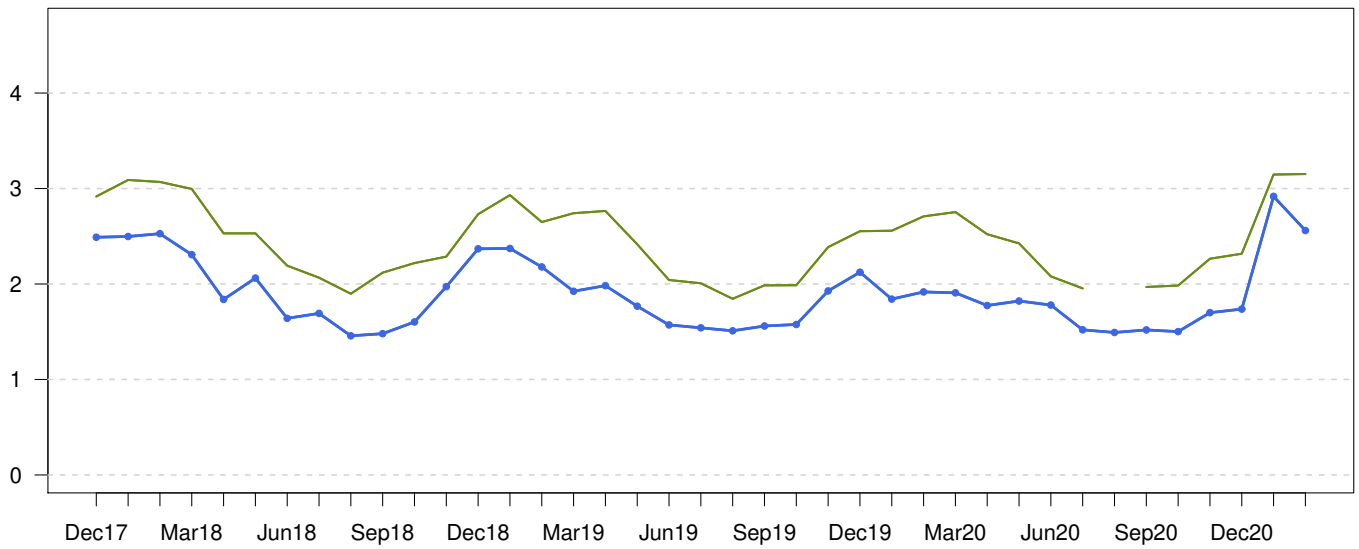
274 Norwegian stations 00+24,+30,+36,+42 UTC



53 Norwegian coastal stations

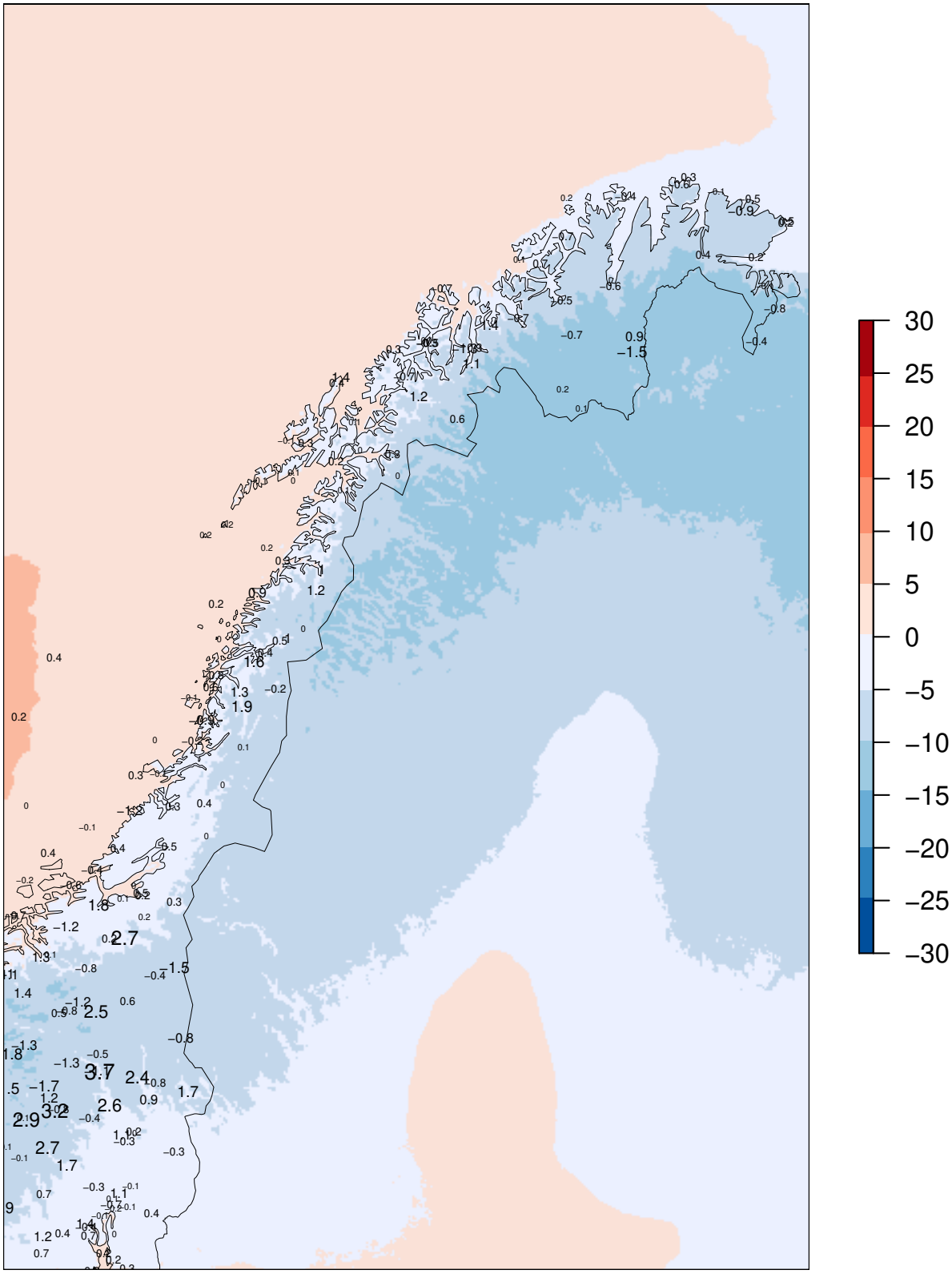


149 Norwegian inland stations



MEPSctrl 00+12

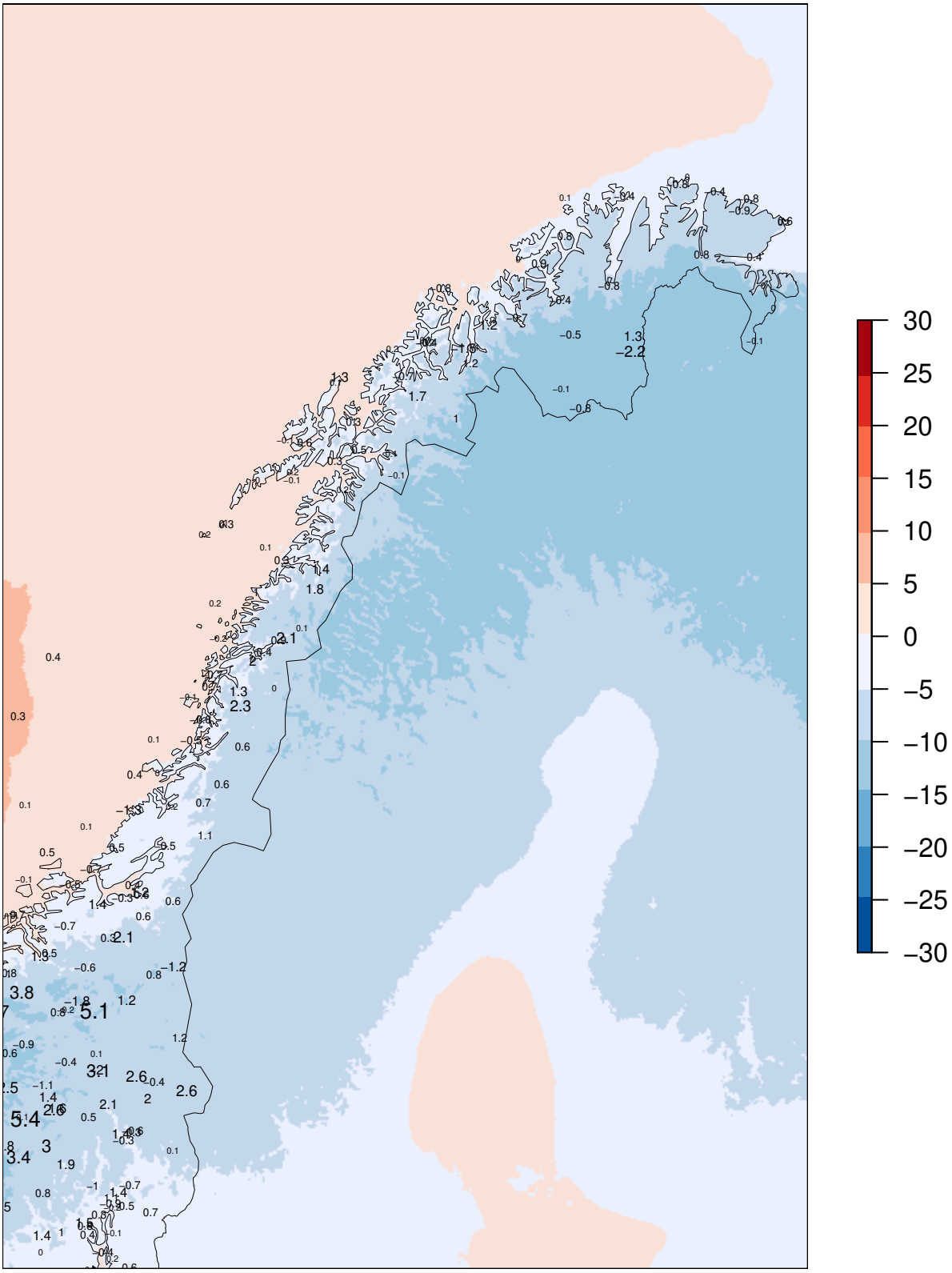
ME at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+24

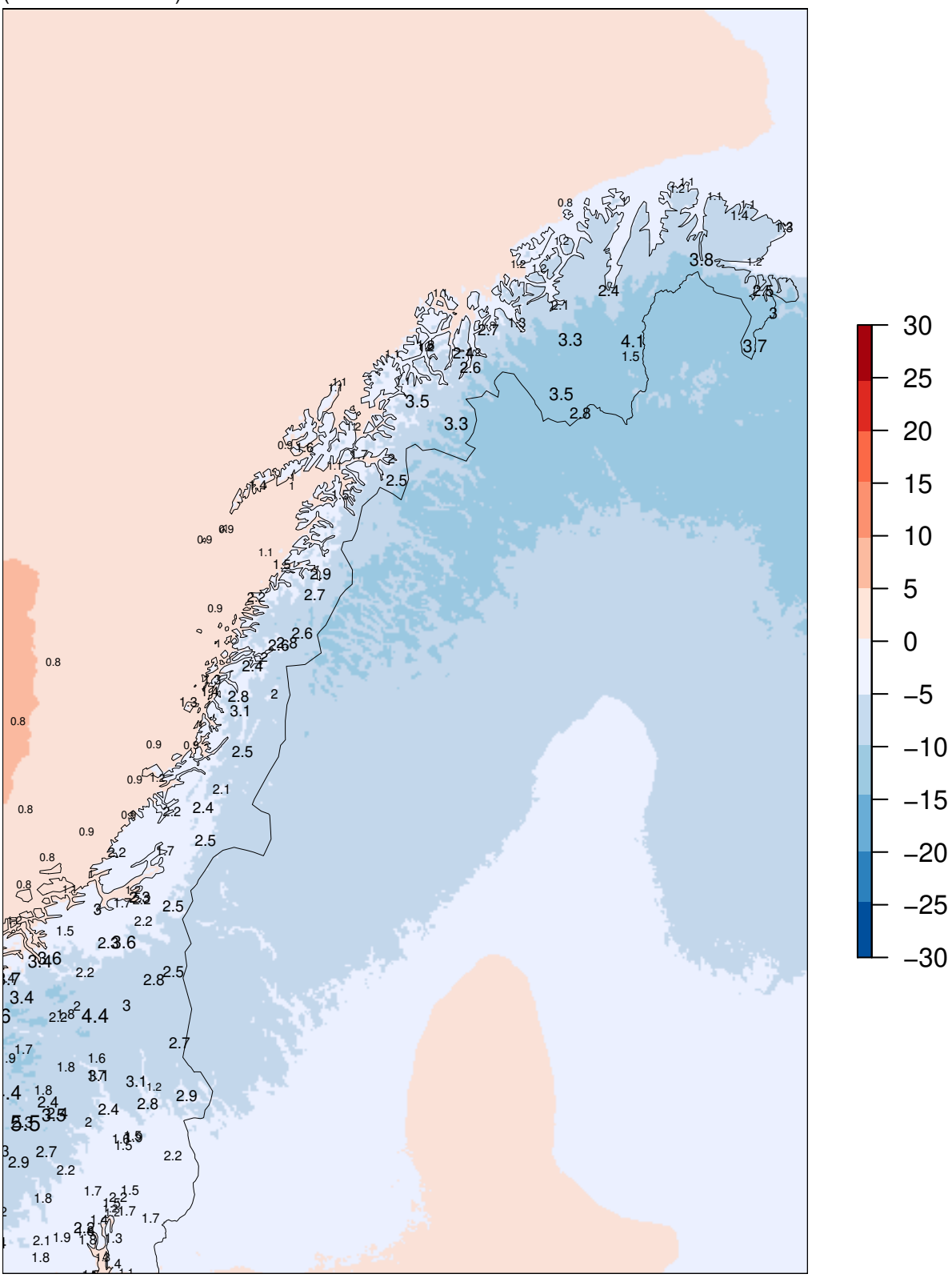
ME at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+12

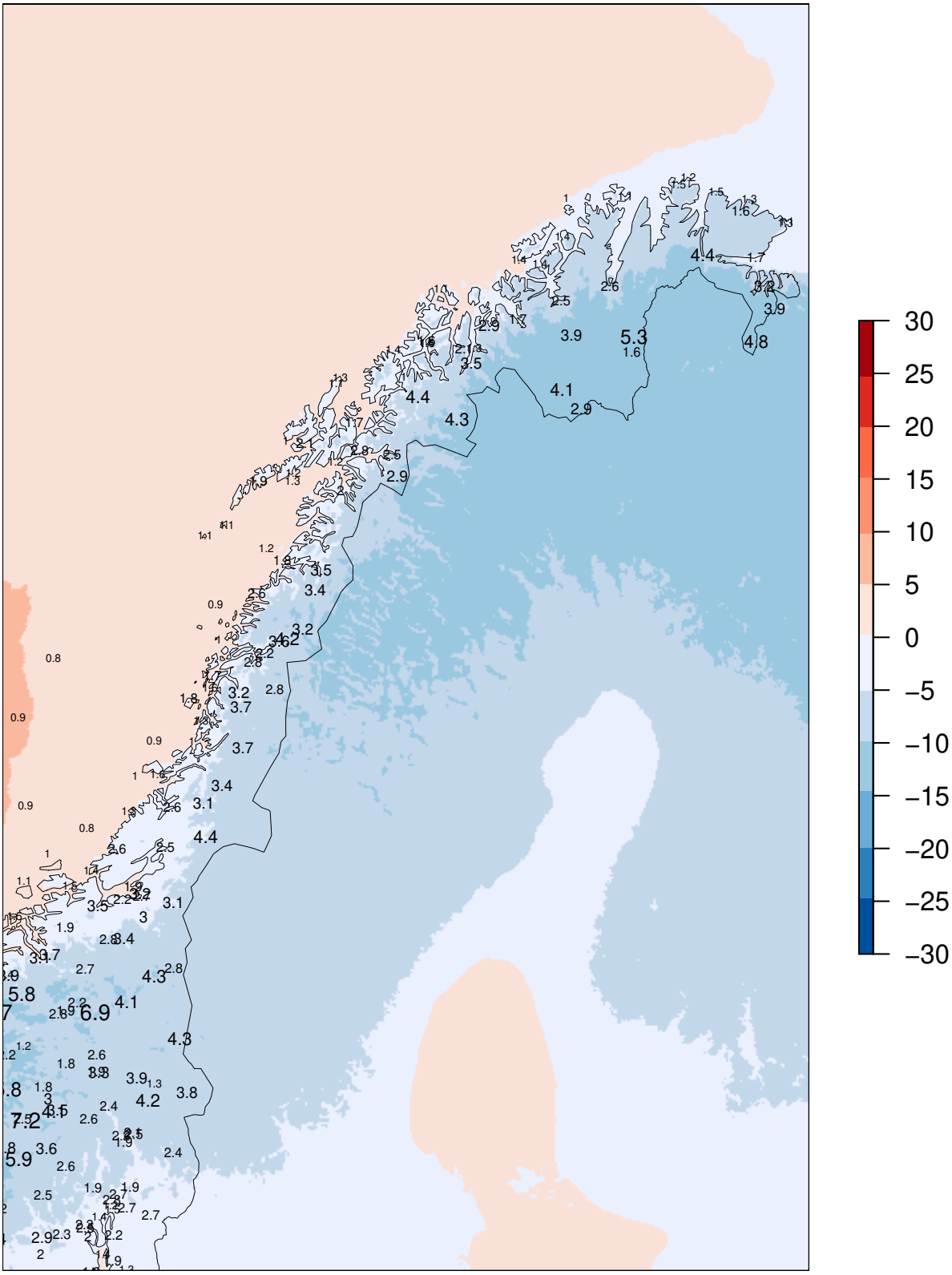
SDE at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+24

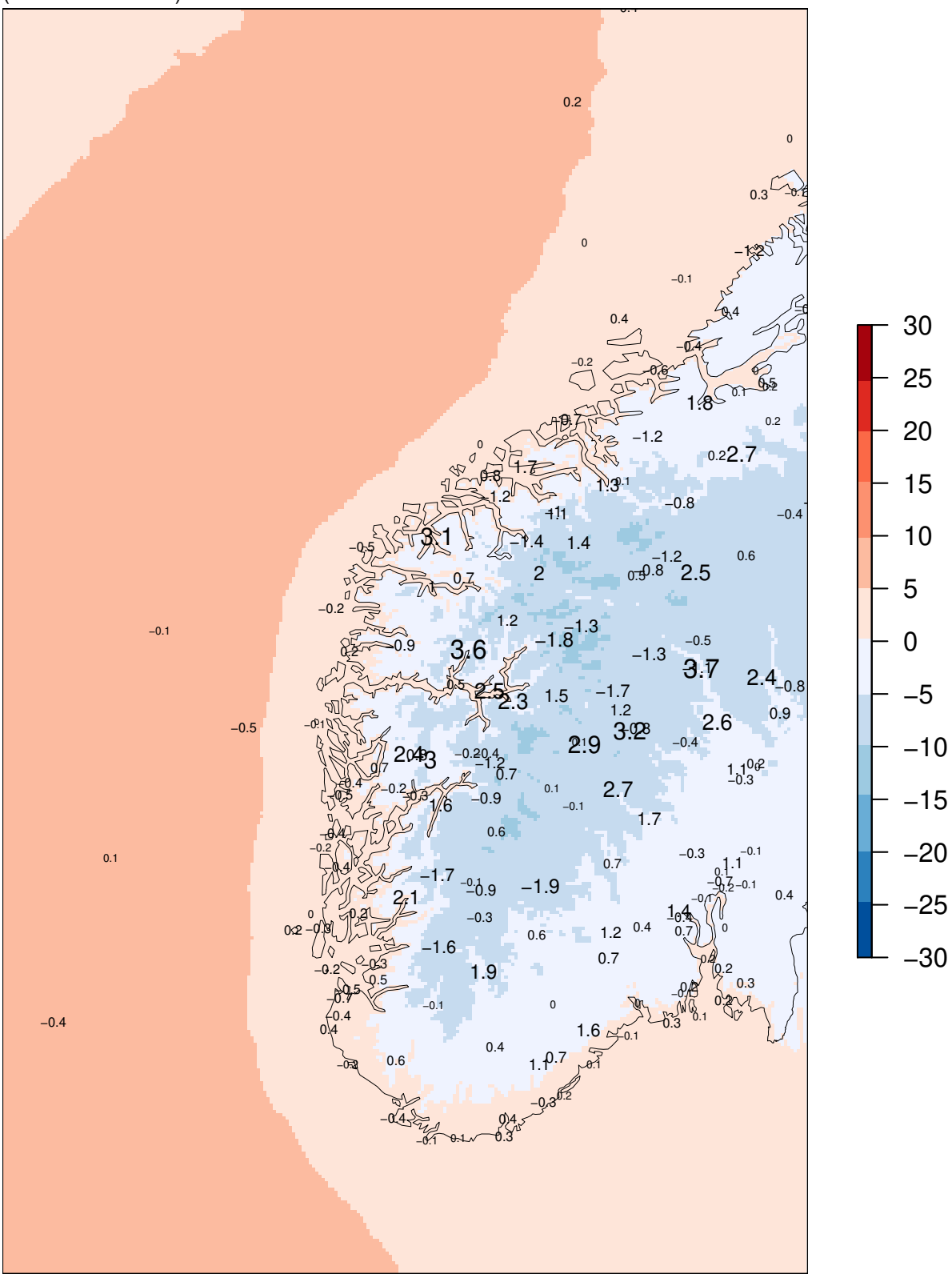
SDE at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+12

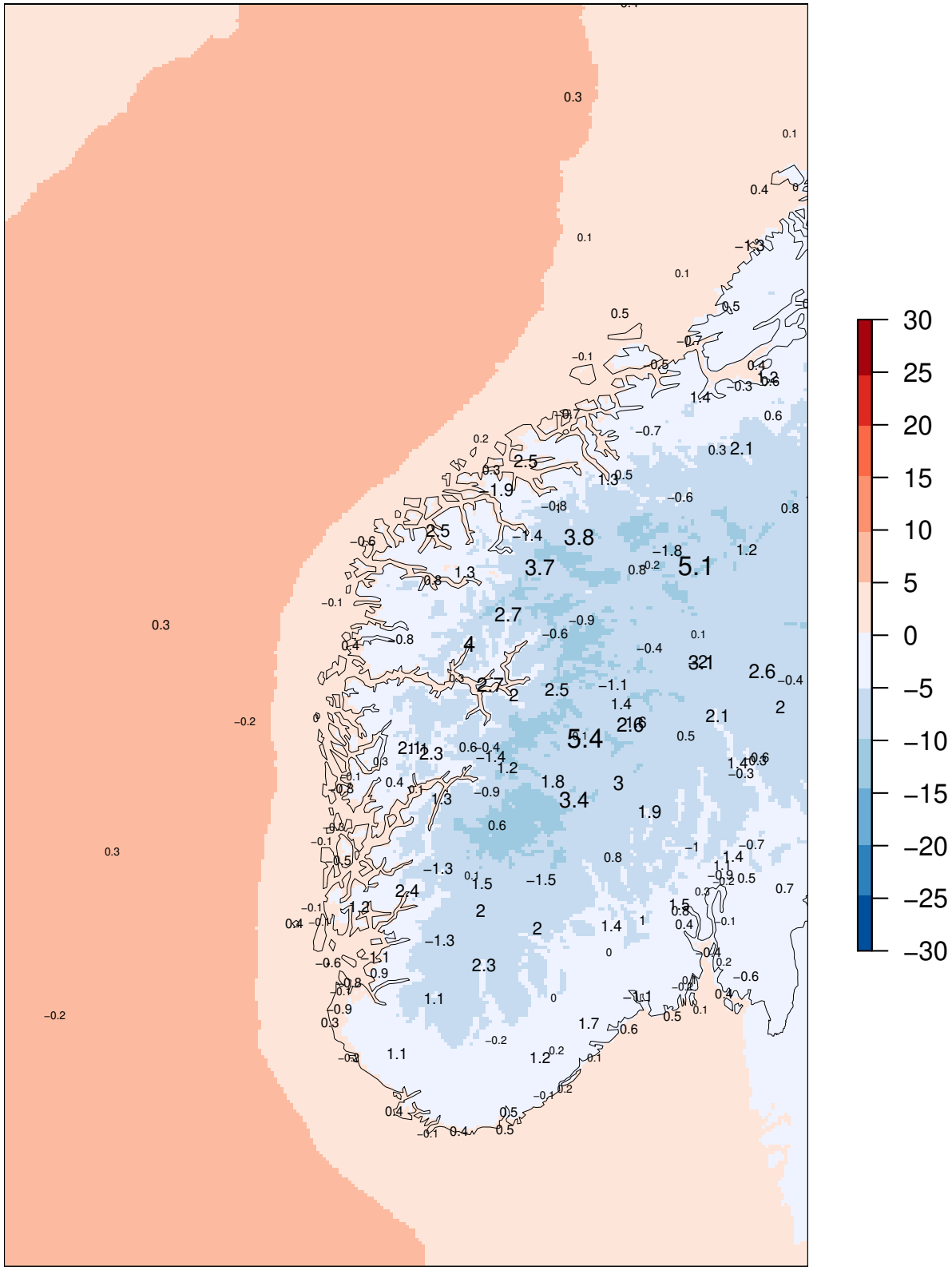
ME at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+24

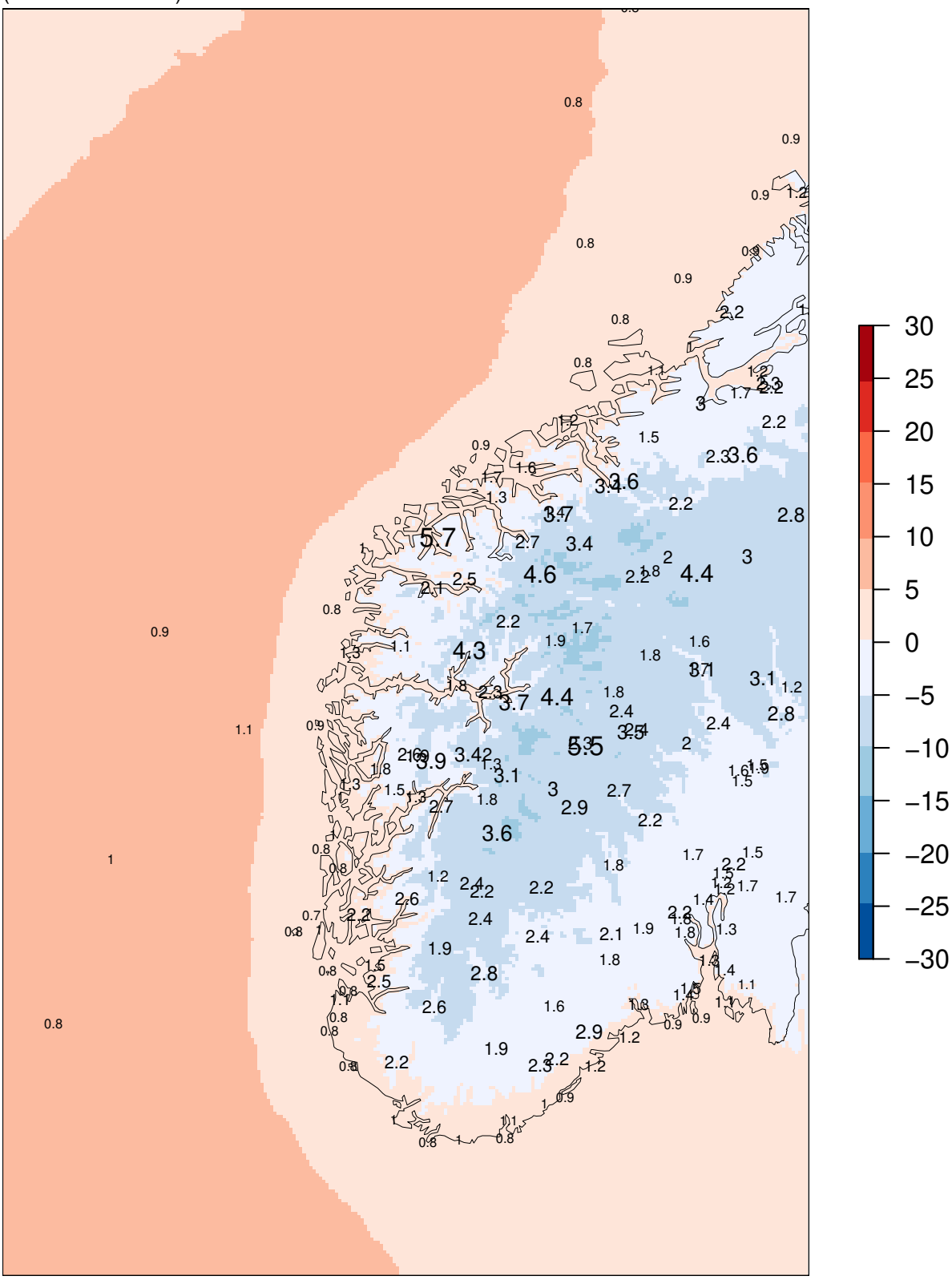
ME at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+12

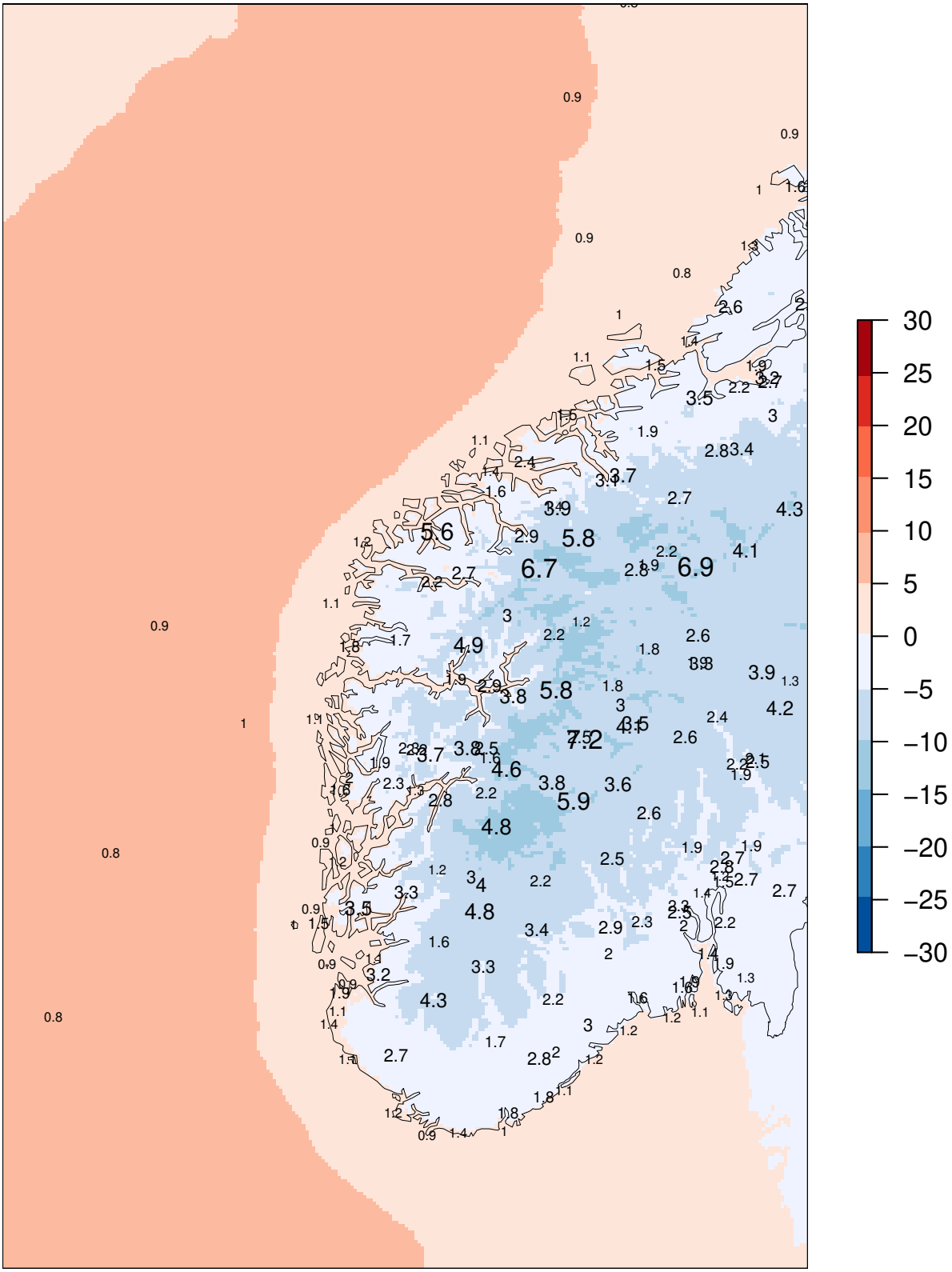
SDE at observing sites
(numbers in black)



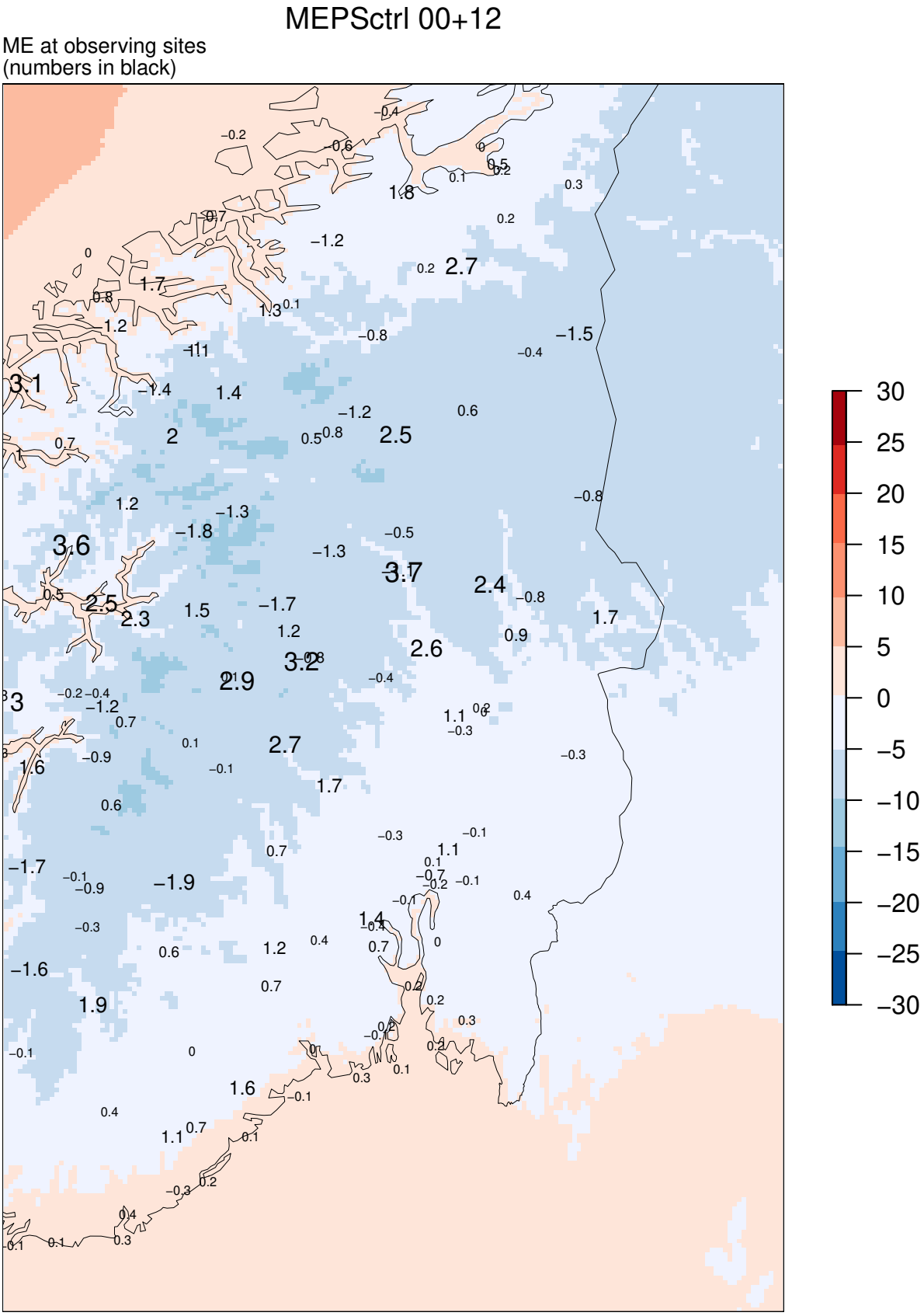
Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+24

SDE at observing sites
(numbers in black)



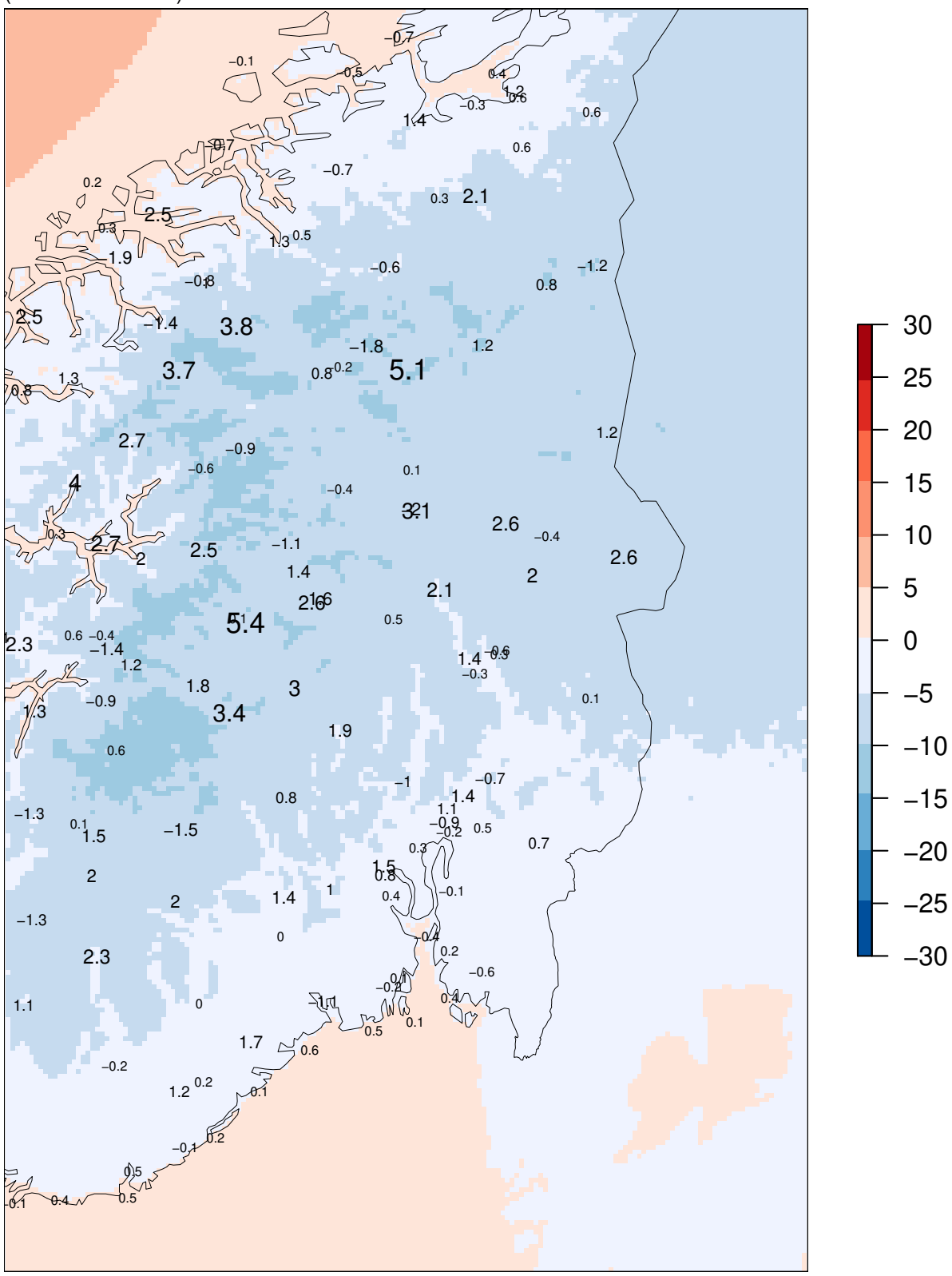
Model "climatology" 01.12.2020 – 28.02.2021



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+24

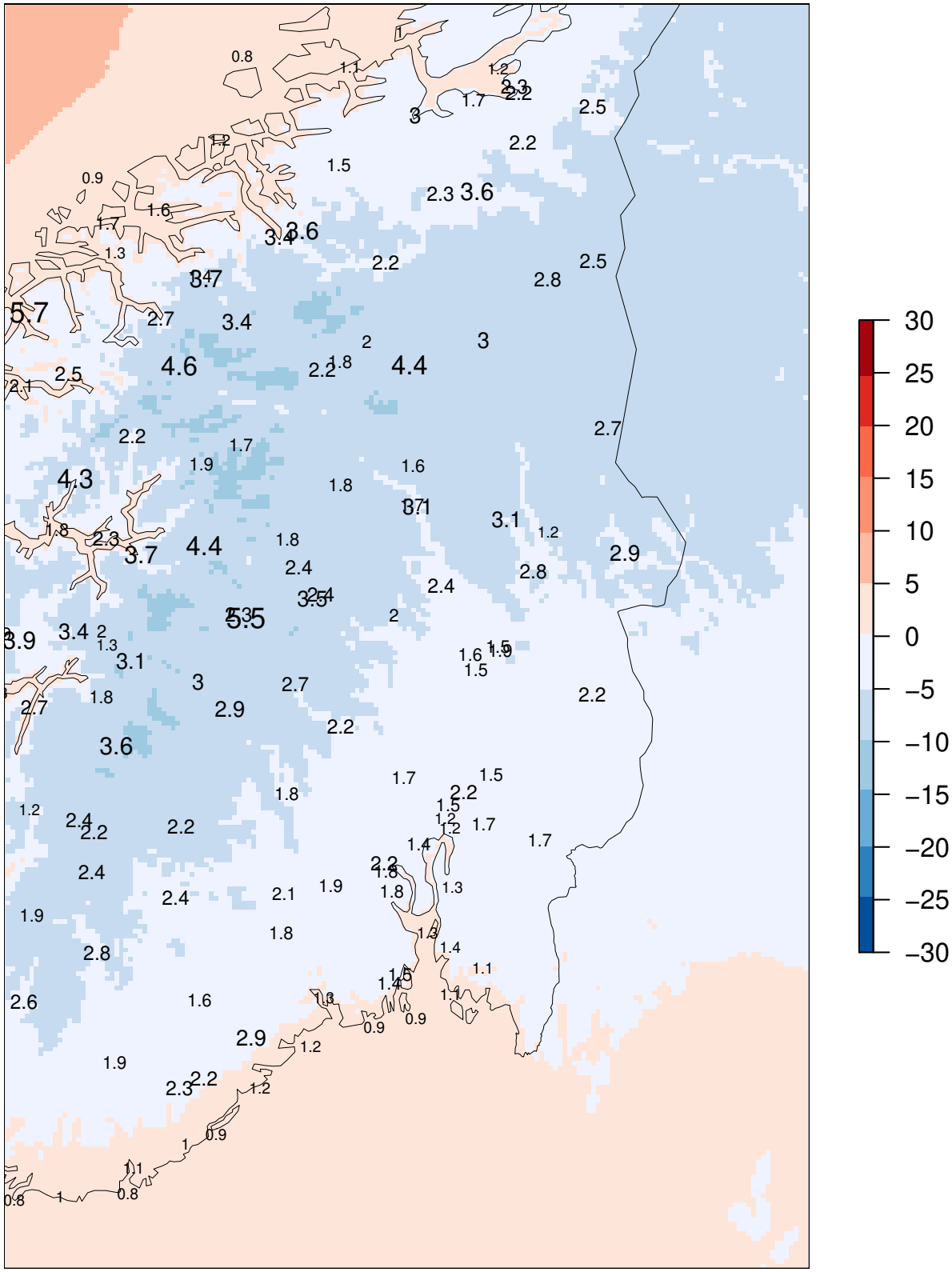
ME at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+12

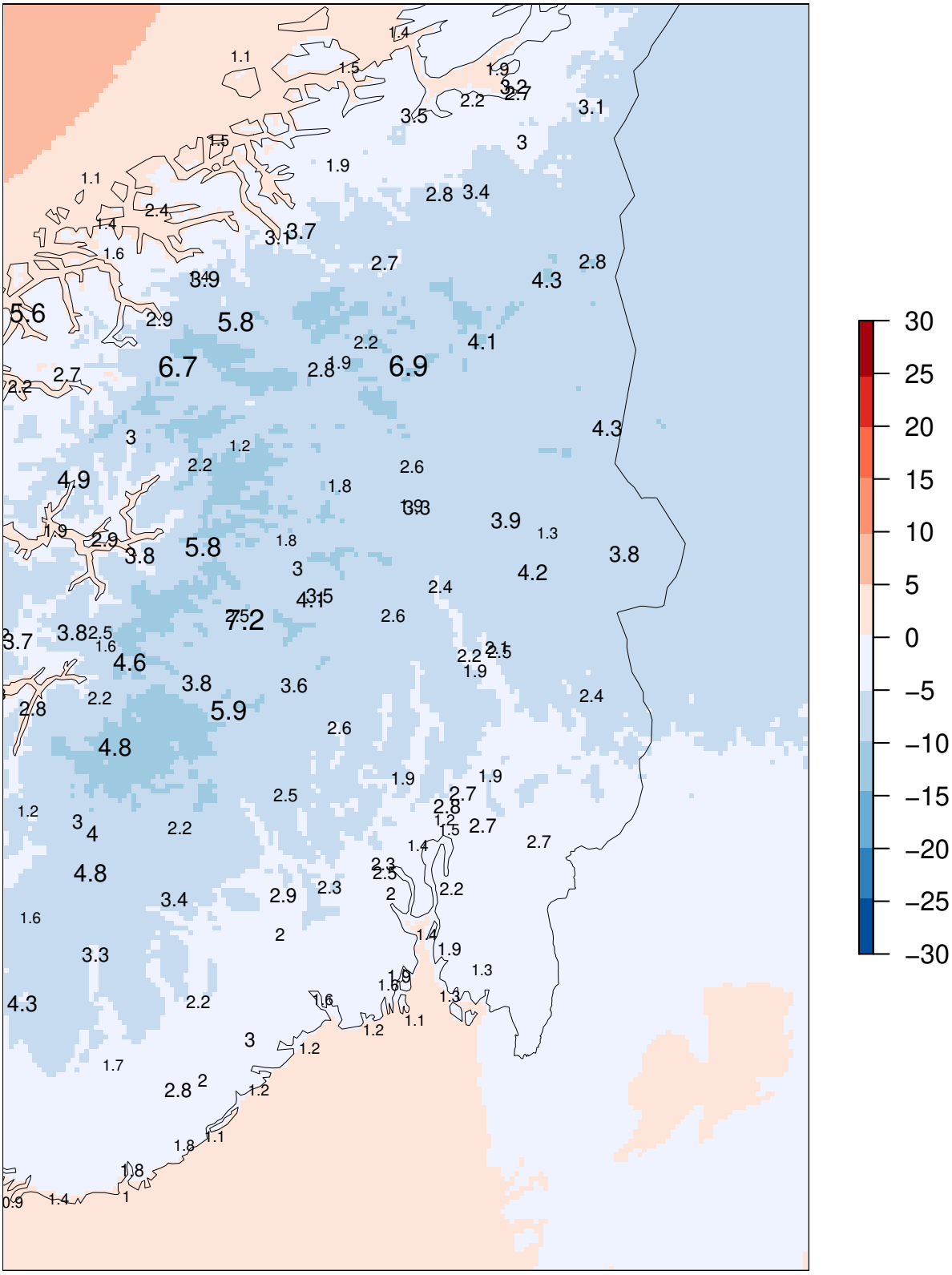
SDE at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

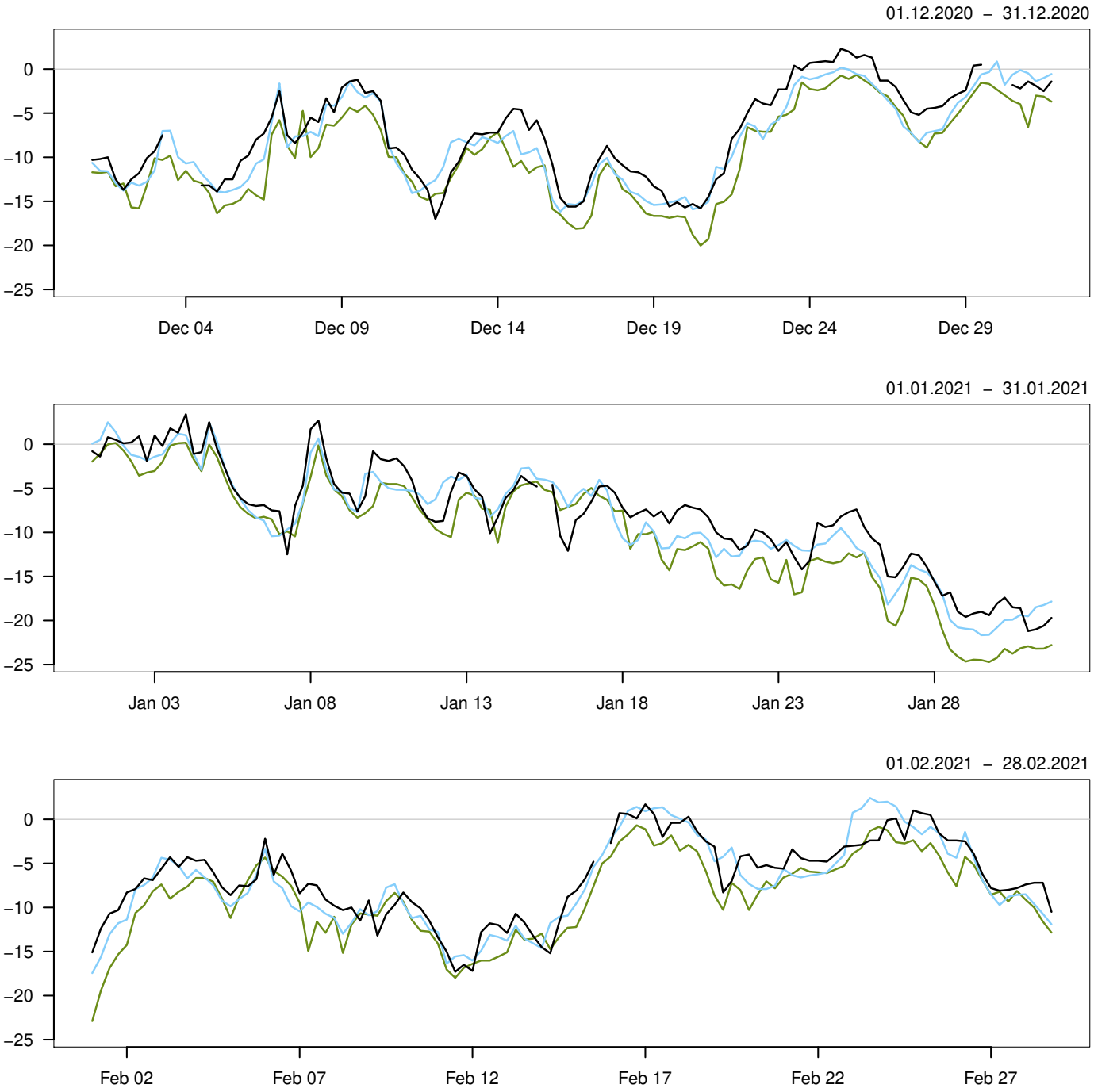
MEPSctrl 00+24

SDE at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

SVALBARD LUFTHAVN

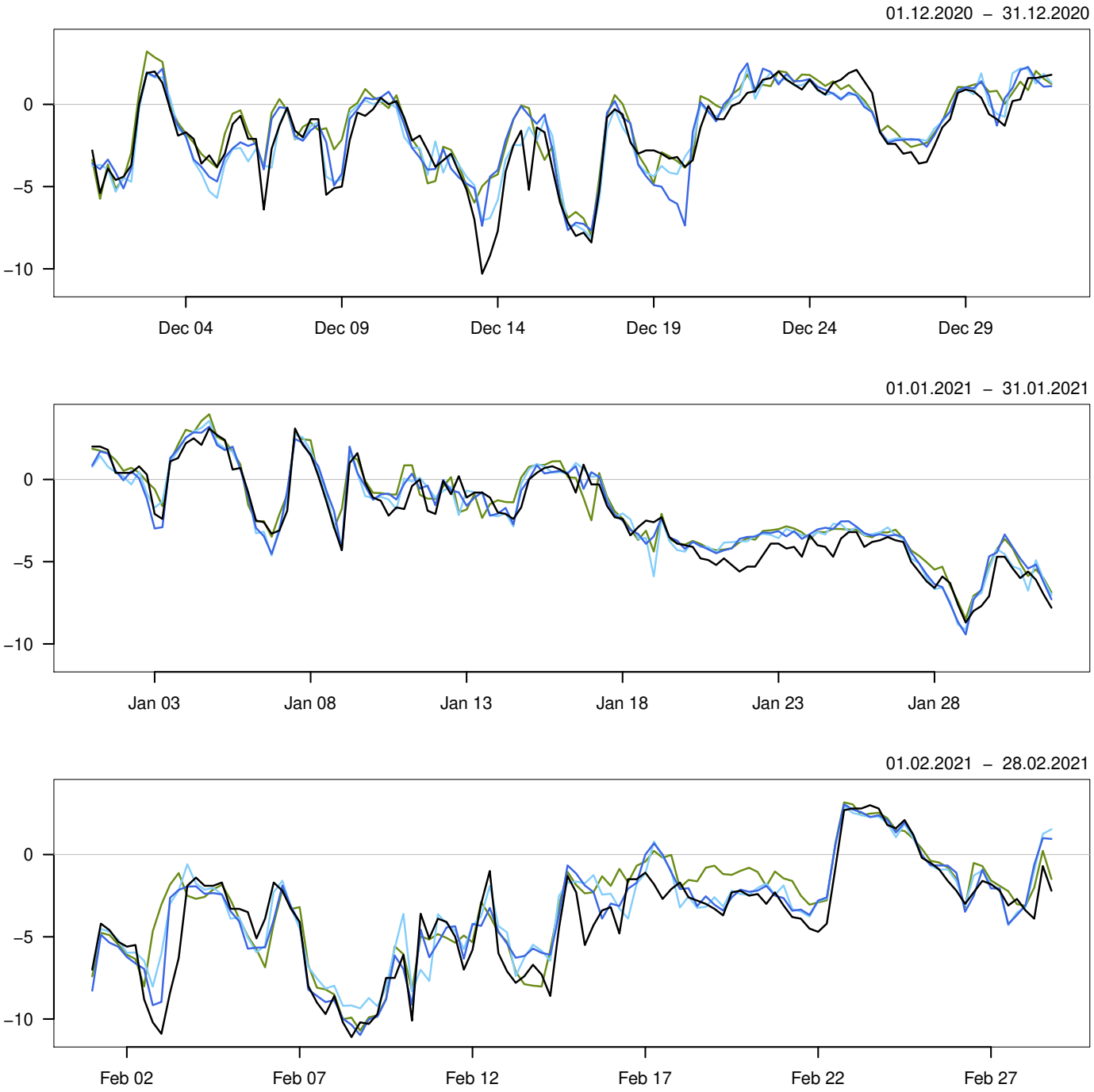


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−21.2	−7.3	3.4	5.2	355
AA25: 12+18,+24,+30,+36	−21.7	−8	2.5	5.4	364
ECMWF: 12+18,+24,+30,+36	−24.7	−9.6	0.2	5.7	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AA25 – synop	−0.8	1.8	2	1.7	5.1	355
ECMWF – synop	−2.4	1.9	3.1	2.6	7.8	355

BJØRNØYA

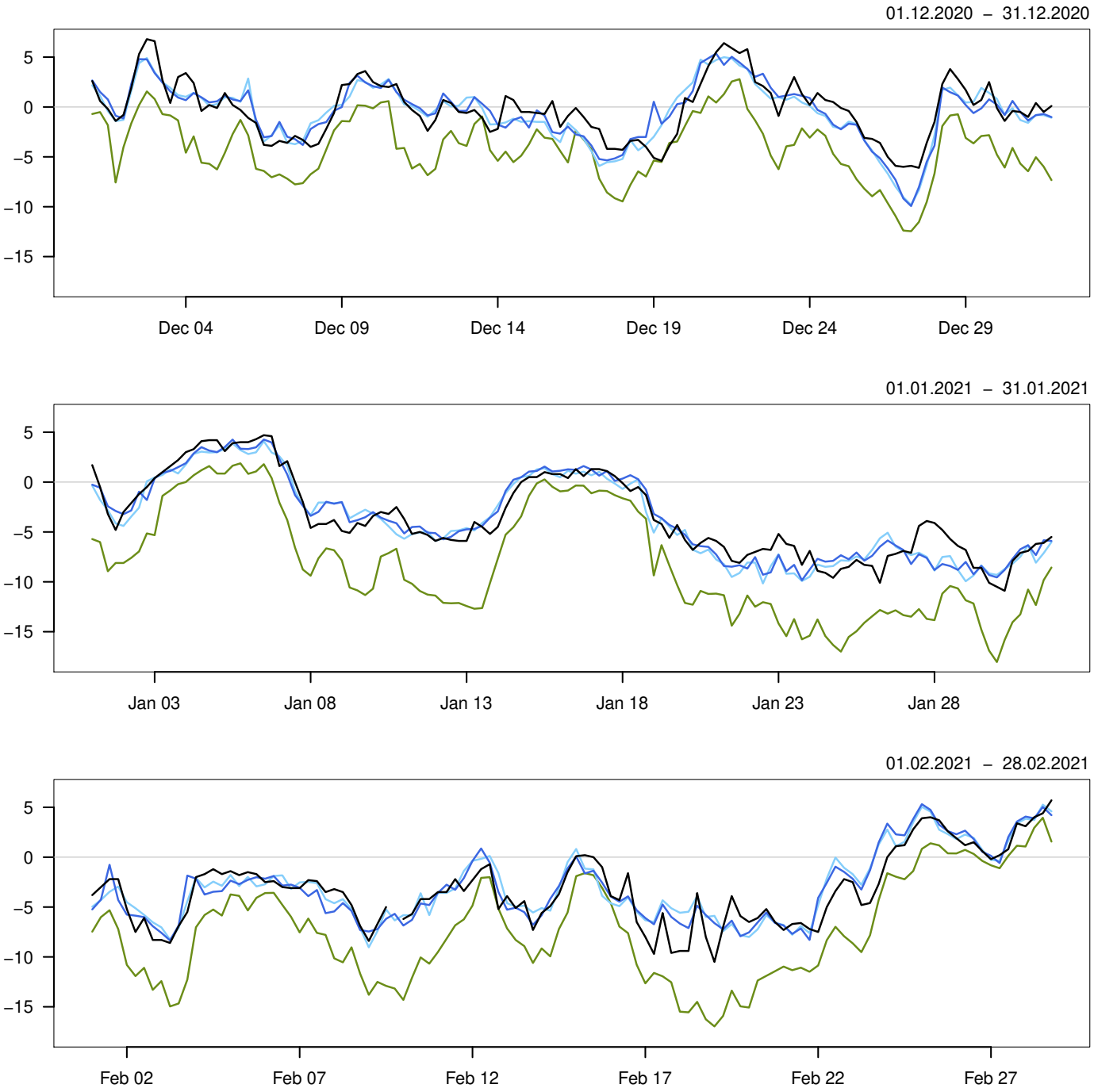


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−11.1	−2.7	3.1	3	364
MEPSctrl: 12+18,+24,+30,+36	−11	−2.4	3.2	2.9	364
AA25: 12+18,+24,+30,+36	−9.4	−2.4	3.6	2.8	364
ECMWF: 12+18,+24,+30,+36	−10.7	−2.1	4	2.8	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.3	1.1	1.2	0.8	5.8	364
AA25 – synop	0.3	1.1	1.2	0.8	5.4	364
ECMWF – synop	0.6	1.2	1.4	0.9	7.9	364

TROMSØ

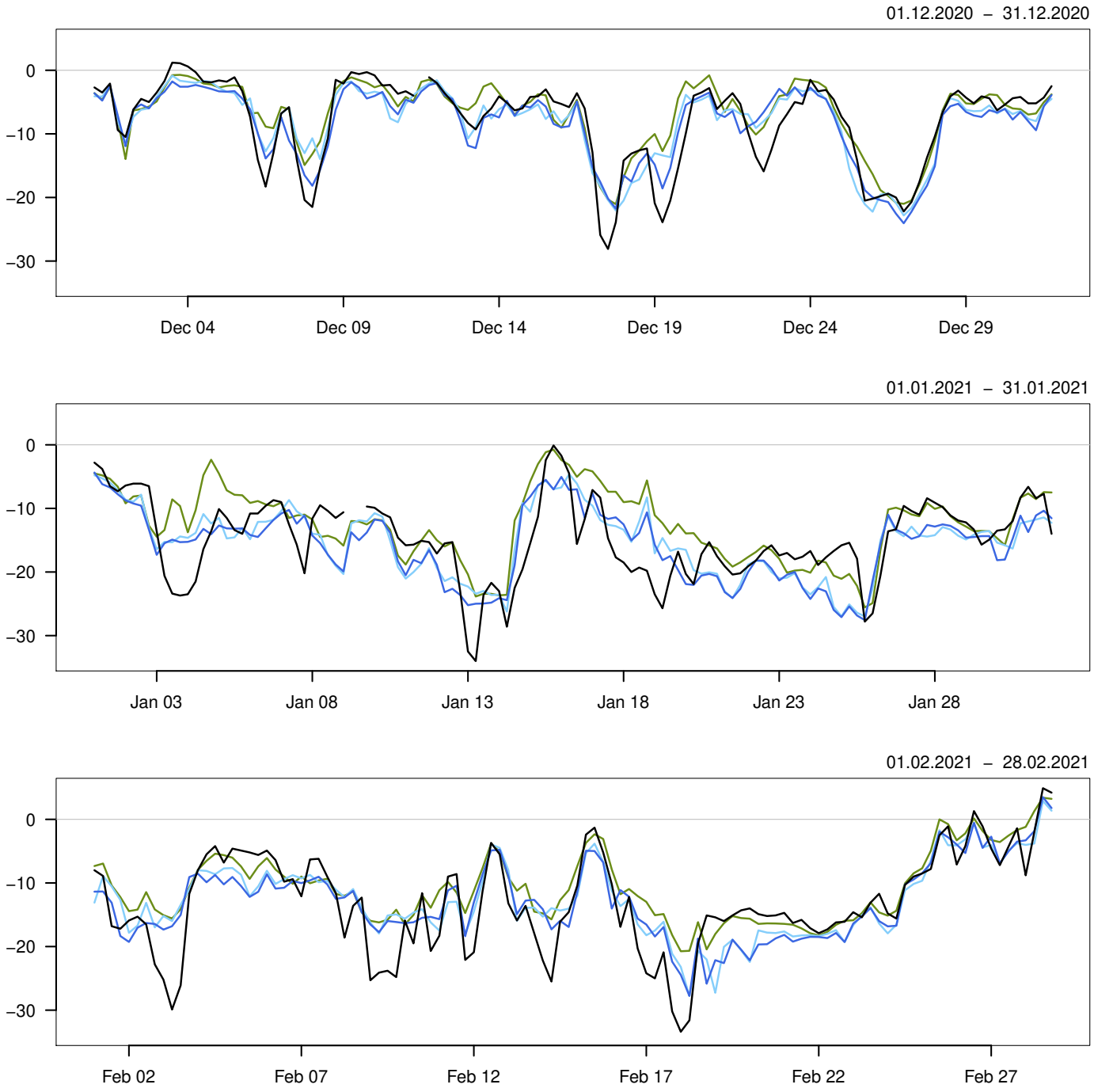


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−10.9	−2.3	6.8	3.8	363
MEPSctrl: 12+18,+24,+30,+36	−9.9	−2.3	5.4	3.8	364
AA25: 12+18,+24,+30,+36	−10.2	−2.4	5.3	3.8	364
ECMWF: 12+18,+24,+30,+36	−18	−6.5	4	5	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0	1.5	1.5	1.1	5.6	363
AA25 – synop	−0.1	1.5	1.5	1.2	4.8	363
ECMWF – synop	−4.2	2.1	4.7	4.2	10.9	363

KAUTOKEINO

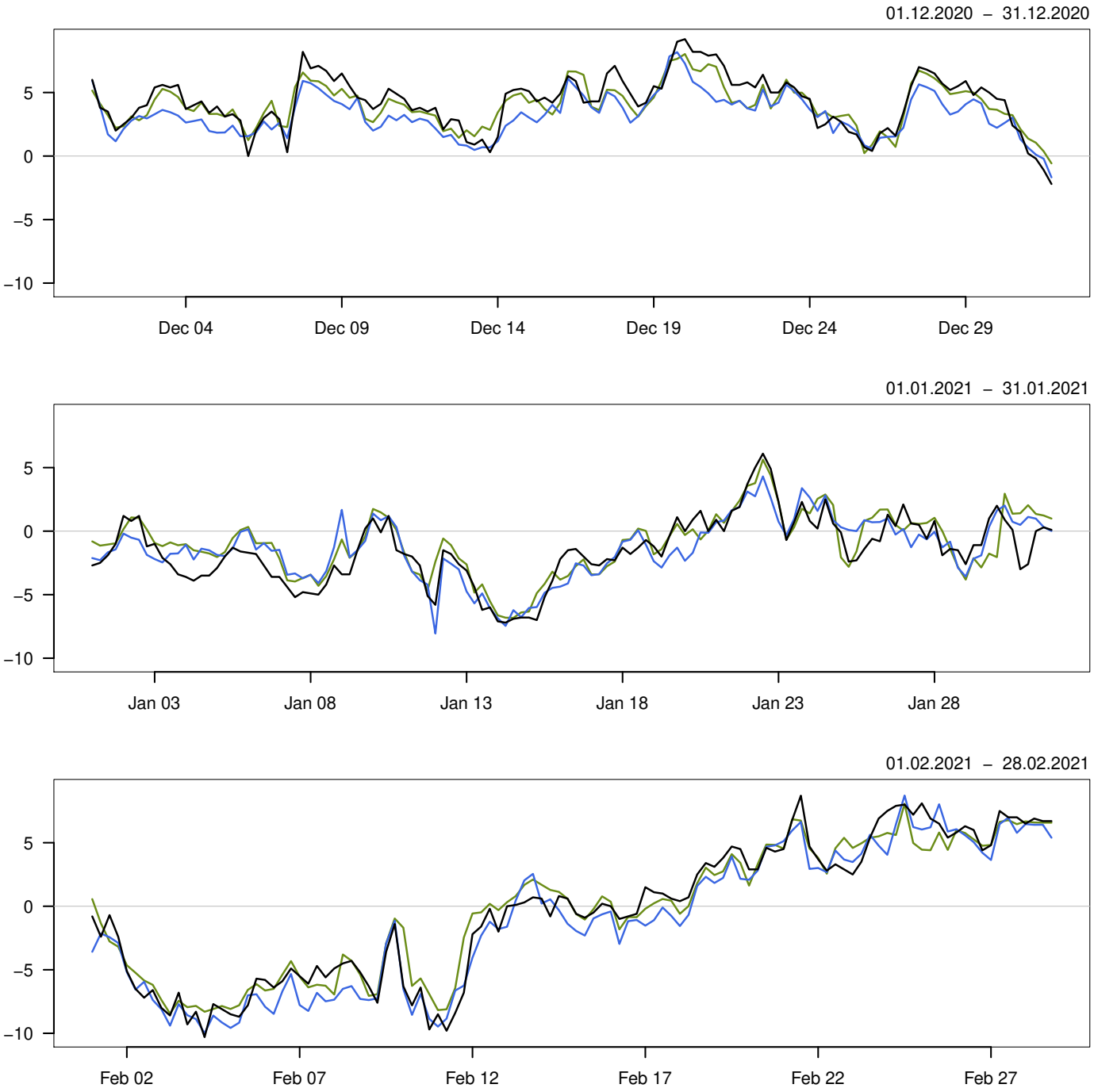


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−34	−11.8	4.9	7.5	361
MEPSctrl: 12+18,+24,+30,+36	−27.8	−12.3	3.5	6.5	364
AA25: 12+18,+24,+30,+36	−27.7	−11.9	2.9	6.4	364
ECMWF: 12+18,+24,+30,+36	−25.6	−9.9	3.4	6	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−0.5	4.1	4.1	3.3	13.1	361
AA25 – synop	−0.2	4.3	4.3	3.3	13.9	361
ECMWF – synop	1.8	4.2	4.6	3.1	14.8	361

ØRLAND III



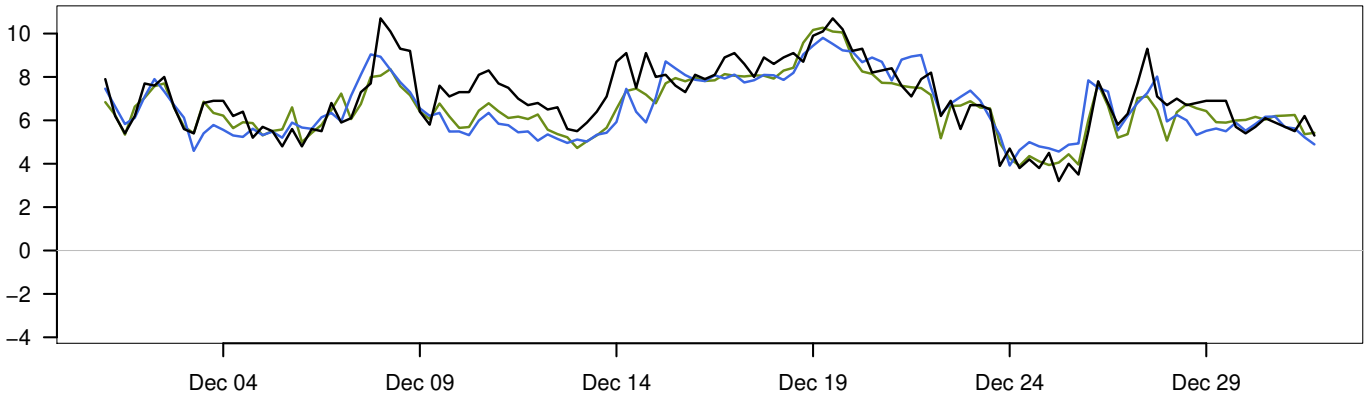
01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−10.3	0.9	9.2	4.4	364
MEPSctrl: 12+18,+24,+30,+36	−10	0.3	8.7	4.1	364
ECMWF: 12+18,+24,+30,+36	−8.4	1	8.1	4	364

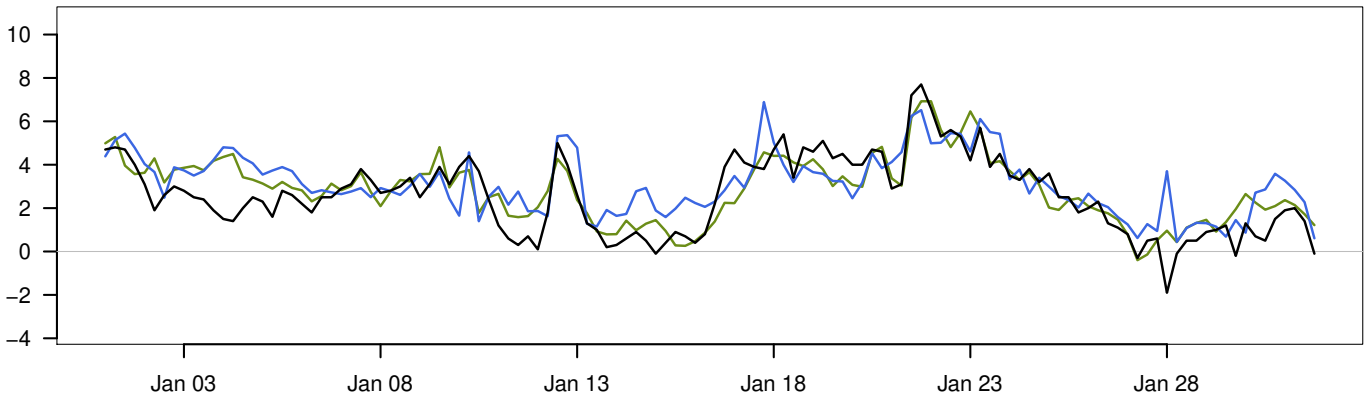
	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−0.5	1.3	1.4	1.1	5.1	364
ECMWF – synop	0.1	1.2	1.2	0.9	4.6	364

YTTERØYANE FYR

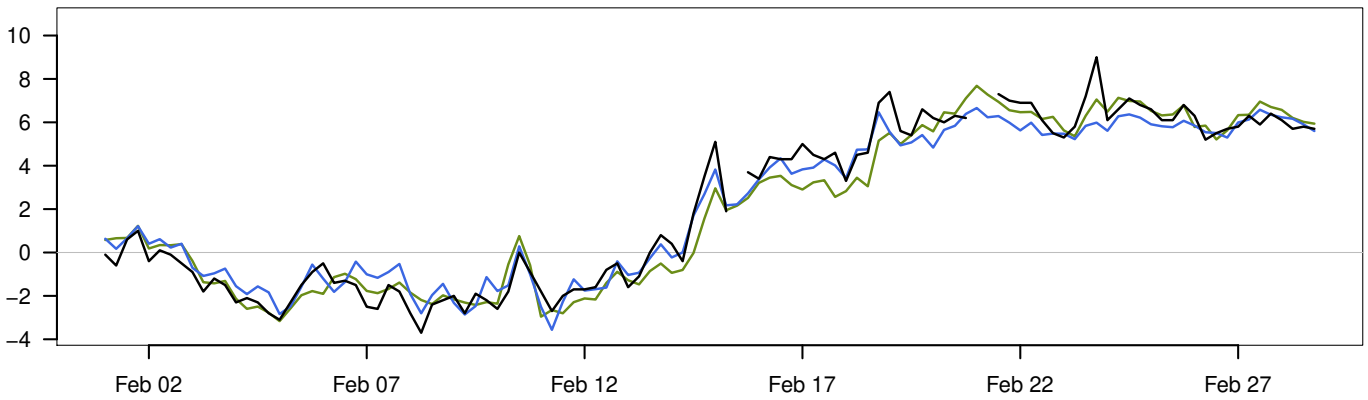
01.12.2020 – 31.12.2020



01.01.2021 – 31.01.2021



01.02.2021 – 28.02.2021

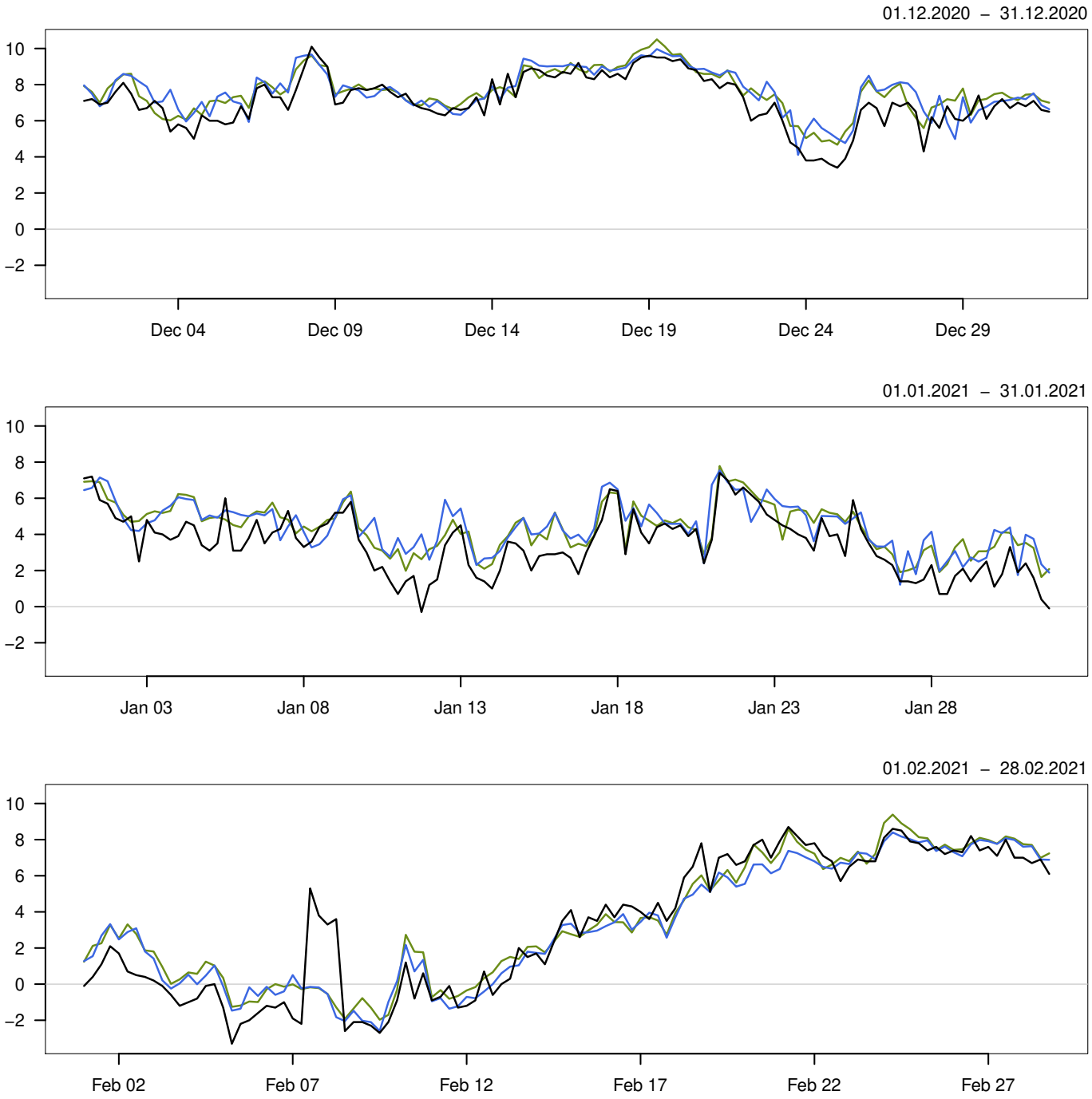


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−3.7	4	10.7	3.3	361
MEPSctrl: 12+18,+24,+30,+36	−3.6	4	9.8	2.9	364
ECMWF: 12+18,+24,+30,+36	−3.2	3.9	10.3	3.1	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0	1.1	1.1	0.8	5.6	361
ECMWF – synop	−0.1	0.9	0.9	0.7	3.1	361

TROLL A

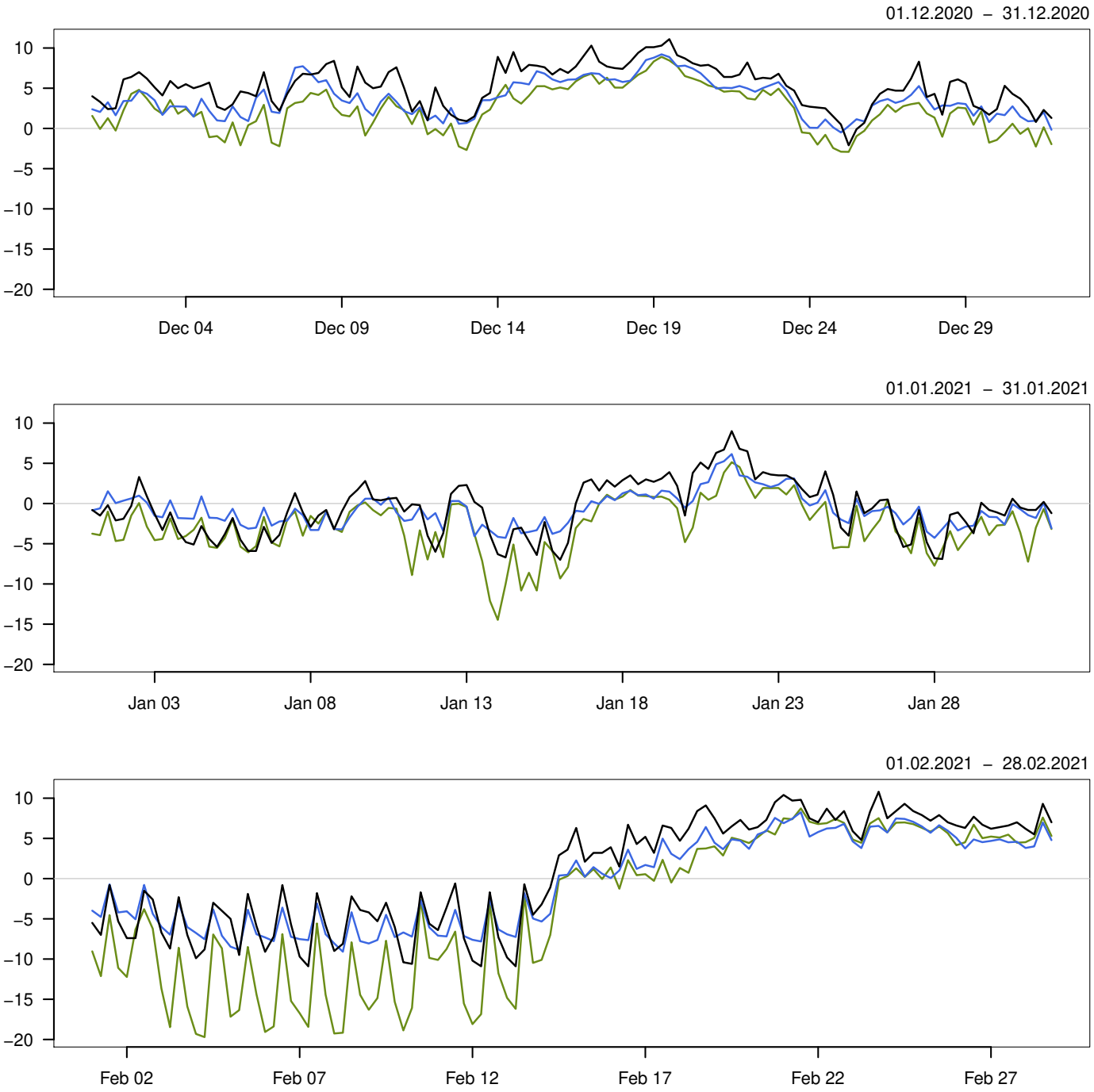


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−3.3	4.7	10.1	3	364
MEPSctrl: 12+18,+24,+30,+36	−2.6	5.2	10	2.8	364
ECMWF: 12+18,+24,+30,+36	−2	5.2	10.5	2.8	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.5	1.1	1.2	0.9	5.5	364
ECMWF – synop	0.6	0.9	1.1	0.8	5.5	364

BERGEN – FLORIDA



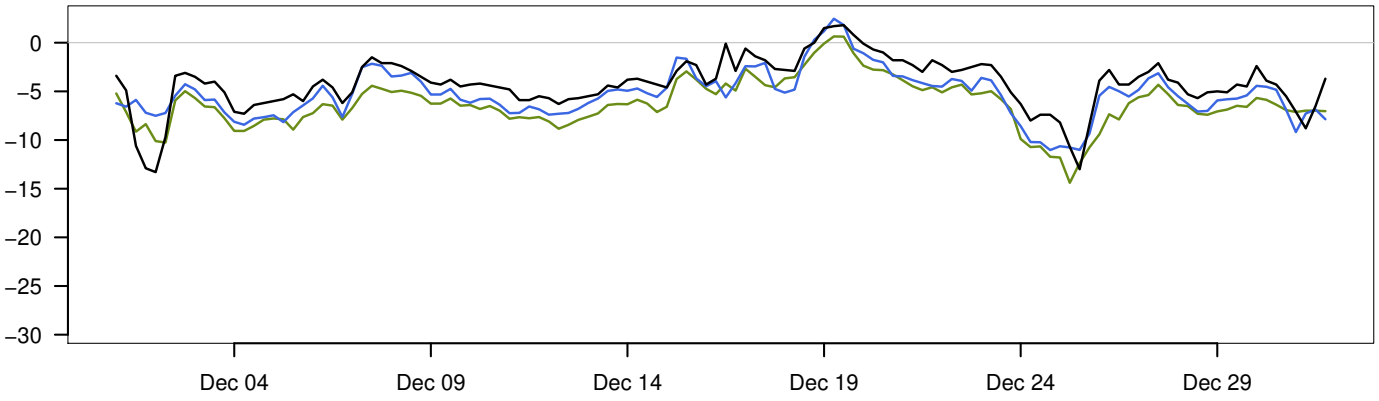
01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−10.9	1.9	11.1	5.2	364
MEPSctrl: 12+18,+24,+30,+36	−9.1	0.9	9.2	4.1	364
ECMWF: 12+18,+24,+30,+36	−19.7	−1.2	8.9	6.3	364

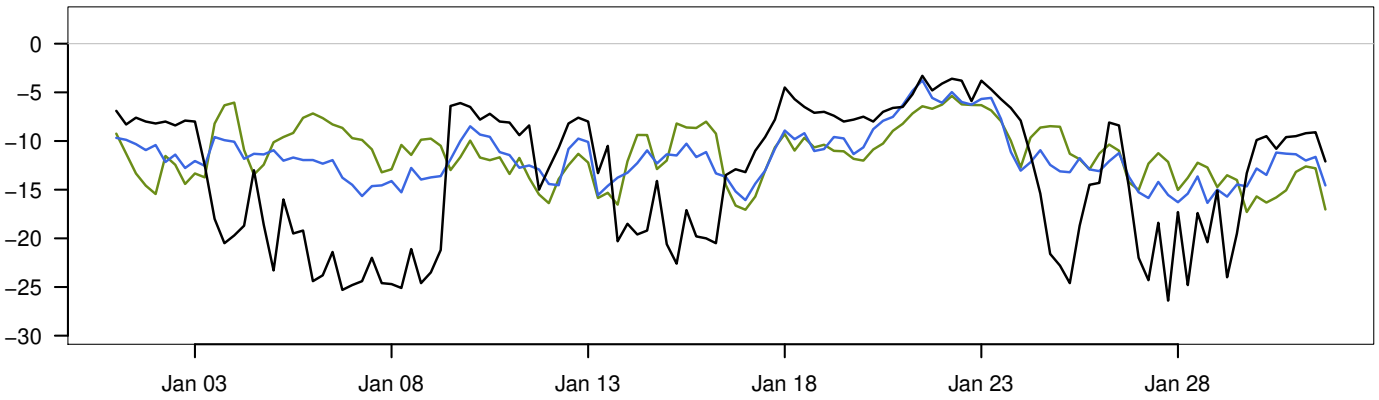
	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−0.9	1.8	2.1	1.8	5	364
ECMWF – synop	−3.1	2.4	3.9	3.2	12.2	364

FINSEVATN

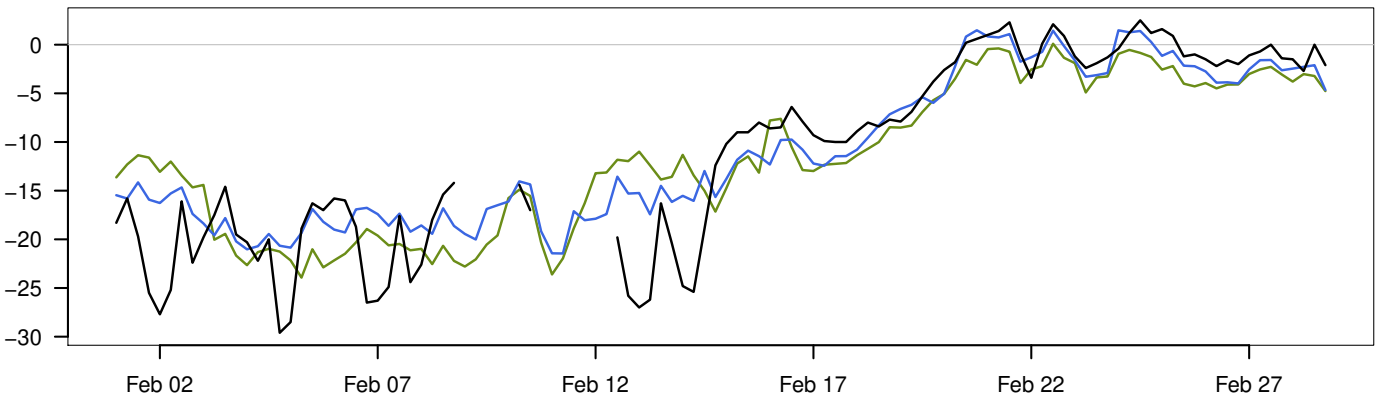
01.12.2020 – 31.12.2020



01.01.2021 – 31.01.2021



01.02.2021 – 28.02.2021



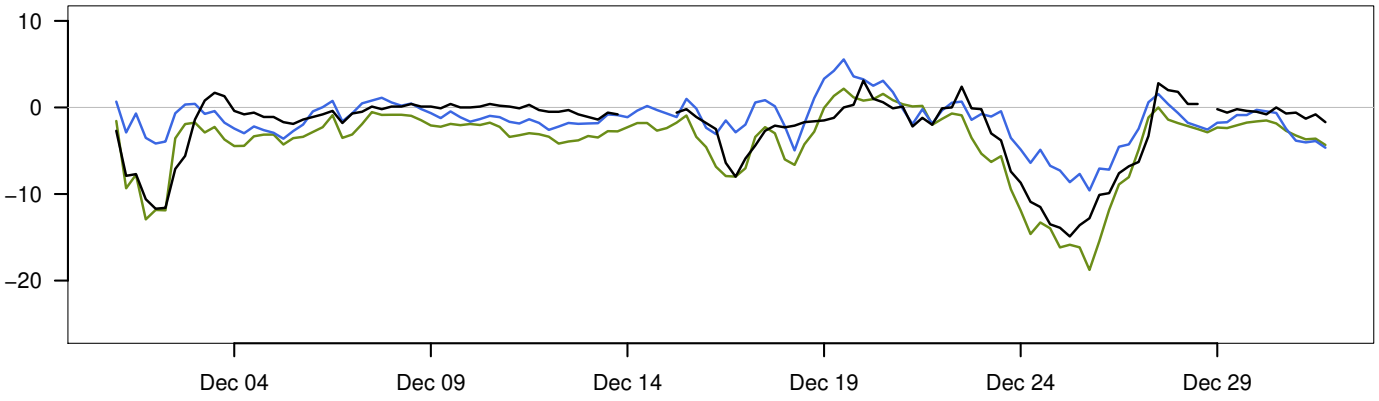
01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−29.6	−9.4	2.5	7.8	352
MEPSctrl: 12+18,+24,+30,+36	−21.5	−9.2	2.5	5.5	364
ECMWF: 12+18,+24,+30,+36	−23.9	−9.6	0.6	5.3	364

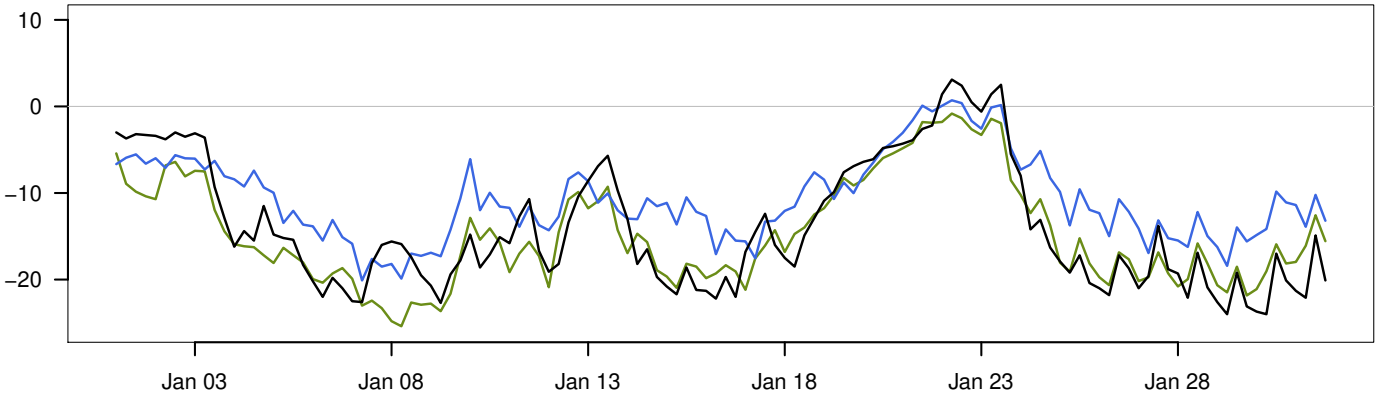
	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.5	4.2	4.2	3	12.4	352
ECMWF – synop	0.1	5.5	5.5	4.2	17.2	352

NESBYEN – TODOKK

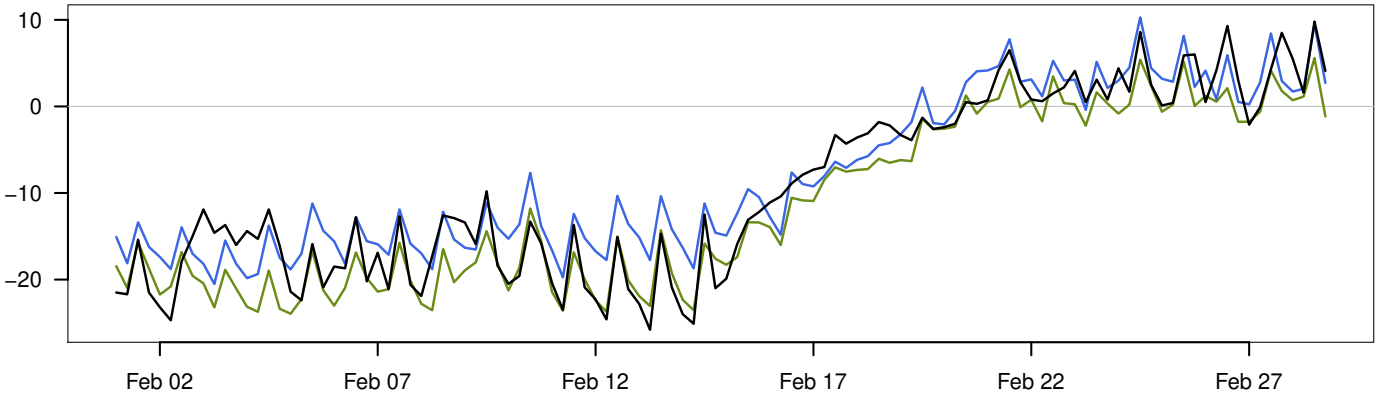
01.12.2020 – 31.12.2020



01.01.2021 – 31.01.2021



01.02.2021 – 28.02.2021

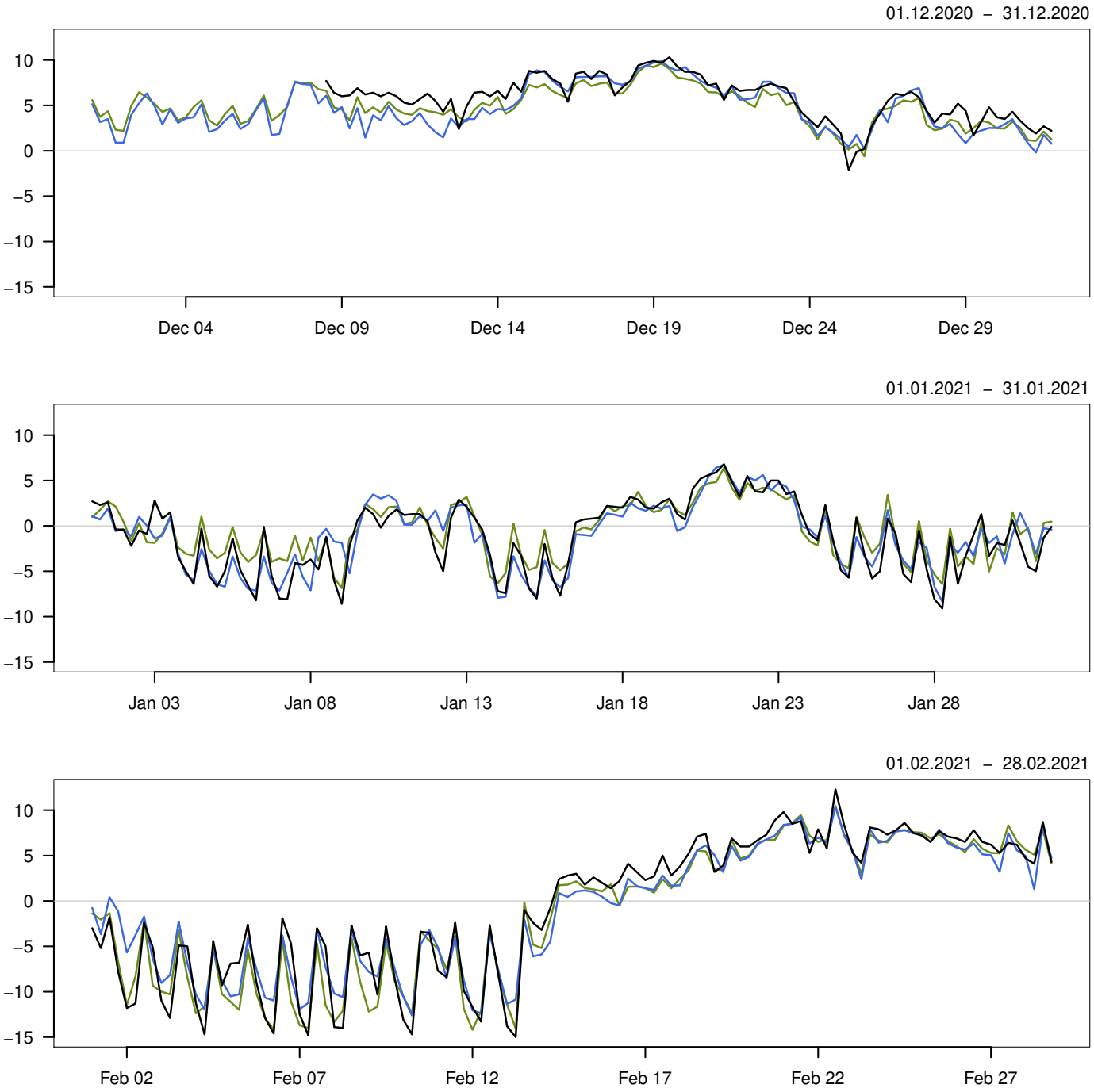


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−25.8	−8.5	9.8	9	359
MEPSctrl: 12+18,+24,+30,+36	−20.5	−6.6	10.3	7.2	364
ECMWF: 12+18,+24,+30,+36	−25.4	−9.9	5.6	8.3	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	1.9	3.6	4.1	3.3	9.9	359
ECMWF – synop	−1.5	2.7	3	2.4	9.5	359

SOLA

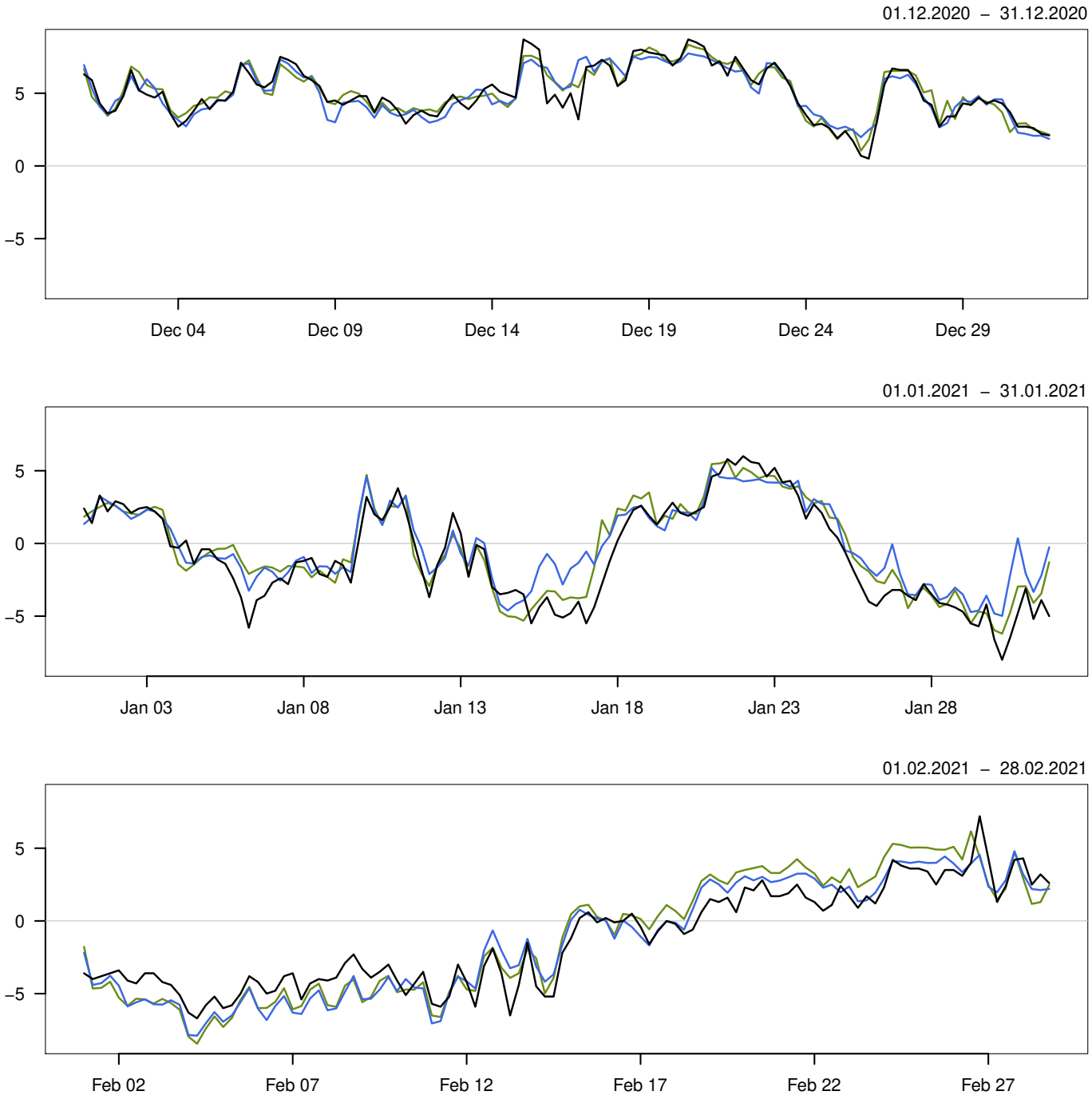


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−15	1.1	12.3	6	338
MEPSctrl: 12+18,+24,+30,+36	−12.6	1	10.4	5.3	364
ECMWF: 12+18,+24,+30,+36	−14.2	1.1	10.5	5.4	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−0.3	1.8	1.8	1.4	7.5	338
ECMWF – synop	−0.3	1.6	1.7	1.3	6.5	338

FÆRDER FYR

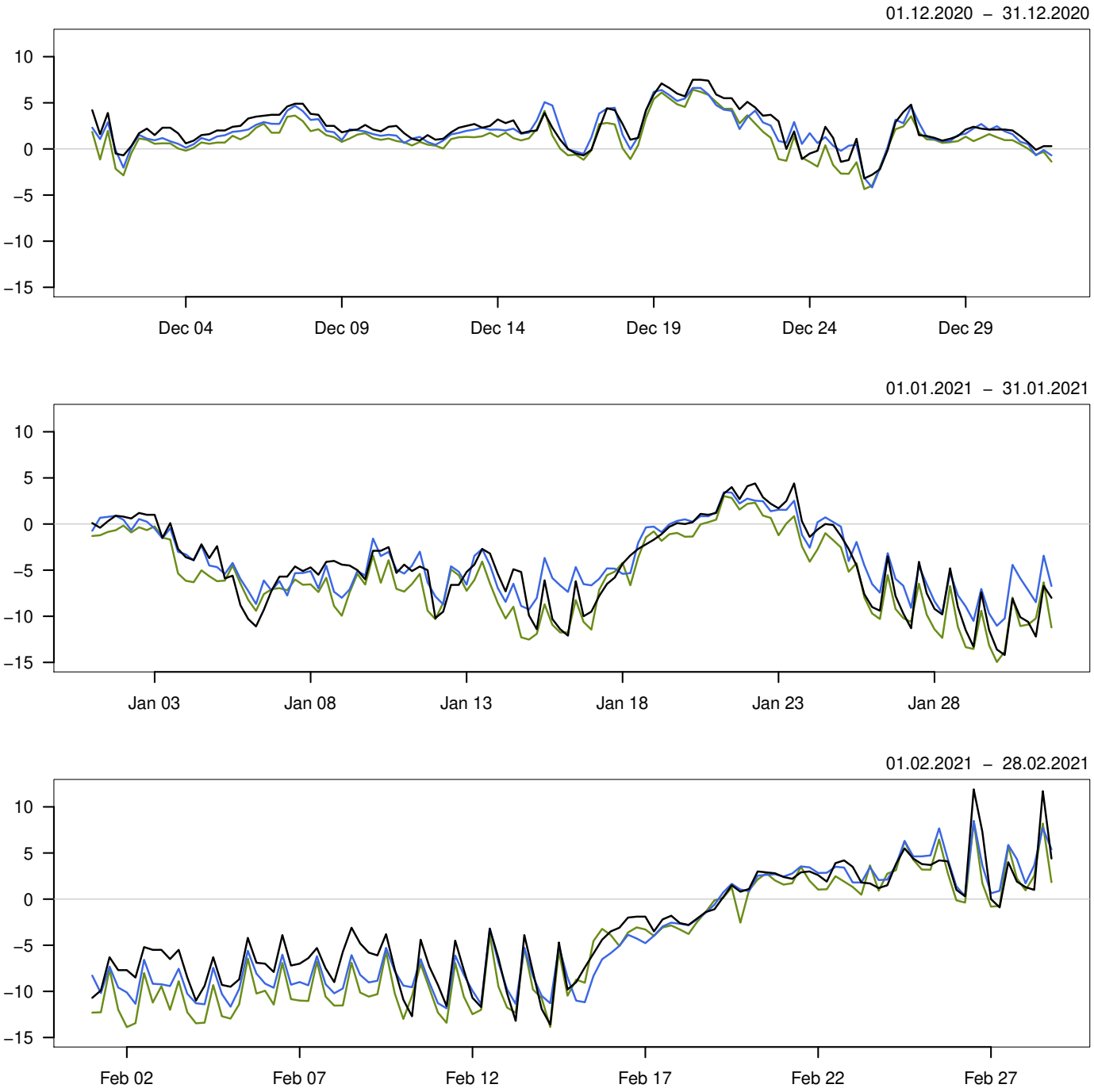


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−8	1.1	8.7	4.1	364
MEPSctrl: 12+18,+24,+30,+36	−7.9	1.3	7.7	3.9	364
ECMWF: 12+18,+24,+30,+36	−8.4	1.3	8.3	4.1	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.2	1.2	1.2	0.9	5.2	364
ECMWF – synop	0.2	1.1	1.1	0.9	4.4	364

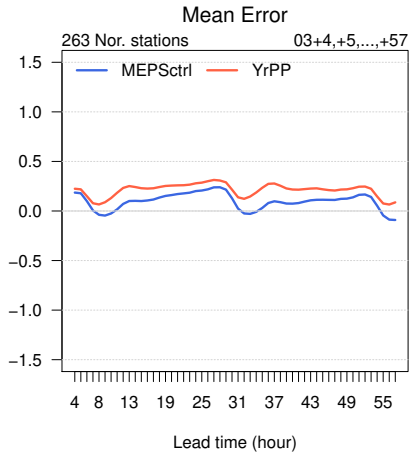
OSLO – BLINDERN

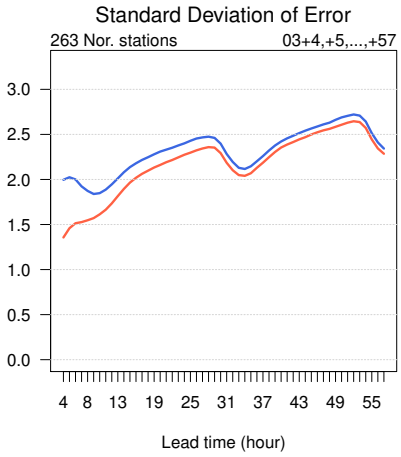


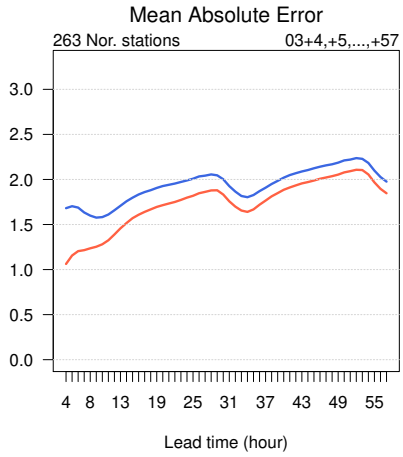
01.12.2020 – 28.02.2021

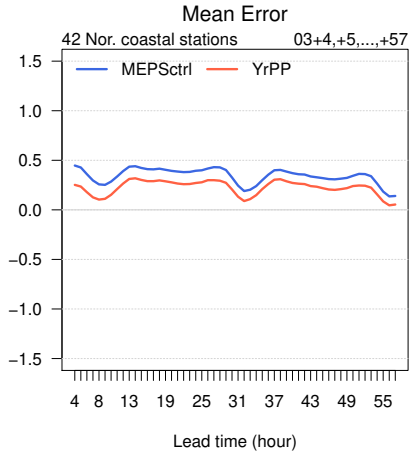
	Min	Mean	Max	Std	N
synop: 00,06,12,18	−14.2	−1.8	11.9	5.1	364
MEPSctrl: 12+18,+24,+30,+36	−11.8	−1.9	8.5	4.9	364
ECMWF: 12+18,+24,+30,+36	−15	−3.1	8.4	5.5	364

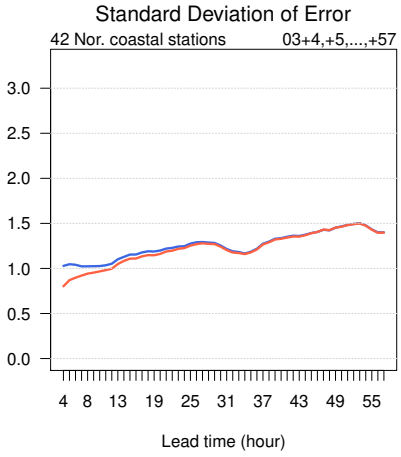
	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−0.1	1.6	1.6	1.2	4.7	364
ECMWF – synop	−1.3	1.5	2	1.6	7.1	364

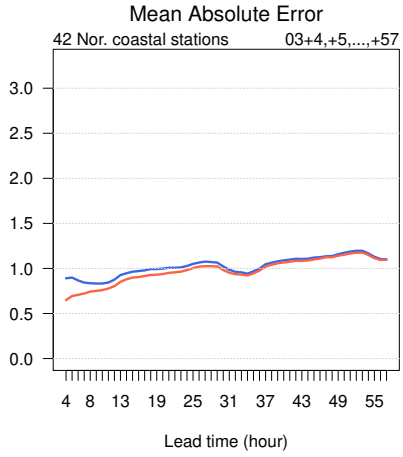

Mean Error
263 Nor. stations
03+4,+5,...,+57
MEPSctrl
YrPP
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
4 8 13 19 25 31 37 43 49 55
Lead time (hour)

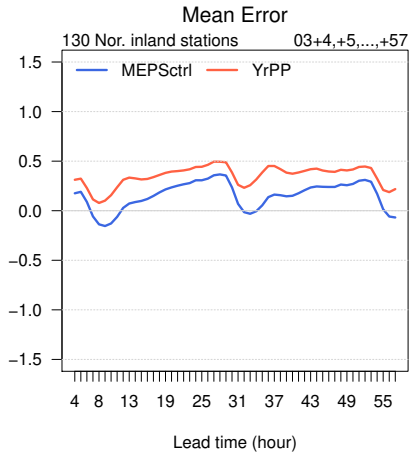

Standard Deviation of Error
263 Nor. stations
03+4,+5,...,+57
3.0
2.5
2.0
1.5
1.0
0.5
0.0
4 8 13 19 25 31 37 43 49 55
Lead time (hour)

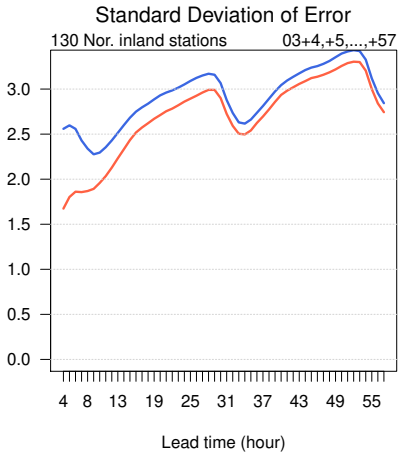

Mean Absolute Error
263 Nor. stations
03+4,+5,...,+57
3.0
2.5
2.0
1.5
1.0
0.5
0.0
4 8 13 19 25 31 37 43 49 55
Lead time (hour)

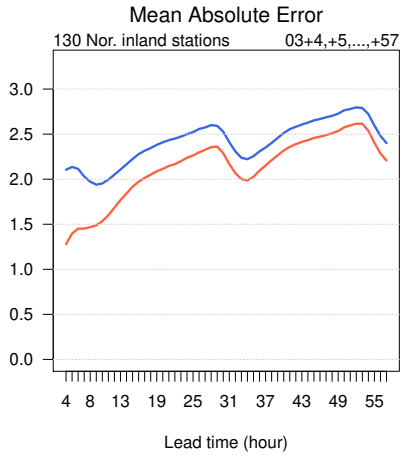

Mean Error
42 Nor. coastal stations
03+4,+5,...,+57
MEPSctrl
YrPP
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
4 8 13 19 25 31 37 43 49 55
Lead time (hour)


Standard Deviation of Error
42 Nor. coastal stations
03+4,+5,...,+57
3.0
2.5
2.0
1.5
1.0
0.5
0.0
4 8 13 19 25 31 37 43 49 55
Lead time (hour)

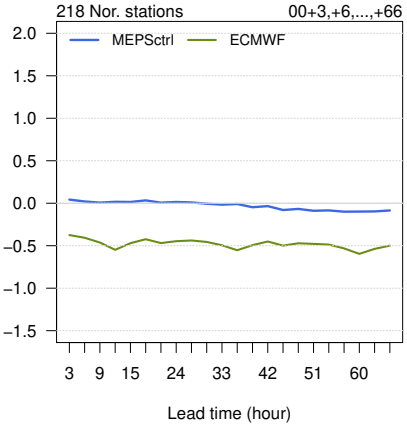

Mean Absolute Error
42 Nor. coastal stations
03+4,+5,...,+57
3.0
2.5
2.0
1.5
1.0
0.5
0.0
4 8 13 19 25 31 37 43 49 55
Lead time (hour)


Mean Error
130 Nor. inland stations
03+4,+5,...,+57
MEPSctrl
YrPP
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
4 8 13 19 25 31 37 43 49 55
Lead time (hour)

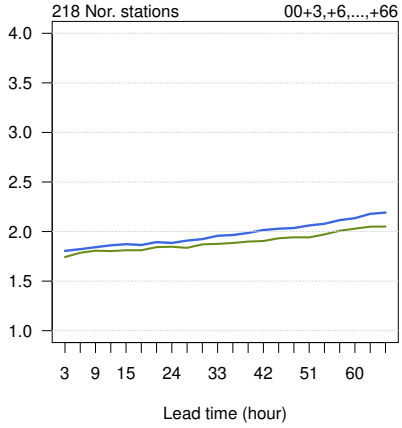

Standard Deviation of Error
130 Nor. inland stations
03+4,+5,...,+57
3.0
2.5
2.0
1.5
1.0
0.5
0.0
4 8 13 19 25 31 37 43 49 55
Lead time (hour)


Mean Absolute Error
130 Nor. inland stations
03+4,+5,...,+57
3.0
2.5
2.0
1.5
1.0
0.5
0.0
4 8 13 19 25 31 37 43 49 55
Lead time (hour)

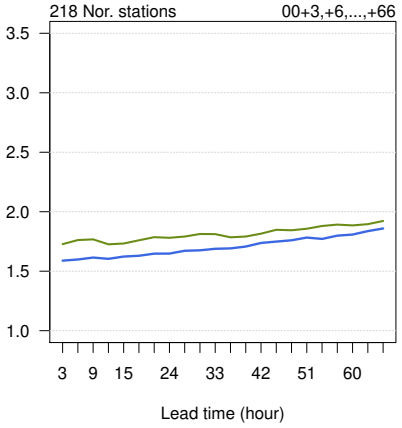
Mean Error



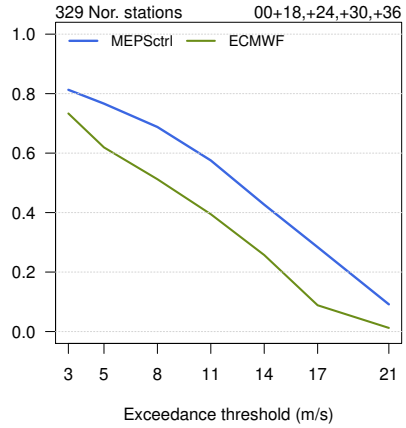
Standard Deviation of Error



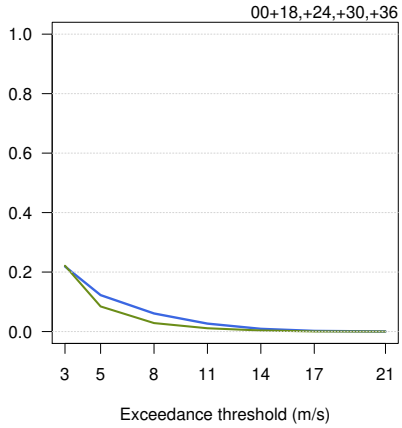
Mean Absolute Error



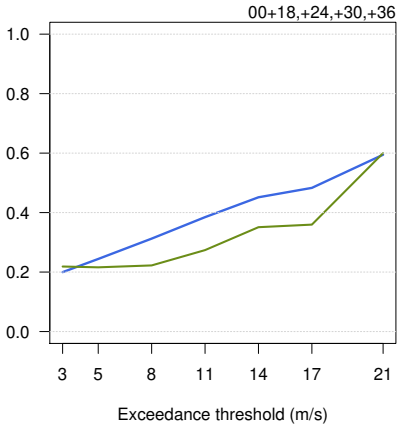
Hit Rate



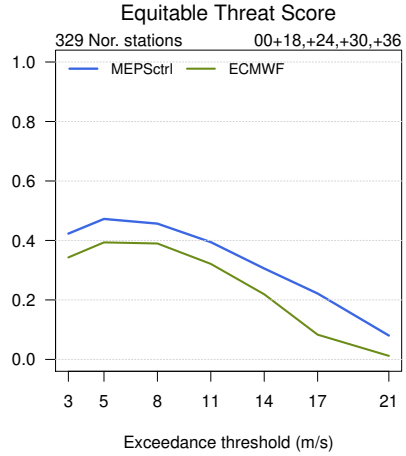
False Alarm Rate



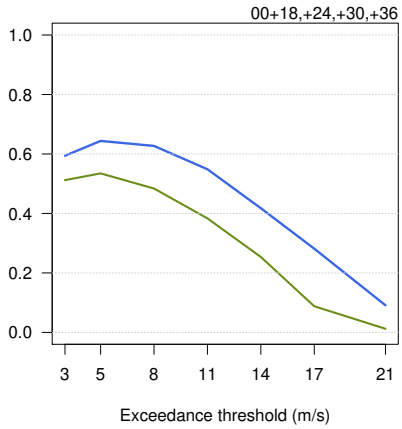
False Alarm Ratio



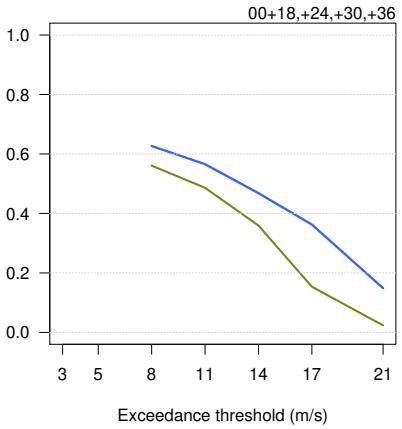
Equitable Threat Score



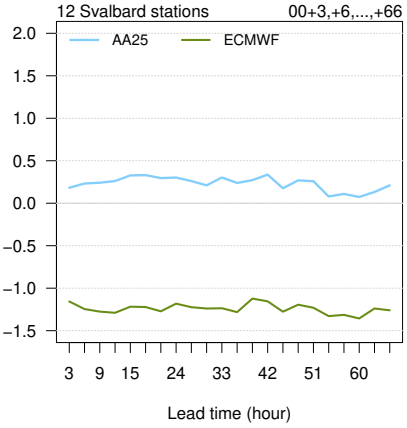
Hansen−Kuiper Skill Score



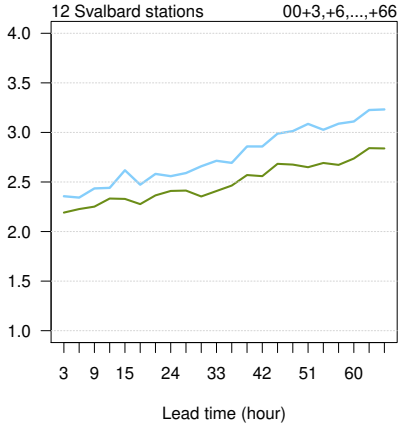
Heidke Skill Score



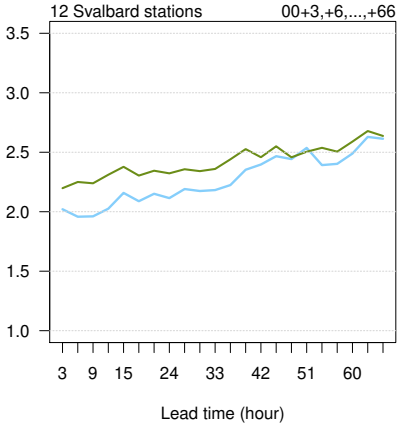
Mean Error



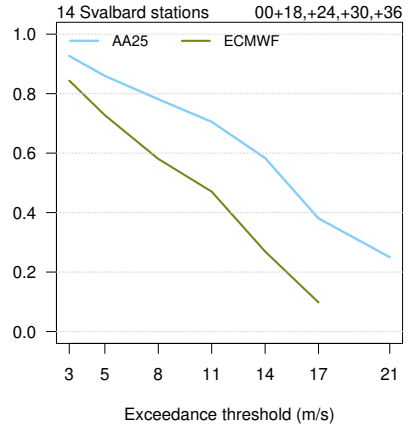
Standard Deviation of Error



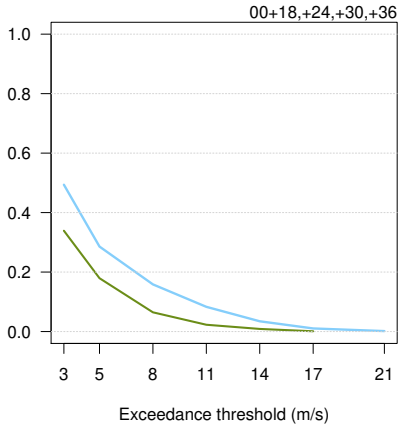
Mean Absolute Error



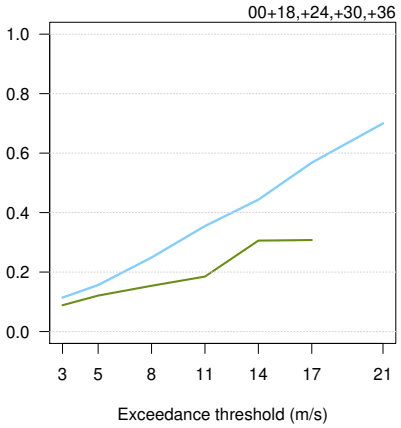
Hit Rate



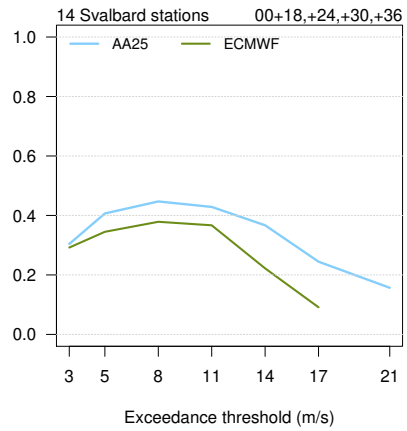
False Alarm Rate



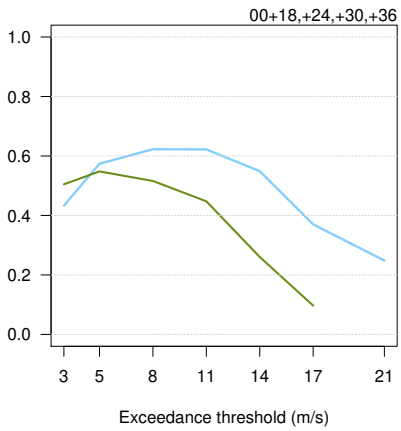
False Alarm Ratio



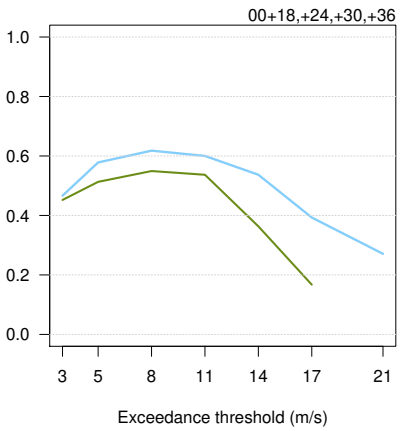
Equitable Threat Score



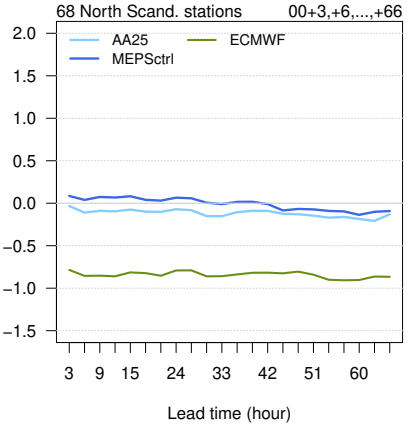
Hansen−Kuiper Skill Score



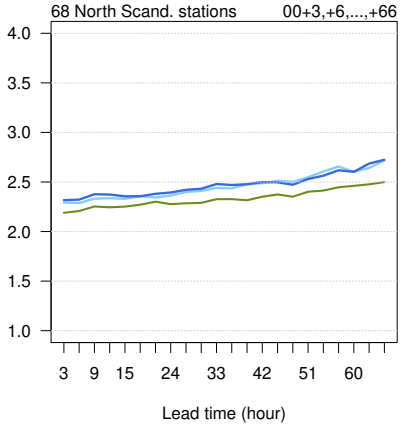
Heidke Skill Score



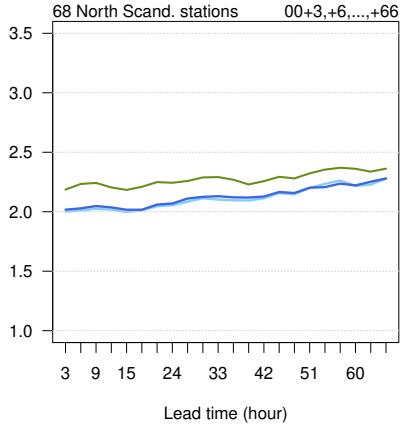
Mean Error



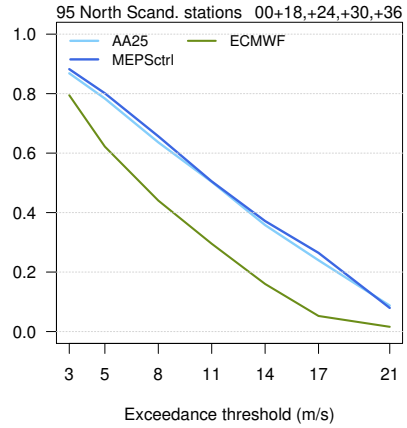
Standard Deviation of Error



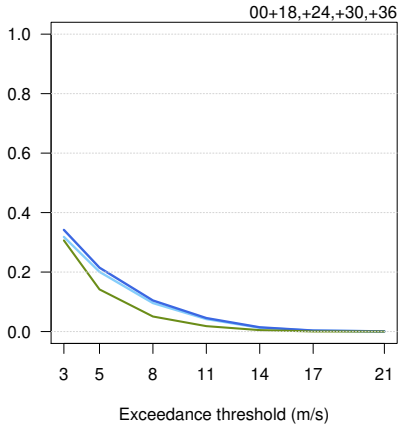
Mean Absolute Error



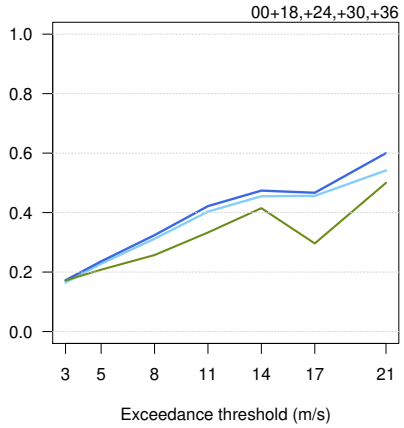
Hit Rate



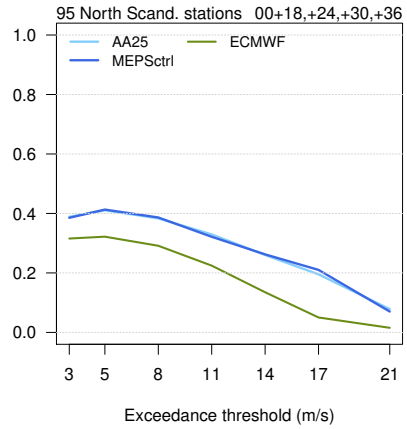
False Alarm Rate



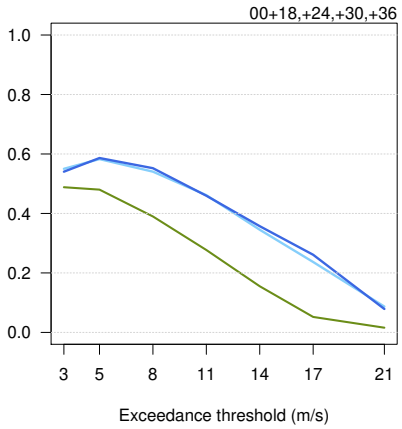
False Alarm Ratio



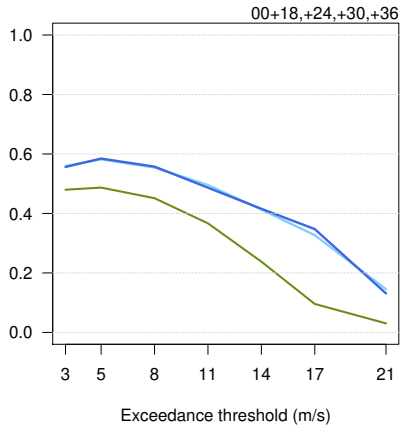
Equitable Threat Score



Hansen−Kuiper Skill Score

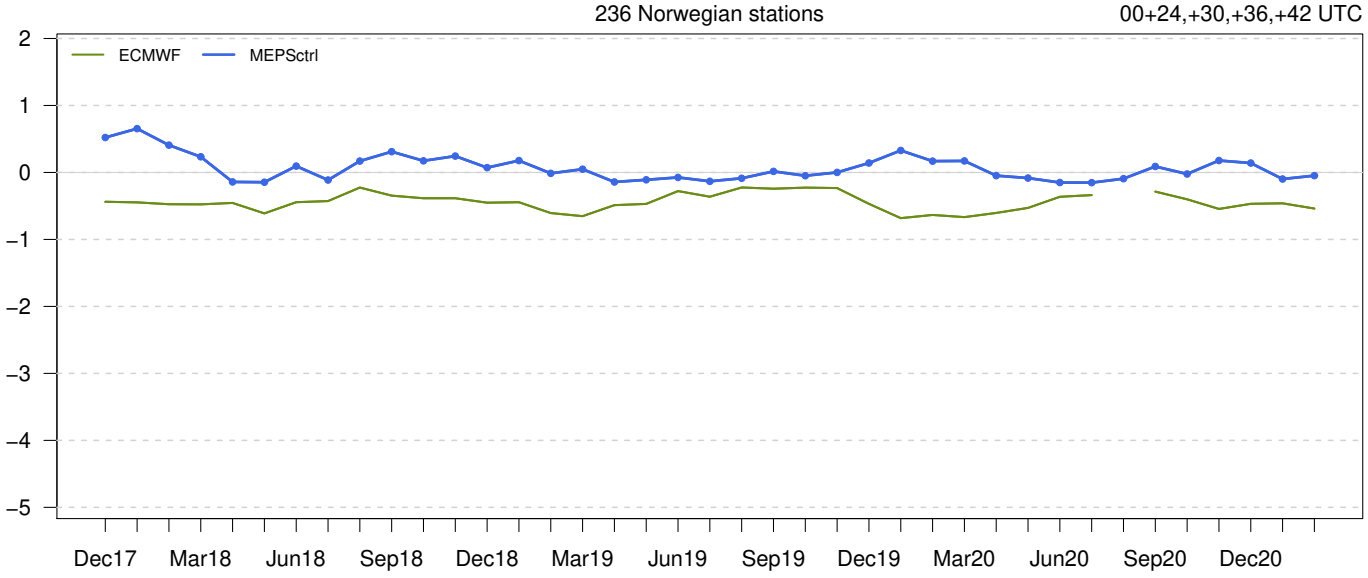


Heidke Skill Score

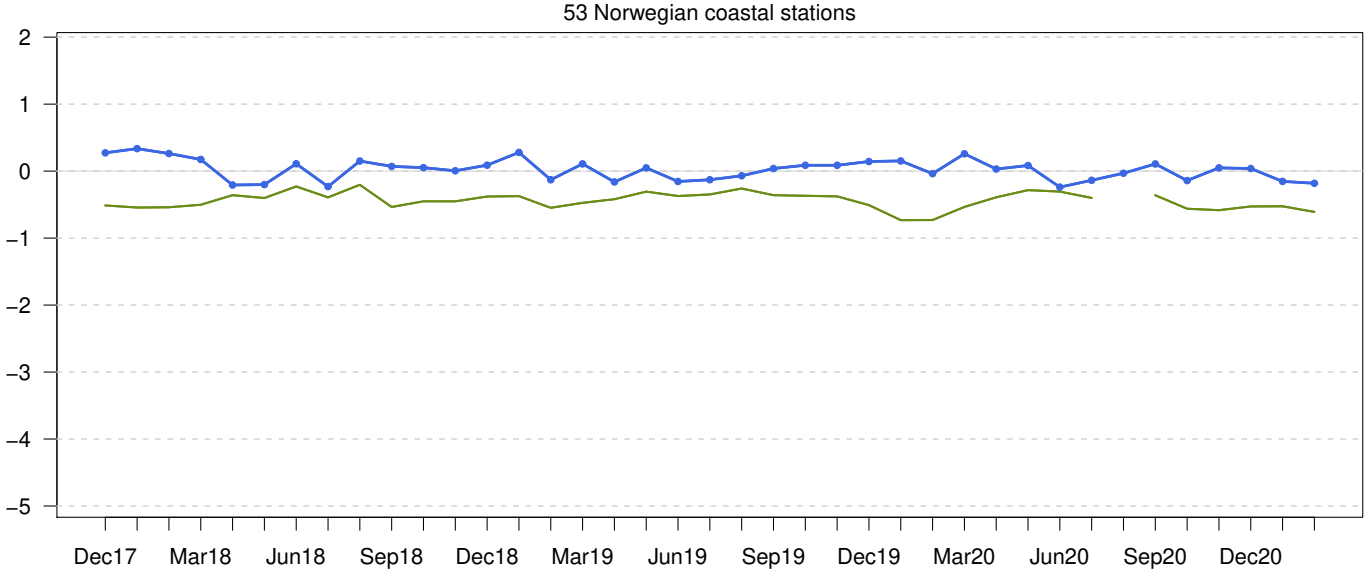


Mean Error

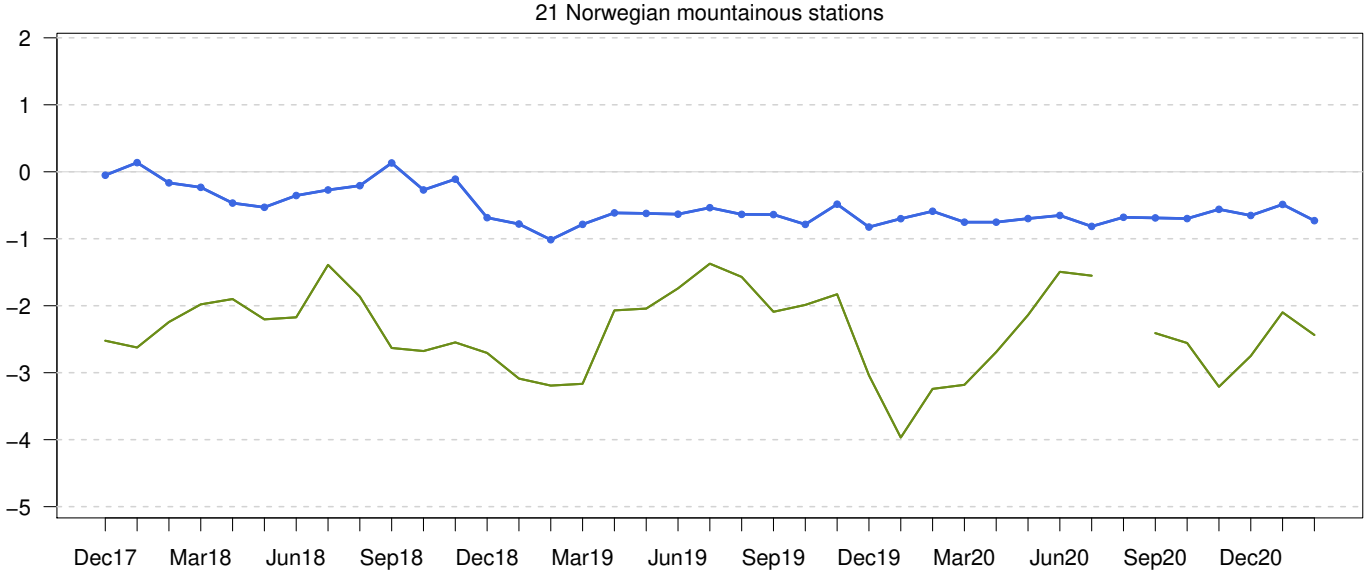
236 Norwegian stations 00+24,+30,+36,+42 UTC



53 Norwegian coastal stations

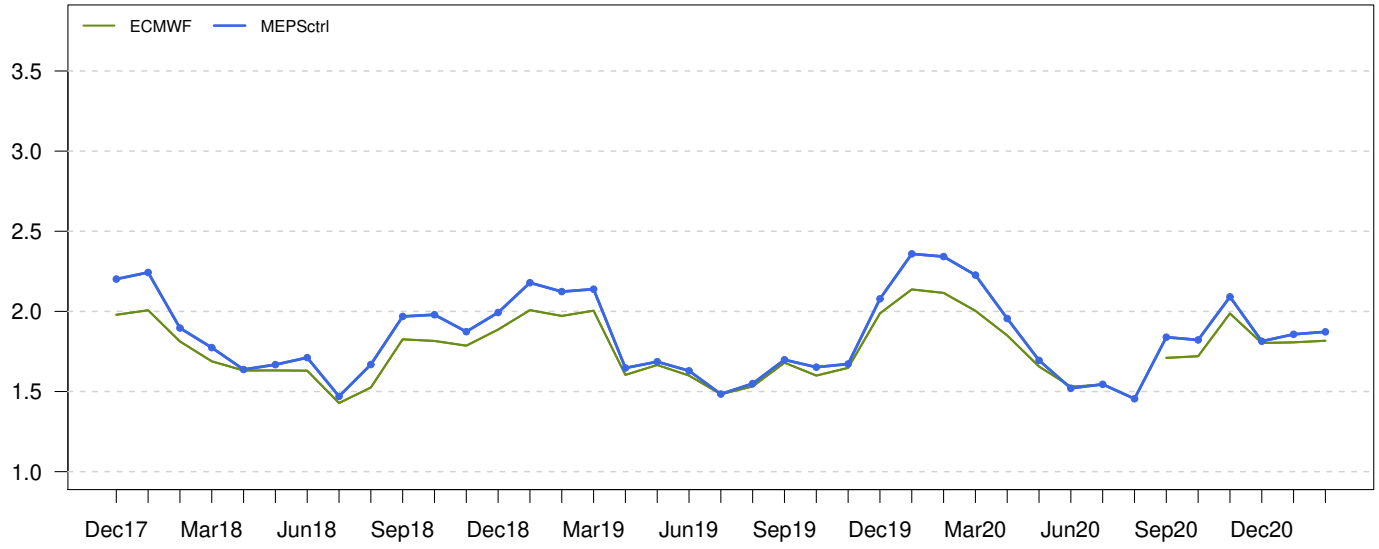


21 Norwegian mountainous stations

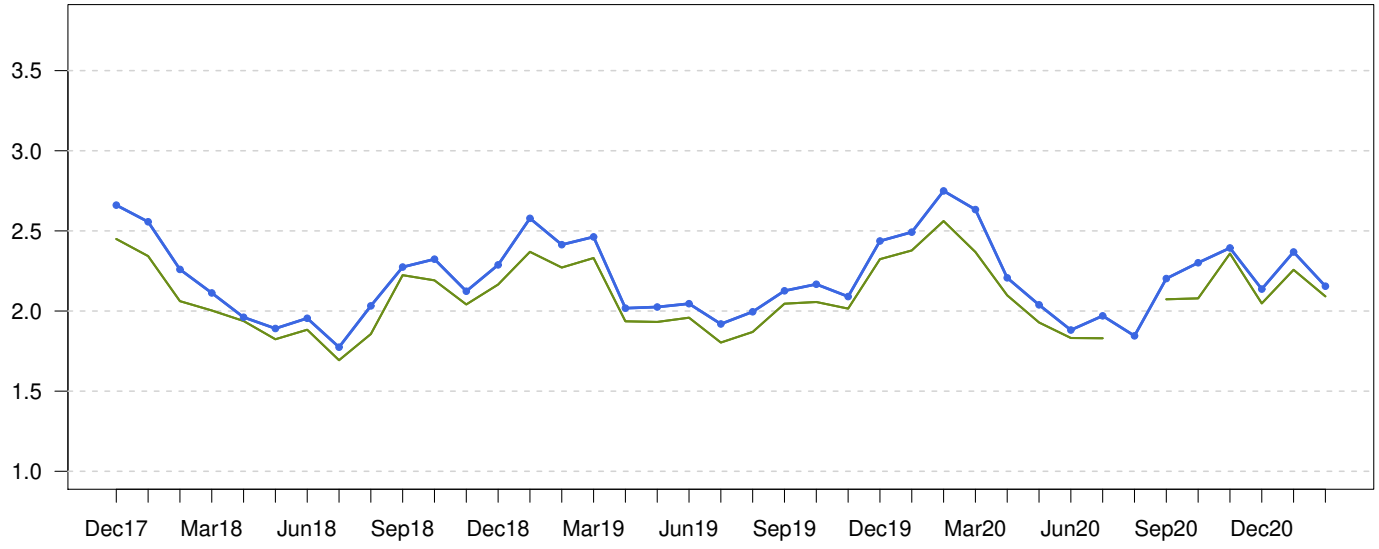


Standard Deviation of Error

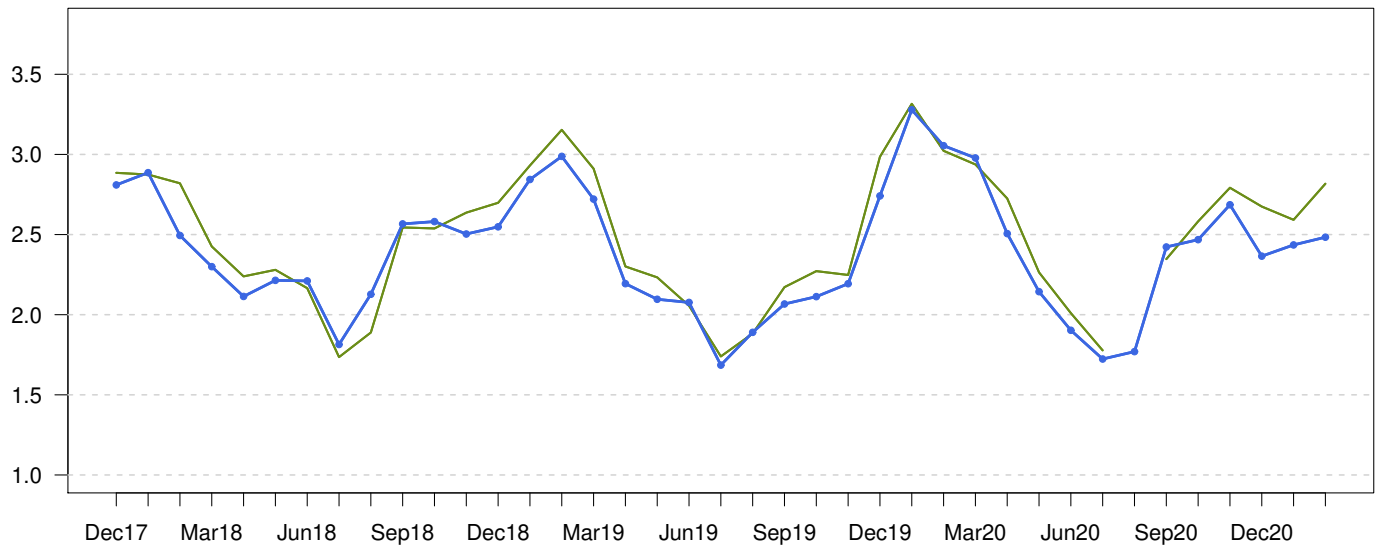
236 Norwegian stations 00+24,+30,+36,+42 UTC



53 Norwegian coastal stations

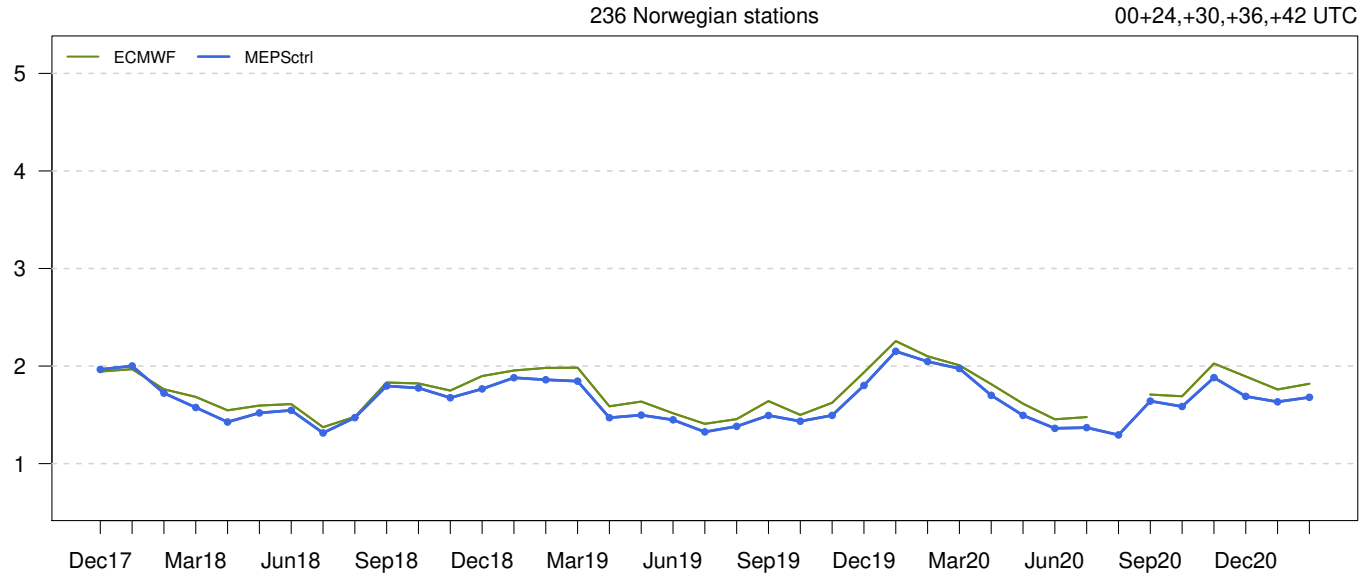


21 Norwegian mountainous stations

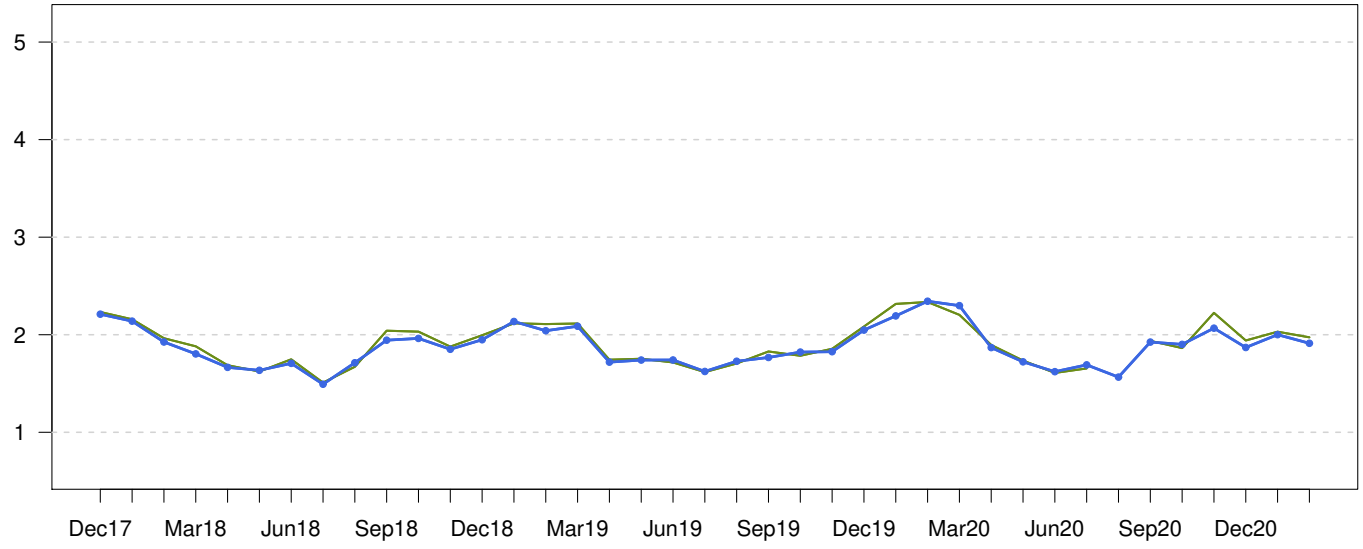


Mean Absolute Error

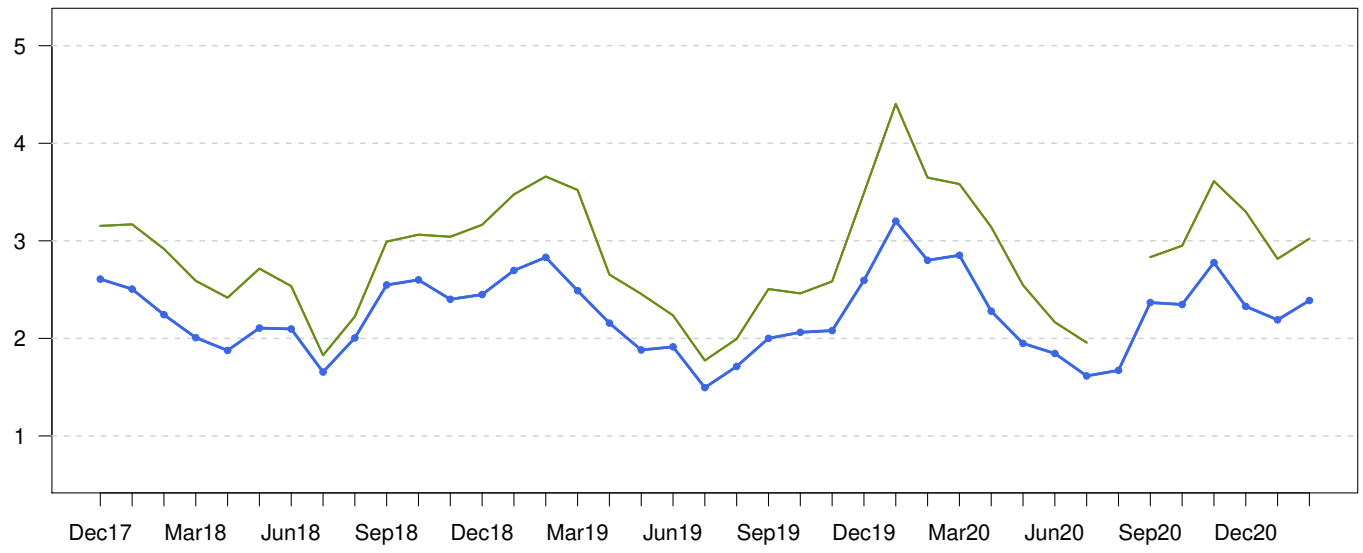
236 Norwegian stations 00+24,+30,+36,+42 UTC



53 Norwegian coastal stations

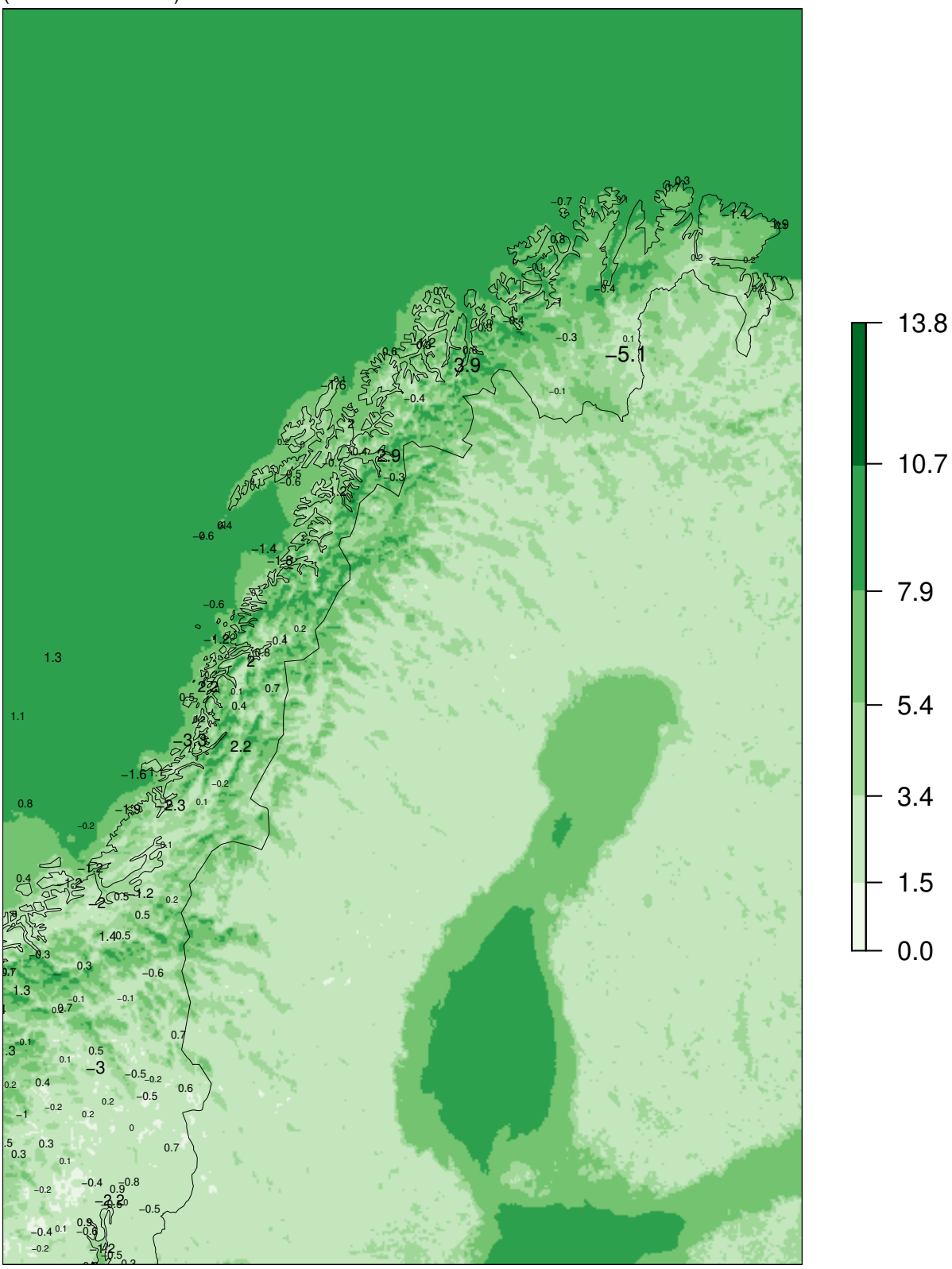


21 Norwegian mountainous stations



MEPSctrl 00+12

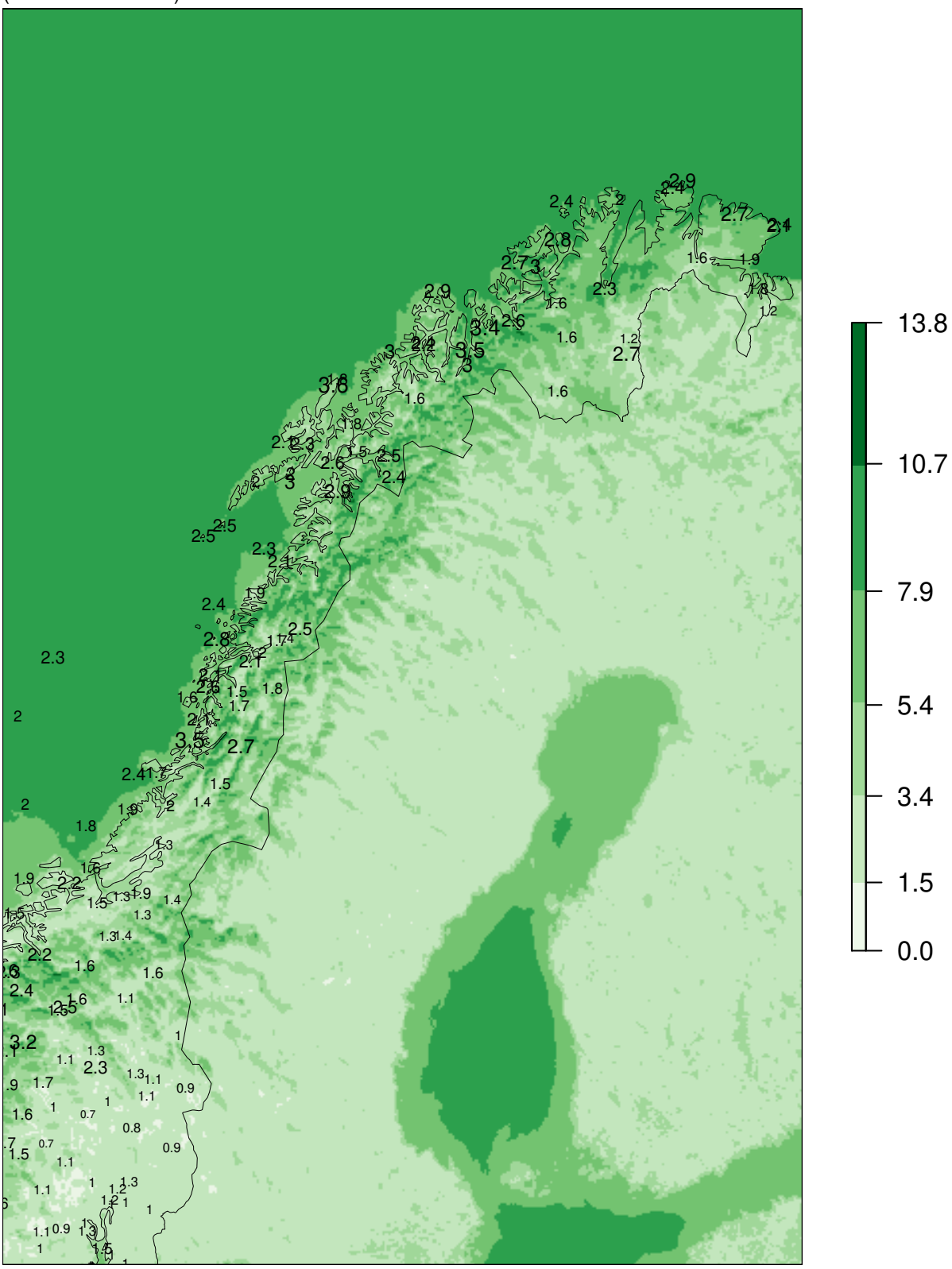
ME at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+12

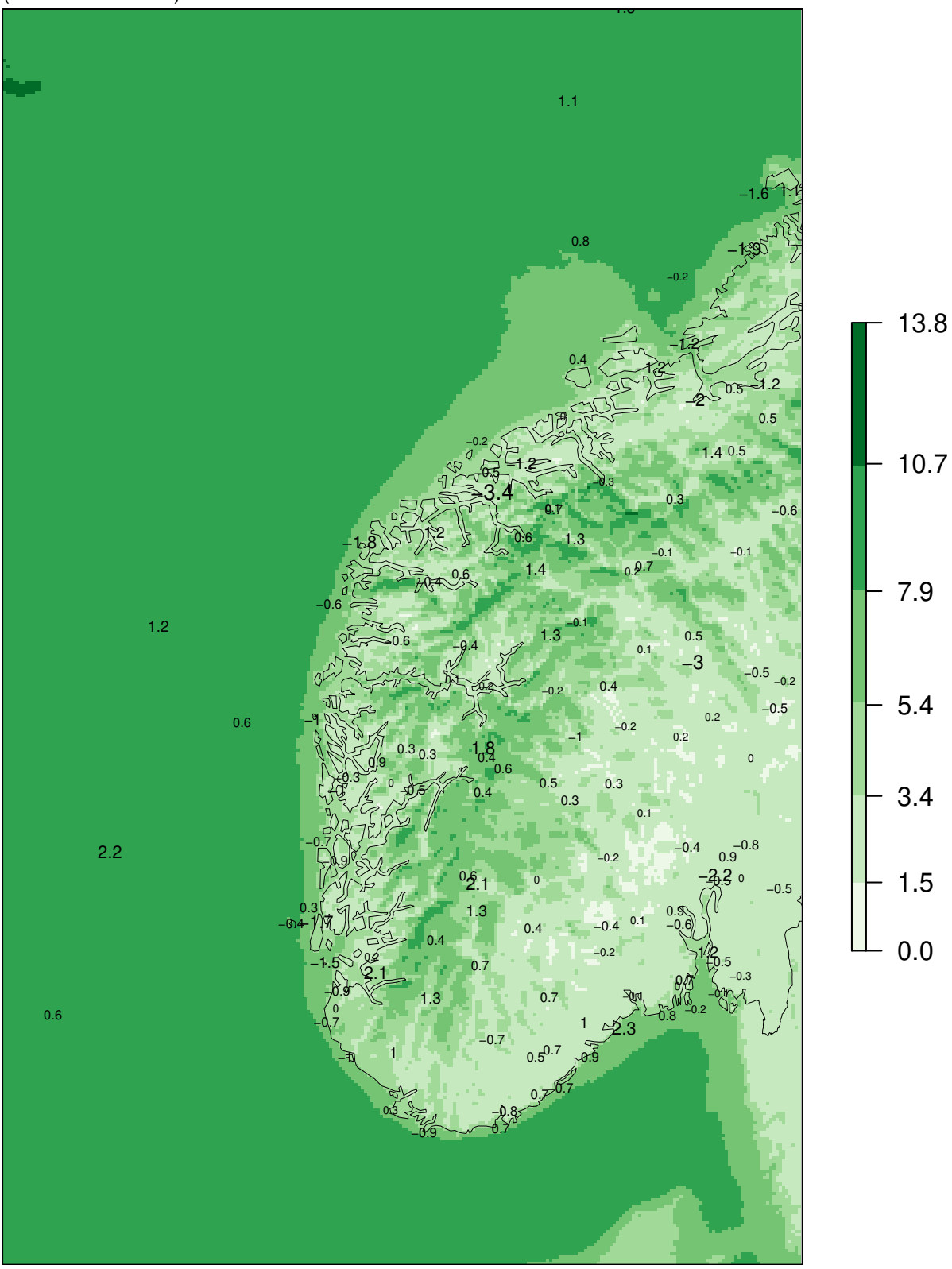
SDE at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+12

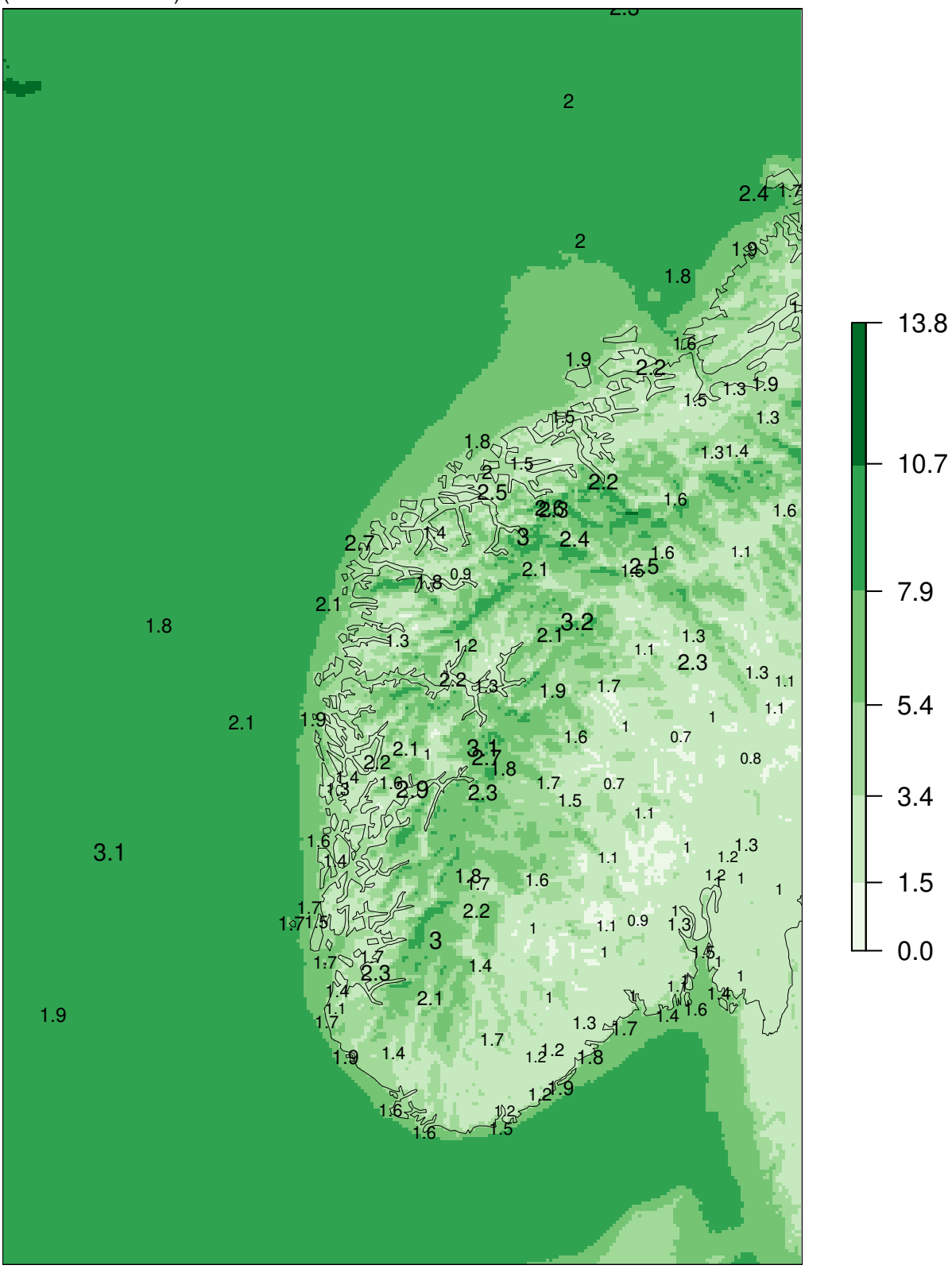
ME at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+12

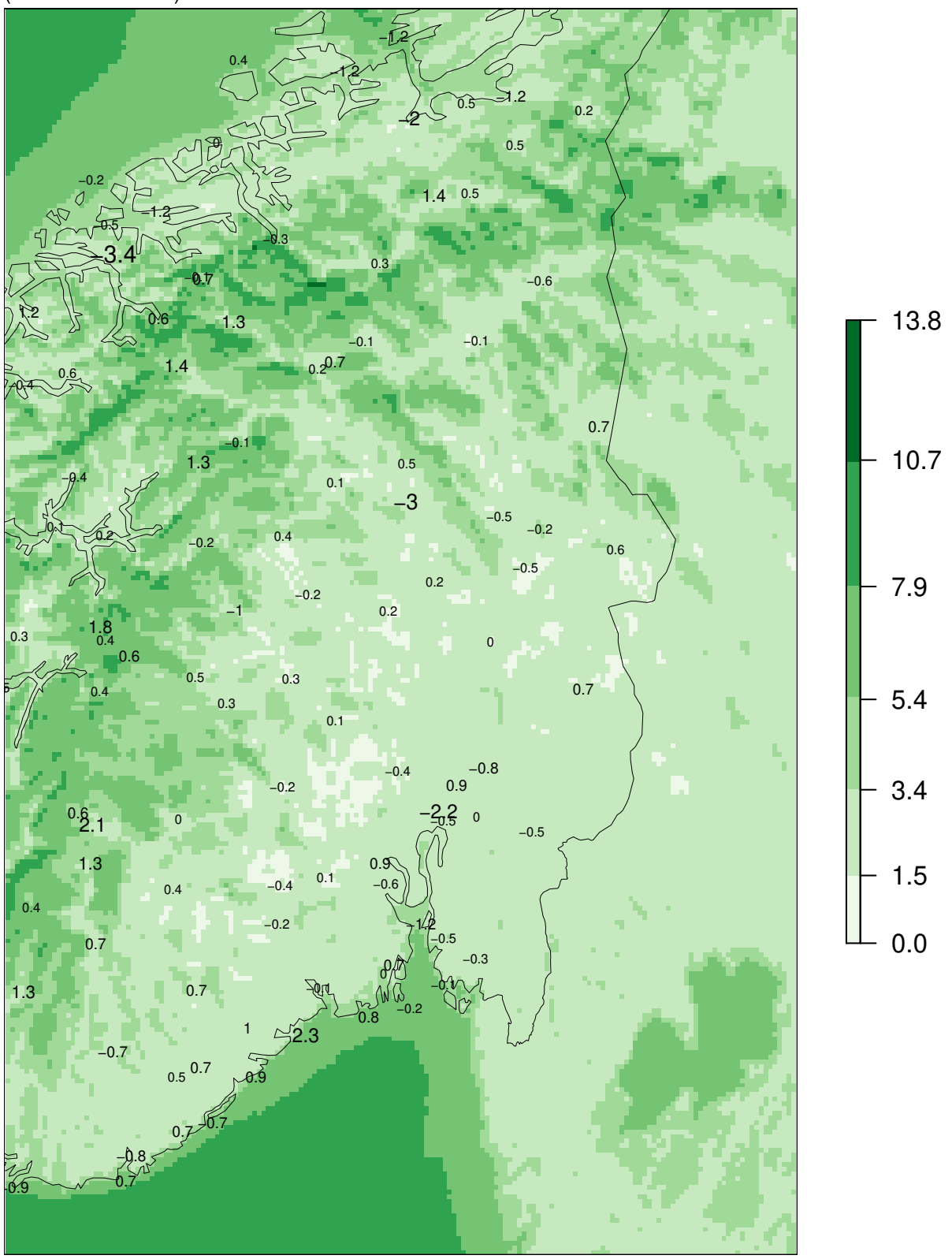
SDE at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+12

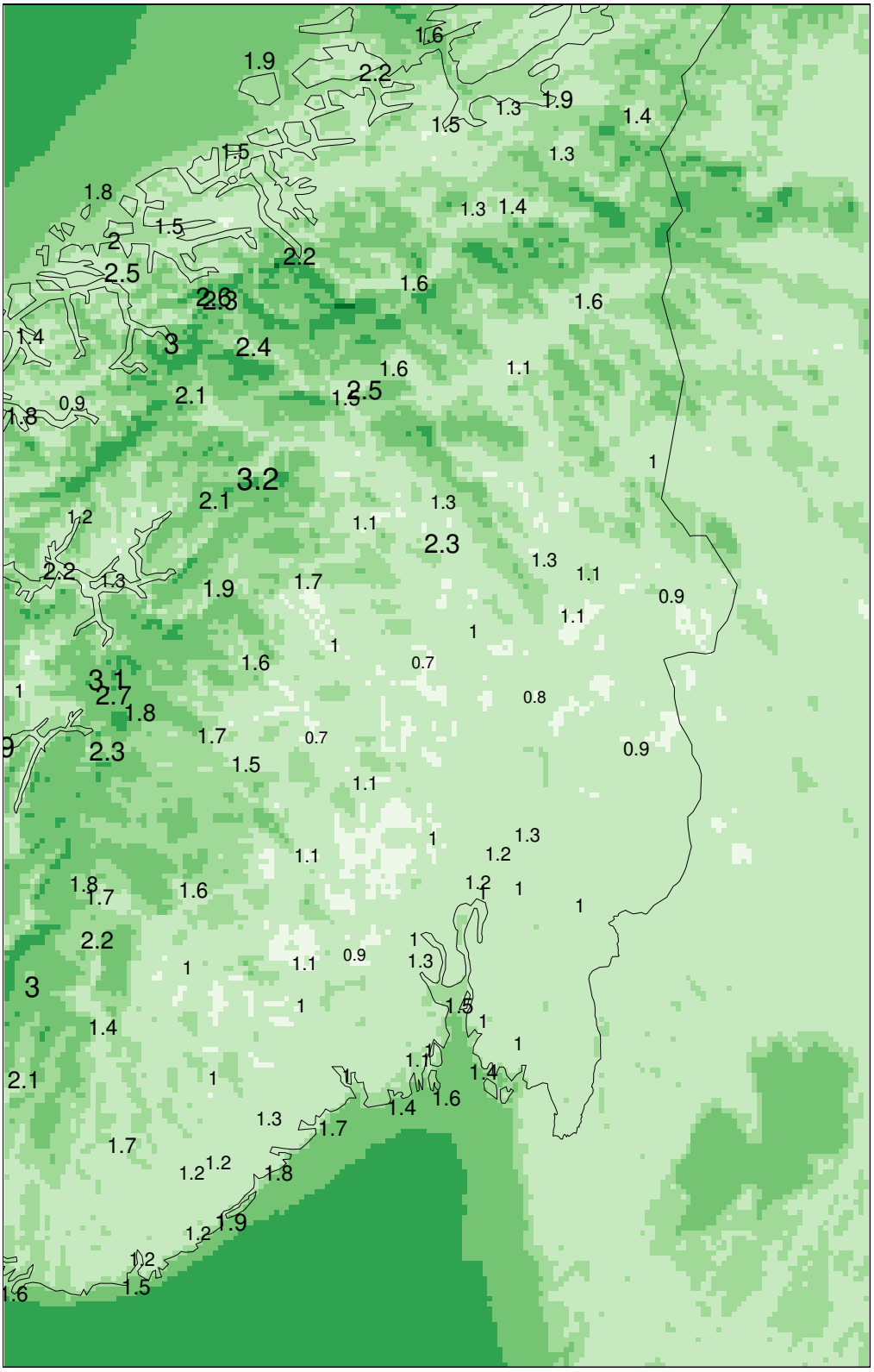
ME at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

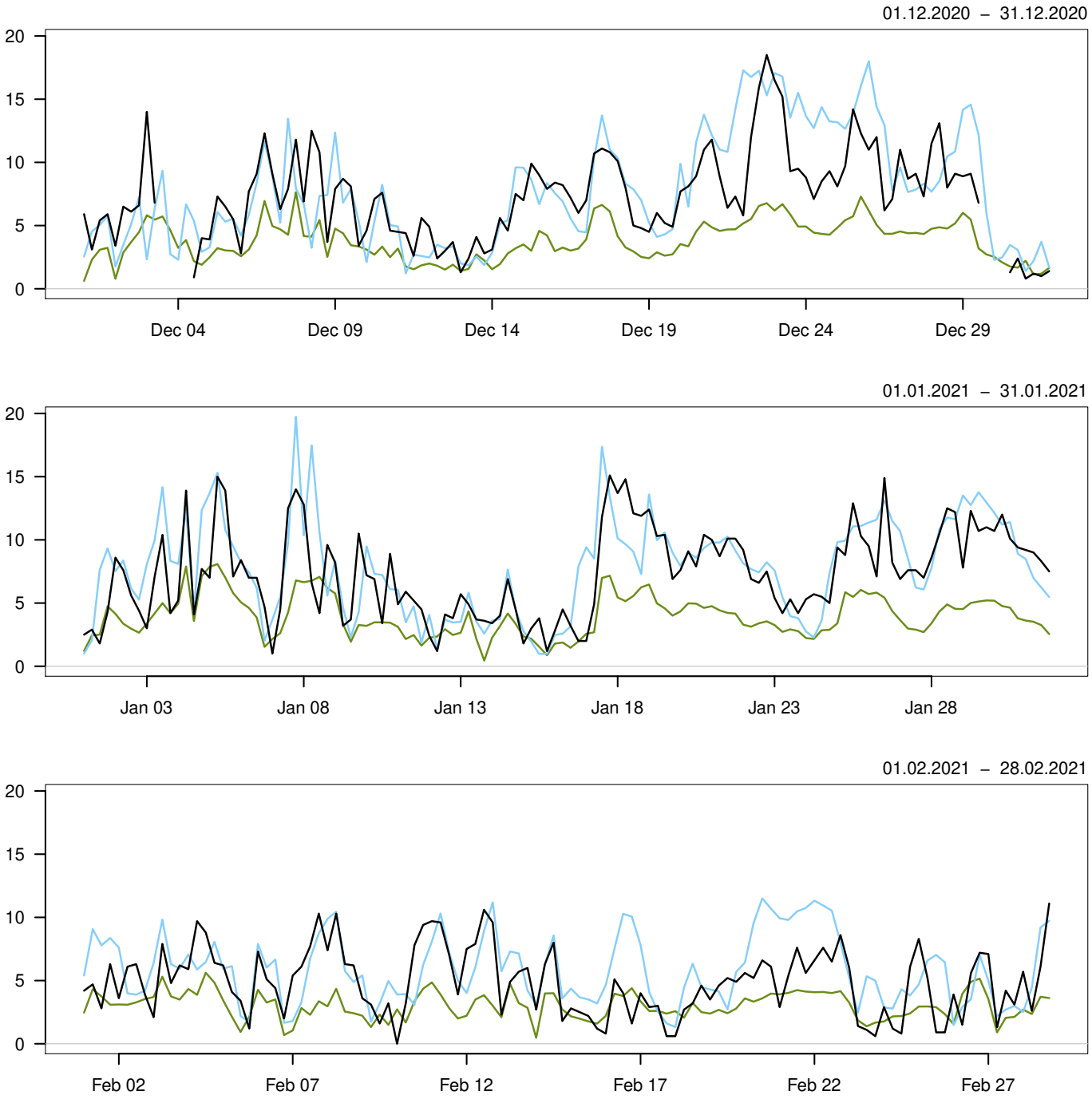
MEPSctrl 00+12

SDE at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

SVALBARD LUFTHAVN

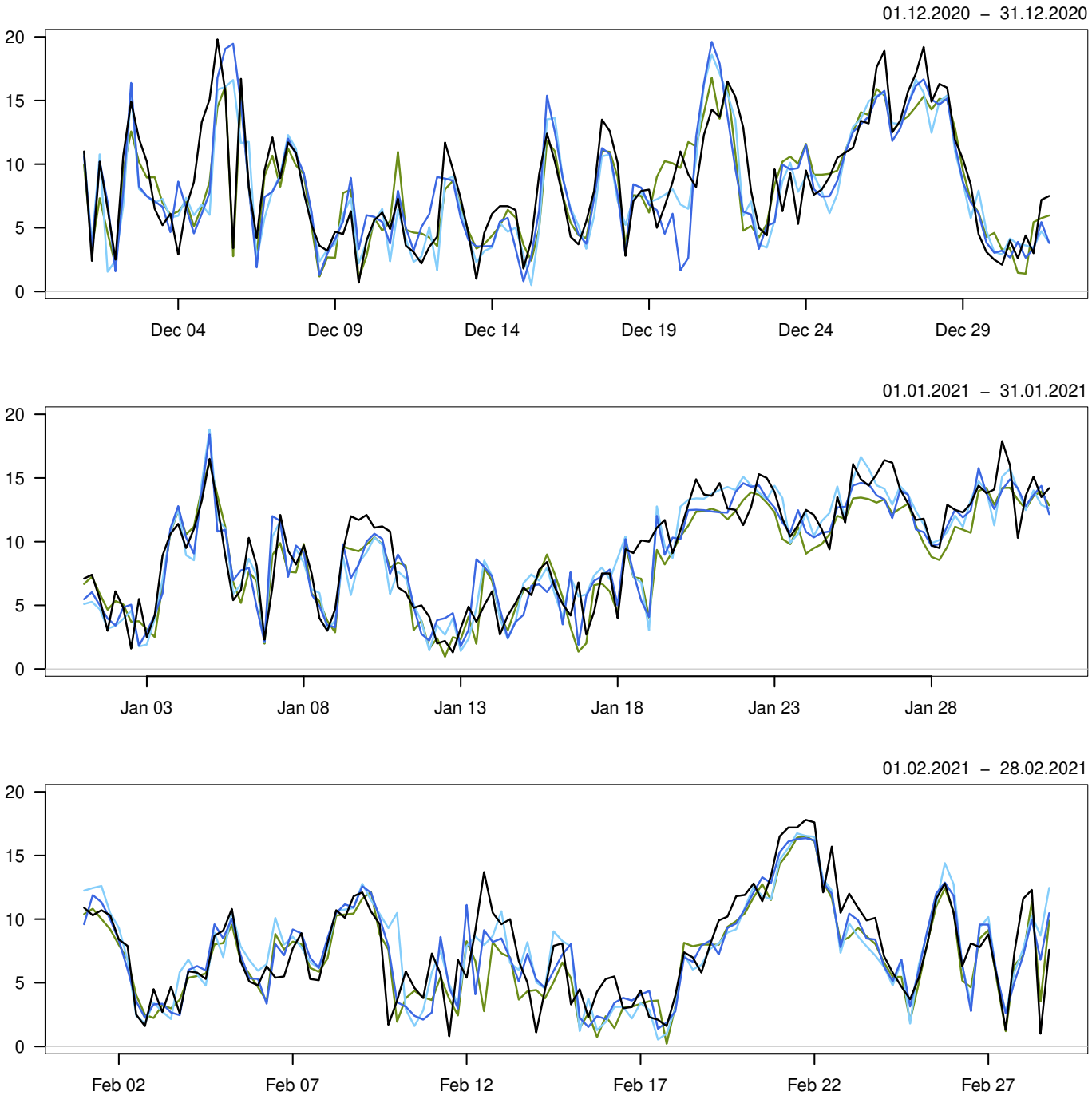


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0	6.5	18.5	3.5	357
AA25: 12+18,+24,+30,+36	1	7.2	19.7	3.9	364
ECMWF: 12+18,+24,+30,+36	0.4	3.6	8.1	1.5	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AA25 – synop	0.7	2.8	2.9	2.2	11.7	357
ECMWF – synop	–2.9	2.5	3.9	3.2	11.7	357

BJØRNØYA

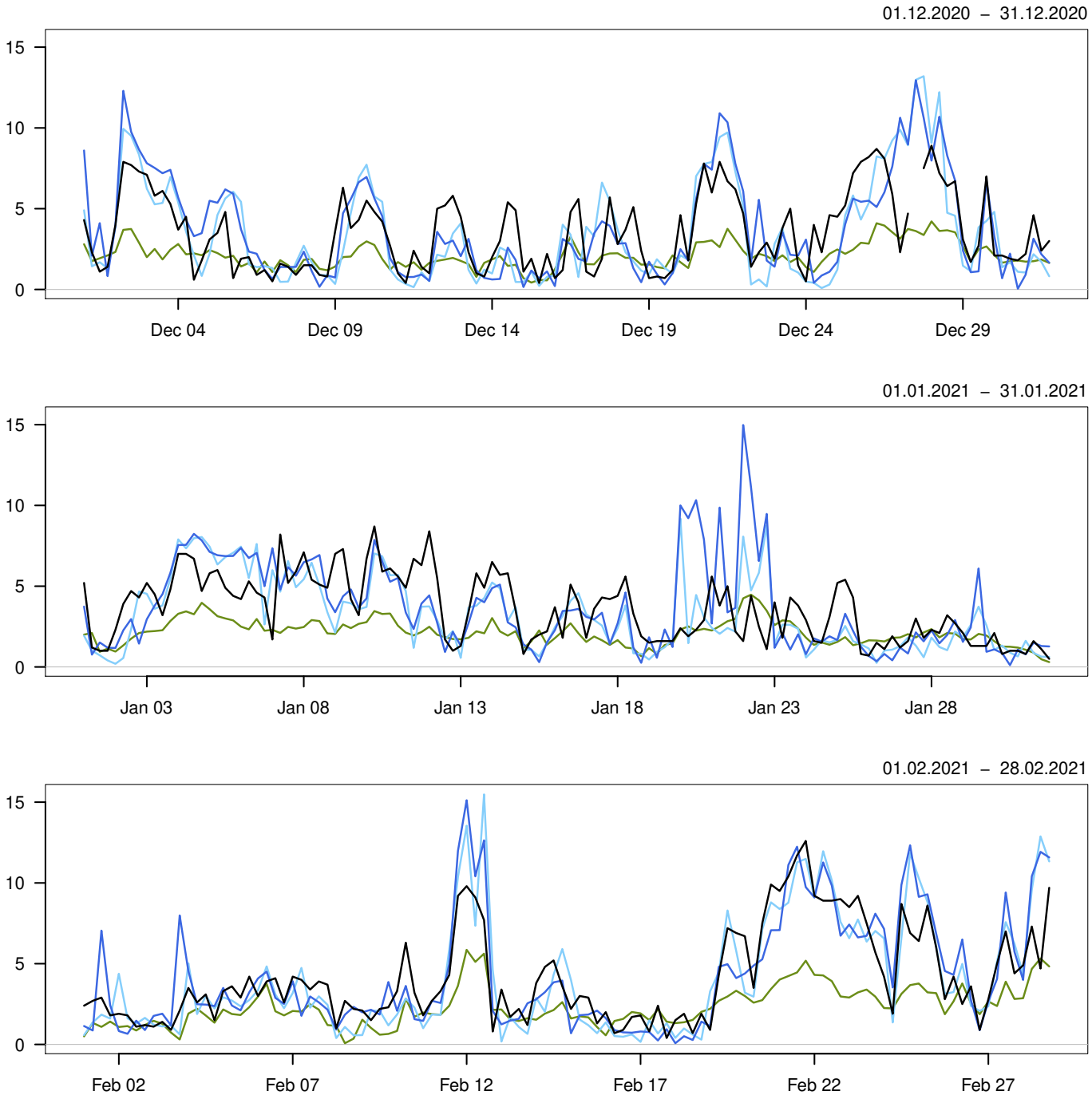


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.7	8.6	19.8	4.2	364
MEPSctrl: 12+18,+24,+30,+36	0.8	8.3	19.6	4.1	364
AA25: 12+18,+24,+30,+36	0.5	8.3	18.8	4.2	364
ECMWF: 12+18,+24,+30,+36	0.2	8	16.8	3.8	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−0.3	2.4	2.4	1.8	16.1	364
AA25 – synop	−0.3	2.4	2.4	1.7	13.2	364
ECMWF – synop	−0.6	2	2	1.5	10.9	364

TROMSØ



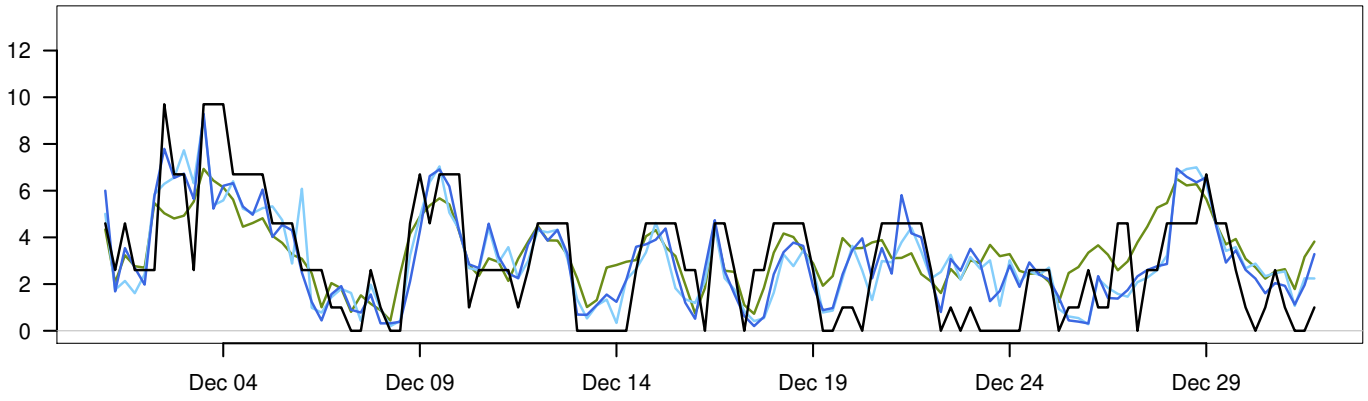
01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.4	3.8	12.6	2.5	363
MEPSctrl: 12+18,+24,+30,+36	0	3.9	15.1	3.2	364
AA25: 12+18,+24,+30,+36	0.1	3.6	15.5	3.1	364
ECMWF: 12+18,+24,+30,+36	0.1	2.2	6.4	1	364

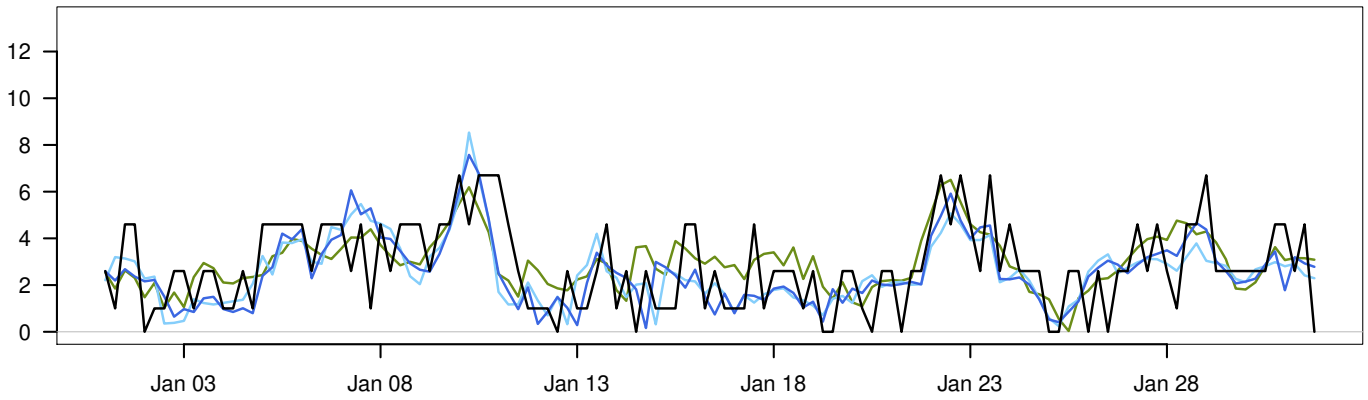
	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.1	2.3	2.3	1.6	13.4	363
AA25 – synop	−0.2	2.1	2.1	1.5	8.2	363
ECMWF – synop	−1.6	1.9	2.5	1.9	7.4	363

KAUTOKEINO

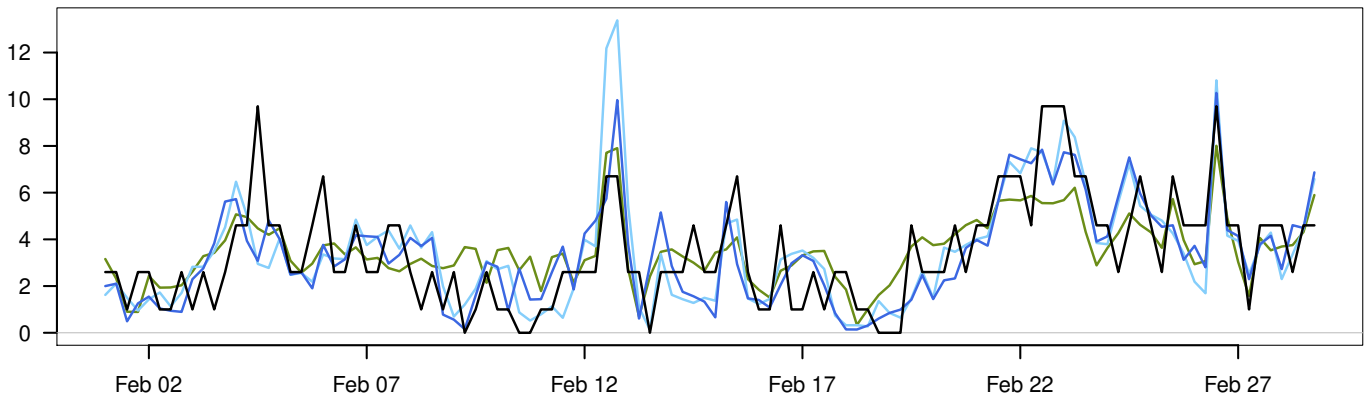
01.12.2020 – 31.12.2020



01.01.2021 – 31.01.2021



01.02.2021 – 28.02.2021

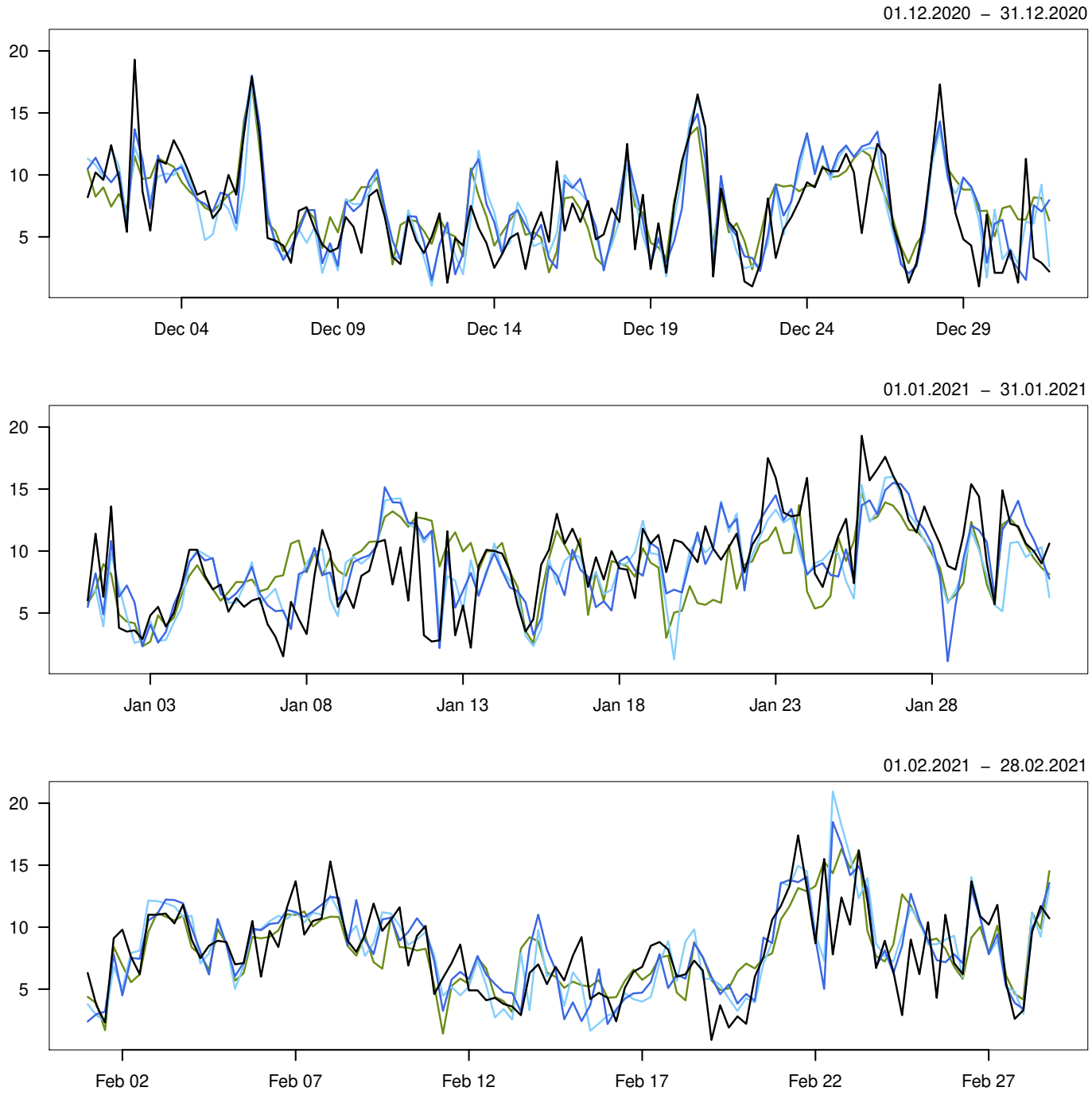


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0	3.1	9.7	2.2	364
MEPSctrl: 12+18,+24,+30,+36	0.1	3	12.2	2	364
AA25: 12+18,+24,+30,+36	0.1	3.1	13.4	2	364
ECMWF: 12+18,+24,+30,+36	0	3.3	8.5	1.4	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0	1.7	1.7	1.3	7.6	364
AA25 – synop	0	1.8	1.8	1.4	6.8	364
ECMWF – synop	0.2	1.7	1.7	1.4	5.2	364

SLETTNES FYR



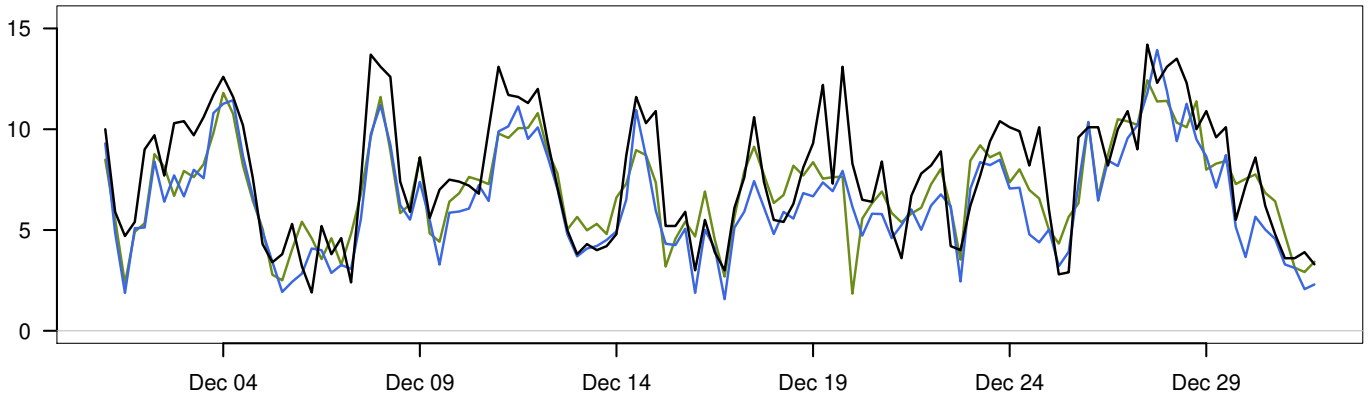
01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.9	8.1	19.3	3.8	364
MEPSctrl: 12+18,+24,+30,+36	1.1	8.3	18.5	3.4	364
AA25: 12+18,+24,+30,+36	1.1	8.1	20.9	3.5	364
ECMWF: 12+18,+24,+30,+36	1.4	8.2	17.3	2.9	364

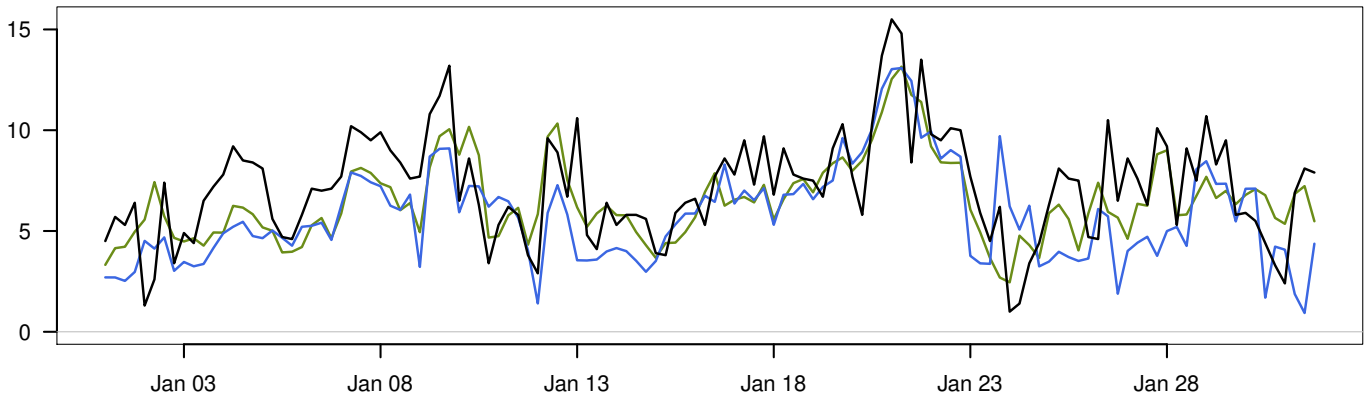
	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.2	2.7	2.7	2	10.7	364
AA25 – synop	0	2.8	2.8	2.1	13.1	364
ECMWF – synop	0.1	2.8	2.8	2.1	9.8	364

ØRLAND III

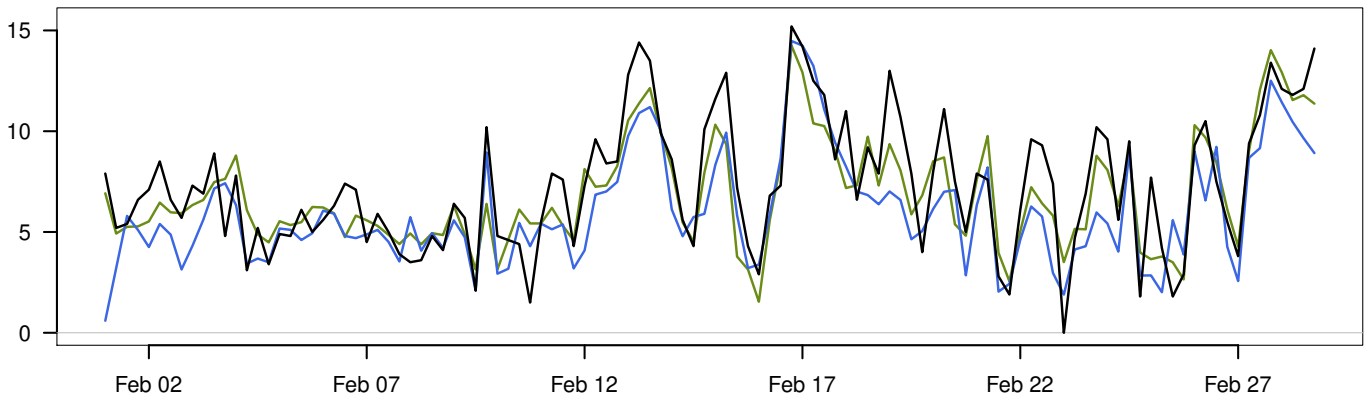
01.12.2020 – 31.12.2020



01.01.2021 – 31.01.2021



01.02.2021 – 28.02.2021

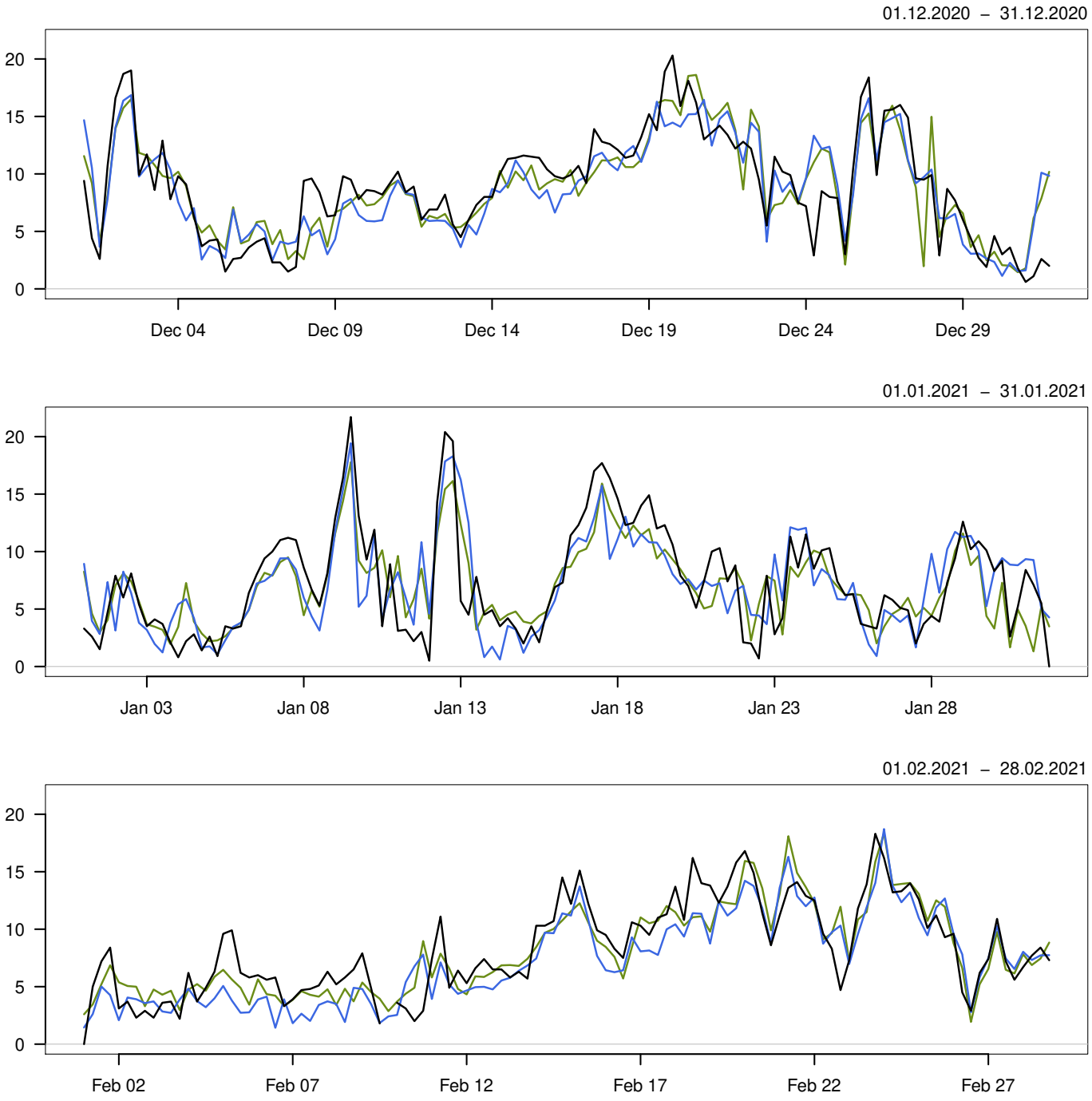


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0	7.4	15.5	3	364
MEPSctrl: 12+18,+24,+30,+36	0.6	6.1	14.5	2.6	364
ECMWF: 12+18,+24,+30,+36	1.5	6.8	14.4	2.4	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−1.3	1.9	2.3	1.9	7.3	364
ECMWF – synop	−0.6	1.7	1.9	1.5	6.5	364

YTTERØYANE FYR

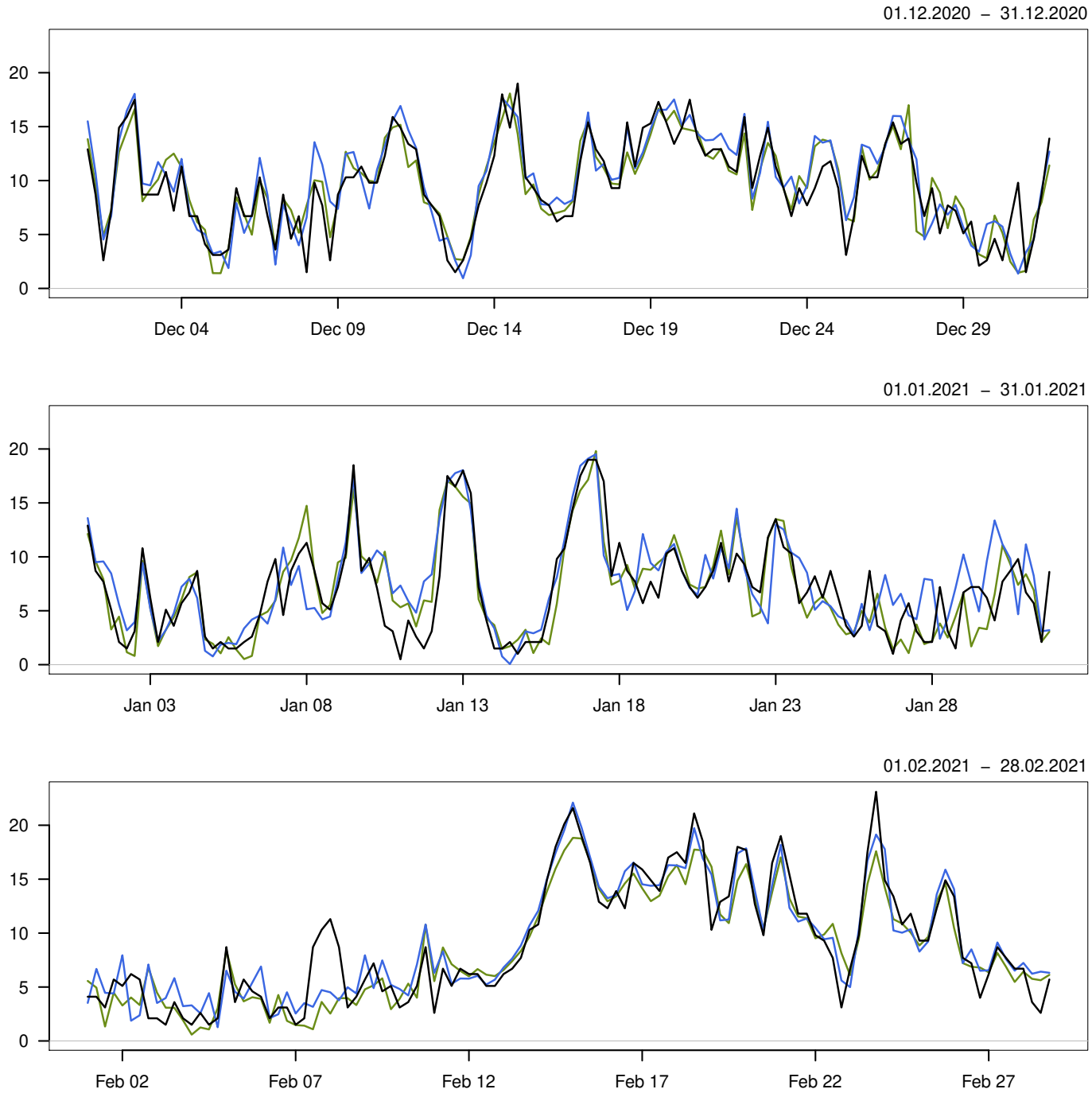


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0	8.2	21.7	4.4	363
MEPSctrl: 12+18,+24,+30,+36	0.6	7.7	19.4	4	364
ECMWF: 12+18,+24,+30,+36	1.3	8	18.6	3.8	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−0.5	2.6	2.6	2.1	10.6	363
ECMWF – synop	−0.2	2.4	2.4	1.8	8.2	363

TROLL A

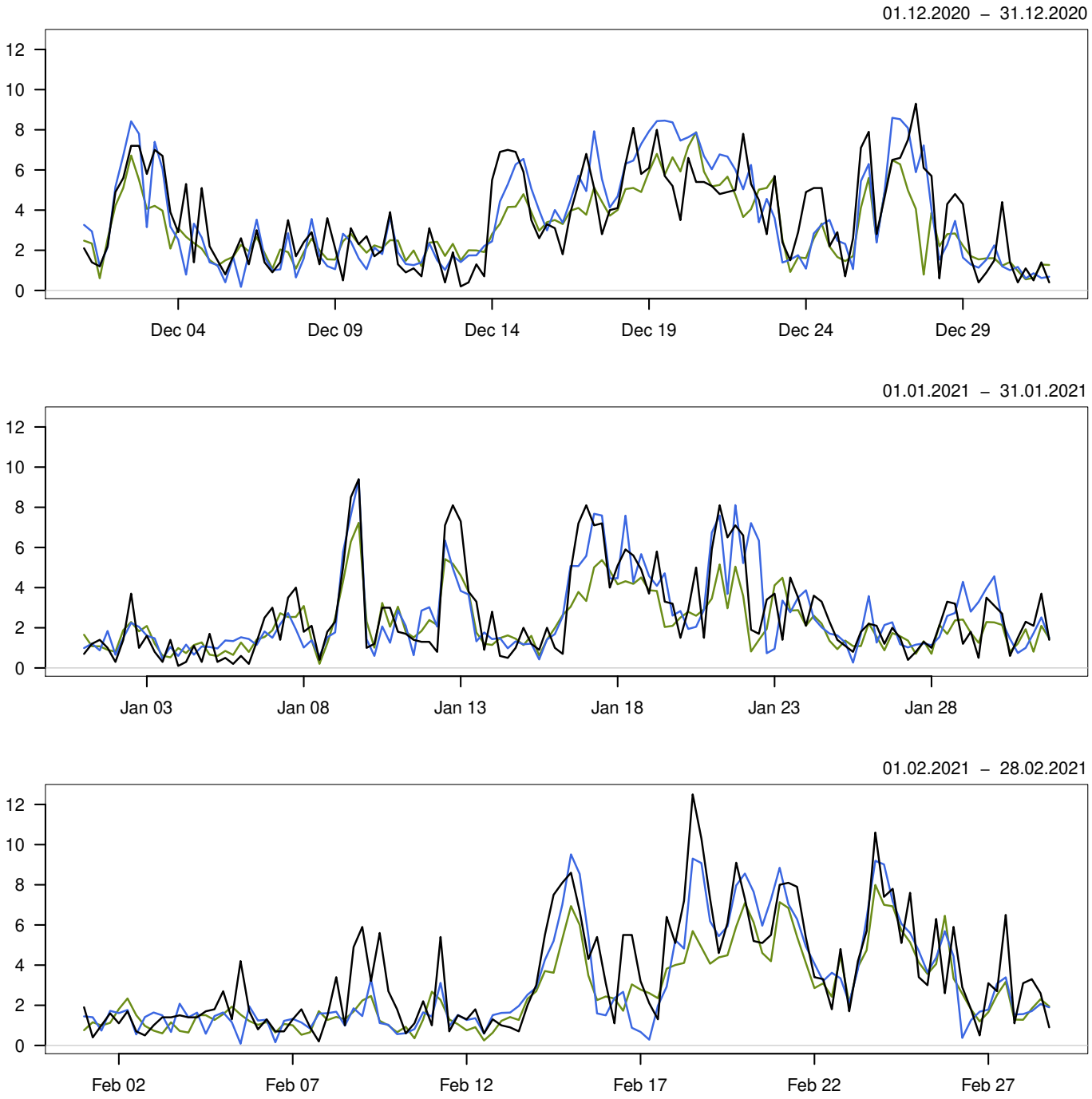


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.5	8.5	23.1	4.8	364
MEPSctrl: 12+18,+24,+30,+36	0.1	8.9	22.1	4.6	364
ECMWF: 12+18,+24,+30,+36	0.5	8.4	19.8	4.5	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.4	2.4	2.4	1.8	9.3	364
ECMWF – synop	−0.1	2.1	2.1	1.5	8.8	364

BERGEN – FLORIDA

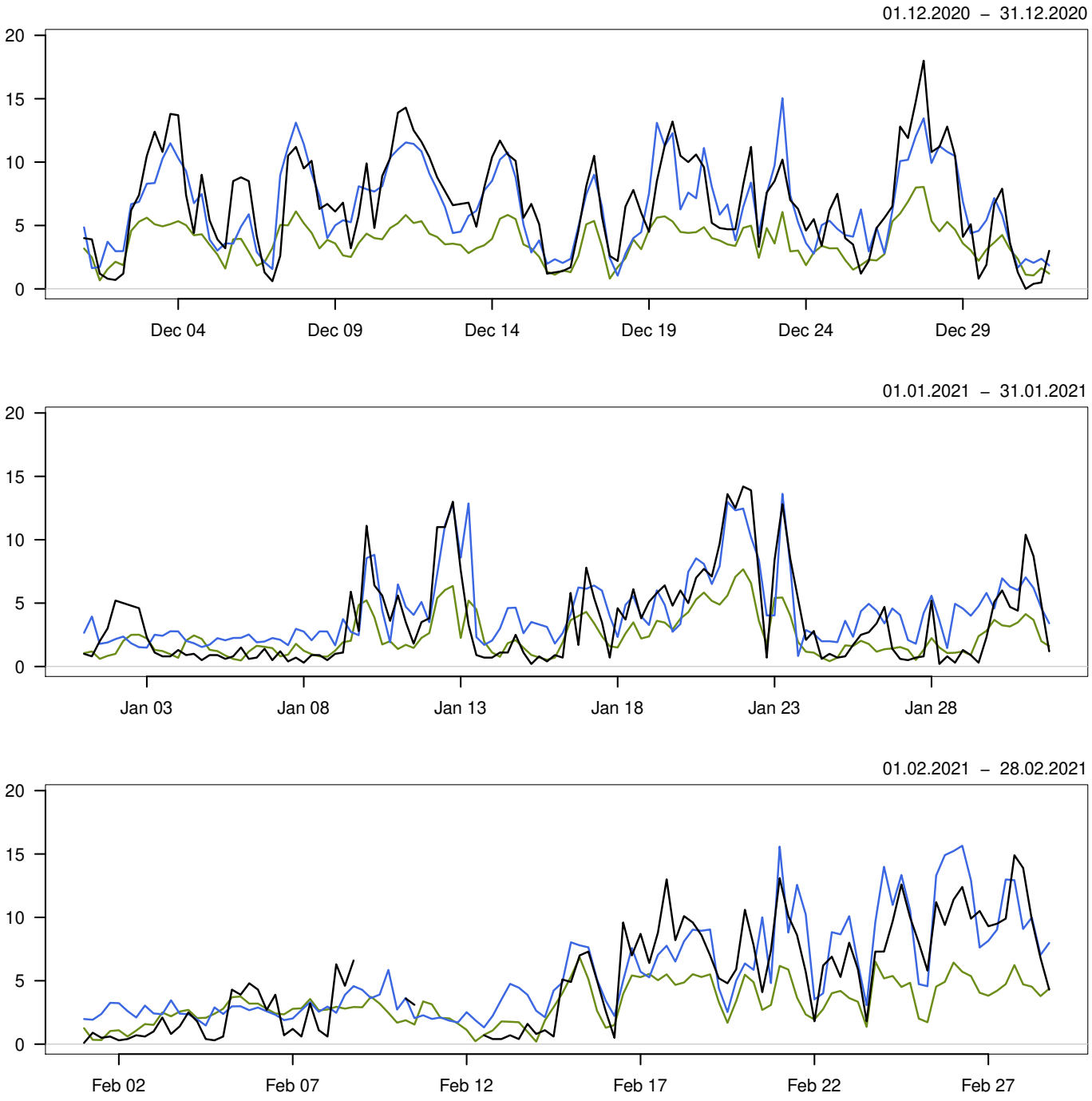


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.1	3.3	12.5	2.4	364
MEPSctrl: 12+18,+24,+30,+36	0.1	3.1	9.5	2.3	364
ECMWF: 12+18,+24,+30,+36	0.2	2.7	8	1.7	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−0.2	1.5	1.5	1.1	5.3	364
ECMWF – synop	−0.6	1.4	1.5	1.1	6.8	364

FINSEVATN

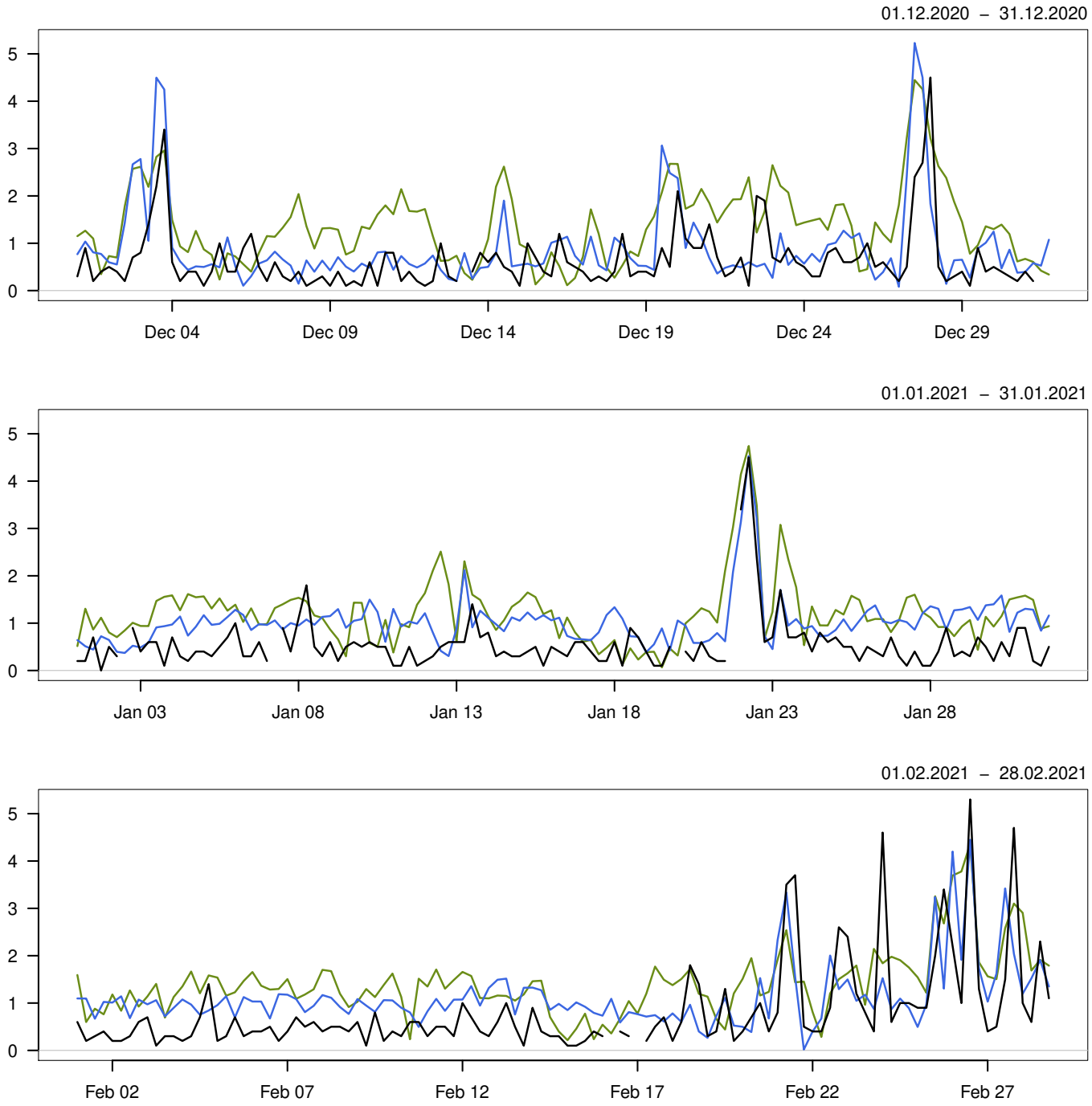


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0	5.3	18	4.1	352
MEPSctrl: 12+18,+24,+30,+36	0.8	5.6	19.7	3.5	364
ECMWF: 12+18,+24,+30,+36	0.2	3.1	8.1	1.7	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.3	2.3	2.3	1.9	9.6	352
ECMWF – synop	–2.2	2.7	3.5	2.7	10	352

NESBYEN – TODOKK

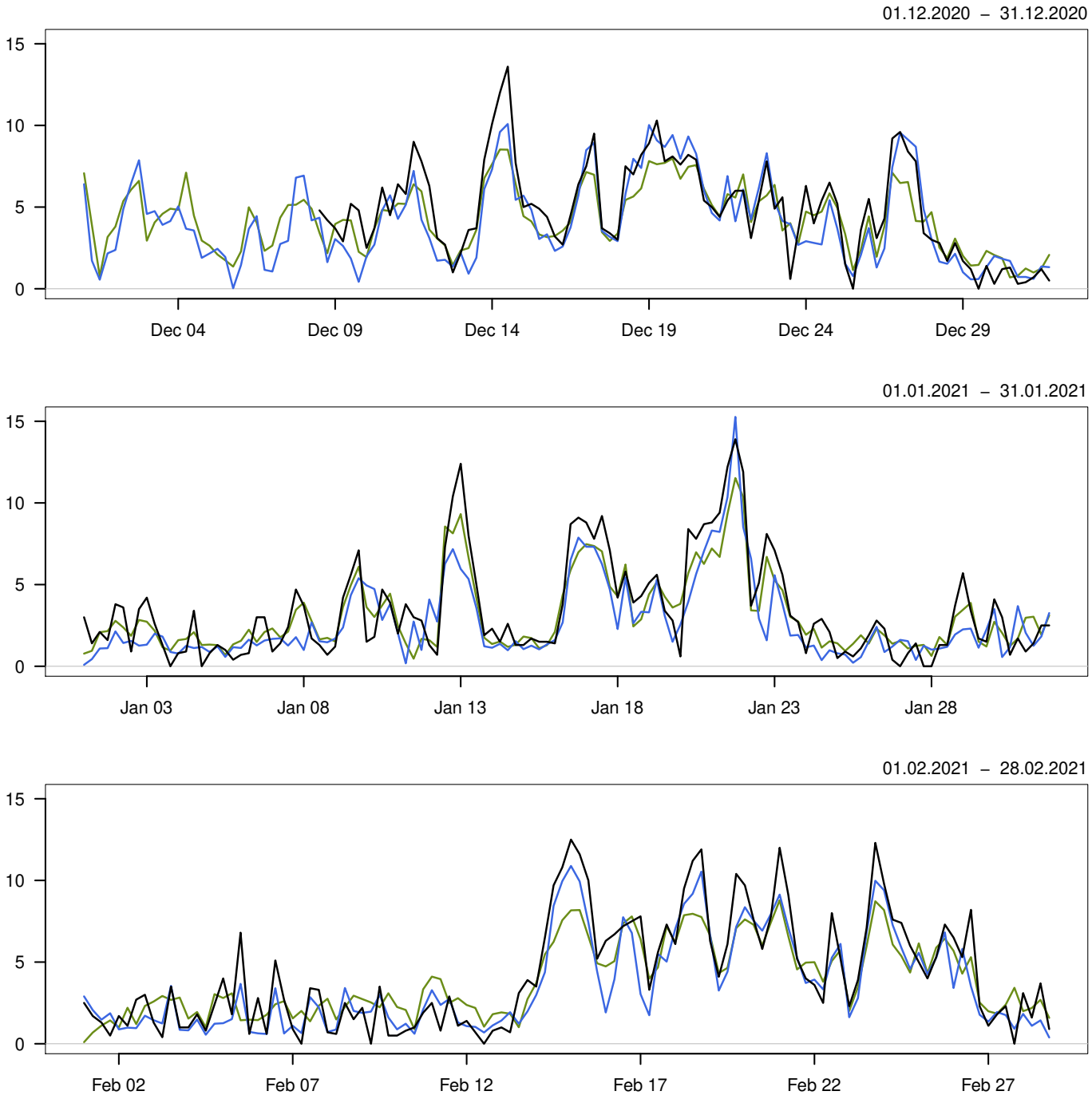


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0	0.7	5.3	0.8	355
MEPSctrl: 12+18,+24,+30,+36	0	1	5.2	0.7	364
ECMWF: 12+18,+24,+30,+36	0.1	1.4	4.7	0.8	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.4	0.7	0.8	0.6	3.1	355
ECMWF – synop	0.7	0.7	1	0.8	2.8	355

SOLA

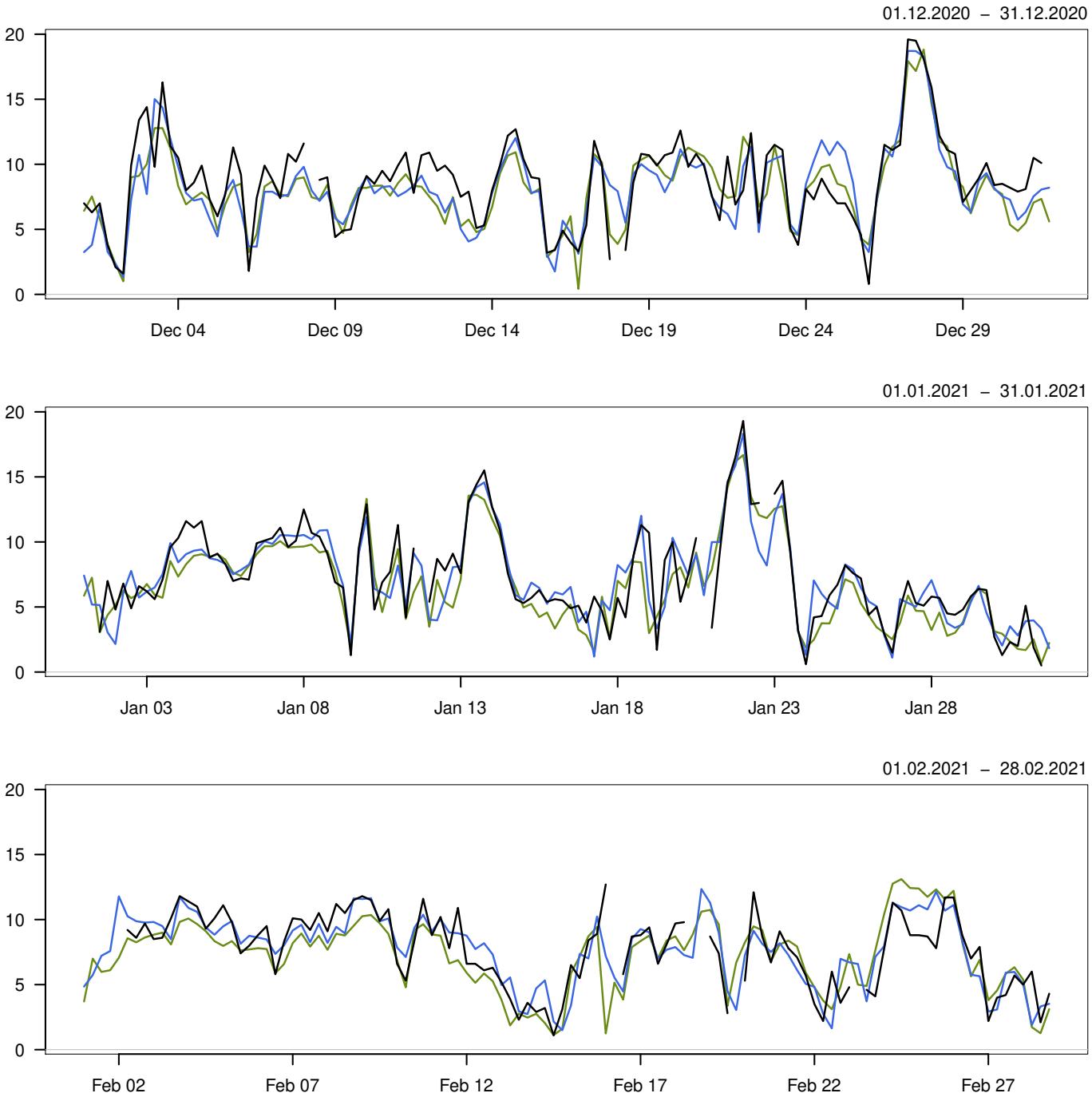


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0	4.1	13.9	3.2	338
MEPSctrl: 12+18,+24,+30,+36	0	3.4	15.3	2.7	364
ECMWF: 12+18,+24,+30,+36	0.1	3.7	11.5	2.2	364

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	–0.7	1.5	1.6	1.2	6.5	338
ECMWF – synop	–0.4	1.4	1.5	1.2	5.4	338

FÆRDER FYR

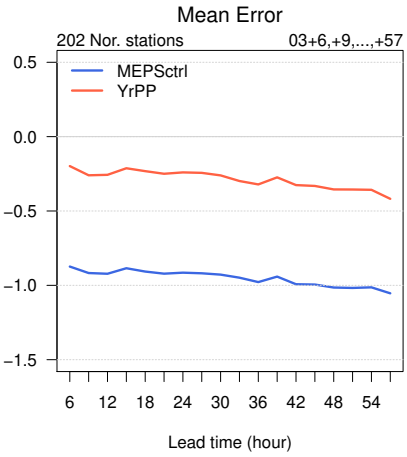


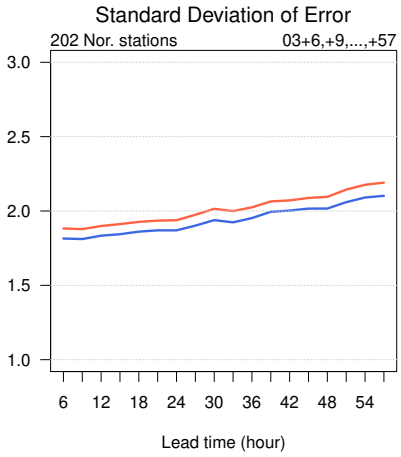
01.12.2020 – 28.02.2021

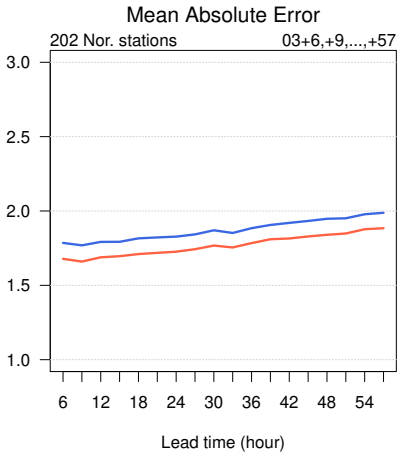
	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.5	7.9	19.6	3.3	347
MEPSctrl: 12+18,+24,+30,+36	1.1	7.6	18.7	3.1	364
ECMWF: 12+18,+24,+30,+36	0.4	7.3	18.8	3.1	364

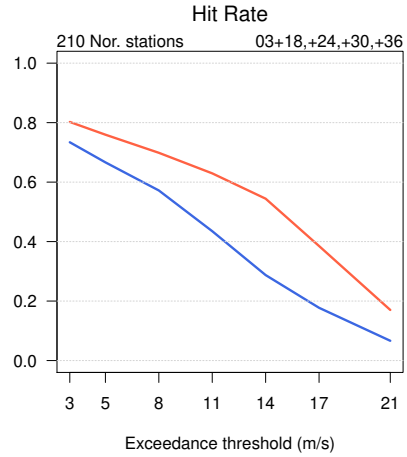
	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−0.2	1.8	1.8	1.3	6.7	347
ECMWF – synop	−0.6	1.7	1.8	1.4	11.5	347

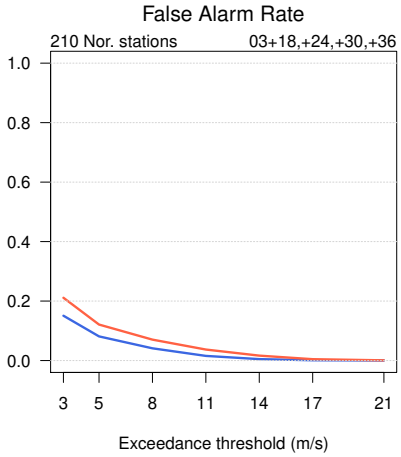
Post processed maximum mean wind speed 10m (YrPP)

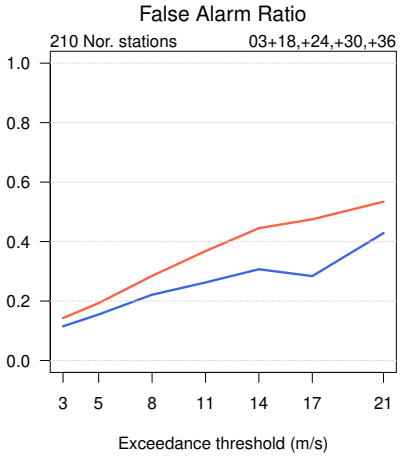


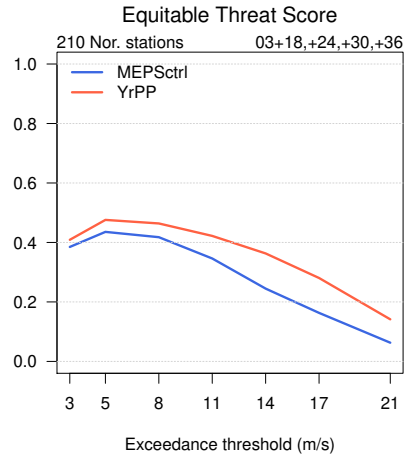


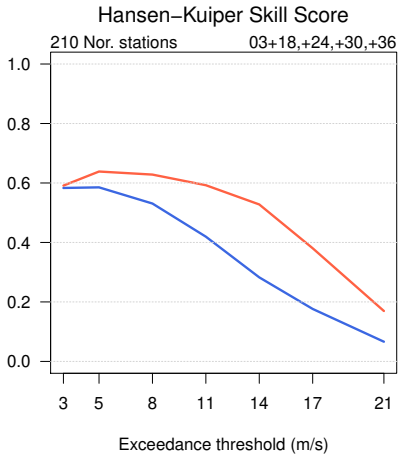


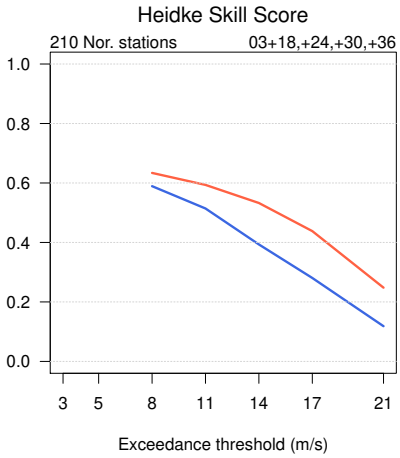




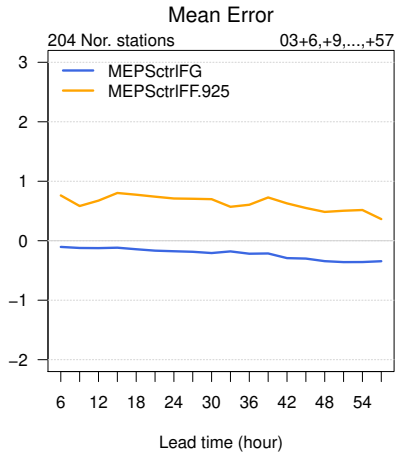


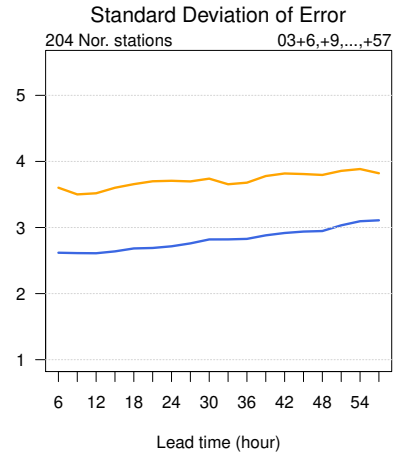


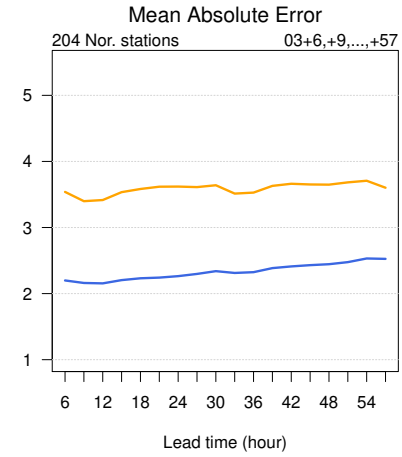


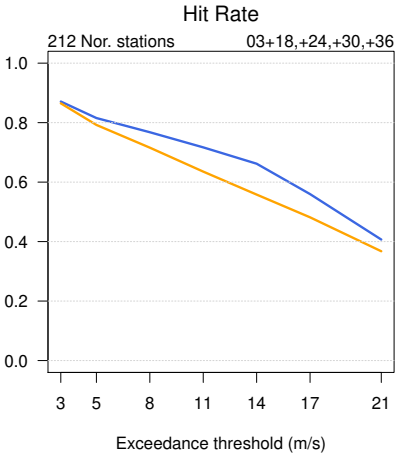


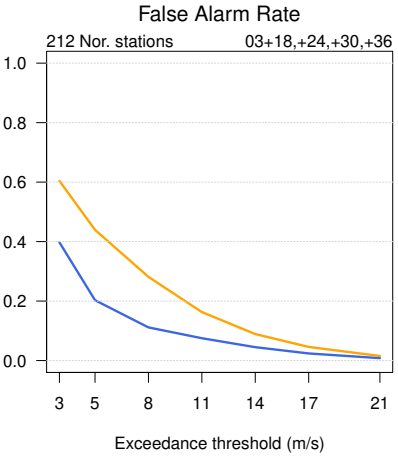
Wind gust (FG) and wind speed in 925 hpa (FF.925)

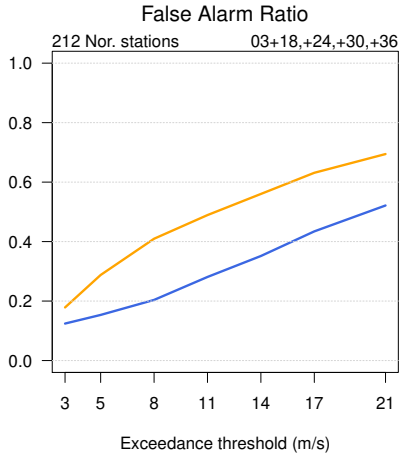


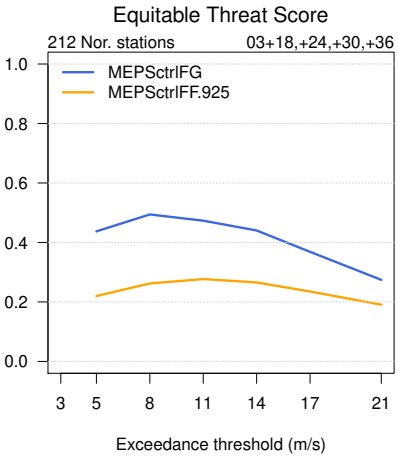


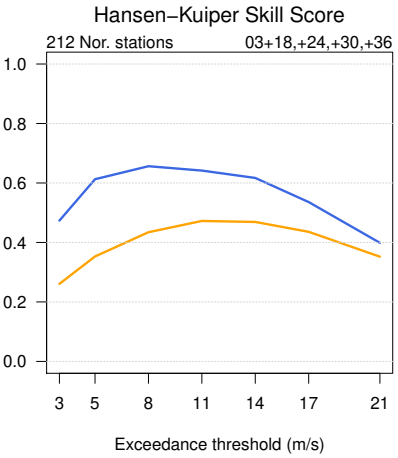


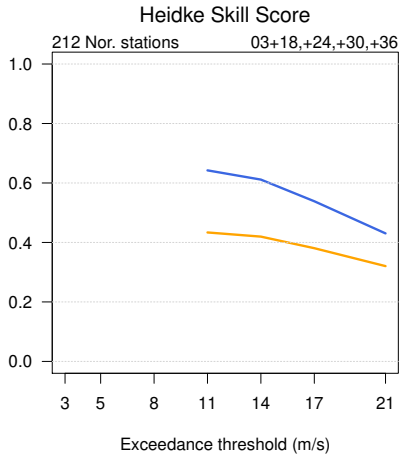


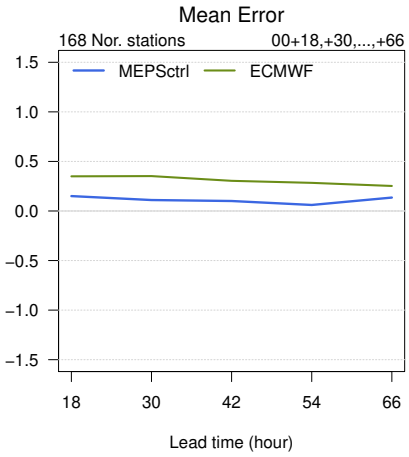


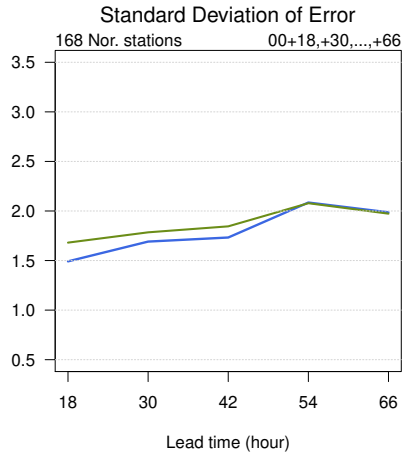


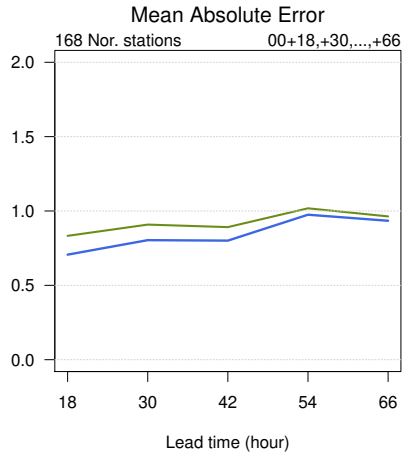


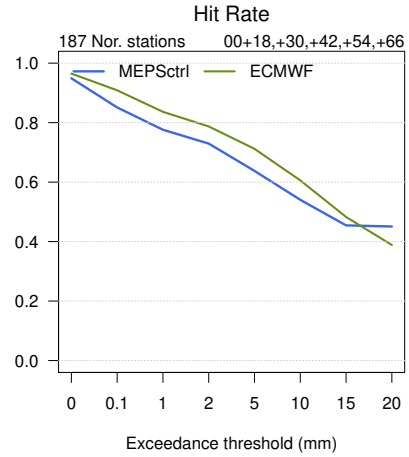


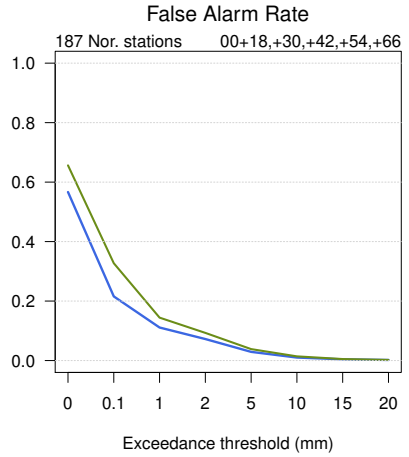


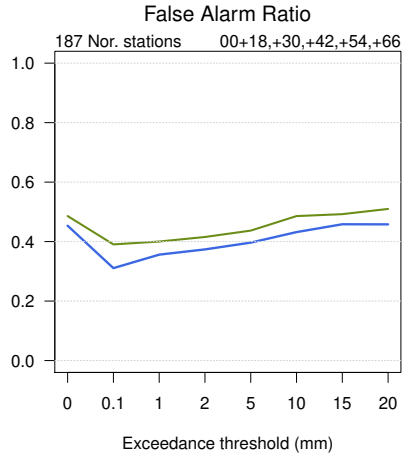

Mean Error
168 Nor. stations
00+18,+30,...,+66
MEPSctrl
ECMWF
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
18
30
42
54
66
Lead time (hour)

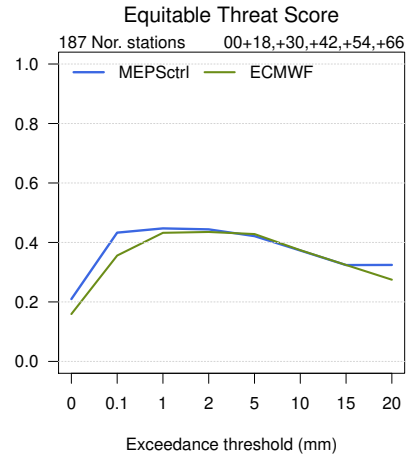

Standard Deviation of Error
168 Nor. stations
00+18,+30,...,+66
3.5
3.0
2.5
2.0
1.5
1.0
0.5
18
30
42
54
66
Lead time (hour)

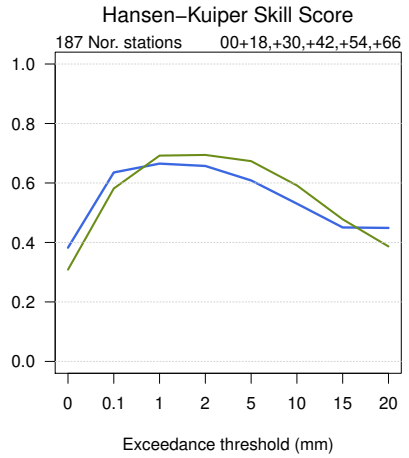

Mean Absolute Error
168 Nor. stations
00+18,+30,...,+66
2.0
1.5
1.0
0.5
0.0
18
30
42
54
66
Lead time (hour)

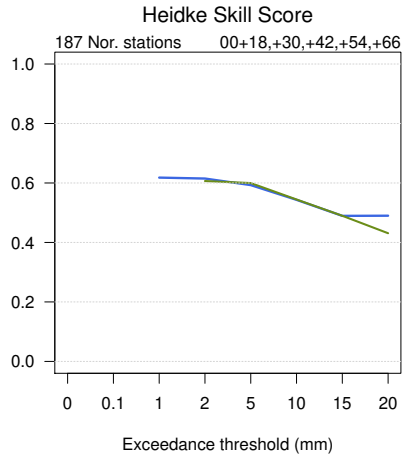

Hit Rate
187 Nor. stations
00+18,+30,+42,+54,+66
MEPSctrl
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
0
0.1
1
2
5
10
15
20
Exceedance threshold (mm)


False Alarm Rate
187 Nor. stations
00+18,+30,+42,+54,+66
1.0
0.8
0.6
0.4
0.2
0.0
0
0.1
1
2
5
10
15
20
Exceedance threshold (mm)


False Alarm Ratio
187 Nor. stations
00+18,+30,+42,+54,+66
1.0
0.8
0.6
0.4
0.2
0.0
0
0.1
1
2
5
10
15
20
Exceedance threshold (mm)

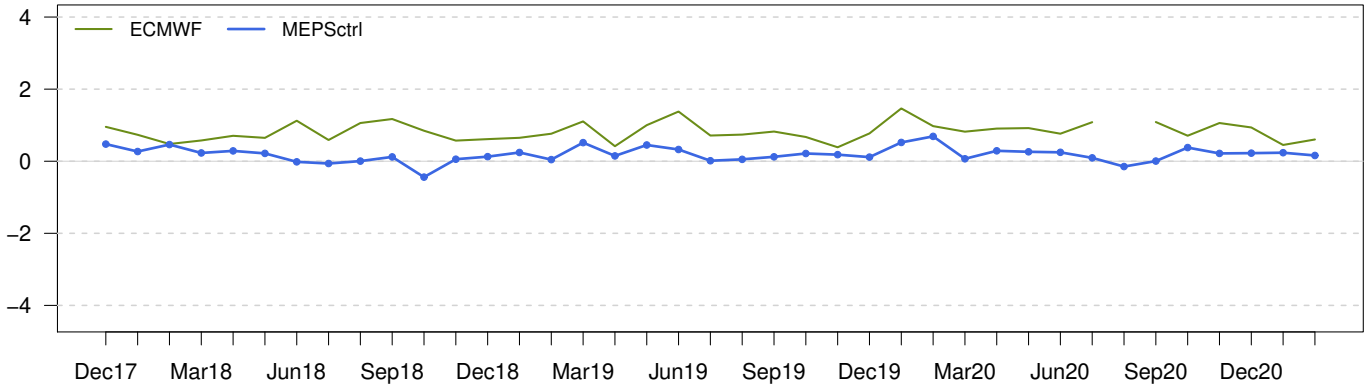

Equitable Threat Score
187 Nor. stations
00+18,+30,+42,+54,+66
MEPSctrl
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
0
0.1
1
2
5
10
15
20
Exceedance threshold (mm)


Hansen−Kuiper Skill Score
187 Nor. stations
00+18,+30,+42,+54,+66
1.0
0.8
0.6
0.4
0.2
0.0
0
0.1
1
2
5
10
15
20
Exceedance threshold (mm)

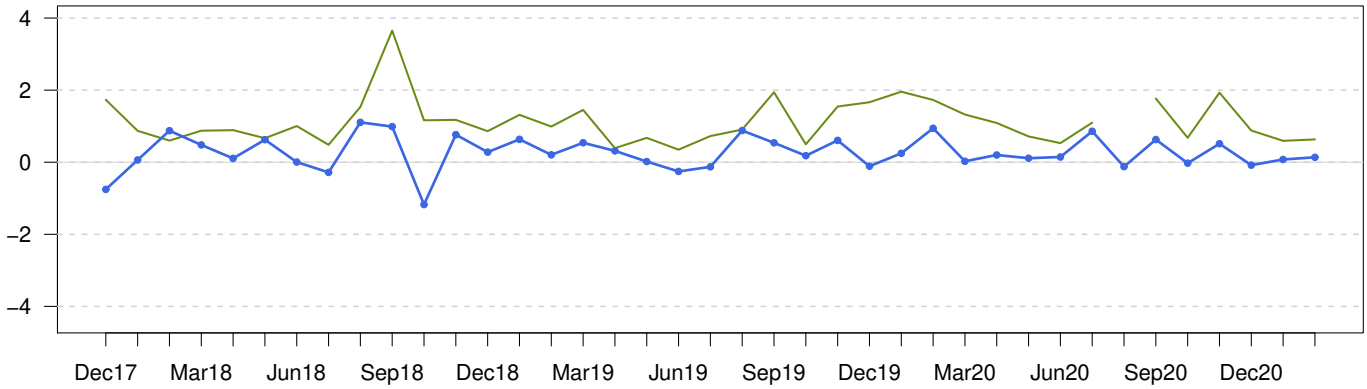

Heidke Skill Score
187 Nor. stations
00+18,+30,+42,+54,+66
1.0
0.8
0.6
0.4
0.2
0.0
0
0.1
1
2
5
10
15
20
Exceedance threshold (mm)

Mean Error

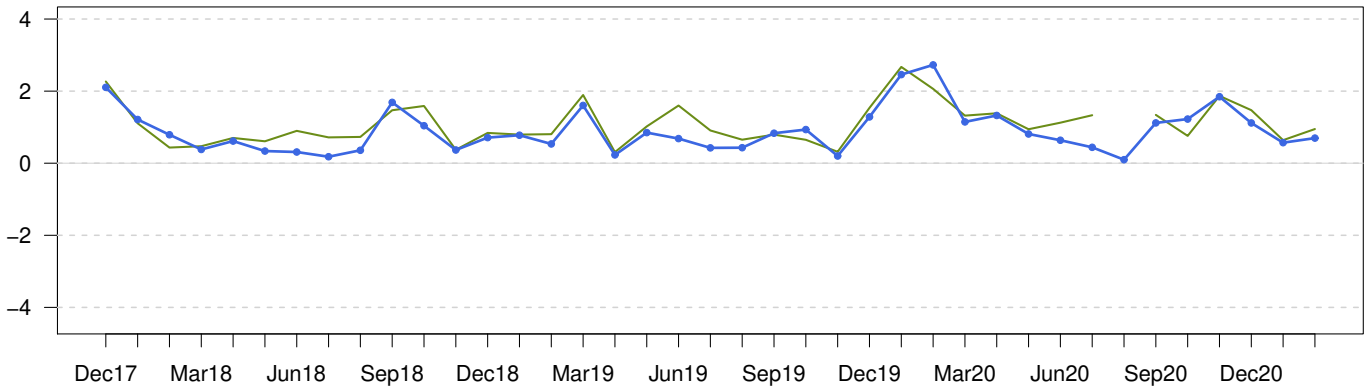
184 Norwegian stations 00+30 UTC



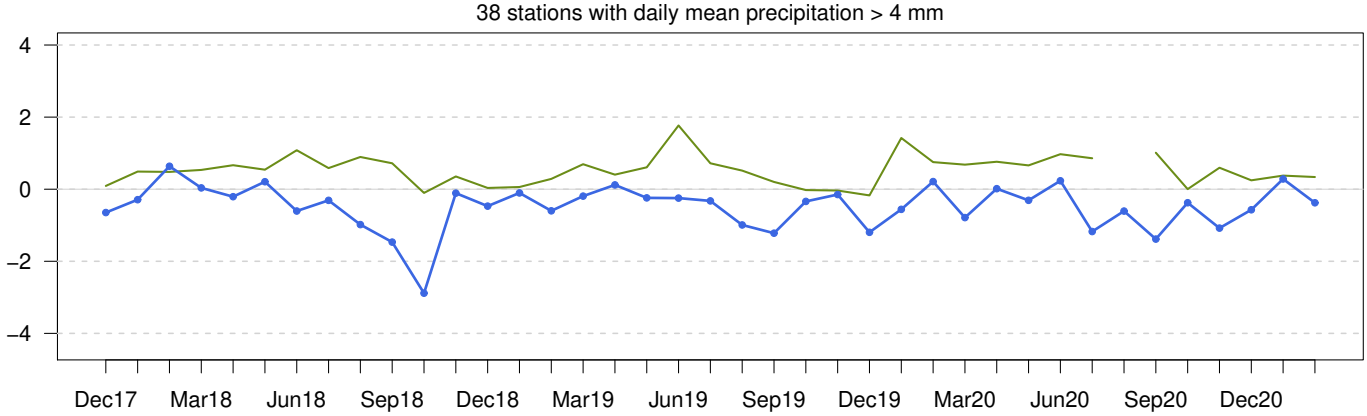
6 coastal stations



43 stations more than 500 m above sea level

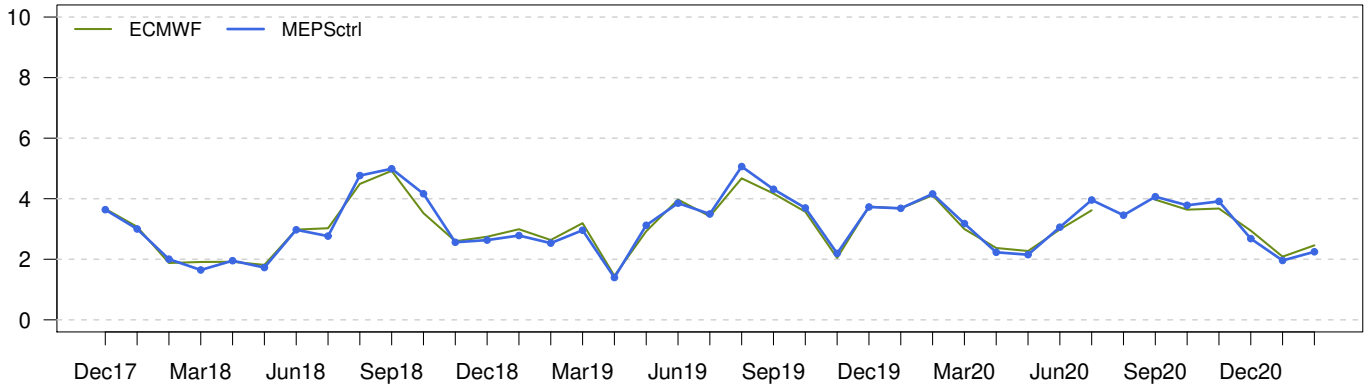


38 stations with daily mean precipitation > 4 mm

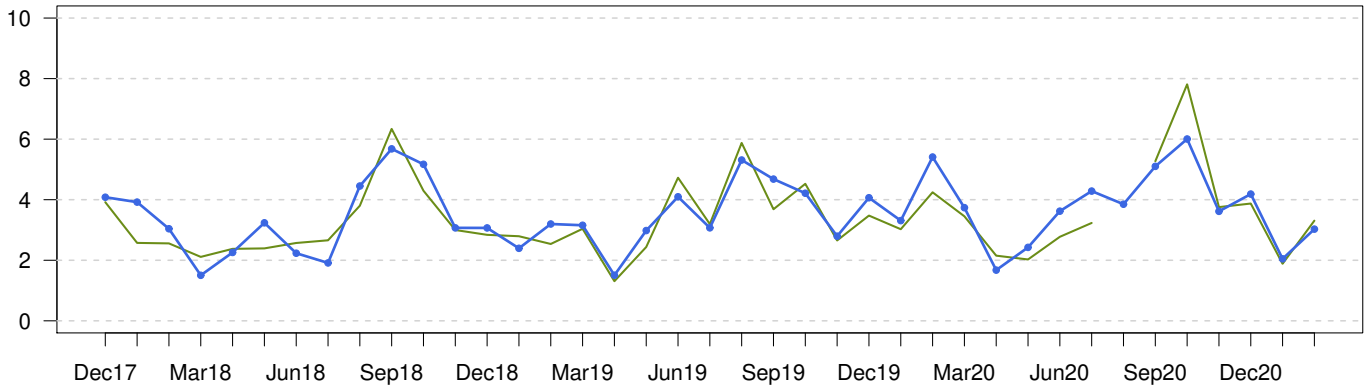


Standard Deviation of Error

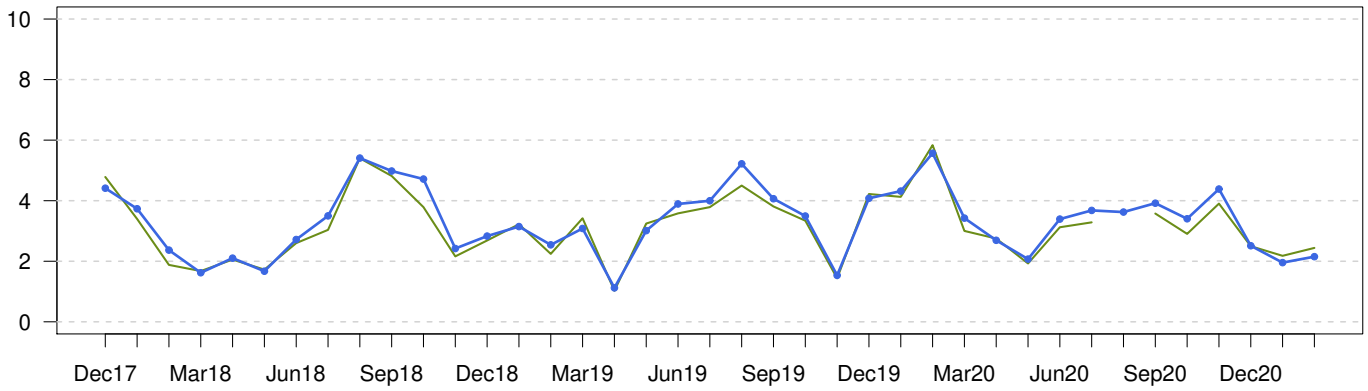
184 Norwegian stations 00+30 UTC



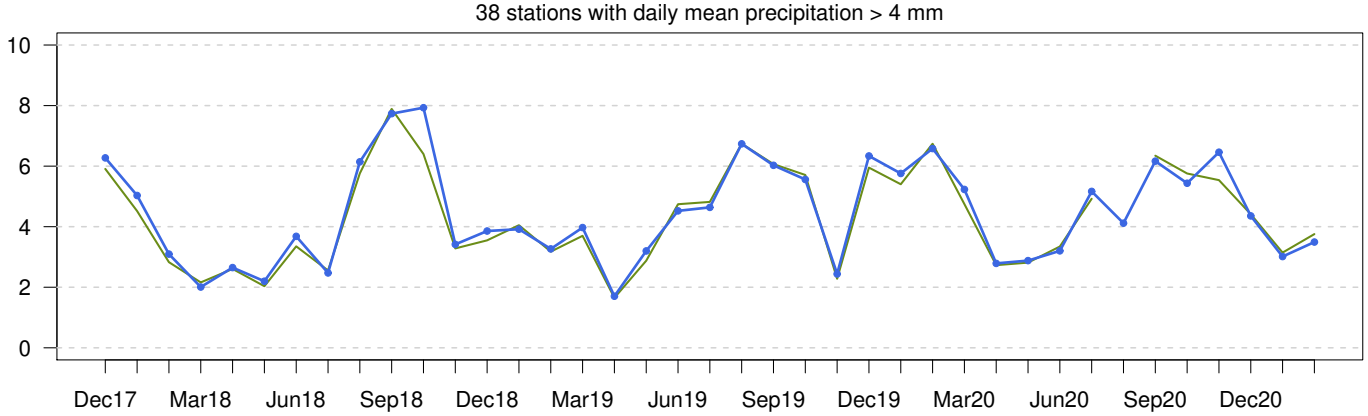
6 coastal stations



43 stations more than 500 m above sea level

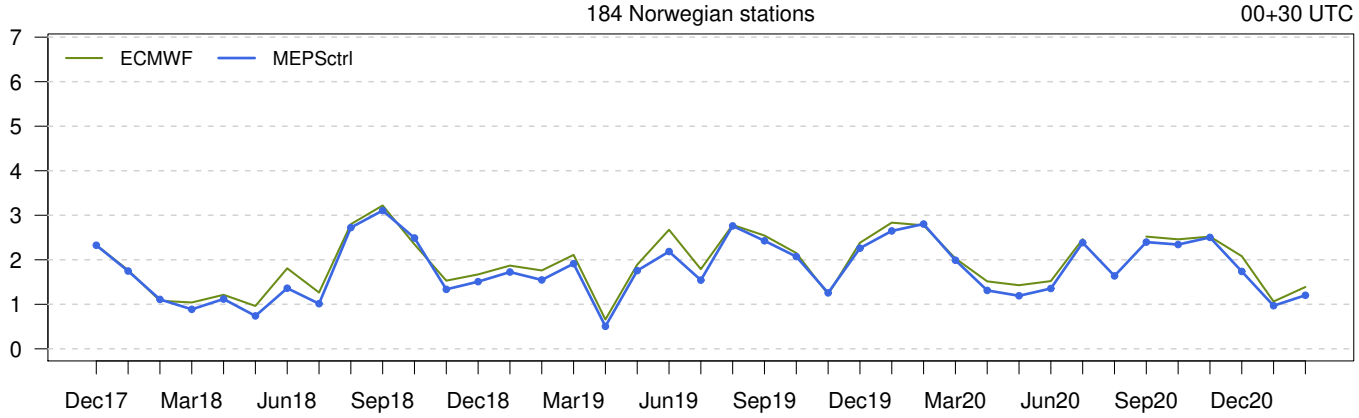


38 stations with daily mean precipitation > 4 mm

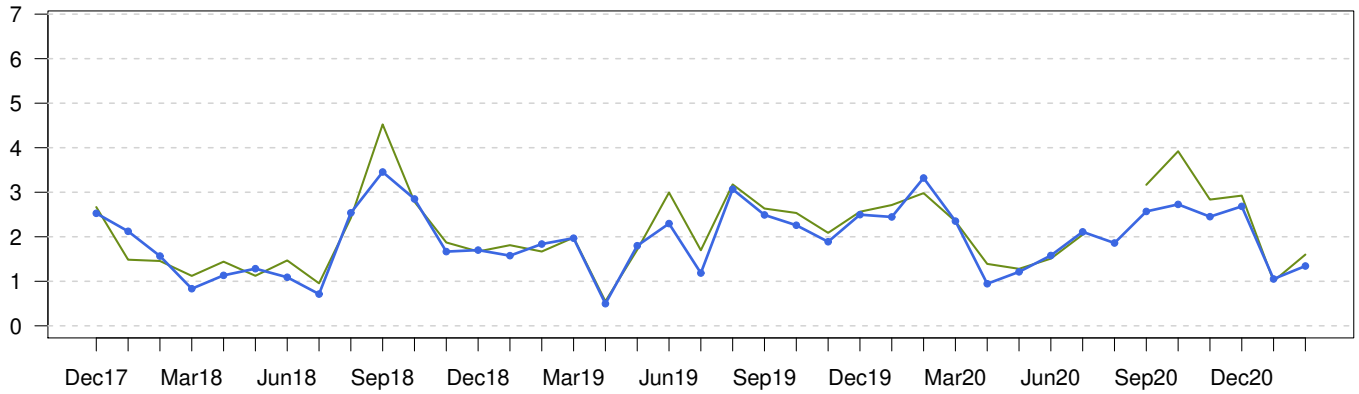


Mean Absolute Error

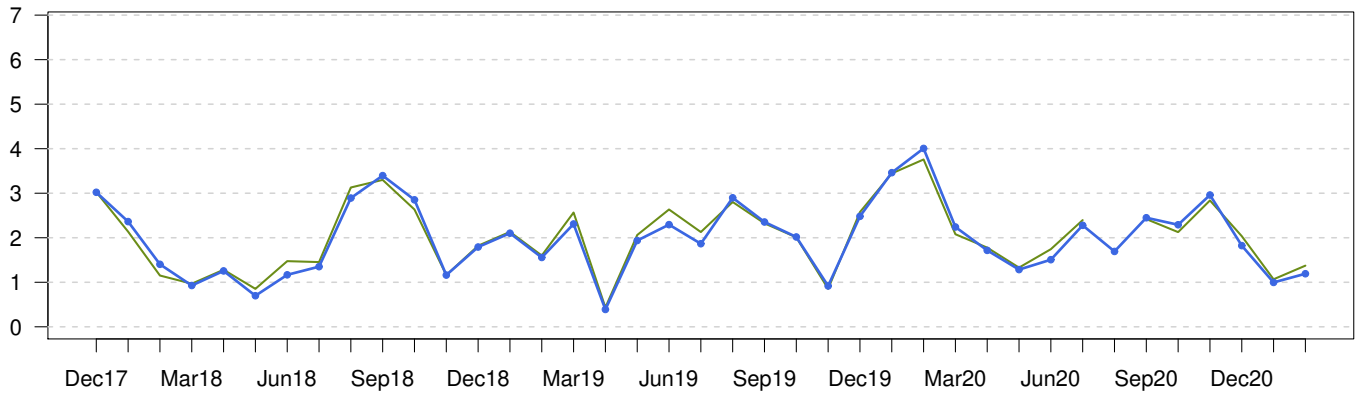
184 Norwegian stations 00+30 UTC



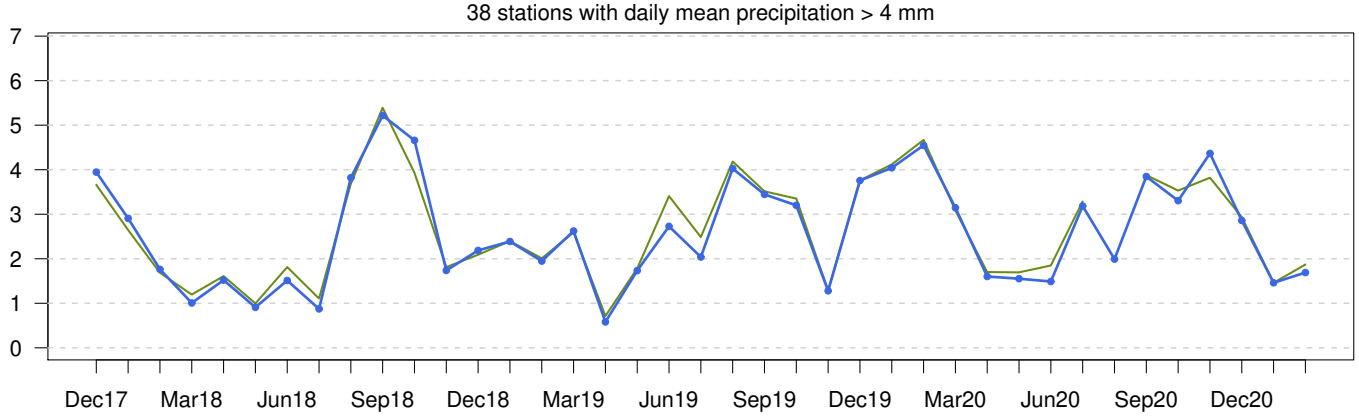
6 coastal stations



43 stations more than 500 m above sea level

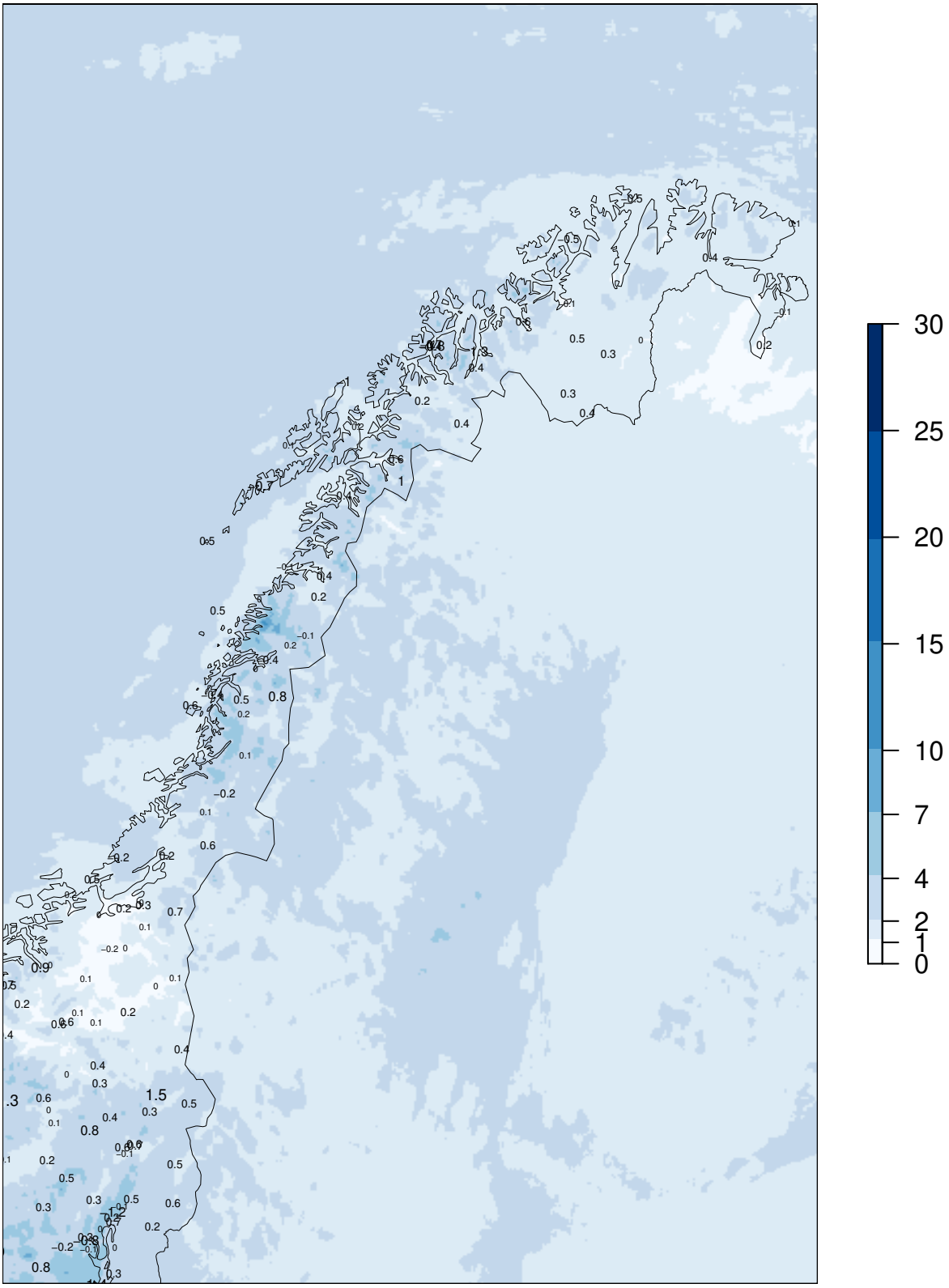


38 stations with daily mean precipitation > 4 mm



MEPSctrl 00+30

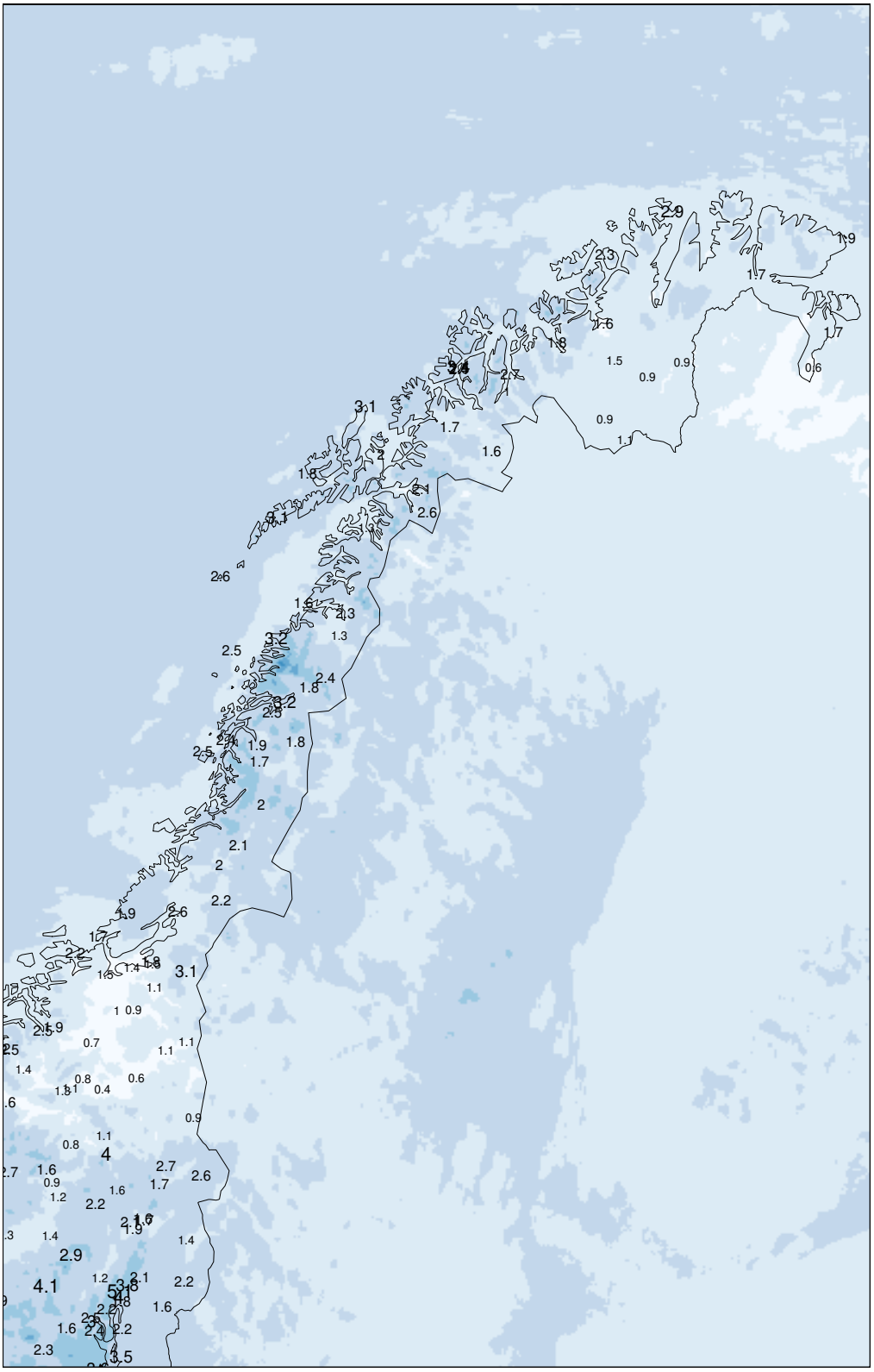
ME at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+30

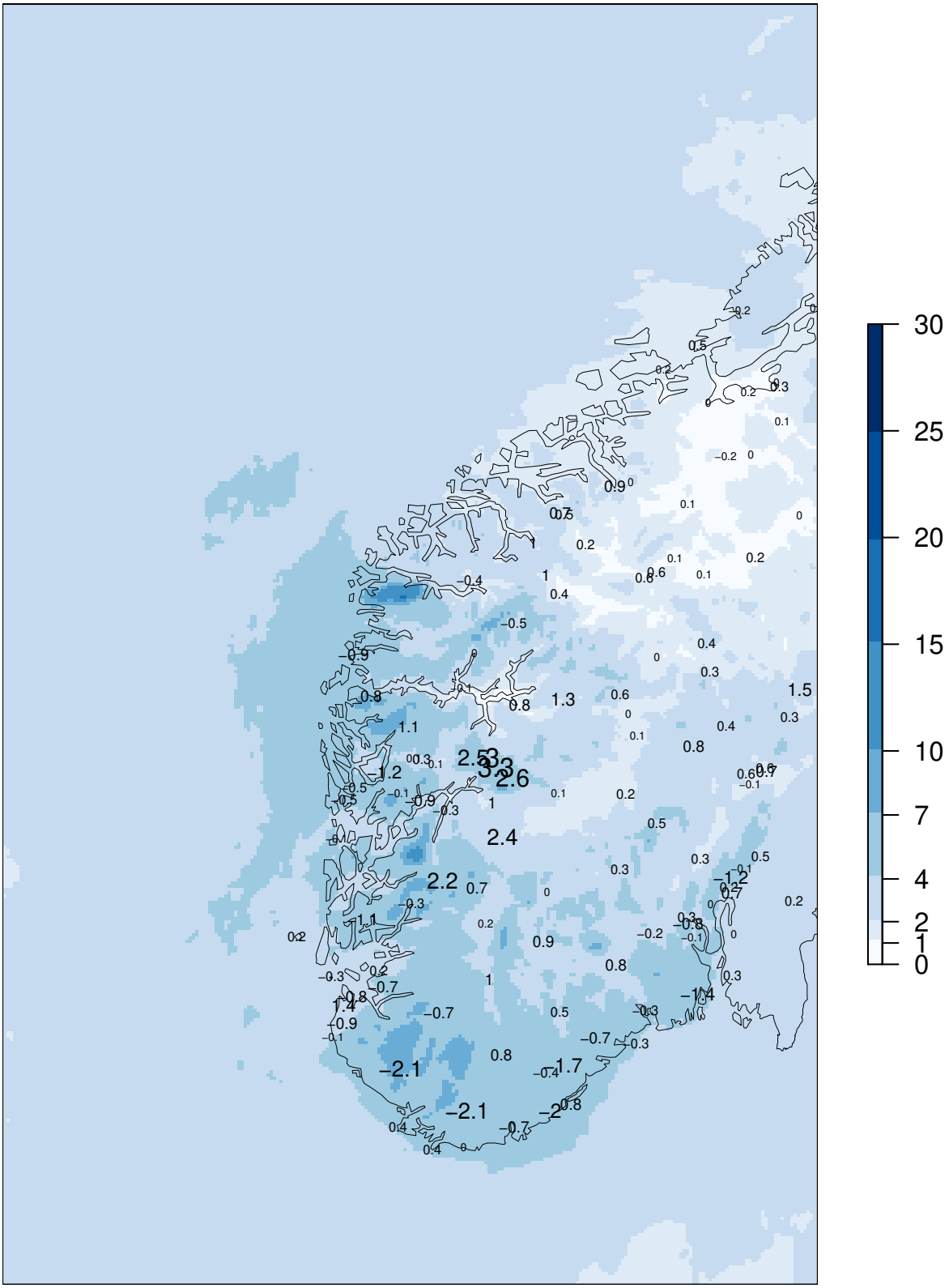
SDE at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+30

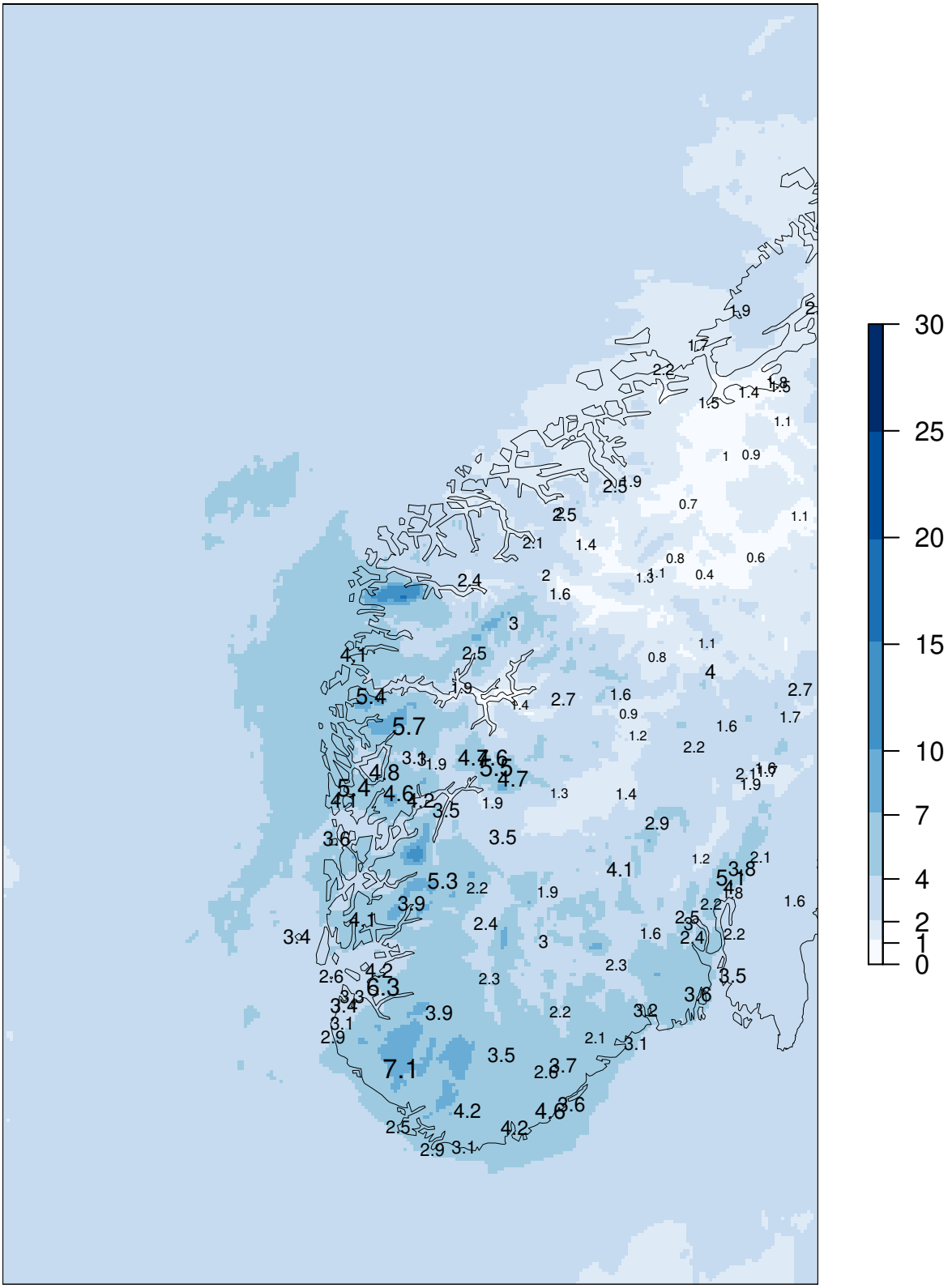
ME at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+30

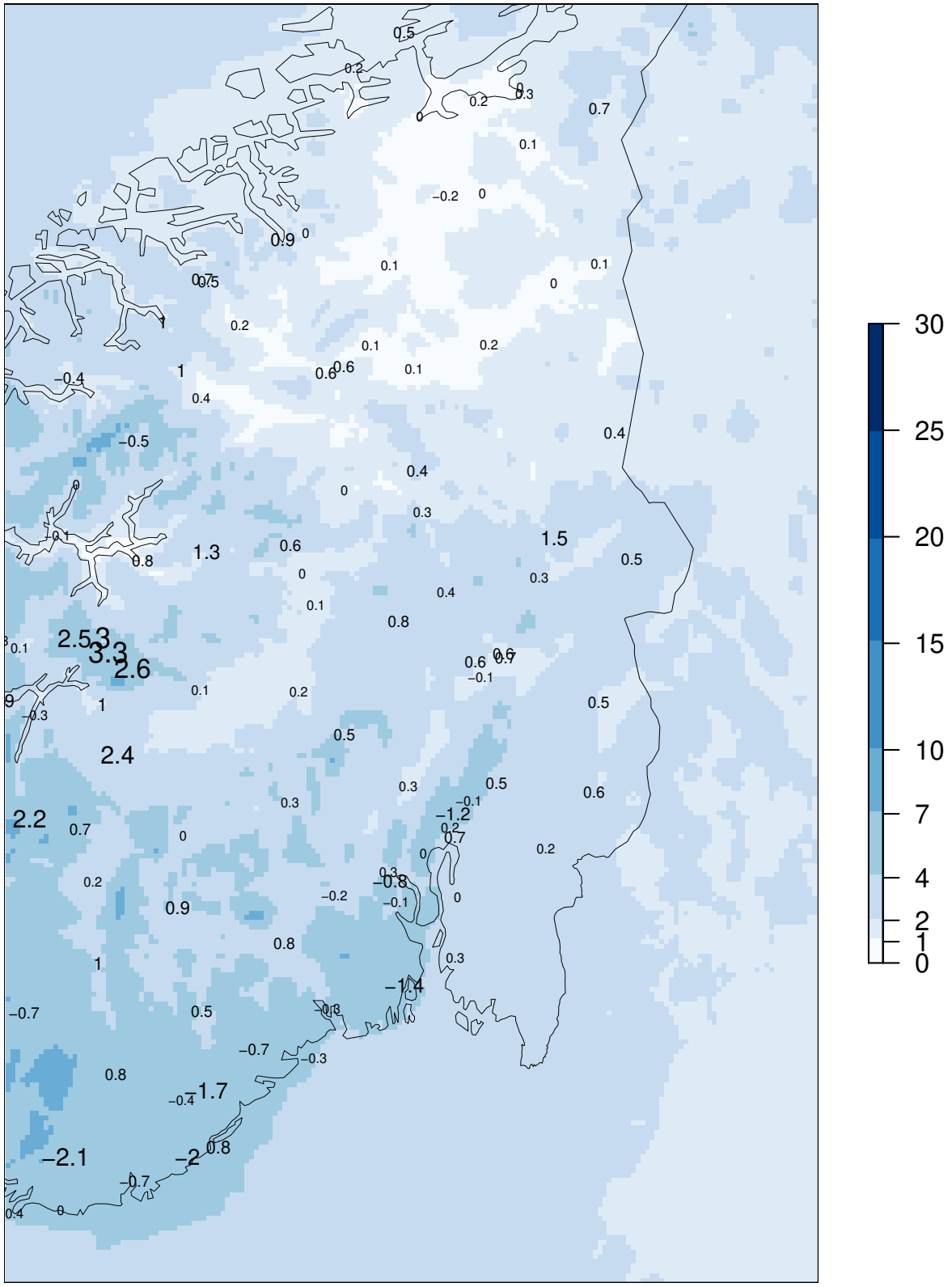
SDE at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+30

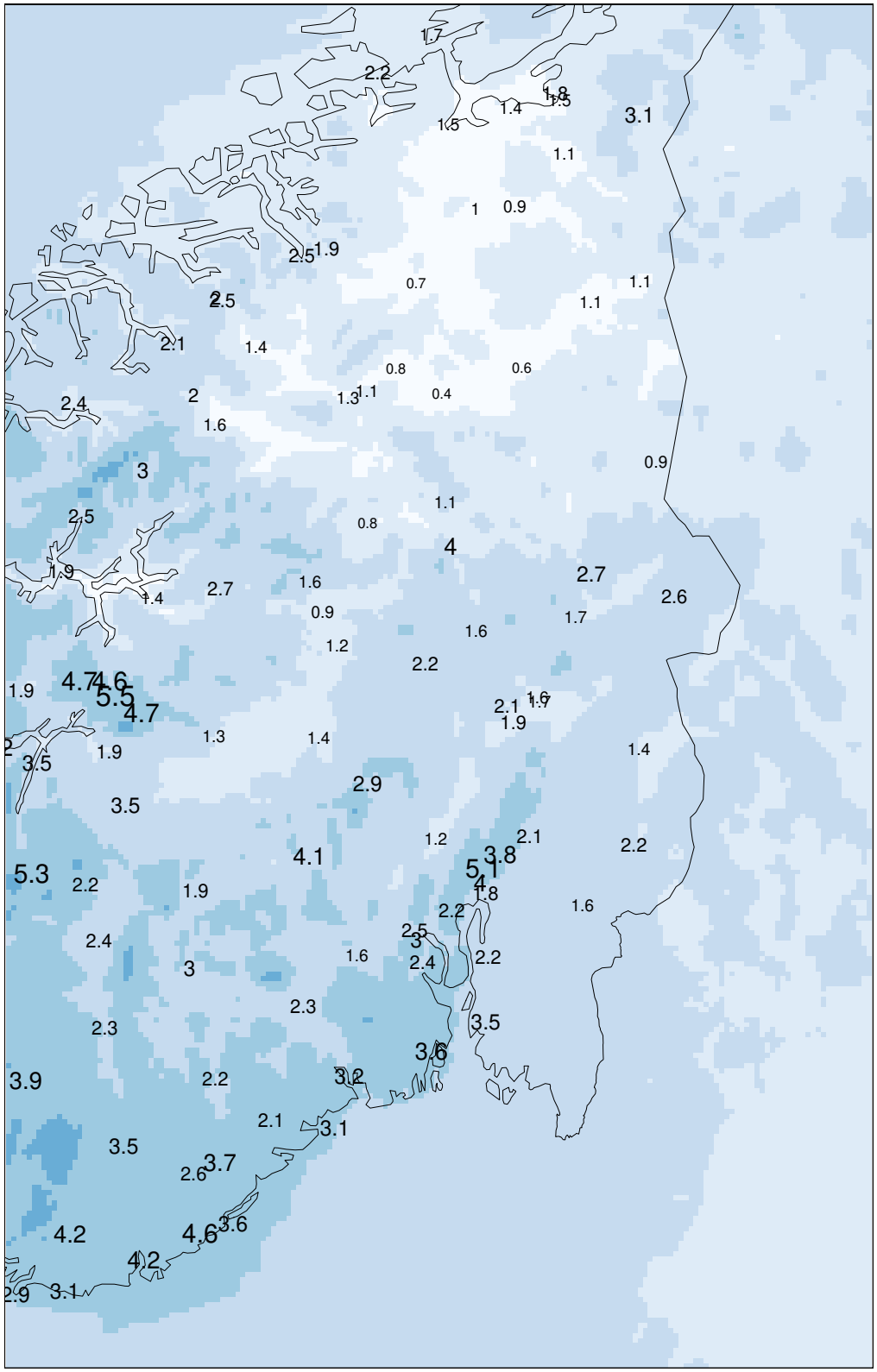
ME at observing sites
(numbers in black)



Model "climatology" 01.12.2020 – 28.02.2021

MEPSctrl 00+30

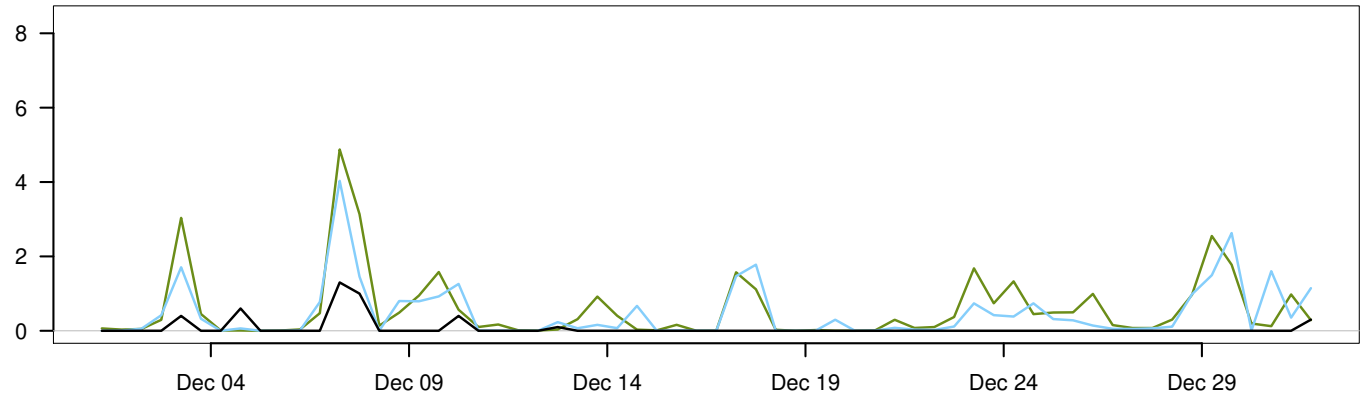
SDE at observing sites
(numbers in black)



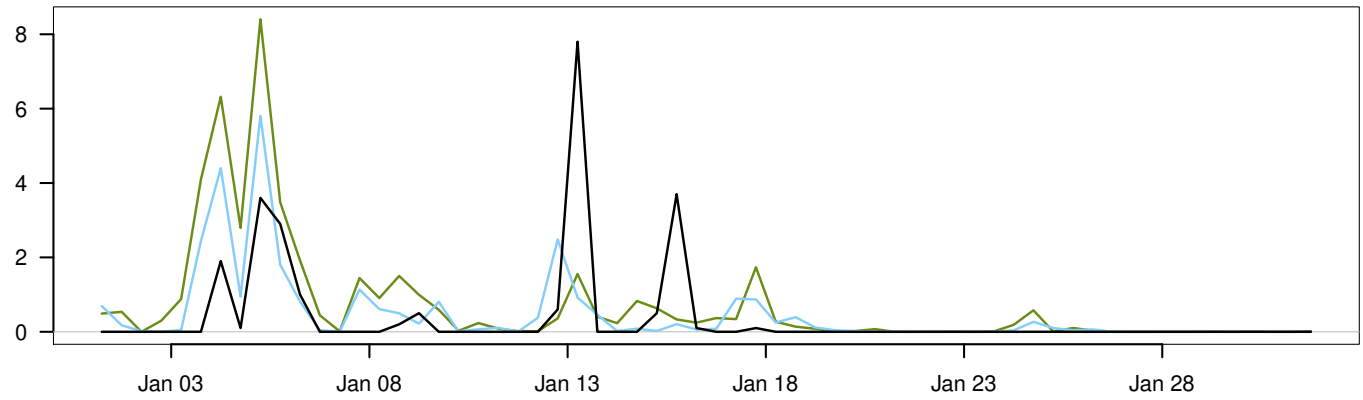
Model "climatology" 01.12.2020 – 28.02.2021

SVALBARD LUFTHAVN

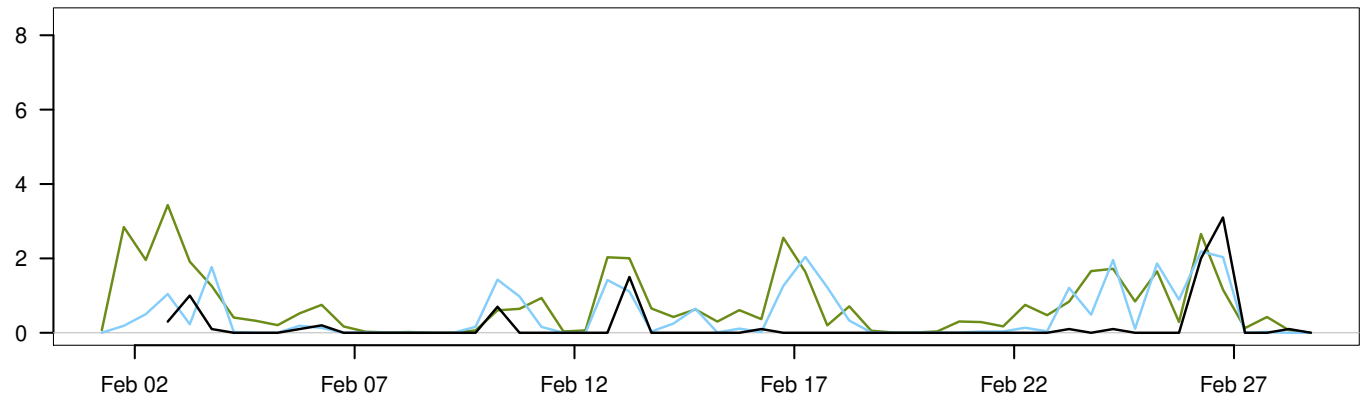
01.12.2020 – 31.12.2020



01.01.2021 – 31.01.2021



01.02.2021 – 28.02.2021



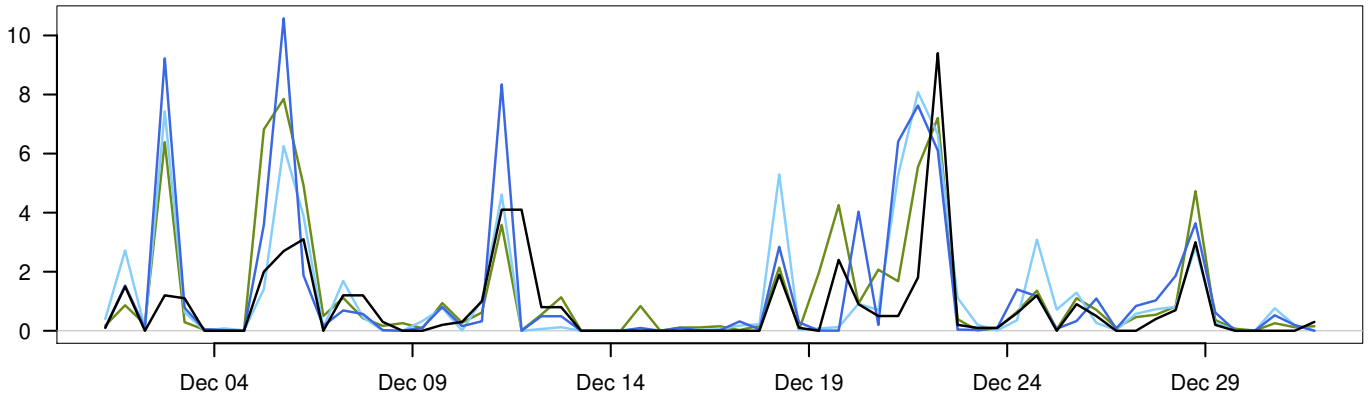
01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 06,18	0	0.2	7.8	0.8	180
AA25: 12+18,+30	0	0.5	5.8	0.8	182
ECMWF: 12+18,+30	0	0.7	8.4	1.1	182

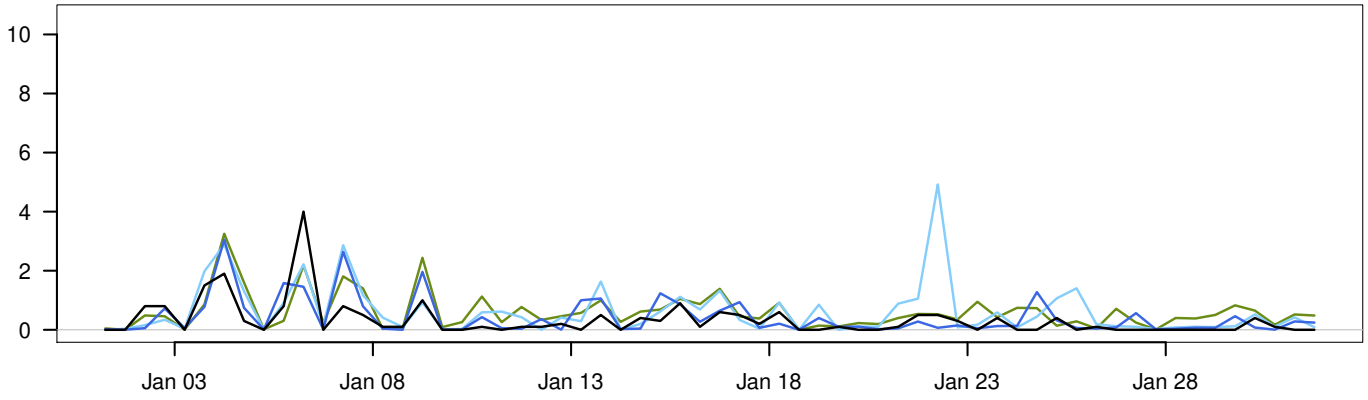
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AA25 – synop	0.3	0.9	0.9	0.4	6.9	180
ECMWF – synop	0.4	1	1.1	0.6	6.2	180

BJØRNØYA

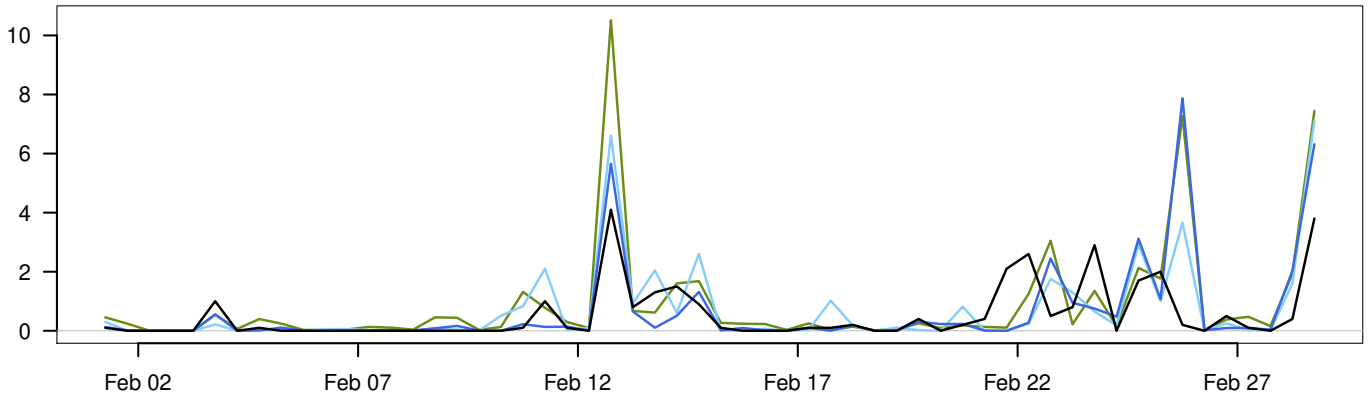
01.12.2020 – 31.12.2020



01.01.2021 – 31.01.2021



01.02.2021 – 28.02.2021



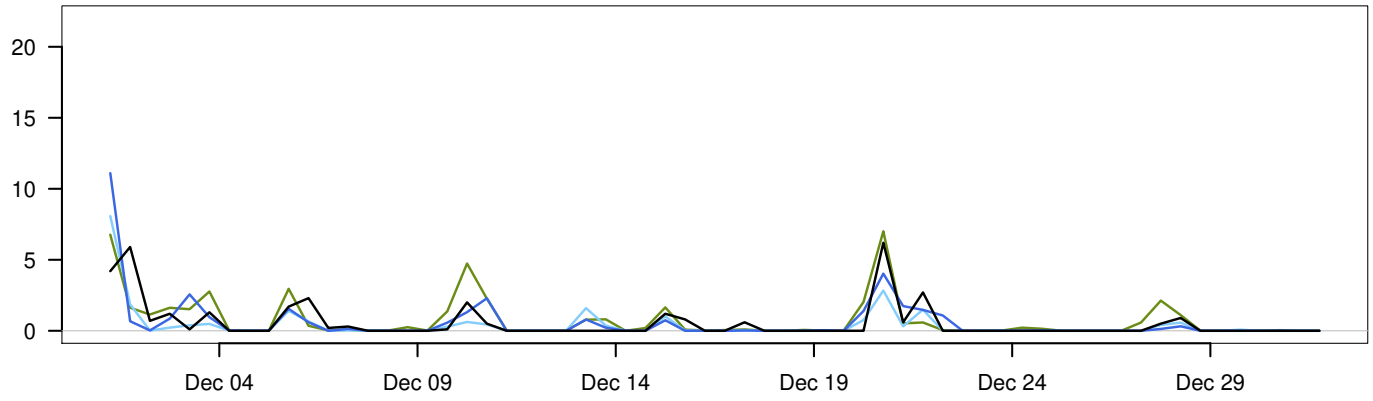
01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 06,18	0	0.6	9.4	1.1	182
MEPSctrl: 12+18,+30	0	0.8	10.6	1.8	182
AA25: 12+18,+30	0	0.8	8.1	1.5	182
ECMWF: 12+18,+30	0	0.9	10.5	1.6	182

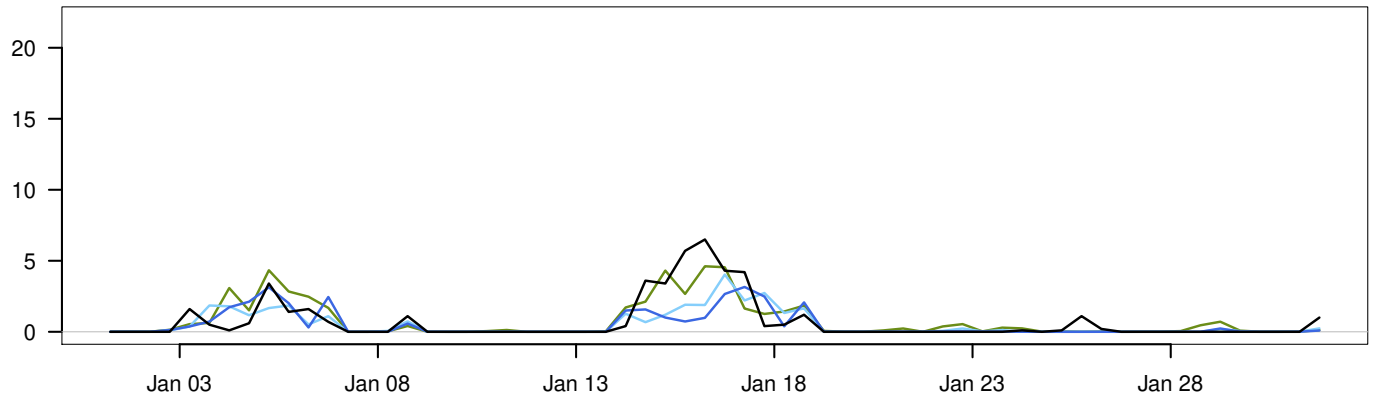
	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.2	1.4	1.5	0.6	8	182
AA25 – synop	0.3	1.2	1.2	0.6	6.3	182
ECMWF – synop	0.4	1.2	1.3	0.6	7.1	182

TROMSØ

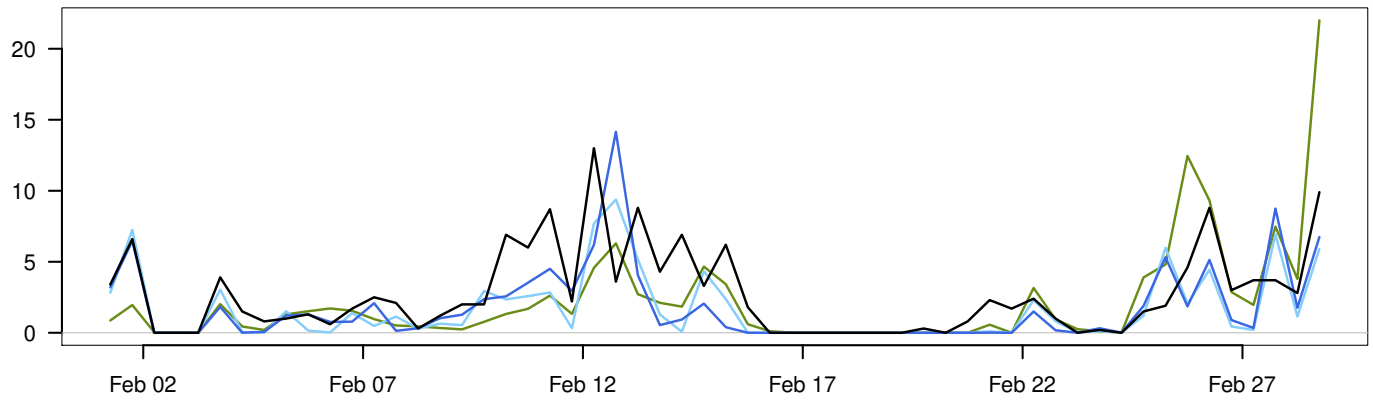
01.12.2020 – 31.12.2020



01.01.2021 – 31.01.2021



01.02.2021 – 28.02.2021

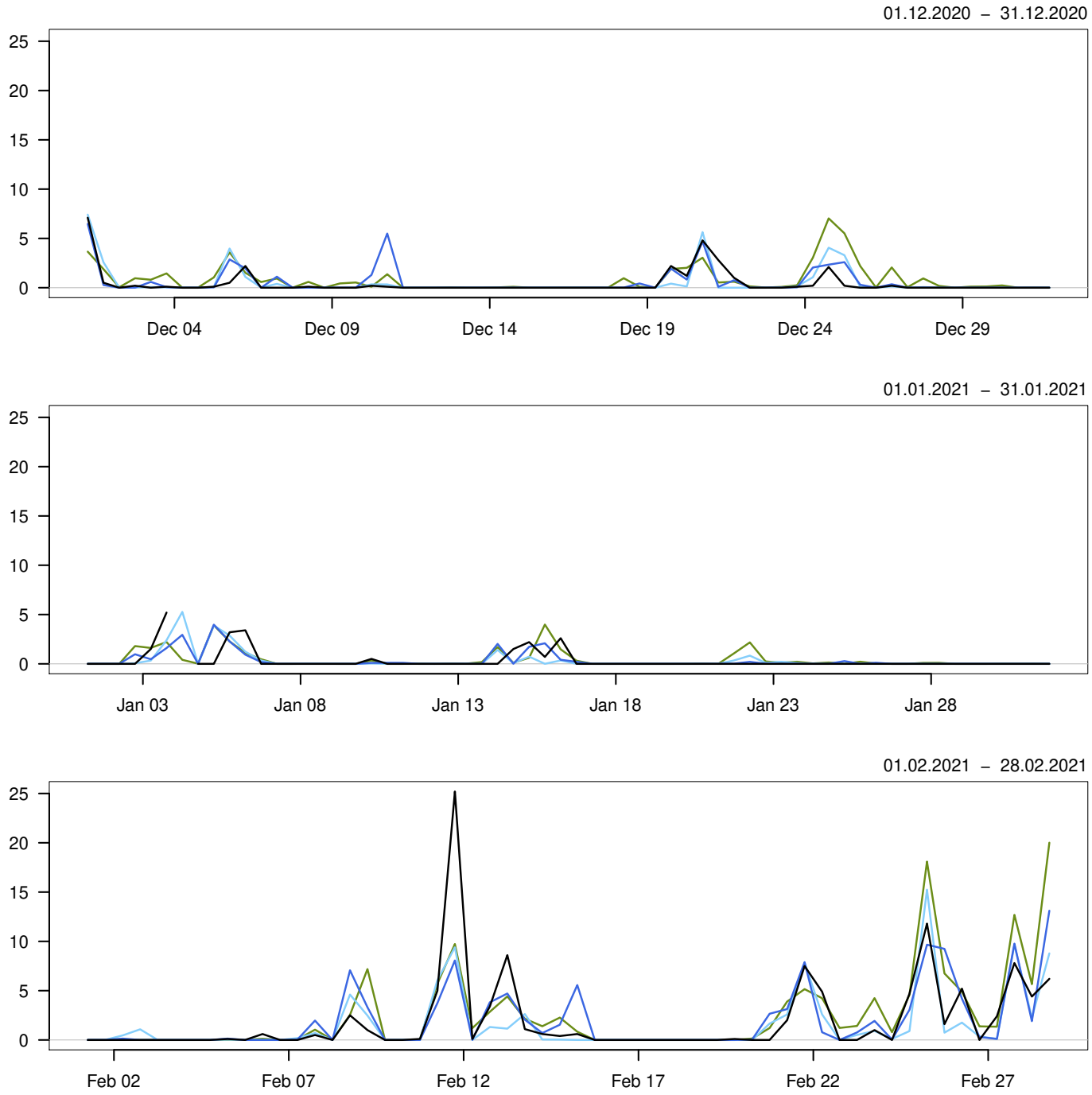


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 06,18	0	1.4	13	2.4	182
MEPSctrl: 12+18,+30	0	0.9	14.2	1.9	182
AA25: 12+18,+30	0	0.8	9.4	1.7	182
ECMWF: 12+18,+30	0	1.3	22	2.5	182

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−0.4	2	2	1	10.6	182
AA25 – synop	−0.5	1.6	1.7	0.9	7.7	182
ECMWF – synop	−0.1	1.9	1.9	0.9	12.1	182

BODØ VI



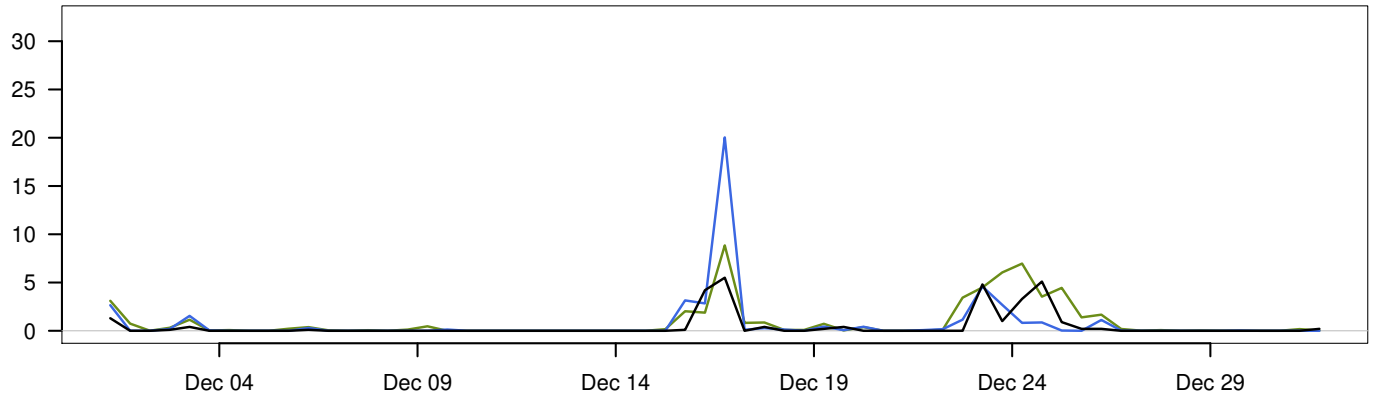
01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 06,18	0	0.9	25.2	2.6	181
MEPSctrl: 12+18,+30	0	0.9	13.1	2.1	182
AA25: 12+18,+30	0	0.8	15.2	2	182
ECMWF: 12+18,+30	0	1.3	20	2.7	182

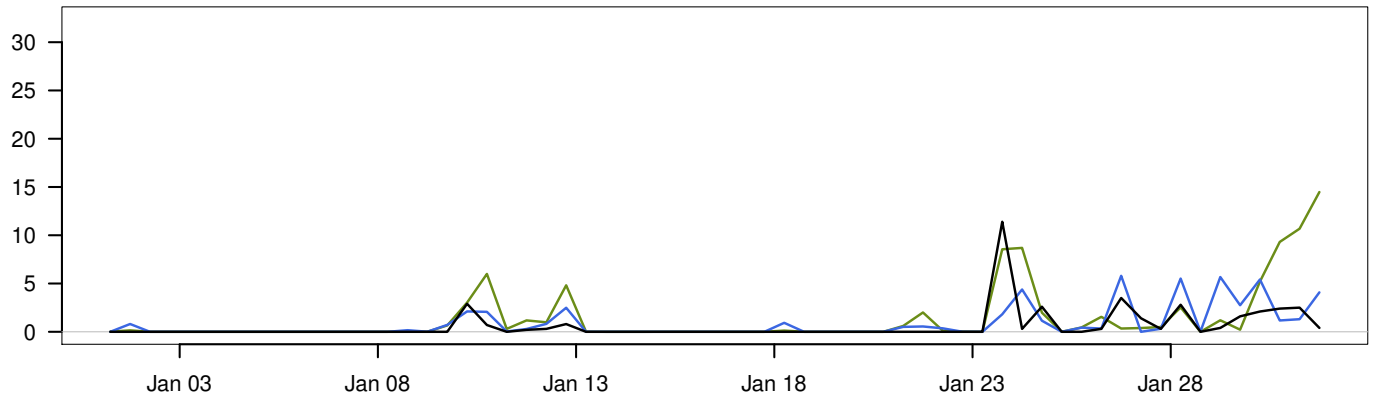
	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.1	1.9	1.9	0.7	17.1	181
AA25 – synop	–0.1	1.6	1.6	0.6	15.8	181
ECMWF – synop	0.4	2.1	2.1	0.9	15.5	181

ØRLAND III

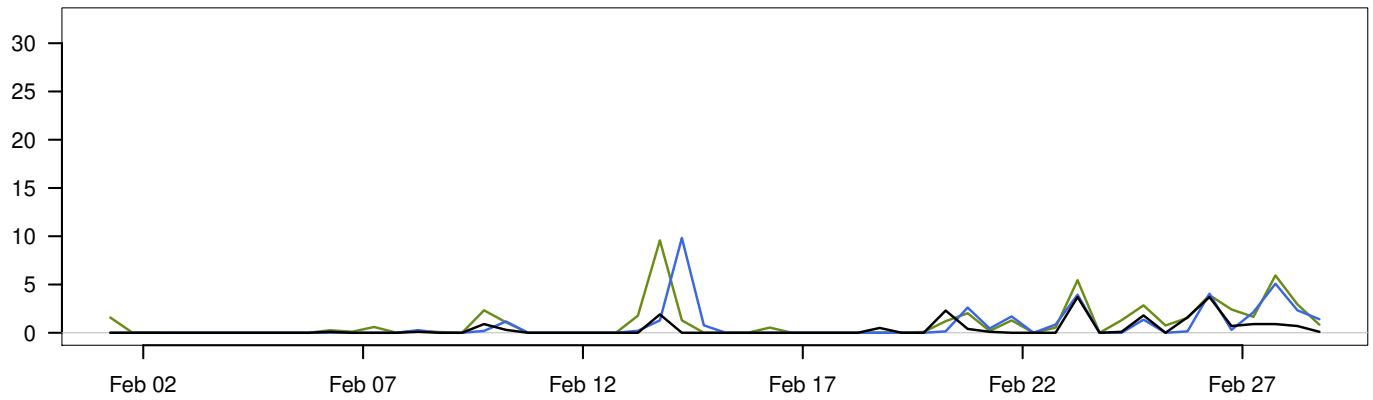
01.12.2020 – 31.12.2020



01.01.2021 – 31.01.2021



01.02.2021 – 28.02.2021



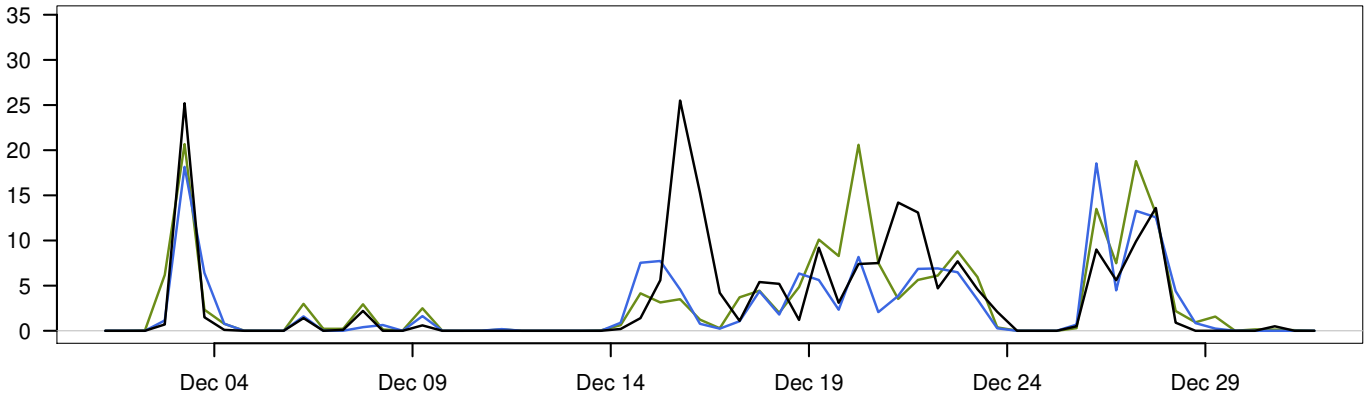
01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 06,18	0	0.6	25.5	2.3	182
MEPSctrl: 12+18,+30	0	0.9	23.5	2.6	182
ECMWF: 12+18,+30	0	1.3	32.4	3.3	182

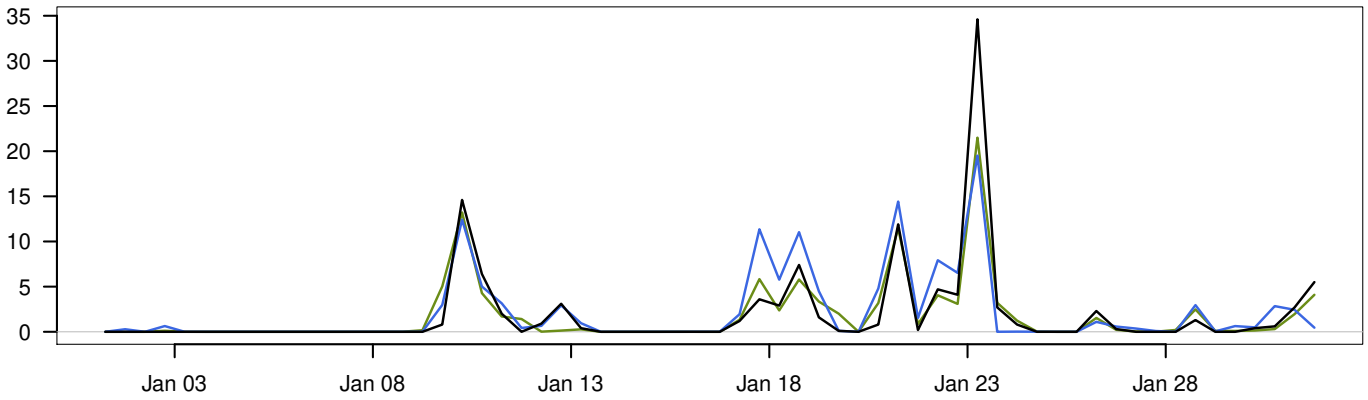
	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.3	1.8	1.8	0.7	14.5	182
ECMWF – synop	0.7	1.9	2	0.8	14.1	182

BERGEN – FLORIDA

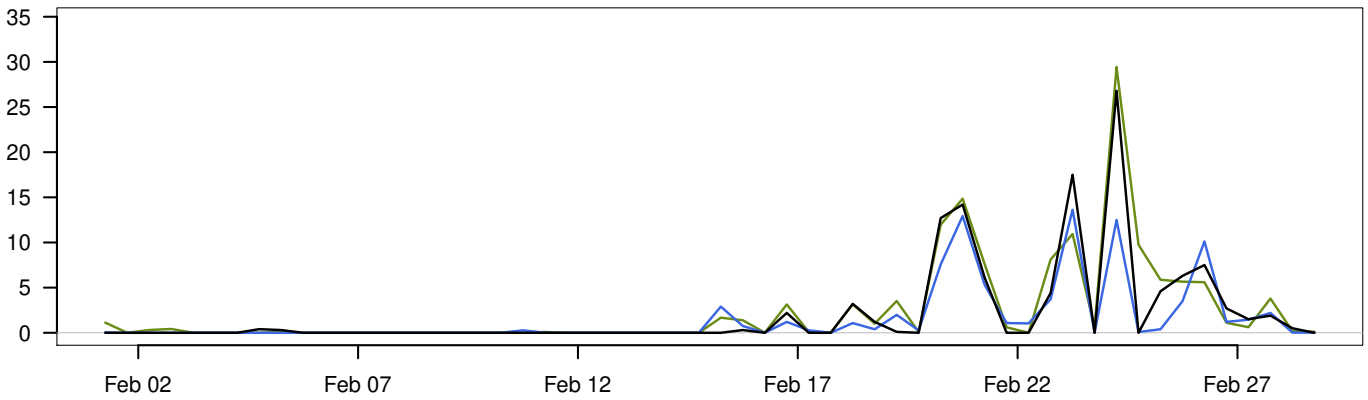
01.12.2020 – 31.12.2020



01.01.2021 – 31.01.2021



01.02.2021 – 28.02.2021

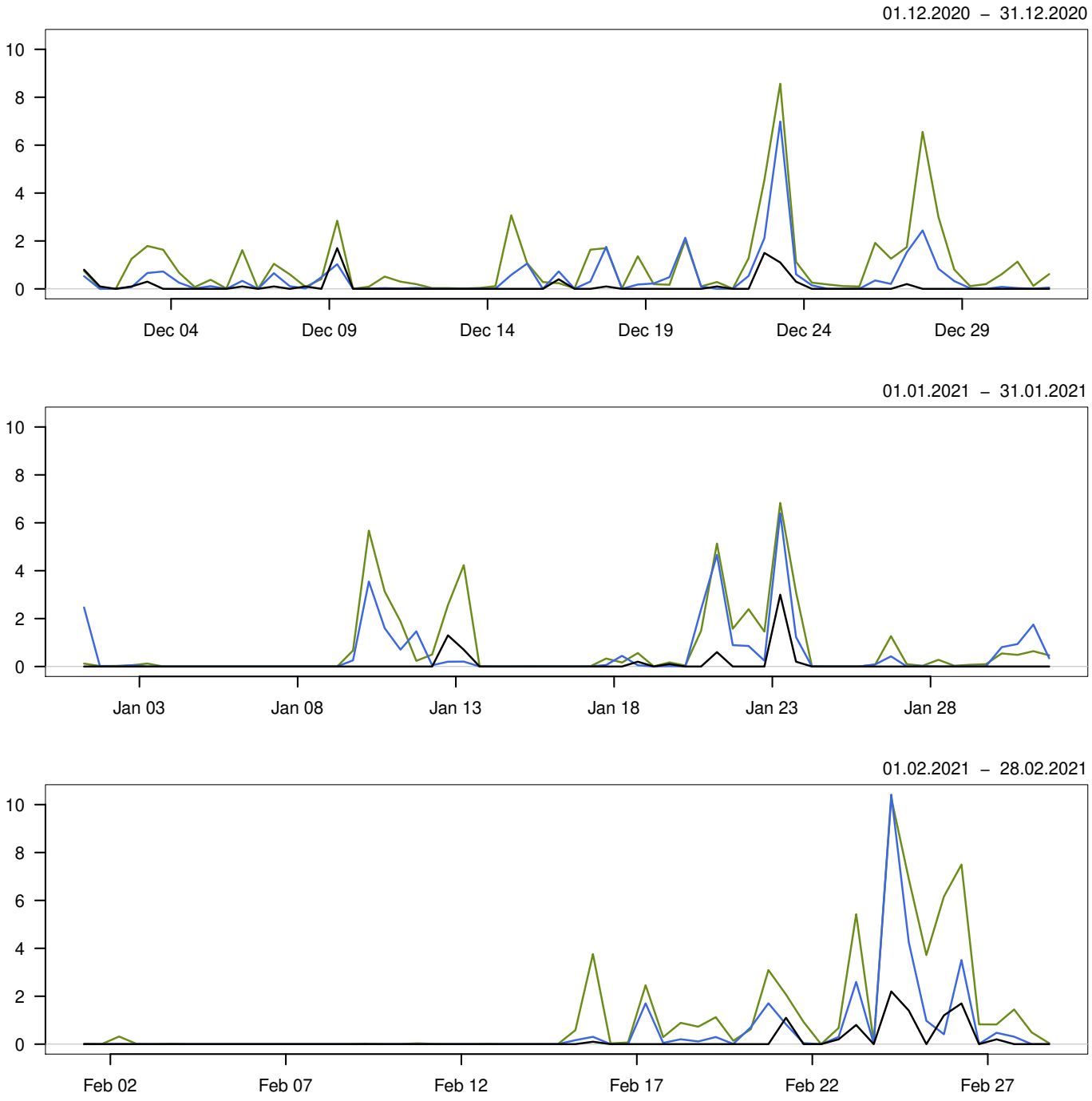


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 06,18	0	2.5	34.6	5.3	182
MEPSctrl: 12+18,+30	0	2.1	19.5	3.9	182
ECMWF: 12+18,+30	0	2.4	29.4	4.6	182

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−0.4	3.2	3.2	1.4	20.9	182
ECMWF – synop	0	3.1	3.1	1.3	22	182

LÆRDAL IV

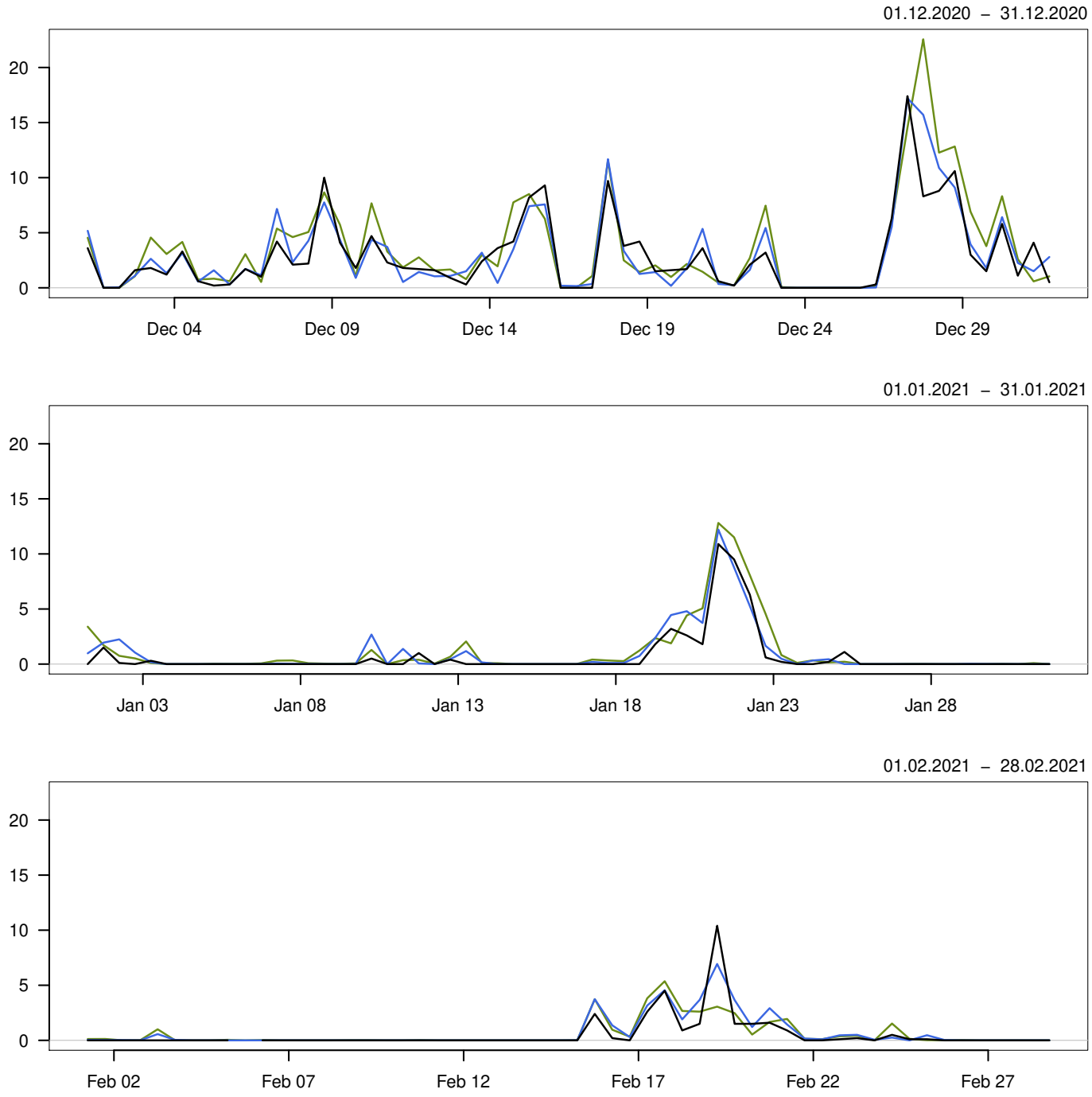


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 06,18	0	0.1	3	0.4	182
MEPSctrl: 12+18,+30	0	0.5	10.4	1.3	182
ECMWF: 12+18,+30	0	0.9	10.3	1.7	182

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.4	1	1.1	0.4	8.2	182
ECMWF – synop	0.8	1.5	1.7	0.8	8.1	182

GARDERMOEN

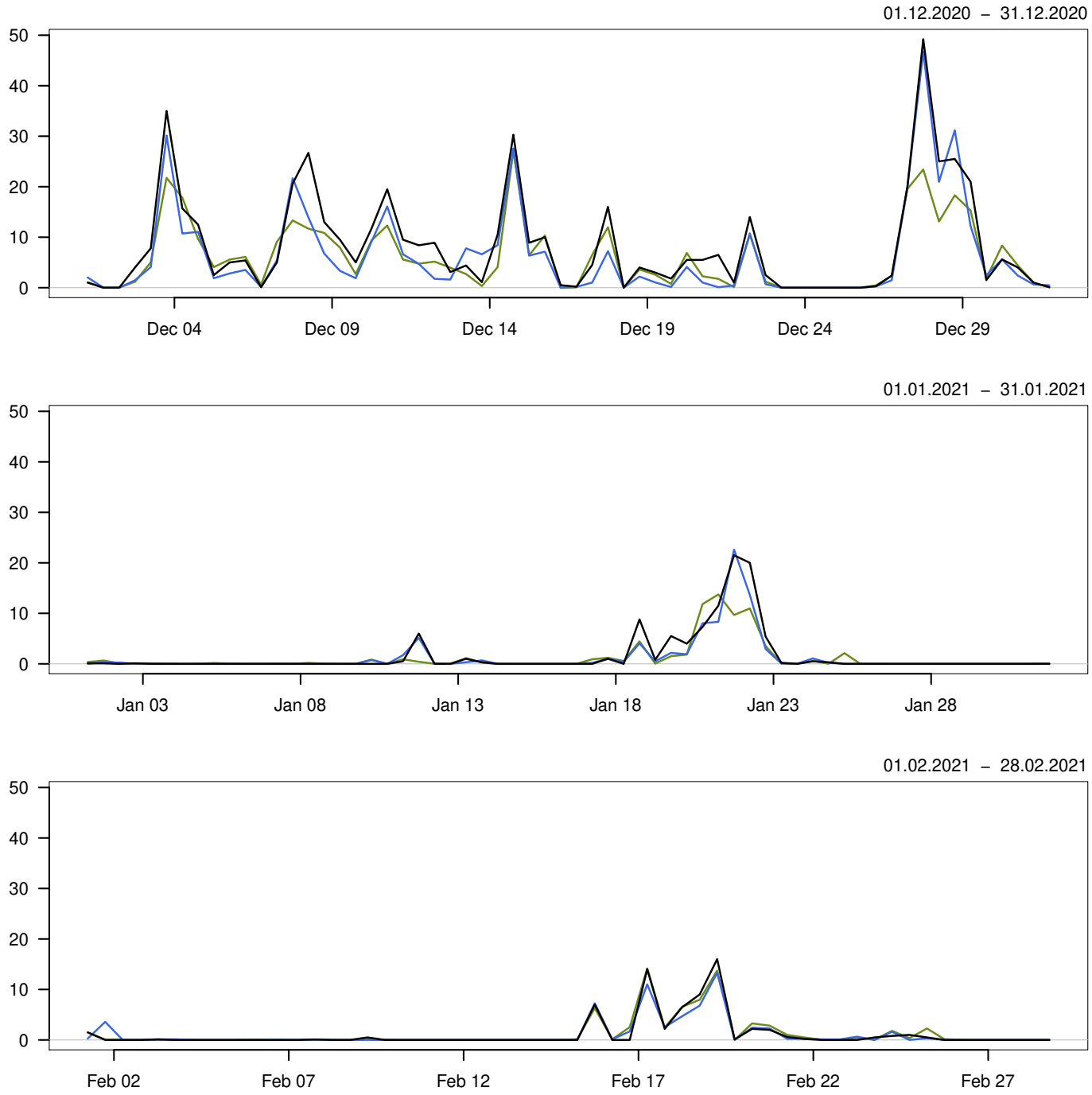


01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 06,18	0	1.4	17.4	2.7	181
MEPSctrl: 12+18,+30	0	1.6	17.2	2.9	182
ECMWF: 12+18,+30	0	1.8	22.6	3.3	182

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	0.2	1.1	1.1	0.5	7.4	181
ECMWF – synop	0.4	1.6	1.7	0.8	14.3	181

NELAUG



01.12.2020 – 28.02.2021

	Min	Mean	Max	Std	N
synop: 06,18	0	3.7	49.2	7.4	182
MEPSctrl: 12+18,+30	0	2.9	46.7	6.5	182
ECMWF: 12+18,+30	0	2.8	27.1	5.1	182

	ME	SDE	RMSE	MAE	Max.abs.err.	N
MEPSctrl – synop	−0.8	2.2	2.3	1.1	12.8	182
ECMWF – synop	−0.9	3.2	3.3	1.3	25.8	182