Norwegian Meteorological Institute

MET info 18/2015 Meteorology

Verification of Experimental and Operational Weather Prediction Models December 2014 to February 2015

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Photo: Ingrid Våset

Contents

1 Models

The following models are verified in this report. All except EC are or have been running at MET.

EC	Global model (IFS) at the ECMWF. From 26 January 2010 resolution $T1279$ or approximately $16 \times 16\ km^2$ horizontally. Available resolution for verification at MET is $0.125°$ latitude and longitude. Number of vertical levels increased from $L91$ to $L137$ 25 June 2013.
Hirlam12 (H12)	Version 7.1, horizontal resolution defined by a $12 \times 12\ km^2$ grid since 13 February 2008.
Hirlam8 (H8)	Version 7.1, horizontal resolution defined by a $8 \times 8\ km^2$ grid since 13 February 2008.
Harmonie5.5	HARMONIE cycle 36h1.3 with ALARO physics run on a $5.5 \times 5.5\ km^2$ grid from 4 May 2011 to 15 January 2013.
Harmonie2.5	HARMONIE cycle 36h1.3 with AROME physics run on a $2.5 \times 2.5\ km^2$ grid from 4 May 2011 to 26 February 2013.
AROME-MetCoOp (AM25)	HARMONIE cycle 38h1.1 with AROME physics run on a $2.5 \times 2.5\ km^2$ grid on same domain as AROME-Norway; experimental since 9 December 2013.

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.

2 HARMONIE, AROME-Norway and AROME-MetCoOp

Experimental HARMONIE models have been run at MET Norway since August 2008, leading to AROME-Norway which on 1 October 2013 was introduced on yr.no, and AROME-MetCoOp which is run in cooperation between Swedish Meteorological and Hydrological Institue and MET Norway and replaced AROME-Norway on yr.no 27 May 2014. HARMONIE is the acronym for HIRLAM's meso-scale forecast system (Hirlam Aladin Regional/Meso-scale Operational NWP In Europe). The HARMONIE system includes several configuration options. This section presents some of the main components and setups that are or has been used at MET. More documentation is available on http://www.cnrm.meteo.fr/gmapdoc/.

2.1 ALARO-0 physics

ALARO-0 has physical parameterizations targeted for grey scale resolutions (4-10 km). It is a spin-off of the Météo-France physical parameterizations used in the globale ARPEGE, but with a separate radiation scheme, 3MT micro-physical frame work, and the Toucans turbulence scheme. Much of the development has been done by the RC LACE (Regional Cooperation for Limited Area modeling in Central Europe) community.

2.2 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.

2.3 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 is already using SURFEX for some of their configurations and is planning to use it for all their configurations. Surface modelling and assimilation benefits from the possibility to run 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 on 1 km resolution. The orography is taken from gtopo30.

“SURFEX Scientific Documentation” and “User’s Guide” are available on http://www.cnrm.meteo.fr/surfex/

2.4 Data assimilation

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

2.4.1 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, 12 and 18.

The Sea Surface Temperature 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. The surface temperature over sea ice is taken from the boundary model and remains unchanged through the forecast.

2.4.2 Upper air analysis

AROME-MetCoOp runs three dimensional variational (3D VAR) data assimilation using conventional observations from synop stations, ships, radiosondes and aircrafts. AMSU-A and AMSU-B/MHS data from the polar orbiting NOAA and METOP satellites is also used.

2.5 Boundaries and initialization of upper air fields

Harmonie5.5 and Harmonie2.5 got their boundary values (3-hourly) from the ECMWF model at approximately 16 km resolution. The upper air fields were initialized from ECMWF forecasts each cycle. Harmonie5.5 had 60 vertical levels (ECMWF60 using the ECMWF definition). Harmonie2.5 had also 60 vertical levels (HIRLAM60 using the HIRLAM definition).

AROME-Norway and AROME-MetCoOp get their boundary values (1-hourly) from the ECMWF model at approximately 16 km resolution. They have currently 65 vertical levels. AROME-Norway do no upper air assimilation, the upper air fields are initialized from ECMWF forecasts

each cycle. None of the HARMONIE configurations at MET have applied digital filter initialization (DFI).

3 Verification measures

All model forecasts in this report are verified against observations by interpolating (bilinear) 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.

3.1 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	$\left(\frac{1}{n} \sum_{i=1}^{n}(f_i - o_i - ME)^2 \right)^{1/2}$	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	$\frac{\frac{1}{n}\sum_{i=1}^{n}(f_i - \bar{f})(o_i - \bar{o})}{SD(f)SD(o)}$	-1 to 1	1

In the formula for COR the following definitions are used

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

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

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

3.2 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)

In the formula for ETS $ar = (a+b)(a+c)/n$.

3.3 Observations

All observations come from Klimadatavarehuset at MET. Only synop stations are used, except for precipitation where all availiable stations are used for better spatial coverage. The model wind speed is verified against the mean wind FF observations. For post processed wind speed, the maxium 10 min mean wind speed last hour, FX, is used.

3.4 Changes since last report

- AROME-Norway now switched off

4 Norway

4.1 Comments to verification results

Mean Sea Level Pressure:
ECMWF scores best for MSLP, but MAE have increased for all models, from about 1.5hPa for the highest lead times during autumn, to 2.5hPa during winter. The increased MAE appears to related to the unsystematic error. The long term verification show that the MAE in MSLP normally have a peak during winter.

Wind speed:
Mean wind speed:
Most models have positive biases for 10m mean wind speed, the exception is ECMWF. AM25 deviates the most from the observations with mean wind speed around $0.7ms^{-1}$ higher. AM25 has the highest SDE, but the lowest MAE up to 33h. After 33h, ECMWF has the lowest MAE.

AM25 has the highest hit rate (HR) for almost all thresholds, but also the highest false alarm ratio. Still, in the ETS, AM25 scores highest. Most models have too few of the wind events between $0 - 3ms^{-1}$ and too many of the $3 - 11ms^{-1}$ AM25 is the model with the best representation of the highest wind speed, but even this model underrepresent the frequency of wind speeds above $21ms^{-1}$.

Max mean wind speed:
After post processing, AM25 has almost no bias for the max mean wind speed. It also scores best at ETS.

Wind gust:
The wind gust in the AM25 model is generally too low compared with the observed wind gust. The 925hPa wind and the H8 wind gust normally have too high wind gusts. In total, AM25_FG has the best representation of the wind gust, except for the two highest categories.

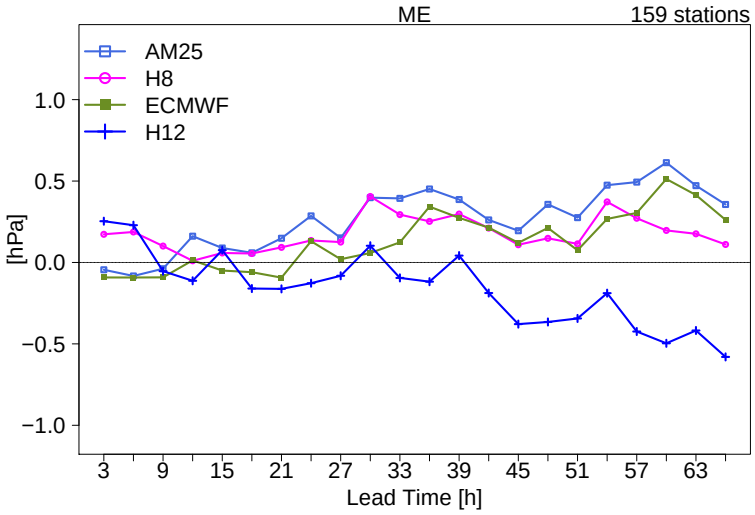
Temperature 2m:
ECMWF has a very clear cold bias and trend in temperature. At the end of the short term forecast, it is nearly 1.5°C too cold. There is also a cold bias and trend in AM25, but not as strong as in ECMWF. H8 has almost no bias. The SDE is lowest for AM25, which also has the lowest MAE. ECMWF has about 0.5°C higher MAE than AM25.

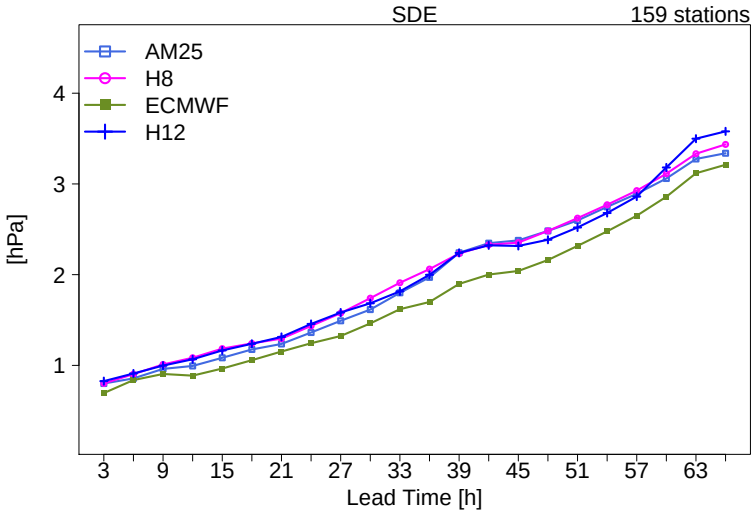
Post processed temperature:
The post processing of AM25 reduces the bias, but there is still a cold trend with longer lead

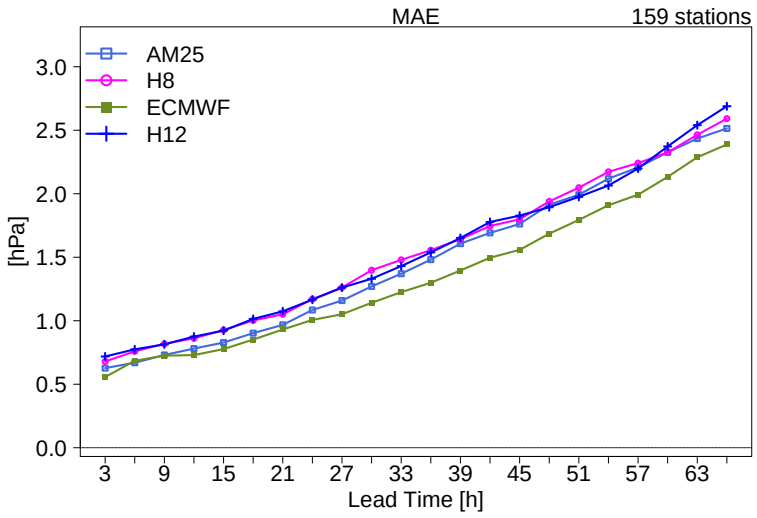
times. With post processing, the overall MAE is reduced with around 0.1°C, most of the reduction is with short lead times.

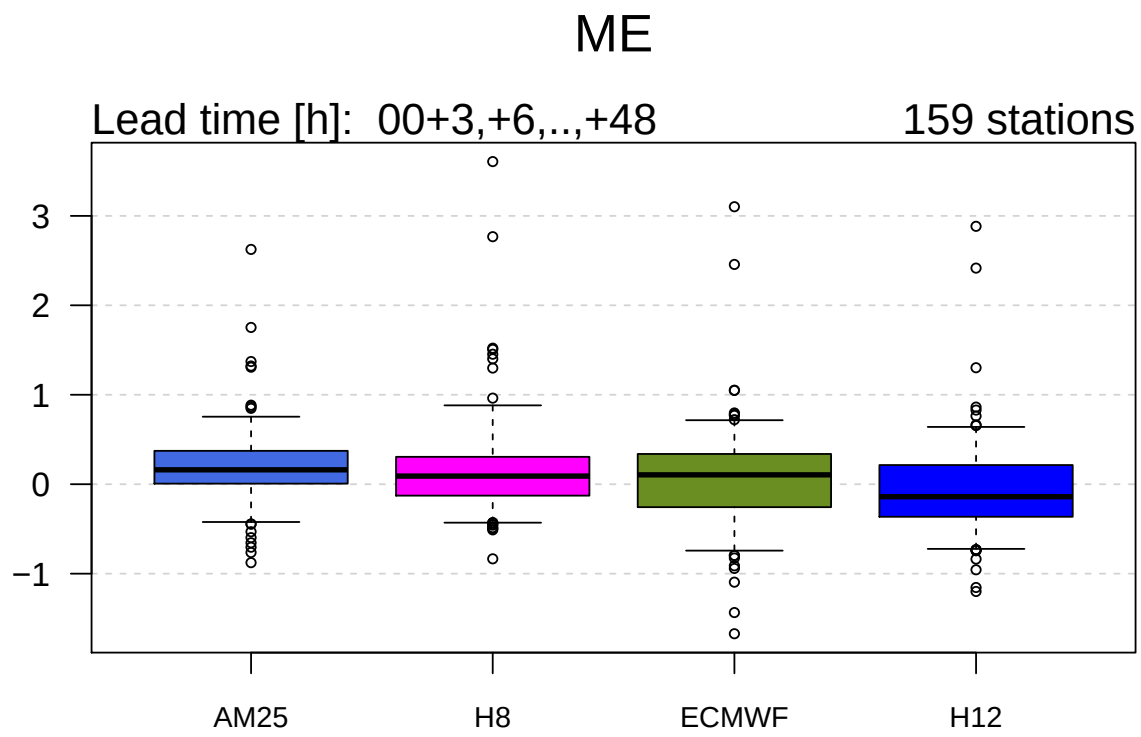
Daily precipitation:
Most models, except ECMWF, have too little precipitation compared with the observations. AM25 has the highest ETS score for all threshold. AM25 also has the best representation of the highest precipitation amounts.

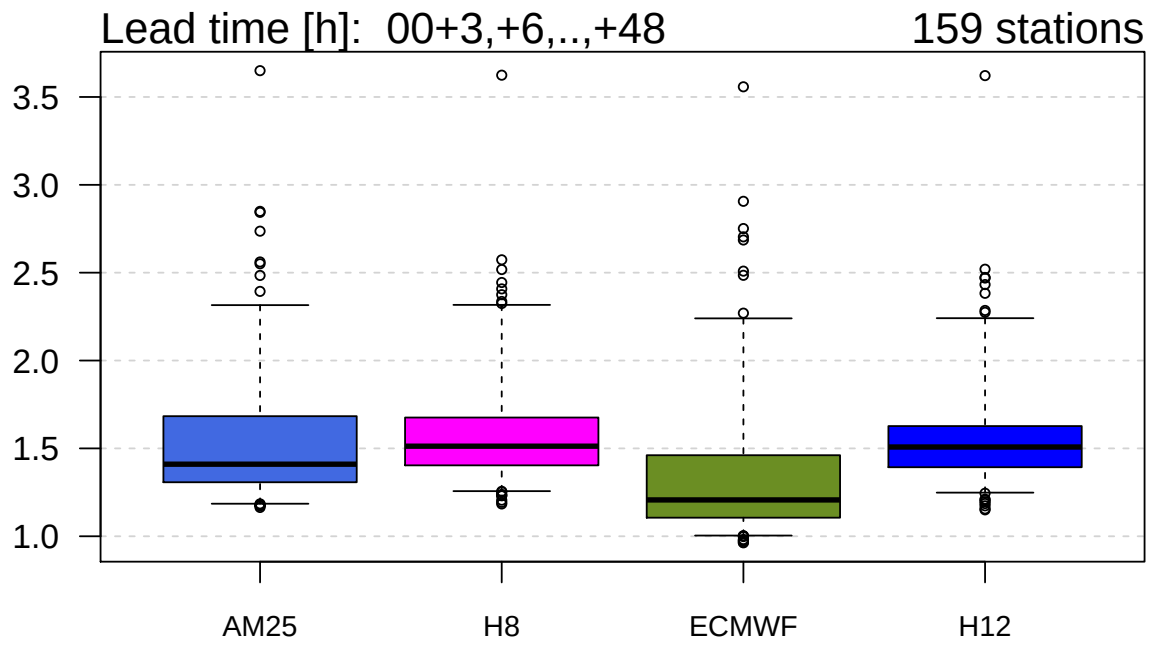
4.2 Pressure and variables at pressure levels



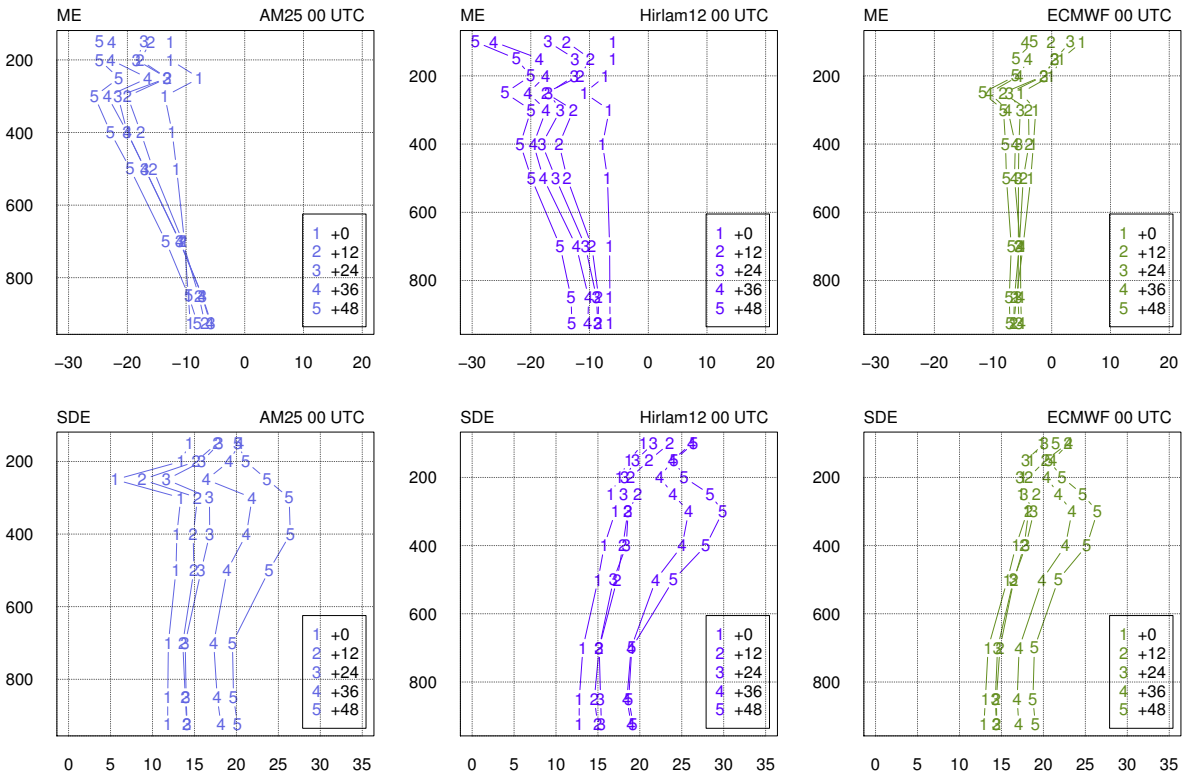




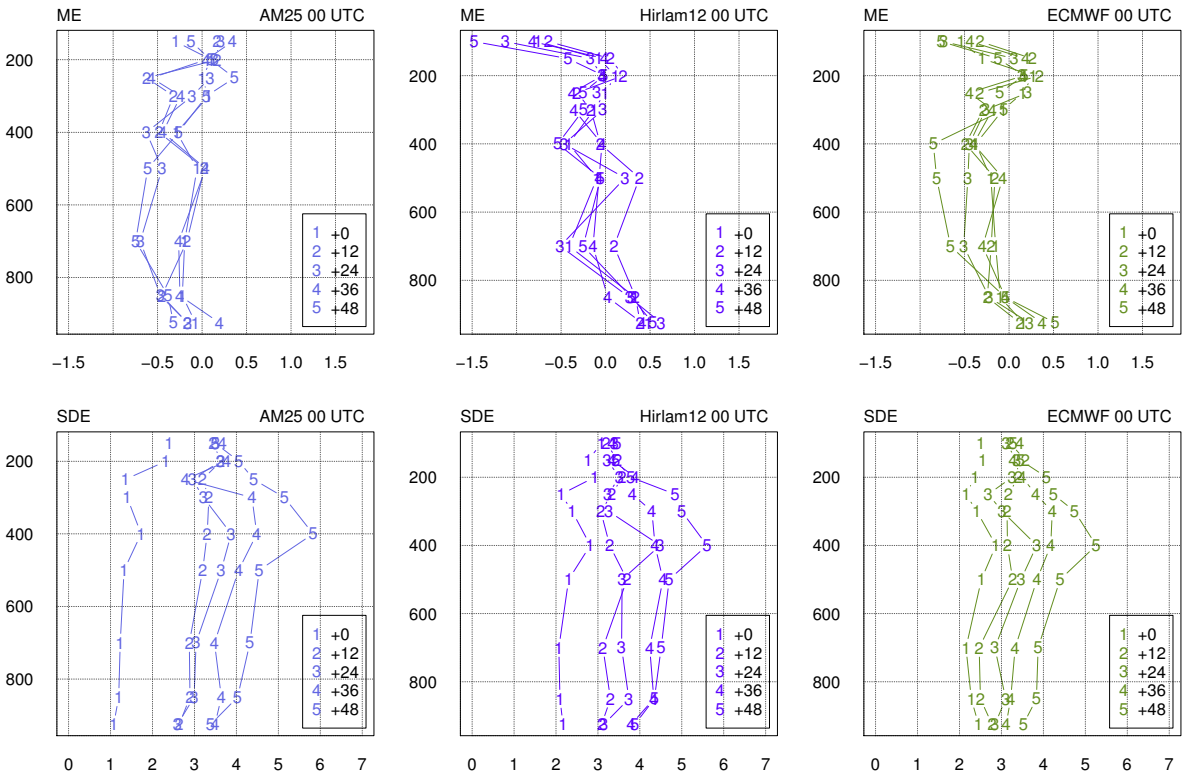

ME
Lead time [h]: 00+3,+6,..,+48
159 stations
3
2
1
0
−1
AM25
H8
ECMWF
H12

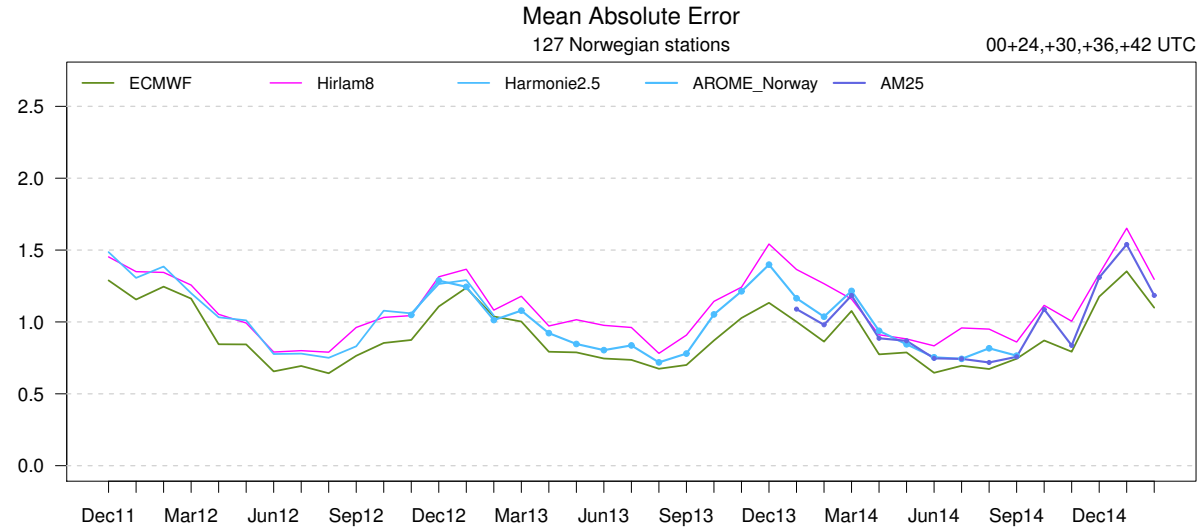

SDE
Lead time [h]: 00+3,+6,..,+48
159 stations
3.5
3.0
2.5
2.0
1.5
1.0
AM25
H8
ECMWF
H12

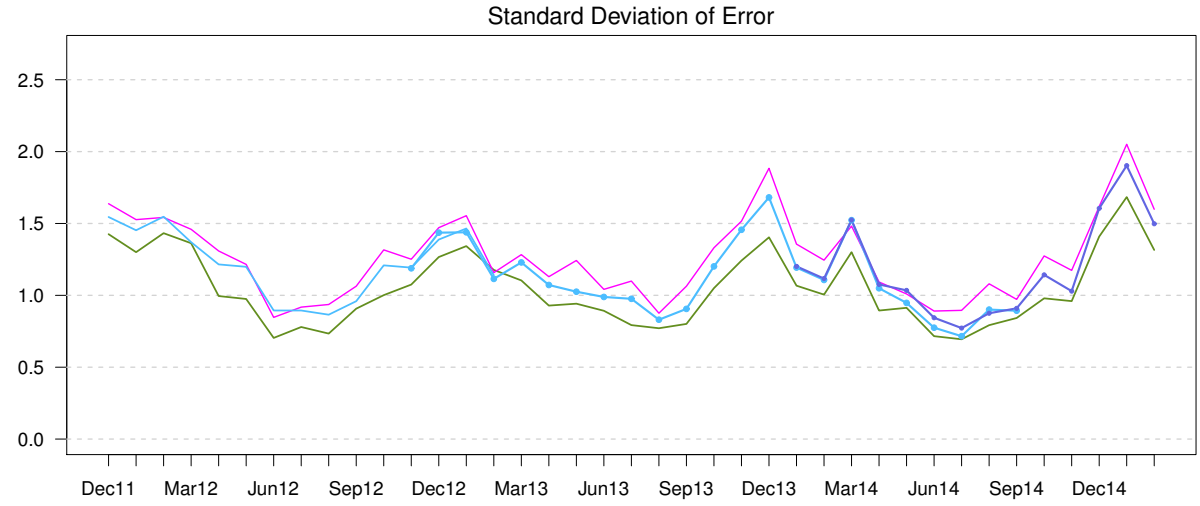
Geopotential height at 3 Norwegian stations

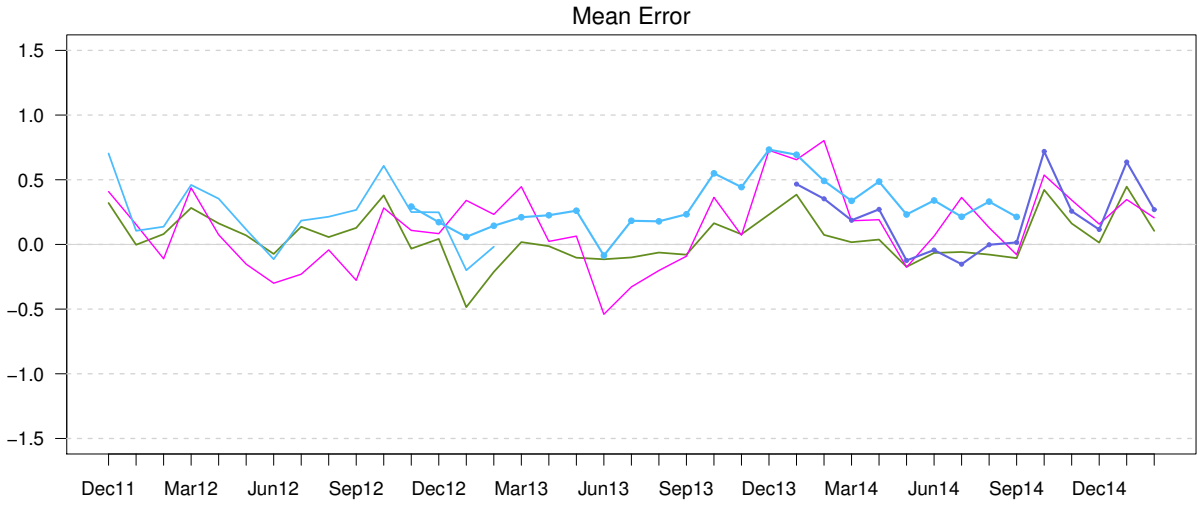


Wind speed at 3 Norwegian stations

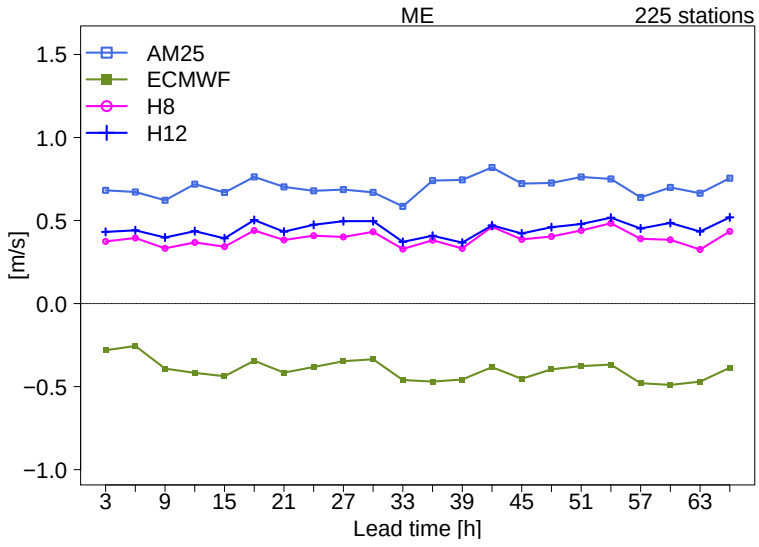


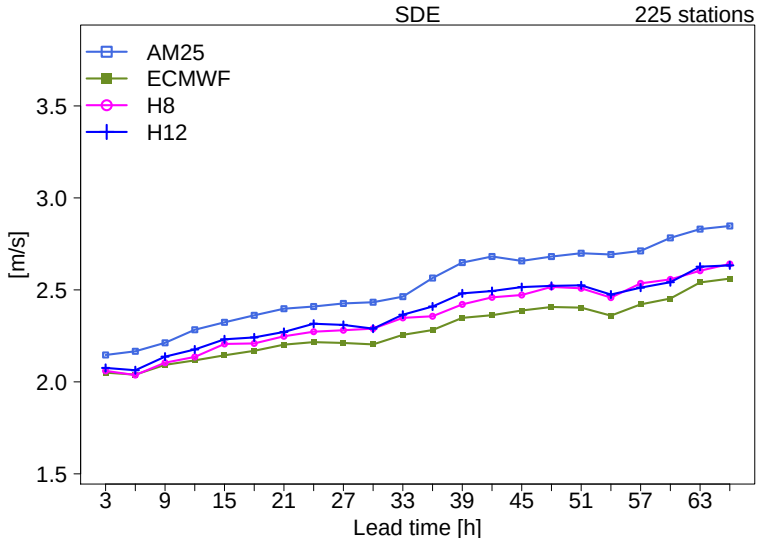

Mean Absolute Error
127 Norwegian stations
00+24,+30,+36,+42 UTC
ECMWF
Hirlam8
Harmonie2.5
AROME_Norway
AM25
2.5
2.0
1.5
1.0
0.5
0.0
Dec11
Mar12
Jun12
Sep12
Dec12
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14

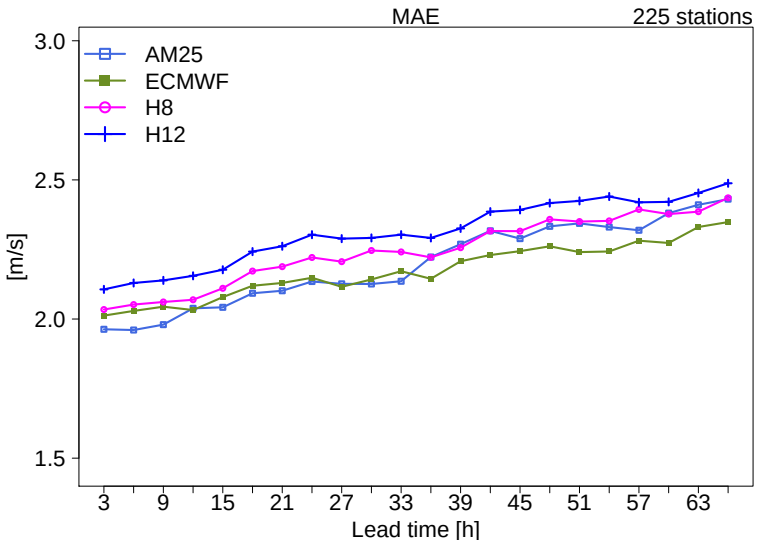

Standard Deviation of Error
2.5
2.0
1.5
1.0
0.5
0.0
Dec11
Mar12
Jun12
Sep12
Dec12
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14

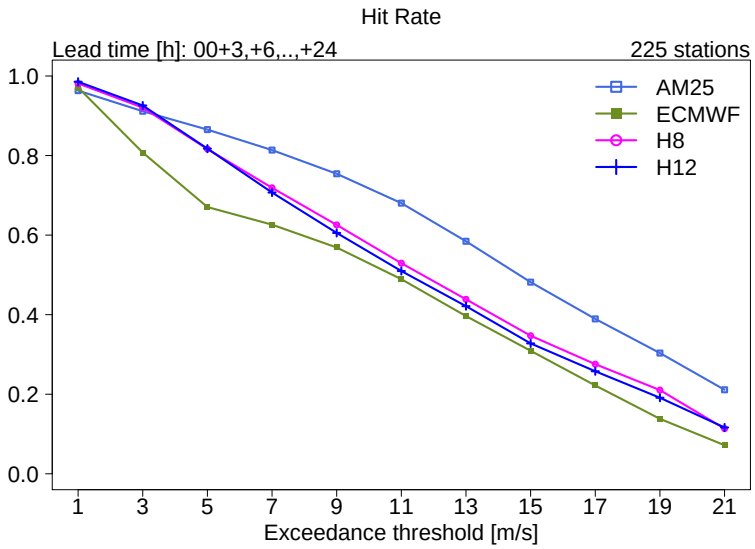

Mean Error
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
Dec11
Mar12
Jun12
Sep12
Dec12
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14

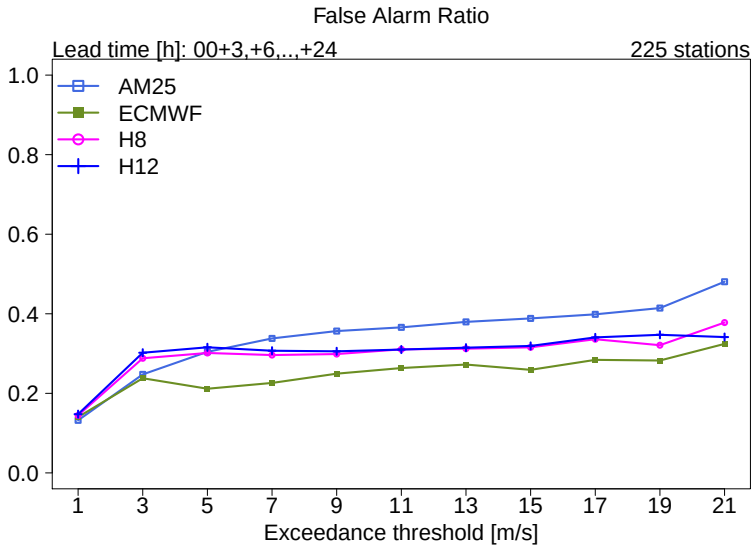
4.3 Wind Speed 10m

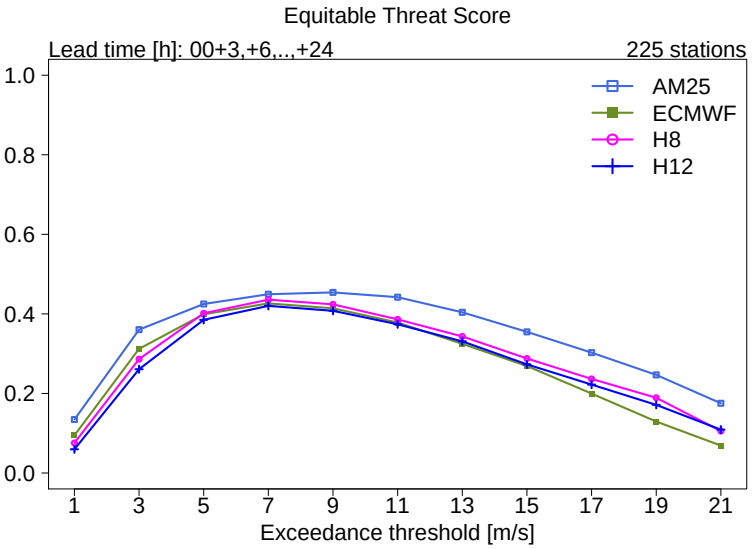


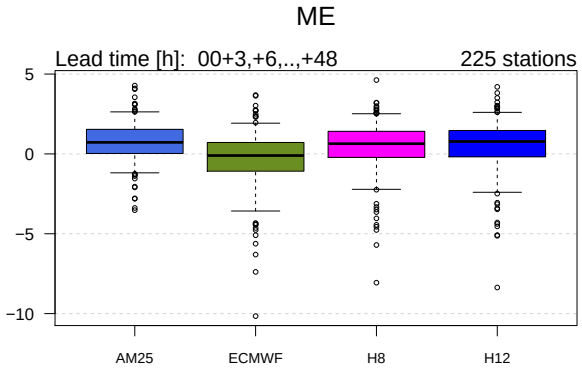


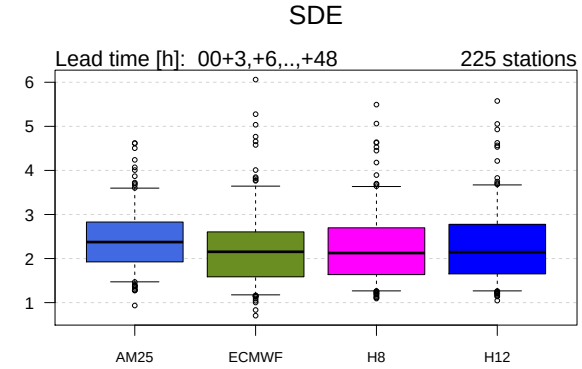



Hit Rate
Lead time [h]: 00+3,+6,..,+24
225 stations
AM25
ECMWF
H8
H12
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


False Alarm Ratio
Lead time [h]: 00+3,+6,..,+24
225 stations
AM25
ECMWF
H8
H12
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


Equitable Threat Score
Lead time [h]: 00+3,+6,..,+24
225 stations
AM25
ECMWF
H8
H12
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]





Lead time [h]: 00+3,+6,..,+48 UTC

225 stations

AM25

OBS

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	70571	14918	163	11	3	85666
(3,11]	48273	103223	9564	474	92	161626
(11,17]	801	11509	14329	2390	500	29529
(17,21]	30	386	1011	1003	555	2985
(21,Inf]	3	35	95	152	248	533
Sum	119678	130071	25162	4030	1398	280339

H8

OBS

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	58852	13236	311	7	5	72411
(3,11]	60599	109359	13062	1135	346	184501
(11,17]	220	7351	11082	2085	492	21230
(17,21]	7	112	690	741	427	1977
(21,Inf]	0	13	17	62	128	220
Sum	119678	130071	25162	4030	1398	280339

ECMWF

OBS

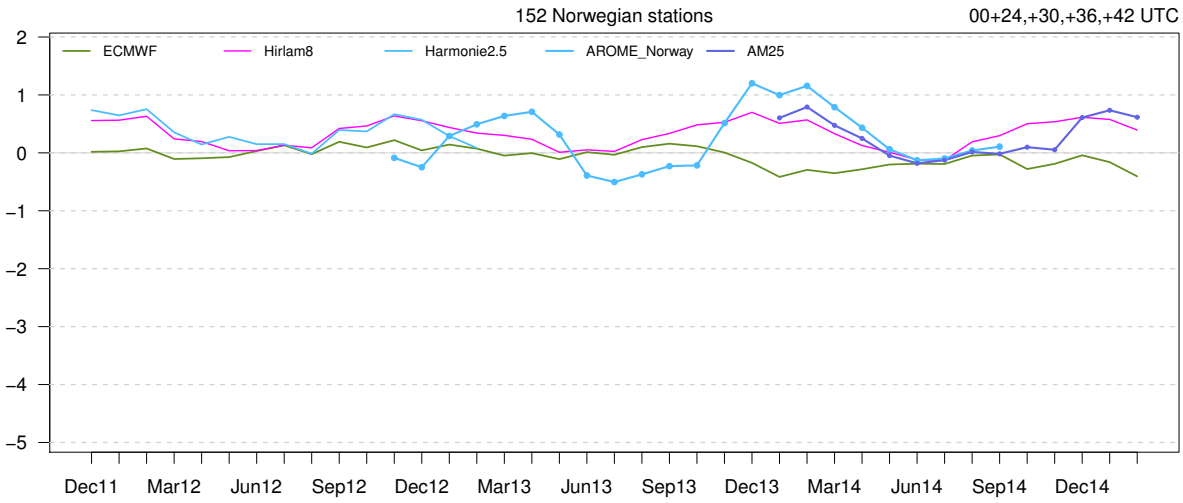
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	78923	29886	1261	215	86	110371
(3,11]	40635	94642	13251	1022	299	149849
(11,17]	113	5475	10225	2205	488	18506
(17,21]	7	67	406	564	449	1493
(21,Inf]	0	1	19	24	76	120
Sum	119678	130071	25162	4030	1398	280339

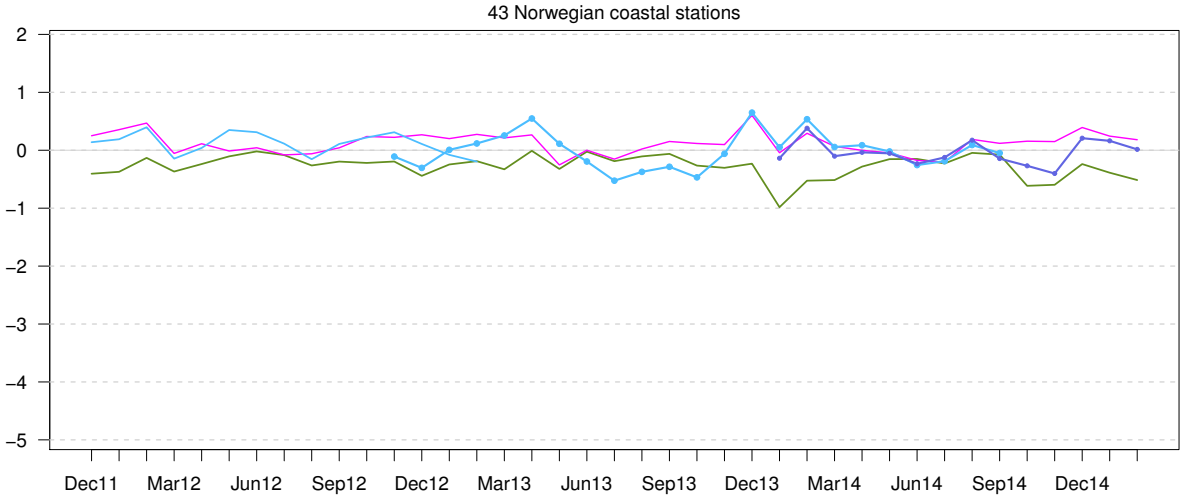
H12

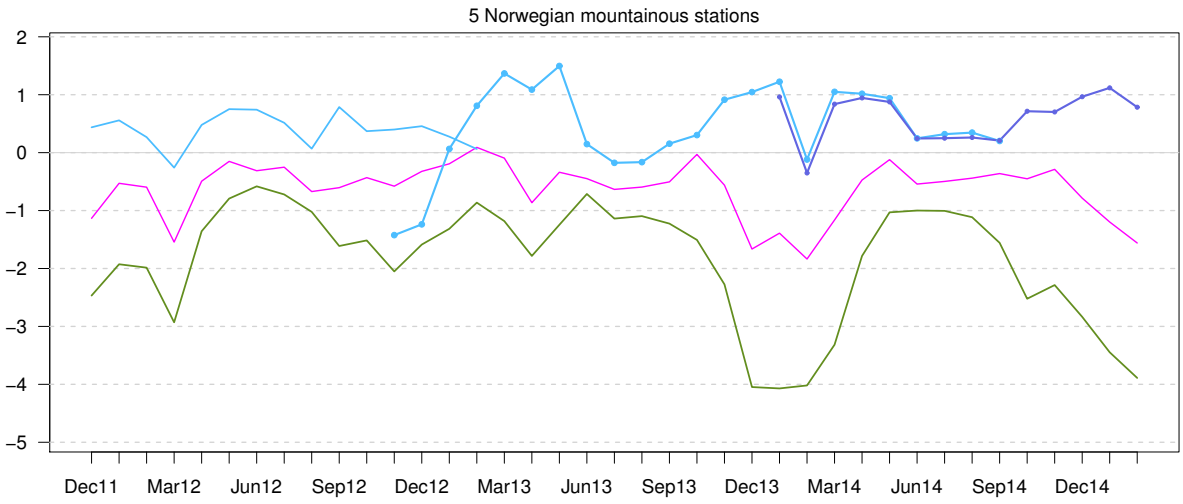
OBS

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	54445	12219	246	17	7	66934
(3,11]	65005	110696	13755	1193	375	191024
(11,17]	224	7043	10520	2078	487	20352
(17,21]	4	106	619	686	413	1828
(21,Inf]	0	7	22	56	116	201
Sum	119678	130071	25162	4030	1398	280339

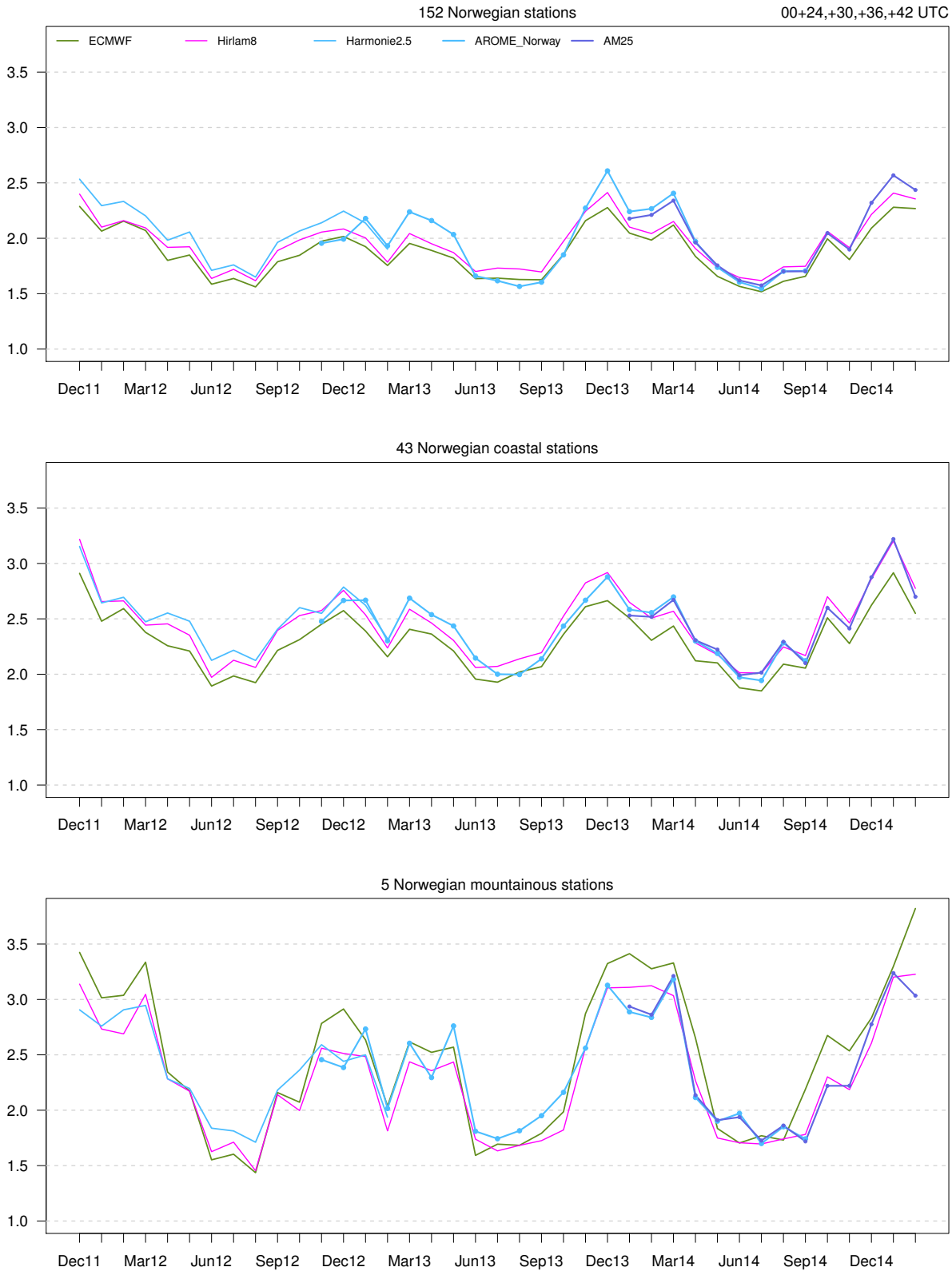
Mean Error


152 Norwegian stations
00+24,+30,+36,+42 UTC
ECMWF
Hirlam8
Harmonie2.5
AROME_Norway
AM25
2
1
0
−1
−2
−3
−4
−5
Dec11
Mar12
Jun12
Sep12
Dec12
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14

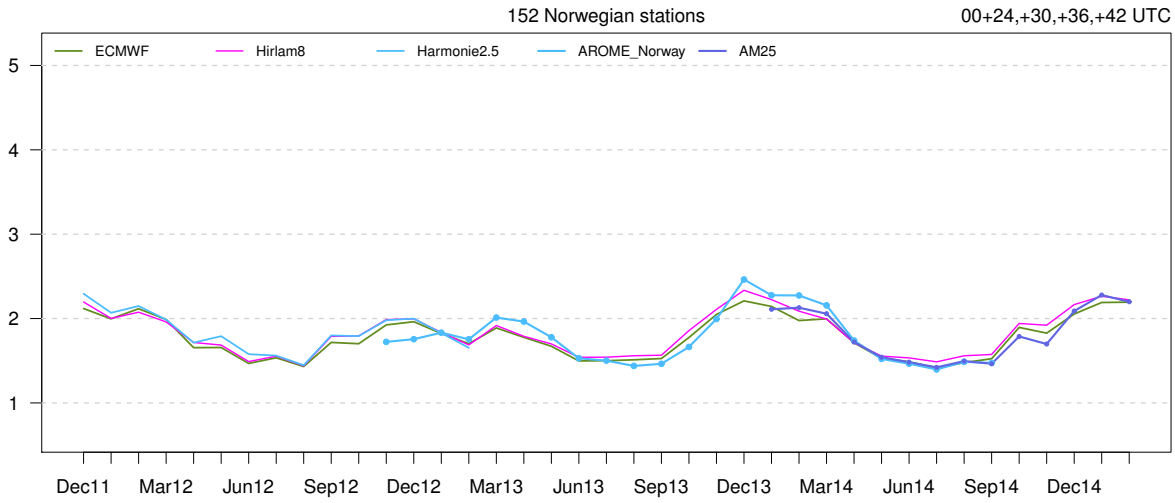

43 Norwegian coastal stations
2
1
0
−1
−2
−3
−4
−5
Dec11
Mar12
Jun12
Sep12
Dec12
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14

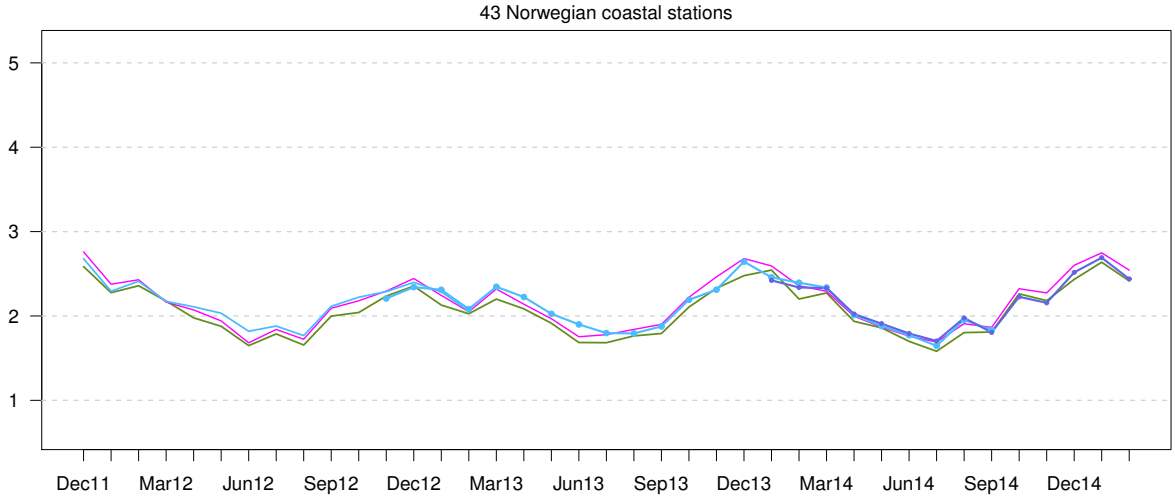

5 Norwegian mountainous stations
2
1
0
−1
−2
−3
−4
−5
Dec11
Mar12
Jun12
Sep12
Dec12
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14

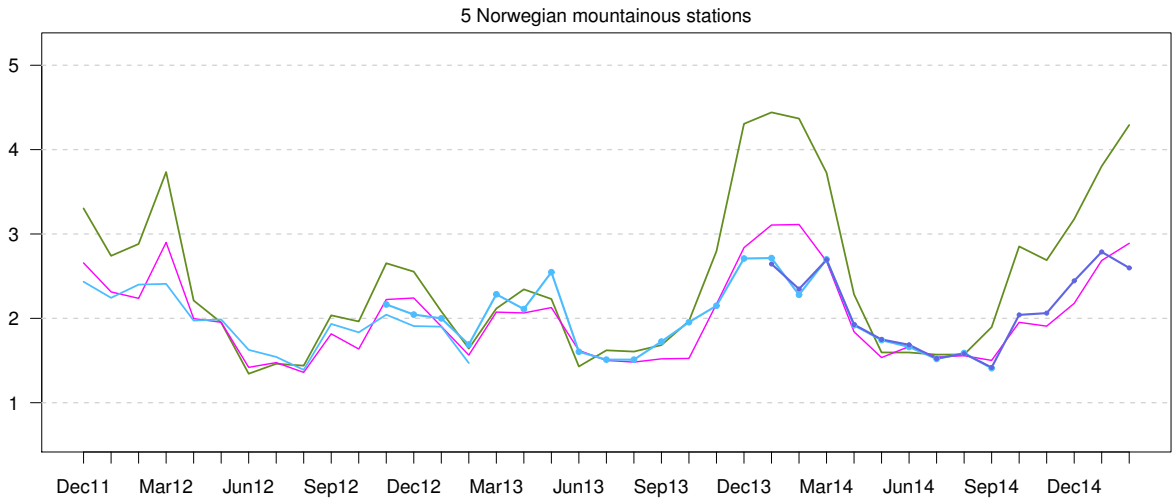
Standard Deviation of Error



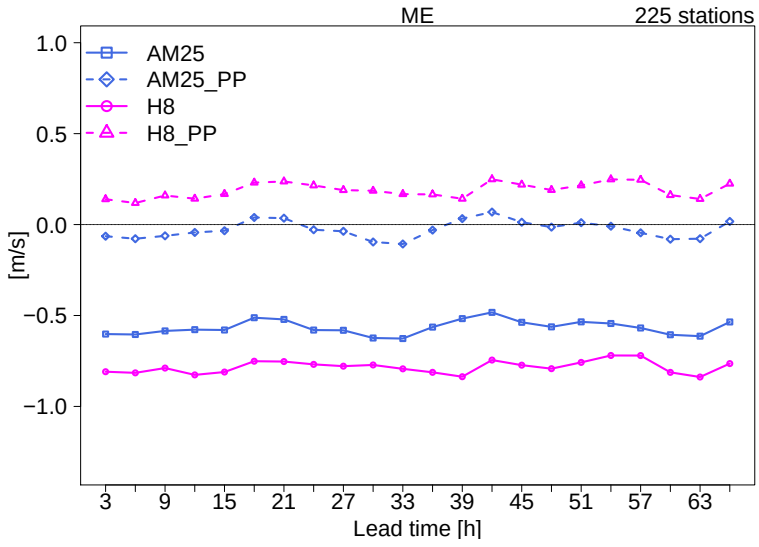
Mean Absolute Error

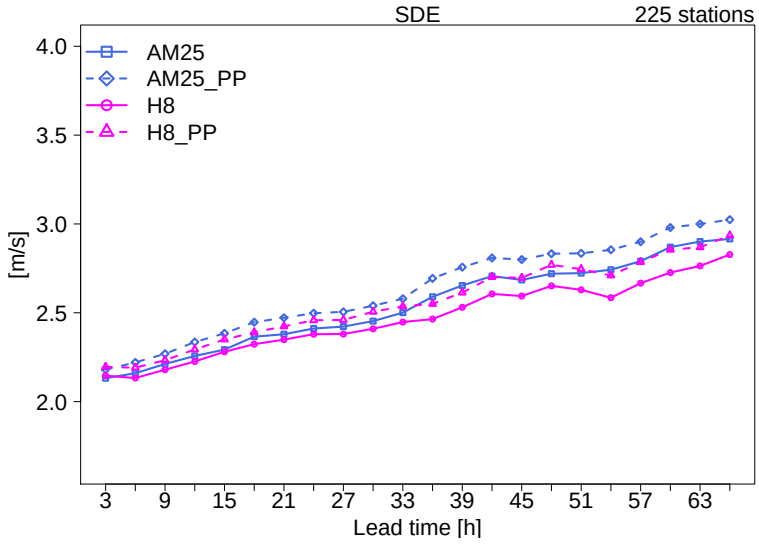


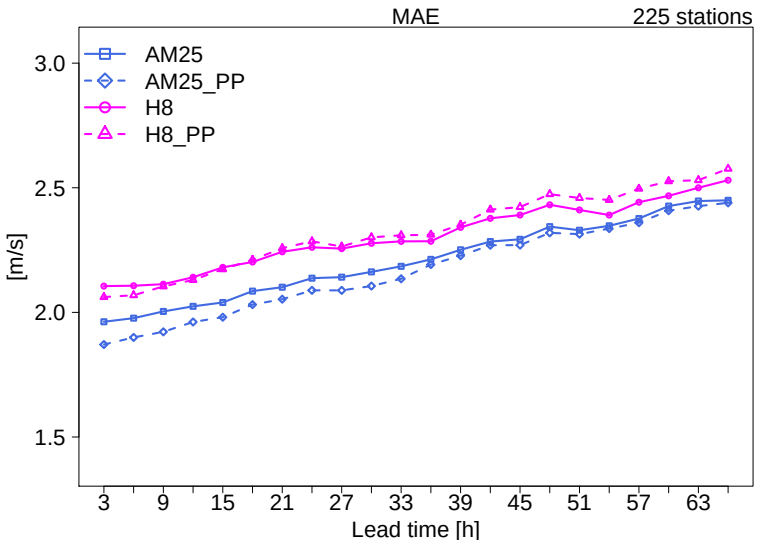


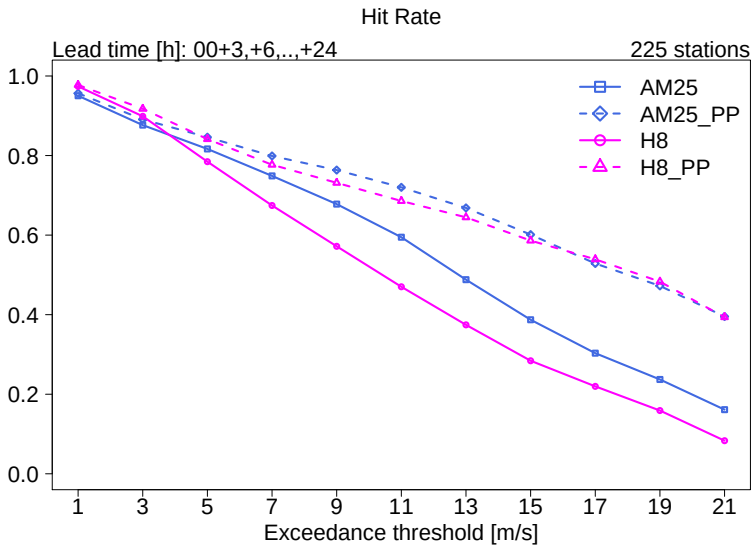


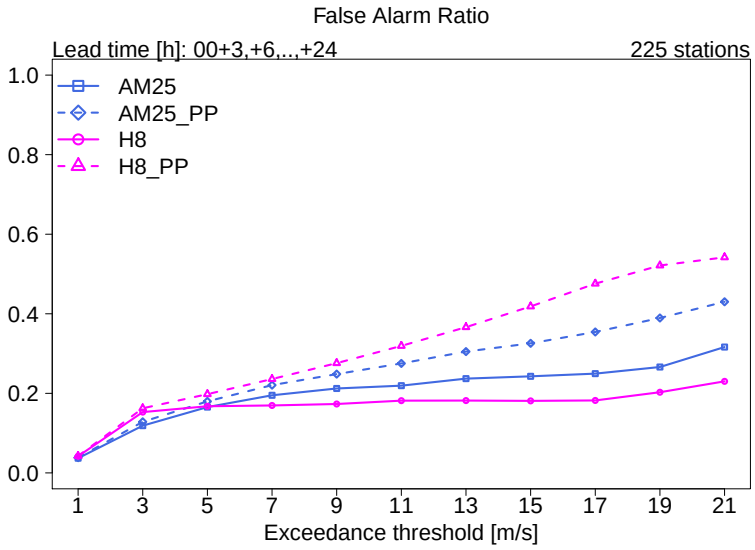
4.4 Max Mean Wind Speed 10m

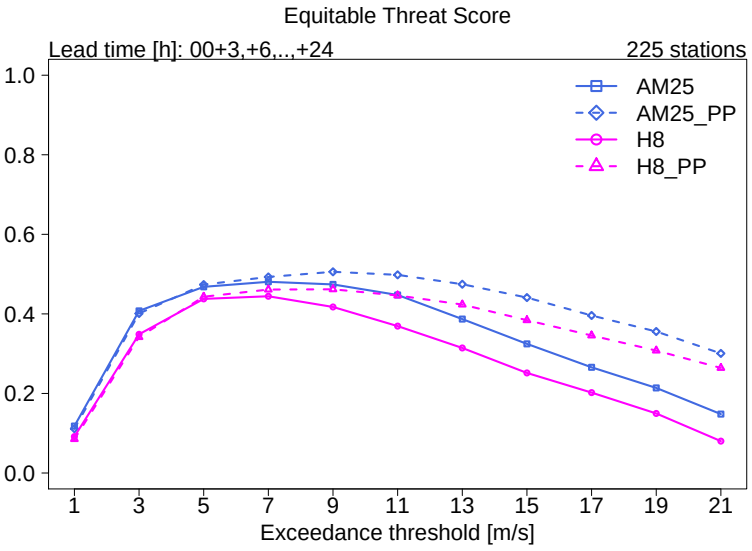


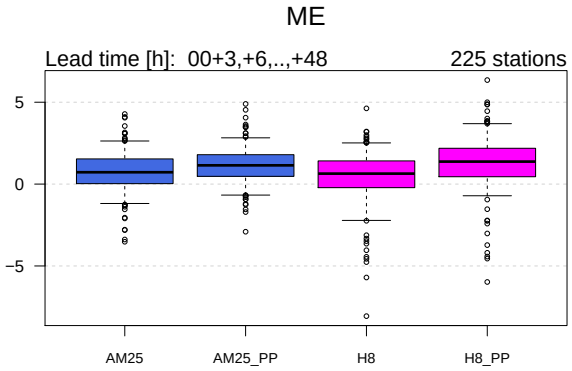


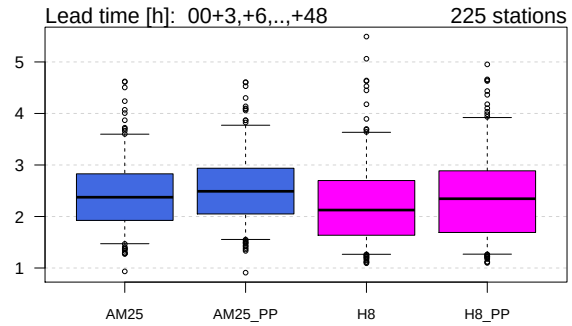



Hit Rate
Lead time [h]: 00+3,+6,..,+24
225 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


False Alarm Ratio
Lead time [h]: 00+3,+6,..,+24
225 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


Equitable Threat Score
Lead time [h]: 00+3,+6,..,+24
225 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]





Lead time [h]: 00+3,+6,..,+48 UTC 225 stations

AM25

OBS

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	44496	20168	294	16	5	64979
(3,11]	19645	95614	15075	810	172	131316
(11,17]	225	6708	14864	3926	954	26677
(17,21]	9	225	648	1038	892	2812
(21,Inf]	0	28	56	104	325	513
Sum	64375	122743	30937	5894	2348	226297

AM25_PP

OBS

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	42472	17978	240	13	4	60707
(3,11]	21570	93659	10901	449	95	126674
(11,17]	321	10584	17695	2957	552	32109
(17,21]	9	445	1895	1993	845	5187
(21,Inf]	3	77	206	482	852	1620
Sum	64375	122743	30937	5894	2348	226297

H8

OBS

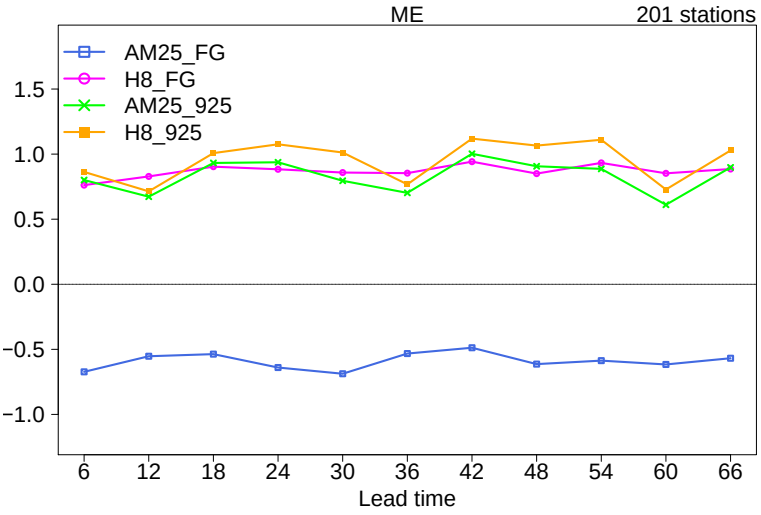
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	37361	16460	512	17	5	54355
(3,11]	26941	101926	18484	1585	549	149485
(11,17]	70	4300	11522	3462	941	20295
(17,21]	3	47	406	793	695	1944
(21,Inf]	0	10	13	37	158	218
Sum	64375	122743	30937	5894	2348	226297

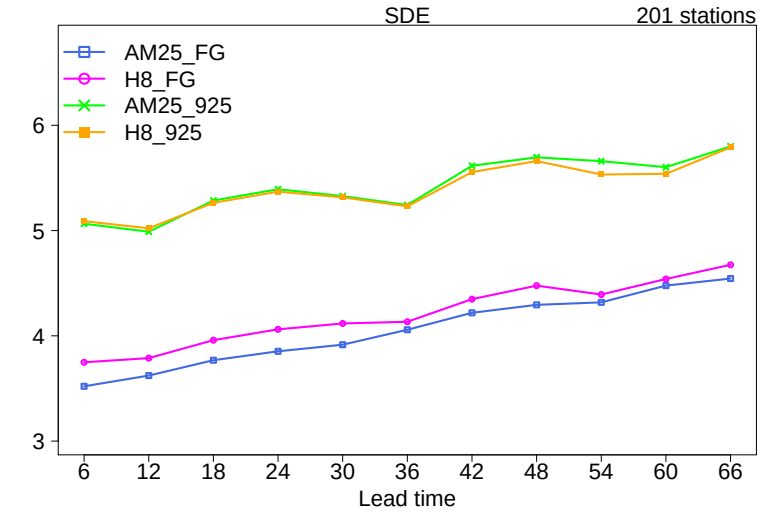
H8_PP

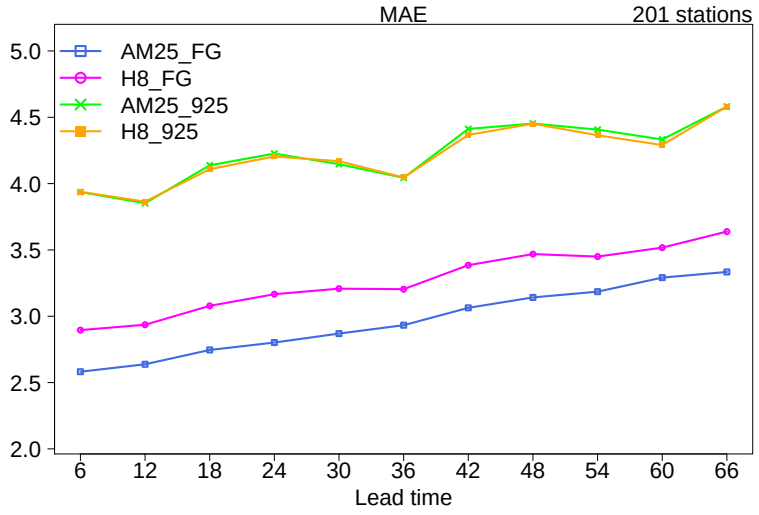
OBS

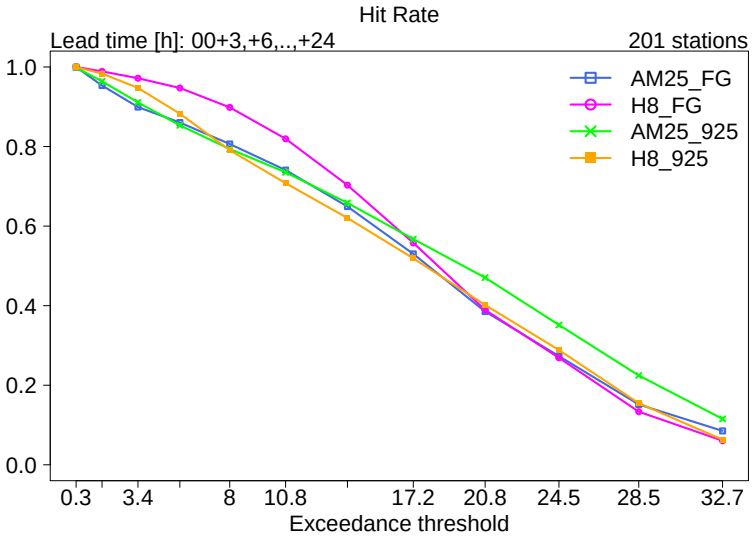
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	34956	13737	242	11	4	48950
(3,11]	29115	95977	11447	850	323	137712
(11,17]	266	12429	15643	2308	510	31156
(17,21]	36	541	3254	1991	678	6500
(21,Inf]	2	59	351	734	833	1979
Sum	64375	122743	30937	5894	2348	226297

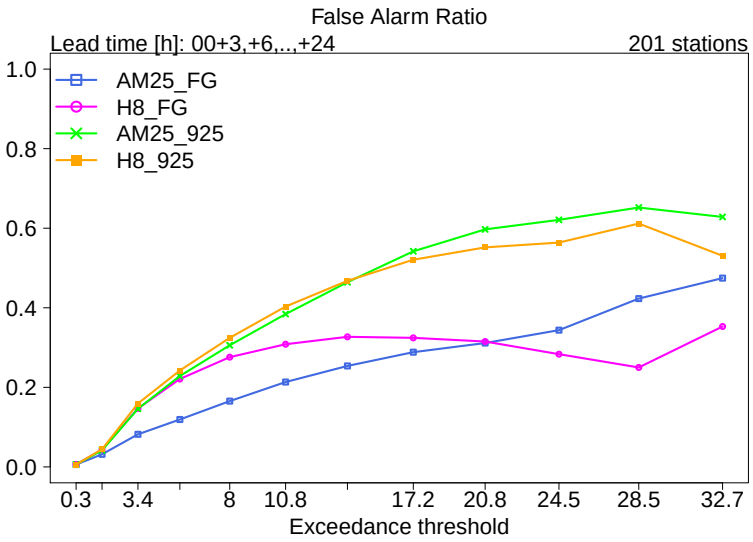
4.5 Wind gust

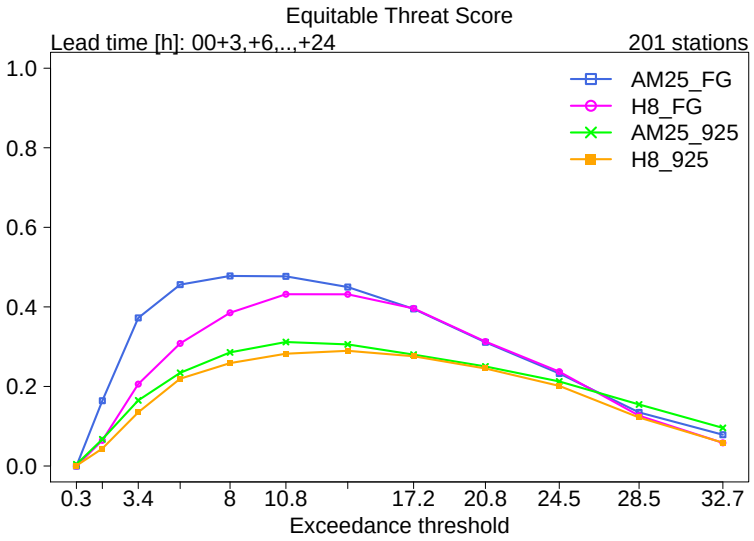

ME
201 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.5
1.0
0.5
0.0
−0.5
−1.0
6
12
18
24
30
36
42
48
54
60
66
Lead time


SDE
201 stations
AM25_FG
H8_FG
AM25_925
H8_925
6
5
4
3
6
12
18
24
30
36
42
48
54
60
66
Lead time

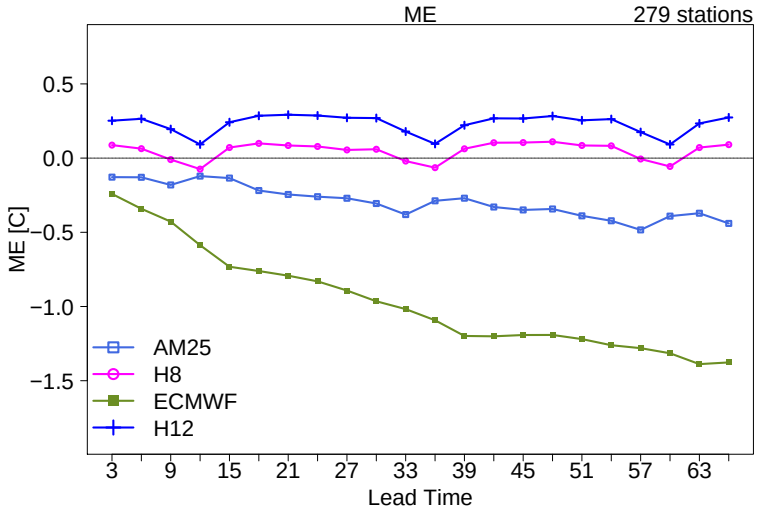

MAE
201 stations
AM25_FG
H8_FG
AM25_925
H8_925
5.0
4.5
4.0
3.5
3.0
2.5
2.0
6
12
18
24
30
36
42
48
54
60
66
Lead time

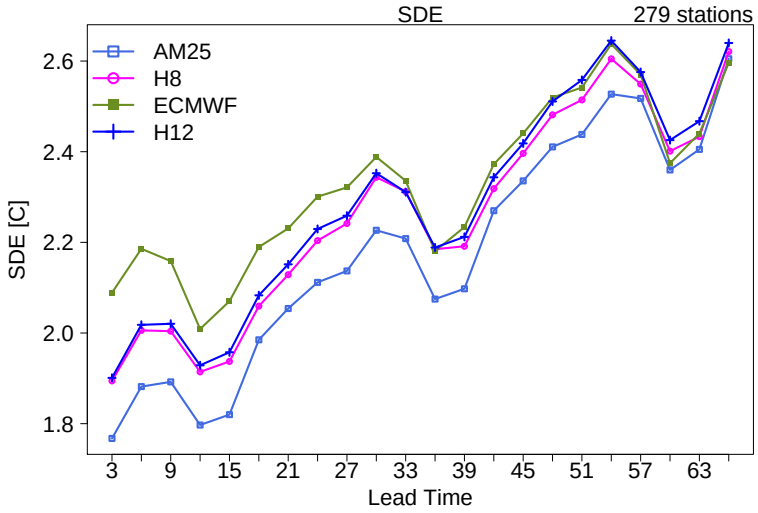

Hit Rate
Lead time [h]: 00+3,+6,..,+24
201 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.0
0.8
0.6
0.4
0.2
0.0
0.3
3.4
8
10.8
17.2
20.8
24.5
28.5
32.7
Exceedance threshold

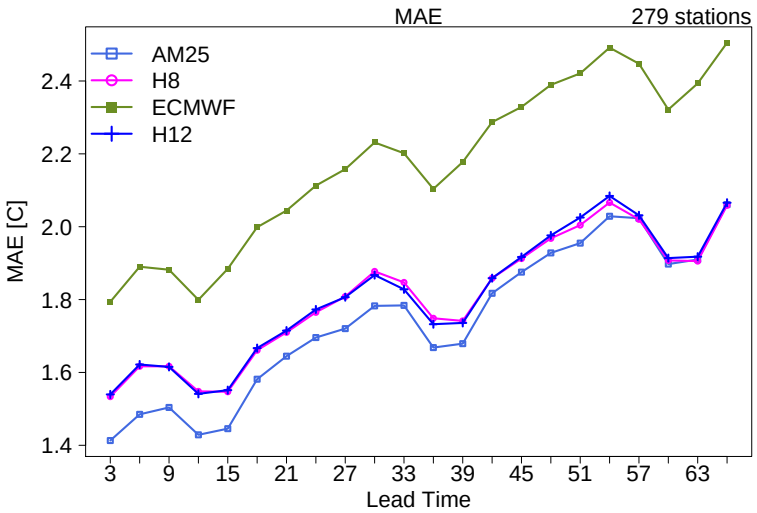

False Alarm Ratio
Lead time [h]: 00+3,+6,..,+24
201 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.0
0.8
0.6
0.4
0.2
0.0
0.3
3.4
8
10.8
17.2
20.8
24.5
28.5
32.7
Exceedance threshold

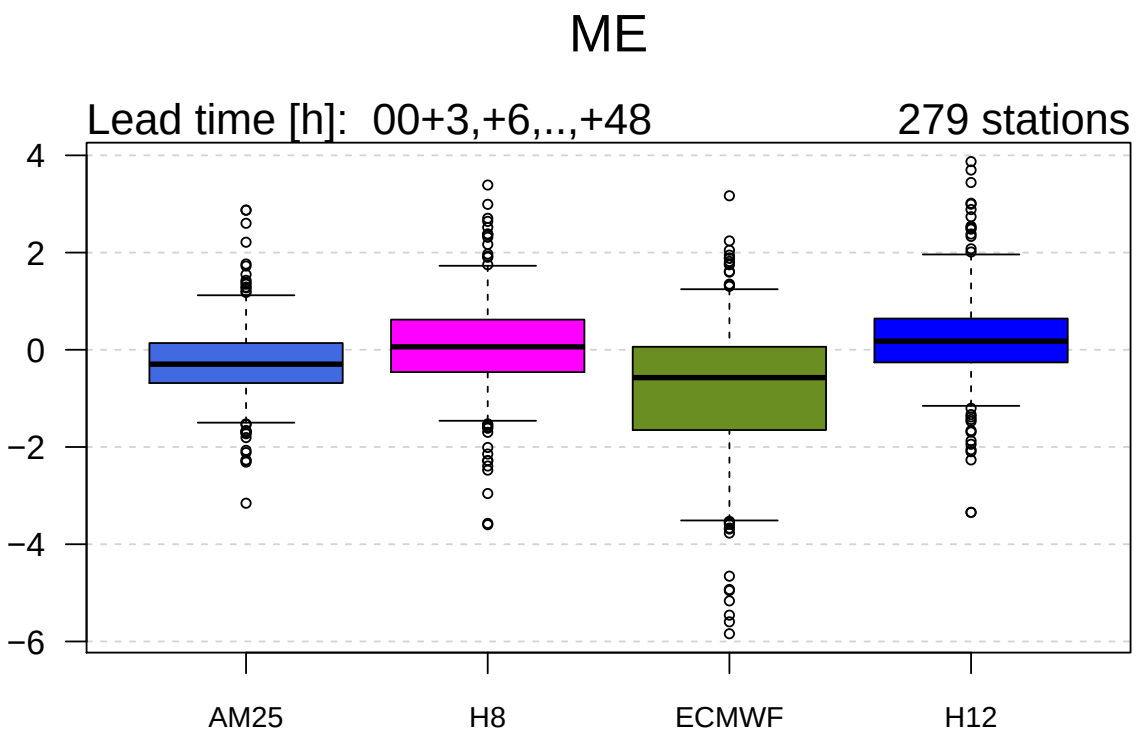

Equitable Threat Score
Lead time [h]: 00+3,+6,..,+24
201 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.0
0.8
0.6
0.4
0.2
0.0
0.3
3.4
8
10.8
17.2
20.8
24.5
28.5
32.7
Exceedance threshold

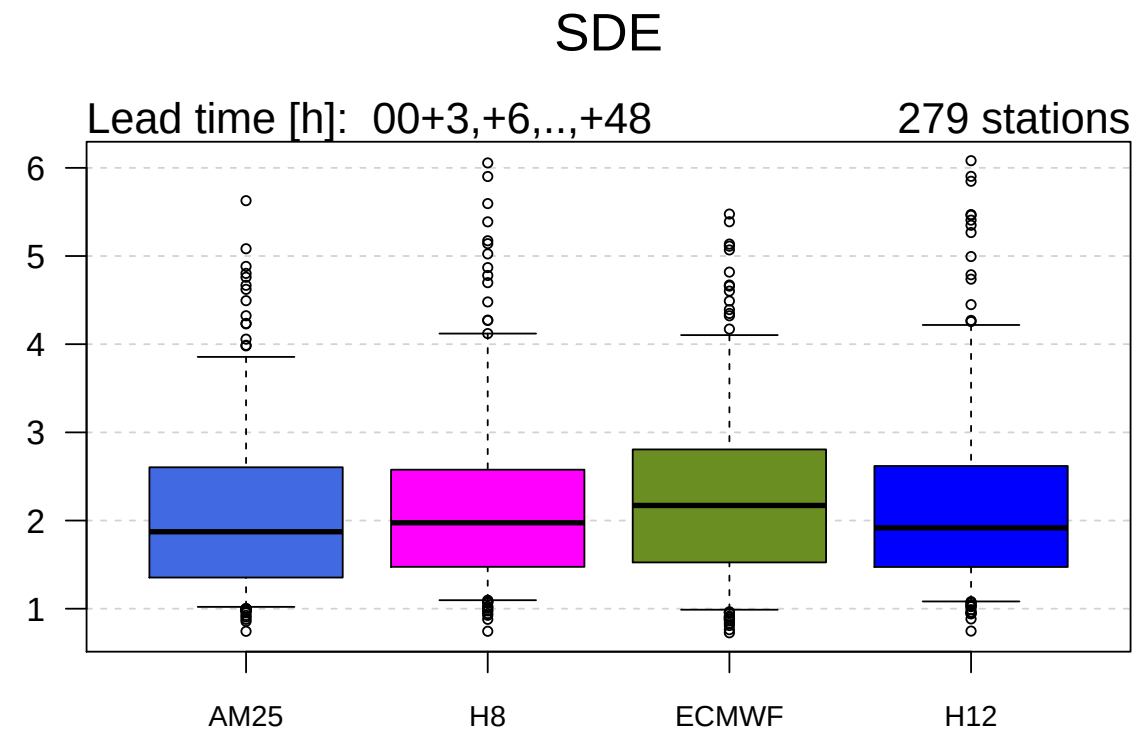
4.6 Temperature 2m



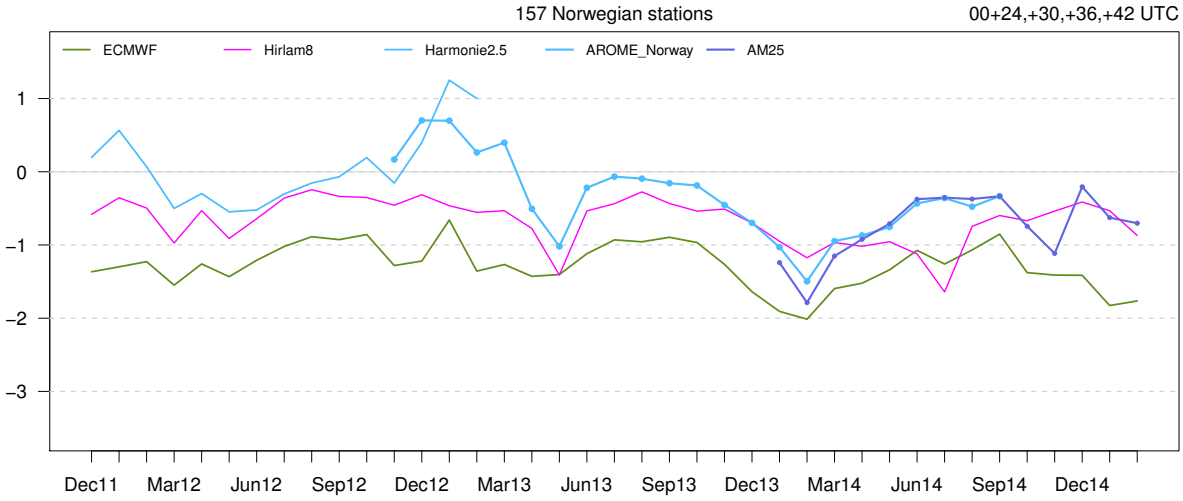


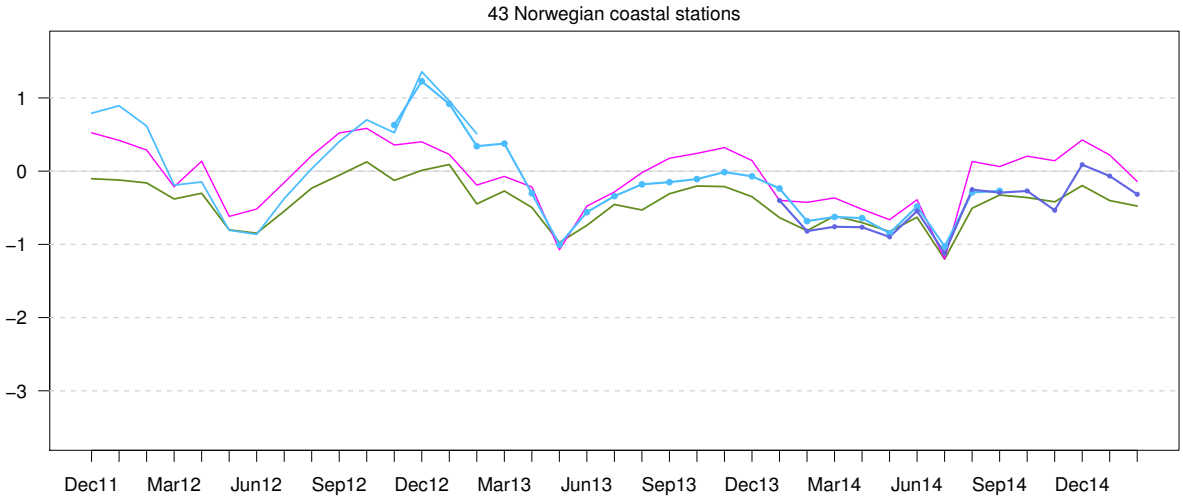


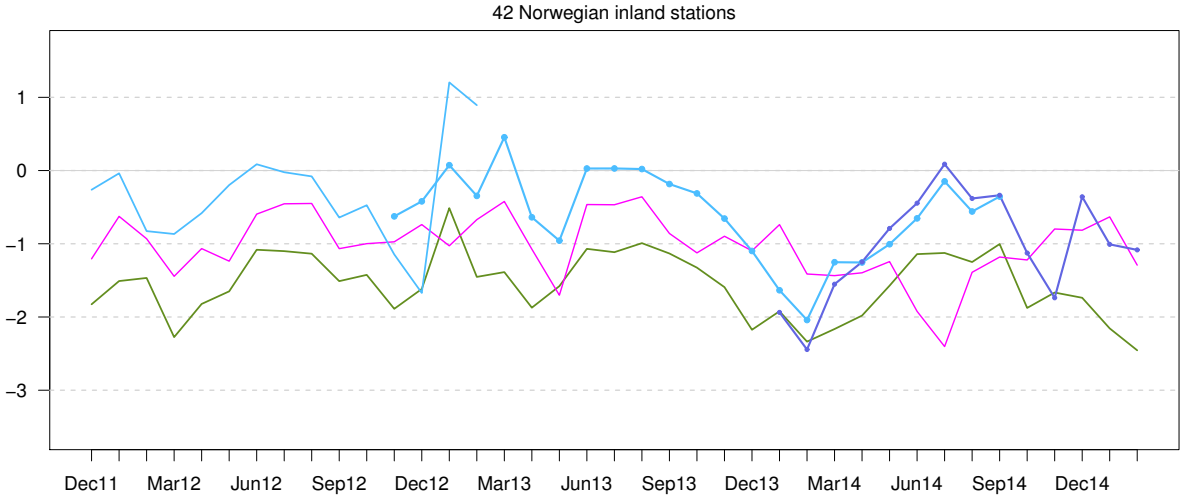

ME
Lead time [h]: 00+3,+6,..,+48
279 stations
4
2
0
−2
−4
−6
AM25
H8
ECMWF
H12


SDE
Lead time [h]: 00+3,+6,..,+48
279 stations
6
5
4
3
2
1
AM25
H8
ECMWF
H12

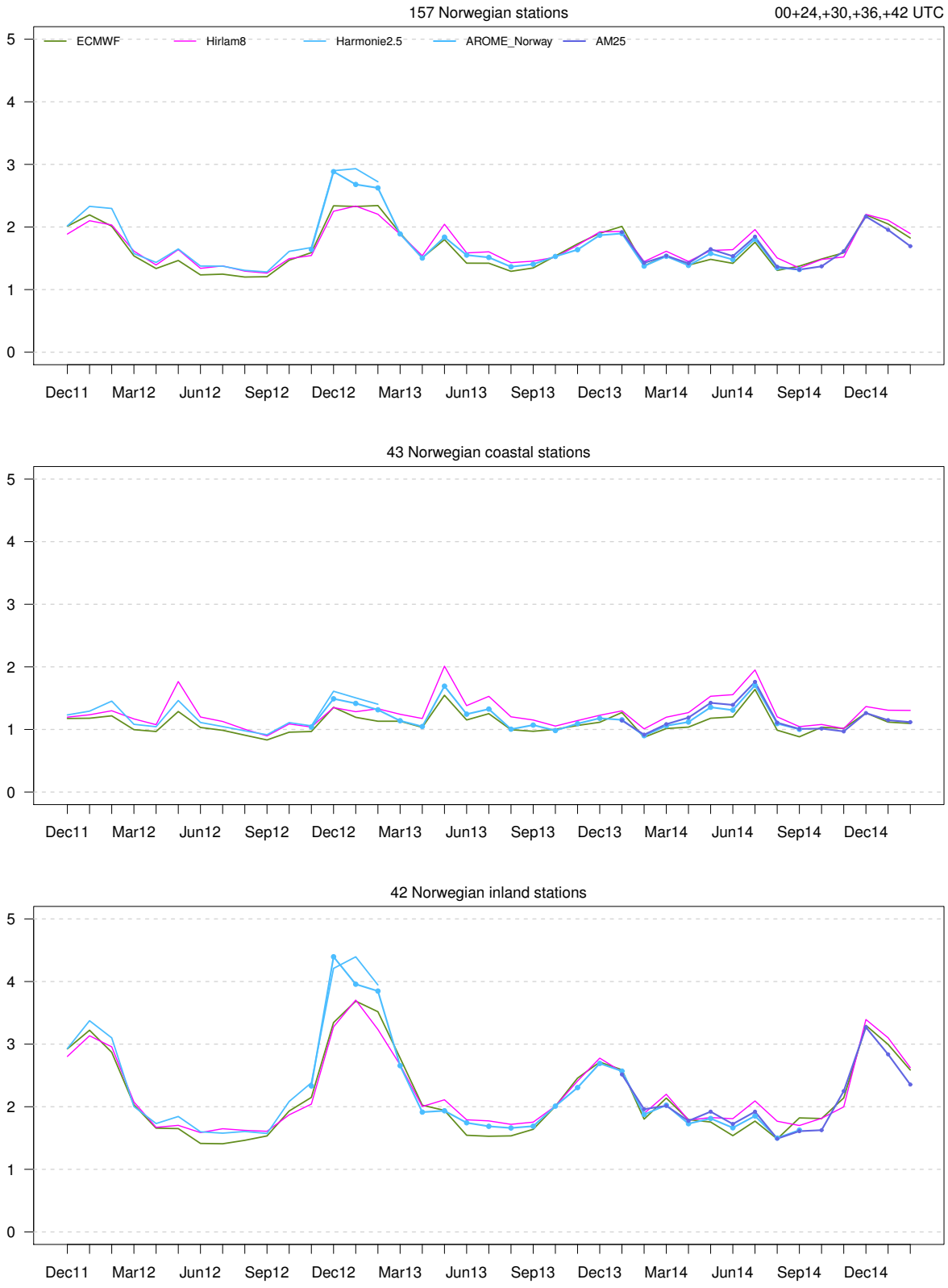
Mean Error


157 Norwegian stations
00+24,+30,+36,+42 UTC
ECMWF
Hirlam8
Harmonie2.5
AROME_Norway
AM25
1
0
−1
−2
−3
Dec11
Mar12
Jun12
Sep12
Dec12
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14

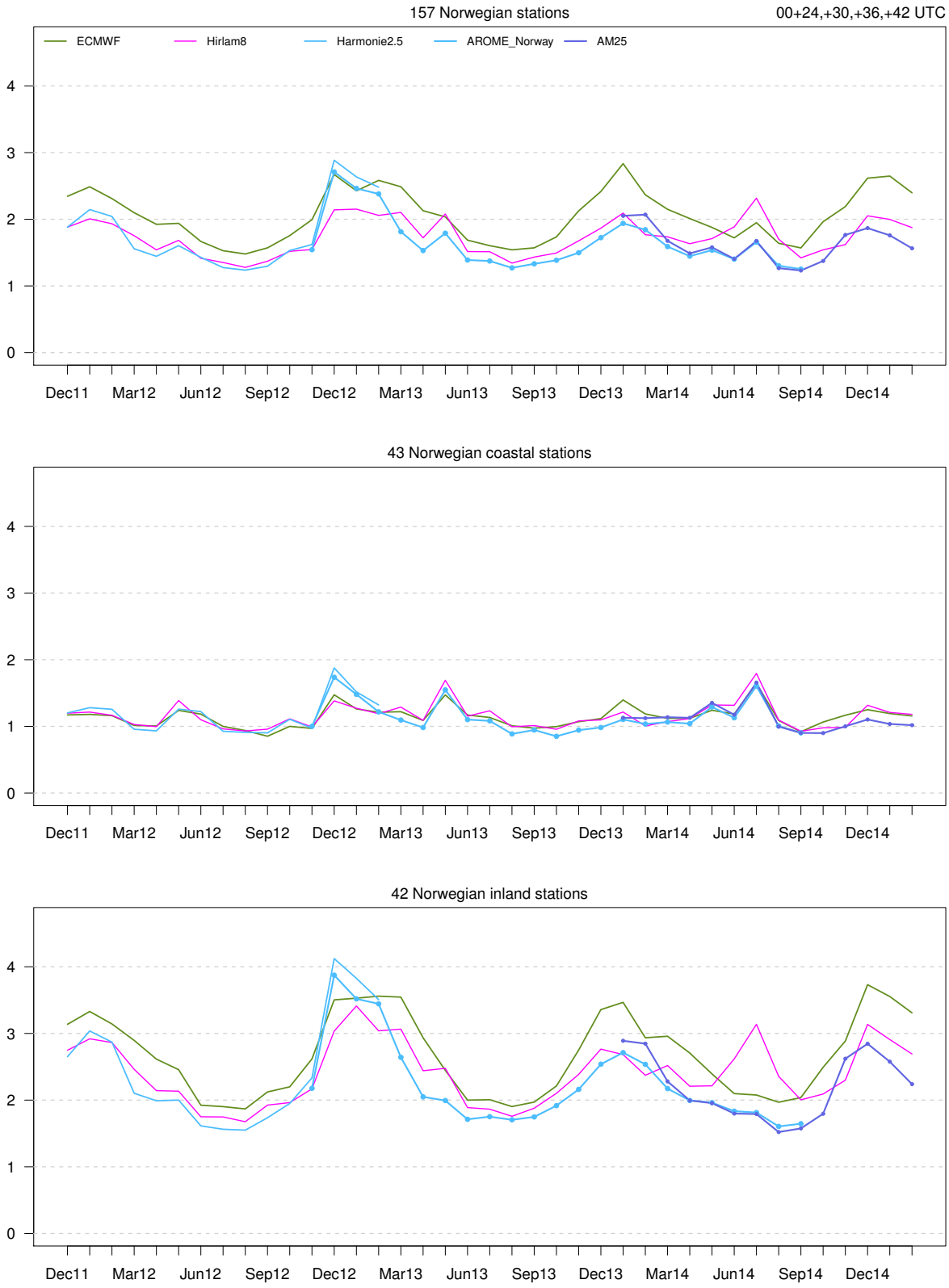

43 Norwegian coastal stations
1
0
−1
−2
−3
Dec11
Mar12
Jun12
Sep12
Dec12
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14


42 Norwegian inland stations
1
0
−1
−2
−3
Dec11
Mar12
Jun12
Sep12
Dec12
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14

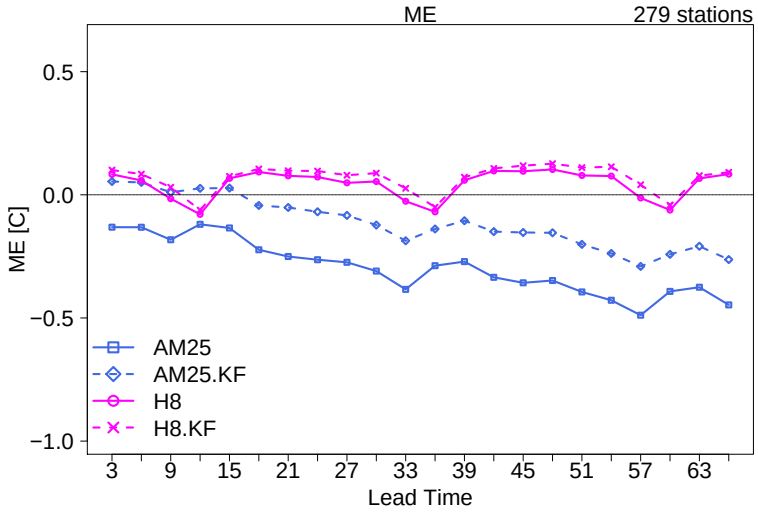
Standard Deviation of Error

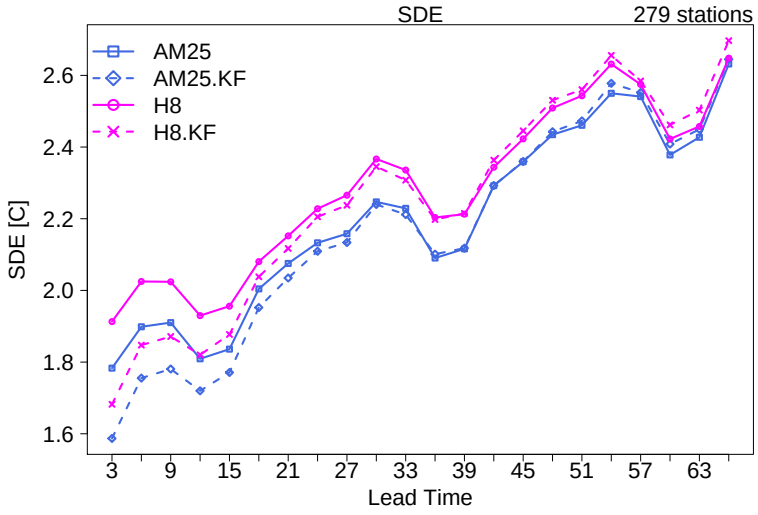


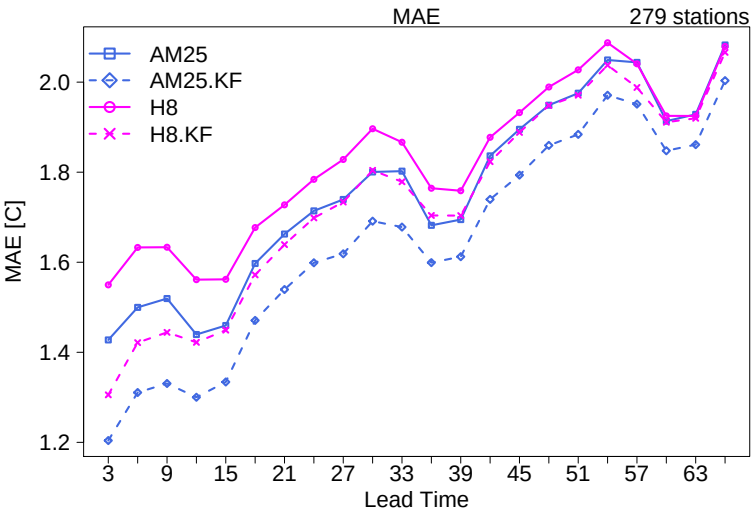
Mean Absolute Error

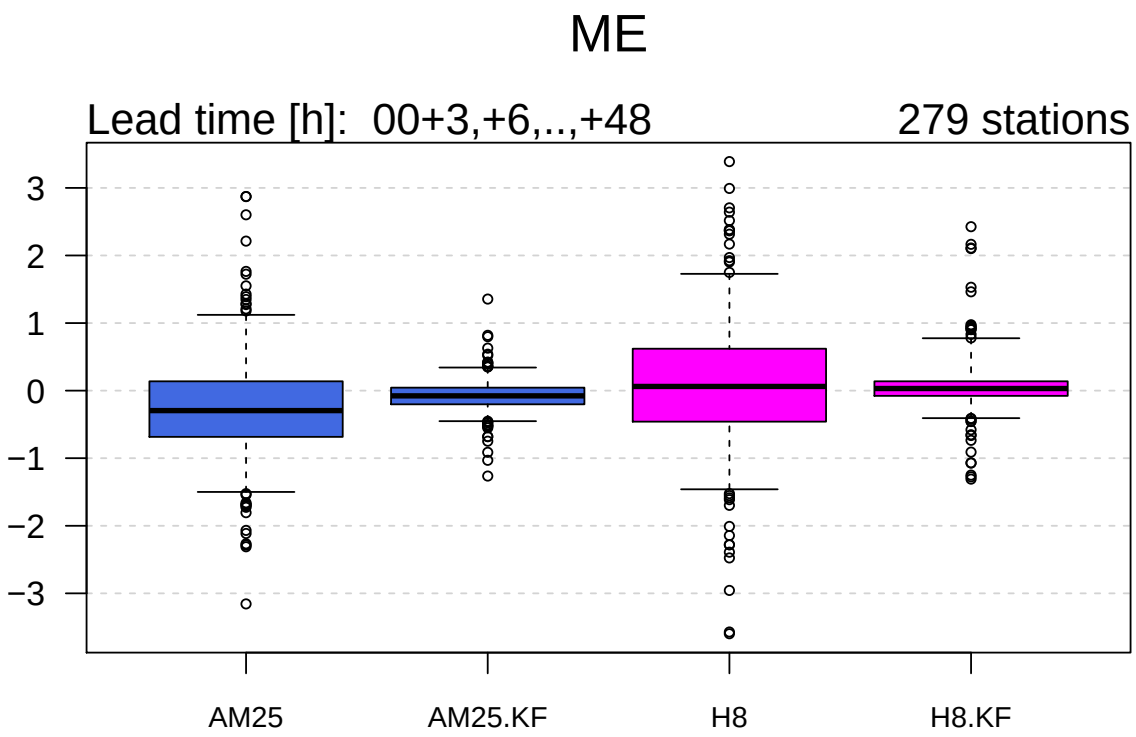


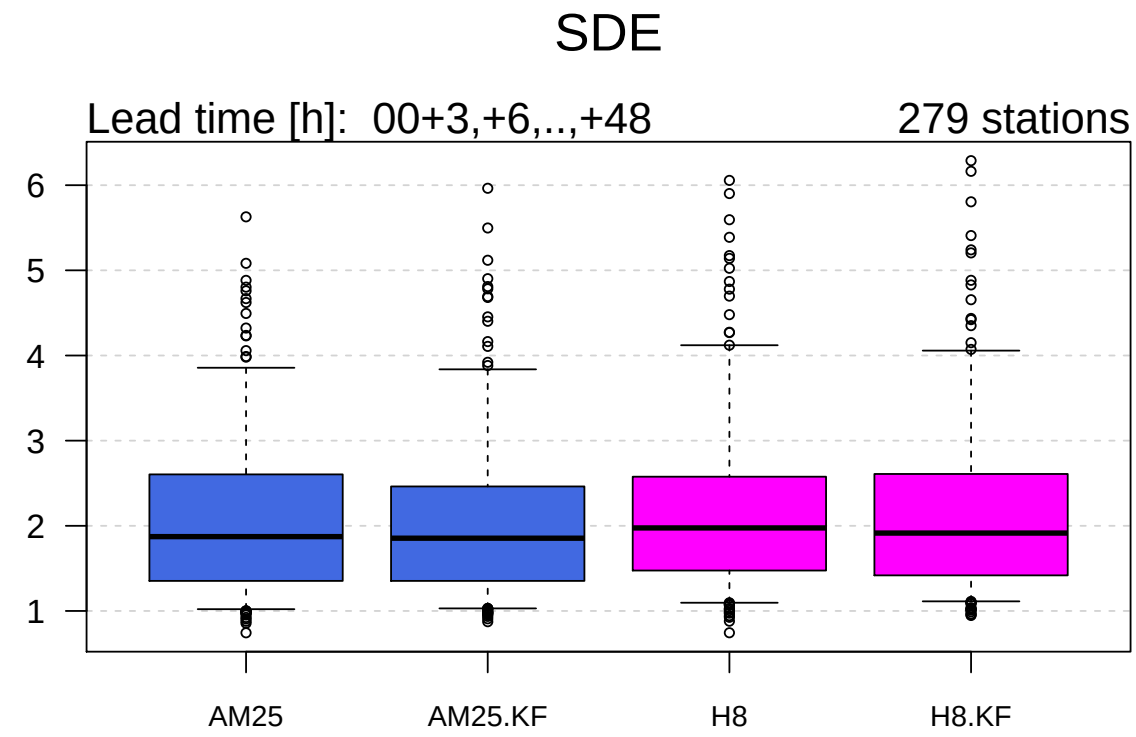
4.7 Post processed temperature 2m



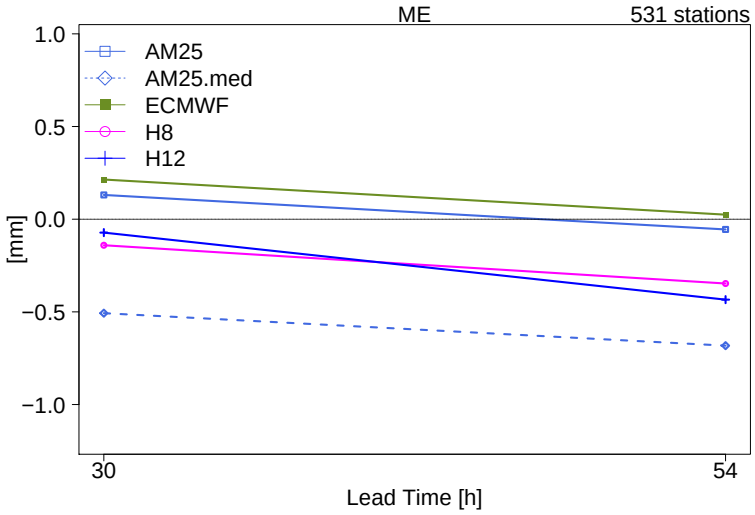


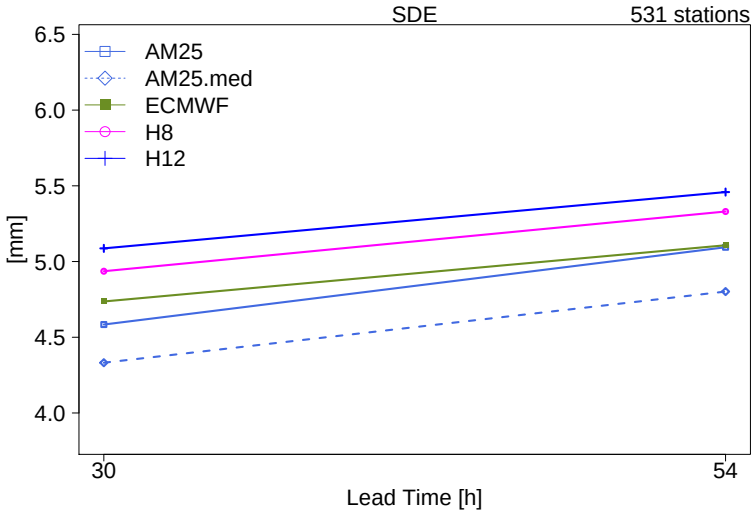


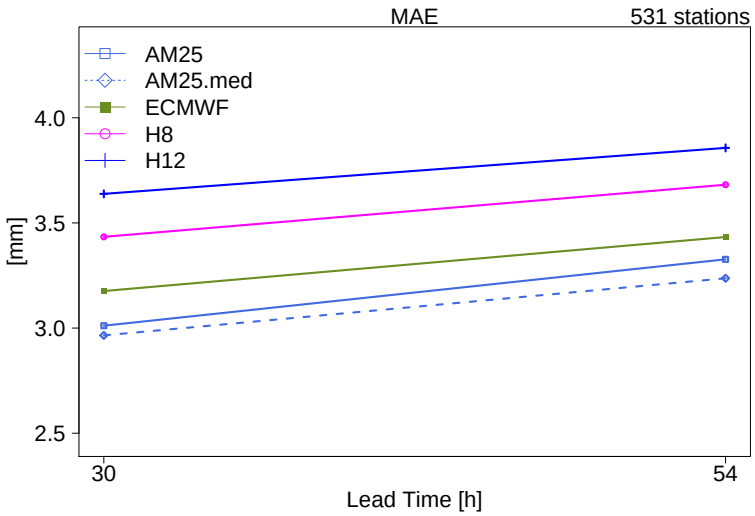

ME
Lead time [h]: 00+3,+6,..,+48
279 stations
3
2
1
0
−1
−2
−3
AM25
AM25.KF
H8
H8.KF

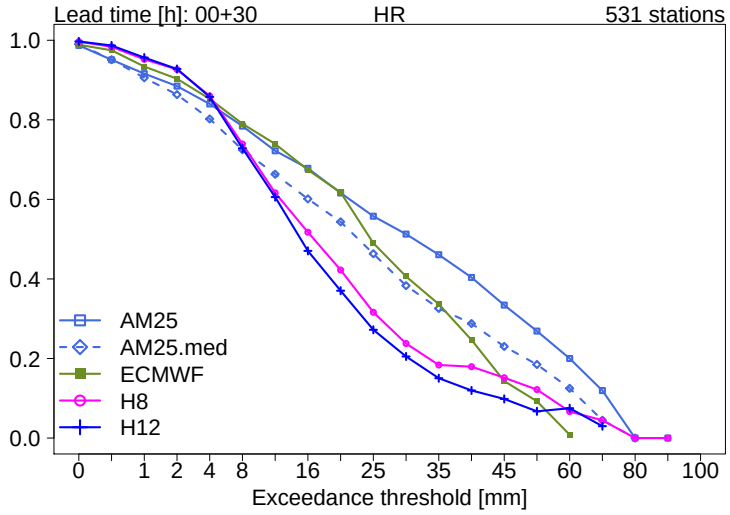

SDE
Lead time [h]: 00+3,+6,..,+48
279 stations
6
5
4
3
2
1
AM25
AM25.KF
H8
H8.KF

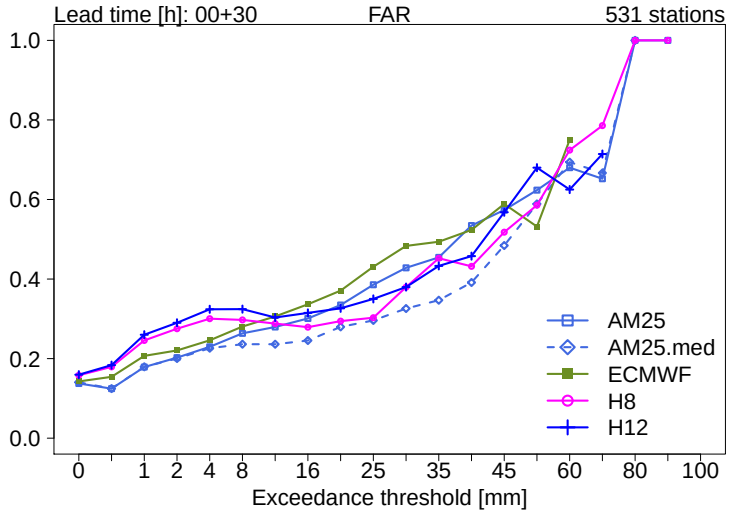
4.8 Daily precipitation

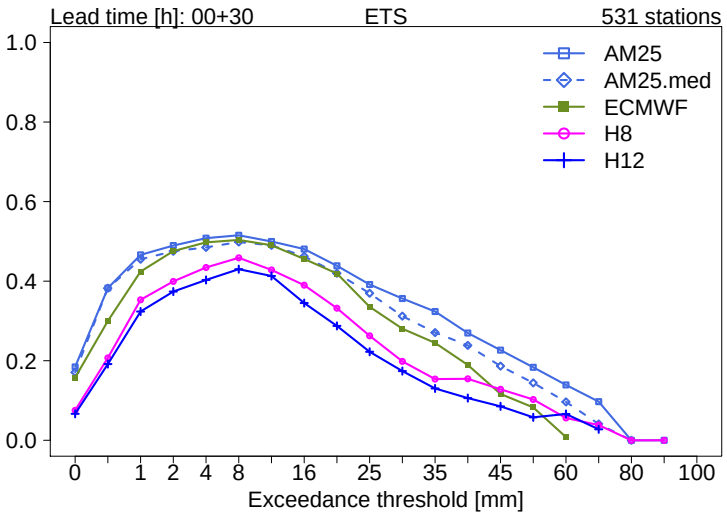


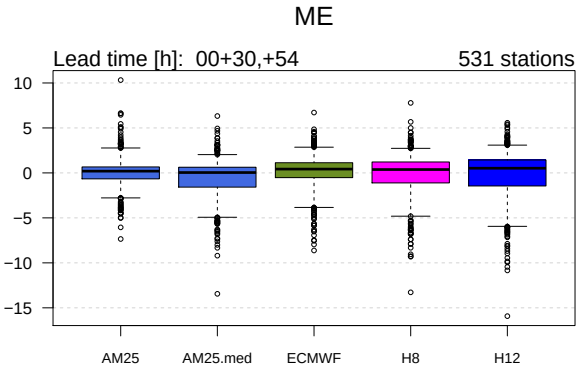


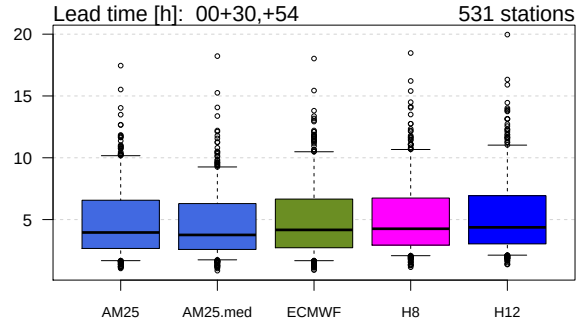



Lead time [h]: 00+30
HR
531 stations
1.0
0.8
0.6
0.4
0.2
0.0
AM25
AM25.med
ECMWF
H8
H12
0 1 2 4 8 16 25 35 45 60 80 100
Exceedance threshold [mm]


Lead time [h]: 00+30
FAR
531 stations
1.0
0.8
0.6
0.4
0.2
0.0
AM25
AM25.med
ECMWF
H8
H12
0 1 2 4 8 16 25 35 45 60 80 100
Exceedance threshold [mm]


Lead time [h]: 00+30
ETS
531 stations
1.0
0.8
0.6
0.4
0.2
0.0
AM25
AM25.med
ECMWF
H8
H12
0 1 2 4 8 16 25 35 45 60 80 100
Exceedance threshold [mm]





Lead time [h]: 00+30,+54 531 stations

AM25

	OBS [0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	9118	3191	156	6	0	12471
(0.1,5]	7364	22914	4645	136	11	35070
(5,20]	513	6028	12539	2180	37	21297
(20,50]	24	158	1754	3021	300	5257
(50,Inf]	1	2	31	171	128	333
Sum	17020	32293	19125	5514	476	74428

AM25.med

	OBS [0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	9073	3143	173	13	0	12402
(0.1,5]	7466	23553	5610	191	12	36832
(5,20]	461	5508	12142	2545	61	20717
(20,50]	19	89	1196	2681	322	4307
(50,Inf]	1	0	4	84	81	170
Sum	17020	32293	19125	5514	476	74428

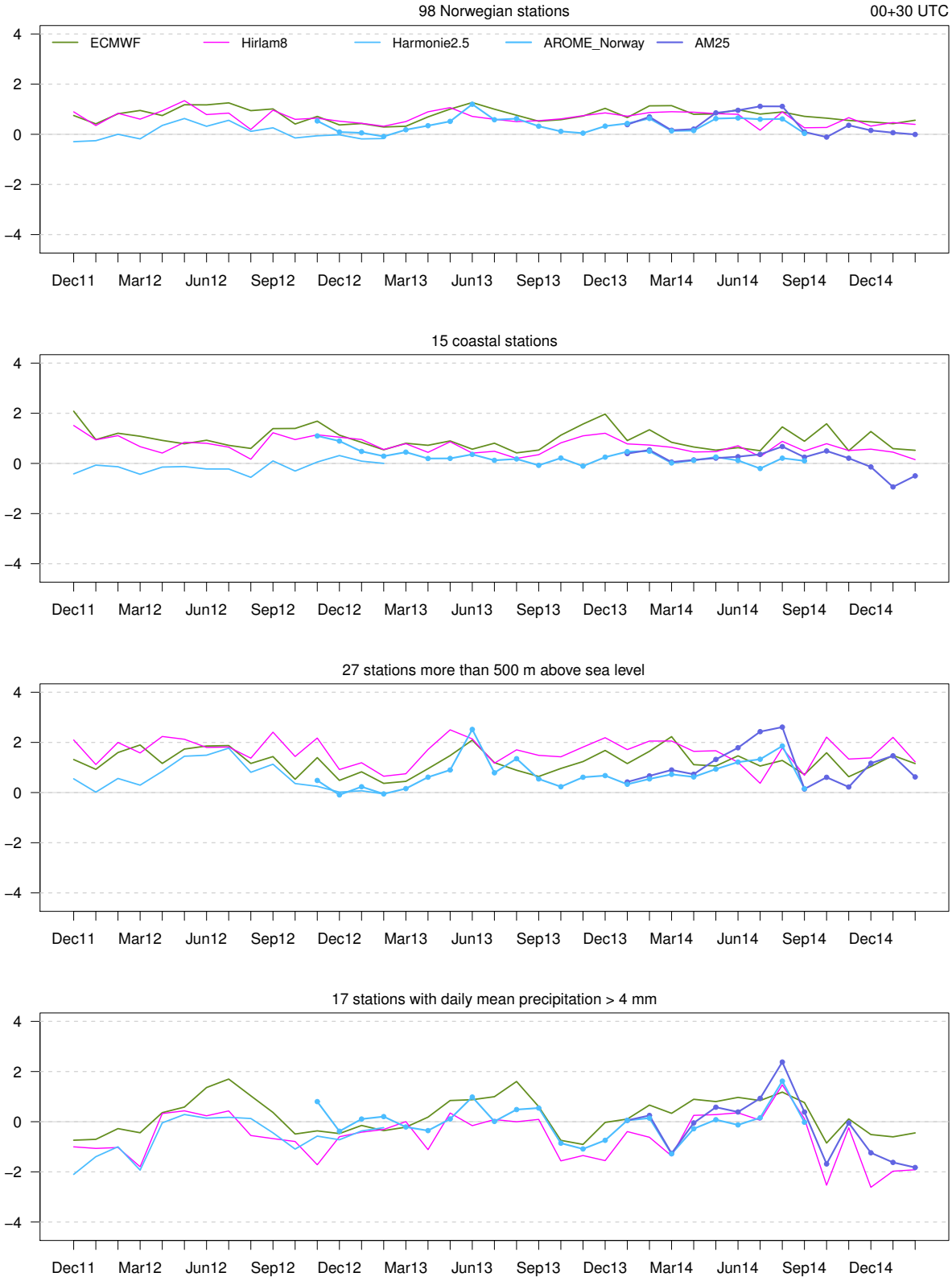
ECMWF

	OBS [0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	7285	1836	119	3	0	9243
(0.1,5]	9233	23608	4336	142	4	37323
(5,20]	488	6697	12607	2253	39	22084
(20,50]	14	152	2048	3072	402	5688
(50,Inf]	0	0	15	44	31	90
Sum	17020	32293	19125	5514	476	74428

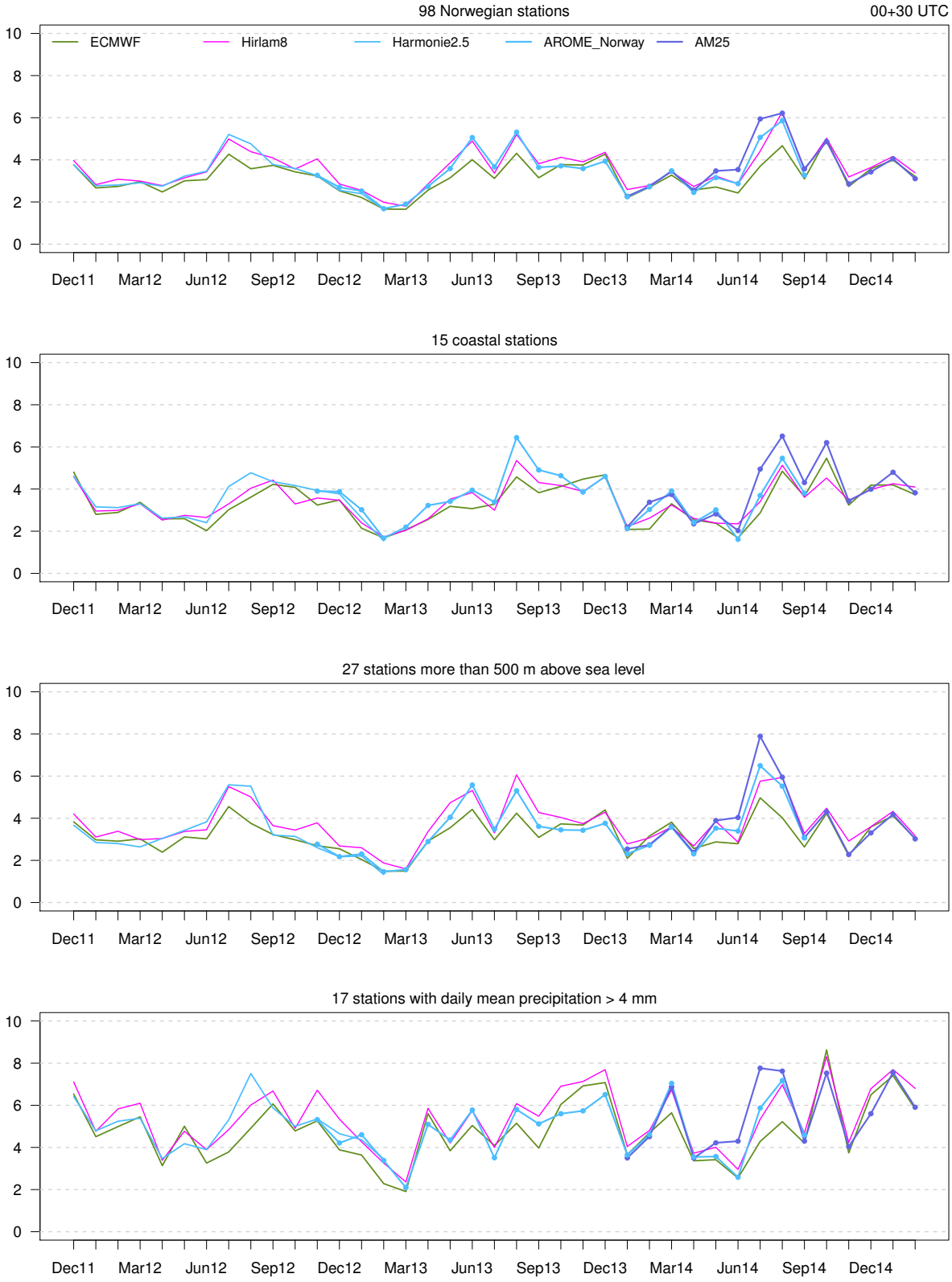
H8

	OBS [0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	4692	1176	108	2	4	5982
(0.1,5]	11403	22929	4583	159	3	39077
(5,20]	908	8107	13420	3225	108	25768
(20,50]	17	80	1010	2079	312	3498
(50,Inf]	0	1	4	49	49	103
Sum	17020	32293	19125	5514	476	74428

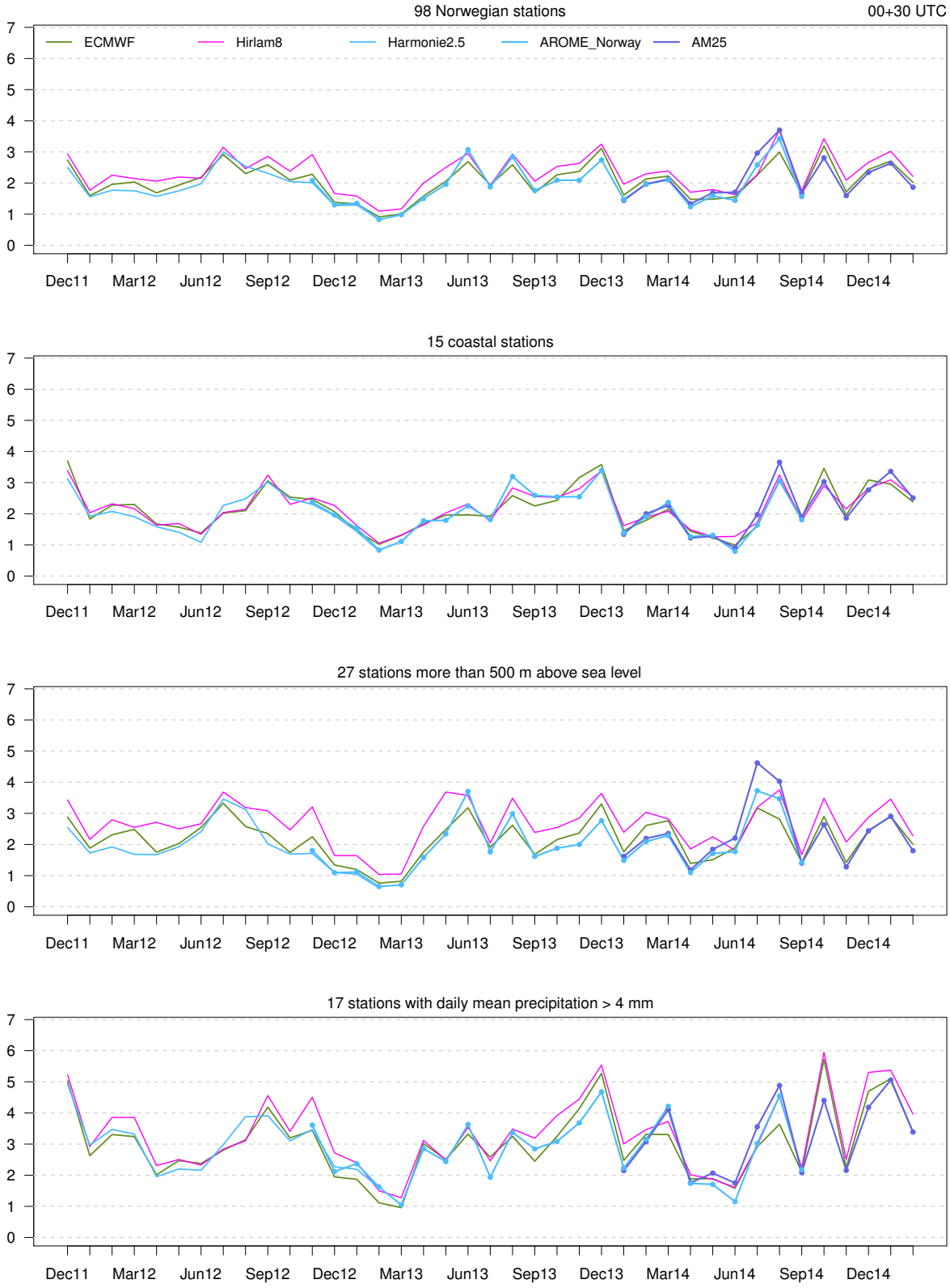
Mean Error


98 Norwegian stations
00+30 UTC
ECMWF
Hirlam8
Harmonie2.5
AROME_Norway
AM25
15 coastal stations
27 stations more than 500 m above sea level
17 stations with daily mean precipitation > 4 mm
4
2
0
−2
−4
Dec11
Mar12
Jun12
Sep12
Dec12
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14

Standard Deviation of Error



Mean Absolute Error



5 Eastern Norway

5.1 Comments to the verification results

Case 1 VA: Too much fog/low stratus

Stable high pressure systems over Eastern Norway, here from March 16. Lowest levels are too humid compared with observations, which then results in fog and low stratus that is not observed. The inversion is observed to be around 5000ft, while the model is often stable from 1000ft or even from the ground.

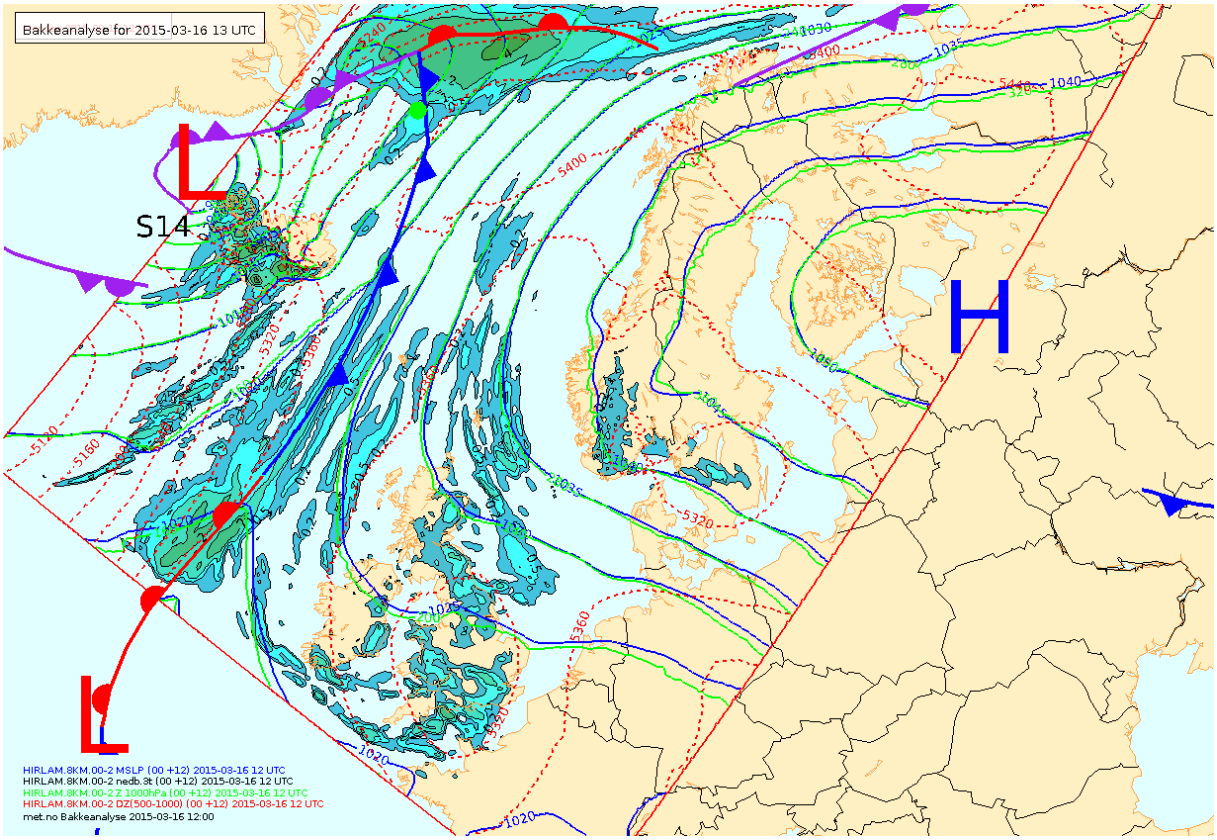


Figure 1: Synoptic situation at March 16 at 12Z.

Case 2 VA: Precipitation phase

Snow event March 22. AROME handles the situation better than Hirlam. The Hirlam models are too fast in with warm air near the surface, which then gives precipitation as rain. The vertical temperature profile to AROME fits better with the observations, and gives precipitation as snow.

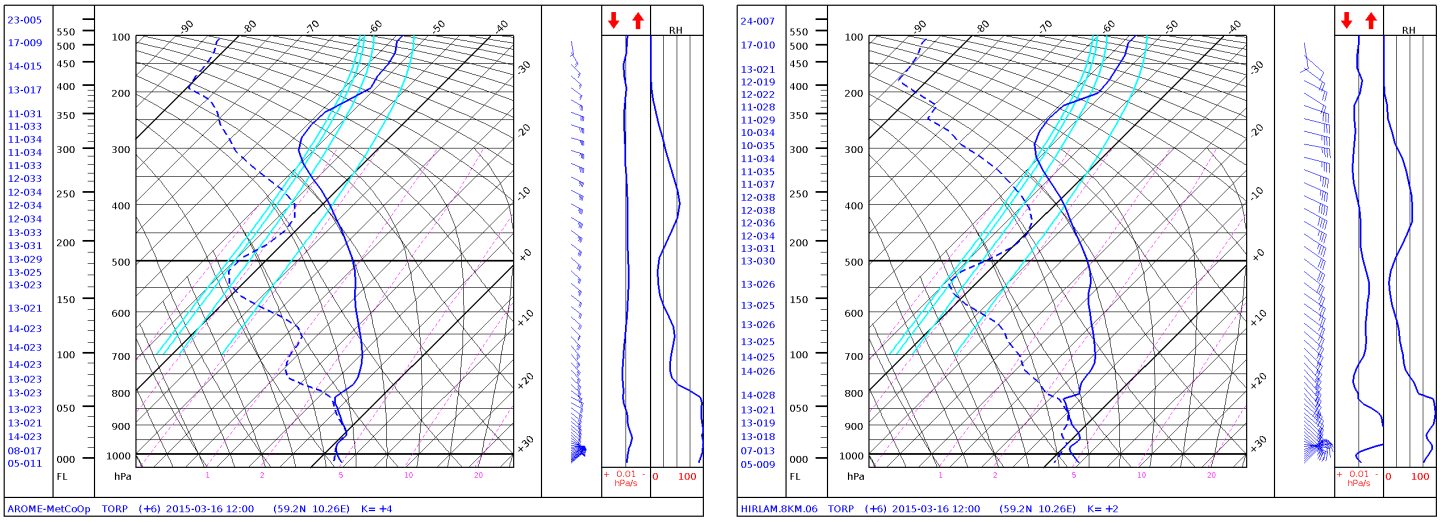


Figure 2: Figures from the March 16 case. Left: AM25 at Torp at 12Z. Right: H08 at Torp at 12Z.

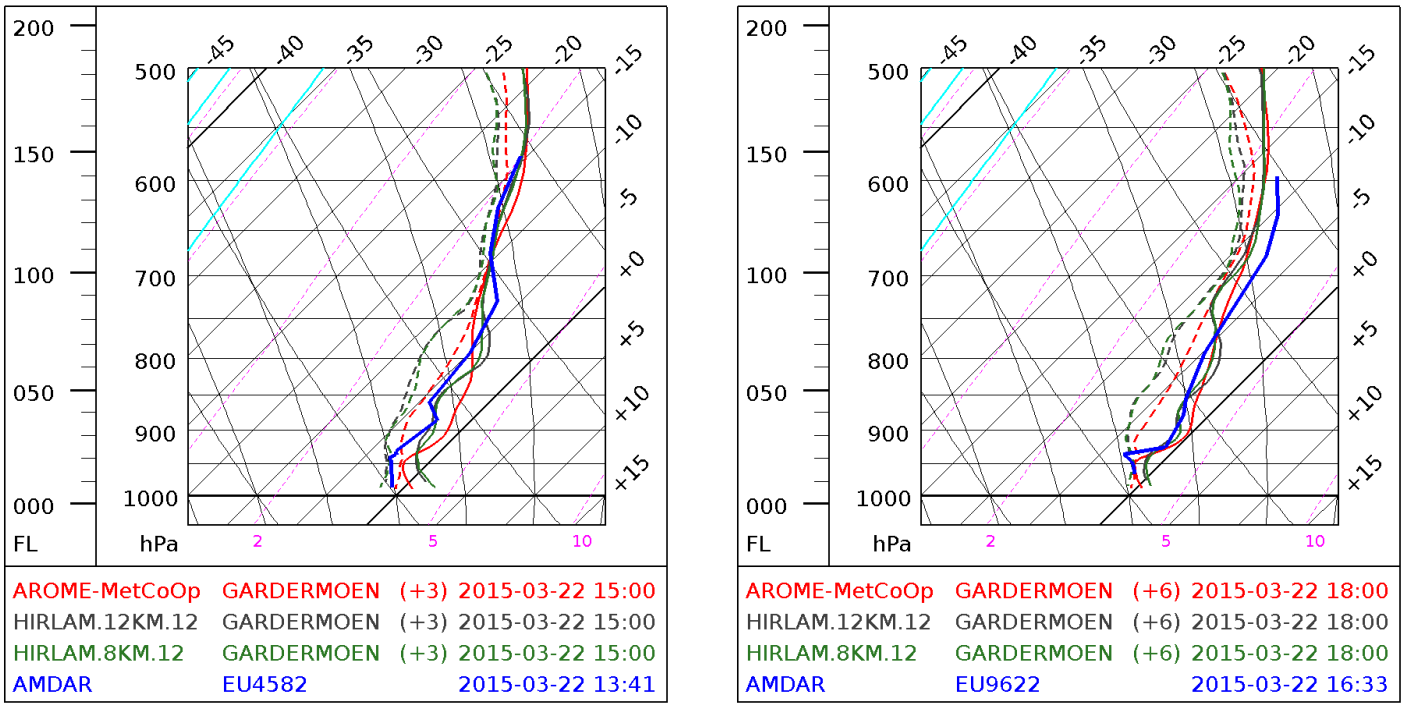
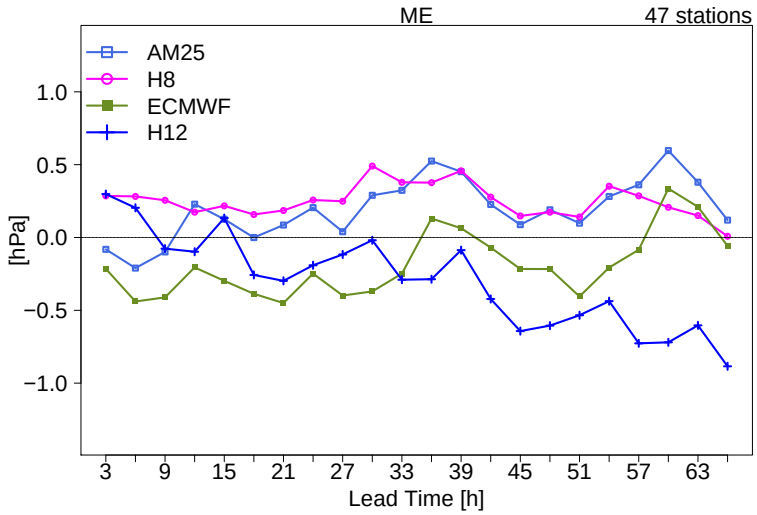
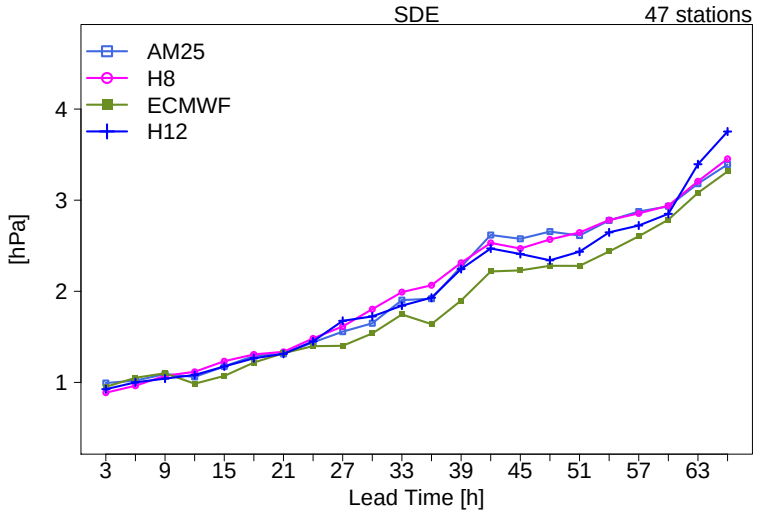
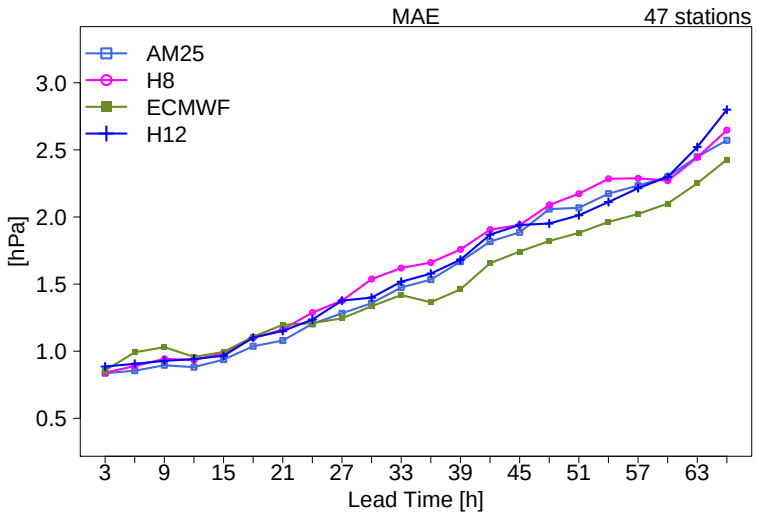


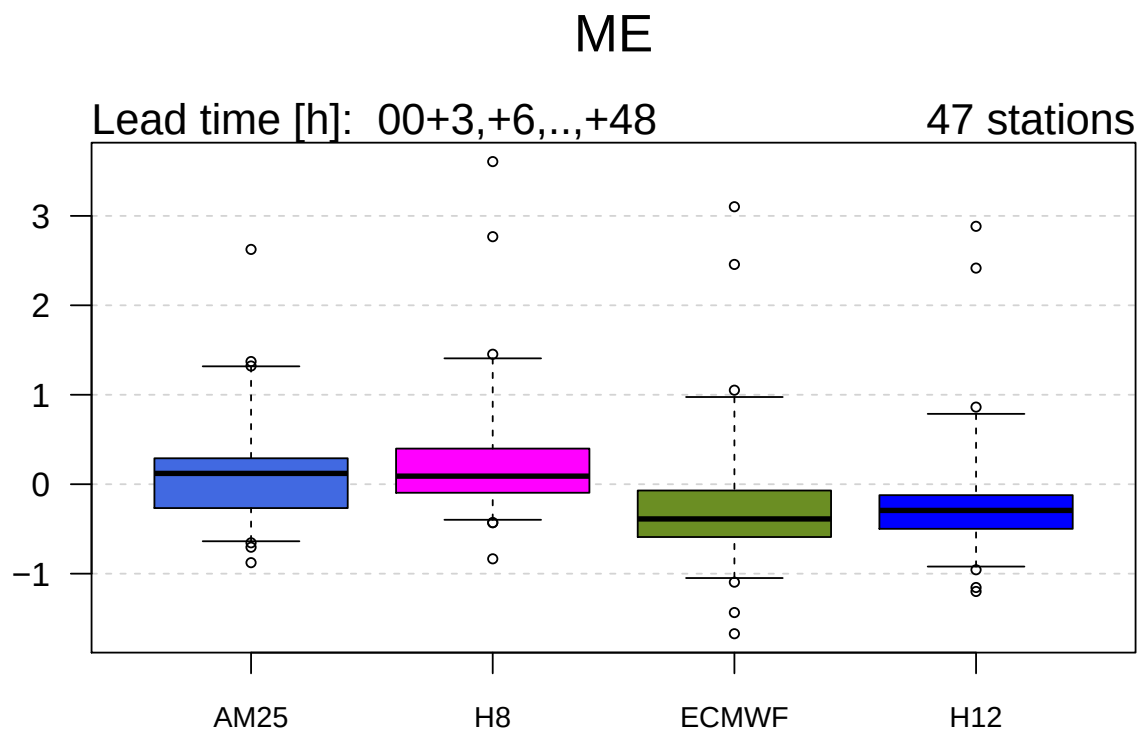
Figure 3: Figures from the March 22 case. Left: Vertical profiles at Gardermoen at 15Z. Right: Vertical profiles at Gardermoen at 18Z.

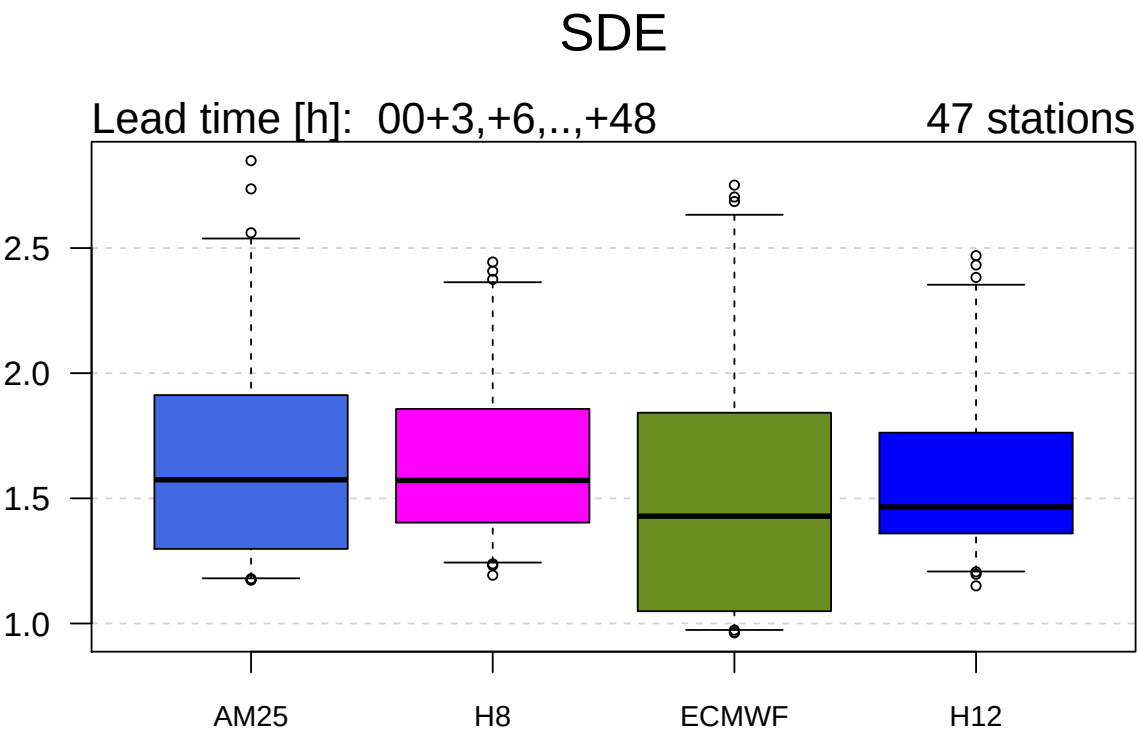
5.2 Pressure


ME
47 stations
AM25
H8
ECMWF
H12
1.0
0.5
0.0
−0.5
−1.0
[hPa]
3
9
15
21
27
33
39
45
51
57
63
Lead Time [h]

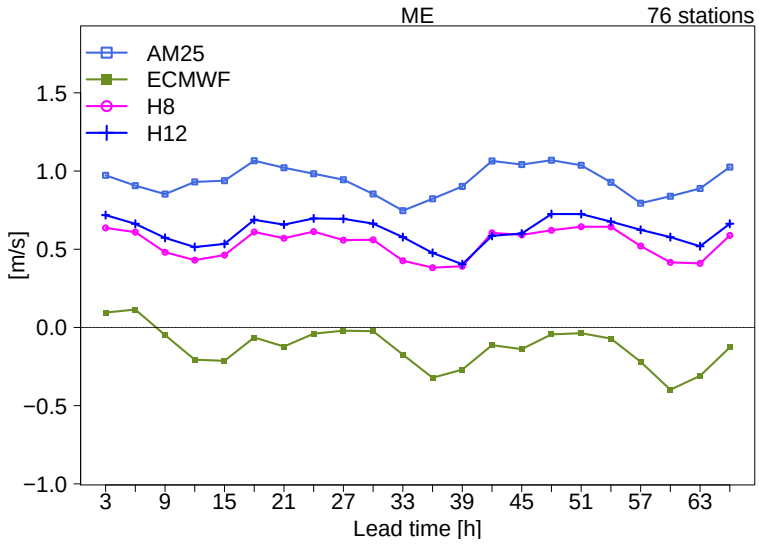

SDE
47 stations
AM25
H8
ECMWF
H12
4
3
2
1
[hPa]
3
9
15
21
27
33
39
45
51
57
63
Lead Time [h]

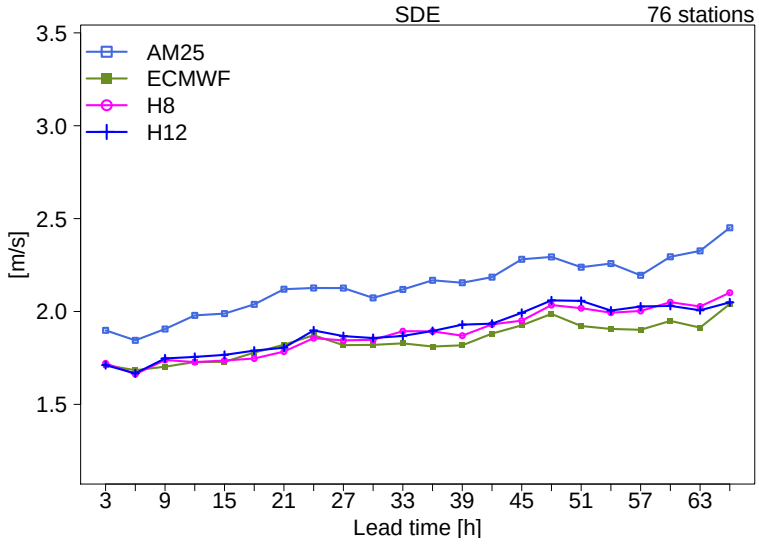

MAE
47 stations
AM25
H8
ECMWF
H12
3.0
2.5
2.0
1.5
1.0
0.5
[hPa]
3
9
15
21
27
33
39
45
51
57
63
Lead Time [h]

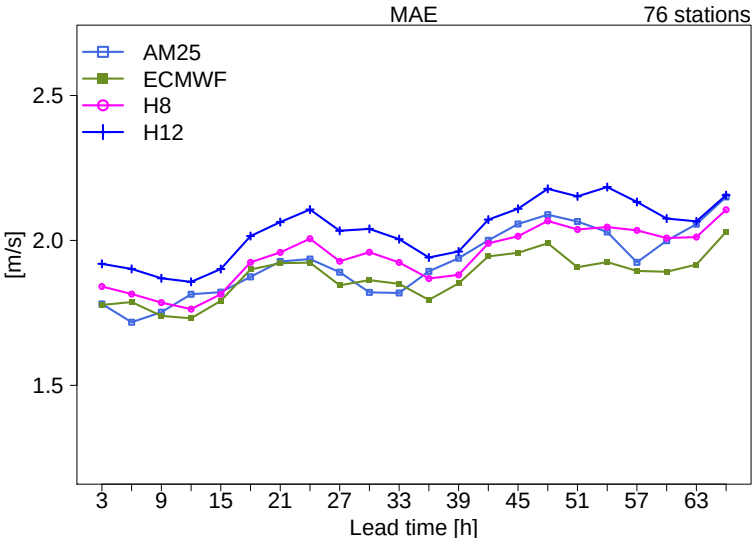

ME
Lead time [h]: 00+3,+6,..,+48
47 stations
3
2
1
0
−1
AM25
H8
ECMWF
H12

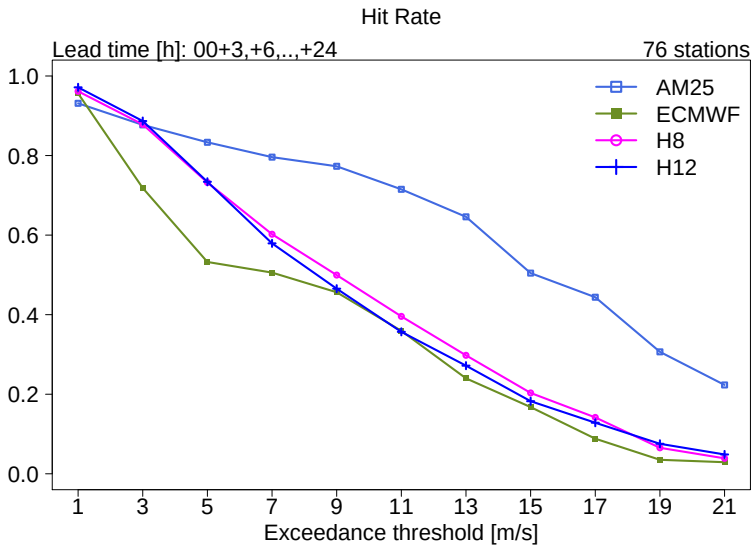

SDE
Lead time [h]: 00+3,+6,..,+48
47 stations
2.5
2.0
1.5
1.0
AM25
H8
ECMWF
H12

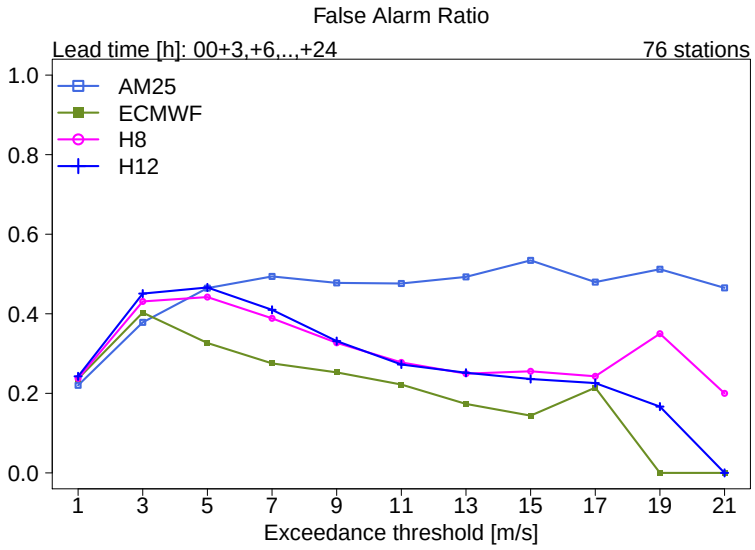
5.3 Wind Speed 10m

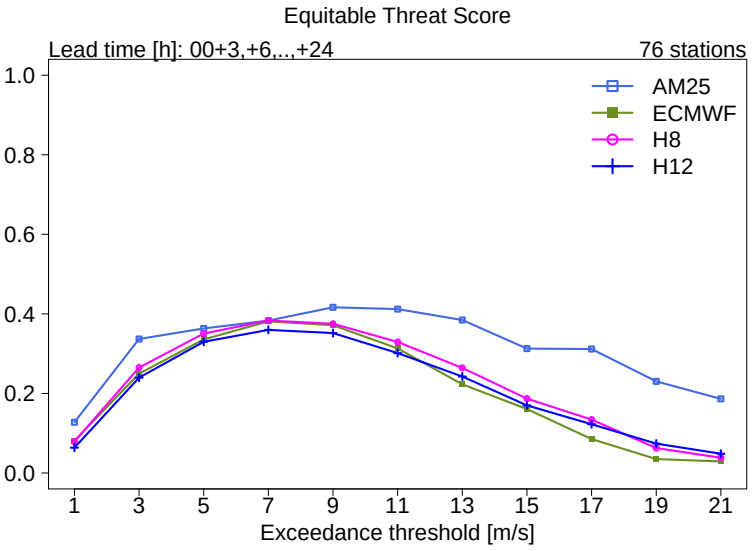


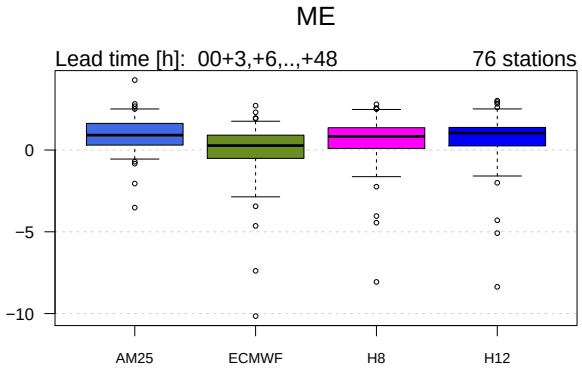


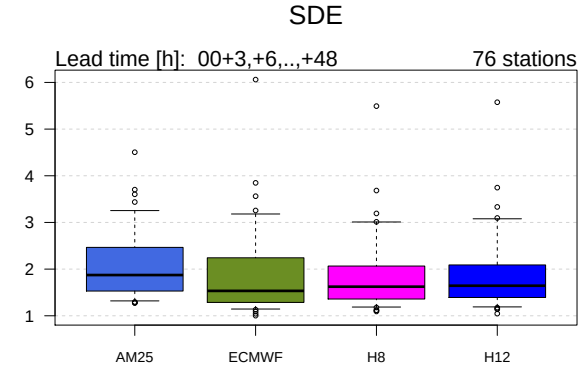



Hit Rate
Lead time [h]: 00+3,+6,..,+24
76 stations
AM25
ECMWF
H8
H12
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


False Alarm Ratio
Lead time [h]: 00+3,+6,..,+24
76 stations
AM25
ECMWF
H8
H12
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


Equitable Threat Score
Lead time [h]: 00+3,+6,..,+24
76 stations
AM25
ECMWF
H8
H12
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]





Lead time [h]: 00+3,+6,..,+48 UTC 76 stations

AM25 — **OBS**

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	37875	4811	36	2	0	42724
(3,11]	19140	24911	1183	63	10	45307
(11,17]	300	2212	2039	313	75	4939
(17,21]	14	132	140	158	84	528
(21,Inf]	2	4	14	25	39	84
Sum	57331	32070	3412	561	208	93582

H8 — **OBS**

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	33126	4696	103	1	0	37926
(3,11]	24174	26802	2129	246	131	53482
(11,17]	31	571	1149	254	41	2046
(17,21]	0	1	31	59	31	122
(21,Inf]	0	0	0	1	5	6
Sum	57331	32070	3412	561	208	93582

ECMWF — **OBS**

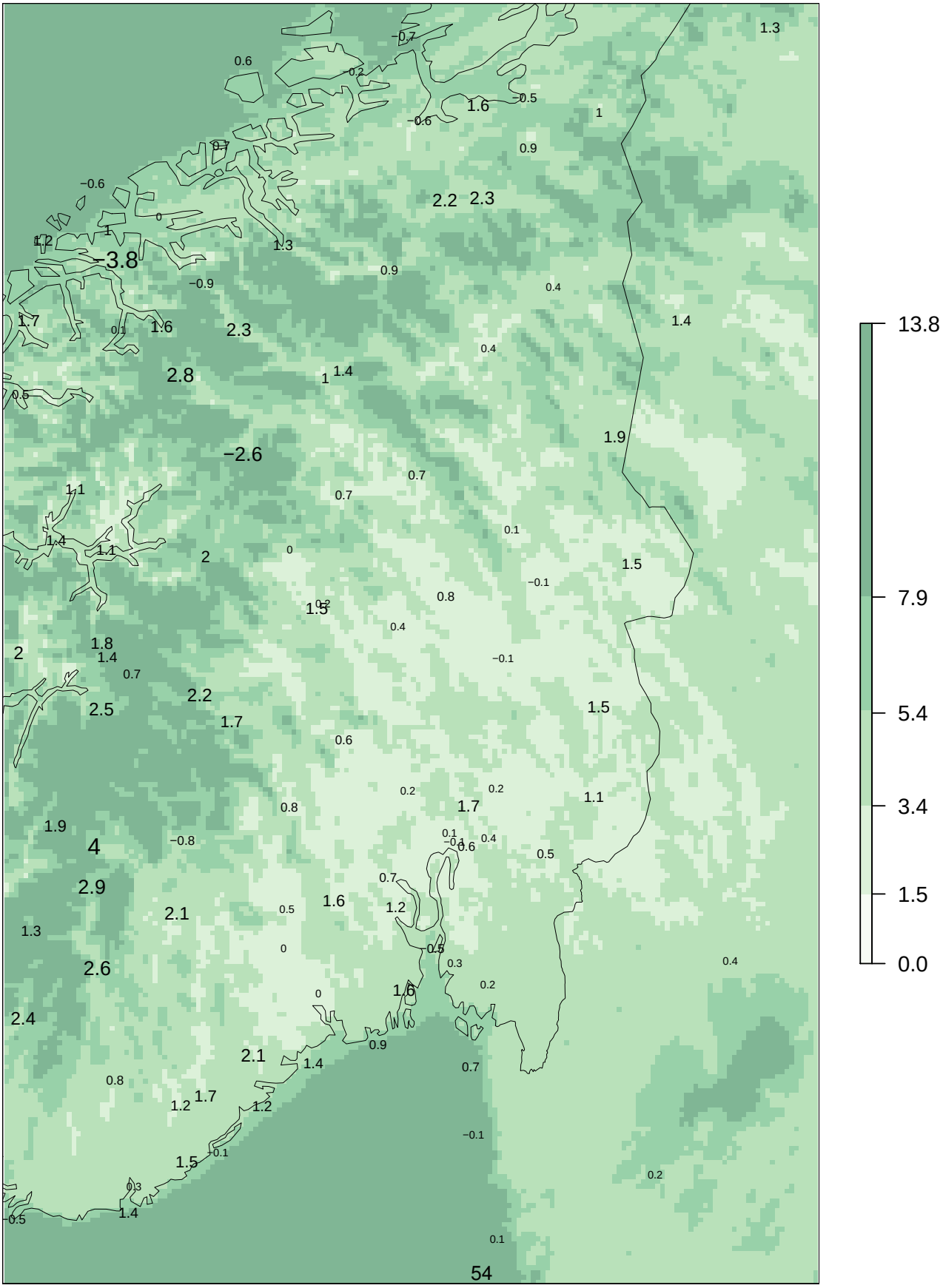
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	40007	9721	562	154	82	50526
(3,11]	17319	21936	1749	139	63	41206
(11,17]	5	412	1085	231	33	1766
(17,21]	0	1	16	37	27	81
(21,Inf]	0	0	0	0	3	3
Sum	57331	32070	3412	561	208	93582

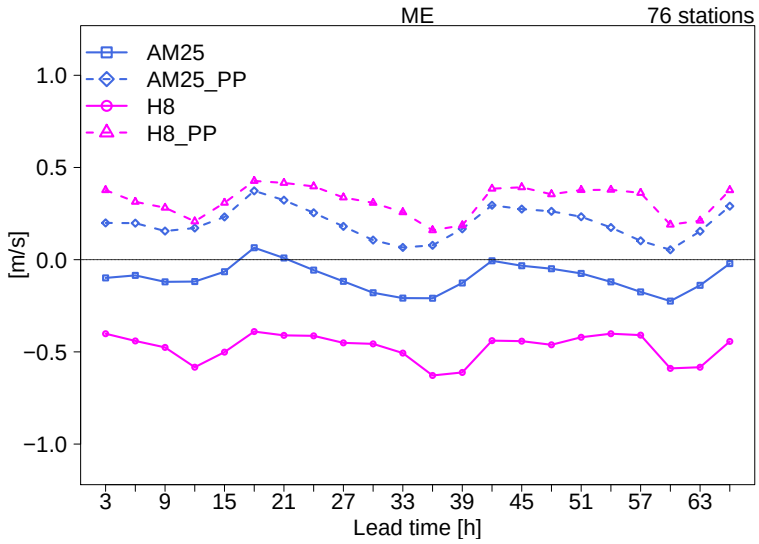
H12 — **OBS**

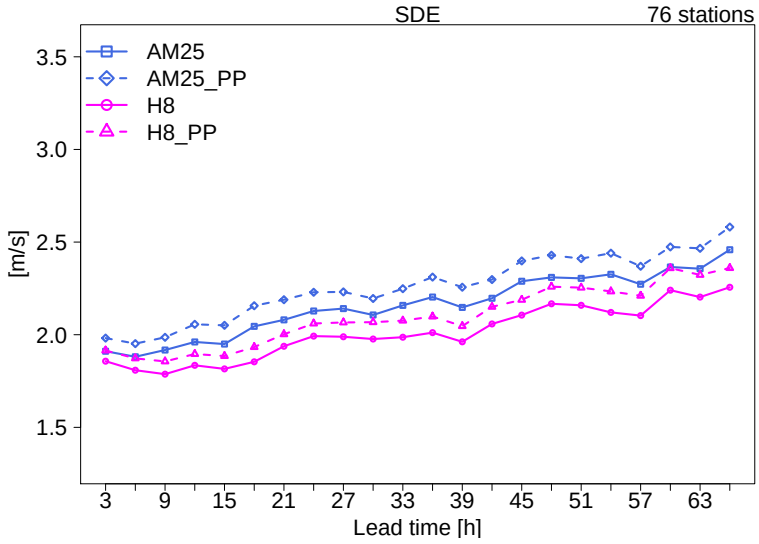
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	30890	4314	105	7	1	35317
(3,11]	26414	27215	2270	257	139	56295
(11,17]	27	540	1016	251	32	1866
(17,21]	0	1	21	46	31	99
(21,Inf]	0	0	0	0	5	5
Sum	57331	32070	3412	561	208	93582

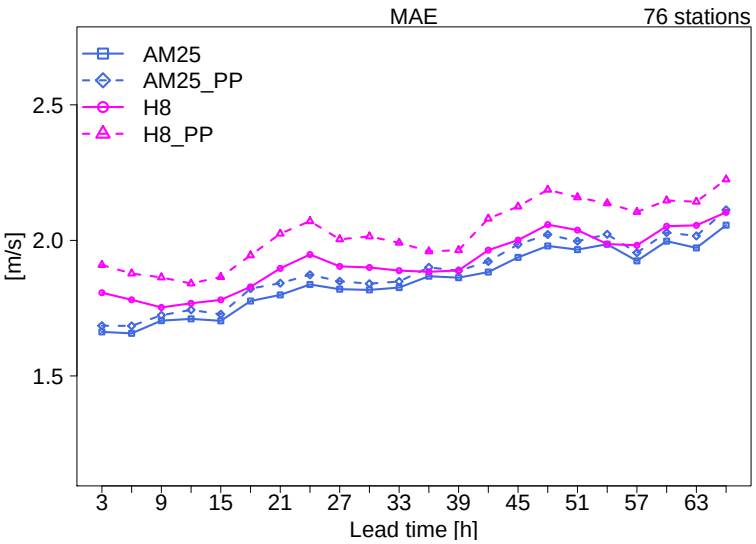
AM25 00+12

ME at observing sites forecast means 01.12.2014 − 28.02.2015



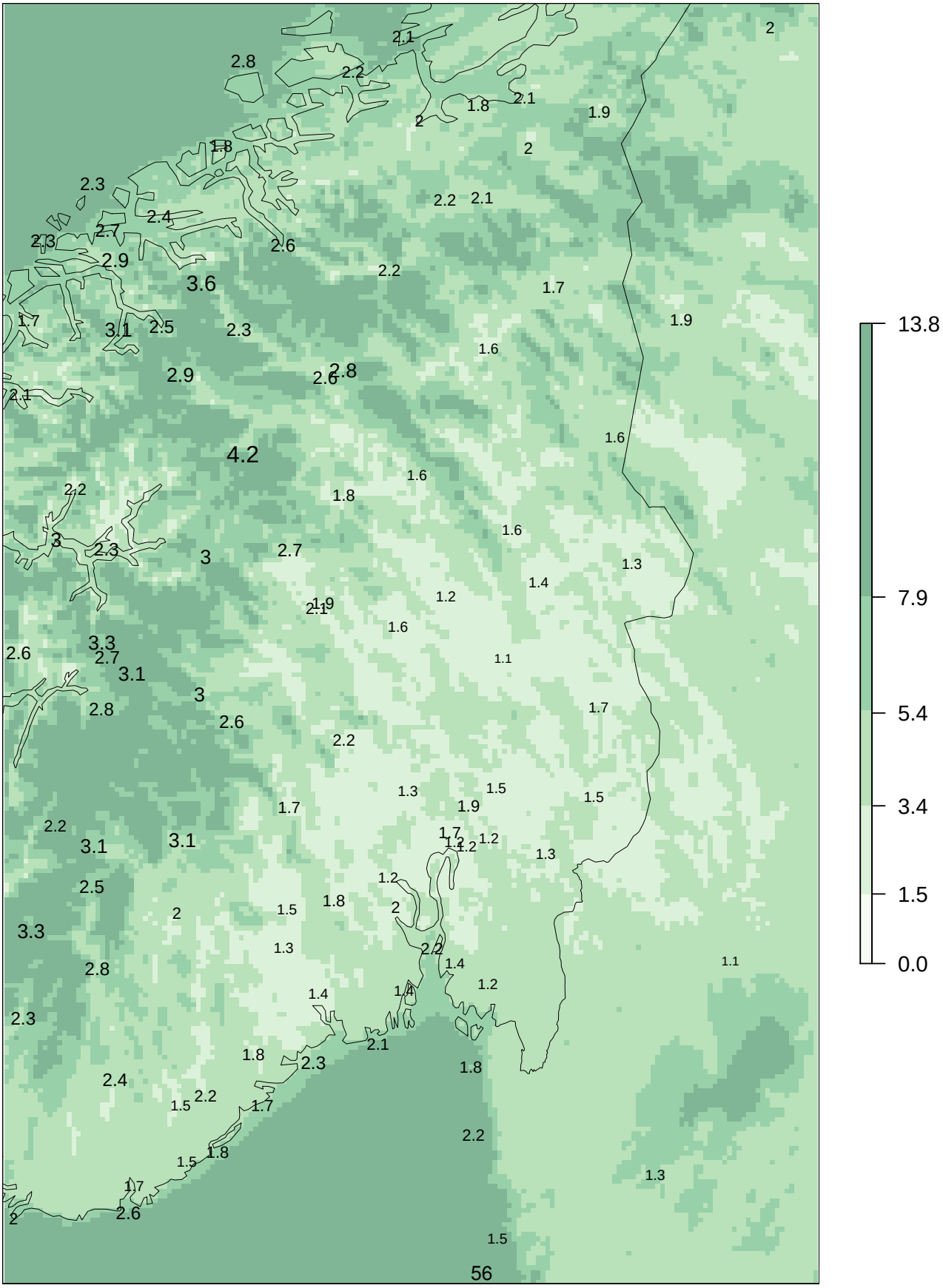

ME
76 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.5
0.0
−0.5
−1.0
[m/s]
3
9
15
21
27
33
39
45
51
57
63
Lead time [h]

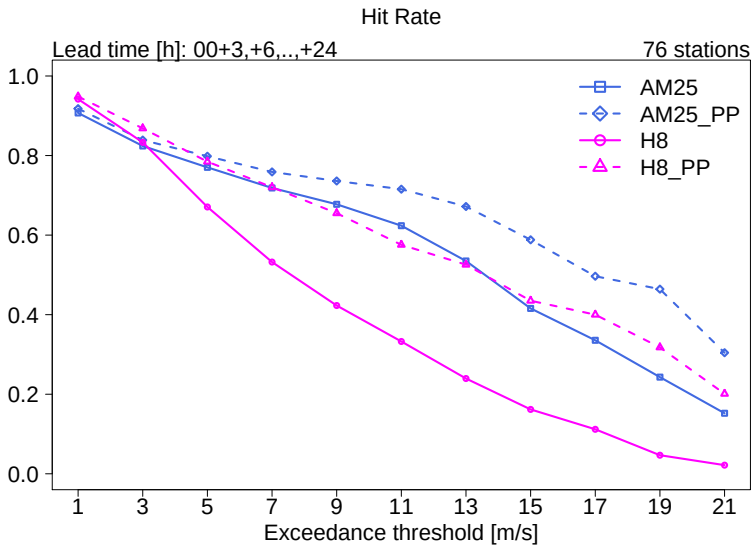

SDE
76 stations
AM25
AM25_PP
H8
H8_PP
3.5
3.0
2.5
2.0
1.5
[m/s]
3
9
15
21
27
33
39
45
51
57
63
Lead time [h]

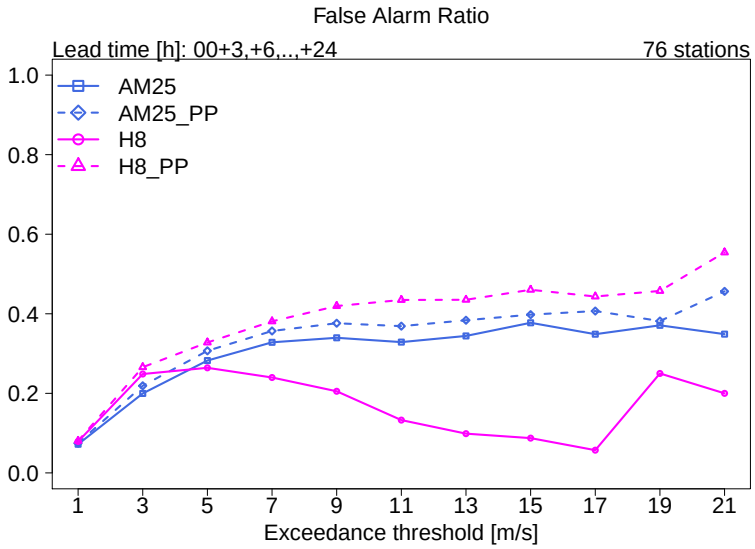

MAE
76 stations
AM25
AM25_PP
H8
H8_PP
2.5
2.0
1.5
[m/s]
3
9
15
21
27
33
39
45
51
57
63
Lead time [h]

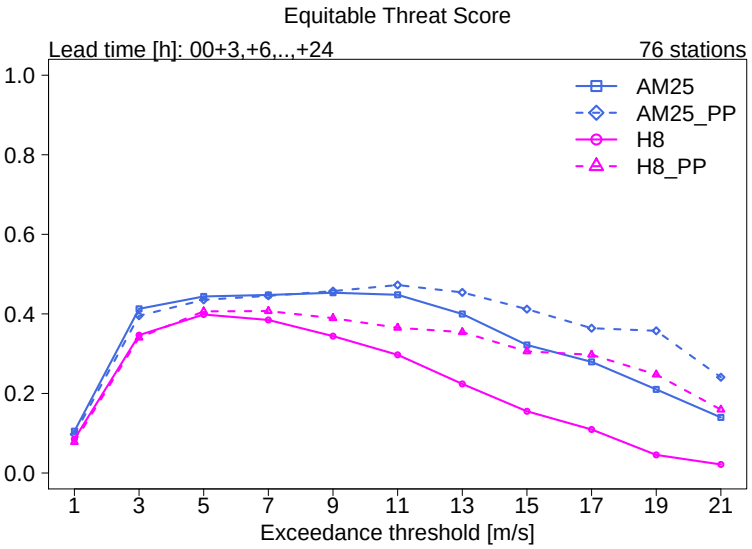
AM25 00+12

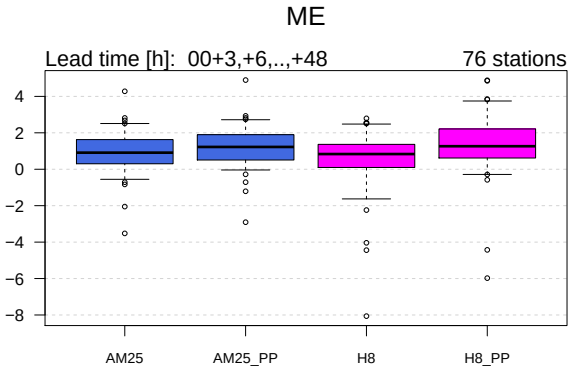
SDE at observing sites forecast means 01.12.2014 − 28.02.2015

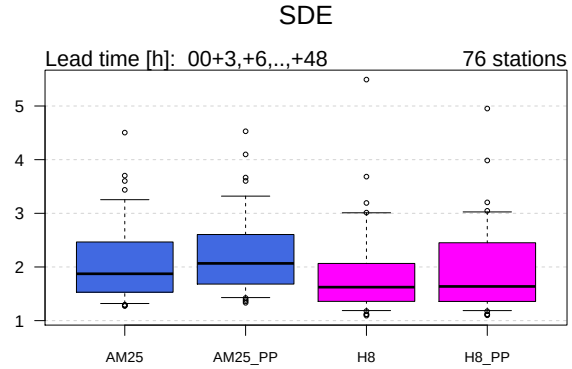



Hit Rate
Lead time [h]: 00+3,+6,..,+24
76 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


False Alarm Ratio
Lead time [h]: 00+3,+6,..,+24
76 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


Equitable Threat Score
Lead time [h]: 00+3,+6,..,+24
76 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]





Lead time [h]: 00+3,+6,..,+48 UTC 76 stations

AM25

OBS

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	25143	7216	78	1	2	32440
(3,11]	8231	25271	2027	105	27	35661
(11,17]	120	1472	2188	551	151	4482
(17,21]	4	100	93	157	140	494
(21,Inf]	0	6	11	13	54	84
Sum	33498	34065	4397	827	374	73161

AM25_PP

OBS

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	24036	6637	66	1	2	30742
(3,11]	9304	25267	1583	77	19	36250
(11,17]	153	1994	2530	440	104	5221
(17,21]	5	139	194	263	137	738
(21,Inf]	0	28	24	46	112	210
Sum	33498	34065	4397	827	374	73161

H8

OBS

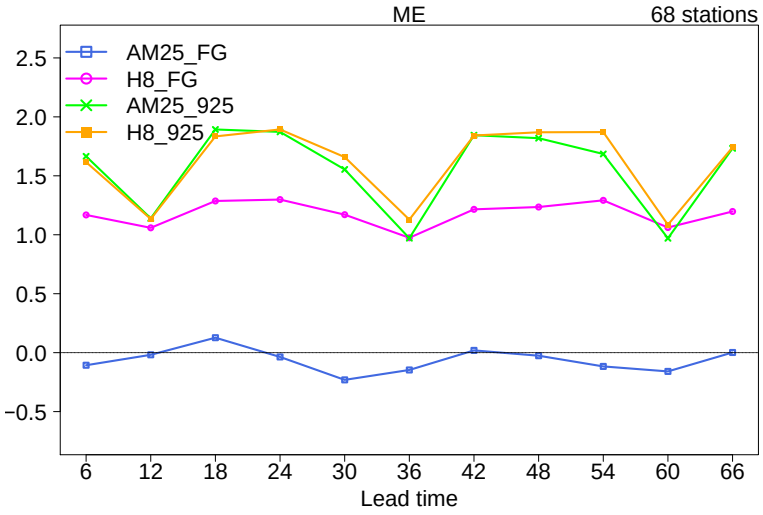
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	22411	6786	174	4	0	29375
(3,11]	11068	26998	3095	348	233	41742
(11,17]	19	281	1119	415	82	1916
(17,21]	0	0	9	59	54	122
(21,Inf]	0	0	0	1	5	6
Sum	33498	34065	4397	827	374	73161

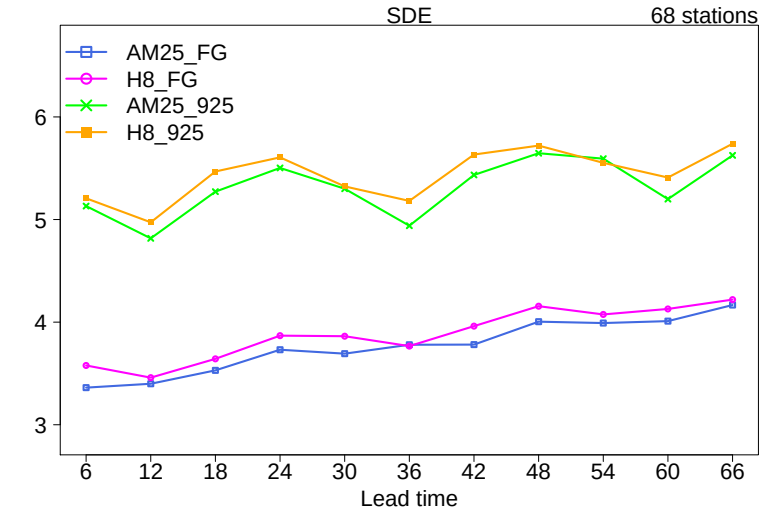
H8_PP

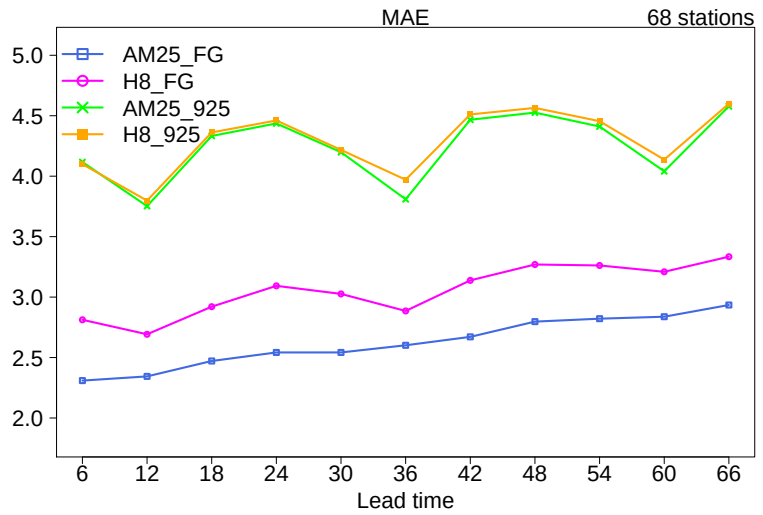
OBS

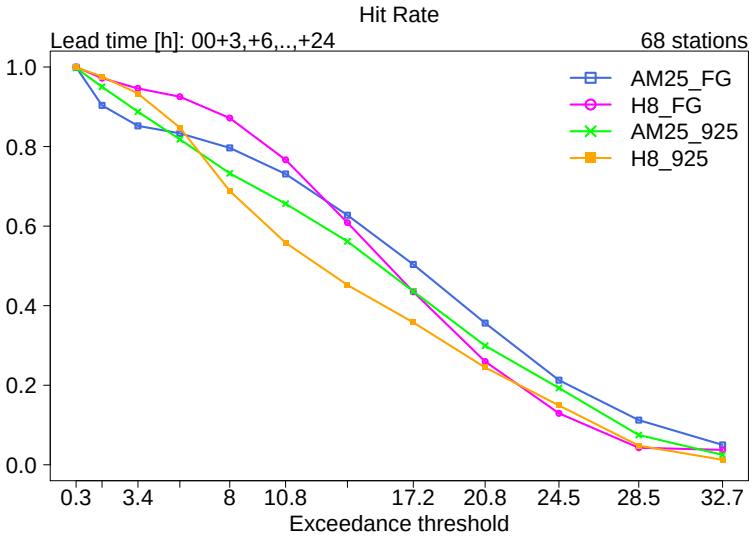
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	20969	5532	85	2	0	26588
(3,11]	12394	26150	1940	249	183	40916
(11,17]	104	2306	2097	265	58	4830
(17,21]	31	69	258	250	60	668
(21,Inf]	0	8	17	61	73	159
Sum	33498	34065	4397	827	374	73161

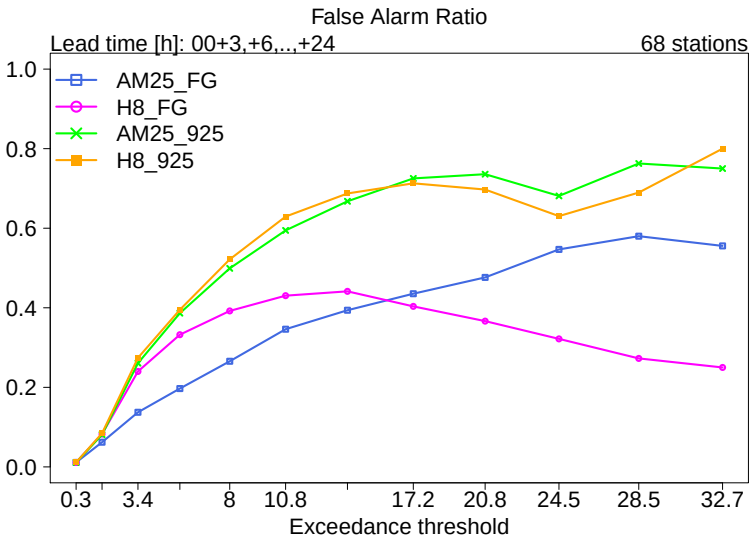
5.4 Wind gust

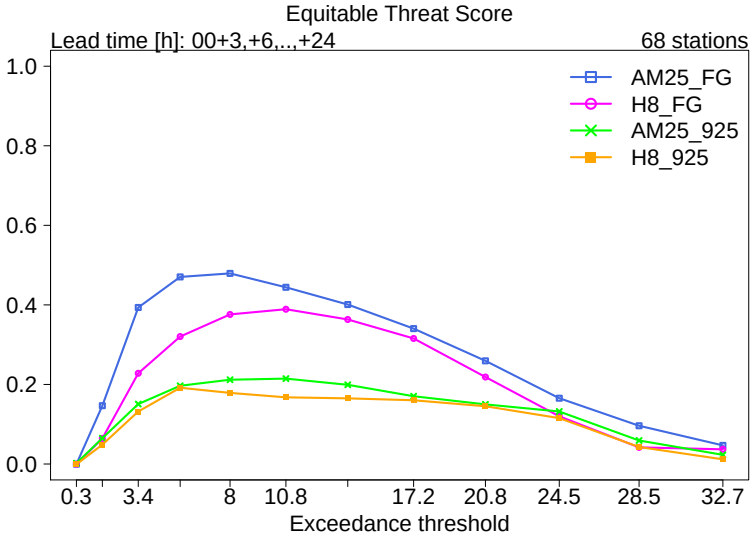

ME
68 stations
AM25_FG
H8_FG
AM25_925
H8_925
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
6
12
18
24
30
36
42
48
54
60
66
Lead time


SDE
68 stations
AM25_FG
H8_FG
AM25_925
H8_925
6
5
4
3
6
12
18
24
30
36
42
48
54
60
66
Lead time

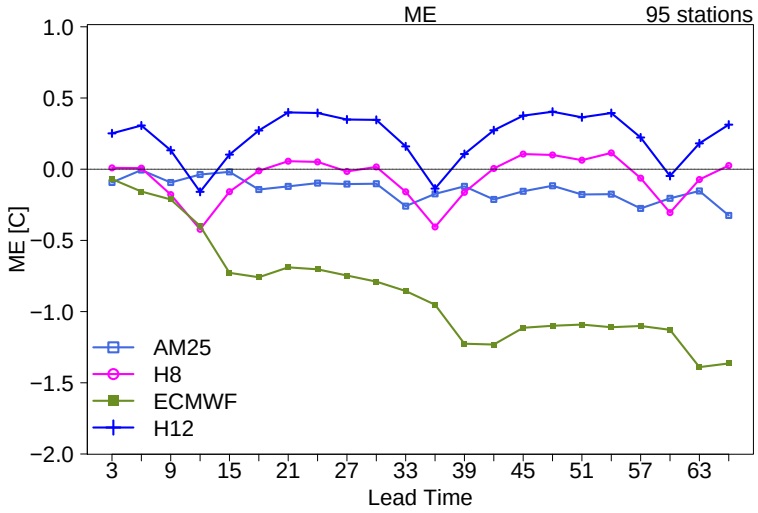

MAE
68 stations
AM25_FG
H8_FG
AM25_925
H8_925
5.0
4.5
4.0
3.5
3.0
2.5
2.0
6
12
18
24
30
36
42
48
54
60
66
Lead time

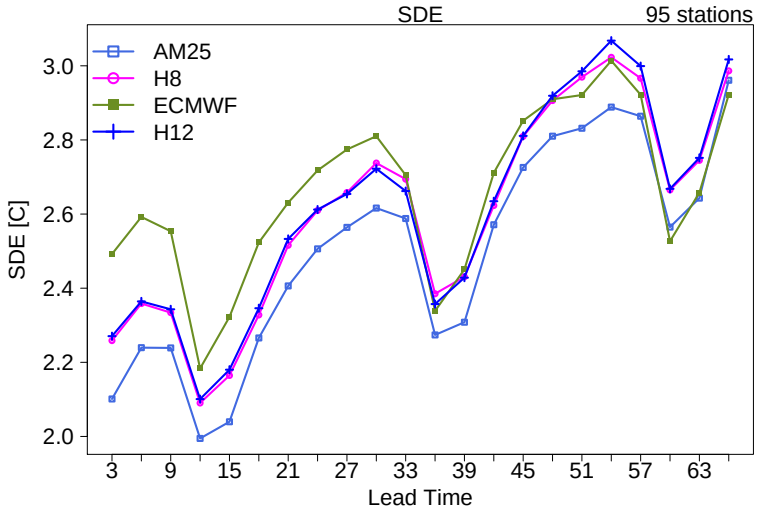

Hit Rate
Lead time [h]: 00+3,+6,..,+24
68 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.0
0.8
0.6
0.4
0.2
0.0
0.3
3.4
8
10.8
17.2
20.8
24.5
28.5
32.7
Exceedance threshold

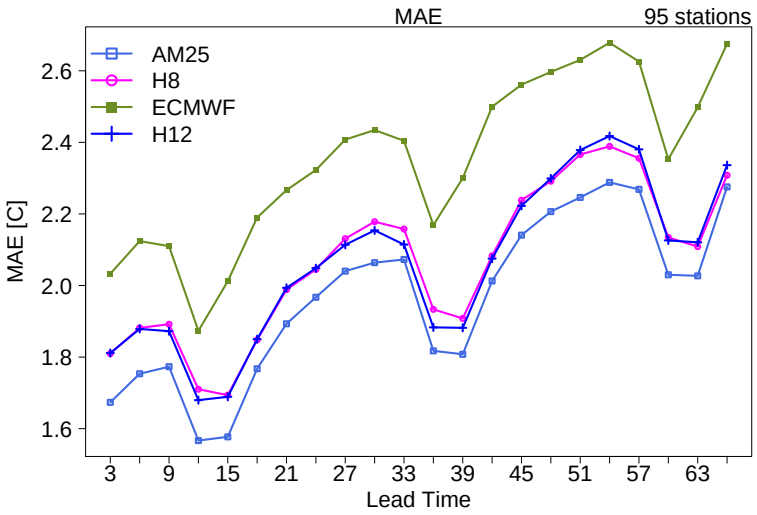

False Alarm Ratio
Lead time [h]: 00+3,+6,..,+24
68 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.0
0.8
0.6
0.4
0.2
0.0
0.3
3.4
8
10.8
17.2
20.8
24.5
28.5
32.7
Exceedance threshold

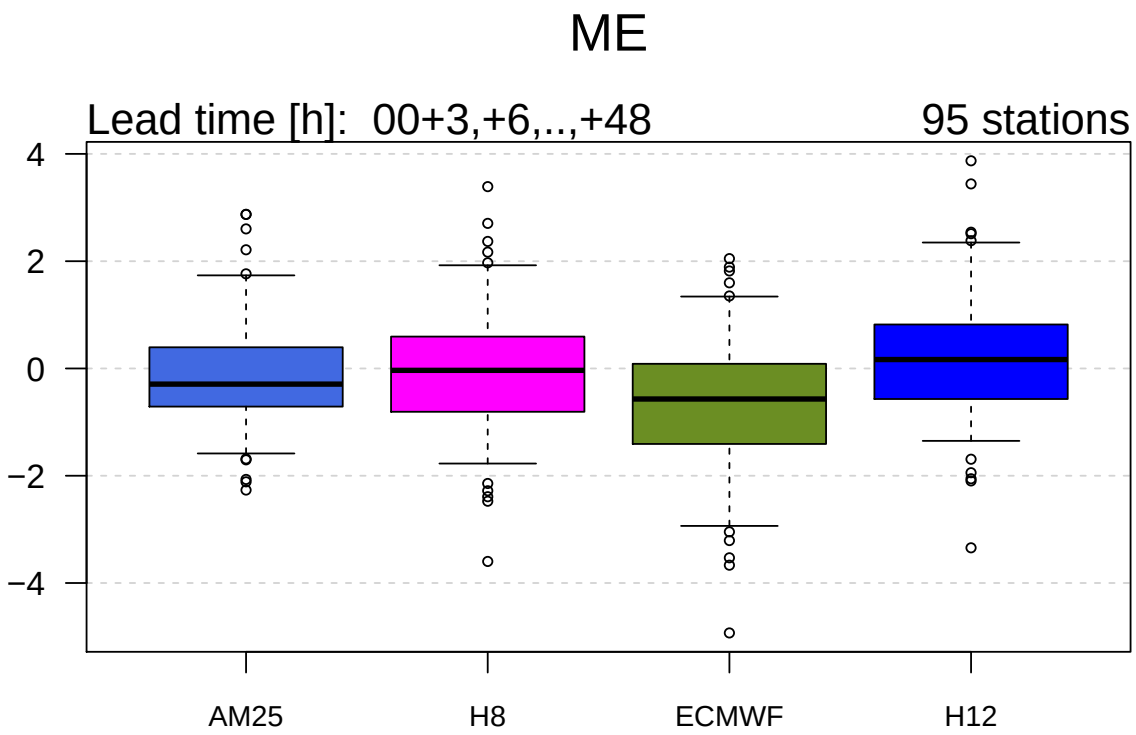

Equitable Threat Score
Lead time [h]: 00+3,+6,..,+24
68 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.0
0.8
0.6
0.4
0.2
0.0
0.3
3.4
8
10.8
17.2
20.8
24.5
28.5
32.7
Exceedance threshold

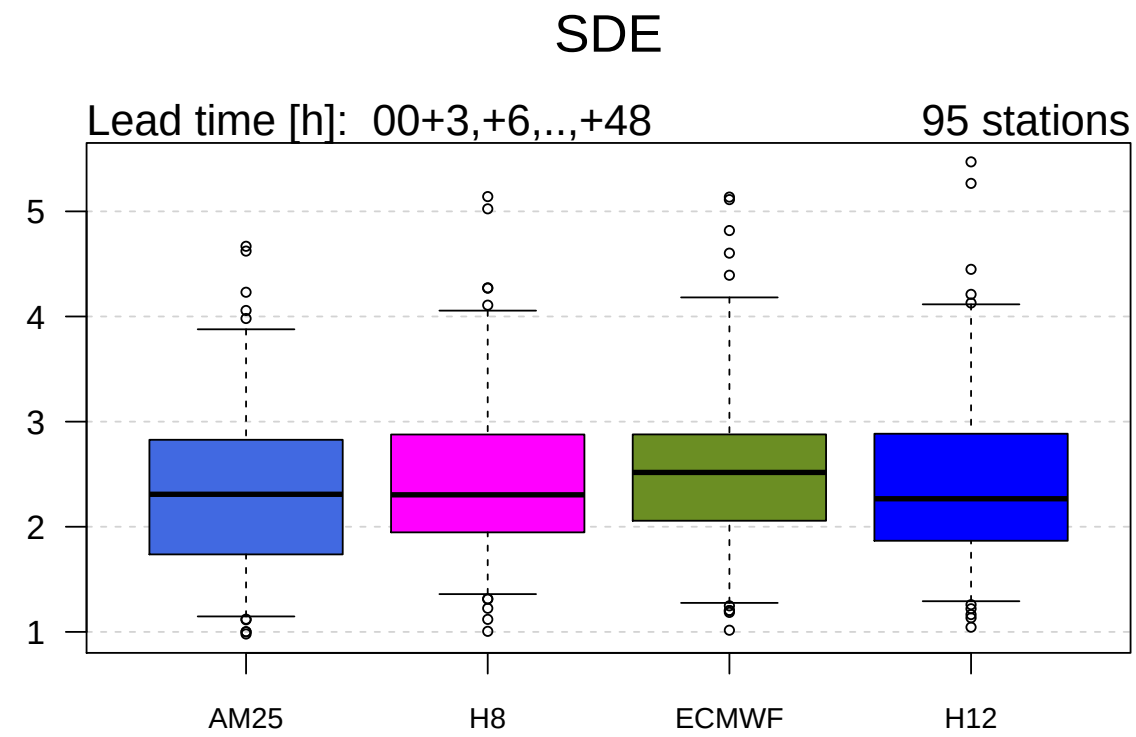
5.5 Temperature 2m





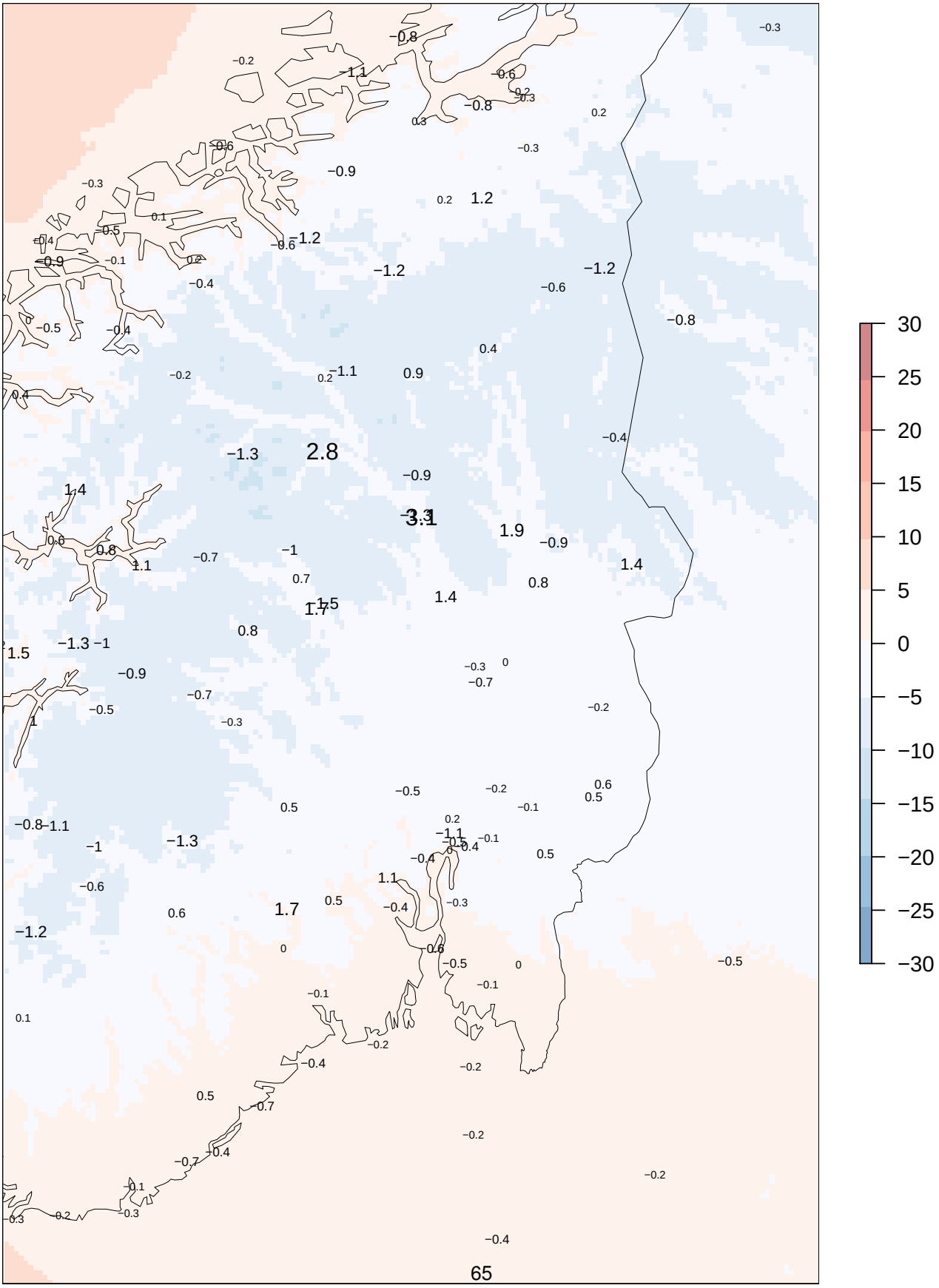



ME
Lead time [h]: 00+3,+6,..,+48
95 stations
4
2
0
−2
−4
AM25
H8
ECMWF
H12


SDE
Lead time [h]: 00+3,+6,..,+48
95 stations
5
4
3
2
1
AM25
H8
ECMWF
H12

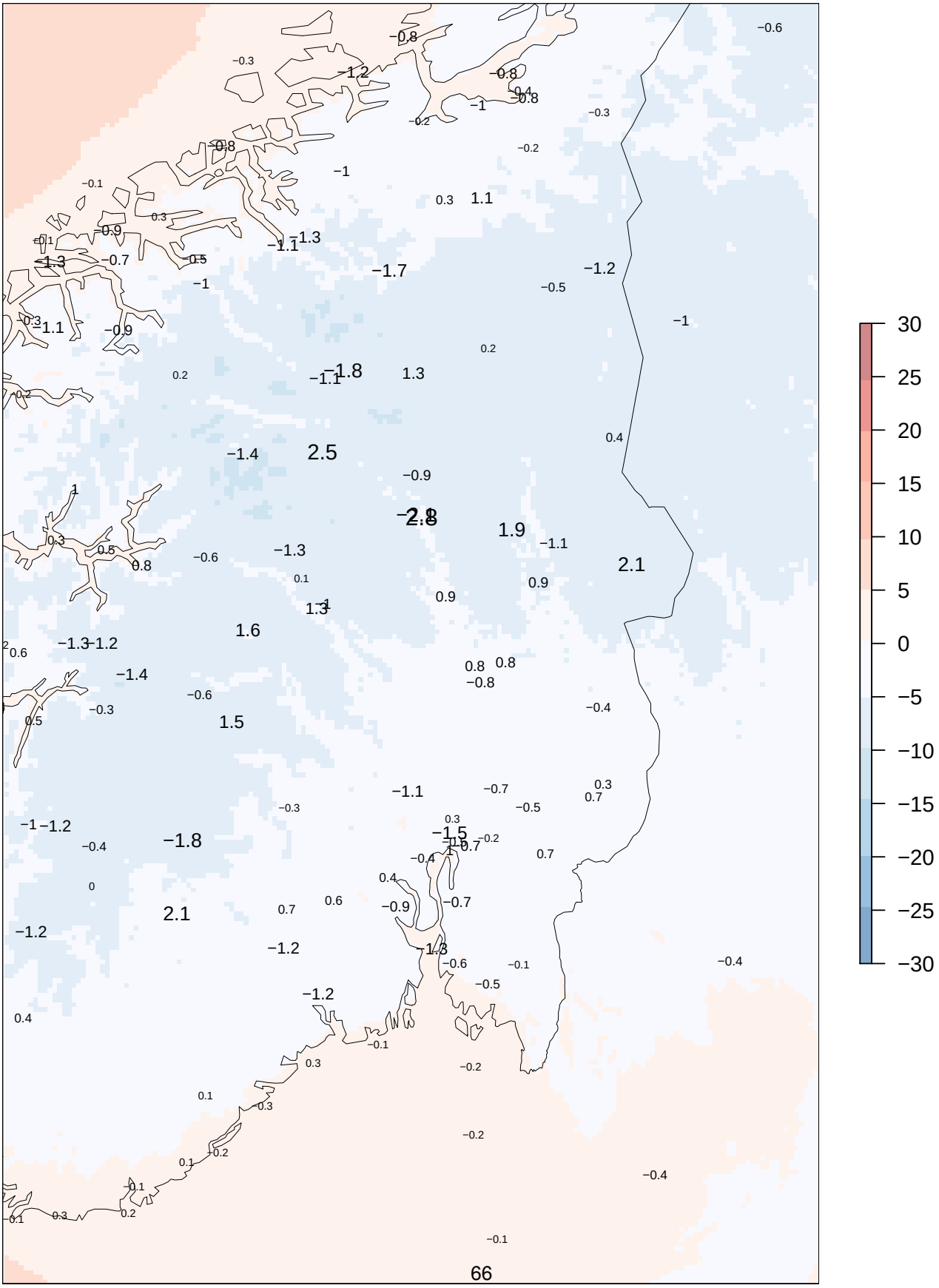
AM25 00+12

ME at observing sites forecast means 01.12.2014 − 28.02.2015



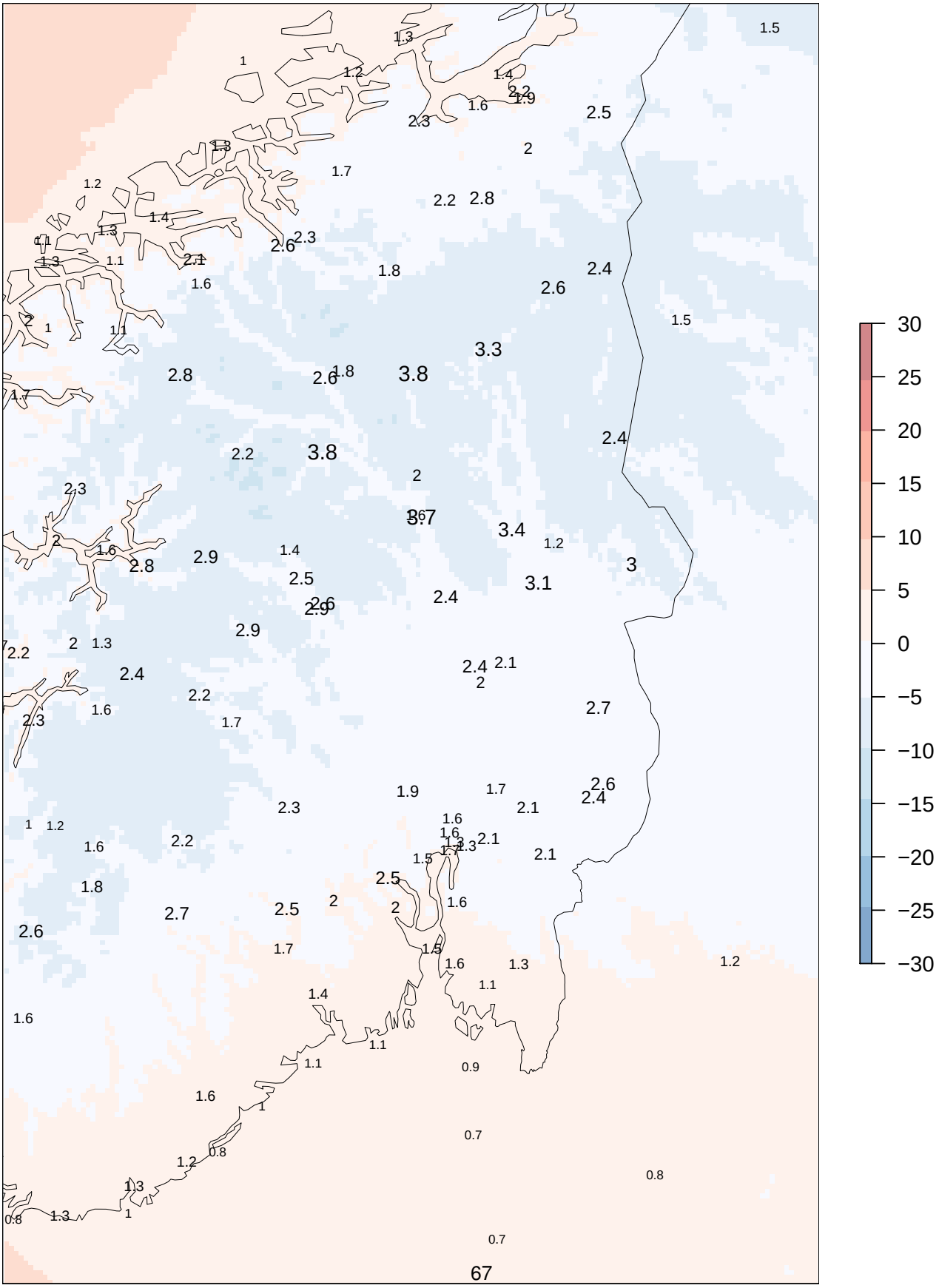
AM25 00+24

ME at observing sites forecast means 01.12.2014 − 28.02.2015



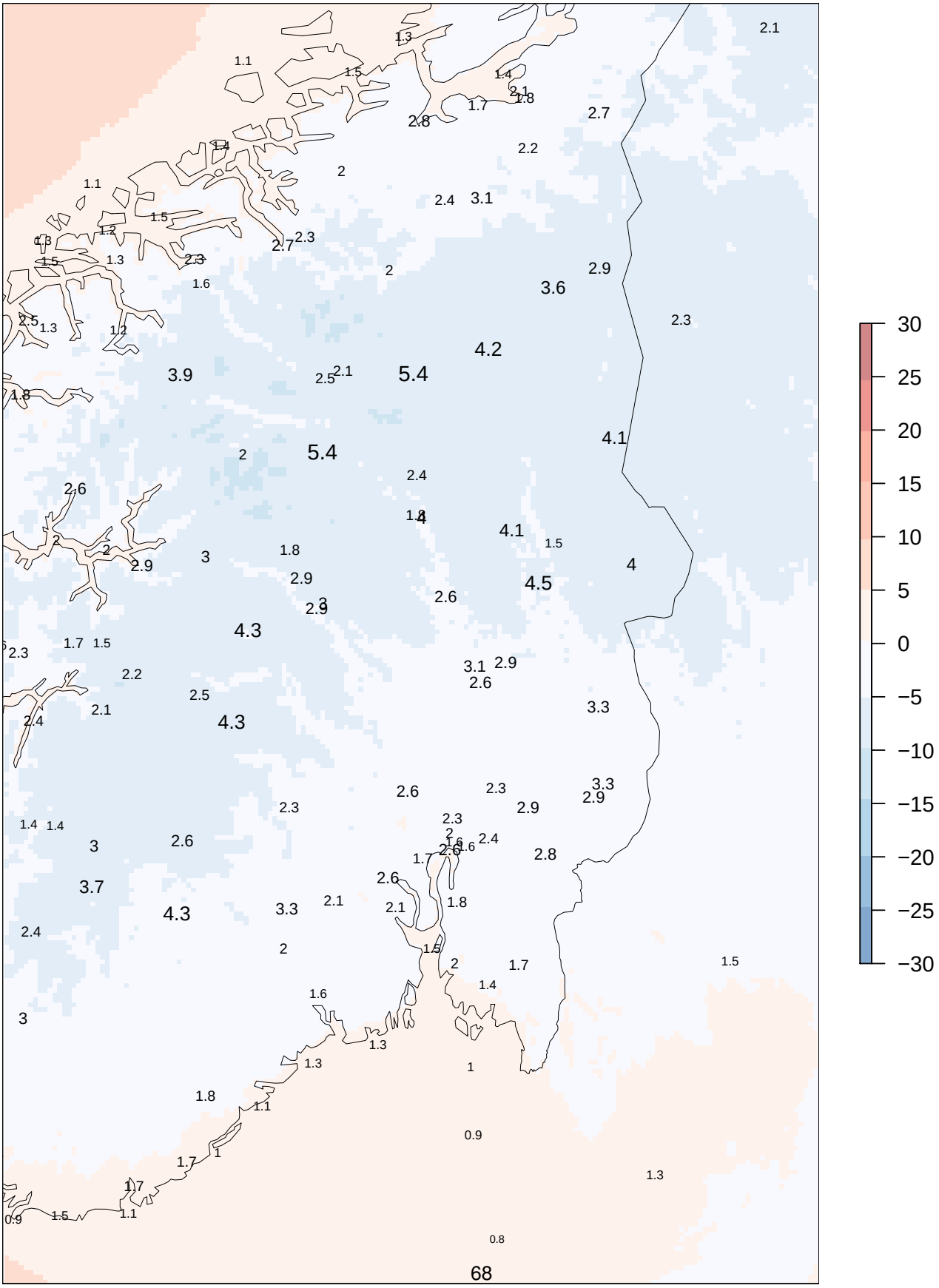
AM25 00+12

SDE at observing sites forecast means 01.12.2014 − 28.02.2015

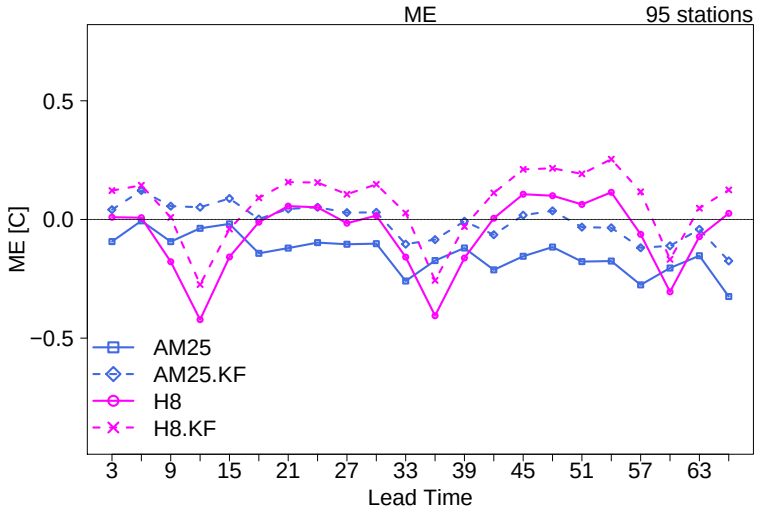


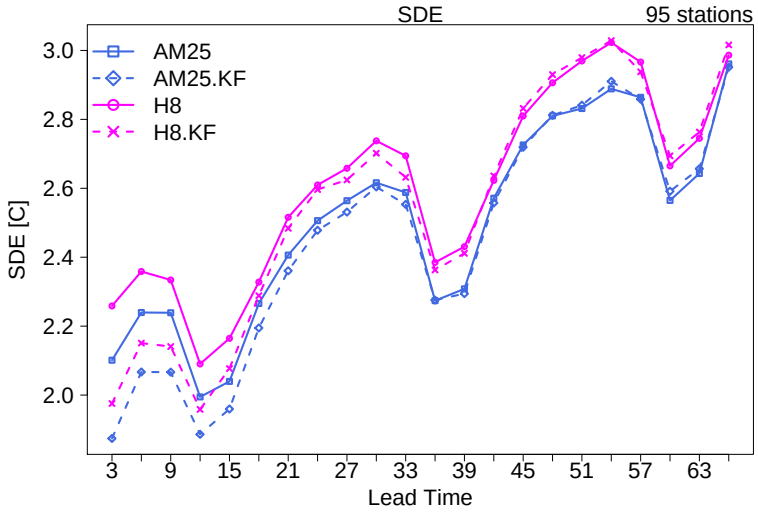
AM25 00+24

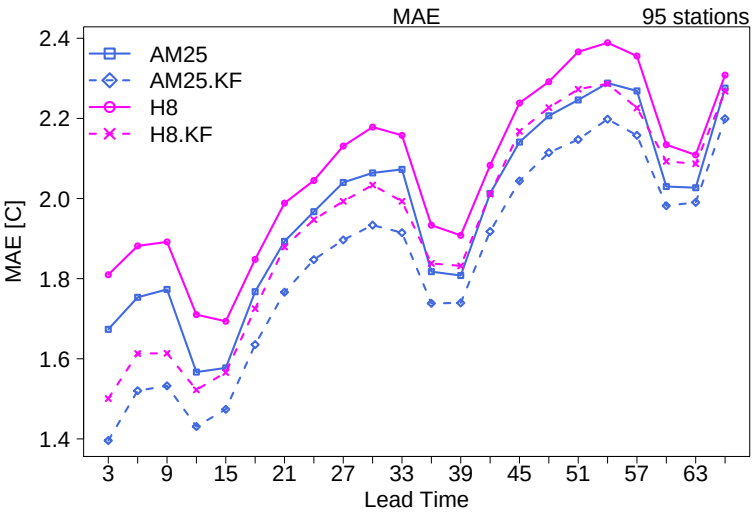
SDE at observing sites forecast means 01.12.2014 − 28.02.2015

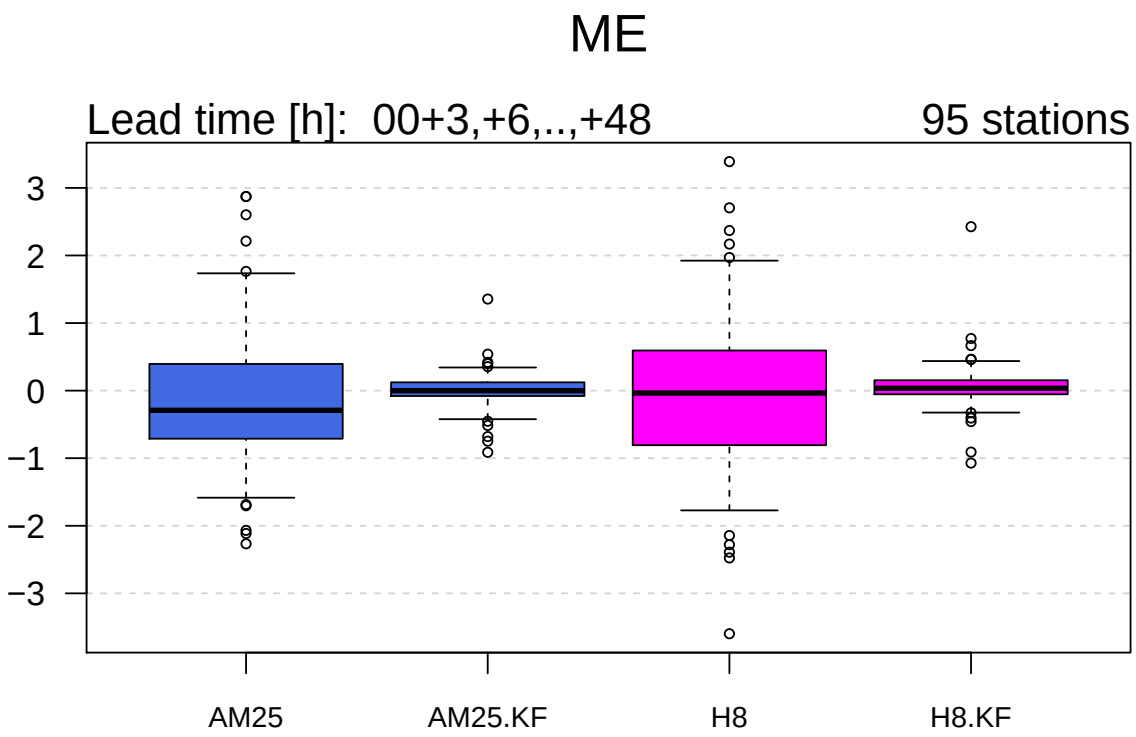


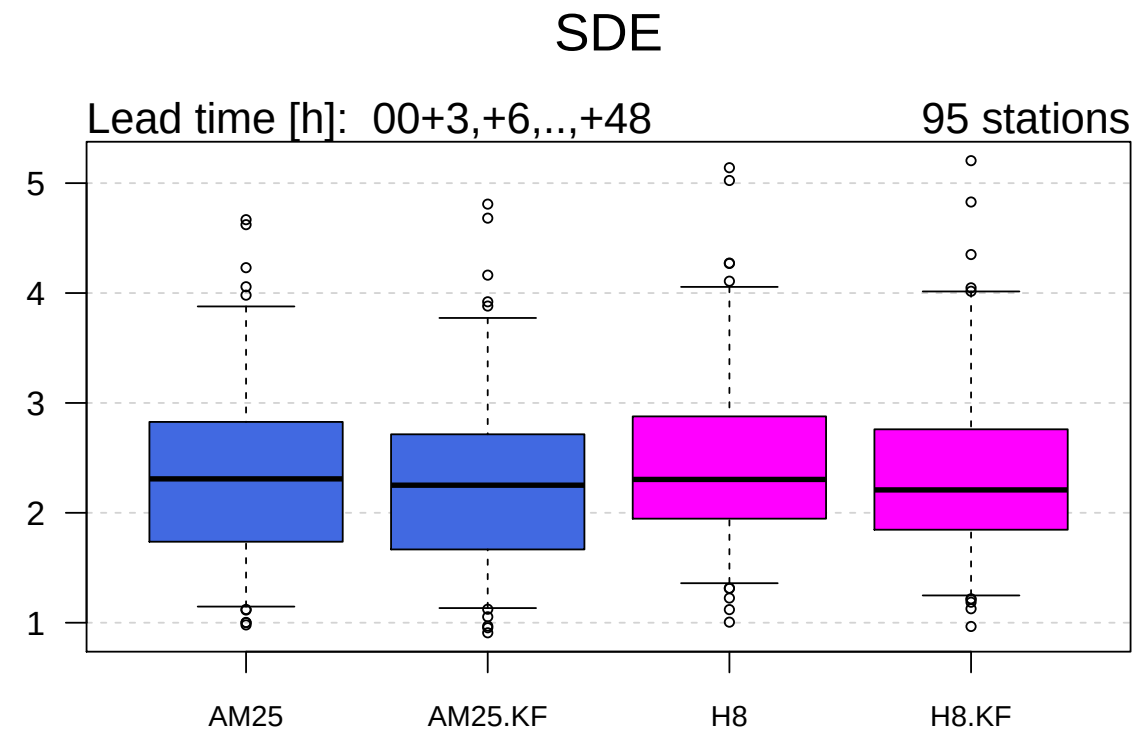
5.6 Post processed temperature 2m



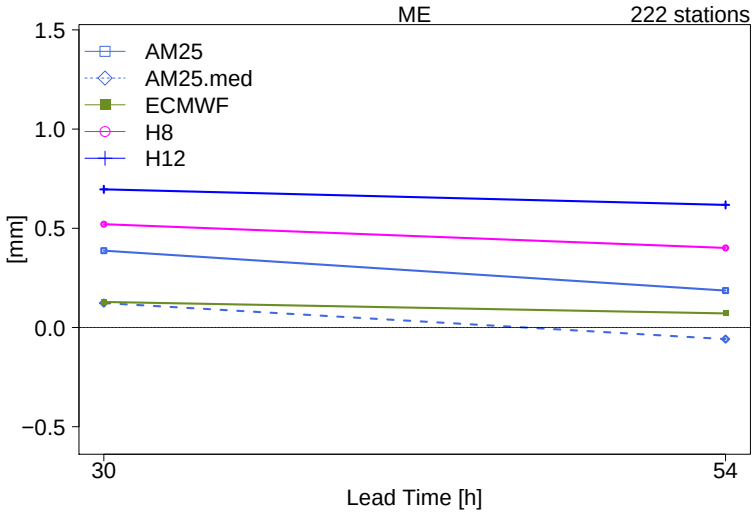


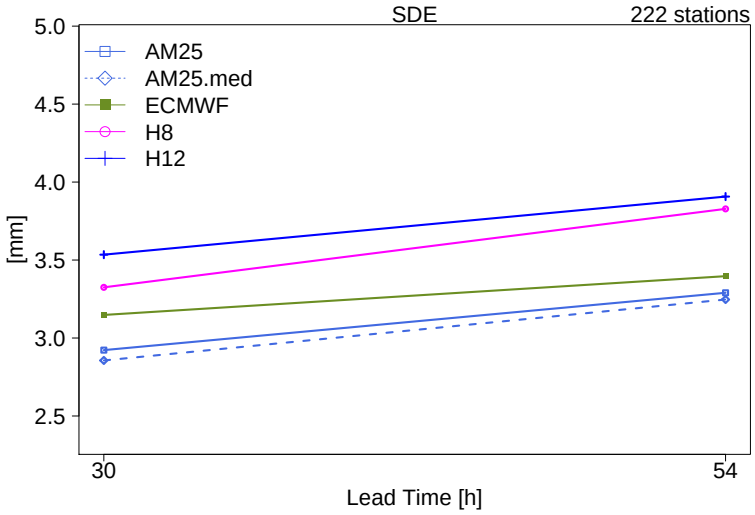


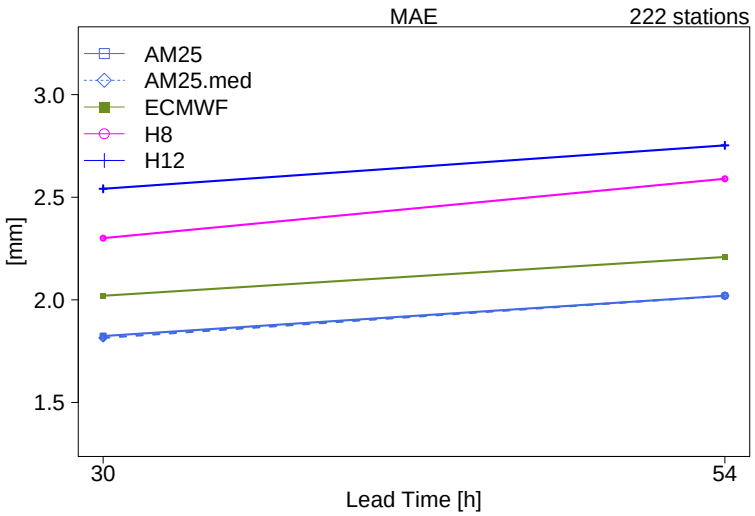

ME
Lead time [h]: 00+3,+6,..,+48
95 stations
3
2
1
0
−1
−2
−3
AM25
AM25.KF
H8
H8.KF

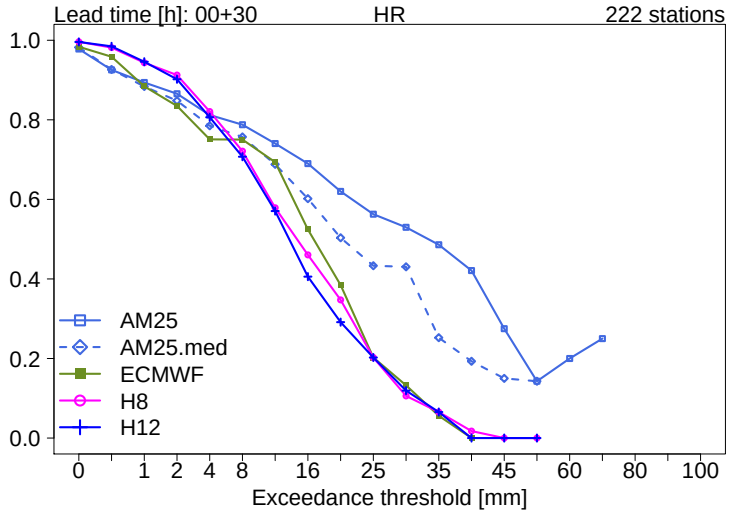

SDE
Lead time [h]: 00+3,+6,..,+48
95 stations
5
4
3
2
1
AM25
AM25.KF
H8
H8.KF

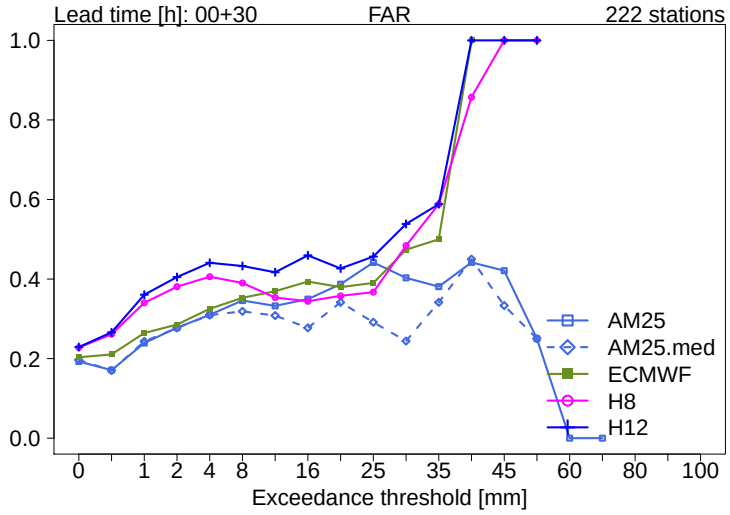
5.7 Daily precipitation

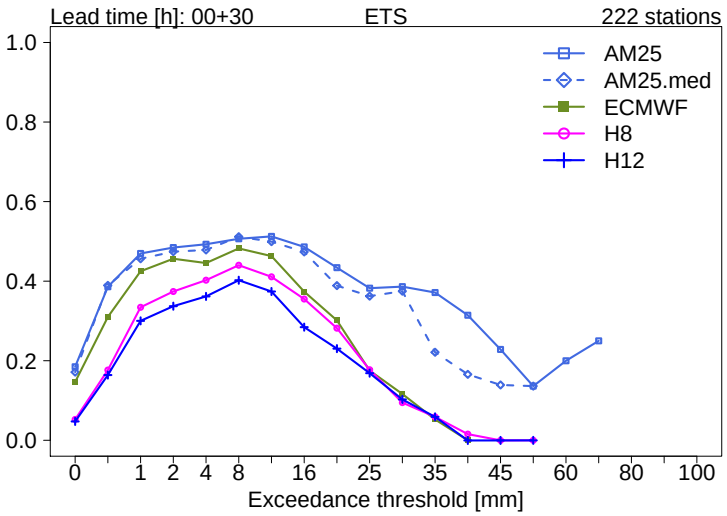


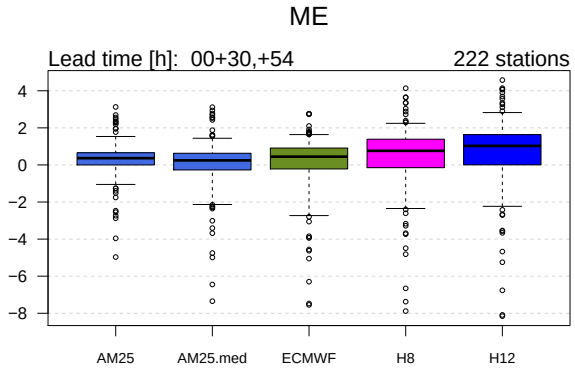


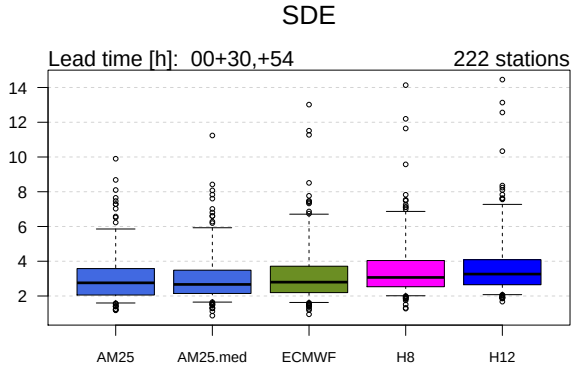



Lead time [h]: 00+30
HR
222 stations
1.0
0.8
0.6
0.4
0.2
0.0
AM25
AM25.med
ECMWF
H8
H12
0 1 2 4 8 16 25 35 45 60 80 100
Exceedance threshold [mm]


Lead time [h]: 00+30
FAR
222 stations
1.0
0.8
0.6
0.4
0.2
0.0
AM25
AM25.med
ECMWF
H8
H12
0 1 2 4 8 16 25 35 45 60 80 100
Exceedance threshold [mm]


Lead time [h]: 00+30
ETS
222 stations
1.0
0.8
0.6
0.4
0.2
0.0
AM25
AM25.med
ECMWF
H8
H12
0 1 2 4 8 16 25 35 45 60 80 100
Exceedance threshold [mm]





Lead time [h]: 00+30,+54 222 stations

AM25 — OBS

	[0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	5594	1597	40	2	0	7233
(0.1,5]	3909	11047	1280	12	1	16249
(5,20]	155	2154	3452	344	2	6107
(20,50]	4	25	290	460	31	810
(50,Inf]	0	0	0	6	8	14
Sum	9662	14823	5062	824	42	30413

AM25.med — OBS

	[0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	5587	1556	46	2	0	7191
(0.1,5]	3915	11166	1453	15	2	16551
(5,20]	156	2085	3386	433	5	6065
(20,50]	4	16	177	370	32	599
(50,Inf]	0	0	0	4	3	7
Sum	9662	14823	5062	824	42	30413

ECMWF — OBS

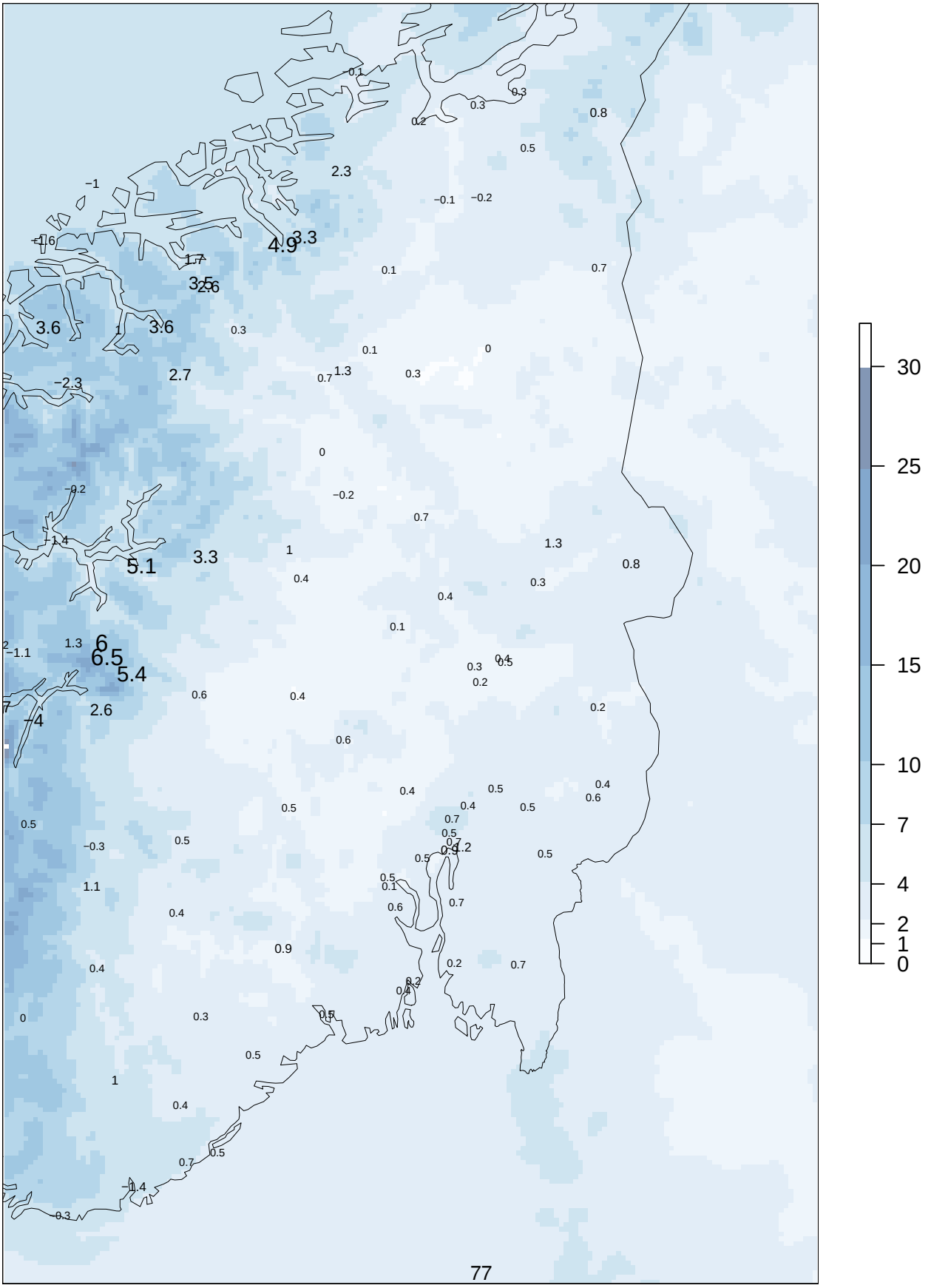
	[0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	4731	1108	41	1	0	5881
(0.1,5]	4757	11477	1523	7	2	17766
(5,20]	172	2226	3306	521	13	6238
(20,50]	2	12	192	295	27	528
(50,Inf]	0	0	0	0	0	0
Sum	9662	14823	5062	824	42	30413

H8 — OBS

	[0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	2584	411	19	0	0	3014
(0.1,5]	6730	11365	1419	22	2	19538
(5,20]	347	3039	3480	556	17	7439
(20,50]	1	8	144	245	23	421
(50,Inf]	0	0	0	1	0	1
Sum	9662	14823	5062	824	42	30413

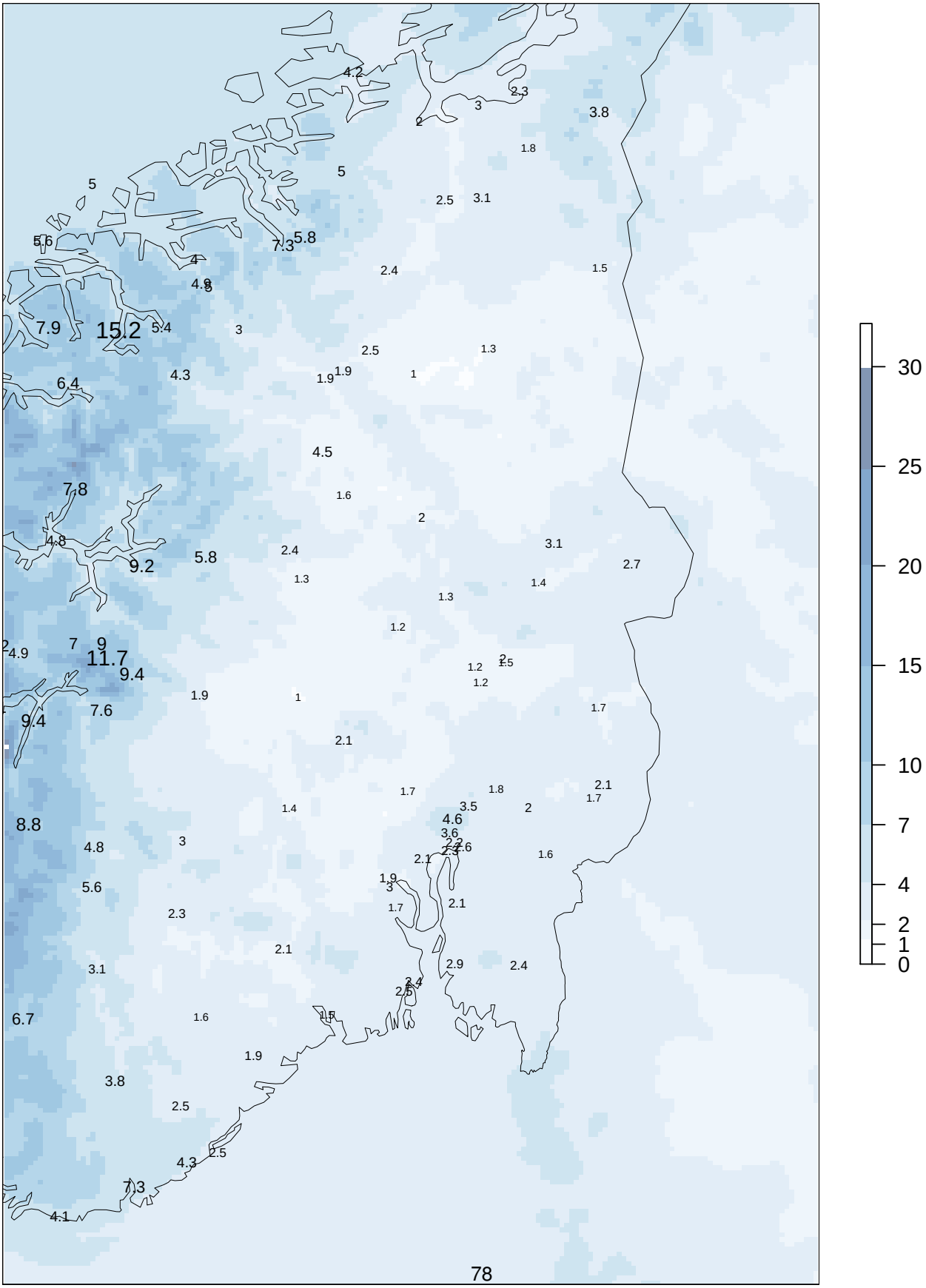
AM25 00+30

ME at observing sites forecast means 01.12.2014 − 28.02.2015



AM25 00+30

SDE at observing sites forecast means 01.12.2014 − 28.02.2015



6 Western Norway

6.1 Comments to the verification results

Wind speed 10 m:
For the period 1st of December 2014 to 28th of February 2015, Arome, Hirlam12 and Hirlam8 all have small positive biases in wind speed, while ECMWF has a negative bias. Arome scores best for all wind speeds.

Max mean wind speed 10 m:
For Max Mean Wind Speed, both Arome and Hirlam8 have negative biases. After postprocessing Arome has almost no bias while Hirlam8 has a small positive bias. For Max mean wind speed Arome scores better for all wind speeds.

Wind gust:
For wind gust Arome has a negative bias between 0.5 and 1 ms^{-1}, while Hirlam8 has a positive bias around $1ms^{-1}$. If we look at wind speed at 925 hPa (which often is used as an estimate of wind gust), there are only minor differences in bias between the Arome and Hirlam8. Both have a positive bias around $1ms^{-1}$. Wind gust from Arome scores best for wind speeds below $15ms^{-1}$, while Hirlam8 scores better for stronger wind gust. Overall wind gust from Arome and Hirlam8 scores better than wind speed at 925 hPa.

Temperature 2m:
For temperature Hirlam12 and Hirlam8 have a small positive bias, Arome has a small negative bias, while ECMWF has an increasing negative bias with lead time. After post-processing there is almost no bias for Hirlam8 and a small negative bias for Arome.

Precipitation:
For precipitation ECWMF and Arome have almost no bias, while Hirlam12 and Hirlam8 have a negative bias. Arome scores best for both light and heavy precipitation.

Case VV: Showers over sea:
AROME does not produce showers over Sea with westerly or southwesterly, unless a strong through is present or there is strong convection. The showers are not produced until they are far inland. Examples from February 20 are shown in the figures below.

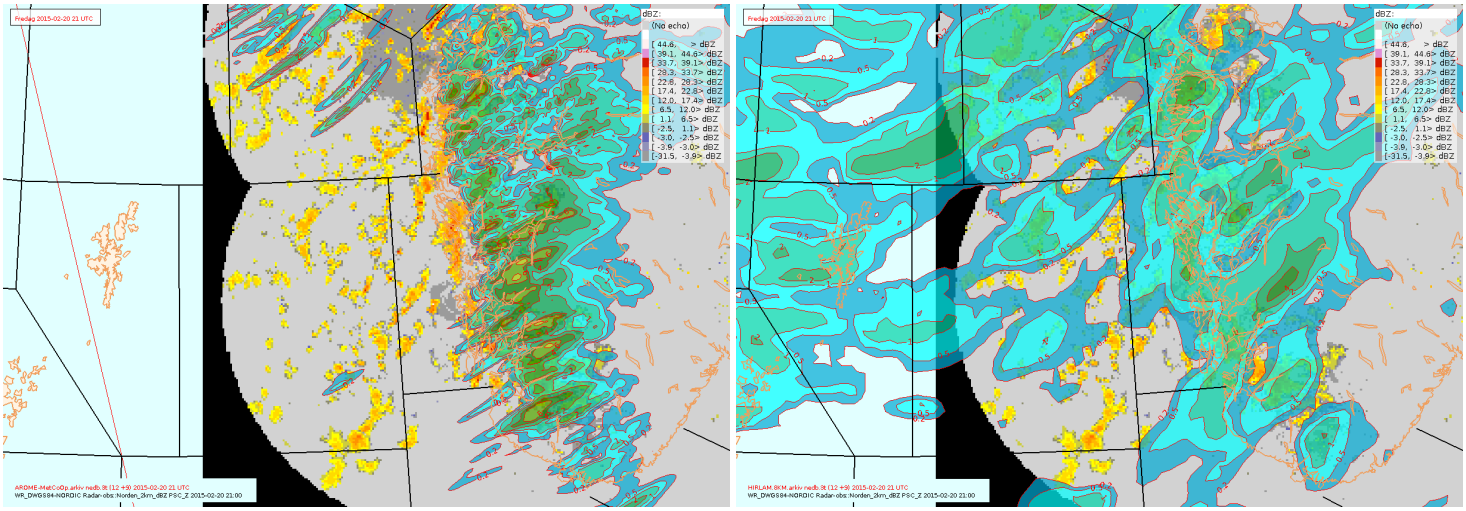
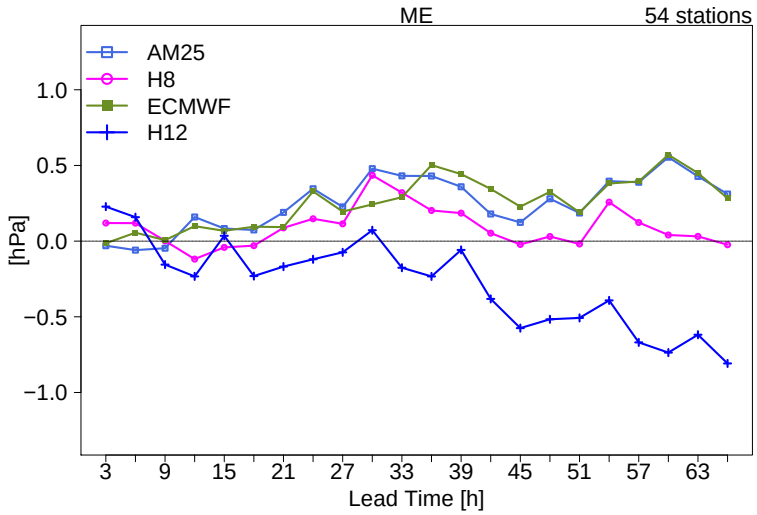
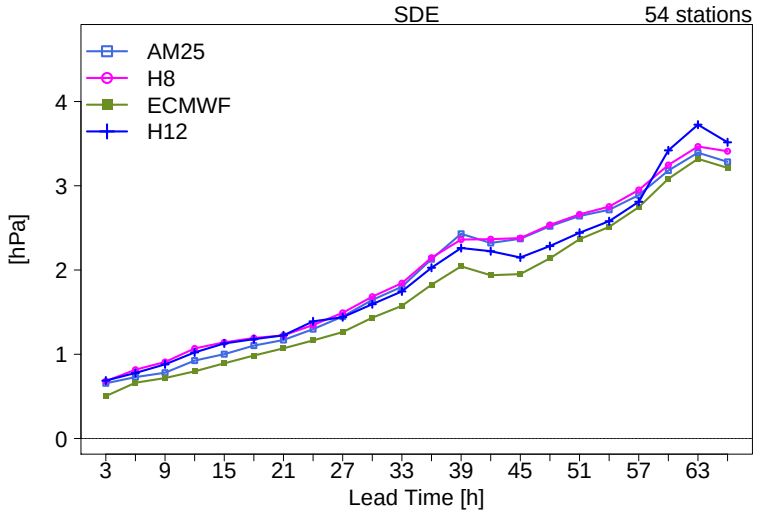
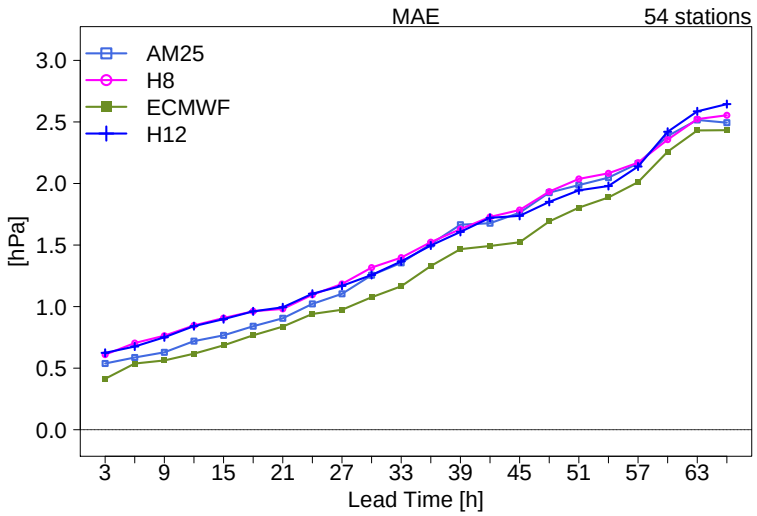


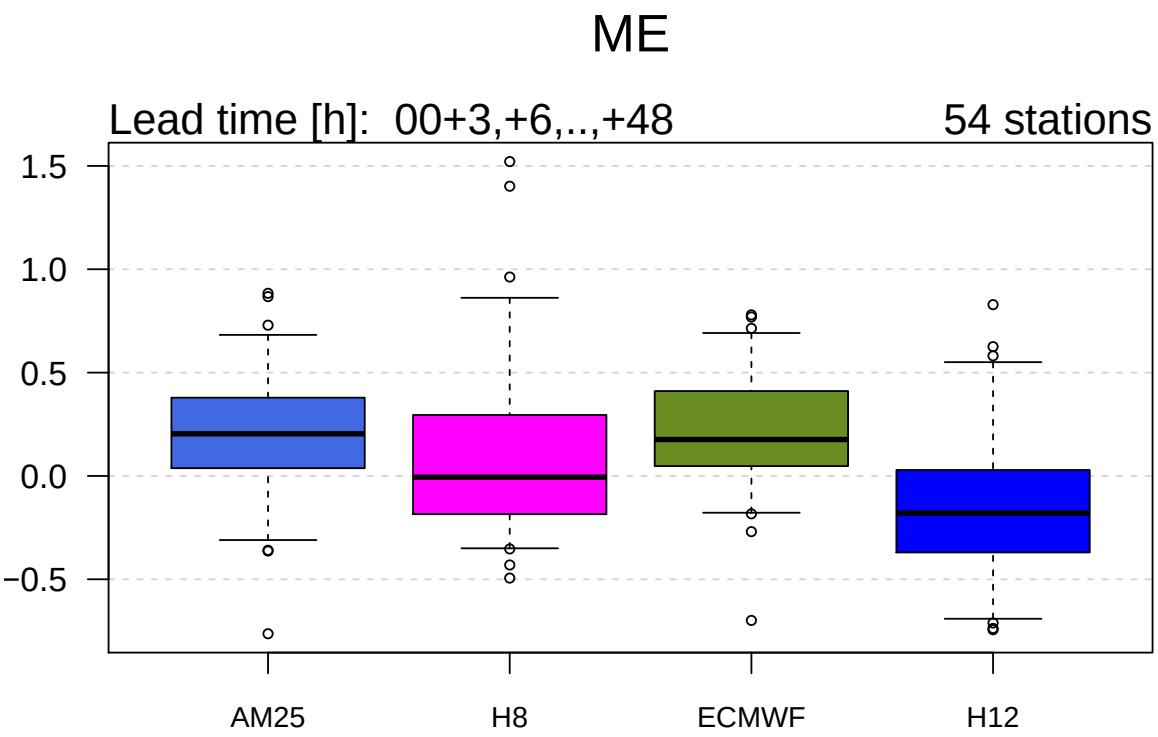
Figure 4: Figures from the February 20 case. Left: 3h precipitation with radar echo from AROME at 21 UTC. Right: 3h precipitation from Hirlam with radar echo at 21 UTC.

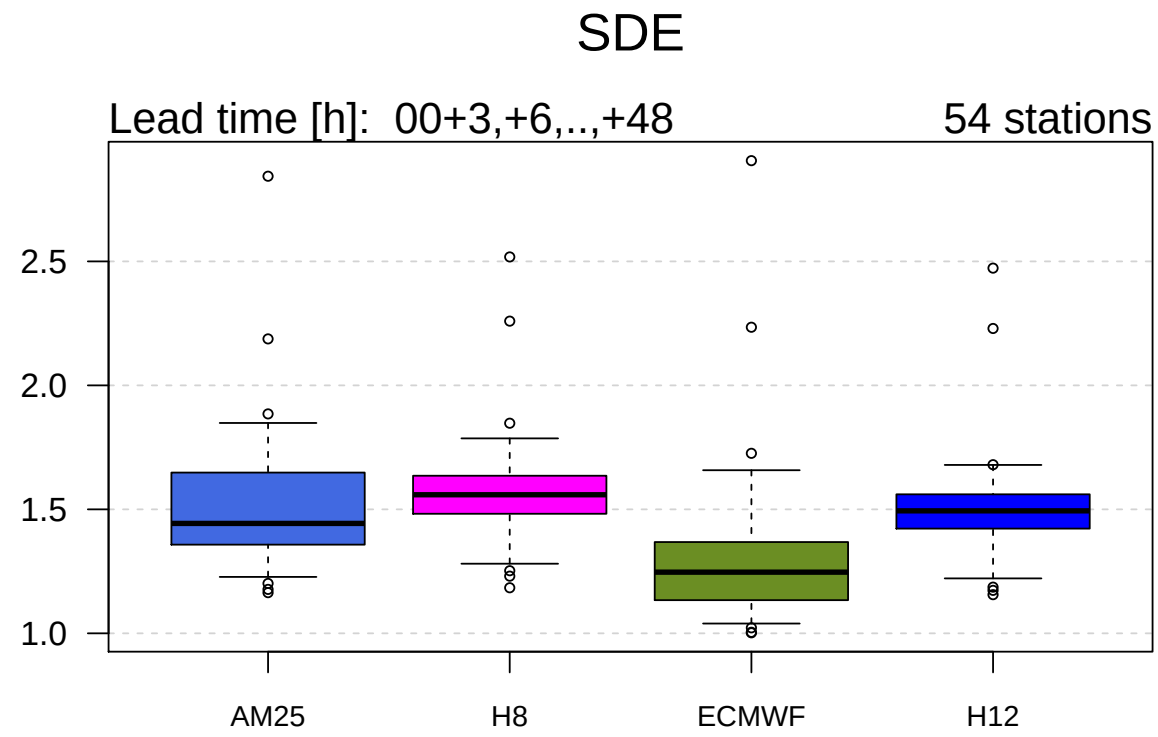
6.2 Pressure


ME
54 stations
AM25
H8
ECMWF
H12
1.0
0.5
0.0
−0.5
−1.0
[hPa]
3
9
15
21
27
33
39
45
51
57
63
Lead Time [h]

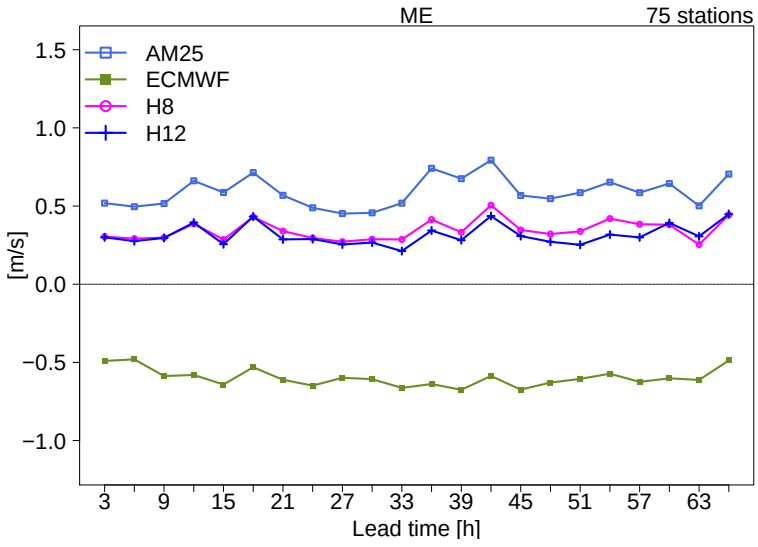

SDE
54 stations
AM25
H8
ECMWF
H12
4
3
2
1
0
[hPa]
3
9
15
21
27
33
39
45
51
57
63
Lead Time [h]

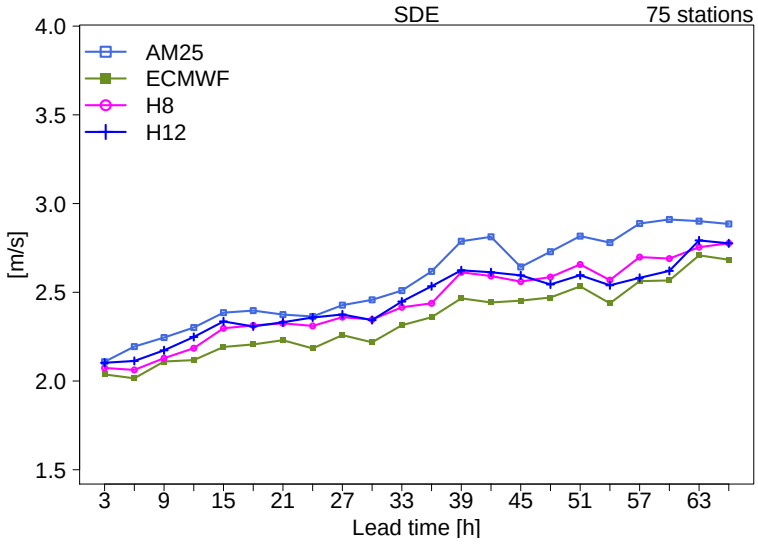

MAE
54 stations
AM25
H8
ECMWF
H12
3.0
2.5
2.0
1.5
1.0
0.5
0.0
[hPa]
3
9
15
21
27
33
39
45
51
57
63
Lead Time [h]

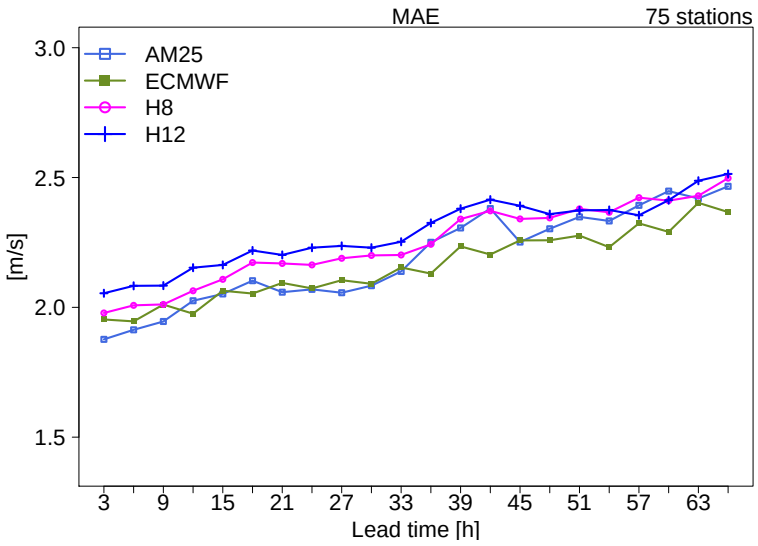

ME
Lead time [h]: 00+3,+6,..,+48
54 stations
1.5
1.0
0.5
0.0
−0.5
AM25
H8
ECMWF
H12

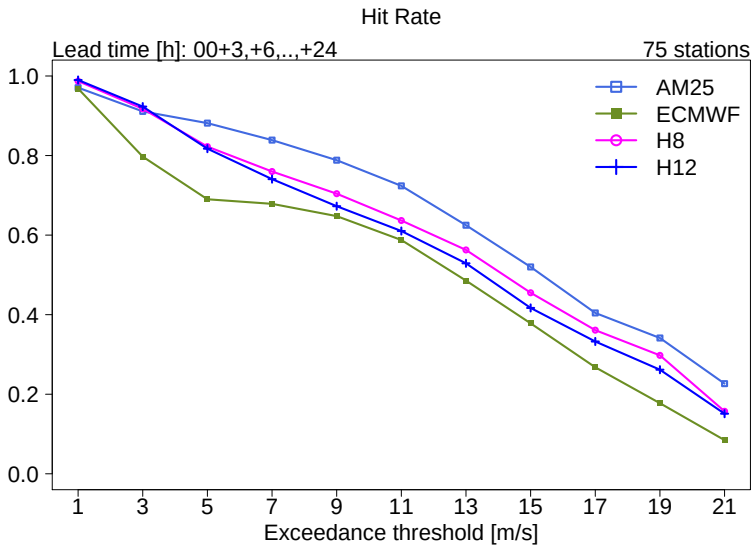

SDE
Lead time [h]: 00+3,+6,..,+48
54 stations
2.5
2.0
1.5
1.0
AM25
H8
ECMWF
H12

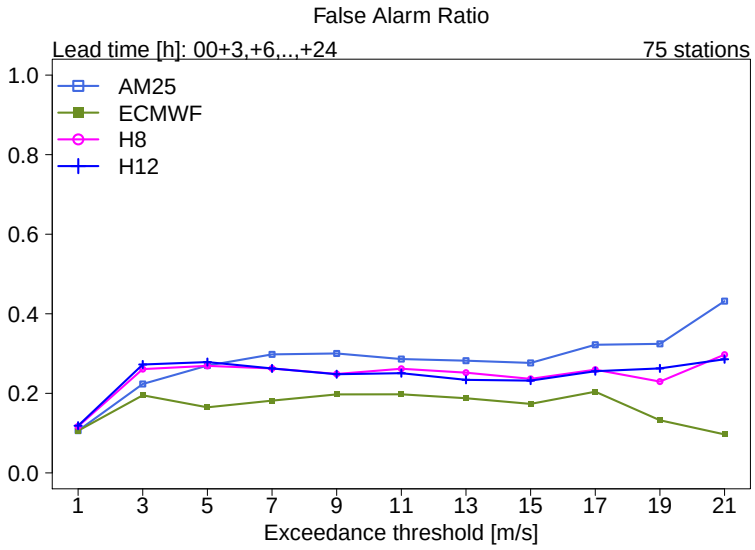
6.3 Wind Speed 10m

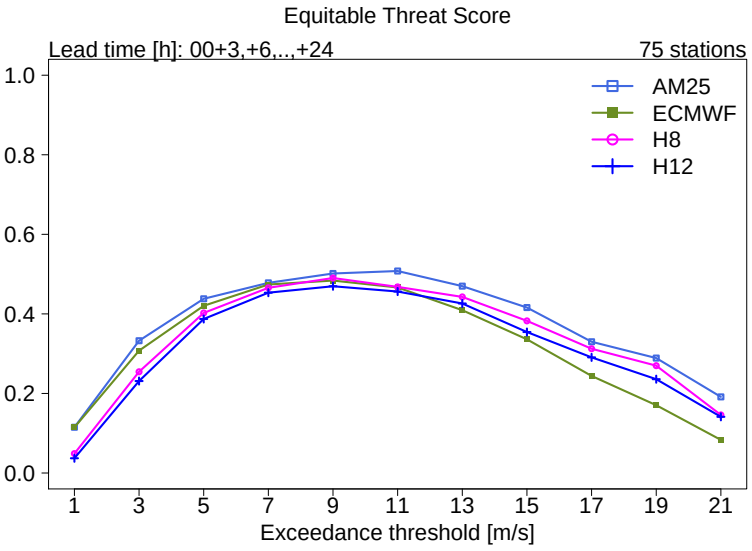


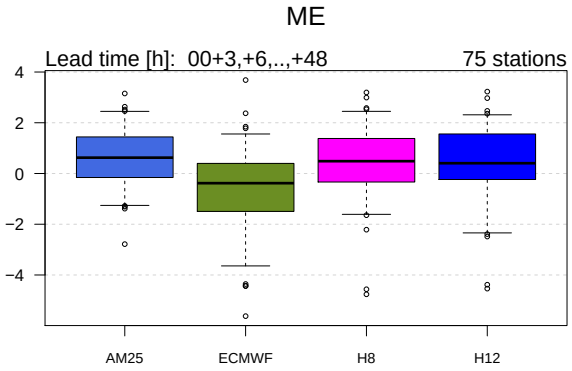


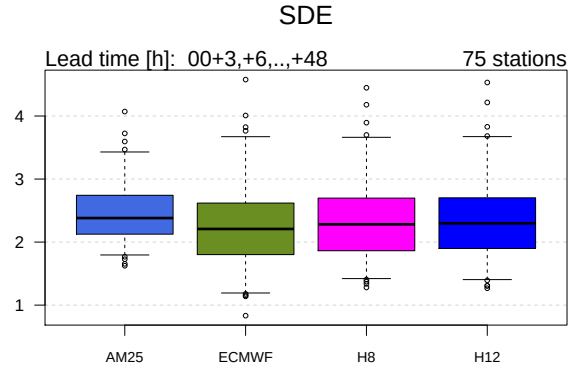



Hit Rate
Lead time [h]: 00+3,+6,..,+24
75 stations
AM25
ECMWF
H8
H12
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


False Alarm Ratio
Lead time [h]: 00+3,+6,..,+24
75 stations
AM25
ECMWF
H8
H12
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


Equitable Threat Score
Lead time [h]: 00+3,+6,..,+24
75 stations
AM25
ECMWF
H8
H12
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]





Lead time [h]: 00+3,+6,..,+48 UTC 75 stations

AM25 — **OBS**

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	19090	5433	44	5	1	24573
(3,11]	15786	37079	3599	125	19	56608
(11,17]	203	3761	6337	1220	245	11766
(17,21]	8	89	462	531	280	1370
(21,Inf]	1	17	34	65	118	235
Sum	35088	46379	10476	1946	663	94552

H8 — **OBS**

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	15423	4995	123	2	3	20546
(3,11]	19594	38319	4531	287	36	62767
(11,17]	65	3019	5473	1153	263	9973
(17,21]	6	37	346	464	282	1135
(21,Inf]	0	9	3	40	79	131
Sum	35088	46379	10476	1946	663	94552

ECMWF — **OBS**

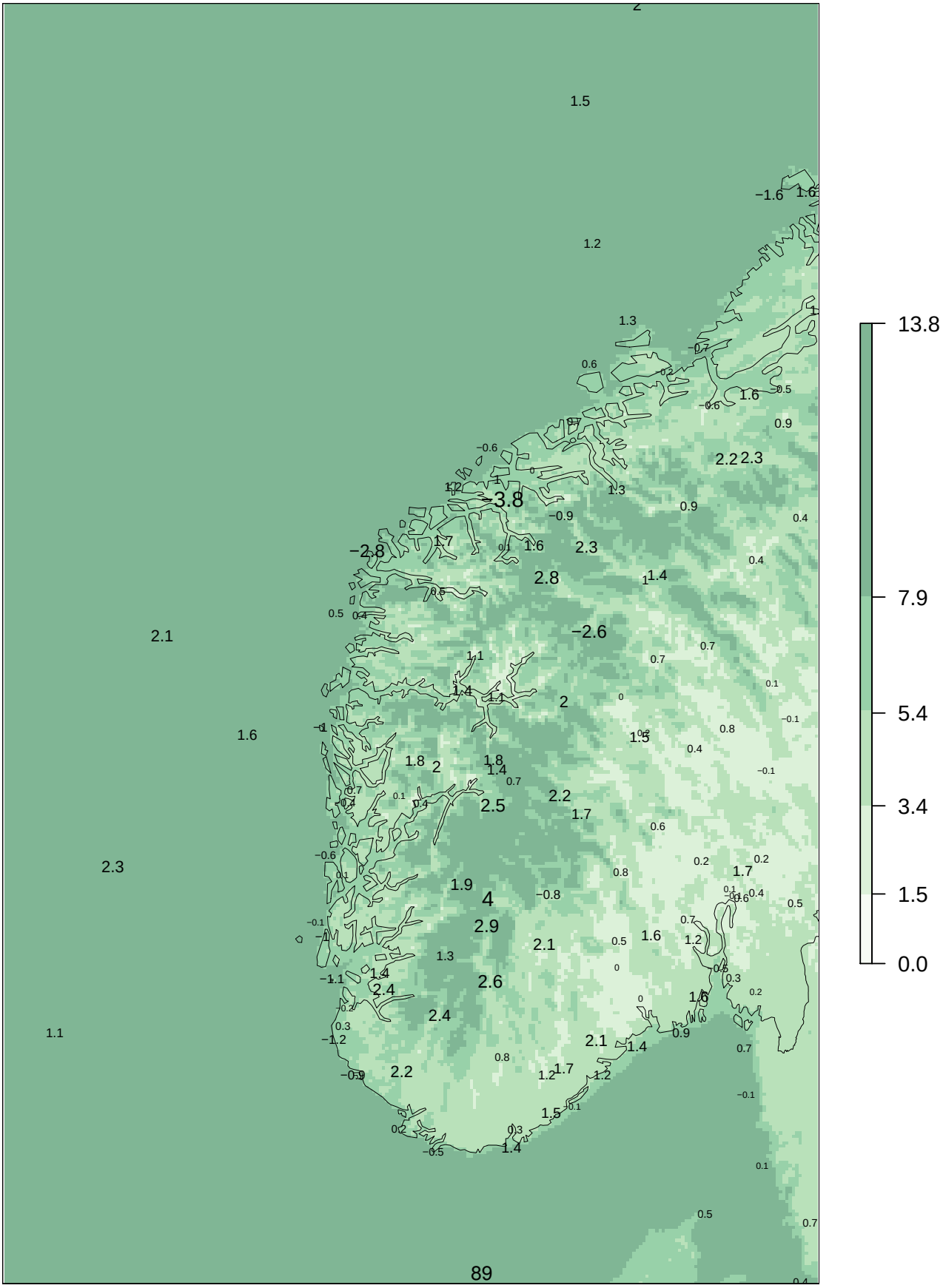
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	23423	11711	482	40	4	35660
(3,11]	11630	32664	4778	300	40	49412
(11,17]	30	1977	5032	1291	289	8619
(17,21]	5	26	181	312	293	817
(21,Inf]	0	1	3	3	37	44
Sum	35088	46379	10476	1946	663	94552

H12 — **OBS**

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	14217	4637	78	4	4	18940
(3,11]	20810	39050	4967	366	51	65244
(11,17]	59	2653	5130	1126	277	9245
(17,21]	2	37	293	421	262	1015
(21,Inf]	0	2	8	29	69	108
Sum	35088	46379	10476	1946	663	94552

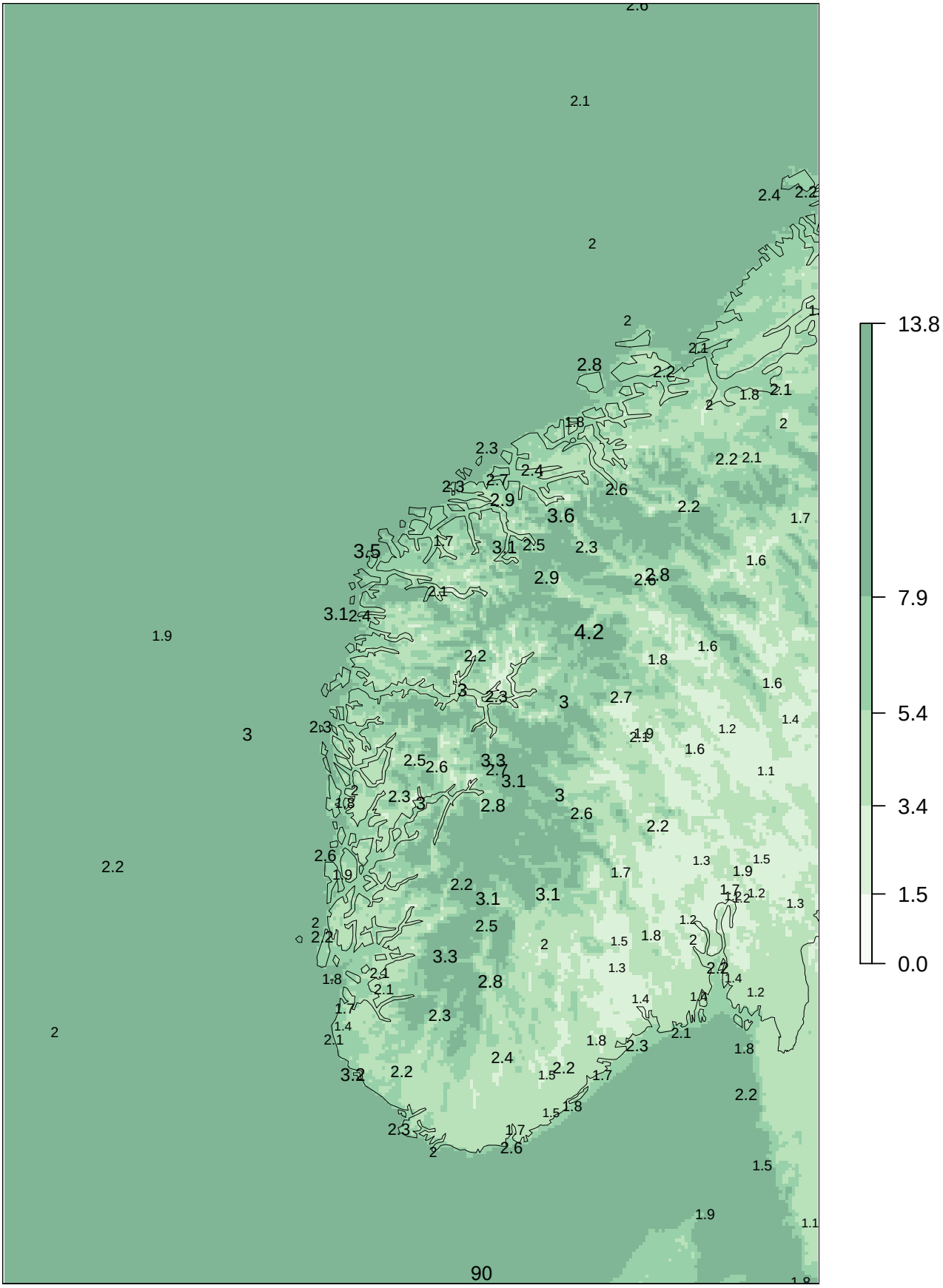
AM25 00+12

ME at observing sites forecast means 01.12.2014 − 28.02.2015

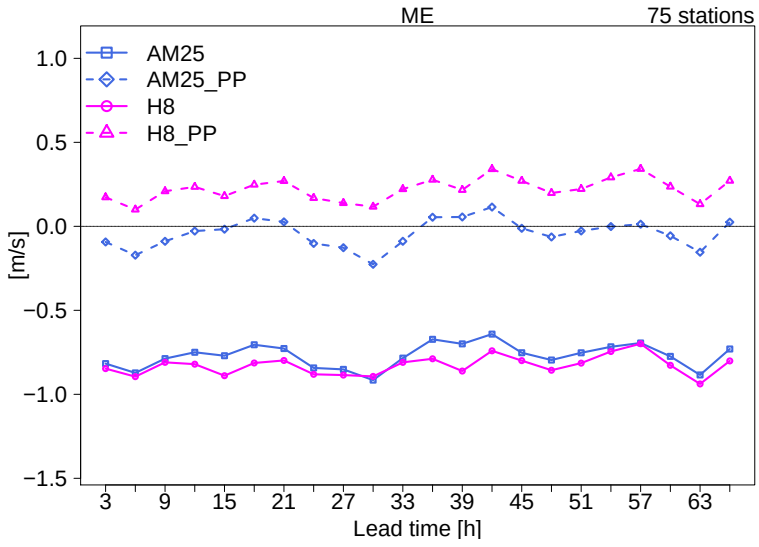


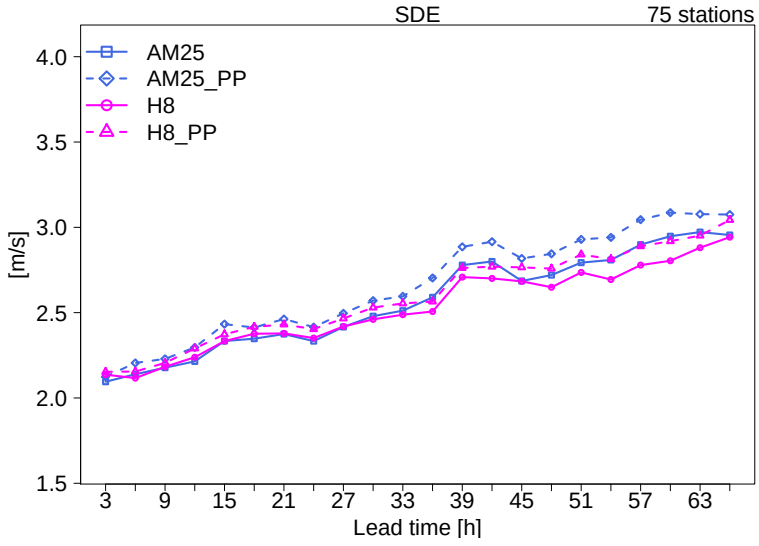
AM25 00+12

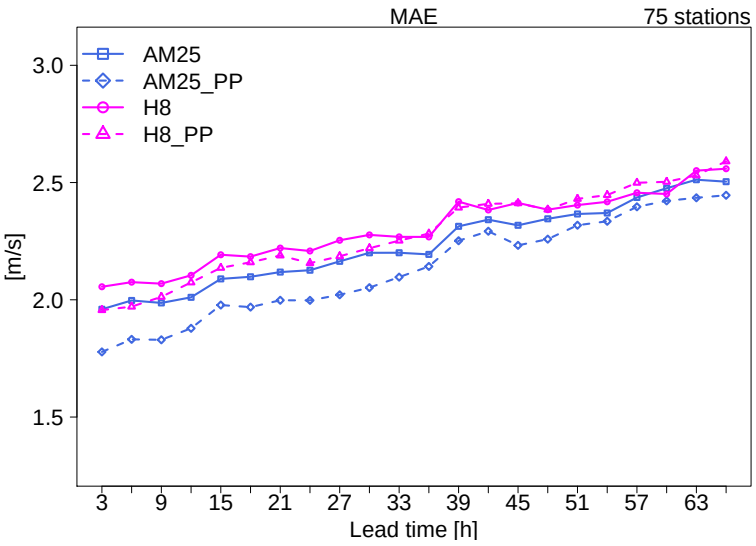
SDE at observing sites forecast means 01.12.2014 − 28.02.2015

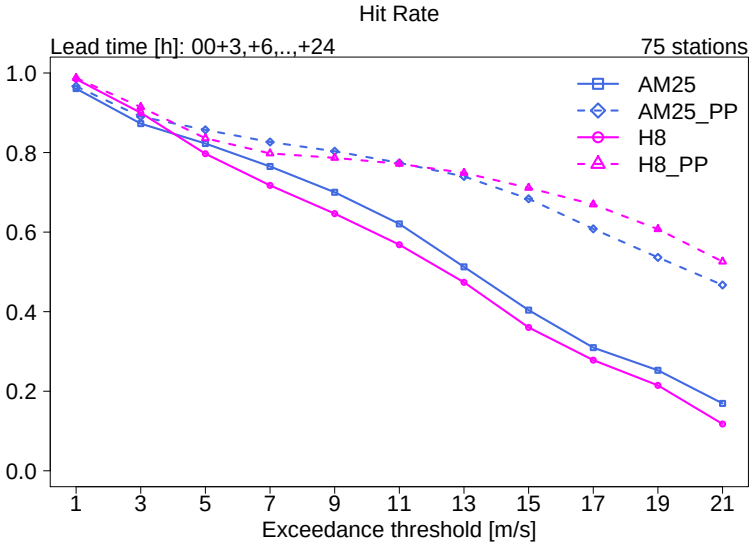


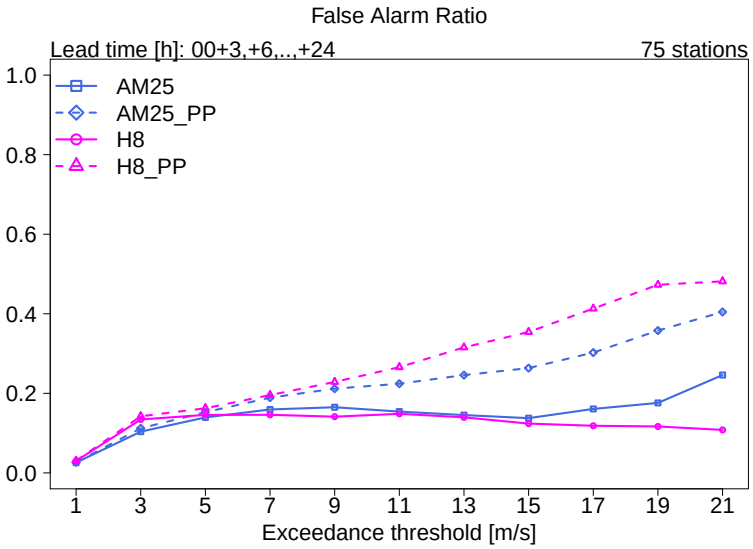
6.4 Max Mean Wind Speed 10m

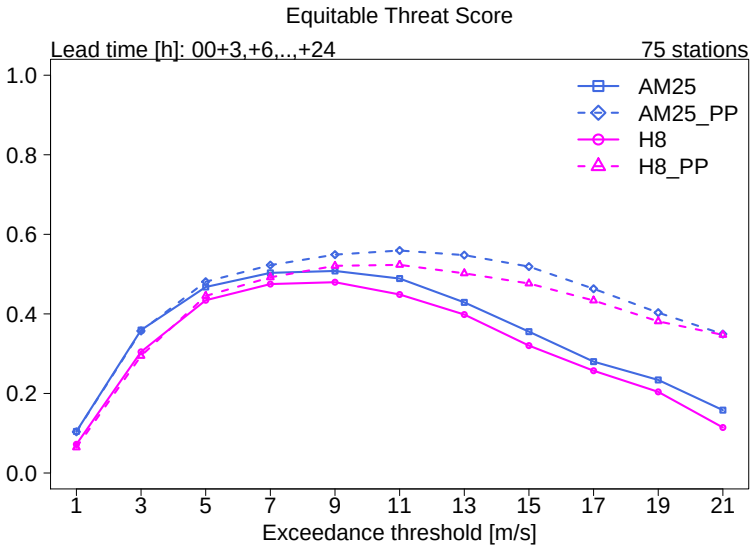




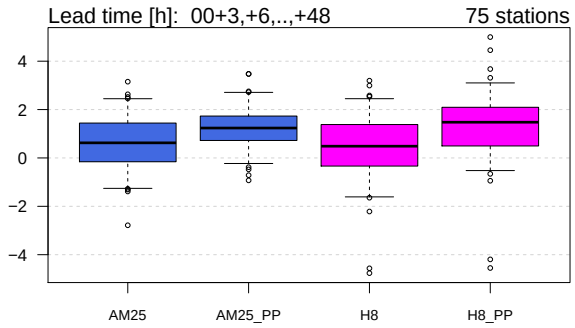



Hit Rate
Lead time [h]: 00+3,+6,..,+24
75 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]

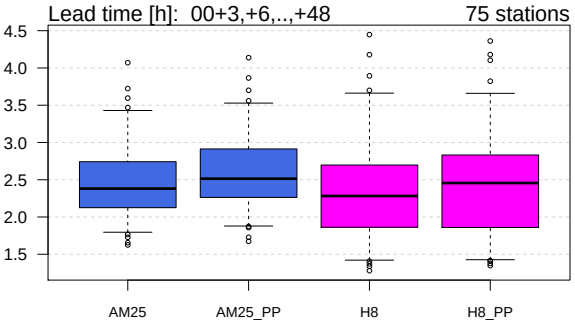

False Alarm Ratio
Lead time [h]: 00+3,+6,..,+24
75 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


Equitable Threat Score
Lead time [h]: 00+3,+6,..,+24
75 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]

ME



SDE



Lead time [h]: 00+3,+6,..,+48 UTC 75 stations

AM25

OBS

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	12537	7938	109	6	1	20591
(3,11]	6644	36065	6114	295	38	49156
(11,17]	44	2041	6318	2026	479	10908
(17,21]	3	41	267	542	458	1311
(21,Inf]	0	16	15	42	152	225
Sum	19228	46101	12823	2911	1128	82191

AM25_PP

OBS

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	11852	6877	89	5	1	18824
(3,11]	7304	35208	3887	127	17	46543
(11,17]	68	3865	7727	1298	197	13155
(17,21]	2	120	1022	1187	439	2770
(21,Inf]	2	31	98	294	474	899
Sum	19228	46101	12823	2911	1128	82191

H8

OBS

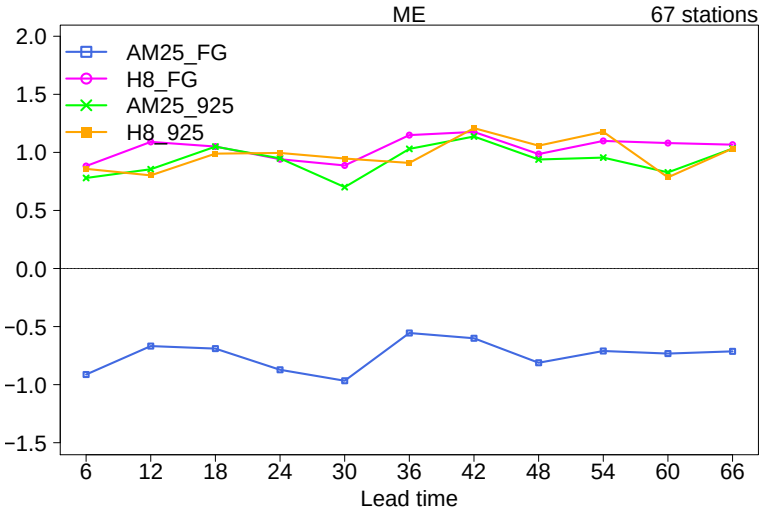
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	10064	6242	223	4	1	16534
(3,11]	9142	38050	6723	464	60	54439
(11,17]	19	1783	5691	1940	517	9950
(17,21]	3	20	180	486	448	1137
(21,Inf]	0	6	6	17	102	131
Sum	19228	46101	12823	2911	1128	82191

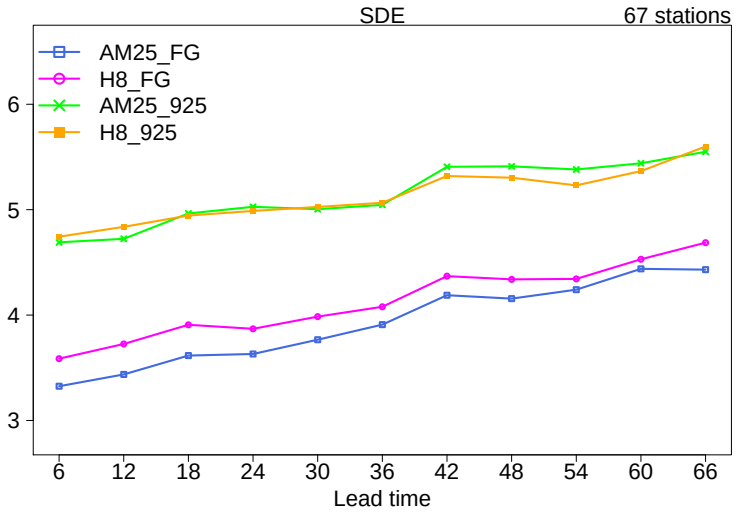
H8_PP

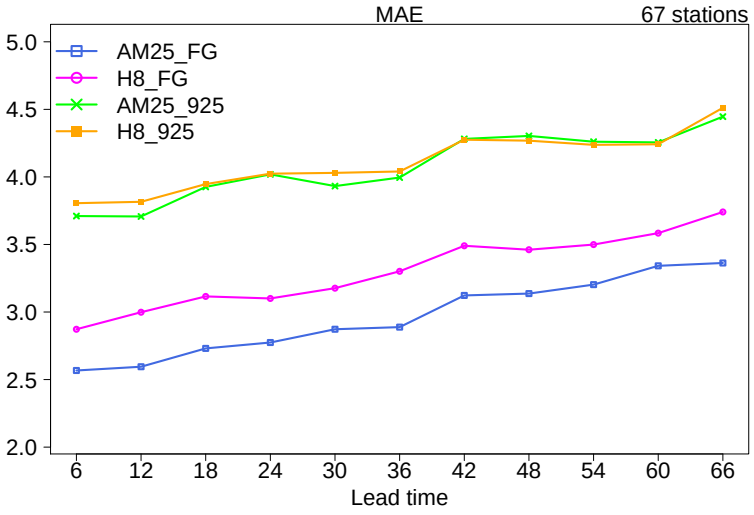
OBS

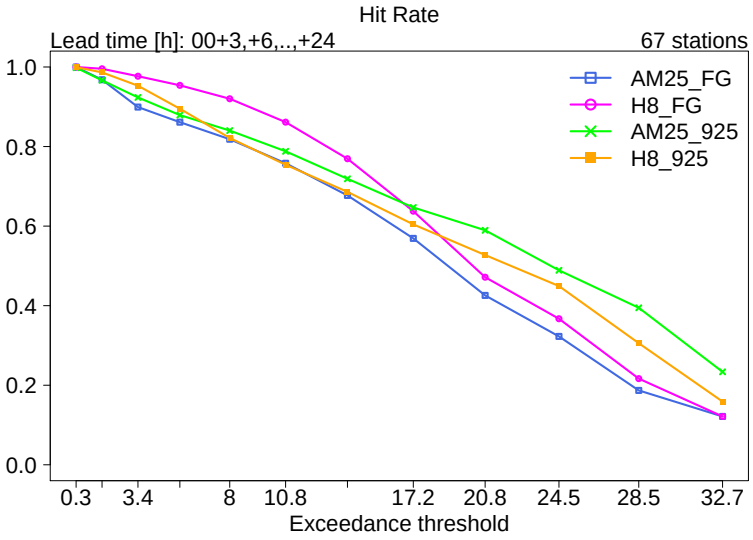
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	9335	5446	82	1	0	14864
(3,11]	9841	35655	3823	198	27	49544
(11,17]	47	4785	7096	1041	164	13133
(17,21]	3	189	1680	1229	407	3508
(21,Inf]	2	26	142	442	530	1142
Sum	19228	46101	12823	2911	1128	82191

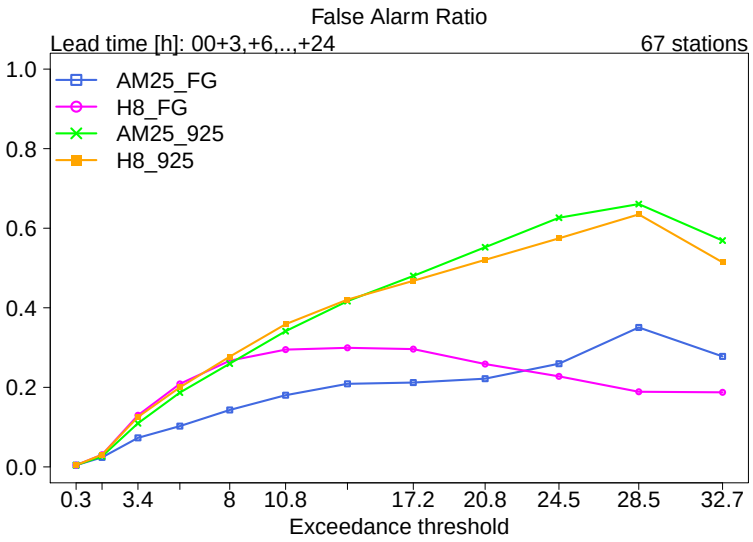
6.5 Wind gust

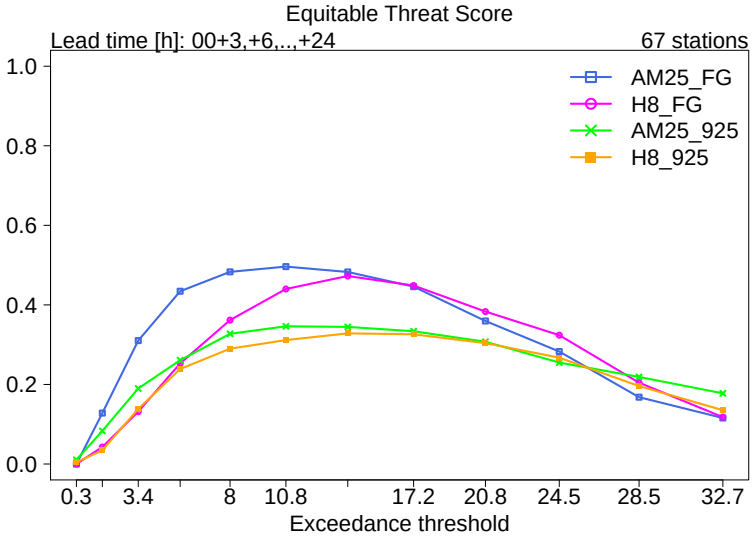

ME
67 stations
AM25_FG
H8_FG
AM25_925
H8_925
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
6
12
18
24
30
36
42
48
54
60
66
Lead time


SDE
67 stations
AM25_FG
H8_FG
AM25_925
H8_925
6
5
4
3
6
12
18
24
30
36
42
48
54
60
66
Lead time

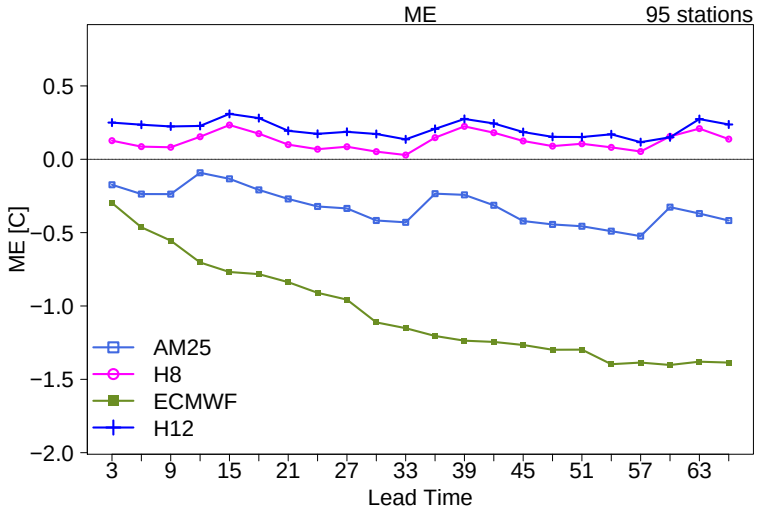

MAE
67 stations
AM25_FG
H8_FG
AM25_925
H8_925
5.0
4.5
4.0
3.5
3.0
2.5
2.0
6
12
18
24
30
36
42
48
54
60
66
Lead time

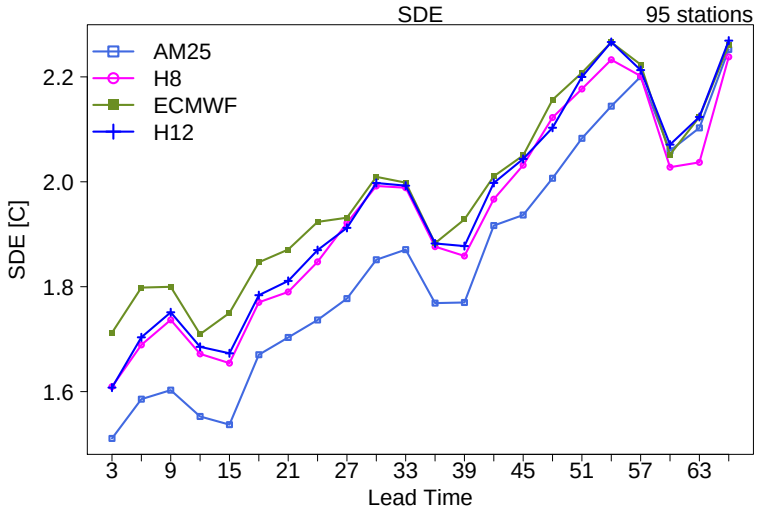

Hit Rate
Lead time [h]: 00+3,+6,..,+24
67 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.0
0.8
0.6
0.4
0.2
0.0
0.3
3.4
8
10.8
17.2
20.8
24.5
28.5
32.7
Exceedance threshold

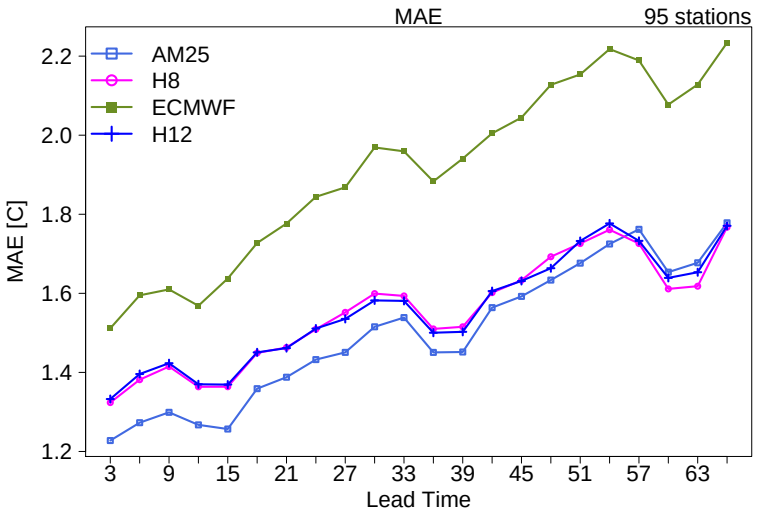

False Alarm Ratio
Lead time [h]: 00+3,+6,..,+24
67 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.0
0.8
0.6
0.4
0.2
0.0
0.3
3.4
8
10.8
17.2
20.8
24.5
28.5
32.7
Exceedance threshold

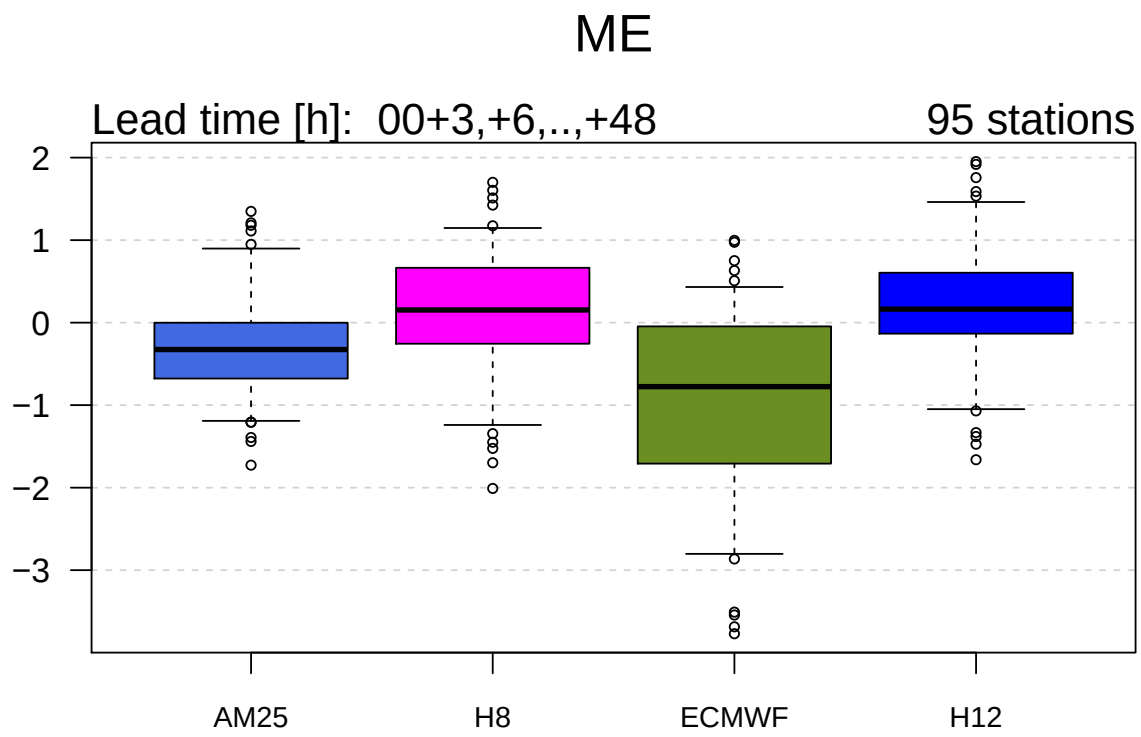

Equitable Threat Score
Lead time [h]: 00+3,+6,..,+24
67 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.0
0.8
0.6
0.4
0.2
0.0
0.3
3.4
8
10.8
17.2
20.8
24.5
28.5
32.7
Exceedance threshold

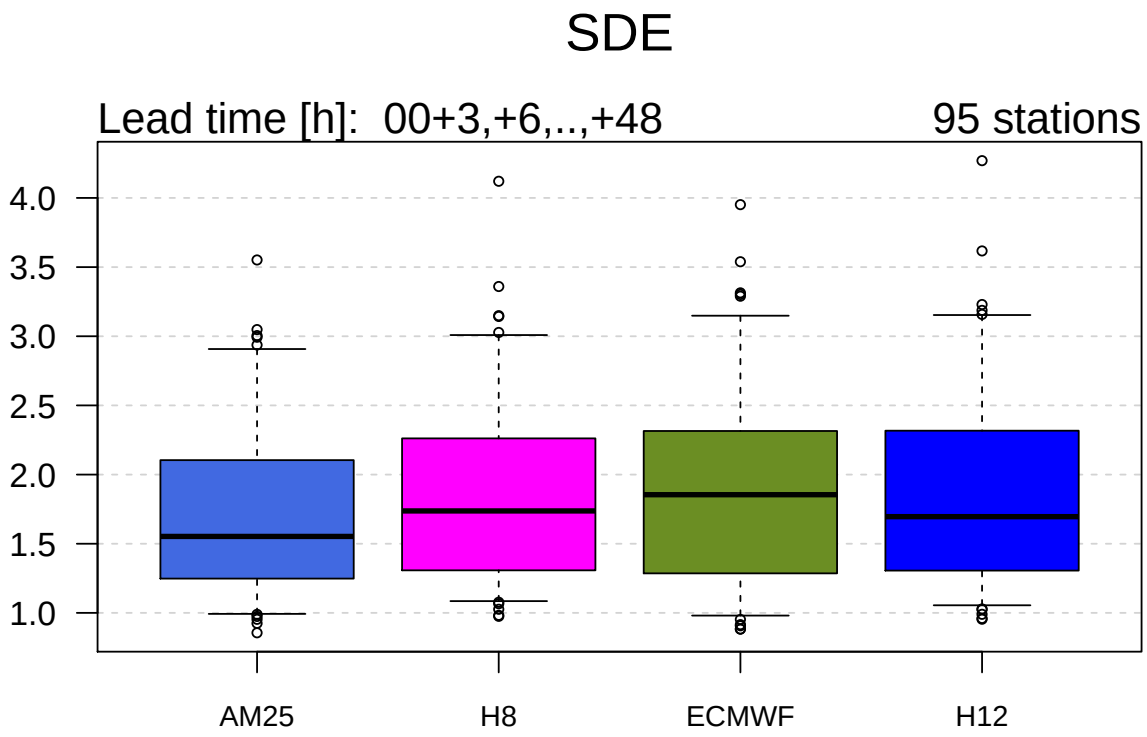
6.6 Temperature 2m





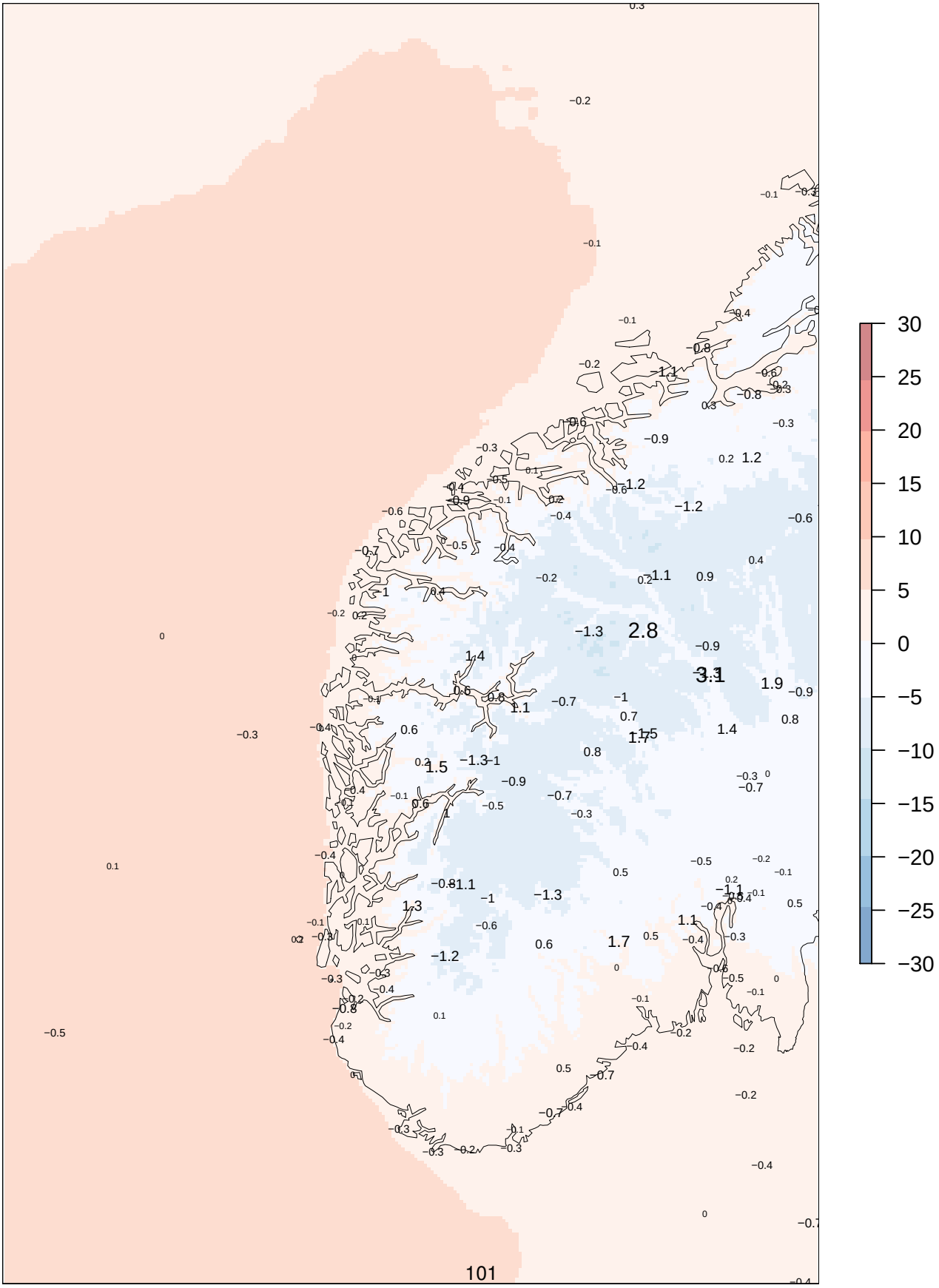



ME
Lead time [h]: 00+3,+6,..,+48
95 stations
2
1
0
−1
−2
−3
AM25
H8
ECMWF
H12


SDE
Lead time [h]: 00+3,+6,..,+48
95 stations
4.0
3.5
3.0
2.5
2.0
1.5
1.0
AM25
H8
ECMWF
H12

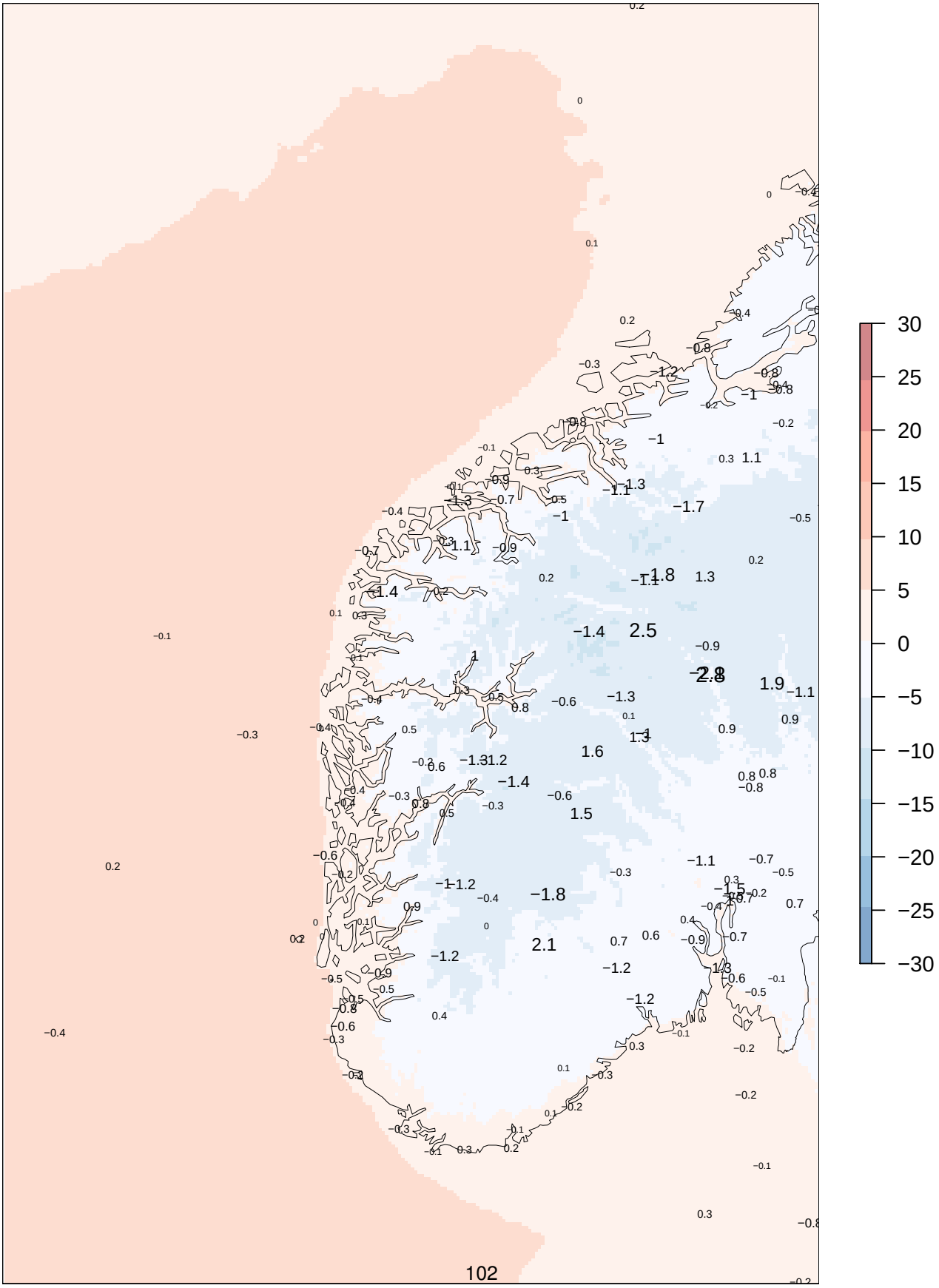
AM25 00+12

ME at observing sites forecast means 01.12.2014 − 28.02.2015



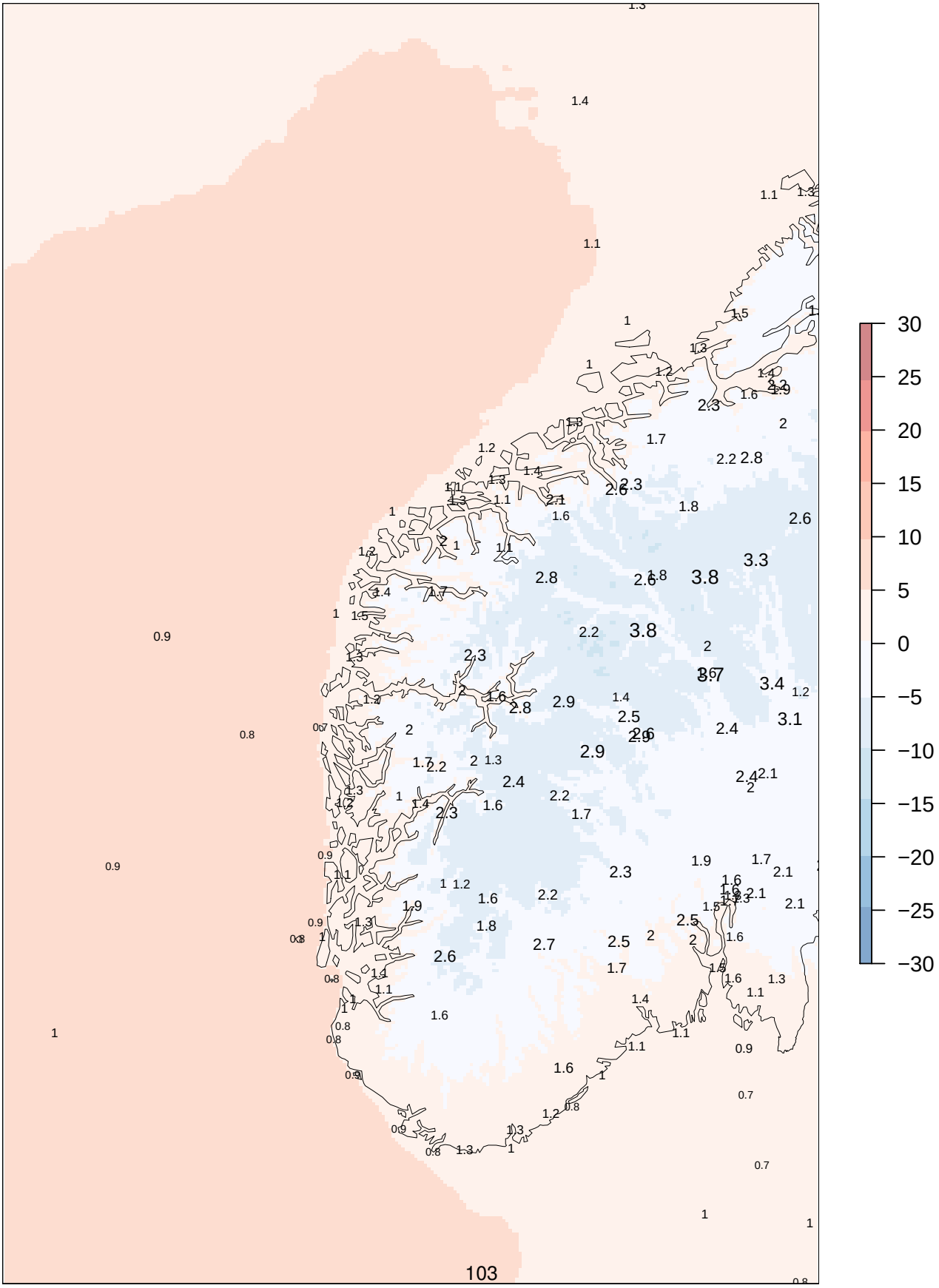
AM25 00+24

ME at observing sites forecast means 01.12.2014 − 28.02.2015



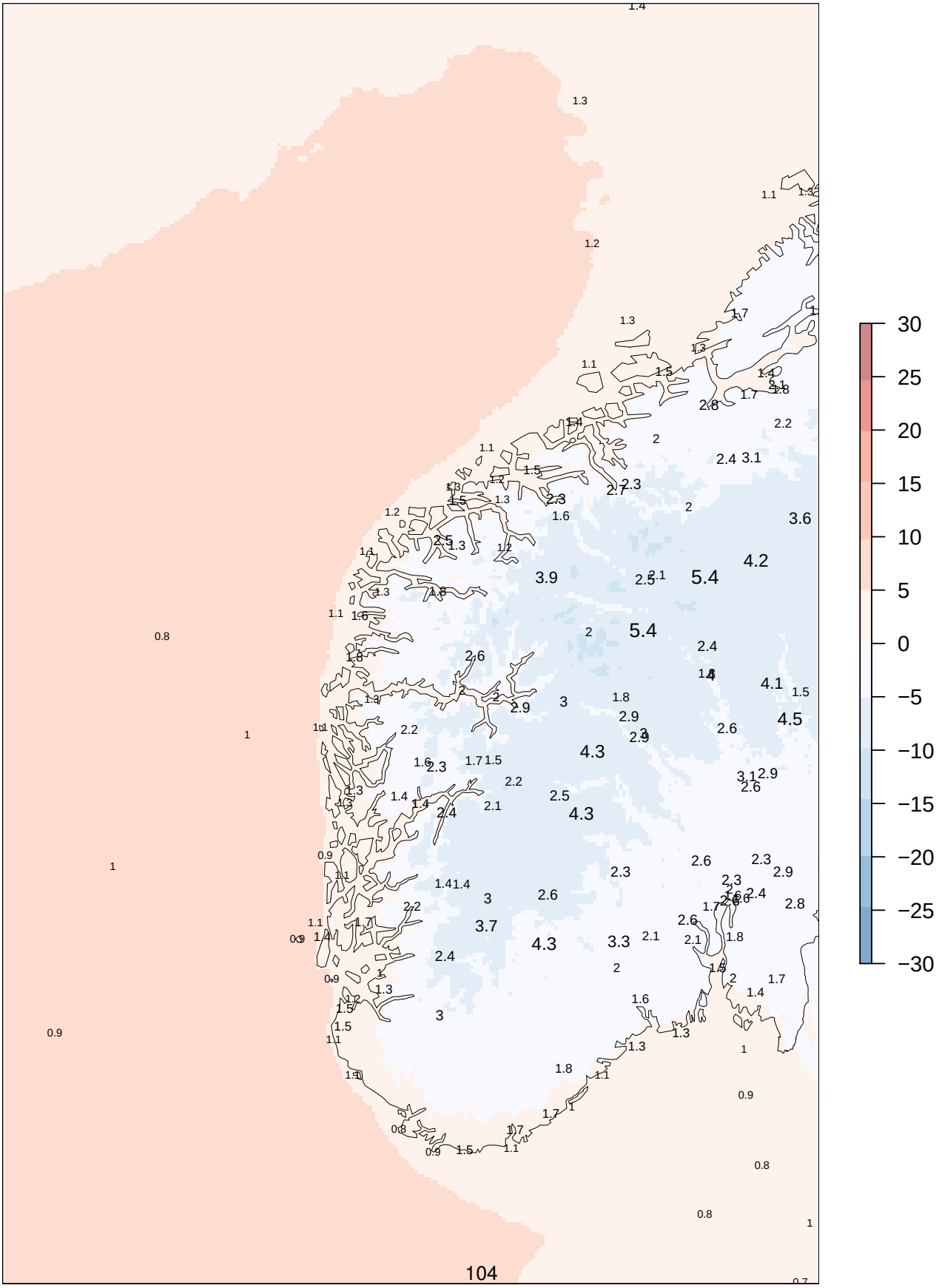
AM25 00+12

SDE at observing sites forecast means 01.12.2014 − 28.02.2015

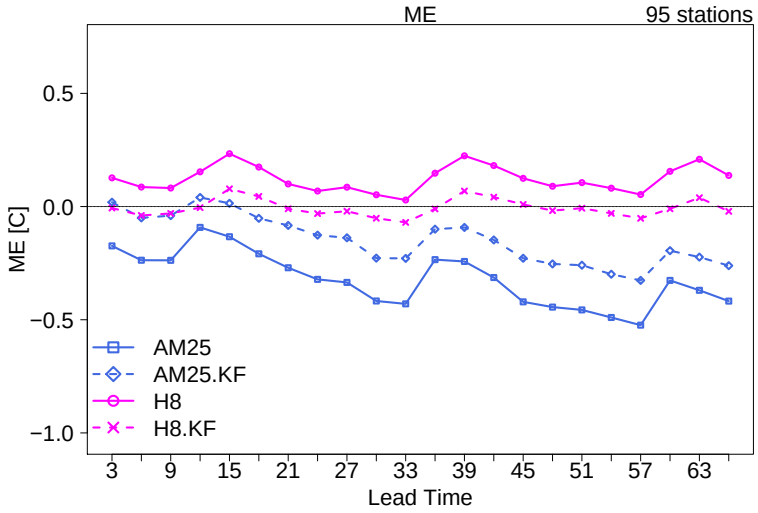


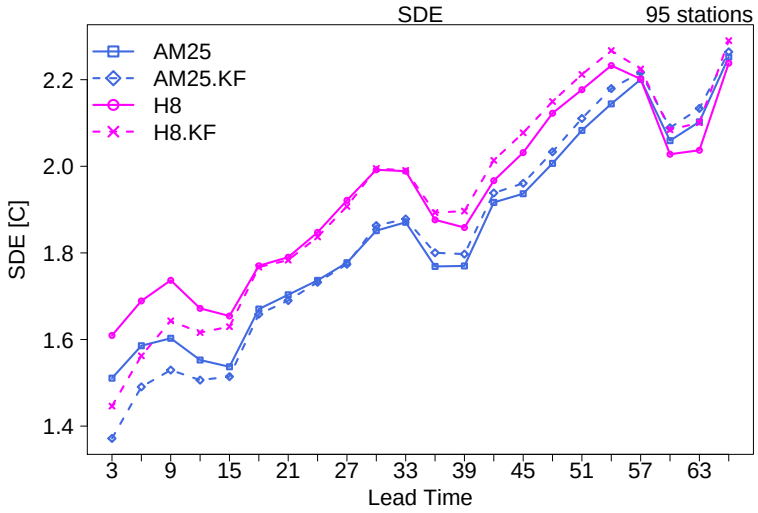
AM25 00+24

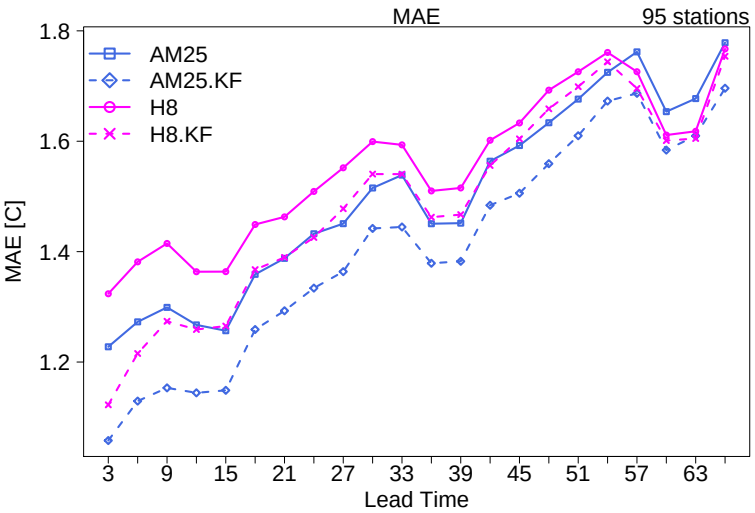
SDE at observing sites forecast means 01.12.2014 − 28.02.2015

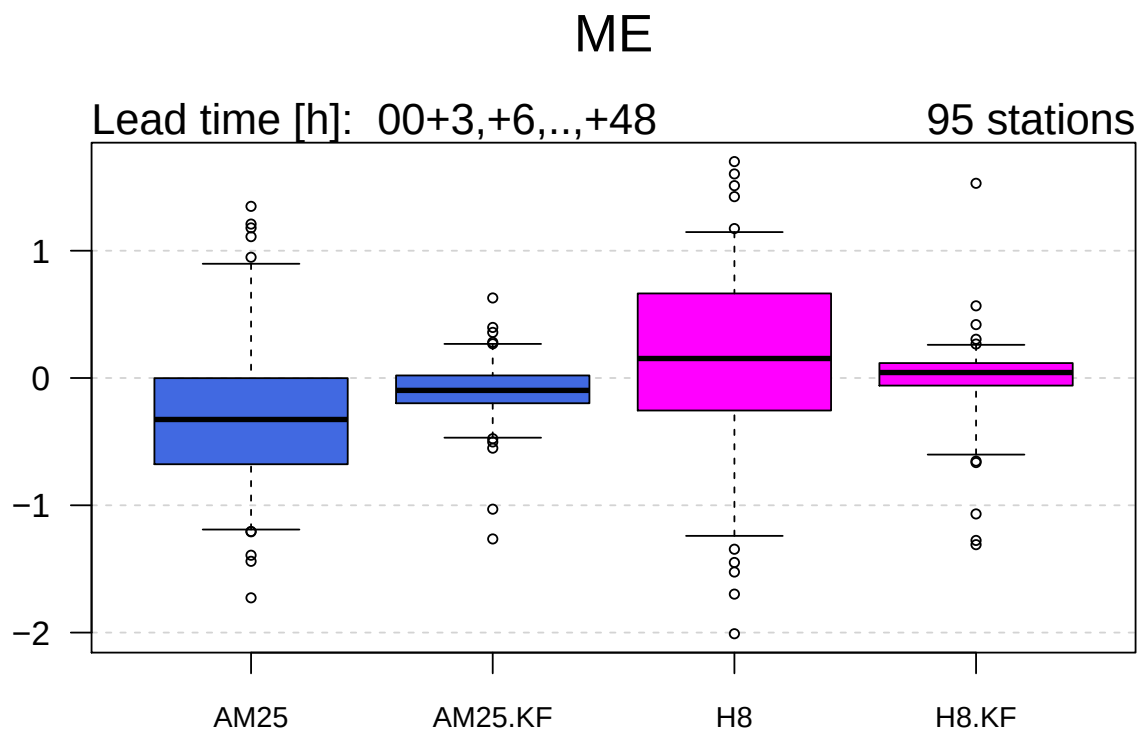


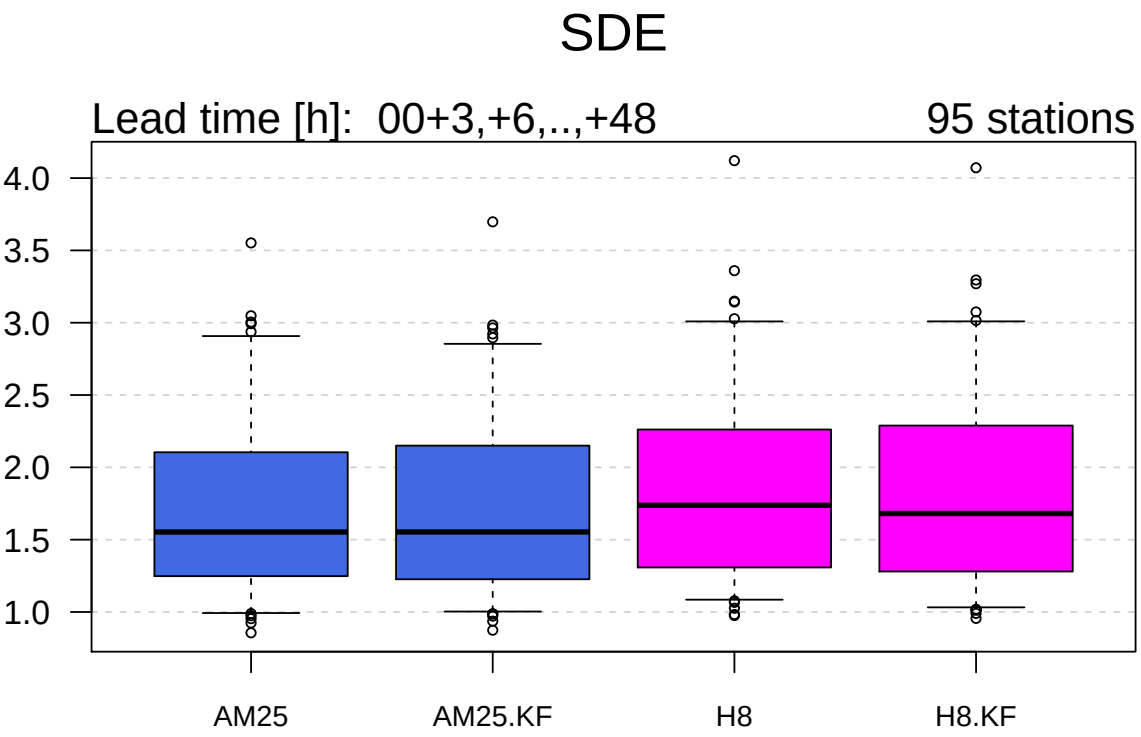
6.7 Post processed temperature 2m



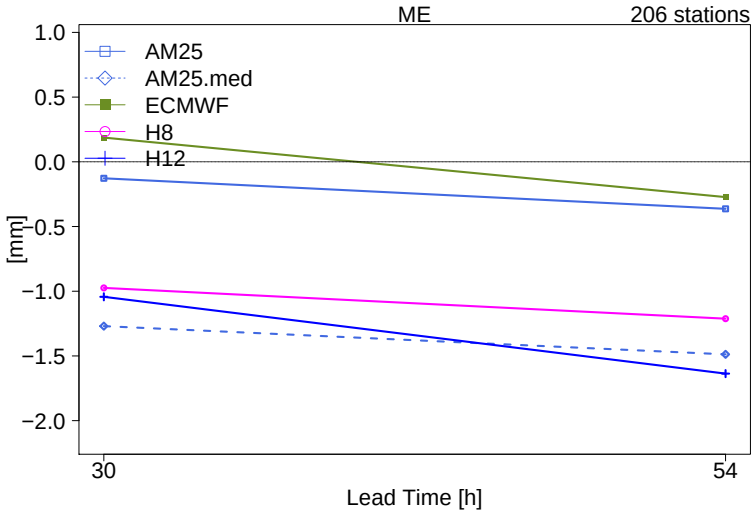


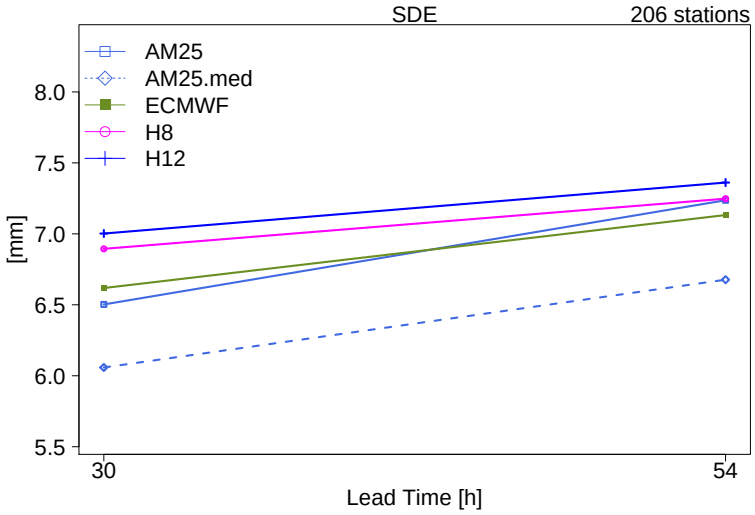


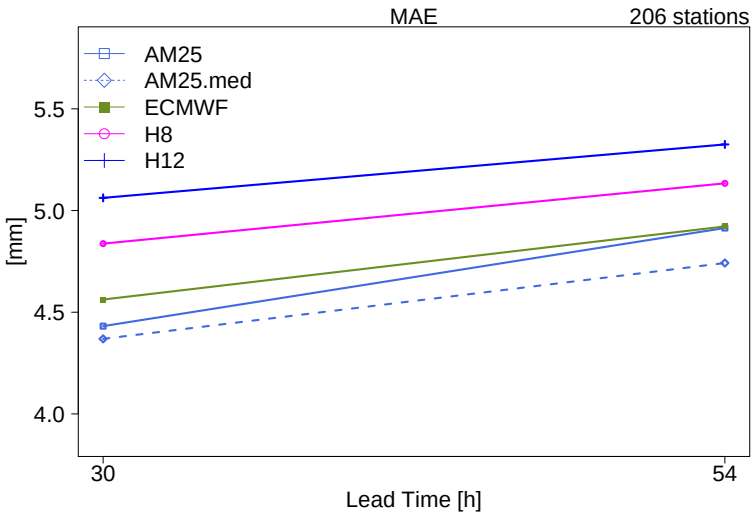

ME
Lead time [h]: 00+3,+6,..,+48
95 stations
1
0
−1
−2
AM25
AM25.KF
H8
H8.KF

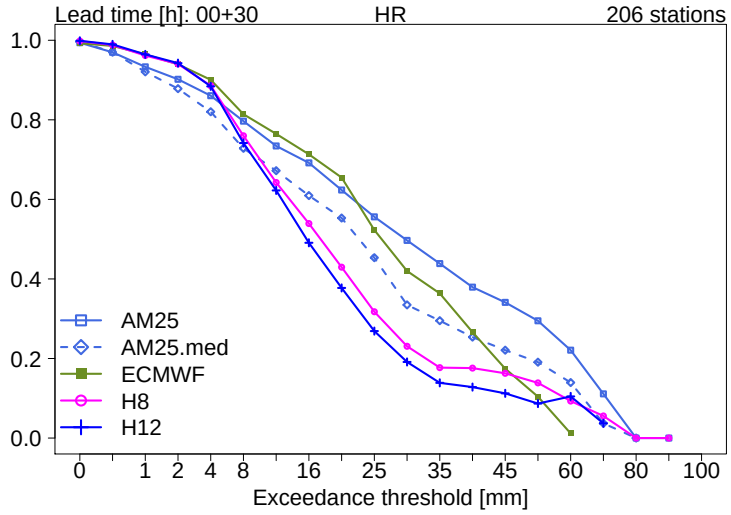

SDE
Lead time [h]: 00+3,+6,..,+48
95 stations
4.0
3.5
3.0
2.5
2.0
1.5
1.0
AM25
AM25.KF
H8
H8.KF

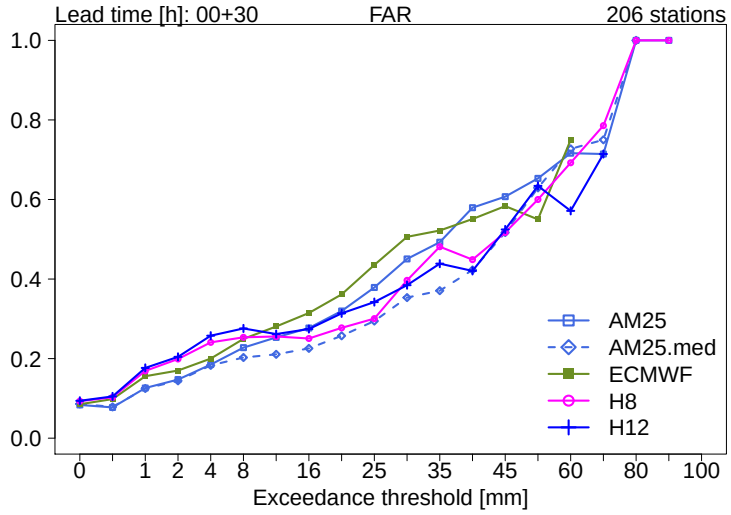
6.8 Daily precipitation

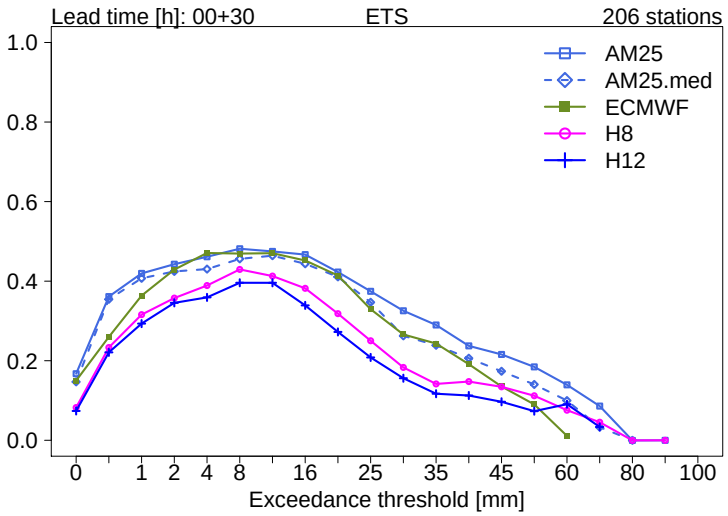


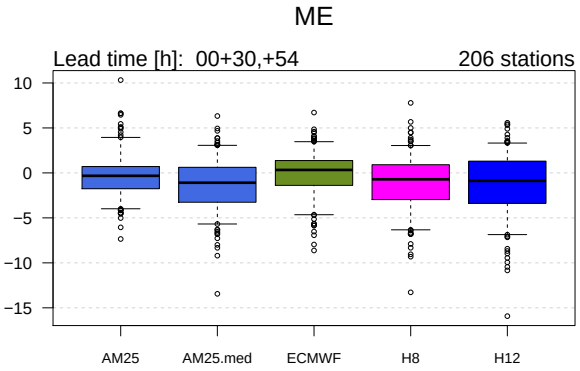


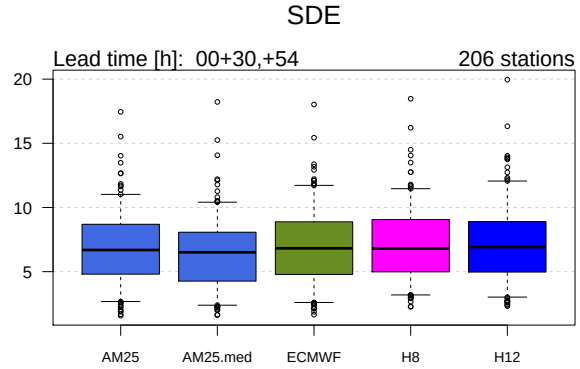



Lead time [h]: 00+30
HR
206 stations
1.0
0.8
0.6
0.4
0.2
0.0
AM25
AM25.med
ECMWF
H8
H12
0
1
2
4
8
16
25
35
45
60
80
100
Exceedance threshold [mm]


Lead time [h]: 00+30
FAR
206 stations
1.0
0.8
0.6
0.4
0.2
0.0
AM25
AM25.med
ECMWF
H8
H12
0
1
2
4
8
16
25
35
45
60
80
100
Exceedance threshold [mm]


Lead time [h]: 00+30
ETS
206 stations
1.0
0.8
0.6
0.4
0.2
0.0
AM25
AM25.med
ECMWF
H8
H12
0
1
2
4
8
16
25
35
45
60
80
100
Exceedance threshold [mm]





Lead time [h]: 00+30,+54 206 stations

AM25 — OBS

	[0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	1980	930	89	4	0	3003
(0.1,5]	1866	7358	2504	100	10	11838
(5,20]	288	2768	6749	1575	30	11410
(20,50]	18	112	1250	2275	206	3861
(50,Inf]	1	2	29	136	100	268
Sum	4153	11170	10621	4090	346	30380

AM25.med — OBS

	[0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	1953	934	95	11	0	2993
(0.1,5]	1931	7643	3111	150	10	12845
(5,20]	253	2530	6574	1836	48	11241
(20,50]	15	63	837	2038	229	3182
(50,Inf]	1	0	4	55	59	119
Sum	4153	11170	10621	4090	346	30380

ECMWF — OBS

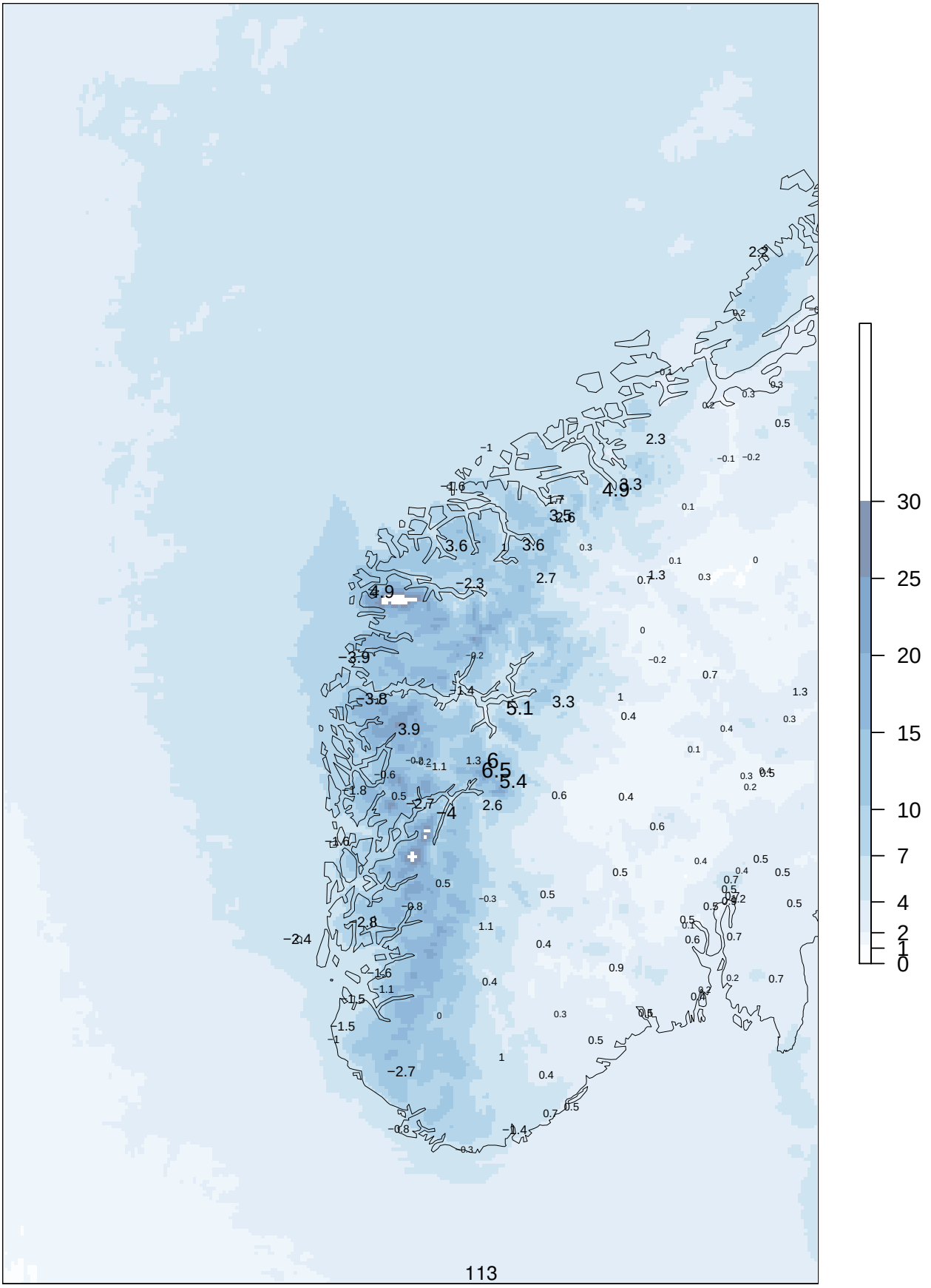
	[0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	1423	441	74	2	0	1940
(0.1,5]	2492	7477	2087	103	2	12161
(5,20]	226	3133	6909	1526	23	11817
(20,50]	12	119	1538	2431	298	4398
(50,Inf]	0	0	13	28	23	64
Sum	4153	11170	10621	4090	346	30380

H8 — OBS

	[0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	1129	435	75	2	4	1645
(0.1,5]	2565	6960	2263	98	1	11887
(5,20]	444	3710	7555	2358	78	14145
(20,50]	15	64	724	1595	225	2623
(50,Inf]	0	1	4	37	38	80
Sum	4153	11170	10621	4090	346	30380

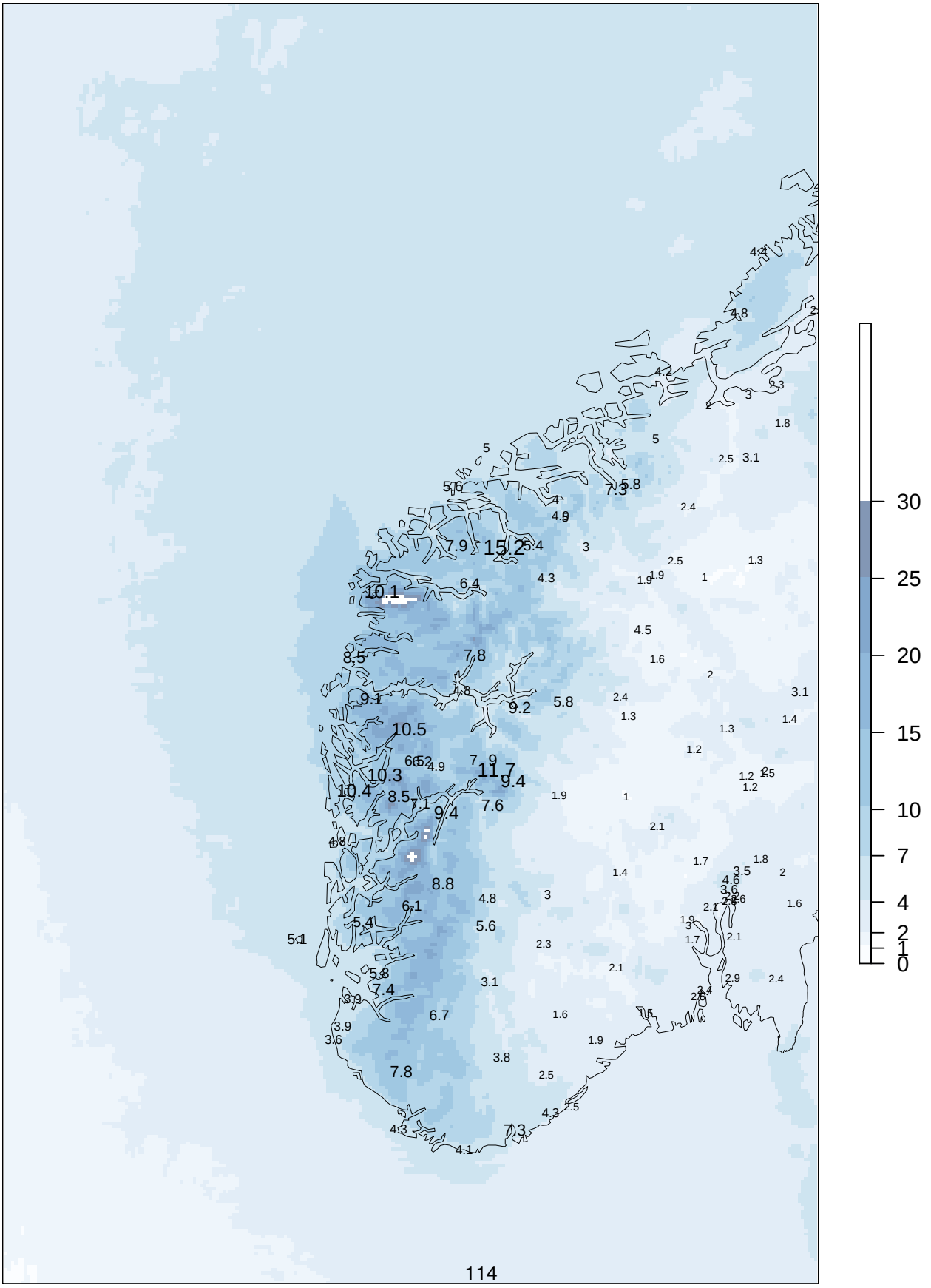
AM25 00+30

ME at observing sites forecast means 01.12.2014 − 28.02.2015



AM25 00+30

SDE at observing sites forecast means 01.12.2014 − 28.02.2015



7 Northern Norway

7.1 Comments to the verification results

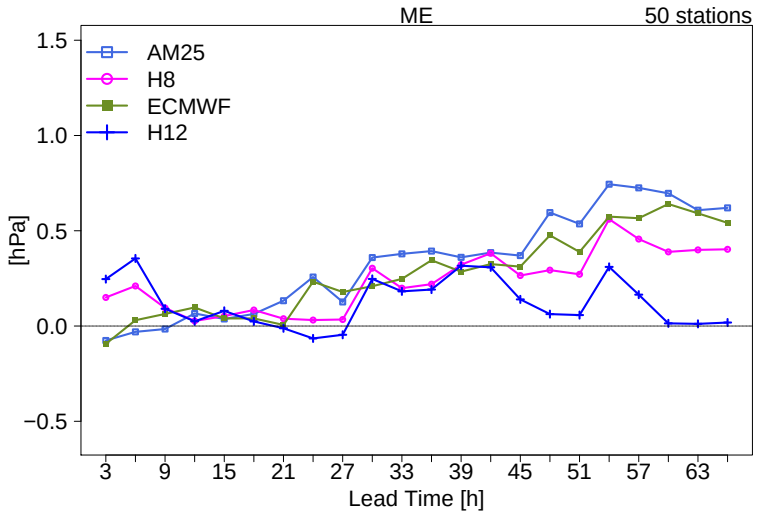
Wind:
10m wind speed does not seem to give enough high values. Northen Norway had 527 observations of wind over $21ms^{-1}$, but Arome only had 214 cases (41%). Compared to Western Norway this is a bit better. There it was 663 observations >$21ms^{-1}$ and 235 occasions in Arome (35%).

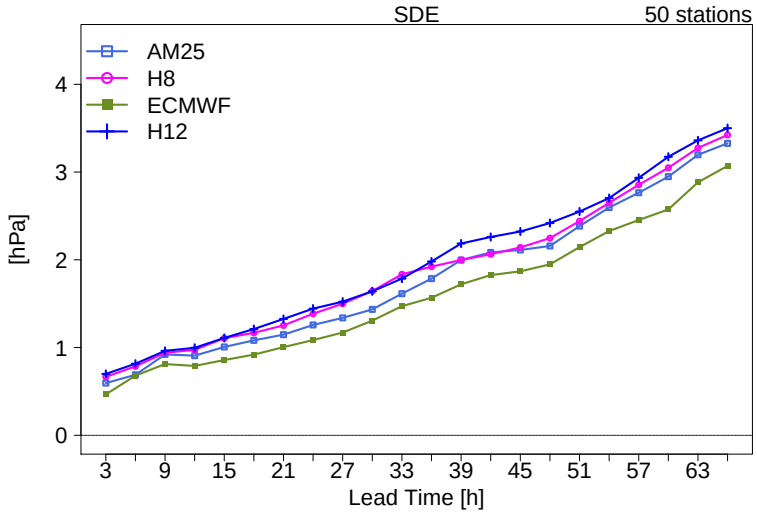
Postprocessed Wind:
The postprocessed wind does not give high enough values. Northen Norway had 846 observations of max wind over $21ms^{-1}$, and the postprocessed Arome wind had 511 cases (60%). However this is a great improvment compared with the previous period where the bias frequency was only about half (33%). Compared to Western Norway this is still a bit low. There it was 1126 observations >$21ms^{-1}$ and 899 cases of postprocessed winds (80%). The lower bias frequency might be due to differences in postprocessing or related to weather situations. The postprocessing is handled differently in western and northern Norway, so this could be looked into.

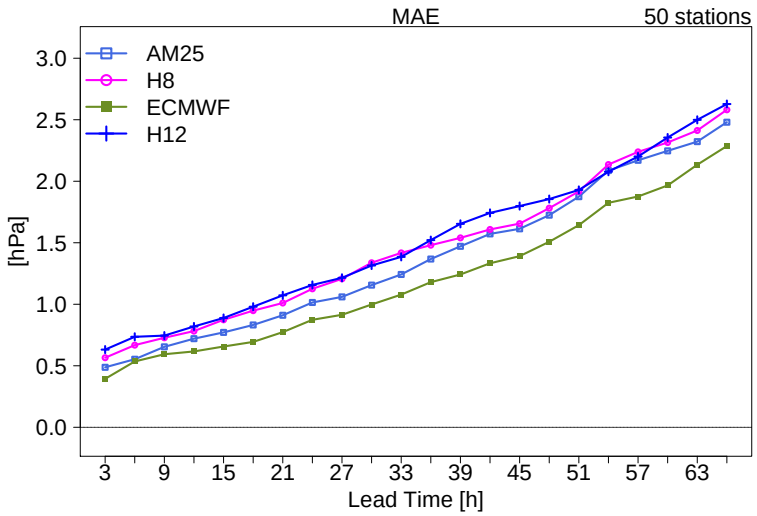
Precipitation:
High amounts of precipitation was handled well at the observation sites with few false alarms (but still occasional high amounts close to mountains). The frequency bias is negative for >20mm, 688 observations and 637 Arome cases (93%). This is the same as for western Norway, 4436 observations and 4129 Arome cases (93%). For values above >50mm the regional difference is less than the previous period with an underforecasting in all regions, Western Norway (frequency bias 77%), in Northern Norway (58%), and finally in Eastern Norway (frequency bias 33%).

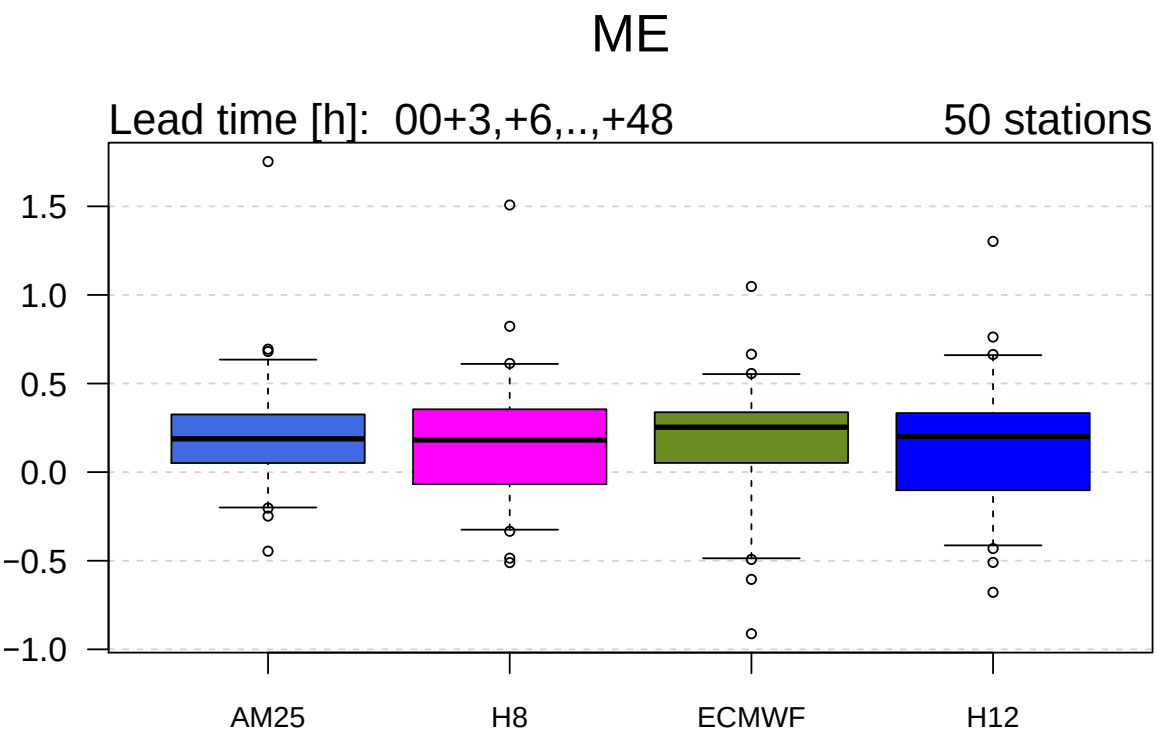
Temperature:
Also in this period the feature that inner parts of Finnmark have relative small ME, but very high SDE values persist. The difference here is more pronounced than in other areas. The four stations on Finnmarksvidda have a ME of -0.9, -0.1, 0.1 and +0.8, compared to an SDE of 3.6, 4.9, 5,1 and 5.8, at lead time 24h. The difference may be due to unsystematic model errors in cloud cover, but may also have other causes.

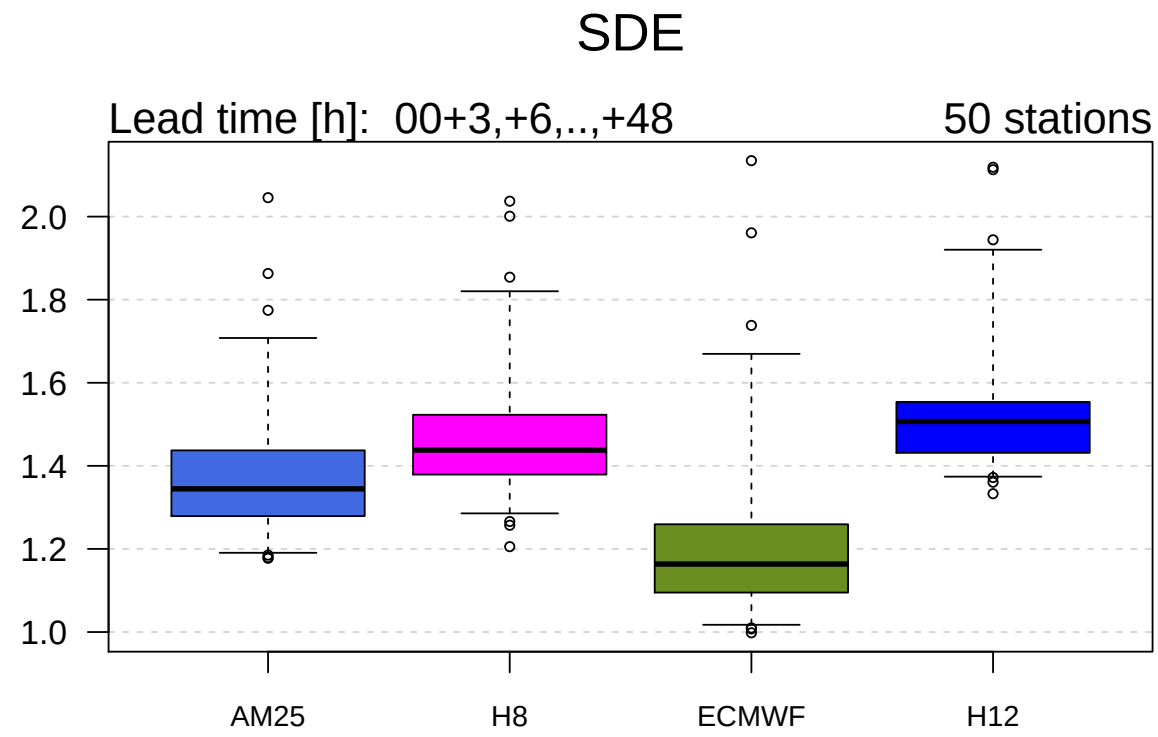
7.2 Pressure


ME
50 stations
AM25
H8
ECMWF
H12
[hPa]
1.5
1.0
0.5
0.0
−0.5
3
9
15
21
27
33
39
45
51
57
63
Lead Time [h]

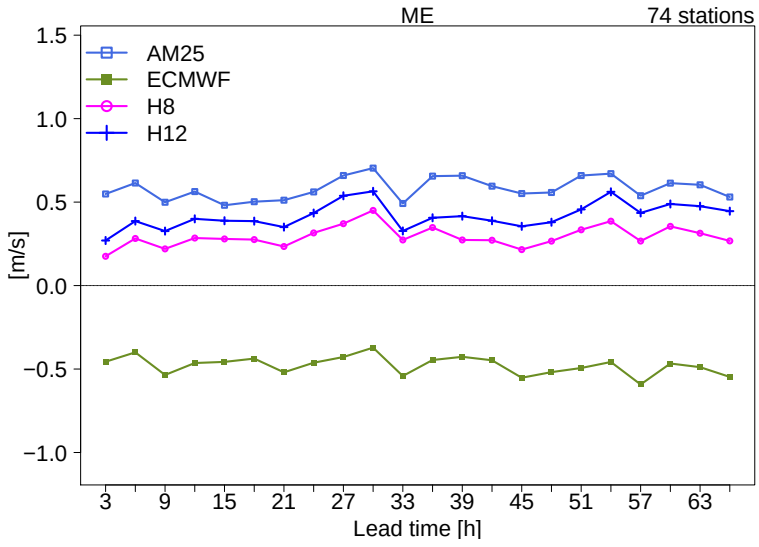

SDE
50 stations
AM25
H8
ECMWF
H12
[hPa]
4
3
2
1
0
3
9
15
21
27
33
39
45
51
57
63
Lead Time [h]

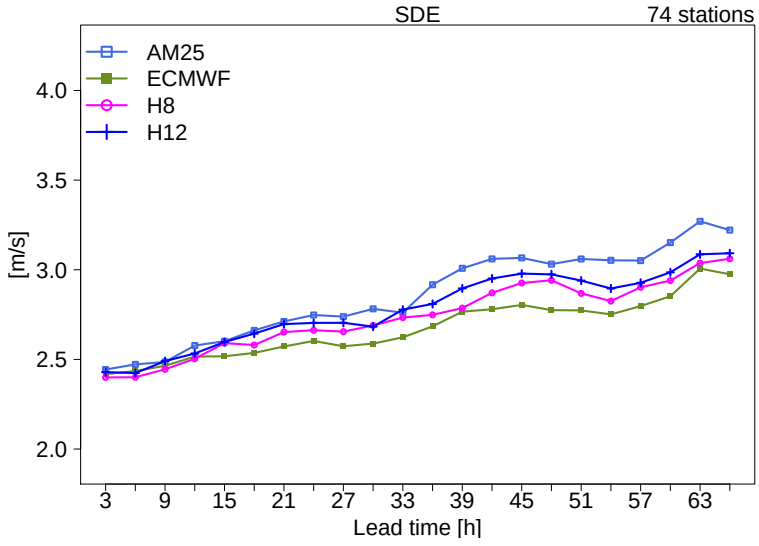

MAE
50 stations
AM25
H8
ECMWF
H12
[hPa]
3.0
2.5
2.0
1.5
1.0
0.5
0.0
3
9
15
21
27
33
39
45
51
57
63
Lead Time [h]

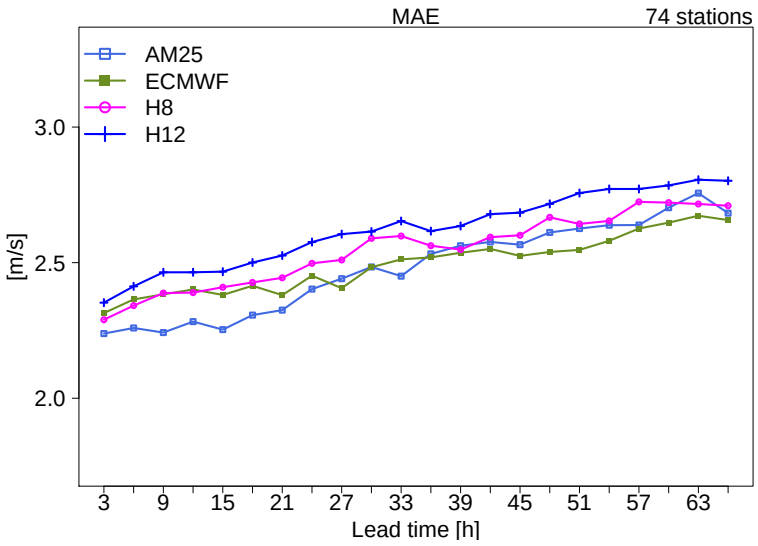

ME
Lead time [h]: 00+3,+6,..,+48
50 stations
1.5
1.0
0.5
0.0
−0.5
−1.0
AM25
H8
ECMWF
H12

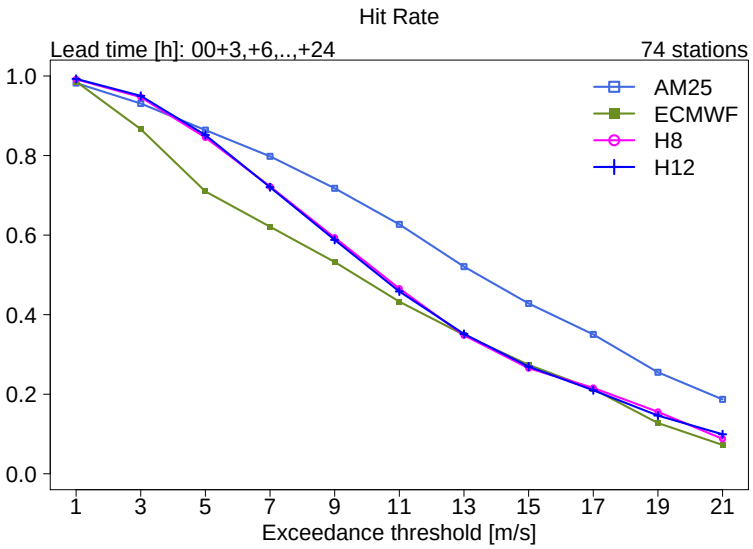

SDE
Lead time [h]: 00+3,+6,..,+48
50 stations
2.0
1.8
1.6
1.4
1.2
1.0
AM25
H8
ECMWF
H12

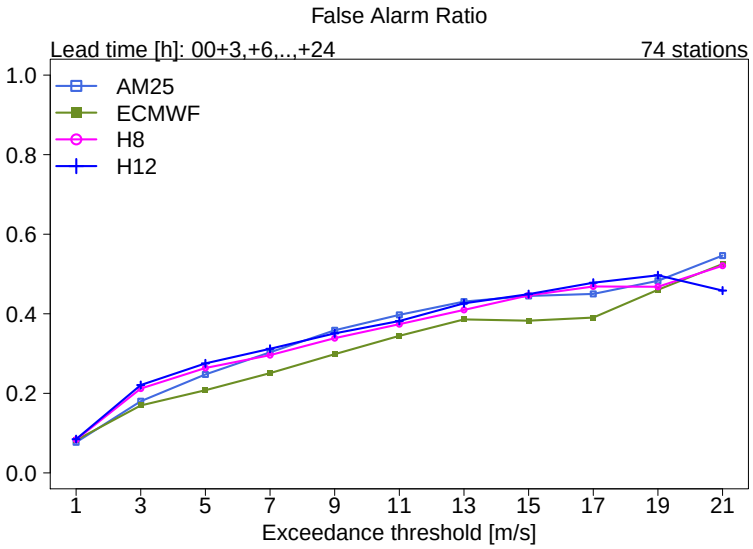
7.3 Wind Speed 10m

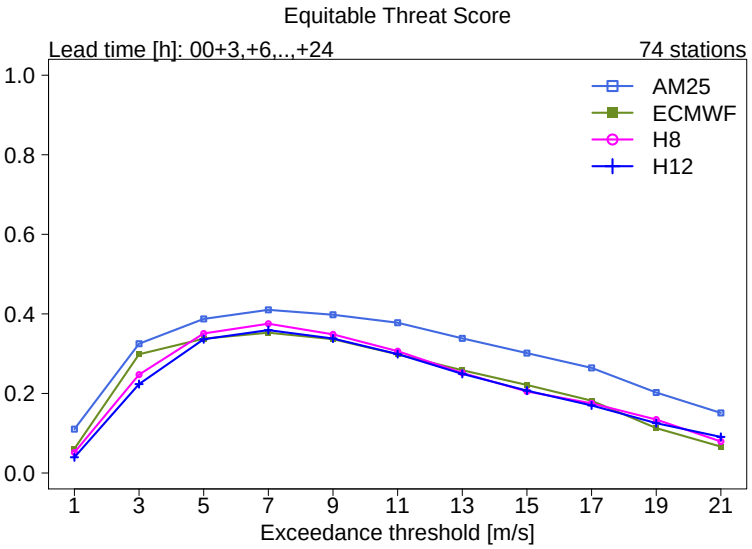


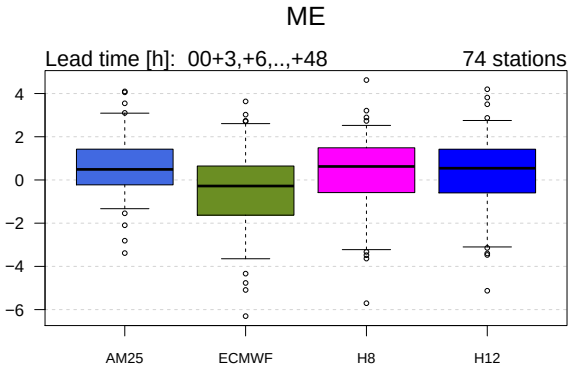


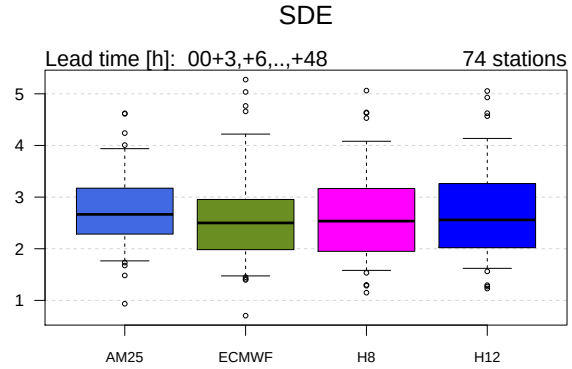



Hit Rate
Lead time [h]: 00+3,+6,..,+24
74 stations
AM25
ECMWF
H8
H12
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


False Alarm Ratio
Lead time [h]: 00+3,+6,..,+24
74 stations
AM25
ECMWF
H8
H12
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]


Equitable Threat Score
Lead time [h]: 00+3,+6,..,+24
74 stations
AM25
ECMWF
H8
H12
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21
Exceedance threshold [m/s]





Lead time [h]: 00+3,+6,..,+48 UTC 74 stations

AM25 — **OBS**

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	13606	4674	83	4	2	18369
(3,11]	13347	41233	4782	286	63	59711
(11,17]	298	5536	5953	857	180	12824
(17,21]	8	165	409	314	191	1087
(21,Inf]	0	14	47	62	91	214
Sum	27259	51622	11274	1523	527	92205

H8 — **OBS**

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	10303	3545	85	4	2	13939
(3,11]	16831	44238	6402	602	179	68252
(11,17]	124	3761	4460	678	188	9211
(17,21]	1	74	313	218	114	720
(21,Inf]	0	4	14	21	44	83
Sum	27259	51622	11274	1523	527	92205

ECMWF — **OBS**

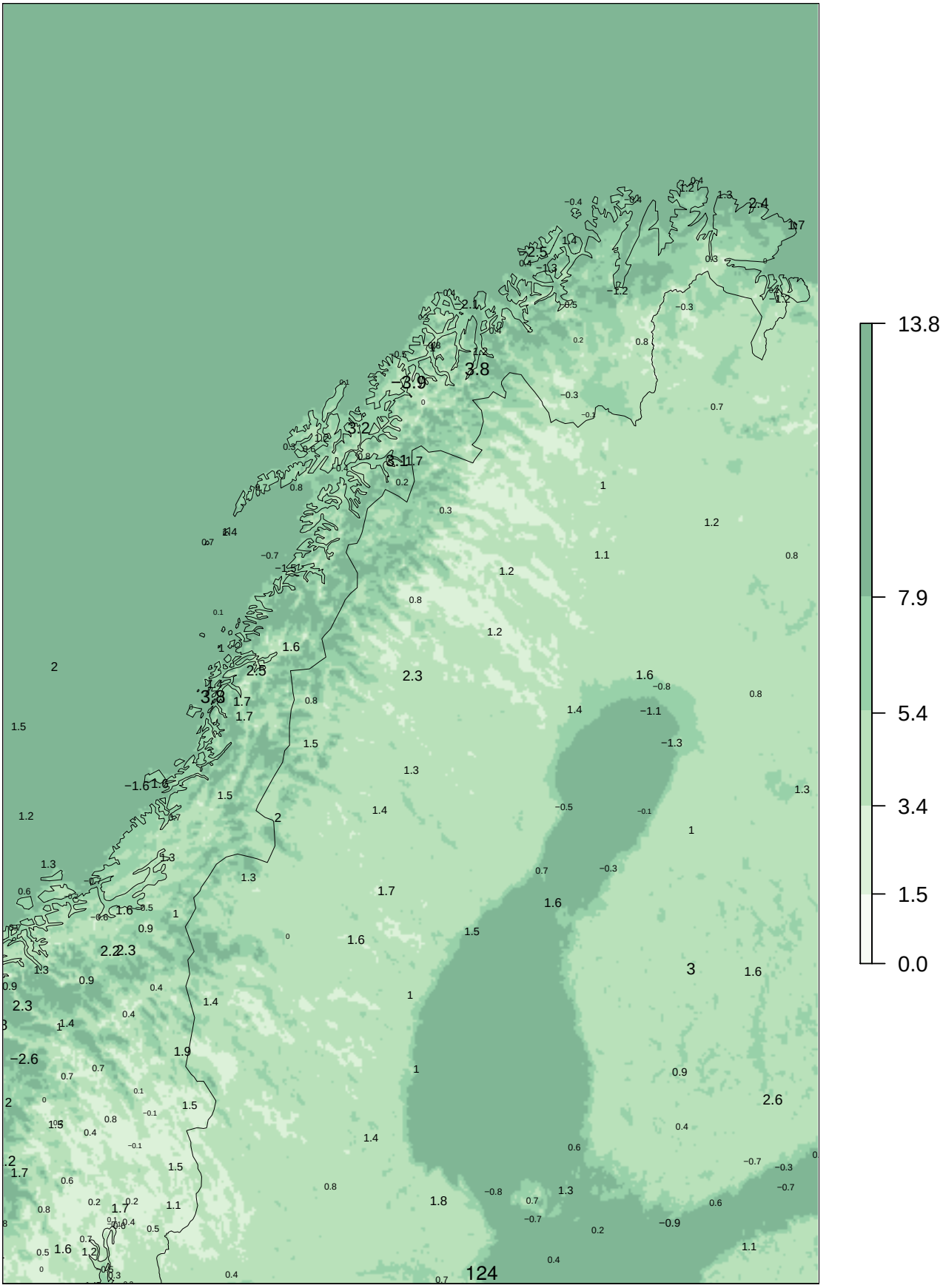
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	15493	8454	217	21	0	24185
(3,11]	11686	40042	6724	583	196	59231
(11,17]	78	3086	4108	683	166	8121
(17,21]	2	40	209	215	129	595
(21,Inf]	0	0	16	21	36	73
Sum	27259	51622	11274	1523	527	92205

H12 — **OBS**

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	9338	3268	63	6	2	12677
(3,11]	17781	44431	6518	570	185	69485
(11,17]	138	3850	4374	701	178	9241
(17,21]	2	68	305	219	120	714
(21,Inf]	0	5	14	27	42	88
Sum	27259	51622	11274	1523	527	92205

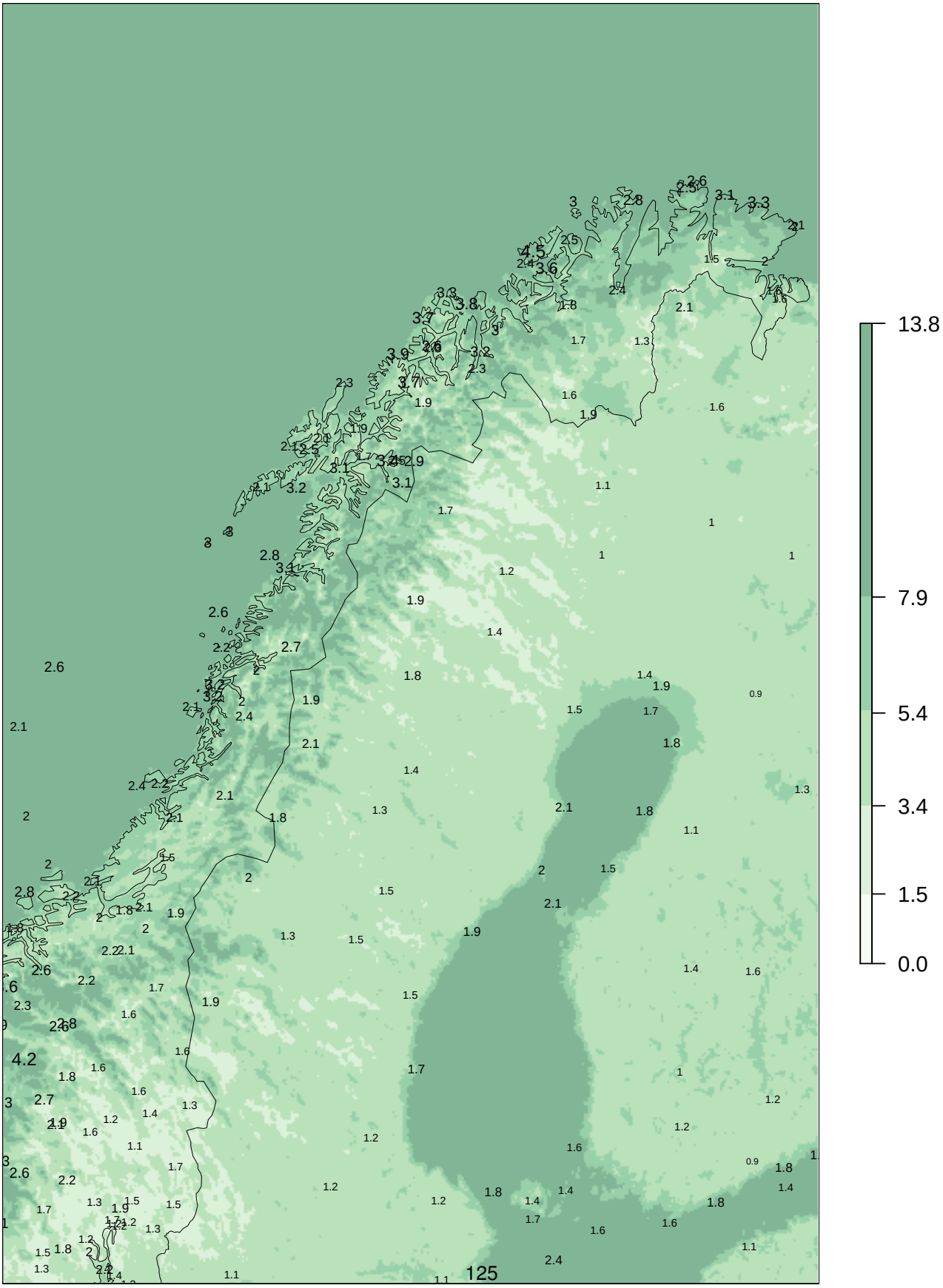
AM25 00+12

ME at observing sites forecast means 01.12.2014 − 28.02.2015

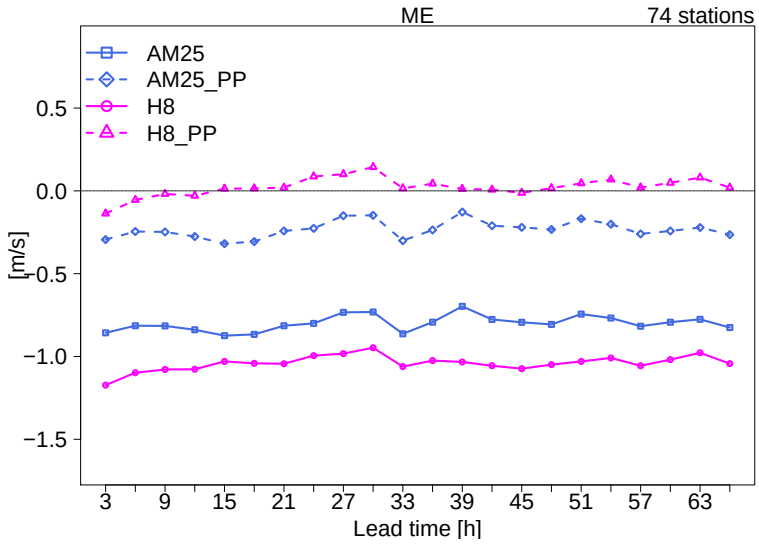


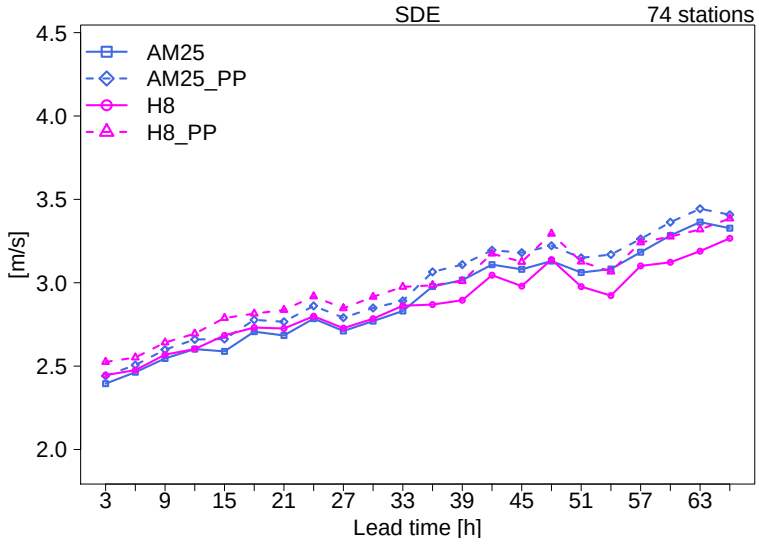
AM25 00+12

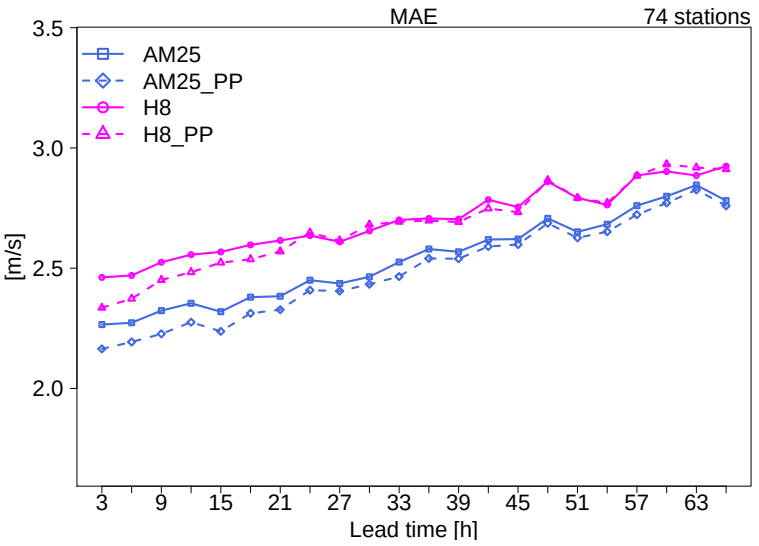
SDE at observing sites forecast means 01.12.2014 − 28.02.2015

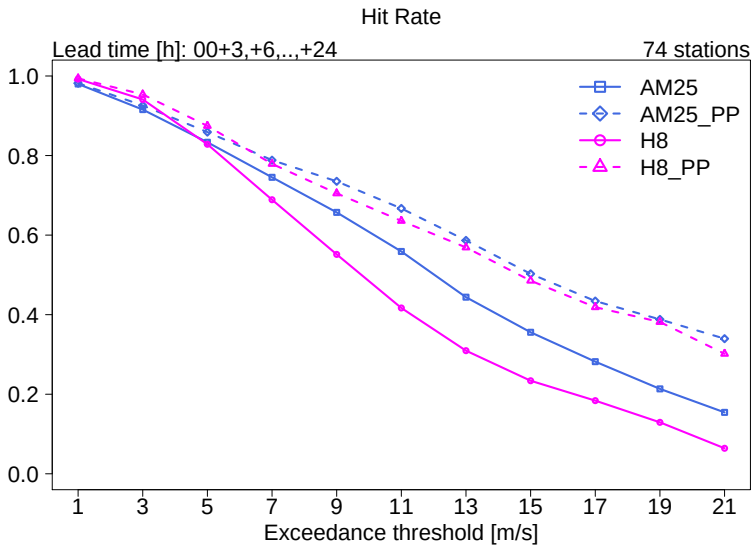


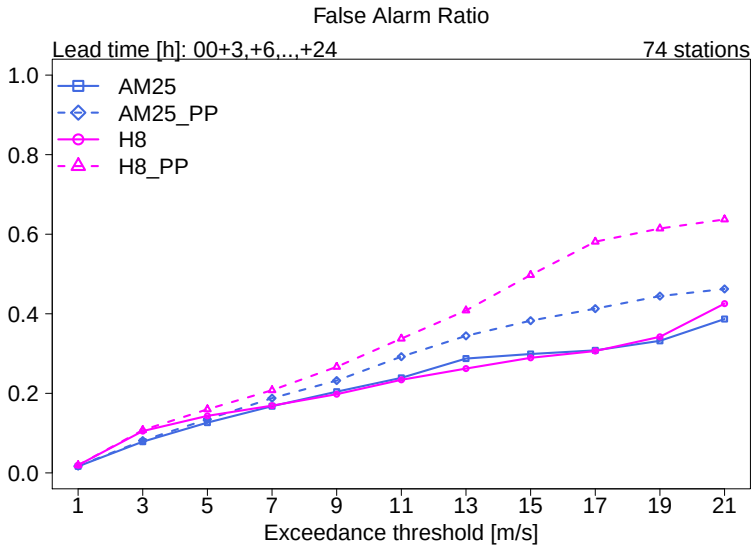
7.4 Max Mean Wind Speed 10m

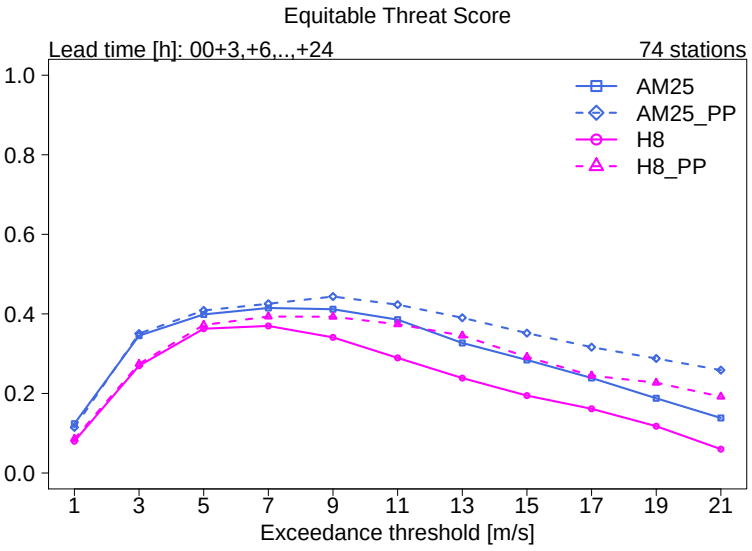




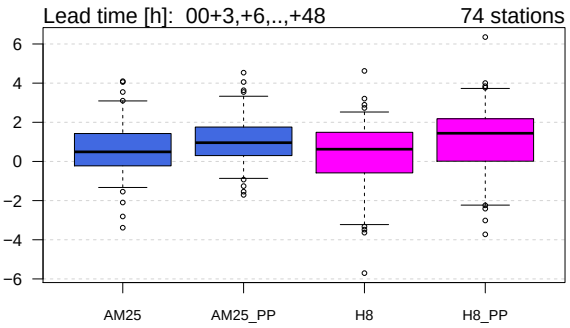



Hit Rate
Lead time [h]: 00+3,+6,..,+24
74 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.8
0.6
0.4
0.2
0.0
1
3
5
7
9
11
13
15
17
19
21
Exceedance threshold [m/s]

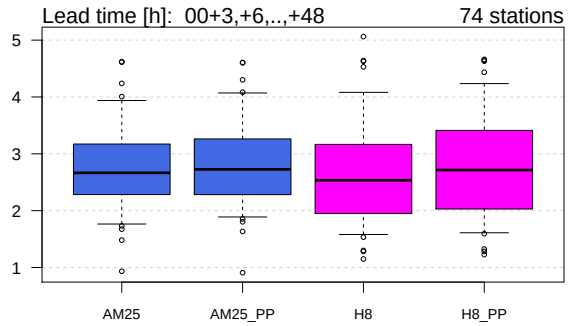

False Alarm Ratio
Lead time [h]: 00+3,+6,..,+24
74 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.8
0.6
0.4
0.2
0.0
1
3
5
7
9
11
13
15
17
19
21
Exceedance threshold [m/s]


Equitable Threat Score
Lead time [h]: 00+3,+6,..,+24
74 stations
AM25
AM25_PP
H8
H8_PP
1.0
0.8
0.6
0.4
0.2
0.0
1
3
5
7
9
11
13
15
17
19
21
Exceedance threshold [m/s]

ME



SDE



Lead time [h]: 00+3,+6,..,+48 UTC 74 stations

AM25

OBS

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	6816	5014	107	9	2	11948
(3,11]	4770	34278	6934	410	107	46499
(11,17]	61	3195	6358	1349	324	11287
(17,21]	2	84	288	339	294	1007
(21,Inf]	0	6	30	49	119	204
Sum	11649	42577	13717	2156	846	70945

AM25_PP

OBS

	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	6584	4464	85	7	1	11141
(3,11]	4962	33184	5431	245	59	43881
(11,17]	100	4725	7438	1219	251	13733
(17,21]	2	186	679	543	269	1679
(21,Inf]	1	18	84	142	266	511
Sum	11649	42577	13717	2156	846	70945

H8

OBS

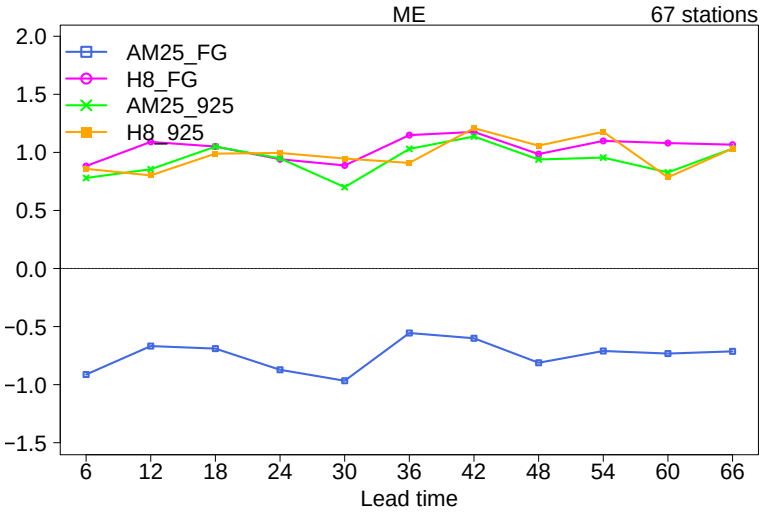
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	4886	3432	115	9	4	8446
(3,11]	6731	36878	8666	773	256	53304
(11,17]	32	2236	4712	1107	342	8429
(17,21]	0	27	217	248	193	685
(21,Inf]	0	4	7	19	51	81
Sum	11649	42577	13717	2156	846	70945

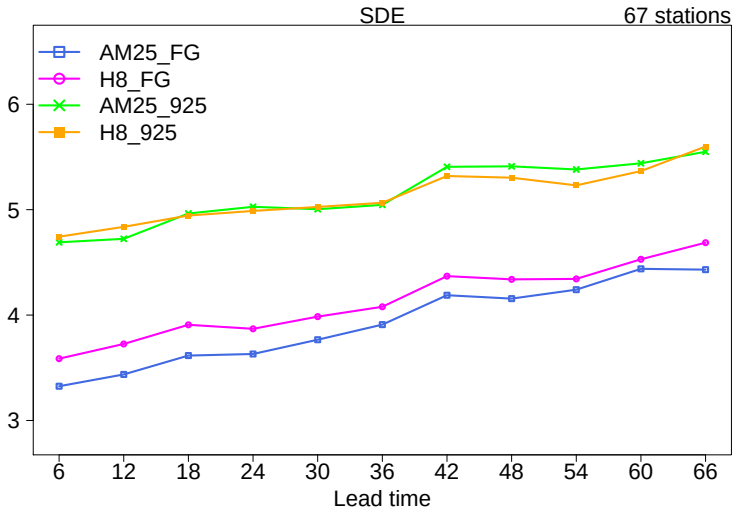
H8_PP

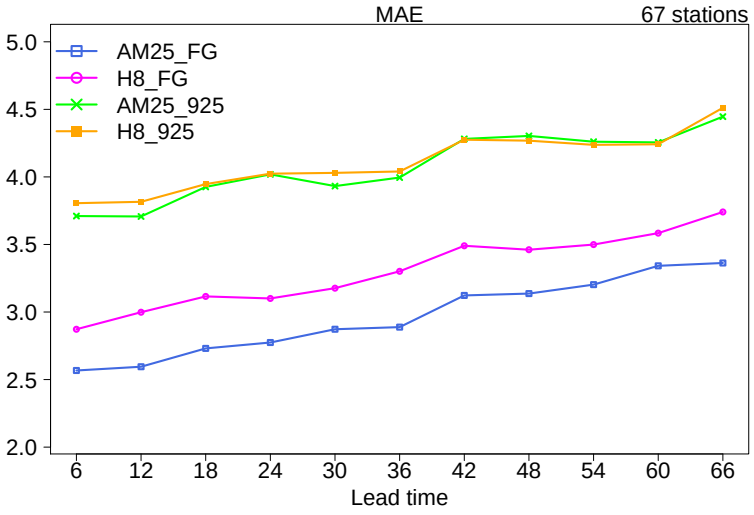
OBS

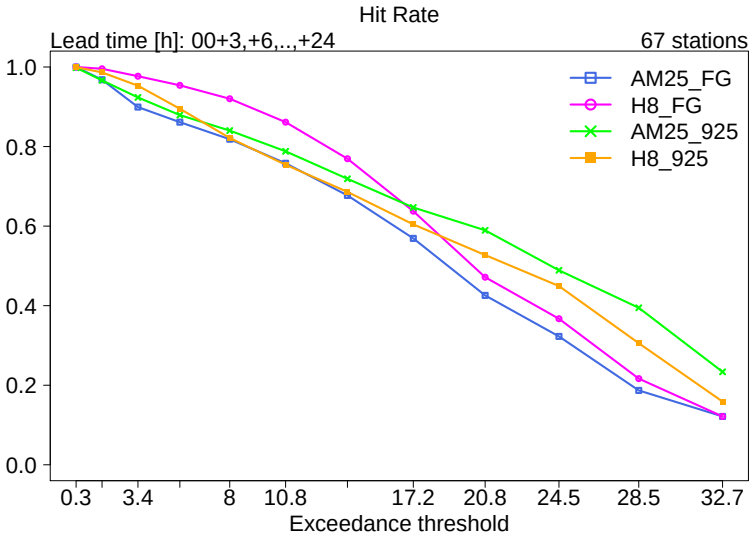
	[0,3]	(3,11]	(11,17]	(17,21]	(21,Inf]	Sum
[0,3]	4652	2759	75	8	4	7498
(3,11]	6880	34172	5684	403	113	47252
(11,17]	115	5338	6450	1002	288	13193
(17,21]	2	283	1316	512	211	2324
(21,Inf]	0	25	192	231	230	678
Sum	11649	42577	13717	2156	846	70945

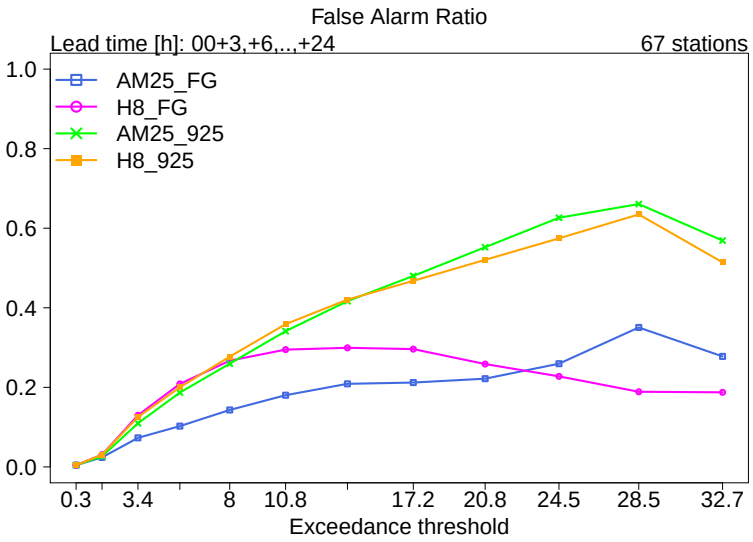
7.5 Wind gust

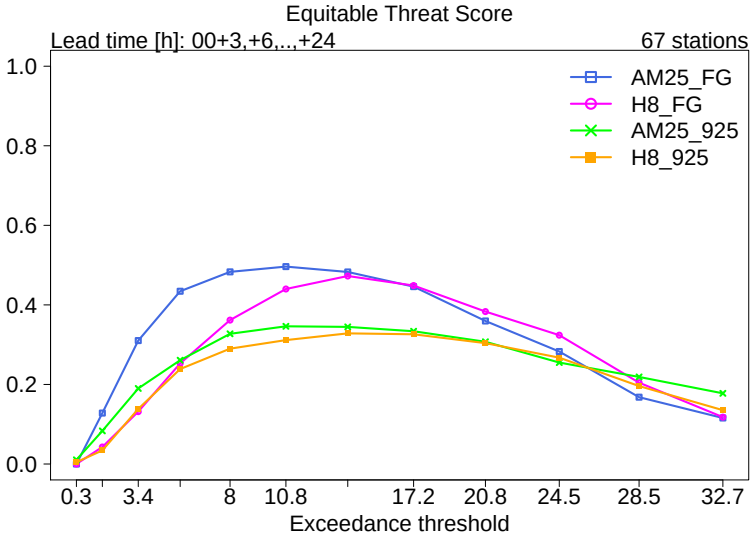

ME
67 stations
AM25_FG
H8_FG
AM25_925
H8_925
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
6
12
18
24
30
36
42
48
54
60
66
Lead time


SDE
67 stations
AM25_FG
H8_FG
AM25_925
H8_925
6
5
4
3
6
12
18
24
30
36
42
48
54
60
66
Lead time

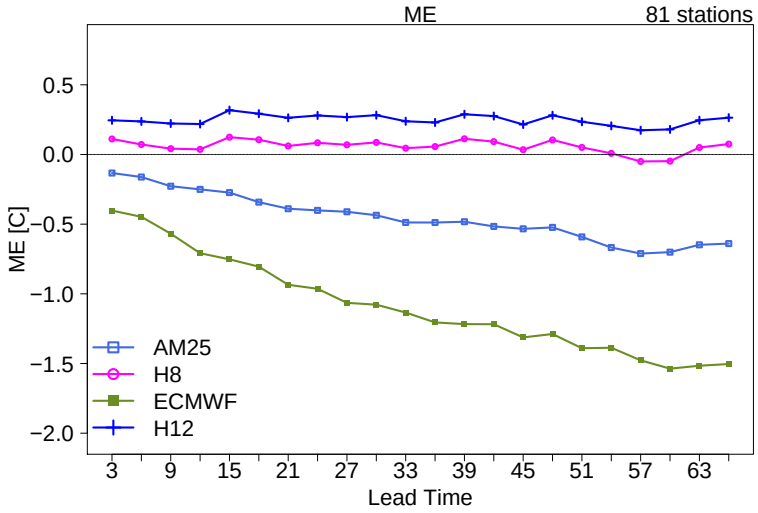

MAE
67 stations
AM25_FG
H8_FG
AM25_925
H8_925
5.0
4.5
4.0
3.5
3.0
2.5
2.0
6
12
18
24
30
36
42
48
54
60
66
Lead time

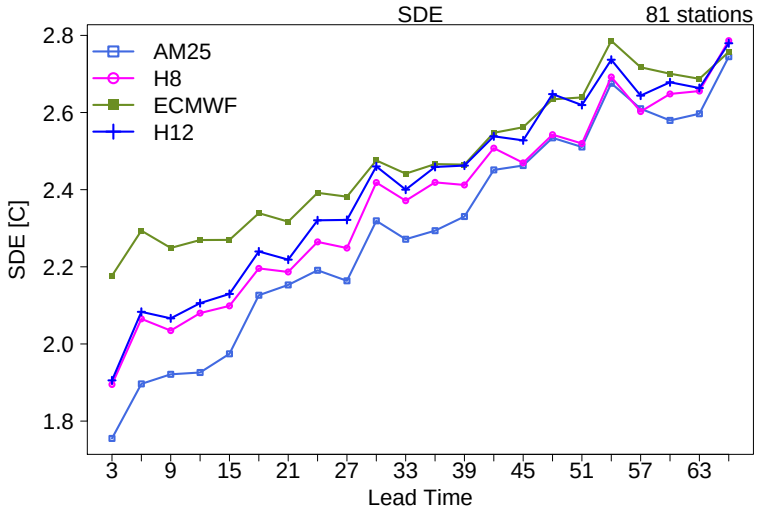

Hit Rate
Lead time [h]: 00+3,+6,..,+24
67 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.0
0.8
0.6
0.4
0.2
0.0
0.3
3.4
8
10.8
17.2
20.8
24.5
28.5
32.7
Exceedance threshold

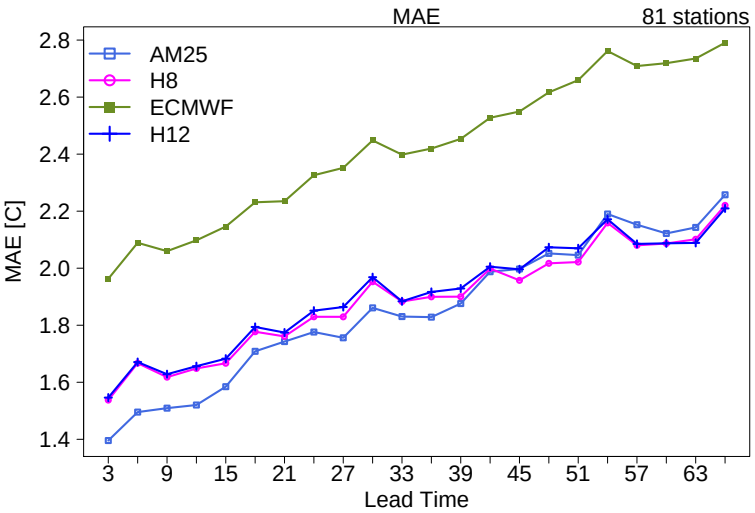

False Alarm Ratio
Lead time [h]: 00+3,+6,..,+24
67 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.0
0.8
0.6
0.4
0.2
0.0
0.3
3.4
8
10.8
17.2
20.8
24.5
28.5
32.7
Exceedance threshold

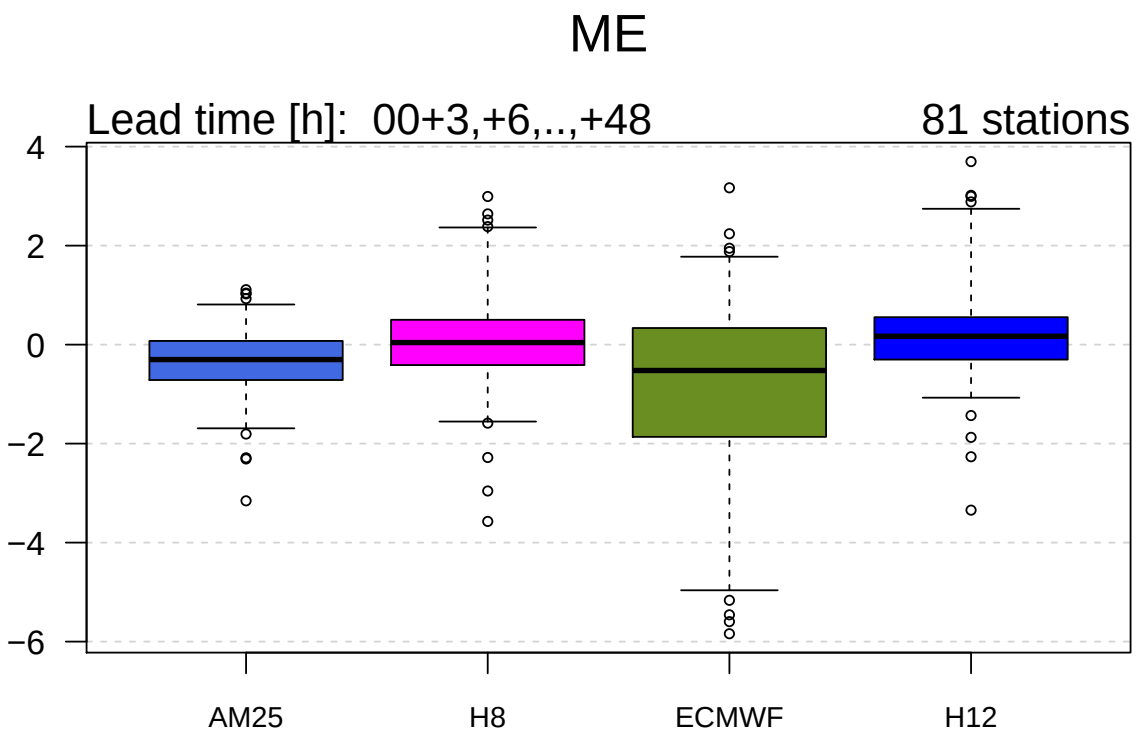

Equitable Threat Score
Lead time [h]: 00+3,+6,..,+24
67 stations
AM25_FG
H8_FG
AM25_925
H8_925
1.0
0.8
0.6
0.4
0.2
0.0
0.3
3.4
8
10.8
17.2
20.8
24.5
28.5
32.7
Exceedance threshold

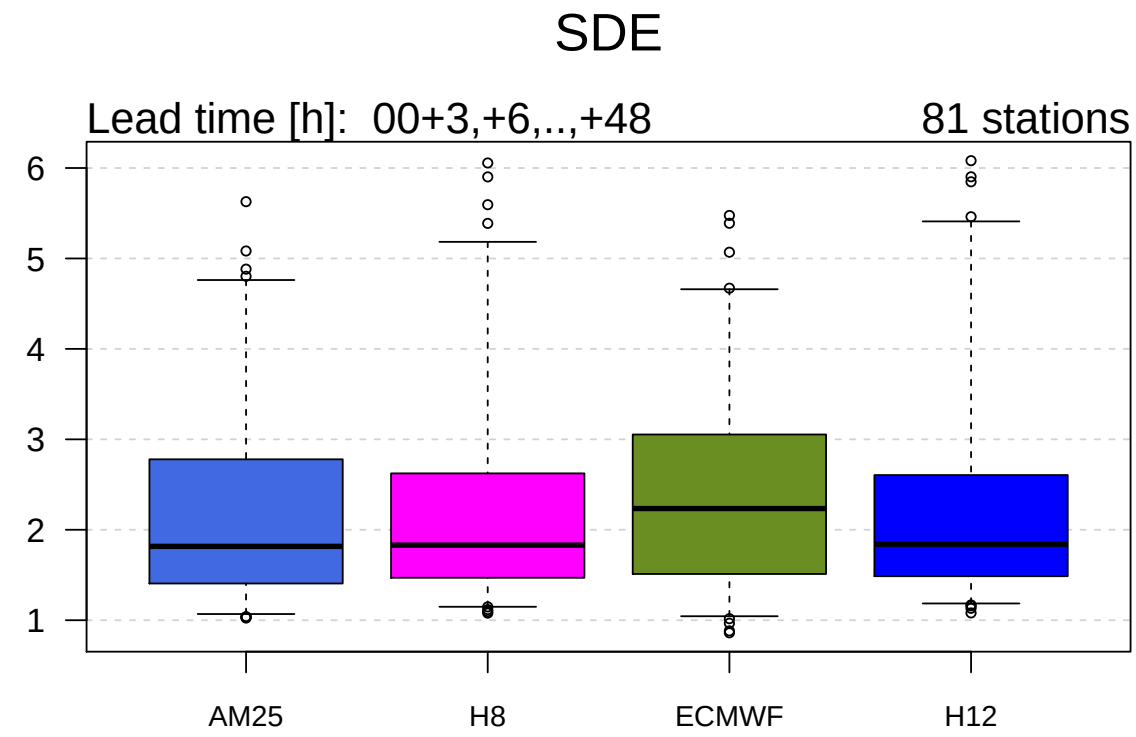
7.6 Temperature 2m





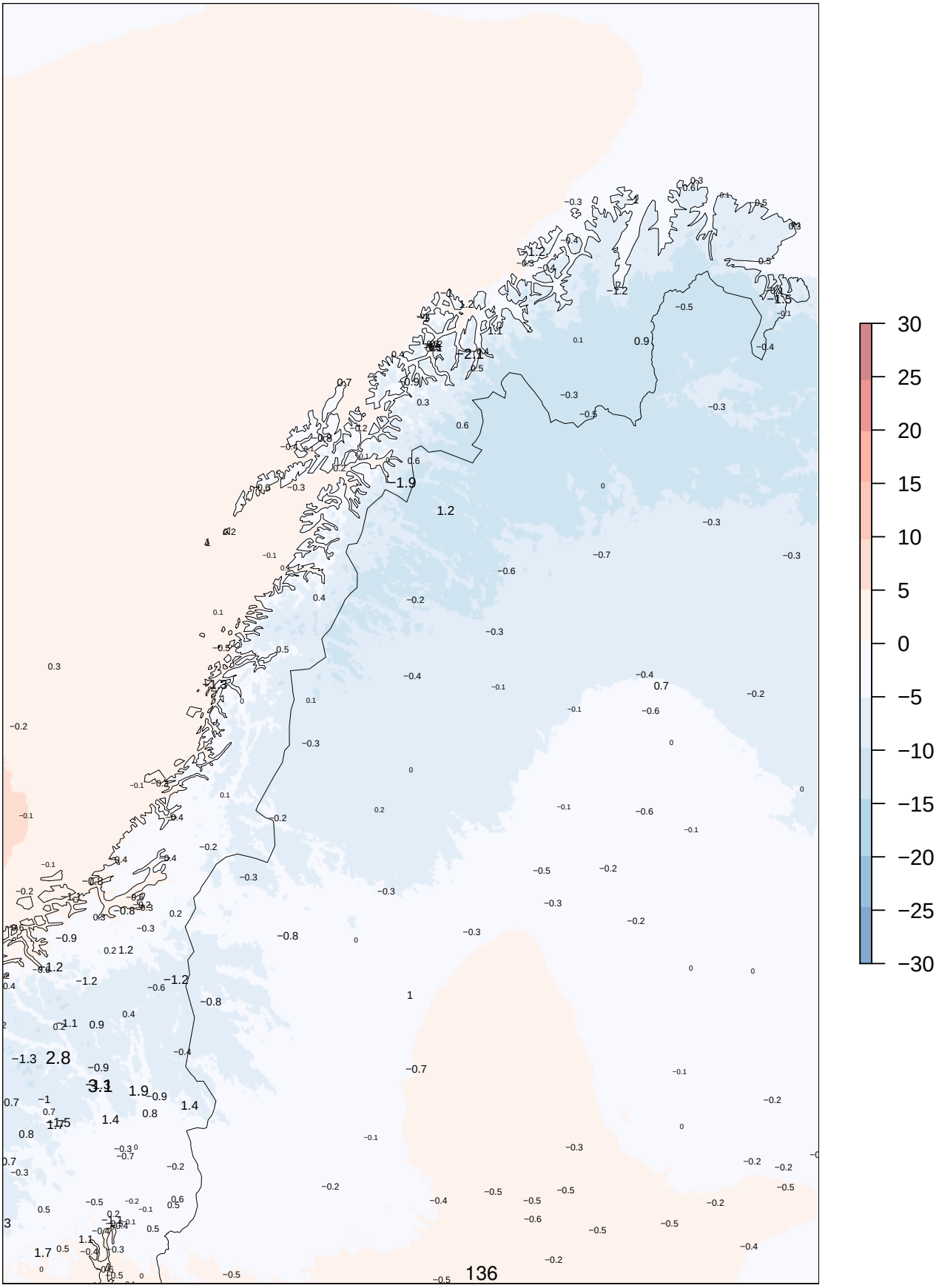



ME
Lead time [h]: 00+3,+6,..,+48
81 stations
4
2
0
−2
−4
−6
AM25
H8
ECMWF
H12


SDE
Lead time [h]: 00+3,+6,..,+48
81 stations
6
5
4
3
2
1
AM25
H8
ECMWF
H12

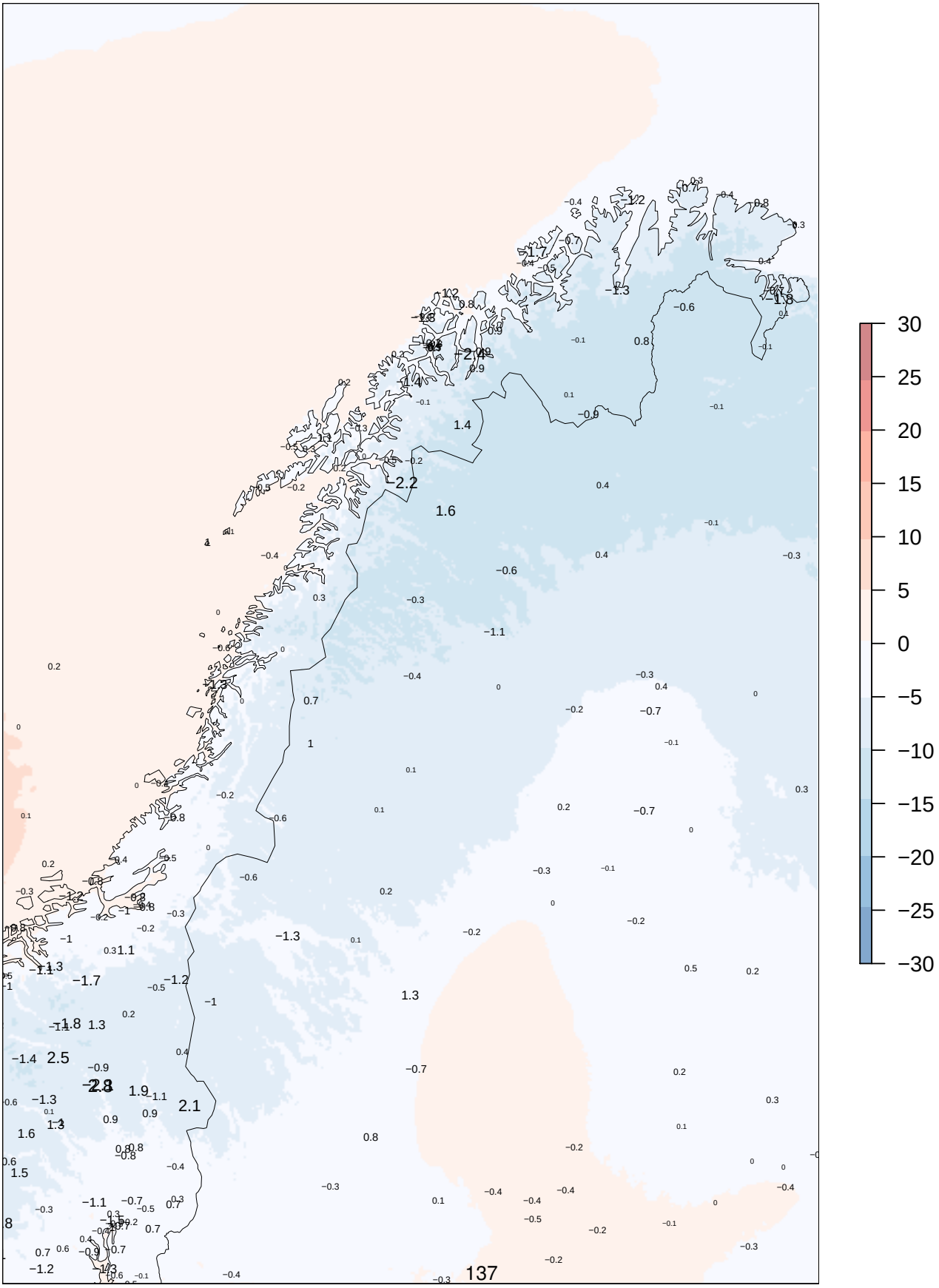
AM25 00+12

ME at observing sites forecast means 01.12.2014 − 28.02.2015



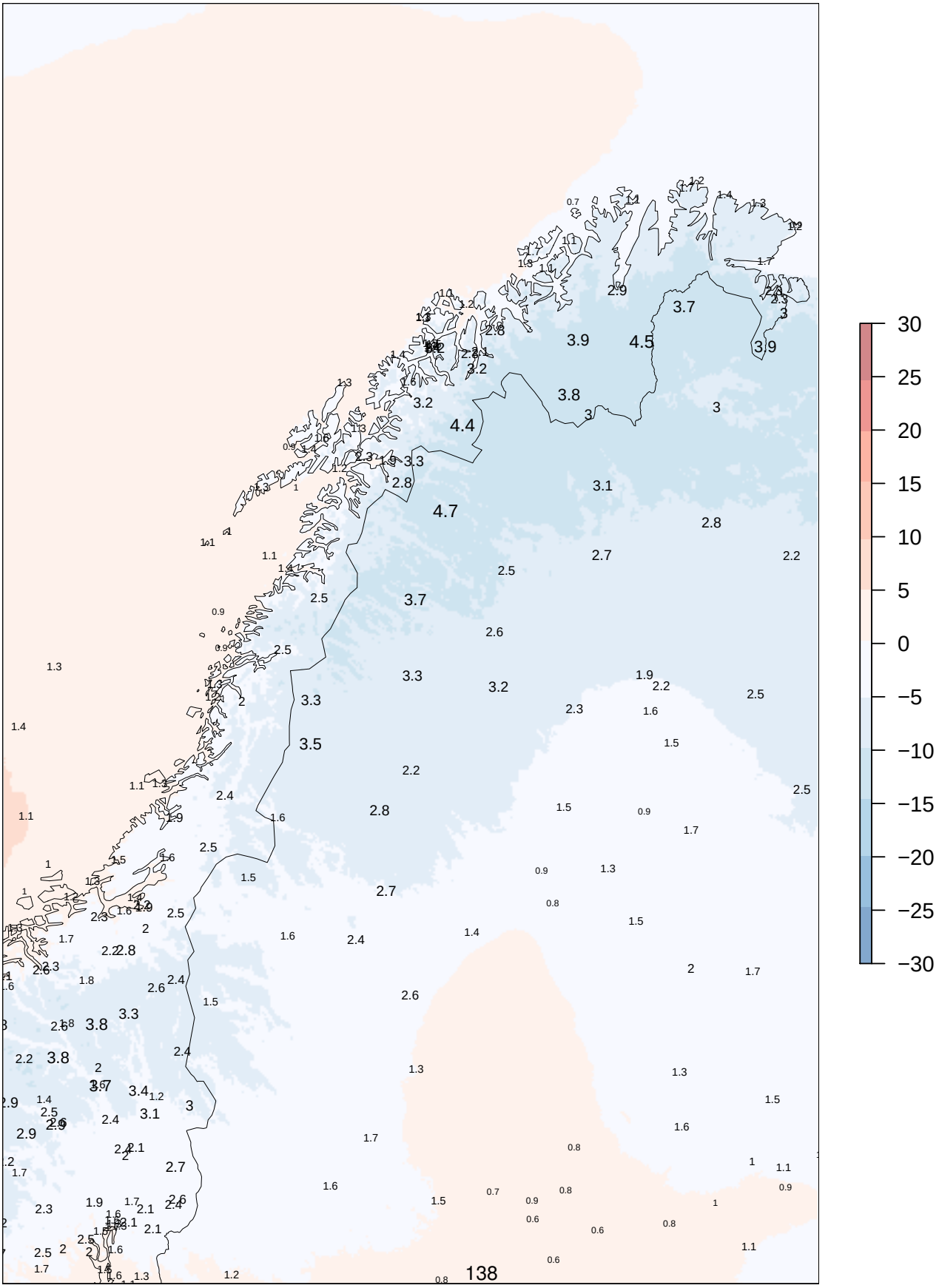
AM25 00+24

ME at observing sites forecast means 01.12.2014 − 28.02.2015



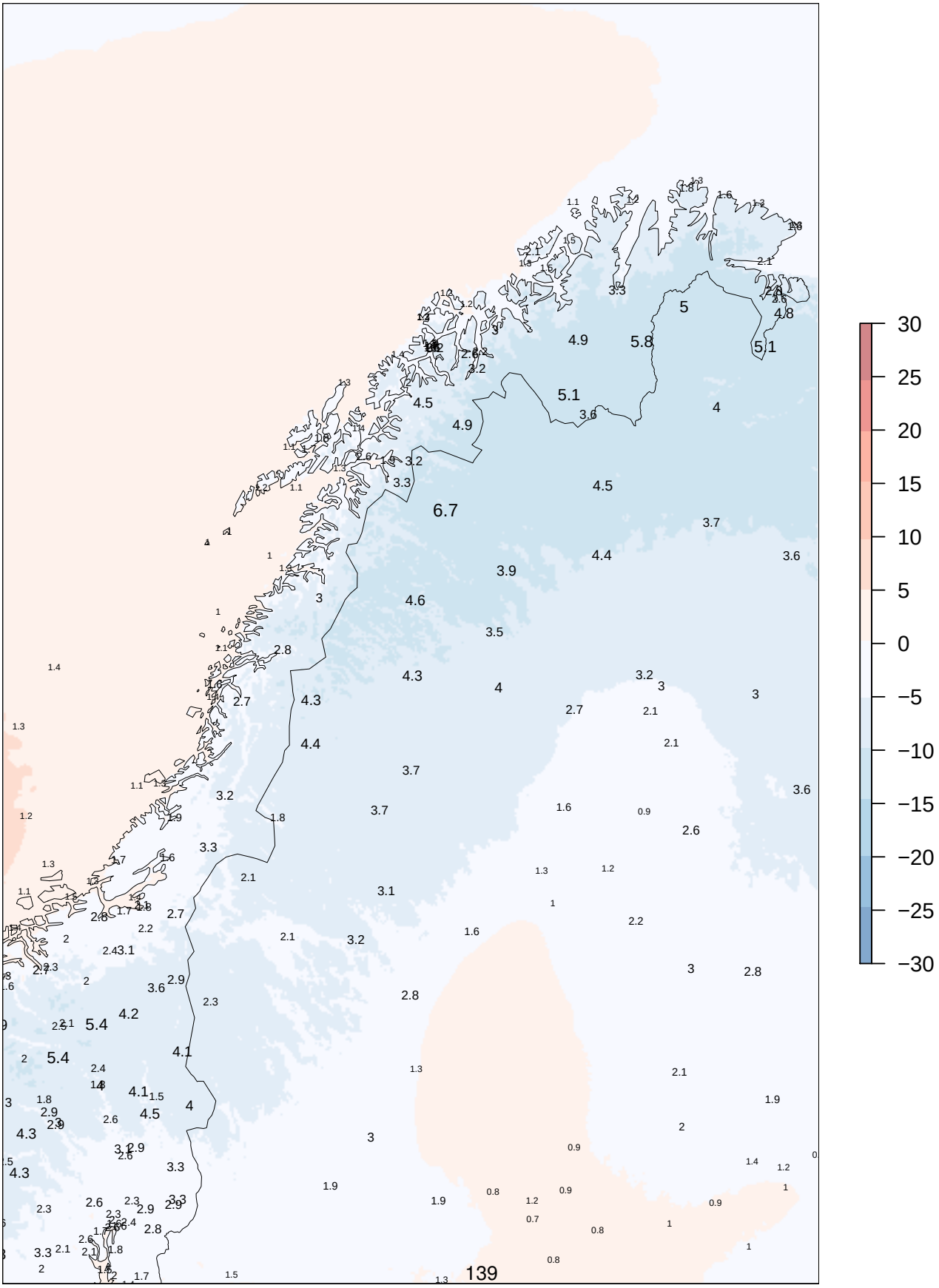
AM25 00+12

SDE at observing sites forecast means 01.12.2014 − 28.02.2015

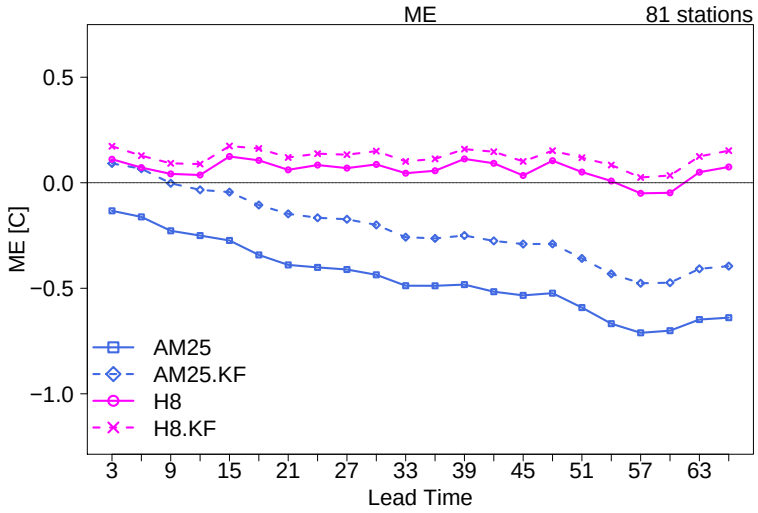


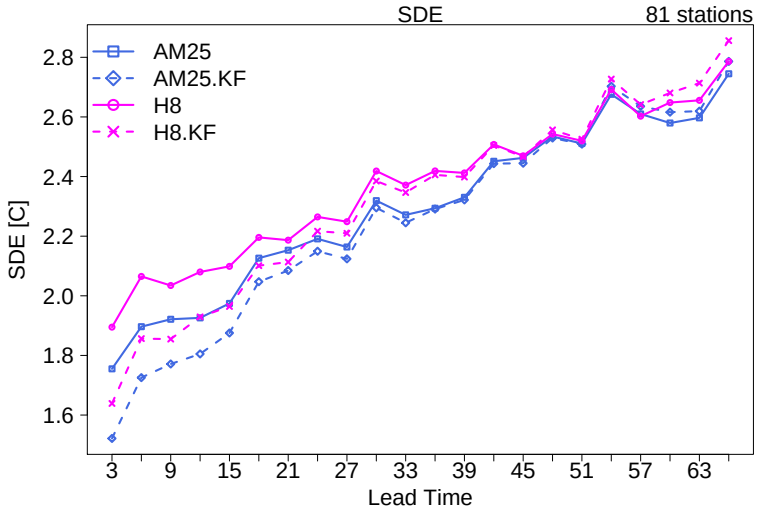
AM25 00+24

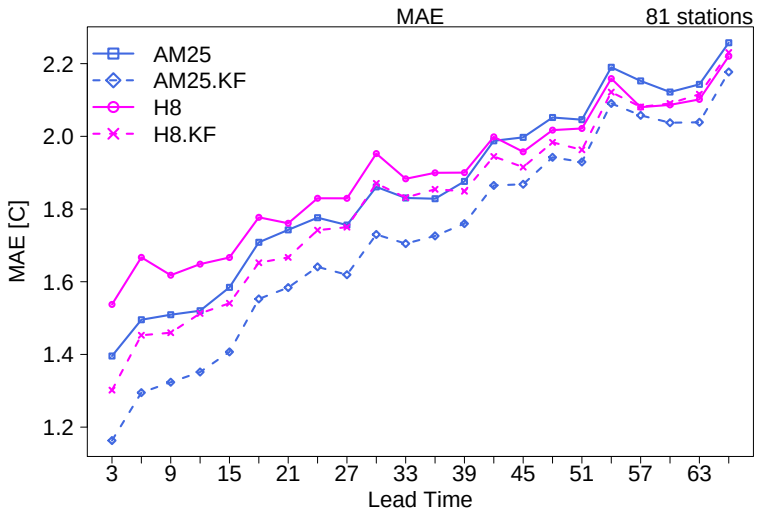
SDE at observing sites forecast means 01.12.2014 − 28.02.2015

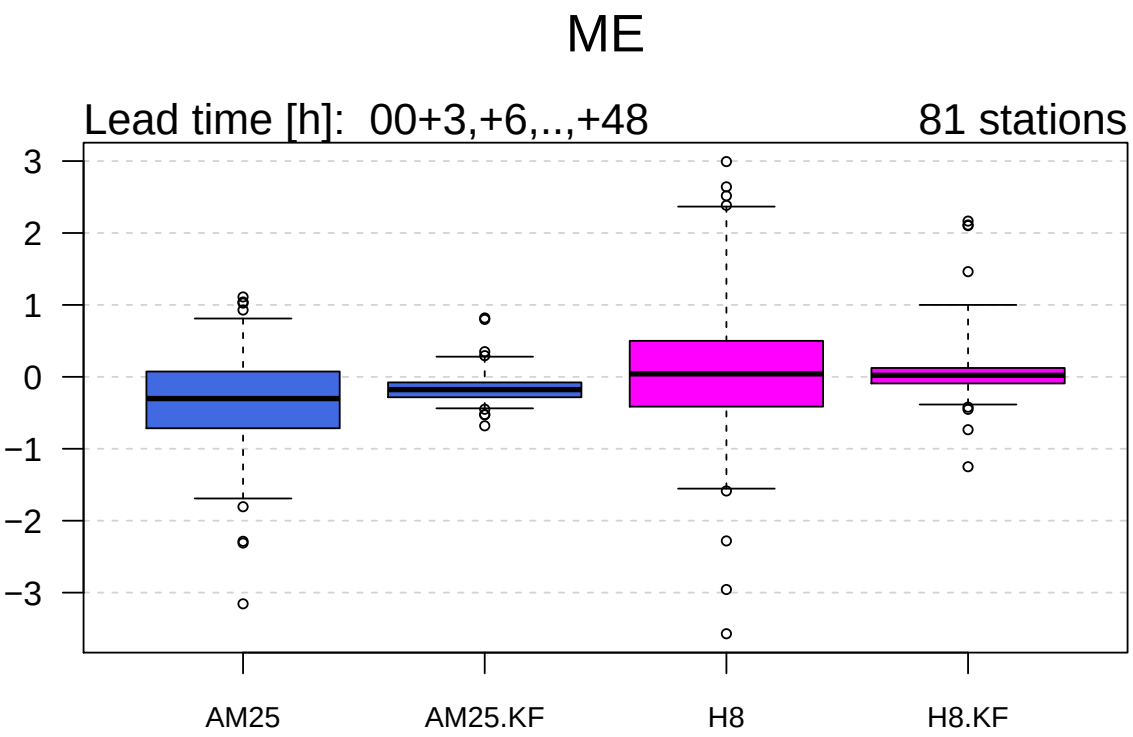


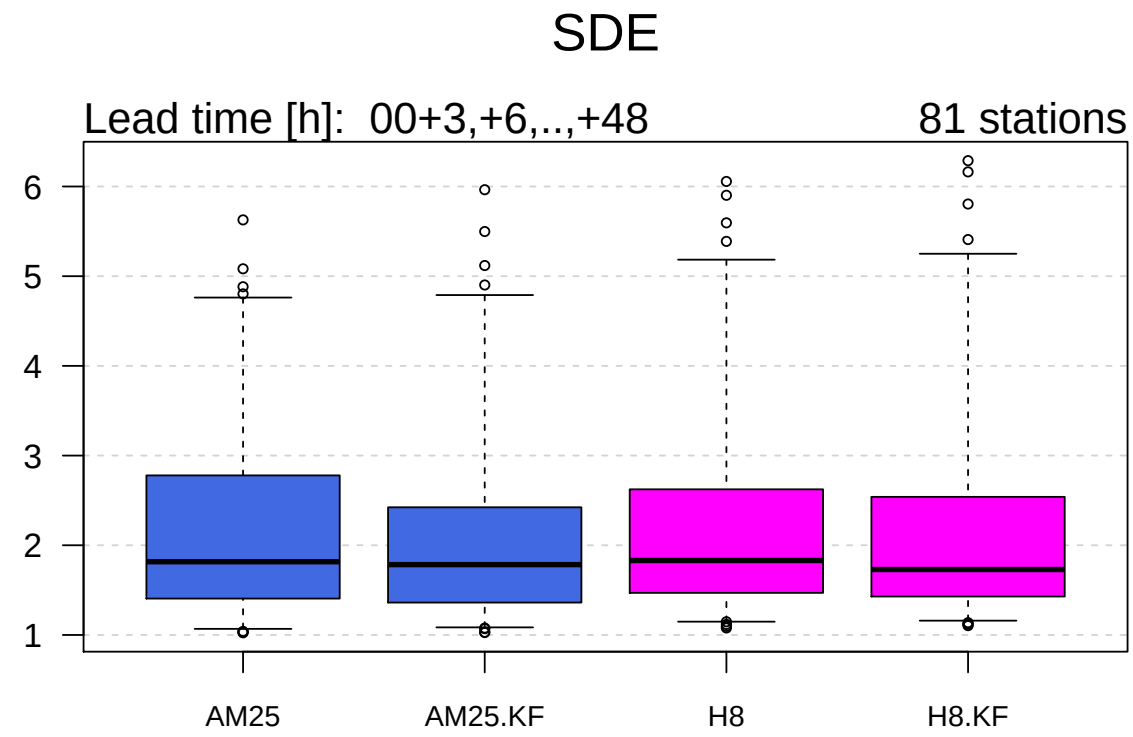
7.7 Post processed temperature 2m



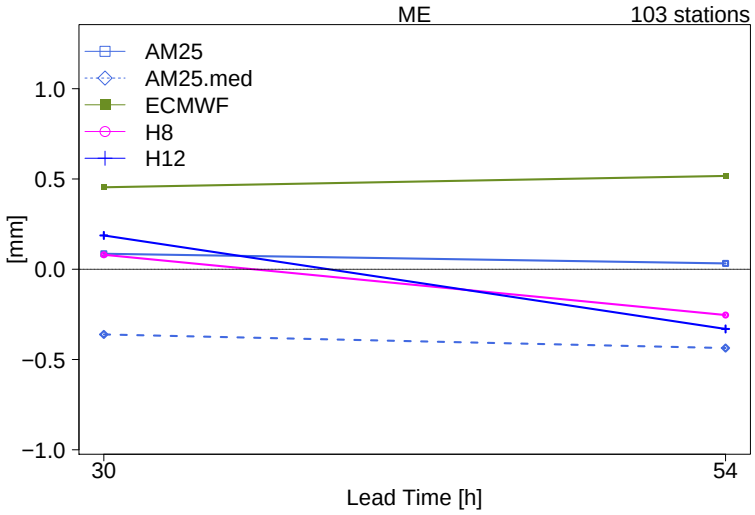


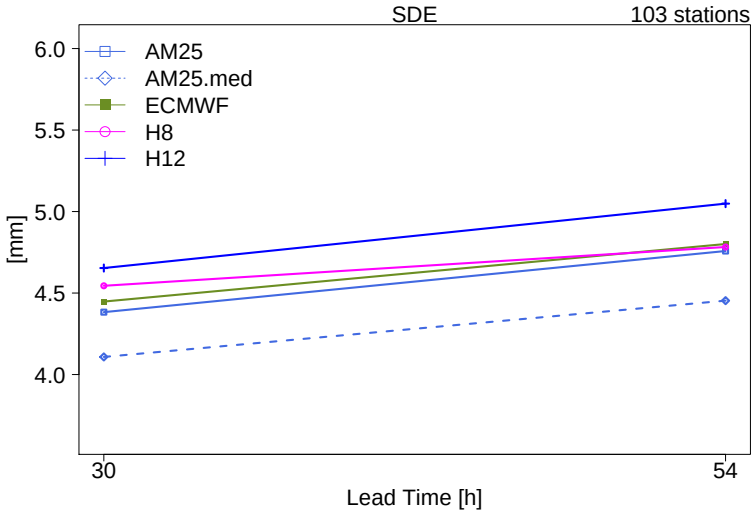


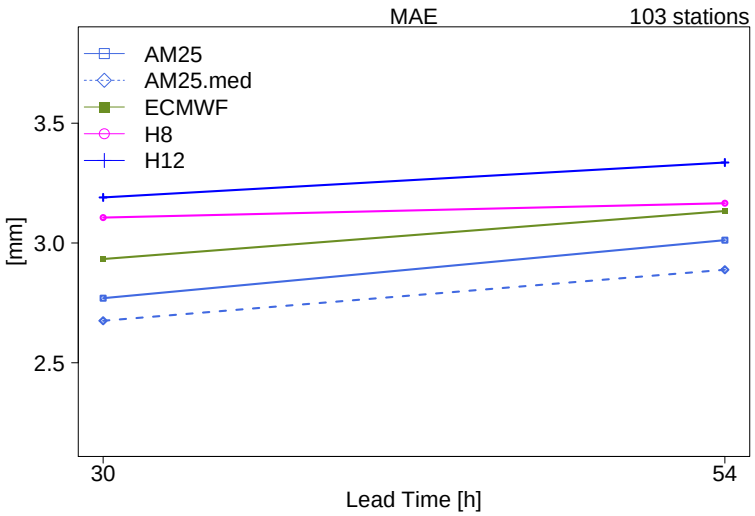

ME
Lead time [h]: 00+3,+6,..,+48
81 stations
3
2
1
0
−1
−2
−3
AM25
AM25.KF
H8
H8.KF

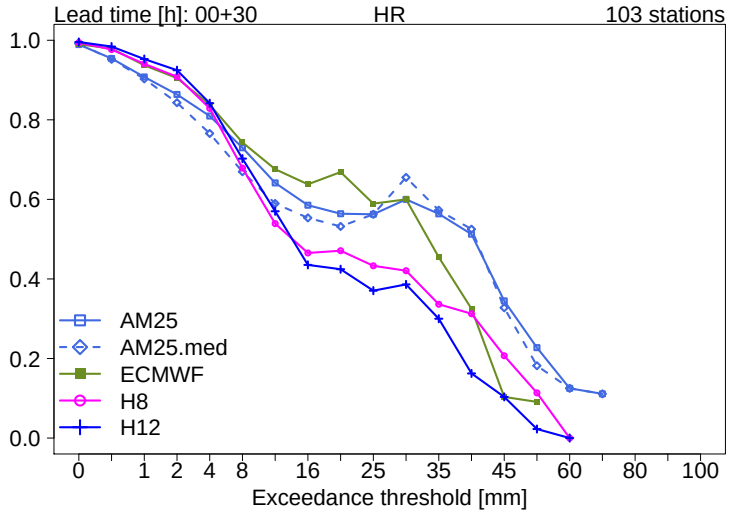

SDE
Lead time [h]: 00+3,+6,..,+48
81 stations
6
5
4
3
2
1
AM25
AM25.KF
H8
H8.KF

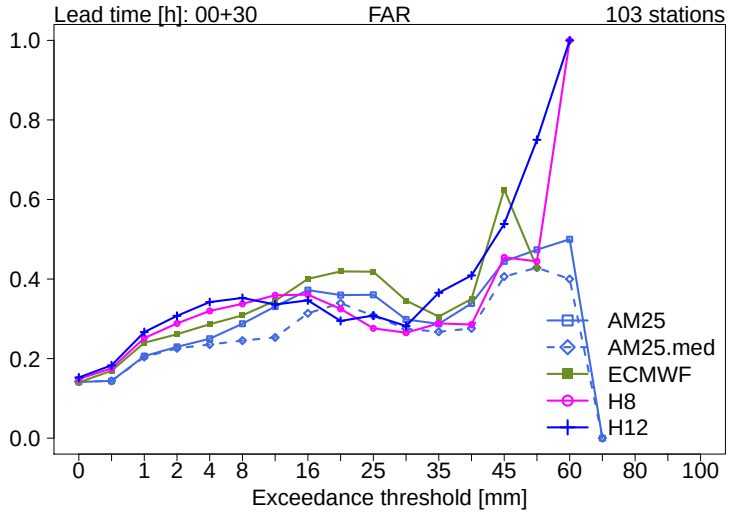
7.8 Daily precipitation

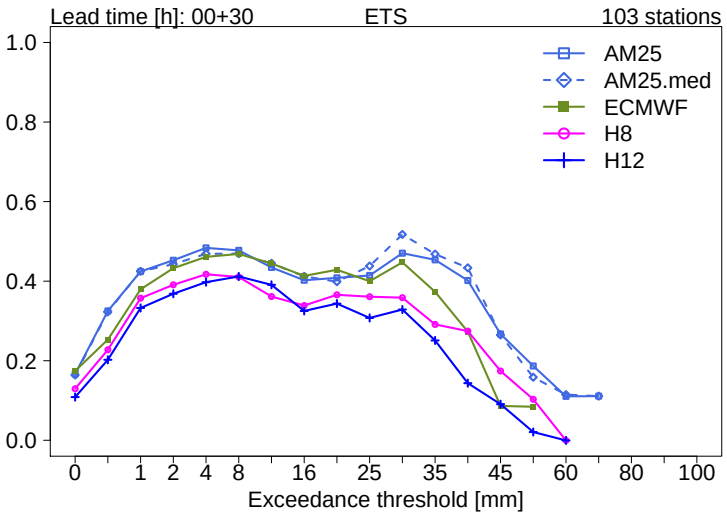


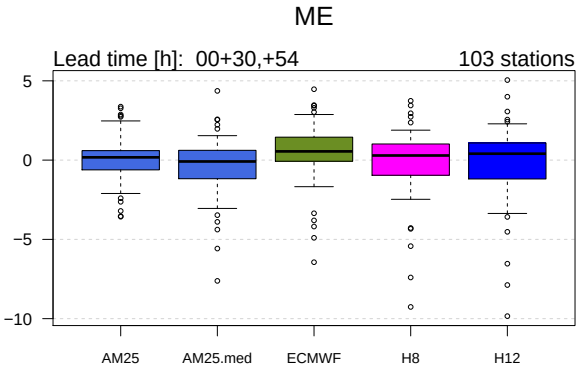


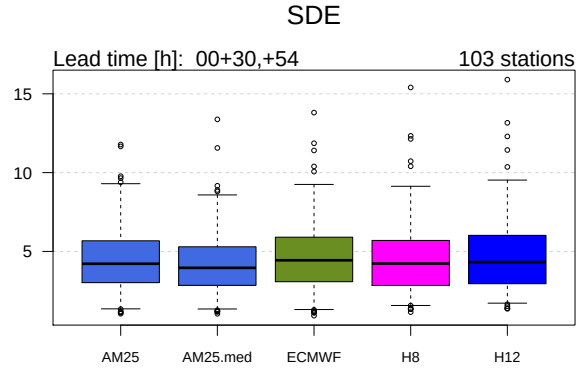



Lead time [h]: 00+30
HR
103 stations
1.0
0.8
0.6
0.4
0.2
0.0
AM25
AM25.med
ECMWF
H8
H12
0 1 2 4 8 16 25 35 45 60 80 100
Exceedance threshold [mm]


Lead time [h]: 00+30
FAR
103 stations
1.0
0.8
0.6
0.4
0.2
0.0
AM25
AM25.med
ECMWF
H8
H12
0 1 2 4 8 16 25 35 45 60 80 100
Exceedance threshold [mm]


Lead time [h]: 00+30
ETS
103 stations
1.0
0.8
0.6
0.4
0.2
0.0
AM25
AM25.med
ECMWF
H8
H12
0 1 2 4 8 16 25 35 45 60 80 100
Exceedance threshold [mm]





Lead time [h]: 00+30,+54 103 stations

AM25

	OBS					
	[0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	1544	664	27	0	0	2235
(0.1,5]	1589	4509	861	24	0	6983
(5,20]	70	1106	2338	261	5	3780
(20,50]	2	21	214	286	63	586
(50,Inf]	0	0	2	29	20	51
Sum	3205	6300	3442	600	88	13635

AM25.med

	OBS					
	[0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	1533	653	32	0	0	2218
(0.1,5]	1620	4744	1046	26	0	7436
(5,20]	52	893	2182	276	8	3411
(20,50]	0	10	182	273	61	526
(50,Inf]	0	0	0	25	19	44
Sum	3205	6300	3442	600	88	13635

ECMWF

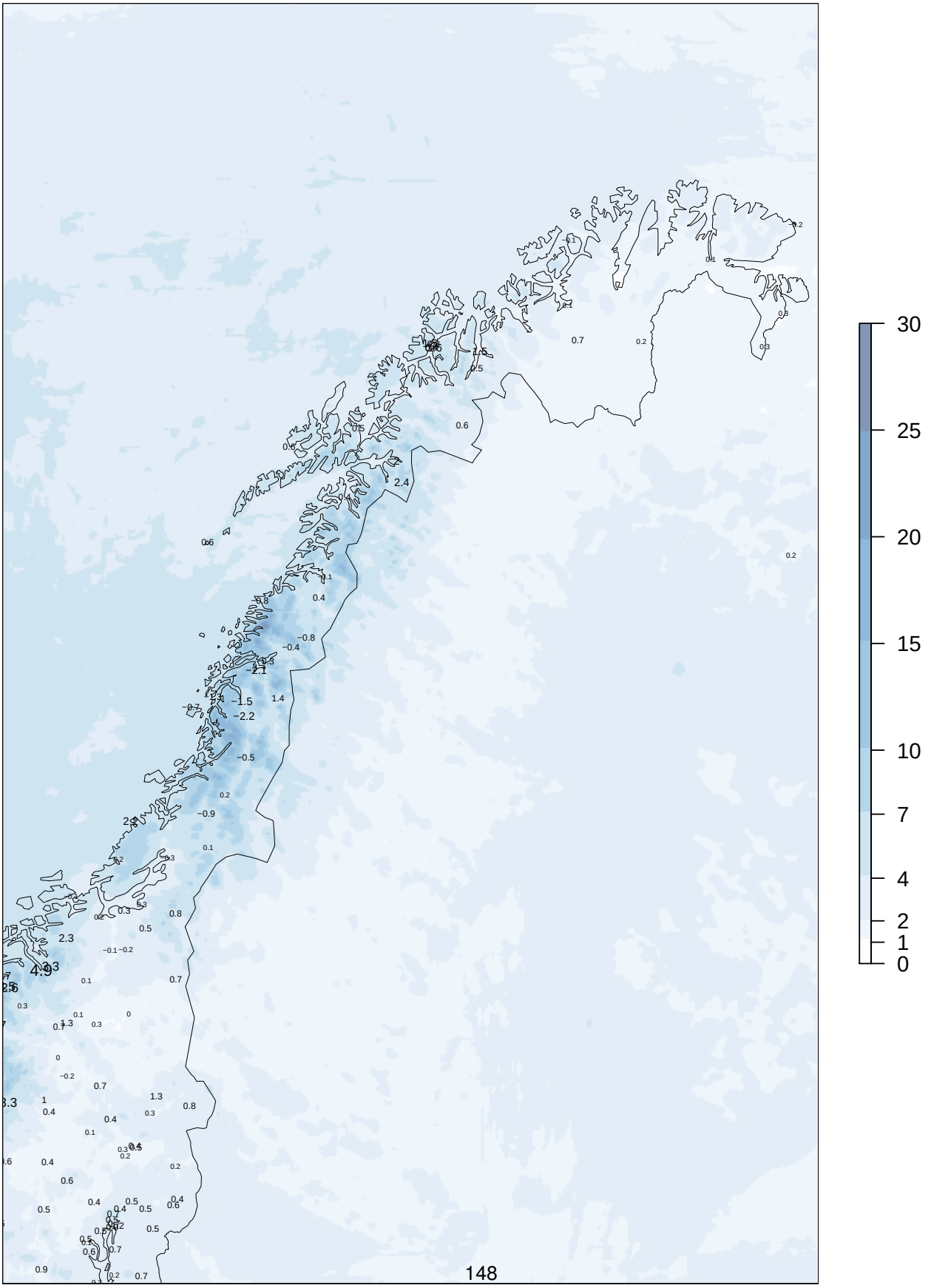
	OBS					
	[0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	1131	287	4	0	0	1422
(0.1,5]	1984	4654	726	32	0	7396
(5,20]	90	1338	2392	206	3	4029
(20,50]	0	21	318	346	77	762
(50,Inf]	0	0	2	16	8	26
Sum	3205	6300	3442	600	88	13635

H8

	OBS					
	[0,0.1]	(0.1,5]	(5,20]	(20,50]	(50,Inf]	Sum
[0,0.1]	979	330	14	0	0	1323
(0.1,5]	2108	4604	901	39	0	7652
(5,20]	117	1358	2385	311	13	4184
(20,50]	1	8	142	239	64	454
(50,Inf]	0	0	0	11	11	22
Sum	3205	6300	3442	600	88	13635

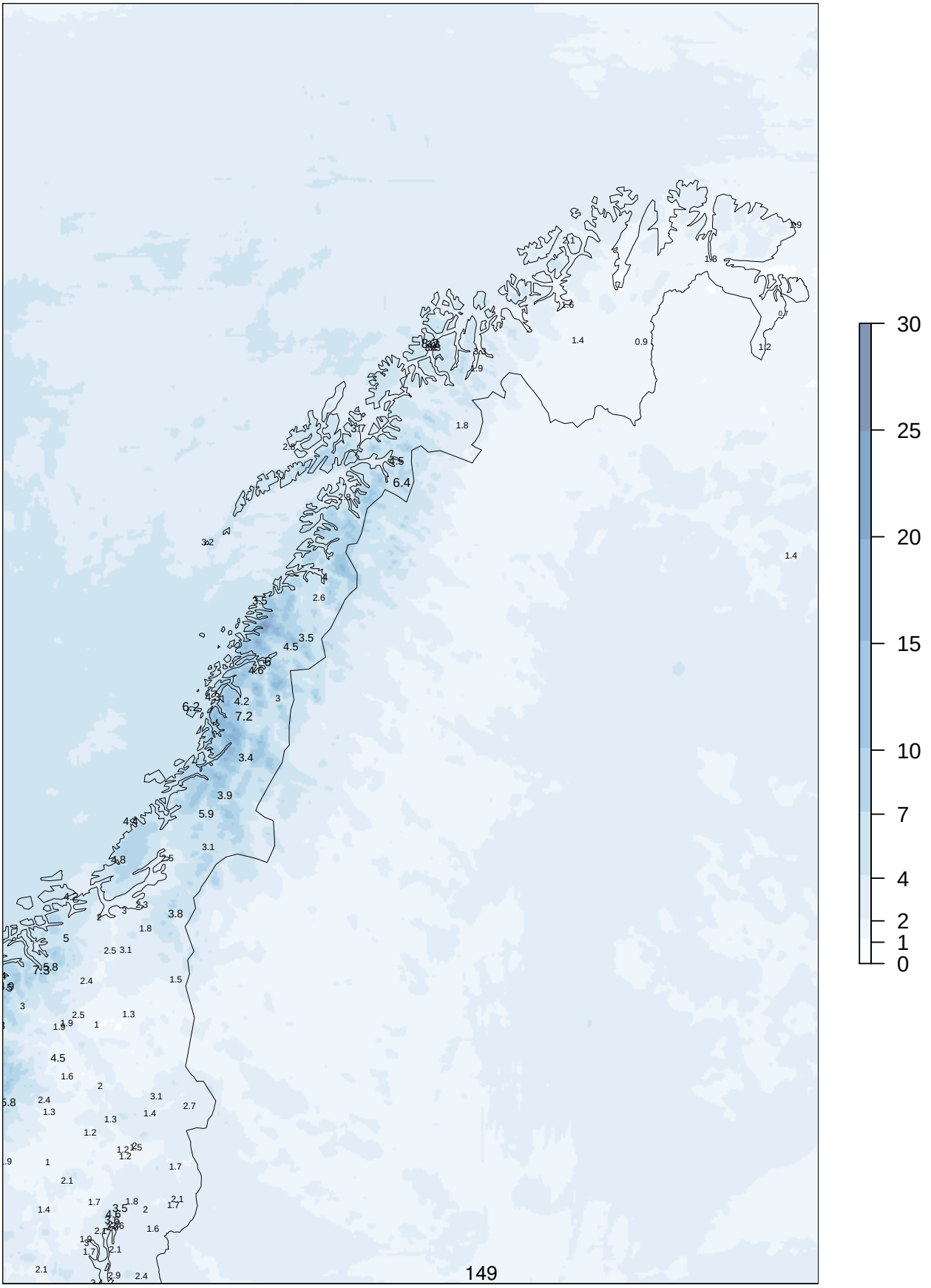
AM25 00+30

ME at observing sites forecast means 01.12.2014 − 28.02.2015



AM25 00+30

SDE at observing sites forecast means 01.12.2014 − 28.02.2015



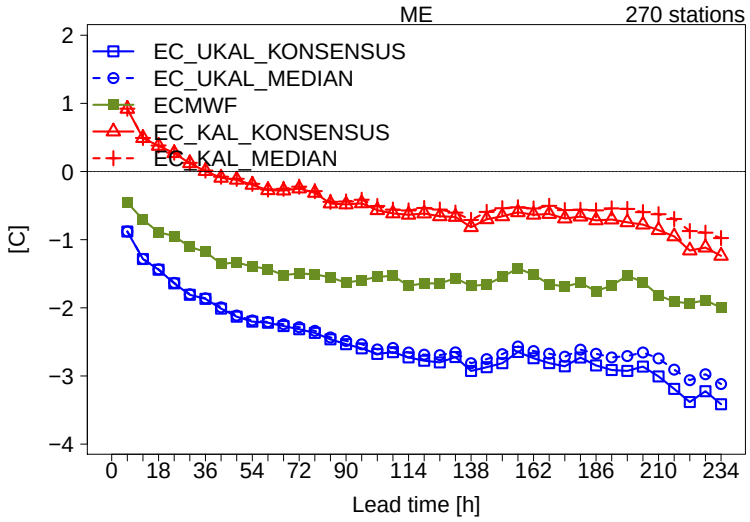
8 Long term forecast

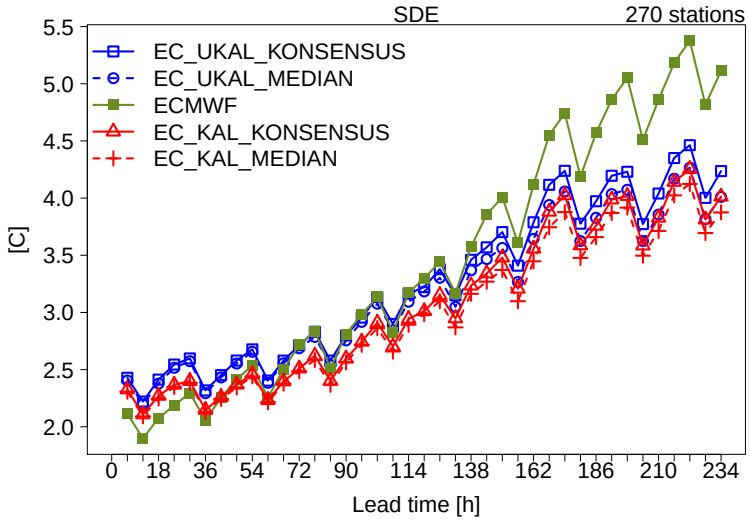
There is a clear cold bias and trend in all forecasts for temperature, yet the calibration reduces the bias with about $2\,^{\circ}\mathrm{C}$. At the longest lead times, the calibrated long term forecast is around 1°C too cold, compared with the observations. The difference between the calibrated and uncalibrated forecast is not so large in SDE, but the calibrated forecast has a smaller SDE. The calibration reduces the MAE with about $1.5\,^{\circ}\mathrm{C}$.

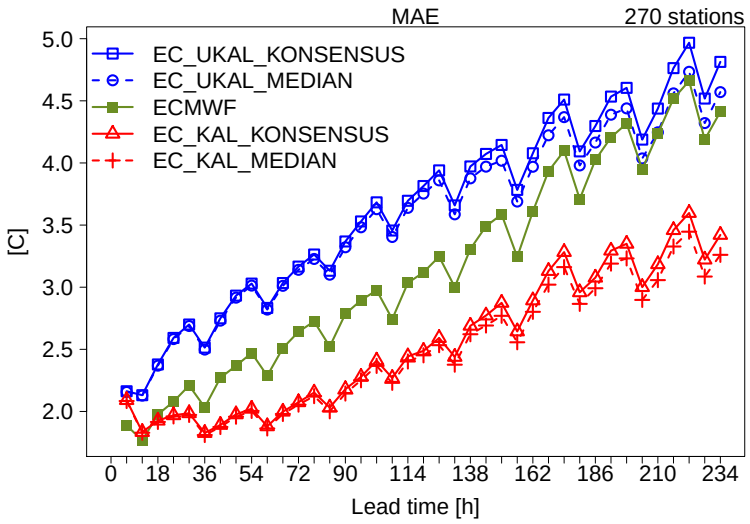
The probabilistic consensus forecast has a lower bias in wind speed, but it is still too low compared with the observation. ETS is almost the same for deterministic and the EPS consensus at 72h. At 216h, the EPS consensus scores slightly better at lower thresholds, while the deterministic is somewhat better for higher thresholds.

The long term precipitation forecasts have quite low biases, except for the longest lead times, where the forecasts have been too dry. At 78h, the deterministic forecasts score higher at ETS, than the probabilistic forecasts. At 222h, the ETS is lower for the deterministic forecast, but both forecasts have relatively low scores. The probabilistic forecast has no events above 20mm per 12h.

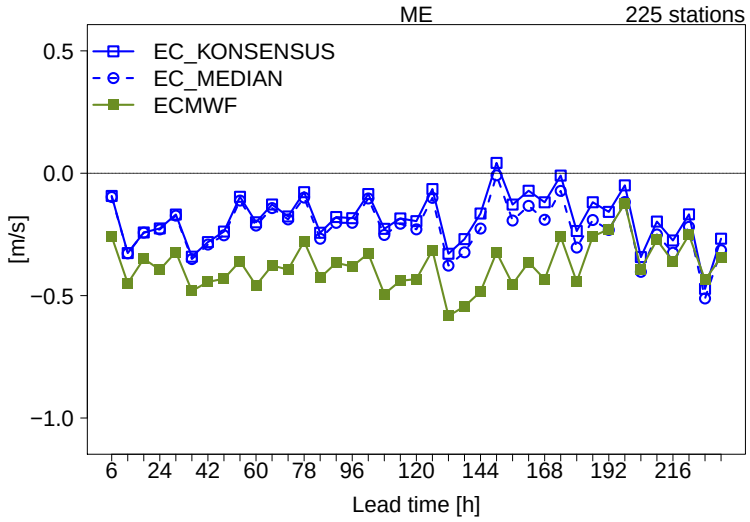
8.1 Temperature 2m

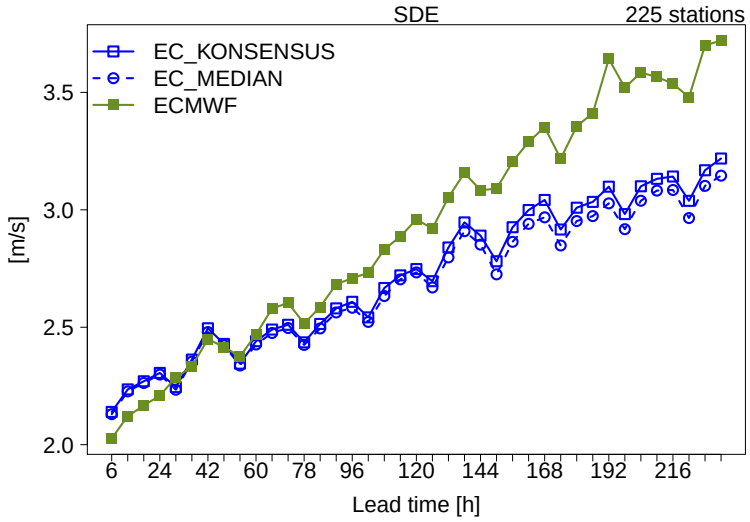


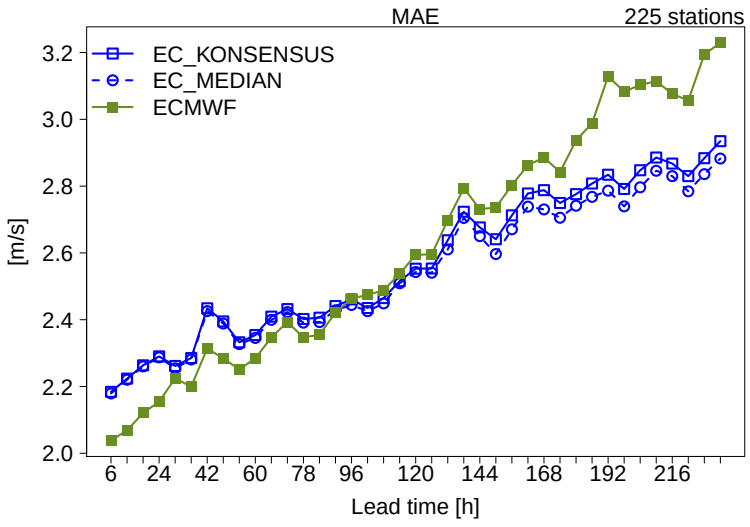


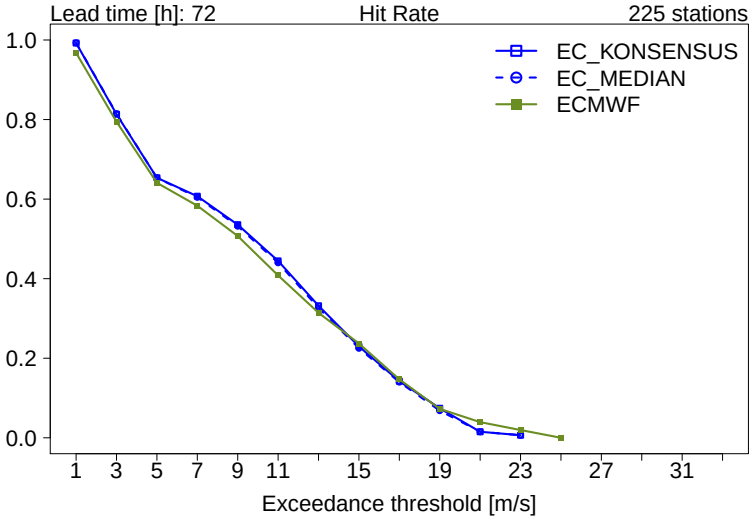


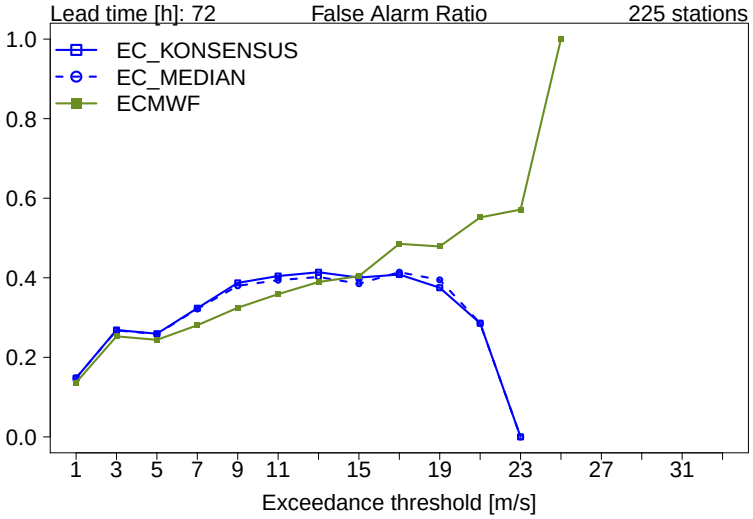
8.2 Wind Speed 10m

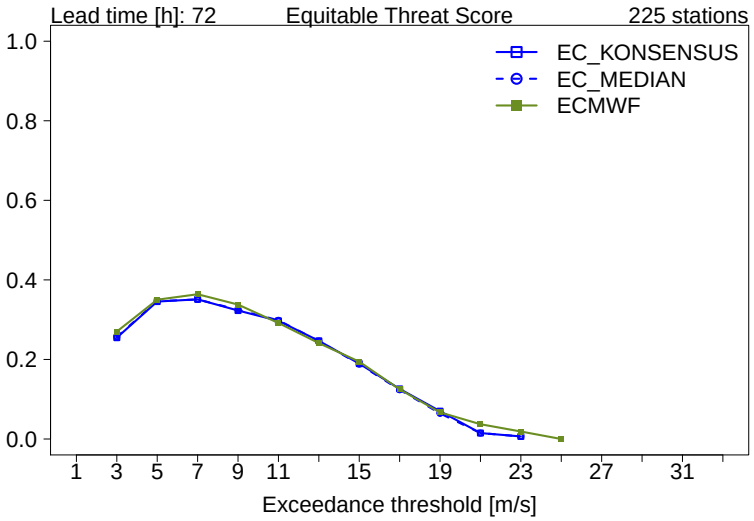


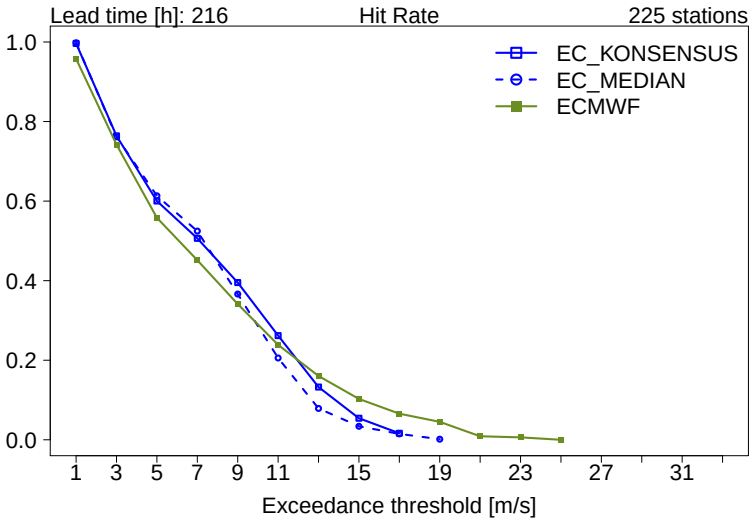


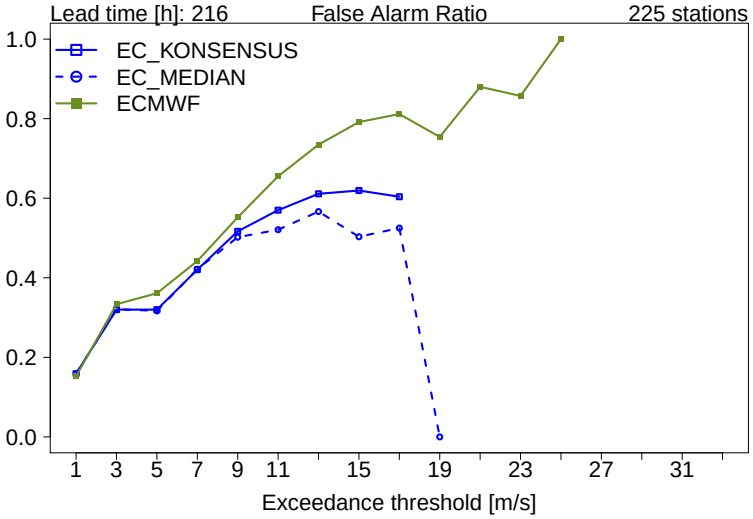


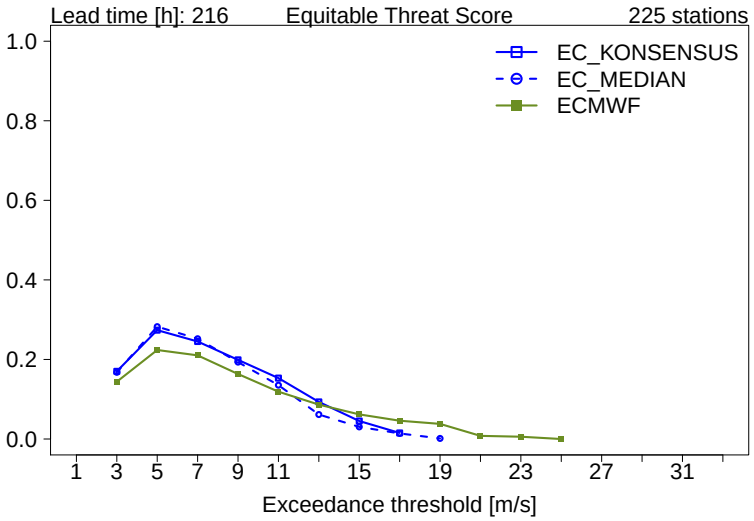

Lead time [h]: 72
Hit Rate
225 stations
EC_KONSENSUS
EC_MEDIAN
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 15 19 23 27 31
Exceedance threshold [m/s]


Lead time [h]: 72
False Alarm Ratio
225 stations
EC_KONSENSUS
EC_MEDIAN
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 15 19 23 27 31
Exceedance threshold [m/s]

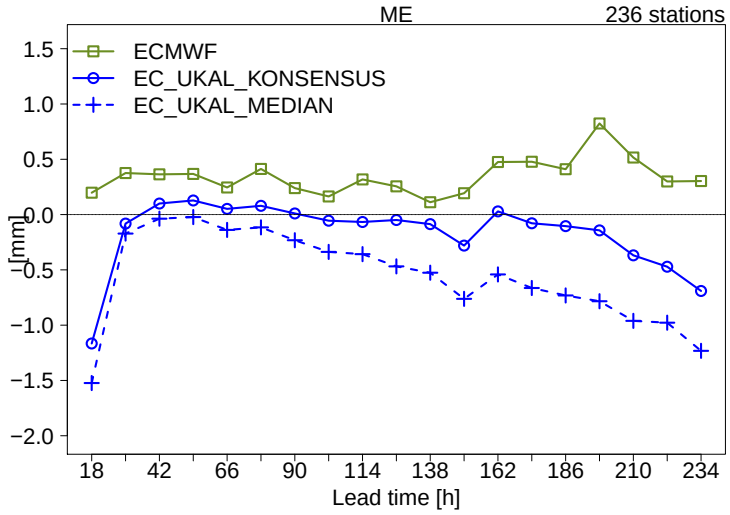

Lead time [h]: 72
Equitable Threat Score
225 stations
EC_KONSENSUS
EC_MEDIAN
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 15 19 23 27 31
Exceedance threshold [m/s]

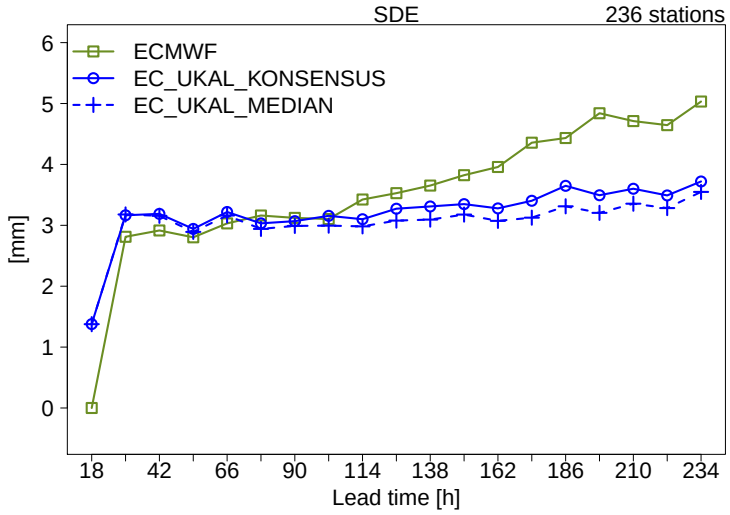

Lead time [h]: 216
Hit Rate
225 stations
EC_KONSENSUS
EC_MEDIAN
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 15 19 23 27 31
Exceedance threshold [m/s]

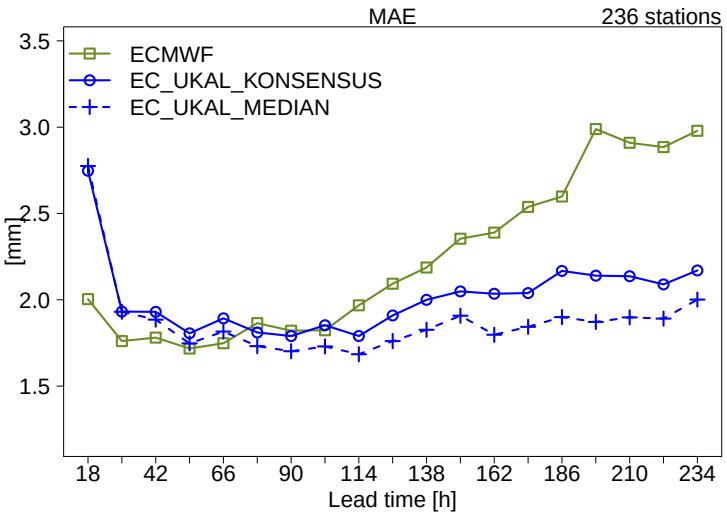

Lead time [h]: 216
False Alarm Ratio
225 stations
EC_KONSENSUS
EC_MEDIAN
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 15 19 23 27 31
Exceedance threshold [m/s]

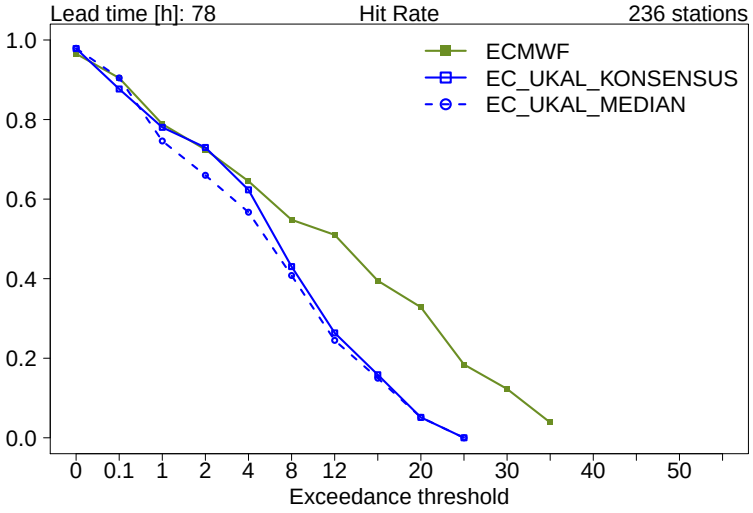

Lead time [h]: 216
Equitable Threat Score
225 stations
EC_KONSENSUS
EC_MEDIAN
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 15 19 23 27 31
Exceedance threshold [m/s]

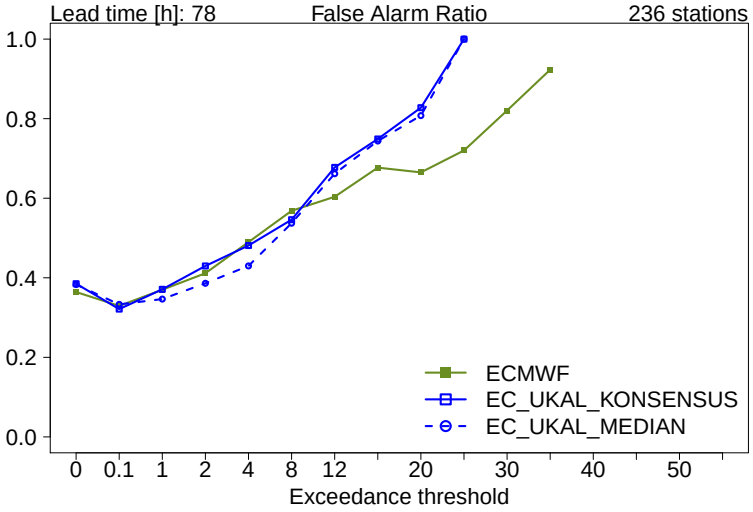
8.3 12h Precipitation

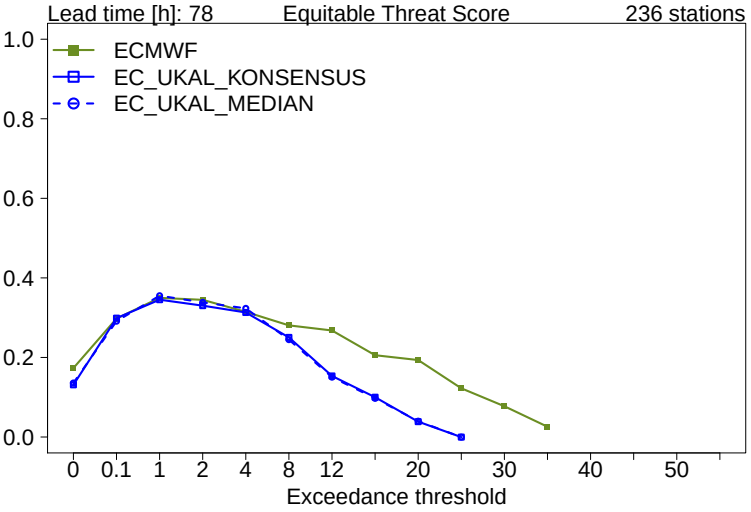


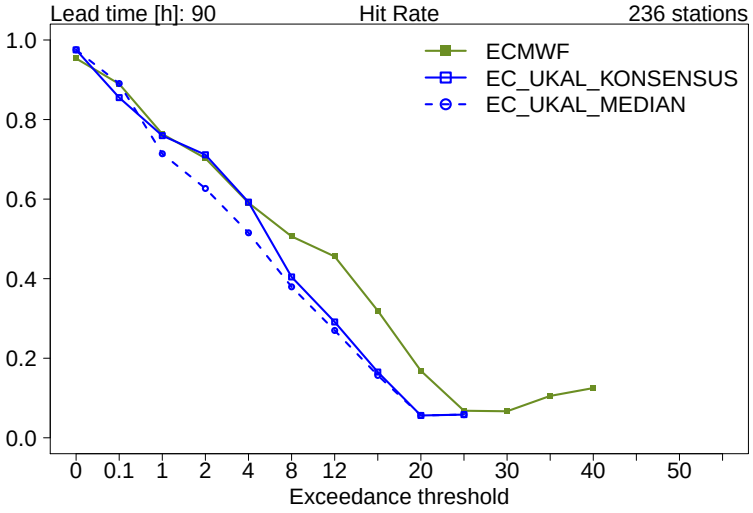


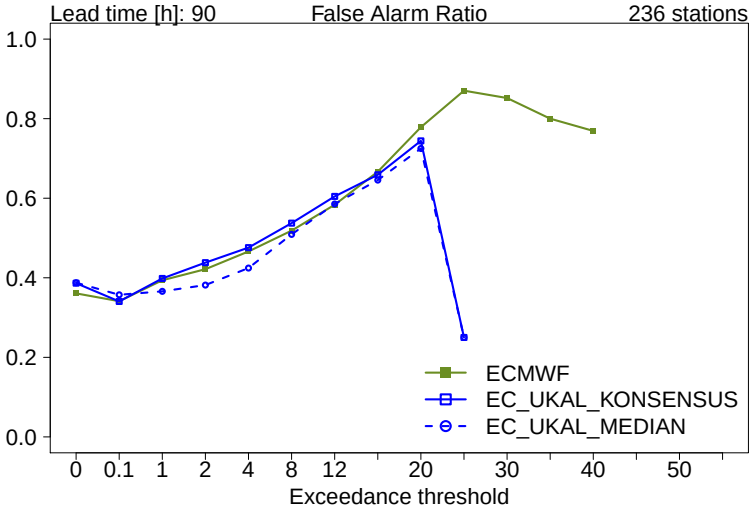


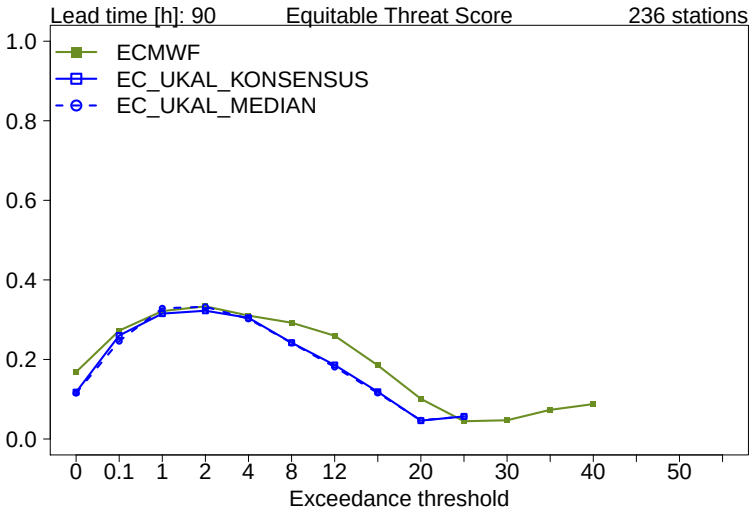

Lead time [h]: 78
Hit Rate
236 stations
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
1.0
0.8
0.6
0.4
0.2
0.0
0 0.1 1 2 4 8 12 20 30 40 50
Exceedance threshold

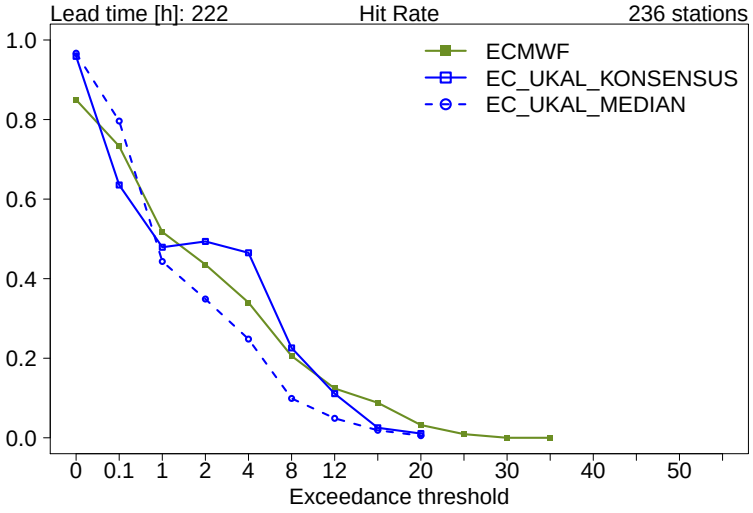

Lead time [h]: 78
False Alarm Ratio
236 stations
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
1.0
0.8
0.6
0.4
0.2
0.0
0 0.1 1 2 4 8 12 20 30 40 50
Exceedance threshold

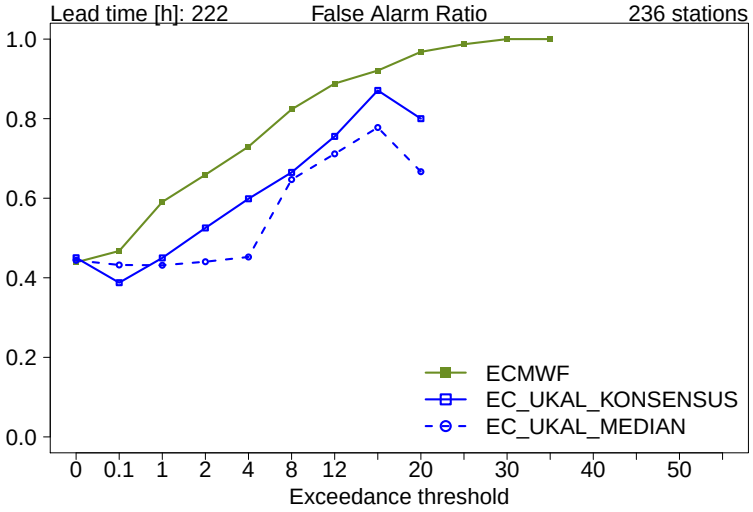

Lead time [h]: 78
Equitable Threat Score
236 stations
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
1.0
0.8
0.6
0.4
0.2
0.0
0 0.1 1 2 4 8 12 20 30 40 50
Exceedance threshold

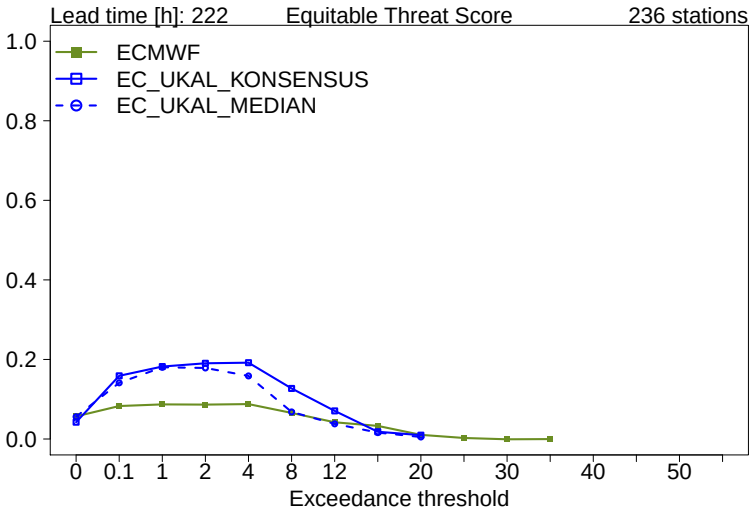

Lead time [h]: 90
Hit Rate
236 stations
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
1.0
0.8
0.6
0.4
0.2
0.0
0 0.1 1 2 4 8 12 20 30 40 50
Exceedance threshold

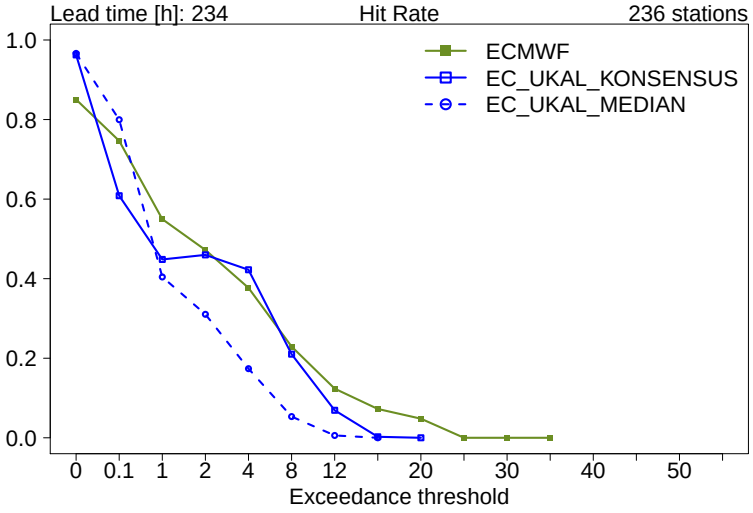

Lead time [h]: 90
False Alarm Ratio
236 stations
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
1.0
0.8
0.6
0.4
0.2
0.0
0 0.1 1 2 4 8 12 20 30 40 50
Exceedance threshold

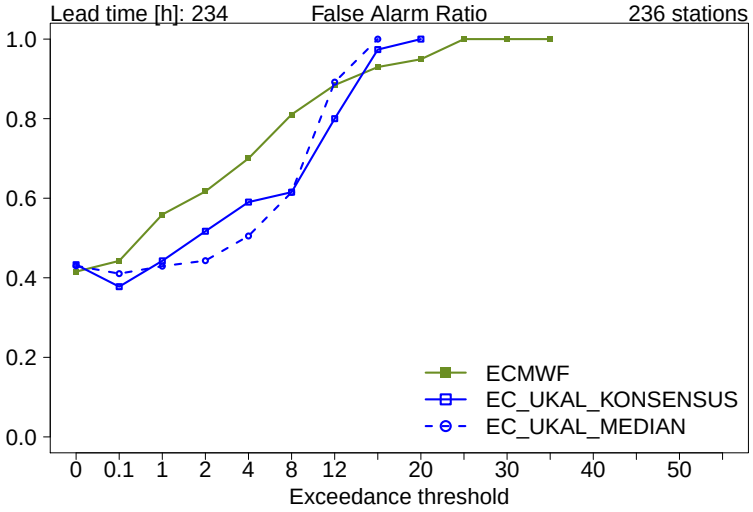

Lead time [h]: 90
Equitable Threat Score
236 stations
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
1.0
0.8
0.6
0.4
0.2
0.0
0 0.1 1 2 4 8 12 20 30 40 50
Exceedance threshold

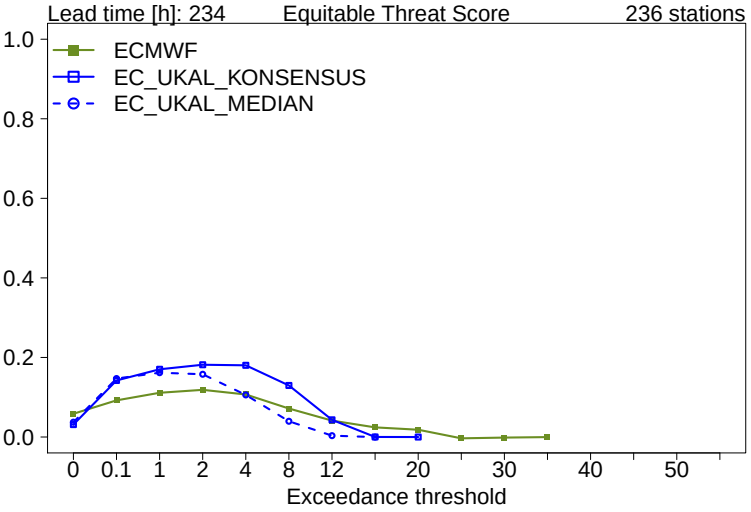

Lead time [h]: 222
Hit Rate
236 stations
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
1.0
0.8
0.6
0.4
0.2
0.0
0 0.1 1 2 4 8 12 20 30 40 50
Exceedance threshold


Lead time [h]: 222
False Alarm Ratio
236 stations
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
1.0
0.8
0.6
0.4
0.2
0.0
0 0.1 1 2 4 8 12 20 30 40 50
Exceedance threshold

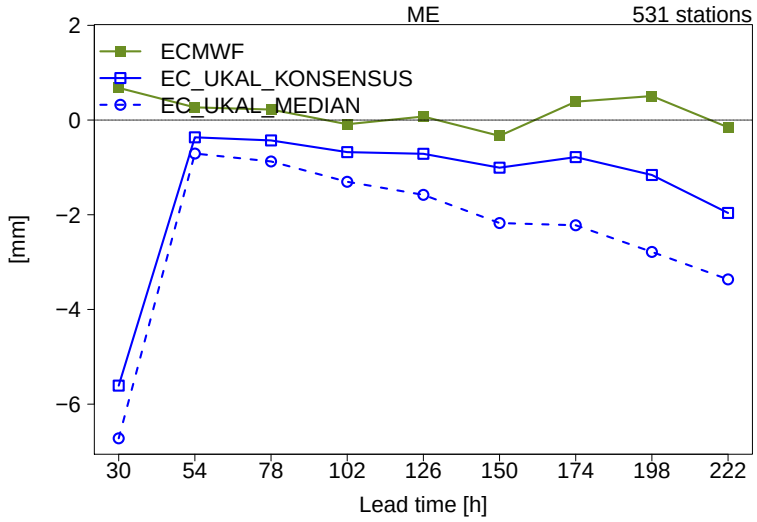

Lead time [h]: 222
Equitable Threat Score
236 stations
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
1.0
0.8
0.6
0.4
0.2
0.0
0 0.1 1 2 4 8 12 20 30 40 50
Exceedance threshold

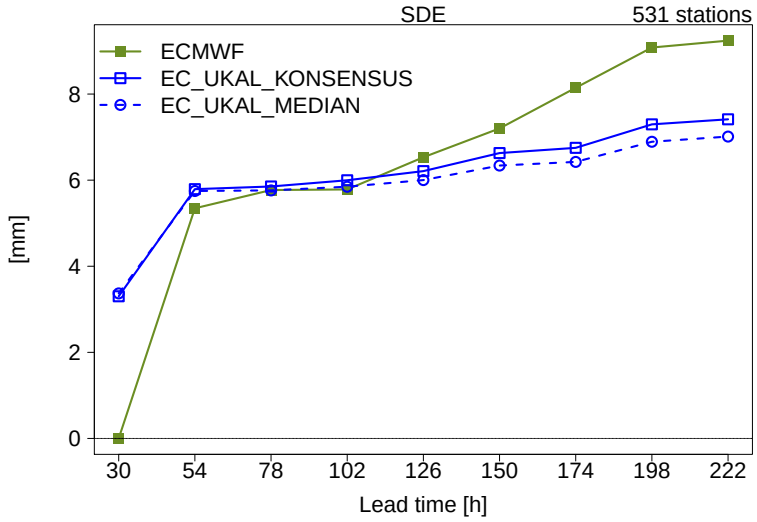

Lead time [h]: 234
Hit Rate
236 stations
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
1.0
0.8
0.6
0.4
0.2
0.0
0 0.1 1 2 4 8 12 20 30 40 50
Exceedance threshold

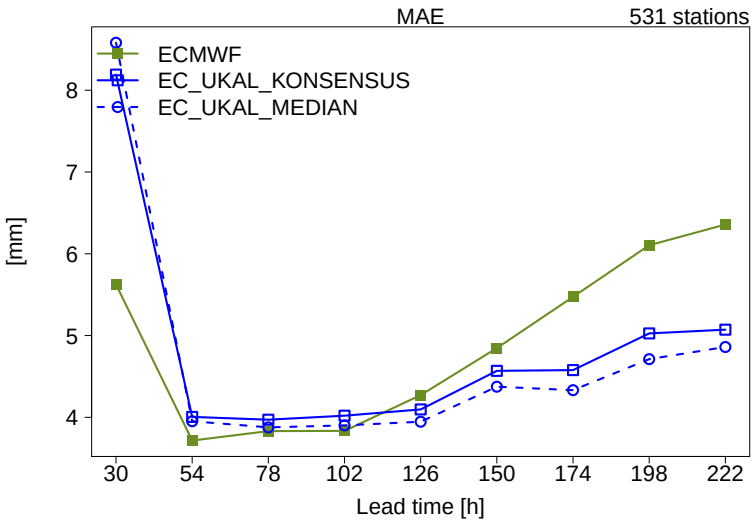

Lead time [h]: 234
False Alarm Ratio
236 stations
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
1.0
0.8
0.6
0.4
0.2
0.0
0 0.1 1 2 4 8 12 20 30 40 50
Exceedance threshold

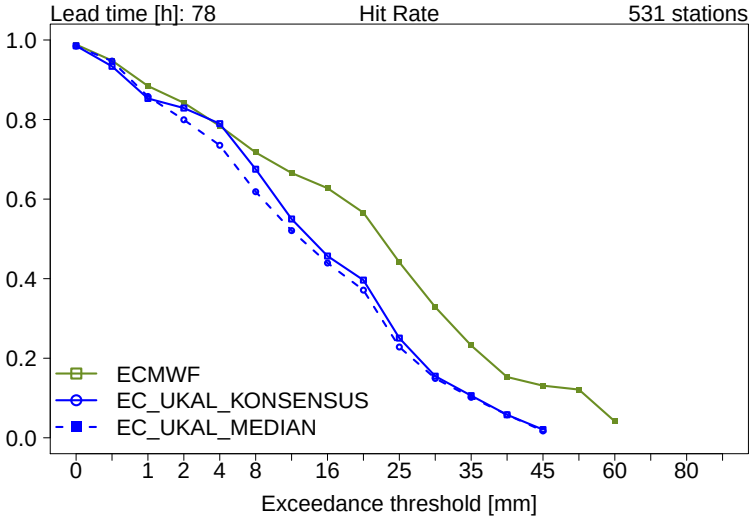

Lead time [h]: 234
Equitable Threat Score
236 stations
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
1.0
0.8
0.6
0.4
0.2
0.0
0 0.1 1 2 4 8 12 20 30 40 50
Exceedance threshold

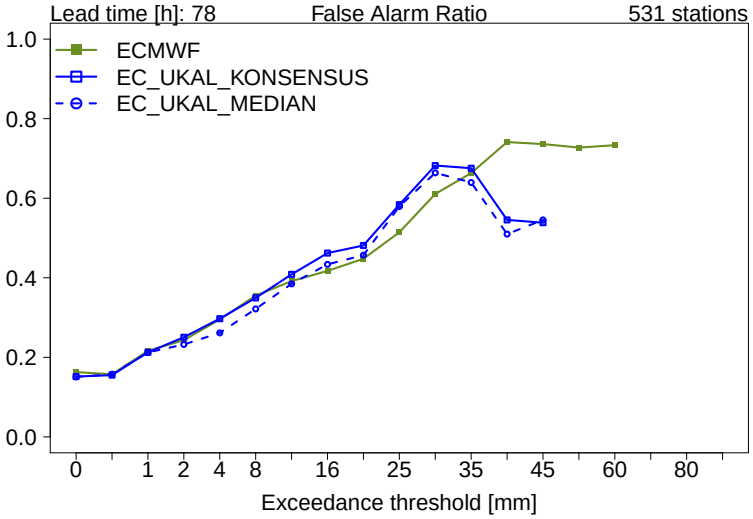
8.4 24h Precipitation

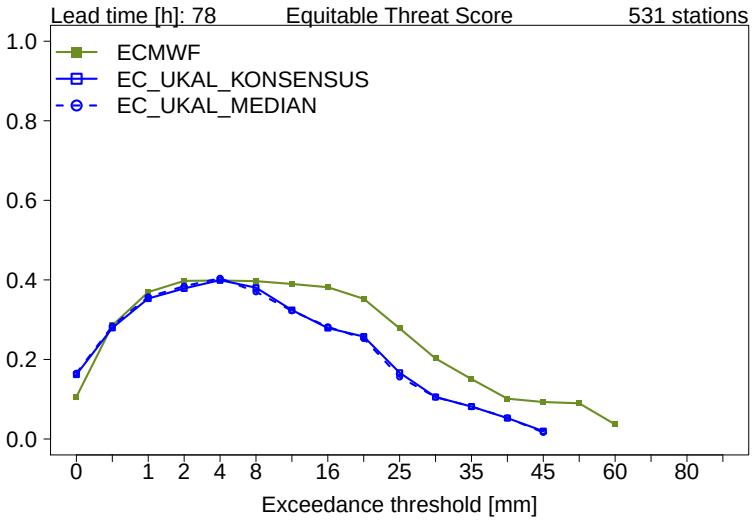


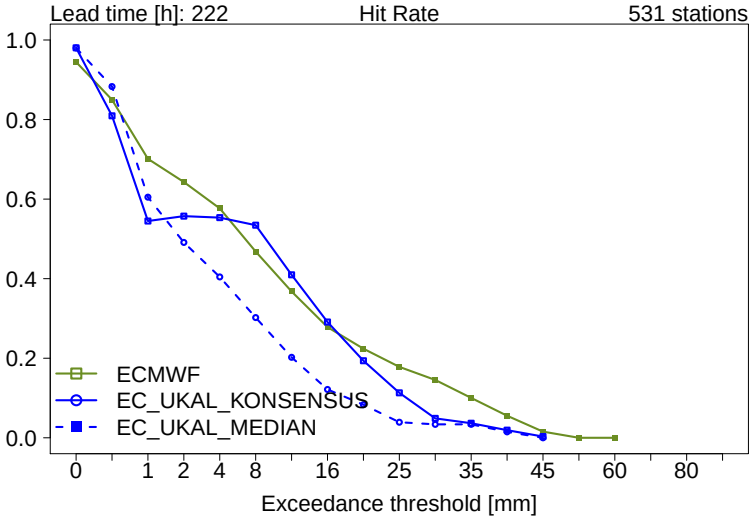


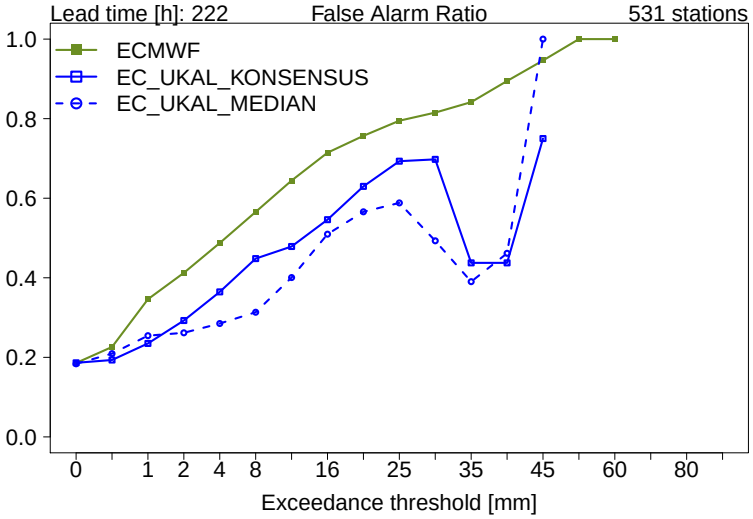


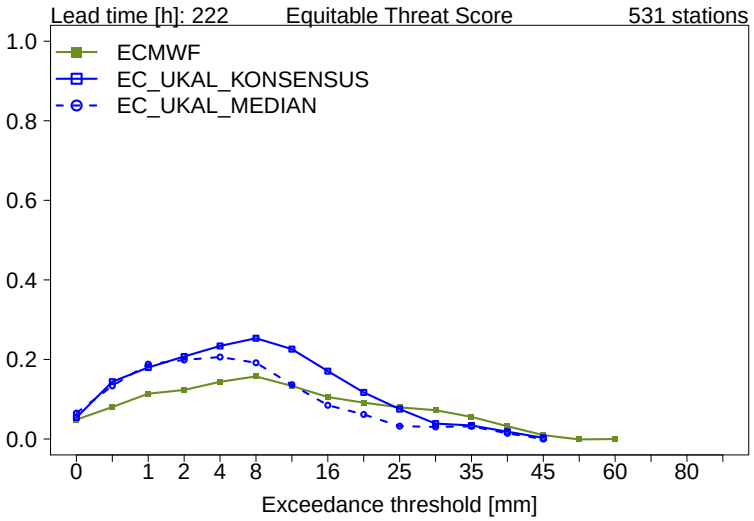

Lead time [h]: 78
Hit Rate
531 stations
1.0
0.8
0.6
0.4
0.2
0.0
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
0 1 2 4 8 16 25 35 45 60 80
Exceedance threshold [mm]


Lead time [h]: 78
False Alarm Ratio
531 stations
1.0
0.8
0.6
0.4
0.2
0.0
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
0 1 2 4 8 16 25 35 45 60 80
Exceedance threshold [mm]


Lead time [h]: 78
Equitable Threat Score
531 stations
1.0
0.8
0.6
0.4
0.2
0.0
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
0 1 2 4 8 16 25 35 45 60 80
Exceedance threshold [mm]


Lead time [h]: 222
Hit Rate
531 stations
1.0
0.8
0.6
0.4
0.2
0.0
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
0 1 2 4 8 16 25 35 45 60 80
Exceedance threshold [mm]

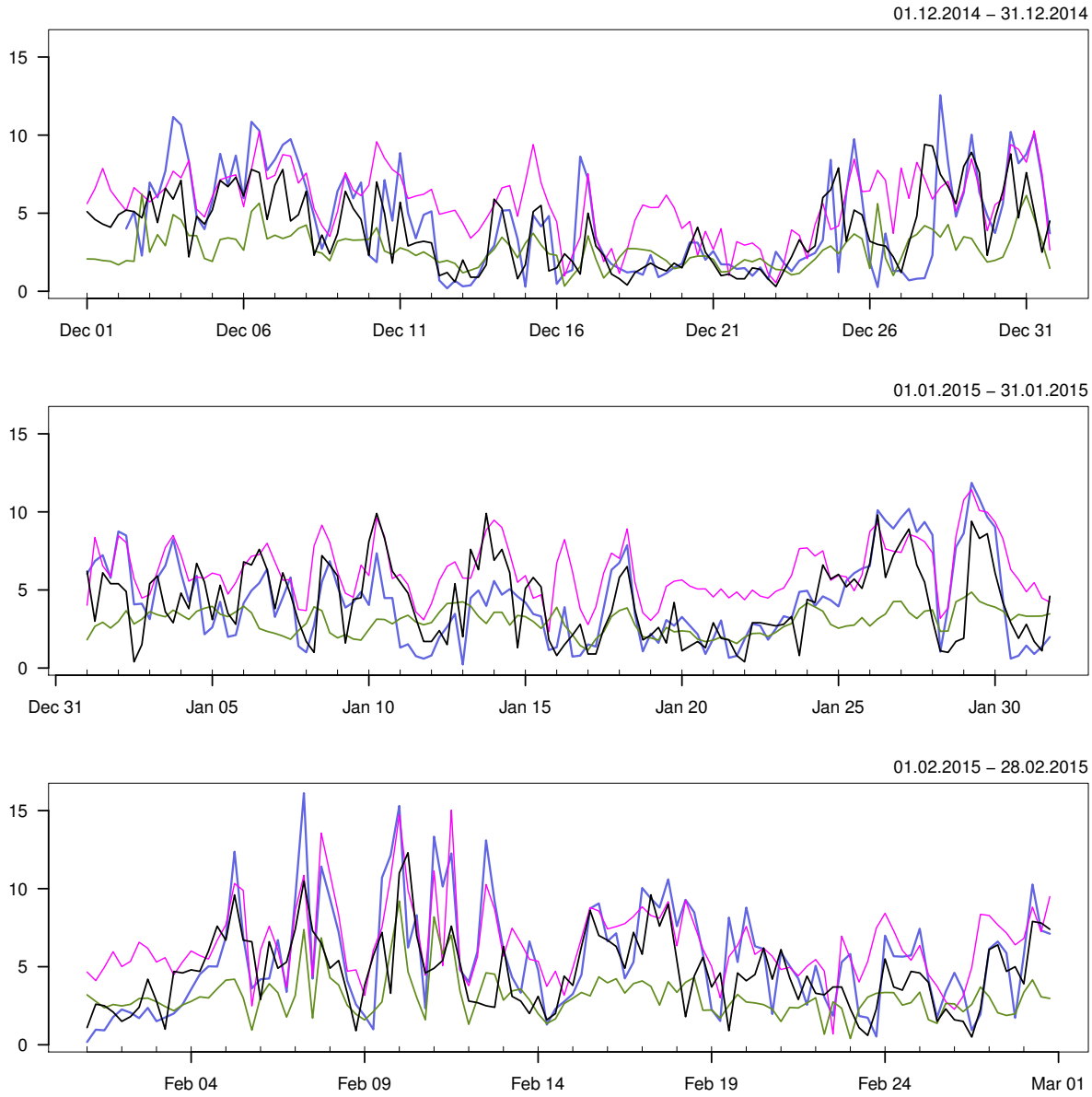

Lead time [h]: 222
False Alarm Ratio
531 stations
1.0
0.8
0.6
0.4
0.2
0.0
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
0 1 2 4 8 16 25 35 45 60 80
Exceedance threshold [mm]


Lead time [h]: 222
Equitable Threat Score
531 stations
1.0
0.8
0.6
0.4
0.2
0.0
ECMWF
EC_UKAL_KONSENSUS
EC_UKAL_MEDIAN
0 1 2 4 8 16 25 35 45 60 80
Exceedance threshold [mm]

9 Appendix

9.1 10m Wind speed

TROMSØ

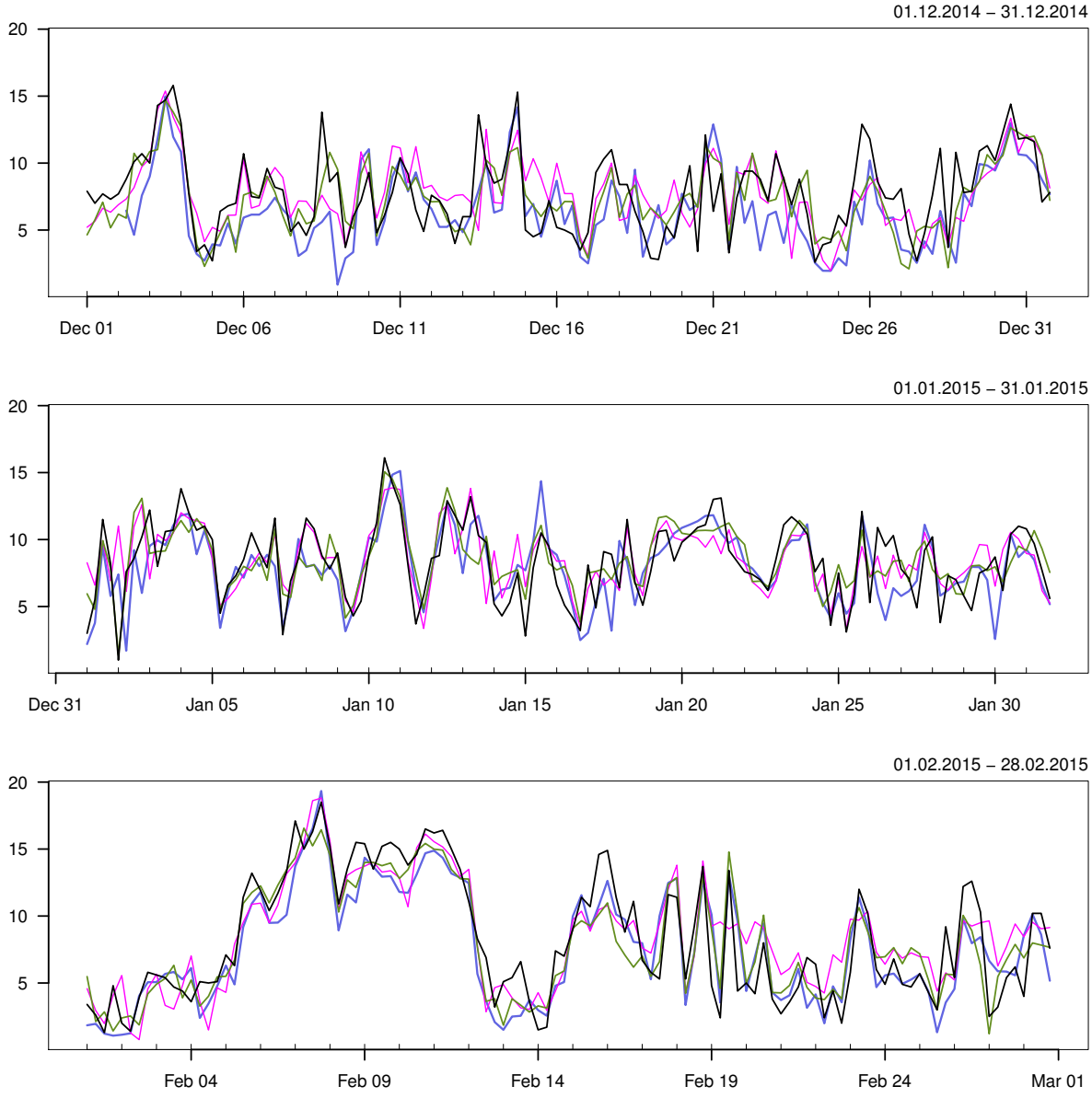


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.3	4.3	12.3	2.4	360
AM25: 12+18,+24,+30,+36	0.2	4.7	16.1	3.1	355
Hirlam8: 12+18,+24,+30,+36	0.6	6.1	15	2.2	360
ECMWF: 12+18,+24,+30,+36	0.3	2.9	9.2	1.1	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.5	2.5	2.5	1.8	10.6	355
Hirlam8 – synop	1.9	2.1	2.8	2.2	8.9	360
ECMWF – synop	–1.3	2.1	2.5	2	7.6	360

ØRLAND

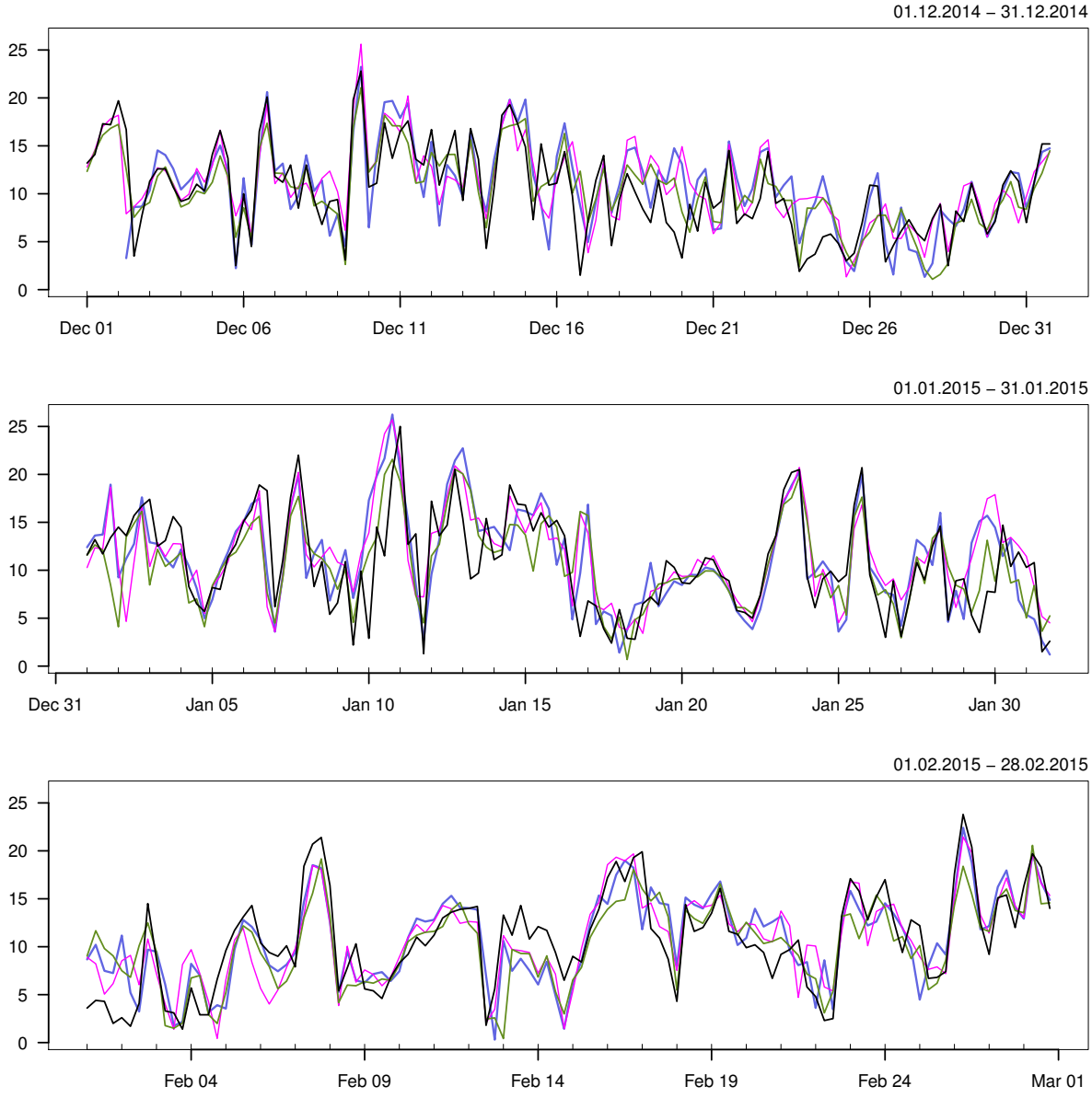


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	1	8.2	18.5	3.5	360
AM25: 12+18,+24,+30,+36	0.9	7.4	19.3	3.4	355
Hirlam8: 12+18,+24,+30,+36	0.8	8.2	18.8	3	360
ECMWF: 12+18,+24,+30,+36	1.2	8	16.6	3.1	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	–0.8	2.3	2.4	1.9	8.4	355
Hirlam8 – synop	0.1	2.3	2.3	1.8	10	360
ECMWF – synop	–0.2	2	2	1.6	6.4	360

YTTERØYANE FYR

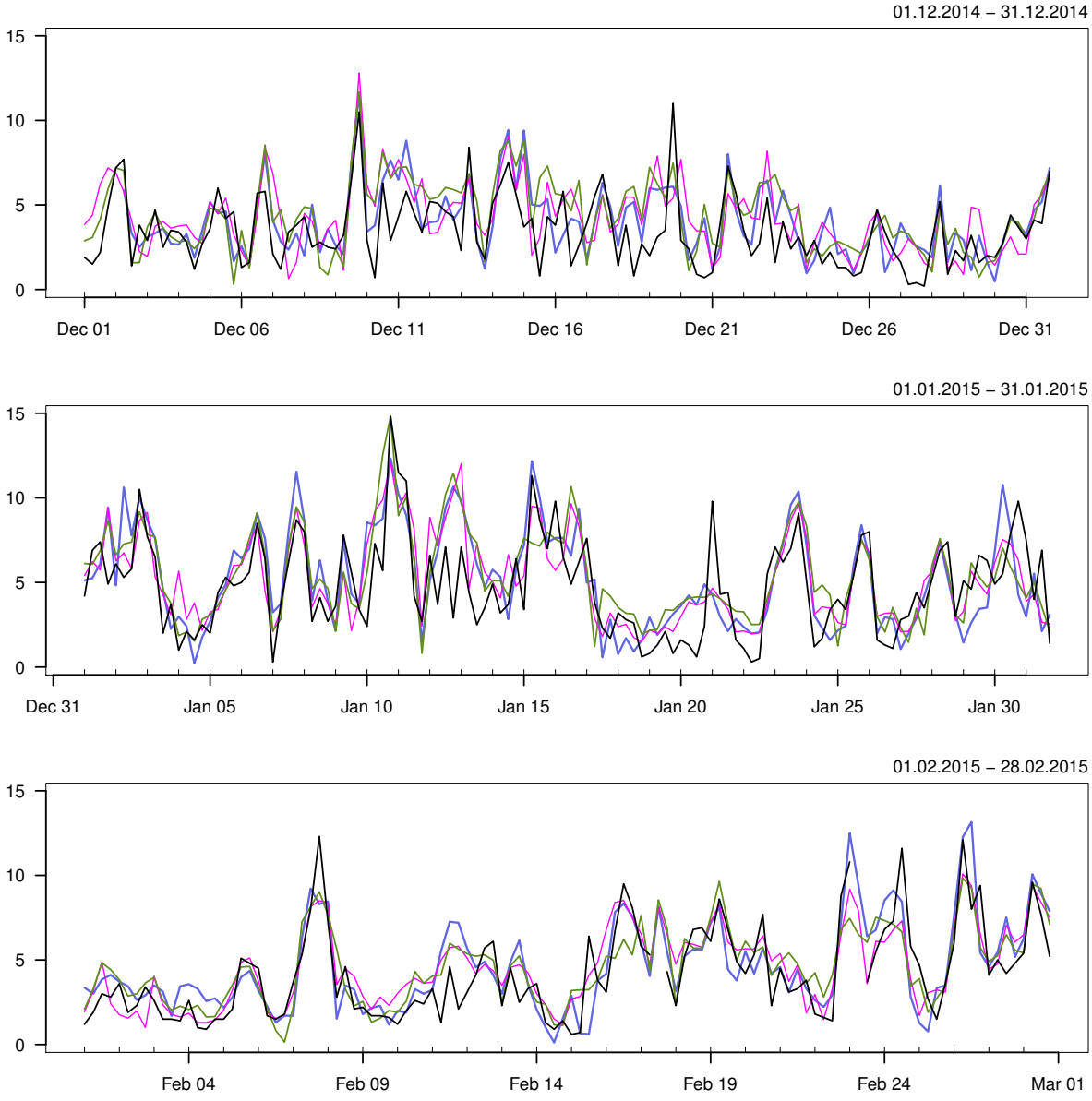


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	1.3	10.6	25	4.9	360
AM25: 12+18,+24,+30,+36	0.3	11	26.2	4.7	355
Hirlam8: 12+18,+24,+30,+36	0.4	11.1	25.7	4.4	360
ECMWF: 12+18,+24,+30,+36	0.4	10.4	21.6	4.2	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.4	3.4	3.5	2.6	14.4	355
Hirlam8 – synop	0.5	3.4	3.4	2.5	12.9	360
ECMWF – synop	–0.2	3.1	3.1	2.2	13	360

BERGEN – FLORIDA

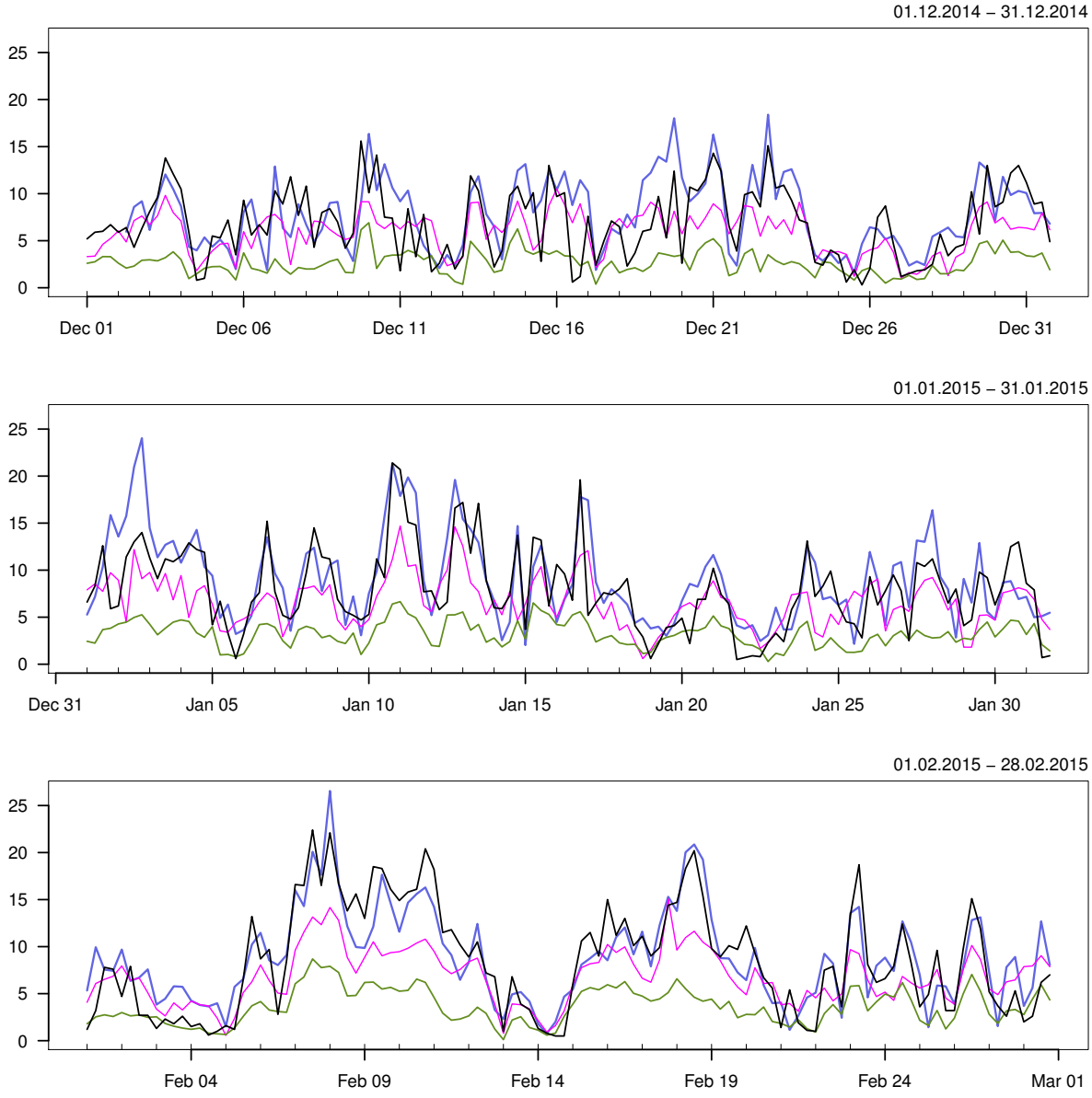


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.2	4.1	14.8	2.6	358
AM25: 12+18,+24,+30,+36	0.1	4.6	13.2	2.6	355
Hirlam8: 12+18,+24,+30,+36	0.6	4.7	12.8	2.3	360
ECMWF: 12+18,+24,+30,+36	0.1	4.8	14.9	2.4	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.5	1.9	2	1.5	7.8	353
Hirlam8 – synop	0.5	1.8	1.9	1.5	7.4	358
ECMWF – synop	0.7	1.9	2	1.5	8.6	358

FINSEVATN

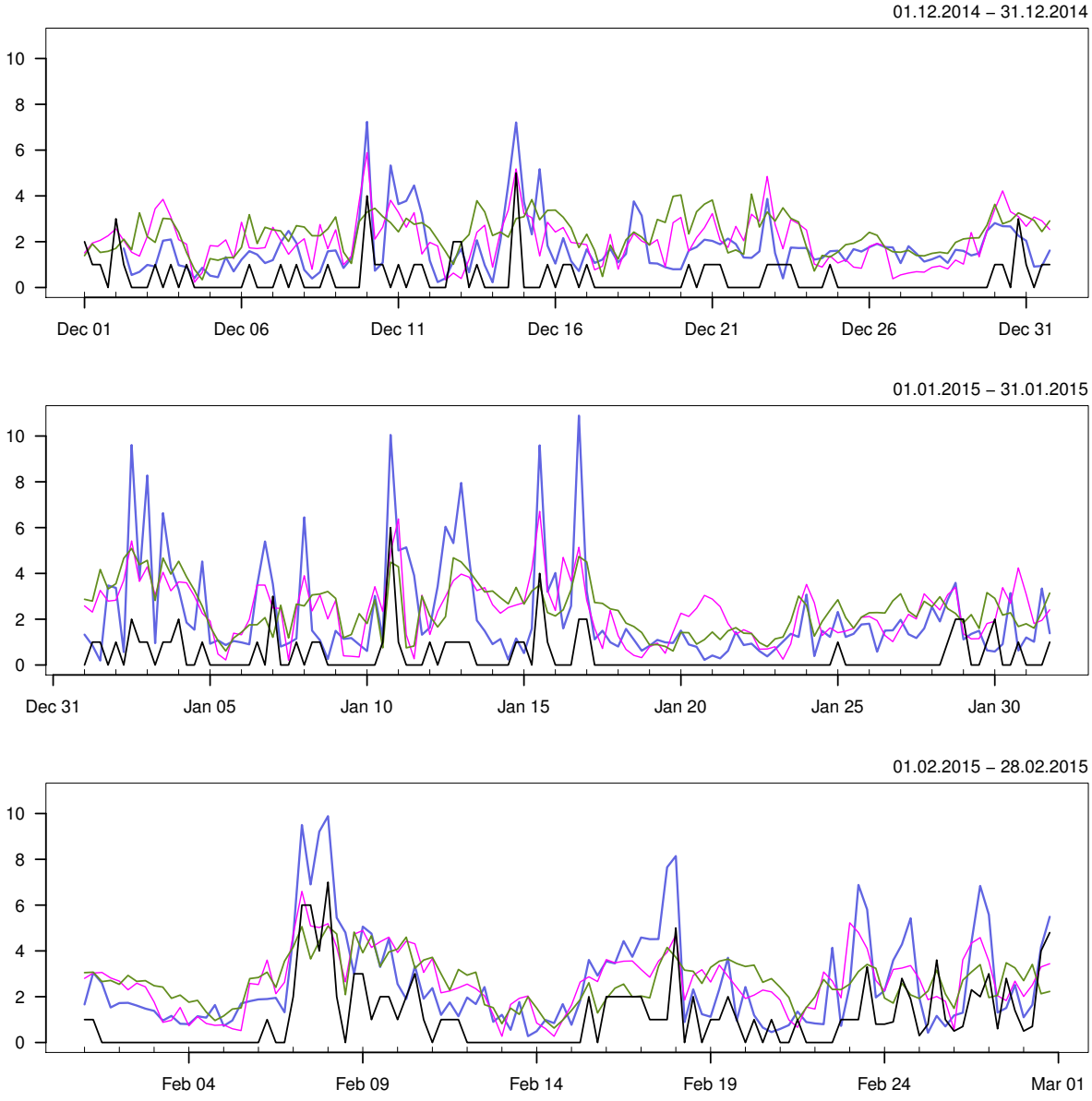


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.3	7.8	22.4	4.7	360
AM25: 12+18,+24,+30,+36	0.8	8.6	26.5	4.5	355
Hirlam8: 12+18,+24,+30,+36	0.6	6.4	15.1	2.6	360
ECMWF: 12+18,+24,+30,+36	0.1	3.2	8.7	1.6	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.8	3.1	3.2	2.5	12.2	355
Hirlam8 – synop	−1.4	3.2	3.5	2.8	10.2	360
ECMWF – synop	−4.6	3.6	5.9	4.8	15.6	360

NESBYEN



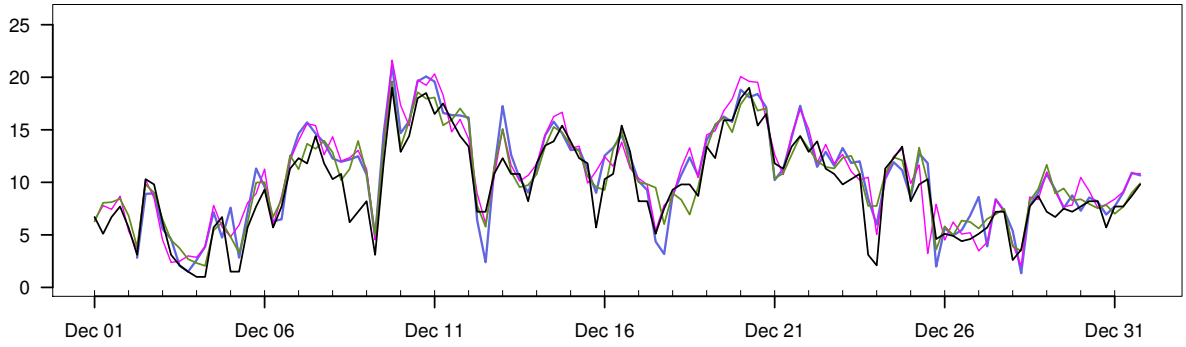
01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0	0.6	7	1.1	360
AM25: 12+18,+24,+30,+36	0.2	2.2	10.9	1.9	355
Hirlam8: 12+18,+24,+30,+36	0.2	2.4	6.7	1.2	360
ECMWF: 12+18,+24,+30,+36	0.3	2.5	5.1	1	360

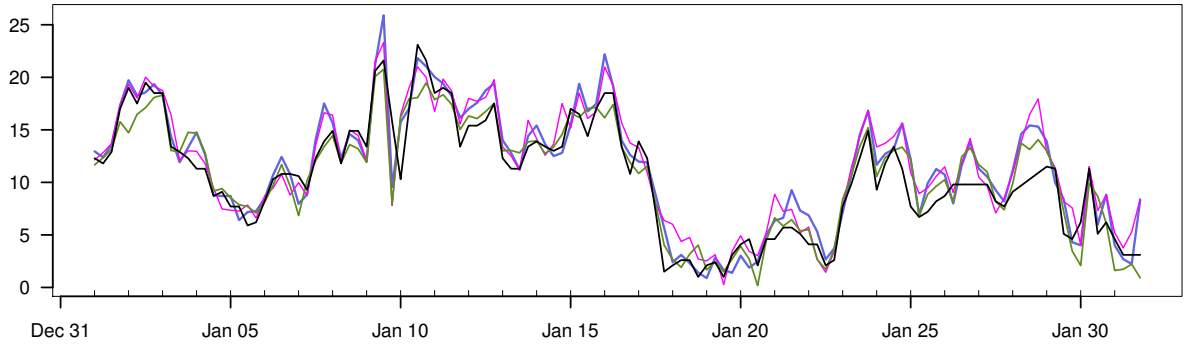
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	1.5	1.4	2.1	1.6	8.9	355
Hirlam8 – synop	1.7	1.1	2	1.8	5.4	360
ECMWF – synop	1.8	1.1	2.1	1.9	4.7	360

EKOFISK

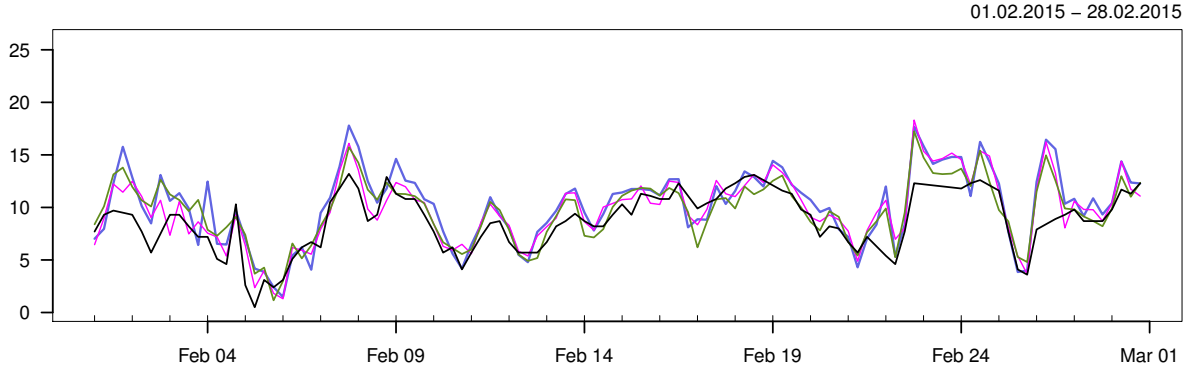
01.12.2014 – 31.12.2014



01.01.2015 – 31.01.2015



01.02.2015 – 28.02.2015

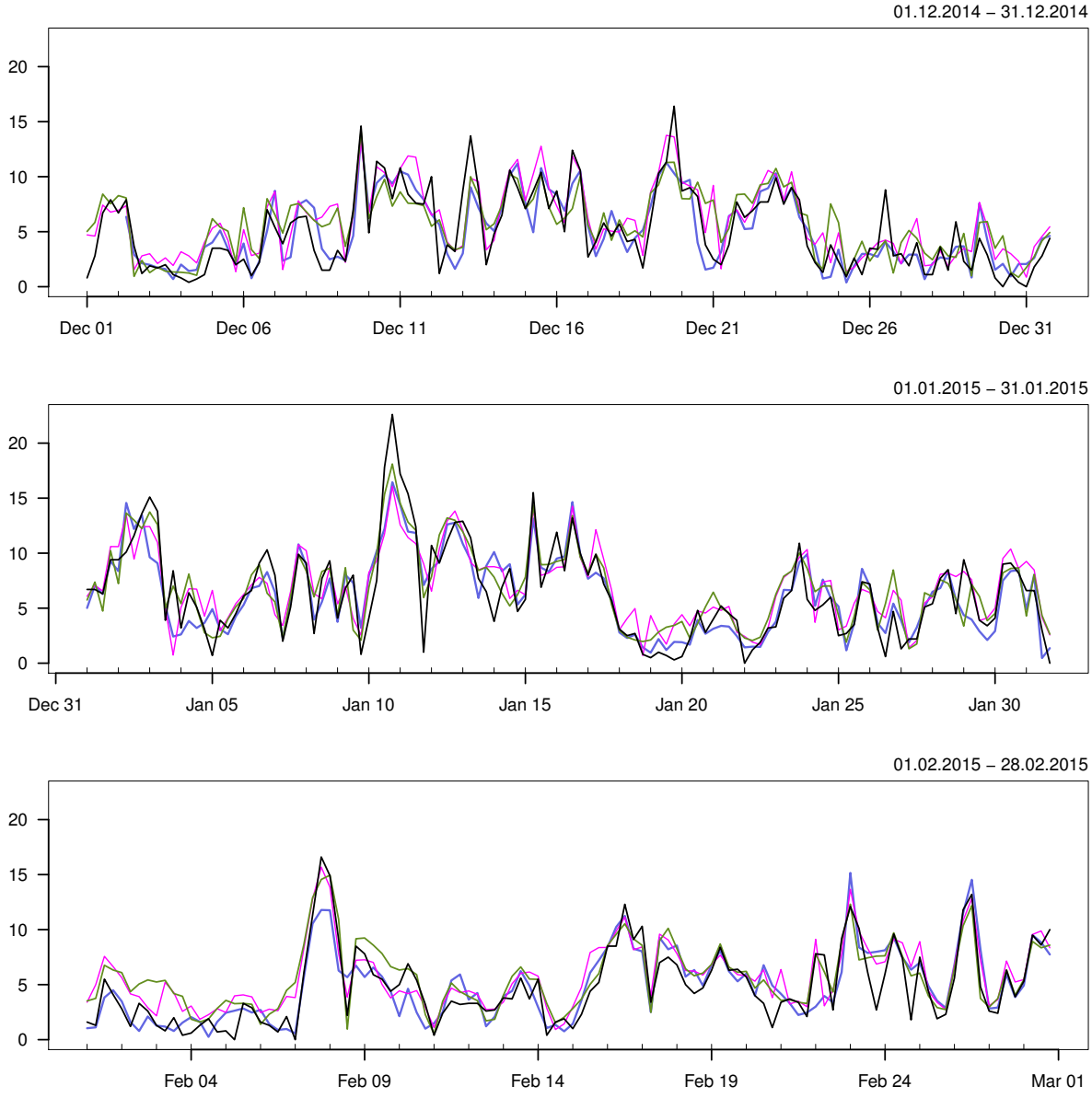


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.5	9.6	23.1	4.3	360
AM25: 12+18,+24,+30,+36	0.9	10.8	25.9	4.6	355
Hirlam8: 12+18,+24,+30,+36	0.3	10.7	23.3	4.5	360
ECMWF: 12+18,+24,+30,+36	0.2	10.2	20.8	4.1	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	1.1	1.9	2.2	1.7	8	355
Hirlam8 – synop	1.1	1.8	2.2	1.6	8	360
ECMWF – synop	0.6	1.8	1.9	1.4	7.9	360

SOLA

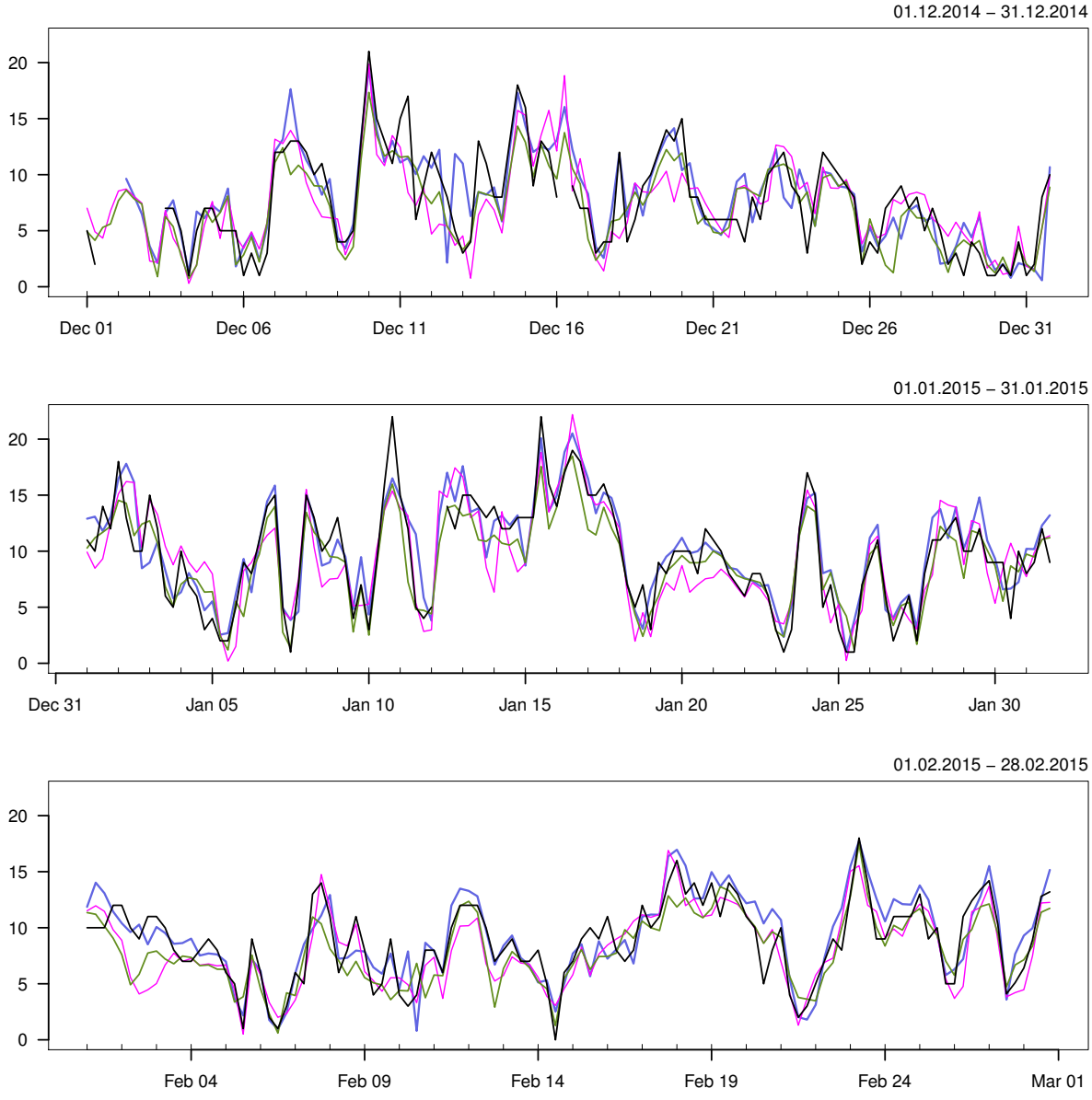


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0	5.5	22.6	3.8	360
AM25: 12+18,+24,+30,+36	0.3	5.4	16.4	3.4	355
Hirlam8: 12+18,+24,+30,+36	0.7	6.2	16.1	3.2	360
ECMWF: 12+18,+24,+30,+36	0.5	6.1	18.1	3.1	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0	1.9	1.9	1.4	6.3	355
Hirlam8 – synop	0.8	2	2.1	1.6	8	360
ECMWF – synop	0.7	1.9	2	1.5	6	360

FERDER FYR

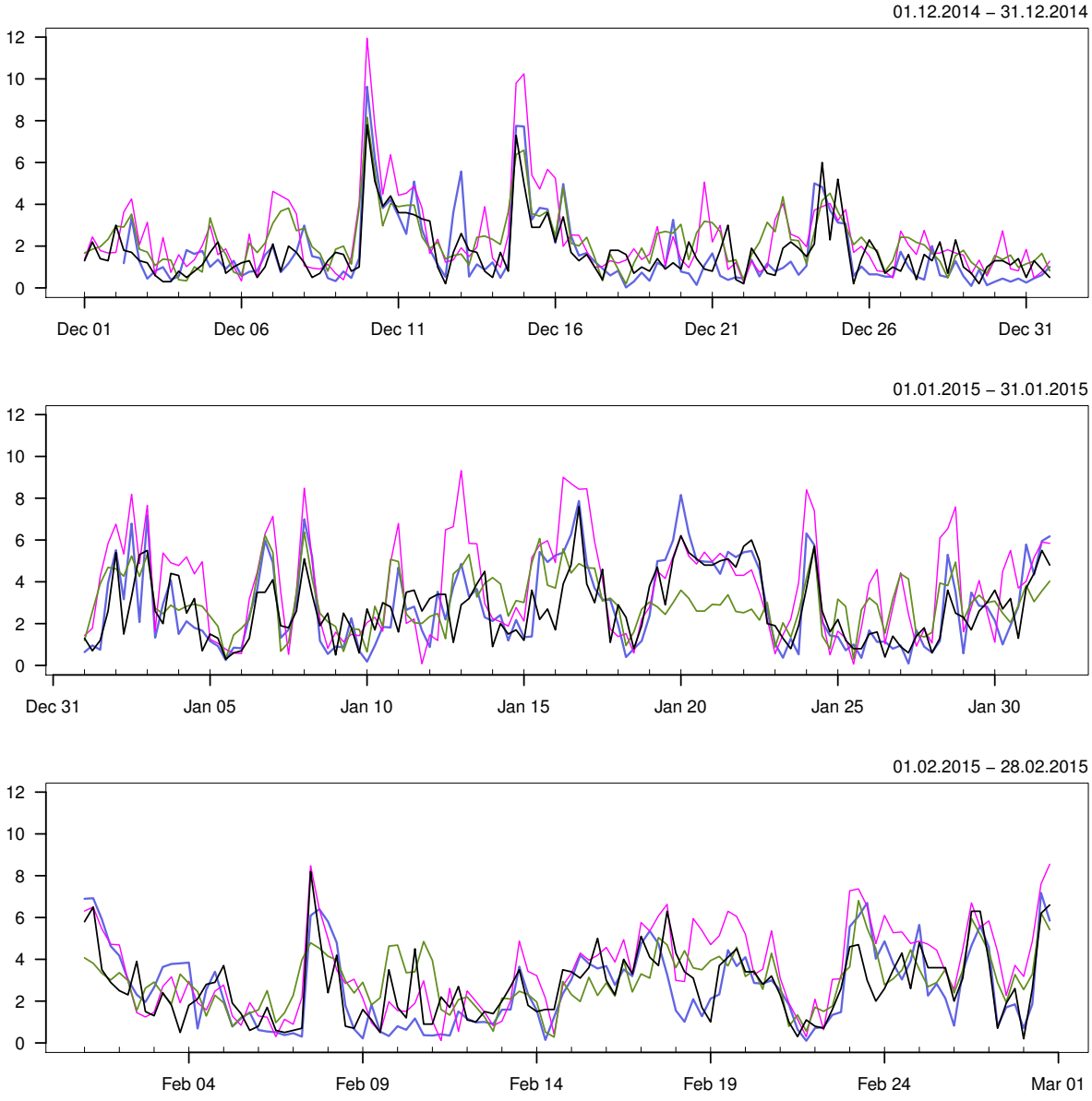


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0	8.7	22	4.2	350
AM25: 12+18,+24,+30,+36	0.6	9.1	20.5	4.1	355
Hirlam8: 12+18,+24,+30,+36	0.2	8.3	22.2	4	360
ECMWF: 12+18,+24,+30,+36	0.6	8	18.5	3.6	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.4	2.2	2.2	1.7	8	348
Hirlam8 – synop	–0.4	2.4	2.4	1.9	8.6	350
ECMWF – synop	–0.7	2	2.1	1.6	6.8	350

OSLO – BLINDERN

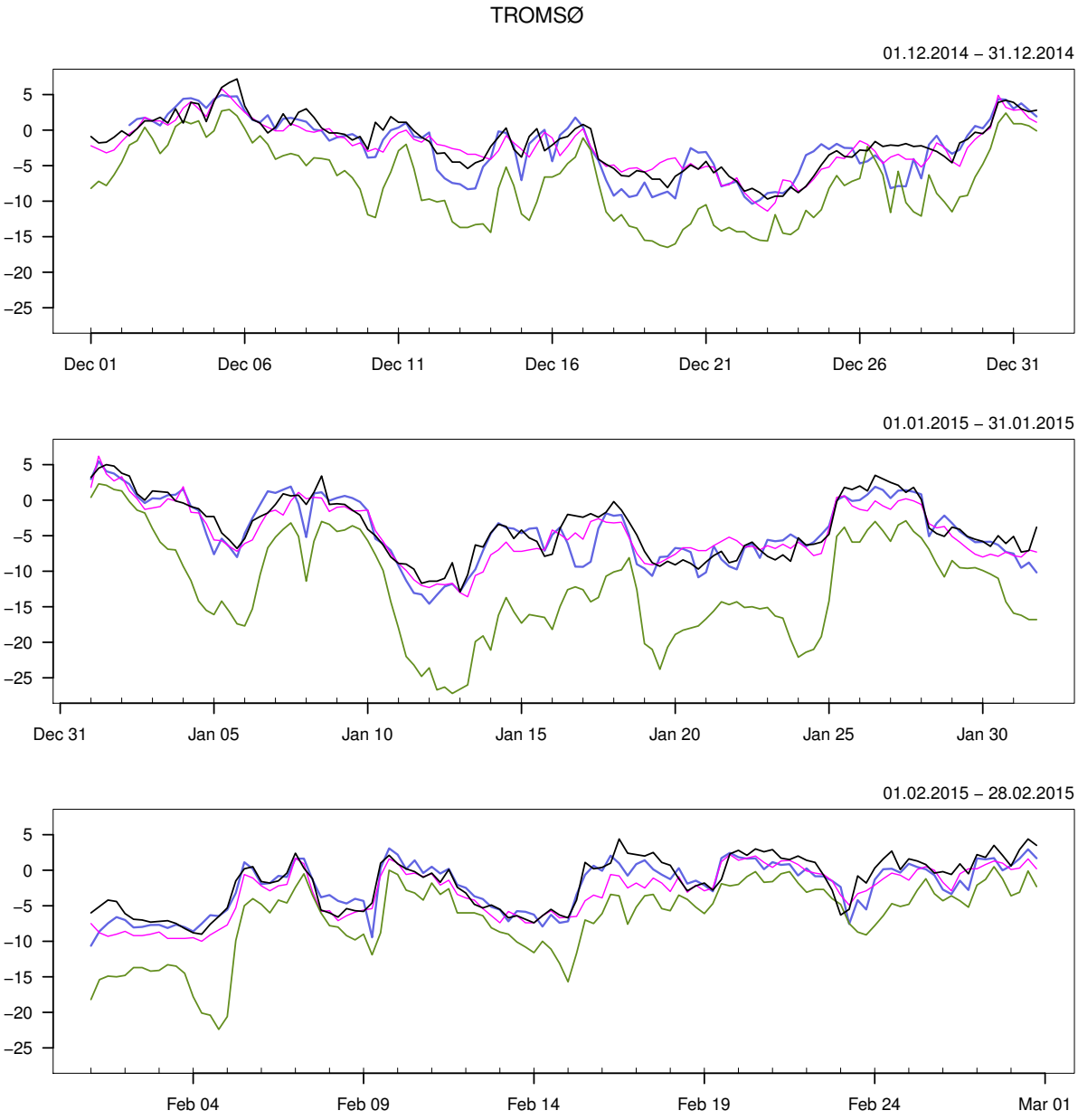


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.2	2.4	8.2	1.6	360
AM25: 12+18,+24,+30,+36	0	2.4	9.6	2	355
Hirlam8: 12+18,+24,+30,+36	0.1	3.2	11.9	2.2	360
ECMWF: 12+18,+24,+30,+36	0.2	2.7	8.2	1.4	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0	1.2	1.2	0.9	3.7	355
Hirlam8 – synop	0.8	1.5	1.8	1.3	6.4	360
ECMWF – synop	0.3	1.3	1.4	1.1	3.9	360

9.2 Temperature 2m

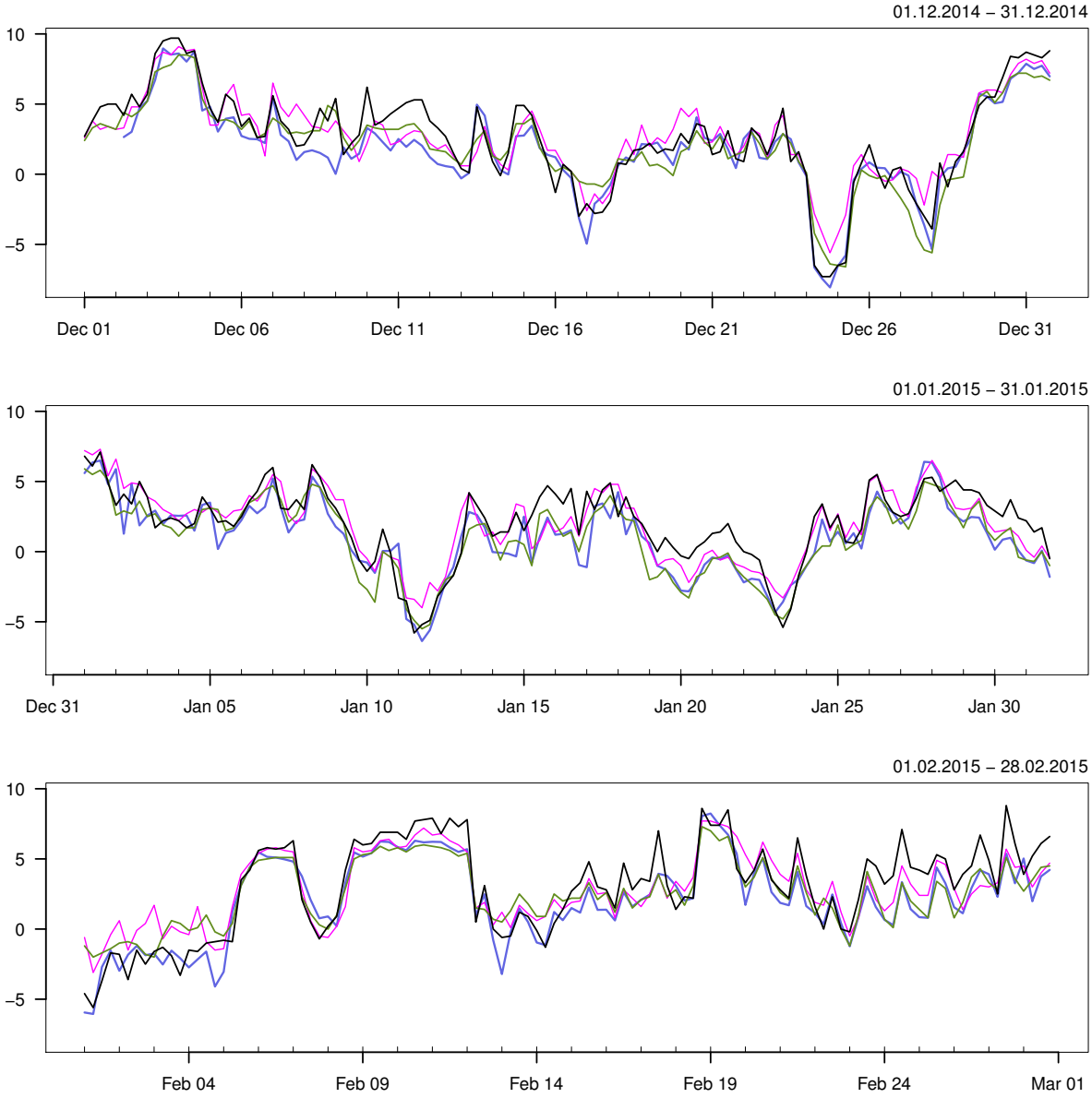


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−12.9	−2.5	7.2	4	360
AM25: 12+18,+24,+30,+36	−14.6	−3.1	5.5	4.2	355
Hirlam8: 12+18,+24,+30,+36	−13.6	−3.4	6.2	3.8	360
ECMWF: 12+18,+24,+30,+36	−27.2	−8.9	2.9	6.4	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−0.5	1.9	1.9	1.5	7.2	355
Hirlam8 – synop	−0.9	1.6	1.8	1.4	5.4	360
ECMWF – synop	−6.4	3.6	7.3	6.4	18.4	360

ØRLAND

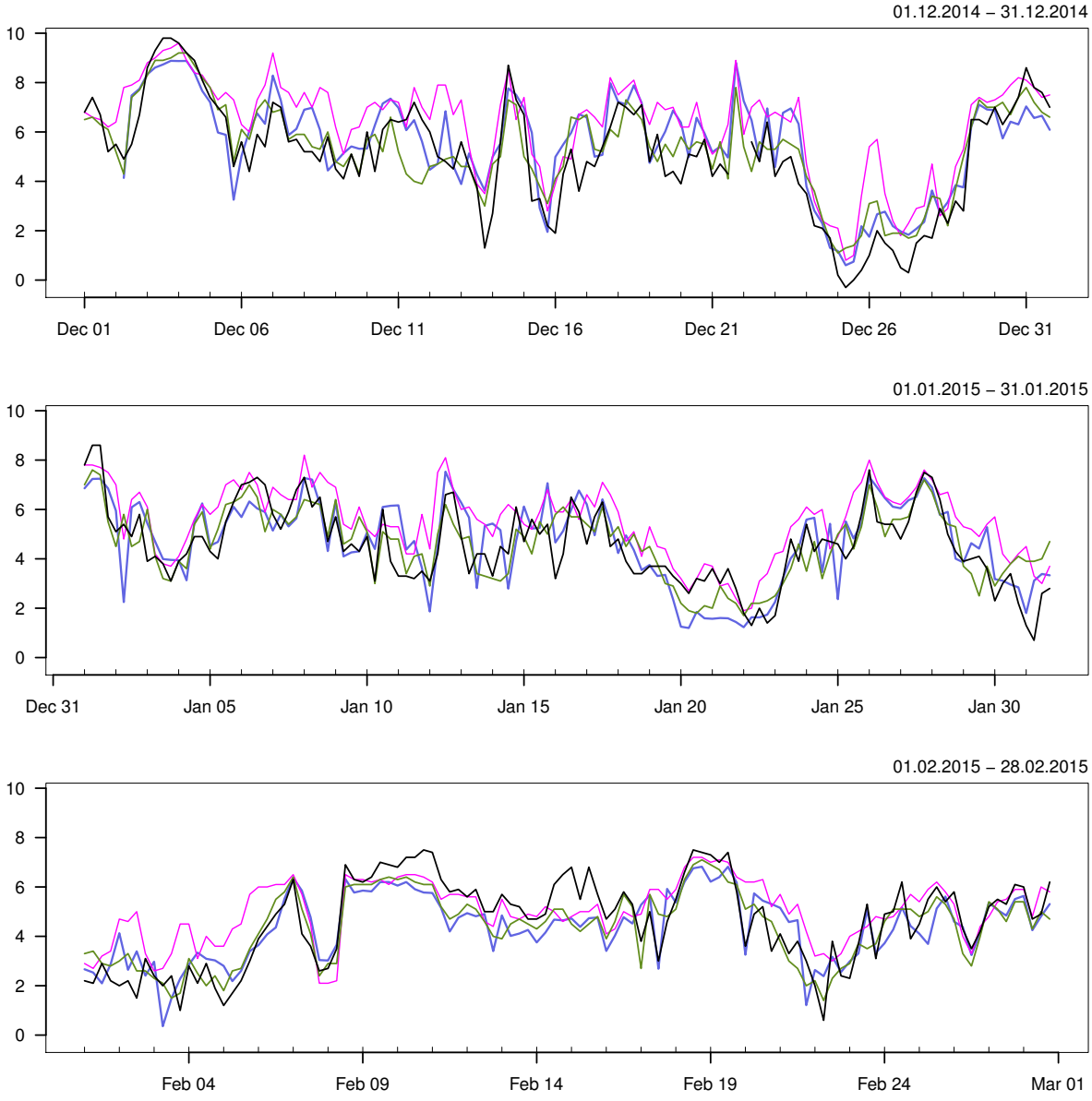


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−7.3	2.5	9.7	3.2	360
AM25: 12+18,+24,+30,+36	−8.1	1.7	9	3	355
Hirlam8: 12+18,+24,+30,+36	−5.6	2.5	9.1	2.7	360
ECMWF: 12+18,+24,+30,+36	−6.6	1.8	8.5	2.8	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−0.9	1.3	1.6	1.3	5.4	355
Hirlam8 – synop	0	1.4	1.4	1.1	4.1	360
ECMWF – synop	−0.7	1.3	1.5	1.2	3.8	360

YTTERØYANE FYR

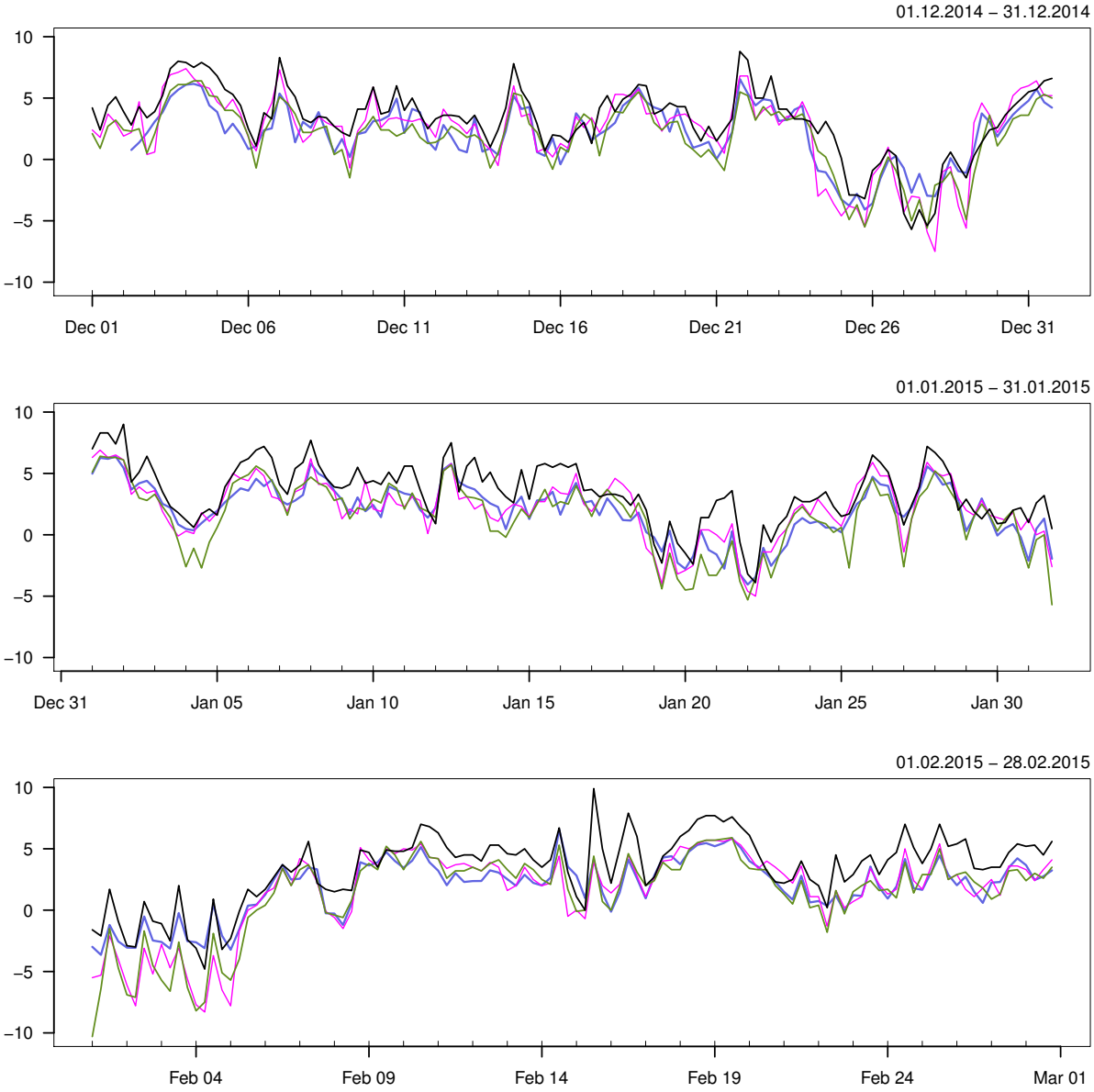


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−0.3	4.8	9.8	1.9	358
AM25: 12+18,+24,+30,+36	0.4	4.9	8.9	1.8	355
Hirlam8: 12+18,+24,+30,+36	0.8	5.7	9.6	1.6	360
ECMWF: 12+18,+24,+30,+36	1.1	4.8	9.2	1.6	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.1	1.1	1.1	0.9	3.2	353
Hirlam8 – synop	0.9	1.1	1.4	1.1	4.4	358
ECMWF – synop	0	1	1	0.7	3.2	358

BERGEN – FLORIDA

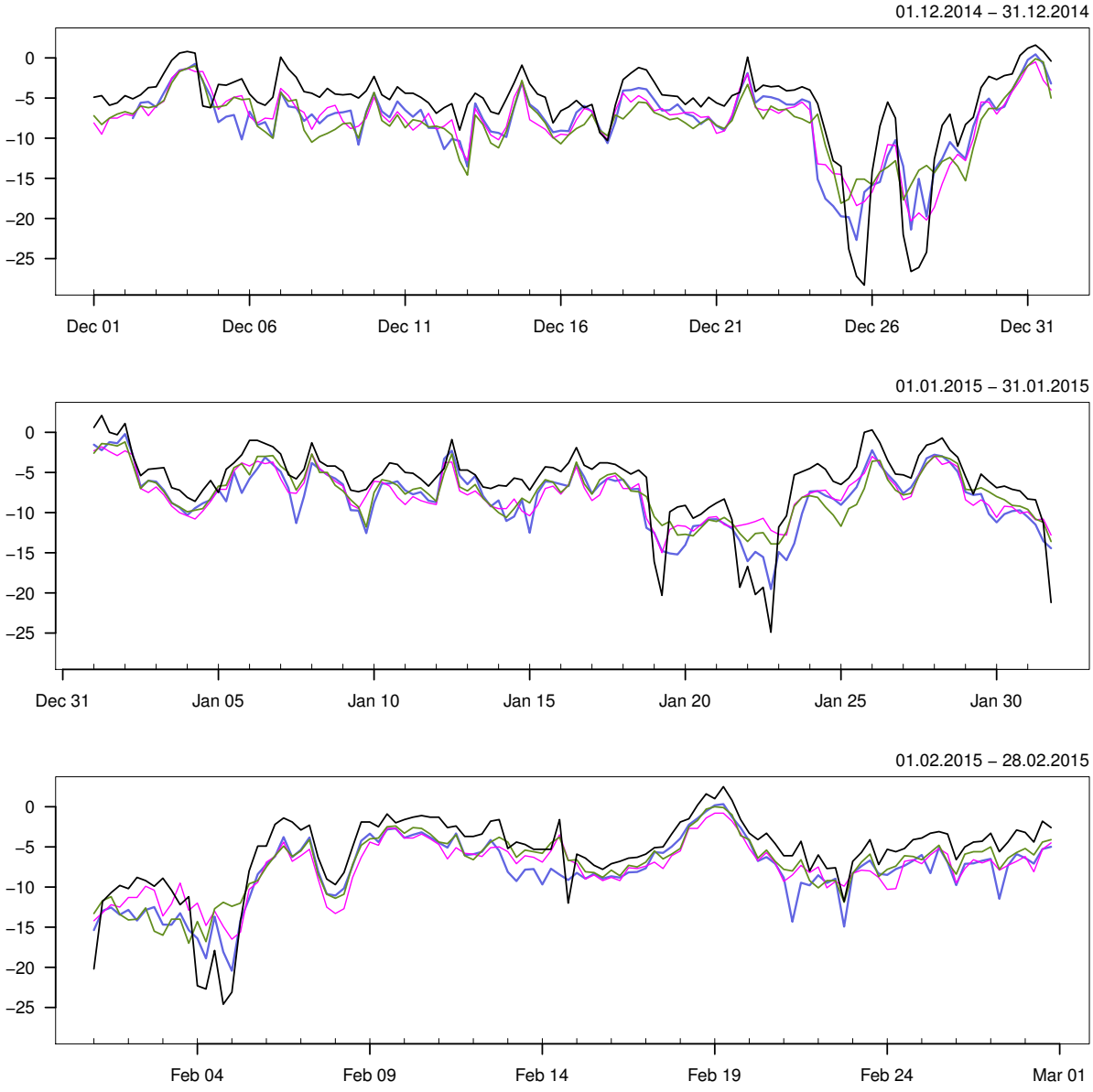


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−5.7	3.4	9.9	2.7	360
AM25: 12+18,+24,+30,+36	−4.1	2	6.6	2.3	355
Hirlam8: 12+18,+24,+30,+36	−8.3	2.1	7.4	3	360
ECMWF: 12+18,+24,+30,+36	−10.3	1.6	6.4	3	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−1.4	1.3	1.9	1.6	5.8	355
Hirlam8 – synop	−1.3	1.4	1.9	1.6	6	360
ECMWF – synop	−1.8	1.3	2.2	1.9	8.7	360

FINSEVATN

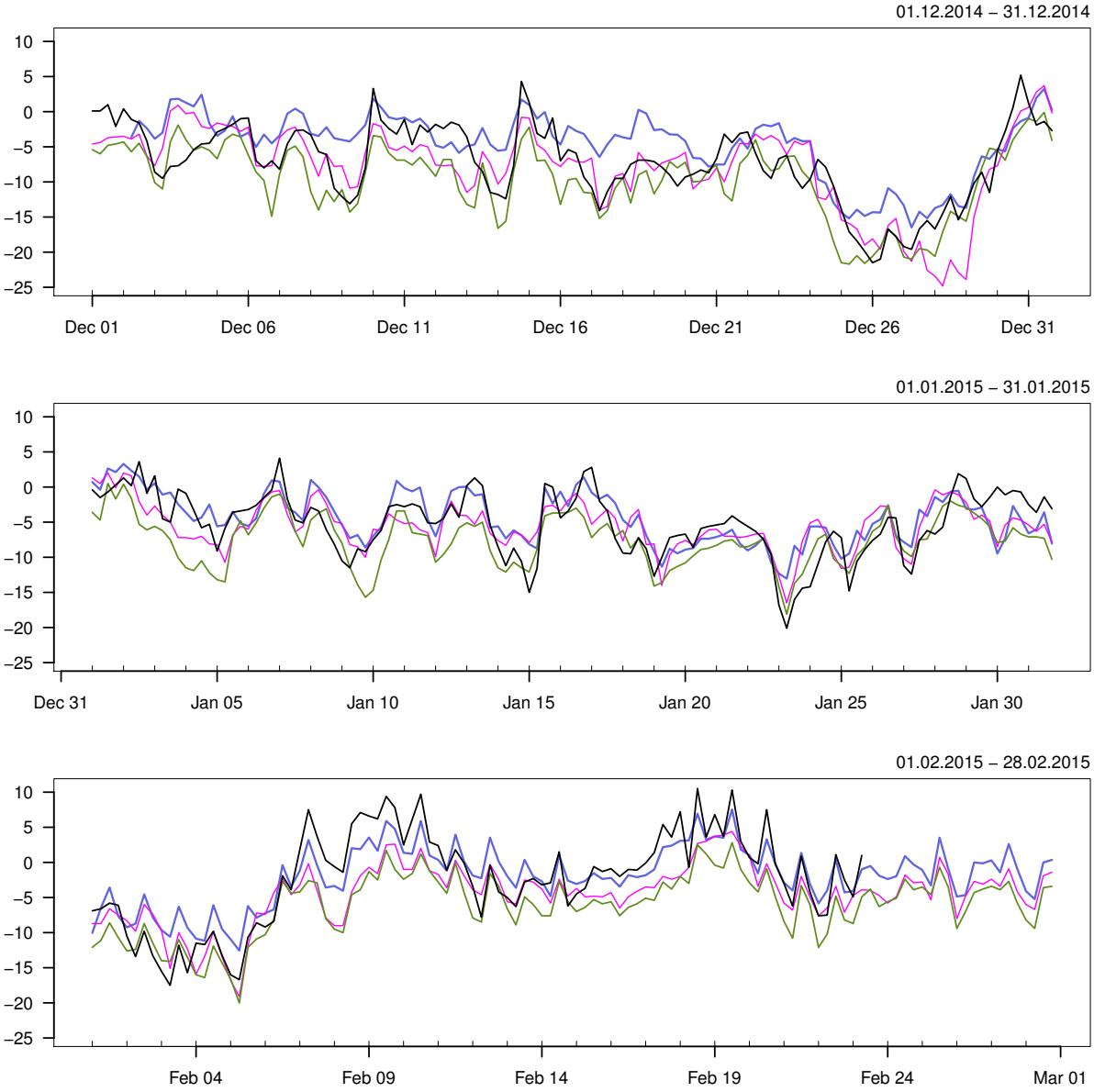


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−28.3	−5.9	2.5	5.1	360
AM25: 12+18,+24,+30,+36	−22.7	−8	0.4	4.1	355
Hirlam8: 12+18,+24,+30,+36	−20.3	−7.8	−0.5	3.4	360
ECMWF: 12+18,+24,+30,+36	−18.1	−7.7	0	3.5	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−2.1	2.5	3.2	2.8	11.6	355
Hirlam8 – synop	−1.9	2.7	3.3	2.8	12.7	360
ECMWF – synop	−1.8	3	3.5	2.8	13.2	360

NESBYEN

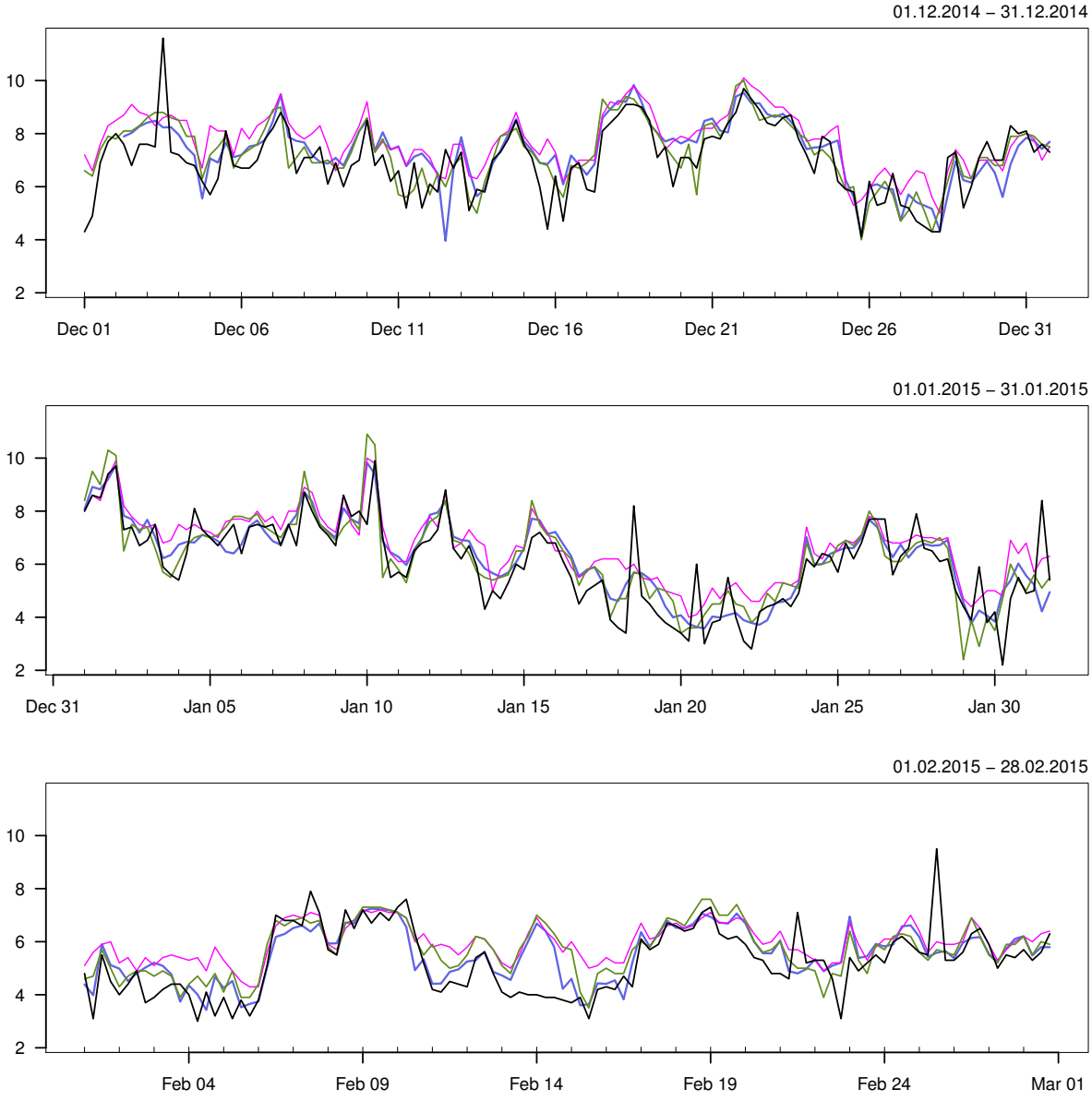


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−21.5	−5.1	10.5	5.9	338
AM25: 12+18,+24,+30,+36	−16.5	−3.7	7.5	4.3	355
Hirlam8: 12+18,+24,+30,+36	−24.8	−5.9	4.4	4.9	360
ECMWF: 12+18,+24,+30,+36	−21.7	−7.8	2.8	4.7	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	1.3	3.4	3.7	3	9.5	333
Hirlam8 – synop	−1	3.7	3.8	3	10.8	338
ECMWF – synop	−2.9	3.3	4.4	3.6	11	338

EKOFISK

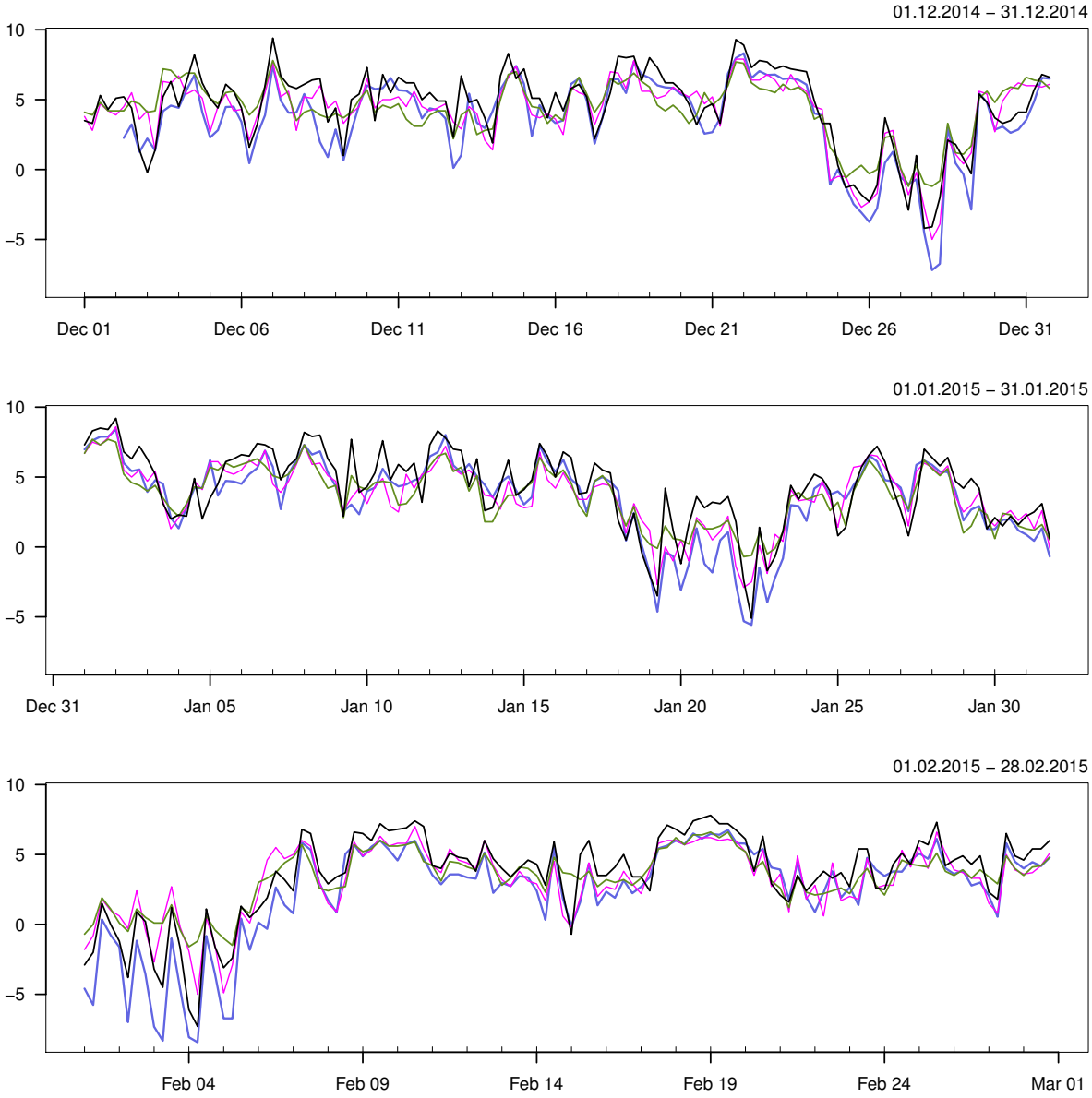


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	2.2	6.1	11.6	1.6	360
AM25: 12+18,+24,+30,+36	3.4	6.4	9.8	1.4	355
Hirlam8: 12+18,+24,+30,+36	4	6.8	10.1	1.3	360
ECMWF: 12+18,+24,+30,+36	2.4	6.4	10.9	1.4	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.3	0.8	0.9	0.6	4.2	355
Hirlam8 – synop	0.7	0.8	1.1	0.8	3.5	360
ECMWF – synop	0.3	0.8	0.9	0.6	3.8	360

SOLA

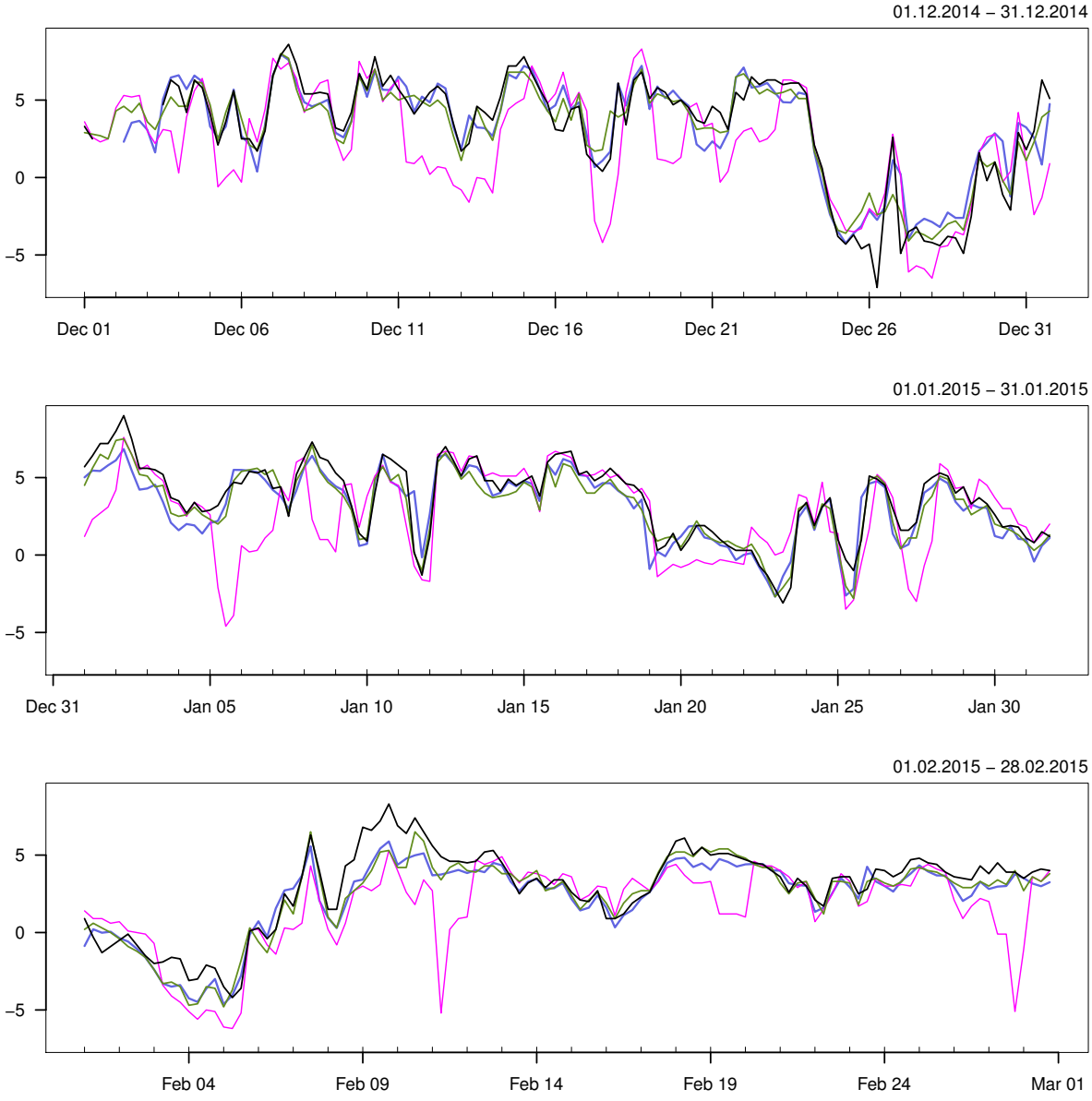


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−7.3	4.1	9.4	2.9	360
AM25: 12+18,+24,+30,+36	−8.4	3.1	8.4	3.2	355
Hirlam8: 12+18,+24,+30,+36	−5	3.7	8.6	2.5	360
ECMWF: 12+18,+24,+30,+36	−1.6	3.8	7.8	2	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−1	1.3	1.6	1.3	5.7	355
Hirlam8 – synop	−0.4	1.3	1.4	1.1	4.8	360
ECMWF – synop	−0.3	1.5	1.5	1.2	6.1	360

FERDER FYR

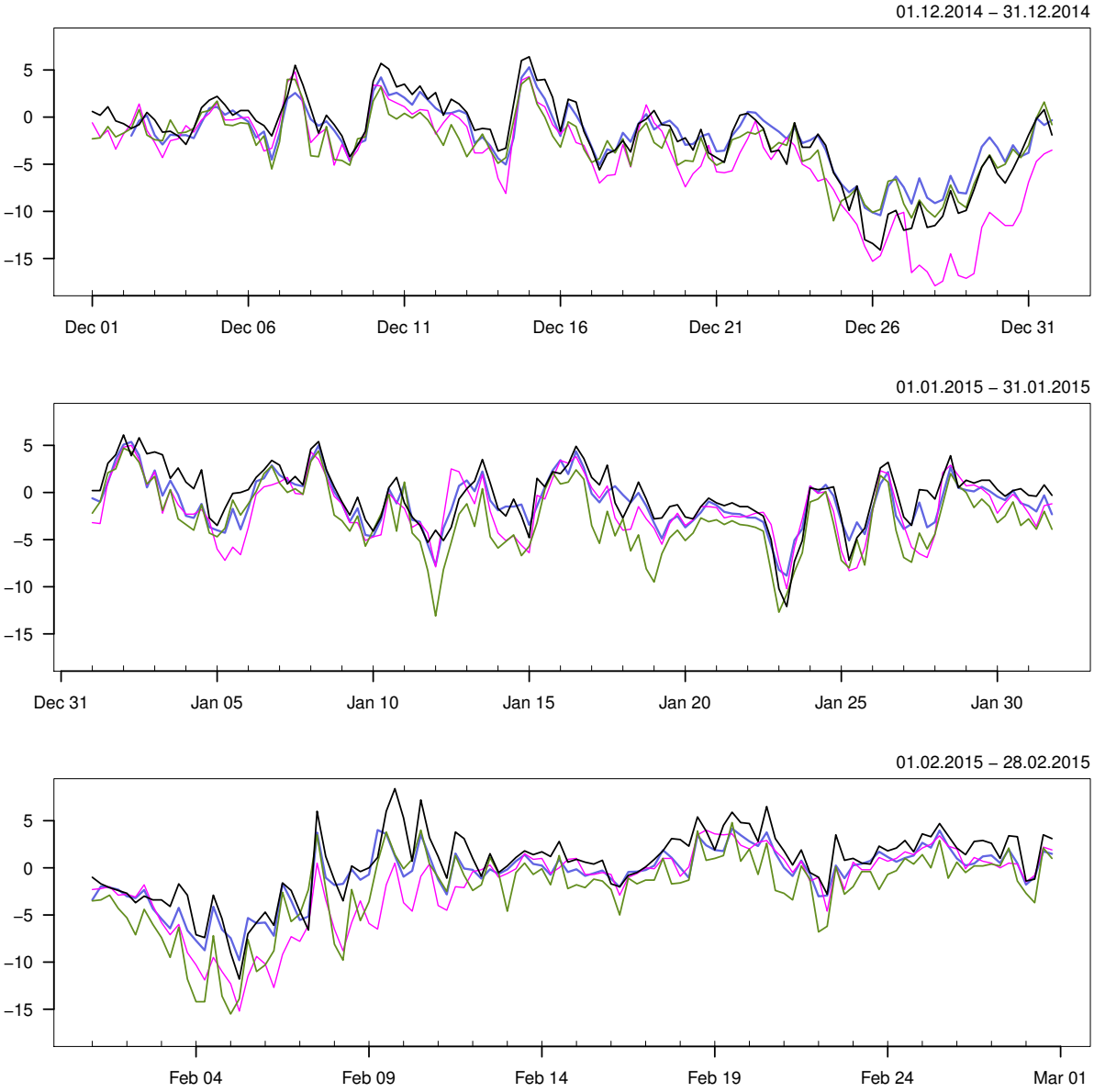


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−7.1	3.2	9	2.9	352
AM25: 12+18,+24,+30,+36	−4.6	2.9	7.9	2.7	355
Hirlam8: 12+18,+24,+30,+36	−6.5	2.2	8.3	3.1	360
ECMWF: 12+18,+24,+30,+36	−4.8	2.9	8	2.6	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−0.3	1.1	1.1	0.8	5.5	350
Hirlam8 – synop	−1.1	2.3	2.5	1.8	10.1	352
ECMWF – synop	−0.3	0.9	1	0.7	4.7	352

OSLO – BLINDERN

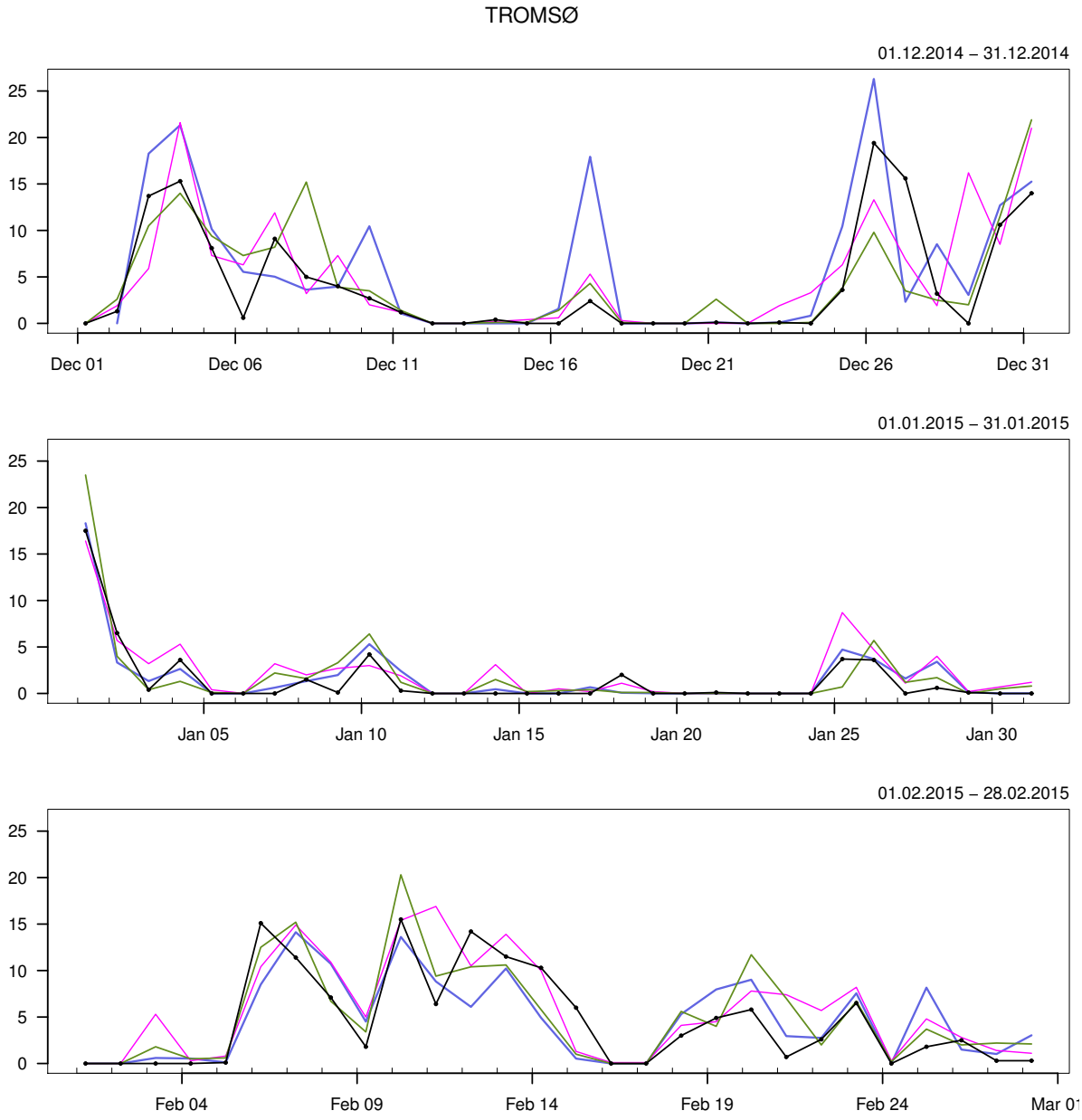


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−14.1	−0.7	8.4	3.8	360
AM25: 12+18,+24,+30,+36	−10.4	−1.3	5.4	3	355
Hirlam8: 12+18,+24,+30,+36	−17.9	−2.7	5	4.5	360
ECMWF: 12+18,+24,+30,+36	−15.5	−2.8	4.8	3.7	360

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−0.6	1.6	1.7	1.3	7.1	355
Hirlam8 – synop	−2	2.2	3	2.3	9	360
ECMWF – synop	−2.1	2.1	2.9	2.4	9.1	360

9.3 Daily precipitation

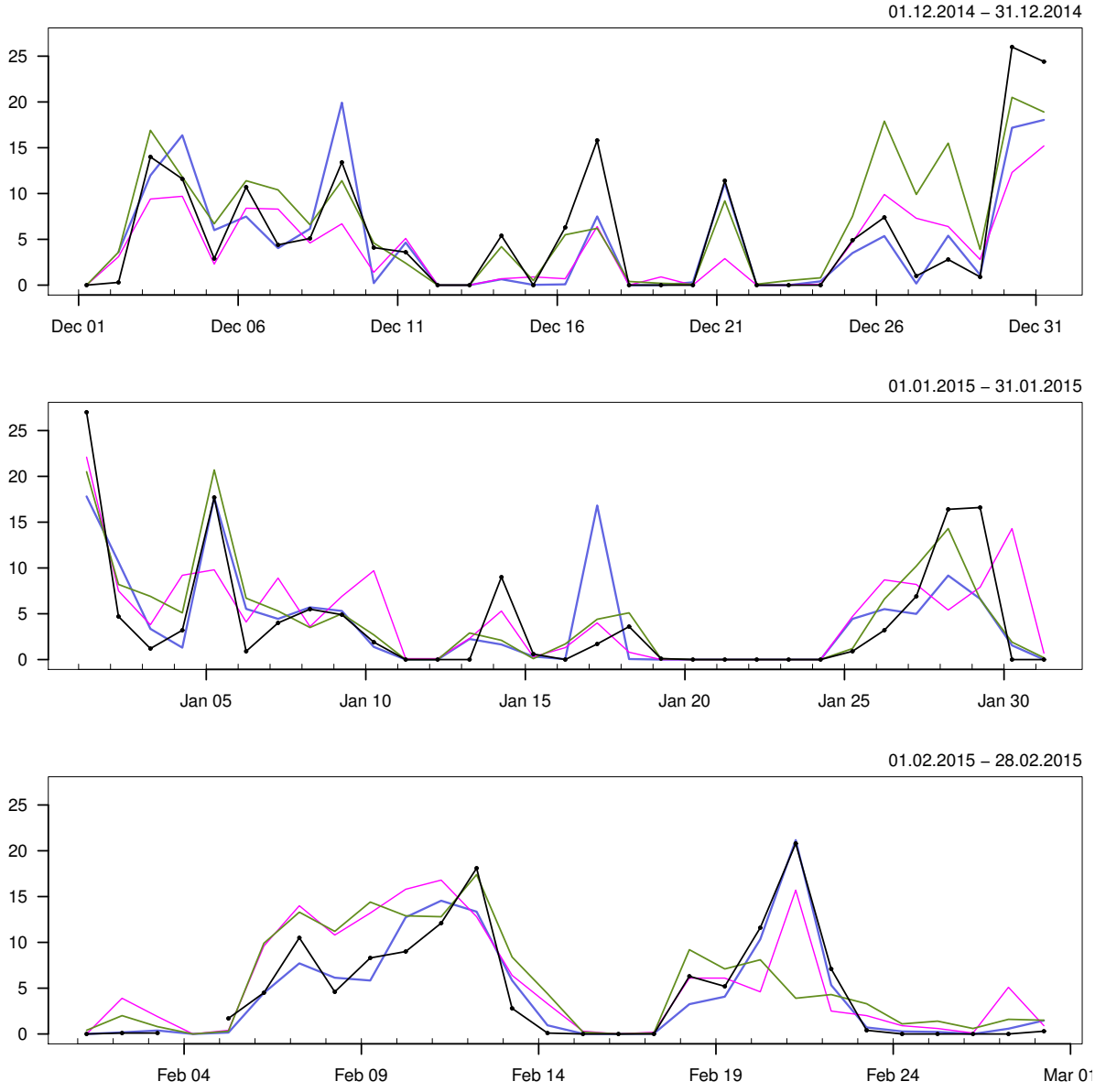


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 06	0	3.4	19.4	5.1	90
AM25: 00+30	0	4.1	26.3	5.7	89
Hirlam8: 00+30	0	4.3	21.6	5.2	90
ECMWF: 00+30	0	3.8	23.5	5.2	90

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.7	3.4	3.5	2	15.5	89
Hirlam8 – synop	1	3.2	3.4	2	16.2	90
ECMWF – synop	0.4	2.9	3	1.7	12.1	90

BODØ

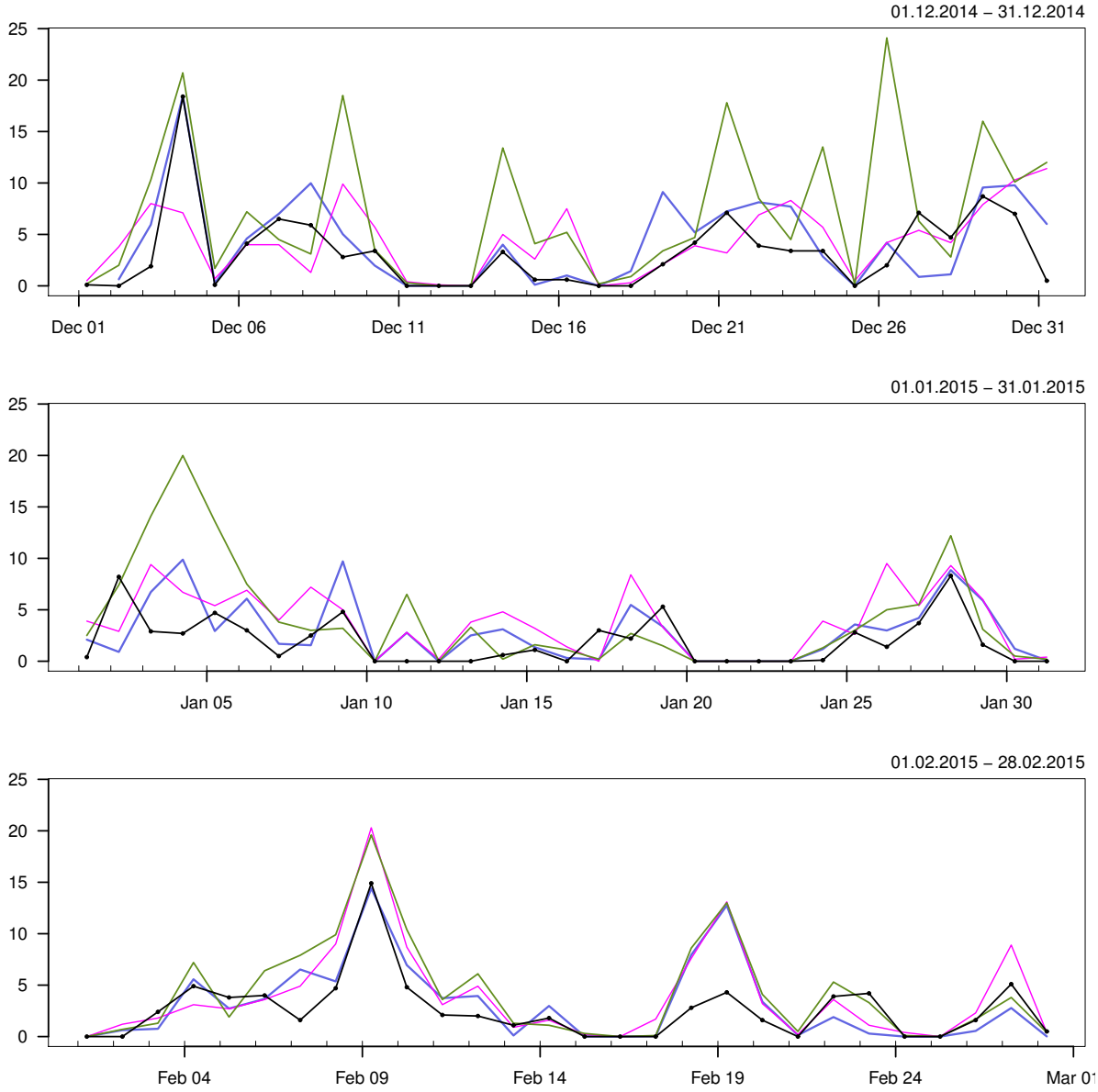


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 06	0	4.8	27	6.5	89
AM25: 00+30	0	4.5	21.2	5.6	89
Hirlam8: 00+30	0	4.8	22.1	5	90
ECMWF: 00+30	0	5.6	20.7	5.8	90

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	–0.4	3.5	3.5	2.1	15.1	88
Hirlam8 – synop	0	4.5	4.5	3.1	14.3	89
ECMWF – synop	0.8	4	4.1	2.6	16.9	89

ØRLAND

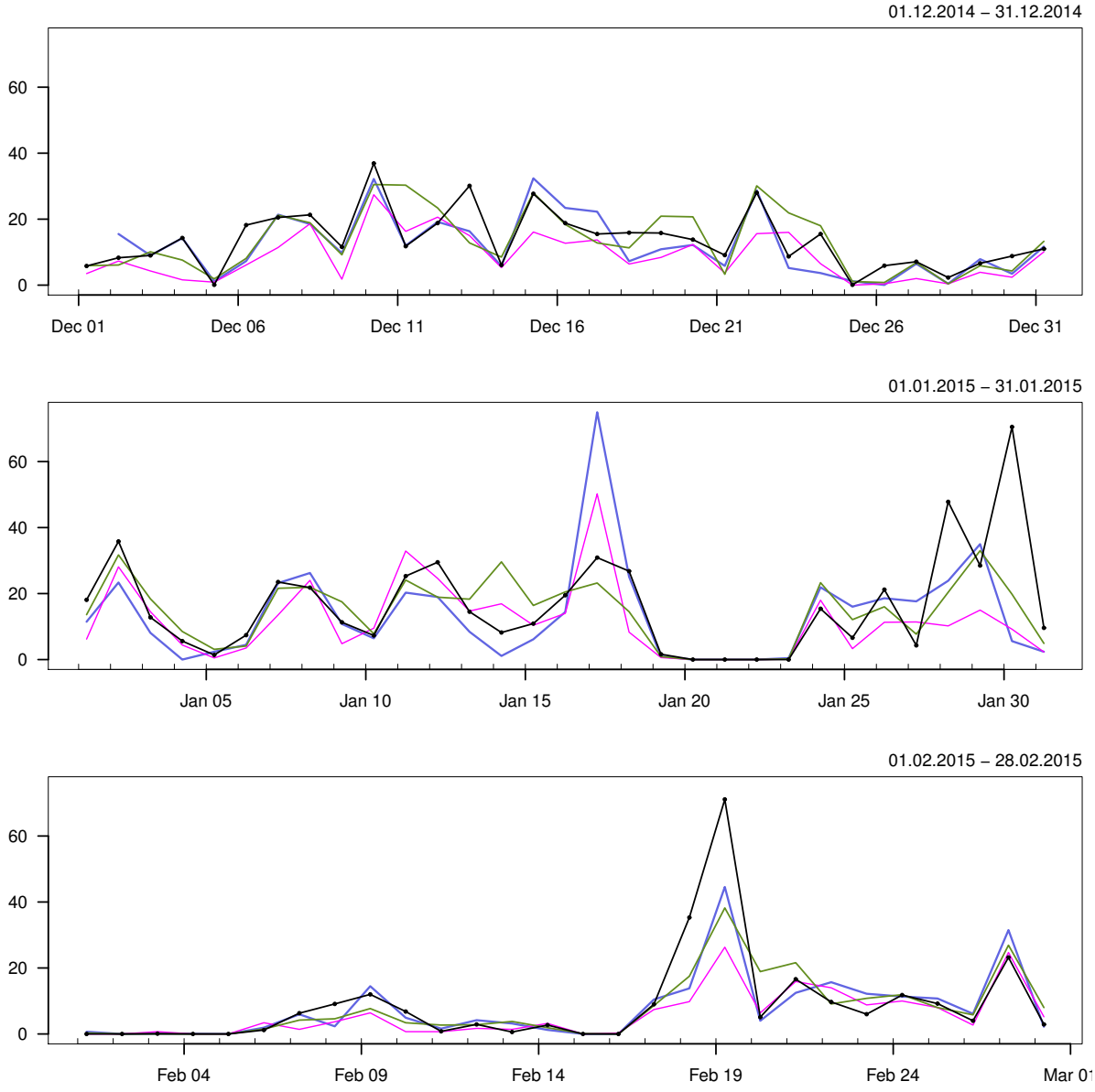


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 06	0	2.6	18.4	3.2	90
AM25: 00+30	0	3.5	18.5	3.8	89
Hirlam8: 00+30	0	4	20.3	3.7	90
ECMWF: 00+30	0	5.1	24.1	5.7	90

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.8	2.5	2.7	1.8	8.4	89
Hirlam8 – synop	1.4	3.2	3.5	2.4	11.3	90
ECMWF – synop	2.5	4.5	5.1	3	22.1	90

BERGEN – FLORIDA

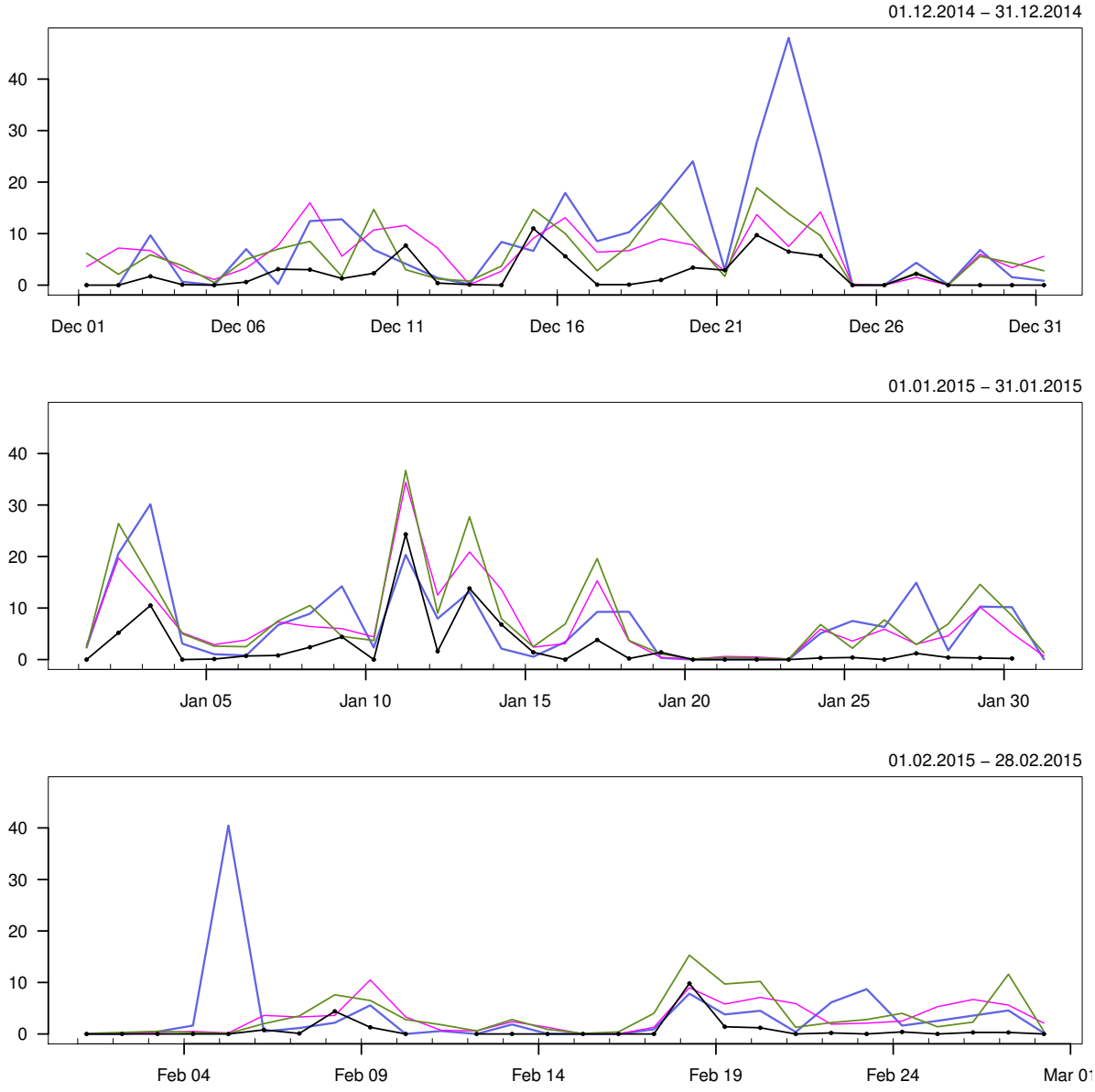


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 06	0	13.2	71.1	13.5	90
AM25: 00+30	0	11.3	75	12	89
Hirlam8: 00+30	0	8.8	50.2	9	90
ECMWF: 00+30	0	12	38.2	9.8	90

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	–1.9	10.4	10.6	5.3	64.9	89
Hirlam8 – synop	–4.3	10.4	11.3	6.2	61.3	90
ECMWF – synop	–1.1	9.1	9.2	5	50.7	90

LÆRDAL

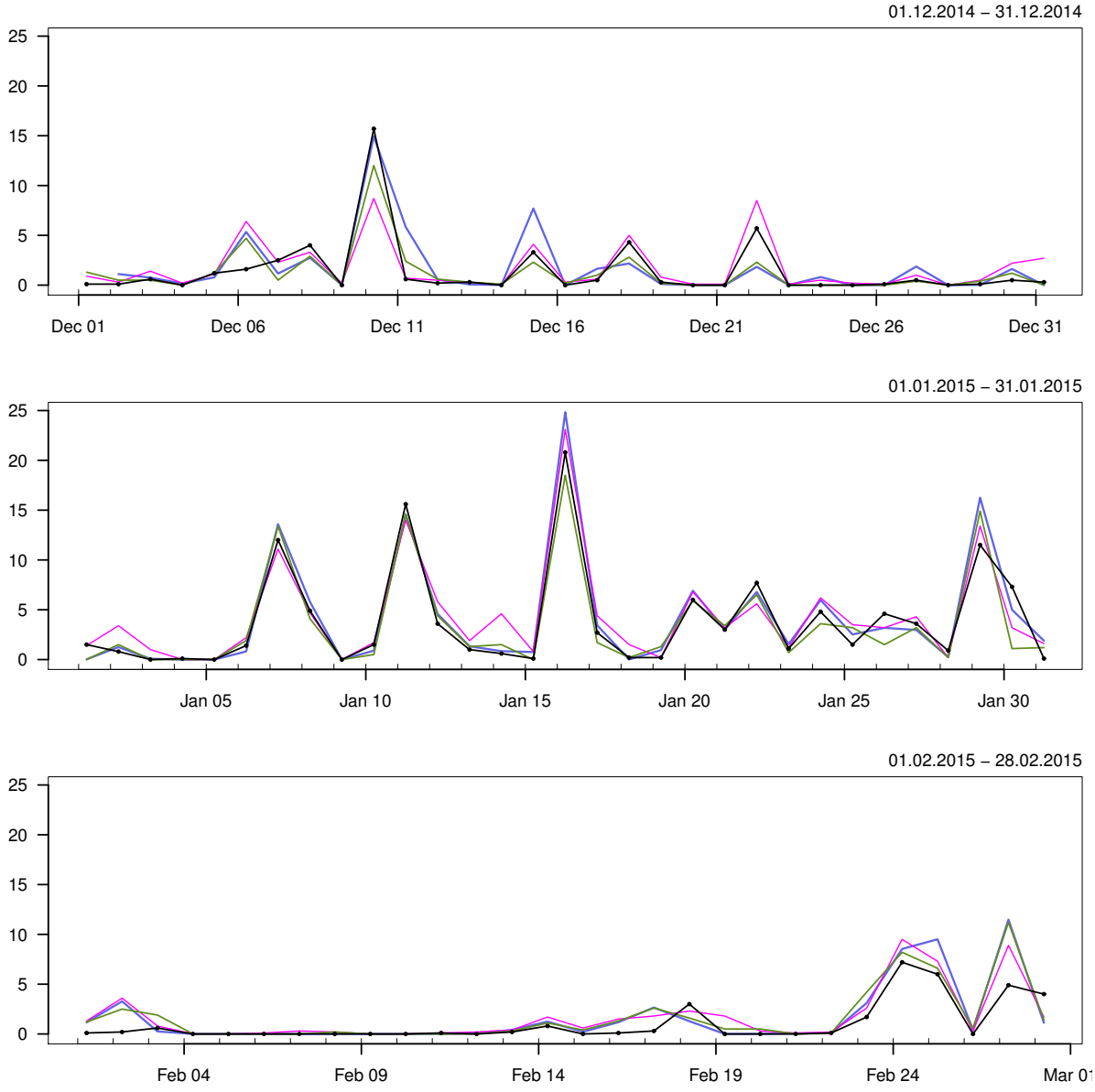


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 06	0	1.9	24.3	3.8	88
AM25: 00+30	0	6.5	48	8.9	89
Hirlam8: 00+30	0	5.5	34.4	5.6	90
ECMWF: 00+30	0	5.9	36.7	6.7	90

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	4.7	7.9	9.2	5.3	41.5	87
Hirlam8 – synop	3.7	3.4	5	3.8	14.5	88
ECMWF – synop	4	4.4	6	4.2	21.2	88

GARDERMOEN

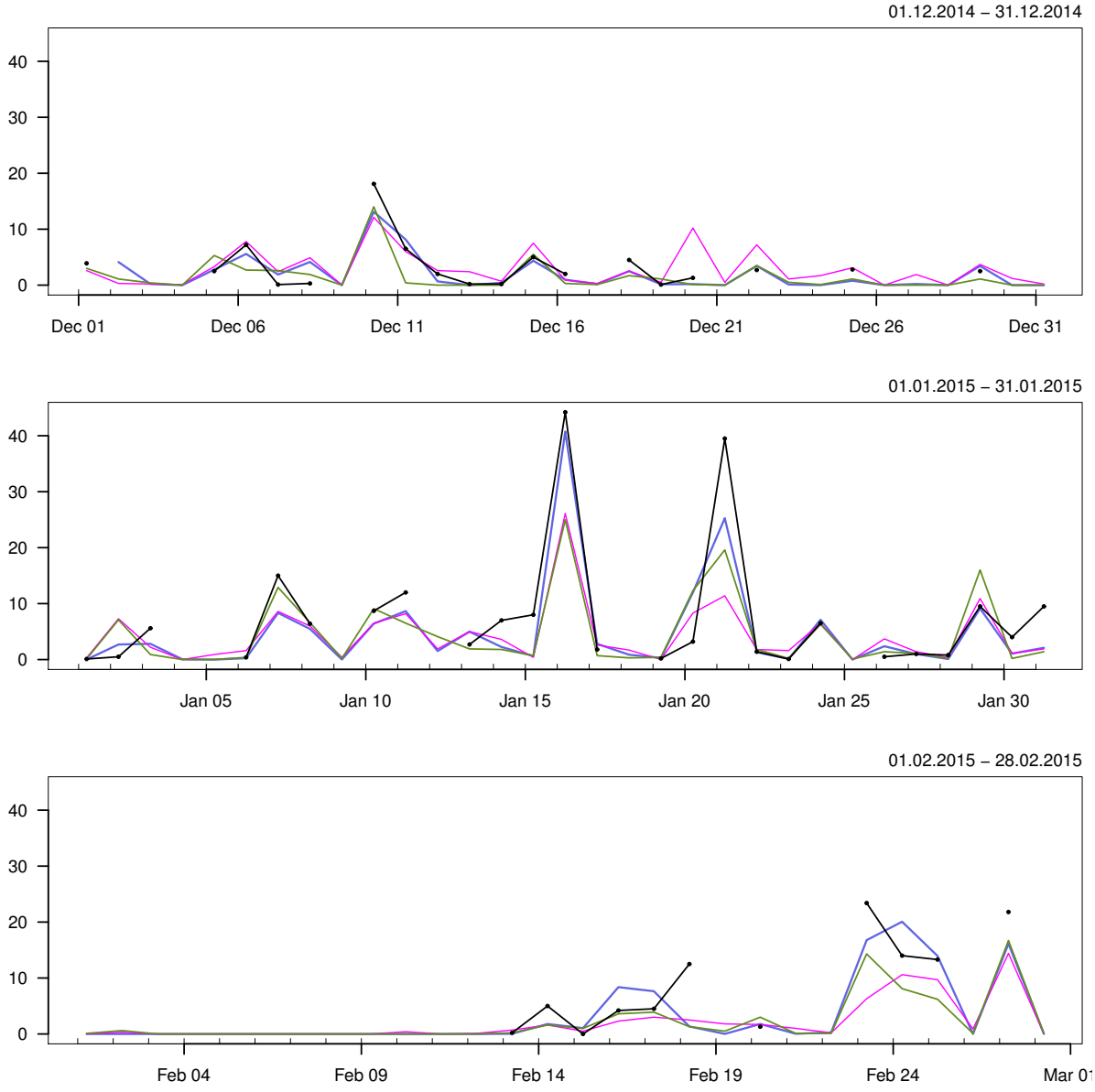


01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 06	0	2.1	20.8	3.8	90
AM25: 00+30	0	2.6	24.8	4.4	89
Hirlam8: 00+30	0	2.6	23.1	3.8	90
ECMWF: 00+30	0	2.2	18.5	3.7	90

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.4	1.6	1.7	1	6.6	89
Hirlam8 – synop	0.5	1.5	1.6	1	7	90
ECMWF – synop	0	1.5	1.5	0.9	6.3	90

NELAUG



01.12.2014 – 28.02.2015

	Min	Mean	Max	Std	N
synop: 06	0	6.5	44.2	9	54
AM25: 00+30	0	3.3	40.7	6.3	89
Hirlam8: 00+30	0	3.1	26.1	4.2	90
ECMWF: 00+30	0	2.7	25	4.9	90

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	–1.1	3.9	4.1	2.7	14.2	53
Hirlam8 – synop	–1.7	6.1	6.3	3.7	28.1	54
ECMWF – synop	–2.1	5.1	5.5	3.4	19.9	54