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Verification of Operational Weather Prediction Models March to May 2016

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Photo: Hanneke Luitjing

Contents

Precipitation figures

More information...

Verification results are also available on internal web pages

- http://metcoop.smhi.se/ - AROME-MetCoOp verification - 7 and 30 last days
- http://verif/vmap/ - timeseries and windroses - on Google map

Models

The following models are verified in this report.

ECMWF	Global model (IFS) at the European Centre for Medium-Range Weather Forecasts. From 26 January 2010 horizontal resolution approximately 16×16 km^2. From 8 March 2016 cycle 41r2 with horizontal resolution about $9km$. ECMWF is available about 5 hours later than models run at MET.
Hirlam8	Version 7.1, horizontal resolution defined by a 8×8 km^2 grid. Operational status since 13 February 2008.
AROME-Norway	HARMONIE cycle 37h1.1 with AROME physics and non-hydrostatic dynamics, horizontal resolution defined by a 2.5×2.5 km^2 grid. Experimental since 25 October 2012, replacing Harmonie2.5 from 26 February 2013, on Yr from 1 October 2013.
AROME-MetCoOp (AM25)	HARMONIE with AROME physics, horizontal resolution defined by a 2.5×2.5 km^2 grid on same domain as AROME-Norway. Run in cooperation with Swedish Meteorological and Hydrological Institute (SMHI). Experimental with cycle 38h1.1 since 9 December 2013, operational since 12 March 2014, cycle 38h1.2 since 8 December 2014.
AROME-Arctic (AA25)	HARMONIE with AROME physics, horizontal resolution defined by a 2.5×2.5 km^2 grid, same domain size as AROME-MetCoOp. Experimental with cycle 38h1.2 since 15 October 2015.

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.

Post processed forecasts

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

For 2m temperature, the raw data is first adjusted to a fine scale (500 m) topography applying a vertical temperature gradient of -1.6 degrees pr. 100 m. The "height corrected" 2m temperature forecasts (AMHC) are in a next step adapted to observations by a Kalman filter at all observing stations. The Kalman filter corrections are interpolated horizontally to the 500 m grid by kriging, using weights which decrease with increasing distance from the observing stations, both horizontally and vertically. The interpolated Kalman filter corrections are finally added to the heigth corrected field, giving AMKF.

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

The precipitation forecasts are post processed by a neighbourhood method giving a median field, AM-median. This field is used to determine the precipitation symbol on Yr.

The HARMONIE system

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 used at MET. More documentation is available on http://www.cnrm.meteo.fr/gmapdoc/ and http://hirlam.org/. A change log for AROME-MetCoOp is found on https://wiki.met.no/nwp/metcoop/changelog/start.

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.

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.

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 will benefit from the possibility of running offline experiments. SURFEX is also used for offline applications in e.g. hydrology, vegetation monitoring and snow avalanche forecasts.

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

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

Data assimilation

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

Surface analysis

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

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

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

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

Upper air analysis

AROME-MetCoOp runs three dimensional variational (3D VAR) data assimilation using conventional observations from synop stations, ships, radiosondes and aircrafts and AMSU-A and AMSU-B/MHS data from polar orbiting NOAA and METOP satellites. GNSS were introduced 17 February 2015, radar reflectivities 16 June 2015 and IASI data 26 November 2015.

Boundary fields

AROME-MetCoOp gets its boundary values (1-hourly) from the ECMWF model at approximately 16 km resolution, and has currently 65 vertical levels. None of the HARMONIE configurations at MET have applied digital filter initialization (DFI).

Verification measures

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

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

Forecasts of continuous variables

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

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

In the formula for COR the following definitions are used

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

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

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

Forecasts of categorical variables

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

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

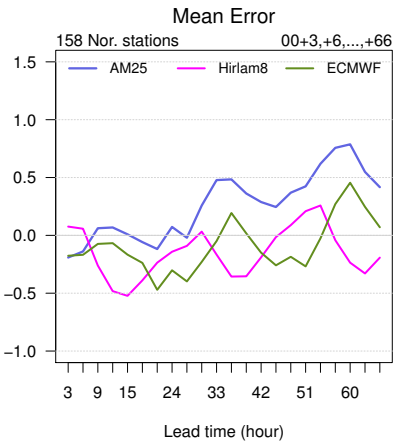
Verification statistics for such forecasts are listed in the following table

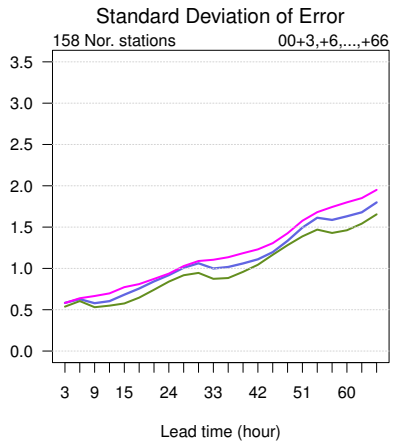
Statistic	Acronym	Formula	Range	Optimal score
Hit rate	HR	$\frac{a}{a+c}$	0 to 1	1
False alarm rate	F	$\frac{b}{b+d}$	0 to 1	0
False alarm ratio	FAR	$\frac{b}{a+b}$	0 to 1	0
Equitable threat score	ETS	$\frac{a-ar}{a+b+c-ar}$	$-1/3$ to 1	1 (0 = no skill)
Hanssen-Kuipers skill score	KSS	HR - F	-1 to 1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

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

Observations

All observations come from Klimadatavarehuset at MET. Only synop stations are used. The model wind speed is verified against mean wind observations, FF. The post processed wind speed is intended to represent maximum wind speed 10m last hour, and is verified against FX.


Mean Error
158 Nor. stations
00+3,+6,...,+66
AM25
Hirlam8
ECMWF
1.5
1.0
0.5
0.0
−0.5
−1.0
3 9 15 24 33 42 51 60
Lead time (hour)


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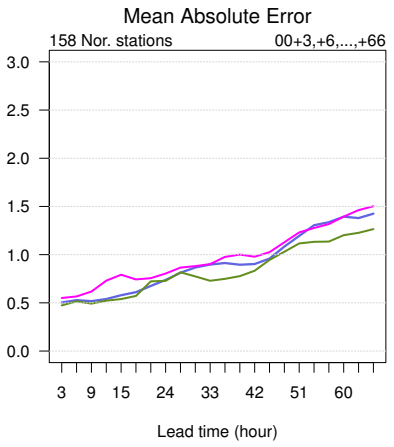
0.5
0.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Absolute Error
158 Nor. stations
00+3,+6,...,+66
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2.5
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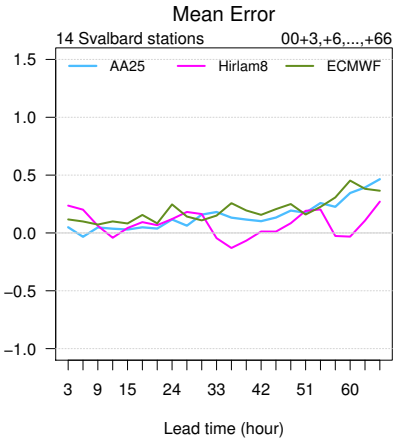
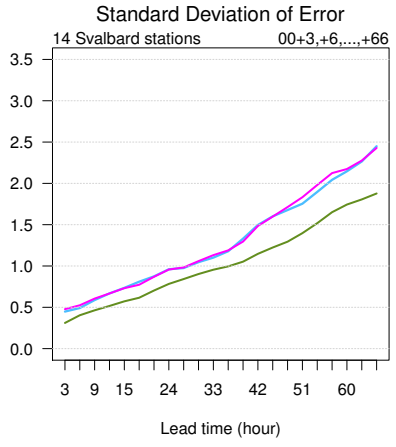
1.5
1.0
0.5
0.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Error
14 Svalbard stations
00+3,+6,...,+66
AA25
Hirlam8
ECMWF
1.5
1.0
0.5
0.0
−0.5
−1.0
3 9 15 24 33 42 51 60
Lead time (hour)


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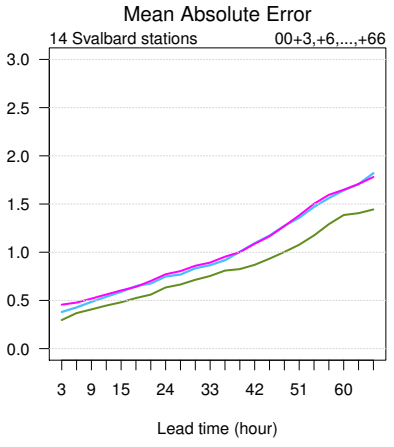
1.5
1.0
0.5
0.0
3 9 15 24 33 42 51 60
Lead time (hour)


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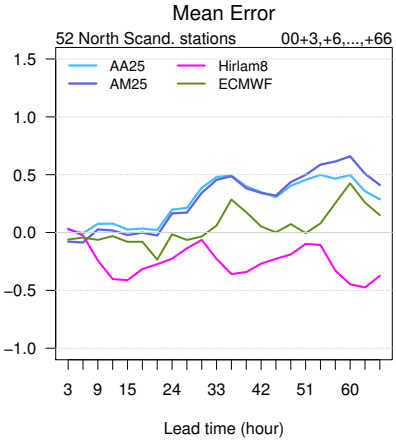
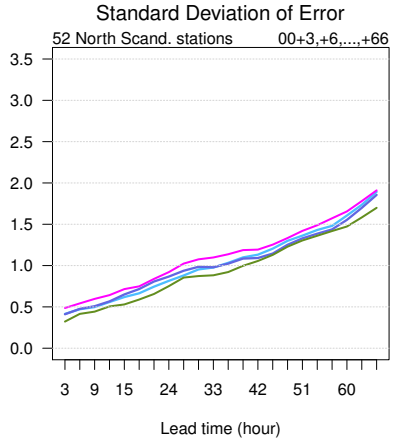
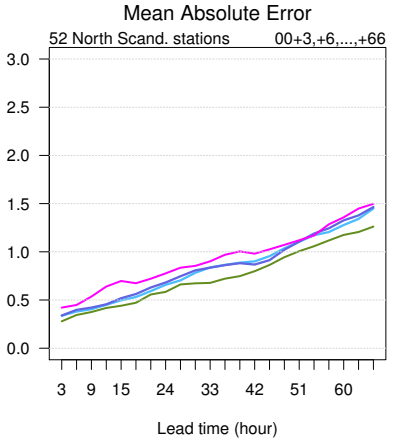
1.0
0.5
0.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Error
52 North Scand. stations
00+3,+6,...,+66
AA25
AM25
Hirlam8
ECMWF
1.5
1.0
0.5
0.0
−0.5
−1.0
3 9 15 24 33 42 51 60
Lead time (hour)


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


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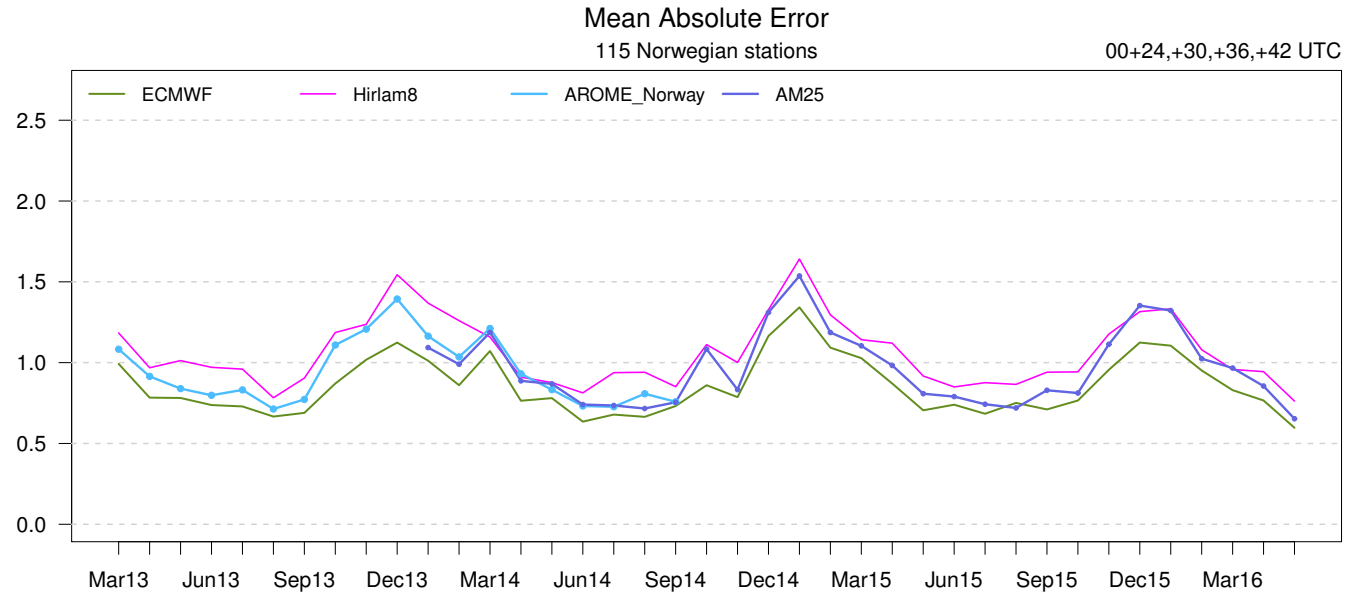
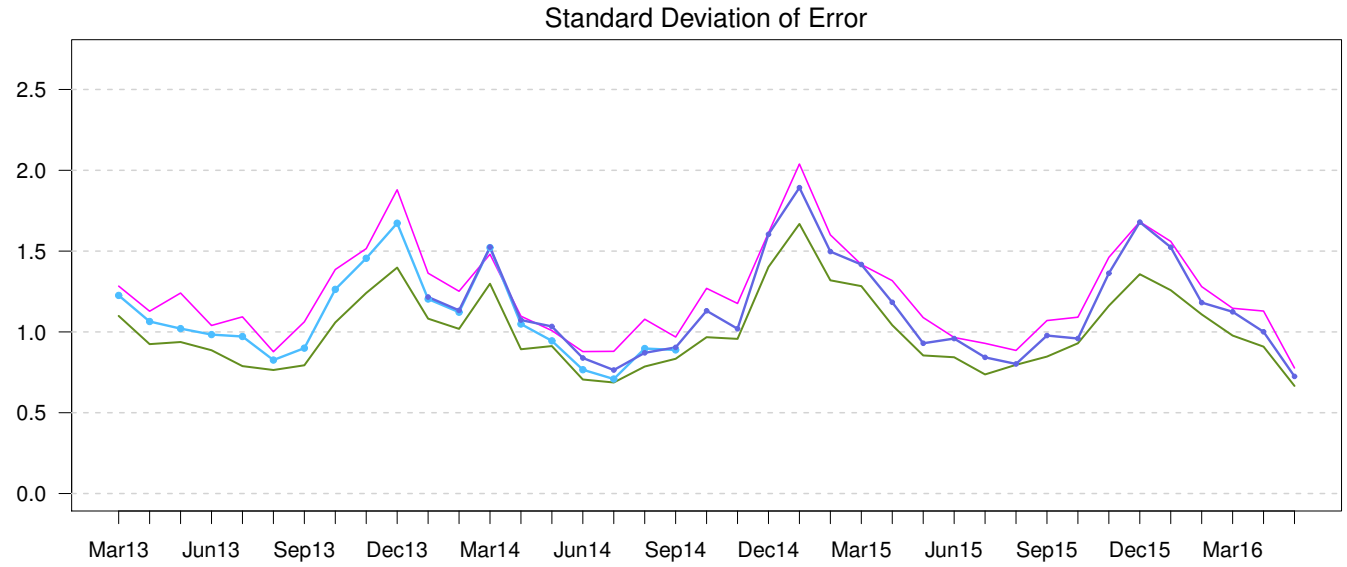
2.5
2.0
1.5
1.0
0.5
0.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Absolute Error
115 Norwegian stations
00+24,+30,+36,+42 UTC
ECMWF
Hirlam8
AROME_Norway
AM25
2.5
2.0
1.5
1.0
0.5
0.0
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14
Mar15
Jun15
Sep15
Dec15
Mar16


Standard Deviation of Error
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2.0
1.5
1.0
0.5
0.0
Mar13
Jun13
Sep13
Dec13
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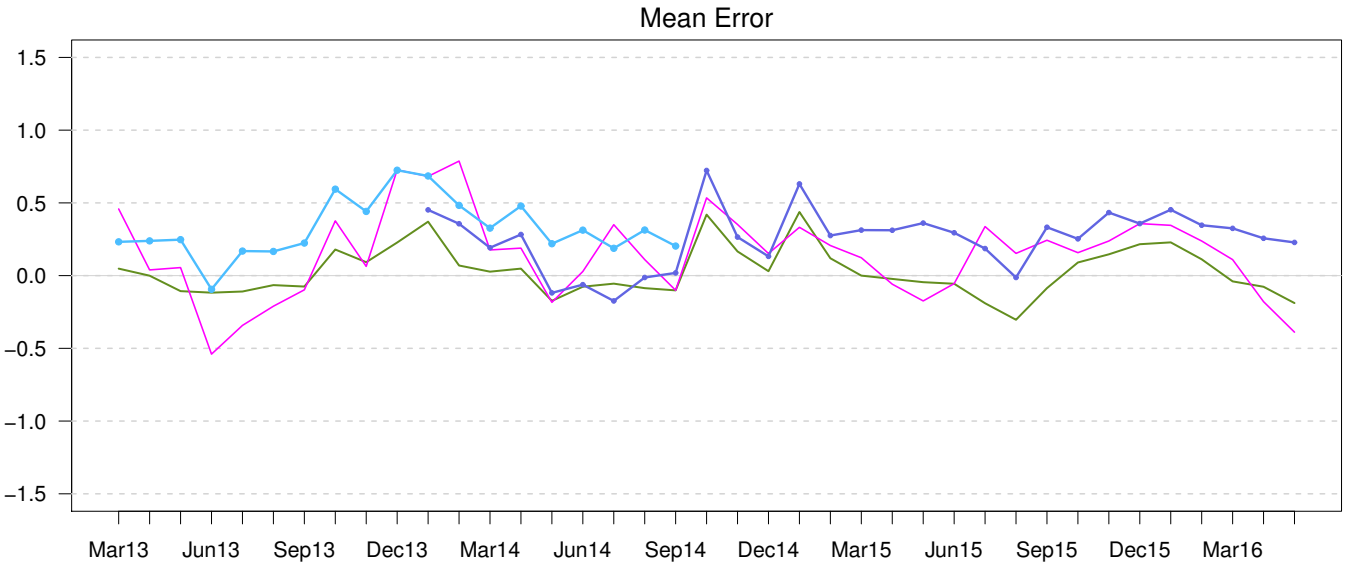
Sep14
Dec14
Mar15
Jun15
Sep15
Dec15
Mar16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0.0
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−1.0
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Jun13
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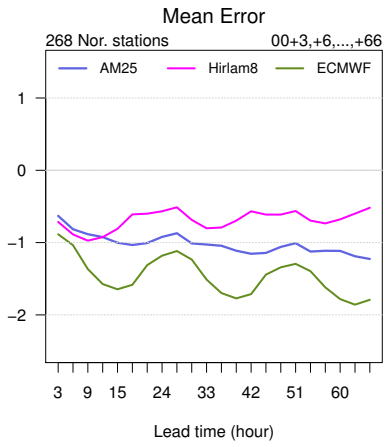
Sep14
Dec14
Mar15
Jun15
Sep15
Dec15
Mar16


Mean Error
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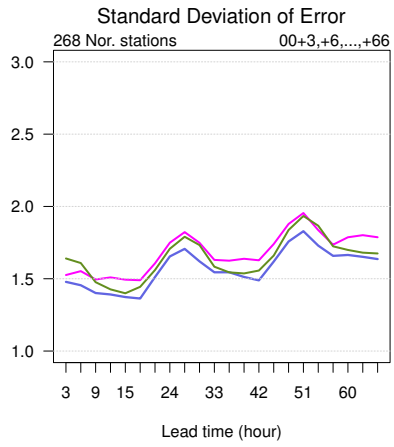
AM25
Hirlam8
ECMWF
1
0
−1
−2
3 9 15 24 33 42 51 60
Lead time (hour)


Standard Deviation of Error
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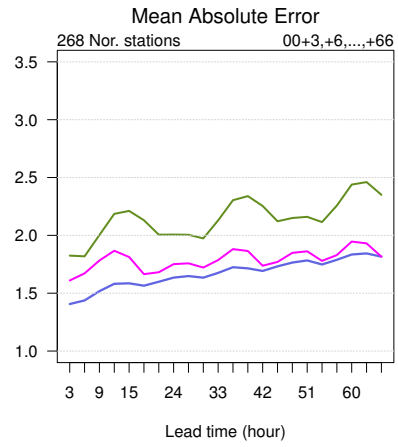
1.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Absolute Error
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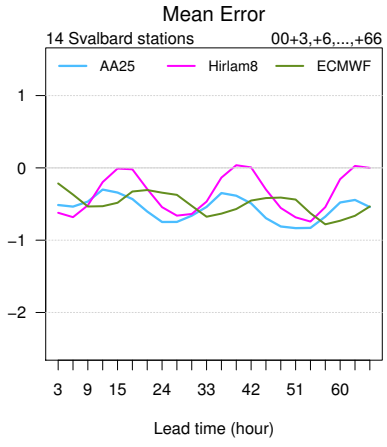
3.0
2.5
2.0
1.5
1.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Error
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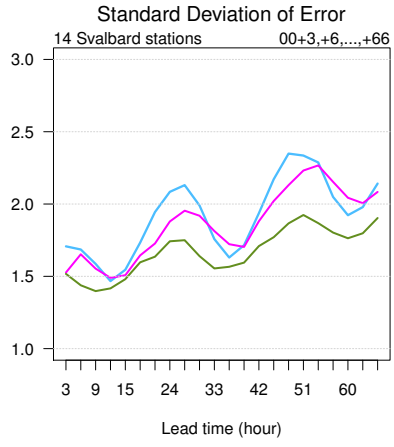
AA25
Hirlam8
ECMWF
1
0
−1
−2
3 9 15 24 33 42 51 60
Lead time (hour)


Standard Deviation of Error
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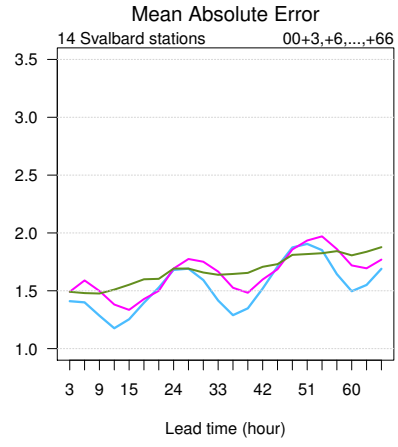
2.5
2.0
1.5
1.0
3 9 15 24 33 42 51 60
Lead time (hour)


Mean Absolute Error
14 Svalbard stations
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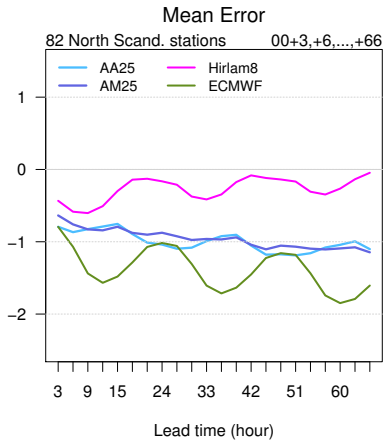
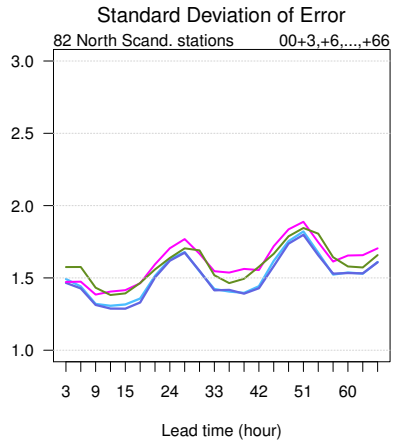
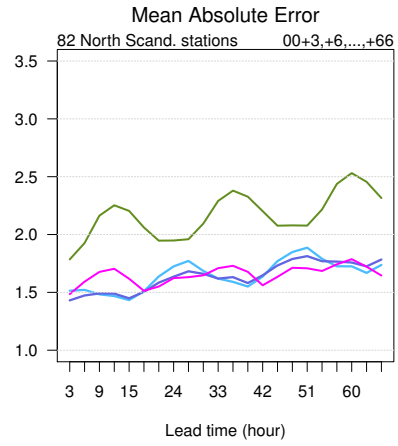
3.0
2.5
2.0
1.5
1.0
3 9 15 24 33 42 51 60
Lead time (hour)

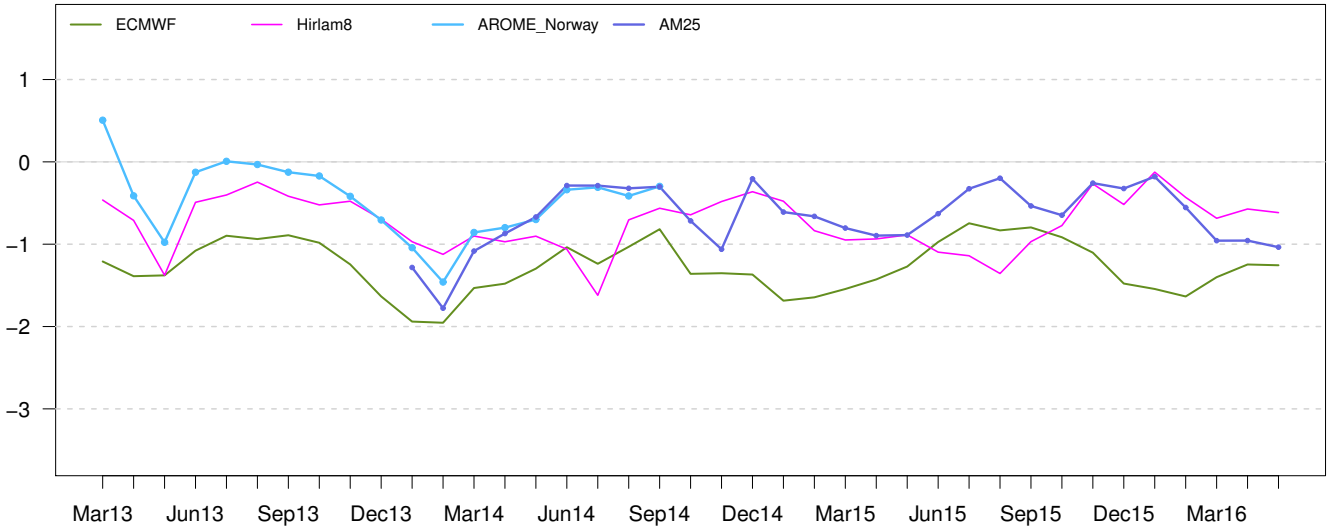

Mean Error
82 North Scand. stations
00+3,+6,...,+66
AA25
AM25
Hirlam8
ECMWF
1
0
−1
−2
3 9 15 24 33 42 51 60
Lead time (hour)


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

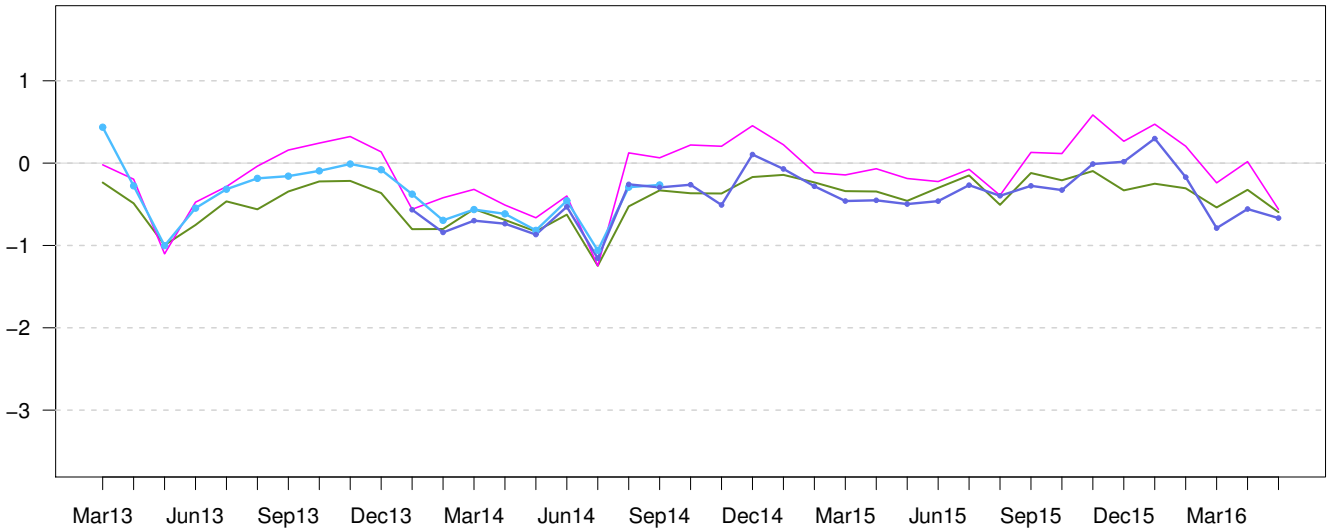

Mean Absolute Error
82 North Scand. stations
00+3,+6,...,+66
3.5
3.0
2.5
2.0
1.5
1.0
3 9 15 24 33 42 51 60
Lead time (hour)

Mean Error

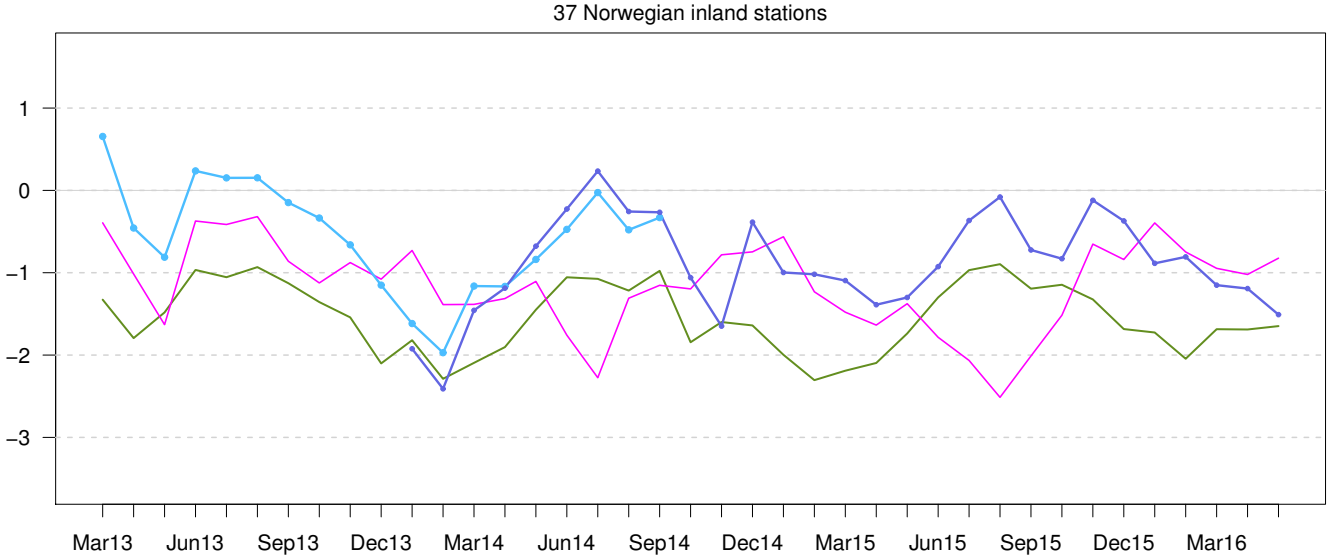
140 Norwegian stations 00+24,+30,+36,+42 UTC



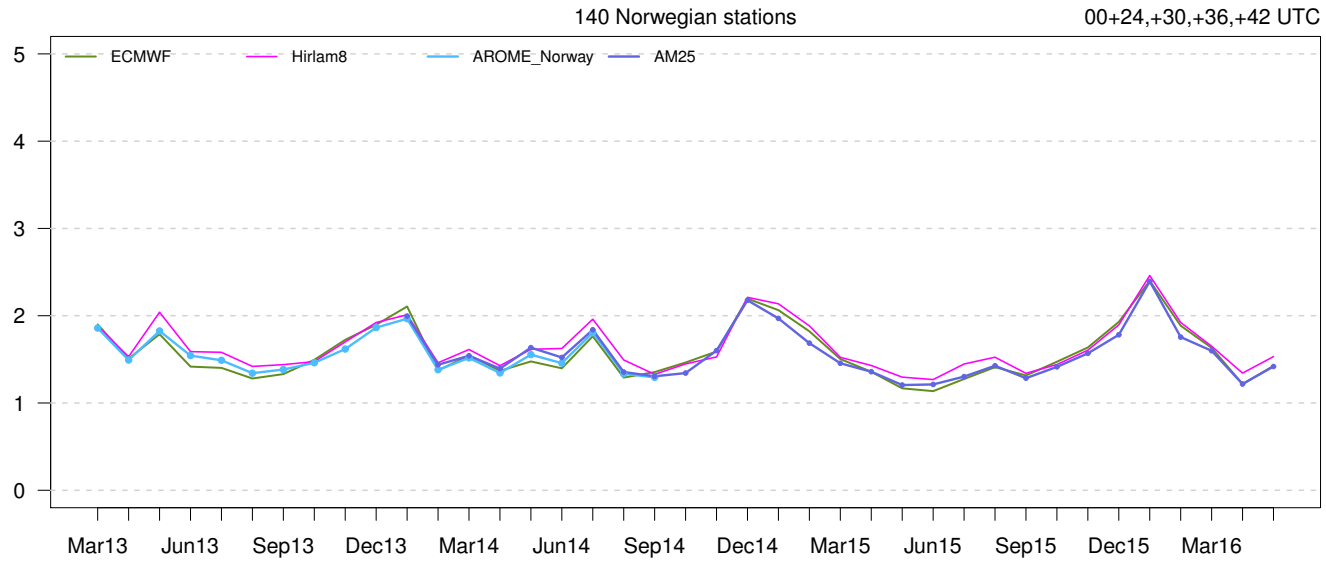
39 Norwegian coastal stations

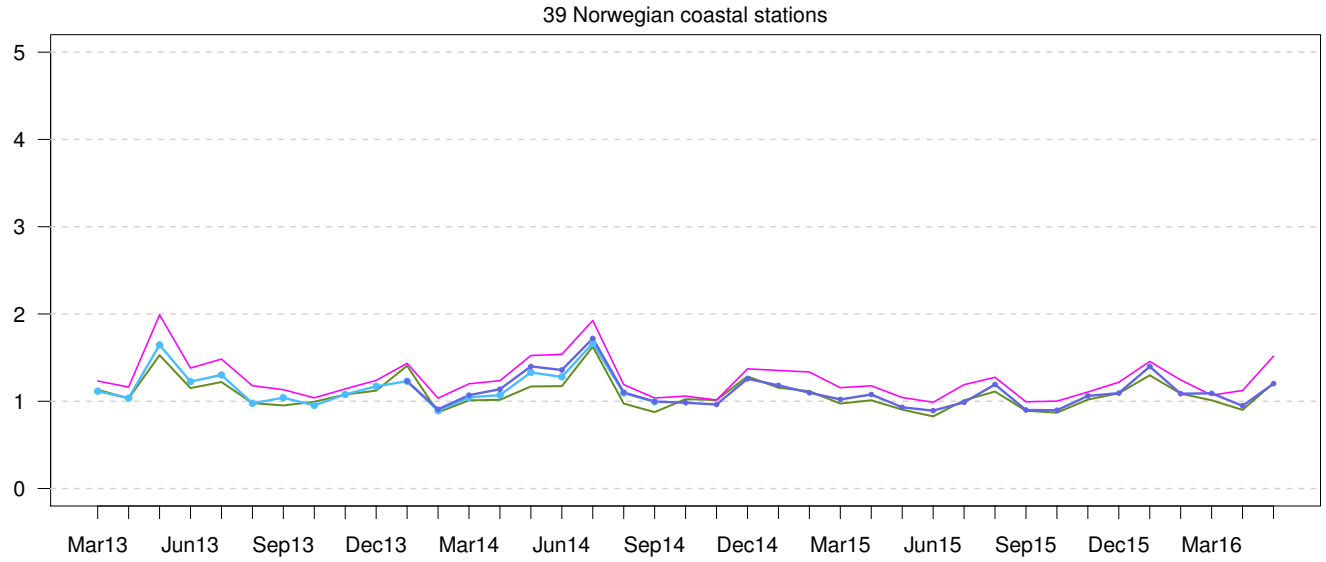


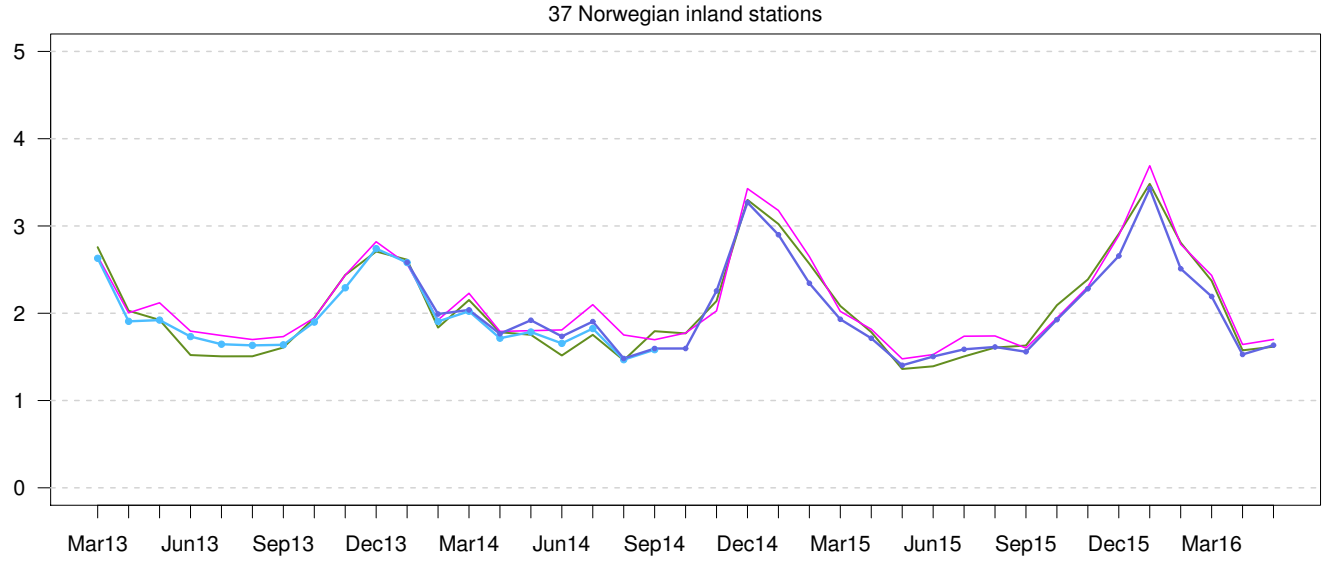
37 Norwegian inland stations



Standard Deviation of Error

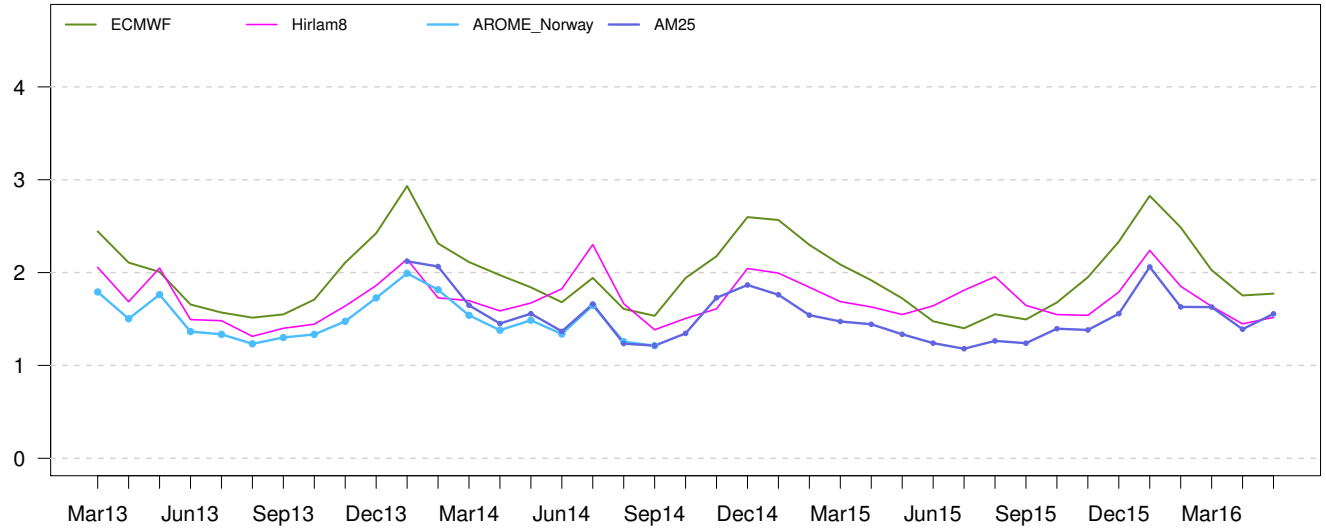




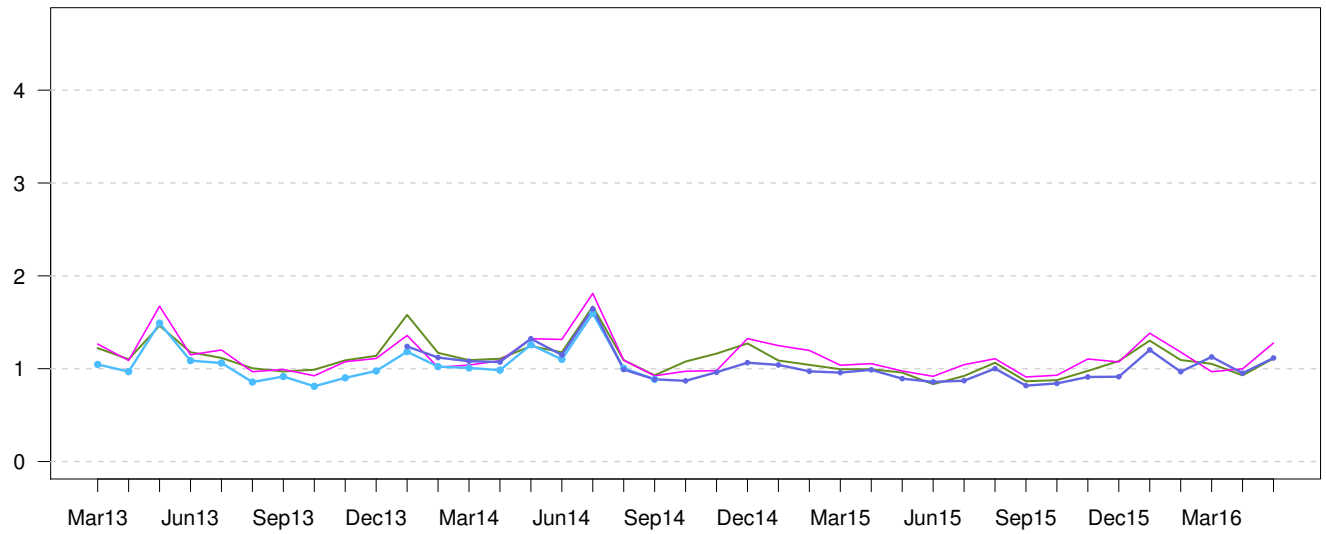


Mean Absolute Error

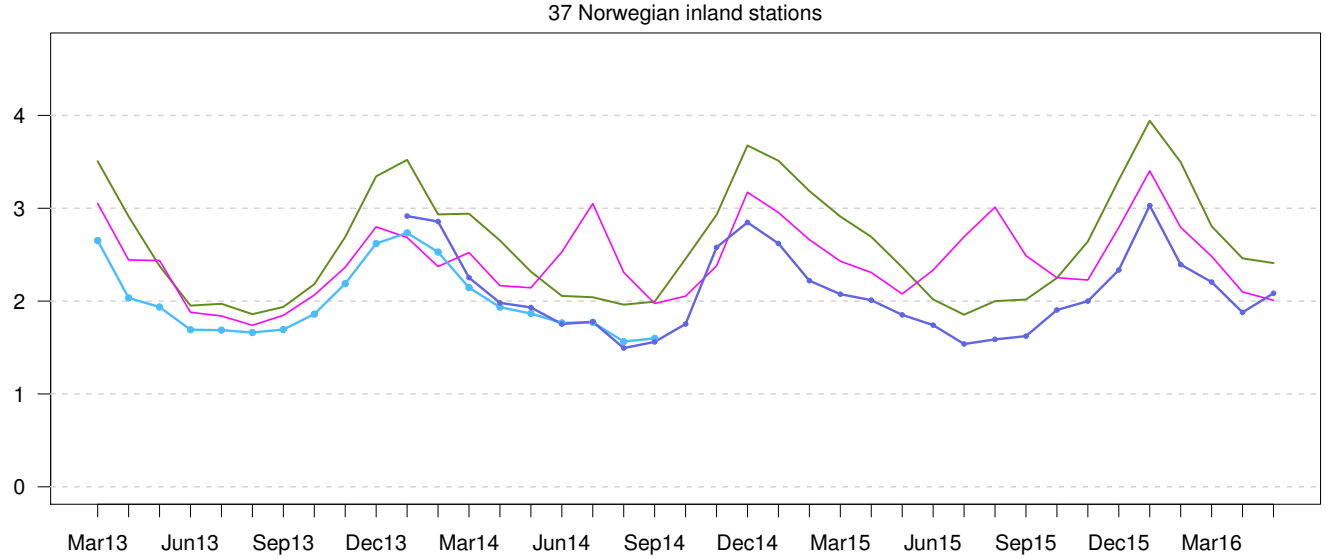
140 Norwegian stations 00+24,+30,+36,+42 UTC



39 Norwegian coastal stations

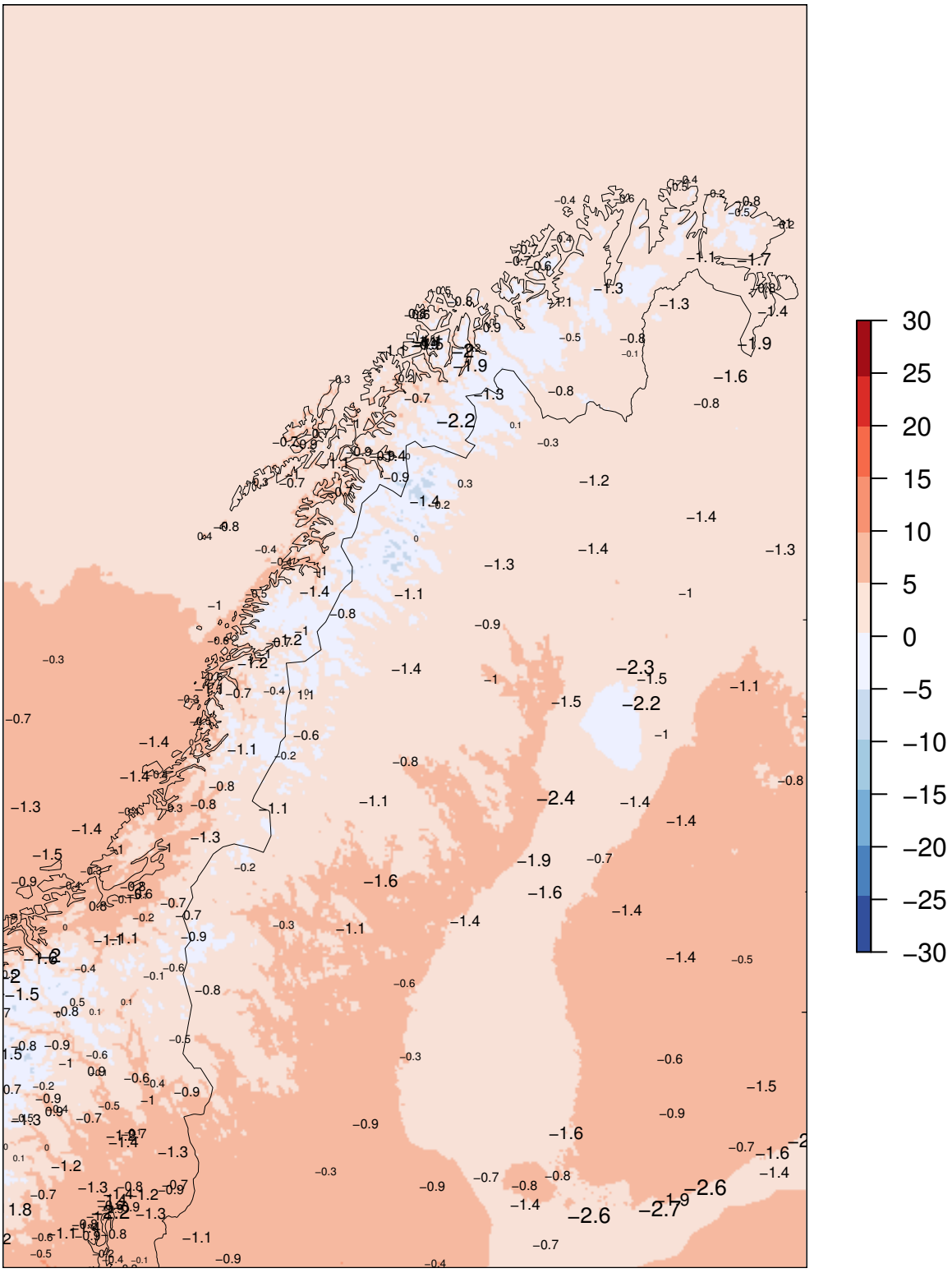


37 Norwegian inland stations



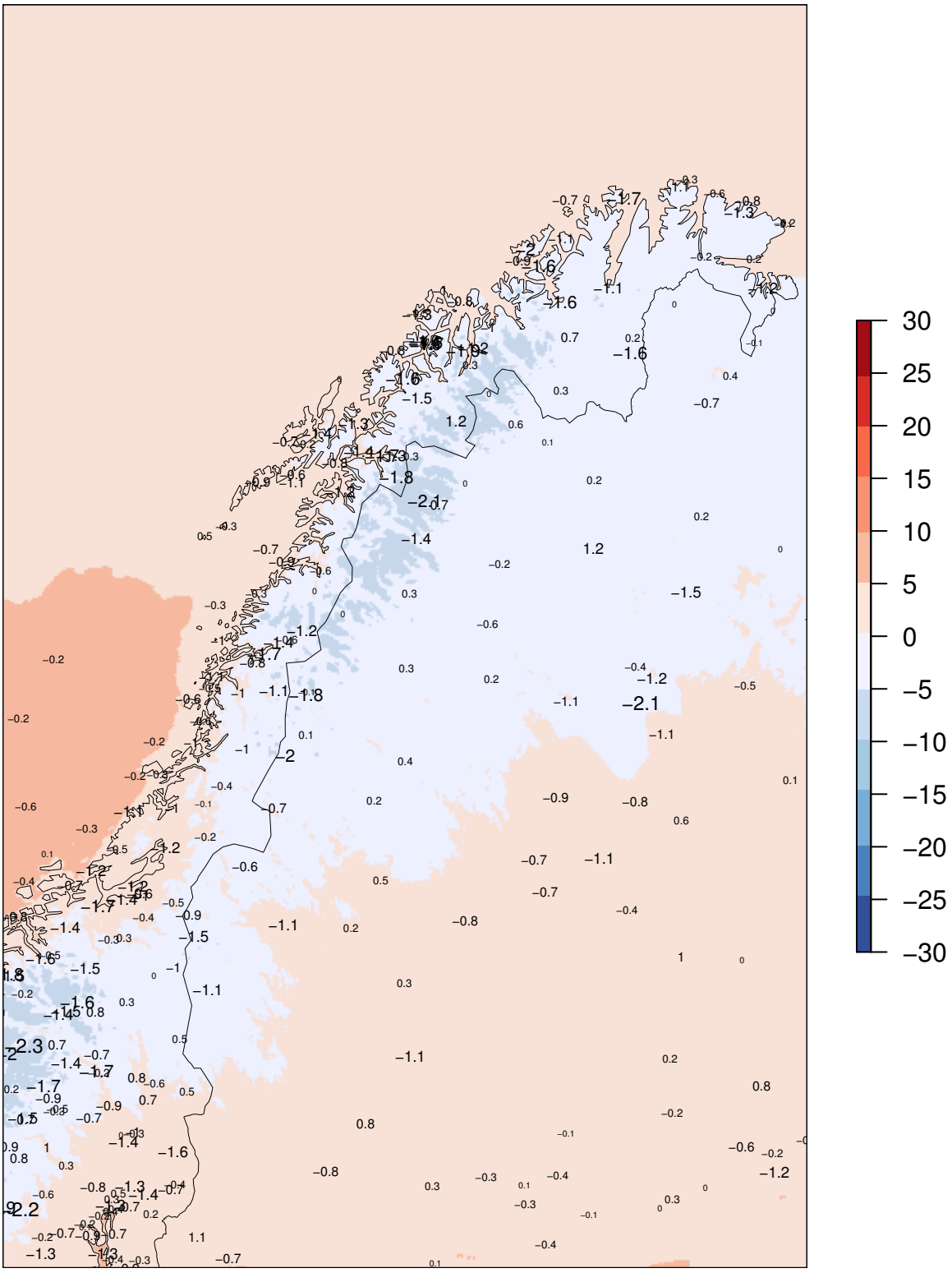
AM25 00+12

ME at observing sites forecast means 01.03.2016 – 31.05.2016



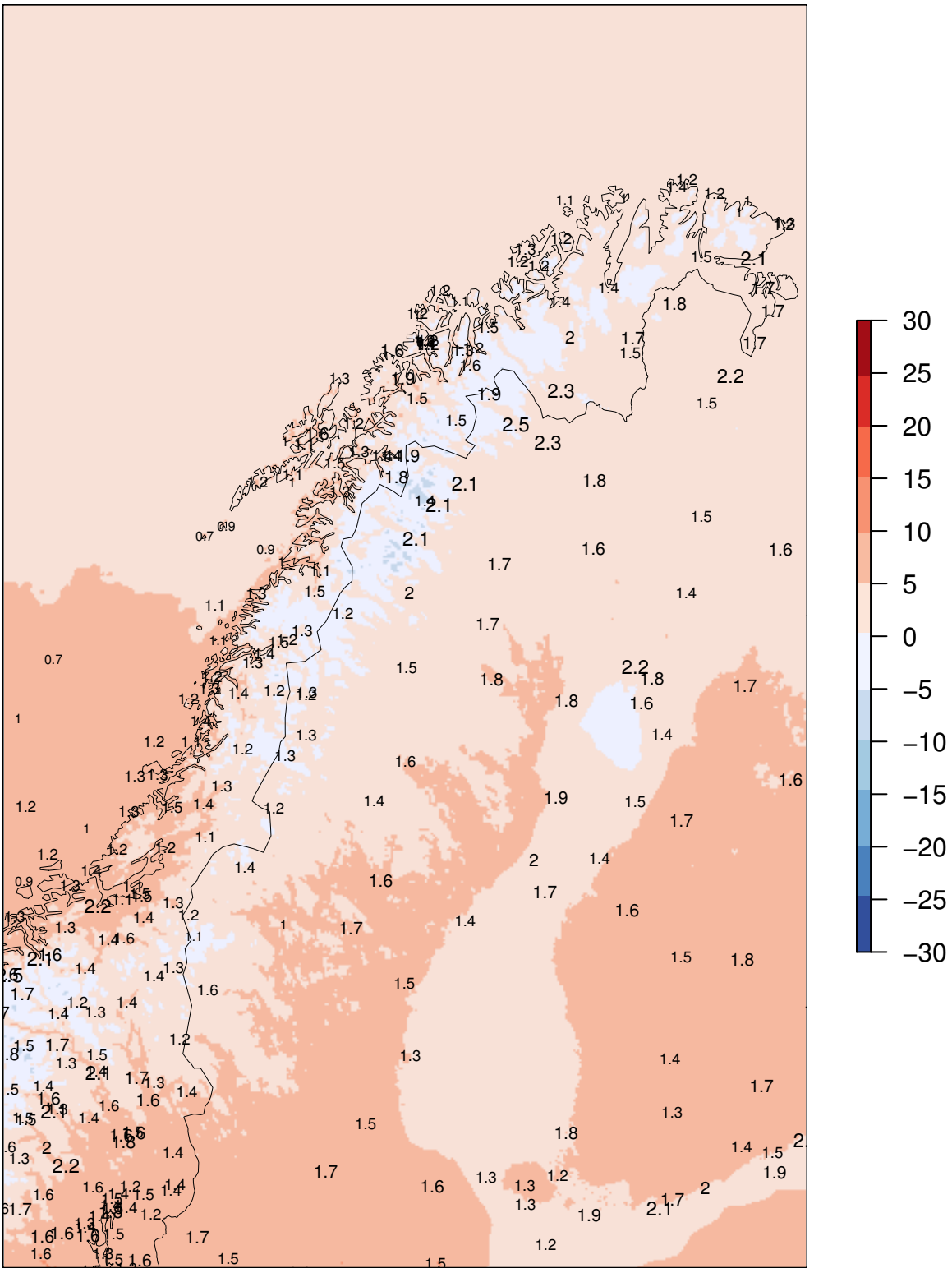
AM25 00+24

ME at observing sites forecast means 01.03.2016 – 31.05.2016



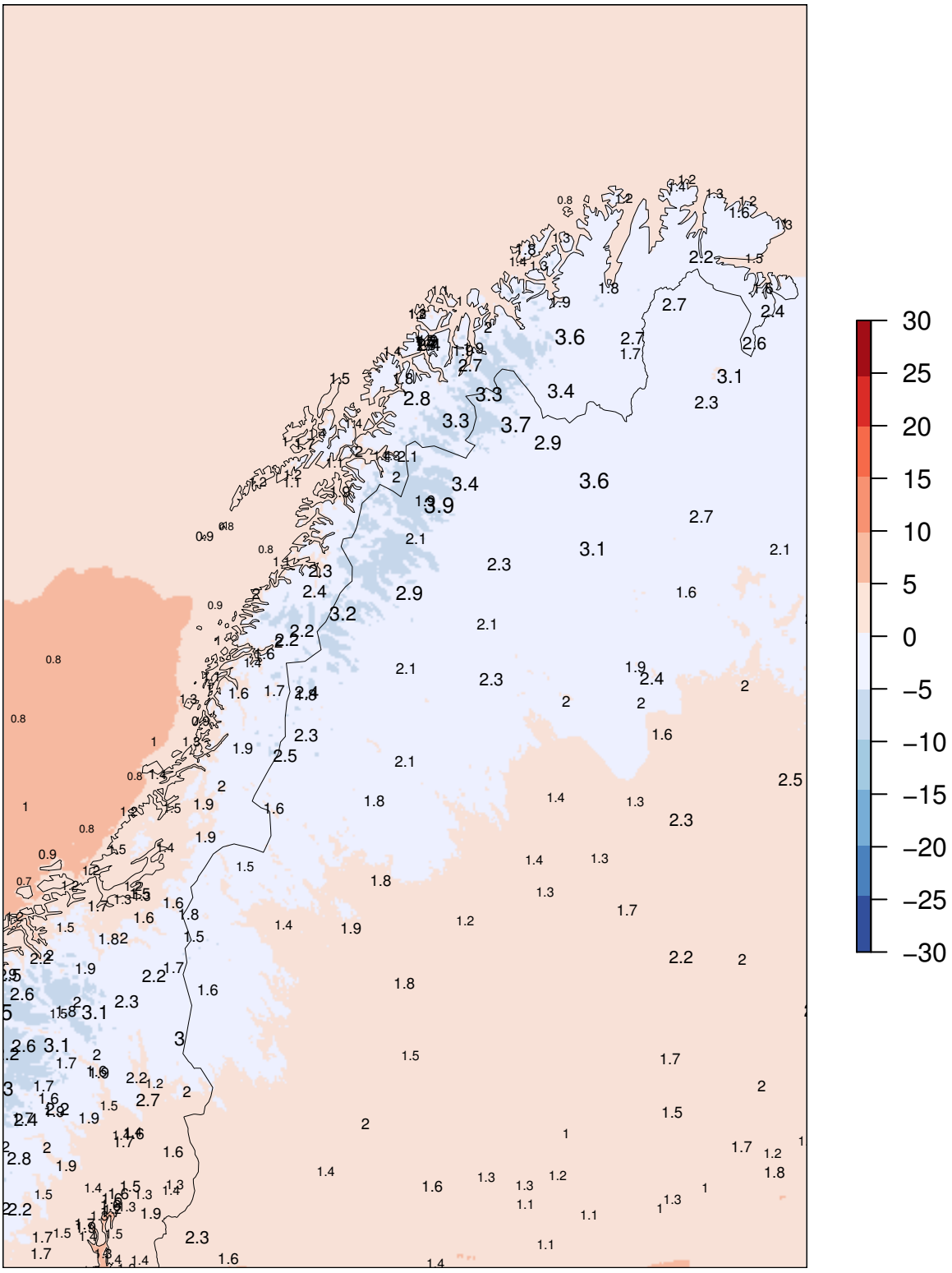
AM25 00+12

SDE at observing sites forecast means 01.03.2016 – 31.05.2016



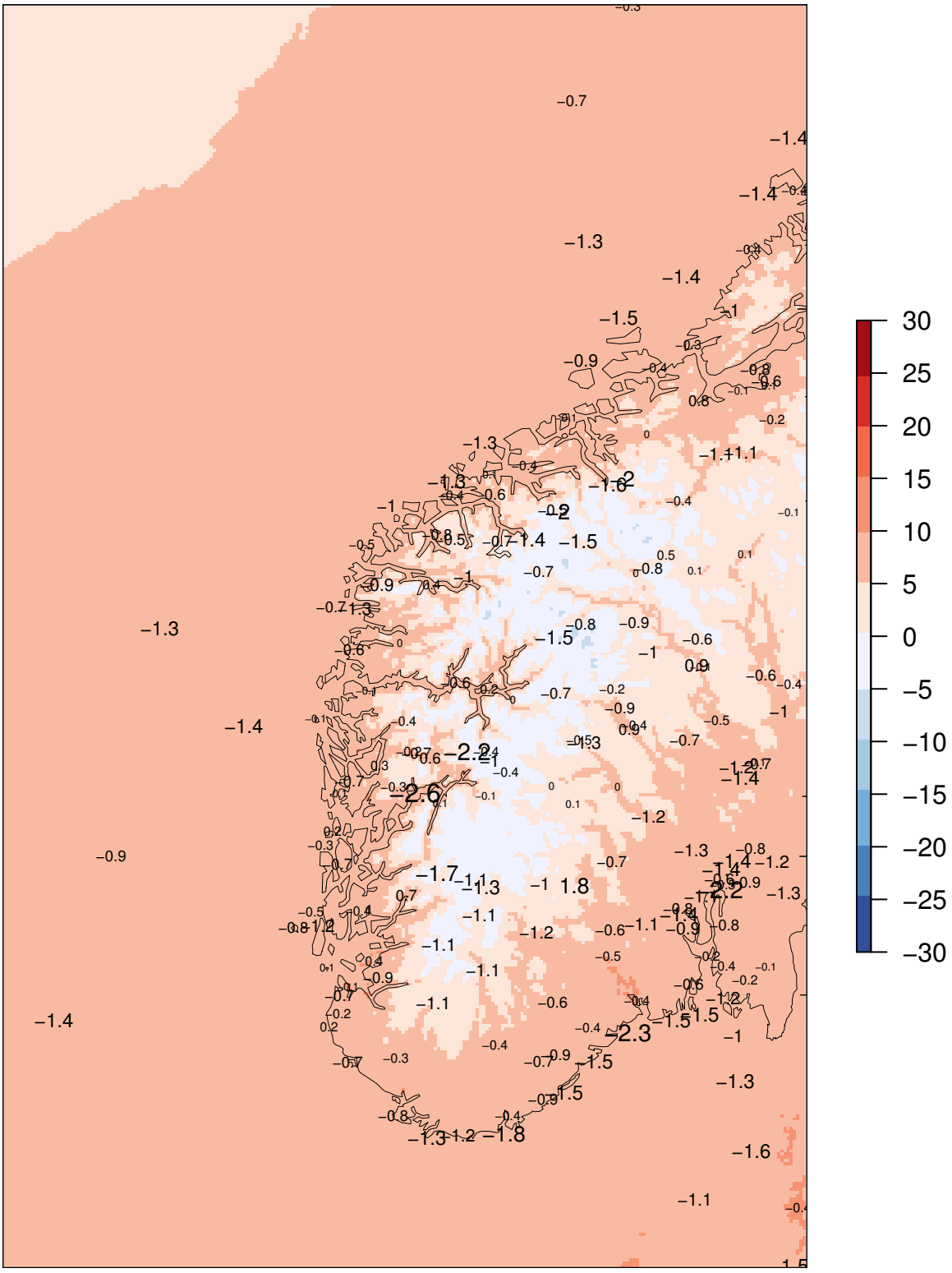
AM25 00+24

SDE at observing sites forecast means 01.03.2016 – 31.05.2016



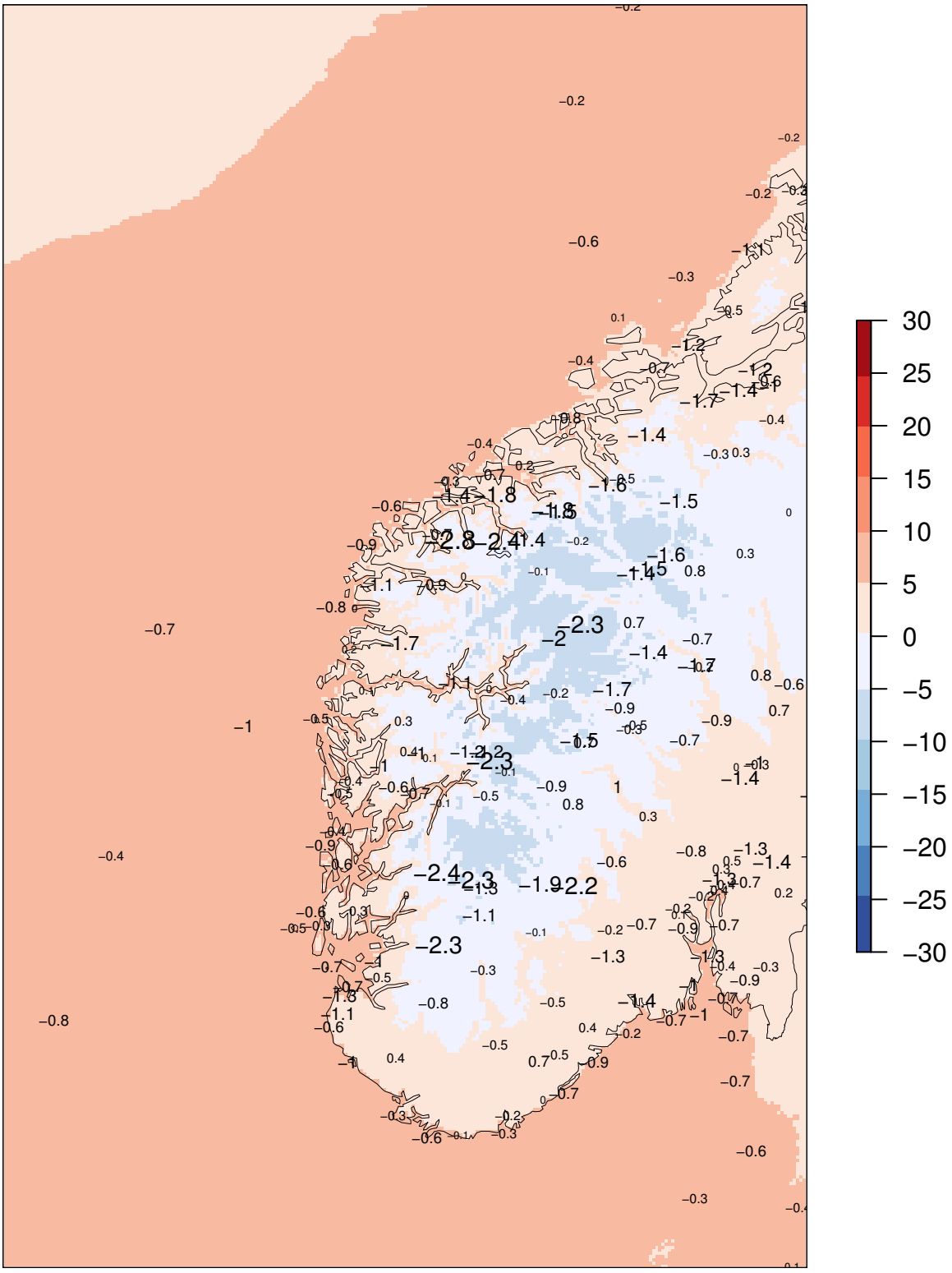
AM25 00+12

ME at observing sites forecast means 01.03.2016 – 31.05.2016



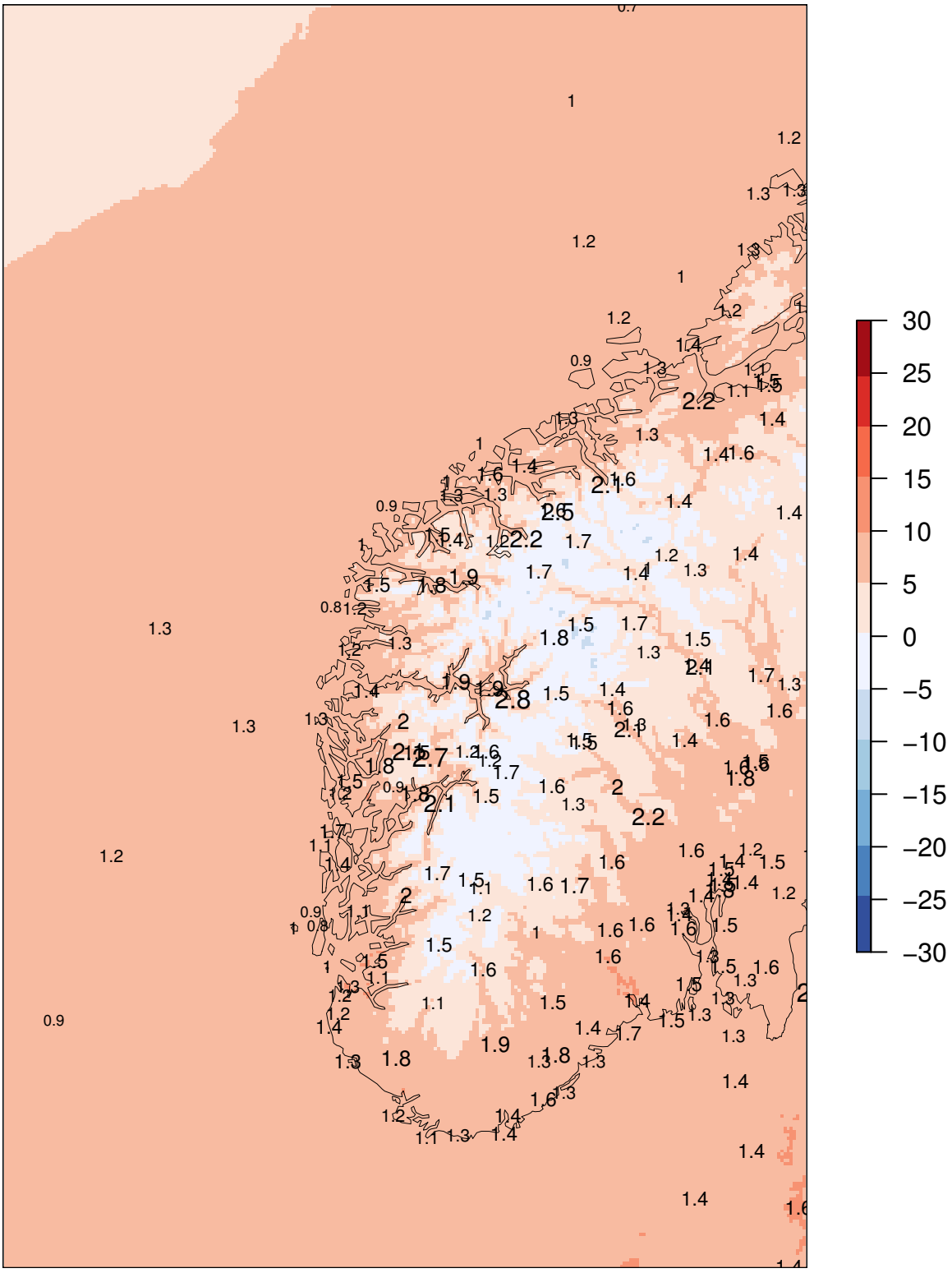
AM25 00+24

ME at observing sites forecast means 01.03.2016 – 31.05.2016



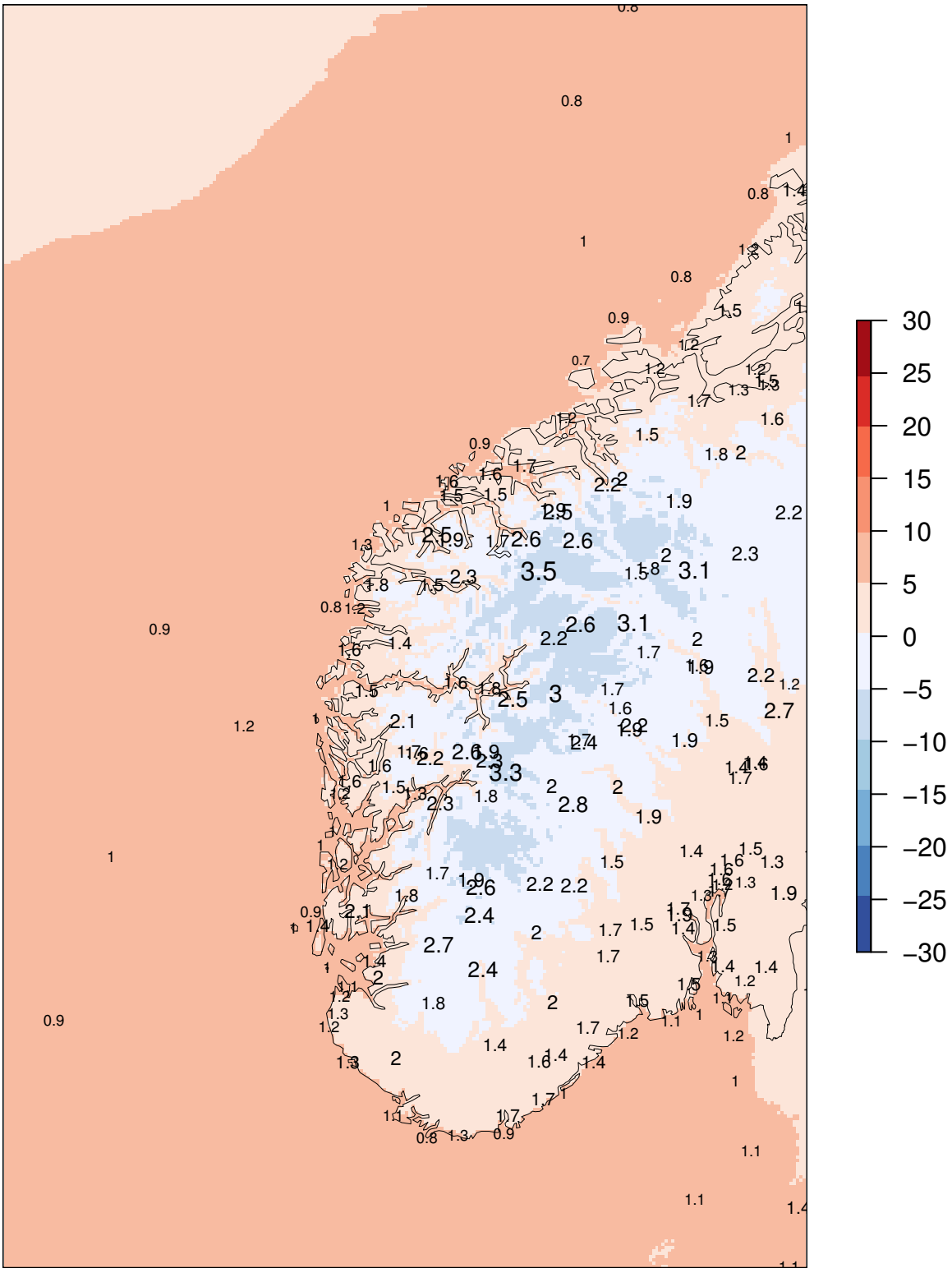
AM25 00+12

SDE at observing sites forecast means 01.03.2016 – 31.05.2016



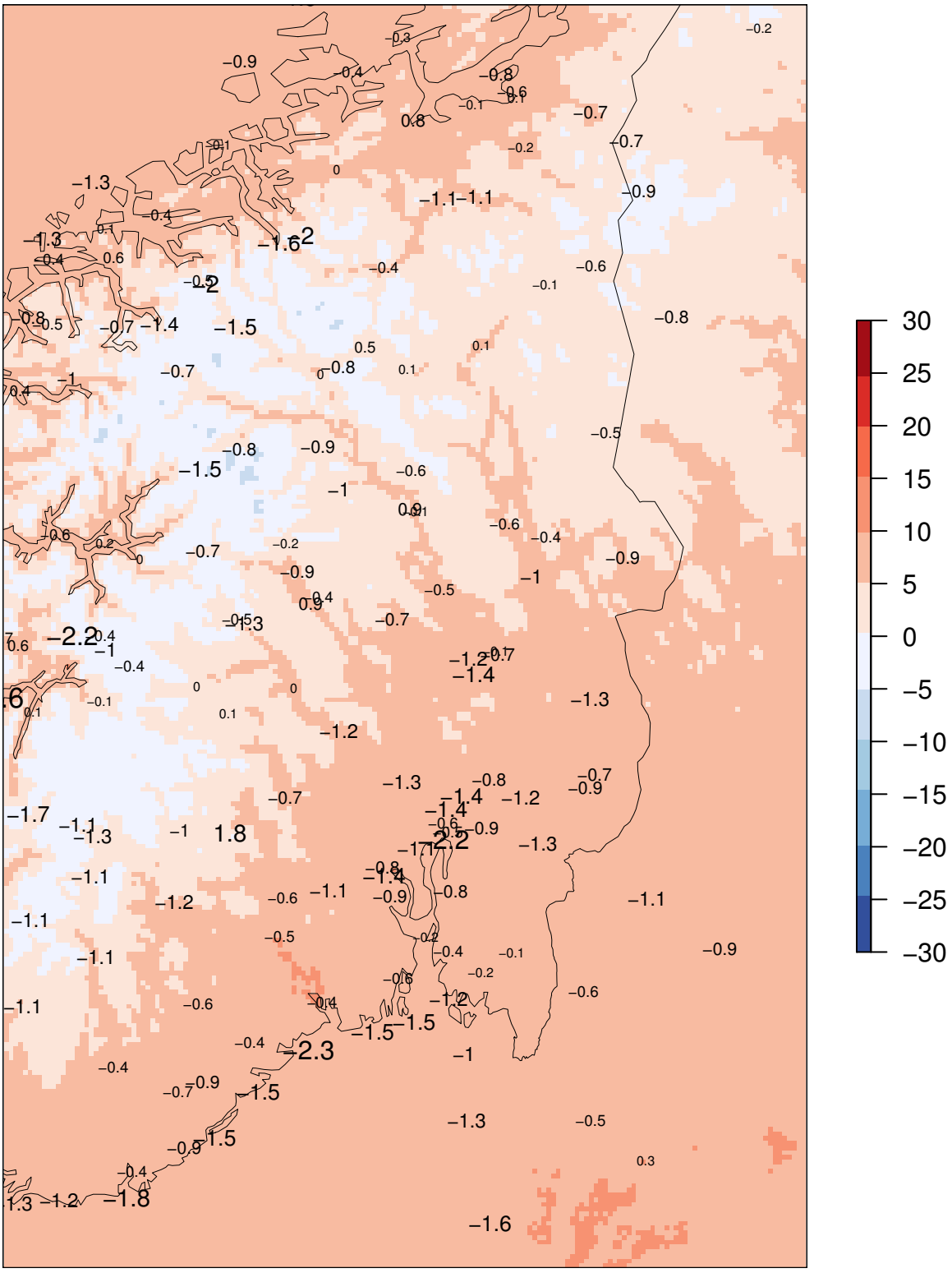
AM25 00+24

SDE at observing sites forecast means 01.03.2016 – 31.05.2016



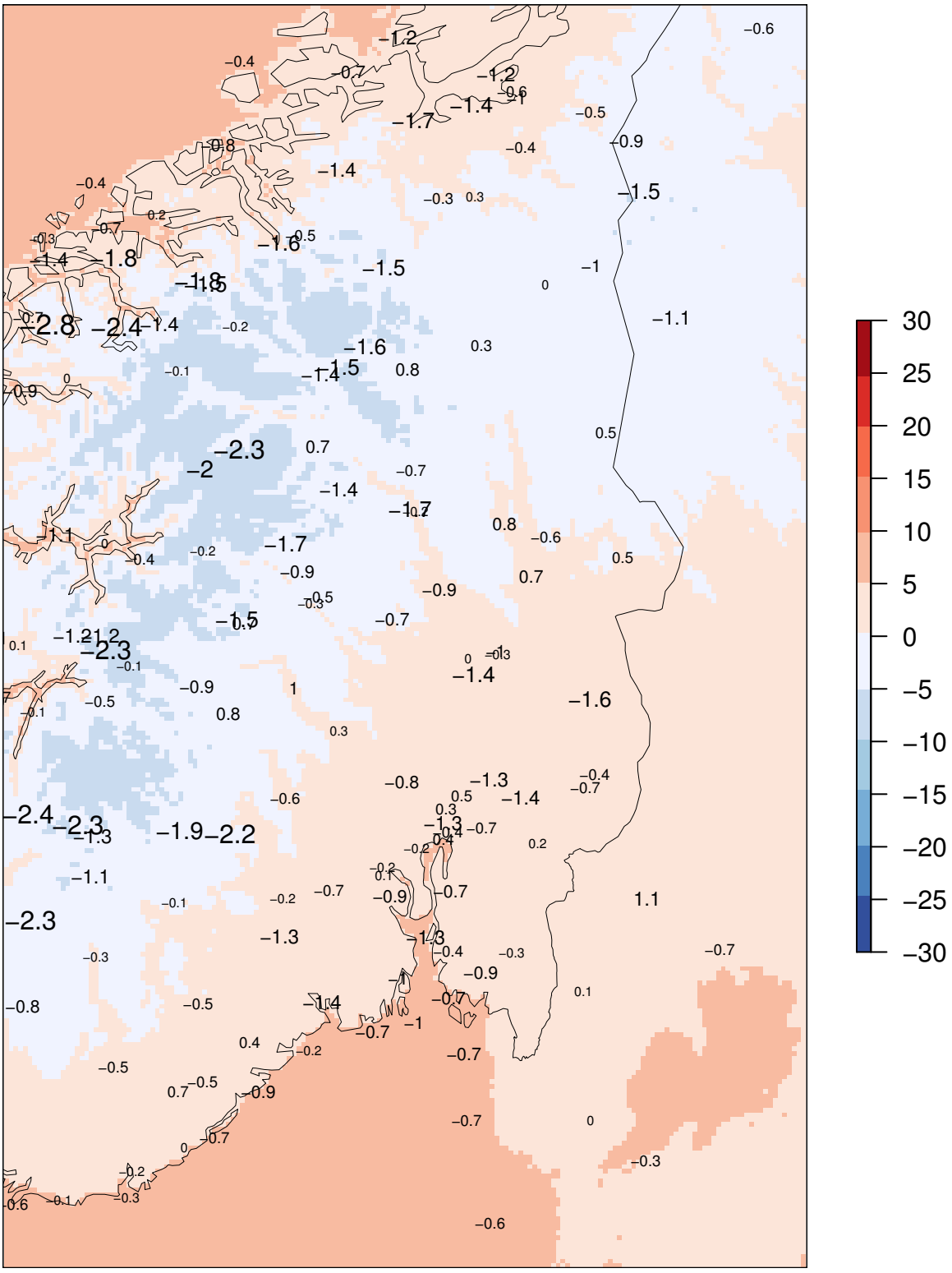
AM25 00+12

ME at observing sites forecast means 01.03.2016 – 31.05.2016



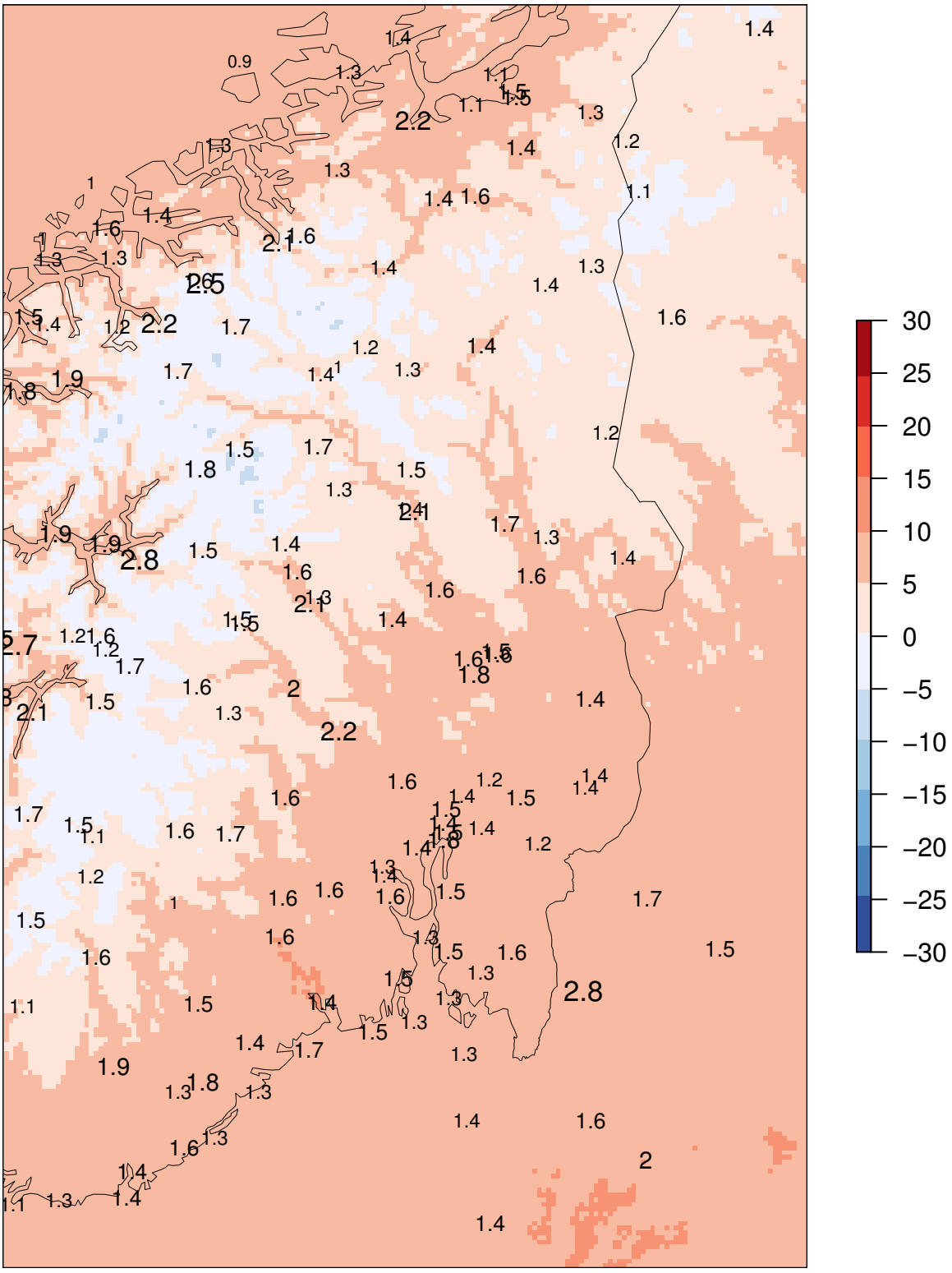
AM25 00+24

ME at observing sites forecast means 01.03.2016 – 31.05.2016



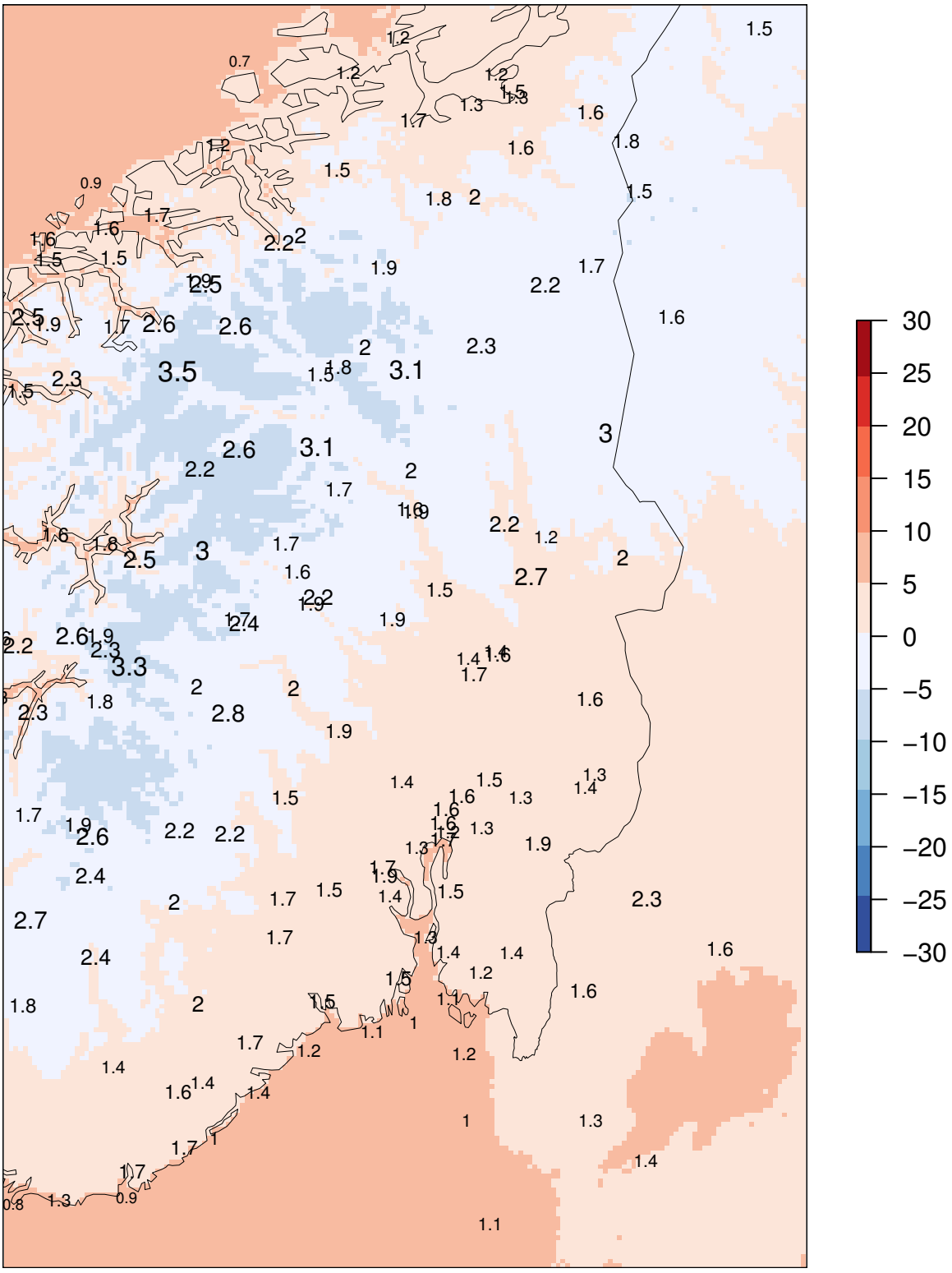
AM25 00+12

SDE at observing sites forecast means 01.03.2016 – 31.05.2016

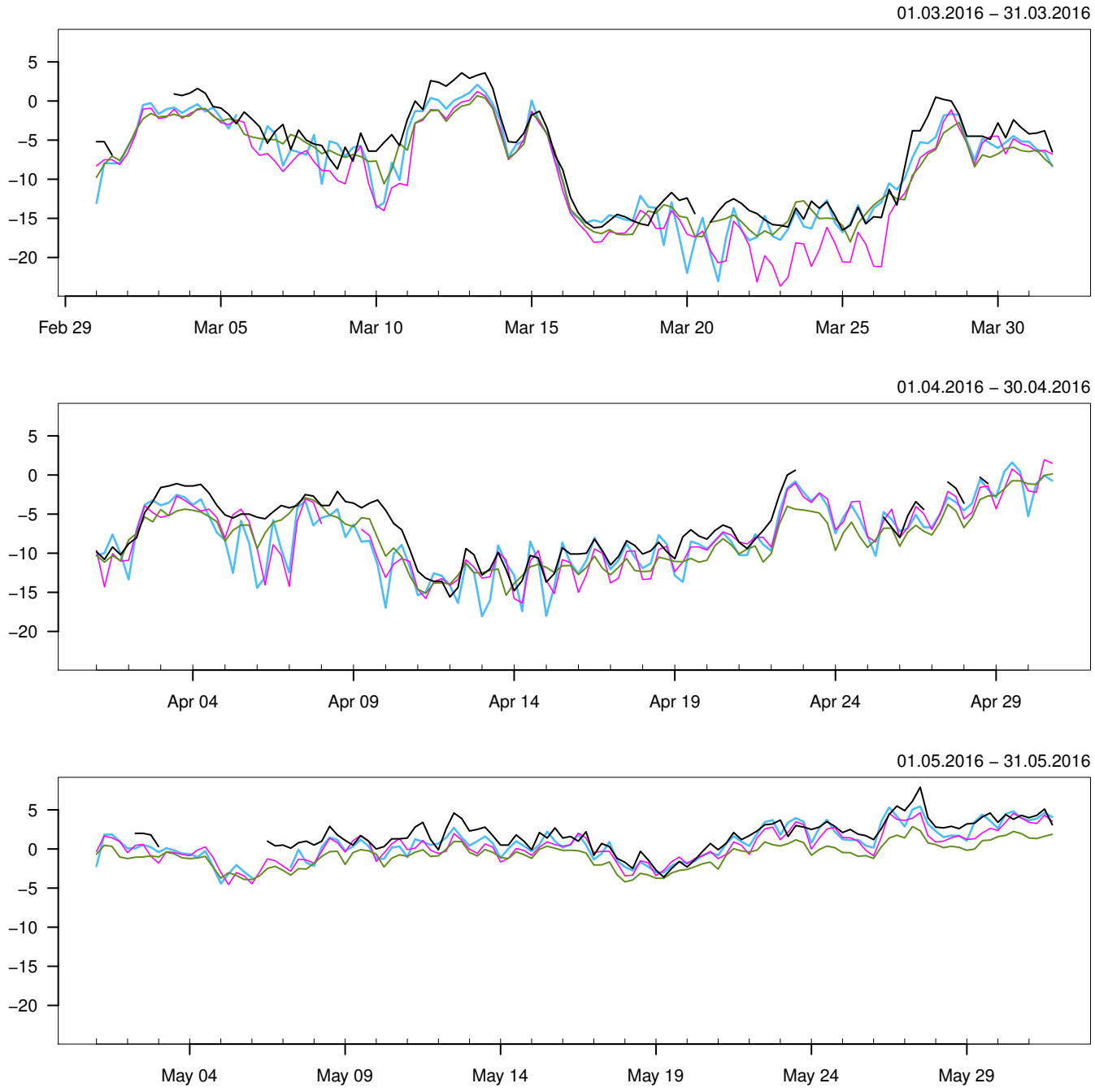


AM25 00+24

SDE at observing sites forecast means 01.03.2016 – 31.05.2016



SVALBARD LUFTHAVN



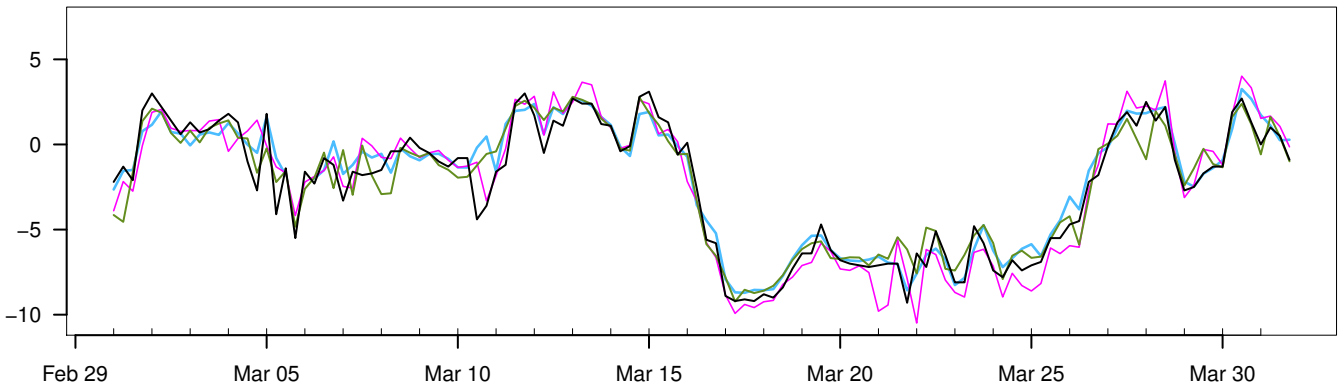
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−16.5	−4.1	7.9	6.1	321
AA25: 12+18,+24,+30,+36	−23	−5.2	5.4	6.2	362
Hirlam8: 12+18,+24,+30,+36	−23.7	−5.7	4.6	6.5	364
ECMWF: 12+18,+24,+30,+36	−18	−5.8	2.9	5.3	368

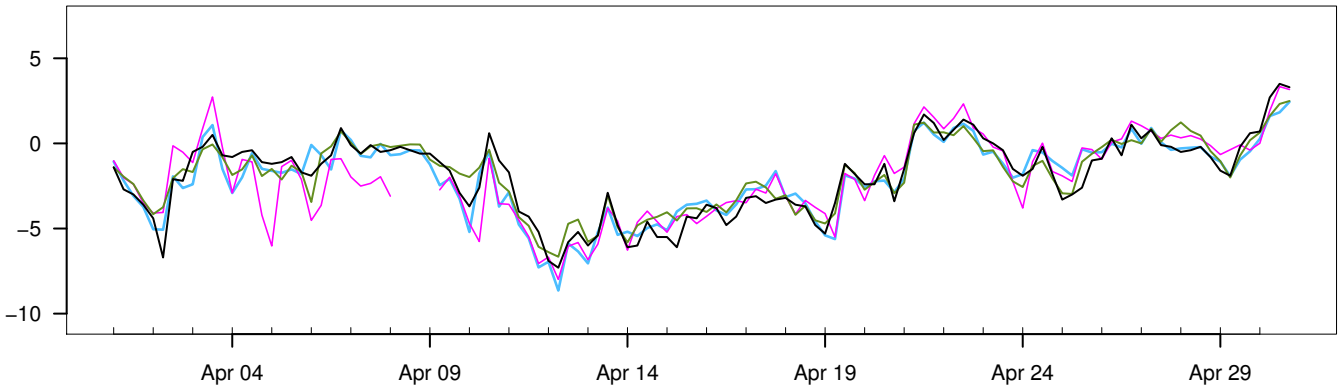
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AA25 – synop	−1.4	2.1	2.5	1.8	12.5	316
Hirlam8 – synop	−2	2	2.8	2.2	10	317
ECMWF – synop	−2	1.5	2.5	2.1	6.7	321

BJØRNØYA

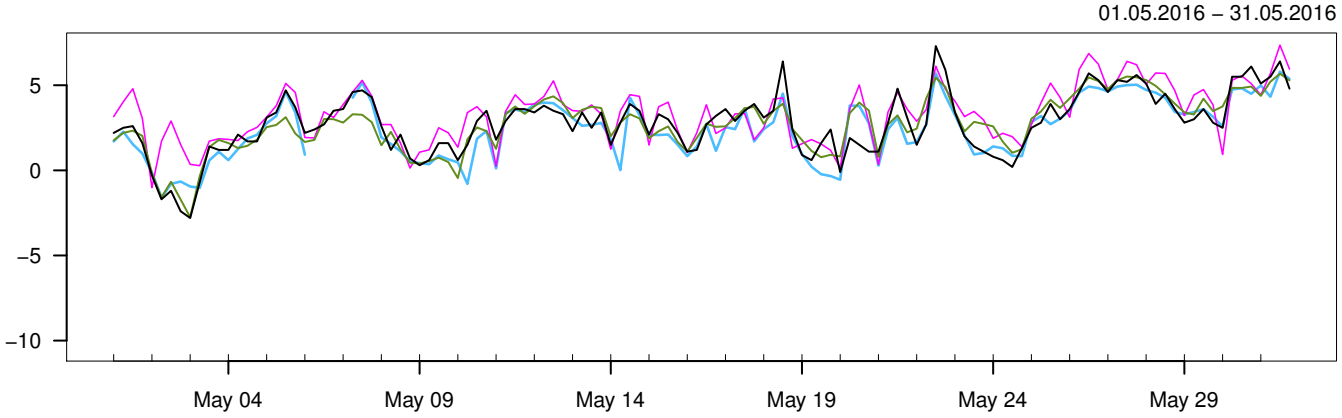
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016



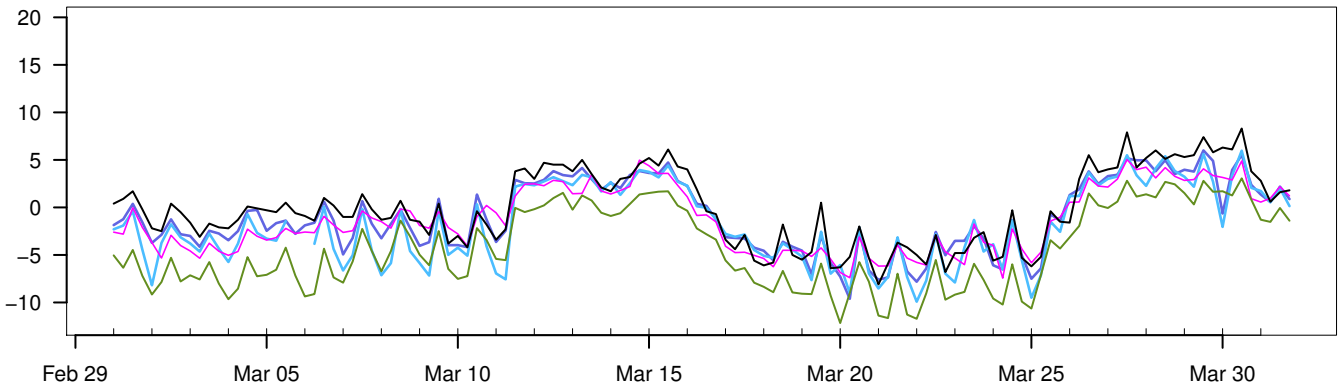
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−9.3	−0.5	7.3	3.6	368
AA25: 12+18,+24,+30,+36	−8.7	−0.6	5.8	3.3	362
Hirlam8: 12+18,+24,+30,+36	−10.5	−0.3	7.4	3.9	364
ECMWF: 12+18,+24,+30,+36	−9.2	−0.4	5.7	3.3	368

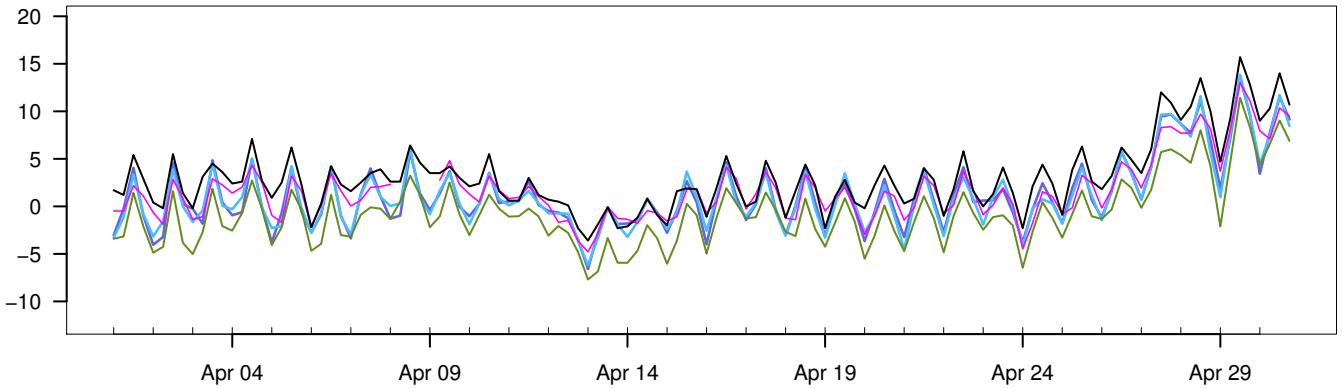
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AA25 – synop	−0.1	0.9	0.9	0.7	4.2	362
Hirlam8 – synop	0.1	1.2	1.2	0.9	4.8	364
ECMWF – synop	0	0.9	0.9	0.7	3.4	368

TROMSØ

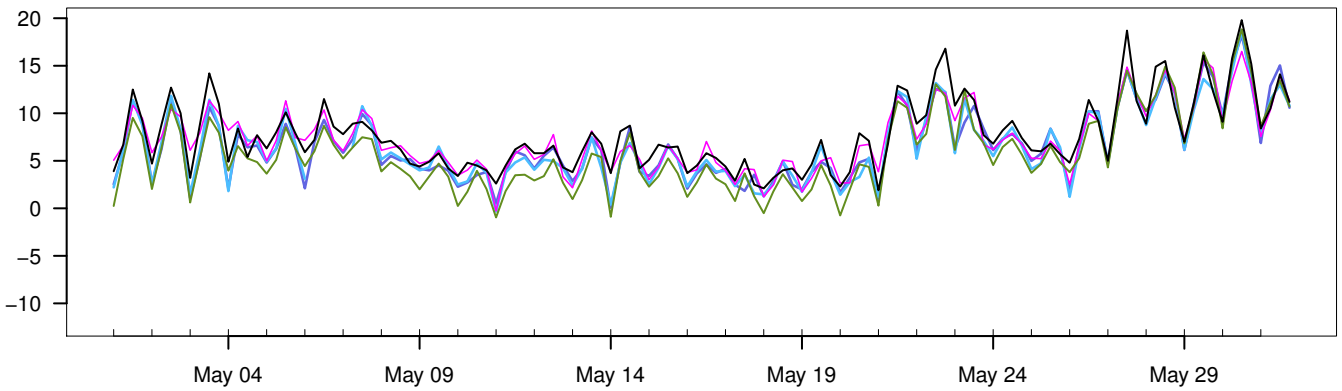
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016

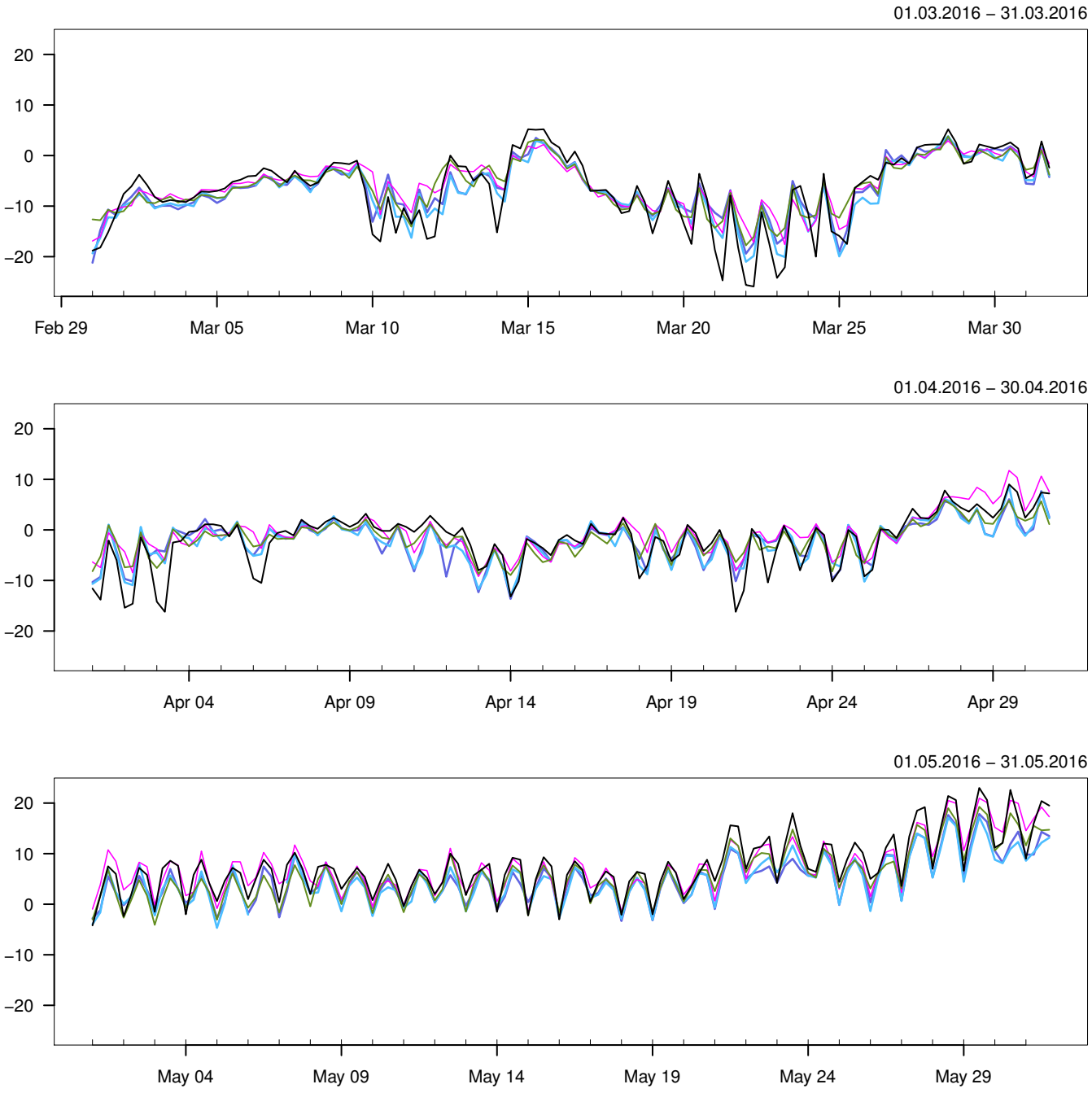


01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−8.1	3.5	19.8	5	368
AM25: 12+18,+24,+30,+36	−9.6	2.3	18.2	4.9	368
AA25: 12+18,+24,+30,+36	−9.9	2	18.7	5.2	362
Hirlam8: 12+18,+24,+30,+36	−7.4	2.6	16.5	4.9	364
ECMWF: 12+18,+24,+30,+36	−12.2	0.3	18.8	5.8	368

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−1.2	1.4	1.9	1.5	6.9	368
AA25 – synop	−1.5	1.5	2.2	1.7	8.3	362
Hirlam8 – synop	−1	1.4	1.7	1.4	4.8	364
ECMWF – synop	−3.2	1.7	3.7	3.3	8.5	368

KAUTOKEINO



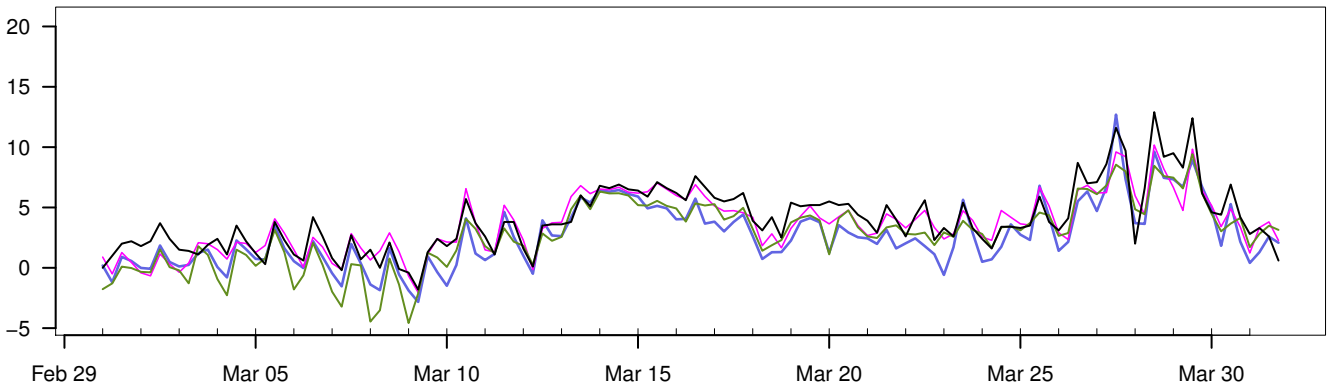
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−25.9	−0.4	23	8.5	368
AM25: 12+18,+24,+30,+36	−21.2	−1.2	17.8	6.6	368
AA25: 12+18,+24,+30,+36	−21	−1.6	17.2	6.9	362
Hirlam8: 12+18,+24,+30,+36	−17.6	0.2	21	7.3	364
ECMWF: 12+18,+24,+30,+36	−17.8	−0.7	19.3	6.7	368

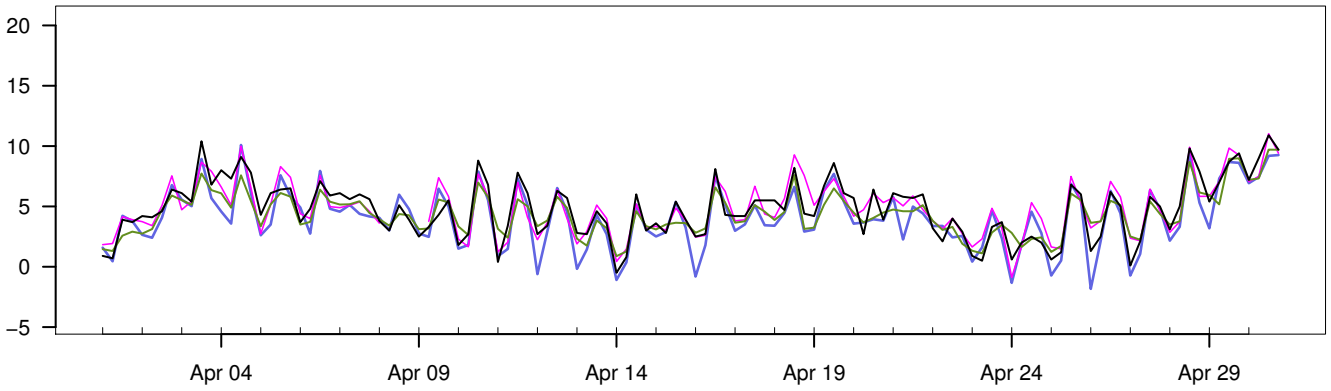
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−0.9	3	3.2	2.4	12.3	368
AA25 – synop	−1.2	2.8	3	2.4	11.7	362
Hirlam8 – synop	0.6	3	3	2.1	12.4	364
ECMWF – synop	−0.4	3	3	2.2	11.7	368

ØRLAND III

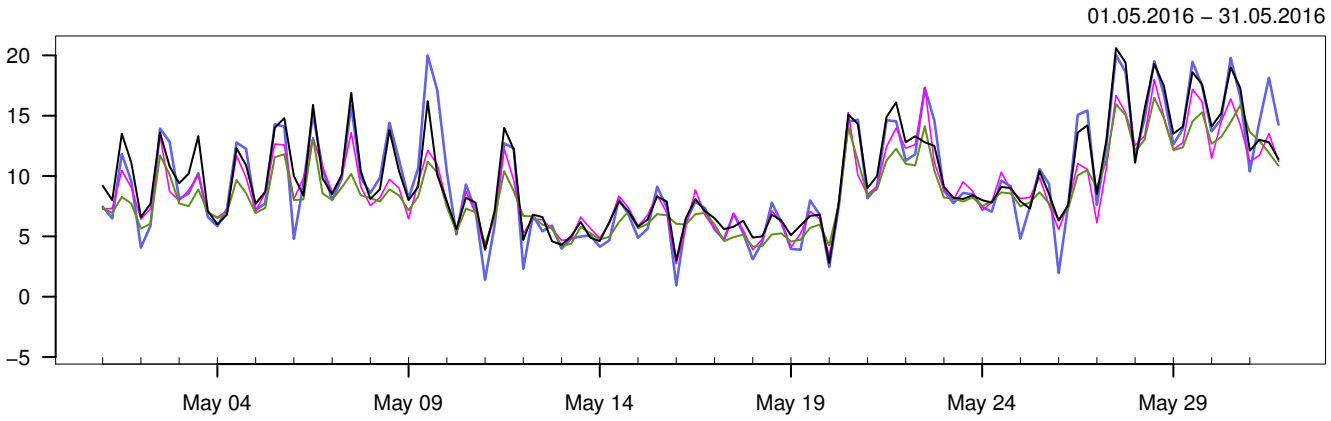
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016



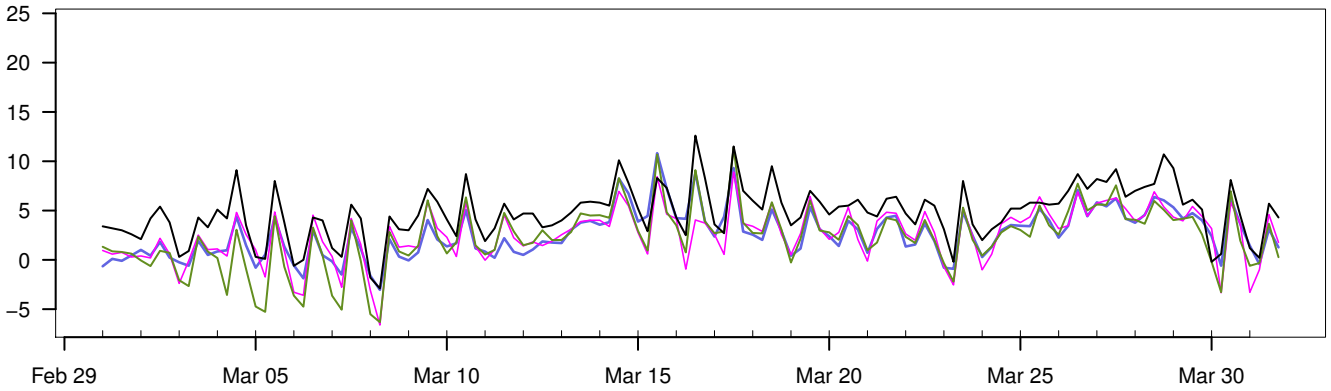
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−1.8	6.2	20.6	4.1	368
AM25: 12+18,+24,+30,+36	−2.8	5.5	20	4.5	368
Hirlam8: 12+18,+24,+30,+36	−2	5.9	18	3.6	364
ECMWF: 12+18,+24,+30,+36	−4.6	5.3	16.5	3.6	368

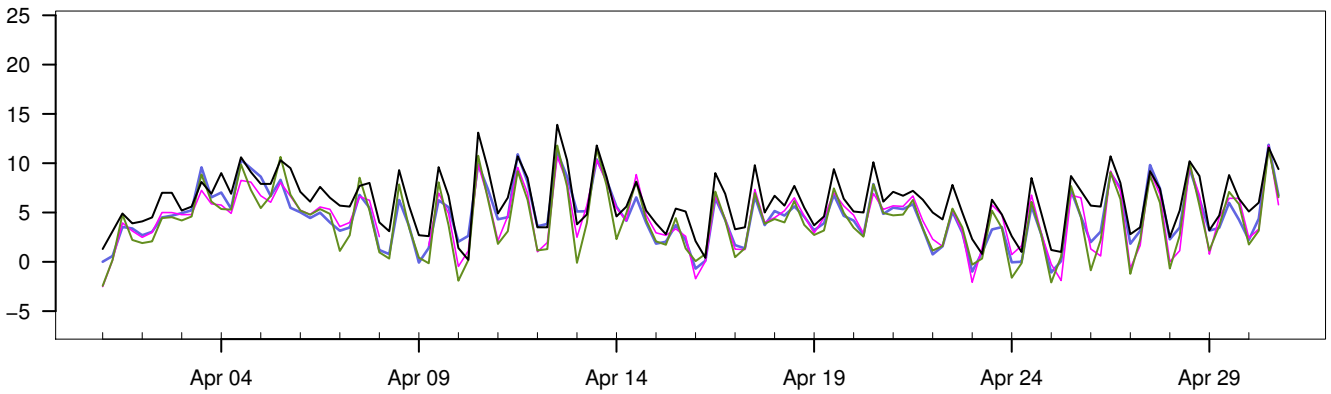
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−0.7	1.4	1.6	1.2	7	368
Hirlam8 – synop	−0.4	1.3	1.3	1	4.5	364
ECMWF – synop	−1	1.4	1.7	1.3	6.7	368

BERGEN – FLORIDA

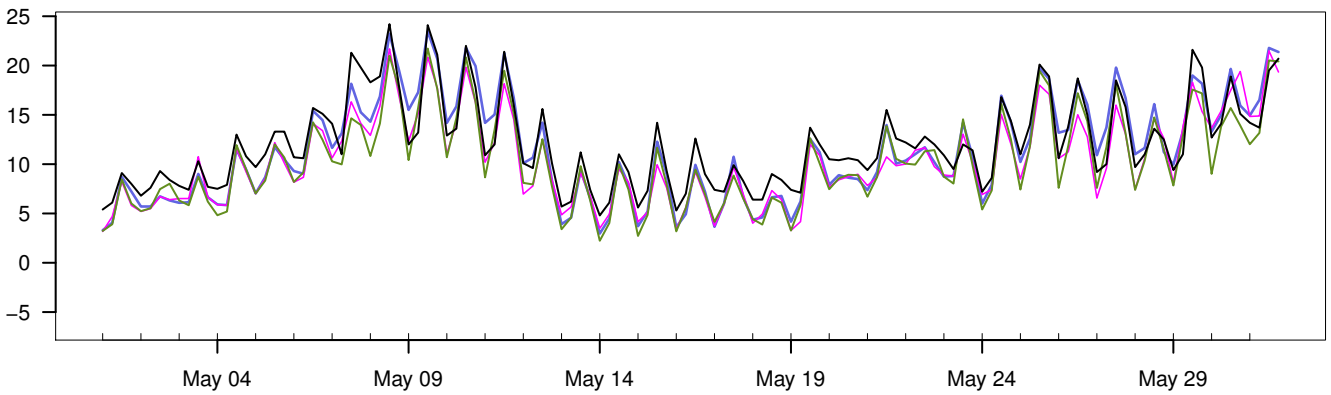
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016

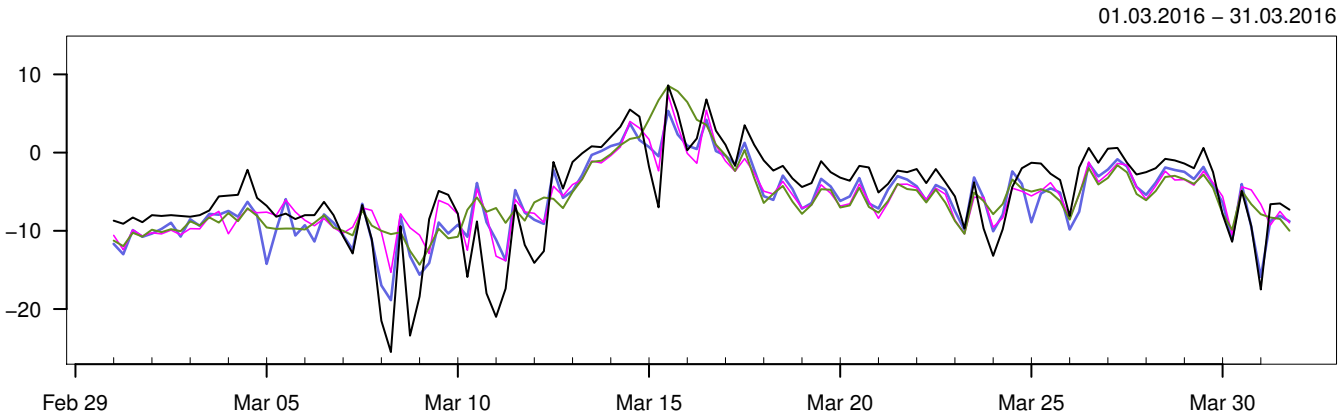


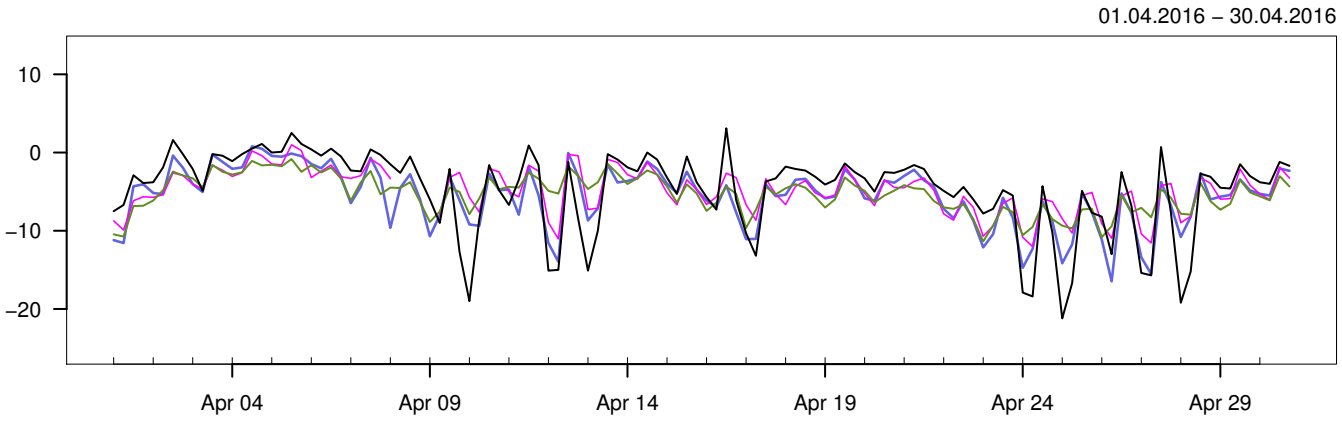
01.03.2016 – 31.05.2016

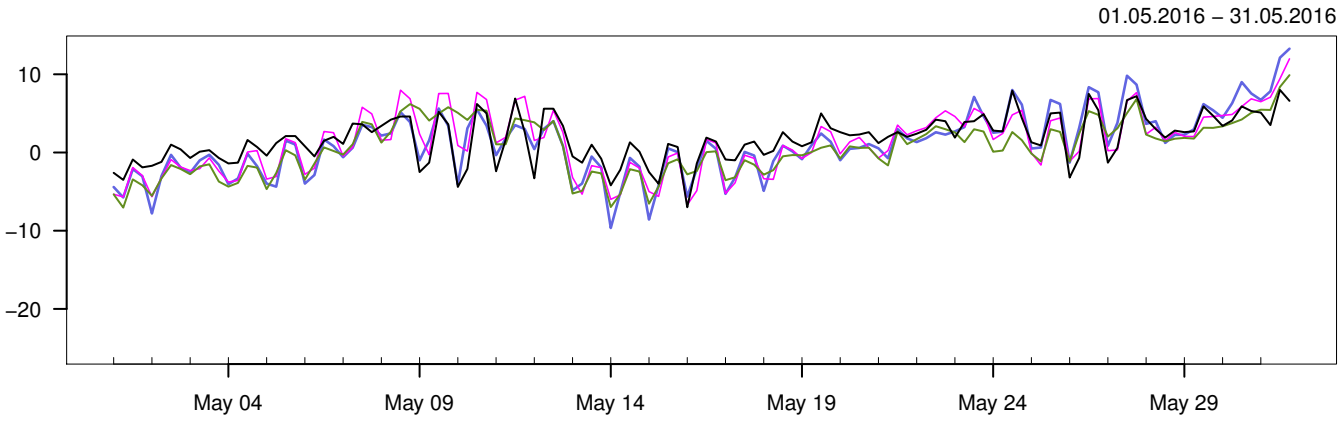
	Min	Mean	Max	Std	N
synop: 00,06,12,18	−2.9	7.7	24.2	4.7	368
AM25: 12+18,+24,+30,+36	−3	6.2	23.5	5.3	368
Hirlam8: 12+18,+24,+30,+36	−6.6	5.9	21.7	4.8	364
ECMWF: 12+18,+24,+30,+36	−6.3	5.6	21.7	5.1	368

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−1.5	1.6	2.2	1.9	4.7	368
Hirlam8 – synop	−1.8	1.4	2.3	2	8.6	364
ECMWF – synop	−2.1	1.4	2.5	2.2	7.8	368

FINSEVATN







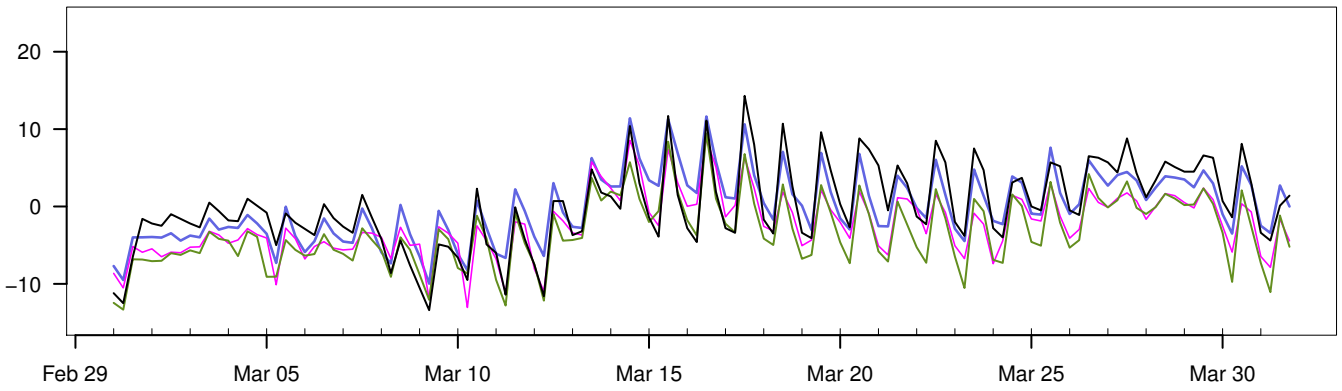
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−25.5	−2.7	8.6	5.8	368
AM25: 12+18,+24,+30,+36	−18.9	−3.5	13.3	5.3	368
Hirlam8: 12+18,+24,+30,+36	−15.3	−3.1	12	4.8	364
ECMWF: 12+18,+24,+30,+36	−14.3	−3.5	9.9	4.6	368

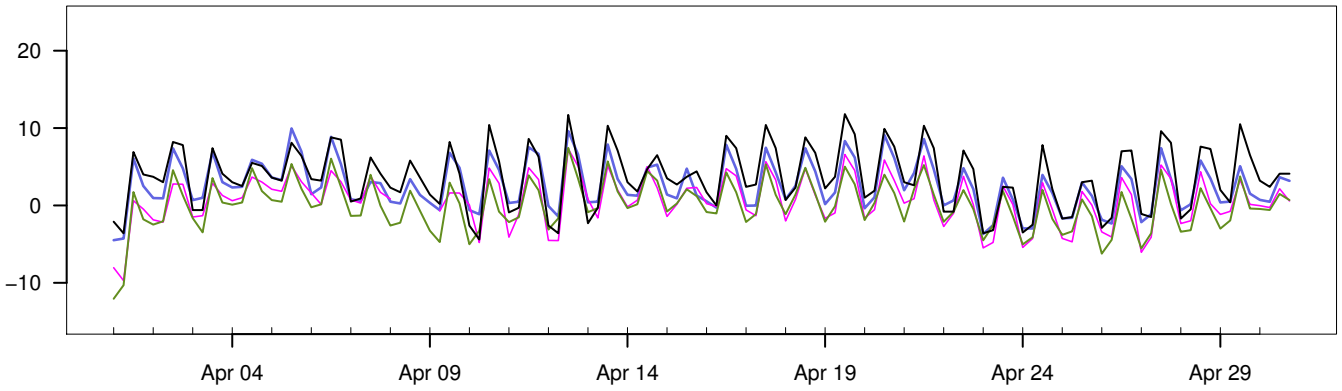
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−0.7	2.7	2.8	2.2	10.1	368
Hirlam8 – synop	−0.4	3.1	3.1	2.4	13.8	364
ECMWF – synop	−0.8	3.6	3.7	2.9	15.1	368

NESBYEN – TODOKK

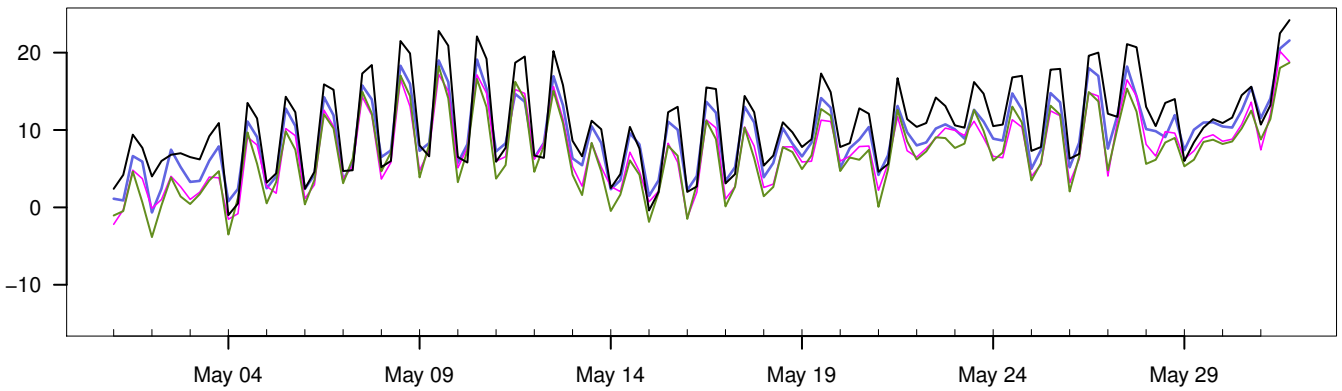
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016



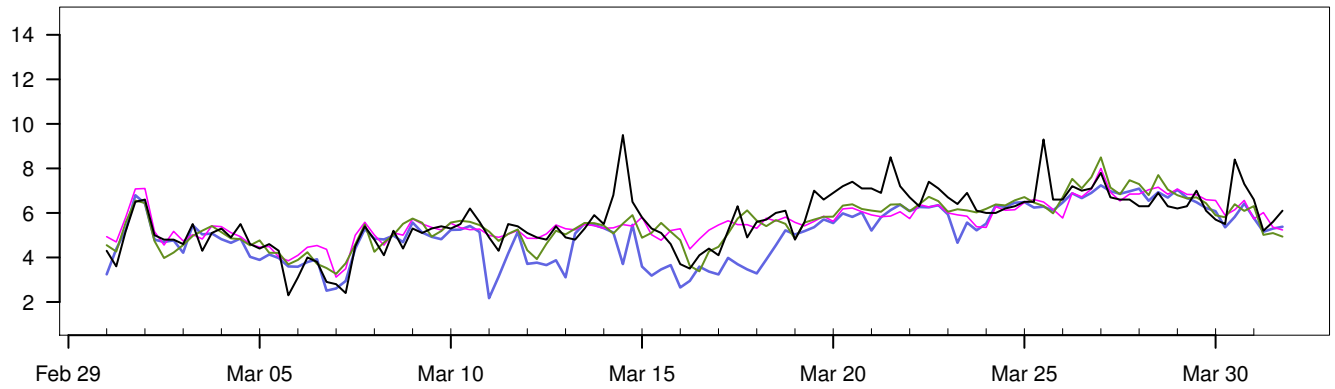
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−13.4	4.8	24.2	6.8	368
AM25: 12+18,+24,+30,+36	−10	4	21.6	5.8	368
Hirlam8: 12+18,+24,+30,+36	−13	2	20.2	5.8	364
ECMWF: 12+18,+24,+30,+36	−13.3	1.3	18.7	6.1	368

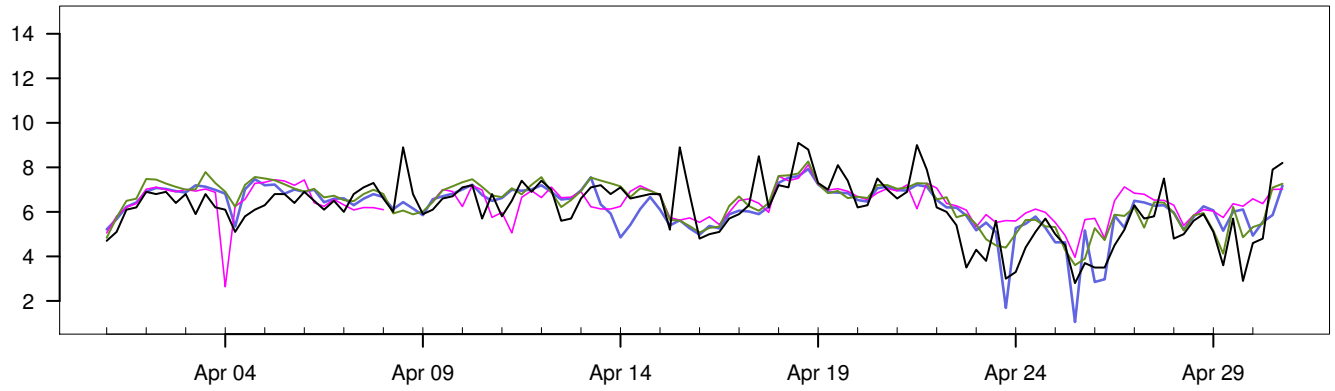
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−0.9	2.2	2.4	1.9	7.8	368
Hirlam8 – synop	−2.9	2.5	3.8	3.2	10.4	364
ECMWF – synop	−3.5	2.3	4.2	3.7	11.1	368

EKOFISK

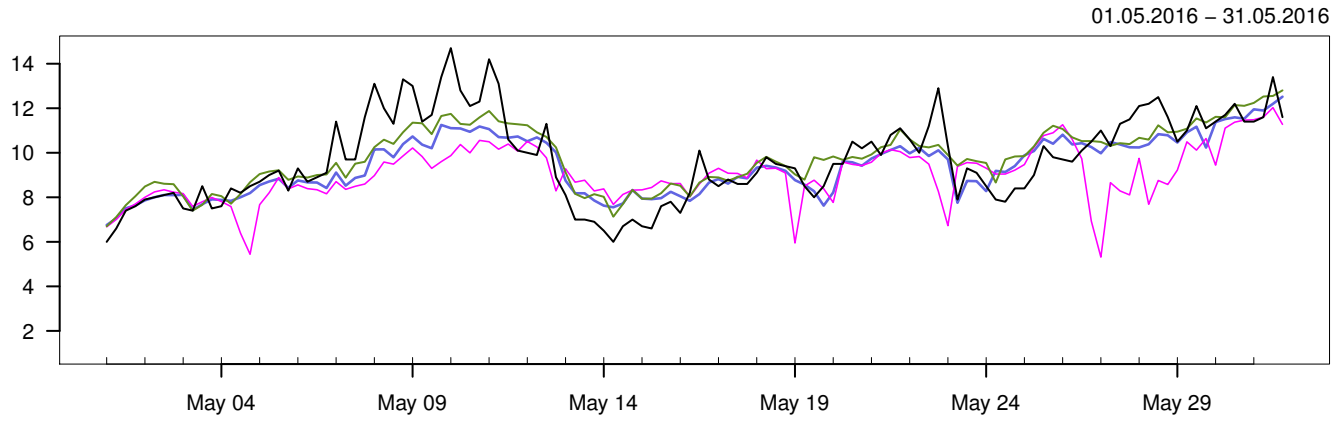
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016



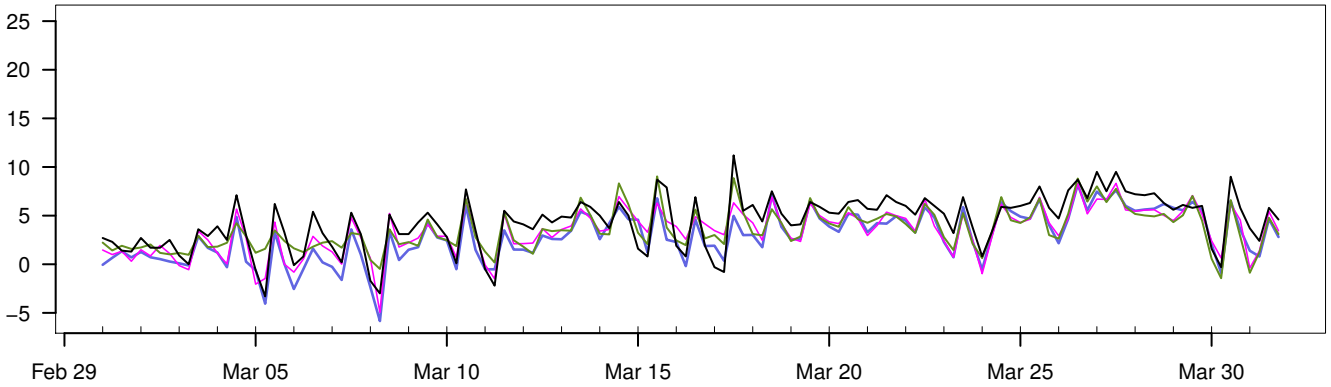
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	2.3	7.2	14.7	2.4	368
AM25: 12+18,+24,+30,+36	1.1	6.9	12.5	2.2	368
Hirlam8: 12+18,+24,+30,+36	2.6	7	12	1.8	364
ECMWF: 12+18,+24,+30,+36	3.3	7.3	12.8	2.2	368

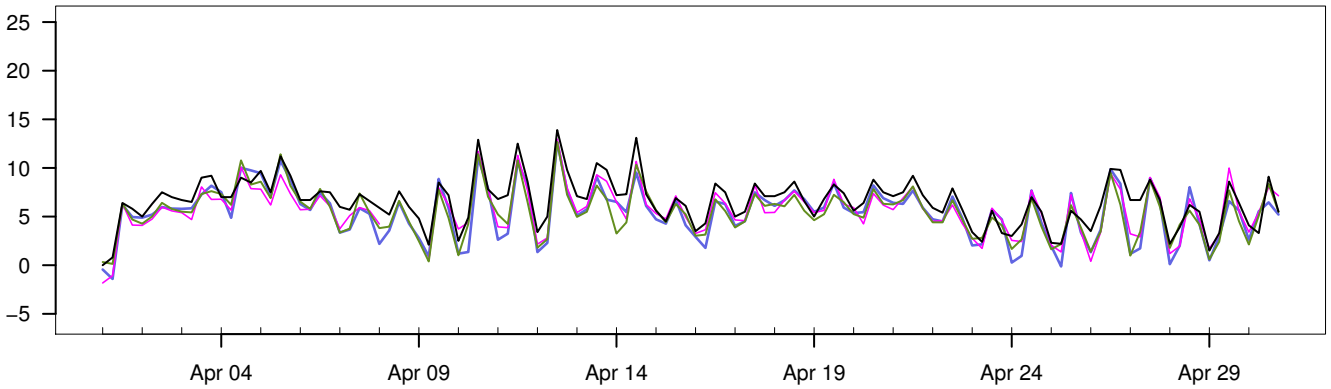
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	–0.3	1	1.1	0.8	5.8	368
Hirlam8 – synop	–0.2	1.3	1.3	0.9	5.7	364
ECMWF – synop	0.1	0.9	0.9	0.7	4	368

SOLA

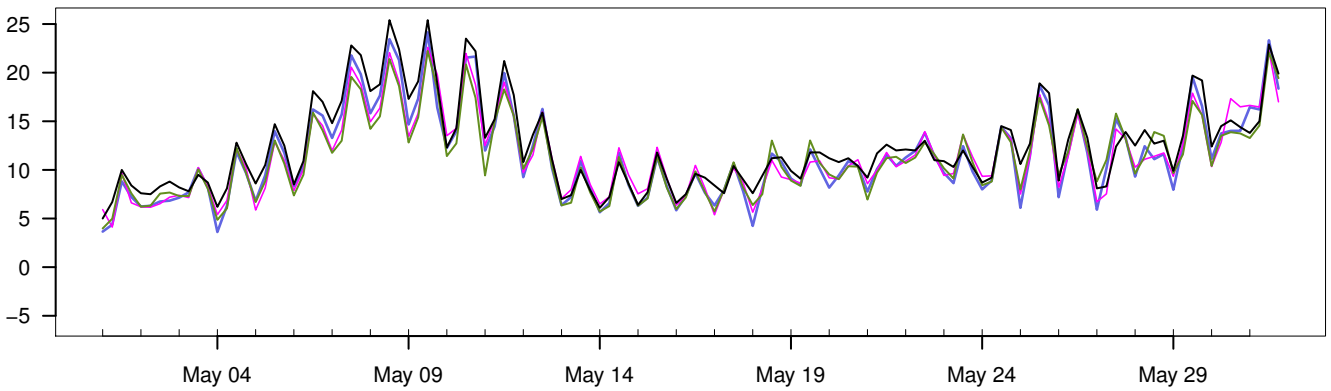
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016



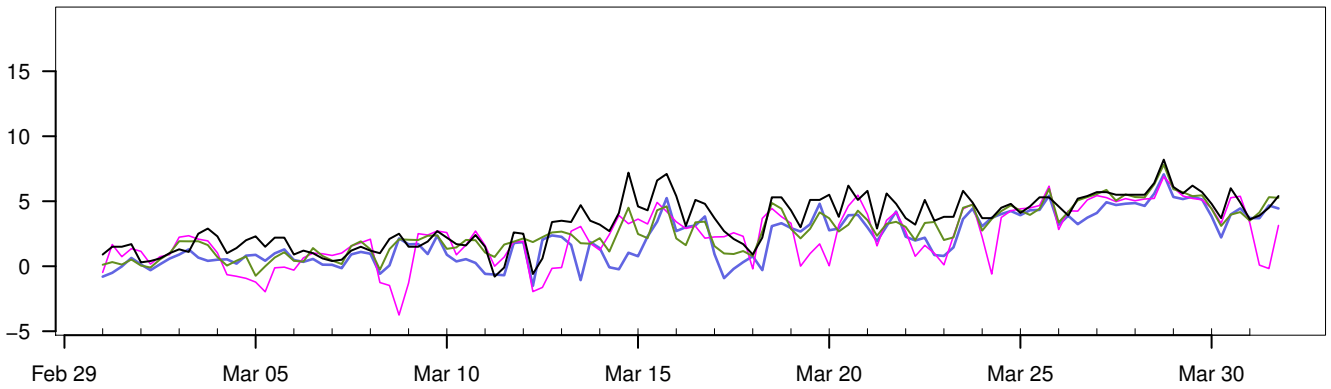
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−3.3	7.8	25.4	4.8	368
AM25: 12+18,+24,+30,+36	−5.8	6.6	24.2	5	368
Hirlam8: 12+18,+24,+30,+36	−4.9	6.9	22.6	4.7	364
ECMWF: 12+18,+24,+30,+36	−1.4	6.8	22.2	4.4	368

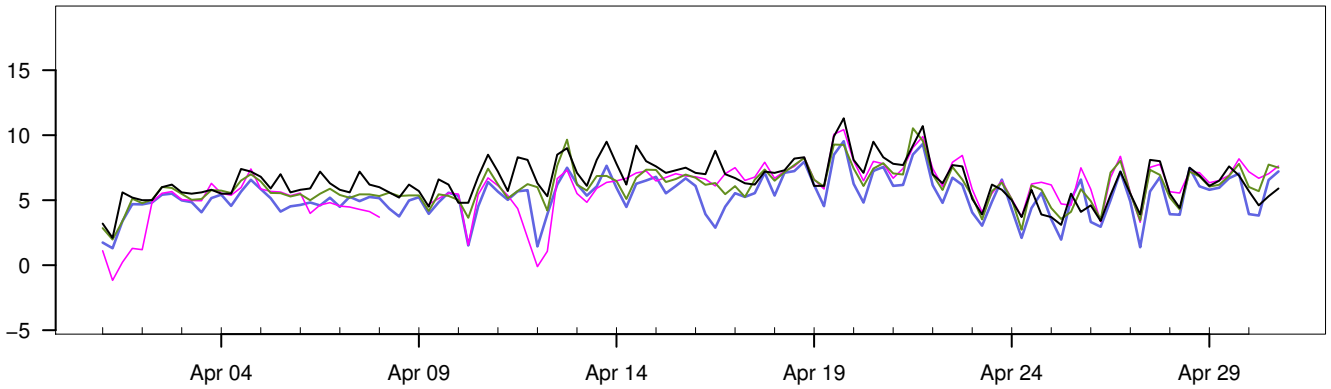
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−1.2	1.2	1.7	1.4	6.2	368
Hirlam8 – synop	−0.9	1.3	1.6	1.3	4.9	364
ECMWF – synop	−1	1.4	1.7	1.4	5.7	368

FÆRDER FYR

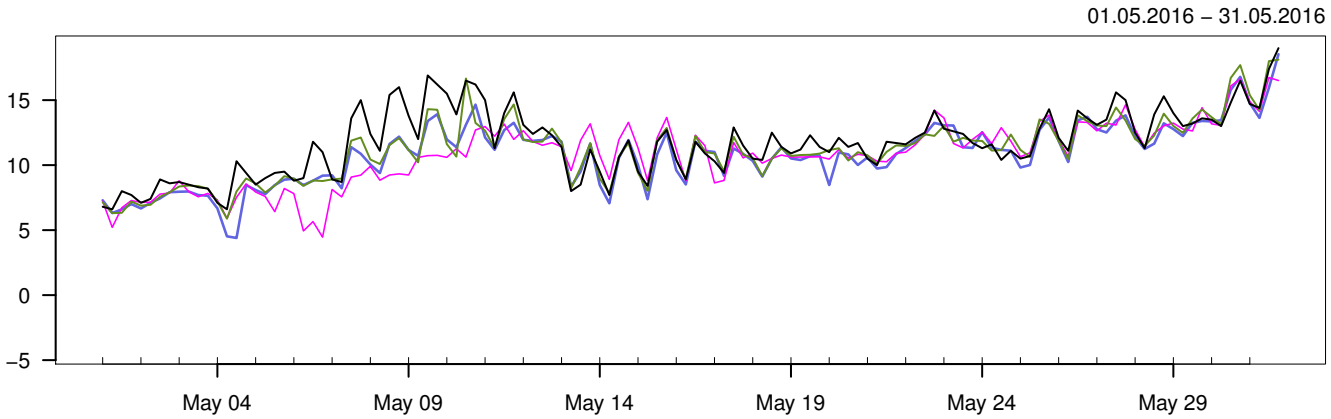
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016



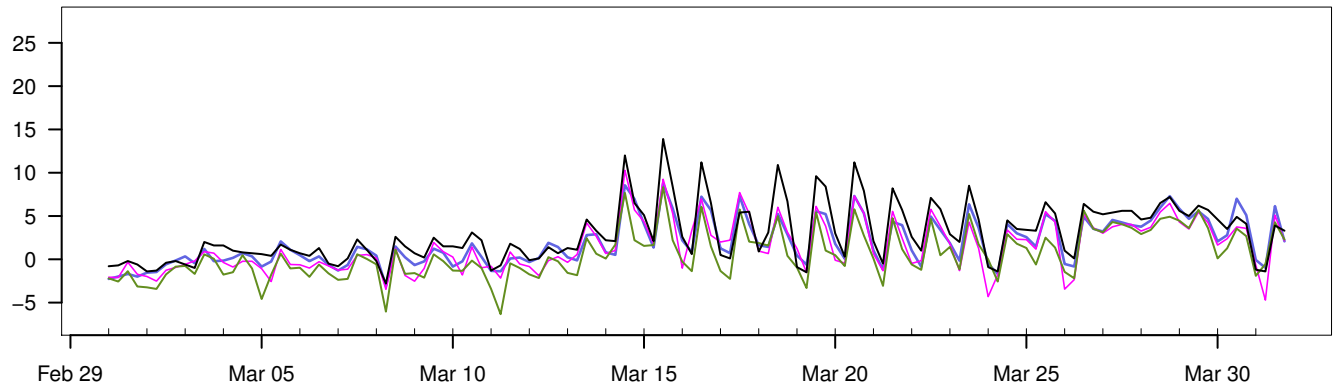
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	−0.8	7.2	19	4	368
AM25: 12+18,+24,+30,+36	−1.5	6.1	18.5	4.1	368
Hirlam8: 12+18,+24,+30,+36	−3.8	6.3	16.7	4.2	364
ECMWF: 12+18,+24,+30,+36	−0.7	6.6	18.1	4	368

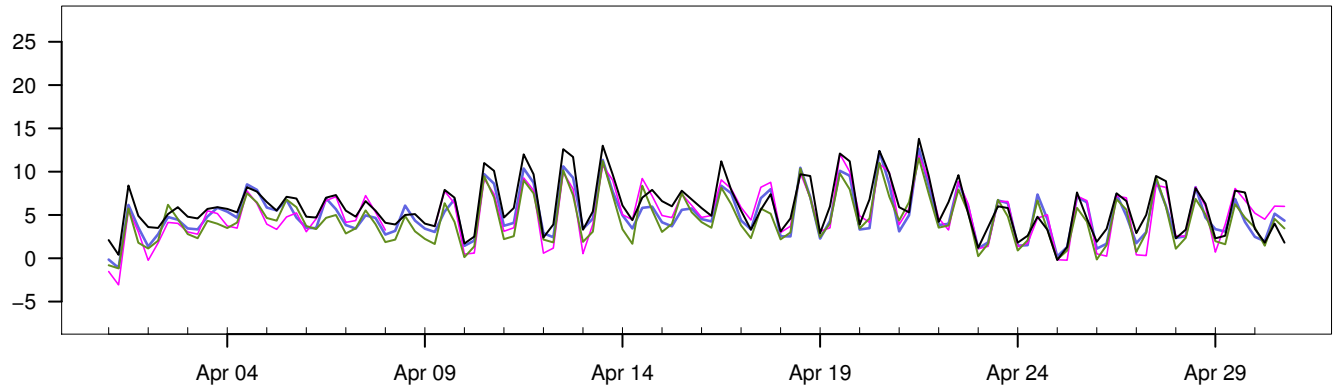
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−1.1	1.1	1.6	1.2	6.2	368
Hirlam8 – synop	−0.9	1.7	1.9	1.3	6.7	364
ECMWF – synop	−0.6	1	1.1	0.8	3.9	368

OSLO – BLINDERN

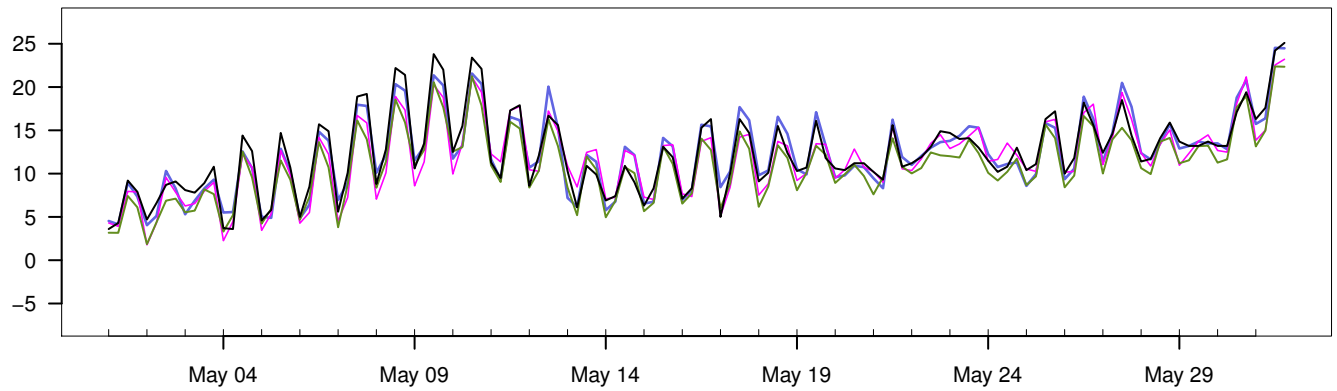
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016

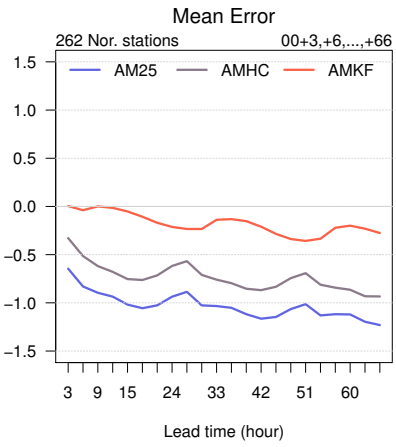


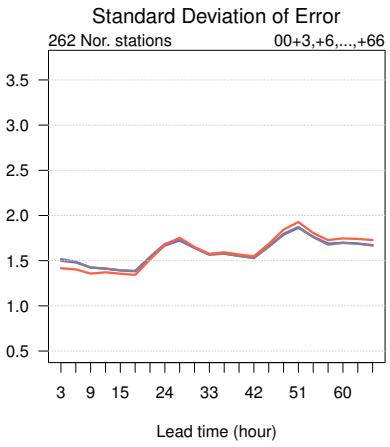
01.03.2016 – 31.05.2016

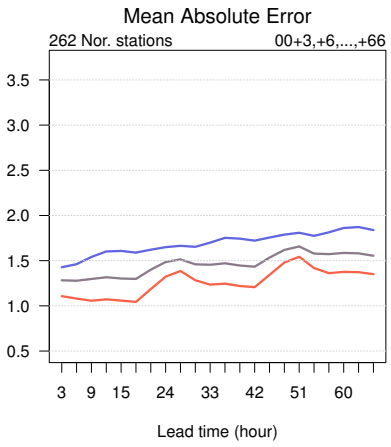
	Min	Mean	Max	Std	N
synop: 00,06,12,18	−2.8	7.1	25.1	5.4	368
AM25: 12+18,+24,+30,+36	−3.1	6.4	24.5	5.6	368
Hirlam8: 12+18,+24,+30,+36	−4.7	6.1	23.2	5.6	364
ECMWF: 12+18,+24,+30,+36	−6.3	5.3	22.4	5.4	368

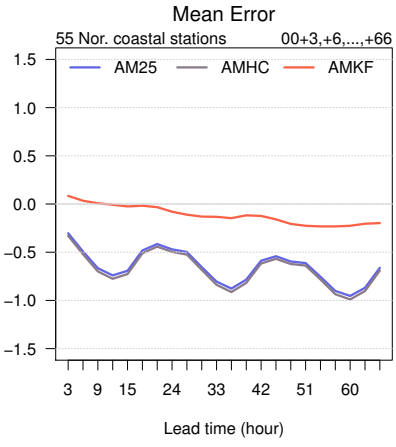
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−0.6	1.3	1.5	1.2	5.7	368
Hirlam8 – synop	−1	1.5	1.8	1.5	4.9	364
ECMWF – synop	−1.7	1.4	2.2	1.9	7.4	368

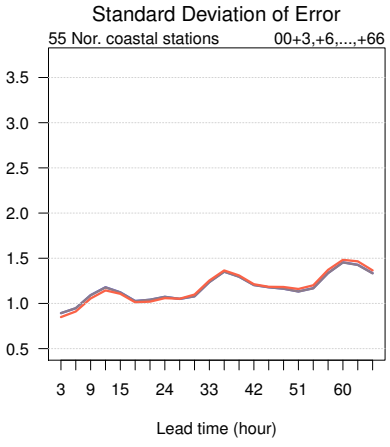
Post processed temperature 2m (AMHC and AMKF)

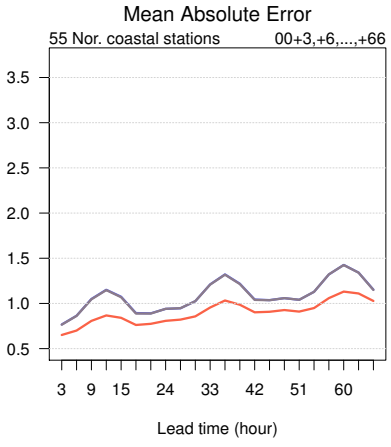


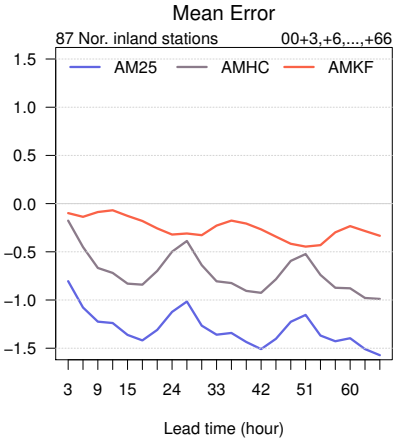


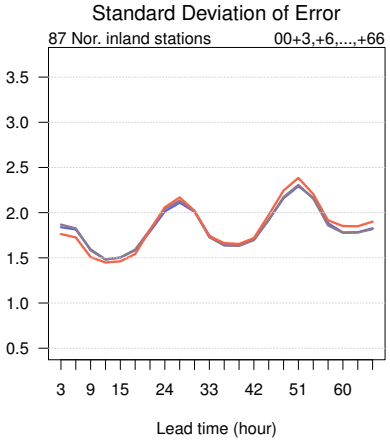


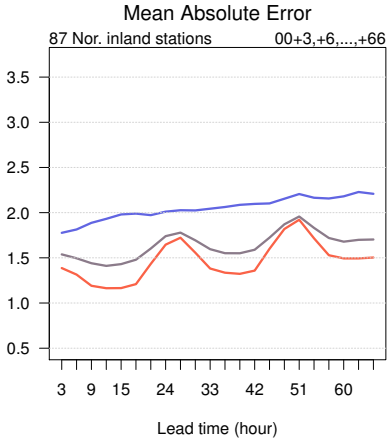


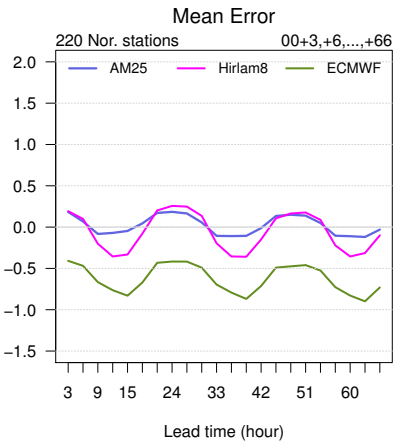


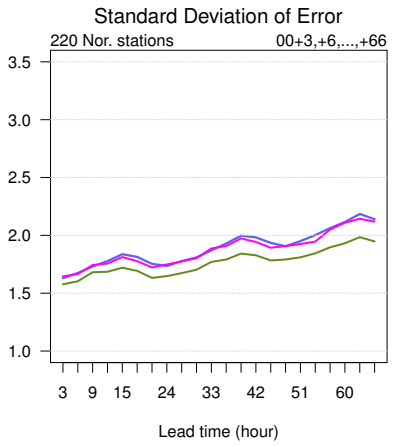


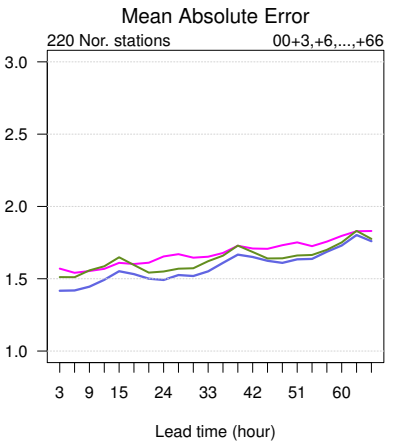


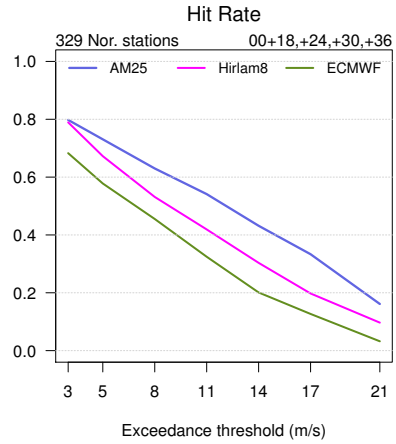


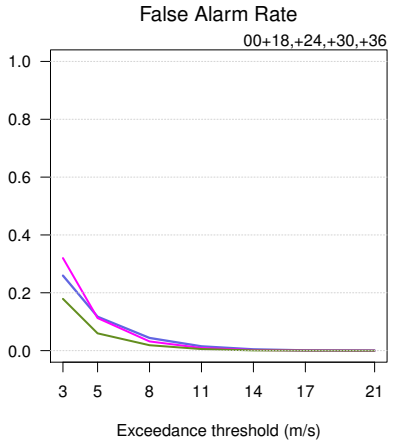


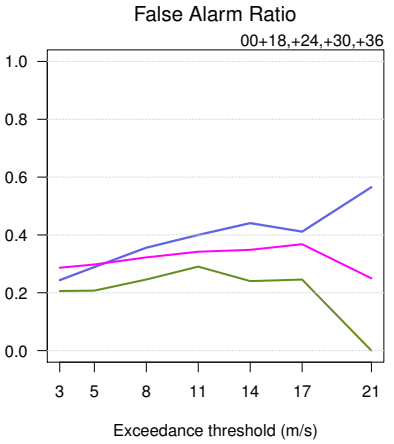

Mean Error
220 Nor. stations
00+3,+6,...,+66
AM25
Hirlam8
ECMWF
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
3 9 15 24 33 42 51 60
Lead time (hour)

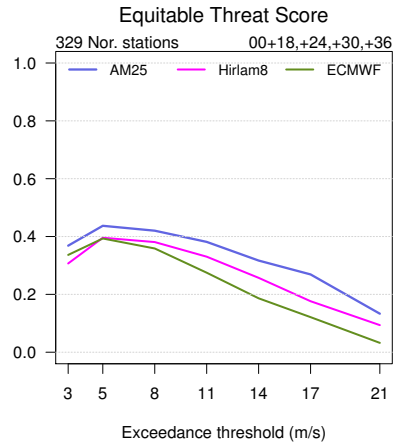

Standard Deviation of Error
220 Nor. stations
00+3,+6,...,+66
3.5
3.0
2.5
2.0
1.5
1.0
3 9 15 24 33 42 51 60
Lead time (hour)

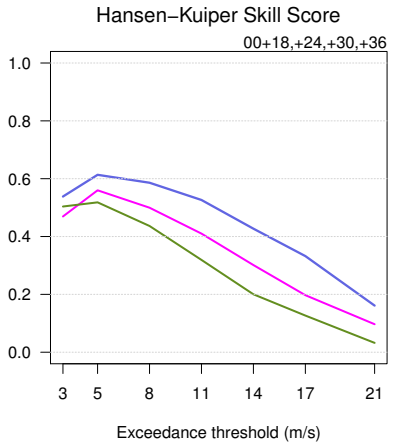

Mean Absolute Error
220 Nor. stations
00+3,+6,...,+66
3.0
2.5
2.0
1.5
1.0
3 9 15 24 33 42 51 60
Lead time (hour)

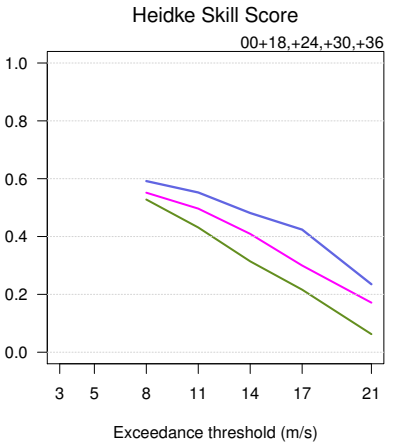

Hit Rate
329 Nor. stations
00+18,+24,+30,+36
AM25
Hirlam8
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

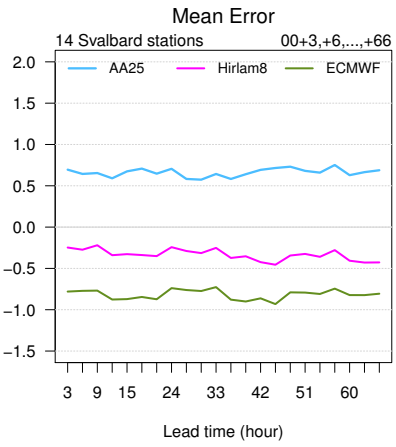

False Alarm Rate
00+18,+24,+30,+36
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

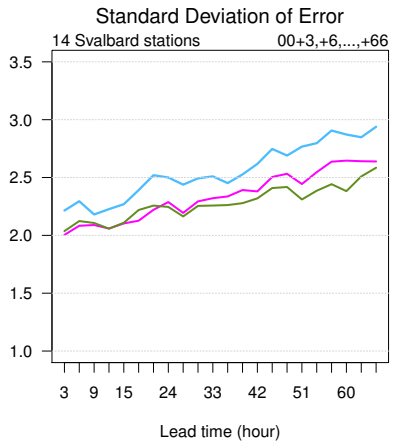

False Alarm Ratio
00+18,+24,+30,+36
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

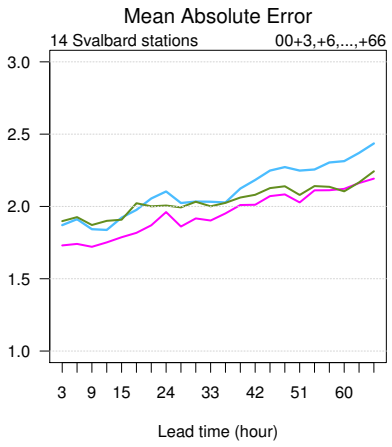

Equitable Threat Score
329 Nor. stations
00+18,+24,+30,+36
AM25
Hirlam8
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

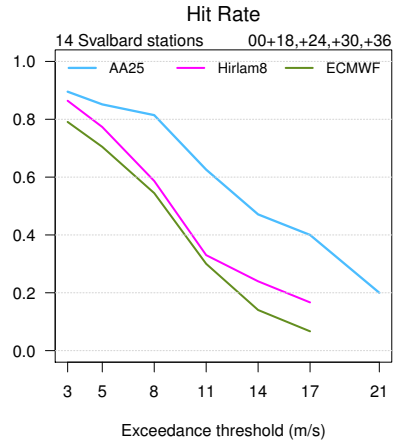

Hansen−Kuiper Skill Score
00+18,+24,+30,+36
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

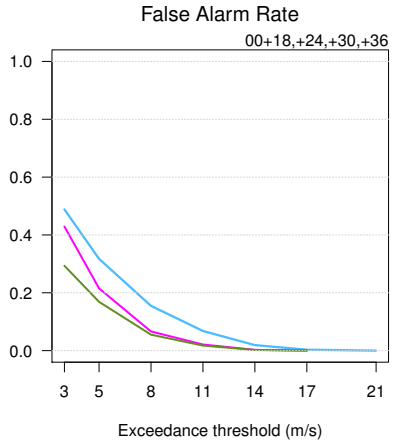

Heidke Skill Score
00+18,+24,+30,+36
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

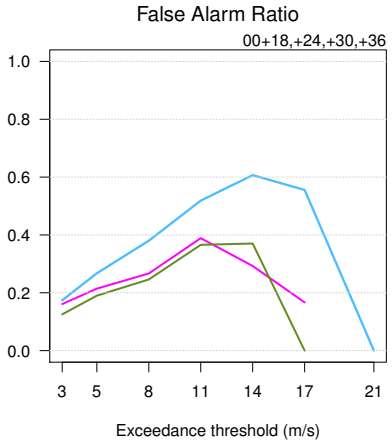

Mean Error
14 Svalbard stations
00+3,+6,...,+66
AA25
Hirlam8
ECMWF
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
3 9 15 24 33 42 51 60
Lead time (hour)

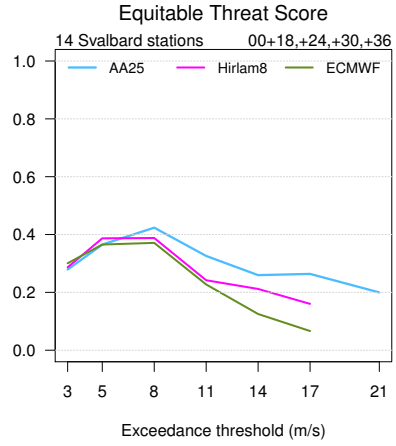

Standard Deviation of Error
14 Svalbard stations
00+3,+6,...,+66
3.5
3.0
2.5
2.0
1.5
1.0
3 9 15 24 33 42 51 60
Lead time (hour)

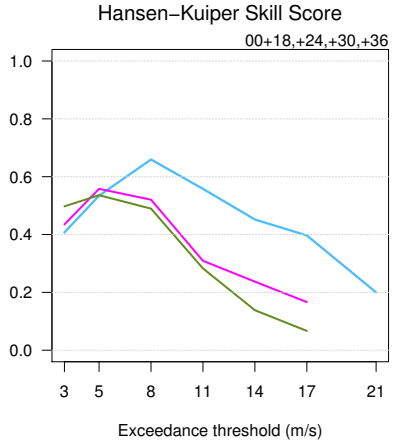

Mean Absolute Error
14 Svalbard stations
00+3,+6,...,+66
3.0
2.5
2.0
1.5
1.0
3 9 15 24 33 42 51 60
Lead time (hour)

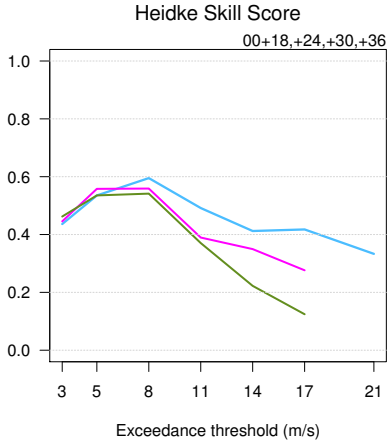

Hit Rate
14 Svalbard stations
00+18,+24,+30,+36
AA25
Hirlam8
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

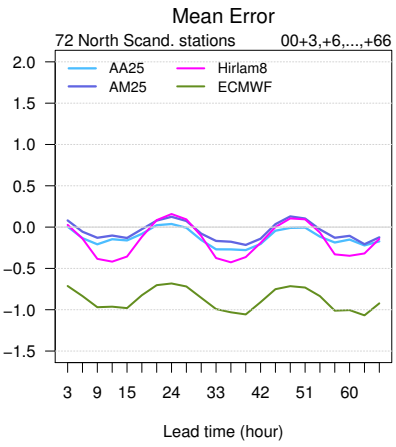

False Alarm Rate
00+18,+24,+30,+36
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

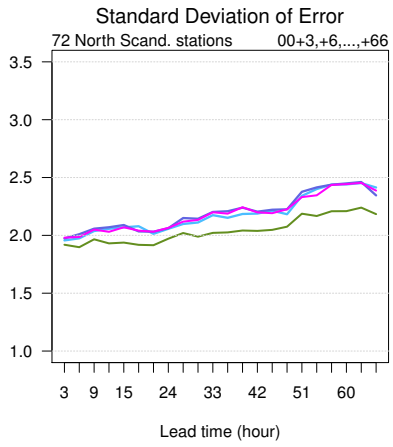

False Alarm Ratio
00+18,+24,+30,+36
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

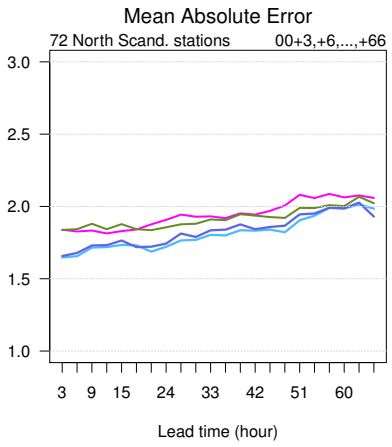

Equitable Threat Score
14 Svalbard stations
00+18,+24,+30,+36
AA25
Hirlam8
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

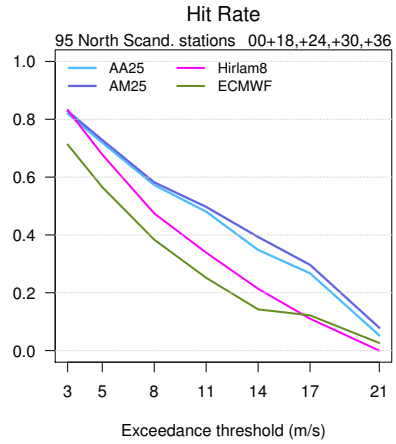

Hansen−Kuiper Skill Score
00+18,+24,+30,+36
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

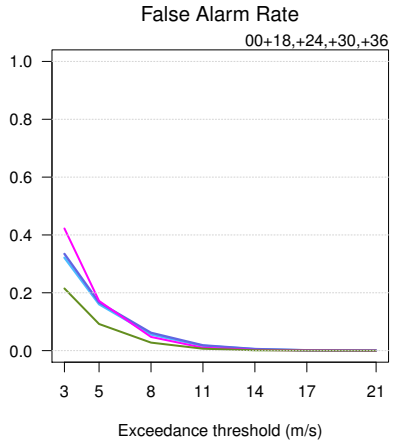

Heidke Skill Score
00+18,+24,+30,+36
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

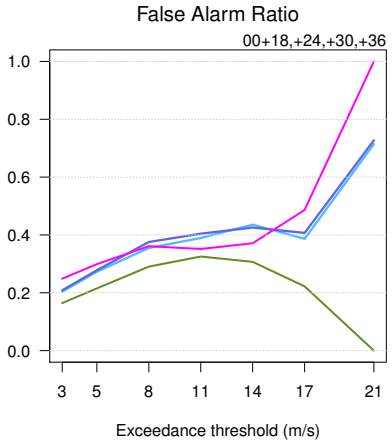

Mean Error
72 North Scand. stations 00+3,+6,...,+66
AA25
AM25
Hirlam8
ECMWF
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
3 9 15 24 33 42 51 60
Lead time (hour)

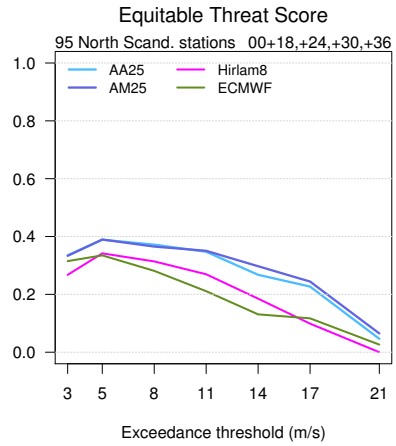

Standard Deviation of Error
72 North Scand. stations 00+3,+6,...,+66
3.5
3.0
2.5
2.0
1.5
1.0
3 9 15 24 33 42 51 60
Lead time (hour)

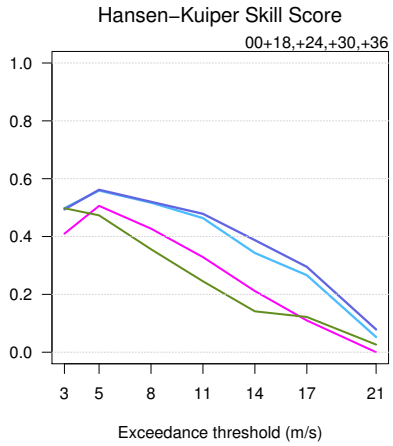

Mean Absolute Error
72 North Scand. stations 00+3,+6,...,+66
3.0
2.5
2.0
1.5
1.0
3 9 15 24 33 42 51 60
Lead time (hour)

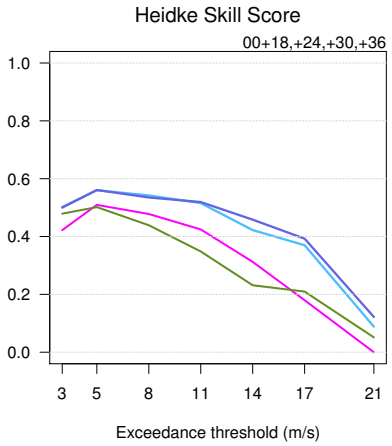

Hit Rate
95 North Scand. stations 00+18,+24,+30,+36
AA25
AM25
Hirlam8
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)


False Alarm Rate
00+18,+24,+30,+36
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

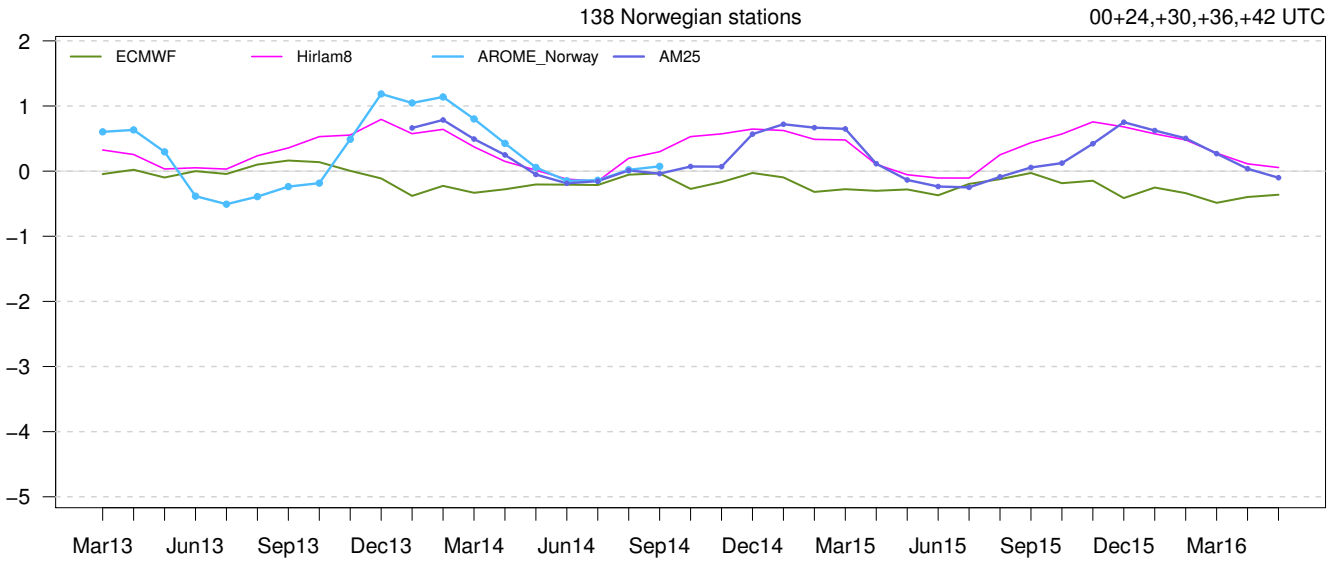

False Alarm Ratio
00+18,+24,+30,+36
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

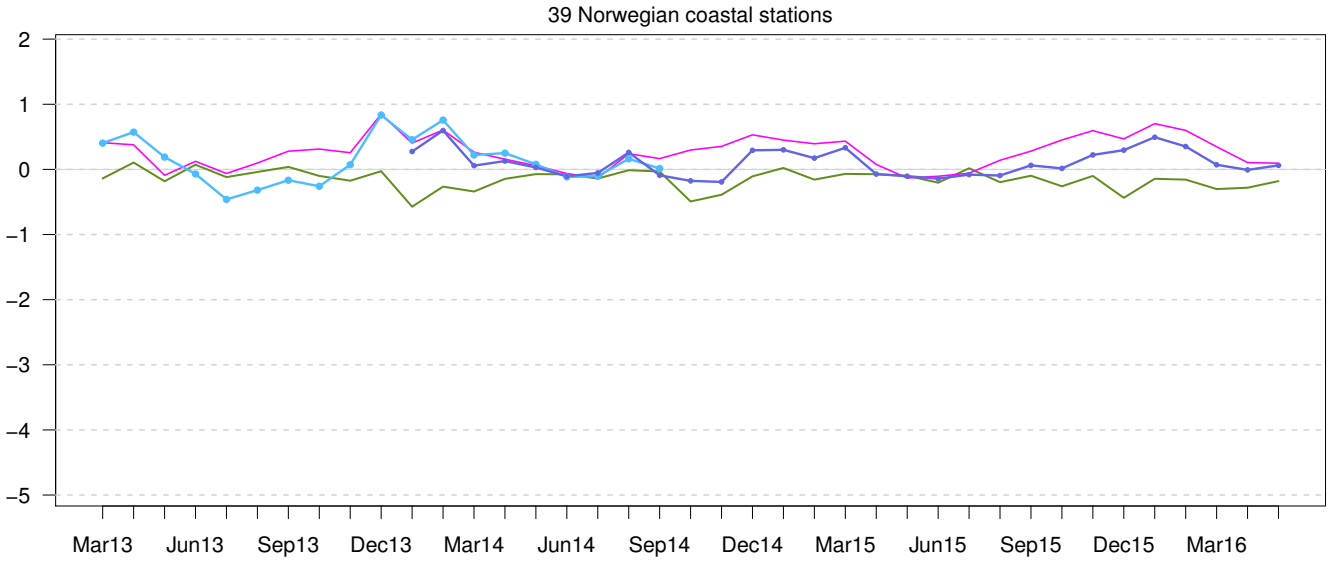

Equitable Threat Score
95 North Scand. stations 00+18,+24,+30,+36
AA25
AM25
Hirlam8
ECMWF
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

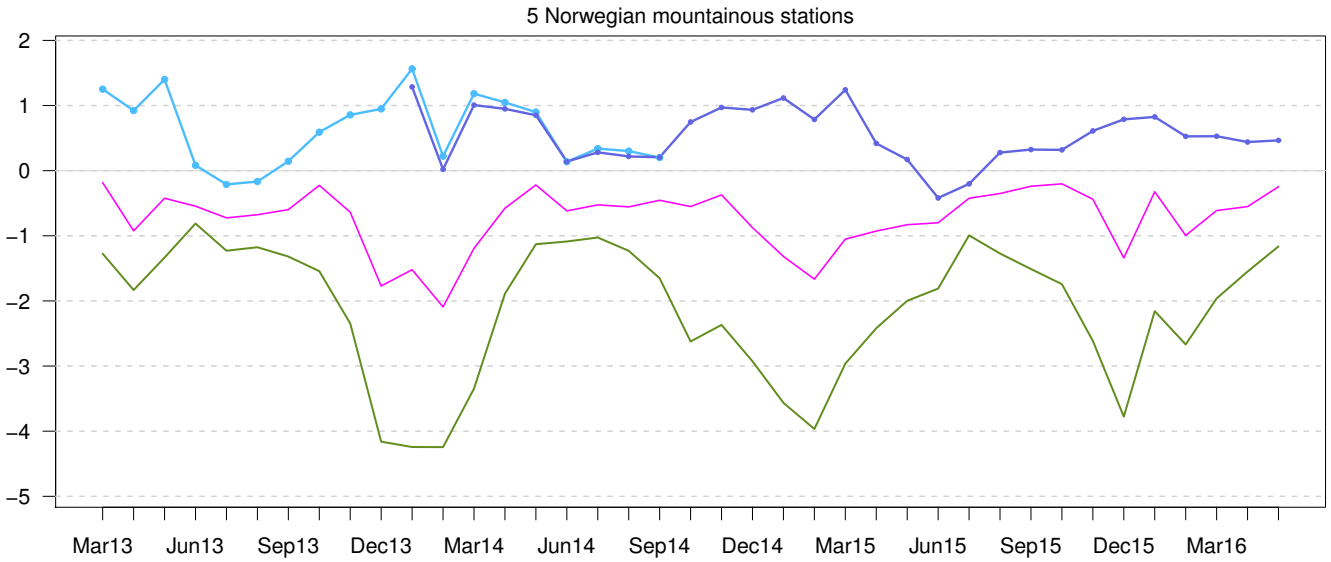

Hansen−Kuiper Skill Score
00+18,+24,+30,+36
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)


Heidke Skill Score
00+18,+24,+30,+36
1.0
0.8
0.6
0.4
0.2
0.0
3 5 8 11 14 17 21
Exceedance threshold (m/s)

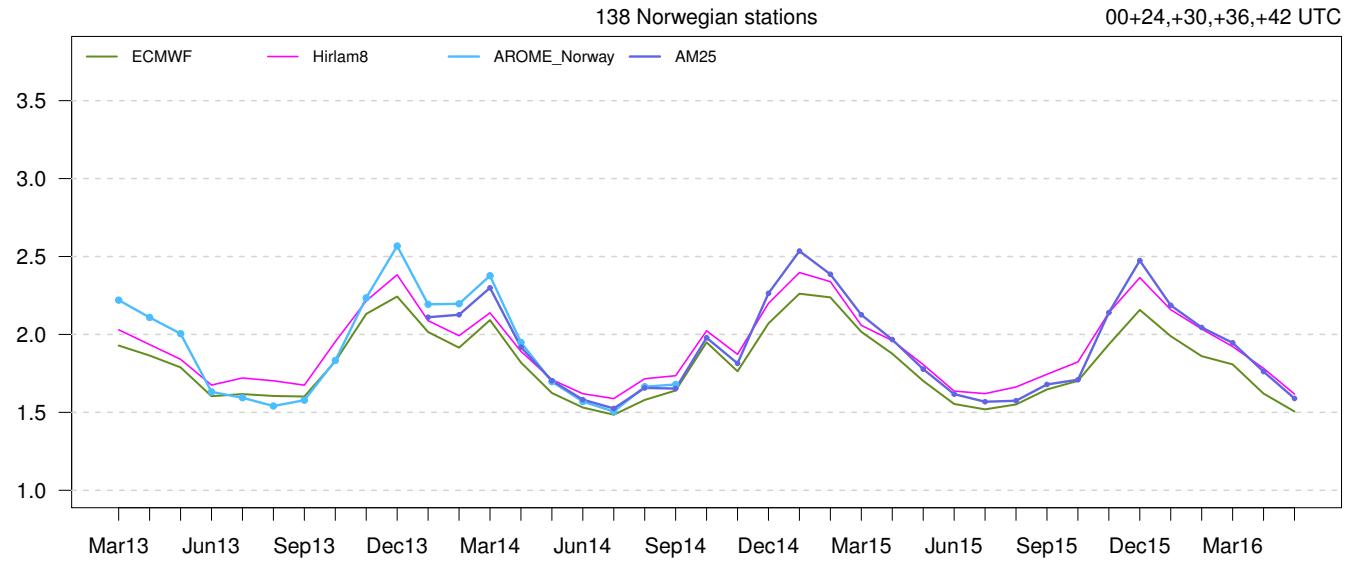
Mean Error

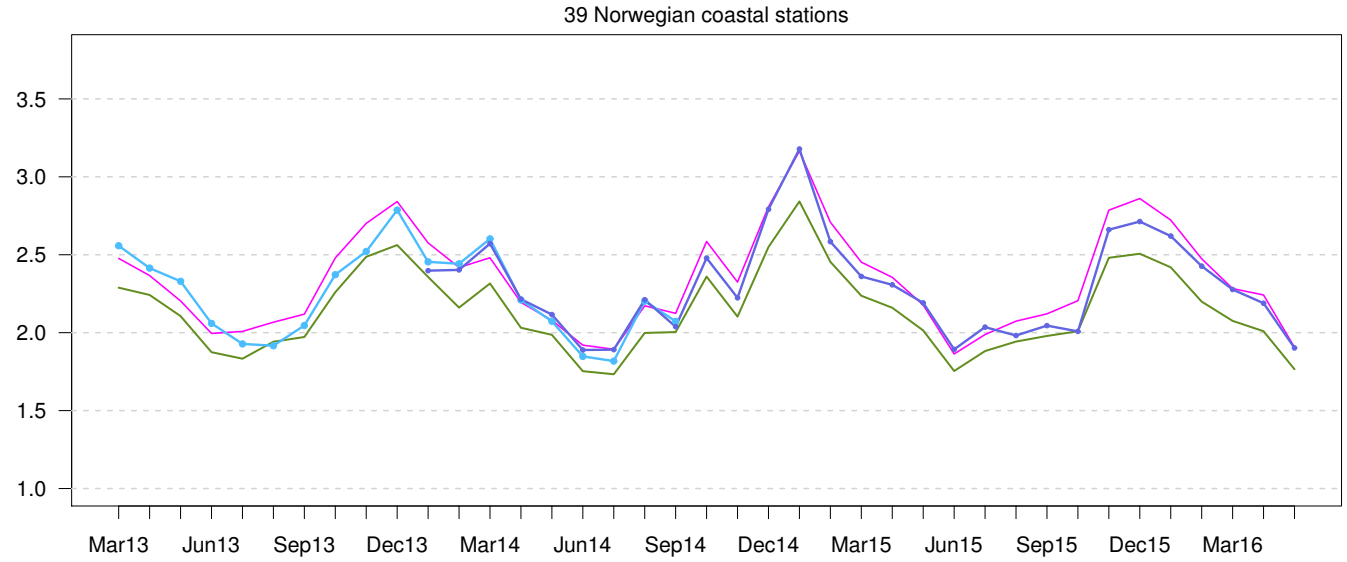

138 Norwegian stations
00+24,+30,+36,+42 UTC
ECMWF
Hirlam8
AROME_Norway
AM25
2
1
0
−1
−2
−3
−4
−5
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14
Mar15
Jun15
Sep15
Dec15
Mar16

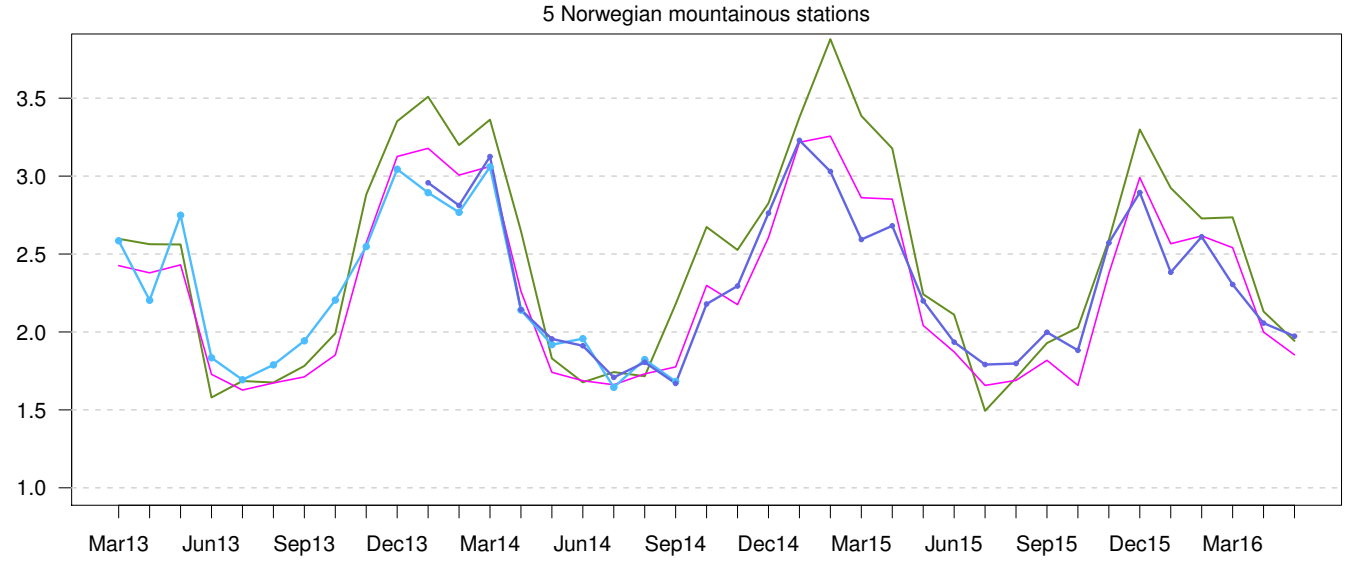

39 Norwegian coastal stations
2
1
0
−1
−2
−3
−4
−5
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14
Mar15
Jun15
Sep15
Dec15
Mar16


5 Norwegian mountainous stations
2
1
0
−1
−2
−3
−4
−5
Mar13
Jun13
Sep13
Dec13
Mar14
Jun14
Sep14
Dec14
Mar15
Jun15
Sep15
Dec15
Mar16

Standard Deviation of Error

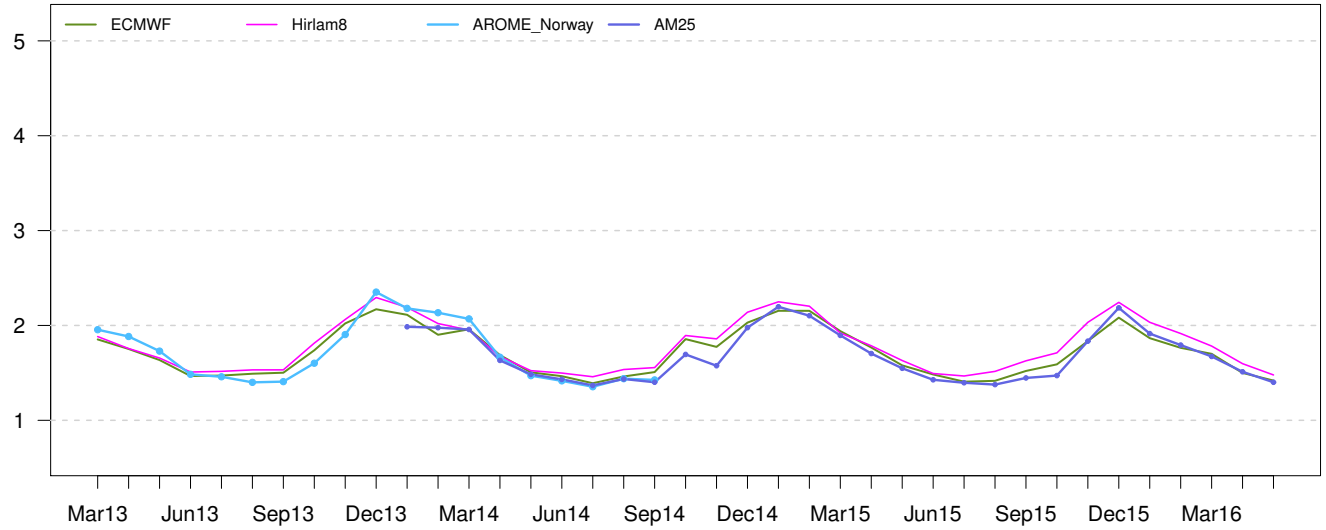




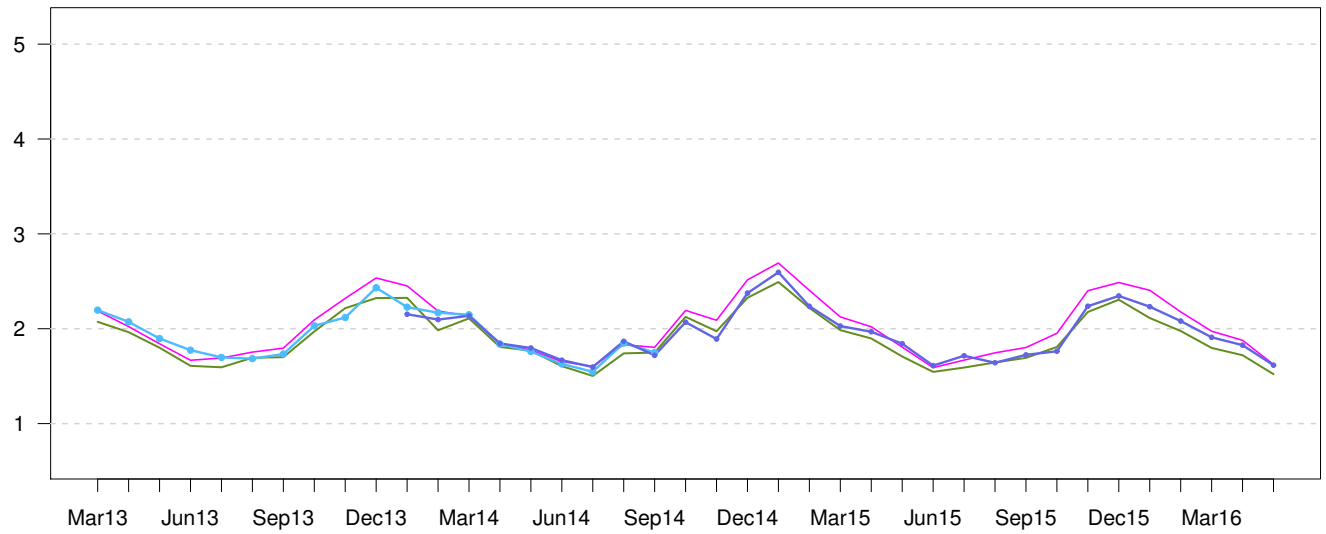


Mean Absolute Error

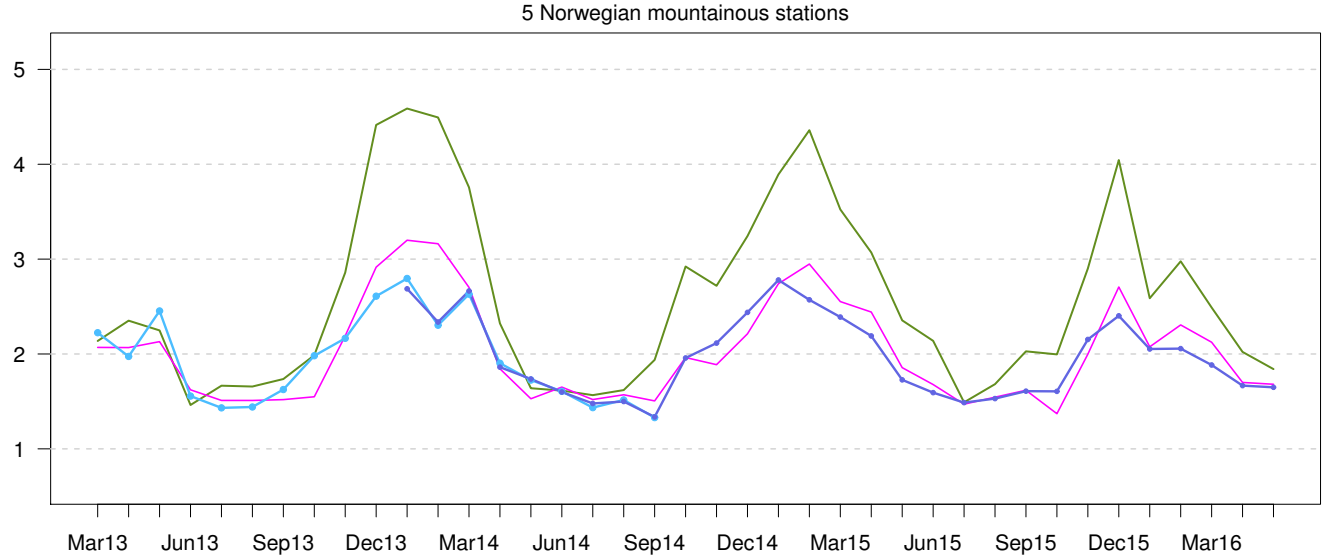
138 Norwegian stations 00+24,+30,+36,+42 UTC



39 Norwegian coastal stations

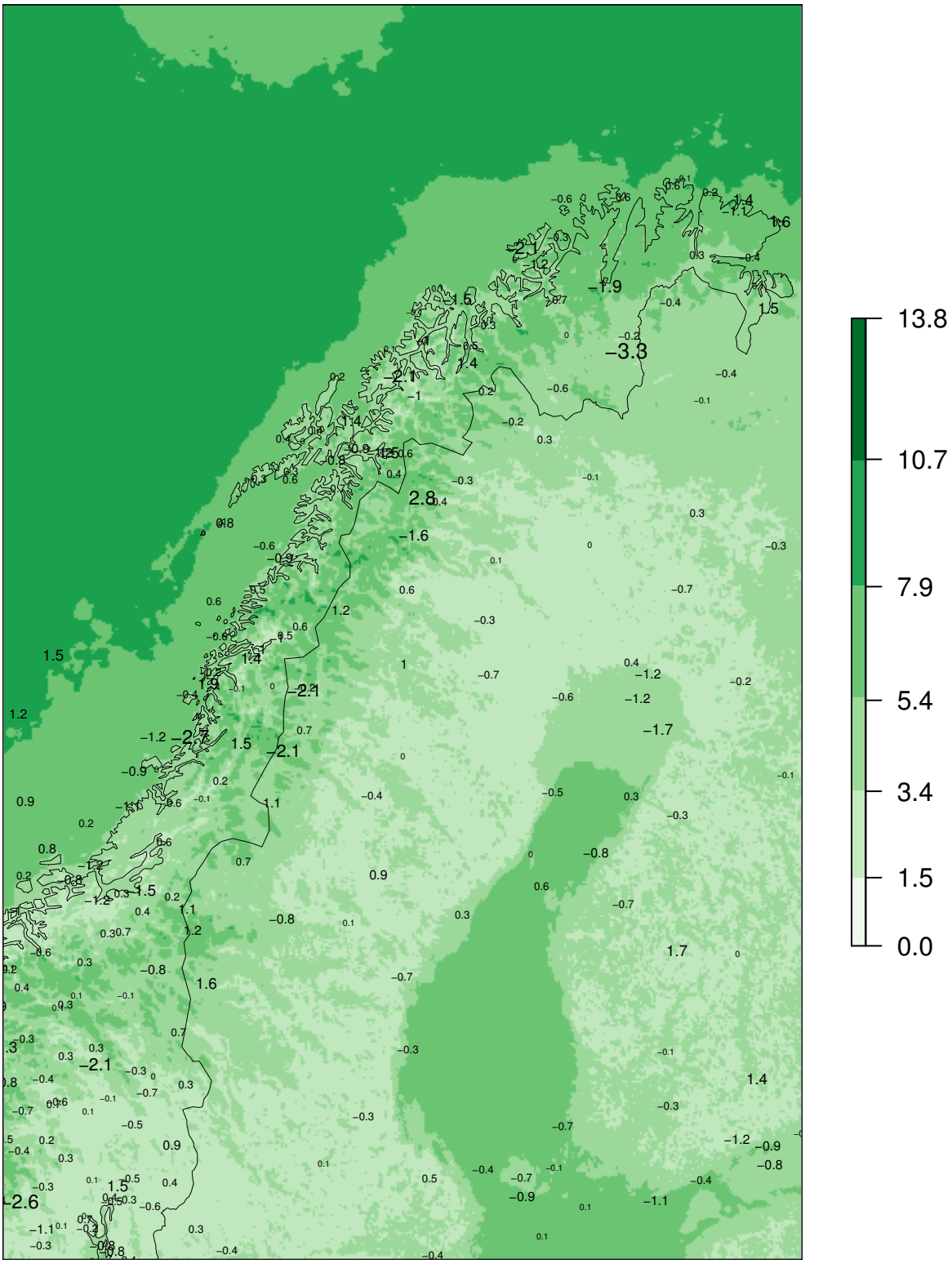


5 Norwegian mountainous stations



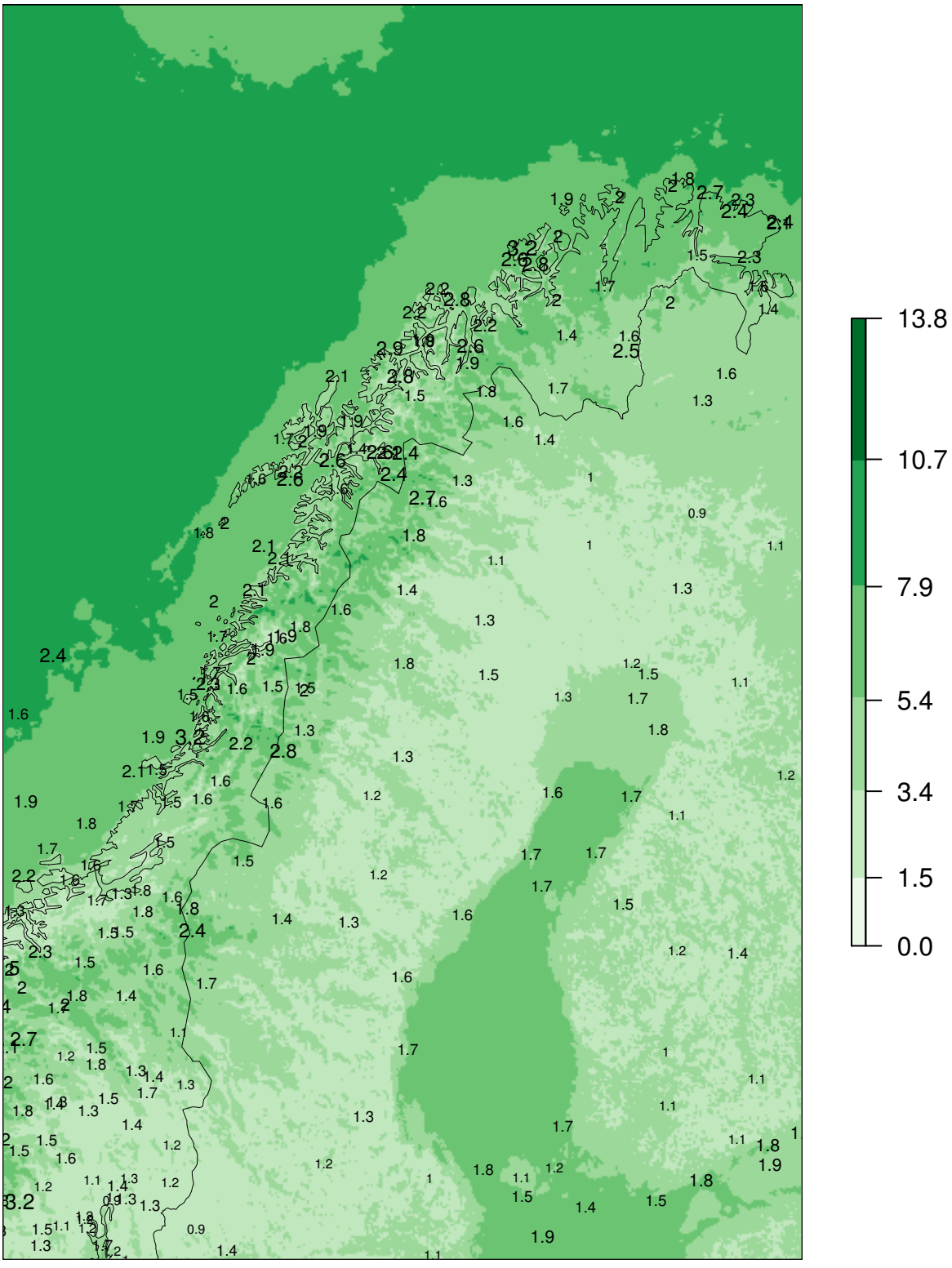
AM25 00+12

ME at observing sites forecast means 01.03.2016 – 31.05.2016



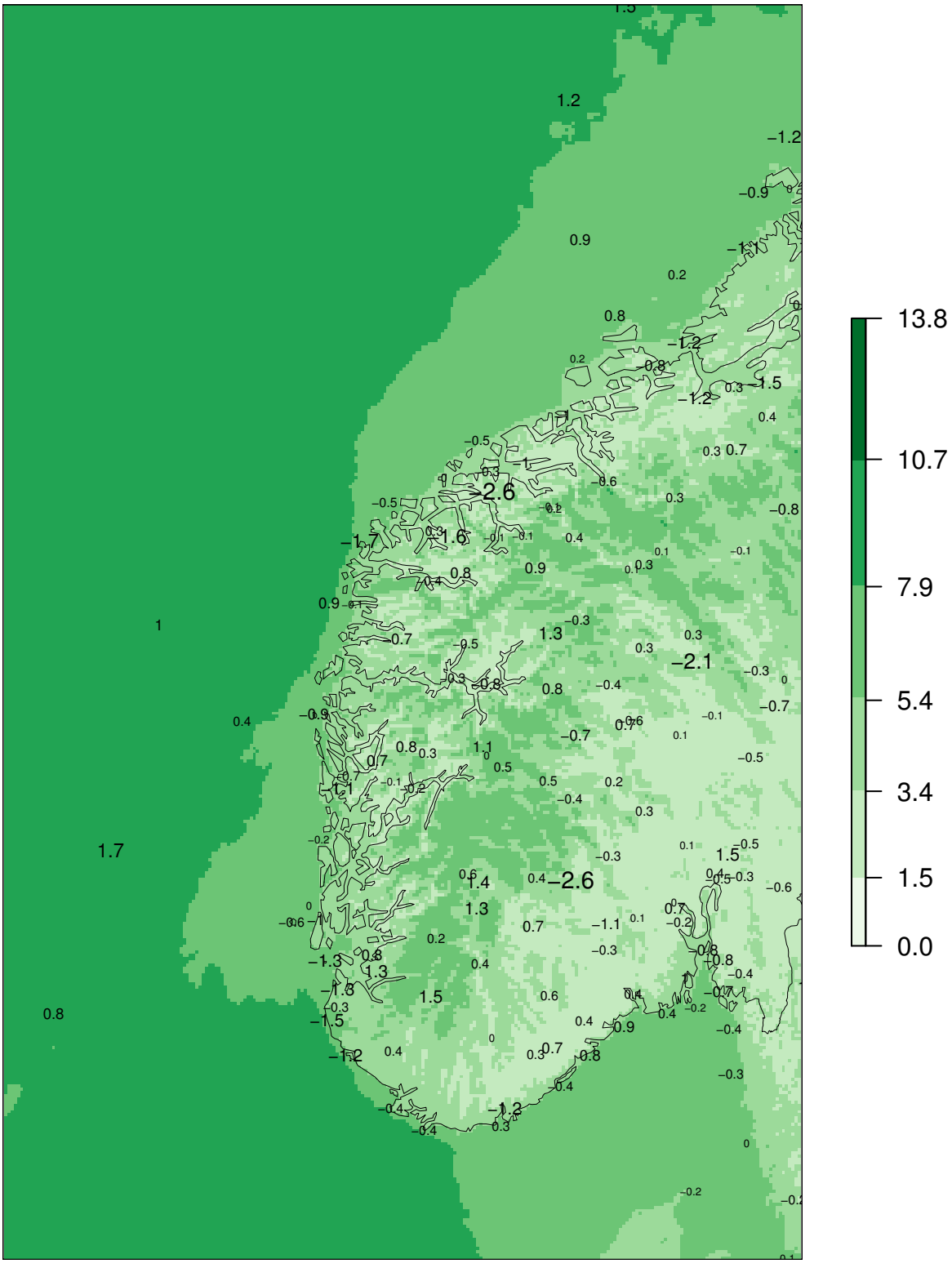
AM25 00+12

SDE at observing sites forecast means 01.03.2016 – 31.05.2016



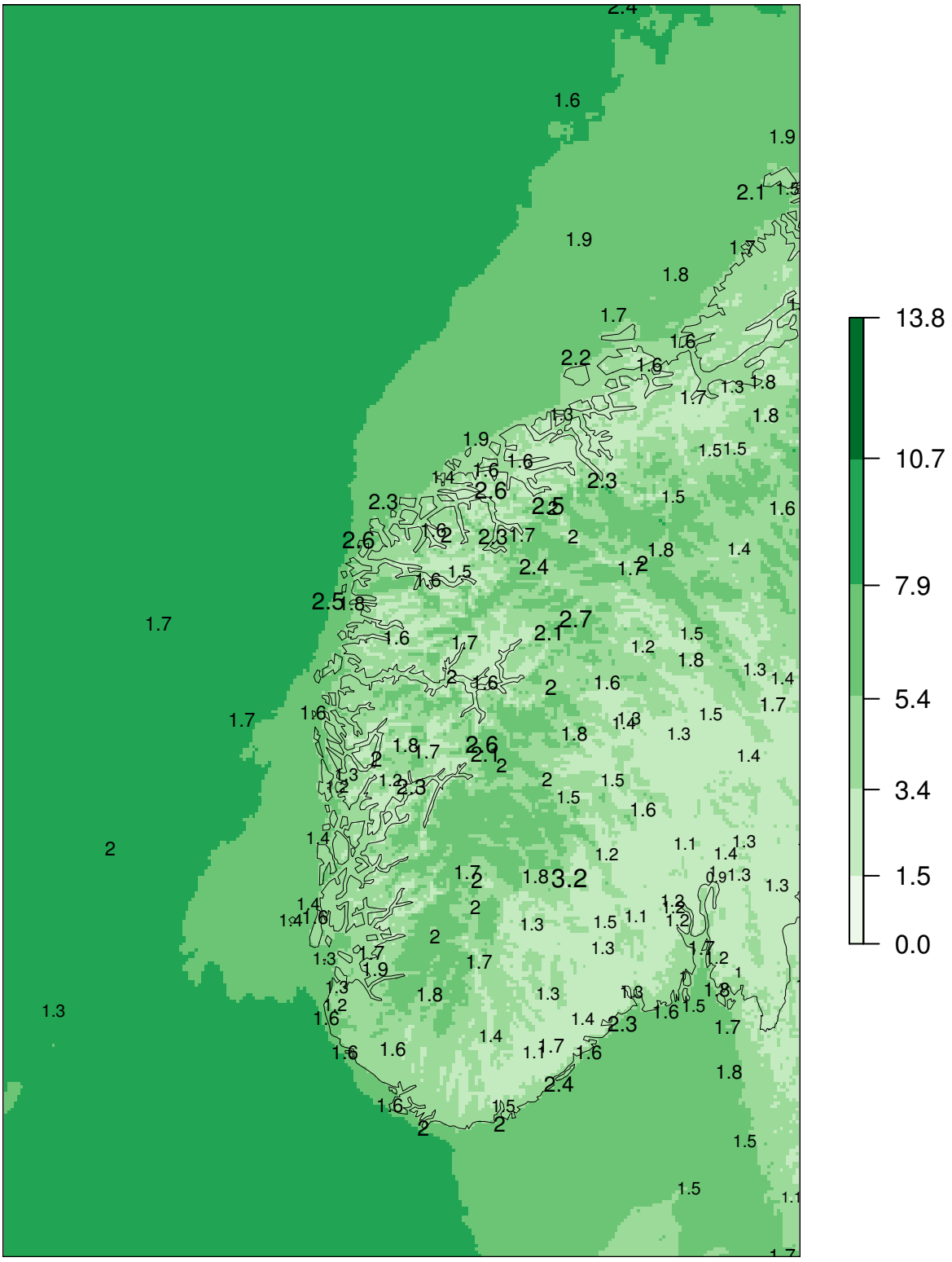
AM25 00+12

ME at observing sites forecast means 01.03.2016 – 31.05.2016



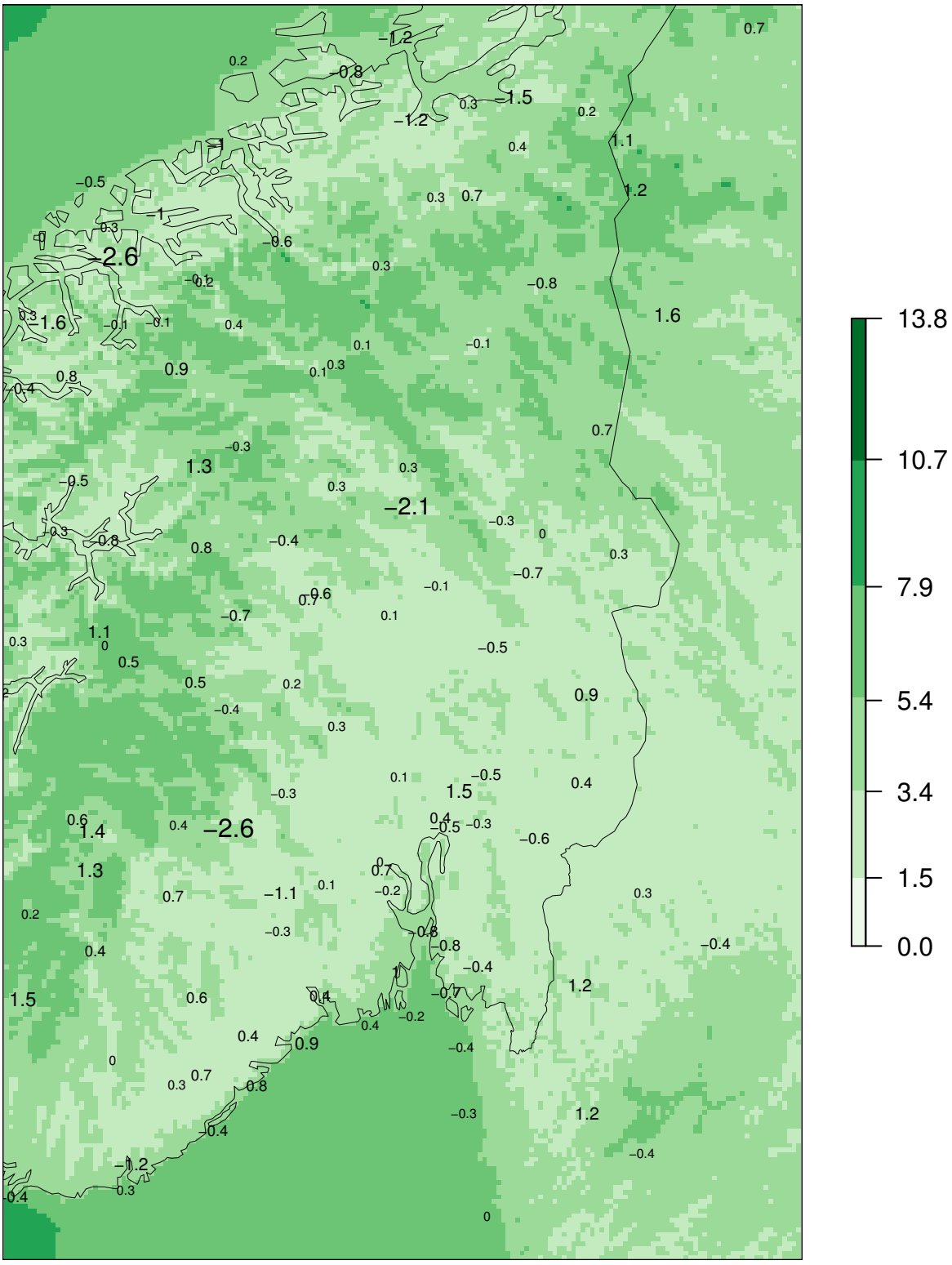
AM25 00+12

SDE at observing sites forecast means 01.03.2016 – 31.05.2016



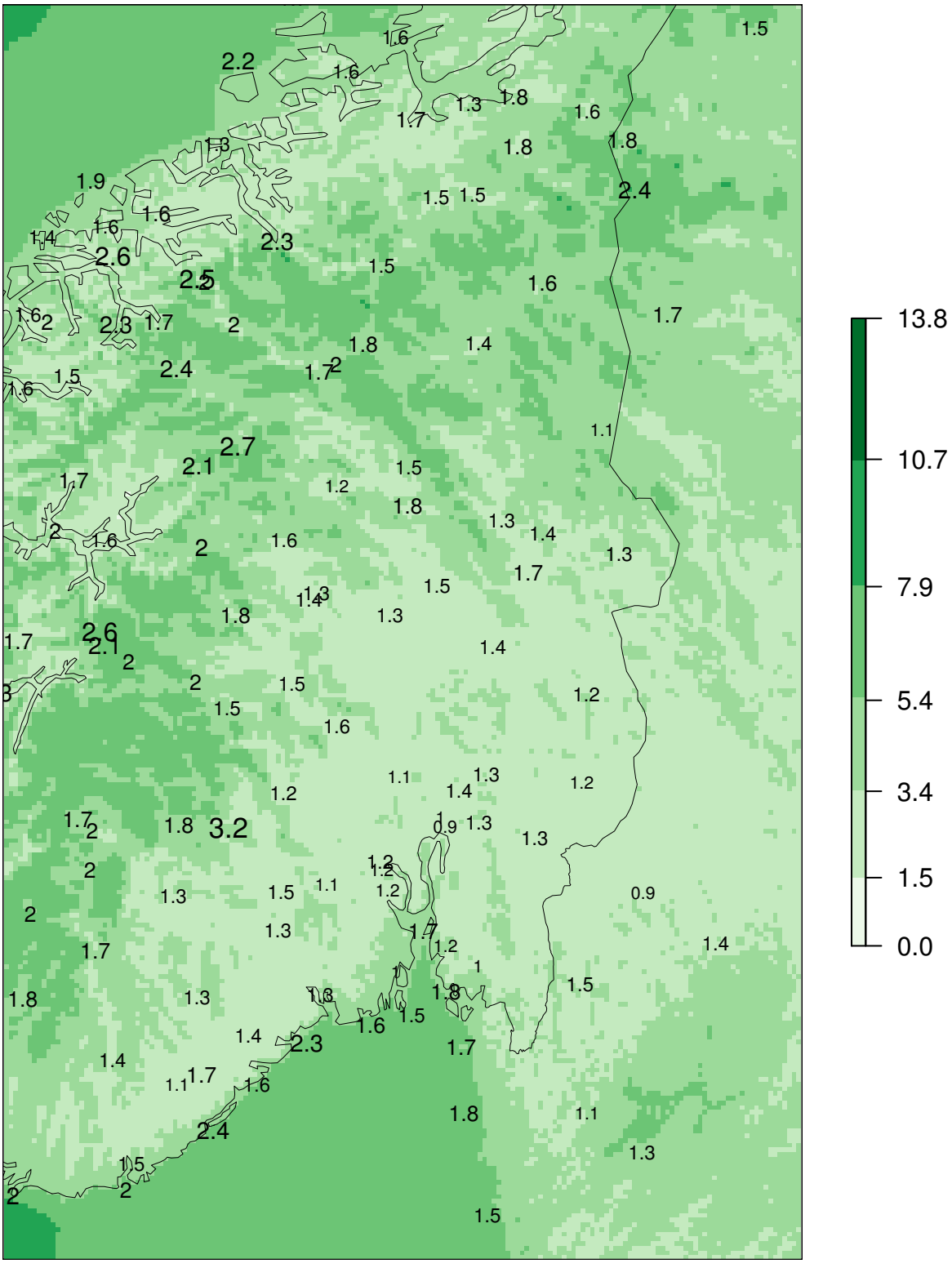
AM25 00+12

ME at observing sites forecast means 01.03.2016 – 31.05.2016

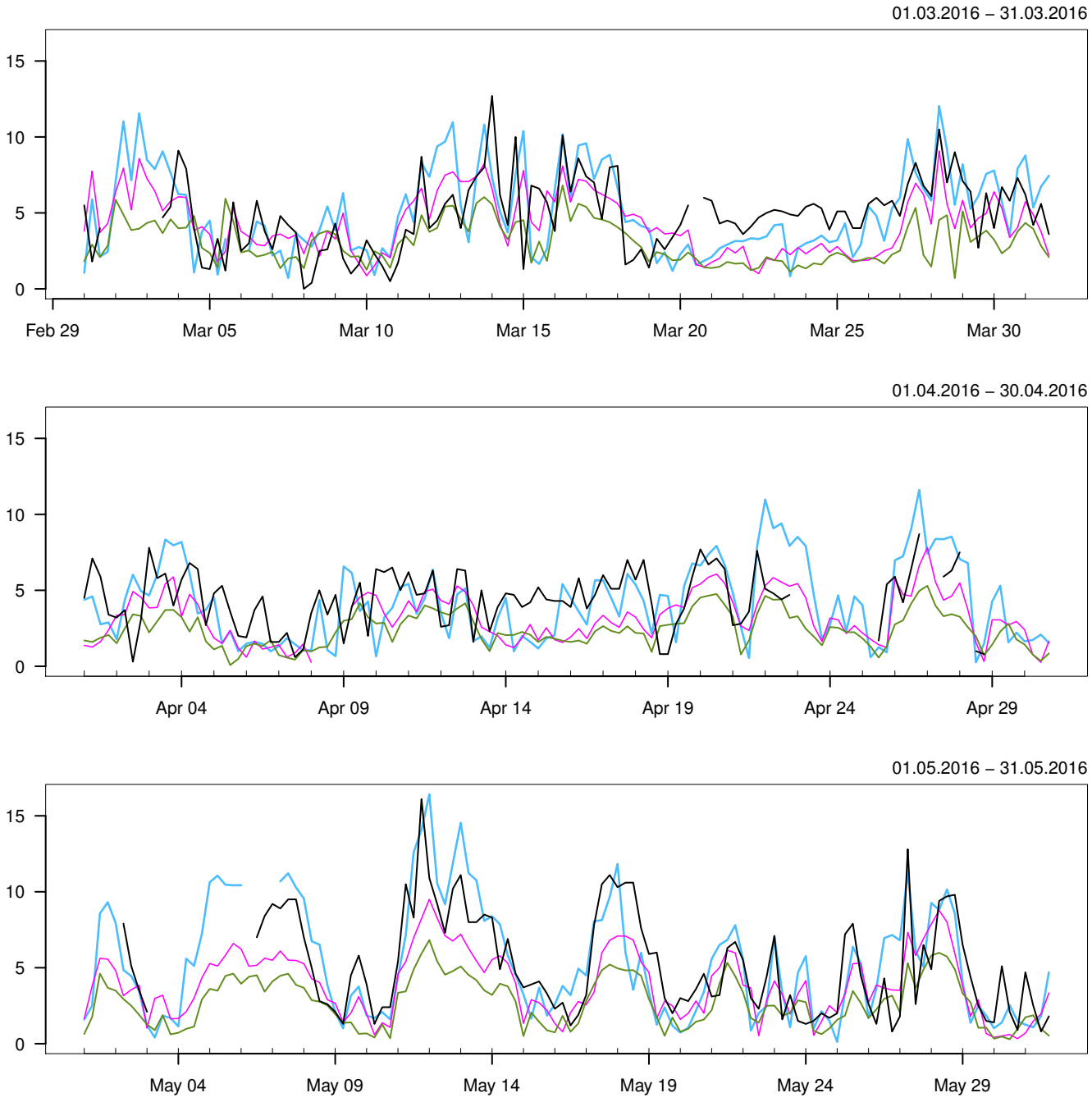


AM25 00+12

SDE at observing sites forecast means 01.03.2016 – 31.05.2016



SVALBARD LUFTHAVN



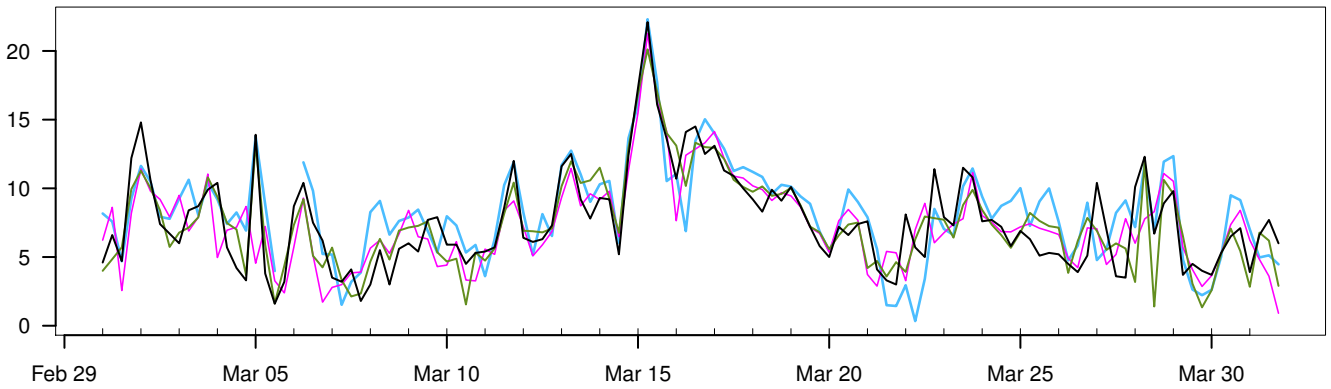
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0	4.9	16.1	2.6	321
AA25: 12+18,+24,+30,+36	0.1	4.9	16.4	3.1	362
Hirlam8: 12+18,+24,+30,+36	0.3	3.8	9.5	2	364
ECMWF: 12+18,+24,+30,+36	0.1	2.8	6.8	1.4	368

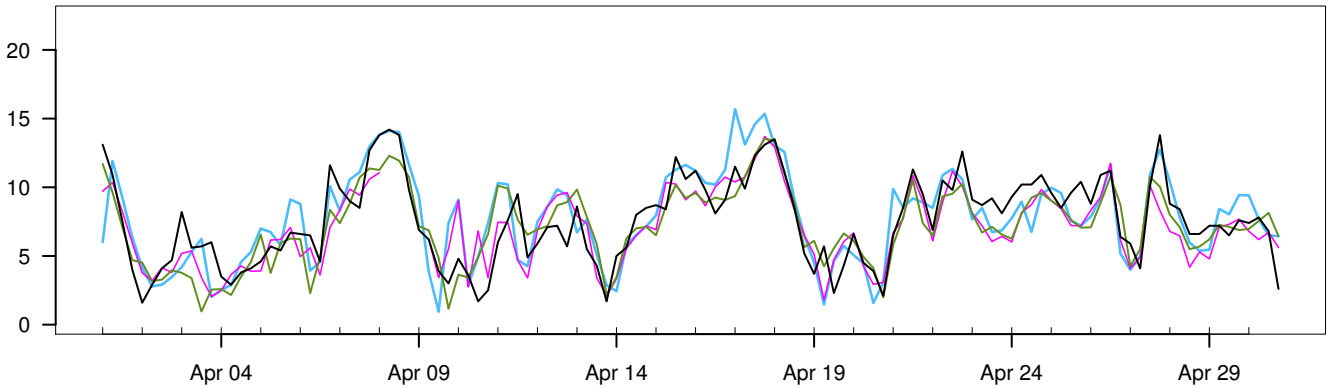
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AA25 – synop	0	2.4	2.4	1.9	9.1	316
Hirlam8 – synop	–1	2.1	2.3	1.9	7.9	317
ECMWF – synop	–2.1	2.1	2.9	2.4	10.2	321

BJØRNØYA

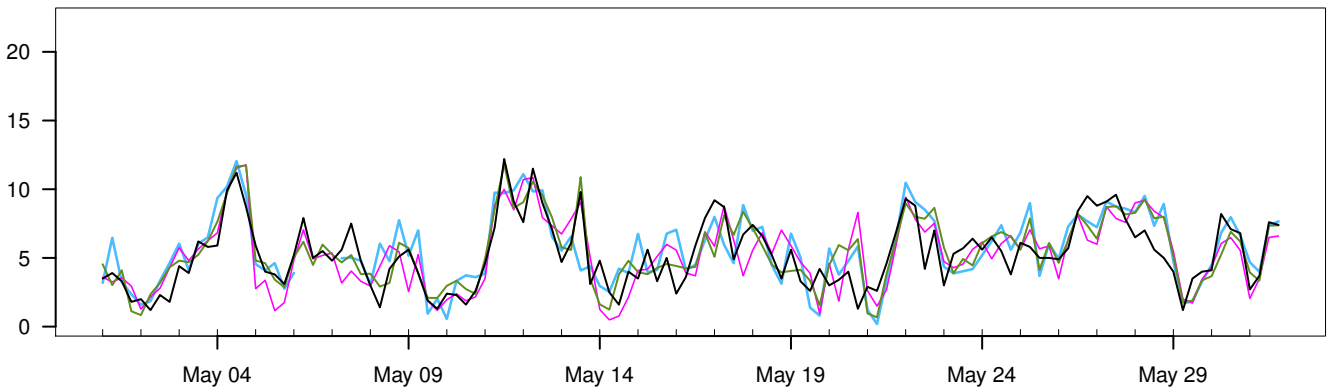
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016



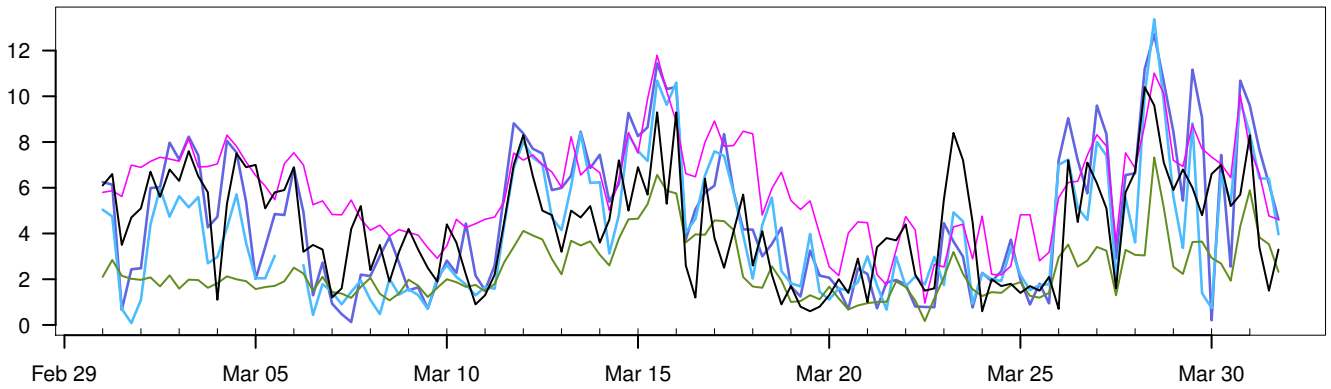
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	1.2	6.8	22.1	3.2	368
AA25: 12+18,+24,+30,+36	0.2	7.2	22.3	3.3	362
Hirlam8: 12+18,+24,+30,+36	0.5	6.5	21.3	2.9	364
ECMWF: 12+18,+24,+30,+36	0.7	6.7	20.1	3	368

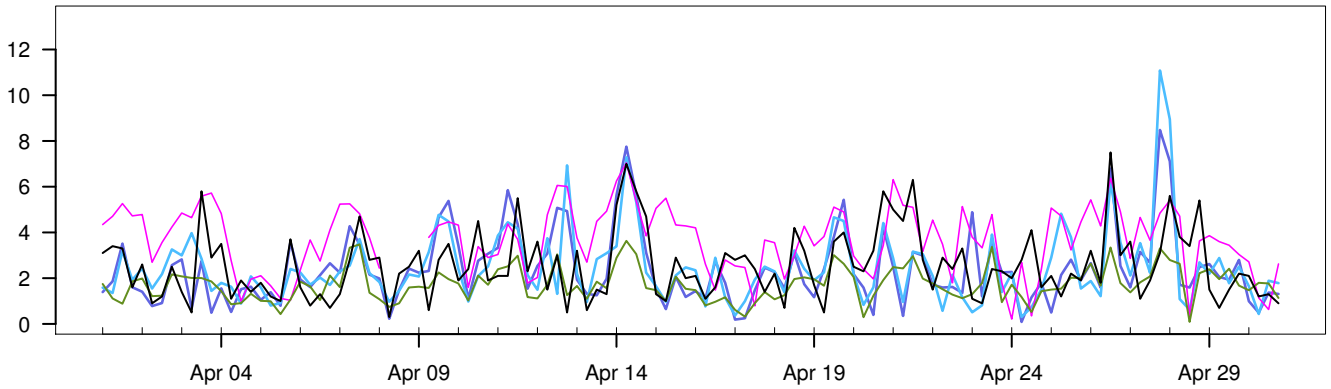
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AA25 – synop	0.4	2.1	2.1	1.6	7.2	362
Hirlam8 – synop	–0.2	2	2	1.5	9.4	364
ECMWF – synop	–0.1	1.7	1.7	1.3	6.9	368

TROMSØ

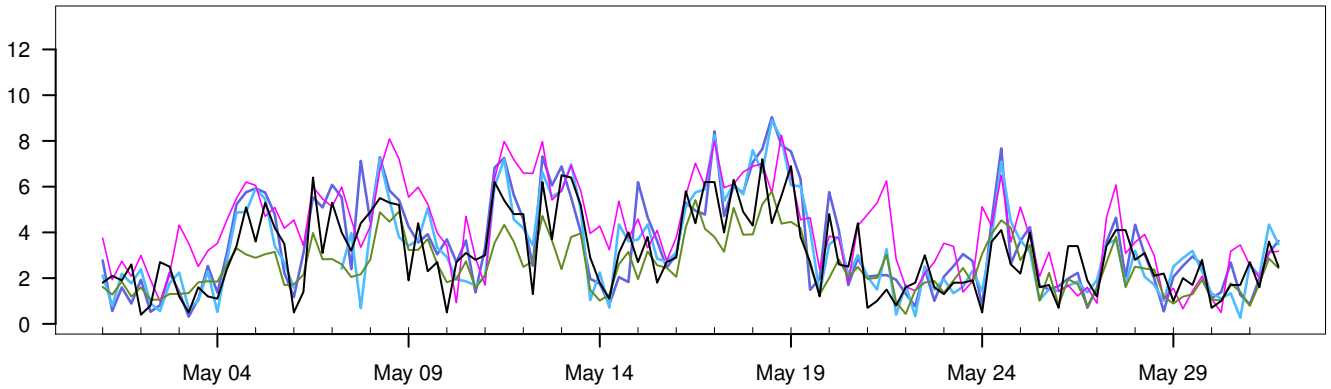
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016



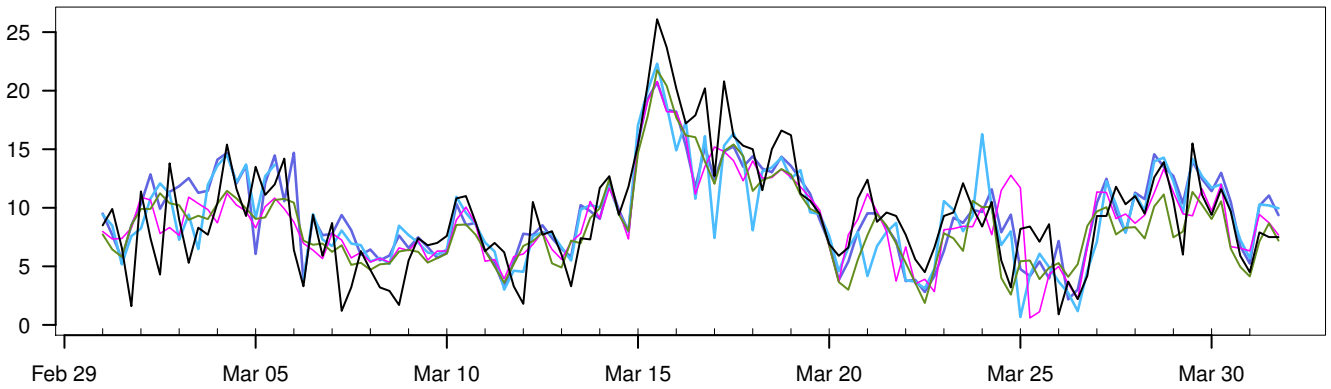
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.3	3.3	10.4	2	368
AM25: 12+18,+24,+30,+36	0.1	3.6	12.7	2.5	368
AA25: 12+18,+24,+30,+36	0.1	3.3	13.4	2.3	362
Hirlam8: 12+18,+24,+30,+36	0.2	4.6	11.8	2.1	364
ECMWF: 12+18,+24,+30,+36	0.1	2.2	7.3	1.2	368

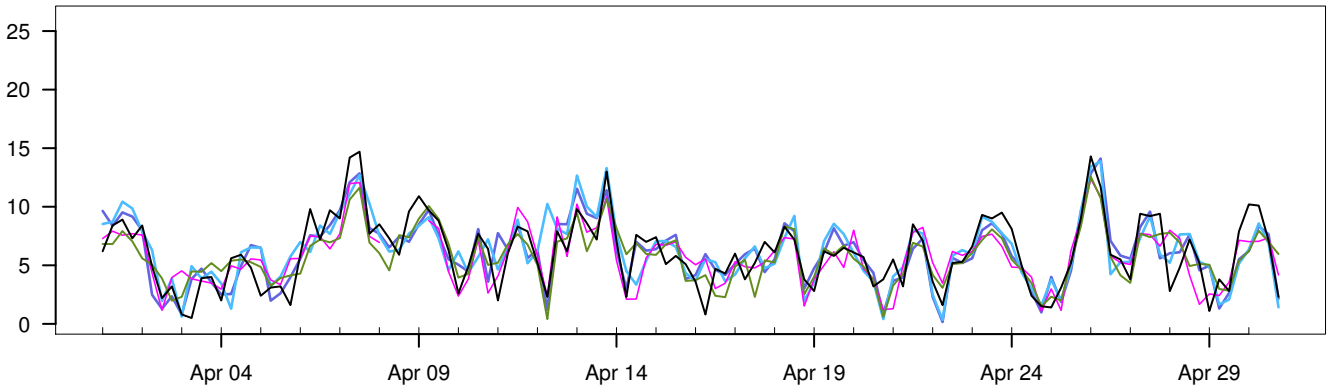
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.2	1.8	1.8	1.4	6.5	368
AA25 – synop	0	1.8	1.8	1.4	8	362
Hirlam8 – synop	1.3	1.7	2.1	1.7	5.9	364
ECMWF – synop	−1.1	1.6	1.9	1.4	7.4	368

SLETTNES FYR

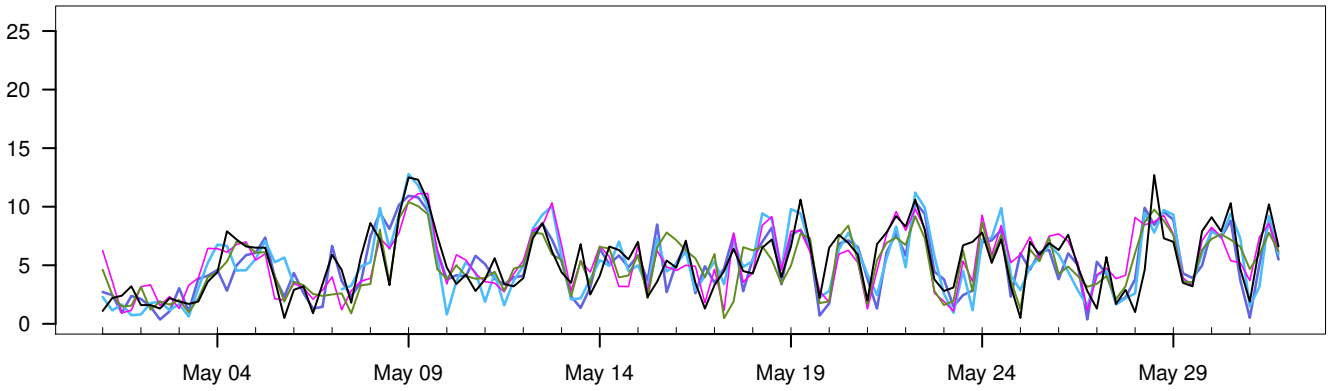
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016

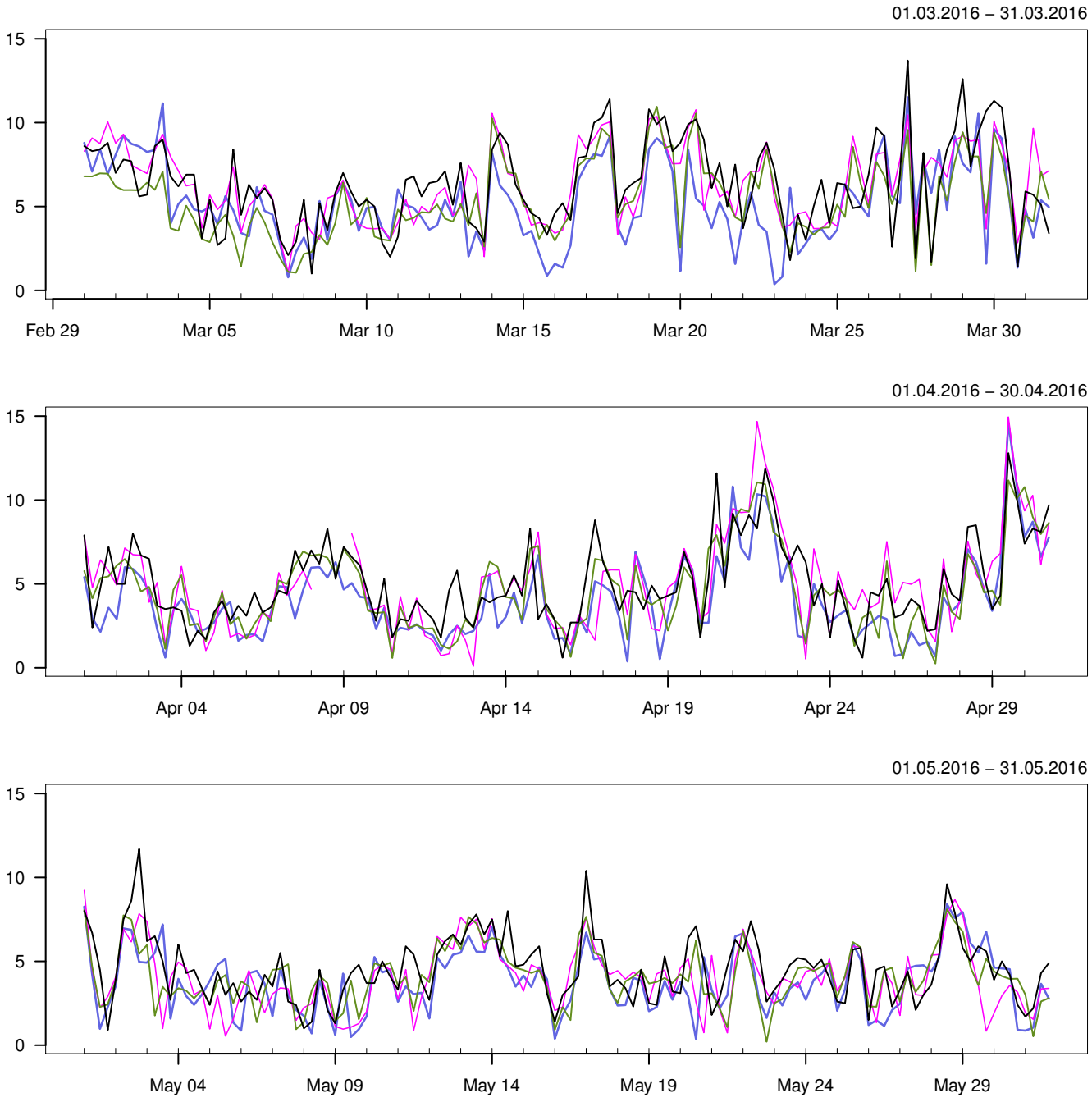


01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.5	6.9	26.1	4	368
AM25: 12+18,+24,+30,+36	0.2	6.9	20.7	3.6	368
AA25: 12+18,+24,+30,+36	0.3	6.9	22.3	3.6	362
Hirlam8: 12+18,+24,+30,+36	0.6	6.7	20.8	3.3	364
ECMWF: 12+18,+24,+30,+36	0.4	6.4	21.8	3.2	368

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0	2.3	2.3	1.7	8.3	368
AA25 – synop	0	2.4	2.4	1.8	8.2	362
Hirlam8 – synop	−0.2	2.4	2.4	1.8	9.6	364
ECMWF – synop	−0.5	2.1	2.1	1.7	6.9	368

ØRLAND III

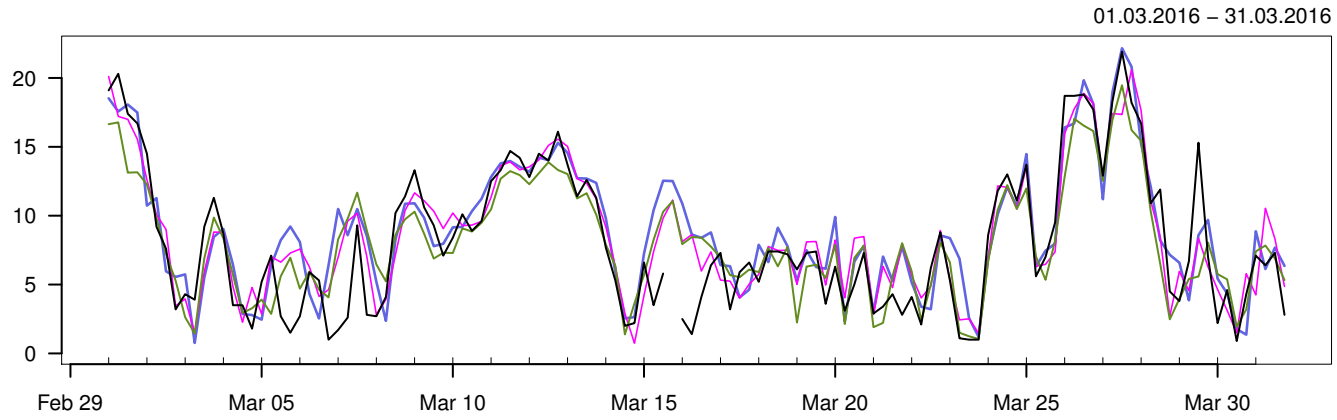


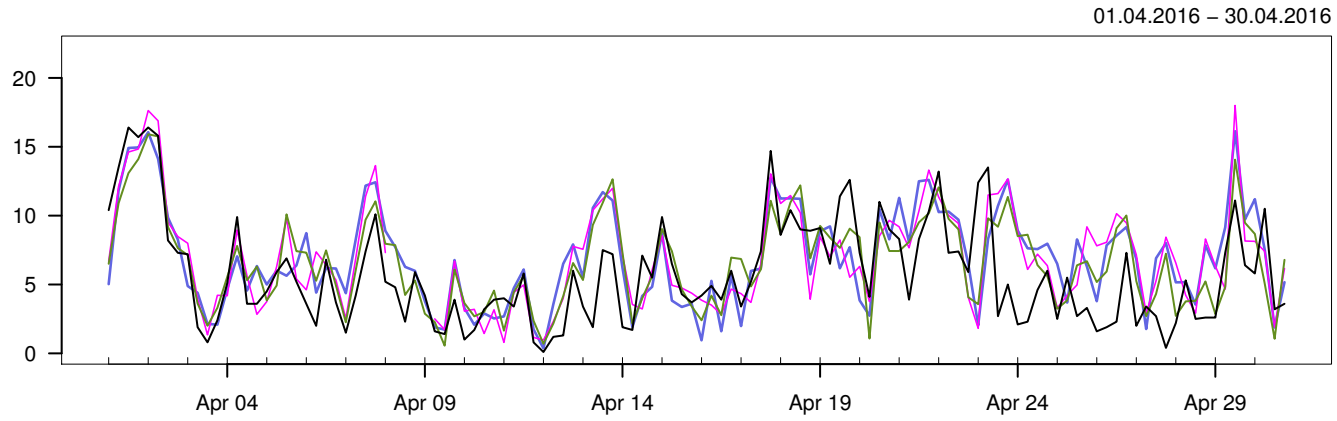
01.03.2016 – 31.05.2016

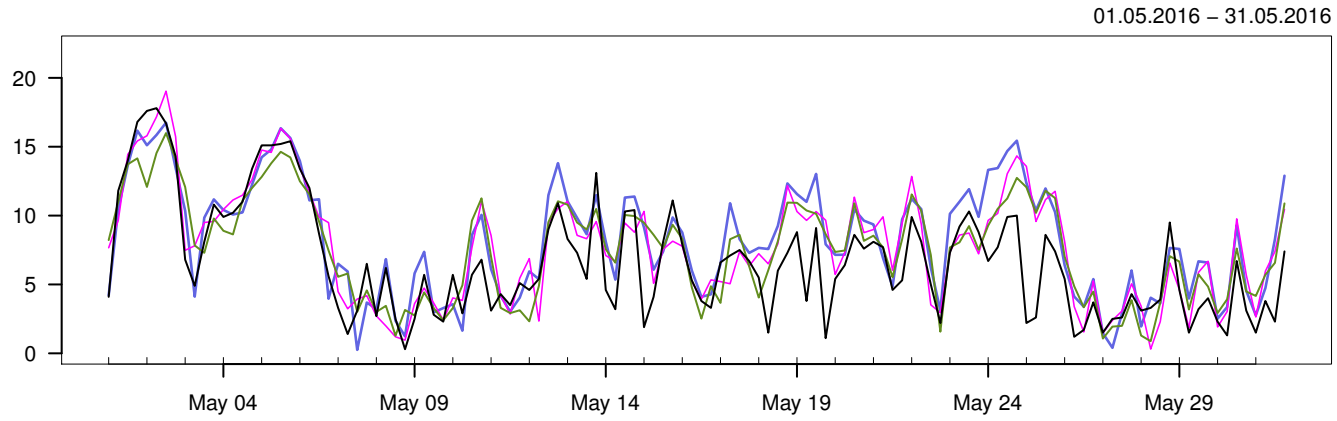
	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.6	5.3	13.7	2.4	368
AM25: 12+18,+24,+30,+36	0.4	4.3	14.6	2.3	368
Hirlam8: 12+18,+24,+30,+36	0.1	5.1	15	2.5	364
ECMWF: 12+18,+24,+30,+36	0.2	4.7	11.2	2.2	368

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	−1	1.8	2.1	1.6	9.1	368
Hirlam8 – synop	−0.2	1.8	1.8	1.4	7.1	364
ECMWF – synop	−0.6	1.6	1.7	1.3	6.3	368

YTTERØYANE FYR





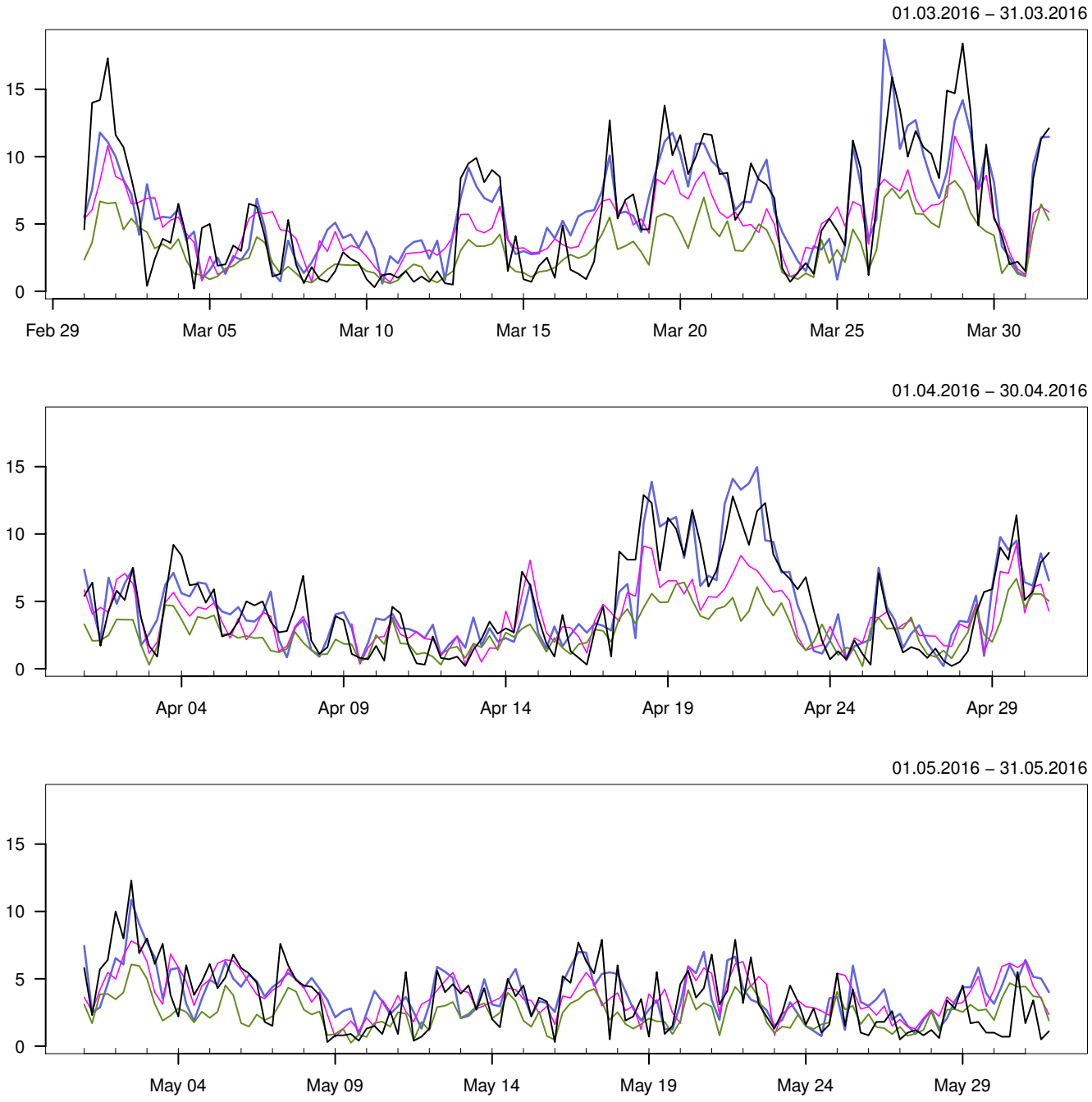


01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.1	6.8	21.9	4.5	367
AM25: 12+18,+24,+30,+36	0.3	8	22.2	4.1	368
Hirlam8: 12+18,+24,+30,+36	0.3	7.8	20.6	4.1	364
ECMWF: 12+18,+24,+30,+36	0.6	7.4	19.5	3.7	368

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	1.2	2.8	3	2.3	10.4	367
Hirlam8 – synop	0.9	2.6	2.8	2	11.4	363
ECMWF – synop	0.6	2.6	2.7	2	9.9	367

FINSEVATN

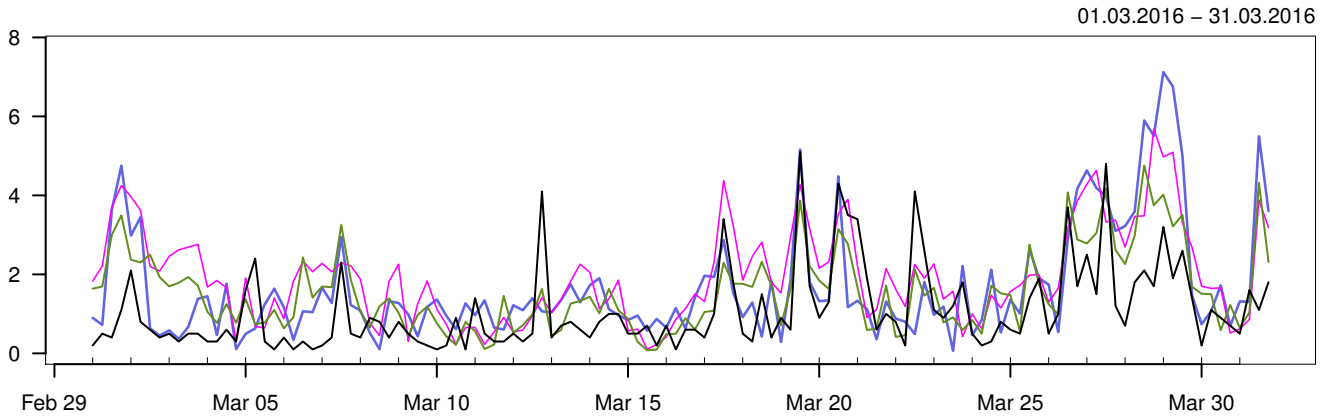


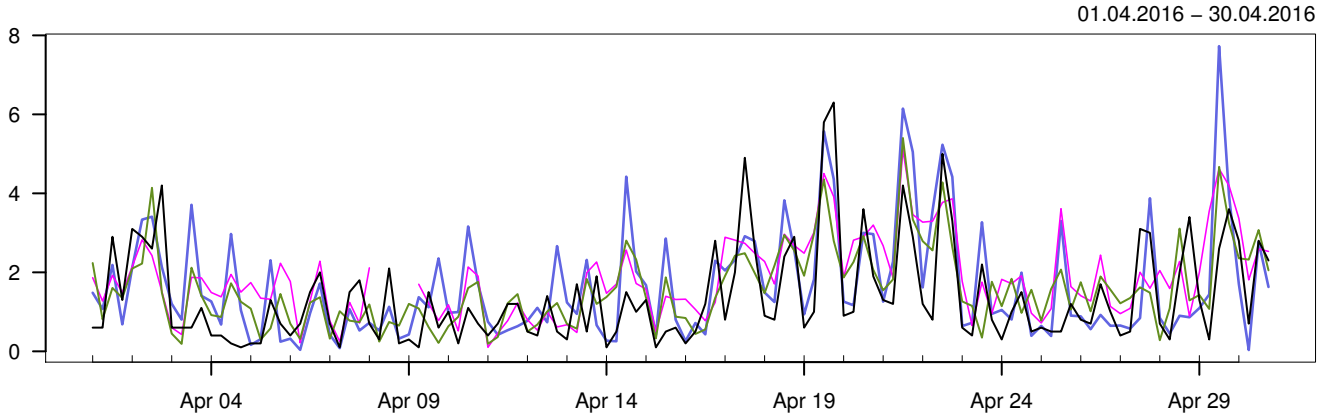
01.03.2016 – 31.05.2016

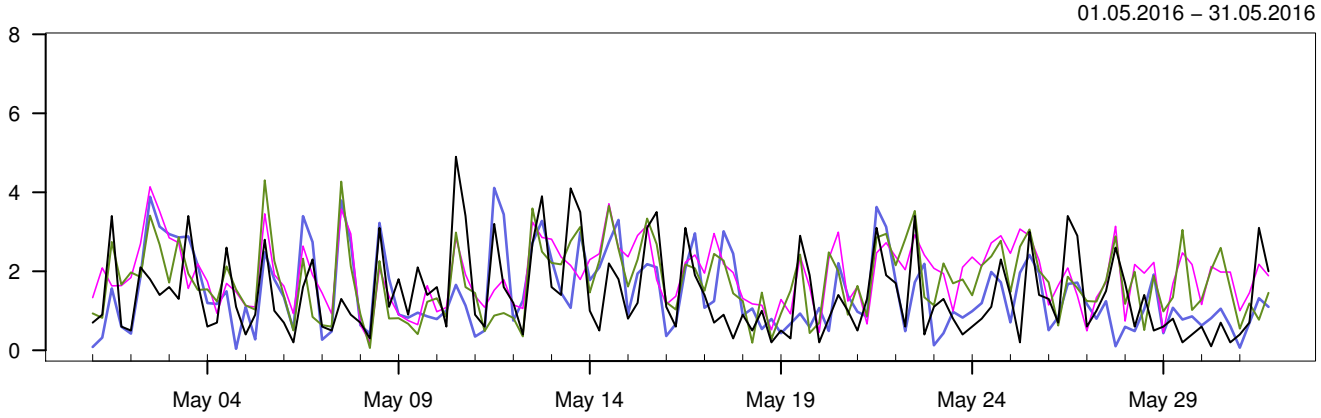
	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.2	4.6	18.4	3.7	368
AM25: 12+18,+24,+30,+36	0.2	4.9	18.7	3.1	368
Hirlam8: 12+18,+24,+30,+36	0.3	4.2	11.5	2.1	364
ECMWF: 12+18,+24,+30,+36	0.2	2.8	8.2	1.6	368

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.3	2	2.1	1.6	7.7	368
Hirlam8 – synop	–0.4	2.5	2.5	1.9	8.1	364
ECMWF – synop	–1.8	2.5	3.1	2.3	10.9	368

NESBYEN – TODOKK





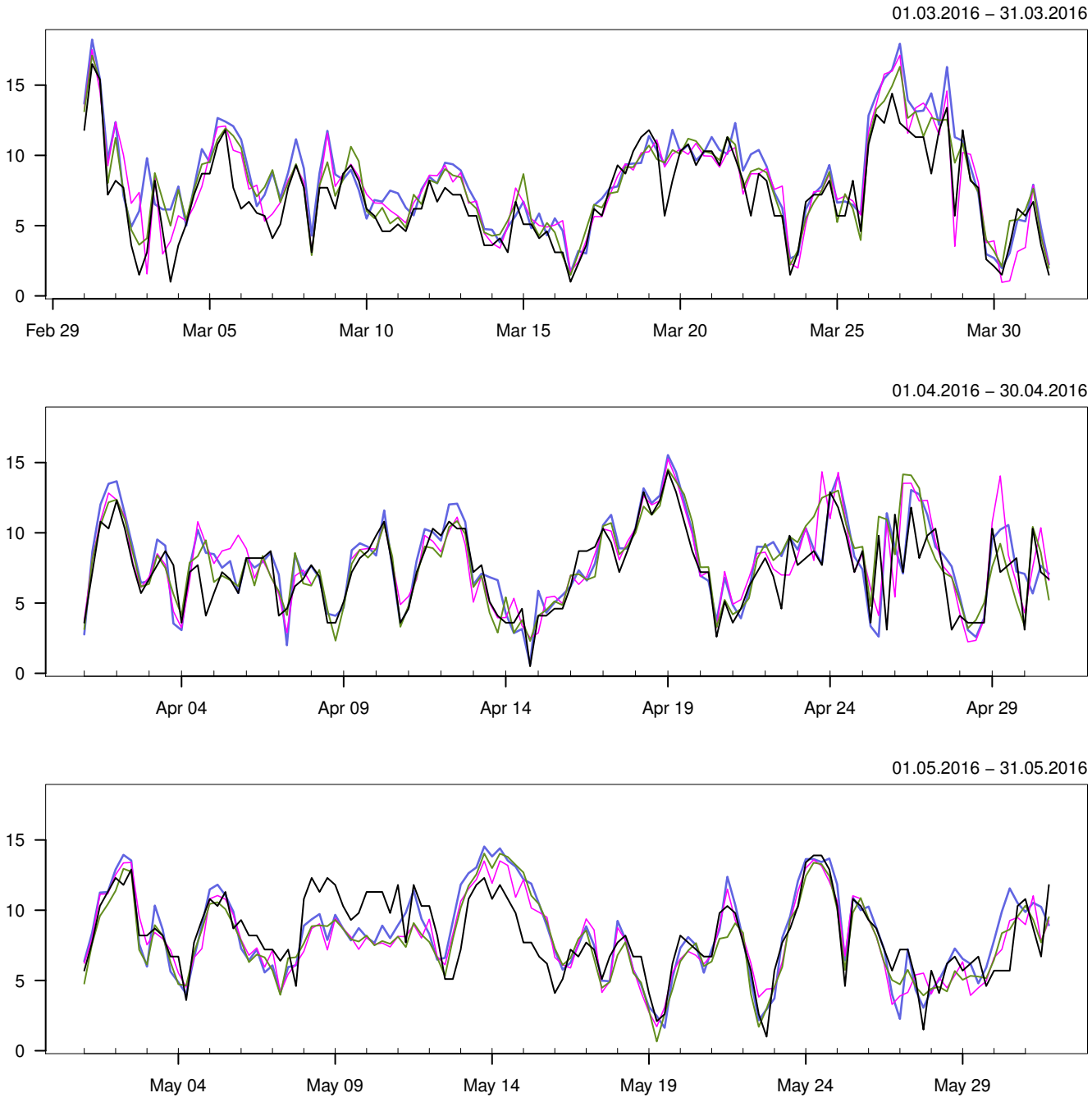


01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.1	1.3	6.3	1.1	368
AM25: 12+18,+24,+30,+36	0	1.6	7.7	1.3	368
Hirlam8: 12+18,+24,+30,+36	0.1	1.9	5.7	1	364
ECMWF: 12+18,+24,+30,+36	0.1	1.6	5.4	1	368

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.3	1.2	1.2	0.9	5.1	368
Hirlam8 – synop	0.6	1.1	1.2	1	4	364
ECMWF – synop	0.3	1	1	0.8	3.5	368

EKOFISK

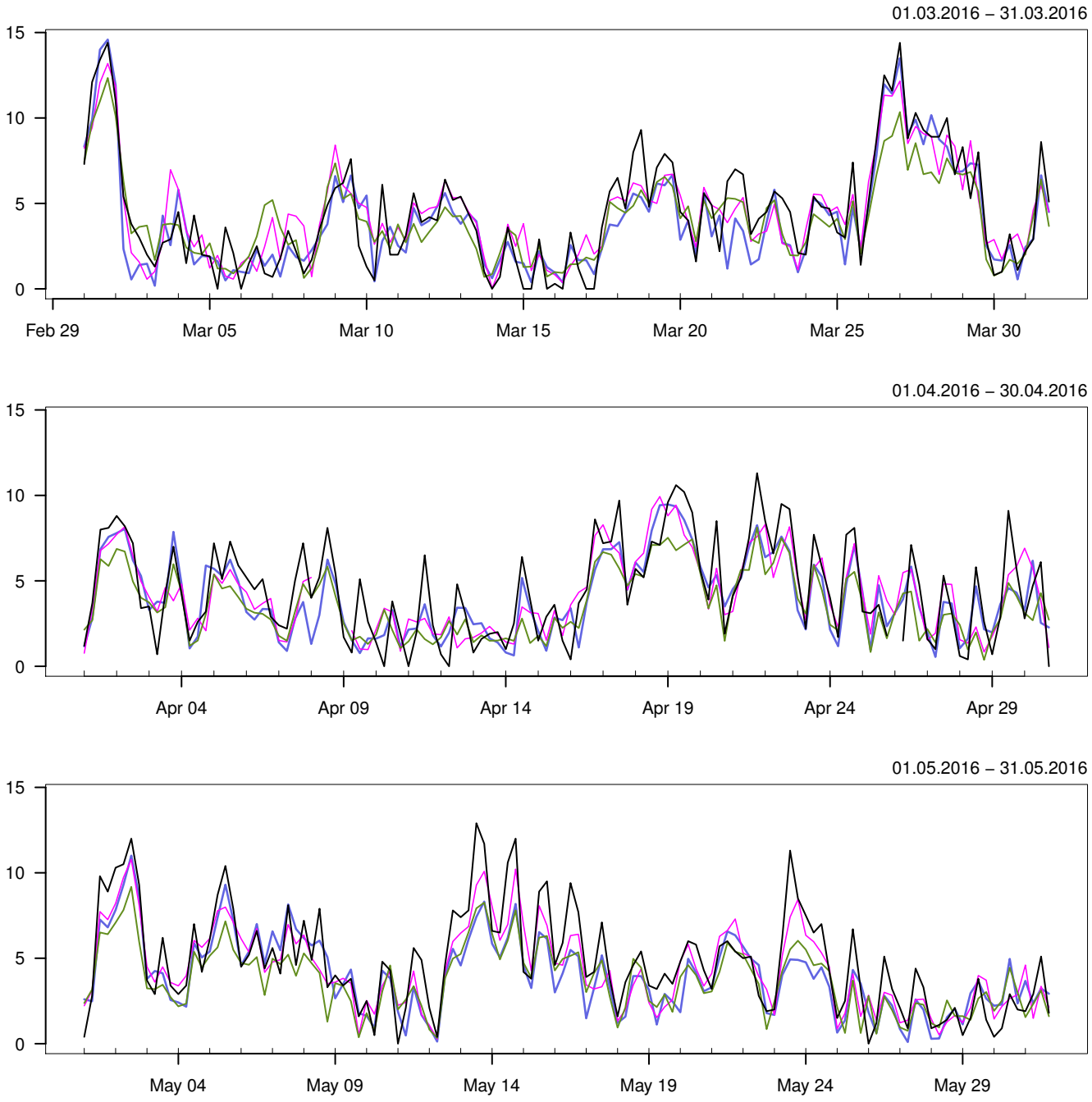


01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.5	7.6	16.5	2.9	368
AM25: 12+18,+24,+30,+36	0.6	8.2	18.2	3.2	368
Hirlam8: 12+18,+24,+30,+36	1	7.9	17.5	3	364
ECMWF: 12+18,+24,+30,+36	0.7	7.8	17.1	2.9	368

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.7	1.9	2	1.5	8.3	368
Hirlam8 – synop	0.3	1.9	1.9	1.4	7.7	364
ECMWF – synop	0.3	1.7	1.7	1.2	7.8	368

SOLA

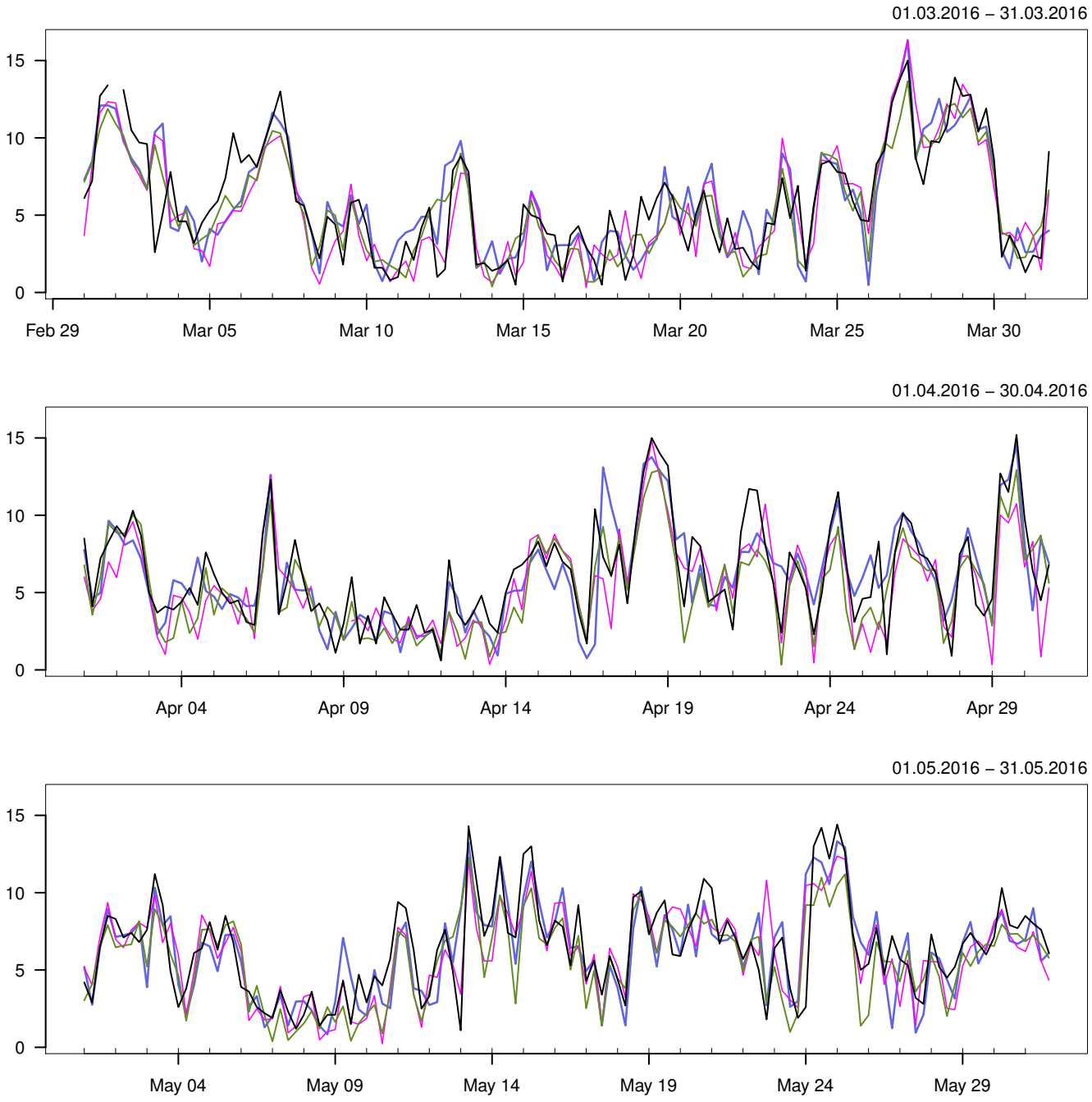


01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 00,06,12,18	0	4.6	14.4	3	367
AM25: 12+18,+24,+30,+36	0.1	4	14.6	2.6	368
Hirlam8: 12+18,+24,+30,+36	0	4.4	13.2	2.5	364
ECMWF: 12+18,+24,+30,+36	0.3	3.8	12.3	2.1	368

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	–0.6	1.5	1.6	1.3	6.4	367
Hirlam8 – synop	–0.2	1.6	1.6	1.2	4.1	363
ECMWF – synop	–0.8	1.6	1.8	1.4	5.8	367

FÆRDER FYR

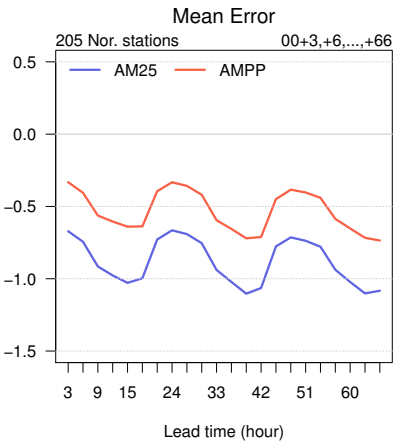


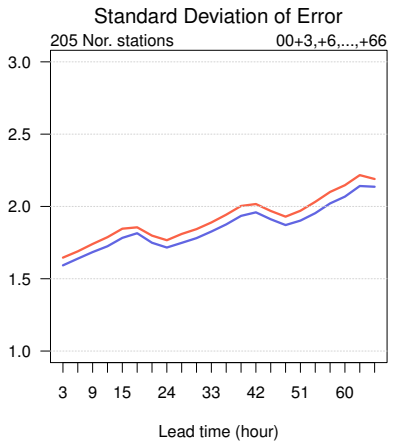
01.03.2016 – 31.05.2016

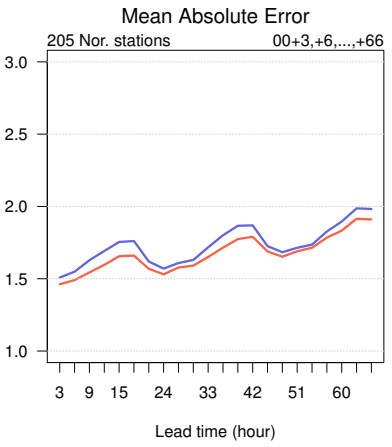
	Min	Mean	Max	Std	N
synop: 00,06,12,18	0.5	6.1	15.2	3.3	367
AM25: 12+18,+24,+30,+36	0.5	6	16.3	3.1	368
Hirlam8: 12+18,+24,+30,+36	0.2	5.7	16.4	3.1	364
ECMWF: 12+18,+24,+30,+36	0.3	5.5	13.7	2.9	368

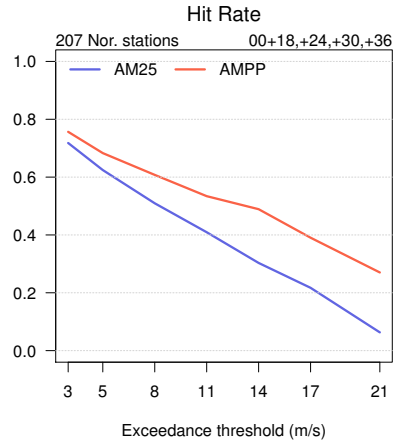
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	–0.1	2	2	1.4	8.7	367
Hirlam8 – synop	–0.5	1.9	2	1.6	9	363
ECMWF – synop	–0.6	1.7	1.9	1.4	7.9	367

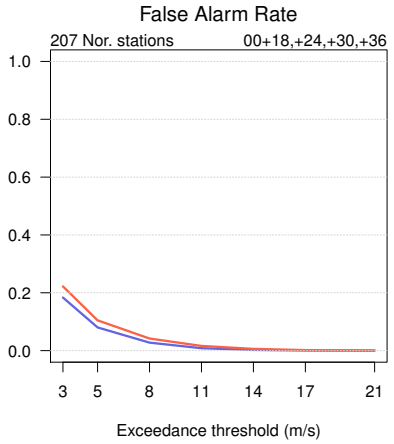
Post processed maximum mean wind speed 10m (AMPP)

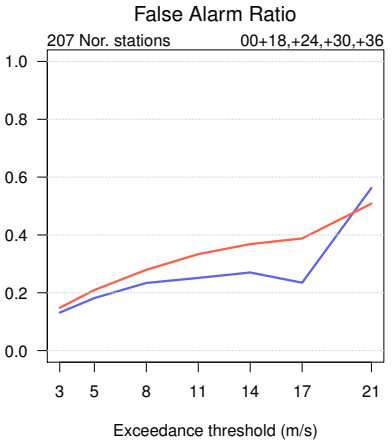


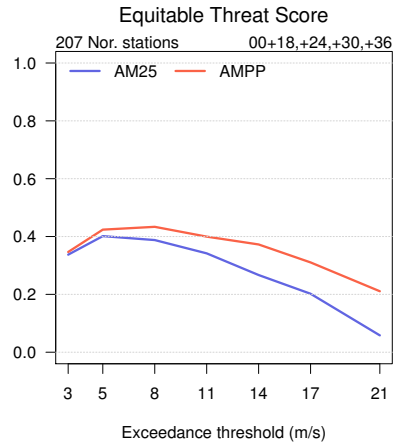


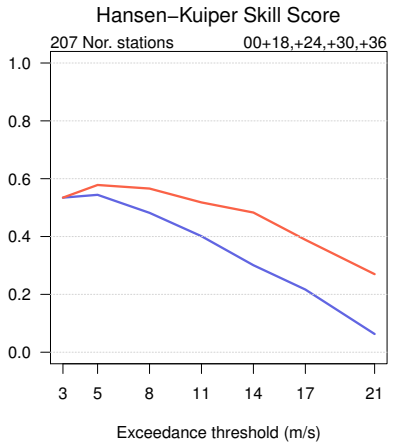


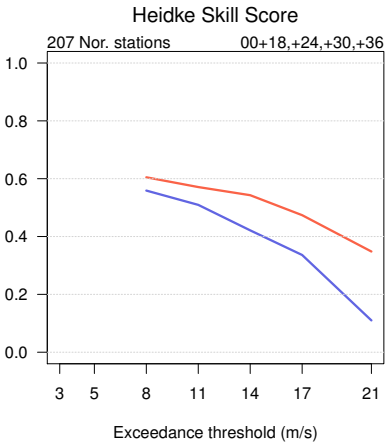




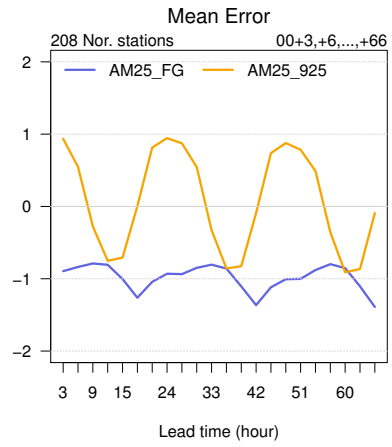


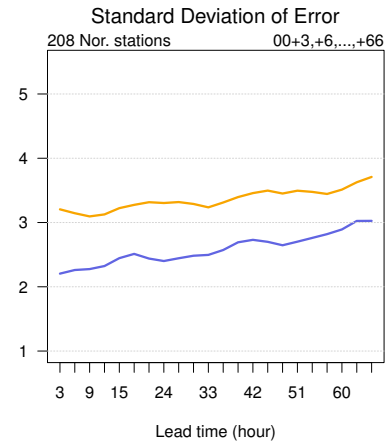


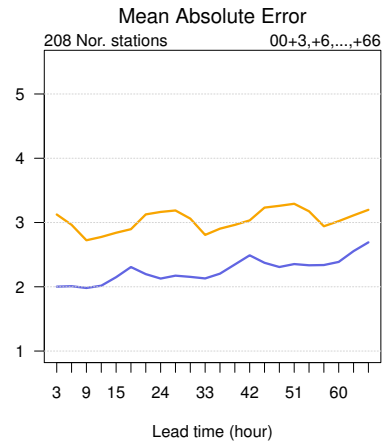


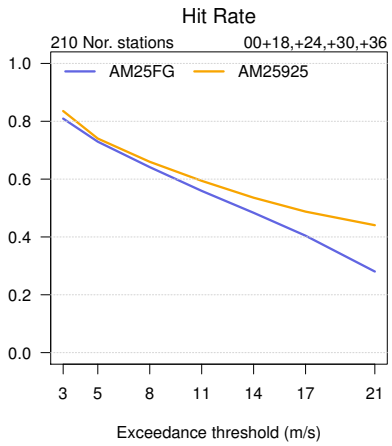


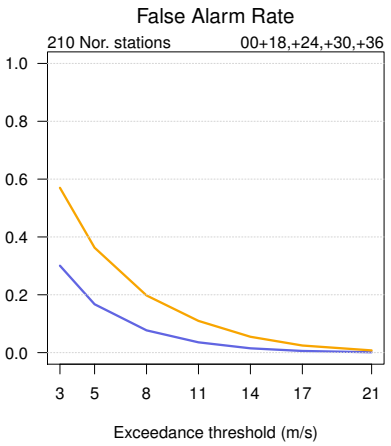
Wind gust (AM25_FG) and AM25_925

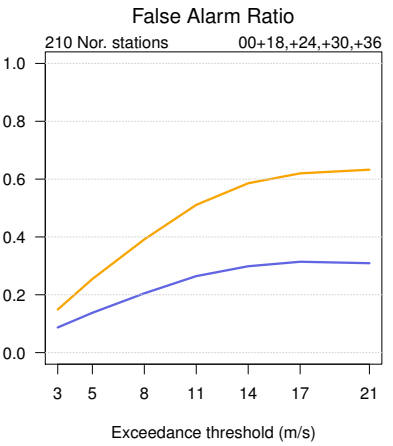


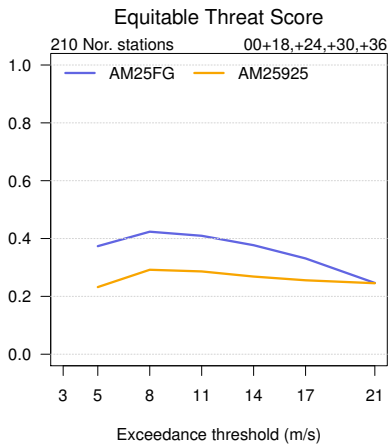


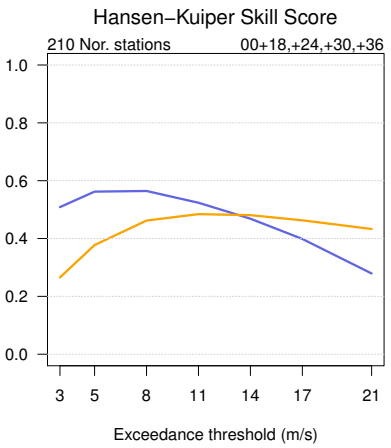


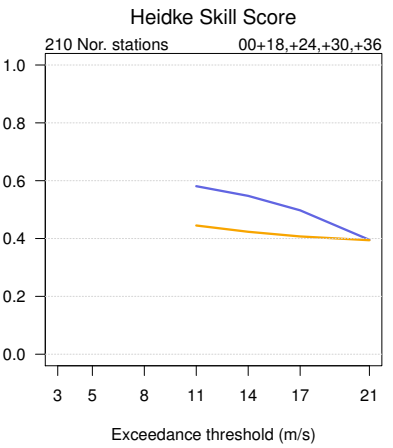


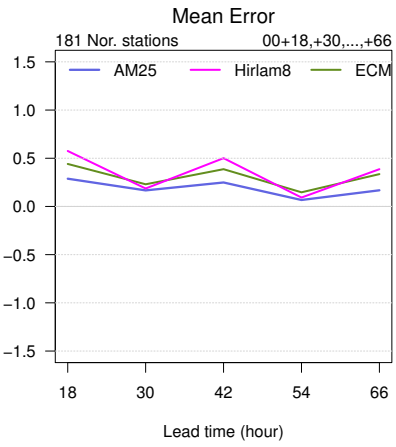


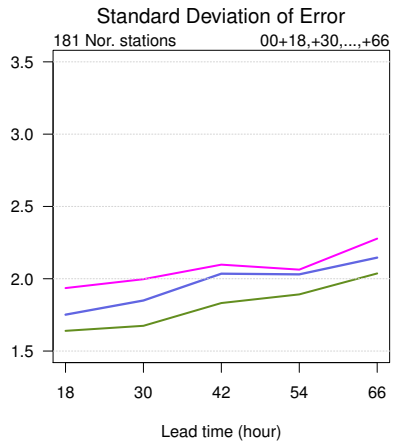


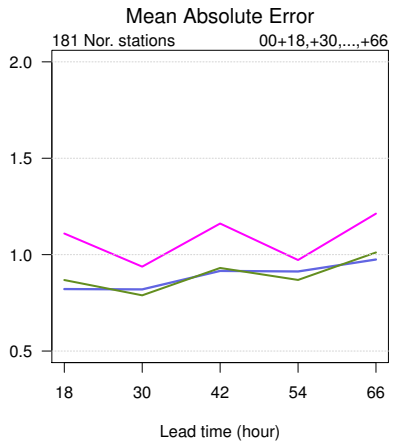


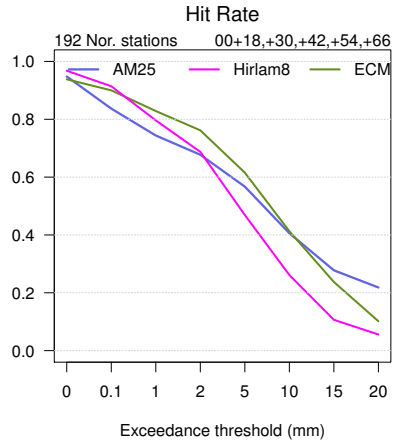


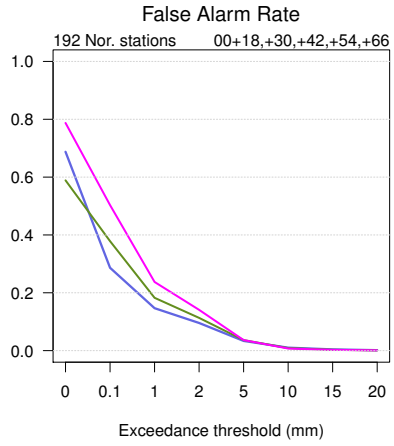


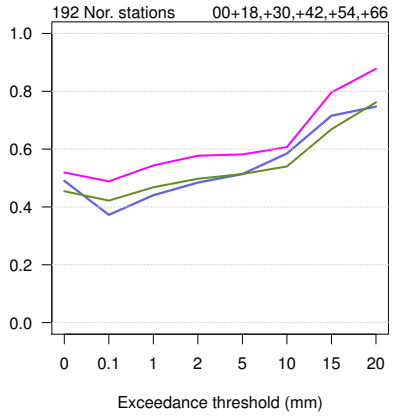

Mean Error
181 Nor. stations
00+18,+30,...,+66
AM25
Hirlam8
ECM
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
18
30
42
54
66
Lead time (hour)

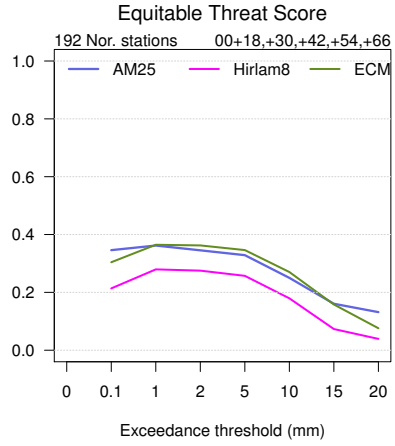

Standard Deviation of Error
181 Nor. stations
00+18,+30,...,+66
3.5
3.0
2.5
2.0
1.5
18
30
42
54
66
Lead time (hour)

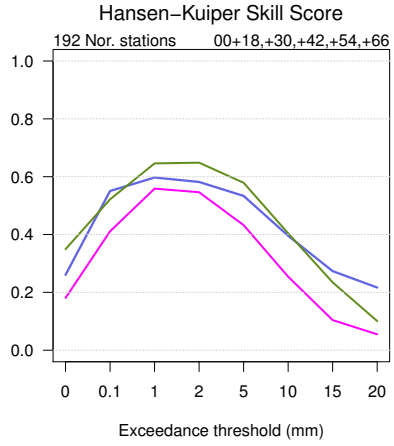

Mean Absolute Error
181 Nor. stations
00+18,+30,...,+66
2.0
1.5
1.0
0.5
18
30
42
54
66
Lead time (hour)

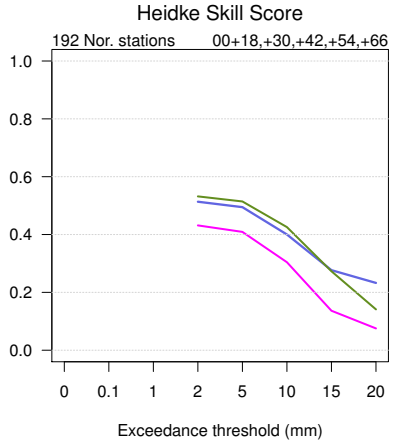

Hit Rate
192 Nor. stations
00+18,+30,+42,+54,+66
AM25
Hirlam8
ECM
1.0
0.8
0.6
0.4
0.2
0.0
0
0.1
1
2
5
10
15
20
Exceedance threshold (mm)


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


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

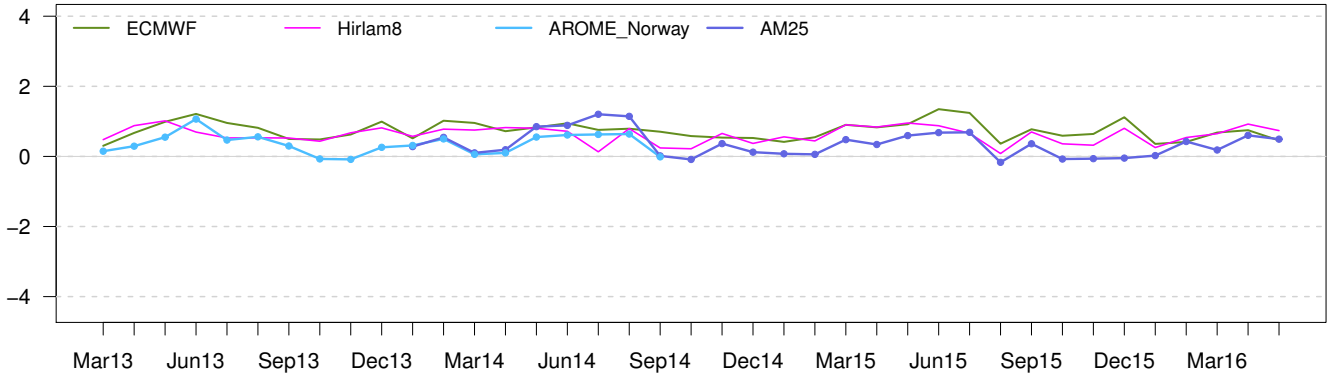

Equitable Threat Score
192 Nor. stations
00+18,+30,+42,+54,+66
AM25
Hirlam8
ECM
1.0
0.8
0.6
0.4
0.2
0.0
0
0.1
1
2
5
10
15
20
Exceedance threshold (mm)


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

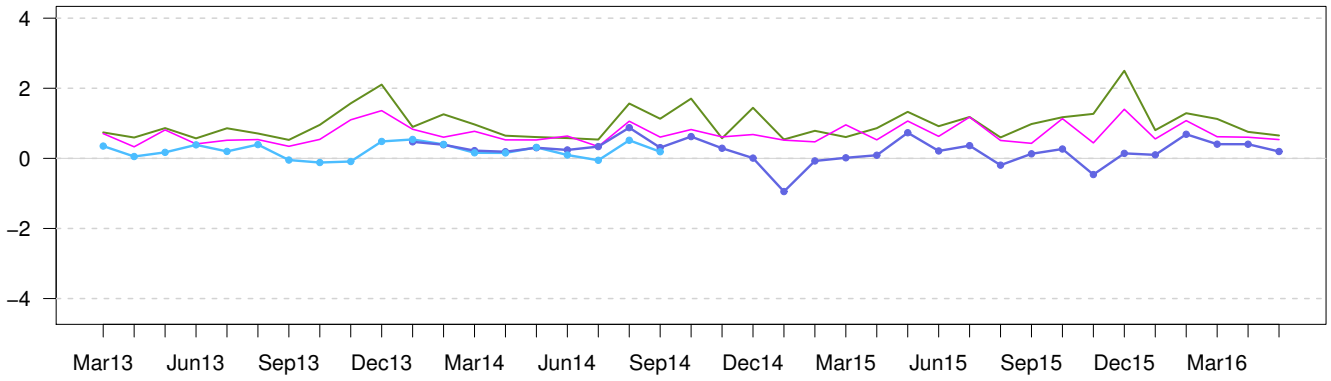

Heidke Skill Score
192 Nor. stations
00+18,+30,+42,+54,+66
1.0
0.8
0.6
0.4
0.2
0.0
0
0.1
1
2
5
10
15
20
Exceedance threshold (mm)

Mean Error

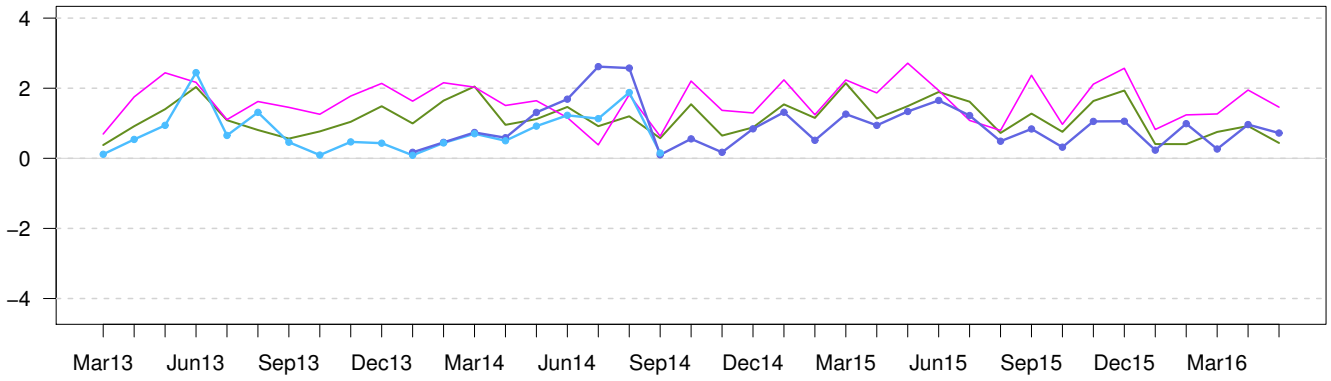
89 Norwegian stations 00+30 UTC



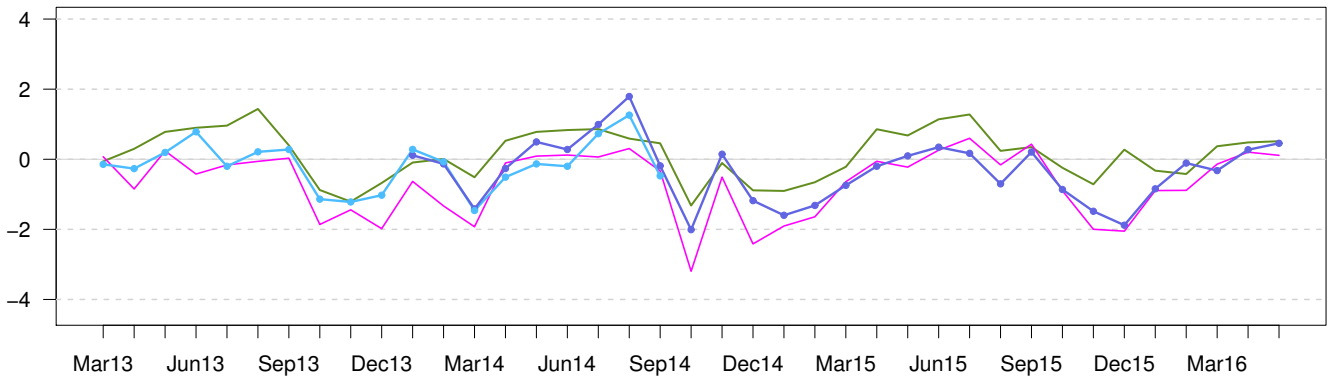
15 coastal stations



24 stations more than 500 m above sea level

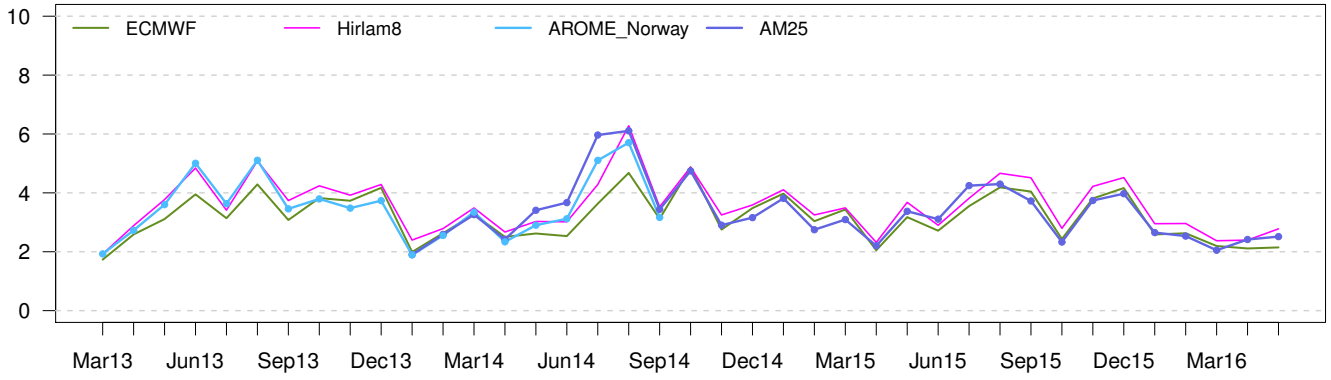


15 stations with daily mean precipitation > 4 mm

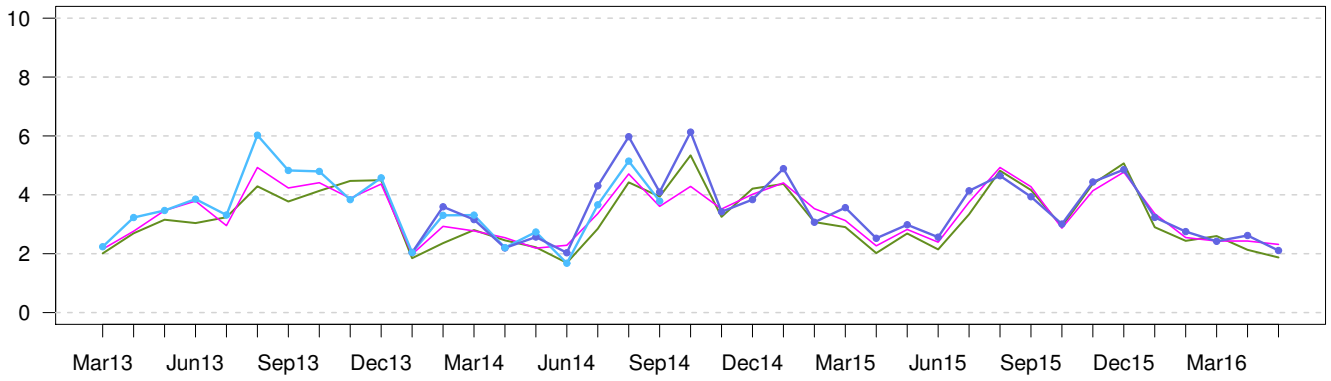


Standard Deviation of Error

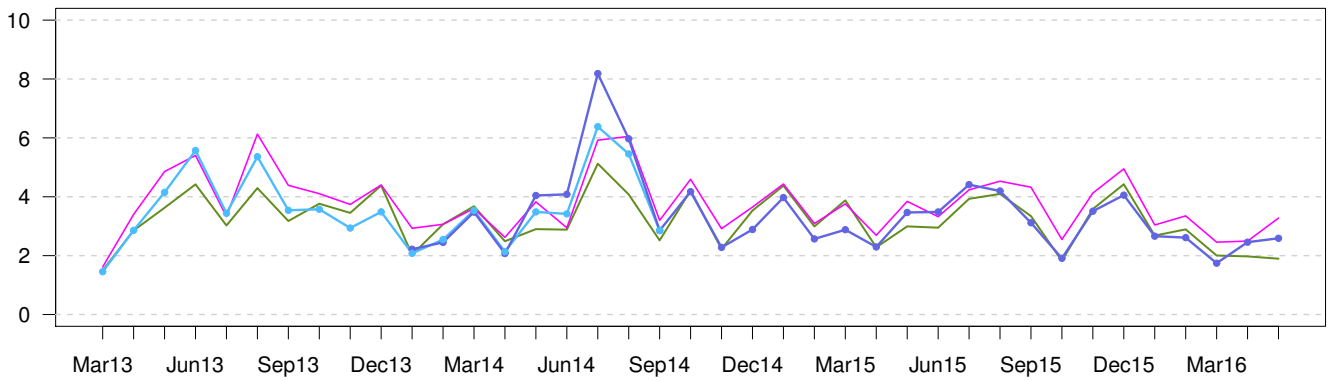
89 Norwegian stations 00+30 UTC



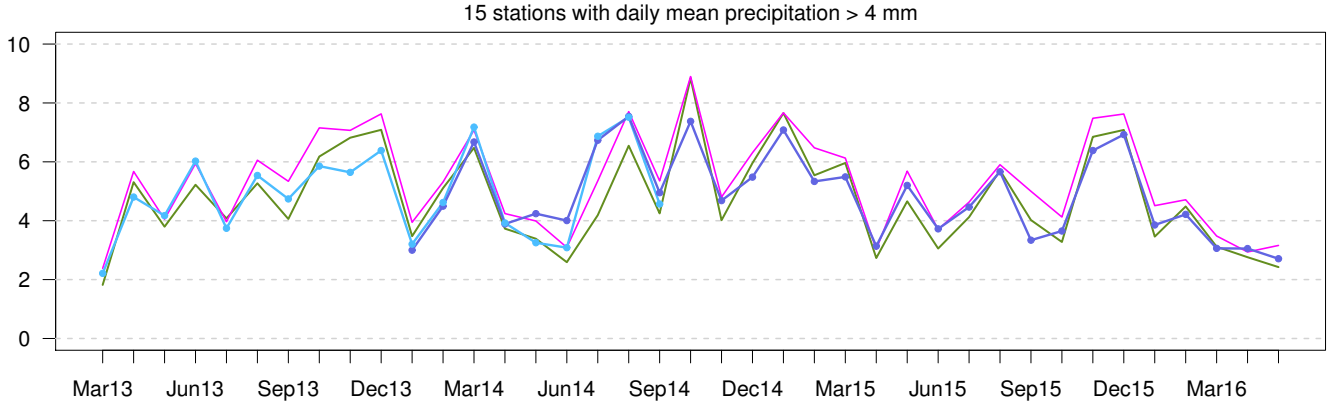
15 coastal stations



24 stations more than 500 m above sea level

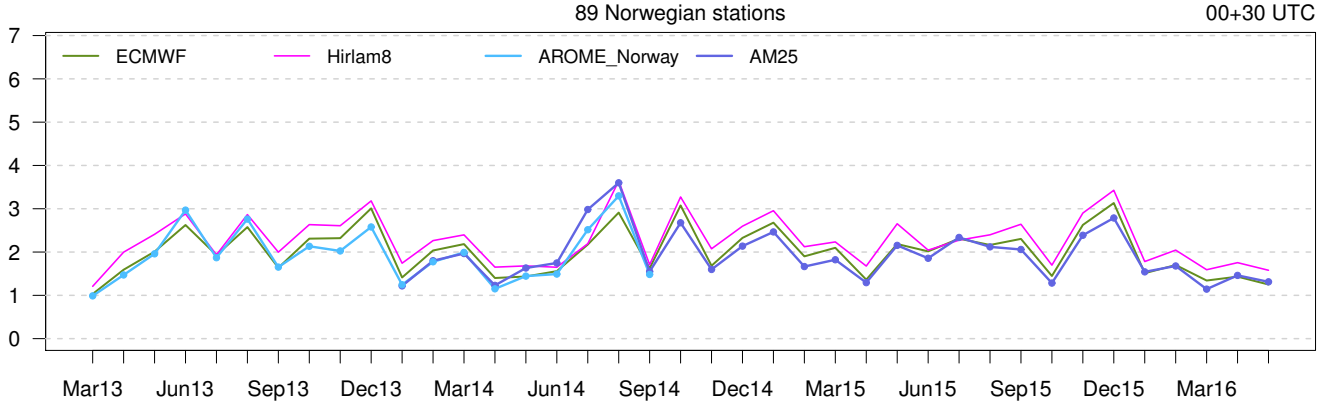


15 stations with daily mean precipitation > 4 mm

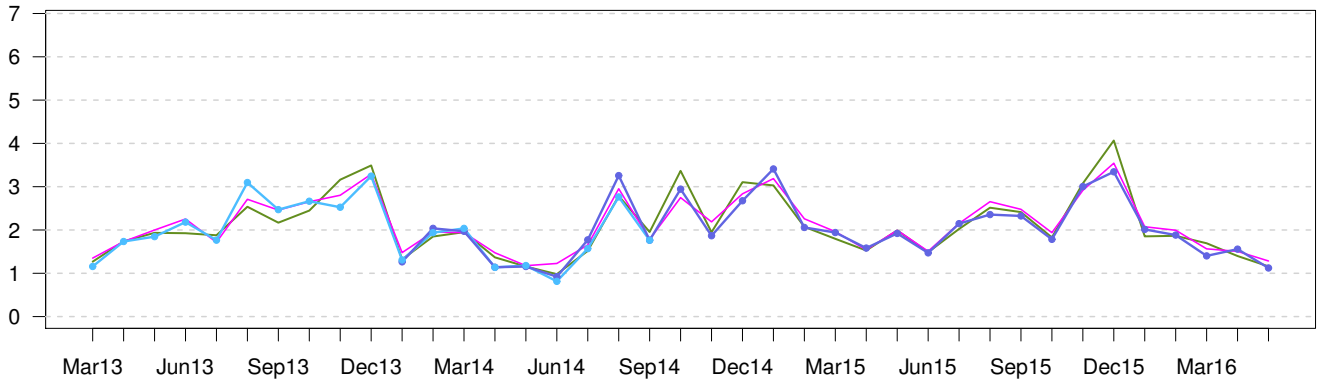


Mean Absolute Error

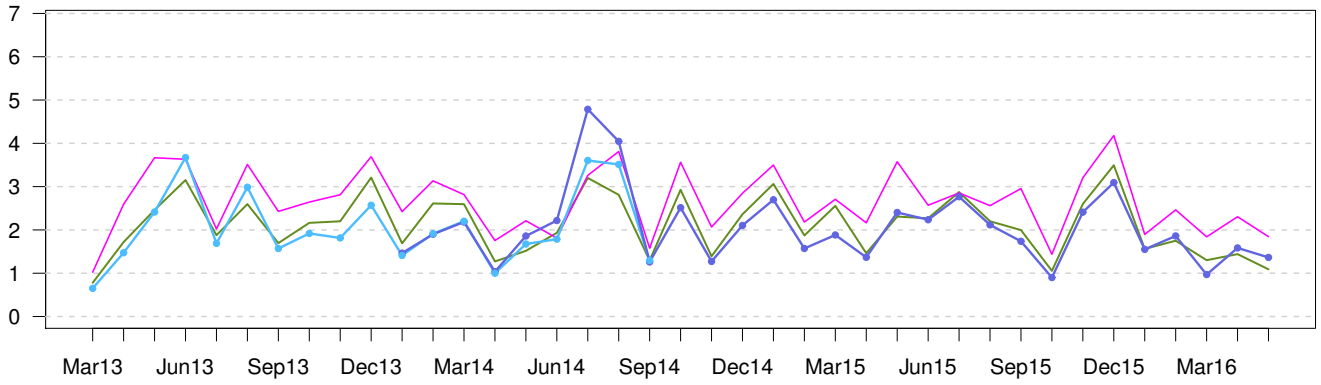
89 Norwegian stations 00+30 UTC



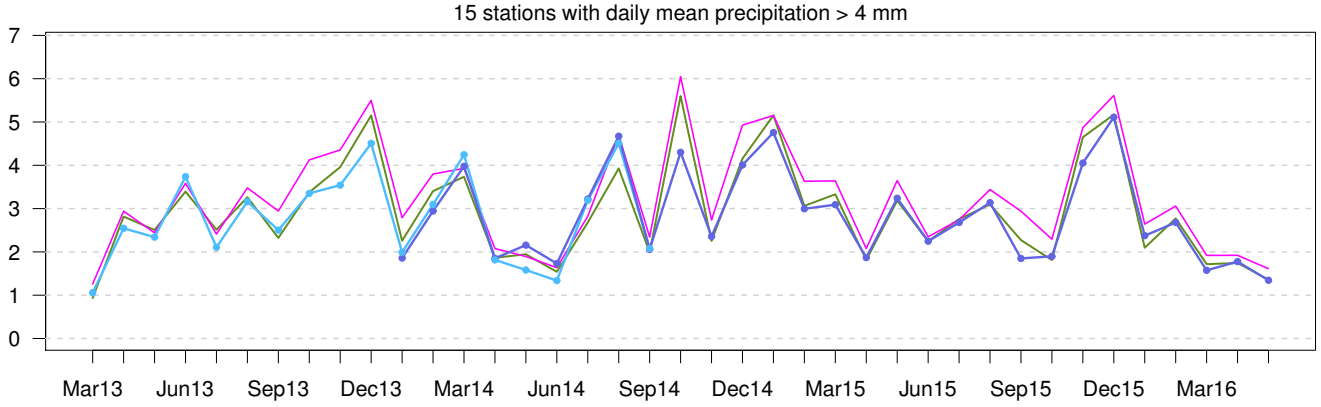
15 coastal stations



24 stations more than 500 m above sea level

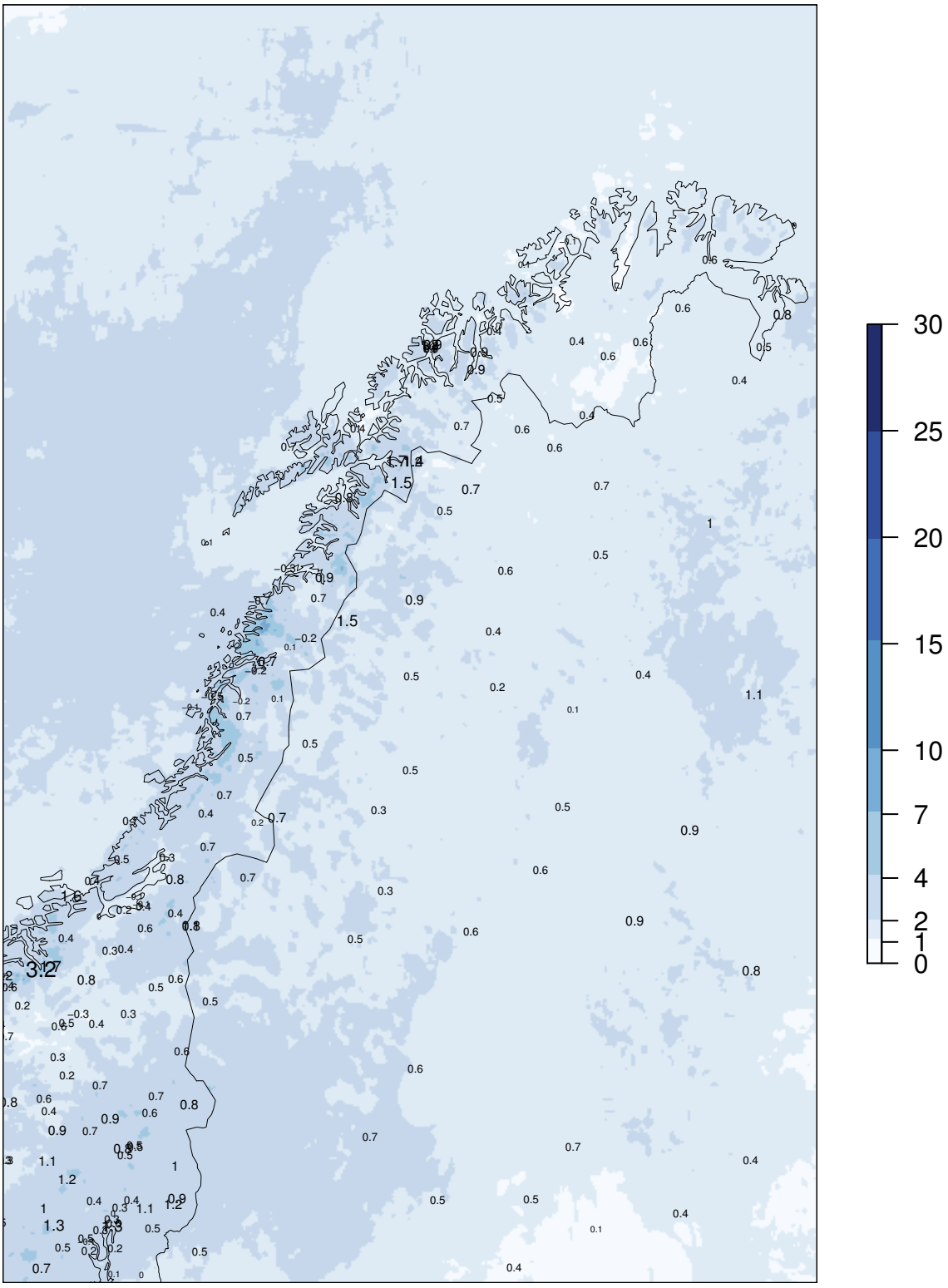


15 stations with daily mean precipitation > 4 mm



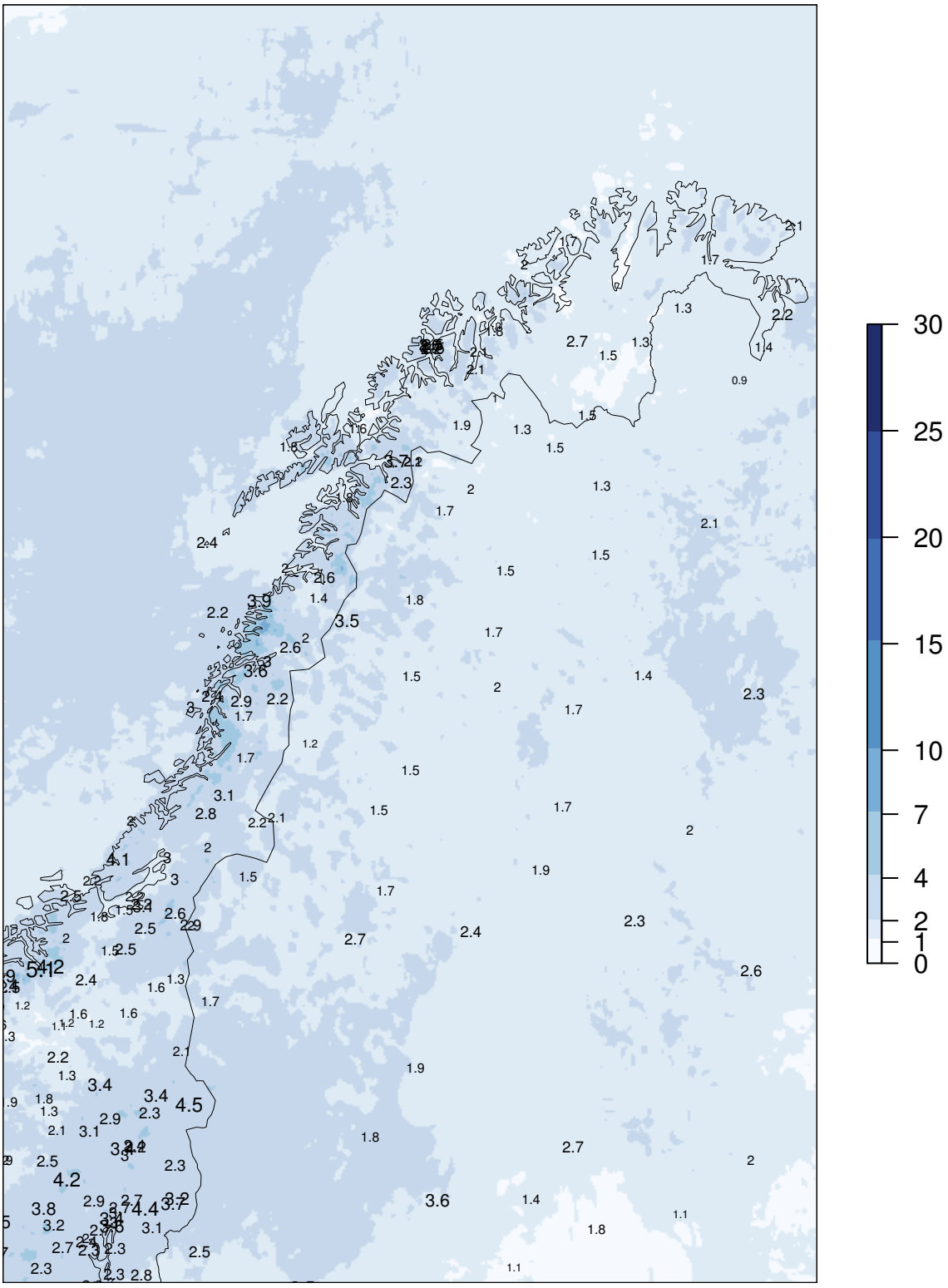
AM25 00+30

ME at observing sites forecast means 01.03.2016 – 31.05.2016



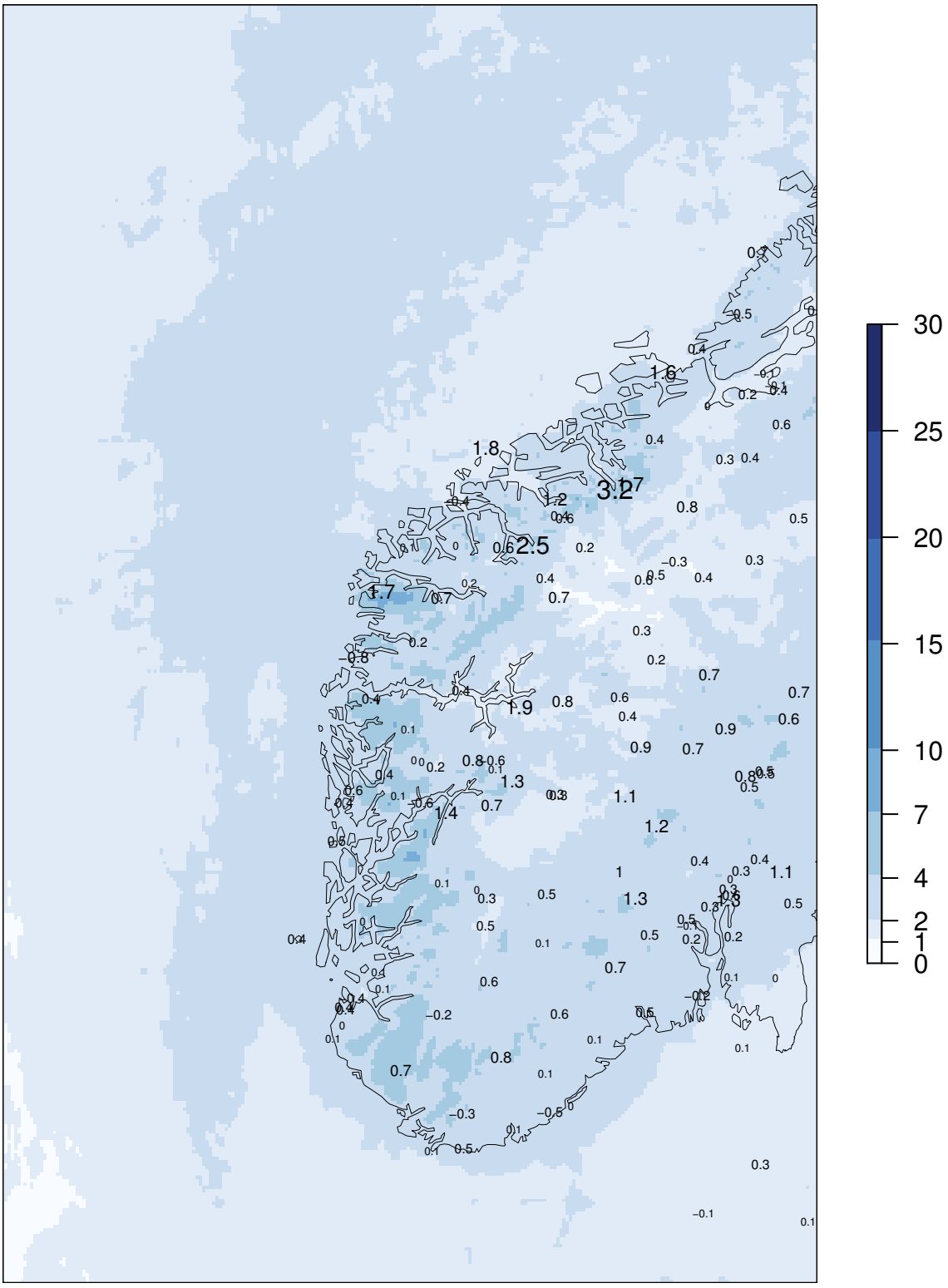
AM25 00+30

SDE at observing sites forecast means 01.03.2016 – 31.05.2016



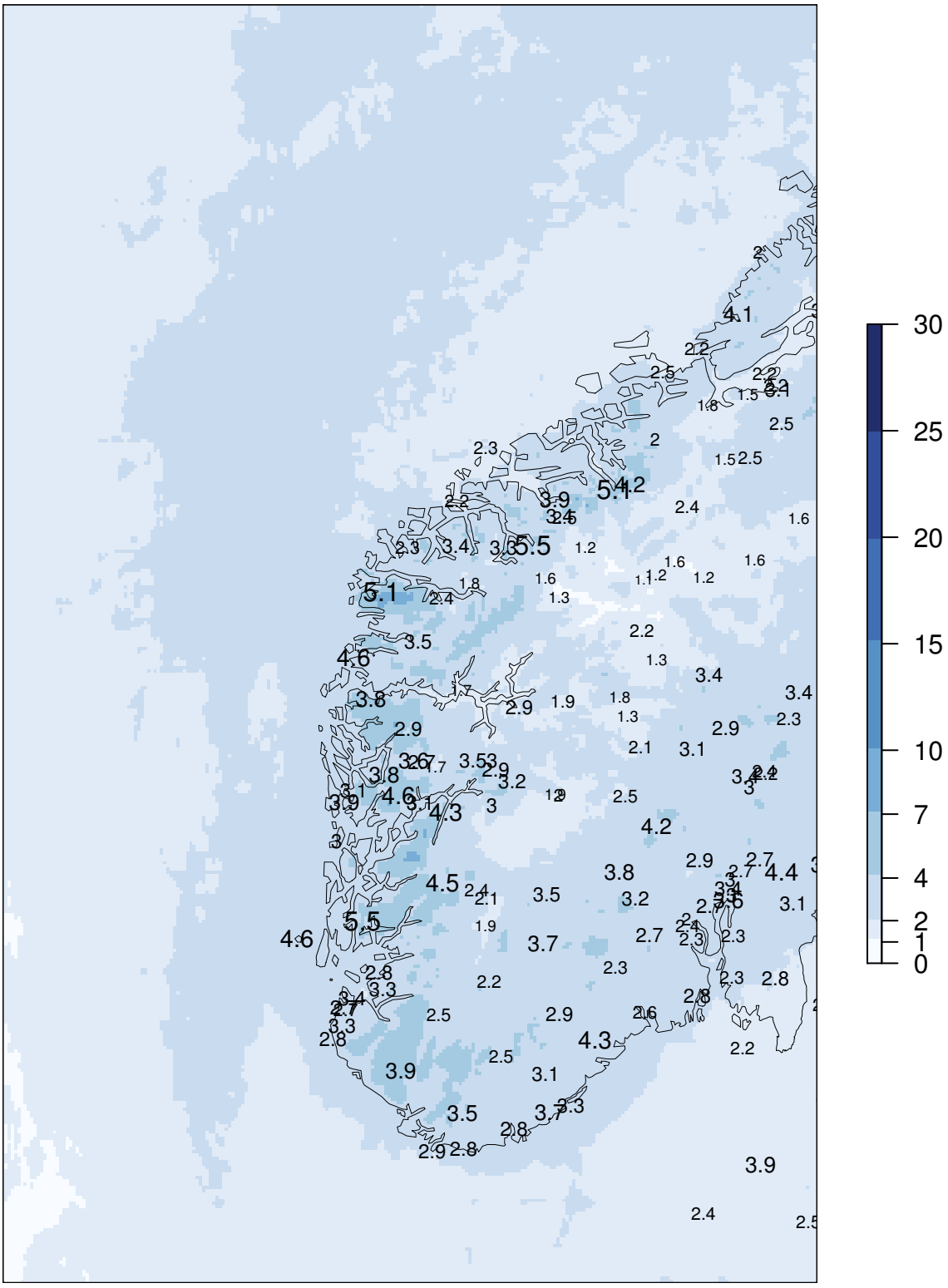
AM25 00+30

ME at observing sites forecast means 01.03.2016 – 31.05.2016



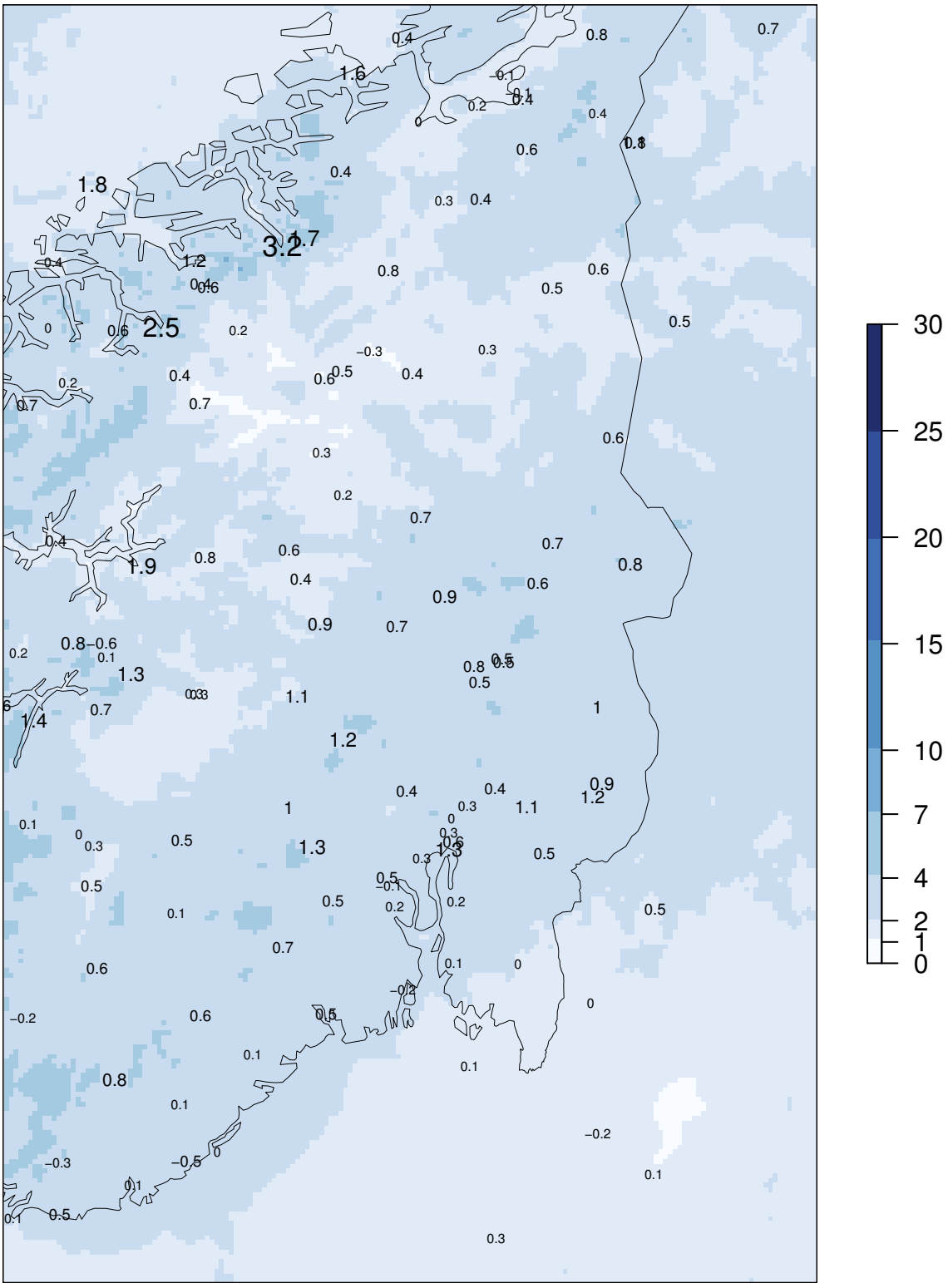
AM25 00+30

SDE at observing sites forecast means 01.03.2016 – 31.05.2016



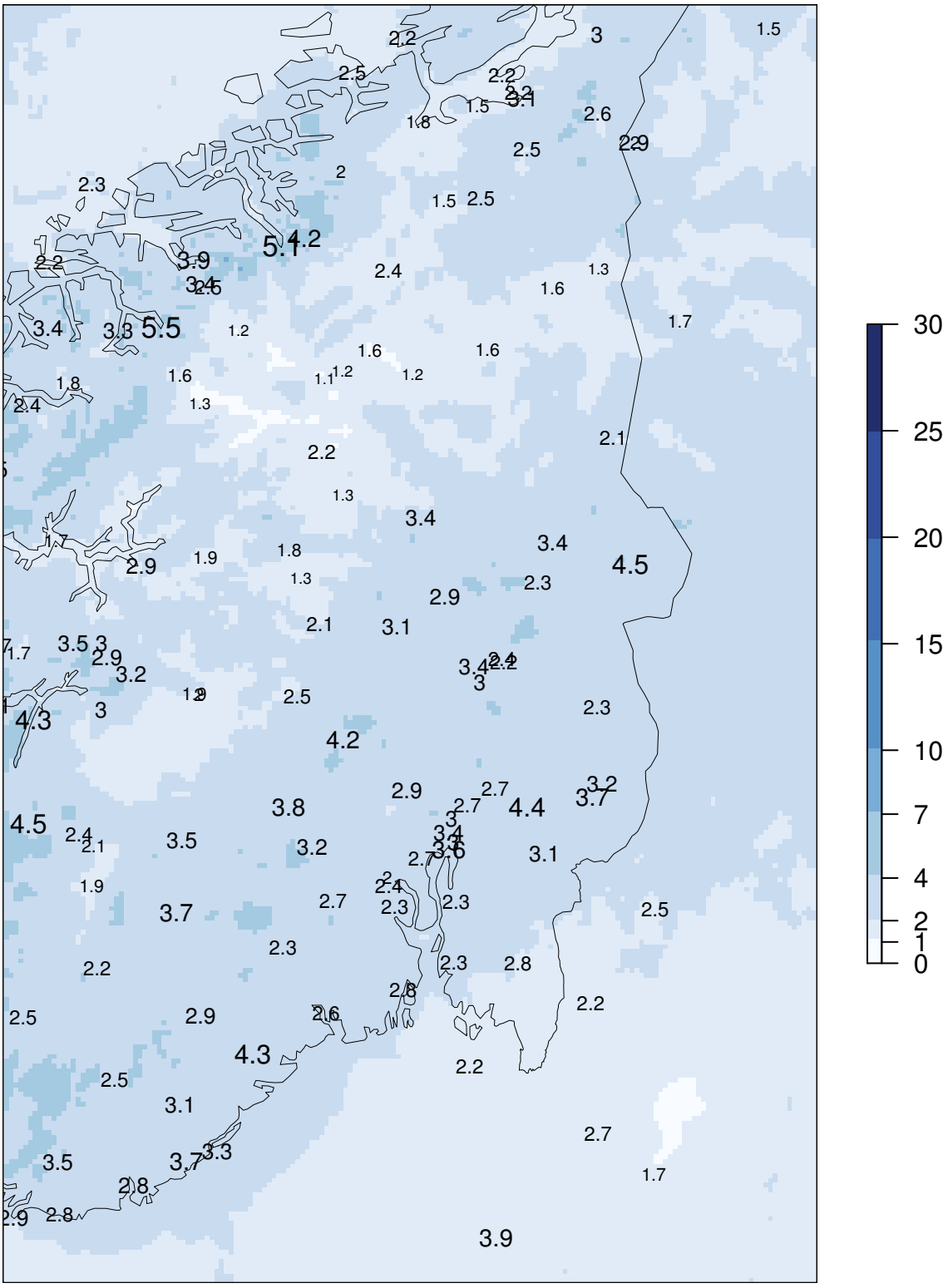
AM25 00+30

ME at observing sites forecast means 01.03.2016 – 31.05.2016



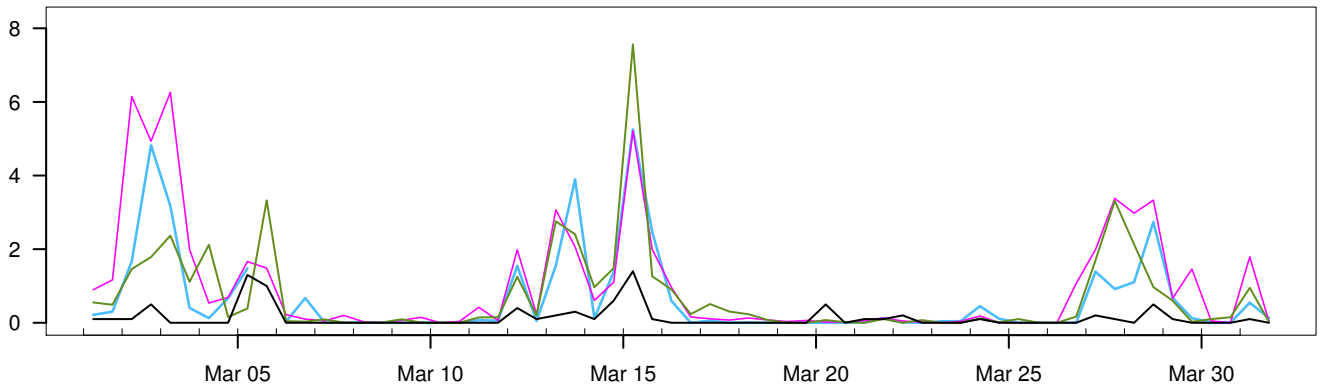
AM25 00+30

SDE at observing sites forecast means 01.03.2016 – 31.05.2016

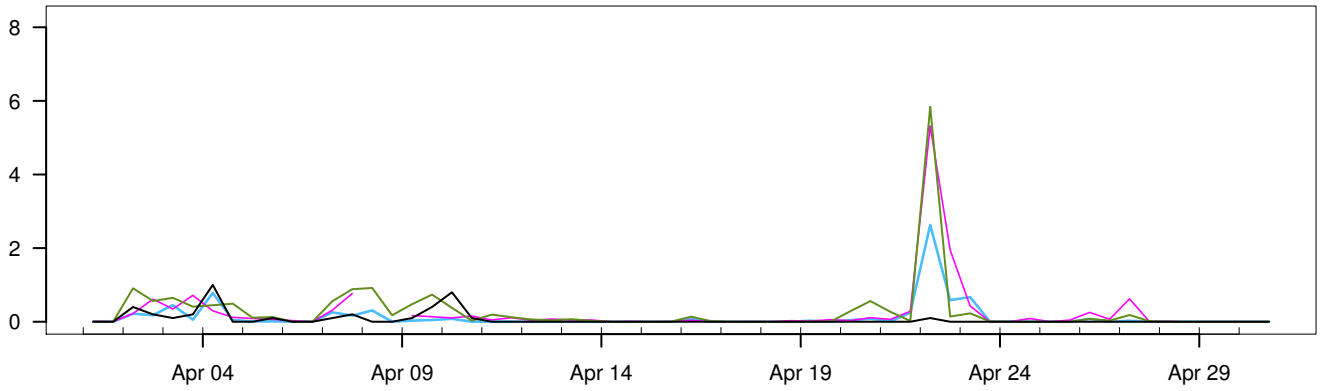


SVALBARD LUFTHAVN

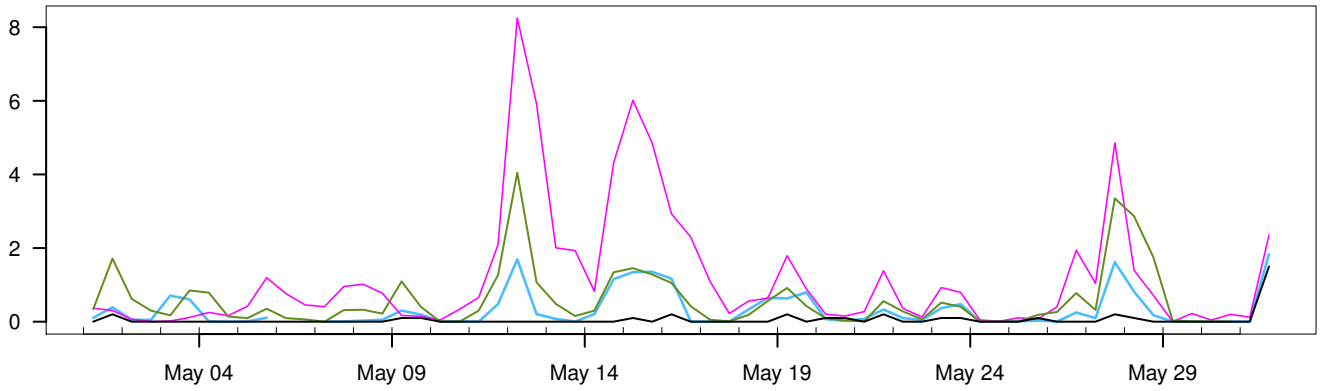
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016

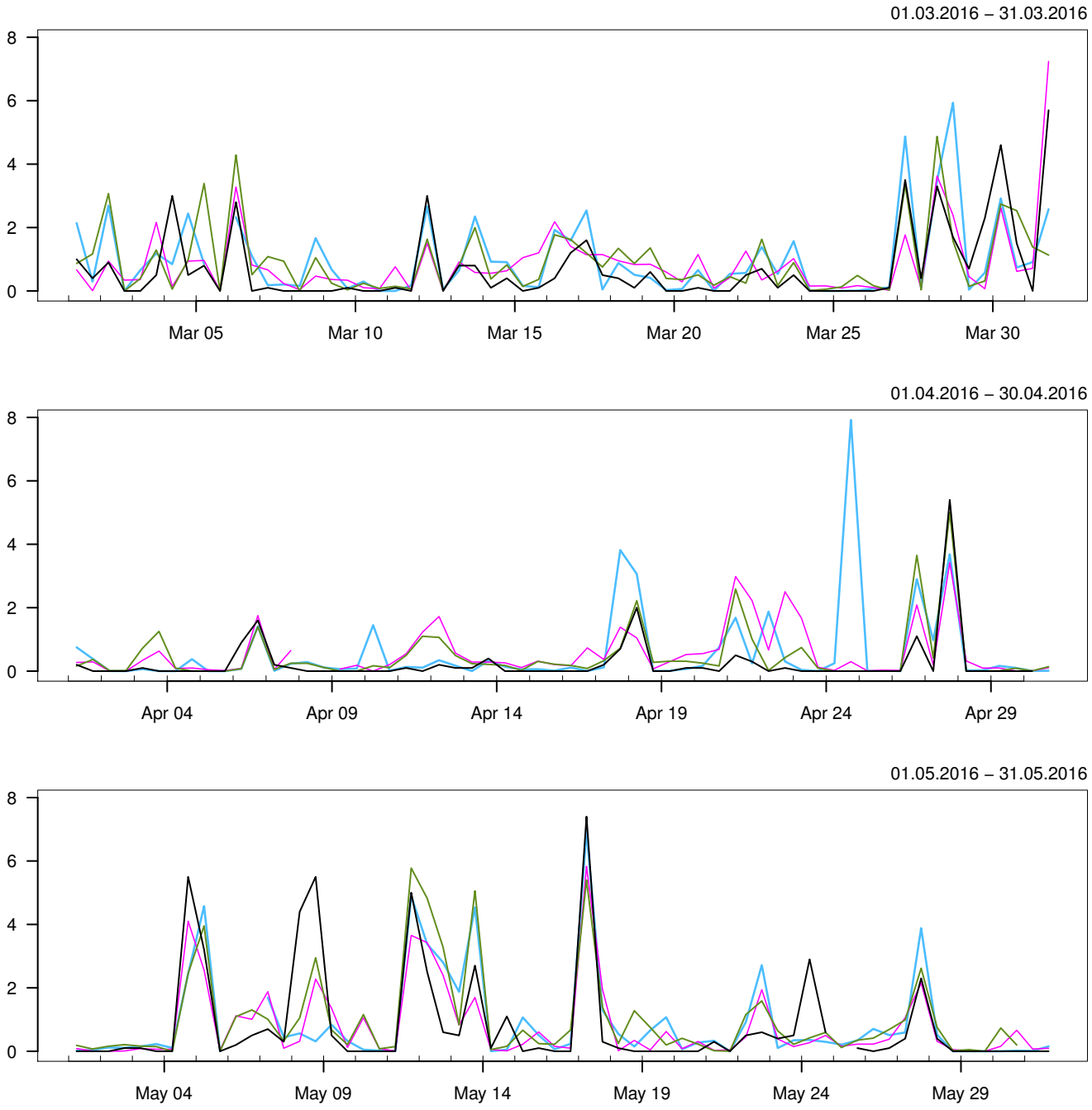


01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 06,18	0	0.1	1.5	0.2	184
AA25: 12+18,+30	0	0.4	5.3	0.8	181
Hirlam8: 12+18,+30	0	0.8	8.2	1.4	182
ECMWF: 12+18,+30	0	0.5	7.6	1	182

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AA25 – synop	0.3	0.7	0.8	0.3	4.3	181
Hirlam8 – synop	0.7	1.4	1.6	0.8	8.2	182
ECMWF – synop	0.5	0.9	1	0.5	6.2	182

BJØRNØYA

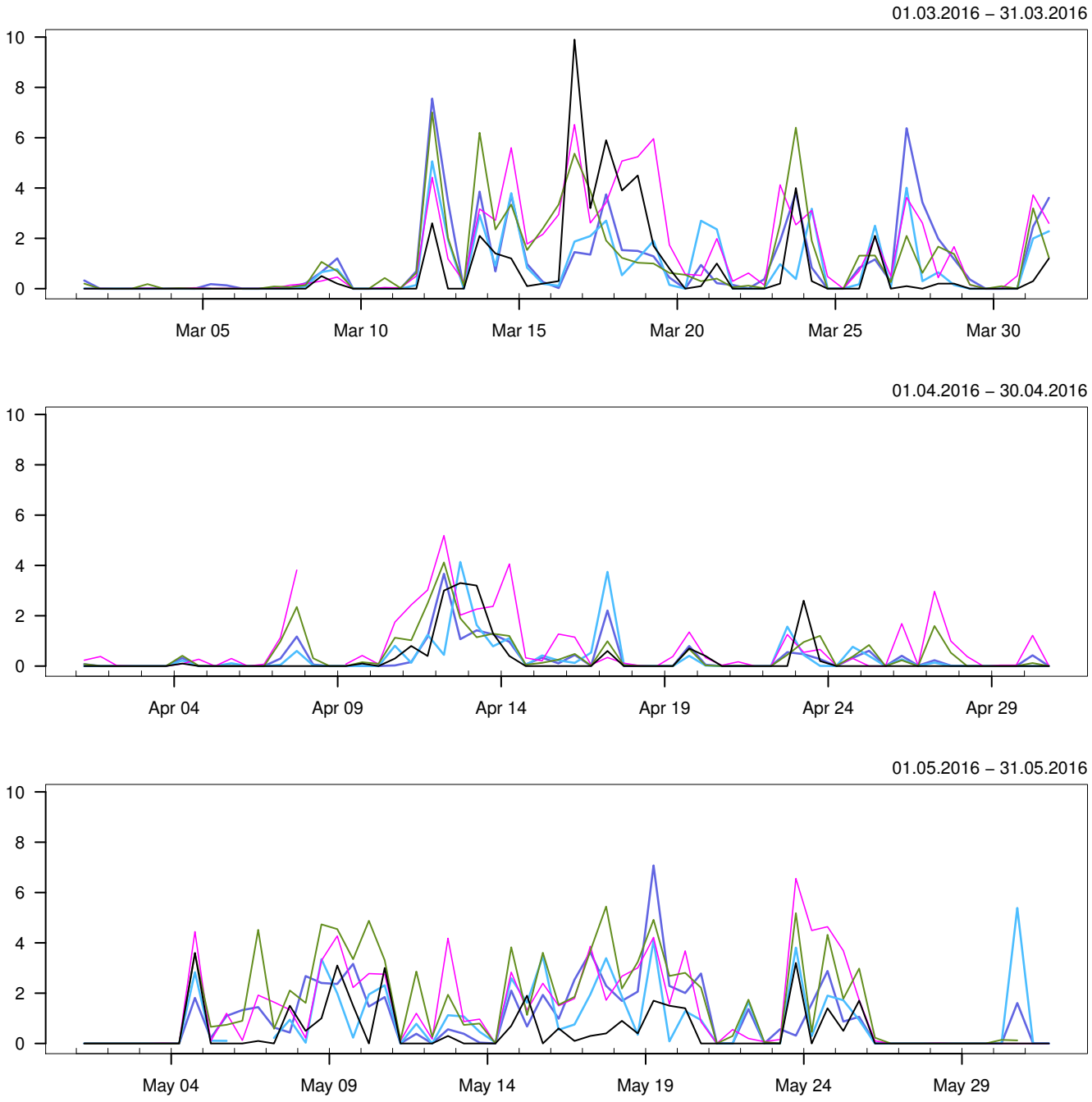


01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 06,18	0	0.6	7.4	1.3	182
AA25: 12+18,+30	0	0.8	7.9	1.3	181
Hirlam8: 12+18,+30	0	0.7	7.2	1.1	182
ECMWF: 12+18,+30	0	0.8	5.8	1.2	182

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AA25 – synop	0.2	1.1	1.2	0.6	7.9	179
Hirlam8 – synop	0.1	0.9	0.9	0.5	4.1	180
ECMWF – synop	0.2	0.9	0.9	0.6	4.6	180

TROMSØ



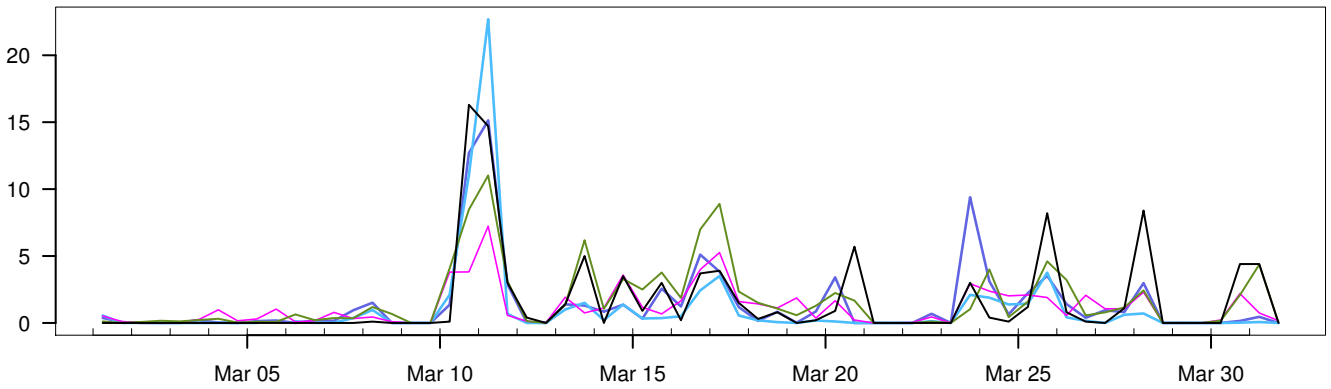
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 06,18	0	0.5	9.9	1.2	184
AM25: 12+18,+30	0	0.8	7.6	1.3	184
AA25: 12+18,+30	0	0.7	5.4	1.1	181
Hirlam8: 12+18,+30	0	1.2	6.6	1.6	182
ECMWF: 12+18,+30	0	1.1	7	1.5	182

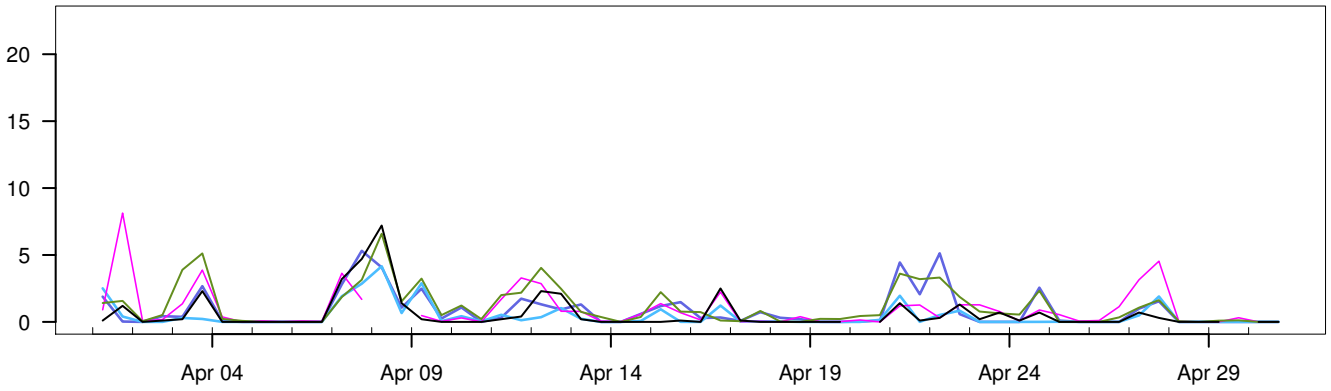
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.3	1.3	1.4	0.7	8.4	184
AA25 – synop	0.2	1.3	1.3	0.6	8	181
Hirlam8 – synop	0.7	1.2	1.4	0.8	4.5	182
ECMWF – synop	0.6	1.3	1.4	0.8	5	182

BODØ VI

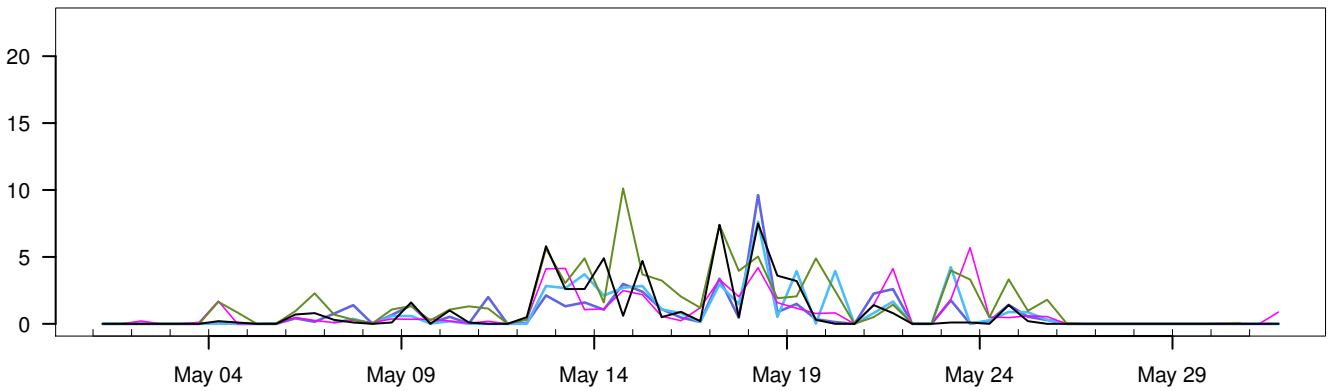
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016

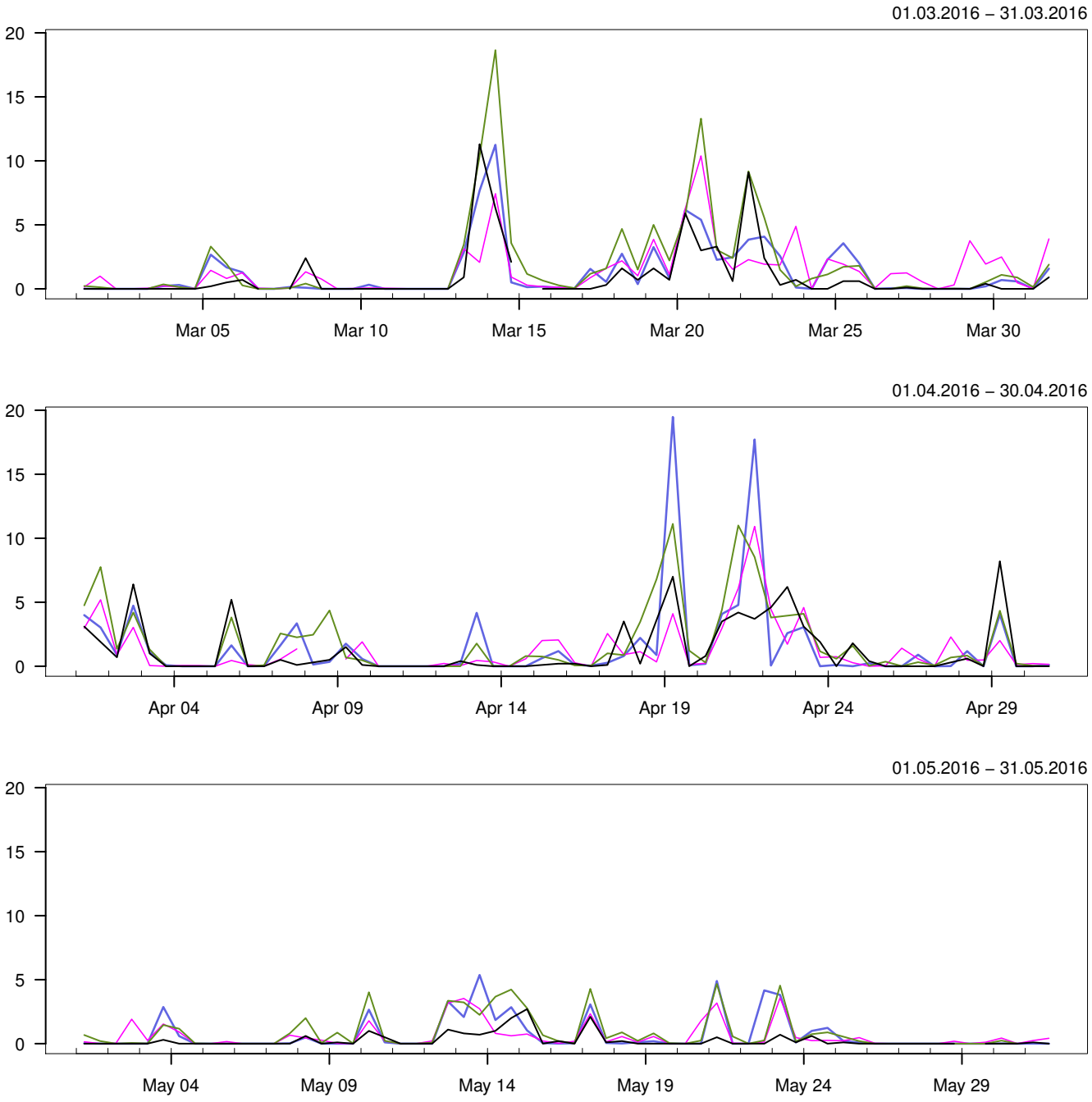


01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 06,18	0	1	16.3	2.3	182
AM25: 12+18,+30	0	1	15.1	2	184
AA25: 12+18,+30	0	0.8	22.7	2.1	181
Hirlam8: 12+18,+30	0	1	8.1	1.4	182
ECMWF: 12+18,+30	0	1.5	11	2	182

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0	1.5	1.5	0.8	6.4	182
AA25 – synop	–0.2	1.5	1.5	0.7	8	179
Hirlam8 – synop	0	1.9	1.9	0.9	12.5	180
ECMWF – synop	0.4	1.7	1.7	1	9.5	180

ØRLAND III

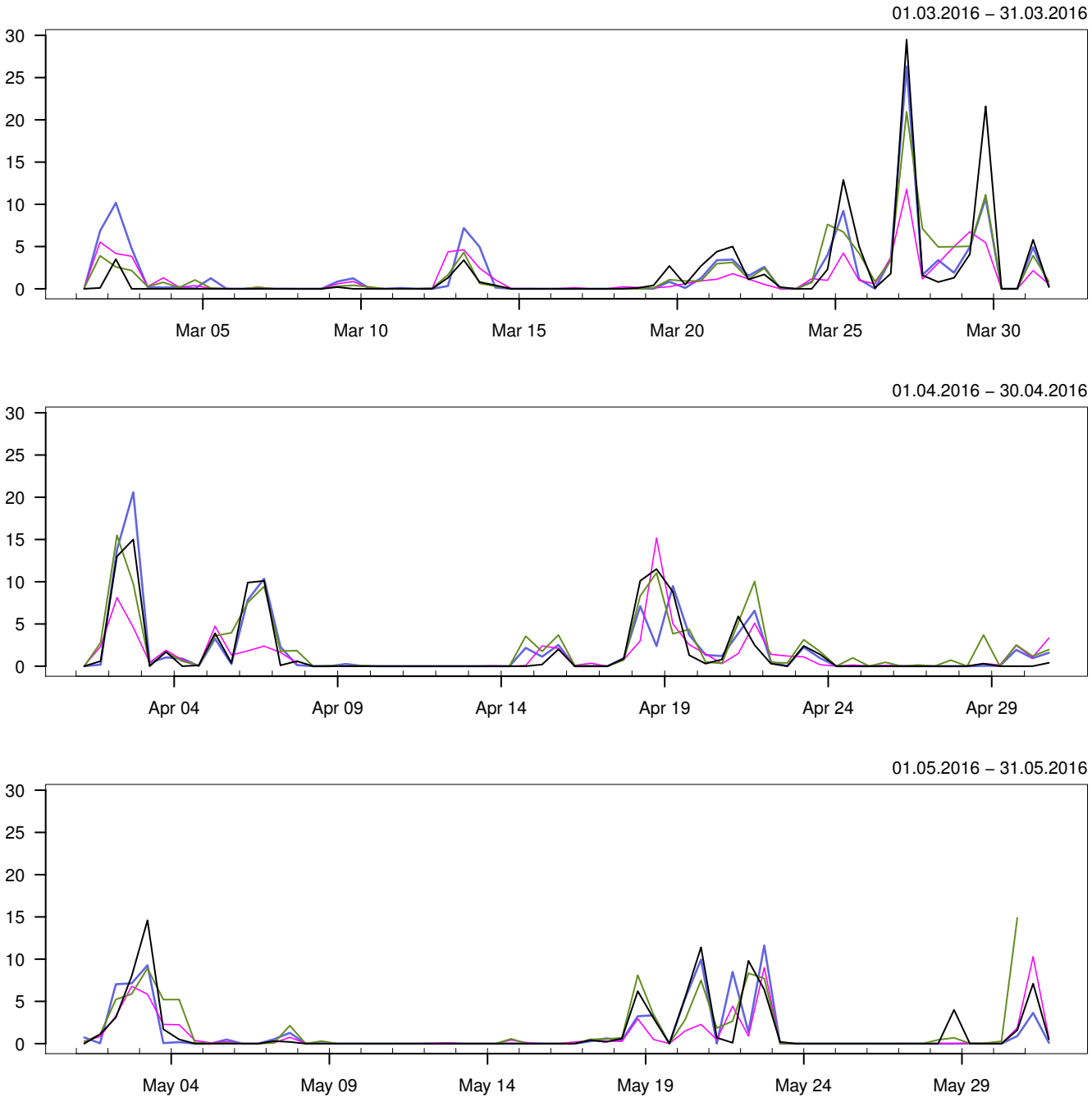


01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 06,18	0	0.8	11.3	1.8	181
AM25: 12+18,+30	0	1.1	19.5	2.5	184
Hirlam8: 12+18,+30	0	1.1	10.9	1.7	182
ECMWF: 12+18,+30	0	1.5	18.6	2.7	182

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.3	1.9	2	0.9	14	181
Hirlam8 – synop	0.3	1.7	1.7	0.9	9.2	179
ECMWF – synop	0.7	1.8	1.9	0.9	12.3	179

BERGEN – FLORIDA

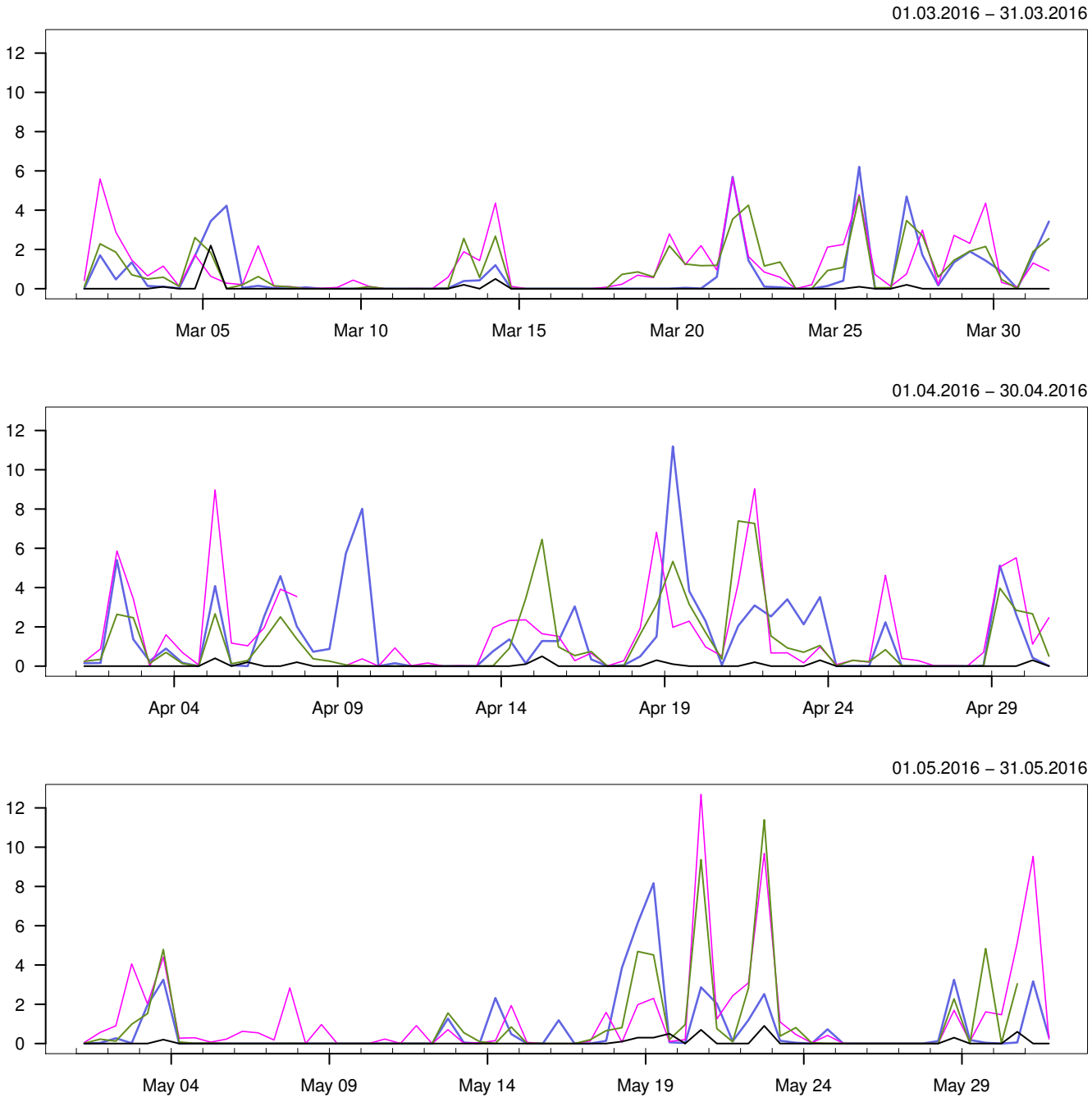


01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 06,18	0	1.7	29.5	4	184
AM25: 12+18,+30	0	1.7	26.3	3.6	184
Hirlam8: 12+18,+30	0	1.2	15.2	2.3	182
ECMWF: 12+18,+30	0	1.9	20.9	3.3	182

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0	2	2	0.9	10.9	184
Hirlam8 – synop	–0.4	2.9	2.9	1.3	17.7	182
ECMWF – synop	0.2	2.2	2.2	1	13.3	182

LÆRDAL IV



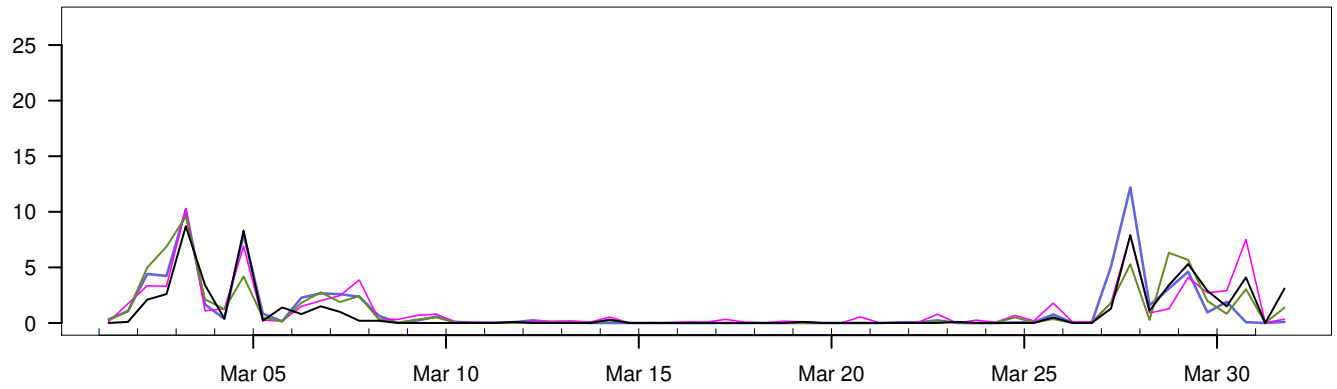
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 06,18	0	0.1	2.2	0.2	184
AM25: 12+18,+30	0	1	11.2	1.8	184
Hirlam8: 12+18,+30	0	1.4	12.7	2.1	182
ECMWF: 12+18,+30	0	1.1	11.4	1.8	182

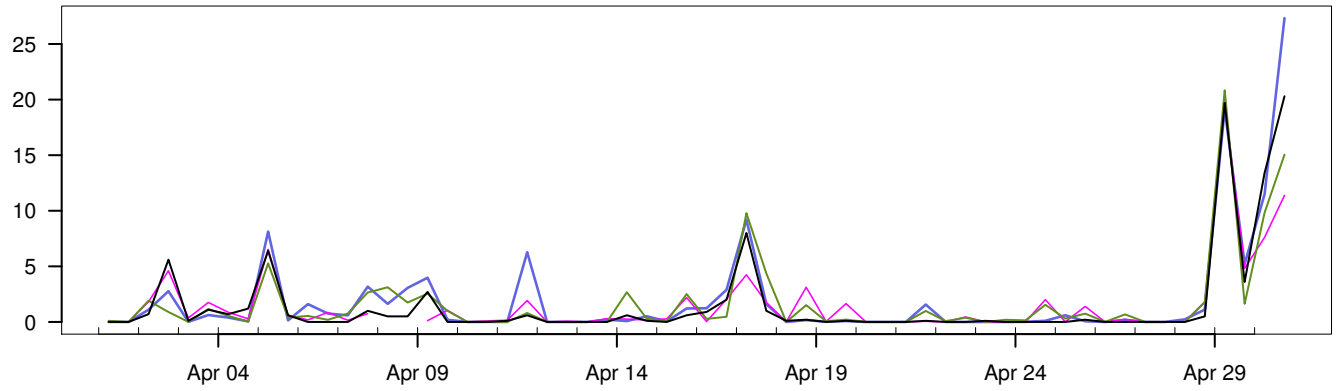
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	1	1.7	2	1	11.1	184
Hirlam8 – synop	1.3	2	2.4	1.3	12	182
ECMWF – synop	1	1.7	2	1	10.5	182

GARDERMOEN

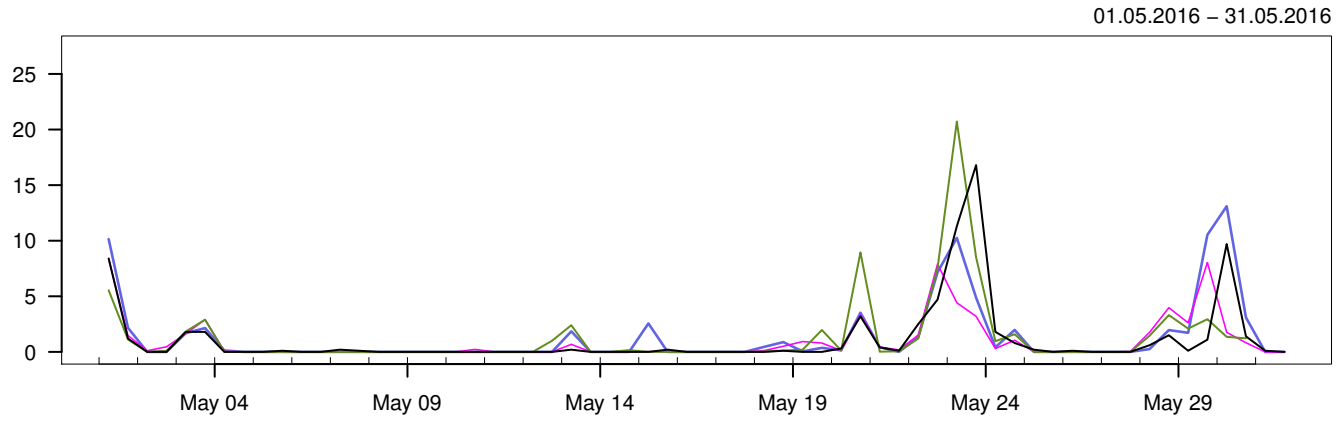
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016



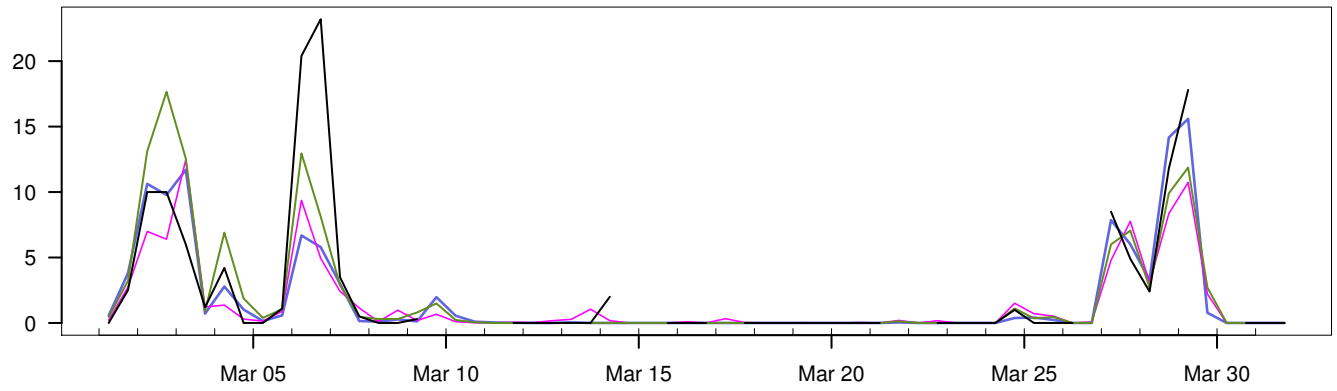
01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 06,18	0	1.2	20.3	3.2	184
AM25: 12+18,+30	0	1.5	27.3	3.5	184
Hirlam8: 12+18,+30	0	1.2	19.7	2.5	182
ECMWF: 12+18,+30	0	1.4	20.8	3	182

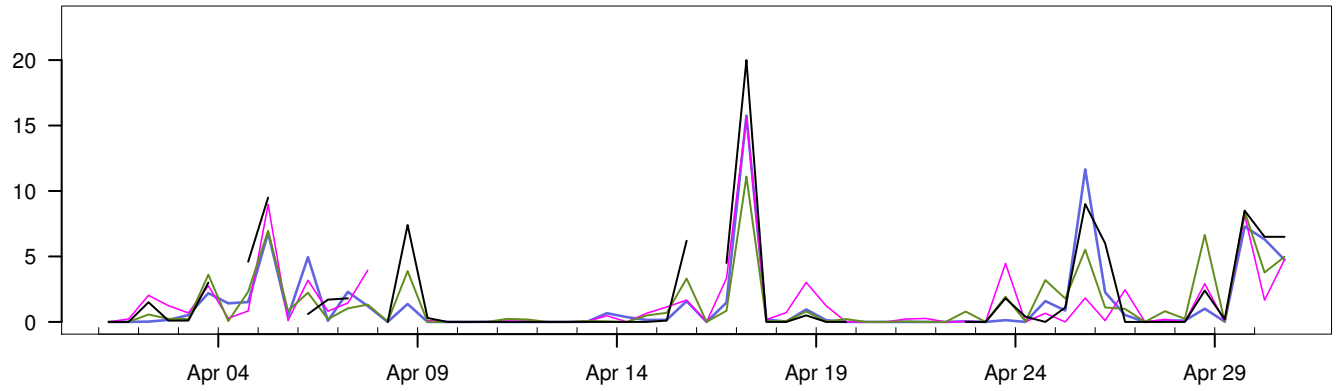
	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	0.3	1.6	1.6	0.7	11.9	184
Hirlam8 – synop	0	1.8	1.8	0.8	13.6	182
ECMWF – synop	0.1	1.7	1.7	0.8	9.4	182

NELAUG

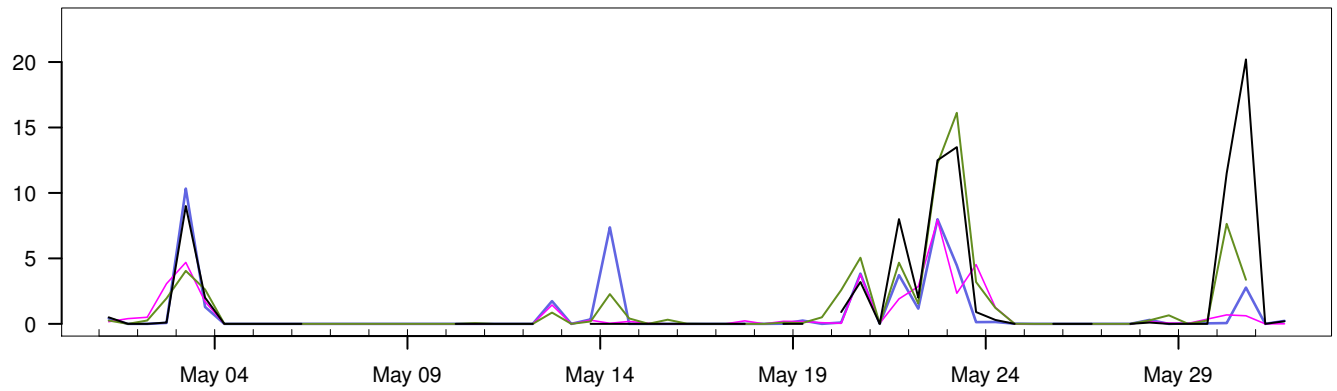
01.03.2016 – 31.03.2016



01.04.2016 – 30.04.2016



01.05.2016 – 31.05.2016



01.03.2016 – 31.05.2016

	Min	Mean	Max	Std	N
synop: 06,18	0	2.1	23.2	4.5	155
AM25: 12+18,+30	0	1.3	15.8	3	184
Hirlam8: 12+18,+30	0	1.2	15.6	2.4	182
ECMWF: 12+18,+30	0	1.6	17.7	3.2	182

	ME	SDE	RMSE	MAE	Max.abs.err.	N
AM25 – synop	–0.6	2.9	2.9	1.1	17.4	155
Hirlam8 – synop	–0.7	3.1	3.2	1.3	19.6	153
ECMWF – synop	–0.3	2.6	2.6	1.1	16.8	153