NIPH
Norwegian Institute of Public Health

Situational awareness and forecasting for Norway

FHI COVID-19 modelling team

Week 2, 19 January 2022

Main results:

We note that the estimated reproduction numbers in this period are subject to considerable uncertainty due to recent increase of the Omicron variant together with the delay from infection to hospitalisation, and the Christmas vacation period affecting the test activity and hospitalisation data. New in this report is that we, in addition to the standard calibration, calibrate the national changepoint model separately on omicron hospitalisations, to estimate a reproduction number for the omicron variant separately. In the short-term projections of this week, we take into account the future trajectory of both the delta variant (showing a decreasing trend) and the omicron variant (showing an increasing trend). Note that the most recent reproduction number for the changepoint model (of the standard calibration) is still mainly informed by the delta variant, as the hospitalisations from December 13 until today have mainly been delta cases. We thus expect the reproduction number to increase in the future (when assuming that everything else stays the same).

- **National epidemiological situation:**

  The most recent reproduction numbers:

Model	Median	5%	95%	Prob>1	period/day	More info
Changepoint	0.93	0.78	1.07	0.16	Since 13. Dec	Table 1
SMC	1.08	0.98	1.17	0.96	11 Jan	Fig. 5
EpiEstim	1.32	1.3	1.33		11 Jan	Table 16, Fig. 24

  In addition, we calibrate the model separately on only the omicron hospital data, and obtain an estimated reproduction number of 1.48 (1.39, 1.55). (Note that the uncertainty is likely underestimated here, as we fix the amplification factor to 1.9 (value obtained in the standard calibration).)

- **National forecasting:**

  One-week-ahead national forecasts from changepoint model:

Indicator	Median/Mean 95% PI	day	Info 2-3 weeks forecasts
Hospital beds	185/184 (128-254)	24 Jan	Table 2
Ventilator beds	47/46 (30-66)	24 Jan	Table 2

  * Age-specific hospital prevalence predictions are provided in Figures 7 and 8.

- **Regional epidemiological situation:**

  The newest regional reproduction numbers for Oslo:

Model	Median	5%	95%	Prob>1	period/day	Info other counties
SMC	1.19	0.74	2.01	0.77	29 Dec - 1 Jan	Fig. 3
EpiEstim	1.13	1.11	1.15		10 Jan	Table 16, Fig. 24

- **Telenor mobility data and the number of foreign visitors:** The most recent mobility development is found in Figures 18 and 19 for the largest municipality in each county and for each county, respectively. Figure 20 shows the total number of roamers per day per county.

1 Estimated national reproduction numbers

Calibration of our national changepoint model to hospitalisation incidence data leads to the following estimates provided in table 1. Figure 3 shows the estimated daily number of COVID-19 patients admitted to hospital (??), with blue medians and interquantile bands, which are compared to the actual true data, provided in red. The uncertainty captures the uncertainty in the calibrated parameters in addition to the stochastic elements of our model and the variability of other model parameters.

Table 1: Calibration results

Reff	Period
2.5/2.48(1.84-3.11)	From Feb 17 to Mar 14
0.6/0.6(0.45-0.74)	From Mar 15 to Apr 19
0.61/0.62(0.06-1.22)	From Apr 20 to May 10
0.65/0.66(0.07-1.32)	From May 11 to Jun 30
0.83/0.84(0.09-1.76)	From Jul 01 to Jul 31
0.89/0.87(0.28-1.4)	From Aug 01 to Aug 31
1.04/1.05(0.62-1.48)	From Sep 01 to Sep 30
1.16/1.16(0.81-1.56)	From Oct 01 to Oct 25
1.17/1.19(0.67-1.82)	From Oct 26 to Nov 04
0.89/0.89(0.73-1.06)	From Nov 05 to Nov 30
0.99/0.99(0.87-1.11)	From Dec 01 to Jan 03
0.66/0.67(0.4-0.96)	From Jan 04 to Jan 21
0.85/0.85(0.51-1.23)	From Jan 22 to Feb 07
1.33/1.34(1.09-1.68)	From Feb 08 to Mar 01
1.12/1.13(0.96-1.3)	From Mar 02 to Mar 24
0.81/0.82(0.63-1.03)	From Mar 25 to Apr 12
0.81/0.82(0.61-1.05)	From Apr 13 to May 05
1.03/1.02(0.66-1.33)	From May 06 to May 26
0.75/0.75(0.33-1.15)	From May 27 to Jun 20
0.91/0.91(0.61-1.16)	From Jun 21 to Aug 04
1.14/1.14(0.9-1.4)	From Aug 05 to Aug 31
0.84/0.84(0.68-1.02)	From Sep 01 to Sep 24
1.07/1.07(1.03-1.12)	From Sep 25 to Dec 12
0.93/0.92(0.78-1.07)	From Dec 13

Median/Mean (95% credible intervals)

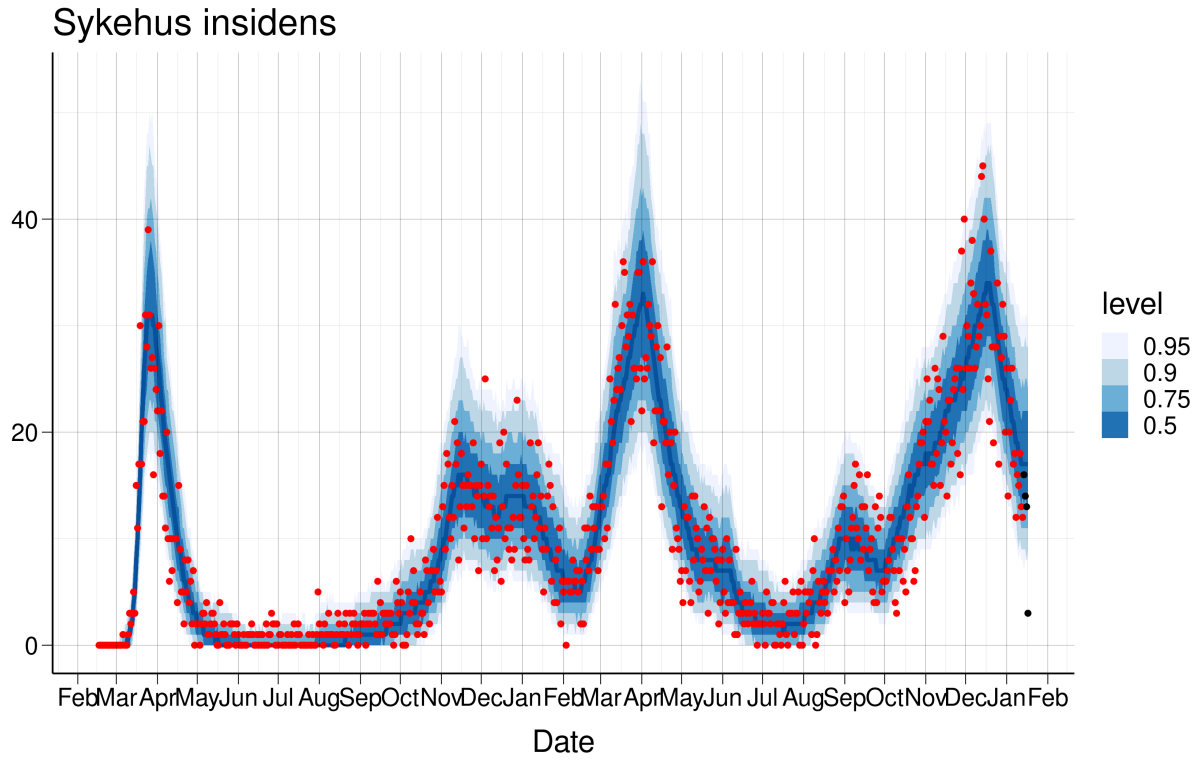
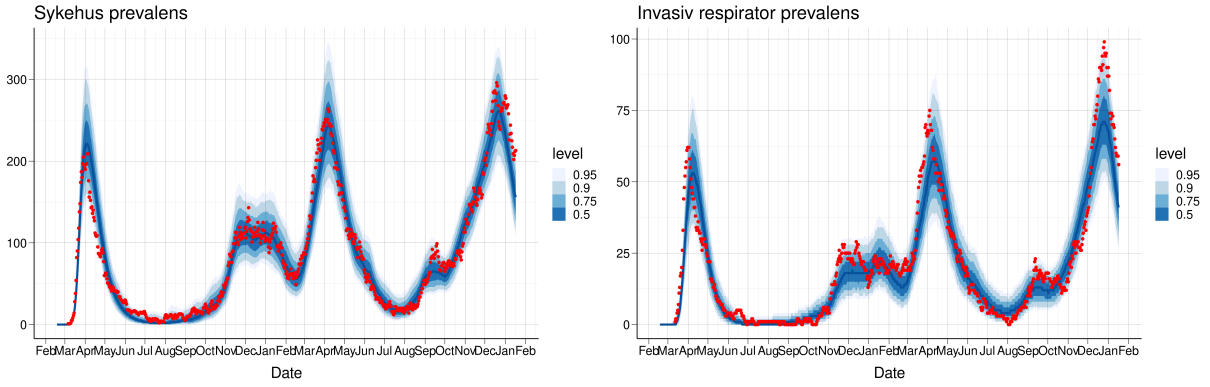


Figure 1: A comparison of true data (red) and predicted values (blue) for hospital admissions. The last four data points (black) are assumed to be affected by reporting delay. The uncertainty captures the uncertainty in the calibrated parameters, in addition to the stochastic elements of our model and the variability of other model parameters.

In figure 4, we show how our national model fits the national hospital prevalence data (4a) and the daily number of patients receiving ventilator treatment (4b). Those data sources are not used to estimate the parameters, and can therefore be seen as a validation of the model assumptions.



(a) Hospital prevalence

(b) Ventilator prevalence

Figure 2: A comparison of true data (red) and predicted values (blue) for hospital and respirator prevalence. Prevalence data is based on NIPaR and may be different to the data from Helsedirektoratet.

1.0.1 Focus on Omicron

This week, we calibrate our national changepoint model separately on only the omicron hospitalisation data. This calibration starts on the day of the first confirmed omicron case in Norway, and seeds with all known imported cases of omicron from abroad. We calibrate to the known hospitalised cases with omicron. As not all cases are screened to determine the variant, we scale up the omicron imported cases and the omicron hospitalisations with the factor of screened cases that were attributed to omicron. We assume an amplification factor of 1.9, and that the probability to be hospitalised if infected by omicron is 70% smaller than if infected by delta. This calibration results in an estimated reproduction number for omicron of 1.48 (1.39, 1.55). Note that since the amplification factor is here fixed, the uncertainty is likely underestimated.

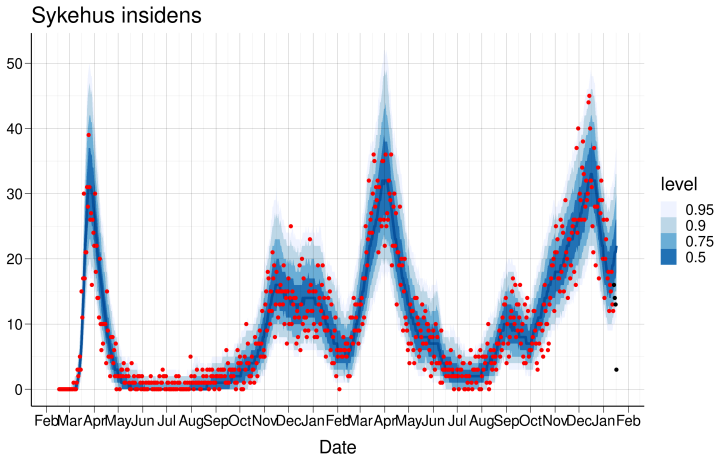
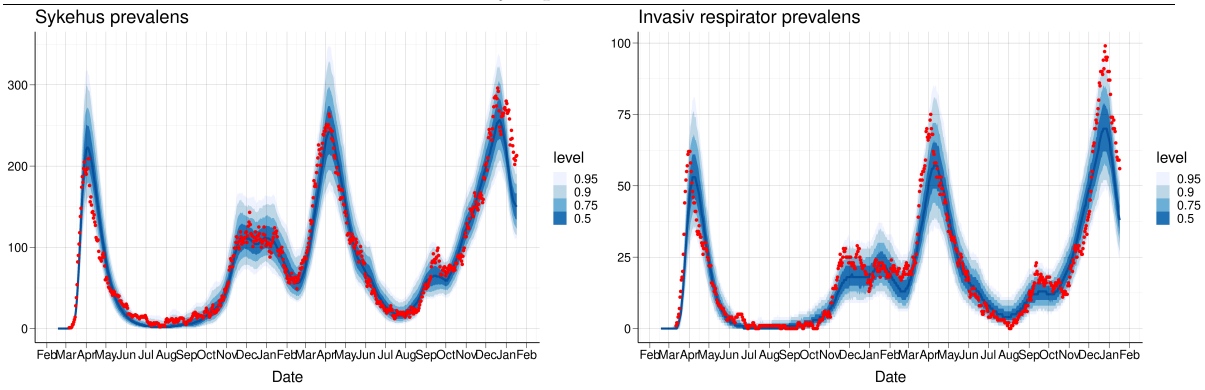


Figure 3: A comparison of true data (red) and predicted values (blue) for hospital admissions from a 2-strain model where the reproductive number for the Omicron variant has been estimated independently. The last four data points (black) are assumed to be affected by reporting delay.



(a) Hospital prevalence

(b) Ventilator prevalence

Figure 4: A comparison of true data (red) and predicted values (blue) for hospital and respirator prevalence estimated from the 2-strain model with independent reproductive numbers for the Omicron and Delta variants. Prevalence data is based on NIPaR and may be different to the data from Helsedirektoratet.

1.1 National SMC-model: Estimated daily reproduction numbers

Figure 5 shows the SMC estimate of the 7-day-average daily reproduction number $R(t)$ from the start of the epidemic in Norway and until today. In the figure we plot the 95% credibility interval and quantiles of the estimated posterior distribution of $R(t)$.

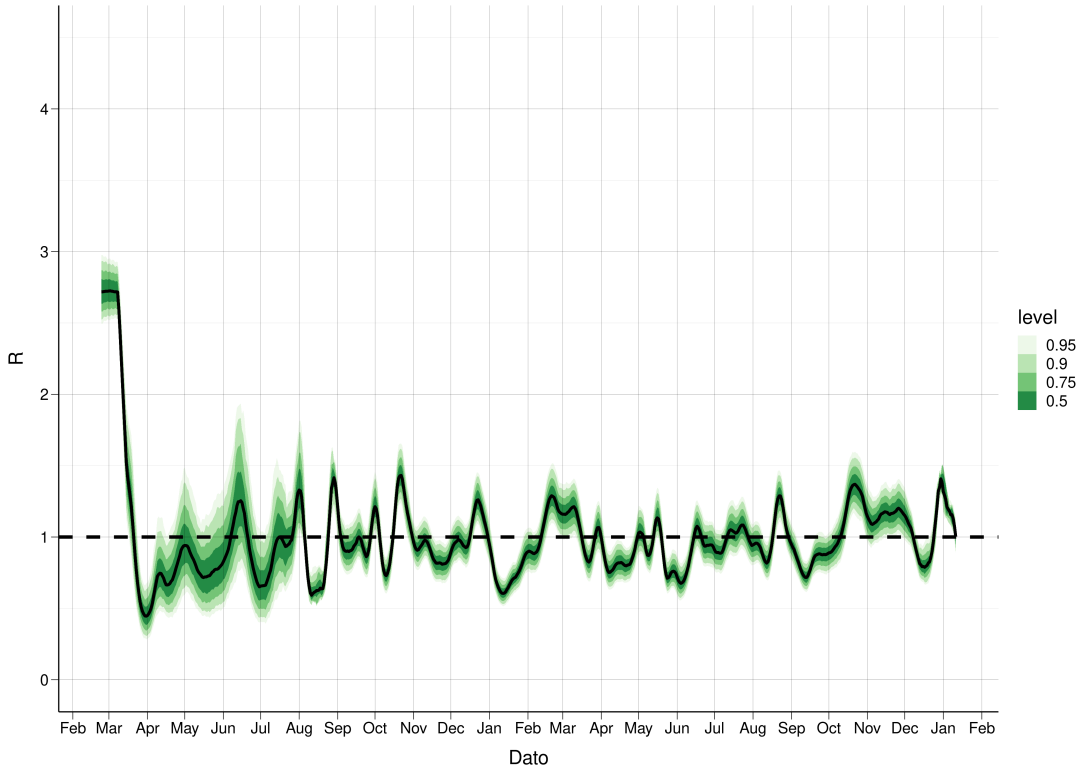


Figure 5: R(t) estimates using a Sequential Monte Carlo approach calibrated to hospitalisation incidence and test data. The large uncertainty during the last 7 days reflects the lack of available data due to the transmission delay, test delay, time between symptoms onset and hospitalisation. The green band shows the 95% posterior credibility interval. As we use test data only from 1 August, the credibility interval becomes more narrow thereafter.

2 National 3-week predictions: Hospital beds and Ventilator bed taking into account increase due to omicron

As our calibration method is only based on hospital incidence, and until now most hospitalised cases have been of the delta variant, our most recently estimated reproduction number is more affected by delta than by omicron. We therefore include an additional analysis where we continue the omicron take-over in the predictions. This is done by first using our calibrated reproduction numbers until January 1 2022. Then, from January 1 2022, we assume that 75% of the disease prevalence is omicron cases, and that the remaining 25% can be attributed to delta. We assume a reproduction number for delta of 0.8 (similar to previously estimated reproduction number under interventions). For omicron, we calibrate the model separately and find a reproduction number with a mean of 1.48. We then show the three-week-ahead trajectories of these analyses, based on these numbers. Note that we do not know the exact proportion of the prevalence in the population that could be attributed to omicron on January 1 2022. The numbers 0.8 and 1.48 are uncertain, while we here apply them without uncertainty.

The table of hospital beds and ventilator beds is provided in Table 2. The corresponding figures are provided in Figure 6. Age-specific hospital prevalence predictions are provided in Figures 7 and 8.

Table 2: Estimated national prevalence of hospital beds and ventilator beds. Median/Mean (CI)

	1 week prediction (Jan 24)	2 week prediction (Jan 31)	3 week prediction (Feb 07)
Hospital beds	162/162 (113-219)	194/191 (134-261)	245/244 (169-330)
Ventilator beds	31/30 (20-44)	27/27 (16-40)	28/28 (17-42)

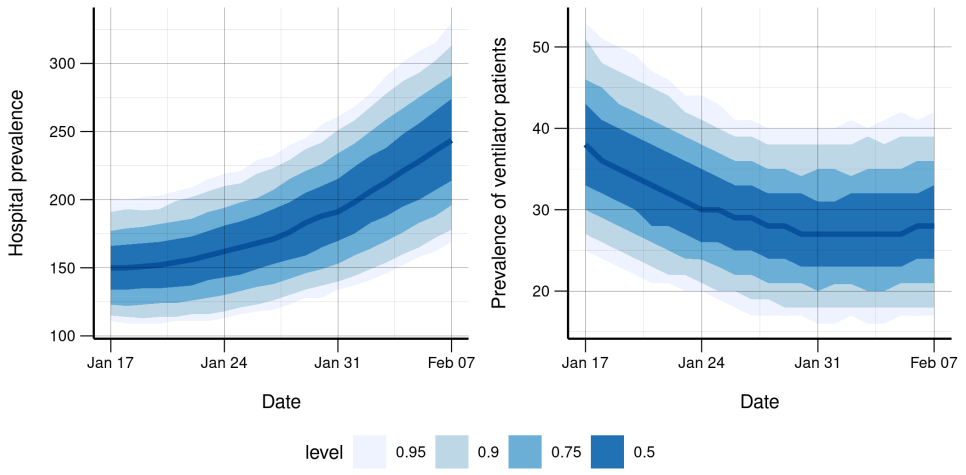


Figure 6: National 3 week predictions for hospital beds (left) and ventilator beds (right) taking into account the omicron takeover.

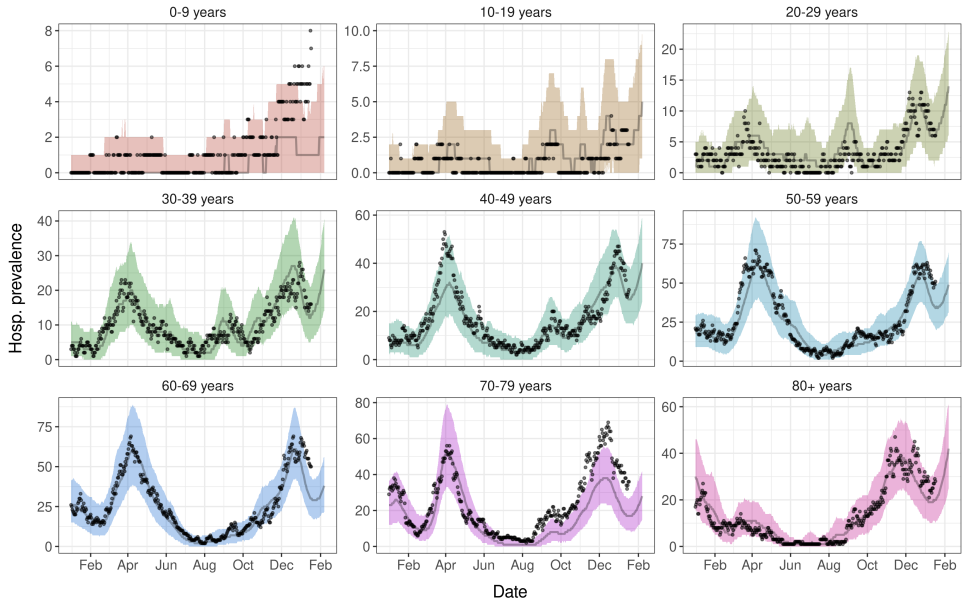


Figure 7: Simulated hospital prevalence by age group taking into account the omicron takeover. Real data is shown as black dots.

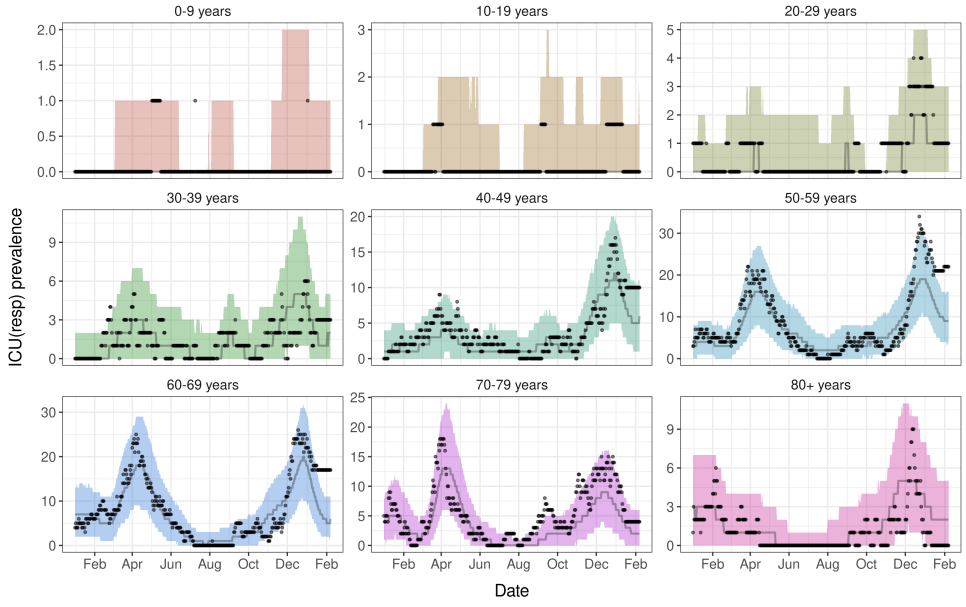


Figure 8: Simulated respirator prevalence by age group taking into account the omicron takeover. Real data is shown as black dots.

3 Estimated regional reproduction numbers

Calibration of our regional SMC model to hospitalisation incidence data leads to the following estimates for current regional reproduction numbers by county (Table 3).
Below we show the estimated daily number of COVID-19 patients admitted to hospital in each county. Model estimates are shown with blue medians and interquantile bands, which are compared to the actual true data, provided in red. The blue bands describe the uncertainty in the calibrated parameters, in

addition to the stochastic elements of our model. Last four data points are shown in black as they may be affected by reporting delay.

Table 3: Regional estimates, 29 Dec-1 Jan

County	Median	95CI	Prob>1
Oslo	1.19	0.74-2.01	0.77
Rogaland	1.04	0.56-1.85	0.56
Møre og Romsdal	0.79	0.39-1.46	0.22
Nordland	0.97	0.52-1.73	0.46
Viken	0.77	0.42-1.3	0.16
Innlandet	0.63	0.31-1.06	0.04
Vestfold og Telemark	0.97	0.58-1.62	0.46
Agder	1.37	0.8-2.44	0.88
Vestland	0.93	0.49-1.76	0.4
Trøndelag	1.23	0.74-2.15	0.78
Troms og Finnmark	0.73	0.37-1.34	0.15

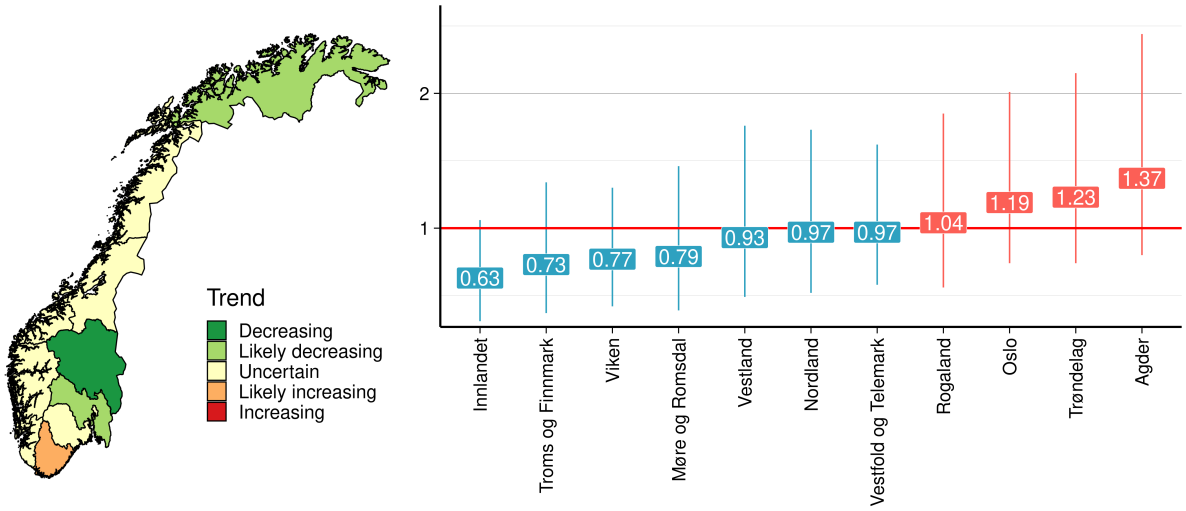
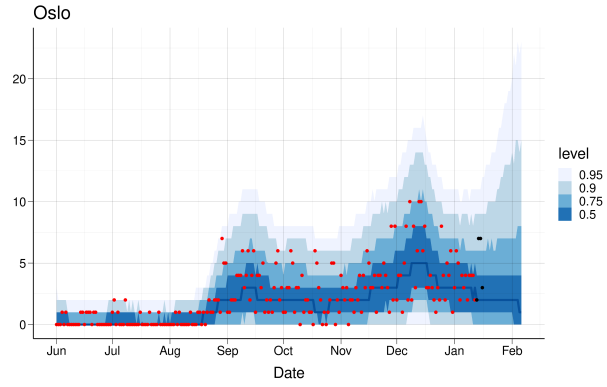
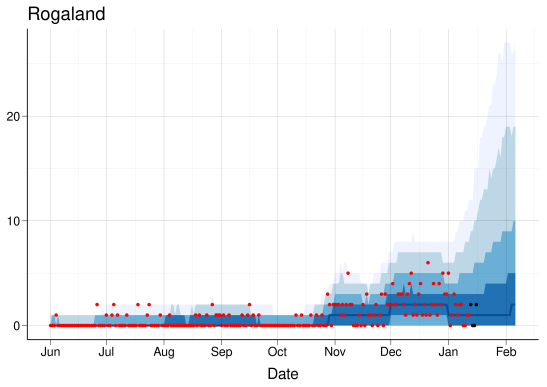


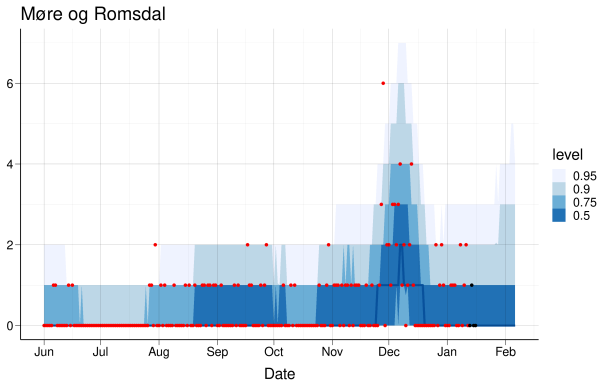
Figure 9: The map shows the direction of the trend in incidence in the counties based on the latest reproduction numbers shown in the other chart. The trend is increasing if the probability that the latest reproduction number is above one is above 95%, the trend is likely increasing if this probability is between 80% and 95%, the trend is uncertain if the probability is between 20% and 80%, the trend is likely decreasing if the probability is between 5% and 20% and is decreasing if the probability that the latest R is above one is less than 5%.

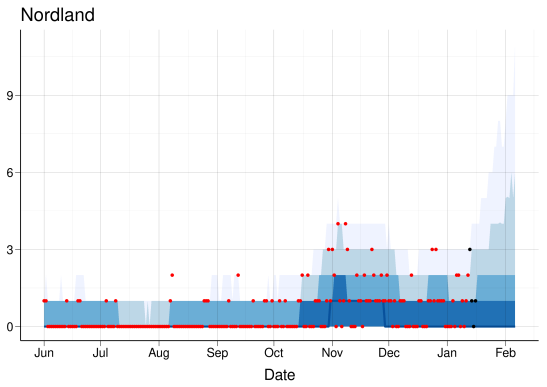
Estimated vs observed hospital incidence and 3 weeks forecast by county:

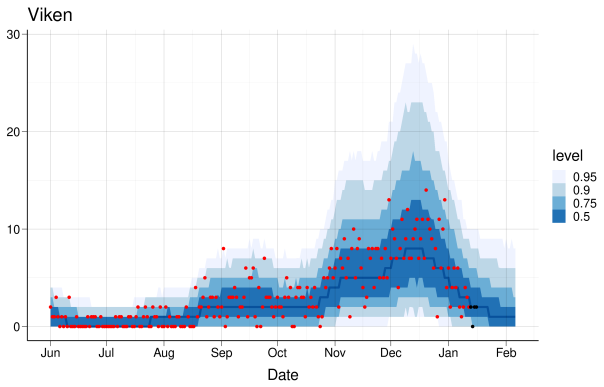
Forecasts are now based on the estimated reproduction numbers obtained by our regional SMC model, for each county. In the forecasted period of three weeks, we use the reproductive numbers showed on Table 3.

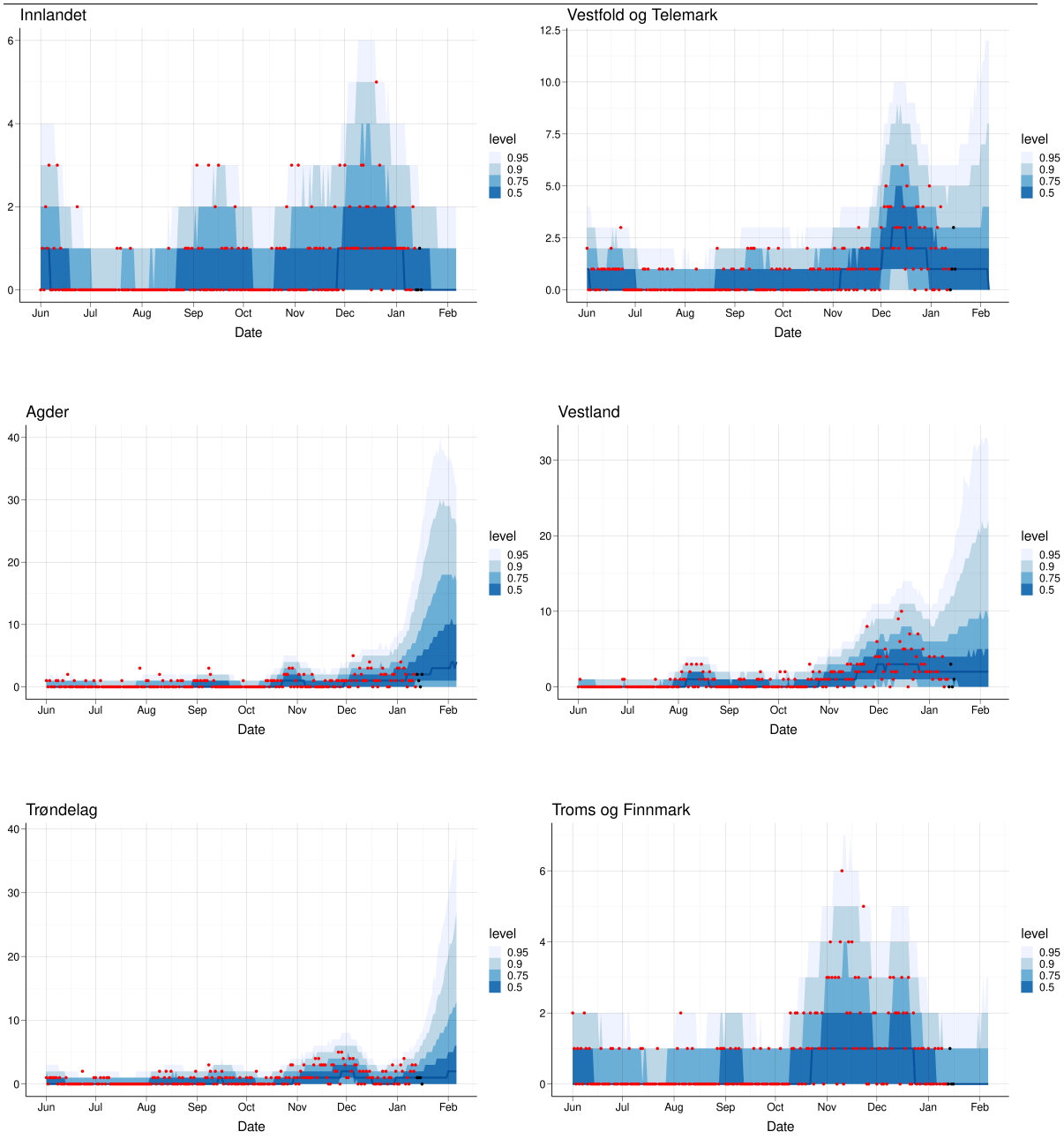











Innlandet
Vestfold og Telemark
Agder
Vestland
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level
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4 Regional 3-week predictions: Cumulative (total) incidence and Prevalence

Below is shown the estimated short-term forecasting of total incidence of infected individuals since 1st of August (2021) (table 4), daily incidence (table 5) and prevalence (table 6) for each county.

Table 4: Estimated cumulative number of infections, 2022-01-16

Region	Total	No. confirmed	Fraction reported	Min. fraction
Oslo	75075 (46912; 116995)	89590	100%	77%
Rogaland	31960 (13295; 86344)	26561	83%	31%
Møre og Romsdal	11131 (7064; 18337)	9082	82%	50%
Nordland	8743 (4241; 20636)	8079	92%	39%
Viken	101017 (64845; 159208)	113254	100%	71%
Innlandet	12661 (8170; 19988)	15445	100%	77%
Vestfold og Telemark	24945 (15097; 42210)	23831	96%	56%
Agder	32314 (8428; 116952)	19495	60%	17%
Vestland	45169 (18387; 117569)	30890	68%	26%
Trøndelag	24022 (12072; 51615)	24911	100%	48%
Troms og Finnmark	10581 (4901; 22405)	12636	100%	56%

Fraction reported=Number confirmed/number predicted; Minimal fraction reported=number confirmed/upper CI

Table 5: Predicted incidence per day: Median/Mean (CI)

Region	1 week prediction (23 Jan)	2 weeks prediction (30 Jan)	3 weeks prediction (06 Feb)
Agder	957/2001 (55-8426)	1119/1955 (46-6745)	1163/1712 (38-5154)
Innlandet	35/60 (5-245)	24/51 (2-252)	16/46 (0-249)
Møre og Romsdal	52/115 (5-600)	46/135 (3-783)	44/156 (2-1013)
Nordland	66/229 (5-1639)	66/282 (4-2277)	69/317 (3-2832)
Oslo	541/964 (101-4617)	469/1019 (59-5909)	400/1009 (36-6425)
Rogaland	459/1135 (28-7120)	520/1229 (22-7343)	563/1216 (18-5963)
Troms og Finnmark	26/70 (3-417)	27/84 (2-577)	28/96 (2-702)
Trøndelag	468/1164 (48-7119)	528/1601 (32-10743)	587/1863 (22-10422)
Vestfold og Telemark	203/401 (24-2086)	172/444 (13-2807)	150/473 (8-3490)
Vestland	507/1229 (43-8338)	497/1235 (30-8553)	439/1143 (21-7178)
Viken	337/488 (73-1820)	245/417 (38-1869)	182/376 (20-1971)

Table 6: Predicted prevalence. Number of infectious individuals (asymptomatic plus pre-symptomatic plus symptomatic) per day. Median/Mean and 95 perc. CI for three weeks prediction.

Region	23 Jan	30 Jan	06 Feb	low CI, 06 Feb	high CI, 06 Feb
Agder	4040/8566	4754/8666	5158/7779	182	23692
Innlandet	172/276	116/235	78/208	6	1097
Møre og Romsdal	242/496	210/576	195/667	10	4207
Nordland	294/953	292/1188	300/1362	16	11988
Oslo	2469/4167	2123/4434	1821/4453	189	27475
Rogaland	1980/4811	2239/5325	2442/5372	84	27543
Troms og Finnmark	116/298	119/355	120/412	10	2972
Trøndelag	2004/4695	2273/6616	2534/7955	107	45986
Vestfold og Telemark	928/1727	790/1912	683/2056	44	14626
Vestland	2236/5292	2199/5437	2017/5126	104	33172
Viken	1611/2248	1168/1904	865/1693	109	8485

5 Regional 3-week predictions: Hospital beds and ventilator beds

Below is shown the estimated short-term forecasting of expected hospital prevalence (table 7) and patients on ventilator treatment for each county (table 8).

Table 7: Number of hospitalisation beds occupied by Covid-19 patients: Median/Mean (CI)

Region	1 week prediction (23 Jan)	2 weeks prediction (30 Jan)	3 weeks prediction (06 Feb)
Agder	17/32 (1-161)	20/40 (0-180)	24/43 (0-166)
Innlandet	3/4 (0-13)	2/3 (0-11)	1/2 (0-9)
Møre og Romsdal	3/4 (0-14)	3/4 (0-17)	2/4 (0-21)
Nordland	3/5 (0-24)	3/6 (0-34)	2/7 (0-48)
Oslo	19/23 (5-63)	17/23 (3-83)	14/23 (2-103)
Rogaland	12/20 (1-93)	11/23 (0-126)	11/25 (0-145)
Troms og Finnmark	2/3 (0-11)	1/2 (0-11)	1/2 (0-14)
Trøndelag	8/14 (1-59)	9/20 (0-109)	11/28 (0-169)
Vestfold og Telemark	9/11 (1-35)	7/11 (0-45)	6/11 (0-59)
Vestland	16/26 (1-123)	14/28 (1-161)	13/29 (0-190)
Viken	23/25 (7-57)	17/19 (4-51)	12/15 (1-48)

Table 8: Number of ICU beds occupied by Covid-19 patients: Median/Mean (CI)

Region	1 week prediction (23 Jan)	2 weeks prediction (30 Jan)	3 weeks prediction (06 Feb)
Agder	4/7 (0-35)	5/10 (0-45)	6/11 (0-45)
Innlandet	1/1 (0-5)	1/1 (0-4)	0/1 (0-3)
Møre og Romsdal	1/1 (0-4)	1/1 (0-4)	1/1 (0-5)
Nordland	1/1 (0-6)	1/1 (0-8)	1/2 (0-11)
Oslo	7/8 (2-18)	6/7 (1-20)	5/7 (1-25)
Rogaland	4/5 (0-21)	3/6 (0-30)	3/6 (0-35)
Troms og Finnmark	1/1 (0-4)	0/1 (0-3)	0/1 (0-4)
Trøndelag	2/3 (0-12)	2/4 (0-22)	3/6 (0-35)
Vestfold og Telemark	3/3 (0-10)	2/3 (0-11)	2/3 (0-14)
Vestland	5/7 (0-28)	4/7 (0-40)	4/8 (0-48)
Viken	8/9 (2-19)	6/6 (1-16)	4/5 (0-14)

6 14-day trend analysis of confirmed cases and hospitalisations by county

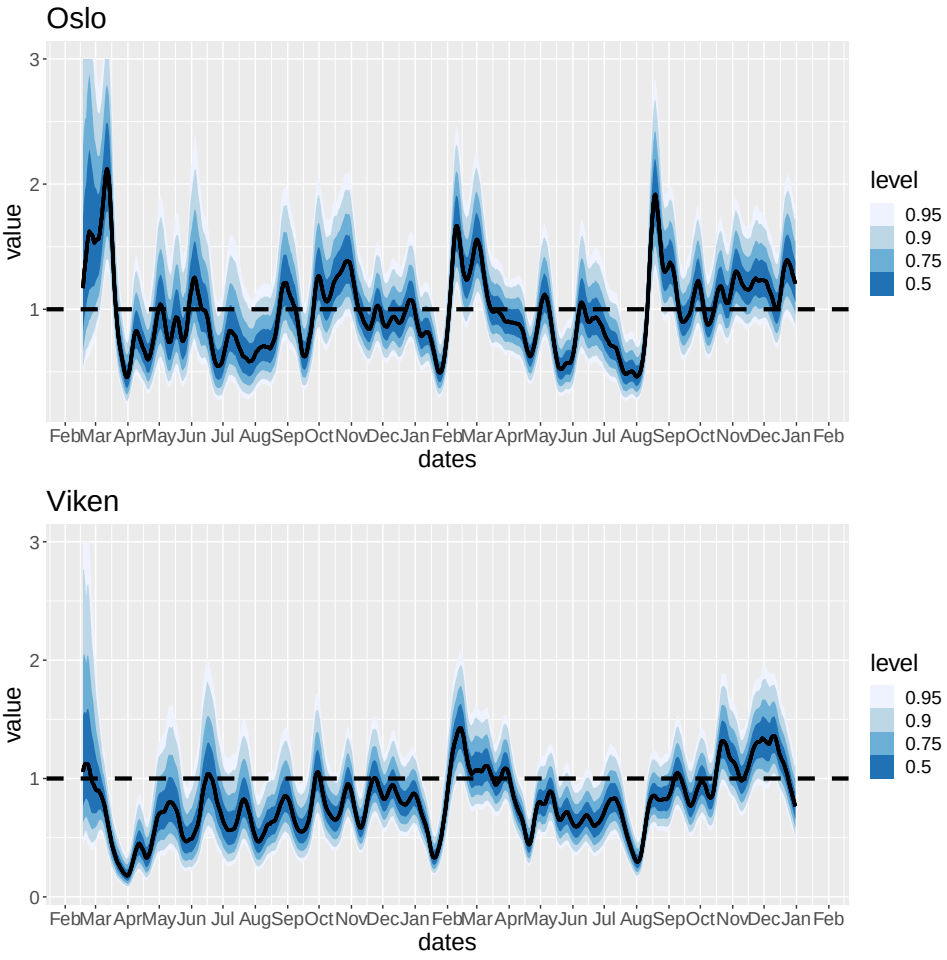
To estimate recent trends in hospitalisation and number of positive tests, we present results in table 9 based on a negative binomial regression where we account for weekend effects. We exclude the last three days to avoid problems of reporting delay and fit the model using data from 17 days to 3 days before the current date. We fit a separate trend model for confirmed cases and for hospital incidence. We only fit a trend model if there has been more than 5 cases or hospitalisations in the 14-day period.

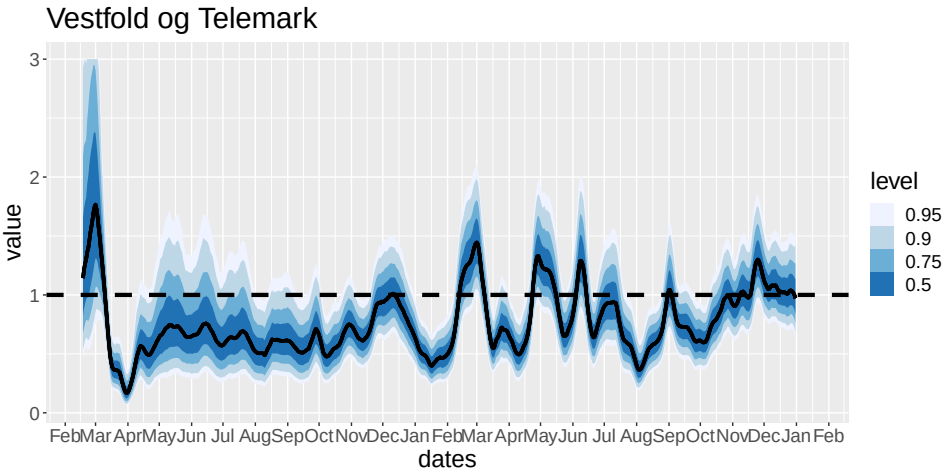
Table 9: Trend analysis for the last 14 days

	Average daily increase last 14 days		Doubling Time (days)	
County	Hospitalisations	Cases	Hospitalisations	Cases
Agder	4.3 (-6, 16) %	1.6 (-2.7, 6) %	16.6 (-11.2, 4.7)	44.6 (-25.6, 11.9)
Innlandet	1 (-12.4, 16.8) %	8.7 (3.8, 13.9) %	66.5 (-5.2, 4.5)	8.3 (18.6, 5.3)
Møre og Romsdal	-3.5 (-17, 11.6) %	5.7 (0.6, 11) %	-19.6 (-3.7, 6.3)	12.5 (111.2, 6.6)
Nordland	-5.8 (-18.3, 7.9) %	3.9 (-1.6, 9.8) %	-11.7 (-3.4, 9.2)	17.9 (-41.7, 7.4)
Norge	-3.1 (-5.7, -0.4) %	5.7 (2.5, 9) %	-22.2 (-11.8, -181.7)	12.6 (28.5, 8.1)
Oslo	0.3 (-5.5, 6.5) %	7.5 (4.8, 10.2) %	215.4 (-12.3, 11)	9.6 (14.7, 7.1)
Rogaland	-3.5 (-11.9, 5.4) %	5.5 (2.2, 9) %	-19.3 (-5.5, 13.1)	12.9 (32.4, 8)
Troms og Finnmark	Not enough data	6.2 (1.6, 11) %	Not enough data	11.6 (44.3, 6.6)
Trøndelag	Not enough data	9.7 (5.4, 14.1) %	Not enough data	7.5 (13.2, 5.2)
Vestfold og Telemark	-0.2 (-11, 12) %	4.1 (1.4, 6.9) %	-434.6 (-6, 6.1)	17.2 (49, 10.4)
Vestland	-5.9 (-14.3, 2.9) %	4.2 (0.5, 8.1) %	-11.4 (-4.5, 23.9)	16.9 (153.9, 8.9)
Viken	-7.2 (-13, -1.3) %	4.8 (1.5, 8.2) %	-9.2 (-5, -55)	14.8 (45.8, 8.8)

7 Regional SMC-model: Estimated daily reproduction numbers

In the figures below we plot the 95% credibility interval and quantiles of the estimated posterior distribution of the regional, daily reproduction numbers. For some counties, uncertainty is large towards the most recent time, because there are very few data and possibly reporting delays which are different in each county.




Vestfold og Telemark
value
dates
level
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0.75
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0
1
2
3
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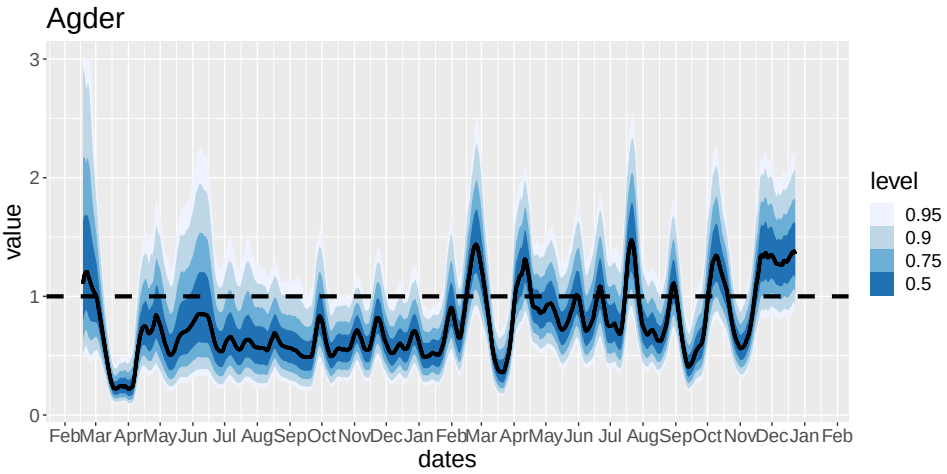
Agder
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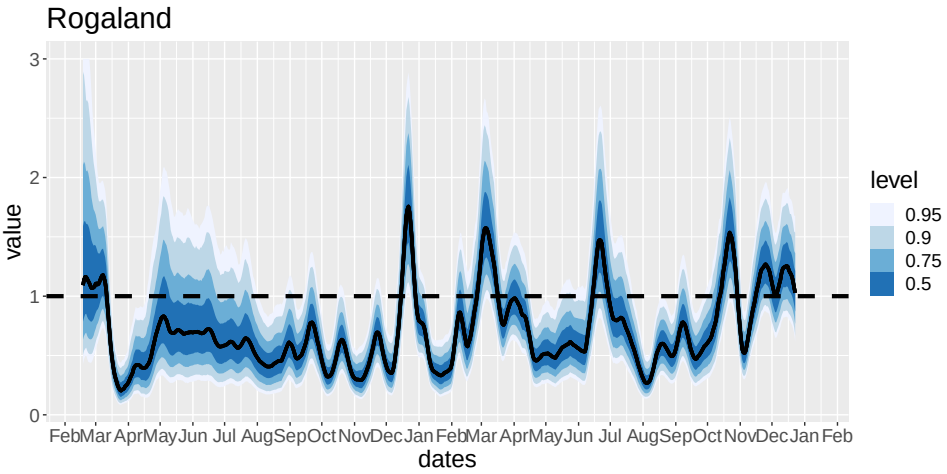
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb


Rogaland
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dates
level
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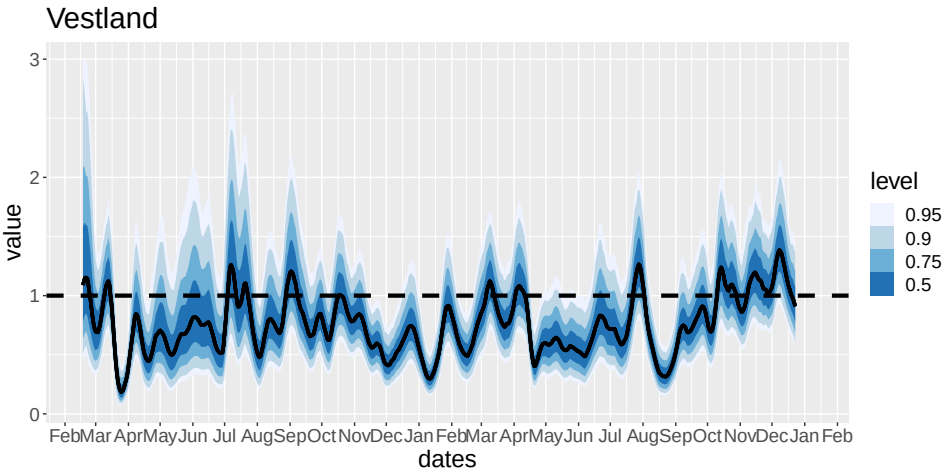
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb


Vestland
value
dates
level
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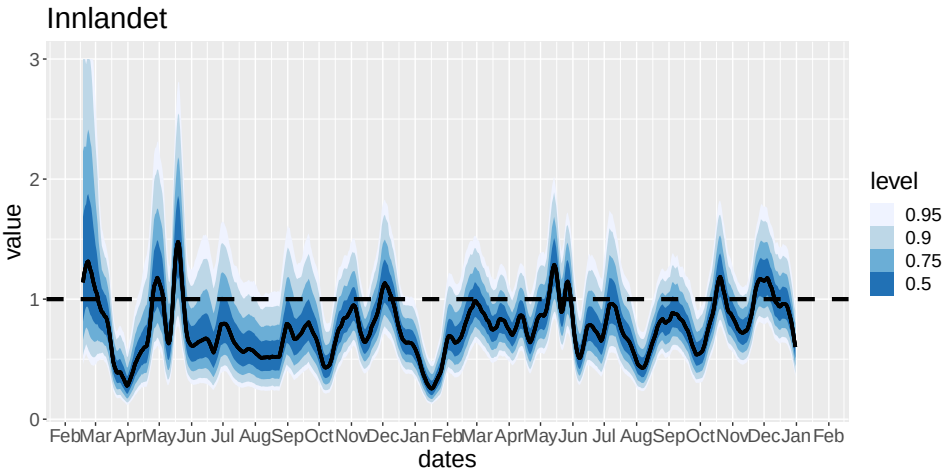
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb


Innlandet
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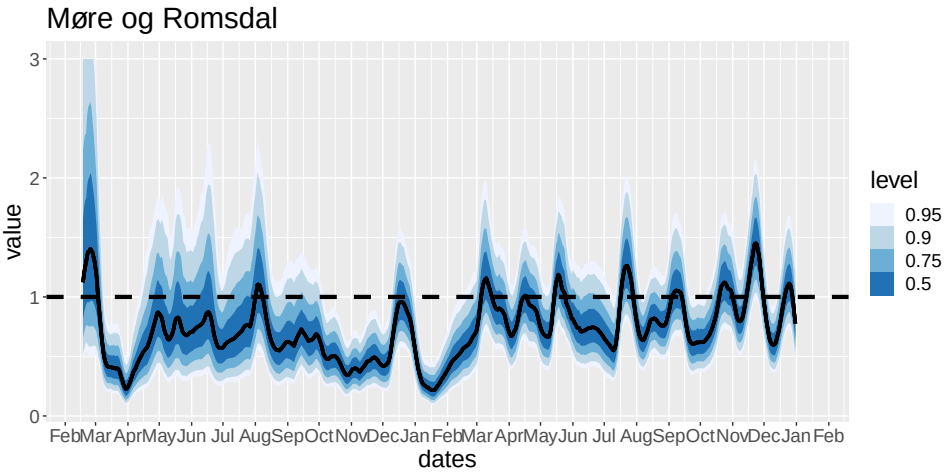
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb


Møre og Romsdal
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dates
level
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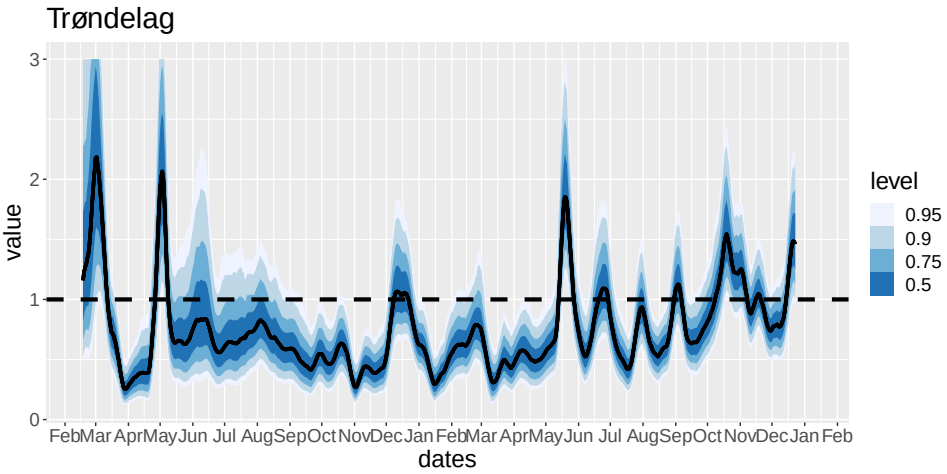
Trøndelag
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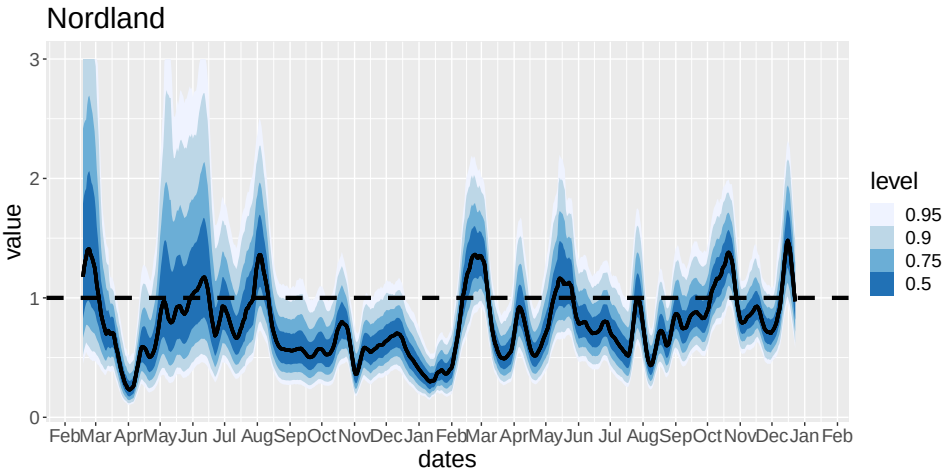
Nordland
value
dates
level
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0.5
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1
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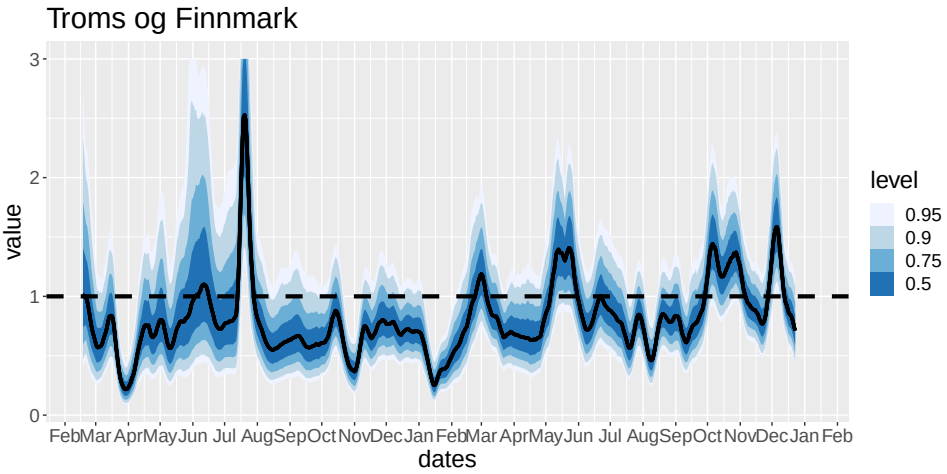
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb


Troms og Finnmark
value
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level
0.95
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0.5
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Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb

8 Short-term predictions per health trust ("helseforetak"): number of occupied covid-19 beds and number of patients receiving ventilator treatment

In the table below we distribute our short-term predictions to the Norwegian health trusts ("helseforetak"), on the basis of their areas of responsibility.

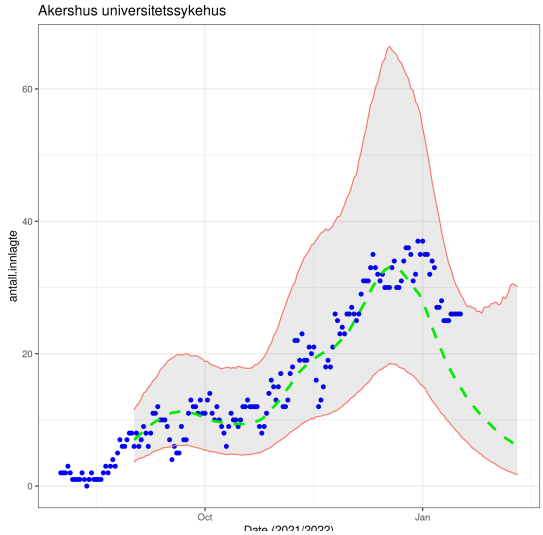
Table 10: Number of hospitalisation beds occupied by Covid-19 patients: Median/Mean (CI)

Helseforetak	1 week prediction (23 Jan)	2 weeks prediction (30 Jan)	3 weeks prediction (06 Feb)
Akershus universitetssykehus	12/13 (6-27)	9/11 (4-28)	7/9 (2-29)
Finnmarksykehuset	1/1 (0-3)	0/1 (0-3)	0/1 (0-4)
Helse Bergen	11/19 (2-88)	10/20 (1-113)	9/21 (1-136)
Helse Fonna	5/8 (1-29)	5/8 (1-37)	5/9 (1-41)
Helse Førde	3/4 (1-21)	2/5 (0-27)	2/5 (0-32)
Helse Møre og Romsdal	3/4 (0-13)	3/4 (0-16)	2/4 (0-21)
Helse Nord Trøndelag	3/4 (0-19)	3/6 (0-34)	4/9 (0-54)
Helse Stavanger	9/16 (2-73)	9/18 (1-95)	9/20 (1-112)
Nordlandssykehuset	2/3 (0-14)	1/3 (0-19)	1/4 (0-27)
Oslo universitetssykehus	17/19 (6-50)	14/19 (4-68)	13/20 (3-86)
St. Olavs hospital	6/9 (1-39)	7/13 (1-74)	7/19 (1-115)
Sykehuset Innlandet	3/4 (0-10)	2/3 (0-8)	2/2 (0-7)
Sykehuset Telemark	4/5 (1-13)	3/5 (0-18)	2/5 (0-24)
Sykehuset i Vestfold	5/7 (1-19)	5/7 (1-26)	4/7 (0-33)
Sykehuset Østfold	6/6 (2-14)	4/5 (1-13)	3/4 (1-12)
Sørlandet sykehus	17/32 (2-161)	20/40 (1-179)	23/43 (1-162)
Universitetssykehuset i Nord-Norge	2/2 (0-8)	1/2 (0-10)	1/2 (0-13)
Vestre Viken	9/10 (4-21)	7/7 (2-19)	5/6 (1-18)

Table 11: Number of respirator beds occupied by Covid-19 patients: Median/Mean (CI)

Helseforetak	1 week prediction (23 Jan)	2 weeks prediction (30 Jan)	3 weeks prediction (06 Feb)
Akershus universitetssykehus	4/5 (2-9)	3/4 (1-8)	2/3 (1-8)
Finnmarksykehuset	0/0 (0-1)	0/0 (0-1)	0/0 (0-1)
Helgelandssykehuset	0/0 (0-2)	0/0 (0-3)	0/1 (0-4)
Helse Bergen	4/5 (0-20)	3/5 (0-29)	3/6 (0-34)
Helse Fonna	1/2 (0-7)	1/2 (0-9)	1/2 (0-11)
Helse Førde	1/1 (0-5)	1/1 (0-7)	1/1 (0-8)
Helse Møre og Romsdal	1/1 (0-4)	1/1 (0-4)	1/1 (0-5)
Helse Nord Trøndelag	1/1 (0-4)	1/1 (0-7)	1/2 (0-11)
Helse Stavanger	3/4 (0-16)	2/5 (0-23)	2/5 (0-27)
Nordlandssykehuset	1/1 (0-3)	1/1 (0-5)	1/1 (0-6)
Oslo universitetssykehus	6/7 (2-15)	5/6 (1-17)	4/6 (1-21)
St. Olavs hospital	1/2 (0-8)	1/3 (0-15)	2/4 (0-24)
Sykehuset Innlandet	1/1 (0-5)	1/1 (0-4)	0/1 (0-3)
Sykehuset Telemark	1/1 (0-4)	1/1 (0-5)	1/1 (0-6)
Sykehuset i Vestfold	2/2 (0-6)	1/2 (0-6)	1/2 (0-8)
Sykehuset Østfold	2/2 (1-5)	2/2 (0-4)	1/1 (0-4)
Sørlandet sykehus	4/7 (0-35)	5/10 (0-45)	6/11 (0-45)
Universitetssykehuset i Nord-Norge	1/1 (0-3)	0/1 (0-3)	0/1 (0-3)
Vestre Viken	3/4 (1-7)	2/3 (0-6)	2/2 (0-6)

In the figures below, we plot the 95% credibility interval and quantiles of the estimated posterior distribution of the daily number of occupied covid-19 beds and the number of patients receiving ventilator treatment for a few health trusts. The others are available on request. In blue are actual data, in green our median prediction and in gray the 95% credibility interval. For some counties, uncertainty is considerable towards the most recent time because there is little data and possibly reporting delays that are different in each county.


Akershus universitetssykehus
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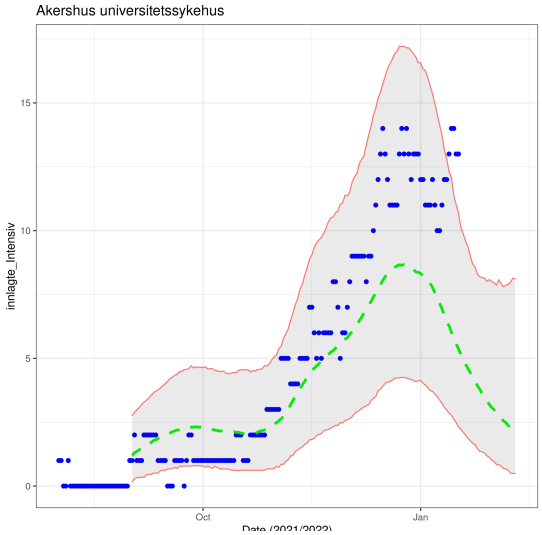
0
20
40
60
Oct
Jan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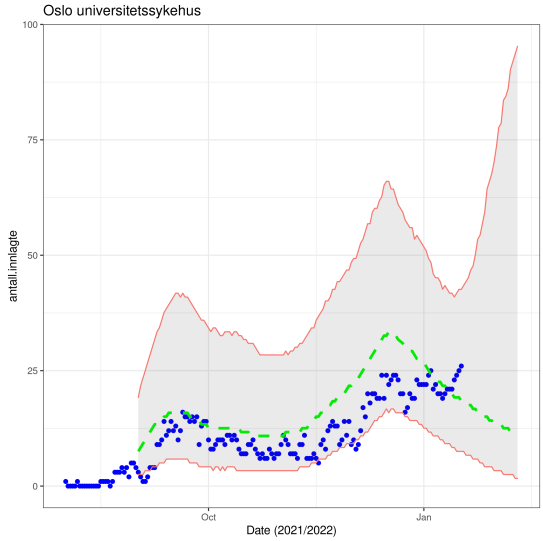
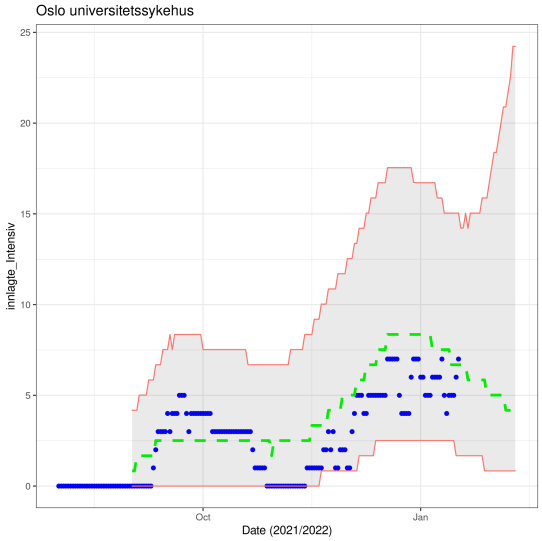
innlagte_Intensiv
0
5
10
15
Oct
Jan


Oslo universitetssykehus
antall.innlagte
0
25
50
75
100
Oct
Jan
Date (2021/2022)


Oslo universitetssykehus
innlagte_Intensiv
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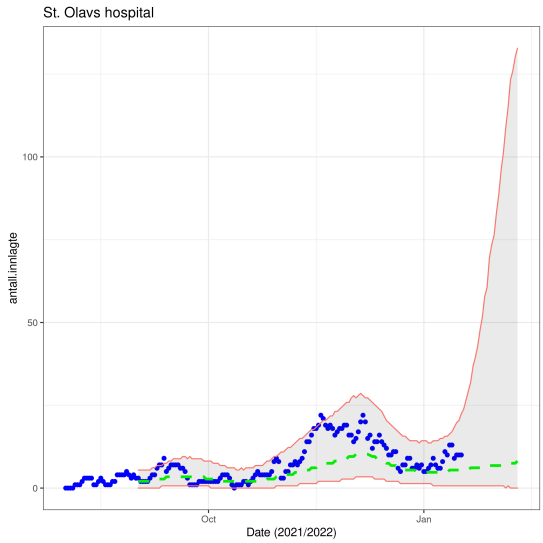
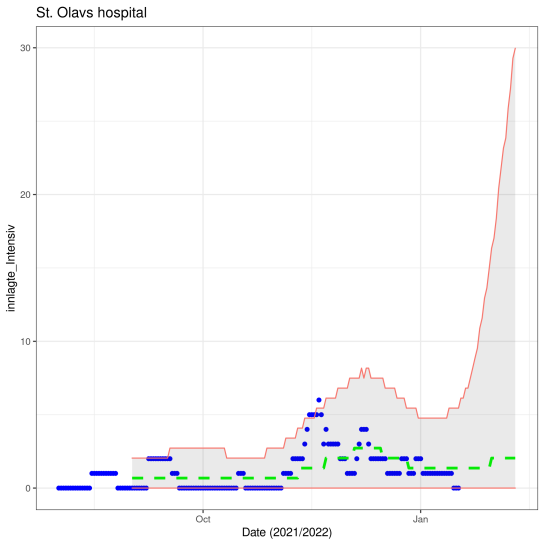
Oct
Jan
Date (2021/2022)


St. Olavs hospital
antall.innlagte
0
50
100
Oct
Jan
Date (2021/2022)


St. Olavs hospital
innlagte_Intensiv
0
10
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30
Oct
Jan
Date (2021/2022)

9 Mobility

Number of trips out from each municipality during each day is based on Telenor mobility data. The reference level is set to 100 on March 2nd 2020 for all the figures in this section, and we plot the seven-day, moving average of the daily mobility. Figure 16 shows an overview of the mobility since March 2020 for the largest municipalities in each county, and Figure 17 shows the total mobility out from all municipalities in each county, including Oslo. Figure 18 and 19, zooms in on mobility from August 16 2021, for municipalities and counties, respectively.

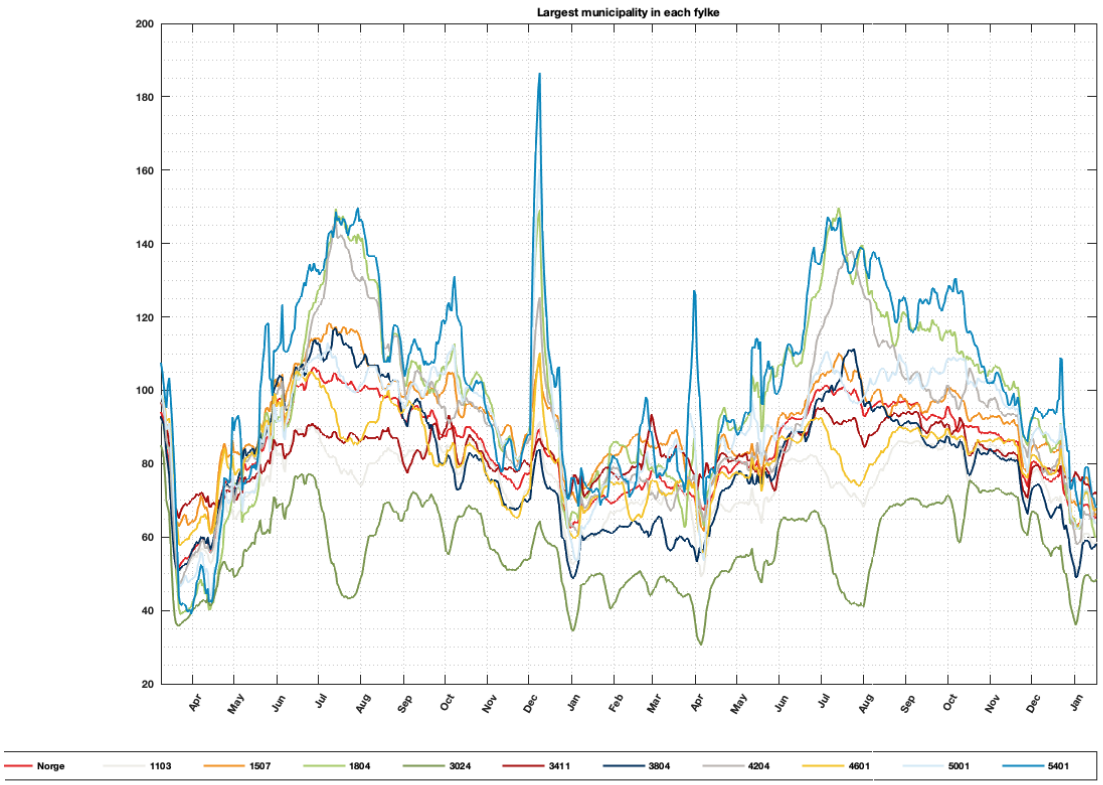


Figure 16: Mobility for selected municipalities since March 2020: Nationally (Norge), Stavanger (1103), Ålesund (1507), Bodø (1804), Bærum (3024), Ringsaker (3411), Sandefjord (3804), Kristiansand (4204), Bergen (4601), Trondheim (5001), Tromsø (5401).

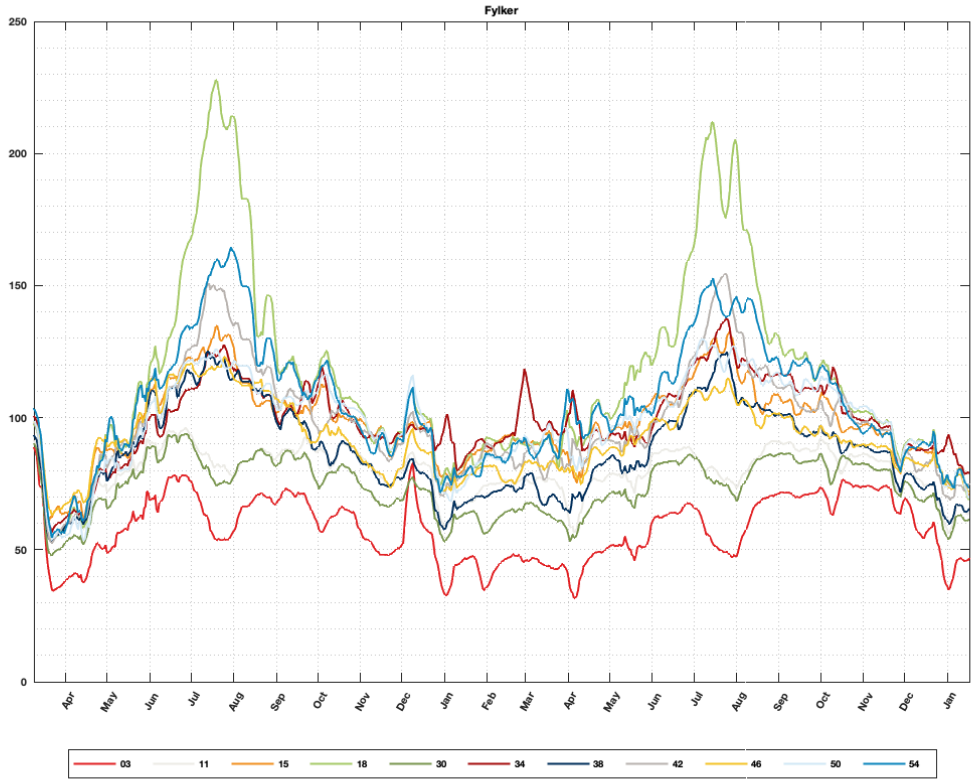


Figure 17: Mobility for fylker since March 2020: Oslo (03), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finmark (54).

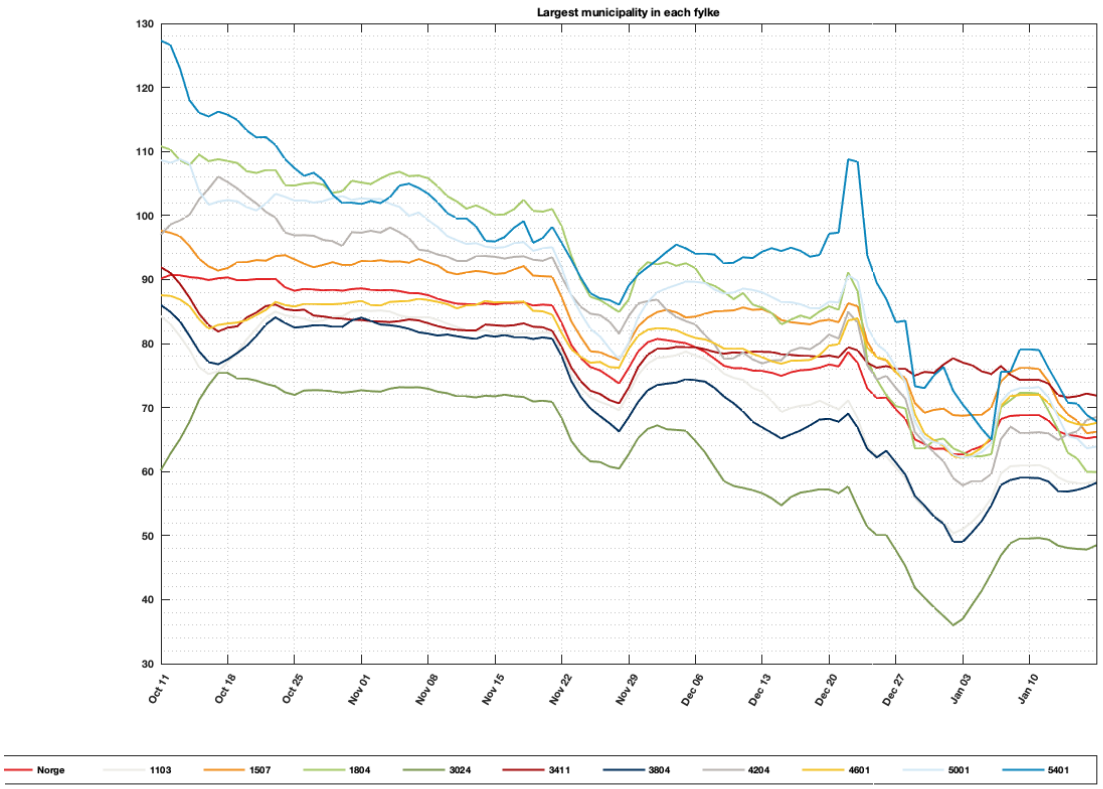


Figure 18: Zoom: Mobility from August 16, 2021 and onwards: Nationally (Norge), Stavanger (1103), Ålesund (1507), Bodø (1804), Bærum (3024), Ringsaker (3411), Sandefjord (3804), Kristiansand (4204), Bergen (4601), Trondheim (5001), Tromsø (5401).

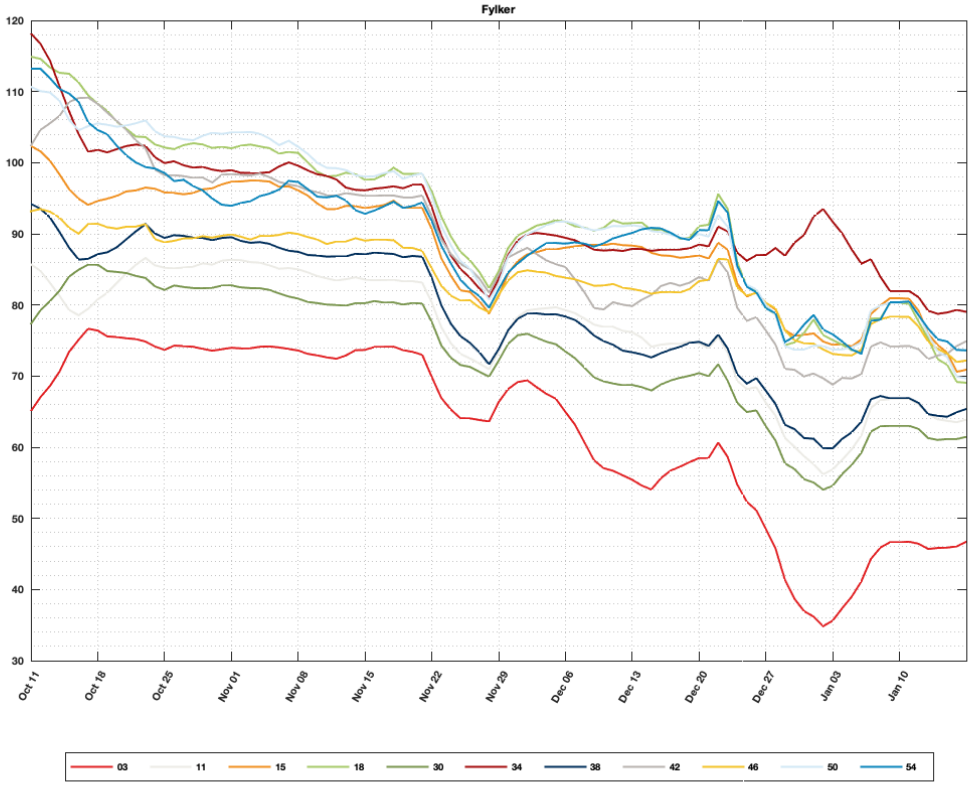


Figure 19: Zoom: Mobility from August 16, 2021 and onwards, per fylker: Oslo (03), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finnmark (54).

	52	53	2	3	4
Norge	76.7	69.7	62.7	68.8	65.4
Stavanger	70.4	60.6	51.0	60.9	58.6
Ålesund	83.7	75.4	68.7	76.2	66.2
Bodø	85.8	70.2	63.0	72.3	59.9
Bærum	57.2	47.7	37.0	49.5	48.5
Ringsaker	78.1	76.0	77.0	74.3	71.9
Sandefjord	68.2	61.4	49.0	59.0	58.2
Kristiansand	81.4	73.1	57.9	66.1	68.5
Bergen	79.7	75.5	62.1	72.0	67.6
Trondheim	86.5	76.3	62.2	73.0	63.9
Tromsø	97.2	83.3	70.5	79.1	67.9

Table 12: Municipalities

	52	53	2	3	4
Oslo	58.5	48.5	35.6	46.6	46.7
Rogaland	74.6	66.2	56.9	66.8	63.9
Møre og Romsdal	87.0	80.3	74.4	80.9	70.9
Nordland	91.1	79.6	75.1	80.3	69.1
Viken	70.4	62.9	54.6	63.0	61.5
Innlandet	88.5	87.0	91.7	82.0	79.0
Vestfold og Telemark	74.8	67.9	59.9	66.9	65.4
Agder	83.9	76.4	68.8	74.2	74.9
Vestlandet	83.3	80.3	73.1	78.3	72.2
Trøndelag	90.0	80.0	73.7	80.3	69.7
Troms og Finnmark	90.5	79.5	75.8	80.4	73.6

Table 13: Counties

Weekly mobility for Norway and selected municipalities is displayed in Table 12 and mobility for counties is displayed in Table 13. The percentages in the tables are to be interpreted towards the reference level of 100 for week 10 in March 2020. The color-coding encodes the following: 'Green' monotonic decrease in mobility, 'Yellow' almost monotonic decrease or flat mobility trend, 'Red' increasing mobility.

9.1 Foreign roamers on Telenor's network in Norway

An analysis of foreign roamers in Norway from January 2020 has been carried out, to better understand the potential virus importation. In Figure 20 the total number of roamers per day per county are displayed.

Figure 21 shows the levels of roamers from the following countries: Poland, Lithuania, Sweden, Netherlands, Denmark, Latvia, Germany, Spain, Finland and the rest of the world. These levels represent the total number of foreign, visiting roamers from each of the countries per day in Norway, since July 5 2021.

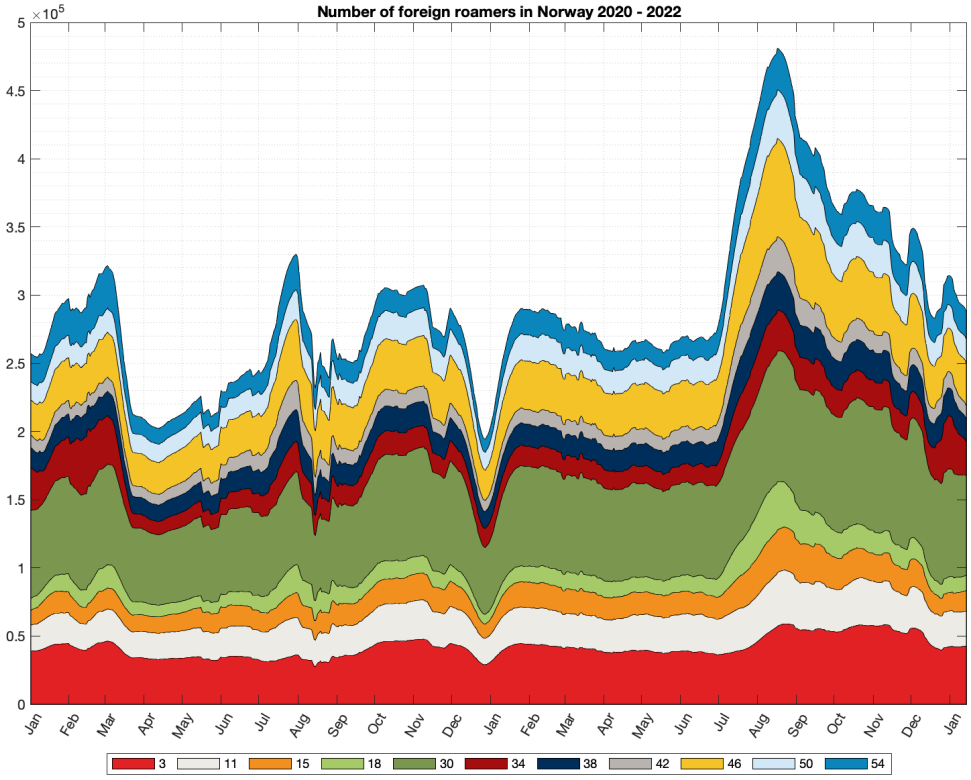


Figure 20: The total number of foreign roamers in Norway broken down on different fylker: Oslo (3), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finnmark (54).

9.1 Foreign roamers on Telenor's network in Norway

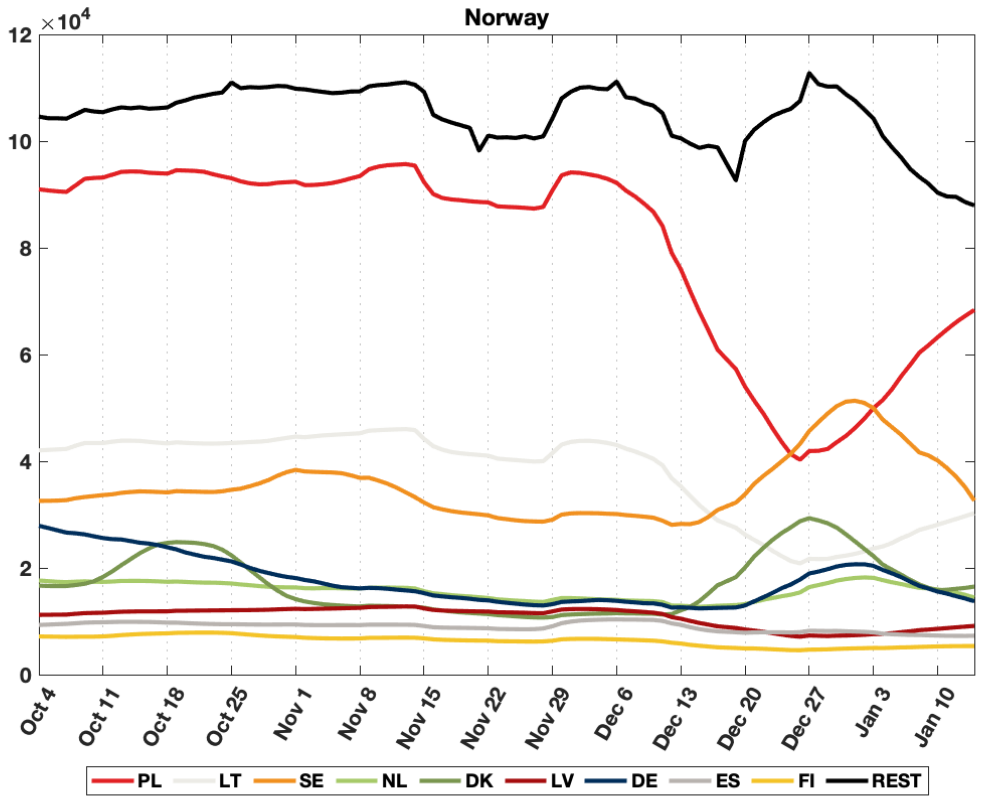
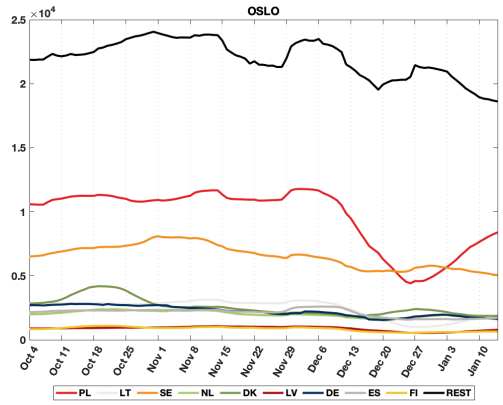
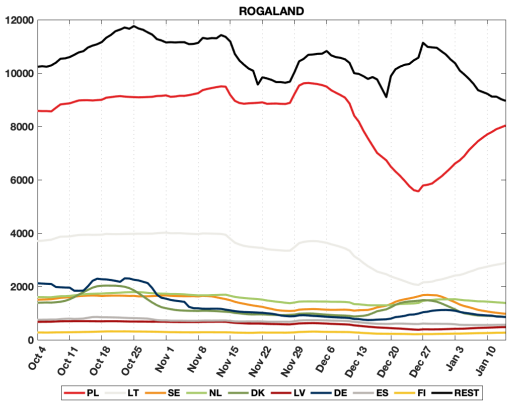
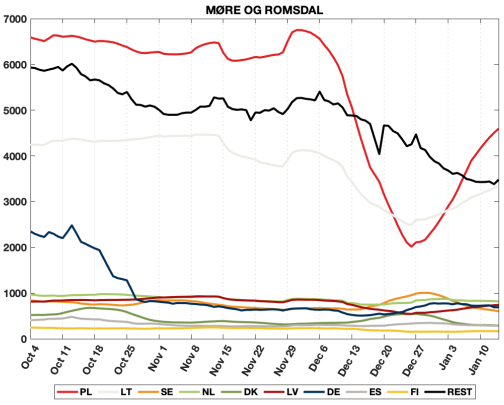


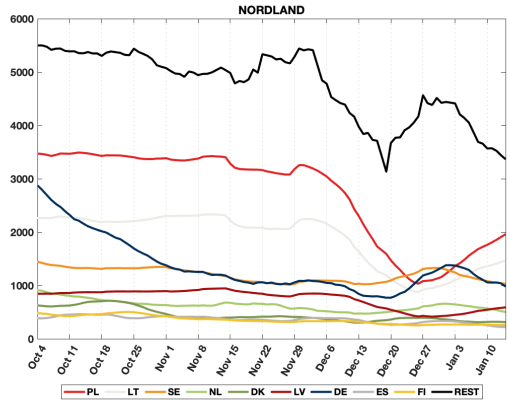
Figure 21: National overview of total number of foreign, visiting roamers from Poland, Lithuania, Sweden, Netherlands, Denmark, Latvia, Germany, Spain, Finland and the rest of the world.

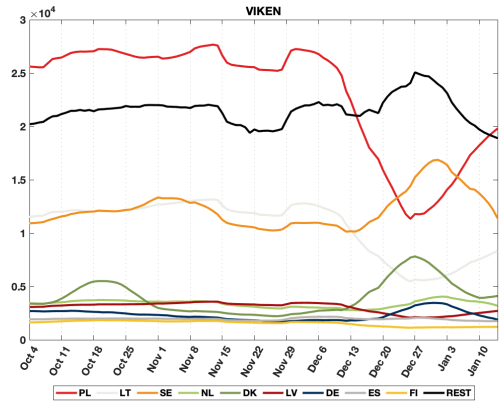
9.2 Foreign roamers per county (fylke) in Norway

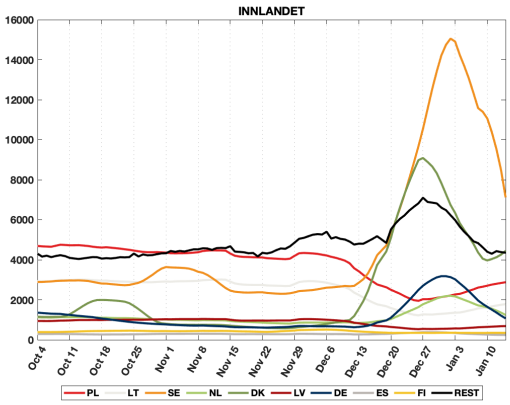




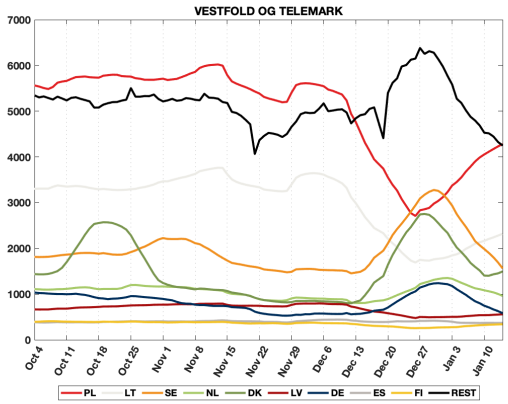


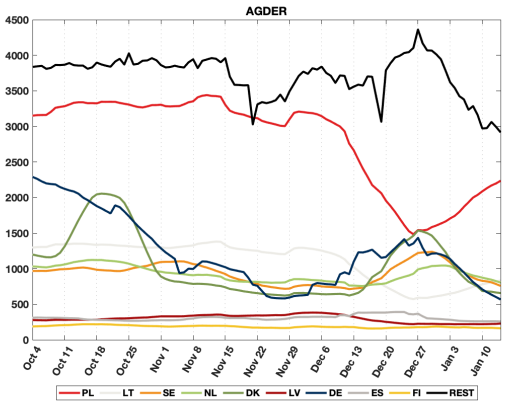


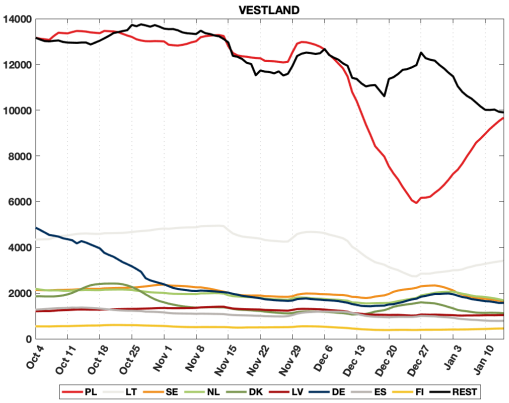


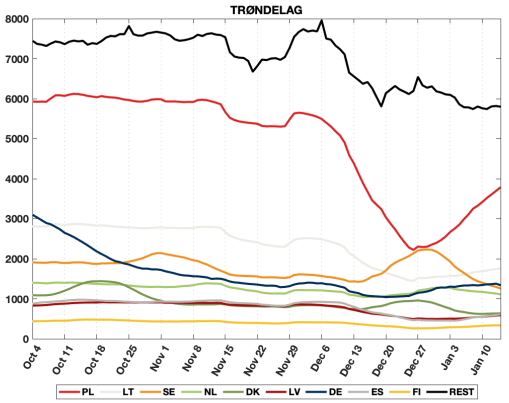


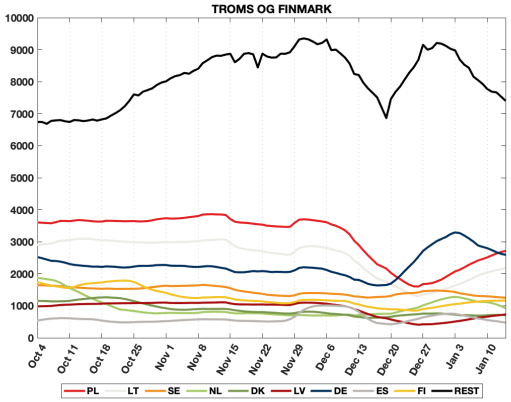
9.2 *Foreign roamers per county (fylke) in Norway*











10 Estimated parameters

Table 14: Estimated parameters

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	Period
R0s	1.334	2.23	2.5	2.476	2.714	3.425	Until March 14
R1s	0.372	0.553	0.605	0.6	0.652	0.791	From 15 March to 19 April
R2s	0.002	0.387	0.61	0.62	0.848	1.521	From 20 April to 10 May
R3s	0.001	0.411	0.65	0.658	0.905	1.658	From 11 May to 30 June
R4s	0.003	0.53	0.833	0.845	1.136	2.064	From 01 July to 31 July
R5s	0.008	0.682	0.894	0.871	1.067	1.678	From 01 August to 31 August
R6s	0.337	0.9	1.04	1.046	1.198	1.814	From 01 September to 30 September
R7s	0.608	1.024	1.157	1.159	1.284	1.889	From 01 October to 25 October
R8s	0.443	0.978	1.172	1.186	1.389	2.152	From 26 October to 04 November
R9s	0.678	0.843	0.89	0.893	0.945	1.168	From 05 November to 30 November
R10s	0.766	0.945	0.99	0.987	1.03	1.163	From 01 December to 03 January
R11s	0.213	0.556	0.659	0.667	0.772	1.146	From 04 January to 21 January
R12s	0.297	0.726	0.854	0.855	0.979	1.43	From 22 January to 07 February
R13s	0.988	1.242	1.325	1.338	1.418	1.873	From 08 February to 01 March
R14s	0.839	1.063	1.124	1.125	1.188	1.385	From 02 March to 24 March
R15s	0.502	0.745	0.814	0.816	0.883	1.18	From 25 March to 12 April
R16s	0.465	0.737	0.809	0.815	0.889	1.212	From 13 April to 05 May
R17s	0.364	0.888	1.031	1.015	1.143	1.531	From 06 May to 26 May
R18s	0.089	0.602	0.749	0.752	0.907	1.416	From 27 May to 20 June
R19s	0.396	0.823	0.912	0.906	0.995	1.408	From 21 June to 04 August
R20s	0.79	1.043	1.139	1.141	1.234	1.566	From 05 August to 31 August
R21s	0.61	0.782	0.84	0.843	0.904	1.075	From 01 September to 24 September
R22s	1.008	1.057	1.074	1.074	1.092	1.141	From 25 September to 12 December
R23s	0.691	0.874	0.929	0.925	0.977	1.137	From 13 December

Table 15: Assumptions

Assumptions	Mean	Distribution	Reference
Mobile Mobility Data			
Telenor coverage	48%		https://ekomstatistikken.nkom.no/
Data updated	January 17th		
Data used in the predictions	January 15th	Fixed	Corrected to preserve population
Model parameters			
Exposed period ($1/\lambda_1$)	2 days	Exponential	changed from Feretti et al 2020
Pre-symptomatic period ($1/\lambda_2$)	2 days	Exponential	Feretti et al 2020
Symptomatic infectious period ($1/\gamma$)	3 days	Exponential	changed from Feretti et al 2020
Asymptomatic, infectious period ($1/\gamma$)	3 days	Exponential	changed from Feretti et al 2020
Infectiousness asympt. (r_{I_a})	0.1	Fixed	Feretti et al 2020
Infectiousness presymp (r_{E_2})	1.3	Fixed	guided by Feretti et al 2020
Prob. asymptomatic infection (p_a)	0.4		Feretti et al 2020
Healthcare			
Fraction asymptomatic infections	40%	Fixed	Mizumoto et al 2020 20% for the old population, Diamond Princess
% symptomatic and asymptomatic infections requiring hospitalization:		Fixed	Saljie et al 2020 corrected for: % of elderly living in elderly homes in Norway (last two age groups) and corrected for presence among positive tested since May 1.
0-9 years	0.1%		
10 - 19 years	0.1%		
20 - 29 years	0.5%		
30 - 39 years	1.1%		
40 - 49 years	1.4%		
50 - 59 years	2.9%		
60 - 69 years	5.8%		
70 - 79 years	9.3%		
80+ years	22.3%		
Probability that an admission has been reported on Monday		Fixed	Estimated from "Beredskapsregistret BeredtC19"
From Sunday	32%		
From Saturday	49%		
From Friday	68%		
From Thursday	86%		
Probability that an admission has been reported		Fixed	Estimated from "Beredskapsregistret BeredtC19"
From one day before	53%		
From two days before	77%		
From three days before	82%		
From four days before	91%		
Probability that a positive laboratory test has been reported		Fixed	Estimated from MSIS
From one day before	6.7%		
From two days before	59%		
From three days before	90%		
From four days before	97%		
Probability that a negative laboratory test has been reported		Fixed	Estimated from MSIS
From one day before	16%		
From two days before	74%		
From three days before	92%		
From four days before	98%		

Supplementary analysis: EpiEstim estimation of reproduction number based on laboratory-confirmed cases

To complement the results of the metapopulation model, we present estimates of the temporal evolution of the reproduction number in Norway based on an analysis of laboratory-confirmed cases. The primary purpose of this analysis is to provide a more comprehensive perspective on the epidemic situation, taking into account several data sources.

Table 16: Estimated reproduction numbers 7 days ago

Location	Reff
National	1.26(1.25 - 1.28)
Oslo	1.13(1.11 - 1.15)
Rogaland	1.19(1.16 - 1.23)
Møre og Romsdal	1.11(1.04 - 1.17)
Nordland	1.32(1.24 - 1.4)
Viken	1.33(1.31 - 1.35)
Innlandet	1.29(1.24 - 1.34)
Vestfold og Telemark	1.39(1.35 - 1.44)
Agder	1.23(1.19 - 1.28)
Vestland	1.32(1.28 - 1.37)
Trøndelag	1.38(1.34 - 1.42)
Troms og Finnmark	1.16(1.09 - 1.23)

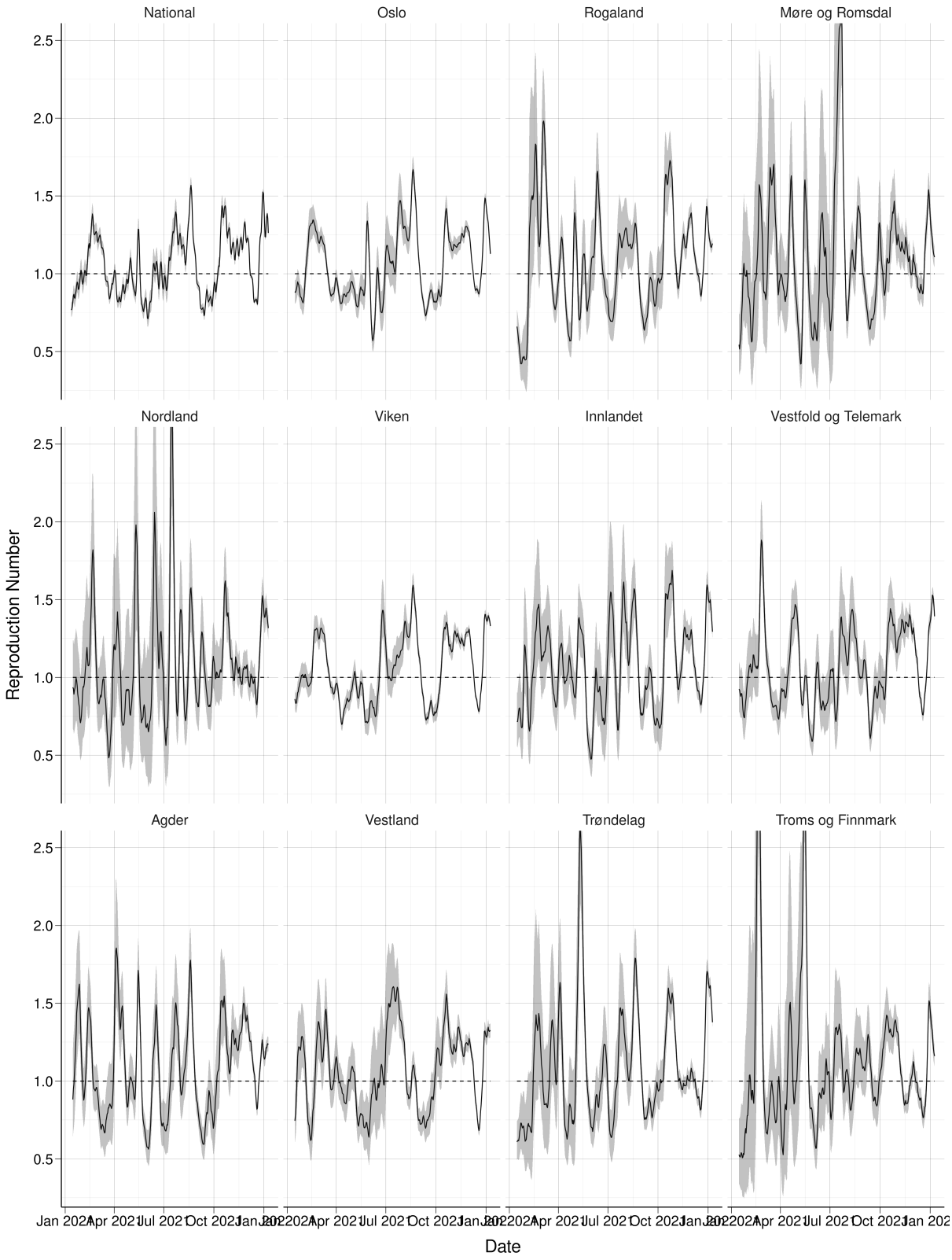


Figure 24: Reproduction number estimated using the R package EpiEstim.

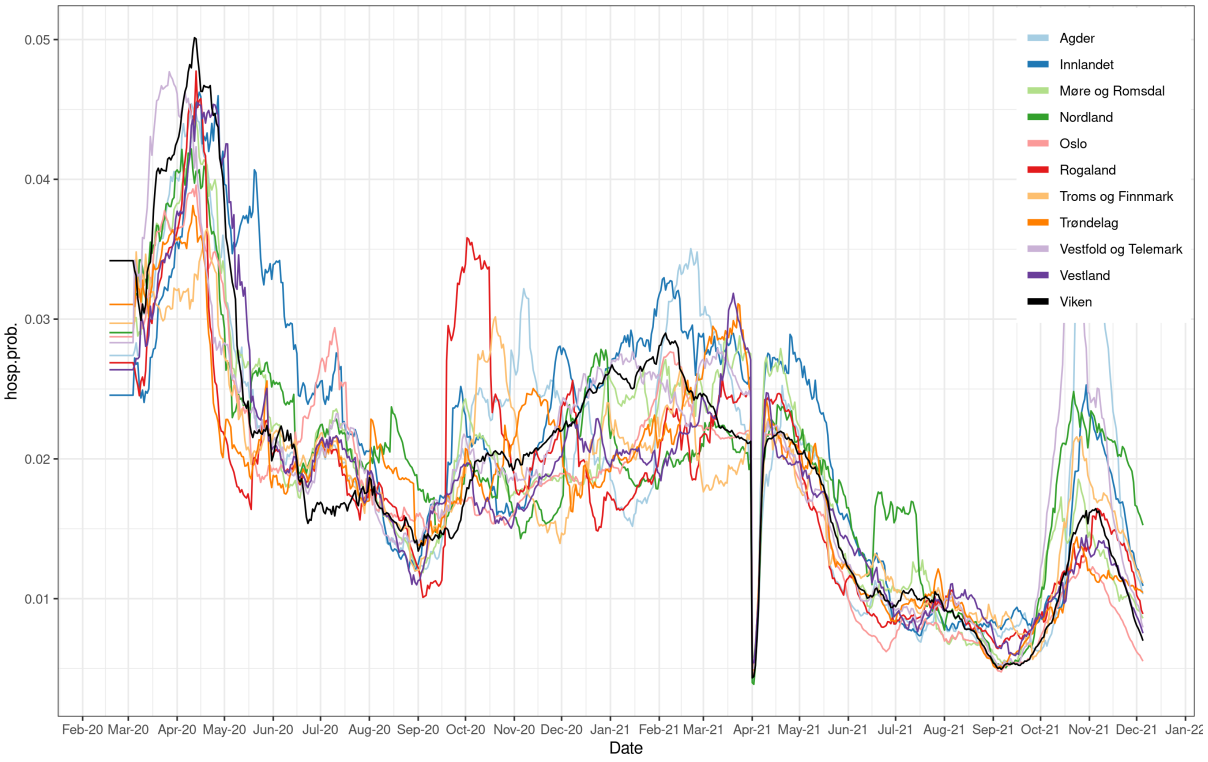


Figure 25: Regional hospitalisation probabilities per infection. The estimates are based on Salje et al., and regional data on the age distribution in the test data and the empirical case-hospitalisation rates.

Models and materials:

This report presents results based on a mathematical infectious disease model describing the geographical spread of COVID-19 in Norway. We use a metapopulation model for situational awareness and short-term forecasting and an individual-based model for long-term predictions. This report does not contain the long-term prediction results. Reproduction numbers of the metapopulation model are estimated in two ways: SMC-ABC is used to estimate a step-function in the transmissibility through prespecified changepoints, and SMC is used to estimate a daily varying reproduction number. We also provide estimates based on EpiEstim and a simple trend analysis. The models are described in previous reports and will not be explained here.

The metapopulation model takes daily varying Telenor mobility data as input. We also provide plots of the recent mobility for situational awareness.

How you should interpret the results: 3-week-ahead predictions and long-term scenarios
We provide both 3-week-ahead predictions and long-term scenarios. These are simulations of the disease spread into the future, under specific assumptions.

In the 3-week-ahead predictions, we assume that all parameters are as today, and simulate disease spread 3-weeks-ahead in time. Hence, these predictions are conditional on the current situation, and specifically on the most recently estimated reproduction number. The 3-week-ahead predictions thus do not take into account changes in transmissibility that are not yet captured by the available data, for example due to the delay between transmission and hospitalisation. Hence one of the conditions for the predictions to be valid is that the intervention policies do not change significantly in the next weeks. Hence, it does not make sense to evaluate or use the predictions if there are big changes in factors like

- new interventions
- relaxation of interventions
- a combination of new interventions and relaxations
- a significant change in vaccination coverage
- new variants with new properties
- a significant change in the contact behaviour of individuals.

As these factors are not likely to stay constant in the long-term future, we do not produce predictions for longer than three weeks ahead in time. Hence, our 3-week-ahead predictions are predictions of what may happen in the future, if there were no significant changes in the assumptions.

In addition to the short-term predictions, we also produce different long-term scenarios. Scenarios are not predictions of how we think the future pandemic will evolve. The scenarios are based on different hypothetical assumptions, and hence cannot be validated against what we later actually observe in the data. They are not meant to be, and hence should not be interpreted as, what we believe to be the most probable future outcome.

The purpose of the scenarios is manifold. Scenarios can contribute to situational awareness, and as information in decision making and future preparedness planning. Scenarios can be used to provide a better understanding of possible future disease spread, under specific assumptions. The assumptions of the scenarios may also sometimes be unrealistic. For example, scenarios can contribute in understanding the current situation, should we not change intervention policies in the future. This does however not mean that we believe that the intervention policies will stay constant. Scenarios can also be used to compare different intervention strategies, like comparing different vaccination strategies.

In this report, the term patient in ventilator treatment includes only those patients that require either invasive mechanical ventilation or ECMO (Extracorporeal membrane oxygenation).

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