

Situational awareness and forecasting for Norway

FHI COVID-19 modelling team

Week 2, 12 January 2022

Main results:

We note that the estimated reproduction numbers in this period are subject to considerable uncertainty due to the increasing dominance of the Omicron variant and the Christmas vacation period affecting the test activity and hospitalisation data. A description of the estimated increase of the Omicron variant, including the method we use, is provided in the COVID-19 Ukesrapport, week 52. New in this report is that the hospitalisation probabilities take into account the decreased severity of omicron. In addition, we use the age-profile in the hospital incidence data instead of the age-profile of the test data in the age-specific hospital predictions, ensuring a better fit to the various age groups. In the short-term projections of this week, we take into account the future increase due to omicron. Note that the most recent reproduction number for the changepoint model is 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 (in particular when assuming that everything else stays the same). New this week is also that we only calibrate to the hospital incidence (and not the test data) in the regional model.

- **National epidemiological situation:**

The most recent reproduction numbers:

Model	Median	5%	95%	Prob>1	period/day	More info
Changepoint	0.9	0.75	1.09	0.19	Since 13. Dec	Table 1
SMC	1.13	0.91	1.38	0.90	4 Jan	Fig. 4
EpiEstim	1.32	1.3	1.34		4 Jan	Table 16, Fig. 23

- **National forecasting:**

One-week-ahead national forecasts from changepoint model:

Indicator	Median/Mean 95% PI	day	Info 2-3 weeks forecasts
Hospital beds	278/268 (188-411)	17 Jan	Table 2
Ventilator beds	73/72 (49-105)	17 Jan	Table 2

* Age-specific hospital prevalence predictions are provided in Figures 6 and 7.

- **Regional epidemiological situation:**

The newest regional reproduction numbers for Oslo:

Model	Median	5%	95%	Prob>1	period/day	Info other counties
SMC	1.47	0.84	2.52	0.91	21 Dec - 24 Dec	Fig. 3
EpiEstim	1.37	1.34	1.4		3 Jan	Table 16, Fig. 23

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- **Telenor mobility data and the number of foreign visitors:** The most recent mobility development is found in Figures [17](#) and [18](#) for the largest municipality in each county and for each county, respectively. Figure [19](#) 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 2 shows the estimated daily number of COVID-19 patients admitted to hospital (1), 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
2.42/2.43(1.91-2.98)	From Feb 17 to Mar 14
0.6/0.6(0.5-0.68)	From Mar 15 to Apr 19
0.69/0.68(0.16-1.18)	From Apr 20 to May 10
0.7/0.7(0.15-1.27)	From May 11 to Jun 30
0.76/0.76(0.1-1.46)	From Jul 01 to Jul 31
1.07/1.05(0.59-1.39)	From Aug 01 to Aug 31
0.92/0.93(0.66-1.23)	From Sep 01 to Sep 30
1.22/1.22(0.92-1.51)	From Oct 01 to Oct 25
1.08/1.09(0.68-1.54)	From Oct 26 to Nov 04
0.9/0.9(0.77-1.02)	From Nov 05 to Nov 30
1/1(0.9-1.08)	From Dec 01 to Jan 03
0.69/0.68(0.52-0.84)	From Jan 04 to Jan 21
0.76/0.76(0.54-1.01)	From Jan 22 to Feb 07
1.4/1.4(1.22-1.59)	From Feb 08 to Mar 01
1.1/1.1(0.99-1.21)	From Mar 02 to Mar 24
0.81/0.81(0.68-0.94)	From Mar 25 to Apr 12
0.84/0.84(0.71-0.97)	From Apr 13 to May 05
0.95/0.94(0.73-1.15)	From May 06 to May 26
0.81/0.82(0.6-1.02)	From May 27 to Jun 20
0.89/0.88(0.69-1.07)	From Jun 21 to Aug 04
1.13/1.14(0.97-1.33)	From Aug 05 to Aug 31
0.8/0.79(0.66-0.93)	From Sep 01 to Sep 24
1.1/1.1(1.05-1.14)	From Sep 25 to Dec 12
0.9/0.91(0.75-1.09)	From Dec 13
Median/Mean (95% credible intervals)	

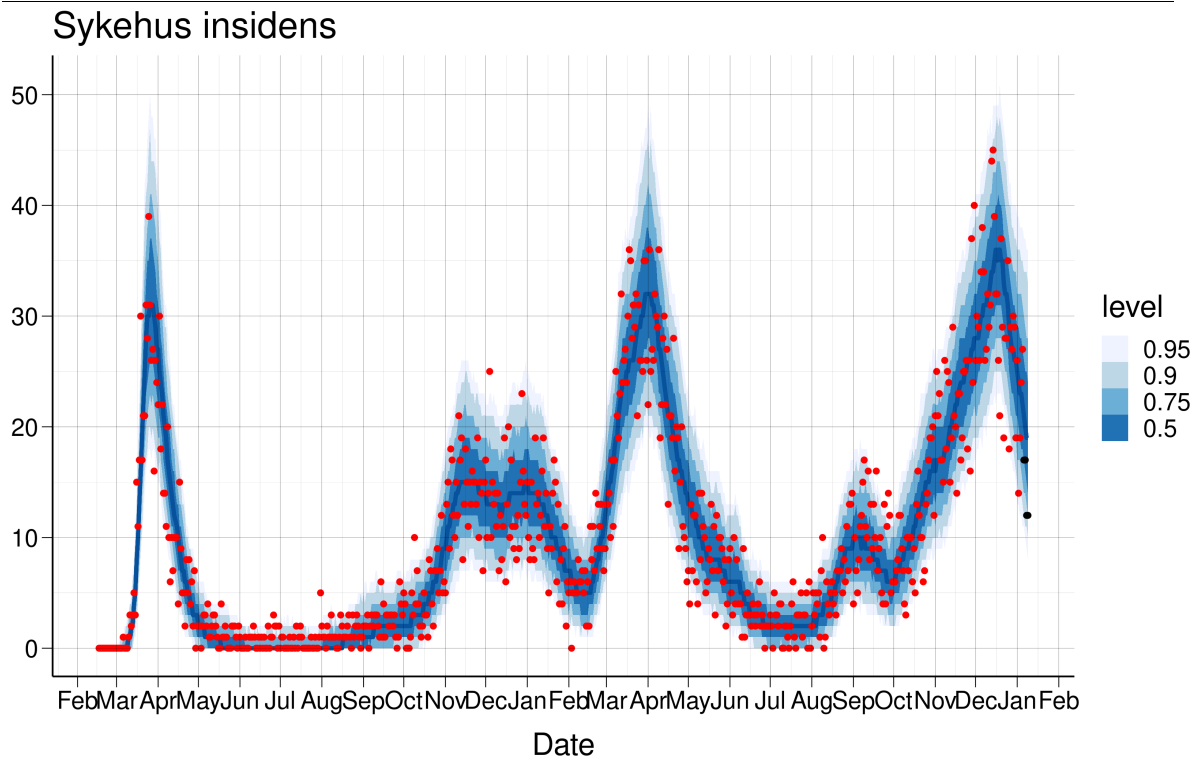


Figure 1: Hospital admissions

Figure 2: 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 3, we show how our national model fits the national hospital prevalence data (3a) and the daily number of patients receiving ventilator treatment (3b). Those data sources are not used to estimate the parameters, and can therefore be seen as a validation of the model assumptions.

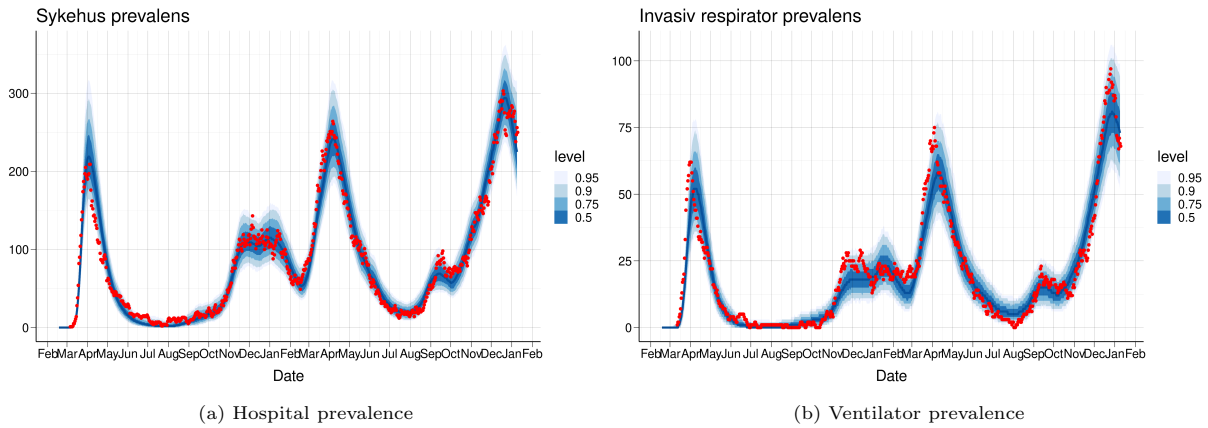


Figure 3: A comparison of true data (red) and predicted values (blue) for hospital and respirator prevalence. Prevalence data is based on NIPaR and may be different to the data from Helsedirektoratet.

1.1 National SMC-model: Estimated daily reproduction numbers

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Figure 4 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 $R(t)$.

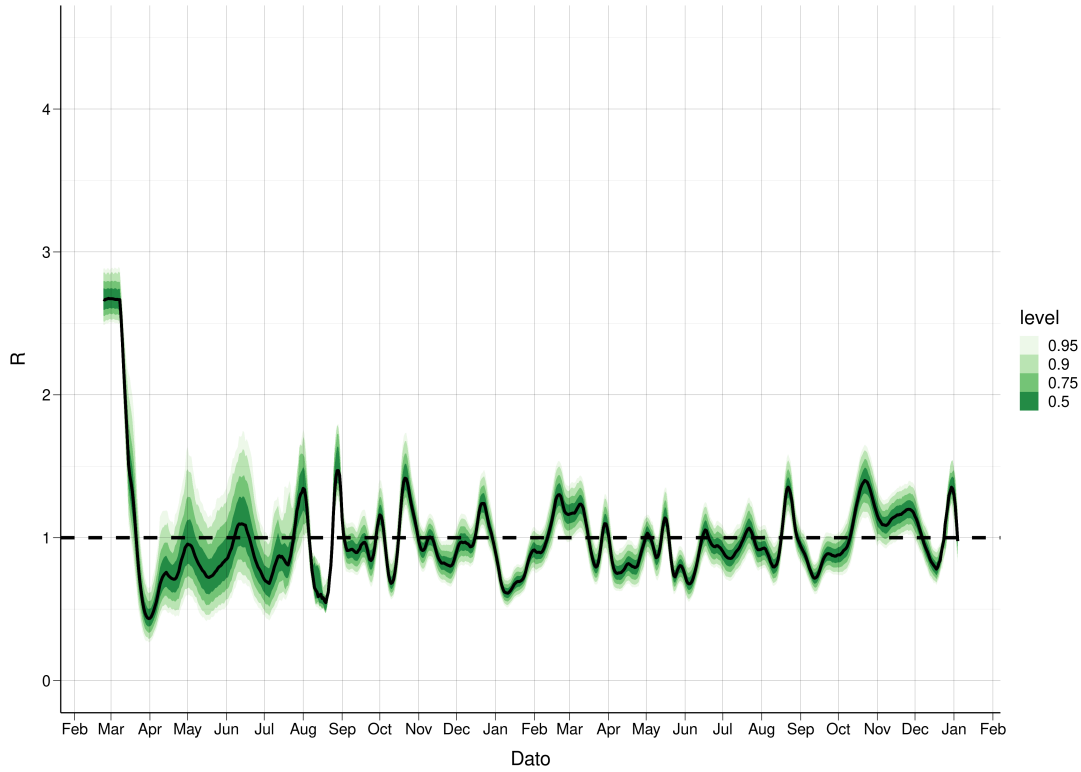


Figure 4: $R(t)$ estimates using a Sequential Monte Carlo approach calibrated to hospitalisation incidence and test data. The large uncertainty during the last 7 days reflects the lack of available data due to the transmission delay, test delay, time between symptoms onset and hospitalisation. The green 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 takeover 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) and that omicron is 2.2 times as infectious as delta (see takeover analysis in this week's weekly report from FHI). We then show the three-week-ahead trajectories of these analyses, based on these numbers. Note that the exact relative infectiousness of omicron to delta is uncertain and based on preliminary data. We also do not know the exact proportion of the prevalence in the population that could be attributed to omicron on January 1 2022.

The table of hospital beds and ventilator beds is provided in Table 2. The corresponding figures are provided in Figure 5. Age-specific hospital prevalence predictions are provided in Figures 6 and 7.

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

	1 week prediction (Jan 17)	2 week prediction (Jan 24)	3 week prediction (Jan 31)
Hospital beds	278/268 (188-411)	400/387 (259-604)	634/615 (414-936)
Ventilator beds	73/72 (49-105)	88/86 (55-135)	128/124 (79-194)

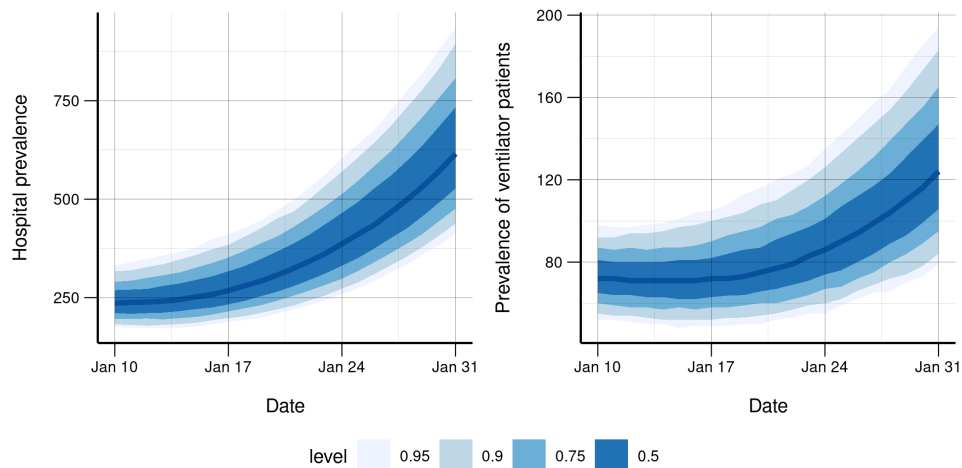


Figure 5: National 3 week predictions for hospital beds (left) and ventilator beds (right) taking into account the omicron takeover.

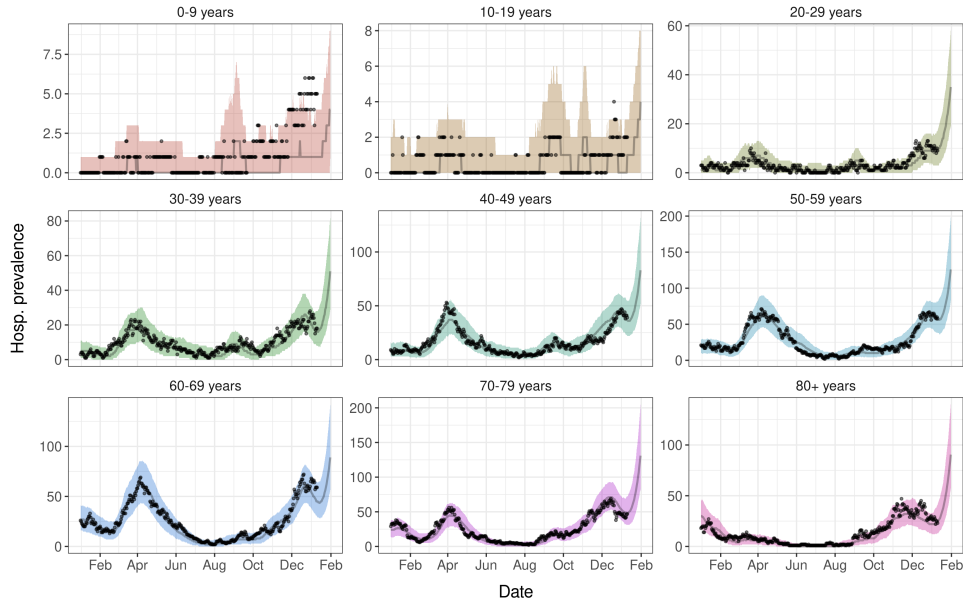


Figure 6: Simulated hospital prevalence by age group taking into account the omicron takeover. Real data is shown as black dots.

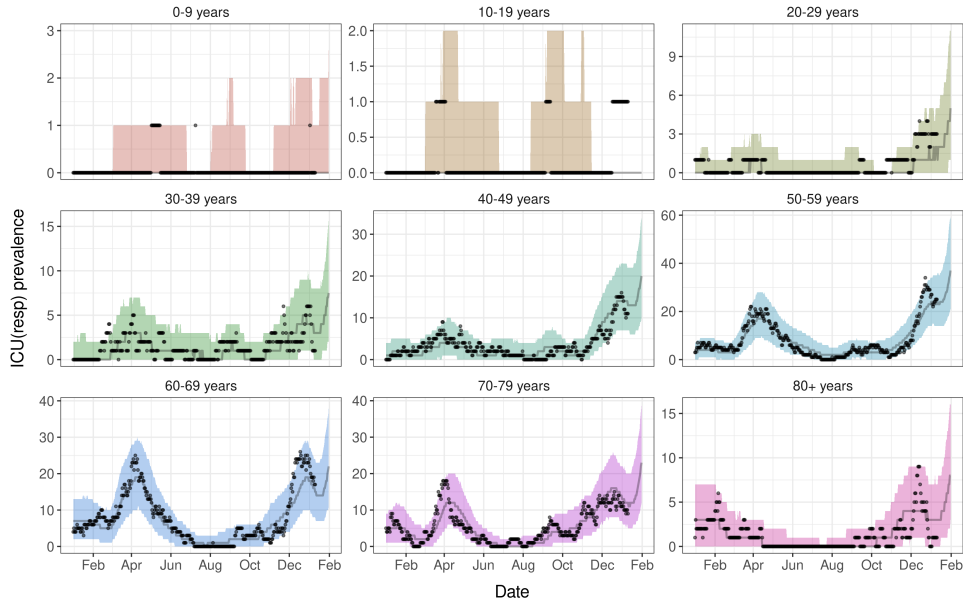


Figure 7: Simulated respirator prevalence by age group taking into account the omicron takeover. Real data is shown as black dots.

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 interquartile 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, 21 Dec-24 Dec

County	Median	95CI	Prob>1
Oslo	1.47	0.84-2.52	0.91
Rogaland	1.04	0.57-1.85	0.56
Møre og Romsdal	0.92	0.48-1.67	0.38
Nordland	0.97	0.53-1.72	0.46
Viken	1.08	0.67-1.77	0.63
Innlandet	0.95	0.55-1.61	0.42
Vestfold og Telemark	0.98	0.6-1.6	0.46
Agder	1.37	0.8-2.47	0.88
Vestland	0.93	0.48-1.77	0.4
Trøndelag	1.51	0.8-2.71	0.9
Troms og Finnmark	0.73	0.37-1.34	0.15

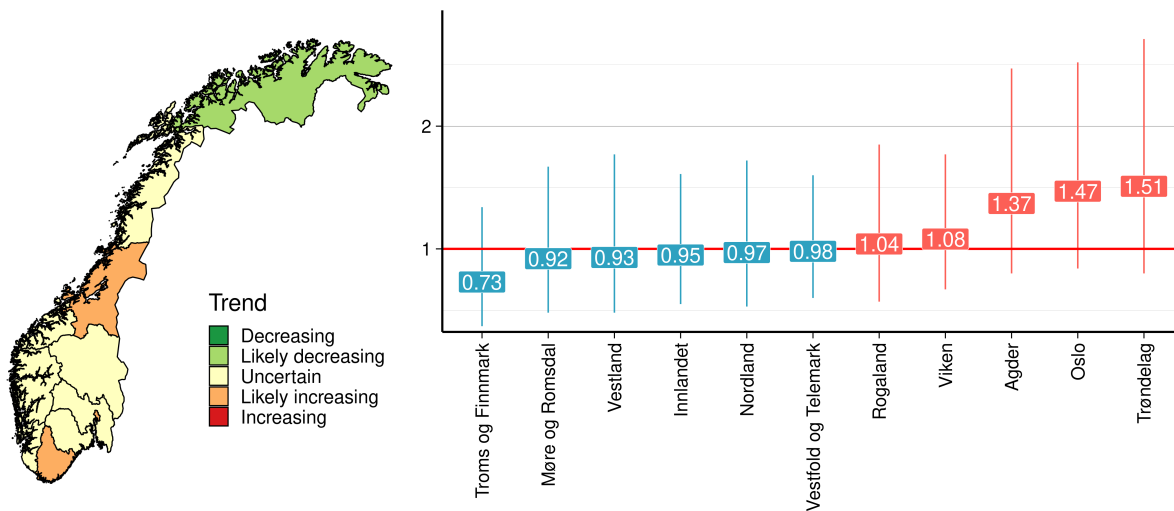
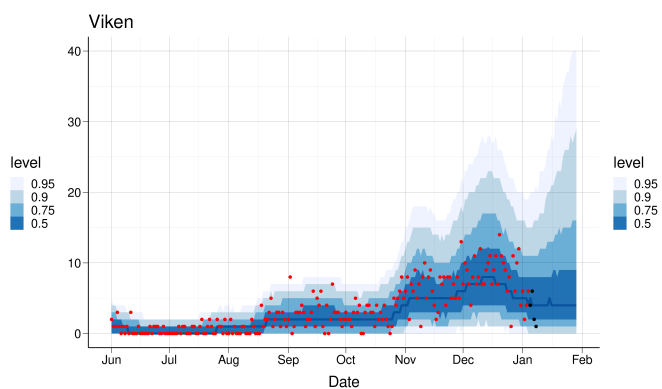
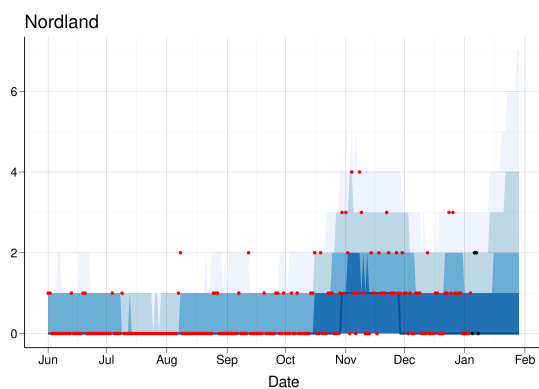
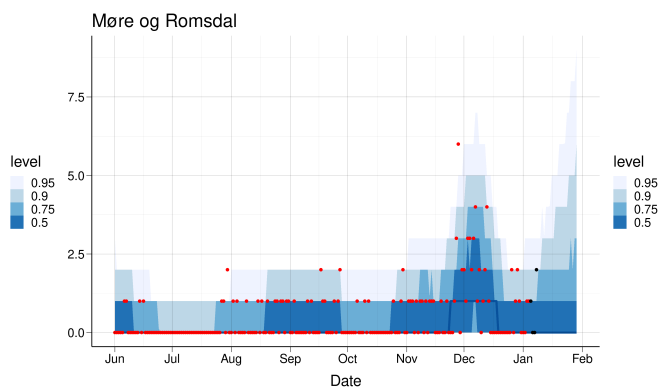
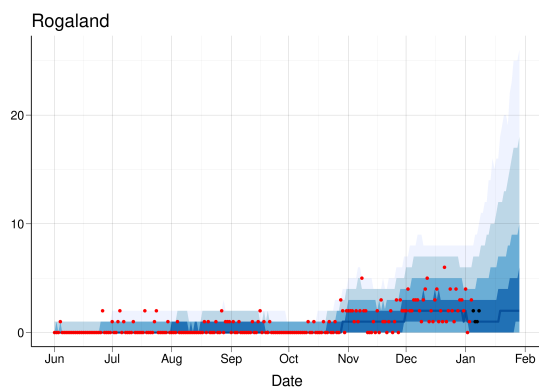
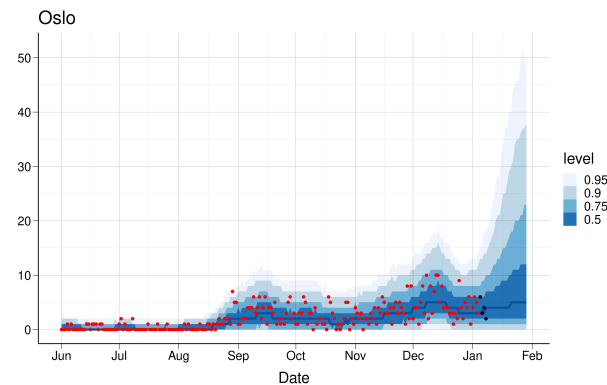
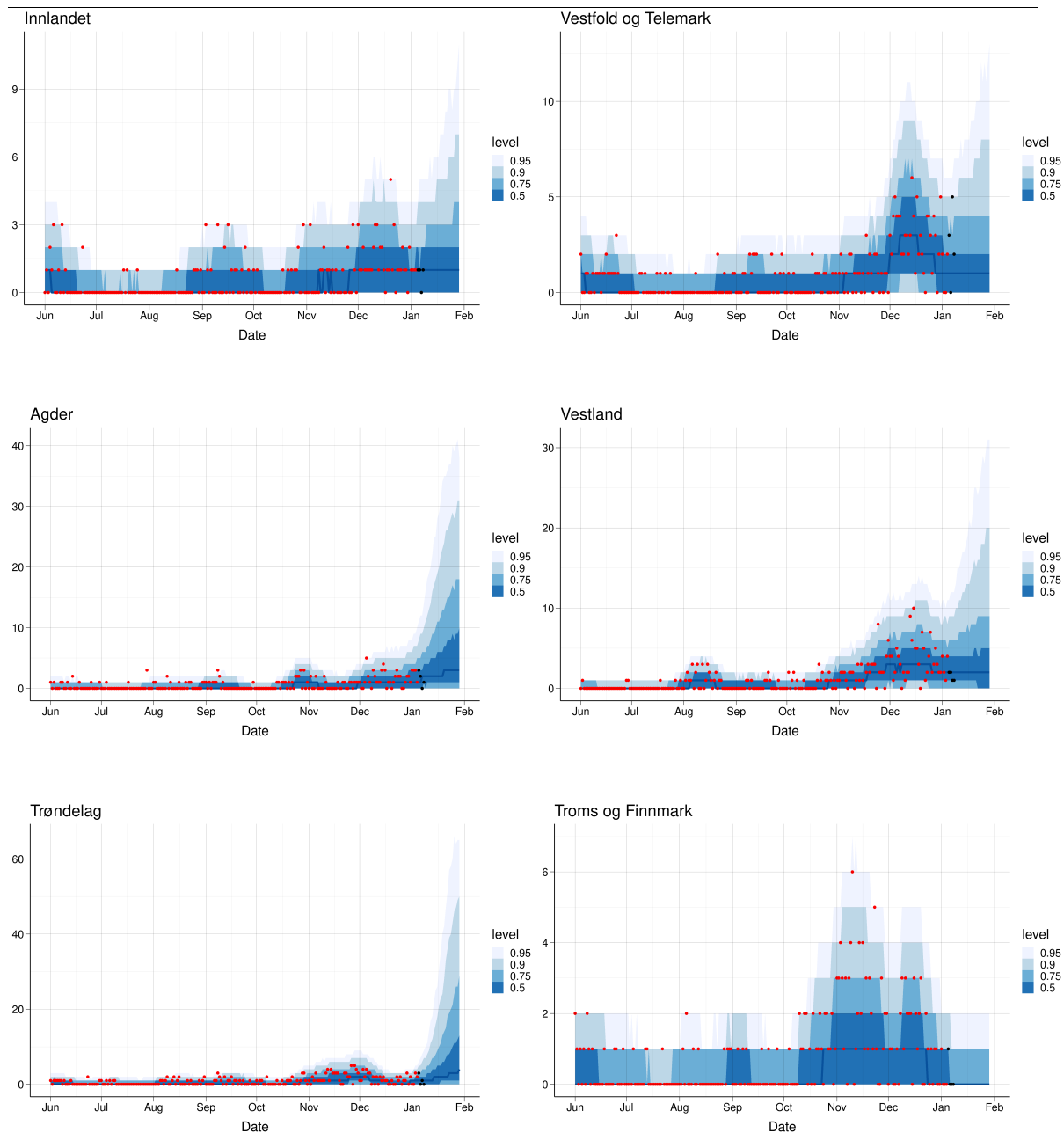


Figure 8: The map shows the direction of the trend in incidence in the counties based on the latest reproduction numbers shown in the other chart. The trend is increasing if the probability that the latest reproduction number is above one is above 95%, the trend is likely increasing if this probability 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.





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, 2022-01-08

Region	Total	No. confirmed	Fraction reported	Min. fraction
Oslo	76777 (44650; 129881)	63188	82%	49%
Rogaland	25309 (12483; 54790)	20371	80%	37%
Møre og Romsdal	10052 (6396; 16384)	7362	73%	45%
Nordland	7453 (3960; 14129)	6381	86%	45%
Viken	99950 (61973; 168786)	86928	87%	52%
Innlandet	12836 (8014; 21324)	11379	89%	53%
Vestfold og Telemark	22694 (13365; 39104)	17756	78%	45%
Agder	20840 (7435; 60800)	15257	73%	25%
Vestland	36701 (17104; 81179)	25360	69%	31%
Trøndelag	22913 (10951; 51227)	18910	83%	37%
Troms og Finnmark	10082 (4708; 21128)	10933	100%	52%

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 (15 Jan)	2 weeks prediction (22 Jan)	3 weeks prediction (29 Jan)
Agder	734/1655 (70-8762)	898/1925 (61-8194)	1025/1904 (54-6706)
Innlandet	180/313 (29-1440)	188/393 (23-2091)	198/473 (19-2704)
Møre og Romsdal	108/205 (17-1050)	106/266 (10-1639)	108/325 (6-2419)
Nordland	69/162 (8-929)	67/211 (6-1433)	67/261 (4-2044)
Oslo	1349/2288 (219-10185)	1463/2699 (151-11848)	1555/2753 (104-10218)
Rogaland	493/988 (61-5129)	671/1292 (61-6500)	885/1508 (56-6336)
Troms og Finnmark	30/58 (4-273)	28/66 (2-361)	26/76 (2-461)
Trøndelag	726/2046 (60-13304)	1077/3178 (44-17014)	1557/3650 (34-14076)
Vestfold og Telemark	251/441 (40-2025)	214/484 (22-2716)	191/521 (15-3277)
Vestland	517/1072 (65-5916)	539/1223 (48-7819)	540/1271 (37-8228)
Viken	1256/1907 (261-7662)	1180/2086 (175-10076)	1130/2193 (117-11054)

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	15 Jan	22 Jan	29 Jan	low CI, 29 Jan	high CI, 29 Jan
Agder	3087/6792	3785/8224	4390/8413	243	30564
Innlandet	789/1320	821/1649	862/2002	91	11234
Møre og Romsdal	486/857	476/1112	472/1369	35	9920
Nordland	307/674	297/878	298/1097	23	8218
Oslo	5786/9530	6325/11493	6759/12090	516	46776
Rogaland	2047/4075	2785/5389	3679/6433	254	27969
Troms og Finnmark	138/255	123/283	117/325	12	1924
Trøndelag	2939/7901	4369/12905	6358/15664	163	62918
Vestfold og Telemark	1134/1902	977/2091	861/2255	77	13935
Vestland	2282/4519	2348/5239	2388/5554	181	36469
Viken	5570/8179	5269/9006	5044/9555	563	48065

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 (15 Jan)	2 weeks prediction (22 Jan)	3 weeks prediction (29 Jan)
Agder	17/28 (2-119)	22/41 (1-202)	26/53 (1-247)
Innlandet	8/10 (1-32)	8/11 (1-42)	8/14 (0-60)
Møre og Romsdal	5/6 (0-20)	5/8 (0-33)	5/9 (0-49)
Nordland	4/5 (0-20)	4/6 (0-28)	3/7 (0-40)
Oslo	37/47 (11-139)	41/60 (10-224)	44/72 (8-295)
Rogaland	16/22 (2-80)	16/27 (2-114)	19/33 (1-160)
Troms og Finnmark	3/4 (0-13)	3/3 (0-12)	2/3 (0-13)
Trøndelag	12/20 (1-96)	17/40 (1-233)	25/66 (1-375)
Vestfold og Telemark	14/17 (2-46)	13/17 (1-58)	10/17 (1-79)
Vestland	22/29 (4-100)	21/33 (3-147)	21/38 (2-198)
Viken	50/60 (18-157)	48/63 (14-207)	46/67 (10-265)

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

Region	1 week prediction (15 Jan)	2 weeks prediction (22 Jan)	3 weeks prediction (29 Jan)
Agder	4/6 (0-21)	5/8 (0-38)	6/11 (0-54)
Innlandet	2/3 (0-8)	2/3 (0-9)	2/3 (0-12)
Møre og Romsdal	1/2 (0-5)	1/2 (0-7)	1/2 (0-10)
Nordland	1/1 (0-5)	1/1 (0-6)	1/2 (0-9)
Oslo	10/12 (3-27)	11/14 (3-40)	12/17 (3-60)
Rogaland	4/5 (0-16)	4/6 (0-23)	5/7 (0-33)
Troms og Finnmark	1/1 (0-5)	1/1 (0-4)	1/1 (0-4)
Trøndelag	3/4 (0-14)	4/7 (0-36)	5/12 (0-70)
Vestfold og Telemark	4/5 (0-12)	4/4 (0-13)	3/4 (0-17)
Vestland	6/7 (1-22)	6/8 (1-29)	6/9 (0-40)
Viken	14/16 (5-36)	13/16 (4-44)	13/17 (3-57)

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

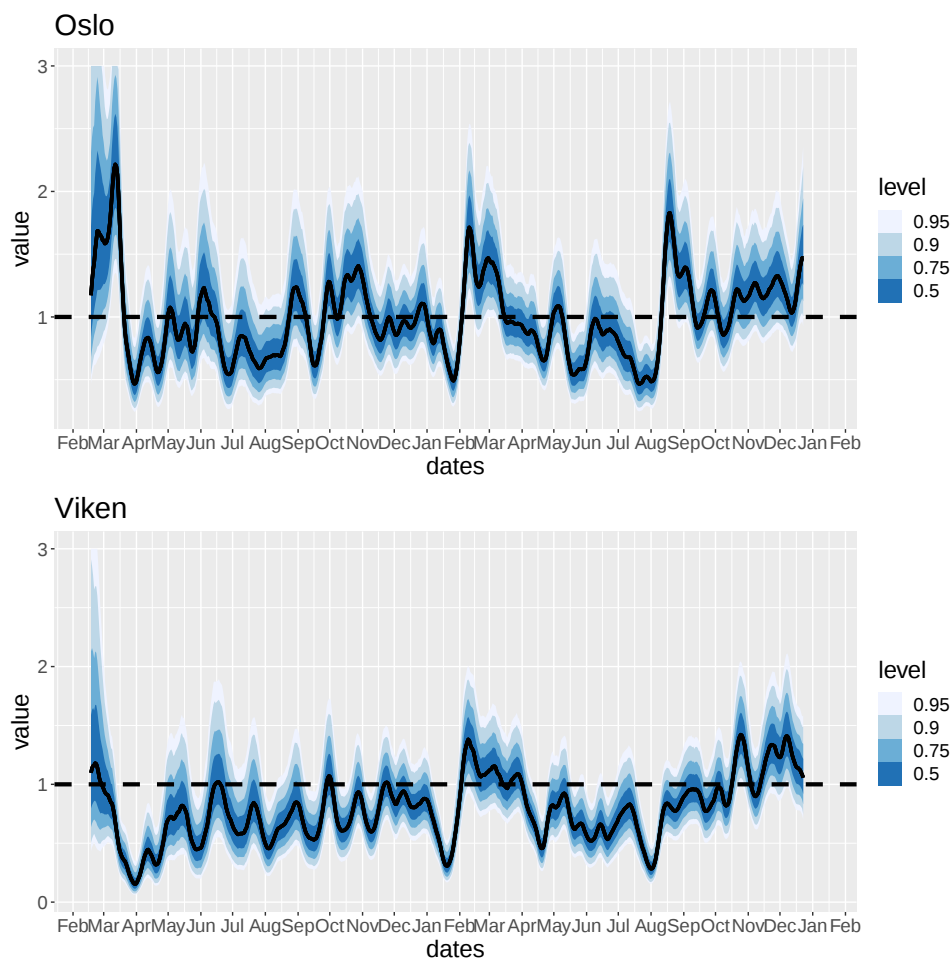
To estimate recent trends in hospitalisation and number of positive tests, we present results in table 9 based on a negative binomial regression where we account for weekend effects. We exclude the last three days to avoid problems of reporting delay and fit the model using data from 17 days to 3 days 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

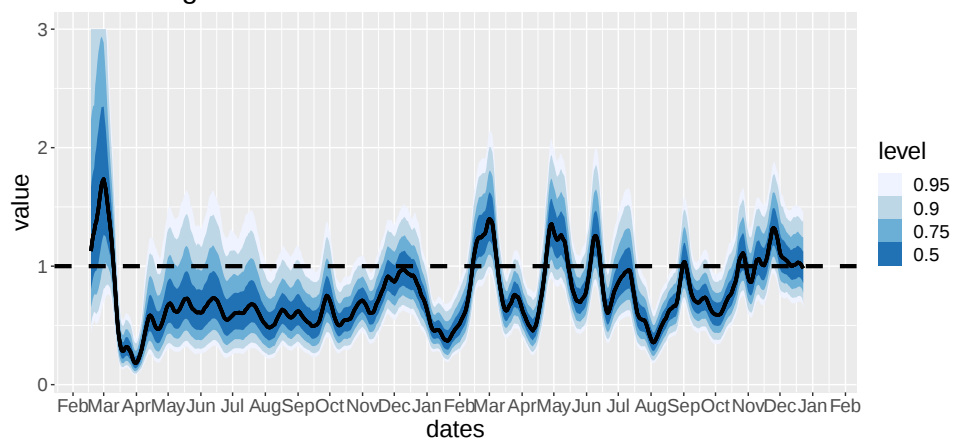
County	Average daily increase last 14 days		Doubling Time (days)	
	Hospitalisations	Cases	Hospitalisations	Cases
Agder	4.3 (-6, 16) %	1.6 (-2.7, 6) %	16.6 (-11.2, 4.7)	44.6 (-25.6, 11.9)
Innlandet	1 (-12.4, 16.8) %	8.7 (3.8, 13.9) %	66.5 (-5.2, 4.5)	8.3 (18.6, 5.3)
Møre og Romsdal	-3.5 (-17, 11.6) %	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

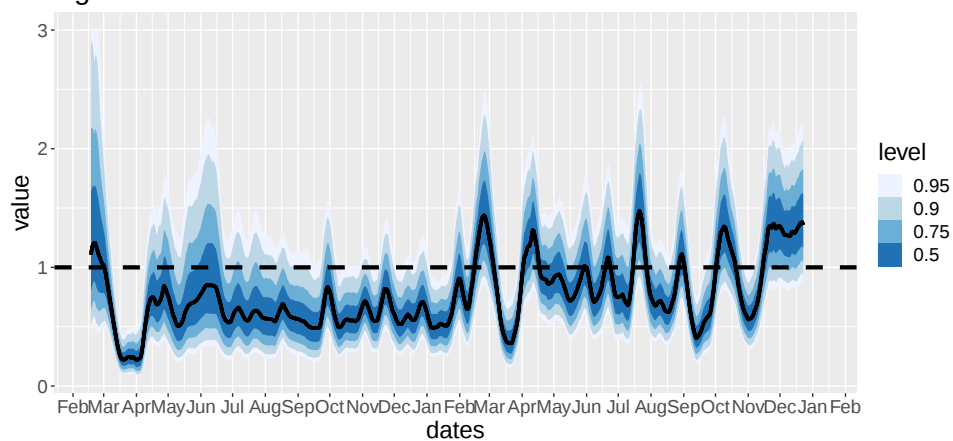
In the figures below we plot the 95% credibility interval and quantiles of the estimated posterior distribution of the regional, daily reproduction numbers. For some counties, uncertainty is large towards the most recent time, because there are very few data and possibly reporting delays which are different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



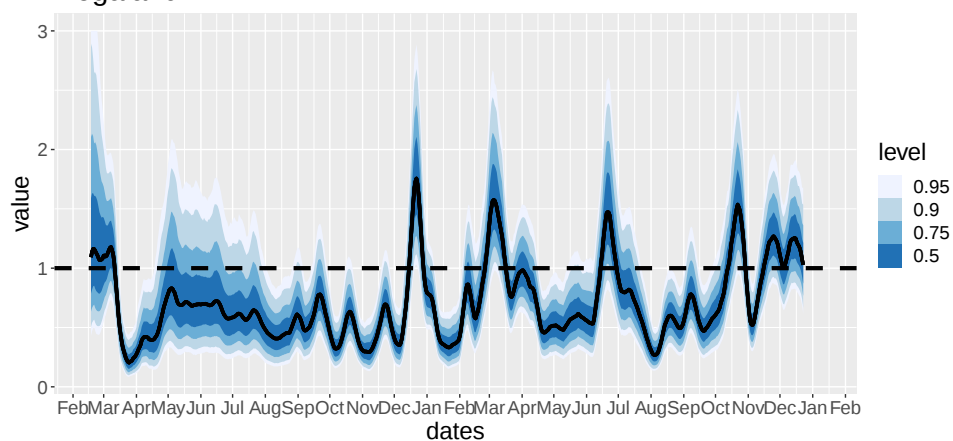
Vestfold og Telemark

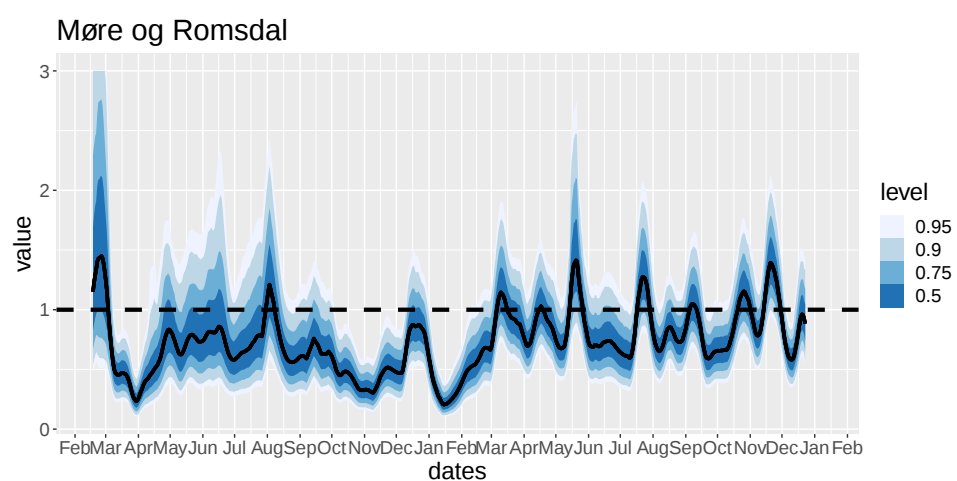
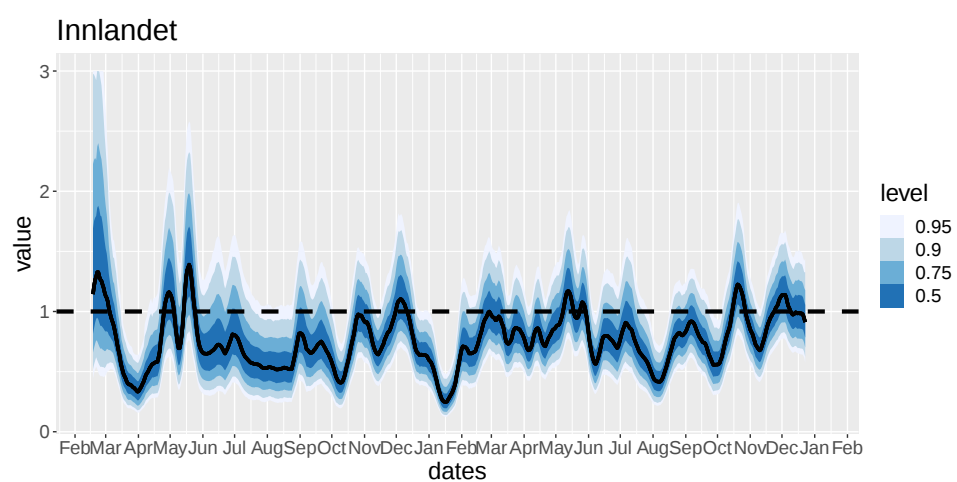
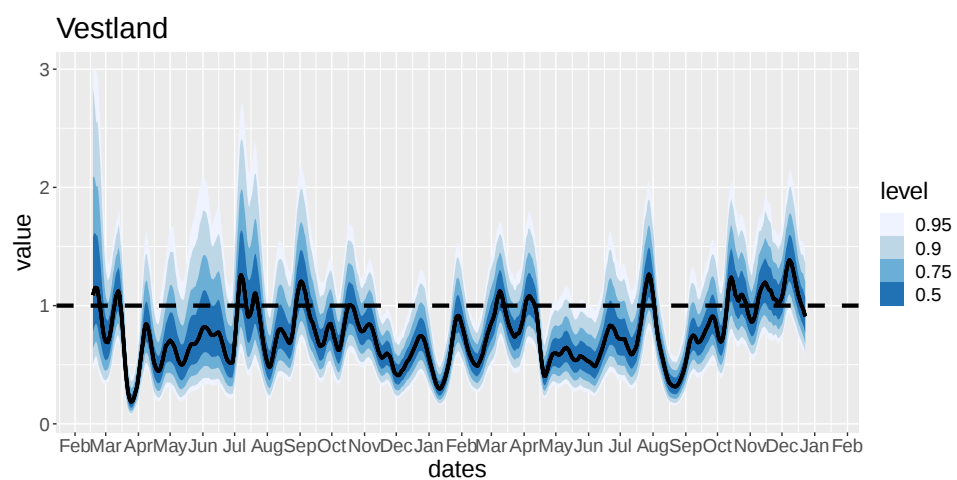


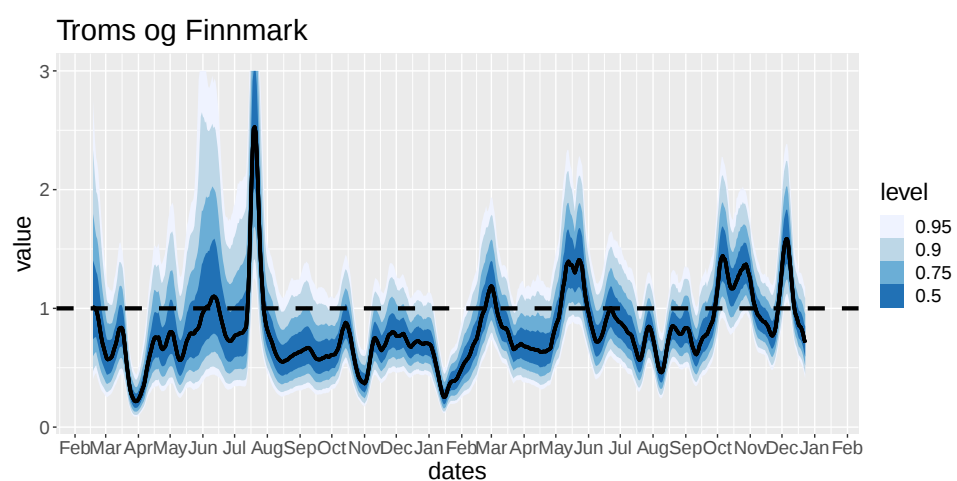
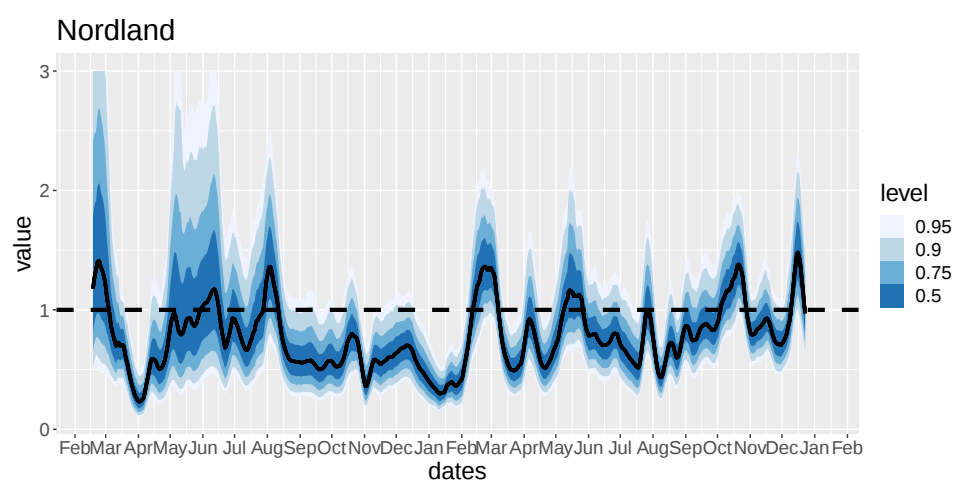
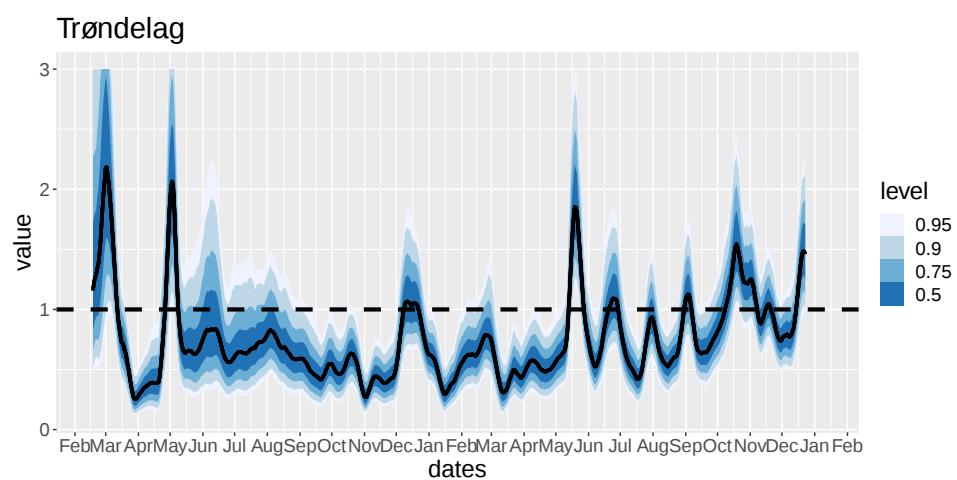
Agder



Rogaland







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)

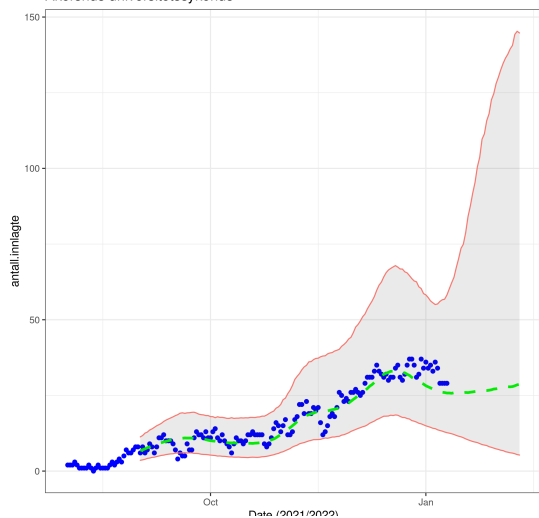
Helseforetak	1 week prediction (15 Jan)	2 weeks prediction (22 Jan)	3 weeks prediction (29 Jan)
Akershus universitetssykehus	26/29 (12-70)	26/33 (10-95)	27/36 (8-123)
Finnmarkssykehuset	1/1 (0-3)	1/1 (0-3)	1/1 (0-4)
Helse Bergen	16/21 (4-72)	15/24 (3-102)	14/27 (2-141)
Helse Fonna	7/8 (2-25)	7/10 (2-35)	8/12 (1-49)
Helse Førde	4/5 (1-17)	4/6 (1-24)	3/6 (1-34)
Helse Møre og Romsdal	5/6 (1-19)	5/8 (0-32)	5/9 (0-48)
Helse Nord Trøndelag	4/6 (1-30)	5/13 (1-73)	8/21 (1-120)
Helse Stavanger	12/17 (3-60)	13/21 (2-87)	15/26 (2-124)
Nordlandssykehuset	2/3 (0-11)	2/3 (0-15)	2/4 (0-23)
Oslo universitetssykehus	31/40 (12-114)	34/50 (9-185)	37/60 (8-245)
St. Olavs hospital	8/14 (1-65)	12/27 (1-157)	17/45 (1-255)
Sykehuset Innlandet	8/10 (2-26)	8/11 (1-37)	8/12 (1-53)
Sykehuset Telemark	6/7 (2-18)	5/7 (1-24)	5/7 (1-32)
Sykehuset i Vestfold	8/10 (2-26)	7/10 (2-34)	6/10 (1-46)
Sykehuset Østfold	13/15 (5-40)	13/16 (4-52)	12/17 (3-66)
Sørlandet sykehus	17/28 (3-121)	22/41 (2-200)	26/53 (2-247)
Universitetssykehuset i Nord-Norge	3/3 (0-9)	2/3 (0-9)	2/3 (0-12)
Vestre Viken	20/23 (7-61)	19/25 (6-80)	18/26 (5-102)

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

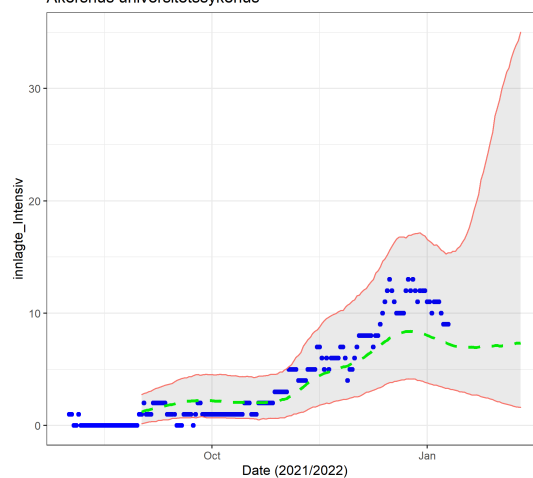
Helseforetak	1 week prediction (17 Jan)	2 weeks prediction (24 Jan)	3 weeks prediction (31 Jan)
Akershus universitetssykehus	7/8 (3-17)	7/8 (3-22)	7/9 (2-28)
Finnmarkssykehuset	0/0 (0-1)	0/0 (0-1)	0/0 (0-1)
Helgelandssykehuset	0/0 (0-2)	0/0 (0-2)	0/1 (0-3)
Helse Bergen	4/5 (1-17)	4/6 (1-23)	4/7 (0-31)
Helse Fonna	2/2 (0-6)	2/2 (0-8)	2/3 (0-11)
Helse Førde	1/1 (0-4)	1/1 (0-5)	1/2 (0-7)
Helse Møre og Romsdal	1/2 (0-5)	1/2 (0-8)	1/2 (0-11)
Helse Nord Trøndelag	1/1 (0-6)	1/3 (0-14)	2/4 (0-25)
Helse Stavanger	3/4 (0-14)	3/5 (0-20)	4/6 (0-28)
Nordlandssykehuset	1/1 (0-3)	1/1 (0-4)	1/1 (0-6)
Oslo universitetssykehus	9/10 (3-26)	9/12 (3-38)	10/14 (2-53)
St. Olavs hospital	2/3 (0-13)	3/6 (0-31)	4/9 (0-53)
Sykehuset Innlandet	2/3 (0-7)	2/3 (0-9)	2/3 (0-12)
Sykehuset Telemark	2/2 (0-5)	2/2 (0-6)	1/2 (0-7)
Sykehuset i Vestfold	2/3 (0-7)	2/3 (0-8)	2/3 (0-11)
Sykehuset Østfold	4/4 (1-10)	3/4 (1-12)	3/4 (1-15)
Sørlandet sykehus	4/6 (0-25)	5/9 (0-41)	6/12 (0-55)
Universitetssykehuset i Nord-Norge	1/1 (0-3)	1/1 (0-3)	1/1 (0-3)
Vestre Viken	6/6 (2-15)	5/6 (1-19)	5/7 (1-24)

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.

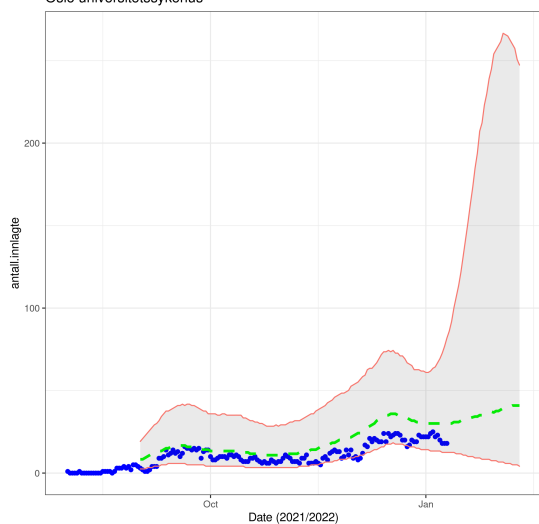
Akershus universitetssykehus



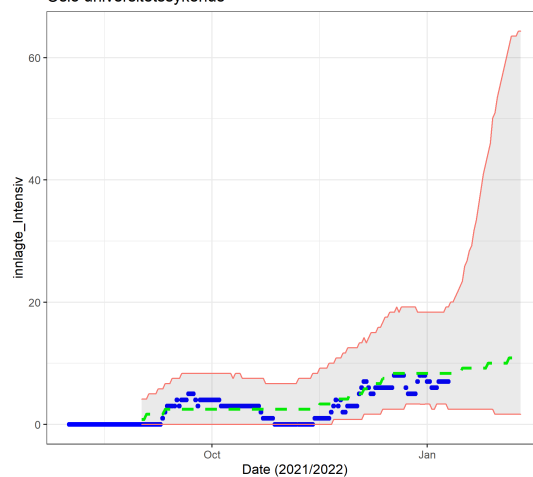
Akershus universitetssykehus



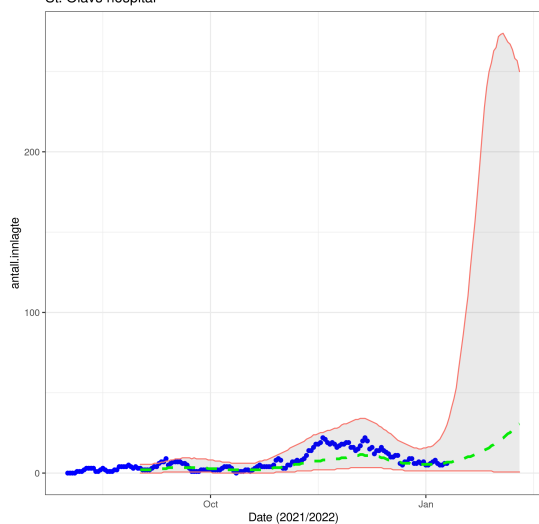
Oslo universitetssykehus



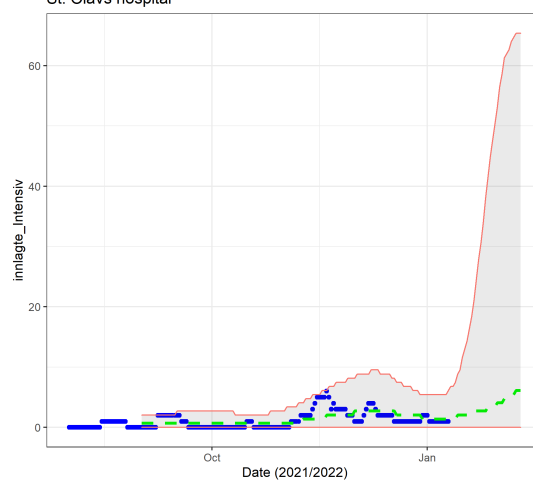
Oslo universitetssykehus



St. Olavs hospital



St. Olavs hospital



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 15 shows an overview of the mobility since March 2020 for the largest municipalities in each county, and Figure 16 shows the total mobility out from all municipalities in each county, including Oslo. Figure 17 and 18, zooms in on mobility from August 16 2021, for municipalities and counties, respectively.

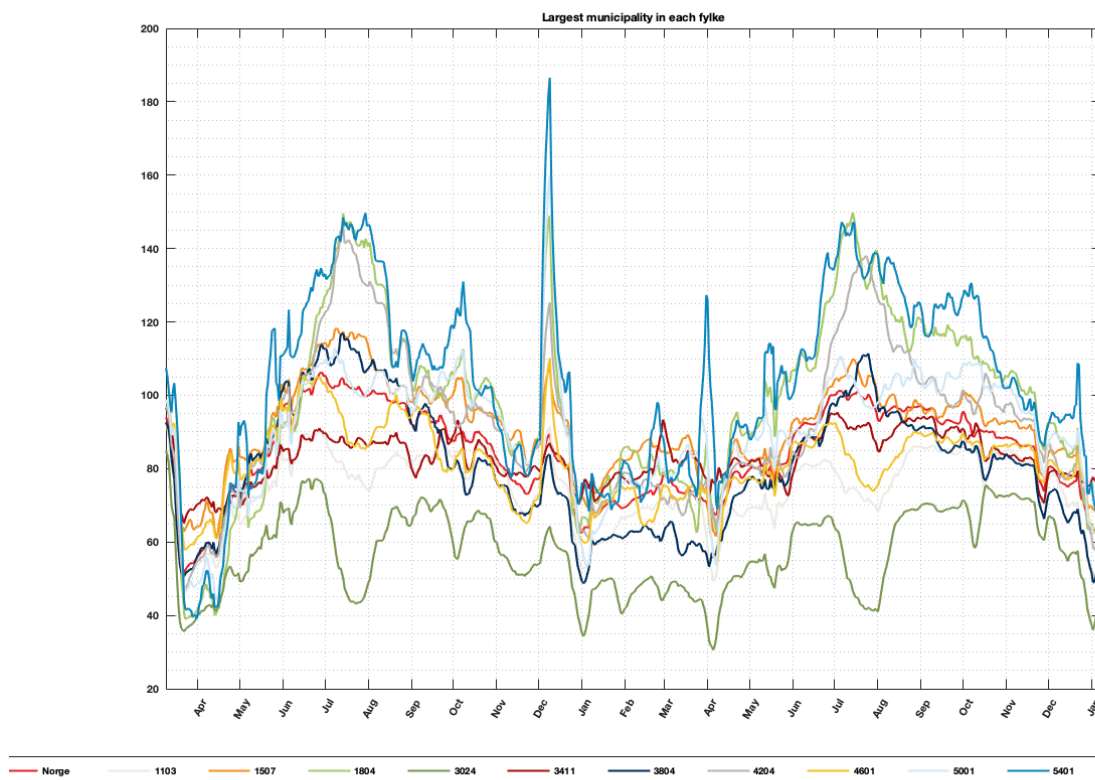


Figure 15: Mobility for selected municipalities since March 2020: Nationally (Norge), Stavanger (1103), Ålesund (1507), Bodø (1804), Bærum (3024), Ringsaker (3411), Sandefjord (3804), Kristiansand (4204), Bergen (4601), Trondheim (5001), Tromsø (5401).

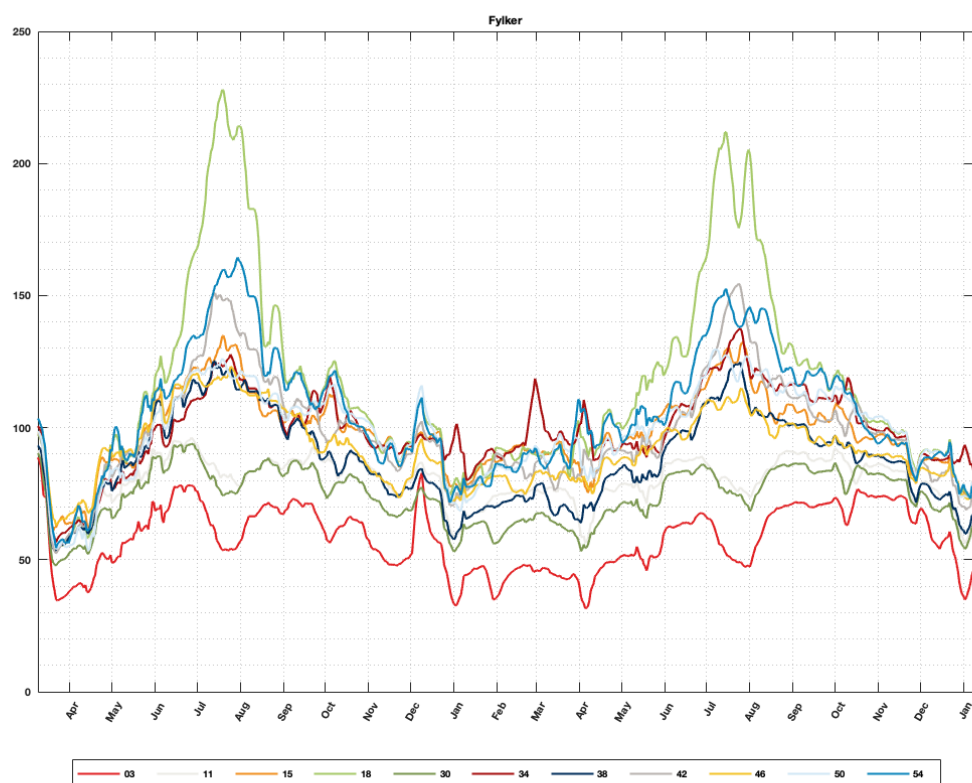


Figure 16: Mobility for fylker since March 2020: Oslo (03), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finmark (54).

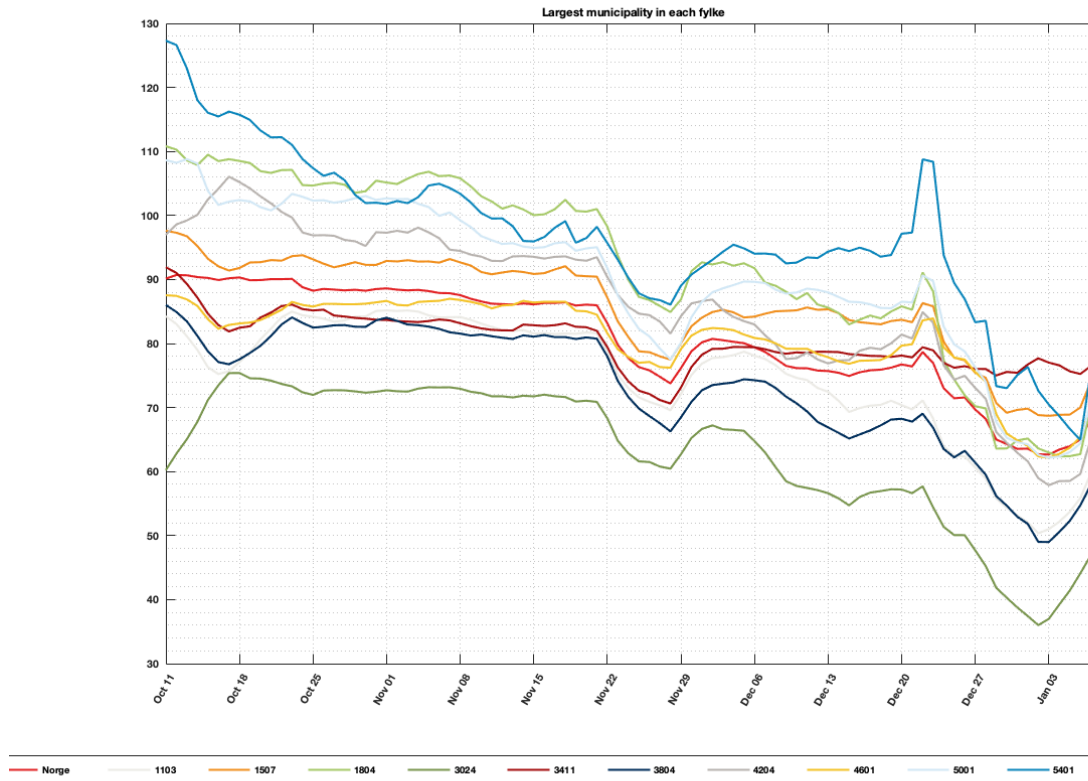


Figure 17: Zoom: Mobility from August 16, 2021 and onwards: Nationally (Norge), Stavanger (1103), Ålesund (1507), Bodø (1804), Bærum (3024), Ringsaker (3411), Sandefjord (3804), Kristiansand (4204), Bergen (4601), Trondheim (5001), Tromsø (5401).

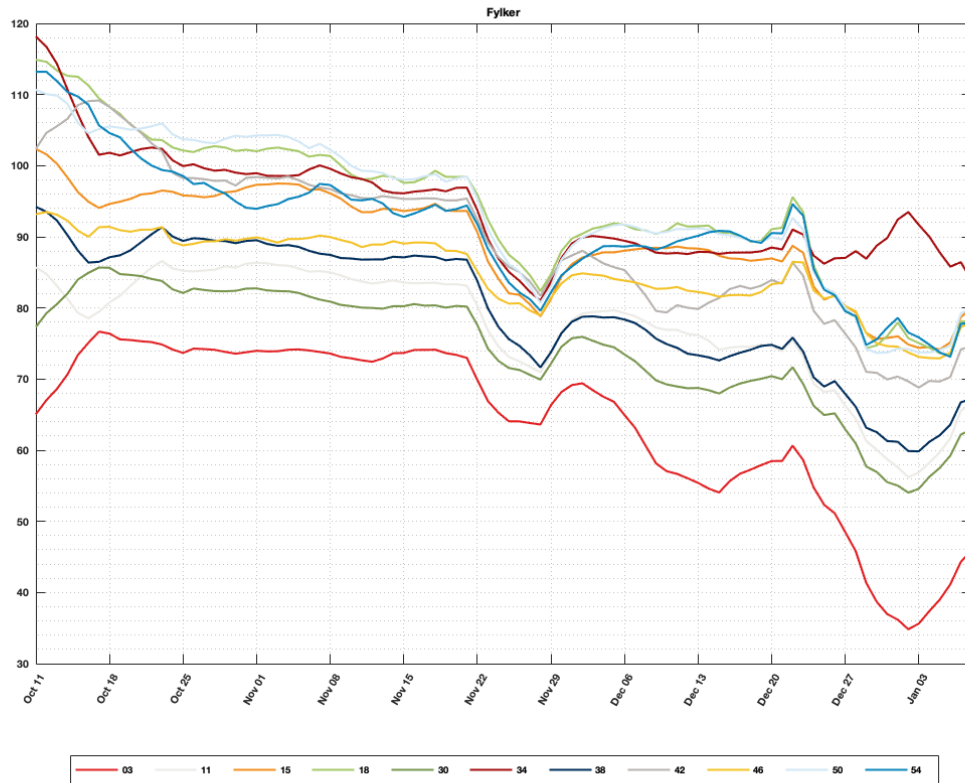


Figure 18: Zoom: Mobility from August 16, 2021 and onwards, per fylker: Oslo (03), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finnmark (54).

	50	51	52	53	2
Norge	79.4	75.7	76.7	69.7	62.7
Stavanger	78.1	72.5	70.4	60.6	51.0
Ålesund	84.2	85.3	83.7	75.4	68.7
Bodø	91.8	85.6	85.8	70.2	63.0
Bærum	64.8	56.6	57.2	47.7	37.0
Ringsaker	79.4	78.7	78.1	76.0	77.0
Sandefjord	74.3	66.9	68.2	61.4	49.0
Kristiansand	83.0	76.9	81.4	73.1	57.9
Bergen	80.9	77.9	79.7	75.5	62.1
Trondheim	89.6	88.0	86.5	76.3	62.2
Tromsø	94.0	94.3	97.2	83.3	70.5

Table 12: Municipalities

	50	51	52	53	2
Oslo	65.0	55.4	58.5	48.5	35.6
Rogaland	79.3	76.2	74.6	66.2	56.9
Møre og Romsdal	88.0	88.3	87.0	80.3	74.4
Nordland	91.7	91.5	91.1	79.6	75.1
Viken	73.5	68.8	70.4	62.9	54.6
Innlandet	89.4	87.9	88.5	87.0	91.7
Vestfold og Telemark	78.4	73.3	74.8	67.9	59.9
Agder	85.3	79.8	83.9	76.4	68.8
Vestlandet	83.8	82.2	83.3	80.3	73.1
Trøndelag	91.7	91.2	90.0	80.0	73.7
Troms og Finnmark	88.6	90.1	90.5	79.5	75.8

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

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 19 the total number of roamers per day per county are displayed.

Figure 20 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.

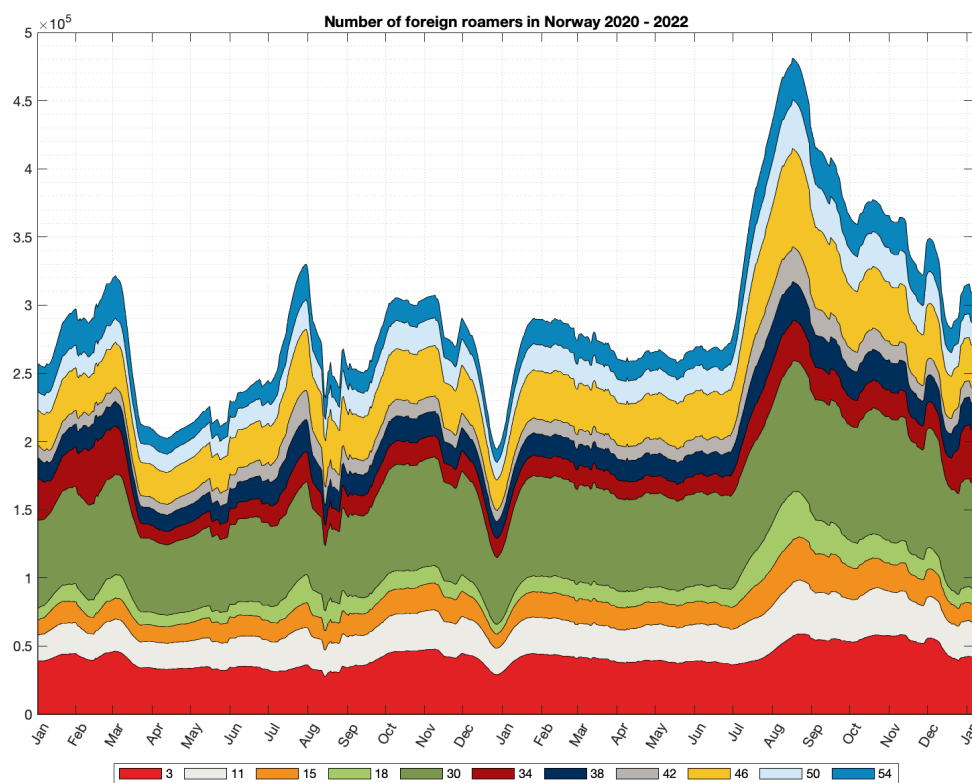


Figure 19: The total number of foreign roamers in Norway broken down on different fylker: Oslo (3), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finnmark (54).

9.1 Foreign roamers on Telenor's network in Norway

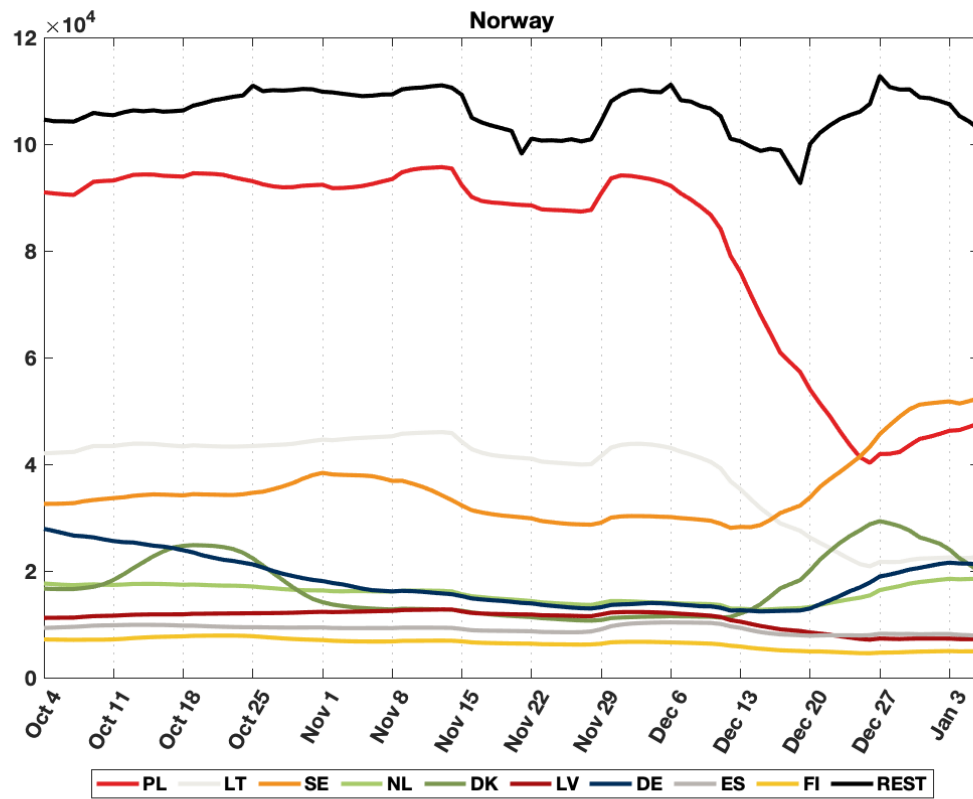
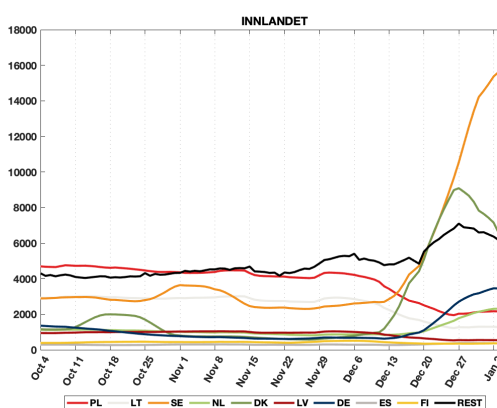
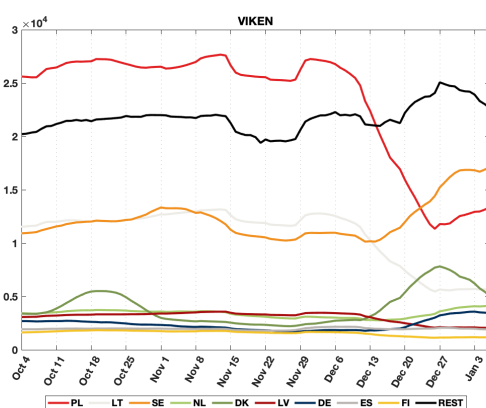
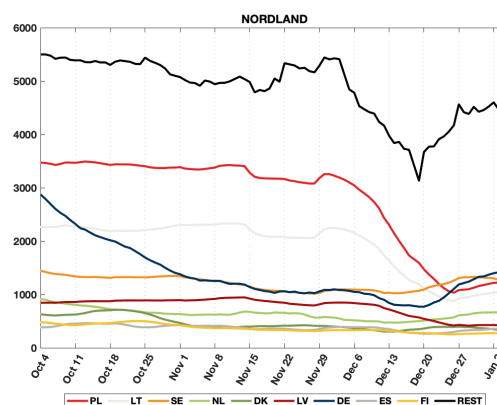
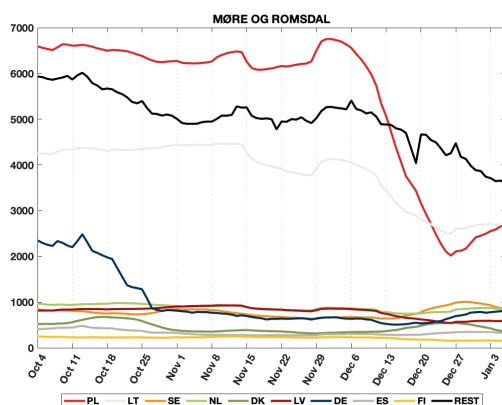
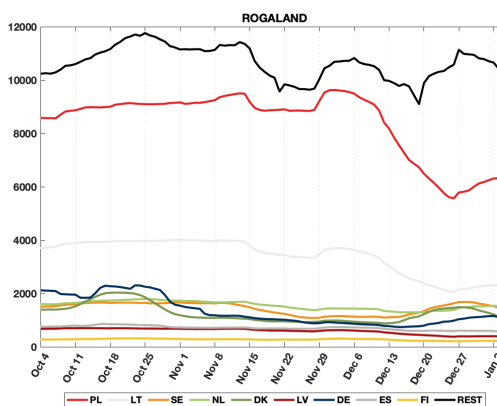
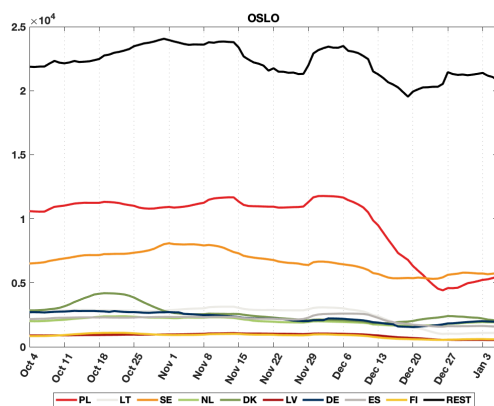


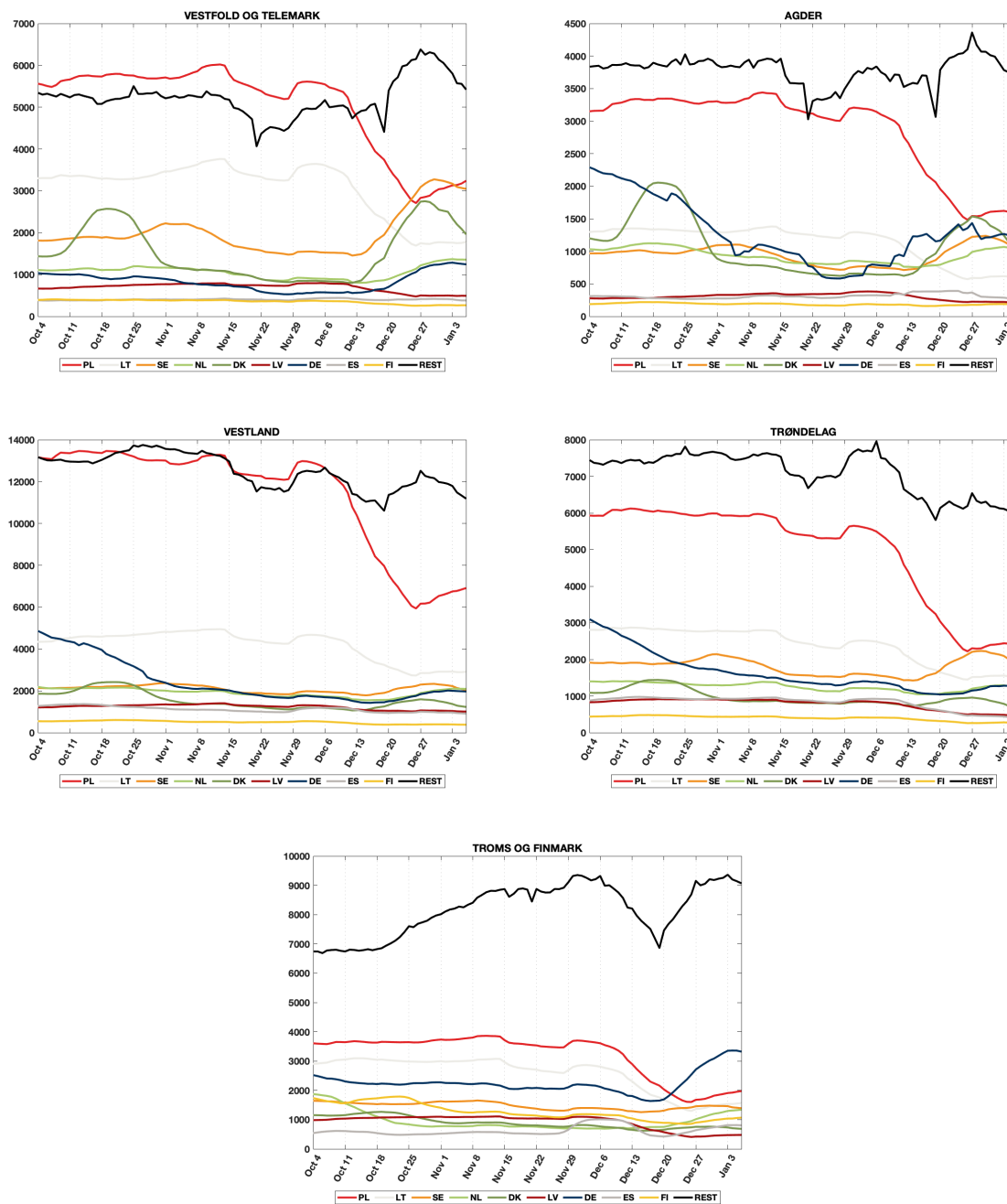
Figure 20: National overview of total number of foreign, visiting roamers from Poland, Lithuania, Sweden, Netherlands, Denmark, Latvia, Germany, Spain, Finland and the rest of the world.

9.2 Foreign roamers per county (fylke) in Norway

9.2 Foreign roamers per county (fylke) in Norway



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	1.511	2.242	2.422	2.428	2.605	3.246	Until March 14
R1s	0.437	0.566	0.596	0.596	0.627	0.733	From 15 March to 19 April
R2s	0.01	0.52	0.693	0.68	0.843	1.461	From 20 April to 10 May
R3s	0.008	0.483	0.702	0.702	0.921	1.496	From 11 May to 30 June
R4s	0.003	0.497	0.762	0.764	0.997	1.733	From 01 July to 31 July
R5s	0.244	0.937	1.071	1.049	1.186	1.534	From 01 August to 31 August
R6s	0.474	0.826	0.923	0.93	1.026	1.46	From 01 September to 30 September
R7s	0.714	1.117	1.221	1.219	1.322	1.715	From 01 October to 25 October
R8s	0.5	0.931	1.081	1.087	1.24	1.856	From 26 October to 04 November
R9s	0.712	0.856	0.9	0.899	0.944	1.085	From 05 November to 30 November
R10s	0.852	0.967	0.999	0.997	1.029	1.135	From 01 December to 03 January
R11s	0.47	0.629	0.686	0.685	0.735	0.941	From 04 January to 21 January
R12s	0.416	0.685	0.763	0.764	0.839	1.152	From 22 January to 07 February
R13s	1.143	1.34	1.405	1.404	1.47	1.685	From 08 February to 01 March
R14s	0.939	1.064	1.103	1.103	1.141	1.268	From 02 March to 24 March
R15s	0.586	0.763	0.813	0.812	0.863	0.993	From 25 March to 12 April
R16s	0.63	0.799	0.844	0.843	0.891	1.09	From 13 April to 05 May
R17s	0.604	0.865	0.948	0.944	1.018	1.298	From 06 May to 26 May
R18s	0.409	0.743	0.815	0.816	0.892	1.151	From 27 May to 20 June
R19s	0.545	0.818	0.886	0.883	0.954	1.191	From 21 June to 04 August
R20s	0.898	1.073	1.134	1.139	1.2	1.458	From 05 August to 31 August
R21s	0.612	0.737	0.797	0.794	0.849	0.985	From 01 September to 24 September
R22s	1.033	1.083	1.098	1.099	1.116	1.155	From 25 September to 12 December
R23s	0.649	0.841	0.899	0.909	0.976	1.158	From 13 December

Table 15: Assumptions

Assumptions	Mean	Distribution	Reference
Mobile Mobility Data			
Telenor coverage	48%		https://ekomstatistikken.nkom.no/
Data updated	January 9th		
Data used in the predictions	January 9th	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:			Salje 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%	Fixed	
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			
From Sunday	32%	Fixed	Estimated from "Beredskapsregistret BeredtC19"
From Saturday	49%		
From Friday	68%		
From Thursday	86%		
Probability that an admission has been reported			
From one day before	53%	Fixed	Estimated from "Beredskapsregistret BeredtC19"
From two days before	77%		
From three days before	82%		
From four days before	91%		
Probability that a positive laboratory test has been reported			
From one day before	6.7%	Fixed	Estimated from MSIS
From two days before	59%		
From three days before	90%		
From four days before	97%		
Probability that a negative laboratory test has been reported			
From one day before	16%	Fixed	Estimated from MSIS
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	1.32(1.3 - 1.34)
Oslo	1.37(1.34 - 1.4)
Rogaland	1.27(1.23 - 1.32)
Møre og Romsdal	1.31(1.22 - 1.4)
Nordland	1.31(1.21 - 1.42)
Viken	1.26(1.24 - 1.29)
Innlandet	1.43(1.36 - 1.51)
Vestfold og Telemark	1.22(1.17 - 1.28)
Agder	1.09(1.04 - 1.14)
Vestland	1.21(1.16 - 1.26)
Trøndelag	1.51(1.44 - 1.57)
Troms og Finnmark	1.39(1.3 - 1.49)

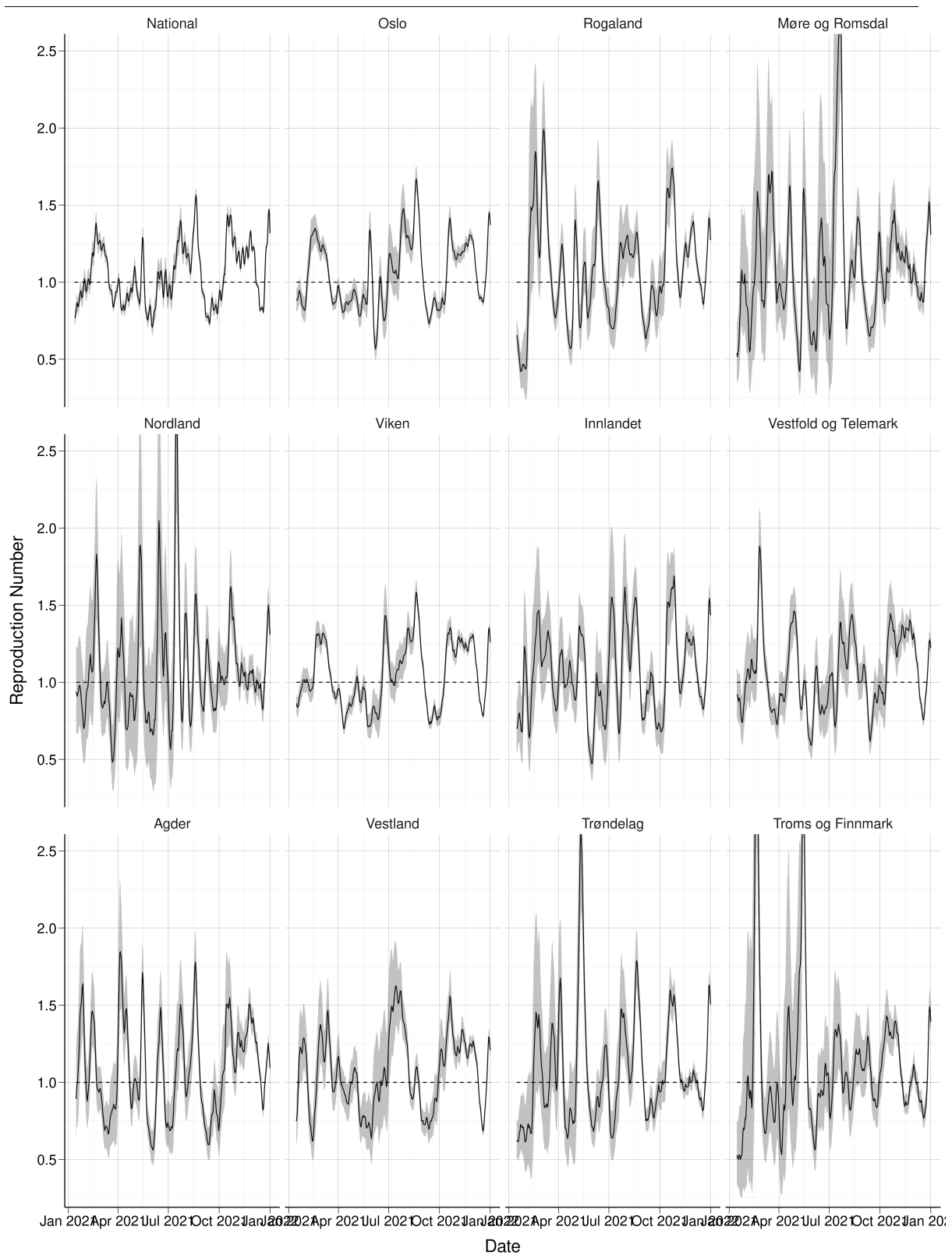


Figure 23: Reproduction number estimated using the R package EpiEstim.

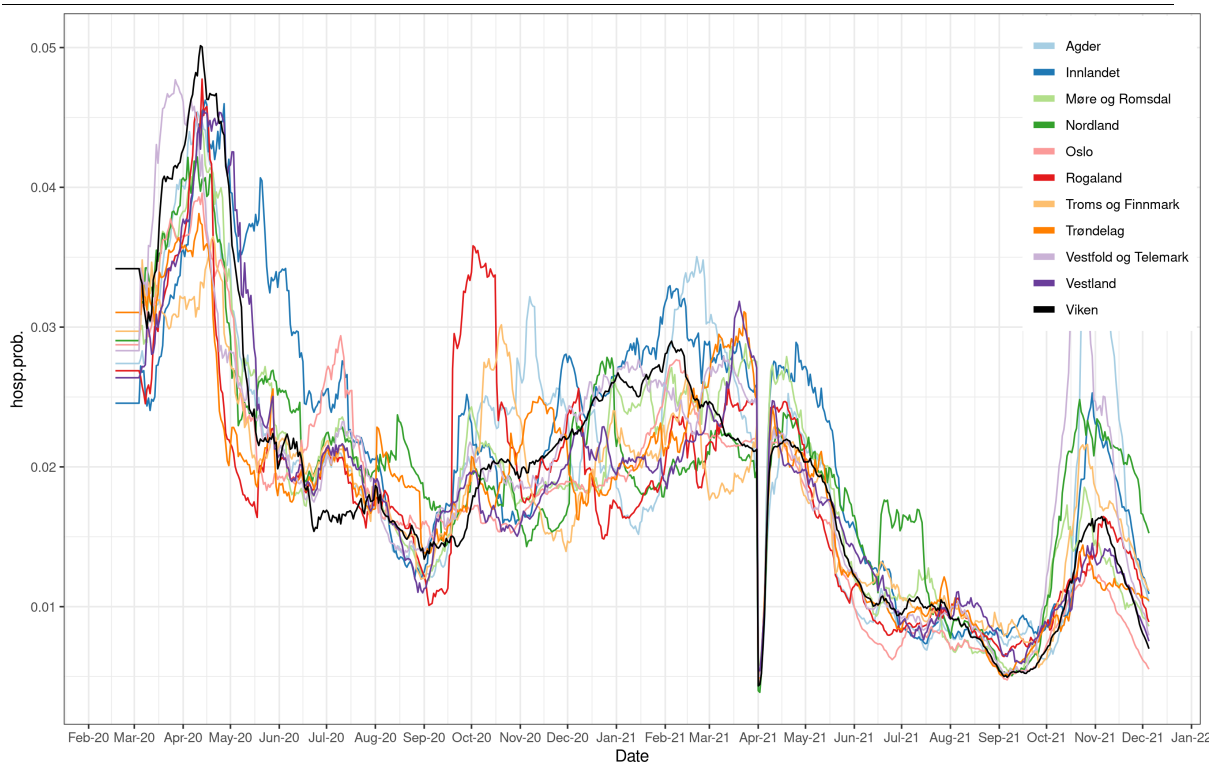


Figure 24: Regional hospitalisation probabilities per infection. The estimates are based on Salje et al., and regional data on the age distribution in the test data and the empirical case-hospitalisation rates.

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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