NIPH
Norwegian Institute of Public Health

Situational awareness and forecasting for Norway

FHI COVID-19 modelling team

Week 46, 17 November 2021

Main results:

- **National epidemiological situation:**

  The most recent reproduction numbers:

Model	Median	5%	95%	Prob>1	period/day	More info
Changepoint	1.29	1.29	1.14	1.55	Since 25 Oct	Table 1
SMC	1.01	0.79	1.26	0.47	7 Nov	Fig. 3
EpiEstim	1.1	1.07	1.13		10 Nov	Table 17, Fig. 27

  The cumulative incidence since the start of the epidemic can be found in Table 2 together with an estimate of the fraction of infections that have been reported.

- **National forecasting:**

  One-week-ahead national forecasts from changepoint model:

Indicator	Median/Mean 95% PI	day	Info 2-3 weeks forecasts
Prevalence	23388/23016 (14725-33606)	21 Nov	Table 3
Daily incidence	5694/5570 (3446-8365)	21 Nov	Table 3
Hospital beds	388/385 (287-507)	21 Nov	Table 3
Ventilator beds	43/43 (29-60)	21 Nov	Table 3

  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
Changepoint	1.39	1.27	1.55	1.00	Since 14 Oct	Table 5
SMC	1.38	0.87	2.12	0.88	7 Nov	Fig. 12
EpiEstim	1.13	1.08	1.18		10 Nov	Table 17, Fig. 27

- **Telenor mobility data and the number of foreign visitors:** The most recent mobility development is found in Figures 21 and 22 for the largest municipality in each county and for each county, respectively. Figure 23 shows the total number of roamers per day per county.

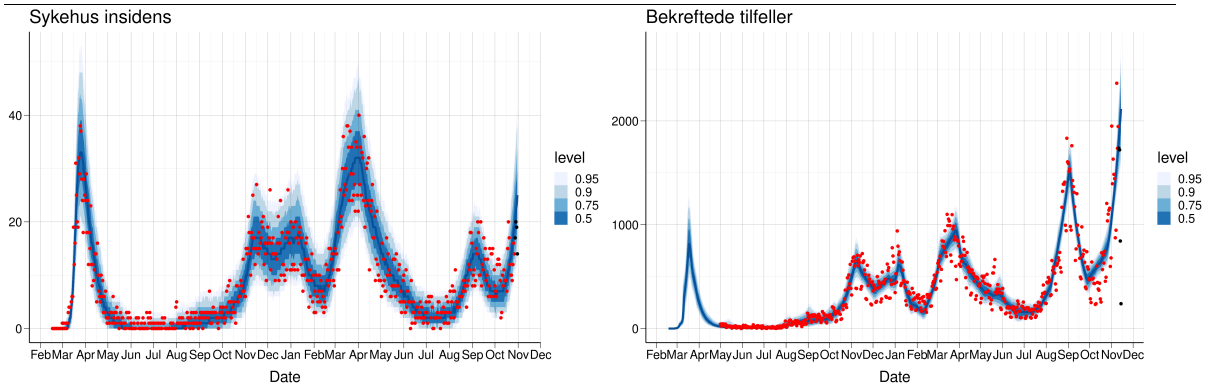
1 Estimated national reproduction numbers

Calibration of our national changepoint model to hospitalisation incidence data and test data leads to the following estimates provided in table 1. Figure 1 shows the estimated daily number of COVID-19 patients admitted to hospital (1a) and the estimated daily number of laboratory-confirmed SARS-CoV-2 cases (1b), 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
2.57/2.56(1.94-3.16)	From Feb 17 to Mar 14
0.54/0.54(0.42-0.67)	From Mar 15 to Apr 19
0.64/0.65(0.07-1.27)	From Apr 20 to May 10
0.68/0.67(0.08-1.24)	From May 11 to Jun 30
0.91/0.89(0.08-1.63)	From Jul 01 to Jul 31
0.94/0.93(0.39-1.33)	From Aug 01 to Aug 31
0.96/0.97(0.58-1.33)	From Sep 01 to Sep 30
1.13/1.14(0.87-1.44)	From Oct 01 to Oct 25
1.22/1.24(0.89-1.68)	From Oct 26 to Nov 04
0.87/0.87(0.75-0.97)	From Nov 05 to Nov 30
1.02/1.02(0.93-1.12)	From Dec 01 to Jan 03
0.65/0.65(0.46-0.85)	From Jan 04 to Jan 21
0.81/0.82(0.56-1.1)	From Jan 22 to Feb 07
1.34/1.35(1.14-1.57)	From Feb 08 to Mar 01
1.06/1.06(0.95-1.15)	From Mar 02 to Mar 24
0.84/0.84(0.72-0.94)	From Mar 25 to Apr 12
0.86/0.86(0.73-0.99)	From Apr 13 to May 05
0.95/0.95(0.76-1.17)	From May 06 to May 26
0.83/0.82(0.58-1.03)	From May 27 to Jun 20
0.95/0.95(0.76-1.1)	From Jun 21 to Aug 04
1.19/1.2(1.08-1.32)	From Aug 05 to Aug 31
0.74/0.74(0.66-0.82)	From Sep 01 to Sep 24
1.08/1.08(0.99-1.19)	From Sep 25 to Oct 24
1.29/1.29(1.14-1.44)	From Oct 25

Median/Mean (95% credible intervals)



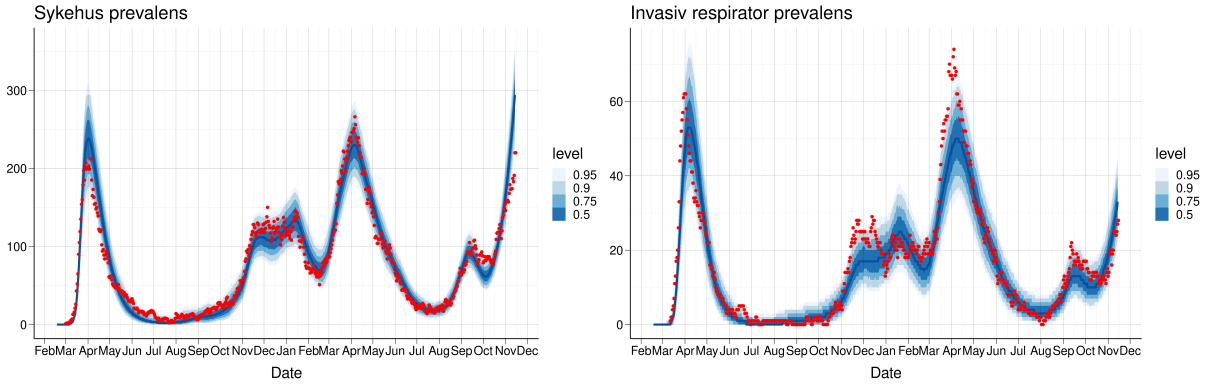
(a) Hospital admissions

(b) Test data

Figure 1: A comparison of true data (red) and predicted values (blue) for hospital admissions and test data. The last four data points (black) are assumed to be affected by reporting delay. B) Comparison of our simulated number of positive cases, with blue median and interquartile bands to the actual true number of positive cases, 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. Note that we do not capture all the uncertainty in the test data–our blue bands are quite narrow. This is likely because we calibrate our model parameters on a 7-days moving average window of test data, instead of daily. This is done to avoid overfitting to random daily variation. Moving averages over 7 days are less variable than the daily data.

1.1 National SMC-model: Estimated daily reproduction numbers

In figure 2, we show how our national model fits the national hospital prevalence data (2a) and the daily number of patients receiving ventilator treatment (2b). 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.

1.1 National SMC-model: Estimated daily reproduction numbers

Figure 3 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 $R(t)$.

1.1 National SMC-model: Estimated daily reproduction numbers

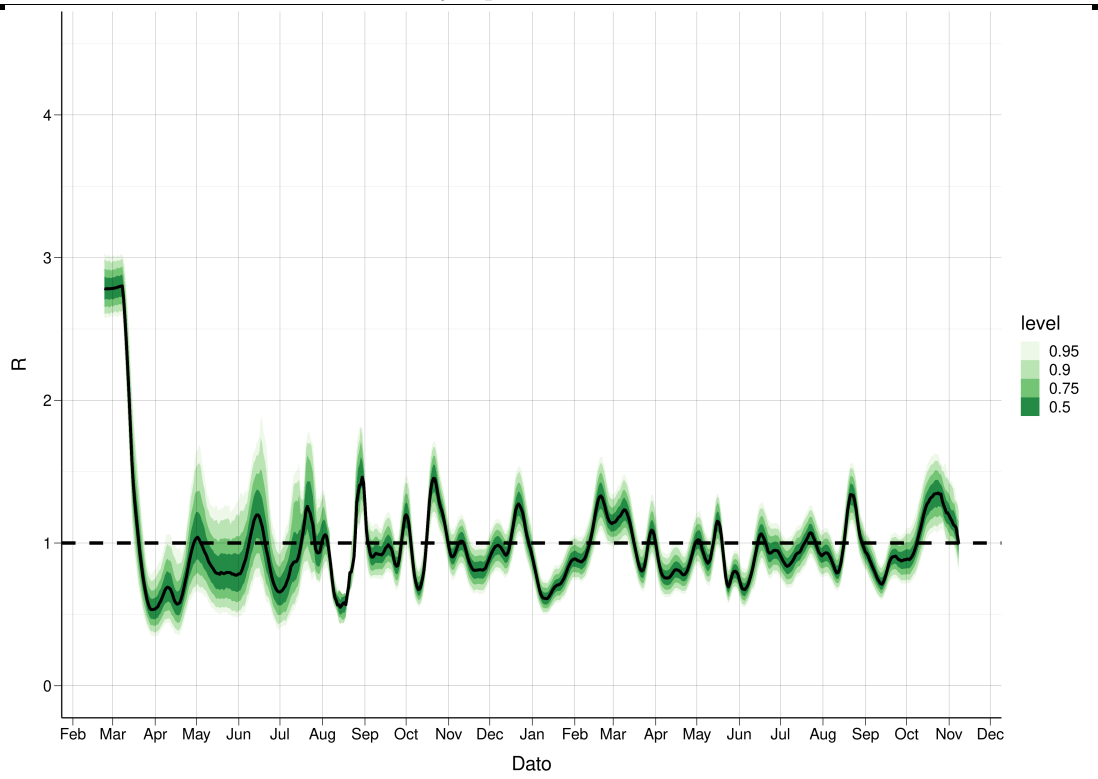


Figure 3: R(t) estimates using a Sequential Monte Carlo approach calibrated to hospitalisation incidence and test data. The large uncertainty during the last 7 days reflects the lack of available data due to the transmission delay, test delay, time between symptoms onset and hospitalisation. The green 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 estimate of cumulative (total) number of infections

The national changepoint model estimates the total number of infections and the symptomatic cases that have occurred (Table 2).
Figure 4 shows the modelled expected daily incidence (blue) and the observed daily number of laboratory-confirmed cases (red). When simulating the laboratory-confirmed cases, we also model the detection probability for the infections (both symptomatic, presymptomatic and asymptomatic).

Table 2: Estimated cumulative number of infections, 2021-11-14

Region	Total	No. confirmed	Fraction reported	Min. fraction
Norway	408662 (361986; 453221)	224290	55%	49%

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

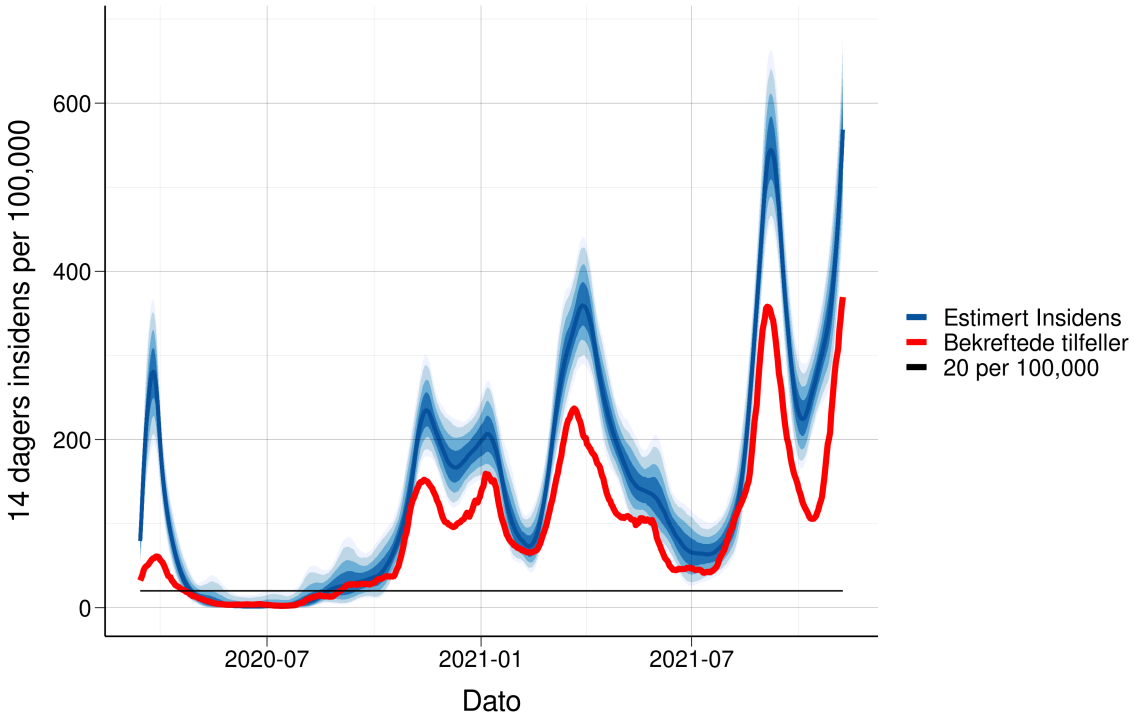


Figure 4: Number of laboratory-confirmed cases vs model-based estimated number of new infected individuals

3 National 3-week predictions: Prevalence, Incidence, Hospital beds and Ventilator beds

The national changepoint model estimates the prevalence and daily incidence of infected individuals (asymptomatic, presymptomatic and symptomatic) for the next three weeks, aggregated to the whole of Norway (table 3). In addition, the table shows projected national prevalence of hospitalised patients (hospital beds) and prevalence of patients receiving ventilator treatment (ventilator beds). The projected epidemic and healthcare burden are illustrated in figure 5.

Table 3: Estimated national prevalence, incidence, hospital beds and ventilator beds. Median/Mean (CI)

	1 week prediction (Nov 21)	2 week prediction (Nov 28)	3 week prediction (Dec 05)
Prevalence	23388/23016 (14725-33606)	32384/31347 (16971-51951)	44167/42186 (19714-75942)
Daily incidence	5694/5570 (3446-8365)	7871/7628 (4002-12806)	10707/10192 (4620-18706)
Hospital beds	388/385 (287-507)	511/505 (343-719)	692/674 (393-1083)
Ventilator beds	43/43 (29-60)	56/55 (36-79)	74/73 (43-109)

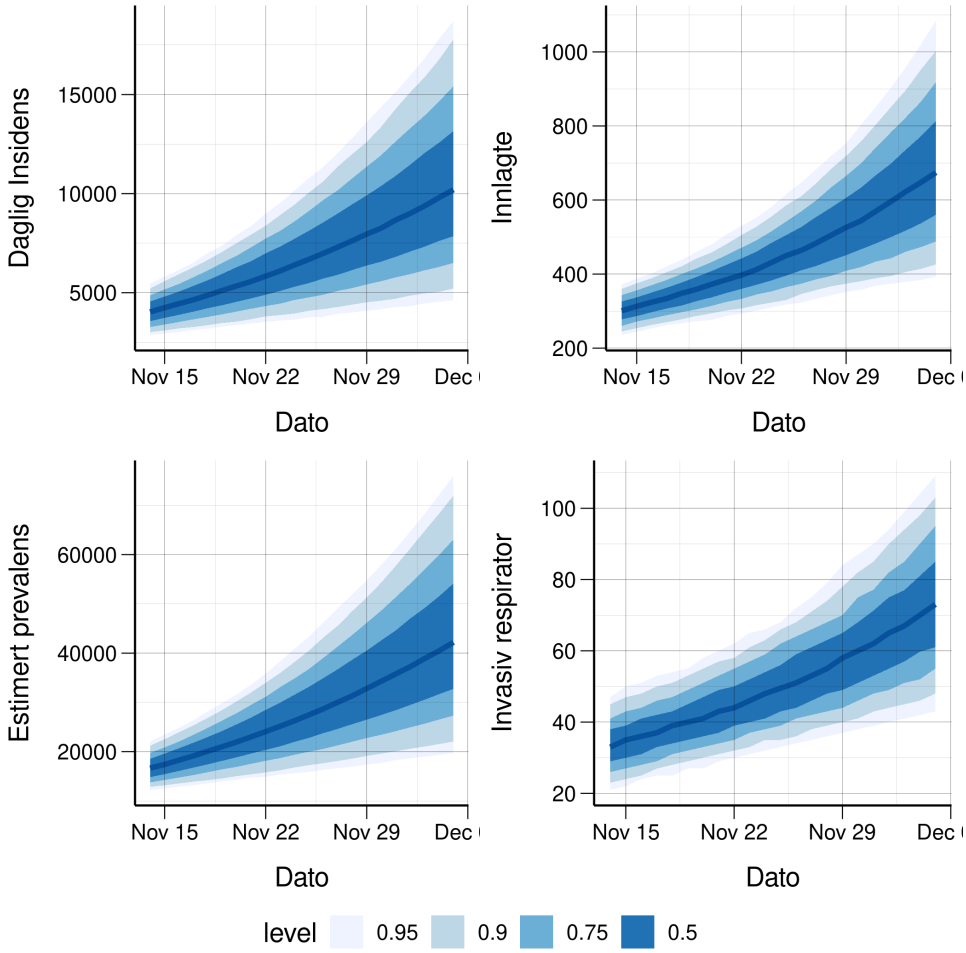


Figure 5: National 3 week predictions for incidence (top left), prevalence (bottom left), hospital beds (top right) and ventilator beds (bottom right)

3.1 Hospital and Ventilator prevalence by age

In Figures 6 and 7 we show the hospital prevalence by age group obtained from the simulations of the national model, including a 3 week forecast period. The real number of patients in each age group is also included (black dots).

In the forecast period, we assume that the age distribution of the cases in hospital and respirator beds will remain the same as today. Specific values for these projections are shown in table 4.

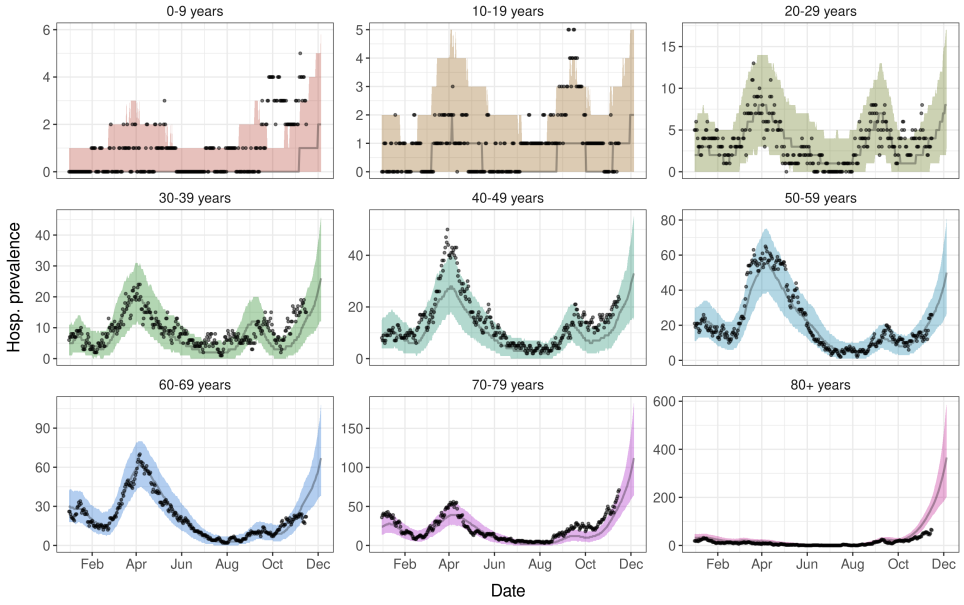


Figure 6: Simulated hospital prevalence by age group. Real data is shown as black dots

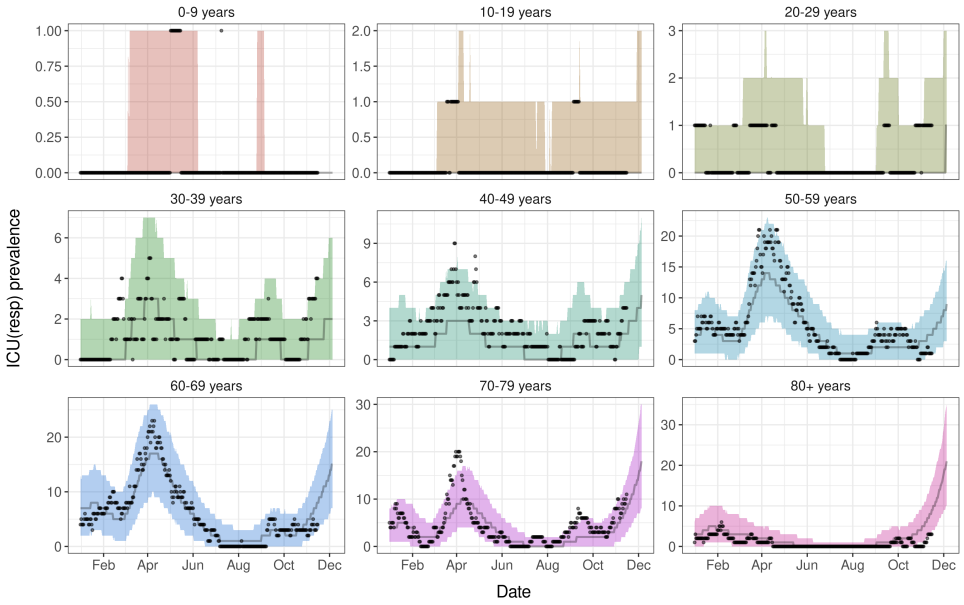


Figure 7: Simulated respirator prevalence by age group. Real data is shown as black dots

Table 4: Hospital and Respirator prevalence per age group: 3 week prediction (2021-12-05). Mean and 95 perc. CI

Age group	Hosp	Resp
0-9 years	2 (0-5)	0 (0-0)
10-19 years	2 (0-5)	0 (0-2)
20-29 years	9 (2-17)	1 (0-3)
30-39 years	27 (12-46)	3 (0-7)
40-49 years	35 (16-56)	5 (1-11)
50-59 years	52 (29-82)	9 (3-17)
60-69 years	70 (39-108)	16 (7-27)
70-79 years	116 (65-178)	18 (8-30)
+80 years	381 (207-610)	22 (10-35)

4 Estimated regional reproduction numbers

Calibration of our regional changepoint model to hospitalisation incidence data and test data leads to the following estimates for current regional reproduction numbers by county (Table 5). A full list of all regional reproduction numbers can be found at the end of the report.
Below we show the estimated daily number of COVID-19 patients admitted to hospital and the estimated daily number of laboratory-confirmed SARS-CoV-2 cases for 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 5: Estimated current regional reproduction numbers

R	Parameter	County	From	Pr(R>1)
1.39 (1.27-1.55)	R18	Oslo	2021-10-14	1
1.56 (1.23-1.87)	R17	Rogaland	2021-10-10	1
1.32 (0.84-1.79)	R16	Møre og Romsdal	2021-10-10	0.9
1.41 (0.84-1.94)	R16	Nordland	2021-10-20	0.92
1.45 (1.32-1.55)	R16	Viken	2021-10-07	1
1.11 (0.68-1.49)	R18	Innlandet	2021-10-10	0.71
0.99 (0.61-1.36)	R17	Vestfold og Telemark	2021-10-10	0.48
1.19 (0.76-1.6)	R16	Agder	2021-10-10	0.82
1.44 (1.15-1.69)	R19	Vestland	2021-10-06	1
1.59 (1.35-1.85)	R17	Trøndelag	2021-10-12	1
1.53 (1.32-1.73)	R18	Troms og Finnmark	2021-10-01	1

Mean and 95% credible intervals

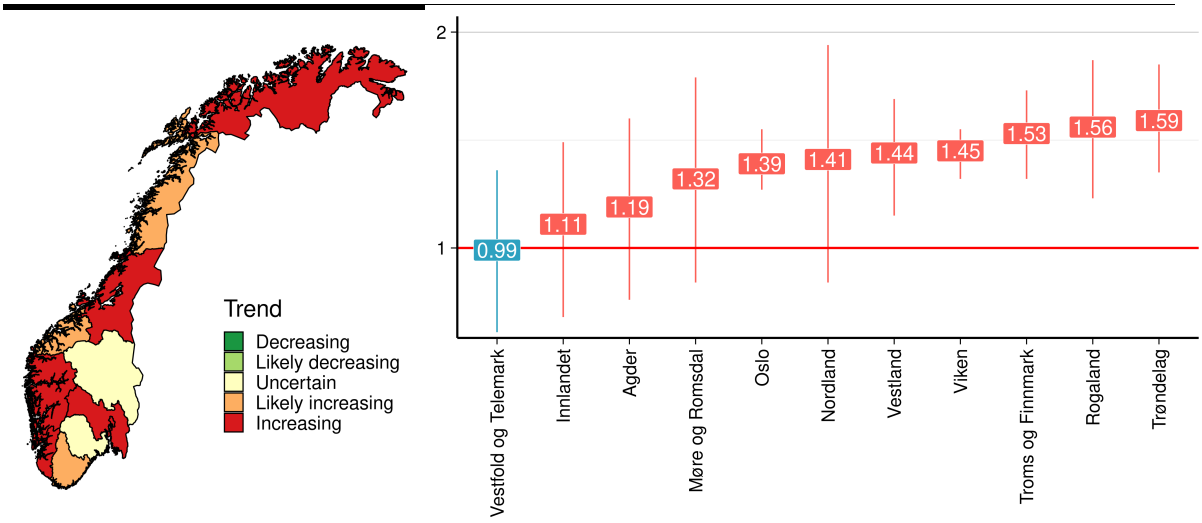
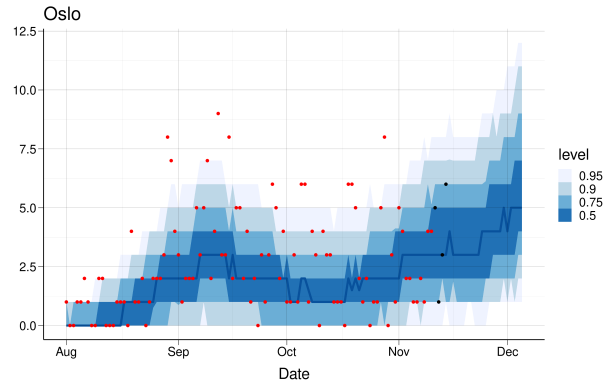
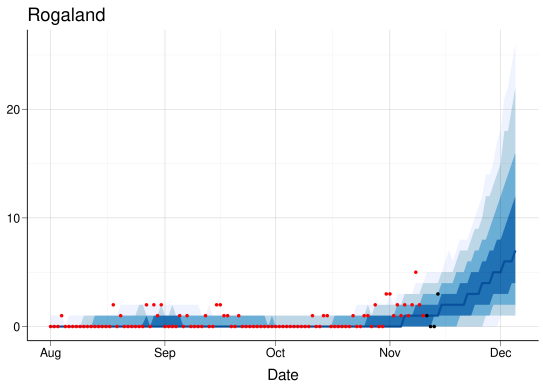
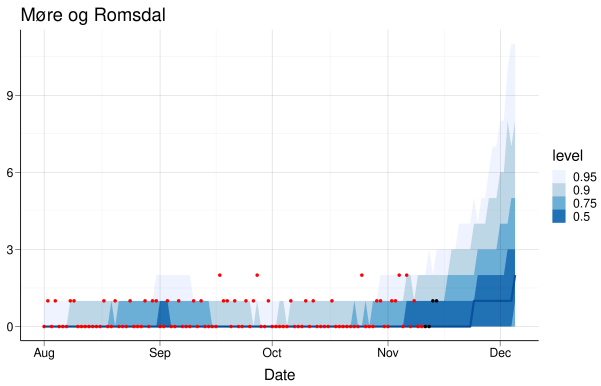


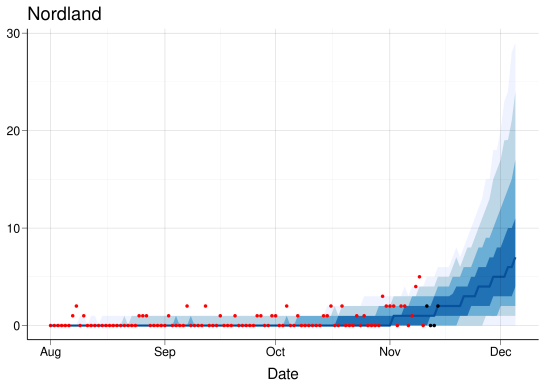
Figure 8: The map shows the direction of the trend in incidence in the counties based on the latest reproduction numbers shown in the other chart. The trend is increasing if the probability that the latest reproduction number is above one is above 95%, the trend is likely increasing if this probability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

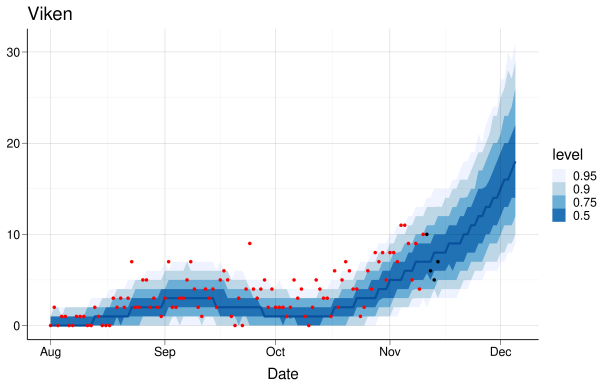
Estimated vs observed hospital incidence and 3 weeks forecast by county:

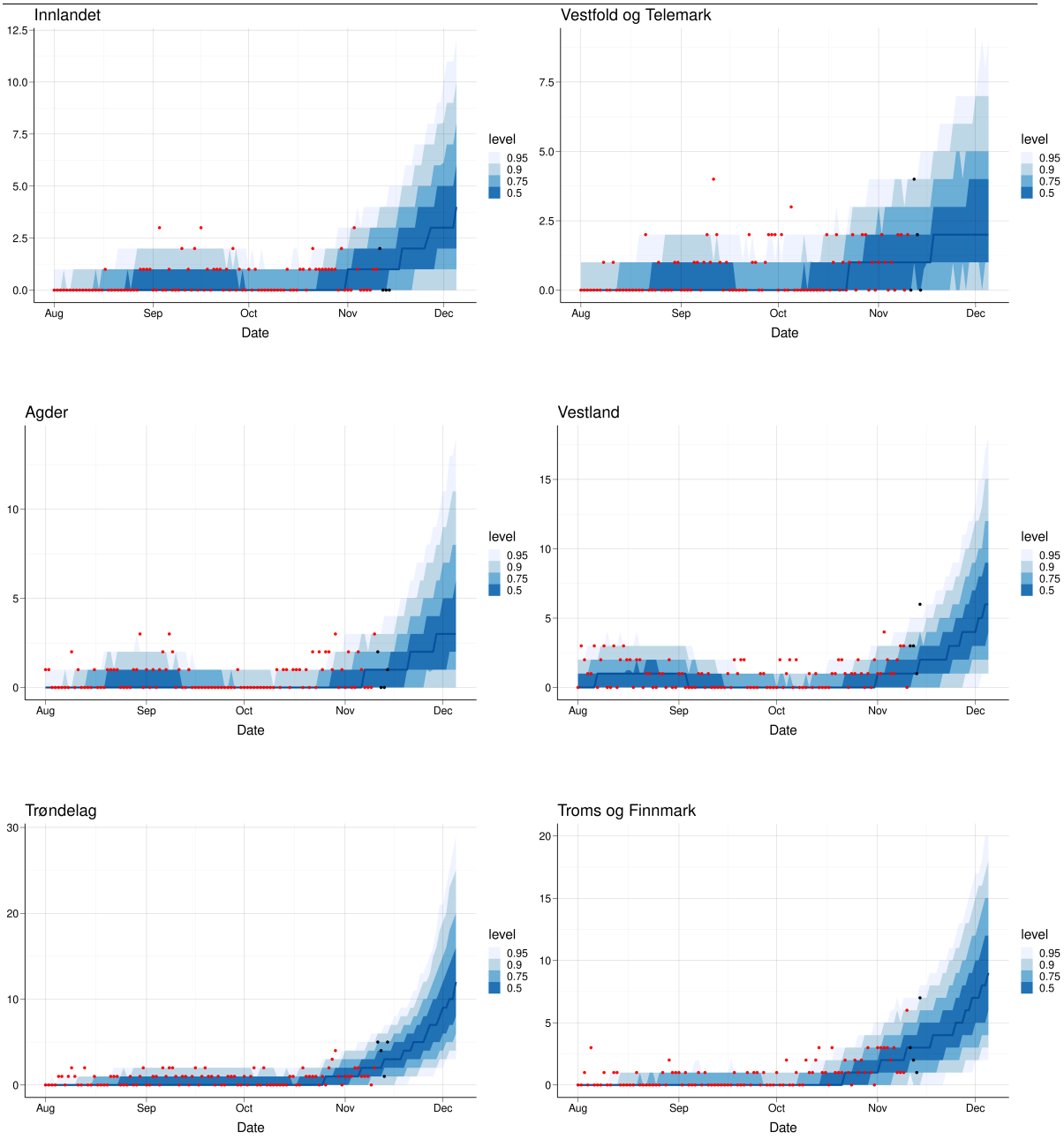











Innlandet
Vestfold og Telemark
Agder
Vestland
Trøndelag
Troms og Finnmark
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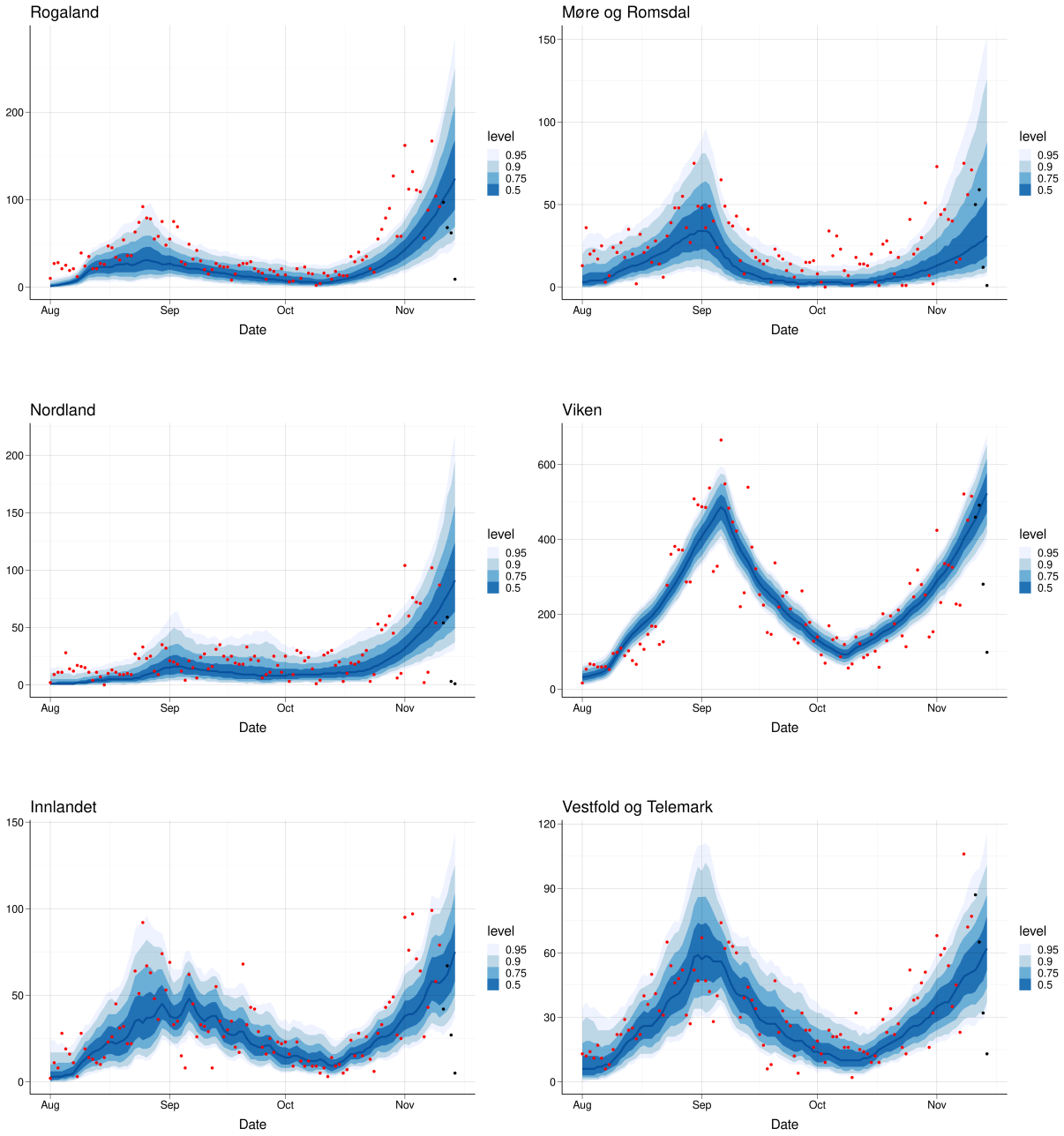
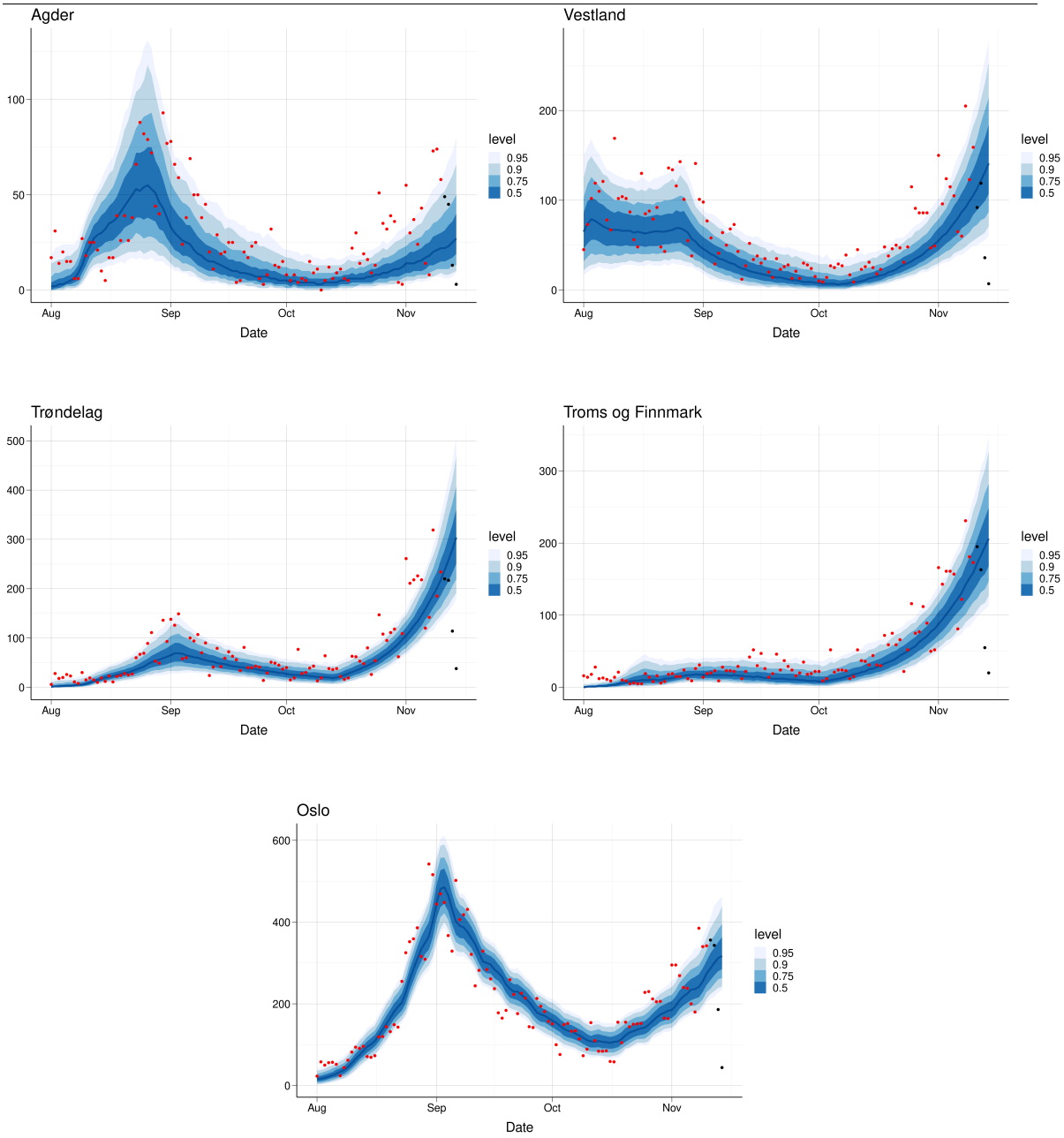
Estimated and observed lab-confirmed test data by county:




Agder
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Aug
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Date

5 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 June (2021) (table 6), daily incidence (table 7) and prevalence (table 8) for each county.

Table 6: Estimated cumulative number of infections, 2021-11-14

Region	Total	No. confirmed	Fraction reported	Min. fraction
Oslo	29734 (24572; 36345)	21537	72%	59%
Rogaland	4144 (2241; 7015)	4412	100%	63%
Møre og Romsdal	2177 (967; 4513)	2658	100%	59%
Nordland	2909 (1483; 5228)	2477	85%	47%
Viken	35176 (29203; 41632)	24377	69%	59%
Innlandet	4294 (2936; 6038)	3317	77%	55%
Vestfold og Telemark	4434 (3252; 5962)	3482	79%	58%
Agder	2799 (1446; 4870)	2921	100%	60%
Vestland	6951 (4310; 10484)	6753	97%	64%
Trøndelag	9117 (6447; 12503)	7494	82%	60%
Troms og Finnmark	5821 (3690; 8282)	4660	80%	56%

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

Table 7: Predicted incidence per day: Median/Mean (CI)

Region	1 week prediction (14 Nov)	2 weeks prediction (21 Nov)	3 weeks prediction (28 Nov)
Agder	57/70 (17-210)	79/110 (17-369)	133/198 (24-735)
Innlandet	153/184 (43-508)	213/285 (50-943)	310/452 (78-1658)
Møre og Romsdal	23/45 (6-260)	46/84 (15-448)	95/159 (30-746)
Nordland	102/111 (43-232)	140/156 (57-358)	209/236 (79-545)
Oslo	398/443 (164-967)	570/648 (229-1535)	836/961 (361-2283)
Rogaland	232/342 (46-1194)	460/776 (70-3105)	870/1619 (107-6969)
Troms og Finnmark	307/323 (128-631)	502/539 (170-1185)	774/855 (237-1944)
Trøndelag	598/649 (209-1407)	1065/1228 (306-3086)	1825/2167 (441-5979)
Vestfold og Telemark	94/111 (28-282)	97/134 (21-417)	116/179 (26-623)
Vestland	153/202 (46-646)	254/359 (78-1223)	455/653 (135-2231)
Viken	751/770 (457-1183)	1081/1115 (594-1870)	1518/1608 (770-2871)

Table 8: 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	21 Nov	28 Nov	05 Dec	low CI, 05 Dec	high CI, 05 Dec
Agder	438/483	567/678	829/1019	250	2906
Innlandet	735/798	930/1065	1391/1591	570	3882
Møre og Romsdal	319/472	538/845	958/1497	293	6223
Nordland	920/1049	1411/1774	2173/2942	439	10053
Oslo	2180/2235	2849/2947	3810/3953	2400	6131
Rogaland	1290/1430	2164/2548	3529/4351	881	12856
Troms og Finnmark	1619/1697	2477/2633	3634/3877	1485	7596
Trøndelag	2879/3037	4763/5200	7477/8362	2980	17675
Vestfold og Telemark	667/715	673/771	743/912	227	2650
Vestland	1367/1498	2153/2447	3390/3955	1125	9579
Viken	4594/4620	6456/6516	8991/9094	5360	13266

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

Below is shown the estimated short-term forecasting of expected hospital prevalence (table 9) and patients on ventilator treatment for each county (table 10).

Table 9: Number of hospitalisation beds occupied by Covid-19 patients: Median/Mean (CI)

Region	1 week prediction (21 Nov)	2 weeks prediction (28 Nov)	3 weeks prediction (05 Dec)
Agder	9/10 (2-24)	14/16 (4-42)	21/25 (5-67)
Innlandet	13/14 (4-29)	18/20 (5-41)	25/27 (7-63)
Møre og Romsdal	3/5 (0-17)	5/7 (0-27)	9/13 (1-51)
Nordland	16/17 (4-39)	24/28 (7-71)	38/48 (8-144)
Oslo	25/26 (12-44)	29/29 (13-49)	34/35 (17-61)
Rogaland	14/16 (4-36)	24/27 (6-66)	40/47 (9-130)
Troms og Finnmark	27/28 (10-49)	37/39 (15-72)	54/57 (21-111)
Trøndelag	26/26 (12-46)	40/42 (17-78)	65/70 (26-142)
Vestfold og Telemark	14/14 (4-28)	16/18 (5-37)	20/21 (5-50)
Vestland	14/15 (4-33)	22/24 (7-53)	35/39 (10-91)
Viken	67/68 (43-100)	87/89 (56-128)	118/120 (71-181)

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

Region	1 week prediction (21 Nov)	2 weeks prediction (28 Nov)	3 weeks prediction (05 Dec)
Agder	1/1 (0-3)	1/2 (0-6)	2/3 (0-8)
Innlandet	1/2 (0-5)	2/2 (0-6)	3/3 (0-8)
Møre og Romsdal	0/0 (0-3)	0/1 (0-3)	1/1 (0-6)
Nordland	2/2 (0-5)	2/3 (0-8)	4/5 (0-13)
Oslo	3/3 (0-8)	4/4 (0-8)	4/4 (1-10)
Rogaland	1/1 (0-5)	2/3 (0-7)	4/5 (0-13)
Troms og Finnmark	3/3 (0-7)	4/4 (1-10)	6/6 (1-14)
Trøndelag	3/3 (0-7)	4/4 (1-10)	7/7 (1-15)
Vestfold og Telemark	2/2 (0-5)	2/2 (0-6)	3/3 (0-7)
Vestland	1/2 (0-5)	2/3 (0-7)	4/4 (0-11)
Viken	8/8 (3-15)	10/11 (5-18)	14/14 (7-25)

7 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 11 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.

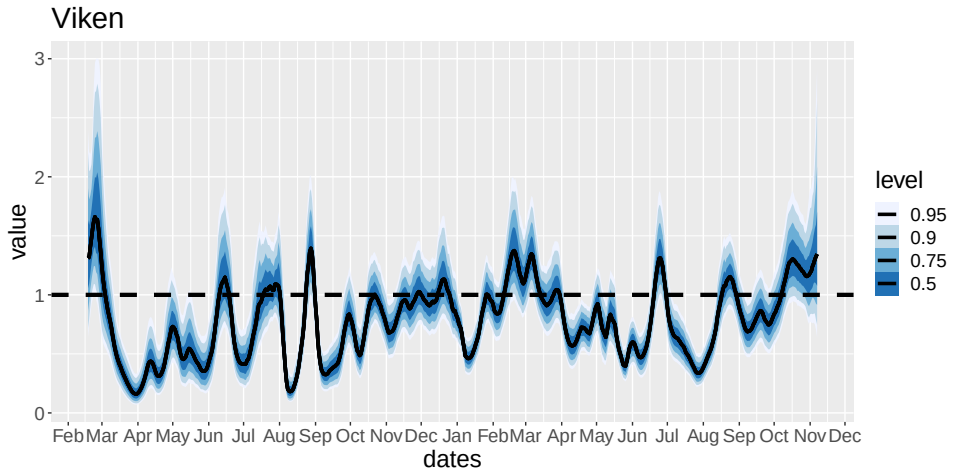
Table 11: Trend analysis for the last 14 days

	Average daily increase last 14 days		Doubling Time (days)	
County	Hospitalisations	Cases	Hospitalisations	Cases
Agder	Not enough data	1.3 (-6.2, 9.4) %	Not enough data	54.2 (-10.8, 7.7)
Innlandet	Not enough data	-5.5 (-9.9, -0.9) %	Not enough data	-12.2 (-6.6, -72.8)
Møre og Romsdal	Not enough data	-7.3 (-11.6, -2.7) %	Not enough data	-9.2 (-5.6, -24.9)
Nordland	Not enough data	-1.7 (-5.1, 1.8) %	Not enough data	-40.5 (-13.2, 38.5)
Norge	-3.5 (-8.1, 1.4) %	-2.6 (-4.3, -0.9) %	-19.7 (-8.2, 50.4)	-26.4 (-15.9, -78.1)
Oslo	-10 (-18.3, -1.4) %	-3.6 (-5.8, -1.4) %	-6.6 (-3.4, -48.2)	-18.8 (-11.6, -48.8)
Rogaland	Not enough data	-4.3 (-7.9, -0.7) %	Not enough data	-15.7 (-8.5, -99.2)
Troms og Finnmark	8 (-10.4, 32.9) %	2.4 (-1.7, 6.6) %	9 (-6.3, 2.4)	29.6 (-40.2, 10.8)
Trøndelag	Not enough data	-2.5 (-6.7, 1.9) %	Not enough data	-27.7 (-10, 36.1)
Vestfold og Telemark	Not enough data	-6.3 (-10.6, -1.8) %	Not enough data	-10.7 (-6.2, -38)
Vestland	Not enough data	0.2 (-2.7, 3.2) %	Not enough data	310.3 (-25.5, 21.9)
Viken	-1.2 (-9.5, 7.9) %	-2.4 (-4.8, 0.2) %	-58.4 (-6.9, 9.2)	-29 (-14, 368.6)

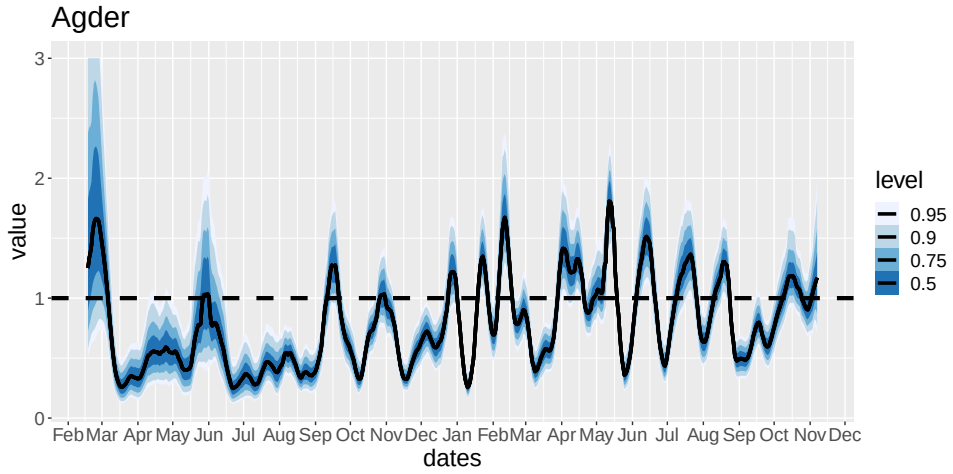
8 Regional SMC-model: Estimated daily reproduction numbers

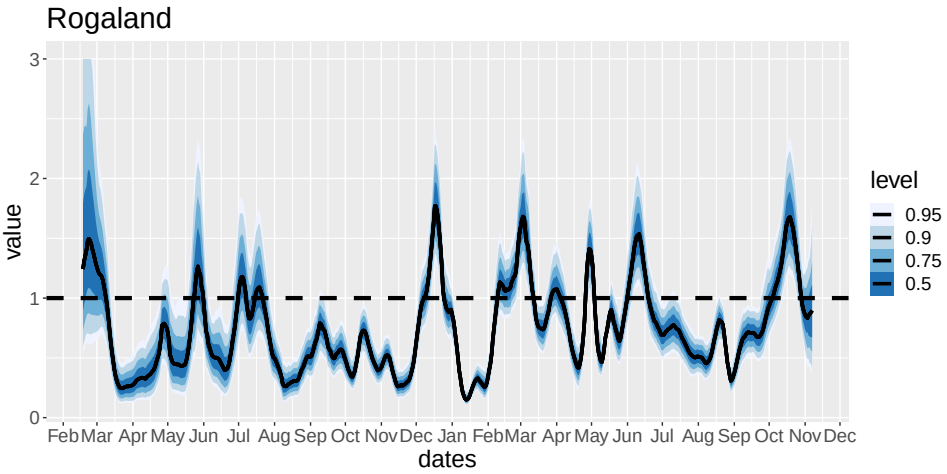
In the figures below we plot the 95% credibility interval and quantiles of the estimated posterior distribution of the regional, daily reproduction numbers. For some counties, uncertainty is large towards the most recent time, because there are very few data and possibly reporting delays which are different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

fig_Nov_17_smo/R_CAR157_rest_smoD_w150w220_B40000_Oslo_nodat.pdf



fig_Nov_17_smo/R_CAR157_rest_smoD_w150w220_B40000_Vestfold og Telemark_nodat.pdf




Rogaland
value
dates
level
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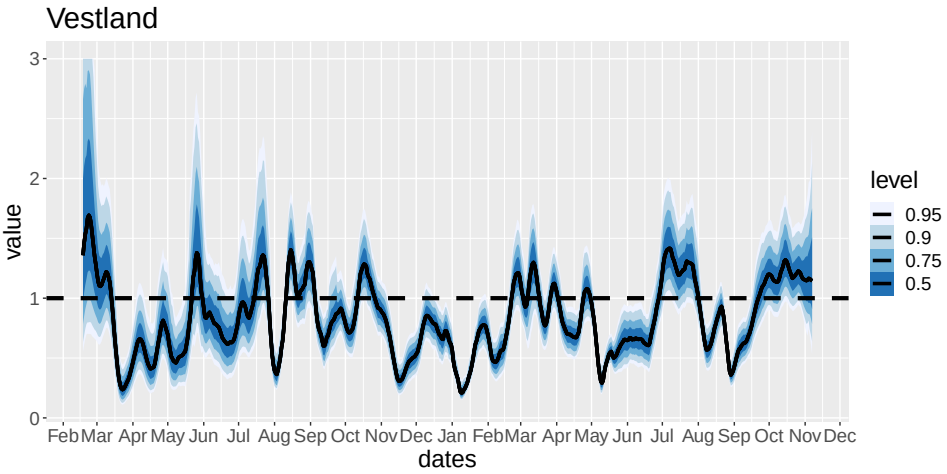
0.9
0.75
0.5
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Vestland
value
dates
level
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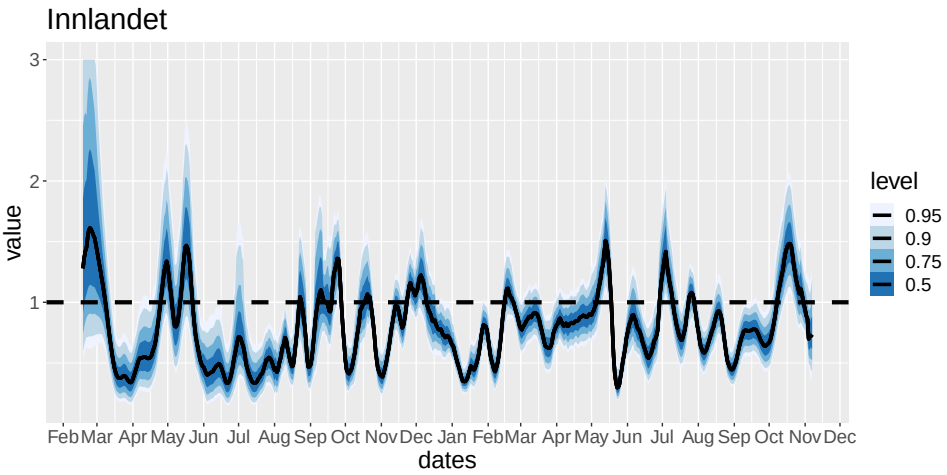
0.9
0.75
0.5
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Innlandet
value
dates
level
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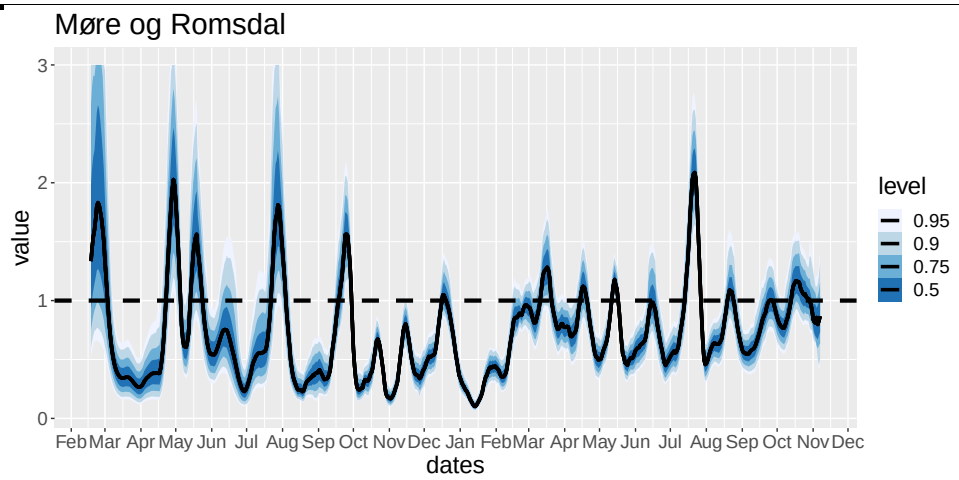
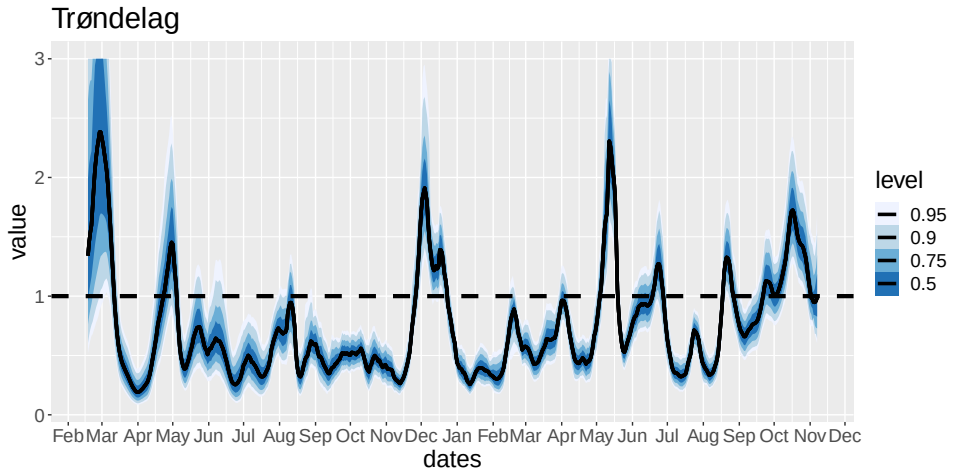
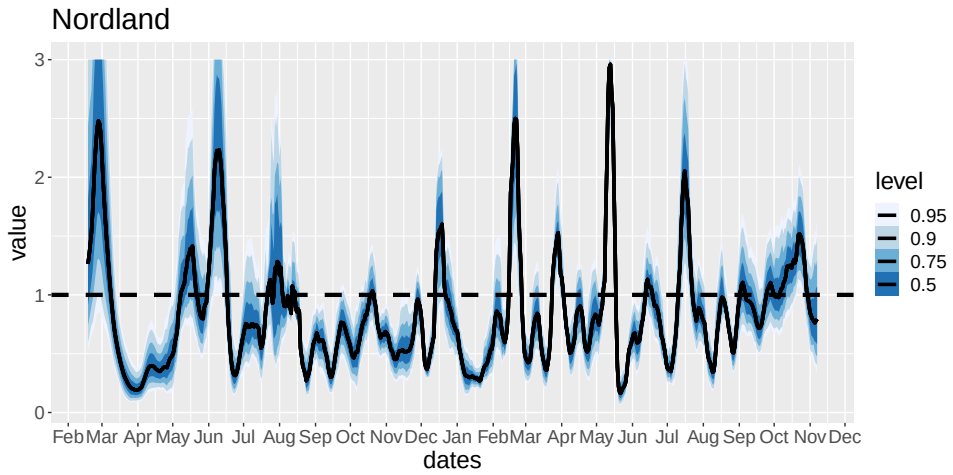
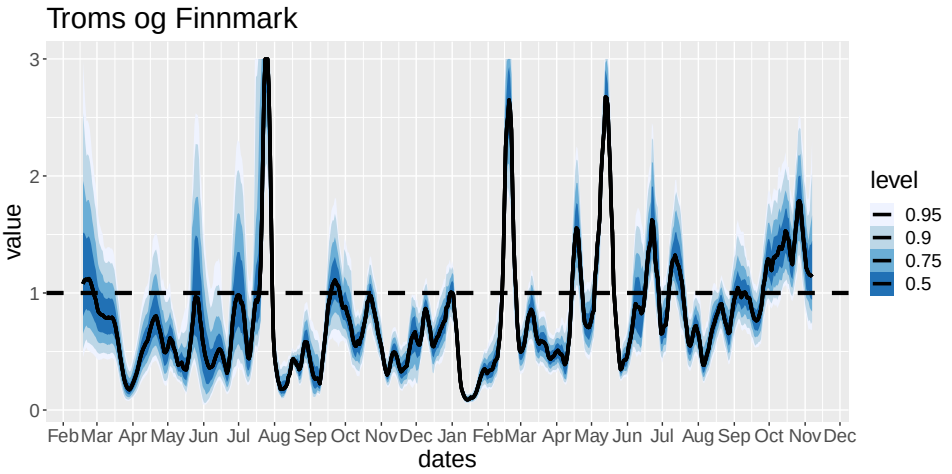
0.9
0.75
0.5
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Møre og Romsdal
value
dates
level
0.95
0.9
0.75
0.5
0
1
2
3
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Trøndelag
value
dates
level
0.95
0.9
0.75
0.5
0
1
2
3
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Nordland
value
dates
level
0.95
0.9
0.75
0.5
0
1
2
3
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Troms og Finnmark
value
3
2
1
0
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
dates
level
0.95
0.9
0.75
0.5

	Median	5%	95%	Prob>1
Oslo	1.384	0.871	2.118	0.883
Rogaland	0.817	0.434	1.240	0.240
Møre og Romsdal	0.751	0.438	1.091	0.138
Nordland	0.715	0.372	1.332	0.184
Viken	1.230	0.765	1.849	0.799
Innlandet	0.672	0.412	1.024	0.065
Vestfold og Telemark	0.970	0.580	1.390	0.471
Agder	1.062	0.765	1.499	0.609
Vestland	1.114	0.679	1.701	0.641
Trøndelag	0.910	0.635	1.249	0.298
Troms og Finnmark	1.051	0.674	1.532	0.593

Table 12: Regional estimates at Nov 7

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 19 shows an overview of the mobility since March 2020 for the largest municipalities in each county, and Figure 20 shows the total mobility out from all municipalities in each county, including Oslo. Figure 21 and 22, zooms in on mobility from August 16 2021, for municipalities and counties, respectively.

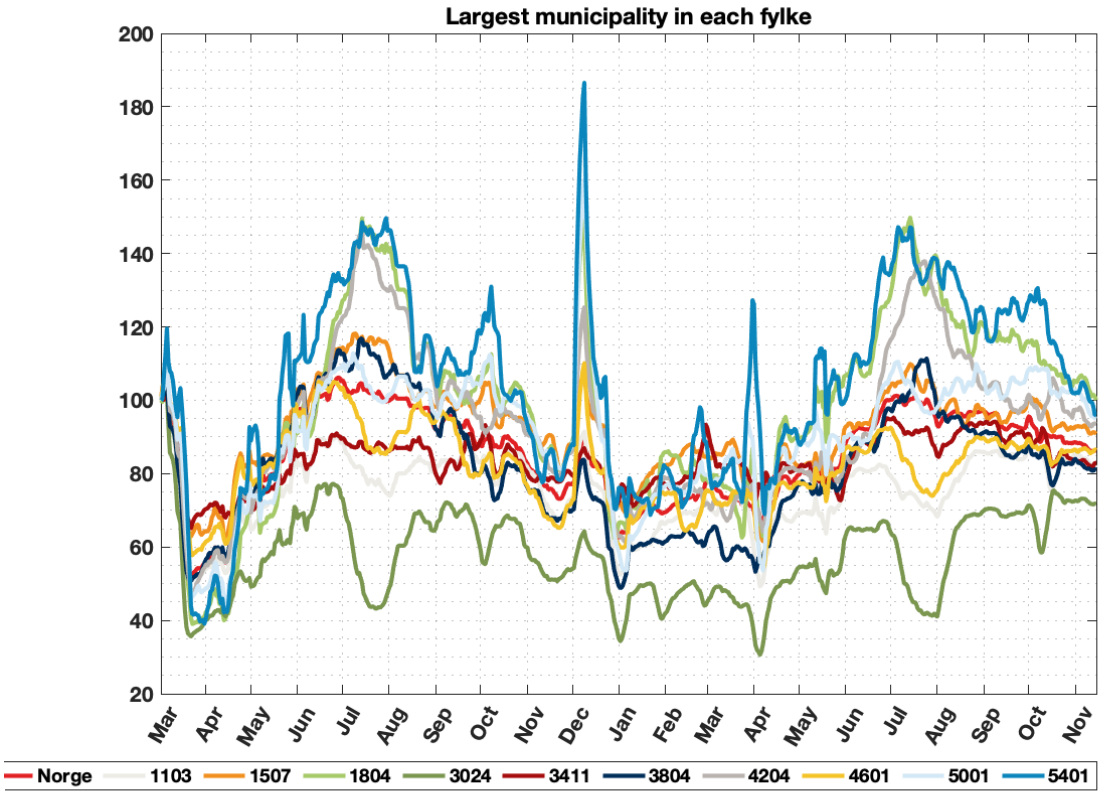


Figure 19: Mobility for selected municipalities since March 2020: Nationally (Norge), Stavanger (1103), Ålesund (1507), Bodø (1804), Bærum (3024), Ringsaker (3411), Sandefjord (3804), Kristiansand (4204), Bergen (4601), Trondheim (5001), Tromsø (5401).

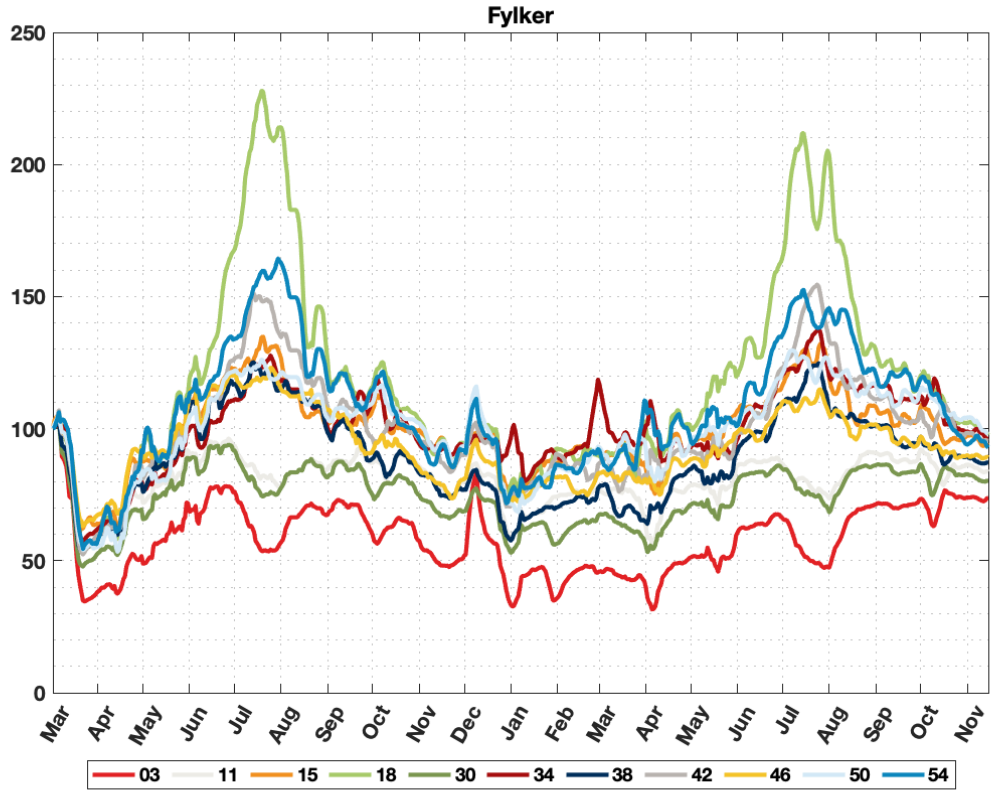


Figure 20: Mobility for fylker since March 2020: Oslo (03), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finmark (54).

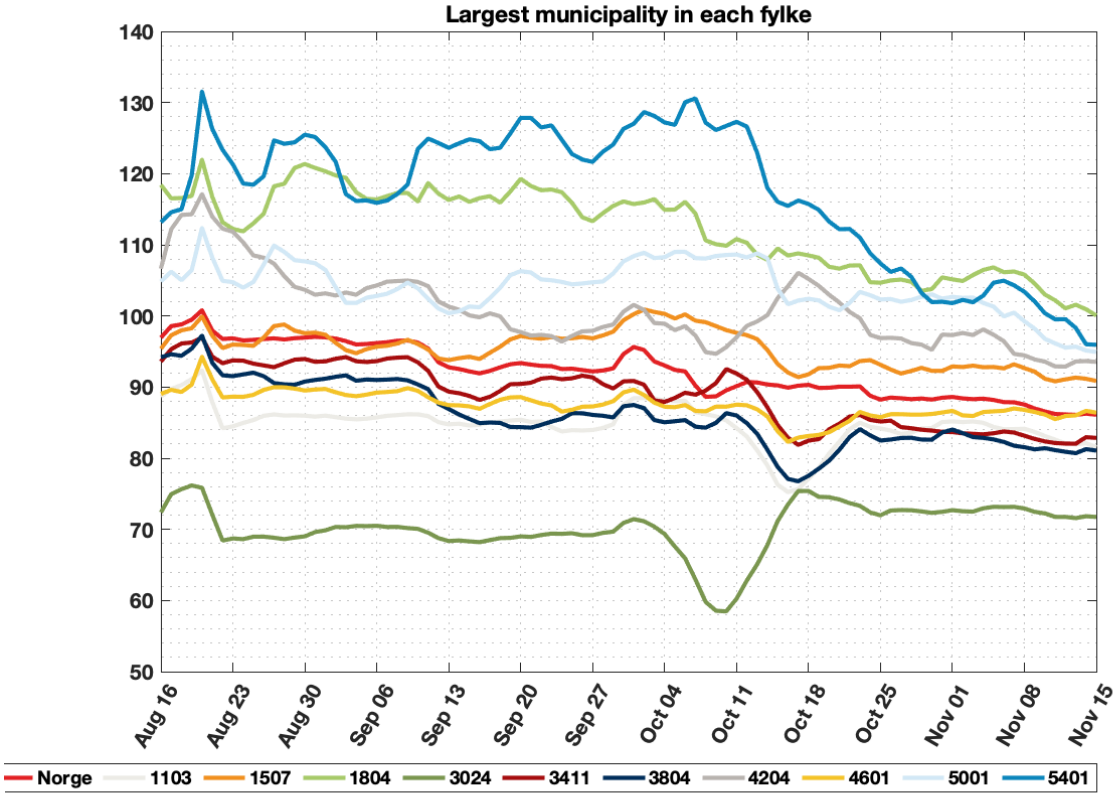


Figure 21: Zoom: Mobility from August 16, 2021 and onwards: Nationally (Norge), Stavanger (1103), Ålesund (1507), Bodø (1804), Bærum (3024), Ringsaker (3411), Sandefjord (3804), Kristiansand (4204), Bergen (4601), Trondheim (5001), Tromsø (5401).

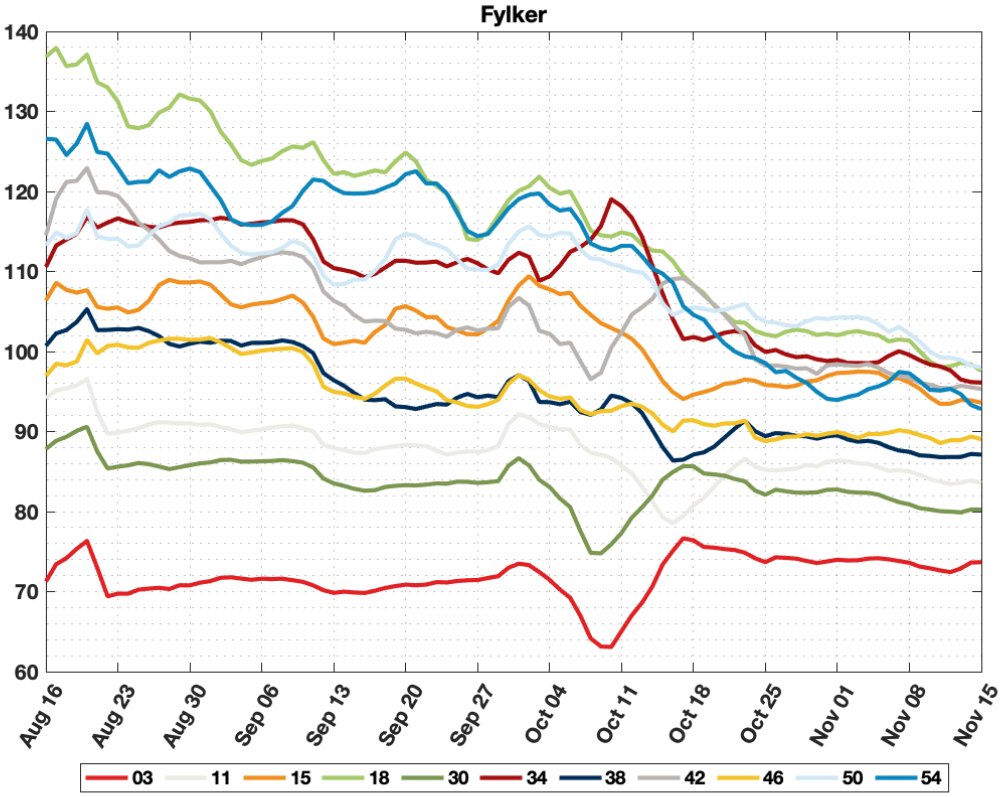


Figure 22: Zoom: Mobility from August 16, 2021 and onwards, per fylker: Oslo (03), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finnmark (54).

	43	44	45	46	47
Norge	90.3	88.2	88.6	87.5	86.1
Stavanger	77.1	84.2	85.2	84.1	81.5
Ålesund	91.8	93.1	92.9	92.7	90.9
Bodø	108.5	104.7	105.1	105.8	100.0
Bærum	75.4	72.0	72.7	72.9	71.7
Ringsaker	82.5	85.2	83.7	83.2	82.8
Sandefjord	77.5	82.5	84.0	81.5	81.1
Kristiansand	105.2	96.9	97.3	94.5	93.5
Bergen	83.1	85.8	86.7	86.8	86.4
Trondheim	102.4	102.3	102.7	99.2	94.9
Tromsø	115.7	107.4	101.8	103.4	95.9

Table 13: Municipalities

	43	44	45	46	47
Oslo	76.4	73.7	74.0	73.6	73.7
Rogaland	80.8	85.2	86.3	85.0	83.6
Møre og Romsdal	94.6	95.8	97.3	96.1	93.6
Nordland	108.3	102.1	102.0	101.4	97.6
Viken	85.7	82.1	82.8	80.9	80.2
Innlandet	101.8	99.9	98.9	99.6	96.1
Vestfold og Telemark	87.1	89.4	89.5	87.5	87.1
Agder	108.3	98.2	98.4	96.7	95.3
Vestlandet	91.4	88.8	89.9	90.0	89.0
Trøndelag	105.5	103.7	104.2	102.2	98.0
Troms og Finnmark	104.6	98.5	93.9	97.3	92.8

Table 14: Counties

Weekly mobility for Norway and selected municipalities is displayed in Table 13 and mobility for counties is displayed in Table 14. 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 23 the total number of roamers per day per county are displayed.

Figure 24 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.

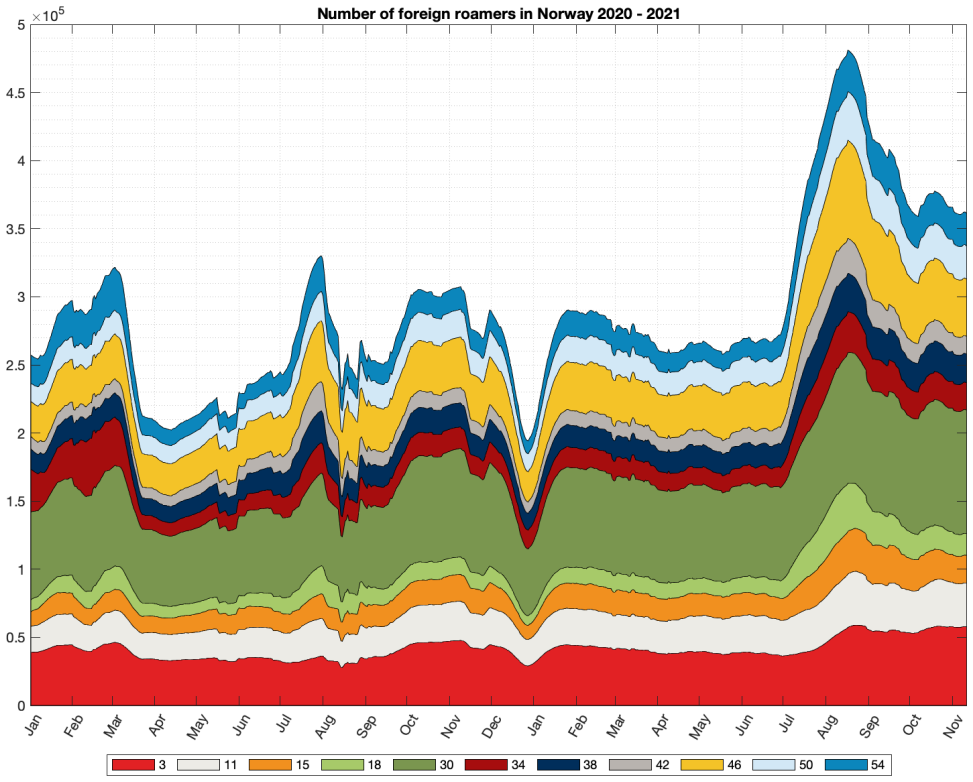


Figure 23: The total number of foreign roamers in Norway broken down on different fylker: Oslo (3), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finnmark (54).

9.1 Foreign roamers on Telenor's network in Norway

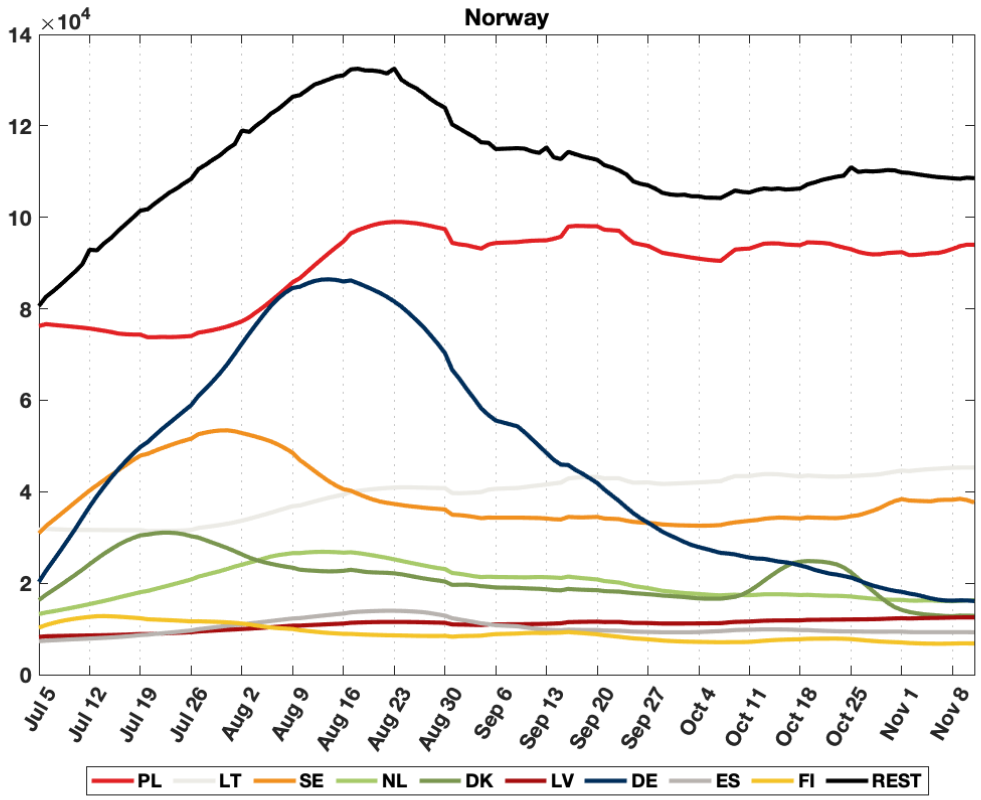
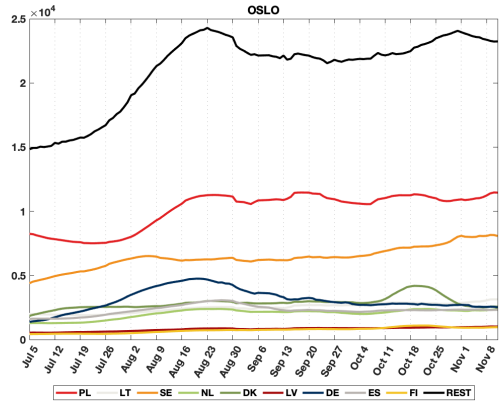
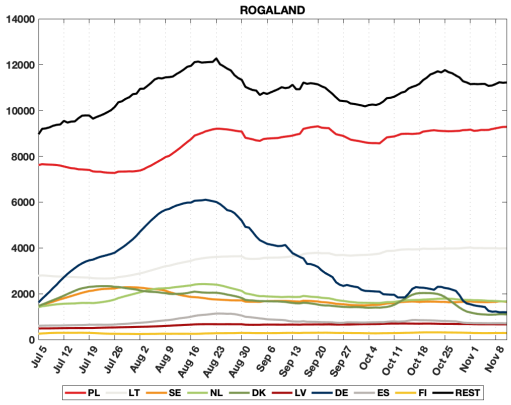
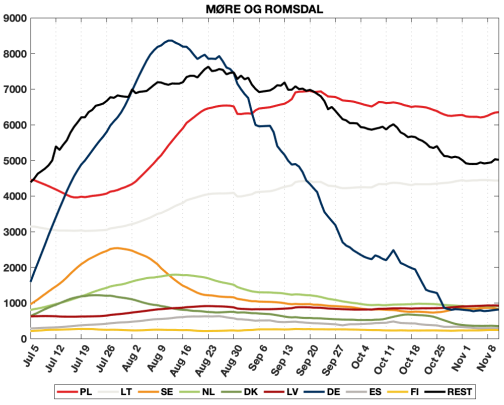


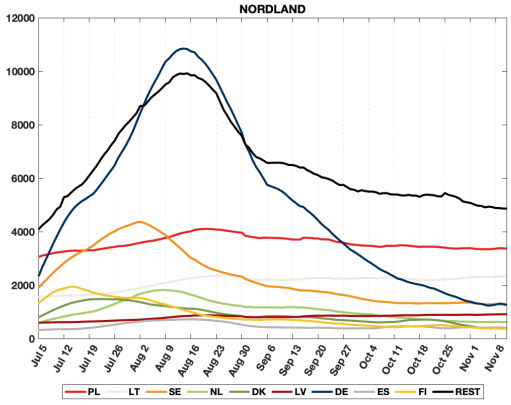
Figure 24: National overview of total number of foreign, visiting roamers from Poland, Lithuania, Sweden, Netherlands, Denmark, Latvia, Germany, Spain, Finland and the rest of the world.

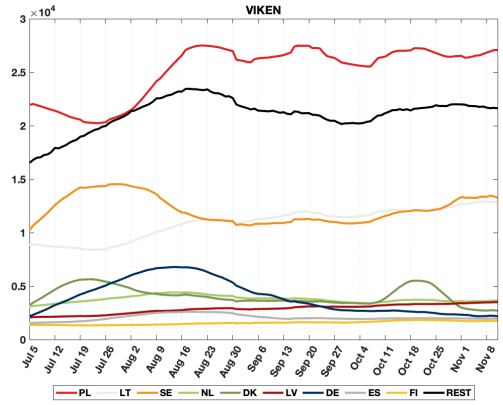
9.2 Foreign roamers per county (fylke) in Norway

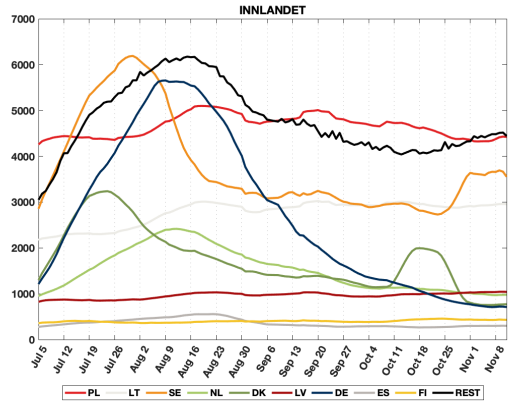




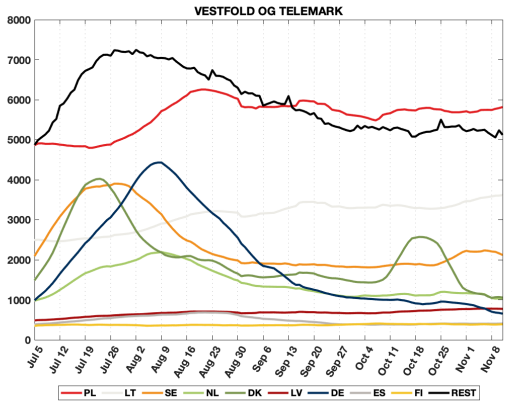


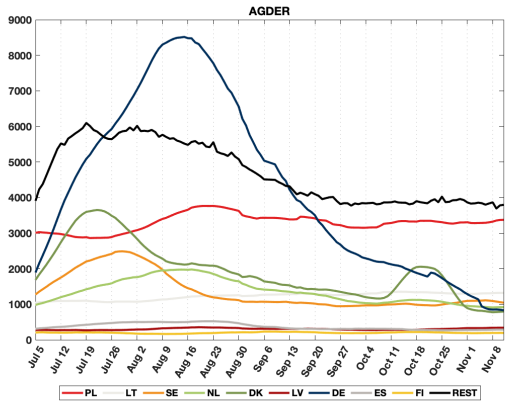


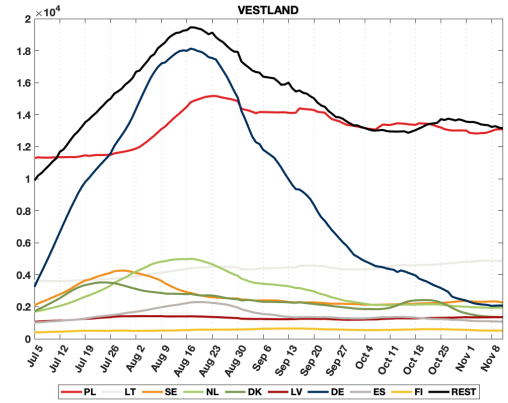


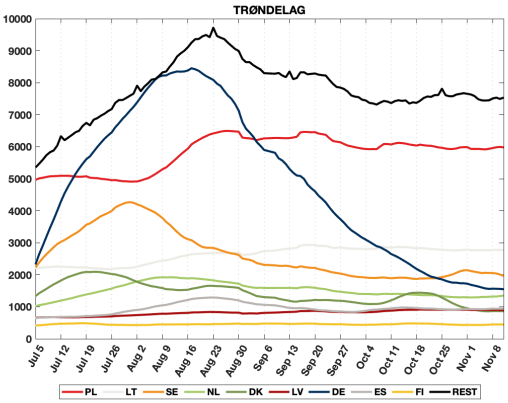


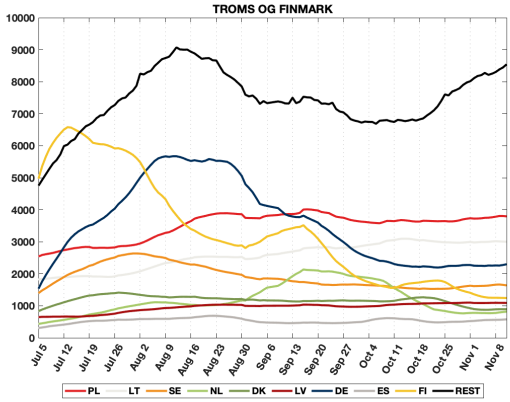
9.2 *Foreign roamers per county (fylke) in Norway*











10 Estimated parameters

Table 15: Estimated parameters

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	Period
R0s	1.673	2.348	2.573	2.565	2.778	3.47	Until March 14
R1s	0.337	0.491	0.539	0.539	0.587	0.76	From 15 March to 19 April
R2s	0.002	0.391	0.641	0.646	0.885	1.558	From 20 April to 10 May
R3s	0.001	0.44	0.678	0.672	0.908	1.517	From 11 May to 30 June
R4s	0.001	0.585	0.915	0.886	1.184	2.114	From 01 July to 31 July
R5s	0.023	0.765	0.942	0.927	1.103	1.562	From 01 August to 31 August
R6s	0.373	0.853	0.964	0.968	1.087	1.628	From 01 September to 30 September
R7s	0.62	1.033	1.125	1.137	1.242	1.652	From 01 October to 25 October
R8s	0.607	1.094	1.219	1.241	1.365	1.896	From 26 October to 04 November
R9s	0.707	0.834	0.871	0.869	0.909	1.022	From 05 November to 30 November
R10s	0.891	0.989	1.019	1.021	1.052	1.17	From 01 December to 03 January
R11s	0.343	0.581	0.653	0.655	0.731	0.942	From 04 January to 21 January
R12s	0.304	0.722	0.814	0.819	0.911	1.303	From 22 January to 07 February
R13s	1.051	1.276	1.343	1.351	1.424	1.803	From 08 February to 01 March
R14s	0.9	1.022	1.057	1.057	1.095	1.194	From 02 March to 24 March
R15s	0.638	0.802	0.841	0.838	0.877	1.025	From 25 March to 12 April
R16s	0.665	0.816	0.858	0.859	0.903	1.111	From 13 April to 05 May
R17s	0.66	0.879	0.946	0.953	1.03	1.275	From 06 May to 26 May
R18s	0.38	0.747	0.834	0.824	0.907	1.136	From 27 May to 20 June
R19s	0.699	0.891	0.946	0.945	1.005	1.187	From 21 June to 04 August
R20s	1.02	1.156	1.194	1.196	1.233	1.378	From 05 August to 31 August
R21s	0.624	0.715	0.741	0.741	0.769	0.869	From 01 September to 24 September
R22s	0.938	1.049	1.082	1.084	1.117	1.26	From 25 September to 24 October
R23s	1.034	1.239	1.295	1.292	1.346	1.506	From 25 October
AMPs	1	1.753	2.201	2.236	2.652	4.415	-
π_0	-1.269	-0.303	-0.021	-0.073	0.174	0.737	-
π_1	1.1e-08	1.6e-05	3.2e-05	4.1e-05	6.1e-05	1.5e-04	-
delays	0	1	1	1.522	2	4	-

Table 16: Assumptions

Assumptions	Mean	Distribution	Reference
Mobile Mobility Data			
Telenor coverage	48%		https://ekomstatistikken.nkom.no/
Data updated	August 29		
Data used in the predictions	August 27th	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: 0-9 years 10 - 19 years 20 - 29 years 30 - 39 years 40 - 49 years 50 - 59 years 60 - 69 years 70 - 79 years 80+ years	 0.1% 0.1% 0.5% 1.1% 1.4% 2.9% 5.8% 9.3% 22.3%	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.
Probability that an admission has been reported on Monday From Sunday From Saturday From Friday From Thursday	 32% 49% 68% 86%	Fixed	Estimated from "Beredskapsregistret BeredtC19"
Probability that an admission has been reported From one day before From two days before From three days before From four days before	 53% 77% 82% 91%	Fixed	Estimated from "Beredskapsregistret BeredtC19"
Probability that a positive laboratory test has been reported From one day before From two days before From three days before From four days before	 6.7% 59% 90% 97%	Fixed	Estimated from MSIS
Probability that a negative laboratory test has been reported From one day before From two days before From three days before From four days before	 16% 74% 92% 98%	Fixed	Estimated from MSIS

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 17: Estimated reproduction numbers 7 days ago

Location	Reff
National	1.1(1.07 - 1.13)
Oslo	1.13(1.08 - 1.18)
Rogaland	0.87(0.79 - 0.94)
Møre og Romsdal	1.11(0.98 - 1.24)
Nordland	0.93(0.83 - 1.04)
Viken	1.23(1.19 - 1.28)
Innlandet	0.9(0.8 - 1)
Vestfold og Telemark	1.2(1.08 - 1.32)
Agder	1.23(1.09 - 1.38)
Vestland	1.11(1.03 - 1.2)
Trøndelag	0.99(0.94 - 1.05)
Troms og Finnmark	1.06(0.99 - 1.13)

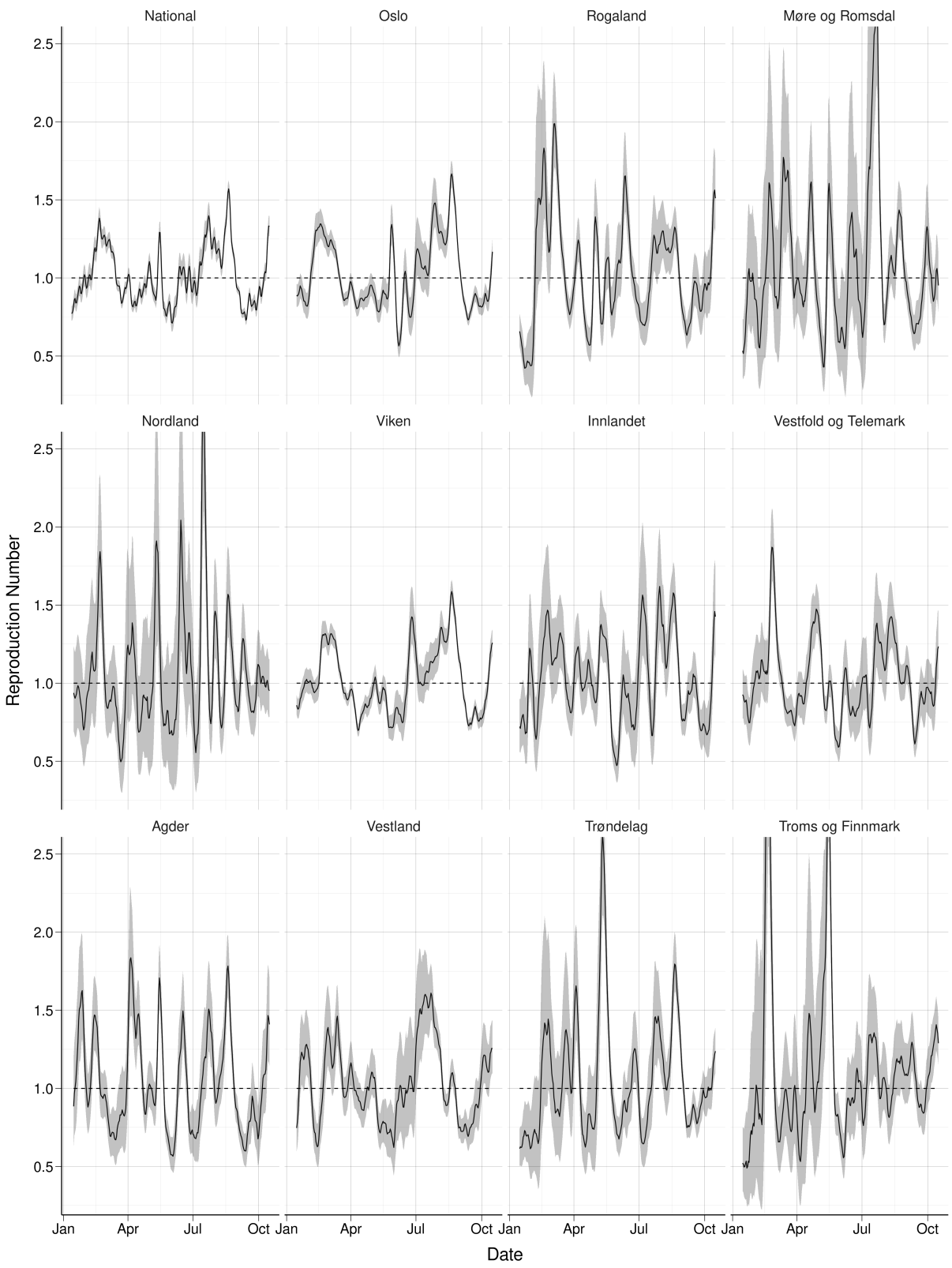


Figure 27: Reproduction number estimated using the R package EpiEstim.

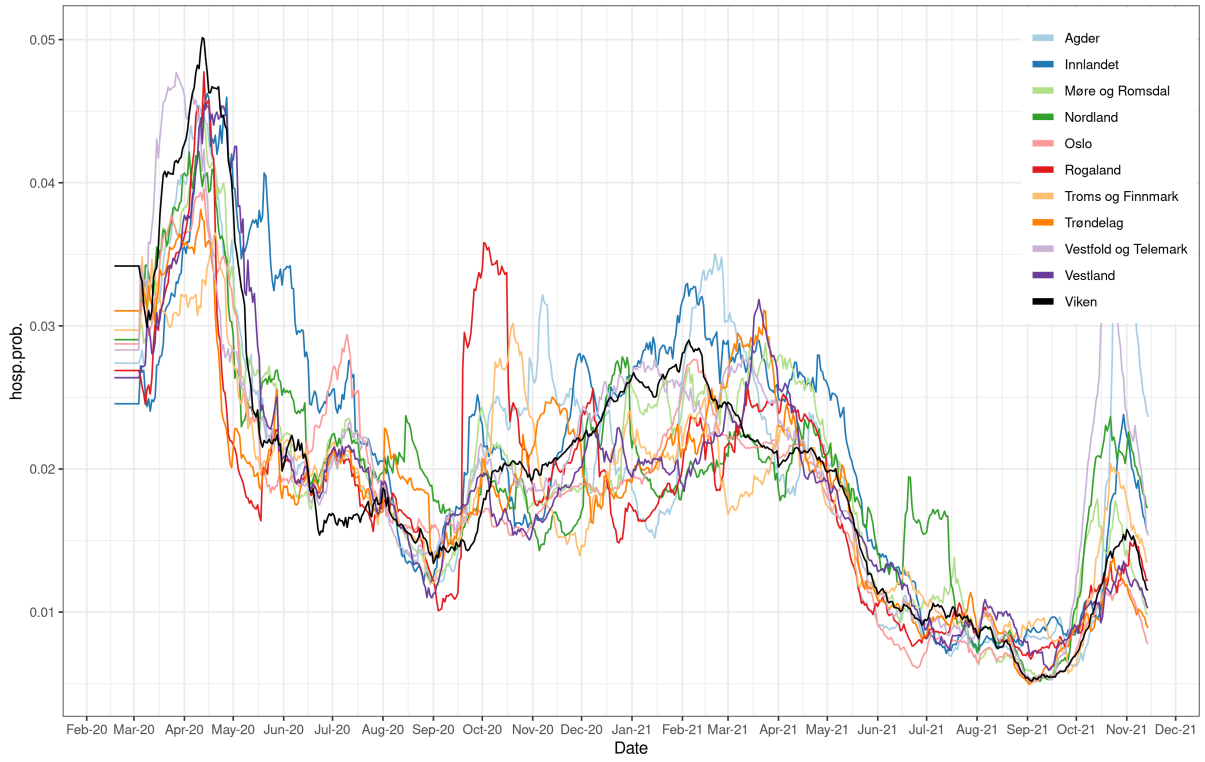


Figure 28: Regional hospitalization probabilities per infection. The estimates are based on Salje et al., and regional data on the age distribution in the test data and the empirical case-hospitalisation rates.

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 positive test and/or 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).

FHI COVID-19 modelling team:

- **Birgitte Freiesleben de Blasio** - Department of Method Development and Analytics. Norwegian Institute of Public Health and Oslo Centre for Biostatistics and Epidemiology, University of Oslo.
- **Francesco Di Ruscio** - Department of Method Development and Analytics. Norwegian Institute of Public Health.
- **Gunnar Øyvind Isaksson Rø** - Department of Method Development and Analytics. Norwegian Institute of Public Health.
- **Solveig Engebretsen** - Norsk Regnesentral.
- **Arnoldo Frigessi** - Oslo Centre for Biostatistics and Epidemiology, University of Oslo and Oslo University Hospital.
- **Alfonso Diz-Lois Palomares** - Department of Method Development and Analytics. Norwegian Institute of Public Health.
- **Magnus Nygård Osnes** - Department of Method Development and Analytics. Norwegian Institute of Public Health.
- **Anja Bråthen Kristoffersen** - Department of Method Development and Analytics. Norwegian Institute of Public Health.
- **Kenth Engø-Monsen** - Telenor Research.
- **Louis Yat Hin Chan** - Department of Method Development and Analytics. Norwegian Institute of Public Health.
- **Jonas Christoffer Lindstrøm** - Department of Method Development and Analytics. Norwegian Institute of Public Health.
- **Richard White** - Department of Method Development and Analytics. Norwegian Institute of Public Health.
- **Gry Marysol Grøneng** - Department of Method Development and Analytics. Norwegian Institute of Public Health.
- **Chi Zhang** - Department of Method Development and Analytics. Norwegian Institute of Public Health.
- **Jørgen Eriksson Midtbø** - Department of Method Development and Analytics. Norwegian Institute of Public Health.
- **Geir Storvik** - Department of Mathematics. University of Oslo.