

Situational awareness and forecasting for Norway

FHI COVID-19 modelling team

Week 51, 22 December 2021

Main results:

We present short-term predictions of hospital prevalence and ventilator beds at health-trust (helseforetak) level, see Section 8. The regional predictions are from the regional SMC model.

- **National epidemiological situation:**

The most recent reproduction numbers:

Model	Median	5%	95%	Prob>1	period/day	More info
Changepoint	1.12	0.9	1.36	0.85	Since 29. Nov	Table 1
SMC	0.85	0.70	1.03	0.04	13 Dec	Fig. 4
EpiEstim	0.92	0.91	0.94		14 Dec	Table 17, Fig. 28

- **National forecasting:**

One-week-ahead national forecasts from changepoint model:

Indicator	Median/Mean 95% PI	day	Info 2-3 weeks forecasts
Hospital beds	392/370 (240-632)	26 Dec	Table 2
Ventilator beds	87/85 (60-124)	26 Dec	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	1.31	0.99	1.67	0.97	30 Nov - 8 Dec	Fig. 4
EpiEstim	0.87	0.85	0.9		13 Dec	Table 17, Fig. 28

- **Telenor mobility data and the number of foreign visitors:** The most recent mobility development is found in Figures 22 and 23 for the largest municipality in each county and for each county, respectively. Figure 24 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
2.58/2.56(1.98-2.94)	From Feb 17 to Mar 14
0.59/0.59(0.51-0.69)	From Mar 15 to Apr 19
0.96/0.9(0.17-1.39)	From Apr 20 to May 10
0.72/0.69(0.16-1.08)	From May 11 to Jun 30
0.93/0.94(0.32-1.6)	From Jul 01 to Jul 31
1.14/1.13(0.73-1.48)	From Aug 01 to Aug 31
0.96/0.98(0.75-1.29)	From Sep 01 to Sep 30
1.19/1.18(0.91-1.4)	From Oct 01 to Oct 25
1.25/1.25(0.89-1.61)	From Oct 26 to Nov 04
0.85/0.86(0.75-0.97)	From Nov 05 to Nov 30
0.99/0.99(0.92-1.07)	From Dec 01 to Jan 03
0.74/0.74(0.57-0.92)	From Jan 04 to Jan 21
0.88/0.88(0.63-1.09)	From Jan 22 to Feb 07
1.33/1.34(1.17-1.49)	From Feb 08 to Mar 01
1.04/1.05(0.93-1.19)	From Mar 02 to Mar 24
0.88/0.86(0.66-1.02)	From Mar 25 to Apr 12
0.84/0.84(0.72-0.98)	From Apr 13 to May 05
0.91/0.91(0.72-1.13)	From May 06 to May 26
0.9/0.9(0.7-1.08)	From May 27 to Jun 20
0.94/0.93(0.8-1.06)	From Jun 21 to Aug 04
1.24/1.24(1.09-1.39)	From Aug 05 to Aug 31
0.78/0.78(0.67-0.87)	From Sep 01 to Sep 24
1.09/1.09(1.05-1.13)	From Sep 25 to Nov 28
1.12/1.12(0.9-1.36)	From Nov 29
Median/Mean (95% credible intervals)	

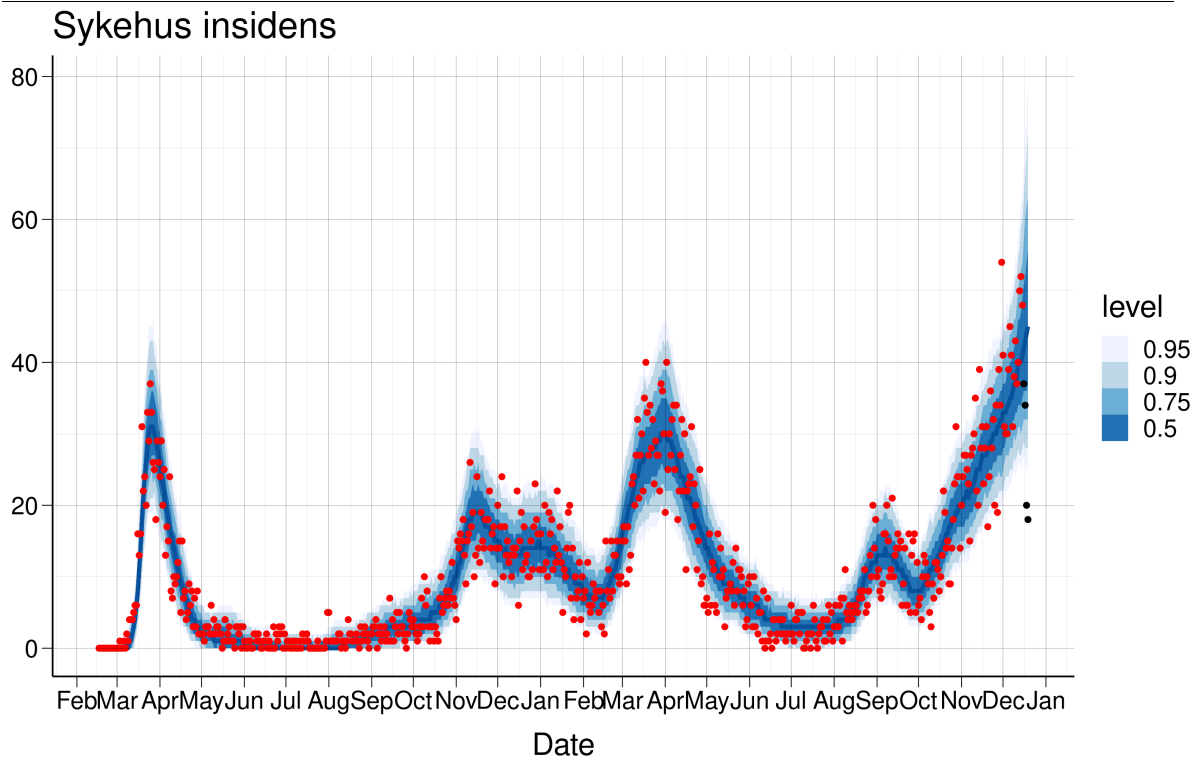


Figure 1: Hospital admissions

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.

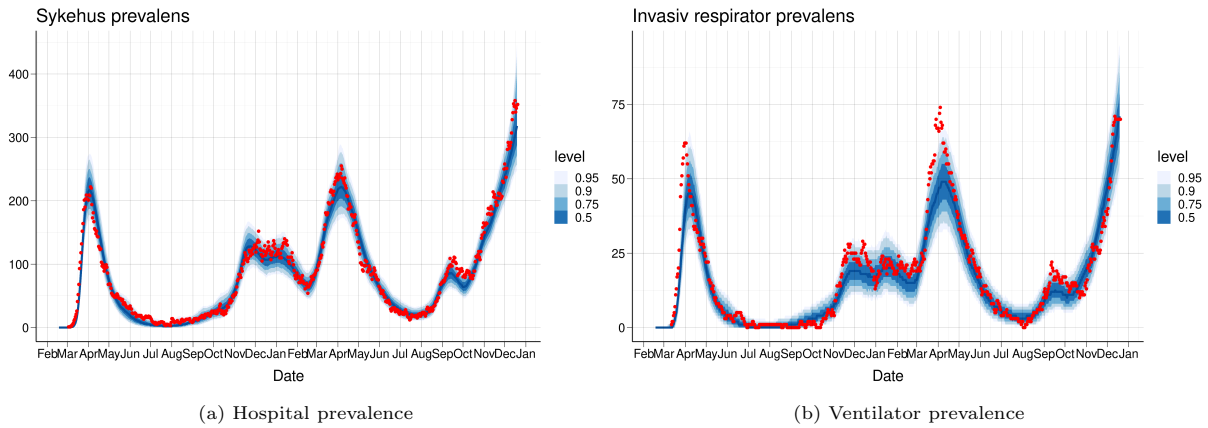


Figure 3: A comparison of true data (red) and predicted values (blue) for hospital and respirator prevalence. Prevalence data is based on NIPaR and may be different to the data from Helsedirektoratet.

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 $R(t)$.

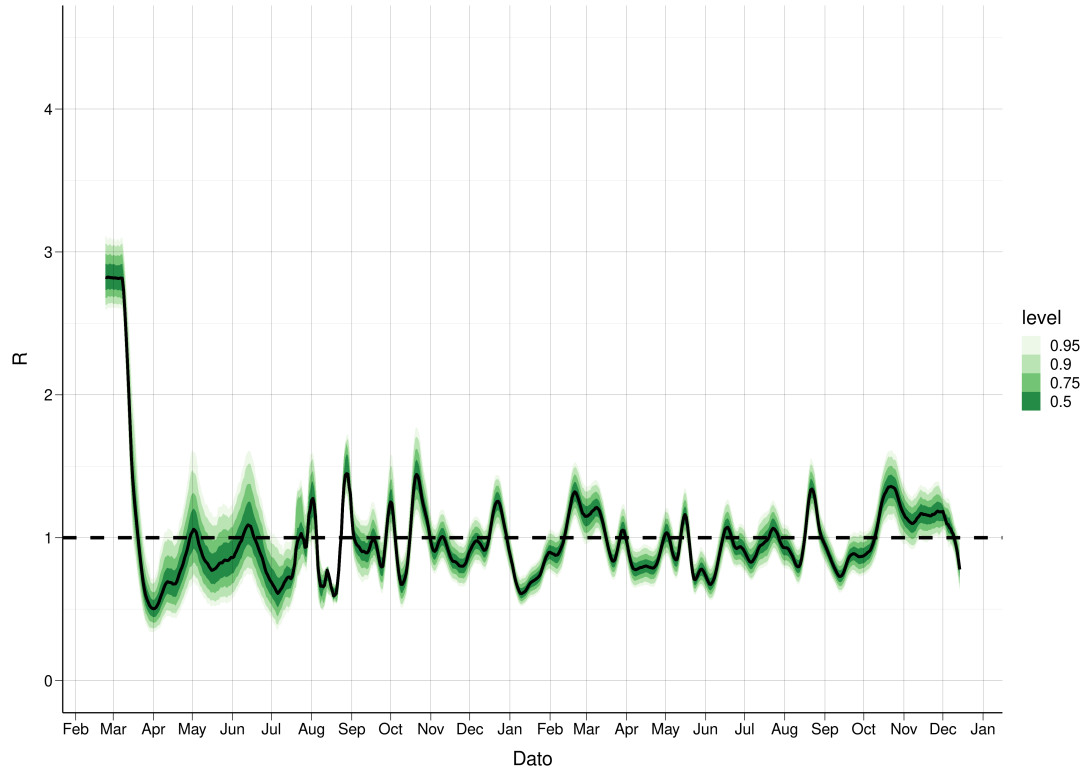


Figure 4: $R(t)$ estimates using a Sequential Monte Carlo approach calibrated to hospitalisation incidence and test data. The large uncertainty during the last 7 days reflects the lack of available data due to the transmission delay, test delay, time between symptoms onset and hospitalisation. The green 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 beds

The national changepoint model estimates the 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 2: Estimated national prevalence, incidence, hospital beds and ventilator beds. Median/Mean (CI)

	1 week prediction (Dec 26)	2 week prediction (Jan 02)	3 week prediction (Jan 09)
Prevalence	28606/25413 (10737-62142)	33778/28484 (9140-85437)	39341/31683 (7884-112349)
Daily incidence	6752/5968 (2361-15302)	7957/6617 (1981-20780)	9237/7332 (1746-27135)
Hospital beds	392/370 (240-632)	461/420 (227-869)	545/476 (207-1239)
Ventilator beds	87/85 (60-124)	102/96 (60-171)	120/111 (59-226)

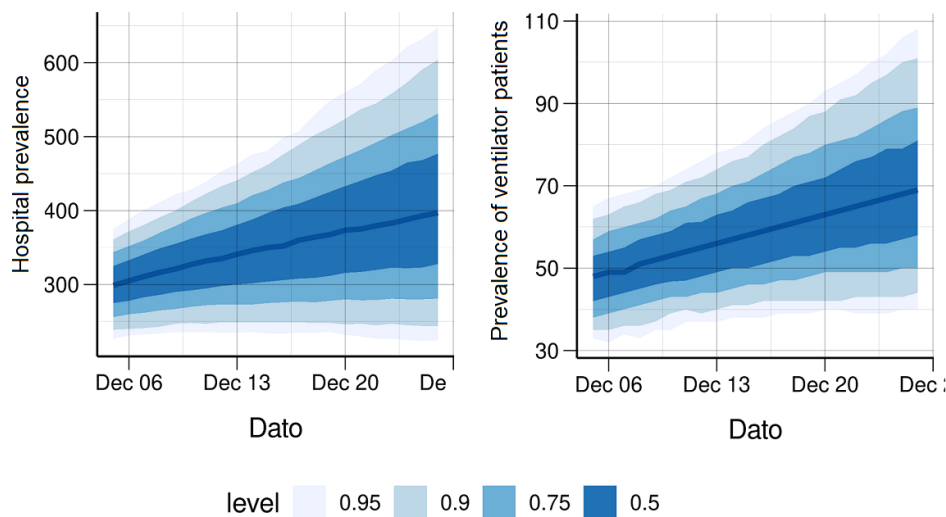


Figure 5: National 3 week predictions for hospital beds (left) and ventilator beds (right)

2.1 Hospital and Ventilator prevalence by age

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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 3.

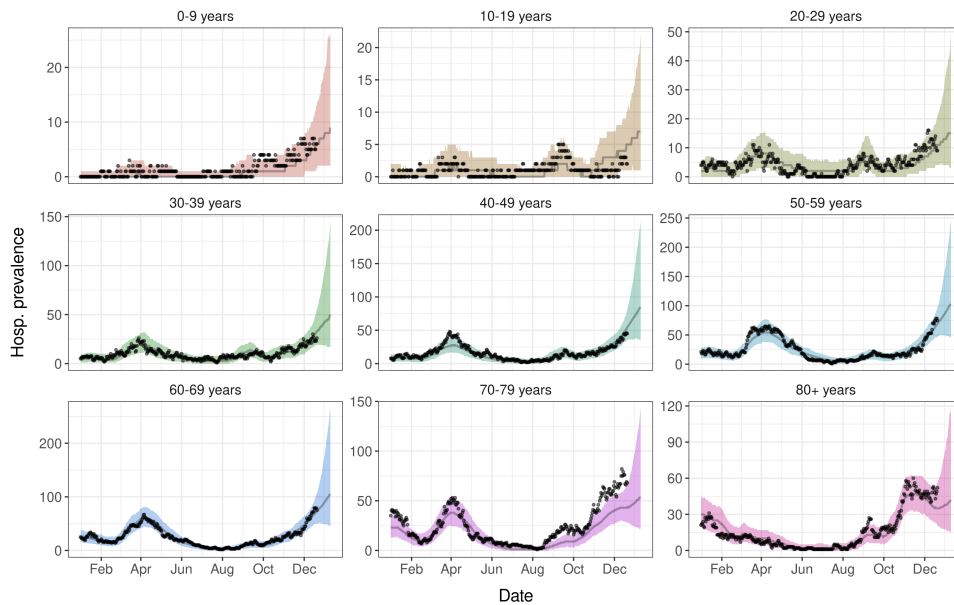


Figure 6: Simulated hospital prevalence by age group. Real data is shown as black dots

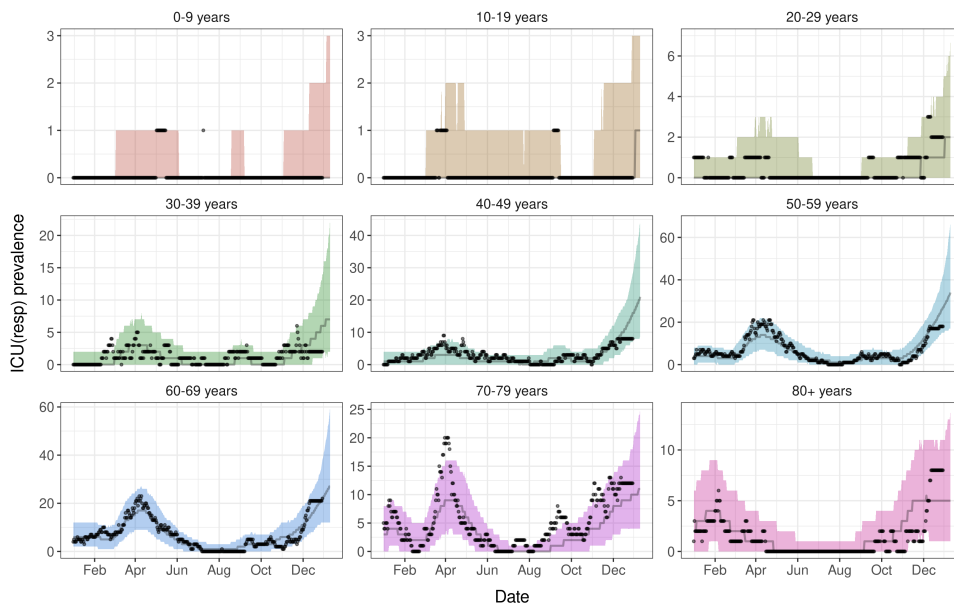


Figure 7: Simulated respirator prevalence by age group. Real data is shown as black dots

2.1 Hospital and Ventilator prevalence by age

Table 3: Hospital and Respirator prevalence per age group: 3 week prediction (2022-01-09). Mean and 95 perc. CI

Age group	Hosp	Resp
0-9 years	11 (2-28)	1 (0-3)
10-19 years	8 (1-21)	1 (0-3)
20-29 years	18 (4-46)	2 (0-6)
30-39 years	58 (18-140)	9 (1-20)
40-49 years	99 (37-222)	22 (9-46)
50-59 years	117 (51-249)	37 (18-68)
60-69 years	121 (47-265)	31 (13-62)
70-79 years	63 (21-142)	12 (4-26)
+80 years	50 (15-122)	6 (1-14)

3 Estimated regional reproduction numbers

Calibration of our regional SMC model to hospitalisation incidence data and test data leads to the following estimates for current regional reproduction numbers by county (Table ??).

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 4: Regional estimates, 30 Nov-8 Dec

County	Median	95CI	Prob>1
Oslo	1.31	0.99-1.67	0.97
Rogaland	1.05	0.78-1.43	0.61
Møre og Romsdal	0.86	0.74-1.03	0.04
Nordland	0.80	0.66-1.01	0.03
Viken	1.27	1.03-1.67	0.99
Innlandet	1.30	1.16-1.52	1
Vestfold og Telemark	1.04	0.83-1.62	0.61
Agder	1.24	1.04-1.54	0.99
Vestland	1.19	0.94-1.56	0.93
Trøndelag	0.92	0.79-1.08	0.14
Troms og Finnmark	0.91	0.76-1.14	0.18

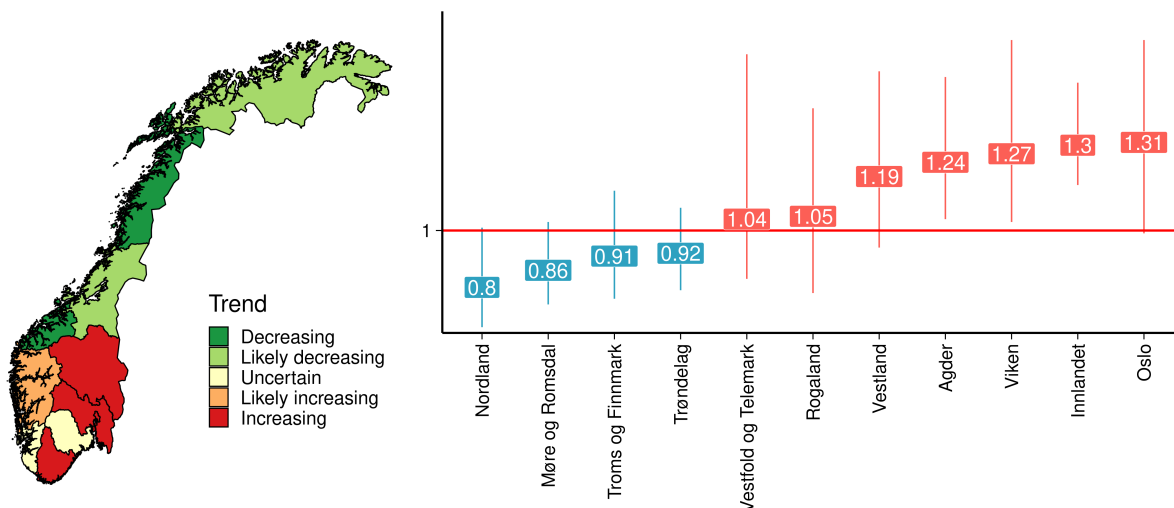
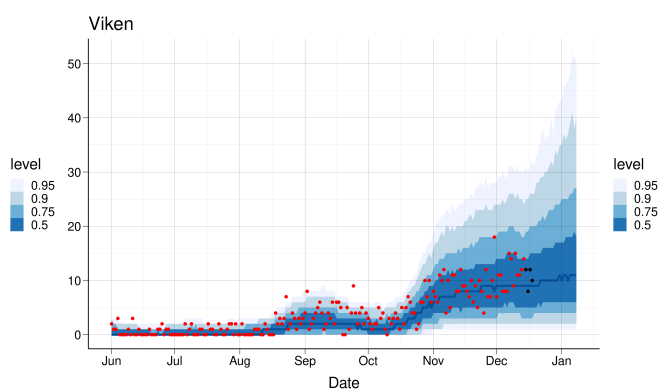
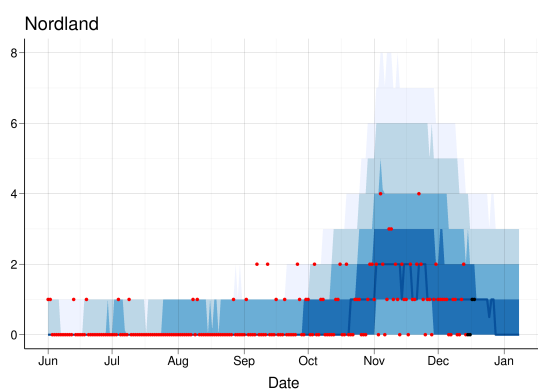
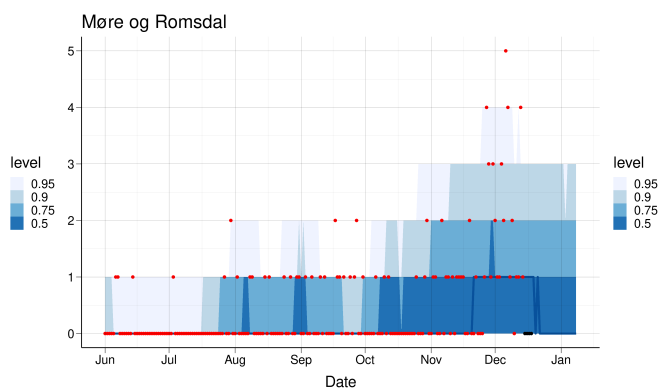
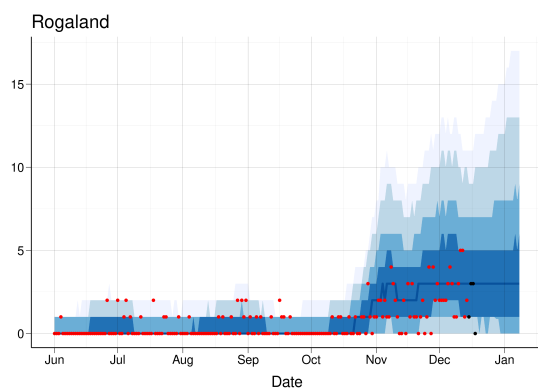
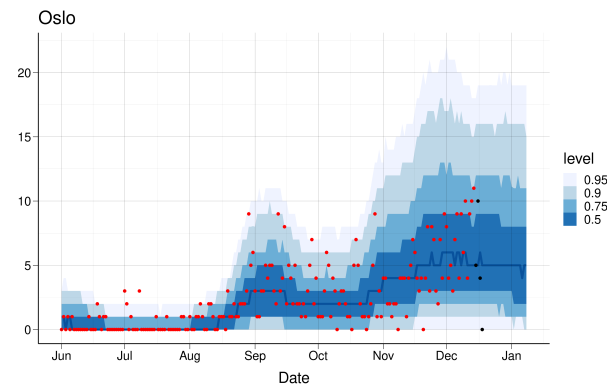
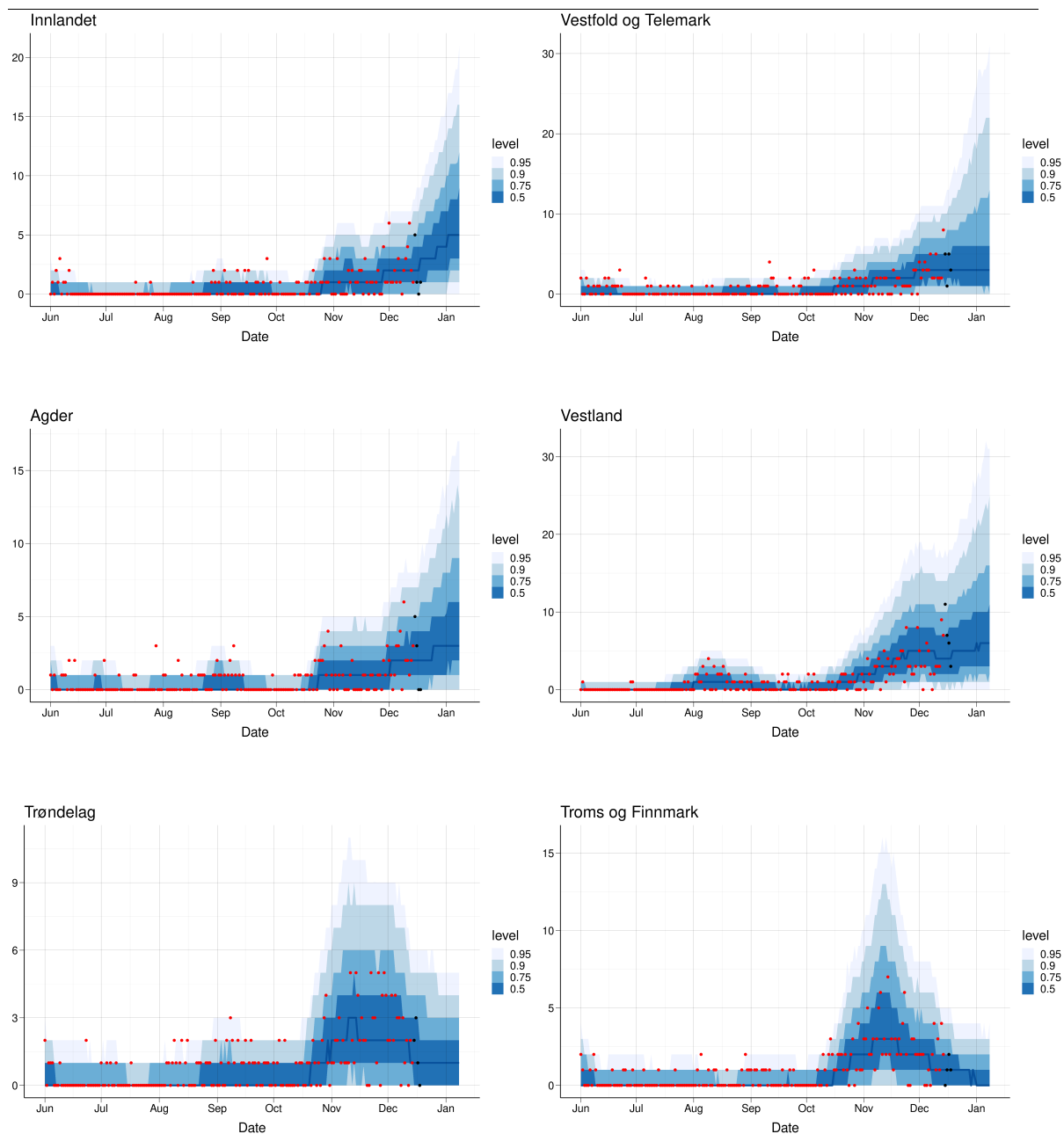


Figure 8: The map shows the direction of the trend in incidence in the counties based on the latest reproduction numbers shown in the other chart. The trend is increasing if the probability that the latest reproduction number is above one is above 95%, the trend is likely increasing if this probability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

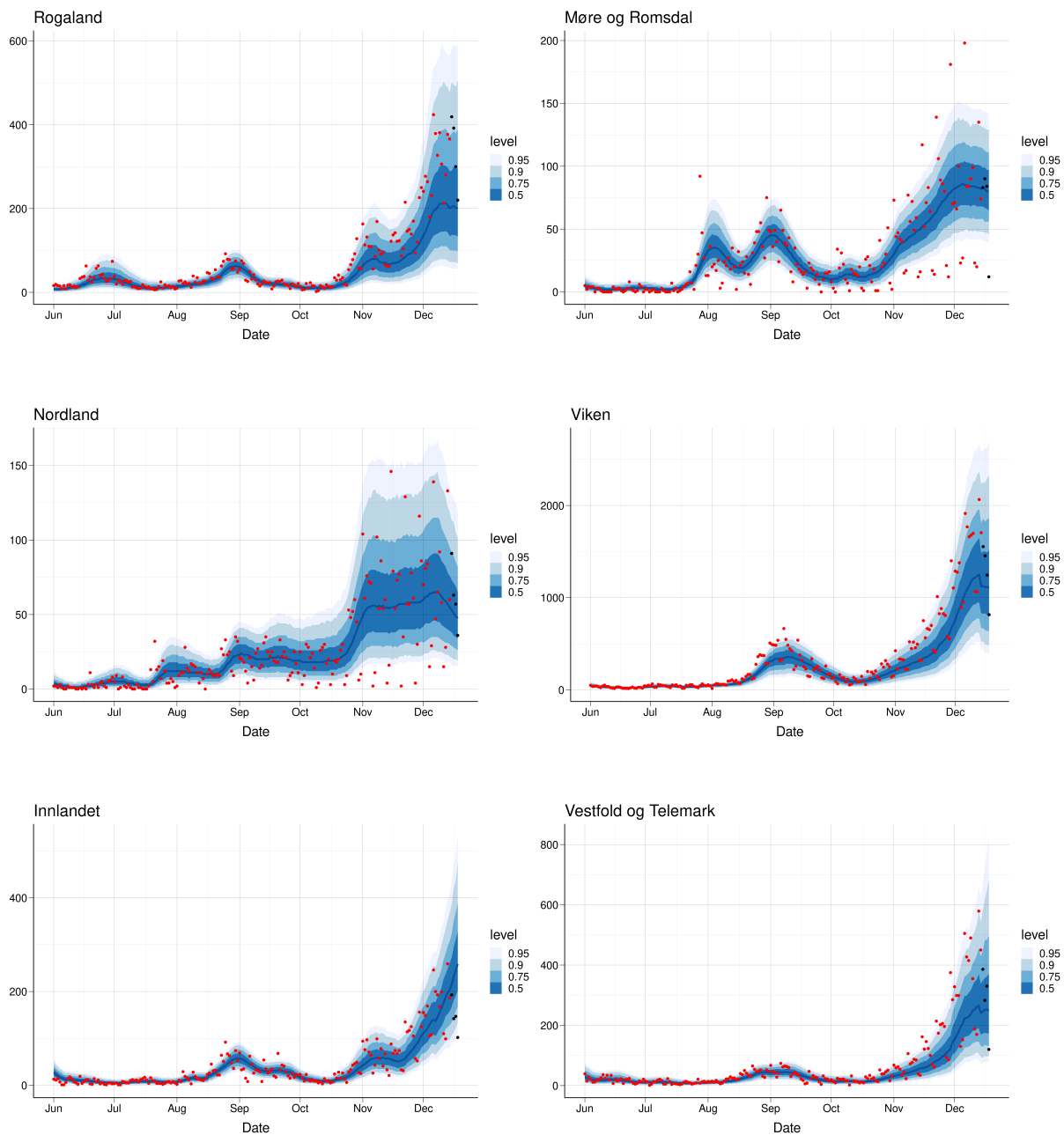
Estimated vs observed hospital incidence and 3 weeks forecast by county:

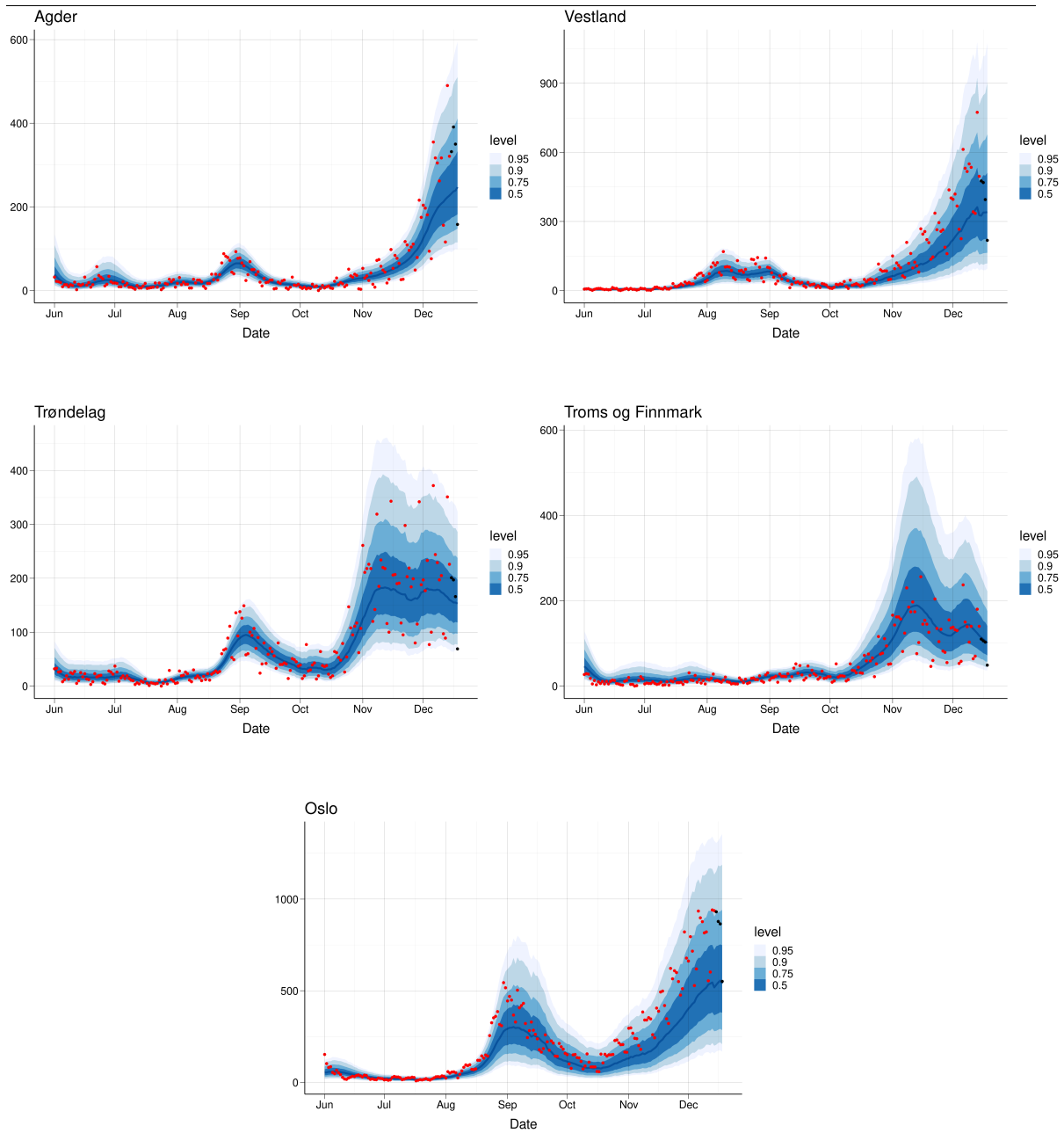
Forecasts are now based on the estimated reproduction numbers obtained by our regional SMC model, for each county. In the forecasted period of three weeks, we use the mean daily reproduction number during the period today - 21 days until today - 10 days.





Estimated and observed lab-confirmed test data by county:





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

Table 5: Estimated cumulative number of infections, 2021-12-18

Region	Total	No. confirmed	Fraction reported	Min. fraction
Oslo	80145 (44772; 132997)	44044	55%	33%
Rogaland	23324 (13629; 41265)	12382	53%	30%
Møre og Romsdal	7055 (5231; 9608)	5241	74%	55%
Nordland	8083 (4513; 14617)	4741	59%	32%
Viken	90998 (60104; 141769)	62191	68%	44%
Innlandet	13403 (9097; 20251)	7687	57%	38%
Vestfold og Telemark	21187 (12829; 36446)	12046	57%	33%
Agder	11830 (7013; 20171)	9051	77%	45%
Vestland	41570 (21901; 77449)	18890	45%	24%
Trøndelag	19175 (11224; 33827)	14157	74%	42%
Troms og Finnmark	14014 (6131; 29835)	8910	64%	30%

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

Table 6: Predicted incidence per day: Median/Mean (CI)

Region	1 week prediction (25 Dec)	2 weeks prediction (01 Jan)	3 weeks prediction (08 Jan)
Agder	403/473 (155-1157)	455/557 (158-1523)	496/631 (150-1879)
Innlandet	568/620 (306-1252)	697/776 (355-1674)	796/899 (381-2068)
Møre og Romsdal	85/90 (47-166)	84/90 (46-168)	98/105 (56-197)
Nordland	57/62 (24-133)	52/58 (22-134)	47/54 (19-130)
Oslo	1098/1242 (454-2805)	1002/1169 (407-2846)	942/1111 (375-2799)
Rogaland	475/599 (152-1787)	463/635 (123-2192)	438/650 (94-2470)
Troms og Finnmark	89/100 (36-230)	83/95 (32-231)	77/91 (29-239)
Trøndelag	156/169 (75-342)	153/167 (75-351)	162/178 (82-384)
Vestfold og Telemark	463/762 (181-2911)	448/852 (159-3582)	425/900 (134-4019)
Vestland	1129/1377 (399-3878)	1191/1533 (375-4826)	1220/1630 (339-5389)
Viken	1943/2307 (847-5959)	2017/2507 (810-7047)	2013/2594 (730-7882)

Table 7: 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	25 Dec	01 Jan	08 Jan	low CI, 08 Jan	high CI, 08 Jan
Agder	1757/2033	1964/2378	2143/2704	672	7930
Innlandet	2489/2699	2980/3305	3409/3837	1656	8683
Møre og Romsdal	413/436	499/525	477/508	308	895
Nordland	272/299	250/279	215/245	95	560
Oslo	5072/5681	4747/5469	4282/5044	1793	12352
Rogaland	2179/2681	2092/2798	1952/2850	451	10617
Troms og Finnmark	416/467	395/447	347/408	144	1052
Trøndelag	737/791	778/839	736/806	399	1682
Vestfold og Telemark	2105/3306	2031/3711	1903/3930	633	17286
Vestland	4977/5979	5258/6671	5391/7102	1537	23056
Viken	8705/10197	9008/11025	8906/11373	3337	33809

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

Below is shown the estimated short-term forecasting of expected hospital prevalence (table 8) and patients on ventilator treatment for each county (table 9).

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

Region	1 week prediction (25 Dec)	2 weeks prediction (01 Jan)	3 weeks prediction (08 Jan)
Agder	22/24 (6-56)	26/29 (8-72)	29/34 (8-87)
Innlandet	25/27 (10-54)	32/35 (12-74)	41/44 (16-97)
Møre og Romsdal	6/7 (1-17)	6/7 (1-16)	6/7 (1-16)
Nordland	9/10 (1-23)	7/8 (1-21)	7/7 (1-19)
Oslo	57/62 (24-126)	57/62 (22-131)	55/61 (20-132)
Rogaland	28/32 (8-74)	28/33 (7-87)	27/35 (6-105)
Troms og Finnmark	10/12 (2-30)	8/10 (1-25)	7/8 (1-22)
Trøndelag	15/17 (4-36)	13/15 (3-33)	12/14 (3-31)
Vestfold og Telemark	29/35 (10-92)	29/40 (9-130)	28/44 (7-168)
Vestland	45/51 (15-122)	49/57 (15-148)	53/64 (16-183)
Viken	90/98 (40-204)	94/107 (40-250)	98/116 (39-306)

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

Region	1 week prediction (25 Dec)	2 weeks prediction (01 Jan)	3 weeks prediction (08 Jan)
Agder	4/4 (0-11)	5/5 (1-13)	5/6 (1-16)
Innlandet	4/5 (1-10)	5/6 (1-13)	7/7 (2-16)
Møre og Romsdal	1/2 (0-5)	1/2 (0-4)	1/1 (0-4)
Nordland	2/3 (0-7)	2/2 (0-6)	2/2 (0-6)
Oslo	17/19 (7-37)	19/20 (7-39)	19/20 (7-40)
Rogaland	6/7 (1-16)	6/7 (1-17)	6/7 (1-19)
Troms og Finnmark	3/3 (0-10)	2/3 (0-8)	2/2 (0-7)
Trøndelag	4/4 (0-10)	3/4 (0-9)	3/3 (0-8)
Vestfold og Telemark	6/7 (1-16)	6/7 (1-20)	6/8 (1-27)
Vestland	9/10 (3-24)	10/11 (2-27)	11/12 (3-32)
Viken	19/20 (8-39)	19/21 (8-44)	20/23 (8-53)

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

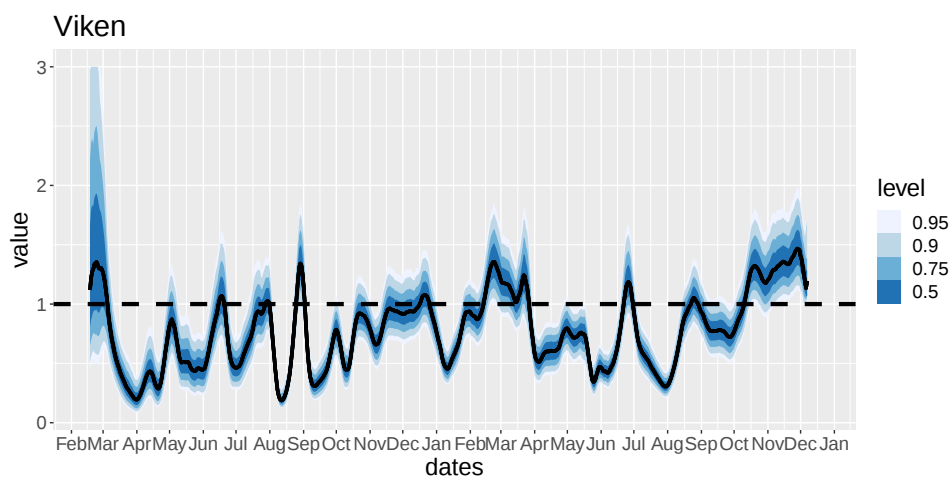
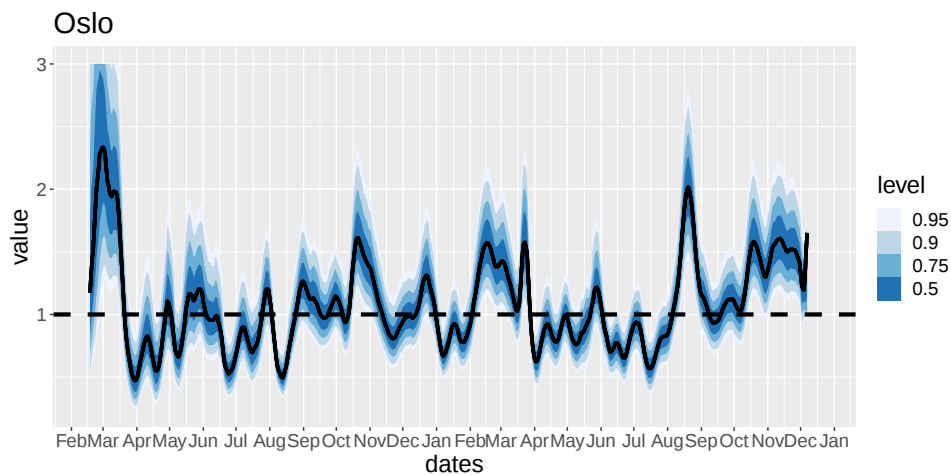
To estimate recent trends in hospitalisation and number of positive tests, we present results in table 10 based on a negative binomial regression where we account for weekend effects. We exclude the last three days to avoid problems of reporting delay and fit the model using data from 17 days to 3 days 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 10: Trend analysis for the last 14 days

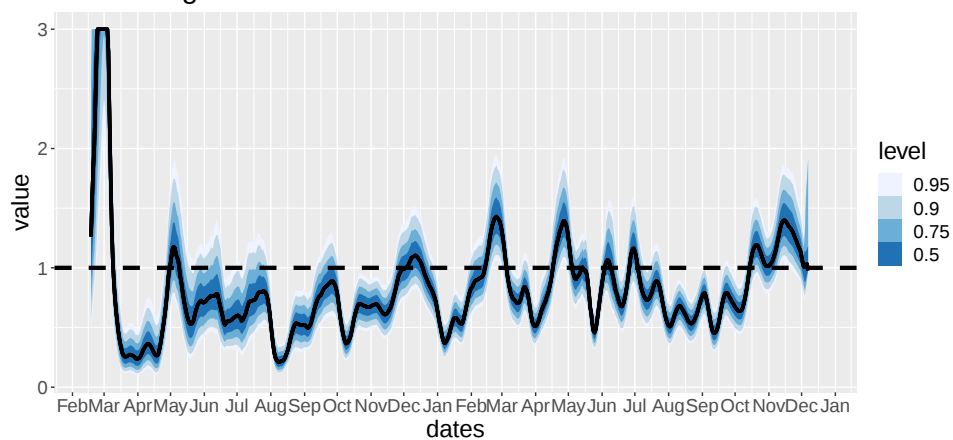
County	Average daily increase last 14 days		Doubling Time (days)	
	Hospitalisations	Cases	Hospitalisations	Cases
Agder	-5.8 (-16.7, 6.1) %	3.6 (1.2, 6) %	-11.7 (-3.8, 11.8)	19.8 (58.6, 11.9)
Innlandet	-0.3 (-10.4, 11) %	-1.9 (-3.7, 0) %	-236.4 (-6.3, 6.7)	-36.7 (-18.2, 2030.3)
Møre og Romsdal	-14.8 (-25.5, -4.1) %	-4 (-7.1, -0.8) %	-4.3 (-2.4, -16.7)	-16.9 (-9.3, -86.9)
Nordland	Not enough data	-0.8 (-5.1, 3.7) %	Not enough data	-84.6 (-13.2, 19.3)
Norge	0 (-2.2, 2.3) %	-1.5 (-2.8, -0.2) %	1535.4 (-31.8, 30.5)	-44.8 (-24.2, -305.5)
Oslo	1.1 (-3.7, 6.1) %	-2.2 (-2.9, -1.6) %	65 (-18.4, 11.7)	-30.5 (-23.8, -42.4)
Rogaland	-2.9 (-10.6, 5.2) %	-0.4 (-1.9, 1.1) %	-23.3 (-6.2, 13.6)	-169 (-36.2, 63.2)
Troms og Finnmark	4.2 (-6.7, 16.7) %	-3.3 (-5.8, -0.7) %	17 (-10, 4.5)	-20.7 (-11.6, -95.1)
Trøndelag	-11.5 (-21.6, -1.1) %	-3.2 (-5.7, -0.7) %	-5.7 (-2.9, -61.5)	-21.2 (-11.9, -100.3)
Vestfold og Telemark	-1 (-8.1, 6.5) %	-1.6 (-3.7, 0.5) %	-66.4 (-8.2, 11)	-41.8 (-18.3, 145.5)
Vestland	5.7 (-2.9, 15.4) %	-1.4 (-3.7, 1) %	12.5 (-23.2, 4.8)	-49.6 (-18.5, 72.6)
Viken	2 (-2.6, 6.8) %	-1.7 (-3.1, -0.4) %	35.6 (-26.5, 10.6)	-39.5 (-22.2, -176.3)

7 Regional SMC-model: Estimated daily reproduction numbers

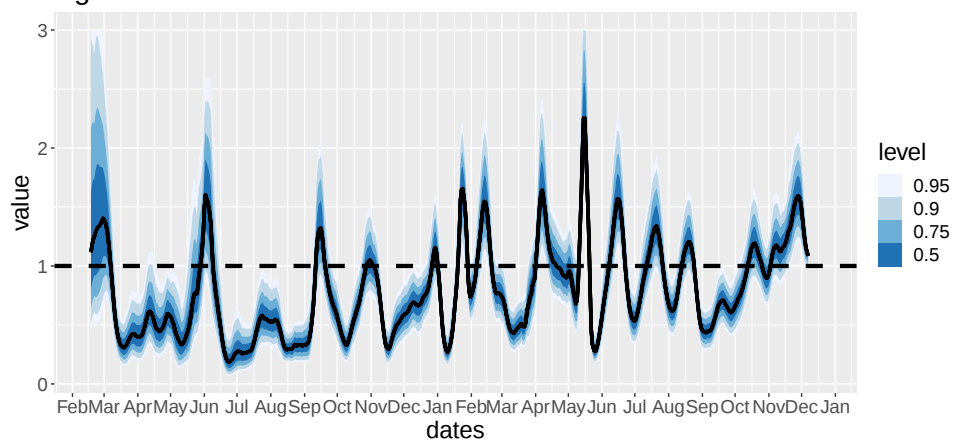
In the figures below we plot the 95% credibility interval and quantiles of the estimated posterior distribution of the regional, daily reproduction numbers. For some counties, uncertainty is large towards the most recent time, because there are very few data and possibly reporting delays which are different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



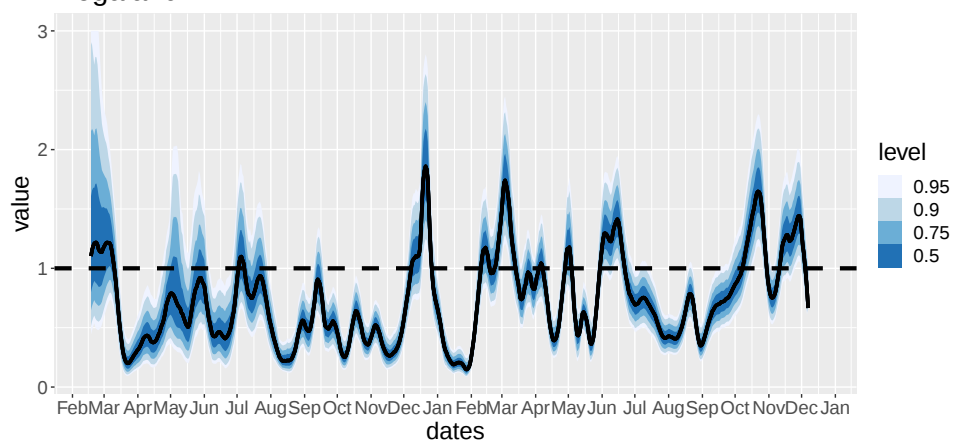
Vestfold og Telemark

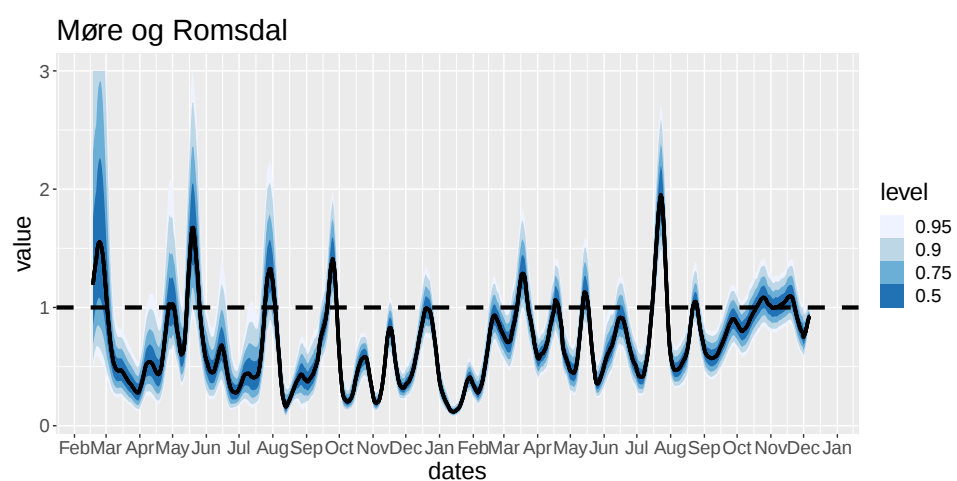
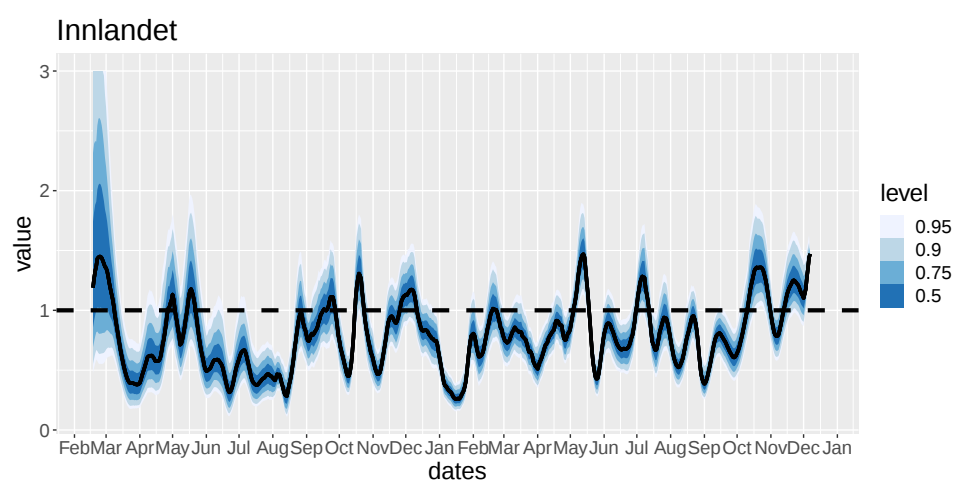
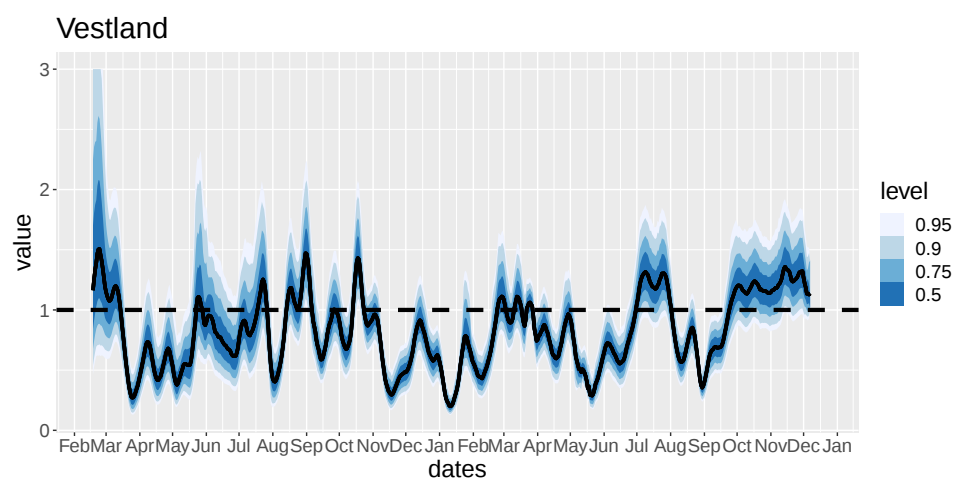


Agder

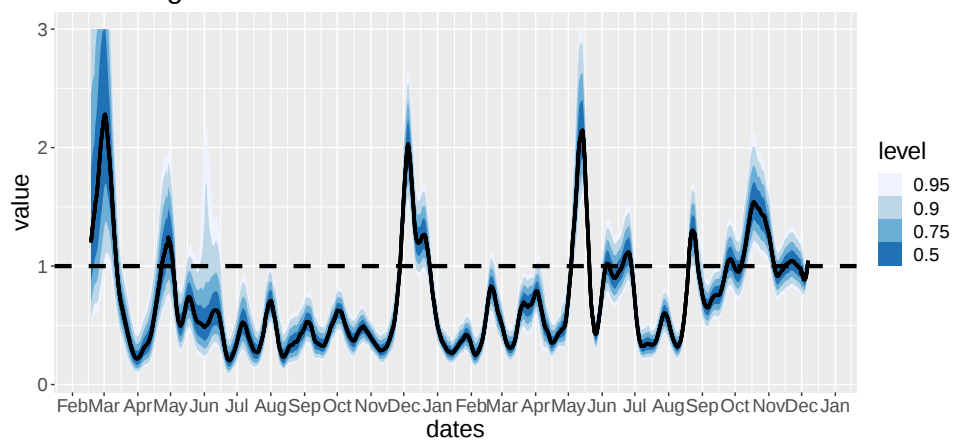


Rogaland

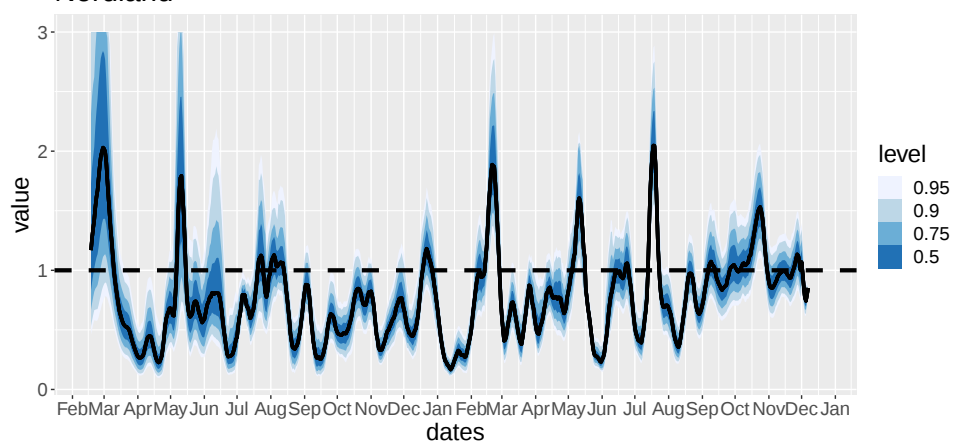




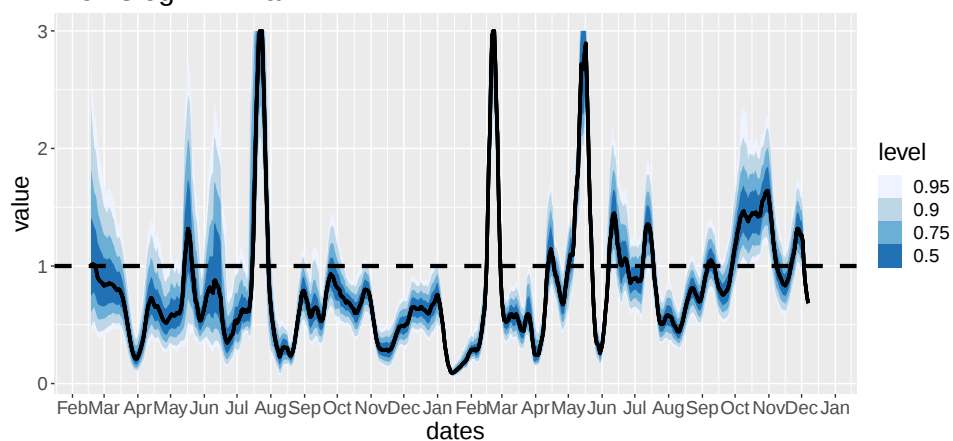
Trøndelag



Nordland



Troms og Finnmark



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

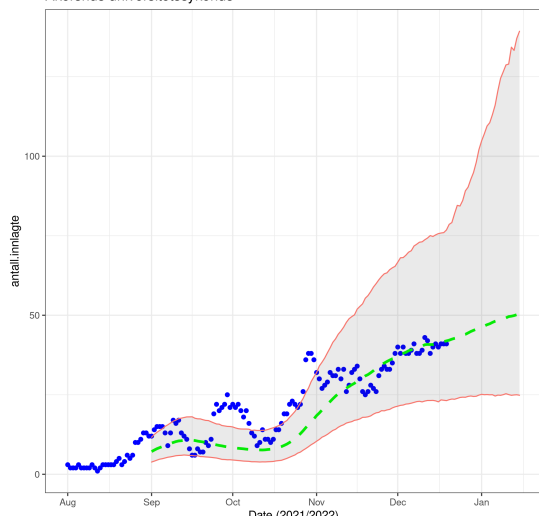
Helseforetak	1 week prediction (25 Dec)	2 weeks prediction (01 Jan)	3 weeks prediction (08 Jan)
Akershus universitetssykehus	44/47 (24-86)	46/51 (25-105)	49/55 (25-124)
Finnmarksykehuset	3/4 (1-9)	3/3 (1-7)	2/3 (1-6)
Helse Bergen	32/37 (12-84)	35/41 (12-102)	38/46 (12-130)
Helse Fonna	12/13 (6-25)	13/14 (6-30)	13/15 (6-37)
Helse Førde	8/9 (3-20)	8/10 (3-24)	9/11 (3-31)
Helse Møre og Romsdal	7/7 (2-14)	6/7 (2-14)	6/7 (1-14)
Helse Nord Trøndelag	5/5 (2-11)	4/5 (2-10)	4/4 (1-10)
Helse Stavanger	22/24 (9-56)	22/26 (7-64)	22/27 (6-80)
Nordlandssykehuset	5/6 (1-13)	5/5 (1-11)	4/4 (1-10)
Oslo universitetssykehus	48/51 (23-100)	48/52 (22-104)	47/51 (20-107)
St. Olavs hospital	10/11 (4-23)	10/10 (3-20)	8/9 (3-20)
Sykehuset Innlandet	24/25 (11-47)	30/32 (13-64)	37/40 (17-85)
Sykehuset Telemark	12/14 (5-37)	12/16 (5-53)	12/18 (4-69)
Sykehuset i Vestfold	17/20 (7-52)	17/23 (6-75)	16/26 (5-98)
Sykehuset Østfold	23/25 (11-51)	24/27 (11-64)	25/30 (10-78)
Sørlandet sykehus	22/24 (8-53)	25/29 (9-69)	29/34 (10-86)
Universitetssykehuset i Nord-Norge	8/9 (3-21)	7/8 (2-17)	6/7 (2-15)
Vestre Viken	35/39 (17-79)	37/42 (17-98)	39/46 (16-120)

Table 12: Number of respirator beds occupied by Covid-19 patients: Median/Mean (CI)

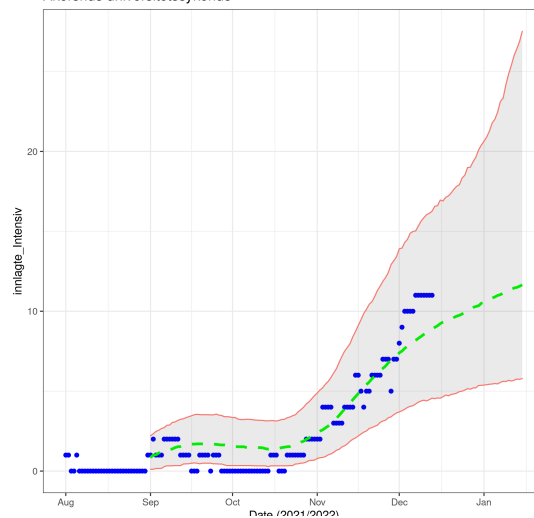
Helseforetak	1 week prediction (25 Dec)	2 weeks prediction (01 Jan)	3 weeks prediction (08 Jan)
Akershus universitetssykehus	10/10 (5-19)	11/11 (5-21)	11/12 (6-23)
Finnmarksykehuset	1/1 (0-3)	1/1 (0-2)	1/1 (0-2)
Helse Bergen	6/7 (2-17)	7/8 (1-19)	8/9 (2-23)
Helse Fonna	3/3 (1-5)	3/3 (1-6)	3/3 (1-7)
Helse Førde	2/2 (1-4)	2/2 (0-5)	2/2 (1-5)
Helse Møre og Romsdal	1/2 (0-5)	1/2 (0-4)	1/1 (0-4)
Helse Nord Trøndelag	1/1 (0-3)	1/1 (0-3)	1/1 (0-3)
Helse Stavanger	5/5 (1-12)	5/5 (1-13)	5/6 (1-15)
Nordlandssykehuset	1/2 (0-4)	1/1 (0-3)	1/1 (0-3)
Oslo universitetssykehus	14/16 (6-31)	16/16 (6-33)	16/17 (6-33)
St. Olavs hospital	3/3 (0-7)	2/3 (0-6)	2/2 (0-5)
Sykehuset Innlandet	4/4 (1-9)	5/5 (1-12)	6/7 (2-14)
Sykehuset Telemark	2/3 (0-7)	2/3 (0-8)	2/3 (0-11)
Sykehuset i Vestfold	4/4 (1-9)	4/4 (1-12)	4/5 (1-16)
Sykehuset Østfold	5/5 (2-10)	5/5 (2-11)	5/6 (2-14)
Sørlandet sykehus	4/4 (0-11)	5/5 (1-13)	5/6 (1-16)
Universitetssykehuset i Nord-Norge	2/3 (0-7)	2/2 (0-6)	1/2 (0-5)
Vestre Viken	7/8 (3-15)	7/8 (3-17)	8/9 (3-21)

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.

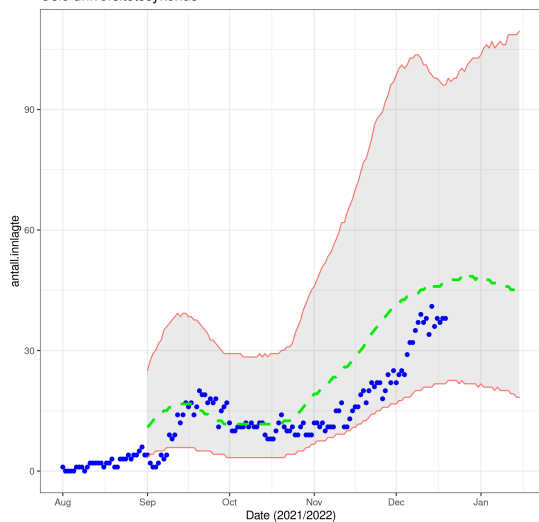
Akershus universitetssykehus



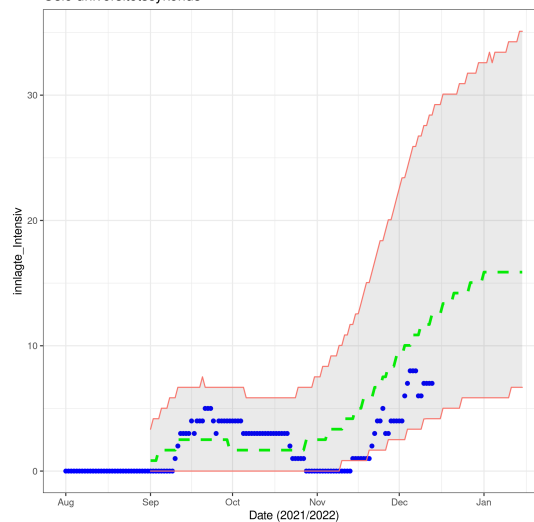
Akershus universitetssykehus



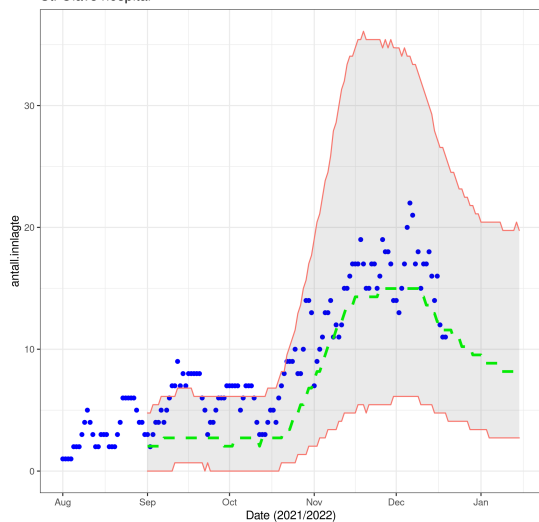
Oslo universitetssykehus



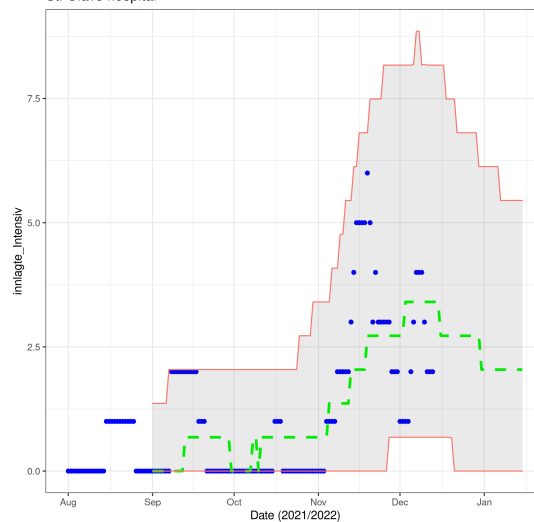
Oslo universitetssykehus



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 20 shows an overview of the mobility since March 2020 for the largest municipalities in each county, and Figure 21 shows the total mobility out from all municipalities in each county, including Oslo. Figure 22 and 23, zooms in on mobility from August 16 2021, for municipalities and counties, respectively.

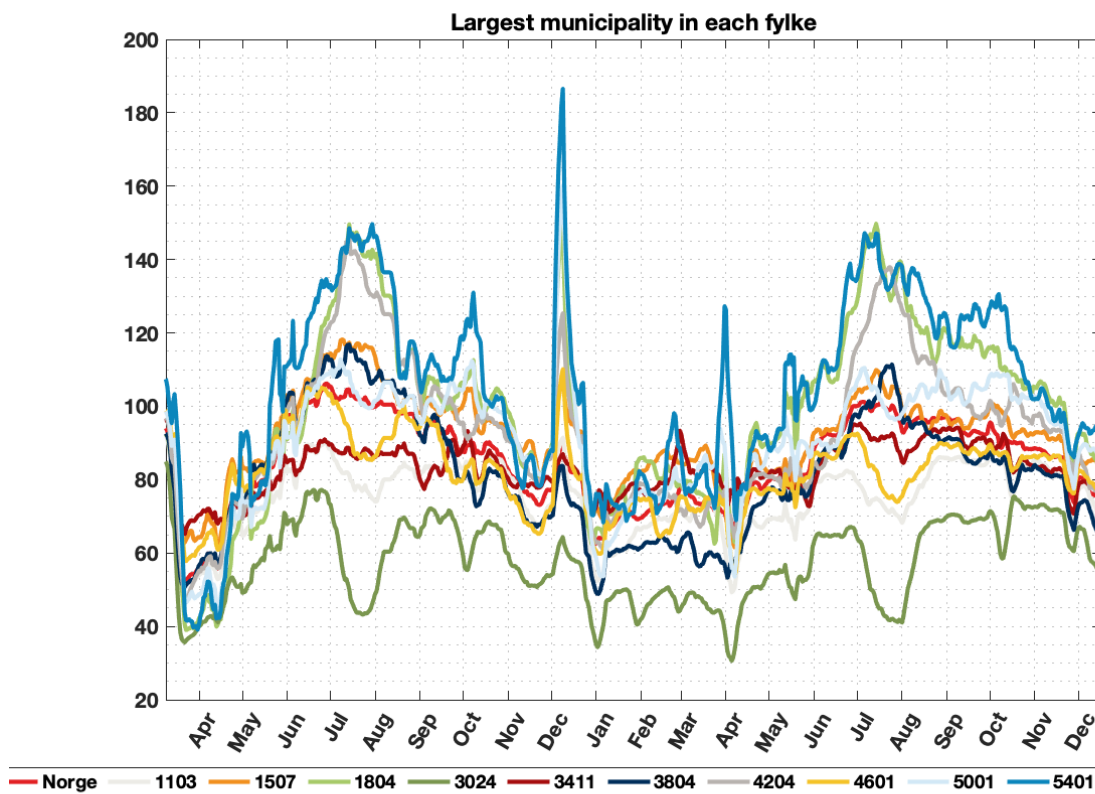


Figure 20: Mobility for selected municipalities since March 2020: Nationally (Norge), Stavanger (1103), Ålesund (1507), Bodø (1804), Bærum (3024), Ringsaker (3411), Sandefjord (3804), Kristiansand (4204), Bergen (4601), Trondheim (5001), Tromsø (5401).

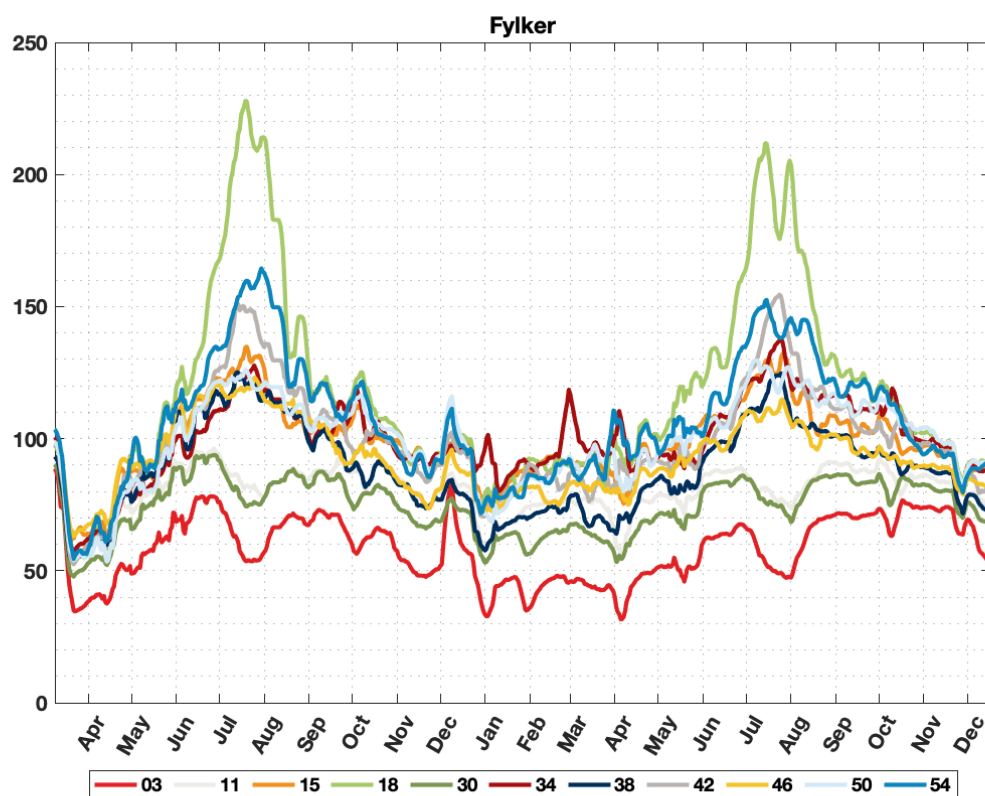


Figure 21: Mobility for fylker since March 2020: Oslo (03), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finmark (54).

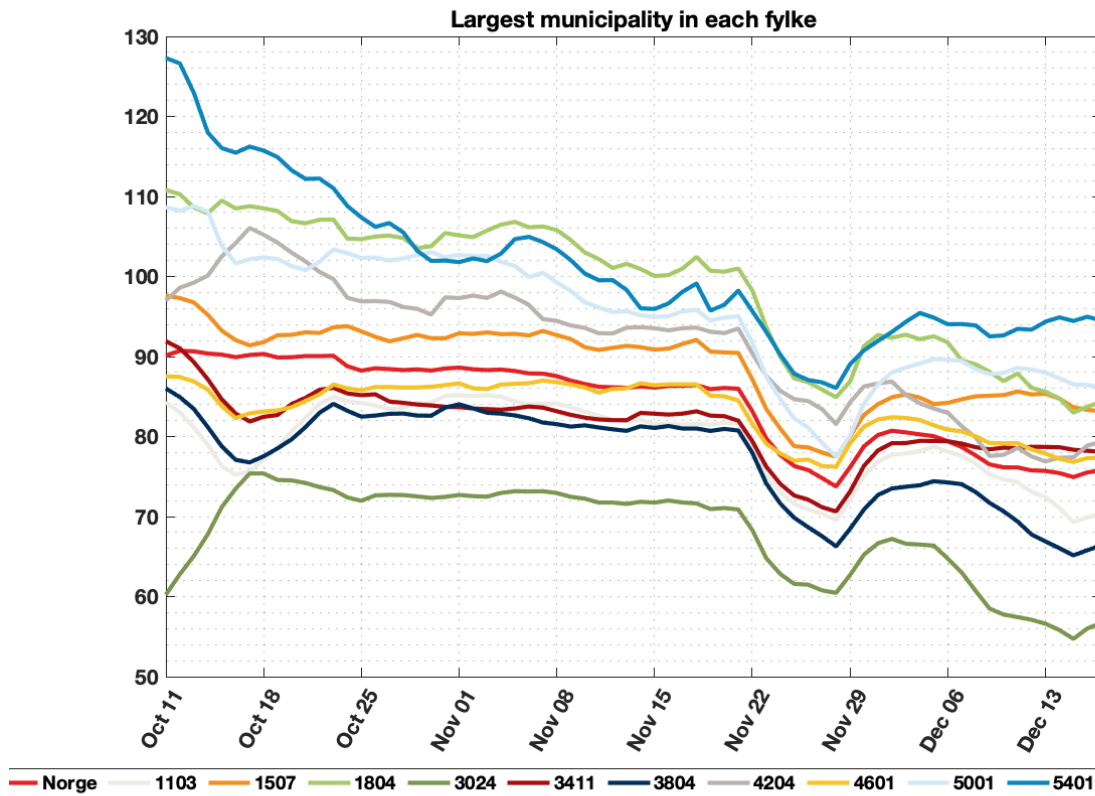


Figure 22: Zoom: Mobility from August 16, 2021 and onwards: Nationally (Norge), Stavanger (1103), Ålesund (1507), Bodø (1804), Bærum (3024), Ringsaker (3411), Sandefjord (3804), Kristiansand (4204), Bergen (4601), Trondheim (5001), Tromsø (5401).

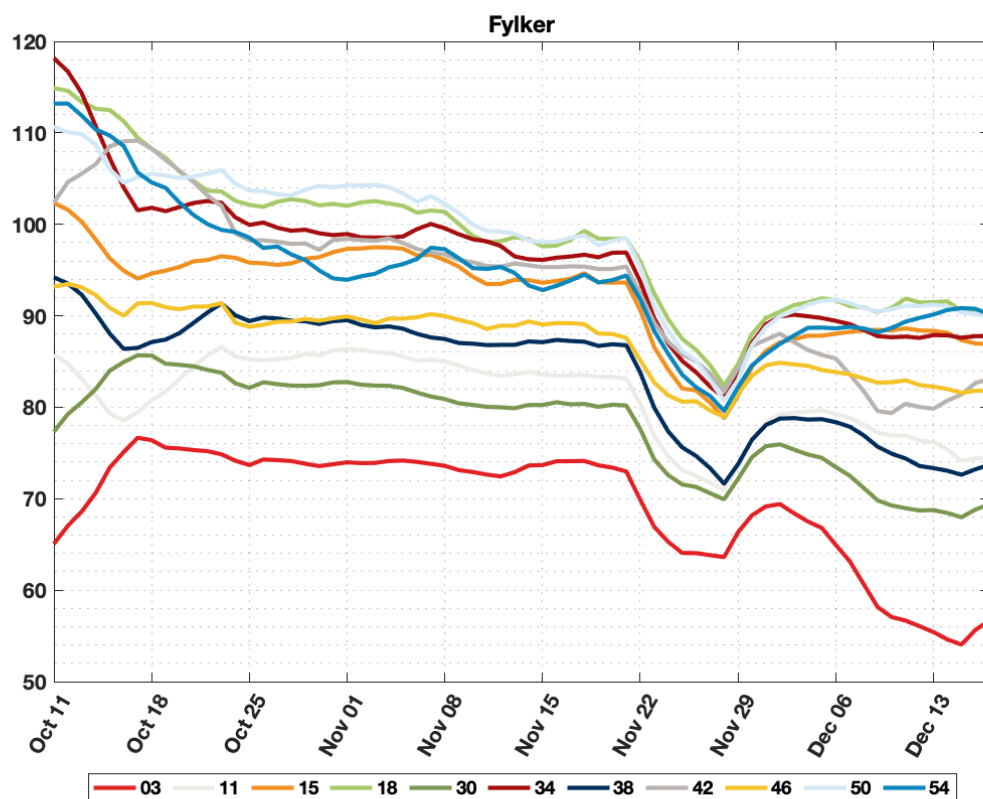


Figure 23: Zoom: Mobility from August 16, 2021 and onwards, per fylker: Oslo (03), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finnmark (54).

	47	48	49	50	51
Norge	86.1	83.2	76.2	79.4	75.7
Stavanger	81.5	78.7	72.1	78.1	72.5
Ålesund	90.9	87.2	80.0	84.2	85.3
Bodø	100.0	98.3	86.9	91.8	85.6
Bærum	71.7	68.3	62.7	64.8	56.6
Ringsaker	82.8	79.4	73.1	79.4	78.7
Sandefjord	81.1	78.0	68.5	74.3	66.9
Kristiansand	93.5	90.4	84.3	83.0	76.9
Bergen	86.4	81.6	79.1	80.9	77.9
Trondheim	94.9	91.8	80.1	89.6	88.0
Tromsø	95.9	95.7	89.0	94.0	94.3

Table 13: Municipalities

	47	48	49	50	51
Oslo	73.7	69.9	66.3	65.0	55.4
Rogaland	83.6	80.3	73.4	79.3	76.2
Møre og Romsdal	93.6	90.6	81.2	88.0	88.3
Nordland	97.6	95.9	84.7	91.7	91.5
Viken	80.2	77.6	72.2	73.5	68.8
Innlandet	96.1	93.7	83.7	89.4	87.9
Vestfold og Telemark	87.1	83.8	73.8	78.4	73.3
Agder	95.3	92.4	84.3	85.3	79.8
Vestlandet	89.0	85.1	81.4	83.8	82.2
Trøndelag	98.0	95.3	83.0	91.7	91.2
Troms og Finnmark	92.8	91.8	82.2	88.6	90.1

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

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

Figure 25 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.

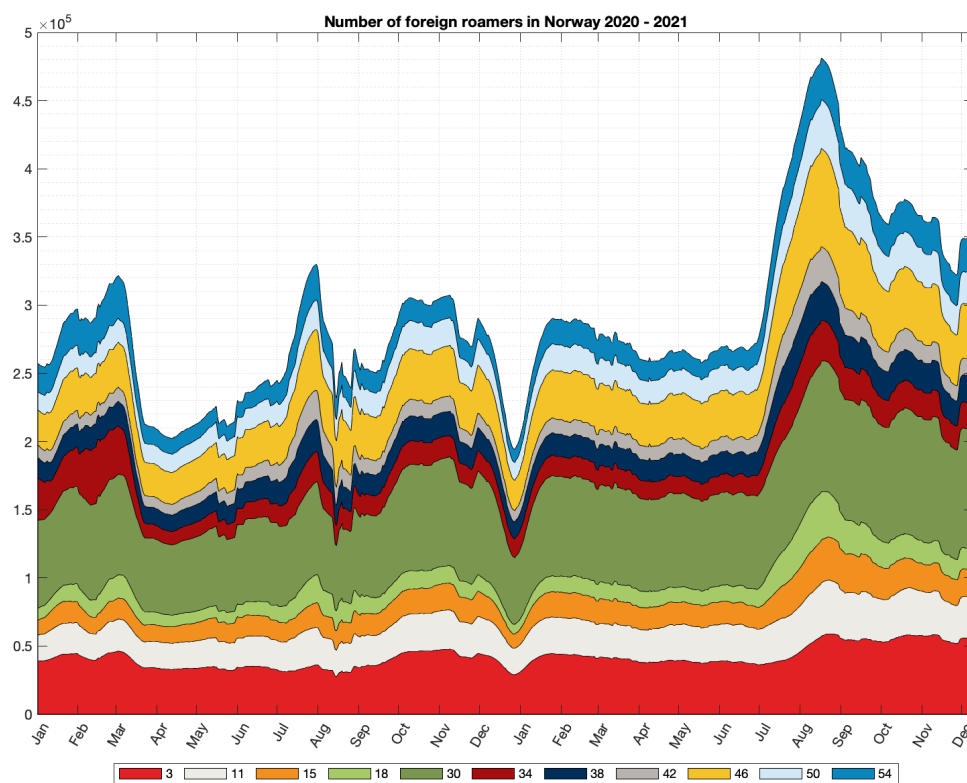


Figure 24: The total number of foreign roamers in Norway broken down on different fylker: Oslo (3), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finnmark (54).

9.1 Foreign roamers on Telenor's network in Norway

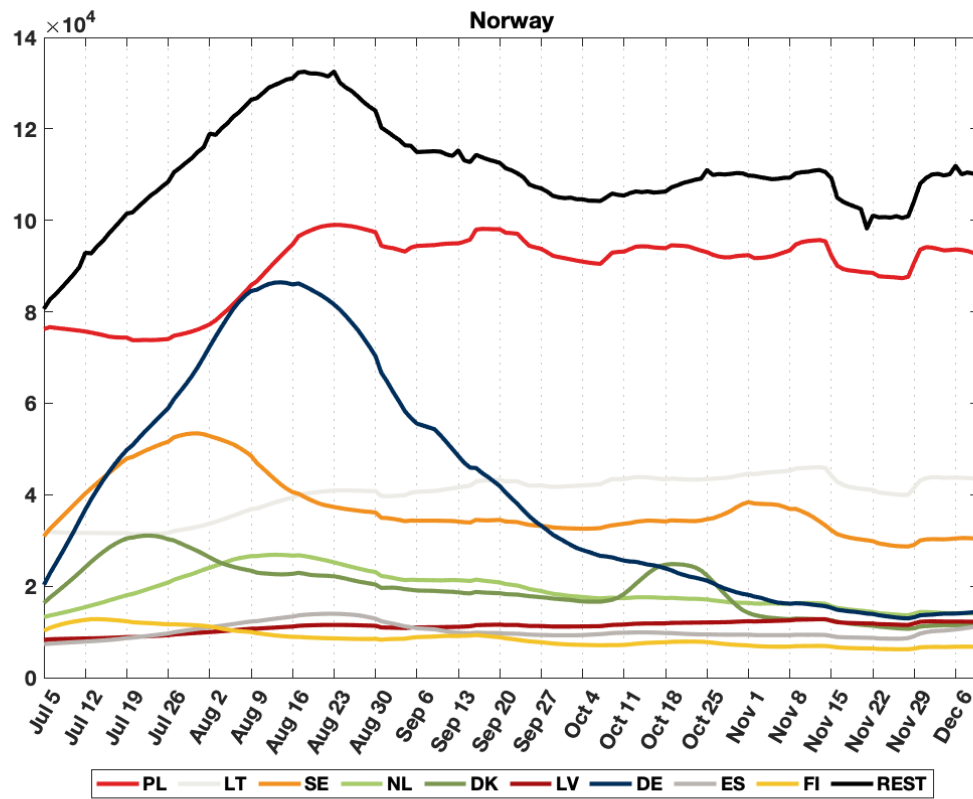
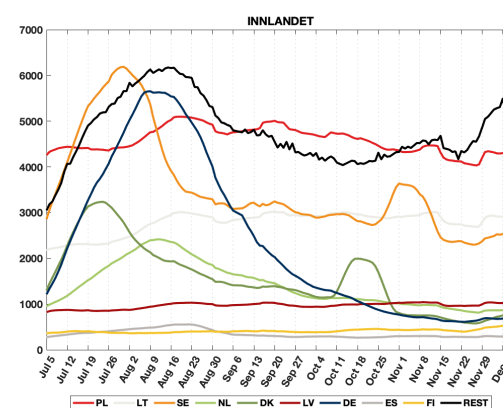
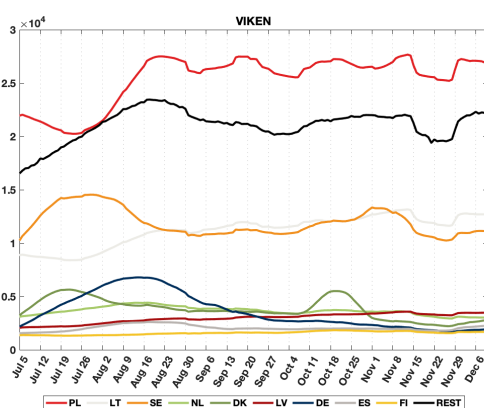
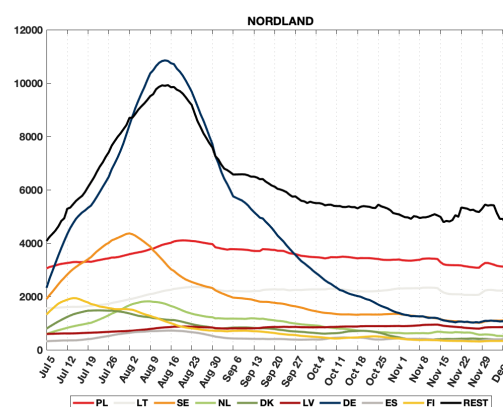
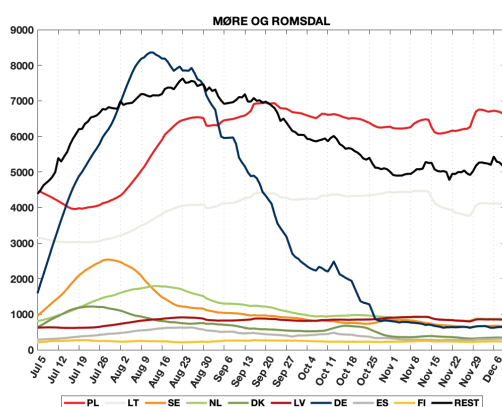
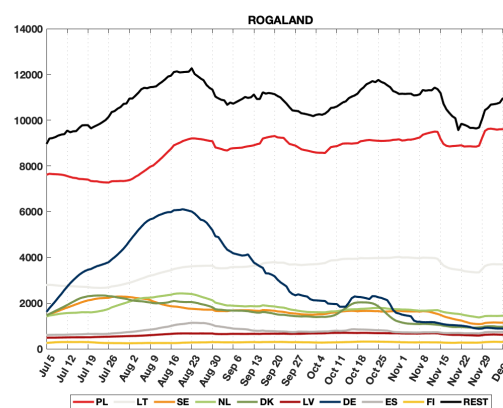
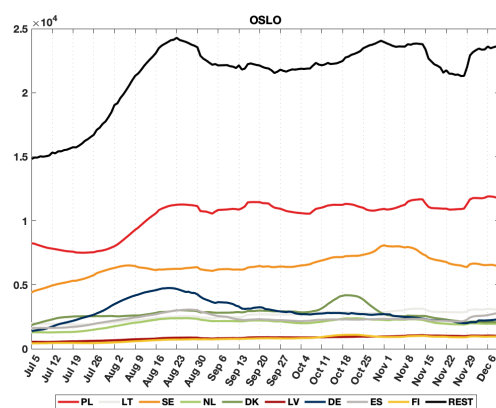


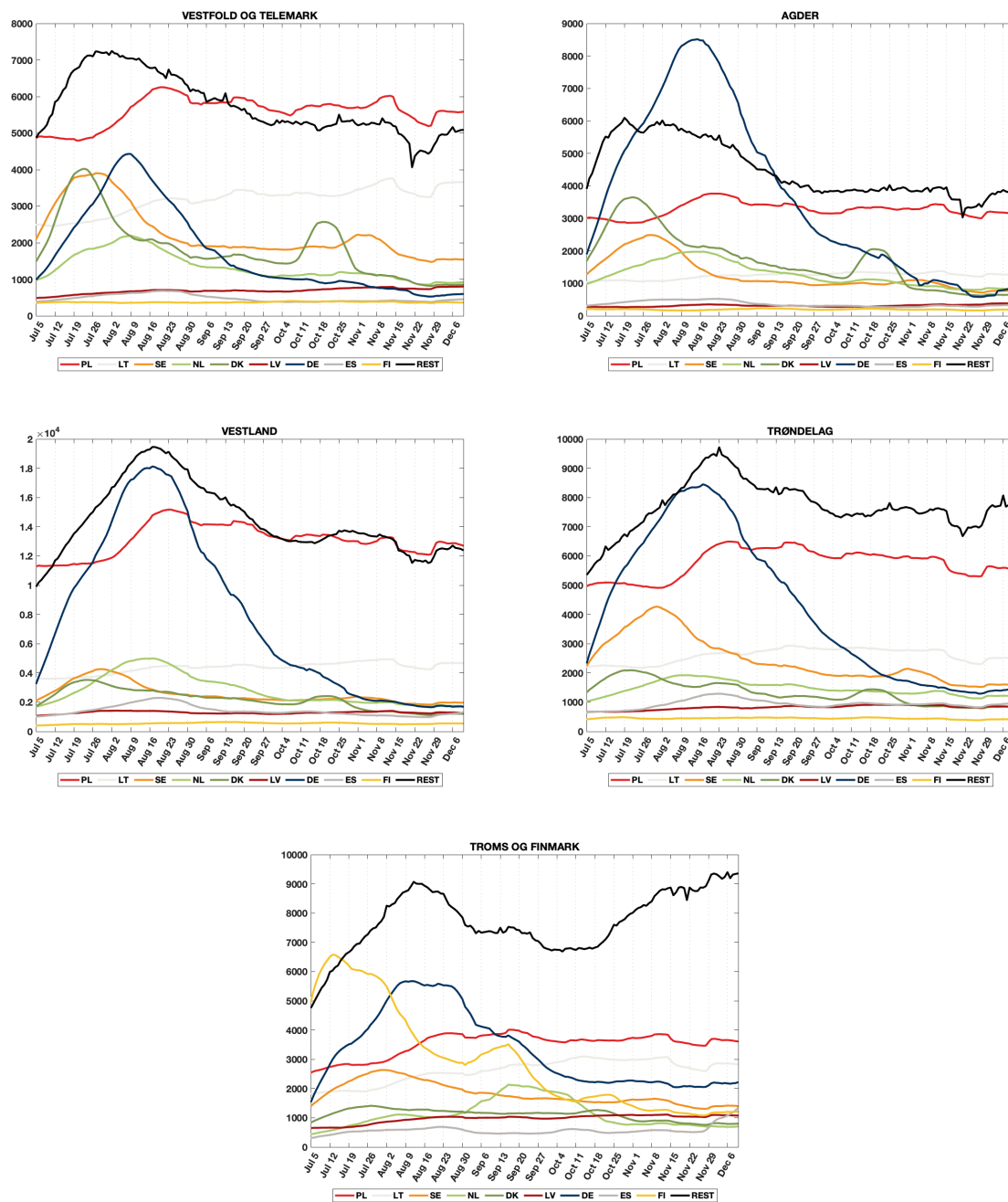
Figure 25: National overview of total number of foreign, visiting roamers from Poland, Lithuania, Sweden, Netherlands, Denmark, Latvia, Germany, Spain, Finland and the rest of the world.

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 15: Estimated parameters

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	Period
R0s	1.722	2.425	2.581	2.559	2.732	3.131	Until March 14
R1s	0.441	0.56	0.59	0.594	0.624	0.739	From 15 March to 19 April
R2s	0.011	0.698	0.959	0.9	1.149	1.597	From 20 April to 10 May
R3s	0.025	0.561	0.72	0.69	0.842	1.279	From 11 May to 30 June
R4s	0.058	0.701	0.932	0.942	1.161	1.79	From 01 July to 31 July
R5s	0.391	0.98	1.139	1.127	1.278	1.598	From 01 August to 31 August
R6s	0.628	0.878	0.957	0.984	1.084	1.503	From 01 September to 30 September
R7s	0.725	1.082	1.19	1.176	1.275	1.482	From 01 October to 25 October
R8s	0.641	1.127	1.245	1.248	1.368	1.858	From 26 October to 04 November
R9s	0.701	0.821	0.854	0.856	0.892	1.019	From 05 November to 30 November
R10s	0.861	0.963	0.988	0.99	1.016	1.104	From 01 December to 03 January
R11s	0.452	0.686	0.739	0.741	0.792	1.03	From 04 January to 21 January
R12s	0.536	0.799	0.881	0.877	0.959	1.183	From 22 January to 07 February
R13s	1.052	1.28	1.335	1.335	1.391	1.584	From 08 February to 01 March
R14s	0.847	1	1.044	1.051	1.098	1.288	From 02 March to 24 March
R15s	0.582	0.782	0.878	0.858	0.934	1.107	From 25 March to 12 April
R16s	0.607	0.8	0.844	0.844	0.887	1.115	From 13 April to 05 May
R17s	0.582	0.836	0.906	0.909	0.97	1.328	From 06 May to 26 May
R18s	0.575	0.836	0.902	0.898	0.96	1.188	From 27 May to 20 June
R19s	0.675	0.891	0.938	0.935	0.981	1.165	From 21 June to 04 August
R20s	0.965	1.19	1.243	1.24	1.29	1.446	From 05 August to 31 August
R21s	0.629	0.745	0.784	0.779	0.815	0.942	From 01 September to 24 September
R22s	1.039	1.078	1.091	1.092	1.105	1.165	From 25 September to 28 November
R23s	0.814	1.046	1.123	1.124	1.202	1.523	From 29 November
AMPs	1.002	1.336	1.571	1.66	1.89	3.404	-
π_0	-35.881	-7.944	0.209	0.065	7.955	35.315	-
π_1	1.7e-07	3.4e-05	6.3e-05	5.8e-05	8.2e-05	1.4e-04	-
delays	0	2	3	2.759	4	4	-

Table 16: Assumptions

Assumptions	Mean	Distribution	Reference
Mobile Mobility Data			
Telenor coverage	48%		https://ekomstatistikken.nkom.no/
Data updated	December 13		
Data used in the predictions	December 10th	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 17: Estimated reproduction numbers 7 days ago

Location	Reff
National	0.92(0.91 - 0.94)
Oslo	0.87(0.85 - 0.9)
Rogaland	1.02(0.97 - 1.07)
Møre og Romsdal	0.86(0.78 - 0.94)
Nordland	0.95(0.86 - 1.05)
Viken	0.93(0.9 - 0.95)
Innlandet	0.93(0.87 - 0.99)
Vestfold og Telemark	0.91(0.87 - 0.95)
Agder	1.09(1.04 - 1.14)
Vestland	0.95(0.91 - 0.99)
Trøndelag	0.9(0.85 - 0.96)
Troms og Finnmark	0.87(0.81 - 0.94)

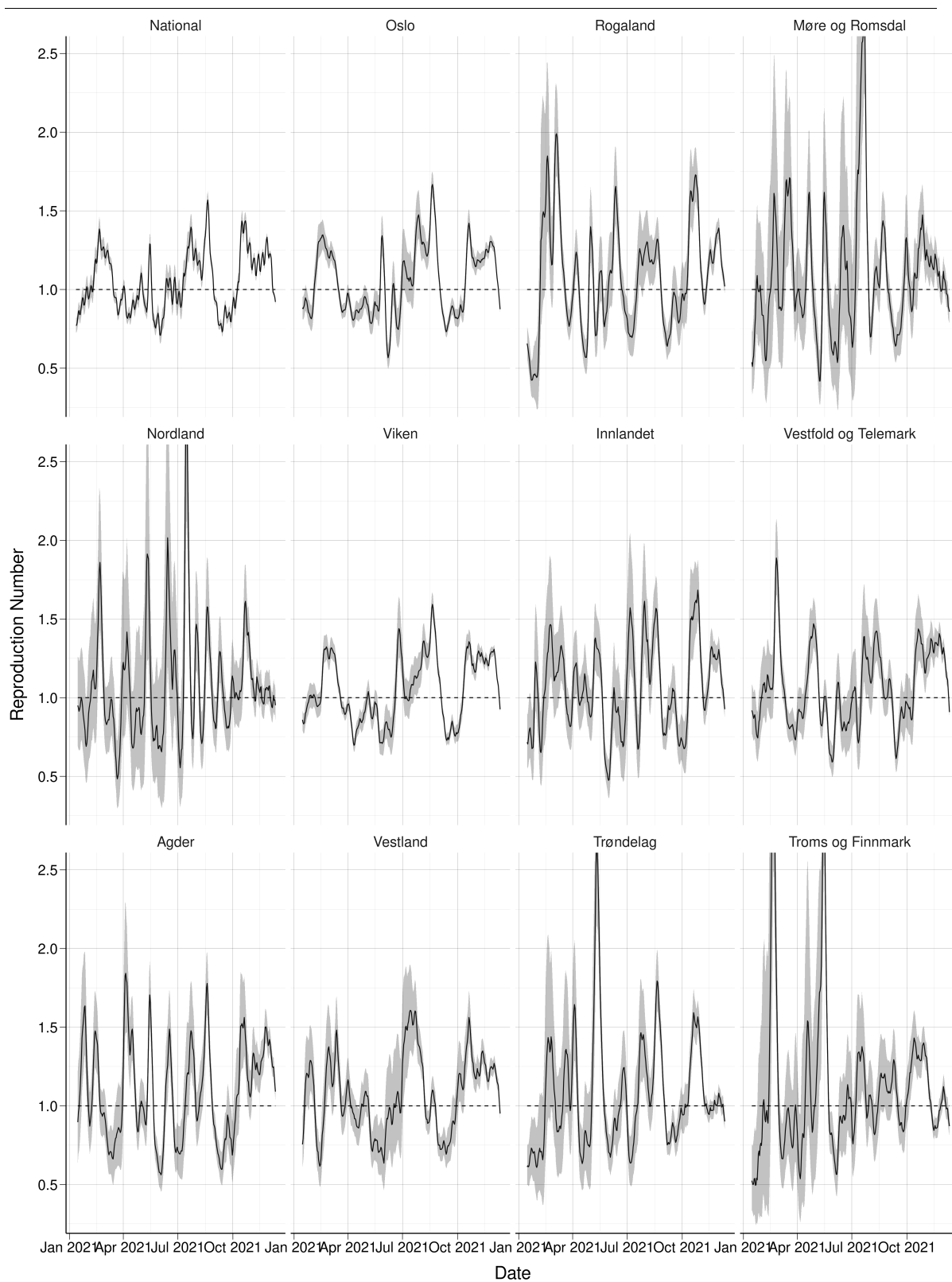


Figure 28: Reproduction number estimated using the R package EpiEstim.

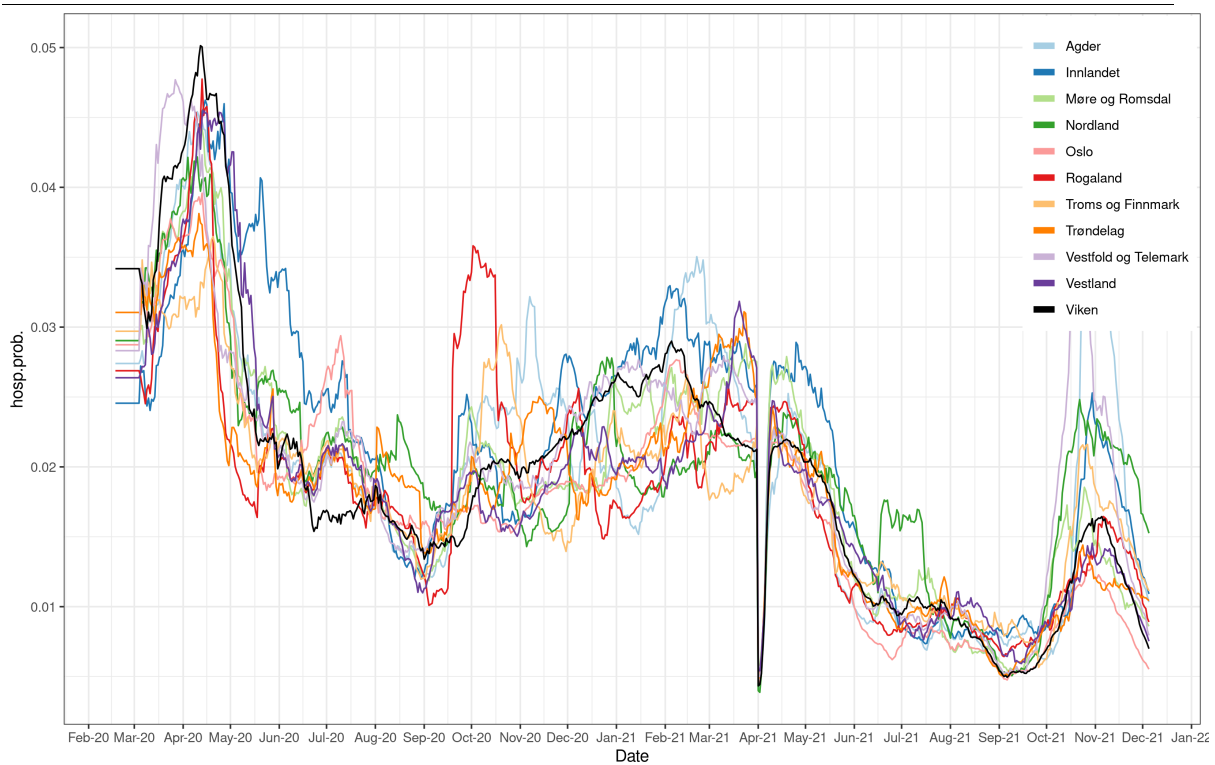


Figure 29: Regional hospitalisation probabilities per infection. The estimates are based on Salje et al., and regional data on the age distribution in the test data and the empirical case-hospitalisation rates.

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).

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.