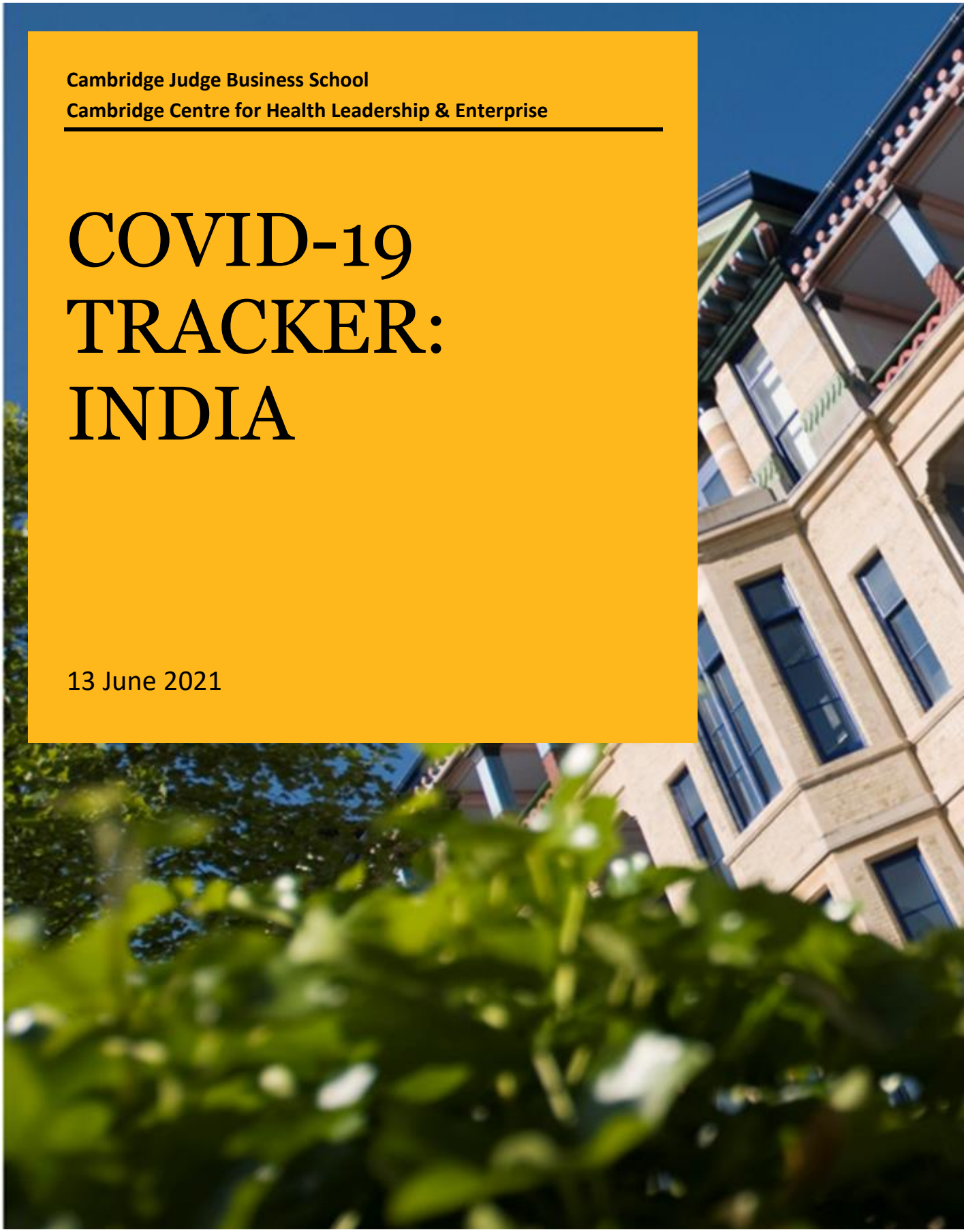
Cambridge Judge Business School
Cambridge Centre for Health Leadership & Enterprise

COVID-19 TRACKER: INDIA

13 June 2021



Centre for Health Leadership & Enterprise
UNIVERSITY OF CAMBRIDGE Judge Business School
HSTP Health Systems Transformation Platform
National Institute of Economic and Social Research

This tracker[1] has been developed by researchers at Cambridge Judge Business School and National Institute of Economic and Social Research, working with Health Systems Transformation Platform in India, as part of a pandemic monitoring series devoted to India and its states and union territories. It provides short term forecasts of the trajectory of the pandemic, identifying states and union territories that are at risk of increases in infection incidence. The forecasts are based on a structural time series model that uses historical data in estimation but adapts to the trend emerging in the most recent period. The model is described in Harvey and Kattuman (2021) "Time series models based on growth curves with applications to forecasting coronavirus". *Harvard Data Science Review*, Special issue 1 - COVID -19.

As of 12 June 2021, the estimated Reproduction number (R_t) for India stood at 0.81. Newly reported COVID-19 cases are likely to decline to about 37,000 per day by 26 June 2021.

The daily reported cases are in rapid decline in all Indian states and union territories. The trend value of the daily growth rate of cases was -5.2% as of 12 June 2021. This implies that reported new cases can be expected to halve in 13 days, under the assumption that the growth rate remains constant.

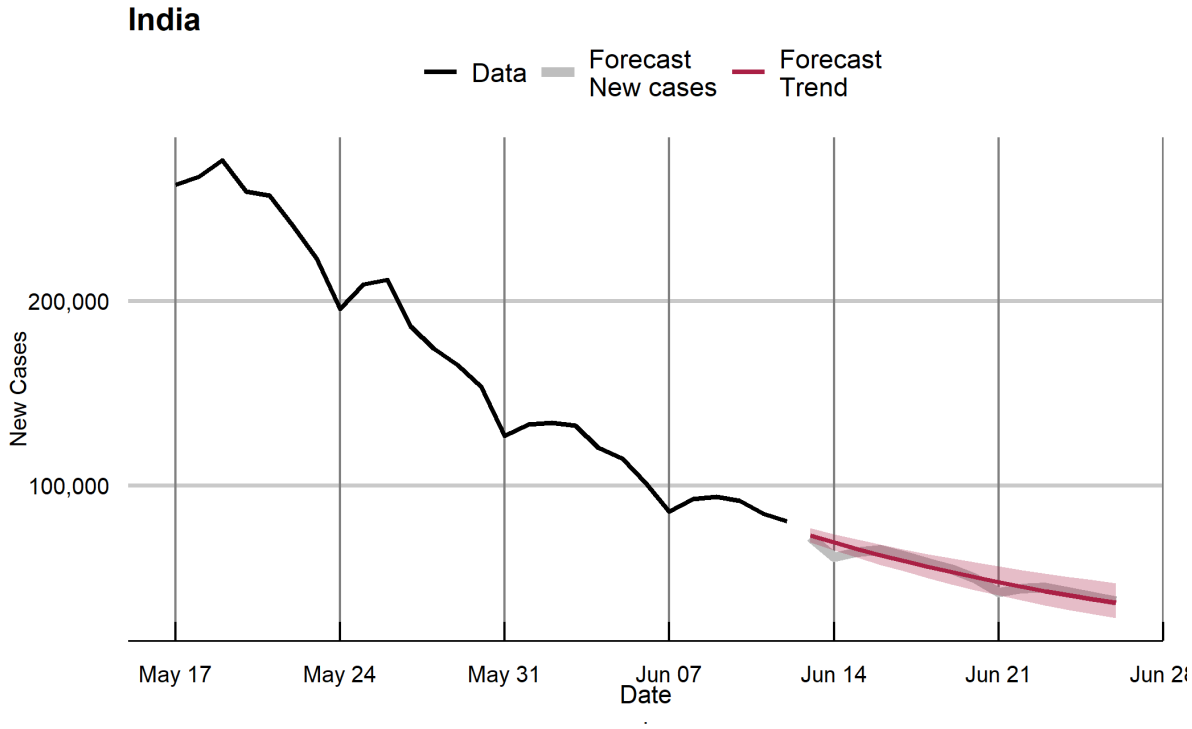
There are indications that the growth rates of cases, though still negative, have reversed direction from their downward paths in recent days in Chandigarh, Delhi, Goa, Haryana, Kerala, Maharashtra, Meghalaya, Rajasthan, Uttarakhand and *Uttar Pradesh.*

Mean absolute percentage error of the forecasts of daily cases in India given in the 6 June tracker, for the week beginning 7 June 2021, is 5%. The accuracy of forecasts rely on the quality of the reported data. Changes in government pandemic policies and in transmission relevant social behaviour may cause realised numbers to depart from forecasts. Data have been volatile for Chandigarh, Haryana, Meghalaya and Sikkim, making their forecasts less accurate.

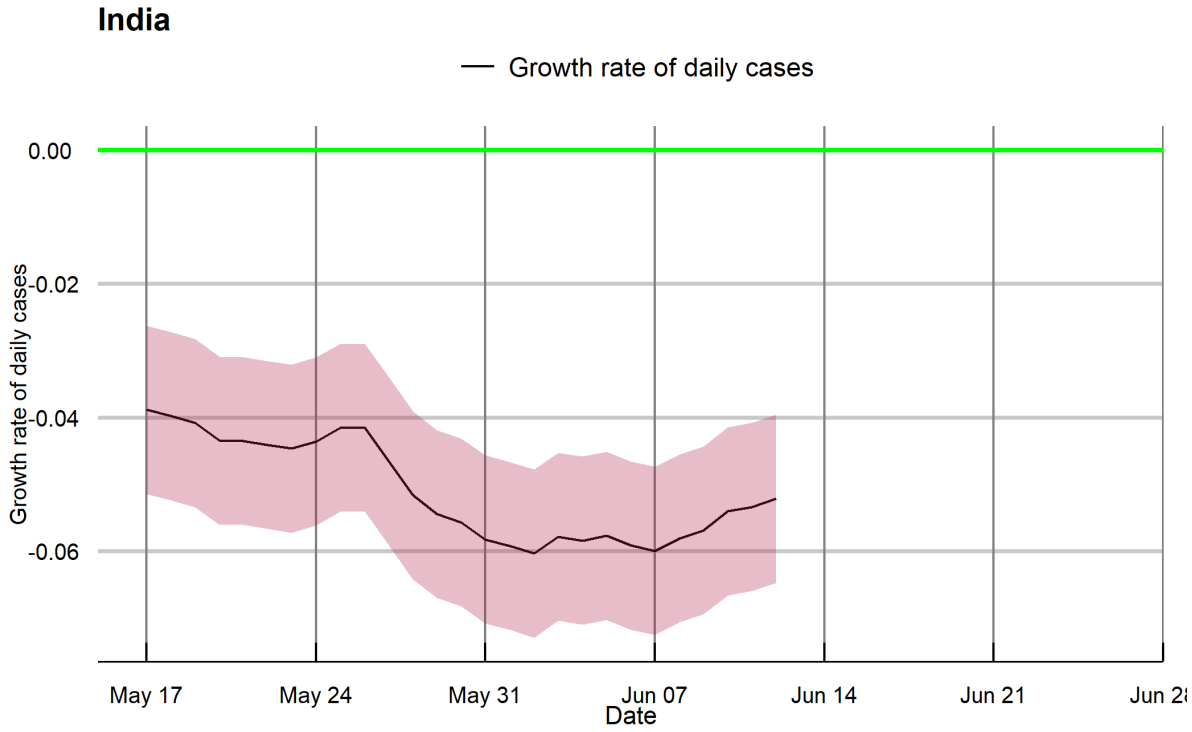
[1] CJBS COVID-19 Tracker for India can be accessed at: www.jbs.cam.ac.uk/covid-india
The companion spreadsheet contains all the estimates and forecasts.

Contact: Paul Kattuman <p.kattuman@jbs.cam.ac.uk>

Daily Covid-19 cases in India: Forecast

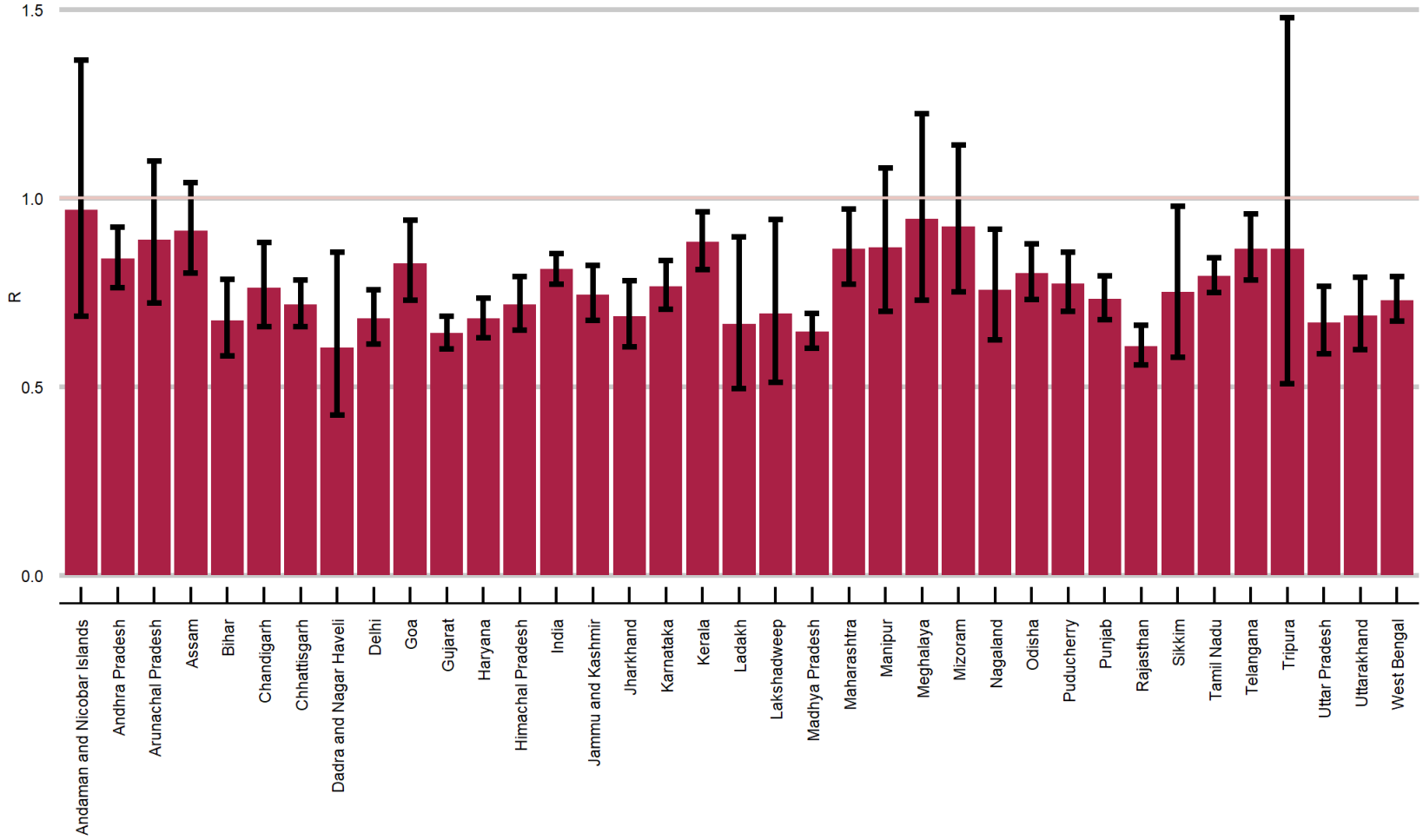


Forecasts of daily new cases for the period 13 June 2021 to 26 June 2021, based on data till 12 June 2021. New COVID-19 cases is likely to decline to about 36,000 per day by 26 June 2021.

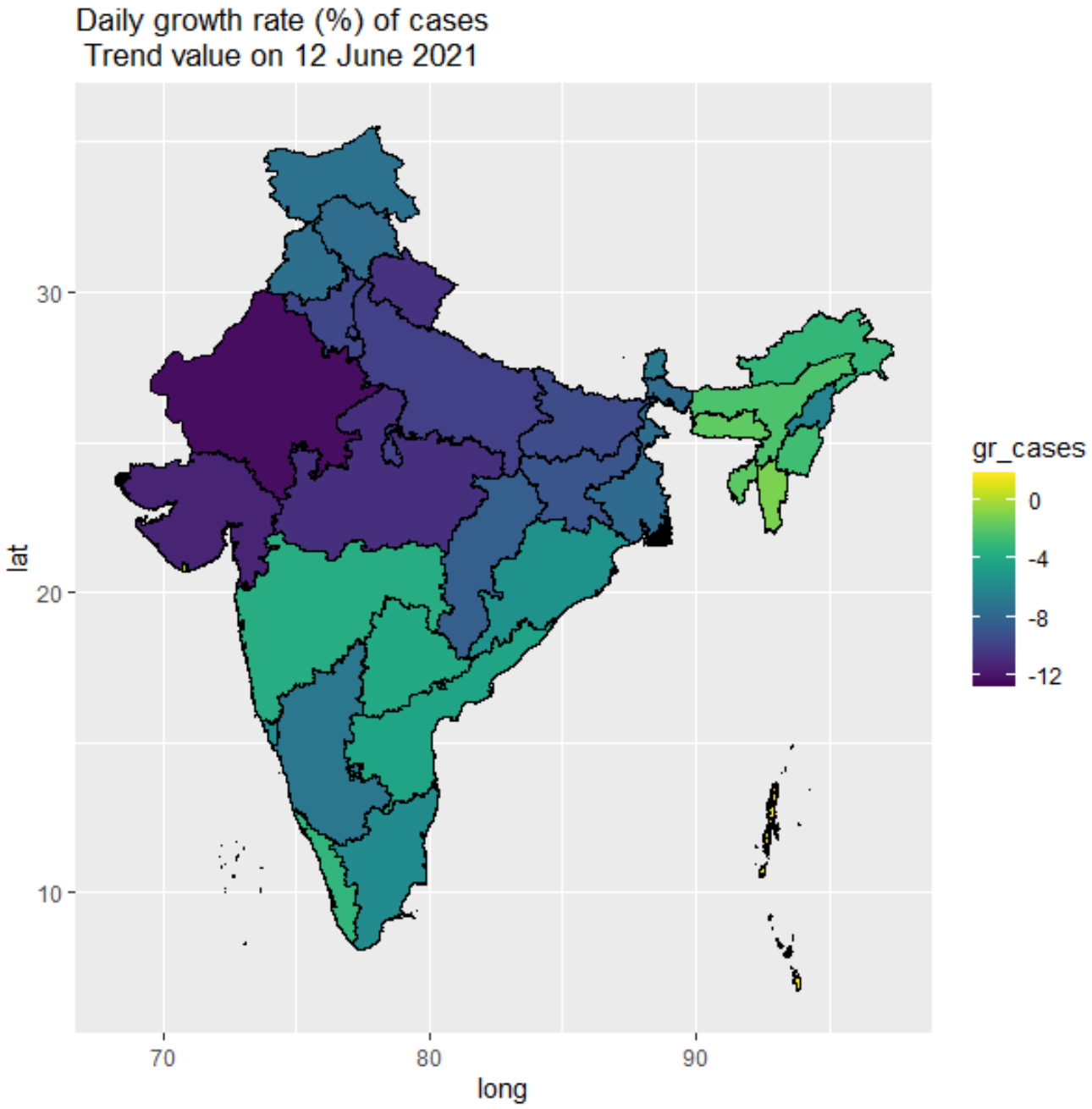


The filtered trend in the growth rate of daily new cases. Final date: 12 June 2021.

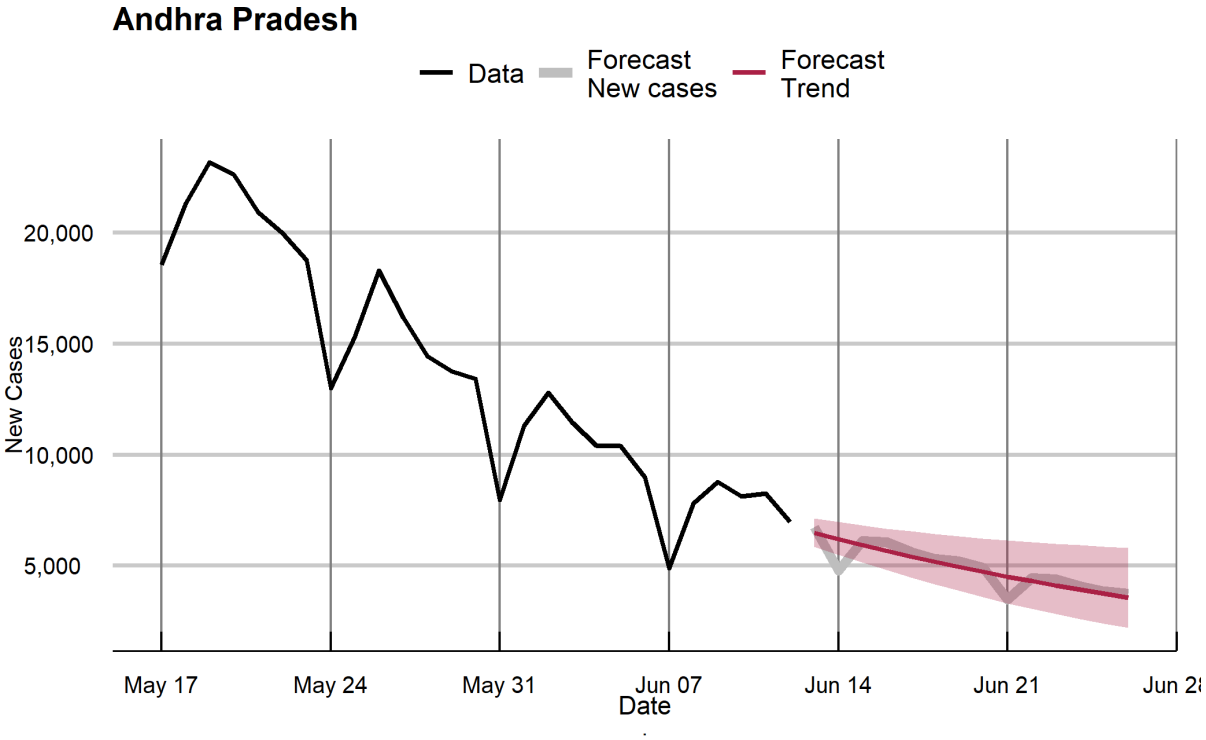
R_t: 12 June 2021

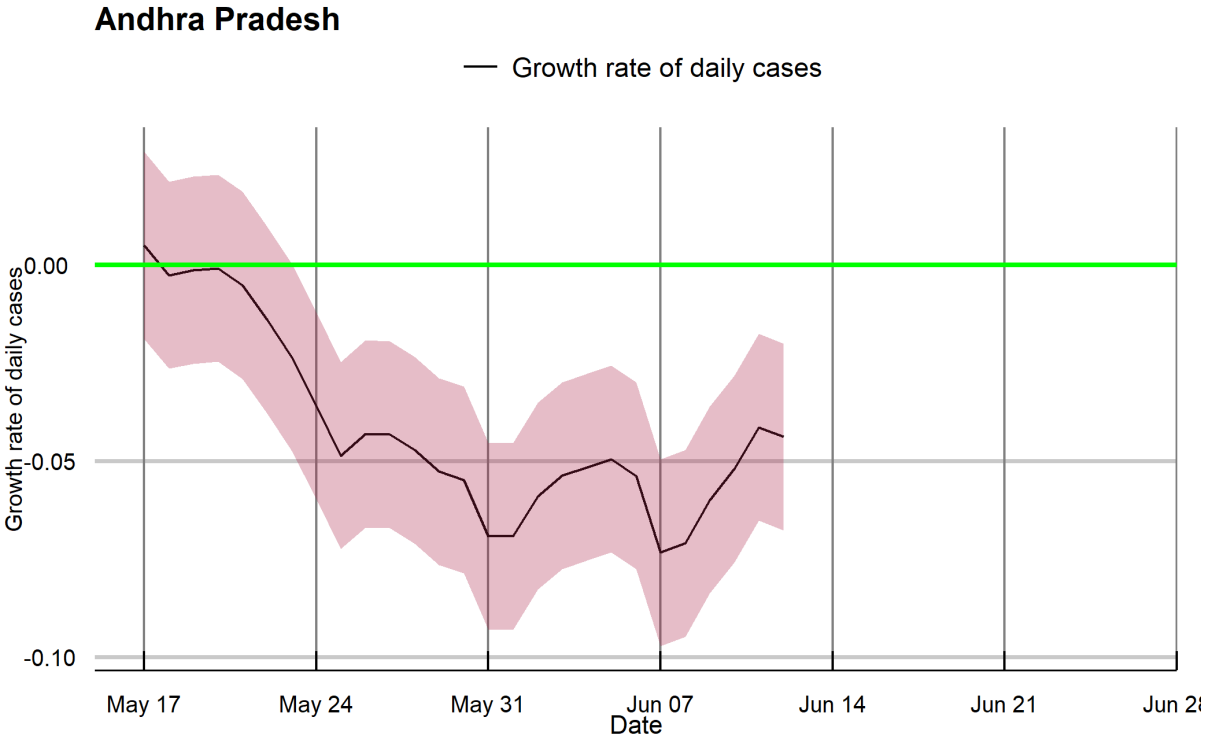


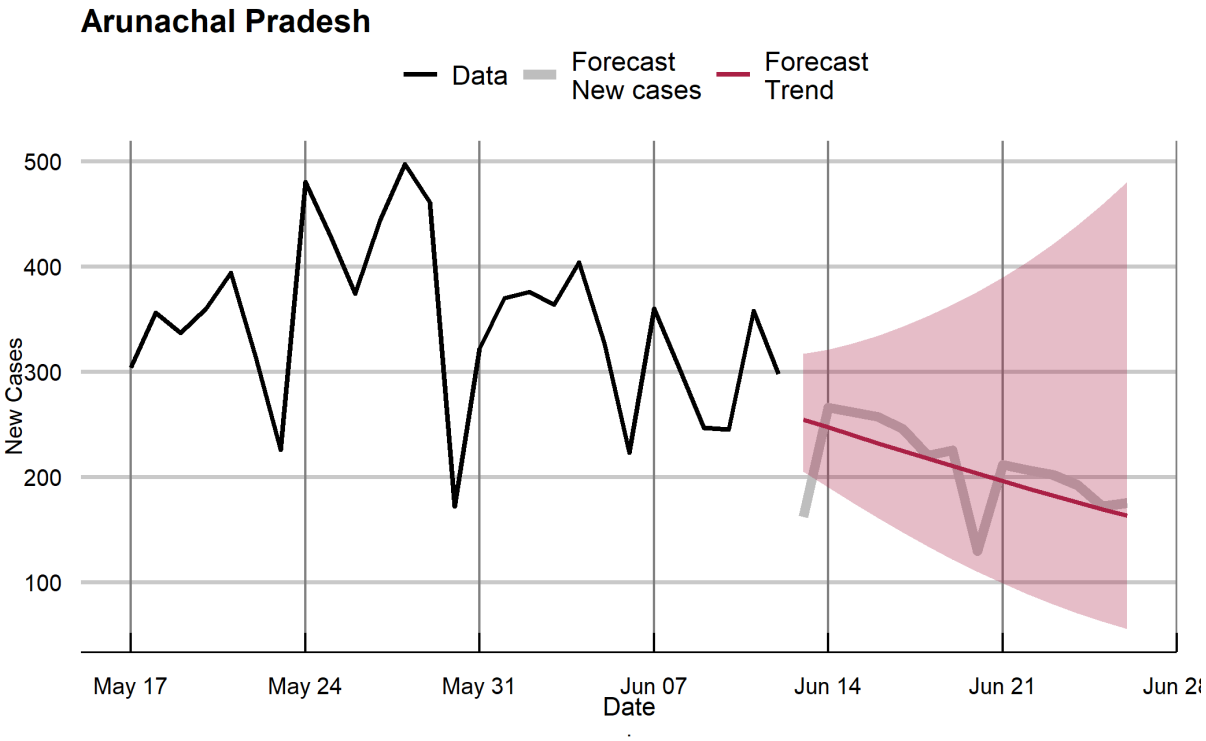
Bar chart shows point estimates of R and the ± 1 standard deviation confidence intervals

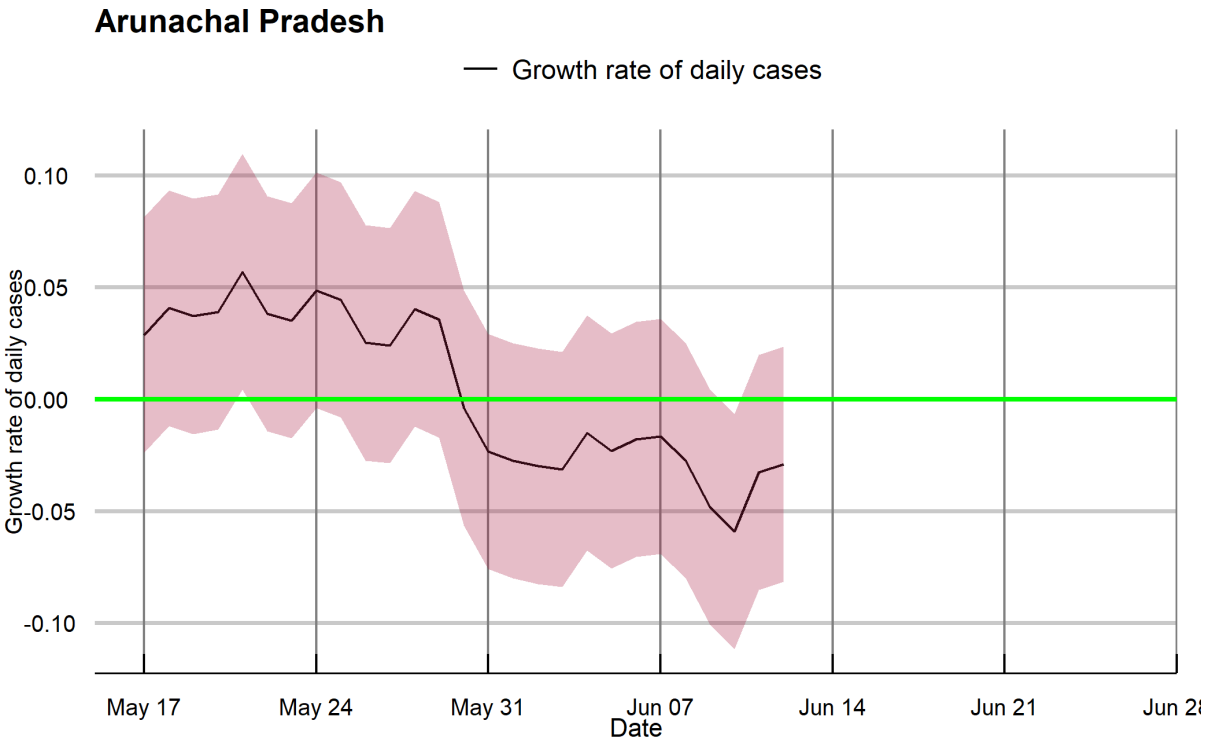

Daily growth rate (%) of cases
Trend value on 12 June 2021
lat
30
20
10
70
80
90
long
gr_cases
0
-4
-8
-12

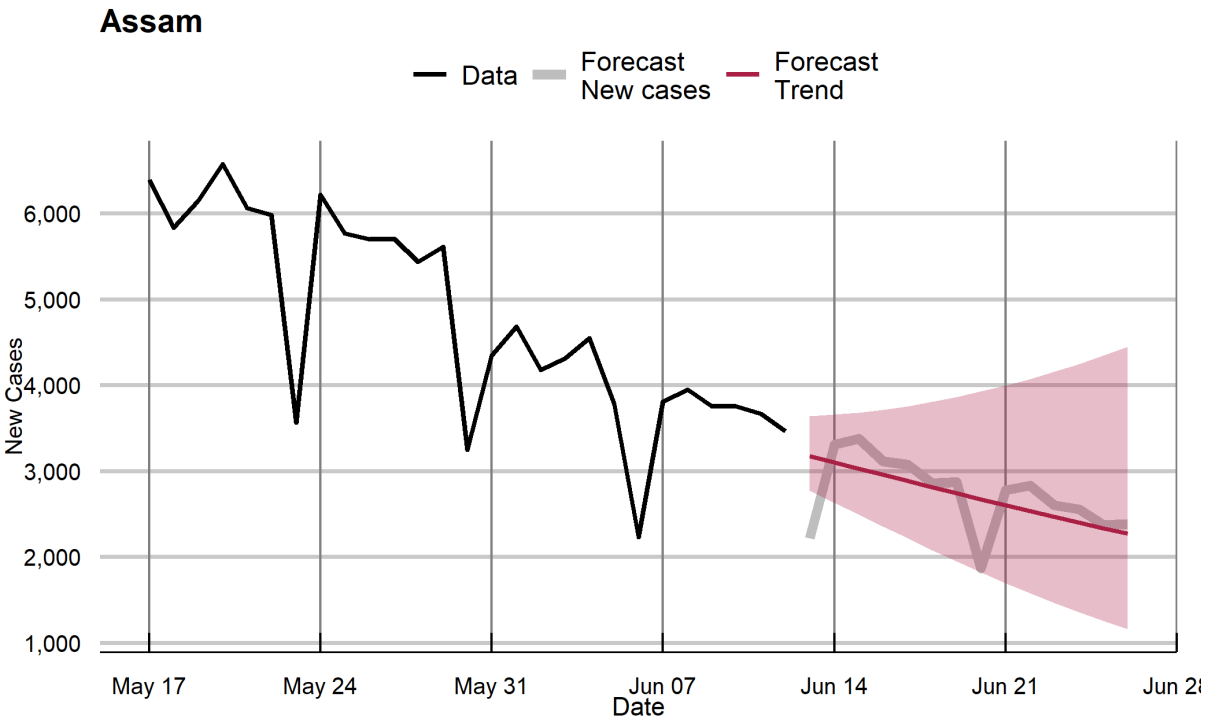
Daily Cases forecast: States and Union territories

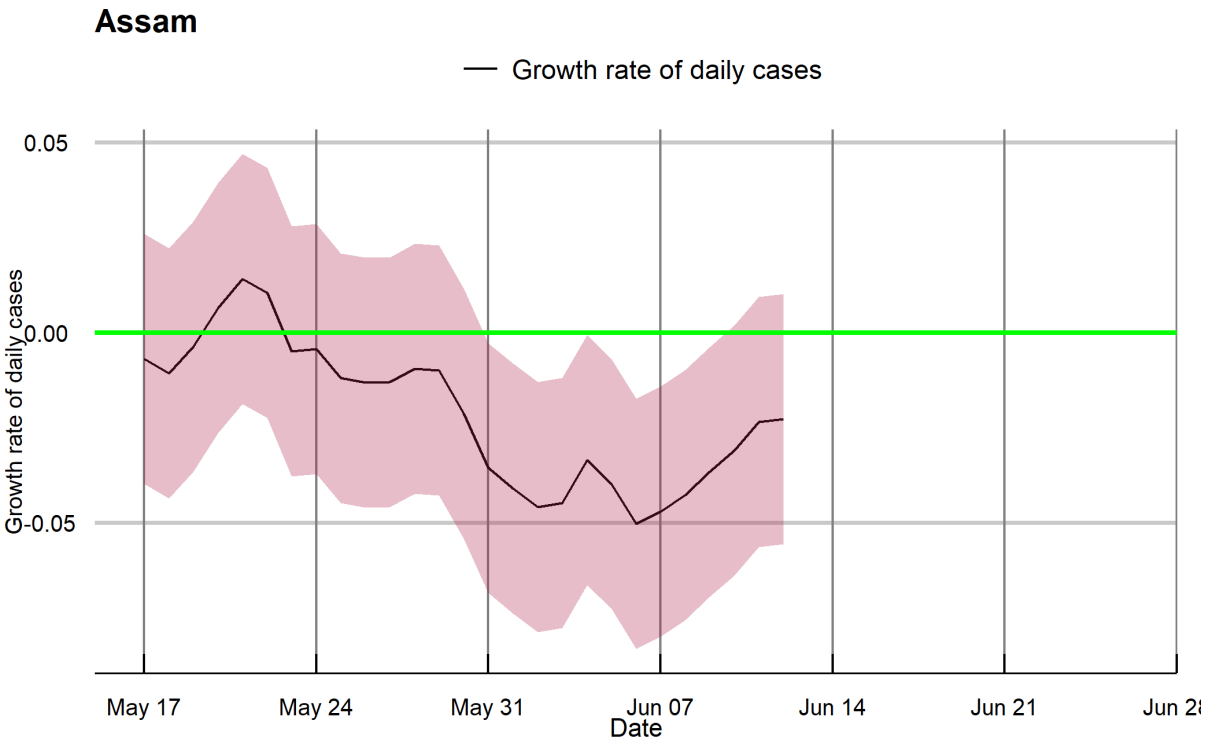


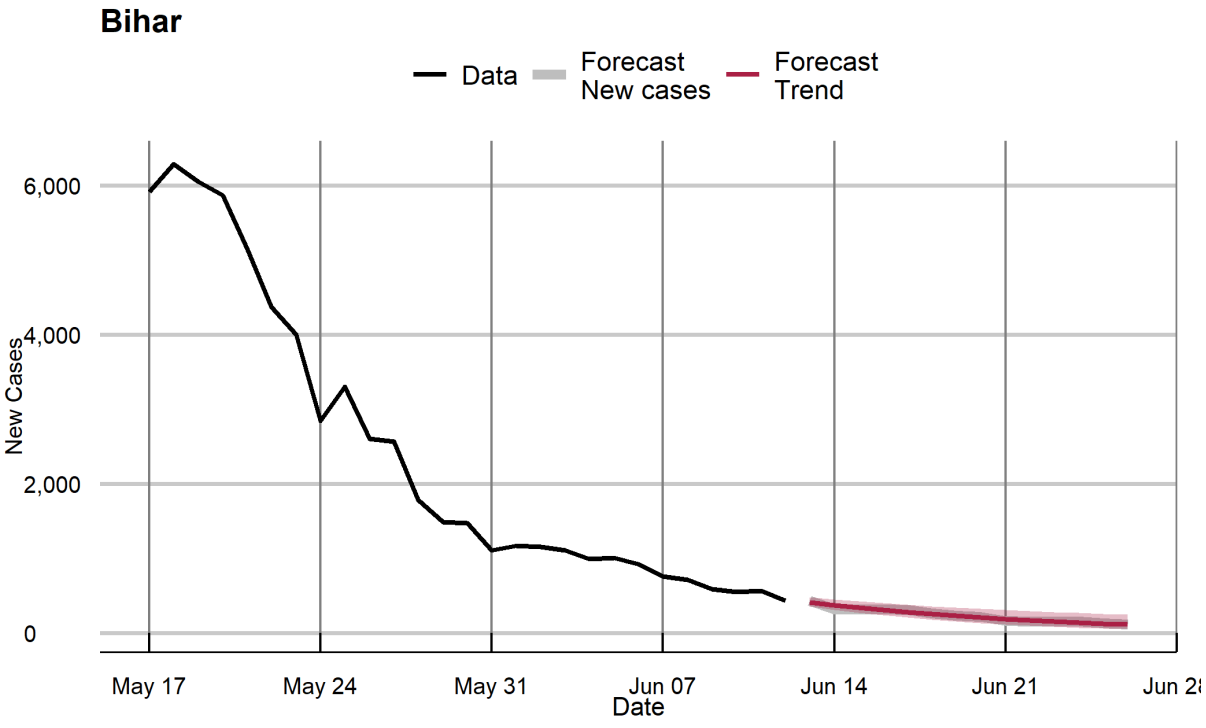


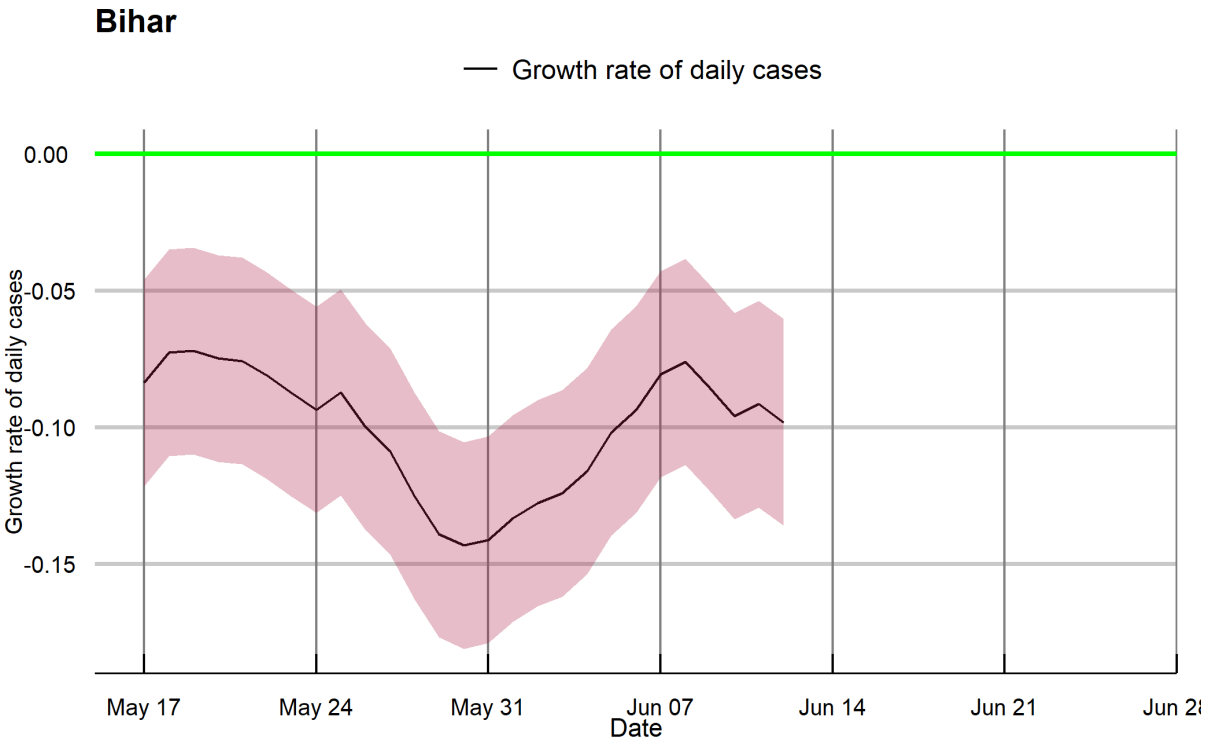

Arunachal Pradesh
Data
Forecast
New cases
Forecast
Trend
500
400
300
200
100
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

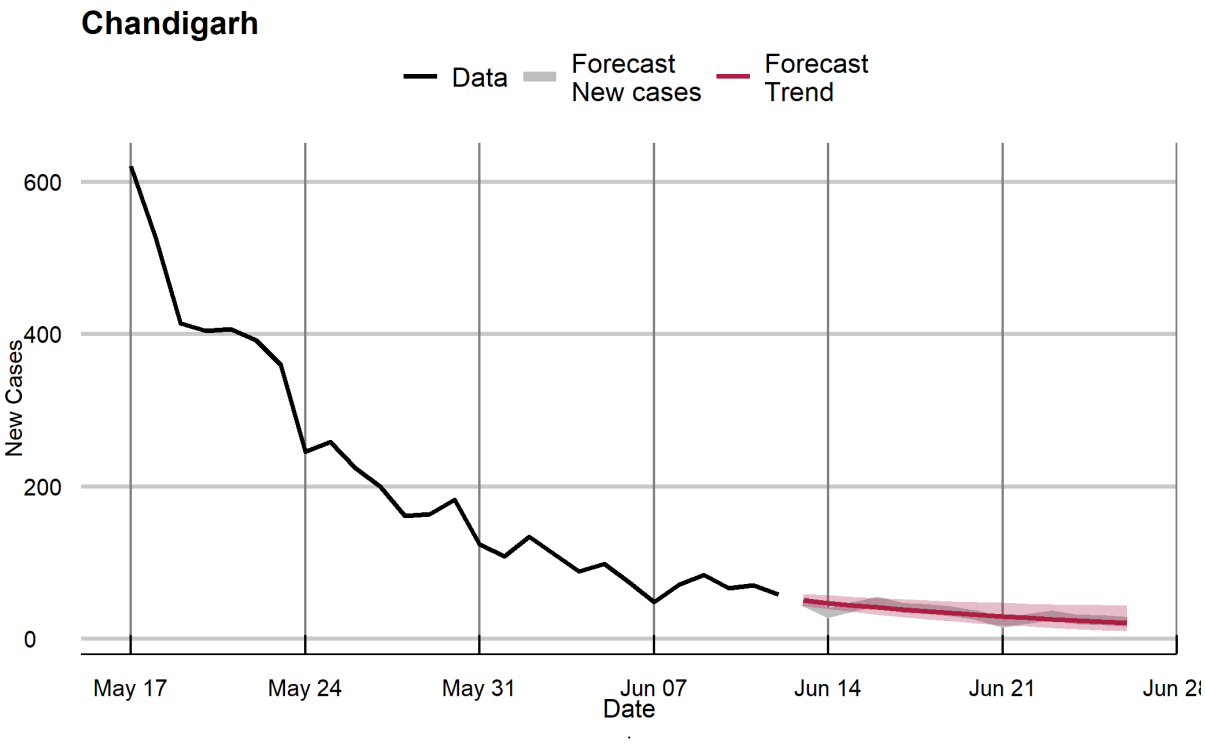

Arunachal Pradesh
Growth rate of daily cases
0.10
0.05
0.00
-0.05
-0.10
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

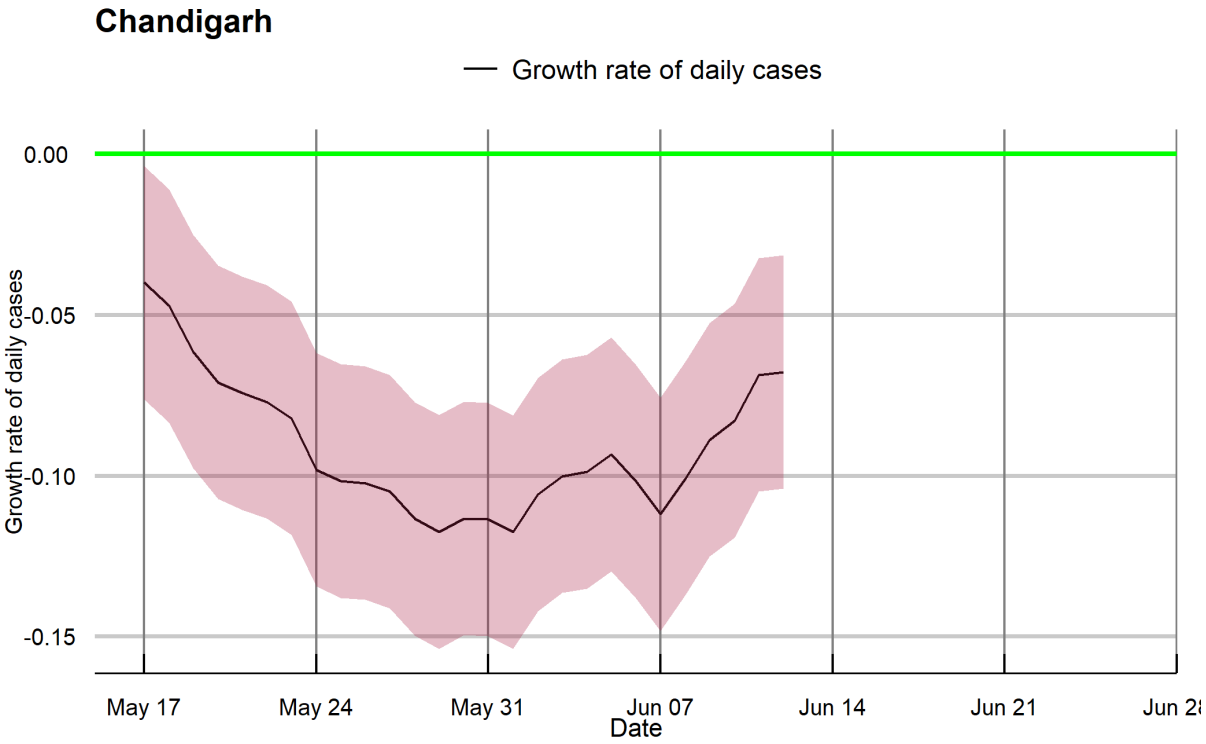

Assam
Data
Forecast
New cases
Forecast
Trend
6,000
5,000
4,000
3,000
2,000
1,000
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

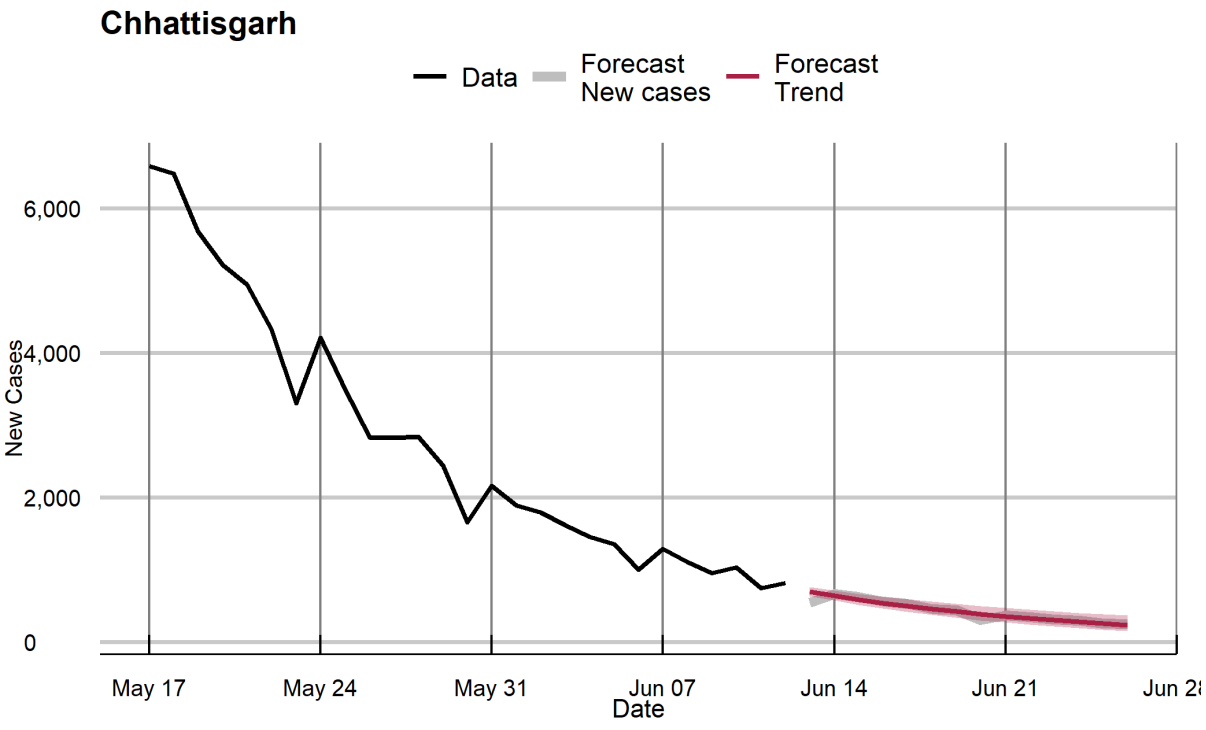

Assam
Growth rate of daily cases
0.05
0.00
-0.05
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

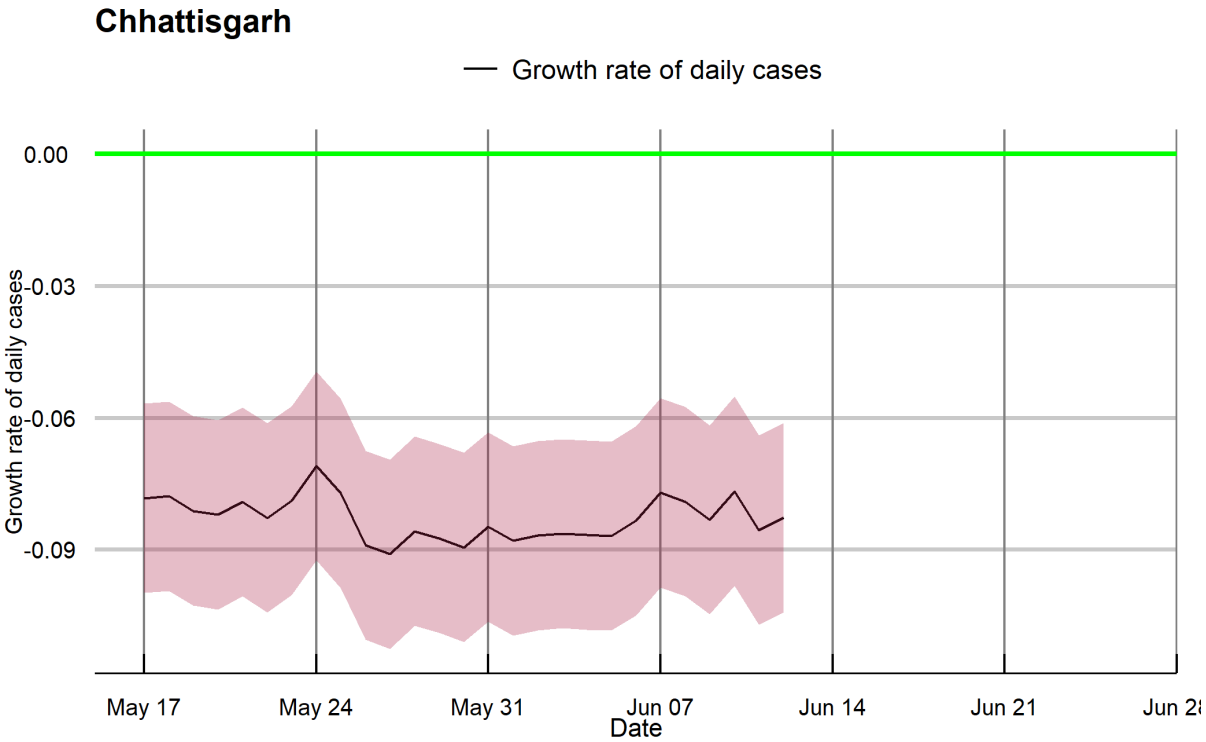

Bihar
Data
Forecast
New cases
Forecast
Trend
6,000
4,000
2,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

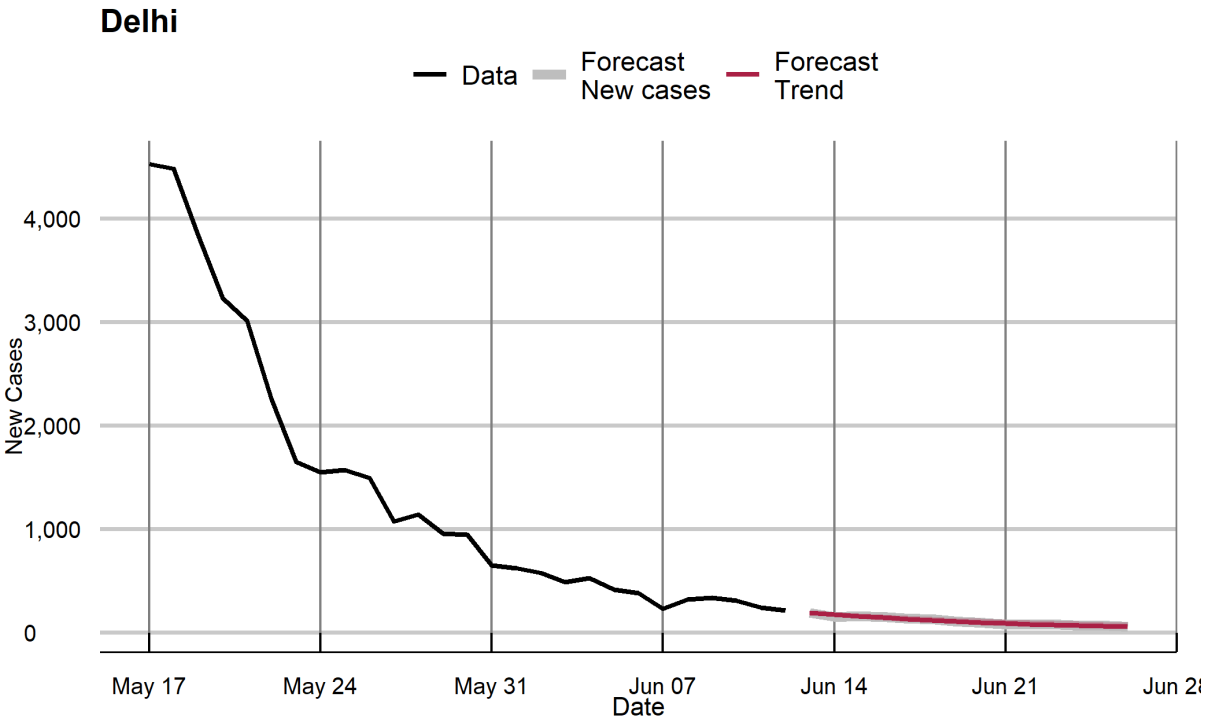

Bihar
Growth rate of daily cases
0.00
-0.05
-0.10
-0.15
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

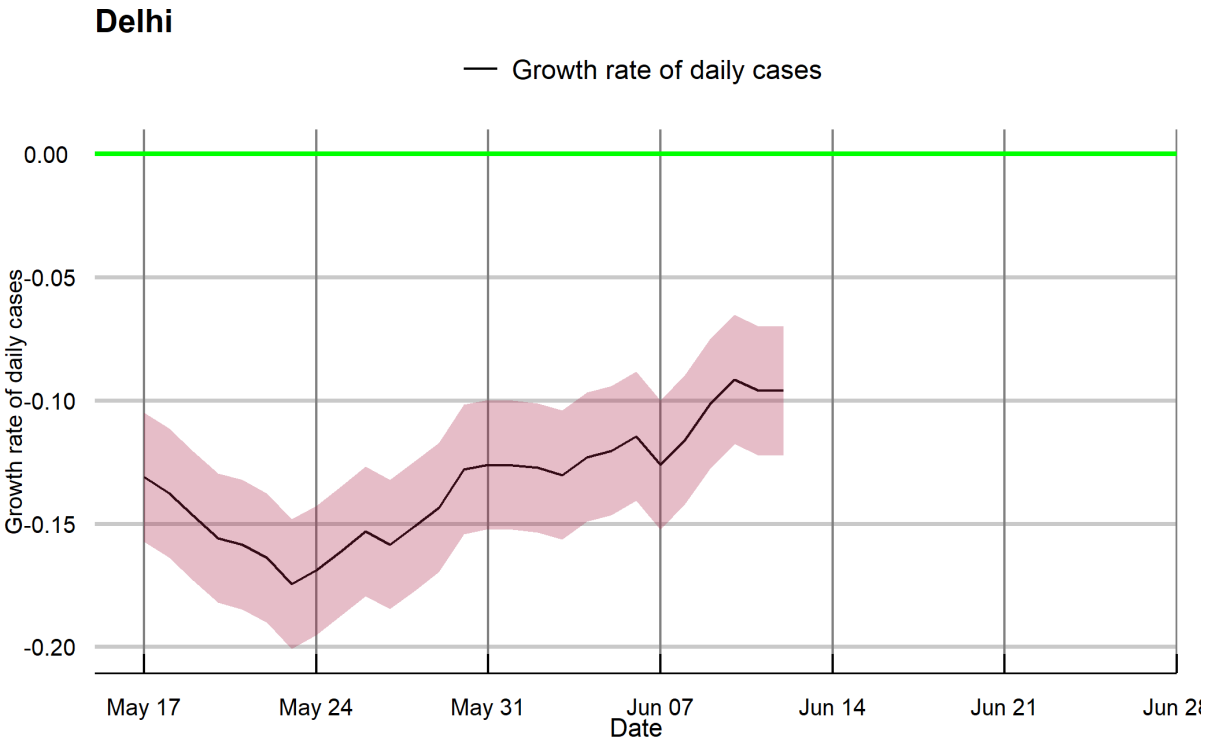

Chandigarh
Data
Forecast
New cases
Forecast
Trend
600
400
200
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Jun 28
Date

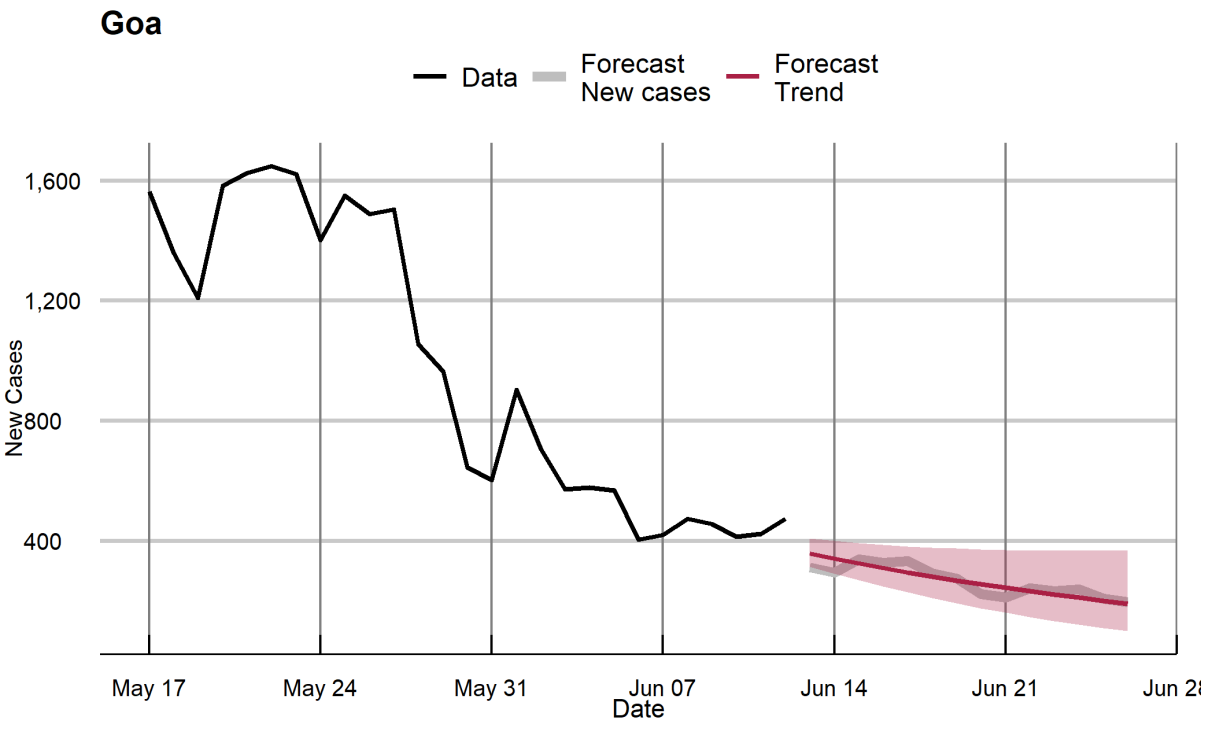

Chandigarh
Growth rate of daily cases
0.00
-0.05
-0.10
-0.15
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Jun 28
Date

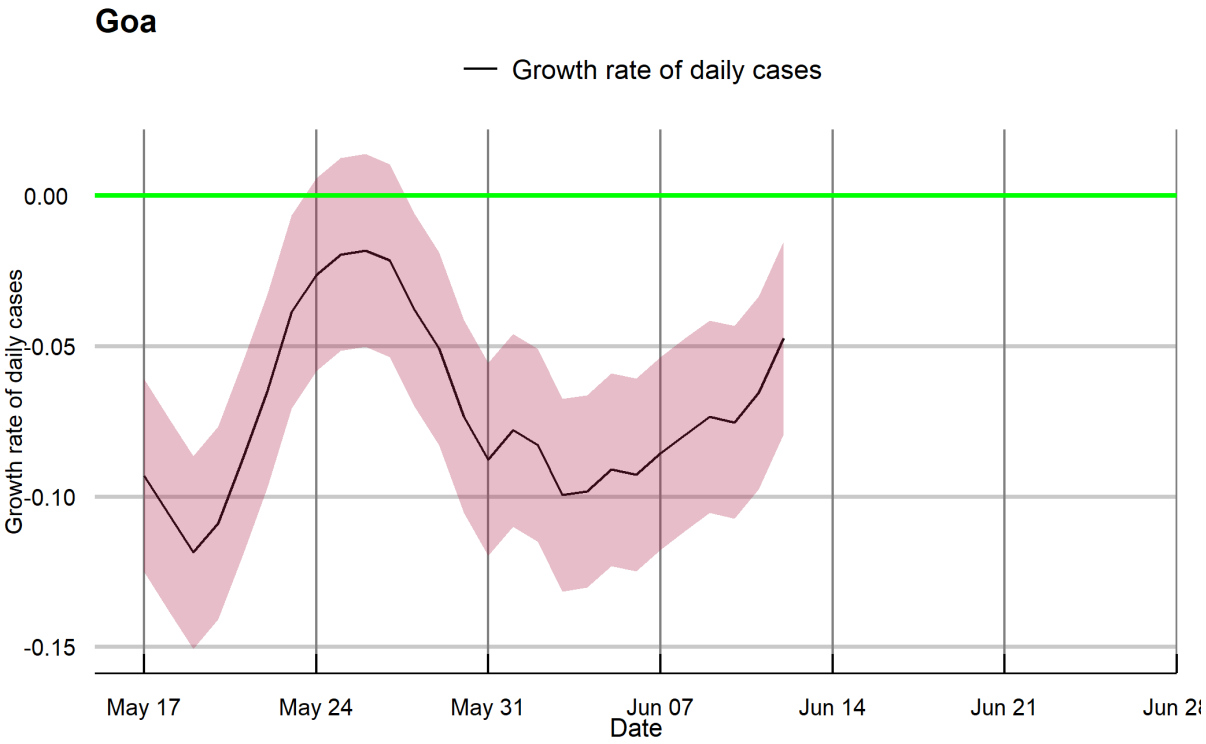

Chhattisgarh
Data
Forecast
New cases
Forecast
Trend
6,000
4,000
2,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

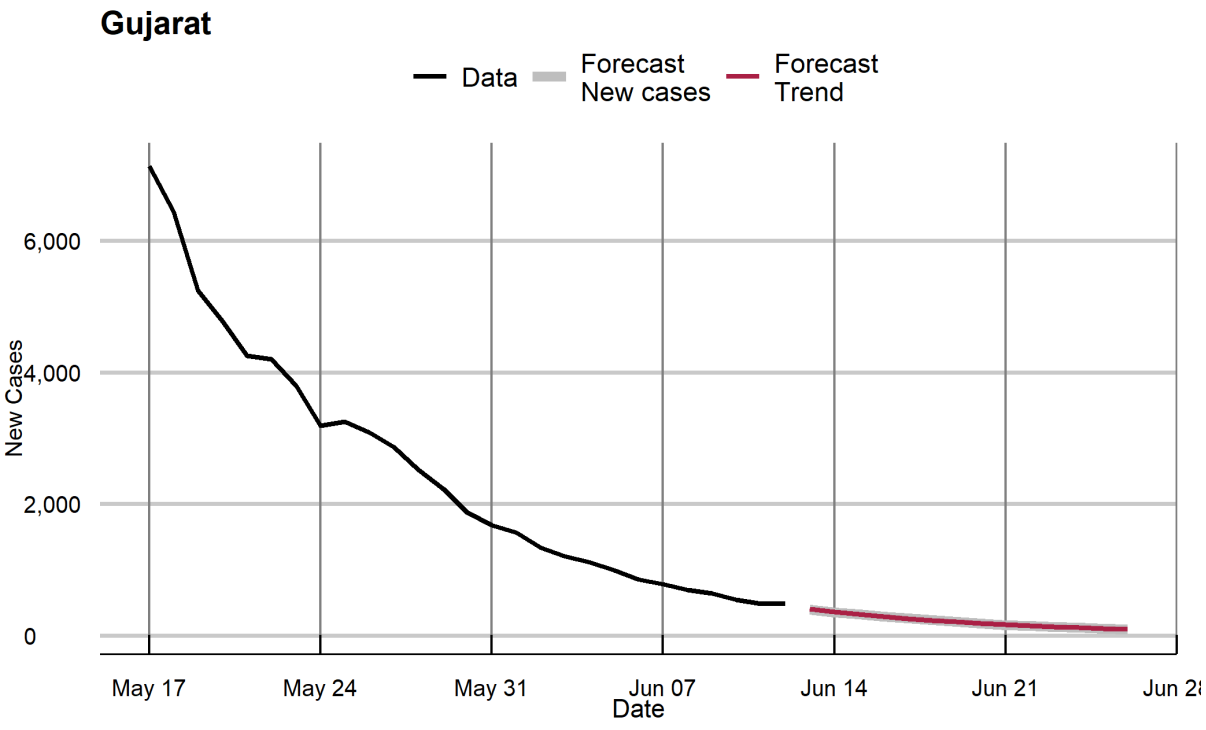

Chhattisgarh
Growth rate of daily cases
0.00
-0.03
-0.06
-0.09
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

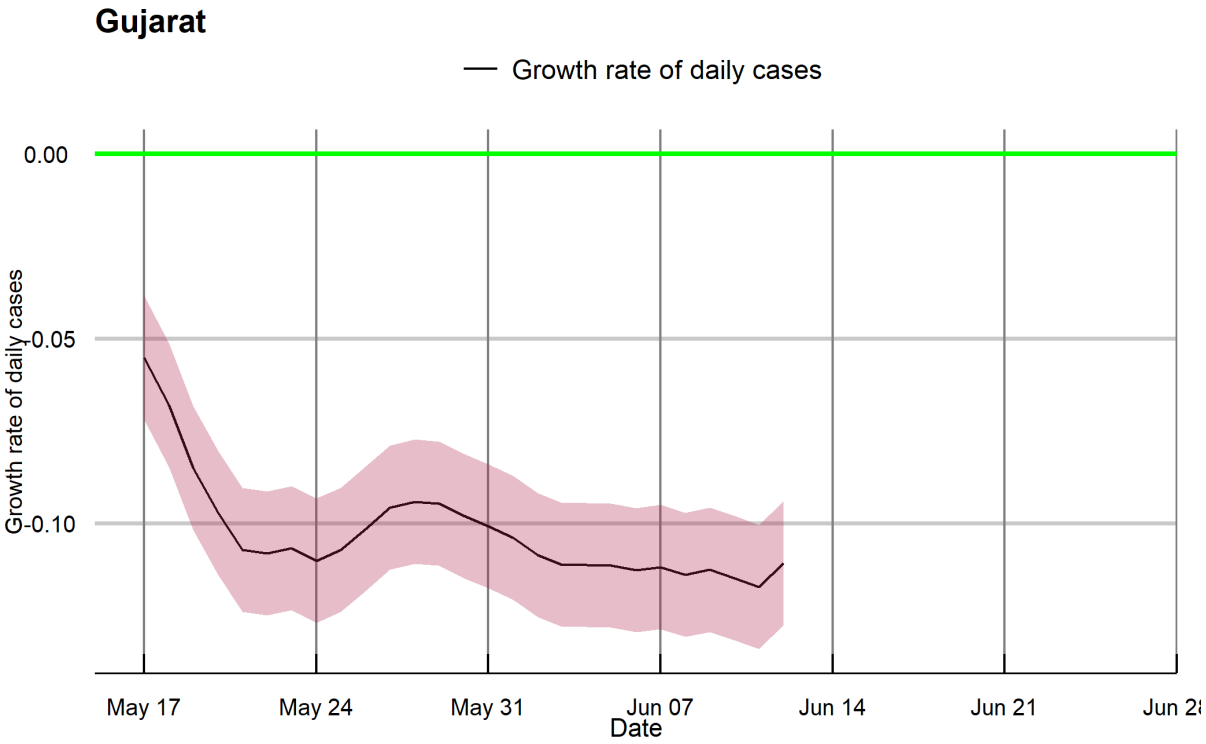

Delhi
Data
Forecast
New cases
Forecast
Trend
4,000
3,000
2,000
1,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

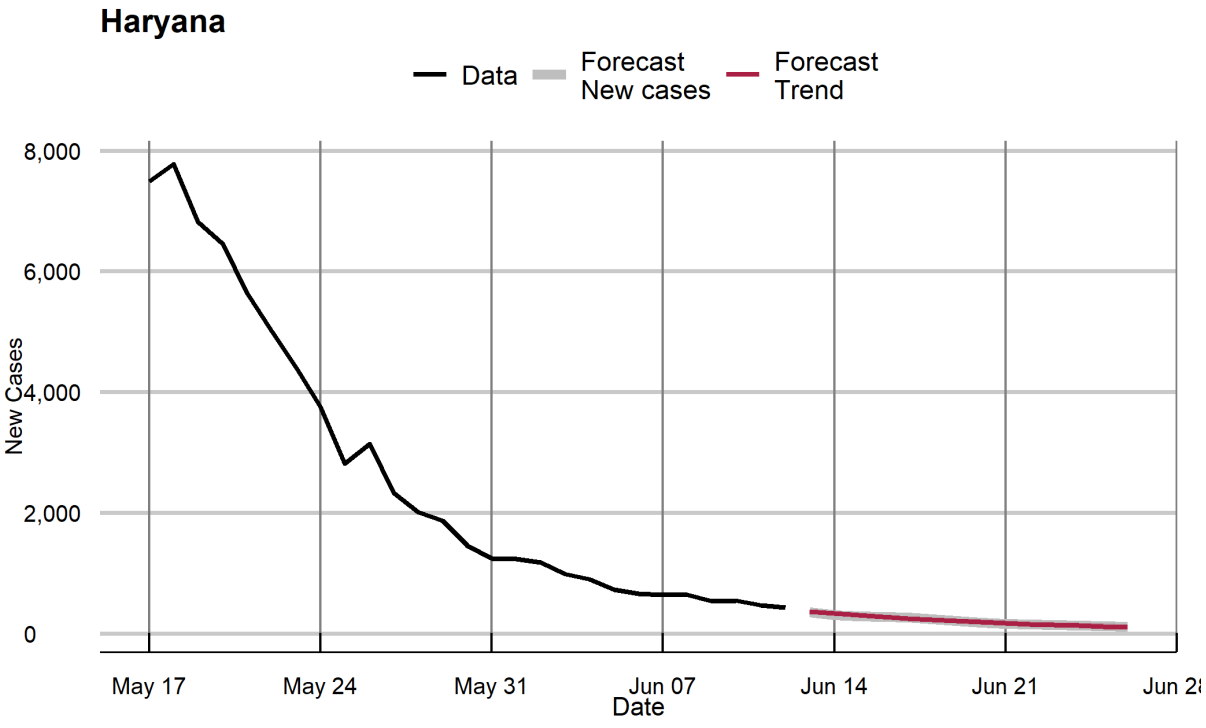

Delhi
Growth rate of daily cases
0.00
-0.05
-0.10
-0.15
-0.20
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

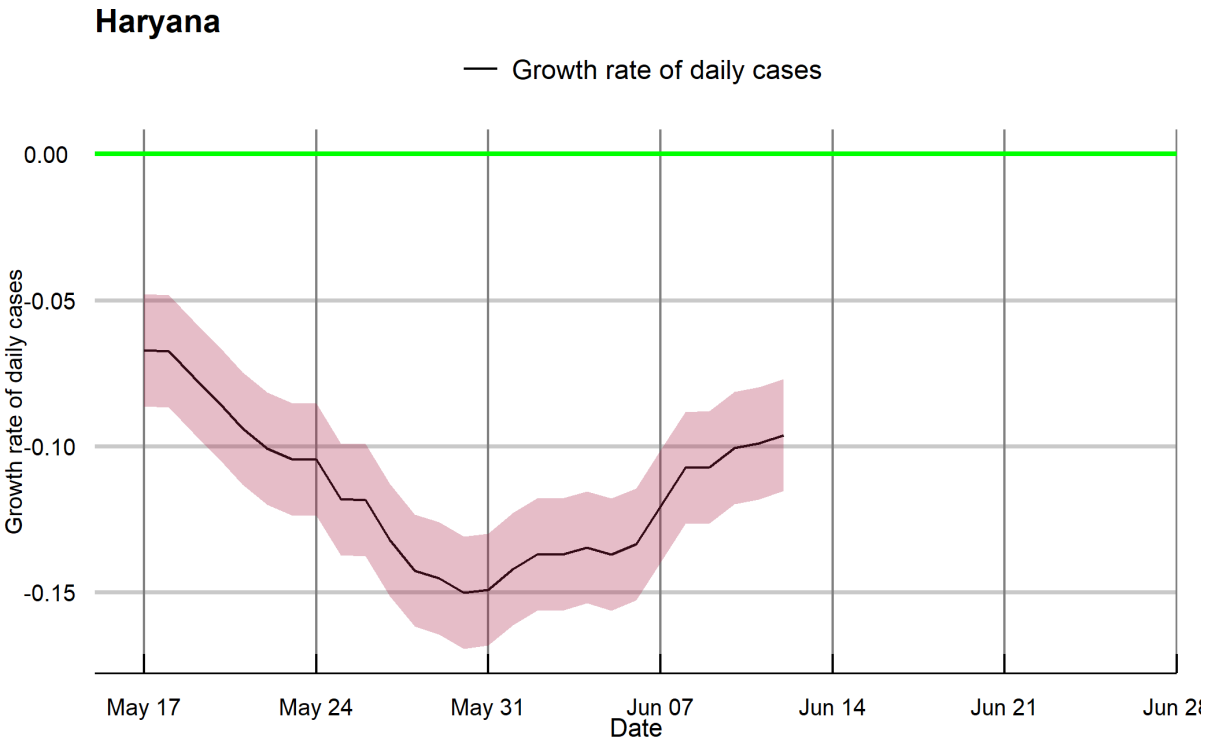

Goa
Data
Forecast
New cases
Forecast
Trend
1,600
1,200
800
400
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

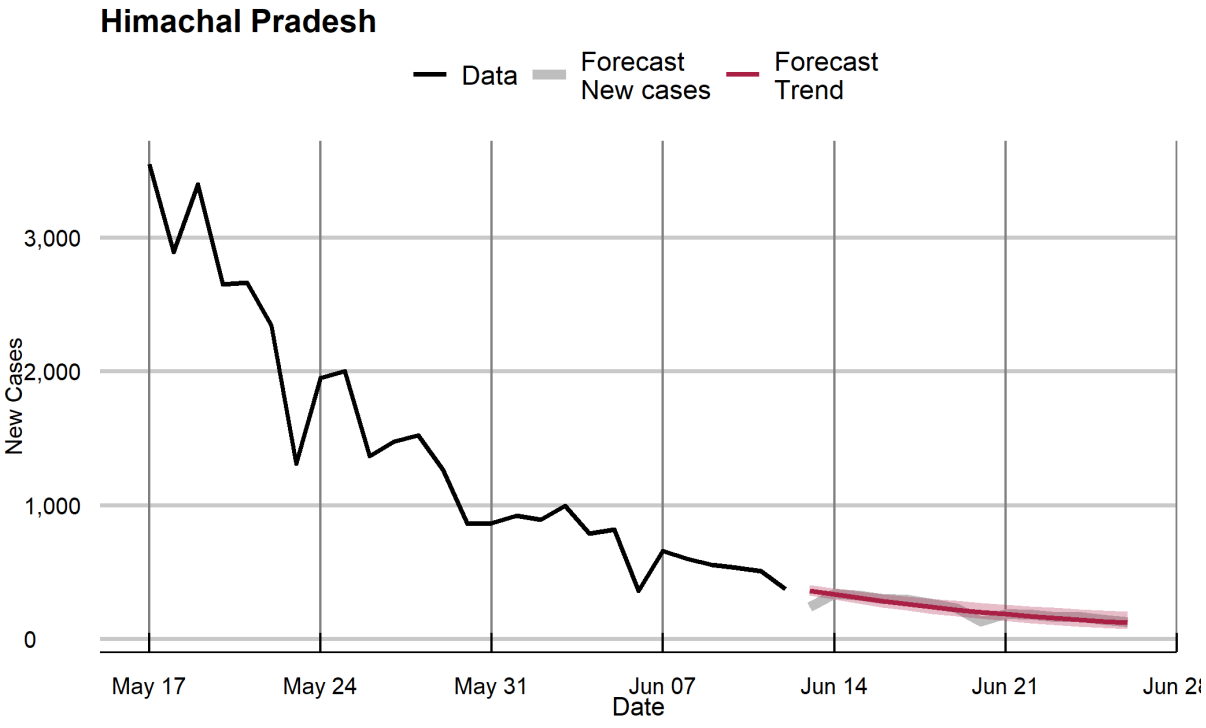

Goa
Growth rate of daily cases
0.00
-0.05
-0.10
-0.15
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

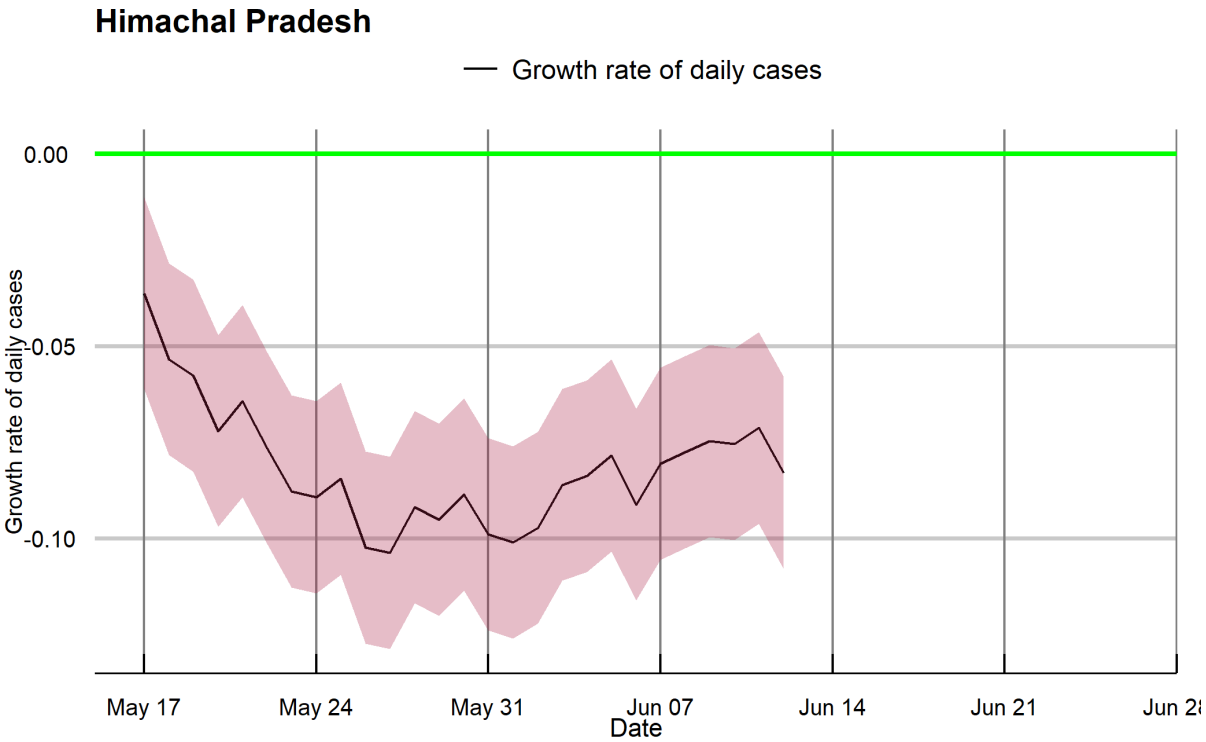

Gujarat
Data
Forecast
New cases
Forecast
Trend
6,000
4,000
2,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

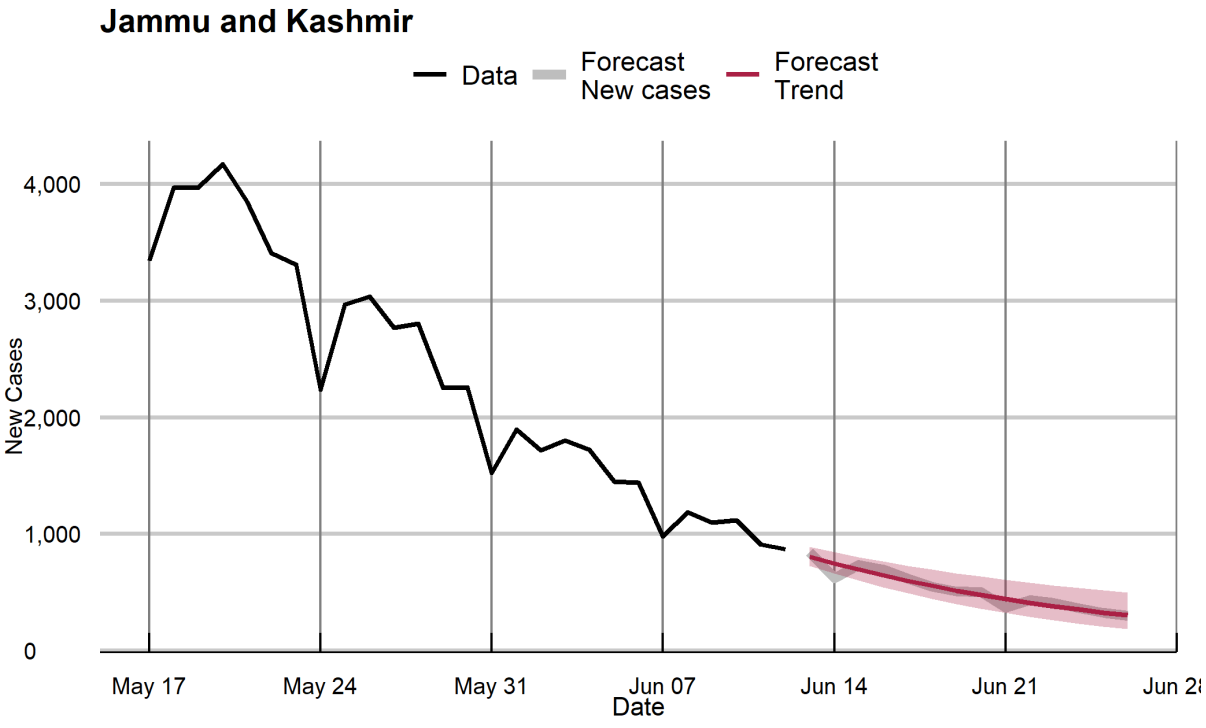

Gujarat
Growth rate of daily cases
0.00
-0.05
-0.10
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

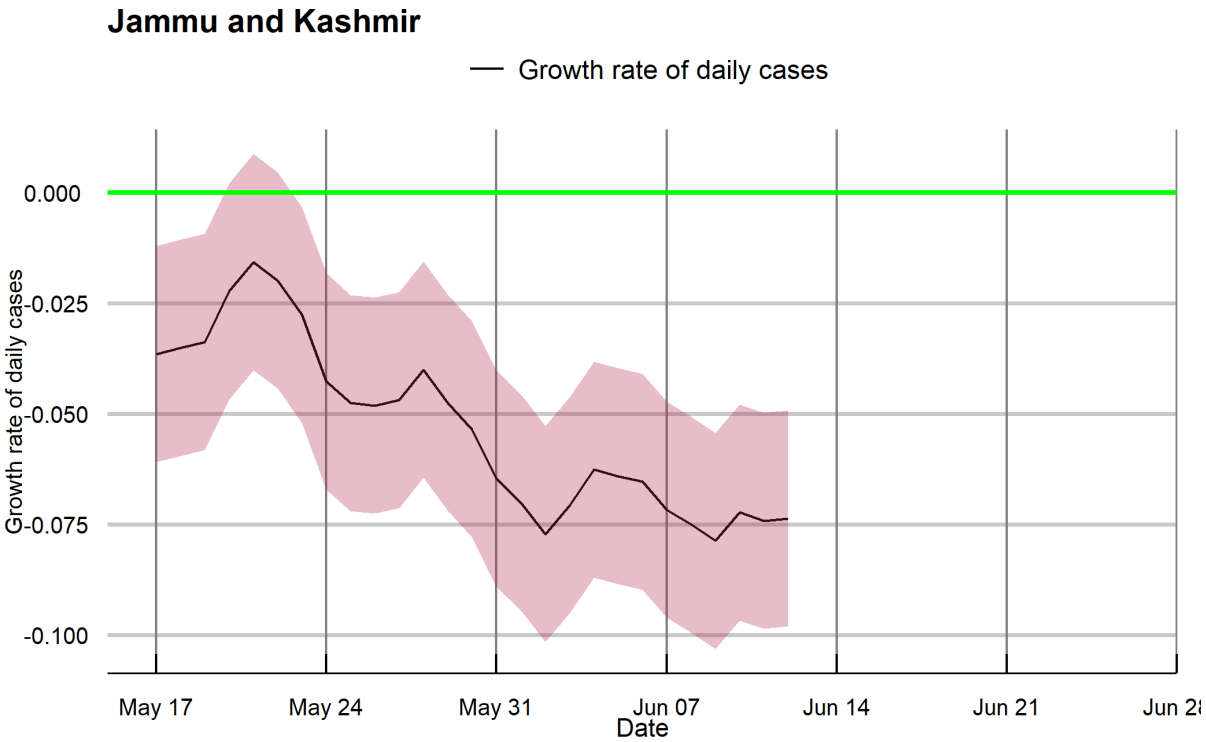

Haryana
Data
Forecast
New cases
Forecast
Trend
8,000
6,000
4,000
2,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

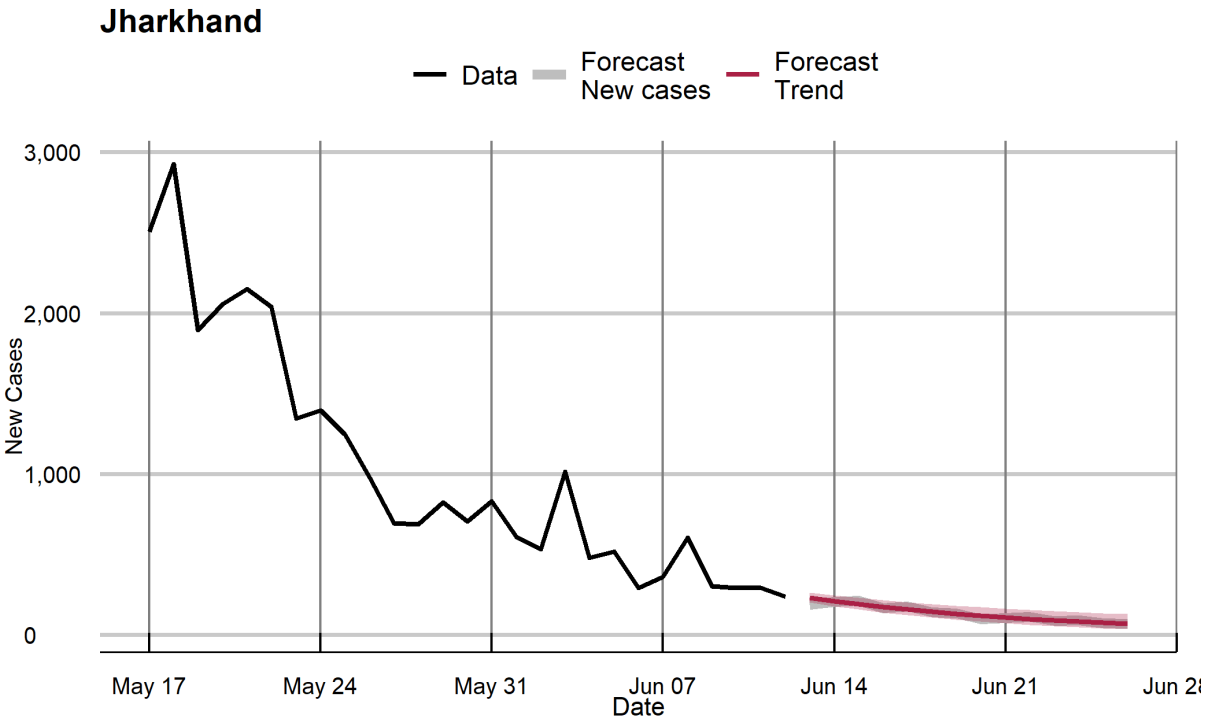

Haryana
Growth rate of daily cases
0.00
-0.05
-0.10
-0.15
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

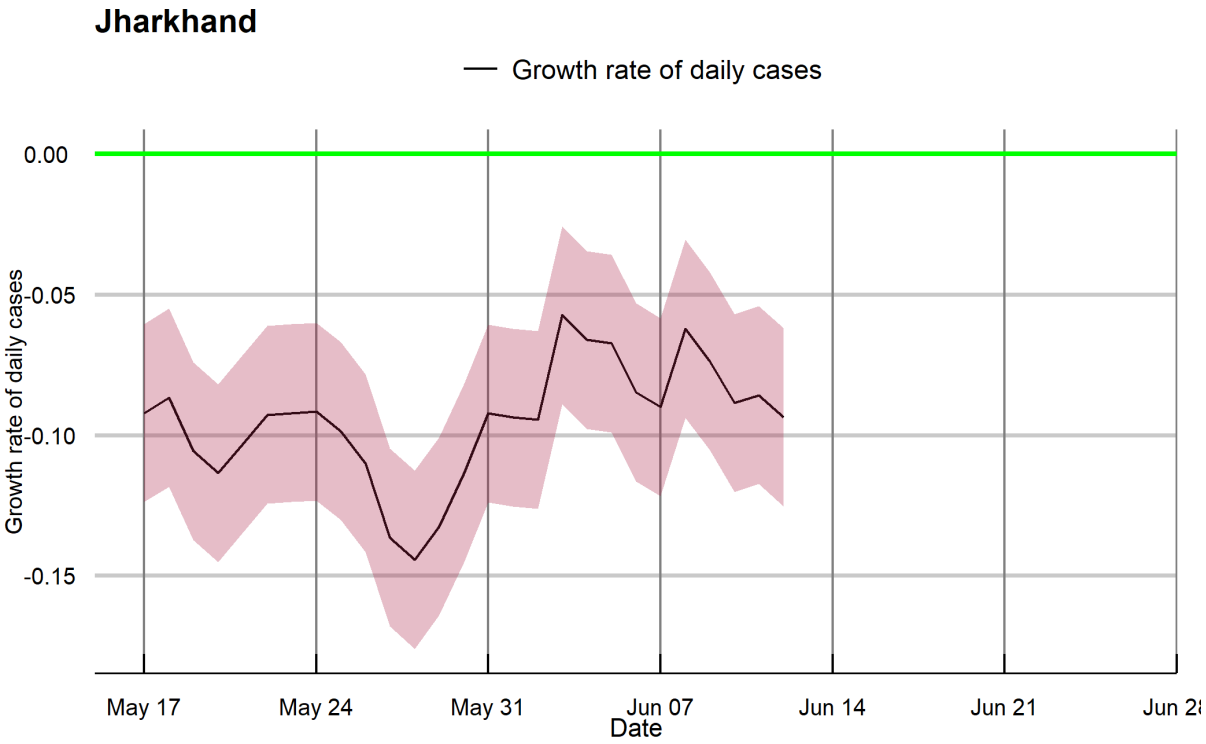

Himachal Pradesh
Data
Forecast
New cases
Forecast
Trend
3,000
2,000
1,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

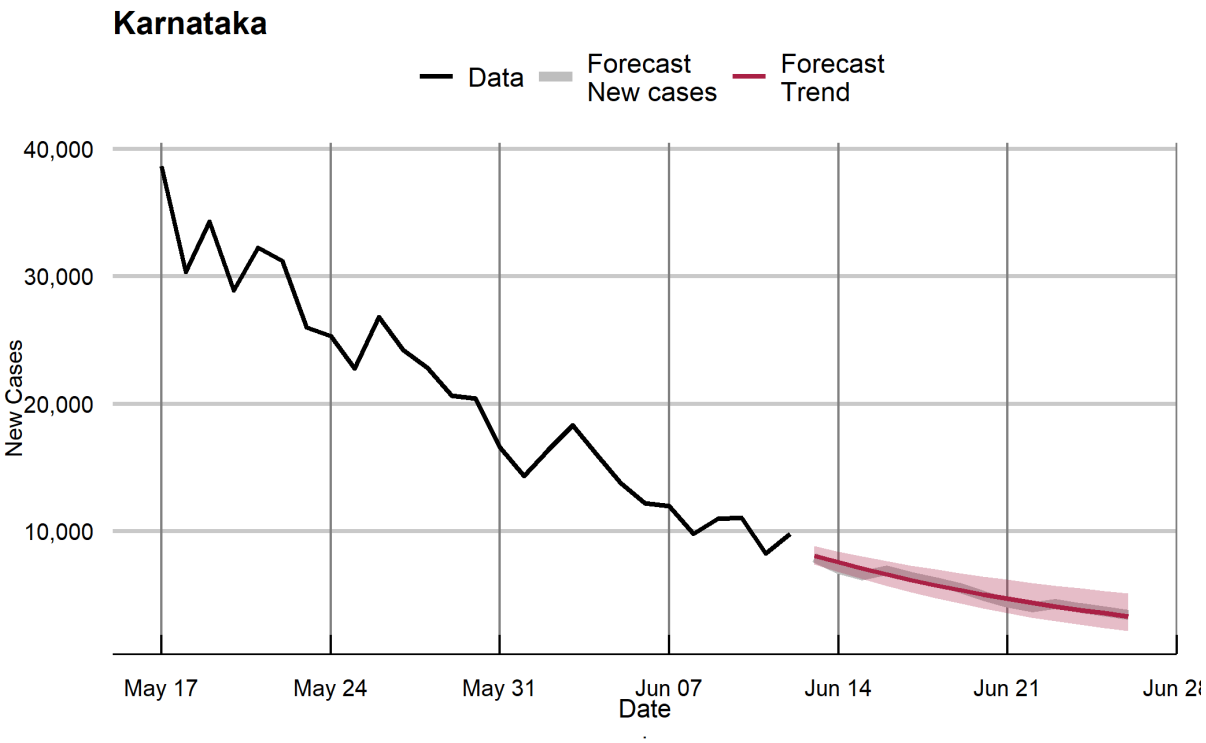

Himachal Pradesh
Growth rate of daily cases
0.00
-0.05
-0.10
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

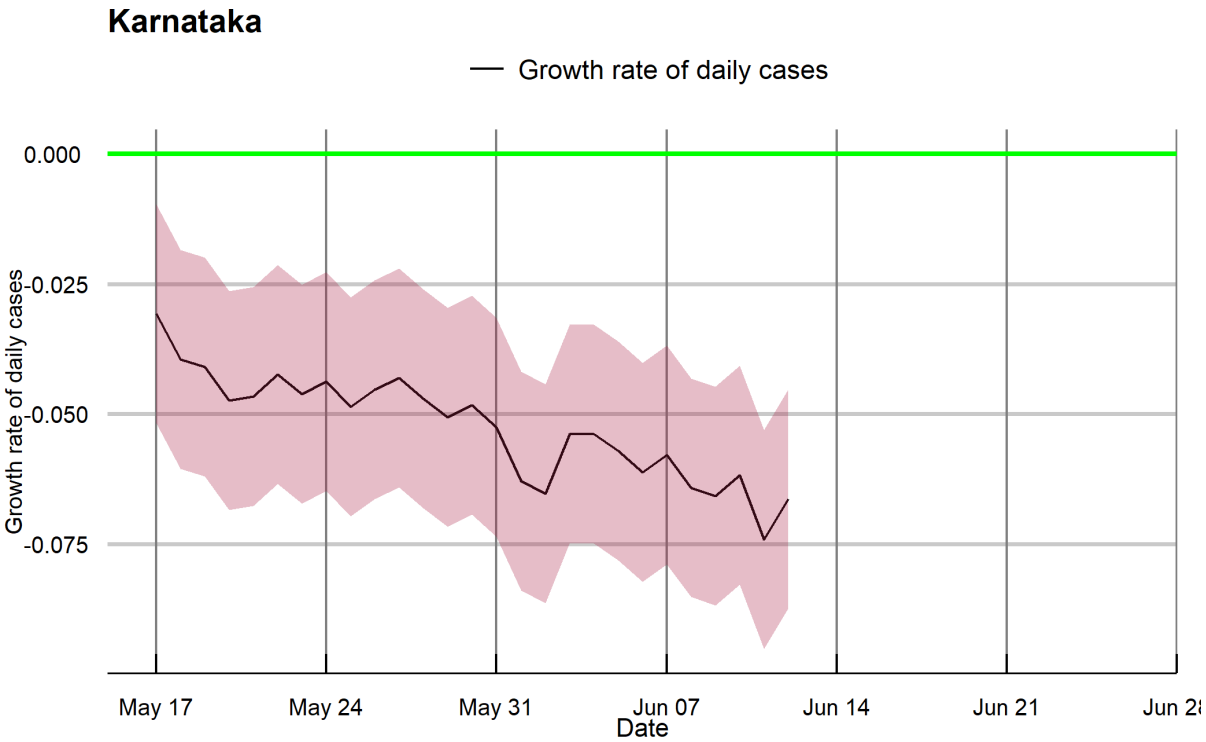

Jammu and Kashmir
Data
Forecast
New cases
Forecast
Trend
4,000
3,000
2,000
1,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

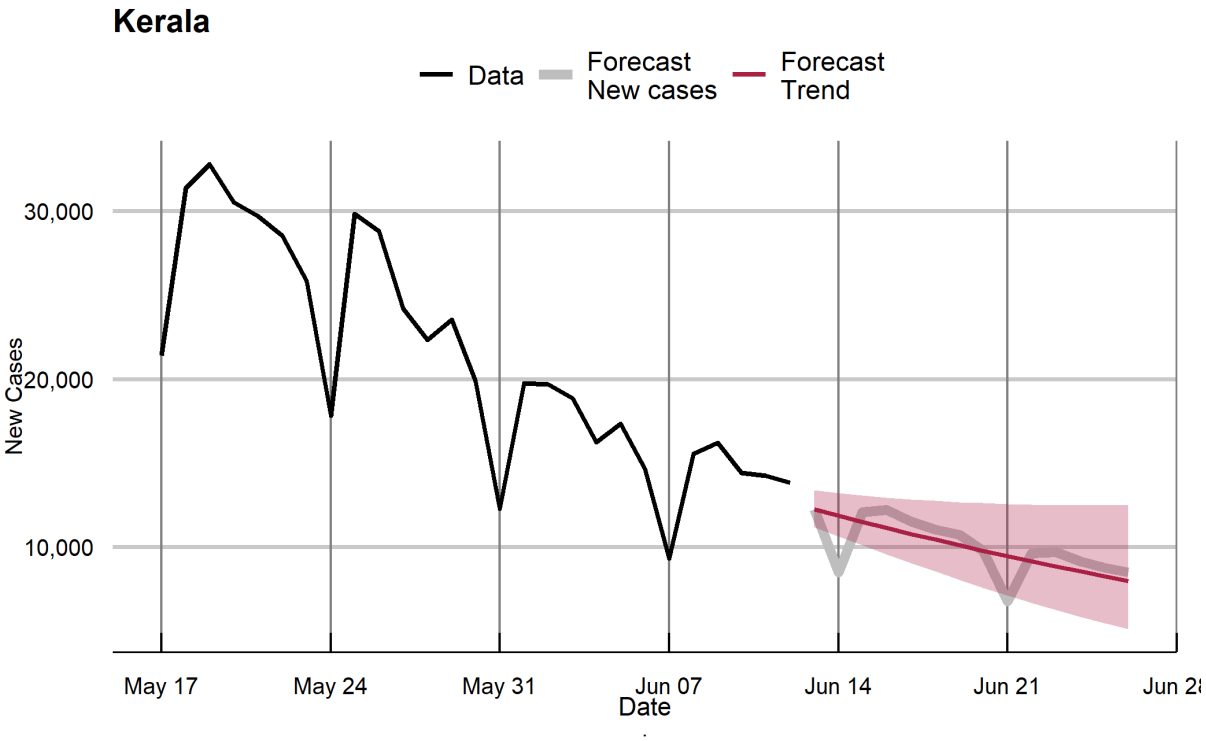

Jammu and Kashmir
Growth rate of daily cases
0.000
-0.025
-0.050
-0.075
-0.100
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

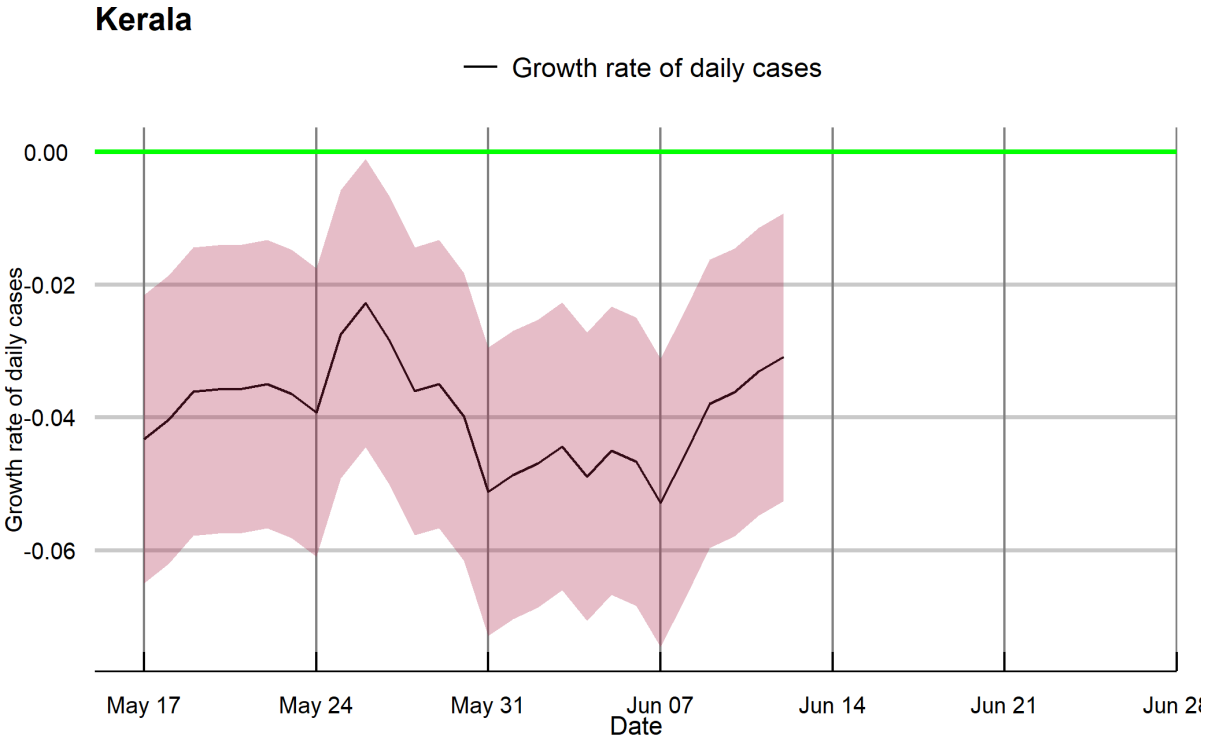

Jharkhand
Data
Forecast
New cases
Forecast
Trend
3,000
2,000
1,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

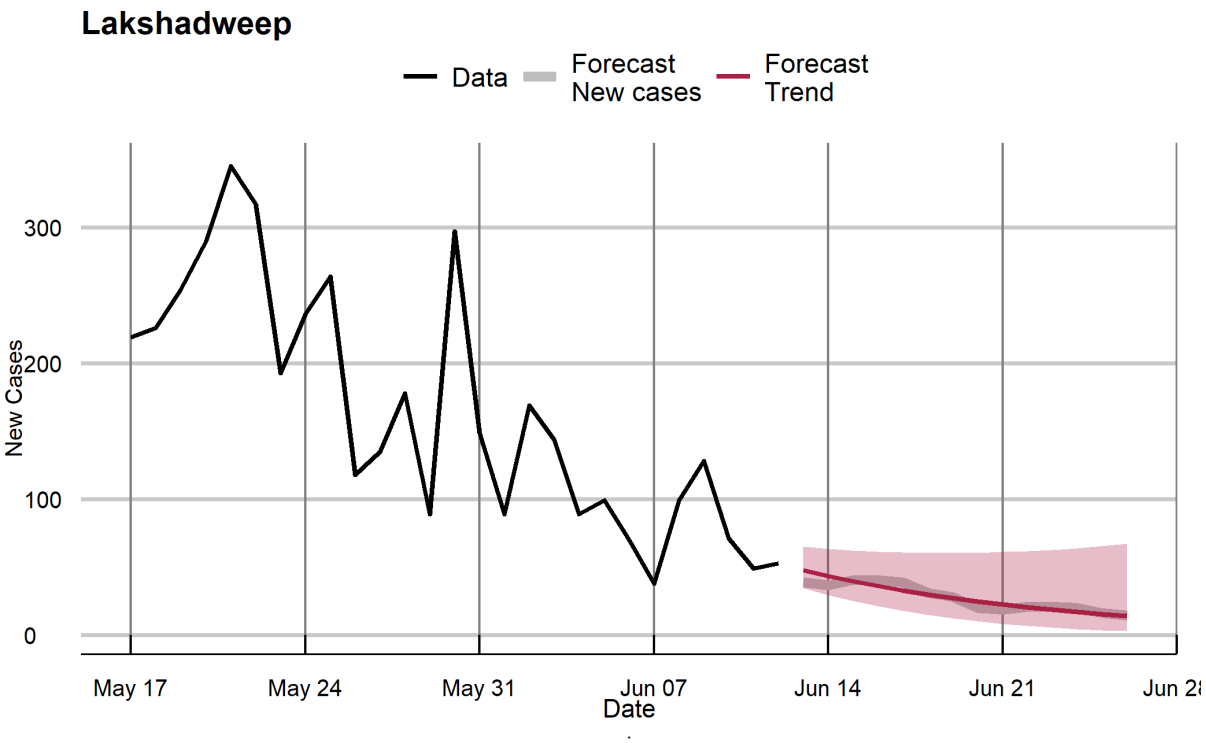

Jharkhand
Growth rate of daily cases
0.00
-0.05
-0.10
-0.15
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

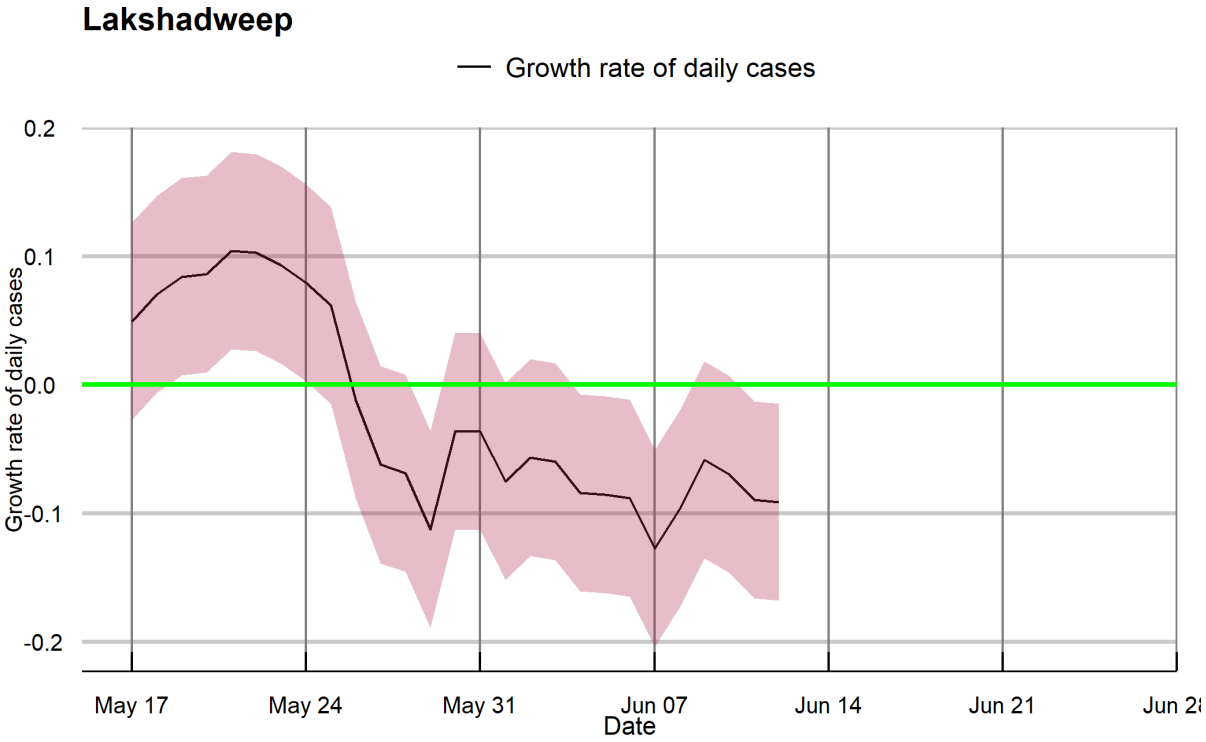

Karnataka
Data
Forecast
New cases
Forecast
Trend
40,000
30,000
20,000
10,000
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

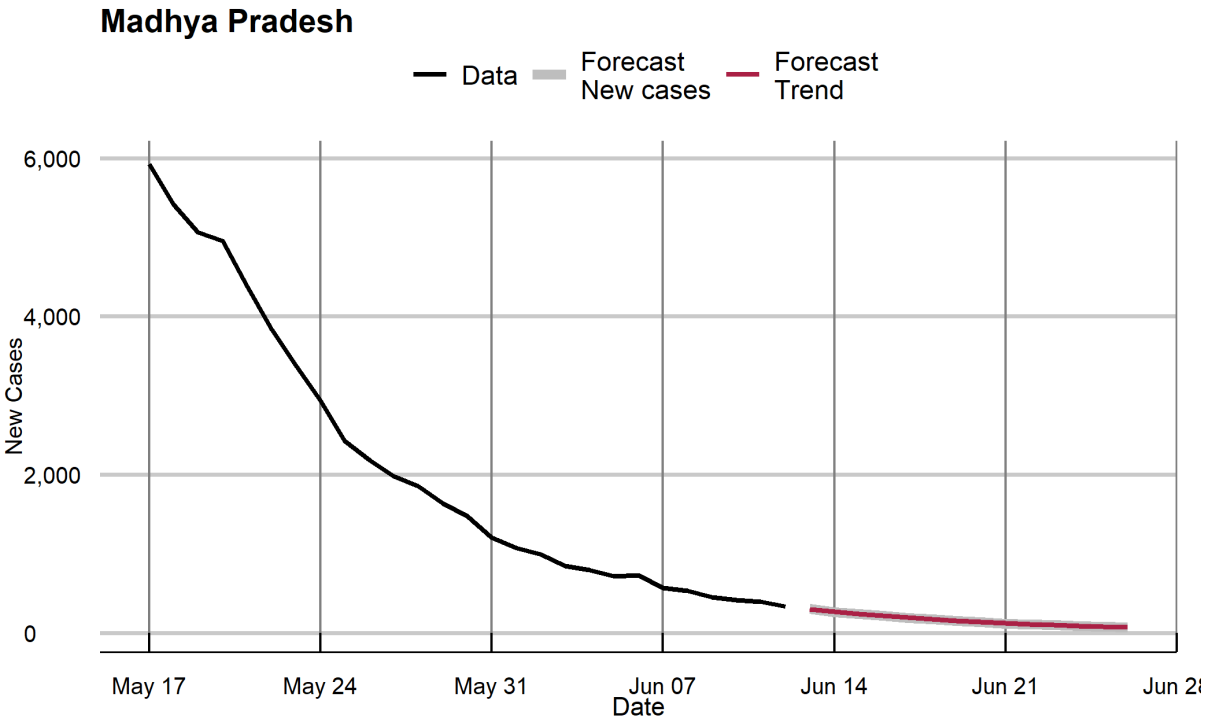

Karnataka
Growth rate of daily cases
0.000
-0.025
-0.050
-0.075
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

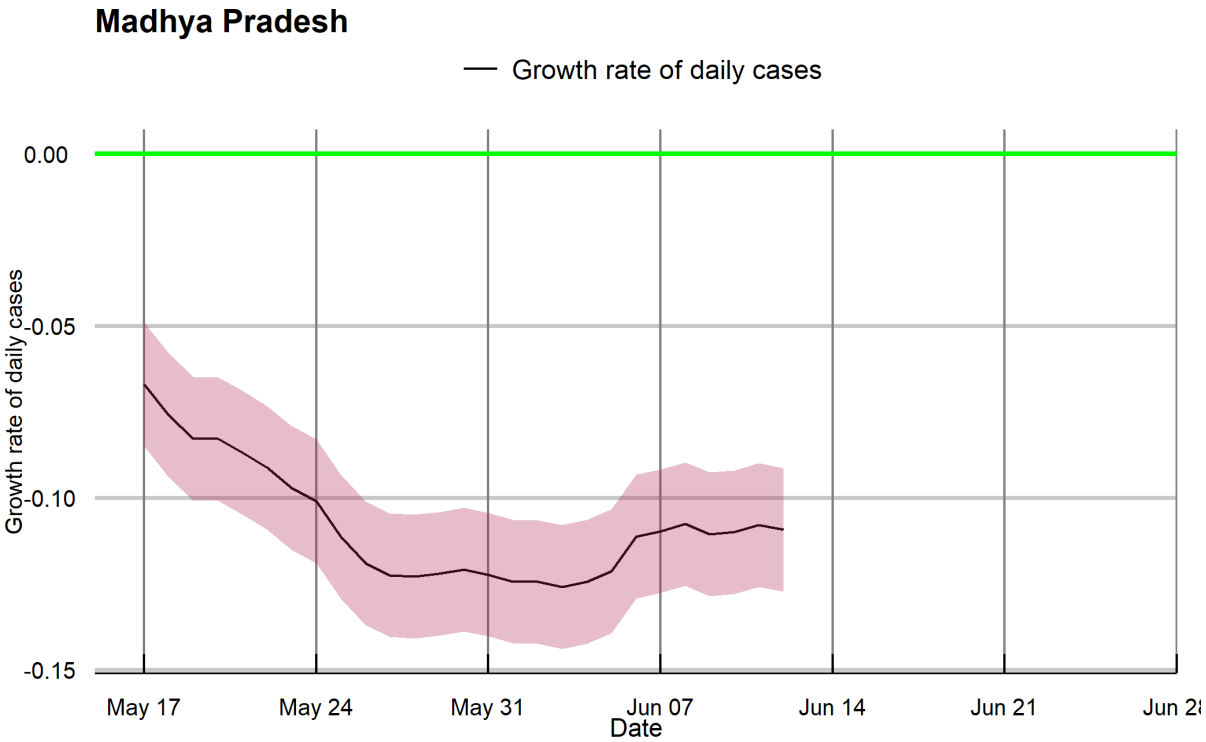

Kerala
Data
Forecast
New cases
Forecast
Trend
30,000
20,000
10,000
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date


Kerala
Growth rate of daily cases
0.00
-0.02
-0.04
-0.06
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

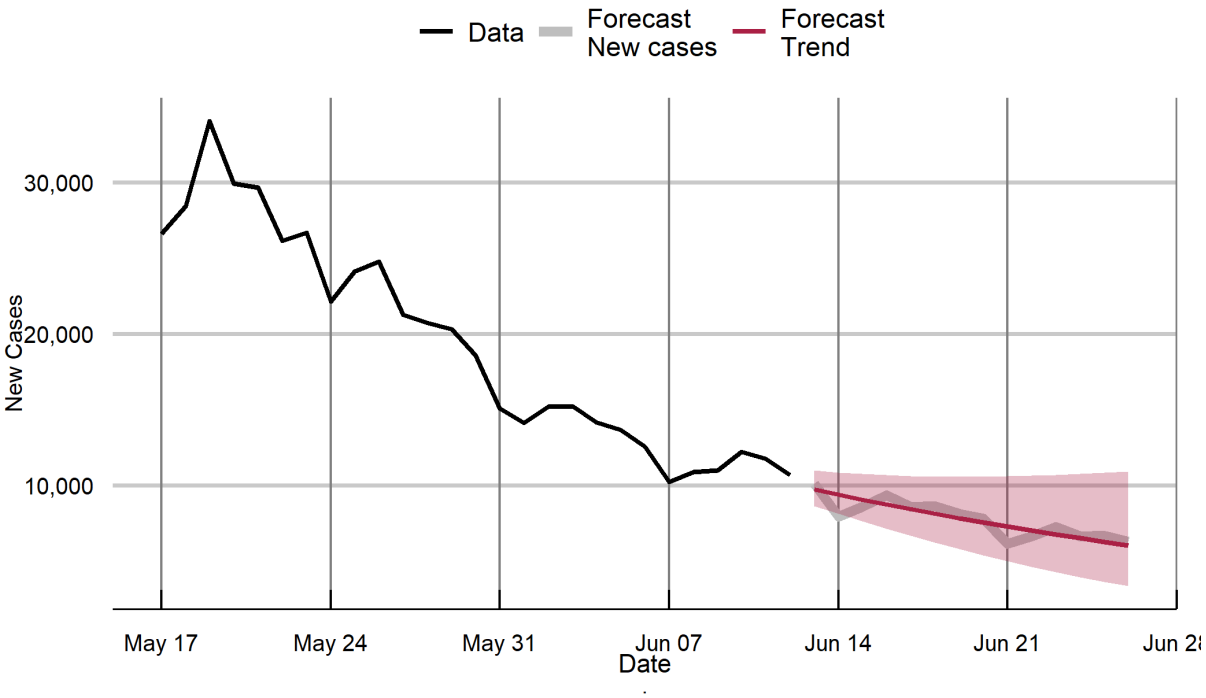

Lakshadweep
Data
Forecast
New cases
Forecast
Trend
300
200
100
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date


Lakshadweep
Growth rate of daily cases
0.2
0.1
0.0
-0.1
-0.2
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

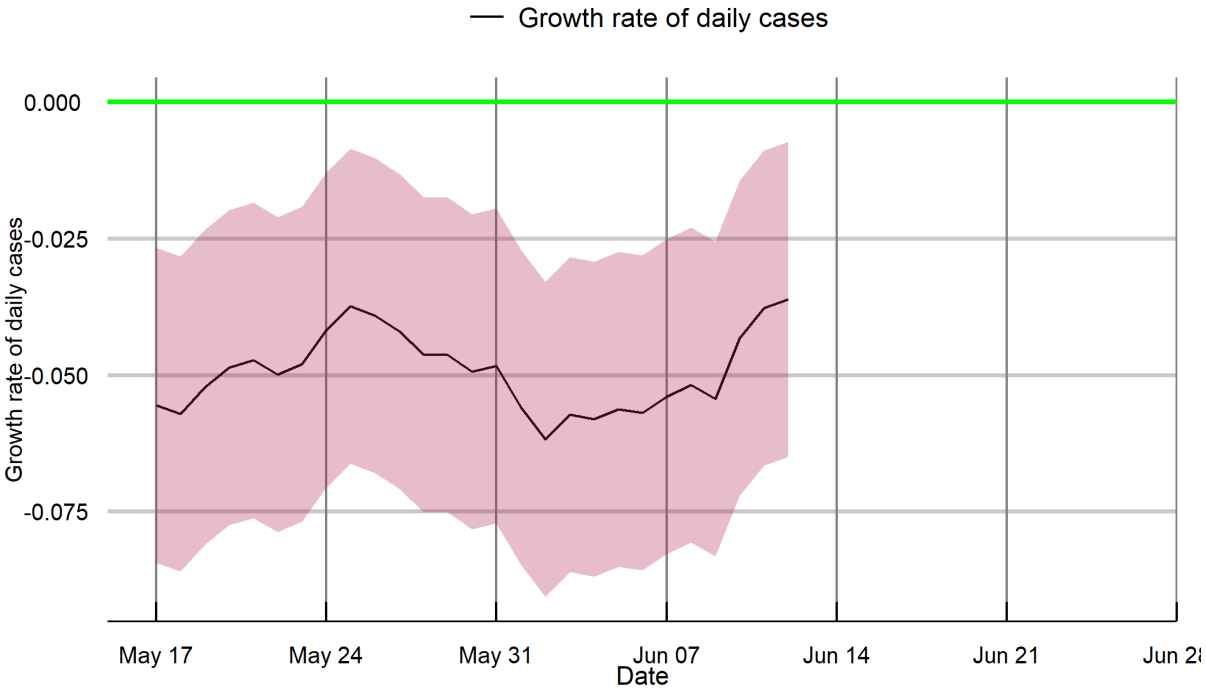

Madhya Pradesh
Data
Forecast
New cases
Forecast
Trend
6,000
4,000
2,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

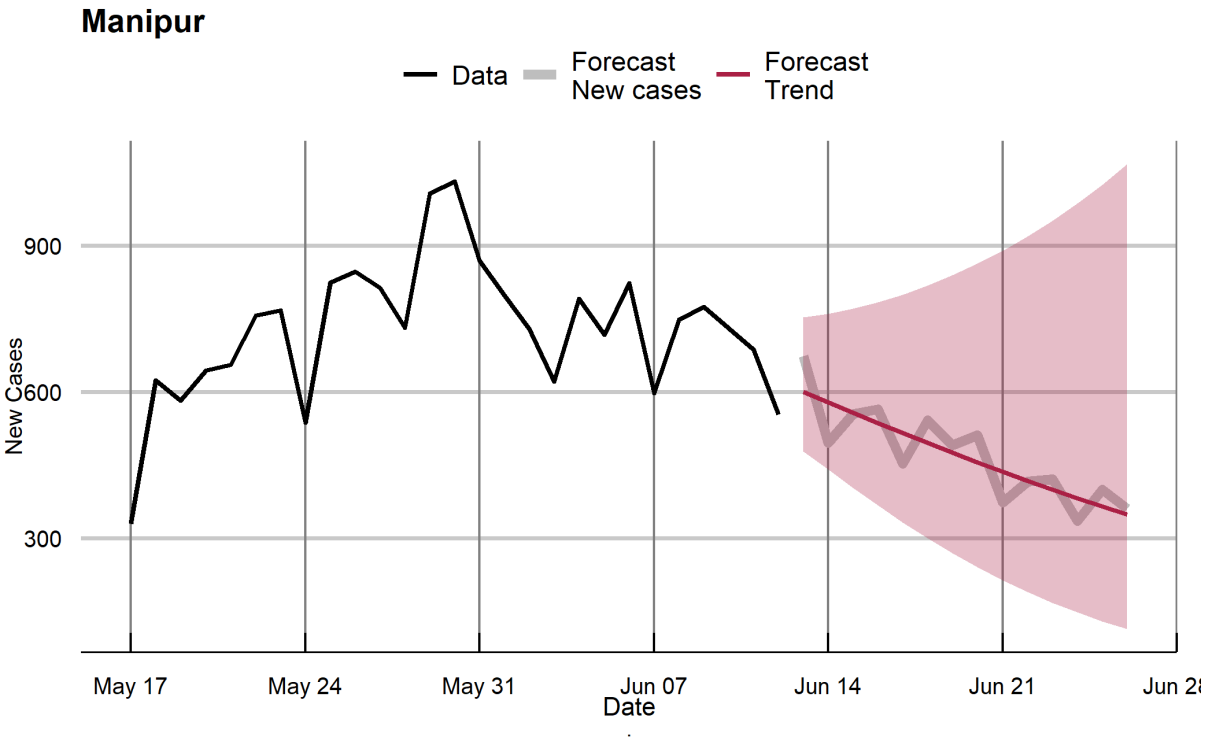

Madhya Pradesh
Growth rate of daily cases
0.00
-0.05
-0.10
-0.15
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

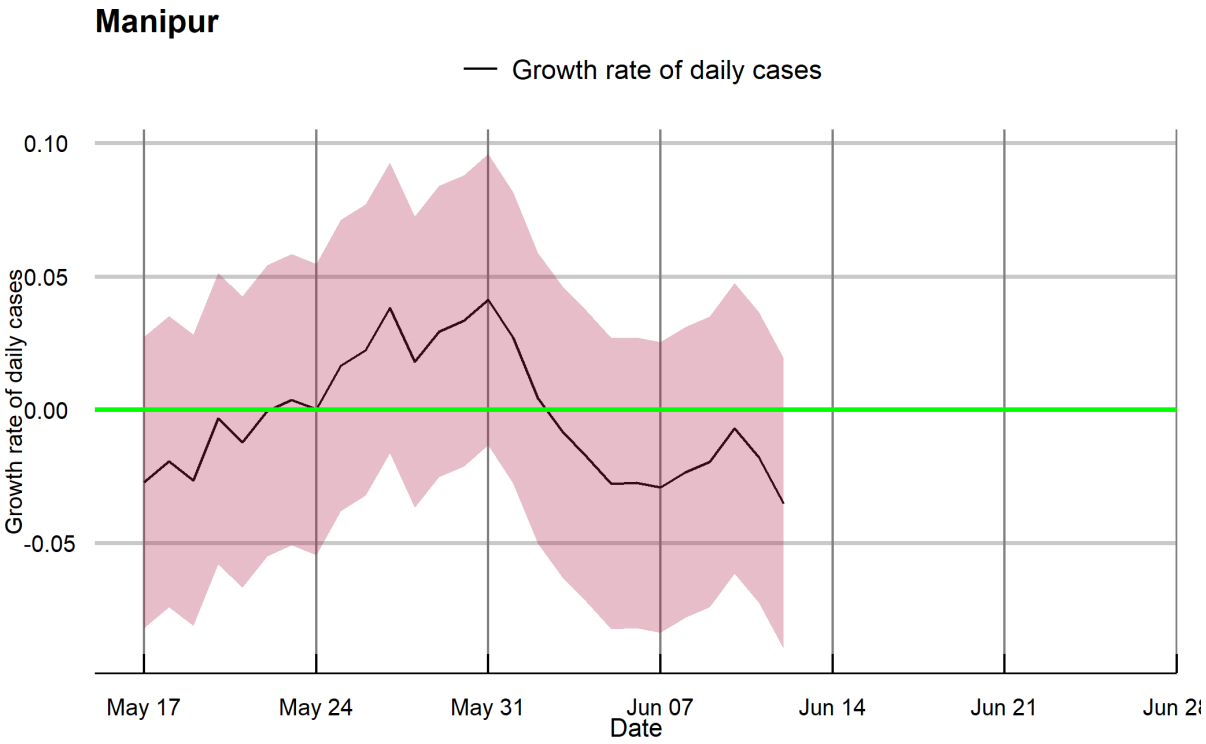
Maharashtra

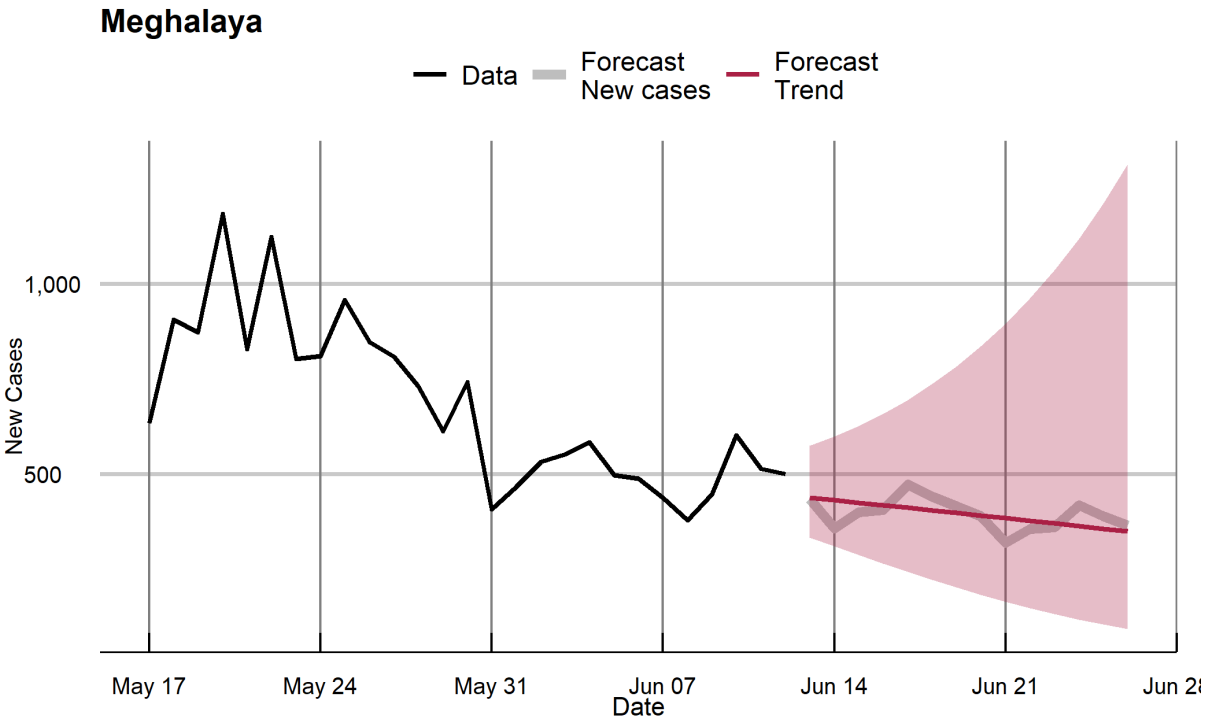


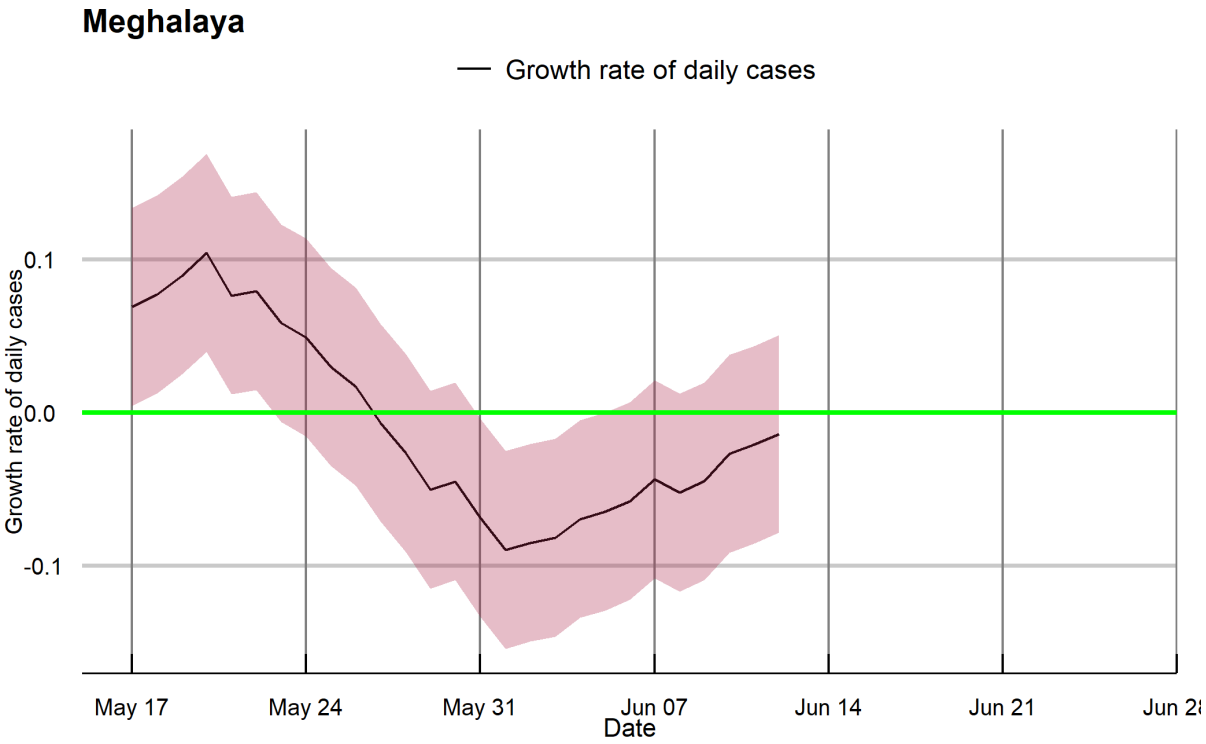
Maharashtra

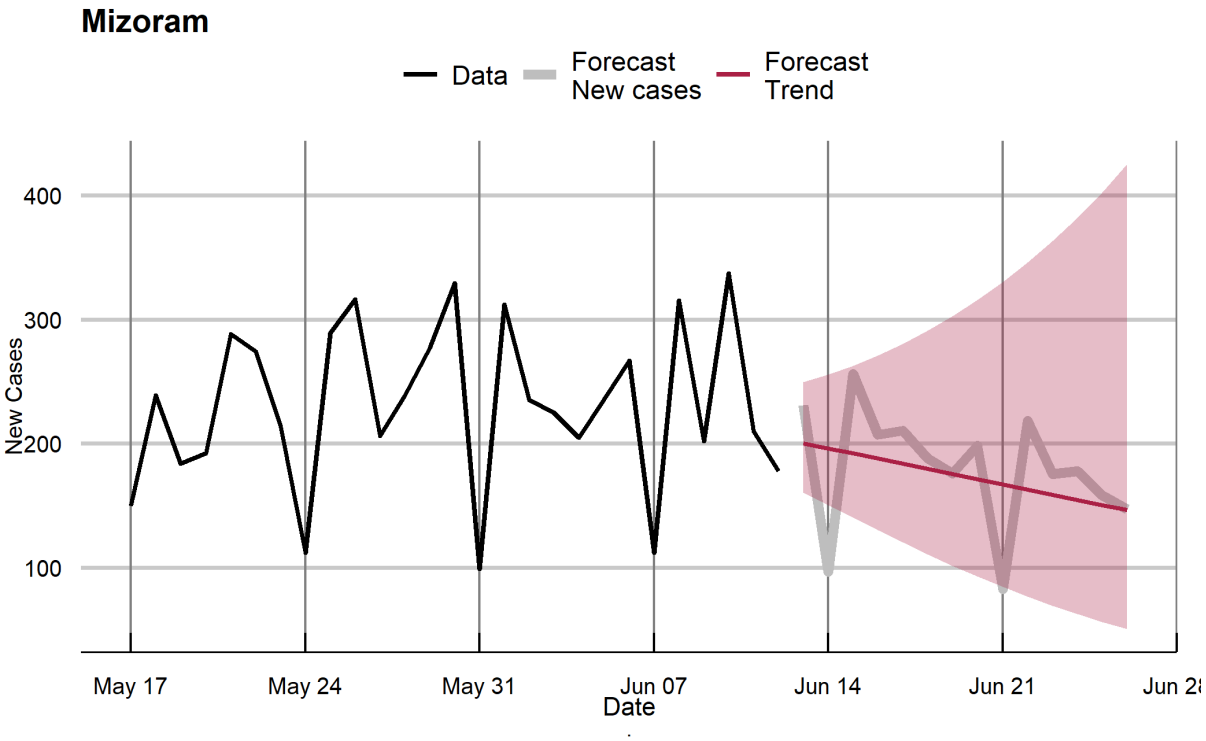


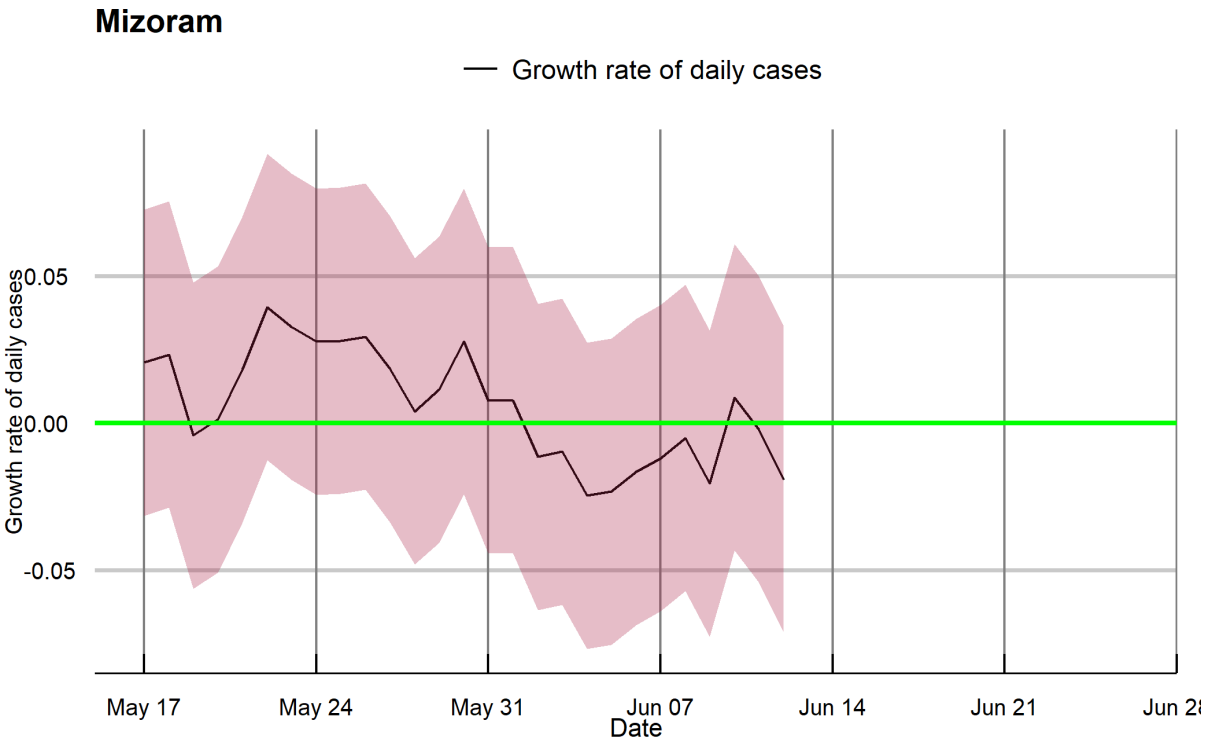

Manipur
Data
Forecast
New cases
Forecast
Trend
900
600
300
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

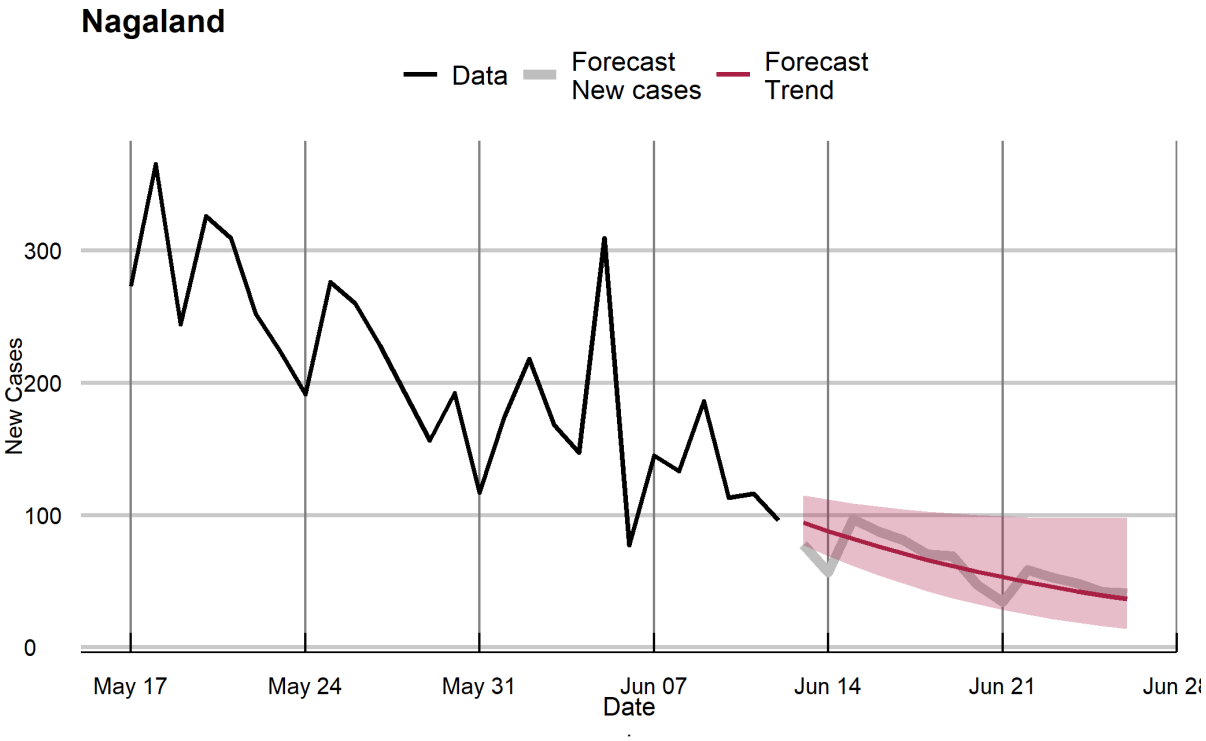

Manipur
Growth rate of daily cases
0.10
0.05
0.00
-0.05
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

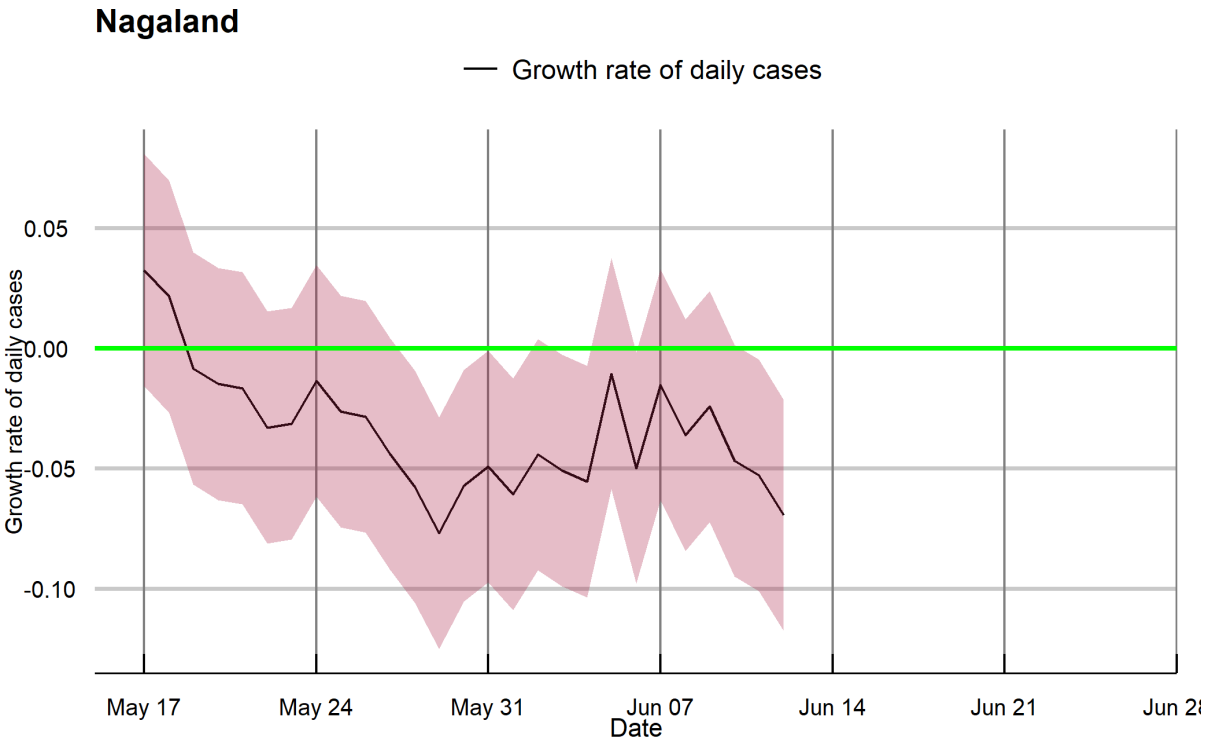

Meghalaya
Data
Forecast
New cases
Forecast
Trend
1,000
500
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date


Meghalaya
Growth rate of daily cases
0.1
0.0
-0.1
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

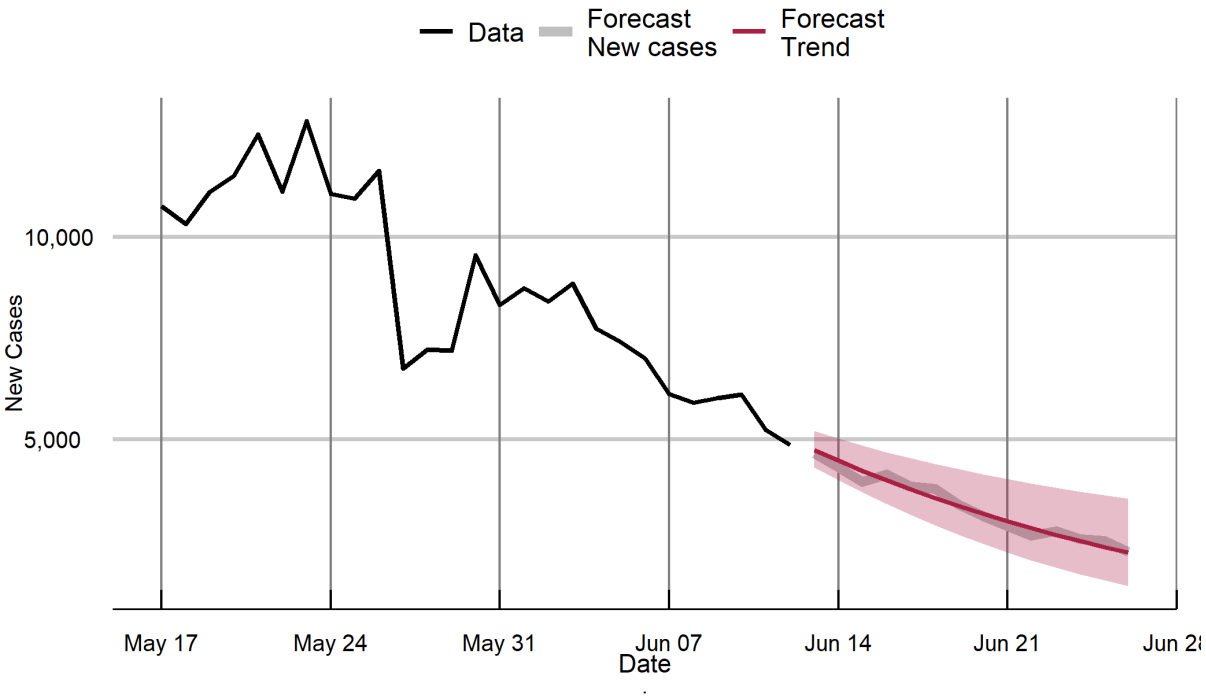

Mizoram
Data
Forecast
New cases
Forecast
Trend
400
300
200
100
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date


Mizoram
Growth rate of daily cases
0.05
0.00
-0.05
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

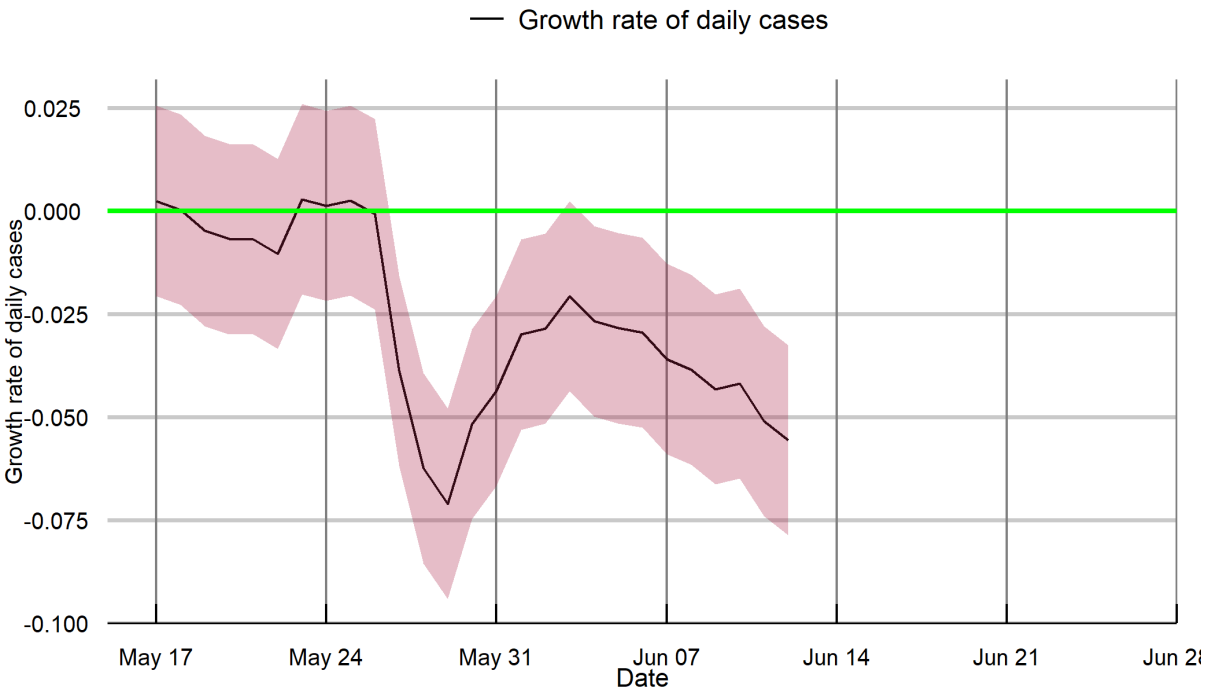

Nagaland
Data
Forecast
New cases
Forecast
Trend
300
200
100
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

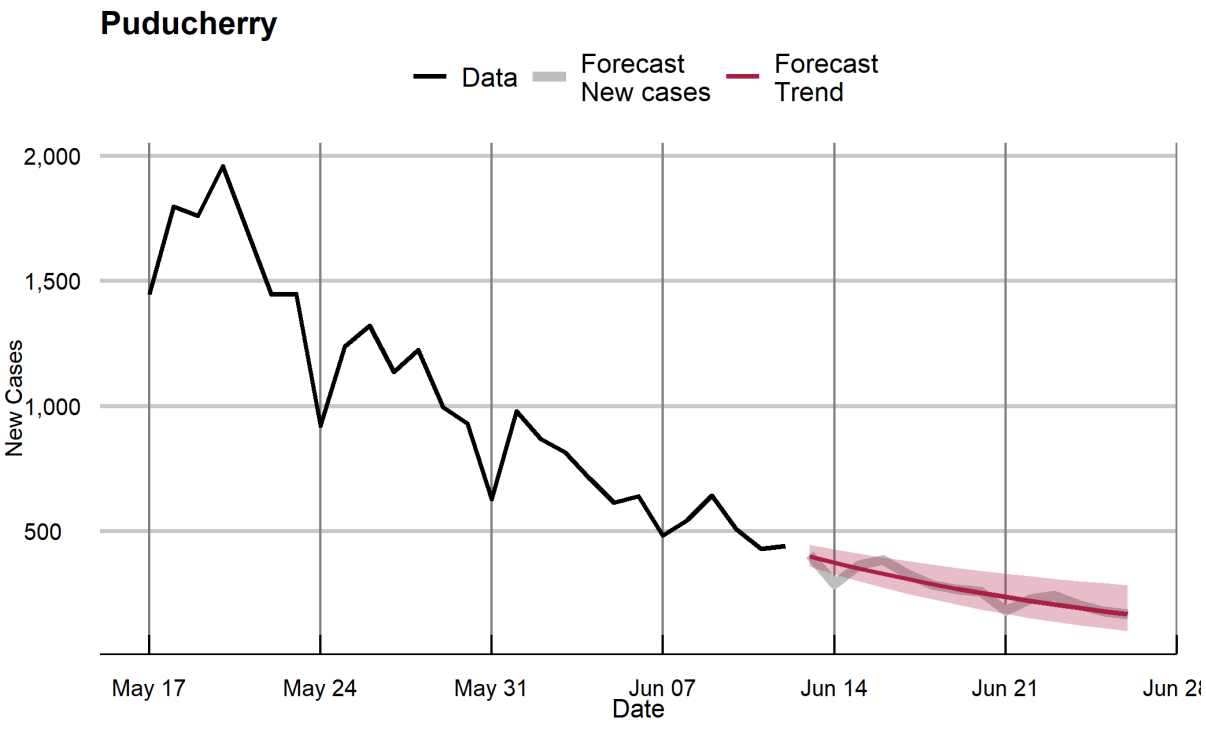

Nagaland
Growth rate of daily cases
0.05
0.00
-0.05
-0.10
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

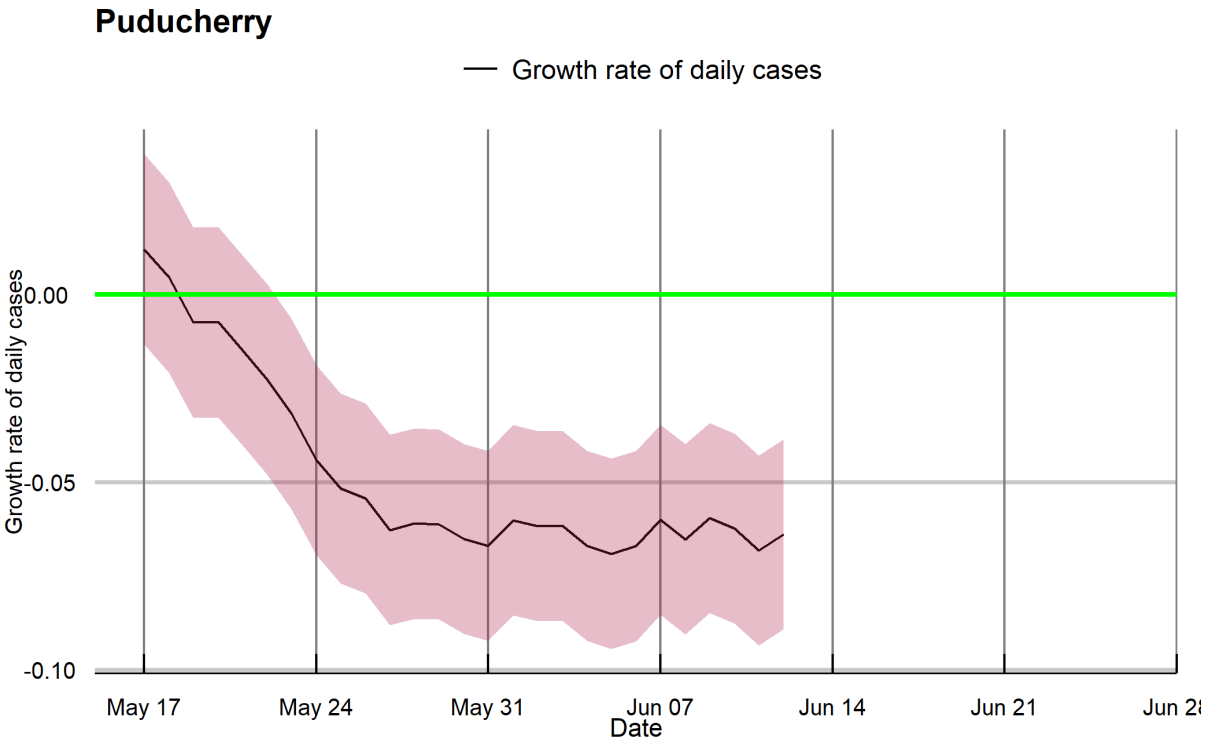
Odisha

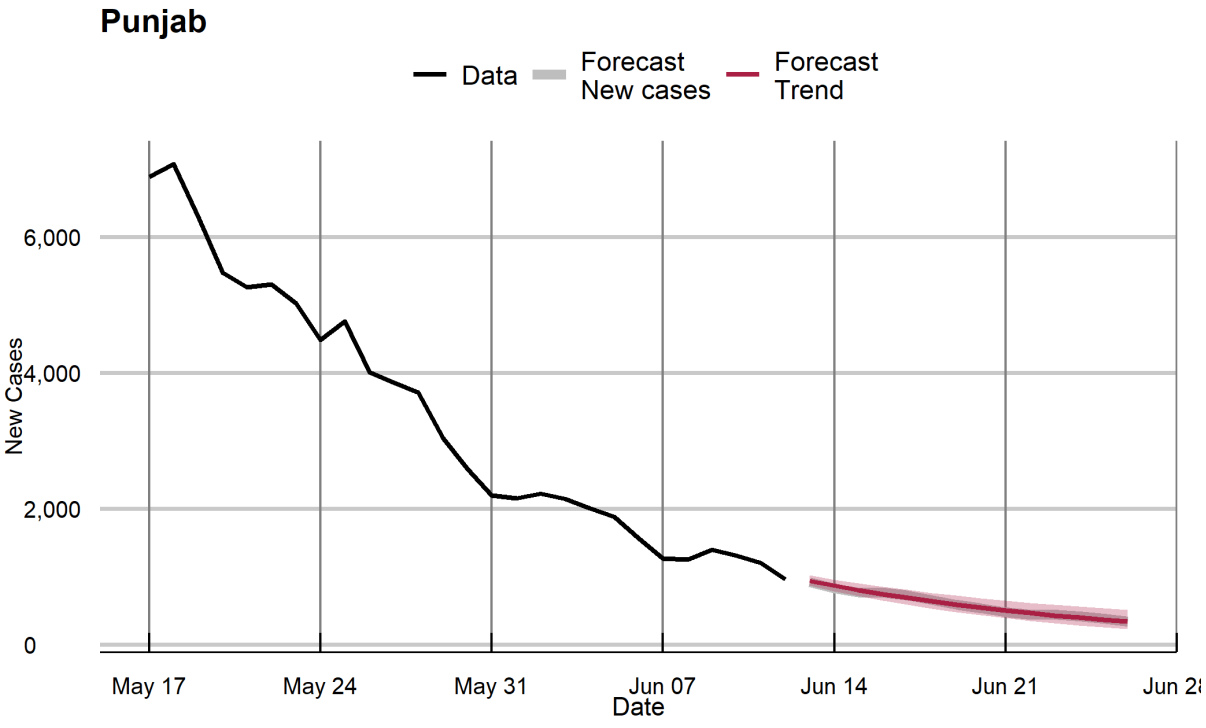


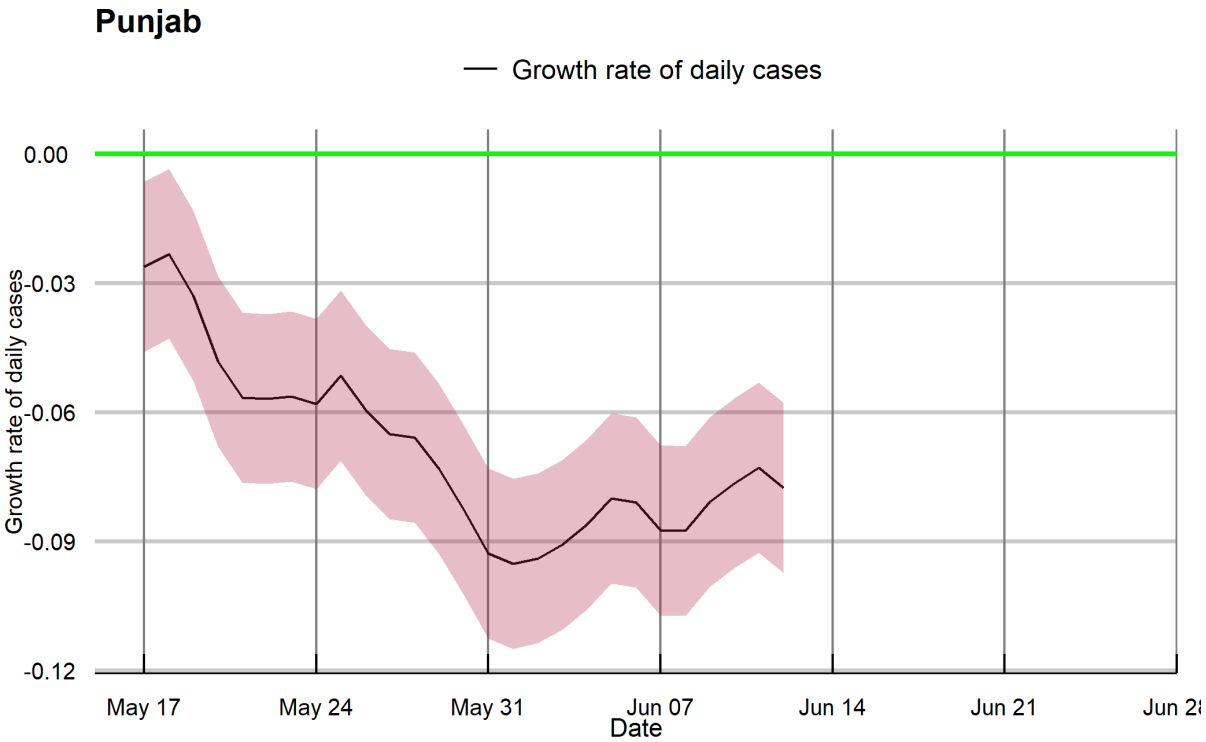
Odisha

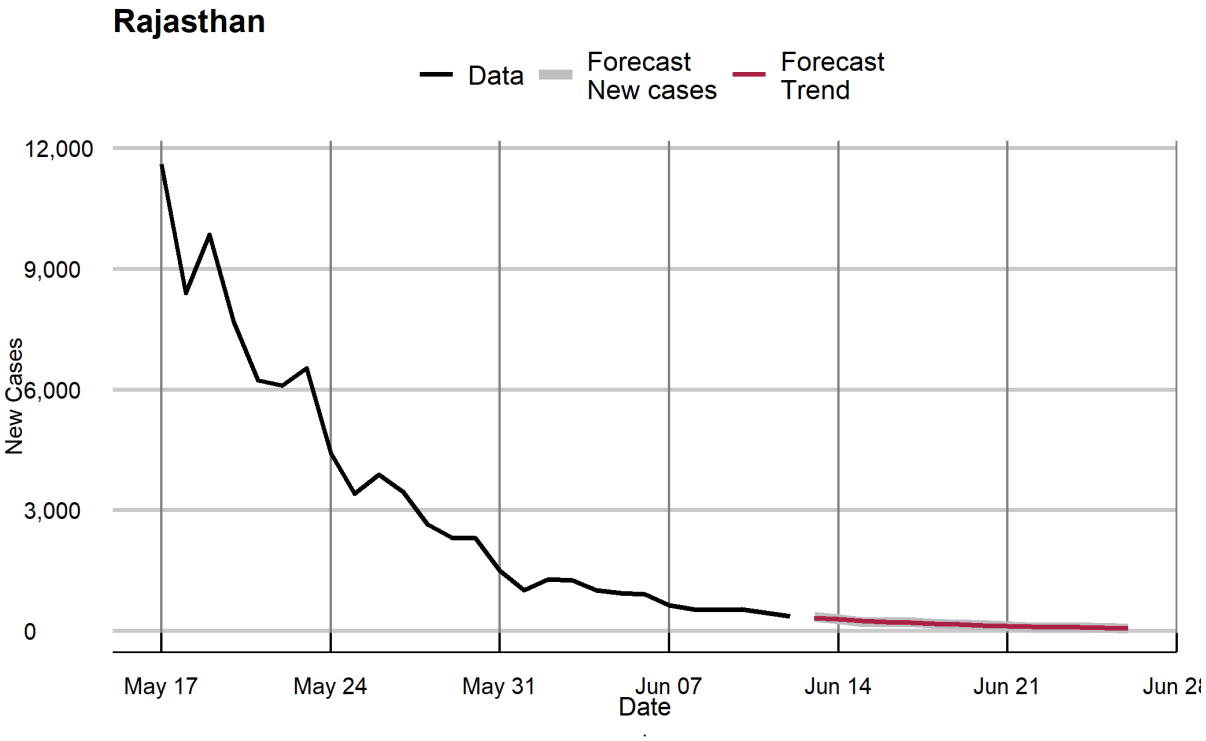


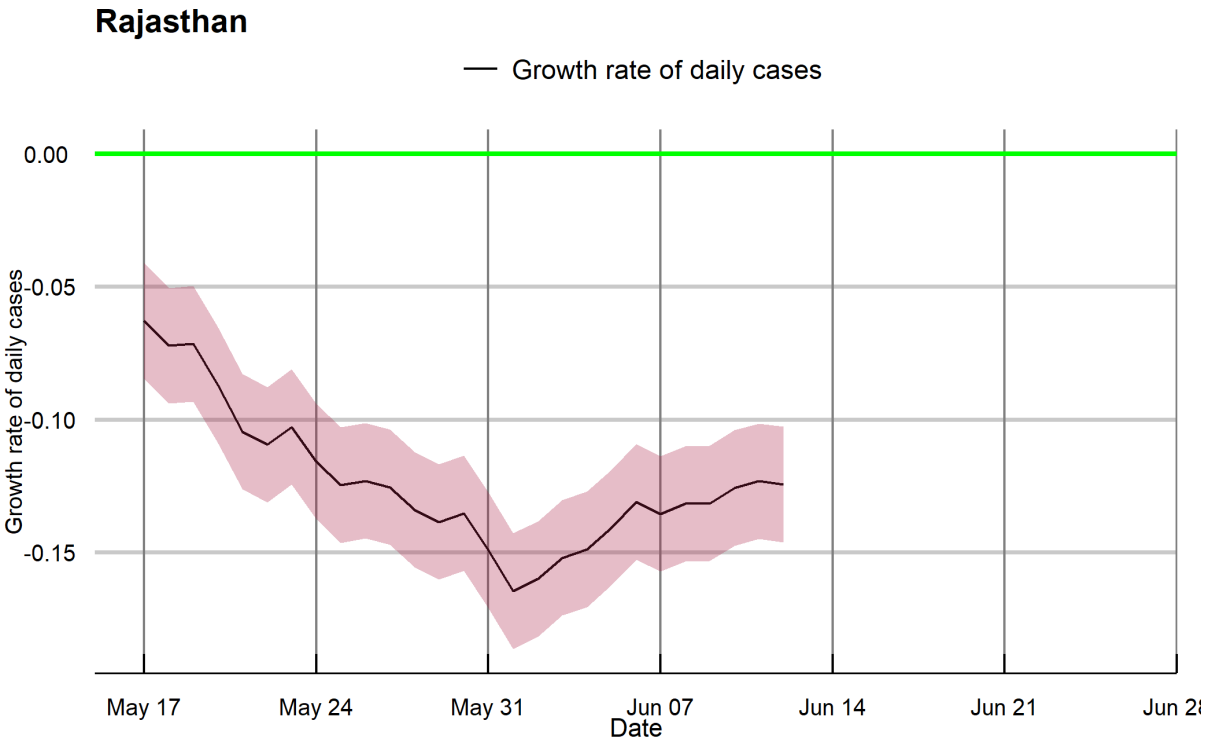

Puducherry
Data
Forecast
New cases
Forecast
Trend
2,000
1,500
1,000
500
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

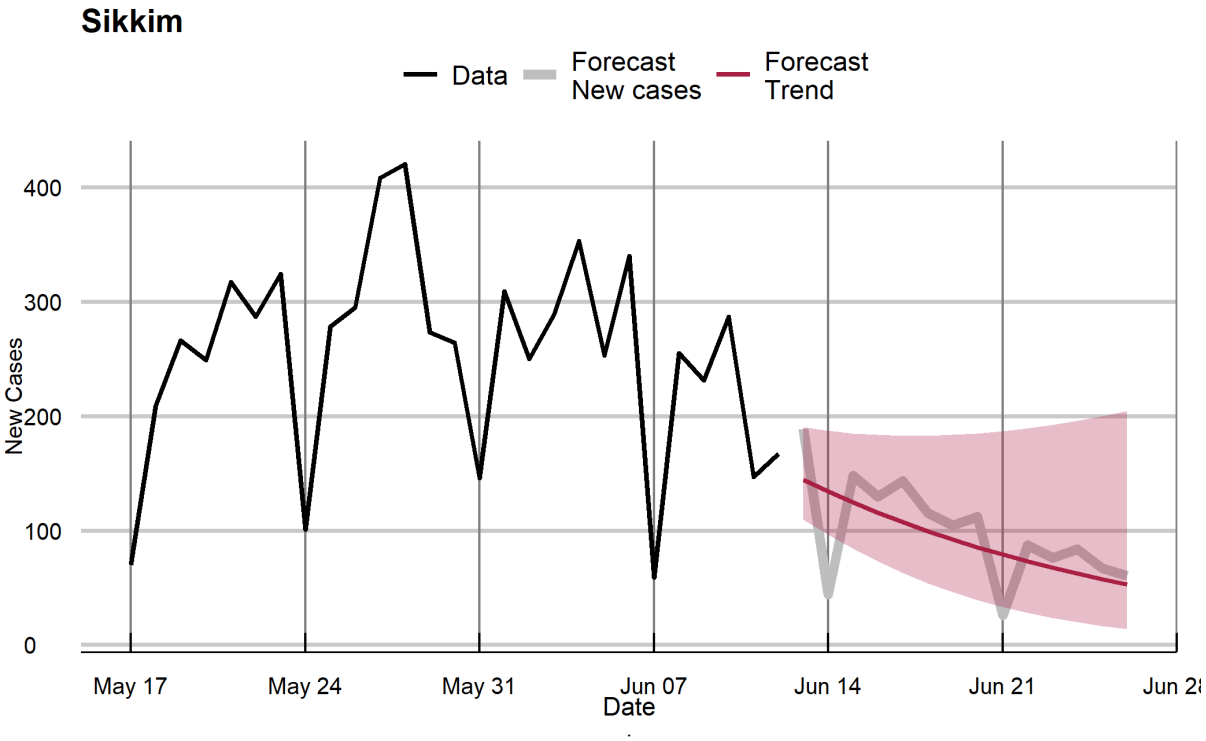

Puducherry
Growth rate of daily cases
0.00
-0.05
-0.10
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

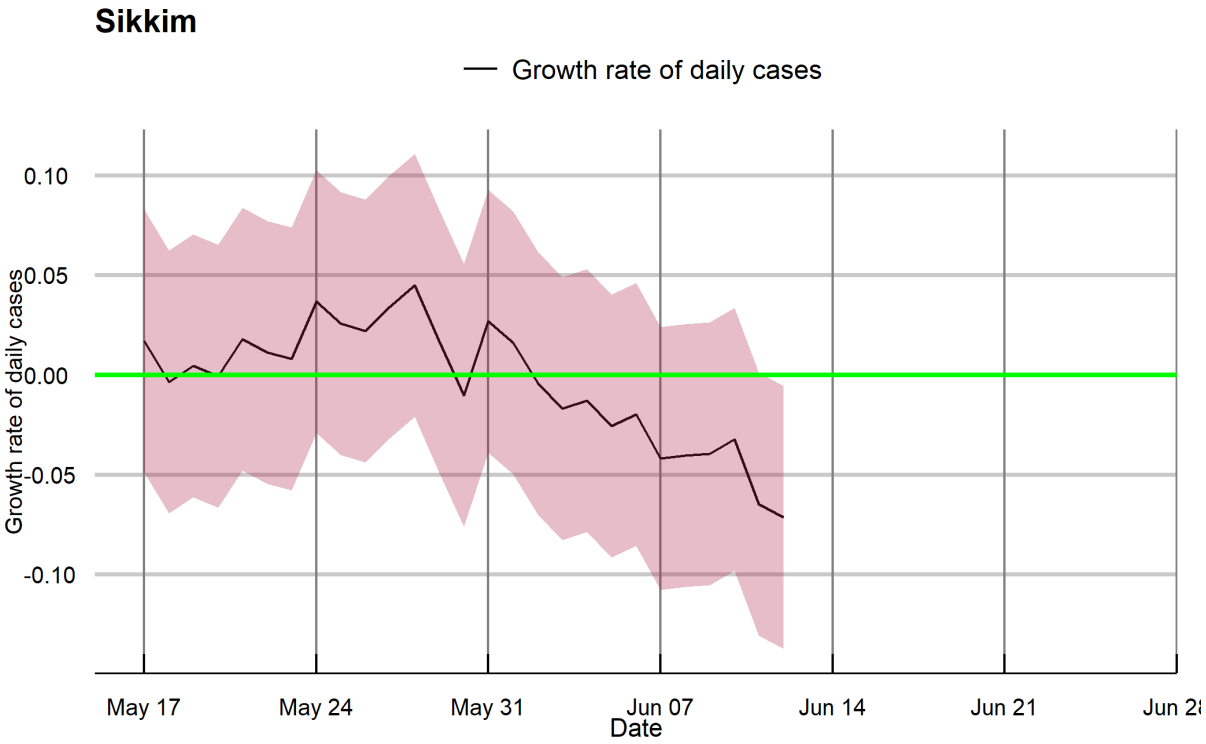

Punjab
Data
Forecast
New cases
Forecast
Trend
6,000
4,000
2,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

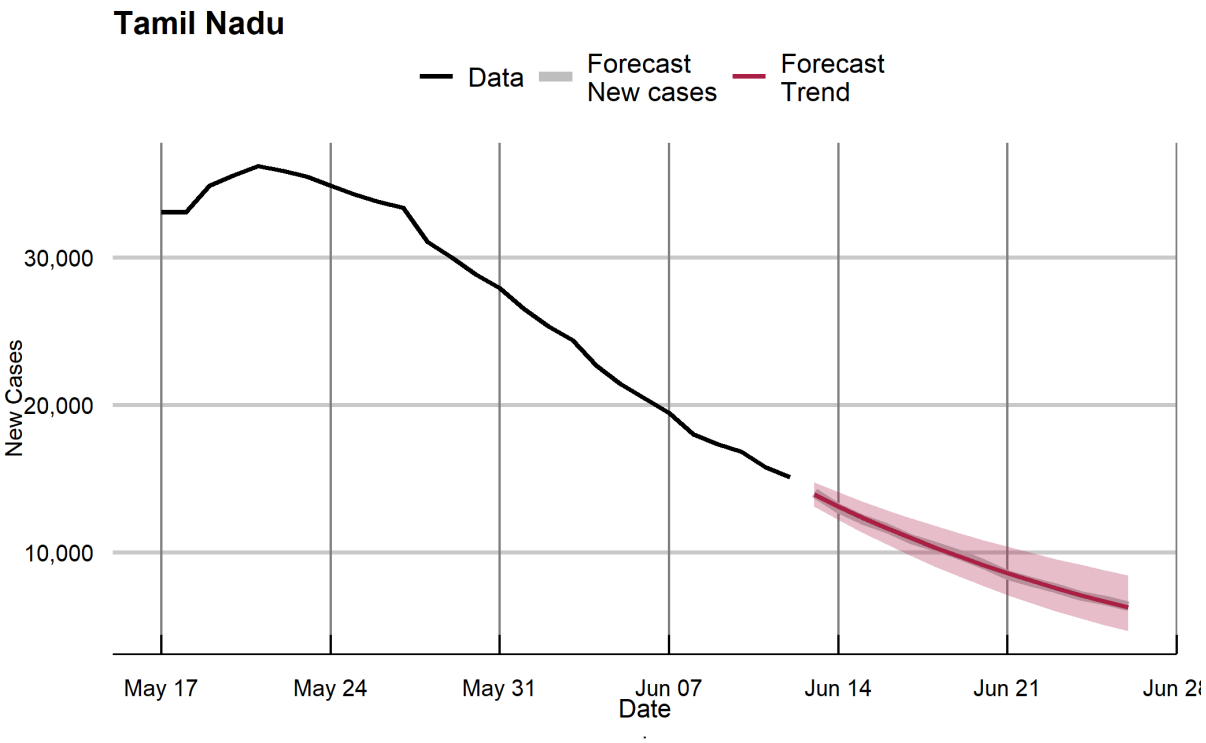

Punjab
Growth rate of daily cases
0.00
-0.03
-0.06
-0.09
-0.12
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

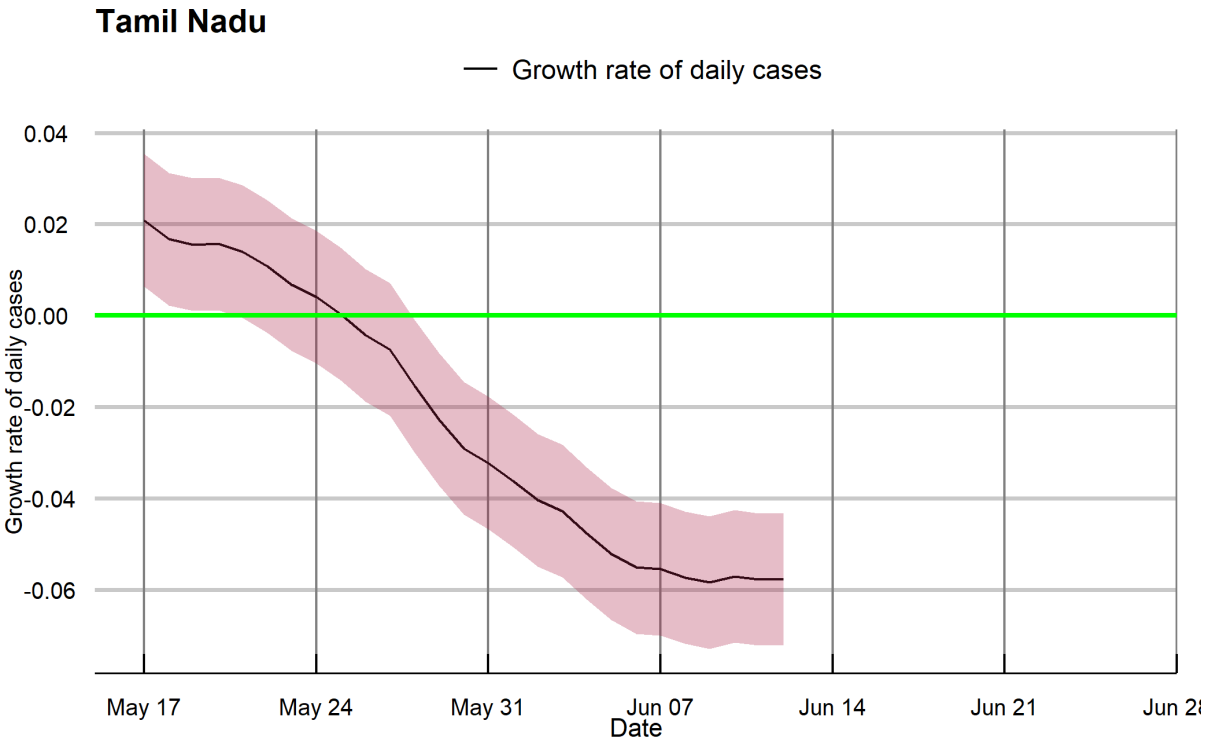

Rajasthan
Data
Forecast
New cases
Forecast
Trend
12,000
9,000
6,000
3,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

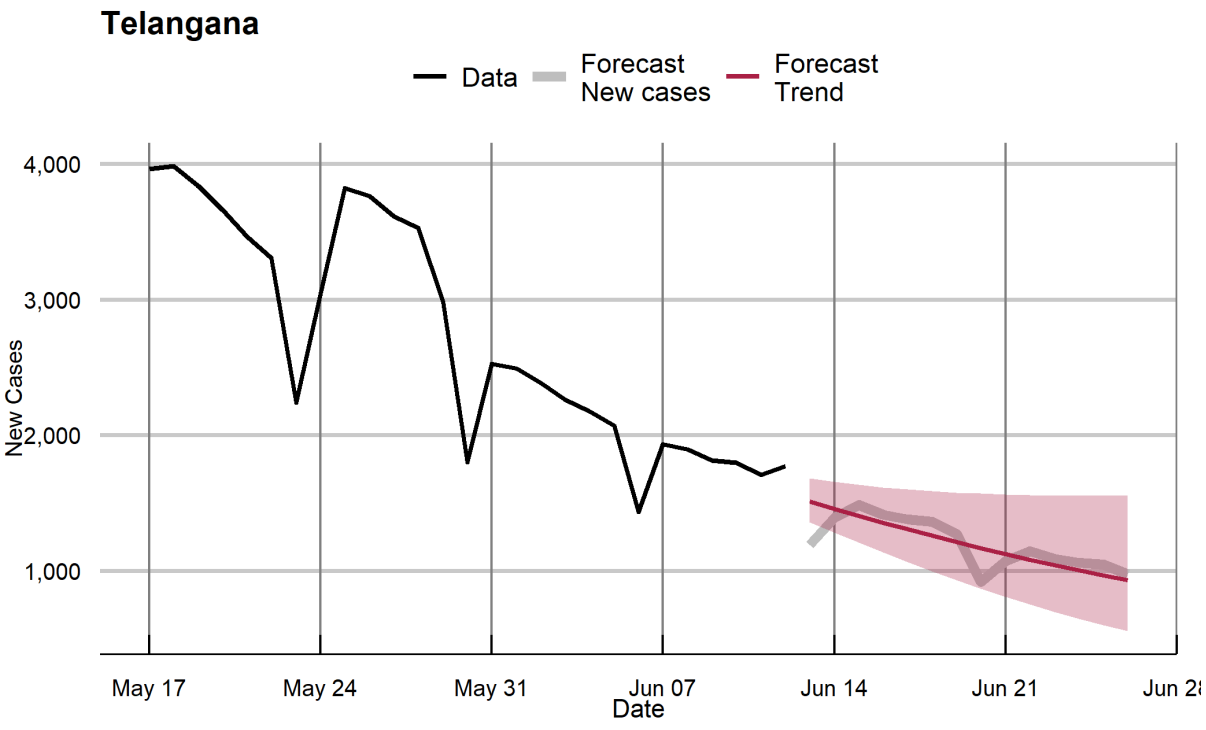

Rajasthan
Growth rate of daily cases
0.00
-0.05
-0.10
-0.15
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

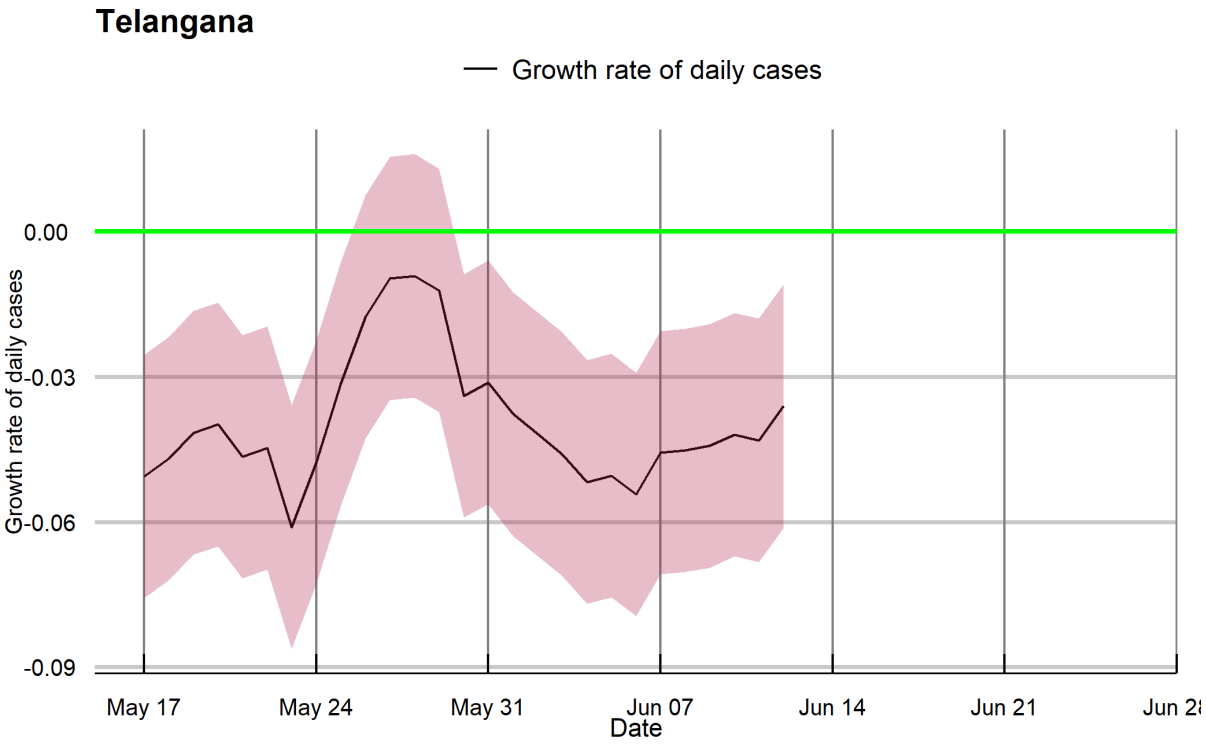

Sikkim
Data
Forecast
New cases
Forecast
Trend
400
300
200
100
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

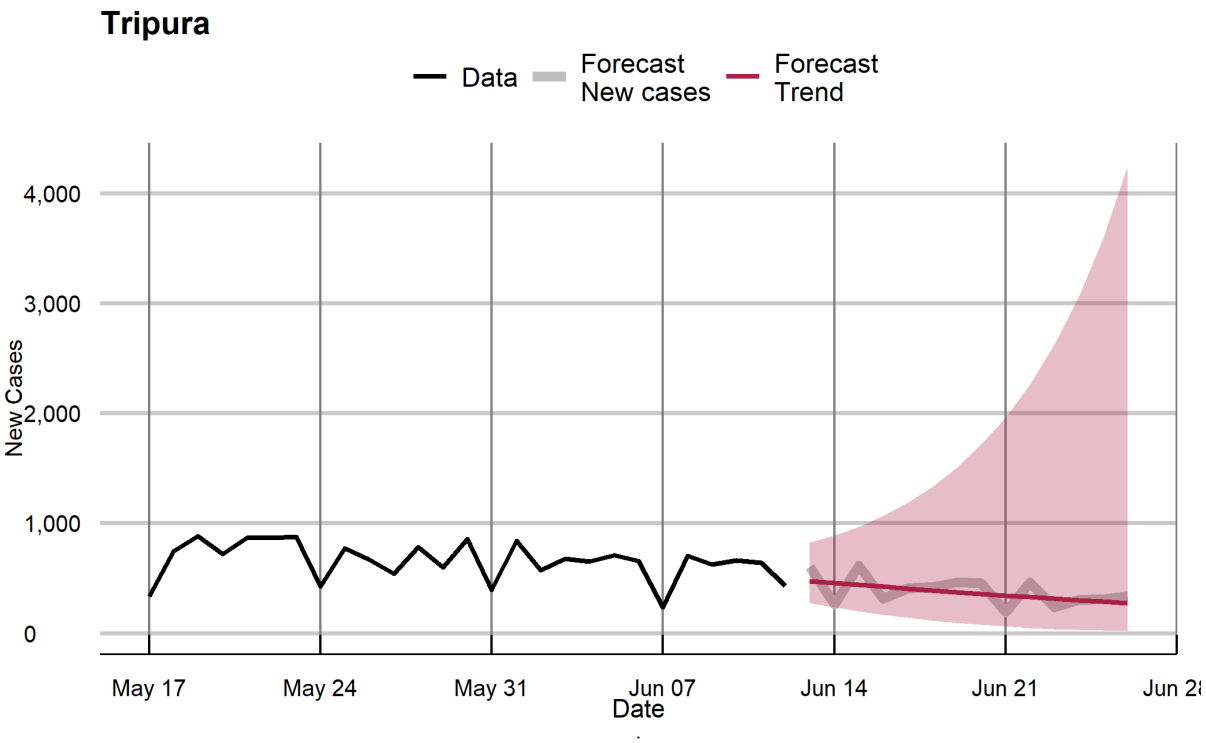

Sikkim
Growth rate of daily cases
0.10
0.05
0.00
-0.05
-0.10
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

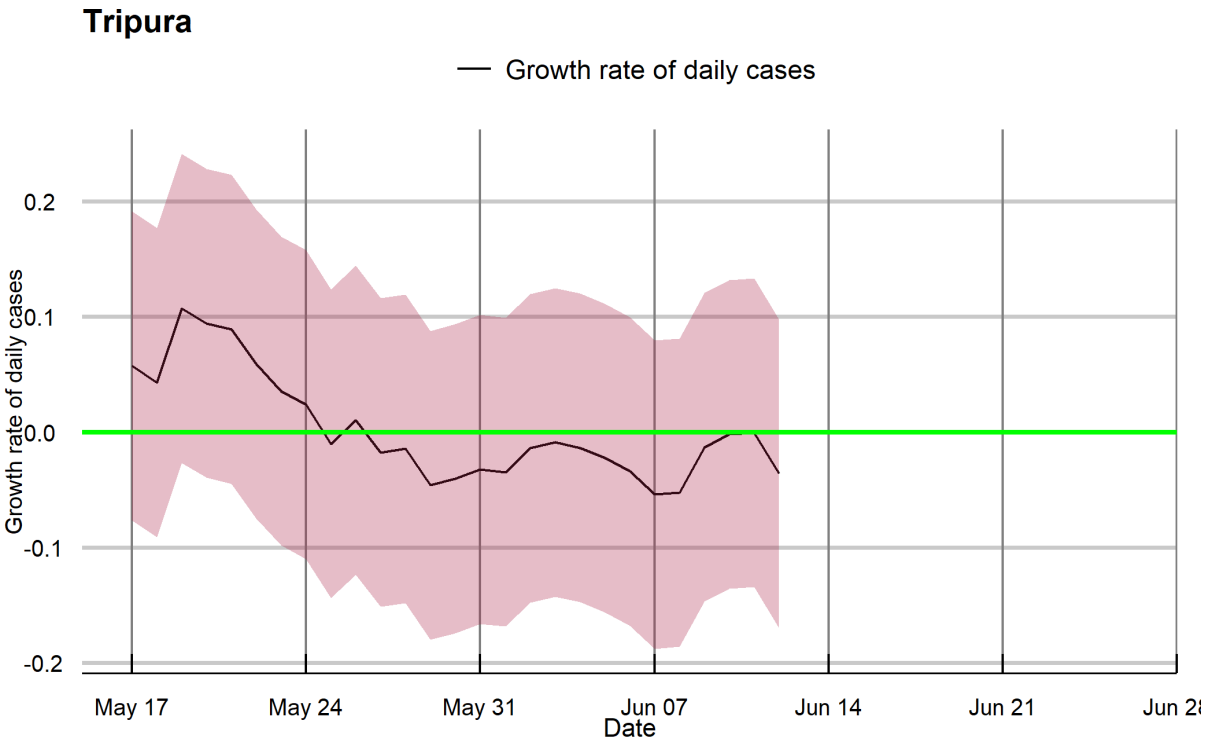

Tamil Nadu
Data
Forecast
New cases
Forecast
Trend
30,000
20,000
10,000
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date


Tamil Nadu
Growth rate of daily cases
0.04
0.02
0.00
-0.02
-0.04
-0.06
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

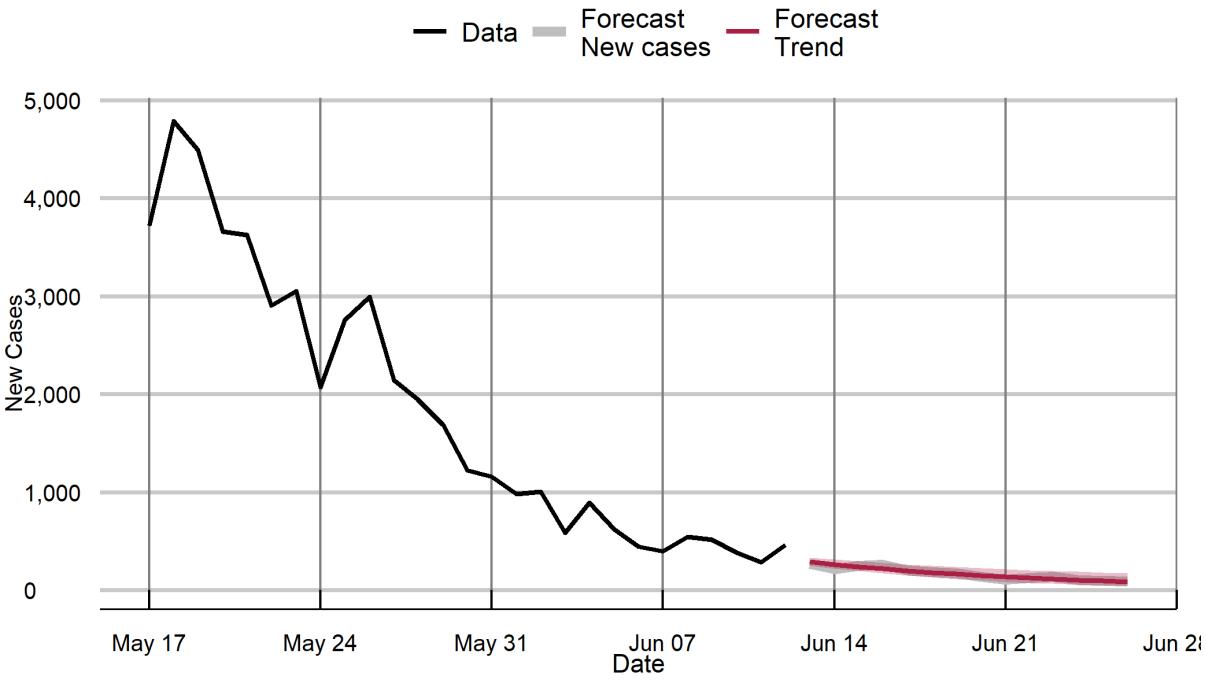

Telangana
Data
Forecast
New cases
Forecast
Trend
4,000
3,000
2,000
1,000
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date


Telangana
Growth rate of daily cases
0.00
-0.03
-0.06
-0.09
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

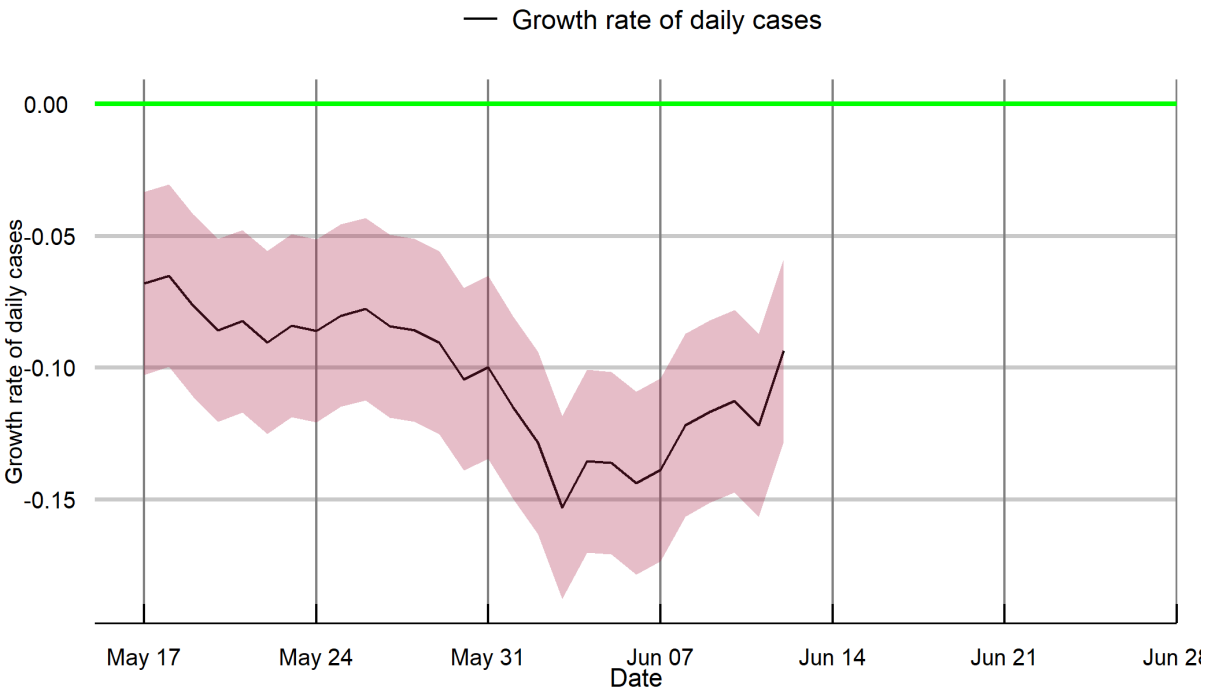

Tripura
Data
Forecast
New cases
Forecast
Trend
4,000
3,000
2,000
1,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

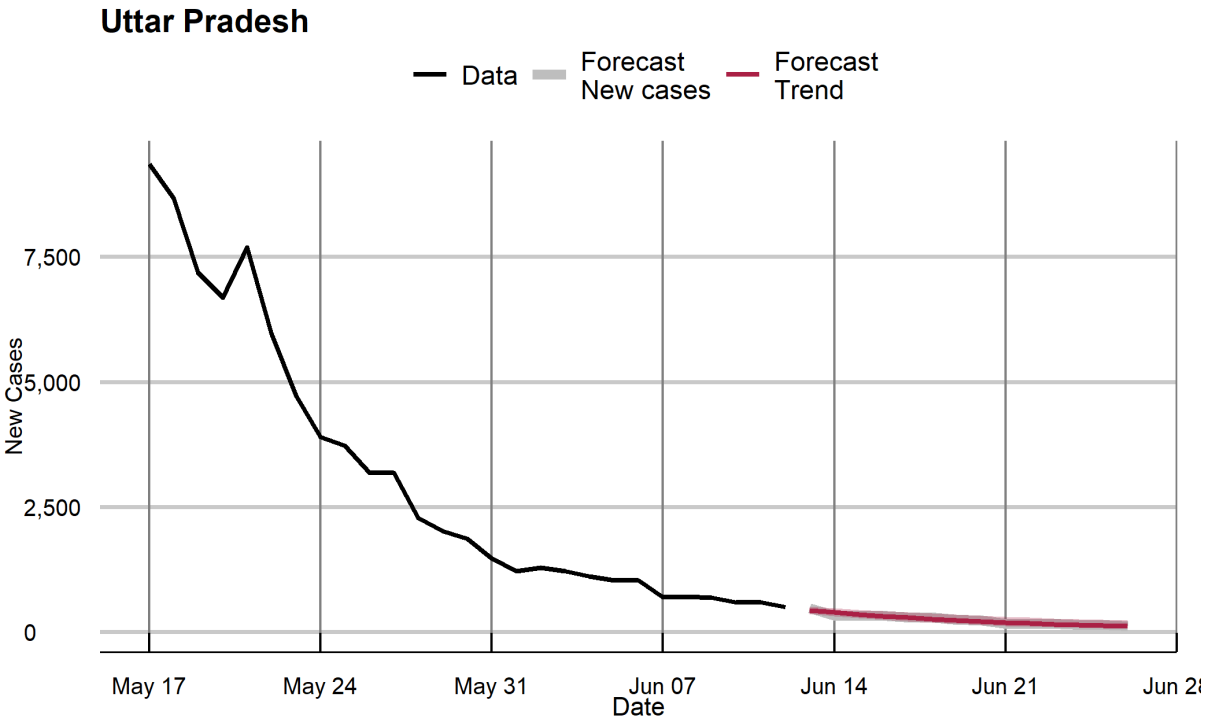

Tripura
Growth rate of daily cases
0.2
0.1
0.0
-0.1
-0.2
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

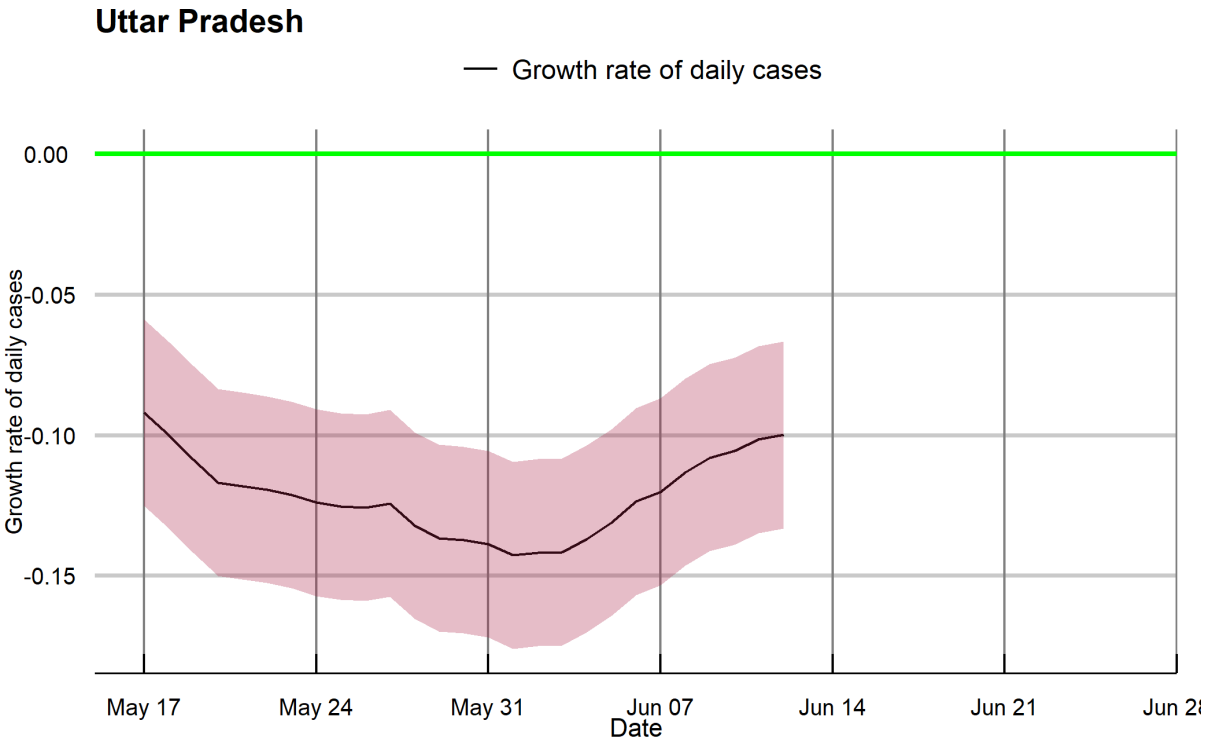
Uttarakhand

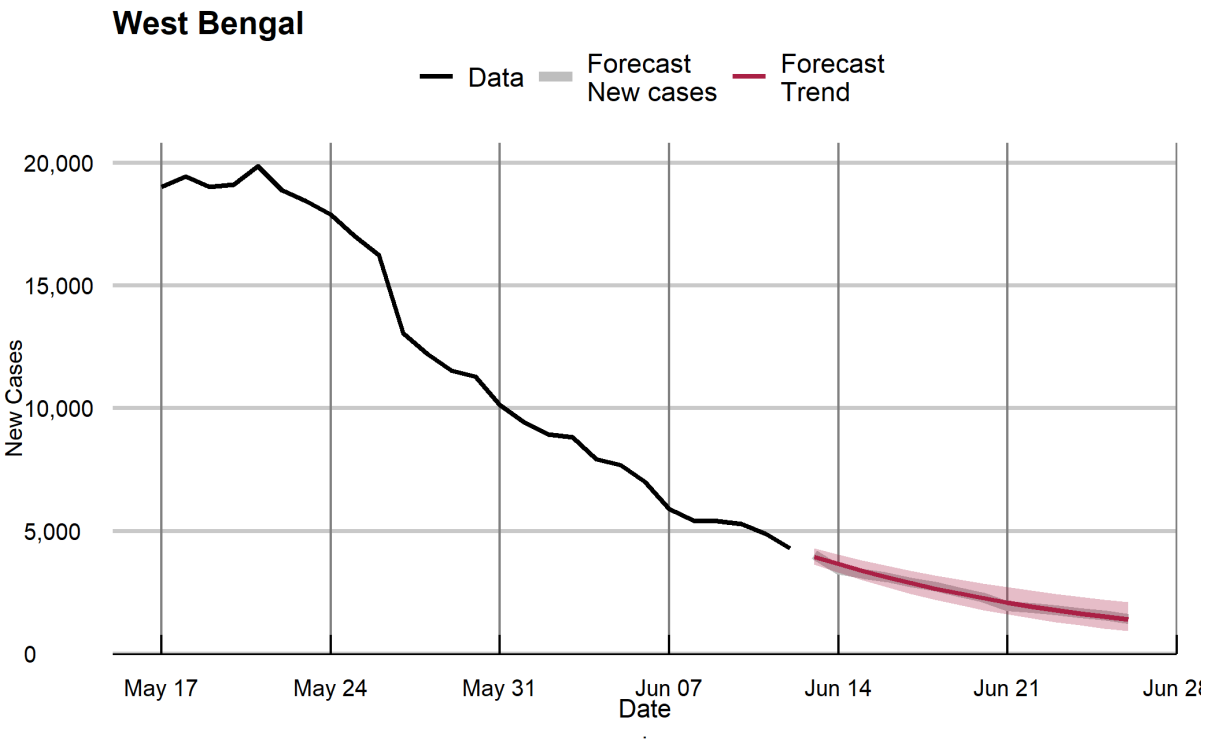


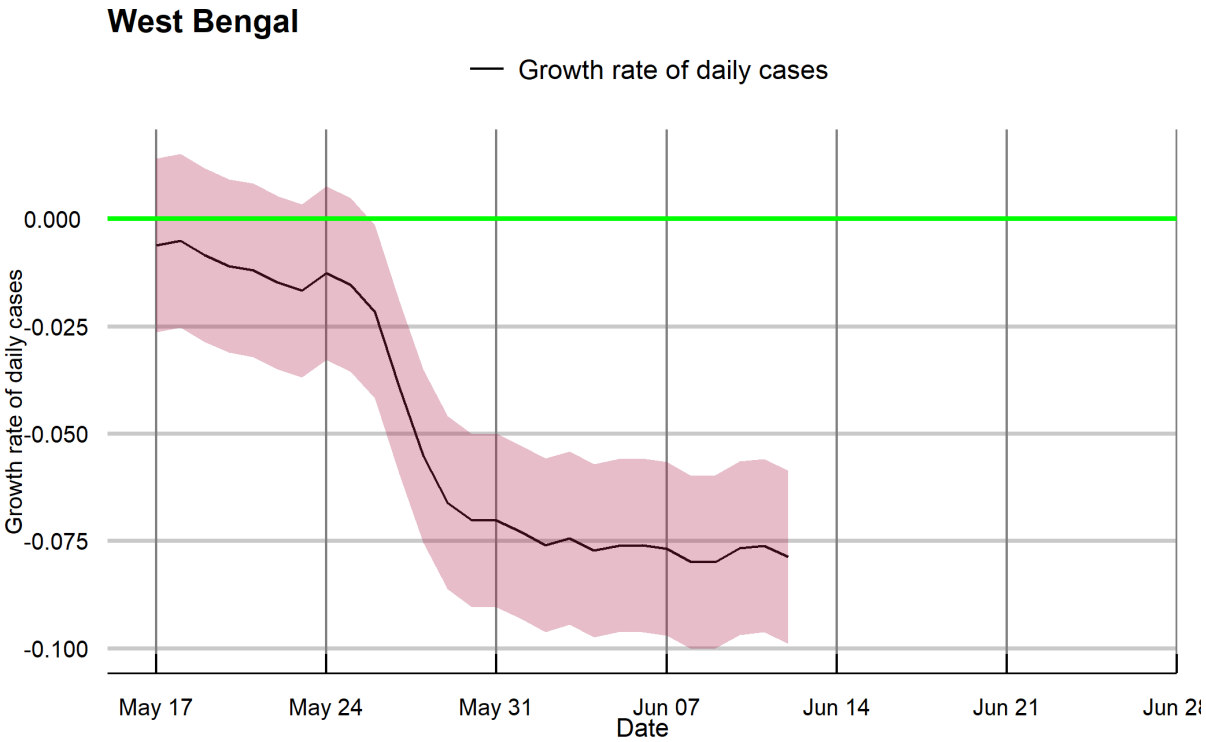
Uttarakhand




Uttar Pradesh
Data
Forecast
New cases
Forecast
Trend
7,500
5,000
2,500
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date


Uttar Pradesh
Growth rate of daily cases
0.00
-0.05
-0.10
-0.15
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date


West Bengal
Data
Forecast
New cases
Forecast
Trend
20,000
15,000
10,000
5,000
0
New Cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date


West Bengal
Growth rate of daily cases
0.000
-0.025
-0.050
-0.075
-0.100
Growth rate of daily cases
May 17
May 24
May 31
Jun 07
Jun 14
Jun 21
Date

Notes

Data: COVID-19 confirmed cases and deaths data are sourced from COVID19-India API: https://api.covid19india.org/

New cases: forecasts. Forecasts above are based on a structural time series model that uses all the data in estimation but adapts to the trend emerging in the most recent period. The method is described in: Harvey, A. and P. Kattuman (2020). Time series models based on growth curves with applications to forecasting coronavirus. *Harvard Data Science Review*, Special issue 1 - COVID -19. https://hdsr.mitpress.mit.edu/pub/ozgjx0yn/release/2 , and Harvey, A., P. Kattuman, and C. Thamotheram (2021). Tracking the mutant: forecasting and nowcasting COVID-19 in the UK in 2021. *National Institute Economic Review*. Forthcoming.

Forecast accuracy: When estimated with data up to June 6, the mean absolute percentage error of the forecasts of cases for India over the period, June 7 – 12, is 7.9%. Forecast accuracy will in general be lower for the smaller states / union territories. It is important to pay attention to the confidence intervals around the forecasts. The coverage of the confidence intervals presented is 68%, implying there is 16% probability of the upper bound being exceeded.

New cases: growth rate. The filtered trends presented for daily growth rates of cases are estimated using the Kalman filter, applied to the observed series. The method filters out day of the week effects and random noise to reveal the underlying signal. Unlike methods such as the moving average, this method adapts the trend to changes in real time and characterises underlying patterns of surges or attenuations that are hidden in the volatile series. The method is described in the papers listed above.

***R*:** The *R*-estimates are based on the nowcast of the growth rate; the estimation approach is described in Harvey, A. and P. Kattuman (2020b). A farewell to R: Time series models for tracking and forecasting epidemics. *Center for Economic Policy Research* (CEPR) working paper, 51. https://cepr.org/content/covid-economics. The confidence interval is based on one standard deviation, with coverage of 68%.

The accuracy of forecasts rely on the quality of the published data. Further, changes in government pandemic policies and in transmission relevant social behaviour may lead realised numbers to deviate from forecasts.

Andrew Harvey[*], Paul Kattuman[*], Rajeev Sadanandan[#], Stefan Scholtes[*], Craig Thamotheram[+]

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