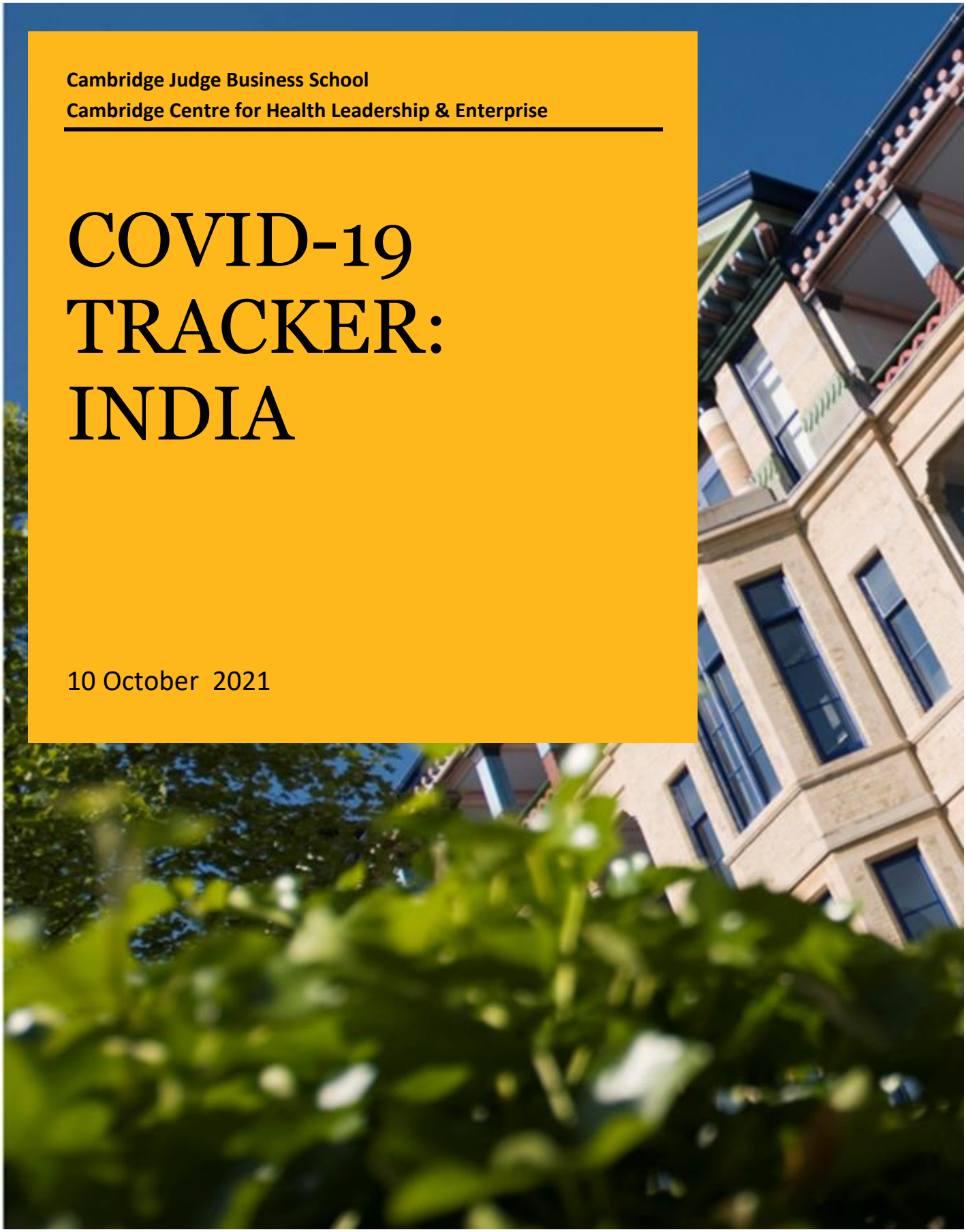


Cambridge Judge Business School
Cambridge Centre for Health Leadership & Enterprise

COVID-19 TRACKER: INDIA

10 October 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] was 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.

Daily case numbers continue to decline steadily in India. The filtered growth rate of new cases is -2.4%, unchanged from a week ago, and the reproduction number remains well below one, at 0.91. The trend value of reported cases is likely to fall just under 13,000 per day in two weeks, by 24 October.

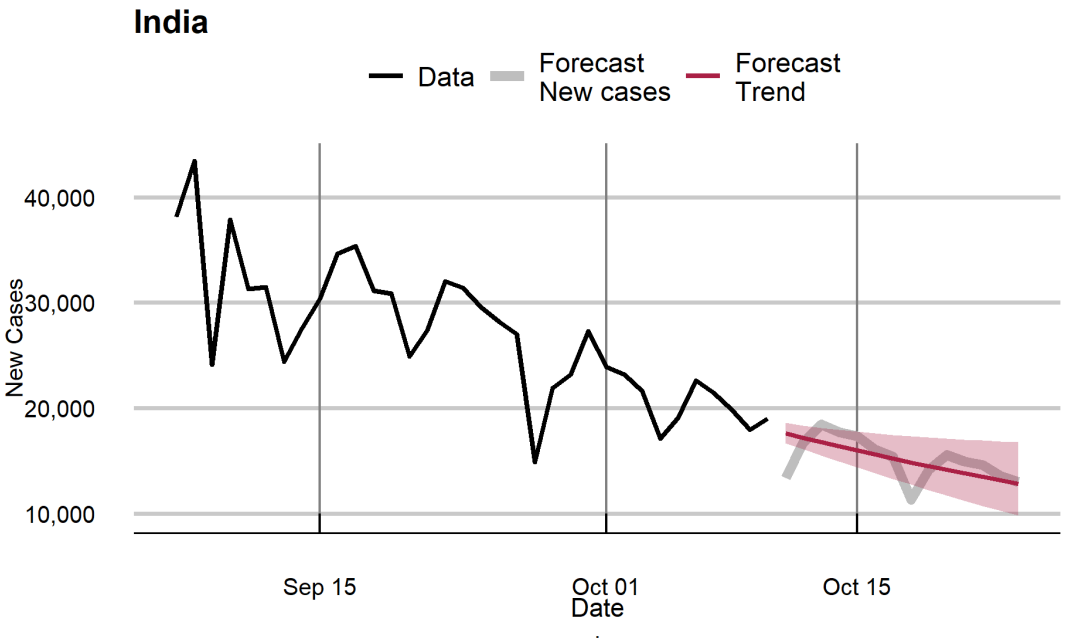
Evidence suggest the India is transitioning to the endemic phase of the disease. Large surges are very unlikely, though there is enduring potential for local flare ups. Currently, Odisha and West Bengal are the only states featuring the combination of relatively high numbers of daily cases and positive if modest growth.

[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. A UK tracker based on the same forecasting method is published by the National Institute of Economic and Social Research.

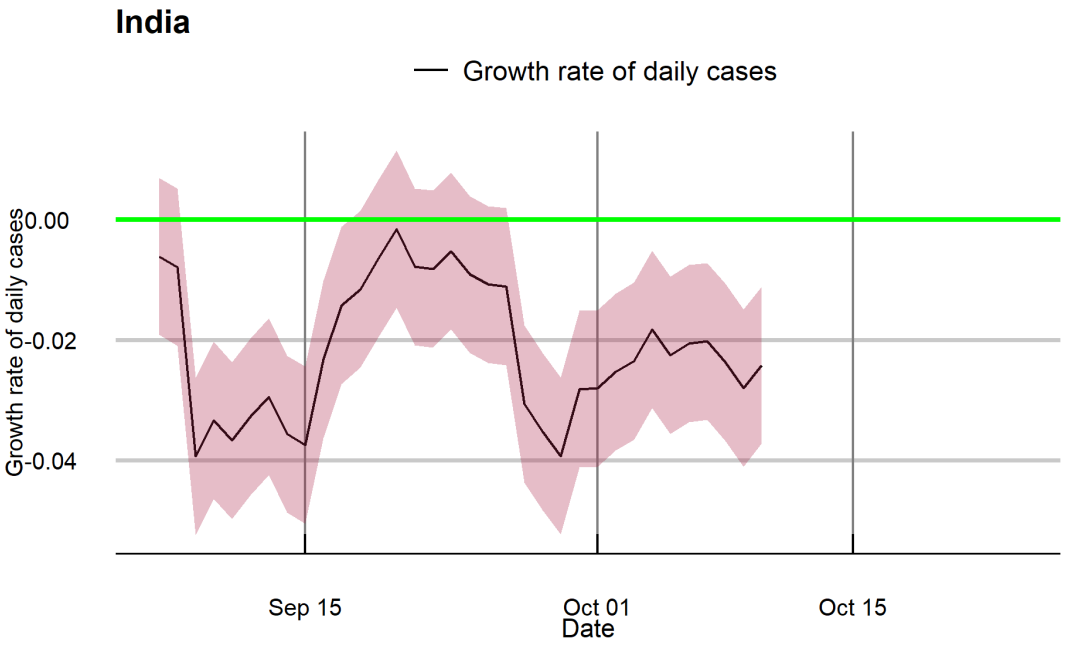
Contact: Paul Kattuman

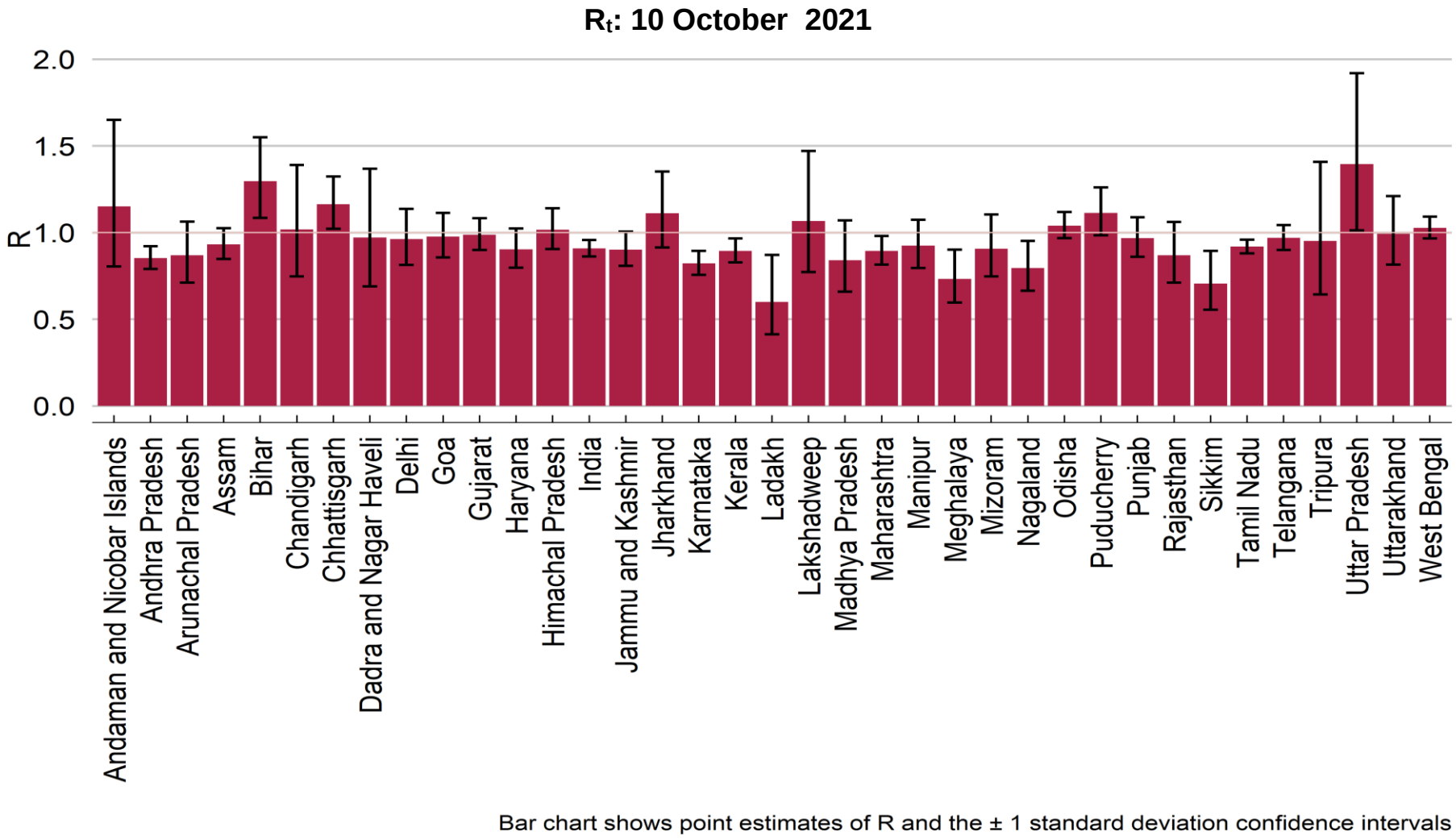
Daily Covid-19 cases in India: Forecast

Forecasts of daily new cases for the period 11 October to 24 October 2021, based on data till 10 October 2021. The trend value of new COVID-19 cases is likely be under 13,000 per day by 24 October.

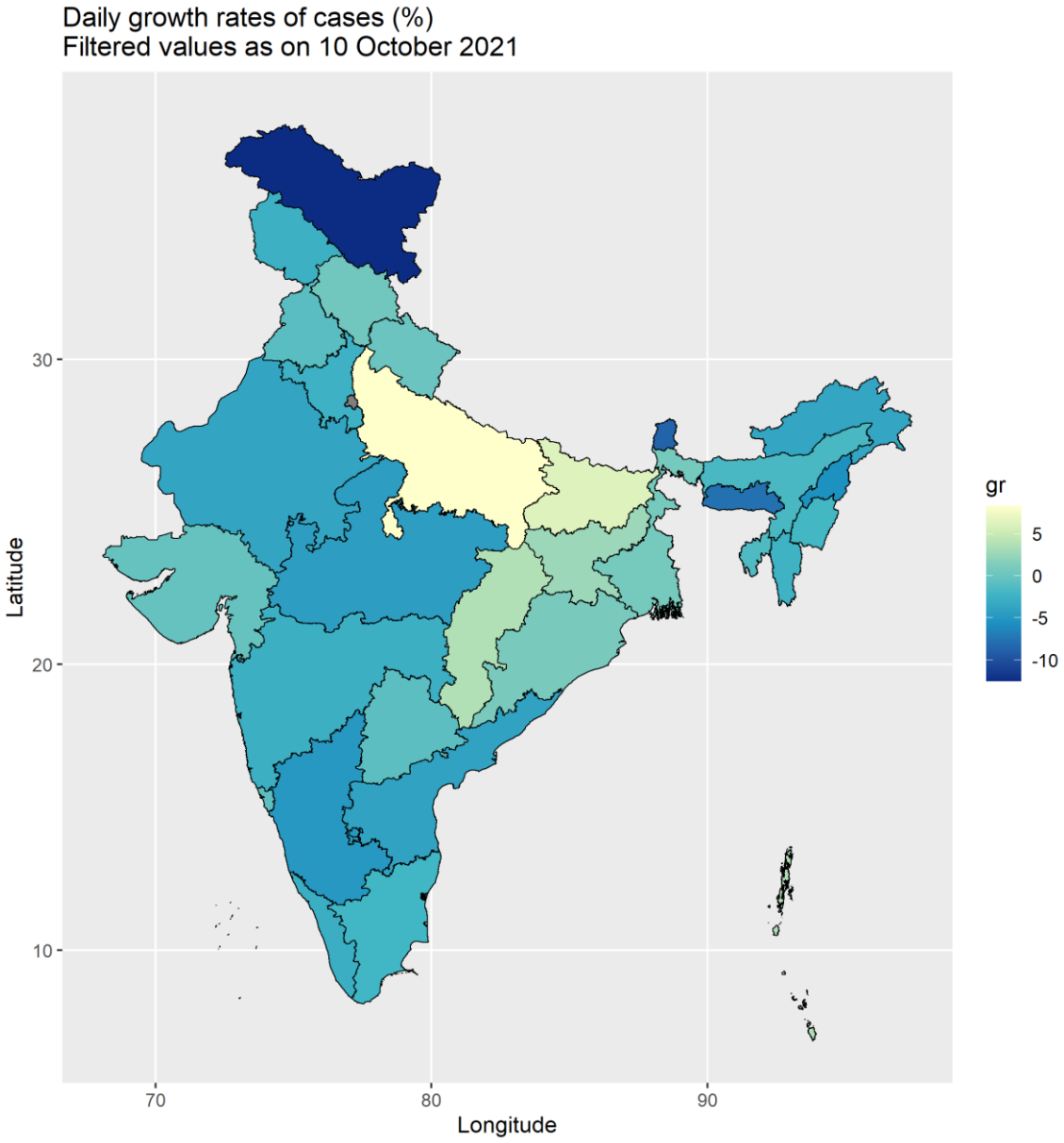


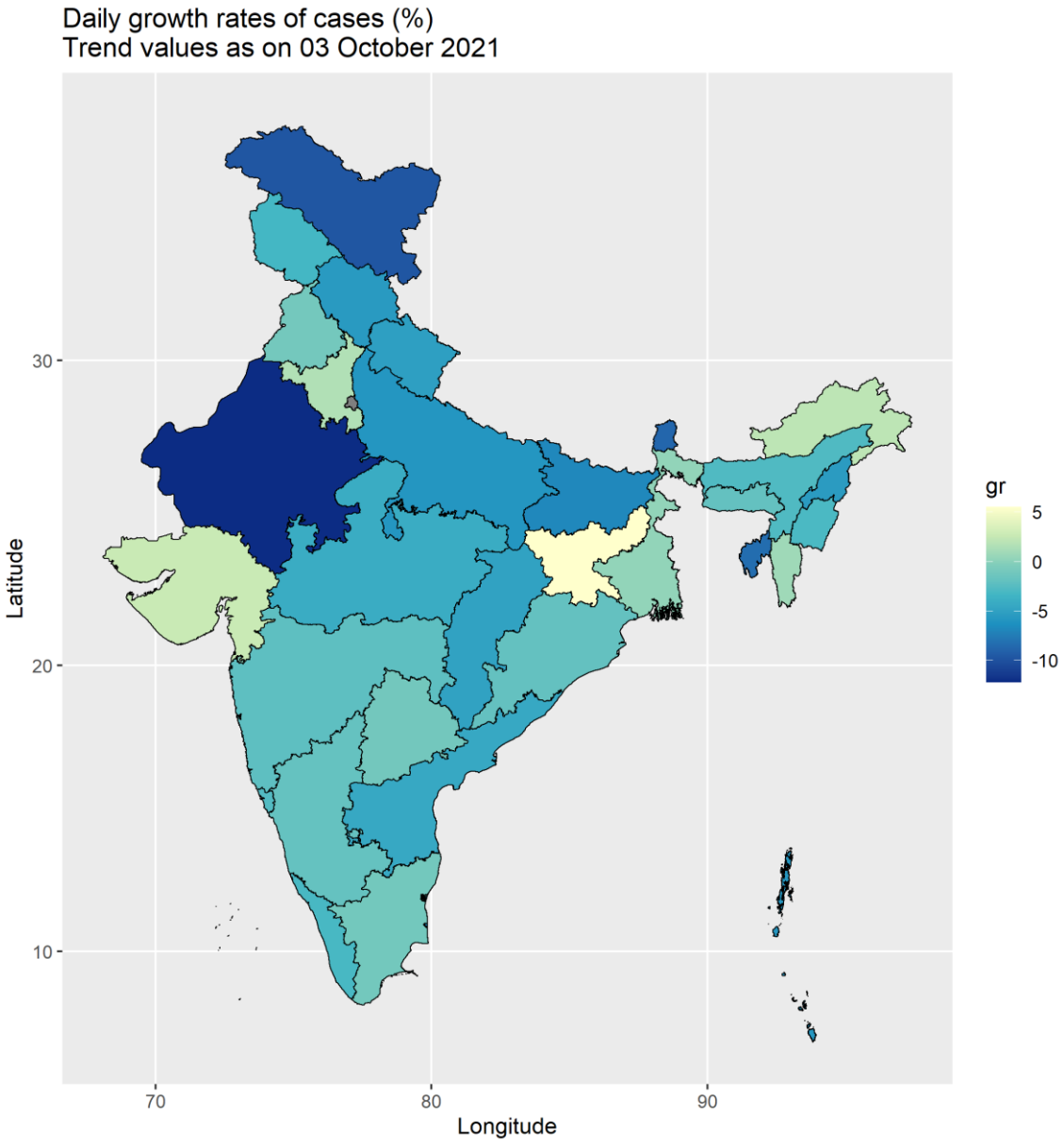
The filtered growth rate of daily new cases was -0.024 (-2.4 %) as on 10 October 2021.





Note: Small daily numbers (less than 25) currently seen in Andaman and Nicobar Islands, Arunachal Pradesh, Bihar, Chandigarh, Chhattisgarh, Dadra and Nagar Haveli, Gujarat, Haryana, Jharkhand, Ladakh, Lakshadweep, Madhya Pradesh, Nagaland, Rajasthan, Sikkim, Tripura and Uttarakhand make their estimates and forecasts less precise.

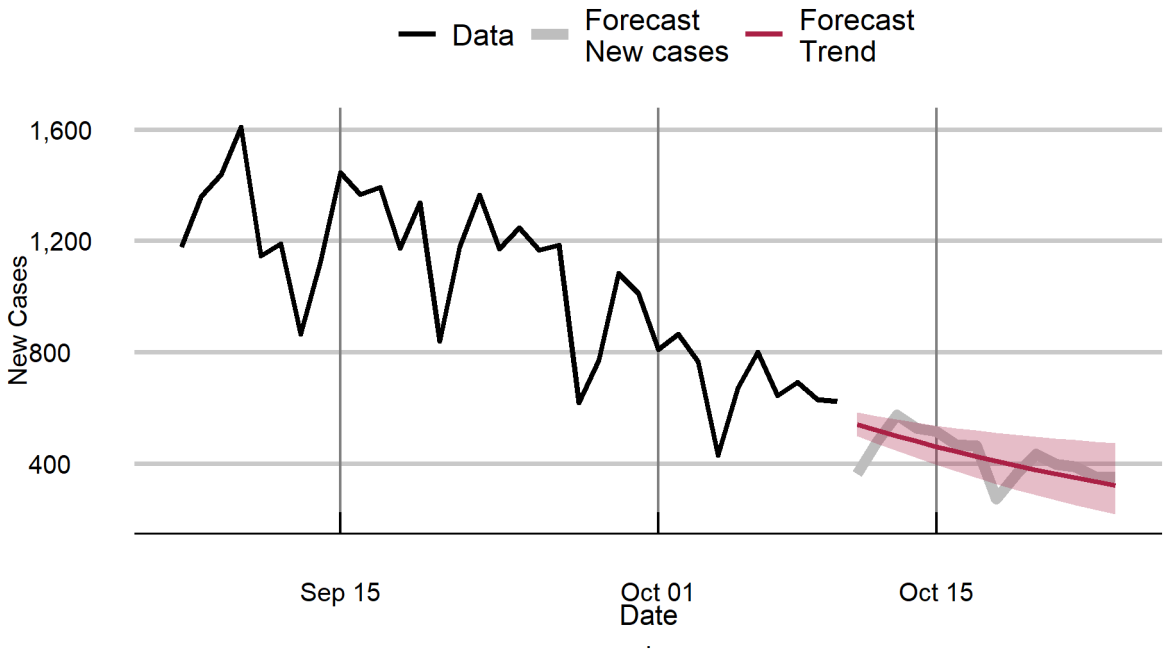

Daily growth rates of cases (%)
Filtered values as on 10 October 2021
Latitude
30
20
10
70
80
90
Longitude
gr
5
0
-5
-10


Daily growth rates of cases (%)
Trend values as on 03 October 2021
Latitude
30
20
10
70
80
90
Longitude
gr
5
0
-5
-10

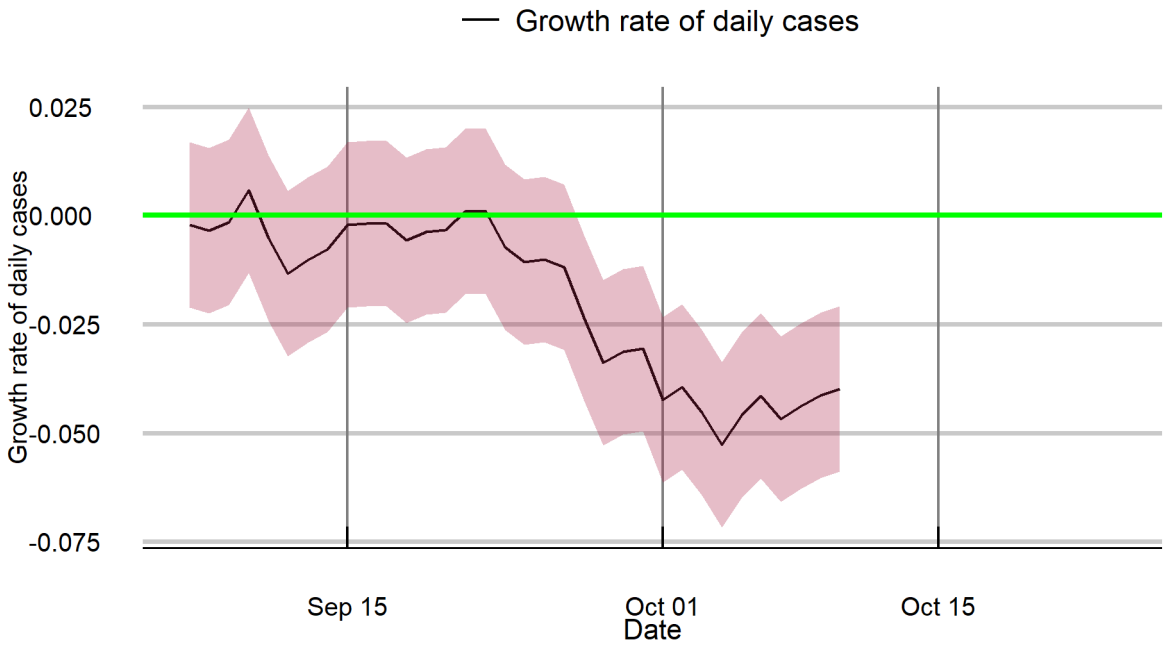
New cases forecasts and daily growth rates:

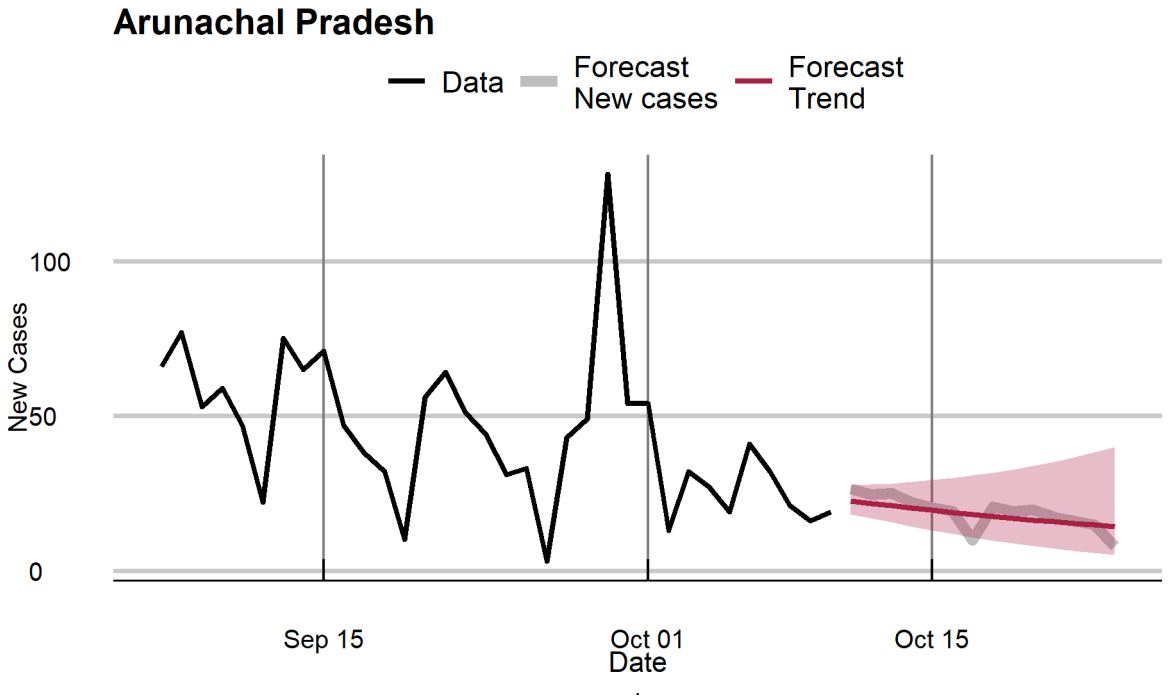
States and Union territories

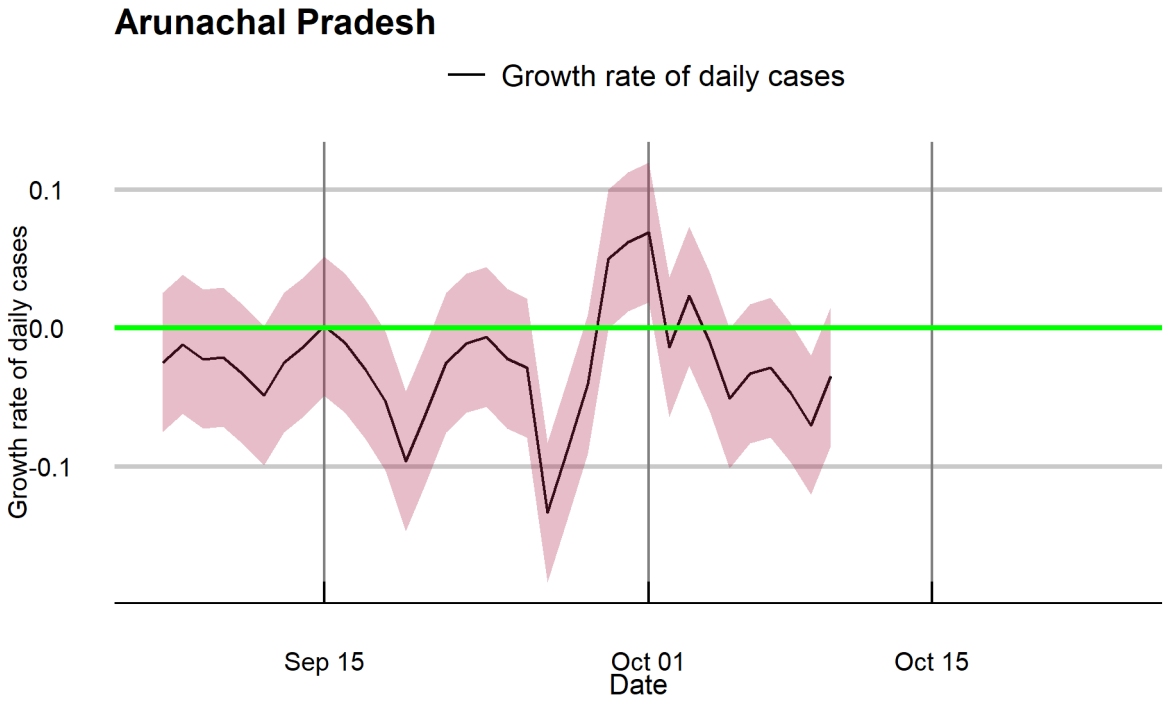
Andhra Pradesh

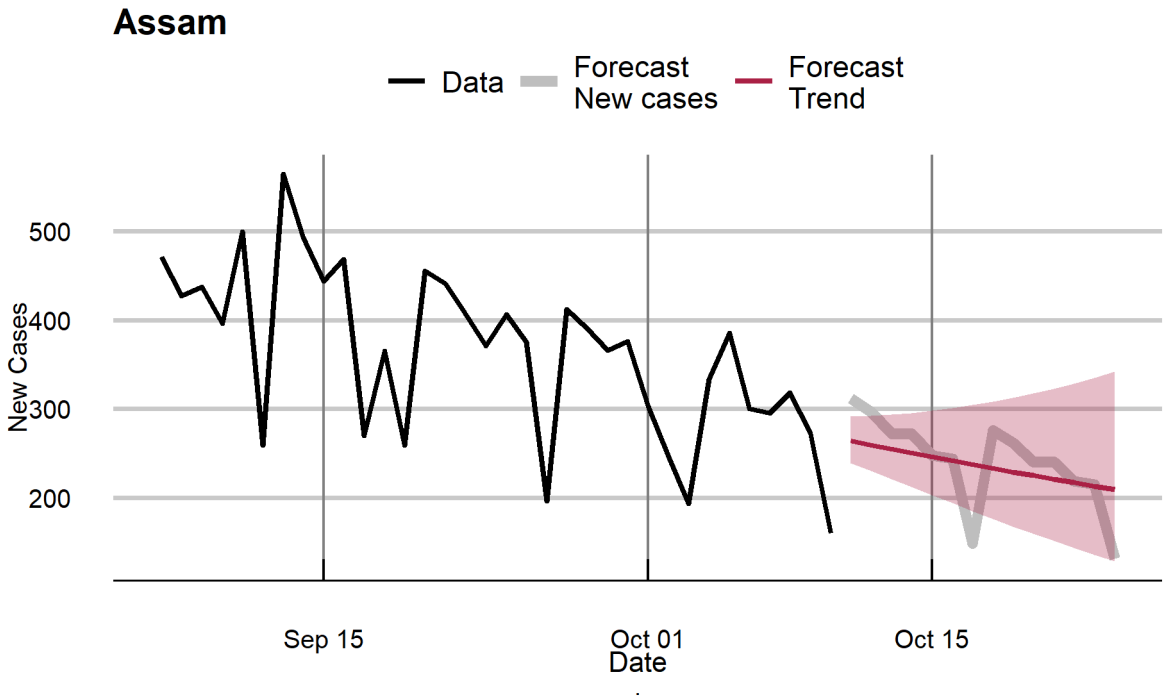


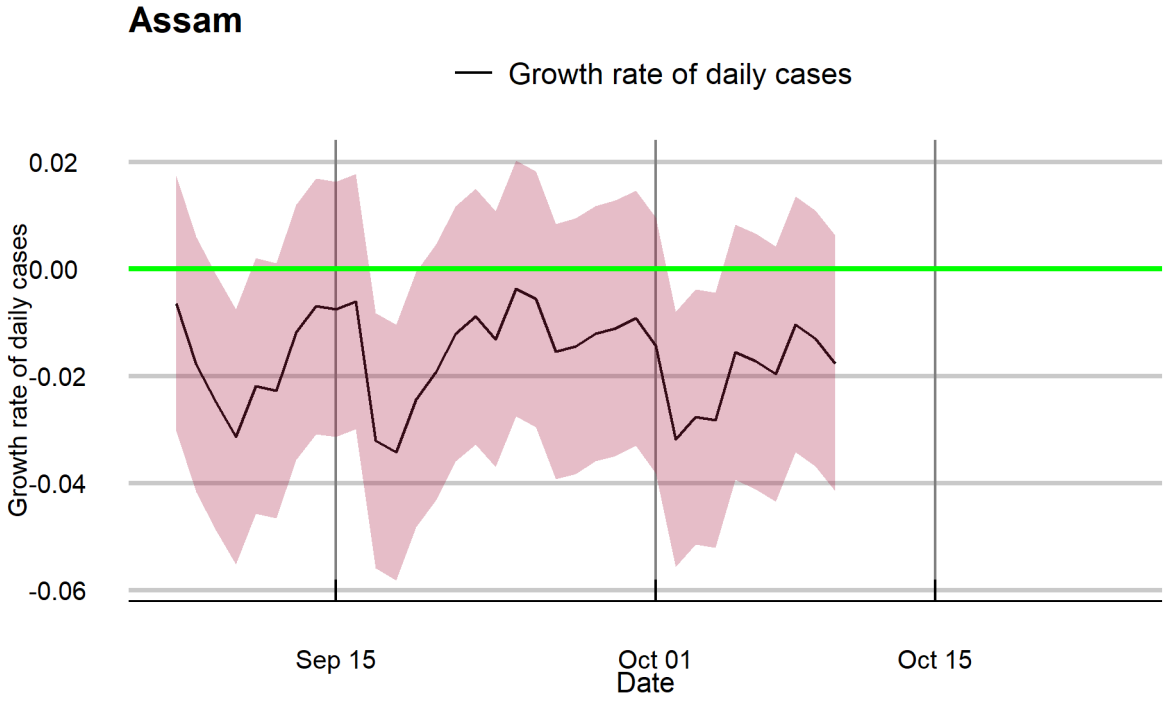
Andhra Pradesh

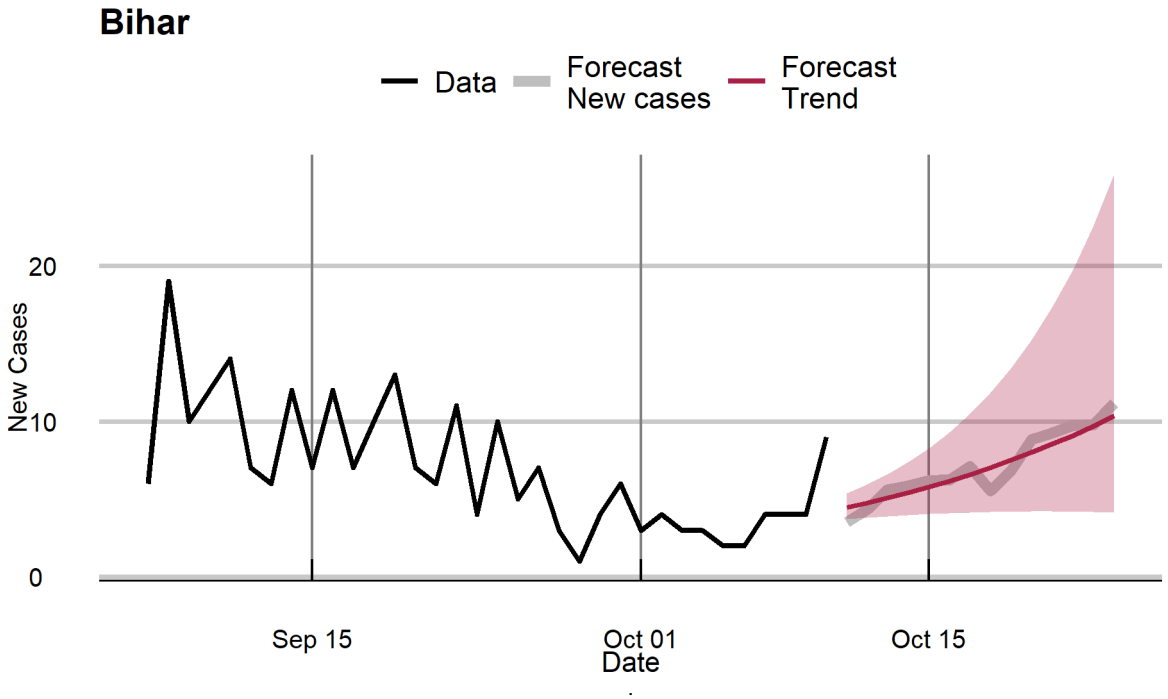


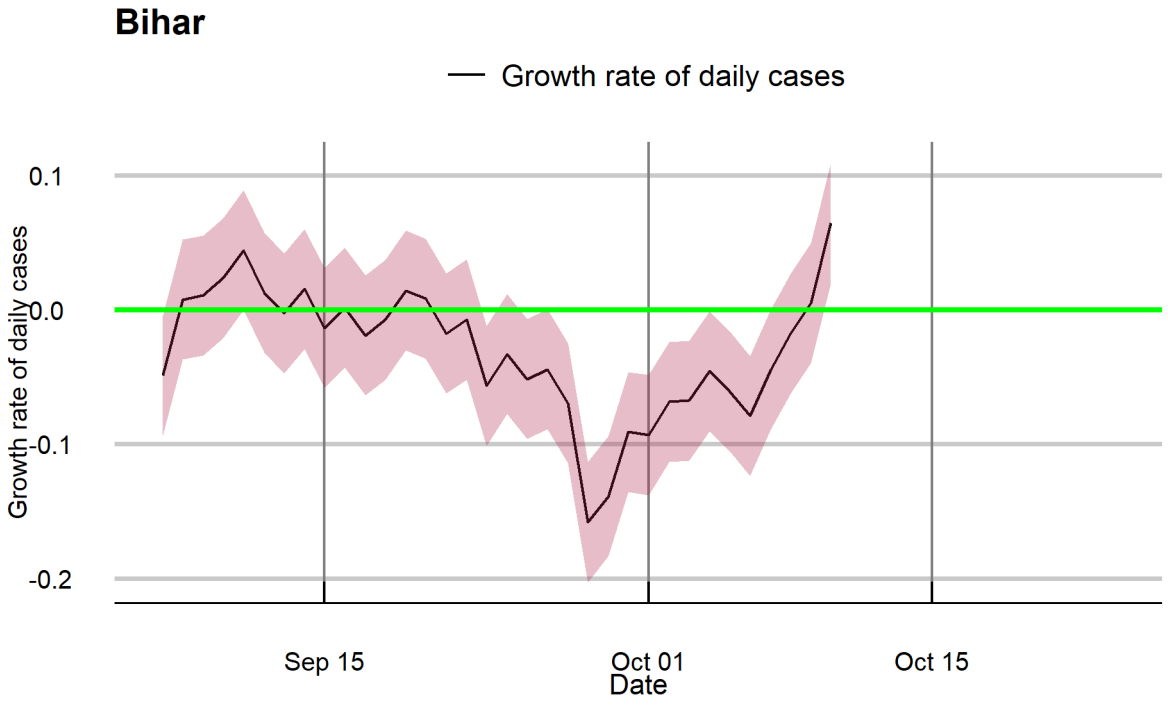

Arunachal Pradesh
Data
Forecast
New cases
Forecast
Trend
100
50
0
New Cases
Sep 15
Oct 01
Oct 15
Date

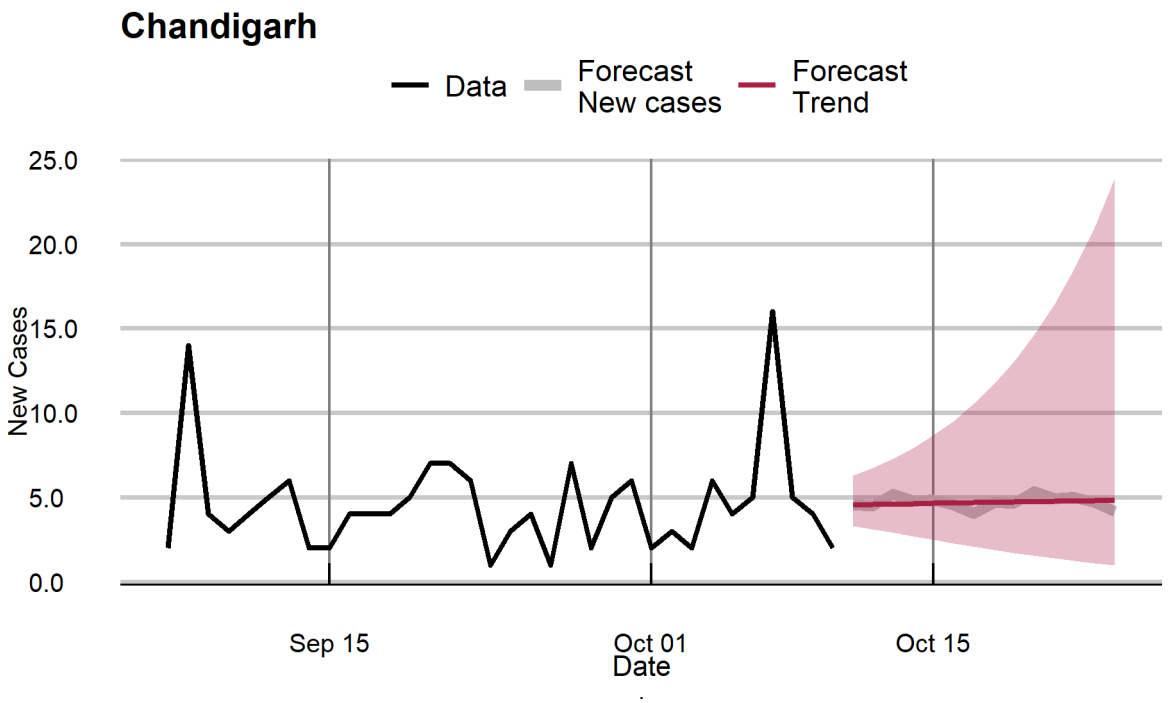

Arunachal Pradesh
Growth rate of daily cases
0.1
0.0
-0.1
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

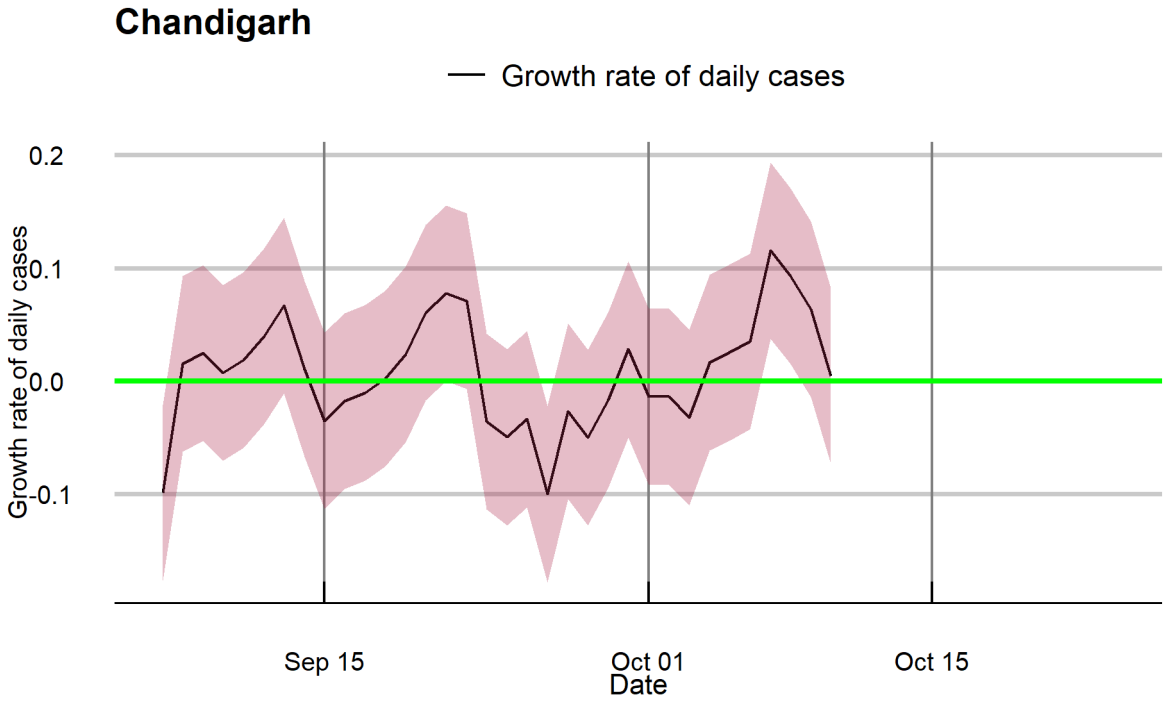

Assam
Data
Forecast
New cases
Forecast
Trend
500
400
300
200
New Cases
Sep 15
Oct 01
Oct 15
Date

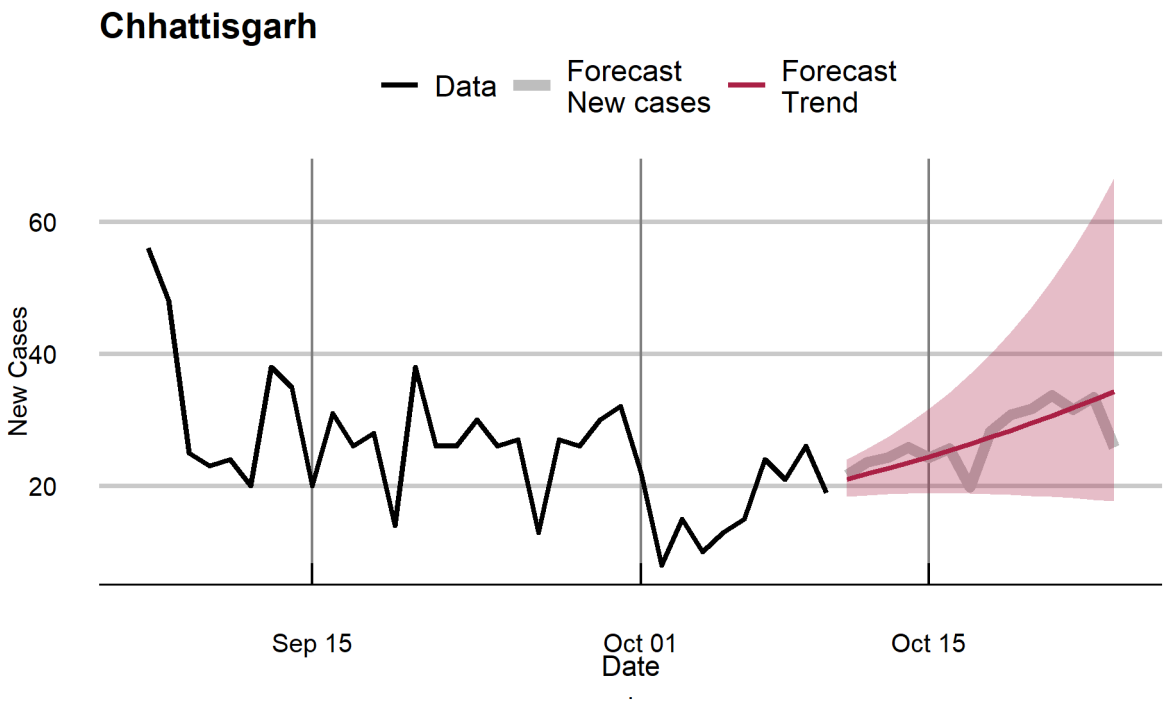

Assam
Growth rate of daily cases
0.02
0.00
-0.02
-0.04
-0.06
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

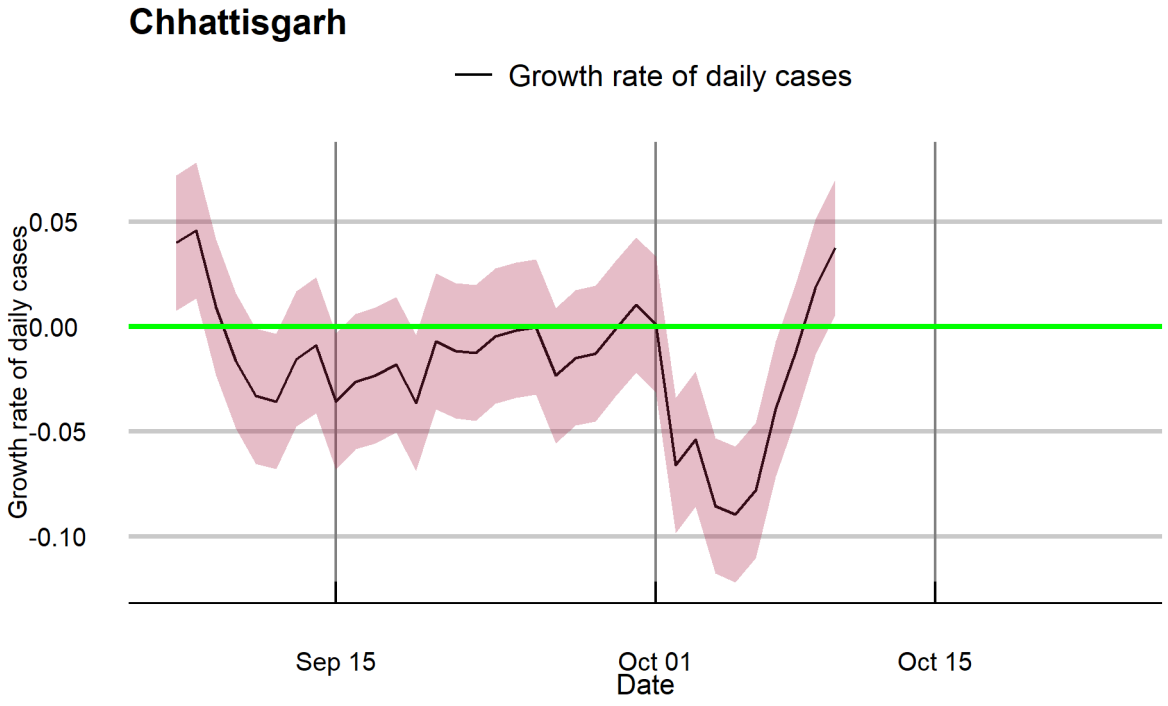

Bihar
Data
Forecast
New cases
Forecast
Trend
20
10
0
New Cases
Sep 15
Oct 01
Oct 15
Date

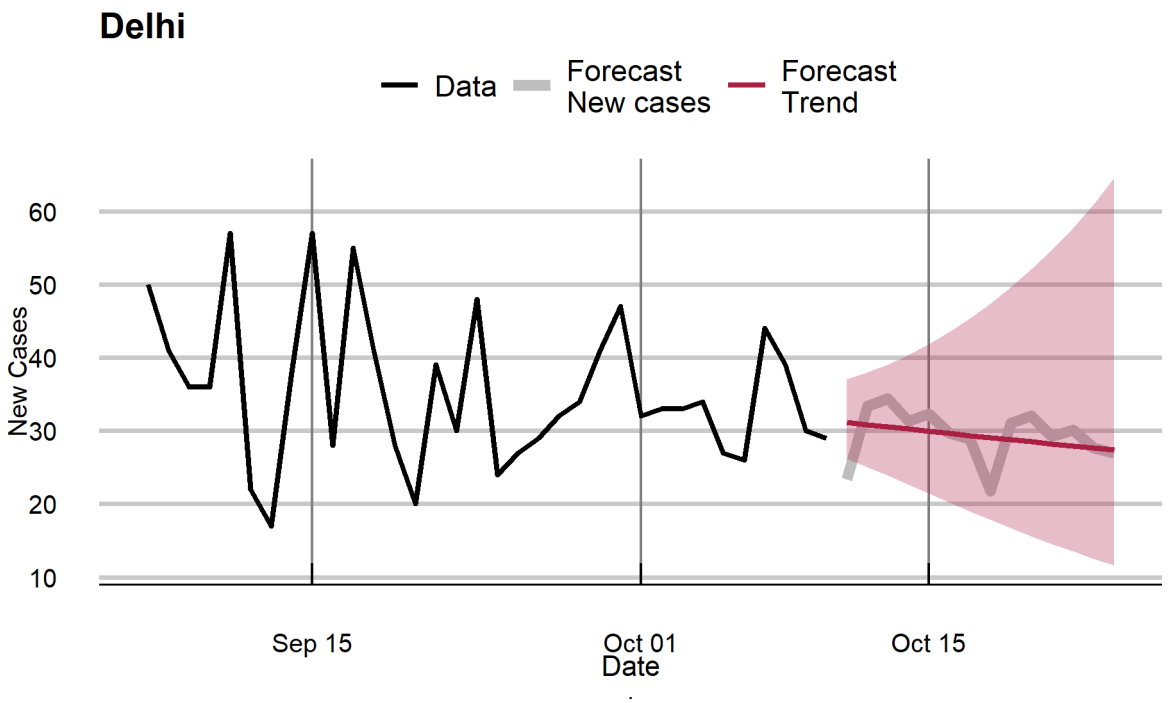

Bihar
Growth rate of daily cases
0.1
0.0
-0.1
-0.2
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

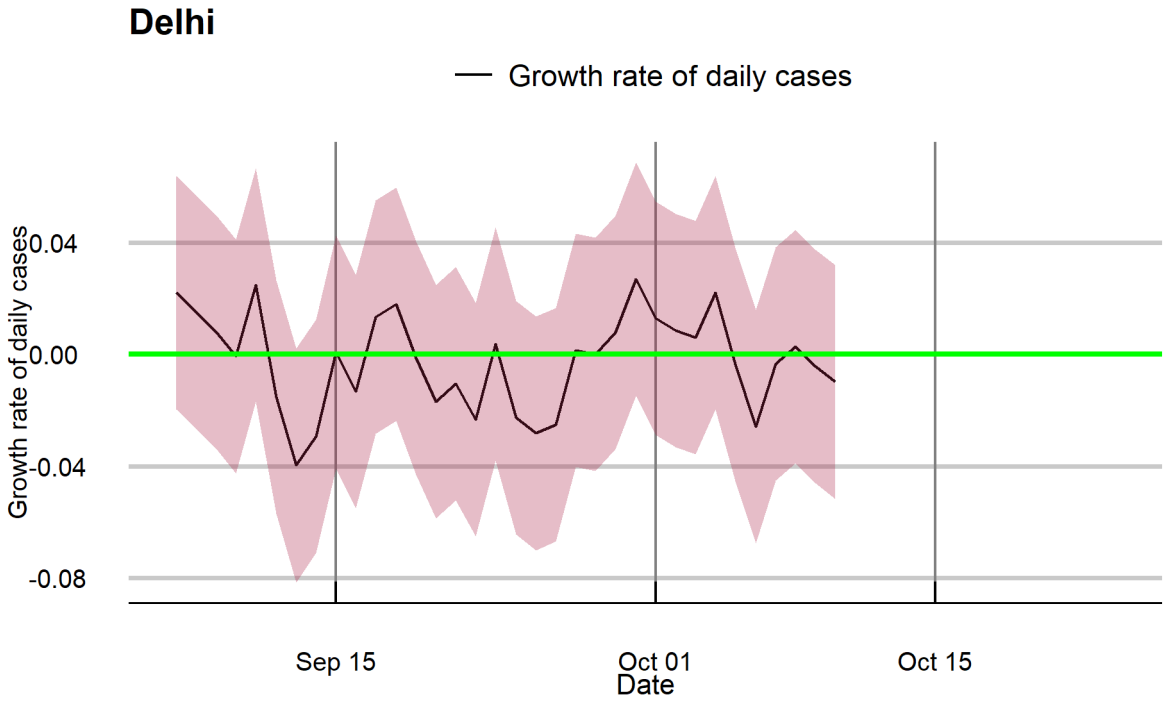

Chandigarh
Data
Forecast
New cases
Forecast
Trend
25.0
20.0
15.0
10.0
5.0
0.0
New Cases
Sep 15
Oct 01
Oct 15
Date

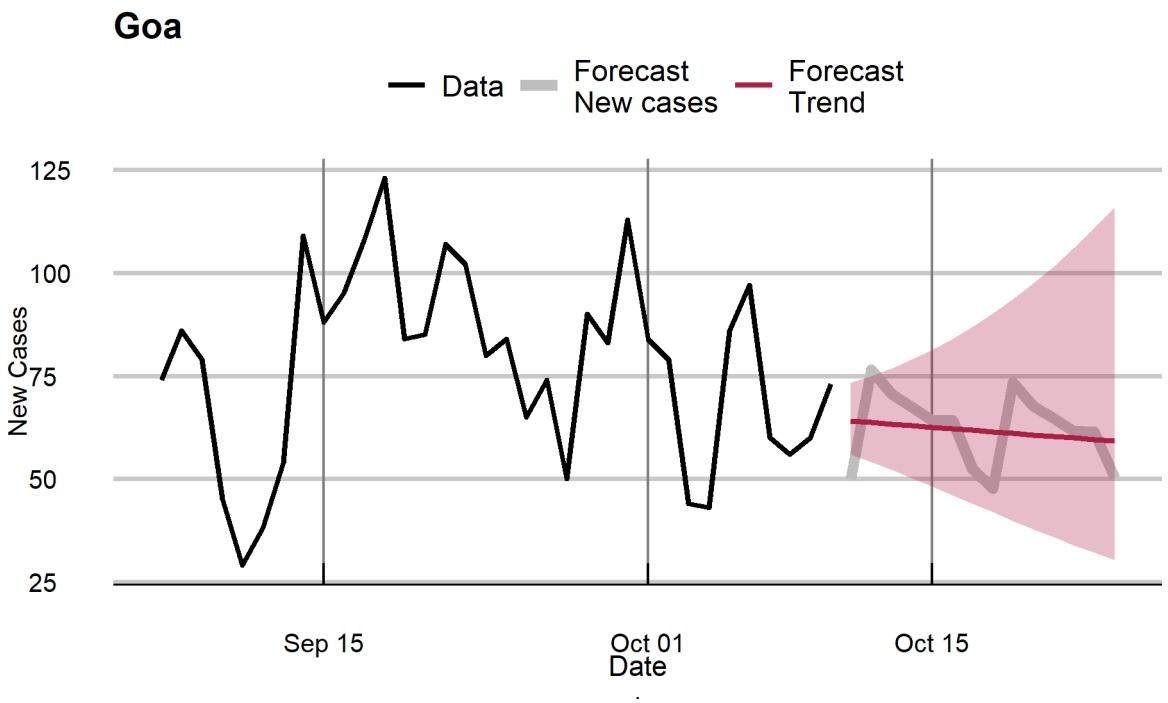

Chandigarh
Growth rate of daily cases
0.2
0.1
0.0
-0.1
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

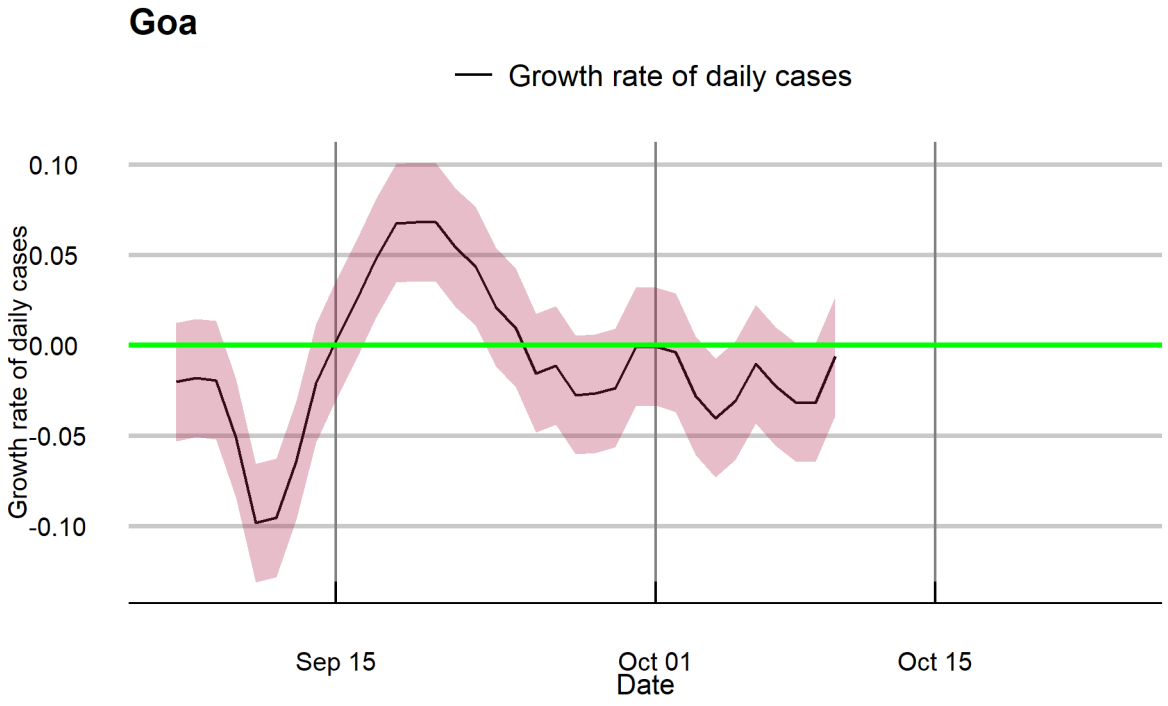

Chhattisgarh
Data
Forecast
New cases
Forecast
Trend
60
40
20
New Cases
Sep 15
Oct 01
Oct 15
Date

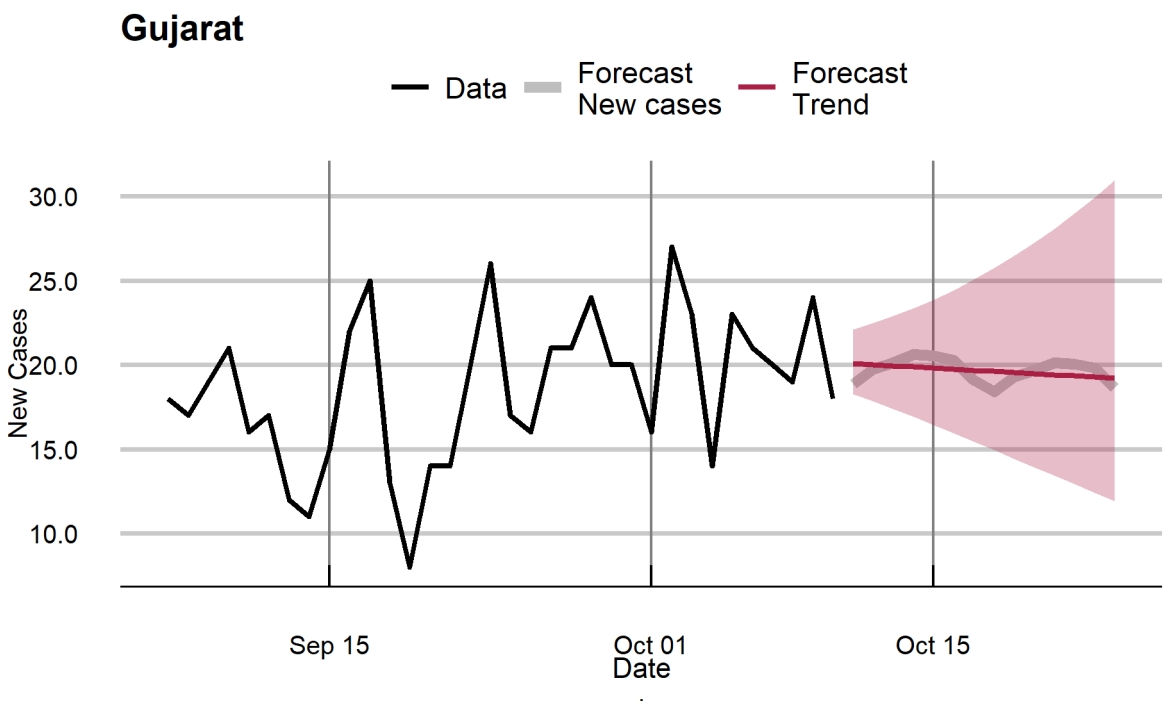

Chhattisgarh
Growth rate of daily cases
0.05
0.00
-0.05
-0.10
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

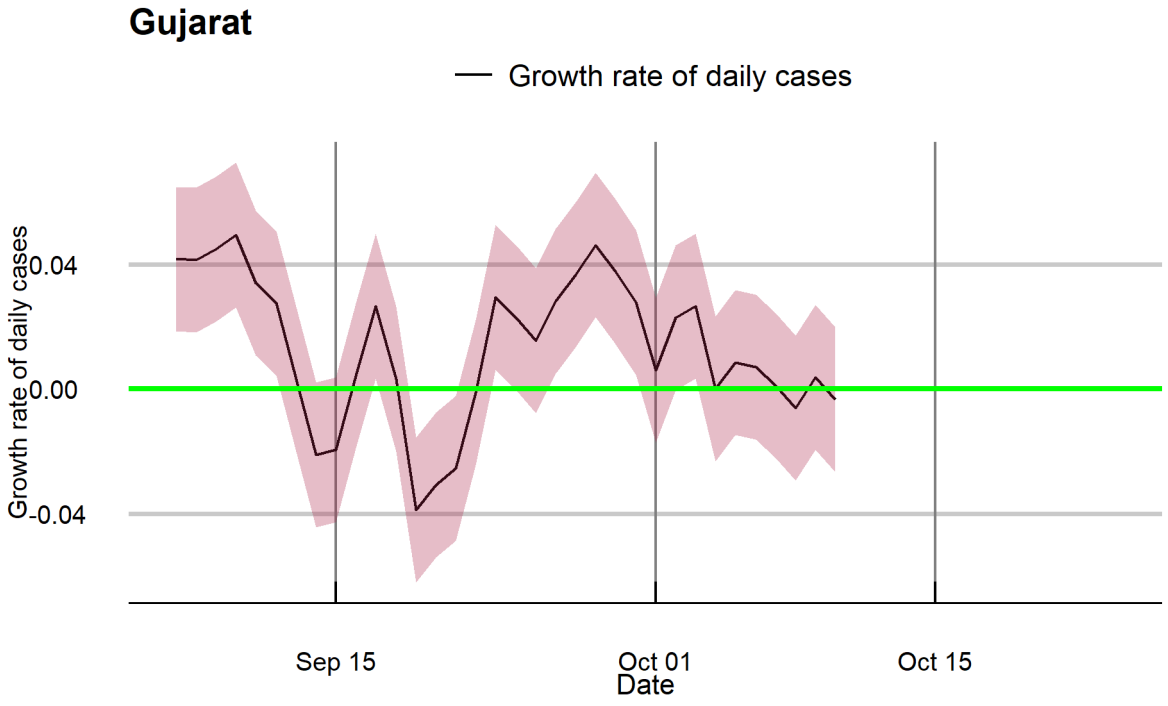

Delhi
Data
Forecast
New cases
Forecast
Trend
60
50
40
30
20
10
New Cases
Sep 15
Oct 01
Oct 15
Date

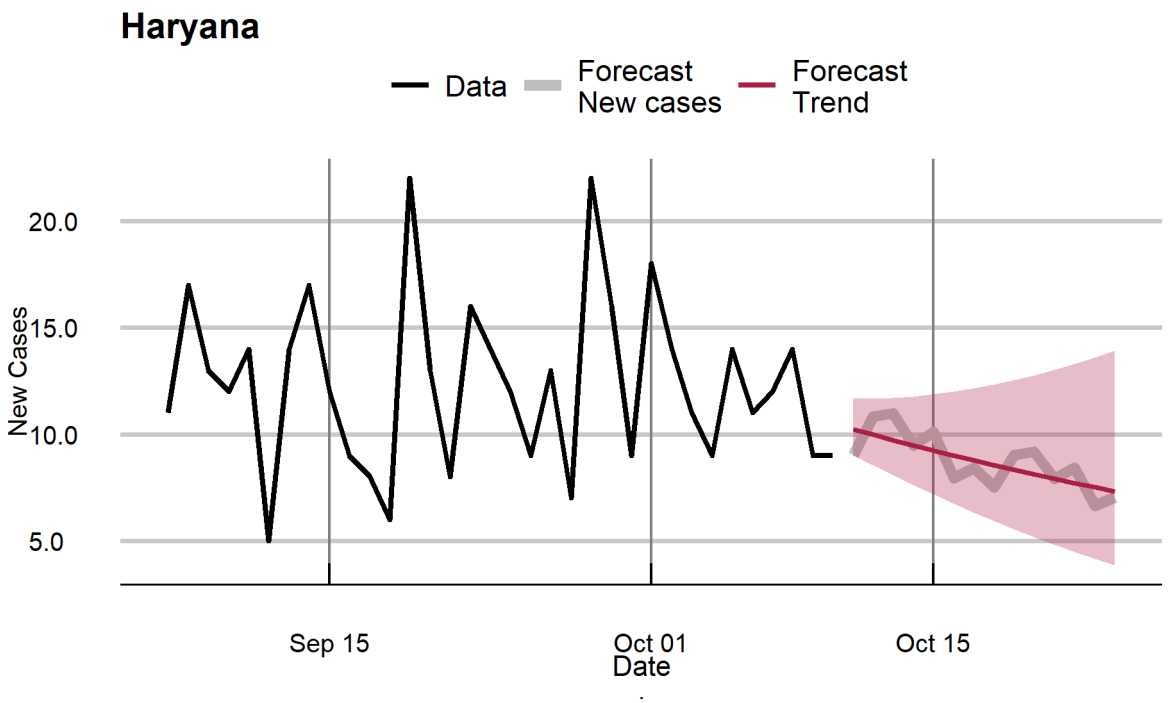

Delhi
Growth rate of daily cases
0.04
0.00
-0.04
-0.08
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

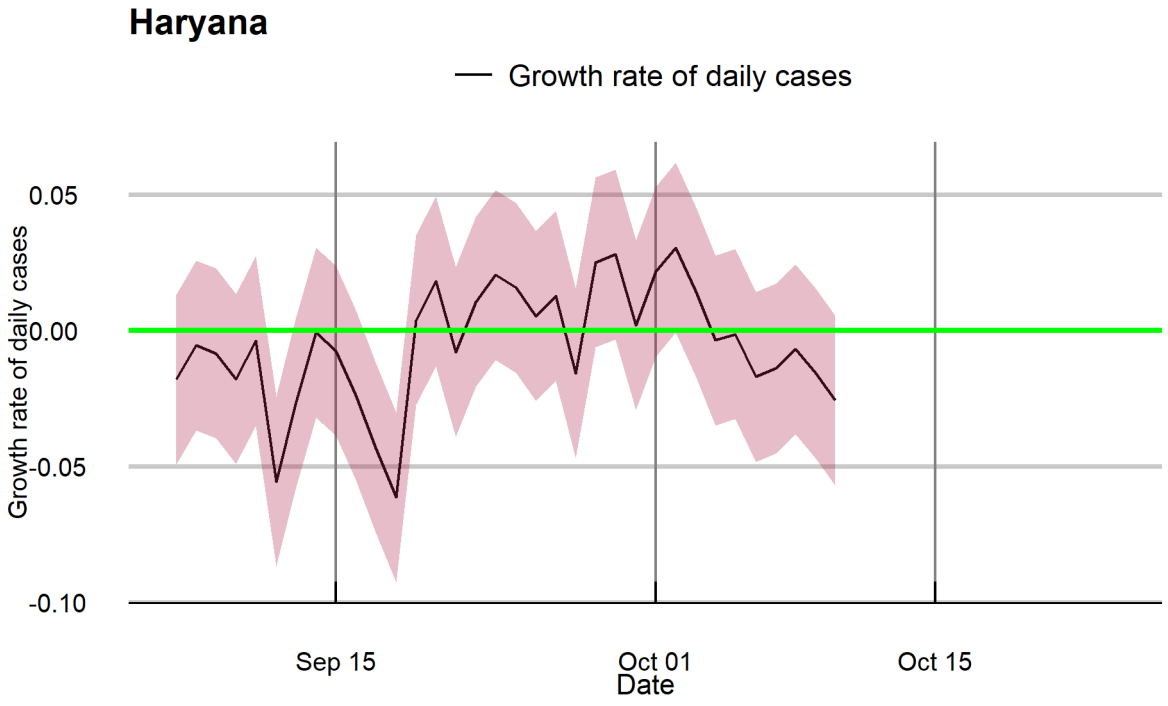

Goa
Data
Forecast
New cases
Forecast
Trend
125
100
75
50
25
New Cases
Sep 15
Oct 01
Oct 15
Date

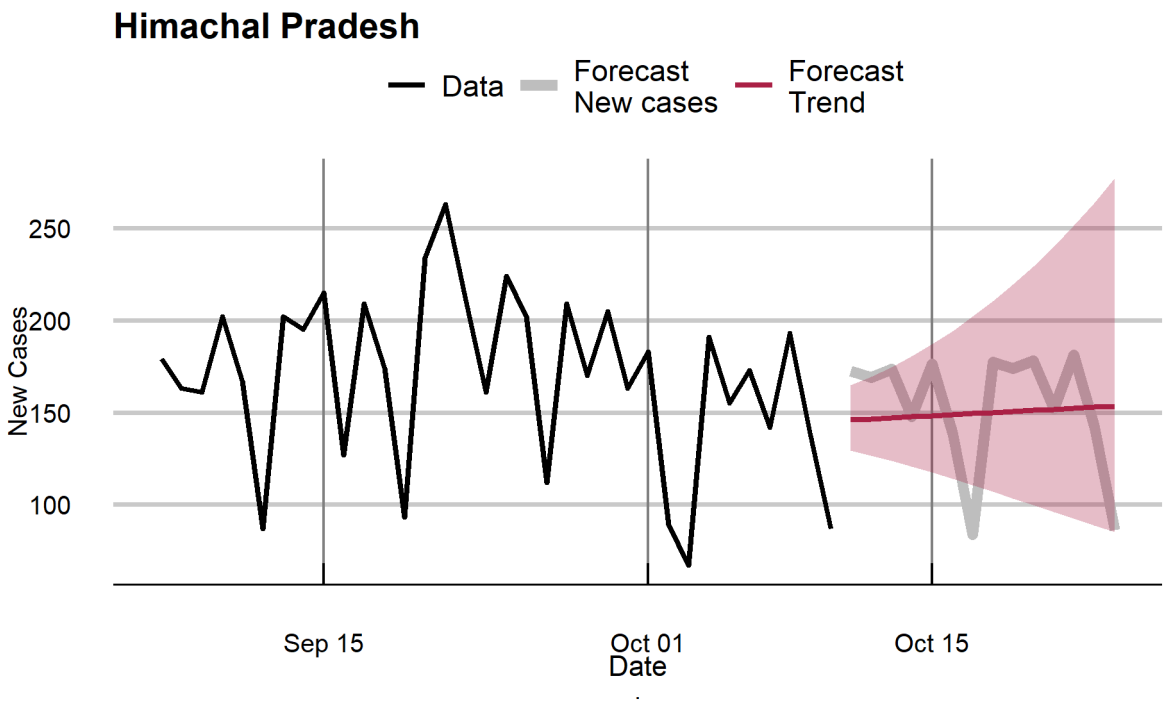

Goa
Growth rate of daily cases
0.10
0.05
0.00
-0.05
-0.10
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

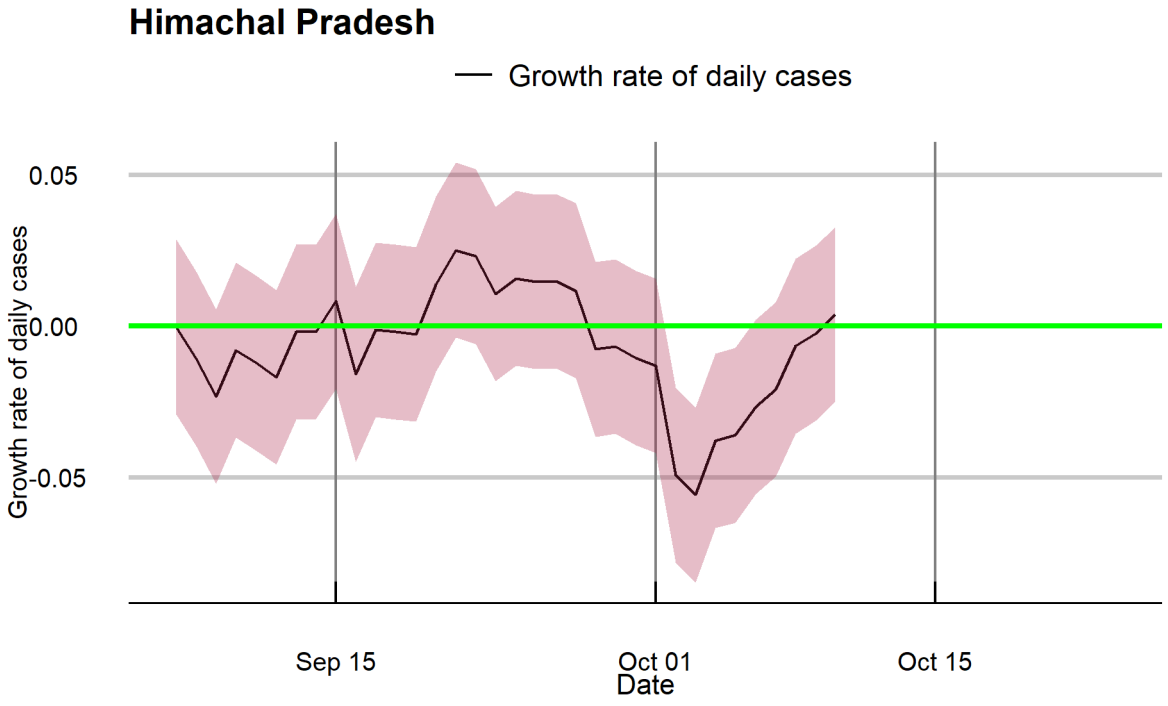

Gujarat
Data
Forecast
New cases
Forecast
Trend
30.0
25.0
20.0
15.0
10.0
New Cases
Sep 15
Oct 01
Oct 15
Date

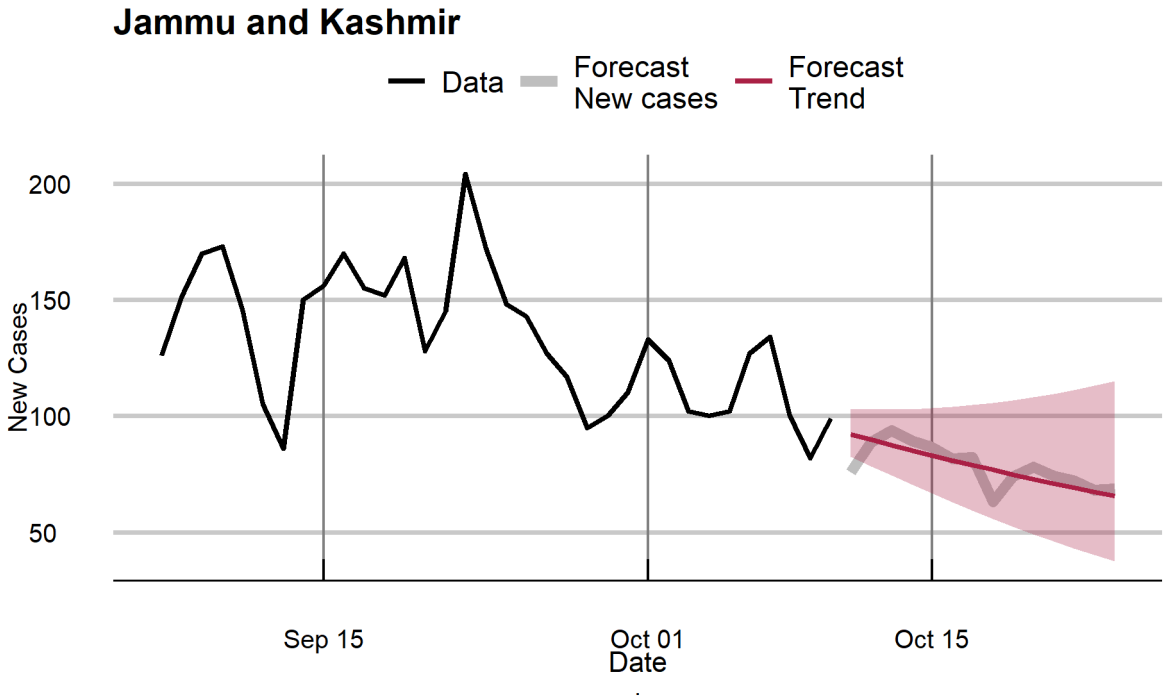

Gujarat
Growth rate of daily cases
0.04
0.00
-0.04
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

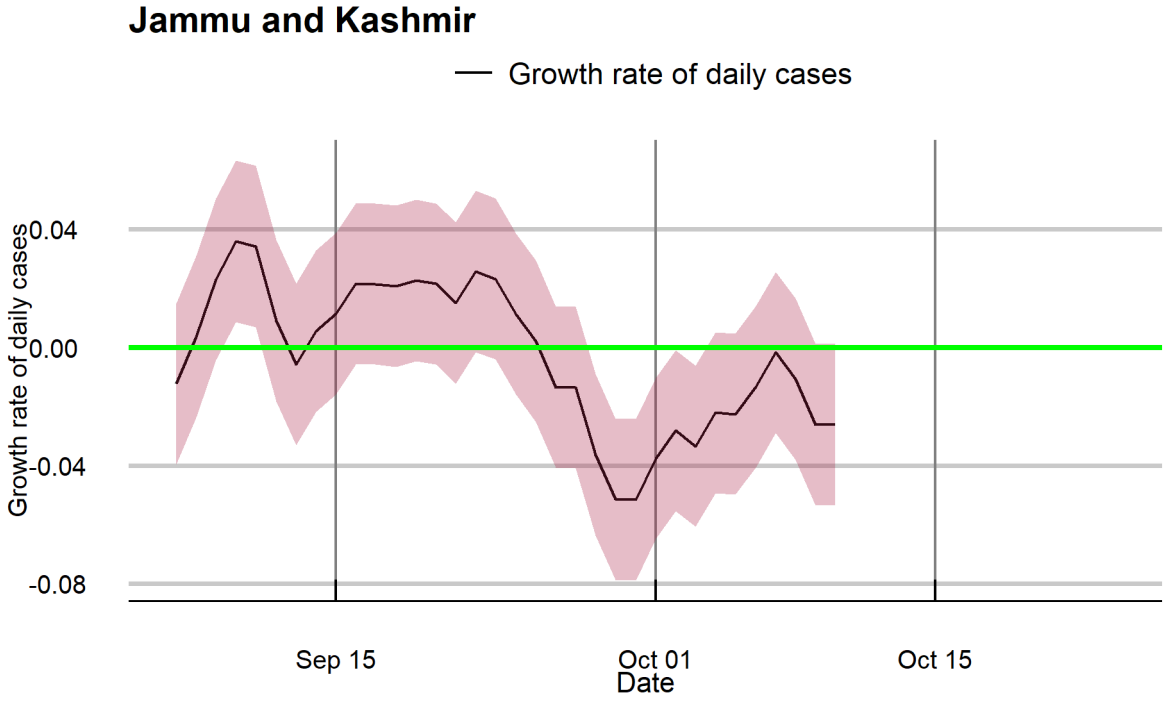

Haryana
Data
Forecast
New cases
Forecast
Trend
20.0
15.0
10.0
5.0
New Cases
Sep 15
Oct 01
Oct 15
Date

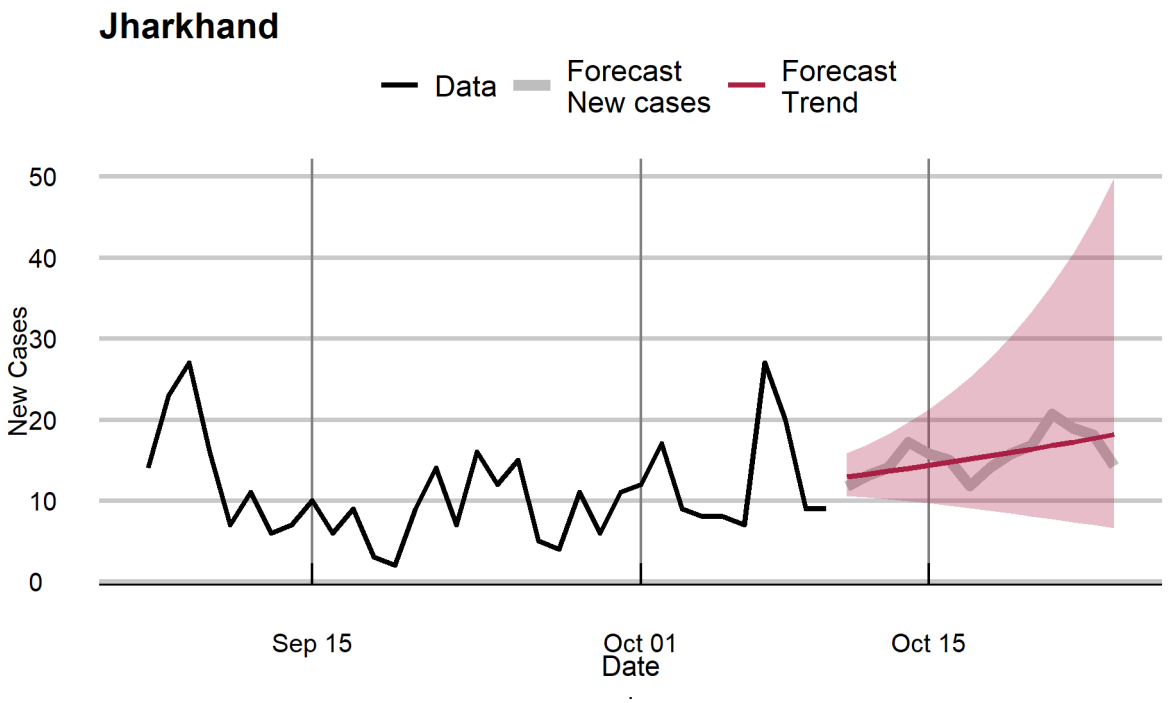

Haryana
Growth rate of daily cases
0.05
0.00
-0.05
-0.10
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

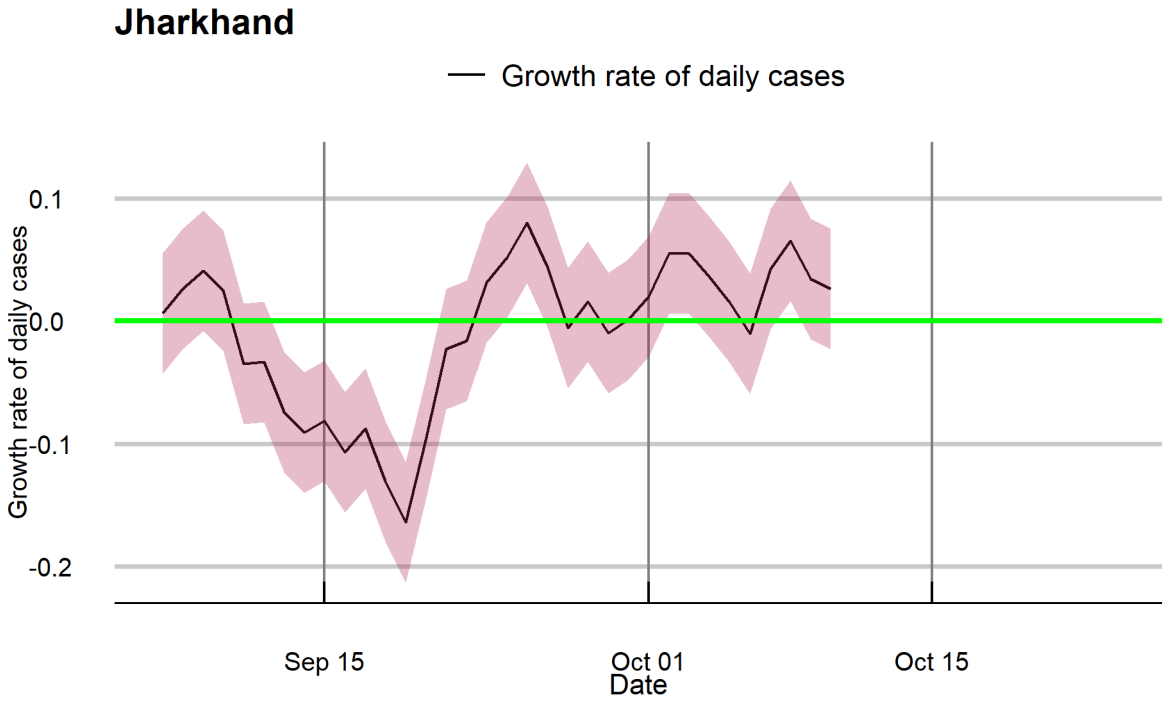

Himachal Pradesh
Data
Forecast
New cases
Forecast
Trend
250
200
150
100
New Cases
Sep 15
Oct 01
Oct 15
Date

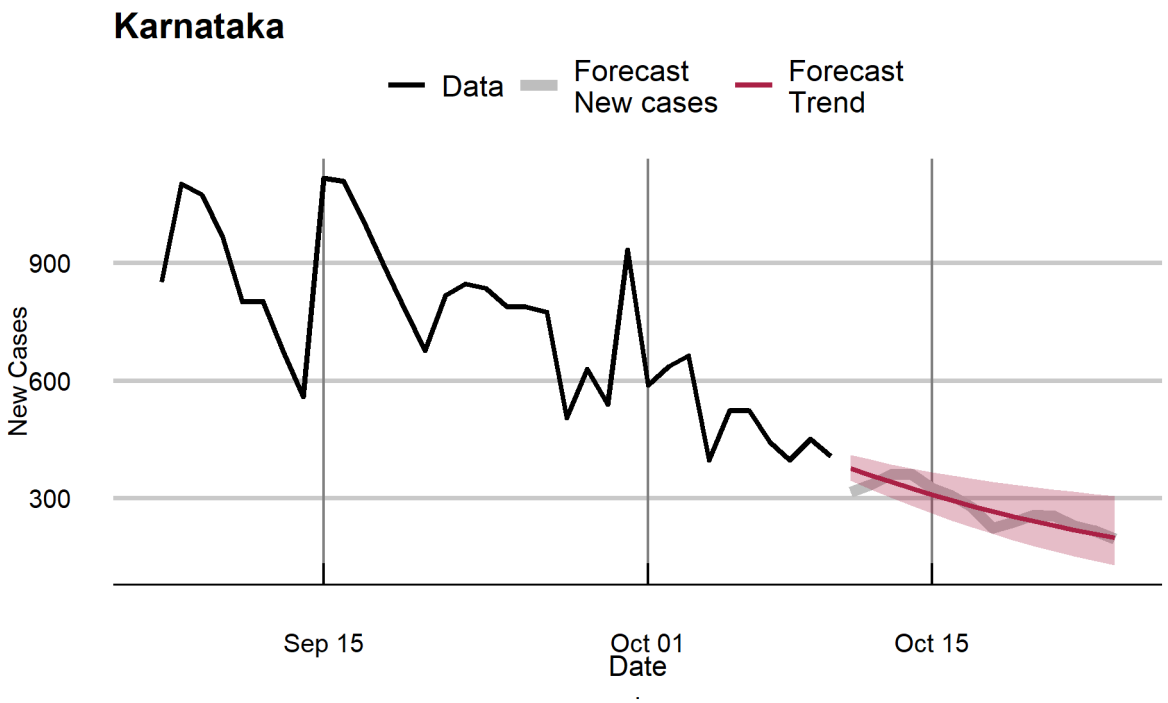

Himachal Pradesh
Growth rate of daily cases
0.05
0.00
-0.05
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

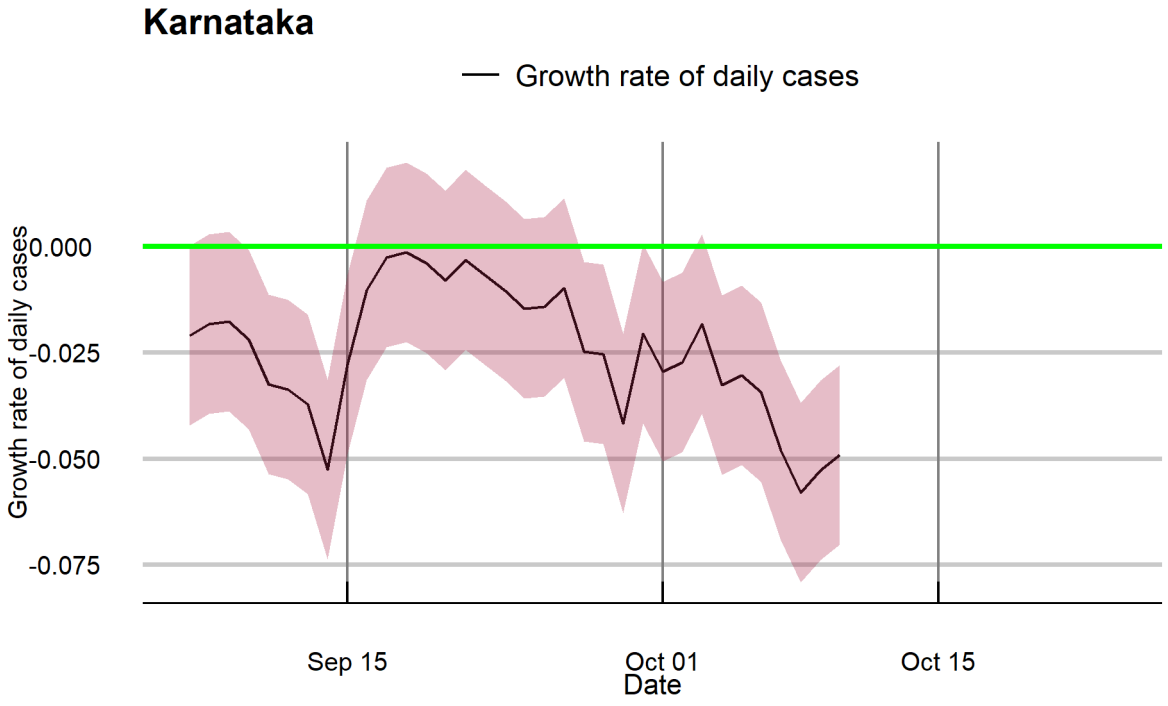

Jammu and Kashmir
Data
Forecast
New cases
Forecast
Trend
200
150
100
50
New Cases
Sep 15
Oct 01
Oct 15
Date

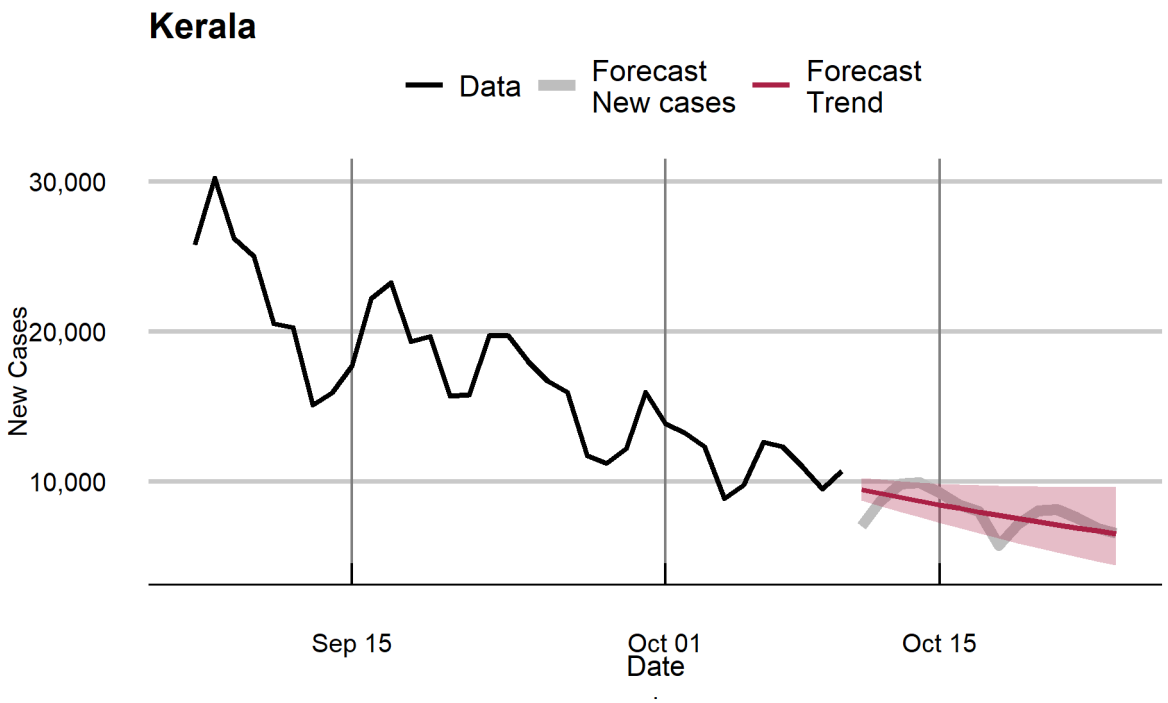

Jammu and Kashmir
Growth rate of daily cases
0.04
0.00
-0.04
-0.08
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

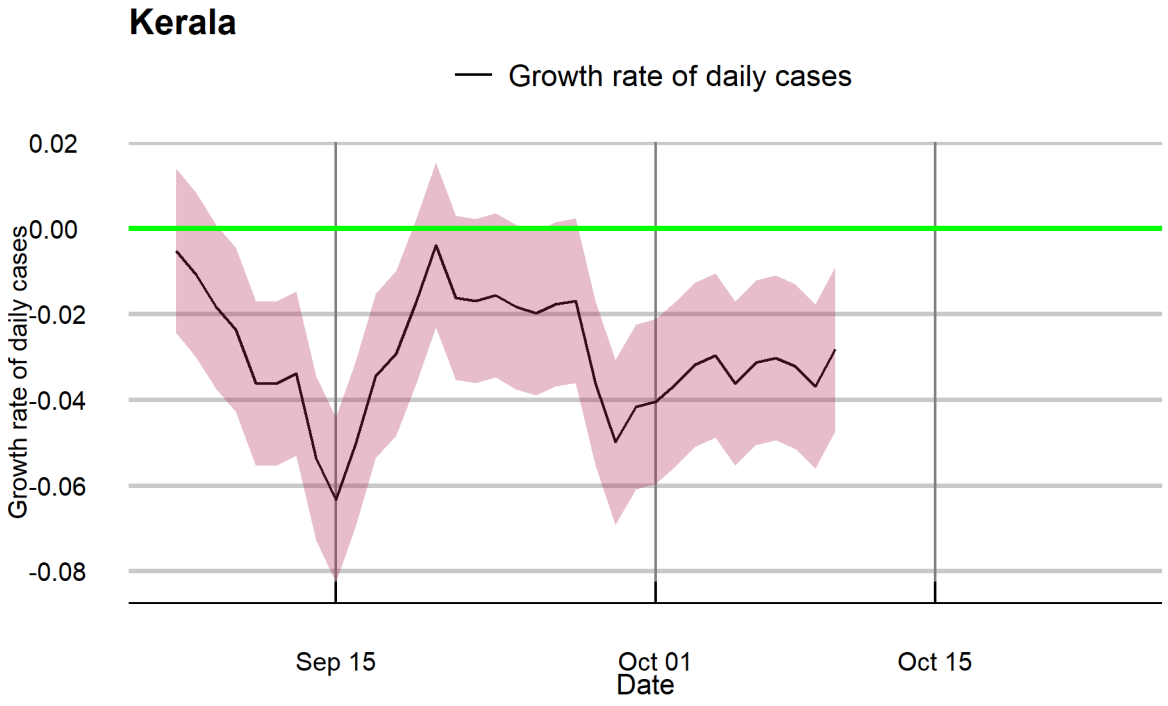

Jharkhand
Data
Forecast New cases
Forecast Trend
50
40
30
20
10
0
New Cases
Sep 15
Oct 01
Oct 15
Date

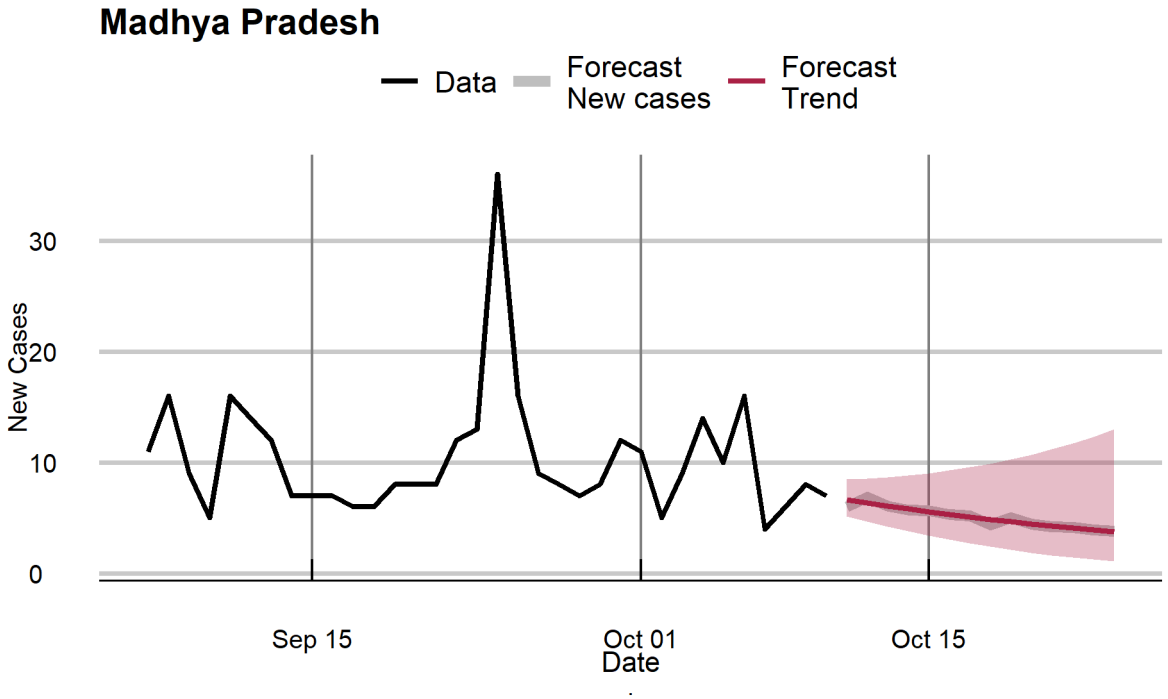

Jharkhand
Growth rate of daily cases
0.1
0.0
-0.1
-0.2
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

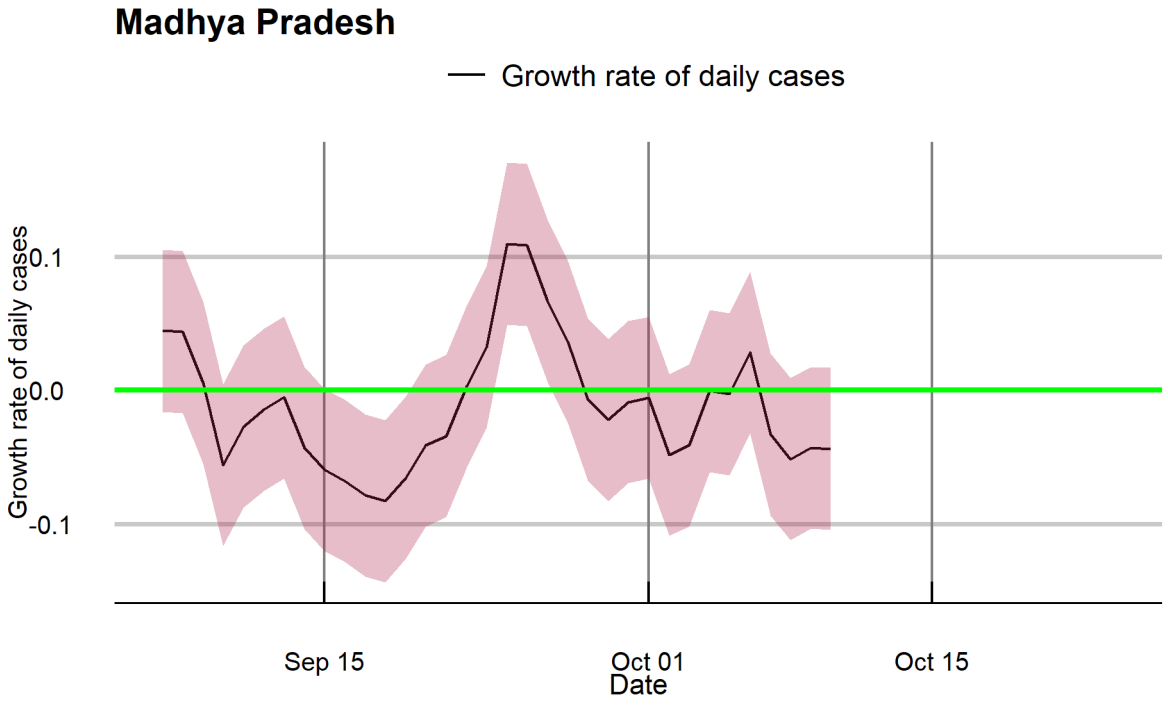

Karnataka
Data
Forecast
New cases
Forecast
Trend
900
600
300
New Cases
Sep 15
Oct 01
Oct 15
Date

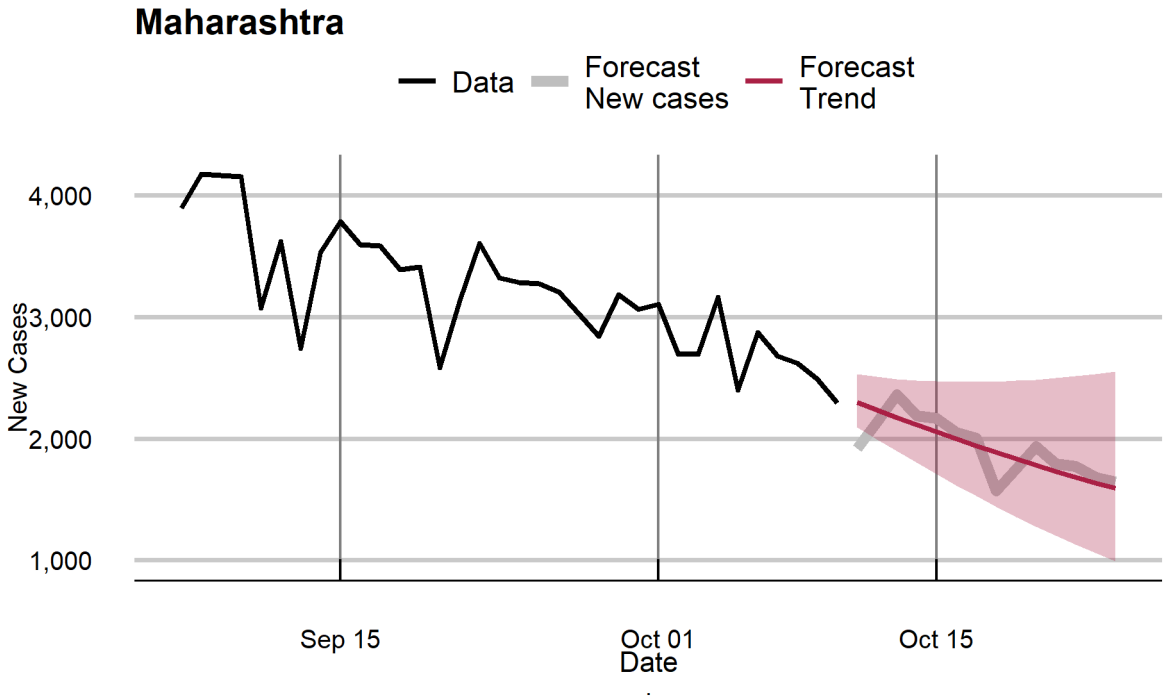

Karnataka
Growth rate of daily cases
0.000
-0.025
-0.050
-0.075
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

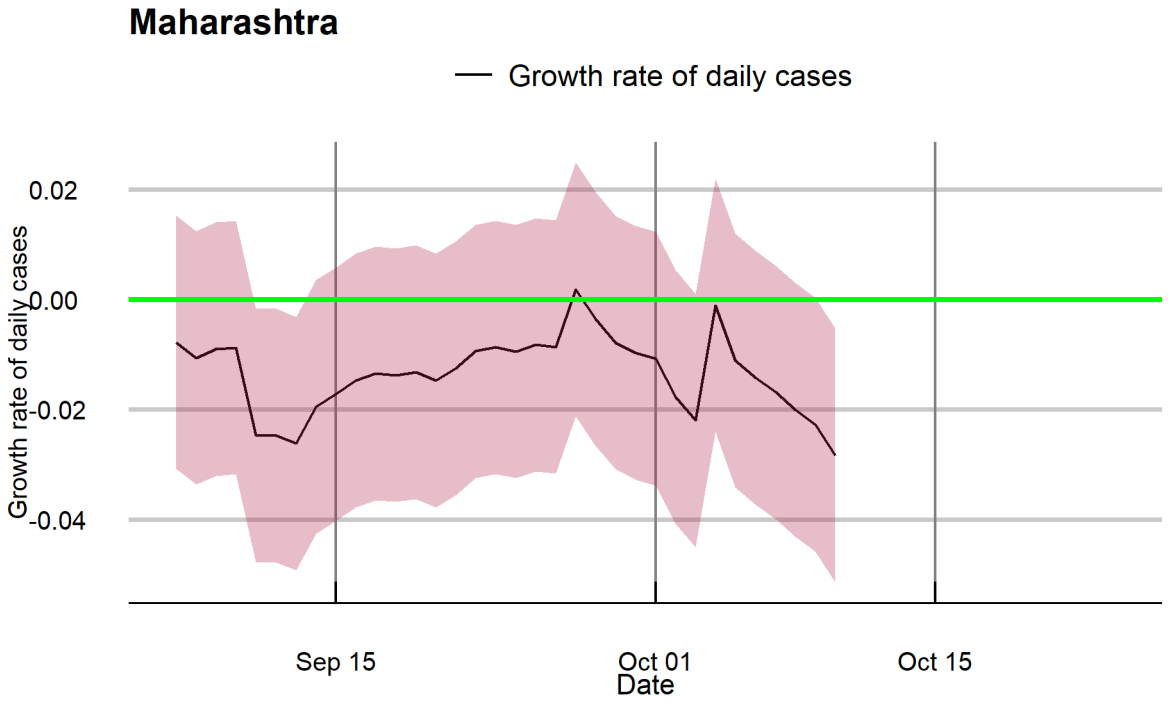

Kerala
Data
Forecast
New cases
Forecast
Trend
30,000
20,000
10,000
New Cases
Sep 15
Oct 01
Oct 15
Date

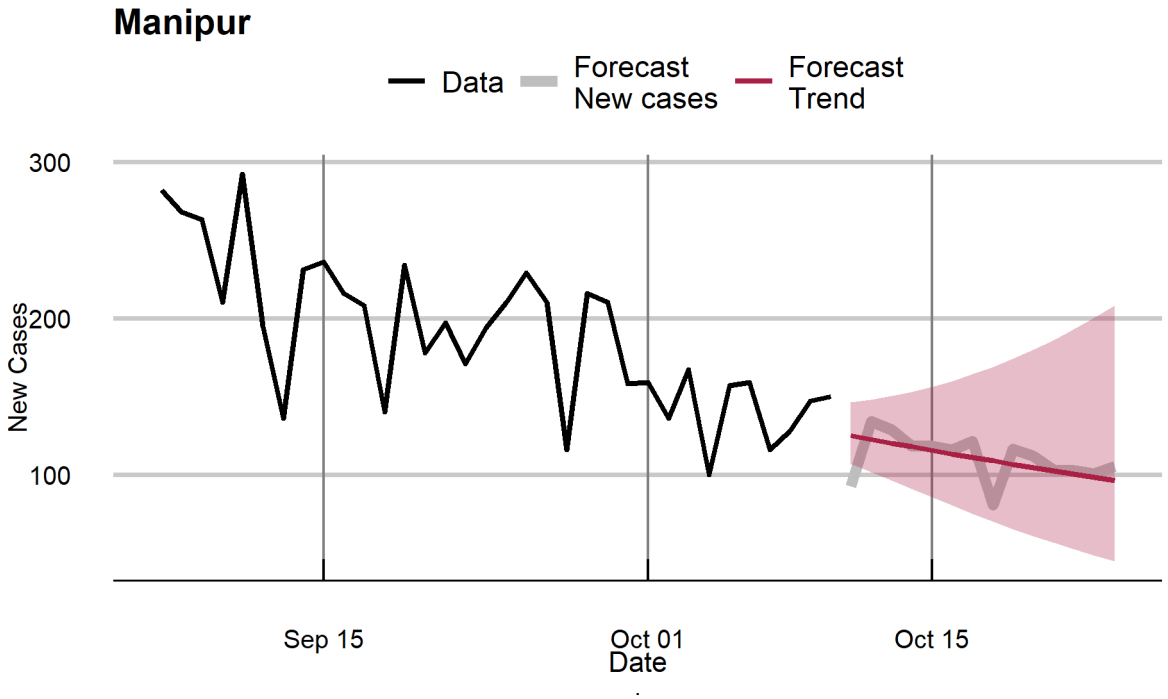

Kerala
Growth rate of daily cases
0.02
0.00
-0.02
-0.04
-0.06
-0.08
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

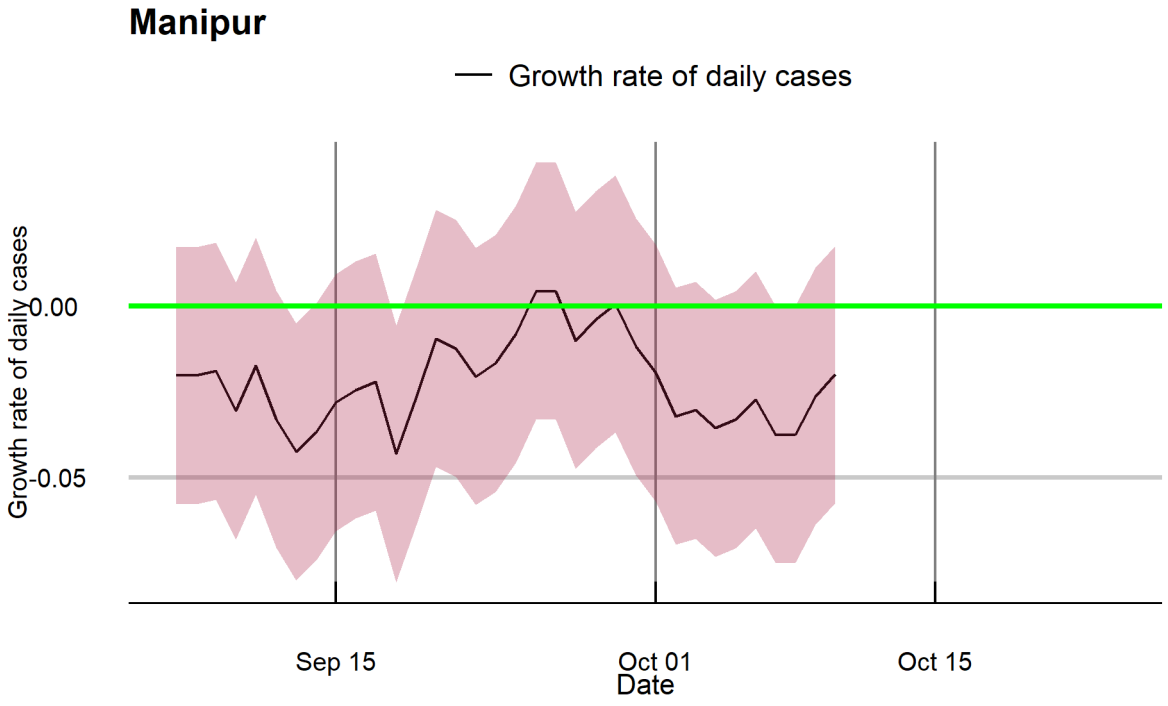

Madhya Pradesh
Data
Forecast
New cases
Forecast
Trend
New Cases
30
20
10
0
Sep 15
Oct 01
Oct 15
Date

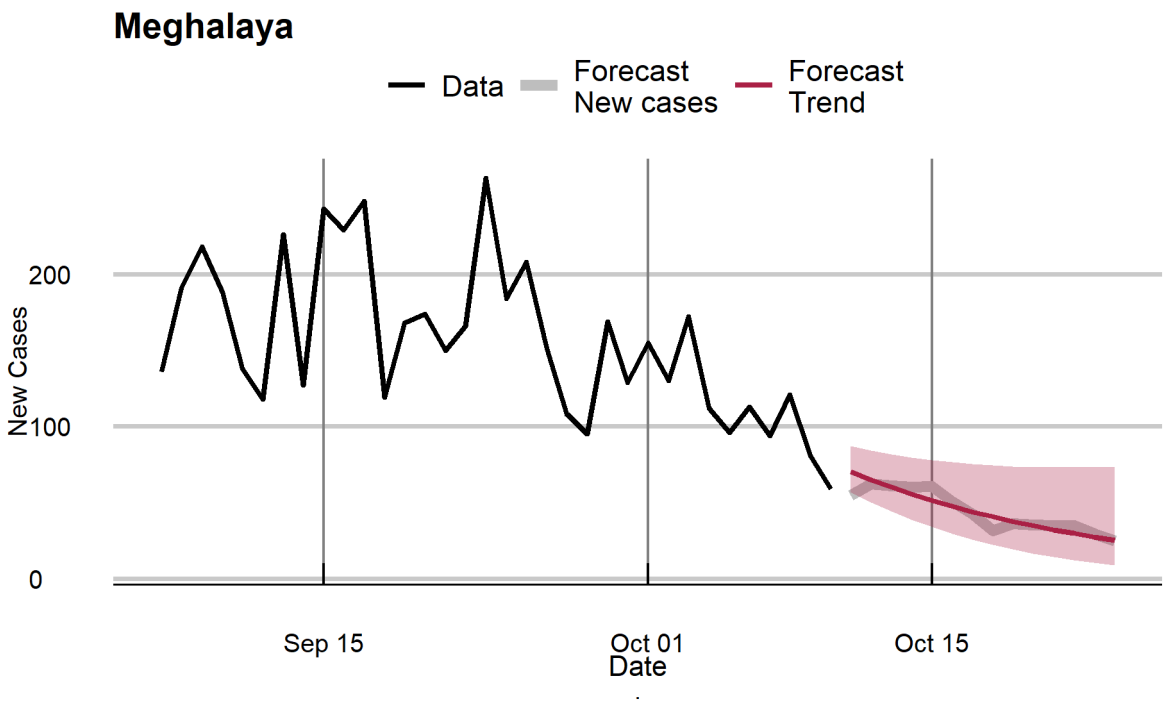

Madhya Pradesh
Growth rate of daily cases
Growth rate of daily cases
0.1
0.0
-0.1
Sep 15
Oct 01
Oct 15
Date

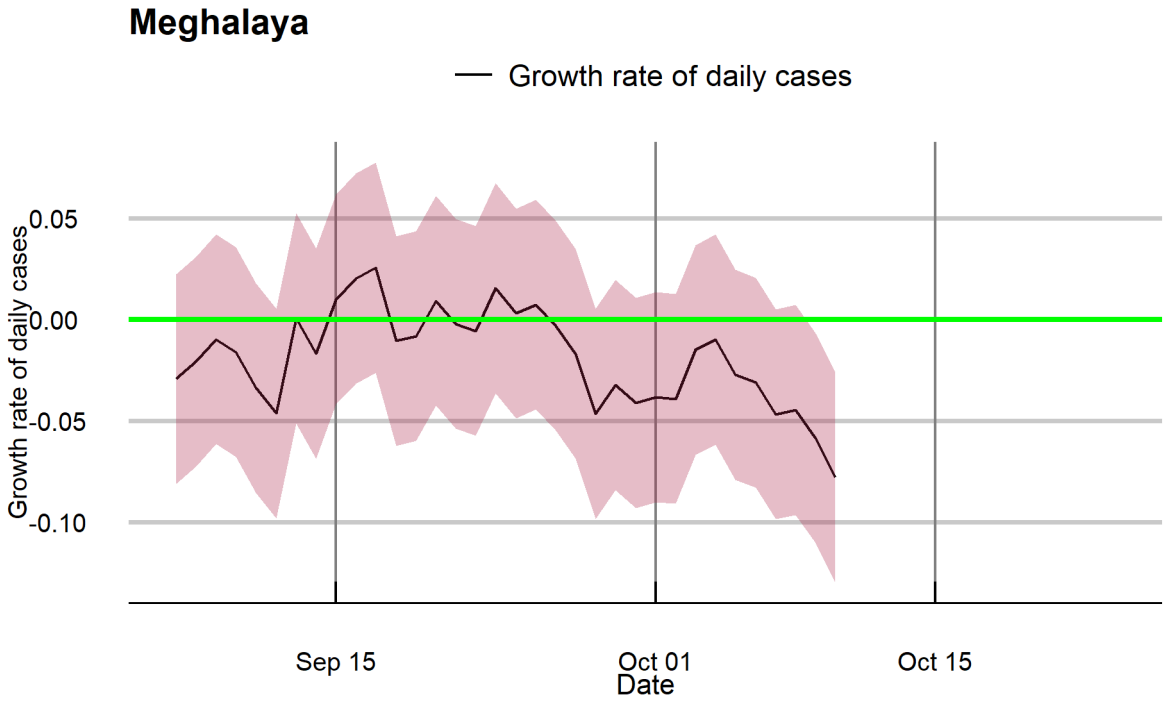

Maharashtra
Data
Forecast
New cases
Forecast
Trend
4,000
3,000
2,000
1,000
New Cases
Sep 15
Oct 01
Oct 15
Date

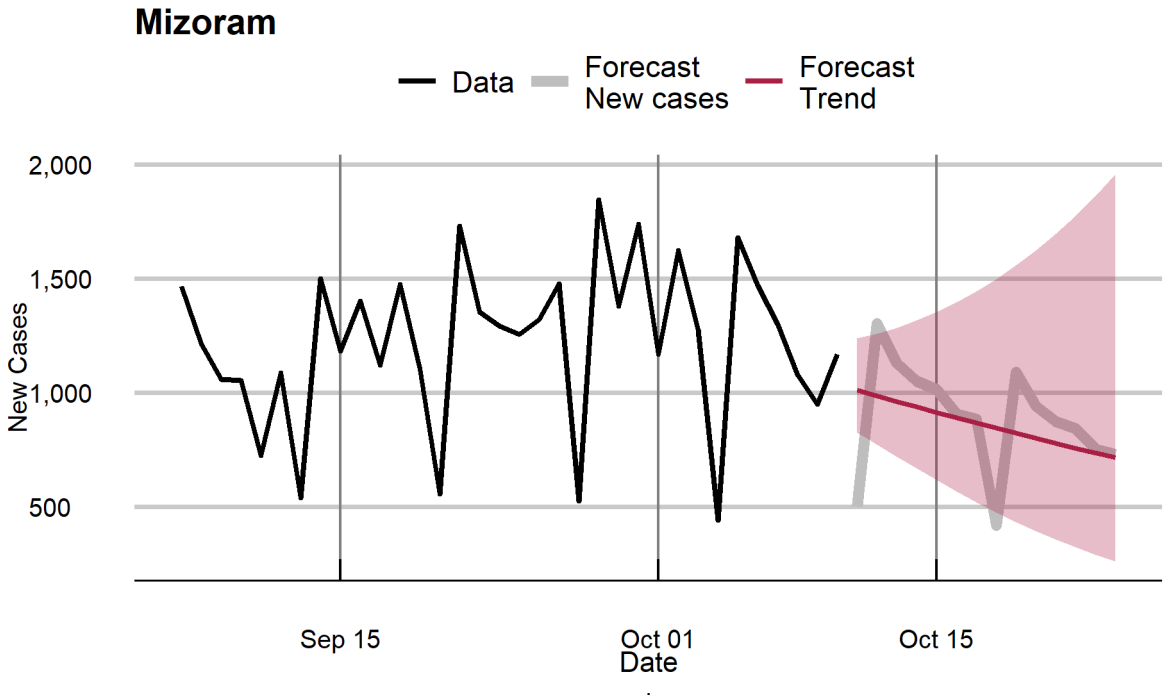

Maharashtra
Growth rate of daily cases
0.02
0.00
-0.02
-0.04
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

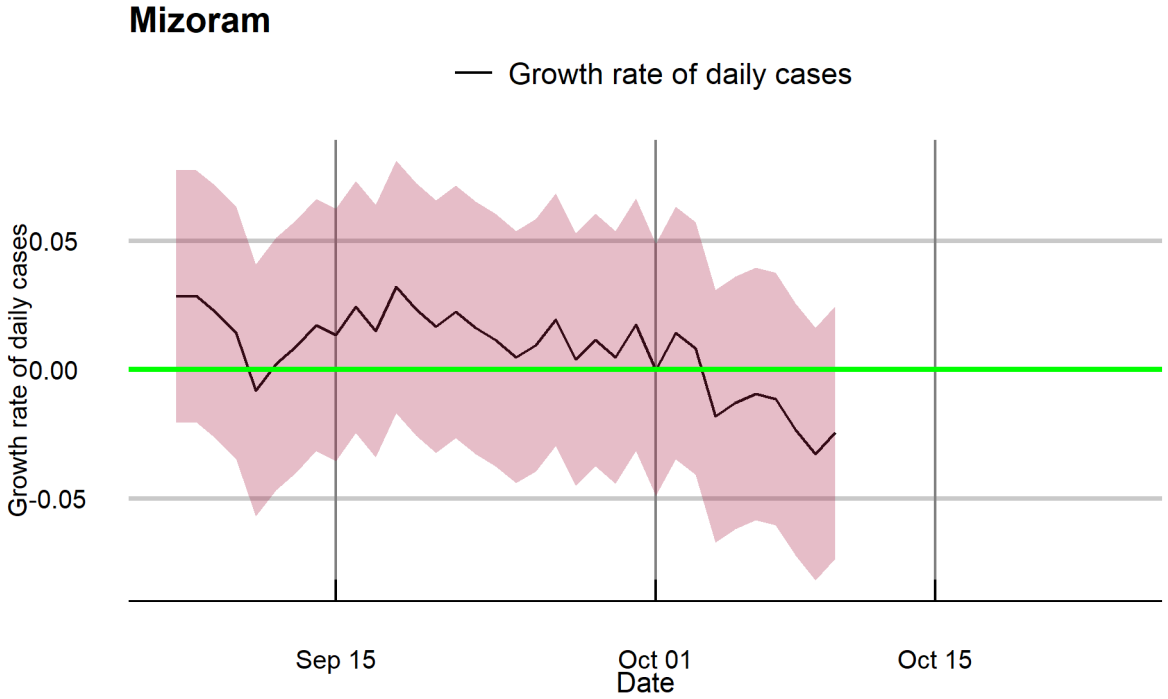

Manipur
Data
Forecast
New cases
Forecast
Trend
300
200
100
New Cases
Sep 15
Oct 01
Oct 15
Date

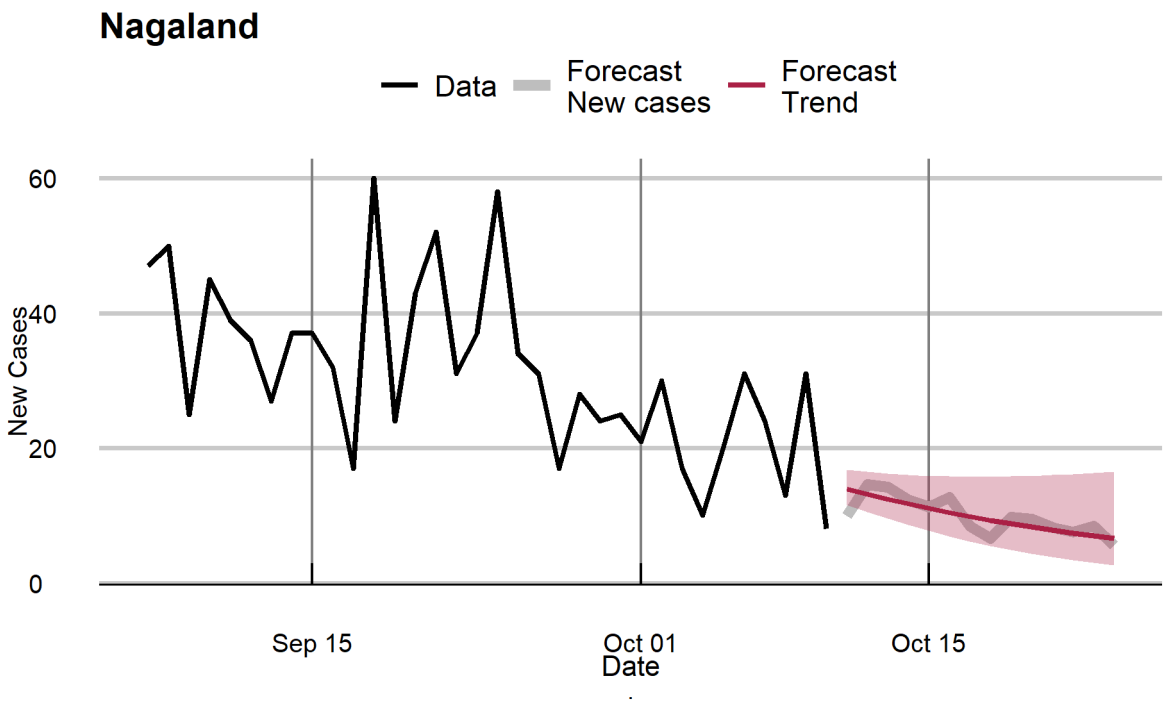

Manipur
Growth rate of daily cases
0.00
-0.05
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

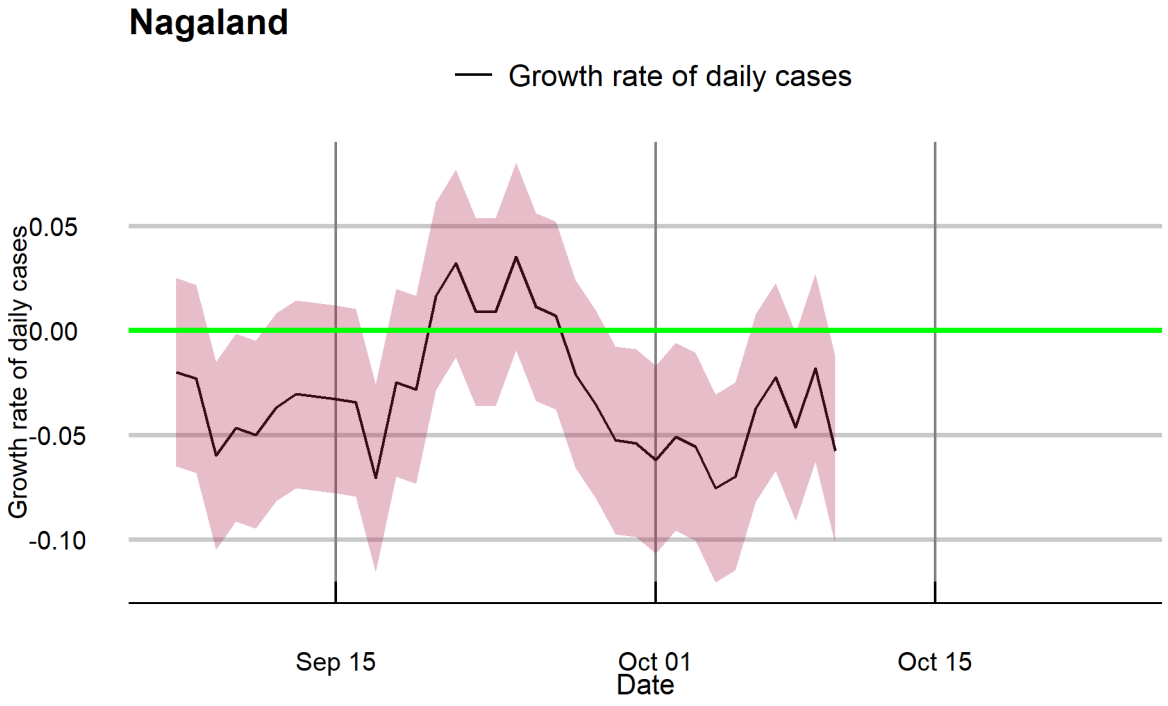

Meghalaya
Data
Forecast
New cases
Forecast
Trend
New Cases
200
100
0
Sep 15
Oct 01
Oct 15
Date

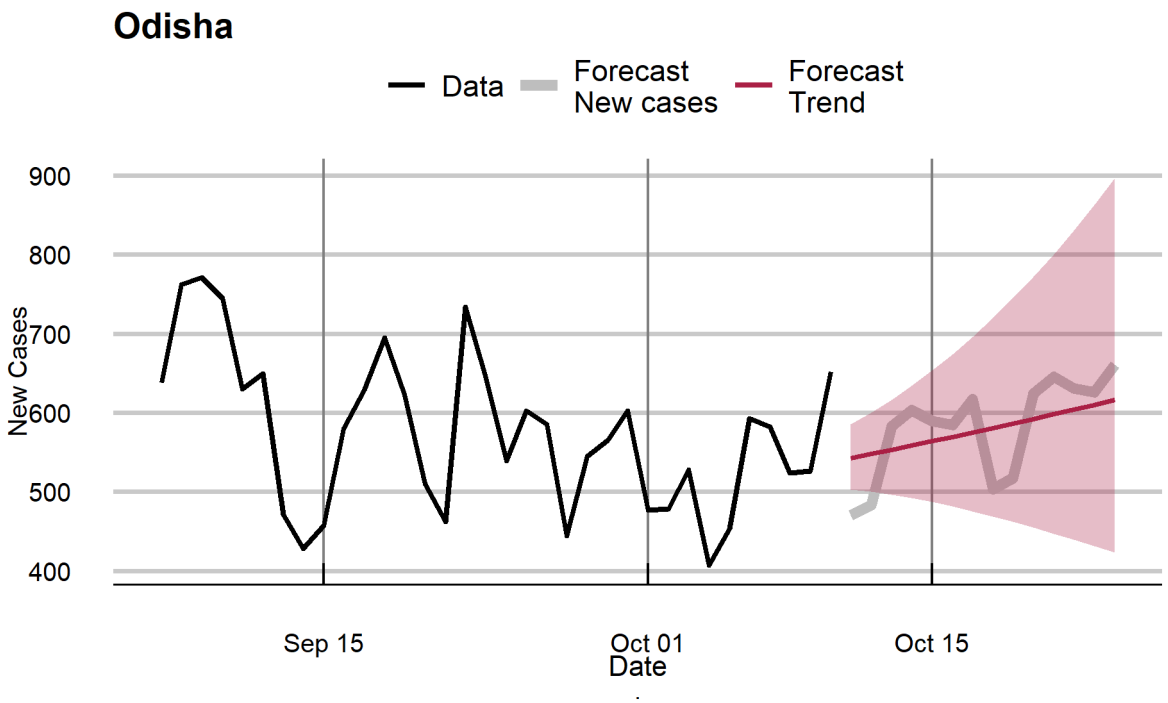

Meghalaya
Growth rate of daily cases
Growth rate of daily cases
0.05
0.00
-0.05
-0.10
Sep 15
Oct 01
Oct 15
Date

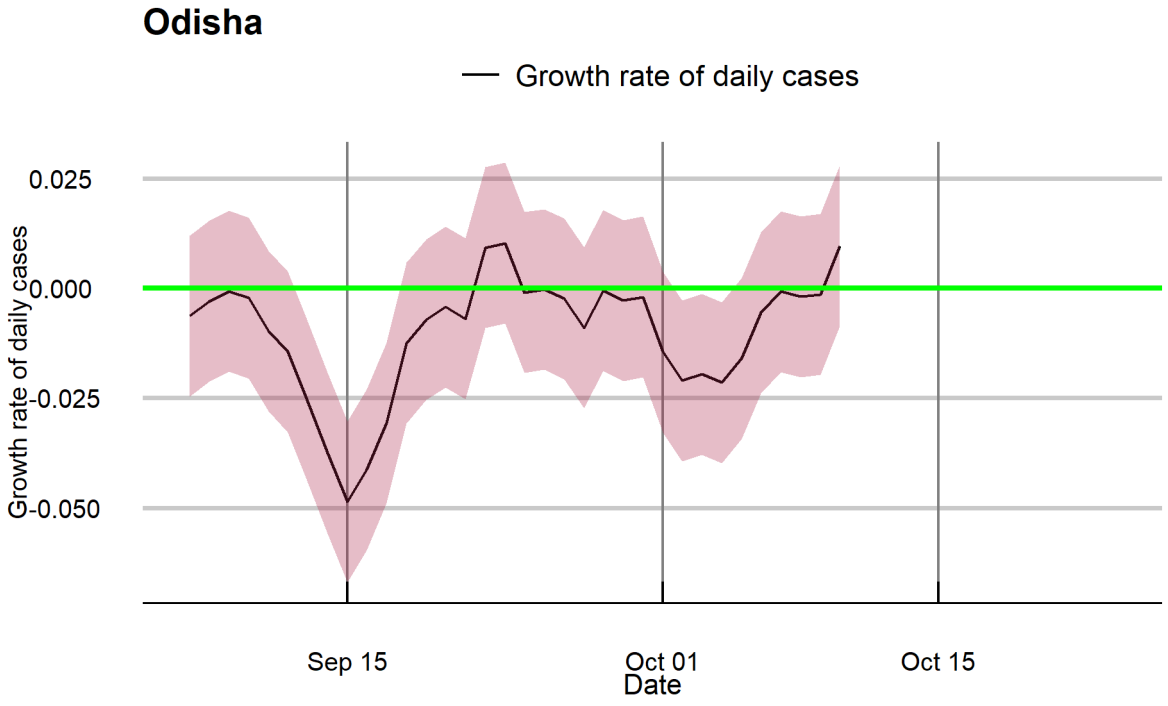

Mizoram
Data
Forecast
New cases
Forecast
Trend
2,000
1,500
1,000
500
New Cases
Sep 15
Oct 01
Oct 15
Date

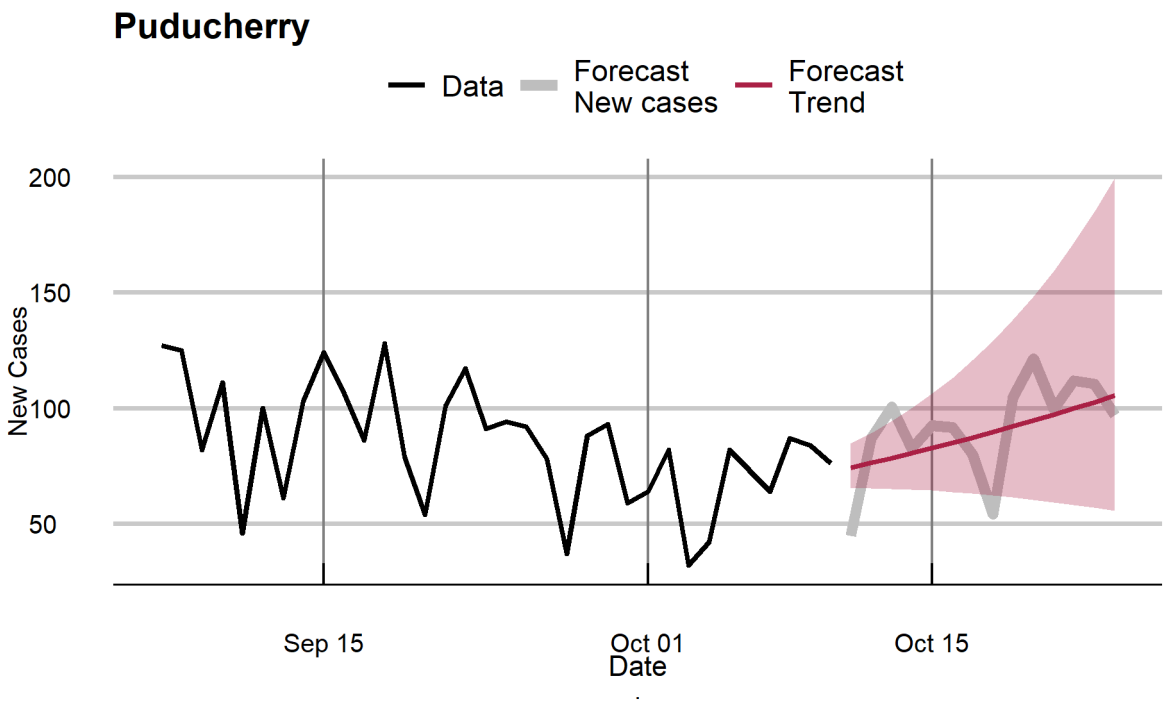

Mizoram
Growth rate of daily cases
0.05
0.00
-0.05
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

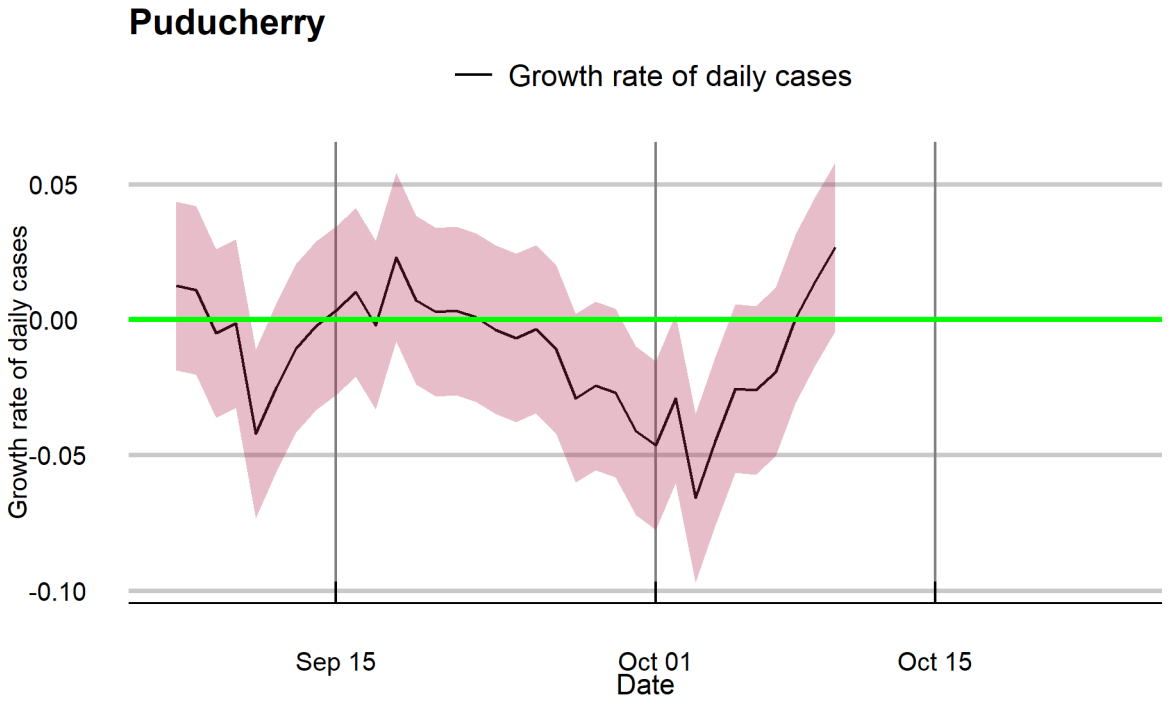

Nagaland
Data
Forecast
New cases
Forecast
Trend
60
40
20
0
New Cases
Sep 15
Oct 01
Oct 15
Date

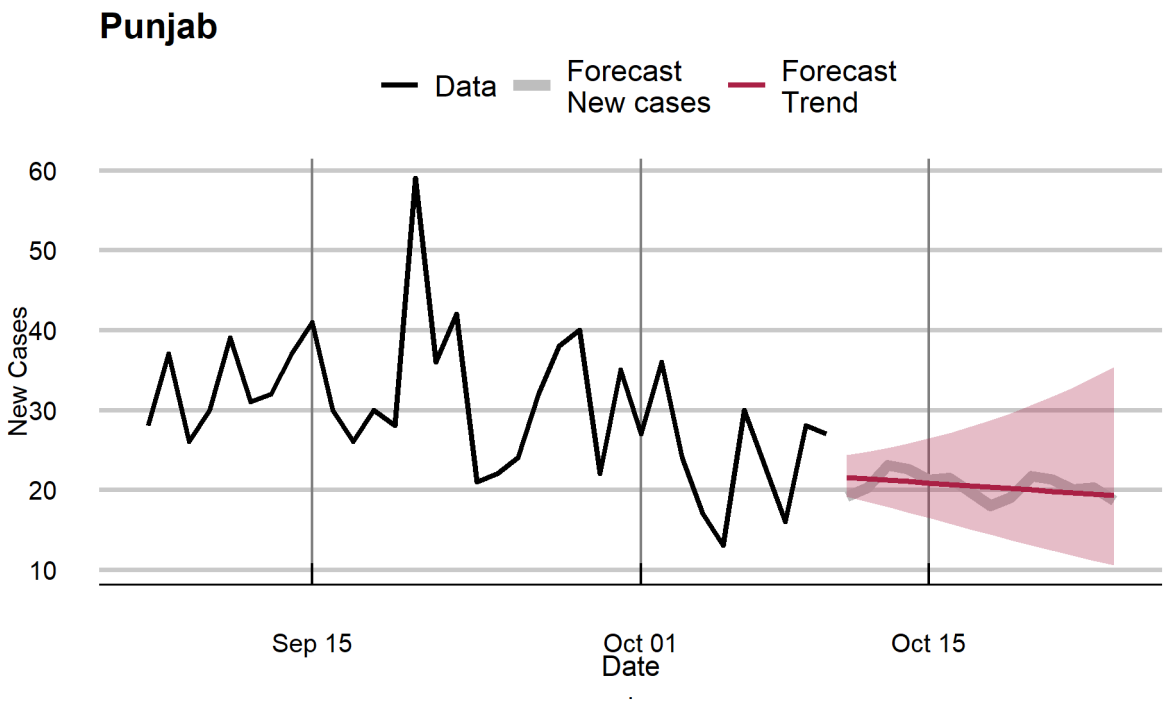

Nagaland
Growth rate of daily cases
0.05
0.00
-0.05
-0.10
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

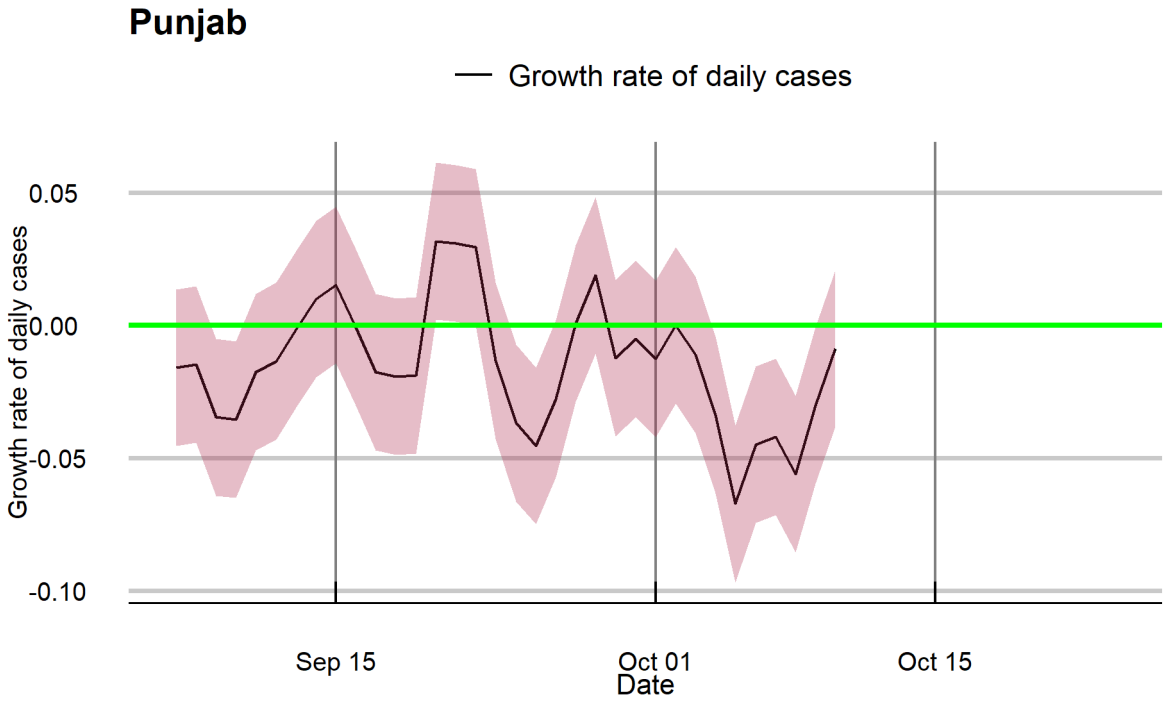

Odisha
Data
Forecast
New cases
Forecast
Trend
900
800
700
600
500
400
New Cases
Sep 15
Oct 01
Oct 15
Date

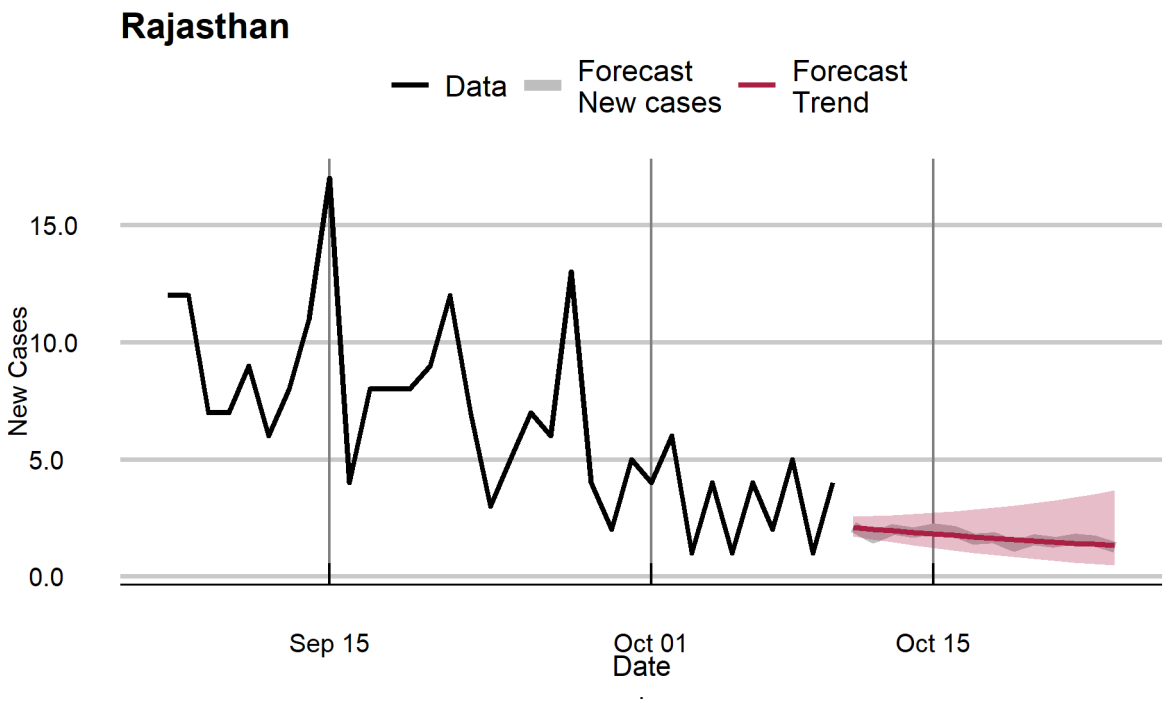

Odisha
Growth rate of daily cases
0.025
0.000
-0.025
-0.050
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

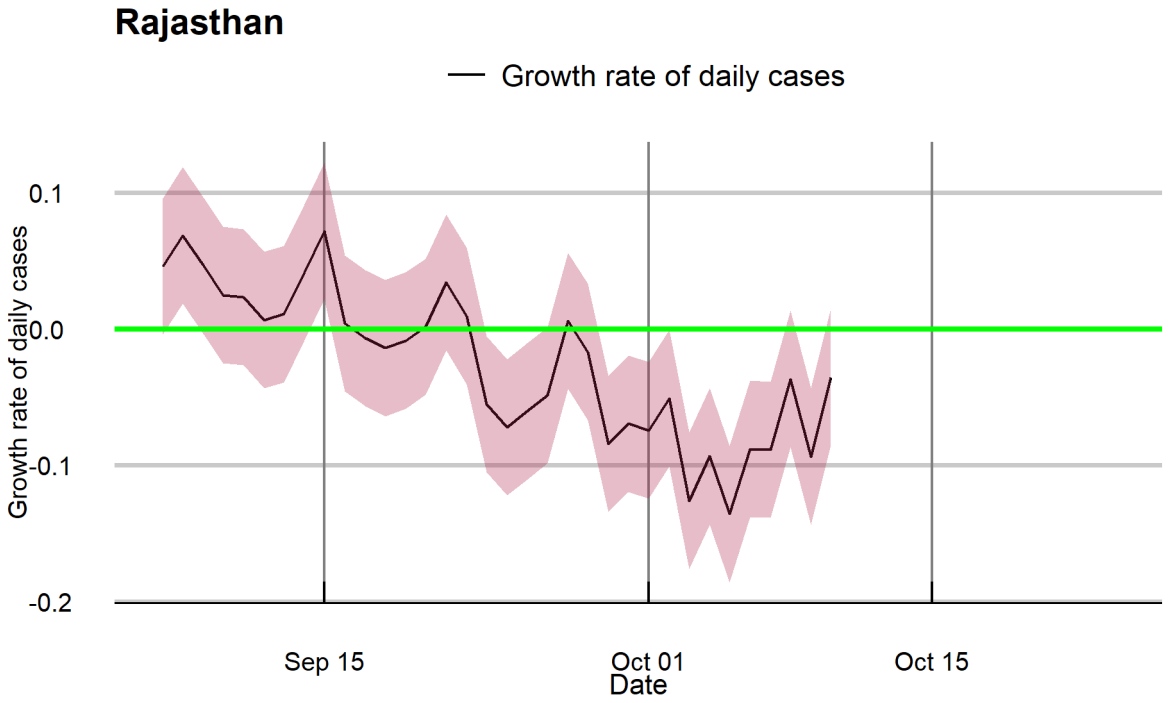

Puducherry
Data
Forecast
New cases
Forecast
Trend
200
150
100
50
New Cases
Sep 15
Oct 01
Oct 15
Date

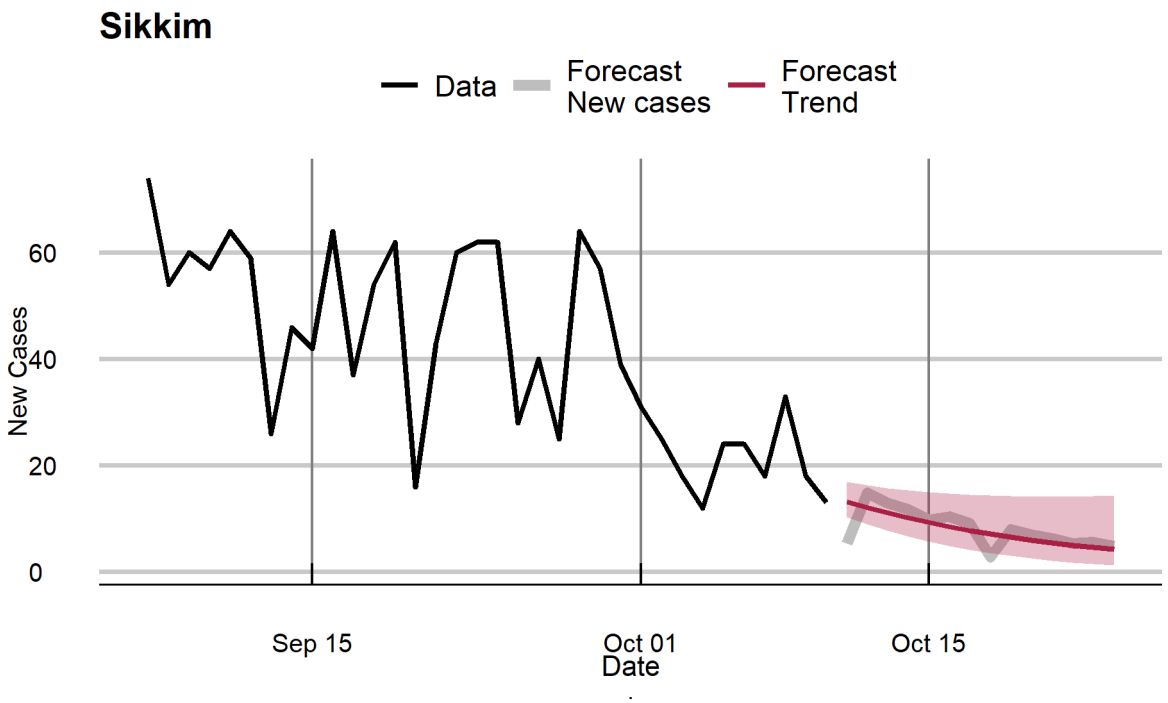

Puducherry
Growth rate of daily cases
0.05
0.00
-0.05
-0.10
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

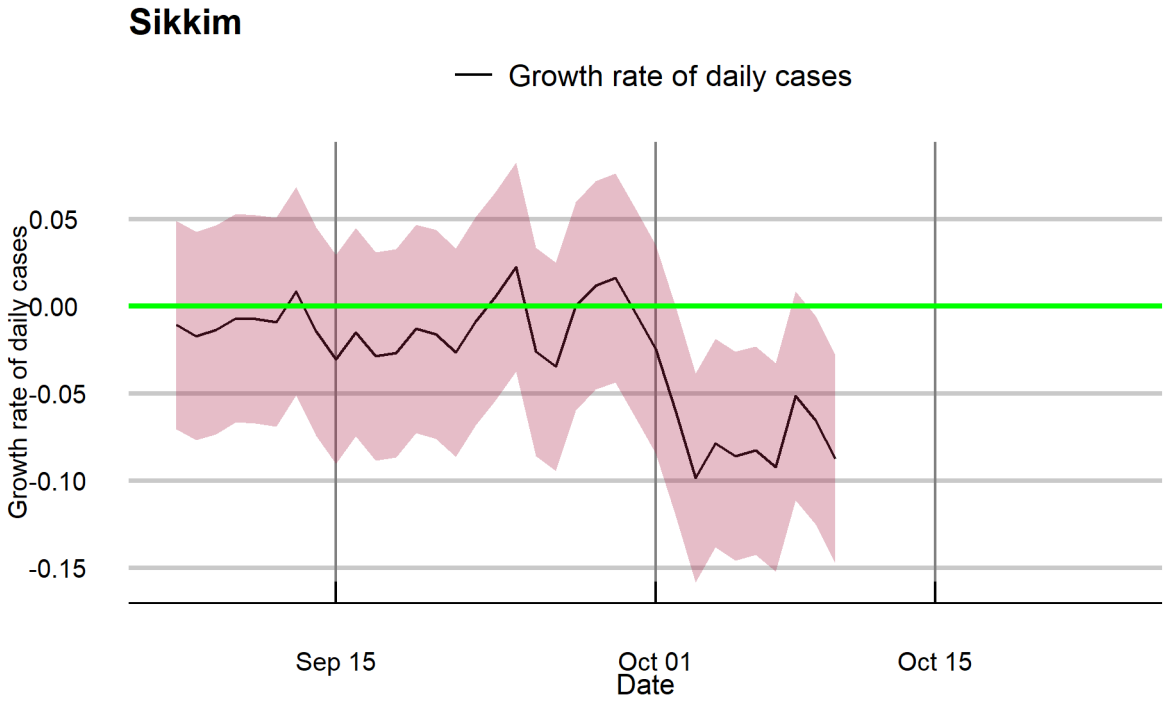

Punjab
Data
Forecast
New cases
Forecast
Trend
60
50
40
30
20
10
New Cases
Sep 15
Oct 01
Oct 15
Date

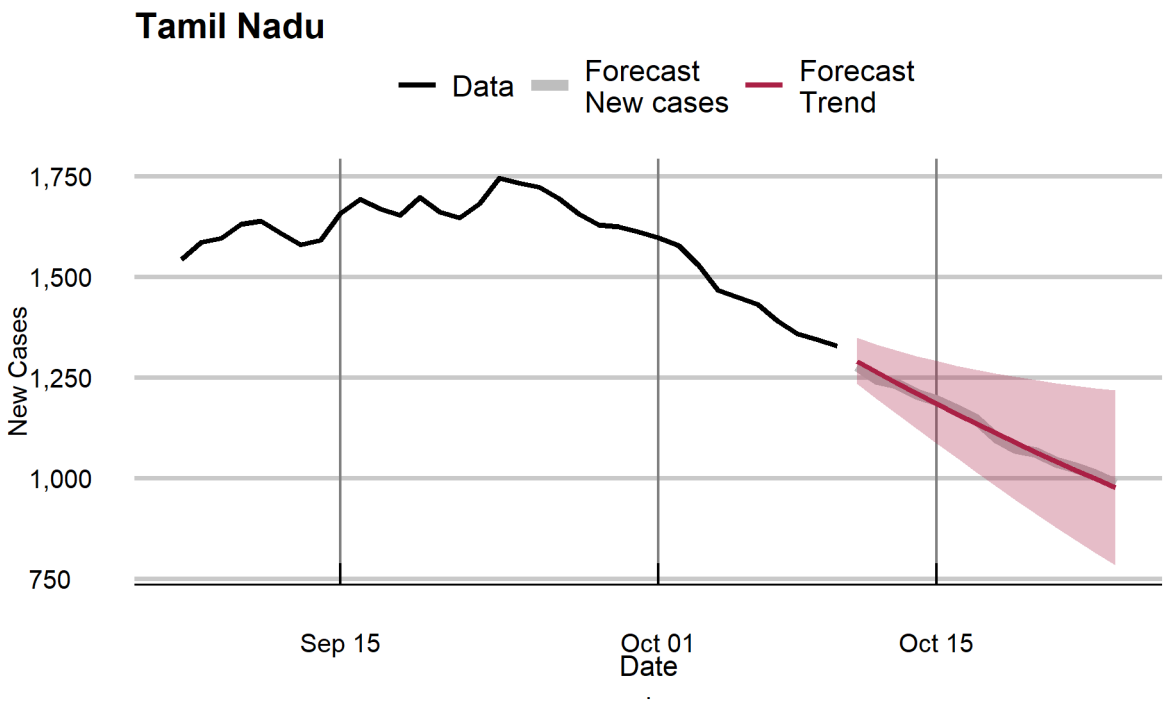

Punjab
Growth rate of daily cases
0.05
0.00
-0.05
-0.10
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

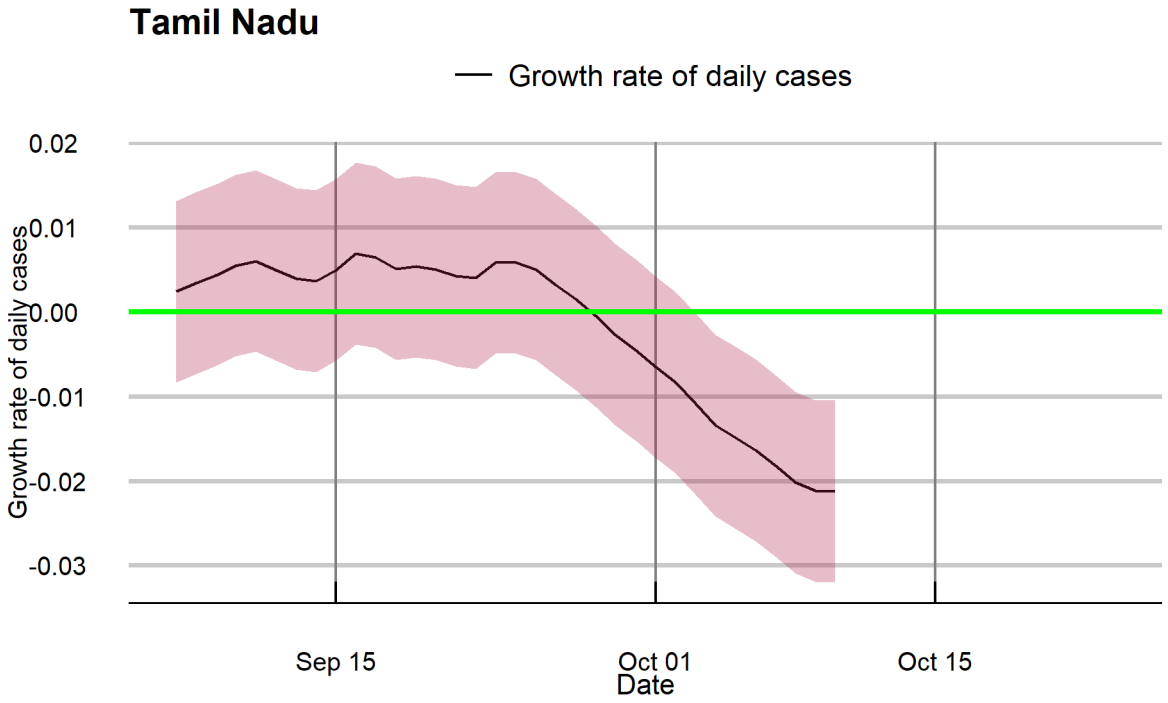

Rajasthan
Data
Forecast
New cases
Forecast
Trend
15.0
10.0
5.0
0.0
New Cases
Sep 15
Oct 01
Oct 15
Date

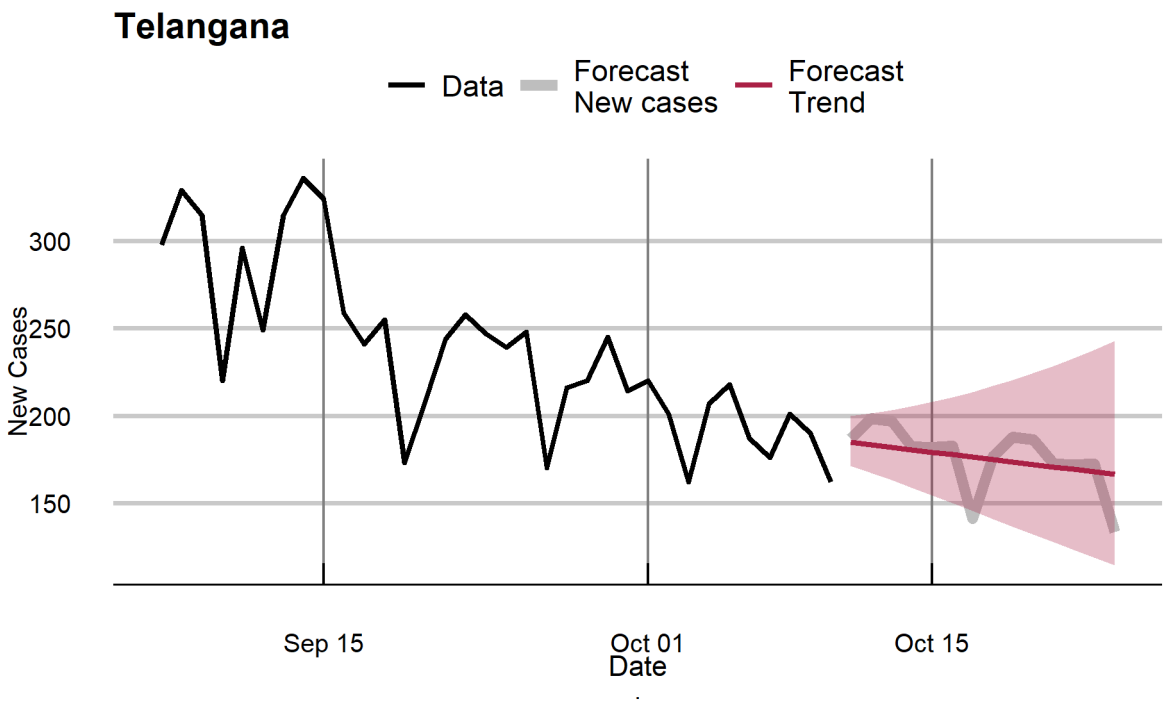

Rajasthan
Growth rate of daily cases
0.1
0.0
-0.1
-0.2
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

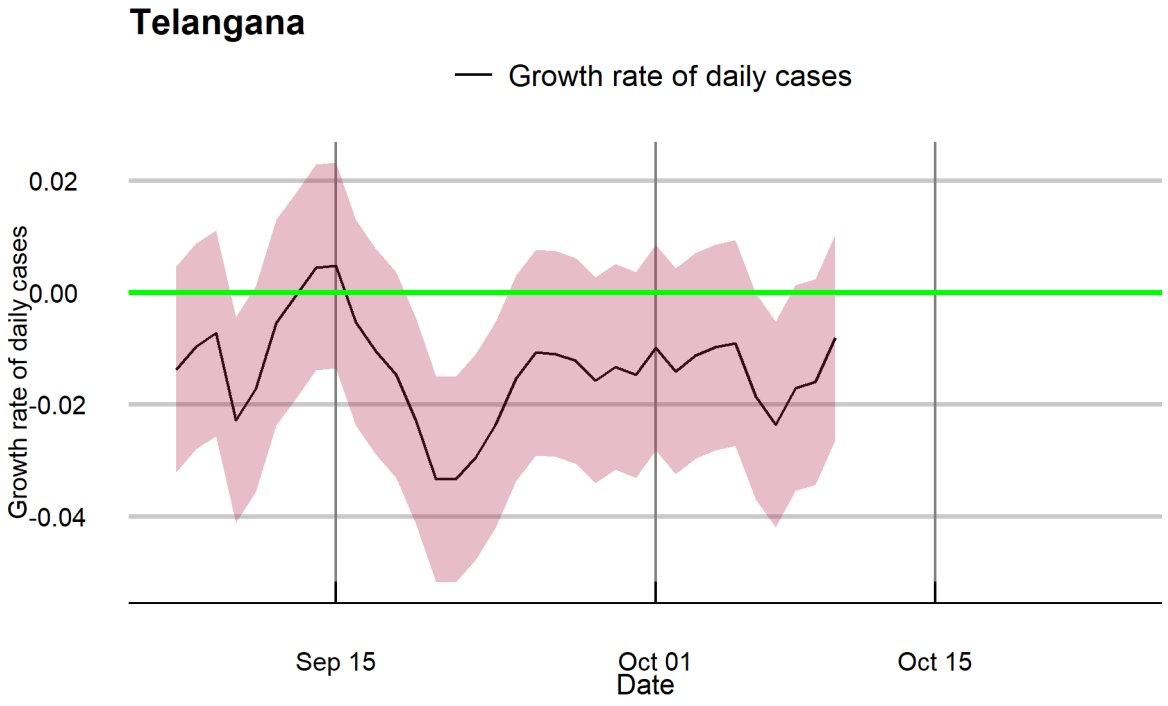

Sikkim
Data
Forecast
New cases
Forecast
Trend
New Cases
60
40
20
0
Sep 15
Oct 01
Oct 15
Date

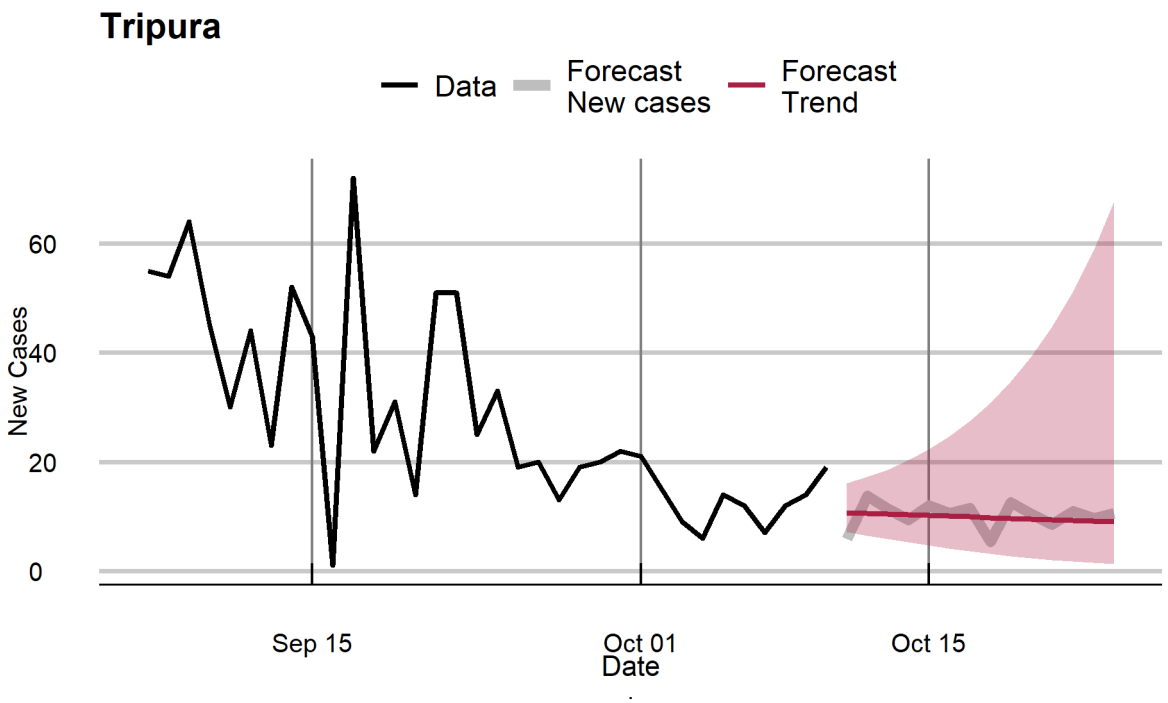

Sikkim
Growth rate of daily cases
Growth rate of daily cases
0.05
0.00
-0.05
-0.10
-0.15
Sep 15
Oct 01
Oct 15
Date

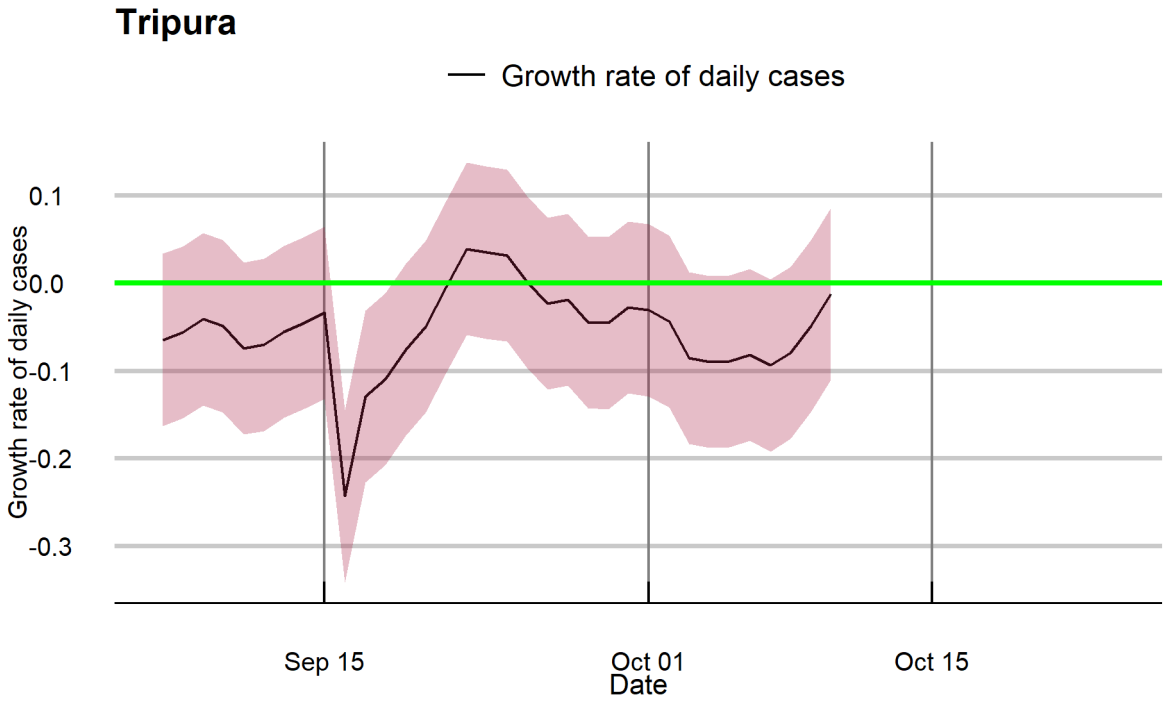

Tamil Nadu
Data
Forecast
New cases
Forecast
Trend
1,750
1,500
1,250
1,000
750
New Cases
Sep 15
Oct 01
Oct 15
Date

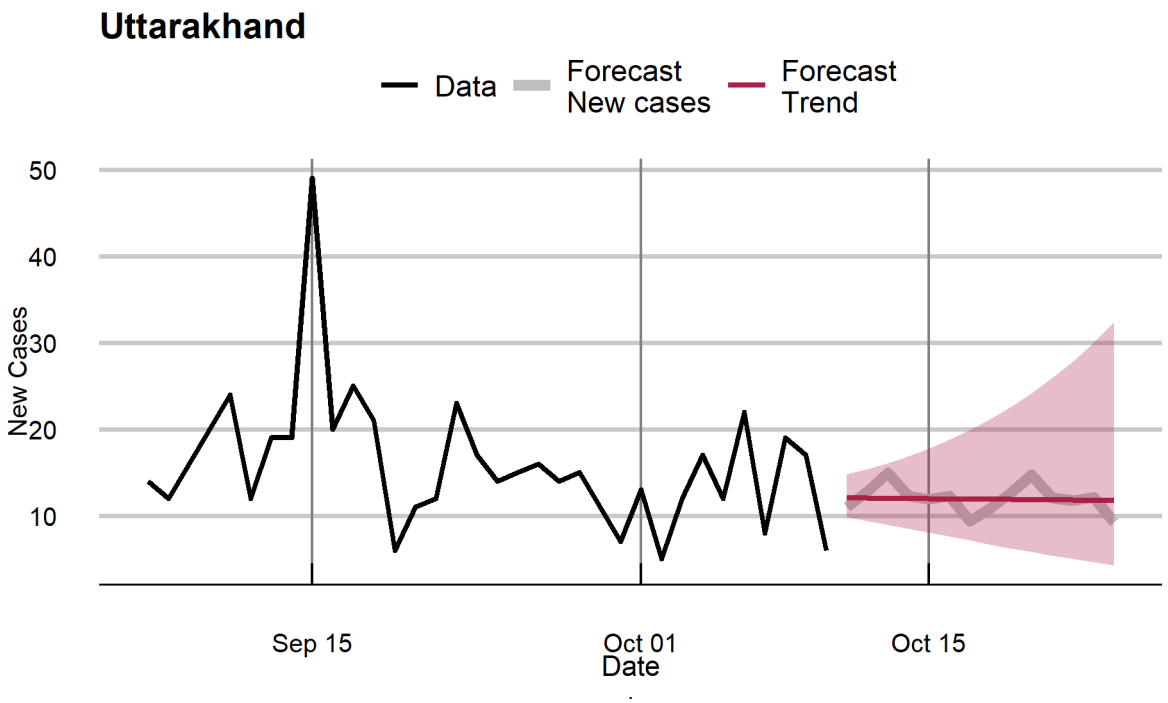

Tamil Nadu
Growth rate of daily cases
0.02
0.01
0.00
-0.01
-0.02
-0.03
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

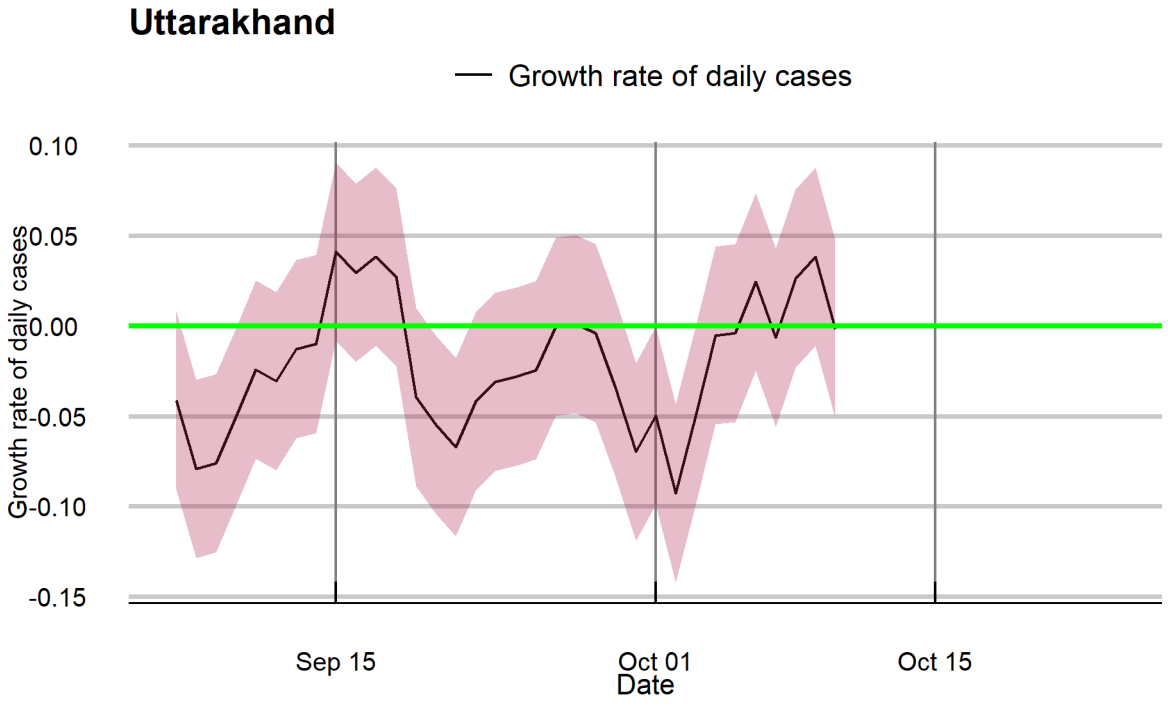

Telangana
Data
Forecast
New cases
Forecast
Trend
300
250
200
150
New Cases
Sep 15
Oct 01
Oct 15
Date

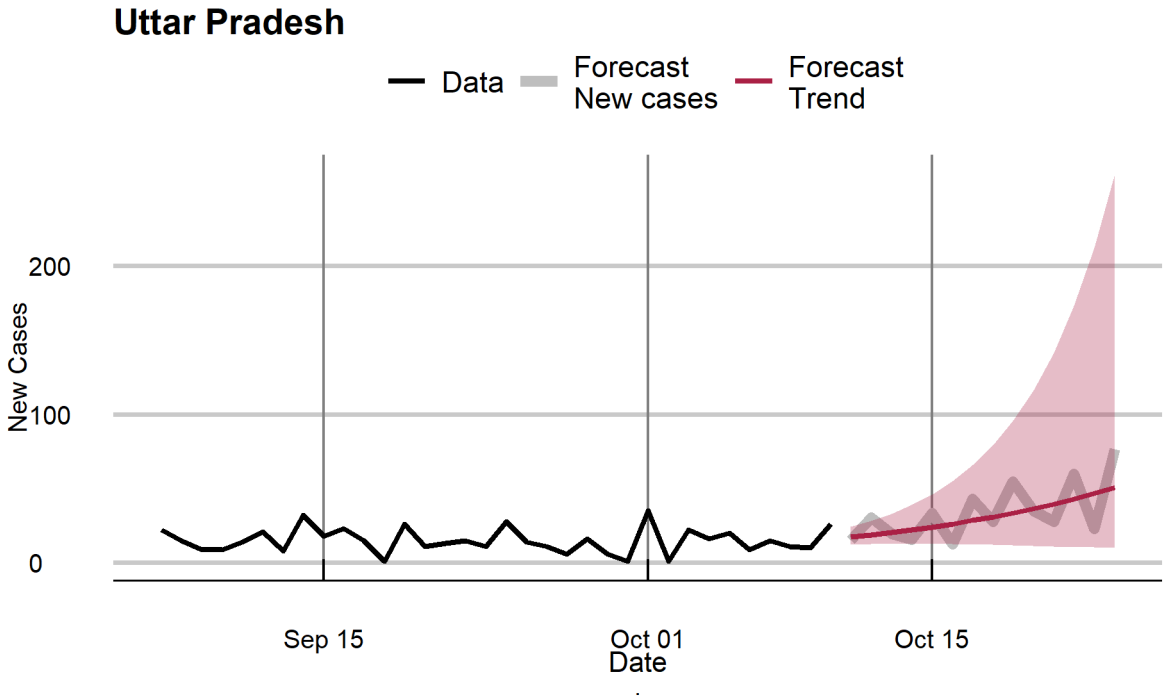

Telangana
Growth rate of daily cases
0.02
0.00
-0.02
-0.04
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

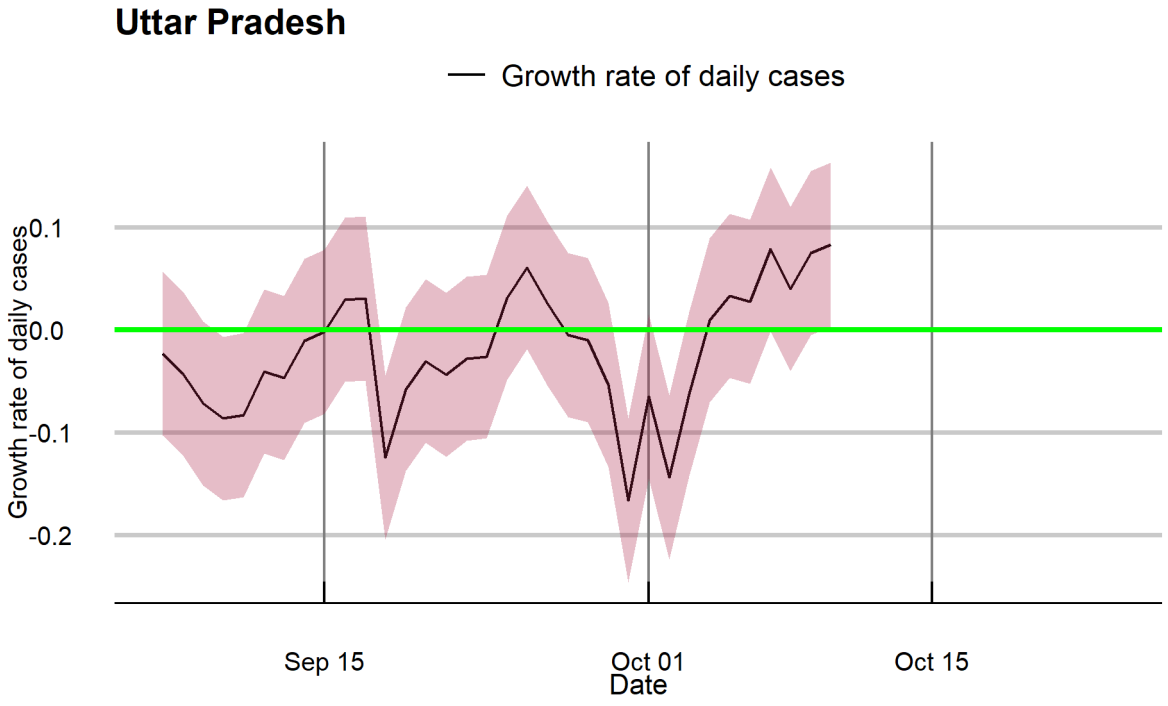

Tripura
Data
Forecast
New cases
Forecast
Trend
60
40
20
0
New Cases
Sep 15
Oct 01
Oct 15
Date

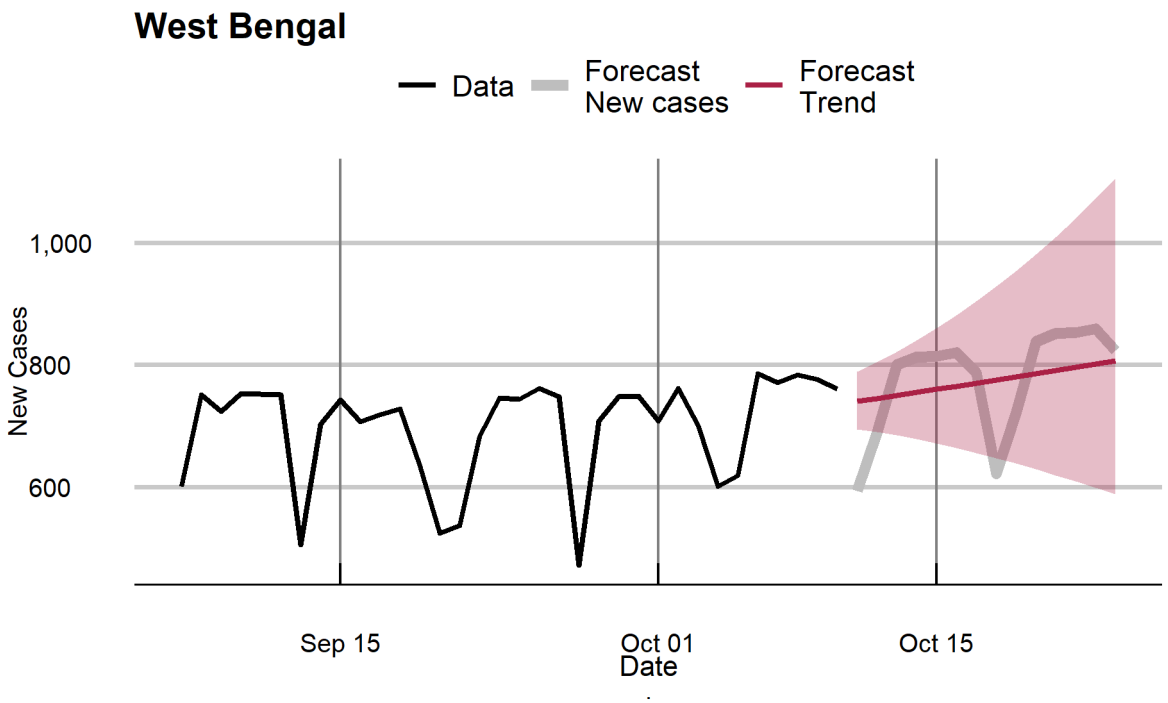

Tripura
Growth rate of daily cases
0.1
0.0
-0.1
-0.2
-0.3
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date

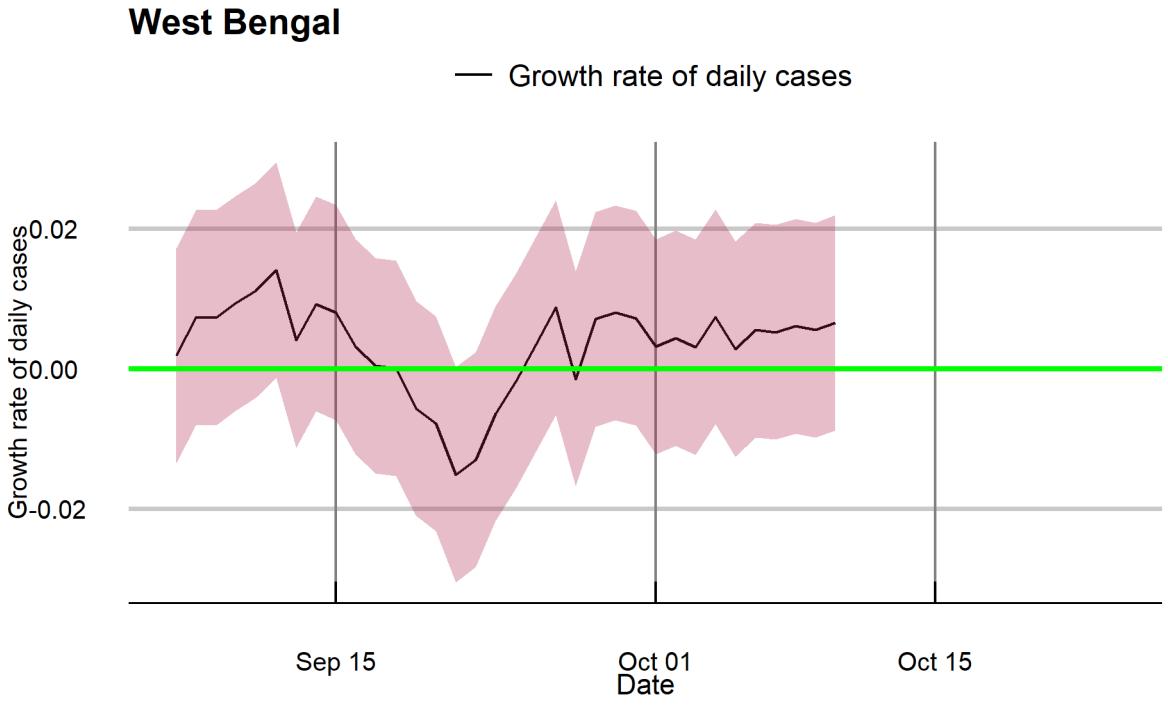

Uttarakhand
Data
Forecast
New cases
Forecast
Trend
50
40
30
20
10
New Cases
Sep 15
Oct 01
Oct 15
Date

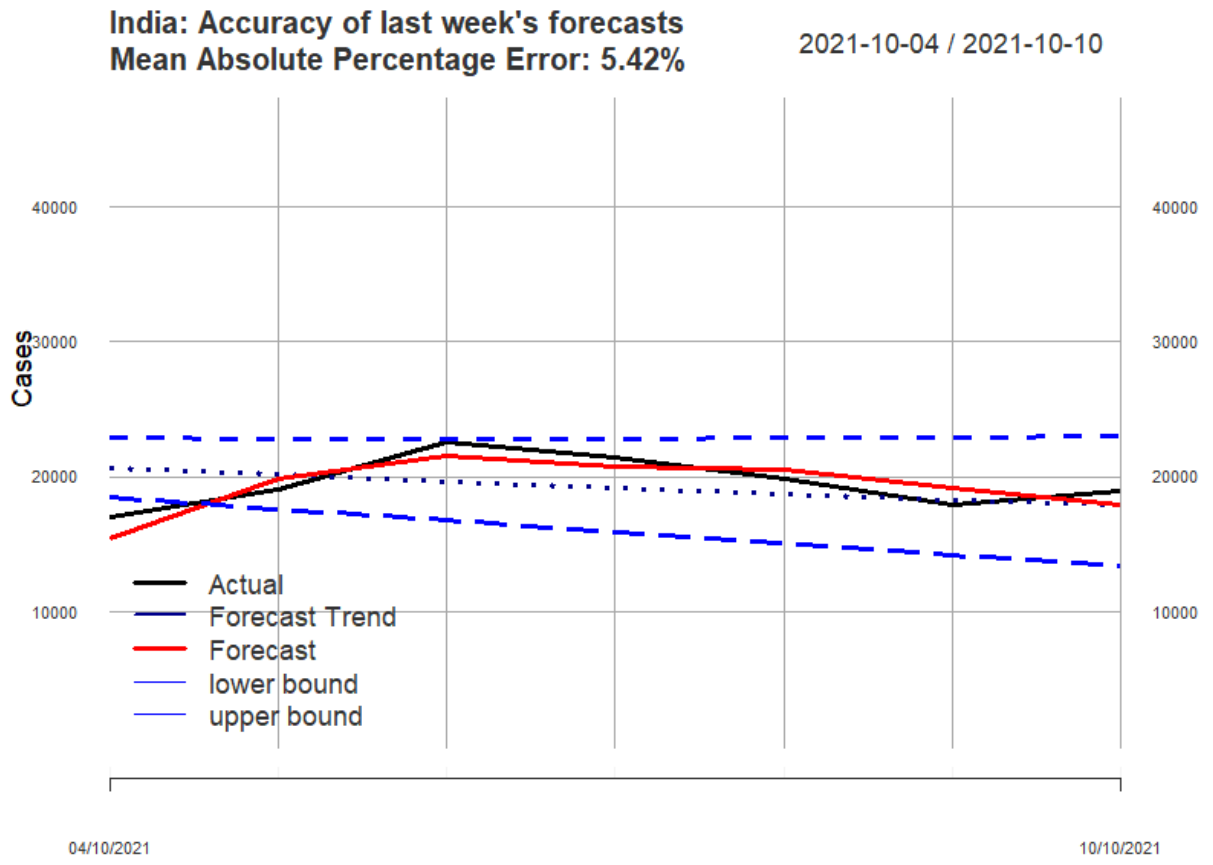

Uttarakhand
Growth rate of daily cases
0.10
0.05
0.00
-0.05
-0.10
-0.15
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date


Uttar Pradesh
Data
Forecast
New cases
Forecast
Trend
200
100
0
New Cases
Sep 15
Oct 01
Oct 15
Date


Uttar Pradesh
Growth rate of daily cases
0.1
0.0
-0.1
-0.2
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date


West Bengal
Data
Forecast
New cases
Forecast
Trend
1,000
800
600
New Cases
Sep 15
Oct 01
Oct 15
Date


West Bengal
Growth rate of daily cases
0.02
0.00
-0.02
Growth rate of daily cases
Sep 15
Oct 01
Oct 15
Date


India: Accuracy of last week's forecasts
Mean Absolute Percentage Error: 5.42%
2021-10-04 / 2021-10-10
Cases
40000
30000
20000
10000
Actual
Forecast Trend
Forecast
lower bound
upper bound
04/10/2021
10/10/2021

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*. 256, 110-126. doi:10.1017/nie.2021.12.

Forecast accuracy: is assessed using mean absolute percentage error of the forecasts of cases over the past week. 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 (2021). A farewell to R: Time series models for tracking and forecasting epidemics. Journal of the Royal Society Interface, 18, 20210179, https://royalsocietypublishing.org/doi/10.1098/rsif.2021.0179.The confidence interval is based on one standard deviation, with coverage of 68%.

Note: 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.

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