

# Forecasting of coronavirus COVID19 epidemic (SIR model)

It is assumed that the model is a reasonable description of the one-stage epidemic. In particular, the model assumes a constant population, uniform mixing of the people, and equally likely recovery of infected. The model is data-driven, so its forecast is as good as data are. The forecasting change with new or changed data.

**DISCLAIMER:** Software and data is for education and not for medical or commercial use. The model may fail in some situations. In particular, the model may be unadequate, the model may fail in the initial phase and in when additional epidemic stages or outbreaks (not described by SIR model) are encountered. Use it at your own discretion.

The data are only for demonstrating the operation of fitVirusCV19. FitVirus and presented demo data are only for educational and academic purposes and should not be used for medical purposes and in commerce. They are provided as is and any express or implied warranties, including but not limited to implied warranties of merchantability and fitness for a particular purpose are disclaimed.

## Notation

$R_0$  Basic reproduction number

$\beta$  Contact (infection) rate

$\gamma$  Removal rate

$N$  Population size (approx. stock of initial susceptible population)

$C_{\text{end}}$  Epidemic size (total recovered individuals)

$S_{\text{end}}$  Final number of susceptible individuals left

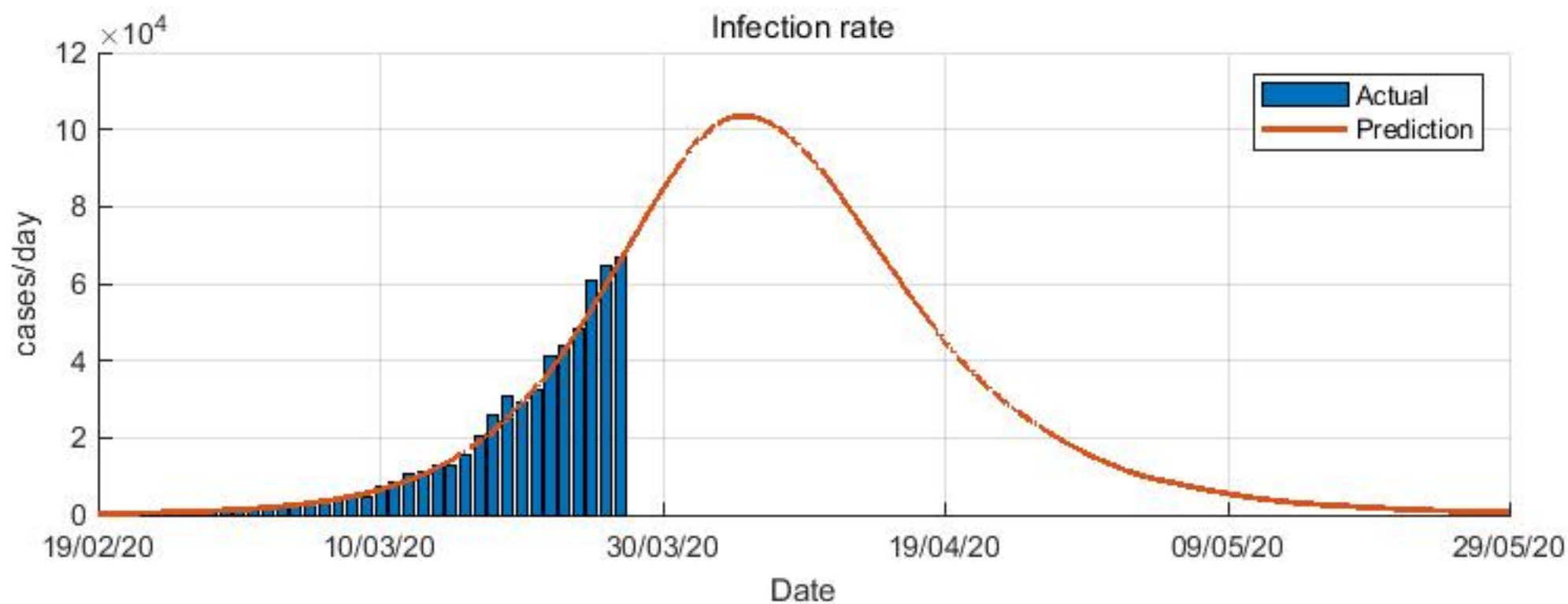
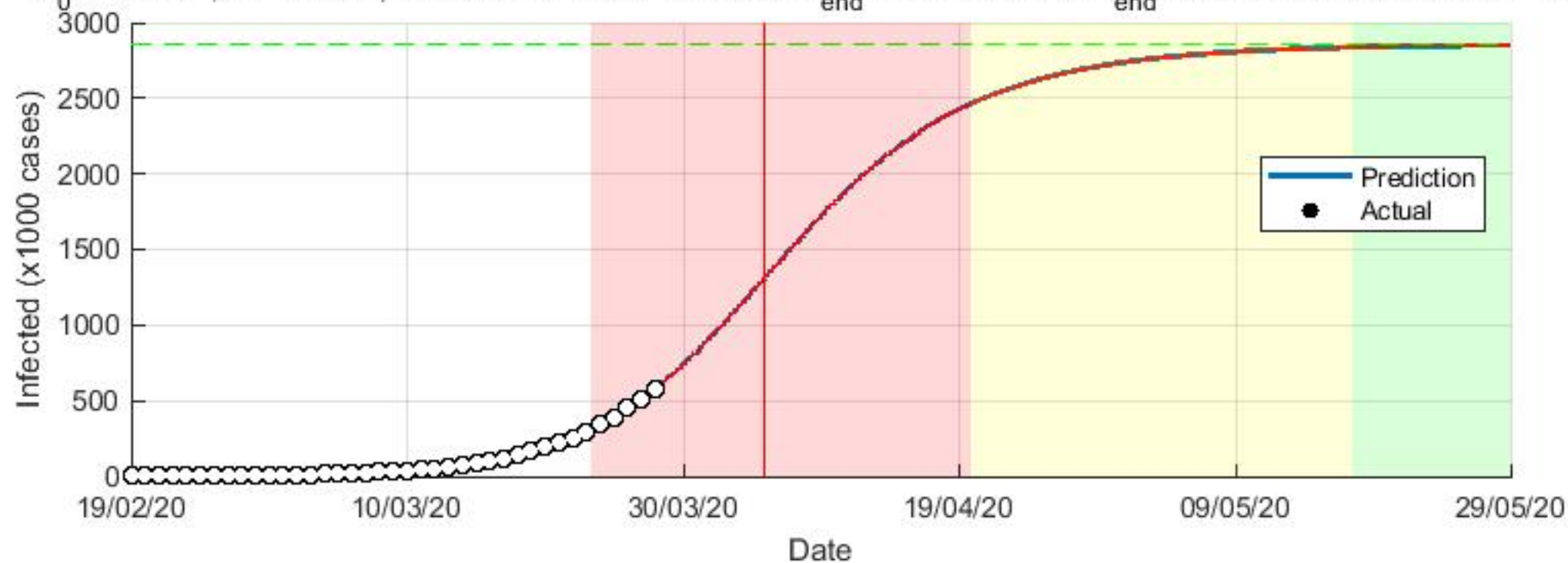
RMSE Root mean square error

## Reference

[https://en.wikipedia.org/wiki/Compartmental\\_models\\_in\\_epidemiology](https://en.wikipedia.org/wiki/Compartmental_models_in_epidemiology)

# Coronavirus epidemic in Wold - China (SIR model): 28-Mar-2020

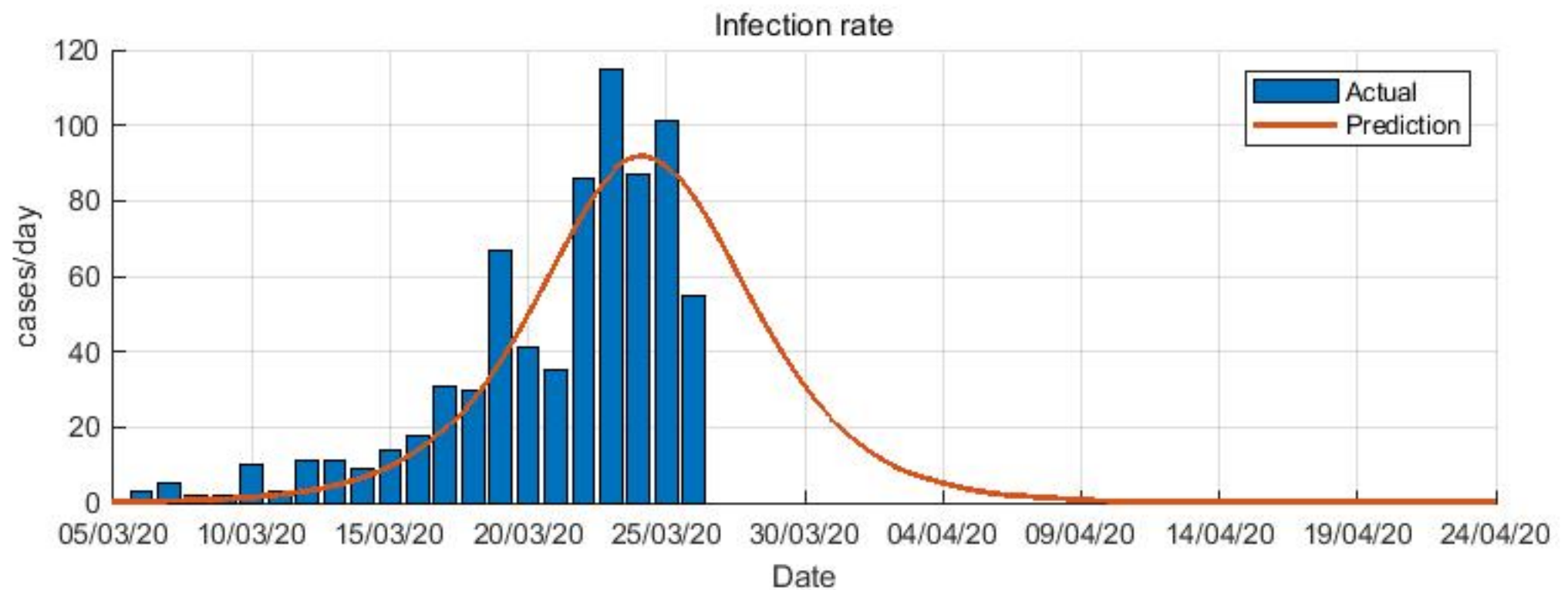
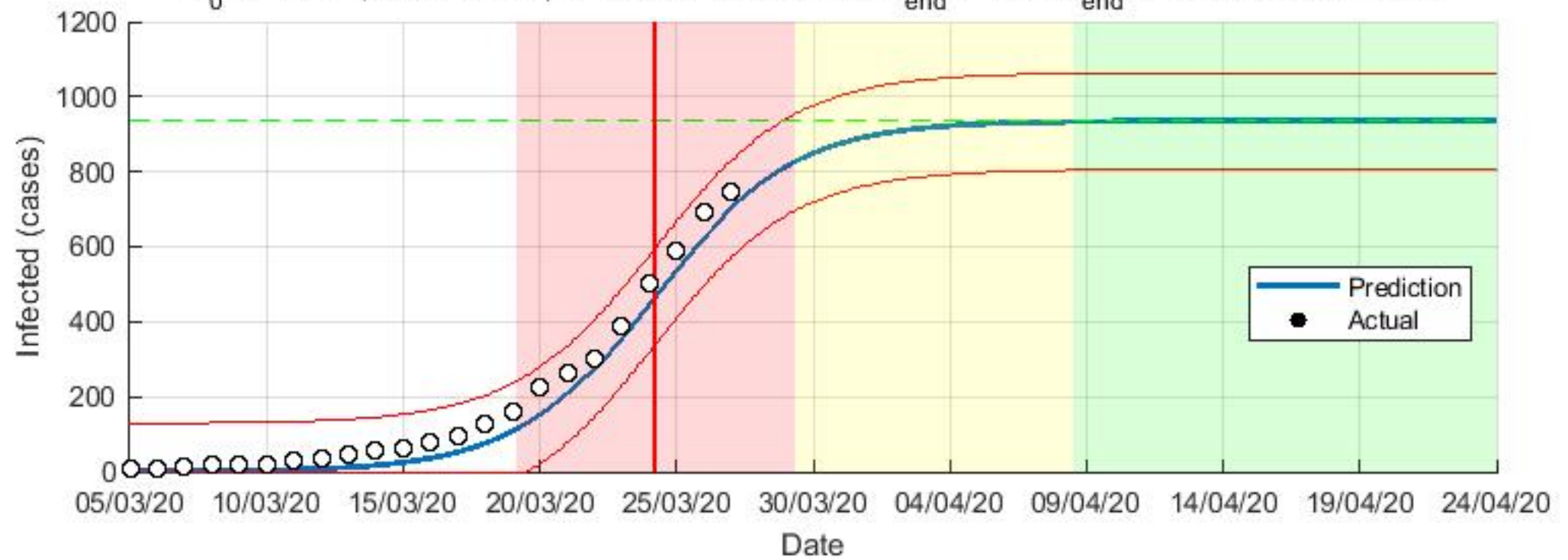
$R_0 = 1.727$   $\beta = 0.387$   $\gamma = 0.224$   $N = 4.06023e+06$   $C_{end} = 2.8559e+06$   $S_{end} = 1.20434e+06$   $RMSE = 1371$





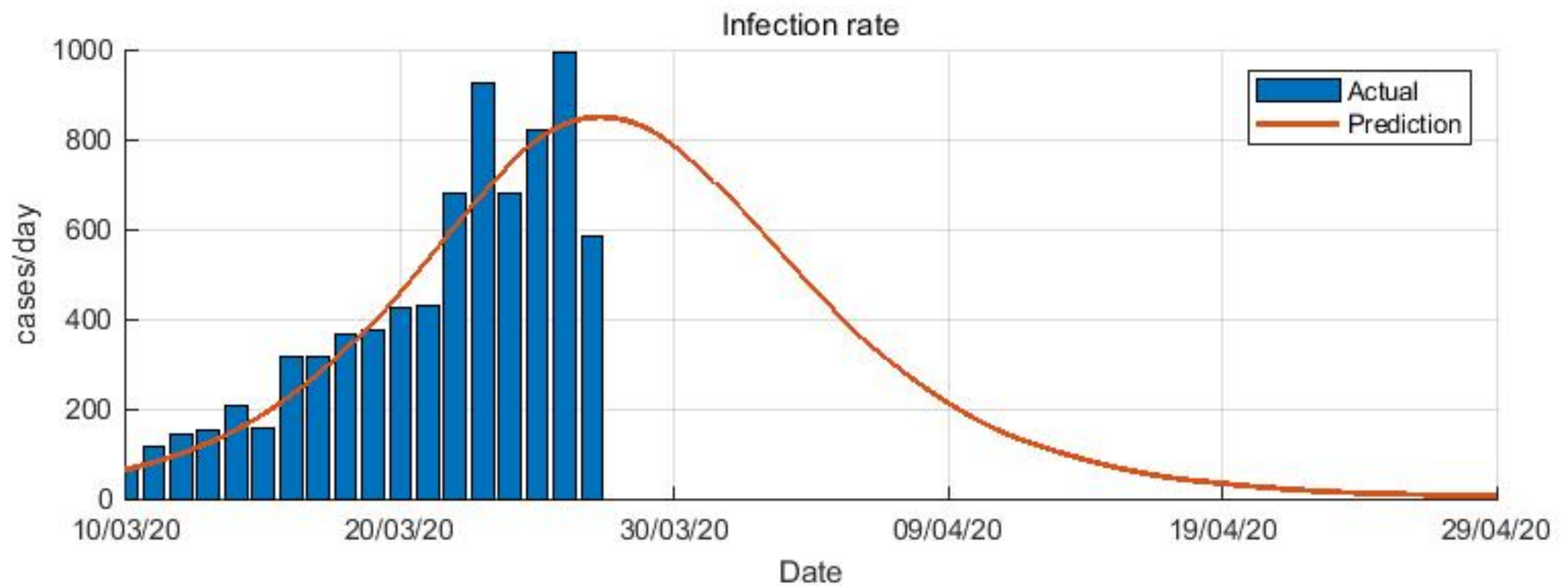
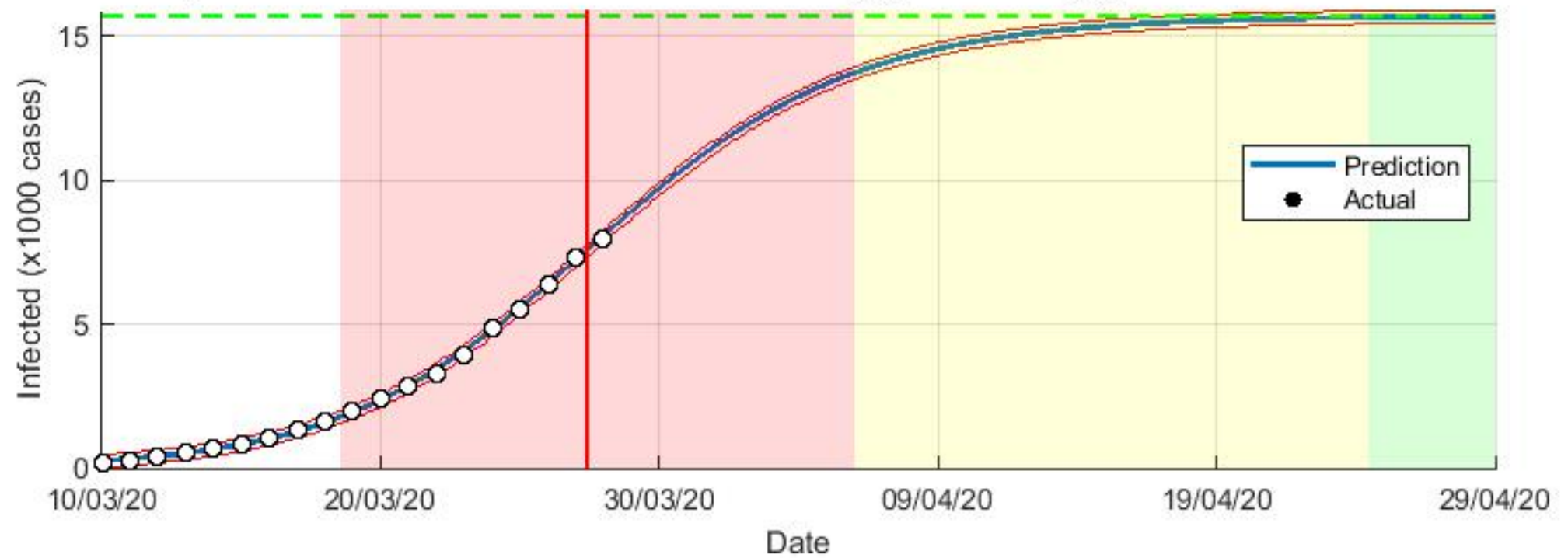
# Coronavirus epidemic in Argentina (SIR model): 27-Mar-2020

$R_0 = 1.017$   $\beta = 23.456$   $\gamma = 23.061$   $N = 27973$   $C_{end} = 935$   $S_{end} = 27038$   $RMSE = 43$

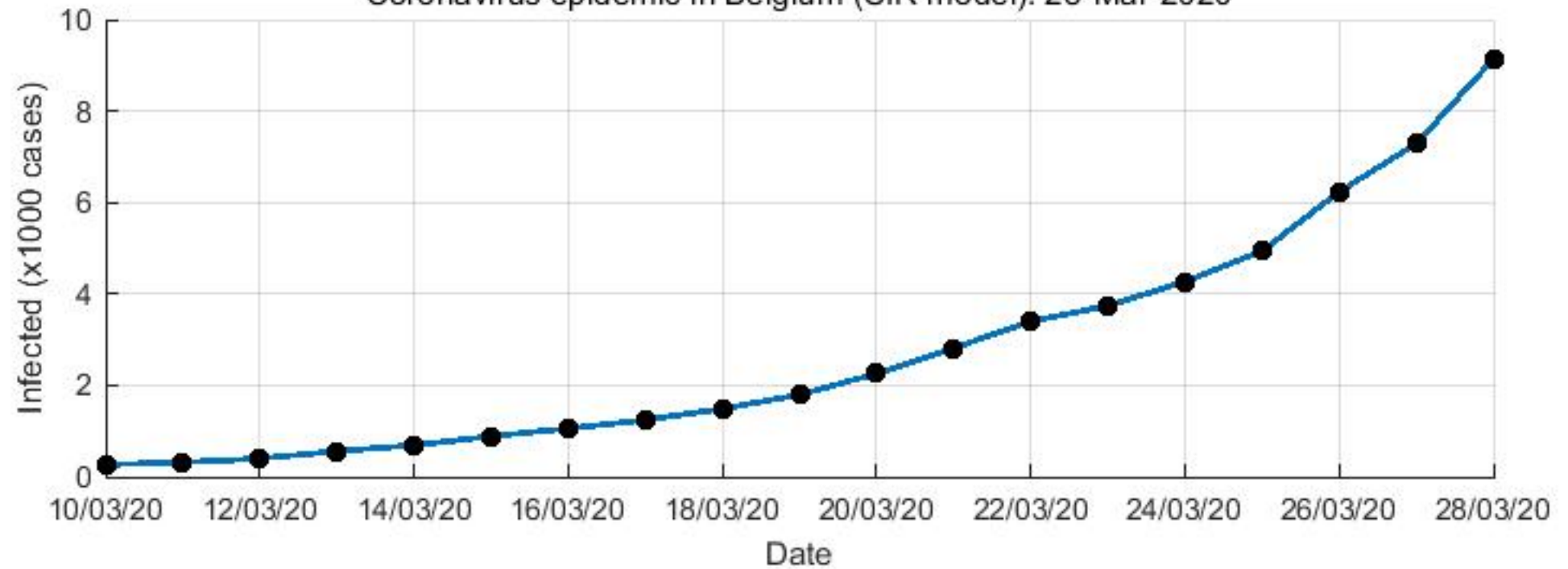


# Coronavirus epidemic in Austria (SIR model): 28-Mar-2020

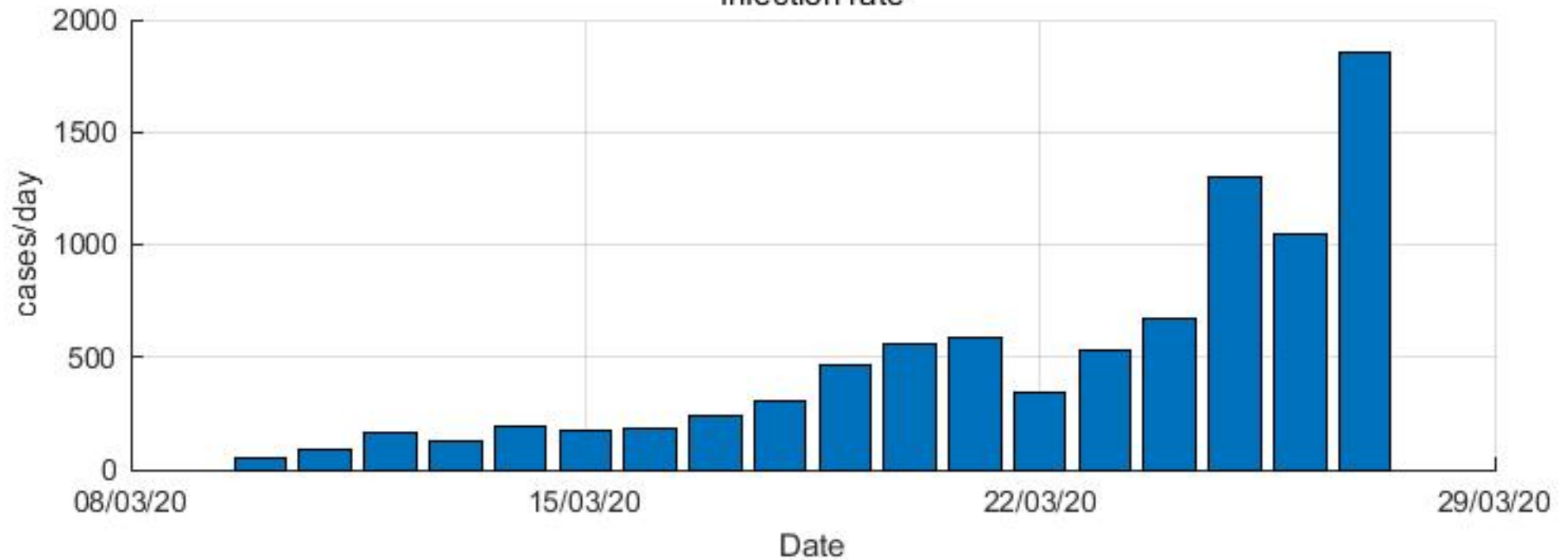
$R_0 = 1.258$   $\beta = 1.122$   $\gamma = 0.892$   $N = 41248$   $C_{end} = 15692$   $S_{end} = 25555$   $RMSE = 74$



Coronavirus epidemic in Belgium (SIR model): 28-Mar-2020

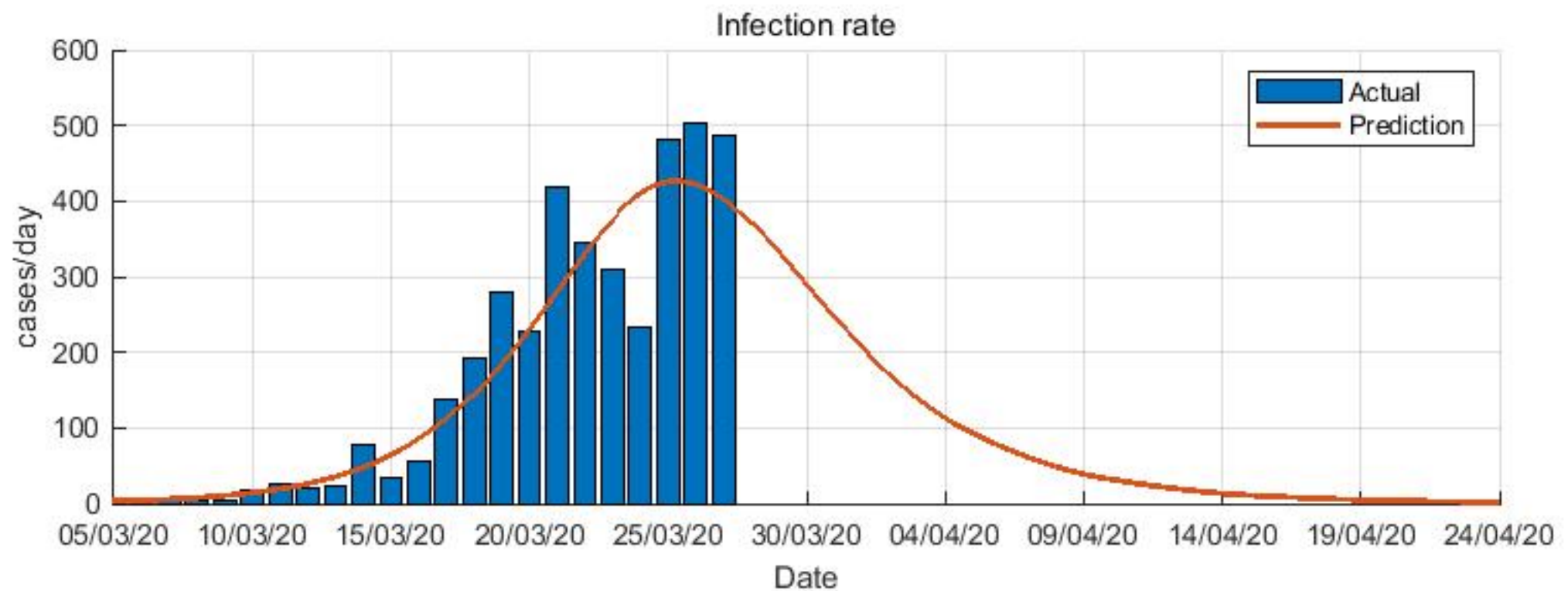
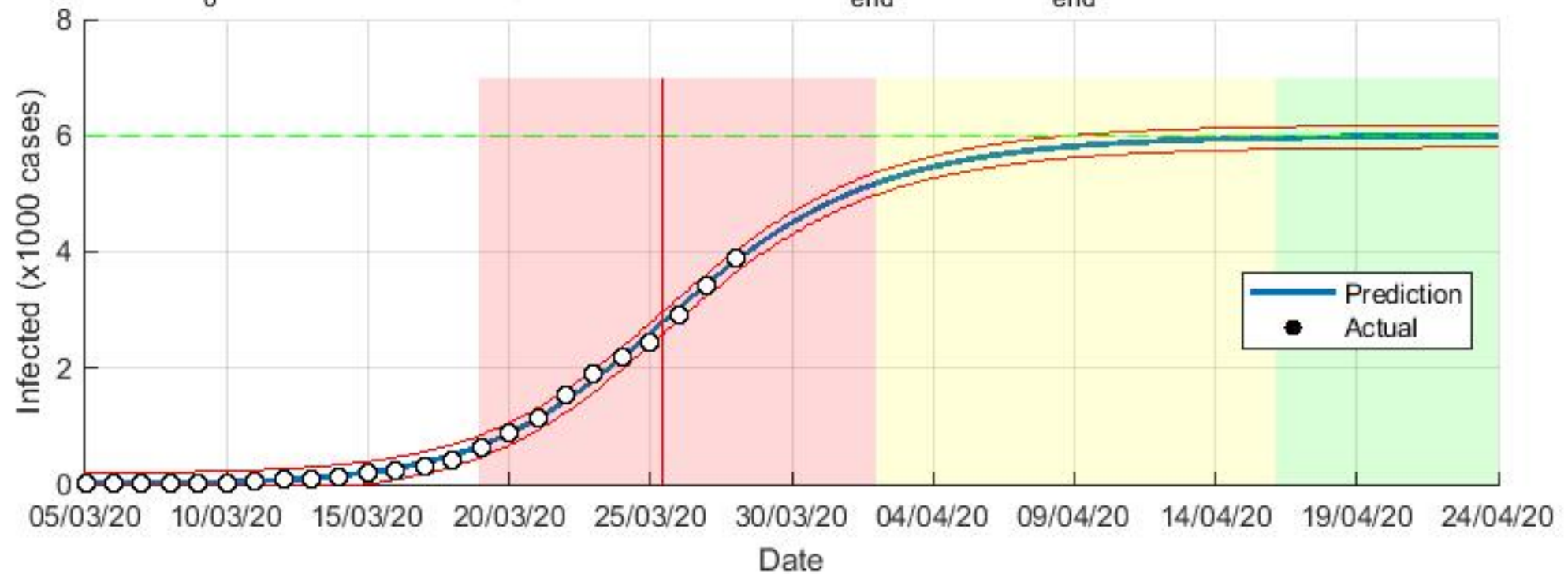


Infection rate



# Coronavirus epidemic in Brazil (SIR model): 28-Mar-2020

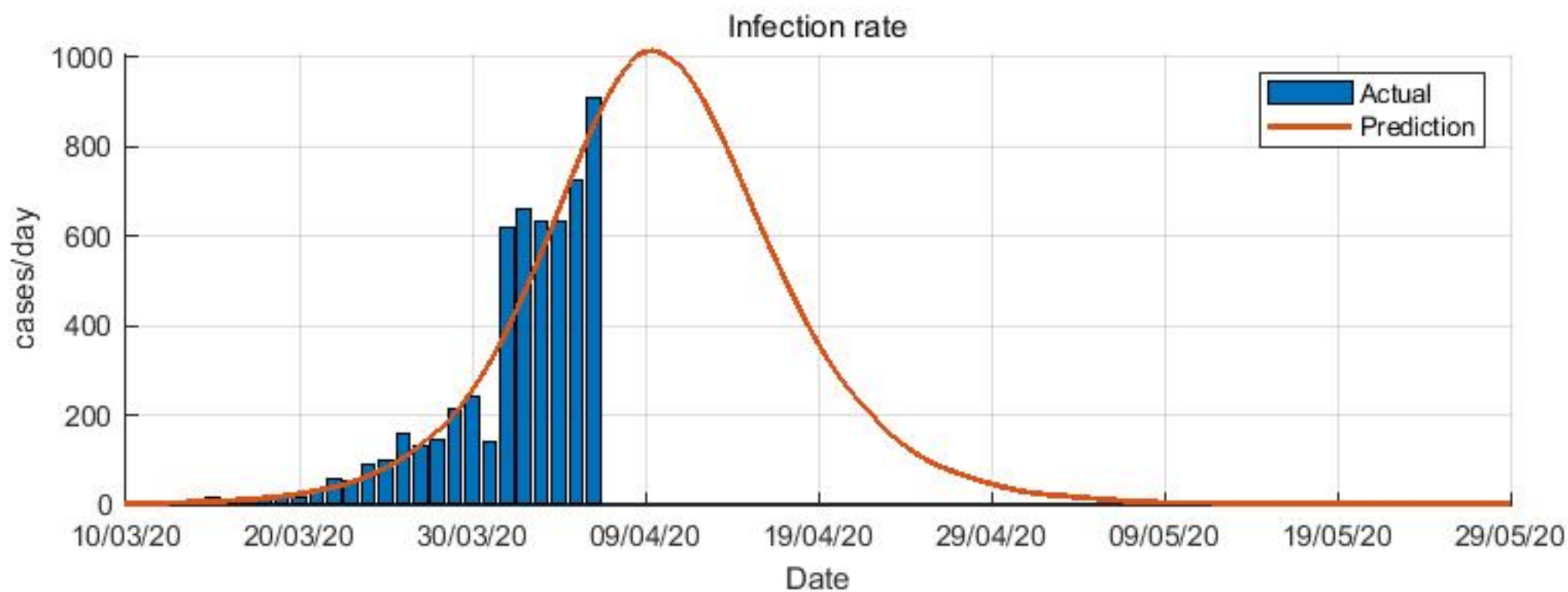
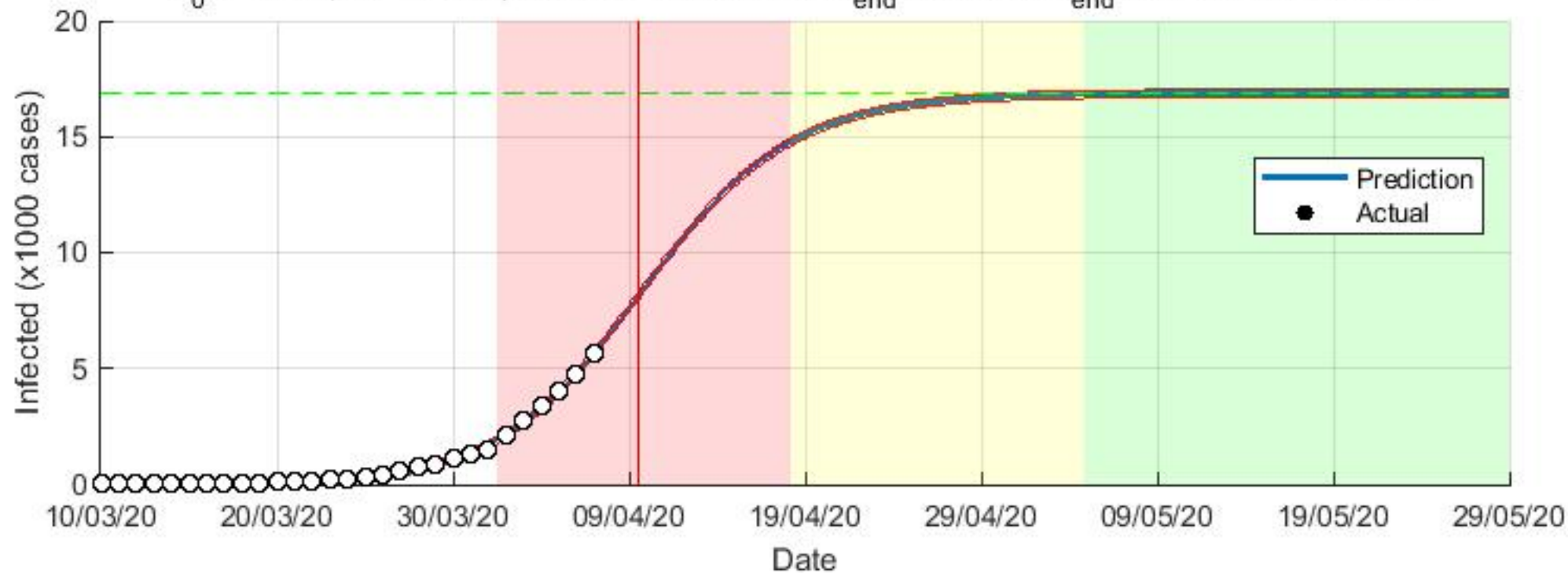
$R_0 = 1.673$   $\beta = 0.79$   $\gamma = 0.472$   $N = 8828$   $C_{\text{end}} = 5996$   $S_{\text{end}} = 2832$   $\text{RMSE} = 64$





# Coronavirus epidemic in Canada (SIR model): 07-Apr-2020

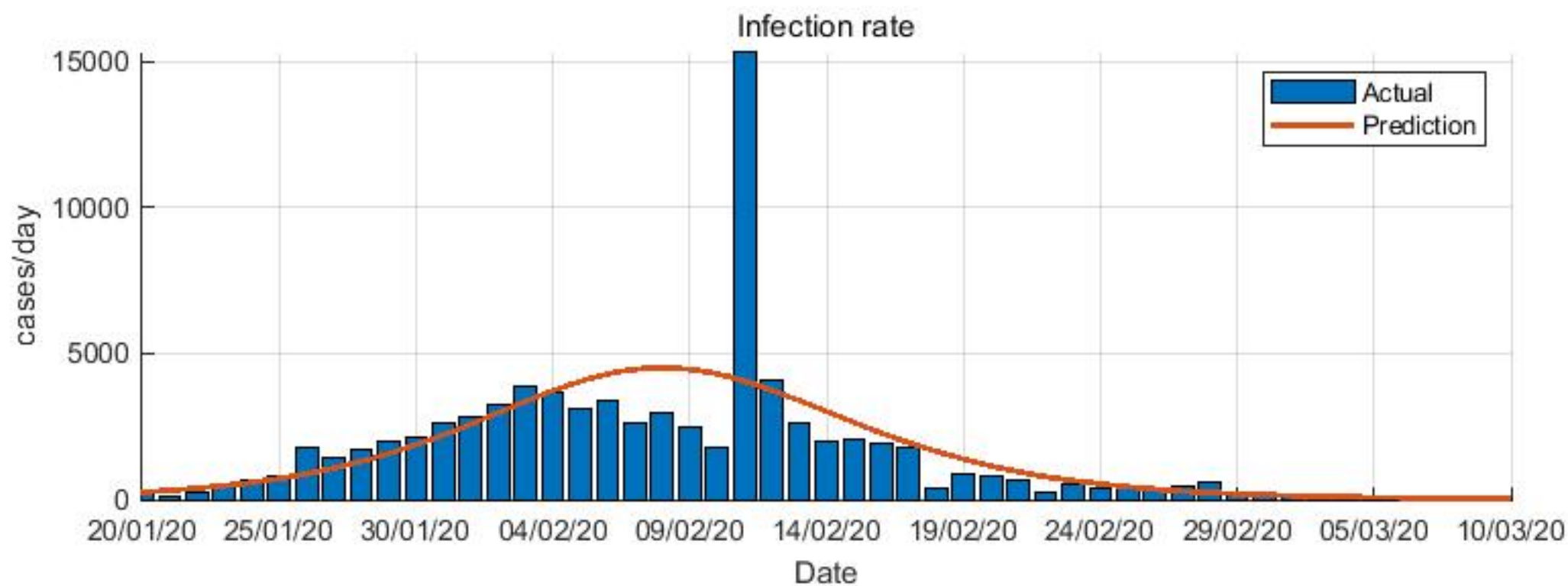
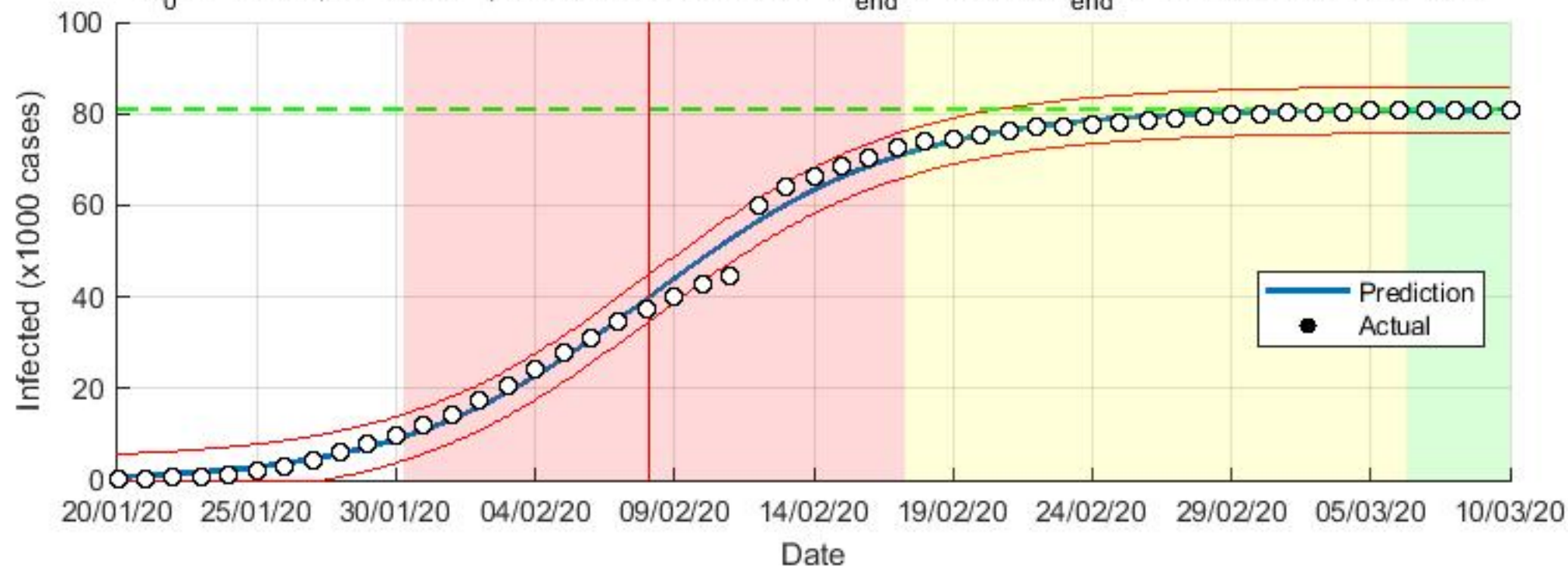
$R_0 = 1.23$   $\beta = 1.366$   $\gamma = 1.111$   $N = 48406$   $C_{end} = 16875$   $S_{end} = 31530$   $RMSE = 55$





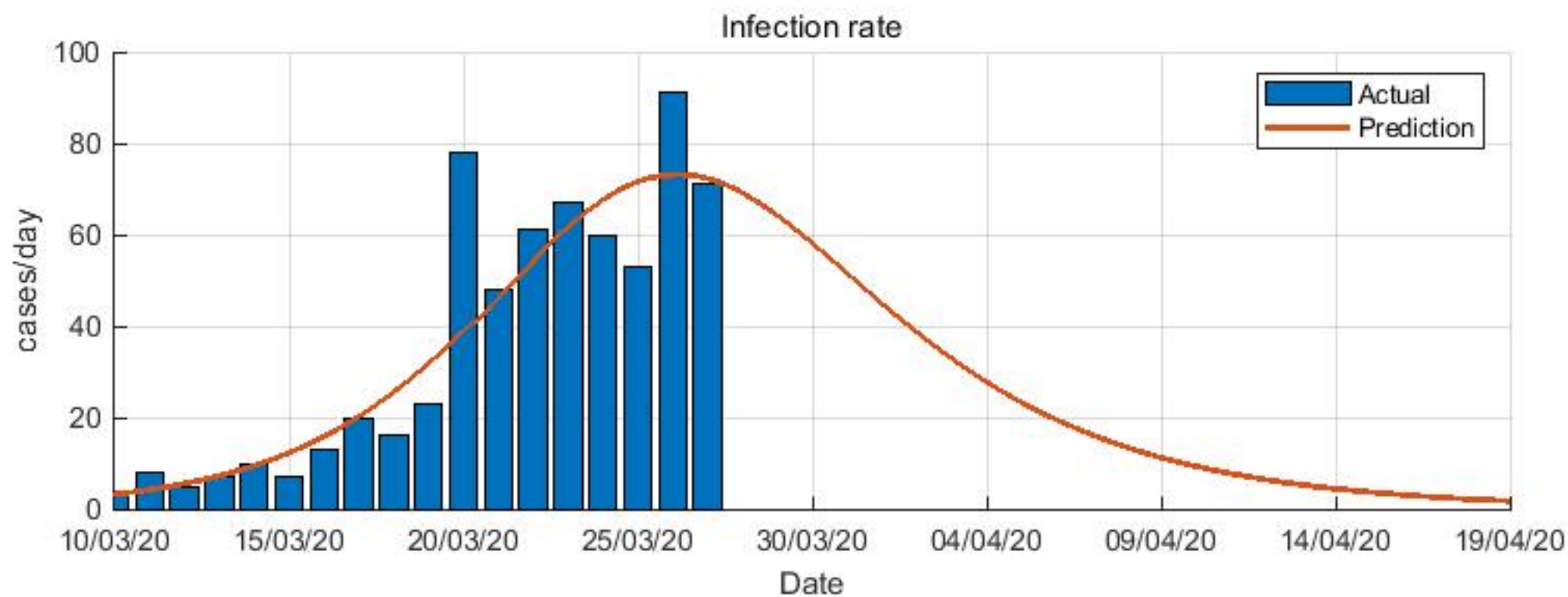
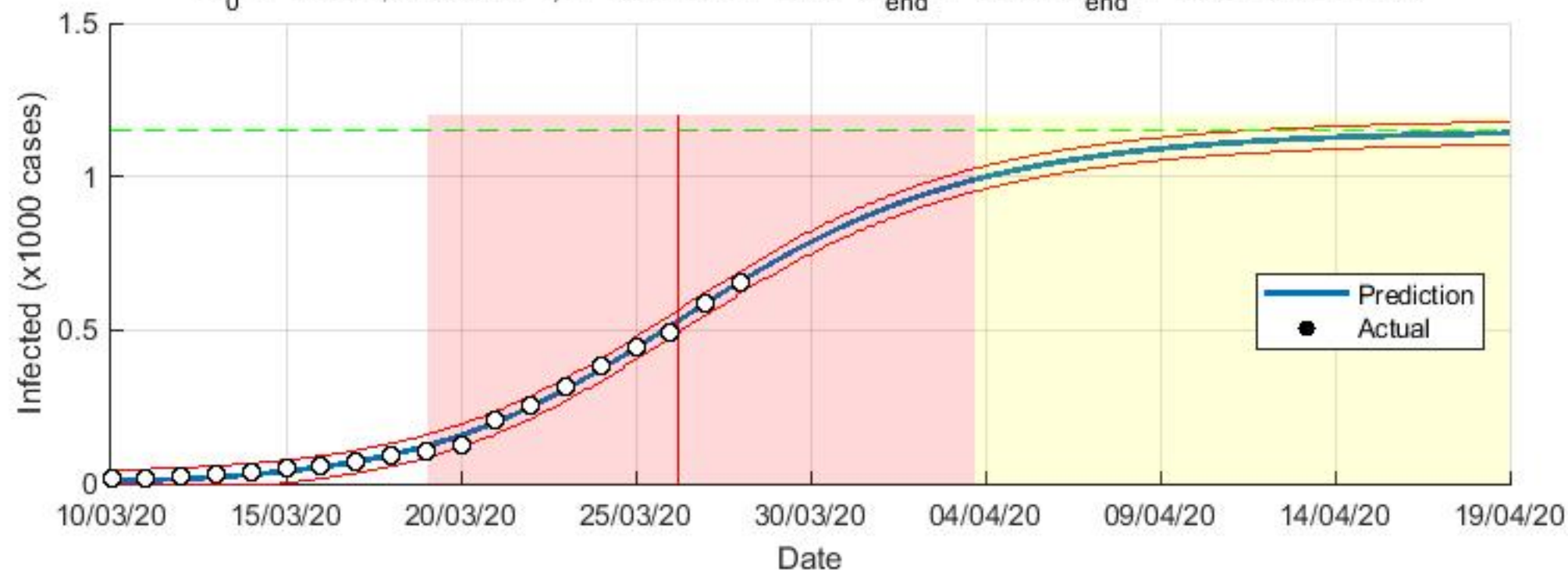
# Coronavirus epidemic in China (SIR model): 27-Mar-2020

$R_0 = 1.079$   $\beta = 3.053$   $\gamma = 2.829$   $N = 562578$   $C_{end} = 81006$   $S_{end} = 481572$   $RMSE = 1678$



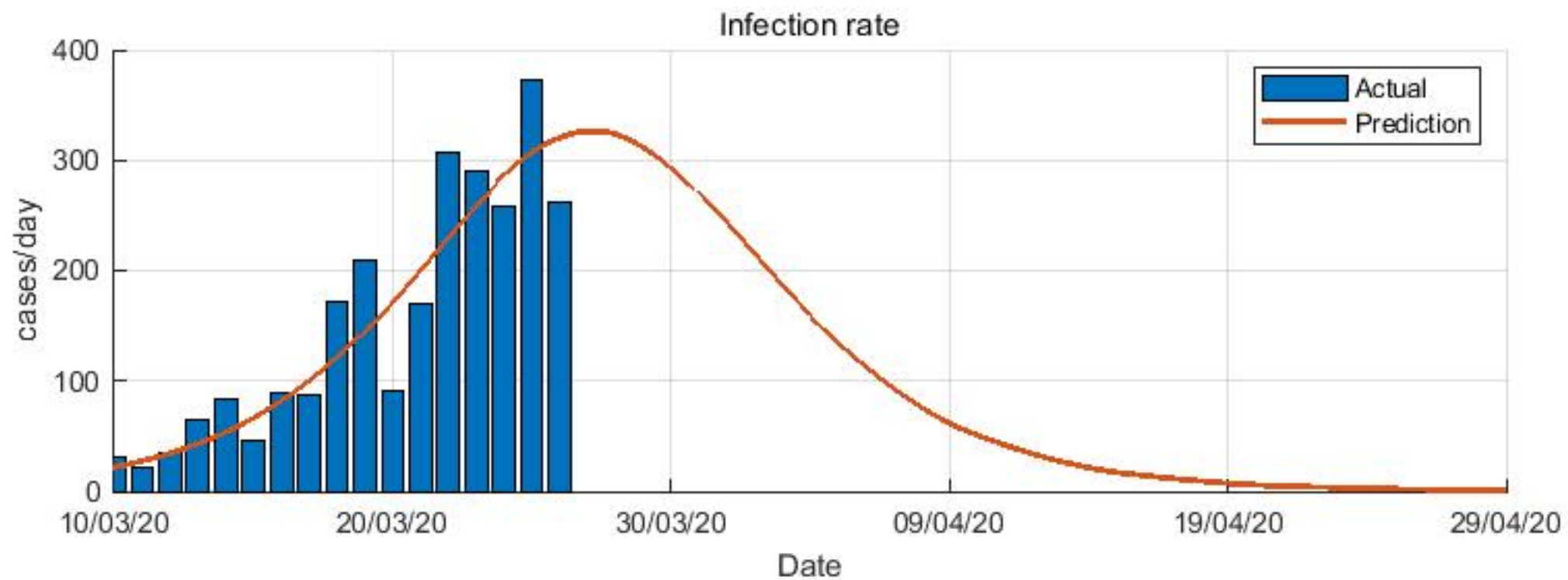
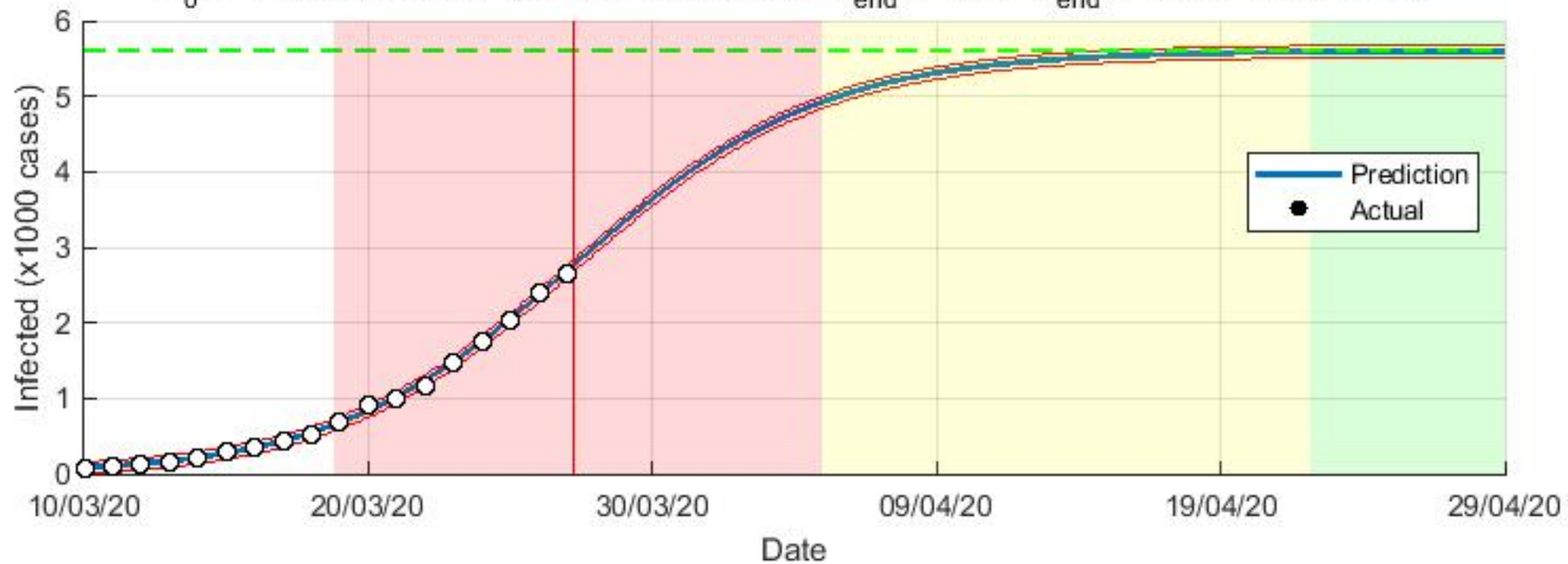
# Coronavirus epidemic in Croatia (SIR model): 28-Mar-2020

$R_0 = 1.724$   $\beta = 0.673$   $\gamma = 0.389$   $N = 1631$   $C_{end} = 1149$   $S_{end} = 482$   $RMSE = 12$



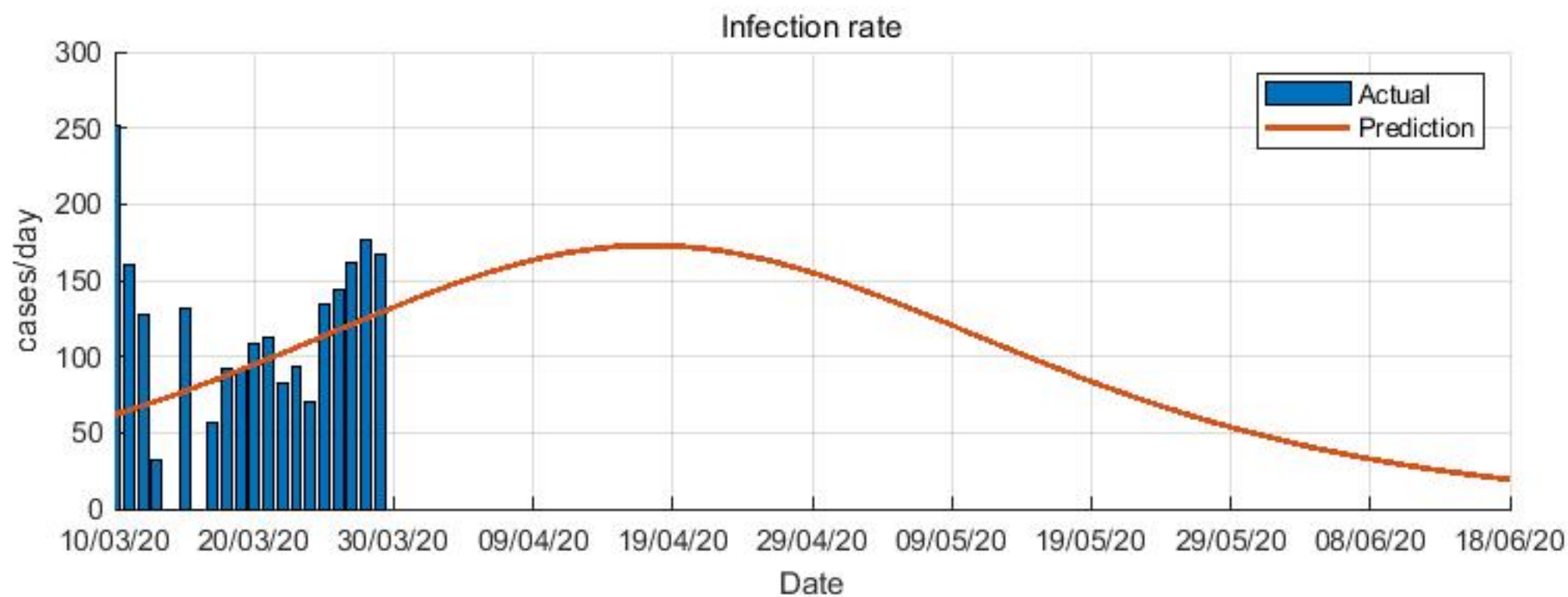
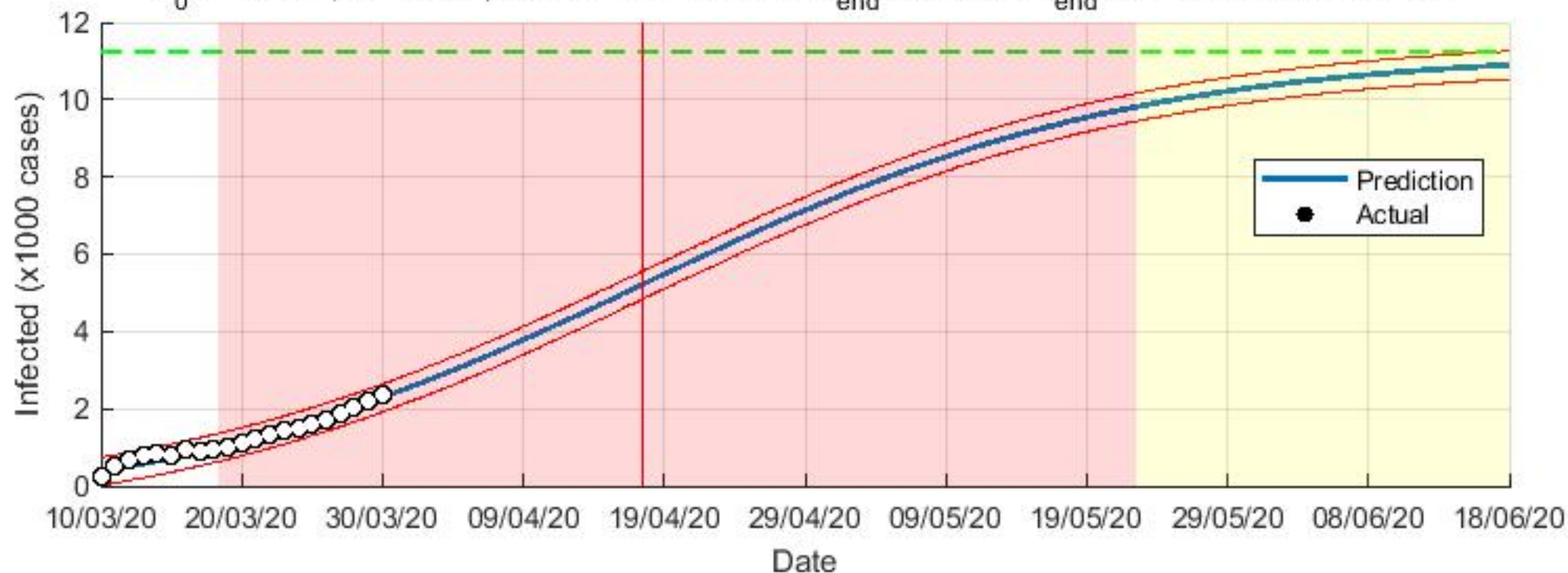
# Coronavirus epidemic in Czech<sub>R</sub>epublic (SIR model): 27-Mar-2020

$R_0 = 1.103$   $\beta = 2.558$   $\gamma = 2.32$   $N = 30989$   $C_{end} = 5602$   $S_{end} = 25387$   $RMSE = 27$



# Coronavirus epidemic in Denmark (SIR model): 30-Mar-2020

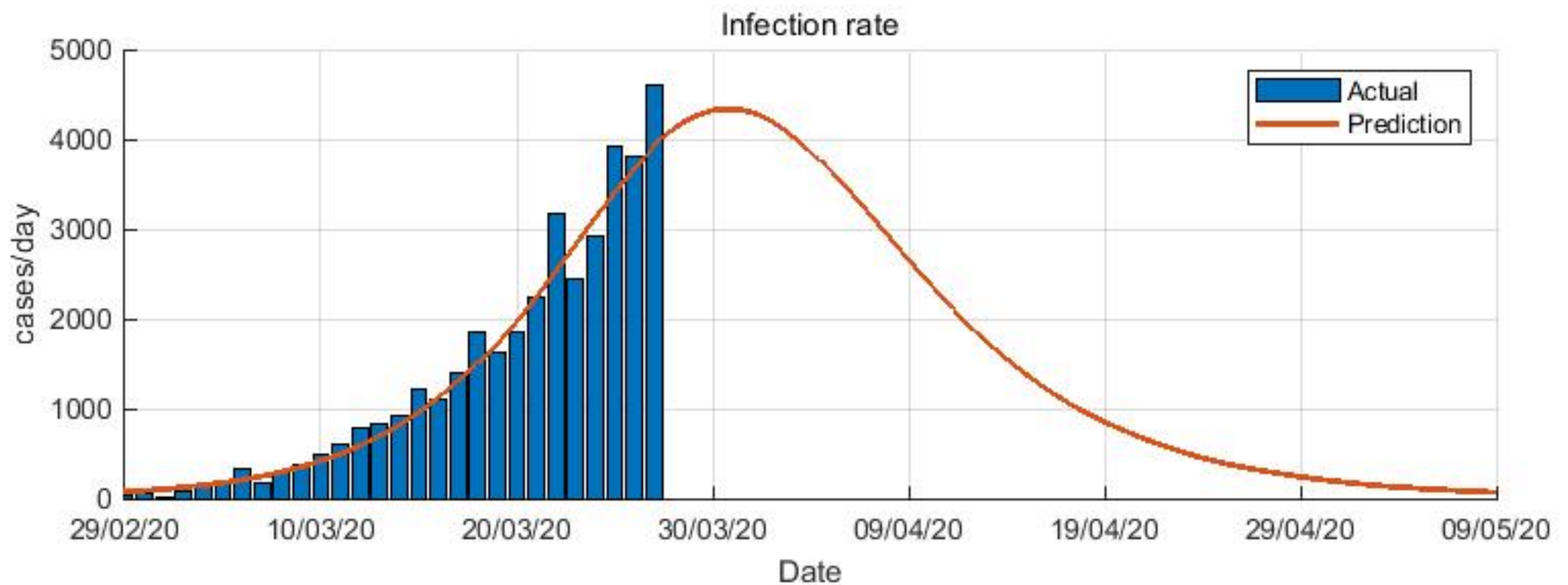
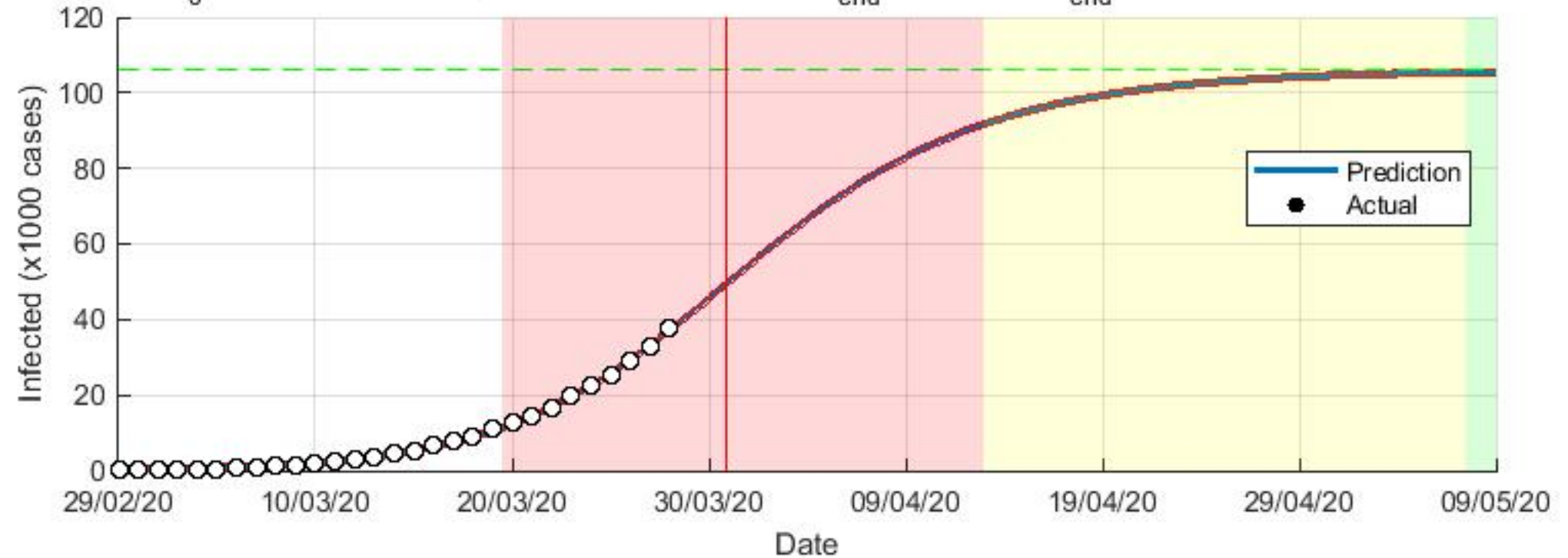
$R_0 = 1.017$   $\beta = 3.03$   $\gamma = 2.98$   $N = 317679$   $C_{end} = 11240$   $S_{end} = 306439$   $RMSE = 121$





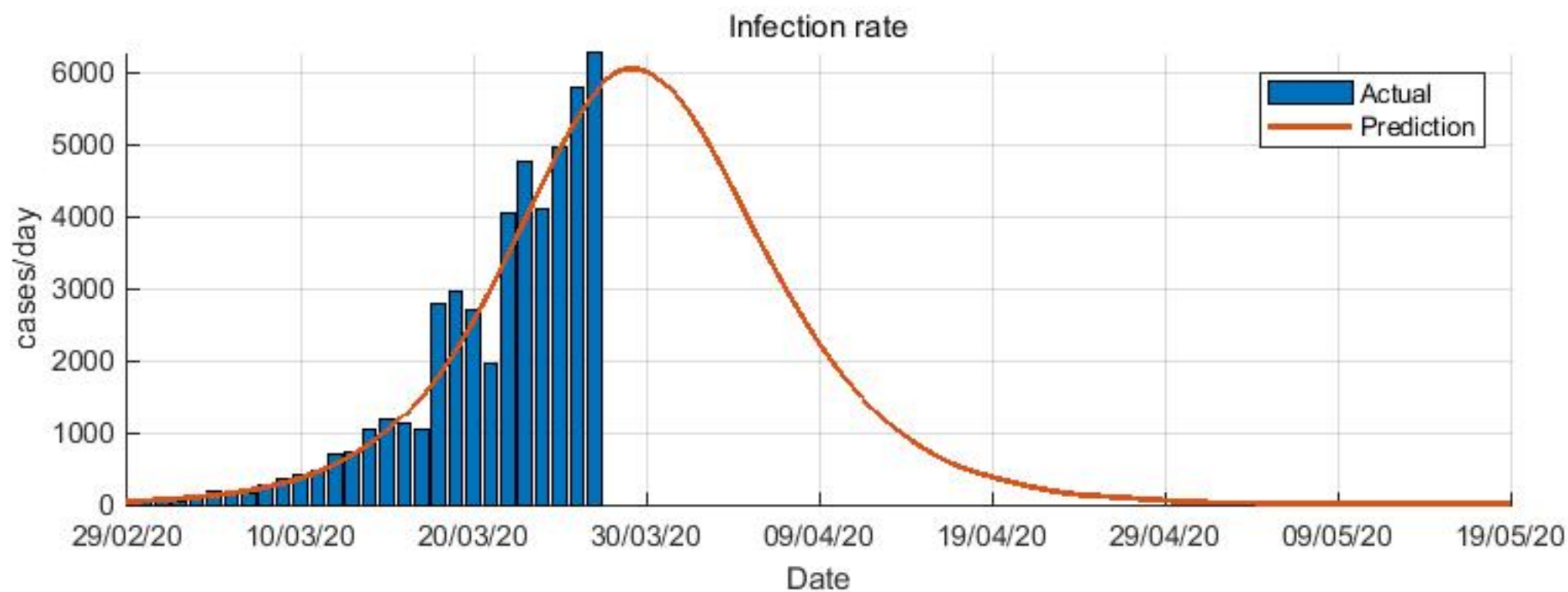
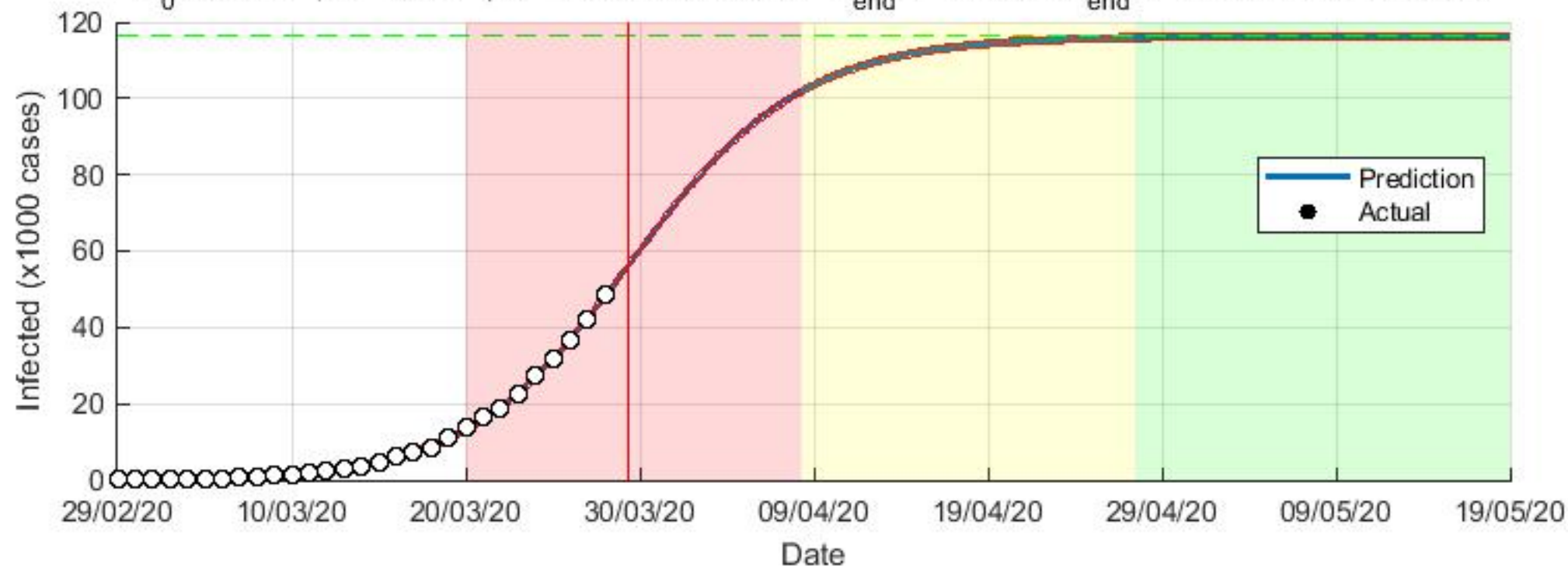
# Coronavirus epidemic in France (SIR model): 28-Mar-2020

$R_0 = 1.567$   $\beta = 0.5$   $\gamma = 0.319$   $N = 169665$   $C_{end} = 106057$   $S_{end} = 63608$   $RMSE = 279$



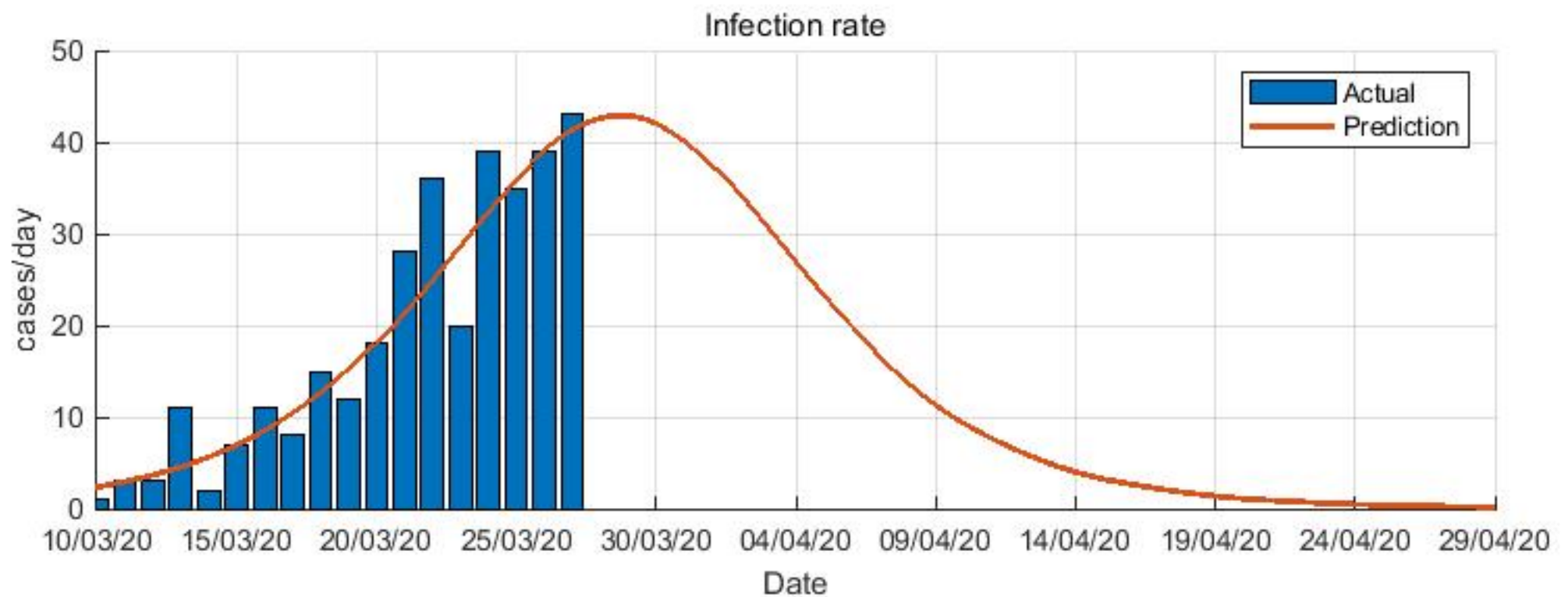
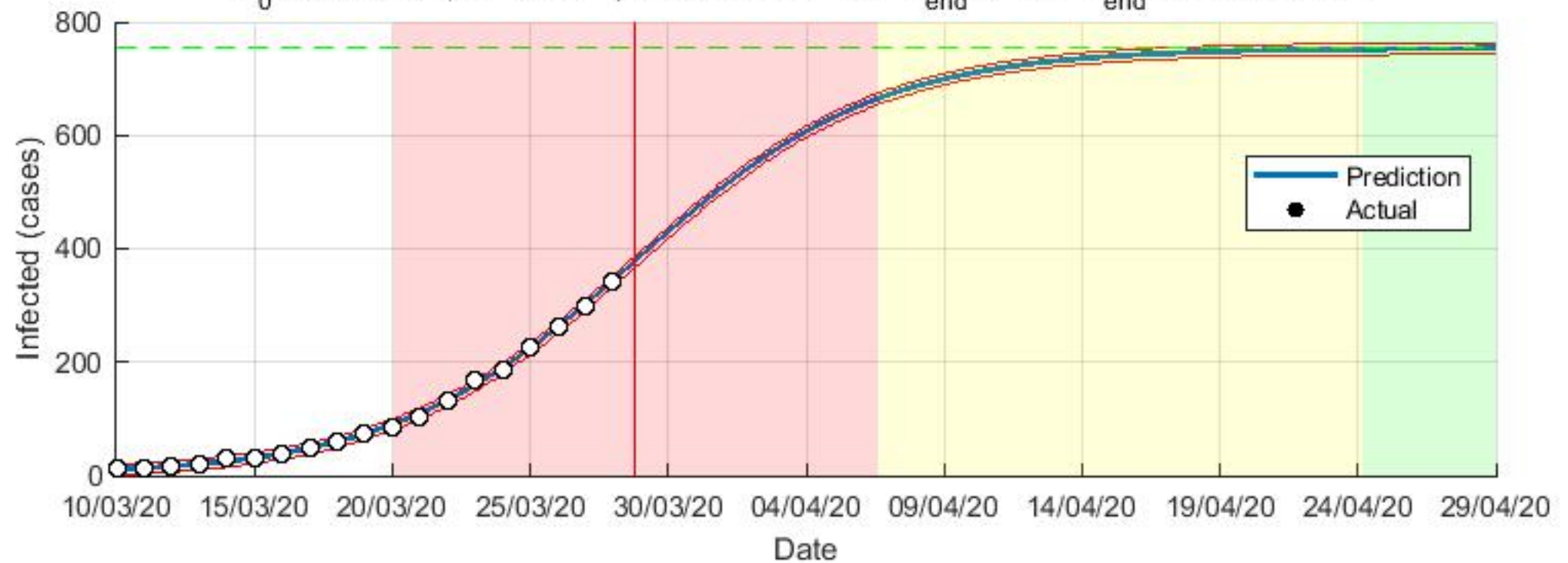
# Coronavirus epidemic in Germany (SIR model): 28-Mar-2020

$R_0 = 1.198$   $\beta = 1.325$   $\gamma = 1.106$   $N = 373371$   $C_{end} = 116326$   $S_{end} = 257045$   $RMSE = 299$



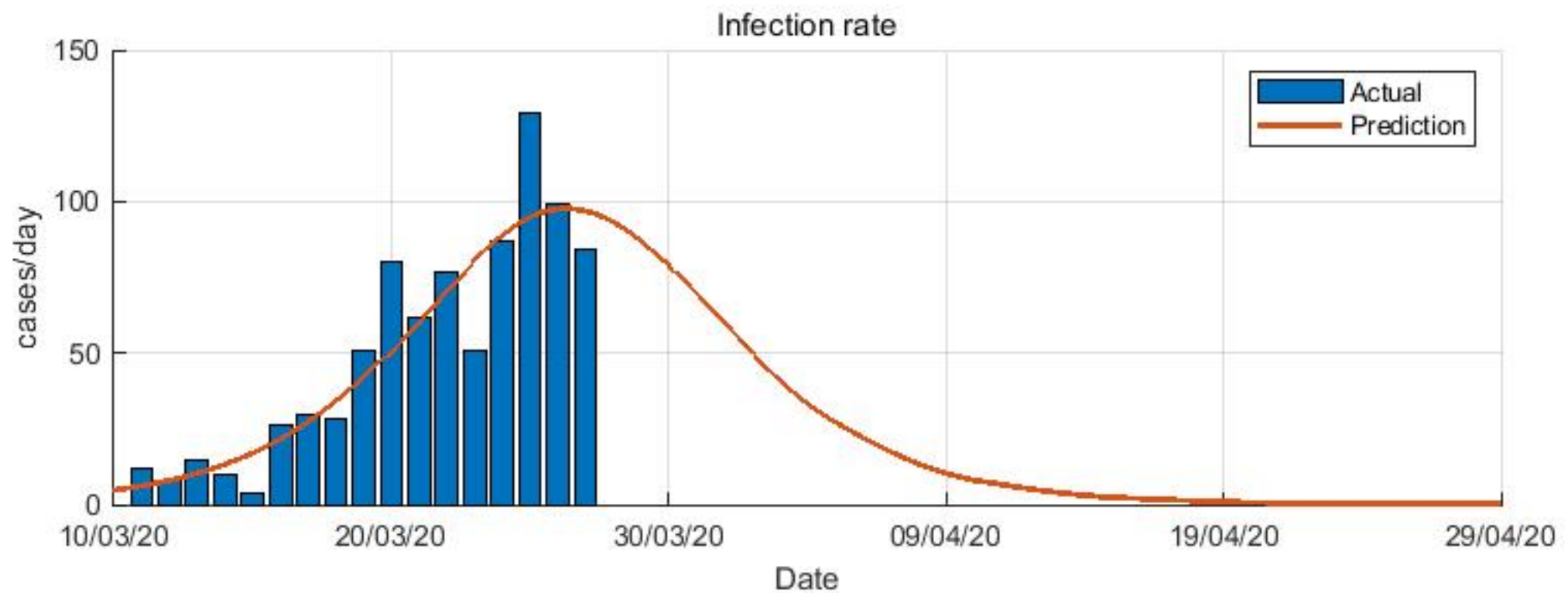
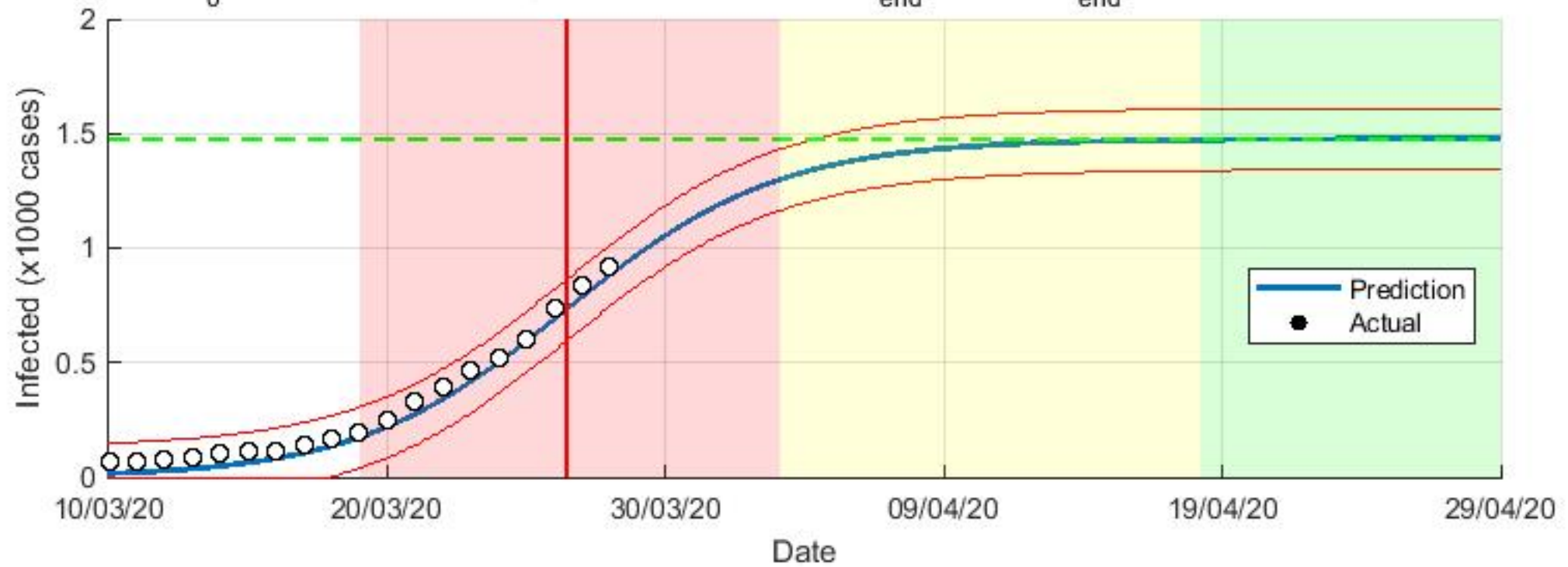
# Coronavirus epidemic in Hungary (SIR model): 28-Mar-2020

$R_0 = 170.772$   $\beta = 0.229$   $\gamma = 0.001$   $N = 754$   $C_{end} = 754$   $S_{end} = 0$   $RMSE = 3$



# Coronavirus epidemic in India (SIR model): 28-Mar-2020

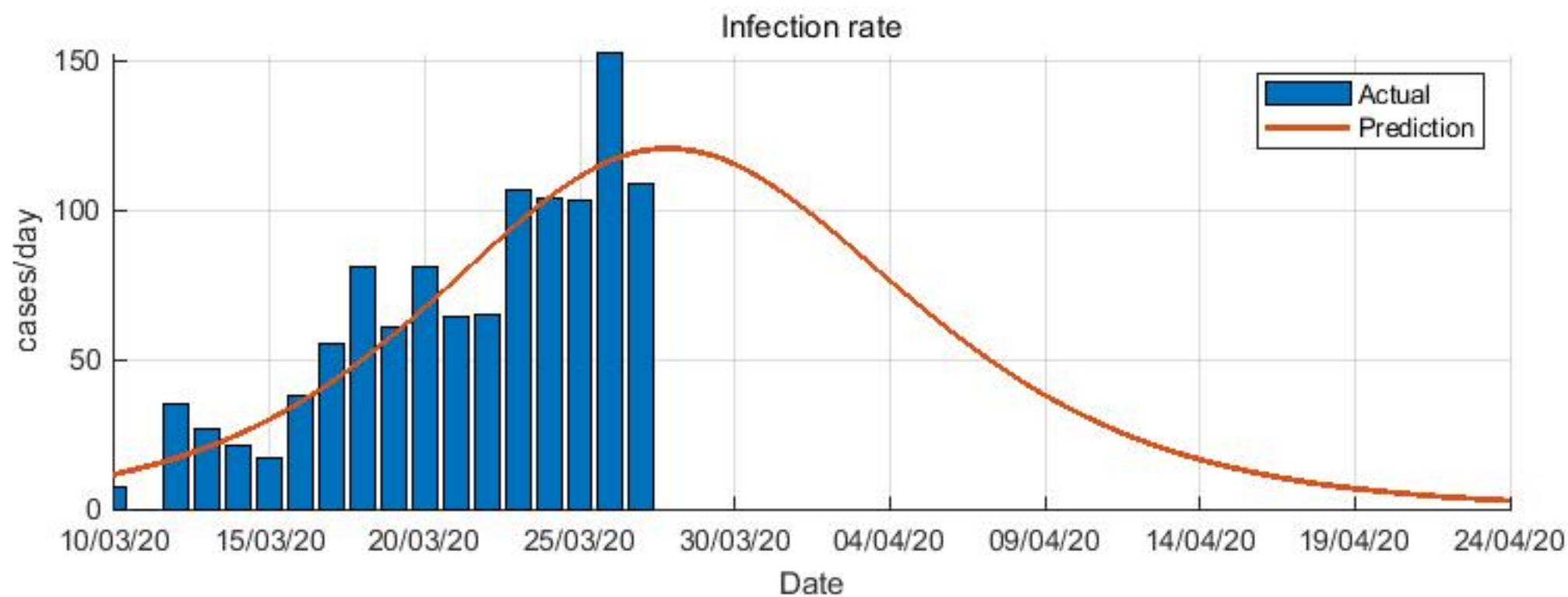
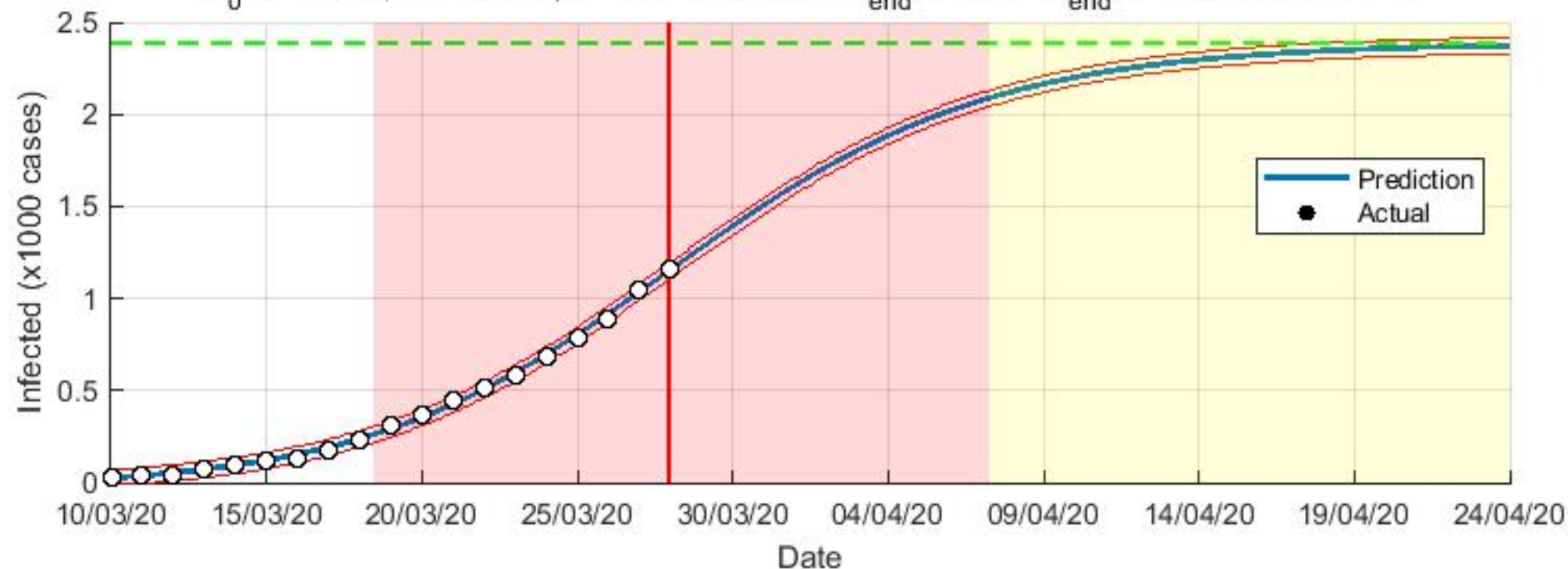
$R_0 = 1.079$   $\beta = 3.686$   $\gamma = 3.416$   $N = 10323$   $C_{\text{end}} = 1476$   $S_{\text{end}} = 8847$   $\text{RMSE} = 45$





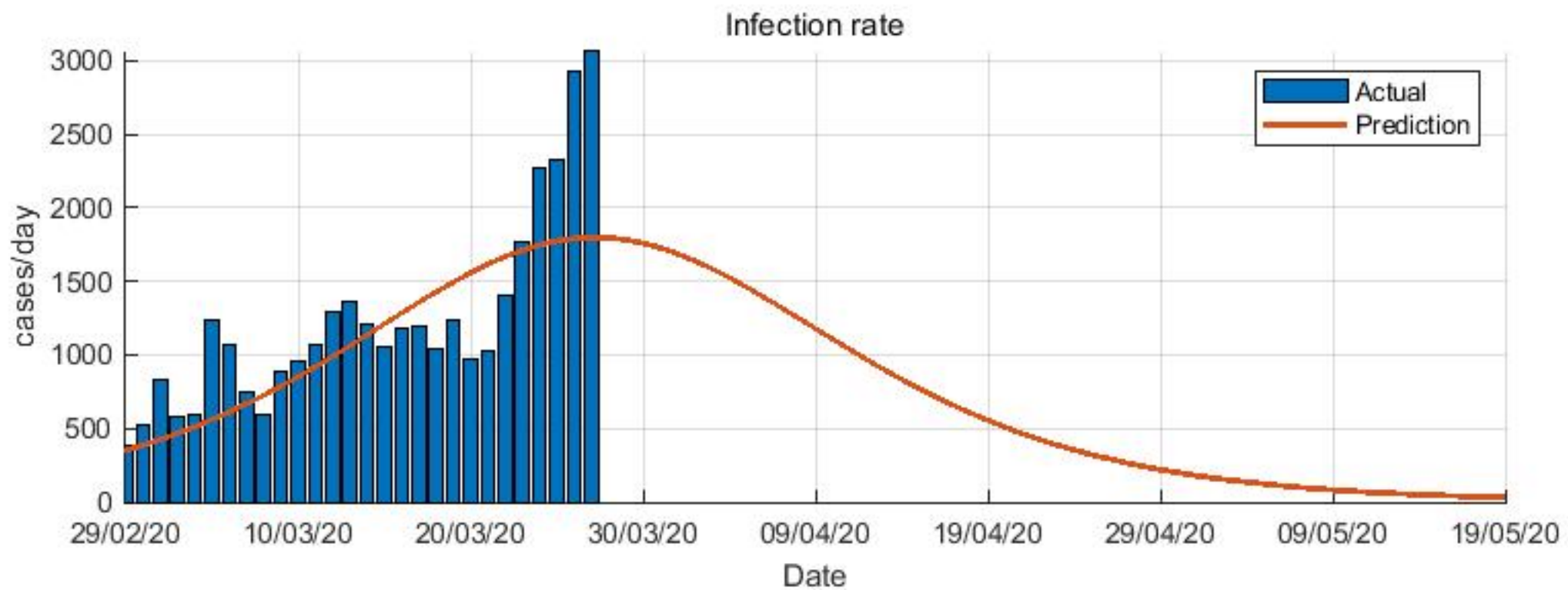
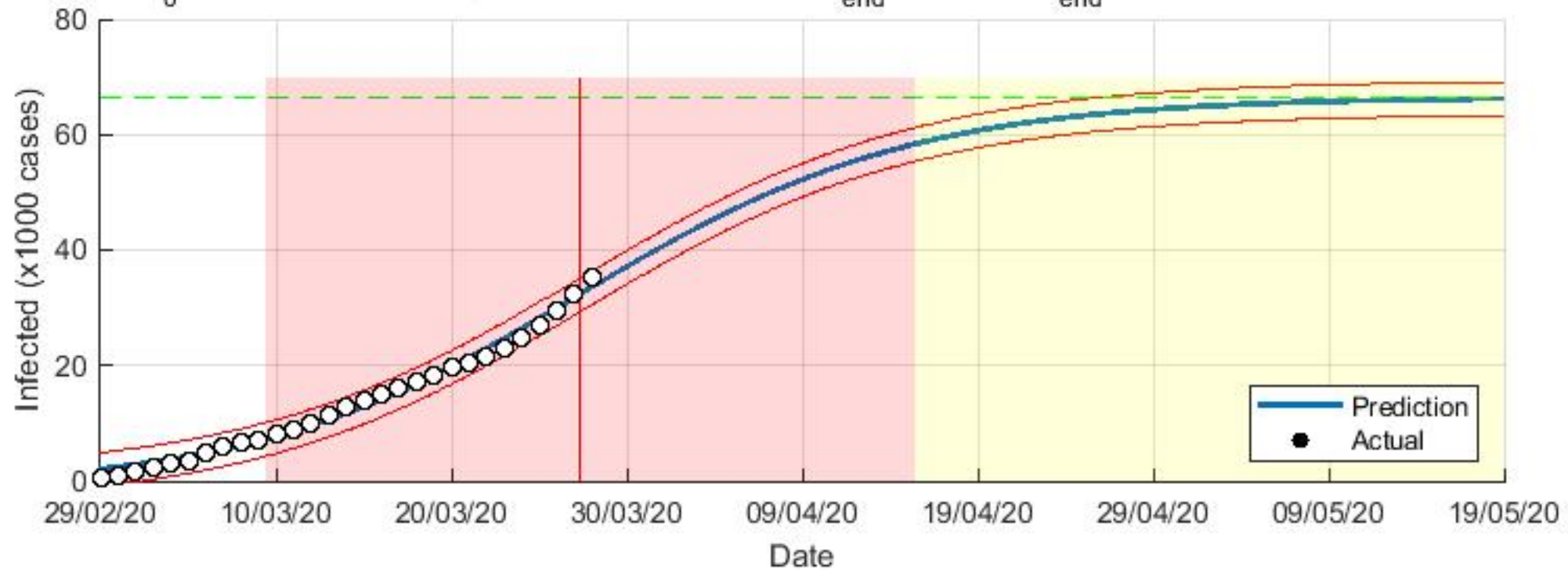
# Coronavirus epidemic in Indonesia (SIR model): 28-Mar-2020

$R_0 = 1.176$   $\beta = 1.365$   $\gamma = 1.16$   $N = 8316$   $C_{\text{end}} = 2387$   $S_{\text{end}} = 5929$   $\text{RMSE} = 15$



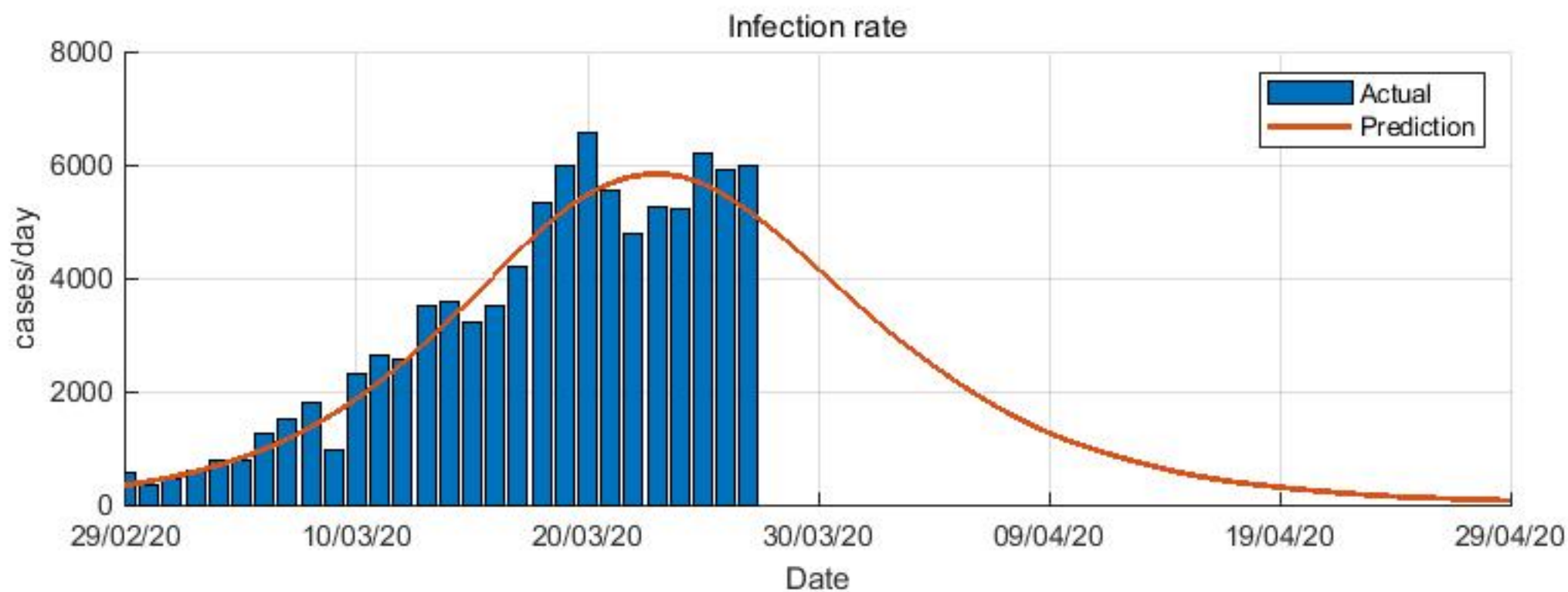
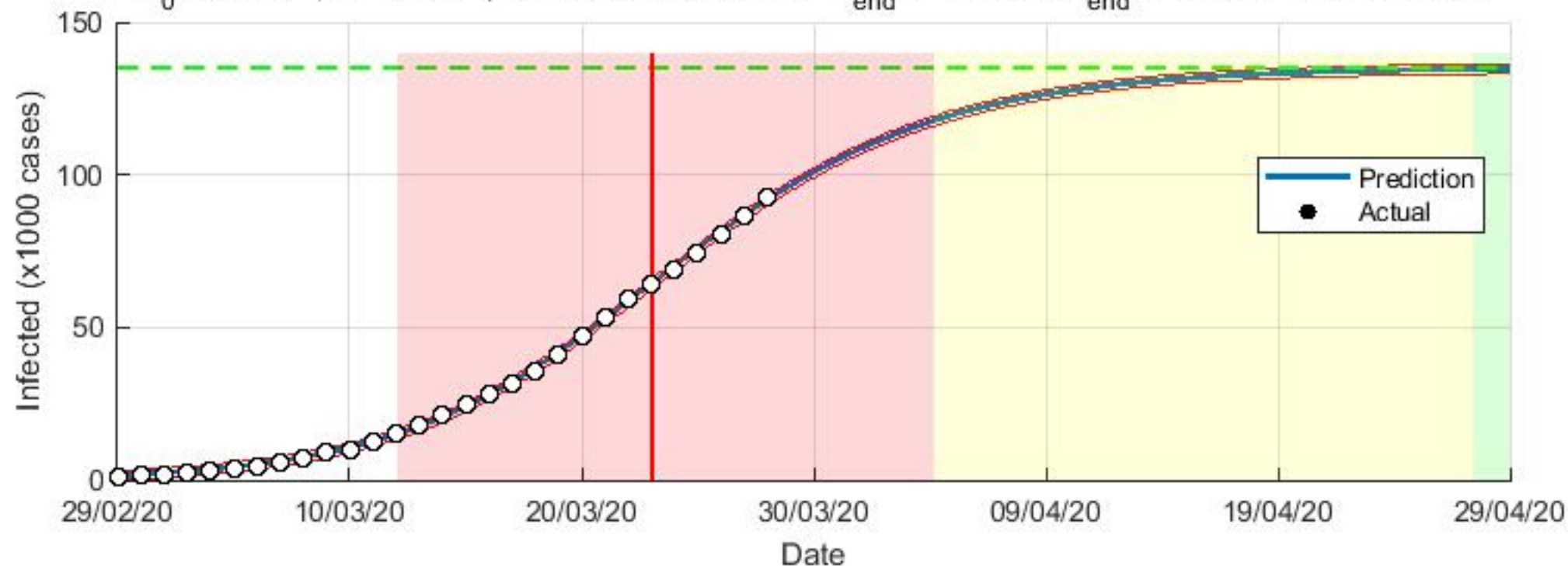
# Coronavirus epidemic in Iran (SIR model): 28-Mar-2020

$R_0 = 1.062$   $\beta = 1.76$   $\gamma = 1.656$   $N = 564678$   $C_{end} = 66499$   $S_{end} = 498180$   $RMSE = 970$



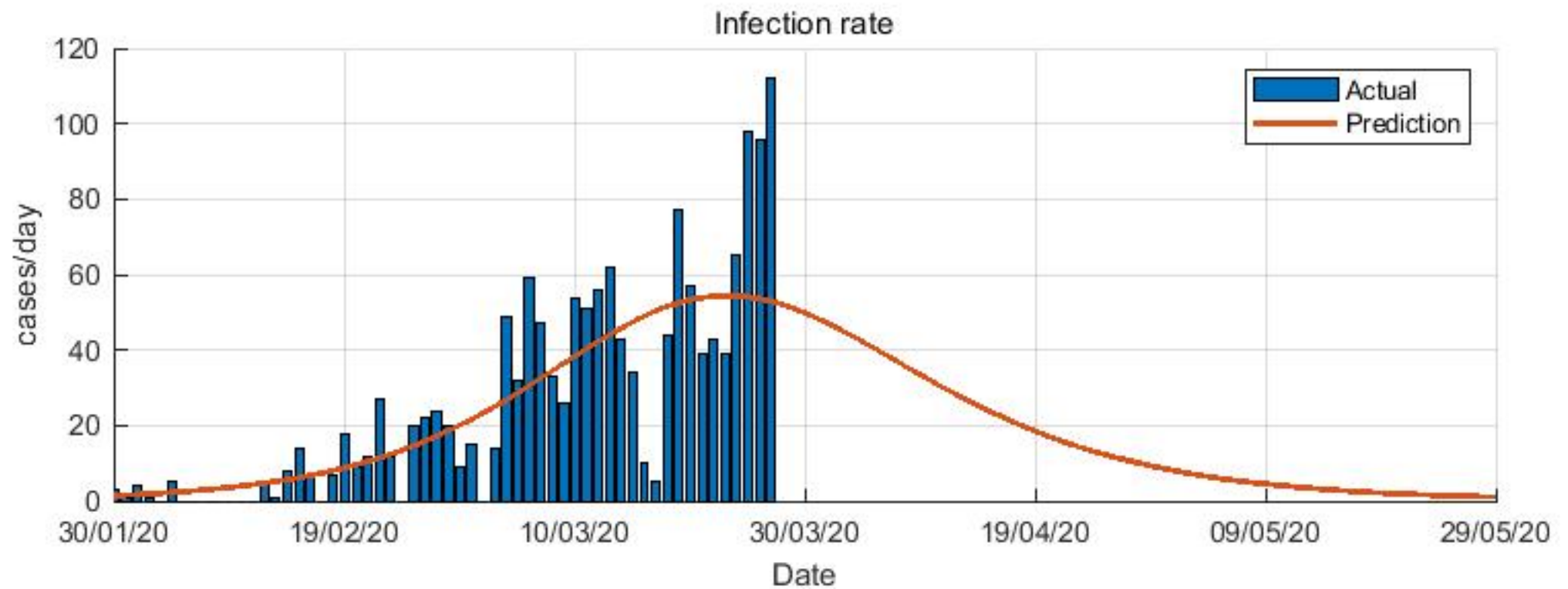
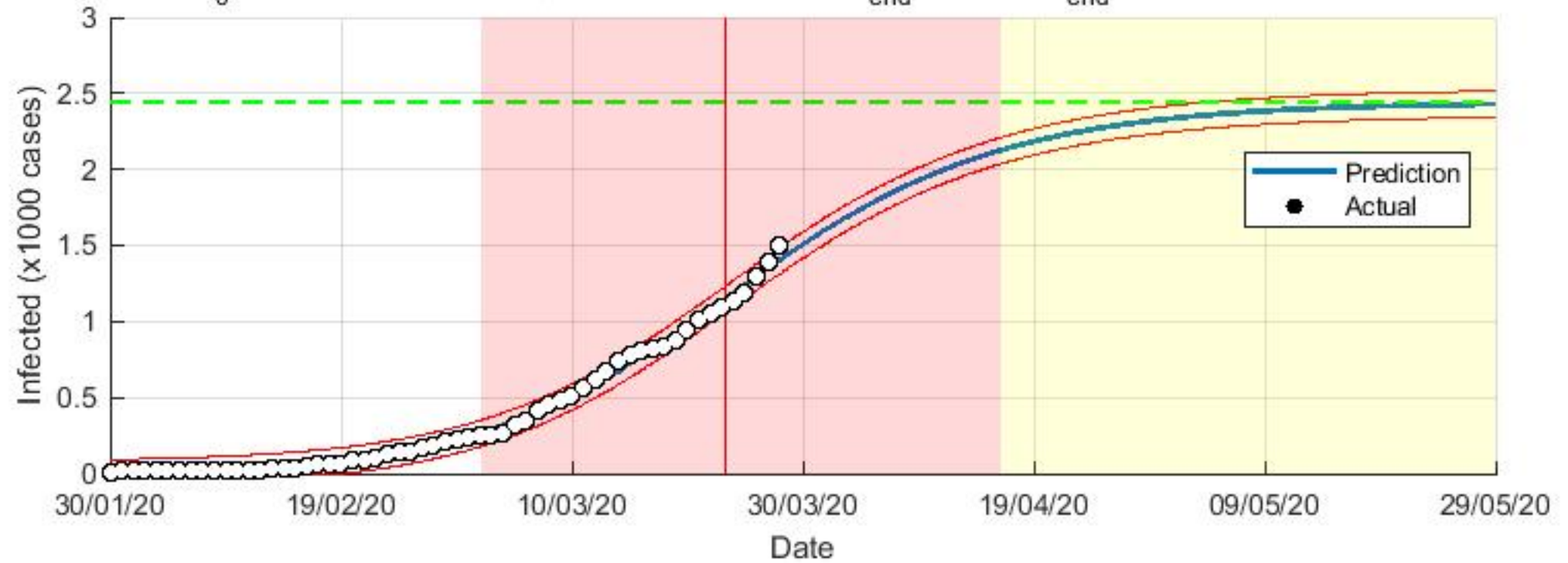
# Coronavirus epidemic in Italy (SIR model): 28-Mar-2020

$R_0 = 1.347$   $\beta = 0.722$   $\gamma = 0.536$   $N = 289046$   $C_{\text{end}} = 135149$   $S_{\text{end}} = 153897$   $\text{RMSE} = 532$



# Coronavirus epidemic in Japan (SIR model): 28-Mar-2020

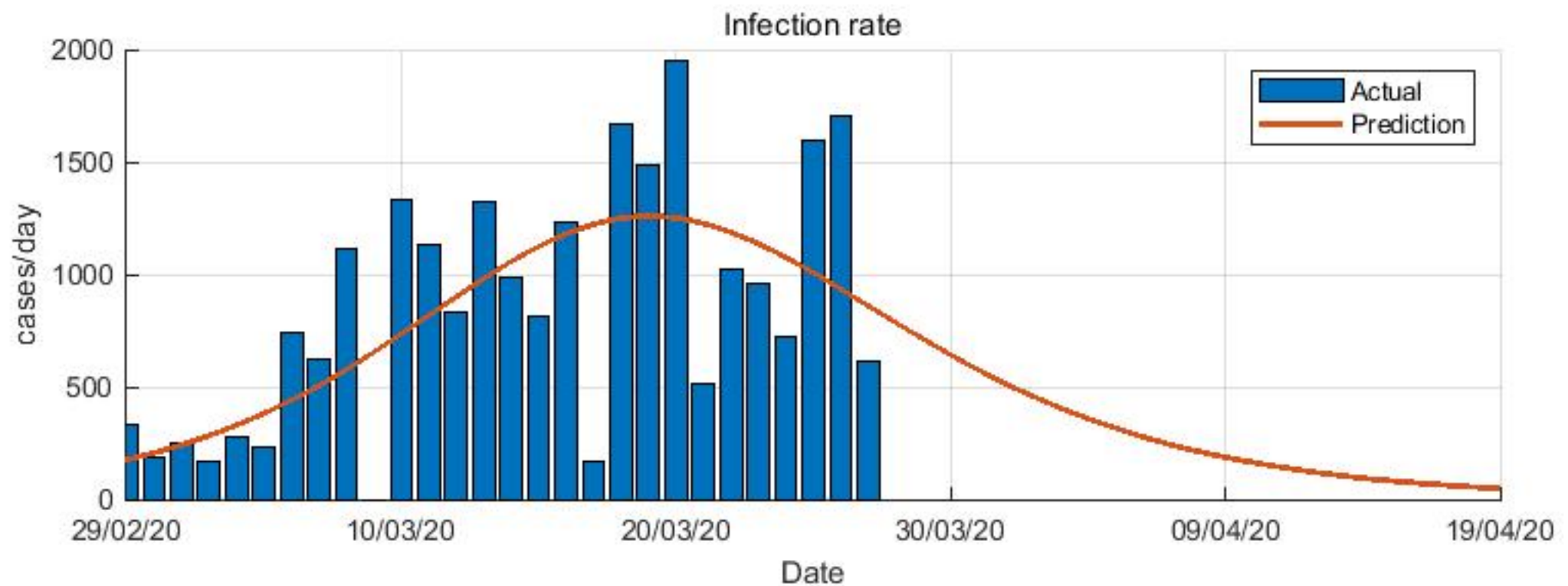
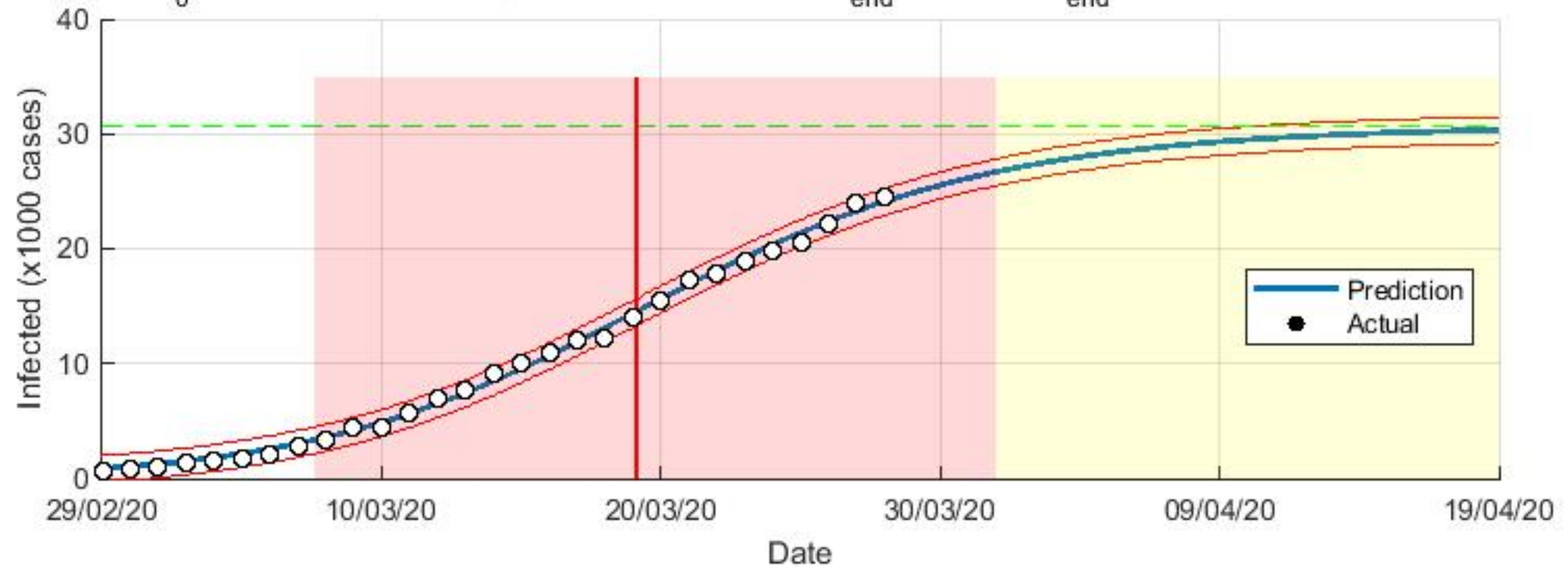
$R_0 = 1.372$   $\beta = 0.353$   $\gamma = 0.257$   $N = 4978$   $C_{end} = 2441$   $S_{end} = 2537$   $RMSE = 29$





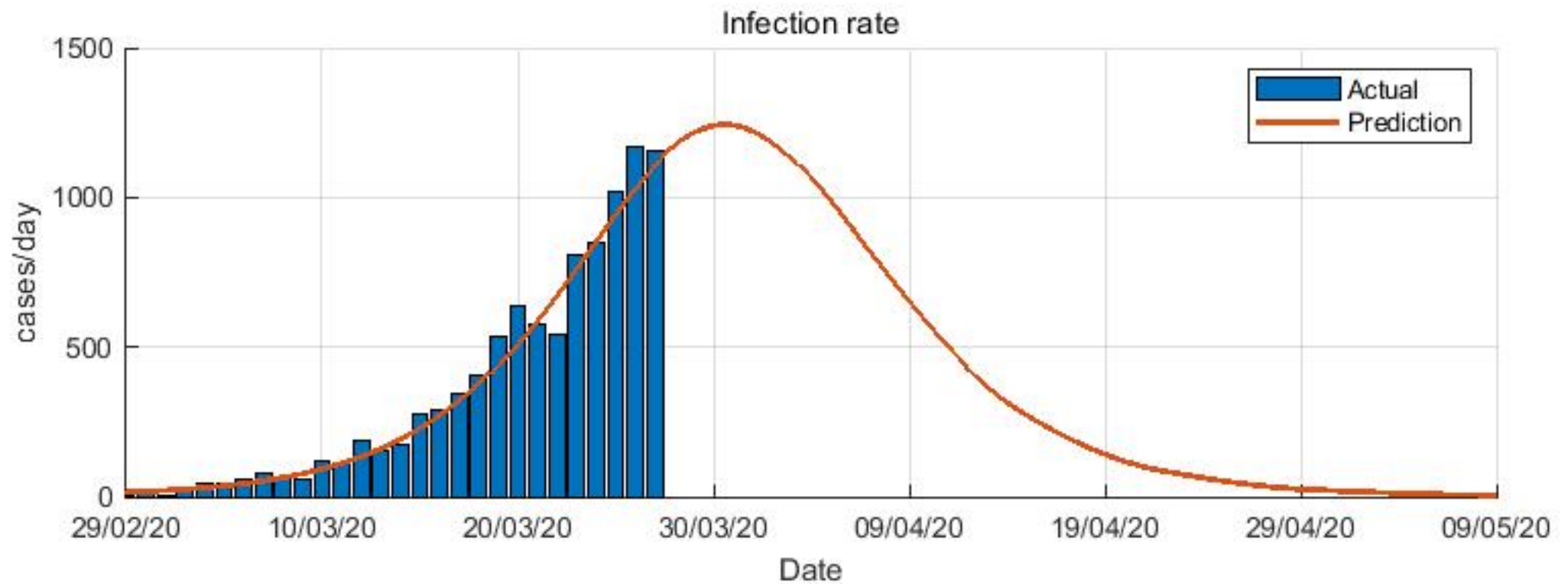
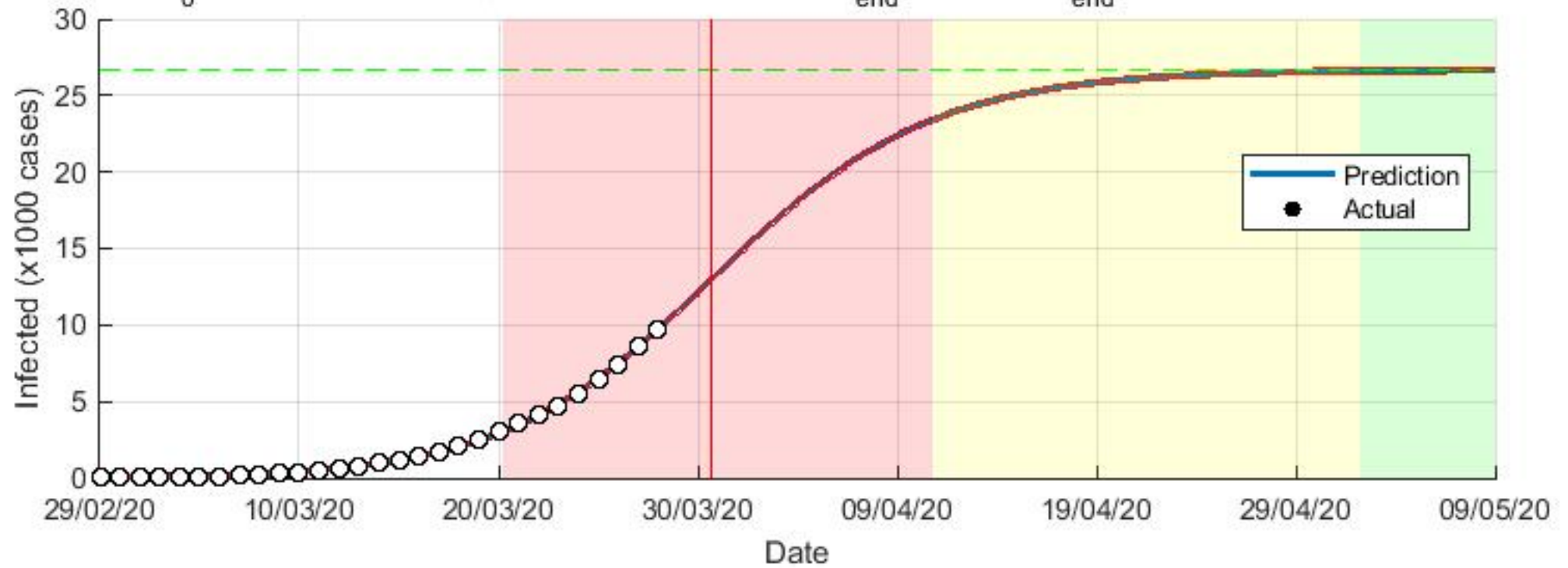
# Coronavirus epidemic in Lombardia (SIR model): 28-Mar-2020

$R_0 = 1.341$   $\beta = 0.685$   $\gamma = 0.511$   $N = 66014$   $C_{\text{end}} = 30644$   $S_{\text{end}} = 35371$   $\text{RMSE} = 389$



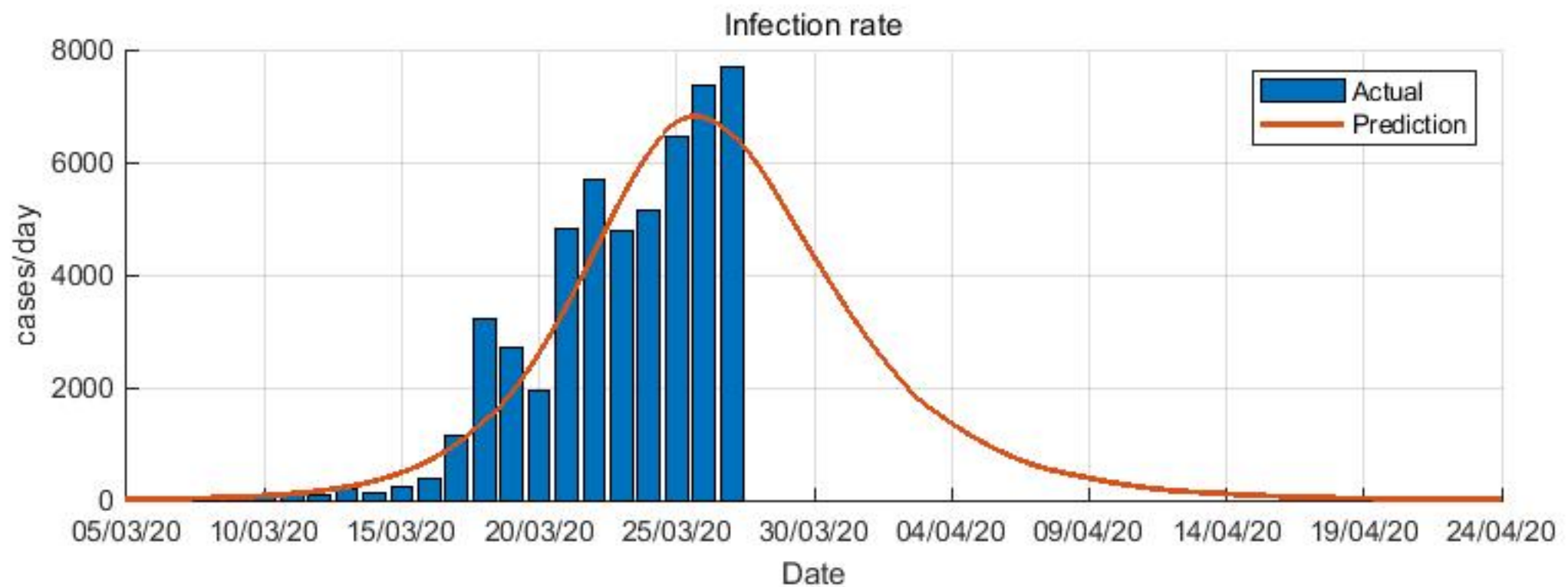
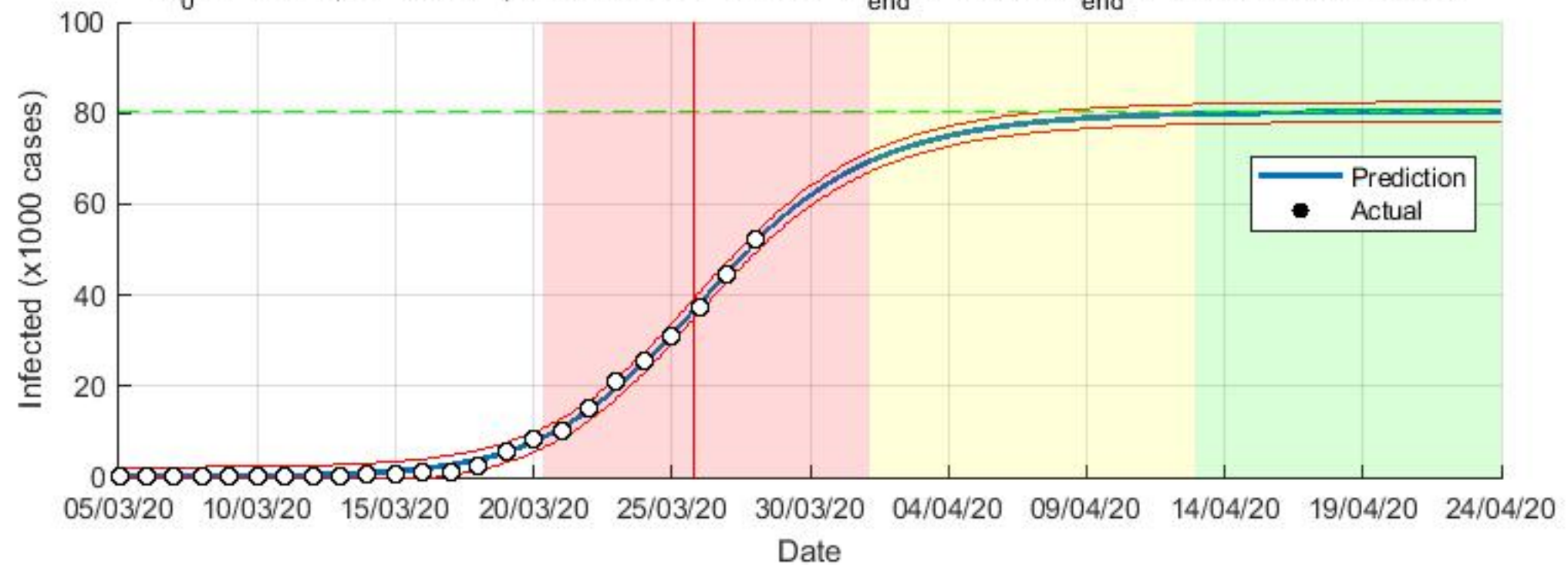
# Coronavirus epidemic in Netherlands (SIR model): 28-Mar-2020

$R_0 = 1.158$   $\beta = 1.42$   $\gamma = 1.226$   $N = 102555$   $C_{end} = 26690$   $S_{end} = 75865$   $RMSE = 60$



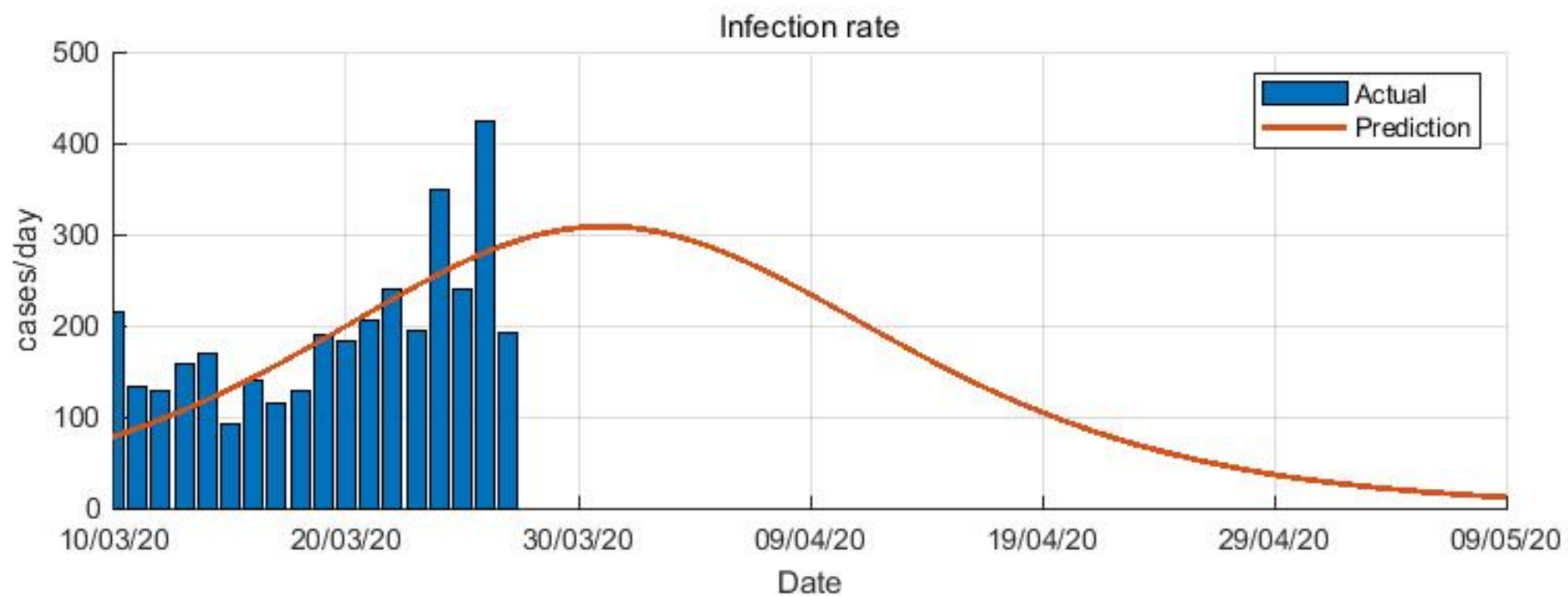
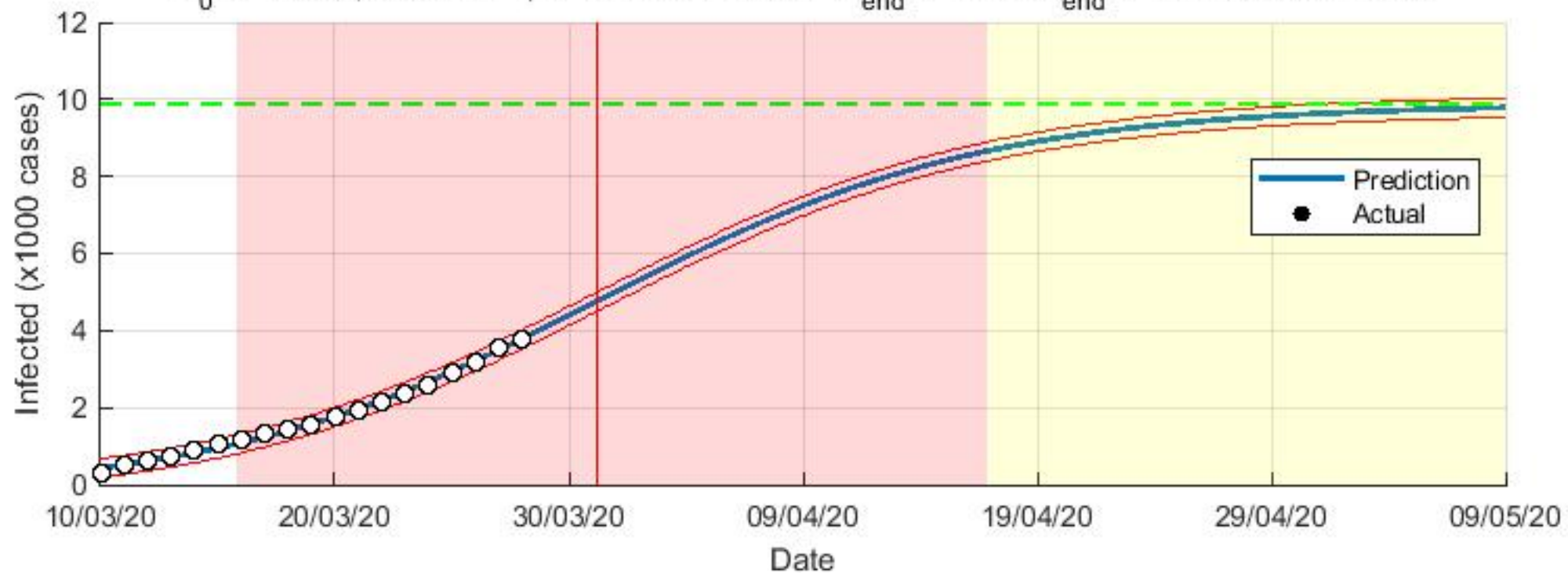
# Coronavirus epidemic in New York State (SIR model): 28-Mar-2020

$R_0 = 1.699$   $\beta = 0.926$   $\gamma = 0.545$   $N = 116210$   $C_{end} = 80275$   $S_{end} = 35935$   $RMSE = 727$



# Coronavirus epidemic in Norway (SIR model): 28-Mar-2020

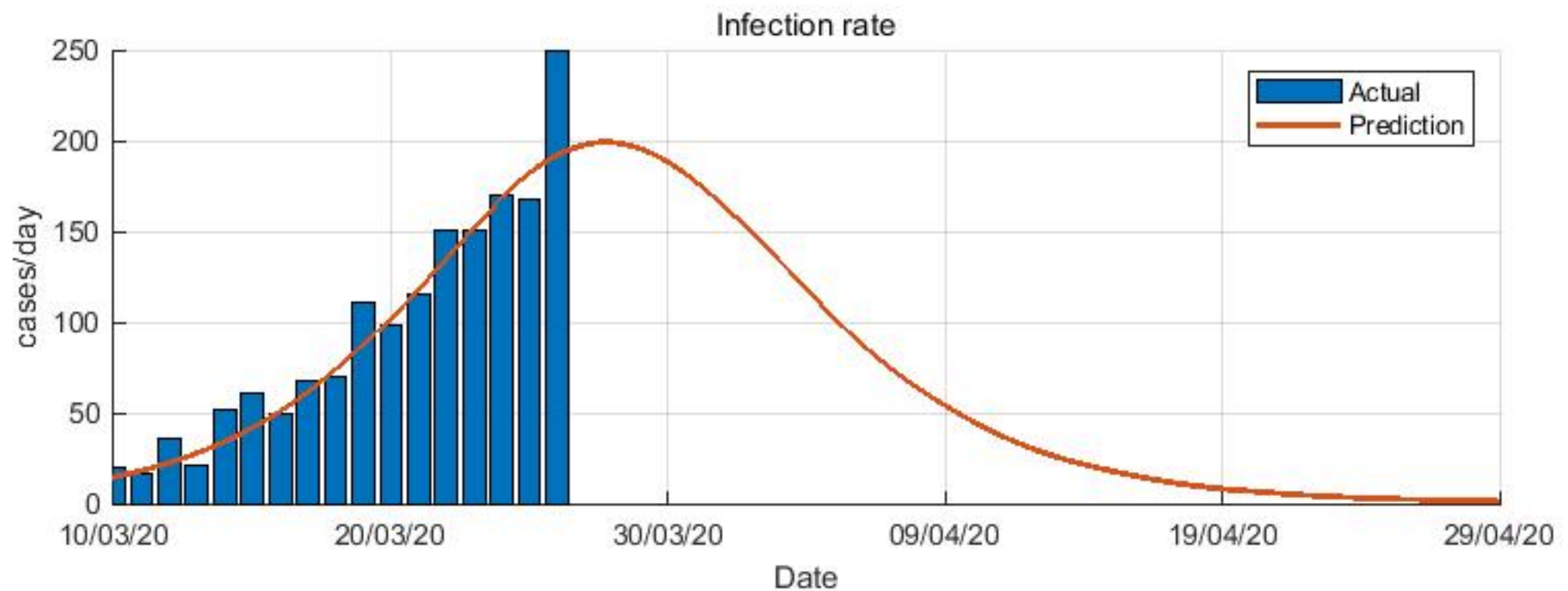
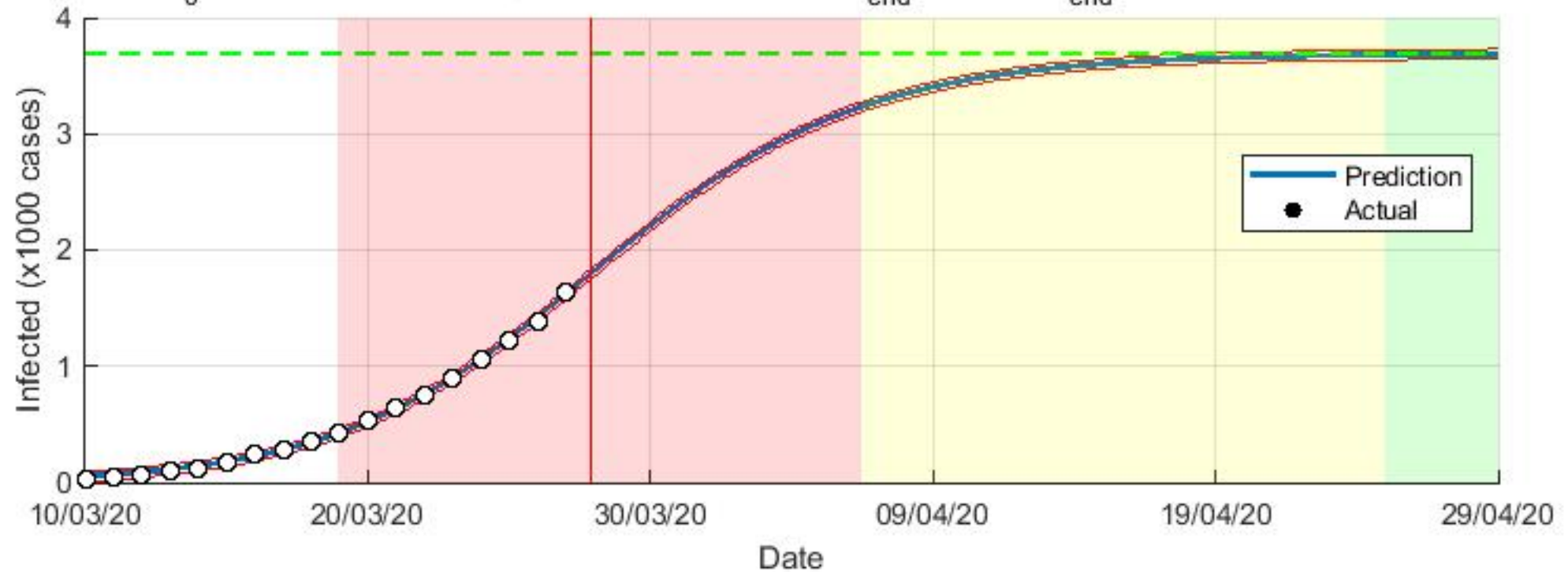
$R_0 = 1.083$   $\beta = 1.559$   $\gamma = 1.44$   $N = 64734$   $C_{end} = 9876$   $S_{end} = 54858$   $RMSE = 83$





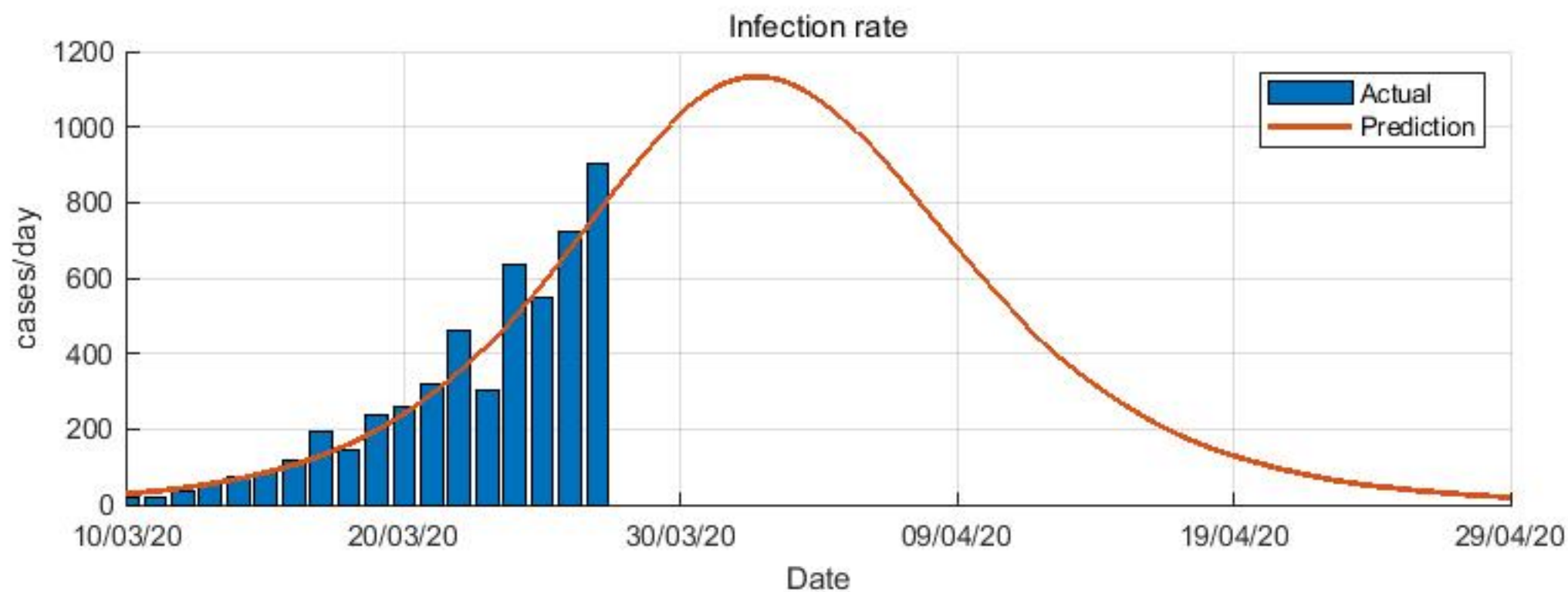
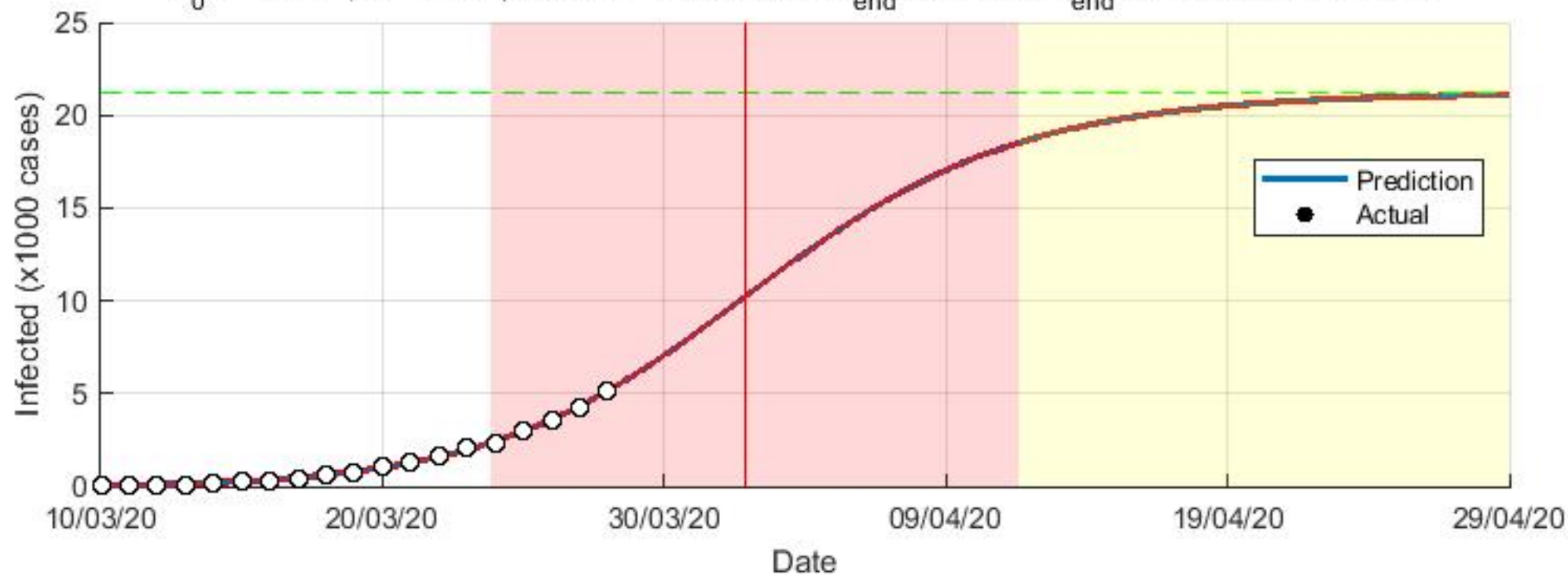
# Coronavirus epidemic in Poland (SIR model): 27-Mar-2020

$R_0 = 1.189$   $\beta = 1.414$   $\gamma = 1.189$   $N = 12274$   $C_{\text{end}} = 3692$   $S_{\text{end}} = 8582$   $\text{RMSE} = 14$



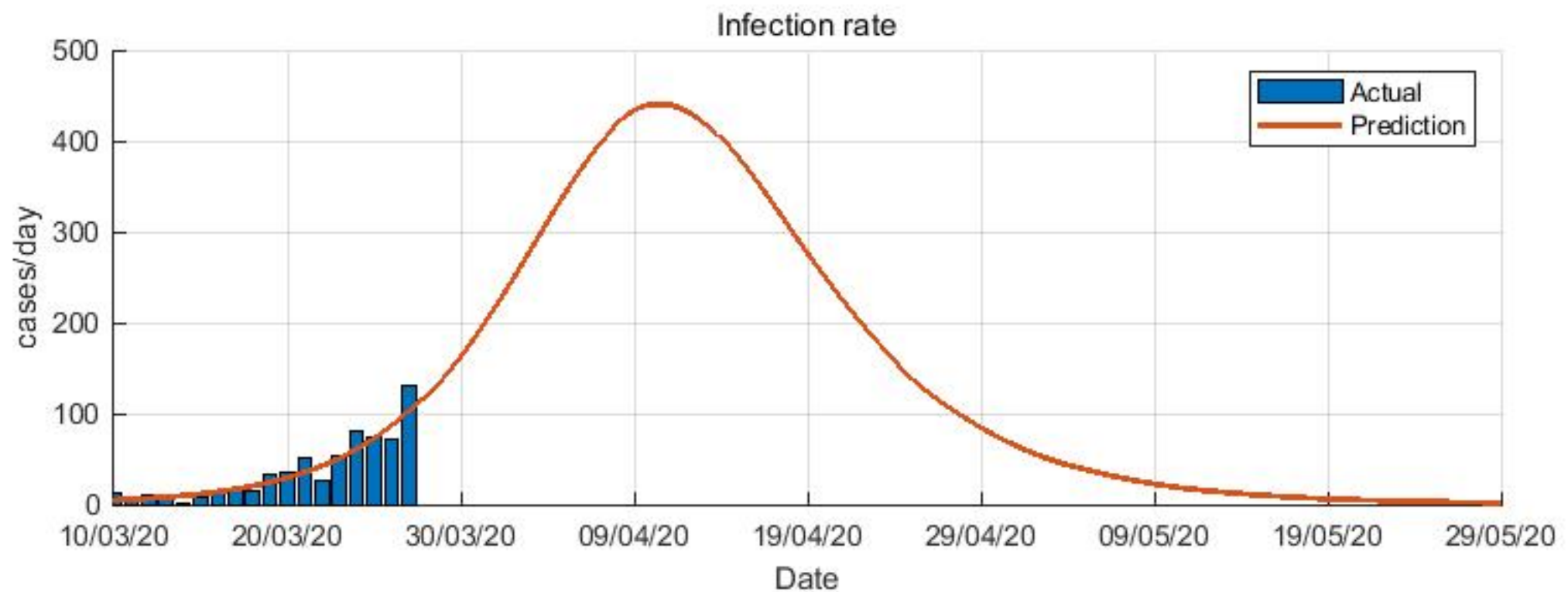
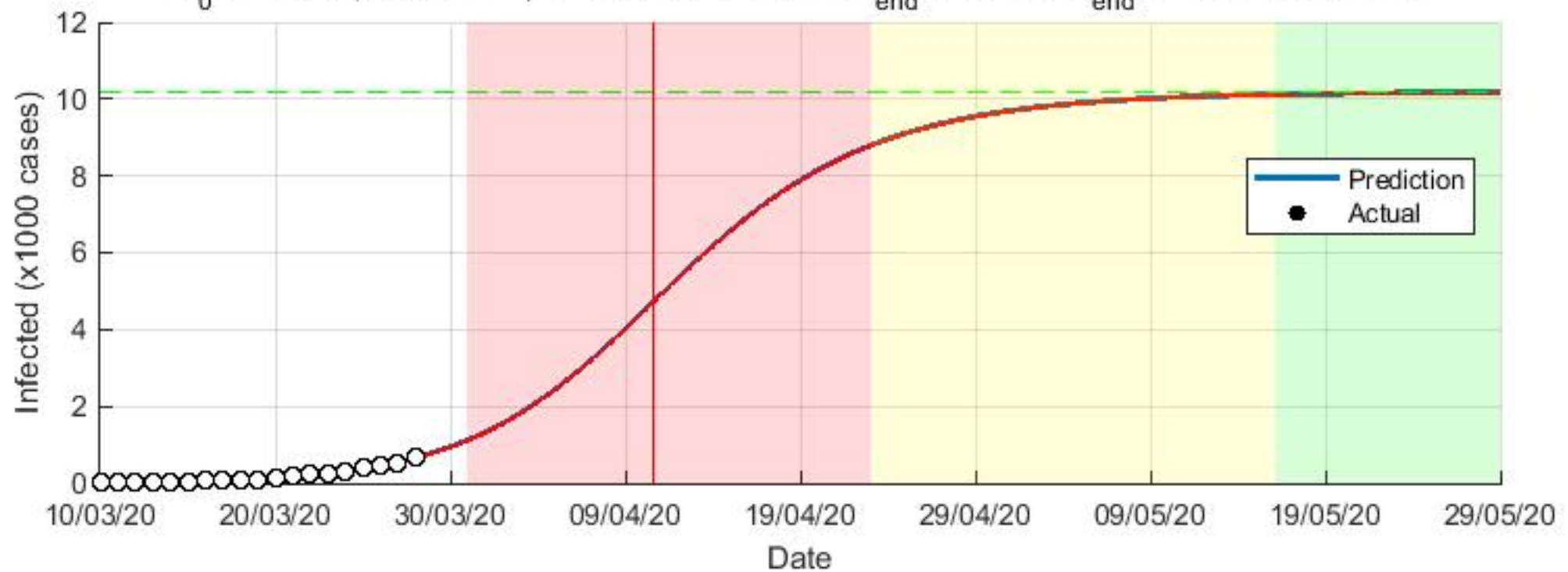
# Coronavirus epidemic in Portugal (SIR model): 28-Mar-2020

$R_0 = 1.226$   $\beta = 1.21$   $\gamma = 0.986$   $N = 61107$   $C_{\text{end}} = 21193$   $S_{\text{end}} = 39913$   $\text{RMSE} = 41$



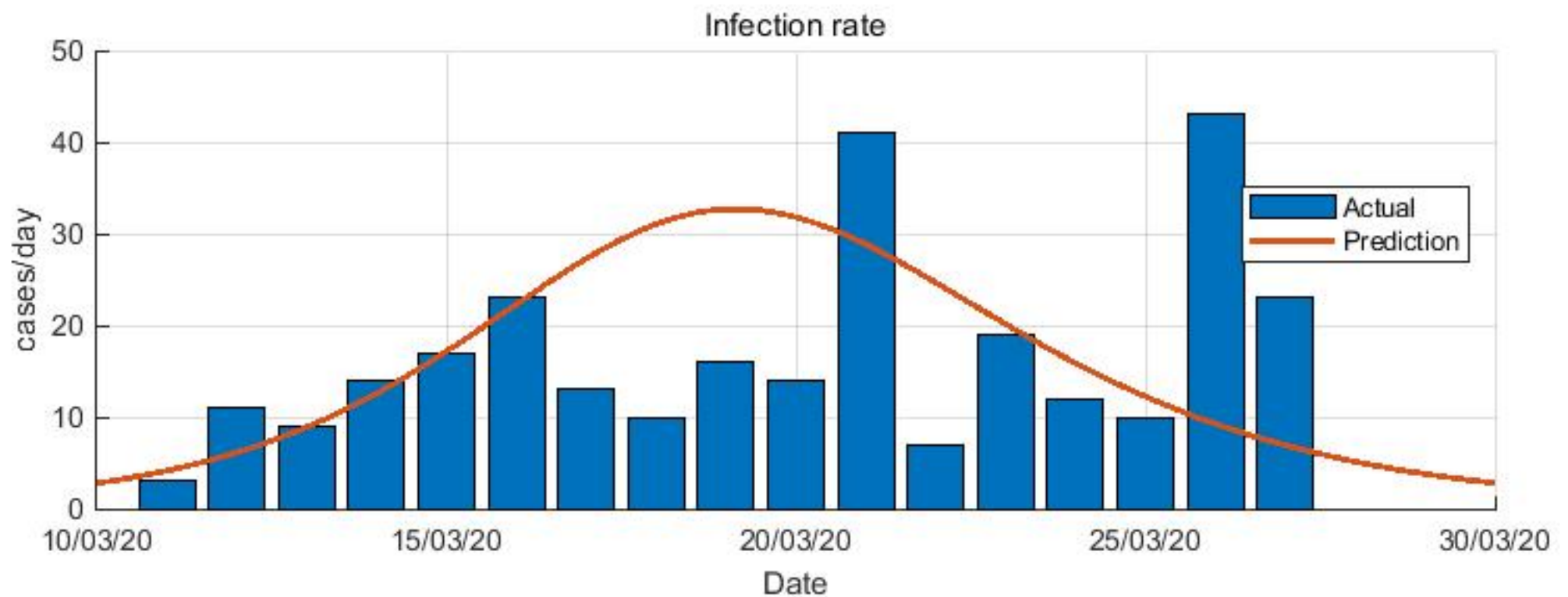
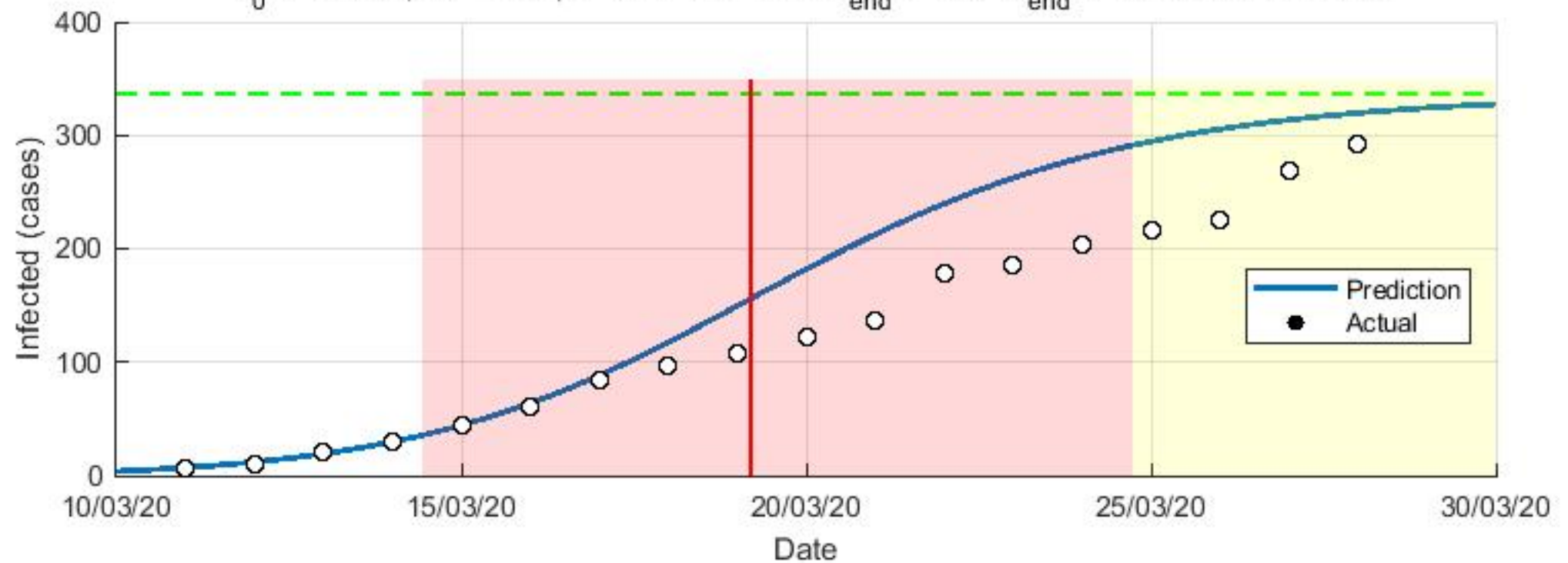
# Coronavirus epidemic in Serbia (SIR model): 28-Mar-2020

$R_0 = 1.639$   $\beta = 0.495$   $\gamma = 0.302$   $N = 15356$   $C_{end} = 10179$   $S_{end} = 5177$   $RMSE = 8$



# Coronavirus epidemic in Slovakia (SIR model): 28-Mar-2020

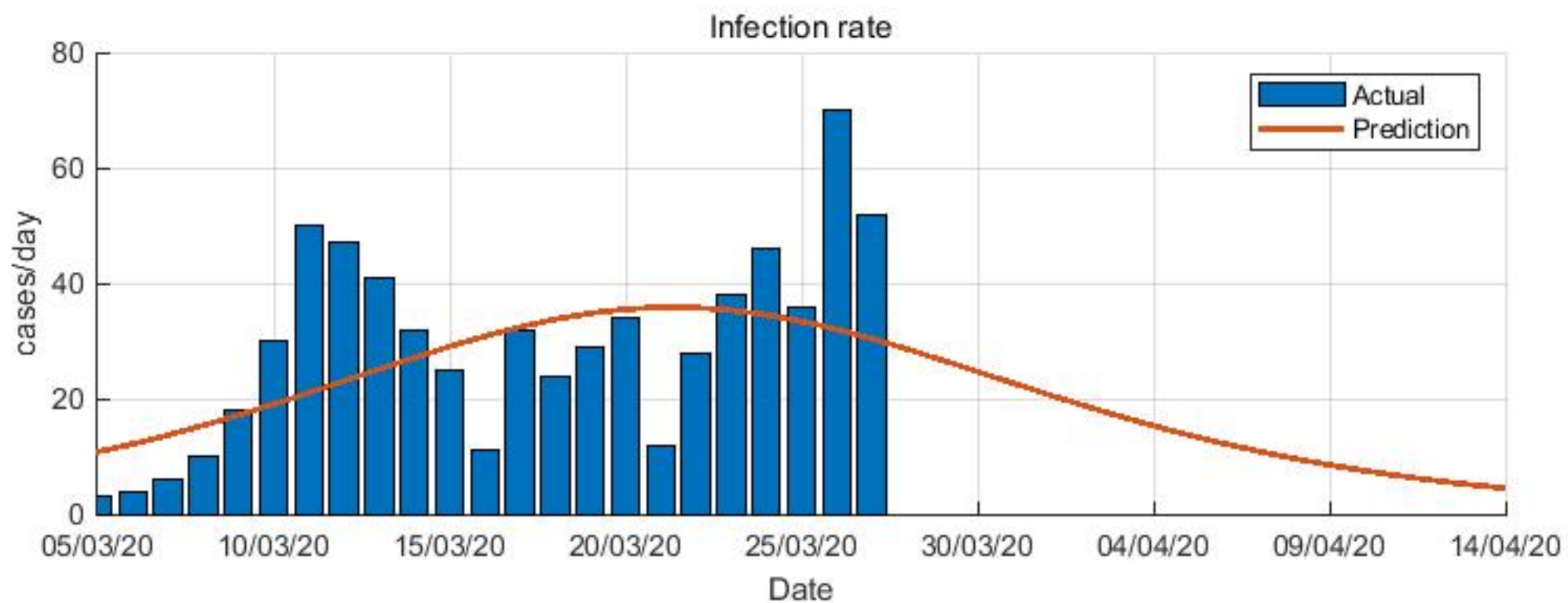
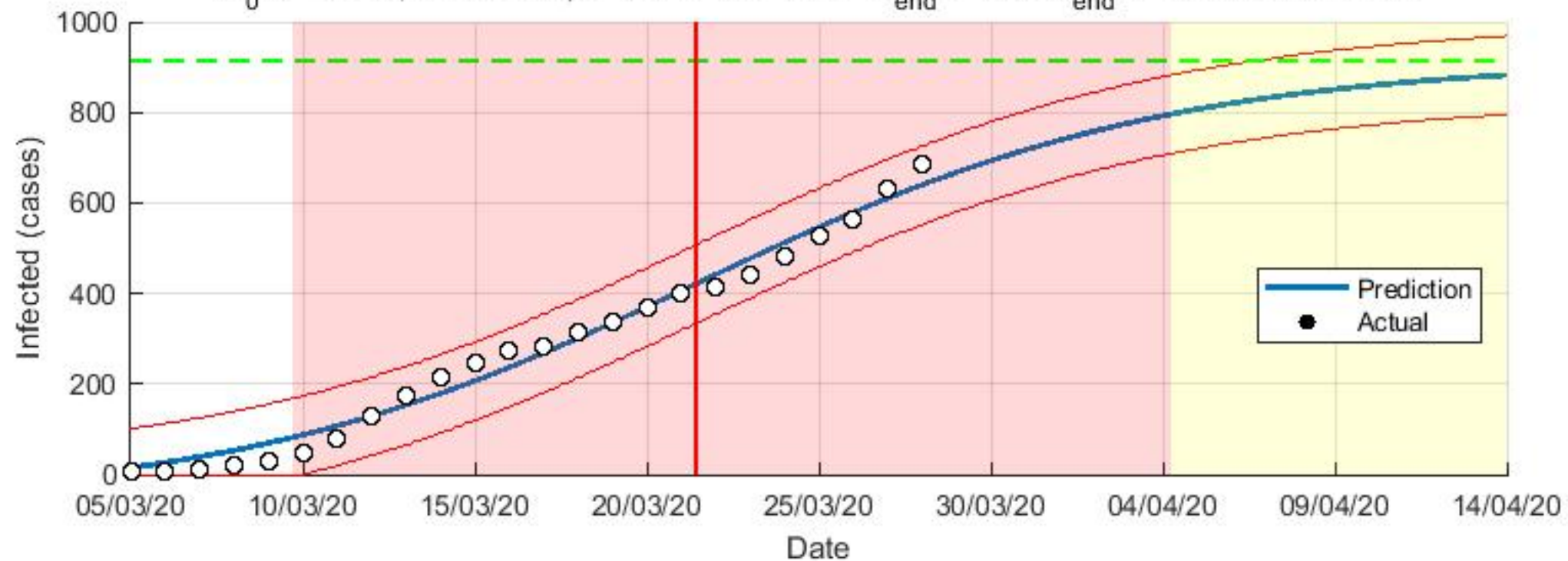
$R_0 = 1.496$   $\beta = 1.26$   $\gamma = 0.84$   $N = 575$   $C_{\text{end}} = 337$   $S_{\text{end}} = 238$   $\text{RMSE} = \text{NaN}$





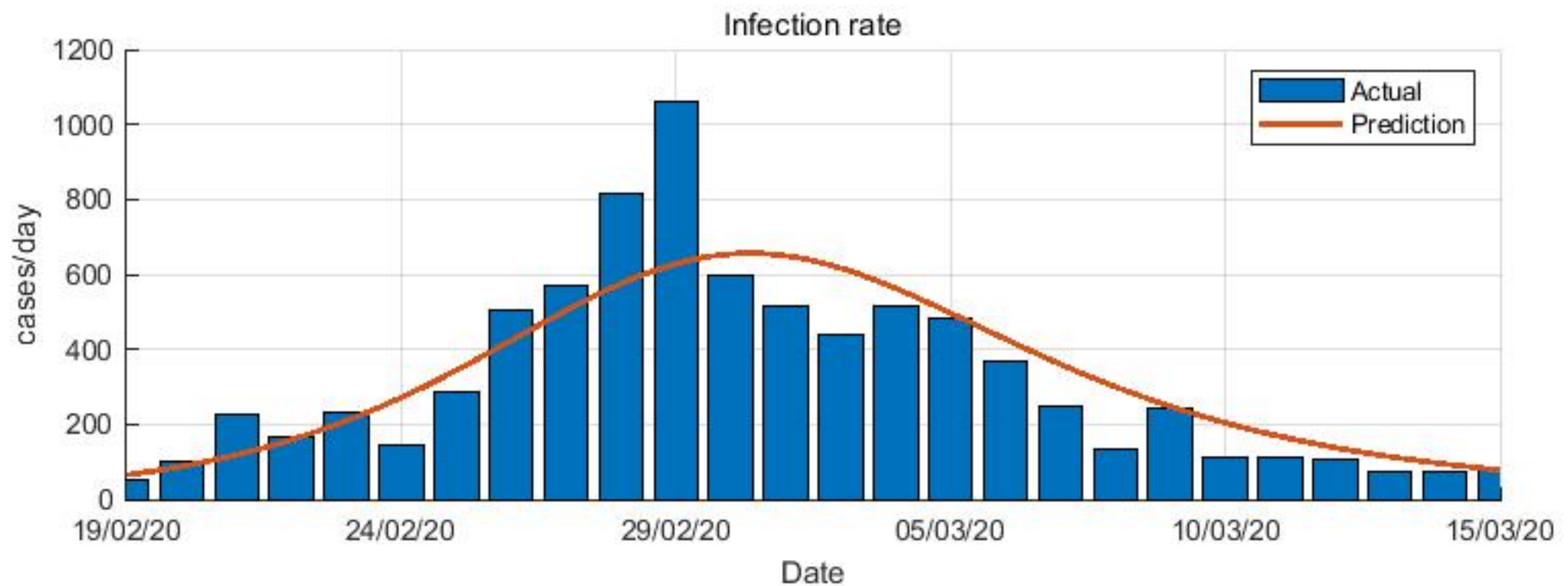
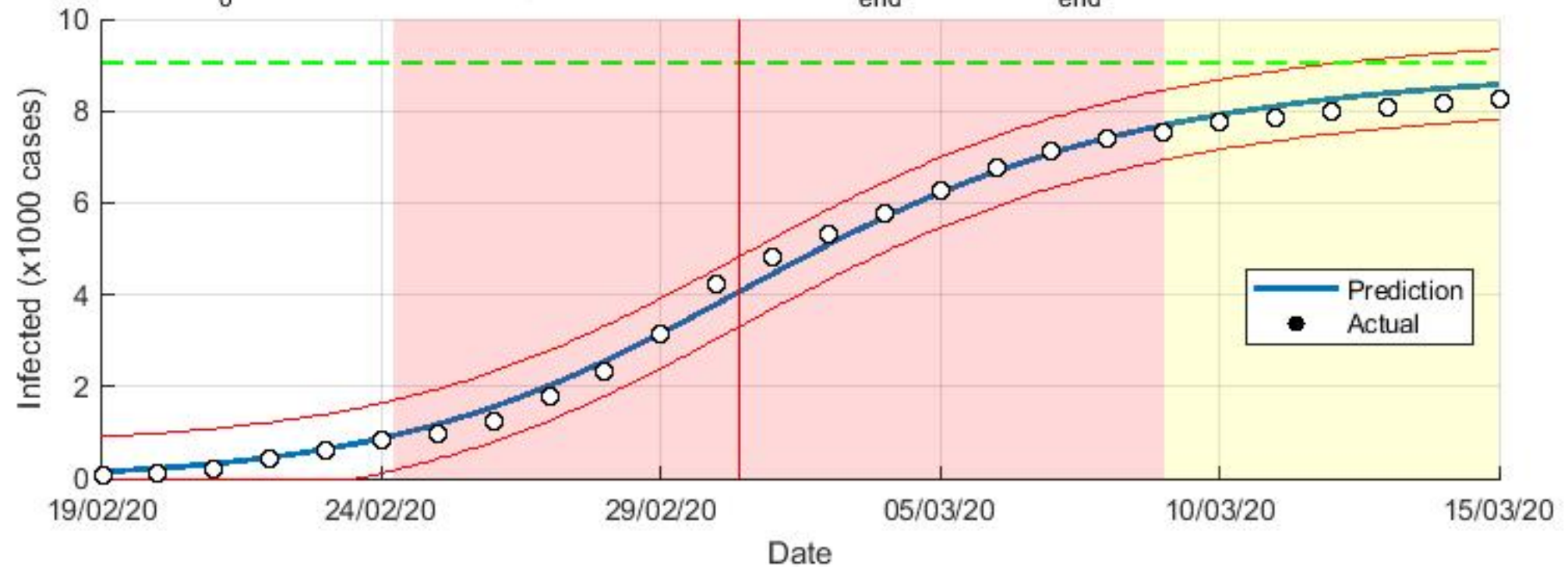
# Coronavirus epidemic in Slovenia (SIR model): 28-Mar-2020

$R_0 = 1.063$   $\beta = 2.183$   $\gamma = 2.052$   $N = 7287$   $C_{\text{end}} = 914$   $S_{\text{end}} = 6373$   $\text{RMSE} = 29$



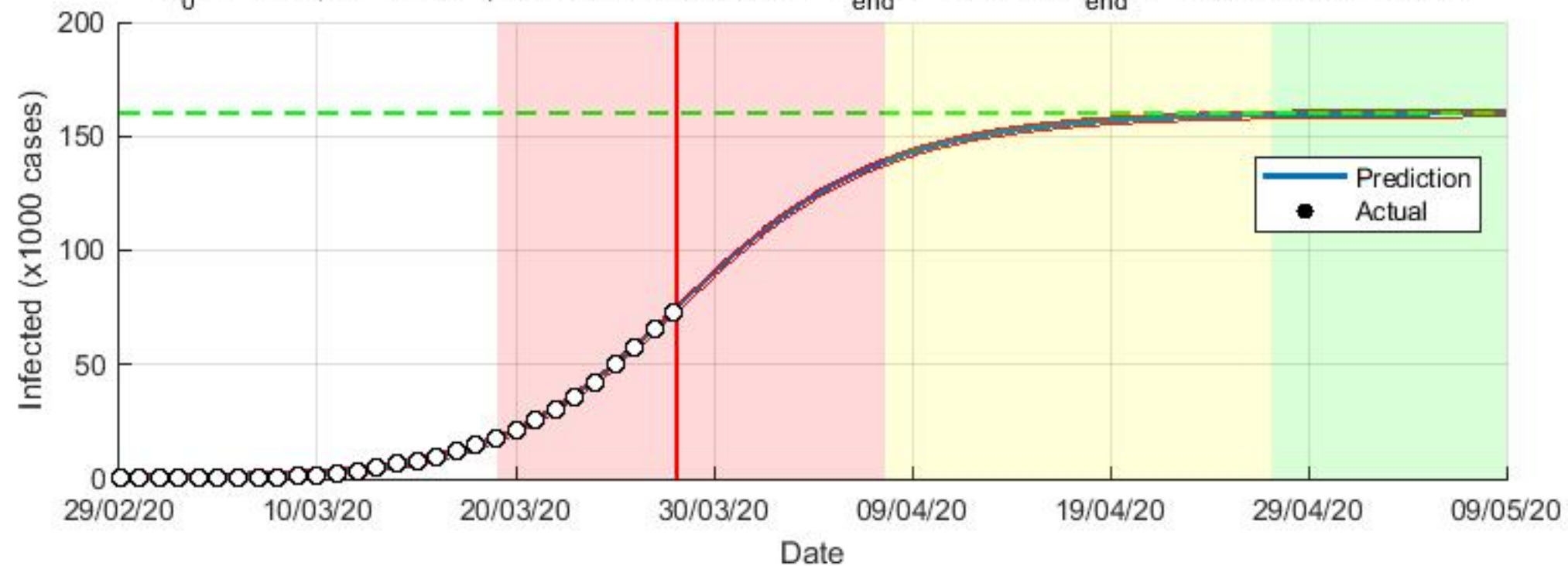
# Coronavirus epidemic in South Korea (SIR model): 28-Mar-2020

$R_0 = 2.75$   $\beta = 0.508$   $\gamma = 0.183$   $N = 9789$   $C_{\text{end}} = 9043$   $S_{\text{end}} = 746$   $\text{RMSE} = 254$

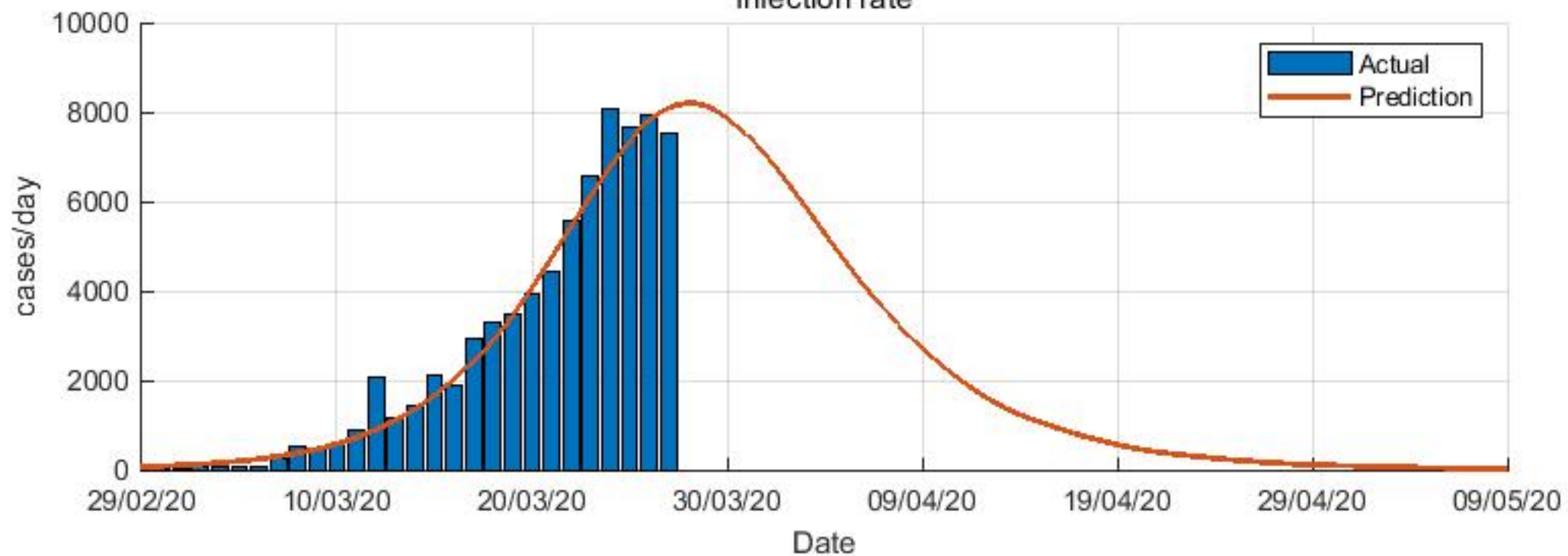


# Coronavirus epidemic in Spain (SIR model): 28-Mar-2020

$R_0 = 1.56$   $\beta = 0.632$   $\gamma = 0.405$   $N = 258505$   $C_{end} = 160213$   $S_{end} = 98292$   $RMSE = 551$

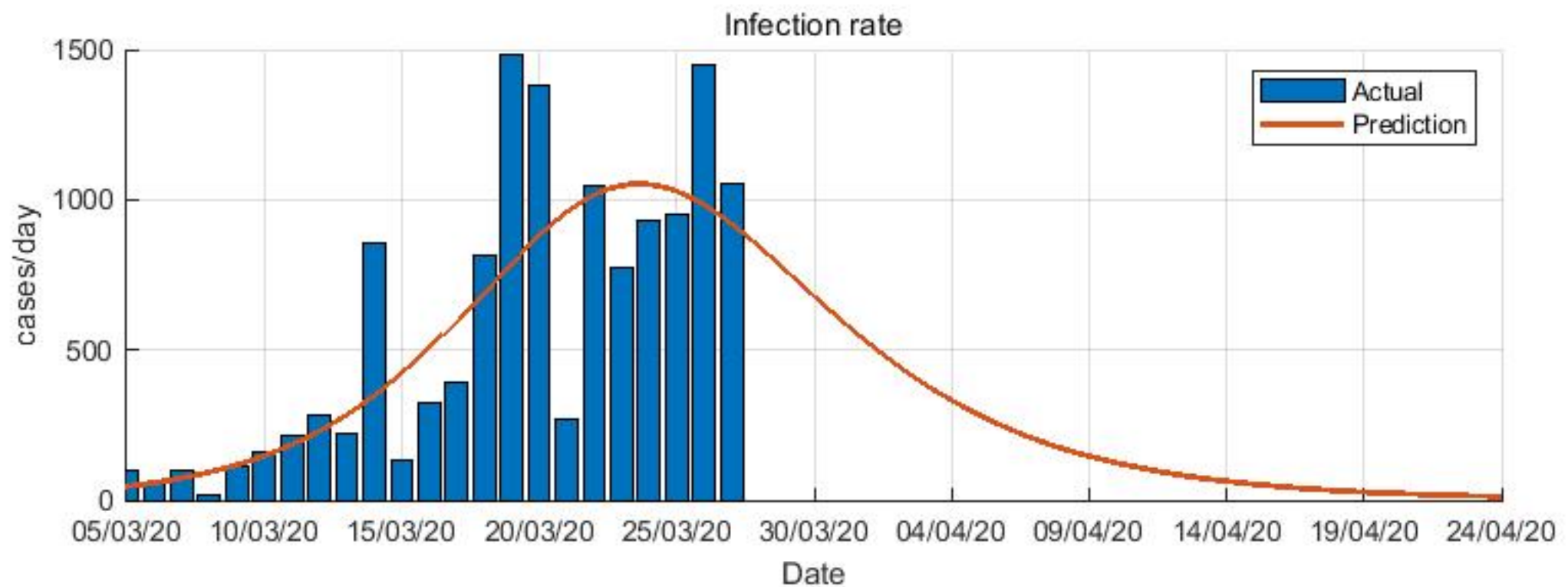
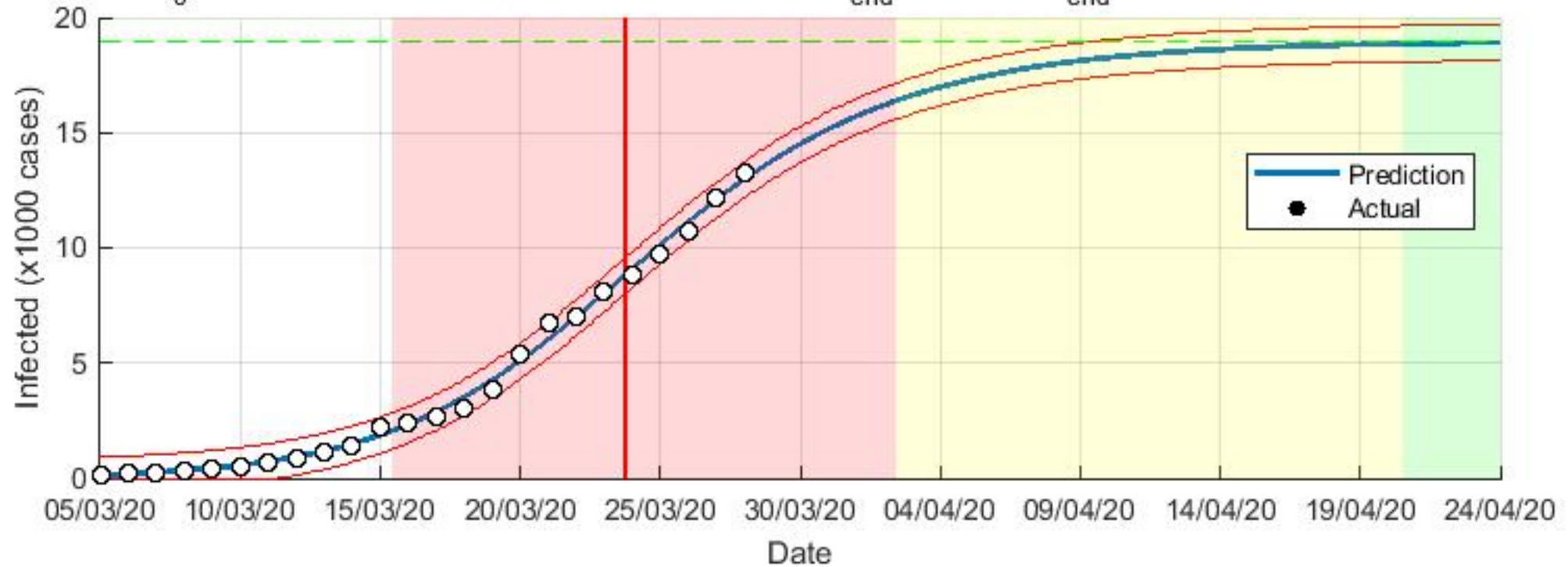


## Infection rate



# Coronavirus epidemic in Switzerland (SIR model): 28-Mar-2020

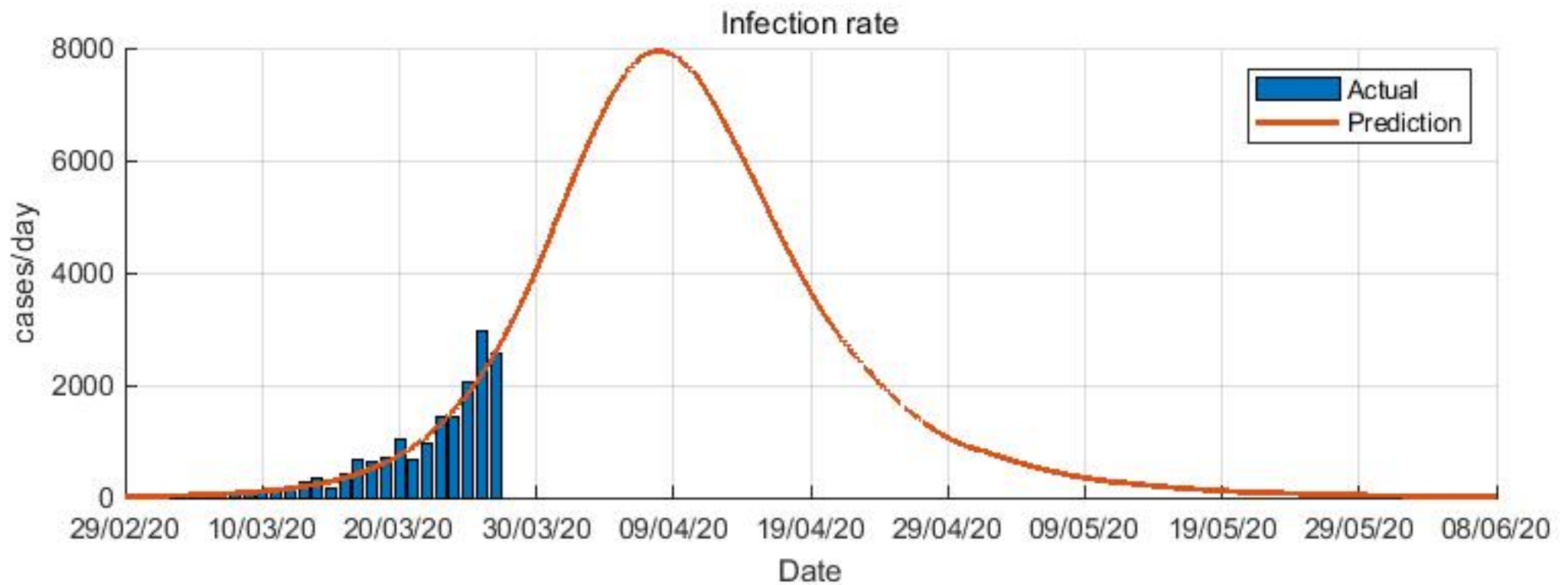
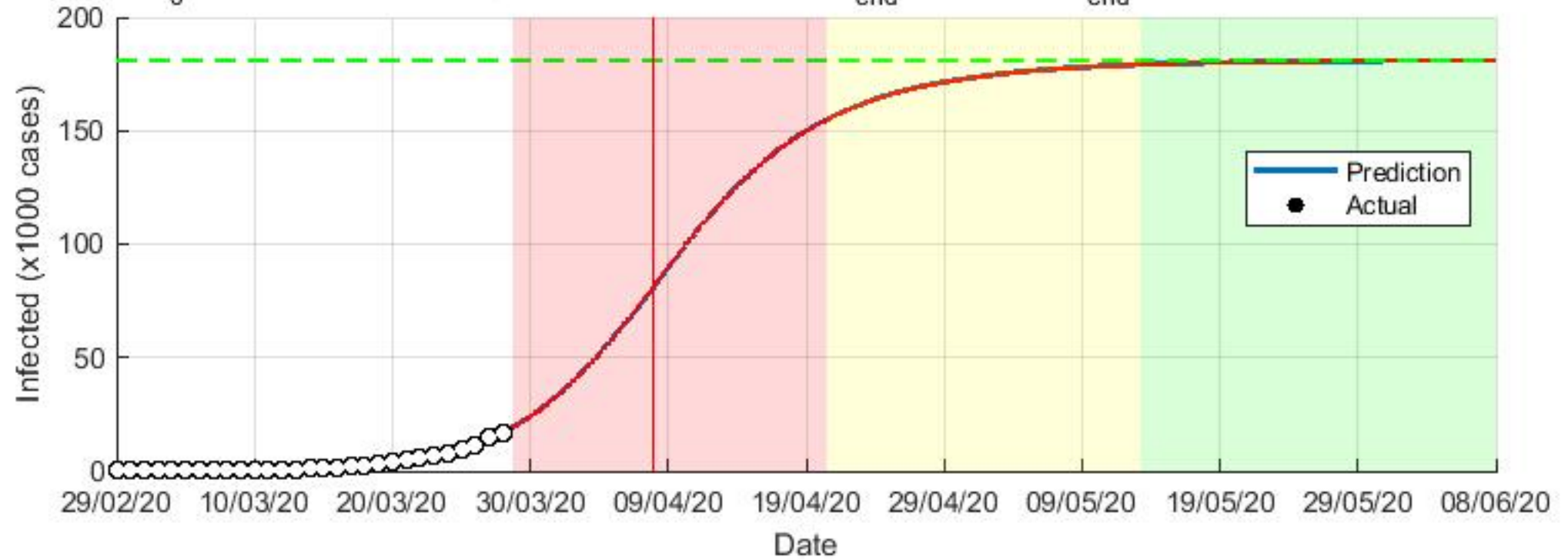
$R_0 = 1.614$   $\beta = 0.644$   $\gamma = 0.399$   $N = 29126$   $C_{end} = 18974$   $S_{end} = 10152$   $RMSE = 261$





# Coronavirus epidemic in UK (SIR model): 28-Mar-2020

$R_0 = 2.214$   $\beta = 0.365$   $\gamma = 0.165$   $N = 213891$   $C_{\text{end}} = 181076$   $S_{\text{end}} = 32814$   $\text{RMSE} = 167$



# Coronavirus epidemic in USA<sub>v</sub>2 (SIR model): 28-Mar-2020

$R_0 = 1.462$   $\beta = 0.952$   $\gamma = 0.651$   $N = 549070$   $C_{\text{end}} = 305808$   $S_{\text{end}} = 243262$   $\text{RMSE} = 716$

