

## Abstract

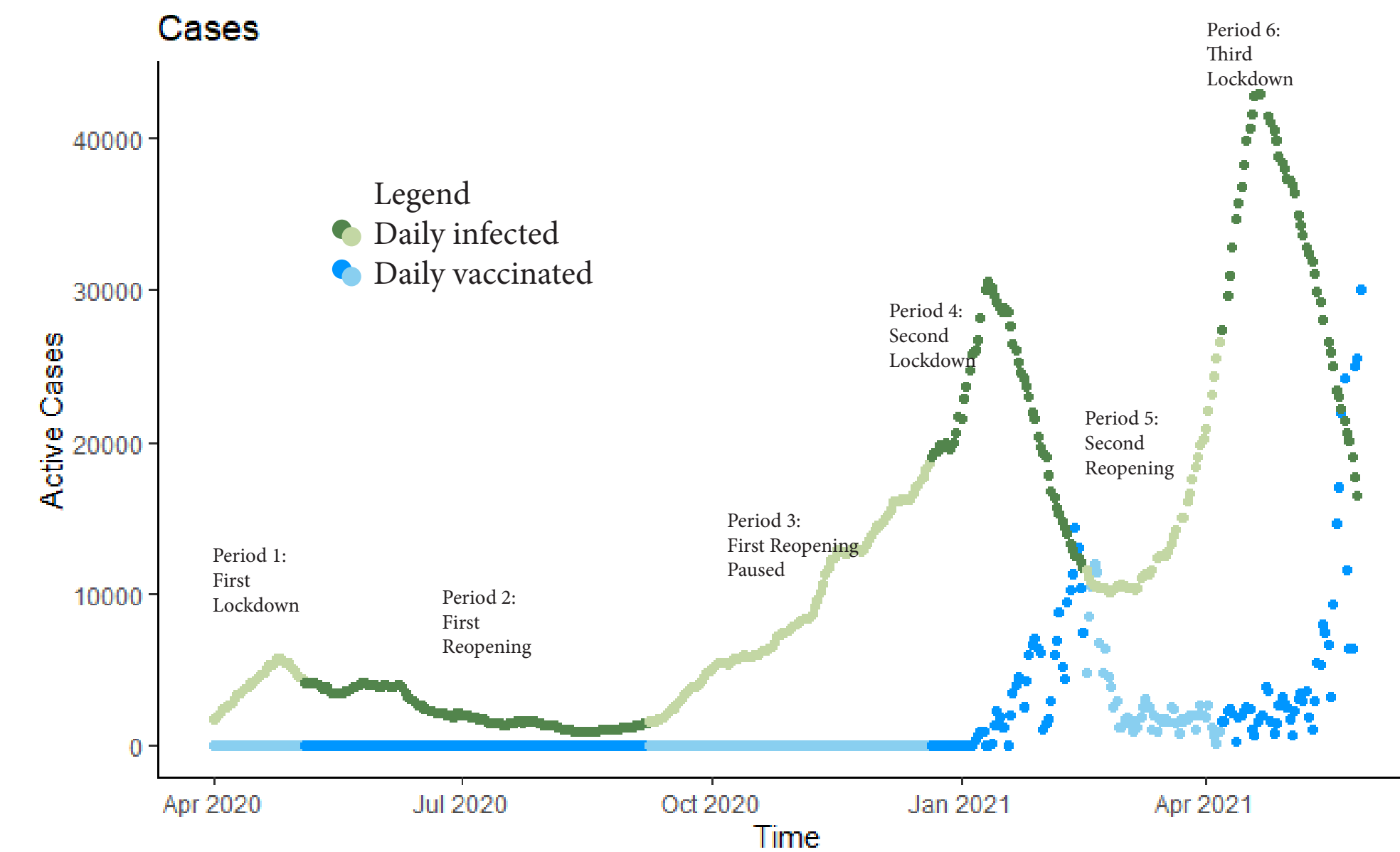
The COVID-19 pandemic startled the world economy and as some countries hurriedly ordered lockdown procedures to be put into place, others took their time. Ontario had its first case of COVID-19 infection on January 25, 2020. And on March 12, 2020, Premier Doug Ford announced that public schools in Ontario would be shut down for two weeks. A few weeks later, the closure of non-essential businesses was announced. As of June 1, Ontario has witnessed three waves since the start of the pandemic.

Our objective is to use an adapted susceptible-infected-removed (SIR) model and SIR model variants to analyze and predict the development of the COVID-19 pandemic in Ontario. All the while, we will account for the public health interventions that are designed to reduce the spread of the disease.

We will fit SIR models during lockdown intervals and reopening intervals that form the three waves. Then we will predict the number of future daily infected individuals using our fitted models.

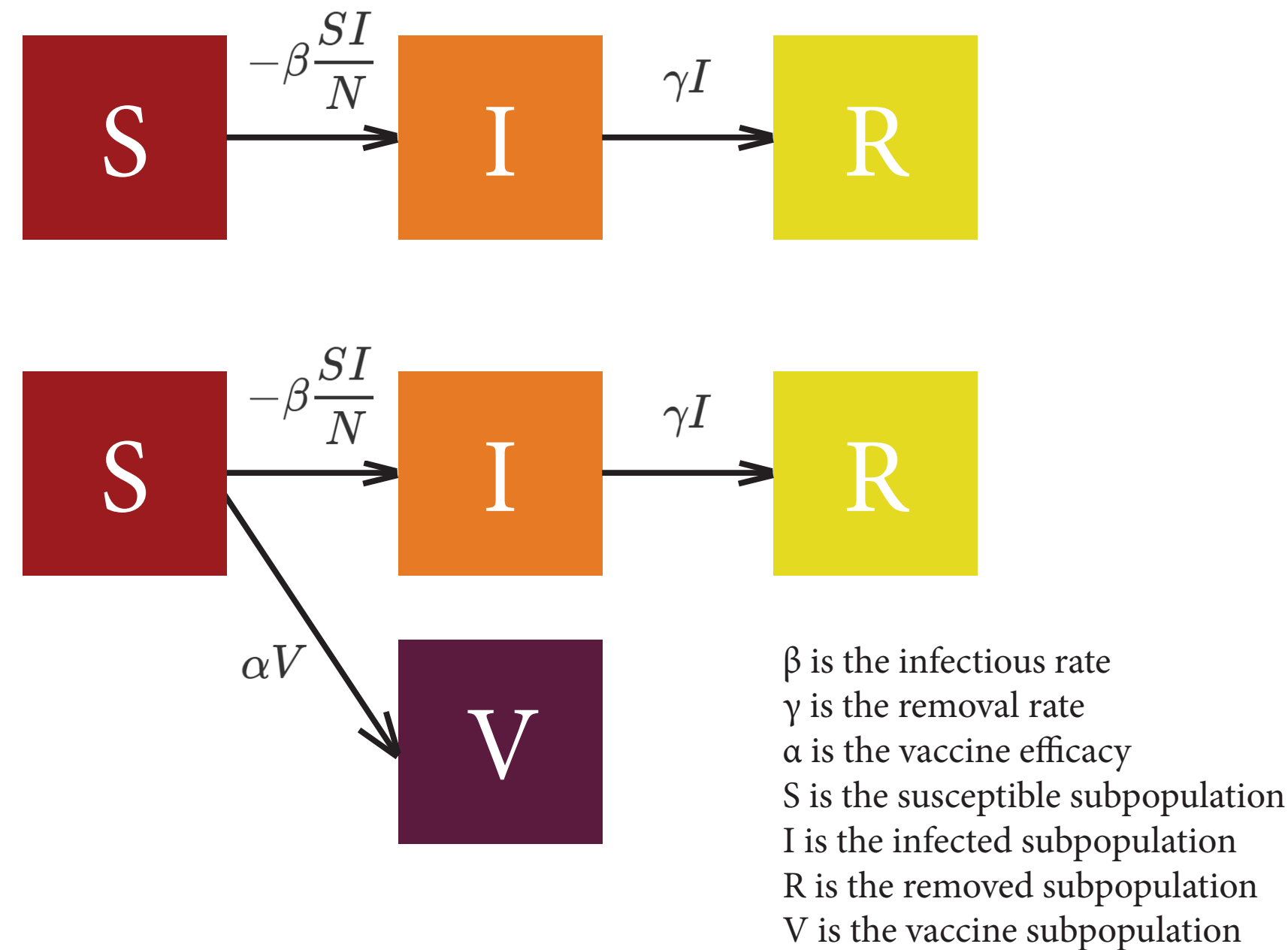
We have observed oscillating values of  $R_0$  over time, which is likely due to the lockdowns and reopenings that were put into place in Ontario. There is also a general increasing trend of daily number of infected individuals over the course of the pandemic. Along with rapid vaccine rollouts during the third wave, hence we believe that it will not long until we reopen the economy once again.

## Data

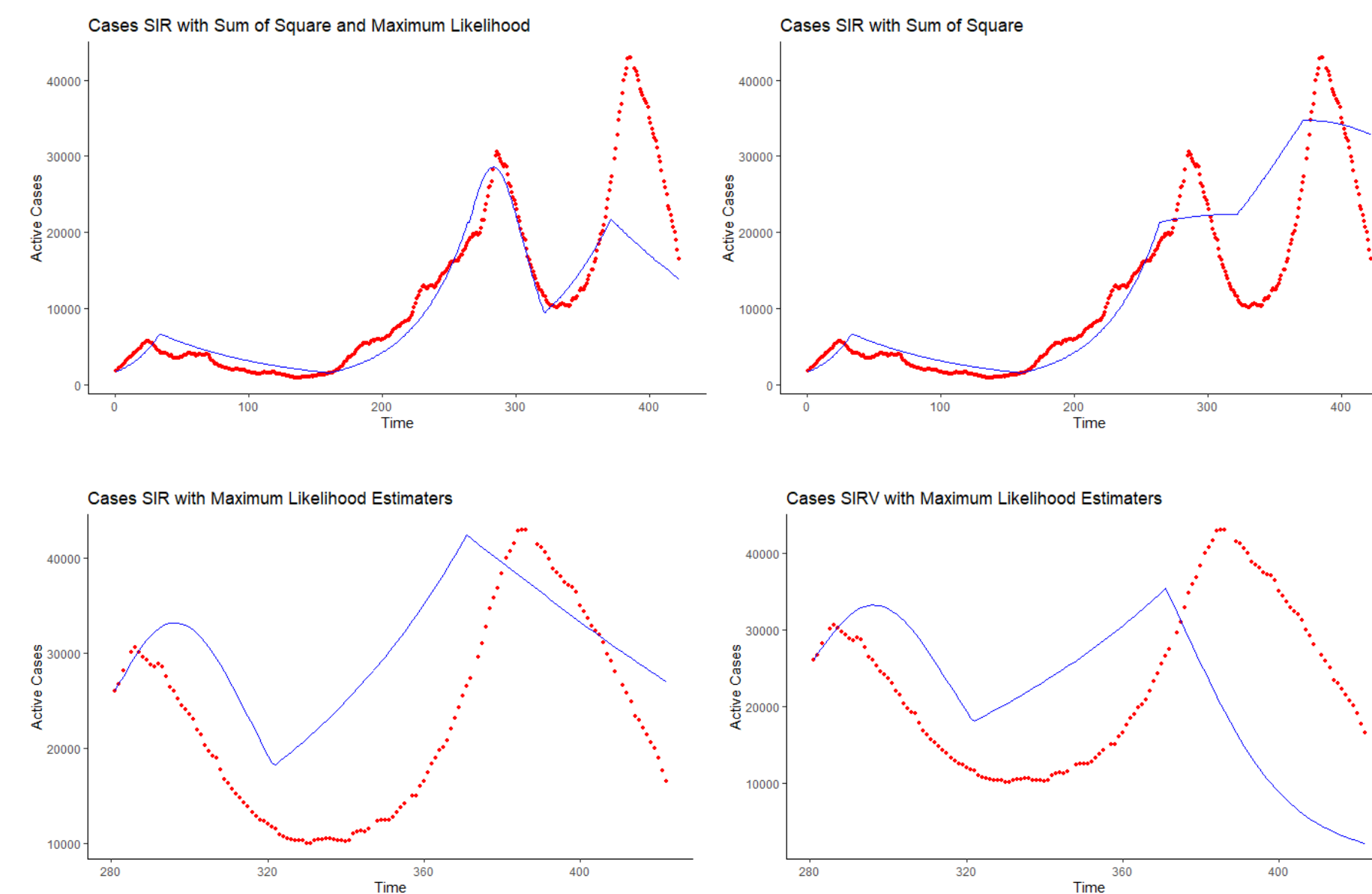


Data from Ontario Data Catalogue

## Model



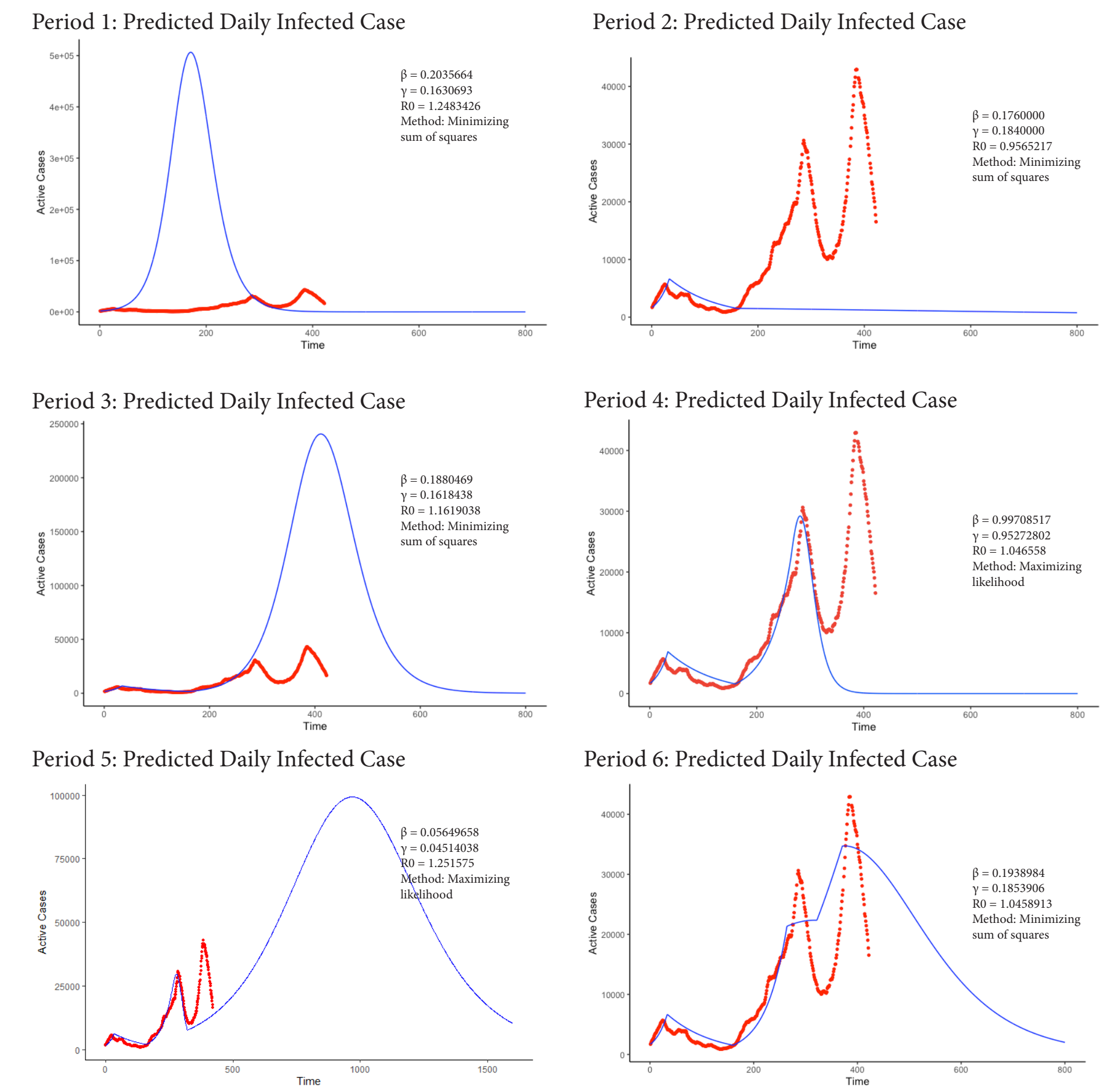
## Analysis



COVID-19 Vaccine Data in Ontario - Ontario Data Catalogue. COVID-19 Vaccine Data in Ontario - Datasets - Ontario Data Catalogue. (n.d.). <https://data.ontario.ca/dataset/covid-19-vaccine-data-in-ontario>.  
Government of Canada, Statistics Canada. (2021, March 18). Population estimates, quarterly. <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000901>.  
Harizi, I., Berkane, S., & Tayebi, A. (2021, February 5). Modeling the Effect of Population-Wide Vaccination on the Evolution of COVID-19 Epidemic in Canada. medRxiv. <https://www.medrxiv.org/content/10.1101/2021.02.05.21250572v1.full.pdf>.  
Nielsen, K. (2021, May 10). A timeline of COVID-19 in Ontario. Global News. <https://globalnews.ca/news/6859636/ontario-corona->

## References

## Results and Predictions SIR



## Conclusions and Assumptions of SIR

The main limitation of the SIR model is non identifiability, which means that although we might have good-fit at certain periods of time at the beginning of the pandemic, because of the complex social and political effects COVID-19 has on our society, a fixed deterministic model like SIR can never fully encapture all the necessary nuances of the situation. Although, it's assumptions of fixed population, fully immunization after recovery, and the assumption of homogenous mix-

ing of the infected and susceptible is easy to achieve at the beginning of the pandemic; more complex variables that appeared at the end of the second and third wave, such as quarantine and vaccinations, proved to be a challenge for the model. Hence, not only is quantifying and examining all the realistic compartments impossible, but the minimalistic model that was fit onto our data is inevitably unsuitable.

## References

virus-timeline/.  
Status of COVID-19 cases in Ontario by Public Health Unit (PHU) - Ontario Data Catalogue. Status of COVID-19 cases in Ontario by Public Health Unit (PHU) - Datasets - Ontario Data Catalogue. (n.d.). <https://data.ontario.ca/dataset/status-of-covid-19-cases-in-ontario-by-public-health-unit-phu>.  
Turk, P. J., Chou, S.-H., Kowalkowski, M. A., Palmer, P. P., Priem, J. S., Spencer, M. D., Taylor, Y. J., & McWilliams, A. D. (2020). Modeling COVID-19 Latent Prevalence to Assess a Public Health Intervention at a State and Regional Scale: Retrospective Cohort Study. JMIR Public Health and Surveillance, 6(2). <https://doi.org/10.2196/19353>