Te Pūnaha Matatini
Data ▪ Knowledge ▪ Insight

Outbreak tracking and projections:

Update for data as at 1pm 7th September 2021

Produced by the TPM Contagion Network Team. For further information contact Dion O'Neale —d.oneale@auckland.ac.nz

SUMMARY

This update presents results from both a Branching Process model (BPM) and an individual based, Aotearoa-specific Contagion Network model (CNM) used to simulate the spread of COVID-19 in the community. Both models assume an initial period of minimally controlled community spread, generated from an unknown seed case, prior to detection of a case on August 17th, 2021. While the BPM contains no geographic information, the CNM further assumes that the outbreak was seeded within the Auckland region.

Both models use parameters that correspond to best estimates of those observed for the Delta (B.1.617.2) variant of SARS-CoV-2. The CNM further uses current best estimates for parameters related to the Test, Trace, Isolate procedures, and Alert Level interventions currently operating in Aotearoa.

We fit Gaussian process (GP) surrogates to realisations from each model to provide model-informed prediction bands conditioned on real-world case data as it becomes available. We also retain and plot models simulations consistent with these prediction bands. These semi-automated daily updates used the same methods as described in the report of 26th August[1].

Branching process model

The branching process model produces a large number of realisations. We then fit a Gaussian process surrogate to these simulations and produce prediction bands conditioned on currently known confirmed case numbers. We also retain and plot simulations that are consistent with these prediction bands. Figure 1 shows the number of **cumulative confirmed** and **cumulative total** cases predicted by the retained simulations of the model.

Figure 2 presents an estimate of **daily case numbers** reported on each day after detection. The surrogate GP model is conditioned on case data and prediction bands formed. We then retain simulations consistent with these predictions. The 50% quantile bands of retained simulations represent a typical expected band of trajectories, while the top 95% quantile band of retained simulations reflects a more pessimistic scenario. In general, daily case numbers can be expected to be more volatile and more dependent on specific assumptions than the general trend of cumulative cases.

We caution that the branching process has no knowledge of the context of infection or the mechanistic effect of alert level interventions and test, trace, isolate policies.

Data Quartiles	September 8 2021	September 10 2021	September 14 2021
25% Quartile	19.0	13.0	7.0
Median	24.0	18.0	11.0
75% Quartile	29.0	24.0	15.0

Table 1. Projected cases in the next 1, 3 and 7 days

Number of Cases	2.5% Quantile	25% Quantile	Median	75% Quantile	97.5% Quantile
10	September 9 2021	September 12 2021	September 15 2021	September 19 2021	September 27 2021

Table 2. Projected date to reach 10 cases

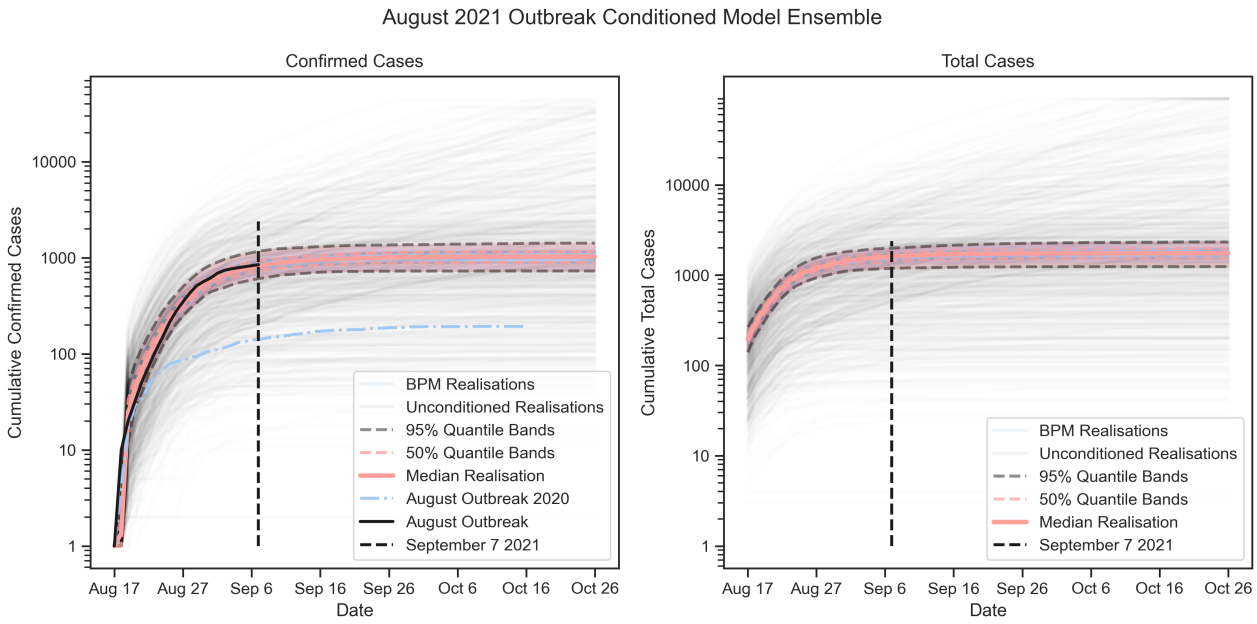

Figure 1. Cumulative case numbers for the branching process model with Gaussian process conditioning on confirmed cases. Confirmed cases (left) and total cases (right). Grey traces indicate individual realisations of the unconditioned branching process model (BPM) for a wide ensemble of parameters. 50% and 95% quantile bands of retained simulations, along with the median case numbers of retained simulations are indicated for the conditioned BPM. The confirmed case numbers for both the August 2020 and the August 2021 outbreaks are shown for comparison.

It is possible to estimate approximate credibility intervals for R_{eff} by taking a large number of BPM realisations, conditioned on case data via the Gaussian process, and looking at the resulting distribution of R_{eff} values in retained simulations. Figure 3 shows the probability distribution of R_{eff} values across the ensemble of simulations.

In the early stages of an outbreak it is difficult to make reasonable predictions about the probability of elimination at future dates. However, given a sequence of recent case numbers, it is not unreasonable to estimate the **probability of never again seeing more than N cases, after some specified date in the future**. The chart in Figure 4 uses the retained realisations of the BPM to estimate constant probability contours for daily case numbers remaining below N for days after a specified future date. It is worth noting that since it is expected that cases numbers will progress with some level of stochasticity around an overall trend, these probabilities will be lower than the probability of detecting fewer than N cases on only a specified day. When N=0 this figure estimates the probability of elimination given current case numbers. *It should be noted that, especially when current cases numbers are far from zero, the probability of elimination suggested by Figure 4 will be pessimistic since the simulations it is based on do not include any of the specific case information that could, in reality, be used to identify and ring-fence any remaining cases once case numbers are low.*

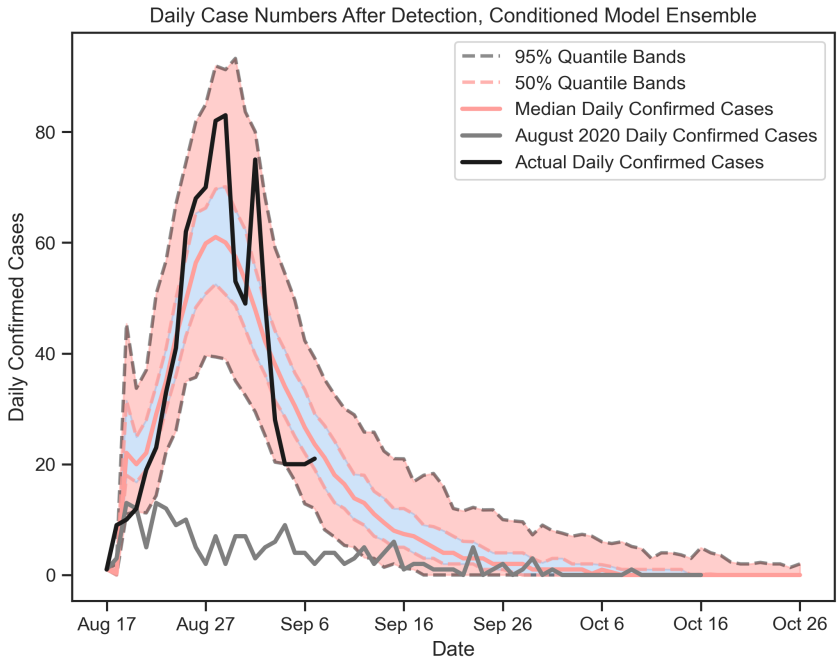

Figure 2. Daily case numbers for the branching process model conditioned to daily reported case numbers. The 50% and 95% quantile bands of retained simulations are indicated and the confirmed case numbers from the August 2020 outbreak are shown for comparison.

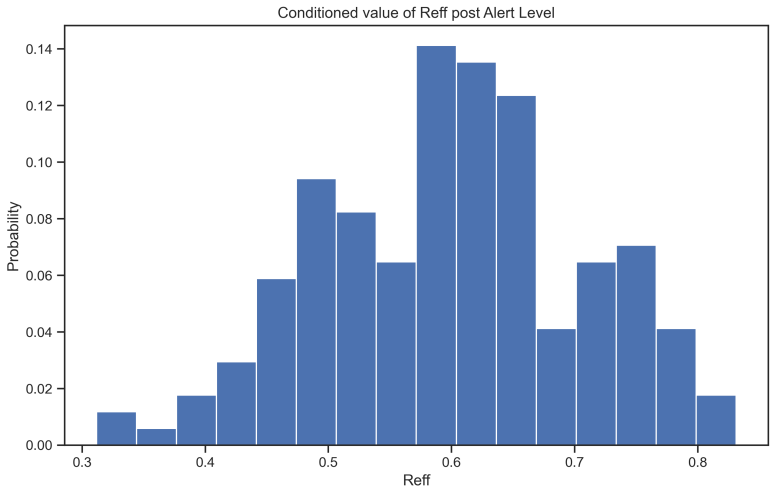

Figure 3. Distribution of R_{eff} values in retained simulations, across an ensemble of BPM simulations conditioned on case data.

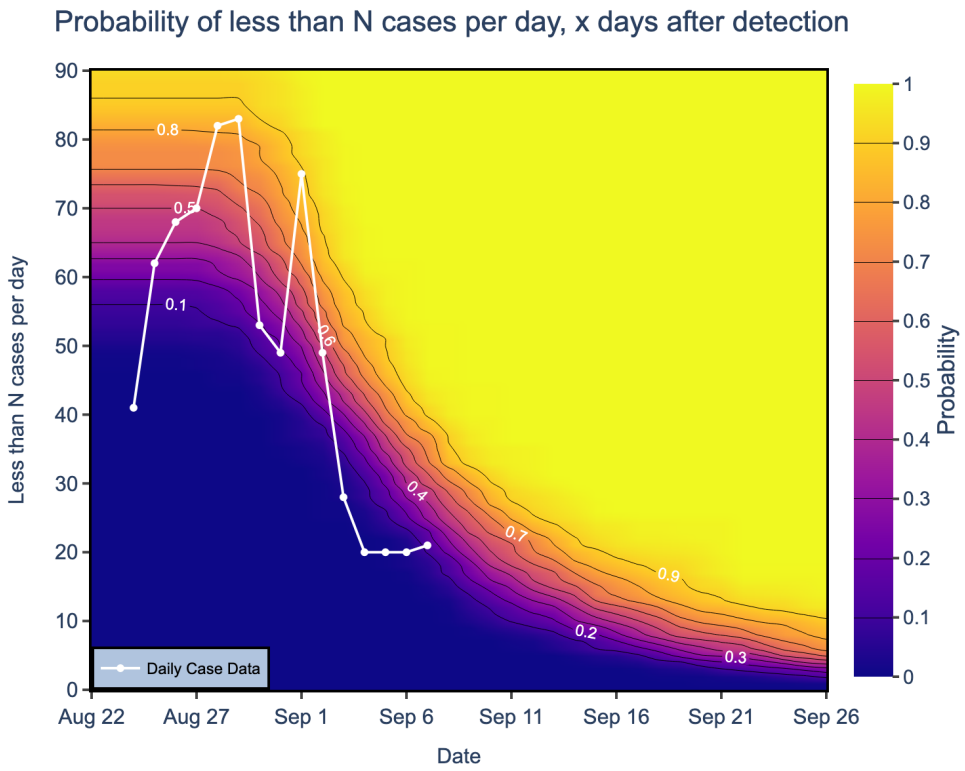

Figure 4. Probability of never again seeing more than *N* cases, after some specified date in the future given current case data to date. Probability contours are calculated by using multiple realisations of the BPM. **How to read this plot:** Select a number of cases on the y axis. Then using this case number look across the x axis for the probability of never again seeing this number of cases by a given date.

Contagion network model

The contagion network model (CNM) includes specific interaction contexts where infection can take place (dwellings, schools, workplaces, and community events) along with mechanistic processes to capture interventions such test, trace, isolate policies and the reduction in interaction at many (non-dwelling) contexts that resulted from the shift to Alert Level 4 on August 18th, 2021. As such, it is able to better capture the different processes which can occur on different time scales.

Data Quartiles	September 08 2021	September 10 2021	September 14 2021
25% Quartile	17.25	15.25	10.25
Median	22.0	20.5	16.0
75% Quartile	30.0	29.5	22.0

Table 3. Projected cases in the next 1, 3 and 7 days

Number of Cases	2.5% Quantile	25% Quantile	Median	75% Quantile	97.5% Quantile
10	September 09 2021	September 16 2021	September 23 2021	After Oct 16 2021	After Oct 16 2021

Table 4. Projected date to reach 10 cases

Figure 5 shows the cumulative confirmed and cumulative total cases for the CNM. A Gaussian process with daily case data for the August 2021 was used to form conditional prediction bands. These were then also used to determine which simulations to retain, and to create projections for cumulative confirmed and cumulative total cases. Figure 6 shows the predicted daily confirmed cases for the conditioned CNM simulations shown in Figure 5.

As noted in the report of August 26th[1], the CNM simulations do not take into account the updated 'Delta' Test-trace-isolate policies for contacts or other Alert Level 4 changes such as very high symptomatic testing rates. This leads to a longer tail (time to elimination) than may be realistic, but reasonable behaviour in the initial phase of the outbreak and the near-term projections.

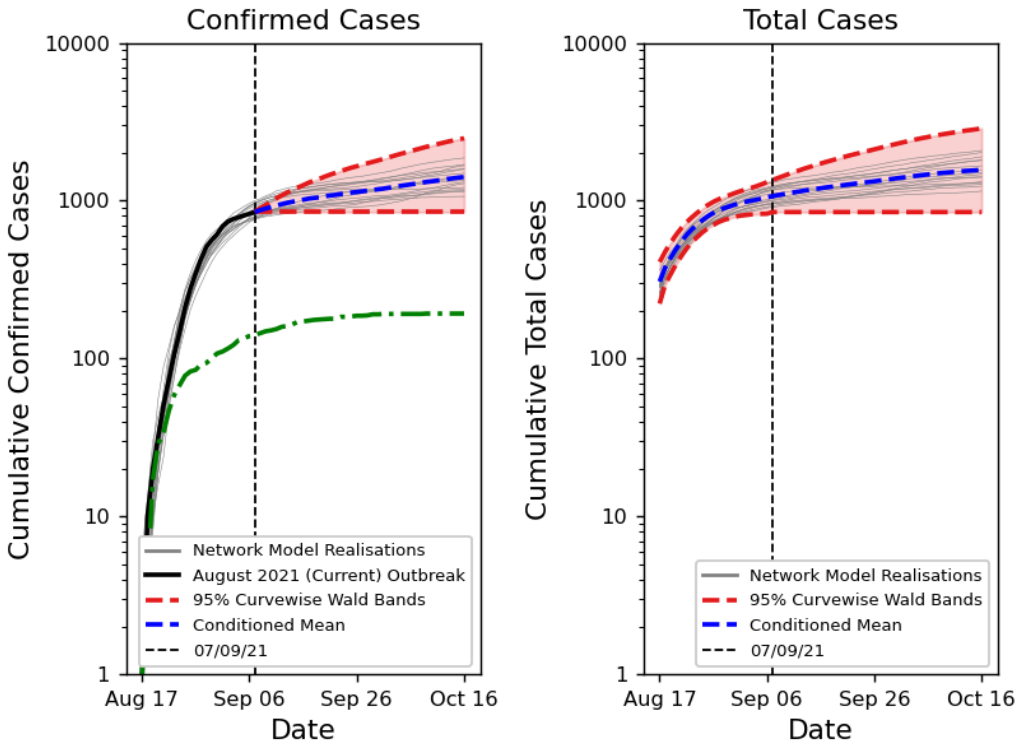

Figure 5. Cumulative confirmed cases (left) and **cumulative total cases** (right) of the contagion network simulations, conditioned on daily case data from the August 2021 outbreak using a Gaussian process. Traces from individual realisations are shown in grey. Dashed lines indicate the median and 95% quantile bands. Case data from August 2020 is shown for comparison.

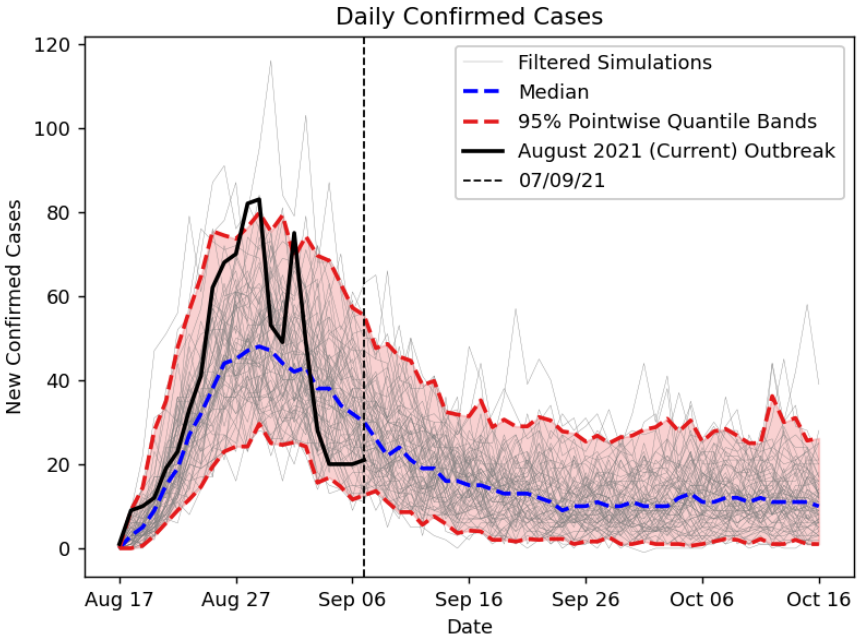

Figure 6. Daily new confirmed cases for an ensemble of contagion network simulations conditioned on daily case data from the August 2021 outbreak. Grey traces indicate individual realisations of the conditioned contagion network model. The median and 95% quantile bands are also indicated.

References

1. Gilmour, J. *et al.* Modelling estimates of expected size: the August 2021 COVID-19 outbreak in Aotearoa. Tech. Rep., Te Pūnaha Matatini (2021).