

Projections for COVID-19 delta wave in Florida

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In summer 2021, the delta variant of concern (VOC) of SARS-CoV-2 was first detected in Florida, and accounted for over 70% of reported cases by mid-July [1, 2]. The delta variant is currently driving a major wave of COVID-19 cases and hospitalizations. Because death due to COVID-19 tends to not occur until a few weeks after symptoms begin, we are likely to see a substantial peak in deaths that follows the peak in reported cases. While there is uncertainty around how the the general public and policy makers will respond to this wave, we do not believe there will be a strong behavioral or policy response in Florida like we saw early in the pandemic. This is consistent with observations from cellphone mobility data. In the results presented here, we do not consider VOCs that might be introduced after delta, potentially driving winter 2021-2022 transmission.

Results

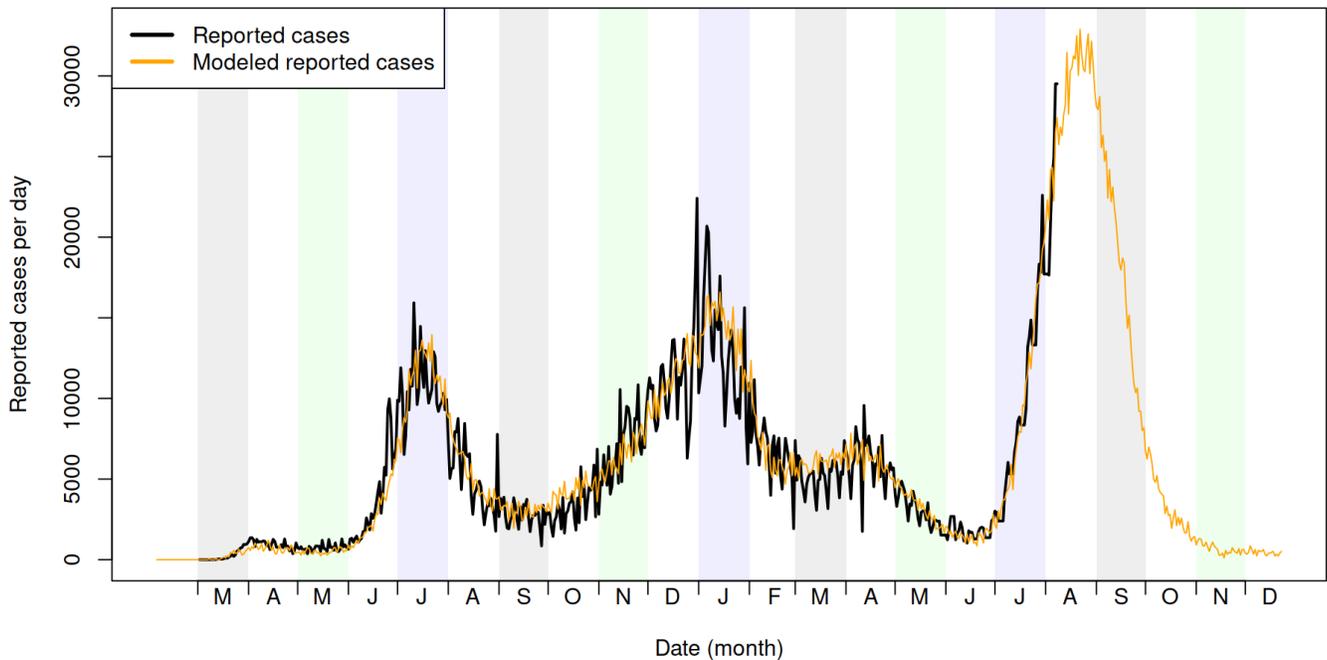


Figure 1: Reported daily cases for Florida, modeled (yellow) compared to empirically reported cases in the state of Florida (black). The projected peak of 33,000 cases per day for the entire state corresponds to about 150 cases per day per 100,000 residents.

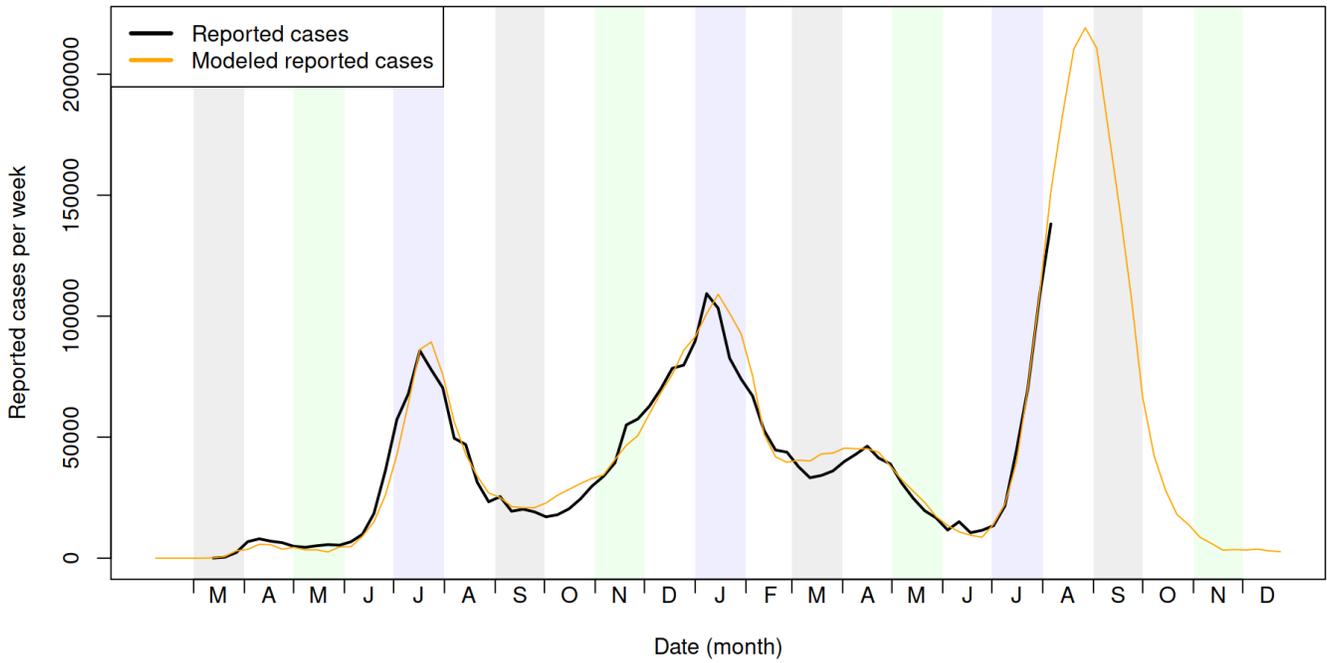


Figure 2: Reported weekly cases for Florida, modeled (yellow) compared to empirically reported cases in the state of Florida (black). The projected peak of 220,000 cases per week for the entire state corresponds to about 1,000 cases per week per 100,000 residents. Incomplete weeks in the reported data at the beginning and end of the time series have been omitted.

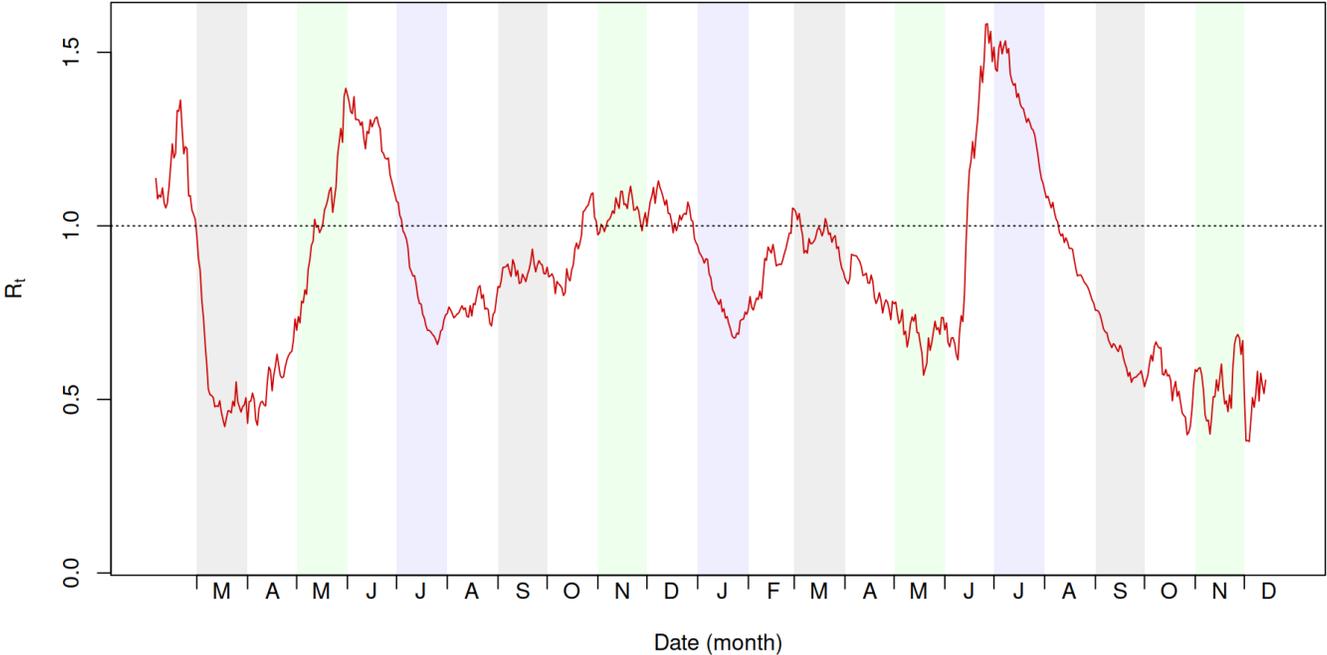


Figure 3: Time-varying reproduction number (R_t) measured from our model. R_t is the average number of infections that will be directly caused by each person infected on a given day. Note that R_t corresponds to how rapidly an epidemic is growing, and not when the most infections are reported, and thus is highest at roughly the halfway point during the growth phase of an epidemic wave.

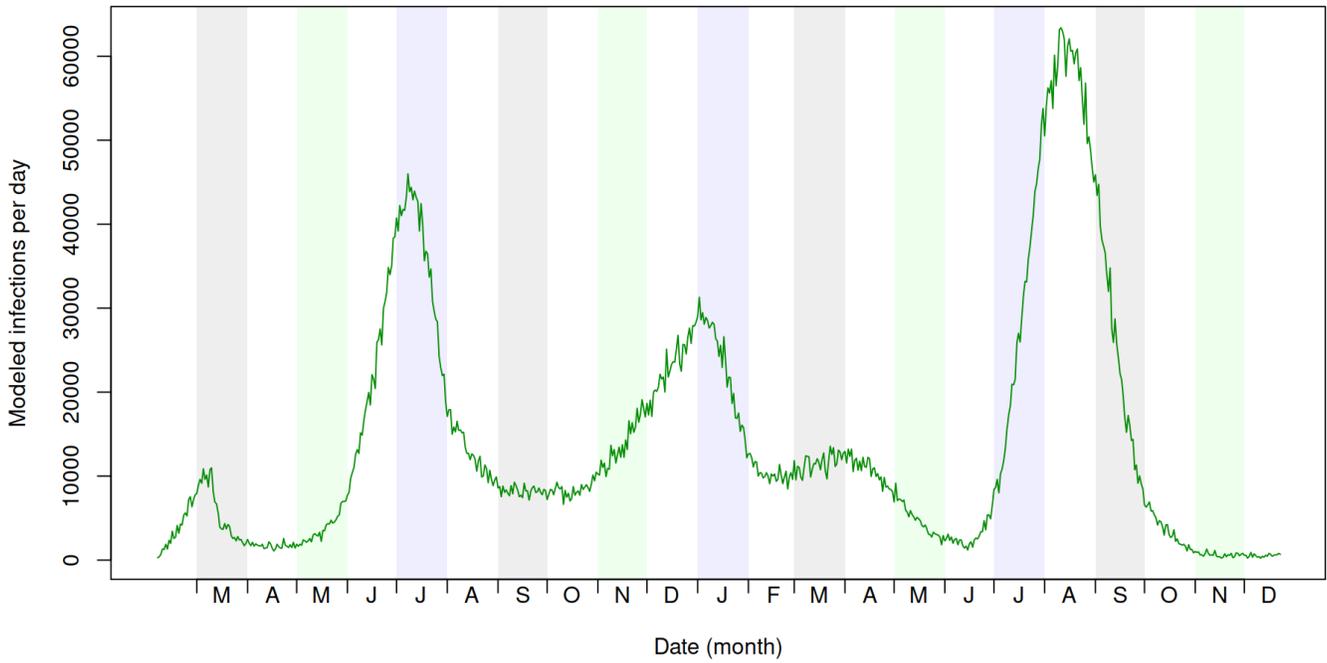


Figure 4: Total (both asymptomatic and symptomatic) infections for Florida from our model. Note that availability of testing and reporting lags have changed during the course of the pandemic, and thus the infection curve looks substantially different from the reported case curve above.

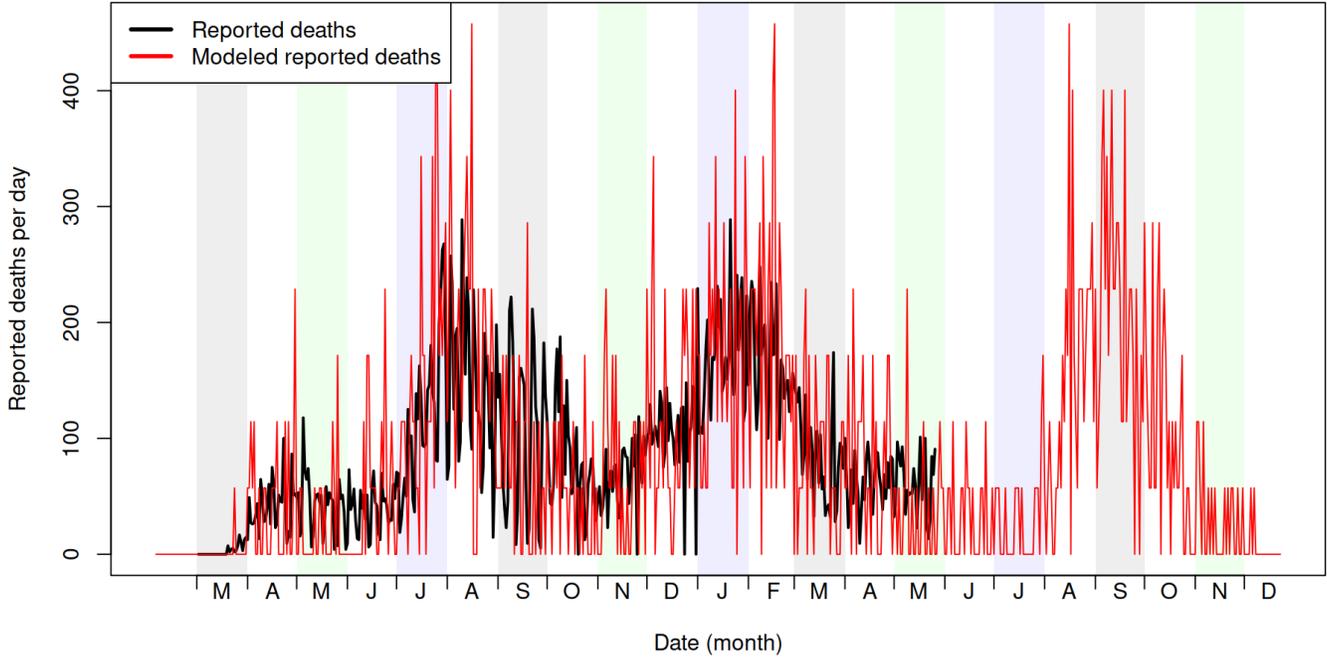


Figure 5: Reported daily deaths for Florida, modeled using the ABM (red) compared to empirically reported cases in the state of Florida (black).

Methods

We have developed a detailed simulation model to serve as a tool for assessing the COVID-19 epidemic in Florida. The model is a data-driven, stochastic, discrete-time, agent based model with an explicit representation of people and places [3]. Households in the model are sampled from census and survey data in order to establish a realistic distribution of age, sex, comorbidity, employment and school-attendance status. Activities and interaction patterns affect how likely someone is to be exposed in the model, and age, health status, and healthcare seeking behavior affect how severe a person’s infection is likely to be. People go to work or school, visit friends, and patronize businesses in the model. The simulation includes closure of non-essential businesses, reduced school attendance, and changes in behaviors during the course of the pandemic. Our full Florida model represents 20.6 million people residing in 11.2 million households and 3.8 thousand long-term care facilities and who work in 2.3 million workplaces and attend 7.6 thousand schools. However, for this simulation study, we created a smaller, representative sample of the entire synthetic population totalling 375,000 people. We rescale the output from the model in order to estimate the cases and deaths for the entire state.

During each simulated day, infectious and susceptible individuals can aggregate in households, workplaces (both as employees and as customers), schools, long-term care facilities, and hospitals at different times in the day (Fig. 6). When susceptible and infectious people come together at the same location, there are new opportunities for the transmission of the virus.

If an individual becomes infected, the progression of the infection follows an *SEIRD* model where people progress through susceptible (*S*), exposed (*E*), infected (*I*), recovered (*R*), and dead (*D*) states. Additionally, infected individuals can develop mild (*I_A*), severe (*I_M*), or critical (*I_C*) symptoms (Fig. 6). People who become ill can may seek healthcare, resulting in that individual receiving hospital care (for severe symptoms) or ICU care (for critical symptoms), which in turn lowers the risk of death.

Beyond non-pharmaceutical interventions (e.g. business or school closures, social distancing, stay-at-home orders), the model also represents vaccination of the synthetic population. In our model, we simulate a generalized mRNA vaccine (Table. 1) that performs similarly to the BioNTech and Moderna mRNA vaccines that have been used in Florida [4]. We simulate a rollout of vaccines that begins in January, 2021, with vaccine availability and campaign phases reflecting the vaccine rollout that has occurred in Florida (i.e. starting with healthcare workers and older members of the population and progressively widening eligibility to younger age groups).

	Wildtype		Alpha		Delta		Details
	Dose 1	Dose 2	Dose 1	Dose 2	Dose 1	Dose 2	
VE_S	0.4	0.8	0.21	0.76	0.05	0.52	Efficacy against susceptibility
VE_P	0.67	0.75	0.35	0.71	0.29	0.75	Efficacy against pathology (given infection)
VE_H	0.9	1.0	0.9	1.0	0.9	1.0	Efficacy against severe outcomes (given infection)
VE_I	0.4	0.8	0.2	0.5	0.1	0.1	Efficacy against infectiousness

Table 1: Vaccine efficacy (VE) values assumed in our model, based on estimates from multiple Phase III trials and other published sources [4].

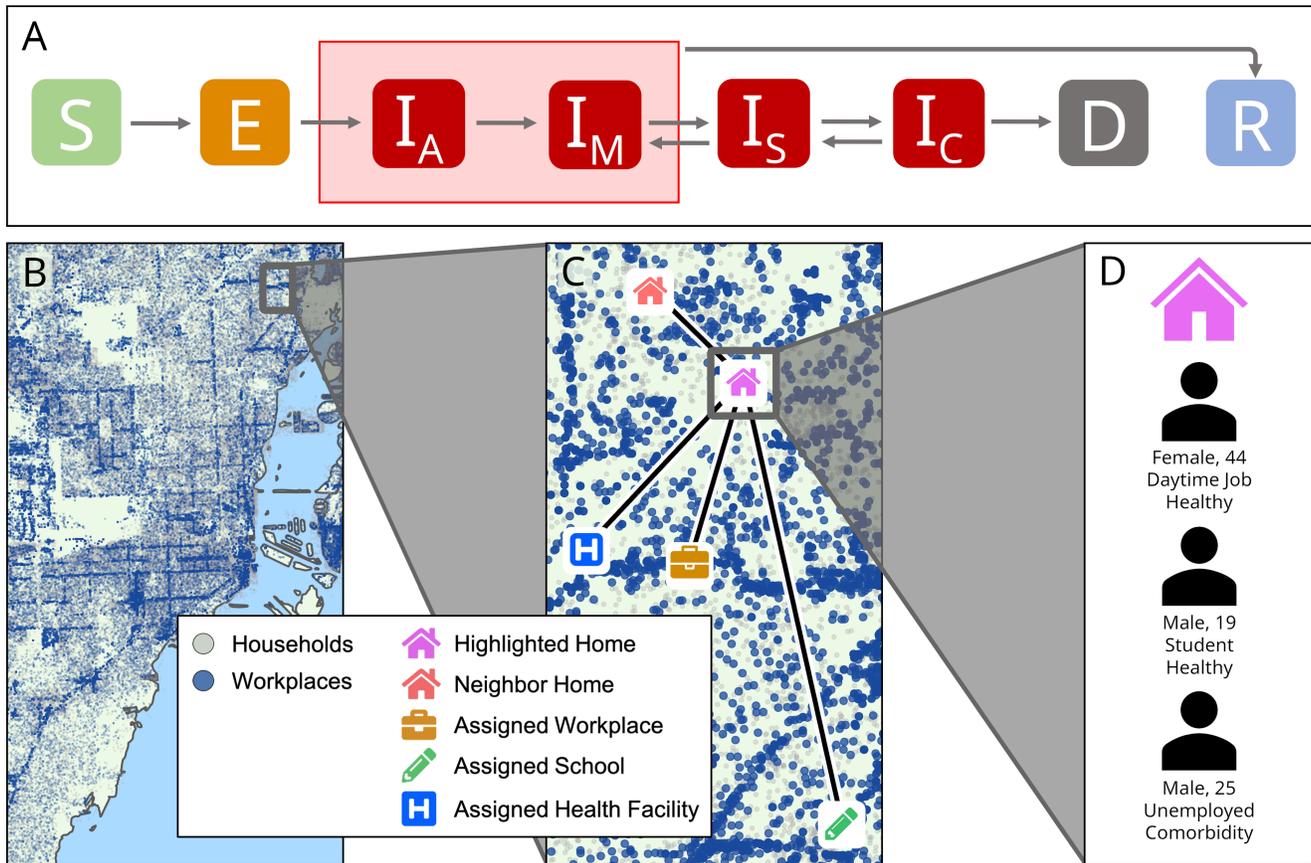


Figure 6: (A) Progression of the disease states in the model: susceptible (S) individuals may become exposed (E) to the virus, then progress to being infected (initially asymptomatic [I_A], possibly progressing to mild [I_M], severe [I_S] or critical [I_C]), and finally recovering (R) or dying (D). (B) Model locations of households and workplaces in an urban region (Miami, FL). (C) An example household. People may contact others by socializing with other households, by going to work or school, by going to the hospital, or by patronizing nearby businesses (not shown). (D) Attributes of the people in this household.

References

1. CDC. *Variant Proportions* <https://covid.cdc.gov/covid-data-tracker/#variant-proportions>.
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3. Shea, K. *et al.* COVID-19 reopening strategies at the county level in the face of uncertainty: Multiple Models for Outbreak Decision Support. *medRxiv*. doi:10.1101/2020.11.03.20225409. <https://www.medrxiv.org/content/early/2020/11/05/2020.11.03.20225409> (2020).
4. Shapiro, J. *et al.* Efficacy Estimates for Various COVID-19 Vaccines: What we Know from the Literature and Reports. *en. medRxiv*, 2021.05.20.21257461. doi:10.1101/2021.05.20.21257461. <https://www.medrxiv.org/content/10.1101/2021.05.20.21257461v1> (2021) (May 2021).