Forecasting COVID-19 mortality in the US Midwest

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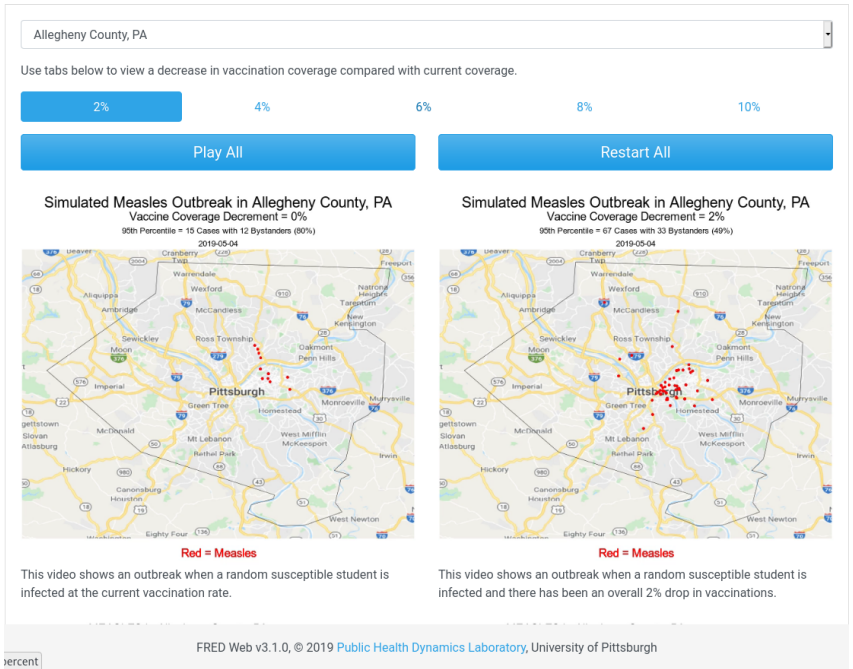
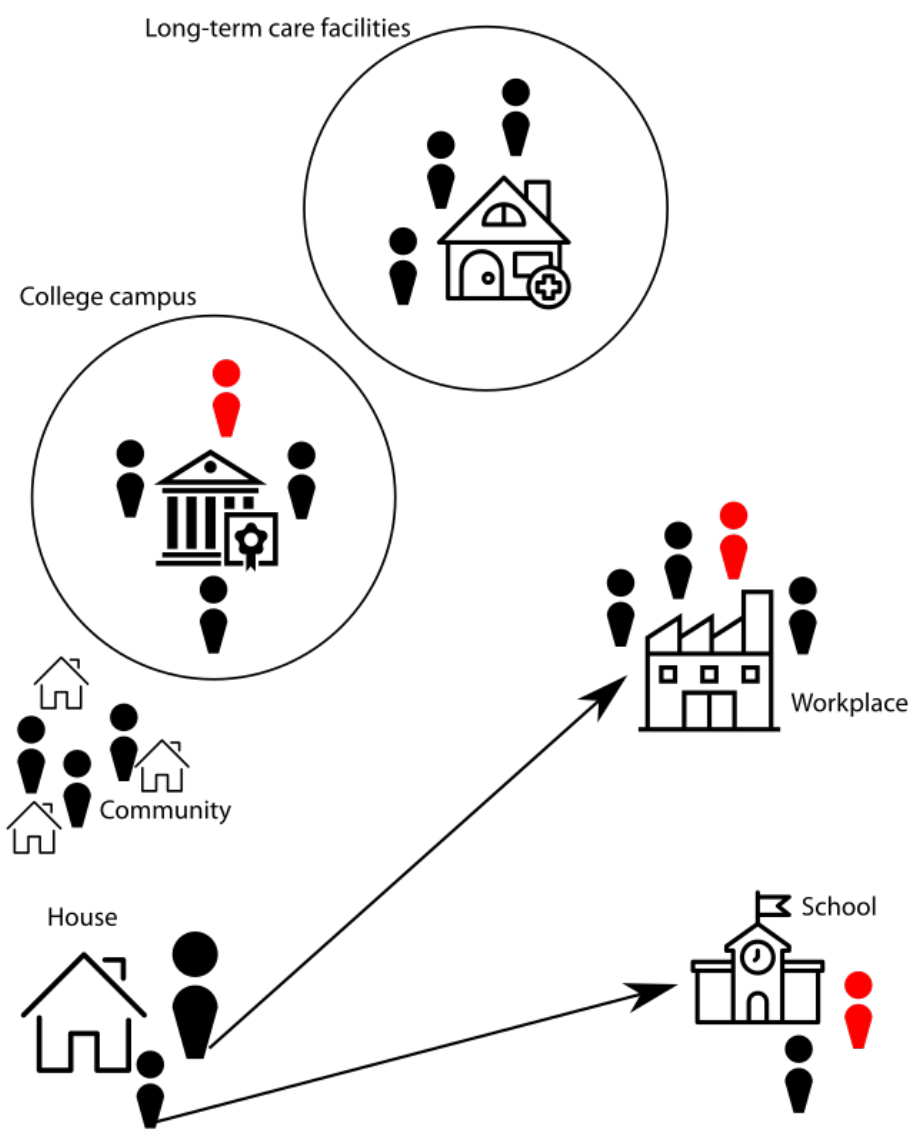
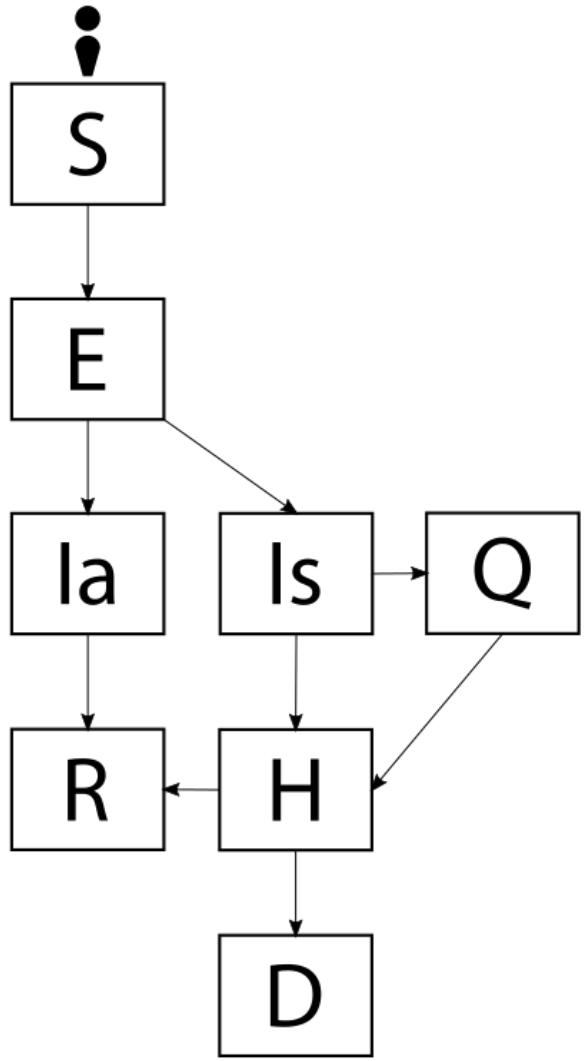
We based our model on the agent-based model platform: FRED



- Developed at the University of Pittsburgh (Grefenstette et al., 2013).
- FRED is an agent-based model framework highly flexible and adaptable.
- We modified FRED to simulate COVID-19, some of the modifications include
  - natural history of disease parameters,
  - implemented adaptive non-pharmaceutical interventions.

Agents can transmit the virus in specific places





- Infectious individuals might spread the virus where susceptible individuals visit the same places the same day.

Probability of symptoms and death

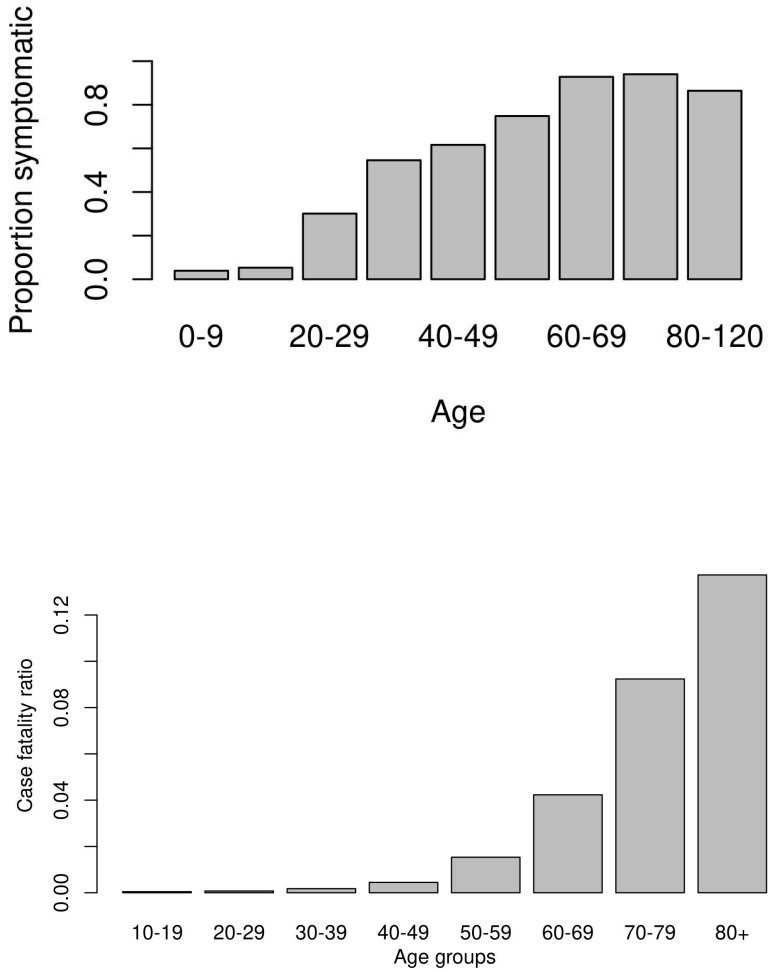


Figure: From (Verity et al., 2020; The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team, 2020).

Infectious period and duration of symptoms

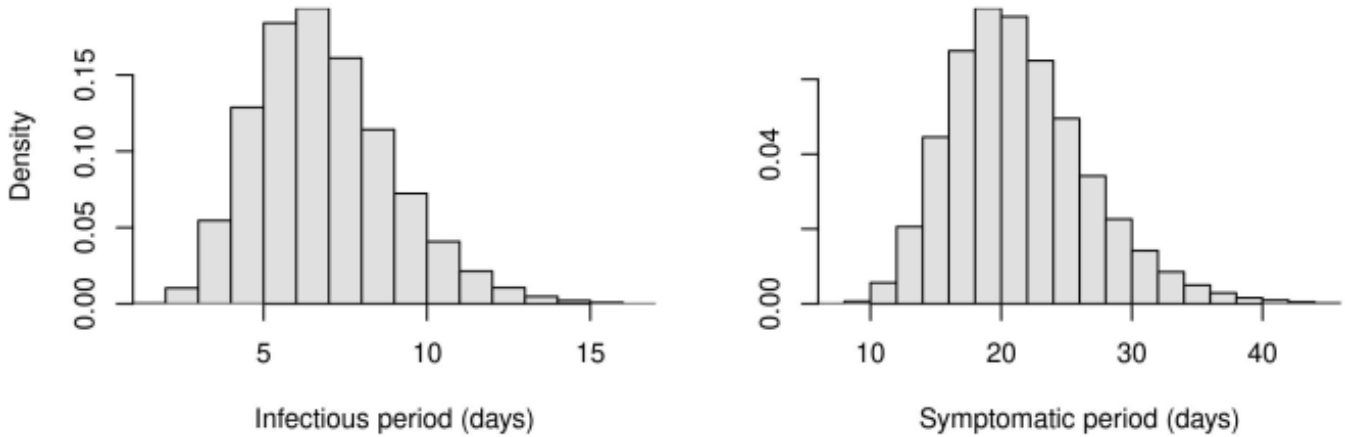
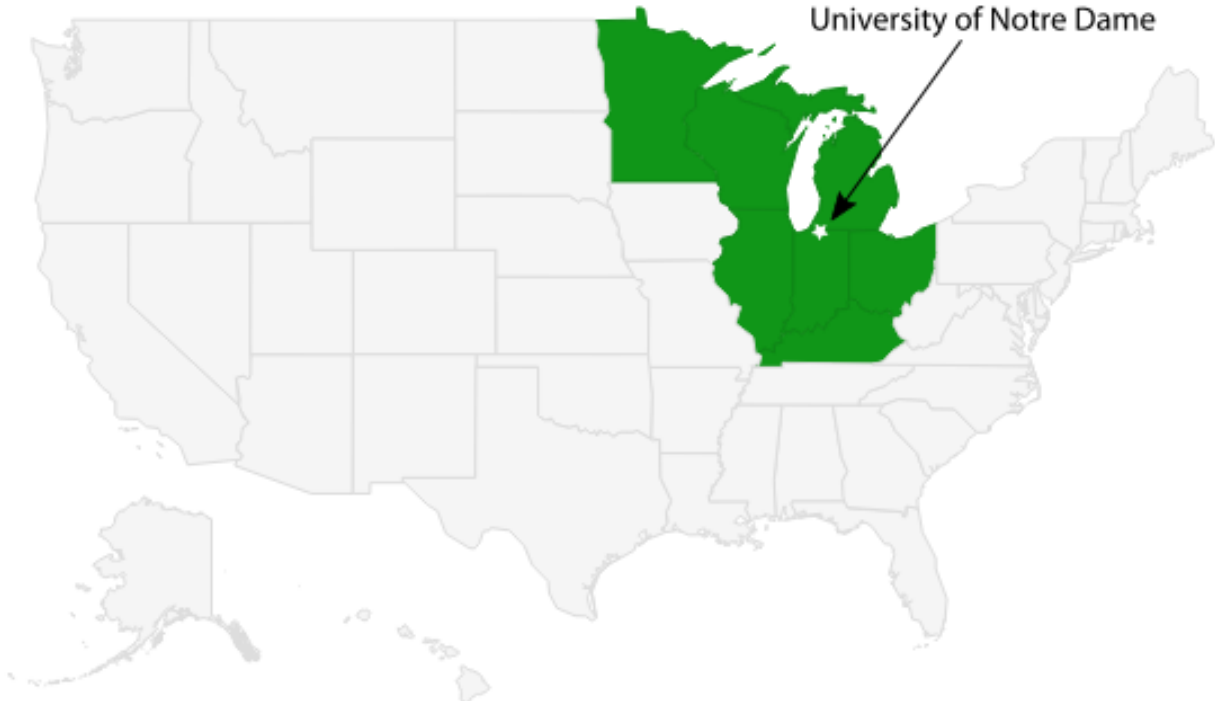


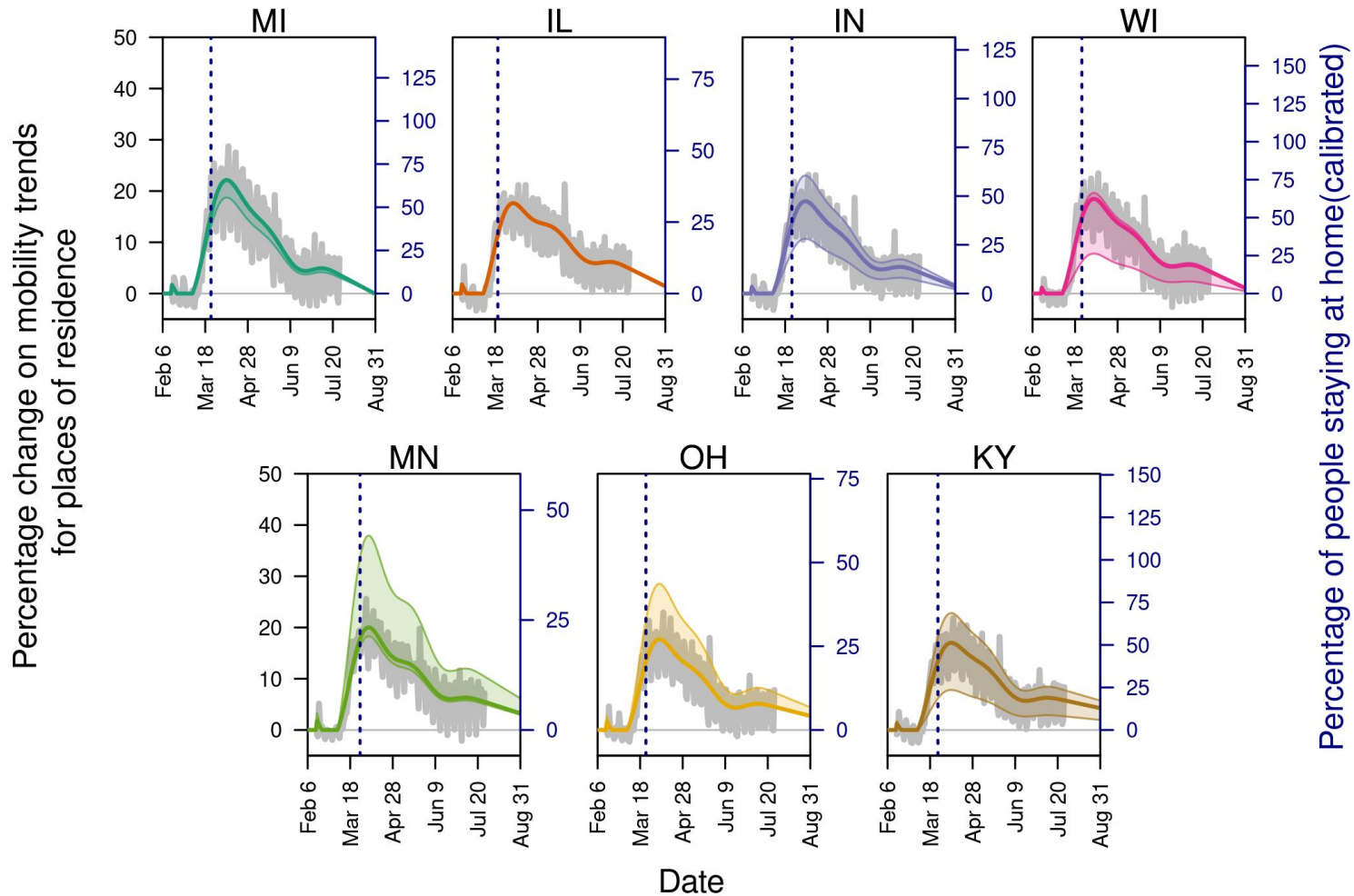
Figure: From (He et al., 2020; Lauer et al., 2020; Bi et al., 2020)

We focused on seven Midwest States



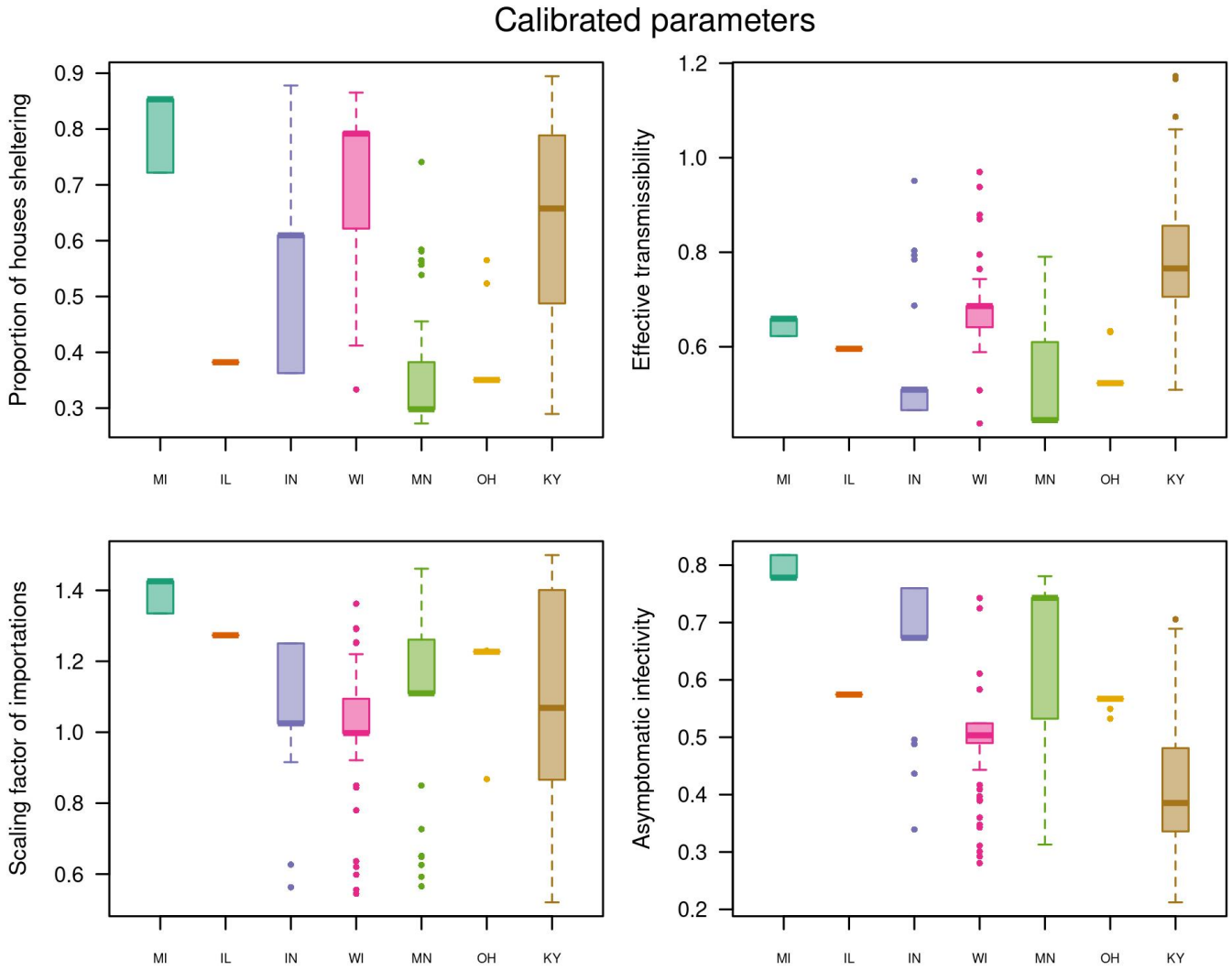
- We used deaths to calibrate the model parameters: shelter-in-place compliance, transmission efficiency, importation scaling, and asymptomatic relative infectivity.
- We simulate 2,000 parameter sets for each state.

We estimated the trend in people staying at home from the google mobility trends



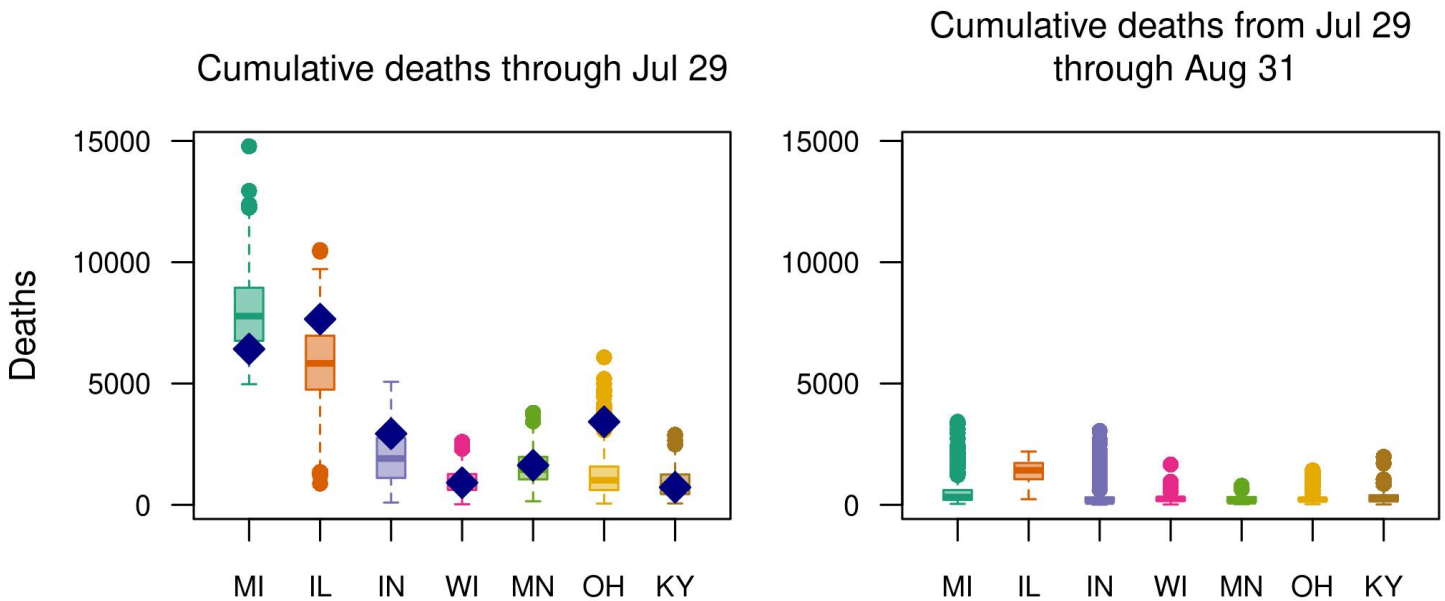
- After the data period, we assumed a linear trend for the forecasting horizon.

Calibrated parameters



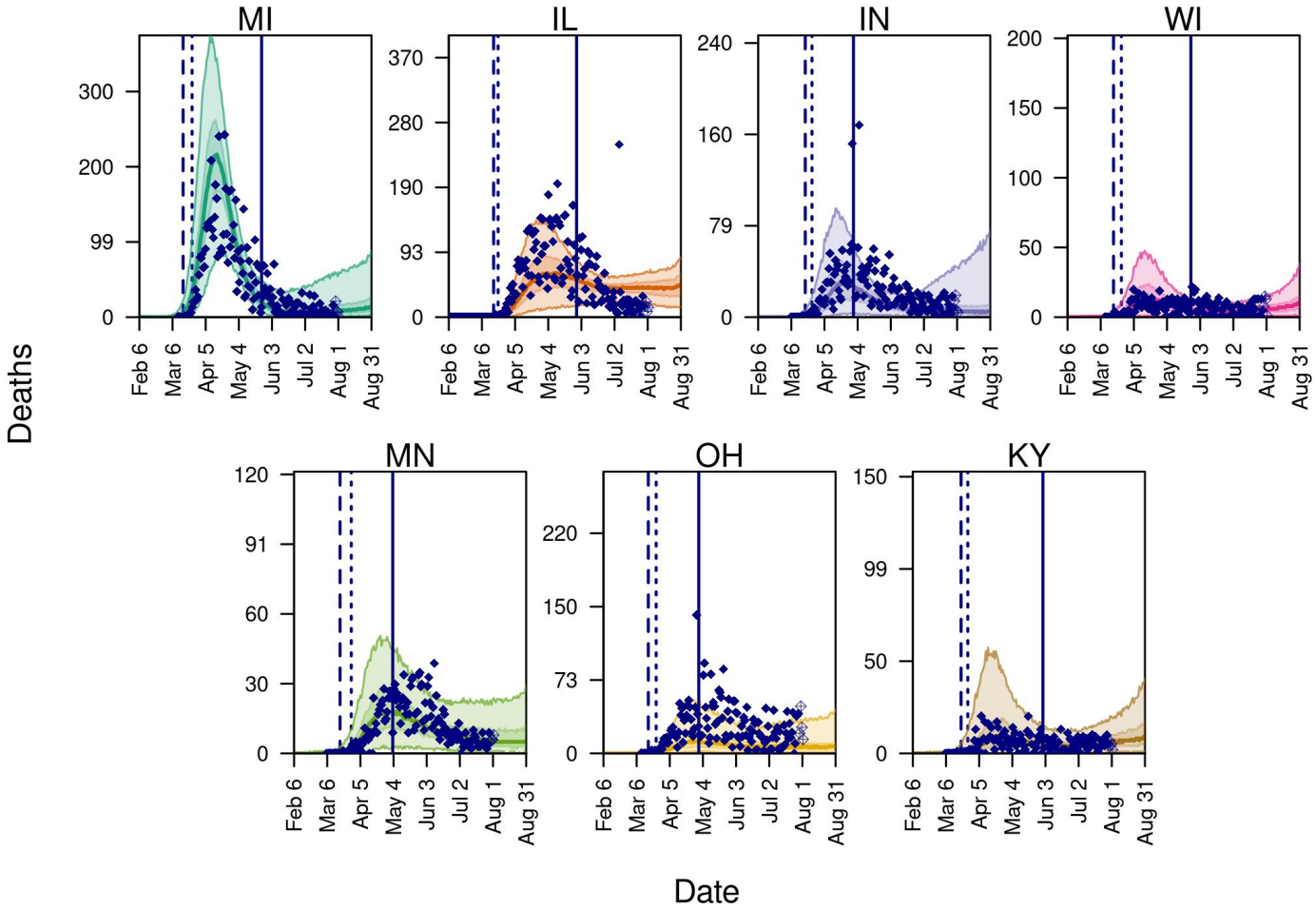
- Parameters were estimated for each state.

Model calibration to deaths



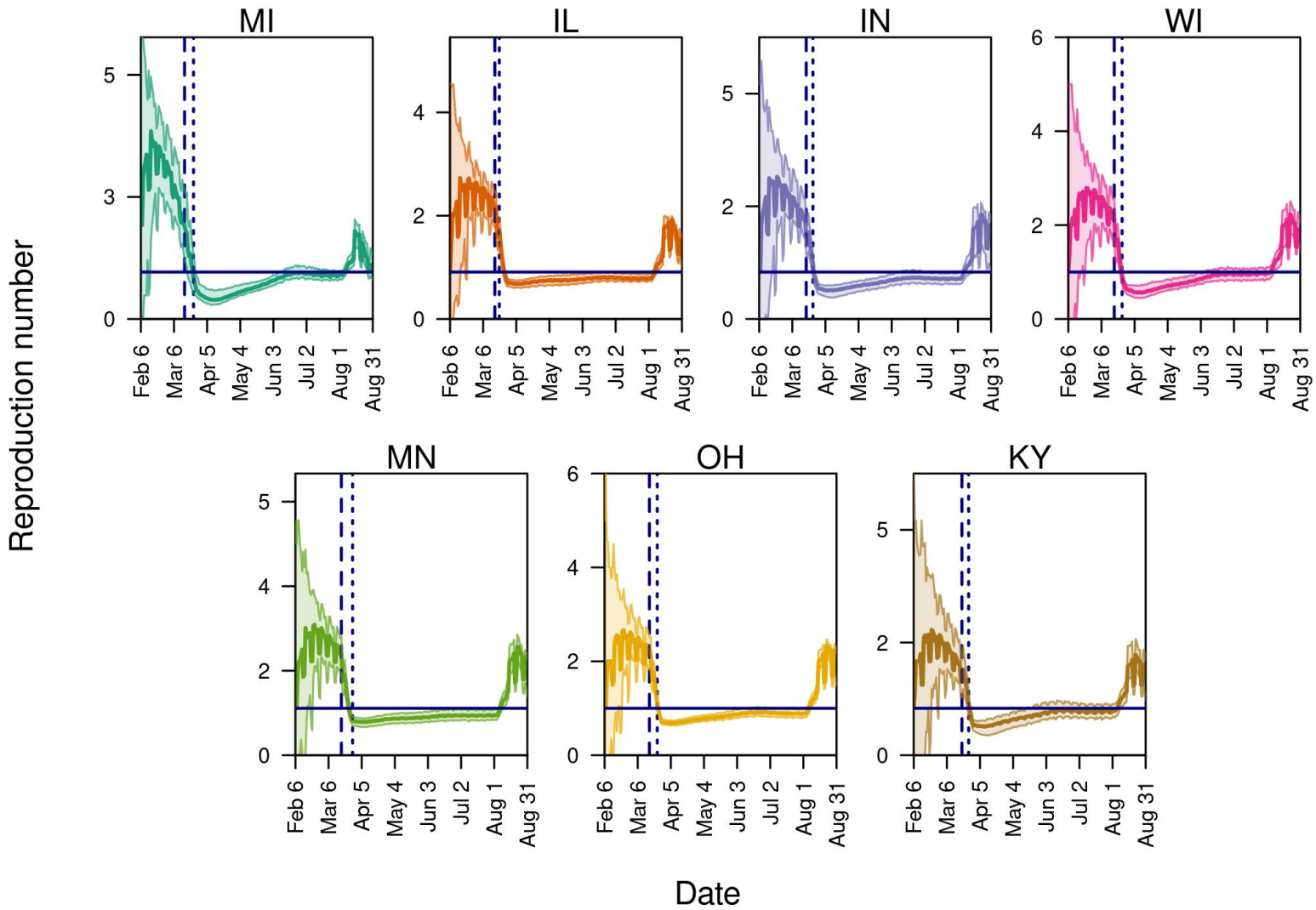
- Cumulative deaths match the reported number of deaths in each state.

Forecast: we assume shelter in place stays with the current trend, schools reopen.

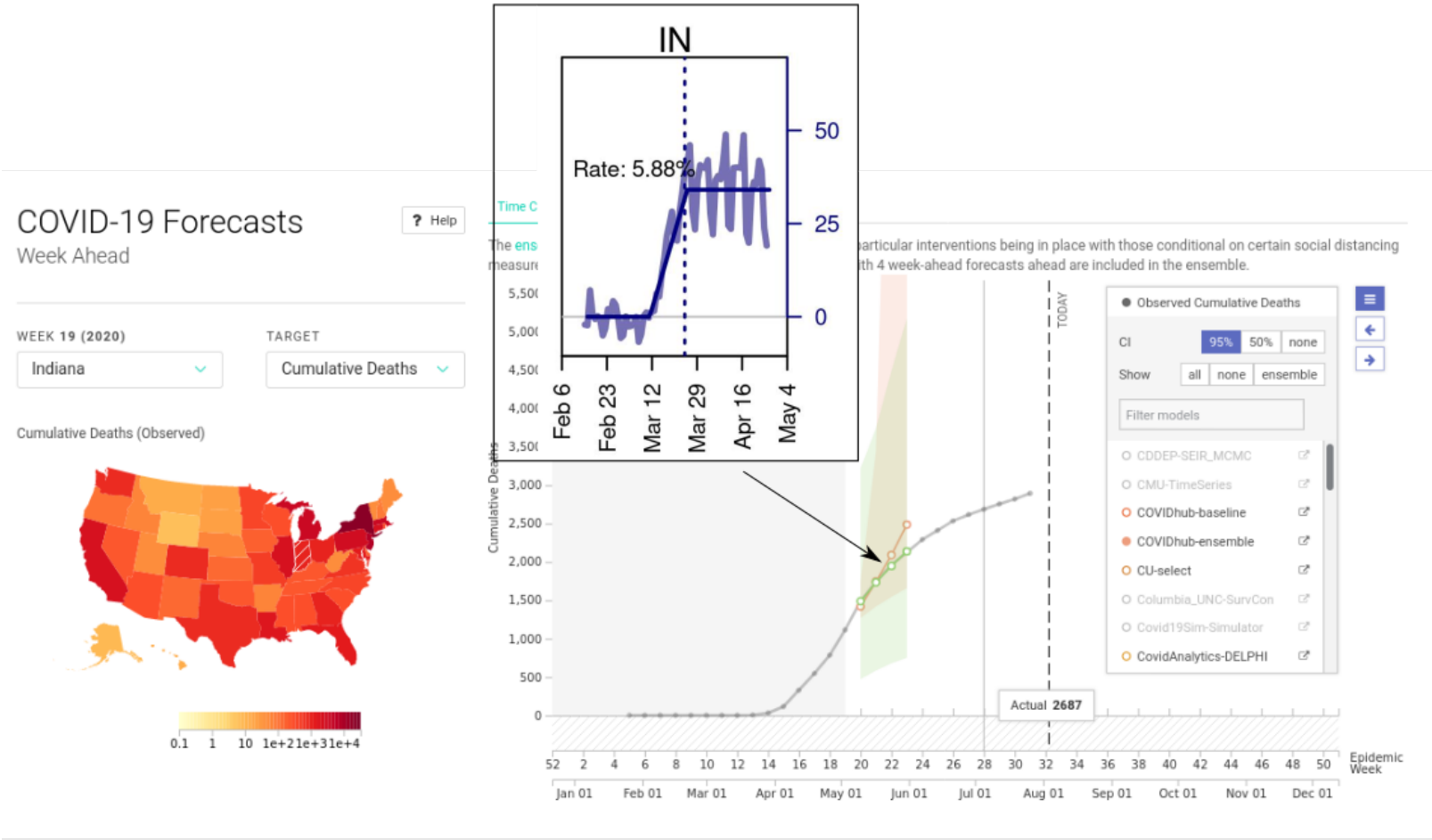


- Large impact of schools. Currently working on school reopen strategies.

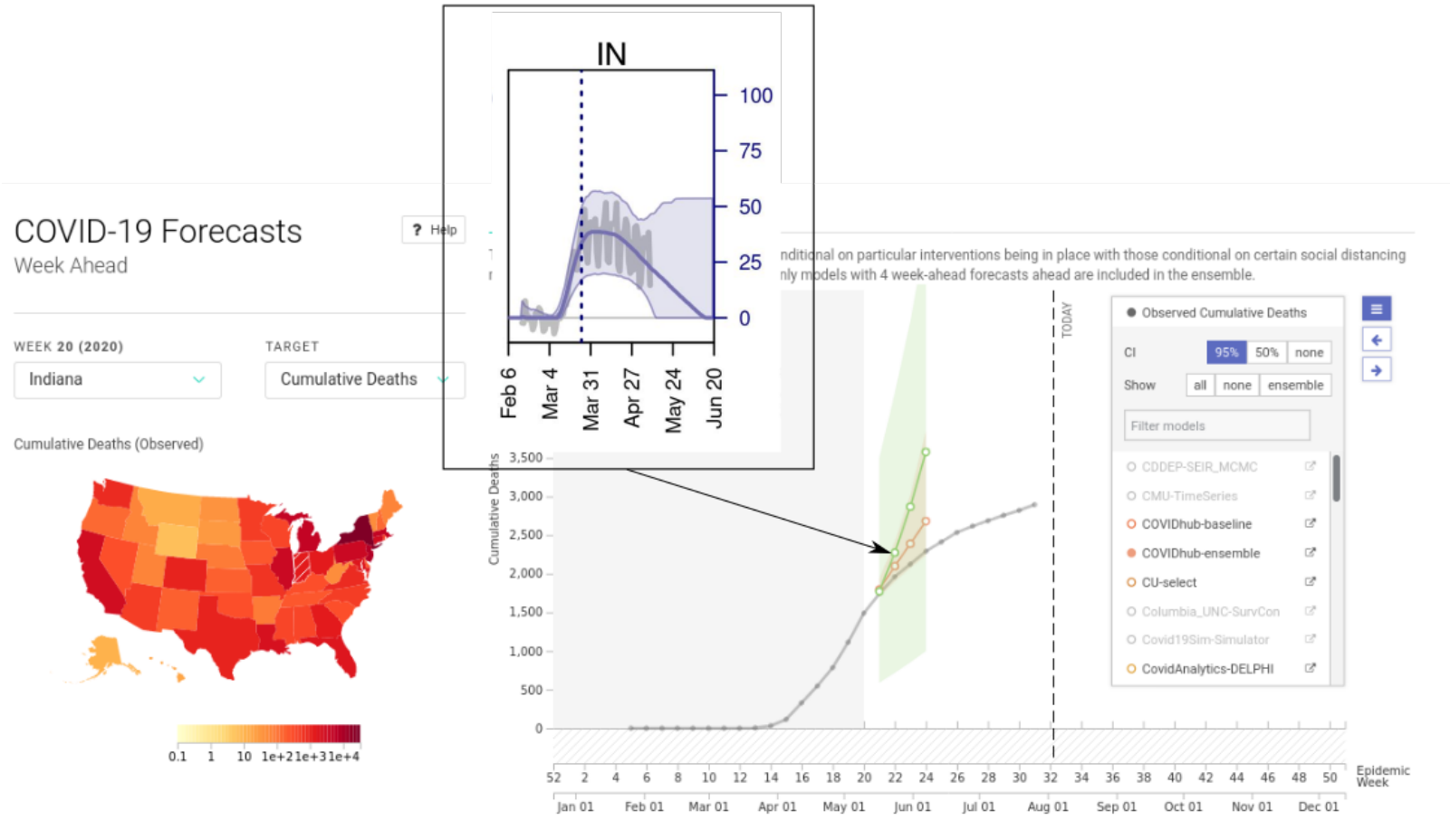
Reproduction number increases after interventions are relaxed and schools are open at full capacity



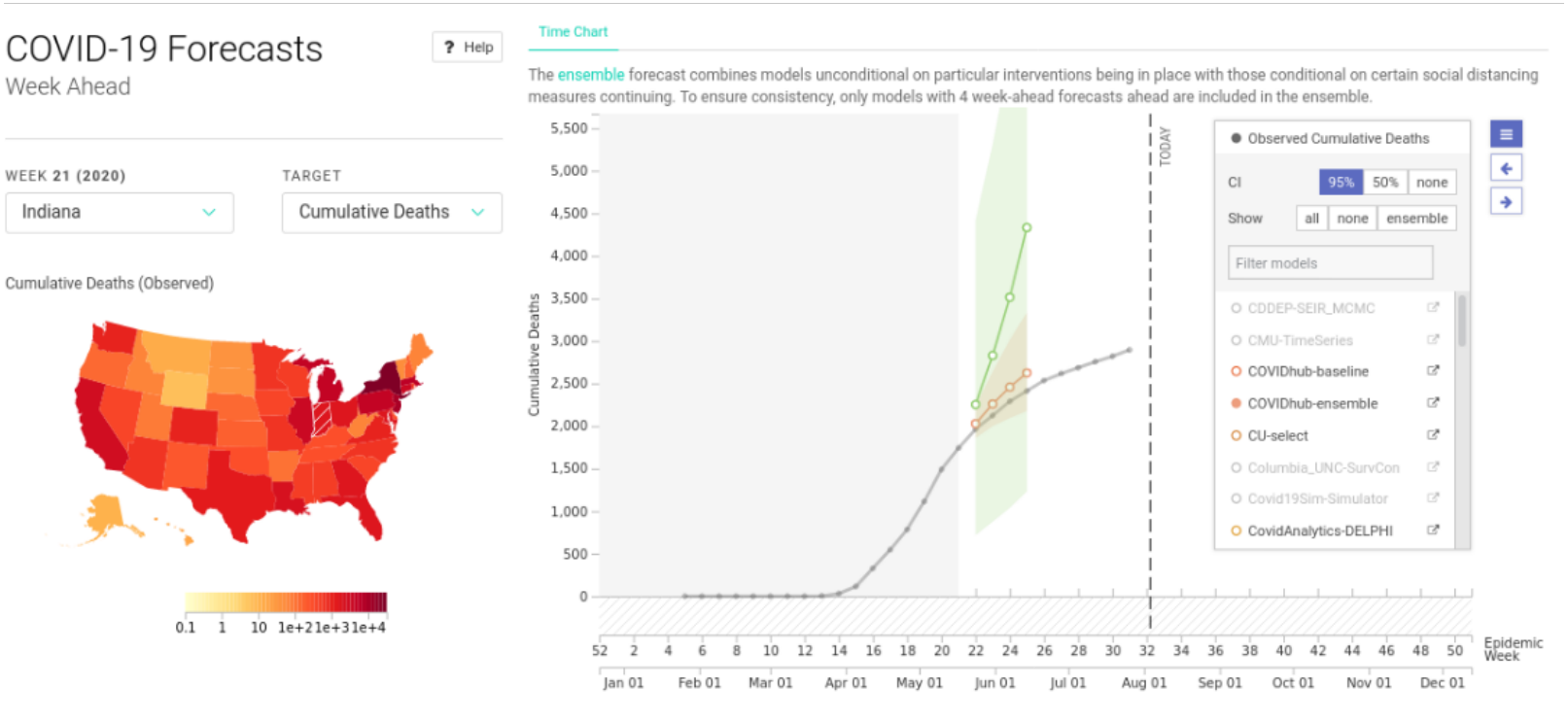
Evolution of forecast



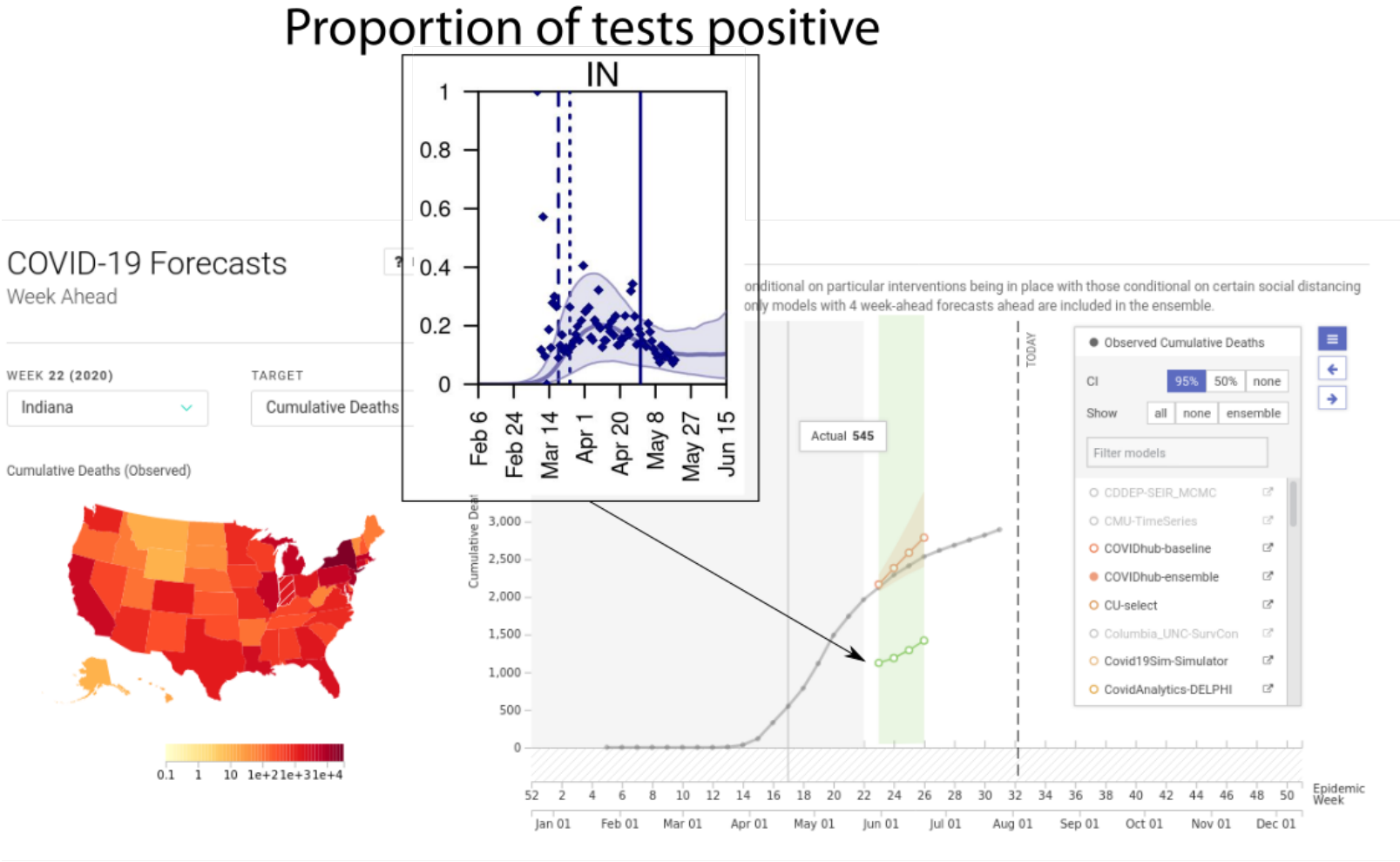
Evolution of forecast



Evolution of forecast



Evolution of forecast



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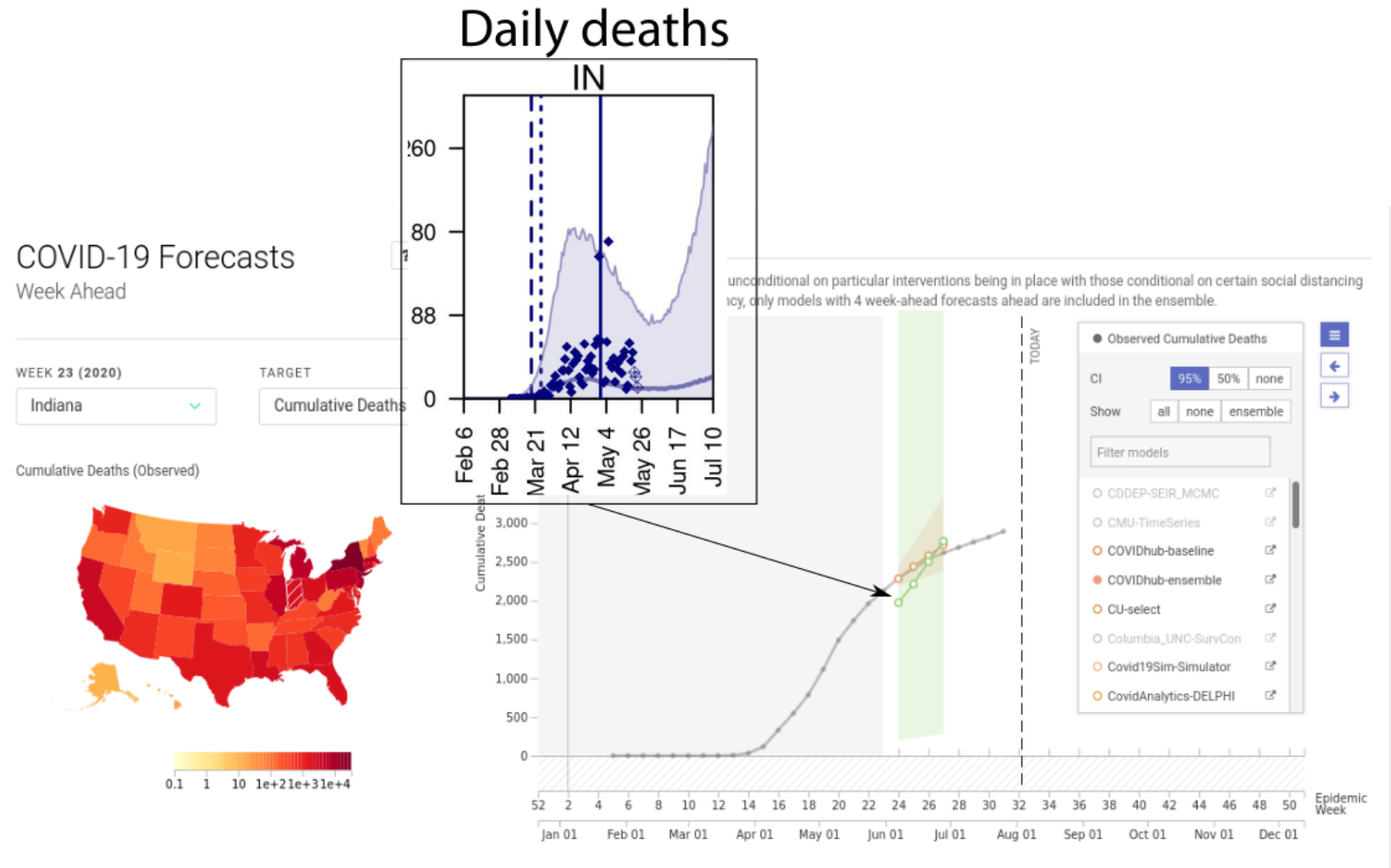
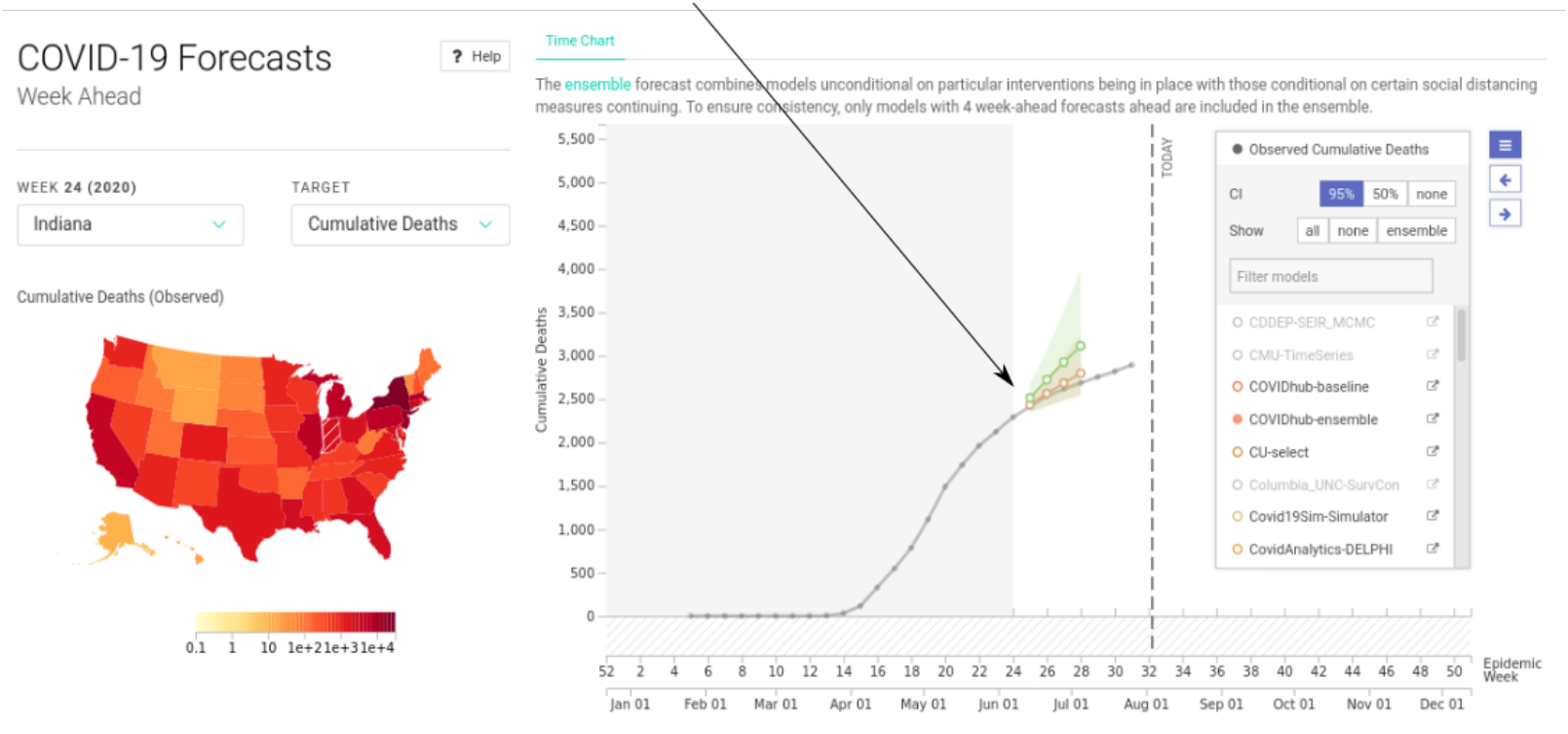


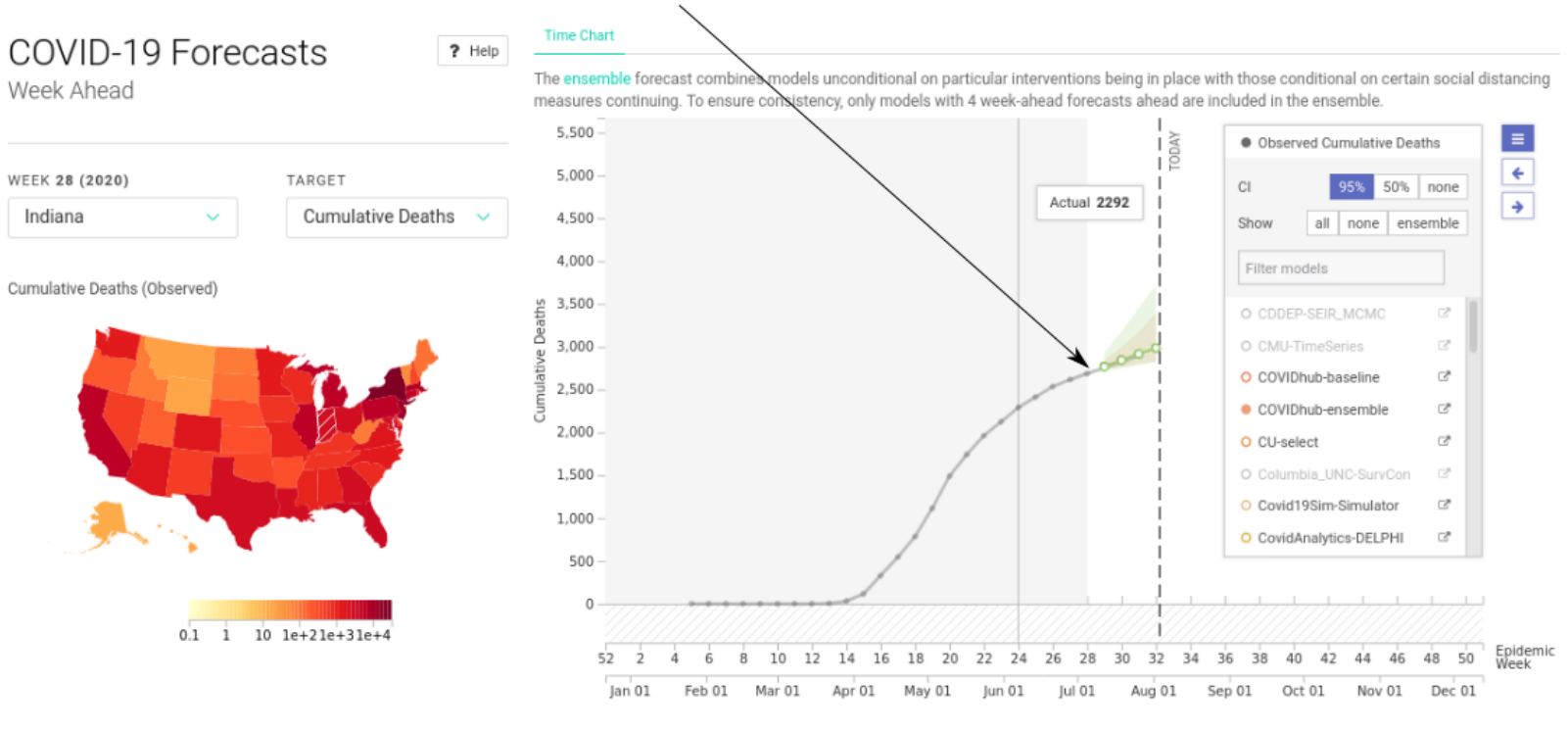
Evolution of forecast

Only forecasting the incidence of deaths after the date of submission

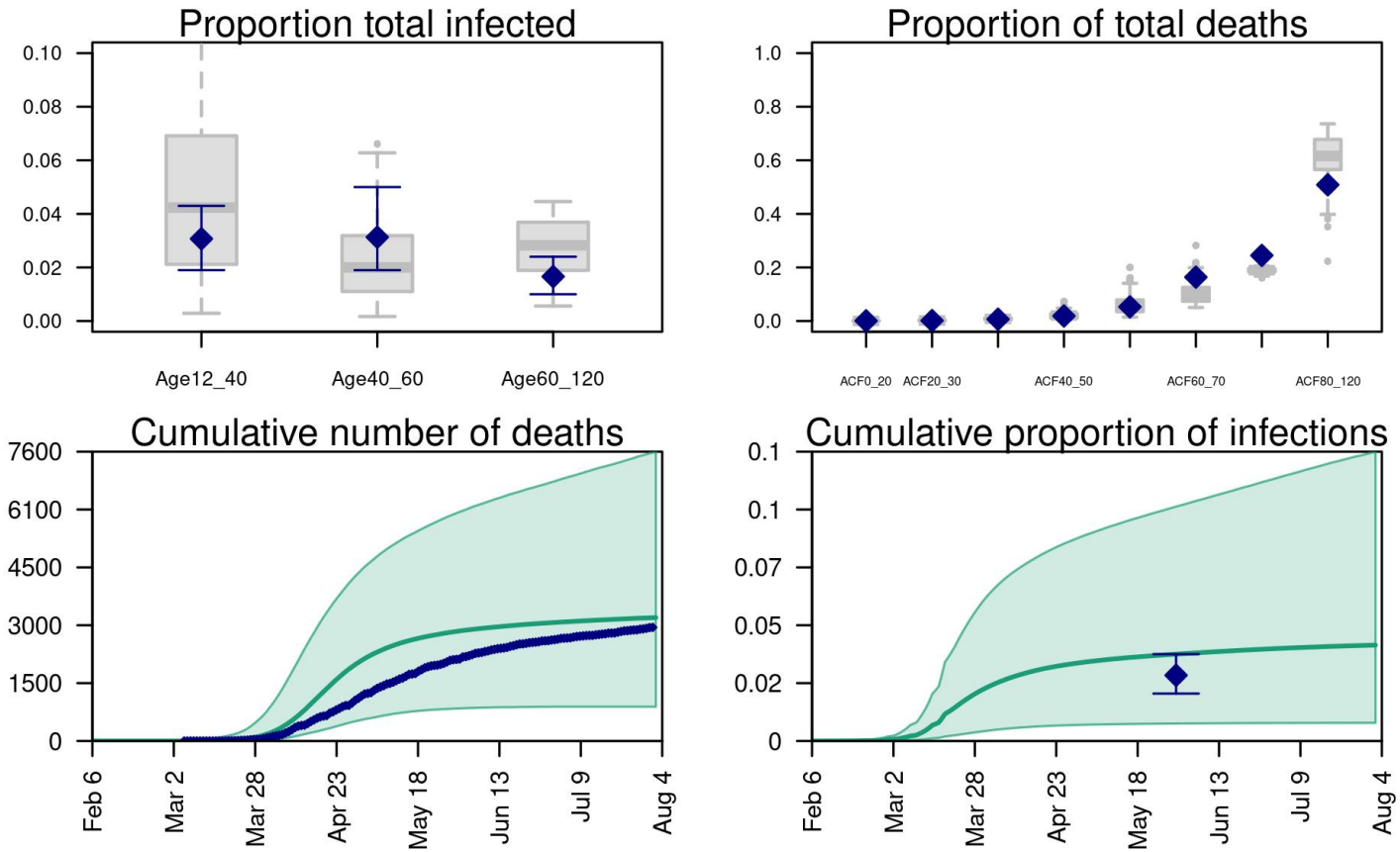


Evolution of forecast

After several updates

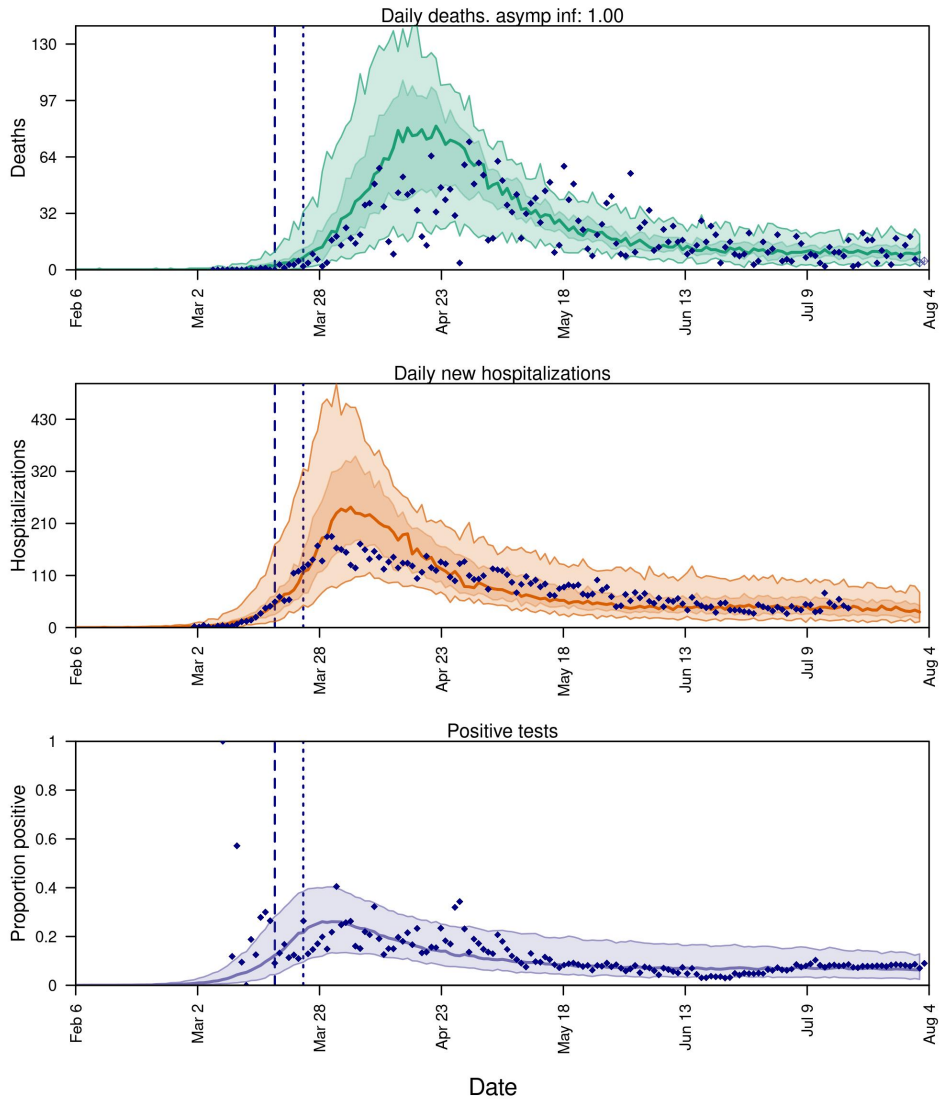


To improve fit in Indiana, we included age-structure data



- Lower susceptibility in <20 based on (Davies et al., 2020).
- We used the number of cases in long-term care facilities and estimated importations to these facilities.
- We calibrated the model to the age structure of deaths in Indiana and validated to serological studies.

To improve fit in Indiana, we included testing and hospitalizations



Future work

- Adding face-masks to improve fit.
- We are using this model to assess school reopening scenarios in Indiana.

Funding statement

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