

# On Obtaining Near Real-Time Insight into the Evolution of the COVID-19 Pandemic

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## MOTIVATION

The emergence of the novel coronavirus (COVID-19) pandemic resulted in the need to gain real-time insight into the pandemic to aid decision making by the government and public health officials.

## OBJECTIVES

- Develop an epidemiological model capable of fusing disparate latency and fidelity sources of data
- Develop a parallel alternative to MCMC that capitalises on HPC resources to allow daily fitting of expensive models

### DATA SOURCES FUSED

- > ONS Death Data (high latency, high fidelity)
- > NHS 111 Calls (low latency, low fidelity)

## ACKNOWLEDGEMENTS

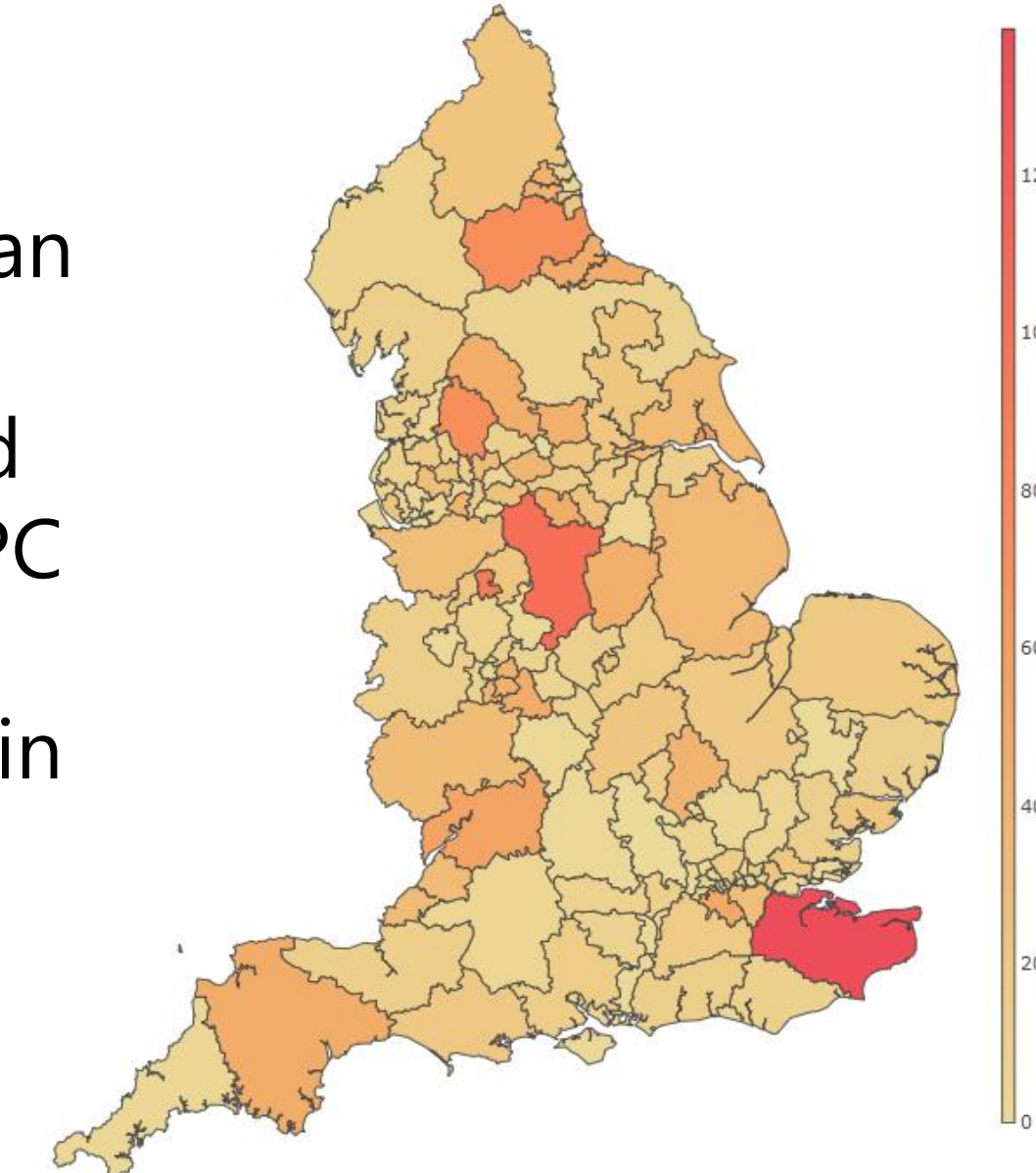


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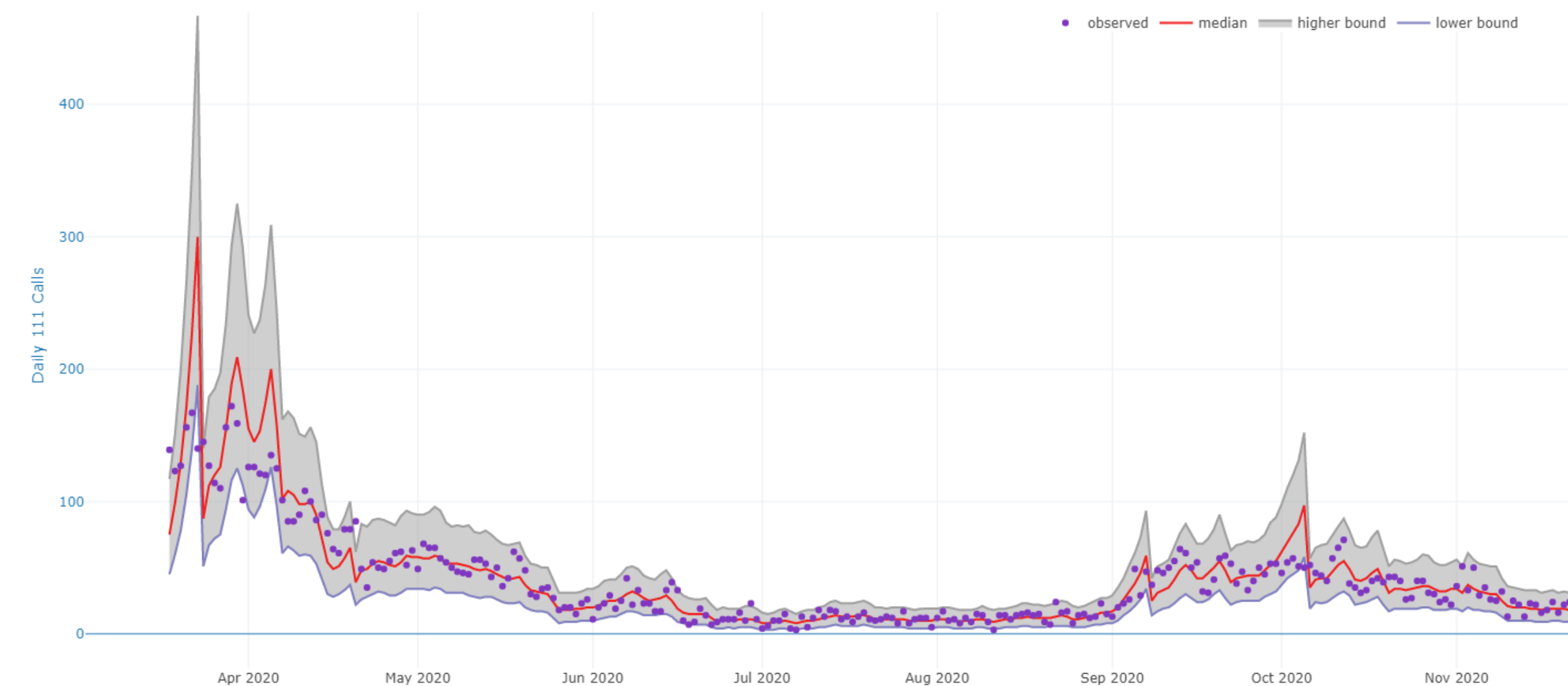
## INSIGHT INTO THE PANDEMIC

- Multiple data sources are fused into an SEIRD
- Automated pipeline to download and preprocess data, and fit model on HPC facilities
- The pipeline runs daily for each CCG in England on Barkla, the University of Liverpool's supercomputer
- Run on 2 nodes, each with 40 cores and 384GB of memory
- Produce a historical timeline of statistics related to COVID-19



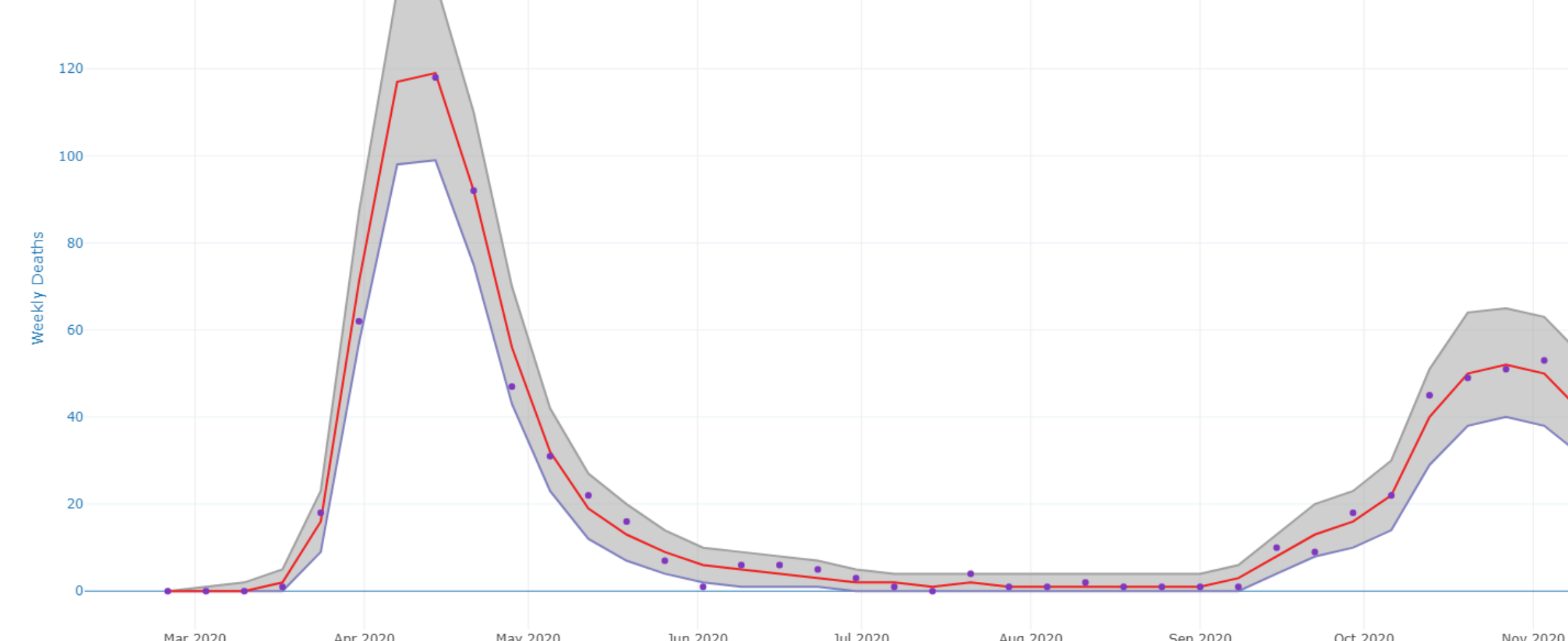
**Figure 1** A heat map showing the predicted number of daily infections across England on the 27/11/2020

• observed — median — higher bound — lower bound



**Figure 2** Predicted daily 111 calls for the Liverpool CCG

• observed — median — higher bound — lower bound



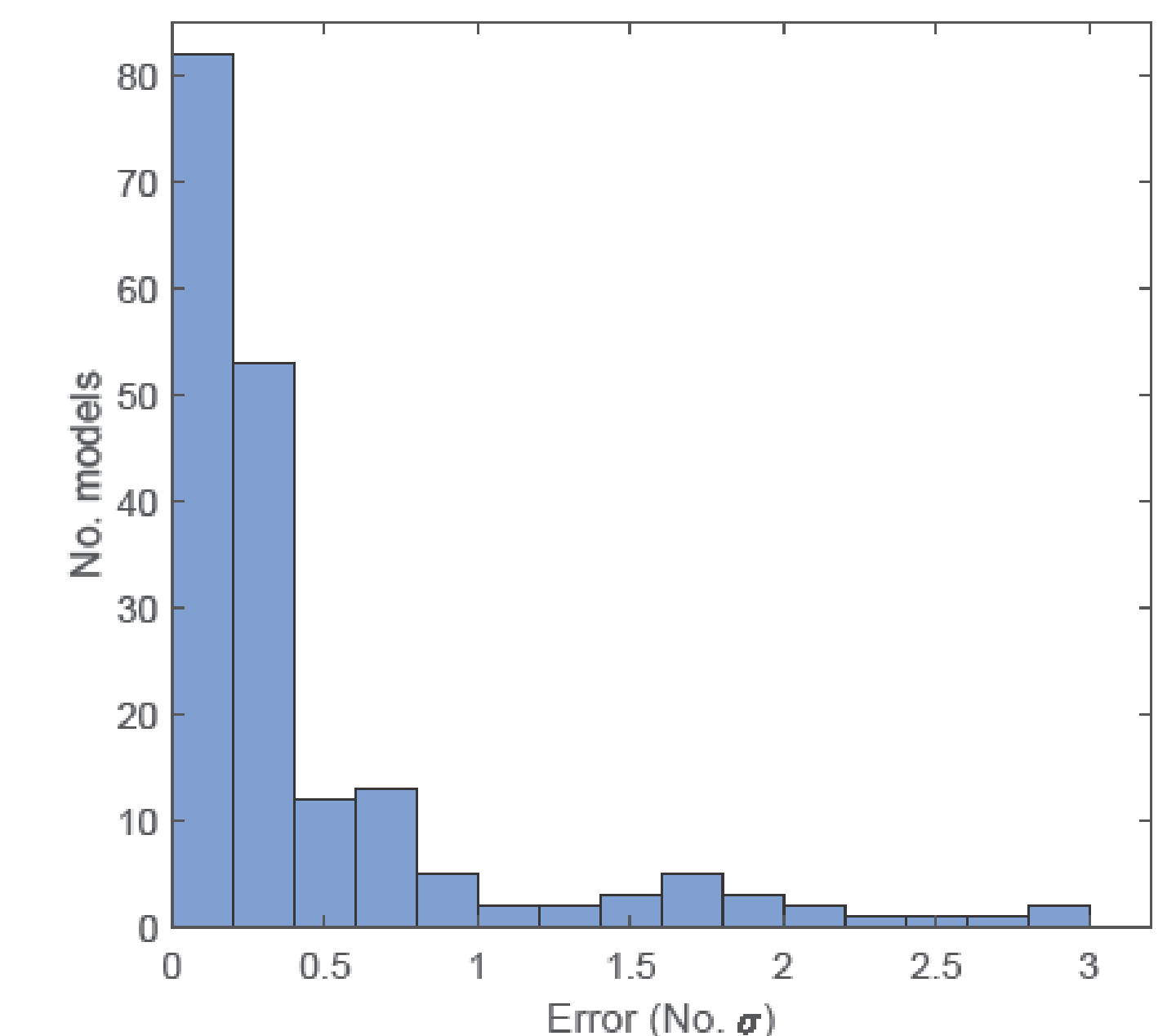
**Figure 3** Predicted weekly deaths for the Liverpool CCG

### ADDITIONAL DATA SOURCES TO FUSE

- > Social media posts pertinent to COVID-19
- > COVID-19 testing data
- > Household surveys from the ONS and NHS Track and Trace
- > Self-based reports through mobile Apps such as the Evergreen Lifestyle App and Zoe App

## FAST BAYESIAN INFERENCE

- MCMC is widely used and widely applicable However, it is inherently sequential and slow.
- Sequential Monte Carlo (SMC) Samplers can capitalise on components of MCMC and more than one processor
- Integrate a high-performance SMC sampler into the backend of Stan as part of the Big Hypotheses research project



**Figure 4** Histogram of mean errors in the parameter values estimated by an SMC Sampler versus NUTS MCMC for 235 Stan models