

Using Agent-Based Simulation to Investigate Behavioural Interventions in a Pandemic using Mobility Data

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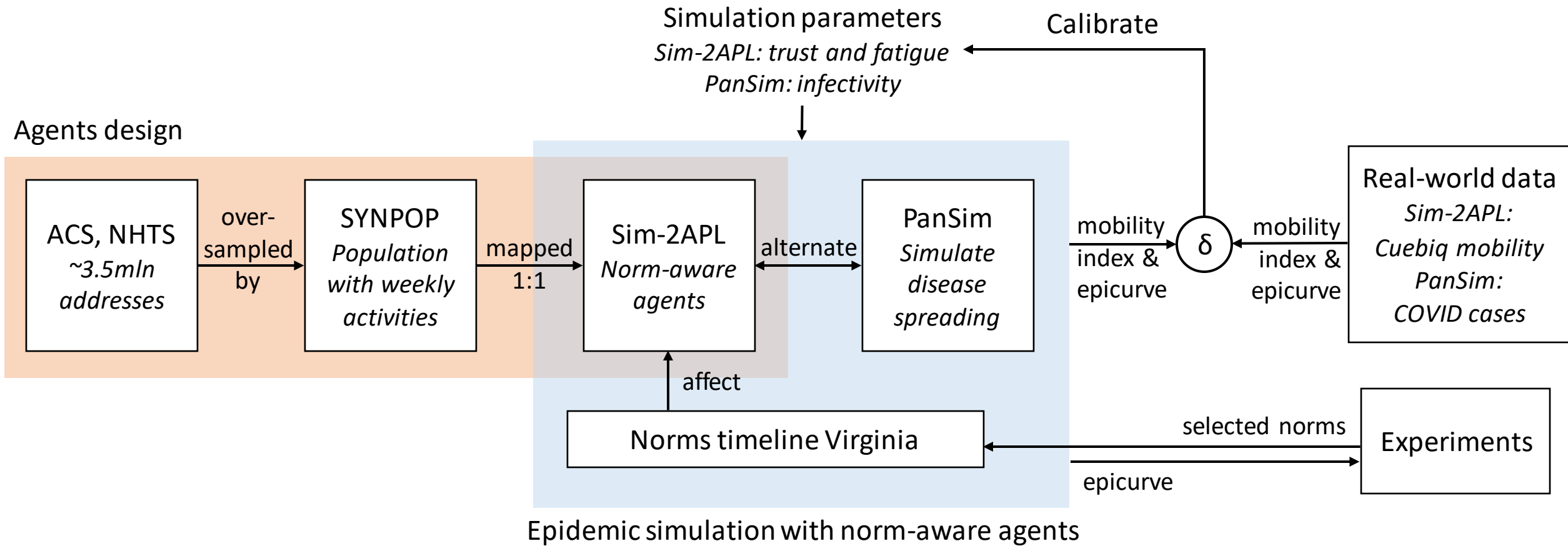
[‡]University of Virginia, USA



**Utrecht
University**

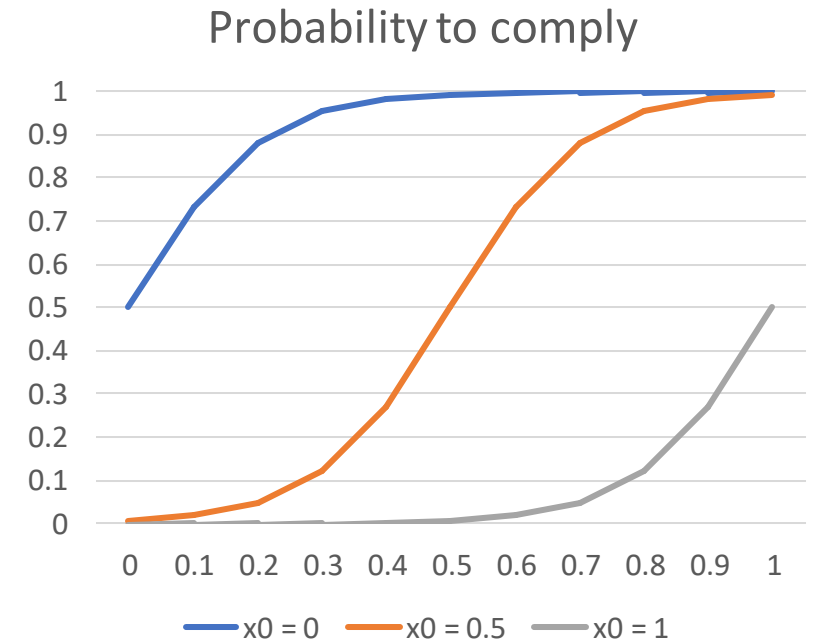
AMPM Workshop
JURIX 2021





Normative Reasoning

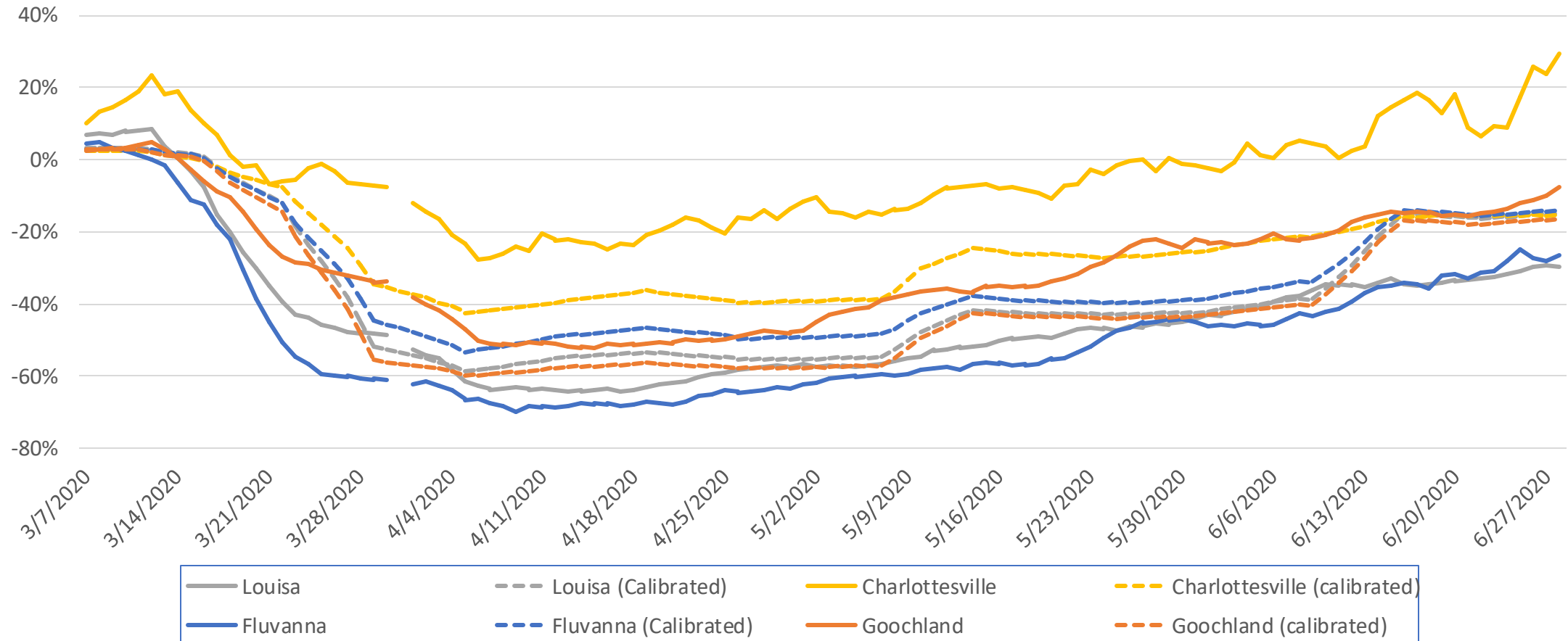
- Is a norm **applicable** to the agent and activity?
- **Probability to comply** with norm n :
 - $p(n, act) = \frac{1}{1 + e^{(-k \cdot (x - x_0))}}$
 - x is (average) **evidence for complying**
 - x_0 is agents **distrust**
 - $k = 10$ **logistic growth rate**
- Applying a norm **transforms** the activity act into an activity act' by
 - **Changing** a **modality** or the **duration**
 - **Cancelling** the activity



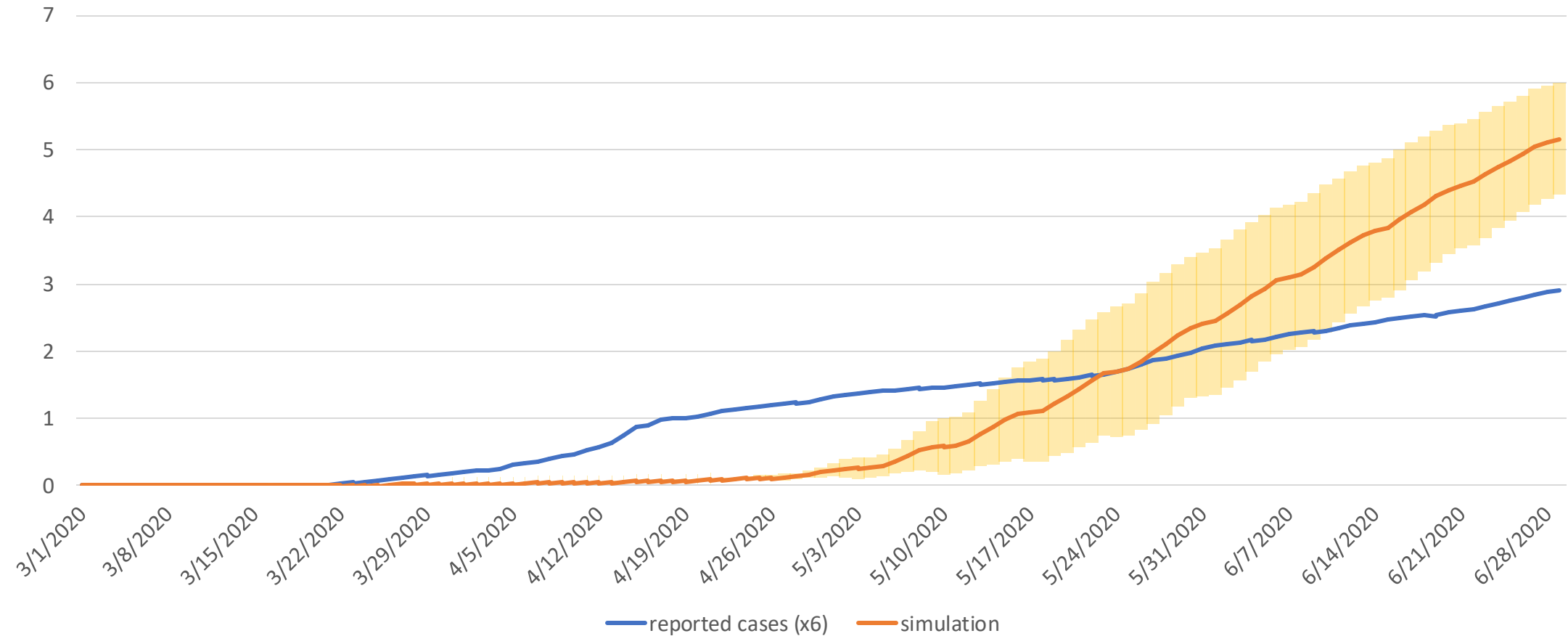
Calibration

- Trust sampled from two Beta distributions: $\text{Beta}(\alpha, \beta)$
 - $\alpha = \mu \cdot \kappa$
 - $\beta = (1 - \mu) \cdot \kappa$
 - $\kappa = \alpha + \beta = 100$ (characterizes spread of distribution; fixed)
- μ is calibrated separately for conservative and progressive voters
- Trust decreases by fatigue
 - fixed rate fatigue factor f
 - starting at time step t_f
- Disease model:
 - Infectivity of symptomatic and asymptomatic agents
 - Per unit-time (5 minutes)
- Nelder-Mead minimisation of Root Mean Square Error
 - Mobility for behavior model
 - Case data vs. recovered agents for disease model
 - Termination condition: No improvement in next 10 runs

Calibration results



Calibrated Disease Progression



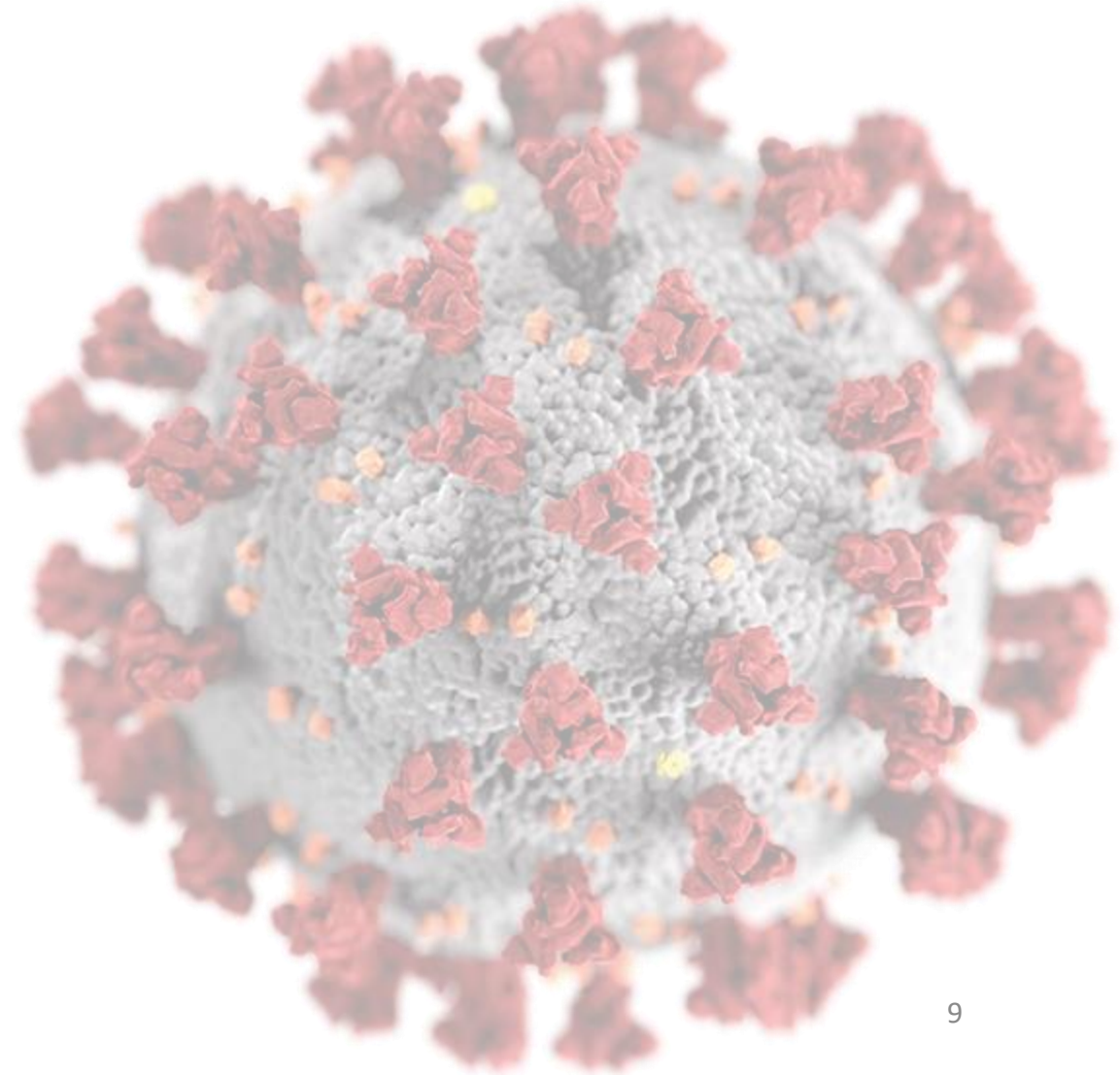
Thank you

Future Work

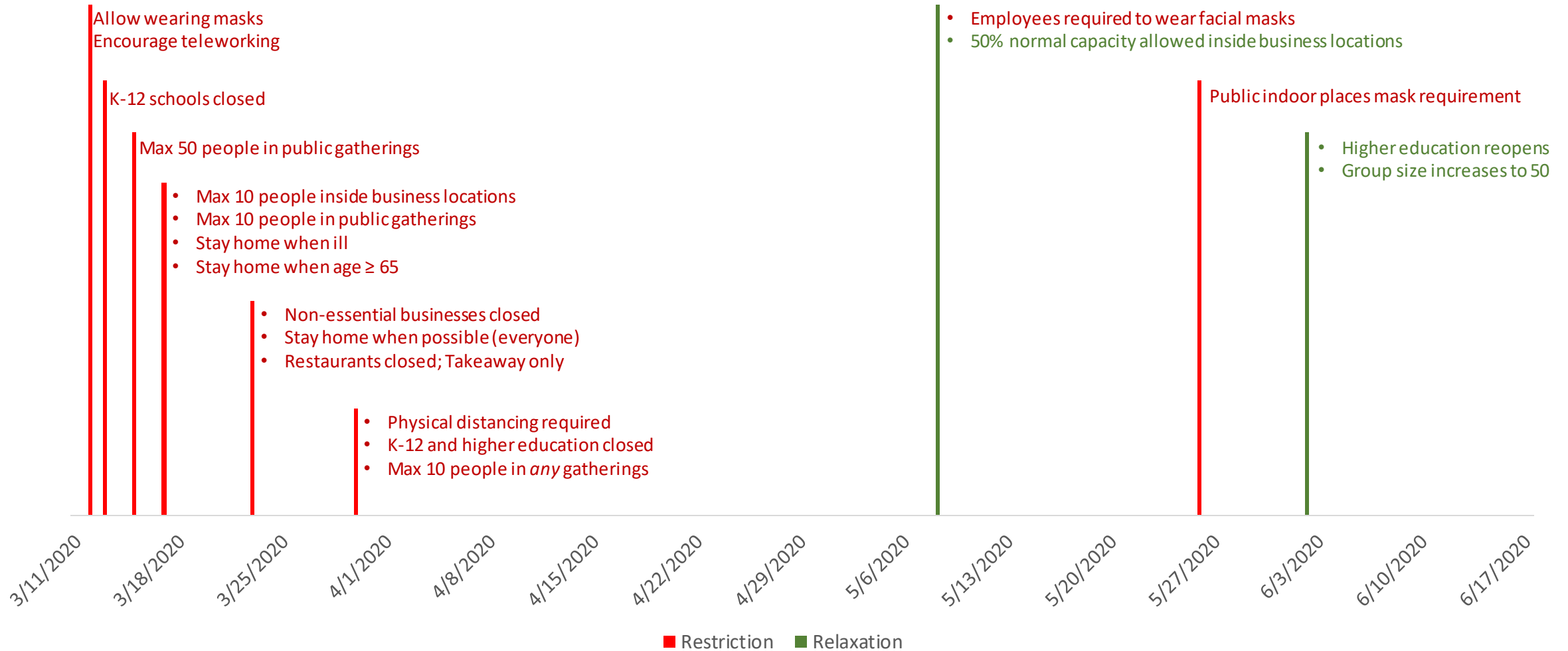
- Improved factors for decision making
- Include more demographic data in decision making
- Automated search for optimal policies

A Covid-19 Epidemic Simulation with Norm-aware Complex Agents

- Non-pharmaceutical interventions have been heavily used to limit the spread of Covid-19
- Important to understand the efficacy of these interventions
- Agent based simulation is an effective tool for this



Timeline of COVID-19 Restrictions in Virginia



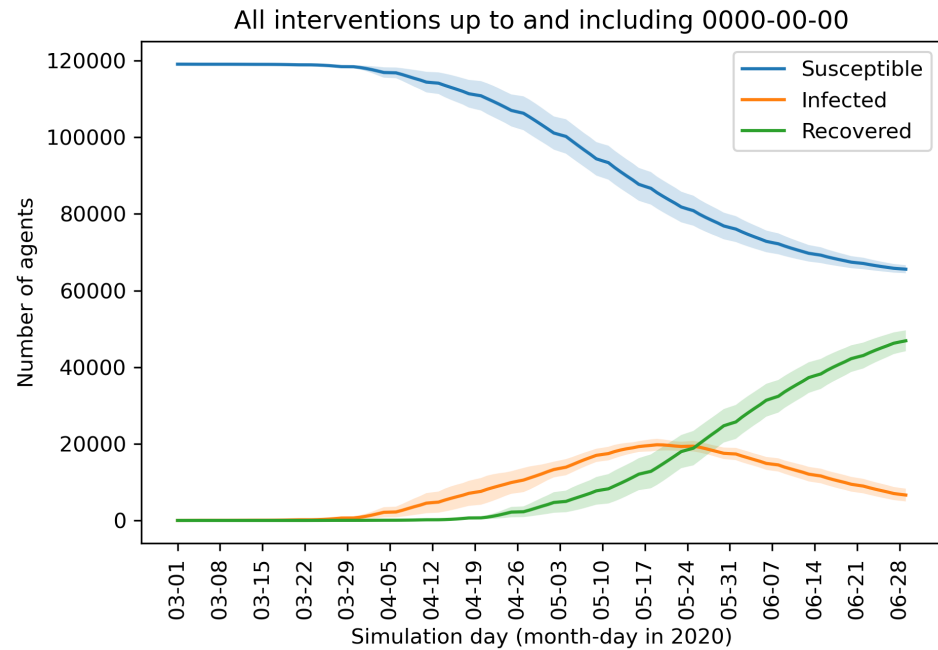
Norms

- **Regimented (R)**
 - Businesses closed
 - Reduce business capacity
 - (50% first, 10 max later)
 - Schools closed
 - (k12 first, k12 & higher education later)
 - Restaurants are closed; takeaway food only
- **Non-Regimented (NR)**
 - Allow wearing of face masks
 - Employees are required to wear masks
 - Teleworking is encouraged
 - Maintain physical distance
 - Keep groups small (<10)
 - Stay home
 - Wear masks at public indoor locations

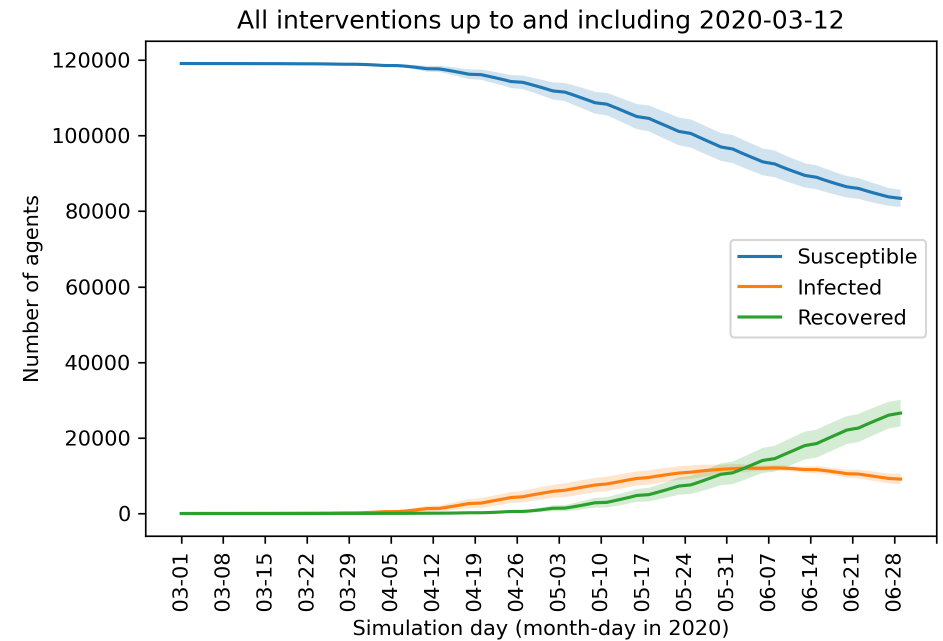
6 Activity Types

- Home
- Work
- Shop
- School
- Religious
- Other

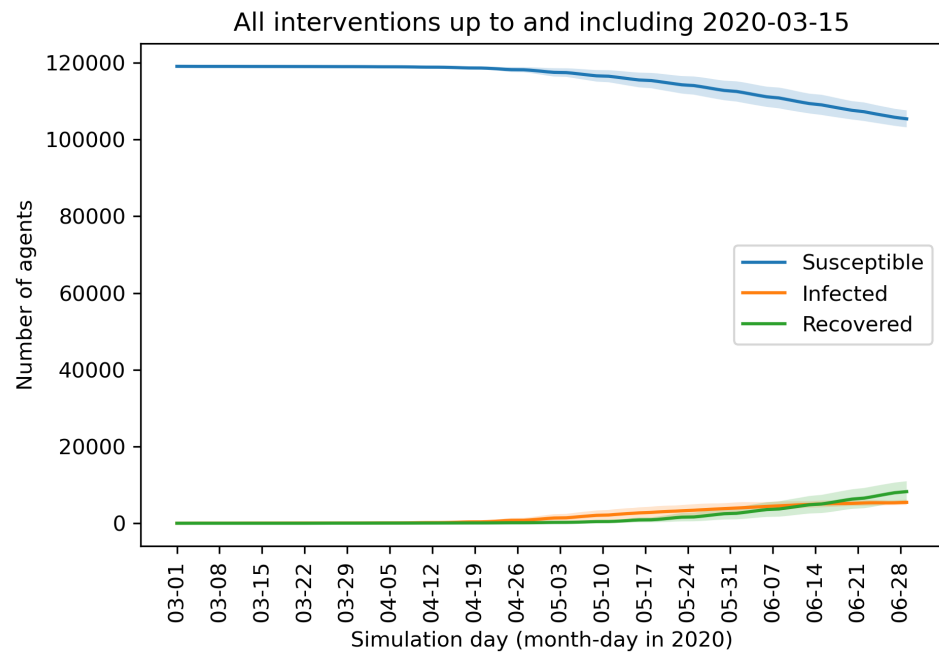
First 0 EOs



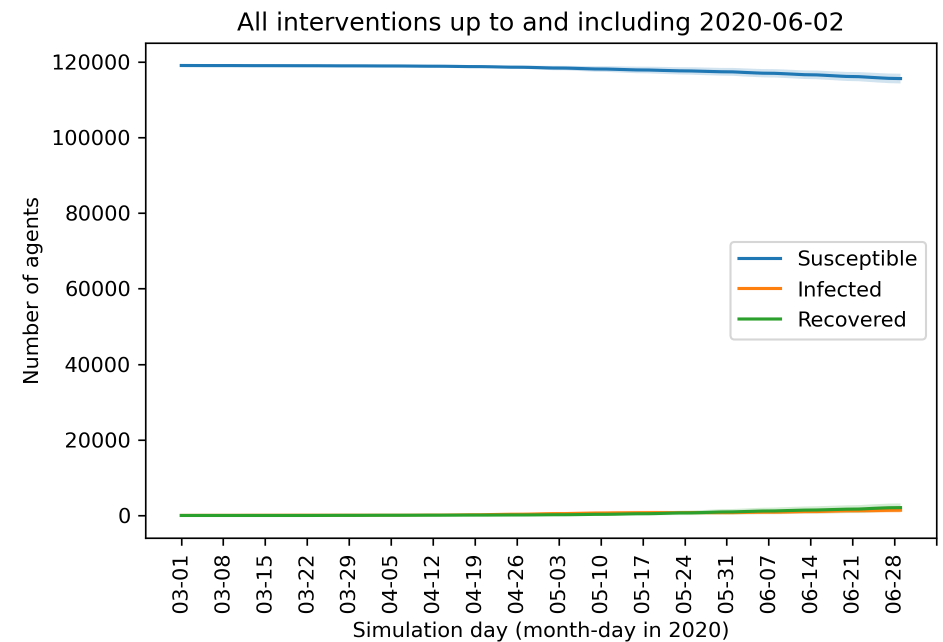
First 1 EOs



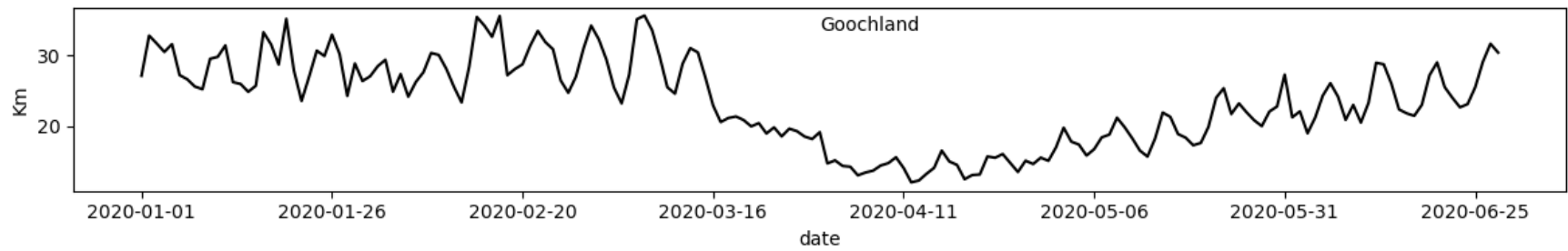
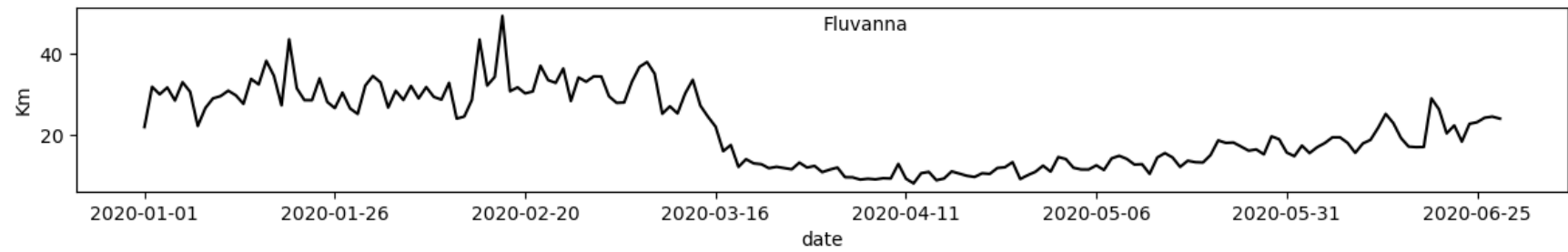
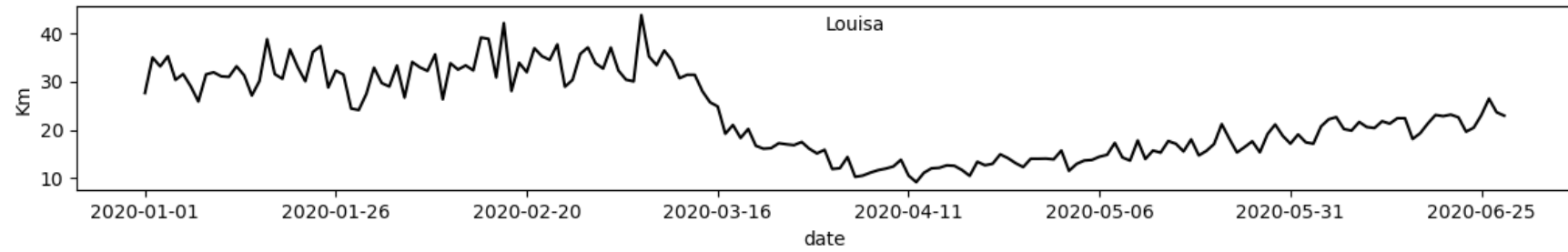
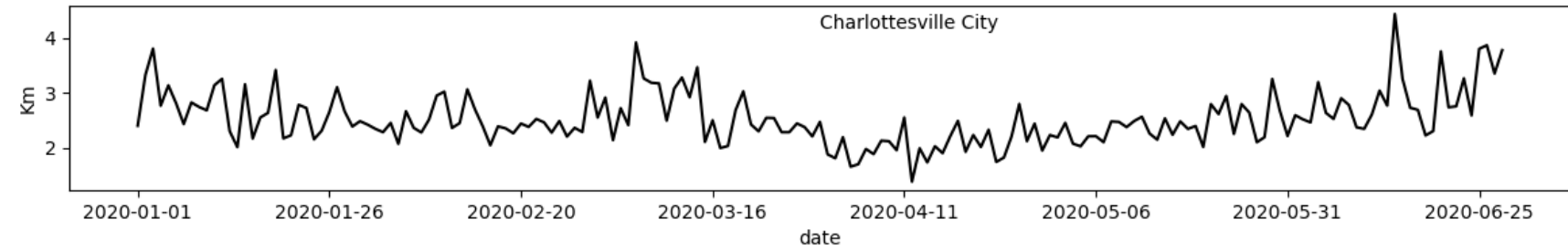
First 3 EOs



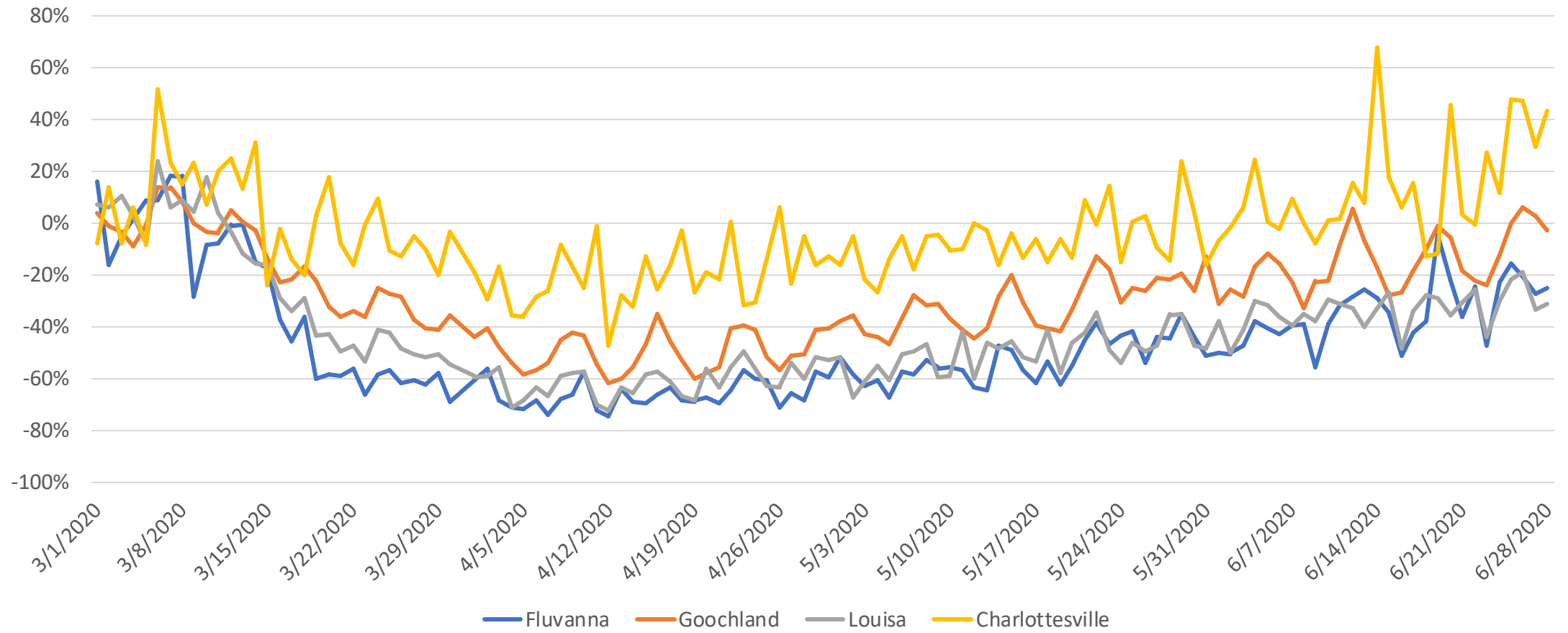
First 9 EOs



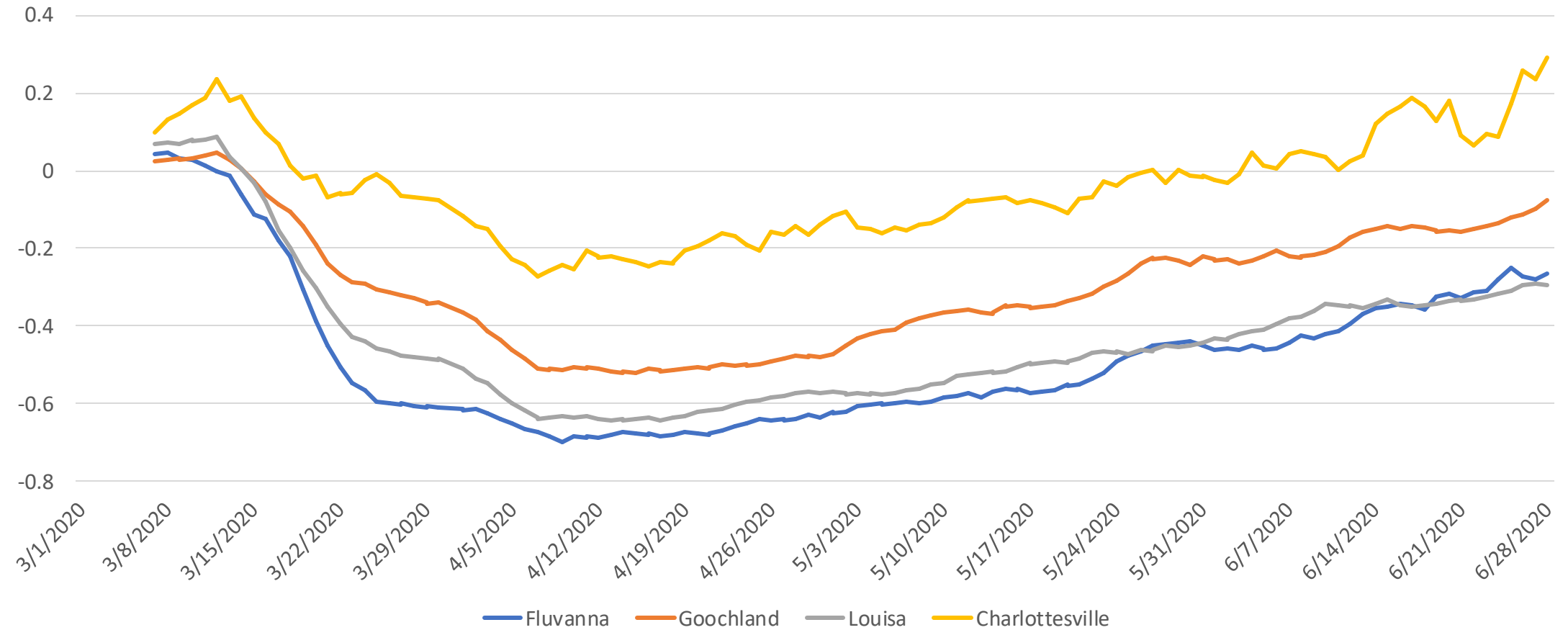
From gyration to mobility index



Mobility Index



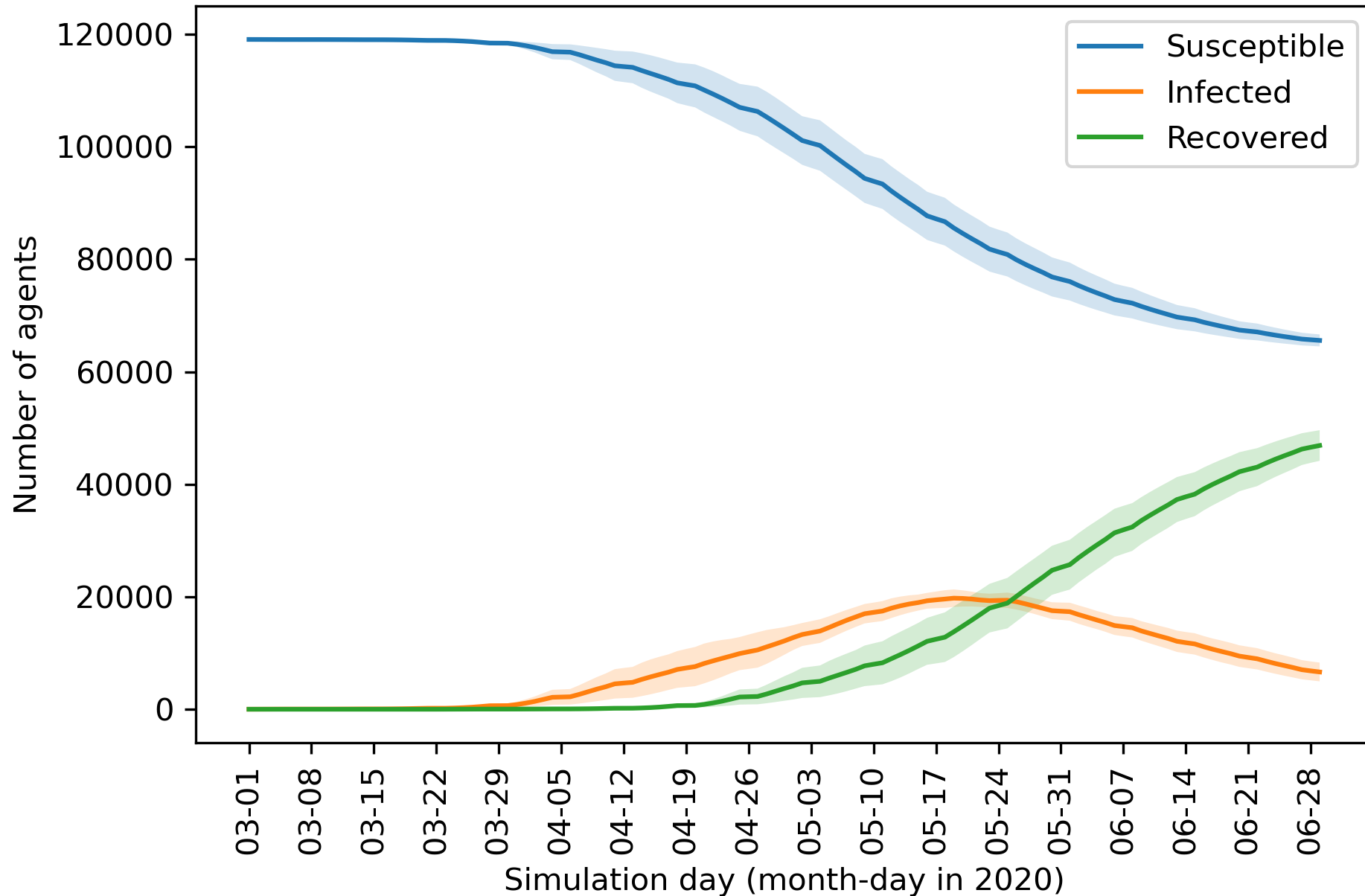
After smoothing



Counterfactual experiments

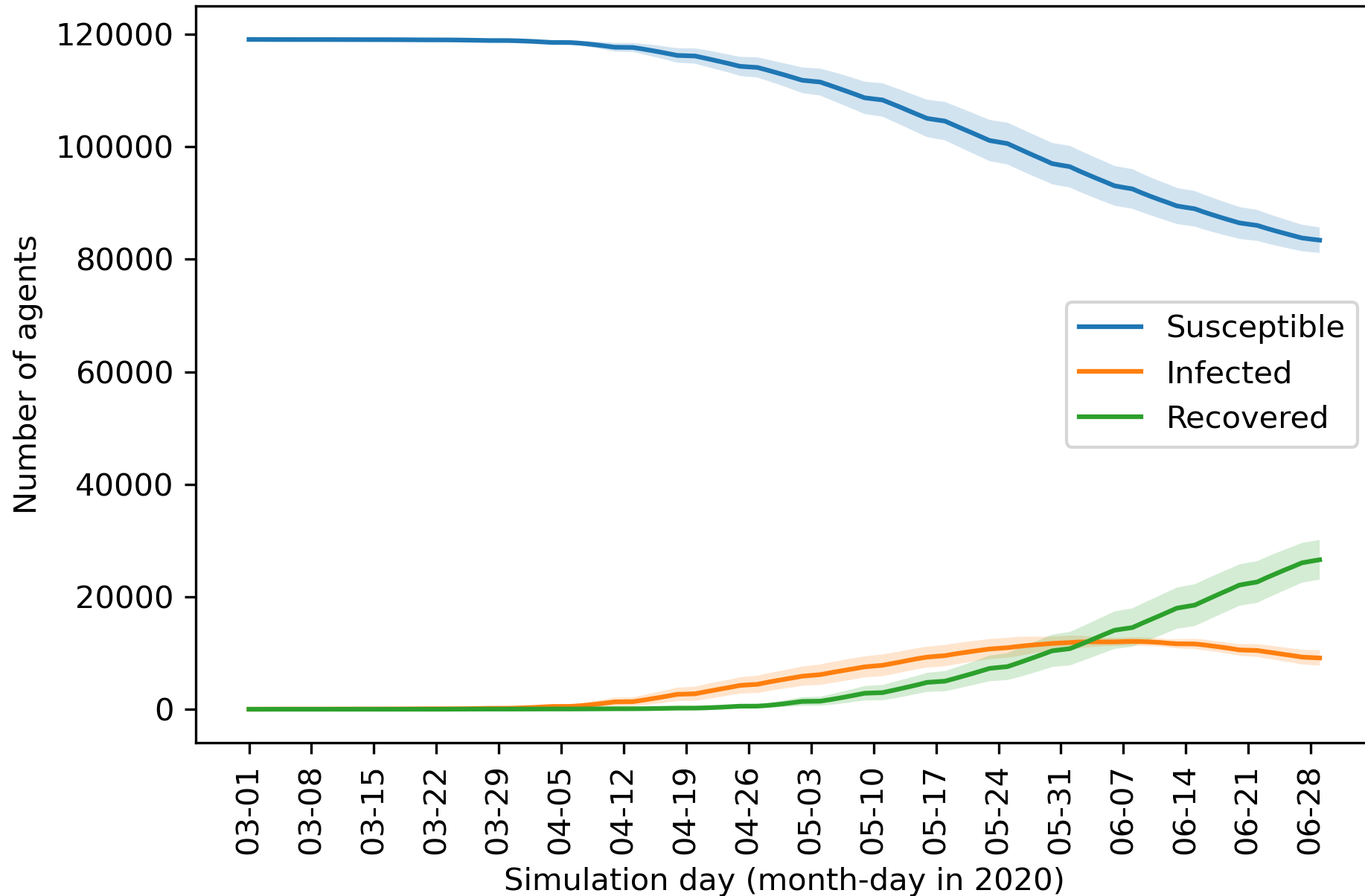
First 0 EOs

All interventions up to and including 0000-00-00



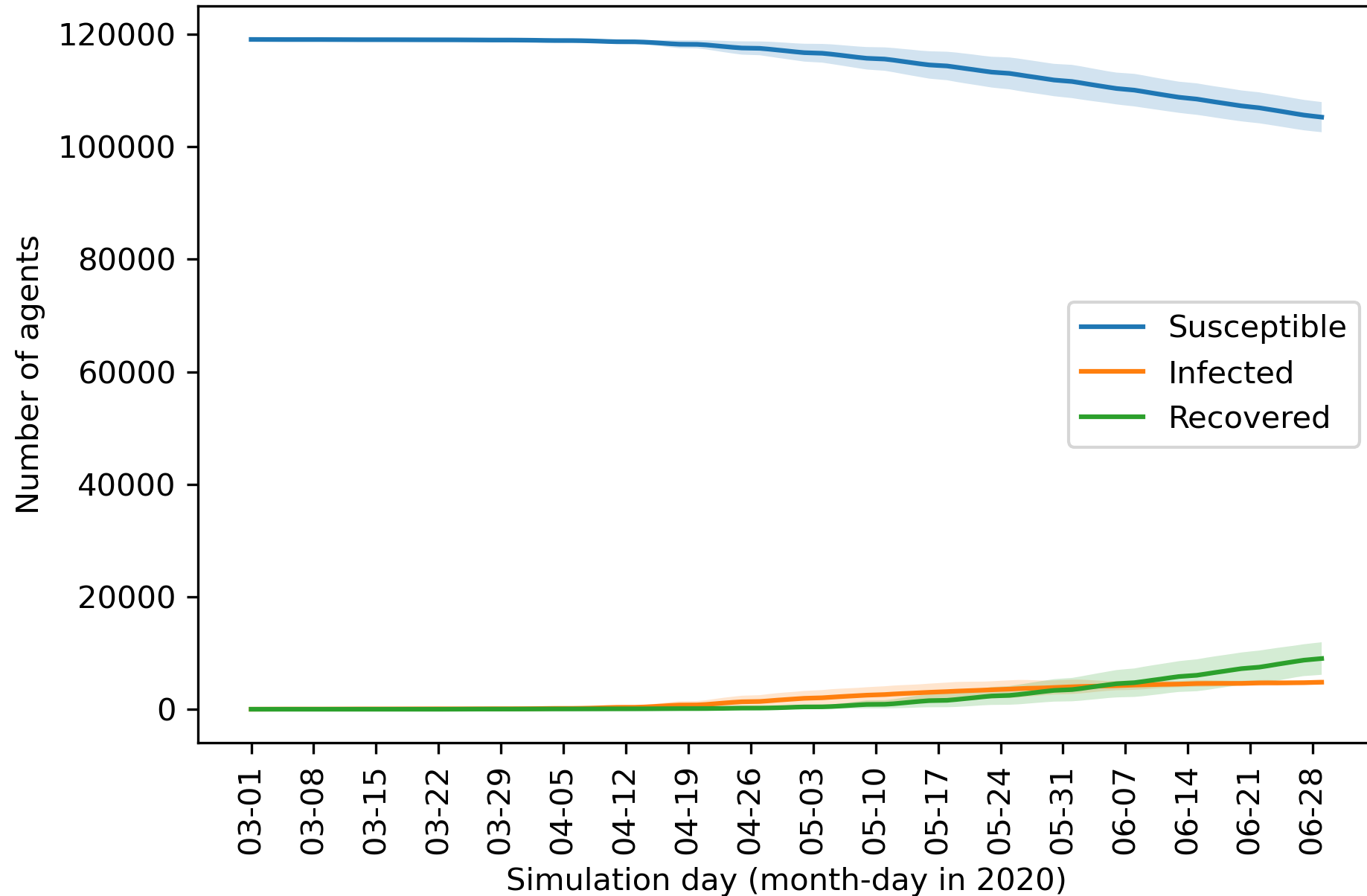
First 1 EOs

All interventions up to and including 2020-03-12



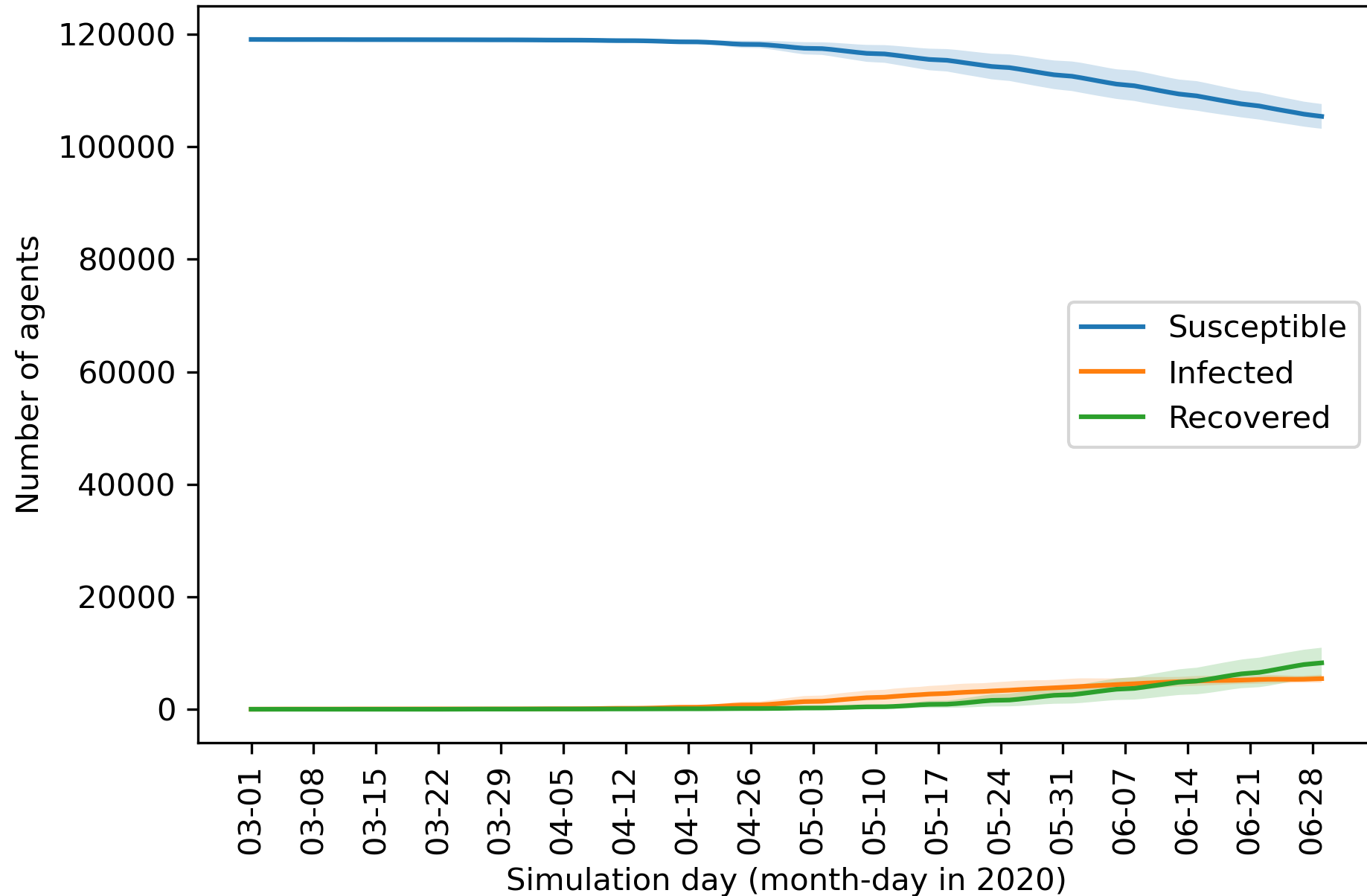
First 2 EOs

All interventions up to and including 2020-03-13



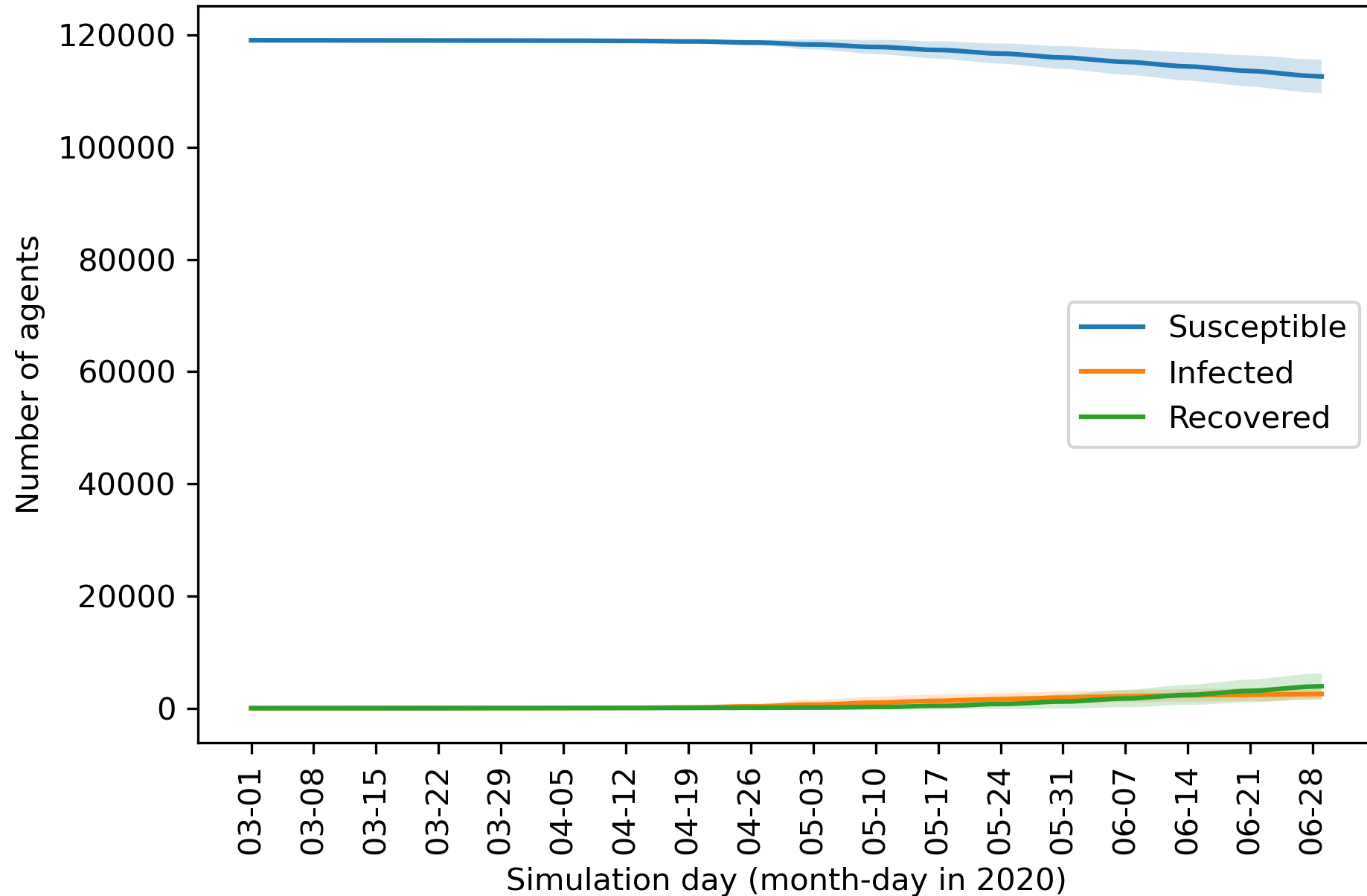
First 3 EOs

All interventions up to and including 2020-03-15



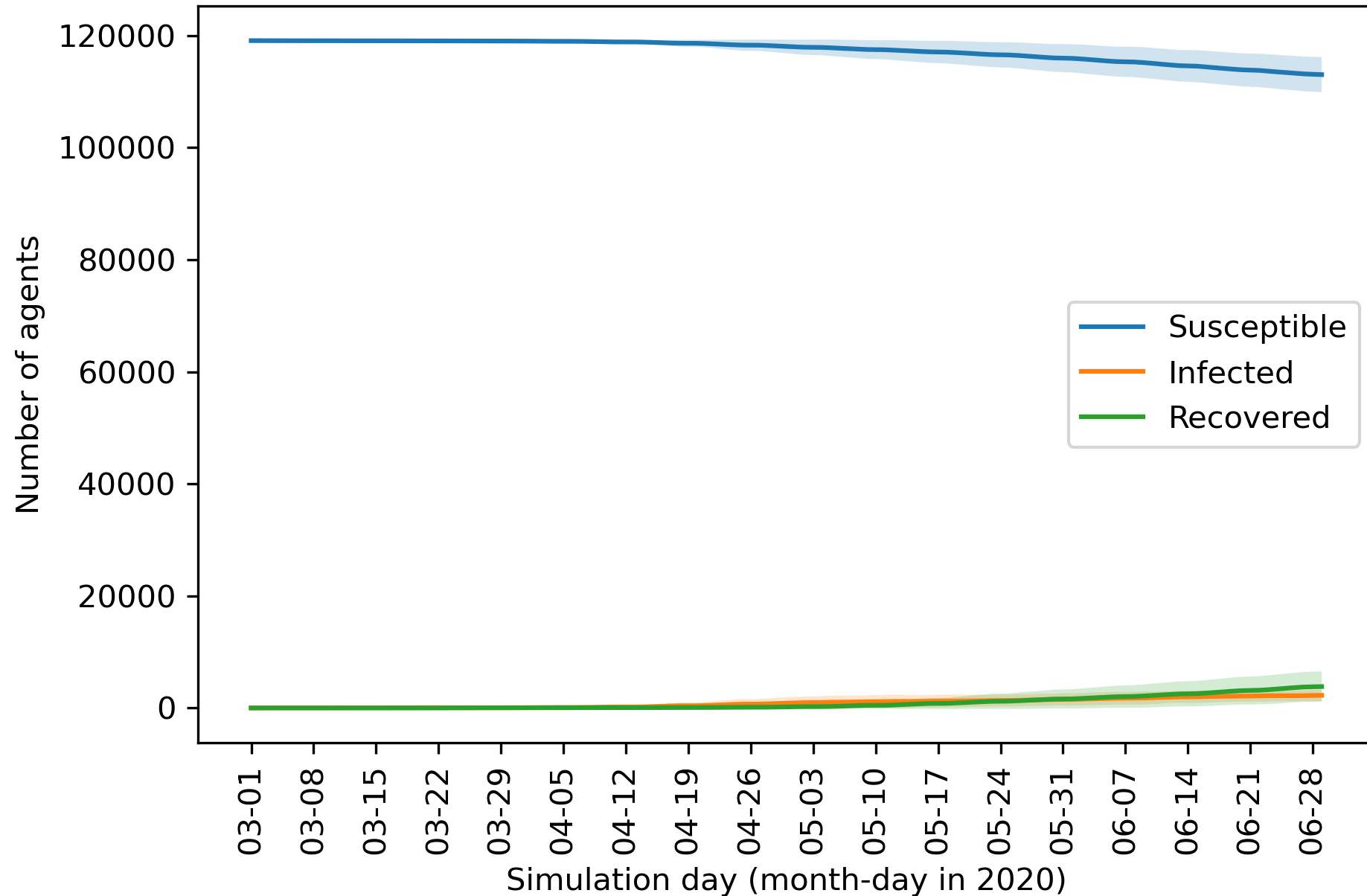
First 4 EOs

All interventions up to and including 2020-03-17



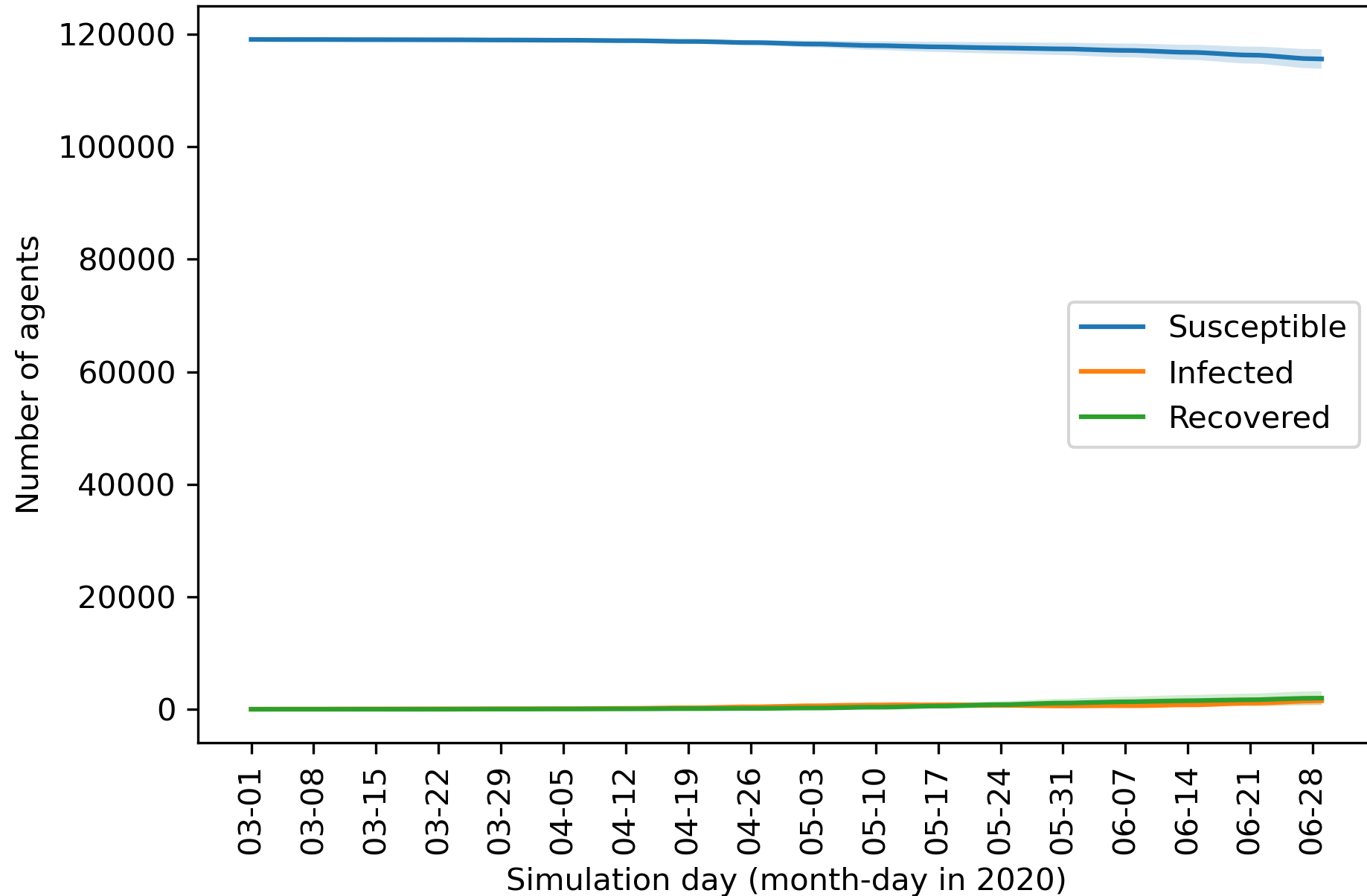
First 5 EOs

All interventions up to and including 2020-03-23



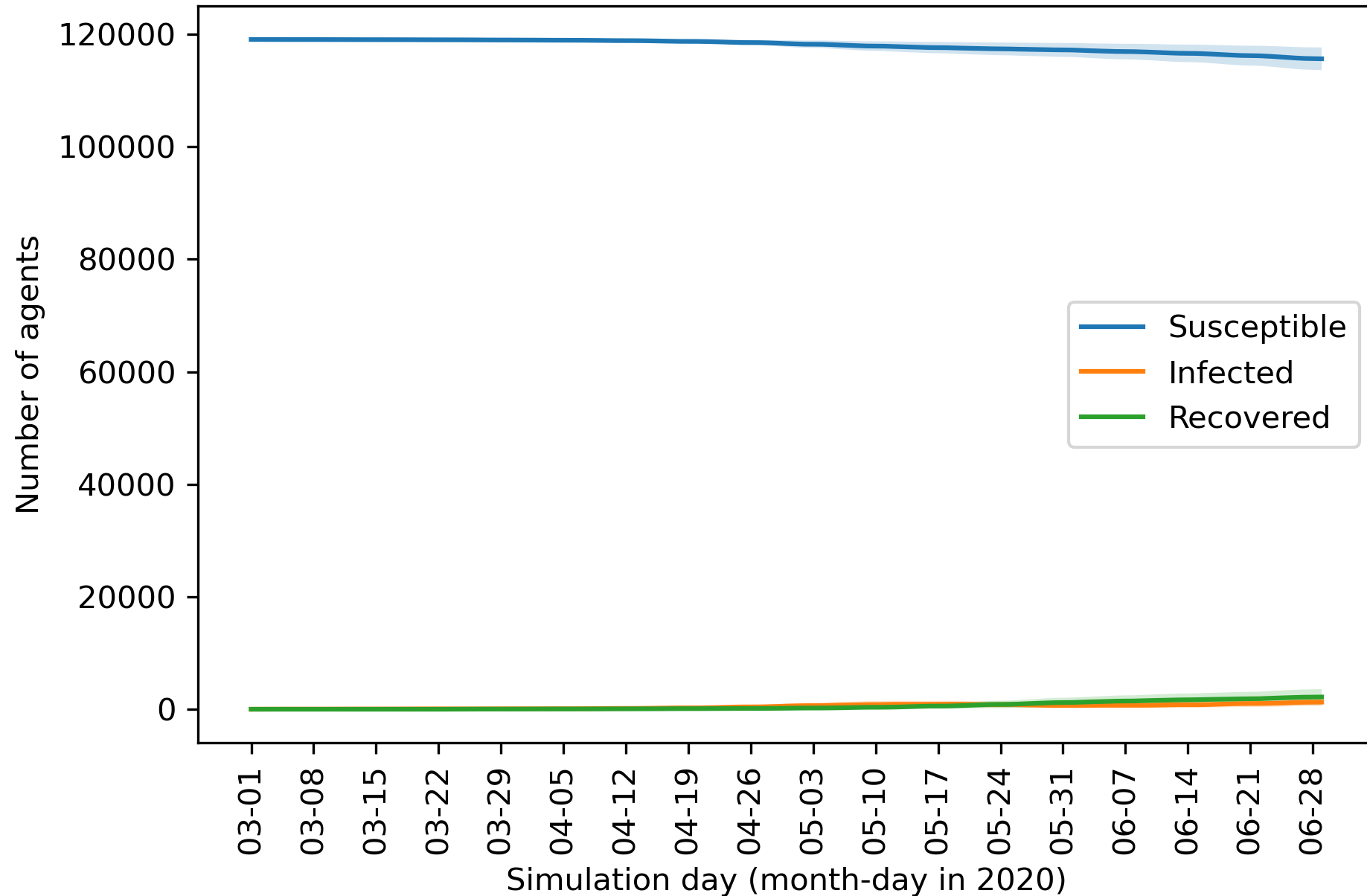
First 6 EOs

All interventions up to and including 2020-03-30



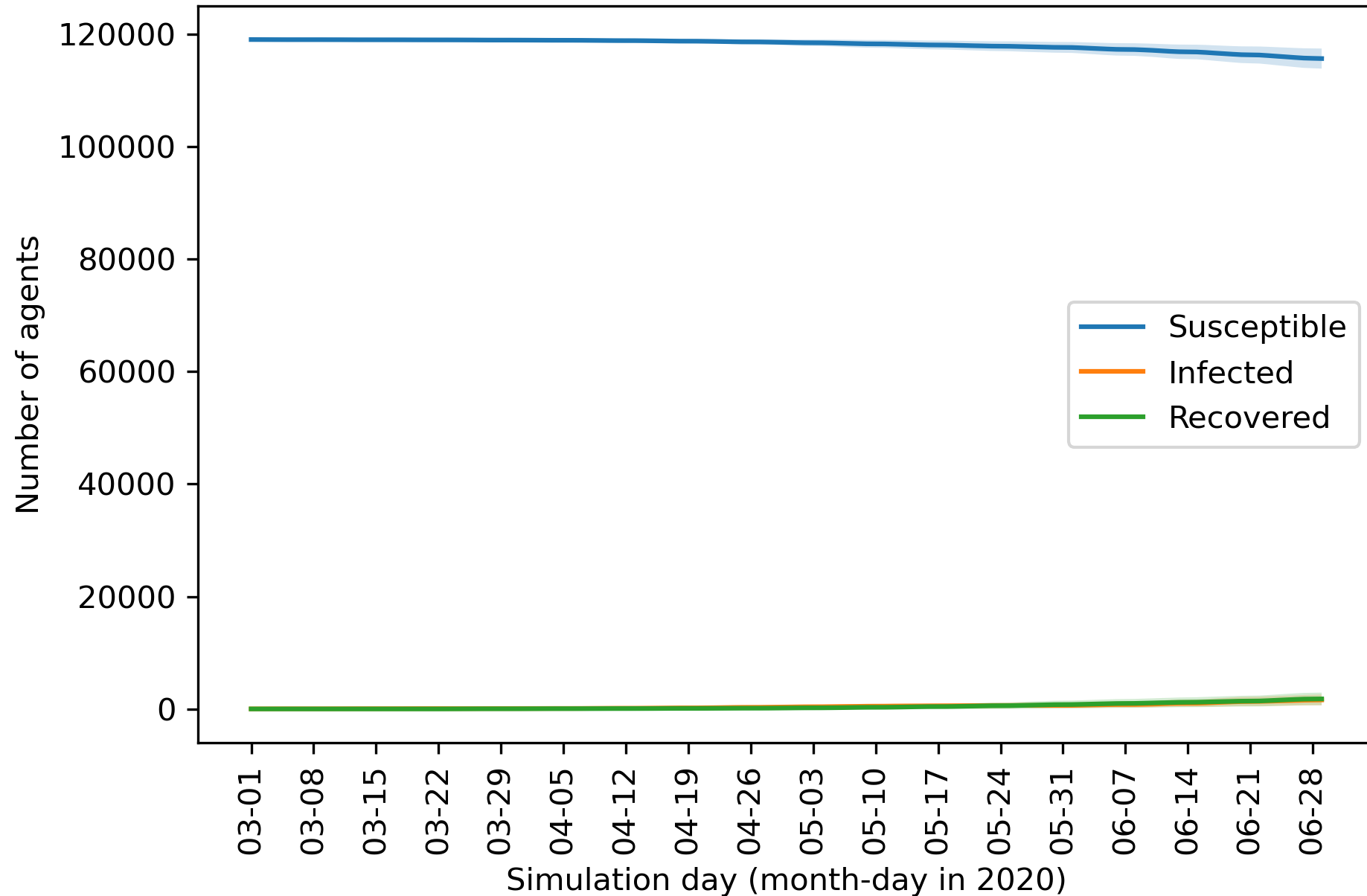
First 7 EOs

All interventions up to and including 2020-05-08



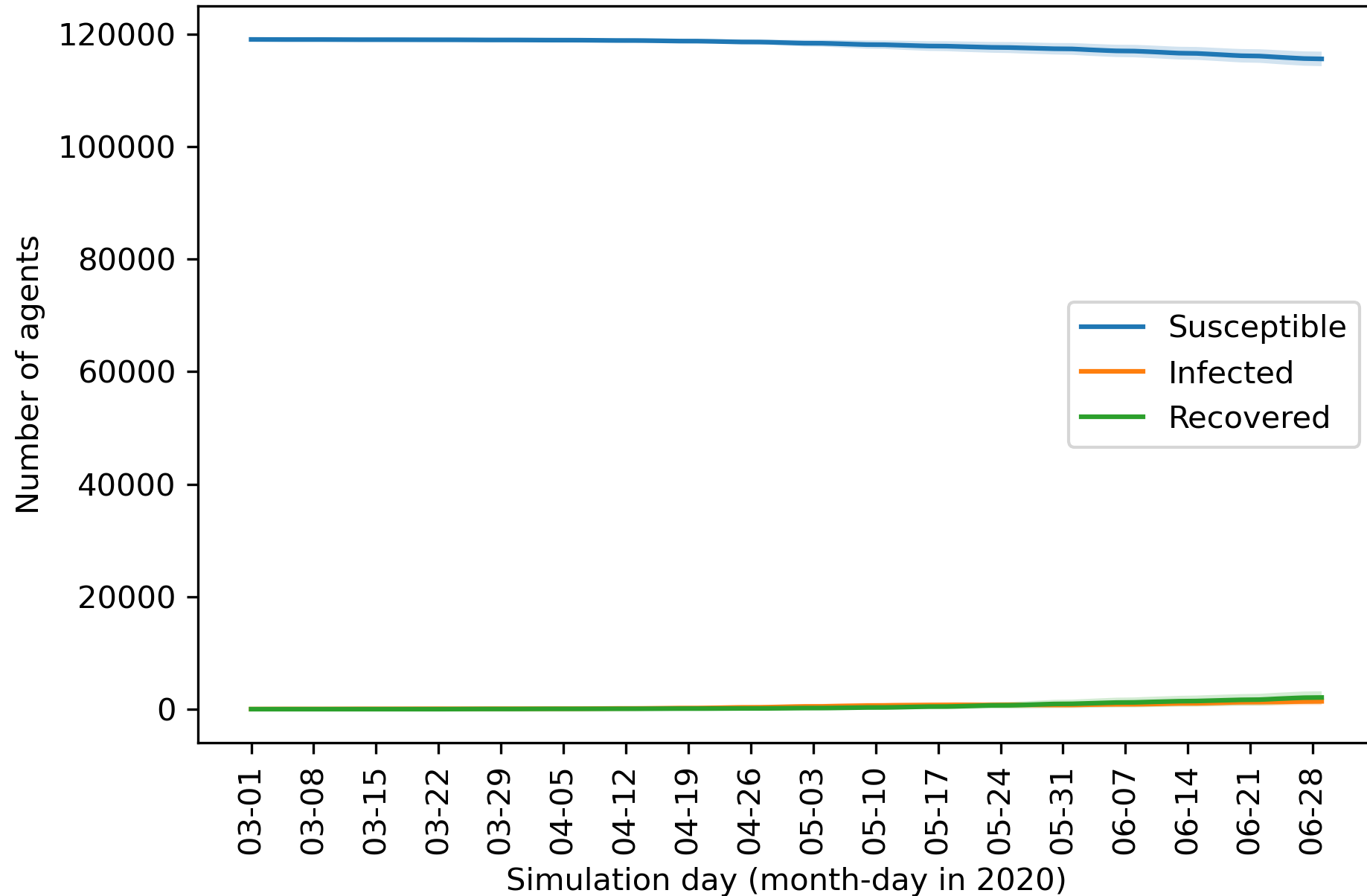
First 8 EOs

All interventions up to and including 2020-05-26

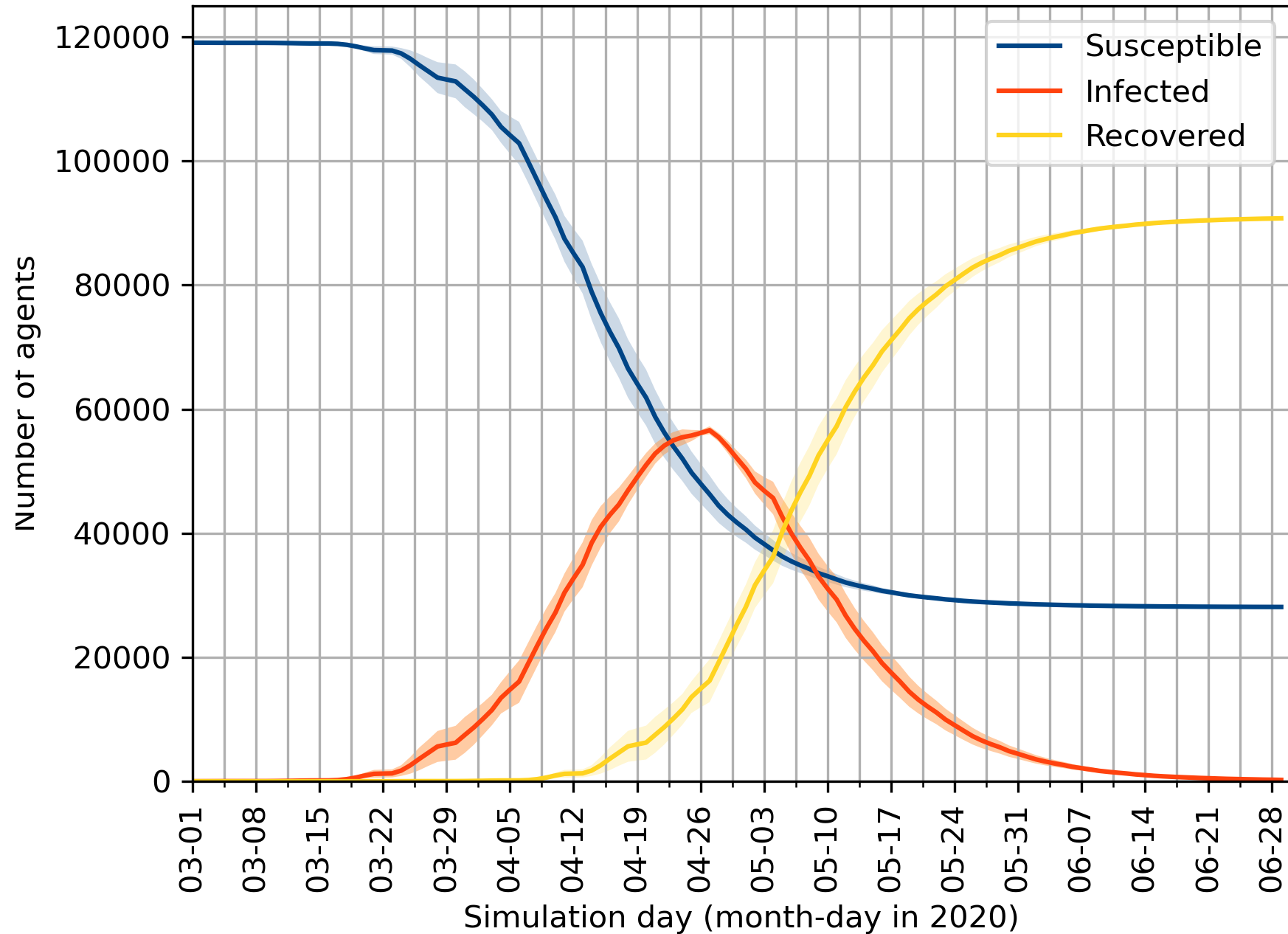


First 9 EOs

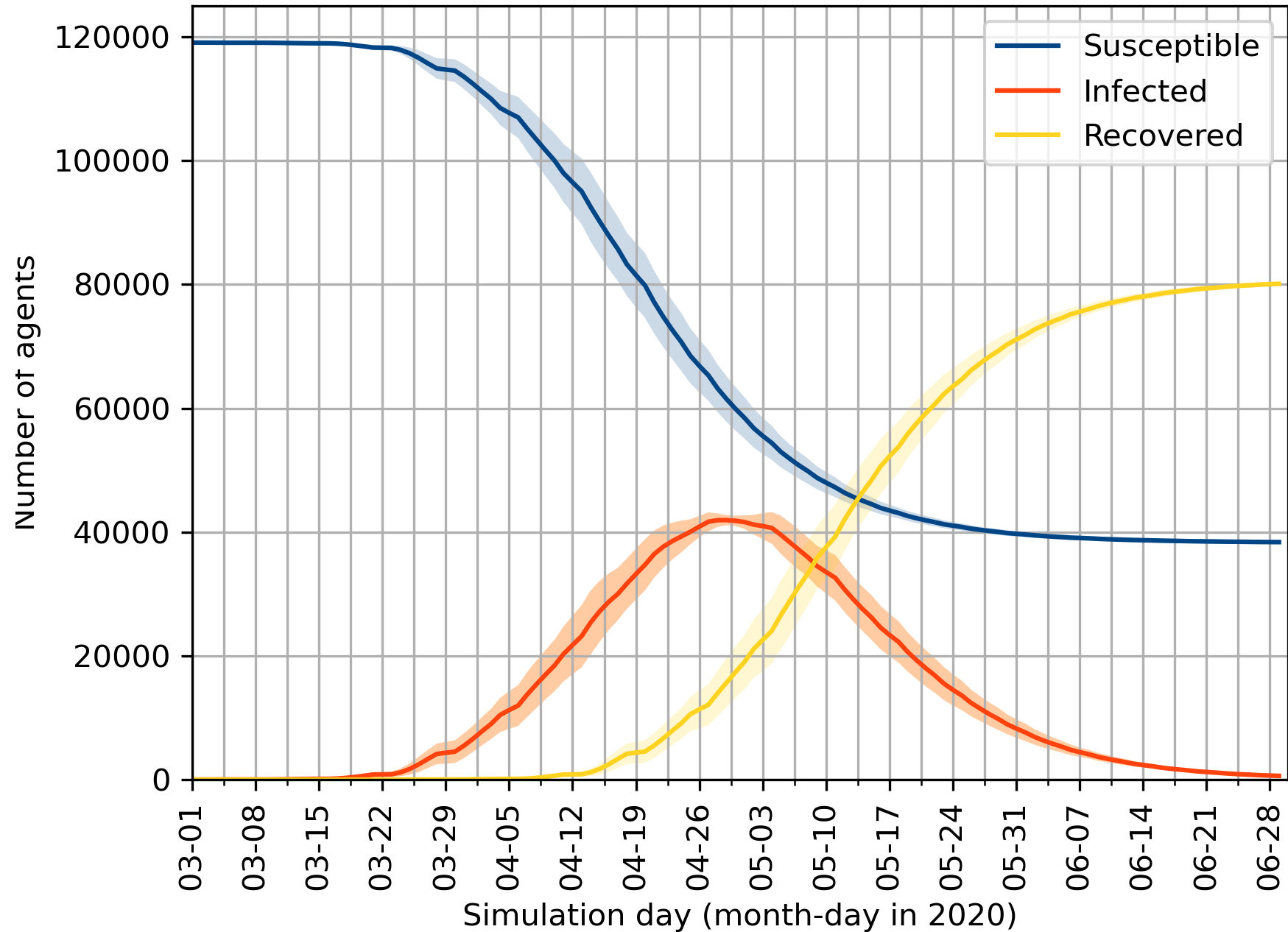
All interventions up to and including 2020-06-02



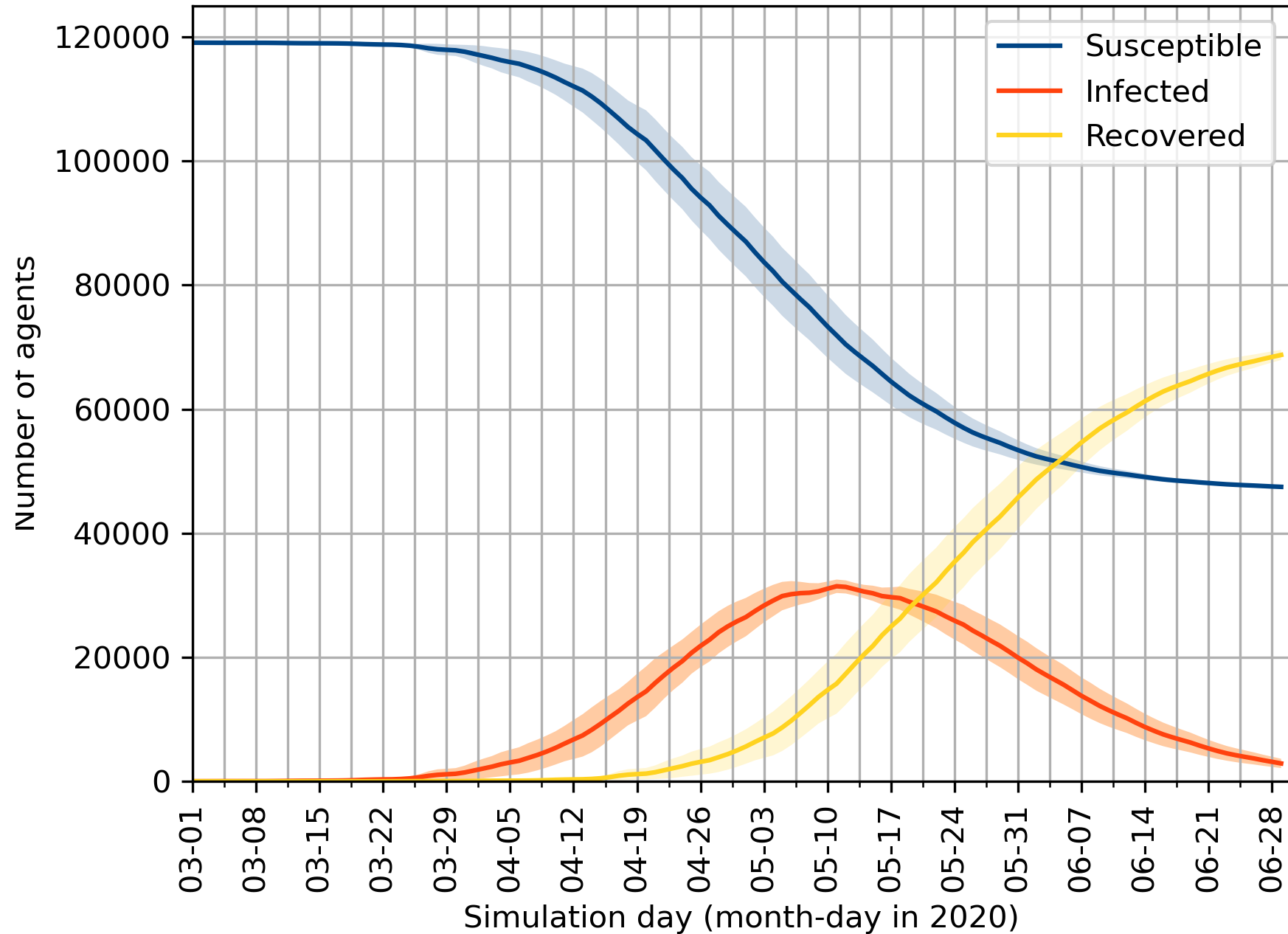
experiment-0-norms-until0000-00-00



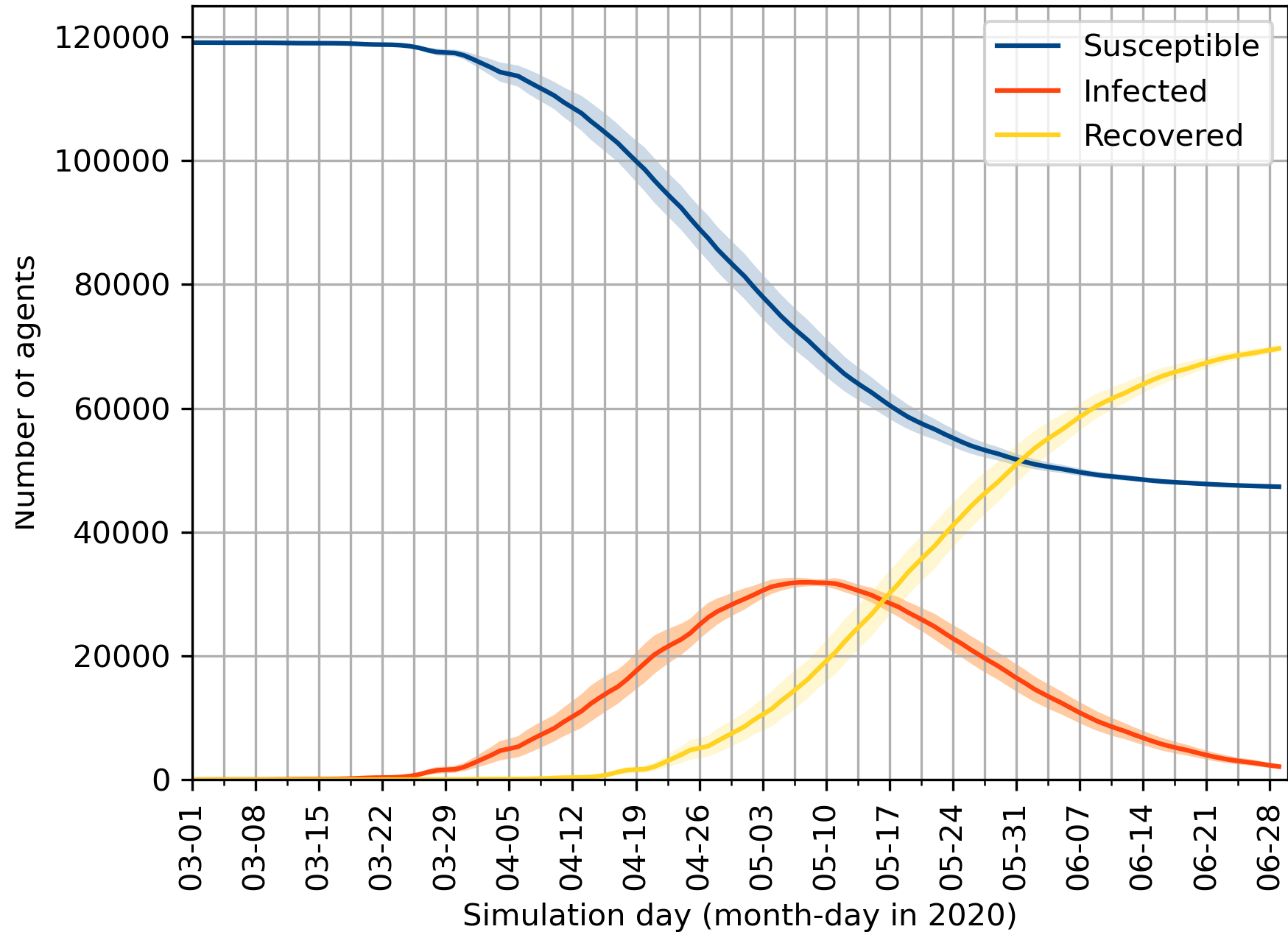
experiment-1-norms-until2020-03-12



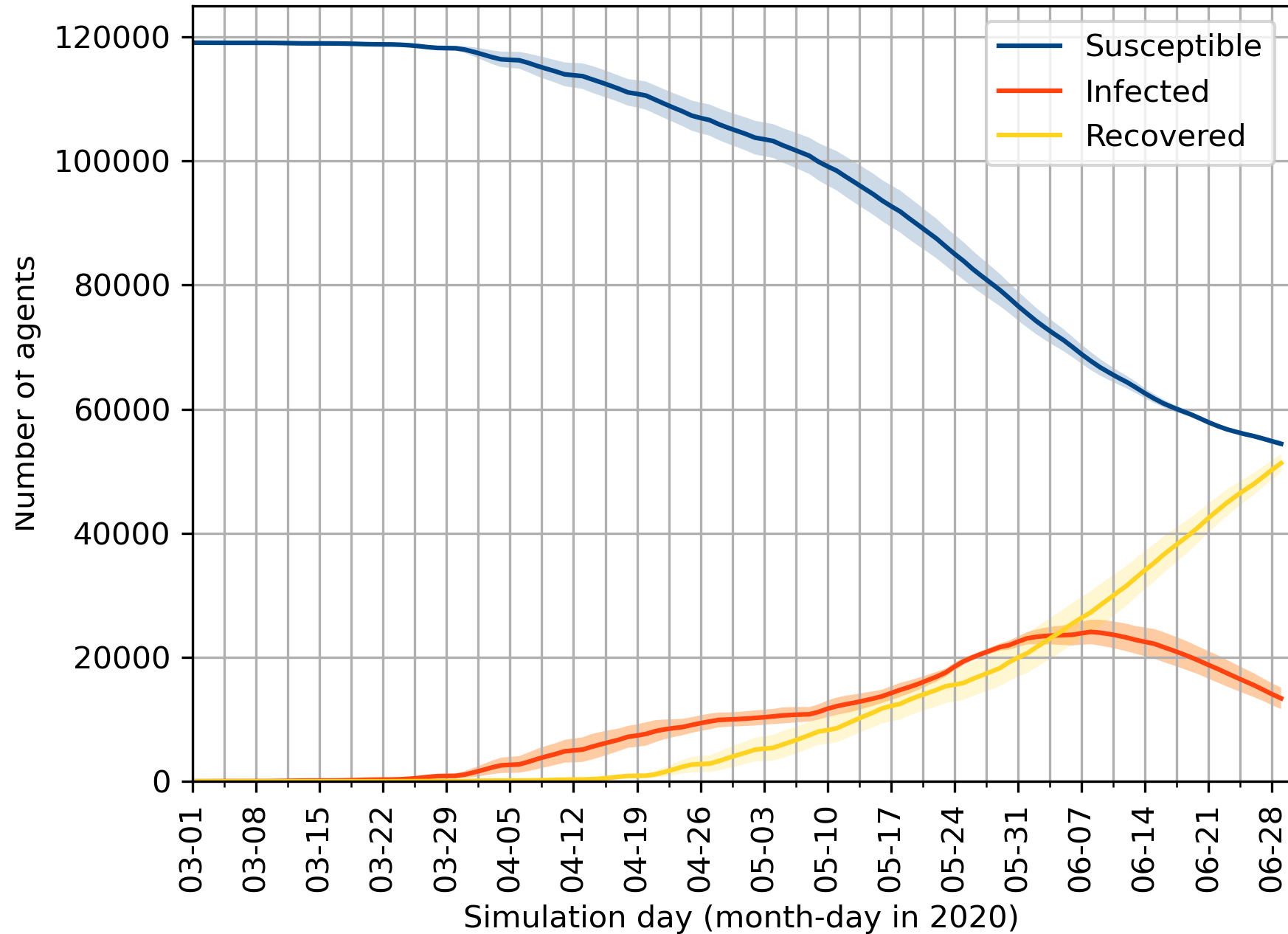
experiment-2-norms-until2020-03-13



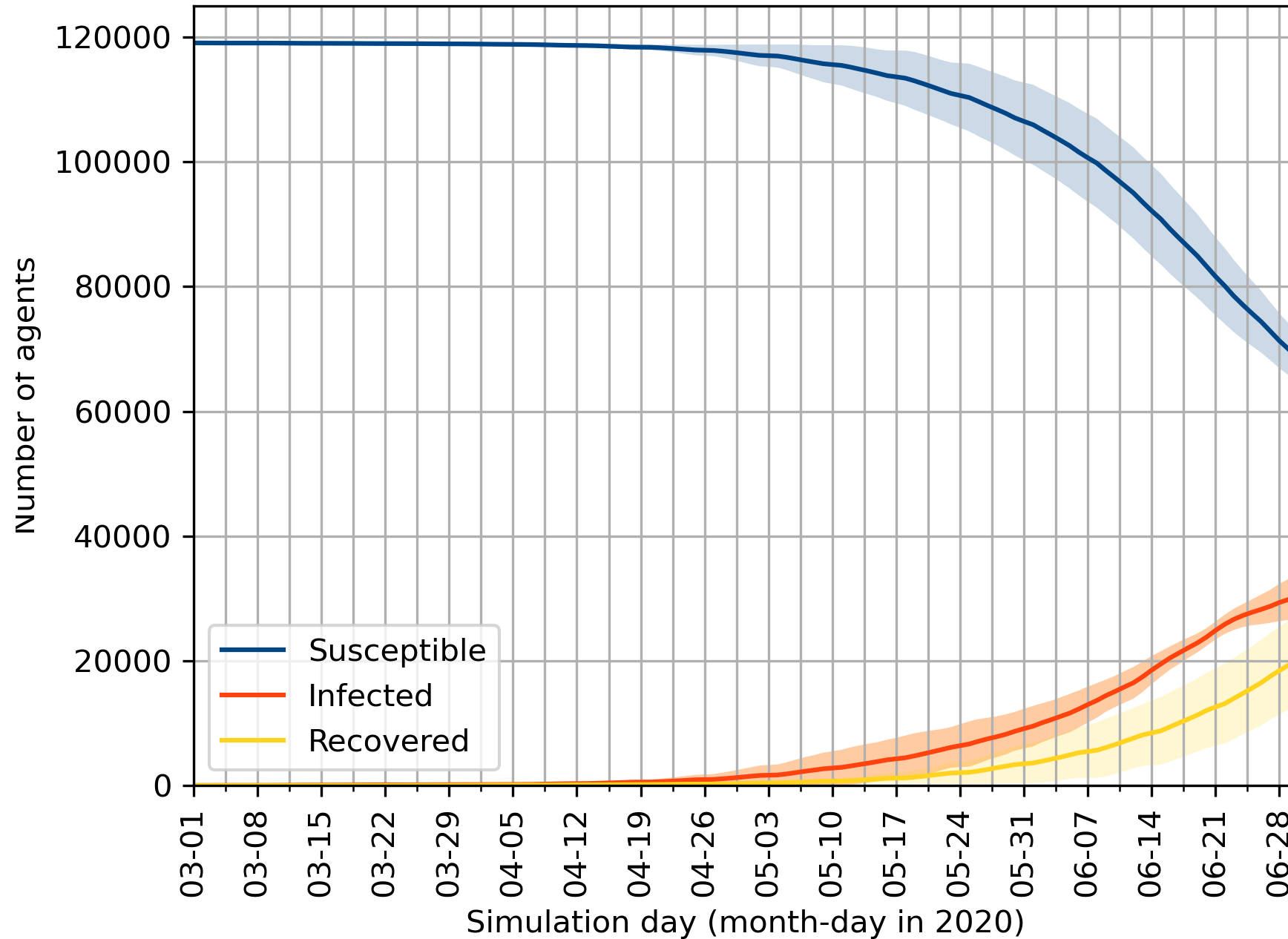
experiment-3-norms-until2020-03-15



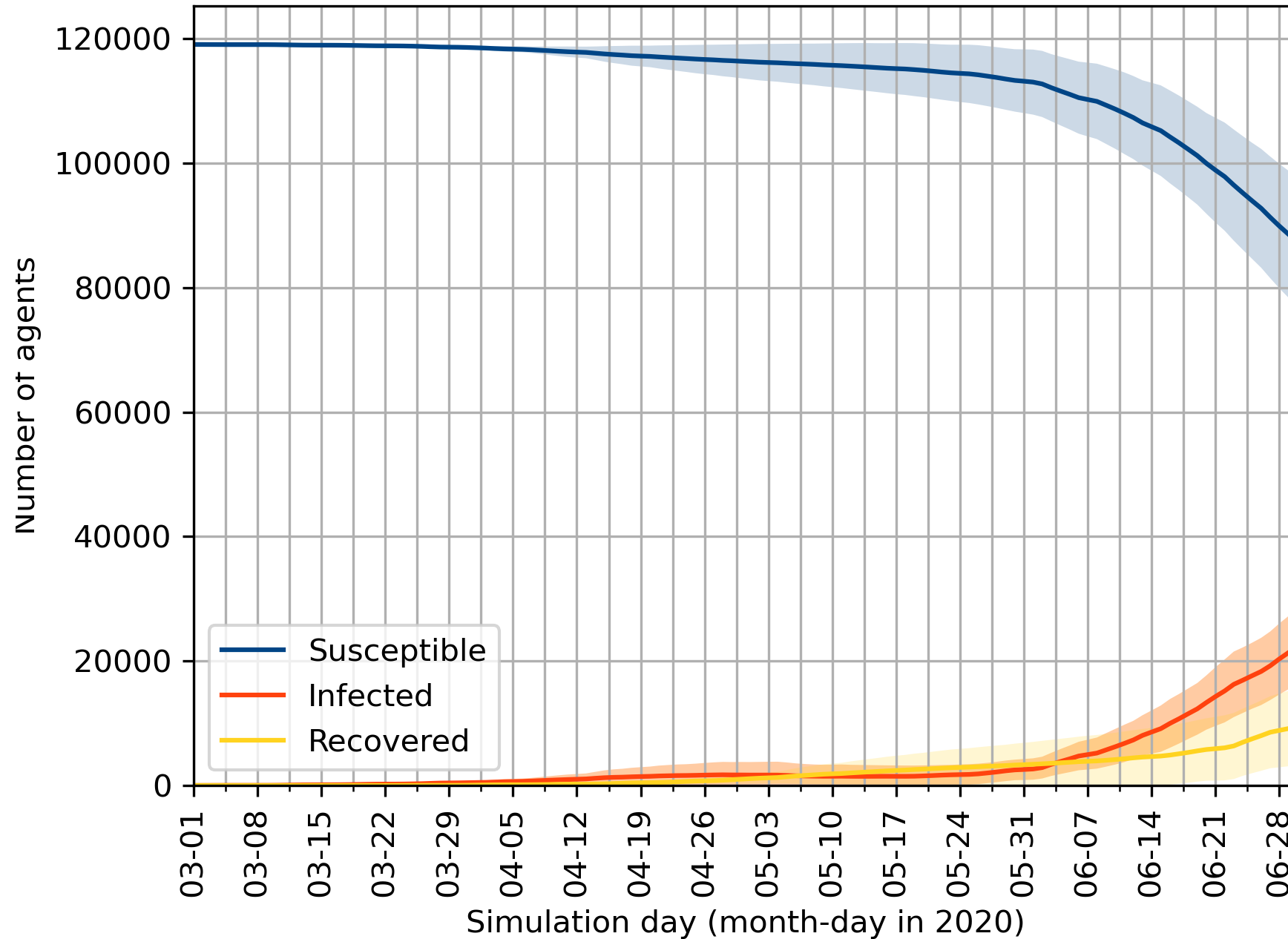
experiment-4-norms-until2020-03-17



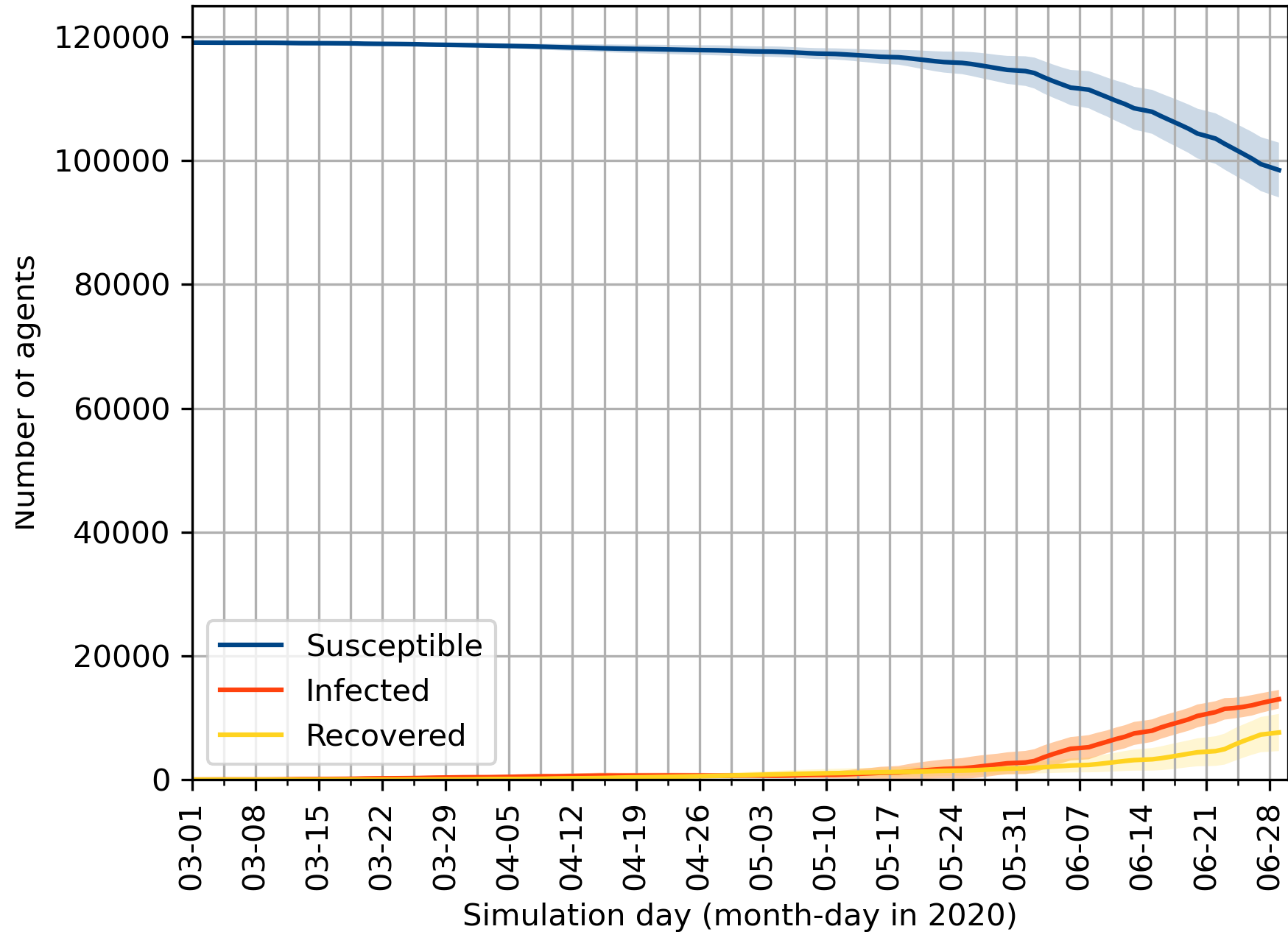
experiment-5-norms-until2020-03-23



experiment-6-norms-until2020-03-30



experiment-7-norms-until2020-05-08



experiment-8-norms-until2020-05-26

