Joint COVID-19 Response Legislative Workgroup

Teleconference Meeting

THIS MEETING WILL BEGIN SHORTLY

April 29, 2020
10:00 a.m.

Agenda Overview

(10:00 a.m. - 10:05 a.m.)

I. Presentation from Dr. Justin Lessler, Johns Hopkins University

II. Presentation from Dr. Lei Zhang, University of Maryland

III. Presentation from Dr. Jeffrey Shaman, Columbia University

IV. Workgroup Discussion and Closing Remarks

Presentation from from Dr. Lessler, JHU

(10:05 a.m. - 10:20 a.m.)

- Justin Lessler, Ph.D.
  Associate Professor, Johns Hopkins Bloomberg School of Public Health
- Limited Questions and Answers
- Contact:

Elizabeth Hafey
Elizabeth.Hafey@jhu.edu

Scenario Modeling Results for Maryland and Beyond

Justin Lessler for the JHU-IDDynamics COVID-19 Working Group

Baltimore MD

29 April 2020

JOHNS HOPKINS
BLOOMBERG SCHOOL
of PUBLIC HEALTH

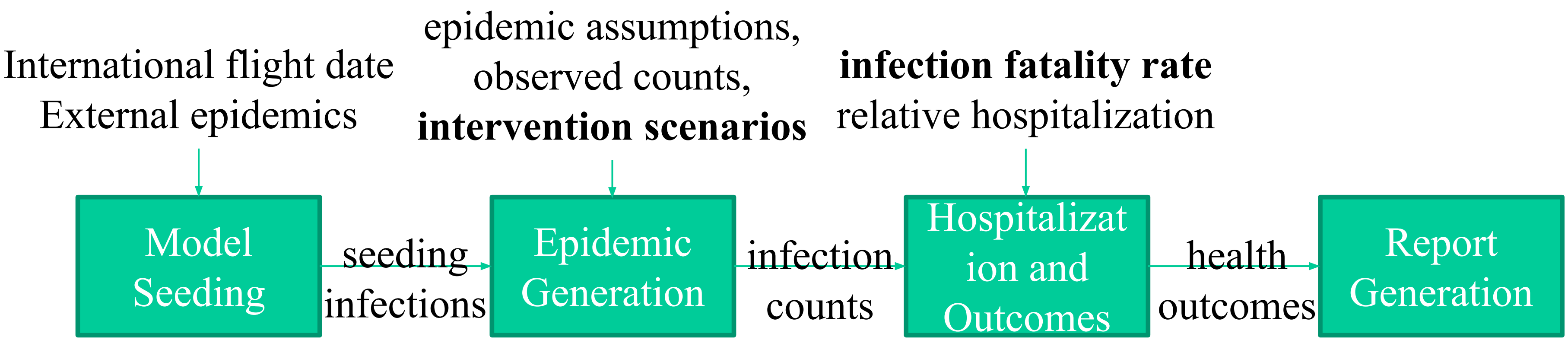
Infectious Disease
DYNAMICS
JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

Approach

PLANNING SCENARIOS NOT FORECASTS

- Focus on scenarios relevant to planning decisions.
- Use rough approximations given best knowledge of disease dynamics, current situation and severity.
  - differences more informative than absolutes
- Use a pipelined approach to ease integration of new knowledge and comparison of models

Scenario Modeling Pipeline



1. **Continued Stay-at-Home Measures with Declining Adherence:** *Continuation of measures currently in place in Maryland, with declining adherence, ending December 31, 2020*

2. **Maryland Strong Roadmap to Recovery:** *Current measures, followed by stages 1 and 2 of the Maryland Strong Roadmap to Recovery, ending December 31, 2020*

3. **Self isolation (SI) and Household (HH) quarantine:** *Current measures, followed by 90% compliant self isolation and household quarantine*

4. **SI, HH, Delayed Manual Contact Tracing:** *Current measures, followed by 90% compliant self isolation, household quarantine, and delayed manual contact tracing of non-household contacts*

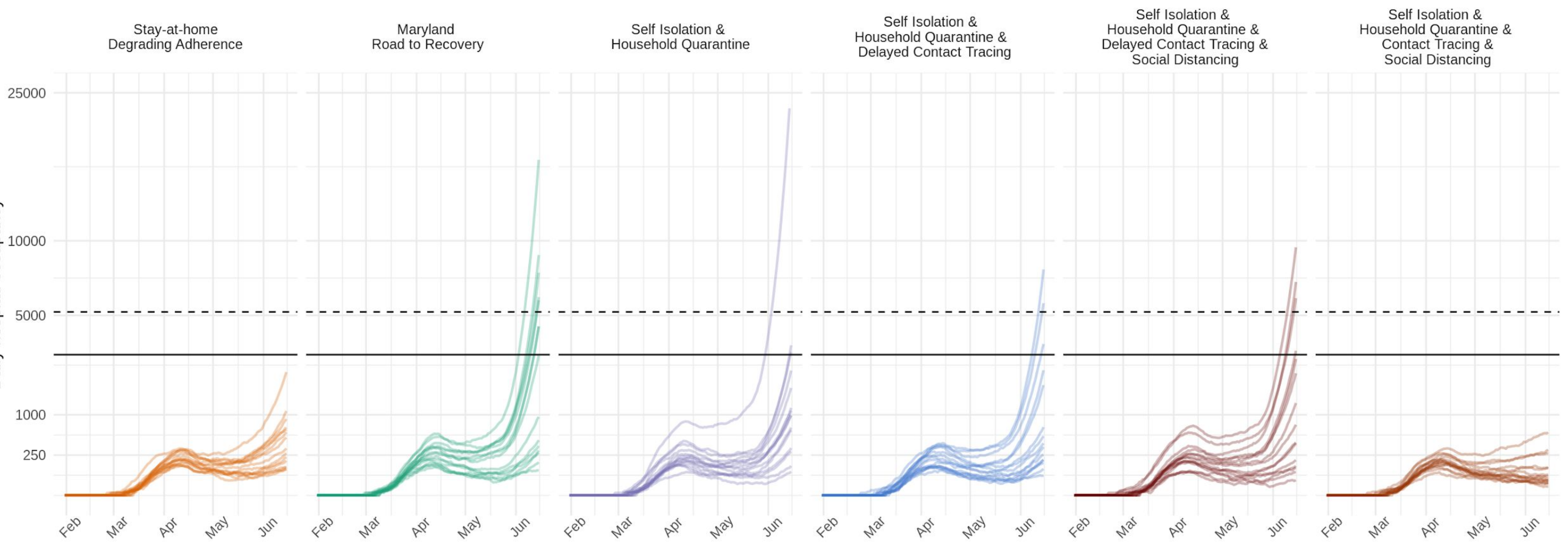
5. **SI, HH, Delayed Manual Contact Tracing + Social distancing:** *Current measures, followed by 90% compliant self isolation and household quarantine, delayed manual contact tracing of non-household contacts, and maintained social distancing*

6. **HH, Manual Contact Tracing + Social distancing:** *Current measures, followed by 90% compliance self isolation and household quarantine and manual contact tracing of non-household contacts and maintained social distancing*

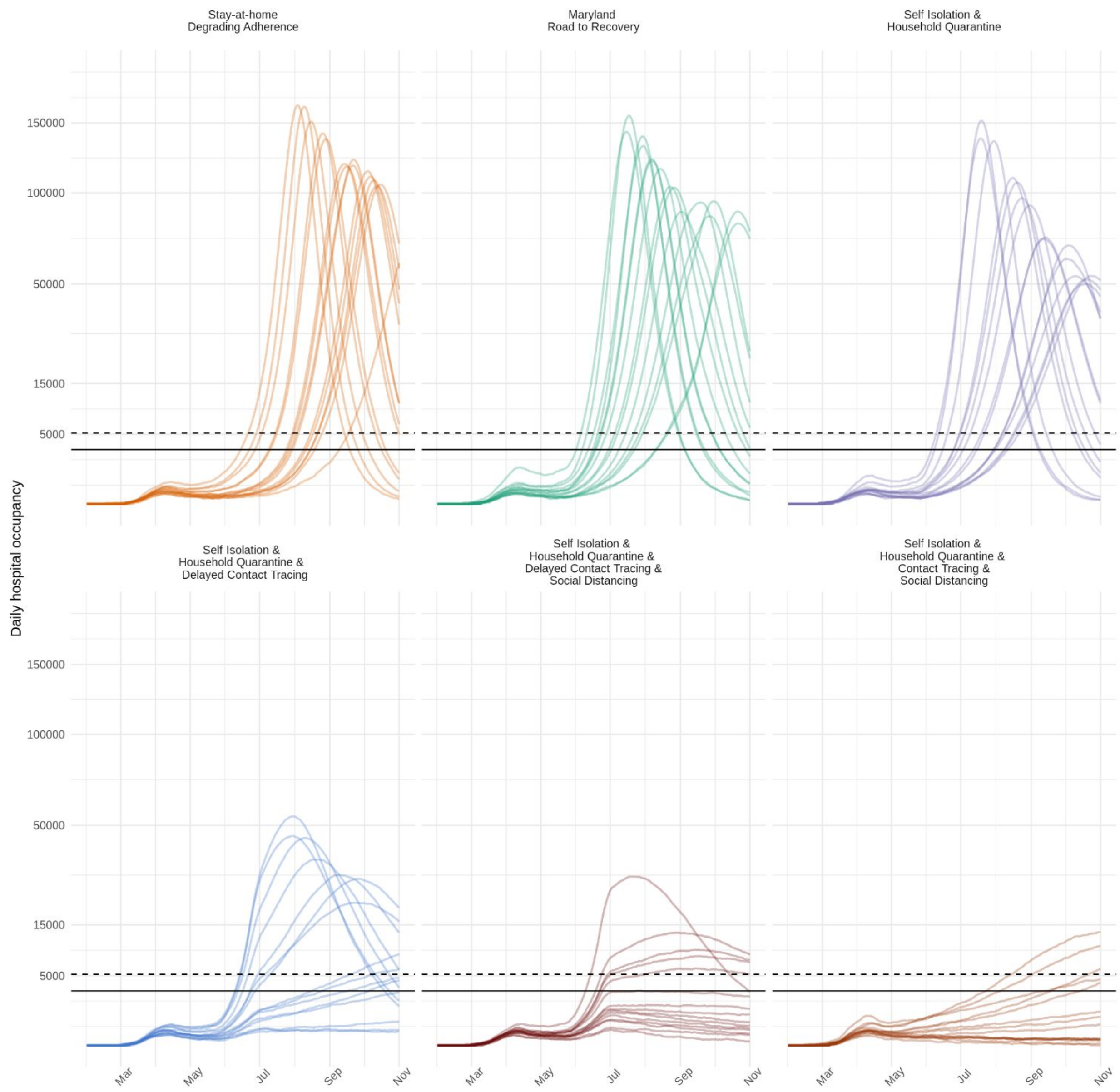
Maryland Strong Roadmap to Recovery

Start Date	End Date	R	Reductions	Intervention Name
01-31-2020	03-12-2020	2.0 - 3.0	-	-
03-13-2020	03-29-2020	0.70 - 1.68	44 - 65%	Mildly restrictive social distancing
03-30-2020	05-14-2020	0.34 - 0.87	71 - 83%	Current Maryland Measures (full adherence)
05-15-2020	09-02-2020	1.26 - 2.31	23 - 37%	Road to Recovery, Stage 1
09-03-2020	12-31-2020	1.60 - 2.70	10 - 20%	Road to Recovery, Stage 2

Hospital occupancy

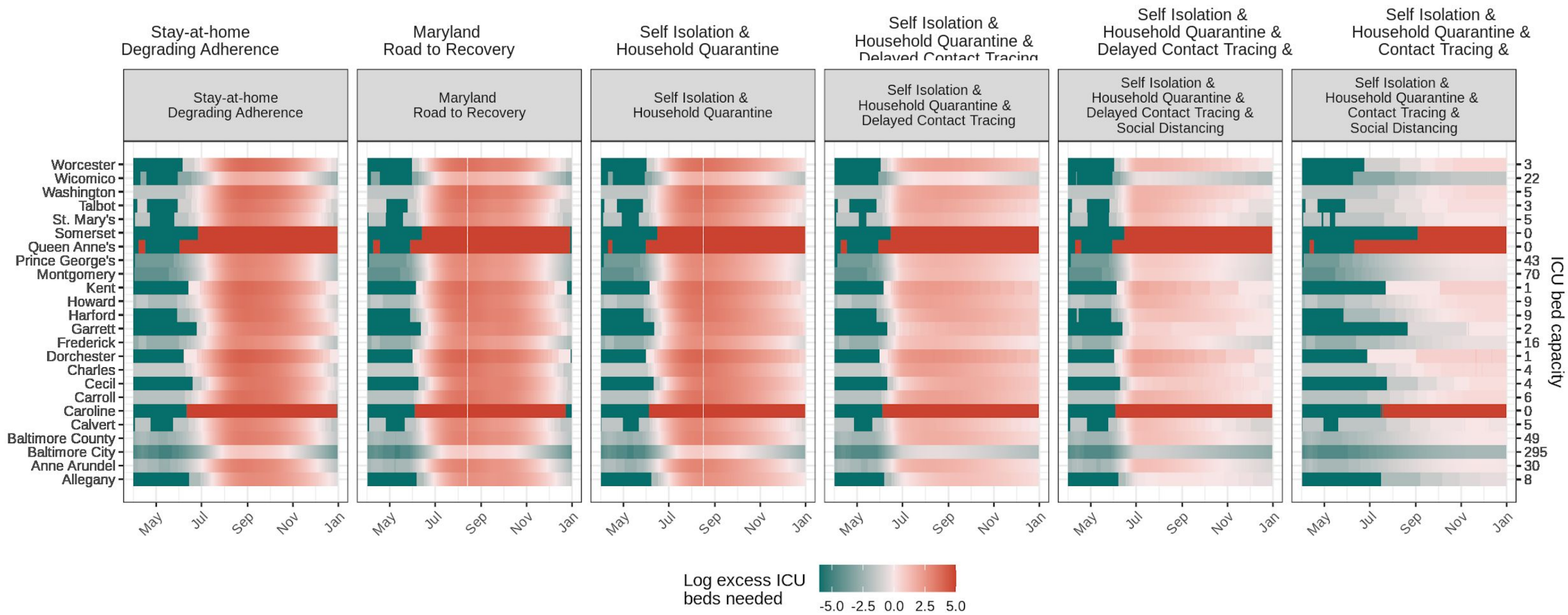


PLANNING SCENARIO – NOT A FORECAST

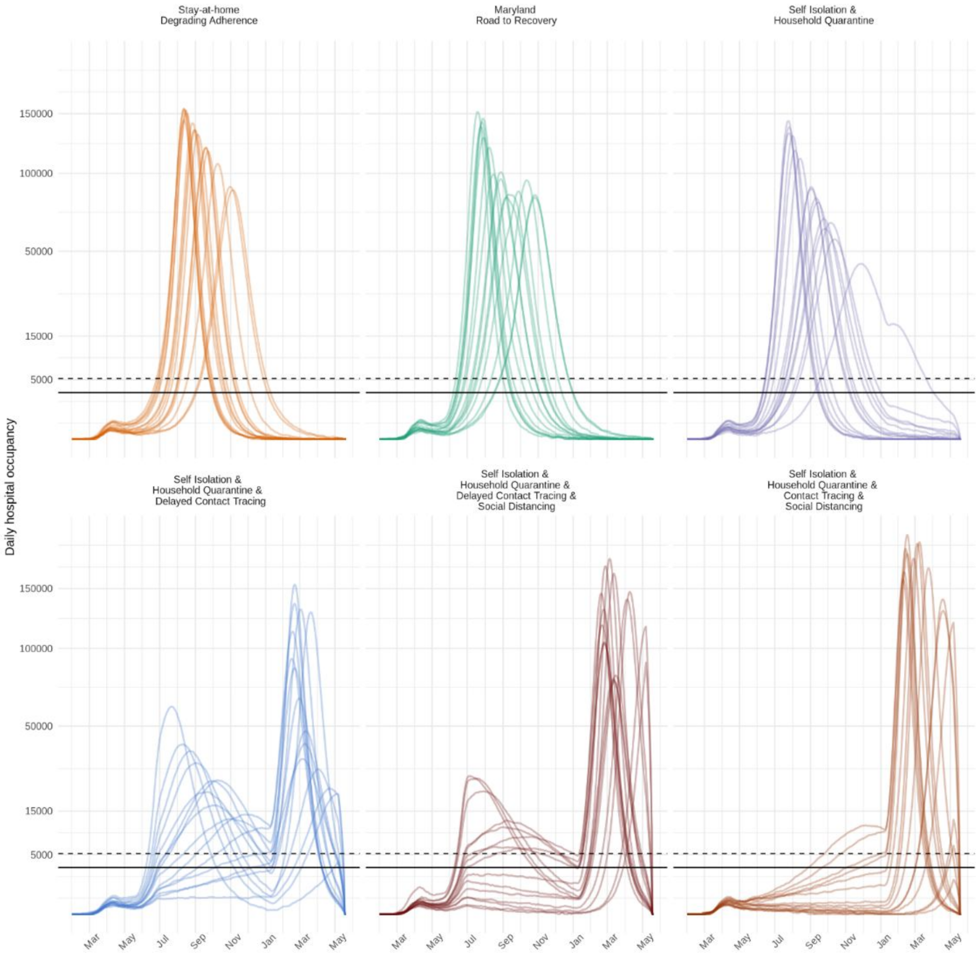


PLANNING SCENARIO – NOT A FORECAST

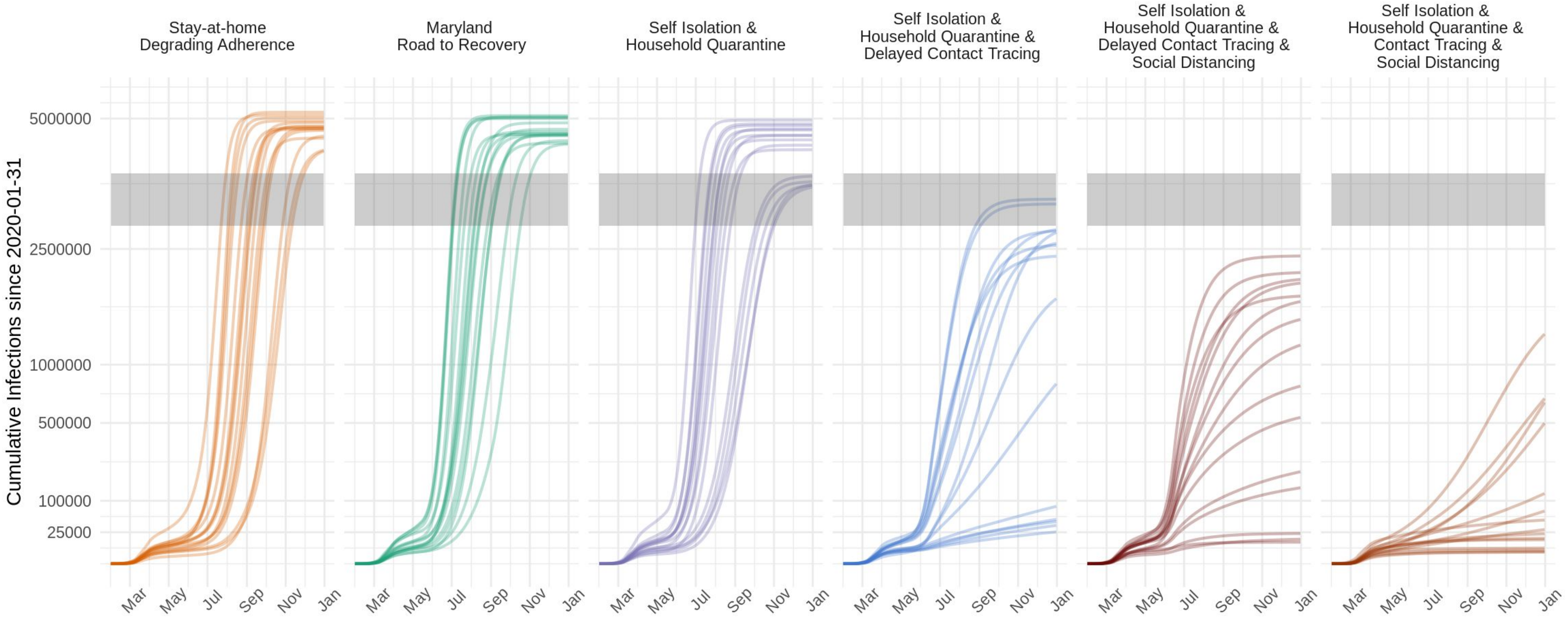
ICU Bed Needs



PLANNING SCENARIO – NOT A FORECAST



PLANNING SCENARIO – NOT A FORECAST



PLANNING SCENARIO – NOT A FORECAST

Simple Math

- **Maryland**

$$858 \times \frac{1.5}{.005} = 257{,}400$$

$$\frac{260{,}000}{6{,}000{,}000} = 4\%$$

$$R = R_0 \times (1 - 0.04) = 1.9 \text{ to } 2.9$$

- **New York City**

$$12{,}509 \times \frac{1.5}{.005} = 3{,}752{,}700$$

$$\frac{3{,}750{,}000}{8{,}400{,}000} = 47\%$$

$$R = R_0 \times (1 - 0.47) = 1.1 \text{ to } 1.6$$

ID Dynamics COVID-19 Working Group et al.

- **Johns Hopkins Infectious Disease Dynamics**
- Elizabeth C. Lee
- Kyra H. Grantz
- Hannah R. Meredith
- Qifang Bi
- Joshua Kaminsky
- Stephen A. Lauer
- Justin Lessler
- Shaun A. Truelove
- **EPFL**
- Joseph C. Lemaitre

- **University of Utah**
- Lindsay T. Keegan

Presentation from Dr. Zhang, UMD

(10:20 a.m. - 10:35 a.m.)

- Lei Zhang, Ph.D.
  Professor, University of Maryland Department of Civil and Environmental Engineering
- Limited Questions and Answers
- Contact:

Molly McKee-Seabrook

mckee@umd.edu

Briefing to the COVID Group at the Maryland General Assembly on April 29, 2020

An Interactive COVID-19 Impact Analysis Platform for Situational Awareness and Decision Support

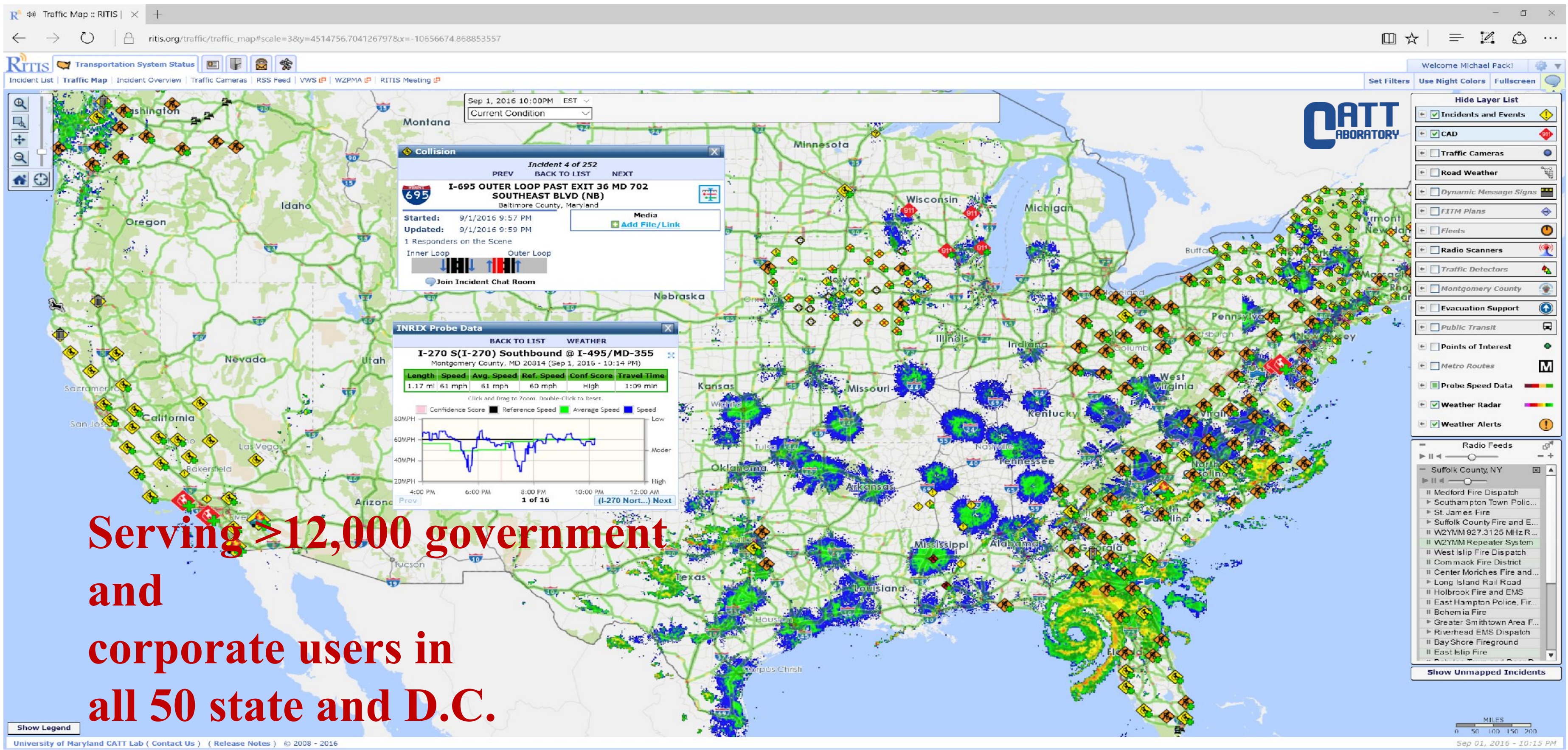
MARYLAND TRANSPORTATION INSTITUTE

Lei Zhang, Ph.D.

Director, Maryland Transportation Institute
Herbert Rabin Distinguished Professor of Engineering
University of Maryland – College Park

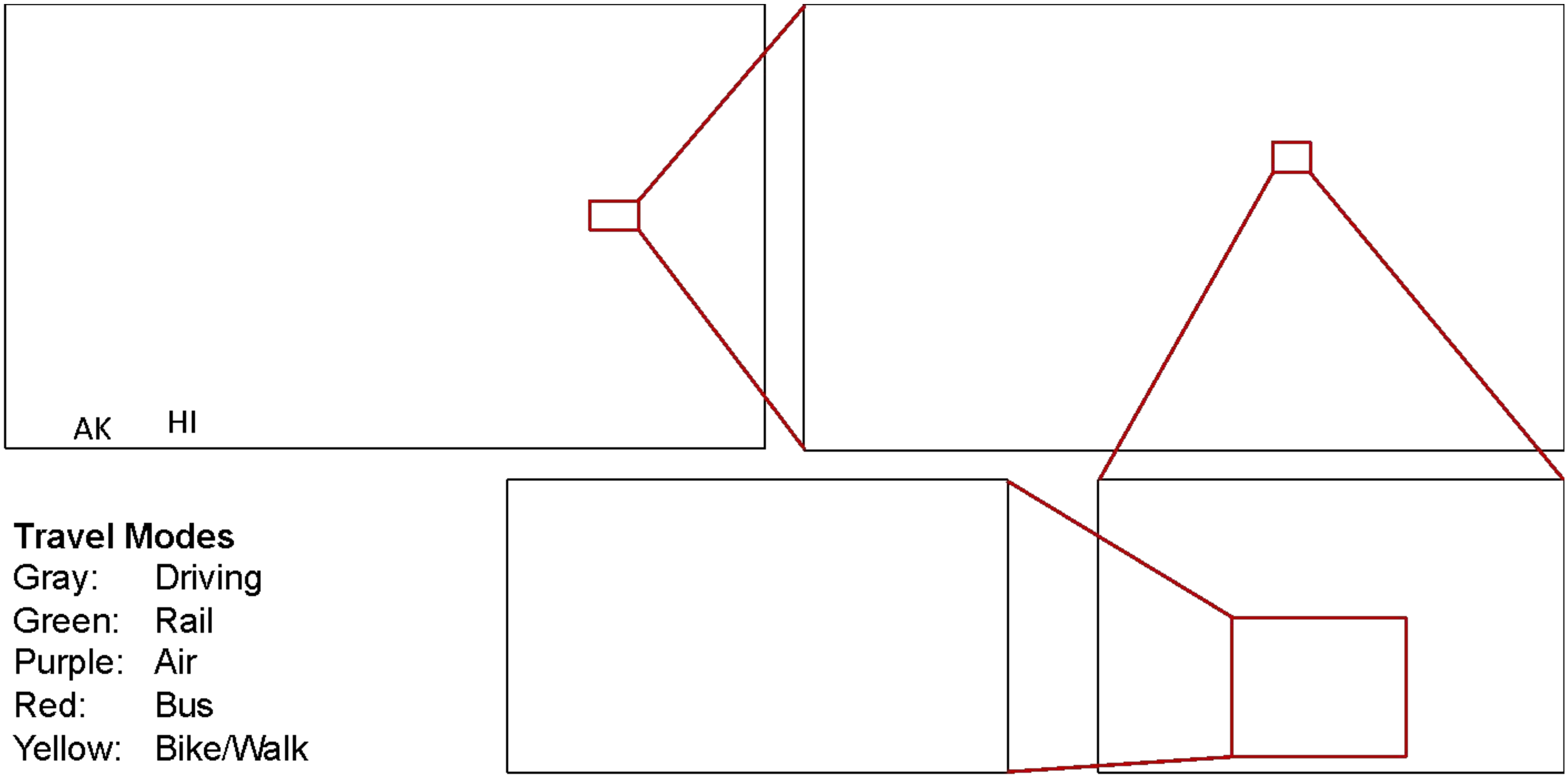
Email: lei@umd.edu; Team Email: data-covid@umd.edu; Web: data.covid.umd.edu

Largest Transportation Data Center in the Nation

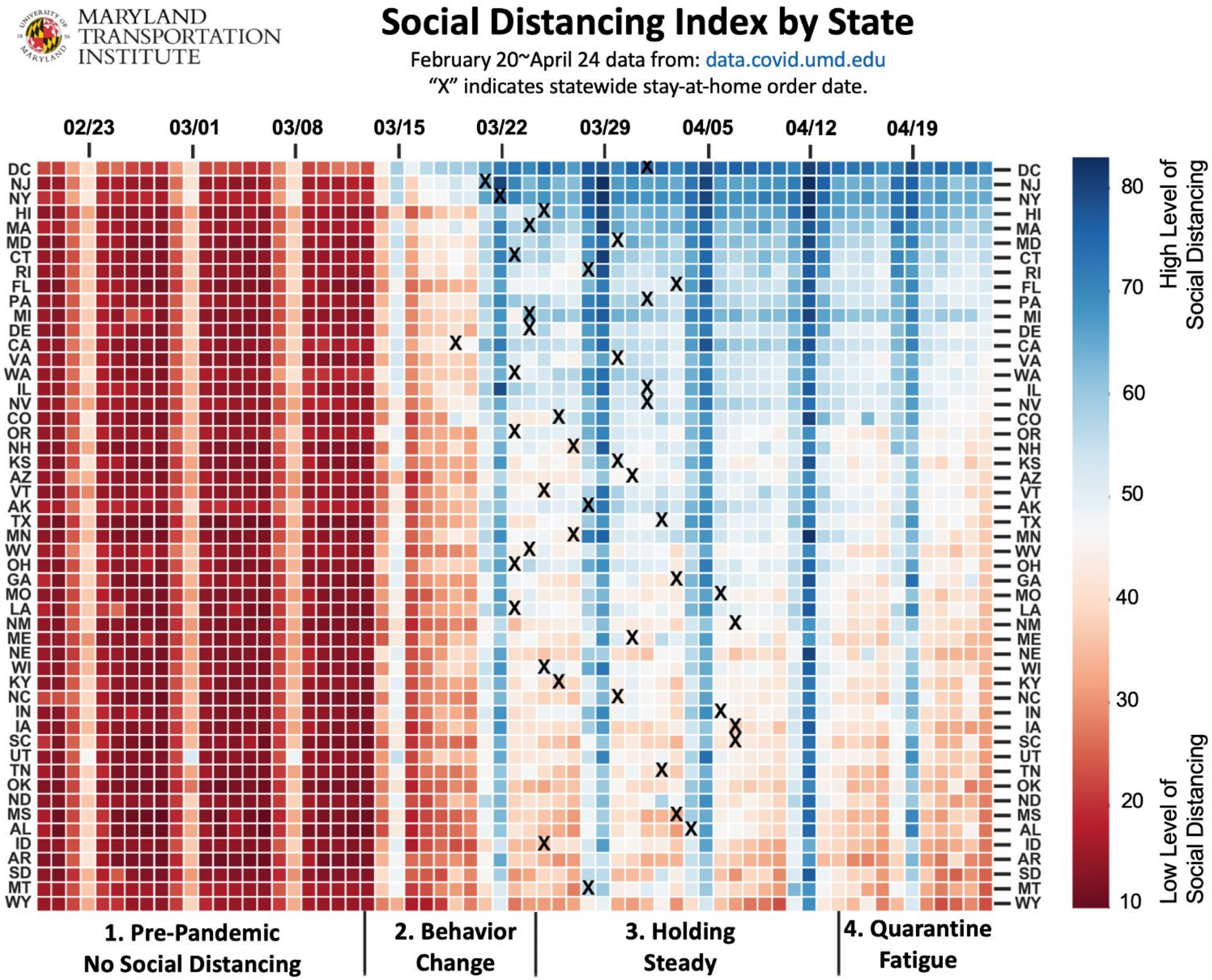


Serving >12,000 government and corporate users in all 50 state and D.C.

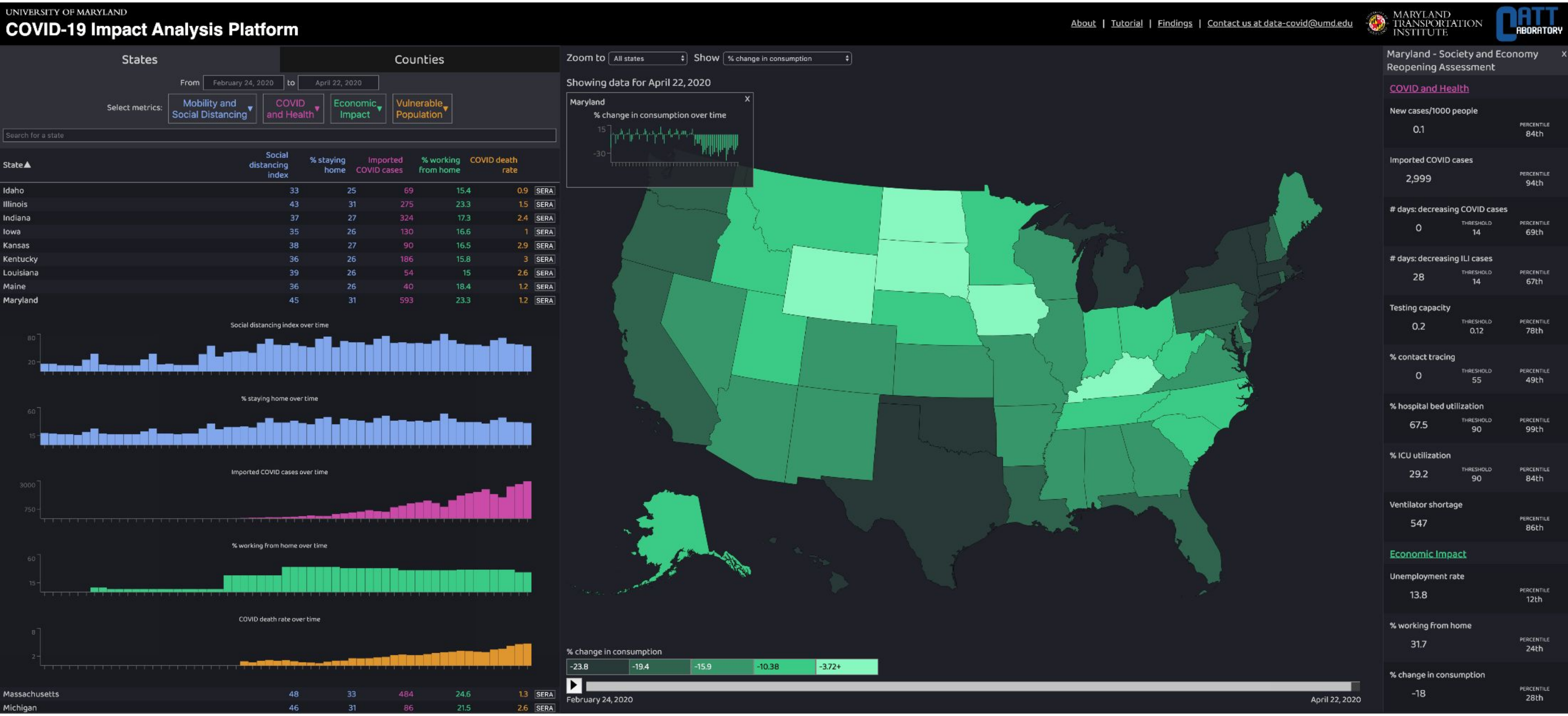
Trip and Visit Data Daily from >150 million Phones




UNIVERSITY OF MARYLAND
COVID-19 Impact Analysis Platform
About | Tutorial | Findings | Contact us at data-covid@umd.edu
MARYLAND TRANSPORTATION INSTITUTE
States
Counties
Aggregate data between February 10, 2020 and April 25, 2020 in the table
Social distancing index
% staying home
Trips per person
% out-of-county trips
Miles traveled per person
Work trips per person
Non-work trips per person
New COVID-19 cases
Population
Baltimore
County
% staying home
Miles traveled per person
Work trips per person
Baltimore County, Maryland 29 26.1 0.4
% staying home over time
Miles traveled per person over time
Work trips per person over time
Baltimore city, Maryland 35 21 0.4
Zoom to Maryland
Show Social distancing index
Showing data for April 25, 2020
Charles County, Maryland
Social distancing index over time
Charles County, Maryland
Date: April 25, 2020
Social distancing index: 54
% staying home: 29
Trips per person: 2.7
% out-of-county trips: 35.9
Miles traveled per person: 22.9
Work trips per person: 0.2
Non-work trips per person: 2.6
New COVID-19 cases: 24
Population: 161,503
Nationwide statistics
Date April 25, 2020
Social distancing index 53
% staying home 32
Trips per person 2.8
% out-of-county trips 25.2
Miles traveled per person 23.5
Work trips per person 0.2
Non-work trips per person 2.5
New COVID-19 cases 32,295
Social distancing index
20 32 44 56 68+
February 10, 2020
April 25, 2020
data.covid.umd.edu


MARYLAND
TRANSPORTATION
INSTITUTE
Social Distancing Index by State
February 20~April 24 data from: data.covid.umd.edu
"X" indicates statewide stay-at-home order date.
02/23
03/01
03/08
03/15
03/22
03/29
04/05
04/12
04/19
DC
NJ
NY
HI
MA
MD
CT
RI
FL
PA
MI
DE
CA
VA
WA
IL
NV
CO
OR
NH
KS
AZ
VT
AK
TX
MN
WV
OH
GA
MO
LA
NM
ME
NE
WI
KY
NC
IN
IA
SC
UT
TN
OK
ND
MS
AL
ID
AR
SD
MT
WY
80
70
60
50
40
30
20
10
High Level of Social Distancing
Low Level of Social Distancing
1. Pre-Pandemic No Social Distancing
2. Behavior Change
3. Holding Steady
4. Quarantine Fatigue

Society-Economy Reopening Assessment (SERA)



SERA MD Results

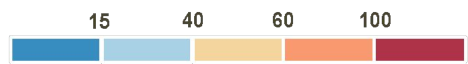
Assessment on 4/22/2020

Number	Variable Name	Value	Ranking (Percentile)
	Category A Name: Mobility and Social Distancing		
1	Social distancing index	54	12
2	% staying home	35.00	-
3	Trips/person	2.80	-
4	% External trips	34.90	90
5	Miles/person	22.00	-
6	Work trips/person	0.40	-
7	Non-work trips/person	2.40	-
8	Transit share	8.53	90
	Category B Name: COVID-19 and Health		
9	New COVID cases	582	78
10	New cases/1000 people	0.11	84
11	Active cases/1000 people	2.33	78
12	Imported COVID cases	2,999	94
13	COVID exposure/1000 people	6.05	-
14	#days: decreasing COVID cases	0 [14]	69
15	#days: decreasing ILI cases	28 [14]	67
16	Testing capacity	0.19 [0.12]	78
17	Tests done/1000 people	12.66	47
18	% contact tracing	1.72 [2]	12
19	% hospital bed utilization	67.50 [90]	99
20	% ICU utilization	29.21 [90]	84
21	Hospital beds/1000 people	2.09	96
22	ICUs/1000 people	0.22	88
23	Ventilator/PPE shortage	547	86
	Category C Name: Economic Impact		
24	Unemployment claims/1000 people	7.72	14
25	Unemployment rate	13.78	12
26	% working from home	31.70	24
27	Cumulative inflation rate	0.23	-
28	% change in consumption	-18.05	28
	Category D Name: Vulnerable Population		
29	% people older than 60	20.77	22
30	Median income	84,342	-
31	% African Americans	29.31	-
32	% Hispanic Americans	9.81	-
33	% Male	48.48	-
34	Population density	483.89	-
35	Employment density	229.56	-
36	# hot spots/1000 people	132.50	49
37	COVID death rate	4.71	75
38	Population	6042718	-

- **The SERA tool provides data and insight on both reopening readiness and post-reopening decision support.**
- **It summarizes the percentile rankings in the nation for key factors and compare them with gating criteria.**
- **SERA monitors social distancing behavior change and offers community-level contact tracing.**
- **It analyzes causes for new outbreaks and suggests containment strategies.**
- **SERA also provides detailed economic and business impact estimates.**

Use case: Outbreaks due to Imported Cases

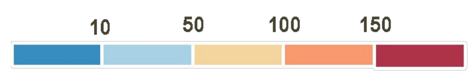
Number of Imported Cases by Out-of-State Travel to Maryland
03/16-04/22



Since 3/16, 31.1 million (19.8 million excluding D.C.) out-of-state trips are destined for MD

Number of Confirmed COVID-19 Cases in Maryland

03/16-04/22



How can We Help You?

The UMD-led COVID-19 impact analysis platform team has:

- comprehensive and timely data on all important aspects of COVID-19 impact on mobility, health, economy, and society;
- more than 30 established faculty members from multiple Maryland universities with expertise in epidemiology, public health, medicine, economics, mobility, social sciences, and public policy;
- a top-notch platform development and research group that can quickly develop data analytics, visualizations, reports, and decision-support tools on demand; and
- computing support from Amazon that allows us to handle even the most demanding data queries and analysis within minutes/hours.

MTI Data-Driven Decision Support Capabilities

- Safety and Health
- Emergency Management
- Infrastructure Investment
- Economic Development
- Equity and Social Justice
- Sustainability
- Crime, Human Trafficking, etc.

BIG DATA FOR PUBLIC GOOD

Presentation from Dr. Shaman, Columbia Univ.

(10:35 a.m. - 10:50 a.m.)

- Jeffrey Shaman, Ph.D.
  Professor, Columbia University
  Mailman School of Public Health
- Limited Questions and Answers

COLUMBIA UNIVERSITY | MAILMAN SCHOOL of PUBLIC HEALTH

ENVIRONMENTAL HEALTH SCIENCES

COVID-19 Transmission

Jeffrey Shaman

April 29, 2020

Funders

NIH (NIGMS)/NSF (DMS) joint initiative to support research at the interface of the biological and mathematical sciences

MIDAS

Models of Infectious Disease Agent Study

Funded by the National Institutes of Health

DARPA

NSF

Collaborators

Columbia/Mailman

Sen Pei
Wan Yang
Sasikiran Kandula
Marta Galanti
Teresa Yamana

Other

Ruiyin Li (Imperial)

- ***Cohort*** —— 214 individuals from October 2016 to April 2018.

(two daycares, CUMC, pediatric and adult ED, high school). Weekly swabs + daily symptoms .

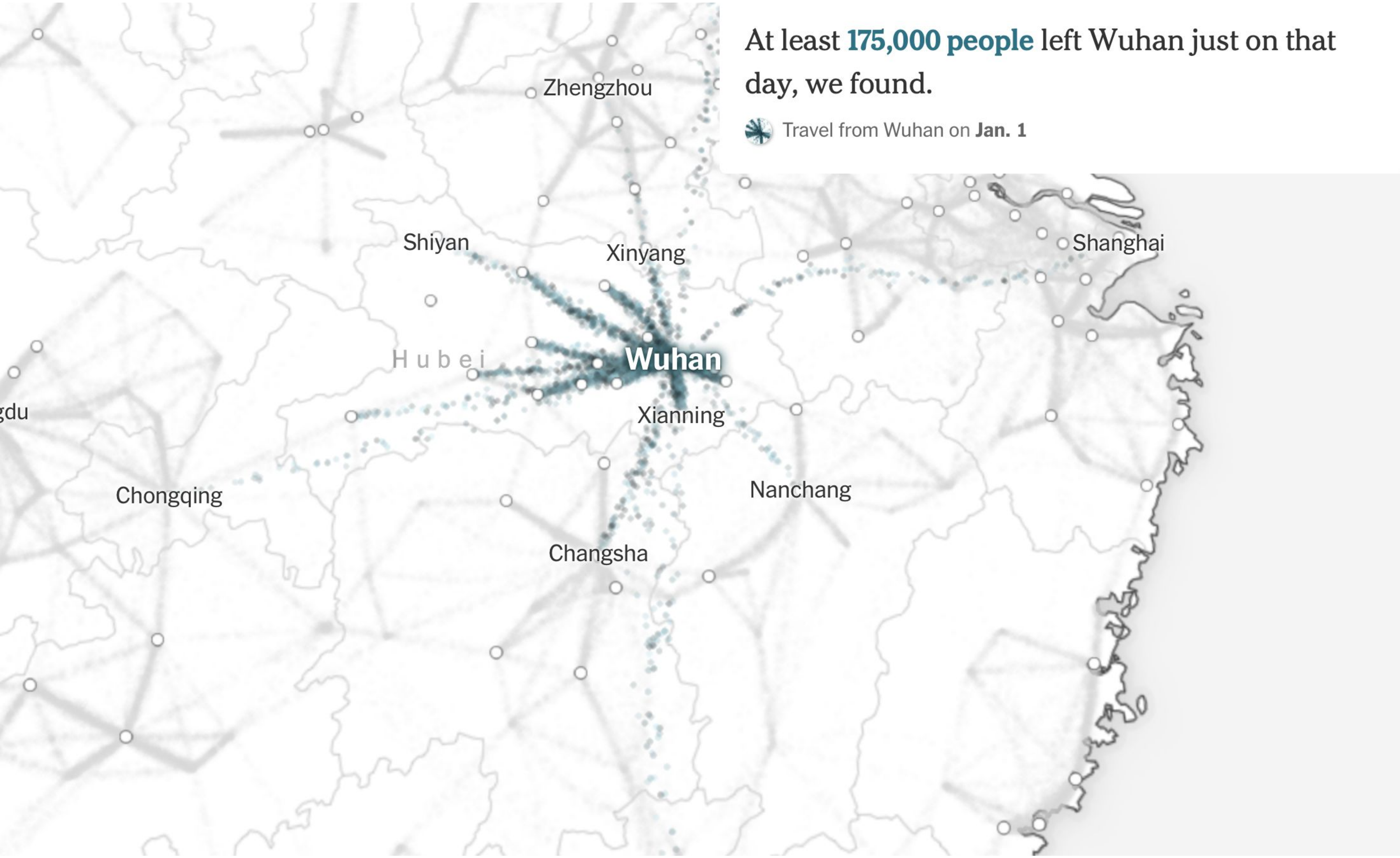
Virome of Manhattan

Most Infections Undocumented

VIRUS	EPISODES*	MA	P(MA|v_i)	HOME	P(HOME|v_i)	MEDS	P(MEDS|v_i)
Influenza	32	7	0.22	14	0.44	18	0.56
RSV	30	2	0.07	6	0.20	12	0.40
PIV	30	3	0.10	4	0.15	9	0.30
HMPV	20	4	0.20	7	0.35	10	0.50
HRV	275	24	0.09	31	0.11	70	0.25
Adenovirus	63	9	0.14	10	0.16	14	0.22
Coronavirus	137	6	0.04	13	0.09	36	0.25

*group of consecutive weekly specimens from a given individual that were positive for the same v
(allowing for a one-week gap to account for false negatives and temporary low shedding).

COVID-19 Rapid Spread



New York Times, March 22, 2018

Inference of Undocumented COVID-19 Infections

Are contagious, undocumented infections supporting the rapid spread of disease?

$$\frac{dS_i}{dt} = -\frac{\beta S_i I_i^r}{N_i} - \frac{\mu \beta S_i I_i^u}{N_i} + \theta \sum_j \frac{M_{ij} S_j}{N_j - I_j^r} - \theta \sum_j \frac{M_{ji} S_i}{N_i - I_i^r}$$

$$\frac{dE_i}{dt} = \frac{\beta S_i I_i^r}{N_i} + \frac{\mu \beta S_i I_i^u}{N_i} - \frac{E_i}{Z} + \theta \sum_j \frac{M_{ij} E_j}{N_j - I_j^r} - \theta \sum_j \frac{M_{ji} E_i}{N_i - I_i^r}$$

$$\frac{dI_i^r}{dt} = \alpha \frac{E_i}{Z} - \frac{I_i^r}{D}$$

$$\frac{dI_i^u}{dt} = (1 - \alpha) \frac{E_i}{Z} - \frac{I_i^u}{D} + \theta \sum_j \frac{M_{ij} I_j^u}{N_j - I_j^r} - \theta \sum_j \frac{M_{ji} I_i^u}{N_i - I_i^u}$$

$$N_i = N_i + \theta \sum_j M_{ij} - \theta \sum_j M_{ji}$$

- Metapopulation network model representing 375 cities in China
- Use Tencent travel records during the Chunyun spring festival
- Coupled with data assimilation methods
- Use daily observations from all 375 cities
- Simulate January 10-23

Li et al., 2020

Inference of Undocumented COVID-19 Infections

Are contagious, undocumented infections supporting the rapid spread of disease?

$$\frac{dS_i}{dt} = -\frac{\beta S_i I_i^r}{N_i} - \frac{\mu\beta S_i I_i^u}{N_i} + \theta \sum_j \frac{M_{ij} S_j}{N_j - I_j^r} - \theta \sum_j \frac{M_{ji} S_i}{N_i - I_i^r}$$

$$\frac{dE_i}{dt} = \frac{\beta S_i I_i^r}{N_i} + \frac{\mu\beta S_i I_i^u}{N_i} - \frac{E_i}{Z} + \theta \sum_j \frac{M_{ij} E_j}{N_j - I_j^r} - \theta \sum_j \frac{M_{ji} E_i}{N_i - I_i^r}$$

$$\frac{dI_i^r}{dt} = \alpha \frac{E_i}{Z} - \frac{I_i^r}{D}$$

$$\frac{dI_i^u}{dt} = (1-\alpha)\frac{E_i}{Z} - \frac{I_i^u}{D} + \theta \sum_j \frac{M_{ij} I_j^u}{N_j - I_j^r} - \theta \sum_j \frac{M_{ji} I_i^u}{N_i - I_i^u}$$

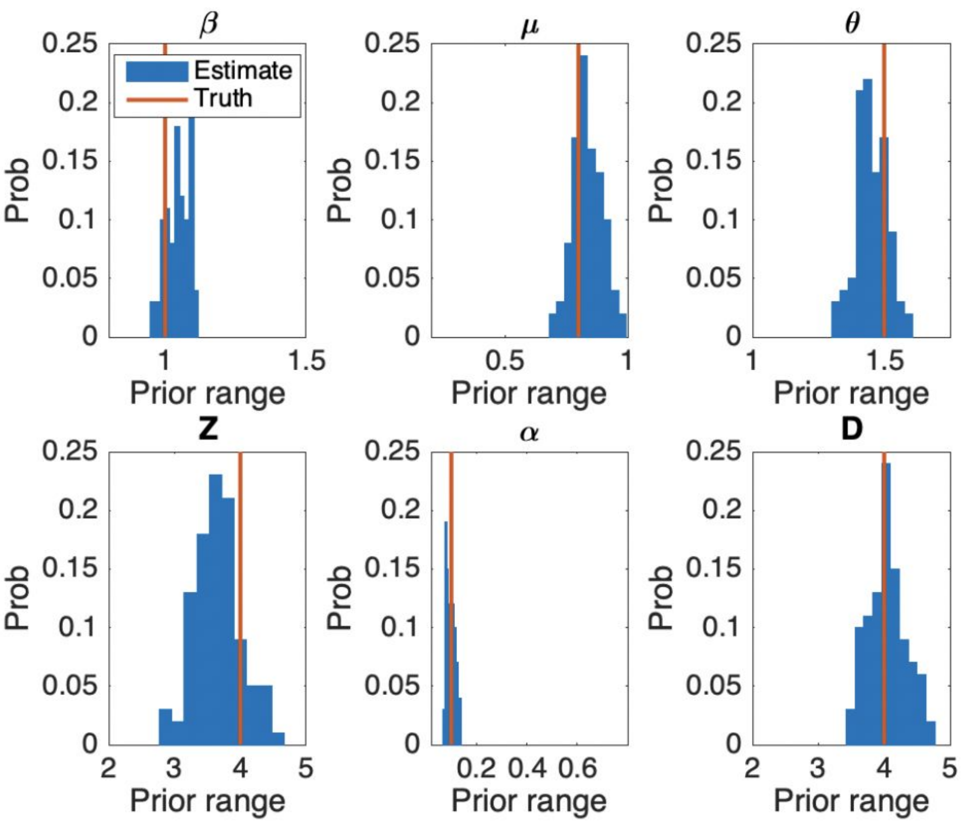
$$N_i = N_i + \theta \sum_j M_{ij} - \theta \sum_j M_{ji}$$

- Simulate January 10-23
- Prior to travel restrictions
- The model separately represents documented and undocumented infections
- The model has a separate contagiousness for documented/undocumented infections

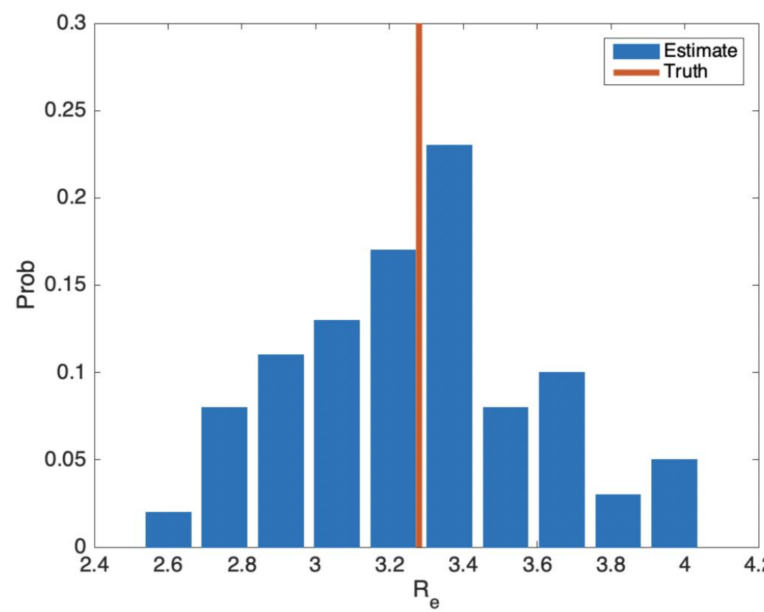
Li et al., 2020

Inference of Undocumented COVID-19 Infections

Are contagious, undocumented infections supporting the rapid spread of disease?



- Synthetic test of model-inference parameter estimation using model-generated observations



Li et al., 2020

Inference of Undocumented COVID-19 Infections

Are contagious, undocumented infections supporting the rapid spread of disease?

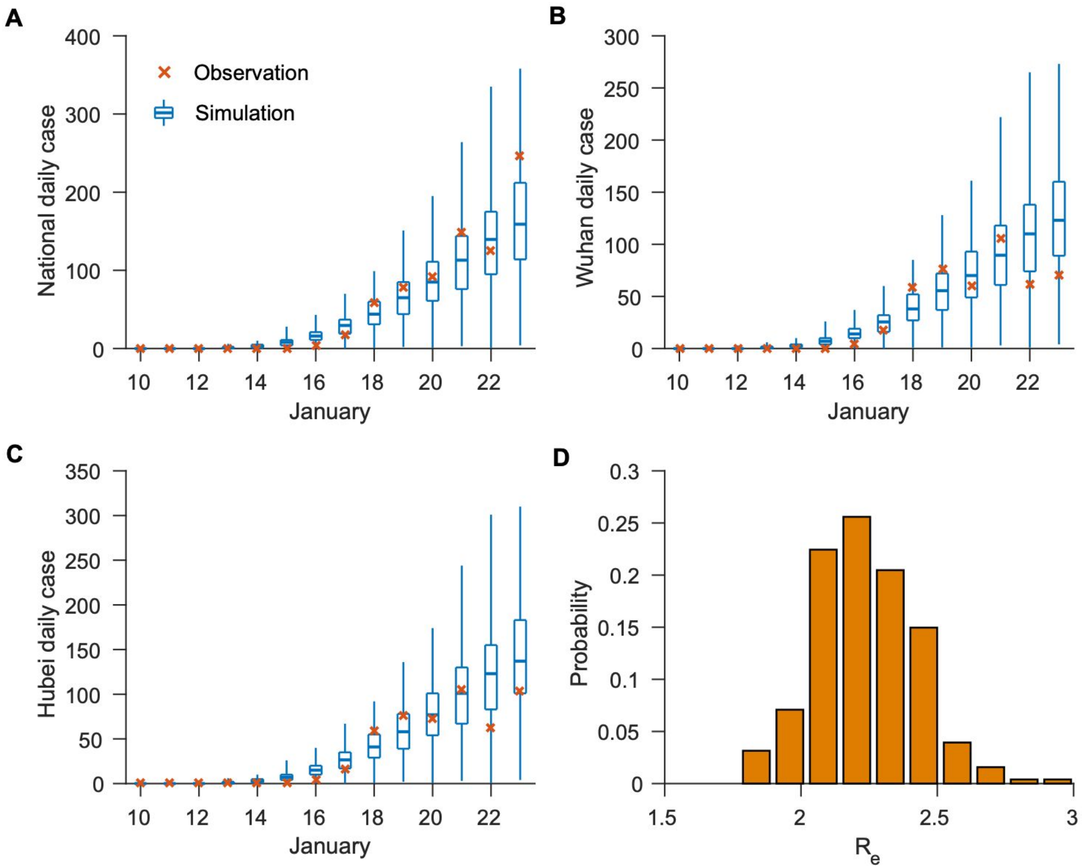
Parameter	Median (95% CIs)
Transmission rate (β, days^{-1})	1.12 (1.04, 1.18)
Relative transmission rate (μ)	0.55 (0.46, 0.62)
Latency period (Z, days)	3.69 (3.28, 4.03)
Infectious period (D, days)	3.48 (3.18, 3.74)
Reporting rate (α)	0.14 (0.10, 0.18)
Basic reproductive number (R_e)	2.38 (2.04, 2.77)
Mobility factor (θ)	1.36 (1.28, 1.43)

- Estimate that 14% of infections are documented
- 86% are undocumented
- Per person, undocumented infections are on average half as contagious (55%) as documented infections
- 2.38 reproductive number

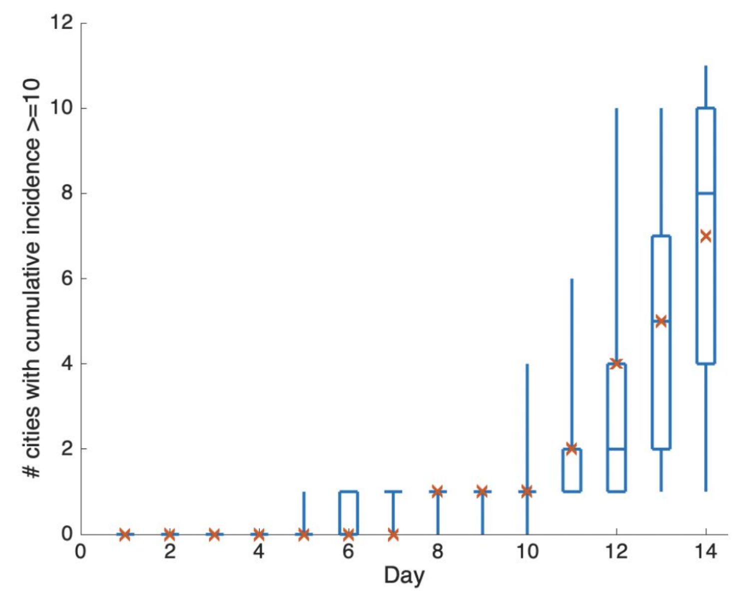
Li et al., 2020

Inference of Undocumented COVID-19 Infections

Are contagious, undocumented infections supporting the rapid spread of disease?



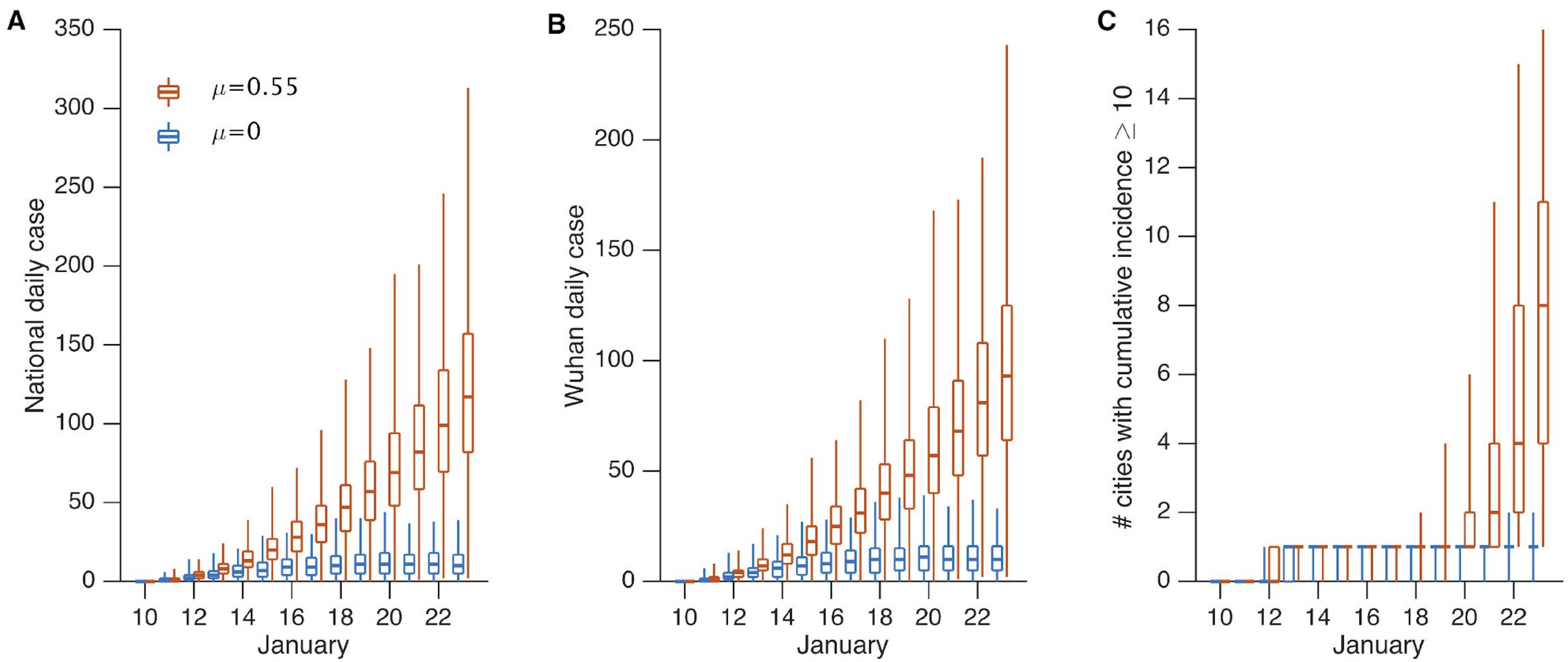
- Simulations with the parameter estimates match the observed outbreak



Li et al., 2020

Inference of Undocumented COVID-19 Infections

Are contagious, undocumented infections supporting the rapid spread of disease?



- Simulations show without transmission from undocumented cases, confirmed cases decrease 79%

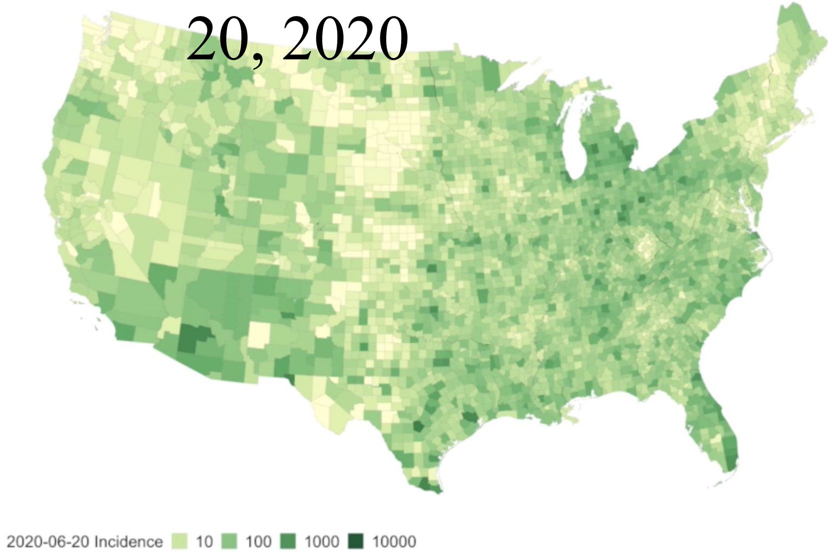
Li et al., 2020

Documentation History of CoV

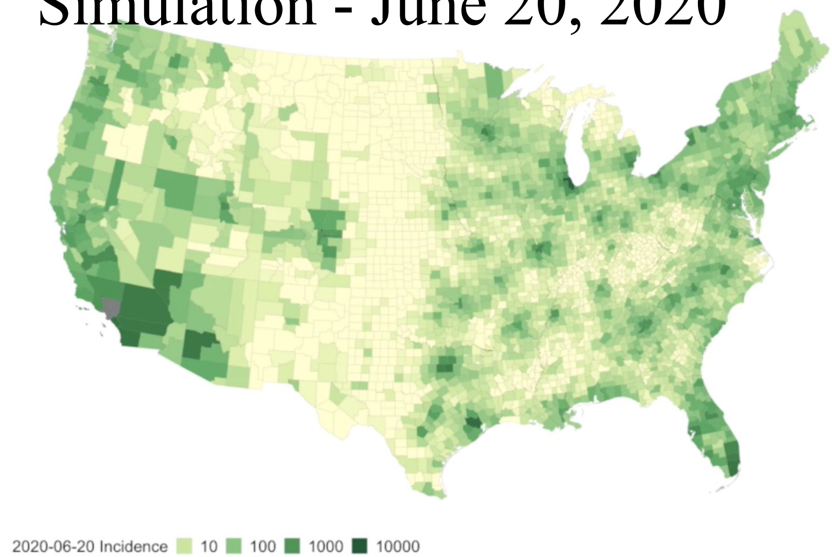
- SARS: sub-clinical infection rates believed to be low (WHO, 2003)
- MERS: 21% of laboratory identified cases were mild or asymptomatic (WHO, 2018)
- Seasonal Coronaviruses (229E, OC43, NL63, HKU1)
  - 135 infection events
  - >60% mild or asymptomatic
  - 4% sought medical care (all had either OC43 or HKU1—the two seasonal betacoronaviruses) (Shaman and Galanti, 2020)
- Our model-inference approach identifies a 14% documentation rate prior to travel restrictions (Li et al. 2020) and indicates that undocumented infections contribute substantially to COVID-19 transmission.

Projections for the US

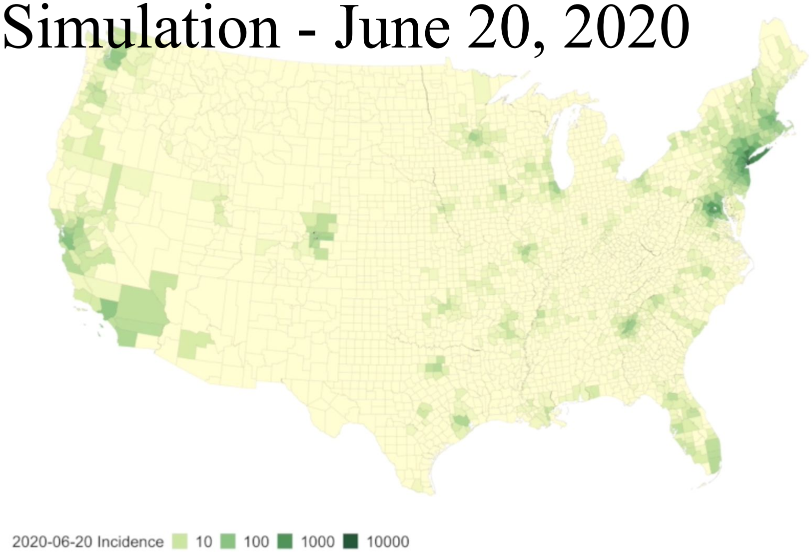
No Control Simulation - June 20, 2020



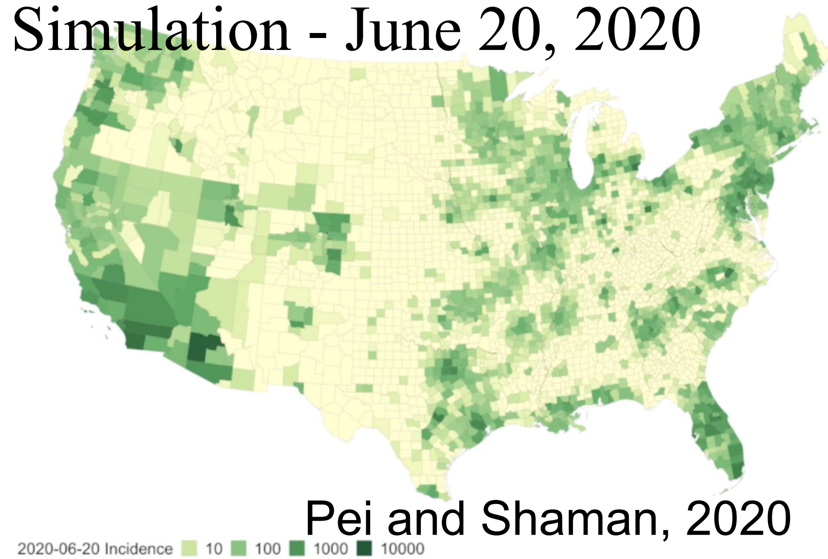
25% Transmission Reduction Simulation - June 20, 2020



50% Transmission Reduction Simulation - June 20, 2020



95% Movement Reduction Simulation - June 20, 2020



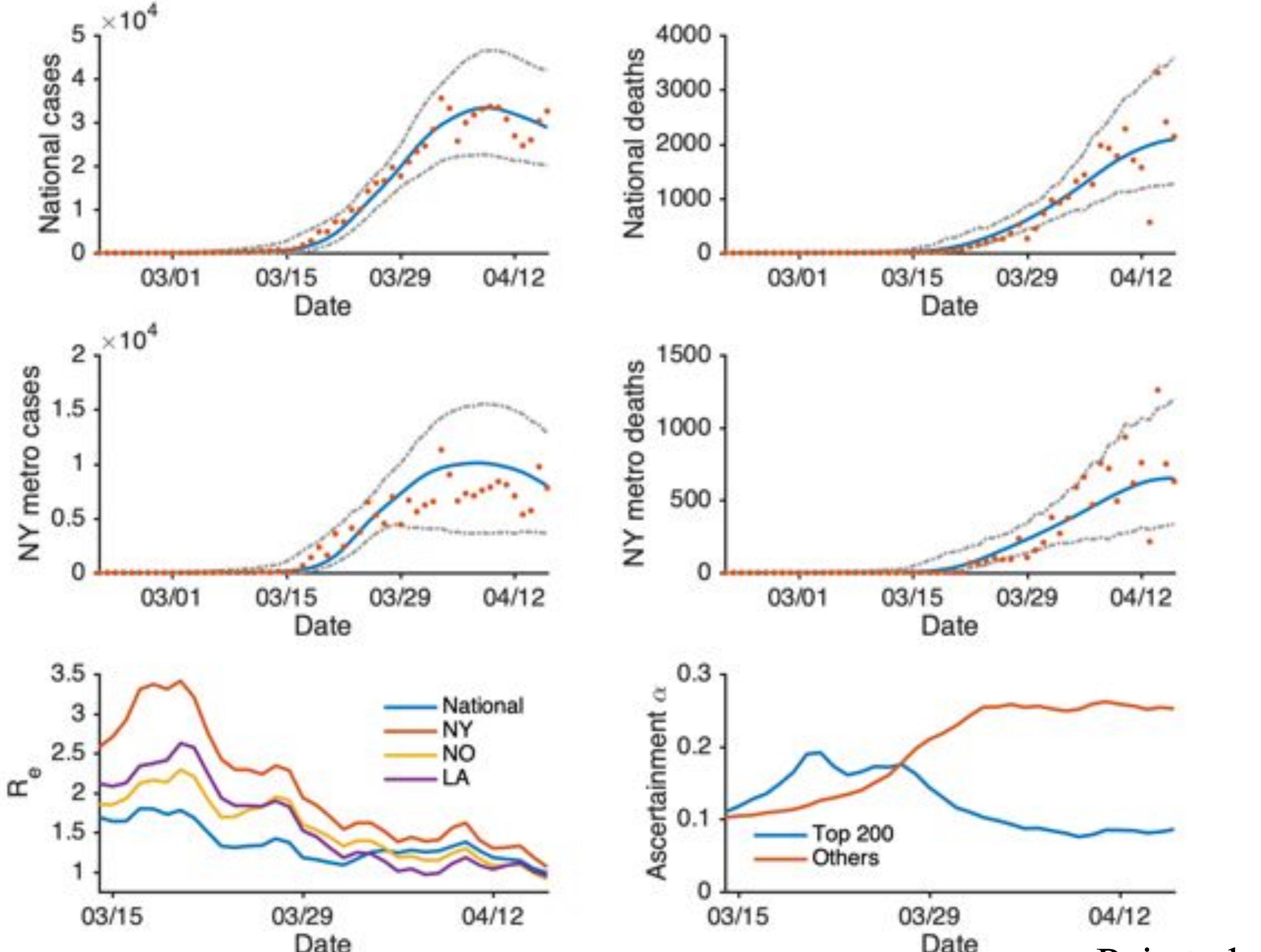
Pei and Shaman, 2020

Initial Estimates for the US (through March 13, 2020)

Parameter	Median (95% CIs)
Transmission rate (β, days^{-1})	0.95 (0.84, 1.06)
Relative transmission rate (μ)	0.64 (0.56, 0.70)
Latency period (Z, days)	3.59 (3.28, 3.99)
Infectious period (D, days)	3.56 (3.21, 3.83)
Reporting rate (α)	0.080 (0.069, 0.093)
Basic reproductive number (R_e)	2.27 (1.87, 2.55)
Mobility factor (θ)	0.15 (0.12,0.17)

Pei and Shaman, 2020

Inference, Fitting and Projection



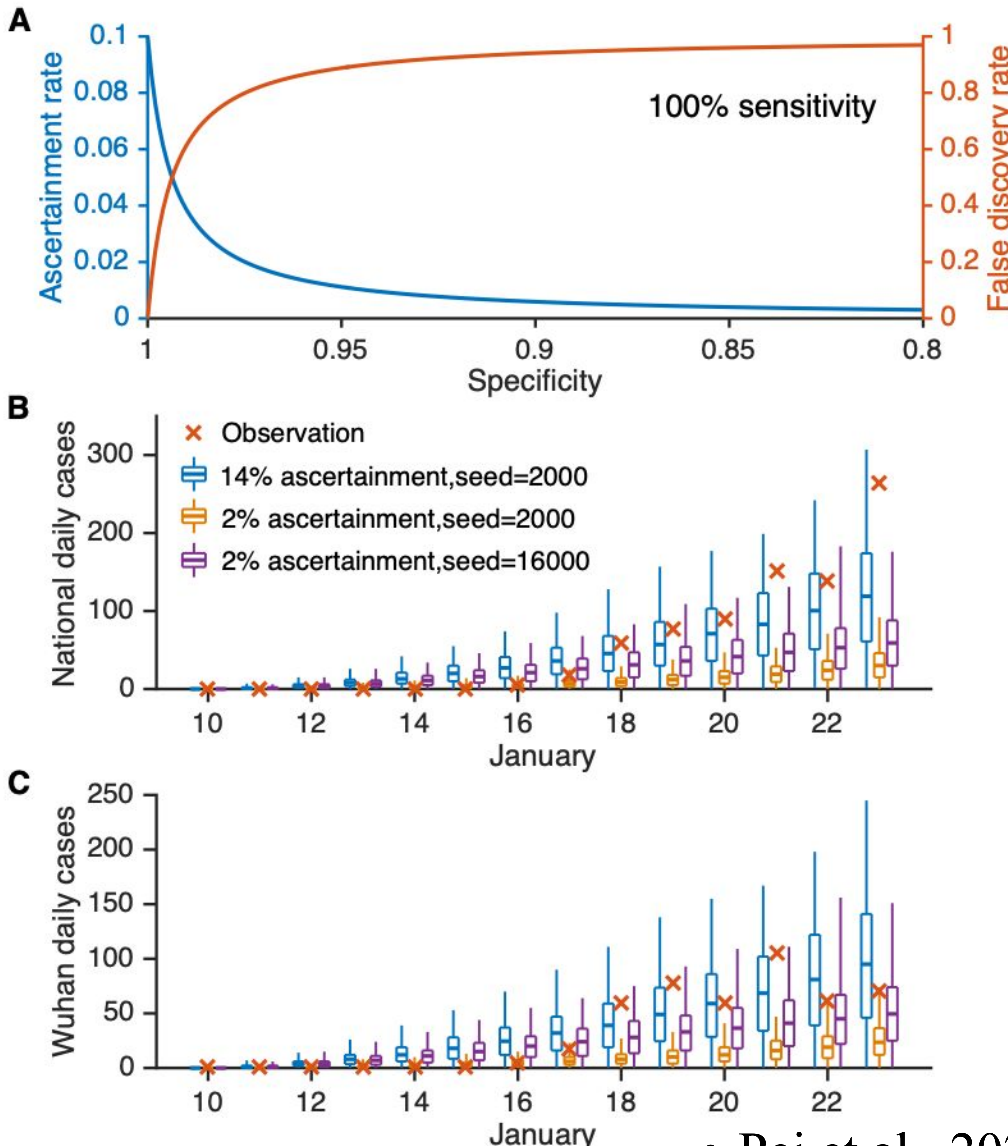
- Pei et al., 2020

COVID-19 in the US-surge

Branas et al., 2020

Seroprevalence

- Recent studies suggest much lower ascertainment rates (Bendavid et al. 2020)
- Seroprevalence studies must account for false positives
- Ascertainment rates of 2% or less seem unlikely



- Pei et al., 2020

Workgroup Discussion and Closing Remarks

(10:50 a.m. - 11:15 a.m.)

- Discussion Topics
  - Top concerns from constituents
  - Innovative policy solutions
  - Long-term systematic issues

- Next meeting with be May 6 at 10 a.m.