Projecting COVID-19 Hospitalizations

for Regions 2, 3, and 4 of the Kentucky Regional Hospital Preparedness Program (HPP) Coalition

<u>during the Implementation of the State's "Targeted Measures"</u>

Projection Period:

14 November 2020 – 15 January 2021

HPP Region	Population (Estimated 2019)	Number of Counties	Largest County	Largest City
2	374,030	11	Daviess	Owensboro
3	1,286,637	15	Jefferson	Louisville
4	308,919	10	Warren	Bowling Green

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The State of Kentucky's Targeted Measures (link)

20 November 2020 to 13 December 2020:

- **Gyms, fitness centers, pools, other indoor recreation facilities: "**<u>33% capacity limit</u>; group classes, team practices and competitions prohibited; masks must be worn while exercising**"**
- **Venues, event spaces and theaters: "**Each room will be limited to <u>25 people</u>. This applies to indoor weddings and funerals**"**
- **Private Social Gatherings: "**<u>Up to eight people</u> from a maximum of <u>two households</u>"
- **Professional services: "**Office-based businesses limited to <u>33% of employees</u>; all employees who are able to work from home must do so; all businesses that can close to the public must do so**"**
- **Restaurant and bars: "**<u>No indoor food</u> or beverage consumption; carryout and delivery encouraged; socially distance outdoor seating"

20 November 2020 to 4 January 2021:

- "All public and private schools (K -12) to cease in-person instruction":
  - **Elementary schools: "**Elementary schools may reopen for in-person instruction Dec. 7**"**
  - **Middle and high schools: "**will remain in remote or virtual instruction until at least Jan. 4, 2021."

Takeaways:

- In the absence of the targeted measures (or if there is no compliance with the restrictions), the number of active hospitalizations is expected to be:

494	in Region 2		870	in Region 2
1,092	in Region 3	and	1,690	in Region 3
210	in Region 4		256	in Region 4
by mid-December 2020			by mid-January 2021.	

  The total numbers of inpatient beds in the regions are:

838	in Region 2
3,942	in Region 3
823	in Region 4

- High compliance with the targeted measures (if it reduces transmission rate by 75%) prevents approximately the following numbers of excess hospitalizations:

439	in Region 2		763	in Region 2
690	in Region 3	and	1,583	in Region 3
117	in Region 4		226	in Region 4
by mid-December 2020			by mid-January 2021.	

- Mid-range compliance with the targeted measures (if it reduces transmission rate by 50%) prevents approximately the following numbers of excess hospitalizations:

371	in Region 2		661	in Region 2
574	in Region 3	and	1,363	in Region 3
141	in Region 4		191	in Region 4
by mid-December 2020			by mid-January 2021.	

- Even low compliance with the targeted measures (if it reduces transmission rate by 25%) prevents approximately the following numbers of excess hospitalizations:

238	in Region 2		459	in Region 2
355	in Region 3	and	933	in Region 3
87	in Region 4		123	in Region 4
by mid-December 2020			by mid-January 2021.	

- Mid-range and high compliance with the new restrictions is projected to prevent excess hospitalizations and will allow the regions' hospitals to operate elective surgeries at normal capacity.

Kentucky Regional Hospital Preparedness Program (HPP) Coalition

HPP Region 3 Counties:
Bullitt, Breckinridge, Grayson, Hardin, Henry, Jefferson, Larue, Marion, Meade, Nelson, Oldham, Shelby, Spencer, Trimble, Washington
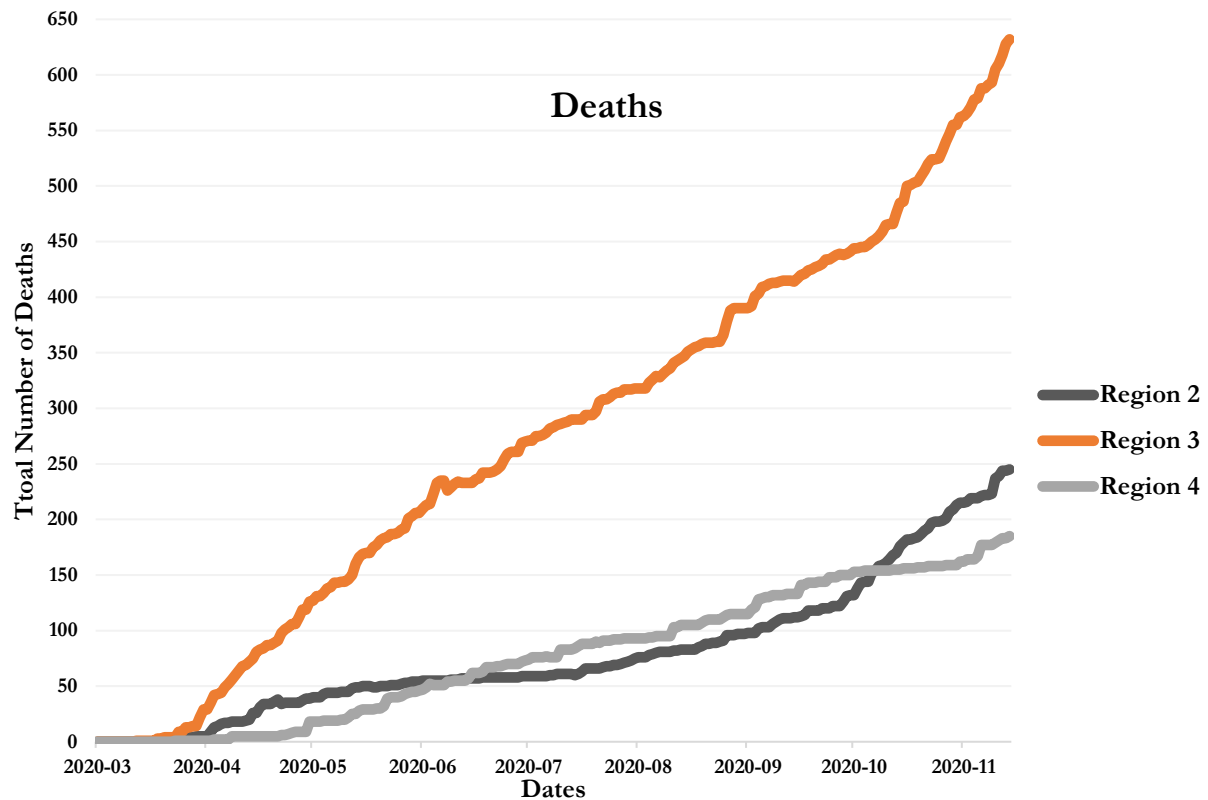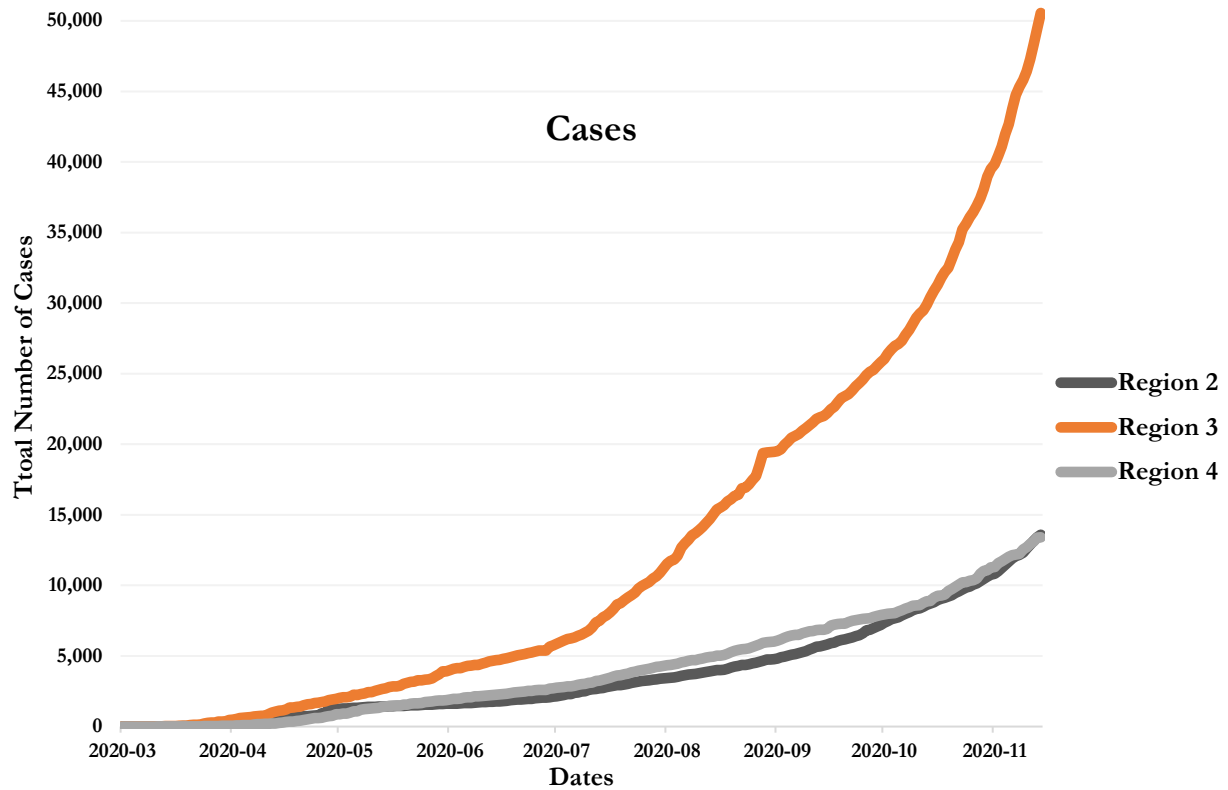
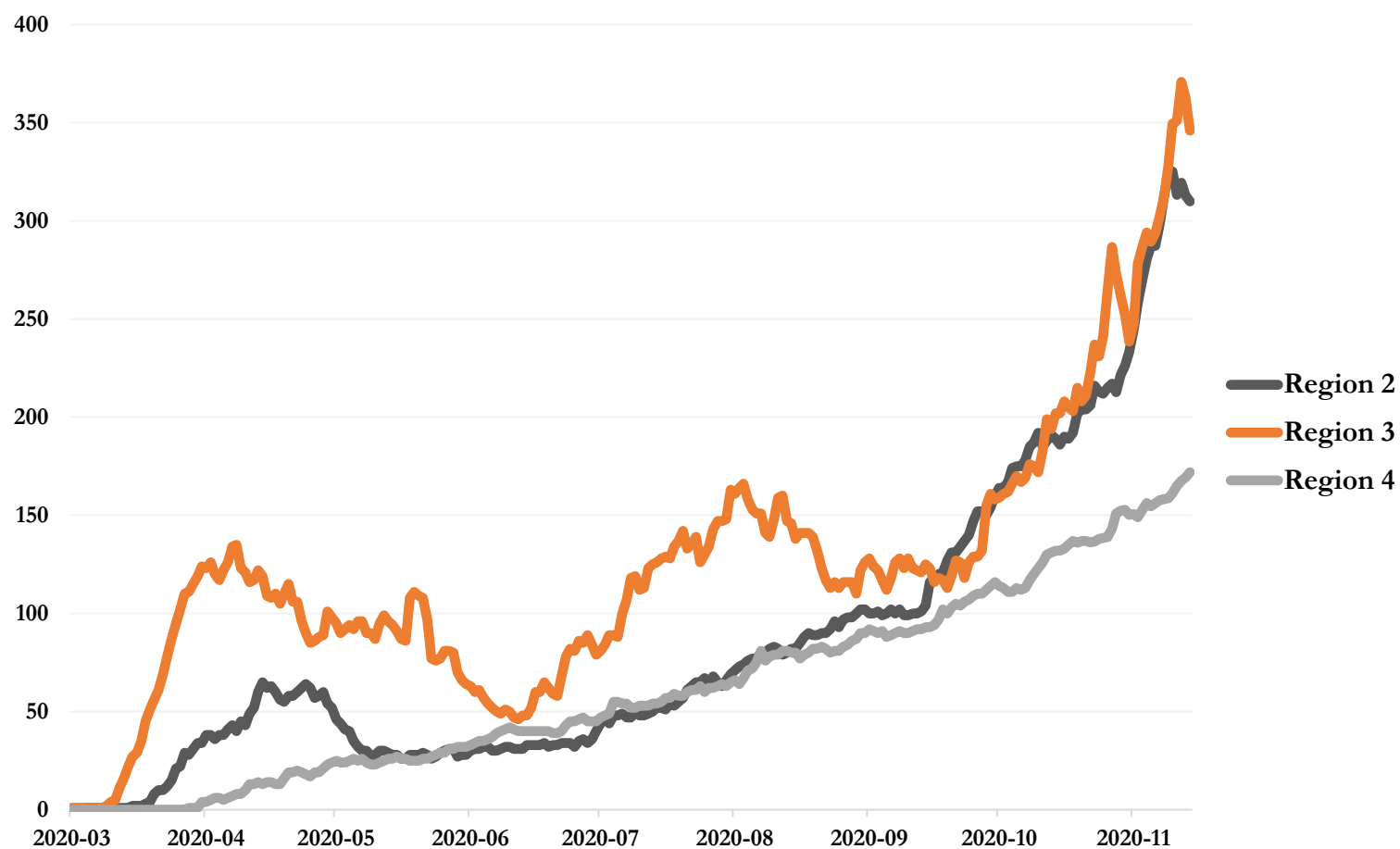**HPP Region**
Christia
Hopkin
Todd, U

HPP Region 4 Counties:
Allen, Barren, Butler, Edmonson, Hart, Logan, Metcalfe, Monroe, Simpson, Warren

Source: https://kyepltc.org/hospital-preparedness/coalitions/

Total Covid-19 Cases and Deaths in Kentucky HPP Regions 2−4
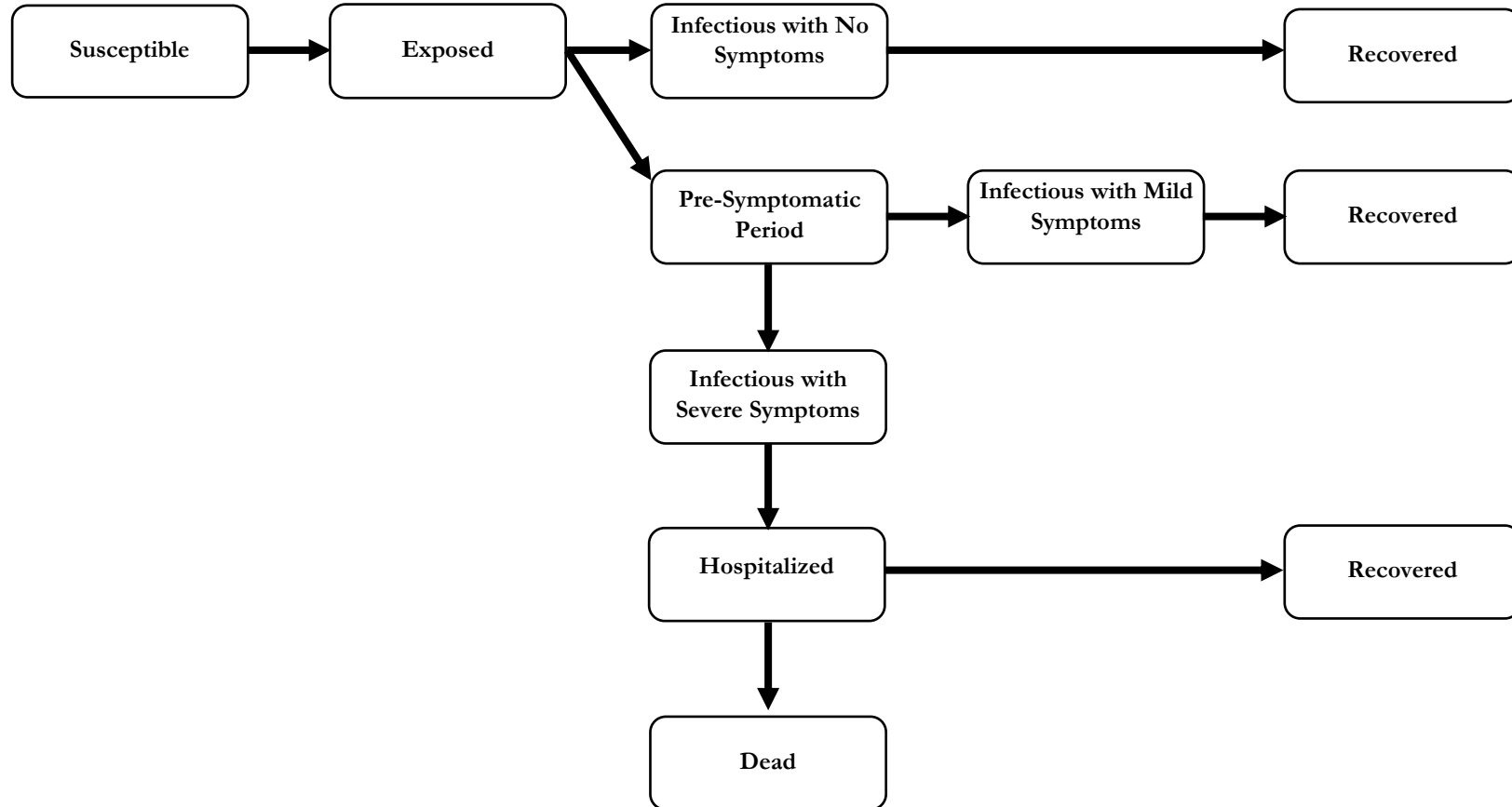
Cases

Deaths

Note: Authors calculations using the New York Times Data (link)

Confirmed Active Covid-19 Hospitalizations for Kentucky HPP Regions 2−4 Based on the Latest Hospitalization Report (Numbers Are Corrected for Reporting Delay)

Notes: Authors' calculations using the data from the Kentucky Health Information Exchange (KHIE).

A Conceptual Framework for Modeling Covid-19 Pandemic in HPP Regions 2-4:

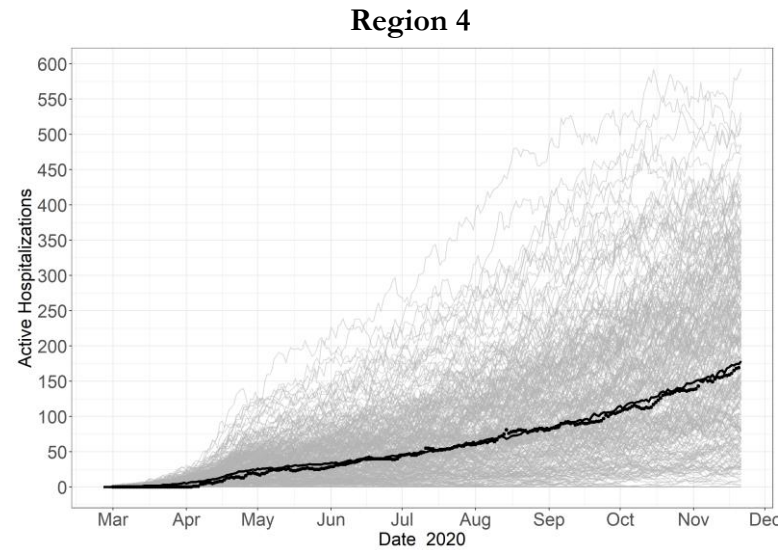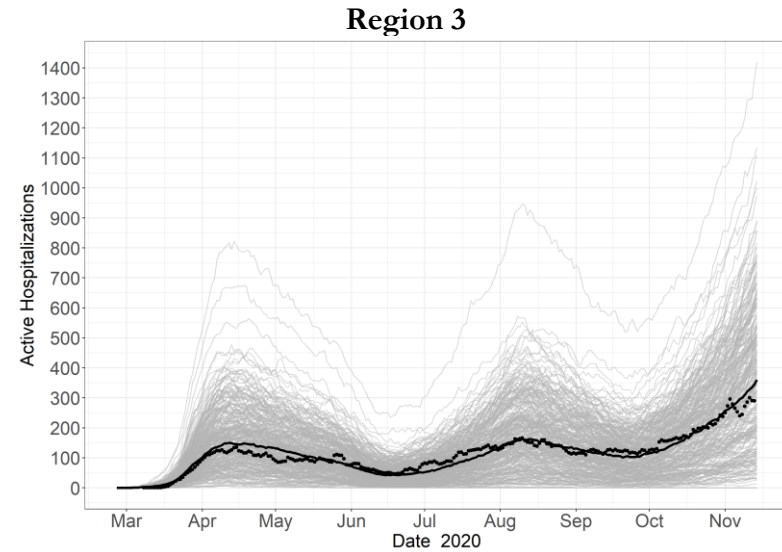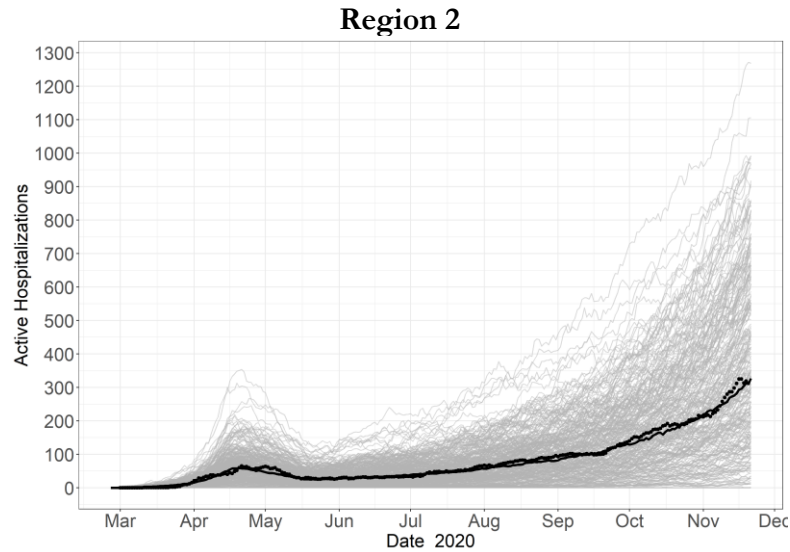## A Susceptible-Exposed-Infectious-Recovered (SEIR) Model

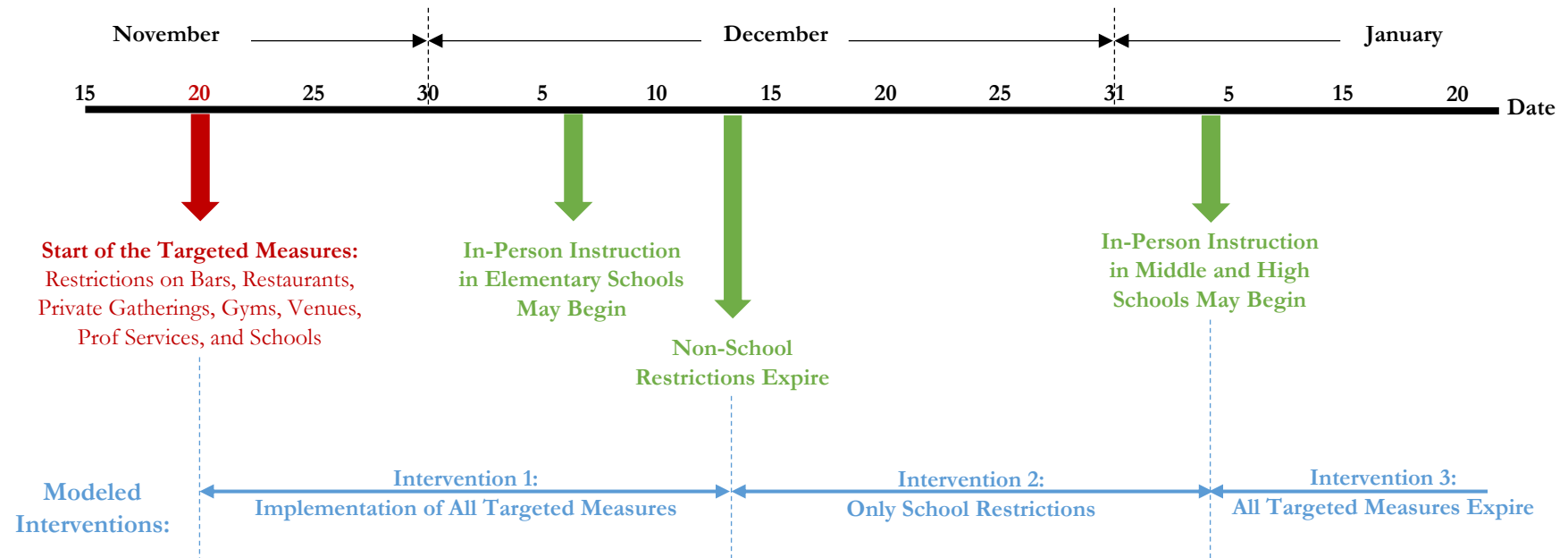# Transmission and Clinical Parameters Used in the SEIR Model

	Region 2			Region 3			Region 4		
	Median	Lower Bound	Upper Bound	Median	Lower Bound	Upper Bound	Median	Lower Bound	Upper Bound
Parameters Extracted from the Literature:									
Proportion of Infections That Are Asymptomatic[1-4]	43%	30%	50%	43%	30%	50%	43%	30%	50%
Incubation Period (Days)[5-8]	3.5	2.0	14.0	3.5	2.0	14.0	3.5	2.0	14.0
Pre-Symptomatic Period (Days)[9-11]	1.5	1.1	2.5	1.5	1.1	2.5	1.5	1.1	2.5
Infectious Period for Asymptomatic Infections (Days)[12,13]	7.0	4.0	10.0	7.0	4.0	10.0	7.0	4.0	10.0
Parameters Extracted from the KHIE and Jefferson County Person-Level Data:									
Infectious Period for Mildly Symptomatic Infections (Days)[14-16]	15.0	8.0	22.0	15.0	8.0	22.0	15.0	8.0	22.0
Infectious Period for Severely Symptomatic Infections (Days)	5.0	2.0	8.0	5.0	2.0	8.0	5.0	2.0	8.0
Proportion of Symptomatic Infections That Required Hospitalization[17,18]	11.5%	6.5%	16.5%	12.6%	7.6%	17.6%	19.3%	14.3%	24.3%
Duration of Hospital Stay of Those Who Recovered from the Infection (Days)	6.0	4.0	18.0	5.0	3.0	9.0	8.0	3.0	18.0
Duration of Hospital Stay of Those Who Died of the Infection (Days)	9.0	5.0	16.0	9.0	5.0	15.0	5.0	3.0	11.0
Fatality Rate Among Hospitalizations	12.2%	7.2%	17.2%	16.5%	11.5%	21.5%	9.2%	4.2%	14.2%

Notes: For each parameter of the SEIR model, a range of values from the lower bound to the upper bound were used in simulations. The parameters in the first section of the table were extracted from the literature. The parameters of the second section are calculated by the authors using two separate person-level data sources: (1) Kentucky Health Information Exchange (KHIE) COVID-19 hospitalization data, collected and compiled at the Kentucky Cabinet for Health and Family Services (CHFS); (2) Jefferson County COVID-19 Case and Fatality Data, collected and compiled at the Louisville Metro Department of Public Health and Wellness (LMPHW). The information on infectious periods is not available in the KHIE data and is extracted from Jefferson County data and used for all regions. A lower bound is the 25th quantile of the distribution of the parameter value in the related subsample, and an upper bound is the 75th quantile. The exceptions are percentages ("proportion of symptomatic infections that require hospitalization" and "fatality rate among hospitalizations") and the upper bound of the number of days of "infectious period for mildly symptomatic infections." The 75th quantile of the latter parameter in Jefferson County data is 53 days, significantly different from what is reported in the literature; therefore, the upper bound was selected such that it has the same distance from the median as the lower bound does. For percentages, 5% above and below was selected as upper and lower bounds, respectively.

The Fit of the SEIR Model to the Observed Active Hospitalization Data in Kentucky HPP Regions 2−4: March 15 to November 13, 2020 (dots are the observed data. The highlighted path us the median of 300 simulations.)

The Timeline of the Targeted Measures and Modelled Interventions

November ————→ December ————→ January

15　　20　　25　　30　　5　　10　　15　　20　　25　　31　　5　　15　　20　　Date

Start of the Targeted Measures:
Restrictions on Bars, Restaurants,
Private Gatherings, Gyms, Venues,
Prof Services, and Schools

**In-Person Instruction
in Elementary Schools
May Begin**

**Non-School
Restrictions Expire**

**In-Person Instruction
in Middle and High
Schools May Begin**

**Modeled
Interventions:**

Intervention 1:
Implementation of All Targeted Measures

Intervention 2:
Only School Restrictions

Intervention 3:
All Targeted Measures Expire

Note: Detailed information on the restrictions is available at Kentucy.gov.
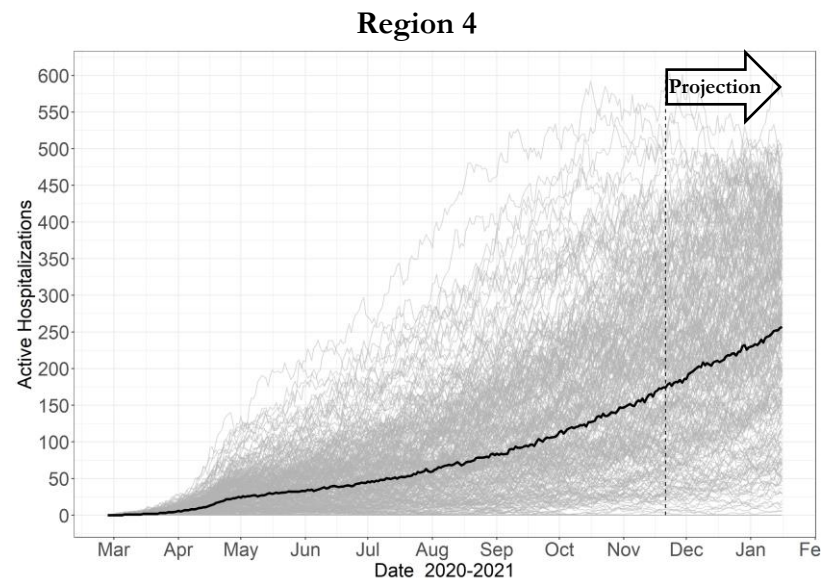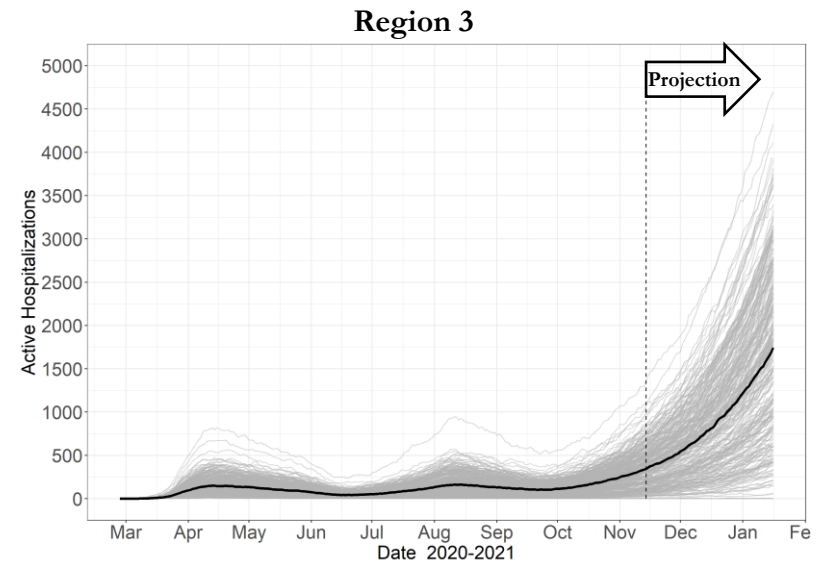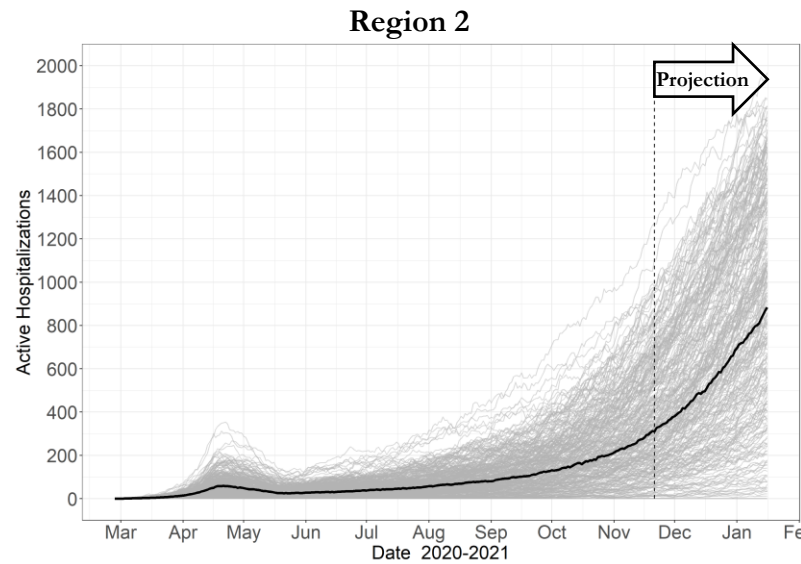
Projection Scenarios

Given the components of the targeted measures, the following projection scenarios were considered:

The ↓ sign indicates a decrease.

| #	Scenarios	Intervention Number	Interventions Description	Intervention Start Date	Intervention End Date	Assumed Percentage Change in Transmission
1	Continuing the Status Quo	None	Absence of the Targeted Measures	-	-	-
2	Low Compliance with the Restrictions	1	Implementation of All Targeted Measures	20-Nov	13-Dec	25% ↓
		2	Only School Restrictions	14-Dec	4-Jan	3% ↓
		3	All Targeted Measures Expire	5-Jan	15-Jan	0
3	Mid-Range Compliance with the Restrictions	1	Implementation of All Targeted Measures	20-Nov	13-Dec	50% ↓
		2	Only School Restrictions	14-Dec	4-Jan	3% ↓
		3	All Targeted Measures Expire	5-Jan	15-Jan	0
4	High Compliance with the Restrictions	1	Implementation of All Targeted Measures	20-Nov	13-Dec	75% ↓
		2	Only School Restrictions	14-Dec	4-Jan	3% ↓
		3	All Targeted Measures Expire	5-Jan	15-Jan	0

Notes: (1) The SEIR model's transmission parameter is the multiplication of the probability of transmission per-contact and the per capita contact rate between the susceptible and the infectious. The latter component carries the effect of a non-pharmaceutical intervention if it influences personal and social protection measures. (2) The new school restrictions are expected to affect about 20% of Jefferson County's student population because the rest attended public schools that applied distance learning from July 2020. Since 6-18 years old constitute 15.8% of Jefferson County's population, if the restriction decreases these students' contact rate by 95%, then it is expected that the overall contact rate in the County decreases by 3% (=20%×15.8%×95%) with respect to the pre-November 20 period. This assumption were appled to all three regions. (3) The presumed percentage decreases in transmission during full implementation of the targeted measures may resemble mask-wearing effectiveness and its take-up in reducing the transmission. High mask-wearing may decrease the reduce the risk of infection by 85%, but low mask-wearing rates will reduce its effectiveness proportionally.
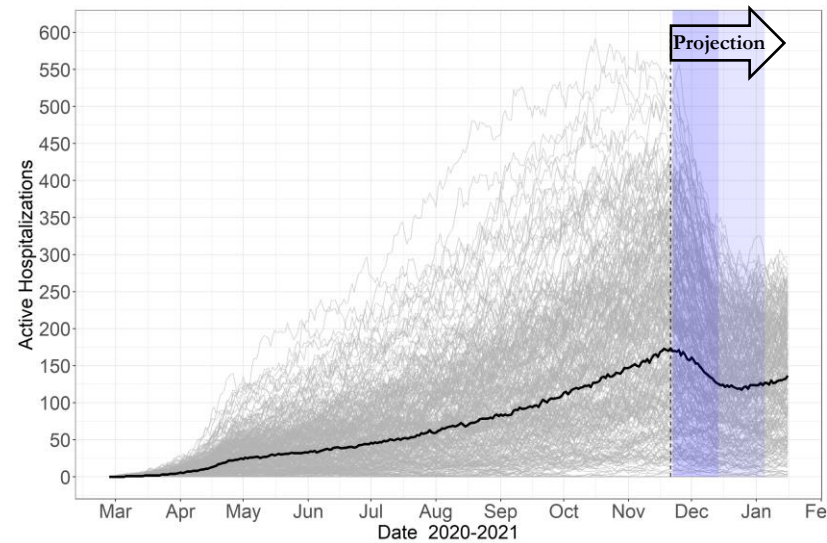
Status Quo's Projections for 14 Nov 2020−15 Jan 2021 (Assumption: no change in contact rate)

Region 2

Region 3

Region 4

Scenario 1's Projections for 14 Nov 2020−15 Jan 2021 (Assumption: low compliance, contact rate 25%↓)
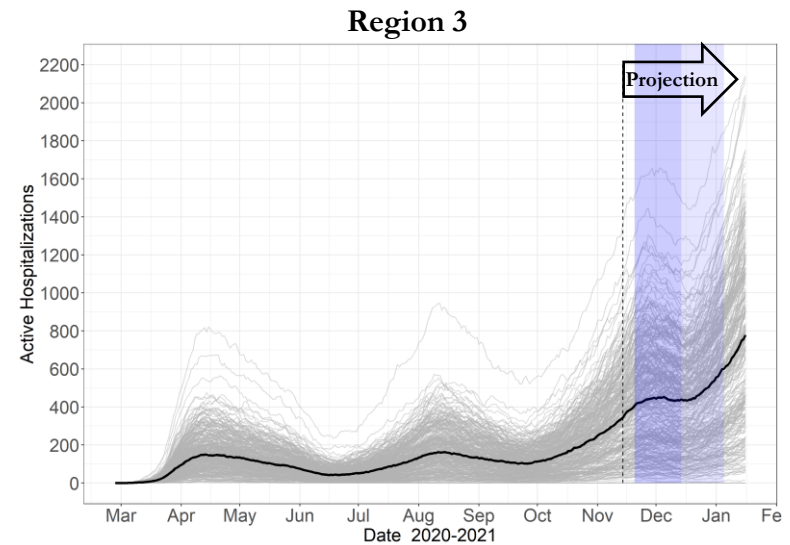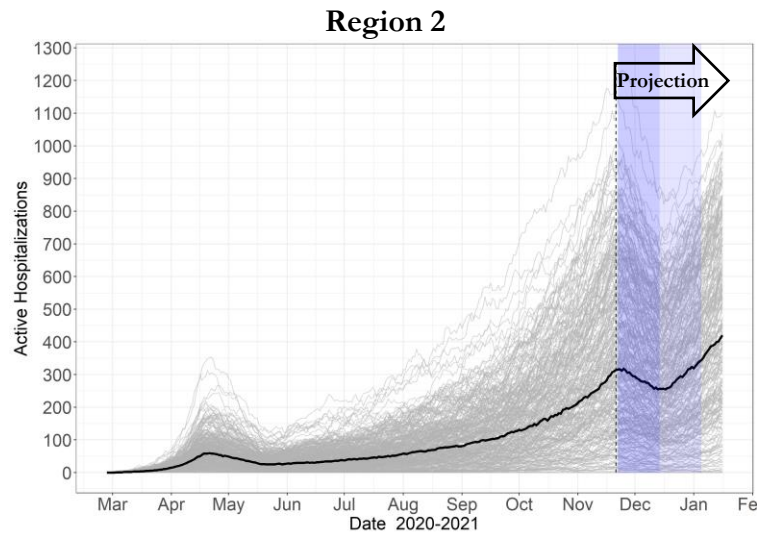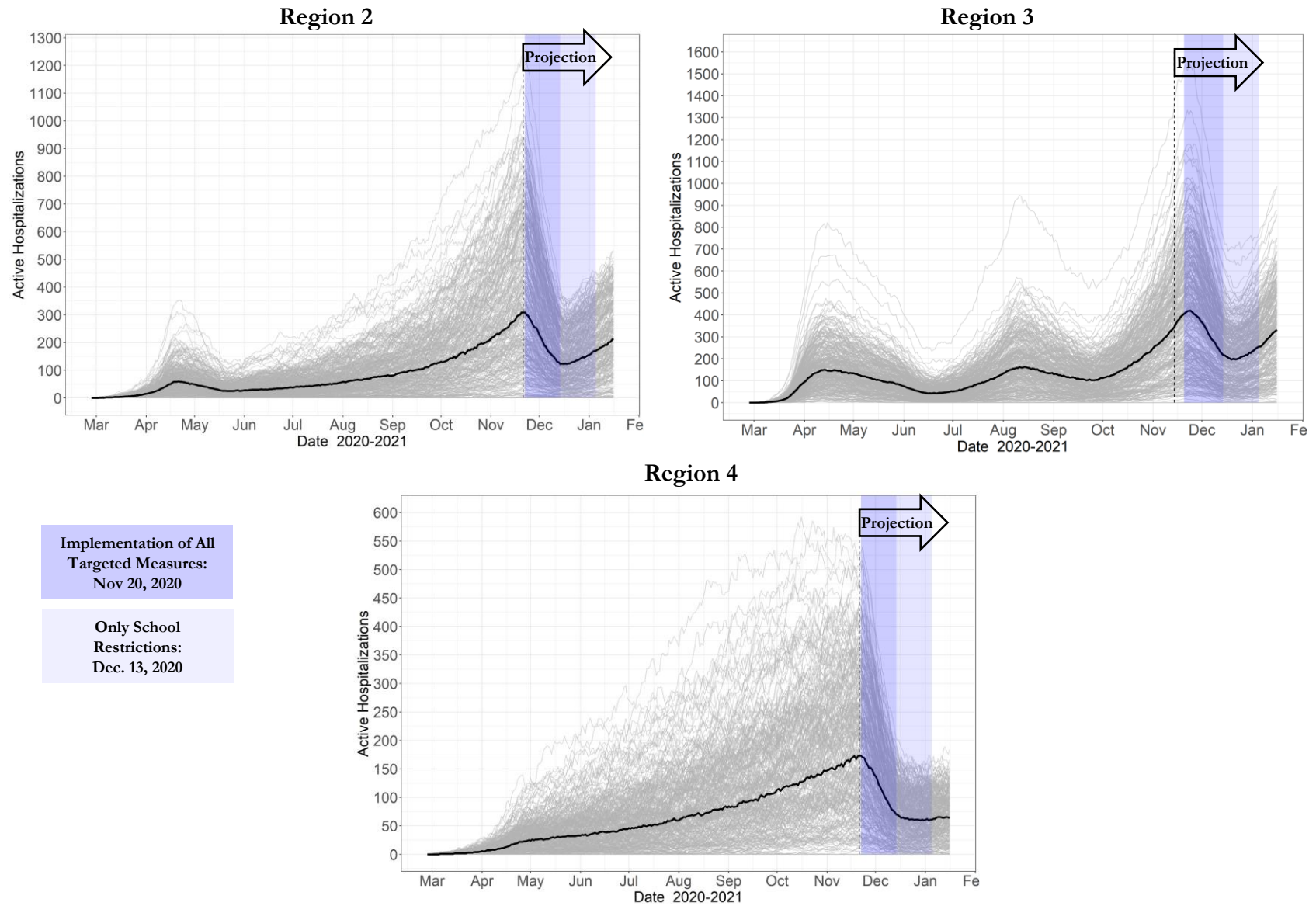
Region 2
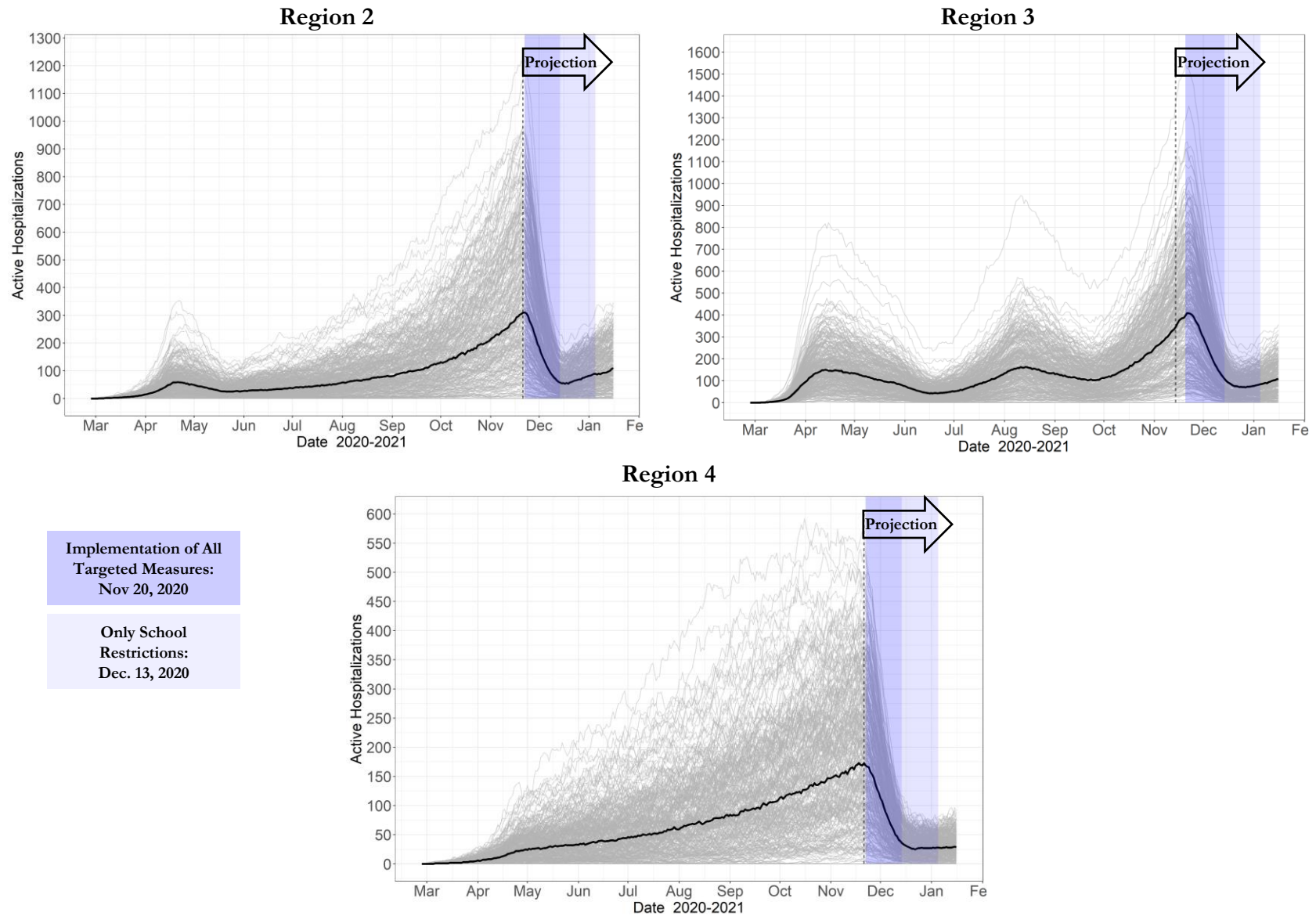

Region 3

Region 4

Implementation of All
Targeted Measures:
Nov 20, 2020

Only School
Restrictions:
Dec. 13, 2020

Scenario 2's Projections for 14 Nov 2020−15 Jan 2021 (Assumption: mid-range compliance, contact rate 50%↓)
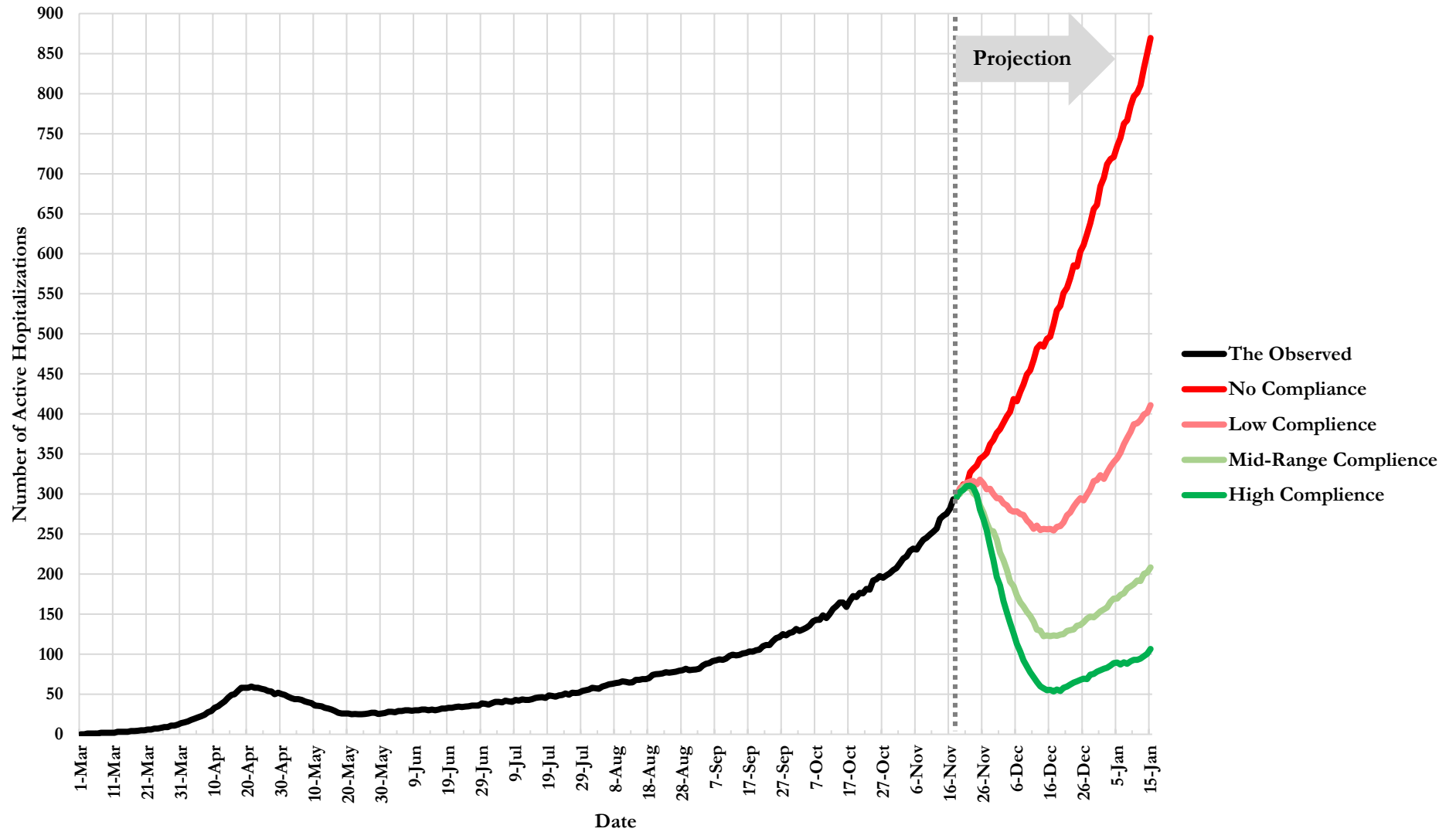
Region 2

Region 3

Region 4

Implementation of All
Targeted Measures:
Nov 20, 2020

Only School
Restrictions:
Dec. 13, 2020

Scenario 3's Projections for 14 Nov 2020−15 Jan 2021 (Assumption: high compliance, contact rate 75%↓)

Region 2

Region 3

Region 4

Implementation of All
Targeted Measures:
Nov 20, 2020

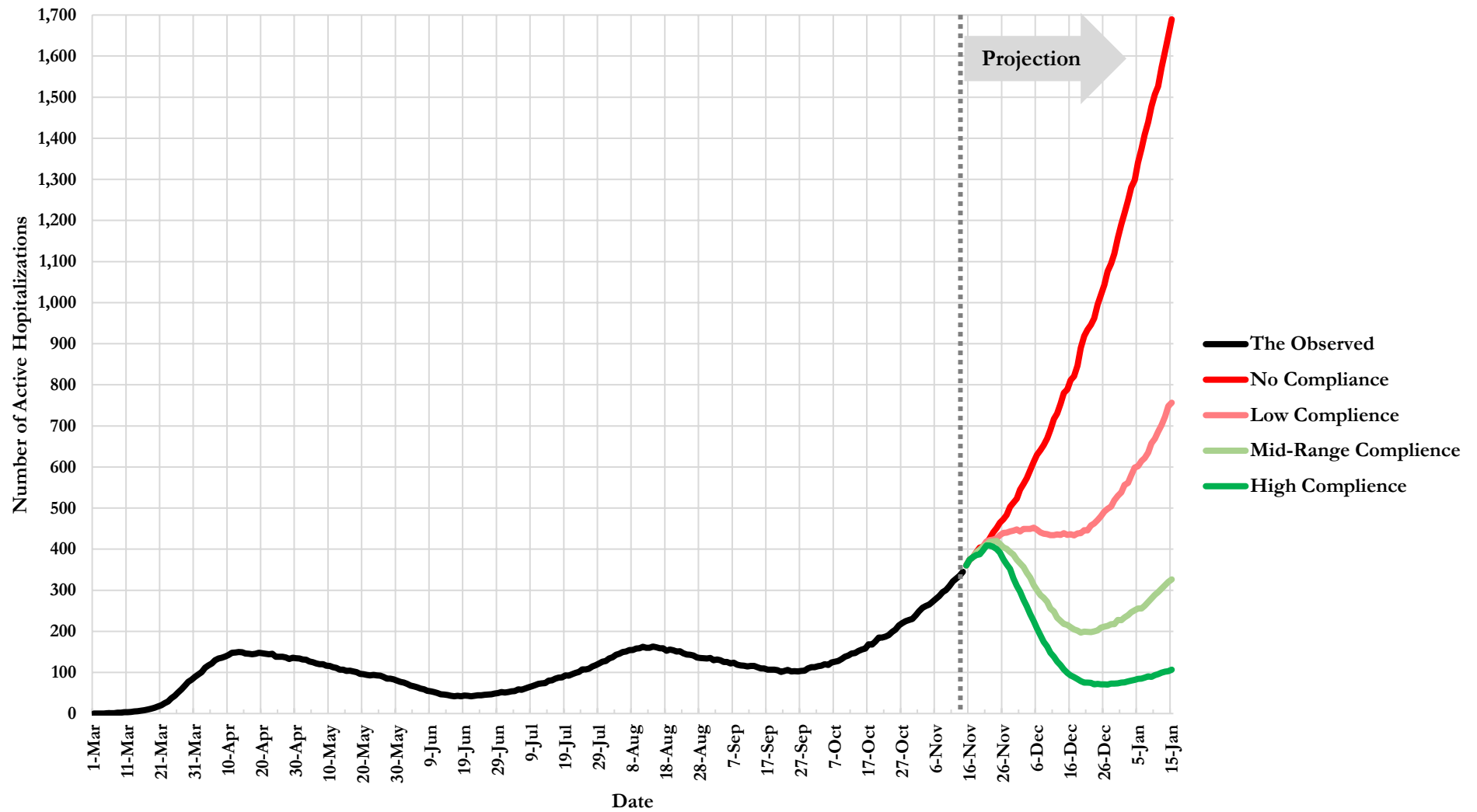Only School
Restrictions:
Dec. 13, 2020

Summary of Projection Results
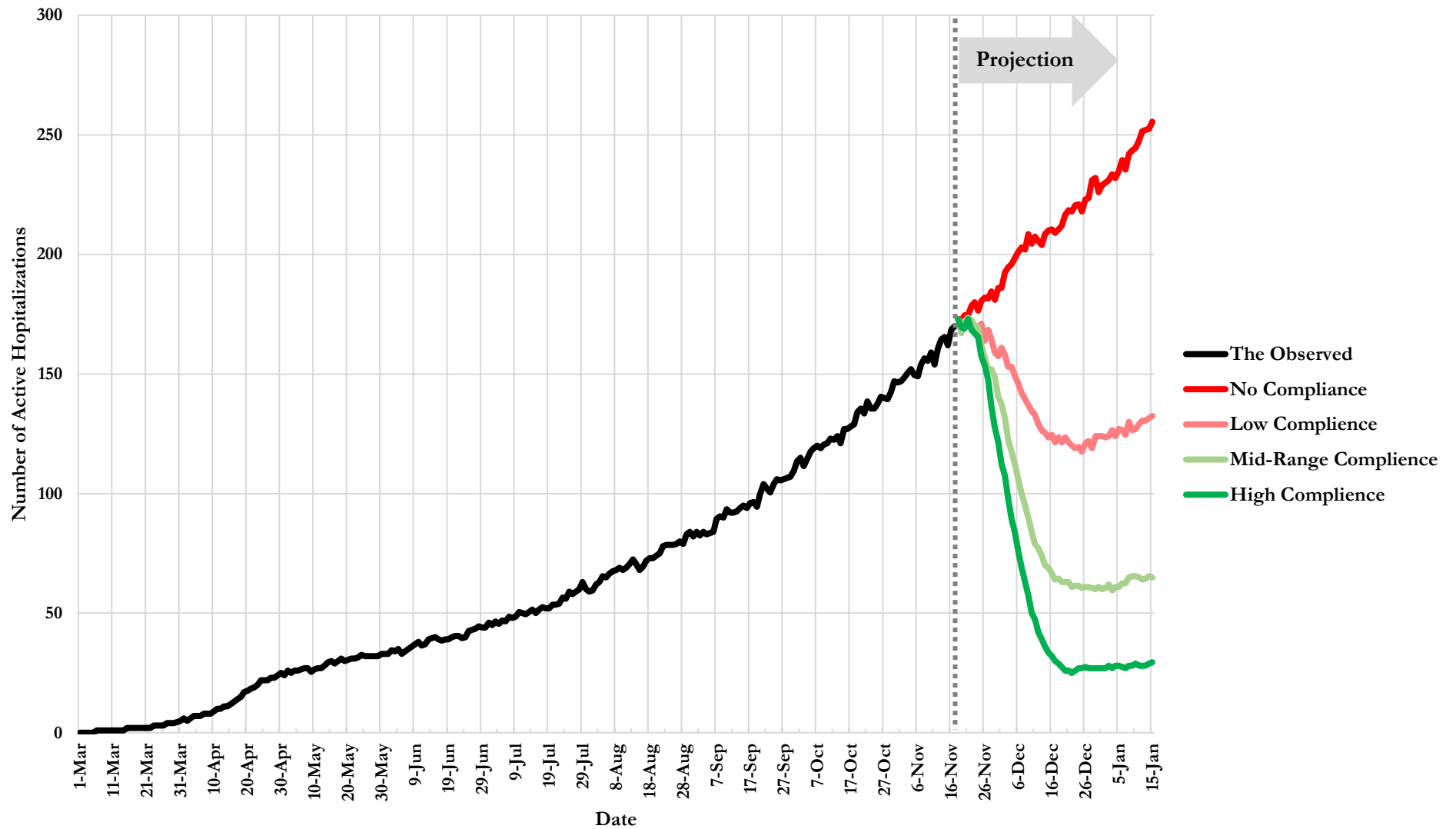
Active Hospitalization in <u>Region 2</u> under Different Scenarios (Medians of 300 simulations)

Active Hospitalization in <u>**Region 3**</u> under Different Scenarios (Medians of 300 simulations)

Active Hospitalization in <u>Region 4</u> under Different Scenarios (Medians of 300 simulations)

- **This report investigated the simulated effect of the implementation of a set of targeted measures by the State of Kentucky to contain the recent sharp increase in COVID-19 cases and active hospitalizations on COVID-19 transmission.**

- **Three scenarios of compliance with the targeted measures were considered: low, mid-range, and high.** The scenarios were assumed to decrease the transmission of the coronavirus by 25%, 50%, 75% in Kentucky HPP Regions 2−4. For these scenarios, the projections for active hospitalizations were made until mid-January 2021. These projections were based on medians of 300 simulations.

- **The status quo scenario (absence of the targeted measures)** estimates that by mid-January 2021 active hospitalizations will increase to approximately:
  - 870   in Region 2
  - 1,690 in Region 3
  - 256   in Region 4

- **Scenario 1 (low compliance with targeted measures) estimates that by mid-January 2021** active hospitalizations will increase to approximately:
  - 411   in Region 2
  - 757   in Region 3
  - 133   in Region 4

- **Scenario 2 (mid-range compliance with targeted measures) estimates that by mid-January 2021** active hospitalizations will increase to approximately:
  - 209   in Region 2
  - 327   in Region 3
  - 65   in Region 4

- **Scenario 3 (high compliance with targeted measures) estimates that by mid-January 2021** active hospitalizations will increase to approximately:
  - 107   in Region 2
  - 107   in Region 3
  - 30   in Region 4

- Given the total number of inpatient beds in the regions,
    - 838 in Region 2
    - 3,942 in Region 3
    - 823 in Region 4,

    even mid-range compliance with the measures will allow the regions' hospitals to operate elective surgeries at normal capacity.

References for the Parameters of the SEIR Model

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