

Network Systems
Science & Advanced
Computing
Biocomplexity Institute
& Initiative
University of Virginia

Foresight and Analysis of Infectious Disease Threats to Virginia's Public Health

February 16th, 2023

(data current to February 9th – February 15th)

Biocomplexity Institute Technical report: TR BI-2023-15



BIOCOMPLEXITY INSTITUTE

biocomplexity.virginia.edu

About Us

- Biocomplexity Institute at the University of Virginia
 - Using big data and simulations to understand massively interactive systems and solve societal problems
- Over 20 years of crafting and analyzing infectious disease models
 - Pandemic response for Influenza, Ebola, Zika, and others



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Overview

- **Goal:** Understand impact of current and emerging Infectious Disease threats to the Commonwealth of Virginia using modeling and analytics
- **Approach:**
 - Provide analyses and summaries of current infectious disease threats
 - Survey existing forecasts and trends in these threats
 - Analyze and summarize the current situation and trends of these threats in the broader context of the US and world.
 - Provide broader overview of other emerging threats

Key Takeaways

Projecting future cases precisely is impossible and unnecessary.

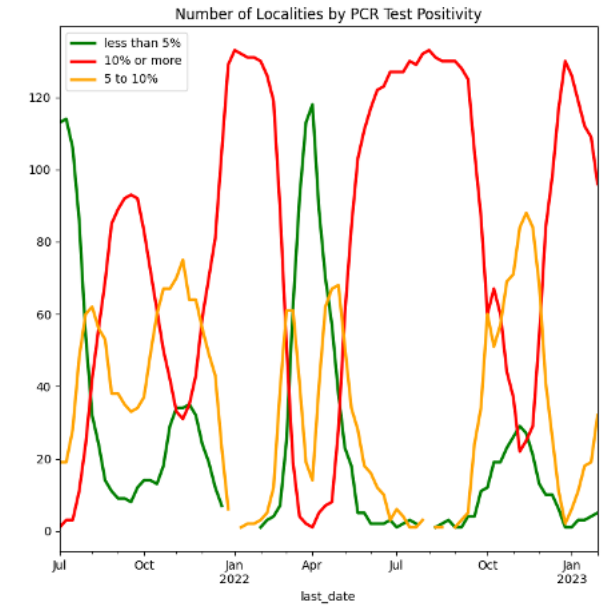
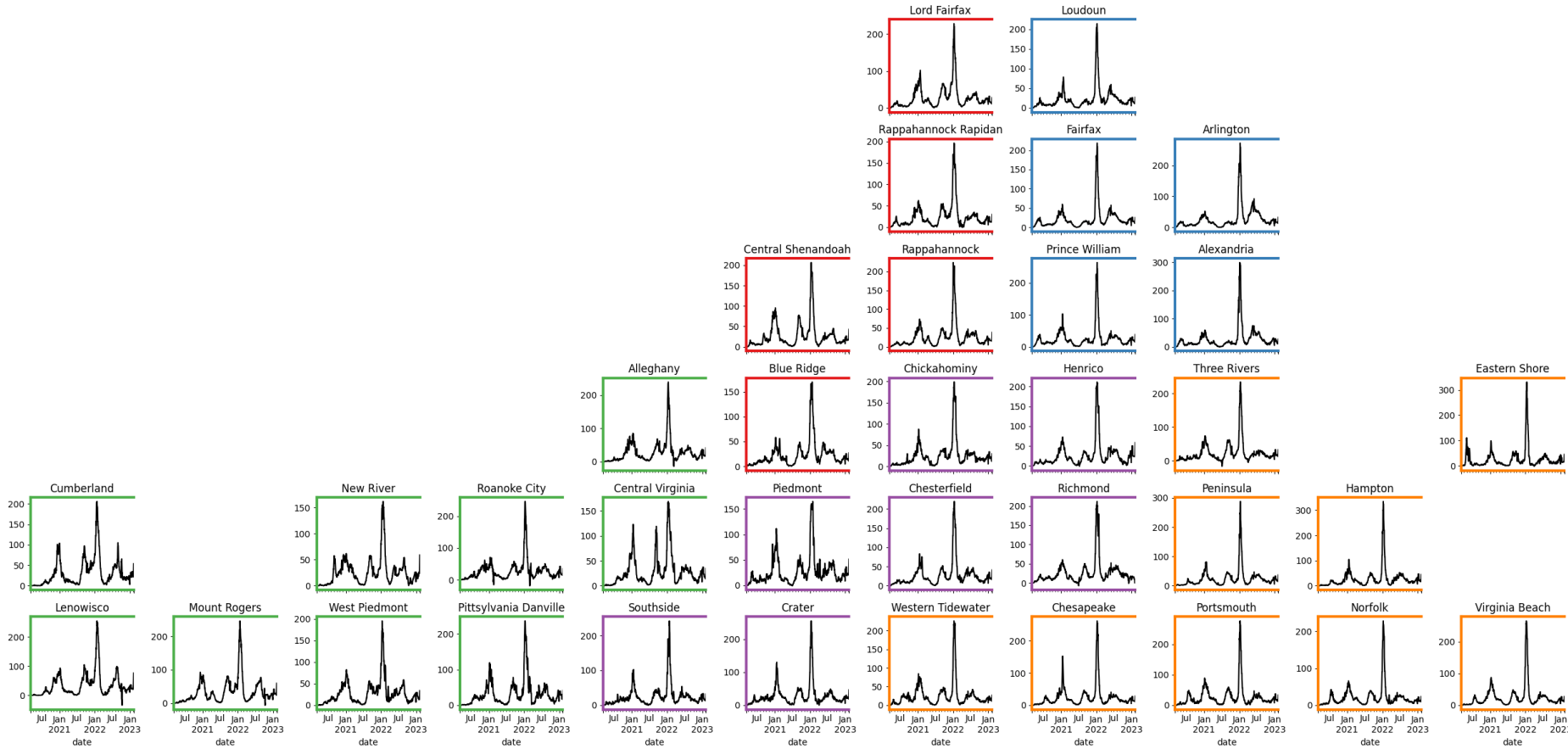
Even without perfect projections, we can confidently draw conclusions:

- Case rates and hospitalizations from COVID-19 have been on decline for weeks, though the rate of decline seems to be slowing
- Case rates and hospitalizations from Influenza are basically non-existent, though some Influenza B is being seen in labs which could spur some additional activity
- Model Updates
 - Projection model updated this week, two new non-specific scenarios added related to increases in transmissibility.
 - Boosted transmissibility can generate new surge in activity and keep levels above Summer 2022 levels through the Spring

COVID-19 Surveillance



Case Rates (per 100k) and Test Positivity



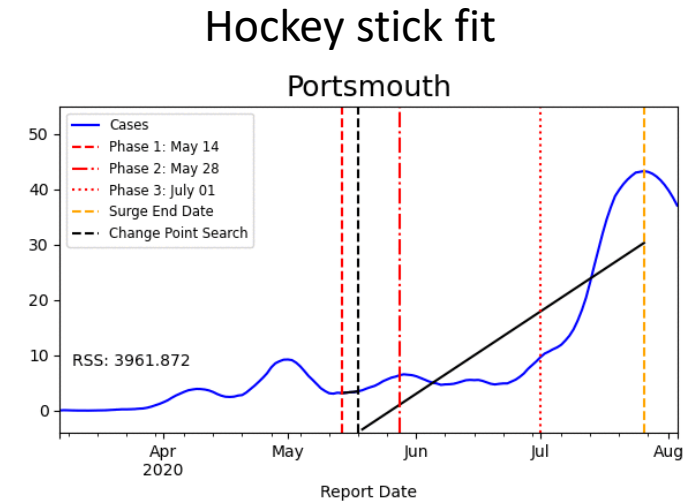
County level RT-PCR test positivity

- Green:** <5.0% (or <20 tests in past 14 days)
- Orange:** 5.0%-10.0% (or <500 tests and <2000 tests/100k and >10% positivity over 14 days)
- Red:** >10.0% (and not "Green" or "Yellow")

District Trajectories

Goal: Define epochs of a Health District's COVID-19 incidence to characterize the current trajectory

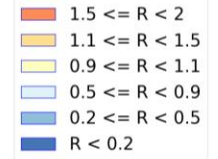
Method: Find recent peak and use hockey stick fit to find inflection point afterwards, then use this period's slope to define the trajectory



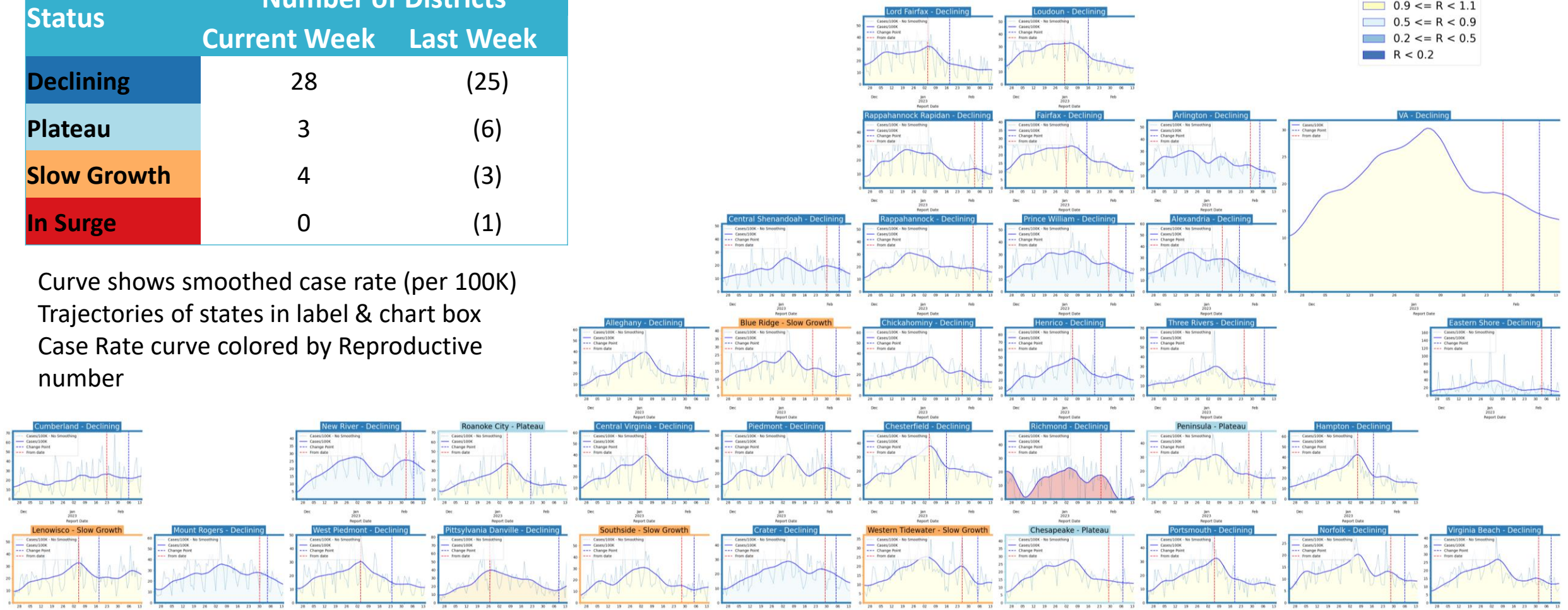
Trajectory	Description	Weekly Case Rate Slope (per 100k)	Weekly Hosp Rate Slope (per 100k)
Declining	Sustained decreases following a recent peak	slope < -0.88/day	slope < -0.07/day
Plateau	Steady level with minimal trend up or down	-0.88/day < slope < 0.42/day	-0.07/day < slope < 0.07/day
Slow Growth	Sustained growth not rapid enough to be considered a Surge	0.42/day < slope < 2.45/day	0.07/day < slope < 0.21/day
In Surge	Currently experiencing sustained rapid and significant growth	2.45/day < slope	0.21/day < slope

District Case Trajectories – last 10 weeks

Status	Number of Districts	
	Current Week	Last Week
Declining	28	(25)
Plateau	3	(6)
Slow Growth	4	(3)
In Surge	0	(1)



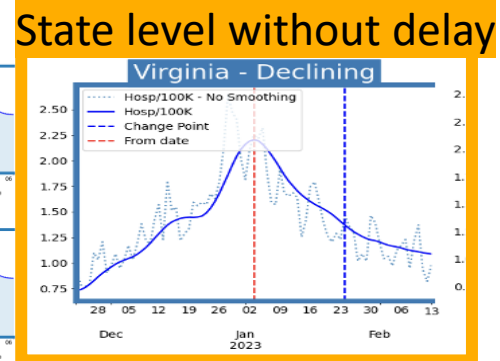
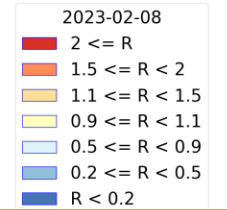
Curve shows smoothed case rate (per 100K)
 Trajectories of states in label & chart box
 Case Rate curve colored by Reproductive number



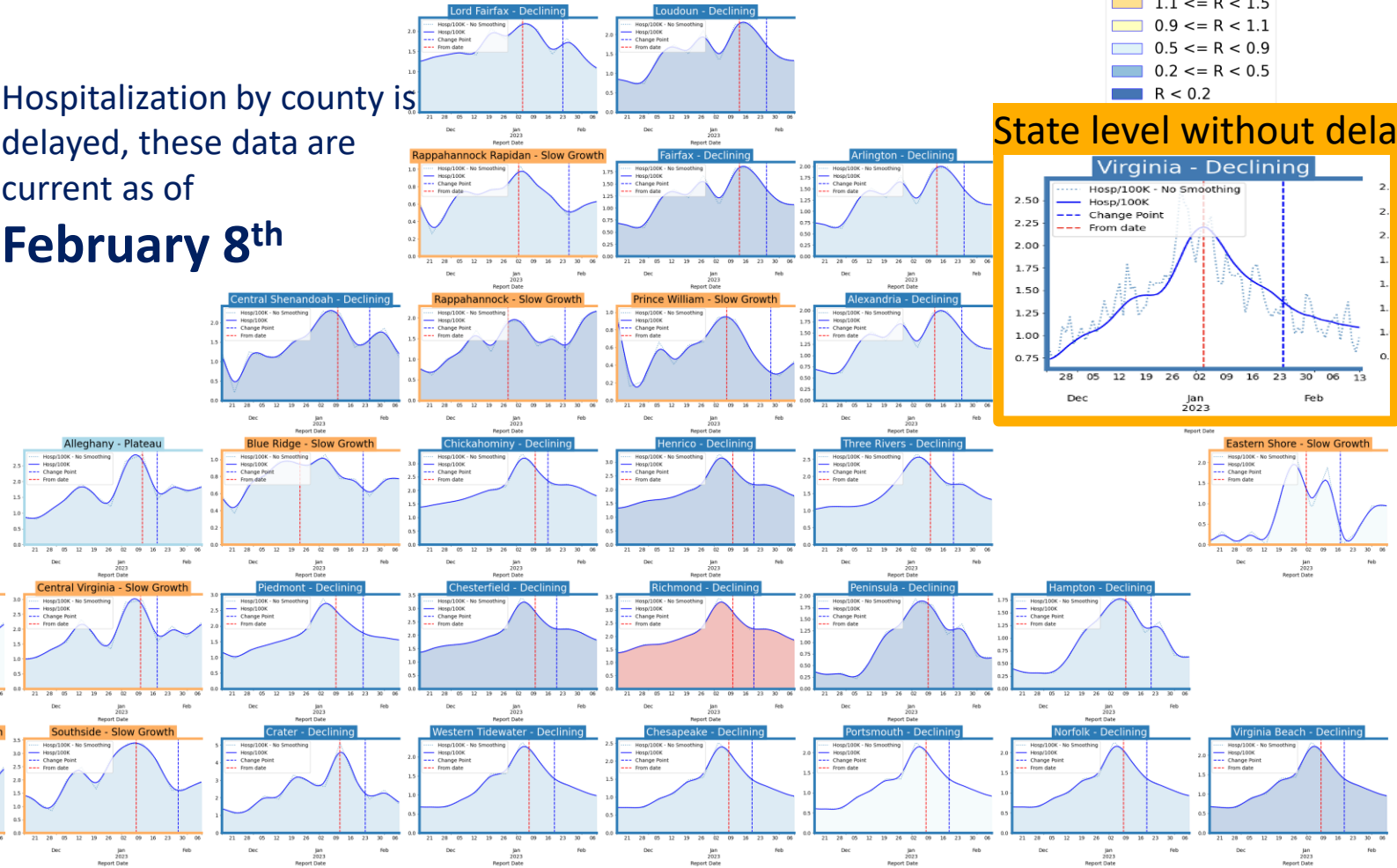
District Hospital Trajectories – last 10 weeks

Status	Number of Districts	
	Current Week	Last Week
Declining	24	(29)
Plateau	1	(1)
Slow Growth	10	(5)
In Surge	0	(0)

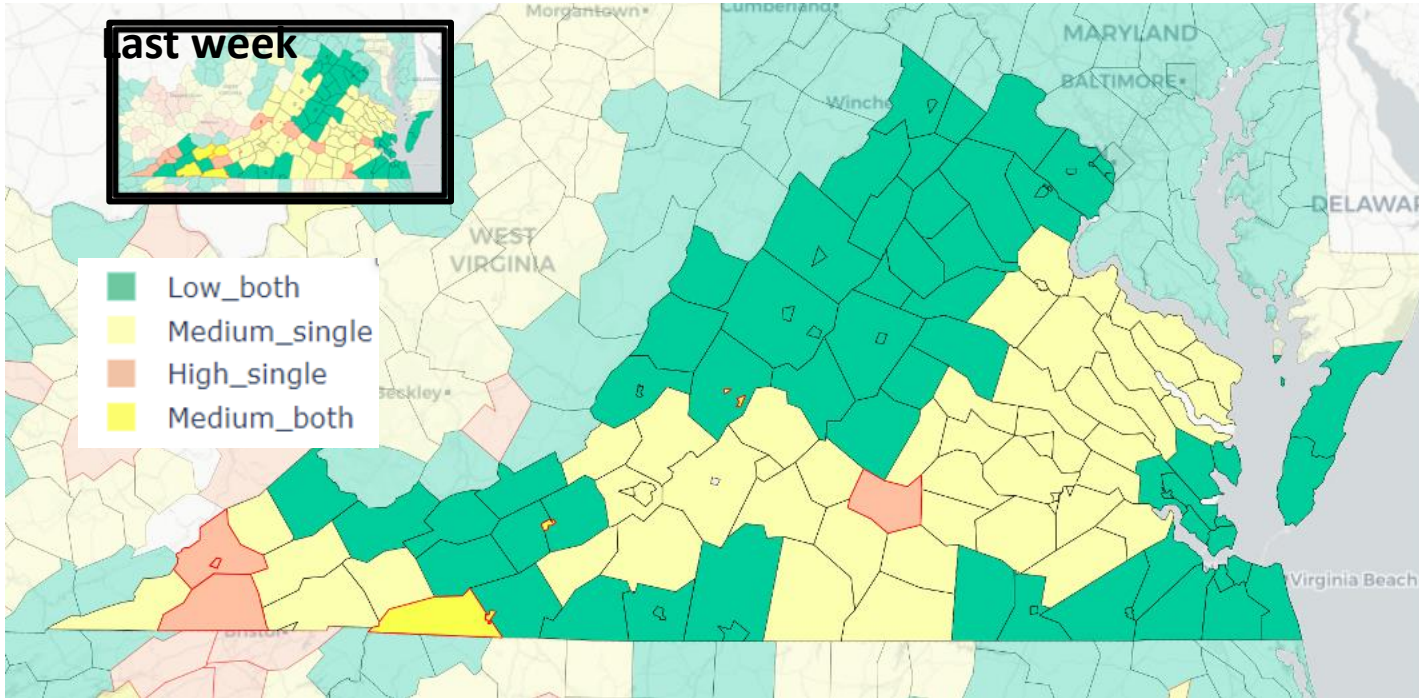
Hospitalization by county is delayed, these data are current as of **February 8th**



Curve shows smoothed hospitalization rate (per 100K) by district
Hosp rate curve colored by R_e number



CDC's COVID-19 Community Levels



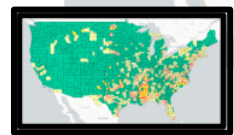
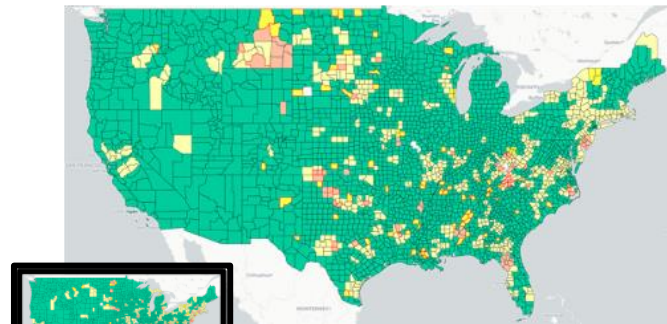
last week

- Low_both
- Medium_single
- High_single
- Medium_both

Red outline indicates county had 200 or more cases per 100k in last week

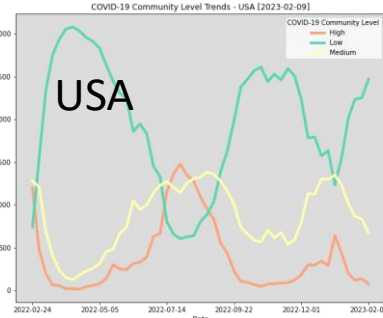
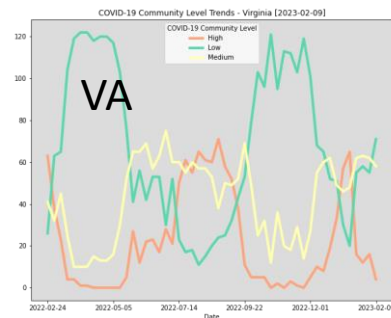
Pale color indicates either beds or occupancy set the level for this county

Dark color indicates both beds and occupancy set the level for this county



Last week

17-Feb-23

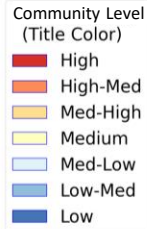


COVID-19 Community Levels - Use the Highest Level that Applies to Your Community				
New COVID-19 Cases Per 100,000 people in the past 7 days	Indicators	Low	Medium	High
Fewer than 200	New COVID-19 admissions per 100,000 population (7-day total)	<10.0	10.0-19.9	≥20.0
	Percent of staffed inpatient beds occupied by COVID-19 patients (7-day average)	<10.0%	10.0-14.9%	≥15.0%
200 or more	New COVID-19 admissions per 100,000 population (7-day total)	NA	<10.0	≥10.0
	Percent of staffed inpatient beds occupied by COVID-19 patients (7-day average)	NA	<10.0%	≥10.0%

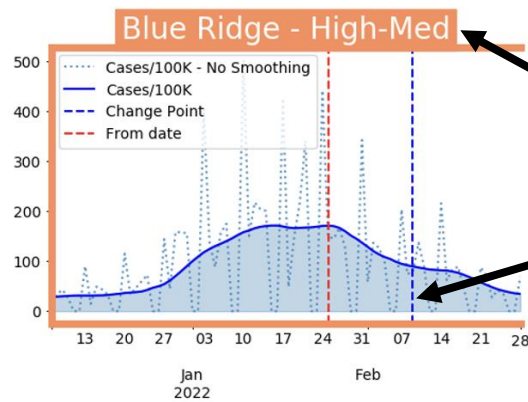
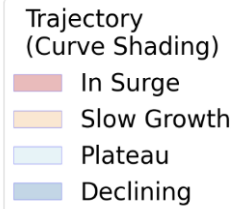
The COVID-19 community level is determined by the higher of the new admissions and inpatient beds metrics, based on the current level of new cases per 100,000 population in the past 7 days



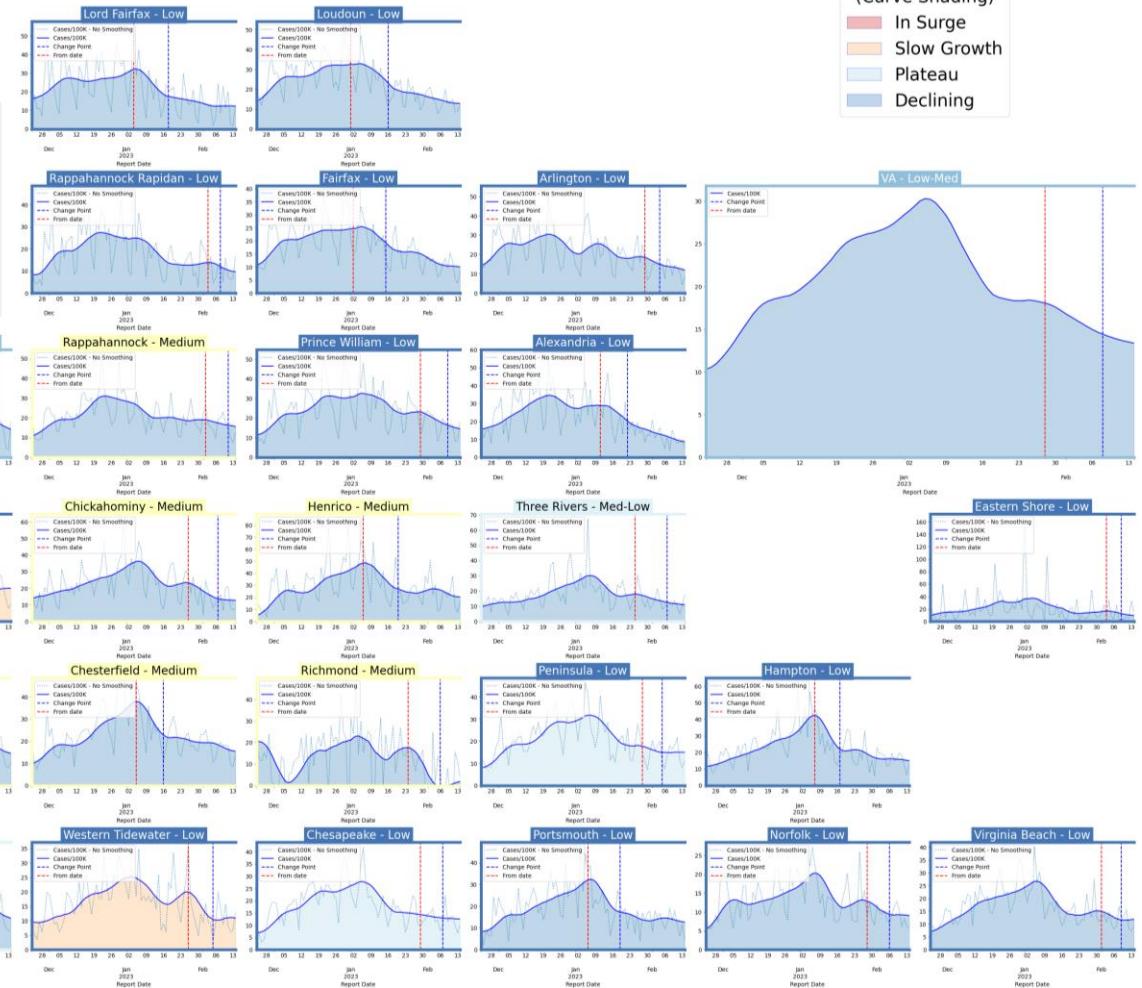
District Trajectories with Community Levels



Curve shows smoothed case rate (per 100K)
 CDC's new [Community Level](#) aggregated to district level in label & chart box color
 Case Rate curve colored by Trajectory



District's Aggregate Community Level
 Aggregate level a simple mean of all levels for counties in district
 Case rate Trajectory

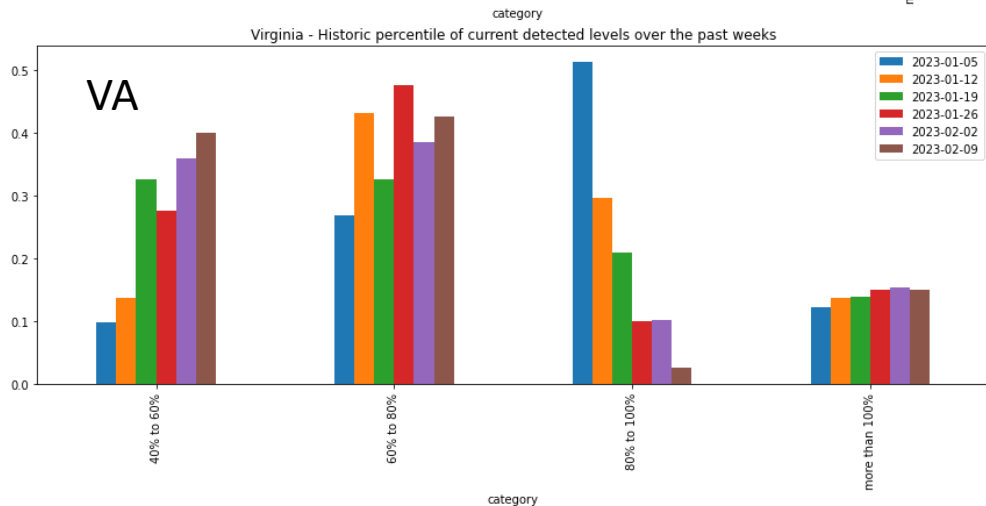
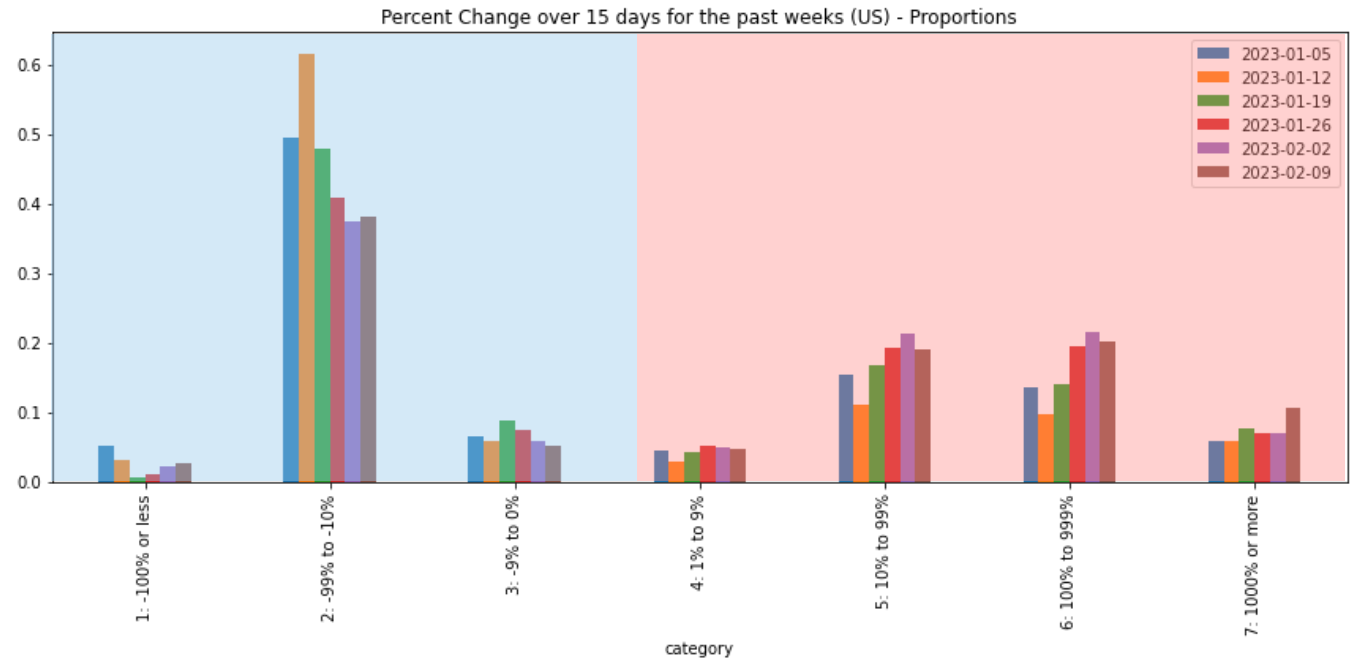
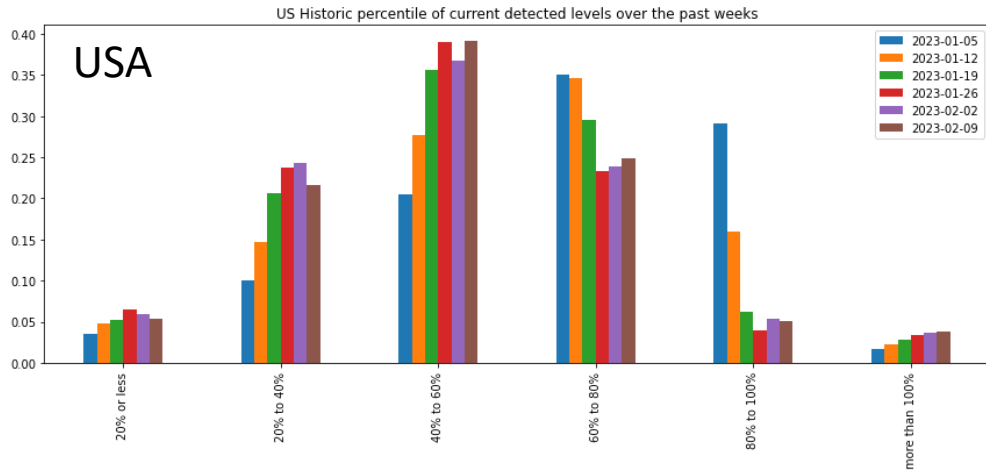


COVID-19 Growth Metrics

Wastewater Monitoring

Wastewater provides a coarse early warning of COVID-19 levels in communities

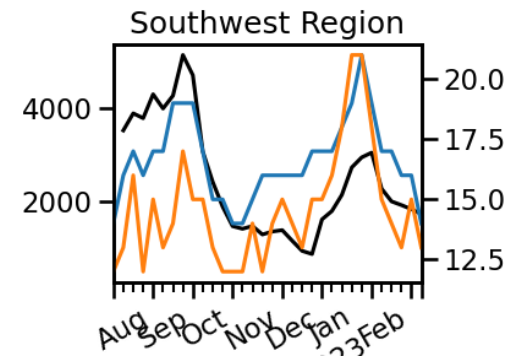
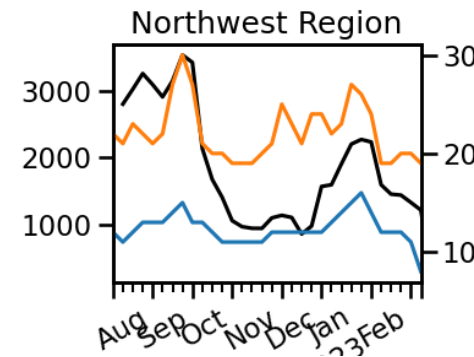
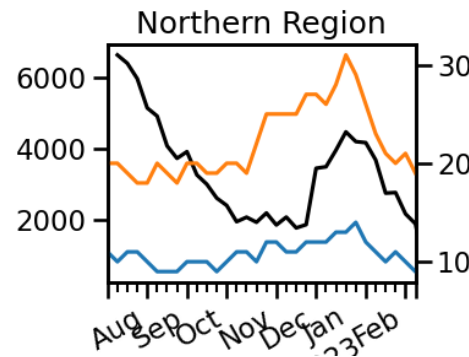
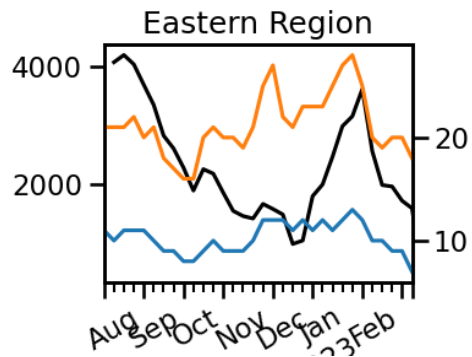
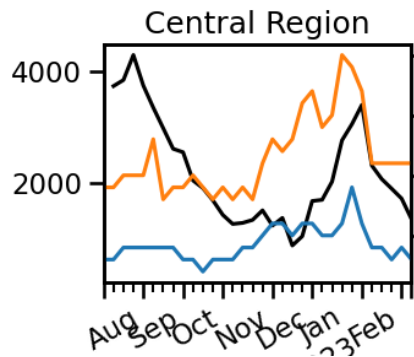
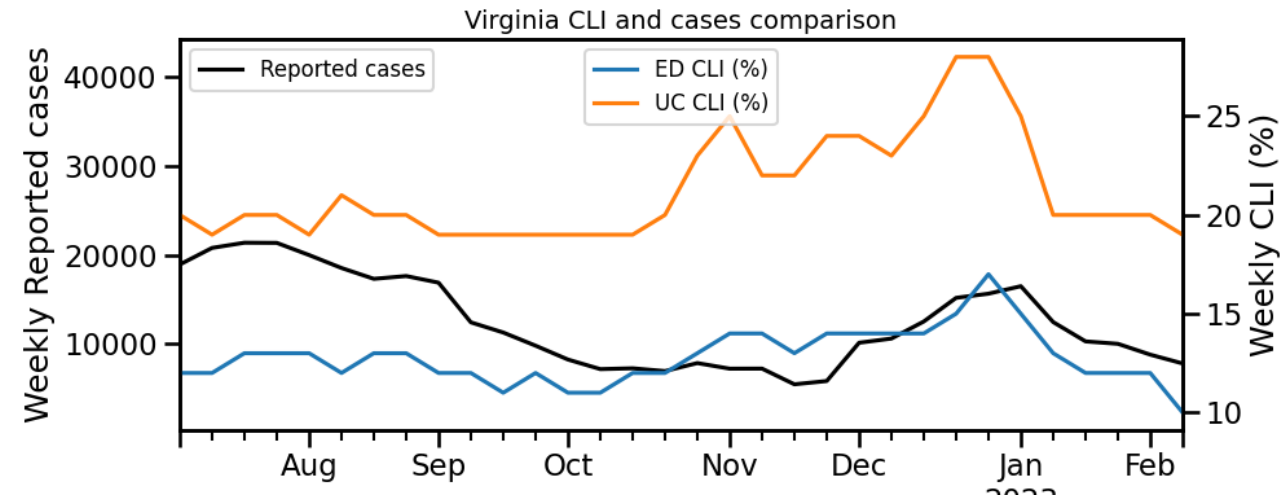
- Overall in the US, there is an increase in sites with increased levels of virus compared to 15 days ago
- Growth seen in the category where current virus levels are at or exceeding max of previous historical levels



COVID-like Illness Activity

COVID-like Illness (CLI) gives a measure of COVID transmission in the community

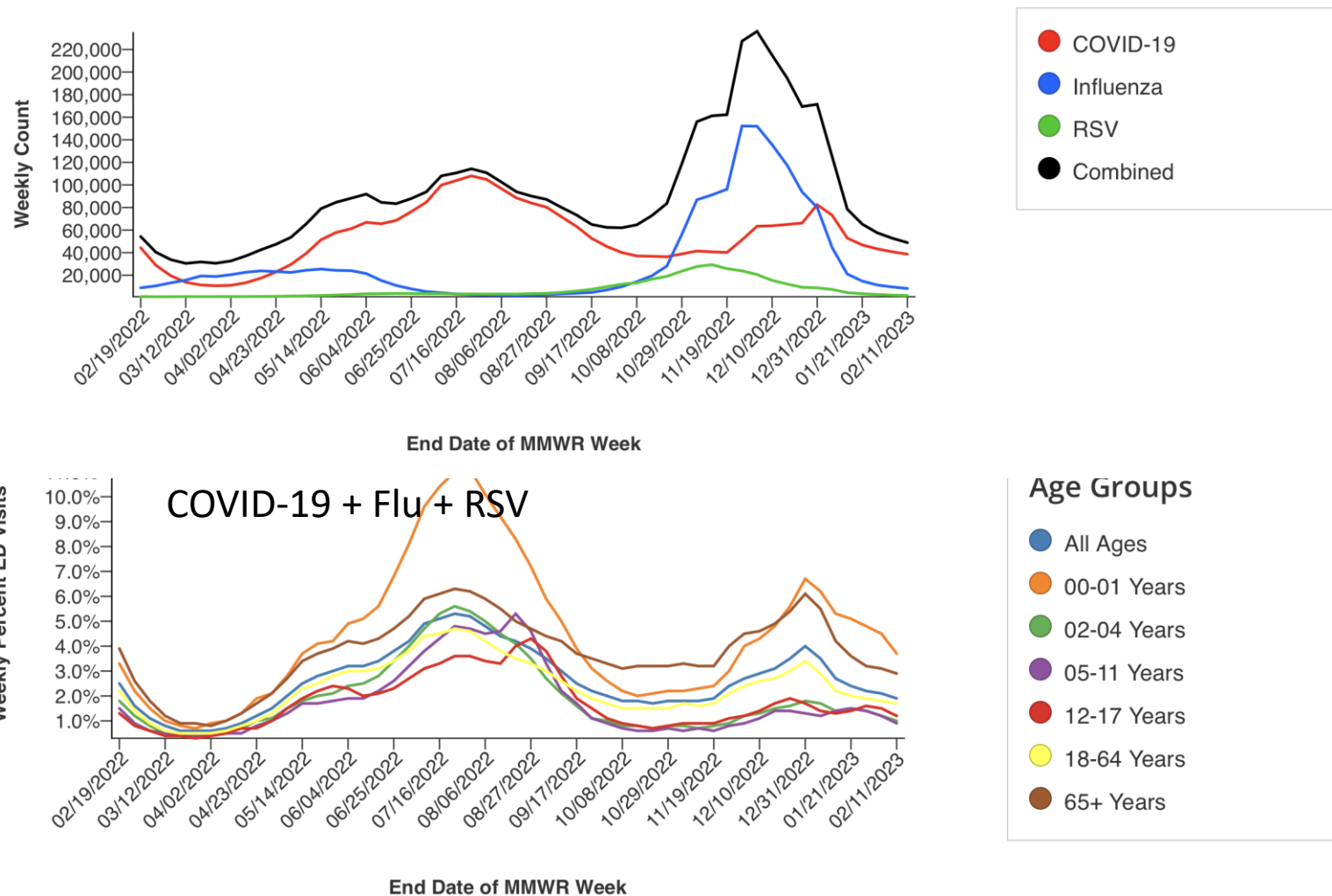
- Emergency Dept (ED) based CLI is more correlated with case reporting
- Urgent Care (UC) is a leading indicator but may be influenced by testing for other URIs
- **After recent surges, levels are now at lowest levels in past 7 months**



Emergency Department Visits

COVID-19 Diagnoses across the Country via the National Syndromic Surveillance Program (NSSP)

- Current declines seen in ED visits across all 3 diseases and across ages



Data Source:
[CDC Surveillance](https://www.cdc.gov/surveillance/)

COVID-19 Spatial Epidemiology

Zip code level weekly Case Rate (per 100K)

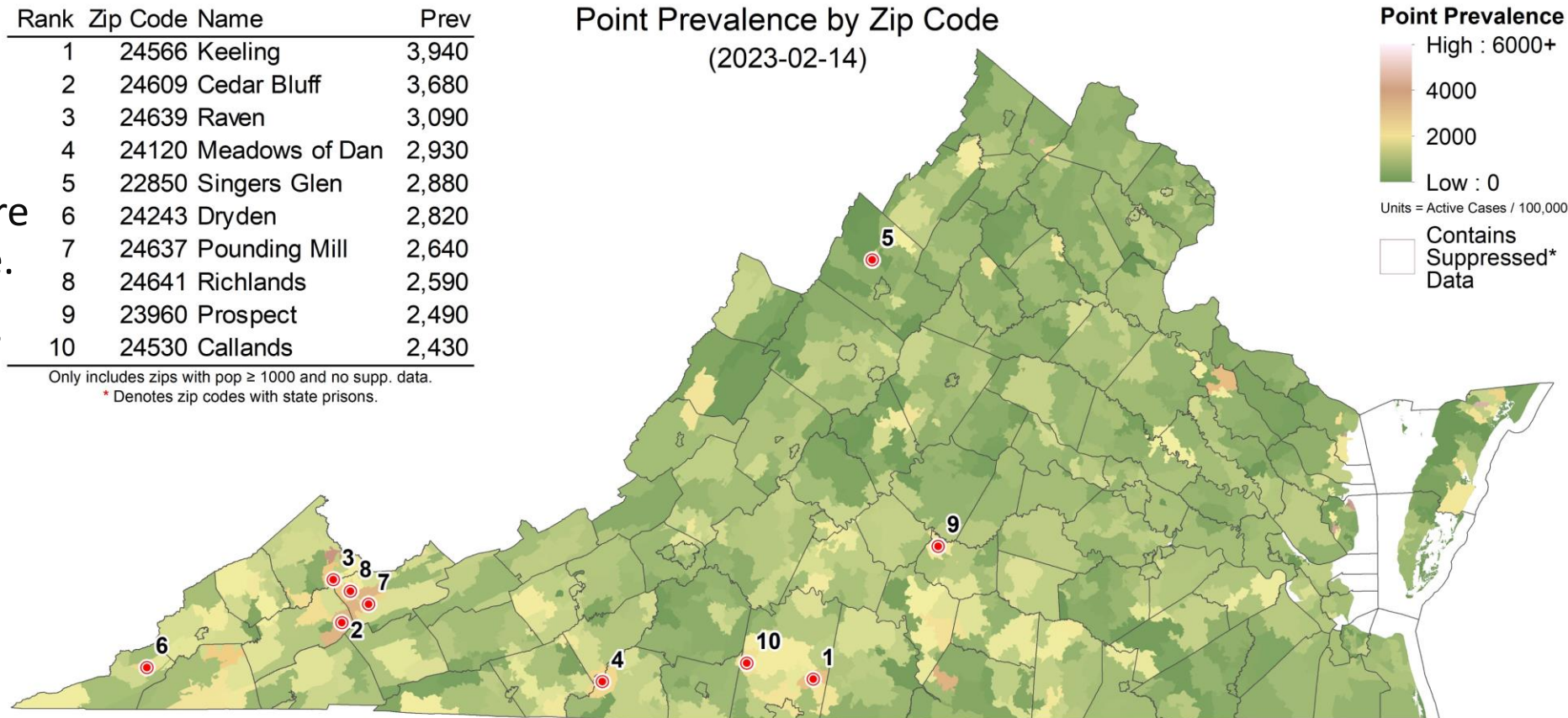
Case Rates in the last week by zip code

- Statewide prevalence continues to decline. Over 75% of zip codes report below 1% prevalence (green).
- No zip code reported more than 4% point prevalence.
- No zip codes with prisons appear in the top 10 list.
- The Far Southwest is showing an unusual cluster of high values.
- Some counts are low and suppressed to protect anonymity. They are shown with a red outline.

Rank	Zip Code	Name	Prev
1	24566	Keeling	3,940
2	24609	Cedar Bluff	3,680
3	24639	Raven	3,090
4	24120	Meadows of Dan	2,930
5	22850	Singers Glen	2,880
6	24243	Dryden	2,820
7	24637	Pounding Mill	2,640
8	24641	Richlands	2,590
9	23960	Prospect	2,490
10	24530	Callands	2,430

Only includes zips with pop ≥ 1000 and no supp. data.
 * Denotes zip codes with state prisons.

Point Prevalence by Zip Code
(2023-02-14)

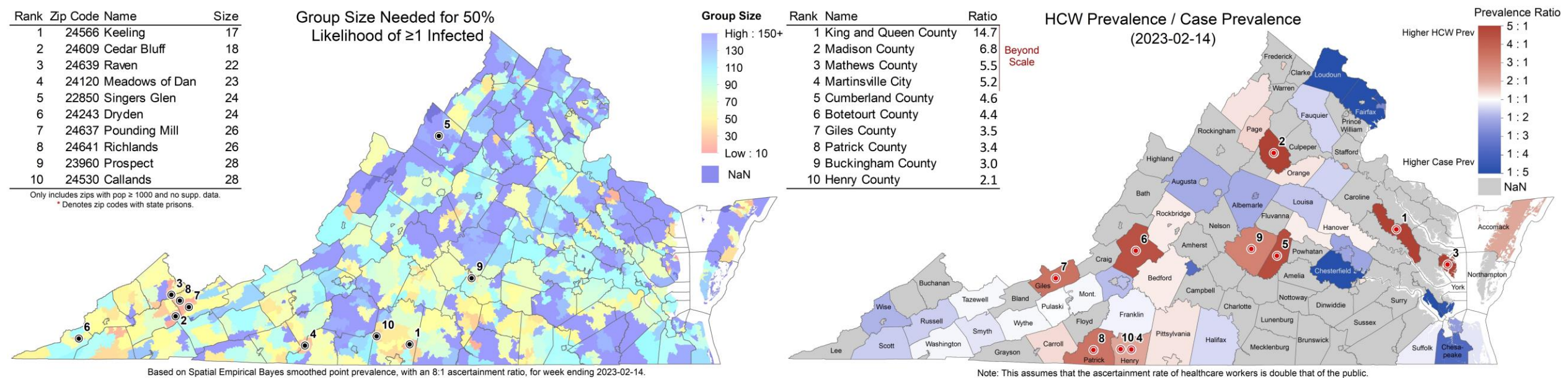


Based on Spatial Empirical Bayes smoothed point prevalence, with an 8:1 ascertainment ratio, for week ending 2023-02-14.

Risk of Exposure by Group Size and HCW prevalence

Case Prevalence in the last week by zip code used to calculate risk of encountering someone infected in a gathering of randomly selected people

- **Group Size:** Assumes **8 undetected infections** per confirmed case (ascertainment rate from recent seroprevalence survey) and shows minimum size of a group with a 50% chance an individual is infected by zip code (e.g., in a group of 17 in Keeling, there is a 50% chance someone will be infected).
- **HCW ratio:** Case rate among health care workers (HCW) in the last week using patient facing health care workers as the numerator / population's case prevalence. Note the cluster in Patrick and Henry counties.

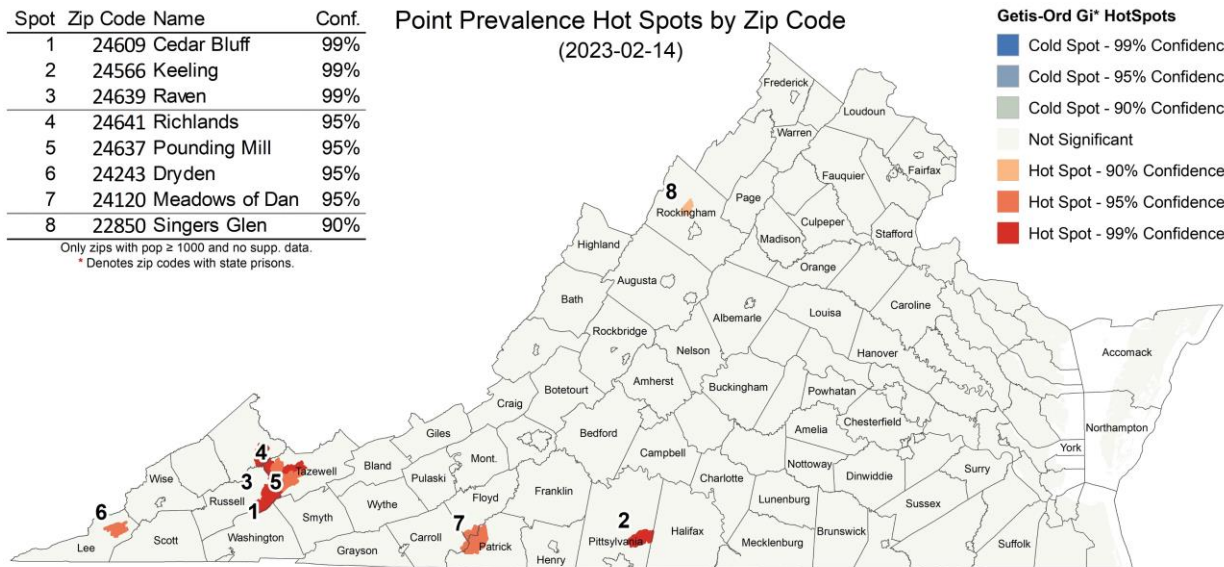


Current Hot-Spots

Case rates that are significantly different from neighboring areas or model projections

- **Spatial:** Getis-Ord G_i^* based hot spots compare clusters of zip codes with weekly case prevalence higher than nearby zip codes to identify larger areas with statistically significant deviations
- **Temporal:** The weekly case rate (per 100K) projected last month compared to those observed by county, which highlights temporal fluctuations that differ from the model's projections.
- Some hotspots are concentrated in the Far SW, specifically in the Clinch Valley. As a result, the models run in mid-December underpredicted cases in the Far SW. This was also an issue in Central VA and Shenandoah.

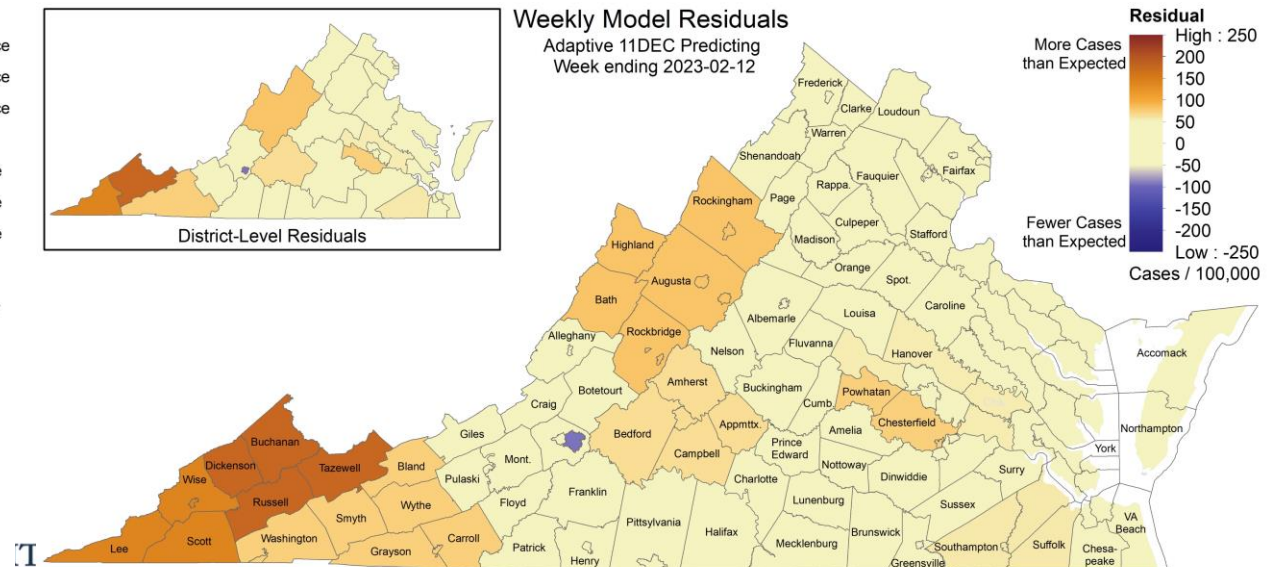
Spatial Hotspots



Based on Global Empirical Bayes smoothed point prevalence for week ending 2023-02-14.

17-Feb-23

Clustered Temporal Hotspots



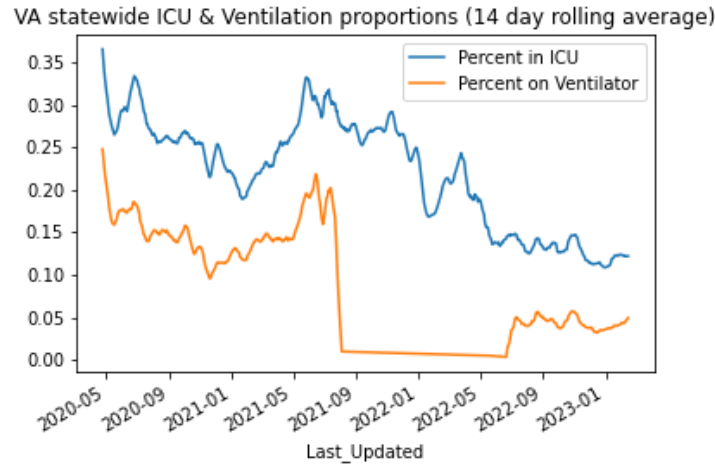
COVID-19 Severity Metrics

Hospitalizations and Severe Outcomes

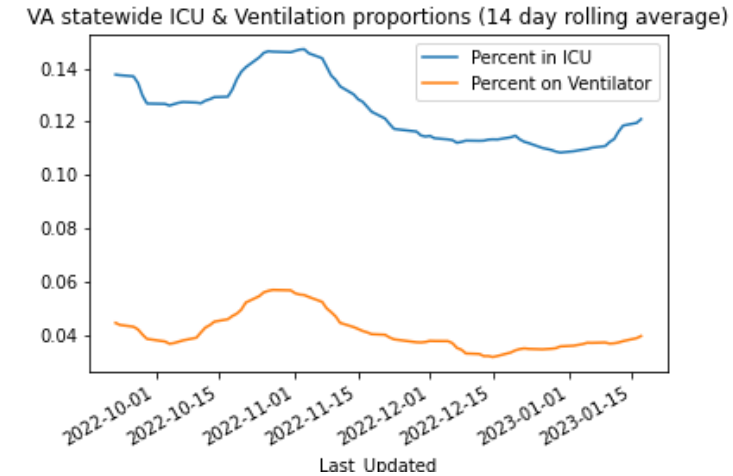
Proportion of most severe outcomes decreasing among those who are hospitalized

- ICU has declined from ~20% of hospitalized to 10-15% since initial Omicron wave
- Recent trend tipping up, though current levels near historic lows
- Regional variation tracks state-level

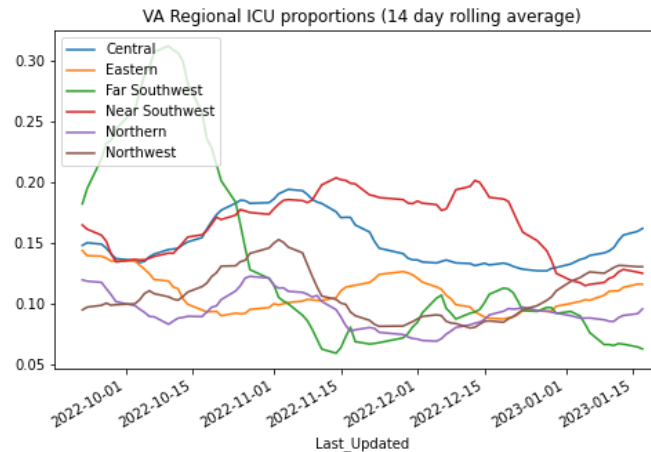
Virginia-wide – full pandemic



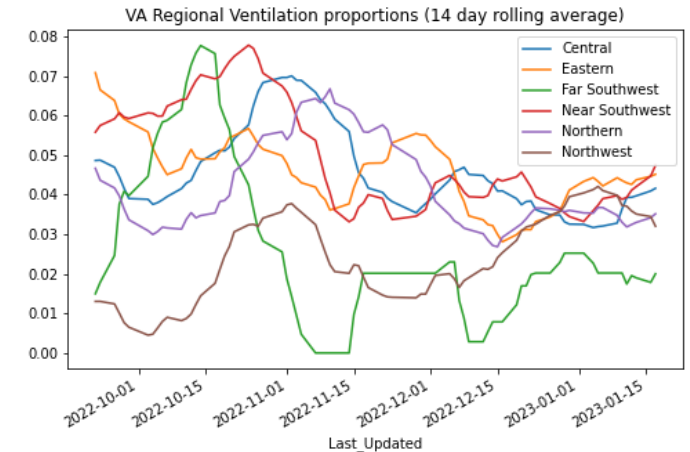
Virginia-wide – recent



Virginia Regional ICU percent



Virginia Regional Ventilation %



Hospitalizations in VA by Age

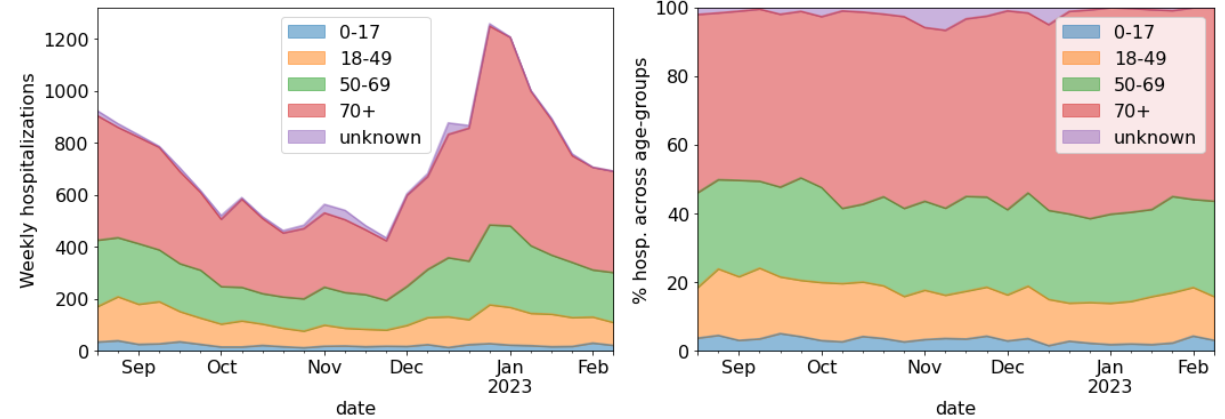
Age distribution in hospitals relatively stable

- Uptick in hospitalizations mostly fueled by 70+ age group
- Pediatric hospitalizations have been steady despite the surge in activity in other age-groups

Note: These data are lagged and based on HHS hospital reporting

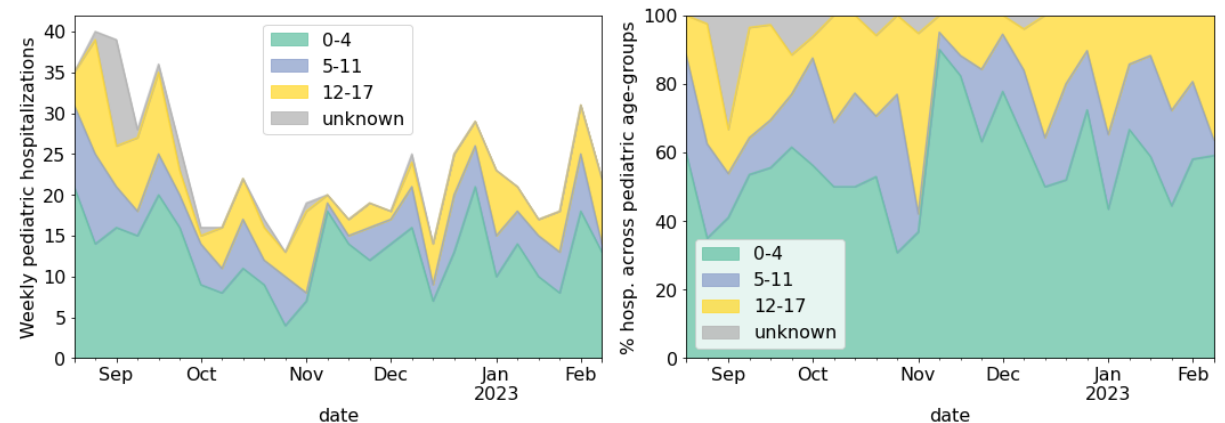
Virginia Hospitalizations by Age (all ages)

Hospitalizations - VA



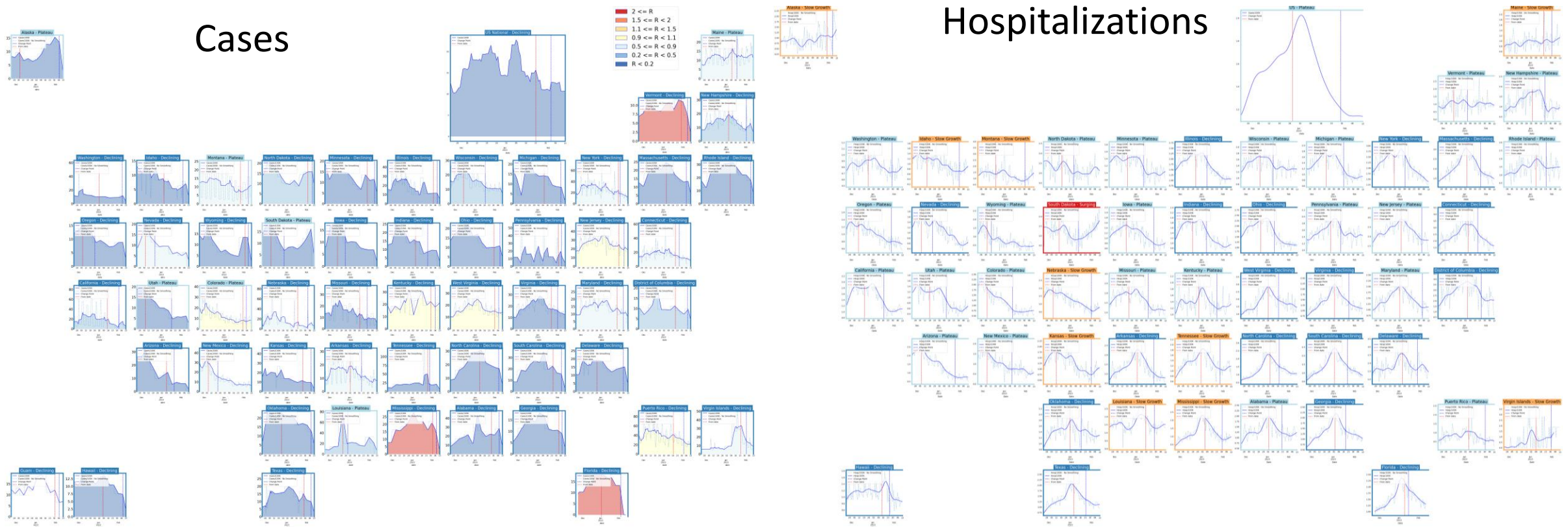
Pediatric Hospitalizations by Age (0-17yo)

Pediatric hospitalizations - VA

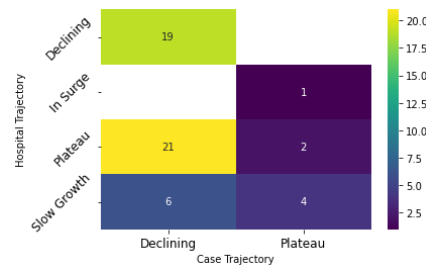


COVID-19 Broader Context

United States Cases & Hospitalizations



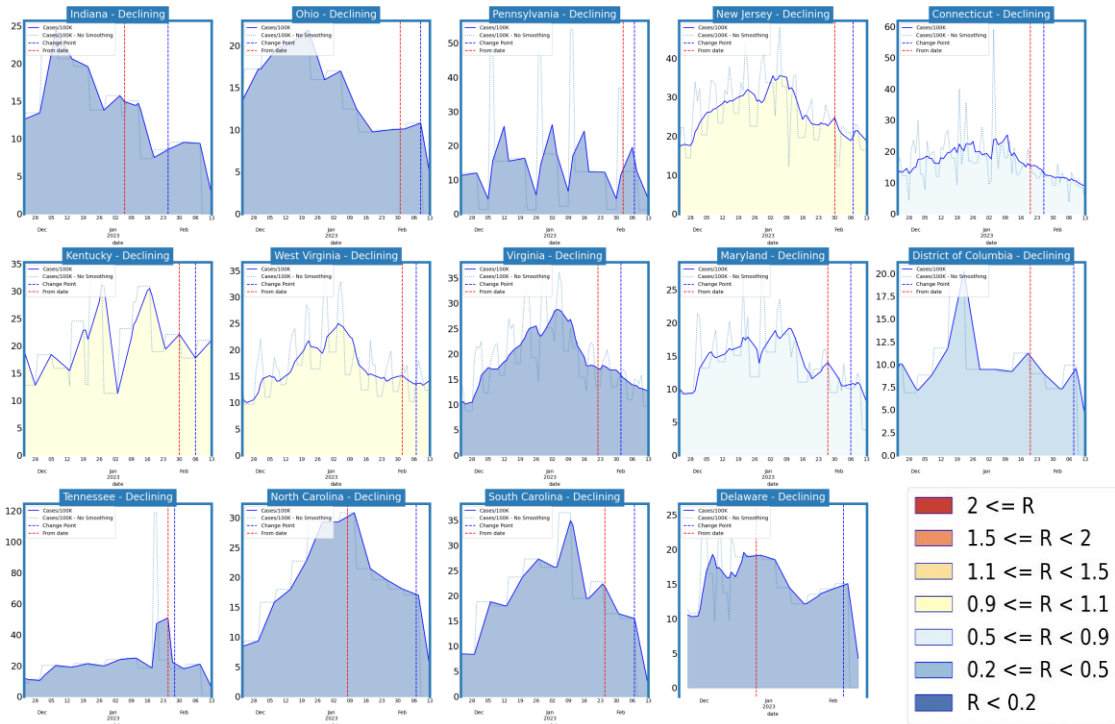
Status	Number of States	
	Current Week	Last Week
Declining	47	(47)
Plateau	7	(6)
Slow Growth	0	(1)
In Surge	0	(0)



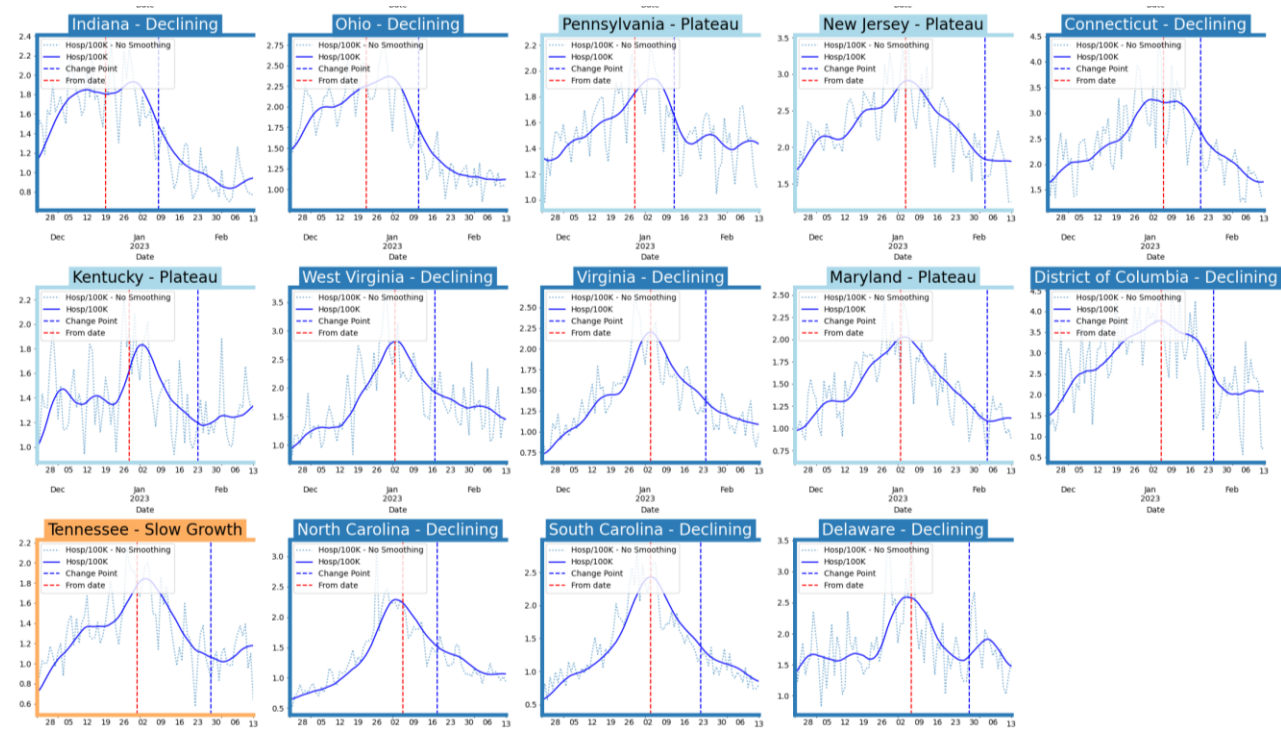
Status	Number of States	
	Current Week	Last Week
Declining	19	(32)
Plateau	23	(16)
Slow Growth	10	(5)
In Surge	1	(0)

Virginia and Her Neighbors

Cases



Hospitalizations

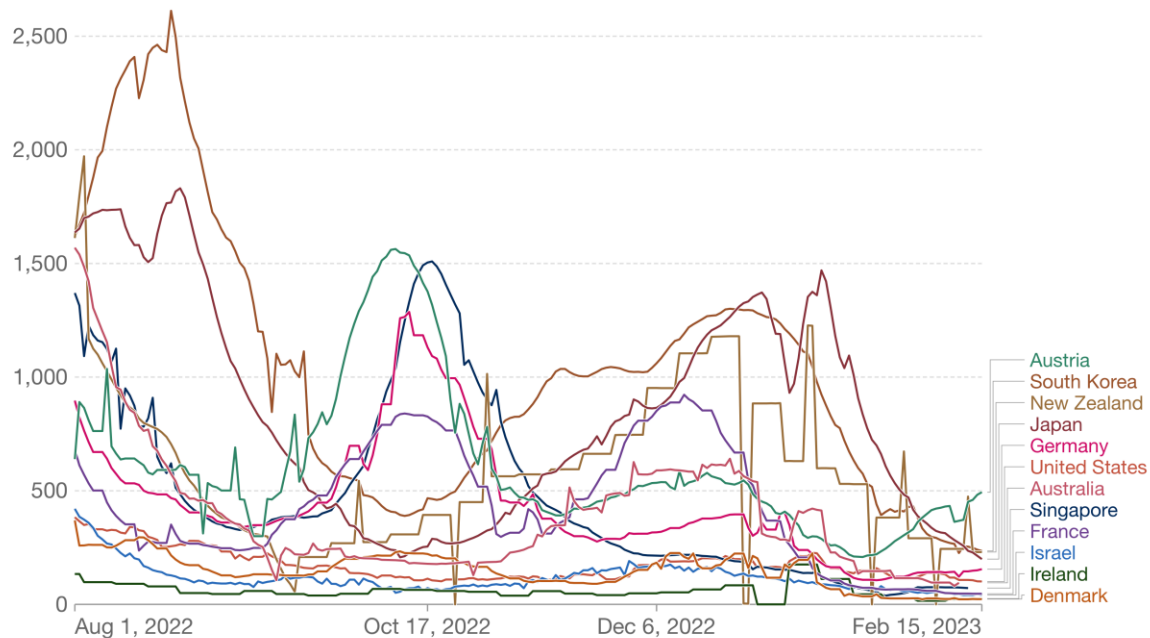


Around the World – Various trajectories

Confirmed cases

Daily new confirmed COVID-19 cases per million people

7-day rolling average. Due to limited testing, the number of confirmed cases is lower than the true number of infections.



Source: Johns Hopkins University CSSE COVID-19 Data

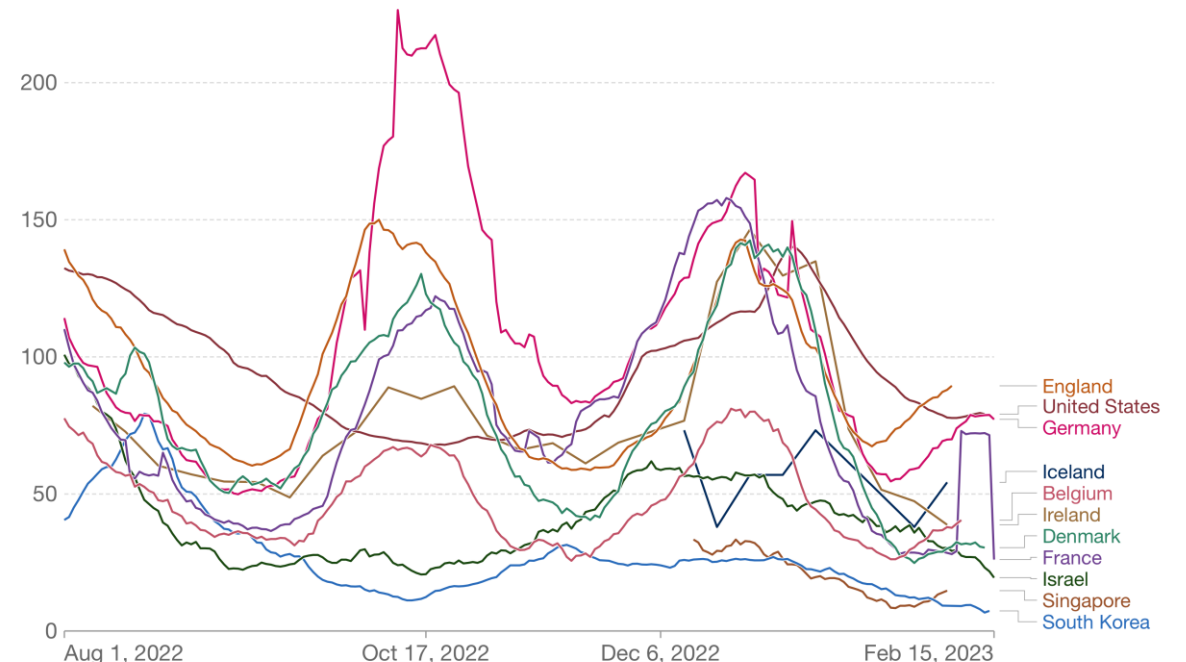


CC BY

Hospitalizations

Weekly new hospital admissions for COVID-19 per million people

Weekly admissions refer to the cumulative number of new admissions over the previous week.



Source: Official data collated by Our World in Data



CC BY



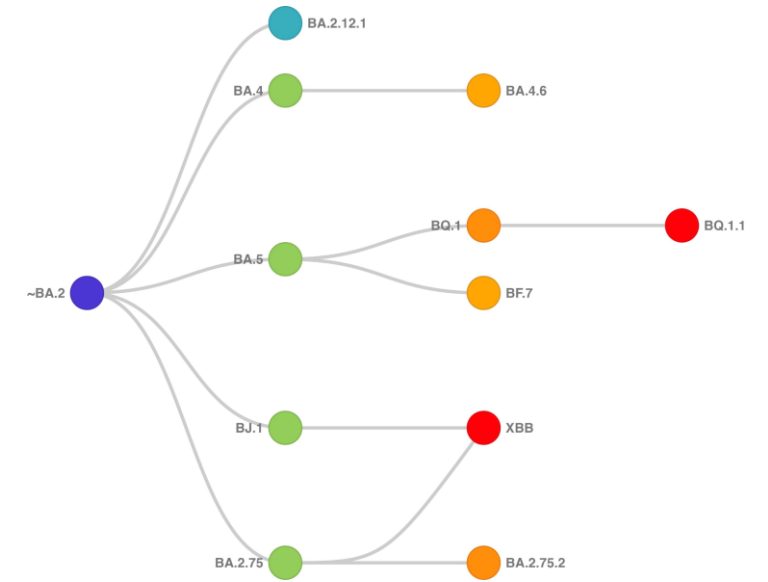
[Our World in Data](https://ourworldindata.org)

COVID-19 Genomic Update

SARS-CoV2 Variants of Concern

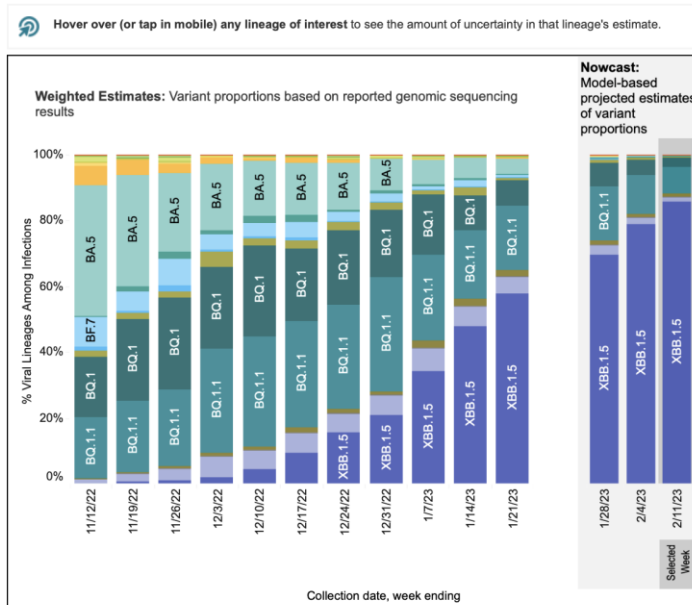
Emerging variants have potential to continue to alter the future trajectories of pandemic and have implications for future control

- Variants have been observed to: increase transmissibility, increase severity (more hospitalizations and/or deaths), and limit immunity provided by prior infection and vaccinations



Weighted and Nowcast Estimates in HHS Region 3 for Weeks of 11/6/2022 – 2/11/2023

Nowcast Estimates in HHS Region 3 for 2/5/2023 – 2/11/2023



Region 3 - Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia

WHO label	Lineage #	US Class	%Total	95%PI
Omicron	XBB.1.5	VOC	85.8%	83.2-88.0%
	BQ.1.1	VOC	8.0%	6.8-9.4%
	BQ.1	VOC	3.0%	2.4-3.7%
	XBB	VOC	1.5%	1.2-1.8%
	CH.1.1	VOC	0.9%	0.6-1.4%
	BN.1	VOC	0.3%	0.3-0.4%
	BA.5	VOC	0.2%	0.1-0.2%
	BF.7	VOC	0.2%	0.1-0.2%
	BA.5.2.6	VOC	0.1%	0.0-0.1%
	BF.11	VOC	0.0%	0.0-0.0%
	BA.2	VOC	0.0%	0.0-0.0%
	BA.2.75	VOC	0.0%	0.0-0.0%
	BA.4.6	VOC	0.0%	0.0-0.0%
	BA.2.75.2	VOC	0.0%	0.0-0.0%
	B.1.1.529	VOC	0.0%	0.0-0.0%
	BA.4	VOC	0.0%	0.0-0.0%
	BA.2.12.1	VOC	0.0%	0.0-0.0%
	BA.1.1	VOC	0.0%	0.0-0.0%
Delta	B.1.617.2	VBM	0.0%	0.0-0.0%
Other	Other*		0.0%	0.0-0.1%

<https://clades.nextstrain.org>

Omicron Updates*

- XBB.1.5 has grown rapidly now accounting for 86%
- BQ.1 and BQ.1.1 are continue to lose ground at 3% and 8% respectively
- XBB not in XBB.1.5 remains at ~2%
- BN.1 separated from BA.2.75 has fallen from 2% to 1%
- CH.1.1 has emerged and started to grow 0.9%

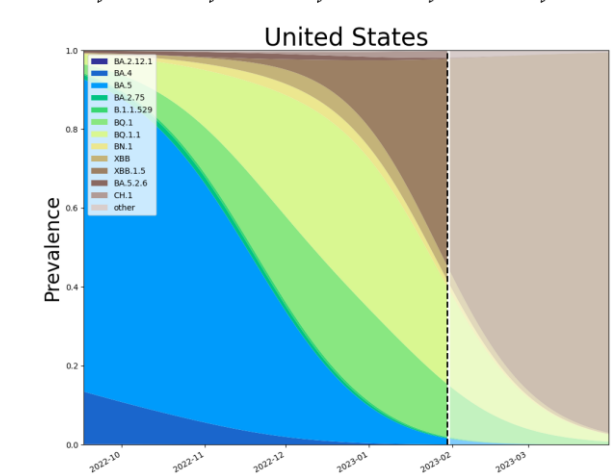
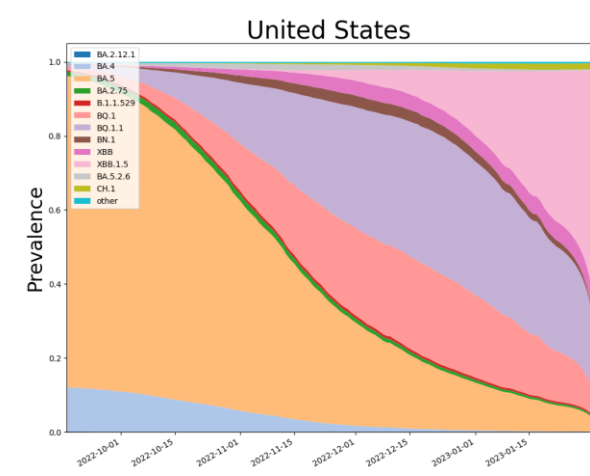
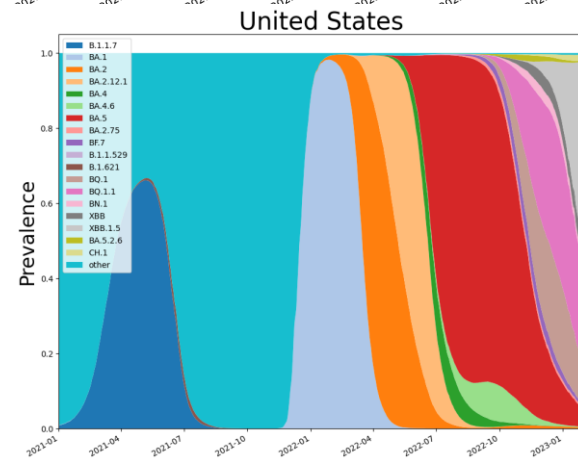
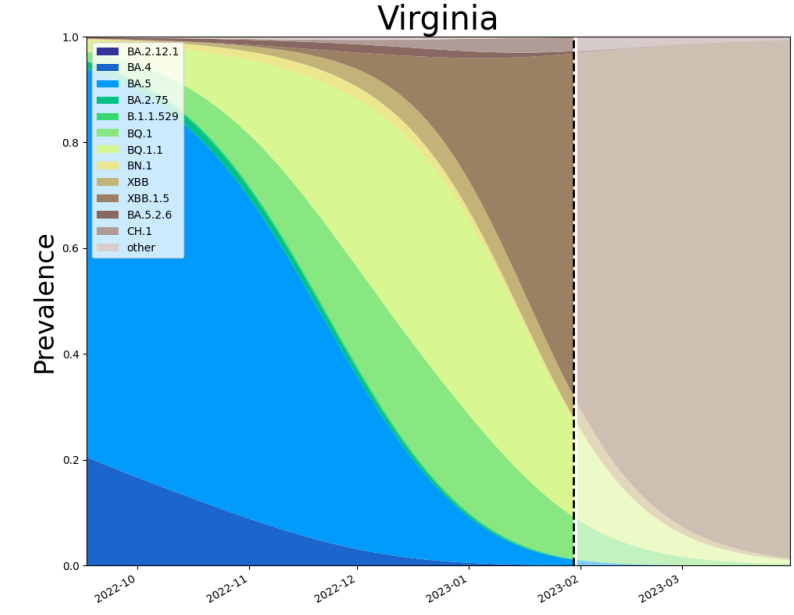
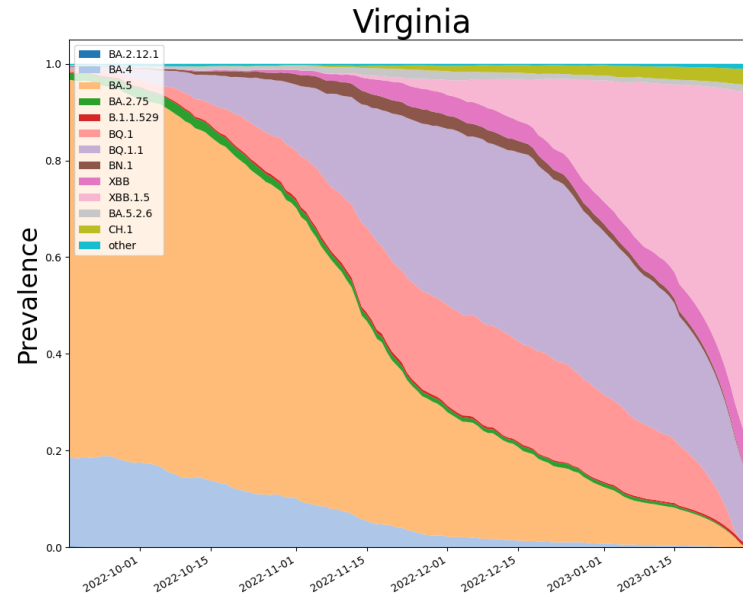
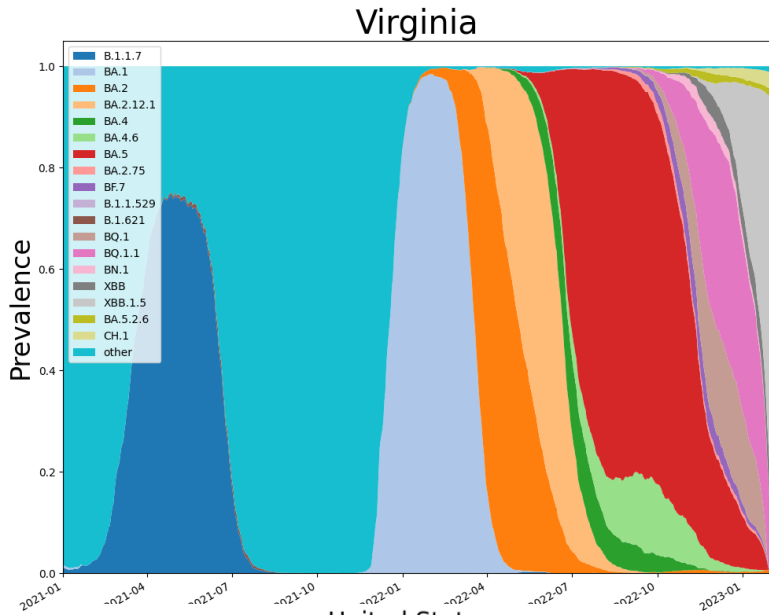
*percentages are CDC NowCast Estimates

* Enumerated lineages are US VOC and lineages circulating above 1% nationally in at least one week period. "Other" represents the aggregation of lineages which are circulating <1% nationally during all weeks displayed.
 # BA.1, BA.3 and their sublineages (except BA.1.1 and its sublineages) are aggregated with B.1.1.529. Except BA.2.12.1, BA.2.75, XBB and their sublineages, BA.2 sublineages are aggregated with BA.2. Except BA.2.75.2, CH.1.1 and BN.1, BA.2.75 sublineages are aggregated with BA.2.75. Except BA.4.6, sublineages of BA.4 are aggregated to BA.4. Except BF.7, BF.11, BA.5.2.6, BQ.1 and BQ.1.1, sublineages of BA.5 are aggregated to BA.5. Except XBB.1.5, sublineages of XBB are aggregated to XBB. For all the other lineages listed, their sublineages are aggregated to the listed parental lineages respectively. Previously, CH.1.1 was aggregated to BA.2.75. Lineages BA.2.75.2, XBB, XBB.1.5, BN.1, BA.4.6, BF.7, BF.11, BA.5.2.6 and BQ.1.1 contain the spike substitution R346T.

SARS-CoV2 Omicron Sub-Variants

As detected in whole Genomes in public repositories

VoC Polynomial Fit Projections



Note: Data lags force projections to start in past. Everything from dotted line forward is a projection.

17-Feb-23

SARS-CoV2 Omicron Sub-Variants

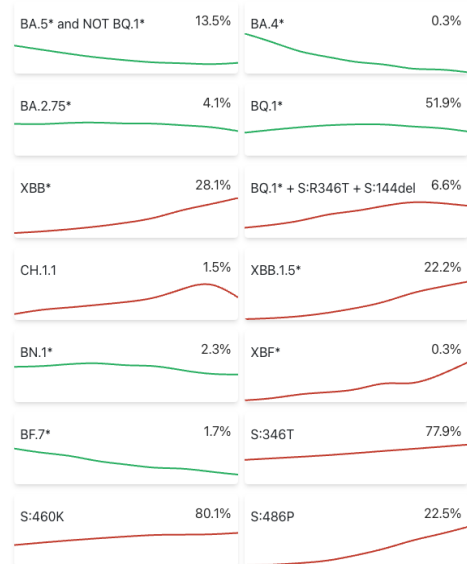
COV-spectrum

“Editor’s choice”
Variants to watch

National

Which variant would you like to explore?

Editor's choice ▼



covSPECTRUM

Enabled by data from 

17-Feb-23

XB.1.5

Virginia

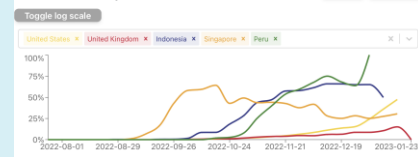
If variants spread pre-dominantly by local transmission across demographic group... (show more)

Estimated proportion through time

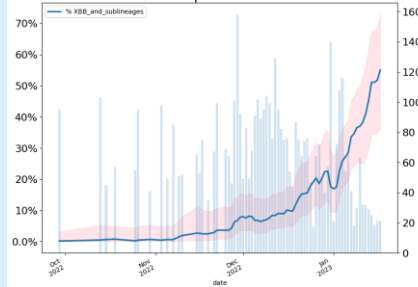


(*) Assumes that the current advantage is due to an intrinsic viral advantage (a combination of increased transmission, immune escape, and prolonged infectious period).

International comparison



Virginia - 55.1% (XBB and sublineages) Last Sample: 2023-01-17



BA.2.75.*

Virginia

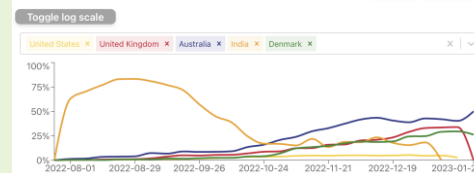
If variants spread pre-dominantly by local transmission across demographic group... (show more)

Estimated proportion through time

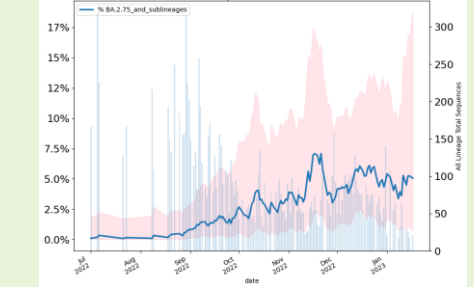


(*) Assumes that the current advantage is due to an intrinsic viral advantage (a combination of increased transmission, immune escape, and prolonged infectious period).

International comparison



Virginia - 5.1% (BA.2.75 and sublineages) Last Sample: 2023-01-17



XBB*

Virginia

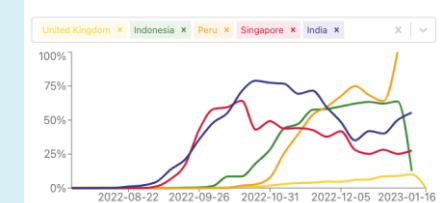
If variants spread pre-dominantly by local transmission across demographic group... (show more)

Estimated proportion through time

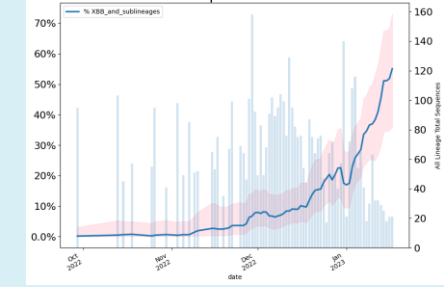


(*) Assumes that the current advantage is due to an intrinsic viral advantage (a combination of increased transmission, immune escape, and prolonged infectious period).

International comparison



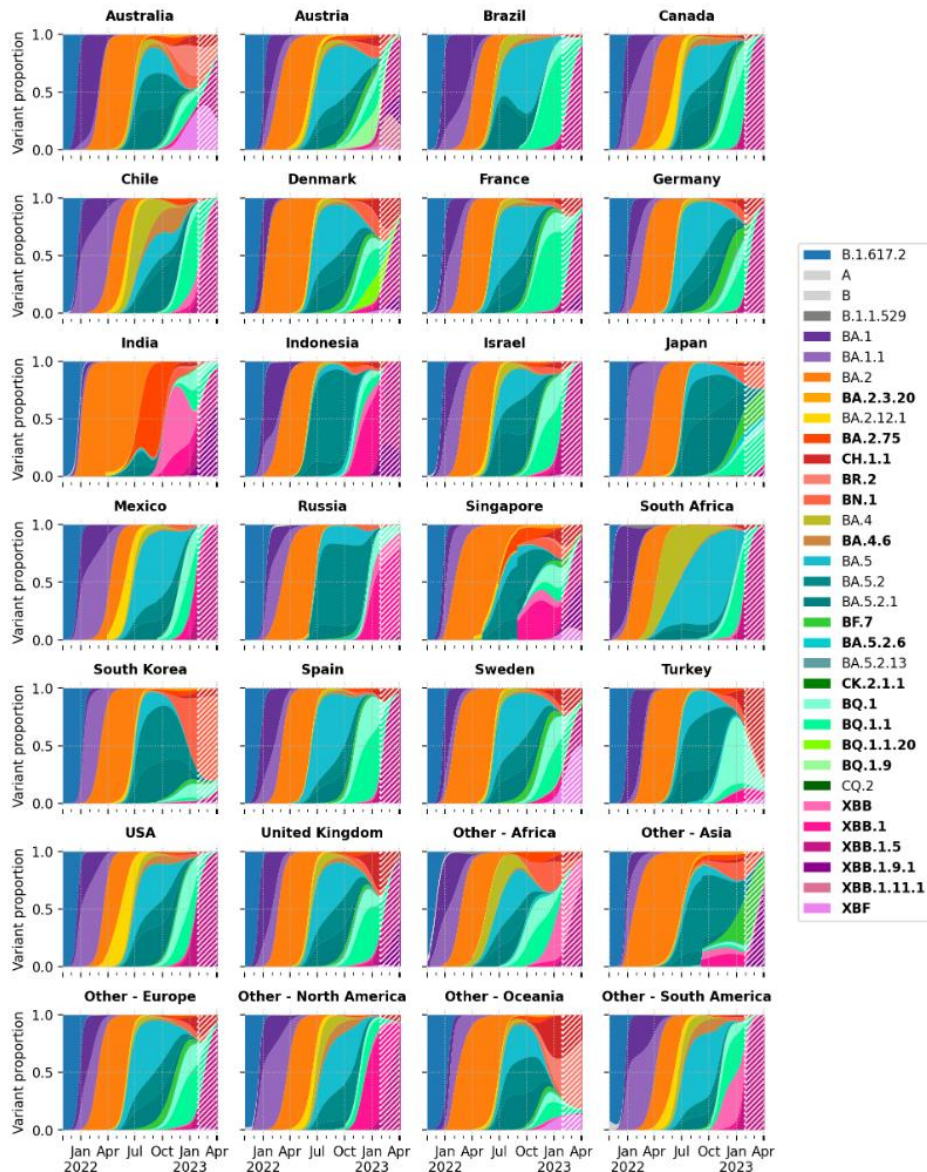
Virginia - 55.1% (XBB and sublineages) Last Sample: 2023-01-17



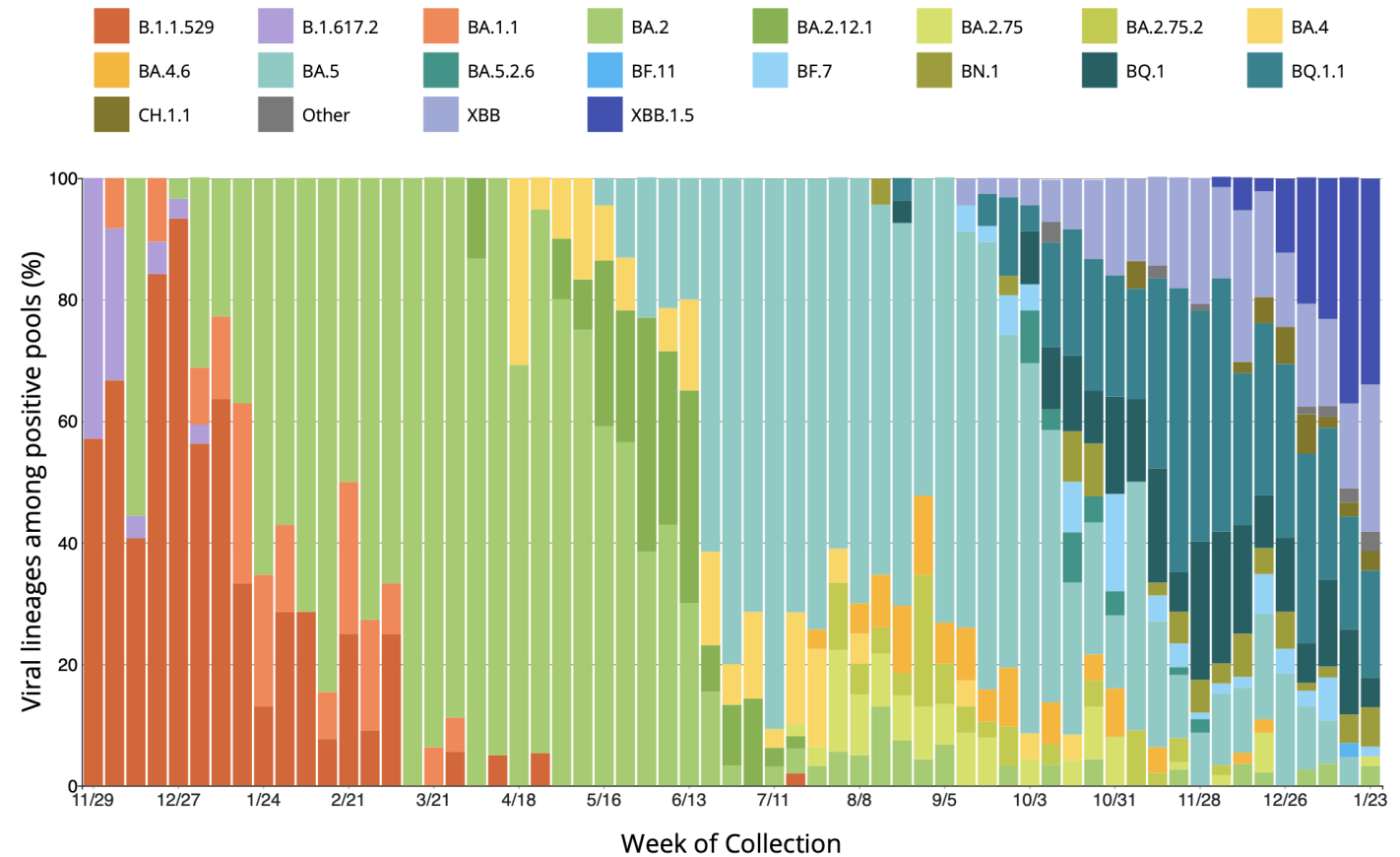
 UNIVERSITY of VIRGINIA

BIOCOMPLEXITY INSTITUTE

Global SARS-CoV-2 Variant Status



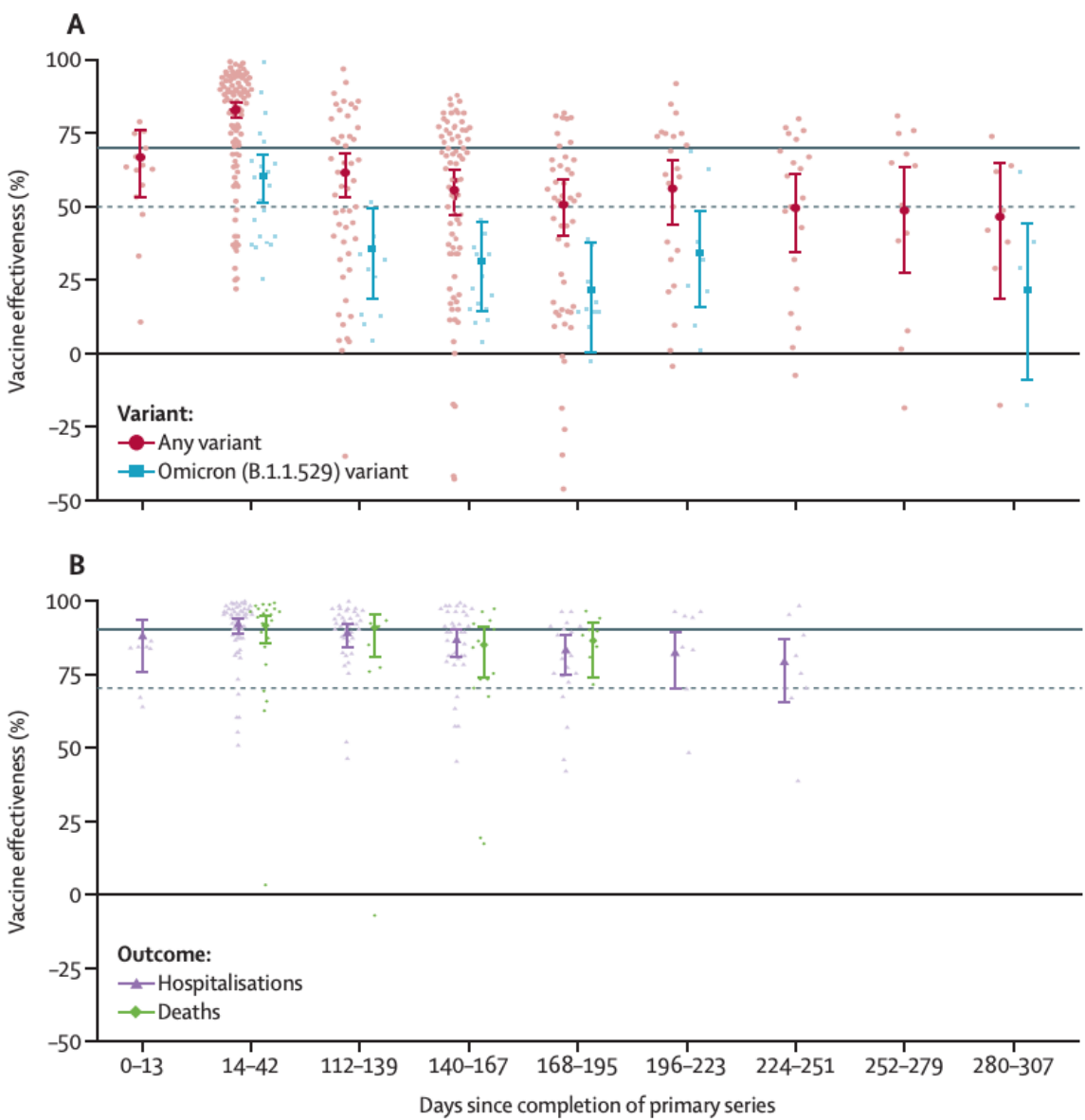
Variants Detected, by Collection Week



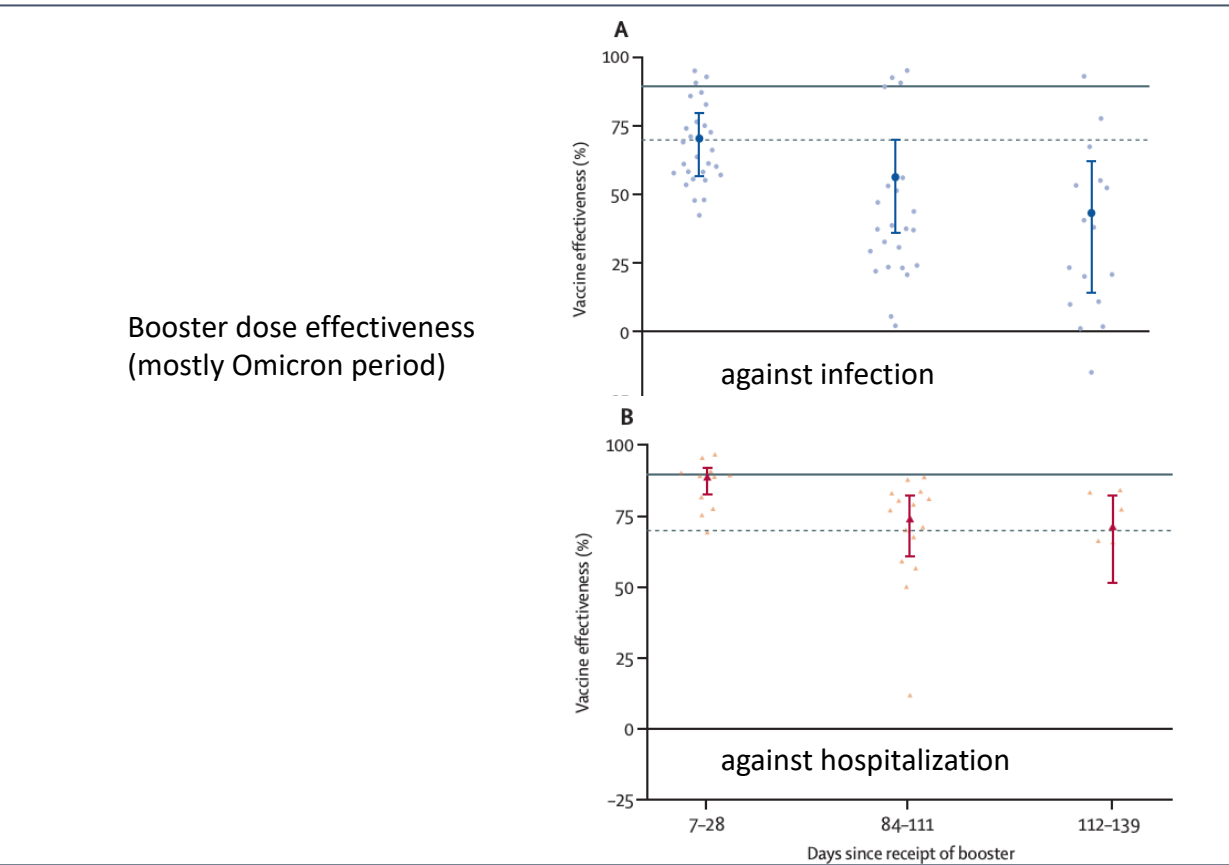
<https://covid.cdc.gov/covid-data-tracker/#traveler-genomic-surveillance>
<https://github.com/gerstung-lab/SARS-CoV-2-International>

Pandemic Pubs (Feb 15th, 2023)

1. A new meta-analysis shows characterizes how vaccine effectiveness generally decreases over time against SARS-CoV-2 infections, hospitalisations, and mortality.



Researchers from Canada conducted a meta-analysis on vaccine effectiveness until December 1, 2022. The baseline vaccine effectiveness levels for the omicron variant were notably lower than for other variants. The authors conclude that preventive measures (eg, face-mask wearing and physical distancing) might be necessary to manage the pandemic in the long term. **For booster doses, which covered mostly omicron studies, vaccine effectiveness at baseline was 70% (56–80) against infections and 89% (82–93) against hospitalisations, and reduced to 43% (14–62) against infections and 71% (51–83) against hospitalisations at 112 days or later.** One limitation of this study is that it did not explore vaccine effectiveness against sublineages of Omicron.



Pandemic Pubs (Feb 15th, 2023)

2. A Risk assessment of the H5N1 Influenza's pandemic threat and severity was recently published by the Institute for progress. Their assessment is there is limited (4%) chance that a pandemic worse than COVID-19 will occur. This was determined by a series

Key forecast points in their report:

- There is a 95% chance that non-human, mammal-to-mammal transmission has actually occurred
- There is a 90% chance that sustained transmission of any kind among non-human mammals has already occurred or will soon occur.
- There is an 85% chance notable genetic changes that facilitate airborne transmission in particular have occurred or will soon occur.
- There is a 40% chance that the H5N1 virus from the above step is at least somewhat transmissible between humans.
- There is a 20% chance that the H5N1 virus that meets the above minimum transmissibility is actually substantially transmissible between humans.
- There is a 90% chance that a new H5N1 virus with a $R_0 > 1$ would not be contained and would spread globally.
- There is a 95% chance that the new H5N1 virus would result in at least 10k confirmed deaths.
- There is a 80% chance that this new H5N1 virus would become a COVID-like pandemic or worse.

All together a 4% chance of COVID-19 like pandemic

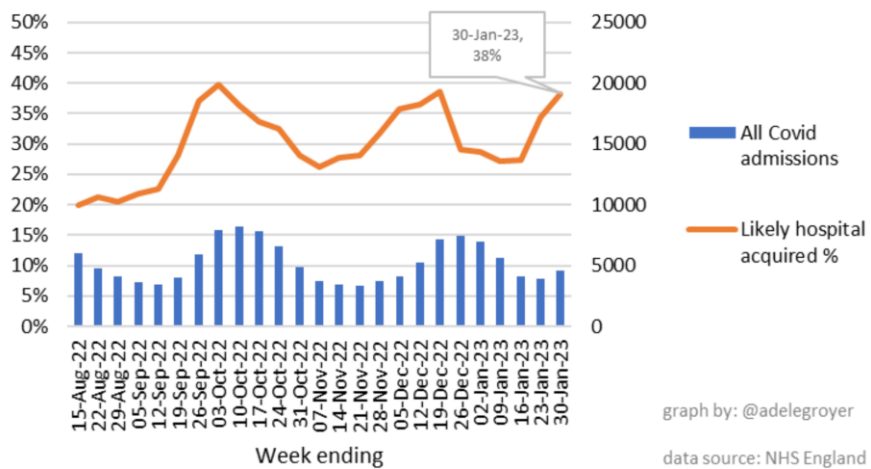
Pandemic Pubs (Feb 08th, 2023)

Data across Europe shows 3-4 month pulses of cases and hospitalizations. Recent data shows higher troughs than in previous years.

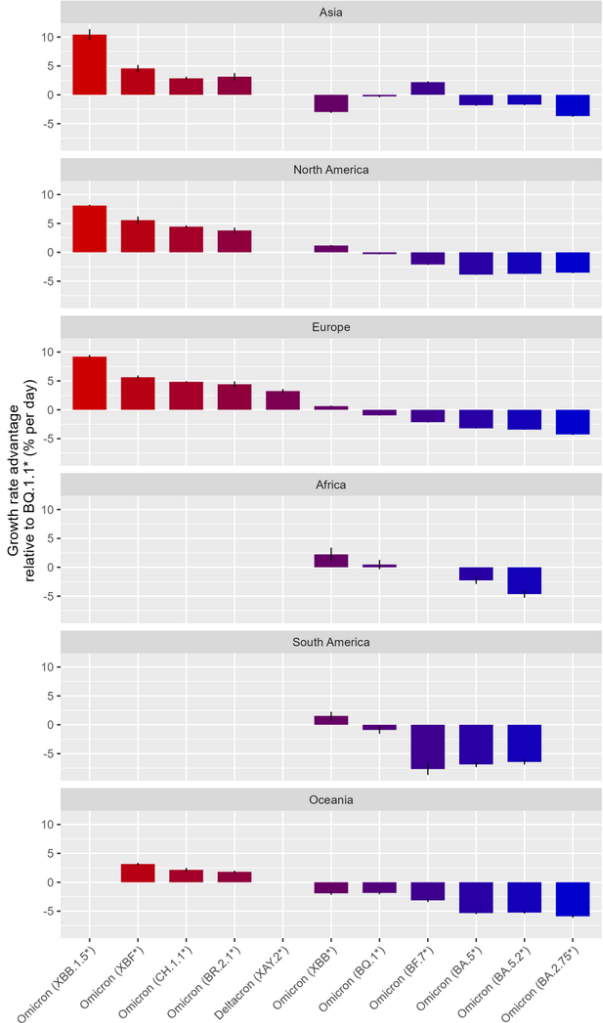
<https://twitter.com/twenseleers/status/1621133287057166336?s=12&t=dENrEmZ29v9Nb49nlkJURg>

1. Variants, cases and hospitalizations in Europe

Weekly Covid hospital admissions in England



GROWTH RATE ADVANTAGE OF SARS-CoV2 VARIANTS
based on multinomial fit variant ~ ns(date, df=2)+ns(date, df=2):region+division
GISAID data with NextcladePangolin lineage definition,
using data from countries with >=5 XBB.1.5* sequences
Estimates shown for regions with >=30 seqs of each variant



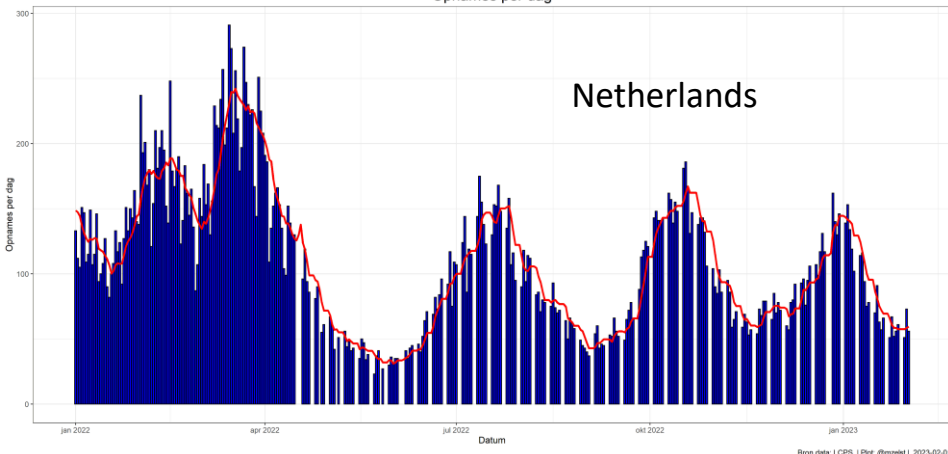
France

Décès à l'hôpital de patients diagnostiqués Covid-19

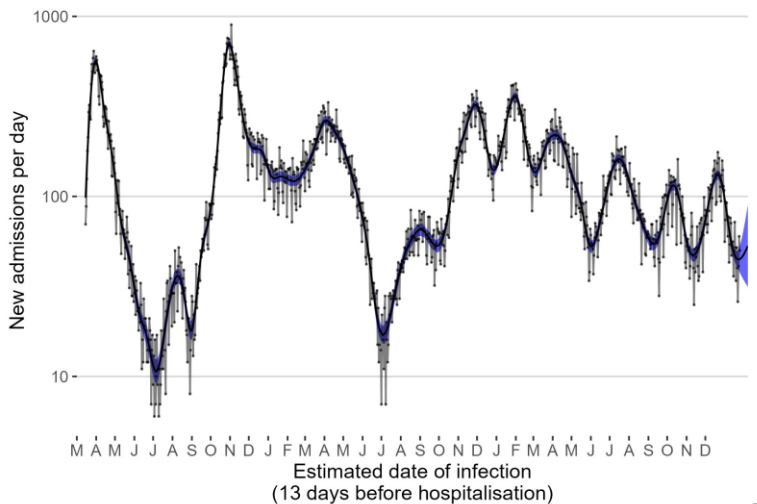


Opmames per dag

Netherlands



NEW COVID HOSPITAL ADMISSIONS PER DAY IN BELGIUM
(negative binomial GAM fit to Sciensano data)

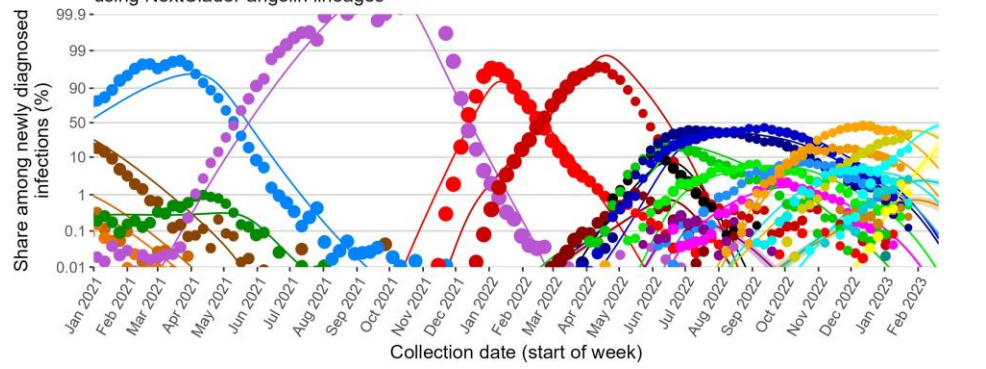


Pandemic Pubs (Feb 08th, 2023)

2. Increasing strain diversity with convergence

SARS-CoV2 LINEAGE FREQUENCIES IN ENGLAND

GISAID data up to 2023-02-06
 multinomial fit variant ~ ns(date, df=2)+ns(date, df=2):region+division
 using NextCladePangolin lineages



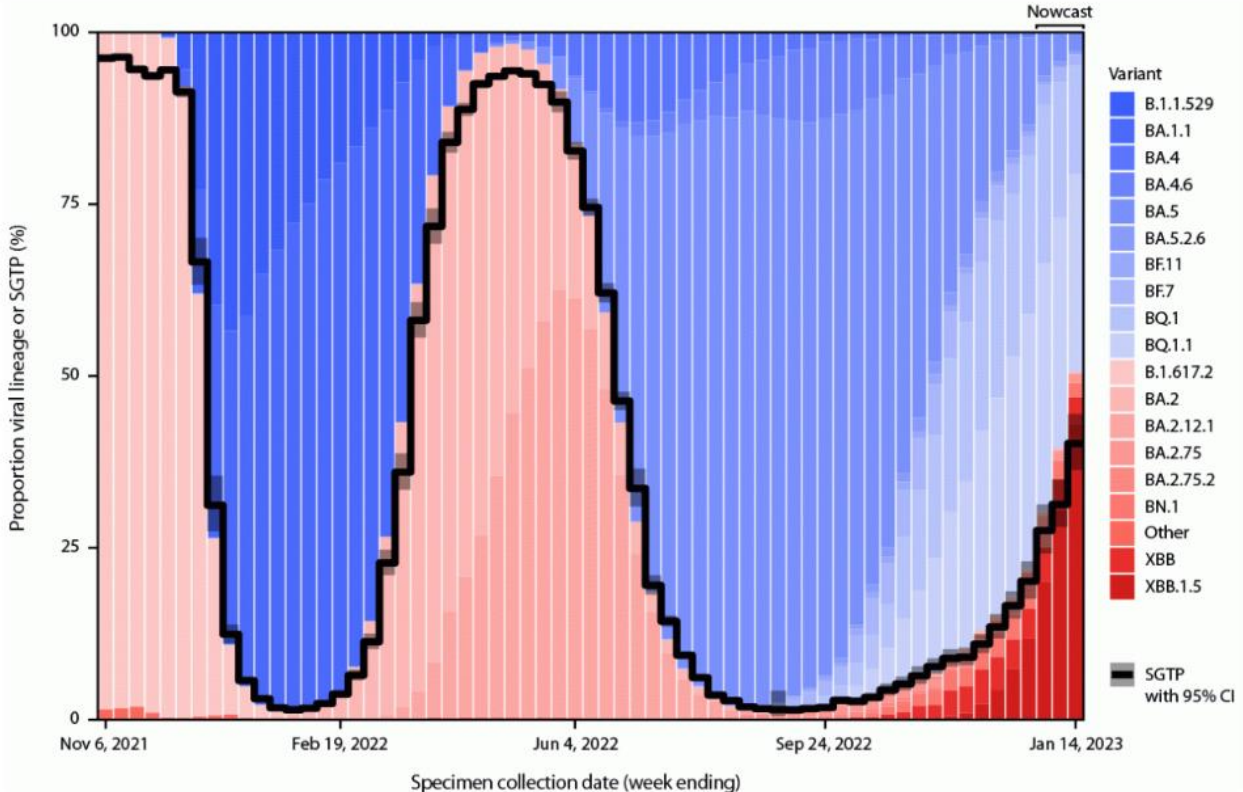
- B.1.177 (EU1)
- Omicron (BA.1*)
- Omicron (BA.5*)
- Omicron (BQ.1*)
- Omicron (XBB.1.5*)
- B.1.160 (EU2)
- Omicron (BA.2*)
- Omicron (BA.5.2*)
- Omicron (BR.2.1*)
- Omicron (XBB.1.9.1*)
- B.1.221 (20A/S:98F)
- Omicron (BA.2.12.1*)
- Omicron (BF.7*)
- Omicron (CH.1.1*)
- Beta
- Omicron (BA.2.38*)
- Omicron (BA.2.76*)
- Deltacron (XAY.2*)
- Alpha
- Omicron (BA.4*)
- Omicron (BA.2.75*)
- Omicron (XBF*)
- Delta
- Omicron (BA.4.6*)
- Omicron (BQ.1.1*)
- Omicron (XBB*)

@TWenseleers
2023-02-06

Increasing diversity of actively circulating strains potentially leading to an increasingly complex immune landscape (left). However certain features such as the S-gene target failure show remarkably stable waves in the face of that diversity (right). One potential explanation is that the double deletion that leads to SGTF compensates for immune escape mutations or is itself associated with evasion of immunity which is manifest in the population and taken advantage of by the virus on a larger time scale than identified strain growth advantage.

- <https://twitter.com/twenseleers/status/1621133287057166336?s=12&t=dENrEmZ29v9Nb49nlkUJRg>
- <https://www.cdc.gov/mmwr/volumes/72/wr/mm7205e2.htm>
- <https://pubmed.ncbi.nlm.nih.gov/34166617/>
- <https://pubmed.ncbi.nlm.nih.gov/34267528/>

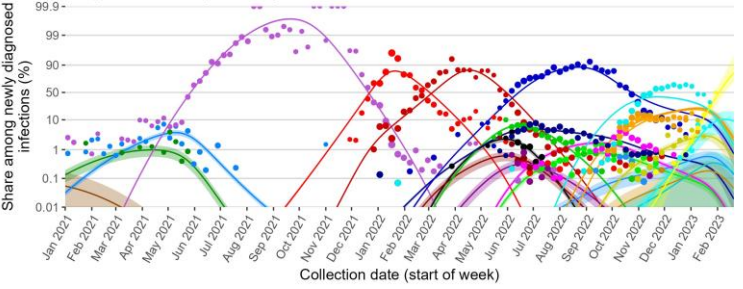
FIGURE. Trends in estimated proportions of SARS-CoV-2 reverse transcription-polymerase chain reaction test results with S-gene target presence and variant proportions and nowcast projections from genomic surveillance classified by S-gene target presence or S-gene target failure* — United States, November 1, 2021–January 14, 2023



Abbreviations: S-gene = spike gene; SGTF = S-gene target failure; SGTP = S-gene target presence.

SARS-CoV2 LINEAGE FREQUENCIES IN INDONESIA

GISAID data up to 2023-02-06
 multinomial fit variant ~ ns(date, df=2)+ns(date, df=2):region+division
 using NextCladePangolin lineages



- B.1.177 (EU1)
- Omicron (BA.1*)
- Omicron (BA.5*)
- Omicron (BQ.1*)
- Omicron (XBB.1.5*)
- B.1.160 (EU2)
- Omicron (BA.2*)
- Omicron (BA.5.2*)
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- Omicron (XBF*)
- Delta
- Omicron (BA.4.6*)
- Omicron (BQ.1.1*)
- Omicron (XBB*)

@TWenseleers
2023-02-06

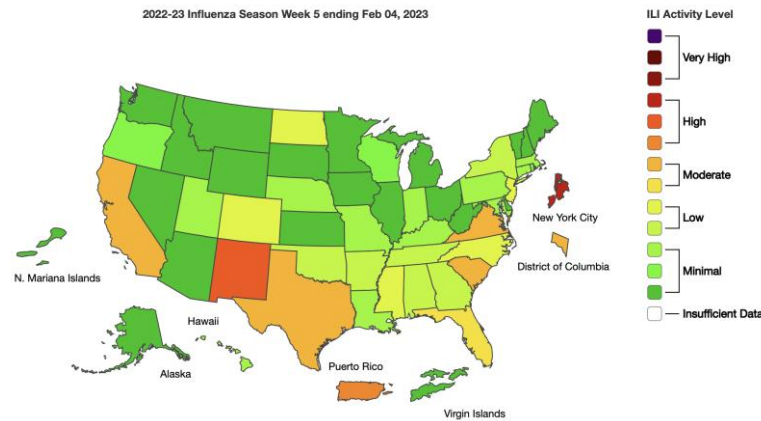
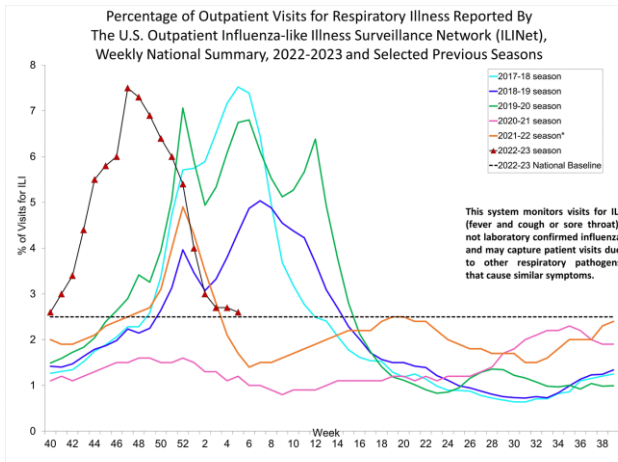
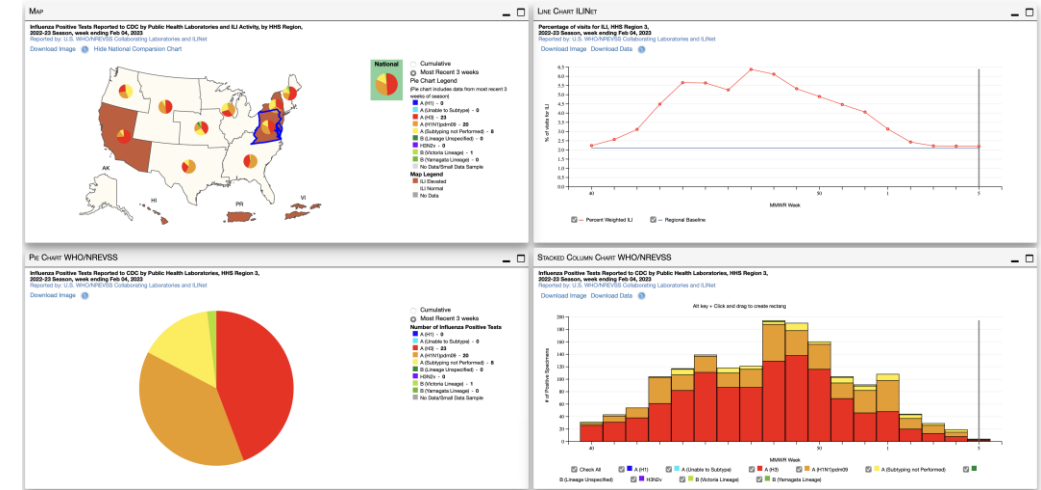
Influenza Update

Current Influenza Situation – ILI Activity

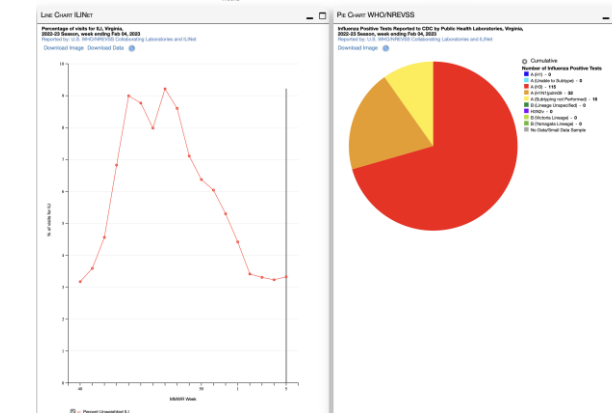
Influenza Activity is Higher than Usual

- Virginia has shifted to “Moderate” level as most states have receded to Low and Minimal levels in the past couple weeks.
- In VA ILI Activity has declined to 3-4% which is the same as in early October at the beginning of the season
- National ILI activity has also consistently declined since a peak in late November, now almost below the seasonal threshold
- Over half of the HHS regions are now below the seasonal threshold for ILI activity

Region 3



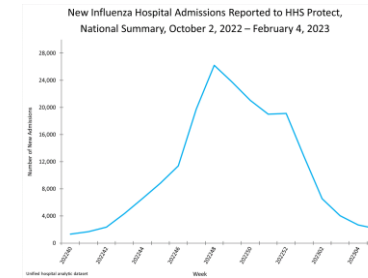
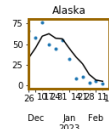
Virginia



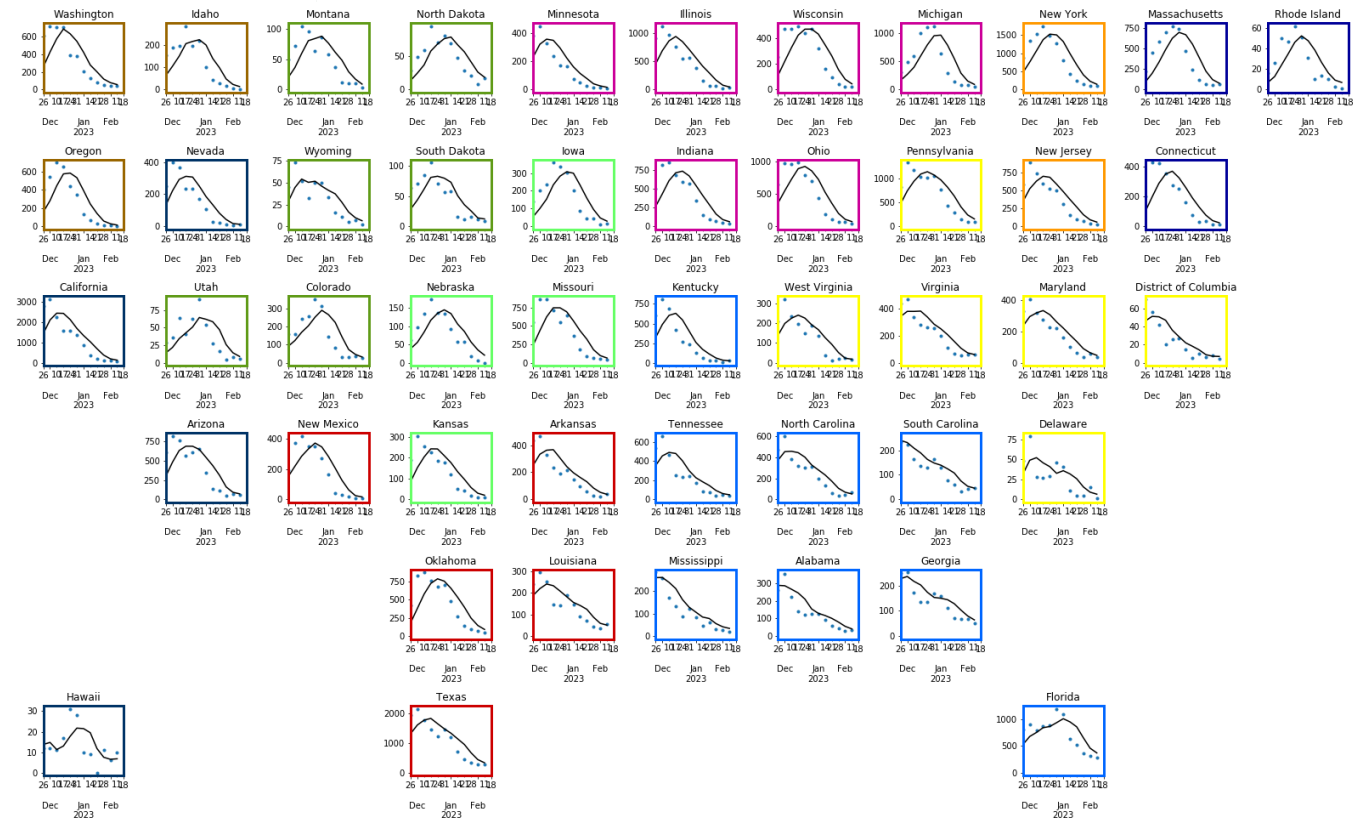
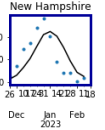
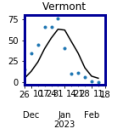
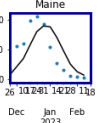
Current Influenza Situation - Hospitalizations

Influenza A hospitalizations continue decline

- National level of influenza hospitalizations have dropped to nearly pre-season levels
- Nearly all states have returned to levels below early December before the initial rise to to the peak



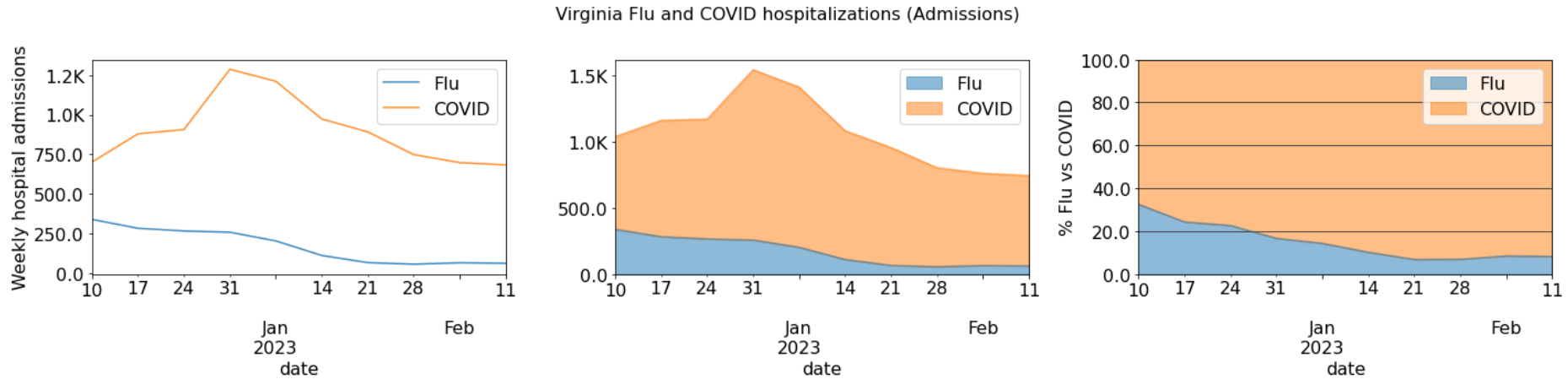
Influenza Hospital Admissions (HHS Protect)



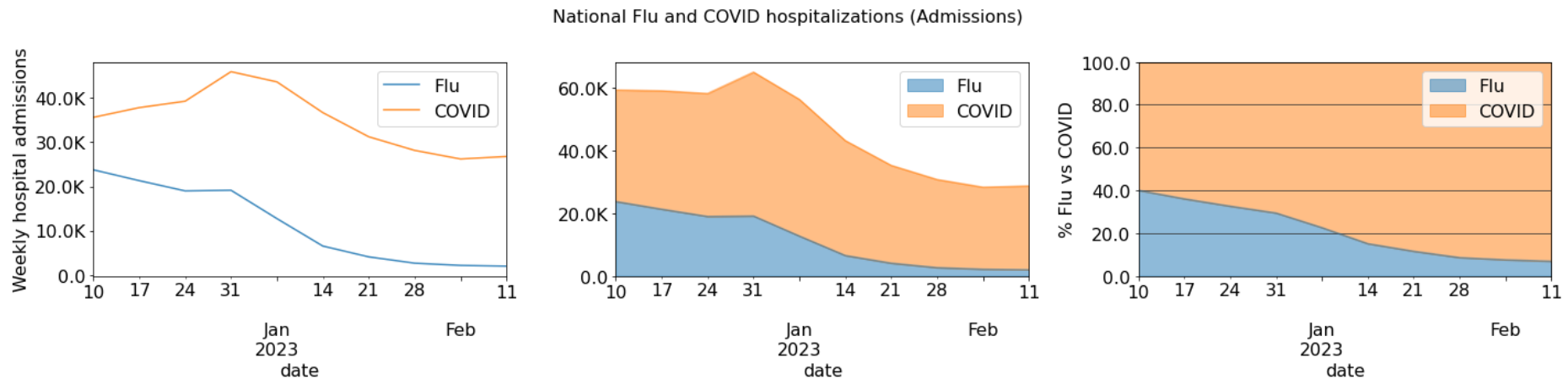
Current Combined Hospitalizations (COVID-19 & Influenza)

COVID-19 and Influenza Weekly Hospitalizations (HHS Protect)

Virginia



USA



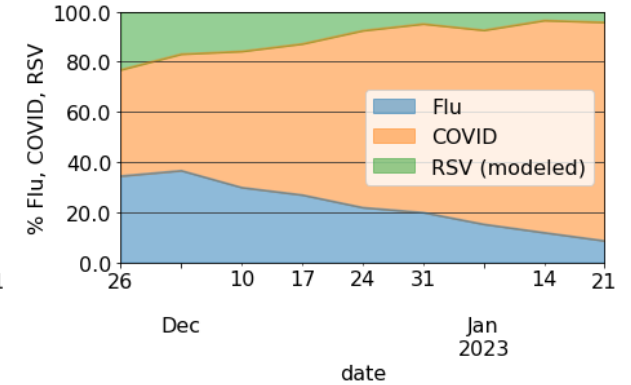
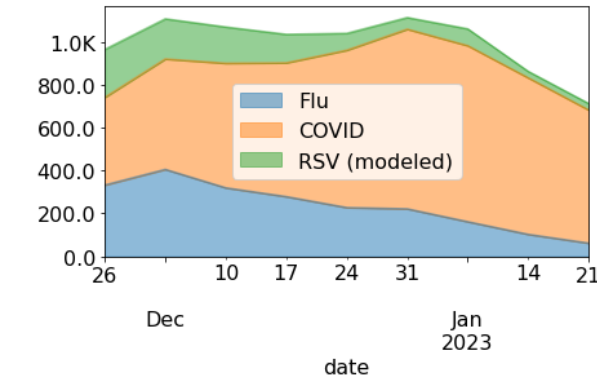
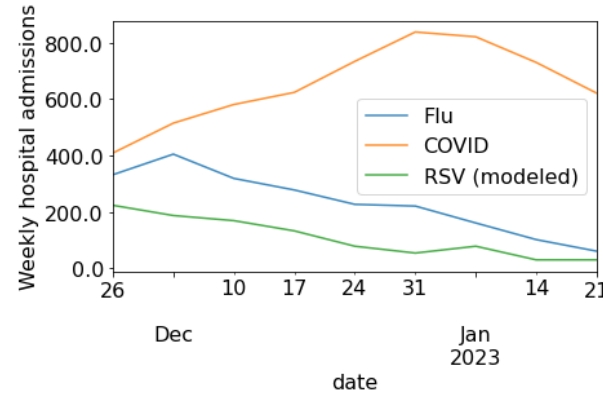
Current Combined Hospitalizations (COVID-19, Flu & RSV)

COVID-19, Influenza, and RSV Weekly Hospitalizations

RSV Hospitalizations captured by RSV-Net which has lagged reporting and does not cover Virginia, thus her closest neighbors are shown for comparison

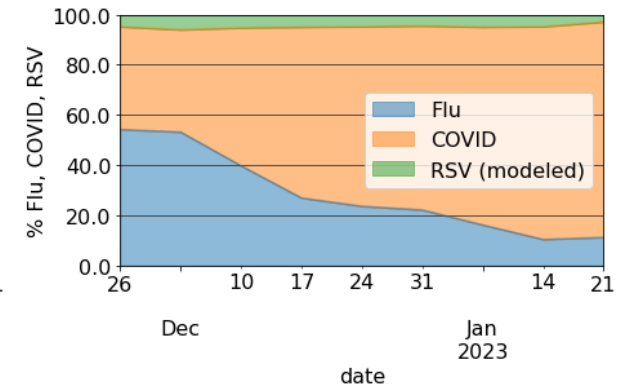
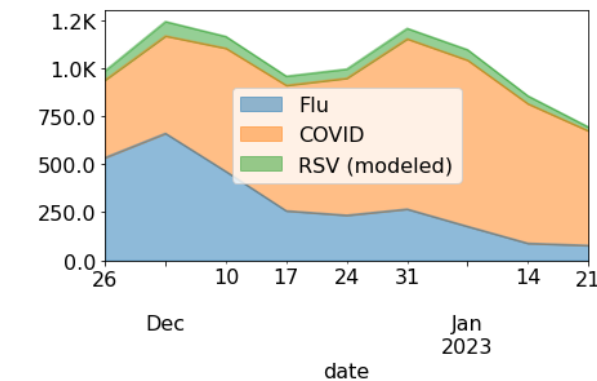
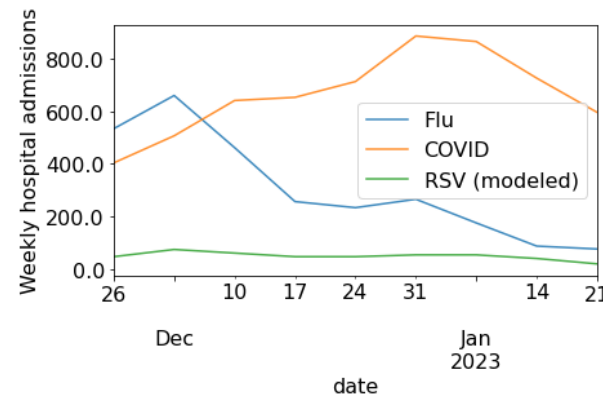
Maryland

Maryland Flu, COVID, RSV hospitalizations (Admissions)



Tennessee

Tennessee Flu, COVID, RSV hospitalizations (Admissions)

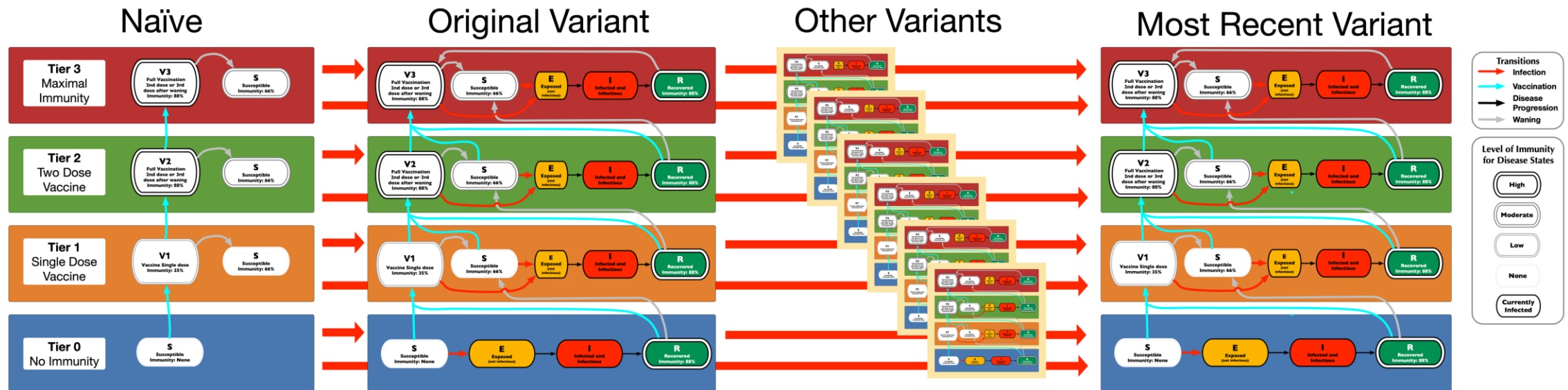


Model Update – Adaptive Fitting

Model Structure Extended for more sub-variants

Omicron sub-variants escape immunity induced by previous sub-variants

- Multiple strain support allows representation of differential protection based on immunological history (BA.1, BA.2, BA.2.12.1, BA.4/5, and future variants (VariantX))
- Each sub-variant has differing levels of immune escape to previous sub-variants, the prevalences are based on observations for fitting purposes, and projections use estimated future prevalences
- Adaptive fitting approach continues to use simulation to generate the full distribution of immune states across the population



Adaptive Fitting Approach

Each county fit precisely, with recent trends used for future projection

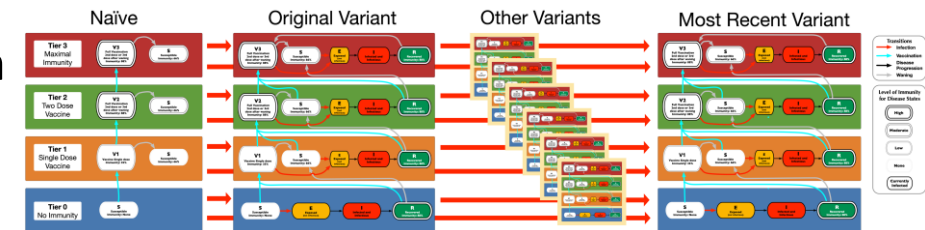
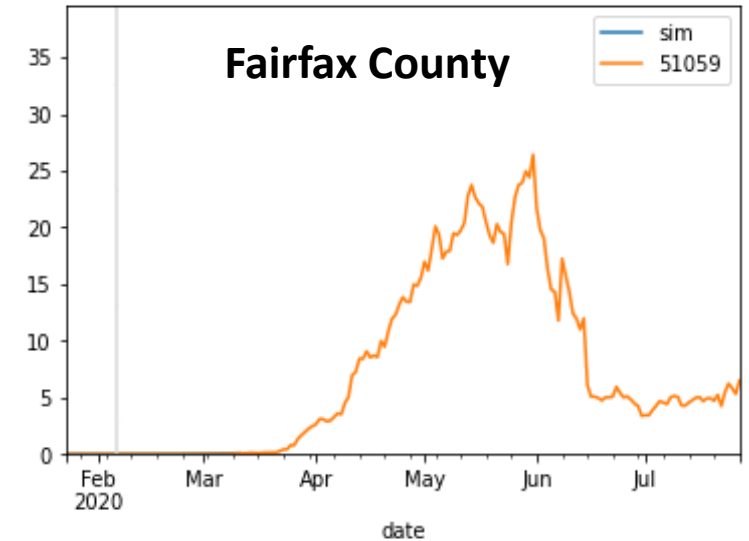
- Allows history to be precisely captured, and used to guide bounds on projections

Model: An alternative use of the same meta-population model, PatchSim with multiple tiers of immunity

- Allows for future “what-if” Scenarios to be layered on top of calibrated model
- Allows for waning of immunity and for partial immunity against different outcomes (eg lower protection for infection than death)

External Seeding: Steady low-level importation

- Widespread pandemic eliminates sensitivity to initial conditions, we use steady 1 case per 10M population per day external seeding



Scenarios – Transmission Conditions

- Variety of factors continue to drive transmission rates
 - Seasonal impact of weather patterns, travel and gatherings, fatigue and premature relaxation of infection control practices
- **Waning Immunity:** Omicron waning with a mean of 4 months
- **Projection Condition Ingredients:**
 - **Adaptive:** Controls remain as currently experienced into the future with NO influence from other conditions (eg seasonal, variants, etc.)
 - **Seasonal:** Controls remain the same, however, seasonal forcing or other seasonal behavior patterns
 - **New Variants (VariantX):** As of yet unidentified novel sub-variant with similar immune escape but no transmission advantage emerges 4 months after the last significant sub-variant and grows at a similar rate

Projection Scenarios – Combined Conditions

Name	Txm	Variant	Booster	Description
Adaptive-VariantX	C	X	Current	Like Adaptive, with emergence of a Variant like XBB.1.5 that tracks its prevalence
Adaptive-VariantX-IncreasePerm	Increase	X	Current	Like Adaptive-VariantX but with an increase of 30% over the course of 4 weeks, that remains constant thereafter
Adaptive-VariantX-IncreaseTemp	Increase	X	Current	Like Adaptive-VariantX but with an increase of 30% over the course of 4 weeks and then recedes over the course of 4 weeks

Transmission:

C = Current levels persist into the future

Increase = Transmission rates increase a total of 30% over 4 weeks representing a delayed seasonally or variant driven bump, this in effect returns transmission rates to similar levels as last summer

Variant:

SQ = Status quo prevalences remain the same (e.g. no significant major driving of transmission anticipated)

X = Novel sub-variant scenario, new variant emerges reaches dominance in near term, 30% immune escape

Booster:

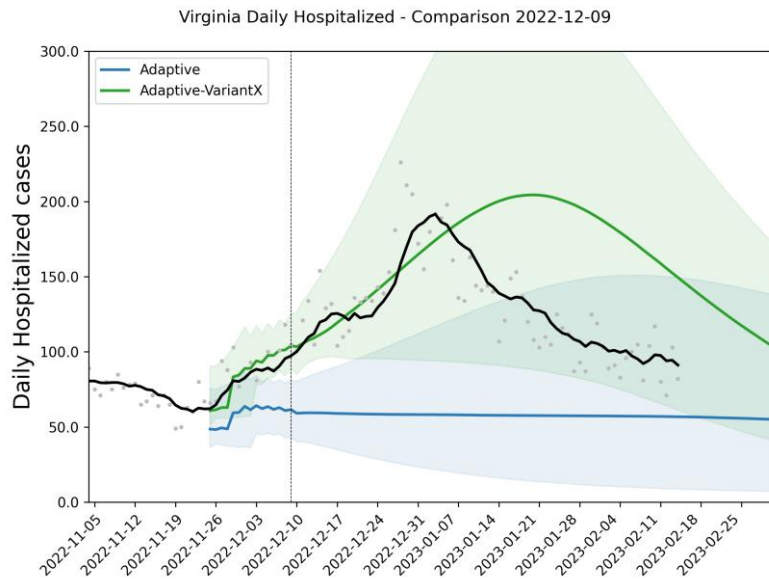
Current = Current pace relative to 3rd dose rollout is maintained in the future

Model Results

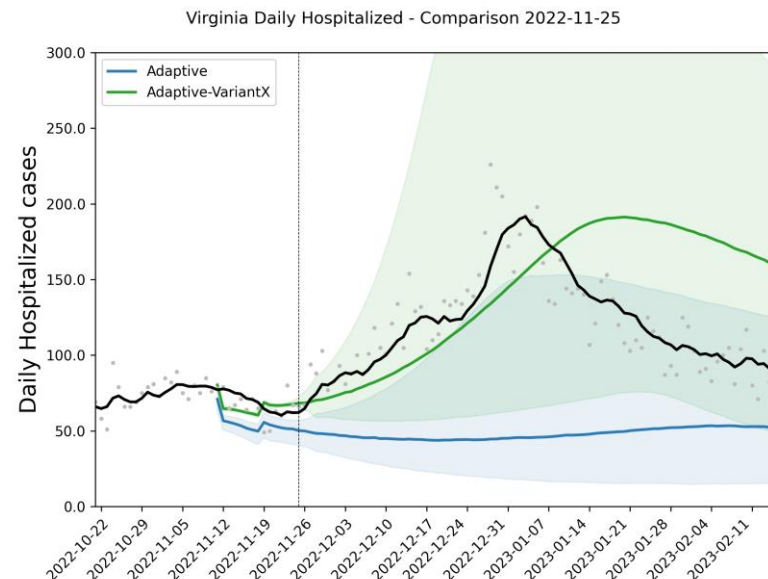
Previous projections comparison - Hospitalizations

- Previous projections have tracked observed hospitalizations well
- Projection from 2 weeks ago had enough growth in hospitalizations to track well
- Projection from 4 weeks ago had declines which delayed the growth
- Projection from early July anticipated a Fall-Winter rise that has tracked well

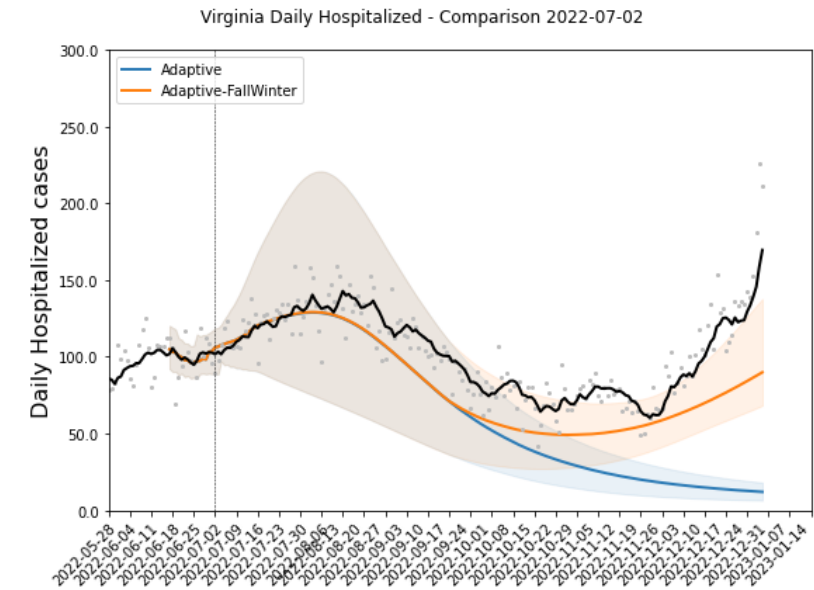
Previous round – mid December



Previous round – late November



Projection from 7 months ago

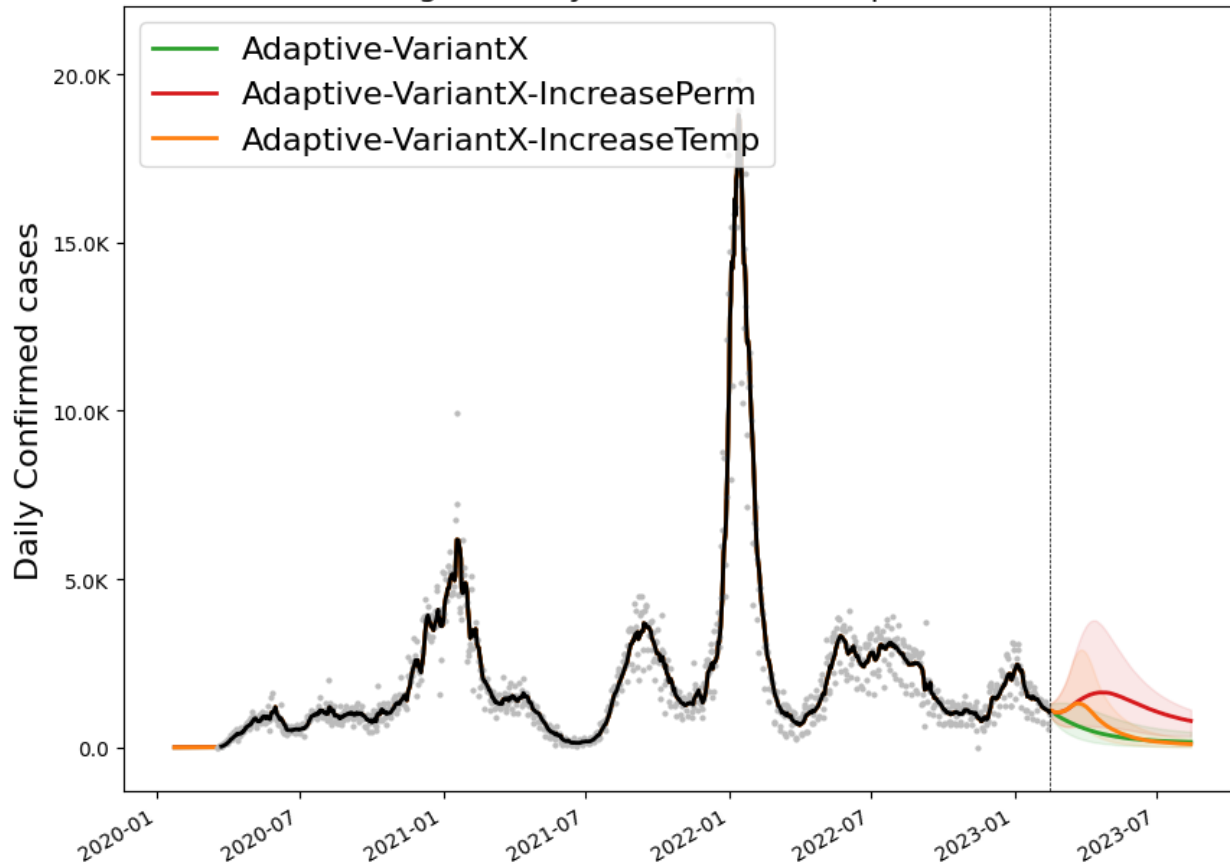


We are now past the 6 month projection window

Outcome Projections

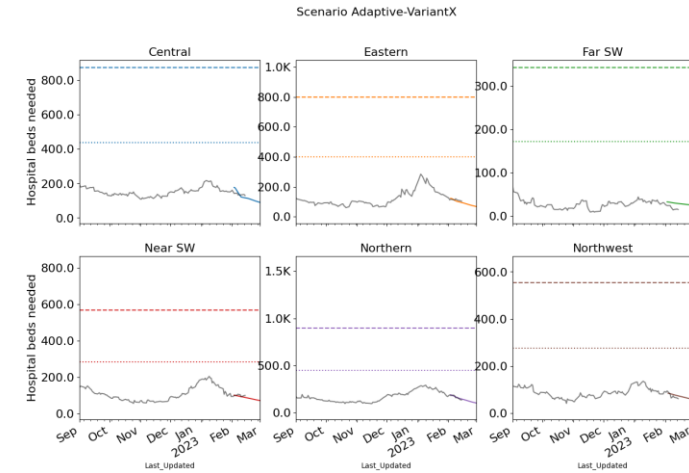
Confirmed cases

Virginia Daily Confirmed - Comparison

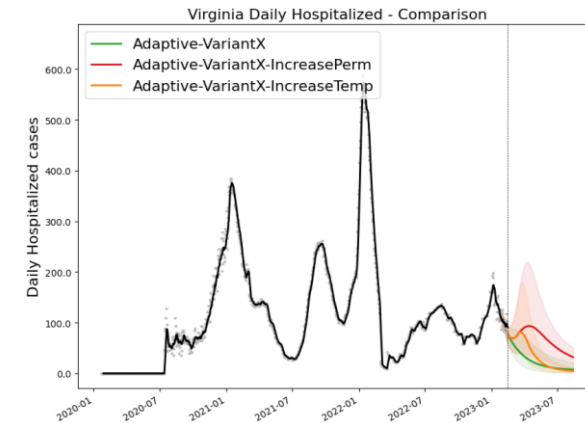


* without surveillance correction VariantBA2 peaked over 10K in July

Estimated Hospital Occupancy

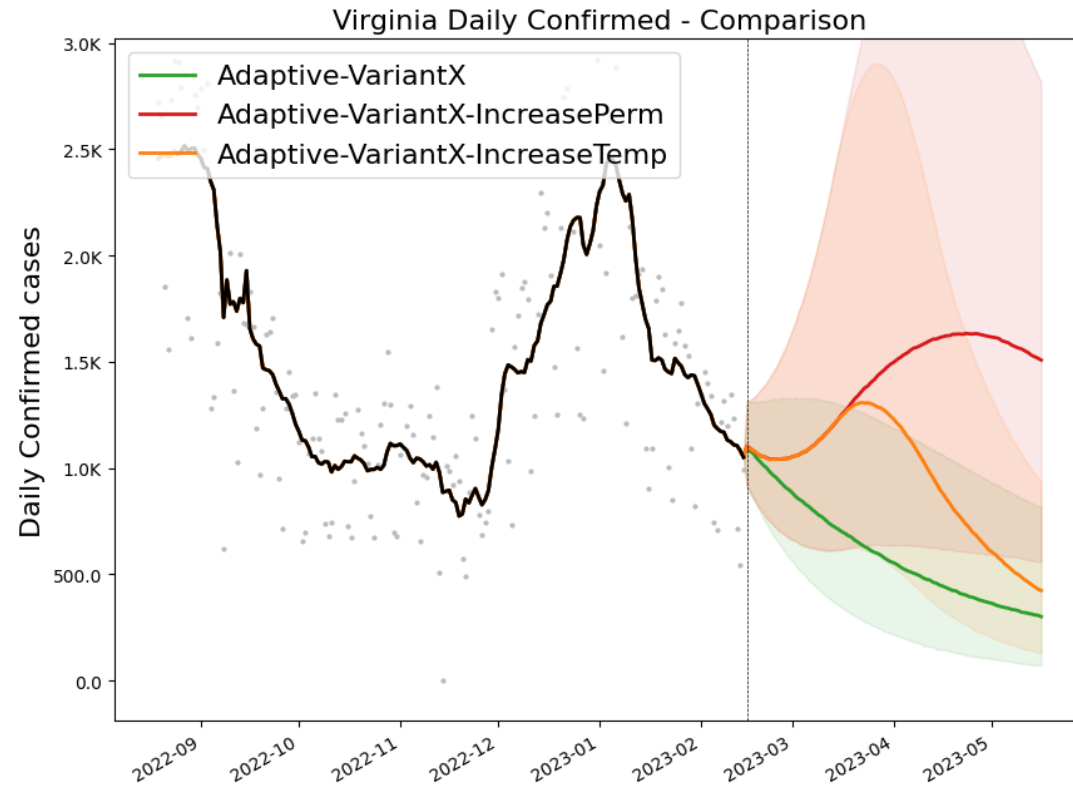


Daily Hospitalized

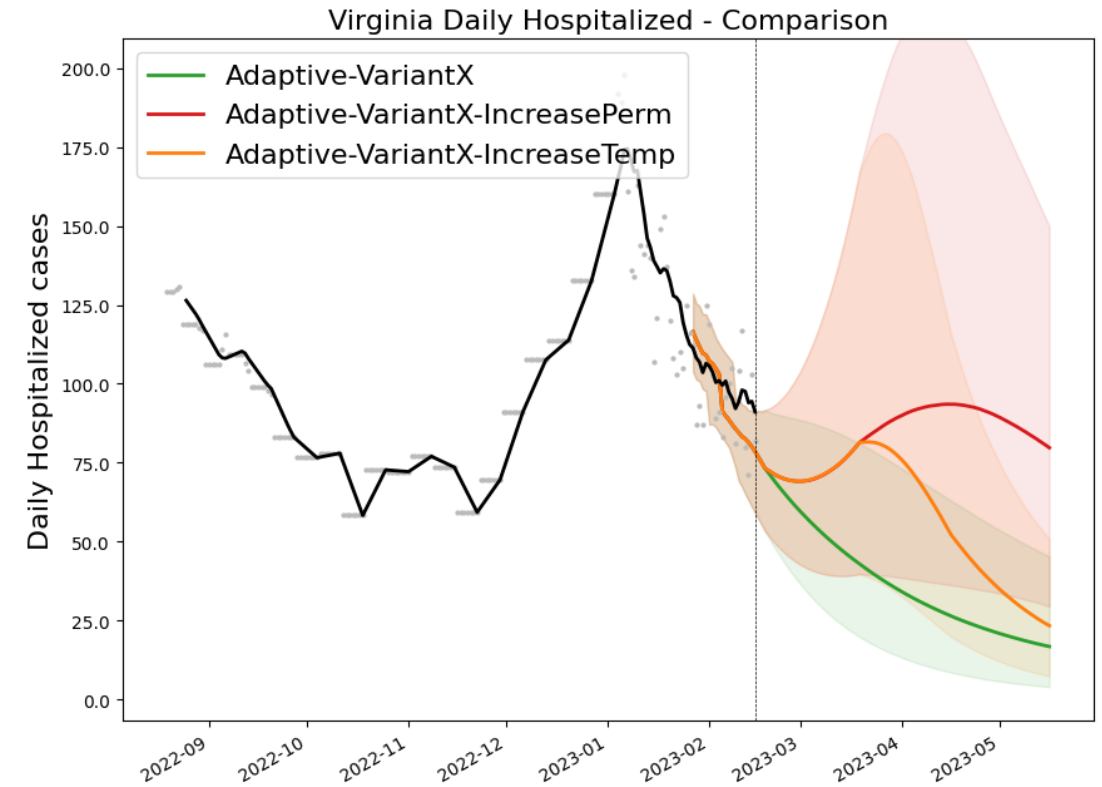


Outcome Projections – Closer Look

Confirmed cases



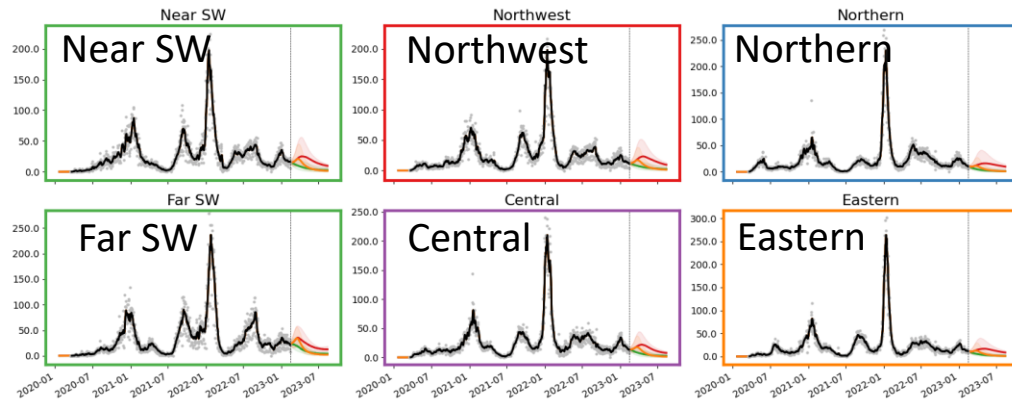
Daily Hospitalized



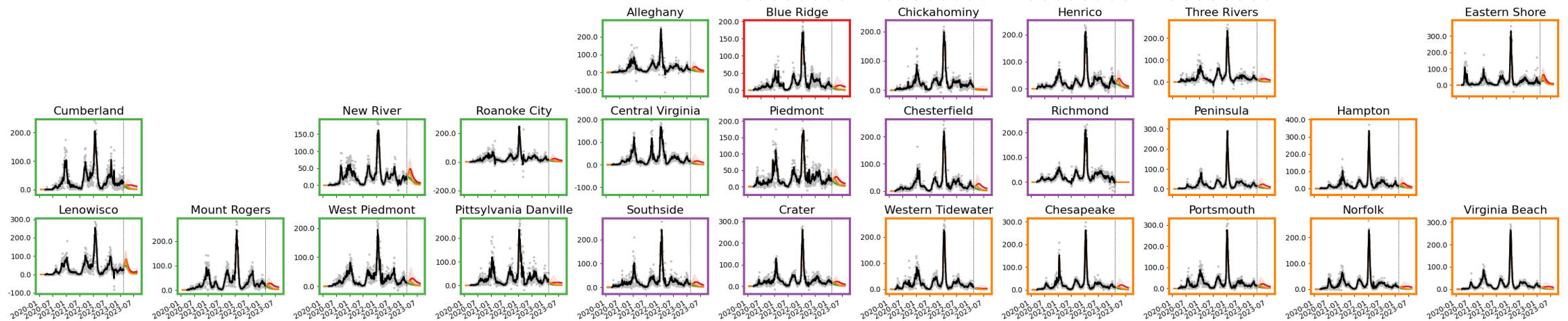
* without surveillance correction VariantBA2 peaked over 10K in July

Detailed Projections: Cases for All Scenarios

Projections by Region



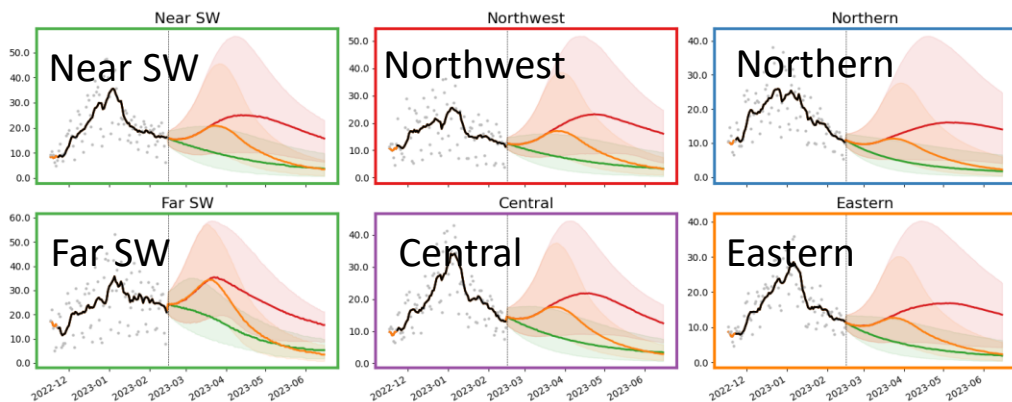
Projections by District



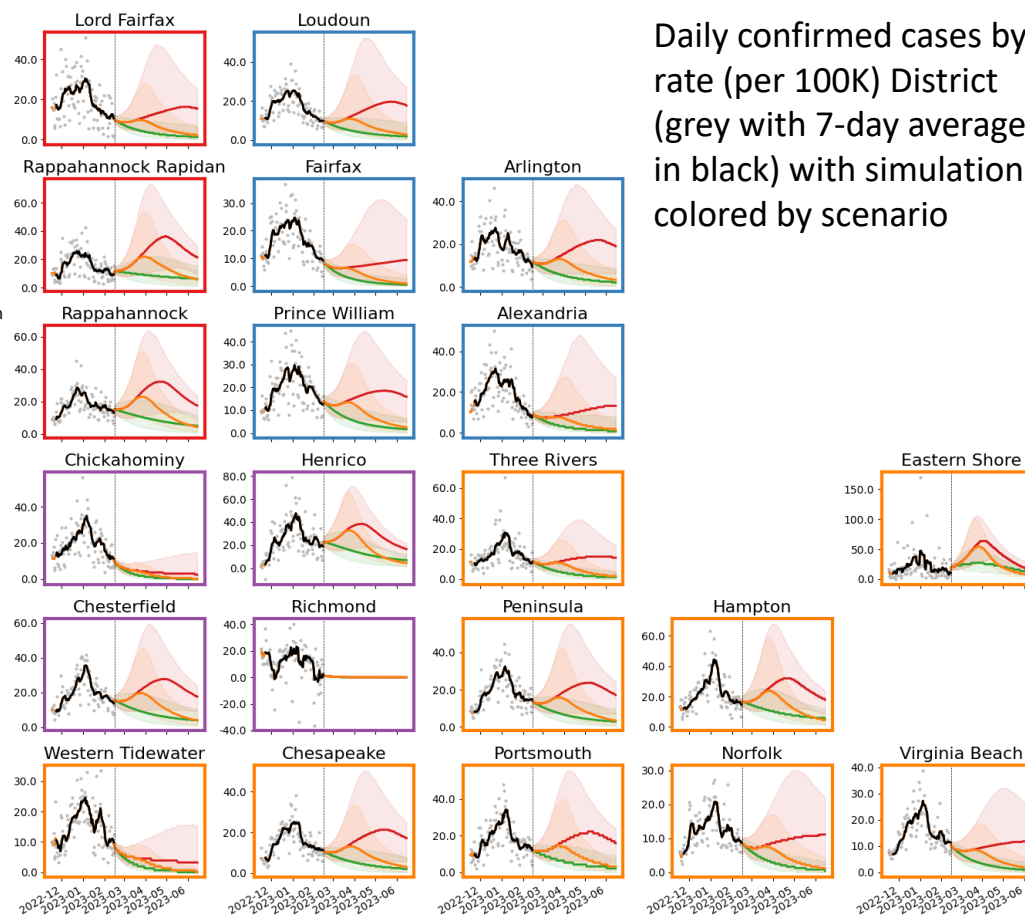
Daily confirmed cases by rate (per 100K) District (grey with 7-day average in black) with simulation colored by scenario

Detailed Projections: Cases for All Scenarios - Closer Look

Projections by Region



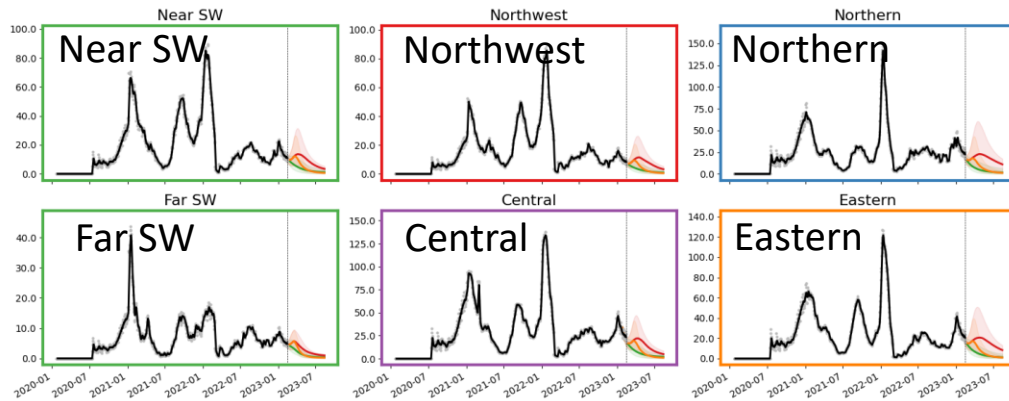
Projections by District



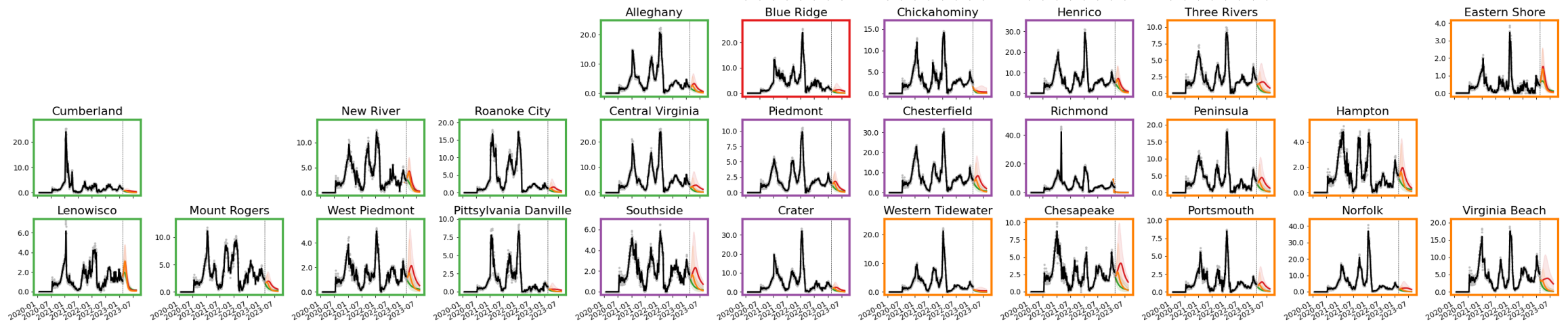
Daily confirmed cases by rate (per 100K) District (grey with 7-day average in black) with simulation colored by scenario

Detailed Projections: Hospitalizations for All Scenarios

Projections by Region



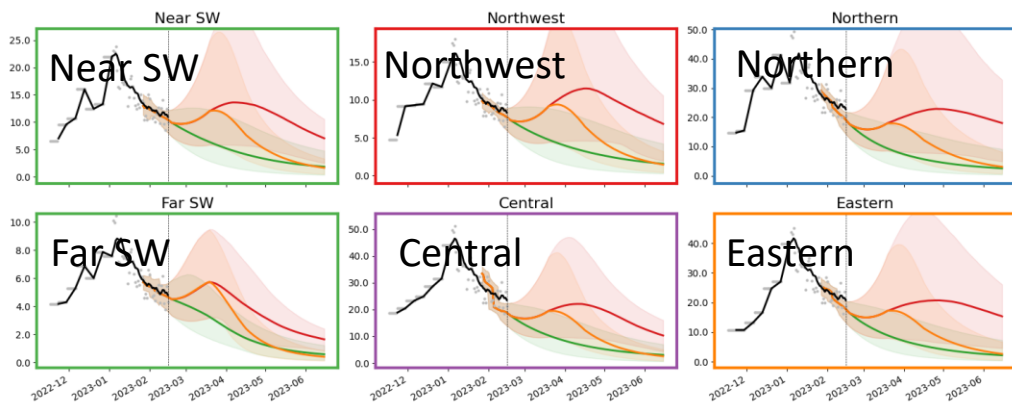
Projections by District



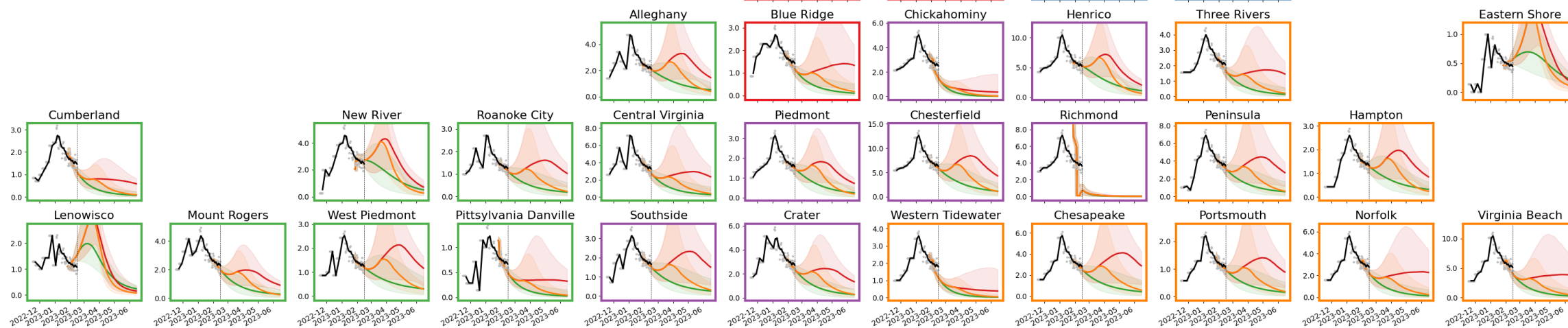
Daily confirmed hospitalizations District (grey with 7-day average in black) with simulation colored by scenario

Detailed Projections: Hosps for All Scenarios - Closer Look

Projections by Region



Projections by District



Daily confirmed hospitalizations District (grey with 7-day average in black) with simulation colored by scenario

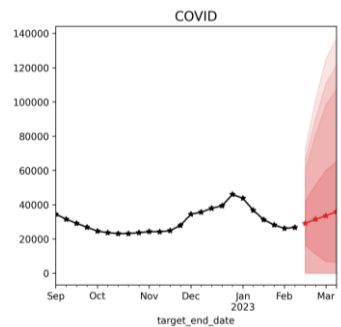
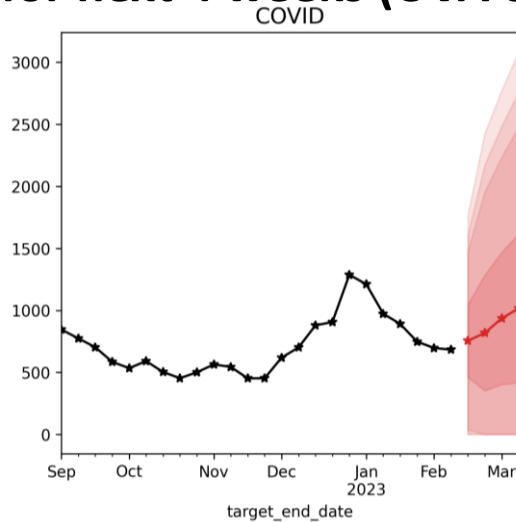
National Modeling Hub Updates

Current COVID-19 Hospitalization Forecast

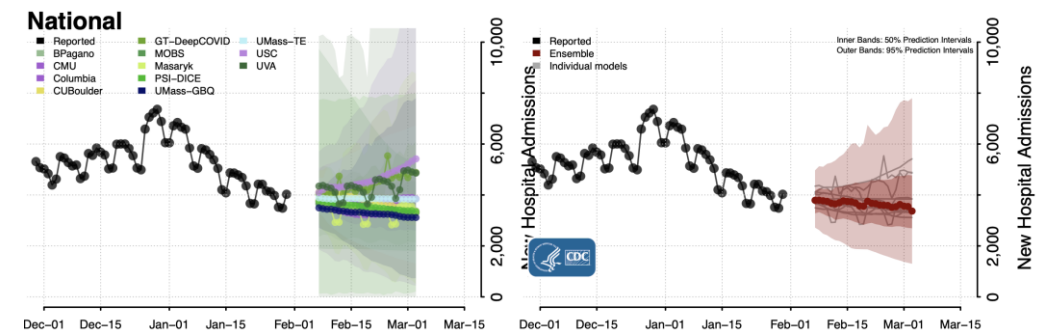
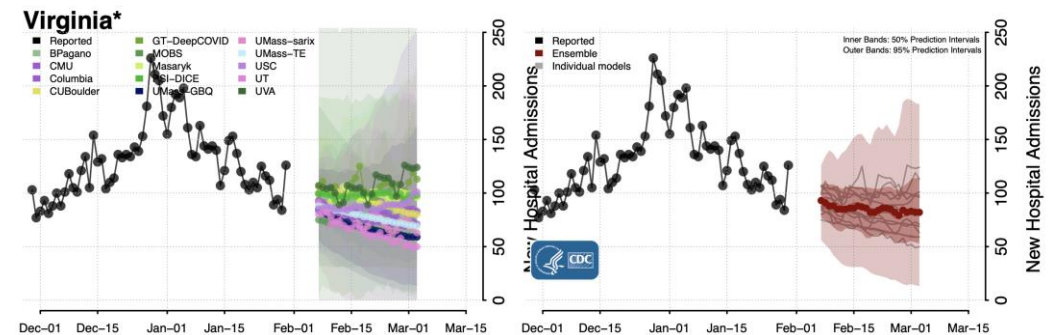
Statistical models for submitting to CDC FluSight forecasting challenge

- Uses a variety of statistical and ML approaches to forecast weekly hospital admissions for the next 4 weeks for all states in the US

Hospital Admissions for COVID-19 and Forecast for next 4 weeks (UVA ensemble)



Hospital Admissions for COVID-19 and Forecast for next 4 weeks (CDC COVID Ensemble)

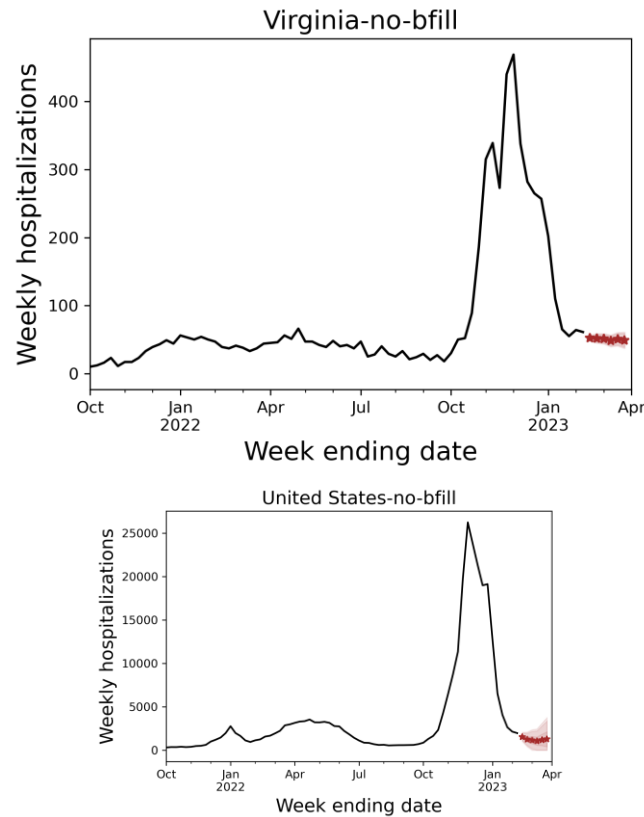


Current Influenza Hospitalization Forecast

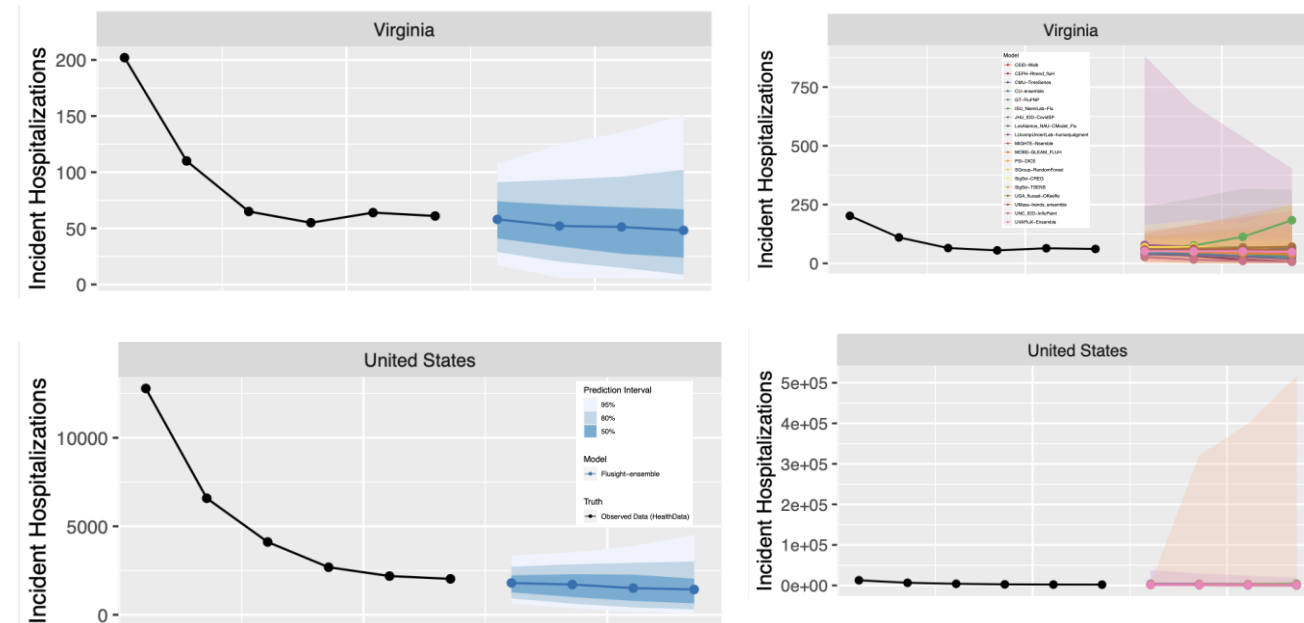
Statistical models for submitting to CDC FluSight forecasting challenge

- Similar to COVID-19 case forecasts, uses a variety of statistical and ML approaches to forecast weekly hospital admissions for the next 4 weeks for all states in the US

Hospital Admissions for Influenza and Forecast for next 4 weeks (UVA ensemble)



Hospital Admissions for Influenza and Forecast for next 4 weeks (CDC FluSight Ensemble)



Combined ILI and COVID-19 Hospitalizations

Ensemble methodology that combines the Adaptive with machine learning and statistical models such as:

- Autoregressive (AR, ARIMA) , Neural networks (LSTM), Kalman filtering (EnKF), G-model (phase), Holt-Winters

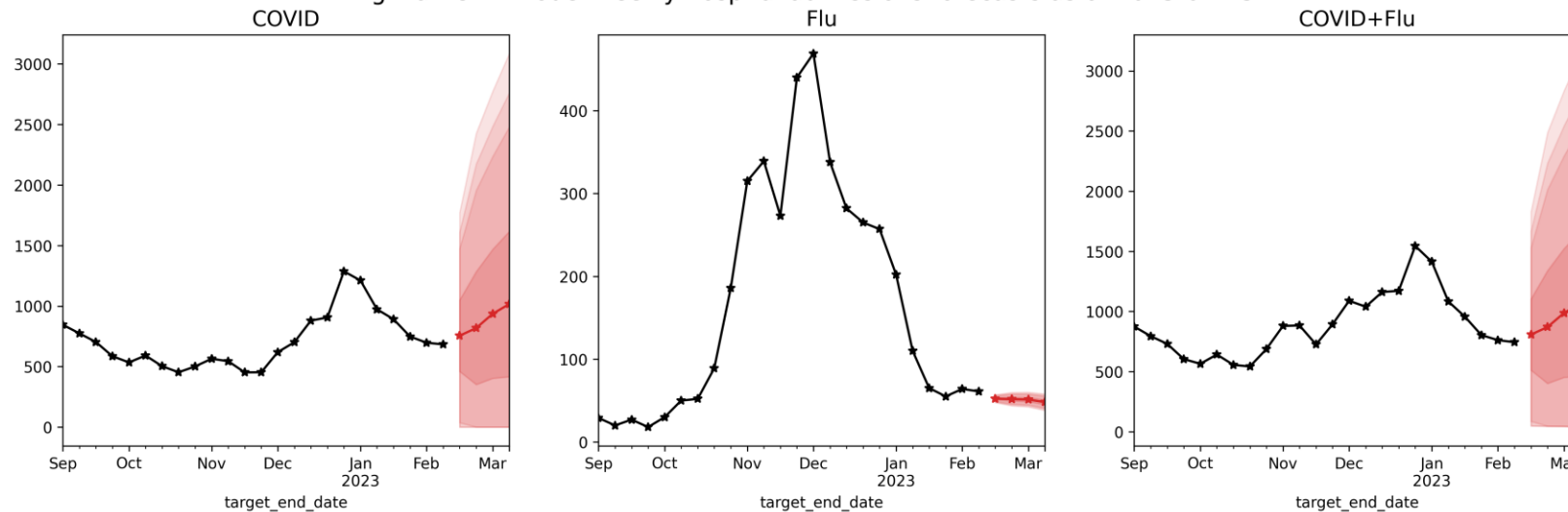
Weekly forecasts of hospitalizations done at state level.

Models chosen because of their track record in disease forecasting and to increase diversity and robustness.

Both are regularly submitted to CDC Forecast Hubs

Weekly Hospitalizations Short-term COVID-19 and Influenza Forecasts

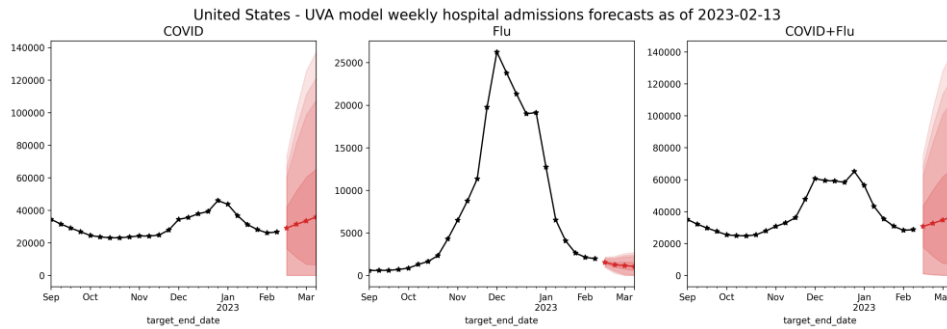
Virginia - UVA model weekly hospital admissions forecasts as of 2023-02-13



Combined ILI and COVID-19 Hospitalizations

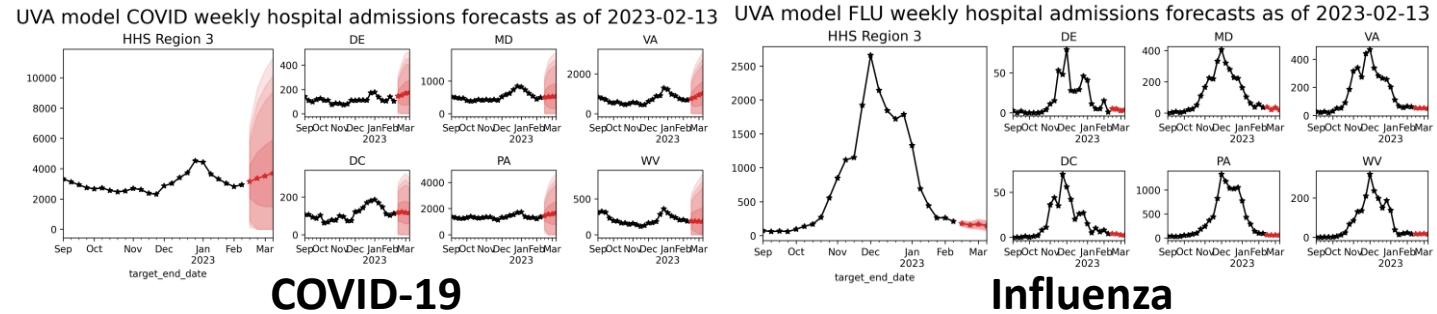
National

Short-term COVID-19 and Influenza Forecasts

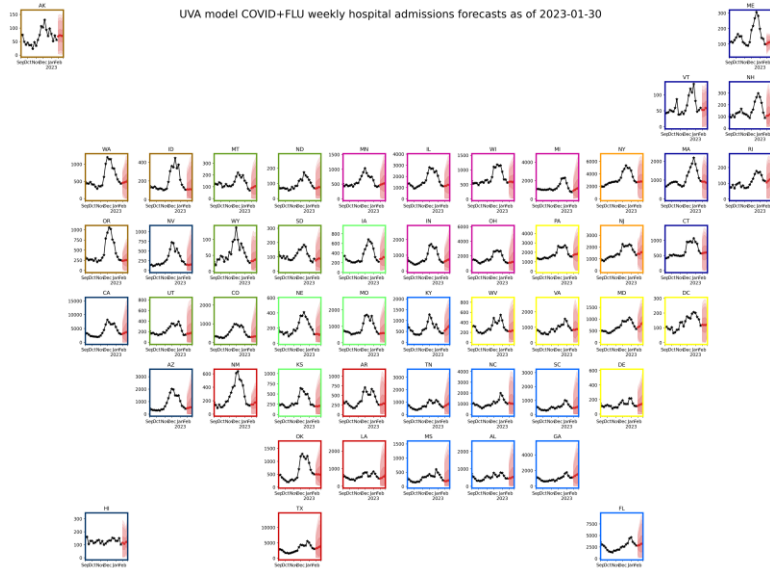
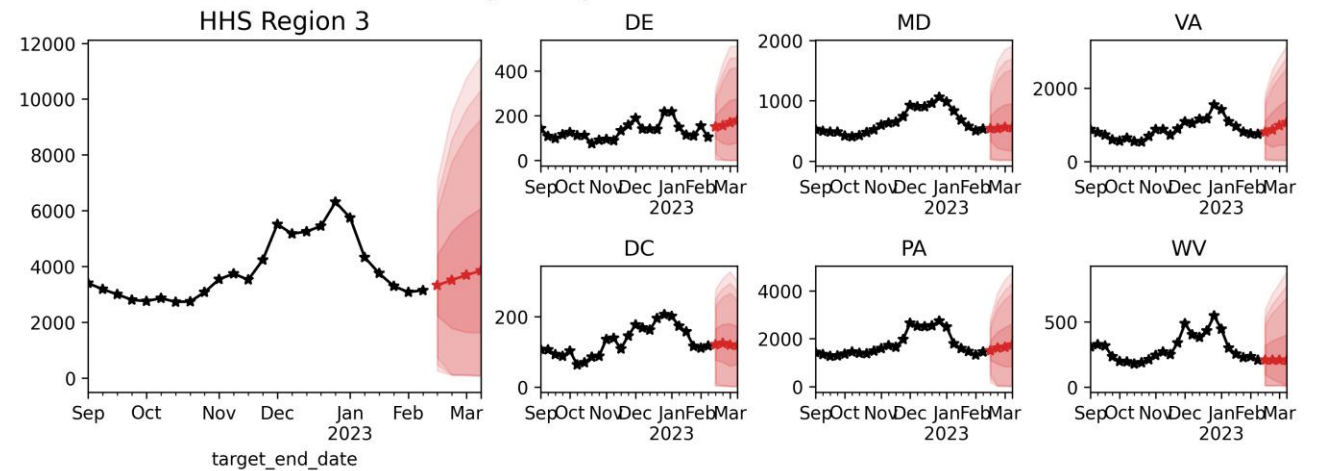


HHS Region 3

Short-term COVID-19 and Influenza Forecasts



UVA model COVID+FLU weekly hospital admissions forecasts as of 2023-02-13



Scenario Modeling Hub – COVID-19 (Round 16)

Collaboration of multiple academic teams to provide national and state-by-state level projections for 4 aligned scenarios

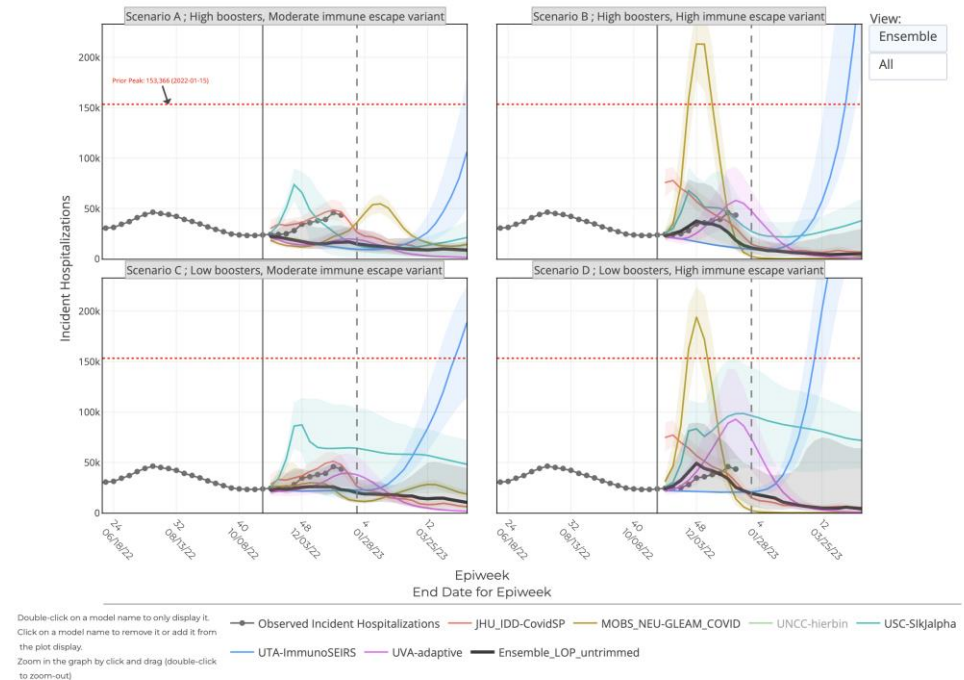
- Round 16 results published
- Moderate escape scenarios tracking best

<https://covid19scenariomodelinghub.org/viz.html>

	"Level 5" Variants	"Level 6/7" Variants
Accelerating uptake levels of reformulated boosters	<p>Scenario A</p> <p>"Level 5" Variants</p> <ul style="list-style-type: none"> - Variants have a 25% immune escape from BA.5.2 - Seeding based on combined observed prevalence of Level 5 variants at the start of the projection period - No change in severity given symptomatic infection <p>Accelerating uptake levels of reformulated boosters, with coverage plateauing at 90% of flu vaccination levels by February 1st, 2023</p> <ul style="list-style-type: none"> - Teams are free to use available data and information from current and previous rollouts as they see fit to define rates - Teams should assume increasing uptake through October and November as necessary to reach the projected February 1st, 2022 plateau 	<p>Scenario B</p> <p>"Level 6/7" Variants</p> <ul style="list-style-type: none"> - Variants have a 50% immune escape from BA.5.2 - Seeding based on combined observed prevalence of Level 6 and 7 variants at the start of the projection period - No change in severity given symptomatic infection <p>Accelerating uptake levels of reformulated boosters, with coverage plateauing at 90% of flu vaccination levels by February 1st, 2023</p> <ul style="list-style-type: none"> - Teams are free to use available data and information from current and previous rollouts as they see fit to define rates - Teams should assume increasing uptake through October and November as necessary to reach the projected February 1st, 2022 plateau
Current uptake levels of reformulated boosters	<p>Scenario C</p> <p>"Level 5" Variants</p> <ul style="list-style-type: none"> - Variants have a 25% immune escape from BA.5.2 - Seeding based on combined observed prevalence of Level 5 variants at the start of the projection period - No change in severity given symptomatic infection <p>Current uptake levels of reformulated boosters, with coverage plateauing at booster 1 levels by the end of the simulation</p> <ul style="list-style-type: none"> - Teams are free to use available data and information from current and previous rollouts as they see fit to define rates - Based on current rates, plateau date is flexible as long as it occurs before the end of the simulation (Teams can adjust rates up if needed to achieve adequate coverage by target date) 	<p>Scenario D</p> <p>"Level 6/7" Variants</p> <ul style="list-style-type: none"> - Variants have a 50% immune escape from BA.5.2 - Seeding based on combined observed prevalence of Level 6 and 7 variants at the start of the projection period - No change in severity given symptomatic infection <p>Current uptake levels of reformulated boosters, with coverage plateauing at booster 1 levels by the end of the simulation</p> <ul style="list-style-type: none"> - Teams are free to use available data and information from current and previous rollouts as they see fit to define rates - Based on current rates, plateau date is flexible as long as it occurs before the end of the simulation (Teams can adjust rates up if needed to achieve adequate coverage by target date)

17-Feb-23

Projected Incident Hospitalizations by Epidemiological Week and by Scenario for Round 16 - US
(- Projection Epiweek - Current Week)



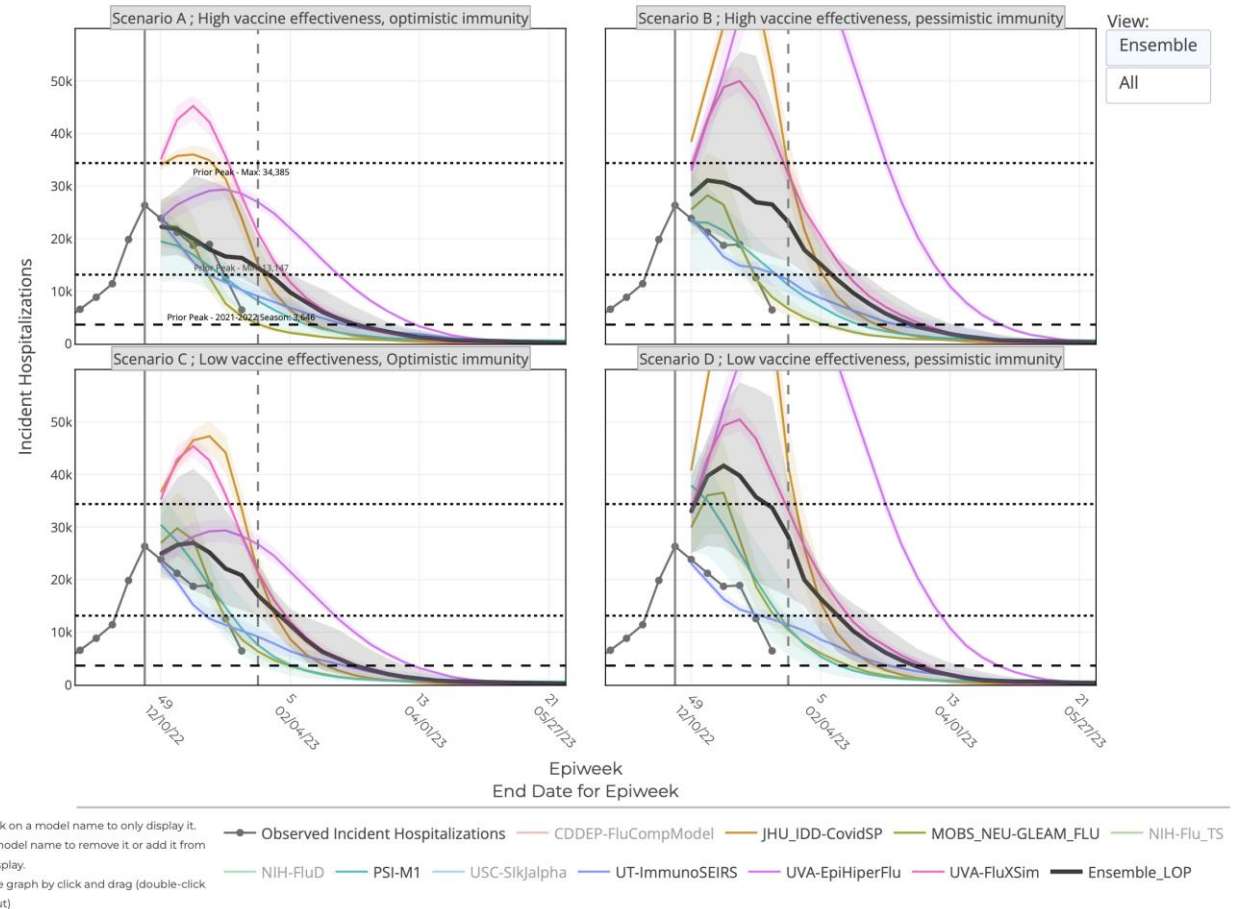
Scenario Modeling Hub – Influenza (Round 3)

Collaboration of multiple academic teams to provide national and state-by-state level projections for 4 aligned scenarios

- All rounds so far have explored the combination of a prior immunity axis and a vaccine effectiveness axis
- Round 2 and 3 are identical in design (Round 3 cutoff December 3rd)

<https://fluscenariomodelinghub.org/viz.html>

Projected Incident Hospitalizations by Epidemiological Week and by Scenario for Round 3 - US
(- Projection Epiweek; -- Current Week)



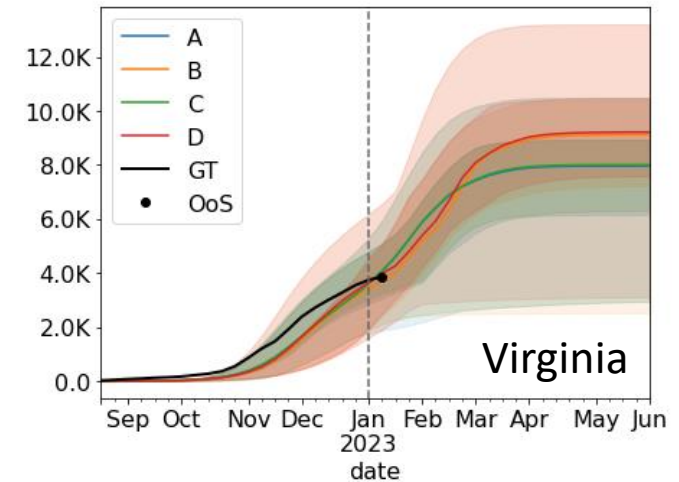
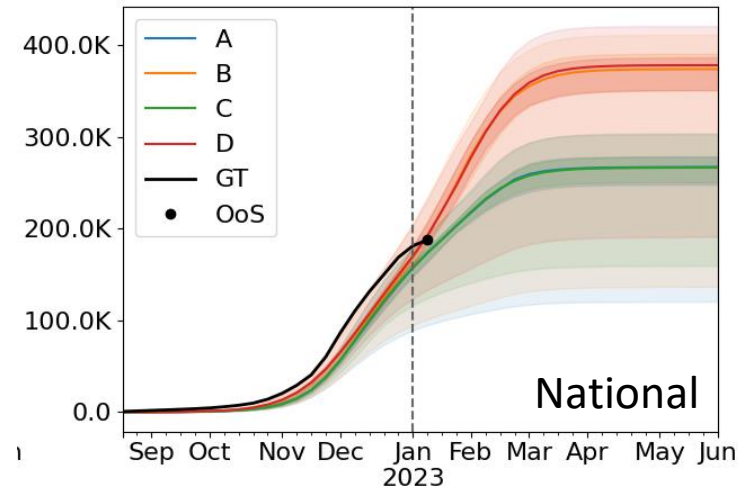
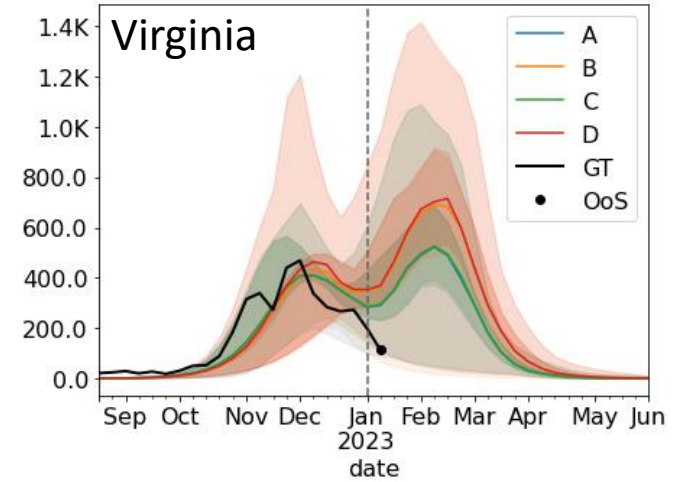
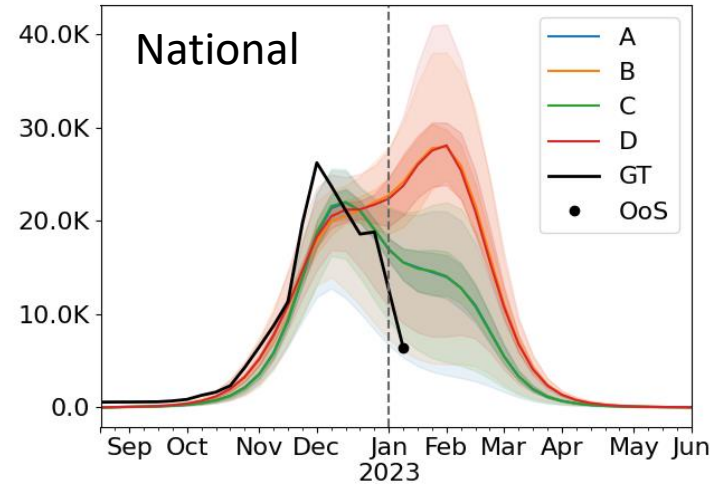
	Optimistic flu prior immunity	Pessimistic flu prior immunity
High Vaccine Effectiveness	<p>Scenario A</p> <p>Optimistic flu prior immunity</p> <ul style="list-style-type: none"> - No impact of missed flu seasons due to the COVID-19 pandemic on prior immunity.* - Same amount of prior immunity as in a typical, pre-COVID19 pandemic prior season. <p>High Vaccine Effectiveness</p> <ul style="list-style-type: none"> - VE = 50% against medically attended influenza illnesses and hospitalizations (comparable to 2015-16 season). 	<p>Scenario B</p> <p>Pessimistic flu prior immunity</p> <ul style="list-style-type: none"> - Substantial impact of missed flu seasons due to the COVID-19 pandemic on prior immunity.* - 50% lower immunity than a typical, pre-COVID19 pandemic season. <p>High Vaccine Effectiveness</p> <ul style="list-style-type: none"> - VE = 50% against medically attended influenza illnesses and hospitalizations (comparable to 2015-16 season).
Low Vaccine Effectiveness	<p>Scenario C</p> <p>Optimistic flu prior immunity</p> <ul style="list-style-type: none"> - No impact of missed flu seasons due to the COVID-19 pandemic on prior immunity.* - Same amount of prior immunity as in a typical, pre-COVID19 pandemic prior season. <p>Low Vaccine Effectiveness</p> <ul style="list-style-type: none"> - VE = 30% against medically attended influenza illnesses and hospitalizations (comparable to 2018-19 season). 	<p>Scenario D</p> <p>Pessimistic flu prior immunity</p> <ul style="list-style-type: none"> - Substantial impact of missed flu seasons due to the COVID-19 pandemic on prior immunity.* - 50% lower immunity than a typical, pre-COVID19 pandemic season. <p>Low Vaccination Protection</p> <ul style="list-style-type: none"> - VE = 30% against medically attended influenza illnesses and hospitalizations (comparable to 2018-19 season).

Scenario Modeling Hub – Influenza

(UVA Update to Round 3)

Collaboration of multiple academic teams to provide national and state-by-state level projections for 4 aligned scenarios

- Update with more data (until Jan 7th)
- No scenarios seem to fully explain season's trajectory



	Optimistic flu prior immunity	Pessimistic flu prior immunity
High Vaccine Effectiveness	<p>Scenario A</p> <p>Optimistic flu prior immunity - No impact of missed flu seasons due to the COVID-19 pandemic on prior immunity.* - Same amount of prior immunity as in a typical, pre-COVID19 pandemic prior season.</p> <p>High Vaccine Effectiveness - VE = 50% against medically attended influenza illnesses and hospitalizations (comparable to 2015-16 season).</p>	<p>Scenario B</p> <p>Pessimistic flu prior immunity - Substantial impact of missed flu seasons due to the COVID-19 pandemic on prior immunity.* - 50% lower immunity than a typical, pre-COVID19 pandemic season.</p> <p>High Vaccine Effectiveness - VE = 50% against medically attended influenza illnesses and hospitalizations (comparable to 2015-16 season).</p>
Low Vaccine Effectiveness	<p>Scenario C</p> <p>Optimistic flu prior immunity - No impact of missed flu seasons due to the COVID-19 pandemic on prior immunity.* - Same amount of prior immunity as in a typical, pre-COVID19 pandemic prior season.</p> <p>Low Vaccine Effectiveness - VE = 30% against medically attended influenza illnesses and hospitalizations (comparable to 2018-19 season).</p>	<p>Scenario D</p> <p>Pessimistic flu prior immunity - Substantial impact of missed flu seasons due to the COVID-19 pandemic on prior immunity.* - 50% lower immunity than a typical, pre-COVID19 pandemic season.</p> <p>Low Vaccination Protection - VE = 30% against medically attended influenza illnesses and hospitalizations (comparable to 2018-19 season).</p>

Key Takeaways

Projecting future cases precisely is impossible and unnecessary.

Even without perfect projections, we can confidently draw conclusions:

- Case rates and hospitalizations from COVID-19 have been on decline for weeks, though the rate of decline seems to be slowing
- Case rates and hospitalizations from Influenza are basically non-existent, though some Influenza B is being seen in labs which could spur some additional activity
- Model Updates
 - Projection model updated this week, two new non-specific scenarios added related to increases in transmissibility.
 - Boosted transmissibility can generate new surge in activity and keep levels above Summer 2022 levels through the Spring

Questions?

Biocomplexity COVID-19 Response Team

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