Network Systems Science & Advanced Computing

Biocomplexity Institute & Initiative

University of Virginia

Estimation of COVID-19 Impact in Virginia

August 24th, 2022

(data current to August 20th – 23rd)

Biocomplexity Institute Technical report: TR BI-2022-1700

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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 COVID-19 mitigations in Virginia
- **Approach:**
  - Calibrate explanatory mechanistic model to observed cases
  - Project based on scenarios for next 4 months
  - Consider a range of possible mitigation effects in "what-if" scenarios
- **Outcomes:**
  - Ill, Confirmed, Hospitalized, ICU, Ventilated, Death
  - Geographic spread over time, case counts, healthcare burdens

Key Takeaways

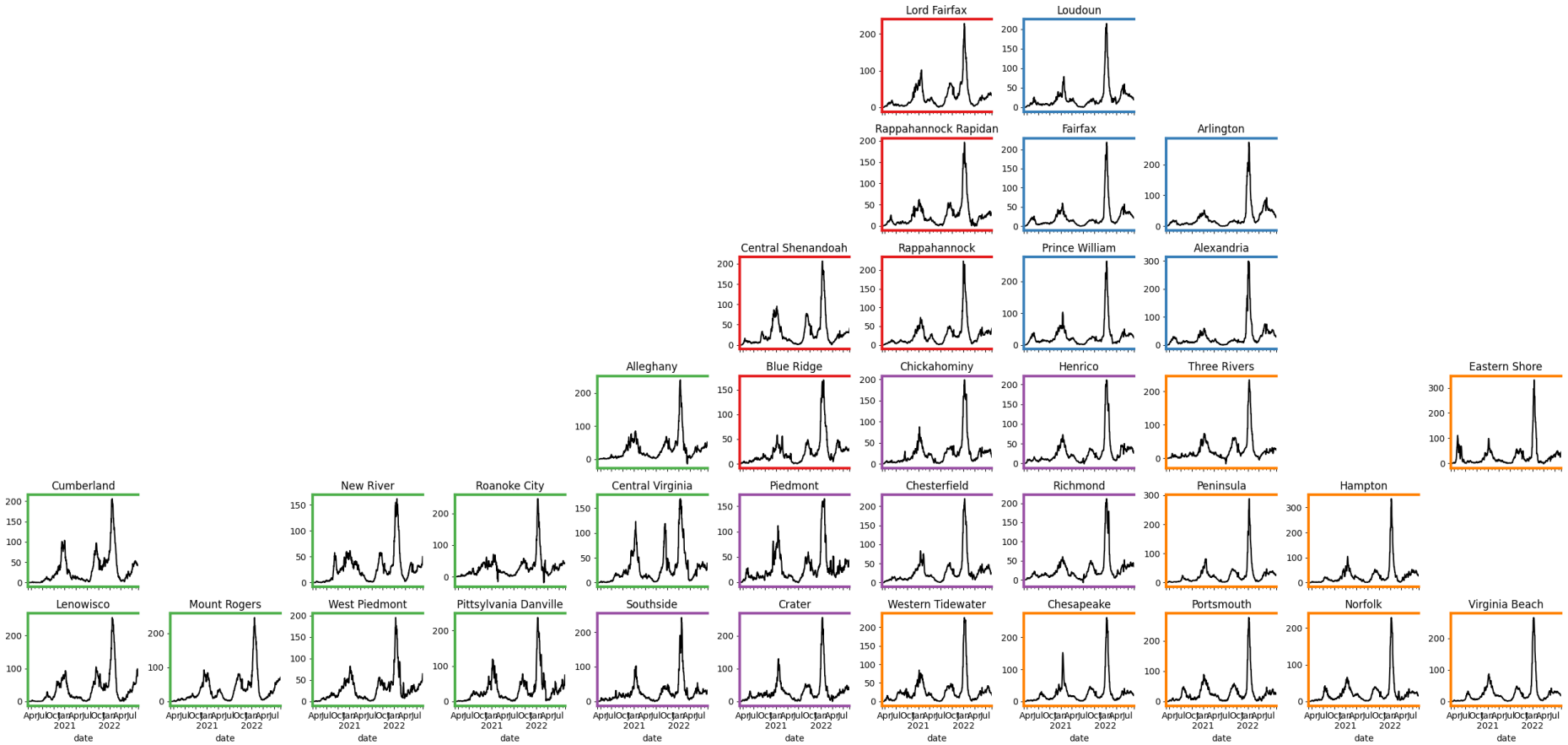
Projecting future cases precisely is impossible and unnecessary.
Even without perfect projections, we can confidently draw conclusions:

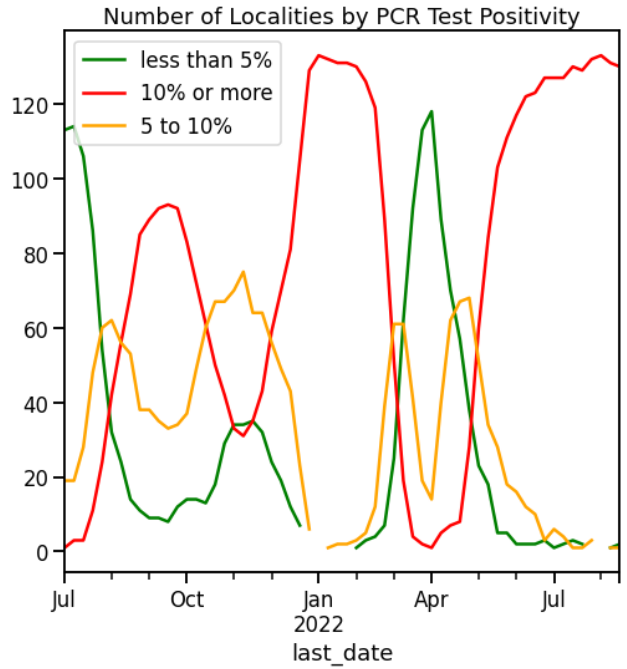
- **Case rates remain high though have continued their decline, hospitalizations have started to follow**
- VA weekly case rate down to 203/100K from 211/100K
  - US weekly case rate is down slightly as well at 189/100K from 207/100K
  - VA hospital occupancy (rolling 7 day mean of 798 slightly up from 786 a week ago) has continued to rise
- Projections anticipate continued declines in cases as well as hospitalizations
- Potential for rebounds due to seasonal forces and/or novel sub-variants in the Fall
- Impact of booster rollout timing is significant in avoiding hospitalizations

The situation continues to change. Models continue to be updated regularly.

Situation Assessment

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")

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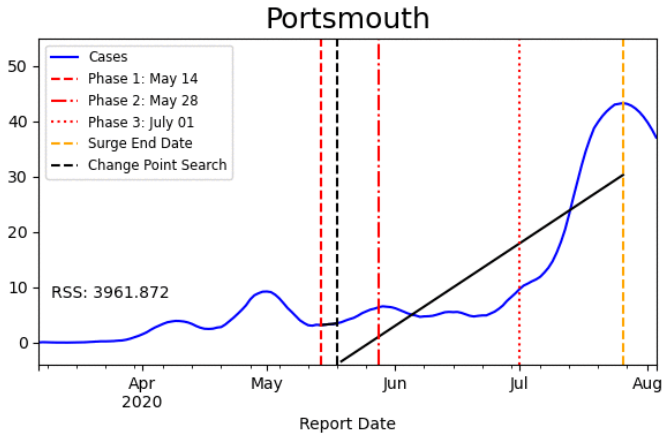
District Trajectories

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

Hockey stick fit

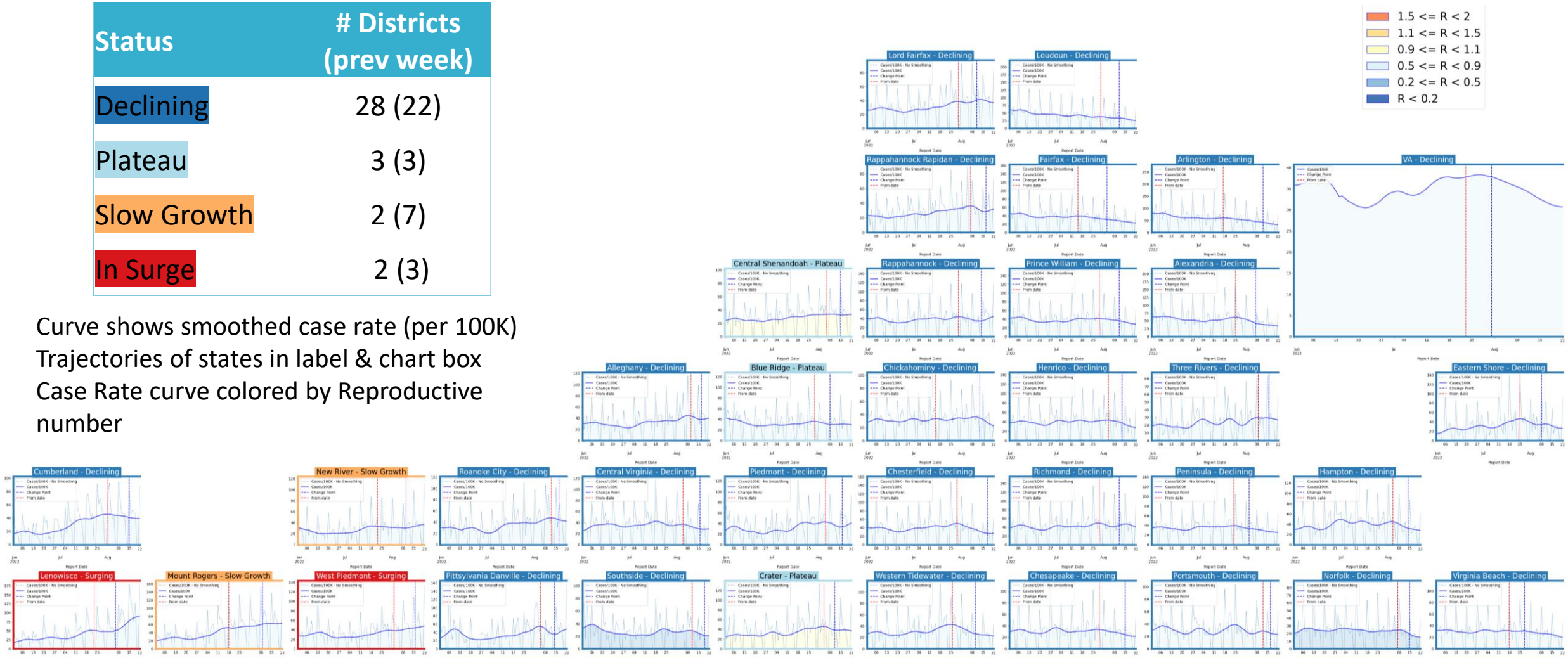


Trajectory	Description	Weekly Case Rate Slope (per 100k)	Weekly Hosp Rate Slope (per 100k)
Declining	Sustained decreases following a recent peak	slope < -0.88/day	slope < -0.07/day
Plateau	Steady level with minimal trend up or down	-0.88/day < slope < 0.42/day	-0.07/day < slope < 0.07/day
Slow Growth	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	# Districts (prev week)
Declining	28 (22)
Plateau	3 (3)
Slow Growth	2 (7)
In Surge	2 (3)

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



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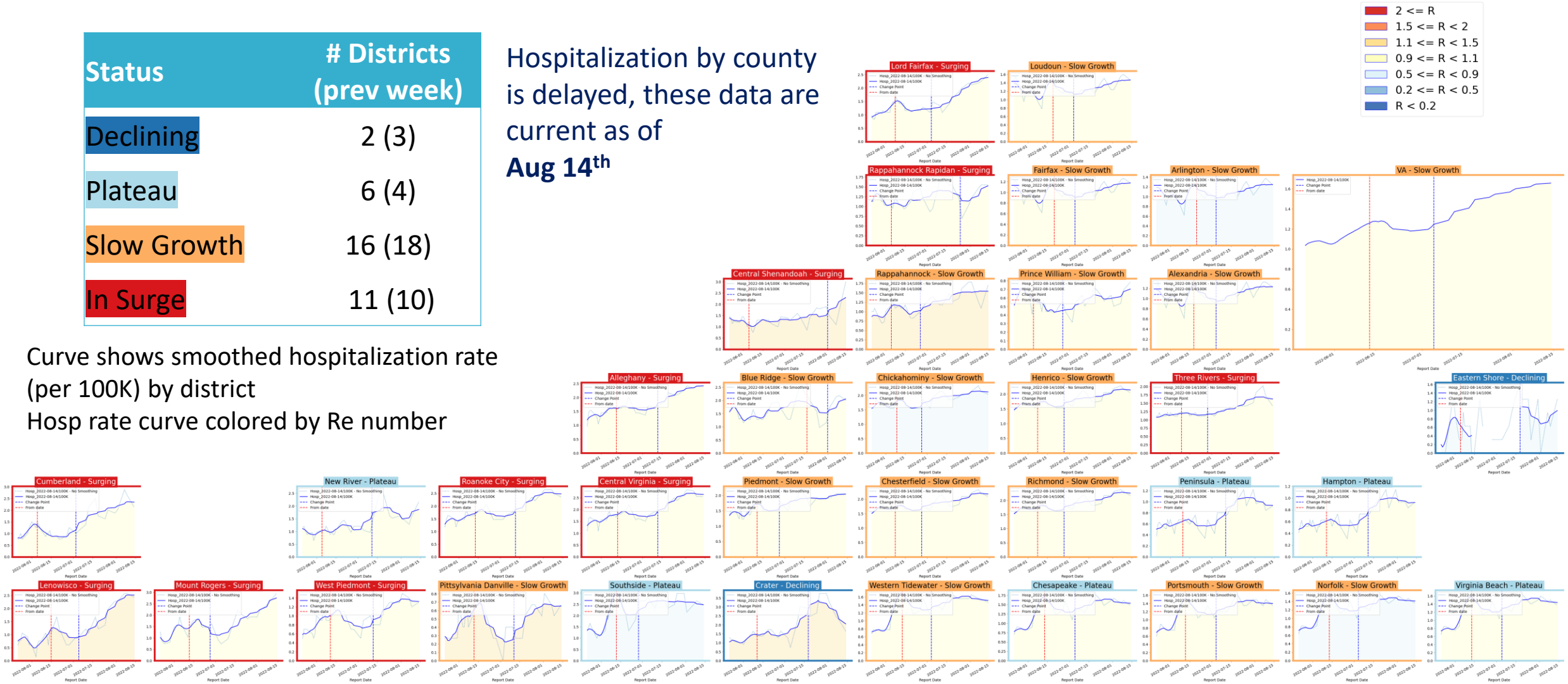
District Hospital Trajectories – last 10 weeks

Status	# Districts (prev week)
Declining	2 (3)
Plateau	6 (4)
Slow Growth	16 (18)
In Surge	11 (10)

Hospitalization by county is delayed, these data are current as of **Aug 14th**

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



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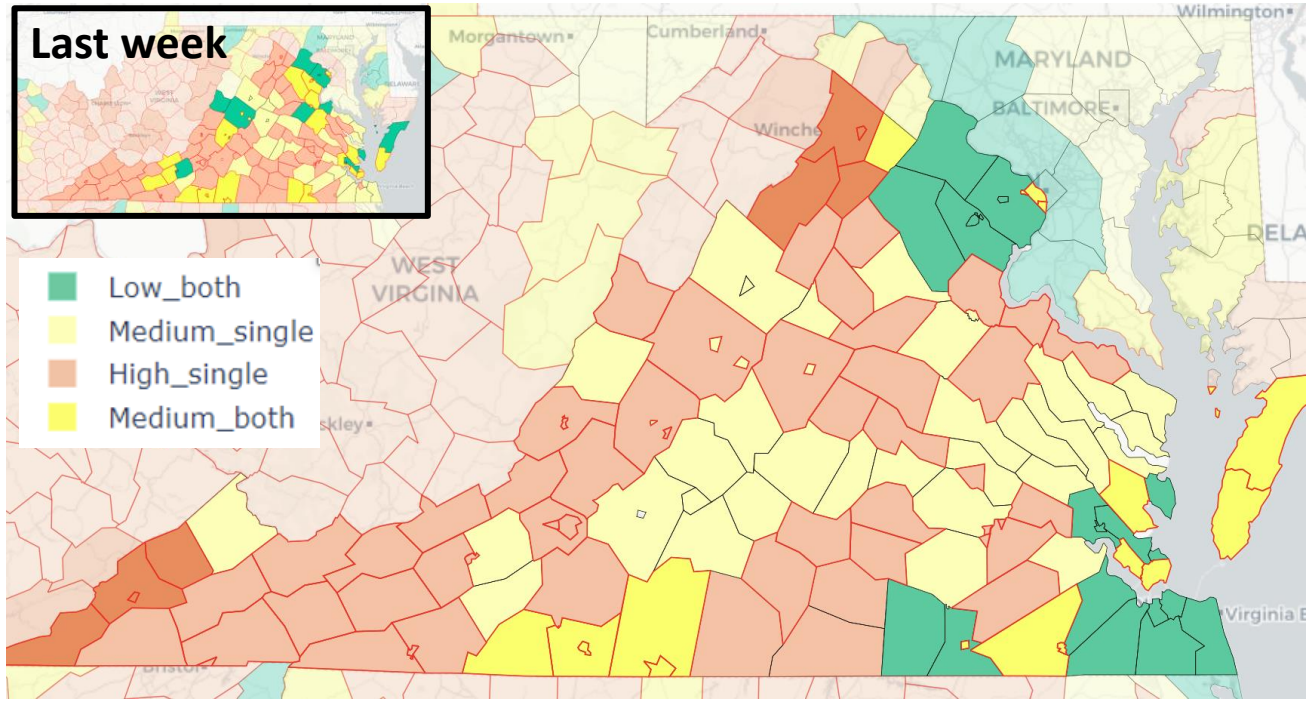
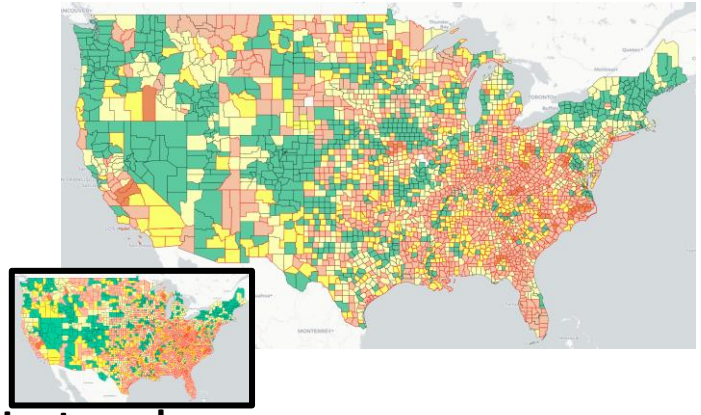
CDC's COVID-19 Community Levels

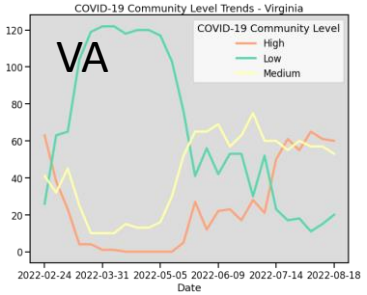


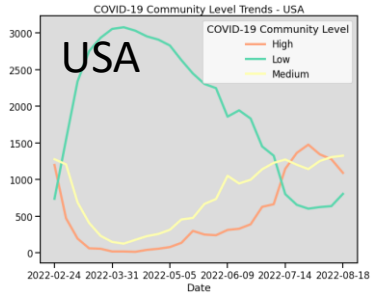
Red outline indicates county had 200 or more cases per 100k in last week

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







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

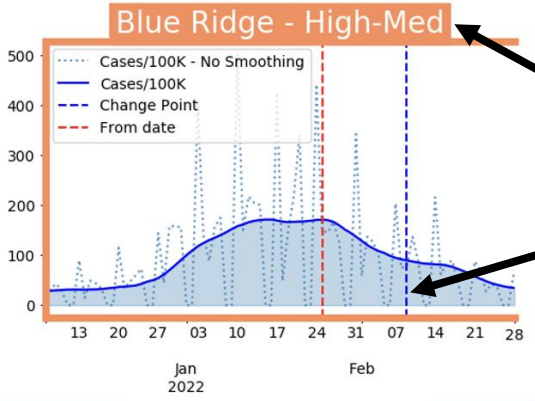
Data from: [CDC Data Tracker Portal]

District Trajectories with Community Levels

Community Level (Title Color)
- High
- High-Med
- Med-High
- Medium
- Med-Low
- Low-Med
- Low

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

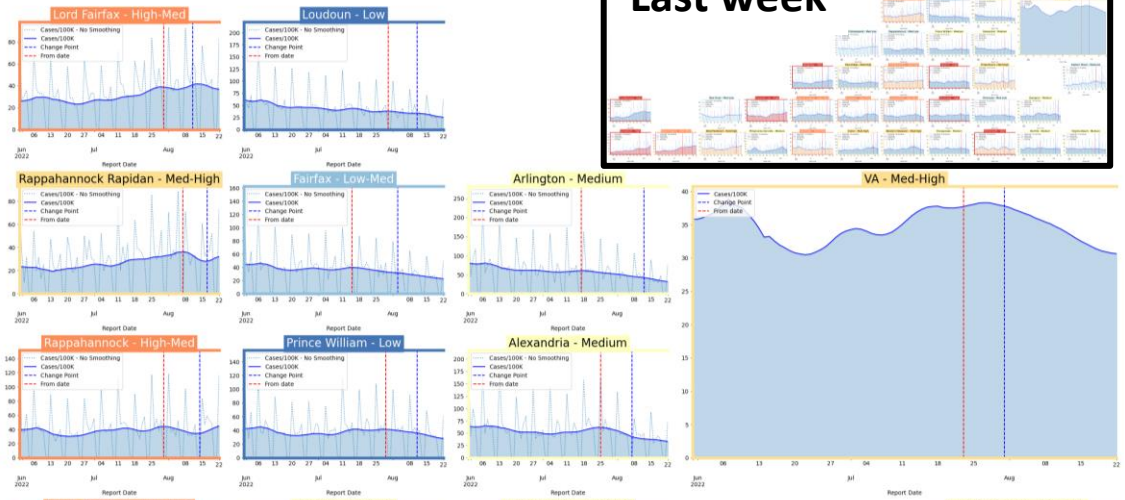
Trajectory (Curve Shading)
- In Surge
- Slow Growth
- Plateau
- Declining

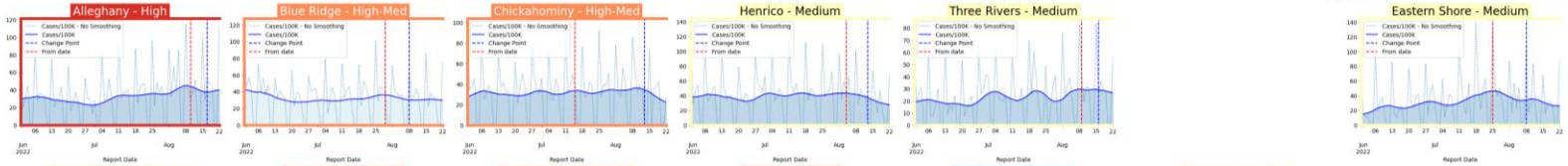


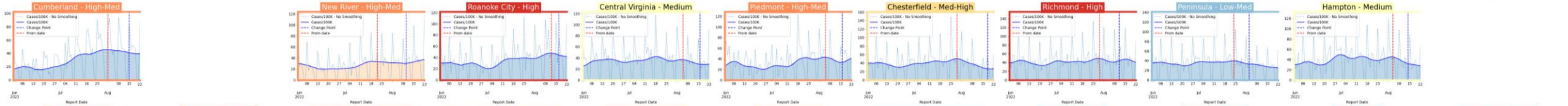
District's Aggregate Community Level

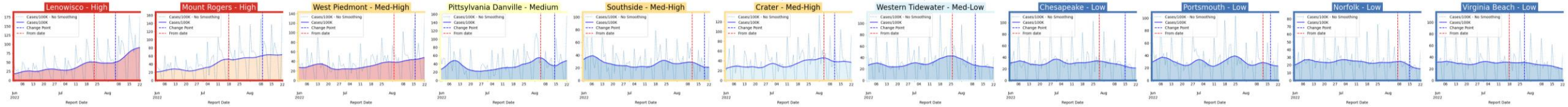
Aggregate level a simple mean of all levels for counties in district

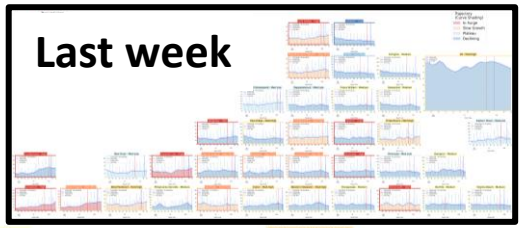
Case rate Trajectory







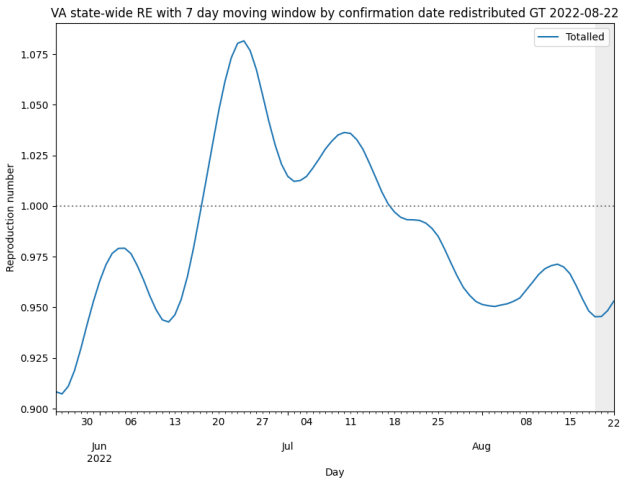


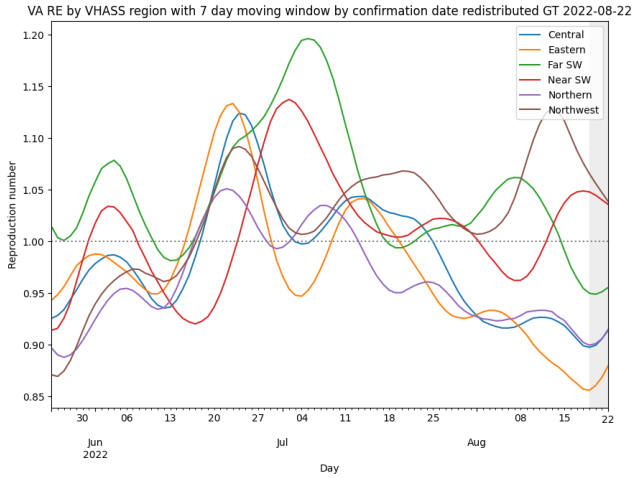


Estimating Daily Reproductive Number –
Redistributed gap

August 22nd Estimates

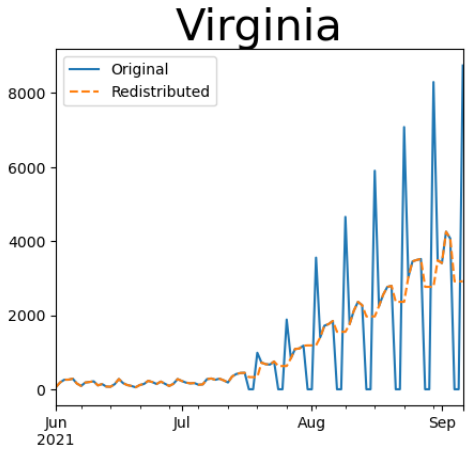
Region	Date Confirmed R_e	Date Confirmed Diff Last Week
State-wide	0.953	0.050
Central	0.915	0.049
Eastern	0.880	-0.013
Far SW	0.956	-0.027
Near SW	1.036	0.105
Northern	0.914	0.029
Northwest	1.039	0.096





Skipping Weekend Reports & holidays biases estimates

Redistributed "big" report day to fill in gaps, and then estimate R from "smoothed" time series



Methodology

- Wallinga-Teunis method (EpiEstim[1]) for cases by **confirmation date**
- Serial interval: updated to discrete distribution from observations (mean=4.3, Flaxman et al, Nature 2020)
- Using Confirmation date since due to increasingly unstable estimates from onset date due to backfill

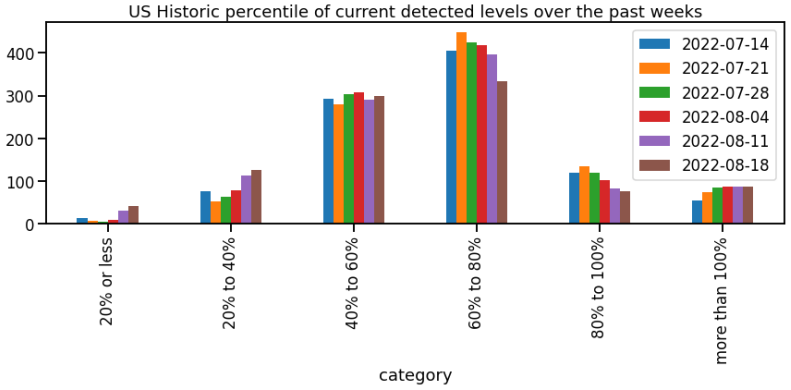
1. Anne Cori, Neil M. Ferguson, Christophe Fraser, Simon Cauchemez. A New Framework and Software to Estimate Time-Varying Reproduction Numbers During Epidemics. American Journal of Epidemiology, Volume 178, Issue 9, 1 November 2013, Pages 1505–1512, https://doi.org/10.1093/aje/kwt133

Wastewater Monitoring

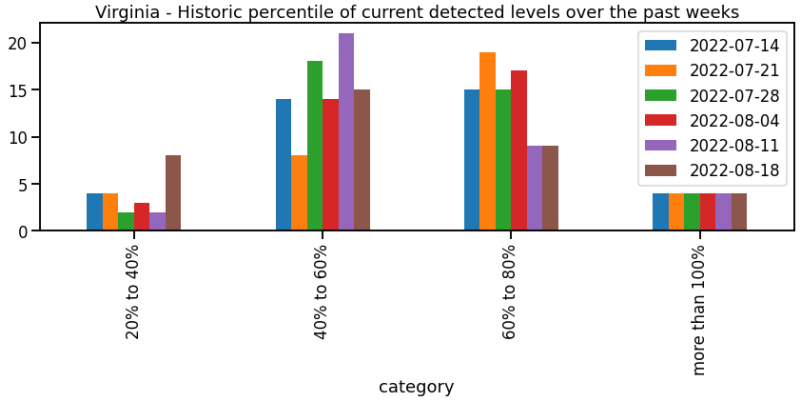
Wastewater provides a coarse early warning of COVID-19 levels in communities

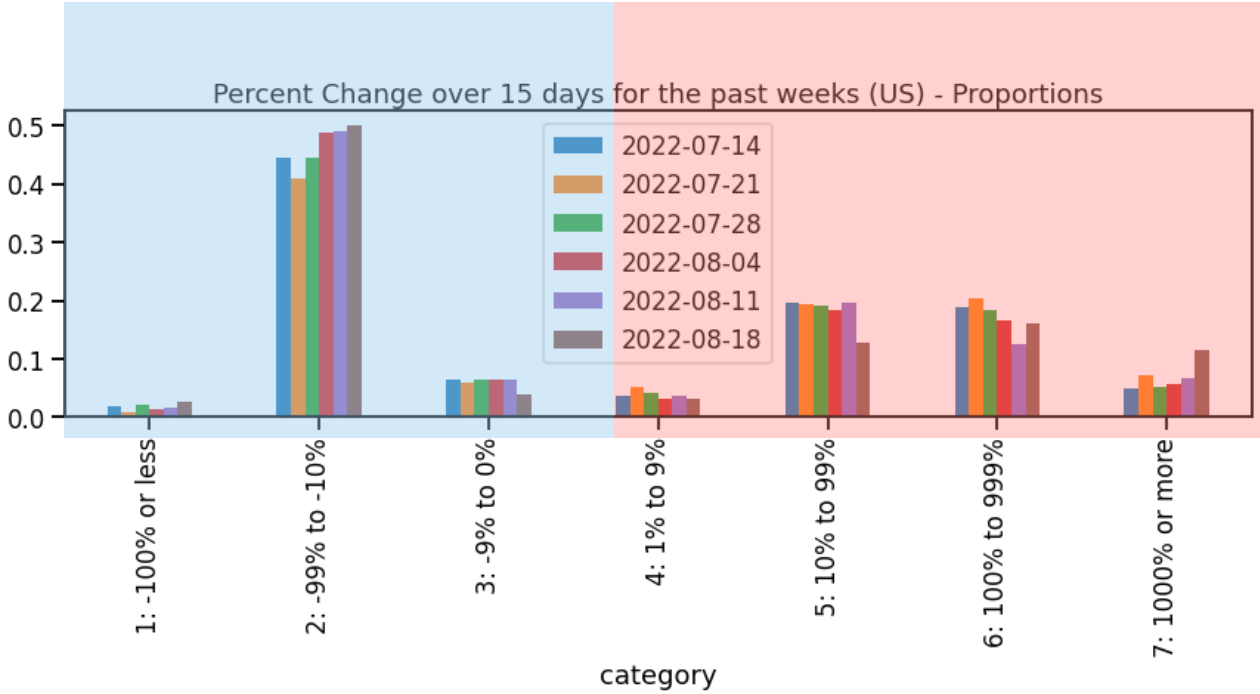
- Overall in the US, there is an increase in sites with increased levels of virus compared to 15 days ago
- Current virus levels are at or exceeding max of previous historical levels, has slowed, though more sites are entering upper quintiles

USA



VA



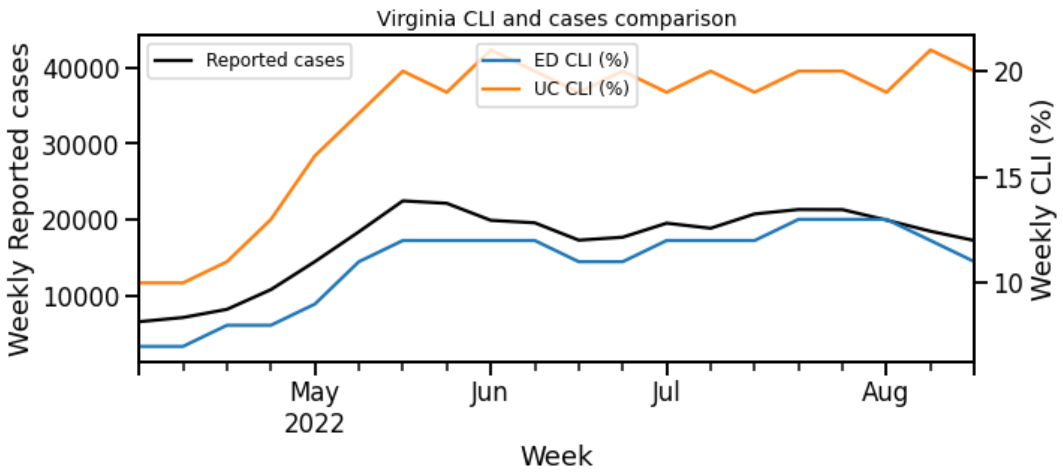


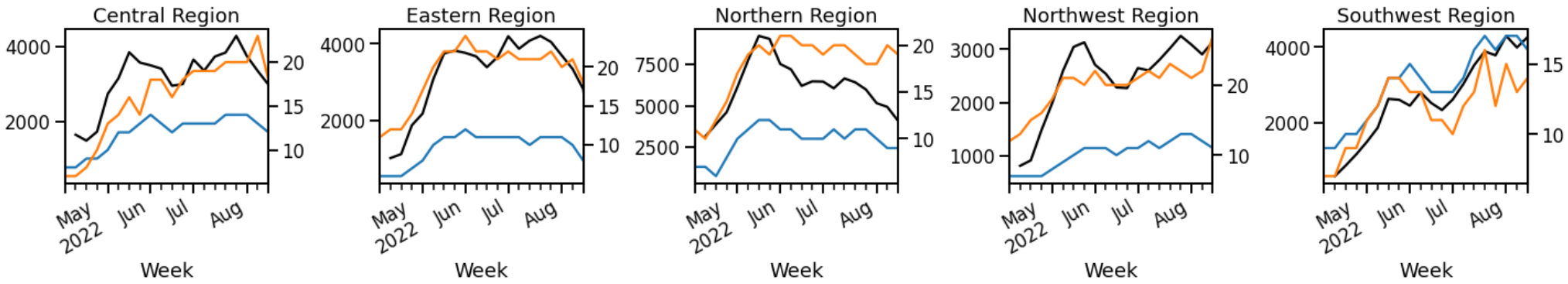
Data Source: [CDC Data Tracker]

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 prone to some false positives
- **Current trends in UC CLI have plateaued for nearly 14 weeks state-wide with some regional signs of decline**

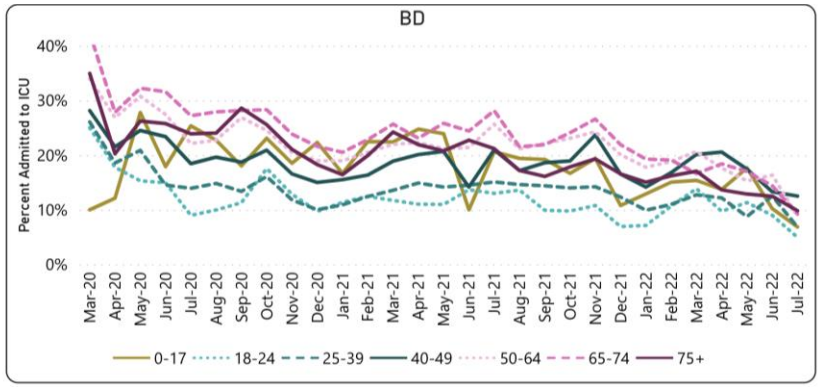


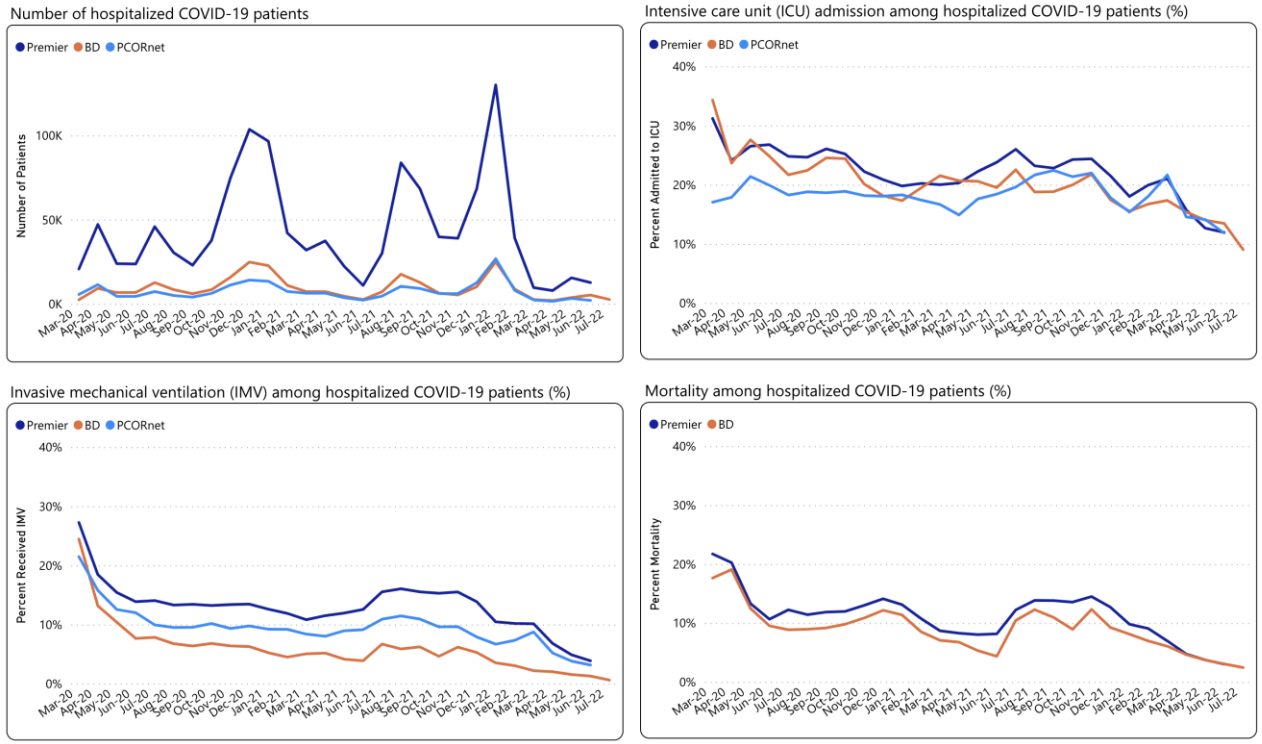


Hospitalizations and Severe Outcomes

Proportion of most severe outcomes decreasing among those who are hospitalized

- ICU has declined from ~20% of hospitalized to nearly 10% since the first wave of Omicron
- Similar levels of decline experienced for mechanical ventilation and death
- Also seen across all age-groups

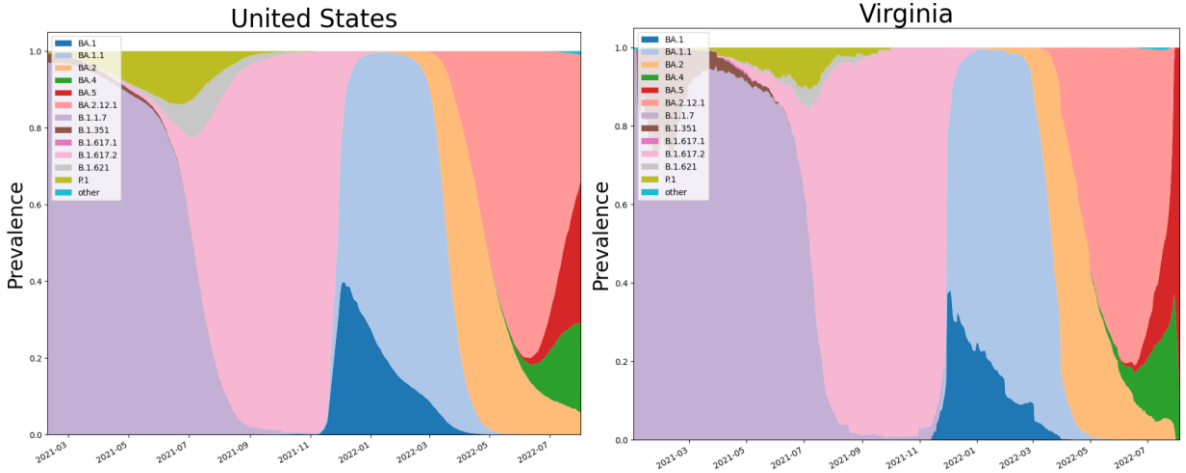




Data Source: [CDC Data Tracker]

SARS-CoV2 Variants of Concern

GISAID outbreak.info



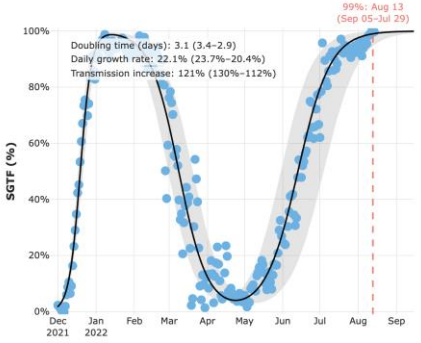
Emerging new variants will alter the future trajectories of pandemic and have implications for future control

- **Emerging variants can:** Increase transmissibility, increase severity (more hospitalizations and/or deaths), and limit immunity provided by prior infection and vaccinations

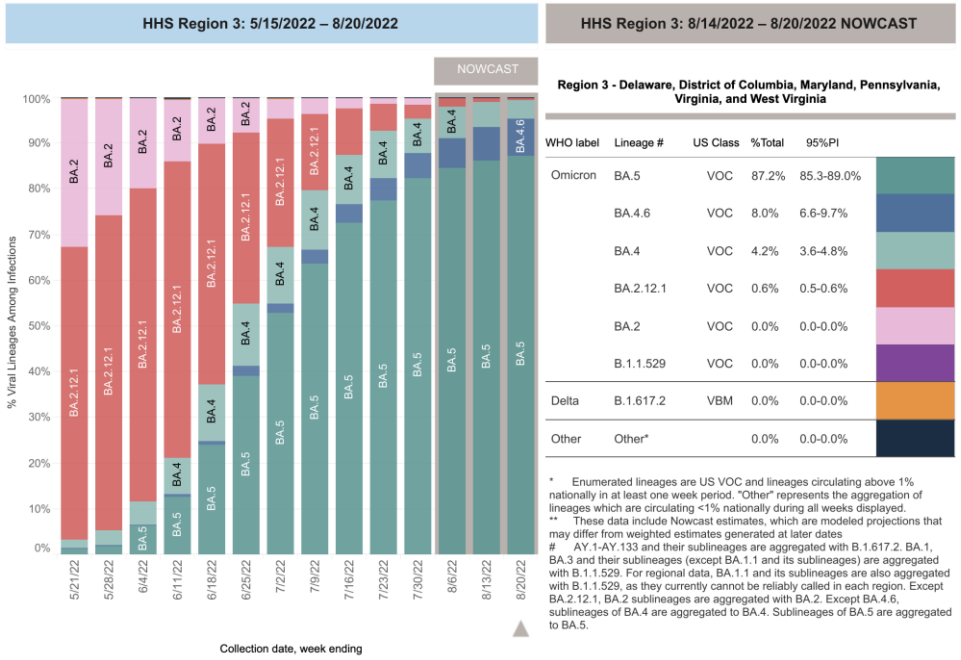
Omicron Updates

- BA.2.12.1 now less than 1%
- BA.4 has shrunk to ~4%, with BA.4.6 growing to about 8%
- BA.5 continues to hold ground, nowcasted at 87%
- BA.4 and BA.5 have same mutation as BA.1 that produces S-gene target failure, so can be tracked in more real time with SGTF from some PCR tests, will continue to monitor for signs of BA.2.x which lacks the mutation, thus should decline if these sub-variants return (e.g., BA.2.75 which has been growing in Europe)

SGTF in San Diego



Estimated to be ~99%



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

WHO label	Lineage #	US Class	%Total	95%PI
Omicron	BA.5	VOC	87.2%	85.3-89.0%
	BA.4.6	VOC	8.0%	6.6-9.7%
	BA.4	VOC	4.2%	3.6-4.8%
	BA.2.12.1	VOC	0.6%	0.5-0.6%
	BA.2	VOC	0.0%	0.0-0.0%
	B.1.1.529	VOC	0.0%	0.0-0.0%
Delta	B.1.617.2	VBM	0.0%	0.0-0.0%
Other	Other*		0.0%	0.0-0.0%

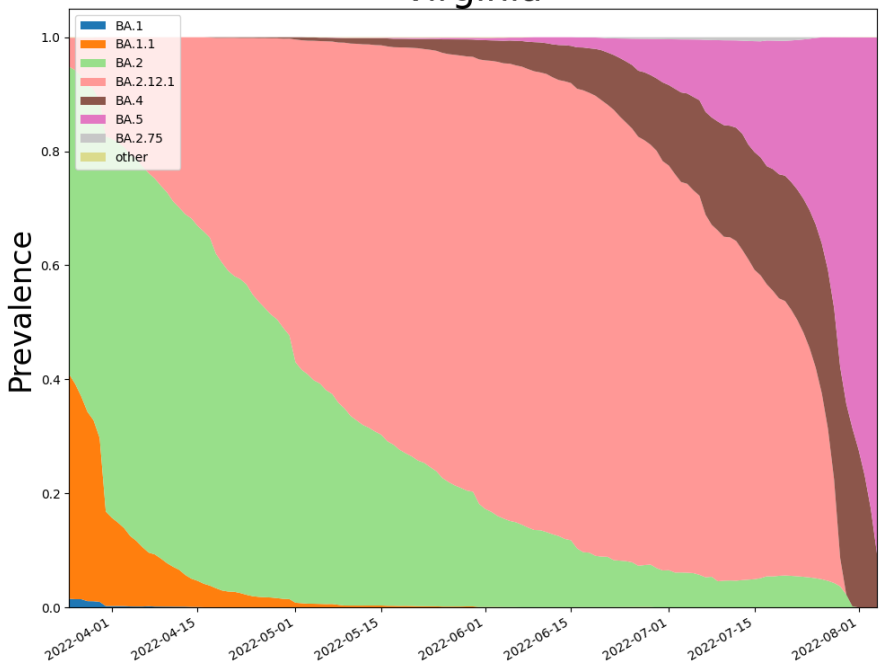
* Enumerated lineages are US VOC and lineages circulating above 1% nationally in at least one week period. "Other" represents the aggregation of lineages which are circulating <1% nationally during all weeks displayed.
** These data include Nowcast estimates, which are modeled projections that may differ from weighted estimates generated at later dates
\# AY.1-AY.133 and their sublineages are aggregated with B.1.617.2. BA.1, BA.3 and their sublineages (except BA.1.1 and its sublineages) are aggregated with B.1.1.529. For regional data, BA.1.1 and its sublineages are also aggregated with B.1.1.529, as they currently cannot be reliably called in each region. Except BA.2.12.1, BA.2 sublineages are aggregated with BA.2. Except BA.4.6, sublineages of BA.4 are aggregated to BA.4. Sublineages of BA.5 are aggregated to BA.5.

CDC Variant Tracking

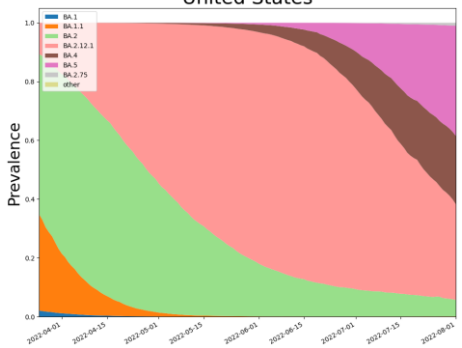
SARS-CoV2 Omicron and Sub-Variants

As detected in whole Genomes in public repositories

Virginia

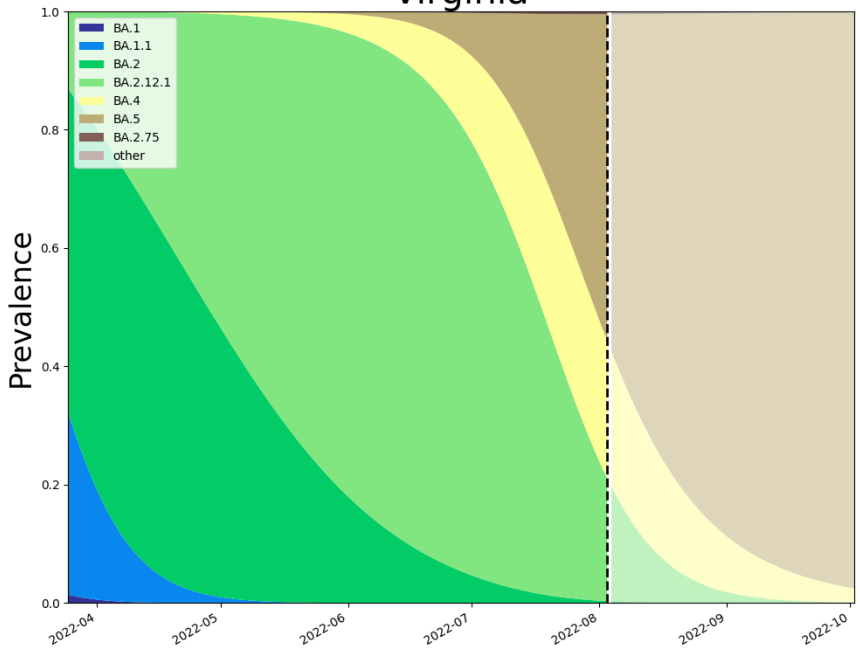


United States

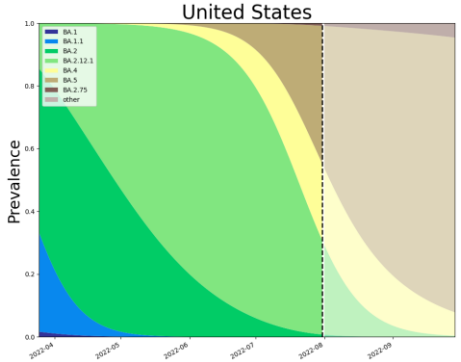


VoC Polynomial Fit Projections

Virginia



United States



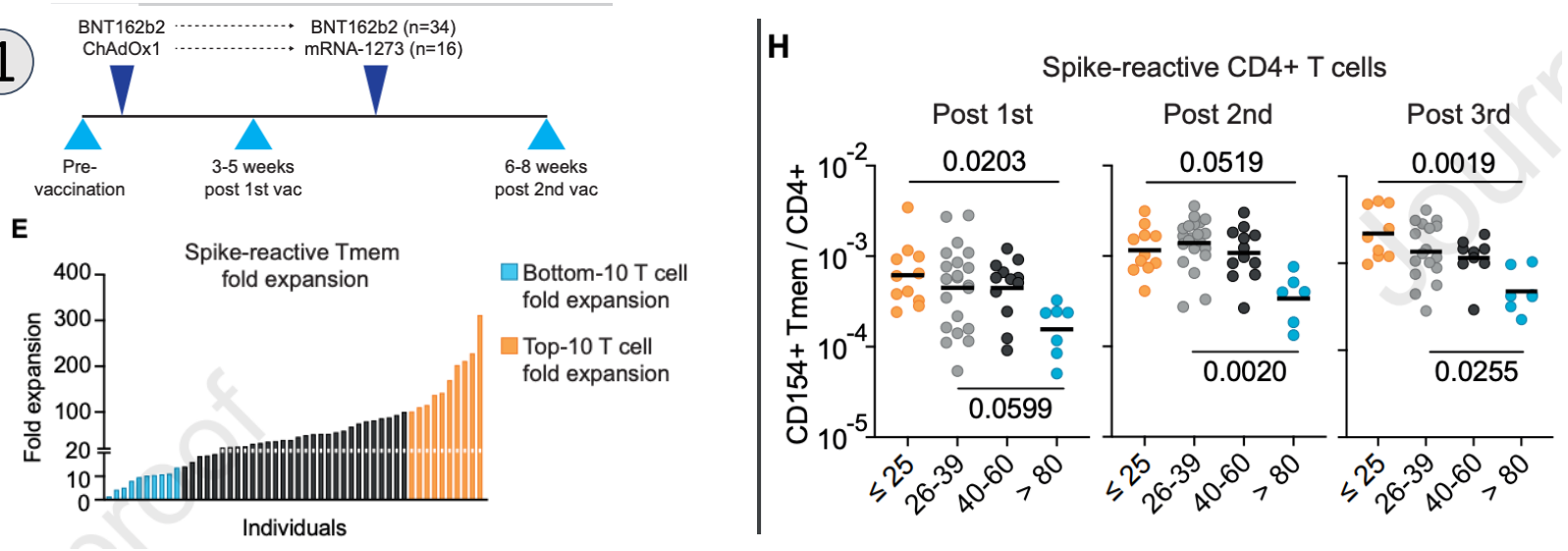
Note: Data lags force projections to start in past. Everything from dotted line forward is a projection.

GISAID outbreak.info

Pandemic Pubs

1. Elderly defect in CD4+ T cell repertoire causes age-dependent decline of immune response quality against SARS-CoV-2
2. Swiss study indicates high quality respirators significantly reduce work-related risk for HCW due to COVID-19
3. SARS-CoV-2 spike antigen in a majority of PASC patients
up to 12 months post-diagnosis, suggesting the presence of an active persistent SARSCoV-2 viral reservoir

1



New study from researchers in Germany highlight the need for alternative strategies to induce high-quality T cell responses against newly arising pathogens in the elderly. Analyzed the SARS-CoV-2 spike protein specific CD4+ T cell response before and after vaccination in 50 SARS-CoV-2-naive individuals, confirmed by being negative for SARS-CoV-2 IgG pre-vaccination
https://www.cell.com/immunity/fulltext/S1074-7613(22)00396-X#relatedArticles

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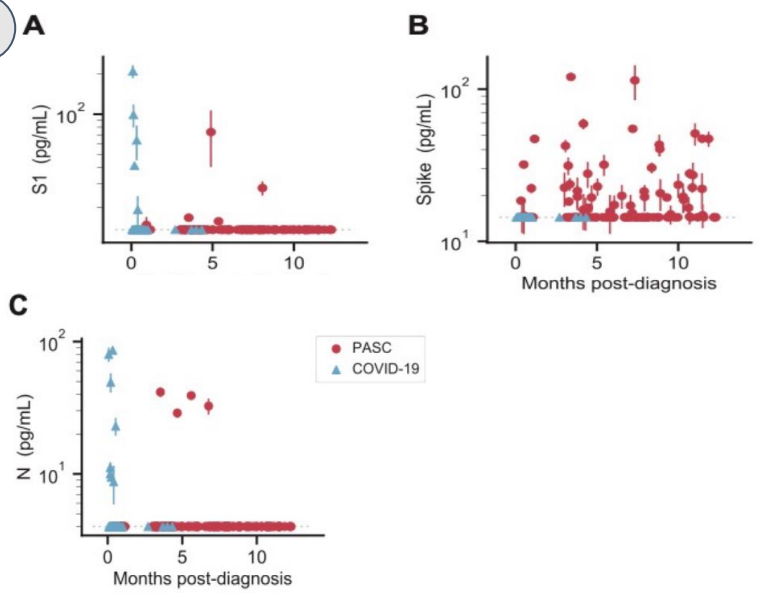

Harvard researchers analyzed plasma samples collected from a cohort of PASC and COVID-19 patients (n = 63) to quantify circulating viral antigens and inflammatory markers. Strikingly, we detect SARS-CoV-2 spike antigen in a majority of PASC patients up to 12 months post-diagnosis, suggesting the presence of an active persistent SARSCoV-2 viral reservoir. Furthermore, temporal antigen profiles for many patients show the presence of spike at multiple time points over several months, highlighting the potential utility of the SARS-CoV-2 full spike protein as a biomarker for PASC.
https://www.medrxiv.org/content/10.1101/2022.06.14.22276401v1

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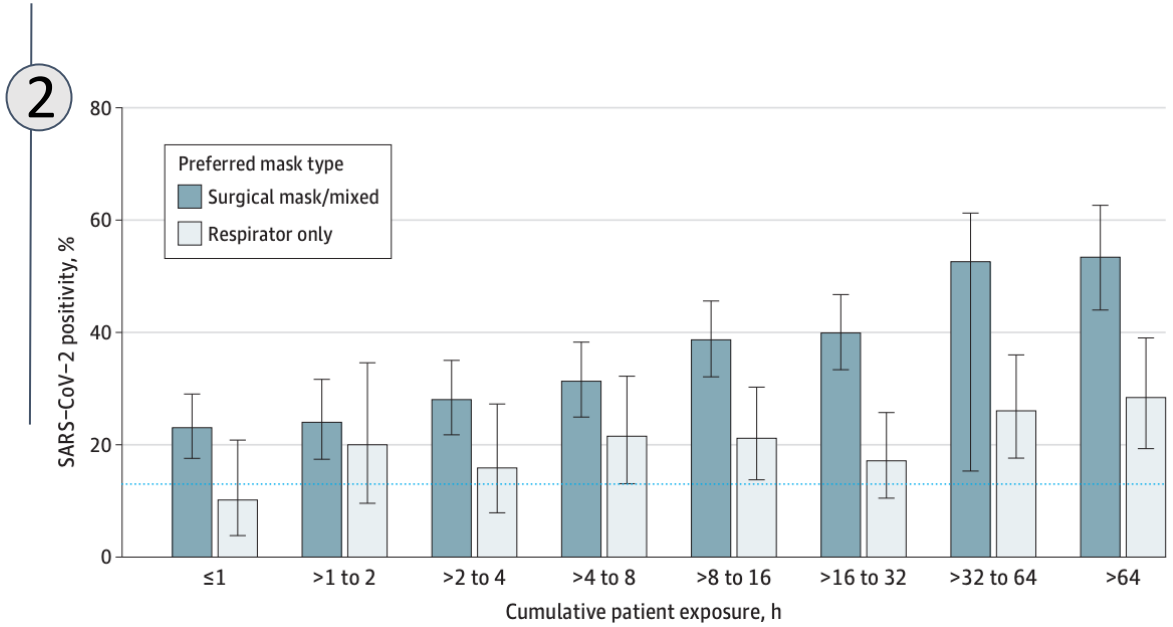
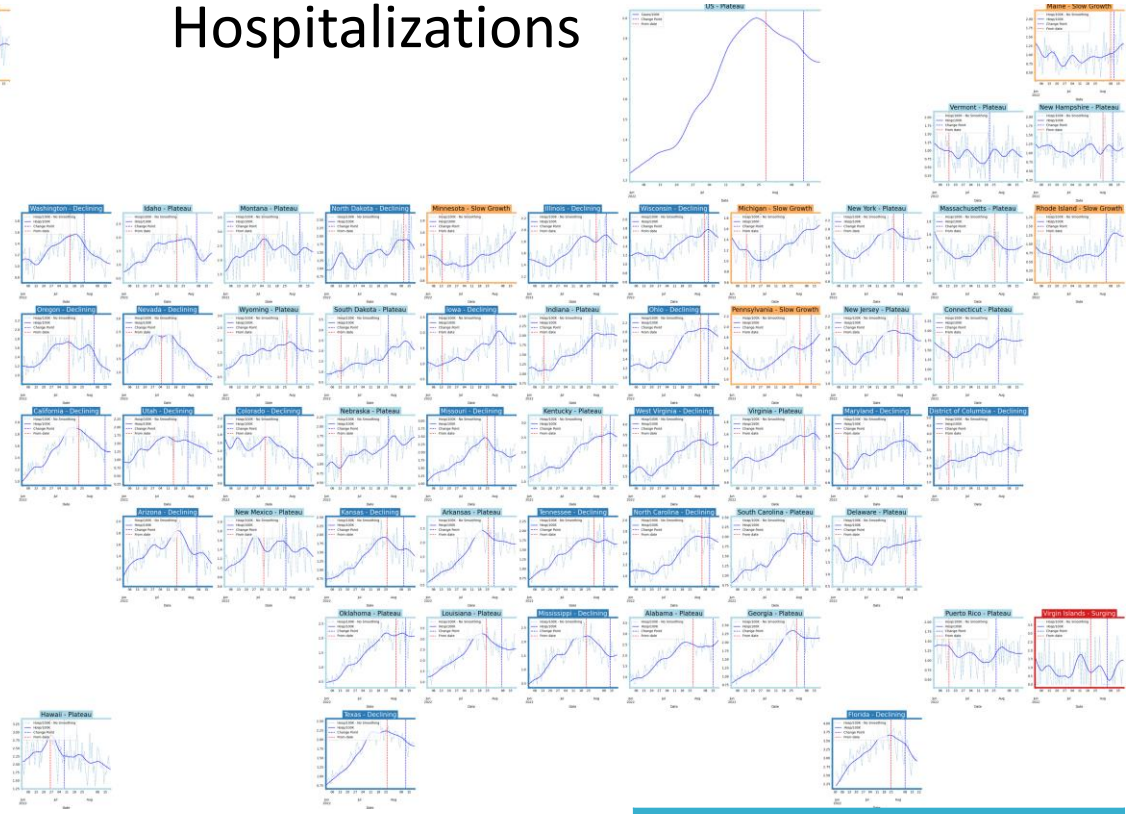


2919 HCWs (median age, 43 years (range, 18-73 years); 749 participants (26%) were infected with SARS-CoV-2. SARS-CoV-2 positivity was 13% in HCWs without patient exposure. For those exposed to patients, positivity was 21% for HCWs using respirator masks and 35% for those using surgical/mixed masks (OR, 0.49; 95% CI, 0.39-0.61), showing an increase for surgical/mixed mask users (OR, 1.21; 95% CI, 1.15-1.28) and respirator mask users (OR, 1.15; 95% CI, 1.05-1.27) across categories of patient exposure
https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2795150

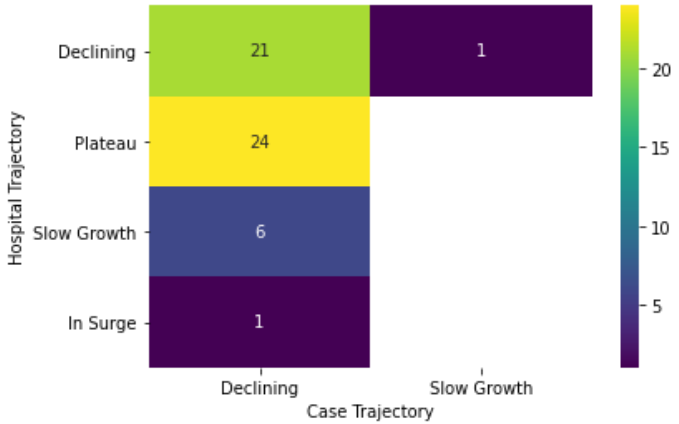
United States Case & Hospitalizations

Cases

Hospitalizations



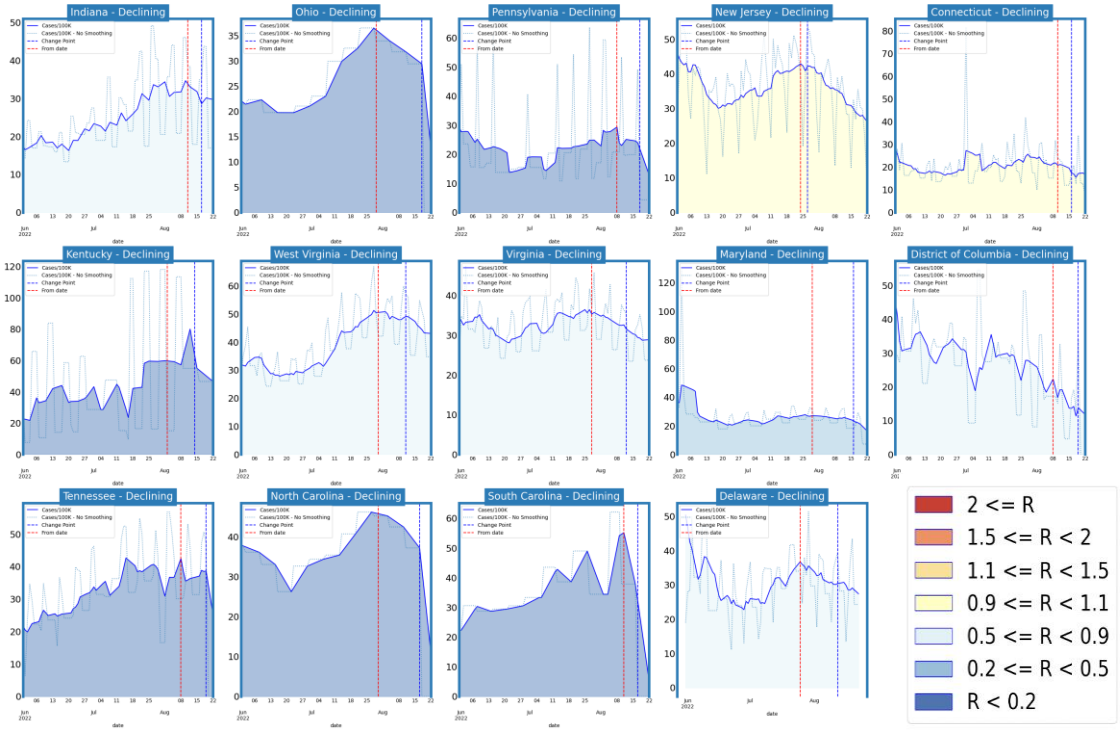
Status	# States
Declining	53 (51)
Plateau	0 (2)
Slow Growth	1 (1)
In Surge	0 (0)



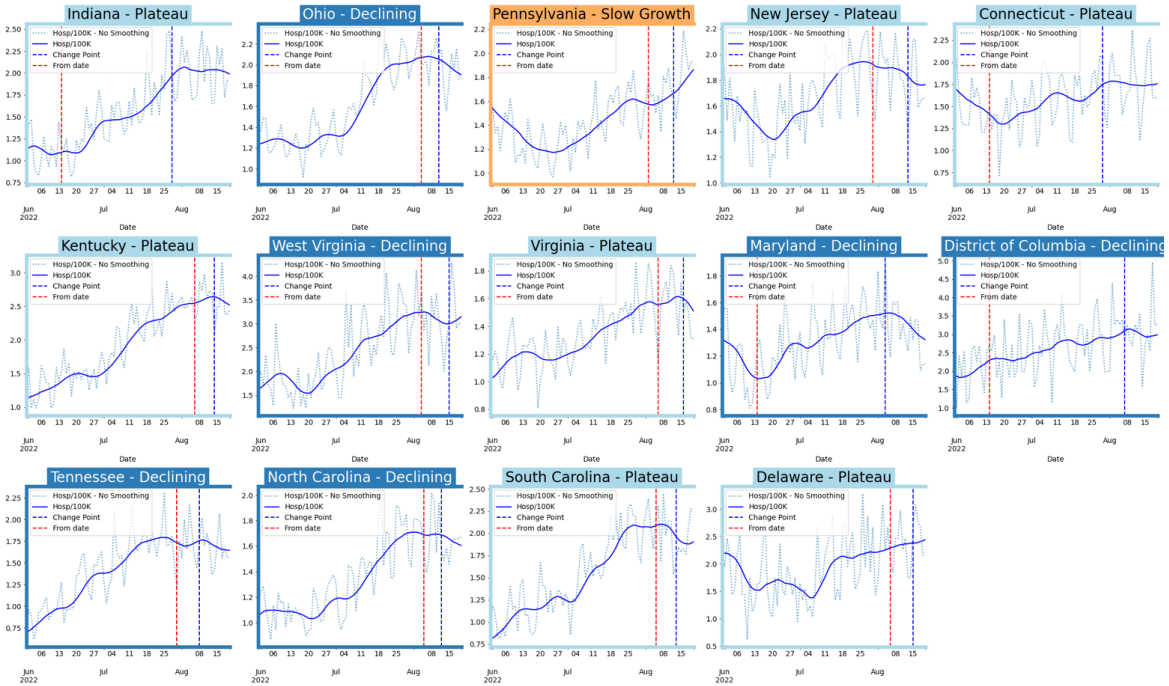
Status	# States
Declining	22 (12)
Plateau	24 (21)
Slow Growth	6 (18)
In Surge	1 (2)

Virginia and Her Neighbors

Cases

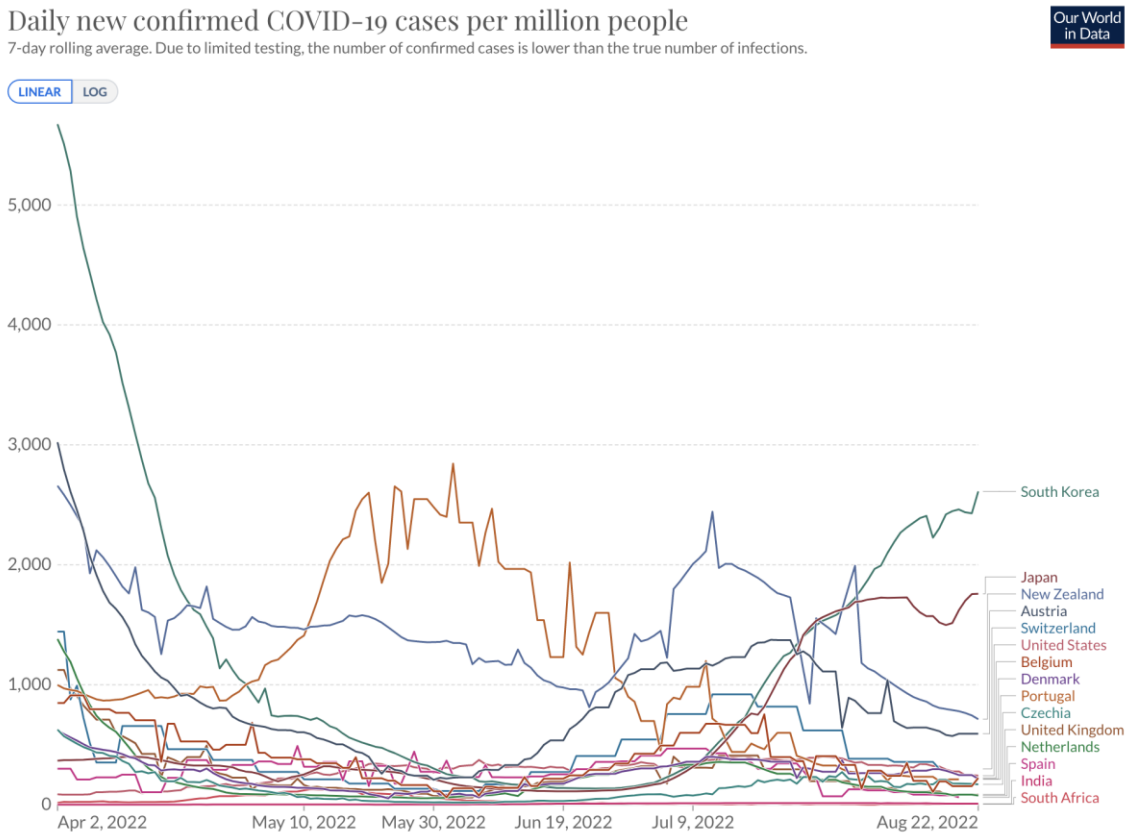


Hospitalizations

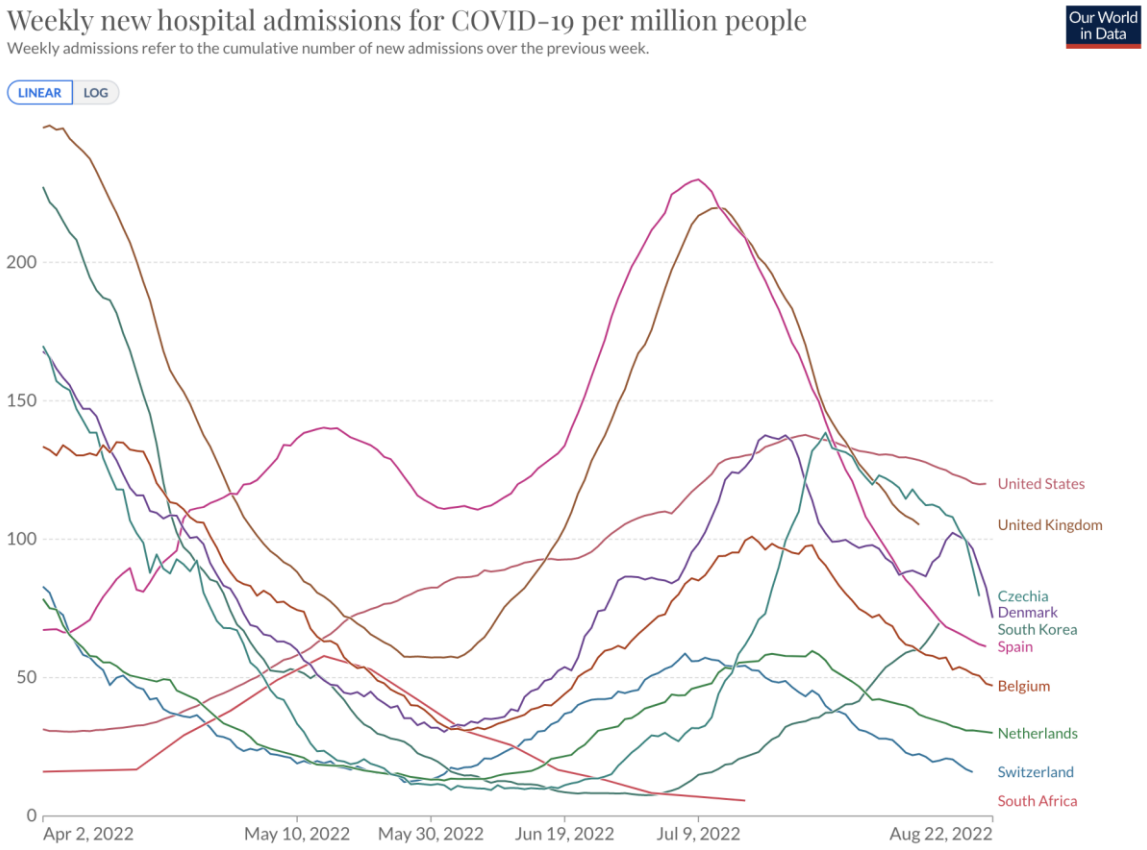


Around the World – Various trajectories

Confirmed cases



Hospitalizations



Our World in Data

Zip code level weekly Case Rate (per 100K)

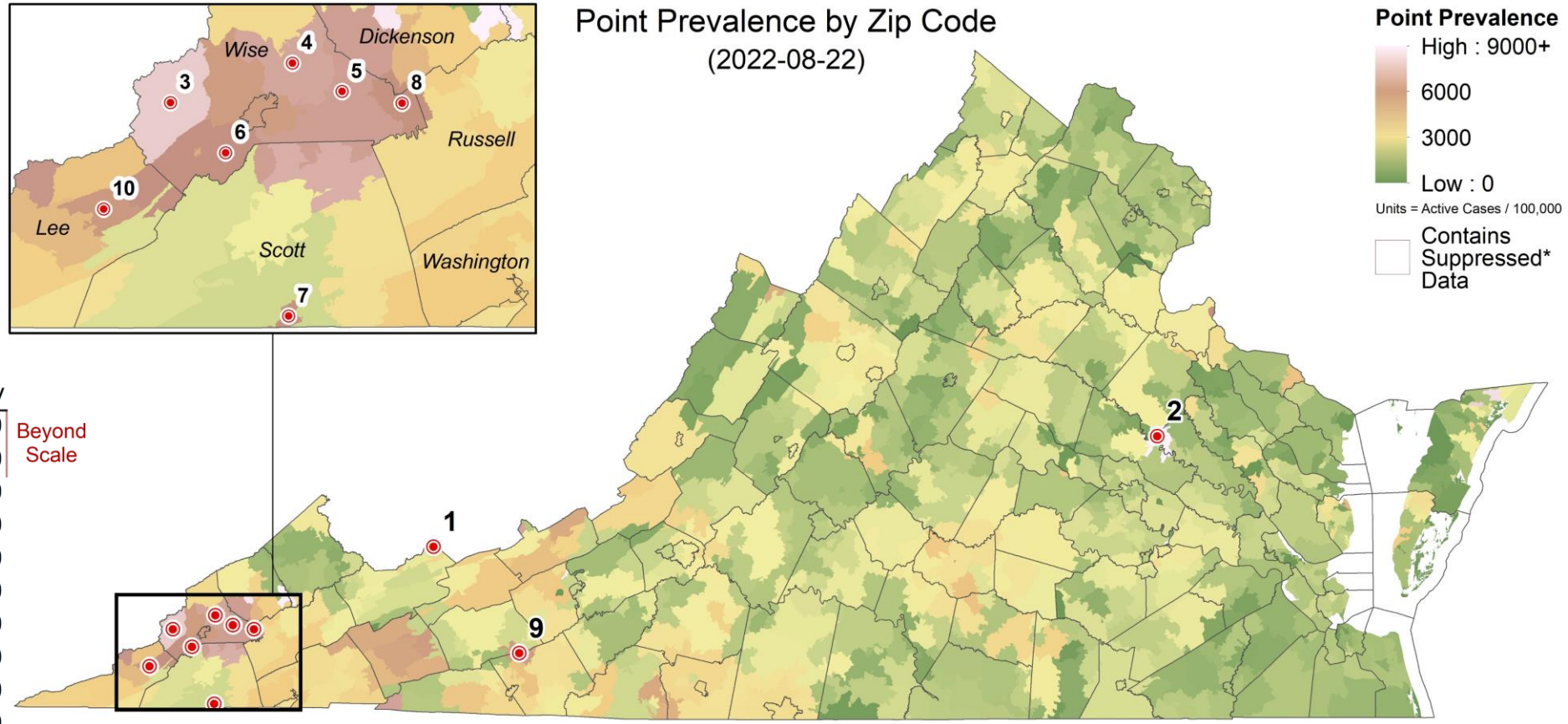
Case Rates in the last week by zip code

- Note change in color ramp (increased 50%).
- Some counts are low and suppressed to protect anonymity. Those are shown with a dark red outline.

Rank	Zip Code	Name	Prev
1	24635	Pocahontas*	15,100
2	23069	Hanover*	10,850
3	24216	Appalachia	8,700
4	24293	Wise	7,330
5	24230	Coeburn*	7,170
6	24219	Big Stone Gap*	6,810
7	24290	Weber City	6,800
8	24283	Saint Paul	6,780
9	24312	Austinville	6,560
10	24243	Dryden	6,450

Beyond Scale

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



Based on Spatial Empirical Bayes smoothed point prevalence, with an 8:1 ascertainment ratio, for week ending 2022-08-22.
Note: New color scale (50% increase from last report).

UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

Risk of Exposure by Group Size and HCW Prevalence

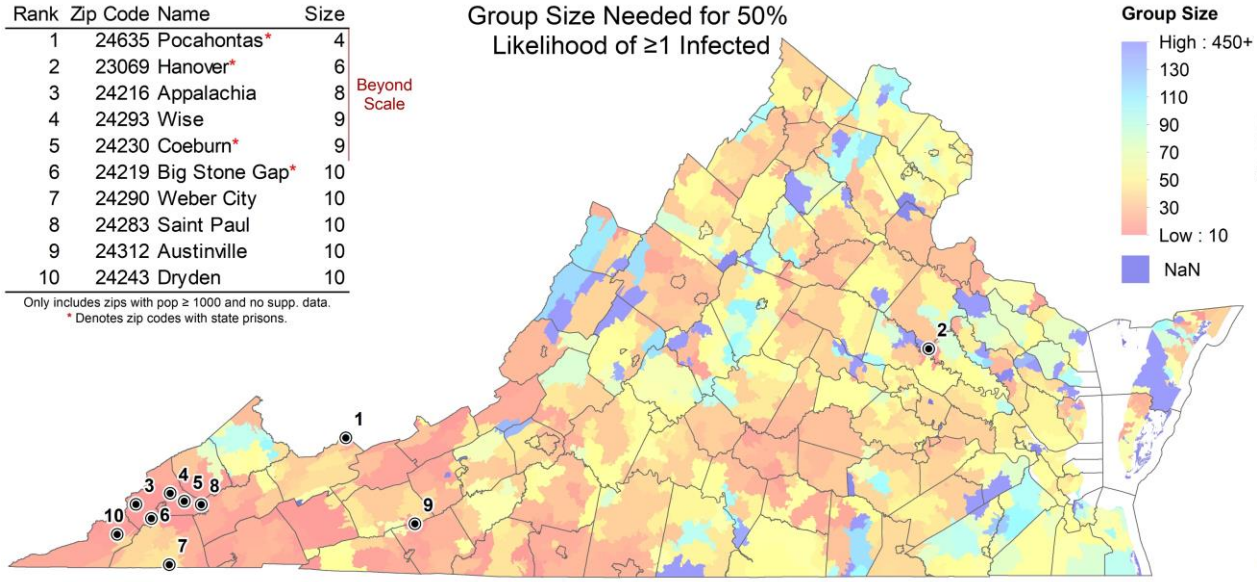
Case Prevalence in the last week by zip code used to calculate risk of encountering someone infected in a gathering of randomly selected people

- **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 4 in Pocahontas, there is a 50% chance someone will be infected).
- **Prevalence in under 20**: As schools open in VA, we are monitoring the association between timing of school opening vs. case rates. Schools have opened in much of the SW and prevalence is also a little higher (darker greens) there, whereas Eastern has few schools open but also has higher under 20 prevalence (darker blues)

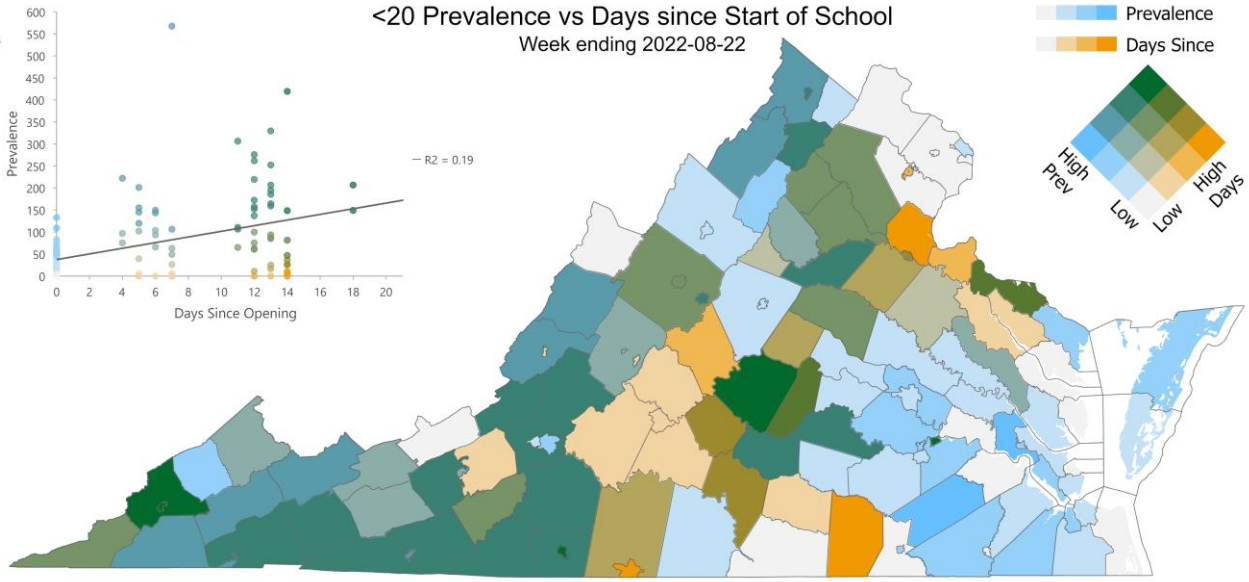
Rank	Zip Code	Name	Size
1	24635	Pocahontas*	4
2	23069	Hanover*	6
3	24216	Appalachia	8
4	24293	Wise	9
5	24230	Coeburn*	9
6	24219	Big Stone Gap*	10
7	24290	Weber City	10
8	24283	Saint Paul	10
9	24312	Austinville	10
10	24243	Dryden	10

Beyond Scale

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



Based on Spatial Empirical Bayes smoothed point prevalence, with an 8:1 ascertainment ratio, for week ending 2022-08-22.



Current Hot-Spots

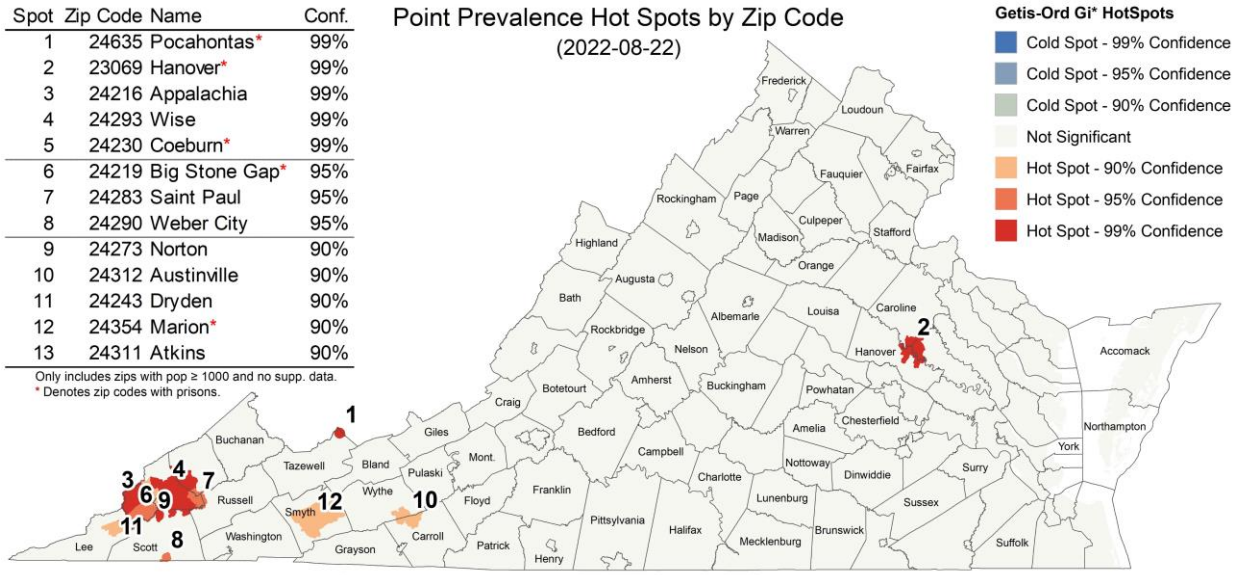
Case rates that are significantly different from neighboring areas or model projections

- **Spatial**: Getis-Ord Gi* 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 week compared to observed by county, which highlights temporal fluctuations that differ from the model's projections

Spatial Hotspots

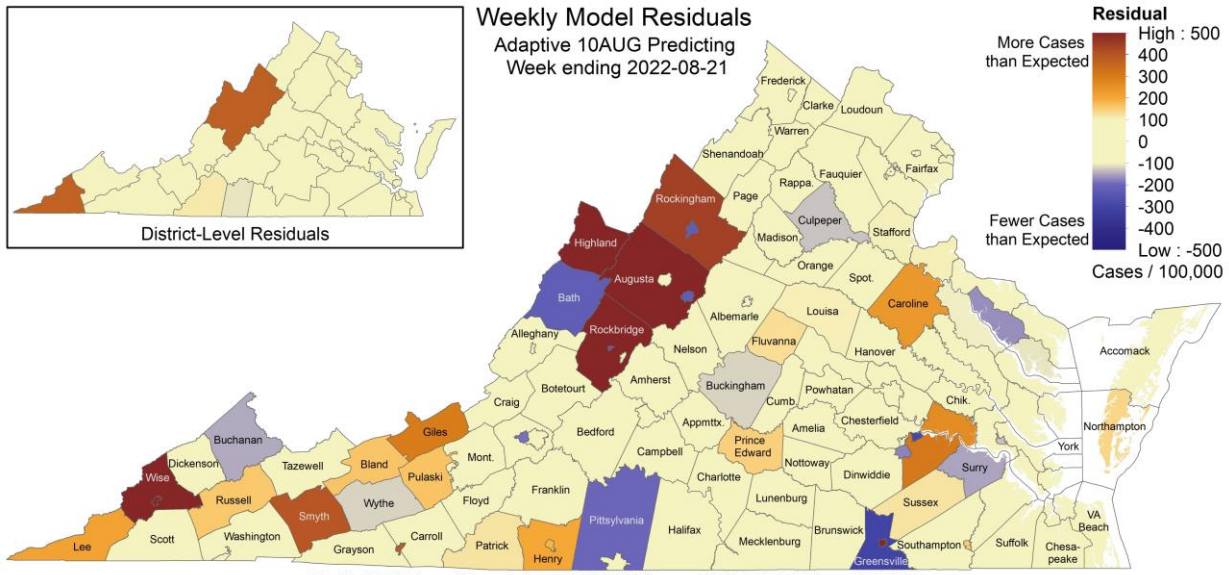
Spot	Zip Code	Name	Conf.
1	24635	Pocahontas*	99%
2	23069	Hanover*	99%
3	24216	Appalachia	99%
4	24293	Wise	99%
5	24230	Coeburn*	99%
6	24219	Big Stone Gap*	95%
7	24283	Saint Paul	95%
8	24290	Weber City	95%
9	24273	Norton	90%
10	24312	Austinville	90%
11	24243	Dryden	90%
12	24354	Marion*	90%
13	24311	Atkins	90%

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



Based on Global Empirical Bayes smoothed point prevalence for week ending 2022-08-22.

Clustered Temporal Hotspots

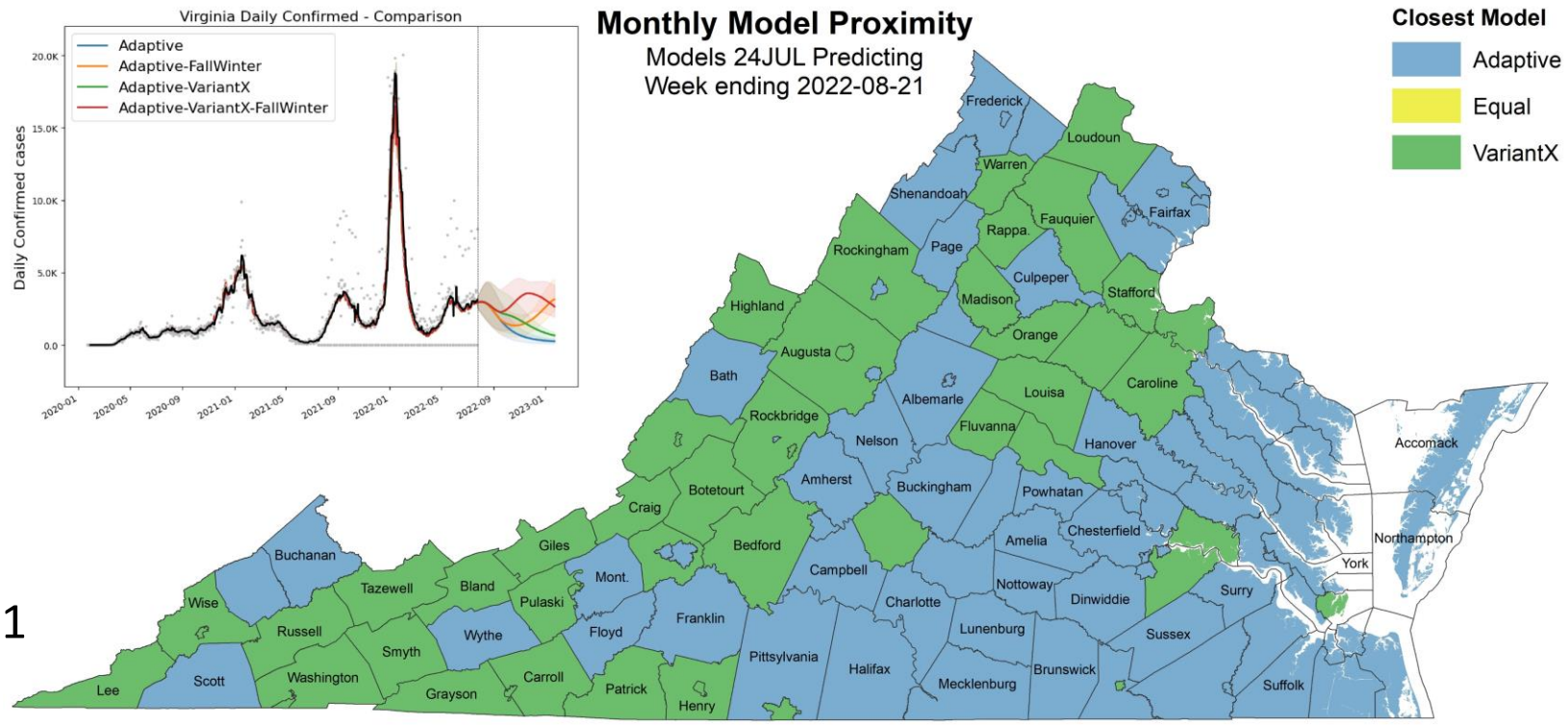


Health District Level Moran's I = -0.001136, Z-Score = 0.522942, P-Value = 0.601015
No Residual Autocorrelation Detected

Scenario Trajectory Tracking

Which scenario from a month ago did projection for each county track closest?

- One month out separates the projections more and reveals larger overall patterns
- FallWinter scenarios are not included as they do not diverge from their base scenarios until more than a month after the projection date
- Overall state level models were on target, with Eastern part of the state moving with the lower growth Adaptive, and the Southwest and I-81 corridor following the more growth-oriented VariantX trajectory

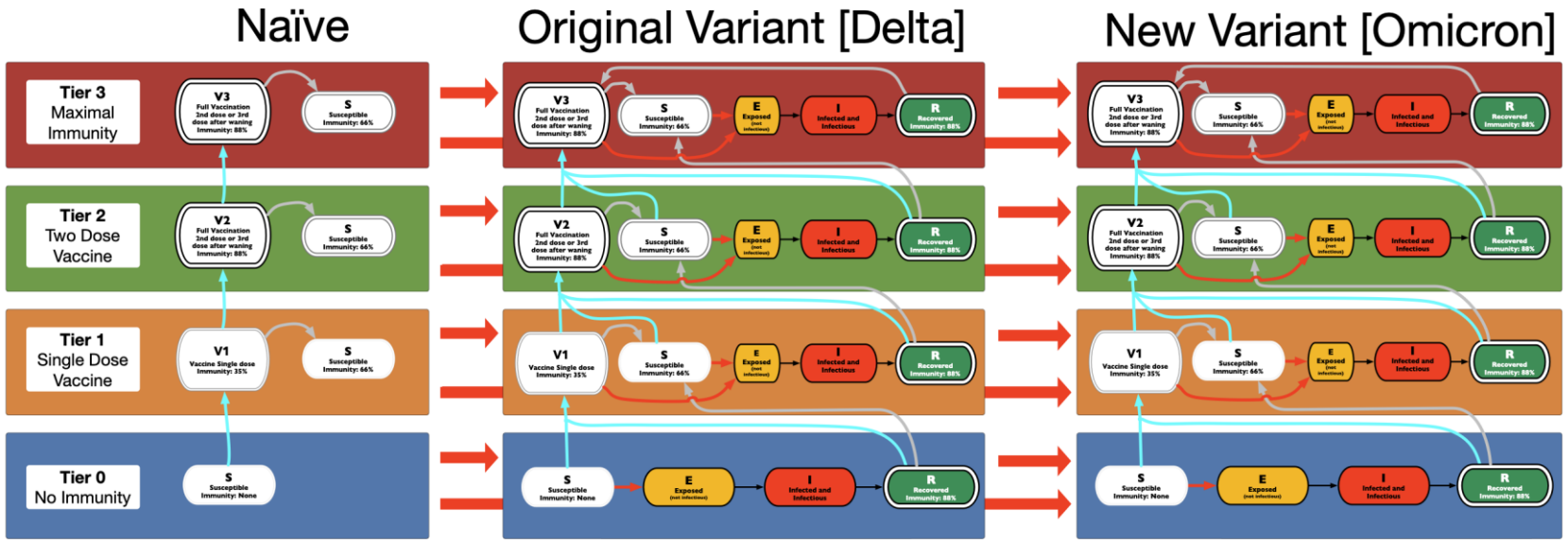


Model Update – Adaptive Fitting

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

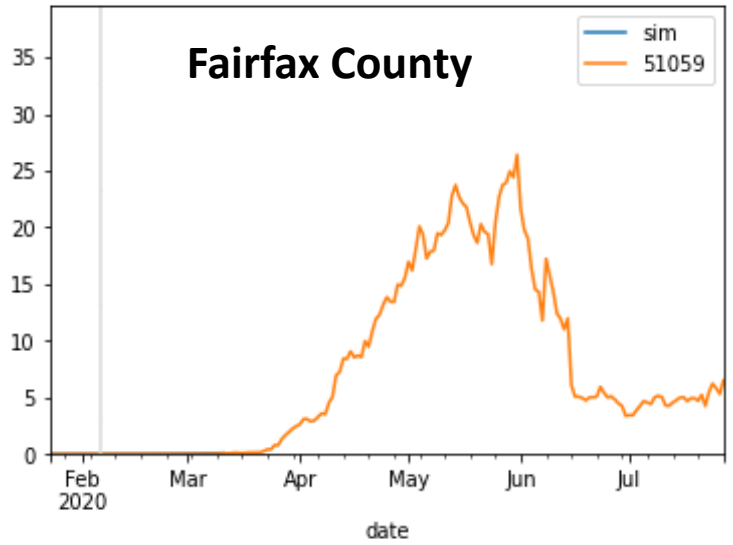
- Allows history to be precisely captured, and used to guide bounds on projections

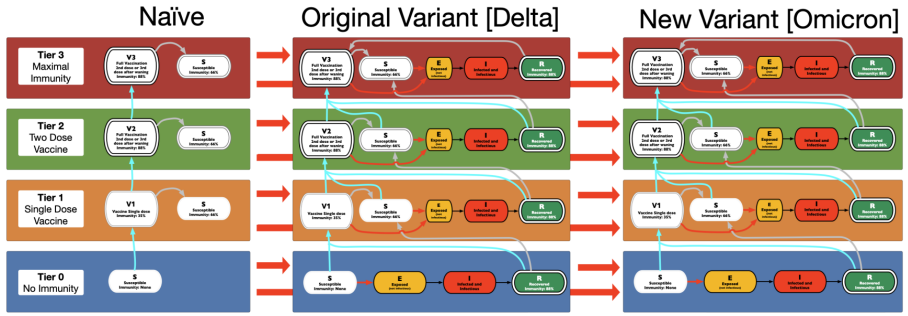
Model: An alternative use of the same meta-population model, PatchSim with multiple tiers of immunity

- 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

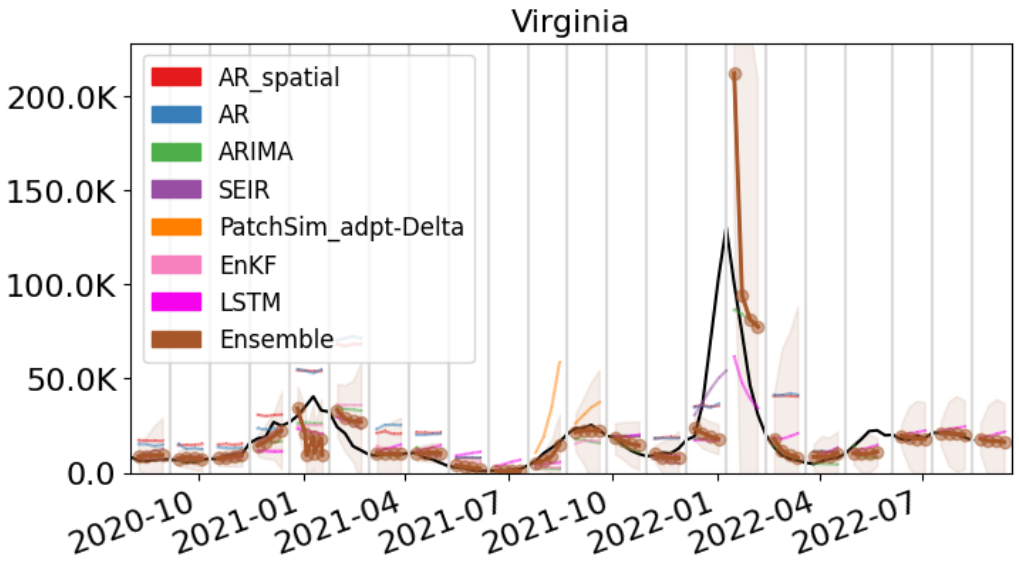




Using Ensemble Model to Guide Projections

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

- Autoregressive (AR, ARIMA)
- Neural networks (LSTM)
- Kalman filtering (EnKF)

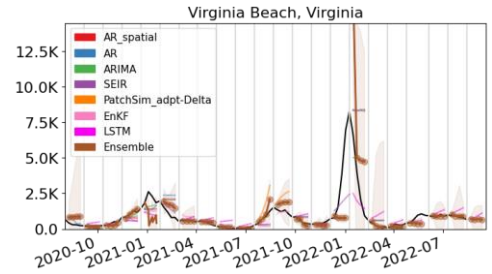


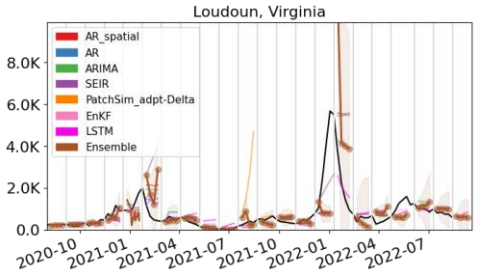
<u>Weekly forecasts</u> done at county level.

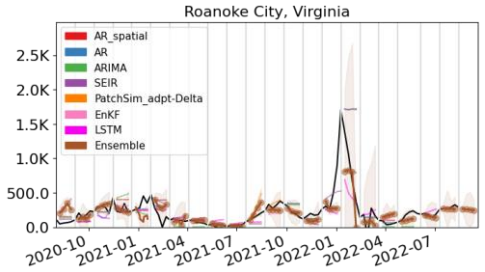
Models chosen because of their track record in disease forecasting and to increase diversity and robustness.

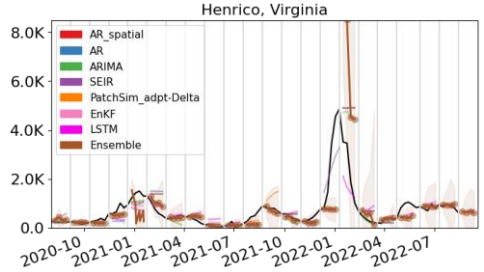
Ensemble forecast provides additional 'surveillance' for making scenario-based projections.

Also submitted to CDC Forecast Hub.









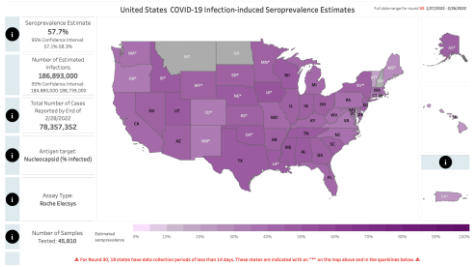
Seroprevalence updates to model design

Several seroprevalence studies have stopped

- CDC Nationwide Commercial Laboratory Seroprevalence Survey is no longer reporting updates; pre-Omicron this data estimated ascertainment ratio of ~4-6x

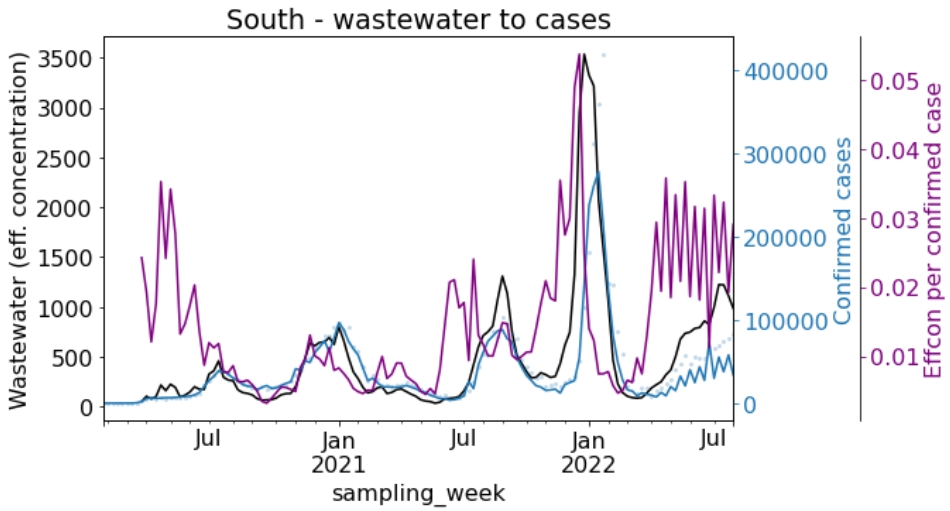
Testing Behavior has changed, fewer cases are reported

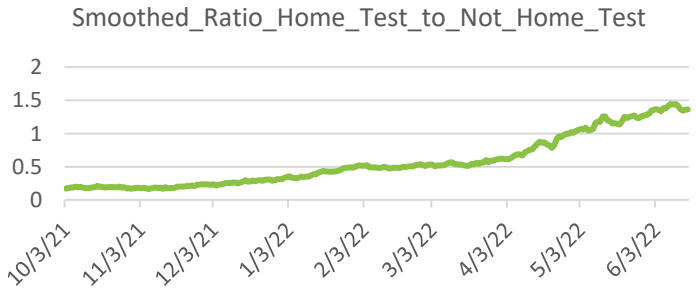
- Home testing, reduced symptoms due to breakthrough / reinfection, and elimination of public health leave
- Outbreaks Near Me from Boston Children's Hospital and Momentive collects reports of home testing
- Wastewater data is consistent with case ascertainment being significantly lower than during the Omicron BA.1 wave
- Accounting for home testing, changes case ascertainment to be 2 times more than pre-Omicron resulting in a current rate of 16 infections to one case



Virginia
Feb 22nd: 45% [42% - 48%];
Jan 22nd: 34% [31%-39%]

https://covid.cdc.gov/covid-data-tracker/#national-lab





OutbreaksNearMe

Calibration Approach

- **Data:**
  - County level case counts by date of onset (from VDH)
  - Confirmed cases for model fitting
- **Calibration:** fit model to observed data and ensemble's forecast
  - Tune transmissibility across ranges of:
    - Duration of incubation (5-9 days), infectiousness (3-7 days)
    - Undocumented case rate (1x to 7x) guided by seroprevalence studies
    - Detection delay: exposure to confirmation (4-12 days)
  - Approach captures uncertainty, but allows model to precisely track the full trajectory of the outbreak
- **Project:** future cases and outcomes generated using the collection of fit models run into the future
  - **Mean trend from last 7 days of observed cases and first week of ensemble's forecast used**
  - Outliers removed based on variances in the previous 3 weeks
  - 2 week interpolation to smooth transitions in rapidly changing trajectories
- **Outcomes**: Data driven by shift and ratio that has least error in last month of observations
  - Hospitalizations: 3 days from confirmation, 6.8% of cases hospitalized
  - Deaths: 11 days from confirmation, 1.45% of cases die

VIRGINIA'S HEALTH IS IN OUR HANDS. Do your part, stop the spread.

COVID-19 in Virginia: Summary

VDH VIRGINIA DEPARTMENT OF HEALTH

Dashboard Updated: 8/24/2022
Data entered by 5:00 PM the prior day.

Cases, Hospitalizations and Deaths

Total Cases*		Total Hospital Admissions**		Total Deaths	
2,022,778		55,018		21,310	
(New Cases: 2,915)^					
Confirmed†	Probable†	Confirmed†	Probable†	Confirmed†	Probable†
1,437,069	585,709	51,642	3,376	17,746	3,564

* Includes both people with a positive test (Confirmed), and symptomatic with a known exposure to COVID-19 (Probable).
** Hospitalization of a case is captured at the time VDH performs case investigation. This underrepresents the total number of hospitalizations in Virginia.
^New cases represent the number of confirmed and probable cases reported to VDH in the past 24 hours.
† VDH adopted the updated CDC COVID-19 confirmed and probable surveillance case definitions on August 27, 2020. Found here: https://wwwn.cdc.gov/nndss/conditions/coronavirus-disease-2019-covid-19/case-definition/2020/08/05/
Source: Cases - Virginia Electronic Disease Surveillance System (VEDSS), data entered by 5:00 PM the prior day.

Outbreaks

Total Outbreaks*	Outbreak Associated Cases
9,544	153,261

* At least two (2) lab confirmed cases are required to classify an outbreak.

Testing (PCR Only)

Testing Encounters PCR Only*	Current 7-Day Positivity Rate PCR Only**
14,697,600	21.5%

* PCR" refers to "Reverse transcriptase polymerase chain reaction laboratory testing."
** Lab reports may not have been received yet. Percent positivity is not calculated for days with incomplete data.

Multisystem Inflammatory Syndrome in Children

Total Cases*	Total Deaths
180	1

*Cases defined by CDC HAN case definition: https://emergency.cdc.gov/han/2020/han00432.asp

Accessed 9:30am Aug 24, 2022
https://www.vdh.virginia.gov/coronavirus/

Scenarios – Transmission Conditions

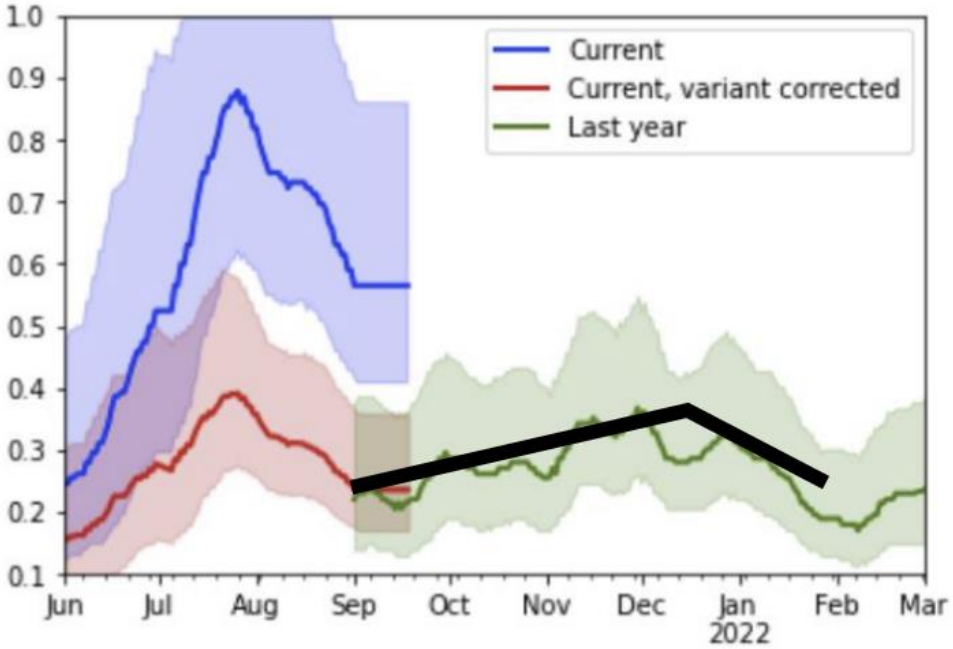
- Variety of factors continue to drive transmission rates
  - Seasonal impact of weather patterns, travel and gatherings, fatigue and premature relaxation of infection control practices
- **Waning Immunity**: Omicron waning with a mean of 4 months
- **Projection Condition Ingredients**:
  - **Adaptive:** Controls remain as currently experienced into the future with NO influence from other conditions (eg seasonal, variants, etc.)
  - **Seasonal (Fall-Winter boosting):** Controls remain the same, however, seasonal forcing similar to past Fall-Winter waves is added from Sept-Feb
  - **Vaccine Booster Campaign (Booster):** Reformulated booster available this fall provides improved immunity against Omicron sub-variants
  - **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

Scenarios – FallWinter

September – February saw strong waves of transmission for both years

- Based on analyses of the past 2 seasons we generate a "coarse baseline transmission boost"
  - In 2021 the distribution of fitted model transmissibility was nearly identical between these periods when corrected for Delta's increased transmissibility
- **FallWinter** captures these "transmission drivers" from the past and uses them as if they were to occur again this season

Fitting:
Black line represents the coarsely fitted base transmissibility



* "Last year" is transplanted into 2021-22

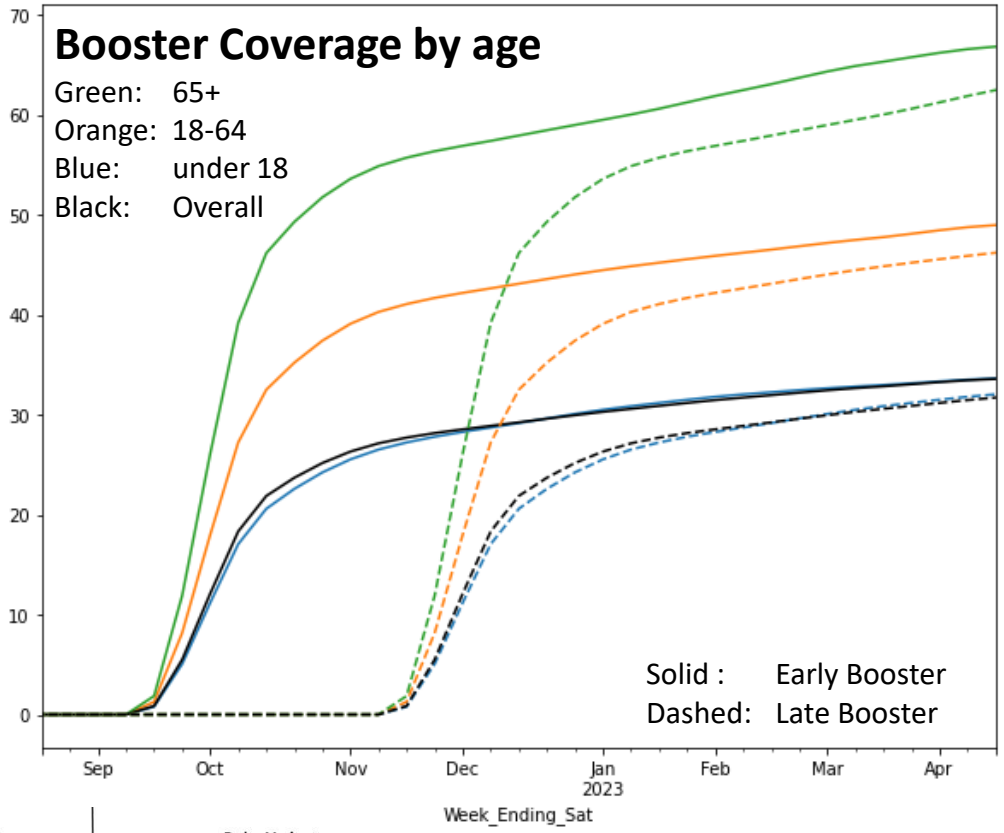
Scenarios – Early vs. Late Booster Campaign

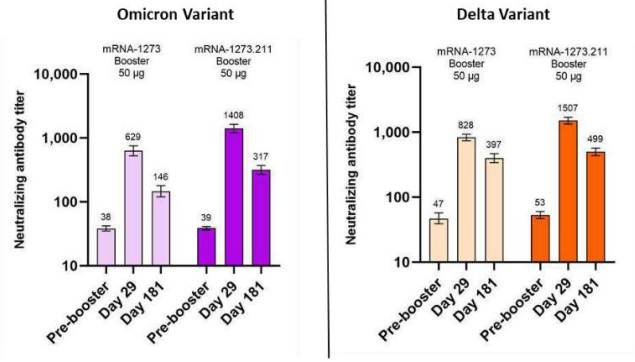
Reformulated Boosters will be available this Fall

- Vax efficacy against BA.4/5 and all previous variants is 80% against symptomatic illness
- Total coverage is 90% of total for seasonal influenza vaccinations (varies by age)
- Pace of vaccination follows that of seasonal influenza, scenarios vary in timing only
- Variant X has same immune escape to these vaccines as against BA.5 (40%)

Early Booster: Mid-September start

Late Booster: Mid-November start





Moderna's bivalent vaccine approach shows promising neutralization profile

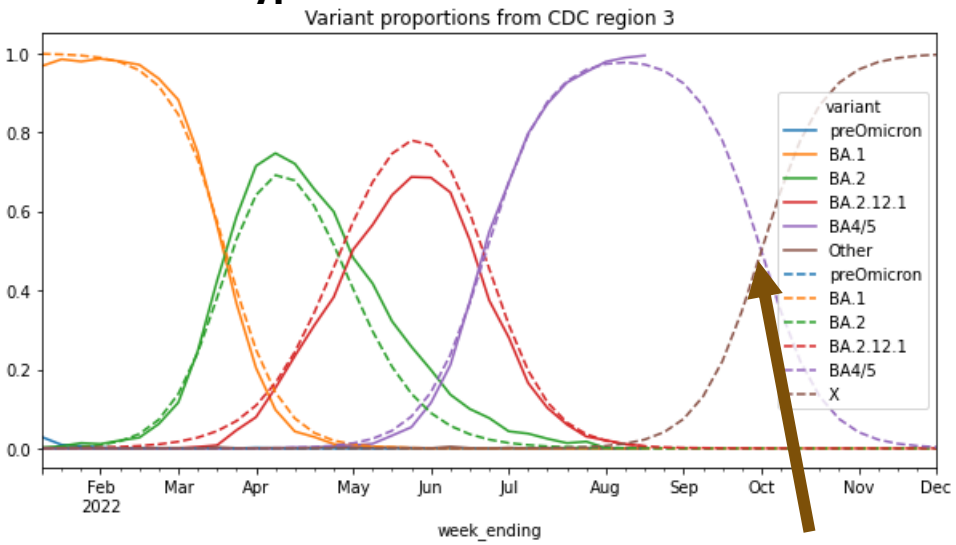
Moderna released data on a bivalent booster vaccine which contains mRNAs for both the original and Beta spike protein. The mRNA-1273.211 booster (50 and 100-µg) elicited higher neutralizing antibody responses against the ancestral SARS-CoV-2 and the Beta variant than that after the second mRNA-1273 dose. It also elicited a 2.15 fold increase against Omicron compared to the original. https://assets.researchsquare.com/files/rs-1555201/v1_covered.pdf?c=1650045900

Scenarios – Variant X

Omicron sub-variants seem to be emerging and then dominating with some regularity

- ECDC currently monitoring BA.2 + L452X and BA.2.75 as VOI and XAK as a VUM
- Limited growth of BA.2.75 observed in US, BA.4.6 being tracked by CDC as well
- Hypothetical future sub-variant, **VariantX**, may continue the pattern. Assumes similar growth and level of immune escape against previous sub-variants as BA.4/5 (same transmissibility and 40% immune escape against BA.4/5, higher for other sub-variants).

Sub-Variants with Fitted Prevalences and Hypothetical Future waves



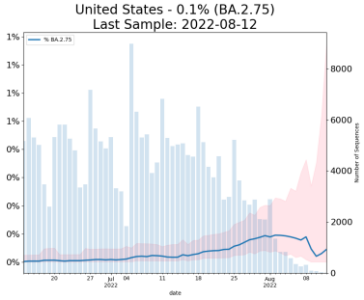
Variants of Interest

WHO label	Lineage + additional mutations	Country first detected (community)	Spike mutations of interest	Year and month first detected	Impact on transmissibility	Impact on immunity	Impact on severity	Transmission in EU/EEA
Omicron	BA.2 + L452X (x)	n/a	L452X	n/a	No evidence	Increased (7)	No evidence	Detected (a)
Omicron	BA.2.75	India	(y)	May 2022	No evidence	Increased (9, 10)	No evidence	Detected (a)

Variants under Monitoring

WHO label	Lineage + additional mutations	Country first detected (community)	Spike mutations of interest	Year and month first detected	Impact on transmissibility	Impact on immunity	Impact on severity	Transmission in EU/EEA
Omicron	XAK	Germany	(y)	June 2022	No evidence	No evidence	No evidence	Detected (a)

BA.2.75 detected in US (very limited samples)



ECDC Variants of Concern

Variant X prevalence mid-point set to Oct 1st

Projection Scenarios – Combined Conditions

Name	Txm	Variant	Description
Adaptive	C	SQ	Likely trajectory based on conditions remaining similar to the current experience, includes immune escape due to Omicron
Adaptive-FallWinter	FallWinter	SQ	Like Adaptive, with seasonal forcing of FallWinter added on
Adaptive-FallWinter-EarlyBooster	FallWinter	SQ	Like Adaptive-Fall Winter but with Early Booster (mid-Sept)
Adaptive-FallWinter-LateBooster	FallWinter	SQ	Like Adaptive-Fall Winter but with Late Booster (mid-Nov)
Adaptive-VariantX	C	X	Like Adaptive, with emergence of a speculative unknown variant 4 months after BA.4/5 with similar level of immune escape and equal transmissibility
Adaptive-VariantX-FallWinter	FallWinter	X	Like Adaptive-VariantX but with the seasonal force of FallWinter added on

Transmission: C = Current levels persist into the future
FallWinter = Transmission rates learned from Sept through February of past seasons are estimated and added as a seasonal boosting to baseline transmission rates

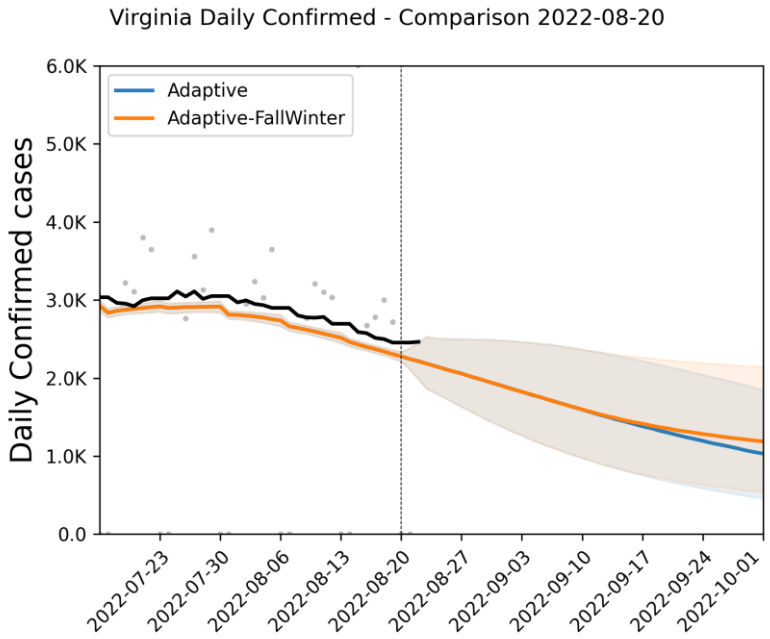
Variant: SQ = Status quo of current transmission driver from BA.5 remains the same (eg already significantly past dominance, thus no significant major driving of transmission anticipated)
X = Speculative novel sub-variant scenario, emerges 4 months after current varian, similar levels of escape

Model Results

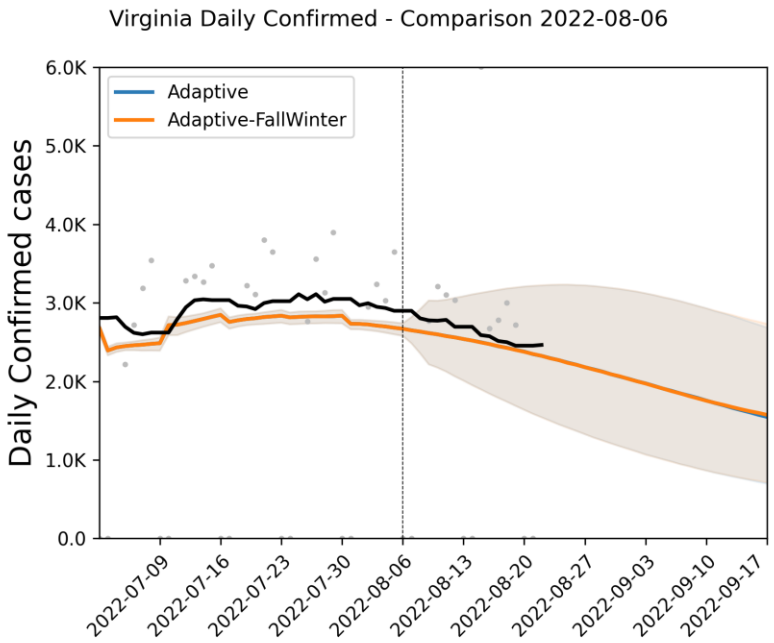
Previous projections comparison - Cases

- Previous projections have tracked observed cases well
- Projection from 2 weeks ago projected continued decline
- Projection from late July anticipated a plateau giving way to gentle decline

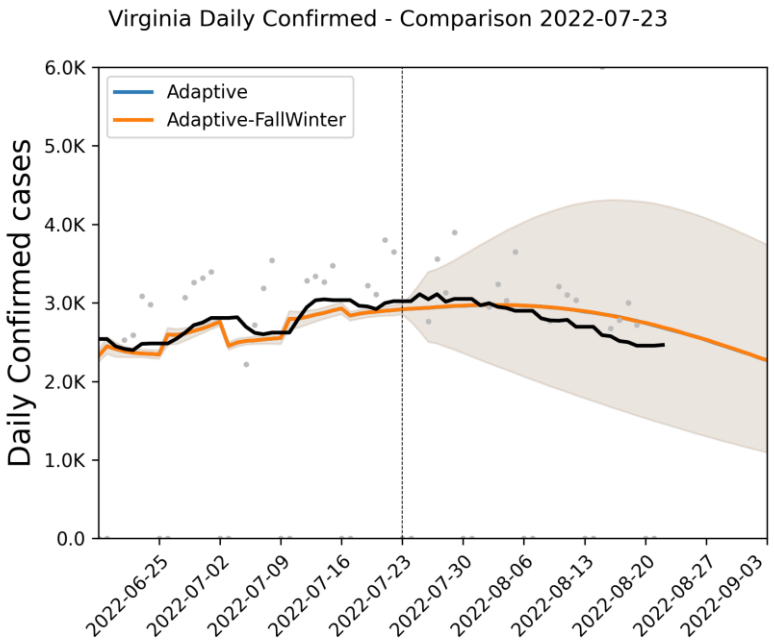
This week's projection



Projection from 2 weeks ago



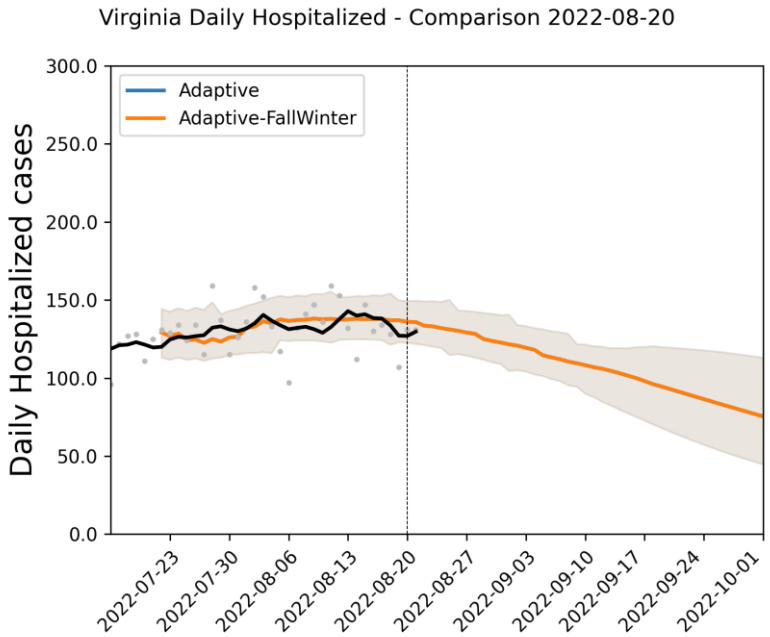
Projection from 4 weeks ago



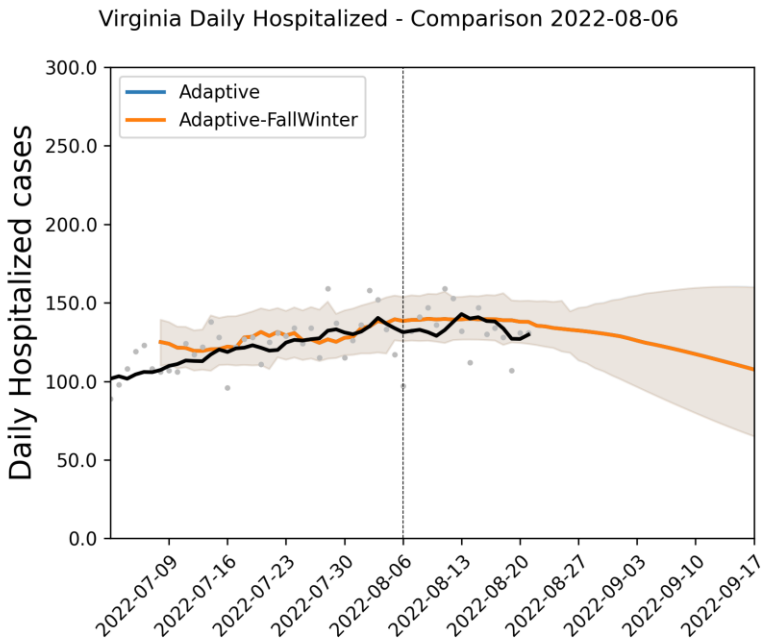
Previous projections comparison - Hospitalizations

- Previous projections have tracked observed hospitalizations well
- Projection from 2 weeks ago projected continued decline
- Projection from late July anticipated a plateau giving way to gentle decline

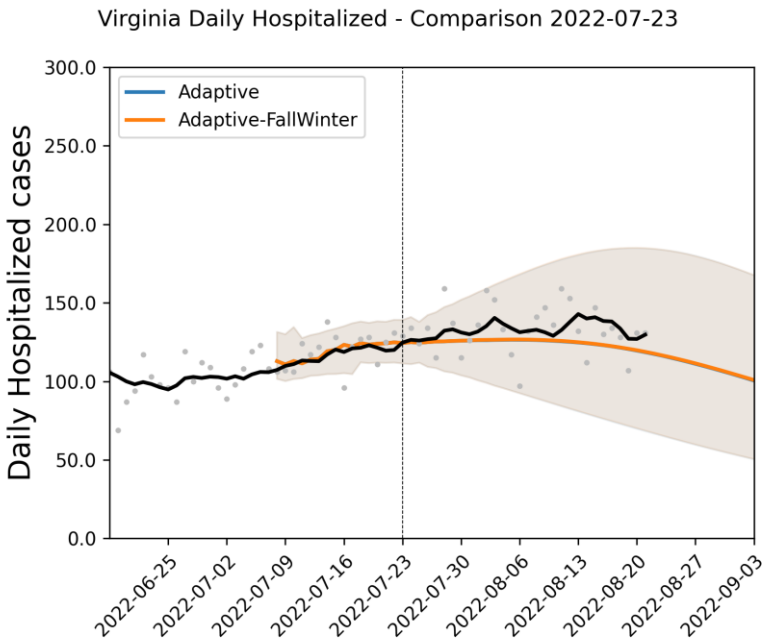
This week's projection



Projection from 2 weeks ago

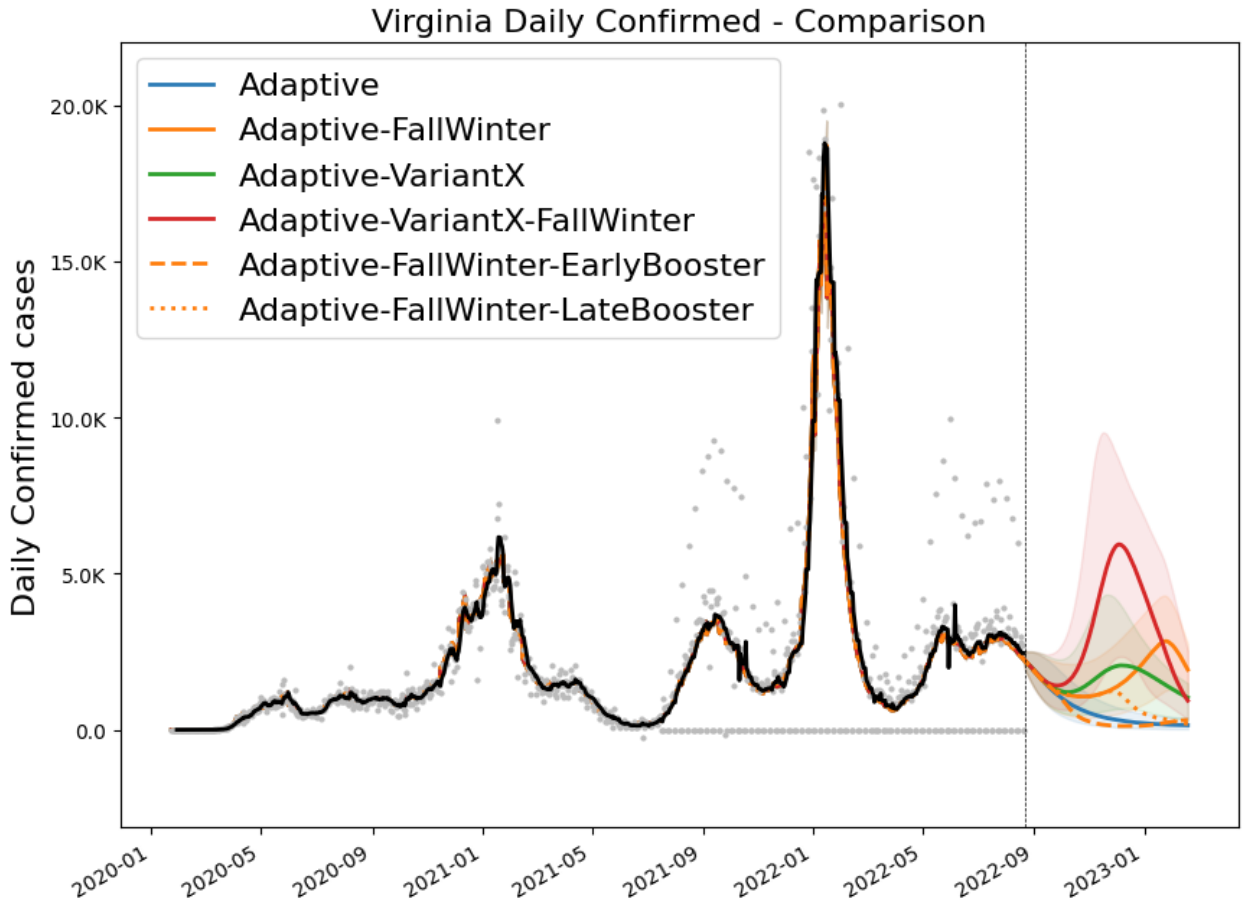


Projection from 4 weeks ago



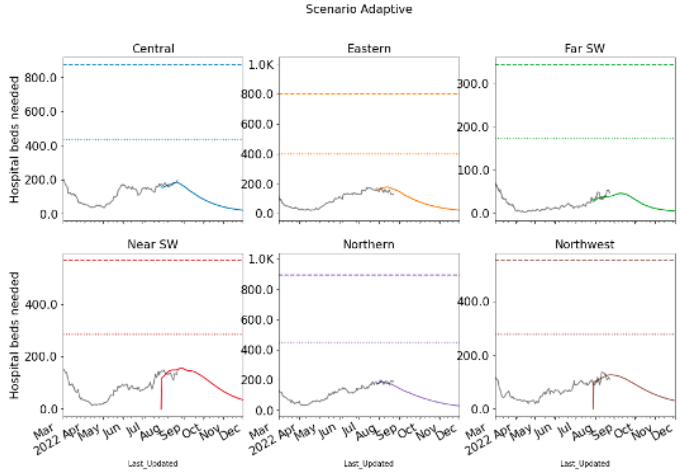
Outcome Projections

Confirmed cases

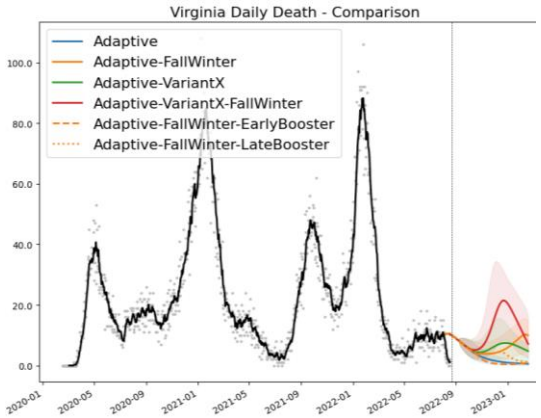


* without surveillance correction VariantBA2 peaked over 10K in July

Estimated Hospital Occupancy

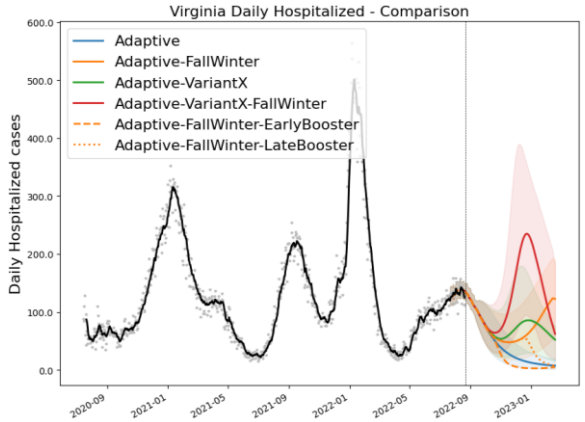


Daily Deaths



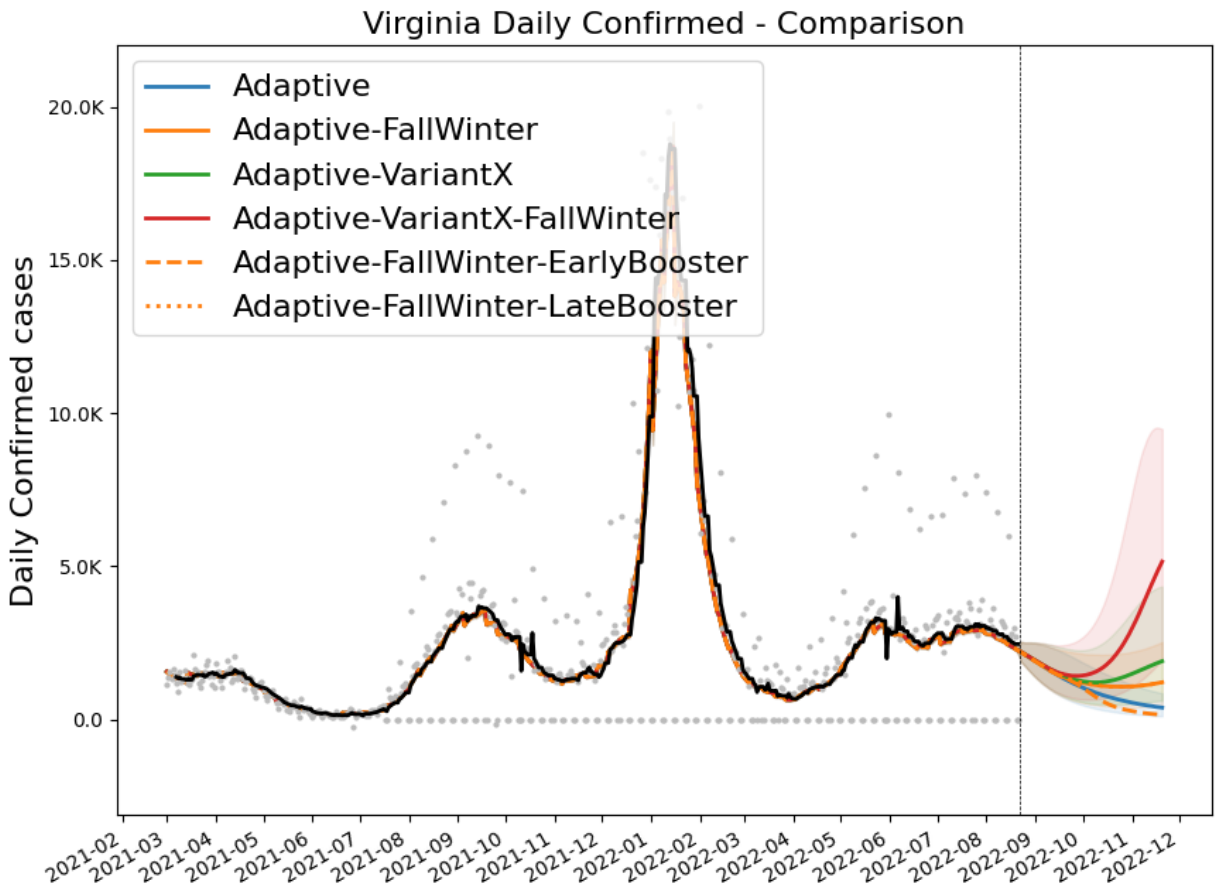
Death ground truth from VDH "Event Date" data, most recent dates are not complete

Daily Hospitalized



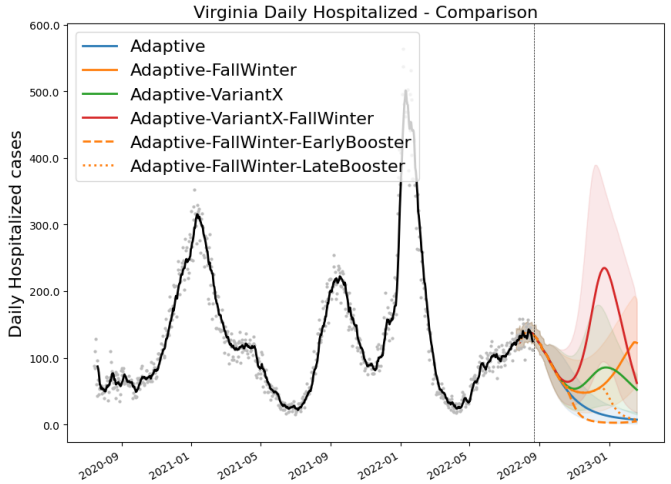
Outcome Projections – Closer Look

Confirmed cases

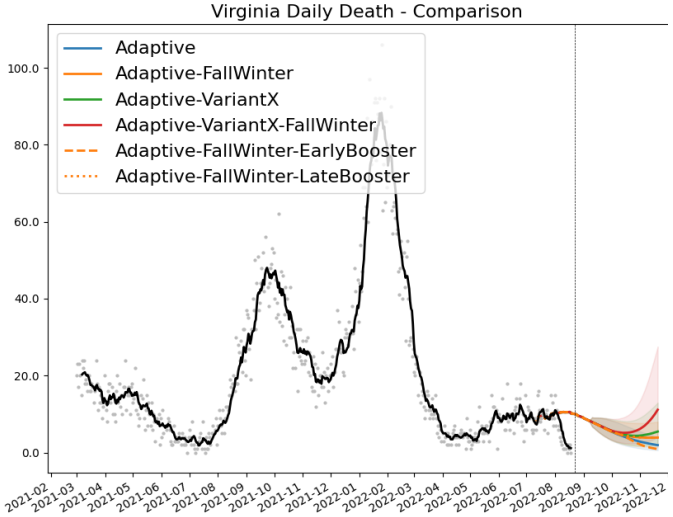


* without surveillance correction VariantBA2 peaked over 10K in July

Daily Hospitalized



Daily Deaths



Death ground truth from VDH "Event Date" data, most recent dates are not complete

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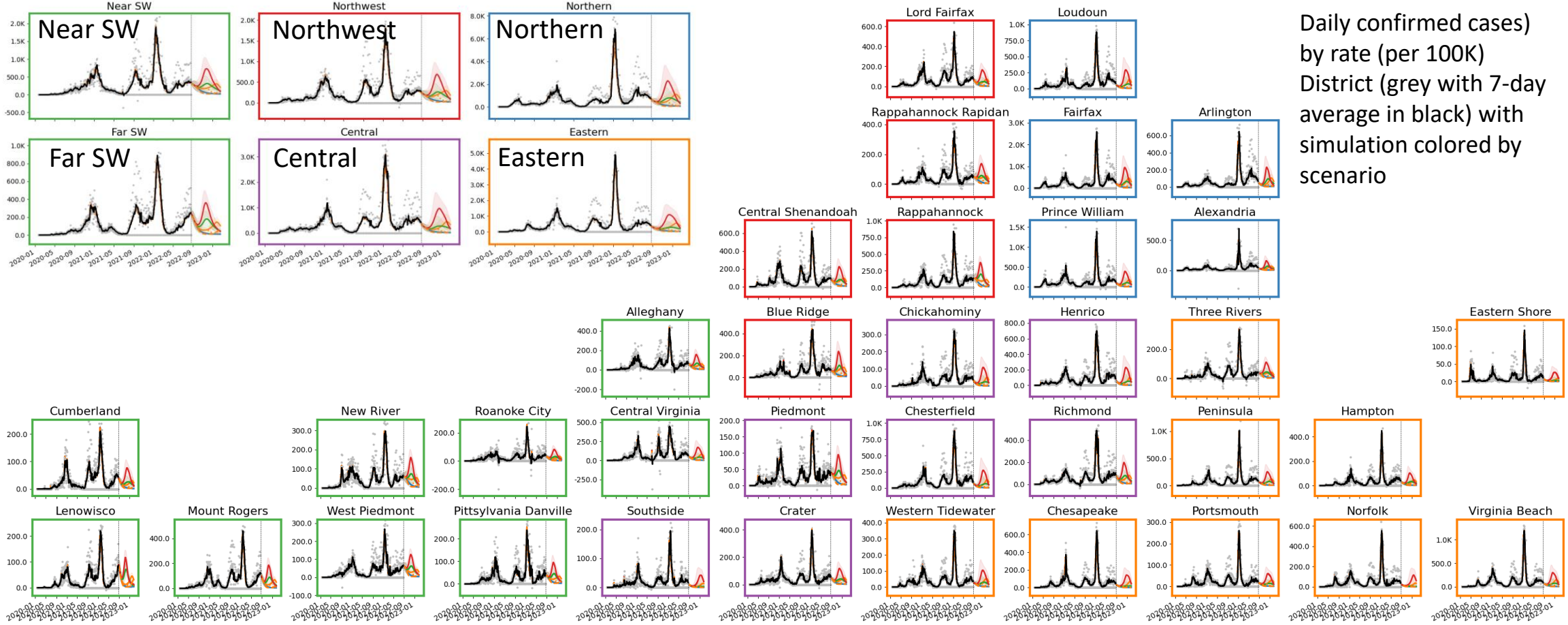
Detailed Projections: All Scenarios

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

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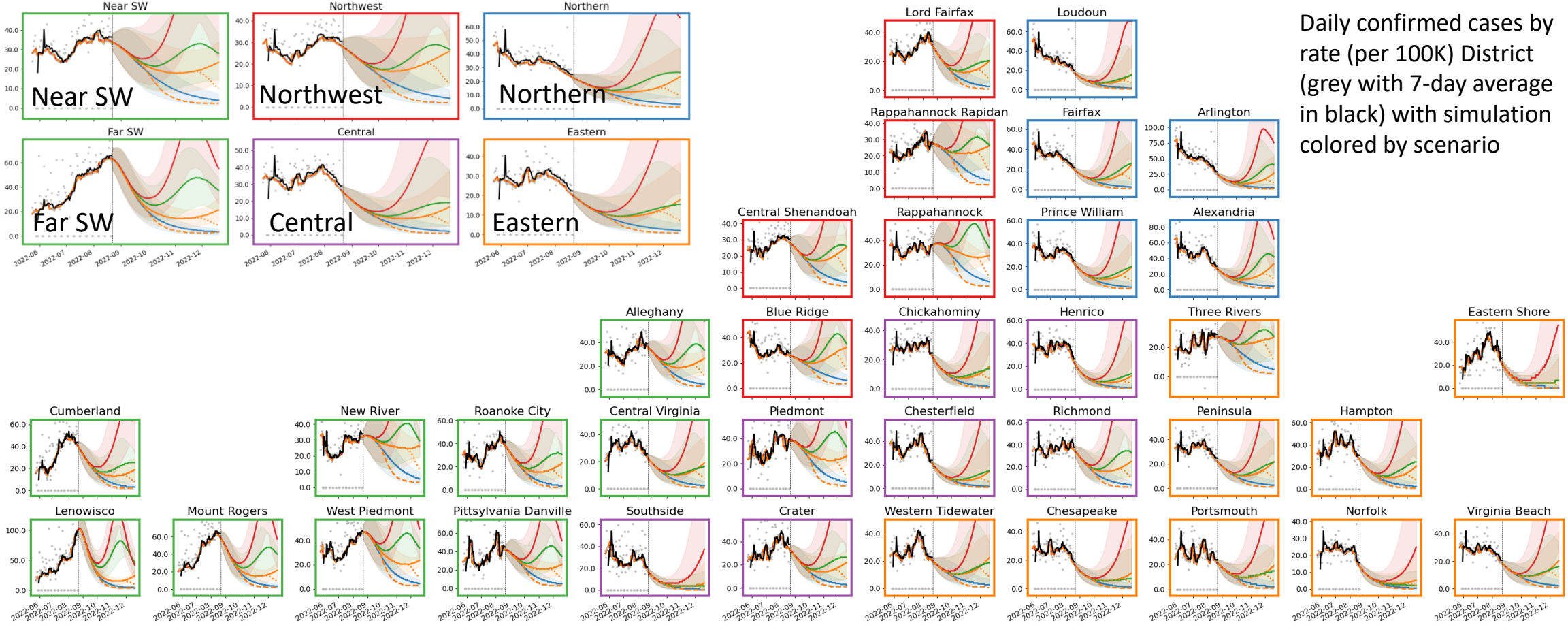
Detailed Projections: All Scenarios - Closer Look

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

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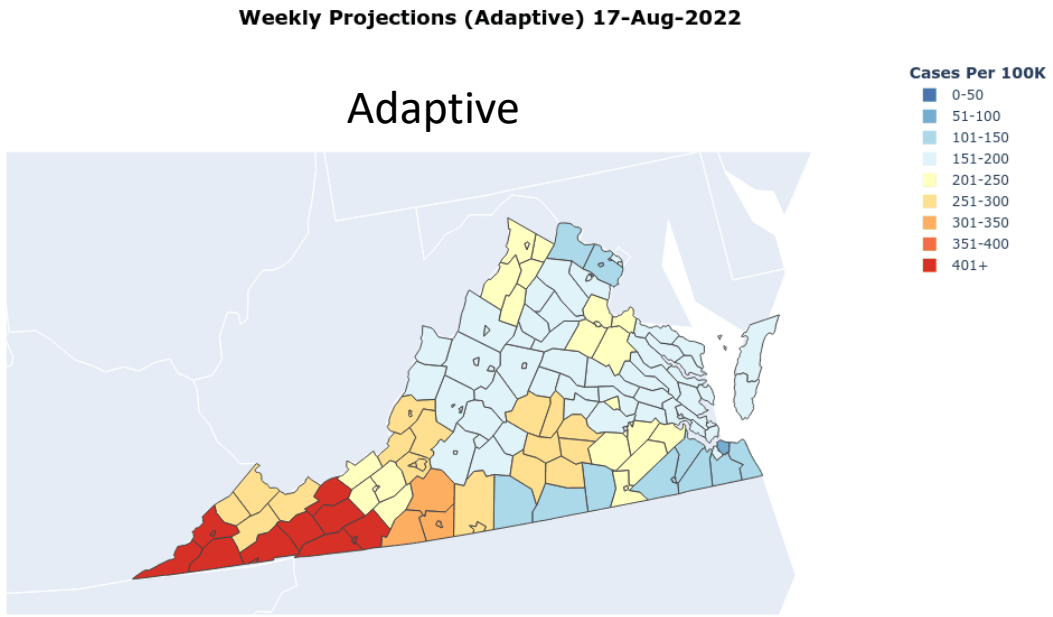
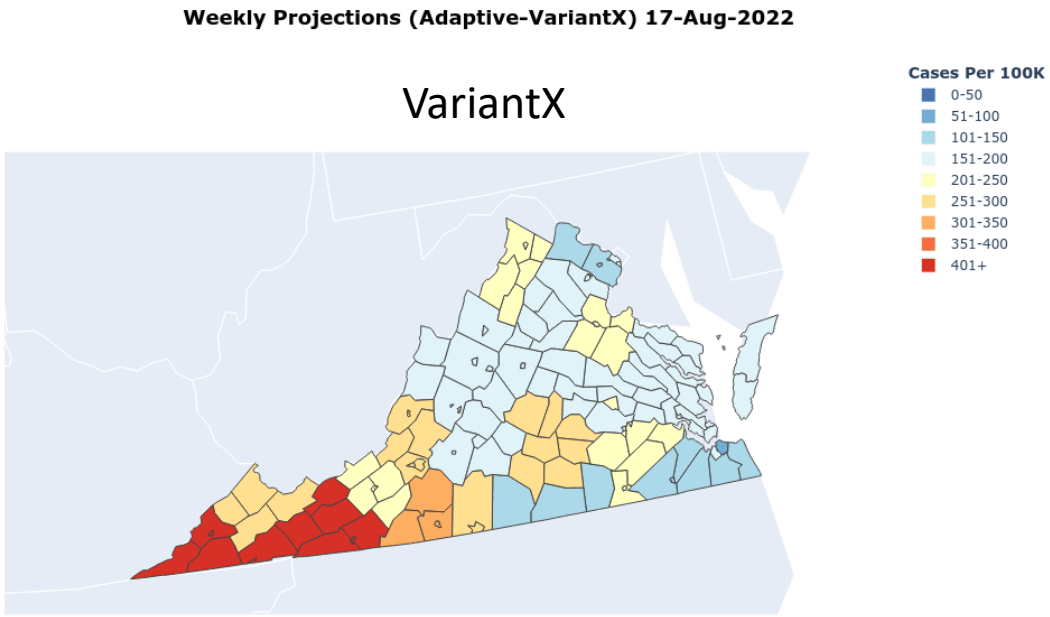
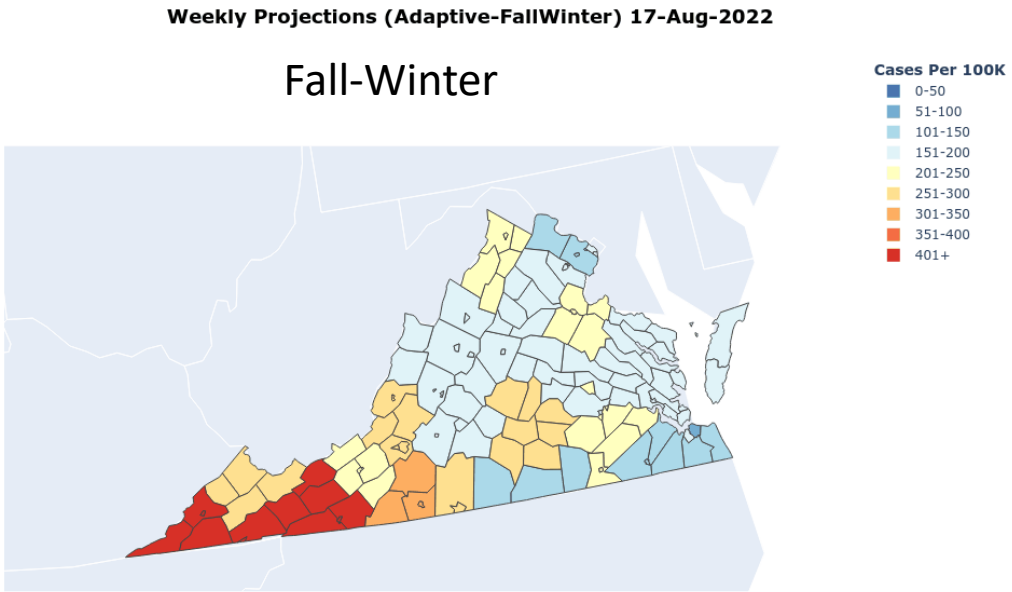
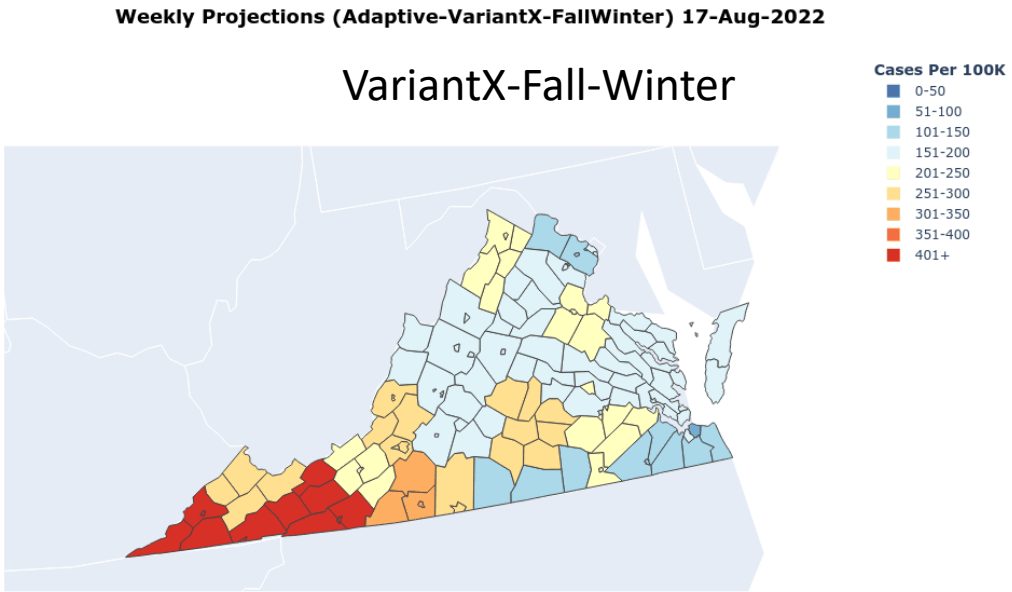
Detailed Projections: Animated Comparison





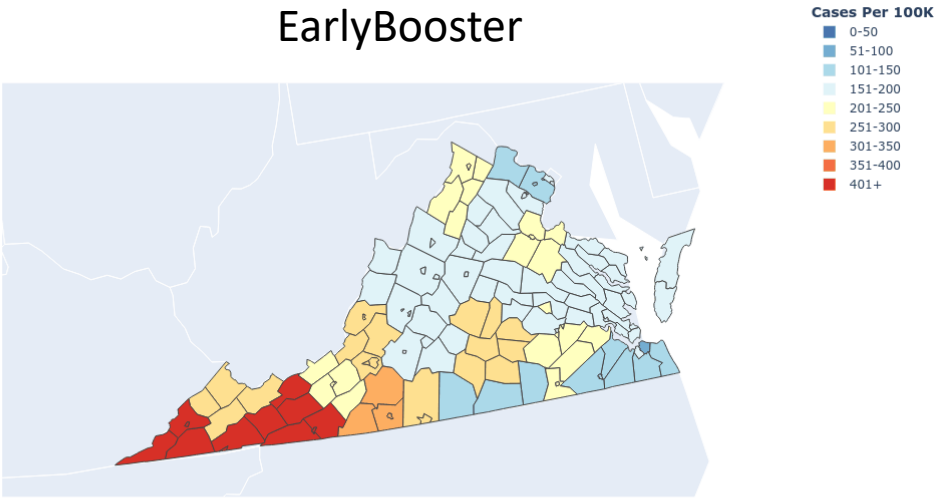




Impact of Early vs. Late Booster Distribution

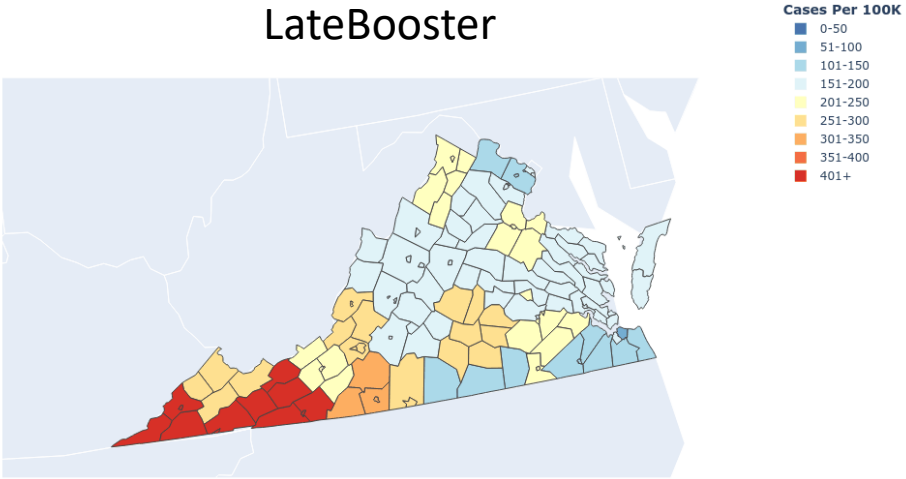
Weekly Projections (EarlyBooster) 17-Aug-2022

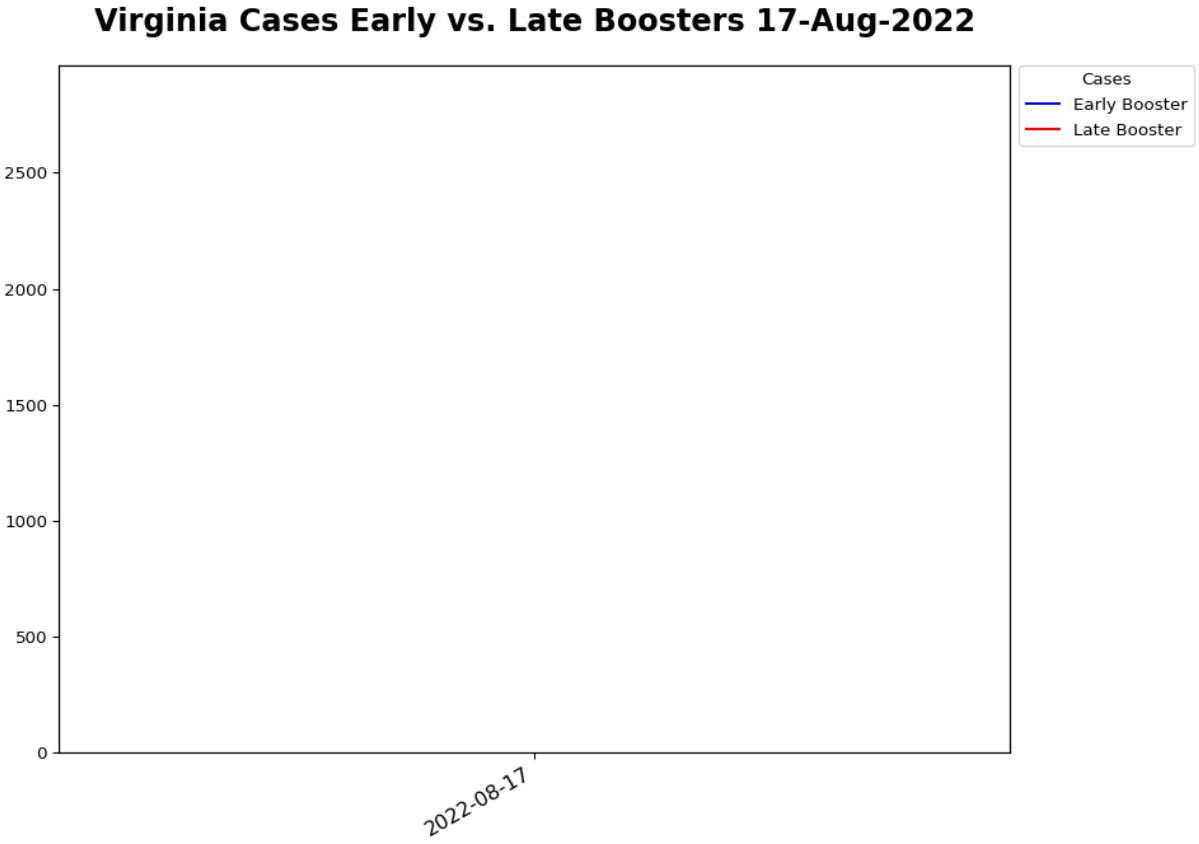
EarlyBooster



Weekly Projections (LateBooster) 17-Aug-2022

LateBooster

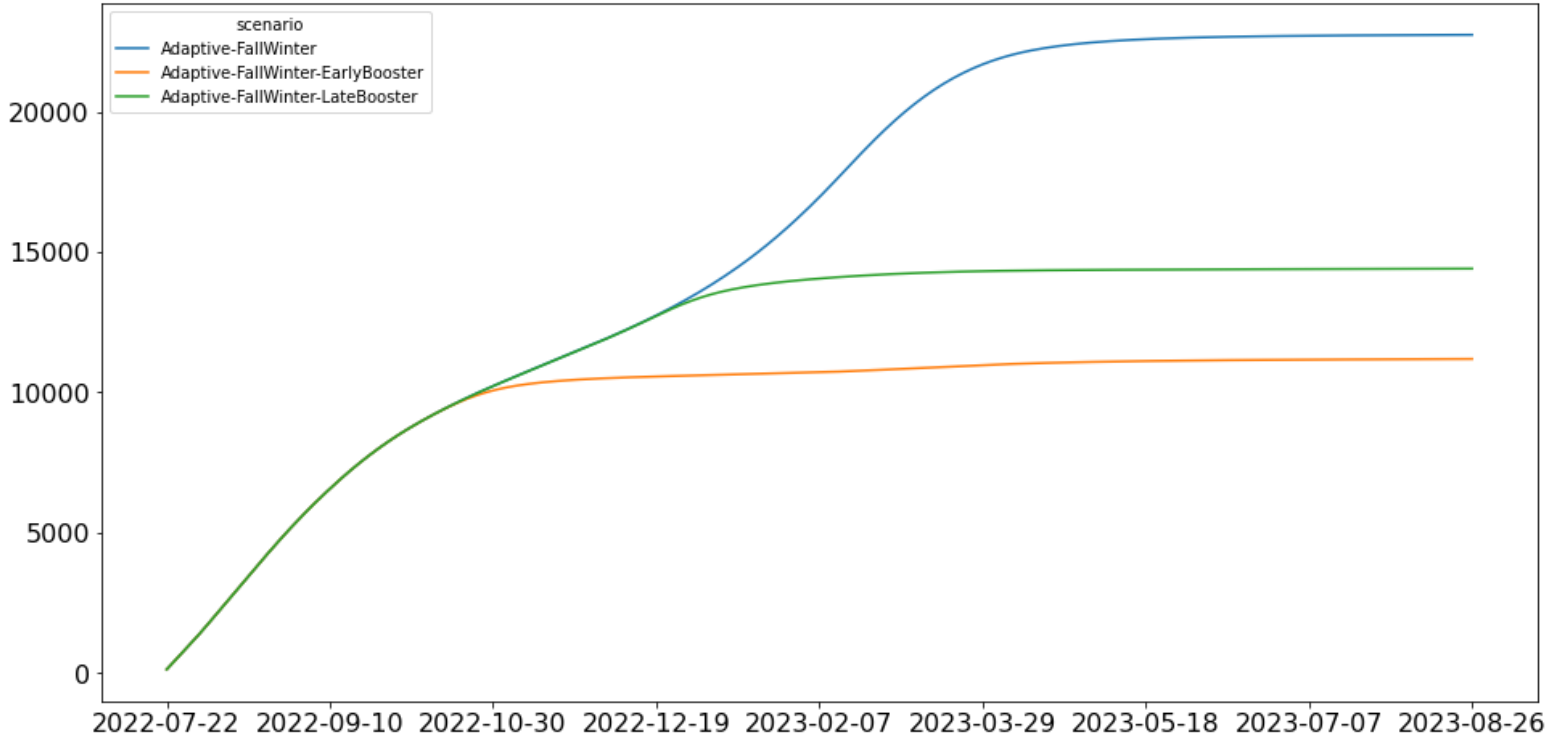




Booster Campaign Timing has impact on future hospitalizations

Booster Campaign can significantly limit future hospitalizations and severe outcomes

- Reduction of 37-50% of future hospitalizations (~8.3K – 11.5K) through Spring 2023
- Early Booster campaign compared to Late Booster campaign could prevent as much as 3.2K (~22%) hospitalizations

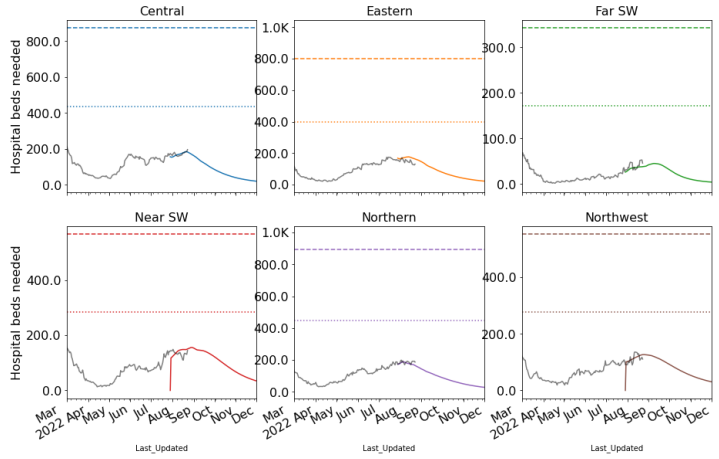


Hospital Demand and Bed Capacity by Region

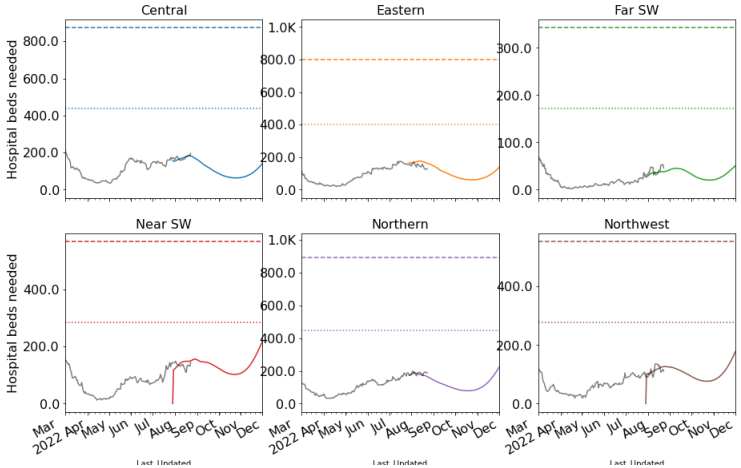
Capacities by Region

COVID-19 capacity ranges from 80% (dots) to 120% (dash) of total beds

Adaptive



Adaptive – VariantX & Fall Winter



Length of Stay more variable with Omicron, occupancy projections may vary as a result, ad-hoc estimation performed per region

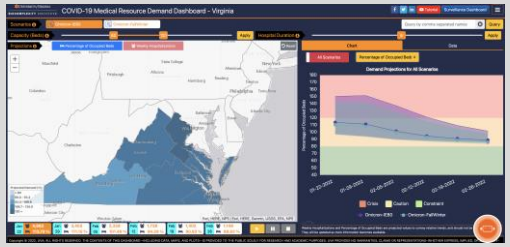
Estimated LOS shortened slightly to better fit observed data

Projections show continued declines and with expanded capacities and adjusted length of stay, no capacities exceeded

Length of Stay Estimates

Central	7
Eastern	6
Far SW	4
Near SW	9
Northern	4
Northwestern	9

Interactive Dashboard with regional projections



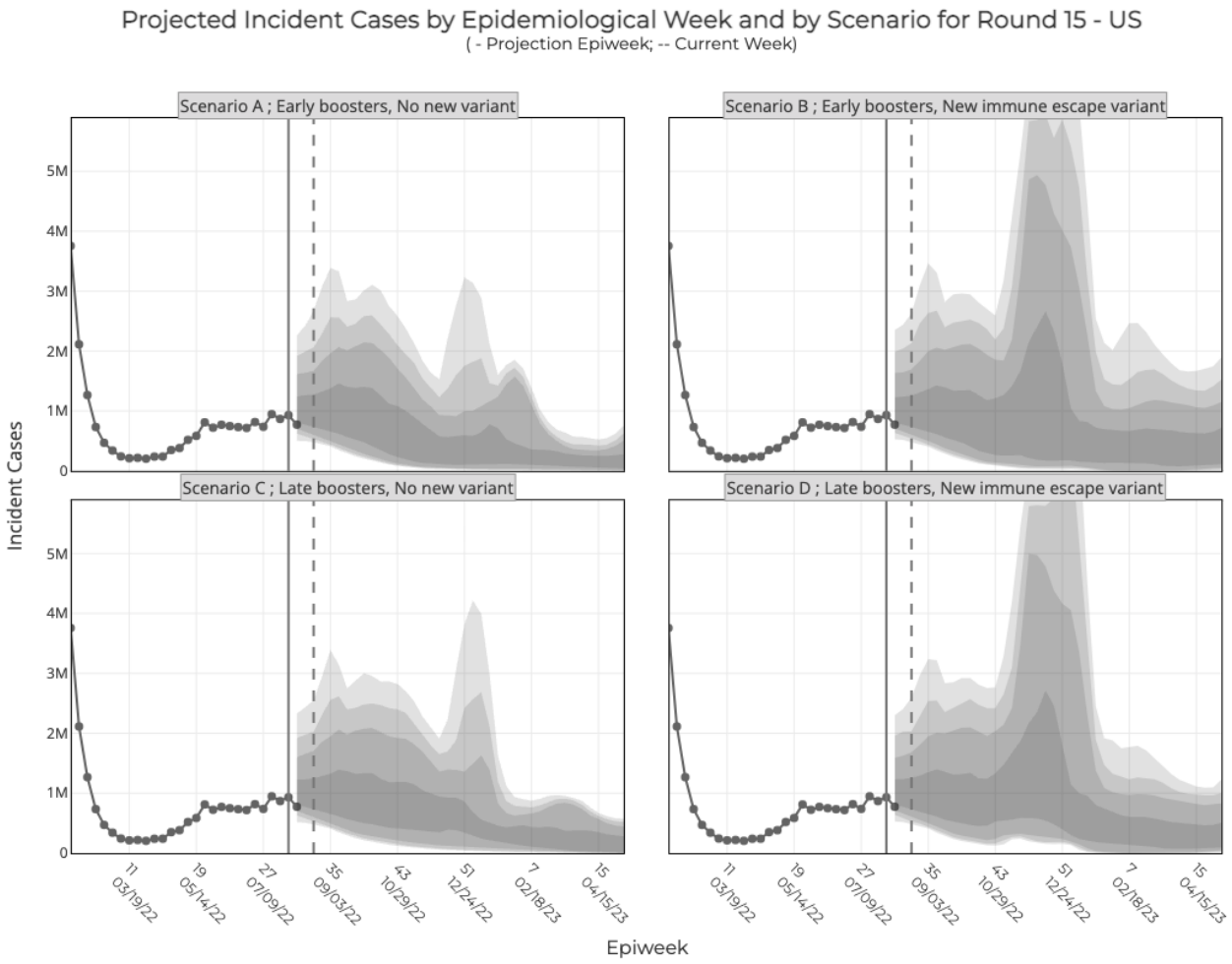
https://nssac.bii.virginia.edu/covid-19/vmrddash/

Scenario Modeling Hub – COVID-19 (Rd15), Flu (Rd1)

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

- Round 15 results published
  - Scenarios: Test benefits of reformulated fall boosters w/ and w/out a new variant
  - Timing of reformulated boosters is one of the axes
- Flu scenarios currently being generated
  - Impact of missed flu seasons on pre-season immunity
  - Testing different seasonal vaccine coverage and efficacy

https://covid19scenariomodelinghub.org/viz.html



Key Takeaways

Projecting future cases precisely is impossible and unnecessary.
Even without perfect projections, we can confidently draw conclusions:

- **Case rates remain high though have continued their decline, hospitalizations have started to follow**
- VA weekly case rate down to 203/100K from 211/100K
  - US weekly case rate is down slightly as well at 189/100K from 207/100K
  - VA hospital occupancy (rolling 7 day mean of 798 slightly up from 786 a week ago) has continued to rise
- Projections anticipate continued declines in cases as well as hospitalizations
- Potential for rebounds due to seasonal forces and/or novel sub-variants in the Fall
- Impact of booster rollout timing is significant in avoiding hospitalizations

The situation continues to change. Models continue to be updated regularly.

References

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Adiga, Aniruddha, Srinivasan Venkatramanan, Akhil Peddireddy, et al. "Evaluating the impact of international airline suspensions on COVID-19 direct importation risk." *medRxiv* (2020)

NSSAC. PatchSim: Code for simulating the metapopulation SEIR model. https://github.com/NSSAC/PatchSim

Virginia Department of Health. COVID-19 in Virginia. http://www.vdh.virginia.gov/coronavirus/

Biocomplexity Institute. COVID-19 Surveillance Dashboard. https://nssac.bii.virginia.edu/covid-19/dashboard/

Google. COVID-19 community mobility reports. https://www.google.com/covid19/mobility/

Biocomplexity page for data and other resources related to COVID-19: https://covid19.biocomplexity.virginia.edu/

Questions?

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