Network Systems
Science & Advanced
Computing

Biocomplexity Institute
& Initiative

University of Virginia

Estimation of COVID-19 Impact in Virginia

October 27th, 2021

(data current to October 23rd – 26th)

Biocomplexity Institute Technical report: TR 2021-113

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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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Key Takeaways

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

- **Case rates in Virginia continue to decline, with nearly all districts declining as well**

- **Case rates are moderating though the rate of decline remains steady**

- VA 7-day mean daily incidence is slightly down to 18/100K from 24/100K; US is also slightly down to 21/100K (from 25/100K)

- Statistical forecasts models show continued declines in the near term

- No major changes in variants, masking, or vax acceptance observed

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

Situation Assessment

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Case Rates (per 100k) and Test Positivity

- Case rate increase across all health districts
- Some past 50% of winter peak and growing
- More than 50% of counties with TPR > 10%

Data source: https://data.cms.gov/covid-19/covid-19-nursing-home-data
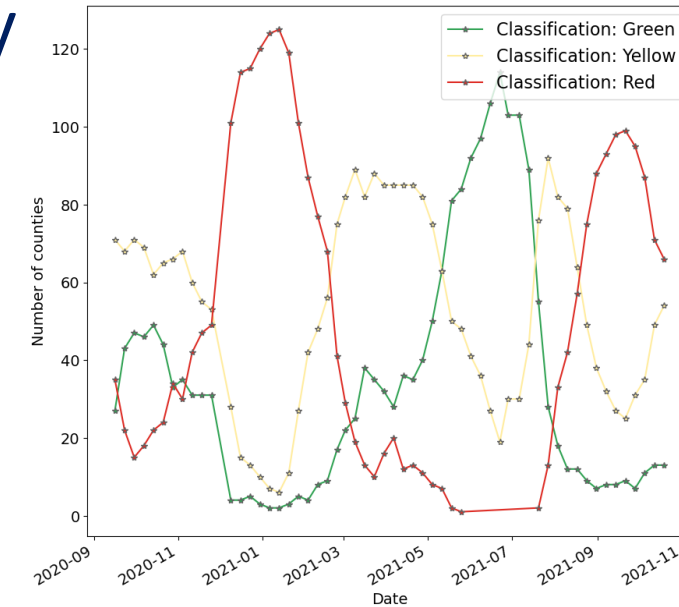
County level RT-PCR test positivity
Green: <5.0% (or <20 tests in past 14 days)
Yellow: 5.0%-10.0% (or <500 tests and <2000 tests/100k and >10% positivity over 14 days)
Red: >10.0% (and not "Green" or "Yellow")

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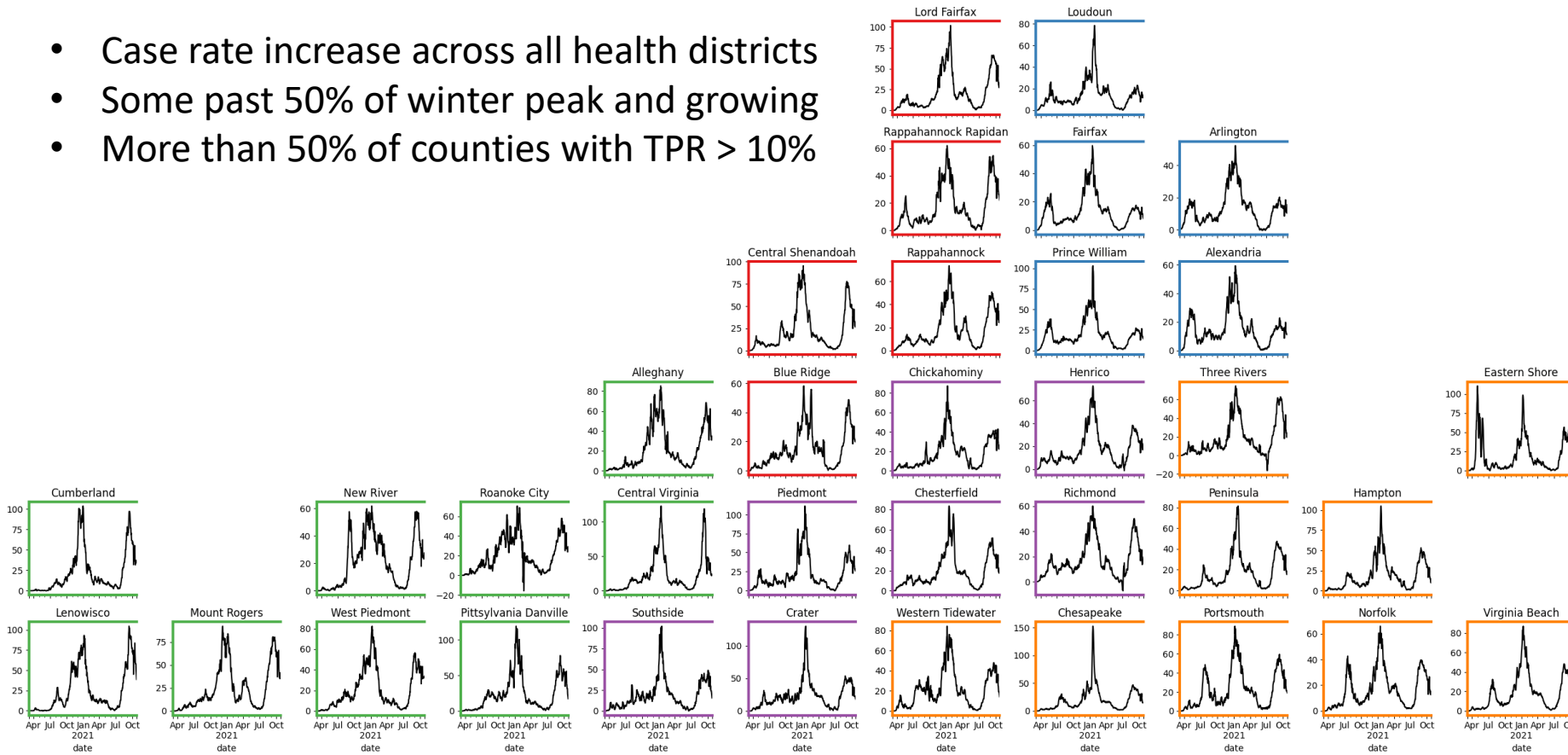
District Trajectories

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
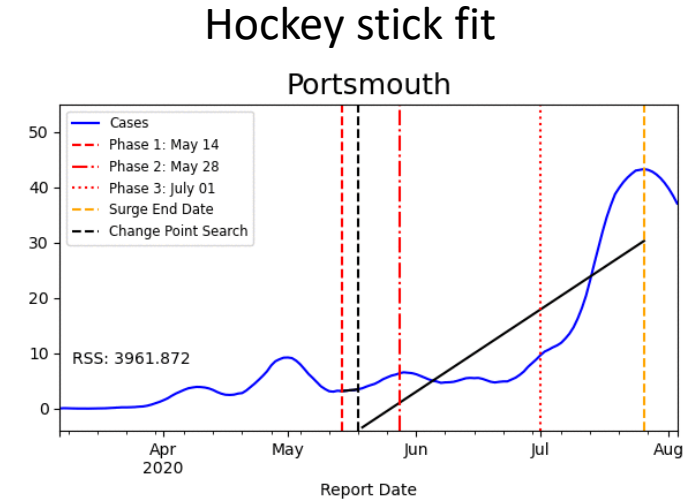
Trajectory	Description	Weekly Case Rate (per 100K) bounds	# Districts (prev week)
Declining	Sustained decreases following a recent peak	below -0.9	32 (31)
Plateau	Steady level with minimal trend up or down	above -0.9 and below 0.5	3 (4)
Slow Growth	Sustained growth not rapid enough to be considered a Surge	above 0.5 and below 2.5	0 (0)
In Surge	Currently experiencing sustained rapid and significant growth	2.5 or greater	0 (0)

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District Trajectories – last 10 weeks

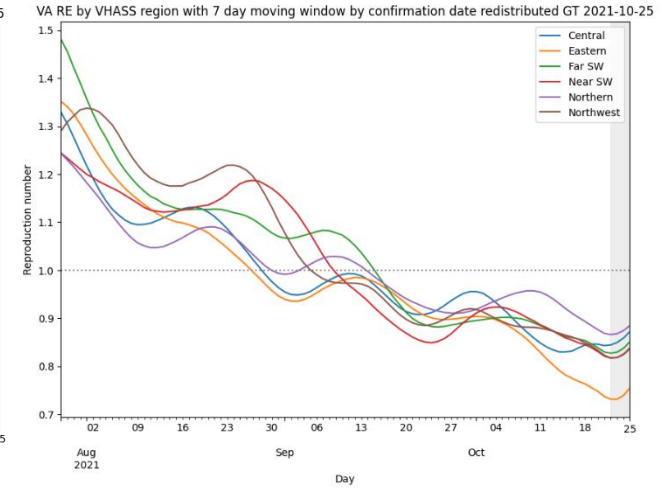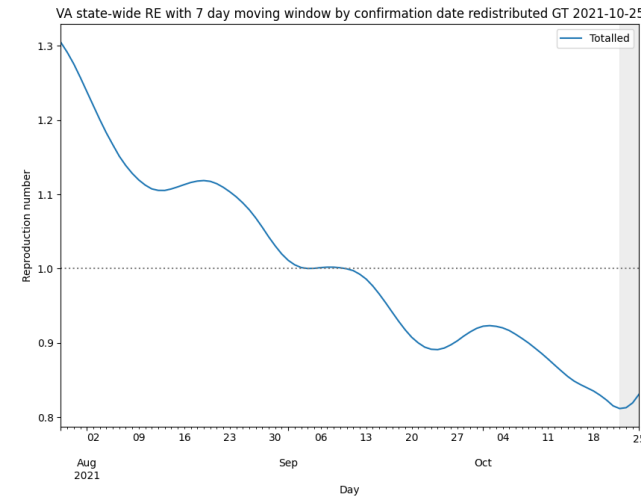| Status	# Districts (prev week)
Declining	32 (31)
Plateau	3 (4)
Slow Growth	0 (0)
In Surge	0 (0)

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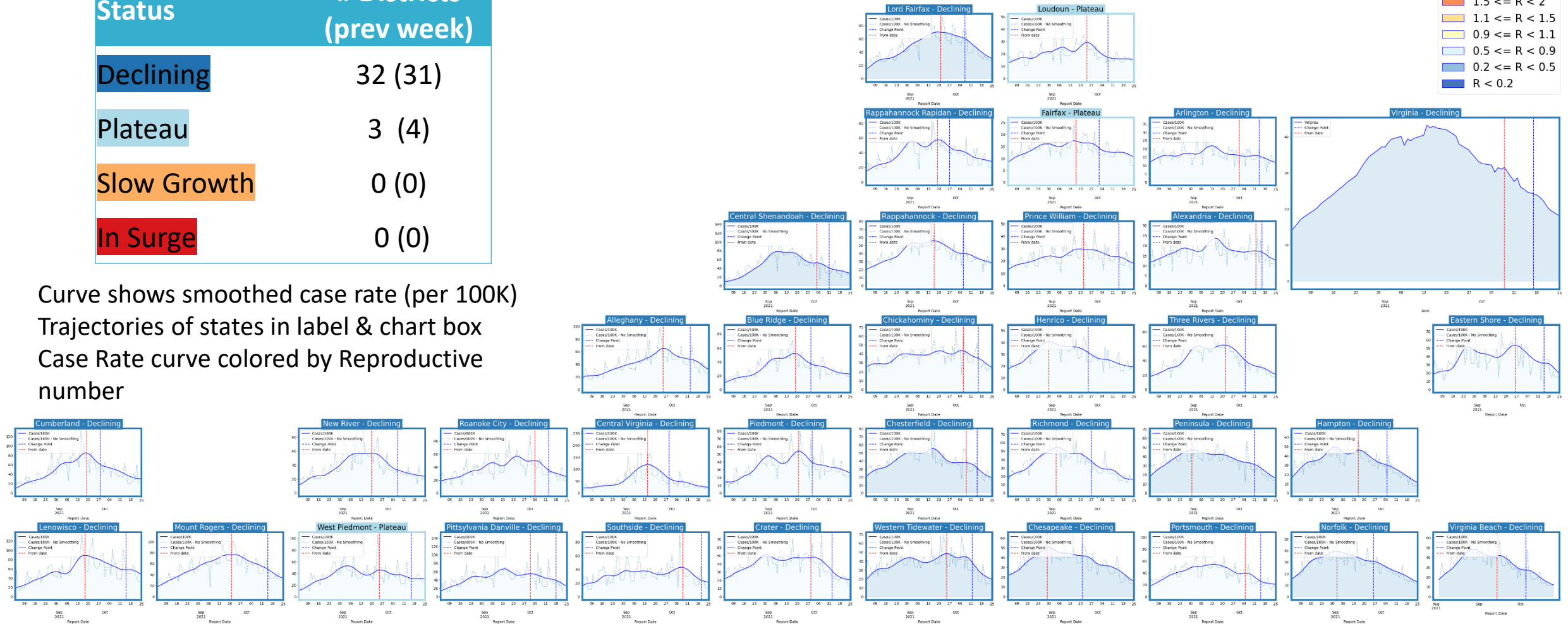
Estimating Daily Reproductive Number – Redistributed gap

Oct 25th Estimates

Region	Date Confirmed R_e	Date Confirmed Diff Last Week
State-wide	0.835	-0.045
Central	0.871	0.053
Eastern	0.752	-0.072
Far SW	0.846	-0.023
Near SW	0.844	-0.044
Northern	0.886	-0.082
Northwest	0.839	-0.054

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

VA state-wide RE with 7 day moving window by confirmation date redistributed GT 2021-10-25

VA RE by VHASS region with 7 day moving window by confirmation date redistributed GT 2021-10-25

Skipping Weekend Reports & holidays biases estimates

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

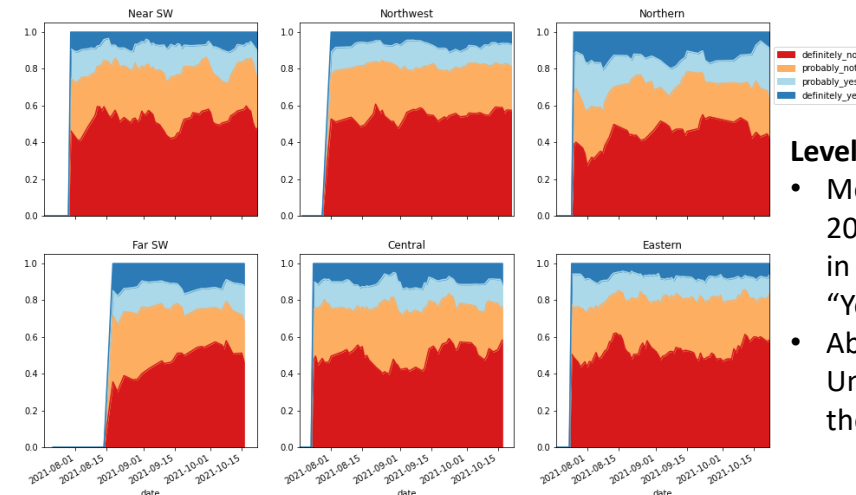Virginia
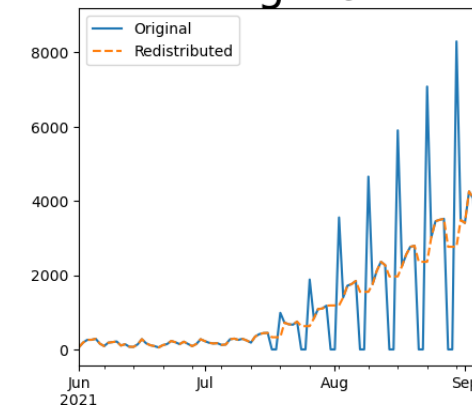
Vaccine Acceptance Components over Time
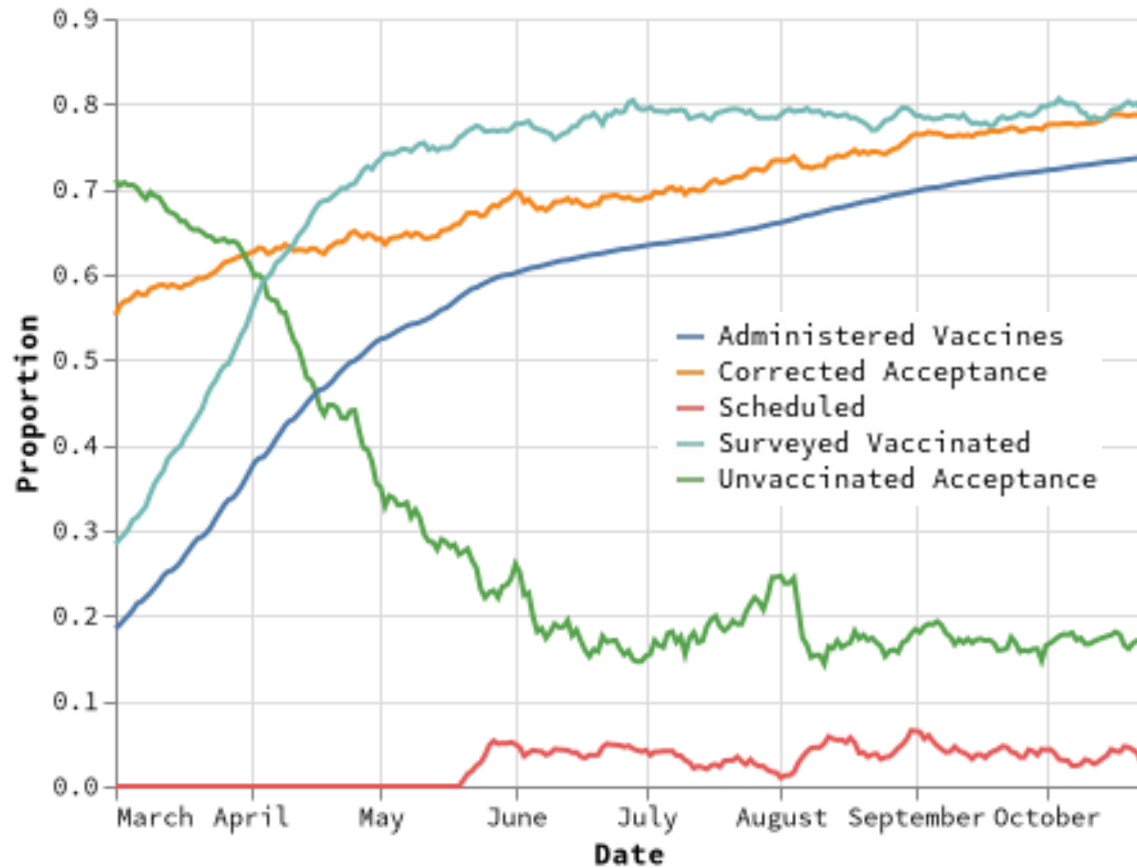
Vaccine Acceptance adjusted to include scheduled appointments

- Steady rise in acceptance over the past couple months
- Unvaccinated Acceptance shows ~20% of those who are unvaccinated are definitely or probably willing to be vaccinated
- Scheduled appointments for vaccination have increased through August but seem to be leveling off

Levels of Vaccine Willingness

Vaccine Readiness, Proportion of Non-Vaccinated

Levels of Acceptance in flux:

- Most regions are steady with 20-30% of unvaccinated still in the Definitely/Probably "Yes" categories.
- About 50% of the Unvaccinated seem to be in the "Definitely Not" category.

Data Source: https://covidcast.cmu.edu

# Reasons for Hesitancy by Likeliness to Accept
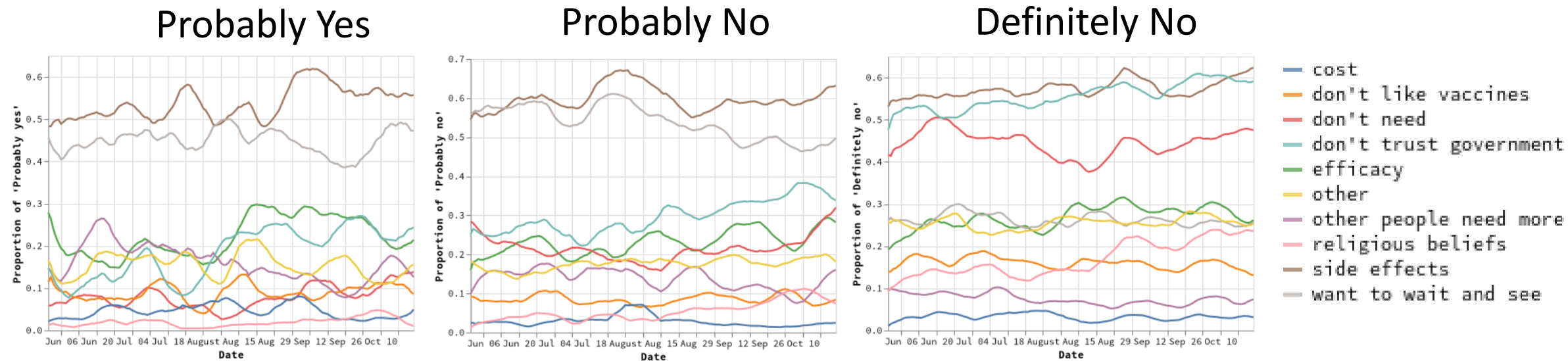
Reasons for Hesitancy vary across tiers of likeliness to accept the vaccine

- Probably Yes and Probably No most concerned about side effects & are waiting to see
- Definitely No are concerned about side effects but also don't think they need the vaccine and don't trust the government, though don't need is declining
- Most other reasons are below 30% within these tiers of likeliness

Data Source: https://covidcast.cmu.edu

Mask Usage Stalls

Self-reported mask usage has plateaued out to ~65%, perhaps slight decline starting
- US and VA similar, though with considerable variation across counties and states
- Mask wearing remains lower amongst unvaccinated especially among least willing to be vaccinated


Data Source: https://covidcast.cmu.edu

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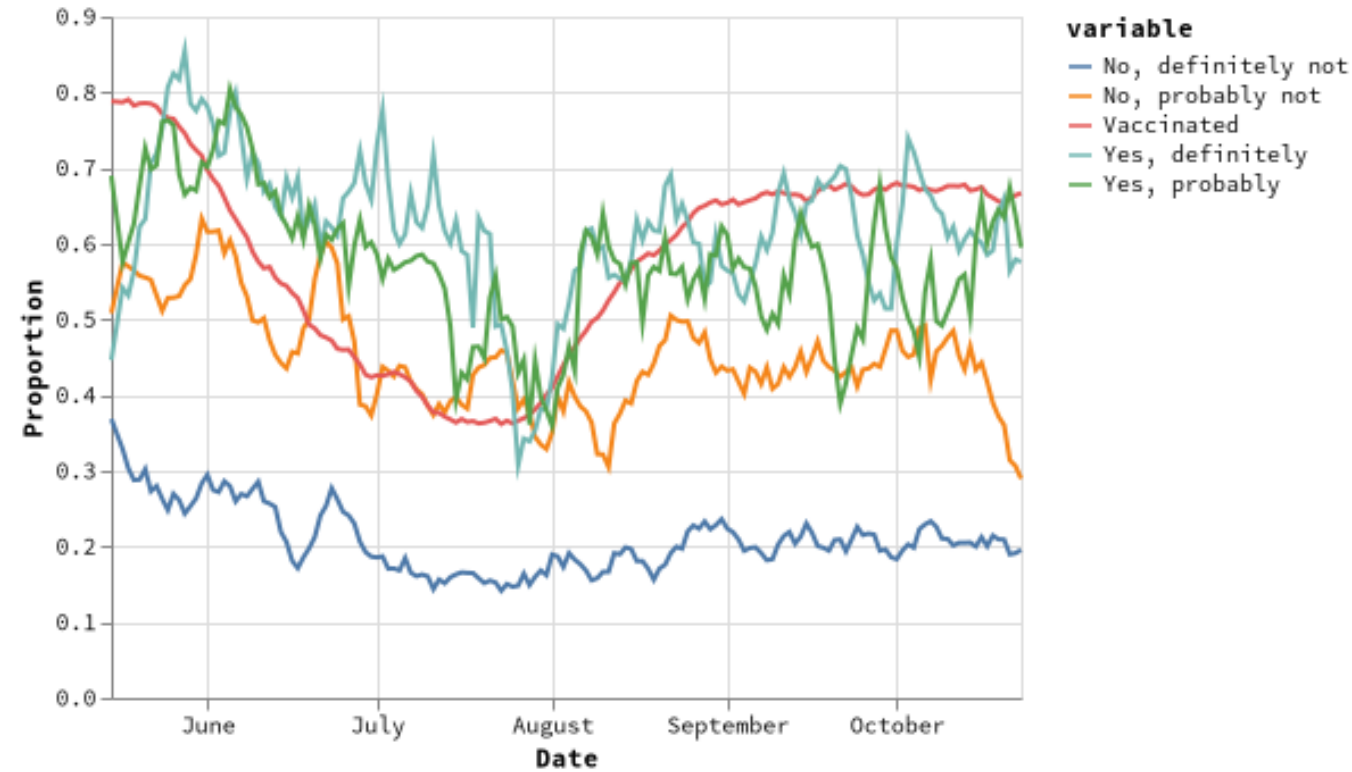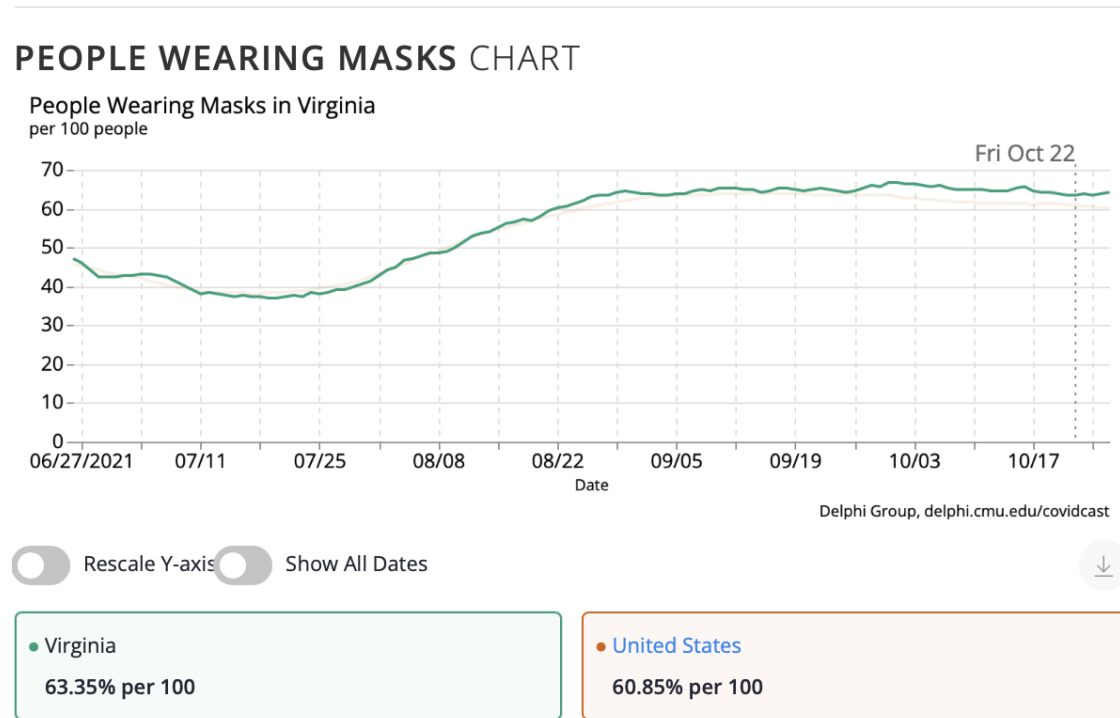
SARS-CoV2 Variants of Concern

Delta δ - Lineage B.1.617.2 and related subvariants

- Delta plus δ+ lineage which contains the K417N mutation is emerging as a sub-variant that is even more transmissible; declared a VoC in India

- Delta variant now dominates most of Europe and US

- CDC recommends resumption of mask wearing indoors due to reports of breakthrough infections of the vaccinated possibly being transmissible

- Recent study from Mayo clinic shows Delta reducing the efficacy of mRNA vaccines (Pfizer more so than Moderna) along with other reports. Israeli study showed 64% efficacy against infection, however, a 3rd dose may counteract this reduction

- Public Health Scotland study in Lancet suggests Delta is 2x more likely to cause hospitalization than Alpha

- Subvariants AY.3 and AY.4 with some significant recent variability (some AY.4 are most prevalent in limited recent observations)
  - While there are limited genomes submitted, these subvariants are mainly clustered in the US, others mainly outside of US
  - More non-US AY.X subvariants are being found in VA as they are being defined.
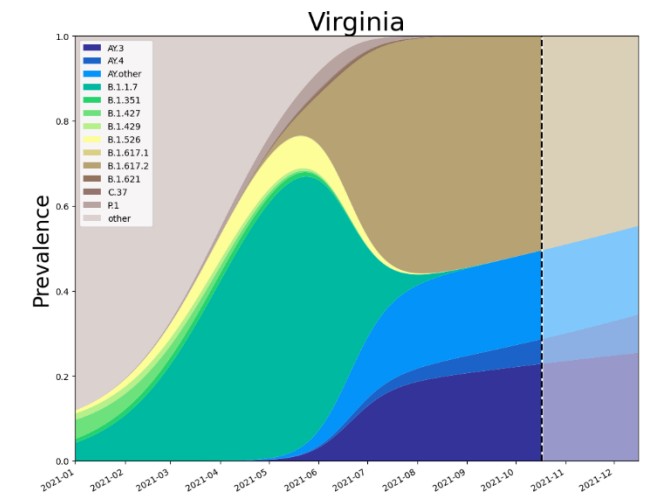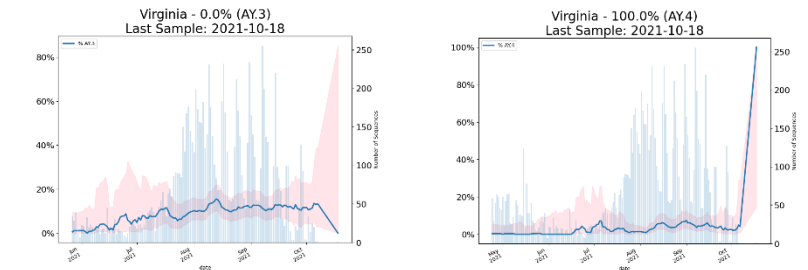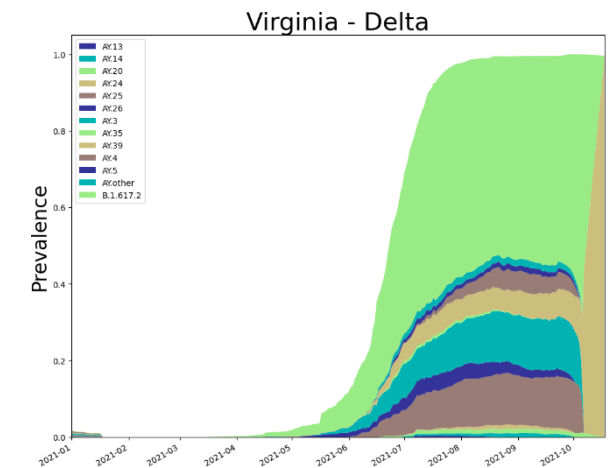
Current fits suggest stable mix of Delta & subvariants into the future
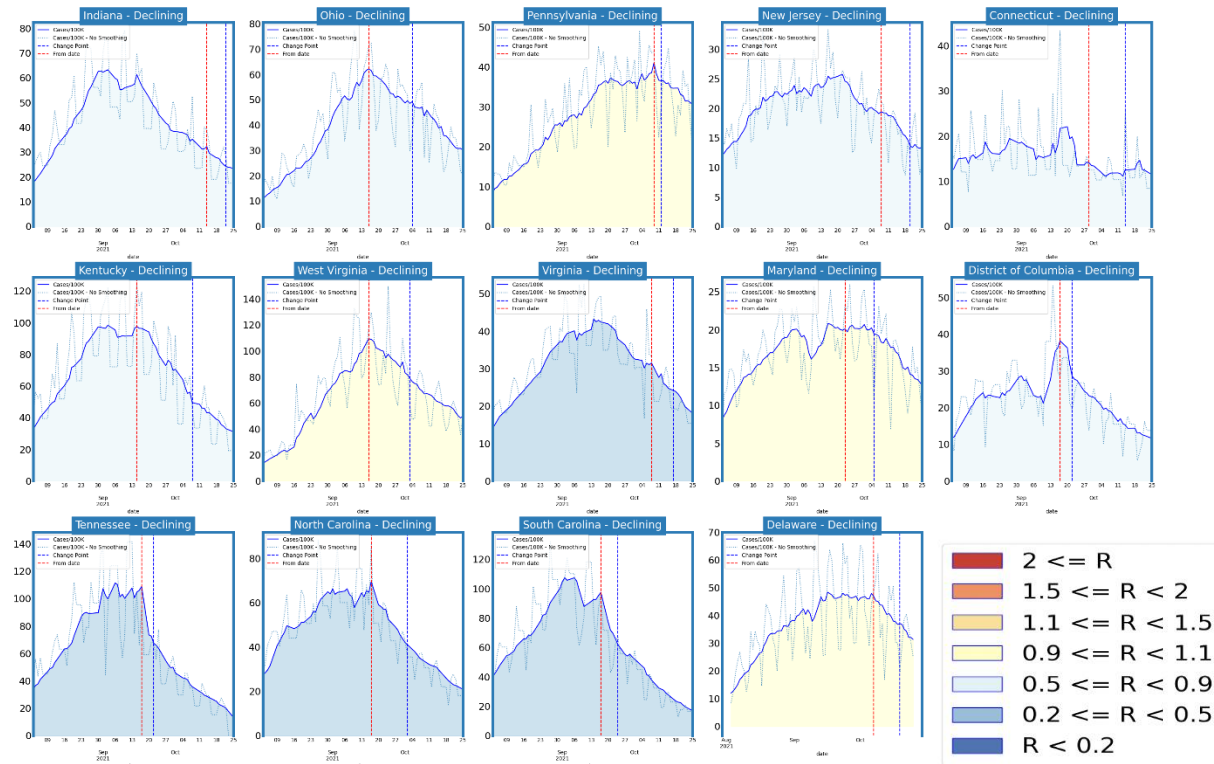
Other State Comparisons

Trajectories of States

Virginia and her neighbors
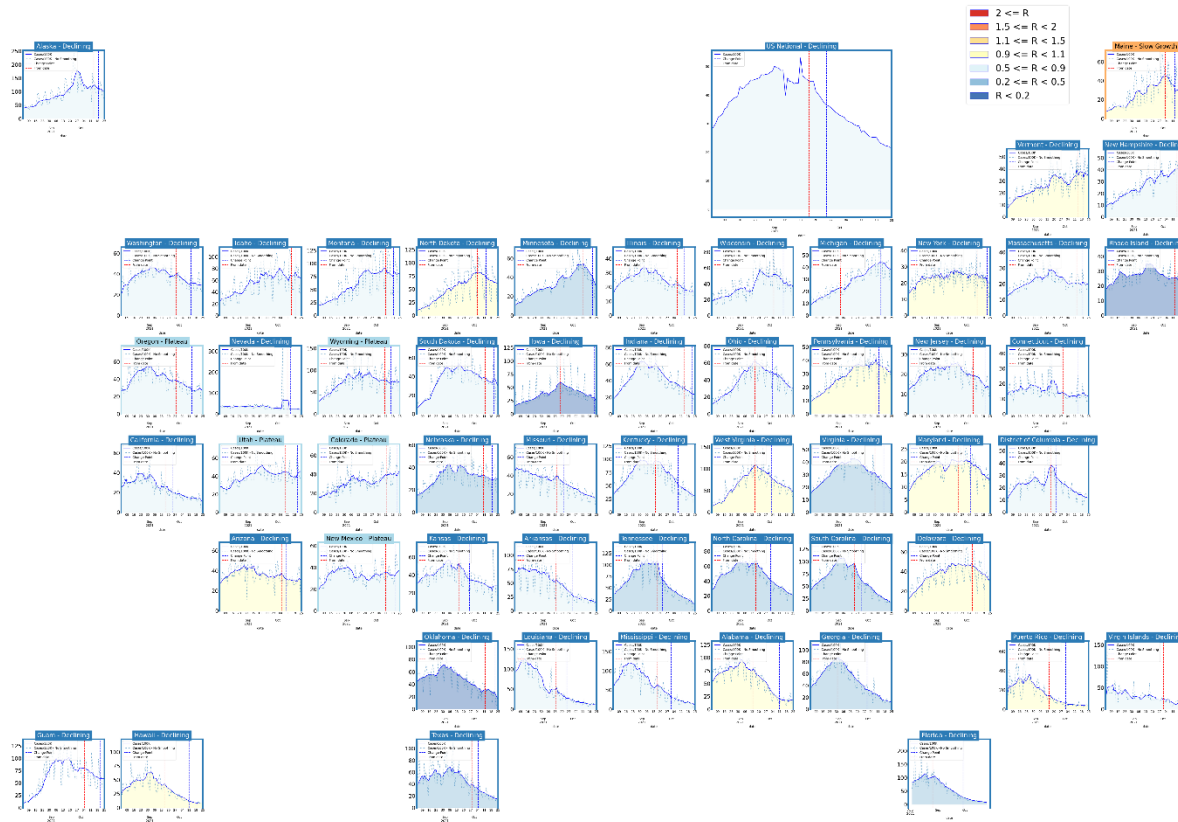
- Most states continue to decline (48)
- Very few states (1) remain in growth, with some in plateau (5)
- Case rates remain high, but nationally rates have been in sustained decline

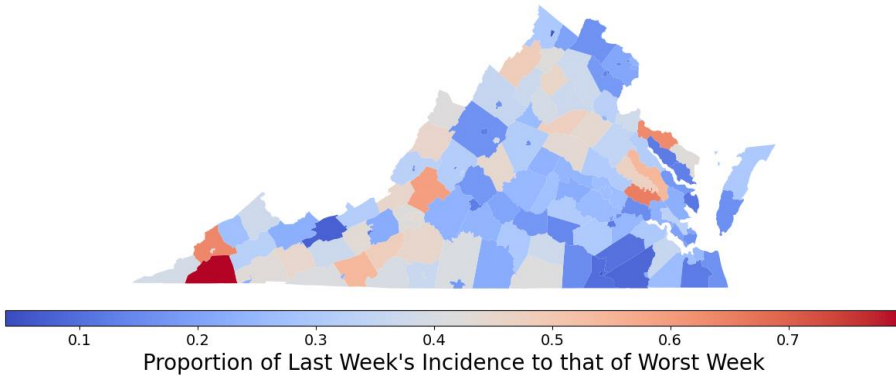- All neighbors now in sustained decline or have started plateauing around 10/100K
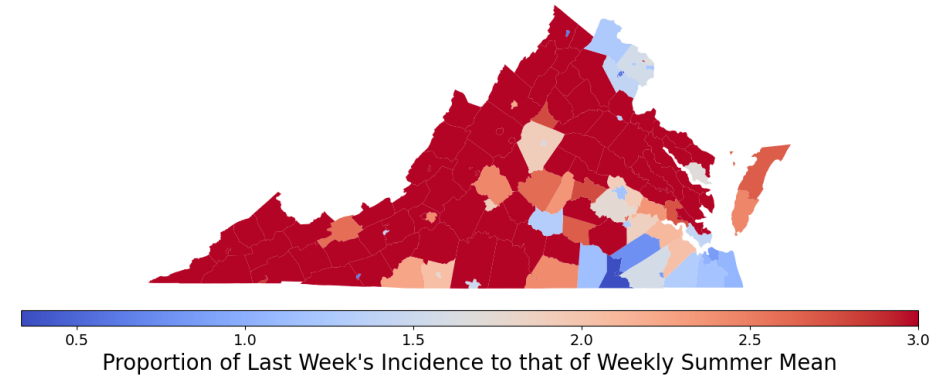- Case rates are now moderating

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Last Week compared to the worst and the best

County level Case Rates (per 100K) proportion when comparing this most recent week to:
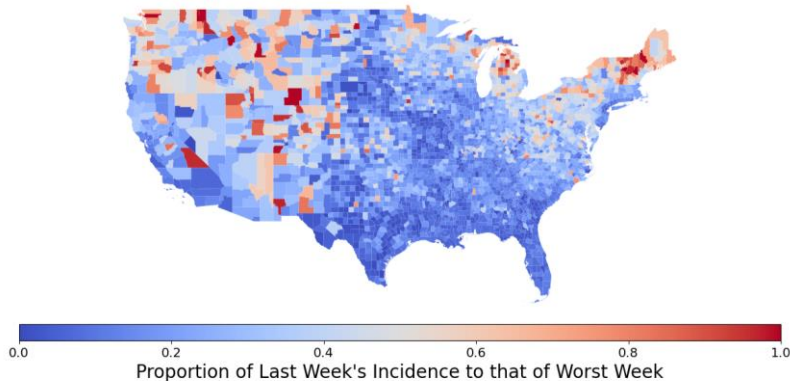
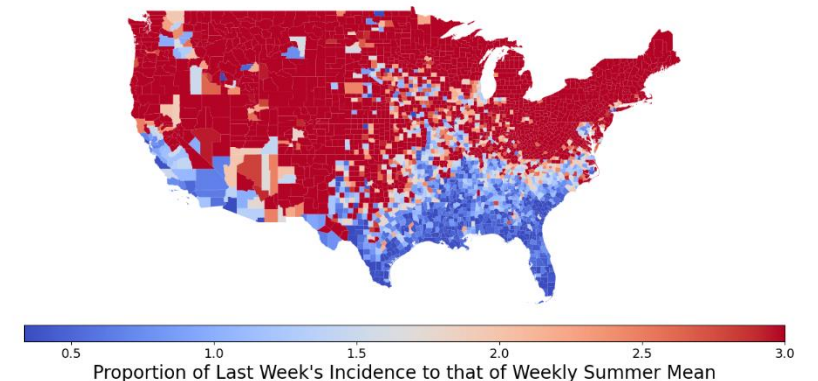**Worst Week of the Pandemic**

Summer 2020 mean

Recent Incidence Compared to Worst Week by County

Recent Incidence Compared to Weekly Summer Mean by County
Mean: 75.24; Median: 3.02; IQR: 1.16-8.05

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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.
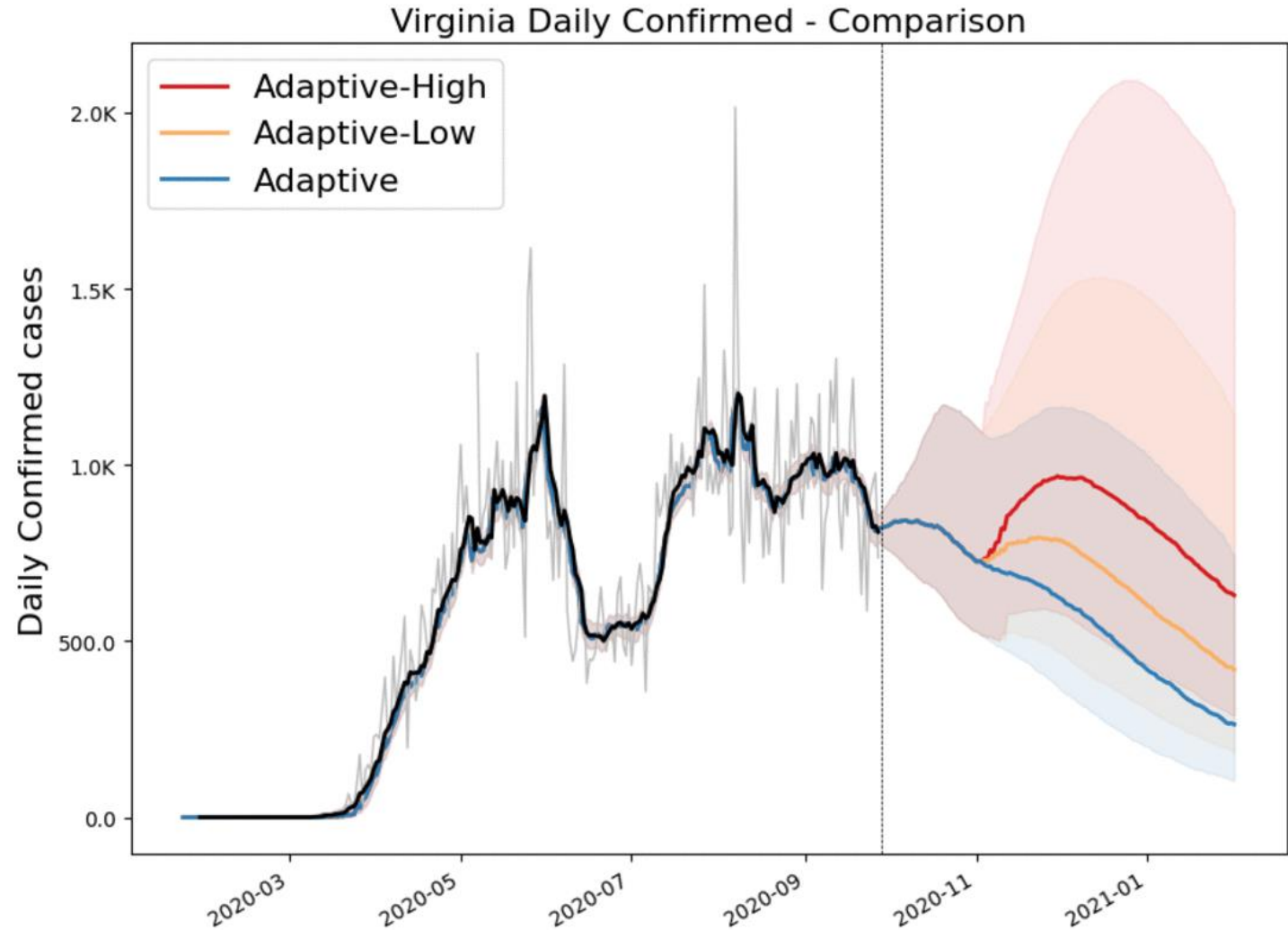
Also submitted to CDC Forecast Hub.

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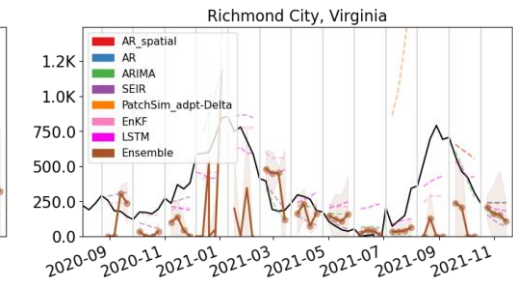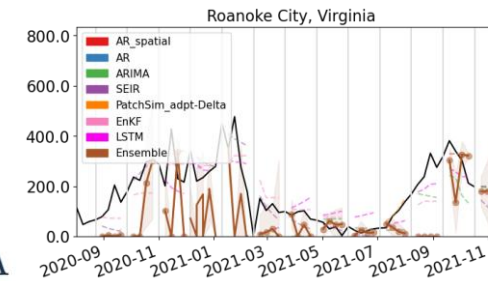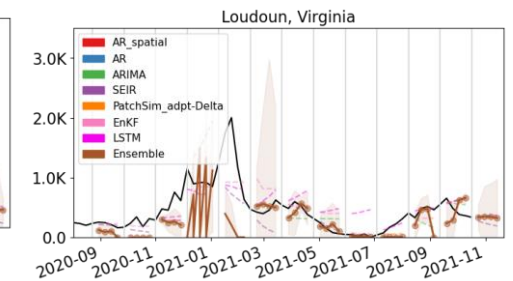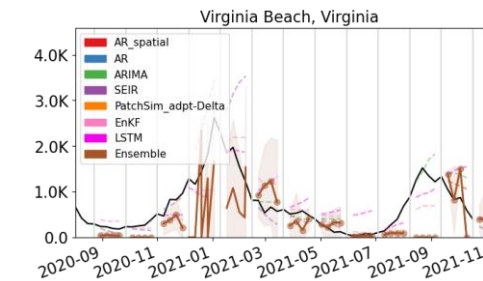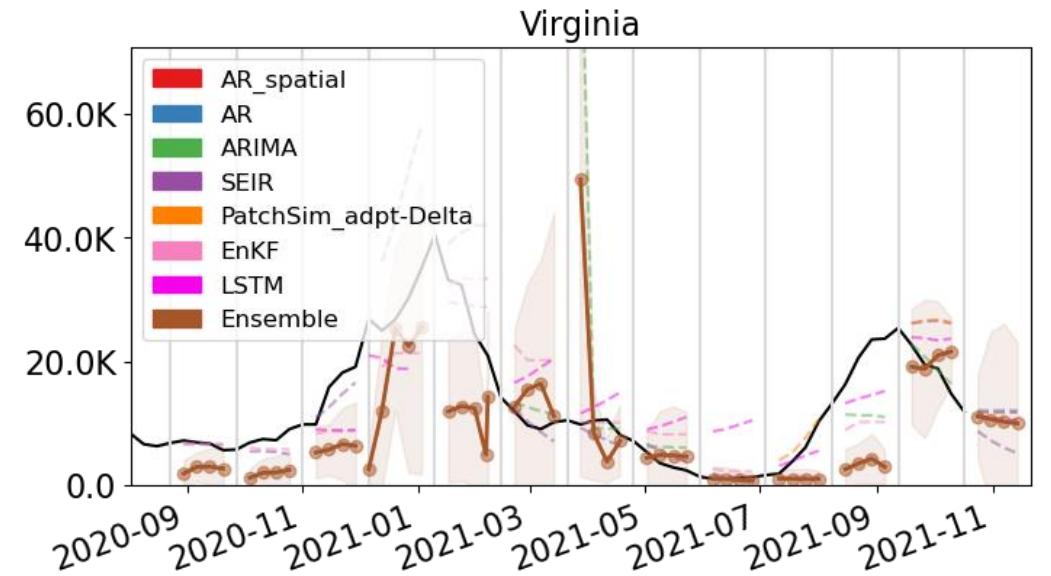
Review of "A Year of Projections"

Confirmed case Projections
Adaptive Approach with associated other projections

Sept 30th, 2020 to
Oct 20th, 2021

Virginia Daily Confirmed - Comparison

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Key Takeaways

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Even without perfect projections, we can confidently draw conclusions:

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