

Flu Scenario Modeling Hub Report

23 December, 2022 Scenario Modeling Hub Team¹

Key Takeaways from the Third Round

Full scenario specifications can be found here.

In Round 3, we produced mid-season projections of influenza in the US, using data up through December 3, 2022. In the four scenarios, we continued to assess the impact of vaccination effectiveness and reduced residual immunity during the 2022-2023 influenza season, a result of reduced transmission of influenza during the COVID-19 pandemic. Ensemble projections are based on contributions from 12 teams (10 nationally) and cover the period from Dec 4, 2022 to June 3, 2023. Scenarios were identical to Round 2, with an additional 3 weeks of calibration data.

- In the most pessimistic scenario, with low vaccine effectiveness and pessimistic pre-existing immunity, weekly hospitalizations are projected to peak at 47,800 nationally (50% PI, 33,300-69,800). In this scenario, peak hospitalizations have a substantial likelihood to exceed the peak of the severe 2017-18 season (n = 34,385 hospitalizations).
- Irrespective of scenario, ensemble hospitalizations are projected to peak in mid- to late-December, 2022, though there is variability between states. Some states whose epidemics started later are expected to peak in January.
- Increased vaccine effectiveness is expected to decrease both the peak and cumulative hospitalizations. Higher vaccine effectiveness has a more pronounced effect on the overall burden in the optimistic immunity scenario (likely because the epidemic is projected to occur later, when a larger fraction of the population is effectively immunized). We project that high vaccination effectiveness decreases cumulative hospitalizations by 27.3% in high immunity scenarios, but only by 14.8% in low immunity scenarios.
- There is substantial agreement in the trajectory of individual models in this round.
- At the time of this report, the national trajectory of hospitalizations is declining, falling below the most pessimistic scenario, but still within the other scenarios. It is possible the US has already peaked nationally, though there is substantial variability at the state-level. Additionally, a resurgence remains possible.

A few caveats are worth noting:

• The amount of calibration data available for the new HHS influenza dataset remains limited, and testing practices could change between and within seasons. Similarly, the amount of death data available for calibration is limited.

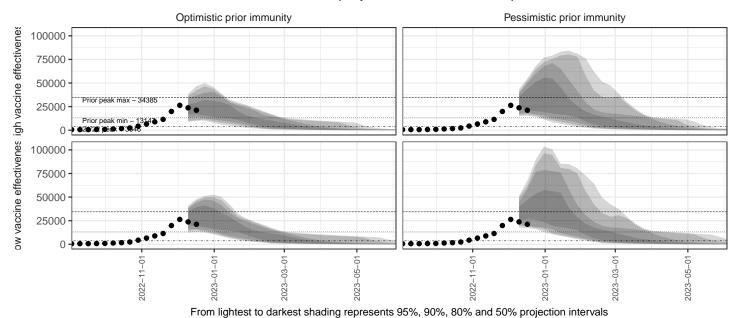
¹Compiled by Sara Loo, Shaun Truelove, Cecile Viboud, Lucie Contamin, Harry Hochheiser.

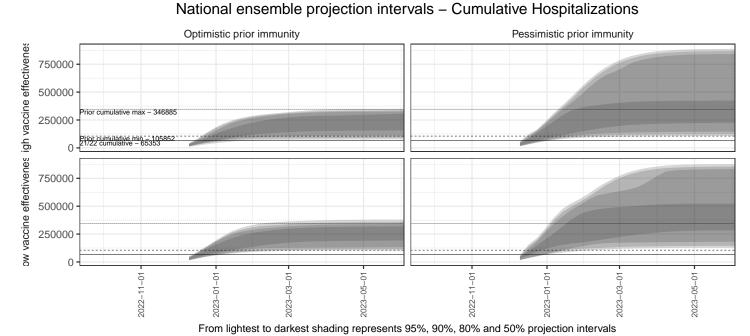
Round 3 Scenario Specifications

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

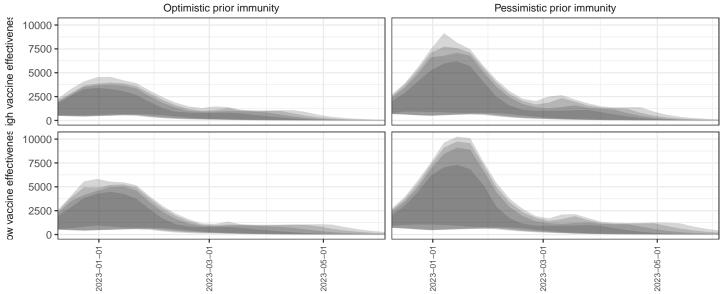
${\bf Ensemble\ projection\ intervals}$

National ensemble projection intervals - Hospitalizations



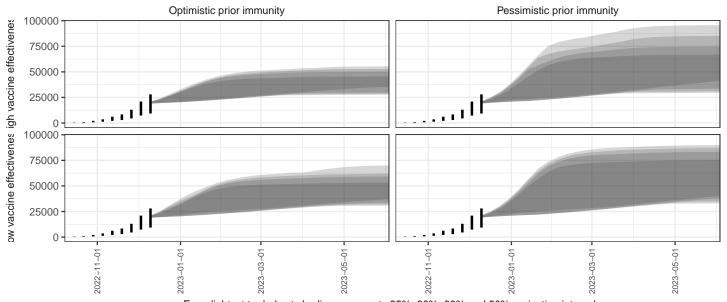


National ensemble projection intervals – Deaths



From lightest to darkest shading represents 95%, 90%, 80% and 50% projection intervals

National ensemble projection intervals – Cumulative Deaths



From lightest to darkest shading represents 95%, 90%, 80% and 50% projection intervals

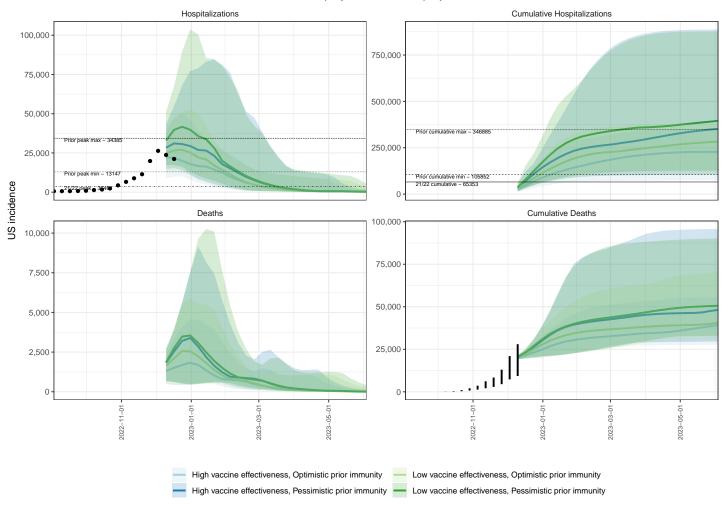
Horizontal lines are given for prior peak incident and cumulative hospitalizations, from seasons from 2012-13 to 2019-20. The minimum and maximum peaks across these seasons are taken from FluSurv-NET (which is used as a proxy for hospitalizations). Nationally, the highest value is from the 2017-18 season, and the lowest from 2015-16. The 2021-22 flu season based on HHS data is also included to mark a small season.

Cumulative death observations are visualized as vertical bars, and are based on in-season death estimates provided by the CDC multiplier approach, which takes into account in-hospital flu deaths reported to FluSurv-NET, propensity to test for flu in the hospital, and risk of dying of flu outside of the hospital. Bars represent 95% uncertainty intervals. Cumulative estimates are shown since the start of the flu season on Oct 1, 2022.

National ensemble projections

Ensemble projections for national incident and cumulative hospitalizations and deaths separated by scenario.

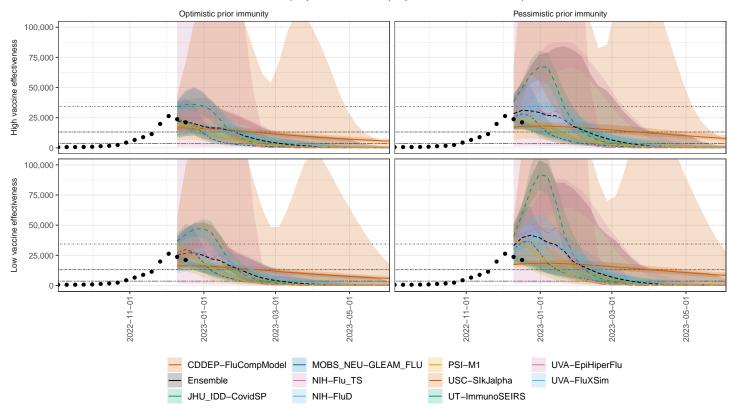
US ensemble projections & 95% projection intervals



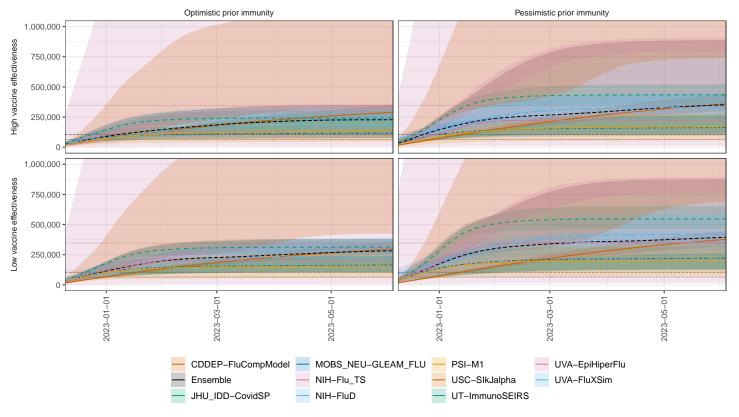
National individual model projections

Individual model projections and ensemble by scenario for national hospitalizations, deaths and cumulative hospitalizations. For visualization we set axes limits; full confidence intervals are shown as a supplemental plot on page 17-18.

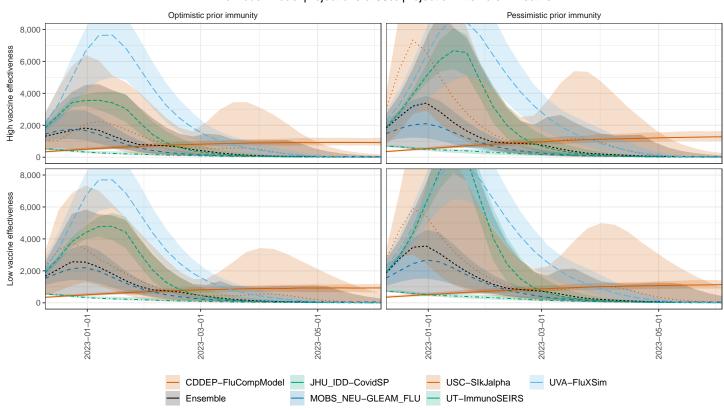
Individual model projections & 95% projection intervals - Hospitalizations



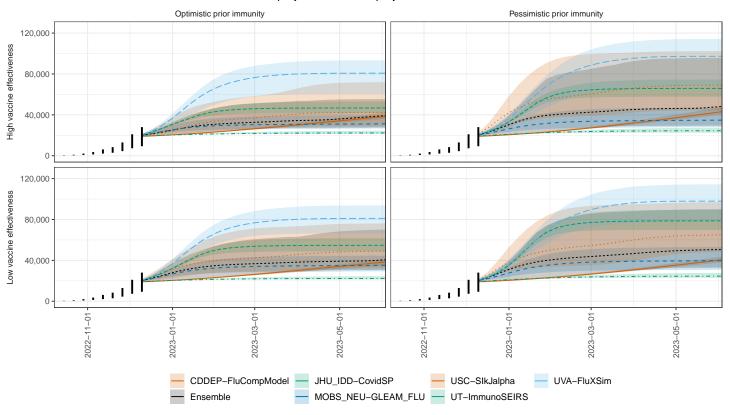
Individual model projections & 95% projection intervals - Cumulative Hospitalizations



Individual model projections & 95% projection intervals – Deaths

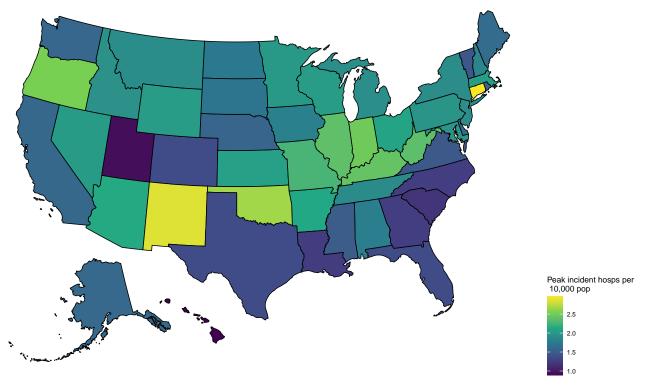


Individual model projections & 95% projection intervals - Cumulative Deaths

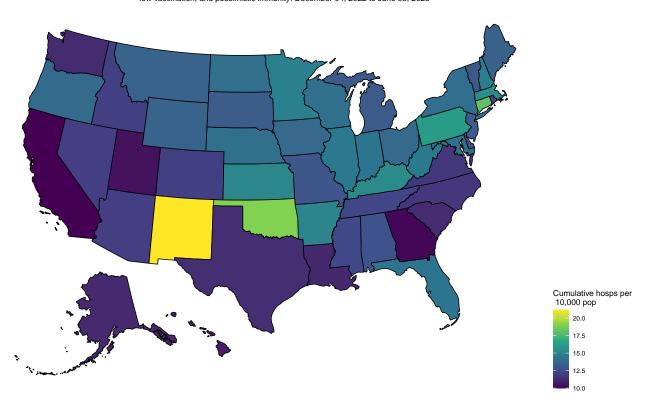


Risk maps

Peak incident reported hospitalizations per 10,000 population in scenario with low vaccination, and pessimistic immunity: December 04, 2022 to June 03, 2023



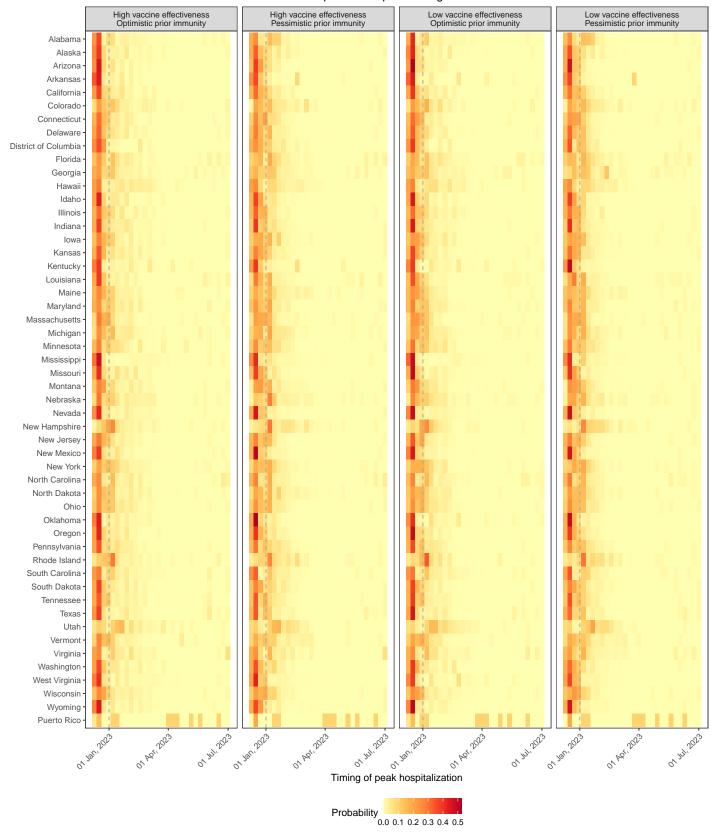
Cumulative reported hospitalizations per 10,000 population in scenario with low vaccination, and pessimistic immunity: December 04, 2022 to June 03, 2023



State variability in peak timing

Ensembles projections for state-level timing of peak hospitalization incidence.

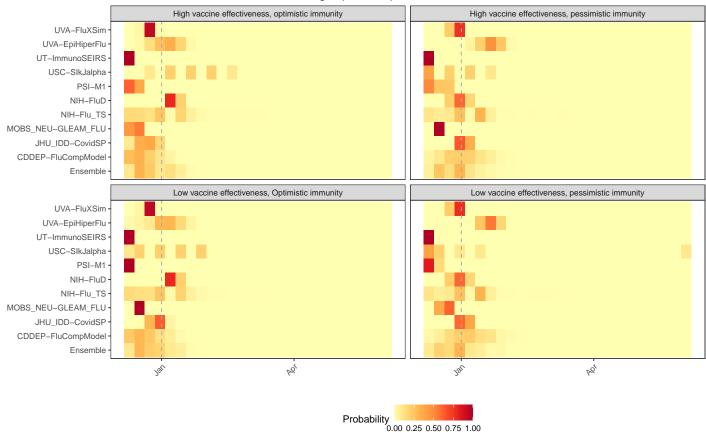
Hospitalization peak timing variation



Peak hospitalizations timing

Individual model probabilities for national timing of peak hospitalizations.

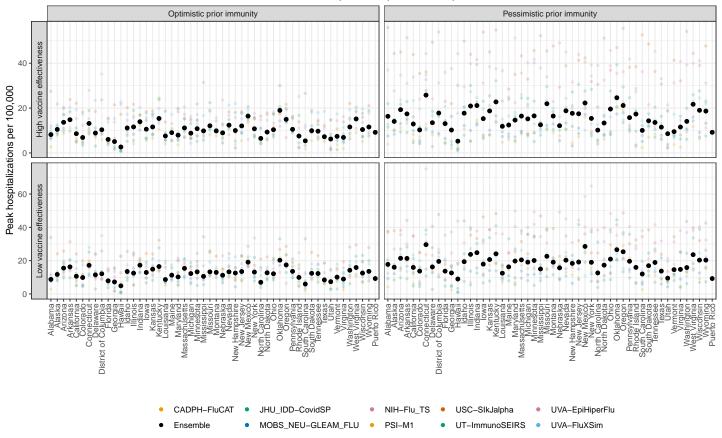
Timing of peak hospitalization across models



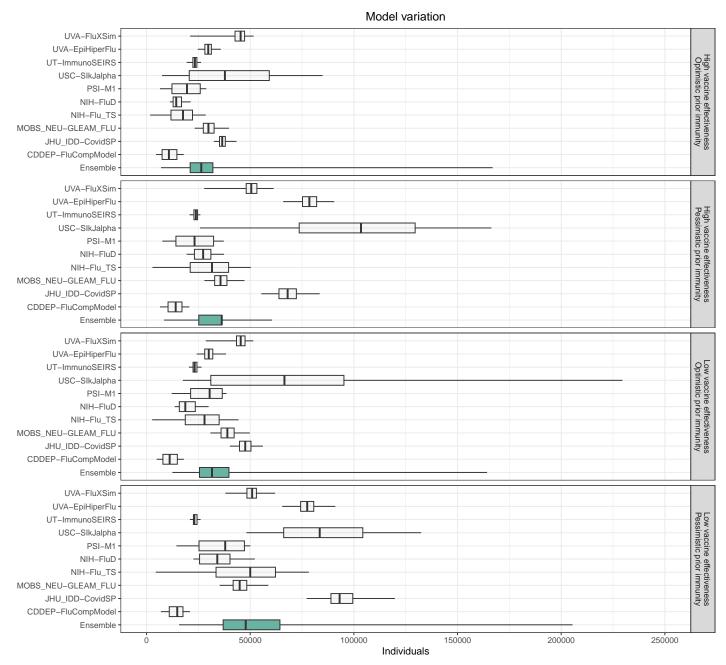
State-level deviation in hospitalization incidence

Individual model and ensembles projections for state-level peak hospitalization incidence.

State variation in peak hospitalizations per 100,000



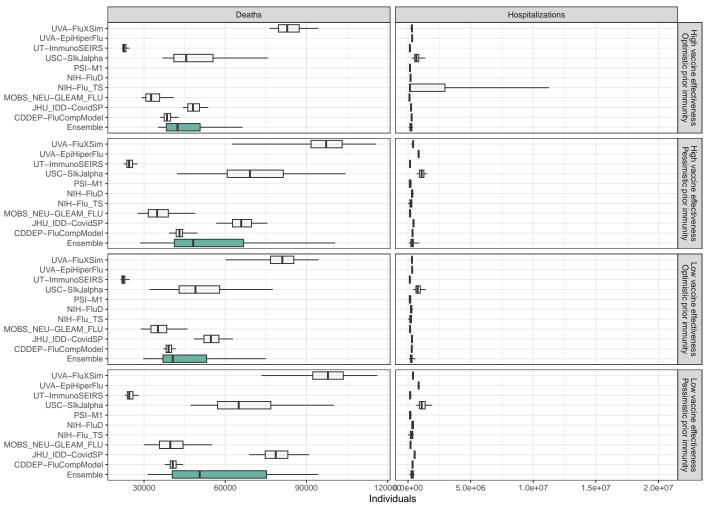
Model Variation in National Peak Size



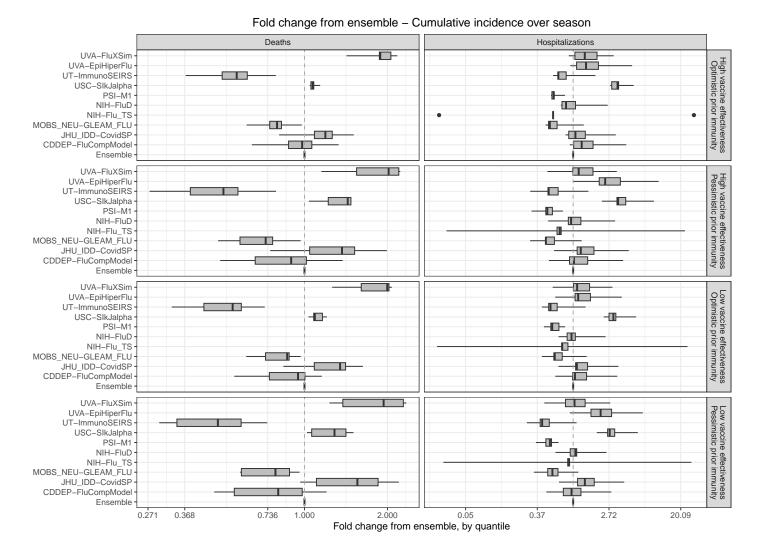
Outliers are removed from boxplots for visualization.

Cumulative incidence over season by model

Model variation - Cumulative incidence over season

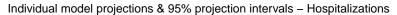


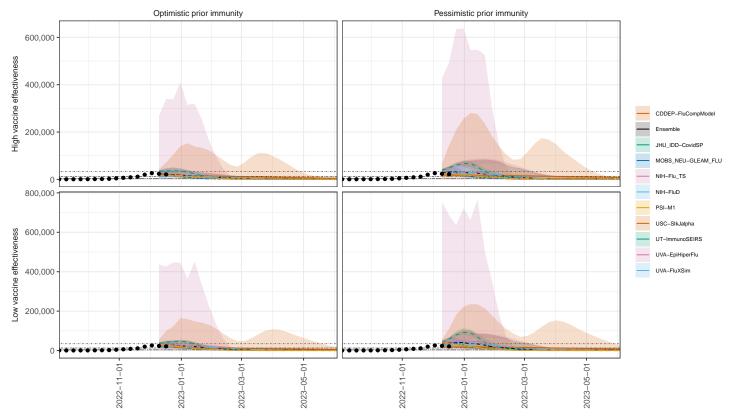
Difference between model and ensemble distributions



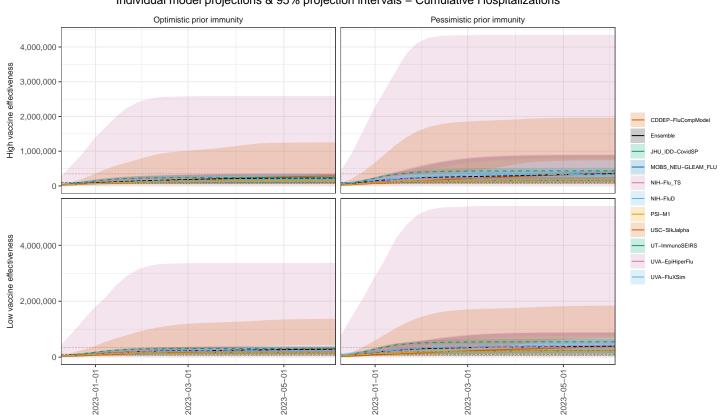
Supplemental Plots

National individual model projections - full confidence intervals

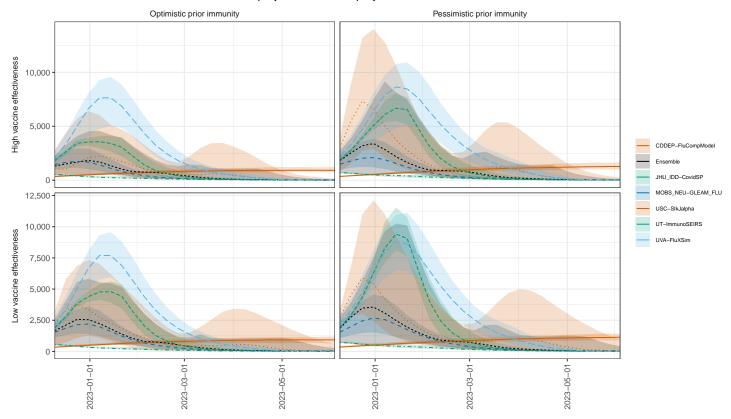




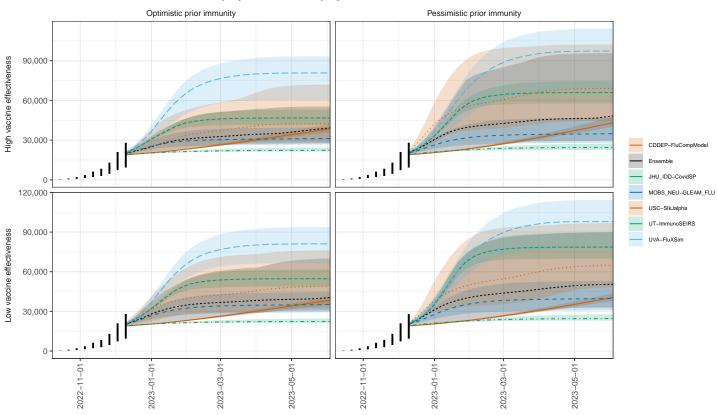
Individual model projections & 95% projection intervals – Cumulative Hospitalizations



Individual model projections & 95% projection intervals - Deaths



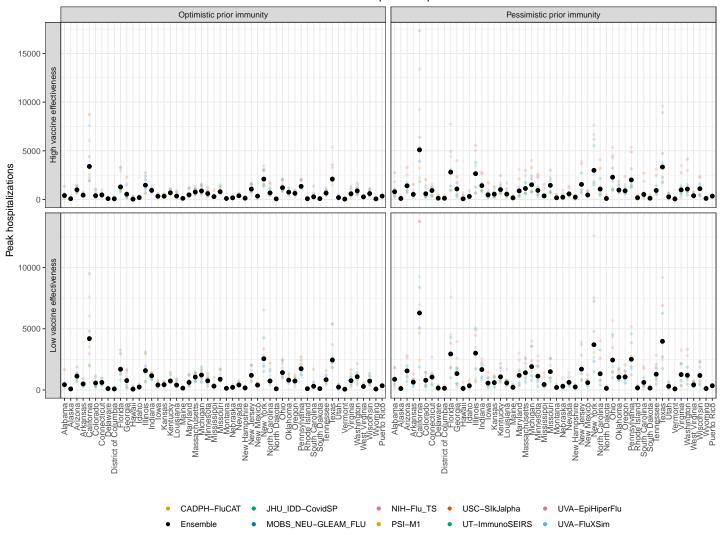
Individual model projections & 95% projection intervals - Cumulative Deaths



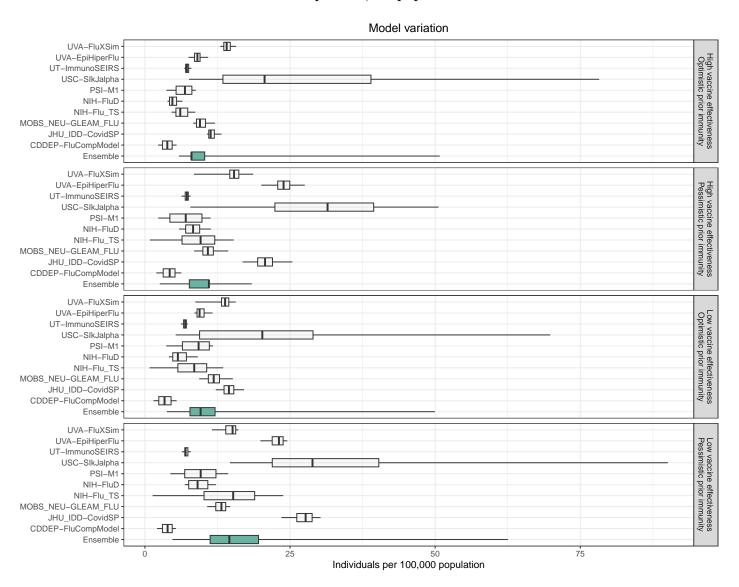
State-level deviation in hospitalization incidence

Individual model and ensembles projections for state-level peak hospitalization incidence.

State variation in peak hospitalizations

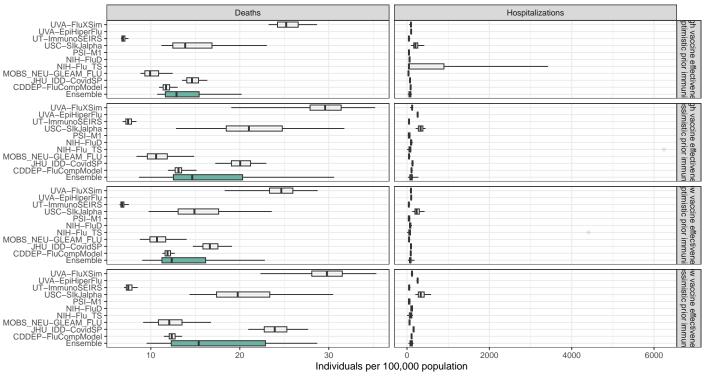


Model Variation in National Peak Size - rates per 100,000 population



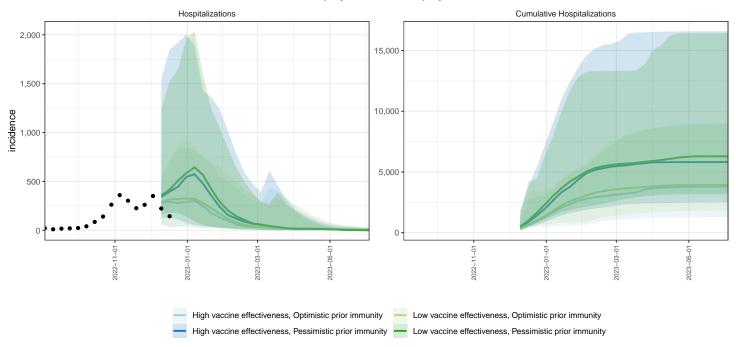
Cumulative incidence over season - rates per $100,\!000$ population

Model variation - Cumulative incidence over season

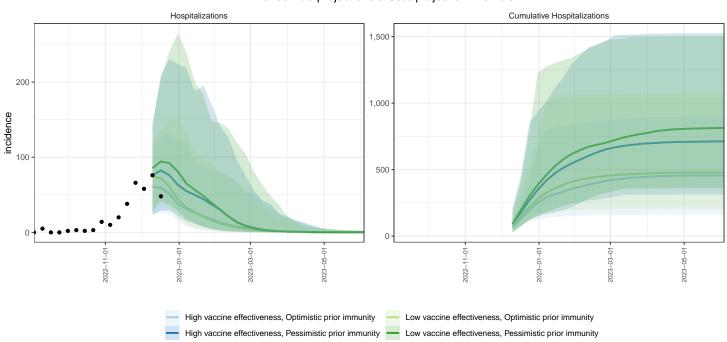


State-level ensemble plots

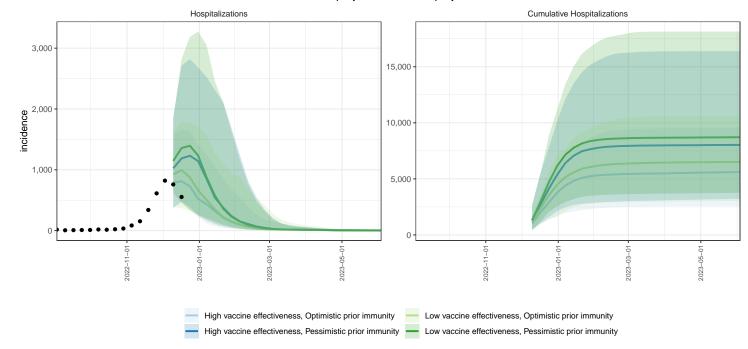
AL ensemble projections & 95% projection intervals



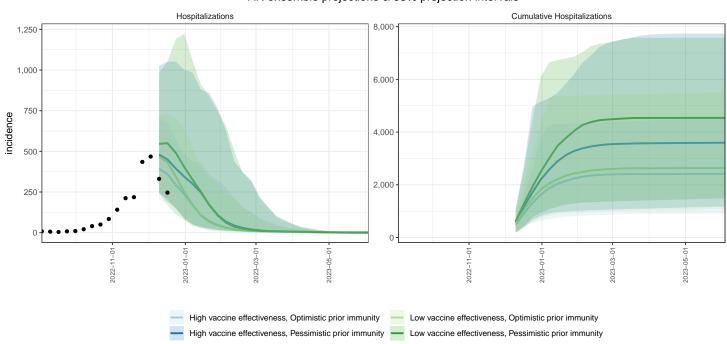
AK ensemble projections & 95% projection intervals



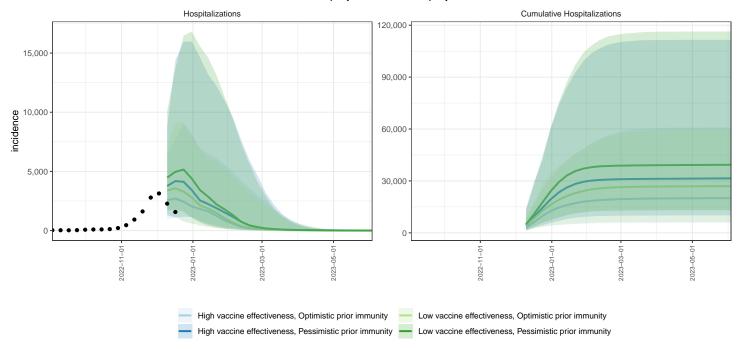
AZ ensemble projections & 95% projection intervals



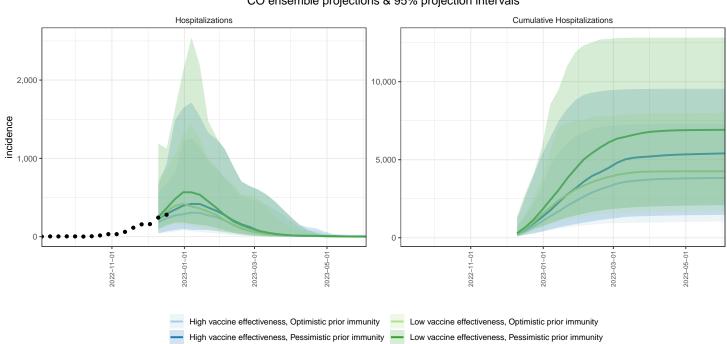
AR ensemble projections & 95% projection intervals



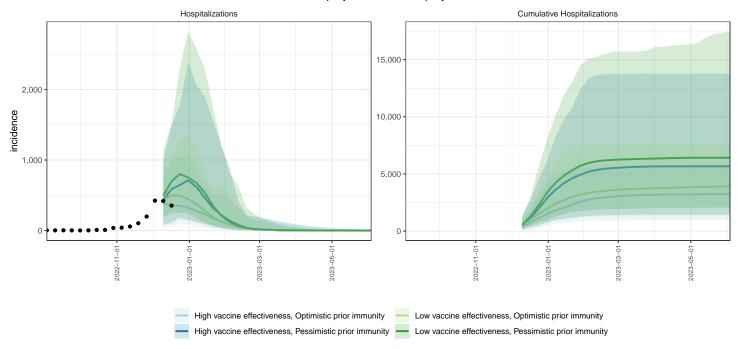
CA ensemble projections & 95% projection intervals



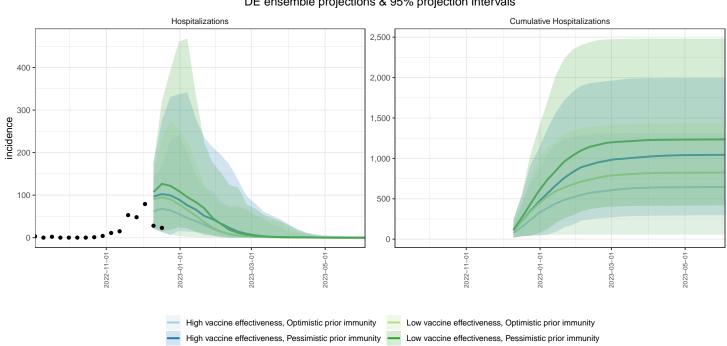
CO ensemble projections & 95% projection intervals



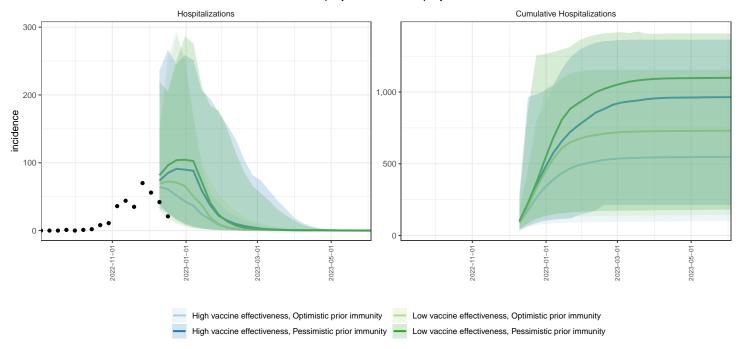
CT ensemble projections & 95% projection intervals



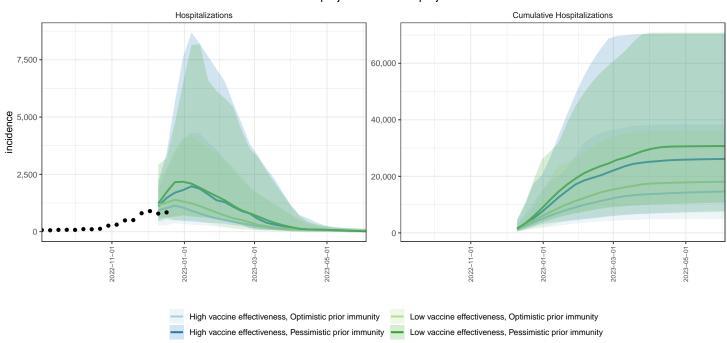
DE ensemble projections & 95% projection intervals



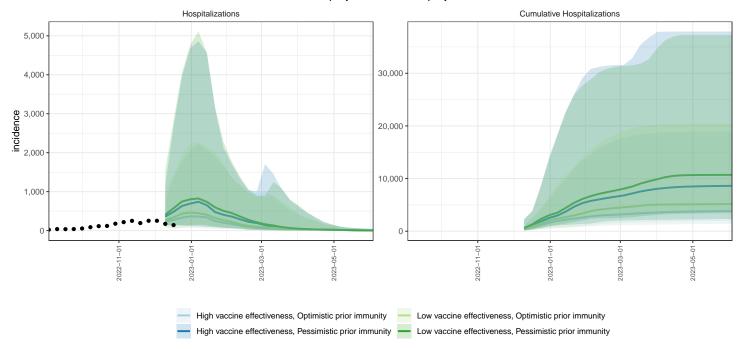
DC ensemble projections & 95% projection intervals



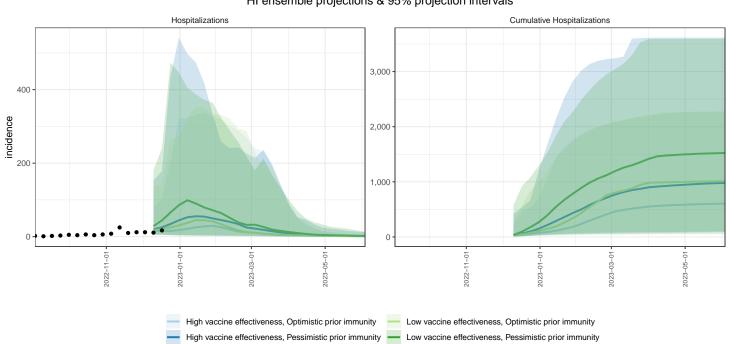
FL ensemble projections & 95% projection intervals



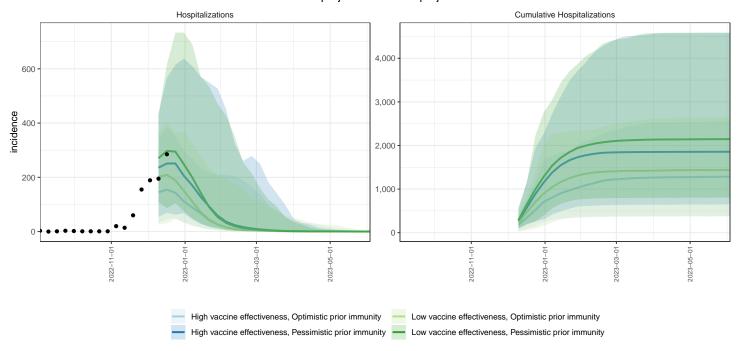
GA ensemble projections & 95% projection intervals



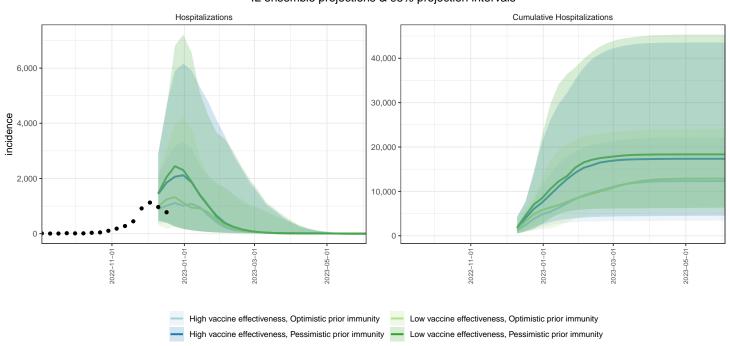
HI ensemble projections & 95% projection intervals



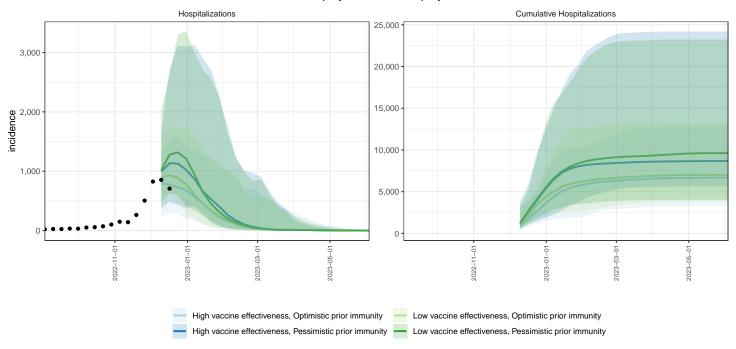
ID ensemble projections & 95% projection intervals



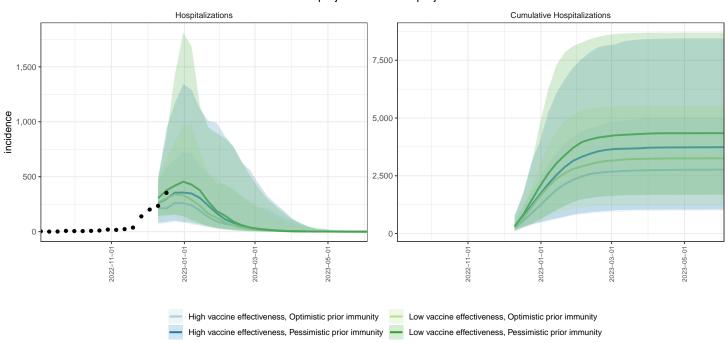
IL ensemble projections & 95% projection intervals



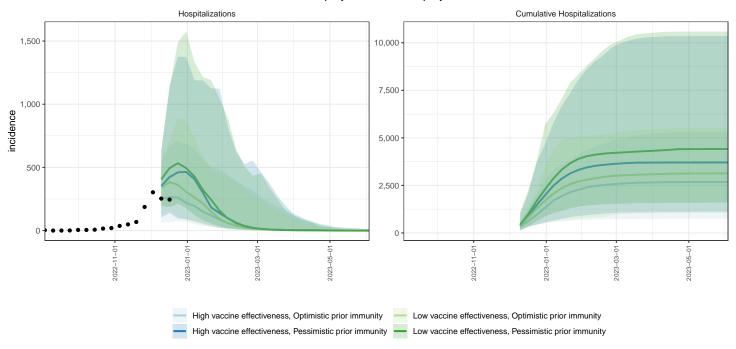
IN ensemble projections & 95% projection intervals



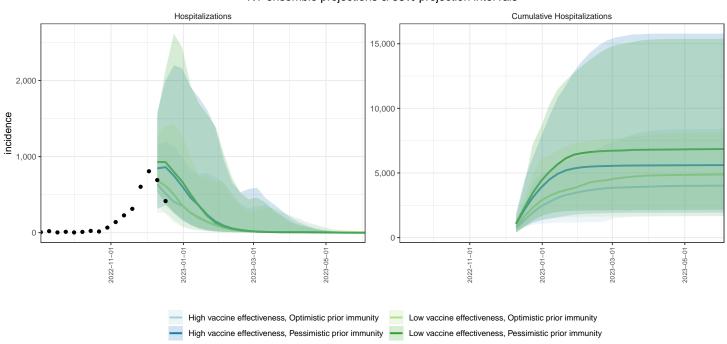
IA ensemble projections & 95% projection intervals



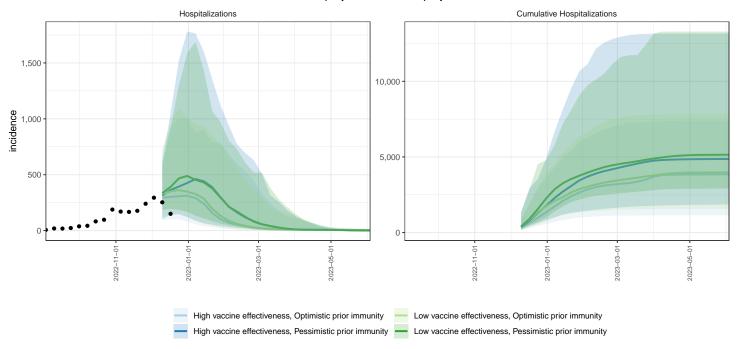
KS ensemble projections & 95% projection intervals



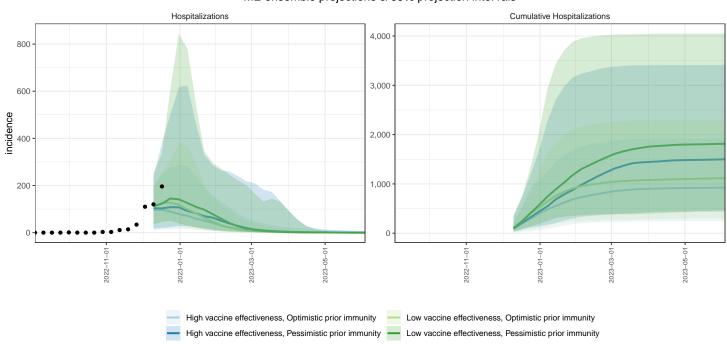
KY ensemble projections & 95% projection intervals



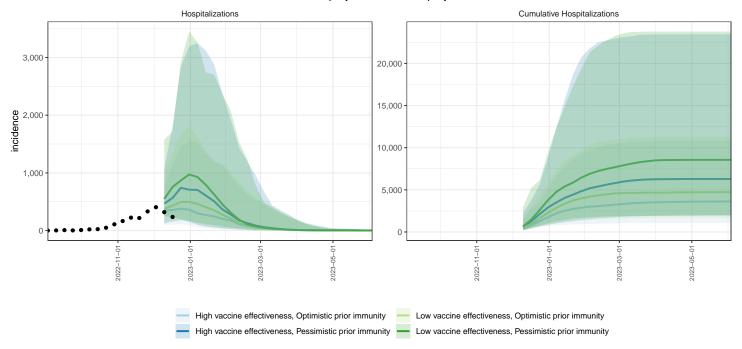
LA ensemble projections & 95% projection intervals



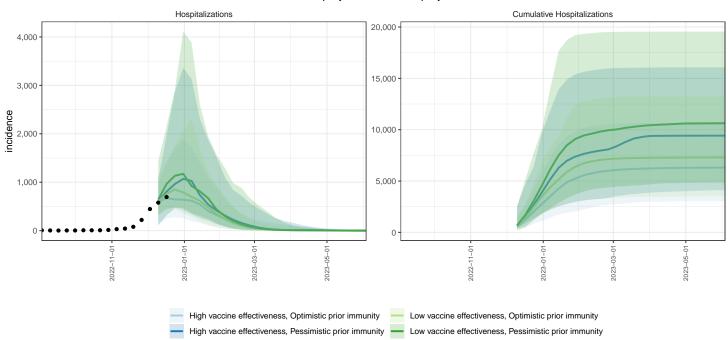
ME ensemble projections & 95% projection intervals



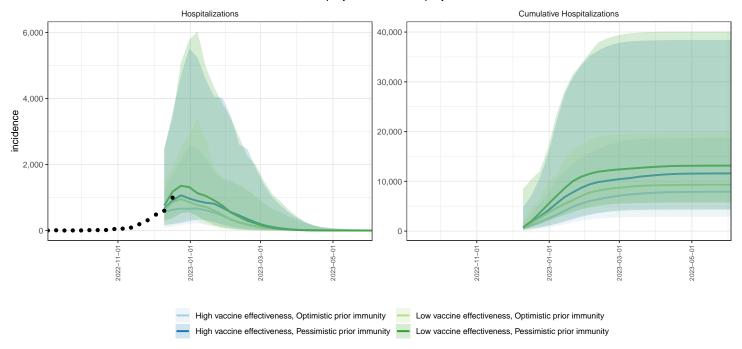
MD ensemble projections & 95% projection intervals



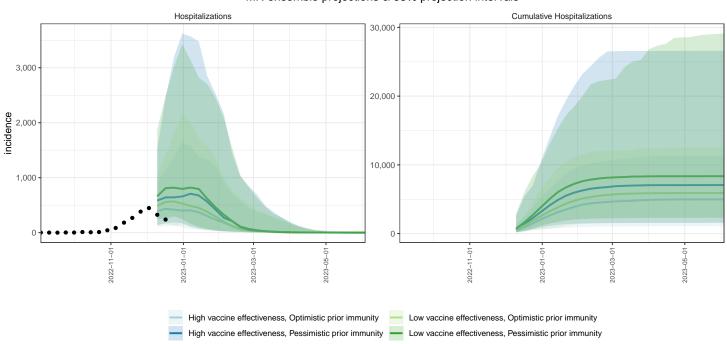
MA ensemble projections & 95% projection intervals



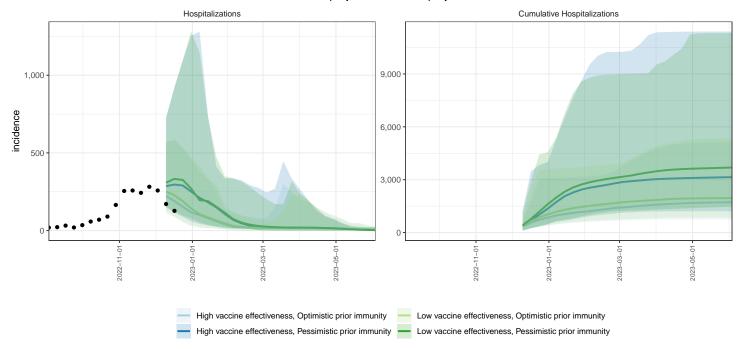
MI ensemble projections & 95% projection intervals



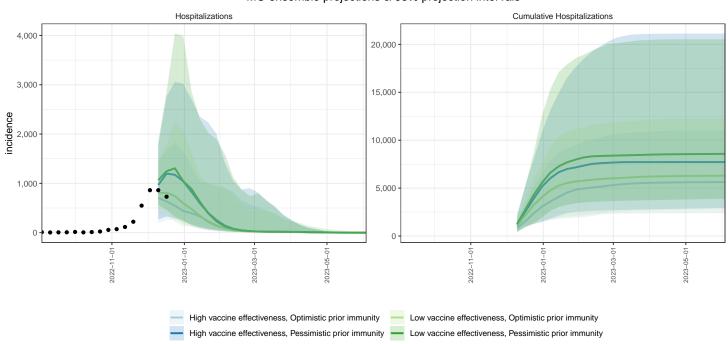
MN ensemble projections & 95% projection intervals



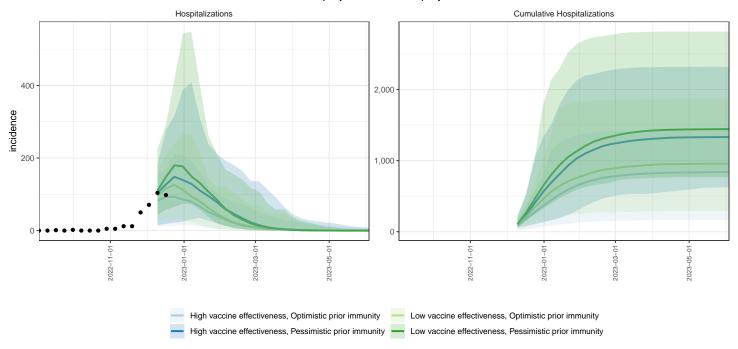
MS ensemble projections & 95% projection intervals



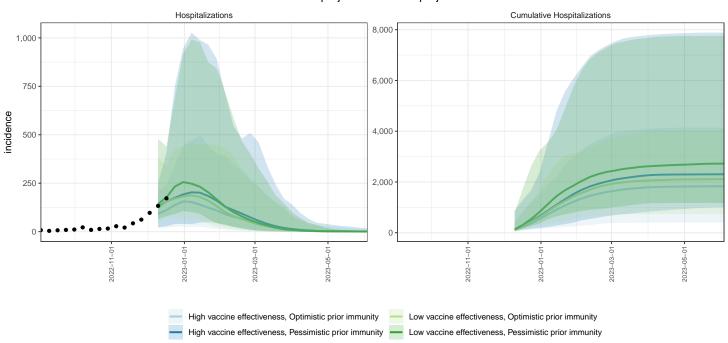
MO ensemble projections & 95% projection intervals



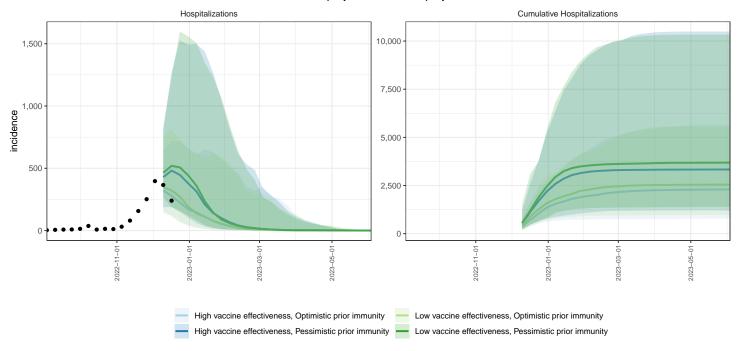
MT ensemble projections & 95% projection intervals



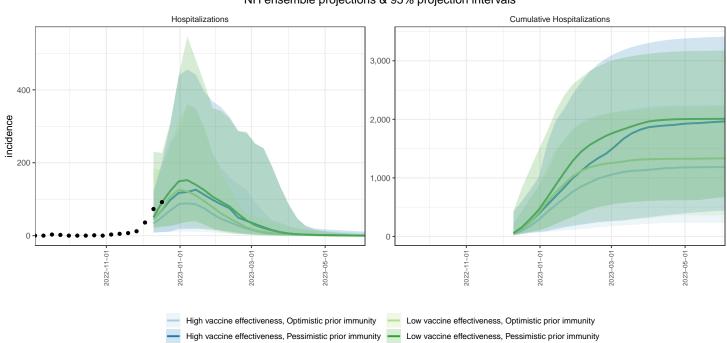
NE ensemble projections & 95% projection intervals



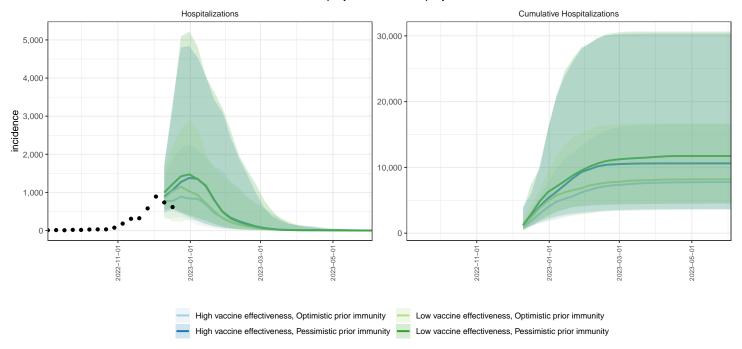
NV ensemble projections & 95% projection intervals



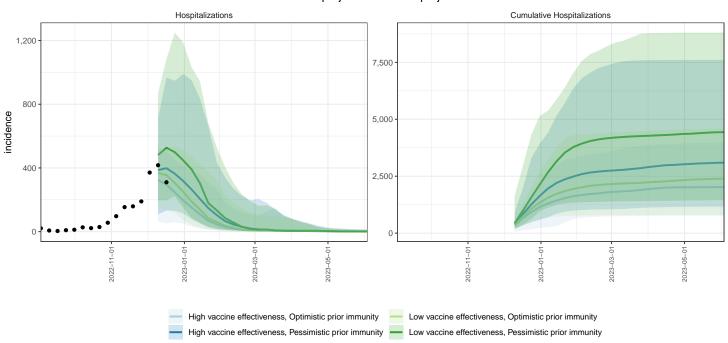
NH ensemble projections & 95% projection intervals



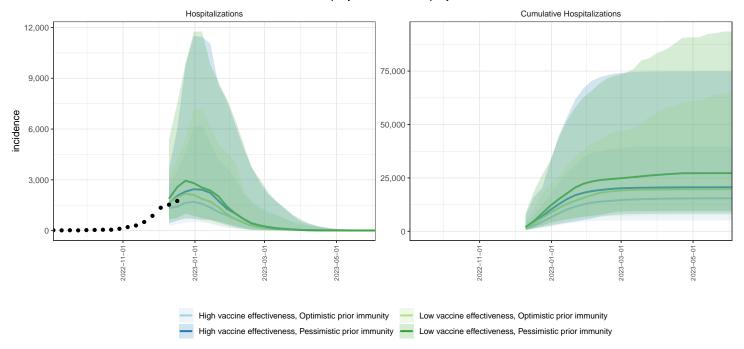
NJ ensemble projections & 95% projection intervals



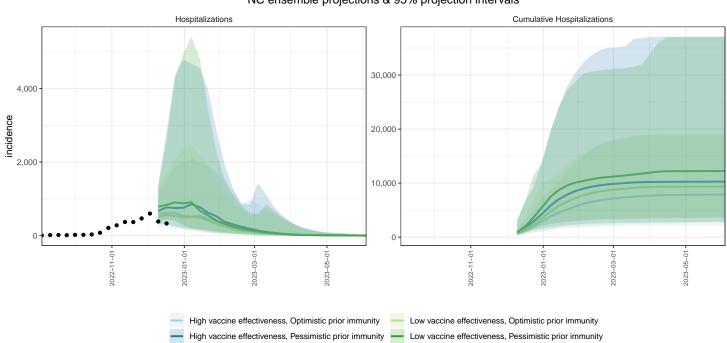
NM ensemble projections & 95% projection intervals



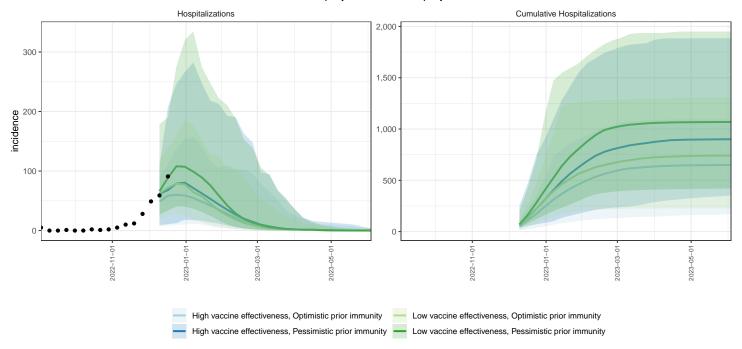
NY ensemble projections & 95% projection intervals



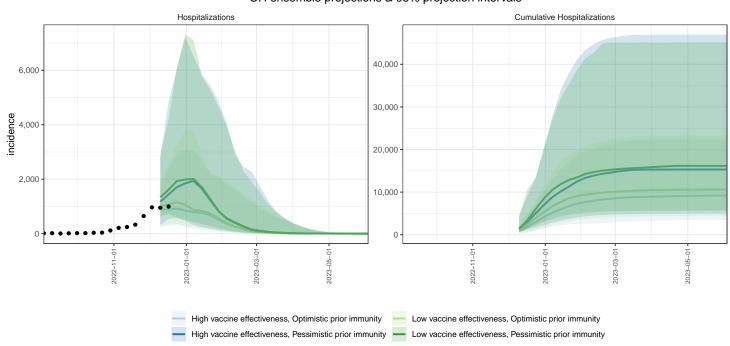
NC ensemble projections & 95% projection intervals



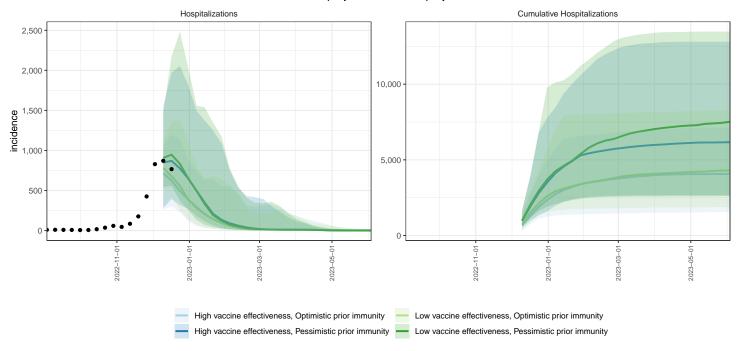
ND ensemble projections & 95% projection intervals



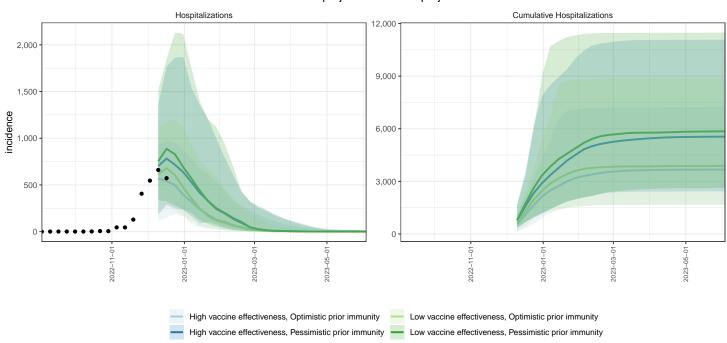
OH ensemble projections & 95% projection intervals



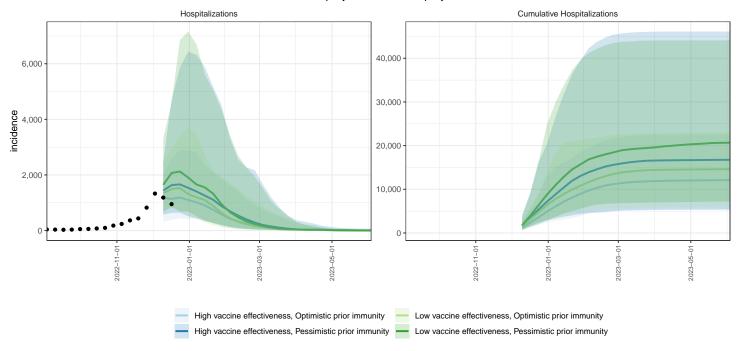
OK ensemble projections & 95% projection intervals



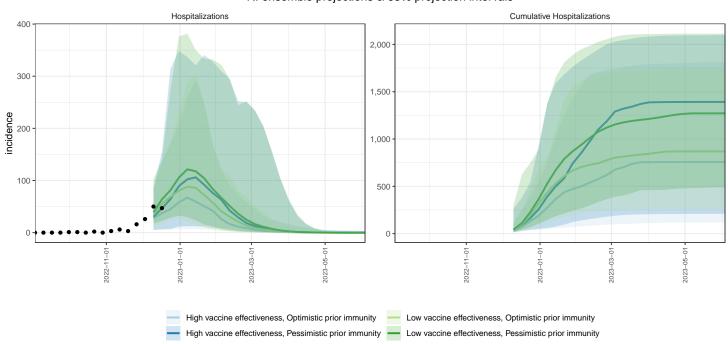
OR ensemble projections & 95% projection intervals



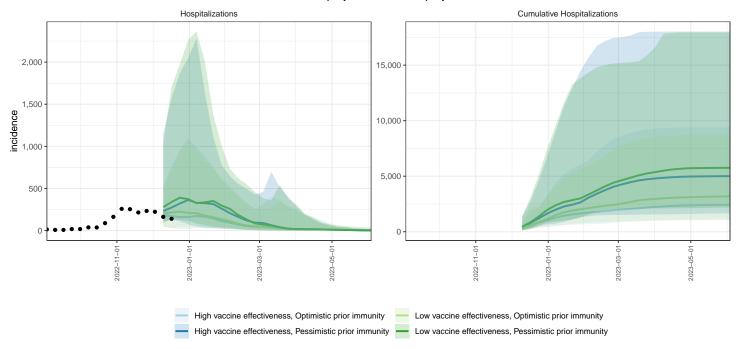
PA ensemble projections & 95% projection intervals



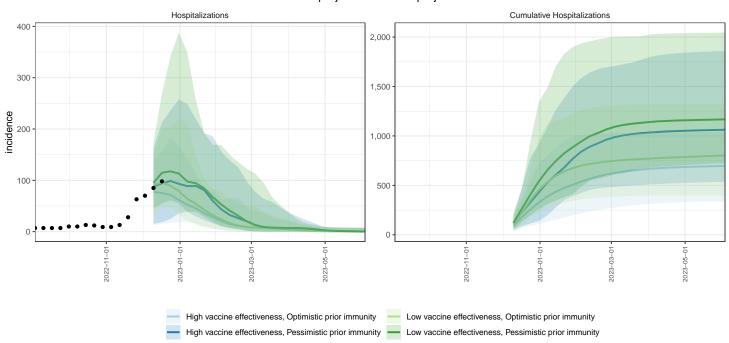
RI ensemble projections & 95% projection intervals



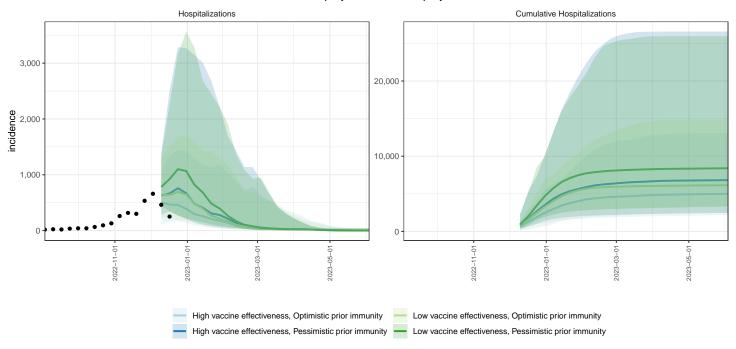
SC ensemble projections & 95% projection intervals



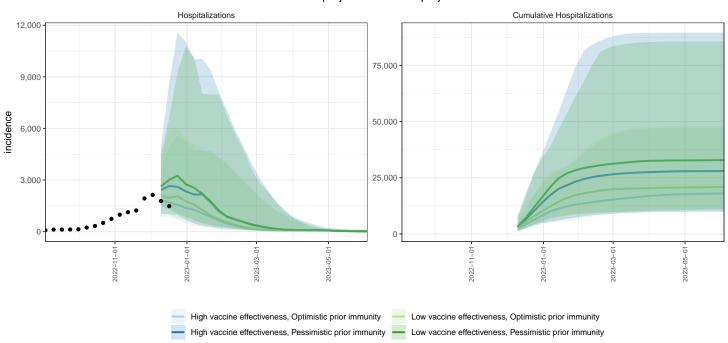
SD ensemble projections & 95% projection intervals



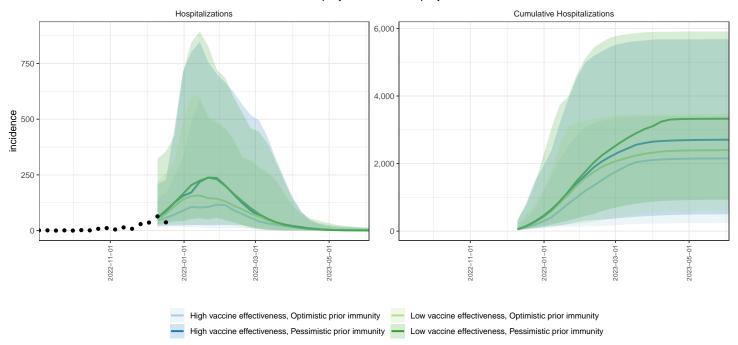
TN ensemble projections & 95% projection intervals



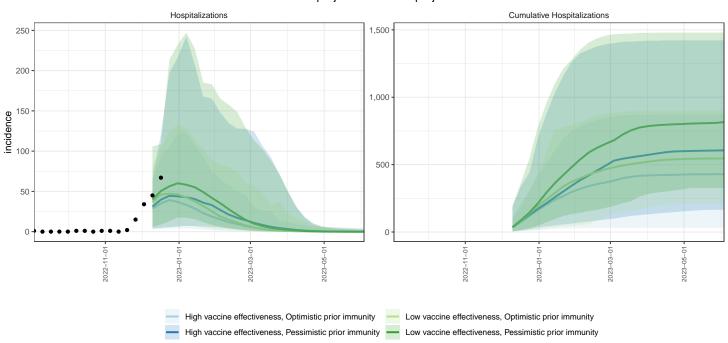
TX ensemble projections & 95% projection intervals



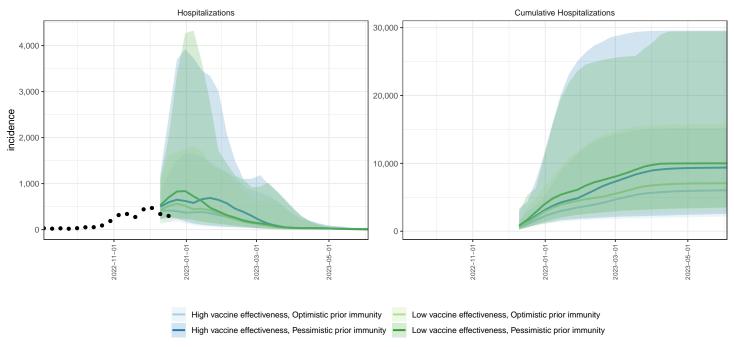
UT ensemble projections & 95% projection intervals



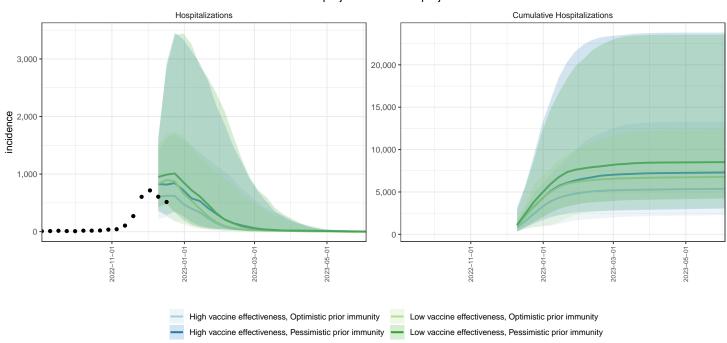
VT ensemble projections & 95% projection intervals



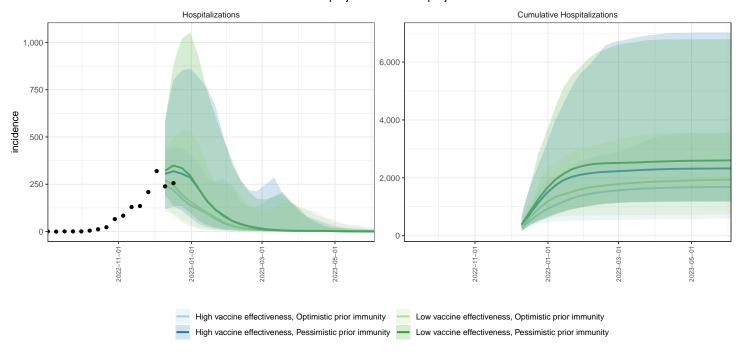
VA ensemble projections & 95% projection intervals



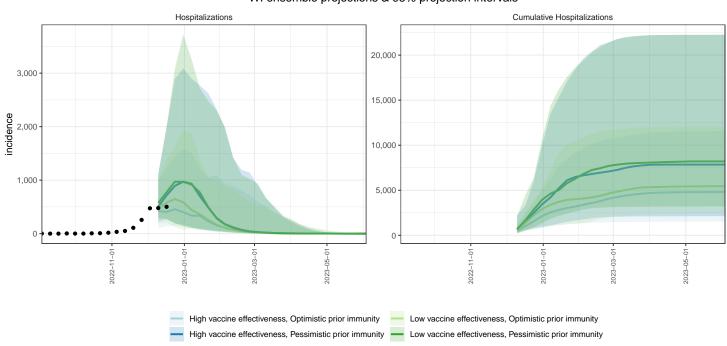
WA ensemble projections & 95% projection intervals



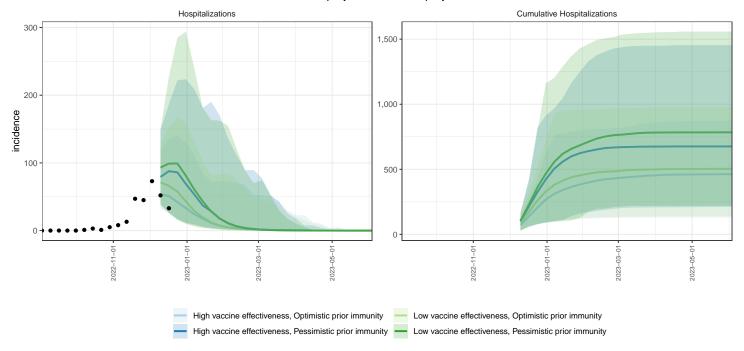
WV ensemble projections & 95% projection intervals



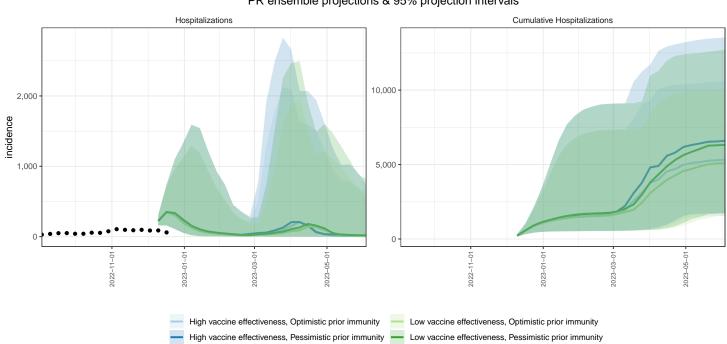
WI ensemble projections & 95% projection intervals



WY ensemble projections & 95% projection intervals



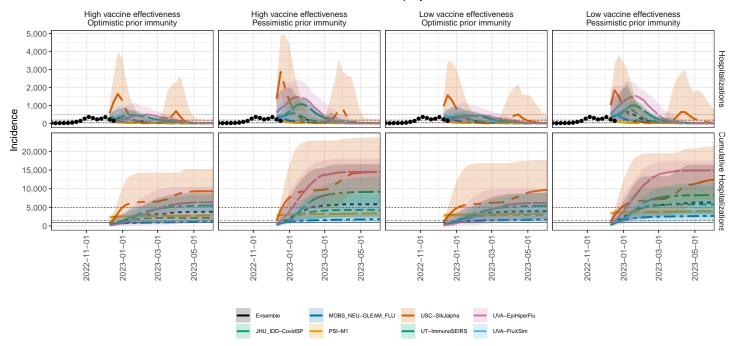
PR ensemble projections & 95% projection intervals



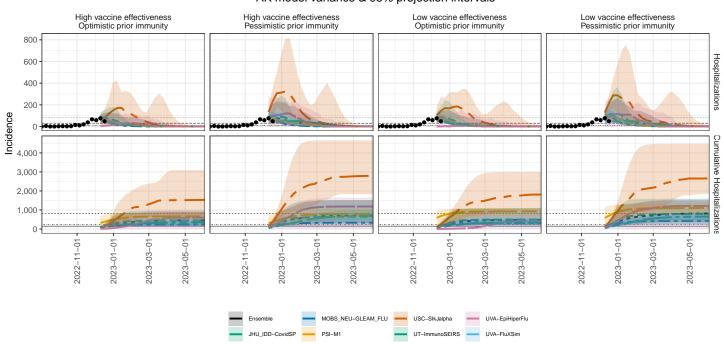
State-level model variation

National model variation for all scenarios.

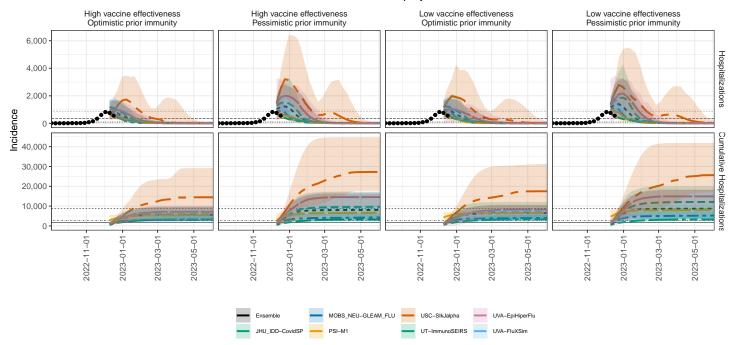
AL model variance & 95% projection intervals



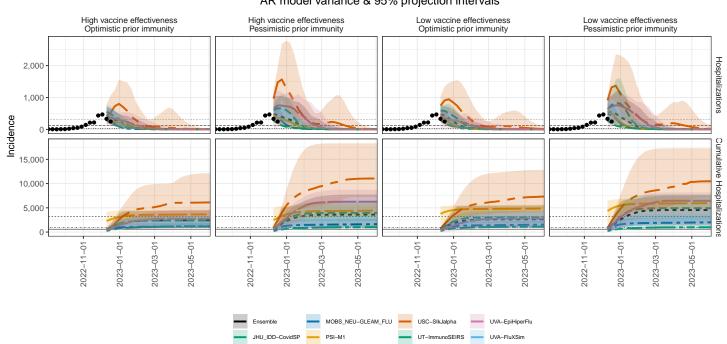
AK model variance & 95% projection intervals



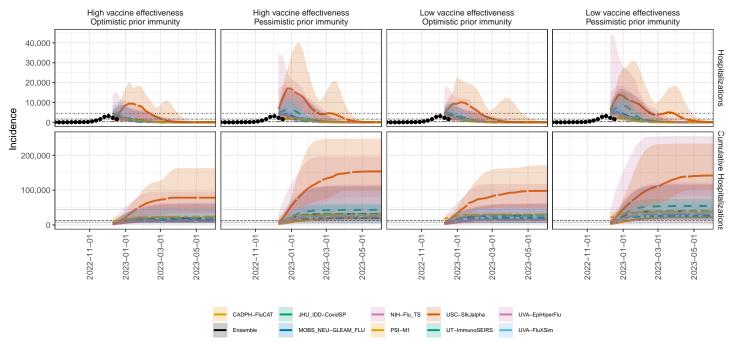
AZ model variance & 95% projection intervals



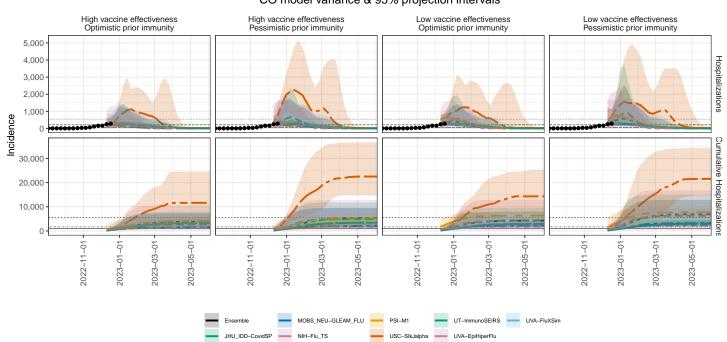
AR model variance & 95% projection intervals



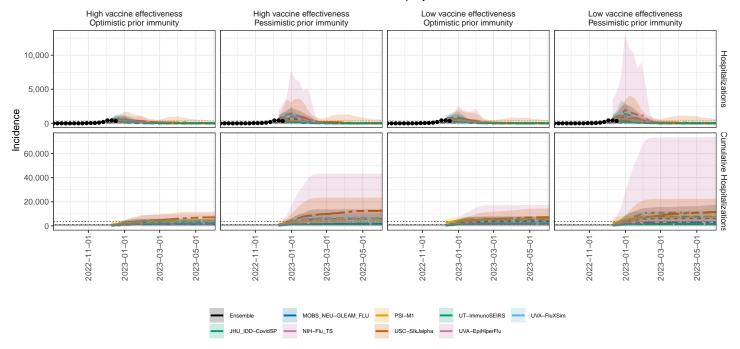
CA model variance & 95% projection intervals



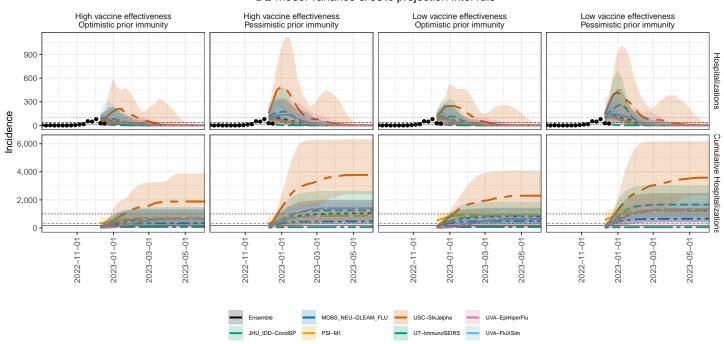
CO model variance & 95% projection intervals



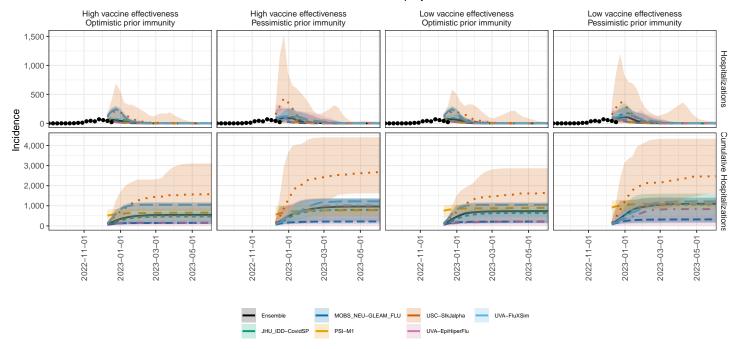
CT model variance & 95% projection intervals



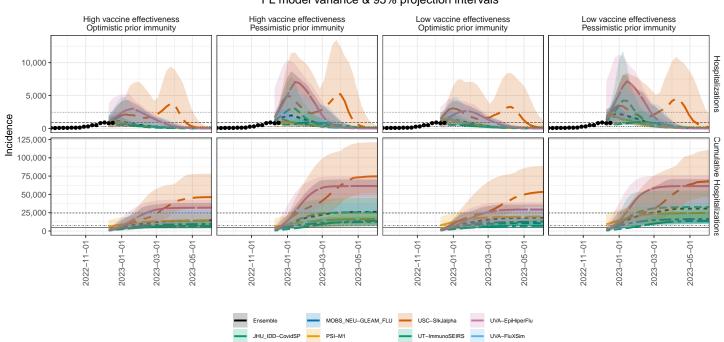
DE model variance & 95% projection intervals



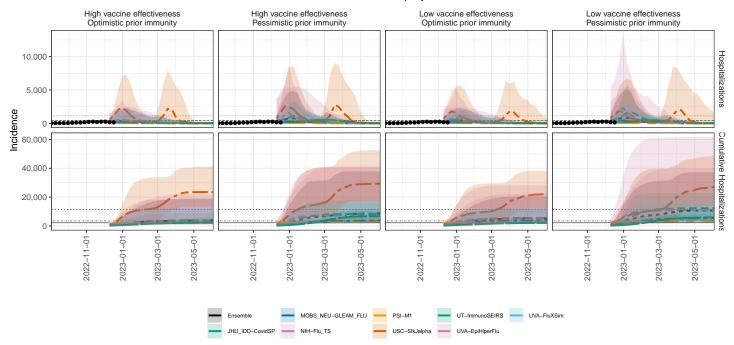
DC model variance & 95% projection intervals



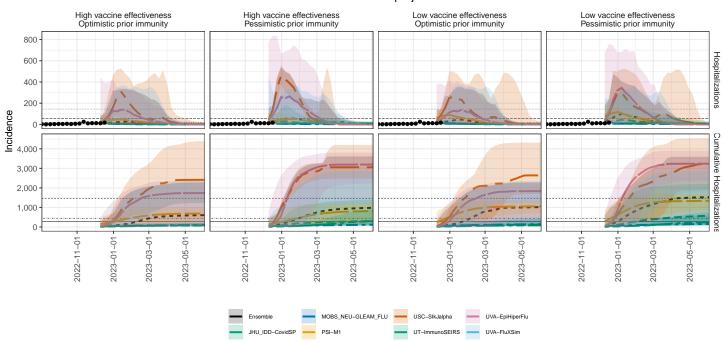
FL model variance & 95% projection intervals



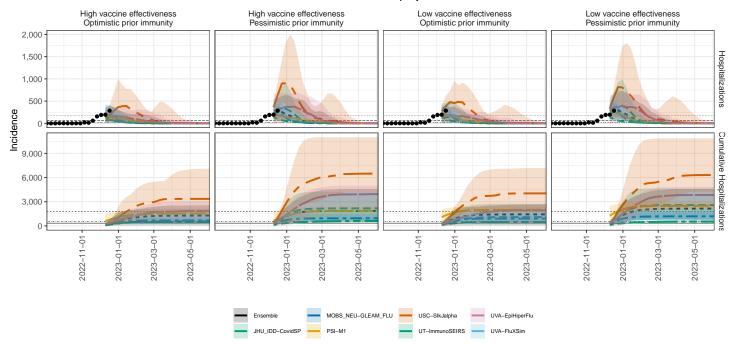
GA model variance & 95% projection intervals



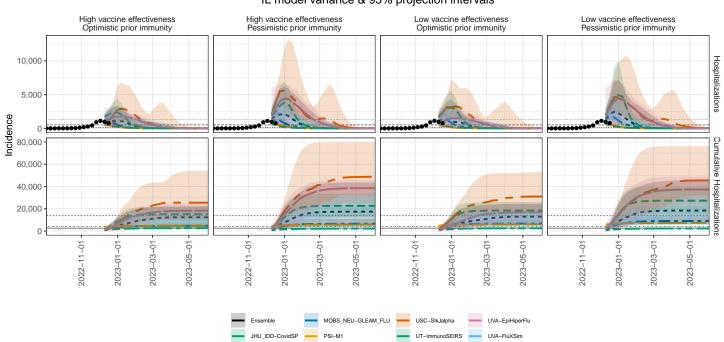
HI model variance & 95% projection intervals



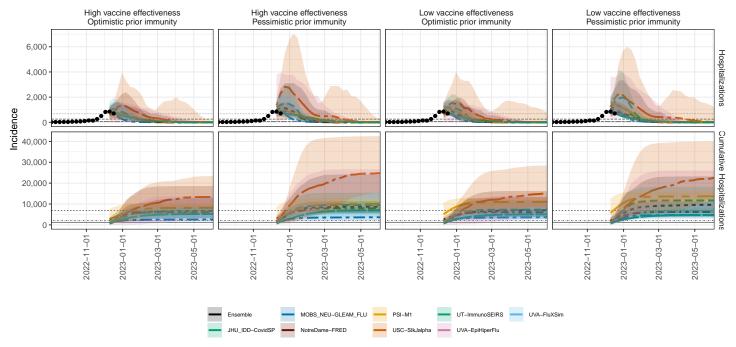
ID model variance & 95% projection intervals



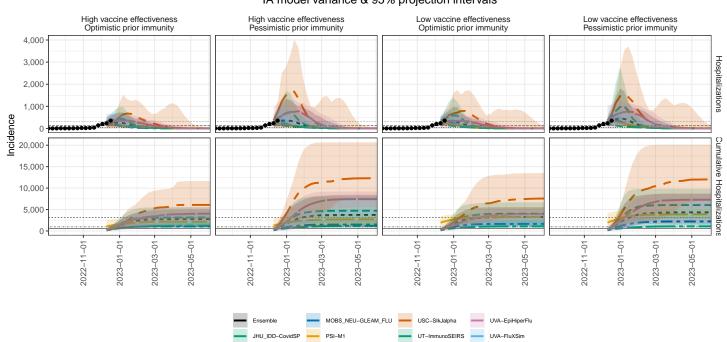
IL model variance & 95% projection intervals



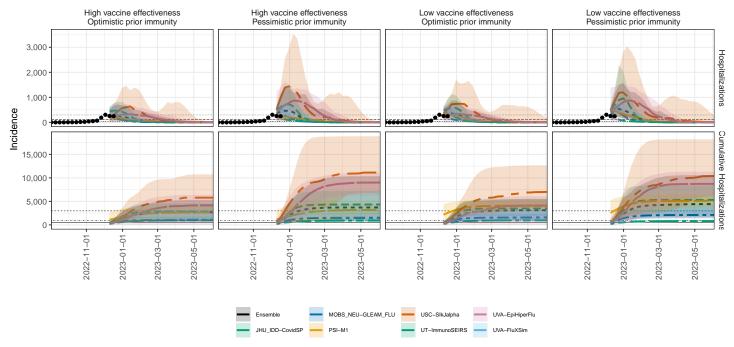
IN model variance & 95% projection intervals



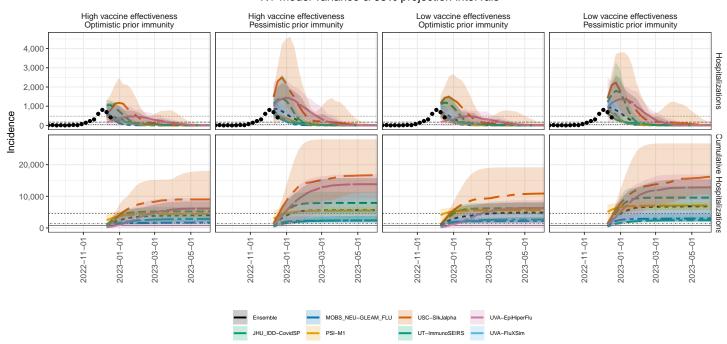
IA model variance & 95% projection intervals



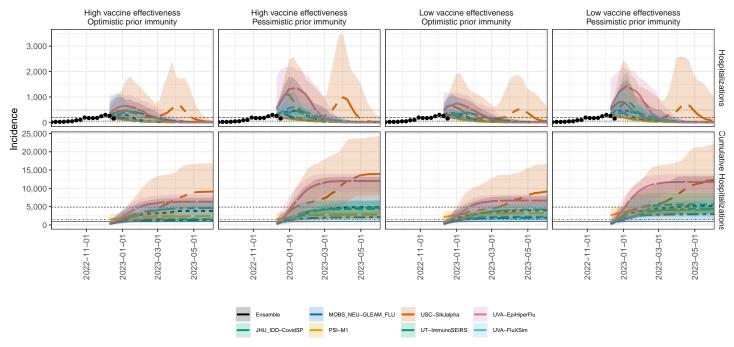
KS model variance & 95% projection intervals



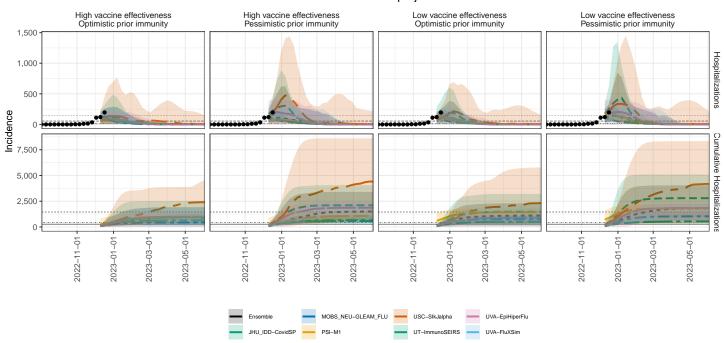
KY model variance & 95% projection intervals



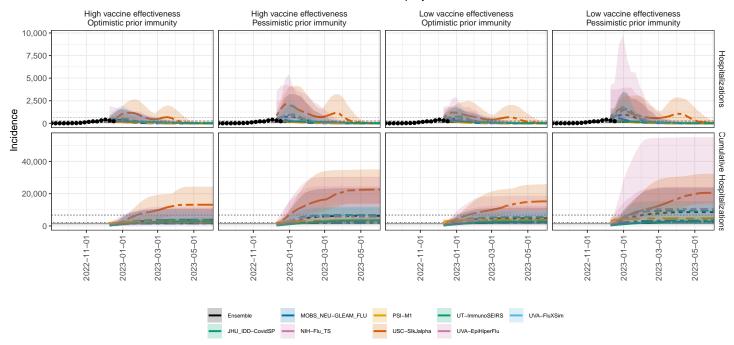
LA model variance & 95% projection intervals



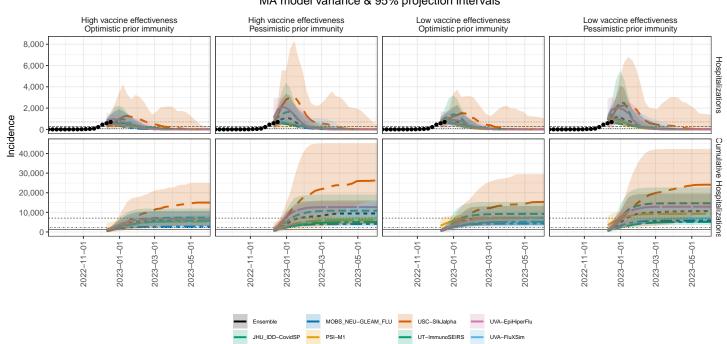
ME model variance & 95% projection intervals



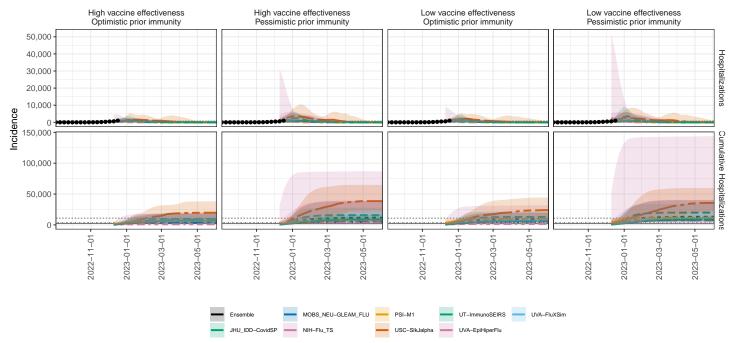
MD model variance & 95% projection intervals



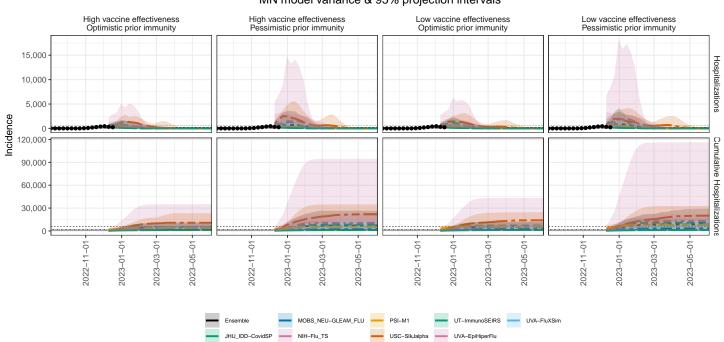
MA model variance & 95% projection intervals



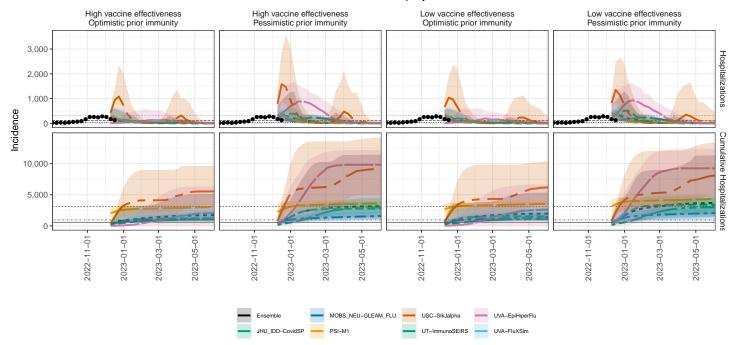
MI model variance & 95% projection intervals



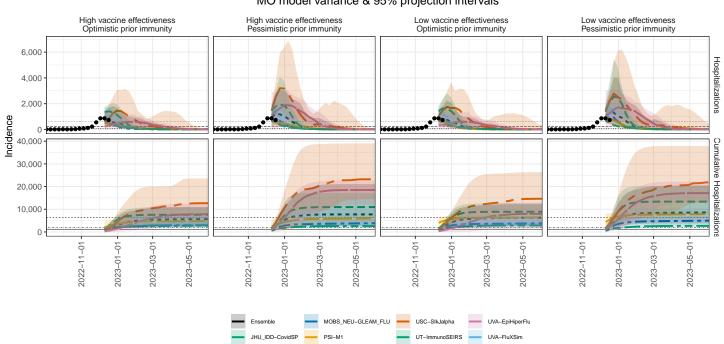
MN model variance & 95% projection intervals



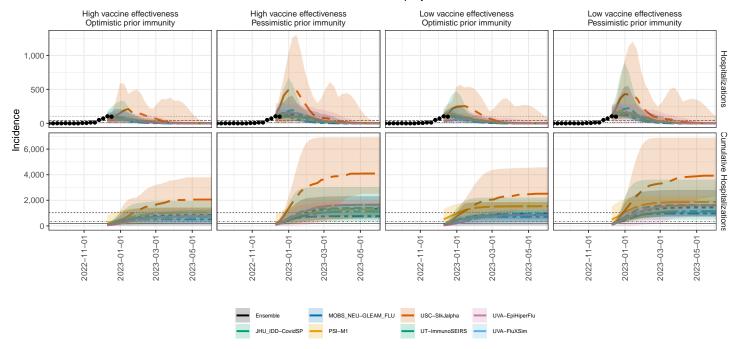
MS model variance & 95% projection intervals



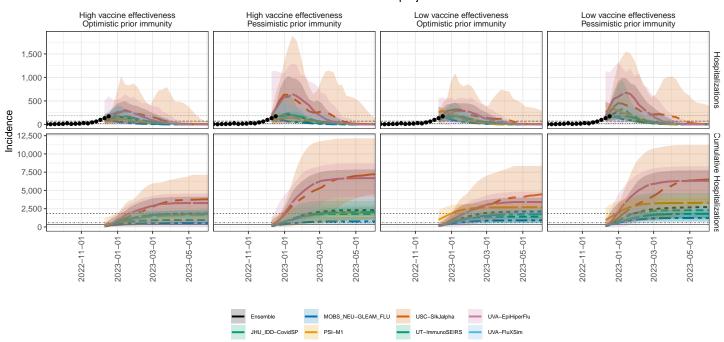
MO model variance & 95% projection intervals



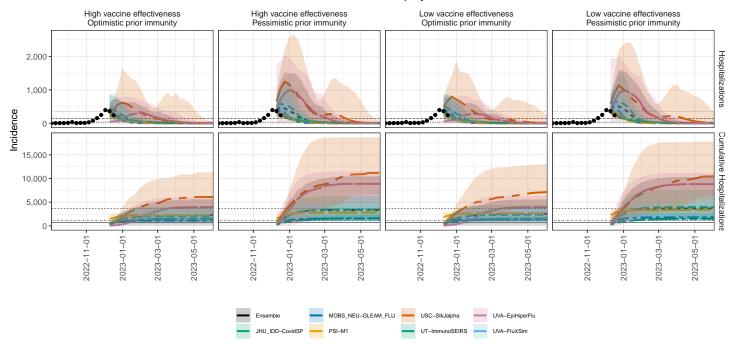
MT model variance & 95% projection intervals



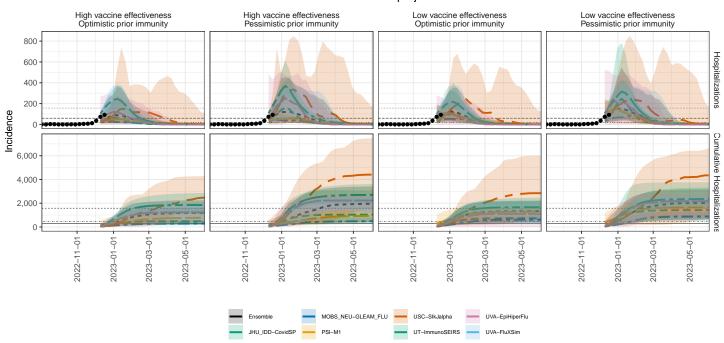
NE model variance & 95% projection intervals



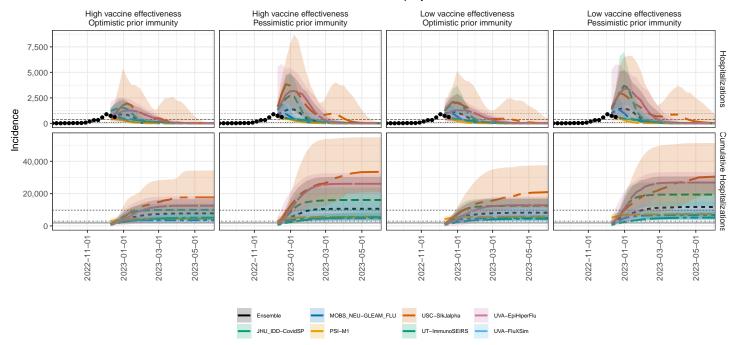
NV model variance & 95% projection intervals



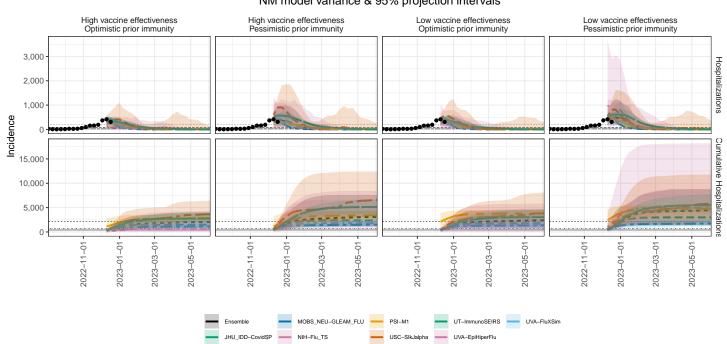
NH model variance & 95% projection intervals



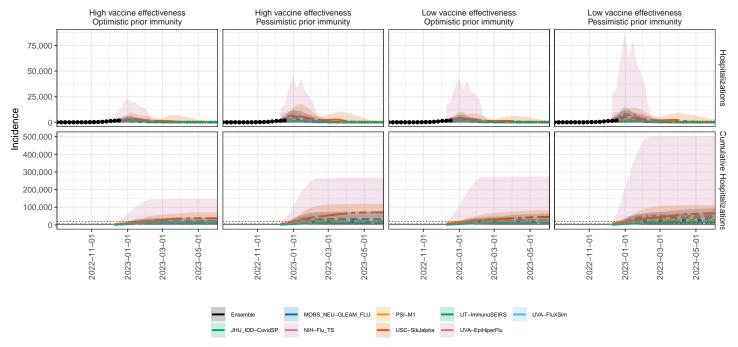
NJ model variance & 95% projection intervals



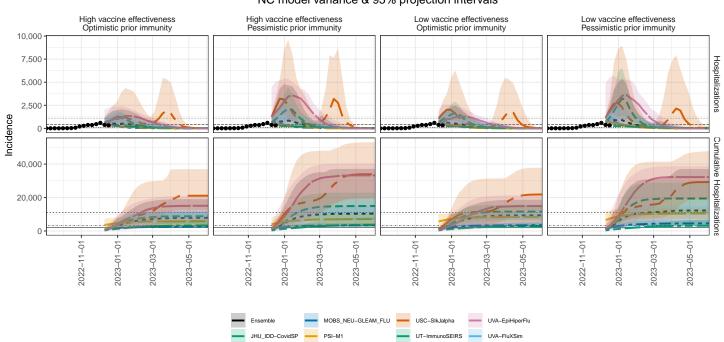
NM model variance & 95% projection intervals



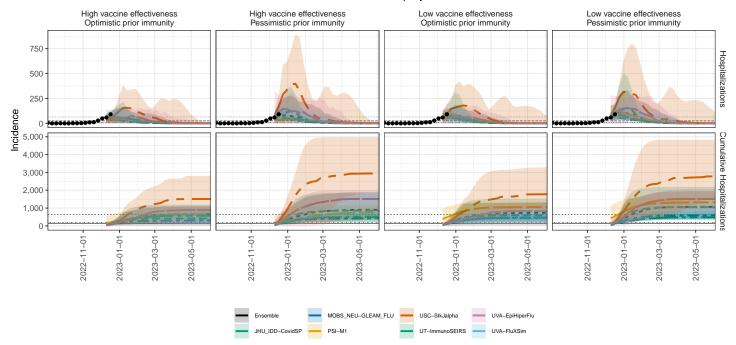
NY model variance & 95% projection intervals



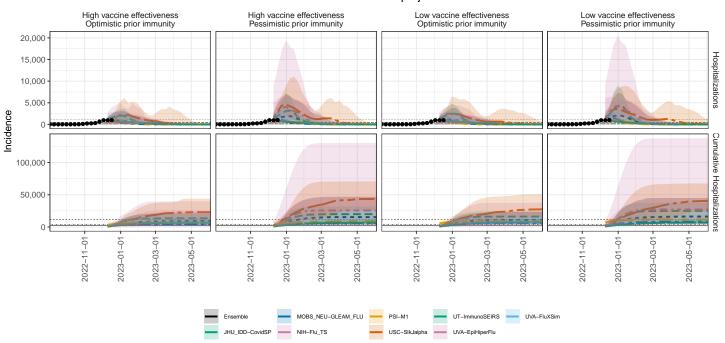
NC model variance & 95% projection intervals



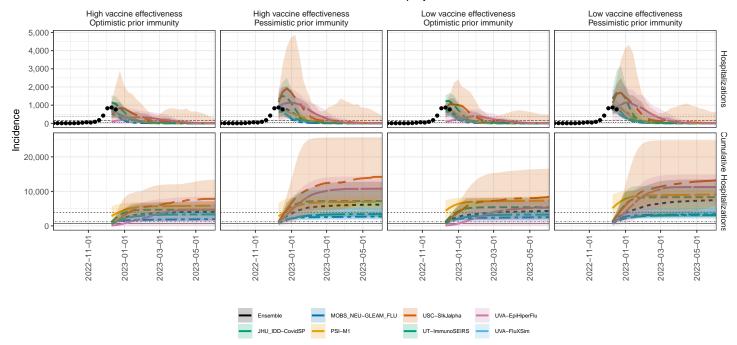
ND model variance & 95% projection intervals



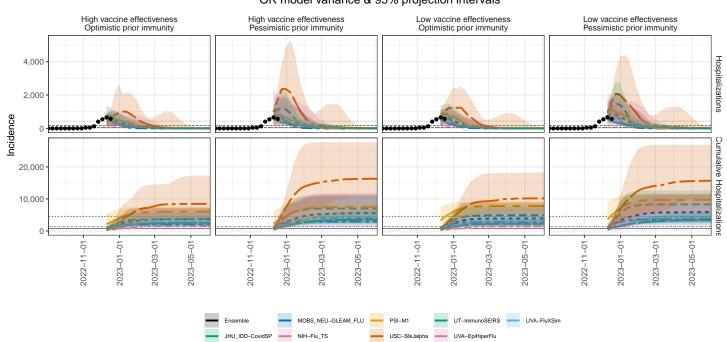
OH model variance & 95% projection intervals



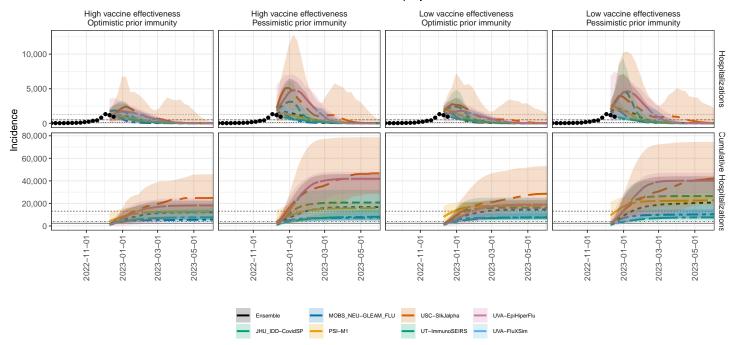
OK model variance & 95% projection intervals



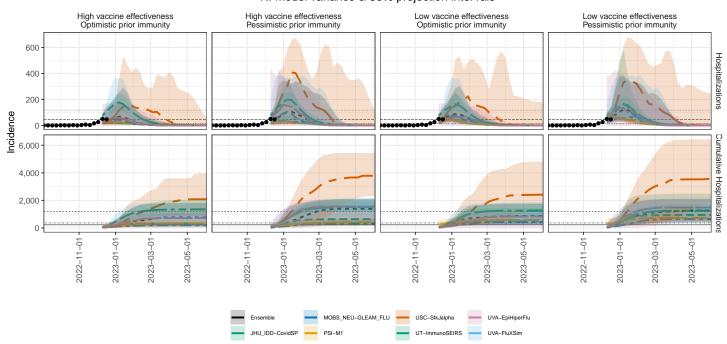
OR model variance & 95% projection intervals



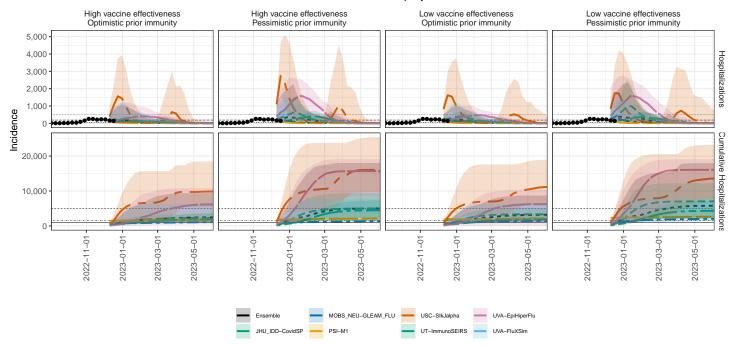
PA model variance & 95% projection intervals



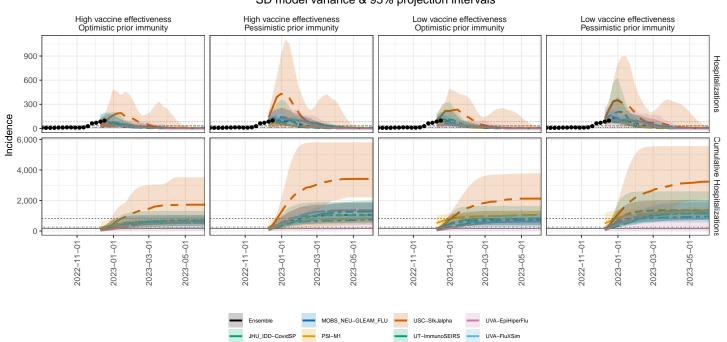
RI model variance & 95% projection intervals



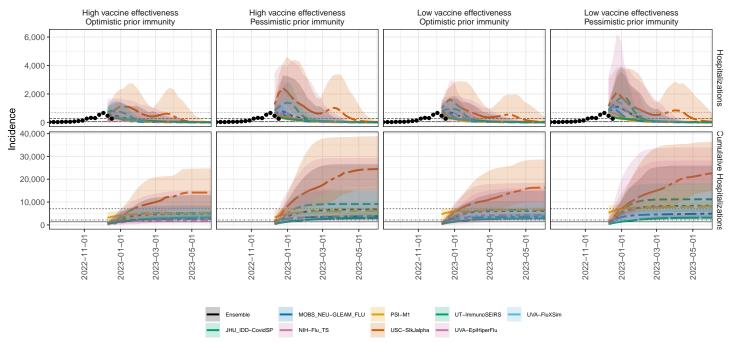
SC model variance & 95% projection intervals



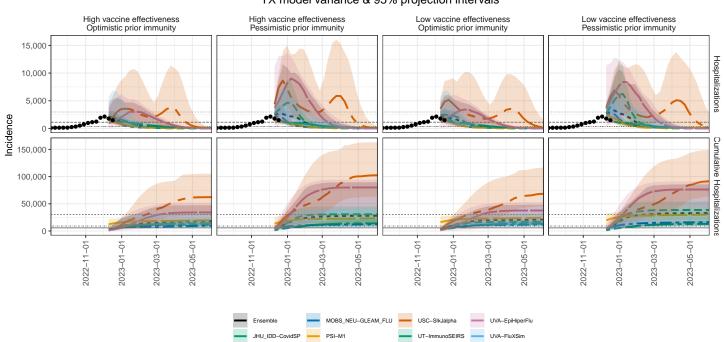
SD model variance & 95% projection intervals



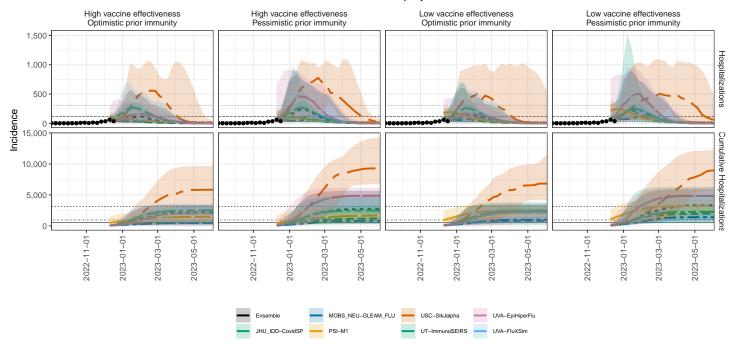
TN model variance & 95% projection intervals



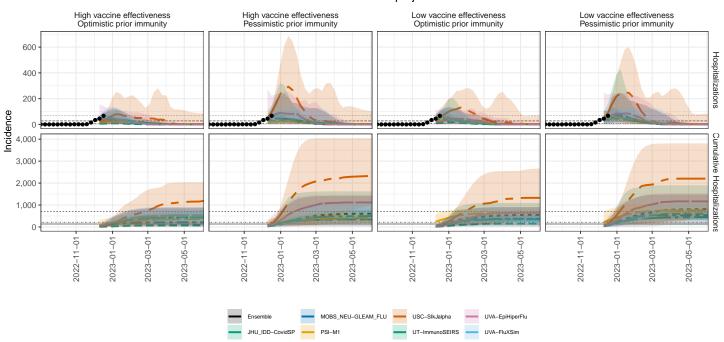
TX model variance & 95% projection intervals



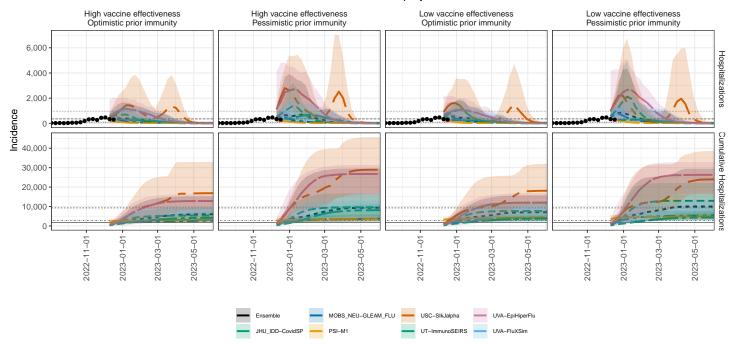
UT model variance & 95% projection intervals



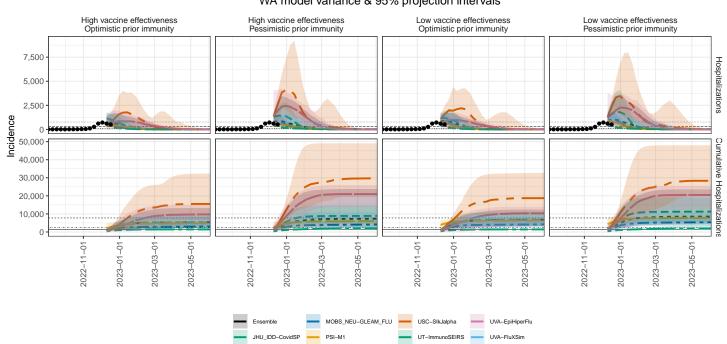
VT model variance & 95% projection intervals



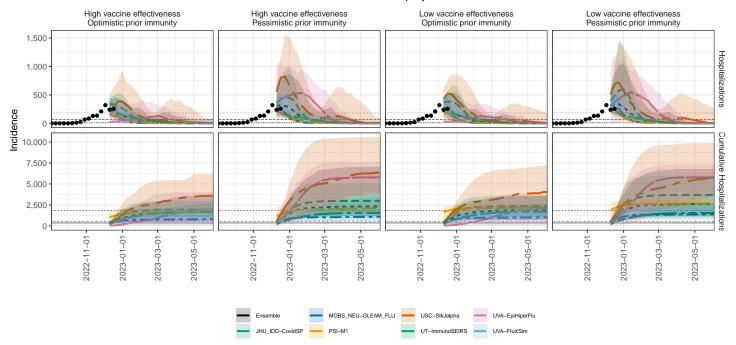
VA model variance & 95% projection intervals



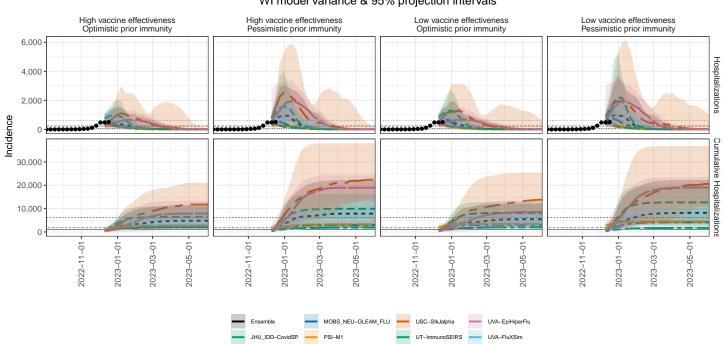
WA model variance & 95% projection intervals



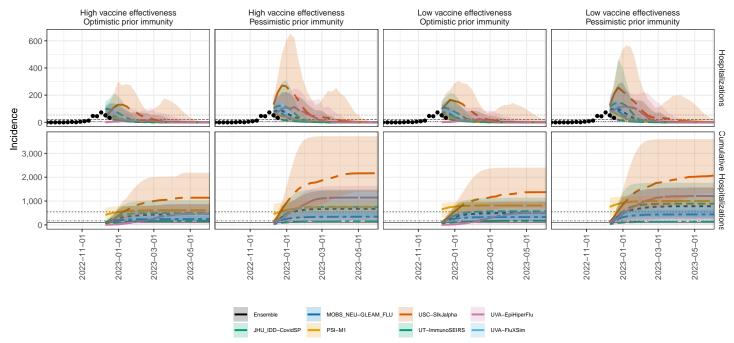
WV model variance & 95% projection intervals



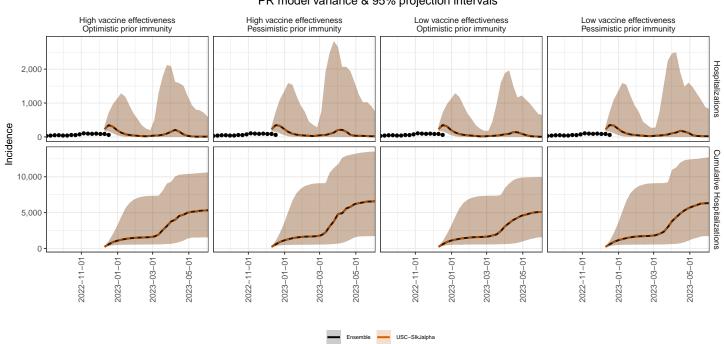
WI model variance & 95% projection intervals



WY model variance & 95% projection intervals



PR model variance & 95% projection intervals



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