Analysis of the IHME COVID 19 Forecasting Model – April 21st Update

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Introduction

- The COVID 19 virus is having a major effect on the economy
- During the last month, roughly 22 million U.S. workers filed for unemployment due to the shut down a significant share of the economy
- It has become clear that the Institute for Health Metrics and Evaluation (IHME) at the University of Washington is playing a large role in the formation of policy
  - The data used in this analysis is sourced from http://www.healthdata.org/covid
- It is important to document and understand the ex-post performance of the prediction model and the periodic revisions that are made in the predictive model
- This is an update of the April 14th discussion that consists of one more released models

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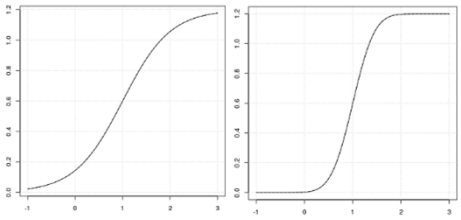
Original IHME Modeling Approach

- A statistical forecasting model using a parameterized spline
  - Using CurveFit
  - Fit in log space
- Assumed a sigmoid shape (logistic function)
- A bounded nonlinear optimization problem
  - Used the L-BFGS-B algorithm that requires derivatives
- Used local and national government and WHO websites
  - John Hopkins Covonavirus data
- Article has not been peer-reviewed as of April 21st.
- https://www.worldometers.info/coronavirus/country/us/ and https://covidtracking.com/



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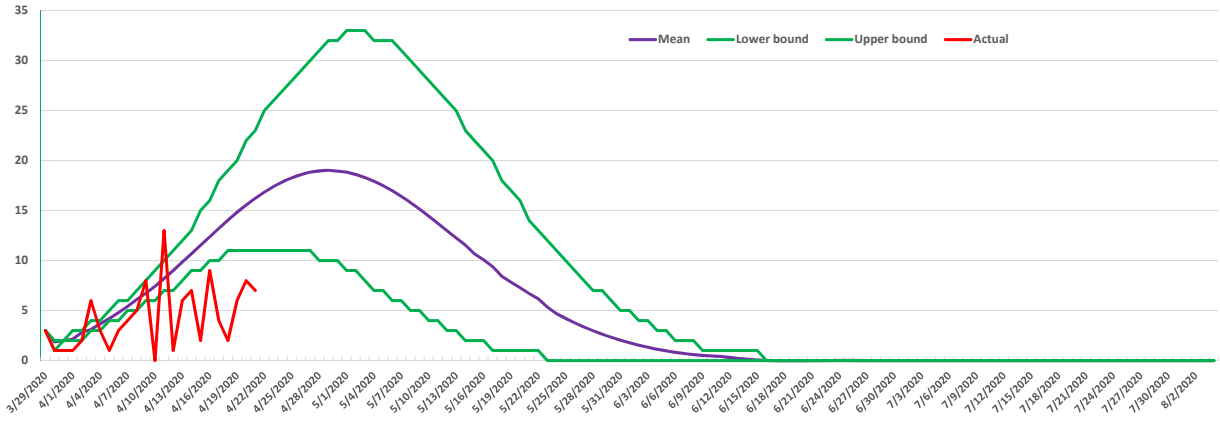
Kansas COVID 19 Daily Death Projections March 26



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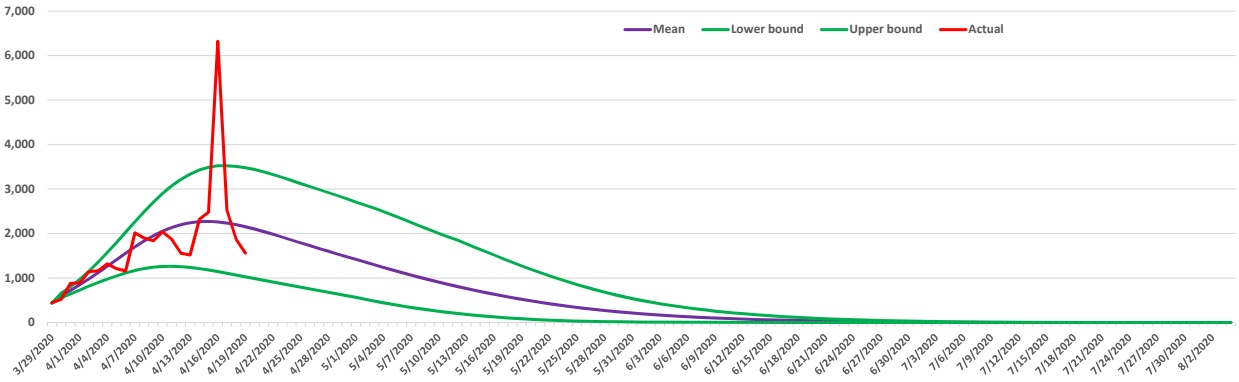
U.S. COVID 19 Daily Death Projections March 26



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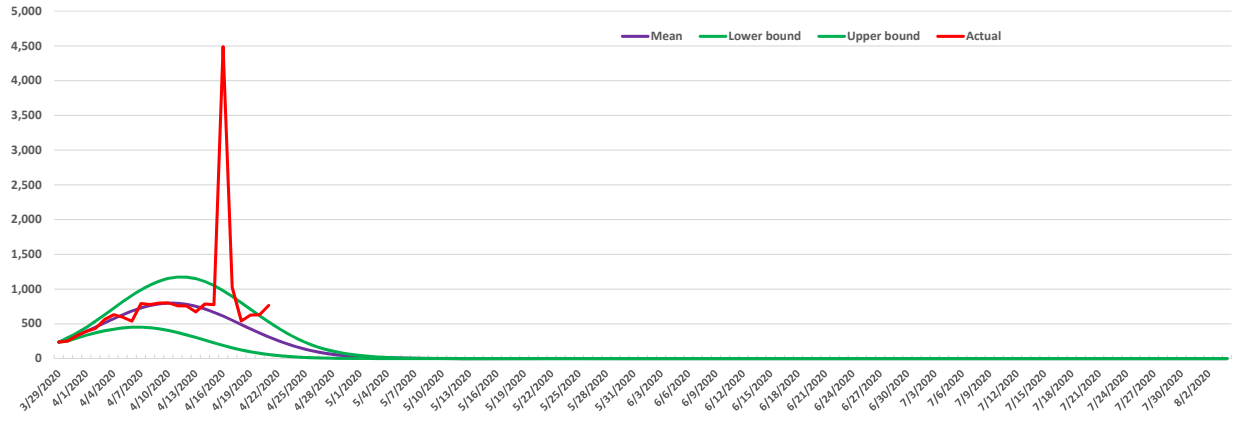
New York COVID 19 Daily Death Projections March 26



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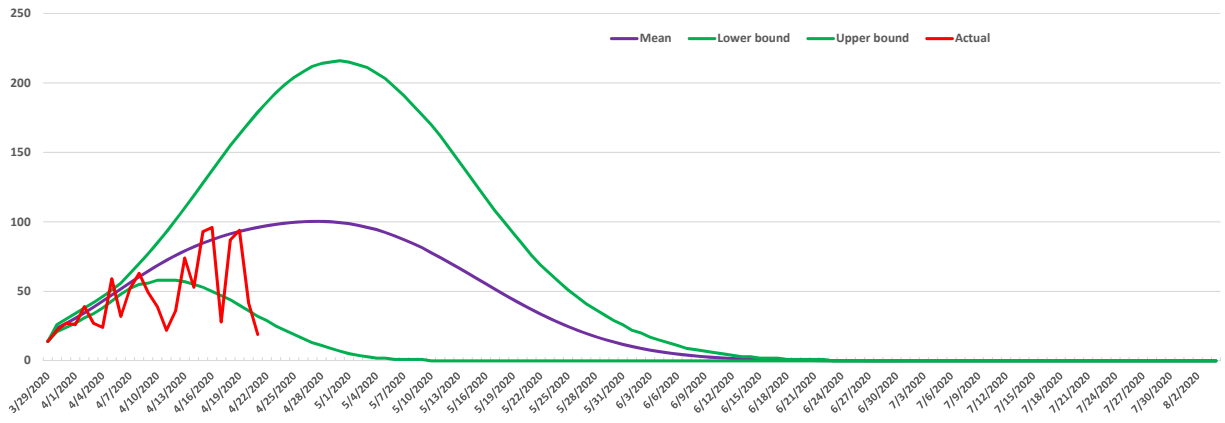
California COVID 19 Daily Death Projections March 26



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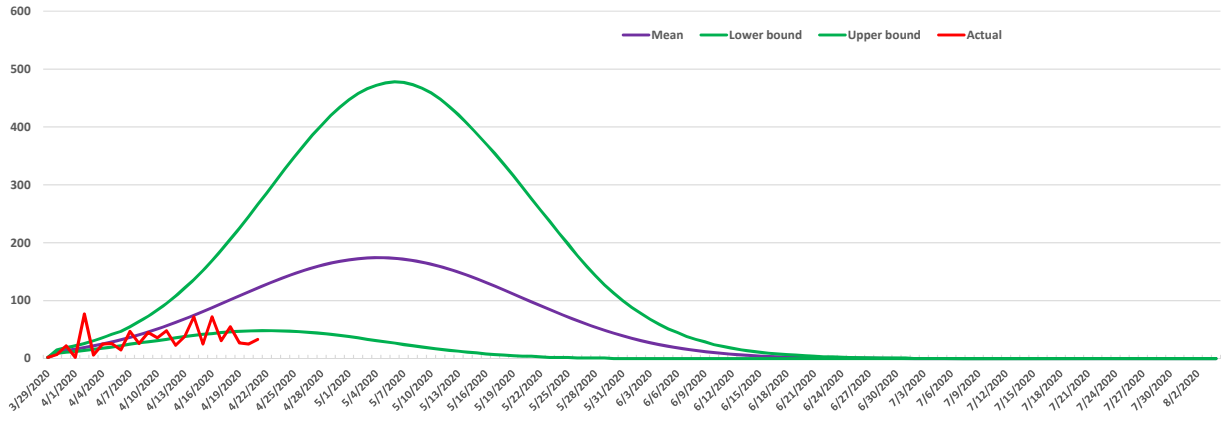
Florida COVID 19 Daily Death Projections March 26



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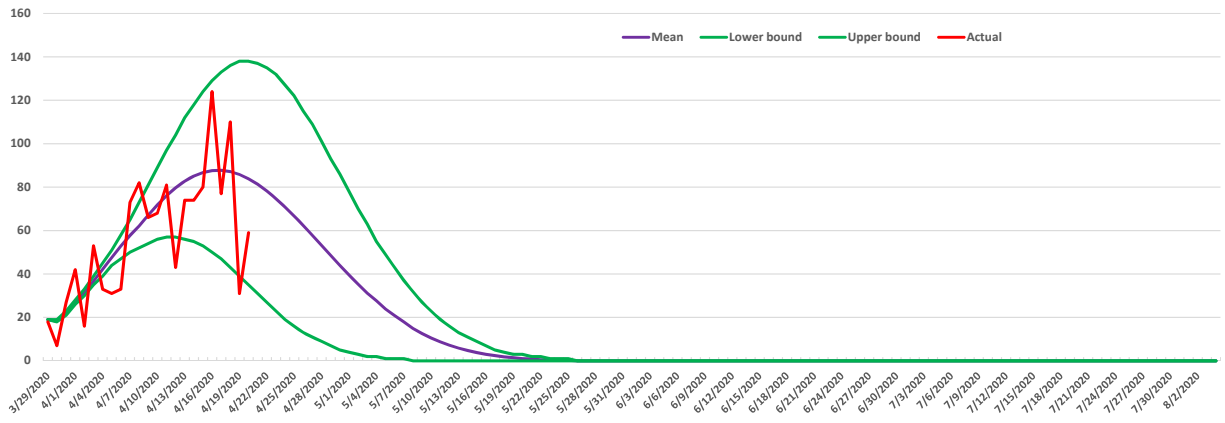
Illinois COVID 19 Daily Death Projections March 26



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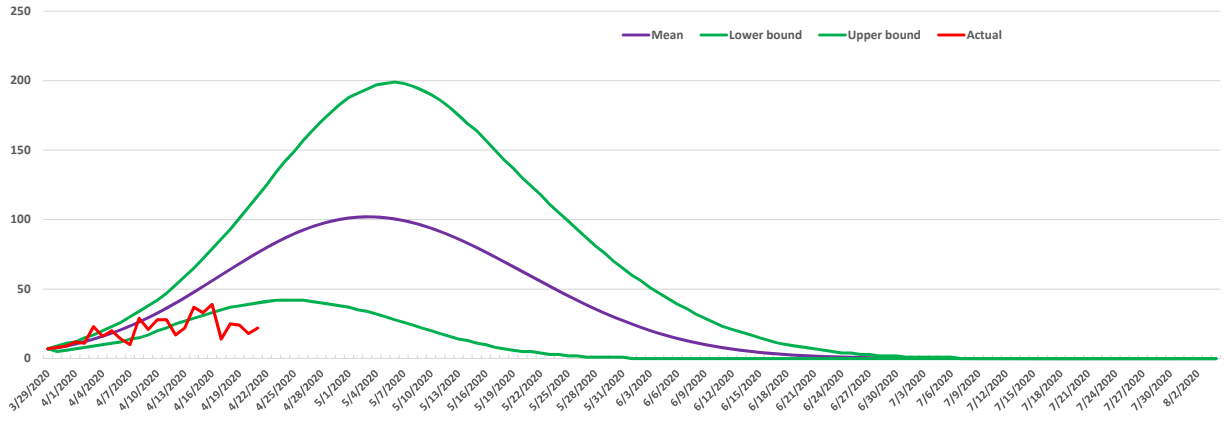
Texas COVID 19 Daily Death Projections March 26



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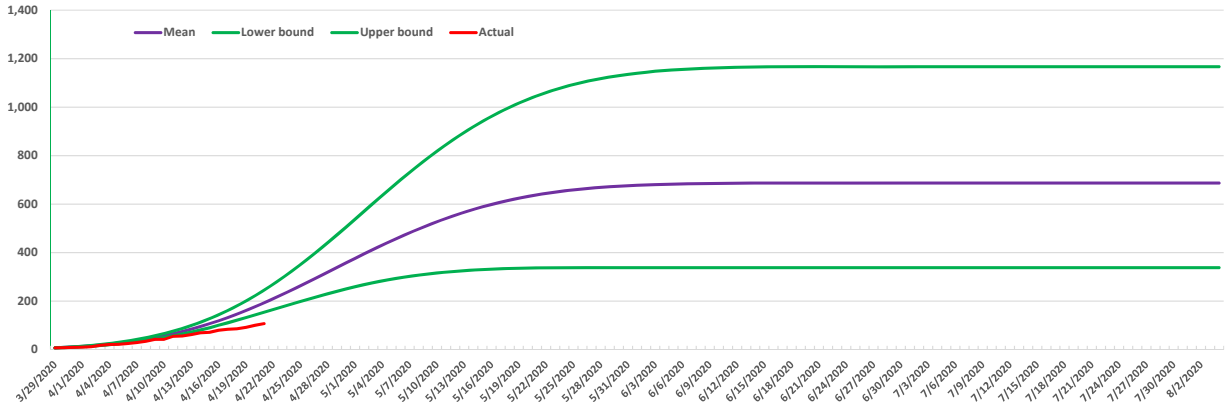
Forecasting performance of the March 26th model daily death projection

State	RMSE	MAE	MAPE	Bias
California	5.23	3.91	156%	3.48
Florida	38.00	27.21	132%	20.25
Illinois	20.78	16.68	43%	4.33
Kansas	5.23	3.91	156%	3.48
New York	837.39	254.53	15%	-221.42
Texas	22.17	15.15	77%	13.76
United States	895.92	391.03	17%	-84.00

RMSE is root mean squared error – square each error, sum the errors, take the average, and calculate the square root
MAE is the mean absolute error – the average absolute value of the error
MAPE is the mean absolute percentage error – take the absolute value of the error, divide by the actual, and average
Bias is the average of the sum of the errors. A positive number indicates an over-prediction

Kansas COVID 19 Cumulative Death Projections



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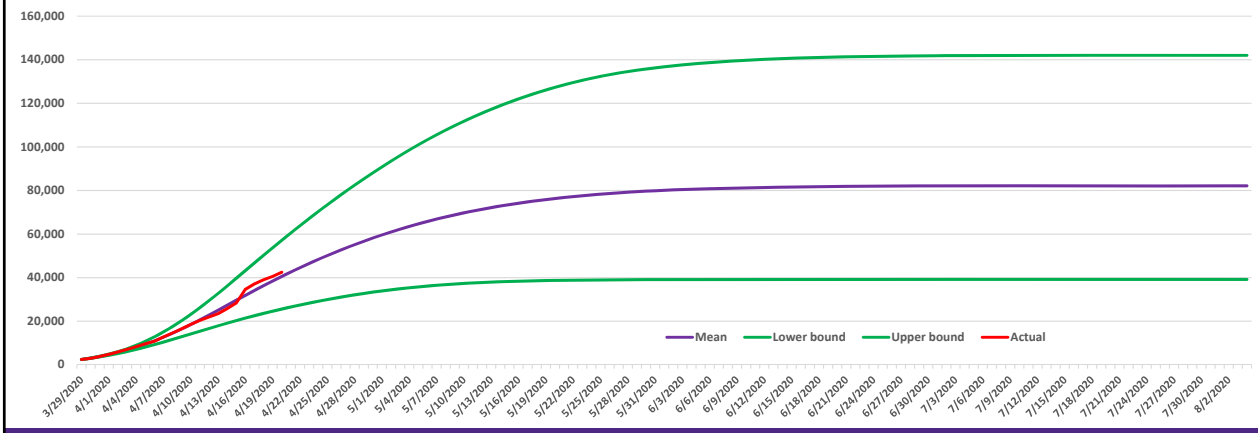
U.S. COVID 19 Cumulative Death Projections



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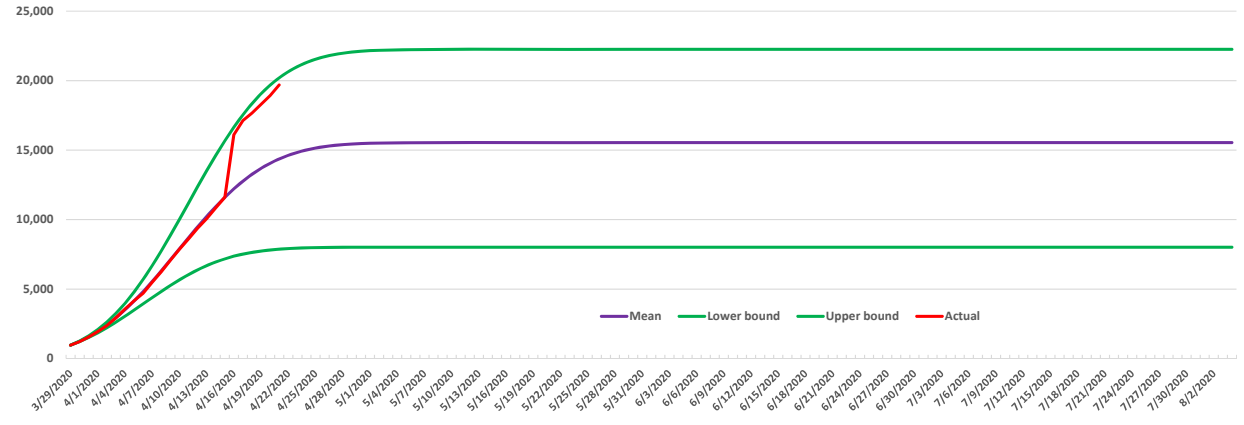
New York COVID 19 Cumulative Death Projections



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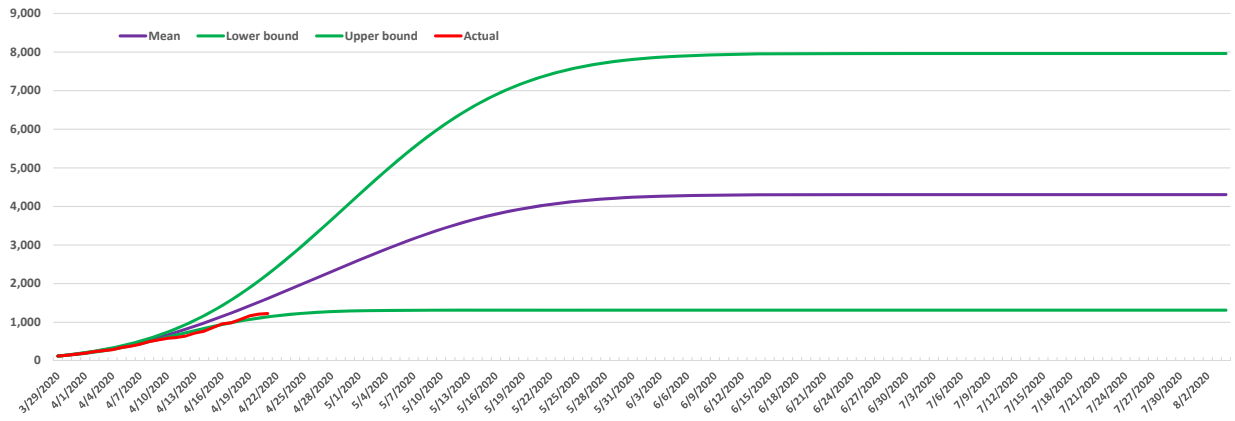
California COVID 19 Cumulative Death Projections March 26



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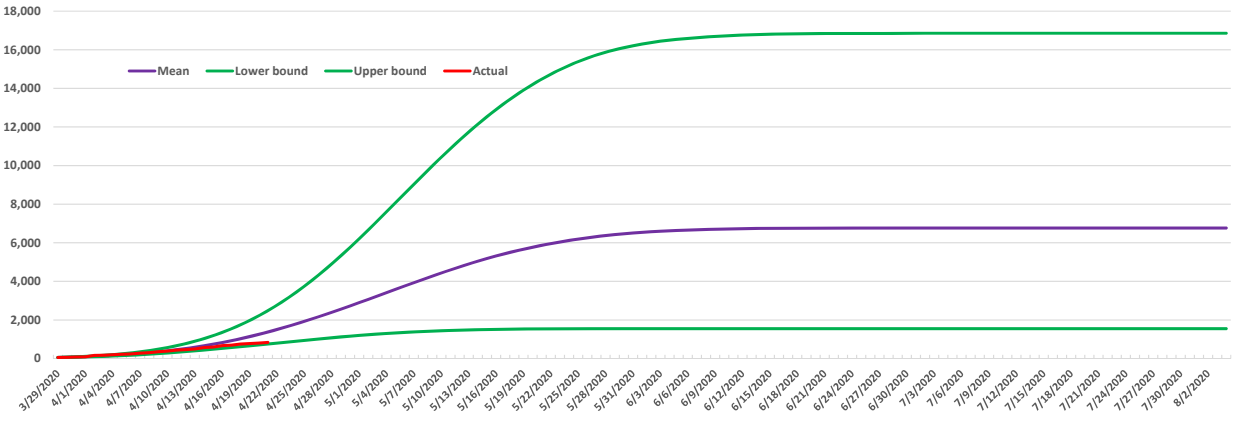
Florida COVID 19 Cumulative Death Projections March 26



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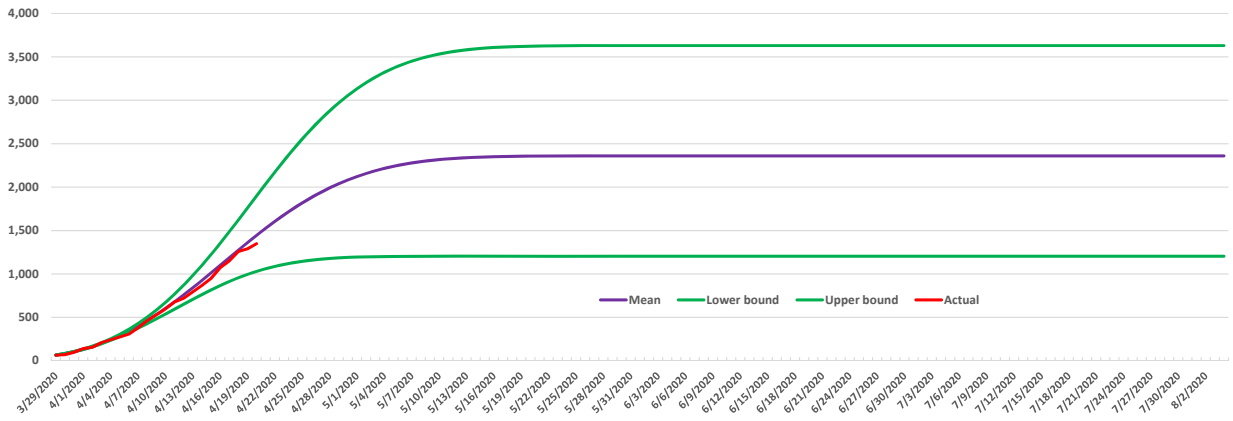
Illinois COVID 19 Cumulative Death Projections March 26



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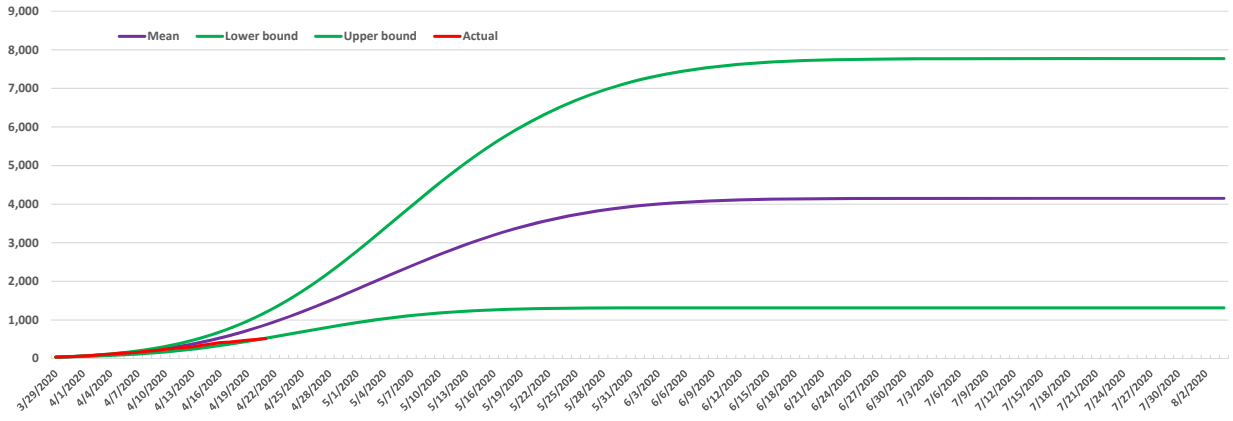
Texas COVID 19 Daily Death Projections March 26



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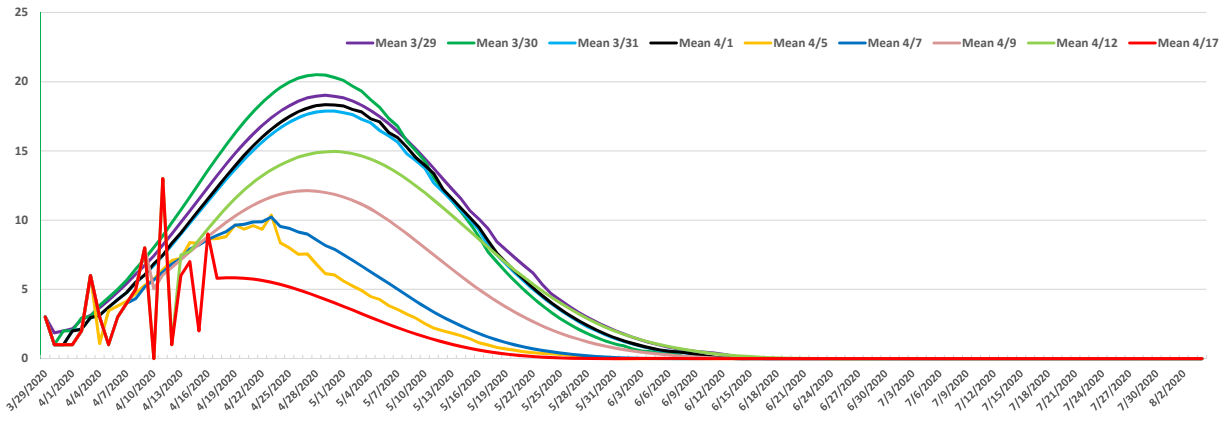
Forecasting performance of the March 26th model cumulative death projection

State	RMSE	MAE	MAPE	Bias
California	154.15	17.52	51%	14.18
Florida	154.59	94.41	18%	78.04
Illinois	37.47	26.98	5%	25.47
Kansas	31.14	20.98	34%	20.98
New York	2,117.58	1,048.85	7%	-972.72
Texas	109.42	66.45	18%	63.00
United States	1,319.95	876.20	4%	-373.59

RMSE is root mean squared error – square each error, sum the errors, take the average, and calculate the square root
MAE is the mean absolute error – the average absolute value of the error
MAPE is the mean absolute percentage error – take the absolute value of the error, divide by the actual, and average
Bias is the average of the sum of the errors. A positive number indicates an over-prediction

Kansas COVID 19 Daily Death Projections Revised Forecasts



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Forecasting performance of the COVID 19 Kansas daily death projections

	RMSE	MAE	MAPE	Bias	Bias/MAE
1 – day	1.53	1.31	53.1%	0.08	6%
2 – day	2.15	1.78	78.8%	0.48	27%
3 – day	3.33	2.53	129.4%	0.63	25%
4 – day	1.36	1.07	47.0%	0.58	54%
5 – day	3.55	2.90	181.1%	2.11	73%
6 – day	4.08	2.97	120.1%	2.29	77%
7 – day	2.52	1.88	66.0%	1.27	67%
8 – day	3.47	2.86	81.0%	2.37	83%
9 – day	3.90	2.80	155.5%	1.58	56%
10 – day	2.75	2.19	43.2%	1.82	83%

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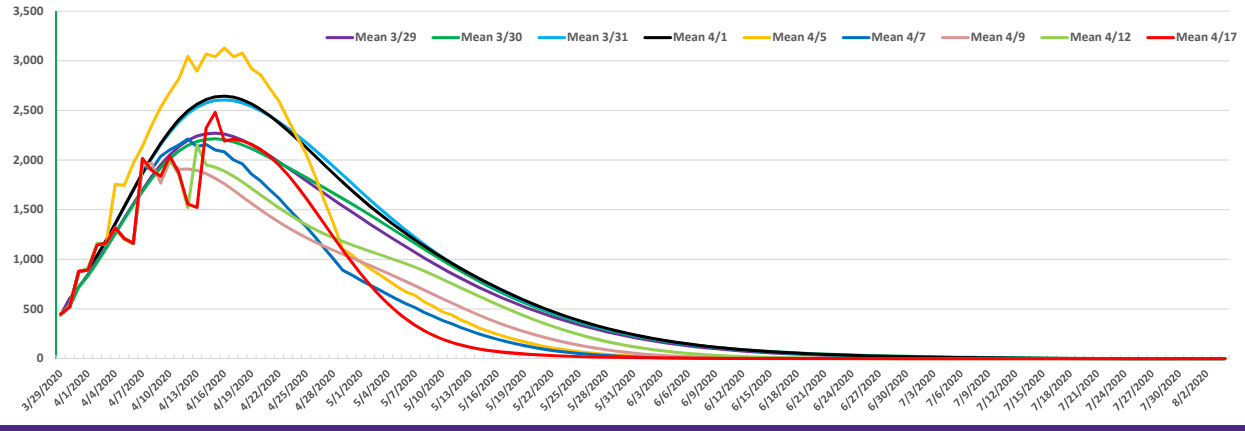
U.S. COVID 19 Daily Death Projections Revised Forecasts



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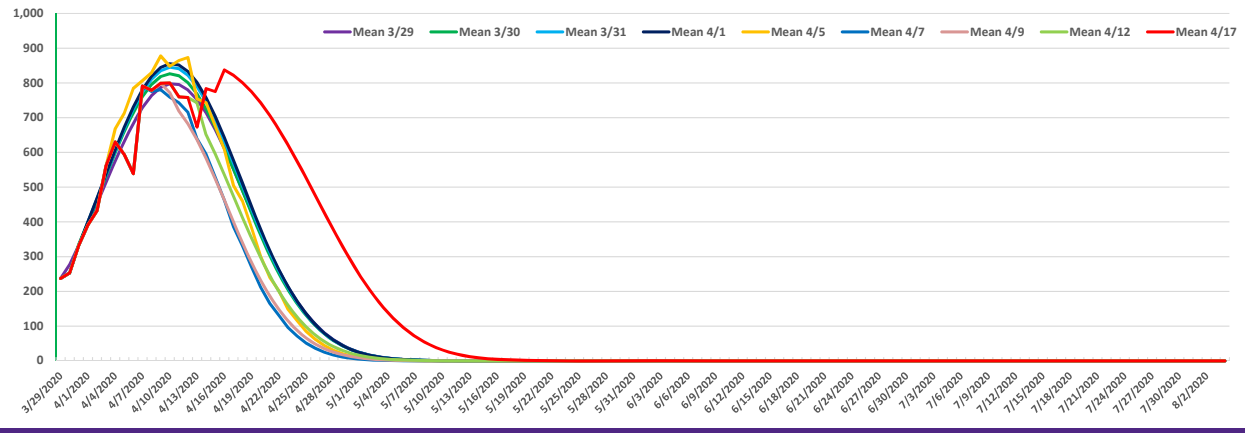
New York COVID 19 Daily Death Projections Revised Forecasts



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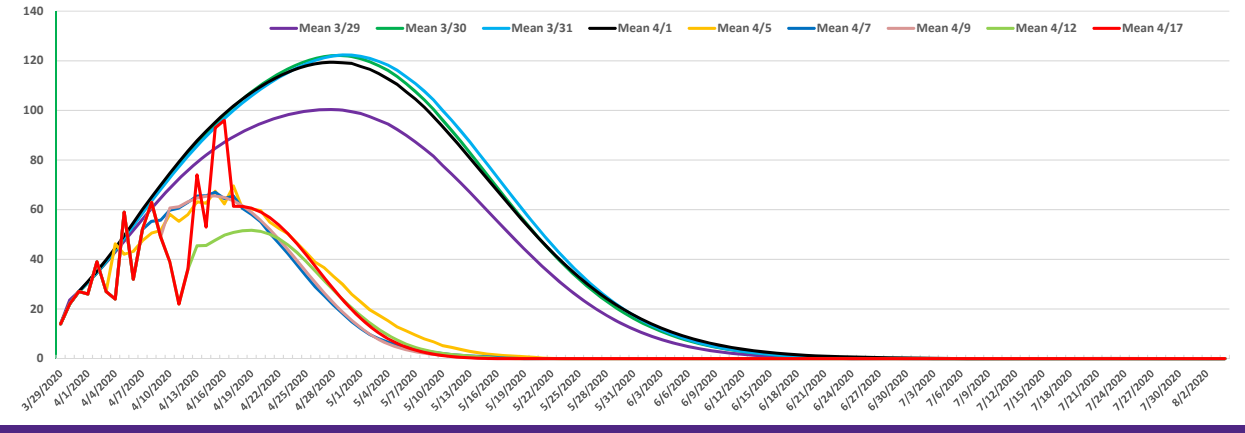
California COVID 19 Daily Death Projections Revised Forecasts



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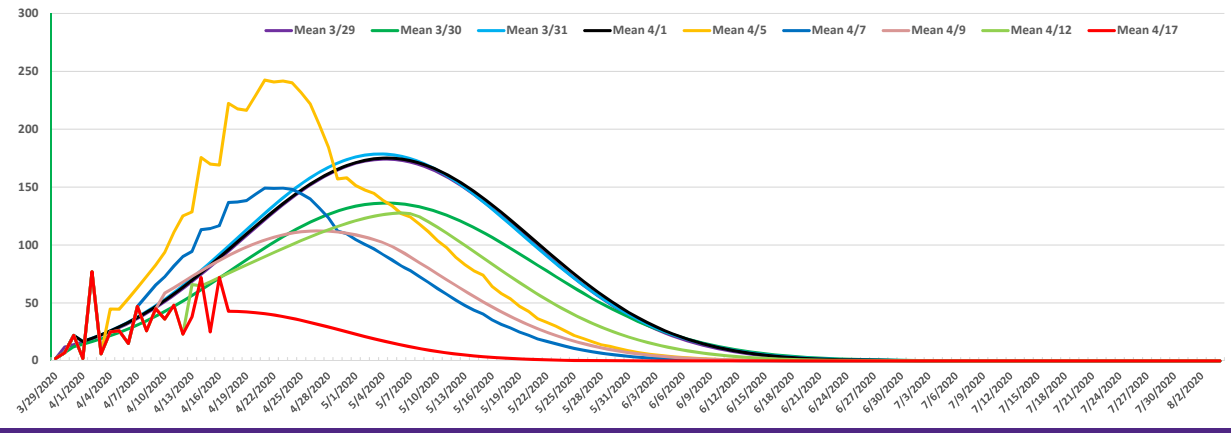
Florida COVID 19 Daily Death Projections Revised Forecasts



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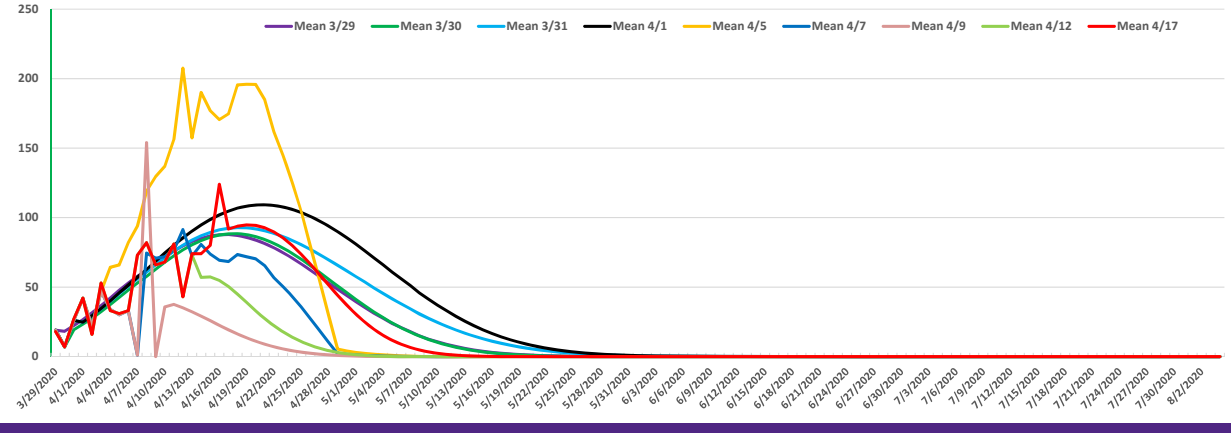
Illinois COVID 19 Daily Death Projections Revised Forecasts



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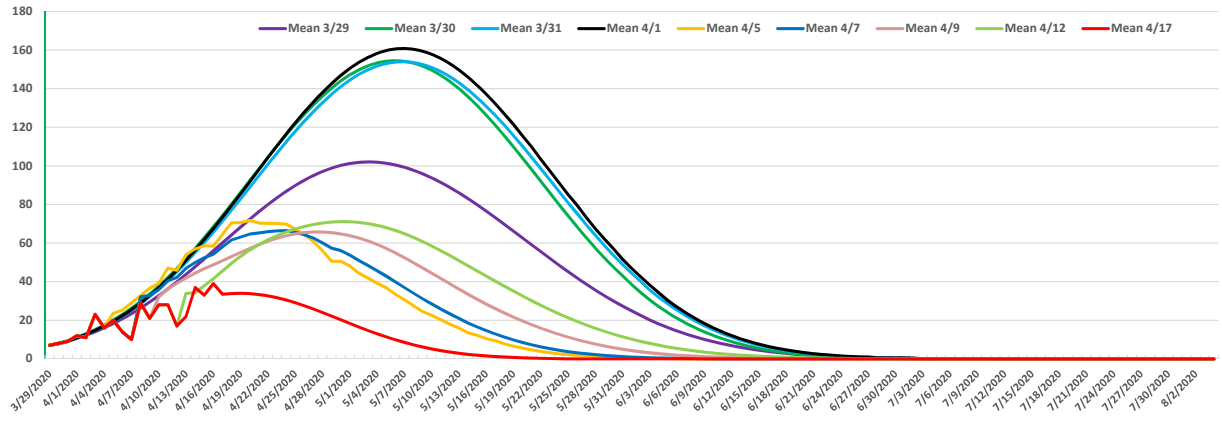
Texas COVID 19 Daily Death Projections Revised Forecasts



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Projected Date of Maximum Daily Death from the IHME COVID 19 Model

Model Date	CA	FL	IL	KS	NY	TX	U.S.
March 29	April 28	May 4	April 17	April 29	April 10	May 3	April 15
March 30	April 29	May 4	April 18	April 28	April 10	May 6	April 15
March 31	April 29	May 4	April 18	April 30	April 10	May 7	April 16
April 1	April 28	May 4	April 21	April 29	April 10	May 7	April 16
April 5	April 17	April 21	April 12	April 23	April 9	April 20	April 16
April 7	April 15	April 23	April 12	April 27	April 9	April 24	April 12
April 9	April 15	April 27	April 11	April 29	April 9	April 28	April 10
April 12	April 19	May 6	April 13	April 30	April 10	April 30	April 13
April 17	April 16	April 2	April 19	April 19	April 16	April 19	April 15

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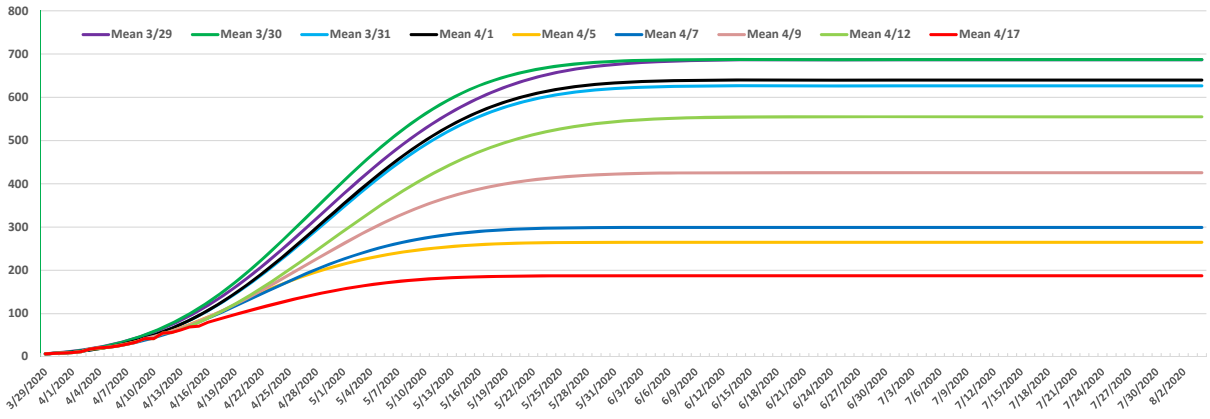
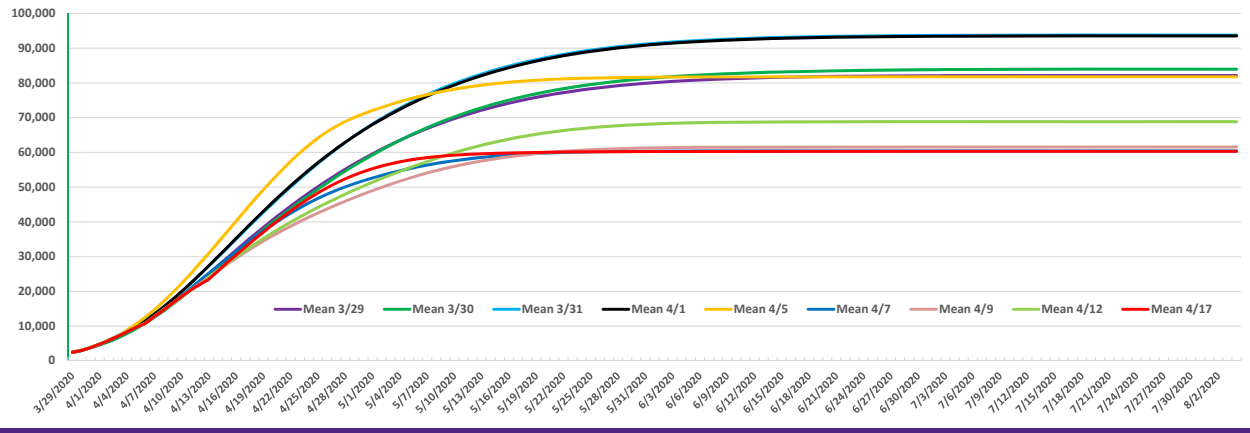
Kansas COVID 19 Cumulative Death Projections Revised Forecasts



Forecasting performance of the COVID 19 Kansas cumulative death projections

	RMSE	MAE	MAPE	Bias	Bias/MAE
1 – day	1.68	1.54	8.0%	0.10	7%
2 – day	2.79	2.41	10.0%	0.16	6%
3 – day	4.37	3.53	10.1%	0.81	23%
4 – day	4.22	3.40	9.3%	1.63	48%
5 – day	6.05	3.94	8.6%	3.94	100%
6 – day	9.92	6.62	13.0%	6.23	94%
7 – day	11.99	8.45	16.1%	7.50	89%
8 – day	14.50	10.46	17.4%	9.87	94%
9 – day	11.03	8.01	14.2%	8.01	100%
10 – day	13.27	9.83	15.1%	9.83	100%

U.S. COVID 19 Daily Cumulative Projections Revised Forecasts



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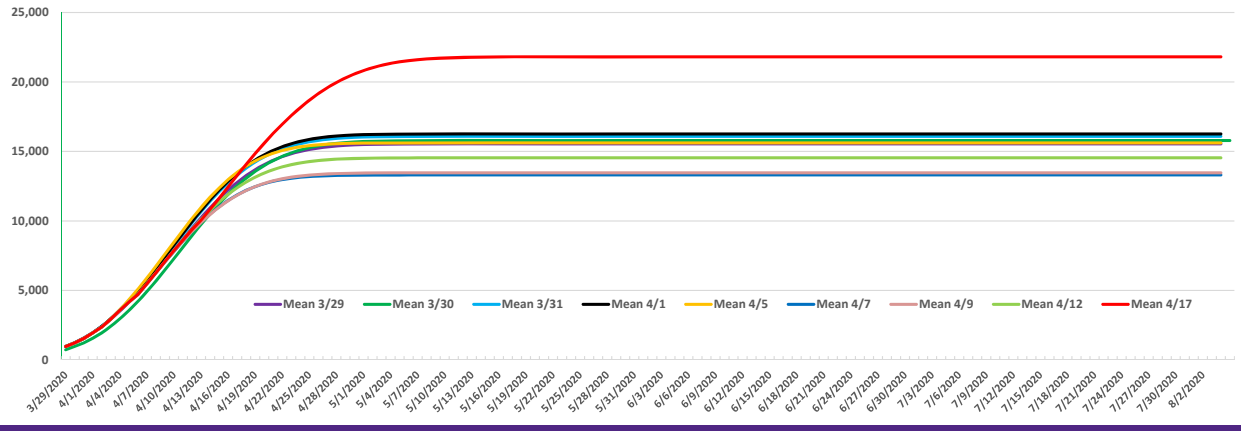
New York COVID 19 Cumulative Death Projections Revised Forecasts



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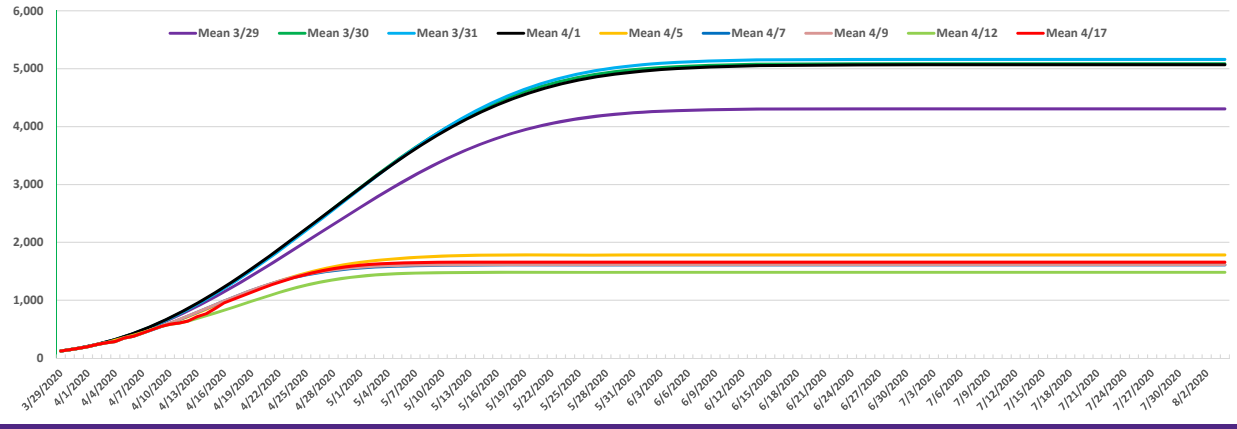
California COVID 19 Cumulative Death Projections Revised Forecasts



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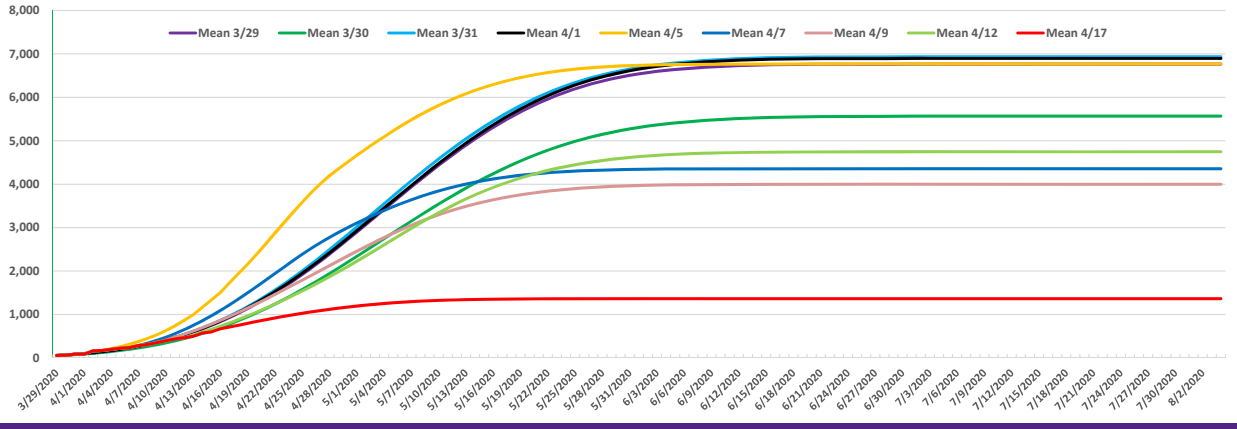
Florida COVID 19 Cumulative Death Projections Revised Forecasts



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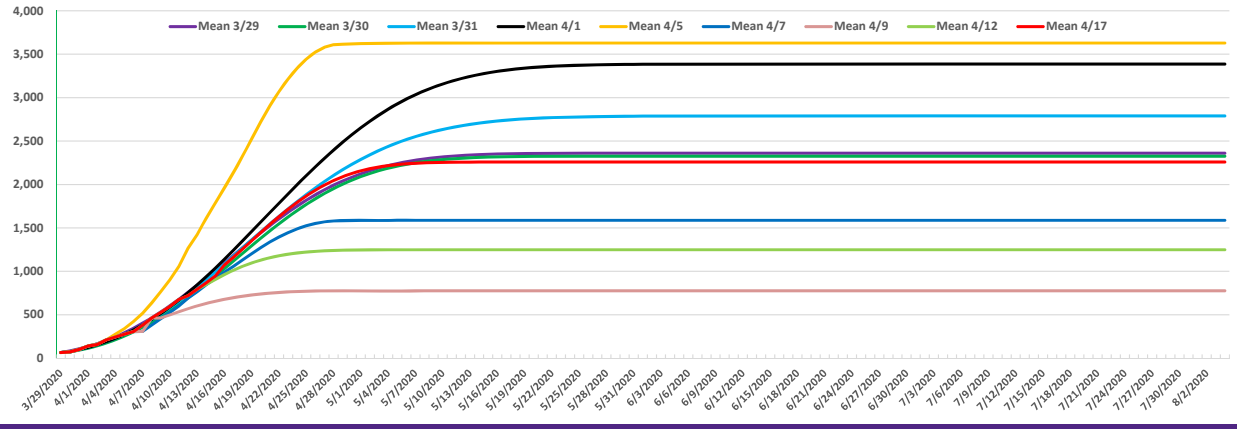
Illinois COVID 19 Cumulative Death Projections Revised Forecasts



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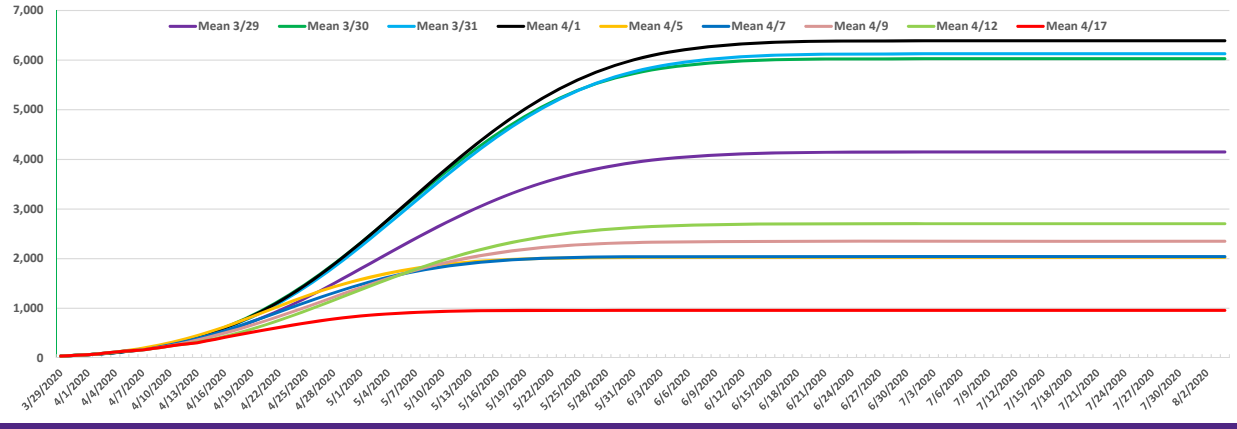
Texas COVID 19 Cumulative Death Projections Revised Forecasts



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Projected August 4th Cumulative Death from the IHME COVID 19 Model

Model Date	CA	FL	IL	KS	NY	TX	U.S.
March 29	4,306	6,766	2,360	687	15,546	4,150	82,141
March 30	5,086	5,568	2,326	687	15,788	6,029	83,967
March 31	5,161	6,937	2,789	627	16,090	6,128	93,765
April 1	5,068	6,897	3,386	640	16,261	6,392	93,531
April 5	1,783	6,770	3,629	265	15,618	2,025	81,766
April 7	1,611	4,357	1,588	299	13.307	2,042	60,415
April 9	1,616	3,999	777	426	13,643	2,350	61,545
April 12	1,483	4,748	1,248	555	14,542	2,704	68,841
April 17	1,658	1,363	2,259	187	21,812	957	60,308

Percentage Change from the Original Model to the April 17 Release

	Percent Change
California	-61.5%
Florida	-79.9%
Illinois	-4.3%
Kansas	-72.7%
New York	40.3%
Texas	-76.9%
United States	-26.6%

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Concluding Thoughts

- The IMHE model has been used to drive policy decisions that have resulted in large negative economic effects for the U.S. in general and the agricultural economy specifically
- The change in data definition has had an effect on the U.S. and New York projections
  - This makes modeling extremely difficult
- Fairly large revisions to the cumulative death totals and the peak of daily deaths both upwards and downwards
- Are the revisions due to society flattening the curve or due to inaccurate models?