Climate Uncertainty and Implications for U.S. State-Level Risk Assessment Through 2050

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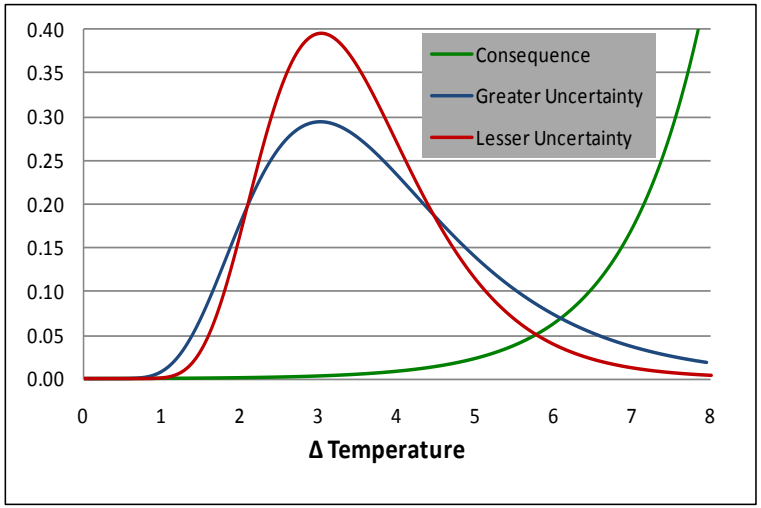
Basis of Methodology

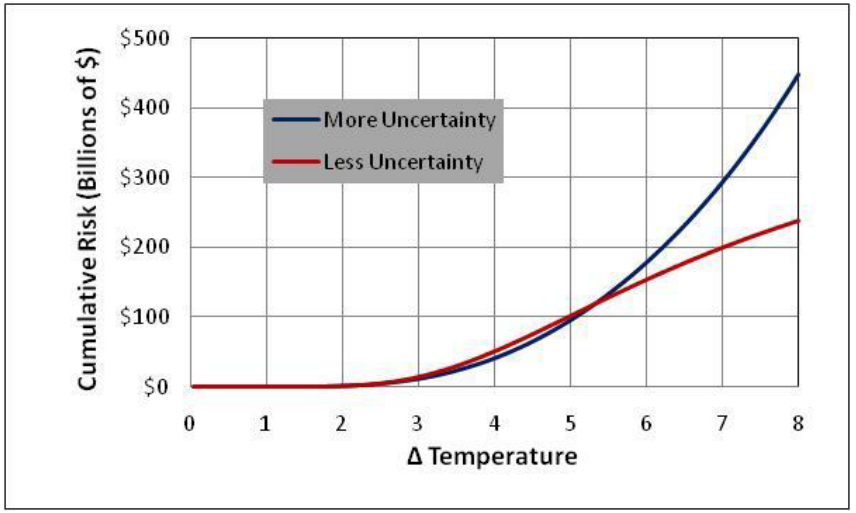
- Idea grew out of discussion with Secretary Chu, recognizing:
  - Uncertainty in climate predictions is frequently cited as a reason to delay action
  - Uncertainty cannot be eliminated and in many (most?) cases, is extremely difficult/expensive to reduce
  - *We maintain that uncertainty is what establishes the need to act protectively and proactively*
  - The justification for implementing climate change policy in the present needs to hinge on the tangible near-term cost of inaction
  - Probabilistic uncertainty quantification (UQ / risk assessment) is a tractable way to address uncertainty

The Greater The Uncertainty, The Greater The Risk

The envelope of uncertainty is not so much an expression of chance as an expected frequency of occurrence.



Probability Distributions with equal modes



Uncertainty changes the CCDF tail of risk.

$$Risk = \iint_{\tau,P} Consequence(t, p) \times dt \times dp$$

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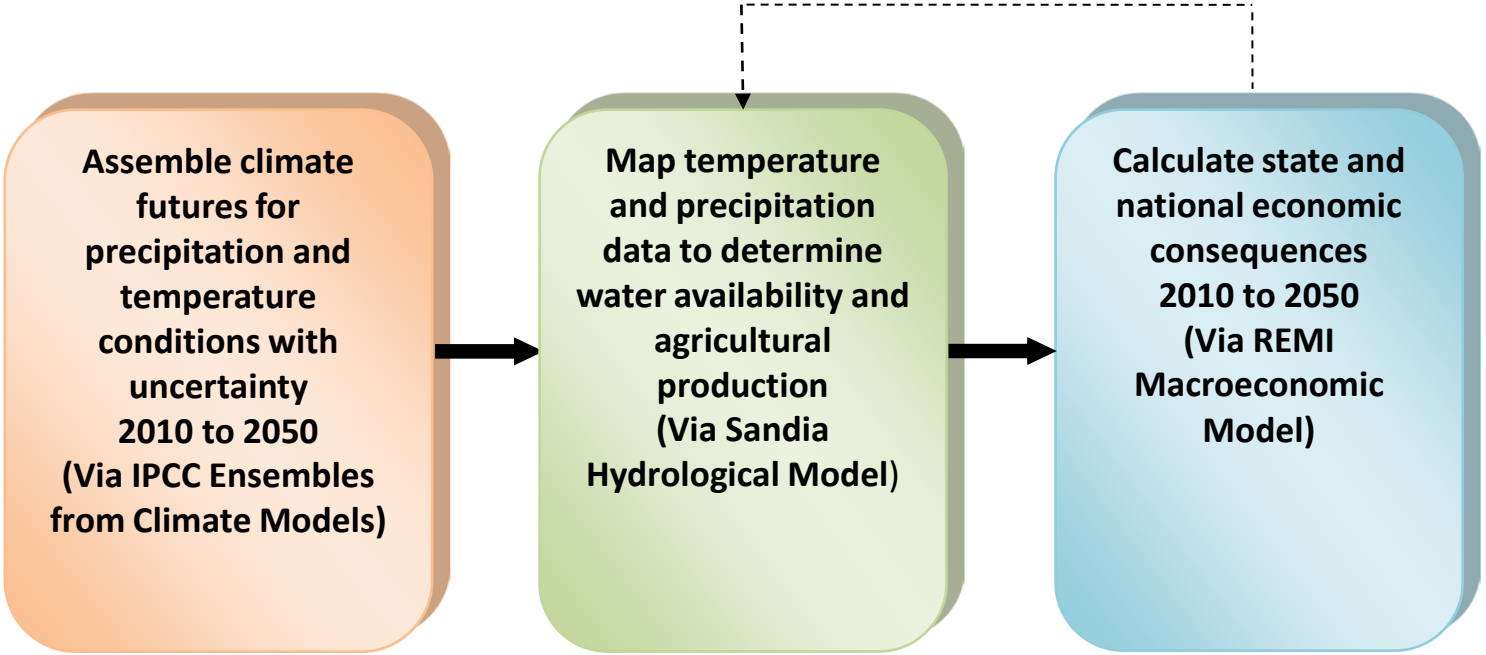
Overview of the analysis process



$$Risk = \iint_{\tau,P} Consequence(t, p) \times dt \times dp$$

p = probability
t = time

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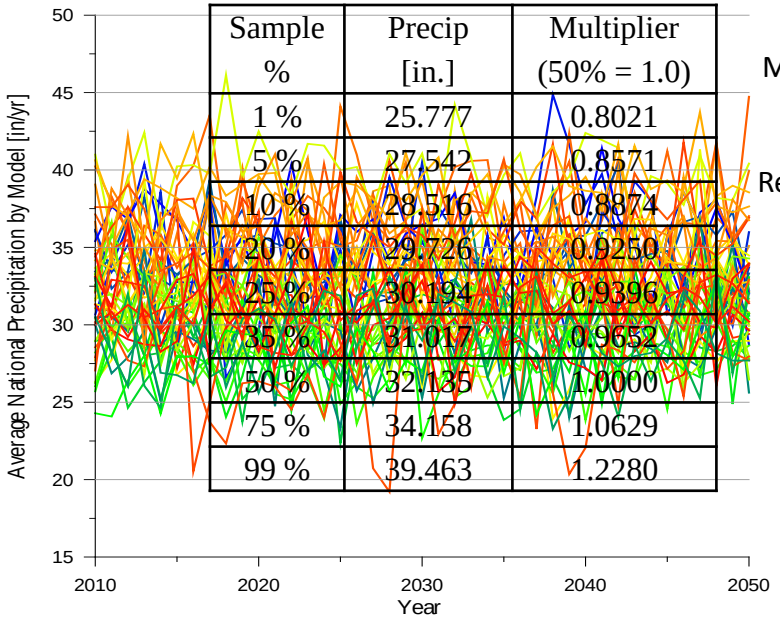
Uncertainty Quantification

Exp. #	Name	Description	ID
1	Pre-industrial control	No anthropogenic or natural forcing. Simulations prior to ~1850.	PICNTRL
2	Present day control	No natural forcing and anthropogenic forcing is set to present day	PDCNTRL
3	Climate of the 20th century (20C3M)	Verification runs ~1850-present	20C3M
4	Committed climate change	Present - 2100, uses end of 20C3M as initial condition	COMMIT
5	SRES A2 experiment	Continuously increasing global population and economic growth, although more fragmented and slower than other scenarios. Present - 2100, uses end of 20C3M as initial condition	SRESA2
6	720 ppm stabilization experiment (SRES A1B)	Rapid economic growth, global population peaks in mid-century and declines after that. Rapid introduction for new technologies. Initialize w/ 20C3M and run to 2100. After 2100, hold concentrations steady and run to 2200	SRESA1B
7	550 ppm stabilization experiment (SRES B1)	Same as A1 conditions but future is based on clean and resource efficient technologies. Initialize w/ 20C3M and run to 2100. After 2100, hold concentrations steady and run to 2201	SRESB1
8	1%/yr CO2 increase experiment to doubling	Hold CO2 fixed after it has doubled. Run is initialized with either pre-industrial or 20C3M.	1PCTTO2X
9	1%/yr CO2 increase experiment to quadrupling	Hold CO2 fixed after it has quadrupled. Run is initialized with either pre-industrial or 20C3M.	1PCTTO4X

- Standard IPCC simulation experiments as determined by the *Special Report on Emissions Scenarios* (SRES)
- Not all models submit results for every experiment
- Single models can submit several realizations of each experiment

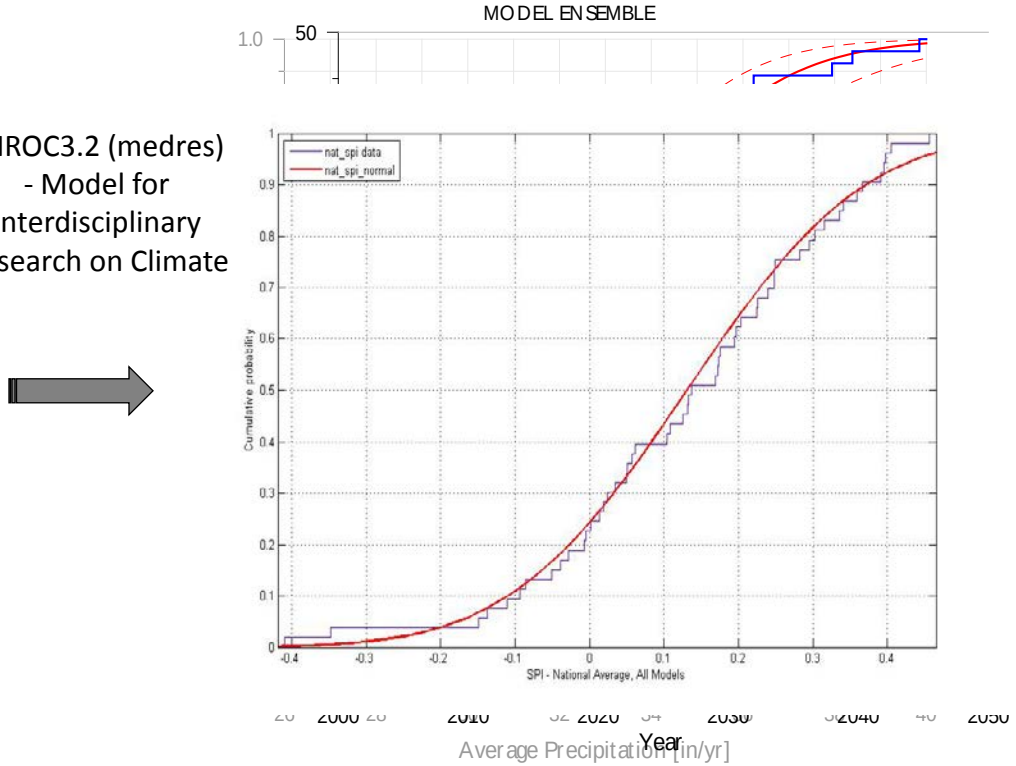
Uncertainty Quantification

1. Calculate the Average National Precipitation from 2010 – 2050
2. Plot as a CCDF to obtain the probability of each prediction
3. Select probability values for a range of probabilities and calculate a scaling multiplier
4. Select the time series of precipitation based on the SPI. Model closest to 10% was used.
5. Scale the MIROC3.2 time series by the scaling multiplier to obtain time series at each probability



Sample %	Precip [in.]	Multiplier (50% = 1.0)
1 %	25.777	0.8021
5 %	27.542	0.8571
10 %	28.516	0.8874
20 %	29.726	0.9250
25 %	30.194	0.9396
35 %	31.017	0.9652
50 %	32.135	1.0000
75 %	34.158	1.0629
99 %	39.463	1.2280

MIROC3.2 (medres) - Model for Interdisciplinary Research on Climate



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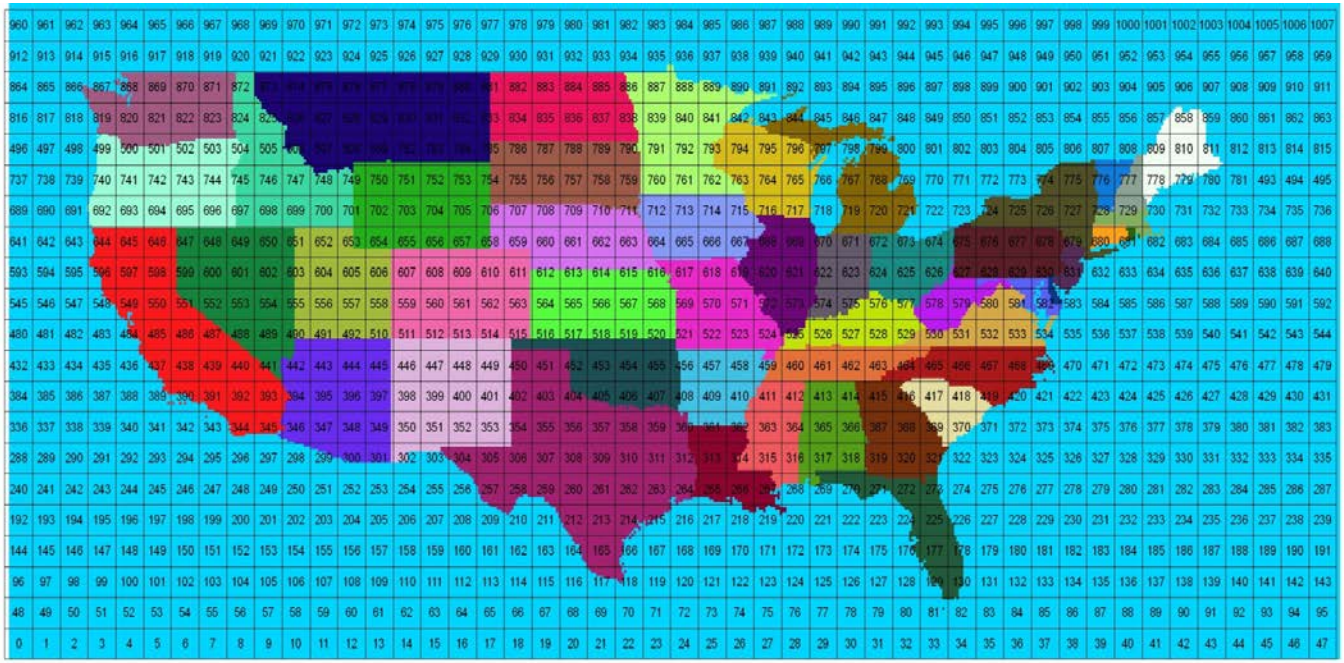

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Hydrologic Consequence: Water Use Analysis

- Water use data taken from U.S. Geological Survey's "Water Use in the United States"
- Data were collected at five year intervals from 1985-1995 at the national, state, county and watershed levels
- Data are disaggregated by:
  - Sector
    - Municipal
    - Industrial
    - Thermoelectric
    - Mining
    - Livestock
    - Agriculture
  - Source
    - Groundwater
    - Surface water
    - other
  - Use and consumption

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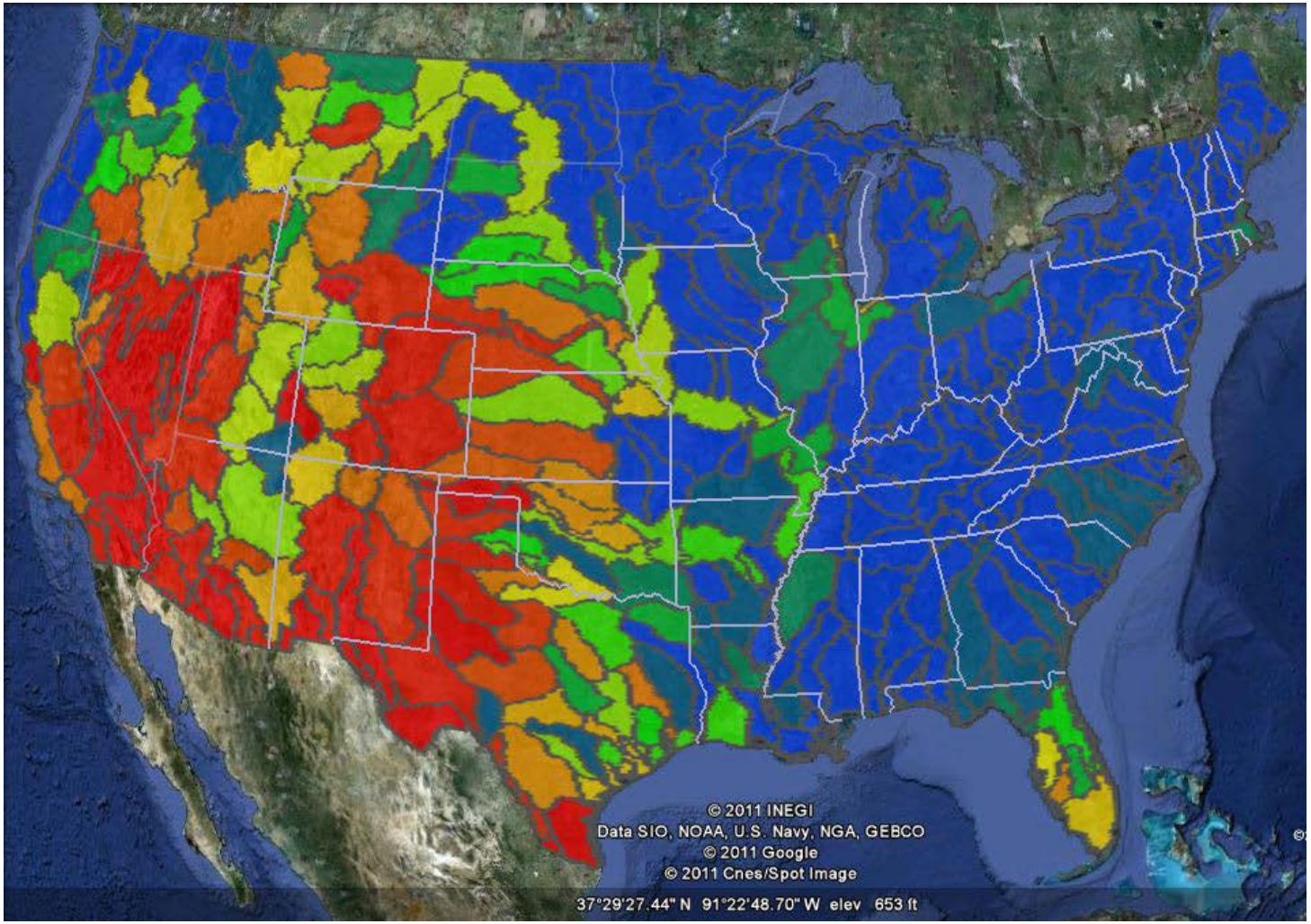
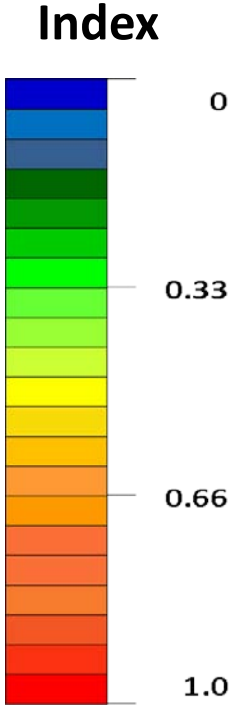
Hydrologic Consequence: Water Availability

Ratio of Mean Water Demand to Stream Flow





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Hydrologic Consequence: Water Shortage

- Water shortage, or the amount of water that goes undelivered, is the threshold value minus the available water
- Water shortages are disproportionately distributed across sectors:
  - 2/3 shortage borne by the agriculture, livestock and mining sectors
  - 1/3 shortage borne by the municipal, industrial, and thermoelectric sectors

Hydrologic Consequence: Impact on Crop Yields

$$y = f(X, \beta) + h(X, \alpha)\varepsilon$$ McCarl et al. (2008)

- Empirical based model using the historical impact of climate changes on crop yield distribution
- The model considers:
  - Temperature -Rainfall Intensity Index
  - Precipitation - PDSI*
  - Variance in inter-annual Temperature
- Rain-fed crops depend only on precipitation while irrigated crops depend both on precipitation and water deliveries.

*PDSI = Palmer Drought Severity Index

Water Availability

(1% Exceedance Probability case)

Year	AL	AZ	AR	CA	CO	CT	DE	DC	FL	GA	ID	IL	IN	IA	KS	KY	LA	ME	MD	MA	MI	MN	MS	MO	MT
2010	1.000	0.924	1.000	0.987	1.000	0.947	0.978	1.000	1.000	0.977	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.981	1.000	1.000	1.000	1.000	1.000
2011	1.000	0.917	1.000	0.941	0.989	0.975	1.000	1.000	1.000	0.946	1.000	1.000	1.000	1.000	0.971	1.000	1.000	1.000	1.000	0.963	1.000	1.000	1.000	1.000	1.000
2012	1.000	0.836	1.000	0.930	0.929	0.895	0.898	1.000	1.000	0.983	1.000	1.000	1.000	1.000	0.929	1.000	1.000	1.000	1.000	0.909	1.000	1.000	1.000	1.000	1.000
2013	1.000	0.977	1.000	0.774	1.000	0.815	0.824	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.870	1.000	1.000	1.000	1.000	1.000
2014	1.000	1.000	1.000	0.807	1.000	0.989	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.827	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2015	0.946	0.548	0.917	0.626	0.678	0.905	0.859	1.000	1.000	0.795	1.000	1.000	1.000	1.000	0.711	1.000	0.961	1.000	1.000	0.942	1.000	1.000	0.973	1.000	1.000
2016	0.980	0.455	1.000	0.524	0.986	0.746	0.842	1.000	0.792	0.650	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.864	1.000	1.000	1.000	1.000	1.000
2017	1.000	0.762	1.000	1.000	1.000	0.961	0.936	1.000	1.000	0.845	1.000	1.000	1.000	1.000	1.000	1.000	0.988	1.000	1.000	0.968	1.000	1.000	1.000	1.000	1.000
2018	0.992	0.524	1.000	0.685	0.837	0.783	0.818	1.000	0.729	0.738	1.000	1.000	0.997	0.950	0.721	1.000	1.000	1.000	1.000	0.775	1.000	1.000	1.000	1.000	1.000
2019	1.000	0.987	1.000	0.903	1.000	0.888	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.890	1.000	1.000	1.000	1.000	1.000
2020	1.000	1.000	1.000	0.897	1.000	0.732	0.836	1.000	1.000	0.885	1.000	1.000	1.000	1.000	0.981	1.000	1.000	1.000	1.000	0.772	1.000	1.000	1.000	1.000	1.000
2021	1.000	0.457	1.000	0.564	0.874	0.714	0.721	1.000	1.000	0.941	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.758	1.000	1.000	1.000	1.000	1.000
2022	0.903	0.748	1.000	0.831	0.896	0.852	0.896	1.000	0.767	0.723	1.000	1.000	1.000	1.000	0.924	1.000	0.945	1.000	1.000	0.811	1.000	1.000	1.000	1.000	1.000
2023	0.993	0.449	1.000	1.000	0.957	0.601	0.793	1.000	0.975	0.850	1.000	1.000	0.869	1.000	1.000	1.000	1.000	0.911	1.000	0.539	0.961	1.000	1.000	1.000	1.000
2024	1.000	0.826	1.000	0.714	1.000	0.778	0.927	1.000	0.706	0.803	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.657	1.000	1.000	1.000	1.000	1.000
2025	0.929	0.622	1.000	0.668	1.000	0.777	0.829	1.000	0.968	0.829	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.844	1.000	1.000	1.000	1.000	1.000
2026	0.942	0.484	1.000	0.488	0.976	0.671	0.813	1.000	0.899	0.794	1.000	1.000	1.000	0.953	0.924	1.000	0.953	1.000	1.000	0.705	1.000	0.943	1.000	1.000	1.000
2027	0.549	0.617	1.000	0.346	0.932	0.695	0.611	0.869	0.593	0.460	0.845	1.000	0.961	0.999	0.983	1.000	0.778	1.000	0.958	0.812	1.000	1.000	1.000	1.000	1.000
2028	0.654	0.704	1.000	0.707	0.973	0.641	0.676	1.000	0.908	0.648	1.000	1.000	1.000	1.000	0.895	1.000	0.776	1.000	1.000	0.669	0.967	1.000	0.960	1.000	1.000
2029	0.787	0.506	1.000	0.491	0.679	0.602	0.609	0.883	0.710	0.607	0.969	1.000	0.923	0.989	0.740	0.813	0.985	1.000	0.937	0.670	1.000	0.994	1.000	1.000	1.000
2030	1.000	0.582	1.000	0.800	0.777	0.588	0.672	1.000	0.928	0.856	1.000	0.985	0.787	0.852	0.930	1.000	1.000	0.974	1.000	0.656	1.000	1.000	1.000	1.000	1.000
2031	0.640	0.731	1.000	0.671	0.882	0.784	0.746	1.000	0.742	0.550	1.000	1.000	1.000	0.825	0.801	1.000	0.895	1.000	1.000	0.808	0.955	0.827	1.000	1.000	1.000
2032	0.832	0.758	1.000	0.787	0.958	0.637	0.773	1.000	1.000	0.767	1.000	0.830	0.671	0.780	0.902	0.929	0.914	1.000	1.000	0.662	0.857	0.845	1.000	1.000	1.000
2033	0.550	0.732	0.919	0.967	0.868	0.753	0.779	1.000	0.753	0.518	1.000	0.932	0.680	0.937	0.806	0.935	0.873	1.000	1.000	0.829	0.955	1.000	0.919	0.975	1.000
2034	0.725	0.689	1.000	0.642	0.927	0.891	0.995	1.000	0.707	0.669	1.000	1.000	0.889	0.823	1.000	1.000	1.000	1.000	1.000	0.833	0.710	0.886	1.000	1.000	1.000
2035	0.610	0.549	0.830	0.542	0.814	0.382	0.621	0.958	0.957	0.634	1.000	0.677	0.522	0.669	0.614	0.734	0.795	0.849	0.882	0.436	0.754	0.870	1.000	0.701	1.000
2036	0.610	0.483	1.000	0.491	0.686	0.759	0.677	0.929	0.701	0.573	1.000	0.741	0.505	0.518	0.646	0.692	0.929	1.000	0.944	0.908	1.000	0.830	1.000	0.917	1.000
2037	1.000	0.374	1.000	0.477	0.894	0.856	1.000	1.000	0.909	1.000	1.000	1.000	0.956	0.733	1.000	1.000	1.000	1.000	1.000	0.873	0.664	0.699	1.000	1.000	1.000
2038	0.582	0.472	1.000	0.594	0.970	0.844	0.906	1.000	0.800	0.743	1.000	1.000	0.784	0.674	0.928	0.841	1.000	1.000	1.000	0.909	0.935	0.640	1.000	1.000	1.000
2039	0.813	0.887	1.000	0.617	1.000	0.690	0.768	1.000	1.000	1.000	1.000	0.894	0.553	0.792	0.852	0.726	0.989	0.857	1.000	0.744	0.874	0.795	1.000	1.000	1.000
2040	0.461	0.298	1.000	0.373	0.707	0.557	0.635	0.868	0.871	0.597	1.000	0.924	0.543	0.830	0.870	0.685	0.991	0.820	0.862	0.610	0.781	0.879	0.958	1.000	1.000
2041	0.542	0.566	1.000	0.455	0.779	0.624	0.568	0.777	0.751	0.644	1.000	0.747	0.488	0.560	0.749	0.458	0.733	0.933	0.774	0.732	0.739	0.598	1.000	0.921	1.000
2042	0.545	0.416	1.000	0.877	0.833	0.676	0.551	0.727	0.689	0.700	1.000	0.881	0.579	0.621	1.000	0.743	0.769	0.945	0.762	0.807	0.624	0.794	1.000	1.000	1.000
2043	0.756	0.469	1.000	0.632	0.694	0.761	0.688	0.990	0.610	0.657	1.000	1.000	0.655	0.809	0.961	0.663	1.000	0.918	0.888	0.762	0.827	1.000	1.000	1.000	1.000
2044	0.544	0.242	0.978	0.427	0.744	0.671	0.739	0.887	0.854	0.682	1.000	0.545	0.342	0.495	0.810	0.585	0.703	0.671	0.965	0.615	0.509	0.733	1.000	0.785	1.000
2045	0.213	0.732	1.000	0.444	0.897	0.518	0.425	0.563	0.402	0.299	1.000	0.729	0.436	0.539	0.651	0.494	0.685	0.750	0.620	0.608	0.760	0.741	0.979	0.920	1.000
2046	0.445	0.639	1.000	0.568	0.779	0.609	0.603	0.869	0.413	0.581	1.000	0.436	0.255	0.239	0.651	0.565	0.580	0.866	0.791	0.587	0.246	0.411	0.910	0.752	1.000
2047	0.287	0.685	0.856	0.717	0.800	0.587	0.549	0.845	0.641	0.479	1.000	0.380	0.111	0.297	0.595	0.151	0.505	0.878	0.727	0.817	0.413	0.454	0.789	0.624	1.000
2048	0.379	0.850	0.933	1.000	0.866	0.658	0.596	0.872	0.523	0.426	1.000	0.417	0.189	0.366	0.747	0.381	0.652	0.724	0.760	0.692	0.367	0.766	0.928	0.745	1.000
2049	0.389	0.604	0.974	0.855	0.985	0.642	0.661	0.940	0.876	0.564	1.000	0.810	0.531	0.768	0.998	0.678	0.557	0.727	0.813	0.558	0.546	0.868	0.905	1.000	1.000
2050	0.460	0.525	0.912	0.724	0.668	0.561	0.543	0.781	0.485	0.507	1.000	0.538	0.217	0.481	0.580	0.472	0.565	0.674	0.734	0.490	0.667	0.704	0.984	0.741	1.000

Year	NE	NV	NH	NJ	NM	NY	NC	ND	OH	OK	OR	PA	RI	SC	SD	TN	TX	UT	VT	VA	WA	WV	WI	WY
2010	1.000	0.957	1.000	1.000	0.940	1.000	0.963	1.000	1.000	1.000	1.000	1.000	0.958	0.953	1.000	1.000	0.998	0.989	1.000	0.974	1.000	1.000	1.000	1.000
2011	1.000	0.963	1.000	1.000	0.926	1.000	0.983	1.000	1.000	0.962	1.000	1.000	1.000	0.917	1.000	1.000	0.978	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2012	0.951	0.874	1.000	1.000	0.858	1.000	0.854	1.000	1.000	0.871	1.000	1.000	0.899	0.902	1.000	1.000	1.000	0.966	1.000	0.807	1.000	1.000	1.000	0.909
2013	1.000	0.788	1.000	1.000	0.916	1.000	0.896	1.000	1.000	1.000	1.000	1.000	0.837	0.944	1.000	1.000	1.000	1.000	1.000	0.719	1.000	1.000	1.000	1.000
2014	0.821	0.828	1.000	1.000	0.872	1.000	0.998	0.839	1.000	0.929	1.000	1.000	1.000	0.968	0.979	1.000	0.967	1.000	1.000	0.953	1.000	1.000	1.000	0.992
2015	0.770	0.565	1.000	1.000	0.535	1.000	0.758	1.000	1.000	0.674	1.000	1.000	0.970	0.626	1.000	0.851	0.721	0.760	1.000	0.670	1.000	1.000	1.000	0.804
2016	1.000	0.457	1.000	1.000	0.644	1.000	0.600	1.000	1.000	1.000	1.000	1.000	0.771	0.410	1.000	1.000	1.000	0.689	1.000	0.689	1.000	1.000	1.000	1.000
2017	1.000	0.840	1.000	1.000	0.952	1.000	0.726	1.000	1.000	0.898	1.000	1.000	0.895	0.579	1.000	1.000	0.907	0.927	1.000	0.793	1.000	1.000	1.000	1.000
2018	0.768	0.713	1.000	1.000	0.575	1.000	0.757	1.000	1.000	0.640	1.000	1.000	0.809	0.585	0.921	0.852	0.744	0.895	1.000	0.550	1.000	1.000	1.000	0.833
2019	1.000	0.818	1.000	1.000	0.935	1.000	1.000	1.000	1.000	0.851	1.000	1.000	0.801	0.993	1.000	1.000	0.940	1.000	1.000	0.946	1.000	1.000	1.000	1.000
2020	0.909	0.979	1.000	1.000	0.916	1.000	0.845	1.000	1.000	1.000	1.000	1.000	0.694	0.735	1.000	1.000	1.000	1.000	1.000	0.640	1.000	1.000	1.000	1.000
2021	1.000	0.571	1.000	0.967	0.612	0.999	0.756	1.000	1.000	1.000	1.000	0.868	0.784	0.700	1.000	1.000	0.996	0.684	1.000	0.590	1.000	1.000	1.000	0.864
2022	1.000	0.826	1.000	1.000	0.620	1.000	0.635	1.000	1.000	0.833	1.000	1.000	0.885	0.448	1.000	0.880	0.814	1.000	1.000	0.668	1.000	1.000	1.000	1.000
2023	1.000	0.970	0.664	0.935	0.534	0.760	0.760	1.000	0.763	1.000	1.000	0.735	0.656	0.689	1.000	0.908	0.883	0.998	0.891	0.652	1.000	0.974	1.000	1.000
2024	1.000	0.648	0.829	1.000	0.799	0.814	0.840	1.000	1.000	1.000	0.952	1.000	0.848	0.722	1.000	1.000	1.000	0.988	0.939	0.891	0.932	1.000	1.000	1.000
2025	1.000	0.586	1.000	1.000	0.747	1.000	0.801	1.000	1.000	1.000	1.000	1.000	0.758	0.699	1.000	0.714	1.000	0.866	1.000	0.677	1.000	1.000	1.000	0.901
2026	0.890	0.462	0.878	1.000	0.647	0.901	0.799	1.000	1.000	0.939	1.000	0.974	0.765	0.635	1.000	0.820	0.872	0.741	1.000	0.796	1.000	1.000	0.951	1.000
2027	0.884	0.338	1.000	0.966	0.682	0.998	0.452	1.000	0.957	0.908	0.731	0.773	0.808	0.164	1.000	0.558	0.813	0.748	1.000	0.379	0.977	0.762	0.988	0.913
2028	0.967	0.677	0.784	0.951	0.547	0.772	0.588	1.000	0.981	0.663	1.000	0.722	0.744	0.456	1.000	0.519	0.476	1.000	0.976	0.429	1.000	0.702	0.955	1.000
2029	0.873	0.413	0.777	0.865	0.441	0.736	0.582	0.969	0.928	0.704	0.988	0.669	0.640	0.304	1.000	0.432	0.880	0.586	0.964	0.292	1.000	0.543	1.000	0.759
2030	0.916	0.798	0.678	0.864	0.453	0.706	0.605	1.000	0.812	0.648	1.000	0.658	0.783	0.514	1.000	0.809	0.595	0.895	0.852	0.445	1.000	0.647	1.000	0.991
2031	0.993	0.717	0.846	1.000	0.630	0.901	0.515	1.000	1.000	0.721	1.000	0.847	0.869	0.187	1.000	0.506	0.549	0.911	1.000	0.583	1.000	0.896	0.768	1.000
2032	0.825	0.708	0.684	0.923	0.701	0.680	0.698	0.877	0.758	0.892	1.000	0.651	0.657	0.515	1.000	0.479	0.918	0.897	0.864	0.539	1.000	0.641	0.917	0.927
2033	0.905	0.878	0.810	0.962	0.625	0.717	0.643	1.000	0.790	0.621	1.000	0.671	0.827	0.262	1.000	0.333	0.720	0.946	0.961	0.615	1.000	0.733	1.000	1.000
2034	0.907	0.529	0.799	1.000	0.786	0.786	0.783	1.000	1.000	0.988	1.000	0.909	0.858	0.442	1.000	0.741	1.000	0.736	0.975	1.000	1.000	1.000	0.792	0.774
2035	0.863	0.539	0.415	0.600	0.527	0.379	0.658	1.000	0.612	0.400	1.000	0.401	0.435	0.383	1.000	0.341	0.413	0.792	0.598	0.410	1.000	0.491	0.872	0.945
2036	0.727	0.512	0.932	0.851	0.573	0.900	0.569	1.000	0.582	0.629	0.948	0.563	0.737	0.191	1.000	0.330	0.720	0.709	1.000	0.413	1.000	0.499	0.901	0.883
2037	0.943	0.533	0.882	1.000	0.635	0.832	1.000	0.942	0.967	1.000	1.000	0.939	0.783	1.000	0.938	1.000	0.973	0.713	1.000	0.964	1.000	0.916	0.735	0.927
2038	0.953	0.632	0.889	0.938	0.694	0.866	0.865	0.831	0.891	0.825	1.000	0.727	0.888	0.725	0.939	0.505	1.000	0.810	0.980	0.603	1.000	0.602	0.712	1.000
2039	0.886	0.715	0.711	0.780	0.716	0.809	0.864	0.974	0.605	0.648	1.000	0.532	0.670	0.991	0.972	0.465	0.715	1.000	0.843	0.570	1.000	0.561	0.852	1.000
2040	0.849	0.348	0.585	0.696	0.462	0.559	0.417	1.000	0.547	0.784	1.000	0.479	0.588	0.000	1.000	0.070	0.829	0.604	0.664	0.225	1.000	0.385	0.874	1.000
2041	0.732	0.433	0.681	0.655	0.659	0.721	0.427	0.734	0.484	0.709	1.000	0.389	0.780	0.000	0.803	0.080	0.683	0.742	0.757	0.000	1.000	0.150	0.710	0.862
2042	0.846	0.688	0.825	0.671	0.638	0.678	0.491	1.000	0.549	0.941	1.000	0.432	0.662	0.000	0.925	0.192	0.771	0.651	0.828	0.000	1.000	0.250	0.694	0.846
2043	0.905	0.602	0.737	0.697	0.543	0.654	0.507	1.000	0.504	0.900	1.000	0.406	0.750	0.000	1.000	0.388	0.851	0.659	0.826	0.154	1.000	0.301	0.951	0.867
2044	0.849	0.367	0.519	0.851	0.532	0.646	0.373	0.874	0.541	0.546	1.000	0.774	0.680	0.000	0.934	0.000	0.539	0.525	0.668	0.191	1.000	0.471	0.559	0.823
2045	0.721	0.436	0.572	0.539	0.766	0.551	0.000	0.815	0.409	0.719	0.941	0.271	0.566	0.000	0.881	0.000	0.818	0.769	0.712	0.000	1.000	0.021	0.774	0.898
2046	0.696	0.463	0.526	0.595	0.604	0.451	0.375	0.764	0.430	0.503	1.000	0.325	0.753	0.000	0.784	0.000	0.562	0.693	0.648	0.000	1.000	0.343	0.332	0.815
2047	0.716	0.712	0.851	0.502	0.737	0.550	0.349	0.871	0.270	0.428	1.000	0.166	0.699	0.000	0.897	0.000	0.552	0.756	0.751	0.000	1.000	0.000	0.362	0.970
2048	0.825	0.988	0.604	0.591	0.635	0.588	0.222	1.000	0.316	0.565	1.000	0.209	0.731	0.000	1.000	0.000	0.765	0.877	0.744	0.000	1.000	0.047	0.482	0.994
2049	1.000	0.815	0.480	0.643	0.662	0.367	0.522	1.000	0.456	0.690	1.000	0.257	0.622	0.000	1.000	0.000	0.660	0.860	0.609	0.064	1.000	0.252	0.631	1.000
2050	0.797	0.682	0.373	0.586	0.481	0.484	0.200	0.998	0.383	0.427	1.000	0.323	0.588	0.000	1.000	0.000	0.521	0.751	0.587	0.000	1.000	0.172	0.623	0.856

Mining

Year	AL	AZ	AR	CA	CO	CT	DE	DC	FL	GA	ID	IL	IN	IA	KS	KY	LA	ME	MD	MA	MI	MN	MS	MO	MT
2010	1.000	0.962	1.000	0.993	1.000	0.974	0.989	1.000	1.000	0.989	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.990	1.000	1.000	1.000	1.000	1.000
2011	1.000	0.959	1.000	0.971	0.994	0.988	1.000	1.000	1.000	0.973	1.000	1.000	1.000	1.000	0.986	1.000	1.000	1.000	1.000	0.981	1.000	1.000	1.000	1.000	1.000
2012	1.000	0.919	1.000	0.965	0.964	0.948	0.949	1.000	1.000	0.992	1.000	1.000	1.000	1.000	0.964	1.000	1.000	1.000	1.000	0.954	1.000	1.000	1.000	1.000	1.000
2013	1.000	0.989	1.000	0.887	1.000	0.908	0.912	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.935	1.000	1.000	1.000	1.000	1.000
2014	1.000	1.000	1.000	0.904	1.000	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.913	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2015	0.973	0.778	0.958	0.814	0.839	0.952	0.929	1.000	1.000	0.898	1.000	1.000	1.000	1.000	0.856	1.000	0.981	1.000	1.000	0.971	1.000	1.000	0.987	1.000	1.000
2016	0.990	0.732	1.000	0.763	0.993	0.873	0.921	1.000	0.896	0.825	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.932	1.000	1.000	1.000	1.000	1.000
2017	1.000	0.883	1.000	1.000	1.000	0.981	0.968	1.000	1.000	0.923	1.000	1.000	1.000	1.000	1.000	1.000	0.994	1.000	1.000	0.984	1.000	1.000	1.000	1.000	1.000
2018	0.996	0.768	1.000	0.844	0.918	0.892	0.909	1.000	0.865	0.869	1.000	1.000	0.999	0.975	0.860	1.000	1.000	1.000	1.000	0.887	1.000	1.000	1.000	1.000	1.000
2019	1.000	0.994	1.000	0.952	1.000	0.944	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.945	1.000	1.000	1.000	1.000	1.000
2020	1.000	1.000	1.000	0.949	1.000	0.866	0.918	1.000	1.000	0.943	1.000	1.000	1.000	1.000	0.991	1.000	1.000	1.000	1.000	0.886	1.000	1.000	1.000	1.000	1.000
2021	1.000	0.737	1.000	0.784	0.937	0.857	0.861	1.000	1.000	0.971	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.879	1.000	1.000	1.000	1.000	1.000
2022	0.952	0.878	1.000	0.916	0.948	0.926	0.948	1.000	0.883	0.862	1.000	1.000	1.000	1.000	0.962	1.000	0.972	1.000	1.000	0.906	1.000	1.000	1.000	1.000	1.000
2023	0.997	0.734	1.000	1.000	0.978	0.800	0.897	1.000	0.988	0.925	1.000	1.000	0.935	1.000	1.000	1.000	1.000	0.955	1.000	0.770	0.981	1.000	1.000	1.000	1.000
2024	1.000	0.916	1.000	0.859	1.000	0.889	0.964	1.000	0.853	0.902	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.829	1.000	1.000	1.000	1.000	1.000
2025	0.965	0.819	1.000	0.836	1.000	0.888	0.914	1.000	0.984	0.915	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.923	1.000	1.000	1.000	1.000	1.000
2026	0.971	0.753	1.000	0.747	0.988	0.835	0.907	1.000	0.949	0.897	1.000	1.000	1.000	0.977	0.962	1.000	0.977	1.000	1.000	0.856	1.000	0.971	1.000	1.000	1.000
2027	0.774	0.818	1.000	0.677	0.966	0.848	0.806	0.934	0.797	0.730	0.922	1.000	0.980	1.000	0.992	1.000	0.889	1.000	0.979	0.909	1.000	1.000	1.000	1.000	1.000
2028	0.827	0.859	1.000	0.855	0.987	0.822	0.840	1.000	0.954	0.824	1.000	1.000	1.000	1.000	0.947	1.000	0.888	1.000	1.000	0.842	0.984	1.000	0.980	1.000	1.000
2029	0.893	0.766	1.000	0.749	0.839	0.805	0.809	0.942	0.855	0.804	0.984	1.000	0.961	0.995	0.870	0.906	0.993	1.000	0.968	0.845	1.000	0.997	1.000	1.000	1.000
2030	1.000	0.803	1.000	0.902	0.889	0.800	0.842	1.000	0.964	0.928	1.000	0.992	0.894	0.926	0.965	1.000	1.000	0.987	1.000	0.840	1.000	1.000	1.000	1.000	1.000
2031	0.820	0.874	1.000	0.838	0.941	0.897	0.879	1.000	0.871	0.775	1.000	1.000	1.000	0.913	0.900	1.000	0.947	1.000	1.000	0.912	0.978	0.913	1.000	1.000	1.000
2032	0.916	0.887	1.000	0.895	0.979	0.828	0.892	1.000	1.000	0.883	1.000	0.915	0.835	0.890	0.951	0.965	0.957	1.000	1.000	0.847	0.929	0.923	1.000	1.000	1.000
2033	0.775	0.875	0.960	0.984	0.934	0.884	0.897	1.000	0.876	0.759	1.000	0.966	0.840	0.968	0.903	0.967	0.937	1.000	1.000	0.924	0.978	1.000	0.959	0.987	1.000
2034	0.862	0.856	1.000	0.824	0.964	0.949	0.998	1.000	0.853	0.836	1.000	1.000	0.945	0.911	1.000	1.000	1.000	1.000	1.000	0.926	0.855	0.943	1.000	1.000	1.000
2035	0.805	0.791	0.915	0.776	0.907	0.715	0.827	0.979	0.978	0.820	1.000	0.839	0.761	0.835	0.807	0.867	0.897	0.925	0.941	0.756	0.877	0.935	1.000	0.850	1.000
2036	0.805	0.762	1.000	0.751	0.843	0.890	0.855	0.964	0.850	0.792	1.000	0.870	0.753	0.759	0.823	0.846	0.965	1.000	0.972	0.961	1.000	0.915	1.000	0.959	1.000
2037	1.000	0.713	1.000	0.744	0.947	0.935	1.000	1.000	0.954	1.000	1.000	1.000	0.978	0.867	1.000	1.000	1.000	1.000	1.000	0.947	0.832	0.850	1.000	1.000	1.000
2038	0.791	0.759	1.000	0.802	0.985	0.930	0.959	1.000	0.900	0.877	1.000	1.000	0.892	0.837	0.964	0.921	1.000	1.000	1.000	0.963	0.968	0.820	1.000	1.000	1.000
2039	0.908	0.949	1.000	0.813	1.000	0.862	0.900	1.000	1.000	1.000	1.000	0.947	0.779	0.896	0.926	0.863	0.994	0.929	1.000	0.896	0.937	0.898	1.000	1.000	1.000
2040	0.738	0.683	1.000	0.695	0.854	0.805	0.845	0.934	0.936	0.810	1.000	0.962	0.779	0.915	0.935	0.843	0.996	0.910	0.931	0.845	0.891	0.939	0.979	1.000	1.000
2041	0.782	0.805	1.000	0.735	0.890	0.836	0.819	0.889	0.876	0.834	1.000	0.874	0.758	0.780	0.875	0.729	0.866	0.966	0.887	0.895	0.870	0.799	1.000	0.961	1.000
2042	0.787	0.740	1.000	0.940	0.917	0.859	0.815	0.864	0.845	0.861	1.000	0.940	0.805	0.811	1.000	0.872	0.885	0.972	0.881	0.926	0.812	0.897	1.000	1.000	1.000
2043	0.888	0.764	1.000	0.822	0.847	0.897	0.873	0.995	0.805	0.842	1.000	1.000	0.844	0.904	0.980	0.831	1.000	0.959	0.944	0.911	0.914	1.000	1.000	1.000	1.000
2044	0.795	0.666	0.989	0.723	0.872	0.859	0.896	0.944	0.927	0.855	1.000	0.773	0.709	0.748	0.905	0.792	0.851	0.836	0.982	0.858	0.758	0.866	1.000	0.893	1.000
2045	0.654	0.883	1.000	0.731	0.949	0.796	0.775	0.781	0.701	0.684	1.000	0.864	0.756	0.772	0.826	0.747	0.843	0.875	0.810	0.859	0.884	0.870	0.990	0.960	1.000
2046	0.761	0.843	1.000	0.792	0.889	0.835	0.847	0.935	0.707	0.813	1.000	0.718	0.686	0.628	0.825	0.783	0.790	0.933	0.895	0.854	0.642	0.705	0.955	0.876	1.000
2047	0.700	0.864	0.928	0.864	0.900	0.827	0.830	0.923	0.821	0.769	1.000	0.690	0.635	0.662	0.798	0.575	0.752	0.939	0.863	0.937	0.726	0.727	0.894	0.812	1.000
2048	0.744	0.936	0.966	1.000	0.933	0.858	0.851	0.936	0.762	0.748	1.000	0.708	0.677	0.699	0.873	0.690	0.826	0.863	0.880	0.897	0.710	0.883	0.964	0.873	1.000
2049	0.755	0.831	0.987	0.931	0.993	0.852	0.877	0.970	0.938	0.810	1.000	0.905	0.819	0.892	0.999	0.840	0.779	0.866	0.907	0.855	0.797	0.934	0.953	1.000	1.000
2050	0.789	0.800	0.956	0.868	0.834	0.820	0.839	0.891	0.744	0.787	1.000	0.769	0.706	0.762	0.790	0.742	0.782	0.842	0.867	0.837	0.854	0.852	0.992	0.870	1.000

Year	NE	NV	NH	NJ	NM	NY	NC	ND	OH	OK	OR	PA	RI	SC	SD	TN	TX	UT	VT	VA	WA	WV	WI	WY
2010	1.000	0.979	1.000	1.000	0.970	1.000	0.982	1.000	1.000	1.000	1.000	1.000	0.979	0.976	1.000	1.000	0.999	0.994	1.000	0.987	1.000	1.000	1.000	1.000
2011	1.000	0.982	1.000	1.000	0.963	1.000	0.992	1.000	1.000	0.981	1.000	1.000	1.000	0.959	1.000	1.000	0.989	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2012	0.976	0.938	1.000	1.000	0.929	1.000	0.927	1.000	1.000	0.935	1.000	1.000	0.949	0.951	1.000	1.000	1.000	0.983	1.000	0.904	1.000	1.000	1.000	0.955
2013	1.000	0.896	1.000	1.000	0.958	1.000	0.948	1.000	1.000	1.000	1.000	1.000	0.918	0.972	1.000	1.000	1.000	1.000	1.000	0.860	1.000	1.000	1.000	1.000
2014	0.910	0.916	1.000	1.000	0.936	1.000	0.999	0.920	1.000	0.964	1.000	1.000	1.000	0.984	0.989	1.000	0.984	1.000	1.000	0.977	1.000	1.000	1.000	0.996
2015	0.885	0.788	1.000	1.000	0.769	1.000	0.879	1.000	1.000	0.837	1.000	1.000	0.985	0.813	1.000	0.926	0.861	0.880	1.000	0.835	1.000	1.000	1.000	0.902
2016	1.000	0.736	1.000	1.000	0.823	1.000	0.800	1.000	1.000	1.000	1.000	1.000	0.885	0.705	1.000	1.000	1.000	0.845	1.000	0.845	1.000	1.000	1.000	1.000
2017	1.000	0.923	1.000	1.000	0.976	1.000	0.863	1.000	1.000	0.949	1.000	1.000	0.947	0.789	1.000	1.000	0.954	0.964	1.000	0.896	1.000	1.000	1.000	1.000
2018	0.884	0.862	1.000	1.000	0.789	1.000	0.879	1.000	1.000	0.820	1.000	1.000	0.904	0.793	0.960	0.926	0.872	0.947	1.000	0.775	1.000	1.000	1.000	0.916
2019	1.000	0.913	1.000	1.000	0.968	1.000	1.000	1.000	1.000	0.926	1.000	1.000	0.900	0.996	1.000	1.000	0.970	1.000	1.000	0.973	1.000	1.000	1.000	1.000
2020	0.955	0.990	1.000	1.000	0.959	1.000	0.922	1.000	1.000	1.000	1.000	1.000	0.847	0.870	1.000	1.000	1.000	1.000	1.000	0.823	1.000	1.000	1.000	1.000
2021	1.000	0.795	1.000	0.983	0.808	1.000	0.878	1.000	1.000	1.000	1.000	0.934	0.892	0.855	1.000	1.000	0.998	0.842	1.000	0.803	1.000	1.000	1.000	0.932
2022	1.000	0.917	1.000	1.000	0.812	1.000	0.817	1.000	1.000	0.916	1.000	1.000	0.942	0.739	1.000	0.940	0.907	1.000	1.000	0.843	1.000	1.000	1.000	1.000
2023	1.000	0.986	0.832	0.967	0.769	0.880	0.881	1.000	0.881	1.000	1.000	0.867	0.828	0.856	1.000	0.954	0.942	0.999	0.945	0.839	1.000	0.987	1.000	1.000
2024	1.000	0.834	0.915	1.000	0.901	0.907	0.921	1.000	1.000	1.000	0.976	1.000	0.924	0.874	1.000	1.000	1.000	0.994	0.970	0.950	0.966	1.000	1.000	1.000
2025	1.000	0.805	1.000	1.000	0.875	1.000	0.903	1.000	1.000	1.000	1.000	1.000	0.879	0.867	1.000	0.857	1.000	0.933	1.000	0.857	1.000	1.000	1.000	0.951
2026	0.945	0.748	0.939	1.000	0.826	0.951	0.903	1.000	1.000	0.969	1.000	0.987	0.883	0.843	1.000	0.910	0.936	0.871	1.000	0.911	1.000	1.000	0.976	1.000
2027	0.942	0.691	1.000	0.983	0.843	0.999	0.739	1.000	0.979	0.954	0.866	0.886	0.904	0.649	1.000	0.779	0.906	0.874	1.000	0.737	0.988	0.881	0.994	0.957
2028	0.984	0.850	0.892	0.975	0.777	0.886	0.807	1.000	0.990	0.832	1.000	0.861	0.872	0.779	1.000	0.760	0.738	1.000	0.988	0.764	1.000	0.851	0.978	1.000
2029	0.937	0.728	0.889	0.933	0.725	0.868	0.807	0.984	0.964	0.852	0.994	0.834	0.820	0.725	1.000	0.722	0.940	0.793	0.982	0.715	1.000	0.772	1.000	0.880
2030	0.958	0.907	0.839	0.932	0.731	0.853	0.820	1.000	0.906	0.824	1.000	0.829	0.892	0.815	1.000	0.909	0.798	0.947	0.926	0.782	1.000	0.823	1.000	0.996
2031	0.996	0.870	0.923	1.000	0.818	0.950	0.783	1.000	1.000	0.860	1.000	0.923	0.934	0.701	1.000	0.771	0.774	0.955	1.000	0.841	1.000	0.948	0.884	1.000
2032	0.912	0.866	0.842	0.961	0.853	0.840	0.867	0.939	0.879	0.946	1.000	0.825	0.828	0.828	1.000	0.765	0.959	0.949	0.932	0.830	1.000	0.820	0.958	0.963
2033	0.952	0.944	0.905	0.981	0.816	0.858	0.846	1.000	0.895	0.810	1.000	0.835	0.914	0.750	1.000	0.709	0.860	0.973	0.980	0.863	1.000	0.867	1.000	1.000
2034	0.954	0.786	0.901	1.000	0.895	0.893	0.908	1.000	1.000	0.994	1.000	0.955	0.930	0.819	1.000	0.891	1.000	0.868	0.987	1.000	1.000	1.000	0.896	0.887
2035	0.932	0.791	0.716	0.800	0.768	0.696	0.858	1.000	0.806	0.700	1.000	0.712	0.724	0.810	1.000	0.733	0.706	0.896	0.799	0.804	1.000	0.746	0.936	0.973
2036	0.864	0.780	0.968	0.925	0.791	0.952	0.824	1.000	0.791	0.815	0.974	0.795	0.873	0.764	1.000	0.739	0.860	0.855	1.000	0.812	1.000	0.755	0.951	0.942
2037	0.972	0.790	0.945	1.000	0.822	0.921	1.000	0.971	0.983	1.000	1.000	0.972	0.896	1.000	0.969	1.000	0.987	0.857	1.000	0.989	1.000	0.960	0.867	0.964
2038	0.977	0.836	0.949	0.969	0.851	0.938	0.947	0.916	0.946	0.913	1.000	0.878	0.947	0.929	0.970	0.824	1.000	0.905	0.990	0.882	1.000	0.815	0.856	1.000
2039	0.943	0.874	0.871	0.890	0.862	0.913	0.949	0.987	0.802	0.824	1.000	0.796	0.844	0.998	0.986	0.819	0.858	1.000	0.921	0.878	1.000	0.802	0.926	1.000
2040	0.925	0.712	0.820	0.848	0.738	0.805	0.784	1.000	0.774	0.892	1.000	0.779	0.807	0.736	1.000	0.702	0.914	0.802	0.832	0.789	1.000	0.731	0.937	1.000
2041	0.866	0.751	0.865	0.827	0.834	0.879	0.793	0.867	0.742	0.854	1.000	0.748	0.898	0.742	0.902	0.722	0.842	0.871	0.880	0.712	1.000	0.641	0.855	0.931
2042	0.923	0.864	0.928	0.836	0.824	0.863	0.821	1.000	0.776	0.970	1.000	0.772	0.845	0.803	0.962	0.770	0.885	0.826	0.916	0.731	1.000	0.694	0.847	0.923
2043	0.953	0.827	0.894	0.849	0.778	0.856	0.832	1.000	0.758	0.950	1.000	0.769	0.886	0.746	1.000	0.838	0.926	0.830	0.917	0.801	1.000	0.725	0.976	0.933
2044	0.925	0.726	0.812	0.925	0.773	0.857	0.793	0.937	0.780	0.773	1.000	0.915	0.856	0.737	0.967	0.747	0.770	0.763	0.843	0.820	1.000	0.800	0.780	0.912
2045	0.861	0.757	0.838	0.769	0.887	0.822	0.680	0.907	0.722	0.859	0.970	0.733	0.806	0.561	0.941	0.686	0.909	0.885	0.866	0.649	1.000	0.644	0.887	0.949
2046	0.848	0.770	0.826	0.798	0.809	0.788	0.807	0.882	0.736	0.752	1.000	0.760	0.891	0.733	0.892	0.780	0.781	0.846	0.839	0.798	1.000	0.772	0.666	0.907
2047	0.858	0.877	0.947	0.754	0.873	0.831	0.806	0.935	0.669	0.714	1.000	0.714	0.869	0.676	0.948	0.612	0.776	0.878	0.888	0.738	1.000	0.664	0.681	0.985
2048	0.912	0.995	0.864	0.800	0.824	0.849	0.776	1.000	0.697	0.782	1.000	0.738	0.884	0.644	1.000	0.733	0.883	0.939	0.887	0.775	1.000	0.699	0.741	0.997
2049	1.000	0.922	0.829	0.827	0.838	0.775	0.868	1.000	0.764	0.845	1.000	0.763	0.839	0.797	1.000	0.729	0.830	0.930	0.831	0.847	1.000	0.777	0.817	1.000
2050	0.898	0.867	0.803	0.801	0.751	0.822	0.789	0.999	0.738	0.713	1.000	0.792	0.826	0.669	1.000	0.729	0.760	0.875	0.825	0.779	1.000	0.767	0.815	0.928

Industry and Thermoelectric

Sandia National Laboratories

Change In Production / Output

(1% Exceedance Probability case)

Year	AL	AZ	AR	CA	CO	CT	DE	DC	FL	GA	ID	IL	IN	IA	KS	KY	LA	ME	MD	MA	MI	MN	MS	MO	MT
2010	0.934	1.016	0.988	0.988	1.031	0.950	0.974	0.964	0.992	0.940	1.025	1.032	1.026	1.042	1.045	0.985	1.008	0.943	0.976	0.953	1.028	1.019	0.982	1.036	0.996
2011	0.844	1.015	0.916	1.033	1.025	0.938	0.966	0.954	0.959	0.851	1.035	0.972	0.972	0.991	1.004	0.918	0.915	0.920	0.964	0.924	0.970	0.969	0.910	0.969	1.032
2012	0.928	1.000	0.935	0.996	1.013	0.947	0.946	0.932	0.968	0.931	1.042	0.957	0.946	0.989	0.993	0.923	0.954	0.923	0.945	0.940	0.959	1.000	0.957	0.965	1.025
2013	0.938	1.001	0.945	1.051	1.021	0.971	0.970	0.958	1.020	1.000	1.100	0.995	1.009	0.979	0.986	0.967	0.934	1.012	0.971	0.981	1.018	1.001	0.953	0.975	1.041
2014	1.008	1.034	0.929	1.026	1.015	0.961	0.969	0.962	1.014	1.011	1.017	0.977	0.976	0.944	0.947	0.954	0.972	0.981	0.969	0.978	0.971	0.905	0.975	0.961	0.998
2015	0.875	0.976	0.791	1.010	1.019	0.976	0.969	0.962	0.949	0.909	0.985	0.955	0.962	0.955	0.964	0.911	0.923	0.943	0.968	0.965	0.973	0.967	0.881	0.927	0.991
2016	0.847	1.030	0.861	1.056	1.031	0.995	0.982	0.957	0.861	0.834	1.058	0.990	0.997	0.996	0.981	0.968	0.940	1.022	0.988	1.009	1.009	0.983	0.912	0.962	1.029
2017	0.892	1.058	0.934	1.094	1.076	1.005	0.973	0.953	0.875	0.866	1.161	1.000	0.996	1.010	1.013	0.960	0.963	0.975	0.974	1.009	1.014	1.021	0.943	0.991	1.100
2018	0.878	1.080	0.891	1.074	1.058	0.927	0.941	0.936	0.866	0.859	1.051	0.942	0.953	0.941	0.986	0.900	0.958	0.943	0.941	0.940	0.962	0.944	0.932	0.935	1.025
2019	0.956	1.026	0.947	0.966	1.039	0.930	0.964	0.960	1.060	0.950	1.022	1.003	1.005	0.999	1.013	0.987	0.954	0.911	0.967	0.943	0.987	0.977	0.980	1.003	1.003
2020	0.937	1.004	0.973	1.020	1.025	0.965	0.956	0.930	0.970	0.934	1.027	0.972	0.975	0.969	0.978	0.951	0.981	1.012	0.958	0.994	1.008	0.993	0.973	0.959	0.969
2021	0.949	0.989	0.994	0.990	1.027	1.007	0.989	0.985	0.915	0.969	1.053	1.002	0.987	1.000	1.050	1.002	0.971	0.998	0.990	1.007	0.999	1.002	0.965	1.025	1.013
2022	0.866	1.031	0.945	1.102	1.038	0.987	0.974	0.958	0.922	0.849	1.035	0.993	0.996	0.988	0.974	0.939	0.951	0.972	0.978	0.985	1.003	0.975	0.924	0.991	1.012
2023	0.971	0.996	0.984	0.948	1.046	0.837	0.908	0.947	1.100	0.993	1.050	0.982	0.973	0.988	1.024	0.906	0.980	0.817	0.896	0.811	0.956	0.999	0.992	1.006	1.048
2024	0.947	0.991	0.948	0.988	1.033	0.968	0.982	0.985	0.946	0.972	0.990	1.018	1.025	1.018	1.020	1.049	0.984	0.911	0.985	0.940	0.996	0.990	0.967	1.018	0.958
2025	0.963	1.034	1.059	1.052	1.040	0.870	0.901	0.912	0.978	0.961	1.003	1.014	1.010	1.019	1.025	0.960	1.025	0.909	0.900	0.887	1.026	1.019	1.012	1.024	1.001
2026	0.943	1.042	0.988	1.078	1.052	0.912	0.974	0.973	0.986	0.927	1.057	1.002	1.010	1.007	1.039	1.019	0.981	0.919	0.981	0.925	1.008	0.990	0.960	0.998	1.023
2027	0.865	1.064	0.950	1.101	1.059	0.963	0.933	0.941	0.980	0.882	1.089	0.946	0.950	0.948	0.991	0.886	0.942	0.928	0.930	0.952	0.956	0.952	0.909	0.941	1.005
2028	0.856	1.041	0.888	1.096	1.071	0.897	0.924	0.924	0.765	0.831	1.160	0.958	0.960	0.947	0.982	0.925	0.909	0.924	0.920	0.912	0.931	0.942	0.906	0.956	1.048
2029	0.770	1.023	0.765	1.051	1.025	0.859	0.897	0.892	0.802	0.794	1.009	0.968	0.974	0.977	0.922	0.880	0.851	0.892	0.896	0.870	0.995	0.996	0.826	0.913	1.004
2030	0.887	1.028	0.892	1.078	1.042	0.915	0.909	0.908	0.908	0.909	1.040	0.969	0.979	0.967	1.000	0.882	0.972	0.954	0.910	0.928	1.013	0.989	0.941	0.953	1.013
2031	0.787	1.034	0.864	1.073	1.049	0.919	0.934	0.932	0.891	0.840	1.083	0.980	0.997	0.954	0.972	0.916	0.923	0.909	0.935	0.909	0.972	0.953	0.880	0.947	1.036
2032	0.824	1.055	0.846	1.094	1.047	0.896	0.920	0.912	0.911	0.837	1.040	0.962	0.967	0.963	0.978	0.903	0.924	0.914	0.920	0.900	0.976	0.967	0.896	0.933	1.029
2033	0.724	1.024	0.752	0.988	1.041	0.927	0.920	0.908	0.831	0.782	1.056	0.948	0.967	0.942	0.962	0.825	0.869	0.931	0.918	0.934	0.979	0.976	0.814	0.905	1.017
2034	0.850	1.036	0.863	1.110	1.018	0.934	0.943	0.950	0.829	0.830	1.017	0.903	0.905	0.910	0.951	0.886	0.962	0.925	0.941	0.927	0.897	0.900	0.900	0.910	0.965
2035	0.700	1.055	0.762	1.078	1.078	0.844	0.890	0.875	0.770	0.707	1.059	0.973	0.989	0.975	0.981	0.859	0.876	0.861	0.896	0.847	0.984	0.964	0.830	0.931	1.056
2036	0.786	1.013	0.778	1.079	0.997	0.930	0.931	0.911	0.848	0.812	0.981	0.944	0.974	0.935	0.905	0.875	0.877	0.956	0.936	0.941	1.001	0.937	0.855	0.915	0.976
2037	0.891	1.019	0.762	1.023	1.033	0.928	0.971	0.958	0.897	0.929	1.056	0.972	1.004	0.935	0.941	0.898	0.869	0.933	0.969	0.916	0.951	0.934	0.887	0.939	1.067
2038	0.916	1.097	0.998	1.134	1.100	0.904	0.925	0.908	0.904	0.904	1.132	1.003	1.001	0.976	1.016	0.929	1.043	0.928	0.928	0.926	1.011	0.954	0.987	1.007	1.077
2039	0.873	1.011	0.894	1.096	1.084	0.801	0.872	0.881	0.902	0.913	1.133	0.991	0.986	0.985	0.983	0.864	0.971	0.772	0.865	0.785	0.995	0.957	0.921	0.980	1.111
2040	0.785	1.102	0.829	1.170	1.102	0.910	0.908	0.876	0.682	0.779	1.155	0.995	0.998	0.991	0.998	0.849	0.932	0.947	0.909	0.929	1.000	0.992	0.881	0.971	1.099
2041	0.722	1.047	0.781	1.117	1.057	0.800	0.854	0.858	0.834	0.796	1.041	0.952	0.966	0.930	0.937	0.780	0.904	0.865	0.848	0.818	0.951	0.902	0.844	0.905	1.016
2042	0.701	1.070	0.858	1.103	1.066	0.844	0.865	0.850	0.810	0.753	1.045	0.982	0.993	0.958	0.997	0.844	0.897	0.874	0.865	0.875	0.997	0.942	0.860	0.982	1.034
2043	0.641	1.035	0.715	1.071	1.058	0.763	0.818	0.826	0.757	0.689	1.057	0.953	0.955	0.968	0.948	0.764	0.829	0.773	0.810	0.779	0.976	0.972	0.791	0.929	1.033
2044	0.753	1.046	0.810	1.098	1.060	0.823	0.869	0.850	0.803	0.764	1.062	0.928	0.937	0.932	0.919	0.805	0.863	0.779	0.867	0.808	0.937	0.938	0.851	0.901	1.056
2045	0.684	1.097	0.782	1.134	1.101	0.867	0.877	0.860	0.754	0.744	1.158	0.984	0.991	0.980	0.991	0.788	0.910	0.911	0.874	0.892	1.038	0.987	0.839	0.955	1.071
2046	0.764	1.076	0.840	1.152	1.080	0.809	0.872	0.869	0.791	0.783	1.166	0.942	0.963	0.907	0.926	0.833	0.913	0.861	0.874	0.832	0.945	0.922	0.860	0.910	1.092
2047	0.642	1.070	0.668	1.125	1.092	0.793	0.814	0.802	0.634	0.605	1.148	0.866	0.897	0.868	0.928	0.692	0.826	0.870	0.811	0.850	0.894	0.869	0.760	0.835	1.096
2048	0.588	1.081	0.723	1.114	1.133	0.757	0.790	0.775	0.692	0.568	1.159	0.942	0.956	0.929	0.964	0.688	0.827	0.818	0.783	0.794	0.953	0.932	0.752	0.901	1.097
2049	0.646	1.074	0.724	1.084	1.085	0.893	0.910	0.892	0.747	0.725	1.045	0.978	0.994	0.973	1.005	0.829	0.863	0.908	0.908	0.905	0.983	0.971	0.785	0.954	1.024
2050	0.662	1.055	0.600	1.130	1.081	0.813	0.838	0.811	0.679	0.678	1.040	0.954	0.974	0.973	0.941	0.753	0.824	0.856	0.840	0.840	0.998	0.964	0.759	0.886	1.056

Year	NE	NV	NH	NJ	NM	NY	NC	ND	OH	OK	OR	PA	RI	SC	SD	TN	TX	UT	VT	VA	WA	WV	WI	WY
2010	1.034	1.004	0.955	0.982	1.015	0.967	0.938	1.012	1.024	1.037	1.023	0.993	0.939	0.939	1.027	0.941	0.962	1.027	0.962	0.951	1.034	0.963	1.029	1.009
2011	0.994	1.042	0.920	0.968	1.011	0.900	0.925	0.953	0.974	0.961	1.068	0.945	0.949	0.891	0.961	0.857	0.939	1.041	0.912	0.924	1.053	0.924	0.969	1.020
2012	0.995	1.033	0.936	0.965	1.004	0.933	0.904	1.026	0.946	0.936	1.049	0.945	0.952	0.910	1.005	0.929	0.983	1.028	0.929	0.915	1.066	0.895	0.981	1.018
2013	0.960	1.058	0.987	0.986	1.007	0.985	0.986	0.983	1.026	1.042	1.121	0.985	0.969	1.014	0.978	0.933	1.055	1.055	0.997	0.946	1.157	0.957	1.007	1.042
2014	0.936	1.024	0.980	0.970	1.017	0.966	0.974	0.876	0.984	0.922	1.040	0.946	0.956	0.983	0.886	0.956	0.989	1.021	0.984	0.954	1.082	0.945	0.943	0.995
2015	0.960	1.003	0.958	0.987	1.006	0.971	0.943	0.974	0.979	0.936	0.981	0.974	0.978	0.930	0.949	0.814	0.965	1.008	0.959	0.946	0.949	0.948	0.963	0.990
2016	0.996	1.045	1.014	1.003	1.037	1.016	0.897	0.986	1.001	0.933	1.090	1.024	0.975	0.859	0.995	0.878	0.975	1.043	1.026	0.963	1.110	0.981	1.001	1.030
2017	1.036	1.144	0.998	1.003	1.051	1.003	0.904	1.031	1.009	1.001	1.158	0.997	1.010	0.879	1.034	0.909	1.035	1.143	1.005	0.941	1.167	0.948	1.010	1.106
2018	0.962	1.080	0.942	0.948	1.067	0.943	0.912	0.925	0.965	0.907	1.073	0.943	0.924	0.881	0.923	0.858	0.958	1.095	0.936	0.919	1.062	0.911	0.944	1.051
2019	1.030	0.991	0.939	0.965	1.027	0.936	0.991	0.993	1.007	0.977	1.040	0.972	0.920	0.984	1.016	0.976	0.986	1.021	0.928	0.967	1.063	0.964	0.974	1.021
2020	0.978	1.043	0.997	0.982	1.020	0.996	0.928	0.957	0.977	1.018	1.053	0.975	0.964	0.927	0.967	0.938	1.088	1.040	1.000	0.935	1.059	0.933	1.003	1.022
2021	1.027	1.043	1.002	1.001	1.001	0.986	0.988	0.994	0.978	1.039	1.026	0.978	1.021	0.986	1.005	0.992	0.950	1.044	0.999	0.993	1.057	0.986	0.998	1.044
2022	0.988	1.078	0.981	0.999	1.009	0.980	0.891	0.950	1.009	0.951	1.077	0.993	0.984	0.862	0.951	0.897	0.949	1.083	0.982	0.921	1.066	0.933	0.992	1.030
2023	1.010	0.980	0.808	0.872	1.025	0.781	0.976	1.020	0.963	1.035	1.019	0.808	0.858	0.995	1.003	0.950	0.989	1.031	0.786	0.895	1.040	0.849	0.972	1.058
2024	1.024	0.971	0.930	0.985	1.027	0.933	0.991	0.972	1.024	1.031	1.017	0.990	0.966	0.992	1.006	1.004	0.998	1.020	0.935	0.988	1.042	1.011	0.998	0.993
2025	1.016	1.056	0.893	0.891	1.036	0.890	0.936	1.008	1.015	1.101	1.036	0.874	0.879	0.952	0.999	0.962	1.080	1.057	0.884	0.894	1.013	0.891	1.026	1.021
2026	1.014	1.098	0.926	0.966	1.033	0.966	0.992	0.968	1.020	1.066	1.106	1.001	0.906	0.980	0.980	0.975	0.976	1.094	0.950	1.002	1.100	1.013	1.000	1.048
2027	0.965	1.120	0.945	0.948	1.046	0.941	0.925	0.982	0.962	0.999	1.069	0.914	0.962	0.925	0.956	0.889	0.966	1.095	0.940	0.897	1.027	0.877	0.950	1.059
2028	0.967	1.106	0.917	0.924	1.060	0.930	0.904	0.942	0.944	0.909	1.104	0.902	0.906	0.877	0.940	0.882	0.882	1.120	0.935	0.890	1.119	0.872	0.928	1.085
2029	0.971	1.026	0.876	0.900	1.025	0.896	0.872	0.979	0.975	0.752	1.018	0.887	0.845	0.846	0.968	0.787	0.811	1.034	0.901	0.862	1.020	0.852	0.992	1.008
2030	0.996	1.082	0.929	0.920	1.039	0.944	0.895	0.965	1.001	0.934	1.056	0.898	0.932	0.915	0.960	0.887	0.993	1.059	0.948	0.868	1.074	0.855	0.982	1.029
2031	0.981	1.070	0.904	0.936	1.035	0.946	0.901	0.939	1.004	0.920	1.080	0.933	0.915	0.882	0.963	0.854	0.962	1.090	0.928	0.907	1.113	0.910	0.946	1.056
2032	0.962	1.063	0.903	0.924	1.043	0.907	0.883	0.957	0.973	0.935	1.090	0.898	0.889	0.861	0.950	0.842	0.956	1.076	0.911	0.885	1.105	0.876	0.964	1.046
2033	0.964	1.009	0.931	0.939	1.030	0.913	0.859	0.962	0.973	0.864	1.025	0.897	0.941	0.827	0.958	0.710	0.941	1.058	0.927	0.875	1.055	0.862	0.966	1.044
2034	0.934	1.082	0.926	0.938	1.027	0.922	0.883	0.875	0.916	0.951	1.070	0.910	0.950	0.853	0.882	0.848	0.954	1.069	0.921	0.909	1.040	0.883	0.888	0.995
2035	0.982	1.071	0.849	0.900	1.072	0.863	0.851	0.944	0.999	0.842	1.089	0.911	0.841	0.805	0.961	0.760	0.888	1.088	0.859	0.878	1.098	0.882	0.980	1.069
2036	0.920	1.019	0.946	0.950	1.002	0.963	0.890	0.924	0.995	0.847	1.055	0.948	0.904	0.858	0.897	0.781	0.865	1.012	0.963	0.932	1.063	0.923	0.966	0.972
2037	0.958	1.051	0.917	0.964	1.016	0.909	0.942	0.954	1.004	0.787	1.049	0.943	0.927	0.938	0.933	0.852	0.823	1.056	0.916	0.940	1.088	0.923	0.923	1.046
2038	0.982	1.138	0.928	0.924	1.075	0.949	0.900	0.952	1.000	1.043	1.156	0.923	0.894	0.905	0.951	0.935	1.038	1.153	0.948	0.884	1.199	0.896	0.980	1.099
2039	0.973	1.096	0.779	0.852	1.035	0.799	0.905	0.959	0.994	0.923	1.162	0.813	0.794	0.916	0.954	0.848	1.004	1.109	0.783	0.861	1.214	0.831	0.981	1.108
2040	0.973	1.182	0.935	0.936	1.110	0.941	0.819	0.998	1.001	0.899	1.172	0.925	0.884	0.795	0.965	0.786	0.953	1.157	0.955	0.864	1.191	0.857	0.993	1.109
2041	0.910	1.095	0.825	0.844	1.065	0.791	0.852	0.879	0.972	0.890	1.114	0.802	0.832	0.830	0.871	0.728	0.943	1.063	0.819	0.822	1.113	0.775	0.940	1.042
2042	0.966	1.063	0.877	0.875	1.073	0.874	0.823	0.957	0.994	0.922	1.110	0.856	0.841	0.800	0.934	0.739	0.902	1.060	0.892	0.829	1.115	0.807	0.962	1.045
2043	0.951	1.079	0.777	0.795	1.039	0.766	0.768	0.939	0.953	0.814	1.100	0.733	0.784	0.720	0.923	0.646	0.822	1.077	0.779	0.762	1.104	0.710	0.975	1.048
2044	0.933	1.046	0.799	0.879	1.041	0.816	0.796	0.941	0.958	0.840	1.126	0.846	0.817	0.771	0.913	0.749	0.900	1.068	0.807	0.813	1.139	0.792	0.934	1.051
2045	0.963	1.128	0.900	0.896	1.096	0.896	0.810	0.970	1.006	0.909	1.172	0.866	0.871	0.775	0.931	0.658	0.939	1.157	0.912	0.820	1.177	0.798	1.018	1.081
2046	0.917	1.126	0.836	0.865	1.065	0.848	0.848	0.933	0.978	0.844	1.171	0.860	0.835	0.809	0.904	0.771	0.950	1.146	0.846	0.852	1.194	0.844	0.924	1.094
2047	0.891	1.097	0.856	0.820	1.082	0.822	0.721	0.873	0.935	0.768	1.184	0.776	0.829	0.637	0.832	0.613	0.855	1.142	0.849	0.748	1.231	0.723	0.862	1.078
2048	0.949	1.102	0.796	0.798	1.102	0.772	0.693	0.908	0.968	0.827	1.145	0.733	0.785	0.623	0.918	0.613	0.926	1.146	0.801	0.727	1.183	0.688	0.947	1.132
2049	0.981	1.049	0.906	0.917	1.076	0.890	0.858	0.948	1.009	0.882	1.096	0.882	0.882	0.818	0.944	0.703	0.921	1.070	0.907	0.881	1.133	0.859	0.988	1.050
2050	0.967	1.081	0.843	0.857	1.065	0.851	0.772	0.976	1.007	0.718	1.093	0.834	0.812	0.728	0.977	0.653	0.828	1.066	0.850	0.805	1.099	0.803	0.982	1.063

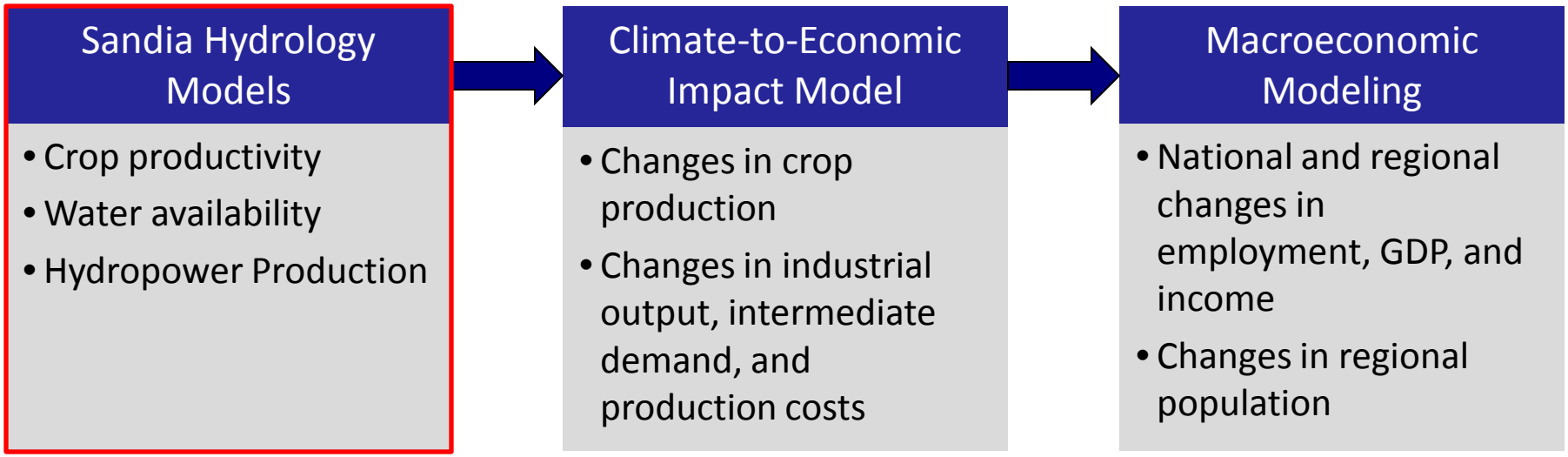
Corn

Year	AL	AZ	AR	CA	CO	CT	DE	DC	FL	GA	ID	IL	IN	IA	KS	KY	LA	ME	MD	MA	MI	MN	MS	MO	MT
2010	0.942	1.004	0.995	0.995	1.013	0.991	1.001	1.001	1.031	0.965	1.004	1.015	1.013	1.015	1.020	0.997	1.013	0.981	1.002	0.991	1.013	1.009	0.992	1.014	1.001
2011	0.884	1.002	0.958	0.989	1.007	0.995	0.999	0.997	0.982	0.880	1.003	0.995	0.996	1.002	1.007	0.929	0.947	0.985	0.999	0.986	1.000	1.003	0.956	0.997	1.005
2012	0.935	0.998	0.956	1.005	1.001	0.986	0.976	0.972	1.025	0.944	1.011	0.986	0.984	0.997	1.001	0.916	0.973	0.968	0.977	0.980	0.990	1.001	0.976	0.993	1.006
2013	0.954	1.006	0.972	1.010	1.009	1.000	0.993	0.984	1.025	1.009	1.027	1.003	1.006	0.997	0.993	0.973	0.948	1.007	0.996	1.000	1.010	1.007	0.974	1.000	1.006
2014	1.032	1.016	0.964	0.998	1.005	1.014	1.011	1.005	1.059	1.037	1.003	0.997	0.997	0.992	0.986	0.966	0.997	1.017	1.013	1.021	1.001	0.981	0.997	0.996	0.991
2015	0.892	0.983	0.870	0.999	0.998	1.010	0.993	0.992	0.989	0.923	0.994	0.988	0.990	0.986	0.988	0.913	0.949	1.010	0.993	1.008	0.996	0.990	0.928	0.989	1.000
2016	0.872	1.001	0.926	1.005	1.008	0.996	0.993	0.988	0.910	0.846	1.012	1.000	1.000	1.000	0.999	0.971	0.967	1.005	0.996	1.001	1.002	0.994	0.954	0.998	1.005
2017	0.916	1.017	0.963	1.022	1.028	1.011	0.997	0.991	0.882	0.897	1.044	1.004	1.002	1.013	1.011	0.976	0.974	0.995	0.999	1.011	1.007	1.012	0.968	1.006	1.027
2018	0.901	1.018	0.936	1.003	1.012	0.988	0.982	0.986	0.888	0.877	1.010	0.983	0.985	0.988	1.000	0.881	0.979	0.981	0.982	0.987	0.990	0.987	0.966	0.991	1.004
2019	1.029	1.013	0.980	0.991	1.019	0.988	1.000	1.000	1.117	1.019	1.007	1.011	1.010	1.008	1.009	1.029	0.976	0.974	1.003	0.993	1.006	0.997	1.003	1.012	0.996
2020	0.966	1.009	0.995	1.009	1.015	0.991	0.988	0.983	1.059	0.976	1.005	0.997	0.997	0.997	0.995	0.961	0.996	1.000	0.990	0.998	1.009	0.998	0.991	0.996	0.980
2021	0.962	0.989	1.000	0.994	1.007	1.000	0.987	0.991	0.954	0.989	1.013	1.000	0.993	1.000	1.022	0.993	0.988	1.007	0.988	1.000	0.999	0.997	0.982	1.008	1.000
2022	0.896	1.006	0.970	1.011	1.008	1.013	1.006	1.002	0.932	0.879	1.008	1.005	1.005	1.002	0.989	0.958	0.969	1.002	1.008	1.006	1.010	0.998	0.955	1.003	0.999
2023	0.993	0.992	0.995	0.996	1.015	0.979	0.988	1.005	1.133	1.018	1.020	1.005	1.001	1.008	1.015	0.915	0.987	0.957	0.985	0.962	1.003	1.013	0.999	1.011	1.020
2024	0.967	0.997	0.975	0.982	1.016	1.001	1.006	1.010	0.952	1.000	0.986	1.009	1.011	1.008	1.012	1.076	1.001	0.964	1.008	0.984	1.003	0.999	0.985	1.008	0.980
2025	0.975	1.009	1.045	1.007	1.014	0.995	0.989	0.995	1.001	0.987	0.995	1.010	1.011	1.010	1.009	0.974	1.010	0.997	0.989	0.997	1.022	1.010	1.006	1.010	0.996
2026	0.960	1.004	0.994	0.994	1.016	0.990	1.003	1.007	1.001	0.944	1.004	1.002	1.006	1.003	1.015	1.041	0.976	0.990	1.007	0.992	1.010	0.999	0.975	0.999	1.003
2027	0.861	1.015	0.970	1.008	1.016	1.004	0.974	0.976	0.963	0.875	1.011	0.982	0.984	0.986	1.000	0.860	0.950	0.999	0.973	1.004	0.994	0.988	0.940	0.984	0.993
2028	0.882	1.007	0.930	1.013	1.020	0.969	0.969	0.982	0.773	0.861	1.036	0.988	0.989	0.987	0.998	0.924	0.934	0.984	0.967	0.970	0.985	0.991	0.944	0.992	1.010
2029	0.806	1.000	0.865	0.998	0.995	0.979	0.970	0.973	0.784	0.808	0.987	0.996	0.998	1.002	0.977	0.868	0.905	0.983	0.971	0.978	1.009	1.008	0.907	0.988	0.992
2030	0.953	0.999	0.945	1.013	1.004	1.001	0.987	0.989	0.928	0.968	1.008	0.998	1.002	0.995	1.004	0.902	0.986	1.006	0.988	1.002	1.014	1.003	0.981	0.998	0.996
2031	0.812	1.005	0.923	1.003	1.009	1.001	0.993	0.996	0.931	0.874	1.015	1.002	1.007	0.992	0.999	0.933	0.943	0.993	0.993	0.992	0.997	0.989	0.927	1.000	1.001
2032	0.878	1.012	0.914	1.006	1.008	0.994	0.993	0.992	0.936	0.879	0.998	0.998	0.996	1.002	0.998	0.911	0.954	0.992	0.993	0.990	1.003	1.000	0.949	0.995	0.997
2033	0.772	1.008	0.859	0.993	1.009	1.000	0.989	0.991	0.838	0.811	1.015	1.001	1.002	0.998	0.996	0.851	0.916	0.987	0.989	0.998	1.005	1.006	0.893	1.000	1.000
2034	0.872	1.006	0.926	1.007	1.002	0.991	0.990	0.998	0.825	0.845	0.990	0.971	0.972	0.973	0.986	0.891	0.984	0.981	0.989	0.981	0.969	0.967	0.949	0.981	0.979
2035	0.766	1.008	0.862	0.997	1.018	0.972	0.968	0.971	0.827	0.754	1.005	1.003	1.004	1.005	1.000	0.871	0.922	0.970	0.971	0.965	1.010	1.007	0.912	1.001	1.009
2036	0.834	0.993	0.875	0.998	0.983	1.010	0.994	0.989	0.880	0.846	0.977	0.994	1.001	0.992	0.969	0.876	0.923	1.024	0.996	1.015	1.010	0.985	0.923	0.995	0.983
2037	0.970	0.998	0.877	0.987	1.000	1.007	1.022	1.019	0.951	1.008	1.008	1.011	1.019	0.996	0.991	0.954	0.921	1.003	1.022	0.996	0.996	0.990	0.951	1.009	1.016
2038	0.945	1.021	1.002	1.012	1.030	0.997	0.996	0.998	0.960	0.943	1.032	1.011	1.010	1.005	1.012	0.943	1.035	1.003	0.998	1.002	1.015	0.996	0.996	1.013	1.015
2039	0.932	0.999	0.939	1.001	1.025	0.994	0.995	1.001	0.956	0.991	1.027	1.014	1.009	1.023	1.006	0.877	0.985	0.966	0.993	0.981	1.026	1.020	0.961	1.016	1.019
2040	0.837	1.016	0.905	1.015	1.019	1.001	0.991	0.986	0.688	0.829	1.038	1.013	1.012	1.014	1.015	0.864	0.962	0.996	0.993	0.996	1.011	1.011	0.936	1.013	1.025
2041	0.776	1.001	0.880	1.002	1.004	0.984	0.977	0.983	0.903	0.826	0.999	1.004	1.005	1.004	0.992	0.785	0.941	0.993	0.975	0.980	1.005	0.993	0.921	1.001	0.990
2042	0.779	1.011	0.929	1.009	1.010	0.995	0.978	0.977	0.868	0.816	1.007	1.013	1.015	1.012	1.014	0.876	0.937	1.002	0.979	1.003	1.020	1.003	0.929	1.018	1.003
2043	0.753	1.004	0.838	1.006	1.005	0.986	0.975	0.982	0.818	0.767	1.011	1.004	1.004	1.009	0.991	0.795	0.898	0.979	0.973	0.985	1.018	1.013	0.899	1.001	1.004
2044	0.799	0.994	0.893	0.989	1.002	0.990	0.985	0.980	0.844	0.803	1.000	0.992	0.992	1.001	0.979	0.820	0.902	0.948	0.986	0.971	1.003	1.005	0.918	0.994	1.004
2045	0.731	1.026	0.879	0.996	1.025	0.992	0.975	0.969	0.737	0.762	1.033	1.013	1.012	1.012	1.006	0.796	0.937	0.992	0.976	0.996	1.028	1.008	0.910	1.013	1.011
2046	0.805	1.014	0.908	1.015	1.012	0.975	0.971	0.977	0.816	0.822	1.034	0.993	0.997	0.984	0.980	0.846	0.940	0.986	0.972	0.976	0.990	0.990	0.919	0.996	1.010
2047	0.706	1.012	0.807	0.990	1.017	0.972	0.957	0.965	0.675	0.659	1.030	0.984	0.986	0.990	0.989	0.697	0.883	0.984	0.957	0.988	0.990	0.987	0.866	0.992	1.018
2048	0.693	1.018	0.848	1.009	1.031	0.974	0.962	0.965	0.746	0.637	1.037	1.015	1.014	1.015	1.005	0.735	0.885	0.968	0.961	0.975	1.015	1.014	0.869	1.012	1.015
2049	0.753	1.016	0.844	1.007	1.022	1.002	1.001	1.003	0.832	0.814	1.005	1.014	1.017	1.008	1.017	0.876	0.920	0.988	1.001	0.995	1.010	1.006	0.890	1.014	0.995
2050	0.757	1.001	0.755	1.012	1.011	0.996	0.982	0.979	0.738	0.743	1.002	1.013	1.014	1.016	0.991	0.786	0.880	0.991	0.985	0.994	1.025	1.008	0.871	1.002	1.008

Year	NE	NV	NH	NJ	NM	NY	NC	ND	OH	OK	OR	PA	RI	SC	SD	TN	TX	UT	VT	VA	WA	WV	WI	WY
2010	1.015	0.998	0.991	1.001	1.004	0.992	0.963	1.005	1.011	1.033	1.008	1.010	0.989	0.969	1.009	0.951	0.971	1.004	0.991	0.972	1.012	0.984	1.013	1.003
2011	1.004	1.003	0.983	0.999	1.004	0.975	0.959	0.992	0.998	0.981	1.001	0.994	1.001	0.918	0.993	0.884	0.946	1.006	0.980	0.952	1.000	0.962	0.998	1.003
2012	0.999	1.010	0.978	0.989	0.999	0.975	0.906	1.011	0.985	0.953	1.016	0.985	0.985	0.923	1.003	0.931	0.996	1.006	0.975	0.913	1.019	0.906	0.994	1.002
2013	0.983	1.012	1.000	1.008	1.009	1.004	0.989	1.000	1.015	1.034	1.021	1.013	0.995	1.018	0.998	0.940	1.037	1.017	1.009	0.954	1.027	0.978	1.006	1.014
2014	0.979	1.004	1.021	1.016	1.010	1.015	1.001	0.965	1.003	0.953	1.002	1.011	1.013	1.009	0.967	0.978	0.996	1.007	1.021	0.983	1.011	0.981	0.991	0.996
2015	0.983	0.994	1.006	1.008	0.996	1.006	0.959	0.994	0.995	0.957	1.001	1.000	1.015	0.950	0.983	0.820	0.975	0.997	1.007	0.951	1.002	0.960	0.989	0.988
2016	1.000	1.000	1.003	1.000	1.012	0.995	0.905	0.996	1.000	0.967	1.014	1.007	0.993	0.870	0.997	0.895	0.989	1.000	1.004	0.965	1.017	0.984	1.000	1.007
2017	1.023	1.035	1.006	1.012	1.025	1.009	0.927	1.012	1.009	1.008	1.034	1.014	1.006	0.906	1.016	0.925	1.027	1.037	1.012	0.961	1.029	0.976	1.008	1.033
2018	0.985	1.011	0.985	0.986	1.018	0.987	0.931	0.978	0.989	0.937	1.005	0.985	0.984	0.901	0.975	0.857	0.969	1.020	0.983	0.922	1.010	0.917	0.985	1.007
2019	1.016	0.996	0.992	0.999	1.012	0.998	1.041	0.999	1.011	0.991	1.009	1.013	0.973	1.045	1.008	1.032	0.998	1.007	0.995	1.002	1.004	1.007	1.000	1.008
2020	0.993	1.017	0.998	0.996	1.018	1.010	0.964	0.985	0.997	1.023	1.003	1.001	0.982	0.970	0.990	0.953	1.076	1.019	1.007	0.951	1.001	0.956	1.005	1.008
2021	1.010	1.006	0.998	0.990	0.995	0.994	0.993	0.992	0.990	1.035	1.006	0.980	1.002	1.001	0.998	0.993	0.971	1.004	1.005	0.986	1.012	0.978	0.997	1.013
2022	0.996	1.013	1.004	1.019	0.997	1.007	0.922	0.987	1.010	0.964	1.008	1.016	1.010	0.889	0.985	0.921	0.954	1.021	1.007	0.949	1.008	0.968	1.006	1.006
2023	1.011	0.995	0.959	0.977	1.001	0.958	1.002	1.015	0.999	1.033	1.010	0.964	0.978	1.018	1.007	0.970	0.996	1.005	0.959	0.926	1.012	0.895	1.006	1.020
2024	1.015	0.984	0.977	1.006	1.010	0.982	1.017	0.993	1.012	1.038	0.982	1.012	0.998	1.022	1.007	1.024	1.013	1.003	0.980	1.011	0.984	1.030	1.002	1.000
2025	1.007	1.009	0.998	0.990	1.013	1.002	0.973	1.002	1.016	1.072	1.009	0.991	0.990	0.987	1.000	0.969	1.054	1.011	1.001	0.926	1.010	0.931	1.017	1.003
2026	1.005	1.010	0.992	1.000	1.006	1.007	1.015	0.993	1.012	1.047	1.003	1.017	0.993	1.001	0.995	0.993	0.976	1.015	1.001	1.023	1.003	1.034	1.002	1.015
2027	0.985	1.016	1.002	0.990	1.011	0.997	0.921	0.996	0.991	1.009	0.998	0.980	1.006	0.922	0.985	0.886	0.981	1.012	0.999	0.891	0.993	0.890	0.989	1.014
2028	0.991	1.019	0.973	0.965	1.012	0.972	0.929	0.992	0.982	0.943	1.010	0.959	0.980	0.913	0.989	0.894	0.909	1.027	0.978	0.895	1.011	0.884	0.982	1.025
2029	0.994	0.993	0.981	0.978	0.997	0.985	0.888	0.995	0.999	0.823	0.993	0.980	0.976	0.855	0.993	0.793	0.866	0.996	0.989	0.870	0.999	0.875	1.005	0.990
2030	1.000	1.020	0.999	0.996	0.998	1.005	0.934	0.989	1.011	0.947	1.005	0.994	1.013	0.961	0.986	0.937	0.989	1.010	1.008	0.902	1.011	0.904	1.001	1.004
2031	0.999	1.011	0.988	0.996	1.004	1.002	0.934	0.983	1.010	0.959	0.999	0.997	1.005	0.917	0.992	0.873	0.973	1.018	0.999	0.932	1.010	0.945	0.985	1.013
2032	0.989	1.006	0.991	0.997	1.010	0.990	0.927	0.988	0.999	0.960	1.002	0.991	0.989	0.902	0.987	0.866	0.974	1.012	0.993	0.917	1.009	0.915	0.999	1.005
2033	0.993	0.998	0.994	0.997	1.006	0.987	0.901	0.996	1.001	0.913	0.998	0.984	1.006	0.864	0.993	0.755	0.964	1.013	0.993	0.916	0.996	0.914	1.002	1.012
2034	0.975	1.009	0.980	0.985	1.009	0.977	0.915	0.960	0.976	0.975	0.990	0.975	0.995	0.875	0.963	0.873	0.972	1.010	0.977	0.947	0.989	0.922	0.963	0.987
2035	0.998	1.006	0.964	0.974	1.014	0.969	0.894	0.989	1.006	0.894	1.003	0.984	0.970	0.853	0.993	0.808	0.918	1.017	0.969	0.898	1.011	0.917	1.009	1.015
2036	0.972	0.993	1.017	1.007	0.989	1.020	0.924	0.982	1.005	0.903	0.988	1.005	1.002	0.891	0.971	0.807	0.906	0.988	1.023	0.958	0.992	0.951	0.995	0.976
2037	0.990	1.003	0.996	1.016	0.994	0.990	1.011	0.991	1.015	0.871	1.005	1.012	1.008	1.016	0.982	0.926	0.881	1.003	0.994	0.995	1.017	0.987	0.988	1.006
2038	0.998	1.022	1.002	0.991	1.021	1.008	0.946	0.989	1.011	1.038	1.013	0.996	1.000	0.953	0.989	0.958	1.035	1.033	1.009	0.920	1.016	0.939	1.002	1.029
2039	1.002	1.014	0.977	0.993	1.007	0.989	0.973	1.004	1.015	0.953	1.014	0.987	0.988	0.992	0.999	0.886	0.999	1.025	0.983	0.920	1.022	0.901	1.023	1.029
2040	0.998	1.031	0.996	1.005	1.025	0.999	0.866	1.007	1.011	0.947	1.022	1.005	0.993	0.847	0.995	0.823	0.974	1.027	1.000	0.897	1.031	0.901	1.009	1.027
2041	0.977	1.009	0.979	0.981	1.014	0.967	0.891	0.972	1.006	0.937	1.004	0.972	0.999	0.866	0.970	0.775	0.963	0.998	0.975	0.855	1.006	0.825	1.003	1.000
2042	0.998	1.005	1.004	0.990	1.016	1.000	0.880	0.997	1.013	0.972	1.022	0.991	0.992	0.866	0.988	0.796	0.935	1.000	1.009	0.869	1.016	0.867	1.012	1.003
2043	0.990	1.012	0.984	0.972	1.002	0.974	0.843	0.991	1.004	0.879	1.010	0.960	0.993	0.795	0.985	0.728	0.869	1.010	0.983	0.828	1.007	0.804	1.015	1.001
2044	0.984	0.986	0.965	0.997	0.996	0.978	0.844	0.993	1.002	0.892	1.004	0.995	0.986	0.816	0.981	0.786	0.924	0.995	0.969	0.865	1.010	0.867	1.003	1.000
2045	0.992	1.014	0.997	0.993	1.028	1.001	0.837	0.994	1.016	0.945	1.009	0.993	0.993	0.804	0.982	0.696	0.956	1.031	1.006	0.844	1.016	0.847	1.020	1.012
2046	0.974	1.016	0.976	0.973	1.011	0.977	0.888	0.989	1.002	0.895	1.018	0.976	0.987	0.852	0.979	0.810	0.967	1.024	0.983	0.885	1.021	0.893	0.986	1.013
2047	0.968	1.006	0.989	0.959	1.021	0.975	0.785	0.974	0.995	0.850	1.010	0.959	0.986	0.694	0.957	0.662	0.898	1.027	0.981	0.797	1.021	0.796	0.982	1.007
2048	0.998	1.017	0.971	0.969	1.025	0.975	0.763	0.989	1.014	0.895	1.017	0.962	0.979	0.687	0.994	0.706	0.960	1.028	0.979	0.797	1.021	0.790	1.018	1.027
2049	1.005	1.007	0.994	1.001	1.016	0.988	0.934	0.993	1.016	0.933	1.003	0.992	0.995	0.903	0.993	0.777	0.956	1.011	0.995	0.935	1.008	0.919	1.012	1.005
2050	0.996	1.011	0.993	0.996	1.005	1.001	0.838	1.003	1.023	0.799	1.014	0.997	0.991	0.789	1.002	0.725	0.872	1.006	0.999	0.865	1.016	0.886	1.020	1.008

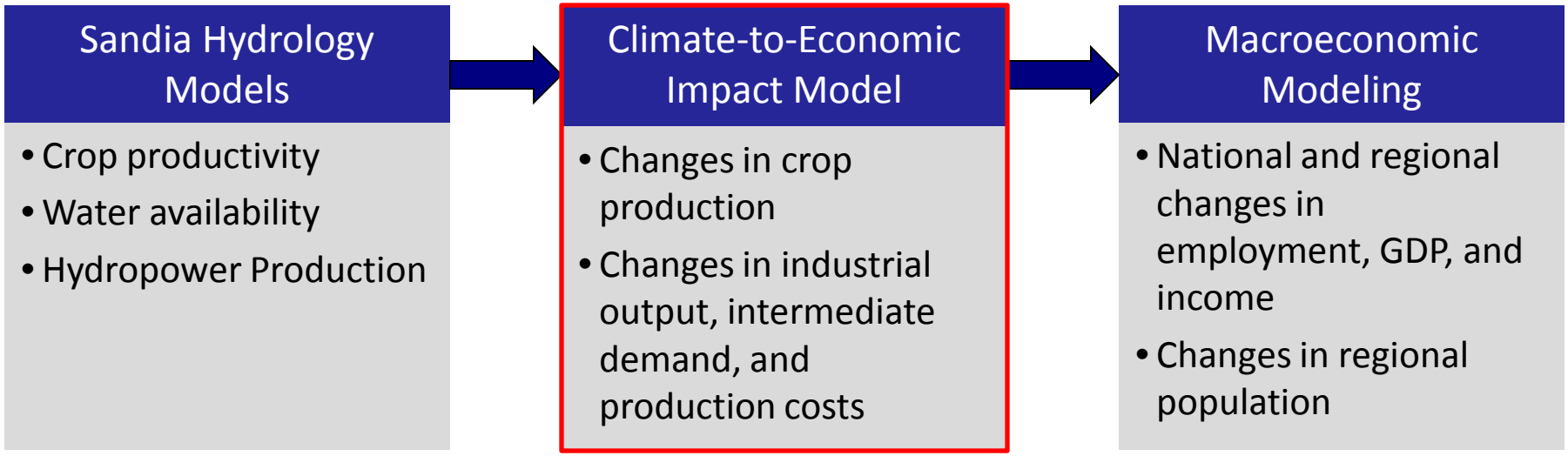
Soy

Modeling Economic Impacts from Hydrology Forecasts



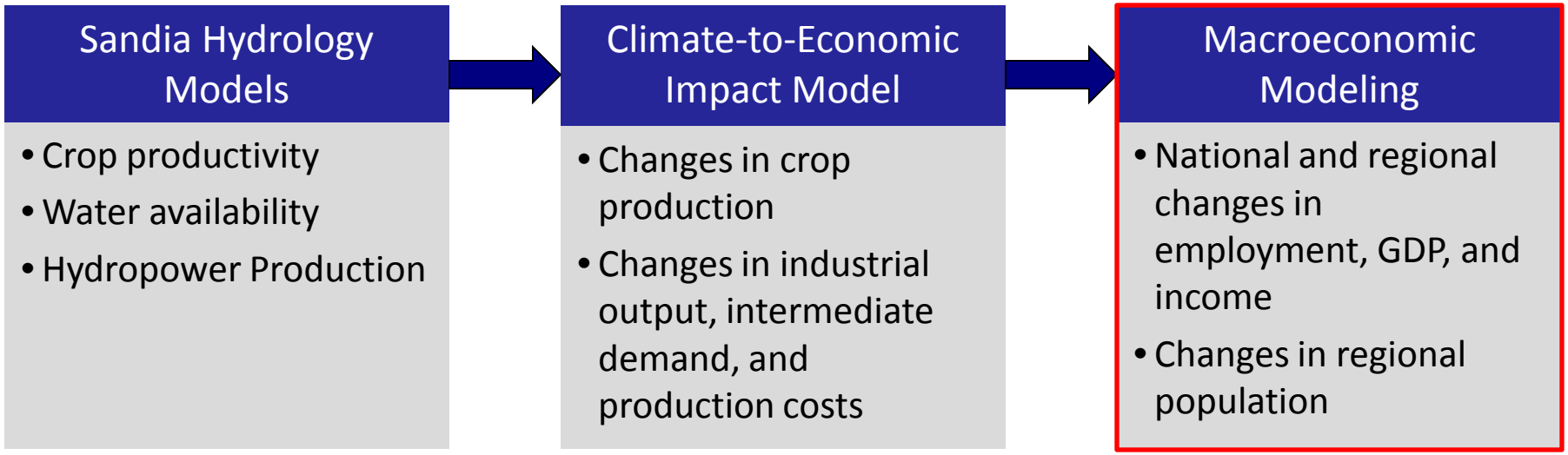
- Uncertainties in precipitation predictions are reflected in the output of the hydrology models, which is used as input to the economic model

Modeling Economic Impacts from Hydrology Forecasts



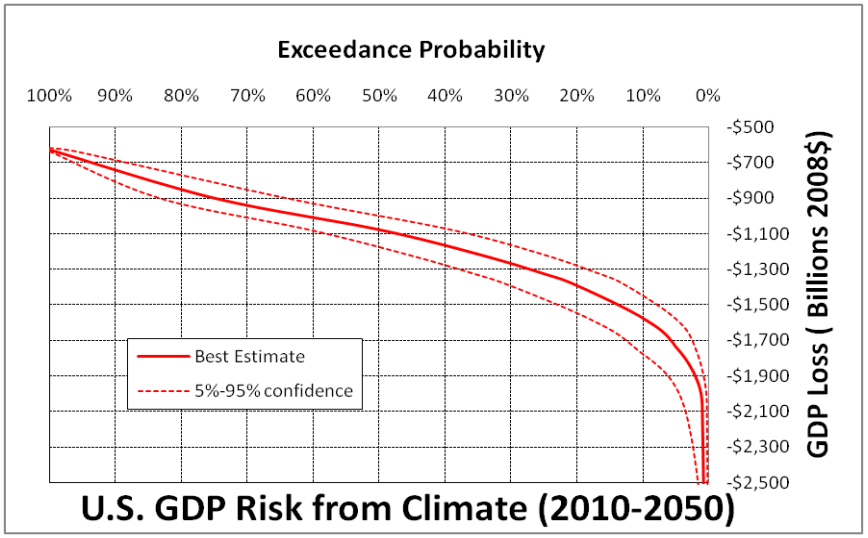
- The Climate-to-Economic Impact Model is a "pre-model" used to make economic sense of the hydrology model output
  - Forecasting direct economic impacts

Modeling Economic Impacts from Hydrology Forecasts



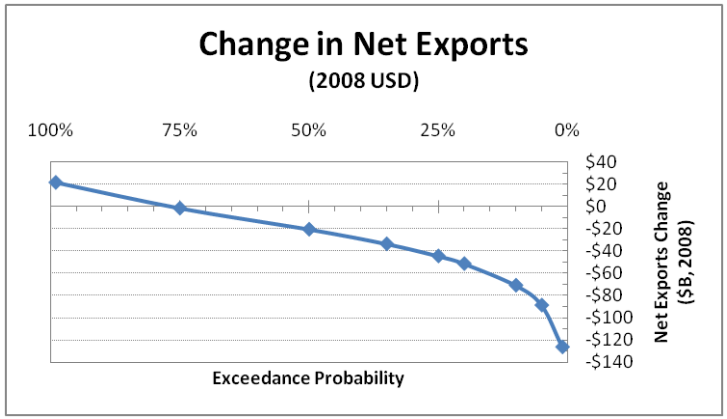
- Regional Economic Models, Inc. (REMI) model used to model broad economic/demographic effects.
  - REMI is a dynamic, 51-region model that creates annual forecasts to 2050

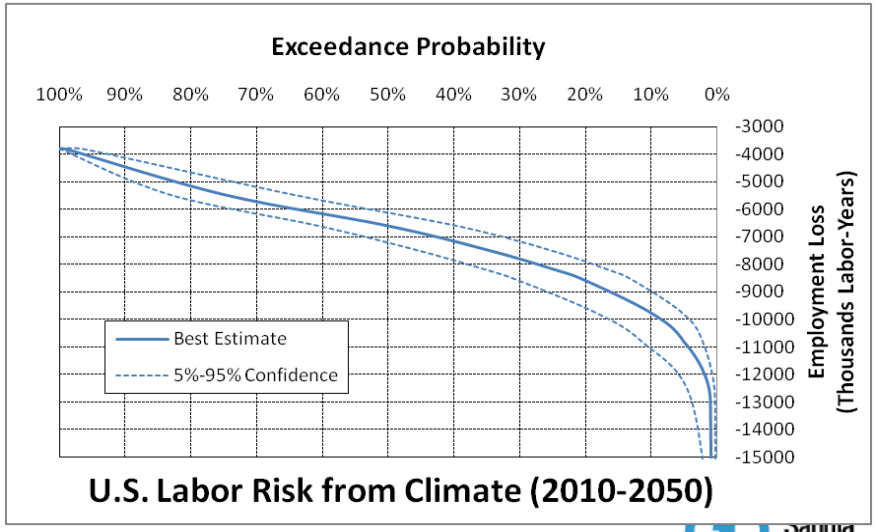
National Summary Results



Change in National GDP (Billions of 2008$)										
Discount rate	Exceedance Probability									Summary Risk
	99%	75%	50%	35%	25%	20%	10%	5%	1%	
0.0%	-$638.5	-$899.4	-$1,076.8	-$1,214.5	-$1,324.6	-$1,390.8	-$1,573.9	-$1,735.4	-$2,058.5	-$1,204.8
1.5%	-$432.0	-$595.9	-$707.4	-$795.0	-$865.1	-$907.2	-$1,024.6	-$1,129.3	-$1,340.2	-$790.3
3.0%	-$301.9	-$407.4	-$479.4	-$536.6	-$582.4	-$610.0	-$687.2	-$756.8	-$898.2	-$534.5

Change in Employment (Thousands)									
Exceedance Probability									Summary Risk
99%	75%	50%	35%	25%	20%	10%	5%	1%	
-3,815	-5,463	-6,601	-7,468	-8,166	-8,587	-9,764	-10,819	-12,961	-6,863



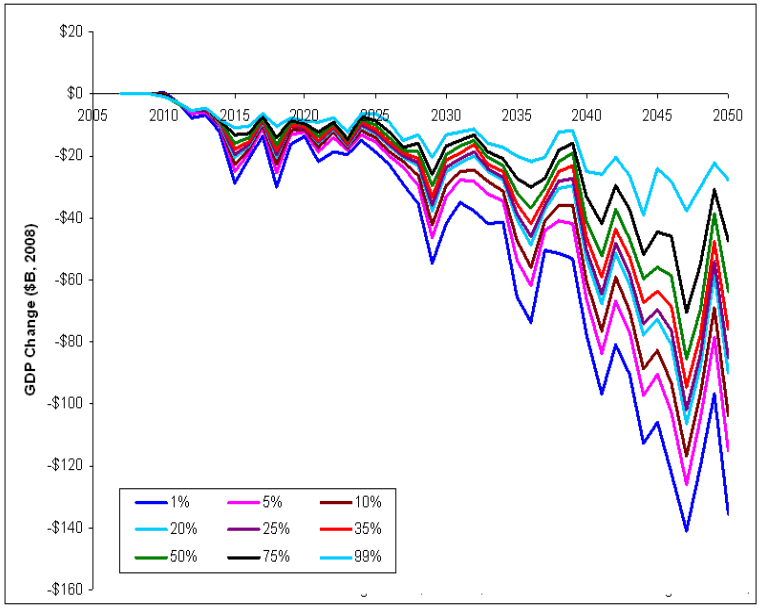


Sandia National Laboratories

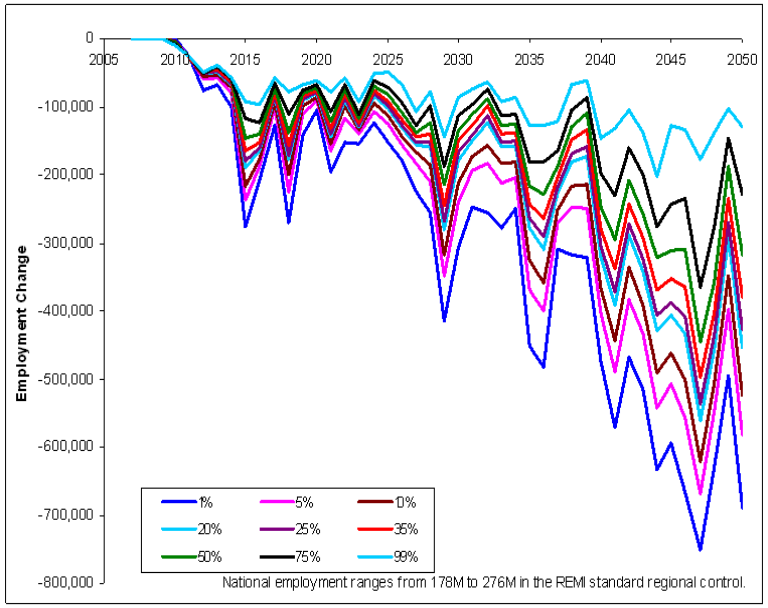
Volatility matters

Volatility brings risks of the future into the present

Annual impacts on the national GDP and employment as a function of varying exceedance probabilities for reduced water availability



Annual U.S. GDP impacts.



Annual U.S. employment impacts

Volatility and its uncertainty creates urgency to use Integrated Risk Assessment for today's decisions

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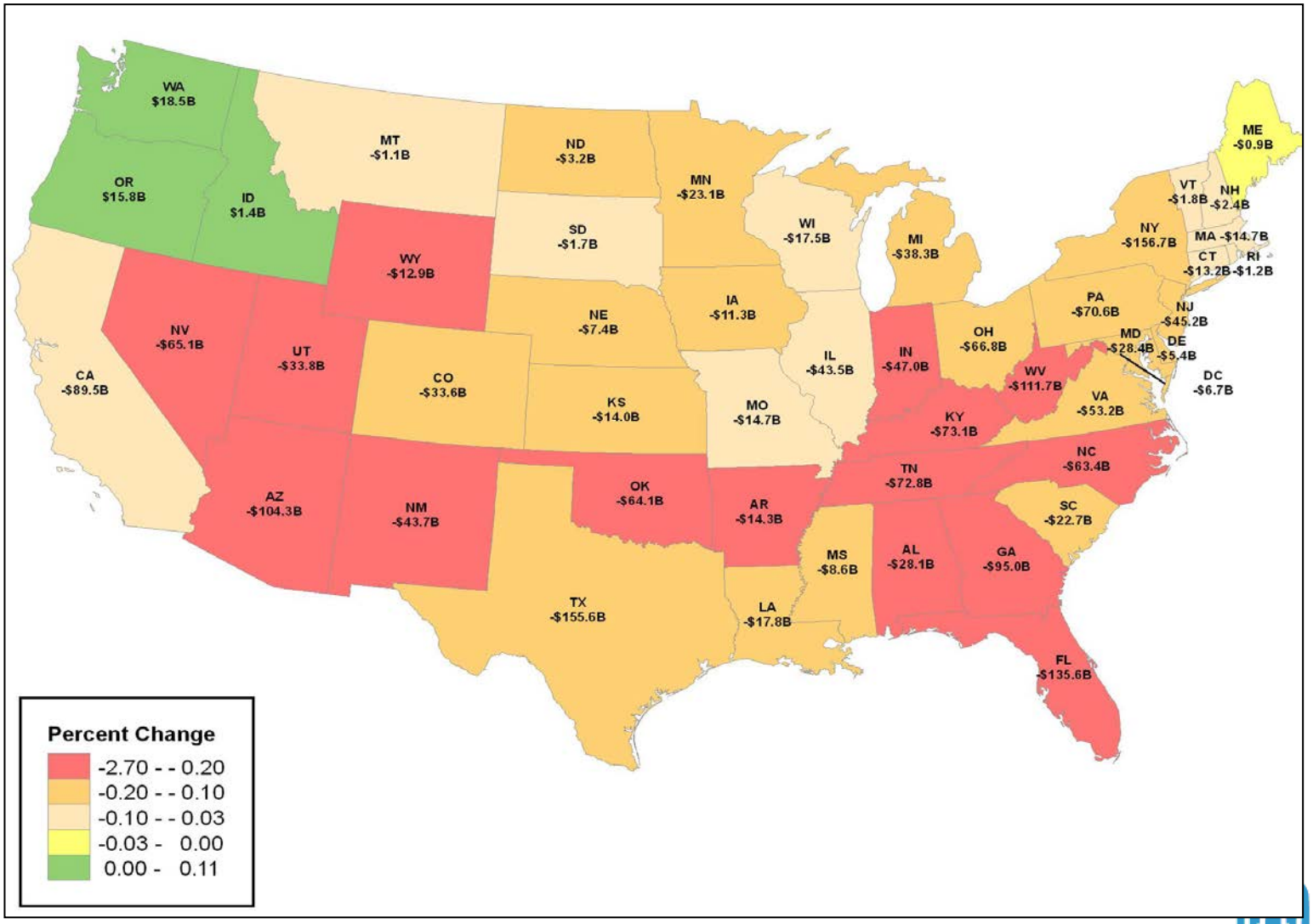
GDP Impact of Climate Change

(1% Exceedance Probability)



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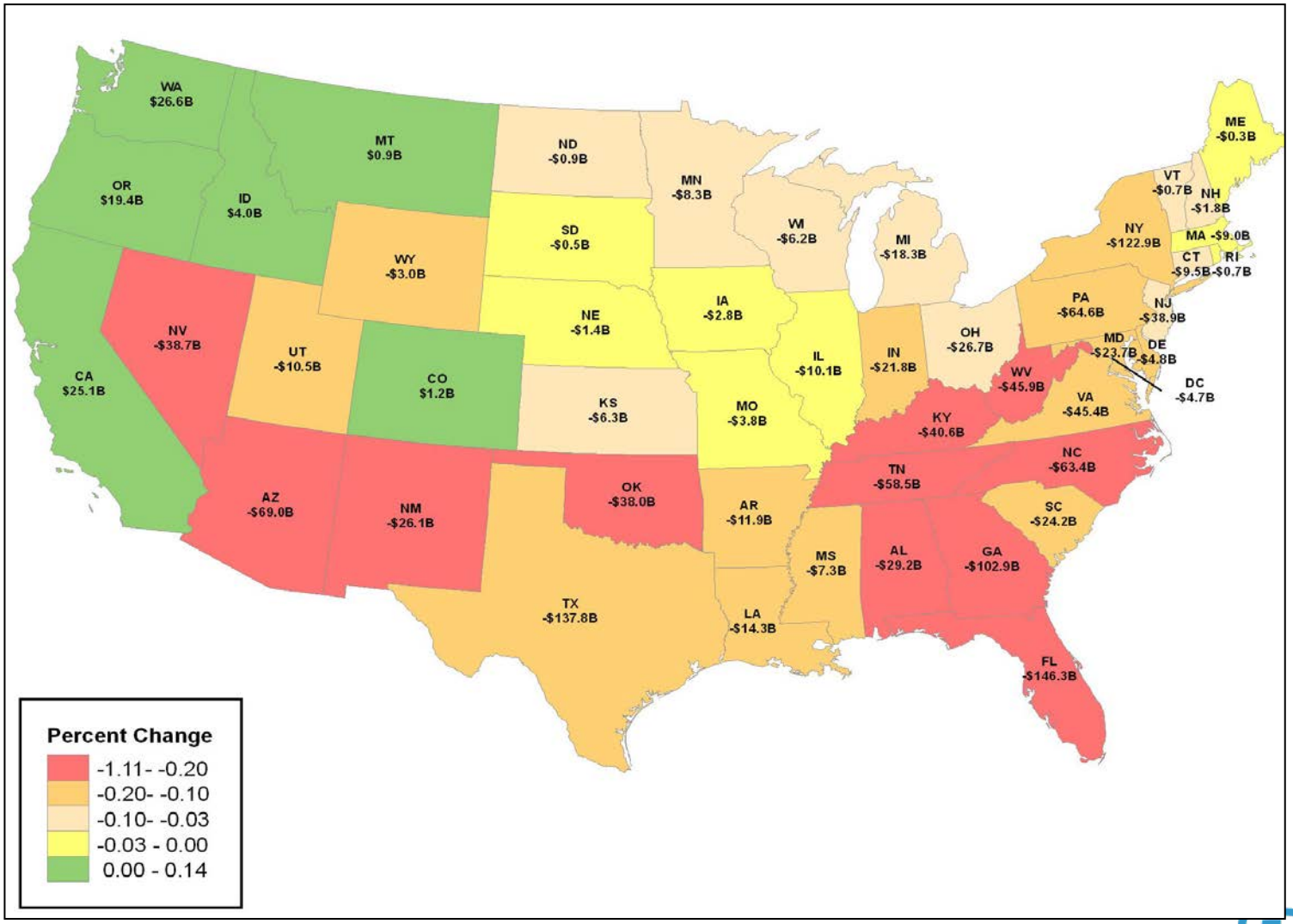
GDP risk by State



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Comparative Impact of Climate Change on Industry

Forestry and logging; Fishing, hunting	-$0.6		Water transportation	$0.0
Agriculture, forestry support activities; Other	-$0.3		Truck transportation, couriers	-$19.9
Oil and gas extraction	-$9.4		Transit and ground passenger transportation	-$0.6
Mining (except oil and gas)	-$86.3		Pipeline transportation	-$0.2
Support activities for mining	-$7.3		Tourist transportation; support activities	-$0.8
Utilities	$13.6		Warehousing and storage	-$2.1
Construction	-$30.8		Publishing industries, except Internet	-$12.4
Wood product manufacturing	-$1.1		Motion picture and sound recording industries	-$4.5
Nonmetallic mineral product manufacturing	-$3.3		Internet publishing, Information services	-$10.8
Primary metal manufacturing	-$2.4		Broadcasting, Telecommunications	-$28.1
Fabricated metal product manufacturing	-$3.7		Monetary authorities, funds, trusts, financials	-$34.1
Machinery manufacturing	-$4.2		Securities, commodity contracts, investments	-$39.9
Computer and electronic product mfg.	-$10.3		Insurance carriers and related activities	-$6.4
Electrical equipment and appliance mfg.	$1.4		Real estate	-$38.2
Motor vehicles, bodies & trailers, parts mfg.	-$8.8		Rental and leasing services	-$8.4
Other transportation equipment manufacturing	-$1.6		Professional and technical services	-$41.4
Furniture and related product manufacturing	-$3.6		Management of companies and enterprises	-$13.9
Miscellaneous manufacturing	$1.4		Administrative and support services	-$21.2
Food manufacturing	-$82.3		Waste management and remediation services	-$0.5
Beverage and tobacco product manufacturing	-$29.4		Educational services	-$2.2
Textile mills	$0.0		Ambulatory health care services	-$66.8
Textile product mills	-$1.0		Hospitals	-$5.5
Apparel manufacturing	$0.8		Nursing and residential care facilities	-$2.0
Leather and allied product manufacturing	-$2.3		Social assistance	-$2.0
Paper manufacturing	-$2.5		Performing arts and spectator sports	-$2.0
Printing and related support activities	-$0.6		Museums, historical sites, zoos, and parks	-$0.2
Petroleum and coal product manufacturing	-$3.6		Amusement, gambling, and recreation	-$5.9
Chemical manufacturing	-$18.2		Accommodation	-$3.8
Plastics and rubber product manufacturing	-$4.5		Food services and drinking places	-$19.9
Wholesale trade	-$45.3		Repair and maintenance	-$4.9
Retail trade	-$127.2		Personal and laundry services	-$11.2
Air transportation	-$4.1		Membership associations and organizations	-$2.0
Rail transportation	-$3.2		Private households	-$1.0

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Extension of Methodology/Capabilities in-Progress

- Current work explores one impact vector (water)
  - Will explore additional impact vectors (e.g. disease)
- Extending assessment to 230 countries, trade, migration, infrastructure, and economic/political stability.
- Will include expectation dynamics that establish tensions and conflict thresholds.
- Next iteration will focus on inter/intra-state conflict evolution, containment, and intervention dynamics.

Thank You

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Project Report and Executive Summary Can be Found At:

http://cfwebprod.sandia.gov/cfdocs/CCIM/docs/Climate_Risk_Assessment.pdf
http://cfwebprod.sandia.gov/cfdocs/CCIM/docs/Climate_Risk_Exec_Summary.pdf