

Using REMI to Assess the Near-Term Risk of Climate Uncertainty

**REMI Seminar on "Economic Analysis of Energy,
Environmental and Transportation Policies,"
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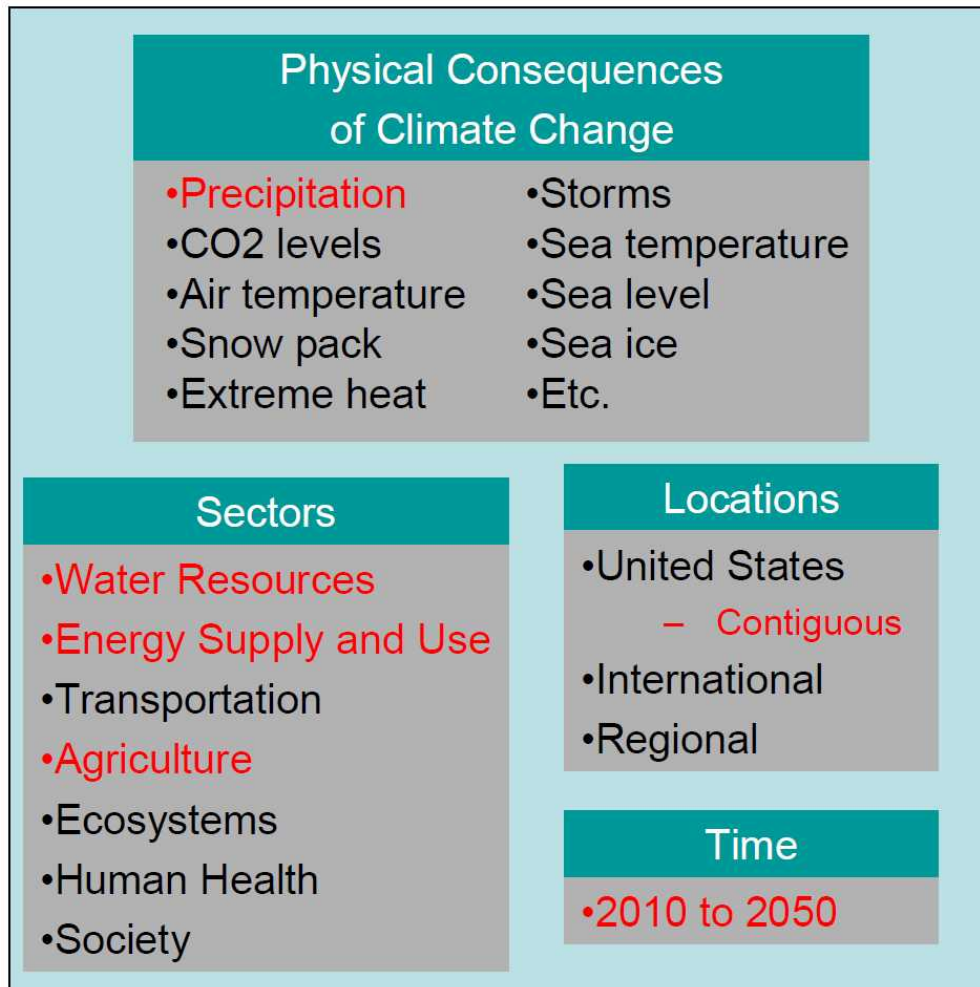


Reports

- “Executive summary for assessing the near-term risk of climate uncertainty : interdependencies among the U.S. states.” SAND2010-2200
- “Assessing the near-term risk of climate uncertainty : interdependencies among the U.S. states.” SAND2010-2052
 - Backus, George A., Lowry, Thomas Stephen, Warren, Drake E., Ehlen, Mark Andrew, Klise, Geoffrey T., Loose, Verne W., Malczynski, Leonard A., Reinert, Rhonda K., Stamber, Kevin Louis, Tidwell, Vincent Carroll, Vargas, Vanessa N., Zagonel, Aldo A., 2010
- “Estimates of the long-term U.S. economic impacts of global climate change-induced drought.” SAND2010-0692
 - Warren, Drake E., Ehlen, Mark Andrew, Loose, Verne W., Vargas, Vanessa N., 2010



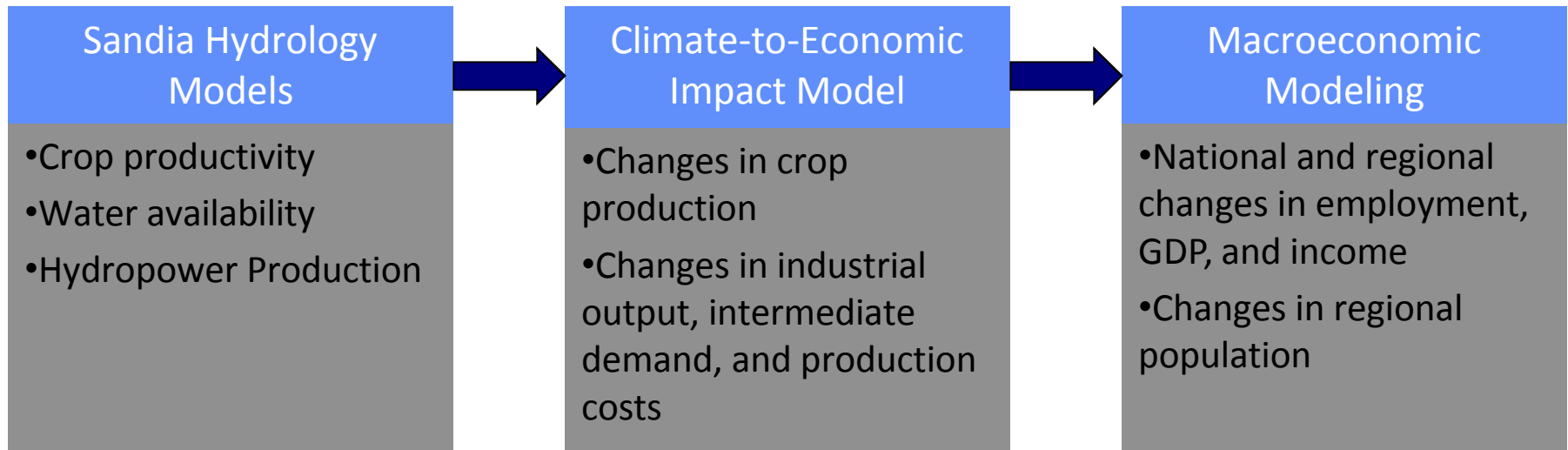
Domains of Climate Change



- **Study examined a relatively narrow mix of domains**
 - **Precipitation (water availability) directly affects economic activities**
- **Sectors chosen are most economically affected by water shortages**



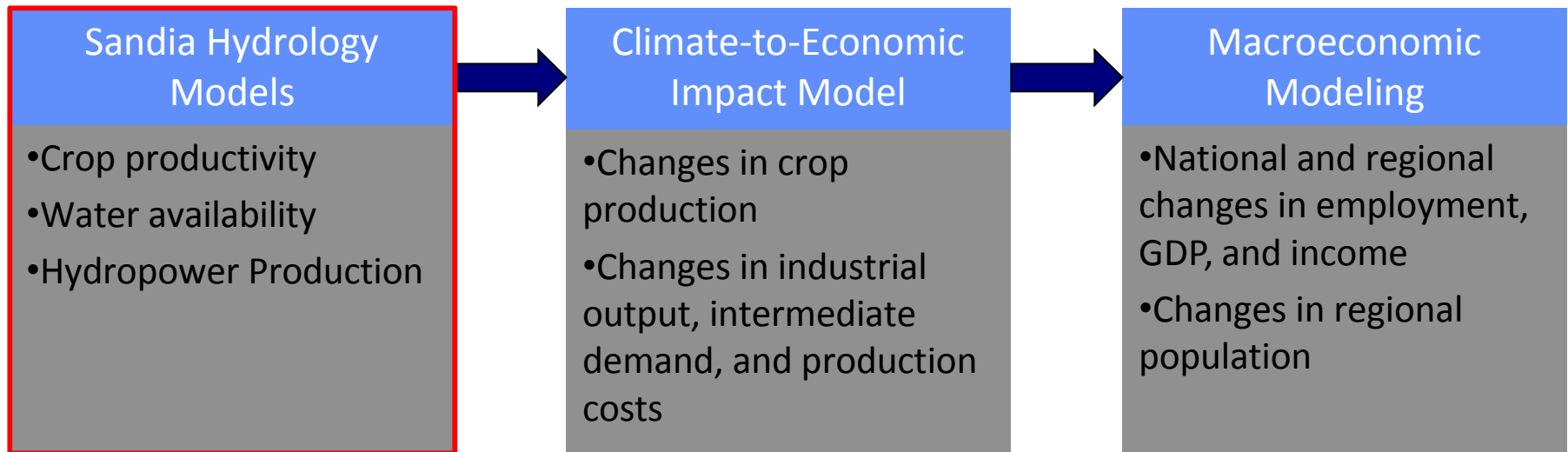
Complete Economic Impact Modeling Process



- **Data flows between:**
 - Hydrology (Sandia analysis of IPCC climate models)
 - direct economic impact (Sandia economic pre-modeling), and
 - macroeconomic modeling (REMI)



Modeling Economic Impacts from Hydrology Forecasts



- **Uncertainties are reflected in the outputs of the hydrology models, which are used as inputs in economic modeling**

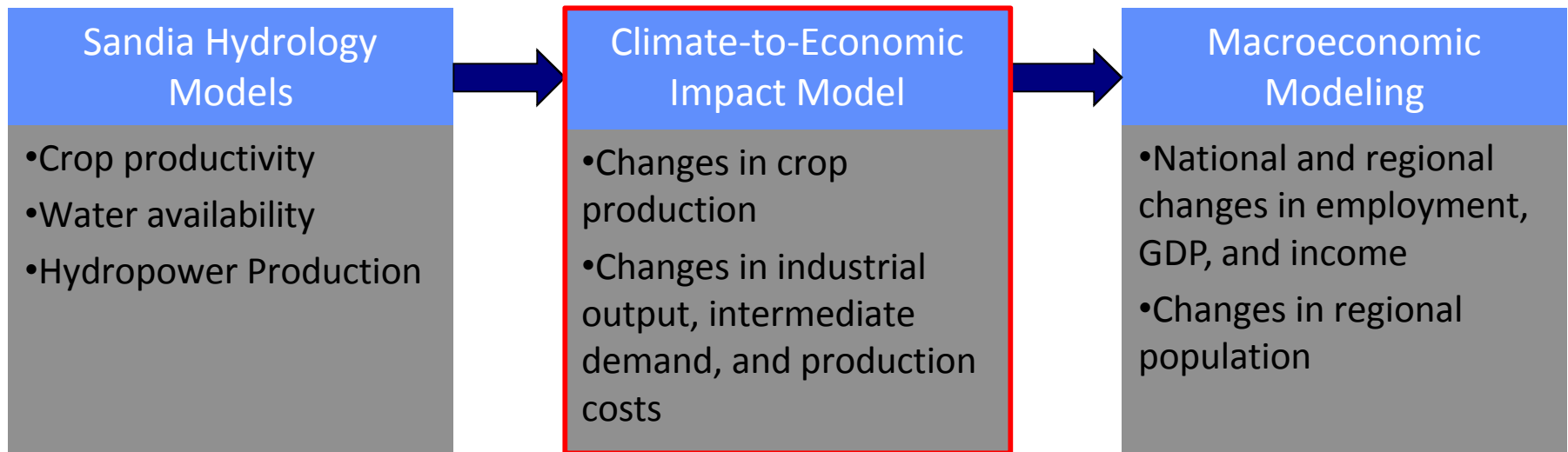


Sandia Hydrology Models Output Variables

Variable	Description
$\alpha_{x,t}^i$	Relative production (compared to a base year) for crop x (both irrigated and non-irrigated crop production, combined)
H_t^i	Fraction of normal water availability for municipal consumption
E_t^i	Fraction of normal water availability for thermoelectric generation consumption
HP_t^i	Fraction of normal hydroelectric power production
I_t^i	Fraction of normal water availability for industrial consumption
M_t^i	Fraction of normal water availability for mining consumption



Modeling Economic Impacts from Hydrology Forecasts



- **The Climate-to-Economic Impact Model is a type of “pre-modeling” by making economic sense of hydrology models**
 - **Forecasting direct economic impacts**

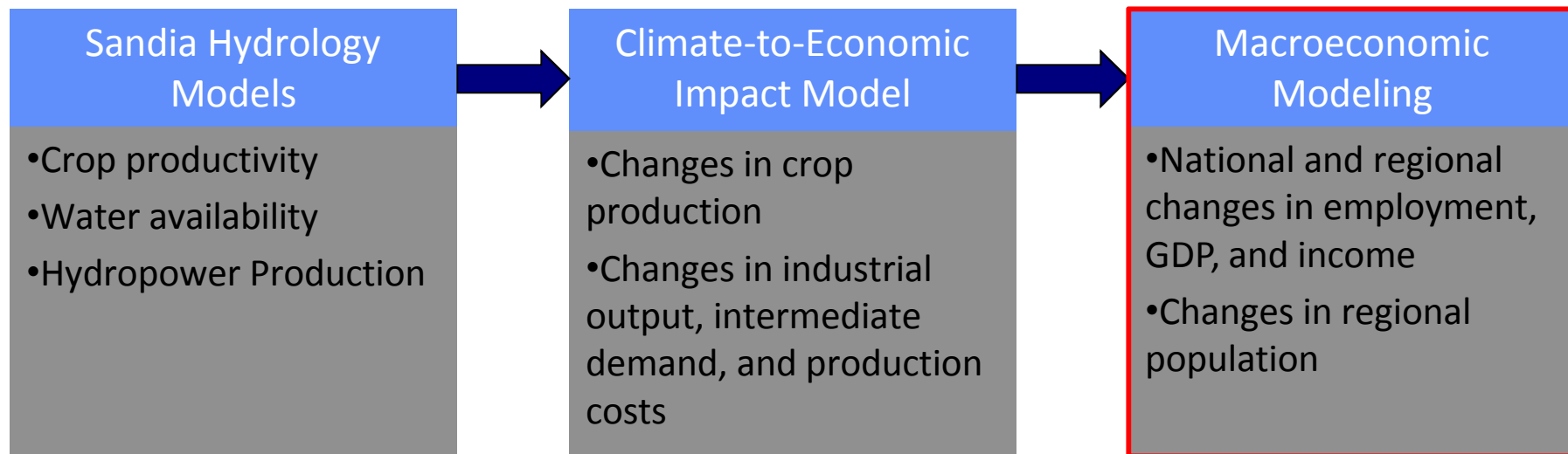


Climate-to-Economic Impact Modeling

- **For agriculture, decreased production and increased production costs (due to transportation costs) were estimated**
- **For industry, consequences of using backstop technologies were estimated, e.g.,**
 - **Retrofits to dry cooling and once-through cooling**
 - **(These have potentially negative environmental externalities)**
 - **Increase in desalination**
 - **Substitution from hydropower production**

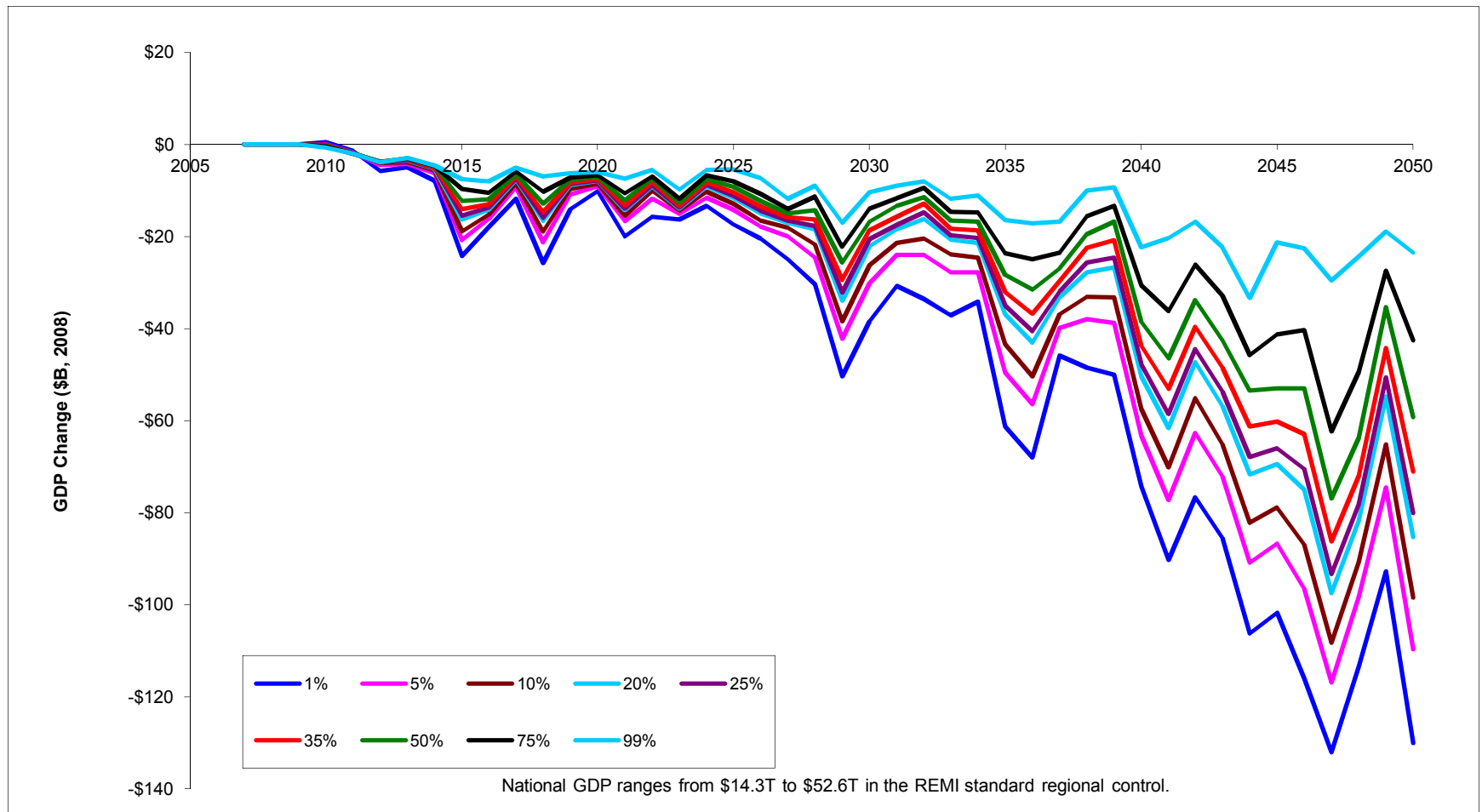


Modeling Economic Impacts from Hydrology Forecasts

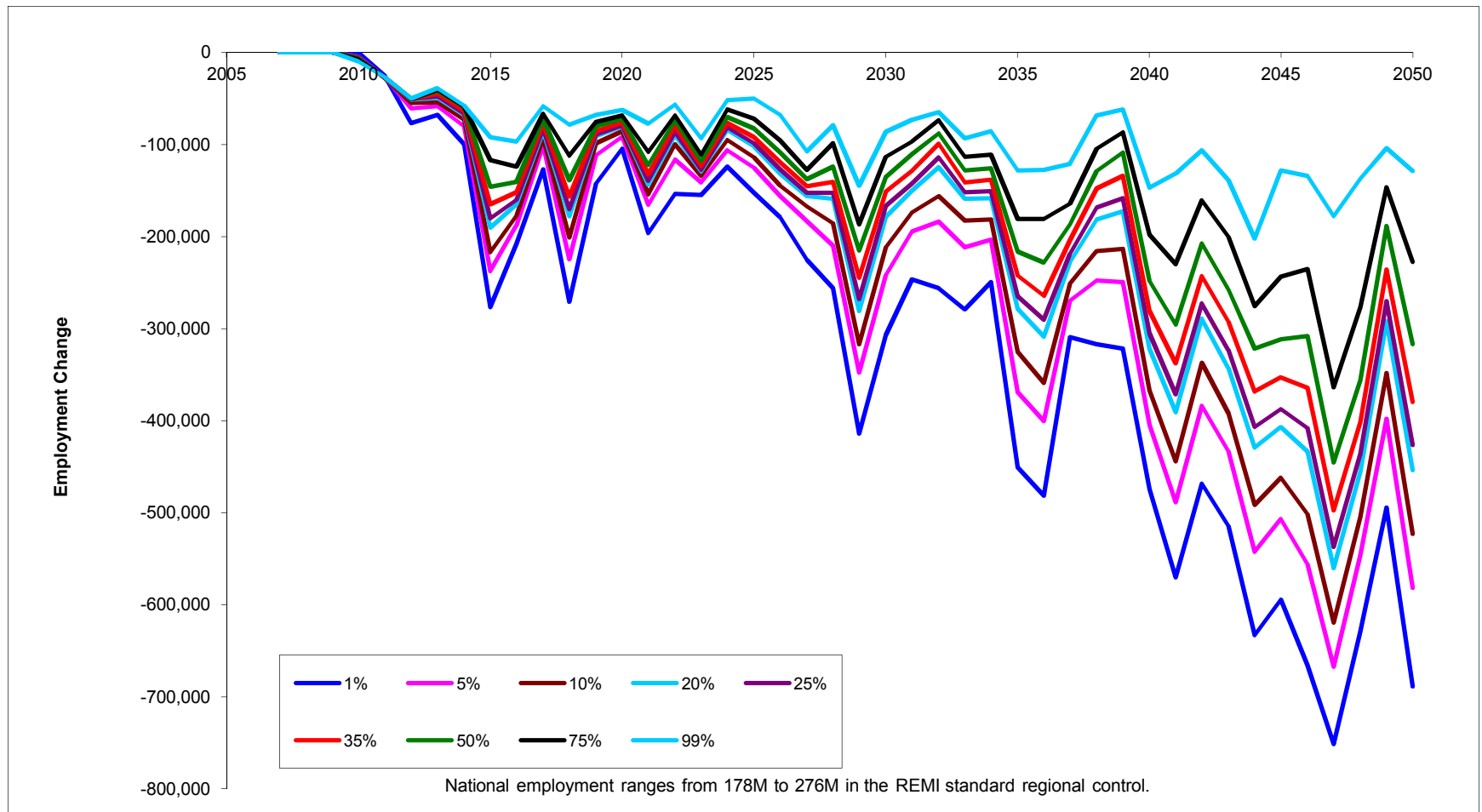


- **Regional Economic Models, Inc. (REMI) model used to model broad economic/demographic effects.**
 - REMI is a dynamic, 51-region model that creates annual forecasts to 2050.

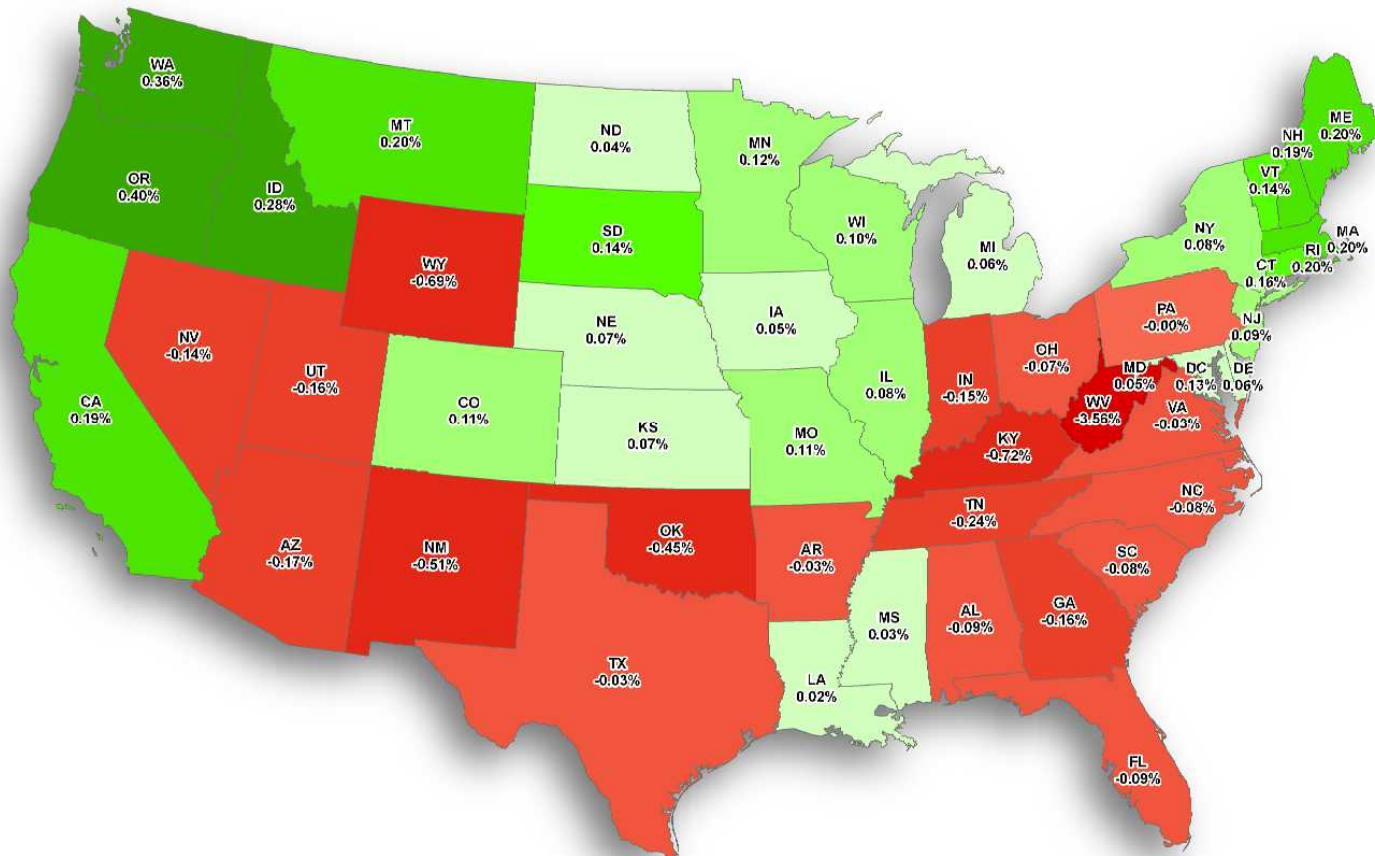
Selected Results: Change in National GDP (from base case)



Selected Results: Change in National Employment (from base case)



Selected Results: Change in Regional Population (from base case, 1% run)





GDP Impacts and Summary Risk (2010-2050)

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