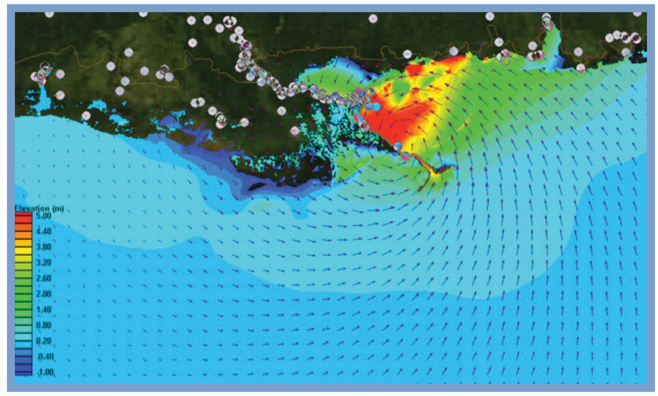
U.S. DEPARTMENT OF ENERGY | Office of Science

DEVELOPING A FRAMEWORK FOR REGIONAL INTEGRATED ASSESSMENT MODELING

Pacific Northwest National Laboratory (PNNL), in partnership with Oak Ridge National Laboratory (ORNL) and supported by the Department of Energy's (DOE) Integrated Assessment Research Program, is developing a framework for regional integrated assessment and Earth system modeling, known as RIAM, and applying this framework to the Gulf Coast region of the United States—a region where climate impacts, land use changes, sea level rise, and energy supply issues are interacting to increase the vulnerability of the energy and agriculture sectors.

The RIAM project links regional climate, hydrology, socioeconomics, energy infrastructure, coastal processes, and agriculture and land use models to investigate the multifaceted impacts of climate change, as well as potential adaptation and mitigation strategies being considered by regional stakeholders. The project is highlighting the vulnerability of regional energy systems to heat waves, droughts, coastal storm surges, and other extreme events, with an initial focus on climate change impacts on electricity supply and demand across the southeast. Another key goal is improving understanding of the benefits and challenges associated with integrated, multiscale modeling and the interdependencies among human and natural systems in the context of climate change.



Simulation of wind and storm surge during Katrina landfall (grey dots = energy facilities)

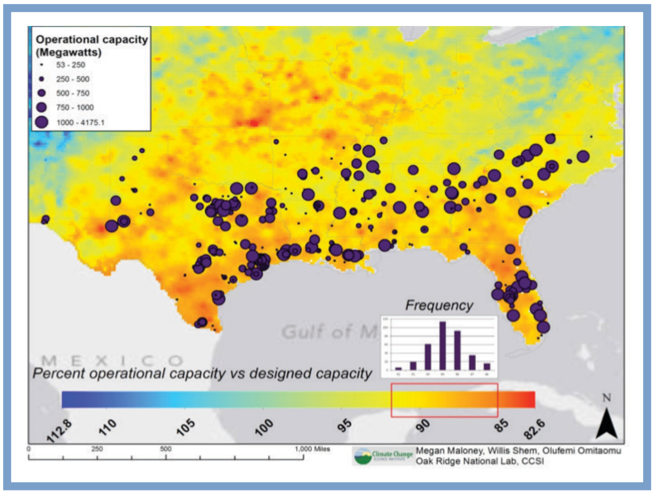
CHALLENGES

The project will generate new insights into the following questions:

- How is climate change affecting the vulnerability of Gulf Coast energy infrastructure to the combined effects of storm surge, subsidence, and sea level rise? How does vulnerability change under different scenarios of future climate change and regional energy and land use planning?
- How will regional climate change, especially changes in the duration, frequency, and intensity of heat waves and droughts, affect building energy demand and the performance of thermal power plants? How will these changes influence regional grid reliability and electricity prices and what potential adaptation measures exist?
- What are the intrinsically regional characteristics and opportunities for mitigation and adaptation? Are there physical or economic constraints that make the implementation of, for example, different energy technologies or land use policies more difficult?
- What are the benefits, challenges, and implications of integrated modeling at regional scales? In particular, are there insights that cannot be gleaned from models that are less integrated or have coarser spatial or temporal resolution?

MAJOR COMPONENTS AND/OR THEMES

This project leverages PNNL's Platform for Regional Integrated Modeling and Analysis (PRIMA) and also includes the development of new models and improvements to existing community models needed to resolve additional regional-scale processes and interactions. The primary integrating element of the framework is a regionalized version of the Global Change Assessment Model (GCAM), which has been extended and downscaled to represent energy supply and demand



SE electricity producing gas fired turbines, +50MW capacity: sensitivities under July 12, 2050 temperatures

at the state level, as well as offer more highly resolved representations of agricultural productivity and land management technologies. A regional Earth system model, driven by global boundary conditions provided by the Community Earth System Model (CESM), provides detailed, dynamically downscaled simulations of regional climate change under different scenarios of global climate forcing. These regional climate change scenarios are used to drive the other modeling components.

For example, the high-resolution coastal storm surge model, which has been validated with historical hurricane data, simulates inland flooding for future hurricanes and can be coupled to a GIS-based model that relates storm surge height to impacts on specific energy infrastructure elements along the affected coastline. Likewise, regional climate is used to drive the detailed models of regional building energy demand and electricity operations at the utility zone scale to provide realistic assessments of increases in electricity demand during heat waves and decreases in electricity supply due to either high air temperatures or low water quantity or quality. Collectively, these unique modeling capabilities are yielding an unprecedented level of detail and insight into the interactions among changes in climate, energy, and water systems at regional scales and allowing the exploration of key issues facing regional stakeholders.

FUTURE WORK

The initial focus of the project on climate change impacts on electricity supply and demand across the Gulf Coast region currently is being extended to include additional climate forcing factors, such as stream temperature and river flooding, and additional infrastructure components, including oil and gas infrastructure. Additional emphasis on changes in agricultural productivity and the potential for increased regional biomass production also are planned. On a longer-term basis, these capabilities could be leveraged to evaluate different regional adaptation and mitigation strategies in an integrated, holistic context that includes both regional climate change and consistent changes in other natural and human systems, both in the Gulf Coast and other important regions.

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Project Website:
http://climatemodeling.science.energy.gov/projects/developing-regional-integrated-assessment-model-framework