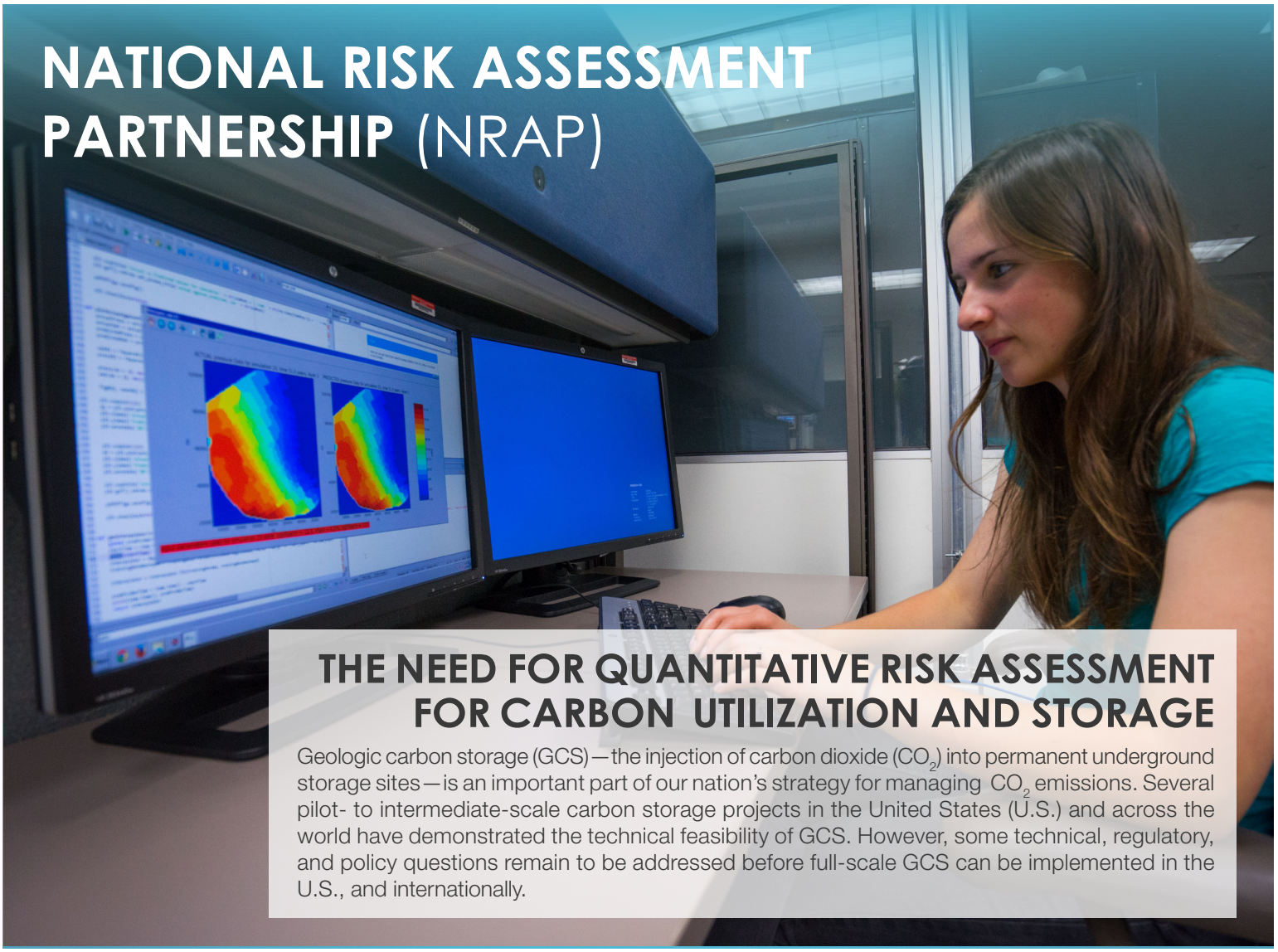
NATIONAL RISK ASSESSMENT PARTNERSHIP (NRAP)



THE NEED FOR QUANTITATIVE RISK ASSESSMENT FOR CARBON UTILIZATION AND STORAGE

Geologic carbon storage (GCS)—the injection of carbon dioxide (CO_2) into permanent underground storage sites—is an important part of our nation's strategy for managing CO_2 emissions. Several pilot- to intermediate-scale carbon storage projects in the United States (U.S.) and across the world have demonstrated the technical feasibility of GCS. However, some technical, regulatory, and policy questions remain to be addressed before full-scale GCS can be implemented in the U.S., and internationally.

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Of particular relevance to making a business case for large-scale, long-term GCS is the development of quantitative, science-based methods for estimating long-term environmental risks related to potential leakage and induced seismicity. Such methods and the tools derived from them, will help inform decision making with respect to two critical considerations for full scale carbon storage: long-term liability and cost of monitoring, particularly in the period of post-injection site care.

THE NATIONAL RISK ASSESSMENT PARTNERSHIP

The National Energy Technology Laboratory's (NETL) Research and Innovation Center is leading a multi-national laboratory effort that leverages broad technical capabilities across the Department of Energy (DOE) into a mission-focused platform to develop critical science base and predictive tools that can be applied to risk assessment for long-term storage of CO_2: the National Risk Assessment Partnership (NRAP). NRAP brings together researchers from five DOE national laboratories: NETL, Los Alamos National Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, and Pacific Northwest National Laboratory.

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The partnership applies DOE's unique core capabilities in science-based prediction of the critical behaviors of engineered natural systems to develop insights into the environmental risk behavior of GCS. The NRAP program also benefits from the perspective of industry, government, non-government organizations, and academia regarding research needs for large-scale CO_2 storage deployment.

NRAP GOAL

The goal of NRAP is to develop defensible, science-based methodologies and platforms for quantifying risks amidst system uncertainty, and to better inform decision making for carbon storage sites.

NRAP PHASE I OBJECTIVES AND ACCOMPLISHMENTS

NRAP is nearing completion of Phase I activities focused on developing approaches to quantitatively assess site-scale risk performance. Phase I included efforts to build a critical science base to constrain key uncertainties in behavior of important system components, develop methodologies and predictive tools for rapid estimation of system risk performance and related uncertainties, and communicate the functionality and utility of those products to key GCS stakeholders. Through Phase I (2011 – 2016), NRAP researchers have:

- Generated the first long-term quantitative risk profiles for a full CO_2 storage system
- Developed predictive tools and conducted focused experimental studies to improve understanding of potential leakage pathway behavior
- Developed a comprehensive risk model for induced seismicity, as well as tools to forecast near-term seismic potential and estimate potential ground motion effects from induced seismicity
- Provided insights into the utility of select monitoring approaches and explored the potential for optimization of monitoring design
- Developed an integrated assessment model coupling computationally efficient reduced-order models of various system components to describe whole-system CO_2 containment behavior and potential leakage risks and impacts

Products from these efforts include the publication of numerous peer-reviewed articles and technical reports detailing key findings from laboratory and computational studies, innovative reduced-order modeling approaches, new risk assessment and uncertainty quantification methodologies, and new insights into whole system risk performance and key storage security relationships and issues. NRAP Phase I efforts have also resulted in the generation of a set of ten risk assessment tools that have been openly distributed for testing and use by the international carbon capture and storage community. Taken together, these accomplishments help to advance the state of understanding and provide a path forward for quantitative assessment of risk management and uncertainty reduction.

NRAP PHASE II

Beginning in late 2016, NRAP will enter a second phase in which predictive capabilities will be applied and extended to consider the active management and mitigation of risk associated with large-scale CO_2 storage, and reducing associated uncertainties through strategic monitoring system design and operation. NRAP Phase II activities will include:

- Development of methodologies and tools to assure effective containment of CO_2 and evaluation of select mitigation alternatives
- Advancement of seismic risk assessment and management strategies
- Development of strategic monitoring for conformance assessment and uncertainty reduction
- Field demonstration, application, and validation of NRAP tools and methodologies

These efforts will be focused toward addressing critical stakeholder questions related to assessment and management of environmental risk at CO_2 storage sites.

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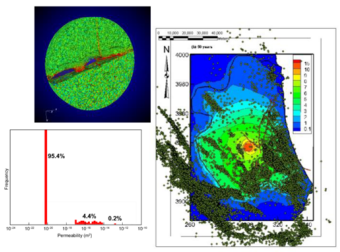
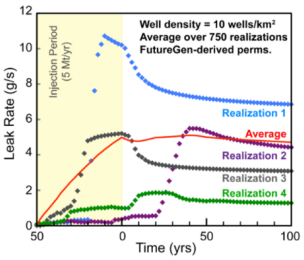
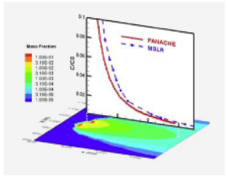


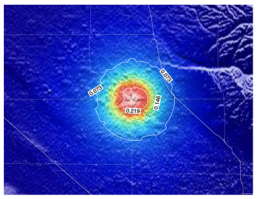
Quantifying potential well leakage and critical well dynamics



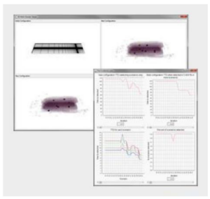
Probabilistic assessment of whole-system containment and leakage risk



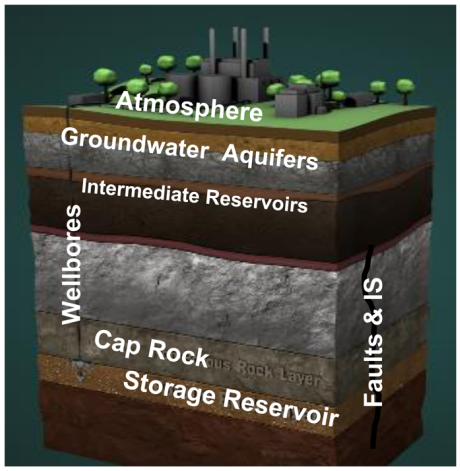
Rapid estimation of atmospheric dispersion

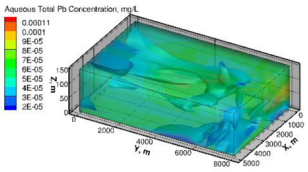


Estimating ground motion response from potential induced seismicity



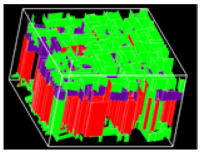
Prototype design approaches for strategic monitoring



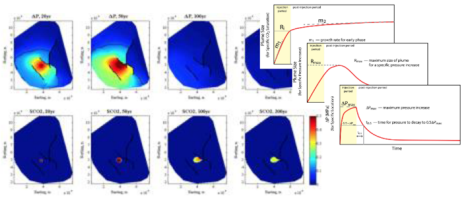


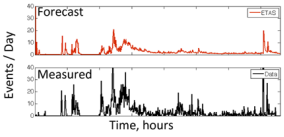
Predicting groundwater impacts from potential leakage

Estimating containment effectiveness of fractured seals



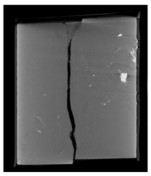
Identify critical reservoir storage/risk relationships





Forecasting short-term, injection-related induced seismicity

Reducing uncertainty in fault/fracture slip-induced permeability changes



Partners

Los Alamos National Laboratory
Lawrence Berkeley National Laboratory
Lawrence Livermore National Laboratory
Pacific Northwest National Laboratory

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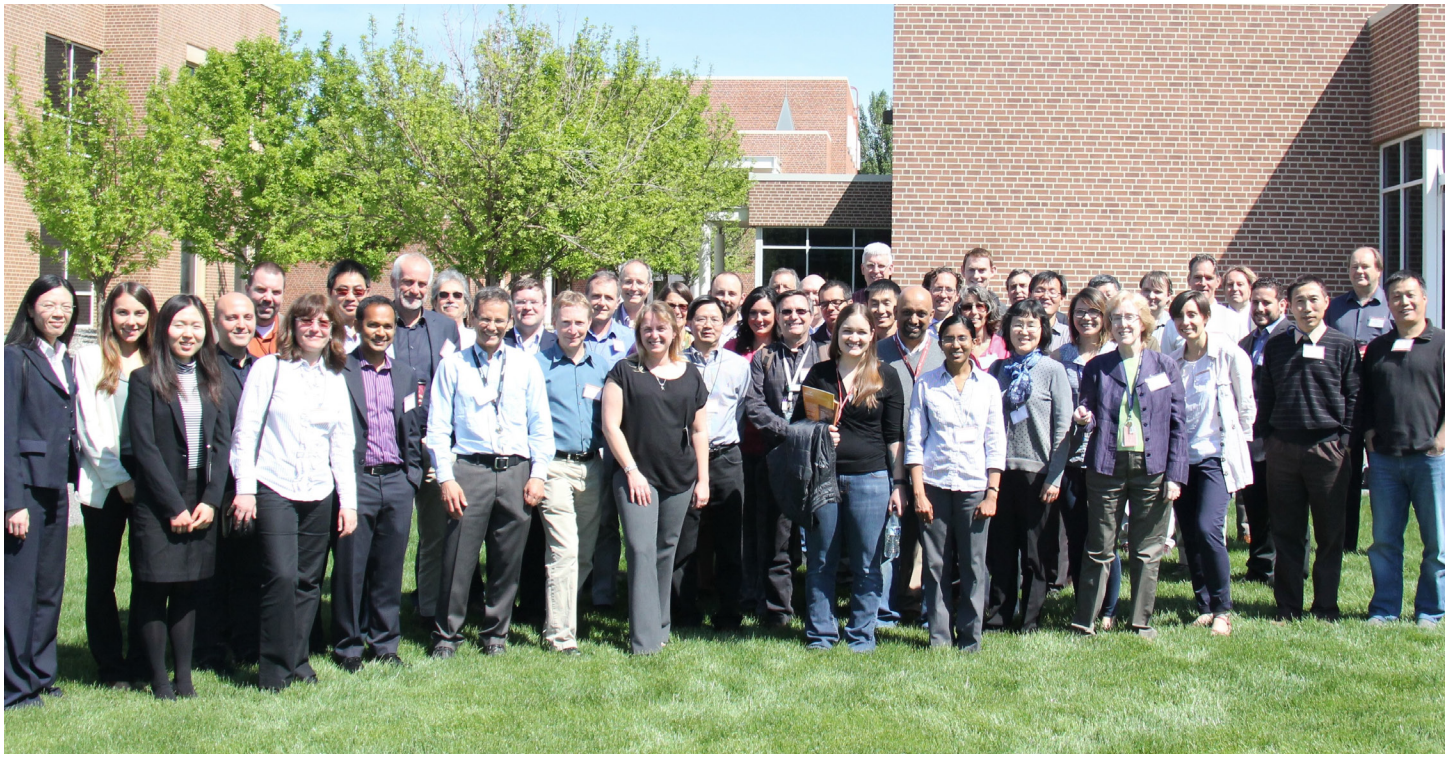

The NRAP technical team includes research collaborators from five contributing national laboratories.

NATIONAL ENERGY TECHNOLOGY LABORATORY

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