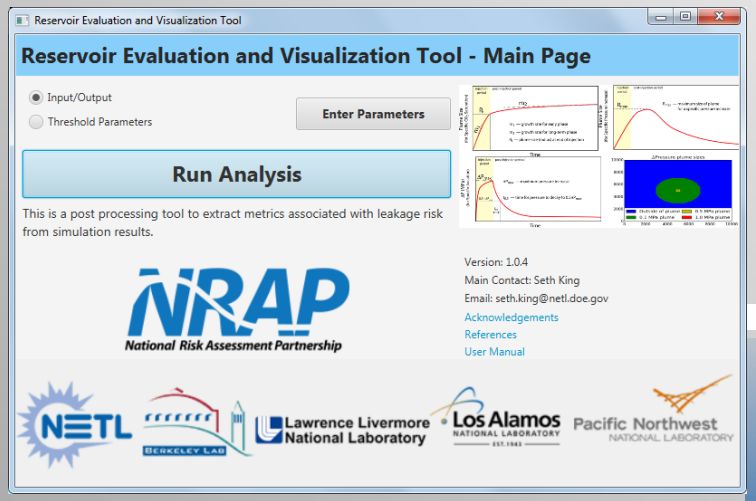

NRAP Tool Webinar Series

Webinar 3

Reservoir Evaluation and Visualization (REV) tool: A tool for measuring reservoir performance as it pertains to risk

Monday October 26, 2015

*Presenter: *Seth King*
NRAP Reservoir workgroup

Contributors: Seth King [1,2*] (NETL), Grant Bromhal[1] (NETL), DaniloArcentales Bastidas[3] (WVU), Jens Birkholzer[5] (LBNL), Abdullah Cihan[5] (LBNL), David Dempsey[6] (LANL), Robert Dilmore[1] (NETL), Ebrahim Fathi[3] (WVU), Rajesh Pawar[6] (LANL), Tom Richard[4] (PSU), Haruko Wainwright[5] (LBNL), Yingqi Zhang [5] (LBNL), George Guthrie [6](LANL)

** Presenter*
[1] National Energy Technology Laboratory, Morgantown, WV
[2] AECOM, Morgantown, WV
[3] West Virginia University
[4] Penn State University
[5] Lawrence Berkeley National Laboratory
[6] Los Alamos National Laboratory

Outline

- Welcome and Overview of NRAP – Technical Approach and Tool Development
- Introduction to the NRAP Reservoir Evaluation and Visualization tool (REV)
- Input needed for the REV tool
- Example use cases
- Analysis of output
- QA/QC
- Lookup table generation and Beta testing
- Questions and Open Discussion

National Risk Assessment Partnership (NRAP)

NRAP leverages DOE's capabilities to help quantify uncertainties and risks necessary to remove barriers to full-scale CO_2 storage deployment.

Objective: Building toolset and improving the science base to address key questions about potential impacts related to release of CO_2 or brine from the storage reservoir, and potential ground-motion impacts due to injection of CO_2

Technical Team

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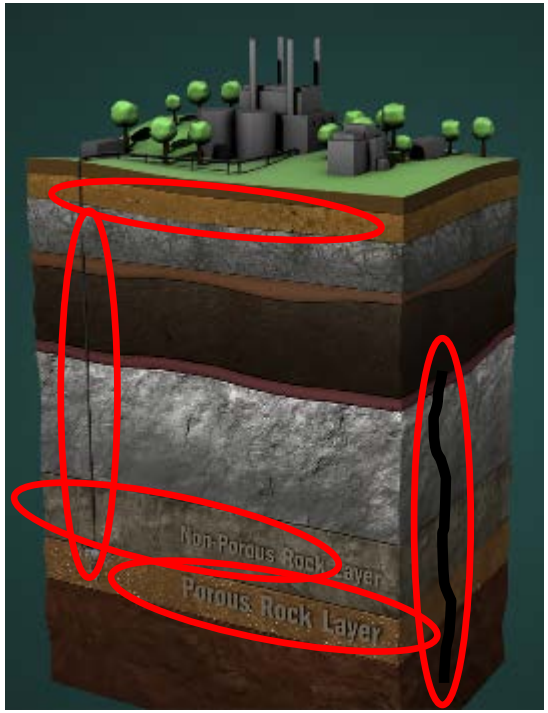
Berkeley Lab
Los Alamos National Laboratory EST. 1943
Pacific Northwest National Laboratory



Stakeholder Group

American Electric Power
Blue Source
bp
EPA United States Environmental Protection Agency
ExxonMobil
ieaghg
IEc
MIT
NRDC
Schlumberger
Southern States Energy Board
Stanford University
Texas Railroad Commission
USGS
The University of Utah
Wade, LLC
Whiting
Zurich

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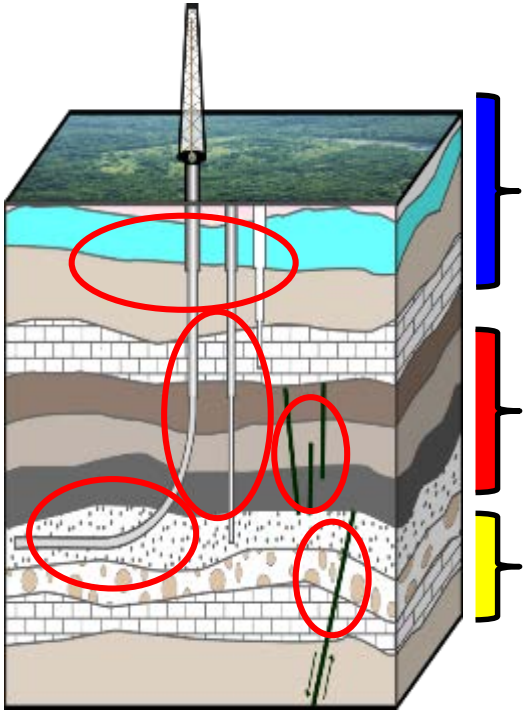
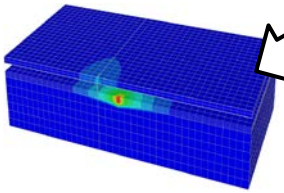
NRAP's approach to quantifying performance relies on reduced-order models to probe uncertainty in the system.

A. Divide system into discrete components



B. Develop detailed component models that are validated against lab/field data

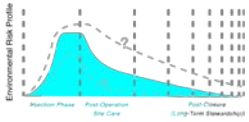


Energy Data Exchange (EDX)

Data

IAM

NRAP Integrated Assessment (System) Models



Potential Receptors or Impacted Media

Release and Transport

Storage Reservoir

C. Develop reduced-order models (ROMs) that rapidly reproduce component model predictions

D. Link ROMs via integrated assessment models (IAMs) to predict system performance & risk; calibrate using lab/field data from NRAP and other sources

E. Develop strategic monitoring protocols that allow verification of predicted system performance

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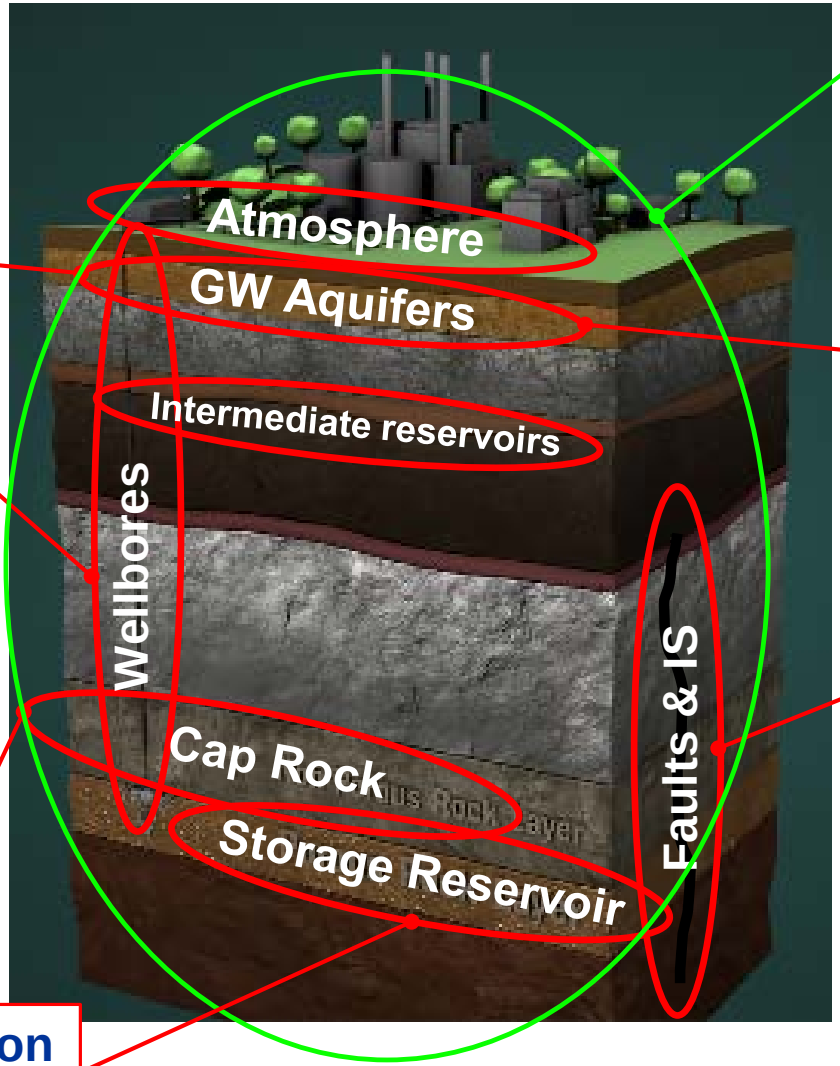
NRAP Tools

Now available for beta testing



NRAP-IAM-CS

Design for Risk Evaluation and Monitoring

Aquifer Impact Model

Wellbore Leakage Analysis Tool

Short Term Seismic Forecasting

Natural Seal ROM

Reservoir Evaluation and Visualization

www.edx.netl.doe.gov/nrap → *TOOL BETA TESTING link*

Schedule for NRAP Tool Webinar Series

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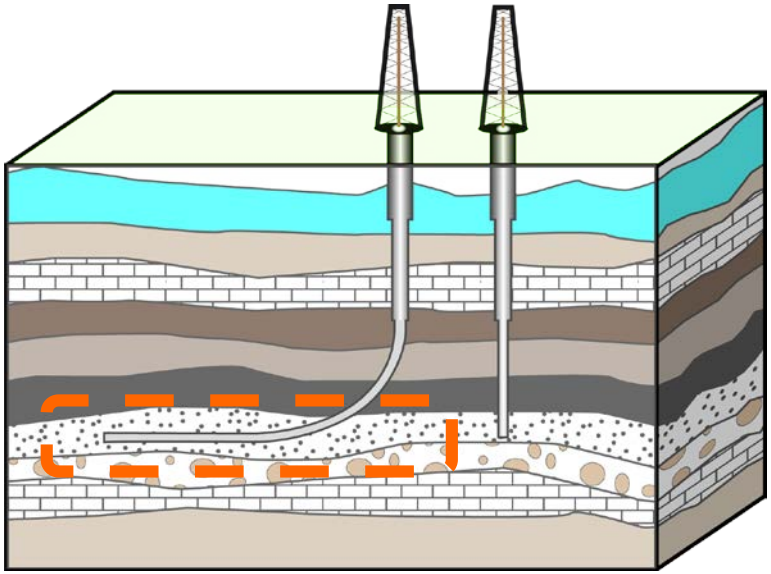
December 7 **Time: 1pm ET**	TBD	

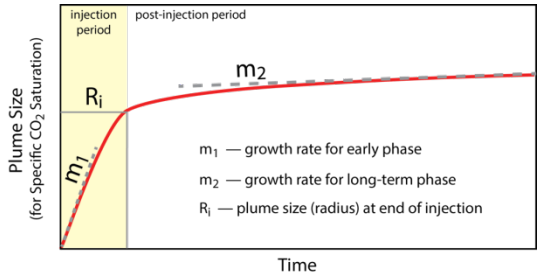
Check for updates at www.edx.netl.doe.gov/nrap

What do we mean by reservoir evaluation?

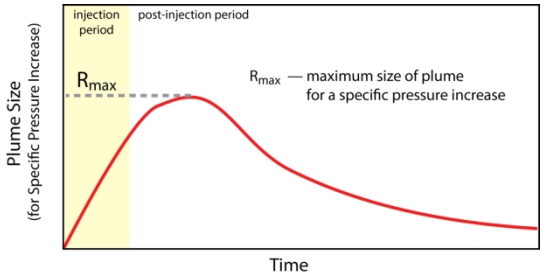
Use of Science-Based Prediction to Characterize Reservoir Behavior as a Function of Injection Characteristics, Geological Variables, and Time

- **Size of CO_2 plume injection**
  - Rate of growth for early phase
  - Rate of growth for long-term phase
  - Plume radius at end of injection
- **Size of pressure plume**
  - Maximum size of plume
  - Various pressure thresholds, relevant
    - Brine rise
    - Fault-slip criteria
- **Pressure at a location**
  - Maximum pressure increase

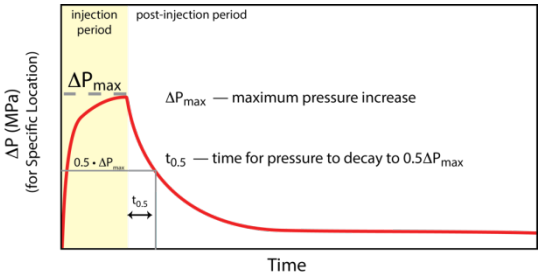




Size of CO_2 Plume



Size of Pressure Plume



Pressure at at a Location

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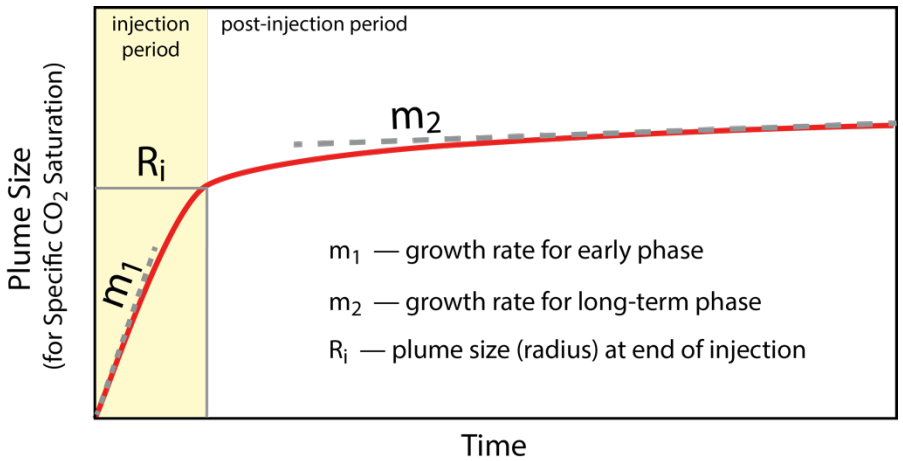
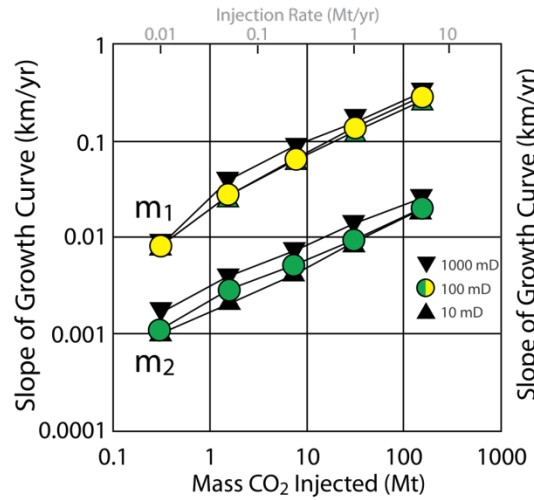
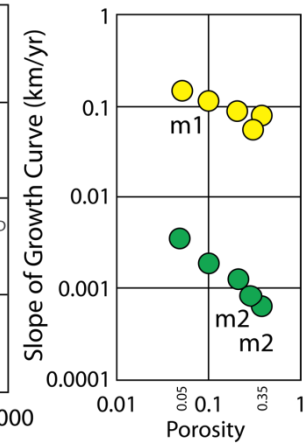
Amount of CO_2 injected is primary factor in the growth rate and size of CO_2 plume.



Unbound Sandstone, Regional Dip *(0° dip)*



Unbound Sandstone, Regional Dip *(1° dip; 1Mt/yr)*



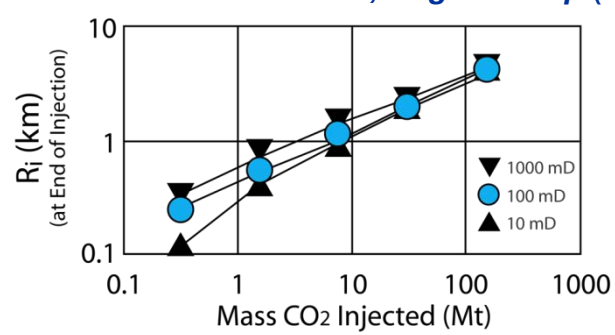
operational

- *Increase in mass of CO_2 increases the growth rate for the CO_2 plume (both early and long-term rates)*

geological

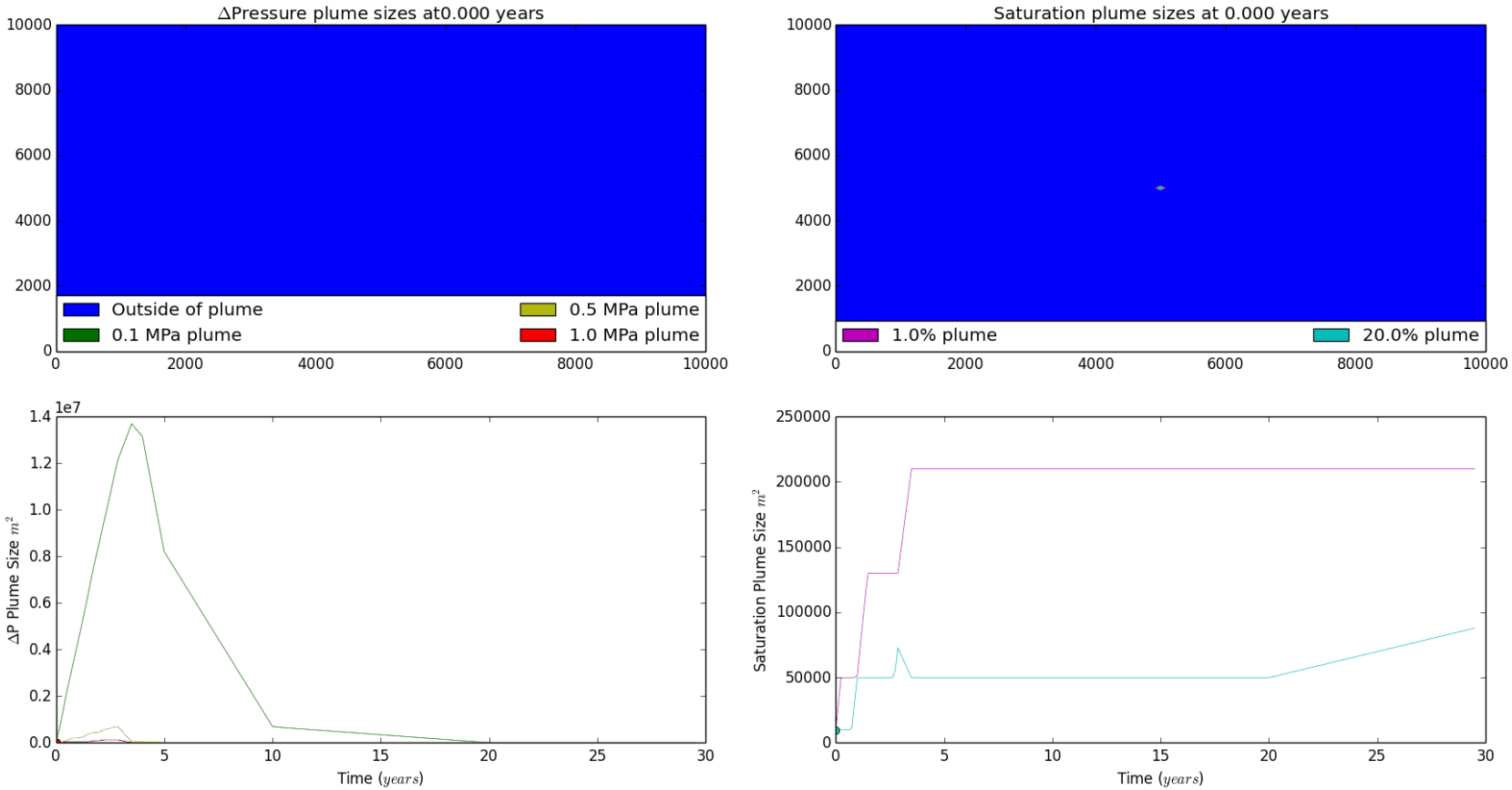
- *Increase in porosity decreases growth rate*
- *Permeability has minimal impact on growth rate and small impact on size of CO_2 plume*

Unbound Sandstone, Regional Dip *(0° dip)*



What does the REV tool do?

Take in pressure and saturation data from a reservoir simulation and returns plume sizes and pressure metrics of performance

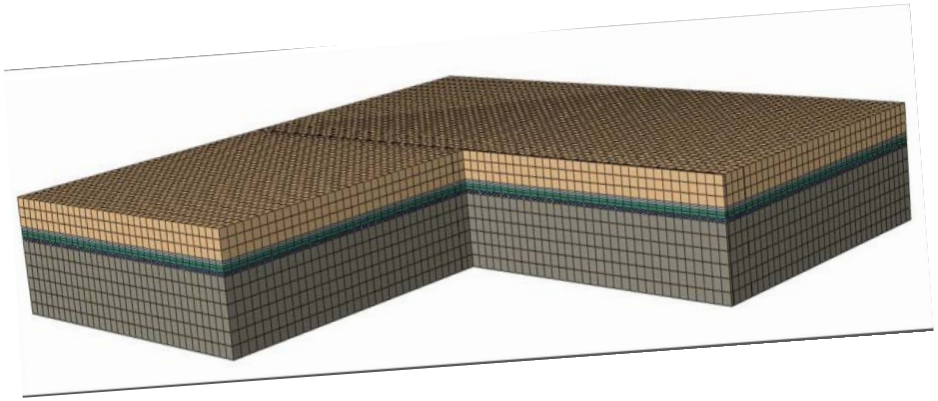


REV tool inputs

- Pressure and Saturation data from reservoir simulations
- Differential pressure and saturation values for plume size definitions
- Grid block numbers for pressure value extraction

Example Case

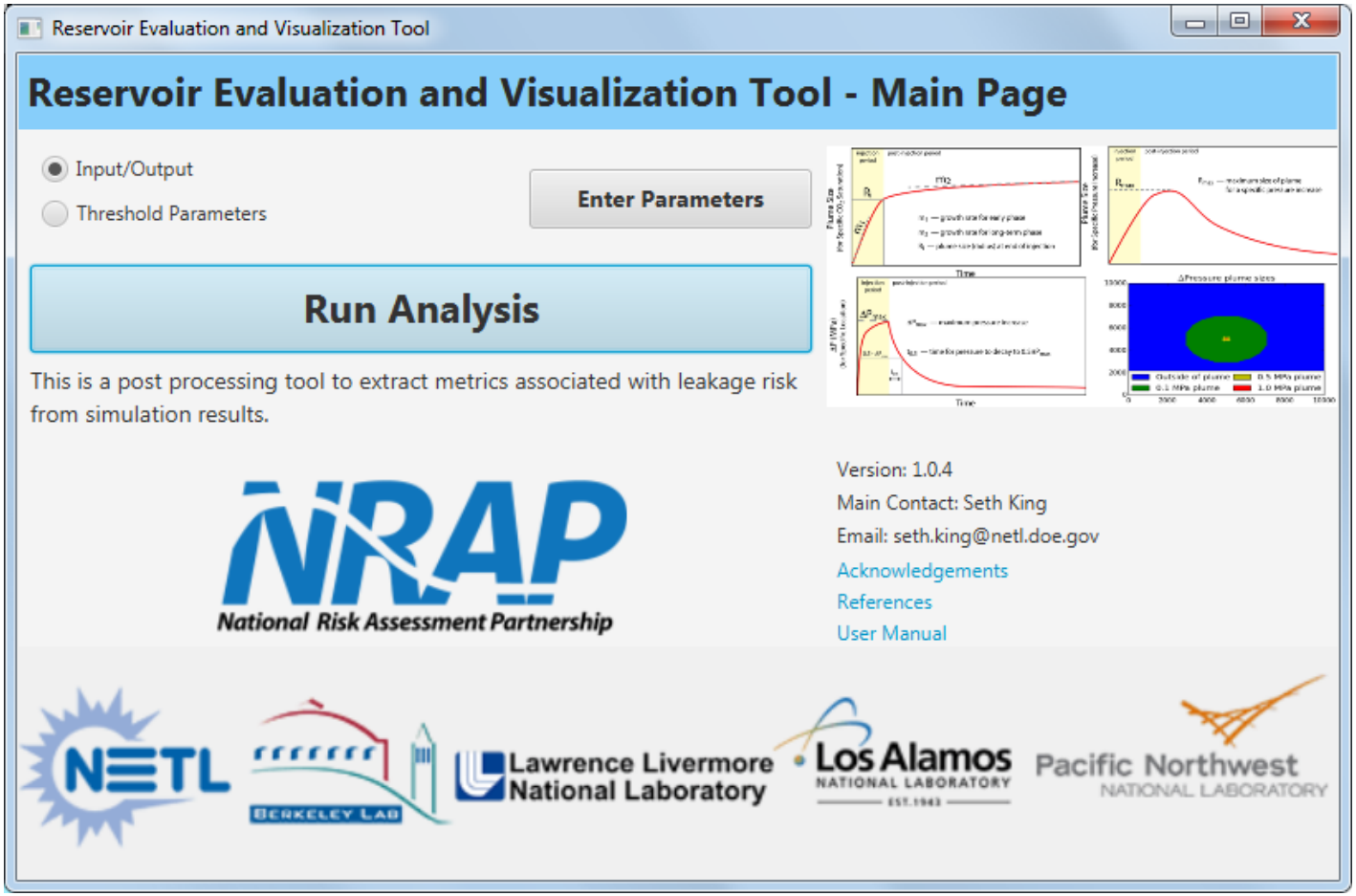
- Unbound sandstone: Regional Dip
  - LBNL Team (Zhang et al.) simulated using TP3D
  - General unstructured, dipping sandstone reservoir



Scenario number (#)	dip degree	k_hor	k_ver	Slr	Sgr	comp	rate	por
19	1	1.e-13	1.e-14	0.3	0.2	1.5e-9	1MT/yr	0.2

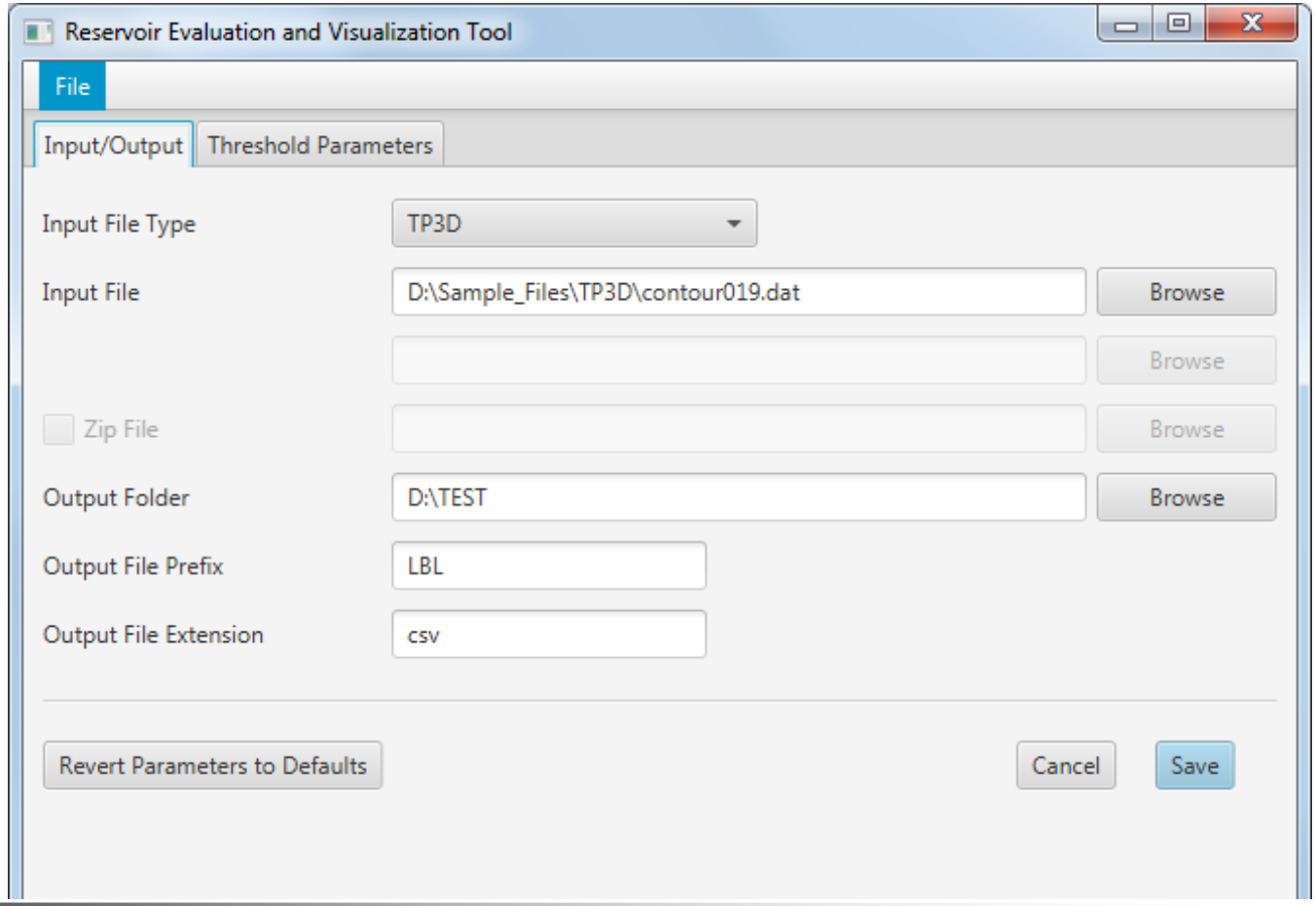
Graphical User Interface with a Simple Workflow

Select Simulation → Define Thresholds → Run REV → View Results



REV Tool – Workflow for Scenario Setup

Select Simulation Data → Define Thresholds → Run REV → View Results



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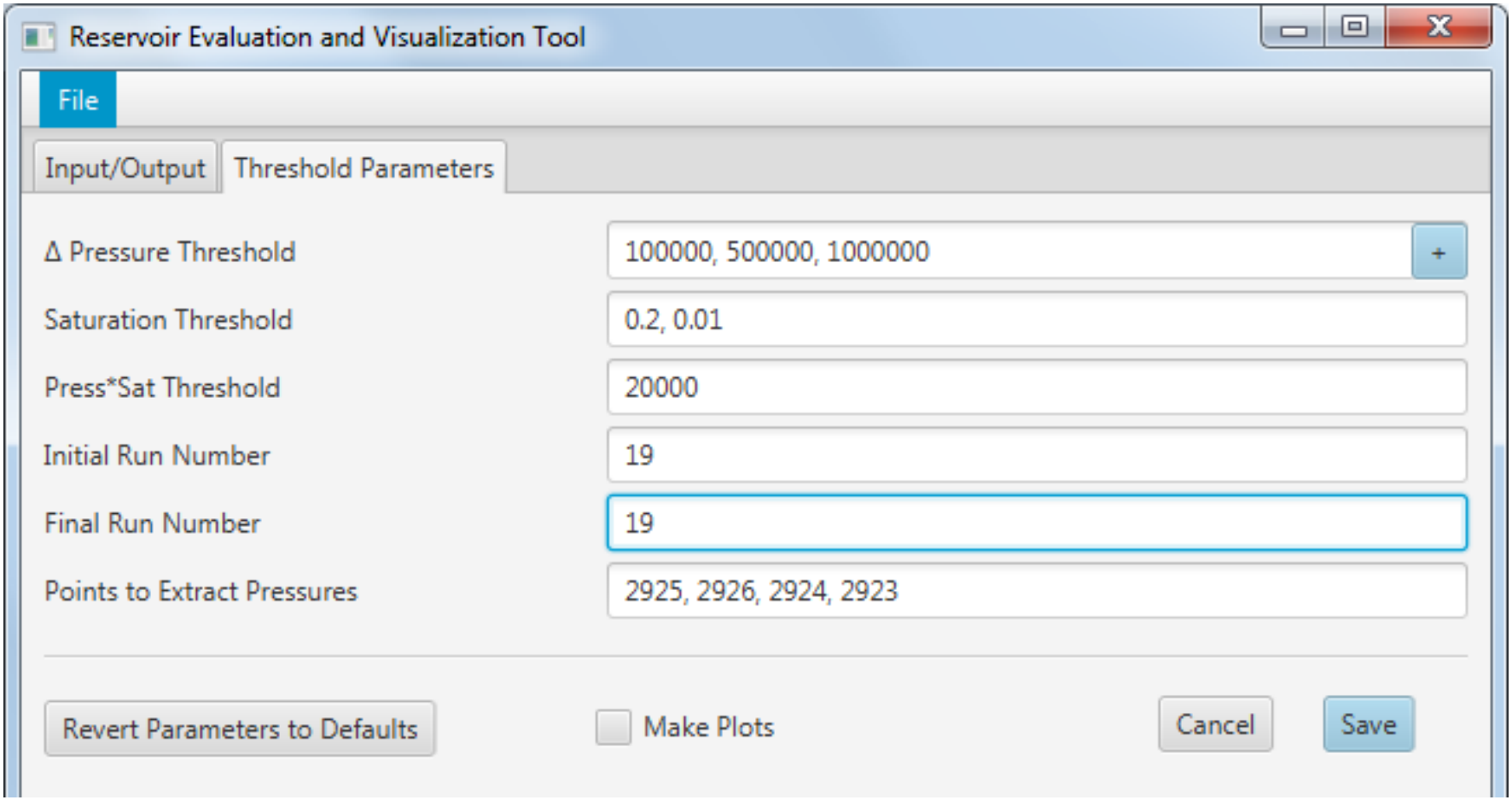
REV Tool – Workflow for Scenario Setup

Select Simulation → **Define Thresholds** → Run REV → View Results



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REV Tool – Workflow for Scenario Setup

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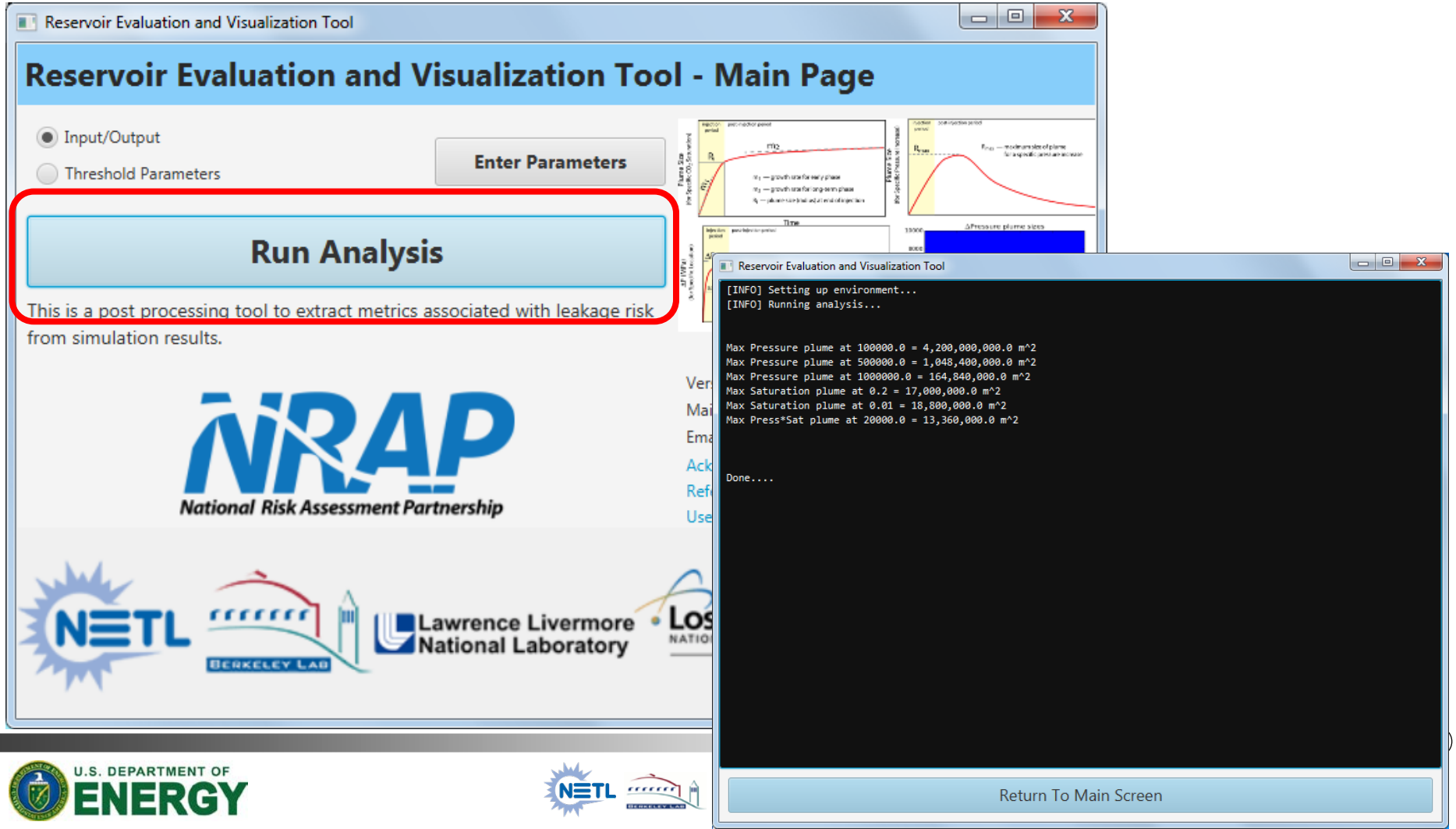
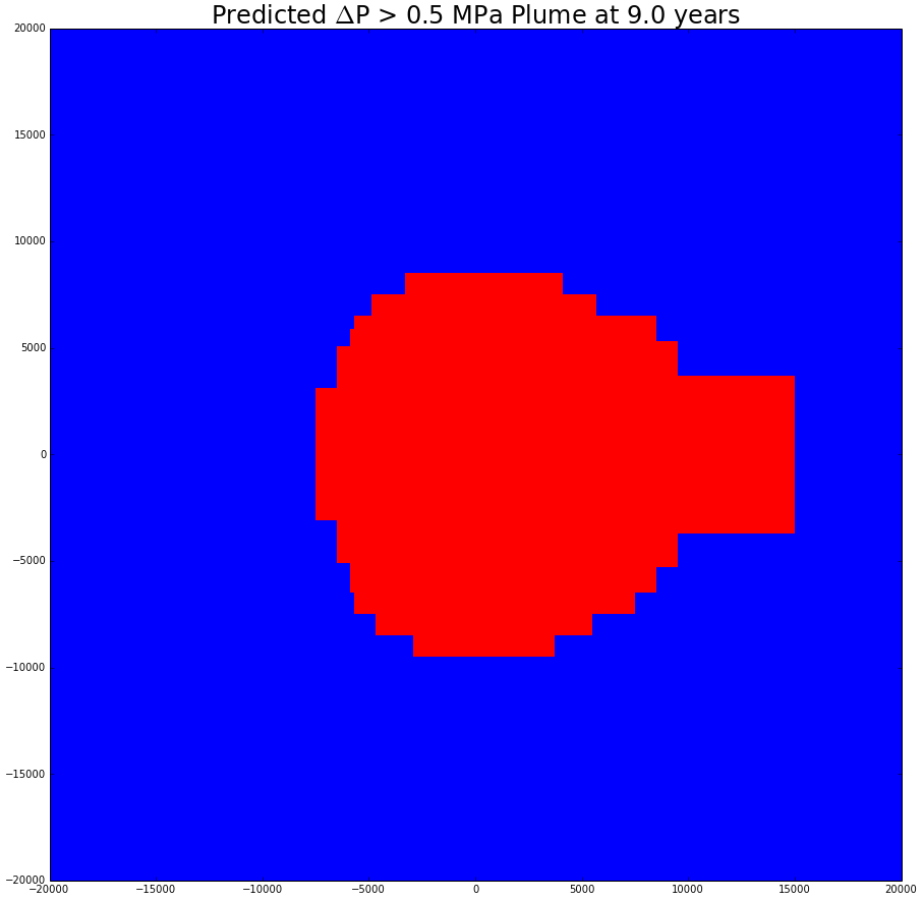


REV Tool – Workflow for Scenario Setup

Select Simulation → Define Thresholds → Run REV → **View Results**



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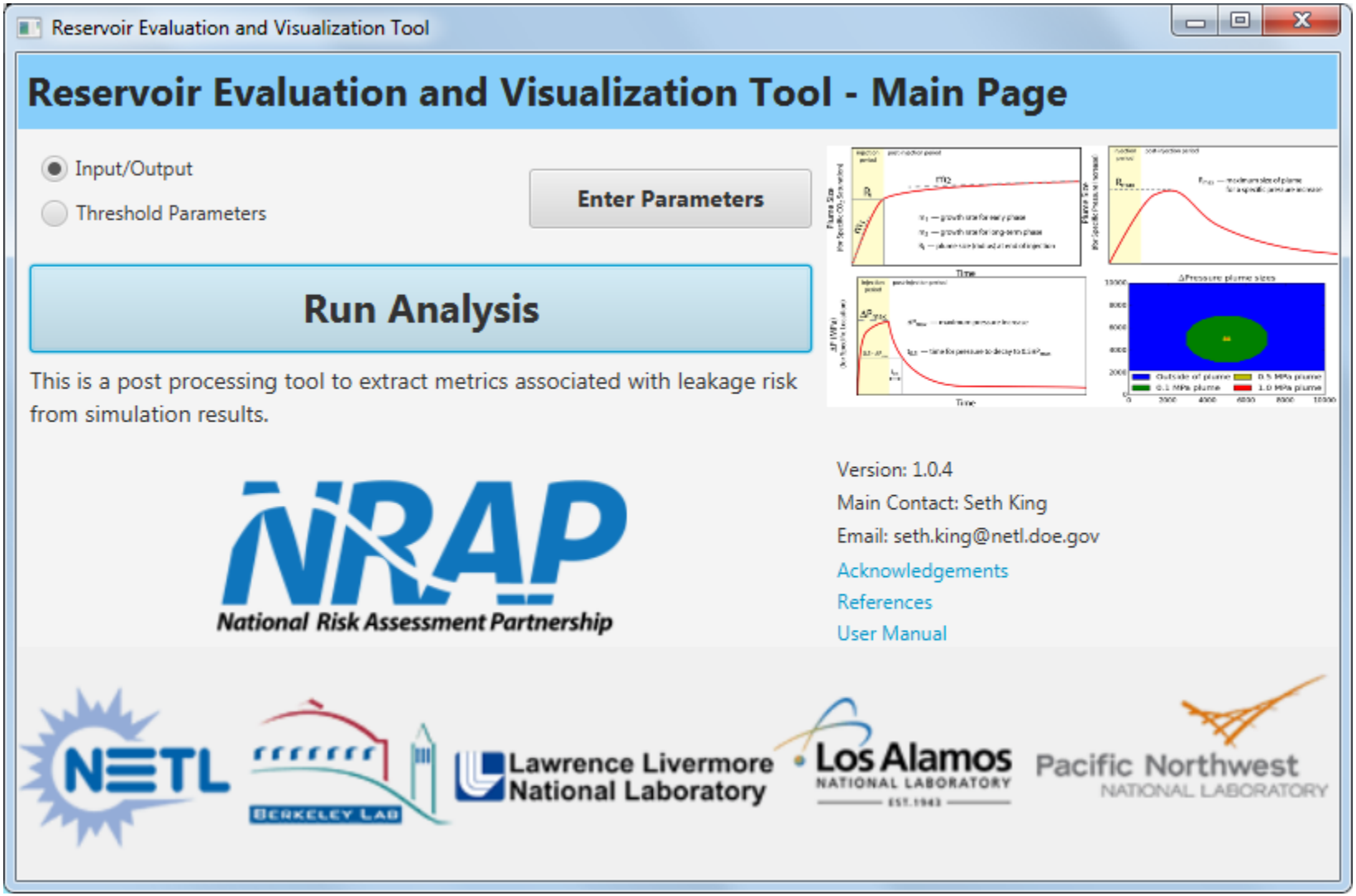
Live Demo!


Reservoir Evaluation and Visualization Tool
Reservoir Evaluation and Visualization Tool - Main Page
Input/Output
Threshold Parameters
Enter Parameters
Run Analysis
This is a post processing tool to extract metrics associated with leakage risk from simulation results.
Version: 1.0.4
Main Contact: Seth King
Email: seth.king@netl.doe.gov
Acknowledgements
References
User Manual
NRAP
National Risk Assessment Partnership
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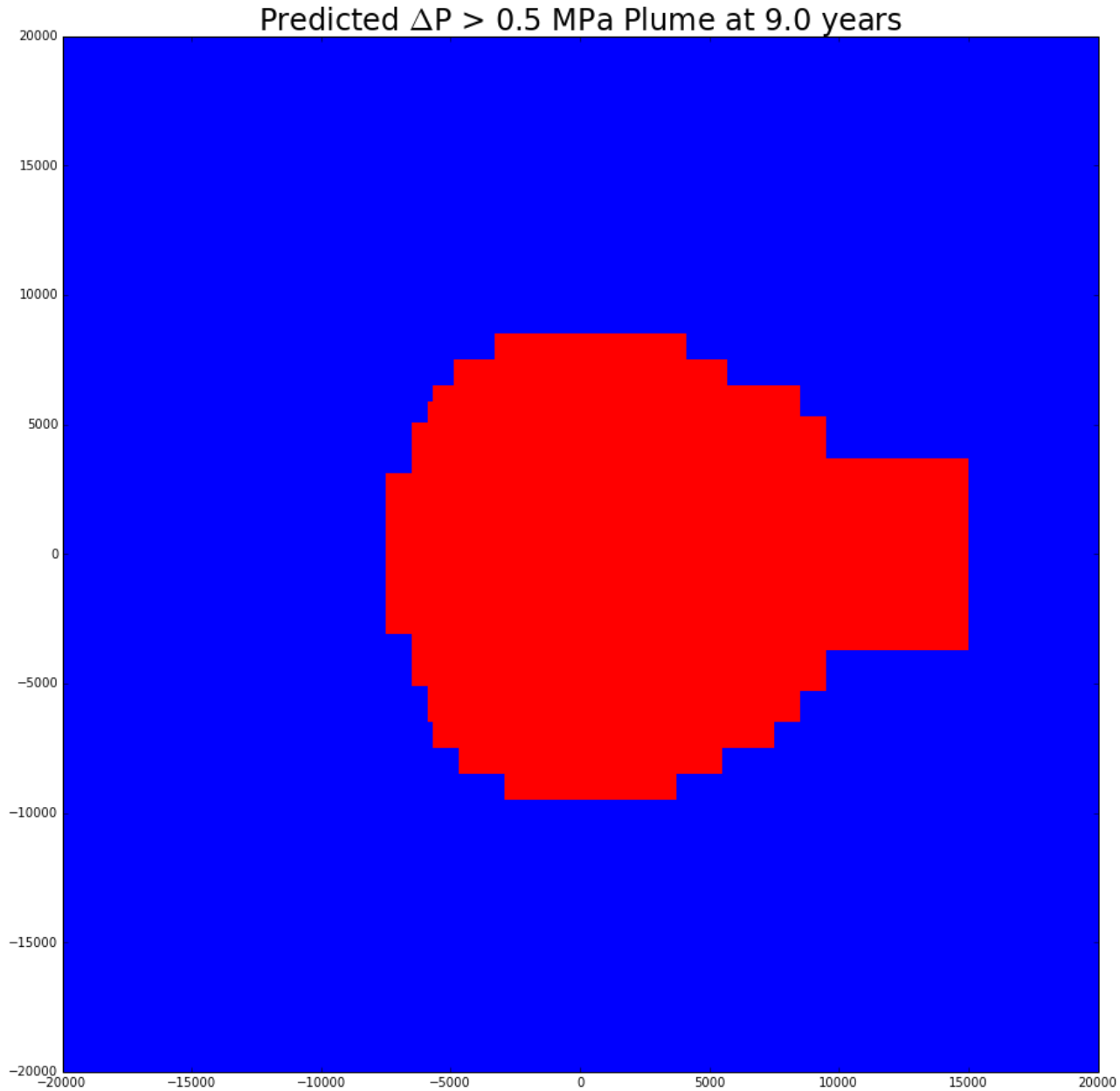

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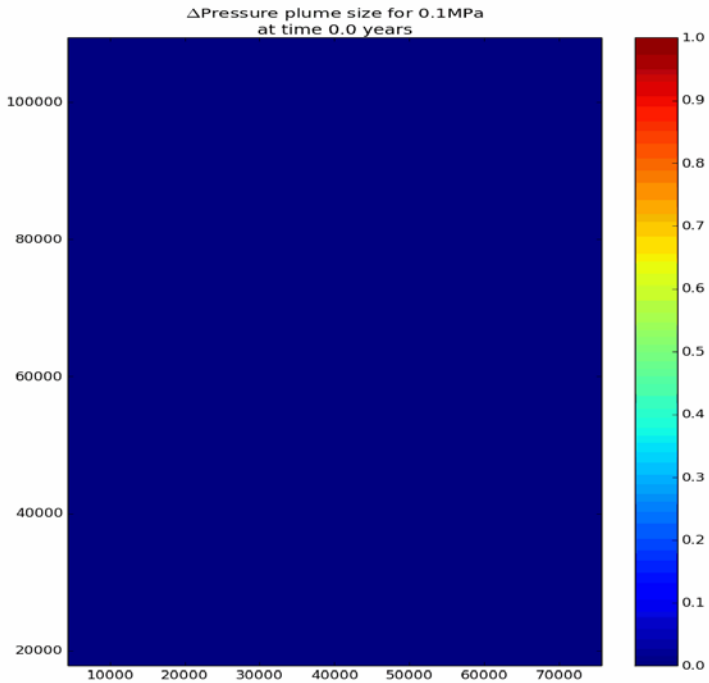
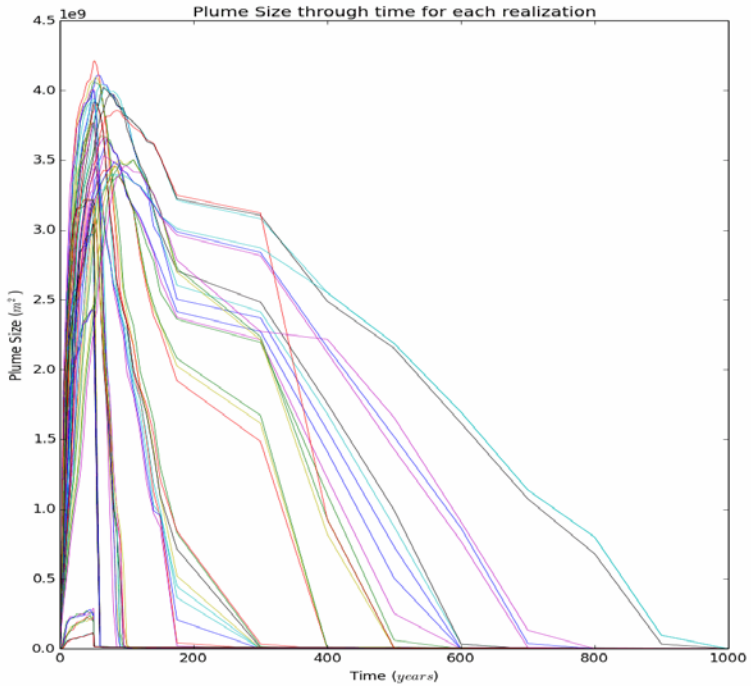
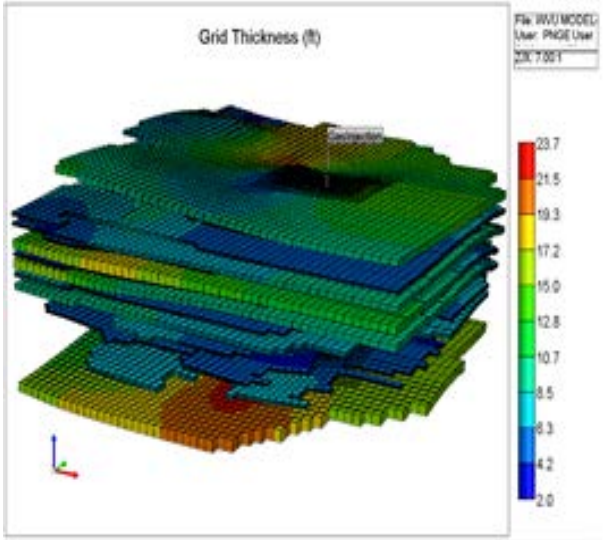
Kimberlina Data Set Analysis

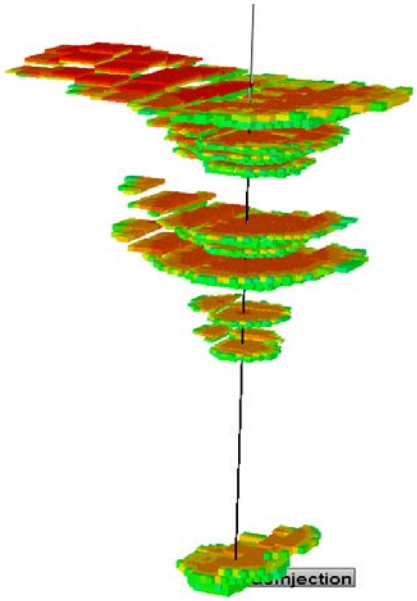




QA/QC



- **Post-processing tool**
  - No model to verify/validate
- **Each component of the program tested**
  - Visual overview and quantitative spot-checking to verify data being read in correctly
  - Synthetic test data sets with know values used to test thresholding, projection, grid size to plume size calculations, and data outputs

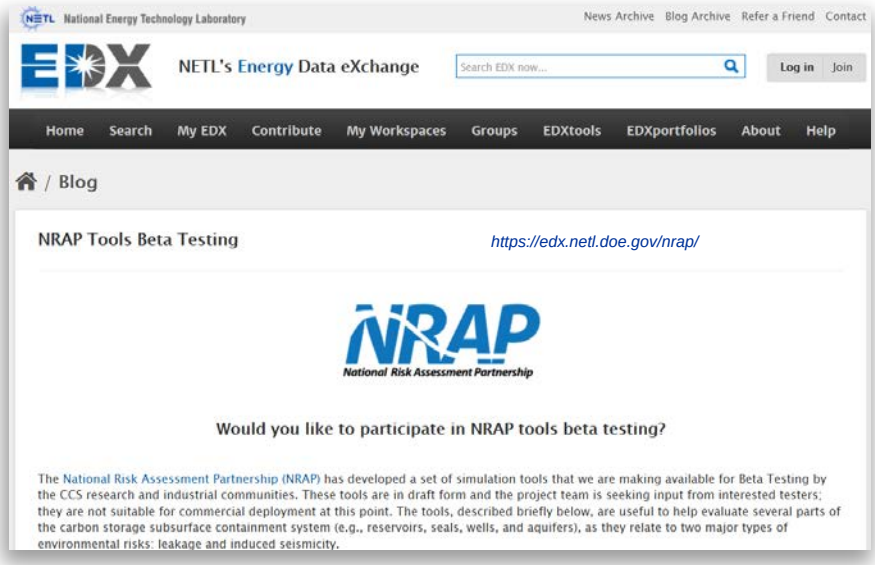


IAM Lookup table generation tool

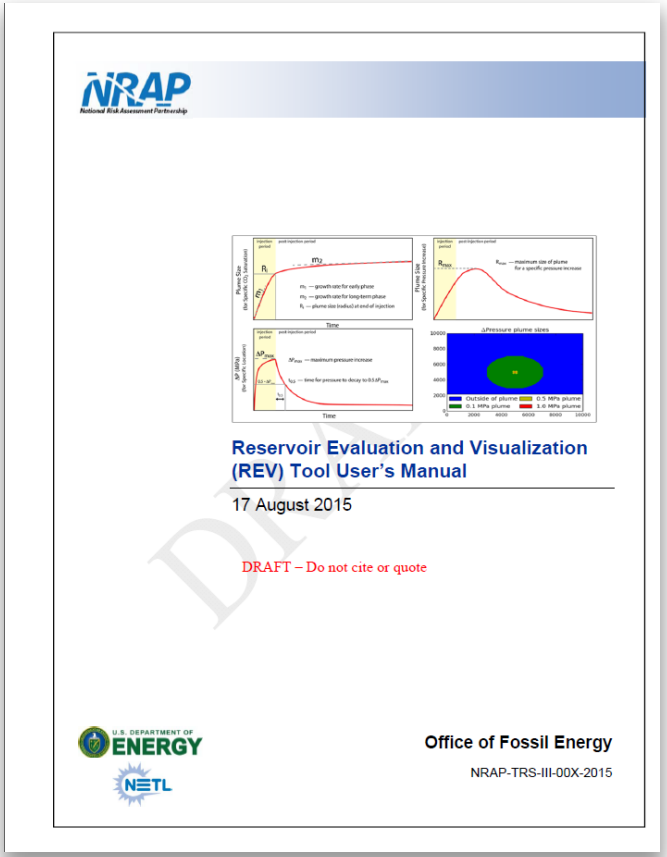
- **Tool to create IAM lookup tables for reservoir component**
- **Re-uses REV tool codebase**
  - Any set of simulations that can be read into the REV tool can be read into the lookup table generation tool
- **Translates results onto a grid compatible with the IAM**
- **Currently being documented and tested, beta version and webinar coming soon**

Beta Tool and User Manual Available on EDX

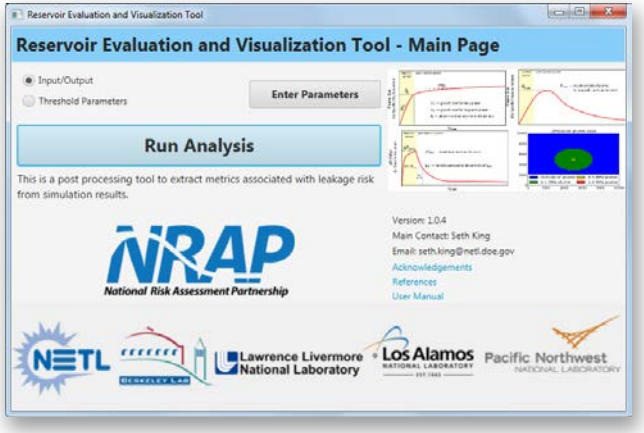
NRAP Tool Beta-Testing Portal



REV tool User's Manual



REV tool main screen



www.edx.netl.doe.gov/nrap → *TOOL BETA TESTING link*

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Check for updates at www.edx.netl.doe.gov/nrap

Questions?

Reservoir Evaluation and Visualization (REV) tool

Questions/comments not addressed during the scheduled meeting time can be addressed to NRAP@netl.doe.gov

Acknowledgements

This technical effort was performed in support of the National Energy Technology Laboratory's research under the RES contract DE-FE-0004000.

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