LA-UR-17-29925
Approved for public release; distribution is unlimited.

Title: Application of an Integrated Assessment Model to the Kevin Dome site, Montana

Author(s): Nguyen, Minh
Zhang, Ye
Carey, James William
Stauffer, Philip H.

Intended for: Project update

Issued: 2017-10-30

Application of an Integrated Assessment Model to the Kevin Dome site, Montana

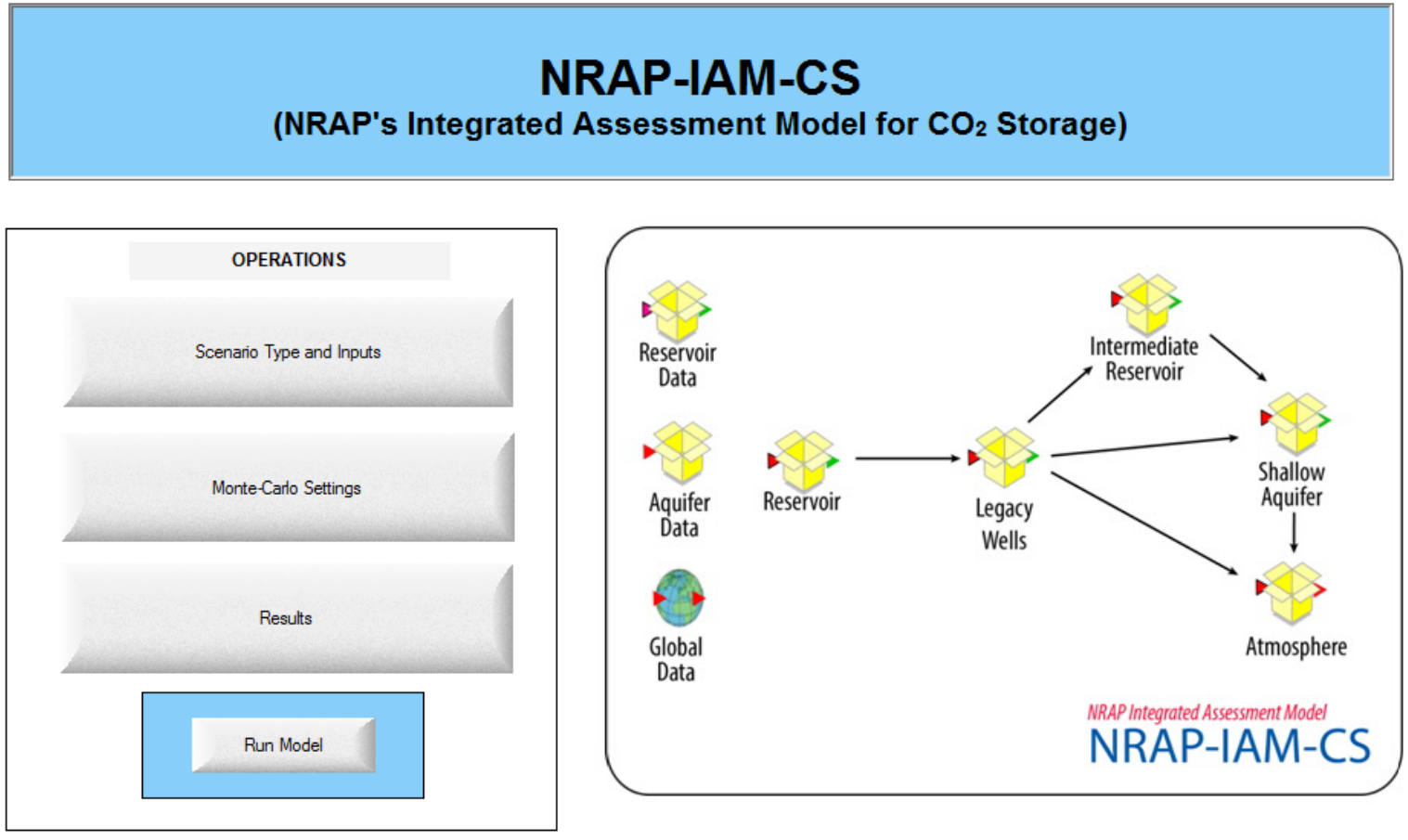
Minh Nguyen and Ye Zhang
Department of Geology & Geophysics, University of Wyoming

Bill Carey and Philip Stauffer
Earth & Environmental Sciences, Los Alamos National Laboratory

Big Sky Annual Meeting, Bozeman, MT, October 18-19, 2017

Outline

- Introduction
  - Study objectives
  - Previous work
- Input Data
- Viewer Results
- Summary & Future Work



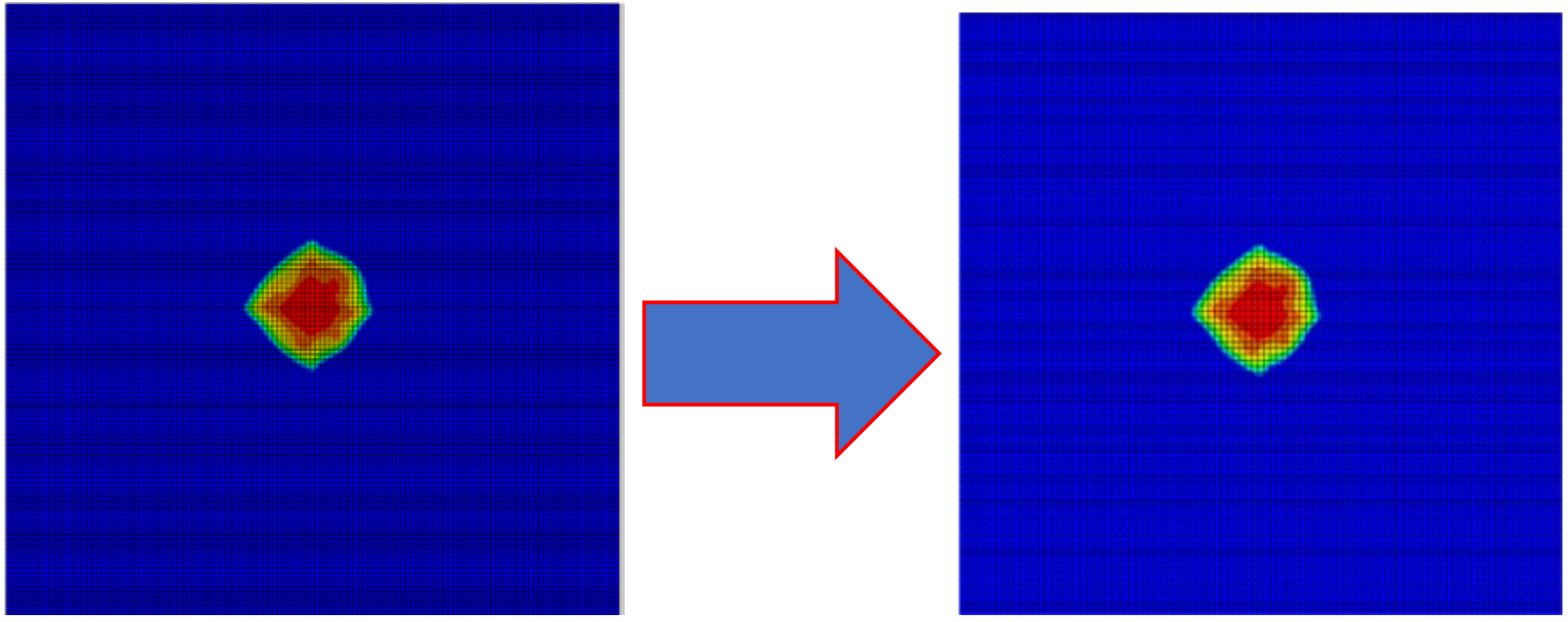
Introduction – Objectives

- Enable the Fault Swarm algorithm in the National Risk Assessment Partnership (NRAP) – Integrated Assessment Model (IAM)
- Ensure faults are working in the NRAP-IAM tool
- Calculate hypothetical fault leakage in NRAP-IAM
- Compare leakage rates to Eclipse simulations (in progress)

Introduction – Previous Work

- Recalibrated pump test data of injection well
- Developed a grid converter for Reduced Order Models (ROMs)
- Simulation to Risk Assessment (Onishi et al., 2017)

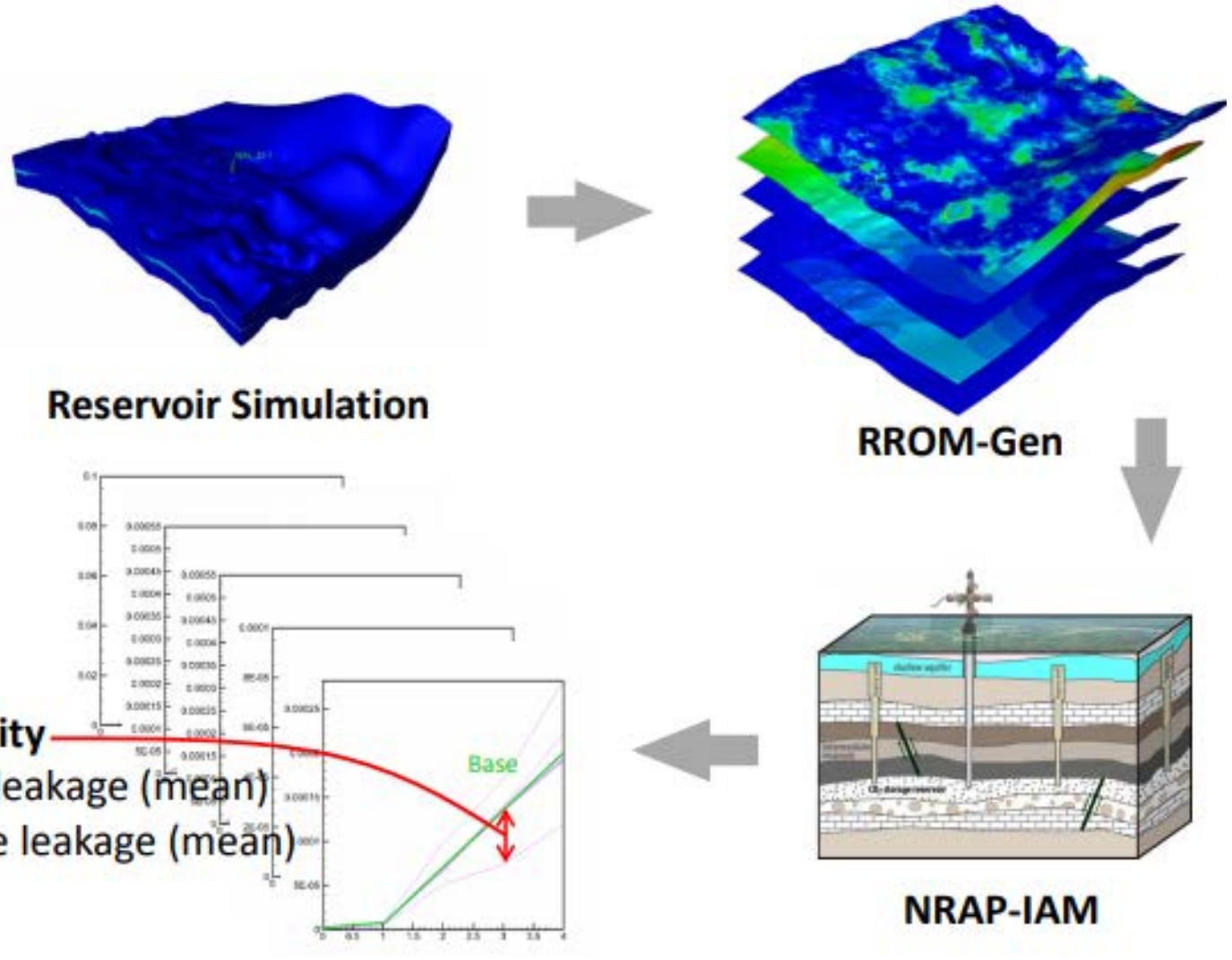
Introduction – Previous Work



Original Grid (129x129)

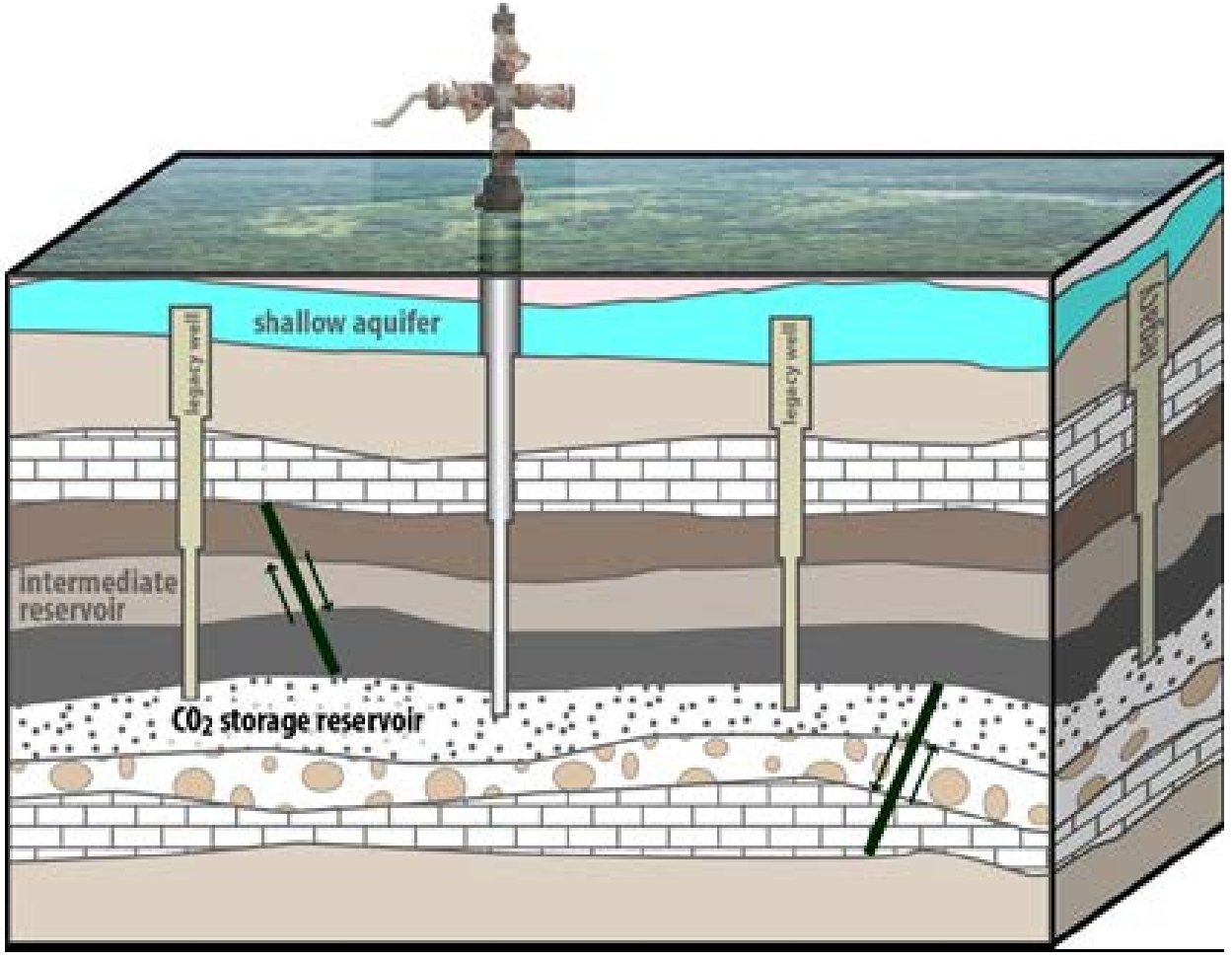
ROM (100x100)

Introduction – Previous Work



Input Data – Overview

- Land Surface
- Shallow Aquifer and Intermediate Reservoir
- Faults
- Legacy Wells
- Reservoir



Input Data – Land Surface

Land Surface Temperature (°C)

Mass fraction of CO_2 leaving from top layer

Geothermal Gradient (°C/km)

Land Surface Elevation above mean sea-level (m) 10

Wind Speed at 10m above land surface 1. m/s

Ambient Temperature 20 °C

Ambient Pressure 1 atm

Leaked Gas Temperature 20 °C

Threshold Concentration 0.002

Number of Checking Point(s)* (if CO_2 Concentration is above Critical) 7

*(Note: a file named "CheckPoints_CO2concentration.txt" is needed to define the receptors' locations)

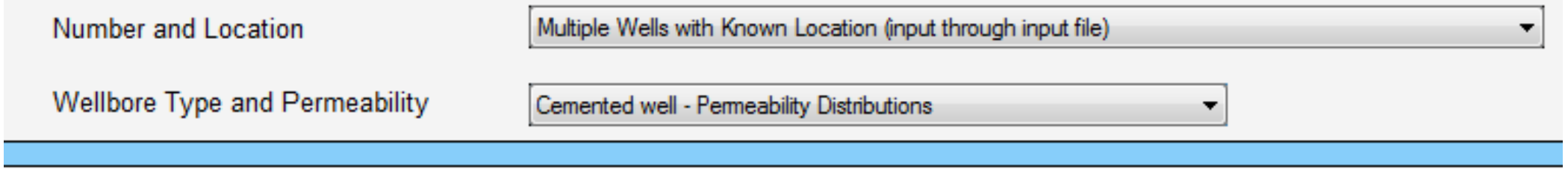
Los Alamos NATIONAL LABORATORY EST. 1943

BIG SKY CARBON SEQUESTRATION PARTNERSHIP

Input Data – Shallow Aquifer

Hydrologic	Single	Distribution				
			Mean	Std. Dev.	Min	Max
Mean Permeability (Darcy)	☑	Uniform	0.631	1	0.01585	25.12
Permeability Variance	☑	Uniform	0.9535	0.56	0.017	1.89
Permeability Correlation Length (km)	☑	Uniform	2.475	0.87	1	3.95
Permeability Anisotropy (Kx/Kz)	☑	Uniform	25.1	14.4	1.1	49.1
Aquifer Thickness (m)	☑	Uniform	300	120	100	500
Horizontal Hydraulic Gradient	☑	Uniform	0.009594	0.00558	0.000288	0.0189

Input Data – Legacy Wells



Location of single known well (X, Y)

X (m) Y (m)

Define rectangular domain for placing wells with unknown locations (for randomly placed single or multiple wells)

Xmin (m) Ymin (m)

Xmax (m) Ymax (m)

Number of Wells

Multiple Wells with Known Locations: 5

Multiple Wells Number Based on User-Defined Spatial Density (wells/km2)

Multiple Wells Number Based on User-Defined Distribution

Mean Min

Std. Deviation Max

Input Data – CO_2 Storage Reservoir

Lookup Table:

The Look-up table option*(s) can be used to specify a look-up table approach based on reservoir simulation runs performed by the user. You can use this option to specify one of the following:

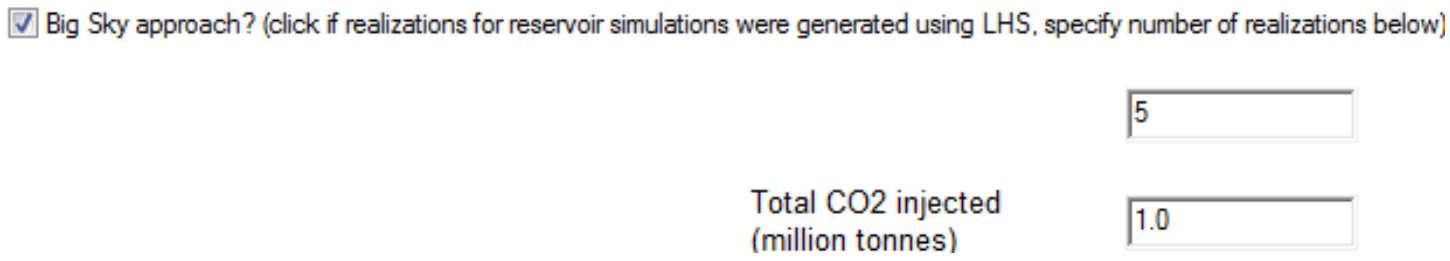
1) A single lookup table based on a single reservoir simulation run.
2) A single lookup table based on a specific reservoir simulation run from a set of runs.
3) Monte-Carlo option with multiple look-up tables based on a set of reservoir simulation runs.

The user can also specify total mass of CO_2 injected in simulation runs. This number is used only to calculate fraction of CO_2 leaked, and does not alter injection rate or volume injected in specified simulation runs or in IAM calculations.

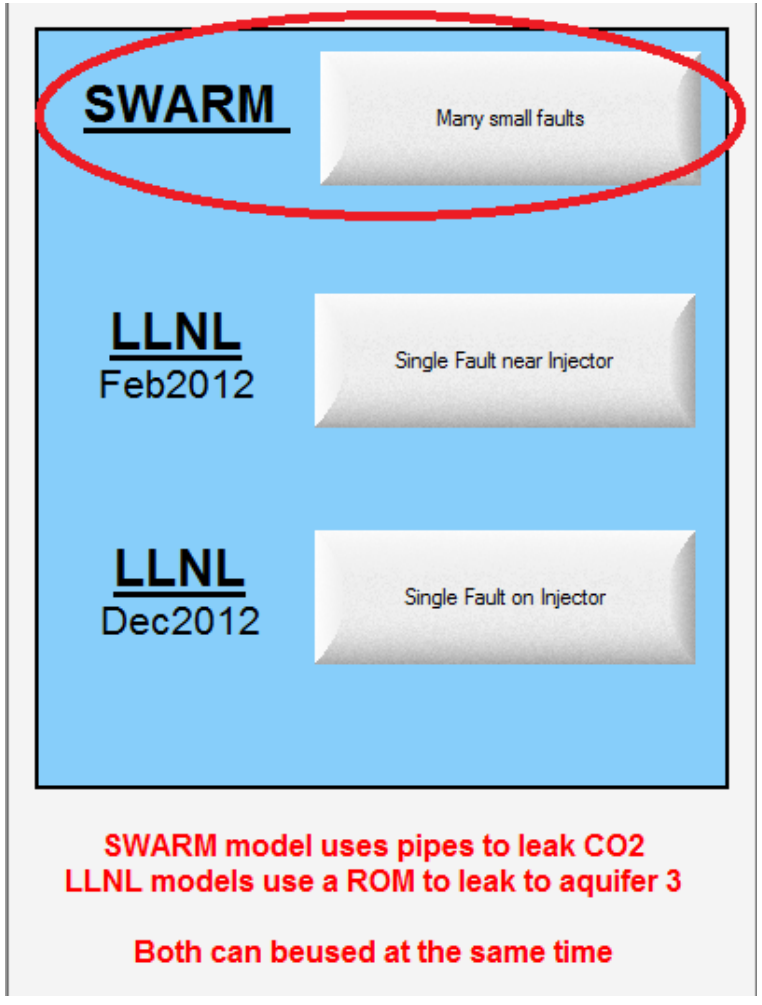
Built-in Reservoir Model:

This option uses a built-in model that assumes a simple reservoir with homogeneous properties. The user can specify various reservoir parameters as well as injection parameters.

*Note: Check the manual for how to specify lookup table based on pre-run reservoir simulation runs.



Input Data – Faults



SWARM model uses pipes to leak CO2
LLNL models use a ROM to leak to aquifer 3

Both can beused at the same time

Fault Data

Number of Fault Swarms

0 5

1

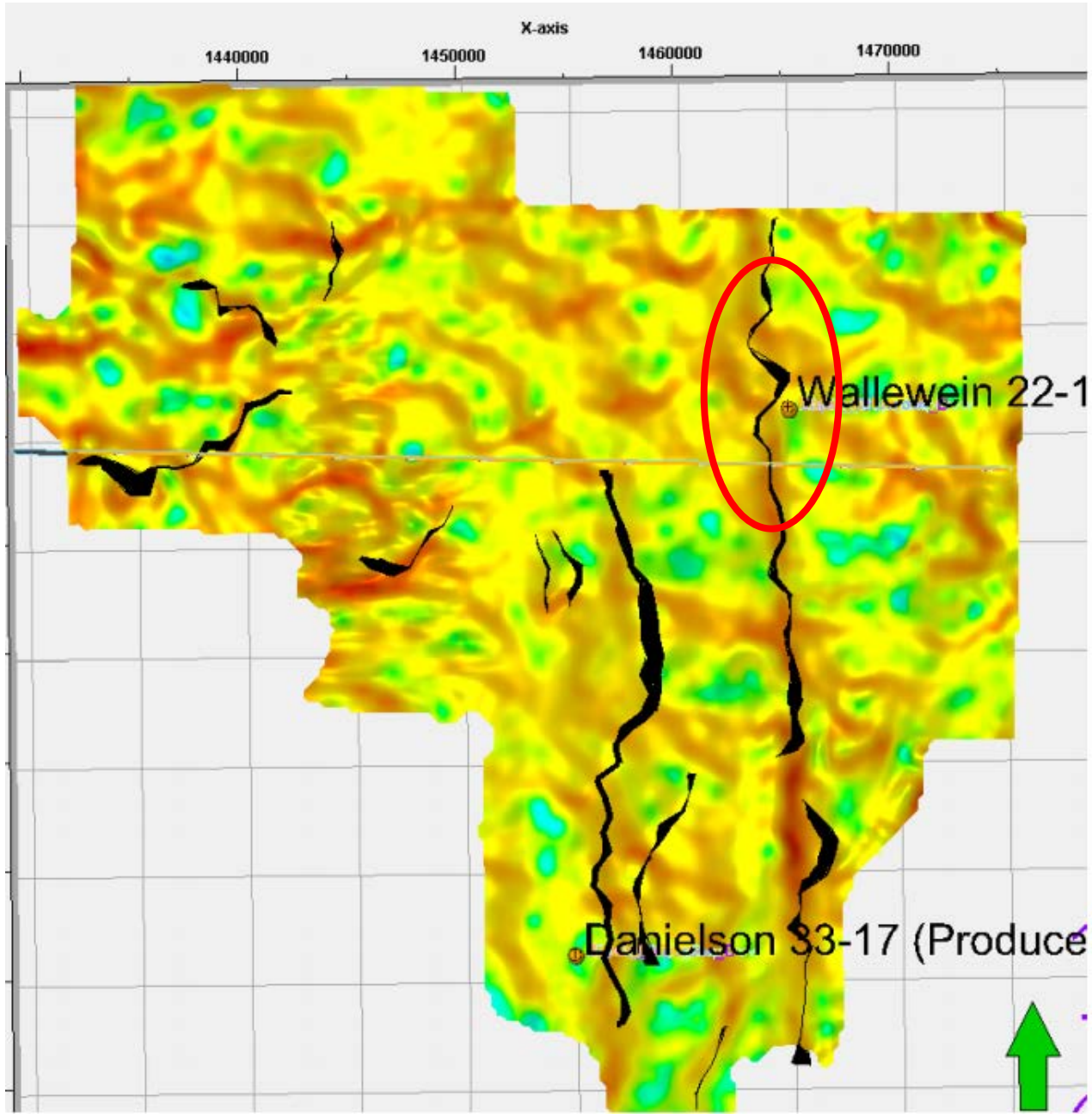
Fault swarm inputs

(Inputs needed only for the number of swarms defined above.
The input is ignored if number of fault swarms set to zero)

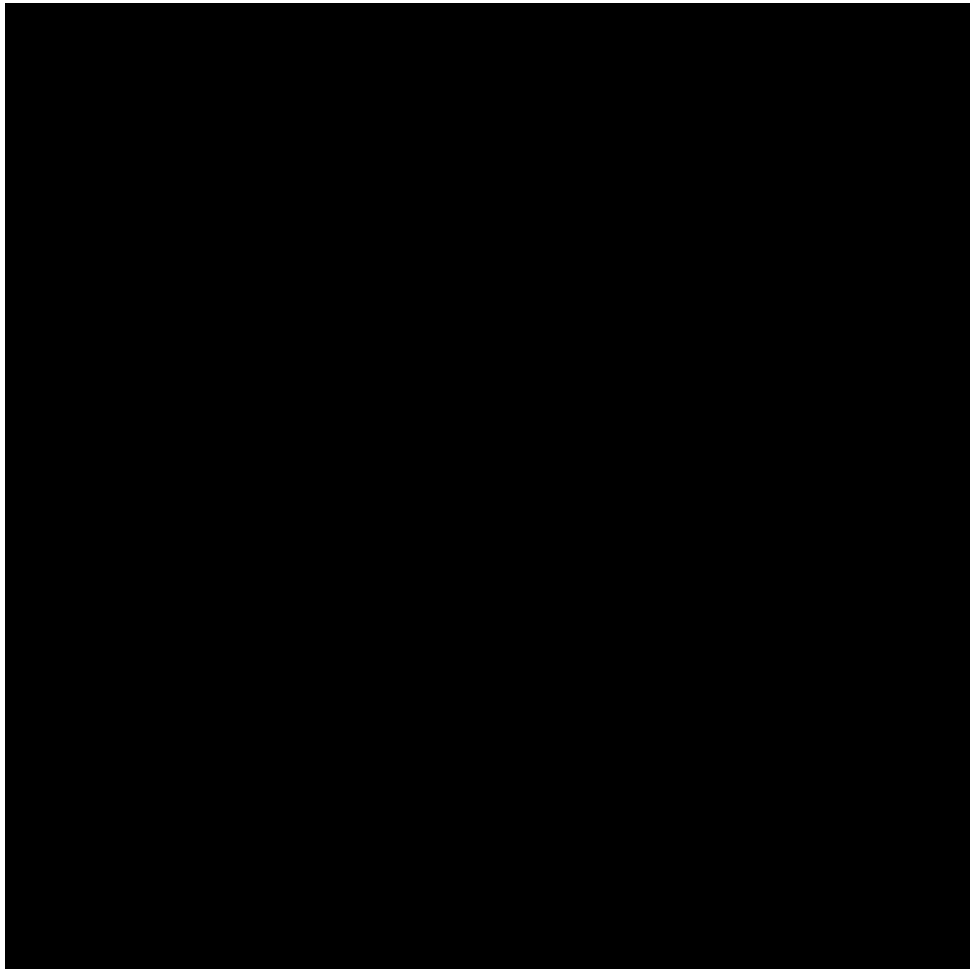
	swarm1	swarm2	swarm3	swarm4	swarm5
Swarm centroid x location (mean) [m]	5258	2000	10000	8000	8000
Swarm centroid x location (stdev) [m]	5	1	100	600	10
Swarm centroid y location (mean) [m]	5258	10000	2000	9000	3000
Swarm centroid y location (stdev) [m]	5	1	100	600	10
Swarm major axis (mean) [km]	2	10	10	15	5
Swarm major axis (stdev) [km]	0	0.1	0.1	1	0.01
Swarm minor axis (mean) [km]	0.5	2	3	1	1
Swarm minor axis (stdev) [km]	0	0.1	0.1	0.5	0.01
Swarm strike (mean) [deg]	90	135	45	180	250
Swarm strike (stdev) [deg]	0	4	10	10	5
Fault density (mean) [1/km]	0.5	2	2	4	3
Fault density (stdev) [1/km]	0	1	1	0.1	0.1
Fault length (mean) [m]	500	3000	2000	400	1000
Fault length (stdev) [m]	3	50	100	40	500
Pipe spacing (mean) [m]	10	500	500	100	200
Pipe spacing (stdev) [m]	1	10	10	10	10
Pipe axis length (mean) [m]	0.2	0.3	0.6	0.4	0.2
Pipe axis length (stdev) [m]	0	0.1	0.3	0.02	0.2
Fault displacement [m]	5000	1333	1300	250	1000

Input Data – Faults

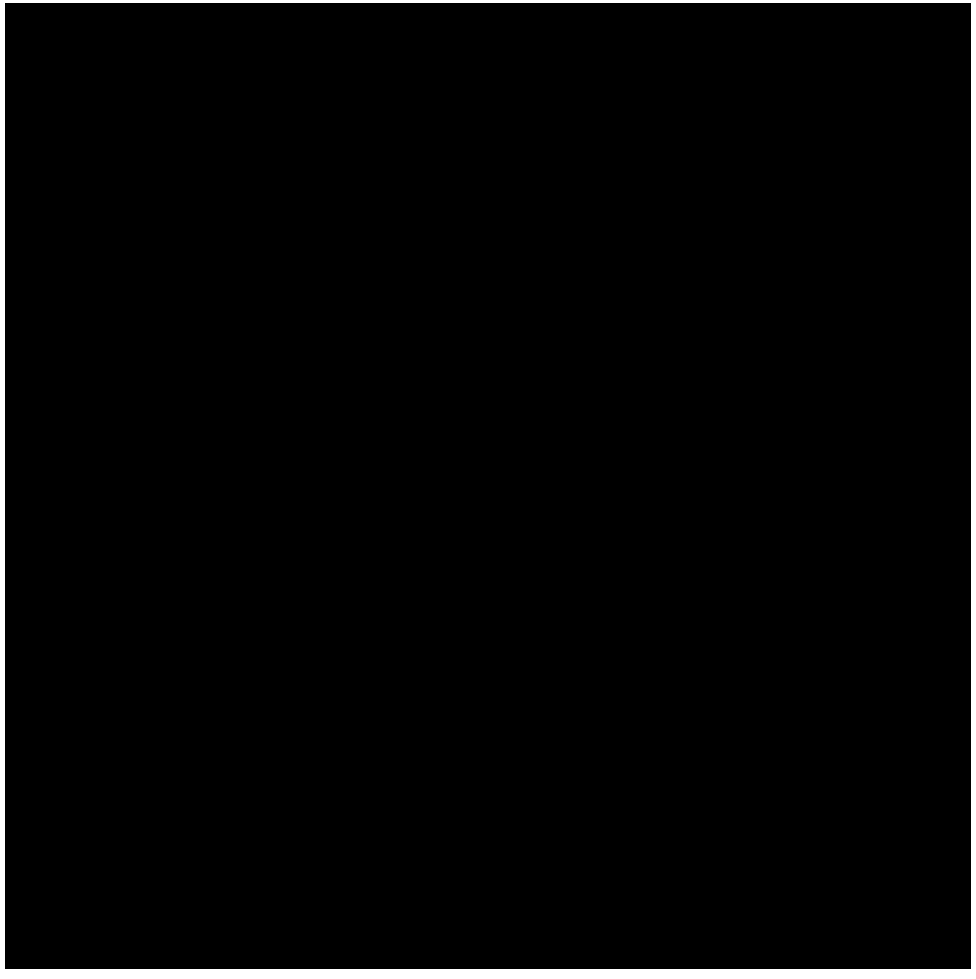
(Wade Zaluski, 2017)



Viewer Results – CO2 Saturation

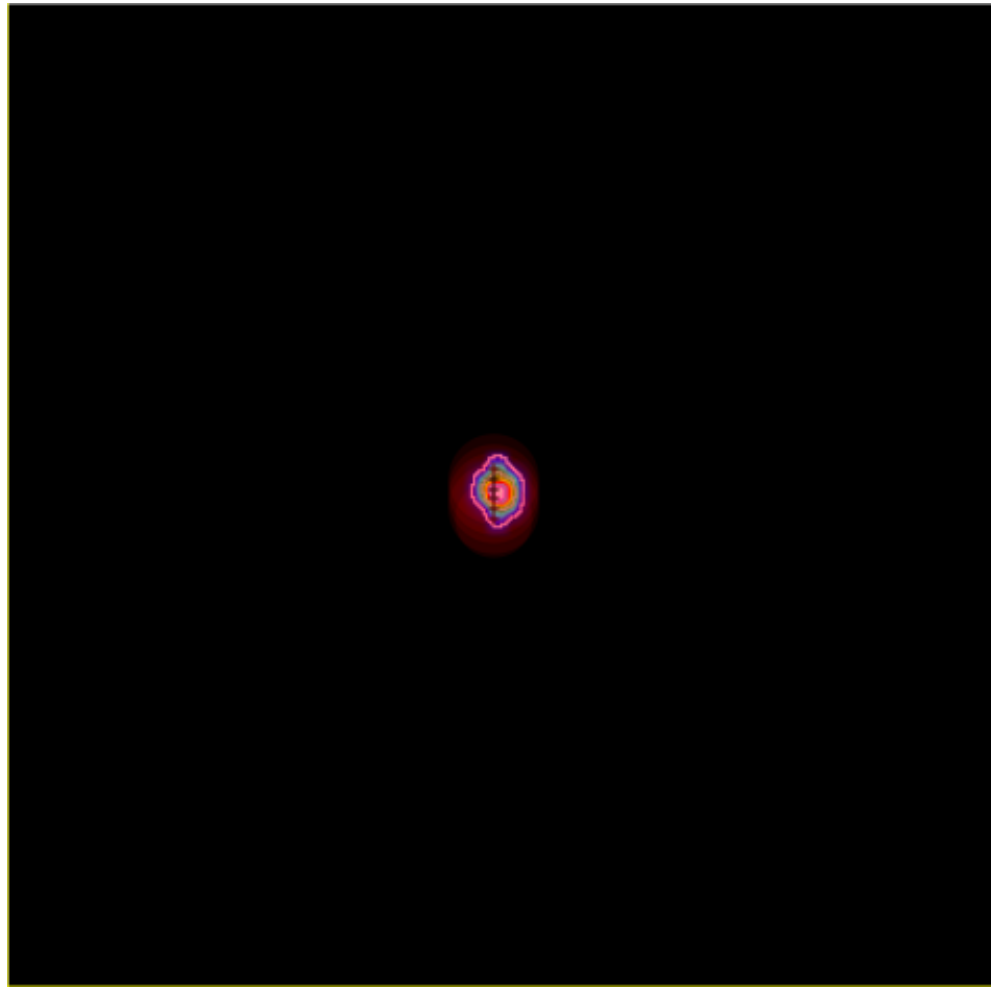


Small CO2 Plume

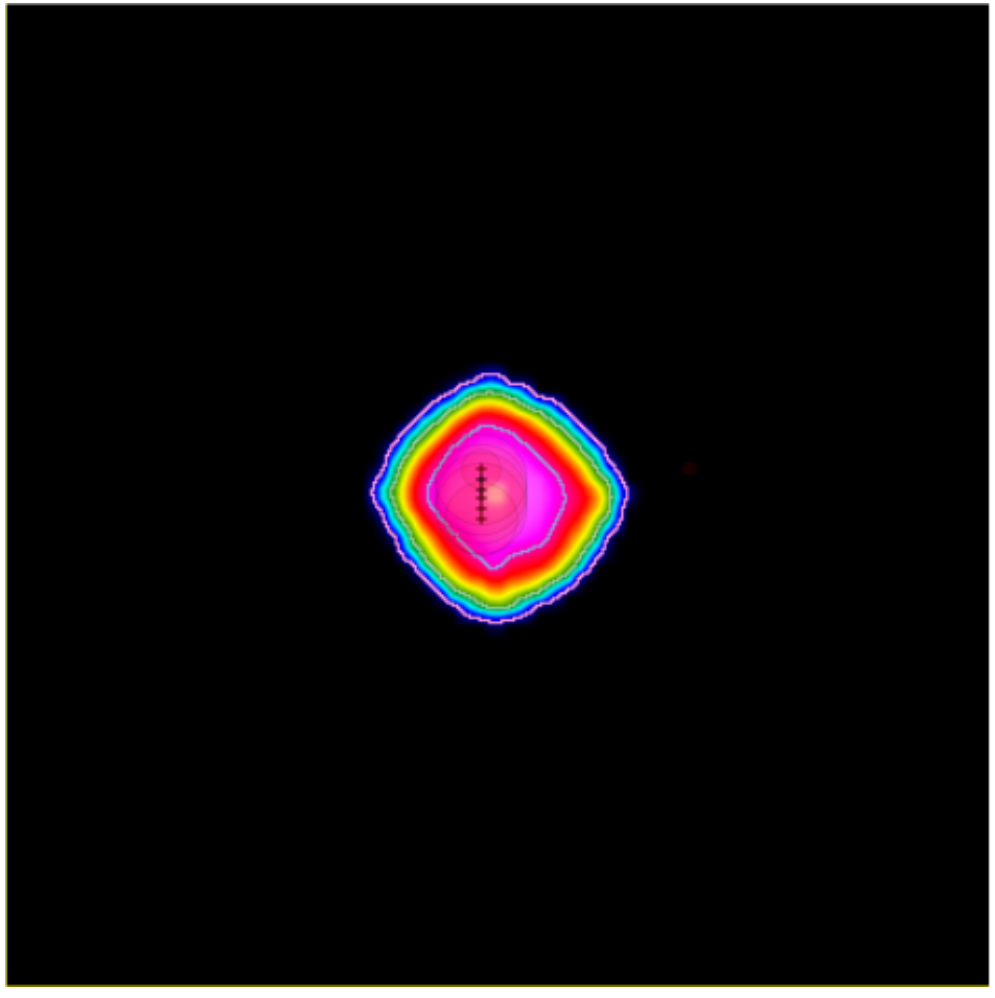


Large CO2 Plume

Viewer Results – Fault Leakage



Small CO2 Plume with fault nodes



Large CO2 Plume with fault nodes

Summary & Future Work

- Demonstrated a workflow of the NRAP-IAM tool
- Confirmed that faults were turned on and allowed leakage calculation in conjunction with the IAM viewer
- Next steps include incorporating the ROM leakage calculation for faults in the NRAP model

Reference

- Wade Zaluski (2017) MSU Slide Geomodel 3 Review Call May 2, 2017, Schlumberger.
- Onishi, T., Stauffer, P. H., Nguyen, M.C., & Carey, J. W. (2017). Big Sky Project Preliminary Results June 28, 2017 (No. LA-UR-17-25222). Los Alamos National Lab.(LANL), Los Alamos, NM