Model Explorer: A Visualization and Analytics Interface for Geological Carbon Storage Modeling and Class VI Permitting

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Science-informed Machine Learning to Accelerate Real Time (SMART) Decisions in Subsurface Applications

Summary

- Allows for quick visualization of the model inputs, simulation output, machine learning (ML) inferences, and other type of data integration, where multiple sets of technical information (e.g., site characterization data and modeling input) can be visualized and evaluated in an integrated fashion.
- Calculates and maps Area of review (AoR) in real-time in response to model inputs.
- Able to display the evolution and maximum predicted extent of the supercritical CO_2 plume, pressure front, and the combined AoR.

Motivation

- **Advancing GCS technologies**: Necessitates better tools for evaluating CO_2 injection operations.
- **Inefficiencies of traditional Methods:** Current class VI permitting involves extensive documentations and static images, leading to prolonged review times.
- **Communication delays:** Iterative exchanges between operators and reviewers are common and time-consuming.
- **Need for improvement:** A dynamic, interactive tool is required to streamline the permitting process and enhance accuracy.
- **Need for open-source tools:** Addressing the gap for tools that evaluate CO_2 injection models and map the Area of Review for class VI permitting.

Features

- **Dynamic and interactive platform:** Provides a platform for real-time interaction with data, allowing users to dynamically explore and manipulate datasets.
- **Real-time:** Computes and maps the Area of Review (AoR) and associated CO_2 plume and pressure front in real-time.
- **3D visualization:** Utilizes advanced 3D graphics for detailed and engaging visual representation of subsurface and surface data.
- **Comprehensive analysis:** Enables in-depth analysis of geologic properties and model outputs, enhancing the evaluation of CO_2 injection operations.

Impact

- **Streamlined permitting:** Reduces iterative review cycles, speeding up the permitting process and improving efficiency.
- **Improved accuracy:** Enhances site characterization with ML models to provide clearer and more accurate assessments.
- **Better communication:** Facilitates effective communication with stakeholder through dynamic and clear data visualization

Future Development

- **Enhanced capabilities:** Integration if additional data sources and advanced interactive geologic modeling features.
- **Expanded ML and cloud resources:** Plans to improve machine learning functionalities and incorporate cloud computing to handle large datasets and enhance tool performance.

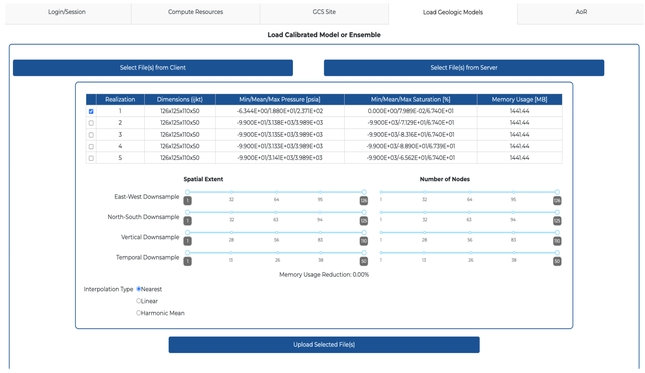

Figure 1. Geologic model controls within Model Explorer. These controls allow a user to load and downscale a set of geologic models and then update the figure settings within the tool.

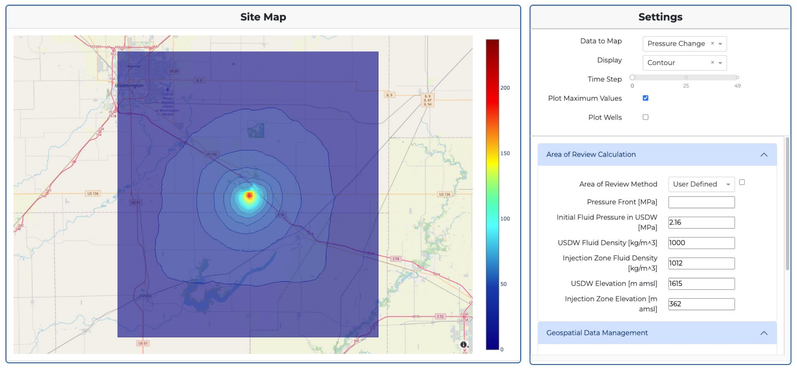

Figure 2. Sample Model Explorer plot output showing interactive visualization options, 3D geologic model.

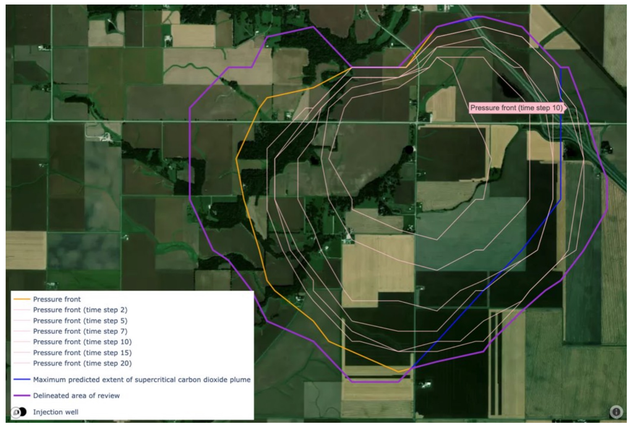

Figure 3. Pressure front with different time steps

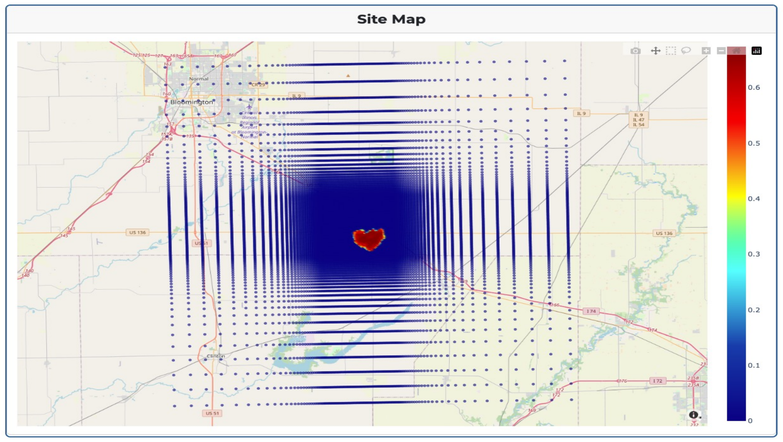

Figure 4. Interactive area of review tab that displays CO_2 Saturation data projected to the surface in map view.

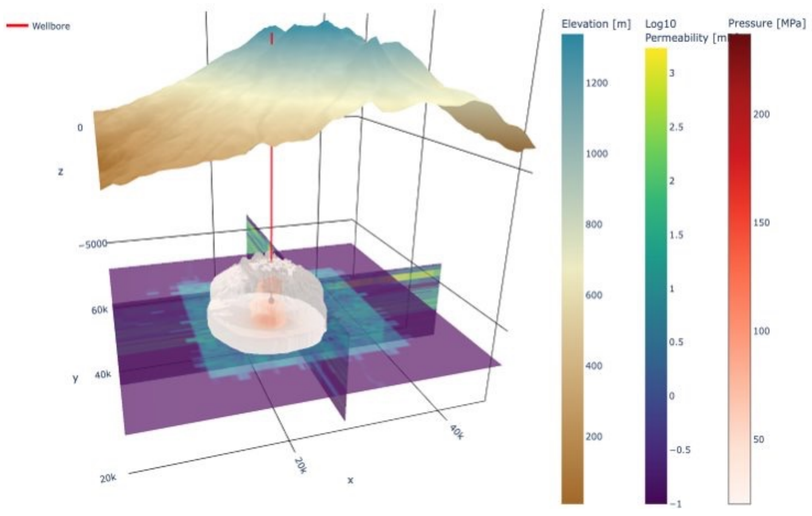

Figure 5. Sample Model Explorer plot output showing interactive visualization options, 3D geologic model.

Acknowledgement

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