disco2ver

Data Infrastructure to Accelerate CCS

Innovating Next-Generation AI & Data Solutions for Offshore CCS

Speaker: Kelly Rose,

Technical Director, NETL's AI/ML Institute, SAMI

4/6/2023

SAMI SCIENCE-BASED AI/ML INSTITUTE

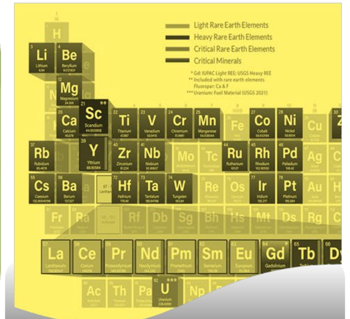
EDX Energy Data eXchange

U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

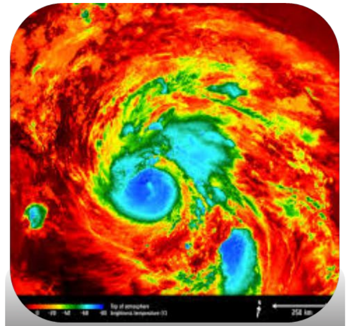
Accelerating AI at NETL through SAMI

NETL's Science-based AI/ML Institute

CARBON MANAGEMENT



RESOURCES AND MATERIALS



INFRASTRUCTURE & ENVIRONMENTAL RESILENCY

FOUNDATIONAL DATA AND A.I. SOLUTIONS

Enabling AI-driven technology solutions to address the nation's applied energy challenges

SAMI SCIENCE-BASED AI/ML INSTITUTE

ACCELERATE AI INNOVATION

Enable NETL to push the frontiers of AI technology and create the next generation architectures, tools and approaches

CATALYZE PARTNERSHIPS & COLLABORATIONS

Strengthen collaborations in research focus areas, within NETL and with external stakeholders to hasten the development of innovative applied-energy AI solutions.

MAKE DATA ACCESSIBLE

Support the entire lifecycle of data with secure, private, collaborative workspaces for research projects.

INFORM GOVERNANCE & STANDARDS

Supporting trustworthy, ethical, and explainable AI for applied science R&D

ADVANCE AI WORKFORCE

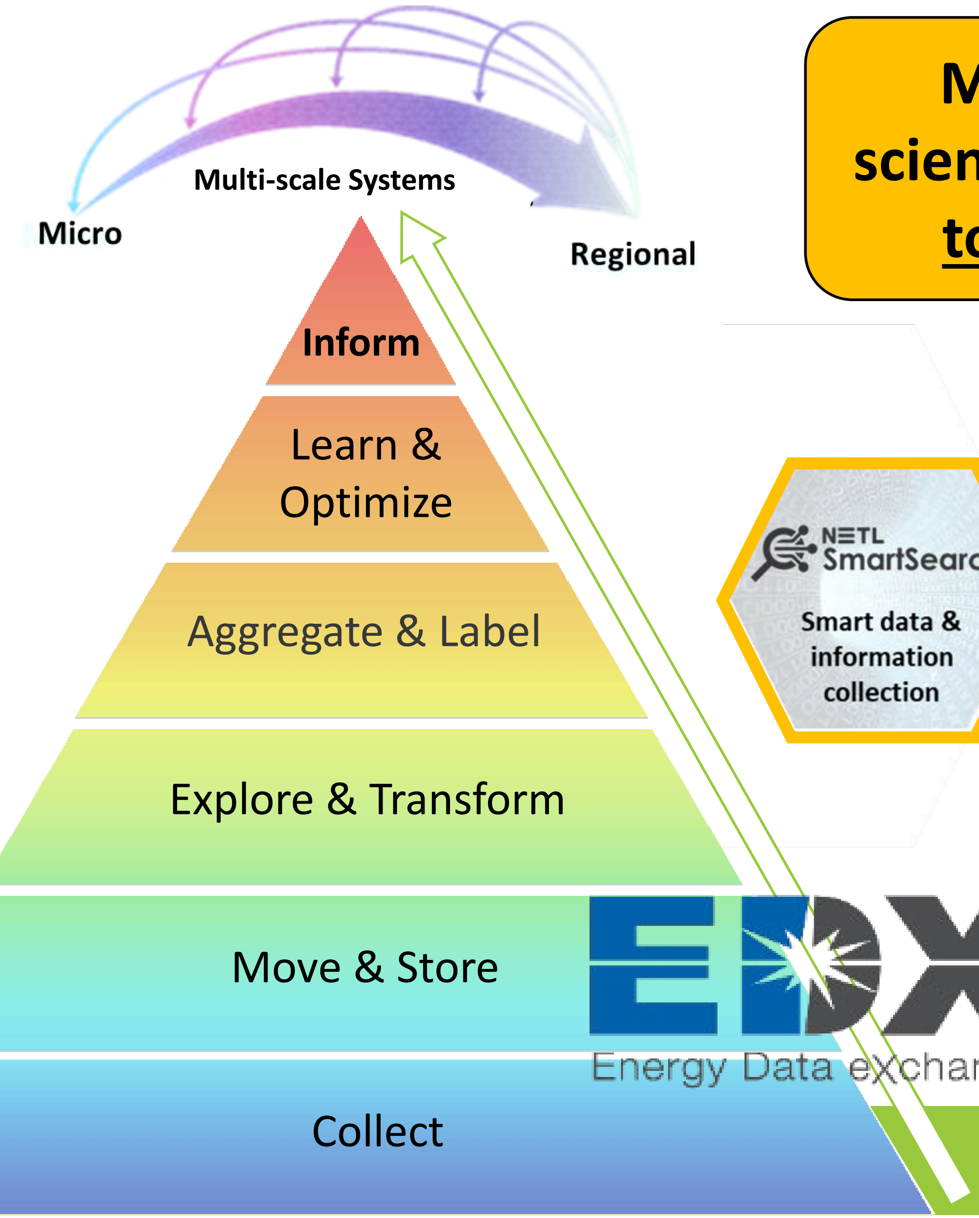
Foster multi-disciplinary AI research and cross-cutting collaborations to cultivate NETL's AI-ready workforce.

https://edx.netl.doe.gov/sami/

NETL's Geo-Data Science Research

NATIONAL ENERGY TECHNOLOGY LABORATORY

Multi-scale, multi-disciplinary R&D that blends data science, advanced computing, and science-based methods to develop data, tools, models & innovate solutions



EDX Energy Data eXchange

United States Department of Energy 2021 Secretary's Honor Awards

2019 CARNEGIE SCIENCE AWARDS

2022 TechConnect National Innovation Awardee

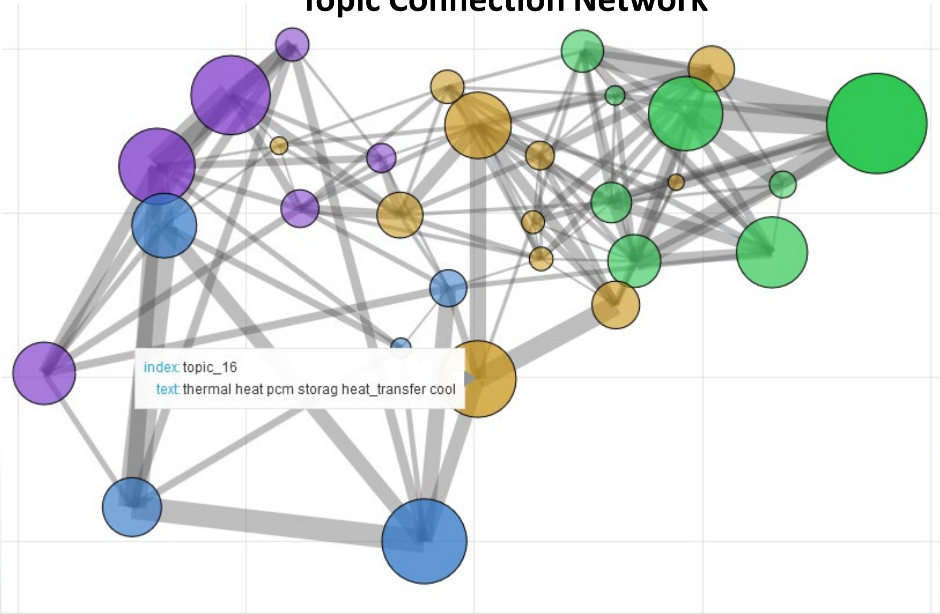
2019 R&D 100 WINNER

SAMI-affiliated Research Highlights

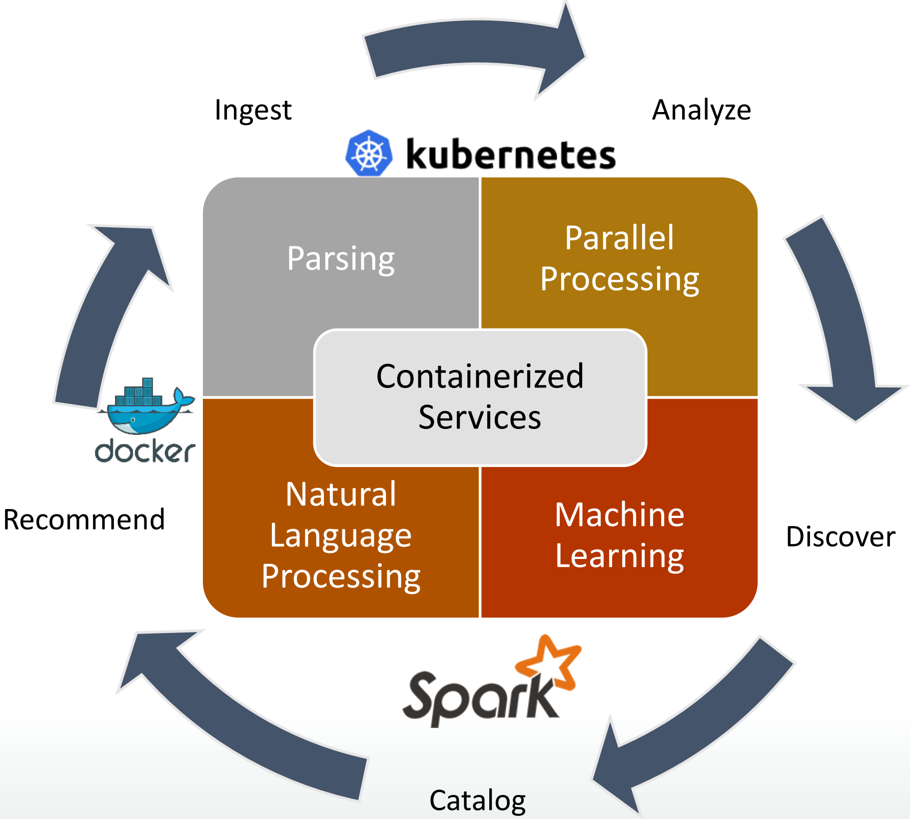
SAMI-affiliated research is at the leading edge of solving some of the most significant challenges applied energy

Topic Modeling & NLP for a variety of Energy Applications

Topic Connection Network



NETL SmartSearch © Deep Learning/ Generative AI for Data Discovery



Digitalization, data management, & AI-informed data discovery

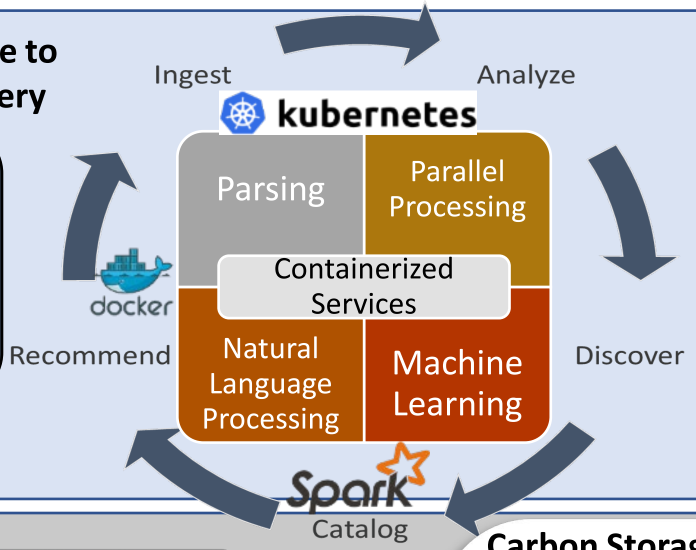
NATIONAL ENERGY TECHNOLOGY LABORATORY

AI informed approach

Challenge: data infrastructure to AI/ML enhanced data discovery

Employing AI/ML tools to find relevant data resources

NETL SmartSearch



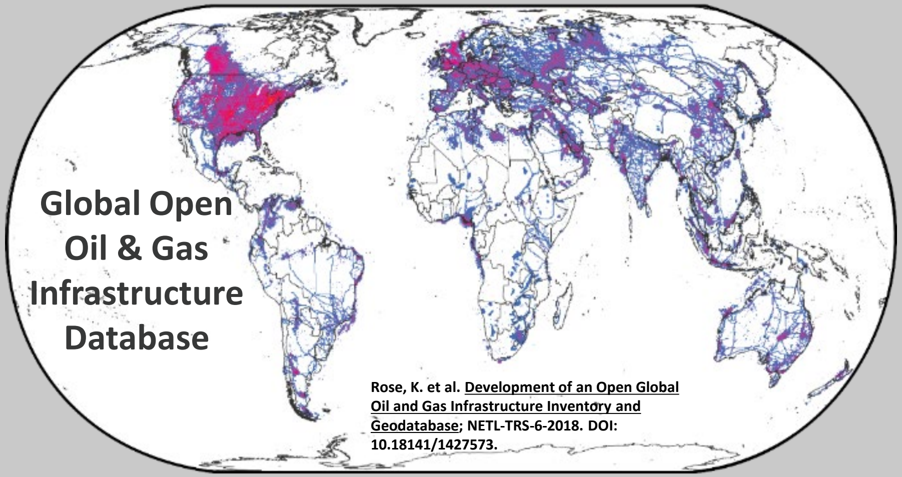
SmartSearch leverages ML+NLP to:

1) **Analyzing** content you like
2) **Finding** new content via www, local, enterprise data stores
3) Telling you **how relevant** the new data is to what you like

Opportunity:

Infinitely scalable to return text, graphical, tabular, image, html, spatial, etc
Driving next-generation of geo-data science R&D

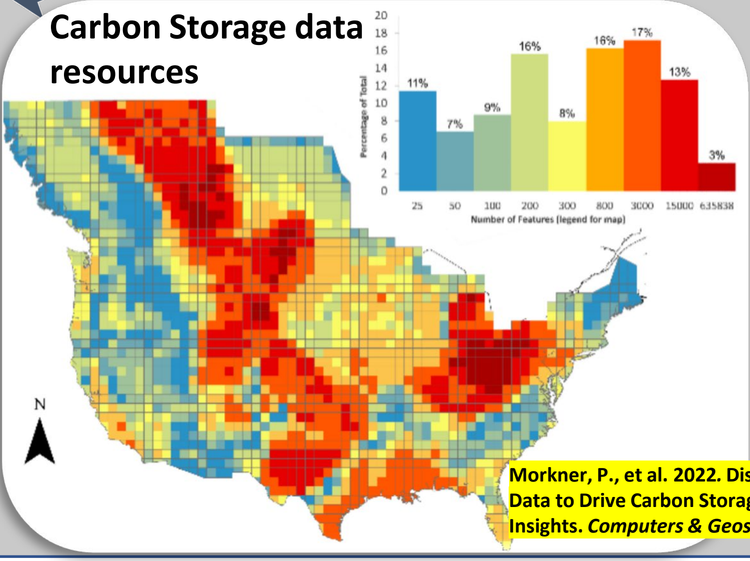
Example applications to date



Global Open Oil & Gas Infrastructure Database

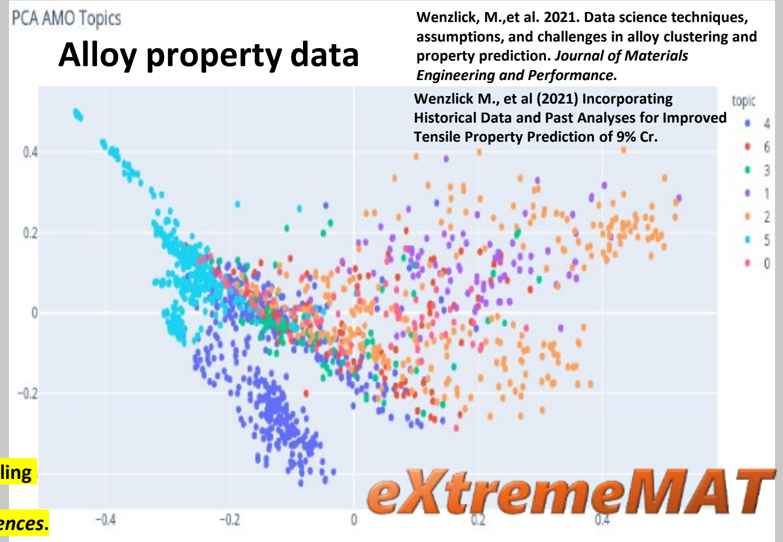
Rose, K. et al. Development of an Open Global Oil and Gas Infrastructure Inventory and Geodatabase; NETL-TRS-6-2018. DOI: 10.18141/1427573.

Carbon Storage data resources



Morkner, P., et al. 2022. Distilling Data to Drive Carbon Storage Insights. *Computers & Geosciences.*

Alloy property data



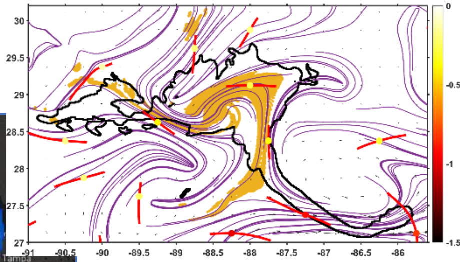
Wenzlick, M.,et al. 2021. Data science techniques, assumptions, and challenges in alloy clustering and property prediction. *Journal of Materials Engineering and Performance.*

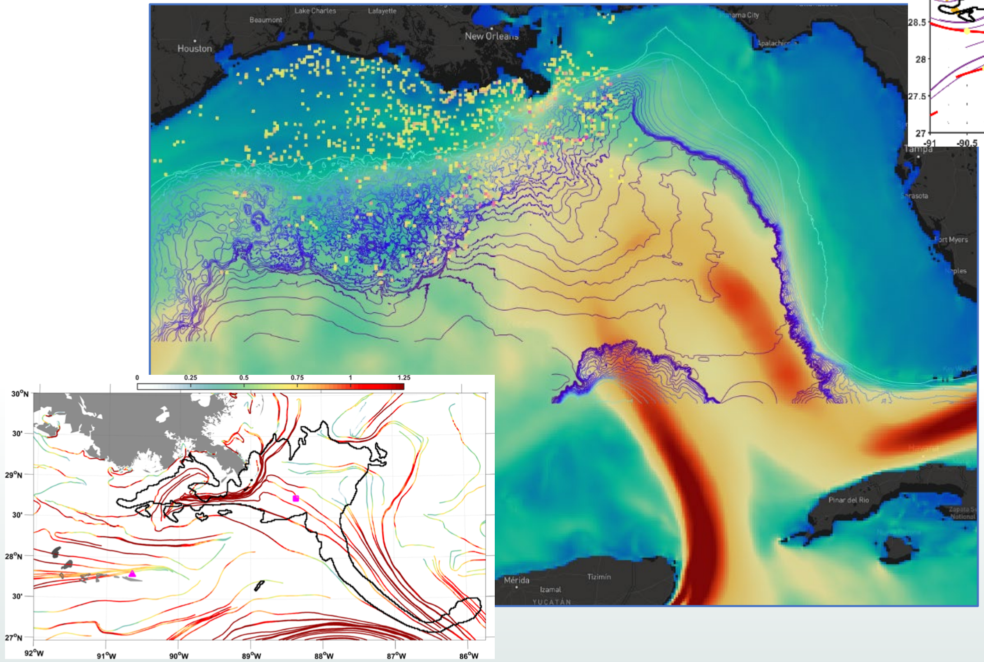
Wenzlick M., et al (2021) Incorporating Historical Data and Past Analyses for Improved Tensile Property Prediction of 9% Cr.

SAMI-affiliated Research Highlights

SAMI-affiliated research is at the leading edge of solving some of the most significant challenges applied energy

Metocean modeling for advanced, adaptive forecasting of ocean systems





http://oceanresearch.xyz/lagrangian-climatologies/

Climatological and Instantaneous Isolation and Attraction Models (CIIAM)

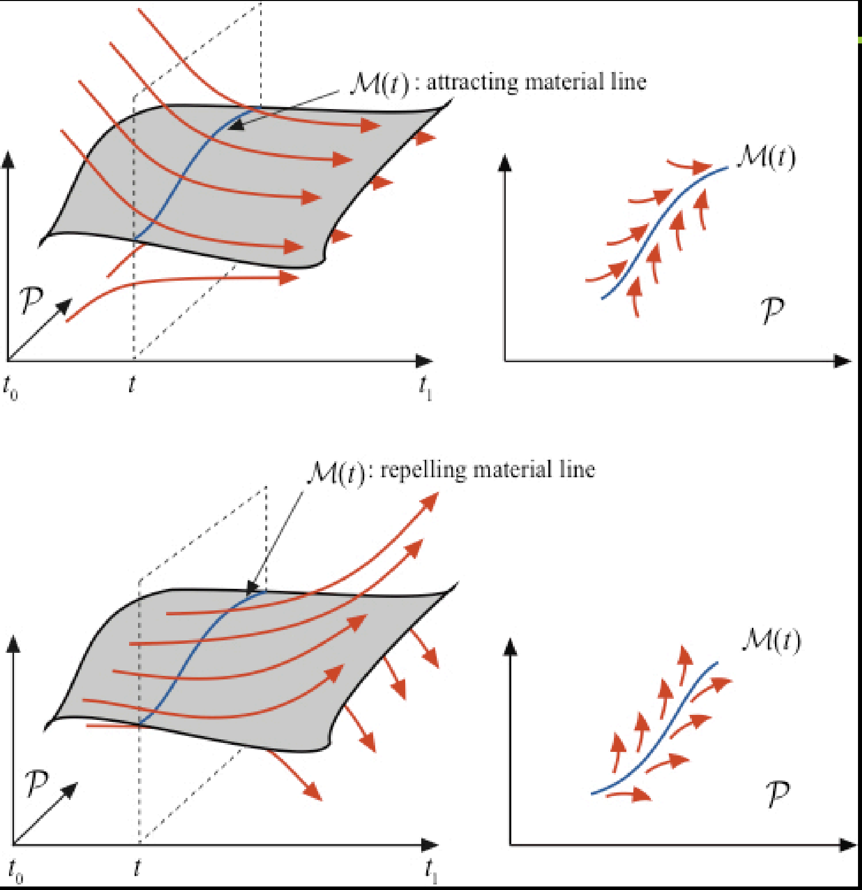
- **Award winning** model leverages the mathematical field of dynamical systems applied to geophysical fluids.
- Efficiently extracts climatological pathways and **trajectory patterns** from large velocity datasets.
- Leveraging of **unsupervised neural network learning**
- **Identifies most influential instantaneous deformation patterns** in fluid tracers bypassing inherent velocity errors.
- Used by research institutes in: USA, Mexico, Spain, UK, Brazil, India, Saudi Arabia, New Zealand.
  - Used for forecasting ocean plastic pollution, migrant boat locations, oil spill, and container ship loss trajectories, as well as fundamental ocean current patterns for transport and climate related insights

https://edx.netl.doe.gov/sami/

Climatological Instantaneous Isolation and Attraction Model - CIIAM

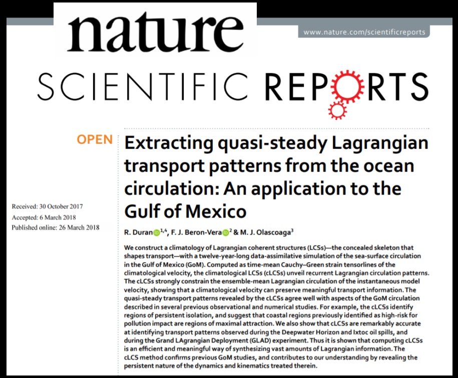
CIIAM | NATIONAL ENERGY TECHNOLOGY LABORATORY

https://edx.netl.doe.gov/dataset/ciam-climatological-isolation-and-attraction-model-climatological-lagrangian-coherent-structures



Using concepts from the mathematical theory of dynamical systems we find:

- most attracting pathways
- lack of attraction i.e. isolation



nature
www.nature.com/scientificreports

SCIENTIFIC REPORTS

OPEN

Extracting quasi-steady Lagrangian transport patterns from the ocean circulation: An application to the Gulf of Mexico

Received: 30 October 2017
Accepted: 6 March 2018
Published online: 26 March 2018

R. Duran[1,4], F. J. Beron-Vera[2] & M. J. Olascoaga[3]

We construct a climatology of Lagrangian coherent structures (LCSs)—the concealed skeleton that shapes transport—with a twelve-year-long data-assimilative simulation of the sea-surface circulation in the Gulf of Mexico (GoM). Computed as time-mean Cauchy–Green strain tensorlines of the climatological velocity, the climatological LCSs (cLCSs) unveil recurrent Lagrangian circulation patterns. The cLCSs strongly constrain the ensemble-mean Lagrangian circulation of the instantaneous model velocity, showing that a climatological velocity can preserve meaningful transport information. The quasi-steady transport patterns revealed by the cLCSs agree well with aspects of the GoM circulation described in several previous observational and numerical studies. For example, the cLCSs identify regions of persistent isolation, and suggest that coastal regions previously identified as high-risk for pollution impact are regions of maximal attraction. We also show that cLCSs are remarkably accurate at identifying transport patterns observed during the Deepwater Horizon and Ixtoc oil spills, and during the Grand LAgrangian Deployment (GLAD) experiment. Thus it is shown that computing cLCSs is an efficient and meaningful way of synthesizing vast amounts of Lagrangian information. The cLCS method confirms previous GoM studies, and contributes to our understanding by revealing the persistent nature of the dynamics and kinematics treated therein.

Duran, R.; Beron-Vera, F. J.; Olascoaga, M. J. Extracting quasi-Steady Lagrangian transport patterns from the ocean circulation: An application to the Gulf of Mexico. *Scientific Reports* **2018,** *8*, 10. DOI:10.1038/s41598-018-23121-y.

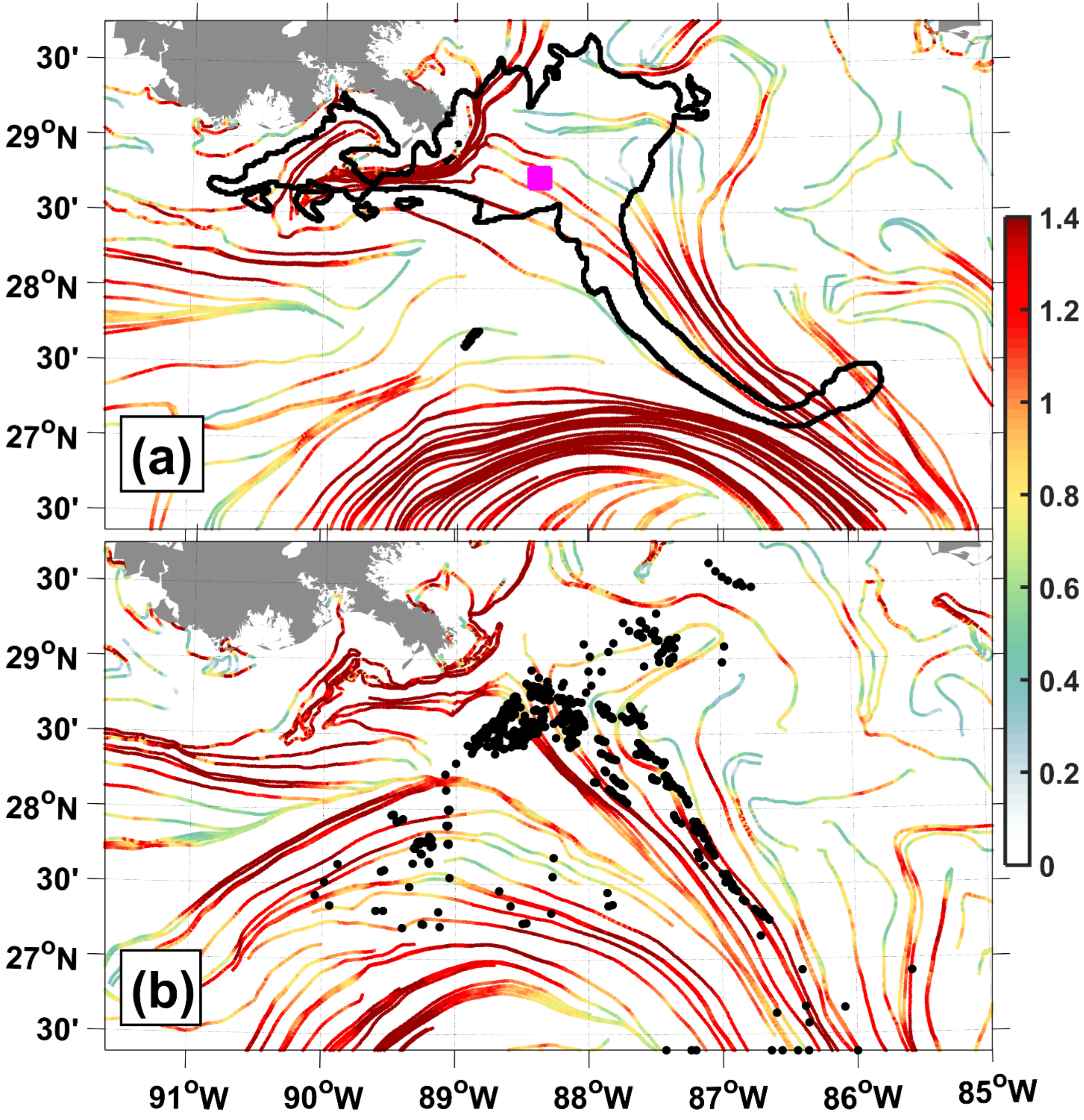
Gough, M. K.; Beron-Vera, F. J.; Olascoaga, M. J.; Sheinbaum, J.; Jouanno, J.; Duran, R. Persistent Lagrangian Transport Patterns in the Northwestern Gulf of Mexico. *Journal of Physical Oceanography* **2019**, 49, 353–367.

CIIAM

Predicts likely pathways

Oil from DwH in May 2010 stretches along May climatological attracting structures.

Drifters released in July 2012, spread along July climatological attracting structures.



NATIONAL ENERGY TECHNOLOGY LABORATORY

Used in domestic & international (Spain, Mexico, Brazil, etc) studies to:

- Predict changes in oceanographic currents
- Forecast fate and transport of refugee vessels
- Assess locations of sediment, chlorophyll, oil, and other particulates

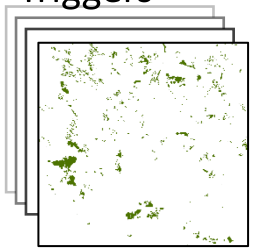
Pathways:
Red=attracting
White=isolated

SAMI-affiliated Research Highlights

SAMI-affiliated research is at the leading edge of solving some of the most significant challenges applied energy

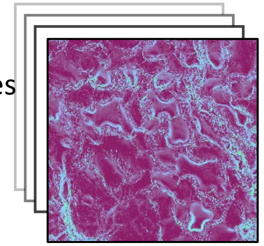
Artificial Intelligence (AI) Enhanced Workflow for Natural Hazards Forecasting

Landslide Triggers



- Hydrates
- Faults
- Seeps
- & more

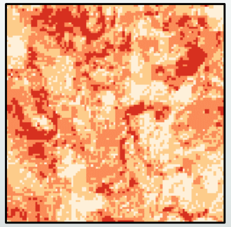
Conducive Conditions



- Slope
- Curvature
- Sediment Type
- Geomorphology
- & more

- **Gradient Boosting Classifier**
- **Artificial Neural Network**

Ocean & Geohazard Analysis



Output Landslide Susceptibility Map

https://edx.netl.doe.gov/sami/

Offshore Geohazard Forecasting

NATIONAL ENERGY TECHNOLOGY LABORATORY | SAMI SCIENCE-BASED AI/ML INSTITUTE

- **Offshore Hazards** include **seabed instability**, **extreme wind/wave/current** events, and **earthquakes**
- **Technology** that integrates Artificial Intelligence and Machine Learning (**AI/ML**) methods with **spatial data** is being developed to **forecast potential hazards** to infrastructure
- **Benefits**
  - Risk mitigation
  - Inform decommissioning and re-use strategies
  - Reduce environmental and economic impacts

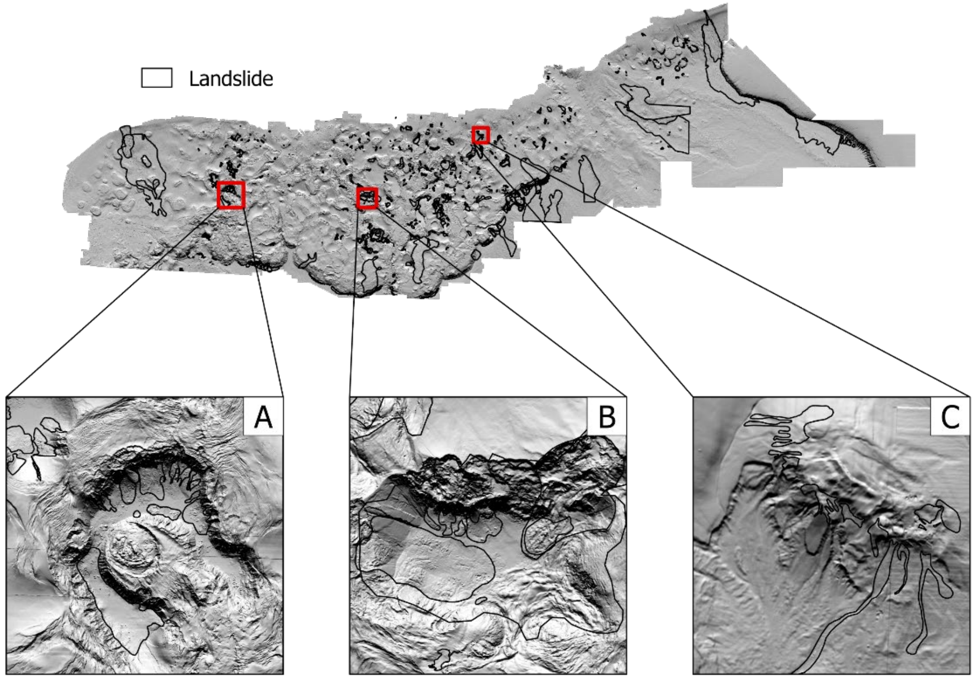
https://edx.netl.doe.gov/offshore

This photo from March 31, 2015, shows the wake of a supply vessel crossing an oil sheen in the Gulf of Mexico at the site of the former Taylor Energy oil rig, which was destroyed in 2004 by an underwater landslide triggered by Hurricane Ivan.
PHOTOGRAPH BY GERALD HERBERT, AP PHOTO

SCIENCE | NEWS

Hidden underwater landslides pose new dangers in the Gulf of Mexico

Seismic data show that earthquakes more than 600 miles away can trigger submarine mudslides that threaten offshore oil rigs and could lead to catastrophic spills.



Ocean & Geohazard Analysis

Dyer, A., et al. Geohazard Analysis of Seafloor Landslide Potential for Infrastructure Protection. In press https://www.researchsquare.com/article/rs-2070041/v1

Dyer, A.S, Mark-Moser, M., and Bauer, J., Submarine Landslide Susceptibility Mapping in the Northern Gulf of Mexico. **In preparation.**

Ocean & Geohazard Analysis Smart Tool Workflow

NATIONAL ENERGY TECHNOLOGY LABORATORY

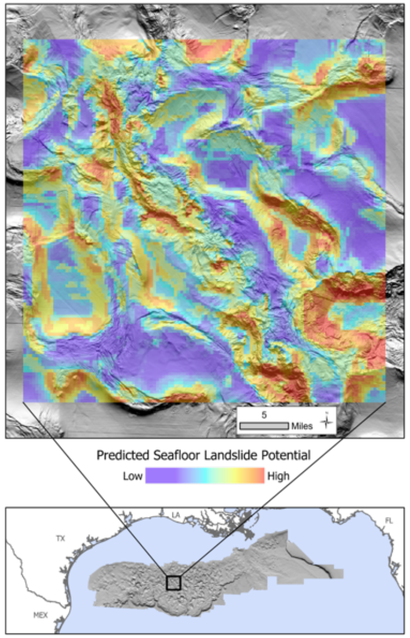
Choose offshore region of interest → *Select hazards for risk assessment* → *Select data & analyses* (*AI/ML and Probabilistic*) → *Advanced risk analytics and spatial visualization*

Recursive

OGA
Ocean & Geohazard Analysis

Hazards:
- *All known hazards*
- *Mudslide*
- *Turbidity flow*
- *Wind event*
- *Wave event*
- *Current event*
- *Earthquake*
- *Hurricane*
- *Hazmat spill*

Default data, default analysis	*Custom data, default analysis*
Default data, custom analysis	*Custom data, custom analysis*



- **Identify datasets for diverse hazard analyses**
- **Develop analytical framework for smart modeling**
- **Train and validate AI/ML models**
- **Metocean statistical and probabilistic analyses**

AI/ML landslide analyses:
- **Gradient Boosting Classifer**
- **Artificial Neural Network**
- **Convolutional Neural Network**
- **Tuning methods**

AI/ML ocean current analysis:
- **Self-organizing maps**

Mark-Moser et al., *2021*

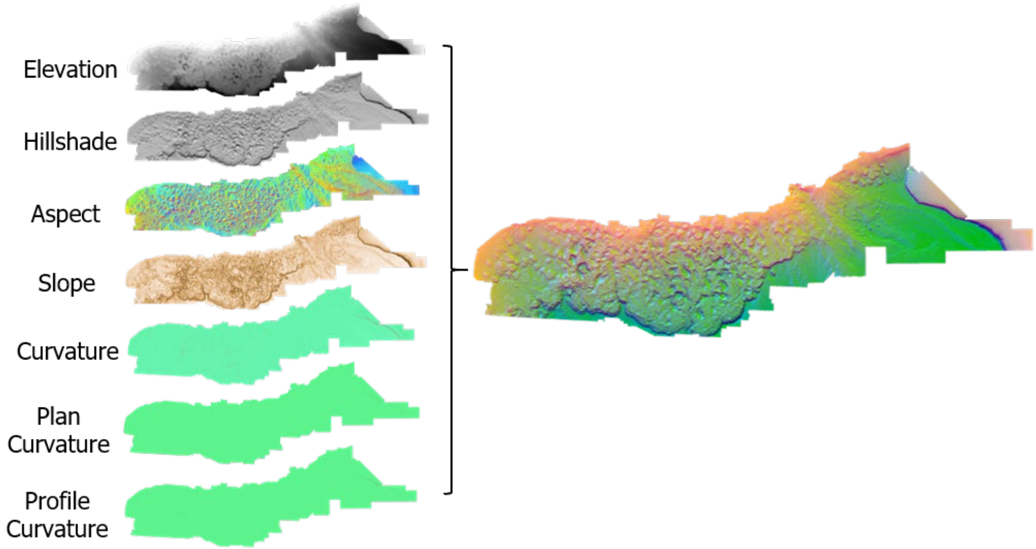
Mark-Moser, M., Wingo, P., Duran, R., Dyer, A., Zaengle, D., Suhag, A., Hoover, B., Pantaleone, S., Shay, J., Bauer, J., and Rose, K. **2021.** AI/ML integration for accelerated analysis and forecast of offshore hazards. AGU Fall Meeting 2021, Dec. 13-17, New Orleans, LA/Virtual. Session: EP027 - Proven AI/ML applications in the Earth Sciences

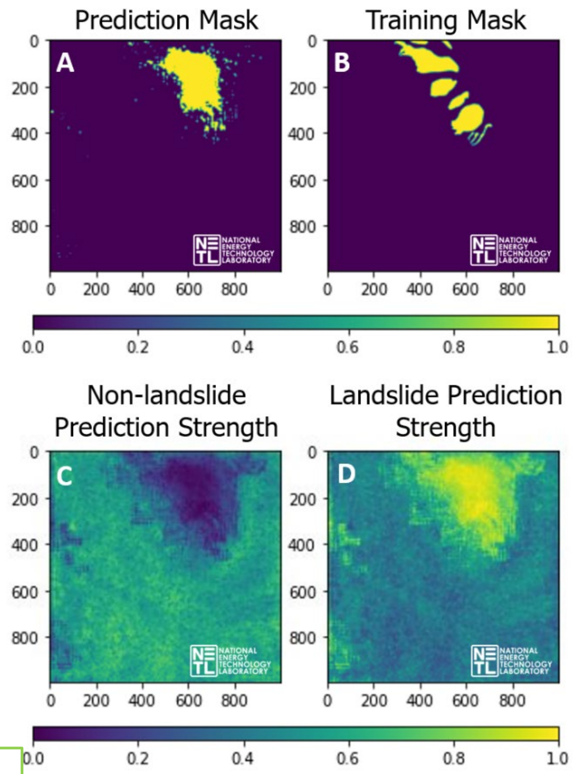
Landslide Detection

- **Supervised computer vision** modeling to **identify historic landslides** in high resolution bathymetry, decreasing time to locate and digitize **training data**
- **Semantic segmentation** deep learning framework developed using a **Fully Convolutional Residual Network** (ResNet50)

https://edx.netl.doe.gov/offshore

- **7 band** composite built from seafloor bathymetry and its derivatives



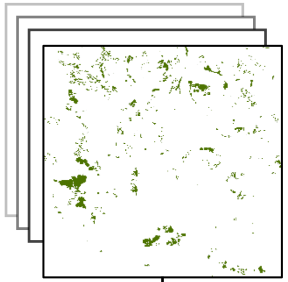


Mark-Moser et al., *in prep*, Integrated Artificial Intelligence/Machine Learning Smart Tool for Metocean and Seafloor Hazards: The Ocean & Geohazard Analysis Tool. NETL Technical Report Series.

Landslide Susceptibility

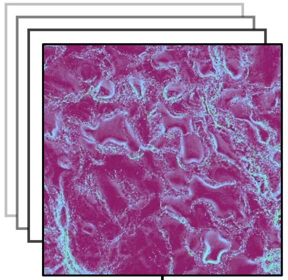
- Predict the **probability** of **landslide occurrence** spatially throughout the northern Gulf of Mexico

Landslide Triggers



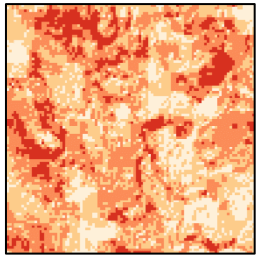
- Hydrates
- Faults
- Seeps
- & more

Conducive Conditions



- Slope
- Curvature
- Sediment Type
- Geomorphology
- & more

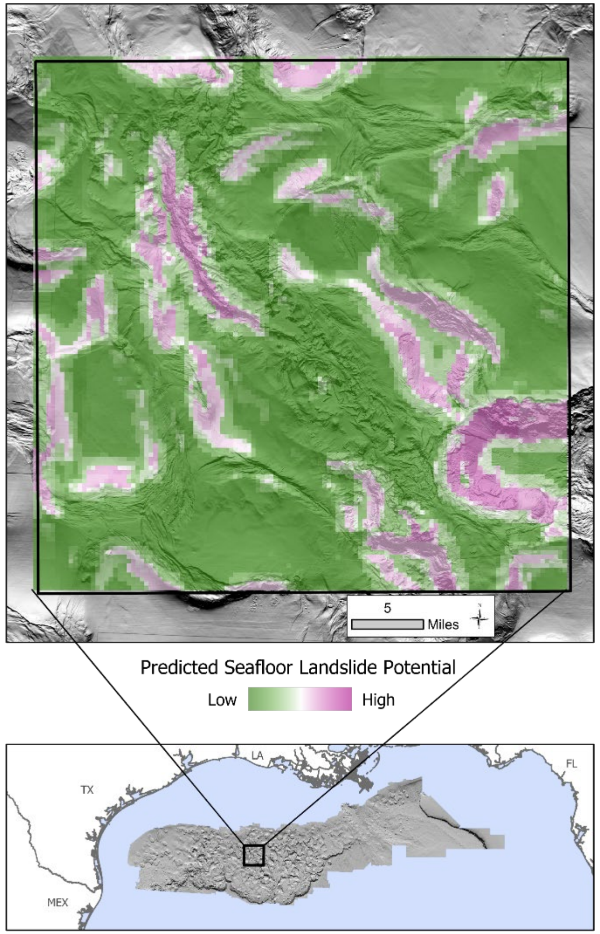
- **Robust ML models** to predict landslide potential
  - **Gradient Boosting Classifier (GBC)**
  - **Artificial Neural Network (ANN)**
- **Spatial kernelling** to enhance spatial information



Output Landslide Susceptibility Map

Dyer, A.S, et al., **In press,** Submarine Landslide Susceptibility Mapping in the Northern Gulf of Mexico.

GBC Model Prediction



Metrics evaluated against testing dataset

F1 score: **0.282**

Accuracy: **0.782**

ROC-AUC: **0.814**

Summary

Key Takeaways

- **AI/ML methods** offer near-real time assessment of **risks to offshore infrastructure** from **submarine landslides**.
- Spatial workflow is **generalizable**, offering implications to accelerate **other risk applications** extending to other geohazard targets both offshore and onshore.

Challenges

- Landslides are **heterogeneous** in shape and structure, making them **difficult to identify** by computer models.
- **Data availability** throughout the Gulf of Mexico regarding **seafloor properties** is **spatially sparse**.

Ocean & Geohazard Analysis

Dyer, A., et al. ***In press*** [*https://www.researchsquare.com/article/rs-2070041/v1*](https://www.researchsquare.com/article/rs-2070041/v1)

Mark-Moser et al., ***in prep***

SAMI-affiliated Research Highlights

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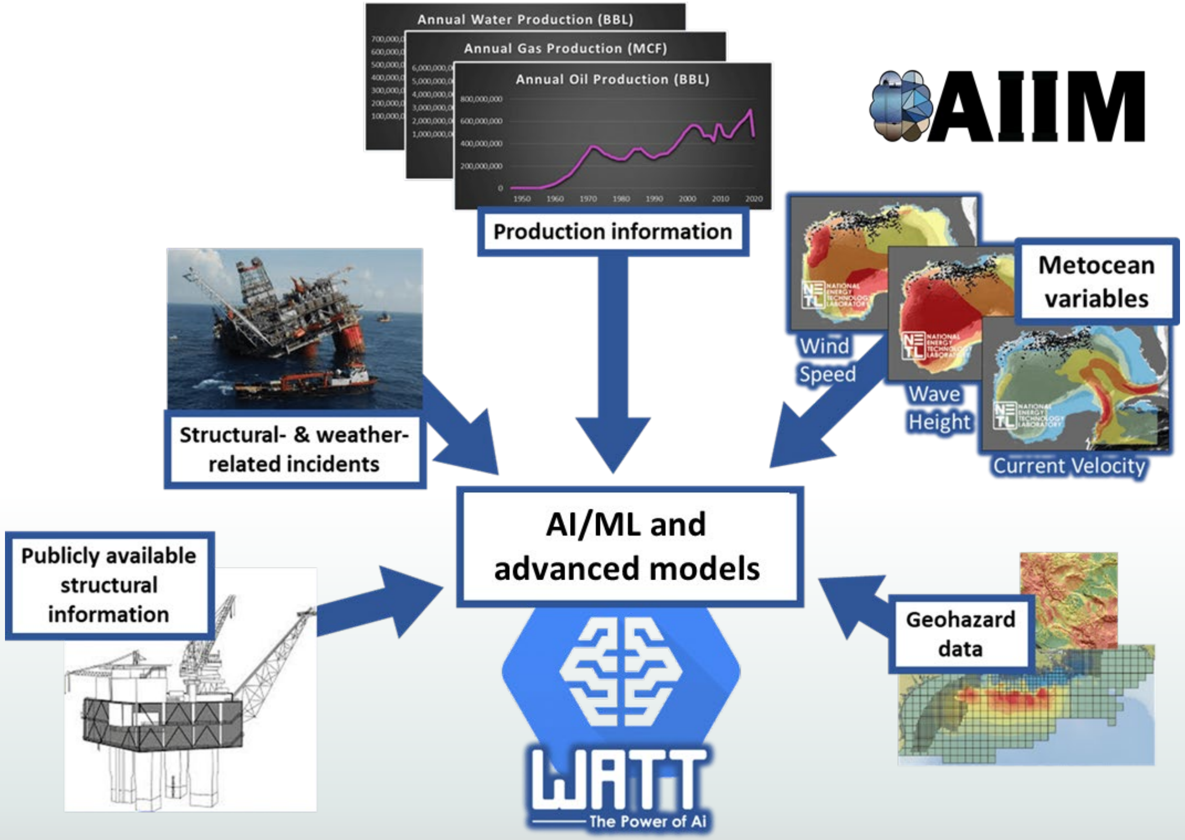
Applied AI/ML Multi-Model Forecasting

Infrastructure Integrity



https://edx.netl.doe.gov/sami/

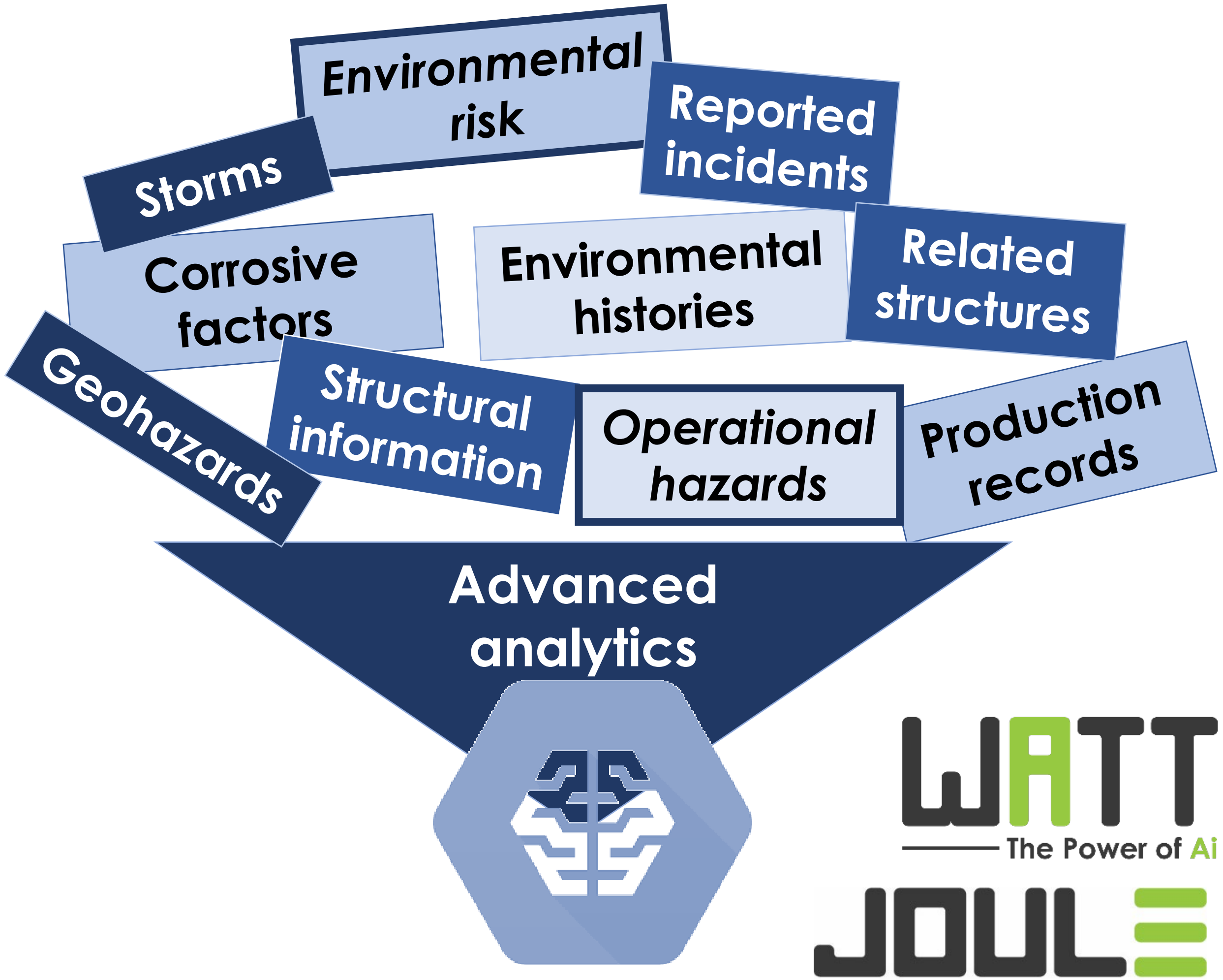
AIIM: Advanced Infrastructure Integrity Model

NATIONAL ENERGY TECHNOLOGY LABORATORY

AIIM utilizes big data, big data computing, multiple predictive machine learning (ML), spatio-temporal, and advanced analyses to **evaluate the current state of platforms, pipelines, and wells** in the U.S. Federal Waters of the Gulf of Mexico.

AIIM results can help:

- Identify **assets** vs. **liabilities**
- Inform **life extension, remediation, & safe use strategies**
- Assess **infrastructure hazards and reuse potential** for other energy sources
- Support **environmental** & **operational risk prevention**



WATT — The Power of Ai

JOULE — NETL SUPERCOMPUTER

AIIM Analytical Approach

Multiple Machine Learning (ML) and Advanced Modeling

Machine Learning Models (Dyer et al. 2022)

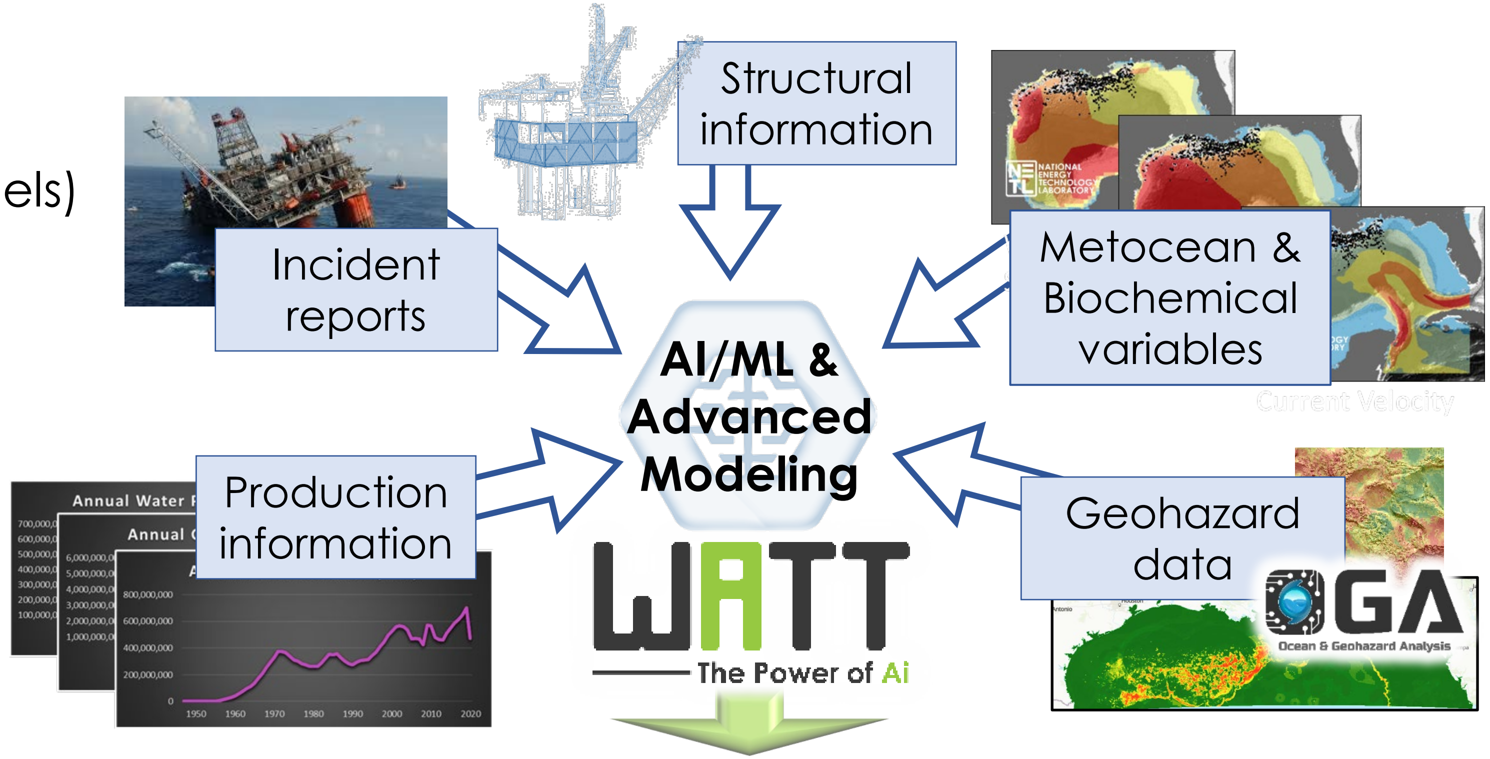
- Gradient Boosted Decision Trees (2 models)
- Artificial Neural Network (2 models)
- Bayesian Network

Advanced Analytics

- Geographically Weighted Regression (Nelson et al. 2021)
- Causality/Time Series Analytics

Why multiple models?

- Evaluate strengths vs. weaknesses
- Internal cross-validation



Identified **significant connections** among **biochemical** variables and **incidents**

Corroborated results with **news** and **reports**

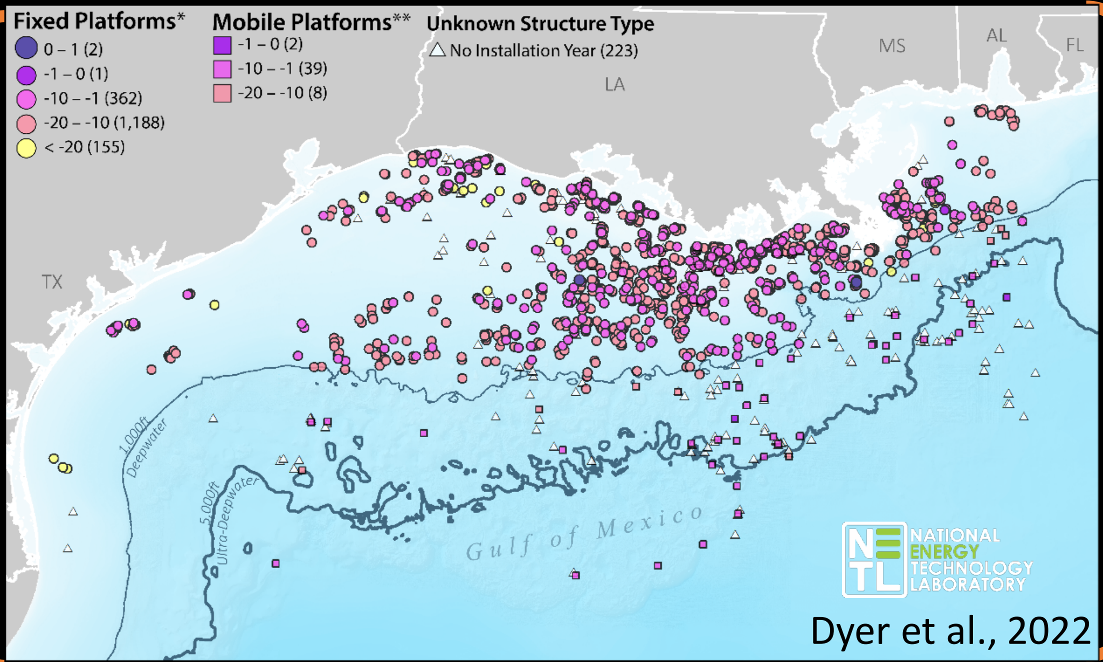
ML models capable of predicting **removal age <u>< 3 years</u>**

Predicting remaining platform lifespan

Gradient Boosted Regression Tree

97% accuracy

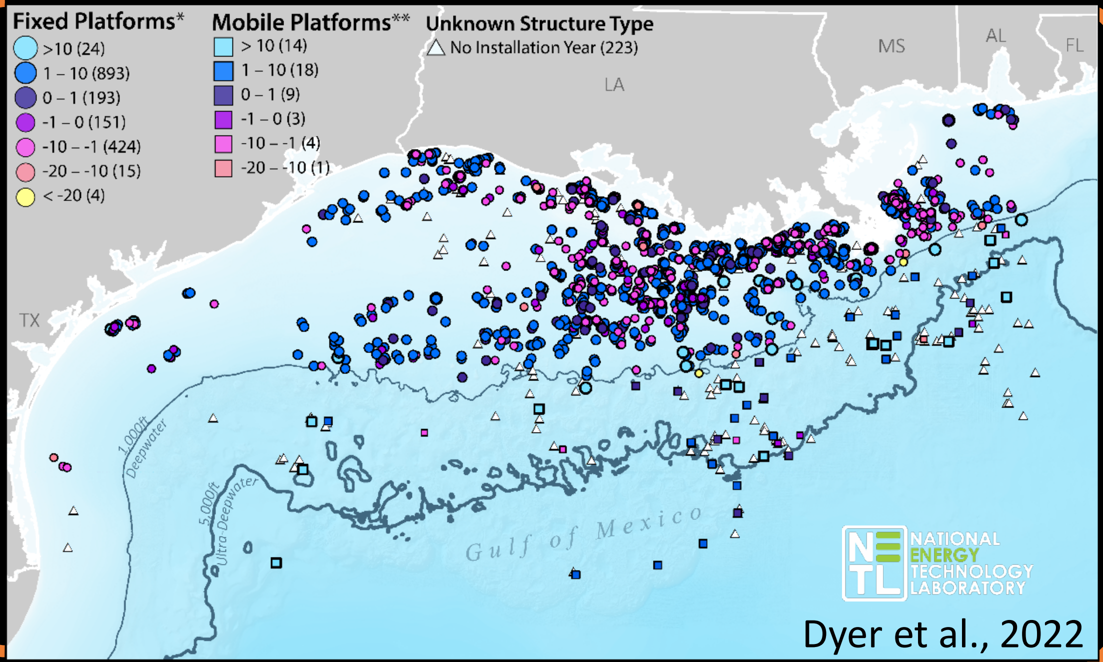
23 features



Artificial Neural Network

95% accuracy

792 features



Running ***multiple models*** allows us to ***internally validate results***

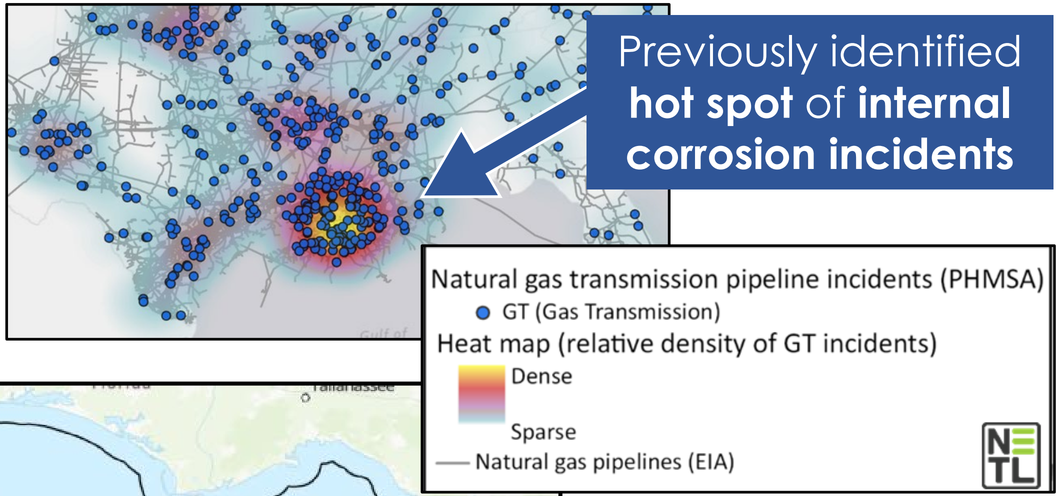
<u>Key Variables:</u>
Metocean
Production
Structural
Location

<u>Key variables:</u>
Metocean
Production
Structural
Location
Incidents
Geohazards

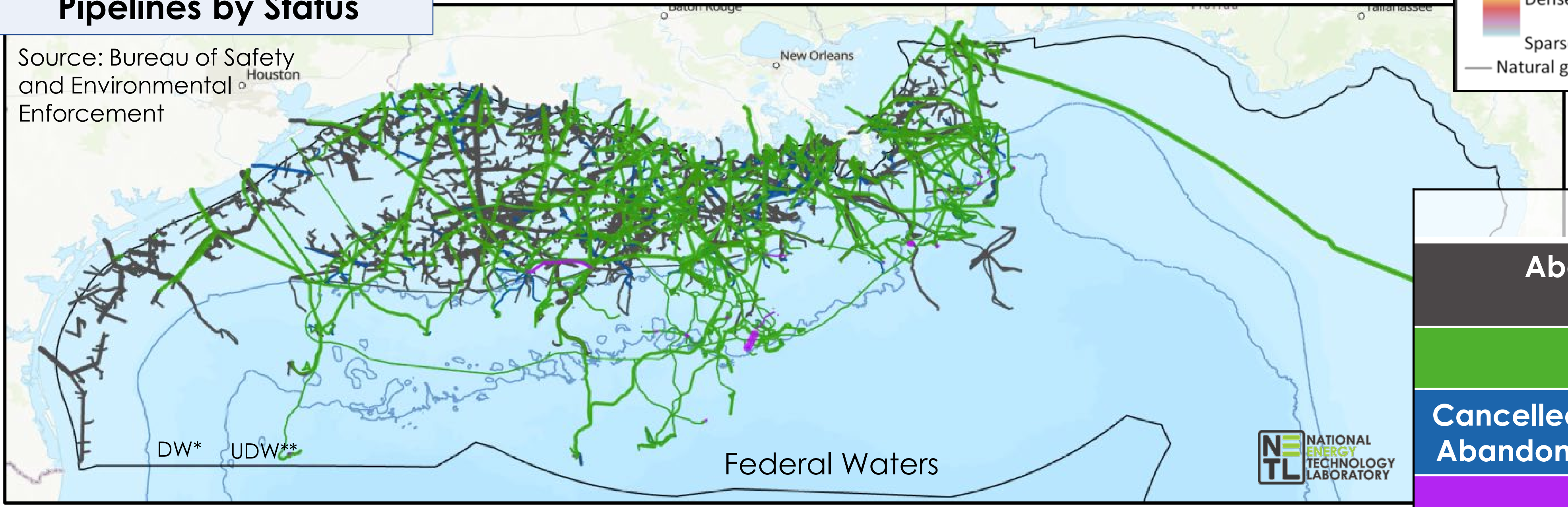
Integrating Pipeline Infrastructure

Utilizing Past Research to Inform New Insights

- **Leveraging data and insights from national pipeline R&D sensor placement**
- **Applying AIIM to evaluate integrity of existing and abandoned pipelines**



Pipelines by Status



Status	Miles
Abandoned or Removed	23,838
Active	19,731
Cancelled, Proposed Abandon or Remove	3,914
Proposed	109

*Deepwater (1,000m+)
**Ultra-deepwater (5,000m+)

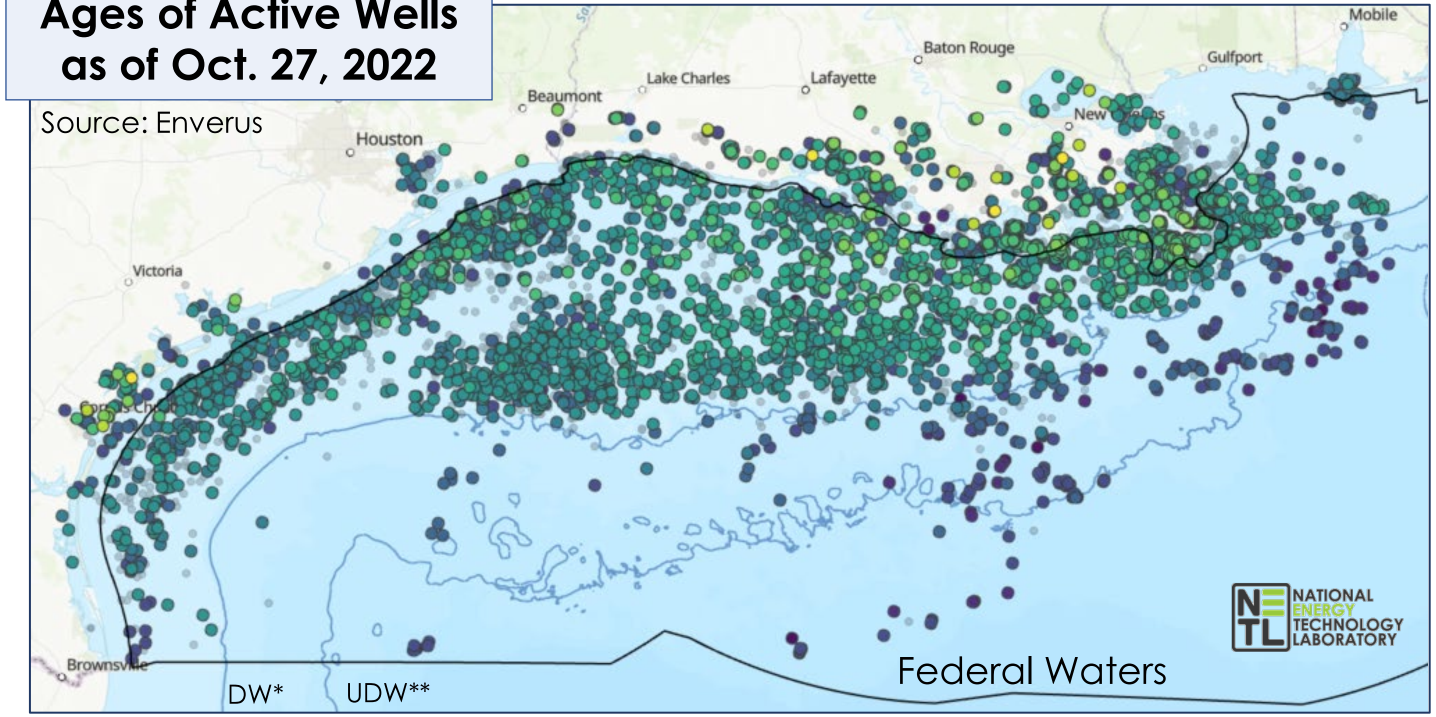
Integrating Well Infrastructure

Utilizing Past Research to Inform New Insights

- **Leveraging data and insights from onshore well integrity testing**
- **Evaluating well integrity for reuse potential**

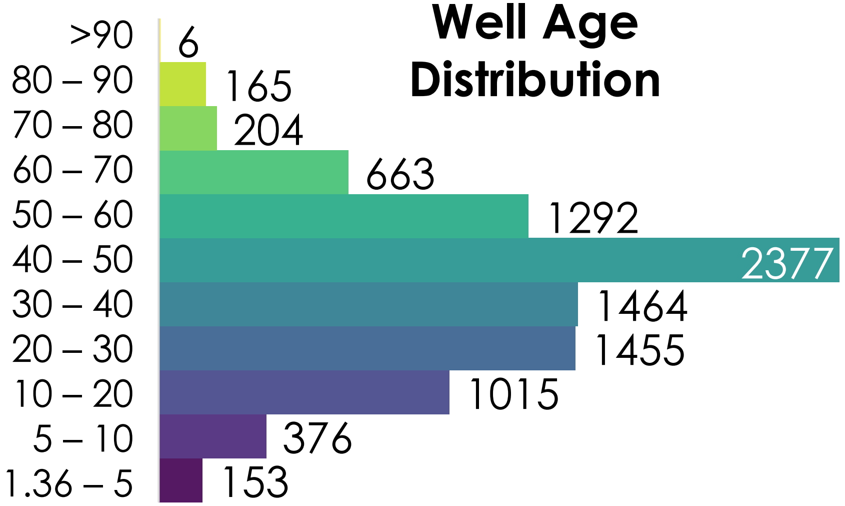
Ages of Active Wells as of Oct. 27, 2022

Source: Enverus



*Deepwater (1,000m+)
**Ultra-deepwater (5,000m+)

Well Age Distribution



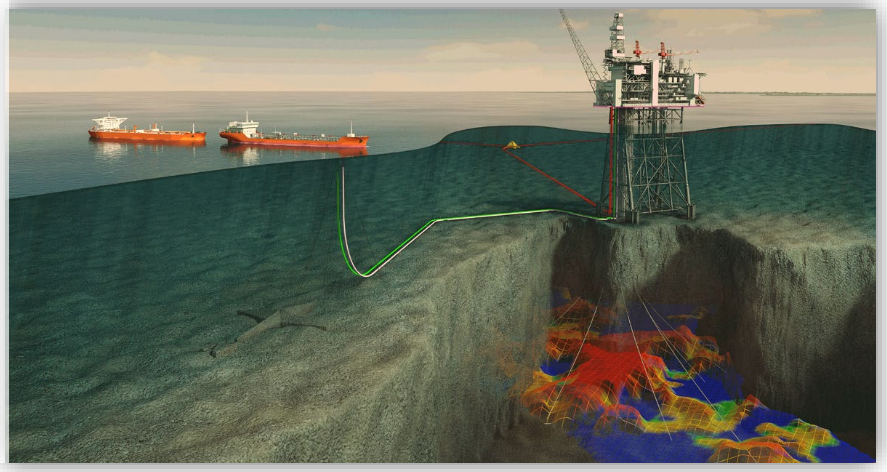
Stressors Identified

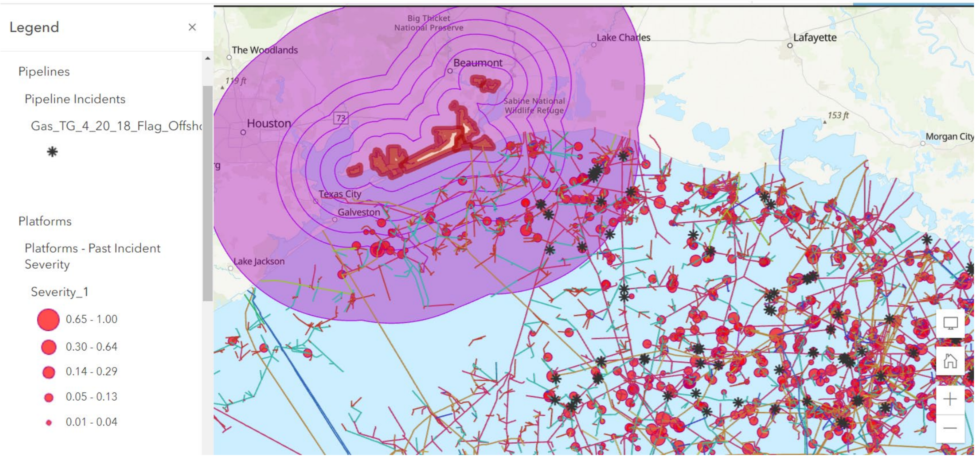
- Age (Dilmore et al, 2015)
- Type (Kiran et al., 2017)
- Concrete type and installation (Wang et al., 2016; Kiran et al., 2017; Wise et al., 2019; Rocha-Valadez et al., 2014)
- Water depth (Wise et al., 2019)
- Corrosion (Kiran et al., 2017)
- Direction (Lackey et al., 2021)
- Pressure and temperature (Rocha-Valadez et al., 2014; Wang et al., 2016; Kiran et al., 2017)
- Seismic/tectonic activity (Kiran et al., 2017)
- Geology (Dilmore et al, 2015; Kiran et al., 2017)

AIIM Applications

Work to release data and insights, as well as aid in applications for other stakeholders

Assess what infrastructure is available or could be reused to support offshore carbon sequestration





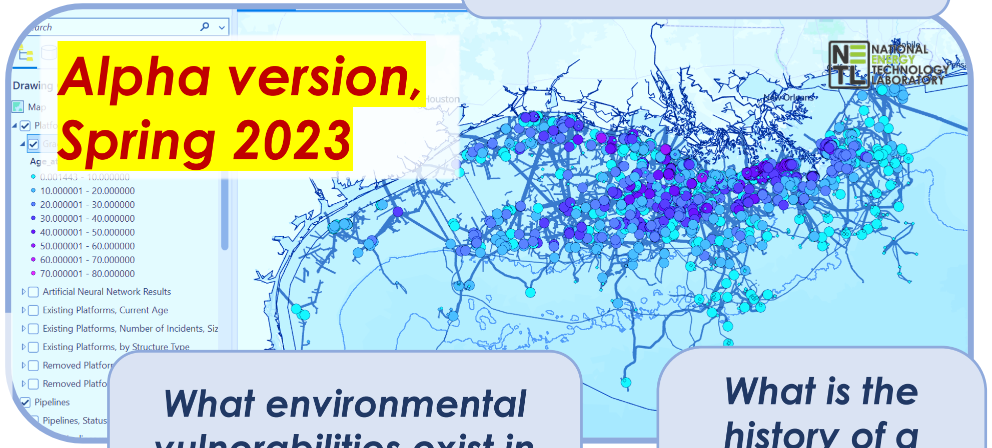
Understand what infrastructure could pose a risk to a project

(example – preliminary assessment with USCG)

AIIM Dashboard under development to help users interrogate data & model results:

What are the most traversed lease blocks by ship traffic?

What is the remaining lifespan of a platform?



Alpha version, Spring 2023

What environmental vulnerabilities exist in the area?

What is the history of a platform? Lease block? Pipeline?

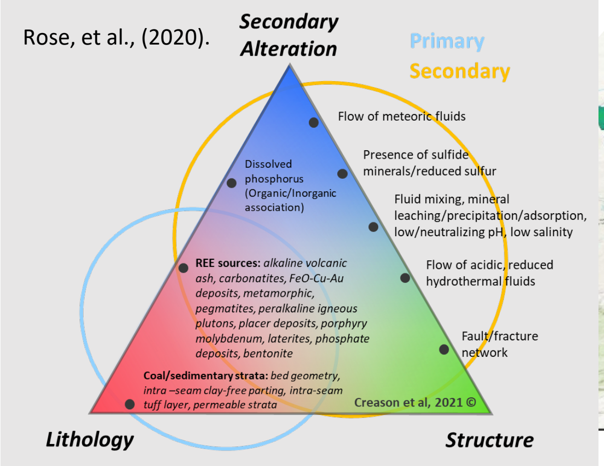
Where are operational risks more likely?

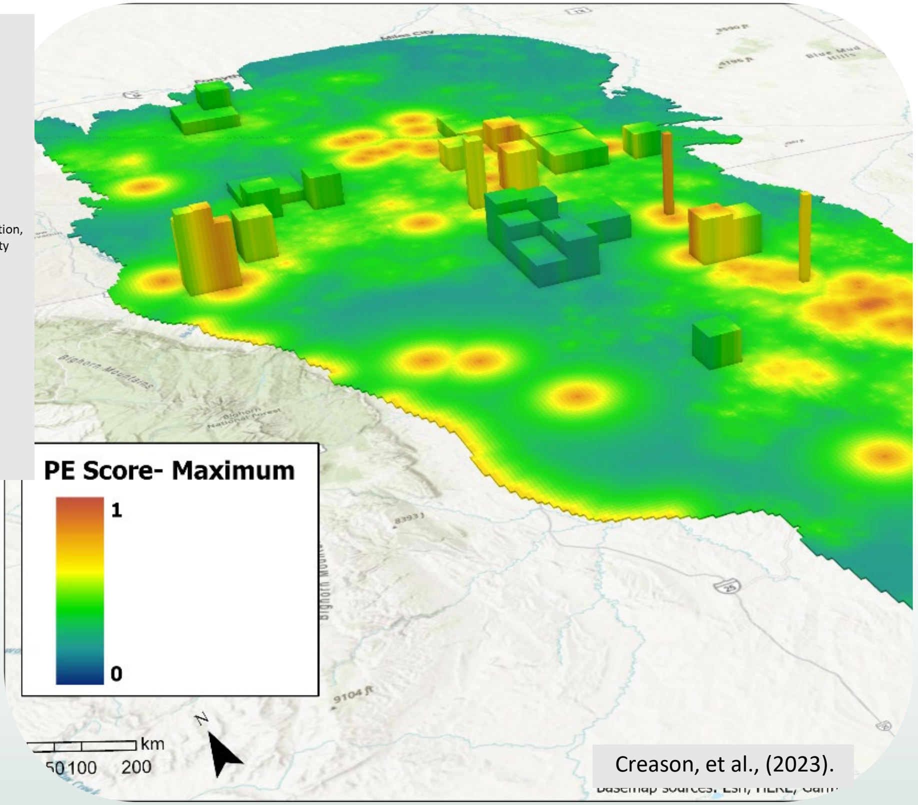
SAMI-affiliated Research Highlights

SCIENCE-BASED AI/ML INSTITUTE

SAMI-affiliated research is at the leading edge of solving some of the most significant challenges applied energy

Federated-AI modeling for improving Natural Resource Assessments





For Groundwater, REE/CM, Carbon Storage, H2, hydrocarbons, geothermal and more

NEWTS

SUBSURFACE TREND ANALYSIS

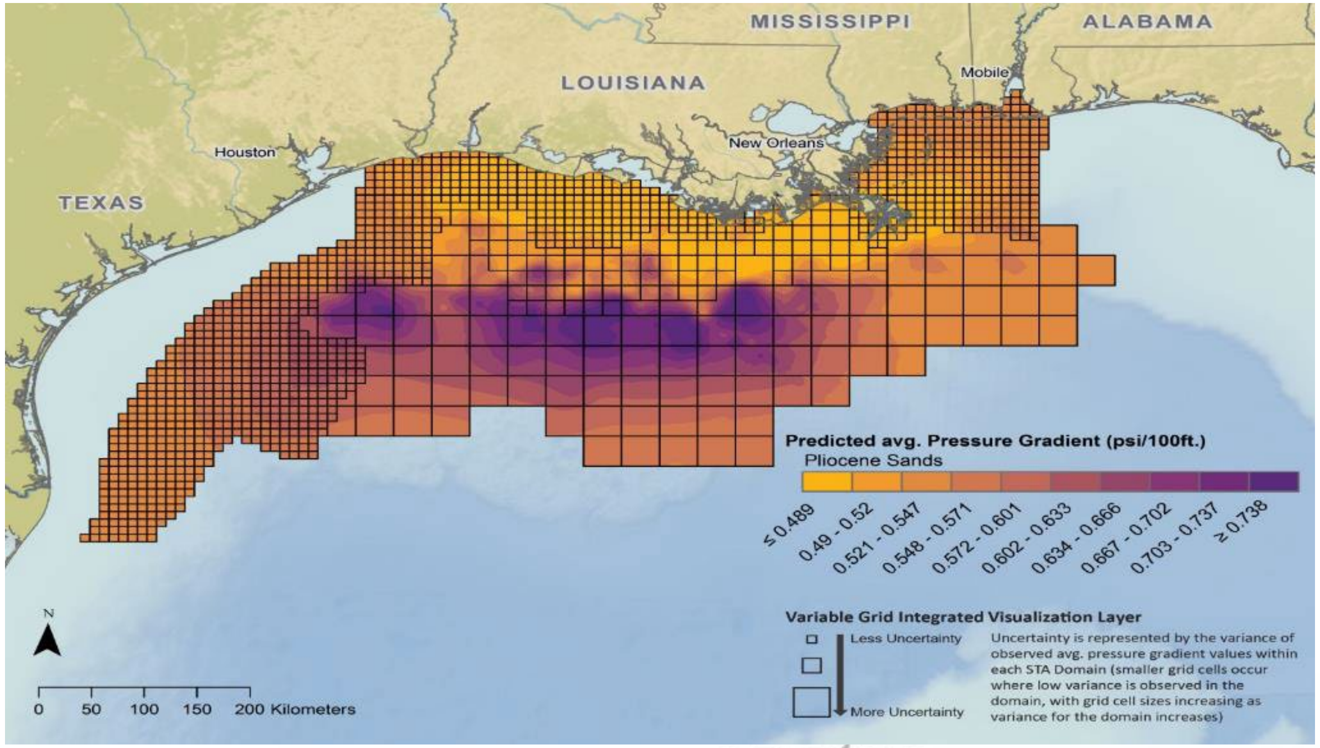
SMART

https://edx.netl.doe.gov/sami/

Subsurface Trend Analysis

Subsurface Hazards and Reservoir Resource Prediction

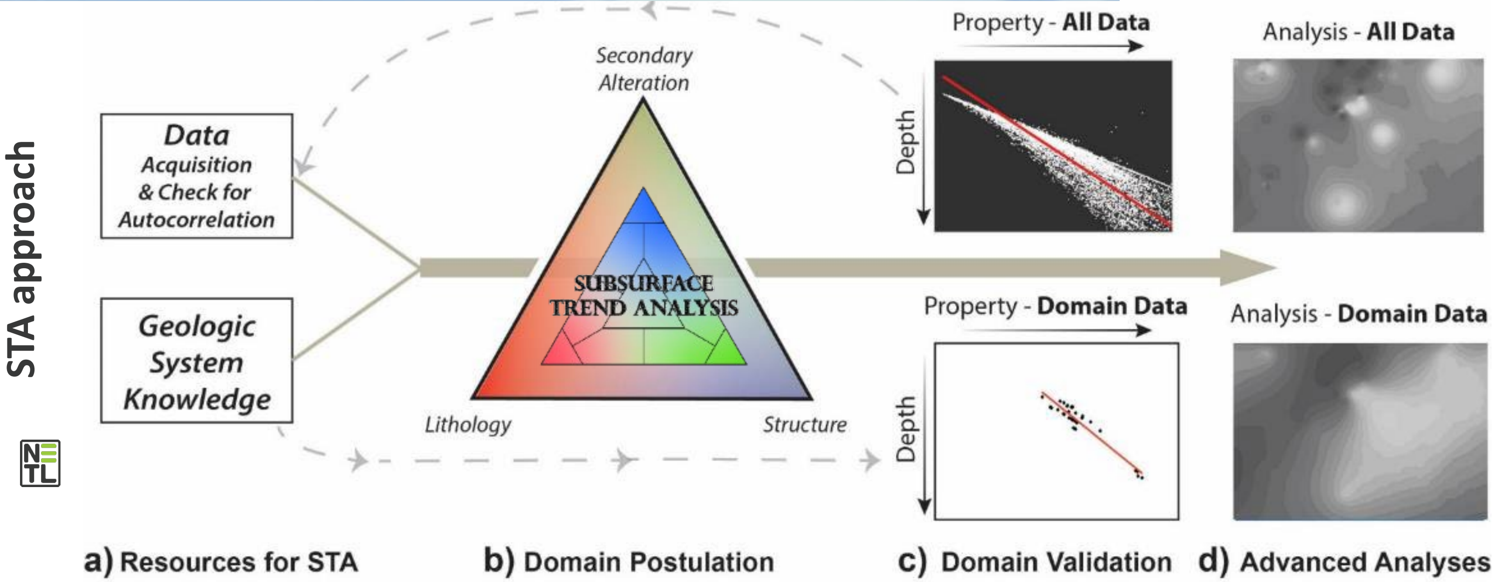
Rose, Bauer, Mark-Moser, 2021, Subsurface Trend Analysis, a Multi-Variate Geospatial Approach for Evaluation of Geologic Properties and Uncertainty Reduction, *Interpretation*.



Reducing subsurface uncertainty, risk

Improving prediction of subsurface properties

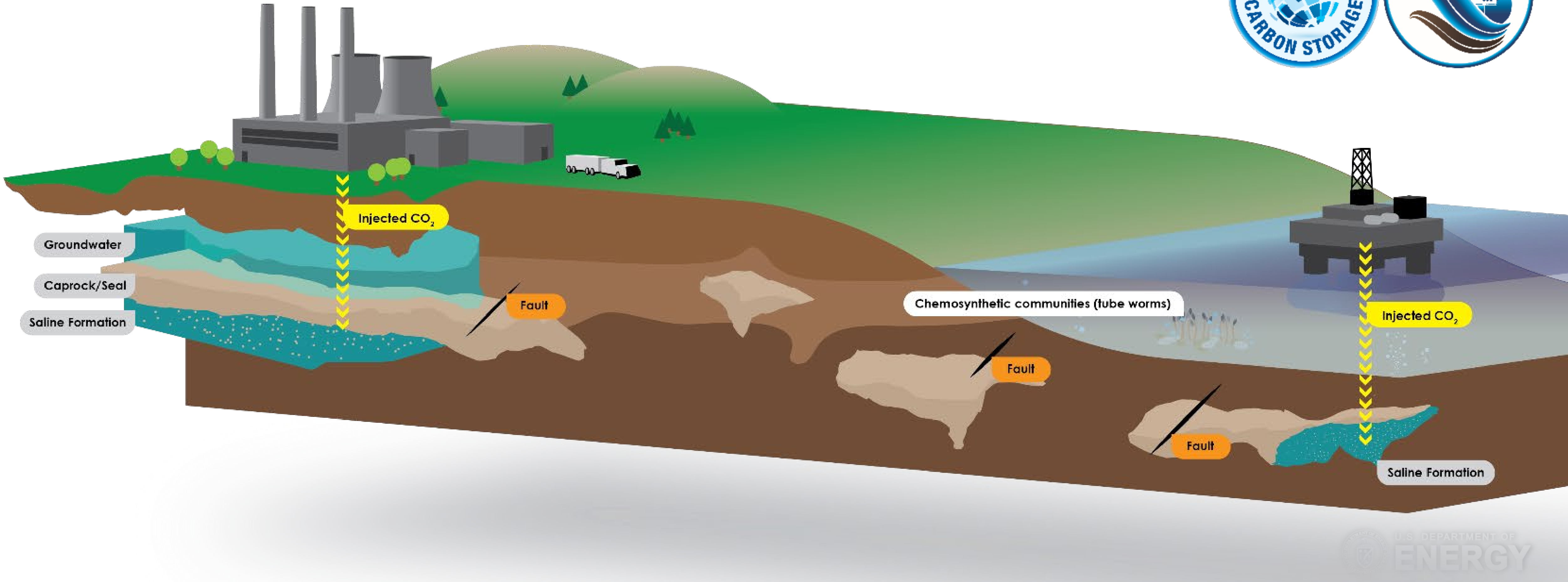
STA approach improves prediction of subsurface property values using combination of *geologic* knowledge & spatio-temporal statistical methods



Reframing Resources: Offshore CO_2 Storage in the Gulf of Mexico

NATIONAL ENERGY TECHNOLOGY LABORATORY

Calculating **safe** resource storage potential to **support decarbonization**



Offshore CO_2 Saline Storage Methodology

Built off the **DOE CO_2 Storage Methodology** for offshore saline systems

Goodman et al., 2016

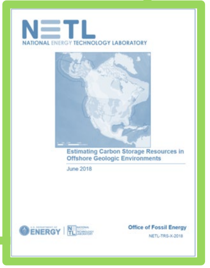
$$G_{CO_2} = A_t h_g \phi_t \rho E_{saline}$$

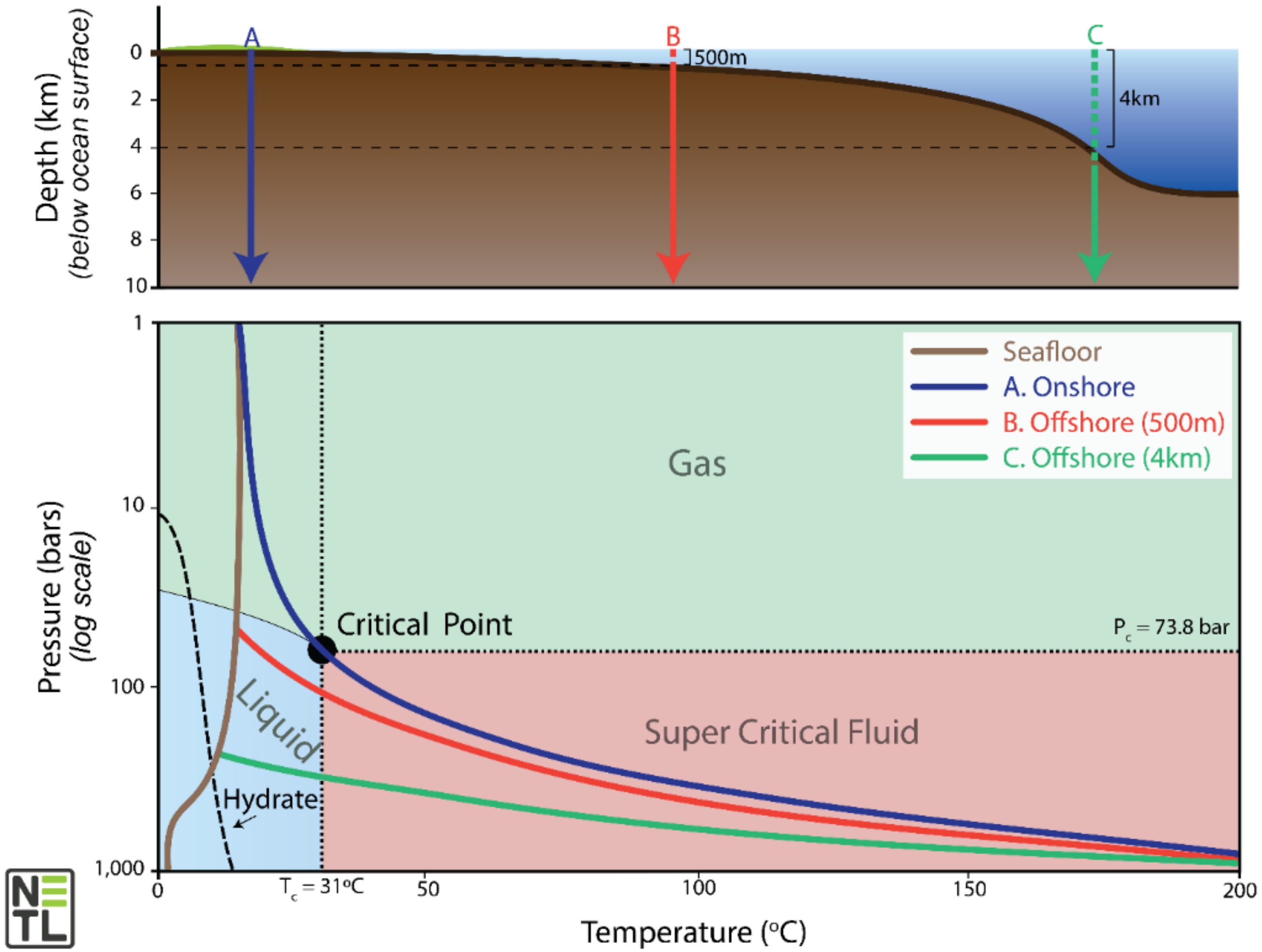
- **Long-term** volumetric estimation in **saline formations**
- Gigatons of CO_2 based on:
  - Area
  - Height
  - Porosity
  - Density
  - Efficiency

In **Offshore Systems:**

- **CO_2** behaves differently
  - *Pressure, temperature, density*
- **Sediments** also behave differently
  - *More porous & permeable*
  - *Unlithified*

Cameron et al., 2018

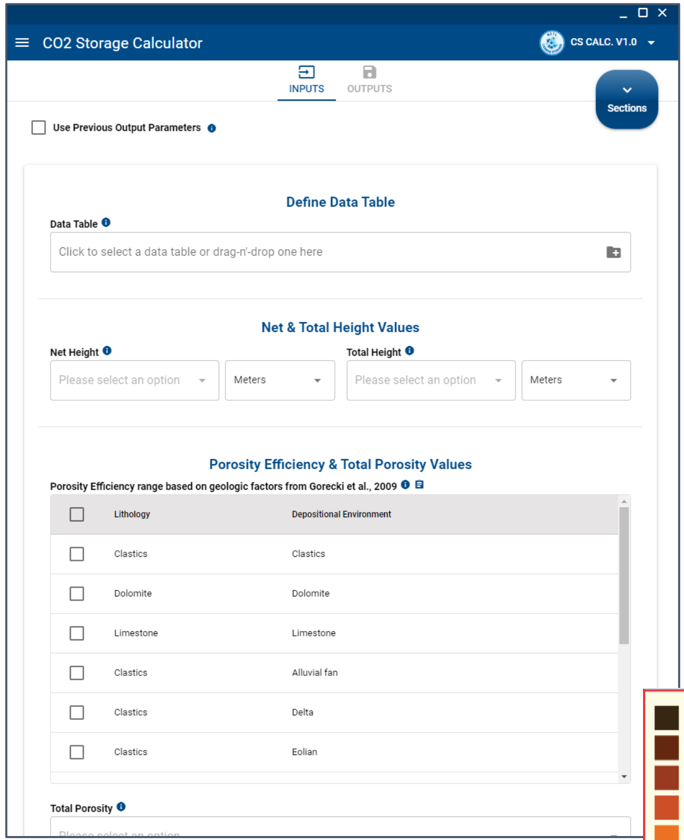




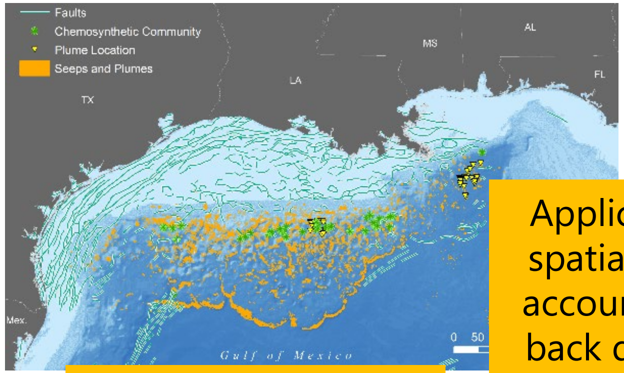
Offshore CO_2 Saline Storage Calculator

Romeo, L., et al IJGGC 2022

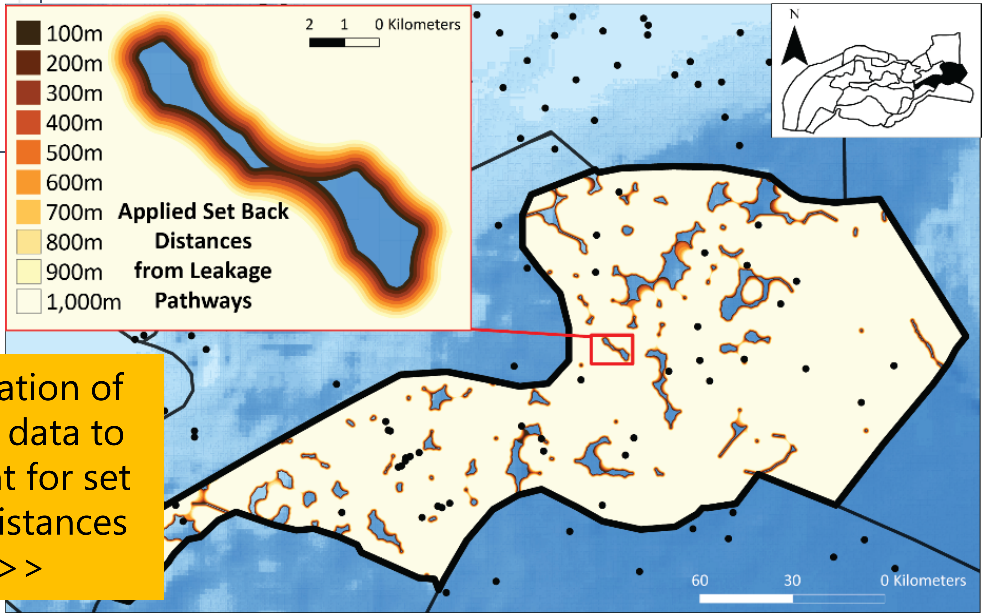
- Accounts for **changes in CO_2 density** given the overlying water column (Lemmon et al.)
- Enables the integration of **setback distances** from **potential leakage pathways**



- **Open-source** and **standalone**
- Enables **multi-scale assessments**
- Leverages **power of spatial data**
- **Flexible tool enables customization**
  - 10-20 parameters
- Applicable to multiple **lithologies** and **depositional environments** in saline formations (Gorecki et al., 2009)



Leakage pathways



Application of spatial data to account for set back distances >>>

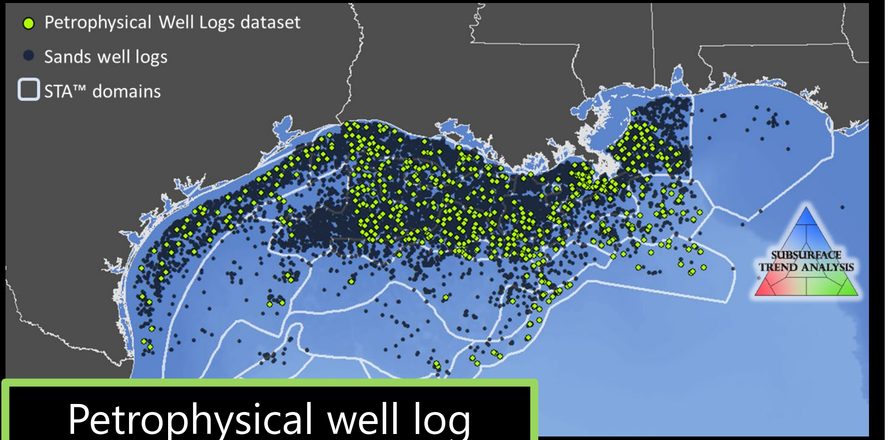
U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

https://edx.netl.doe.gov/dataset/offshore-co2-storage-calculator

Improving Offshore CO_2 Capacity Estimates

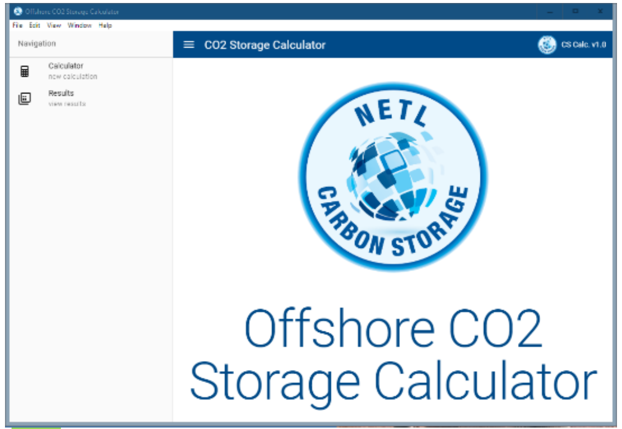
Romeo, L., et al IJGGC 2022

- **Offshore CO_2 Storage Calculator** outputs distributions of CO_2 storage, data, stats, and graphs
- Enables **multi-scale calculations**
- Demonstrated by calculating resource distributions for geologic domains as defined by Subsurface Trend Analysis™ (Mark-Moser et al., 2020)

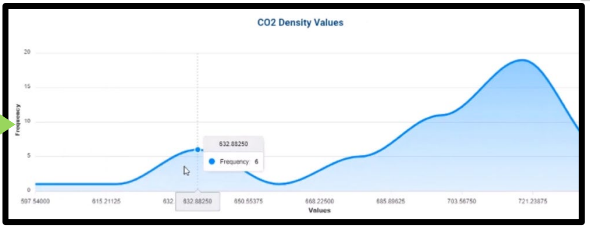


Petrophysical well log data, STA domains, and Calculator all available on EDX®

Energy Data eXchange



6	Storage Potential Values	N=62500000
7	Percentile	P-Value
8	10%	8.798893
9	50%	48.93849
10	90%	197.8562

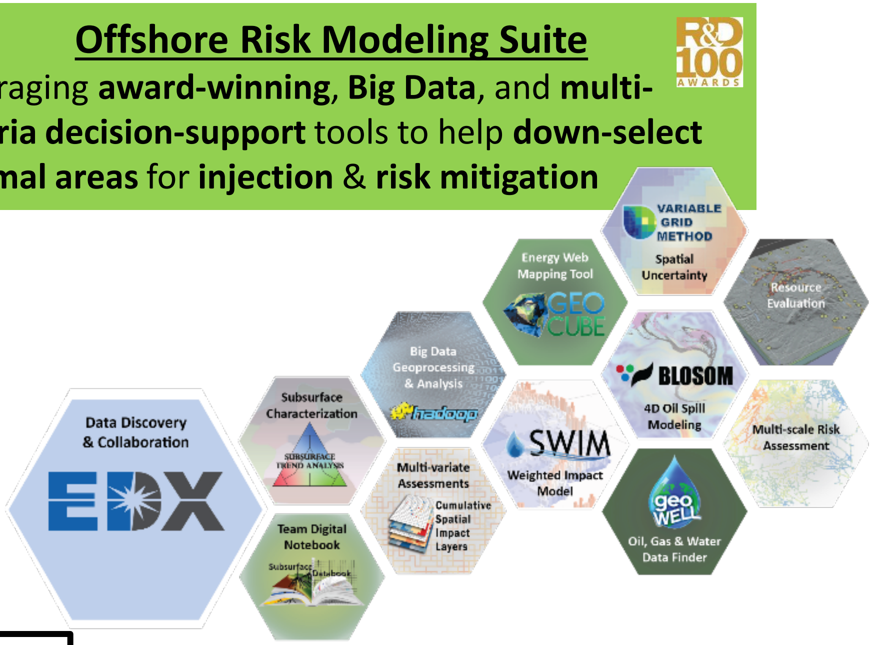


Calculator Results storage efficiency & resource

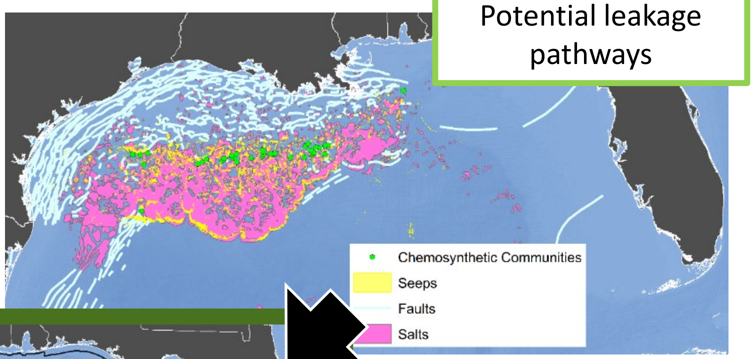
Select injection sites

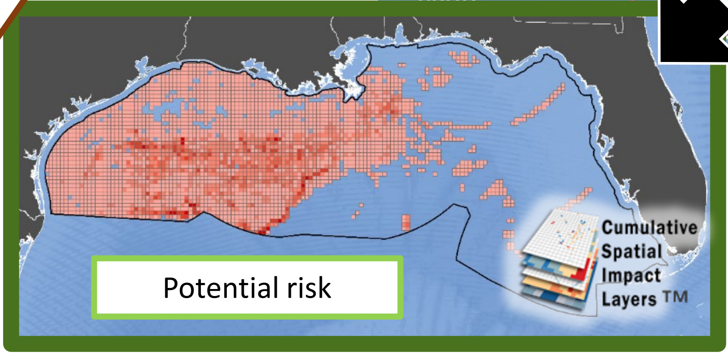
Offshore Risk Modeling Suite

Leveraging **award-winning**, **Big Data**, and **multi-criteria decision-support** tools to help **down-select optimal areas** for **injection** & **risk mitigation**



Potential leakage pathways





Potential risk

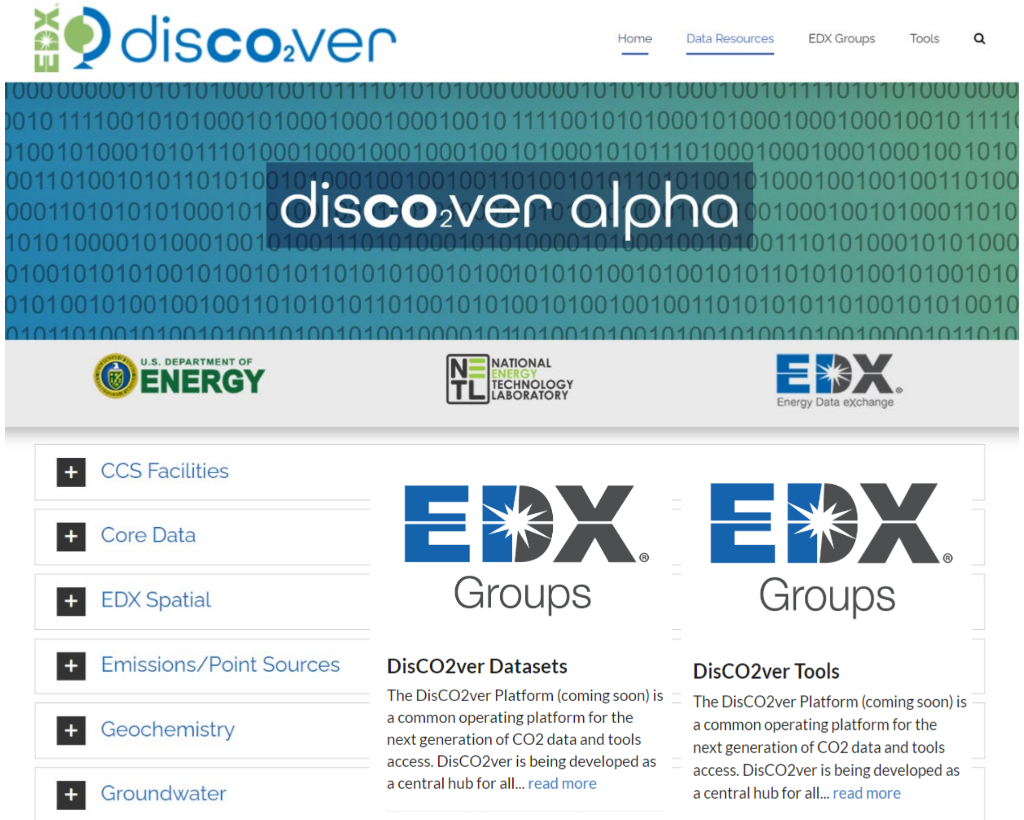
EDX DisCO2ver Platform

Digital Resources for the Carbon Storage Community

Near term (coming live, spring 2023):

EDX DisCO2ver Alpha Website

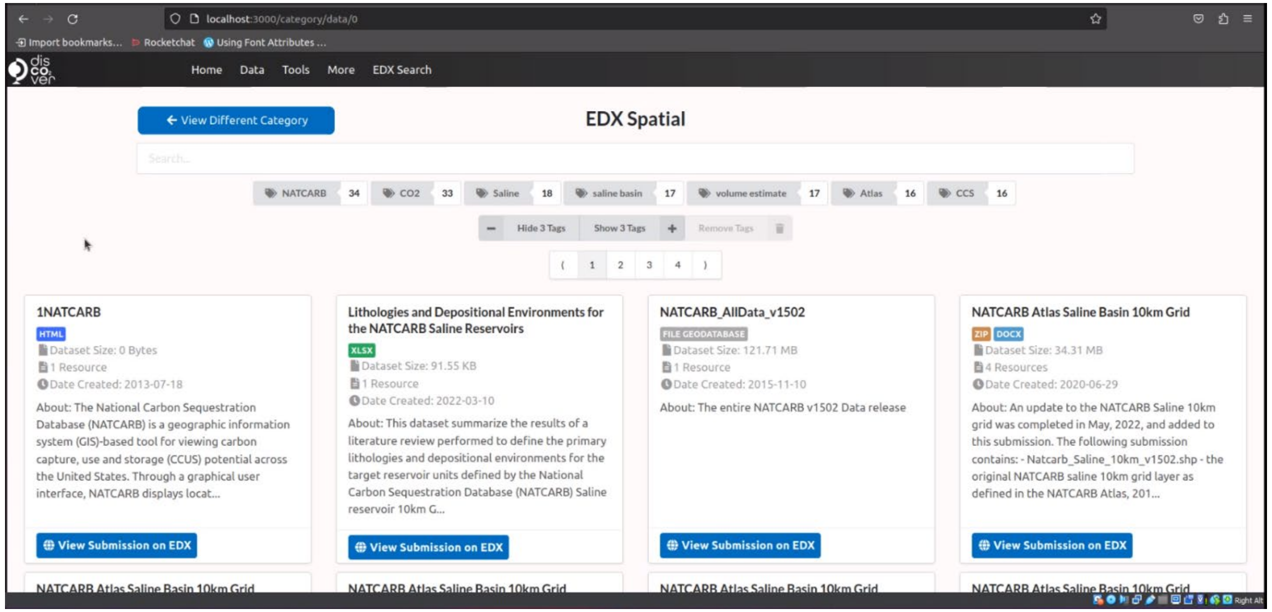
- Static website **hosting CCS specific data, tools, and resources** for user community as we wait for DisCO2ver Beta to launch.



Long term (winter/spring 2024):

EDX DisCO2ver Beta Platform

- Launch with EDX++ Deployment, expected Summer 2023
- **Dynamically** pull data from EDX into platform leveraging the EDX API
  - **Real time updates** to platform resources based on EDX query capabilities as submissions are published on EDX
  - **Integration of cloud compute** tools in future such as SmartSearch (out-year integration).



Additional Resources & References

SAMI SCIENCE-BASED AI/ML INSTITUTE

- CIIAM Model story: NETL's Ocean Current Forecasting Tool Used in Great Pacific Garbage Patch Cleanup Effort | netl.doe.gov
- Bauer, J., Justman, D., Mark-Moser, M., Romeo, L., Creason, C.G., and Rose, K., Exploring beneath the basemap, *in* Wright, D.J. and Harder, C. (Ed.), *GIS for Science: Applying Mapping and Spatial Analytics: Volume 2*, Redlands, CA: Esri Press, pp. 51-67, 2020, plus supplemental material
- Bauer, J. R., and Rose, K., 2015, Variable Grid Method: an Intuitive Approach for Simultaneously Quantifying and Visualizing Spatial Data and Uncertainty, *Transactions in GIS*. 19(3), p. 377-397. https://doi.org/10.1111/tgis.12158
- Duran, R.; Beron-Vera, F. J.; Olascoaga, M. J. Extracting quasi-Steady Lagrangian transport patterns from the ocean circulation: An application to the Gulf of Mexico. *Scientific Reports* 2018, *8*, 10. DOI:10.1038/s41598-018-23121-y
- Dyer, A.S, Mark-Moser, M., and Bauer, J., Submarine Landslide Susceptibility Mapping in the Northern Gulf of Mexico, in press, https://www.researchsquare.com/article/rs-2070041/v1
- Dyer, A.S., Zaengle, D., Nelson, J.R., Duran, R., Wenzlick, M., Wingo, P.C., Bauer, J.R., Rose, K., and Romeo, L. (2022). Applied machine learning model comparison: Predicting offshore platform integrity with gradient boosting algorithms and neural networks, Marine Structures, Volume 83, 103152. https://doi.org/10.1016/j.marstruc.2021.103152
- Mark-Moser, M.; Miller, R.; Rose, K.; Bauer, J.; Disenhof, C. Detailed Analysis of Geospatial Trends of Hydrocarbon Accumulations, Offshore Gulf of Mexico; NETL-TRS-13-2018; NETL Technical Report Series; U.S. Department of Energy, National Energy Technology Laboratory: Albany, OR, 2018; p 108. DOI: 10.18141/1461471
- Morkner, P., Bauer, J., Creason, C., Sabbatino, M., Wingo, P., Greenburg, R., Walker, S., Yeates, D., Rose, K. 2022. Distilling Data to Drive Carbon Storage Insights. *Computers & Geosciences*. https://doi.org/10.1016/j.cageo.2021.104945
- Nelson, J. R., Romeo, L., & Duran, R. (2021). Exploring the Spatial Variations of Stressors Impacting Platform Removal in the Northern Gulf of Mexico. Journal of Marine Science and Engineering, 9(11), 1223
- Romeo, L., Thomas, R., Mark-Moser, M., Bean, A., Bauer, J. and Rose, K., 2022. Data-driven offshore CO2 saline storage assessment methodology. International Journal of Greenhouse Gas Control, 119, p.103736. https://www.sciencedirect.com/science/article/pii/S1750583622001542
- Romeo, L., Nelson, J., Wingo, P., Bauer, J., Justman, D., Rose, K. 2019. Cumulative spatial impact layers: A novel multivariate spatio-temporal analytical summarization tool. Transactions in GIS.00:1–29. https://doi.org/10.1111/tgis.12558
- Rose, K., Bauer, J.R., and Mark-Moser, M., 2020, A systematic, science-driven approach for predicting subsurface properties, *Interpretation, 8:1, 167-181* https://doi.org/10.1190/INT-2019-0019.1

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