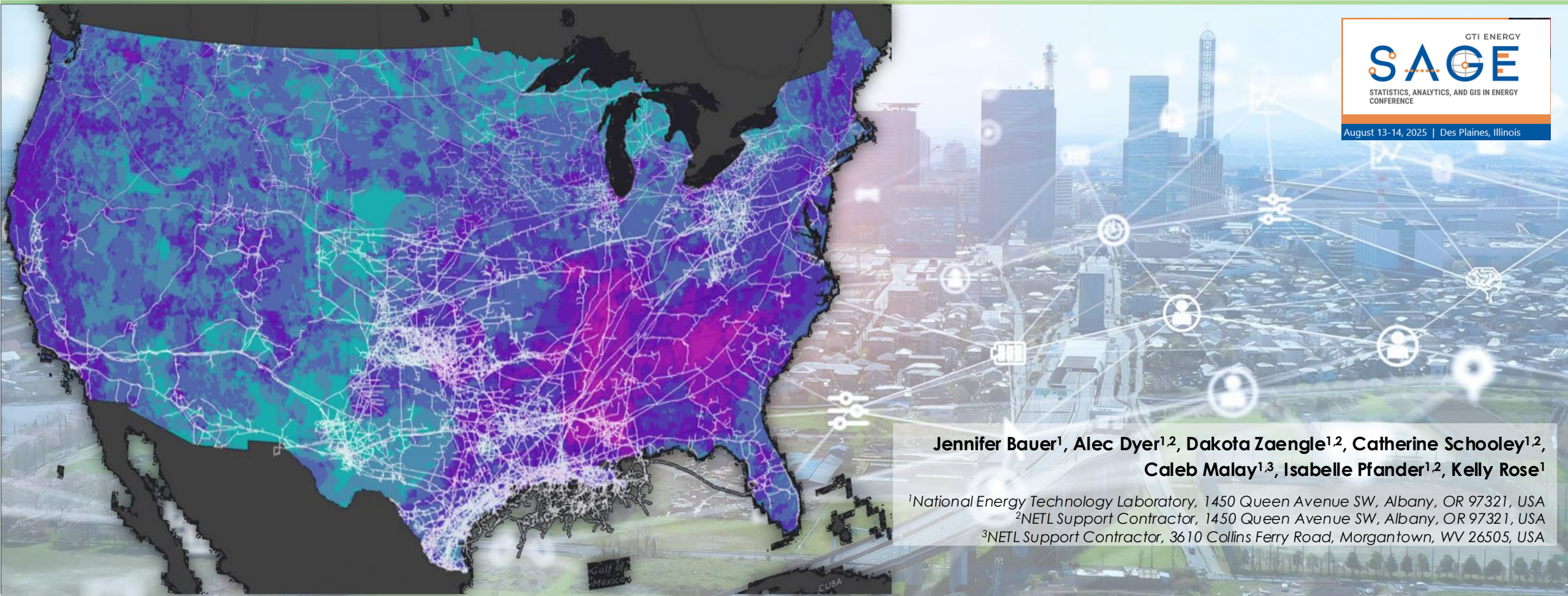# Leveraging AI and Spatial Data to Unlock Pipeline Integrity Insights: NETL's Advanced Infrastructure Integrity Model (AIIM)

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Geo-data Scientist

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- Maintaining the integrity of natural gas infrastructure plays a **critical role in ensuring energy security**

- **Robust, data-driven foundational AI models** for pipeline integrity can help address risk management and mitigation issues

- Trusted foundational models can help with **industry adoption** and **accelerate innovation** by **enhancing integrity predictions**, **reduce costs**, and **informing infrastructure build-out**
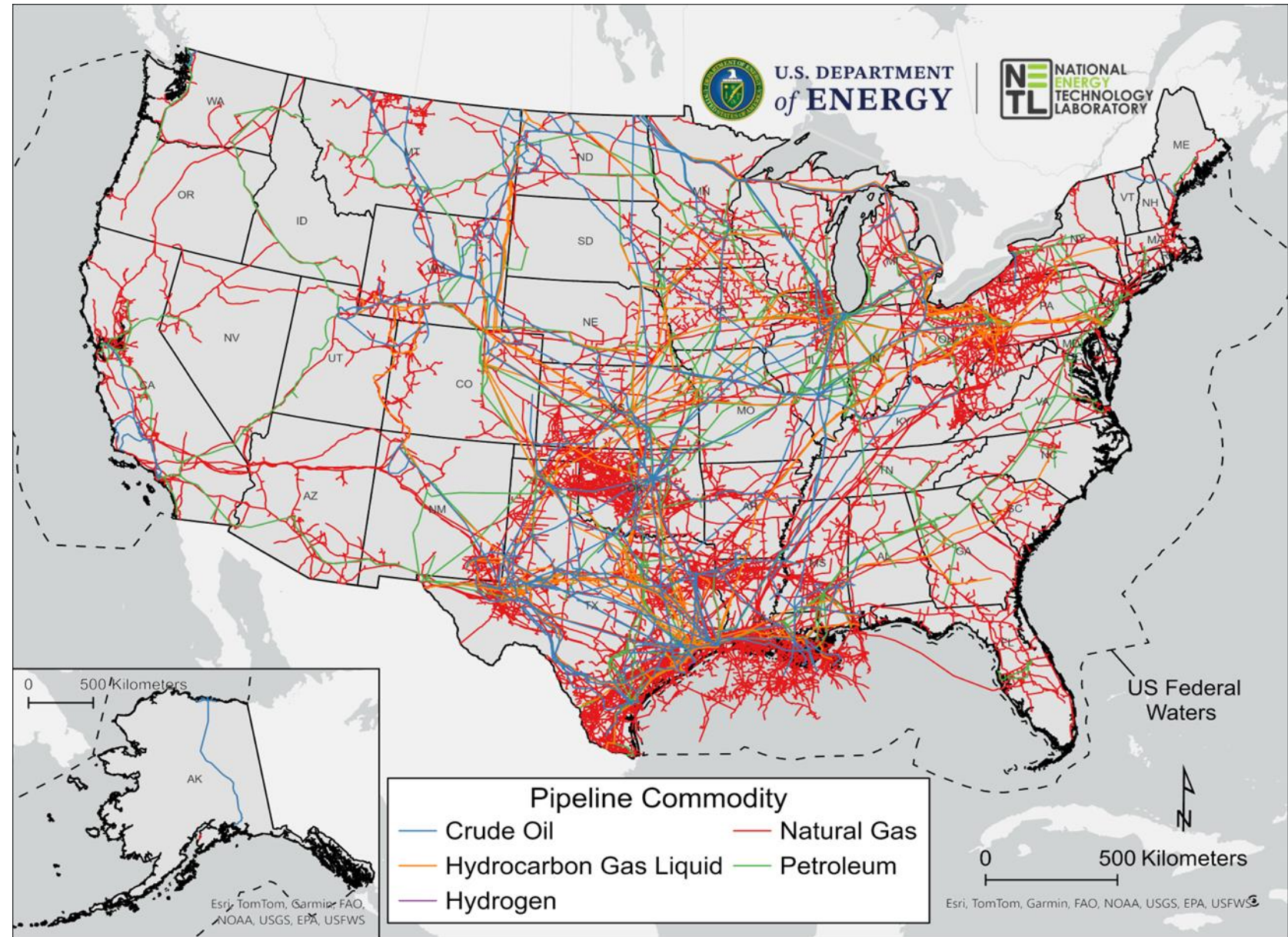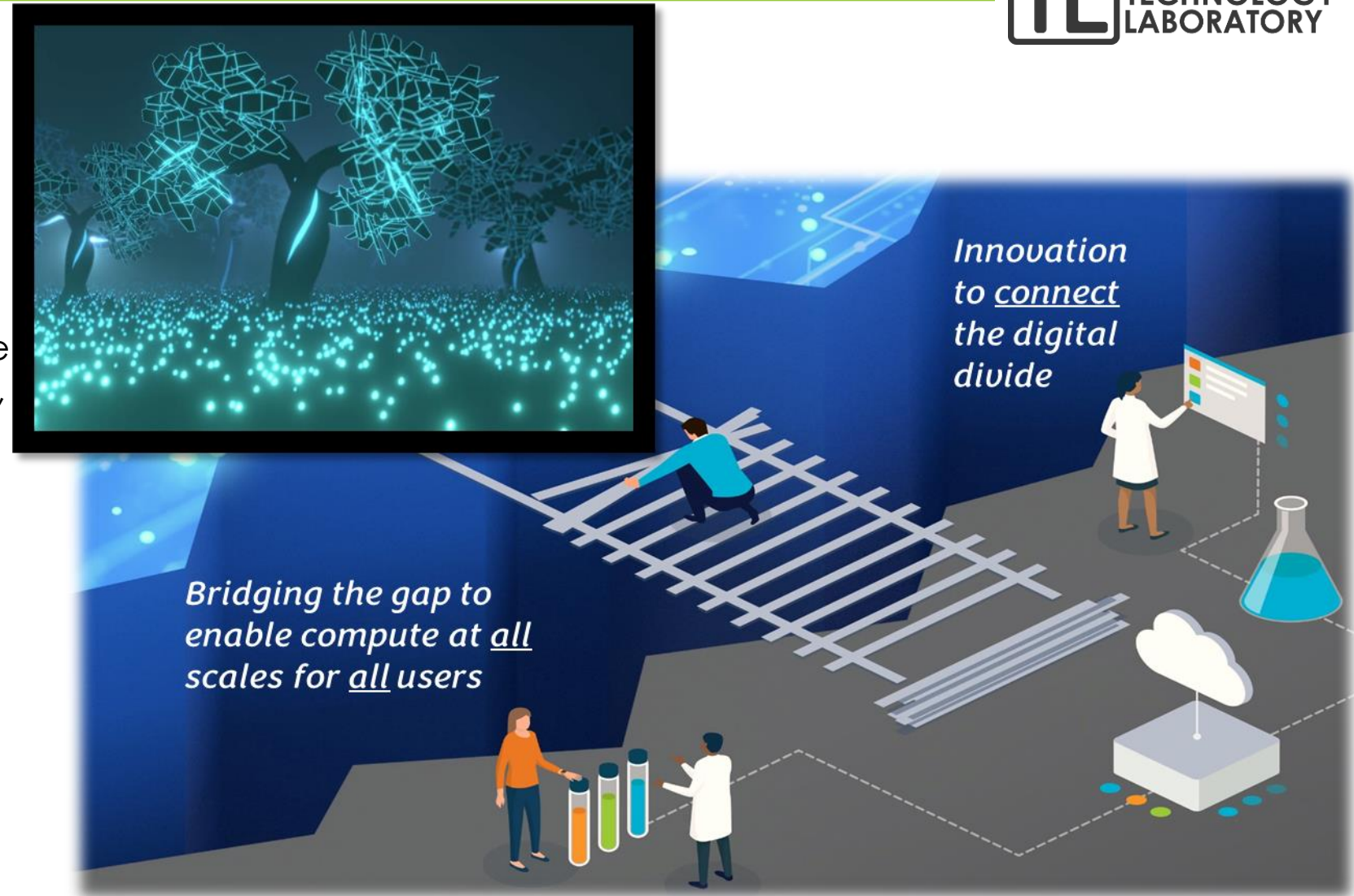
Data: keystone to digital innovation

- **AI foundational models are heavy data consumers**

- **Many data-driven projects are starved for information**

  Crowd Flower study estimates 80% of researcher project time is spent searching for relevant, existing data

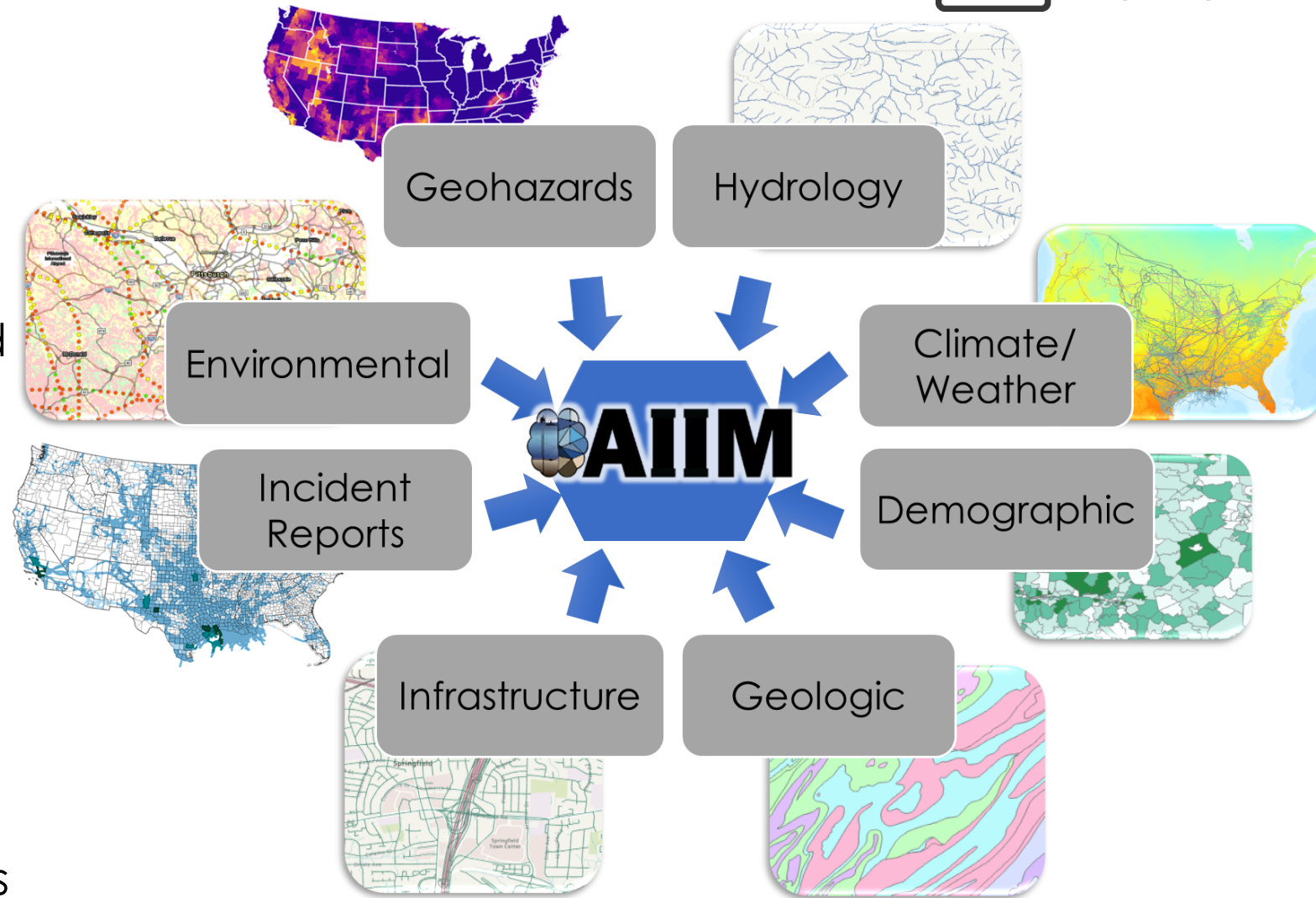 https://visit.figure-eight.com/2015-data-scientist-report

- **Requires access to data resources from different sensors, disciplines, and resources to improve our understanding of the system and improve model performance in forecasting integrity**

Innovation to _connect_ the digital divide

Bridging the gap to enable compute at _all_ scales for _all_ users

Advanced Infrastructure Integrity Model (AIIM)

- Released in 2022

- A big-data-driven, artificial intelligence/machine learning (AI/ML) foundational model

- Originally designed to assess *offshore* energy infrastructure and forecast remaining lifespan and integrity risk

- Generalist natural of model is allowing us to update now for onshore infrastructure

- Leverages data spanning the natural-engineered system to inform local predictions from multiple machine learning models

Geohazards · Hydrology · Climate/Weather · Demographic · Geologic · Infrastructure · Incident Reports · Environmental → AIIM

Amassing Big Data for AIIM

Using the Whole to Inform Local Trends & Predictions

Onshore Data

348k+ miles of pipelines

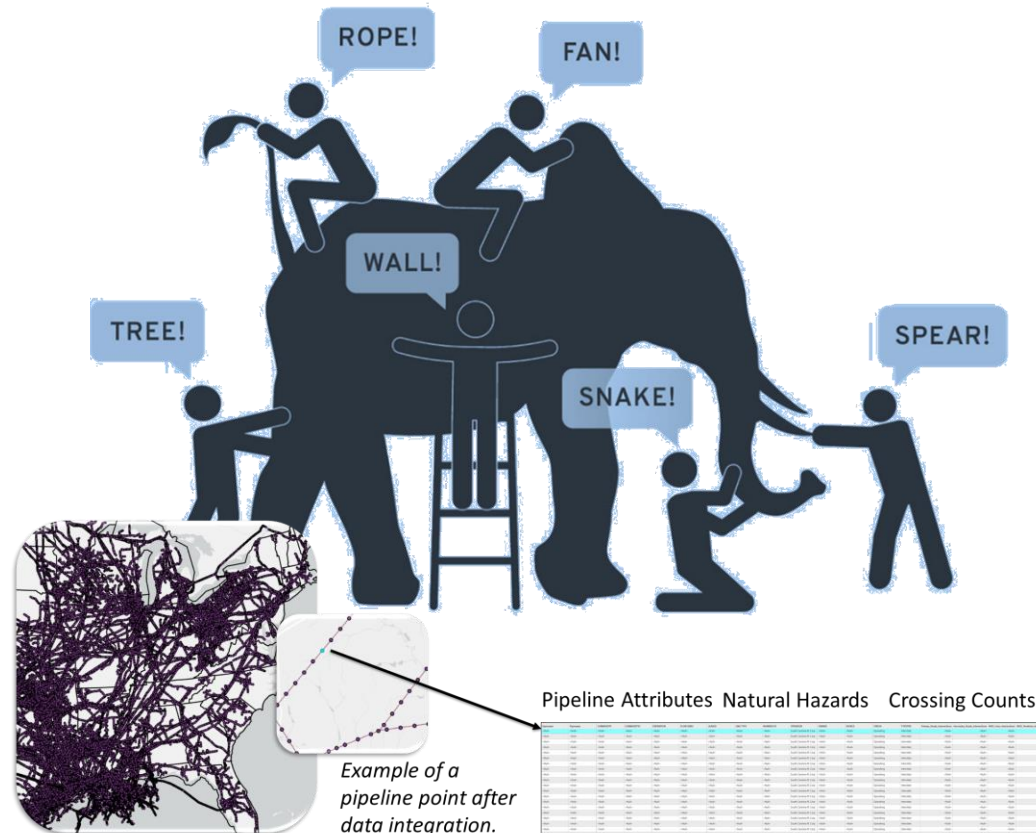including a grid of **500k+ points along every km of pipe, integrated with 350 associated stress-related values:**

environmental and geohazard layers

proximity to infrastructure

biochemical data

35+ years of PHMSA pipeline incidents

Offshore Data

11k+ platform records

47k+ miles of pipelines

55k+ well records

51k+ environmental and geohazard layers

46GB+ biochemical data

Spatio-temporal production data at the well, platform, and lease block level
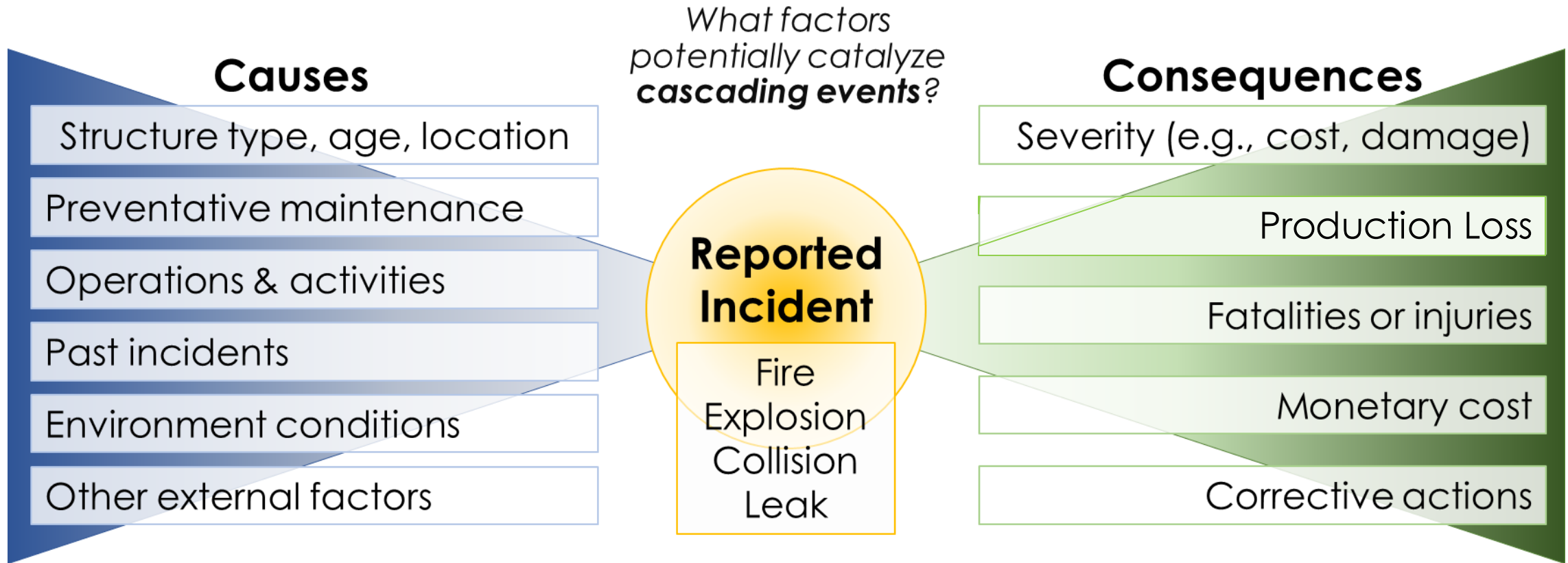
70+ years of platform incidents

30+ years of pipeline incidents
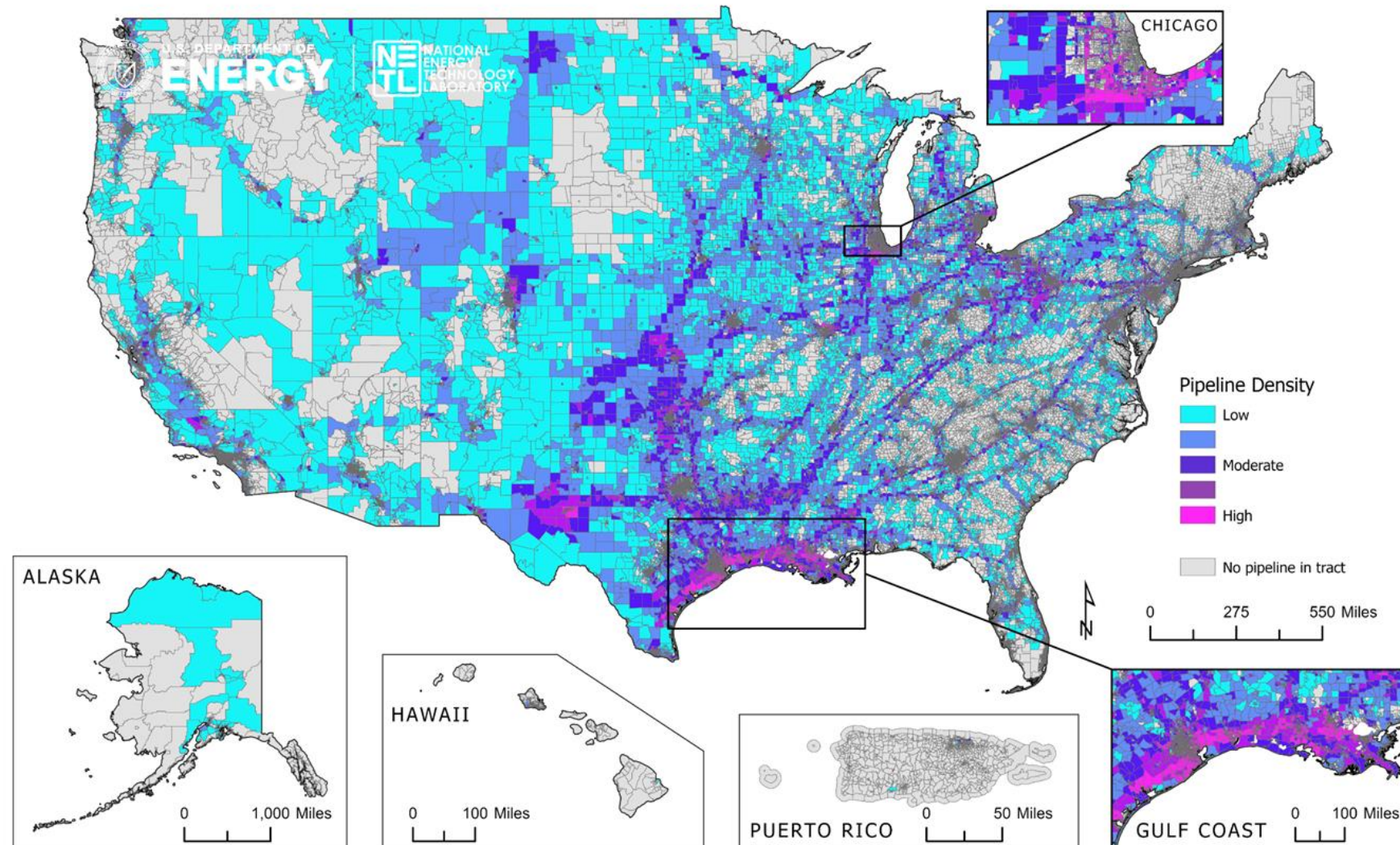
50.6GB of monthly ship trackline data

Example of a pipeline point after data integration.

Pipeline Attributes | Natural Hazards | Crossing Counts

Expanding Analytics on Reported Incidents

Examining Risk Cause and Effect

What factors potentially catalyze **cascading events***?*

Causes

- Structure type, age, location
- Preventative maintenance
- Operations & activities
- Past incidents
- Environment conditions
- Other external factors

Reported Incident

Fire
Explosion
Collision
Leak

Consequences

- Severity (e.g., cost, damage)
- Production Loss
- Fatalities or injuries
- Monetary cost
- Corrective actions

Looking at data trends for onshore pipelines

Utilize Multi-ML Models for ensemble-type model insights

Models Included:

- Gradient Boosted Decision Trees (GBDT) (Dyer et al. 2022)
- Artificial Neural Network (ANN) (Dyer et al. 2022)
- Geographically Weighted Regression (Nelson et al. 2021)

Model output insights, including feature importance, will be accessible along with incident trends
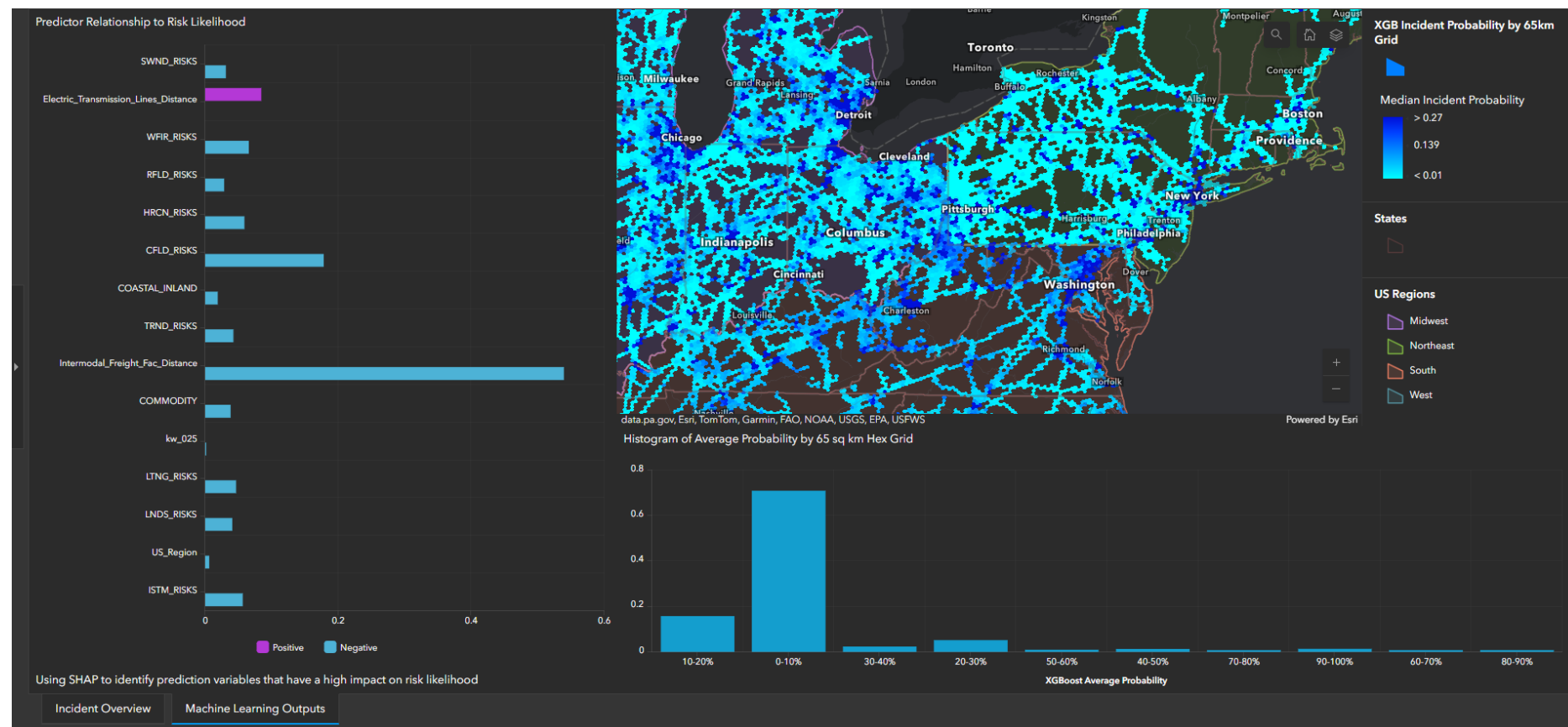
In progress of integrating AIIM model & output insights for onshore pipelines into a dashboard for easy review and use – scheduled for release to EDX at end of October 2025

AIIM Dashboard

## Delivering Data- and Model-Driven Insights

- Developed as an **ESRI Dashboard** to support data visualization & interrogation

- Contains **pipeline data** and model results

- Adding in **updated platform data** and model results

- Enable spatially querying by **areas of interest** (lease blocks, protraction areas, etc.)

EDX
Energy Data eXchange

Database & web tool available

Catherine Schooley, Lucy Romeo, Dakota Zaengle, Isabelle Pfander, Rodrigo Duran, Jennifer Bauer, Kelly Rose, (2024) Advanced Infrastructure Integrity Modeling Dashboard, https://edx.netl.doe.gov/dataset/offshore-aiim-dashboard
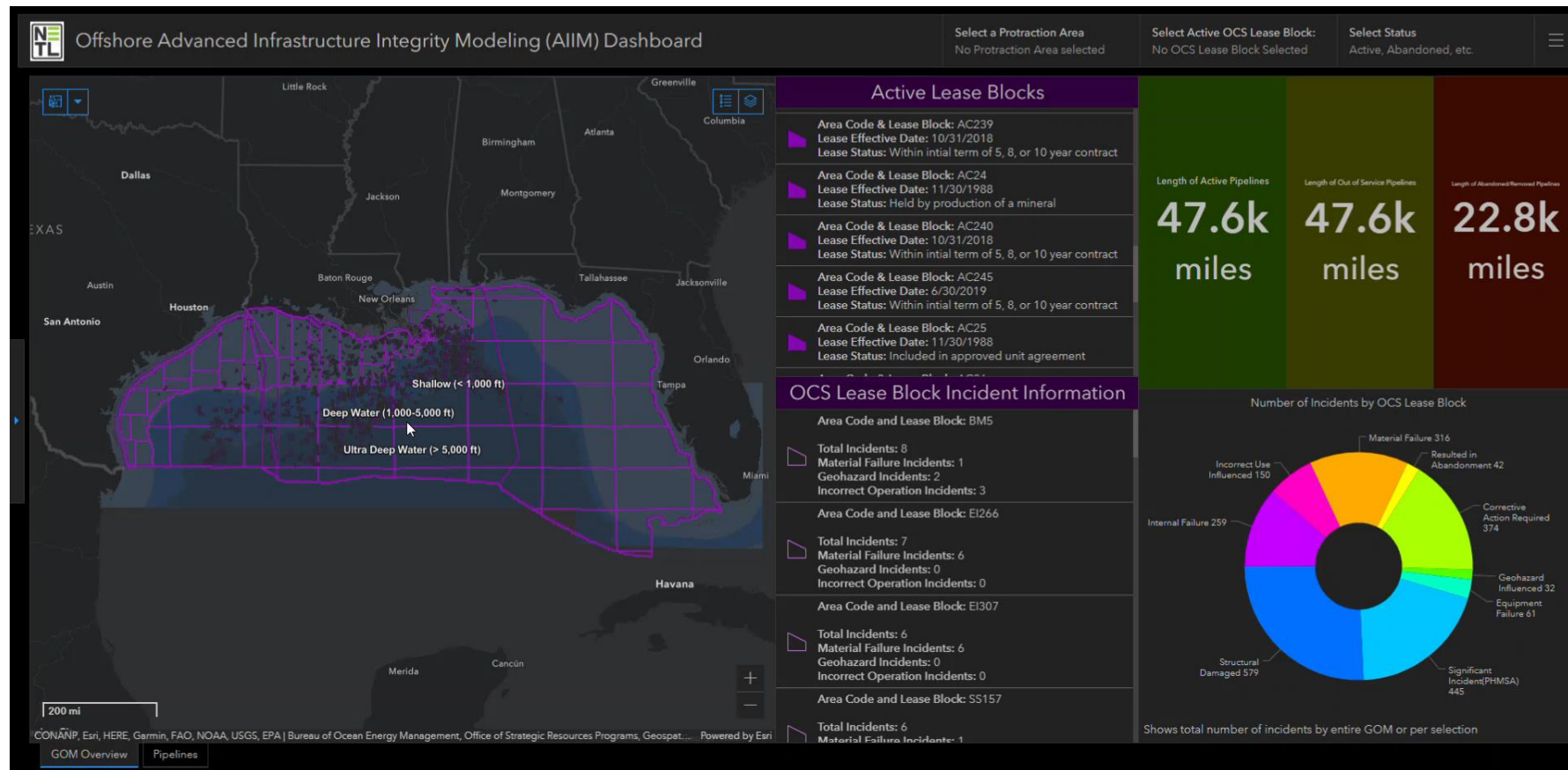
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