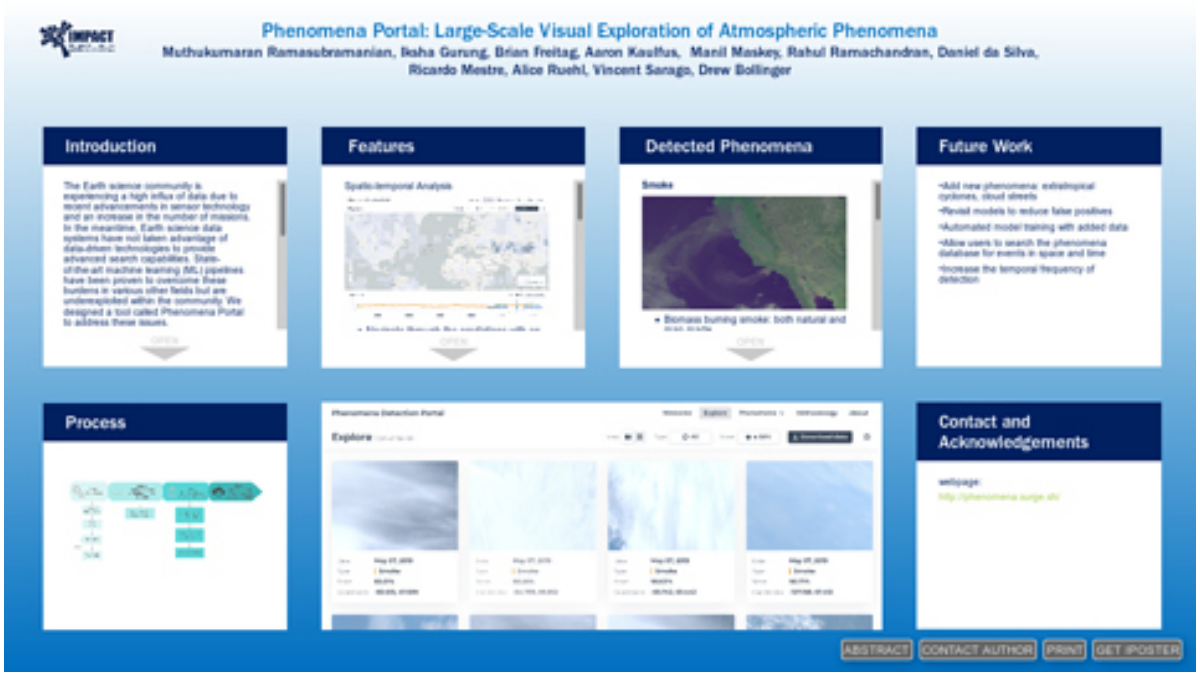
Phenomena Portal: Large-Scale Visual Exploration of Atmospheric Phenomena



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INTRODUCTION

The Earth science community is experiencing a high influx of data due to recent advancements in sensor technology and an increase in the number of missions. In the meantime, Earth science community have not taken advantage of data-driven technologies to provide advanced search capabilities. State-of-the-art machine learning (ML) pipelines have been proven to overcome these burdens in various other fields but are underexploited within the Earth Science community. We designed a tool called Phenomena Portal to address these issues.

Phenomena Portal is a visual exploration tool that uses ML to detect various atmospheric phenomena on a global scale. This allows the Earth and atmospheric science communities to view trends of phenomena occurrences, identify potential relationships between them, and analyze spatiotemporal patterns over time. These detections can also serve as initial labeled data for ML research pertaining to the respective phenomena. The tool also incorporates feedback from subject matter experts to further improve the model detection accuracy, thereby facilitating human-in-the-loop.

FEATURES

Spatio-temporal Analysis

- Navigate through the predictions with an adjustable timeline
- Zoom in anywhere on the map for more refined predictions

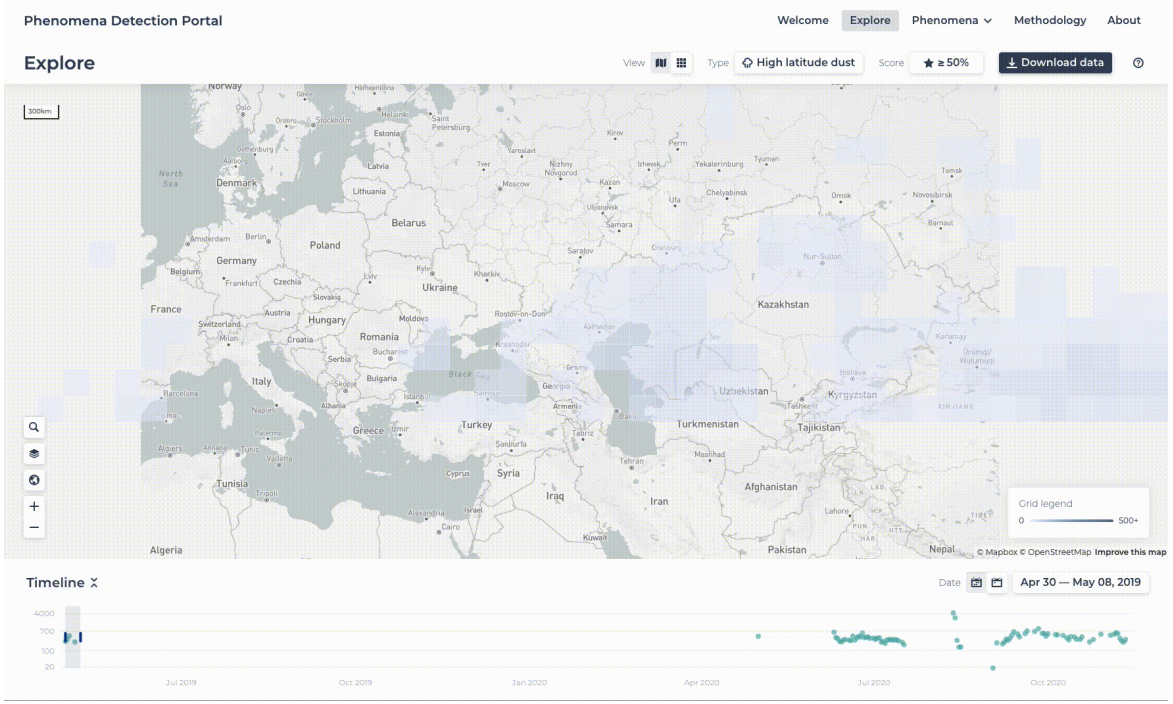
Toggle Map Layers, and Phenomena

- Support for multiple layers (GOES-W, Mapbox, MODIS-Terra)
- Choose any combination of phenomena to visualize at any given time.

Investigate Detections

- Alternative view mode: detections along with the source images, location, time, and confidence score.

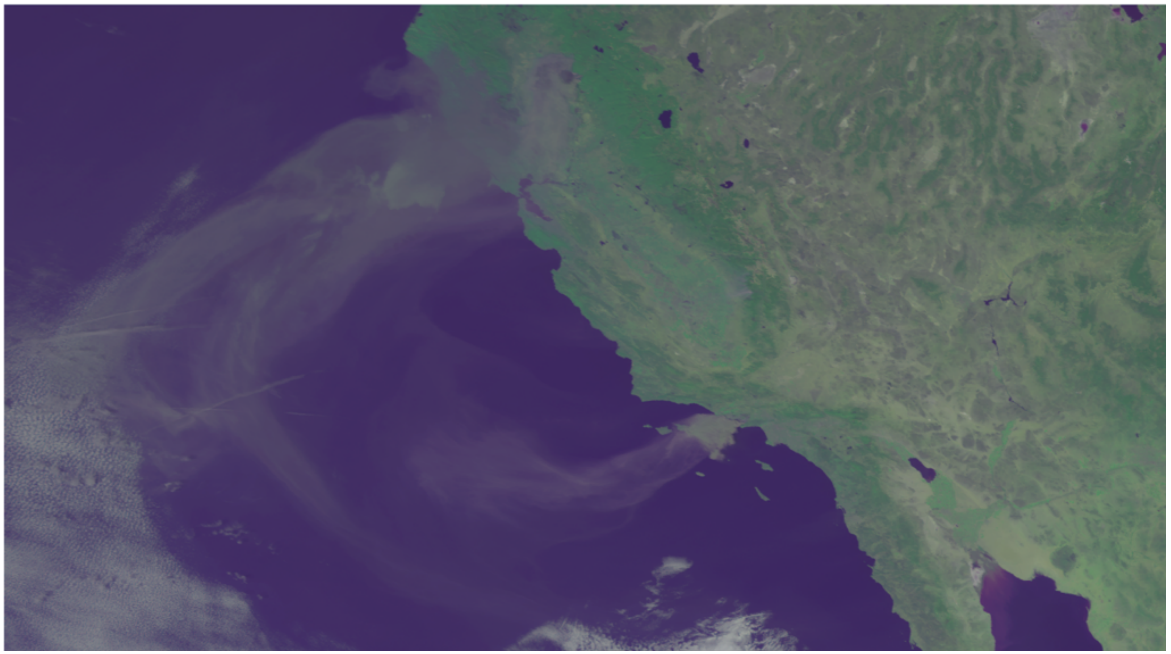
Deep Dive on Specific Event



- Click on the detected polygon on the map for detailed information on the event

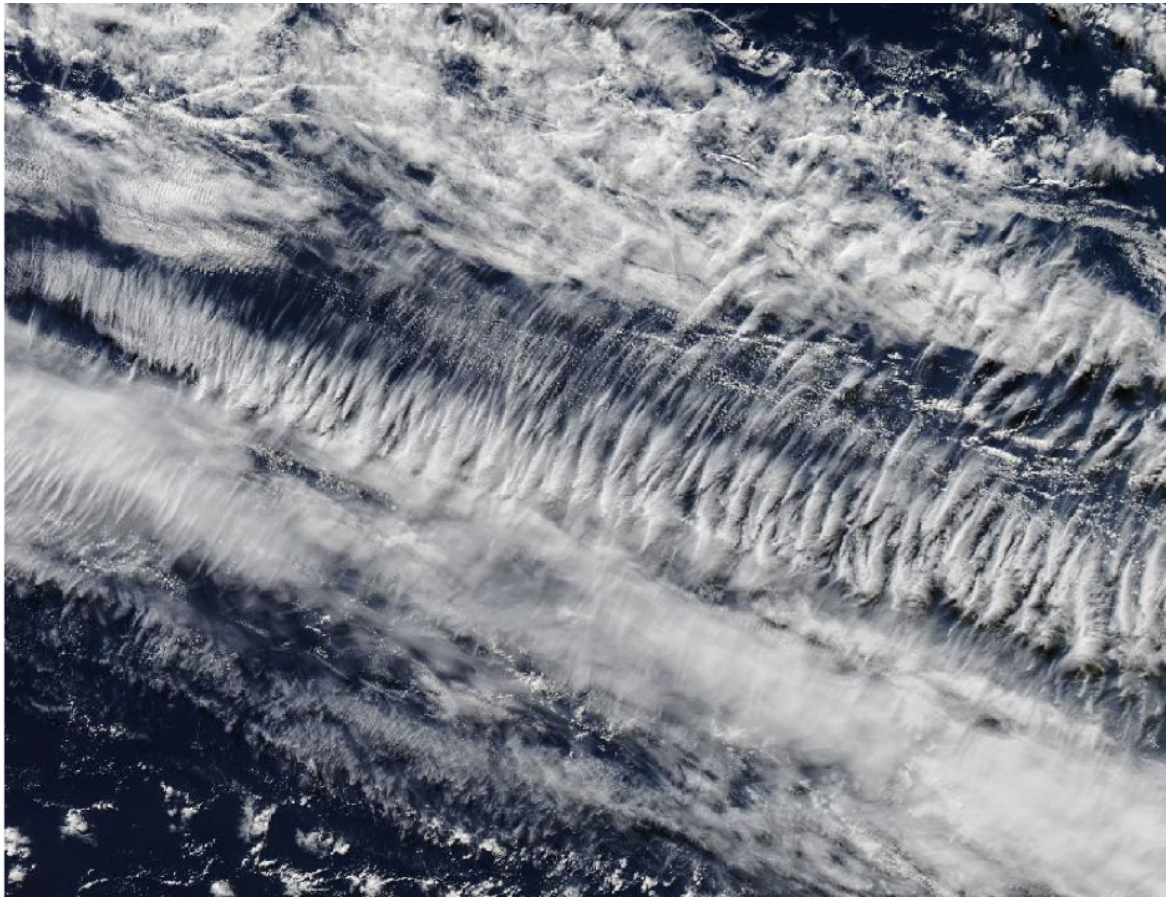
DETECTED PHENOMENA

Smoke



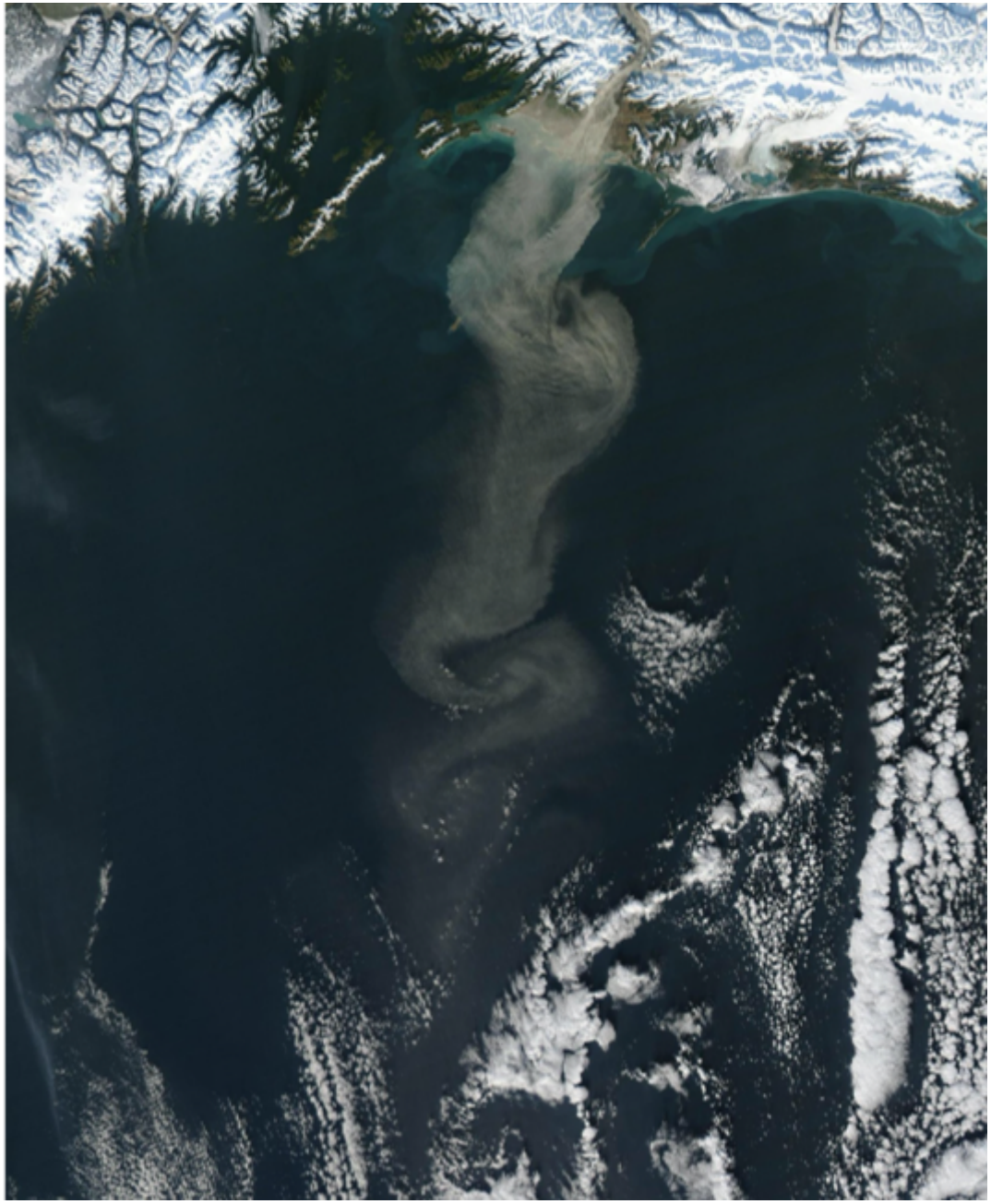
- Biomass burning smoke: both natural and man-made
- U-Net CNN architecture used for segmentation

Transverse Cirrus Bands



- Irregularly spaced band-like cirrus clouds
- Custom “You Only Look Once” (YOLO) network for object localization

High Latitude Dust

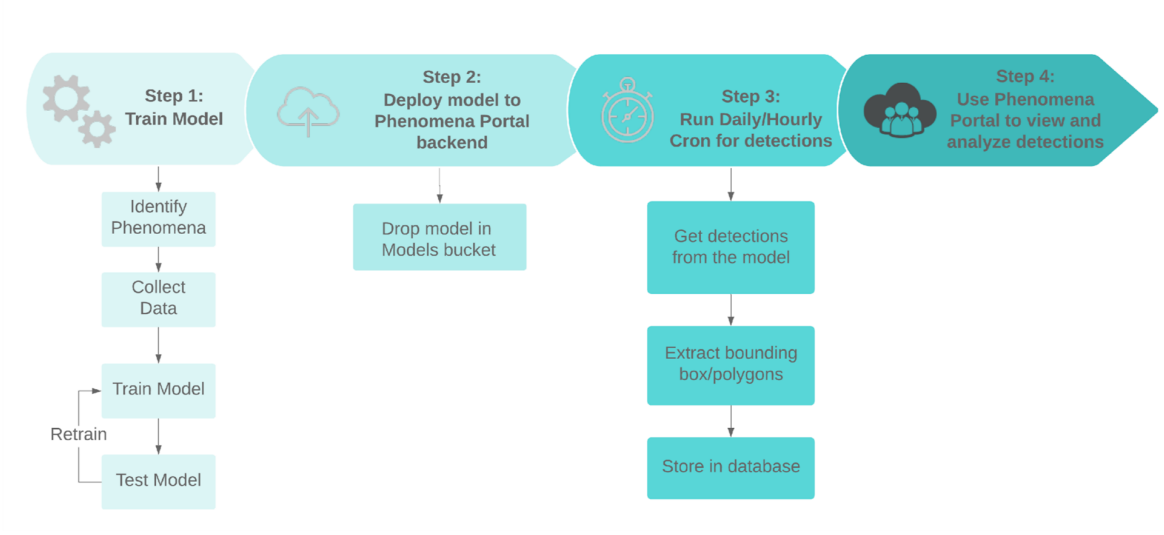


- Dust events occurring in higher latitudes (above 40N and 50S)
- U-Net CNN architecture used for segmentation

FUTURE WORK

- Add new phenomena: extratropical cyclones, cloud streets
- Revisit models to reduce false positives
- Automated model training with added data
- Allow users to search the phenomena database for events in space and time
- Increase the temporal frequency of detection

PROCESS



Step 1: Train Model

- SME's Identify the phenomena to detect utilizing literature surveys as needed, and establish state-of-the-art detection performance.
- The instances phenomena are labeled using an in-house tool called ImageLabeler.
- Data is pre-processed for input into the ML model, and the model is trained using the data.
- Model performance is tested and re-trained until it meets detection standards put forth by SMEs.

Step 2: Deploy Model

- The best model from the training phase is saved in Amazon S3 buckets.

Step 3: Run Daily/Hourly Detections

- The detections are made by invoking the model inference daily/hourly.
- The detections are converted into polygons and spatiotemporally stamped.
- The polygons are stored in the database form of GeoJsons

Step 4: Visualize Detections

- The Phenomena Portal is used to visualize the stored detections for further analysis by the users.
- The optional detection feedback from the users is stored back in the database for further model improvements

CONTACT AND ACKNOWLEDGEMENTS

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Acknowledgments:

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ABSTRACT

The Earth science community is experiencing a high influx of remote sensing data due to recent advancements in sensor technology. This enables the community to extend their research on a larger scale than ever before. Unfortunately, traditional data processing techniques do not scale well to these new, high volume data sources. State-of-the-art machine learning (ML) pipelines have been proven to overcome these burdens in various other fields but are underexploited within the physical sciences community. Moreover, ML is reliant on labeled data, which is currently sparsely available, owing to the fact that ML adoption is still in the early stages within the Earth and atmospheric science communities. To address these issues, we developed the Phenomena Portal, a visual exploration tool that uses ML to detect various atmospheric phenomena on a global scale. This allows the Earth and atmospheric science communities to view trends of occurrences of phenomena, identify potential relationships between them, and analyze spatiotemporal patterns over time. These detections can also serve as initial labeled data for ML research pertaining to the respective phenomena. The tool also incorporates feedback from subject matter experts to further improve the model detection accuracy, thereby facilitating human-in-the-loop. This presentation will provide an overview of the ML model development and cloud deployment. We also discuss the capabilities of the user interface for displaying the detections