Machine Learning-Based Atmospheric Phenomena Detection Platform

Iksha Gurung[1], Brian Freitag[1], Aaron S Kaulfus[1], Muthukumaran Ramasubramanian[1], Manil Maskey[2], Rahul Ramachandran[2], Andrew Bollinger[3]

1- University of Alabama in Huntsville, 2 - NASA Marshall Space Flight Center, 3 – Development Seed

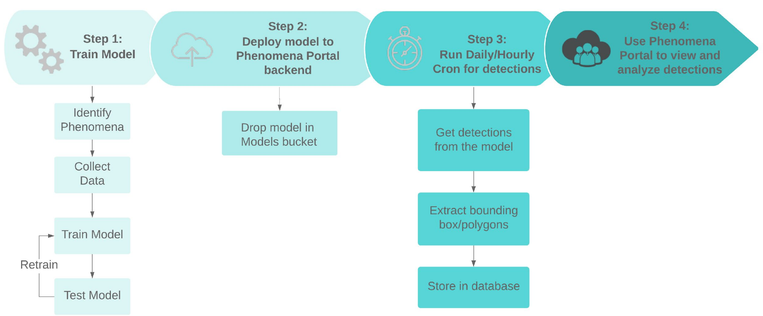
IMPACT
Interagency Implementation and Advanced Concepts Team

Introduction

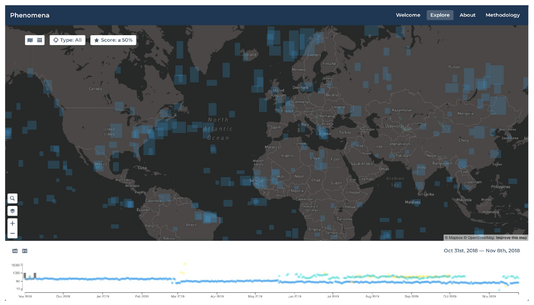
As the number of Earth pointing satellites has increased over the last several decades, the data volume retrieved from instruments onboard these satellites has also increased. It is expected that this trend will continue as more data intensive missions and small satellite constellations are launched. Currently, feature detection - namely atmospheric phenomena - in these datasets is performed manually and is thus not scalable with the growing data archives. Recent advancements in computational efficiency allow for the Earth science community to leverage machine learning to identify interesting atmospheric phenomena. Given the wide range of distinctive features in various atmospheric phenomena, a specialized machine learning model is required for accurate detection of these phenomena independently.

The Phenomena Portal, developed at NASA IMPACT, is designed to provide visualization for the output from these machine learning models. In addition, detected events for each atmospheric phenomena are stored in a database that can be used to more easily use/subset larger spatiotemporal datasets. The user interface also incorporates additional features to enhance the user experience including spatiotemporal analysis, multiple base layer images, and a slider to filter events with lower probabilities of positive detection. Each detection supports user feedback on whether the detection is true or false that can then be stored and used to improve the machine learning model performance.

Process



Features

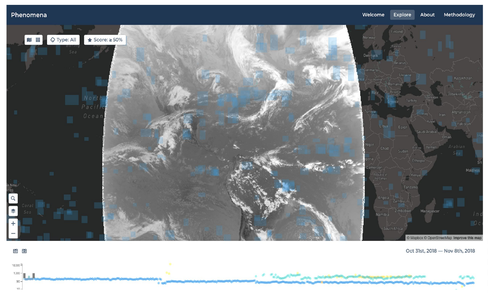


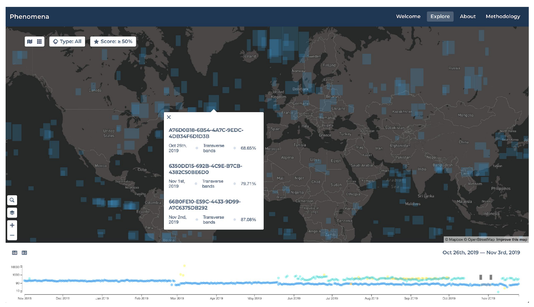
Spatiotemporal Analysis

- Interact with map, navigate through time to perform spatiotemporal analysis on the selected phenomenon.

Toggle Map Layers, and Phenomena

- Toggle between different map layers (Mapbox base map, GOES IR).
- Toggle between phenomena (Transverse Cirrus Bands, High Latitude Dust, Smoke)



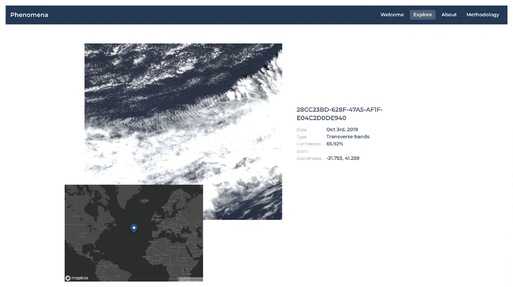


Investigate Detections

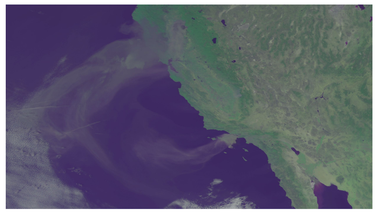
- Detections from machine learning models
- Analyze the detections based on scores and the corresponding Images.

Deep Dive on Specific Event

- Interact with the images used for classification to look at the spatiotemporal information for the image by clicking on a specific event.



Phenomena

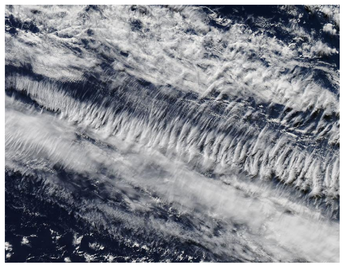


Smoke

- Natural or man made fire
- Custom Convolutional Neural Network (CNN) used for pixel classification

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)
- Custom CNN for pixel classification

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

Contact: ig0004@uah.edu

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