Wildfire detection using GEO satellite imagery and machine learning

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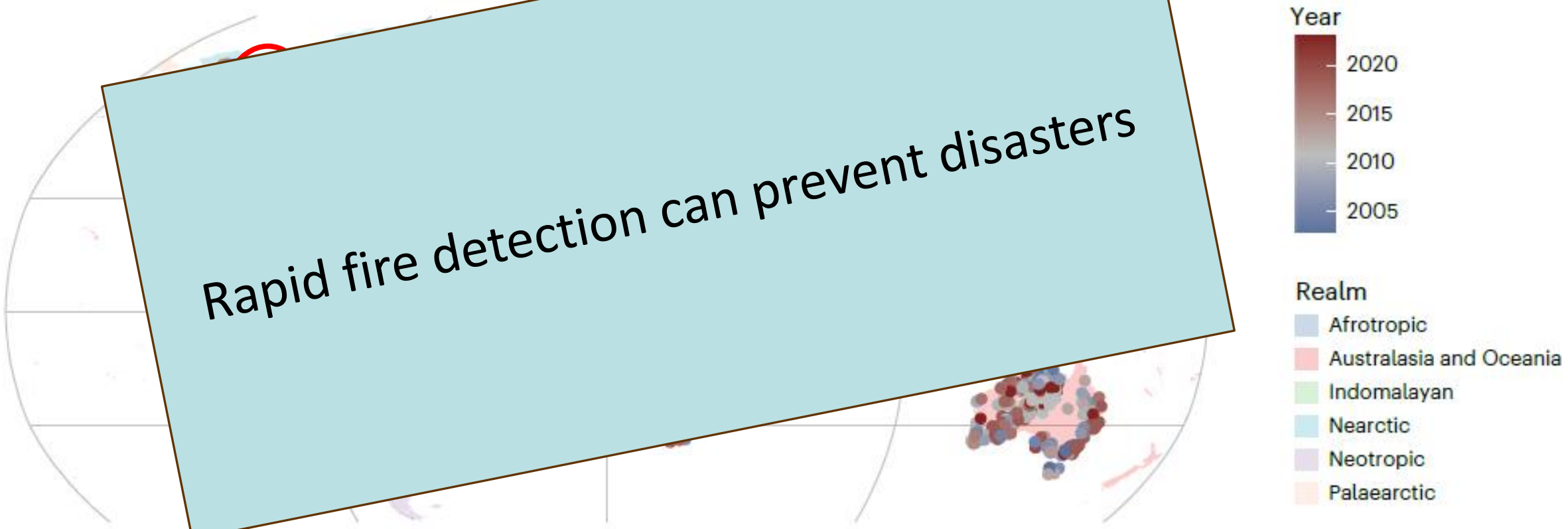
Extreme Fire Events

The frequency of extreme fire events increased by 2.2 from 2003 to 2023 (Cunningham et al., 2024)



Rapid fire detection can prevent disasters

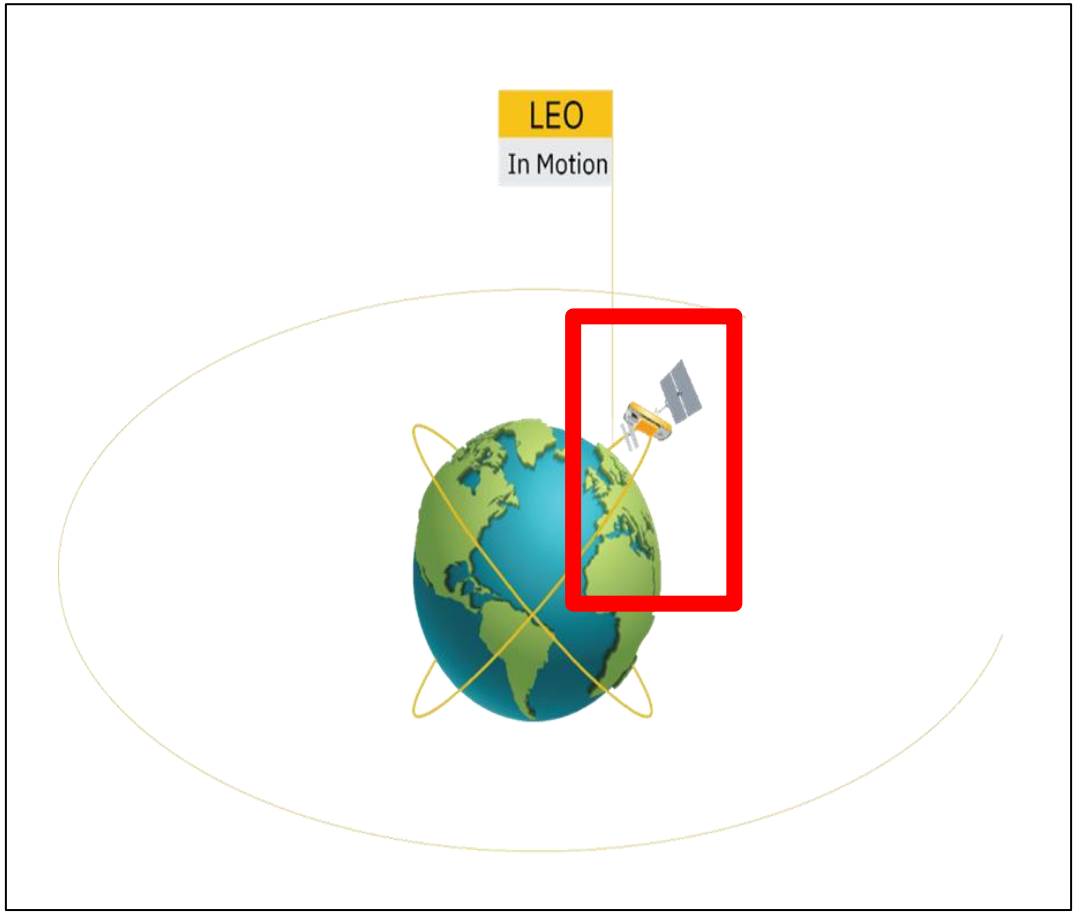
Fire Detection Using Satellite Imagery

Two types of satellites that are used for fire detection:

Low-Earth-Orbit (LEO)

Geosynchronous Equatorial Orbit (GEO)

	LEO
Altitude (km)	400-700
Spatial resolution (m)	30 - 1000
Spectral resolution (bands)	11 - 22
Temporal resolution	12 – 24 hours (up to 16 days)



GEO and LEO Fire Products

So what is the challenge?

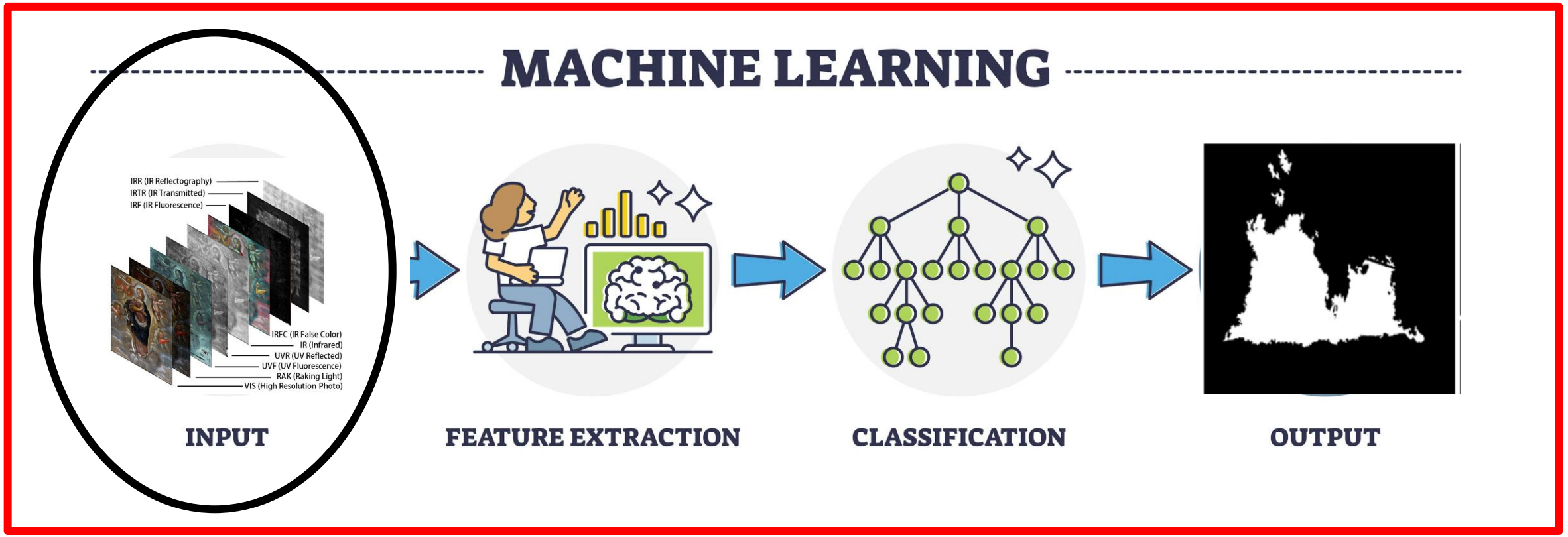
GEO Fire Products Limitations

Main Goal

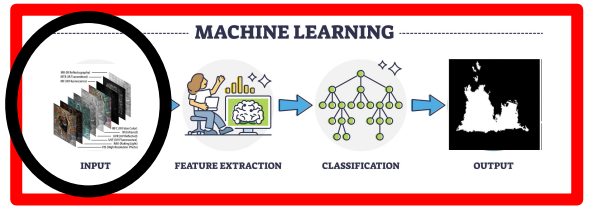
To develop a machine learning model for GEO fire detection:

- More accurate
- Low false alarm rates

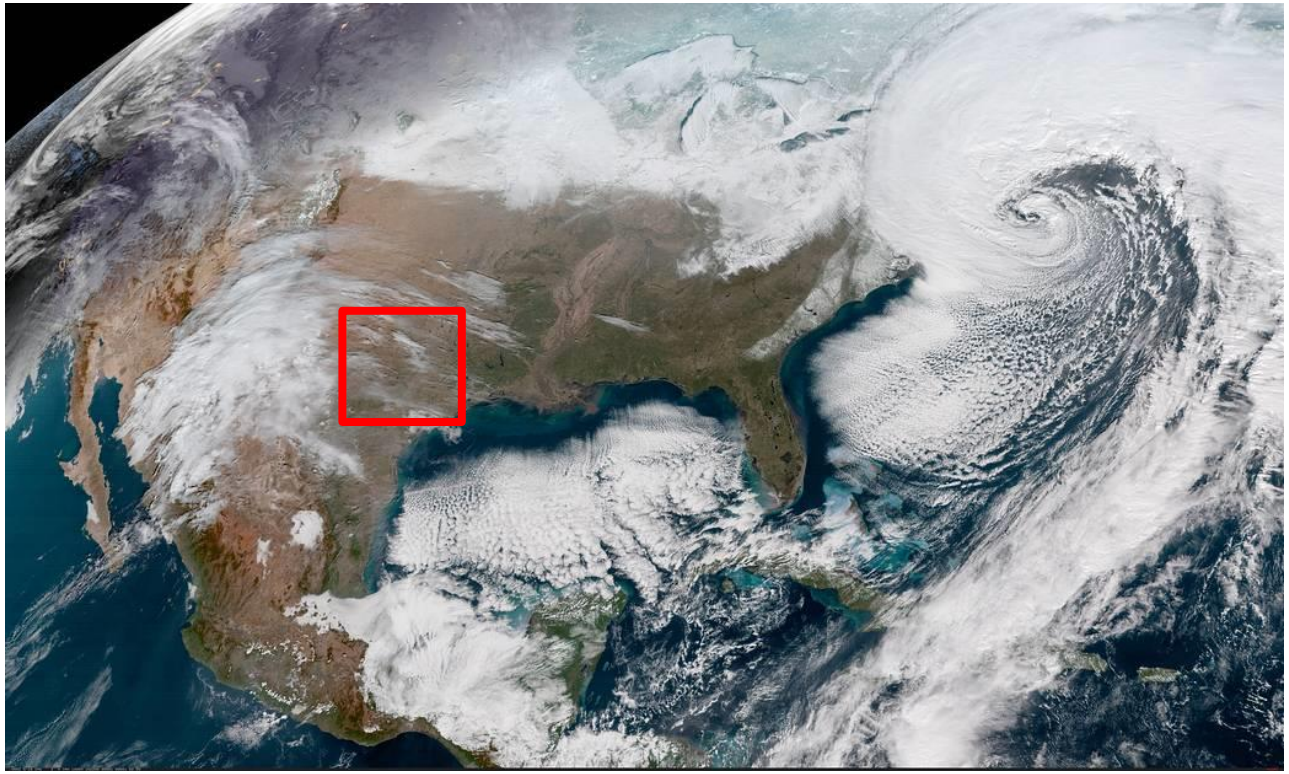
Machine Learning Model Workflow



ML Model Input

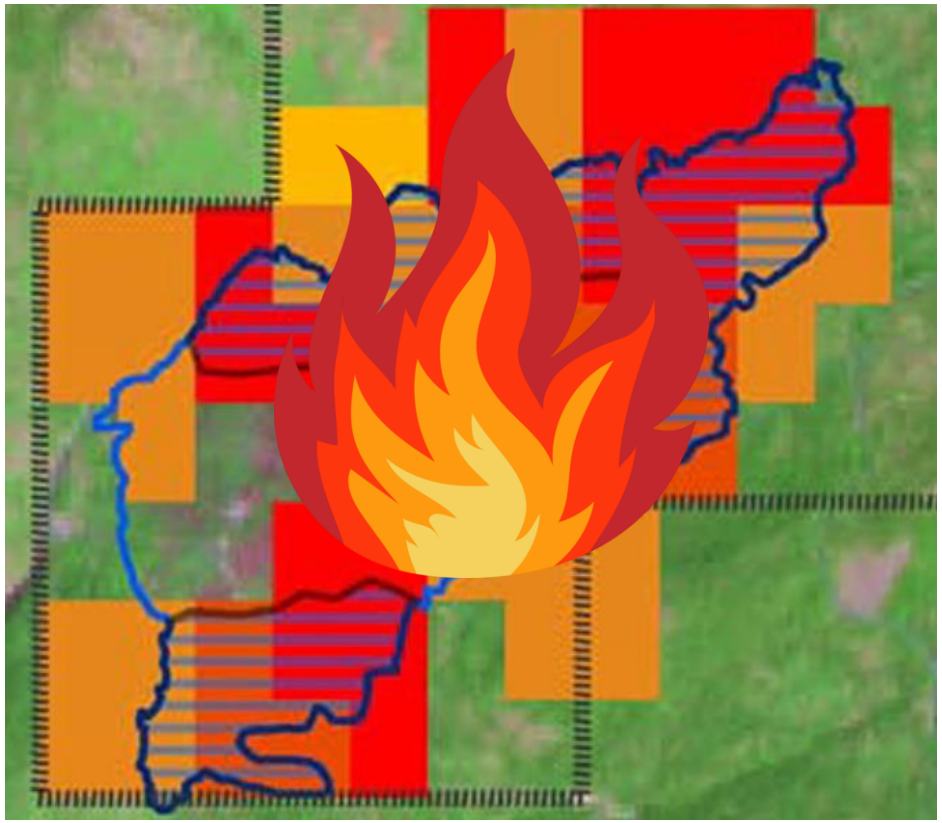


GEO imagery: GOES 16/18 ABI



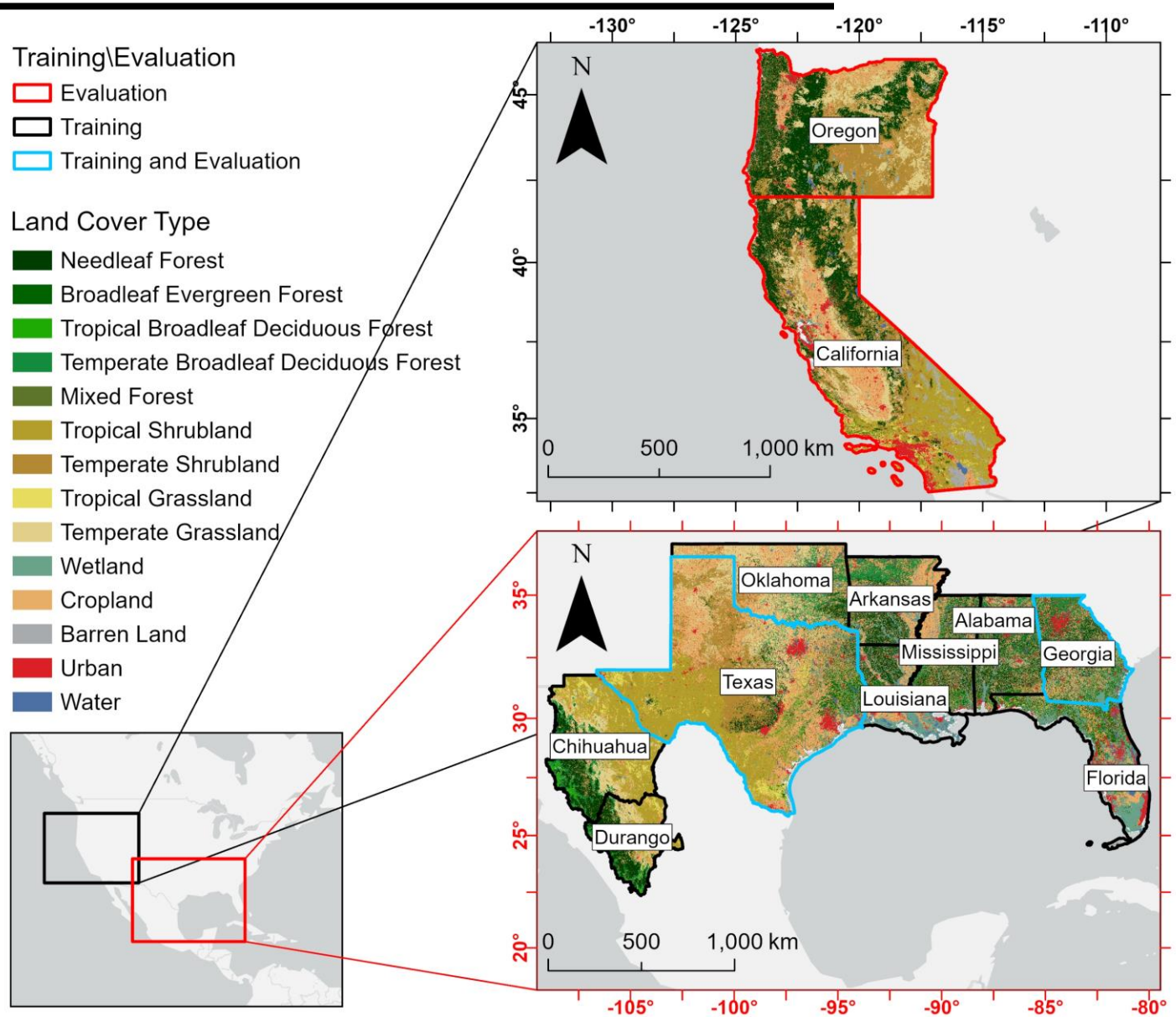
Spectral bands: 16
Spatial resolution: 2 km
Temporal resolution: 5 min

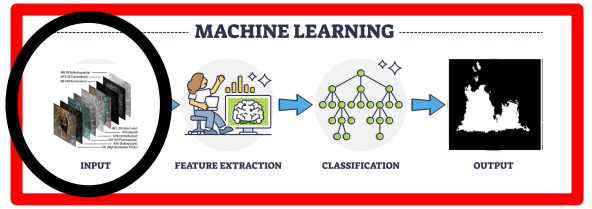
LEO fire detections: VIIRS



Spatial resolution: 375 m
Temporal resolution: 12 hr

Model Input and Study Area





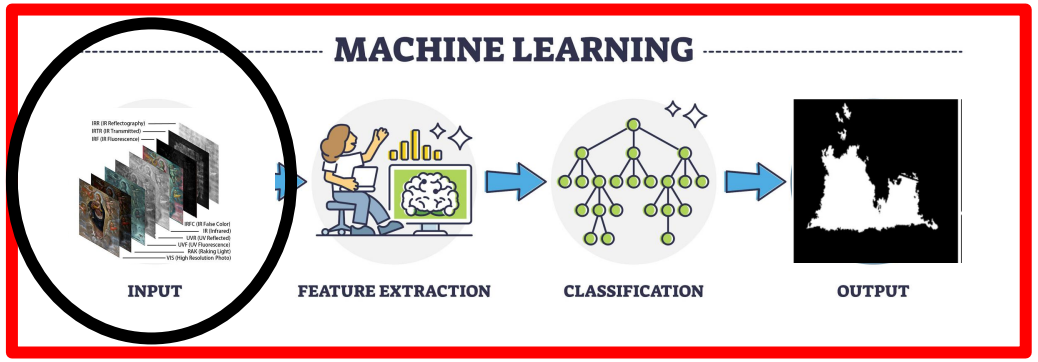
Data period: 2022-2023

Training area: 2.1 million km²

Evaluation area: 1.53 million km²

VIIRS fire detections: 325,000

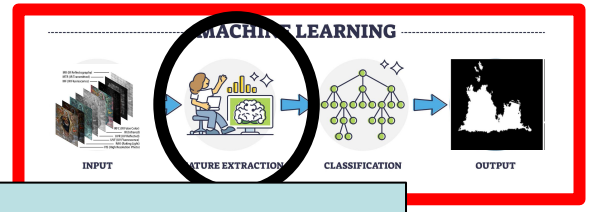
GOES ABI images: 4,330



Feature Extraction

$B_{3.9} - B_{11.2}$

GOES ABI grid



Fir

FI

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17

17

85

on

In total:

Fire pixels: ~66,000

Non-fire pixels: ~1.4 million

Model Output Example

VIIRS

ML model

Model Evaluation and Compression

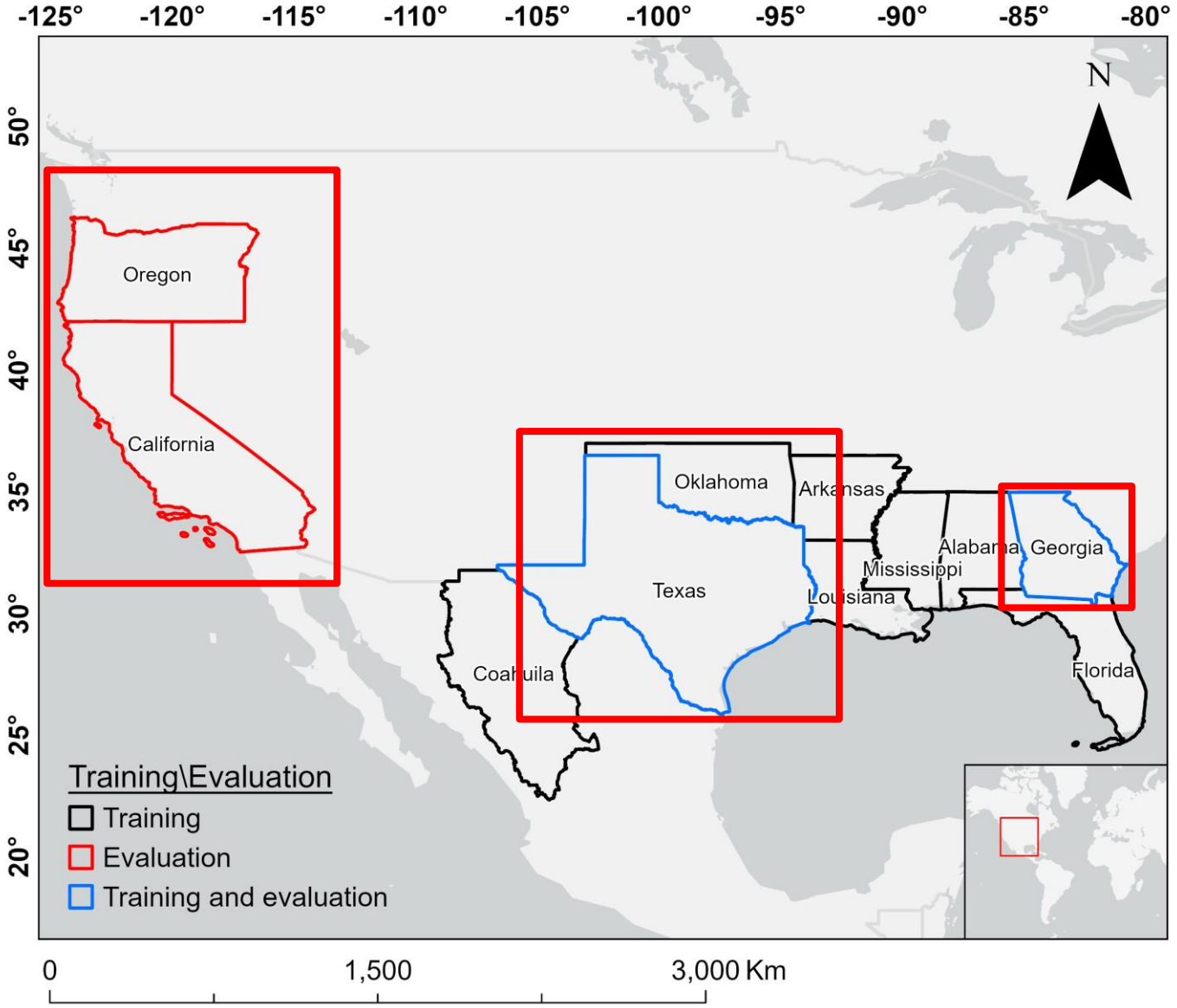
Year: 2024

3 months of data for each region

States: Georgia, Texas, California-Oregon

Reference data: VIIRS fire detections

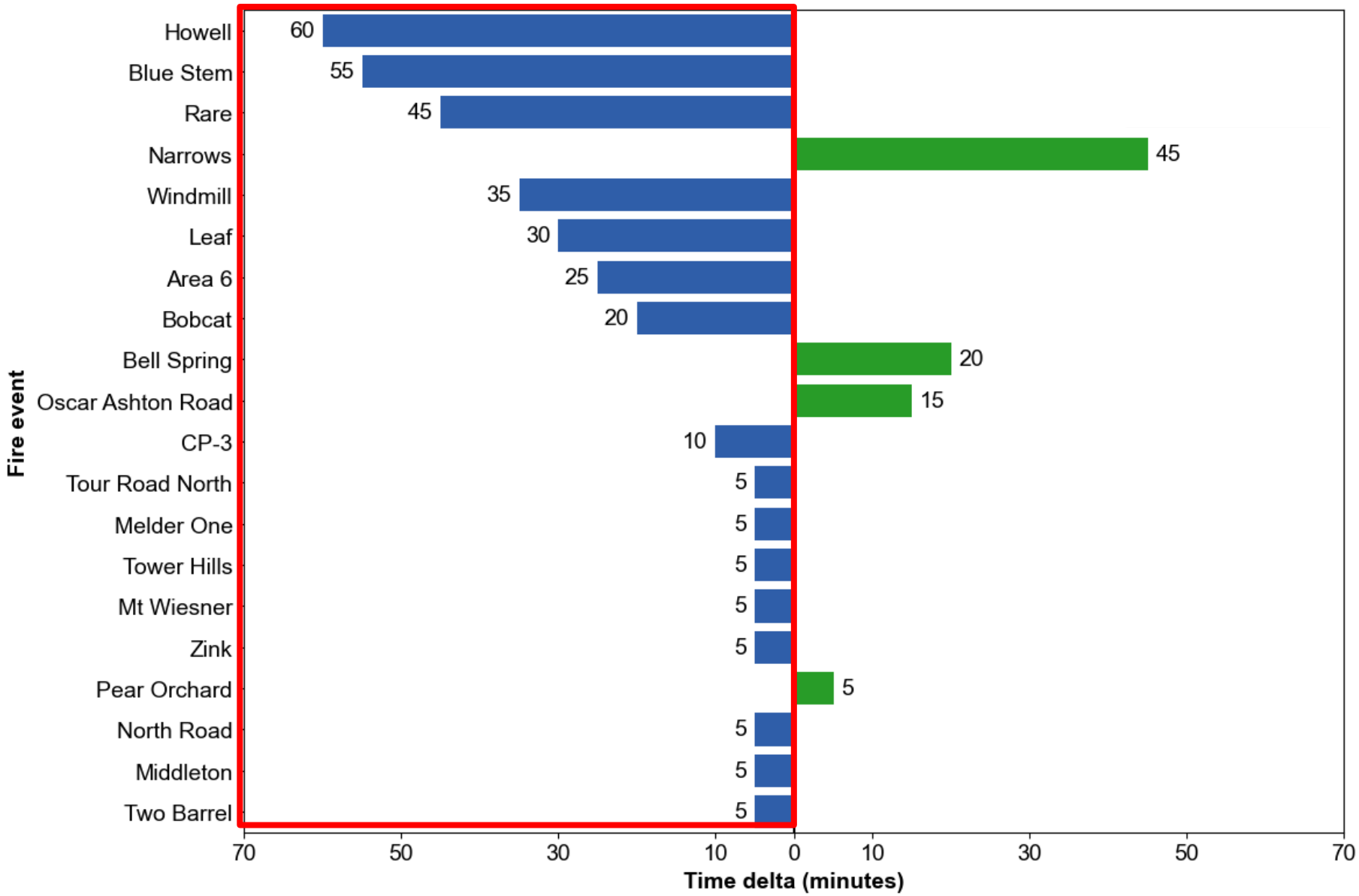
ML model compared to the GOES fire product



Model Evaluation – Accuracy Metrics

The ML model outperform GOES fire product!

Early Detection Capabilities



ML model

GOES fire product

In summary

Thank you
Questions?