

# Alberta Wildfire Prediction

## Viewing from a Different Angle

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# Wildfire Statistics

1. Siberia(55m acres)
2. Australia(42m acres)
3. Canada(8.5m acres)
4. US & Canada(6.6m acres)
5. Australia(5m acres)
6. Canada(5m acres)
7. Canada(4.2m acres)
8. Bolivia(3.7m acres)
9. US(3m acres)
10. China(2.5m acres)
11. Canada(1.7m acres)
12. Canada(1.3m acres)

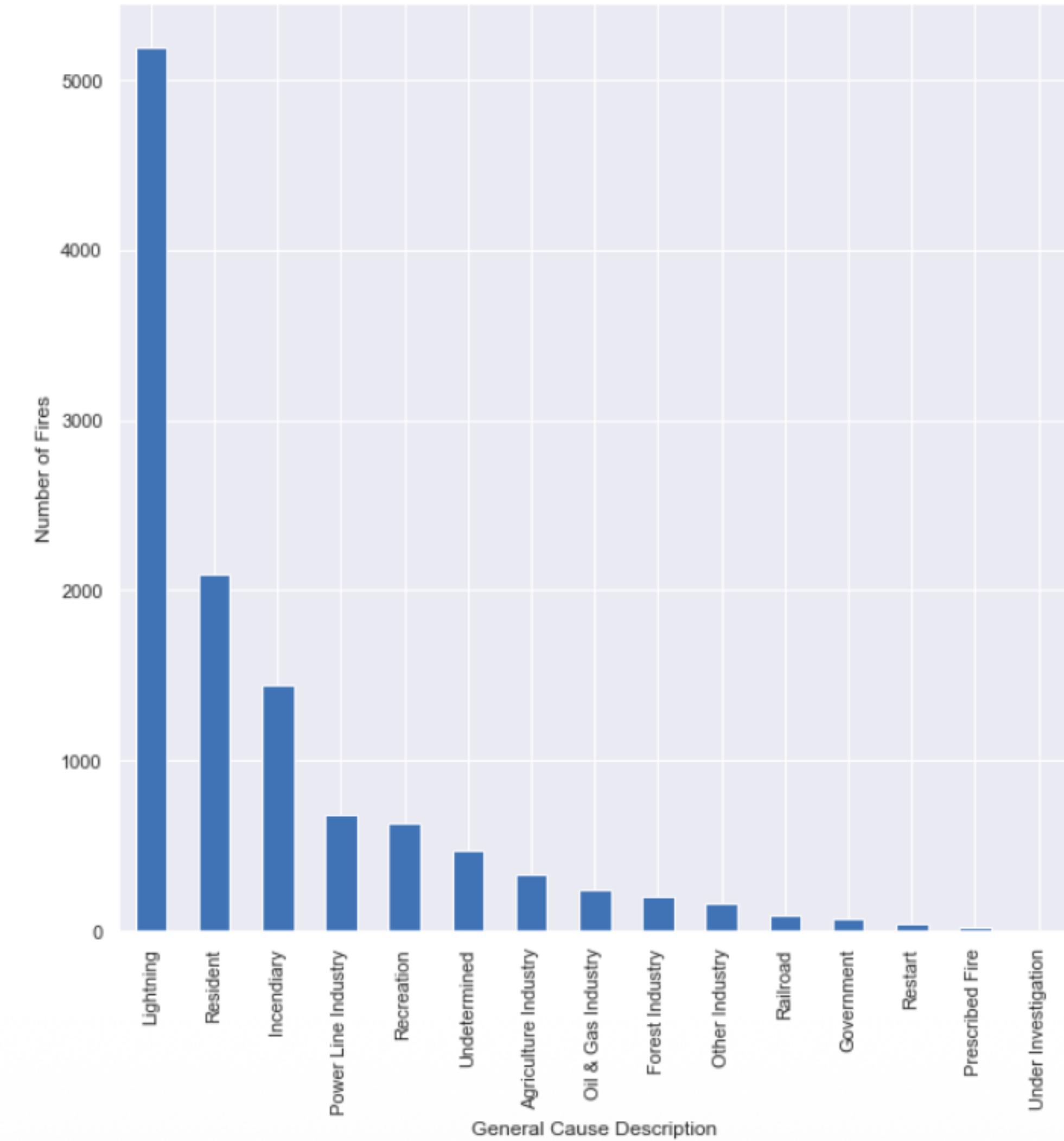


# Methodology

- Analyse existing Wildfires
- Build a model that predicts the probability of fire before fire ignited
- Build a model to predict acreage and a polygon of the fire
- Analyse the impact on indigenous people

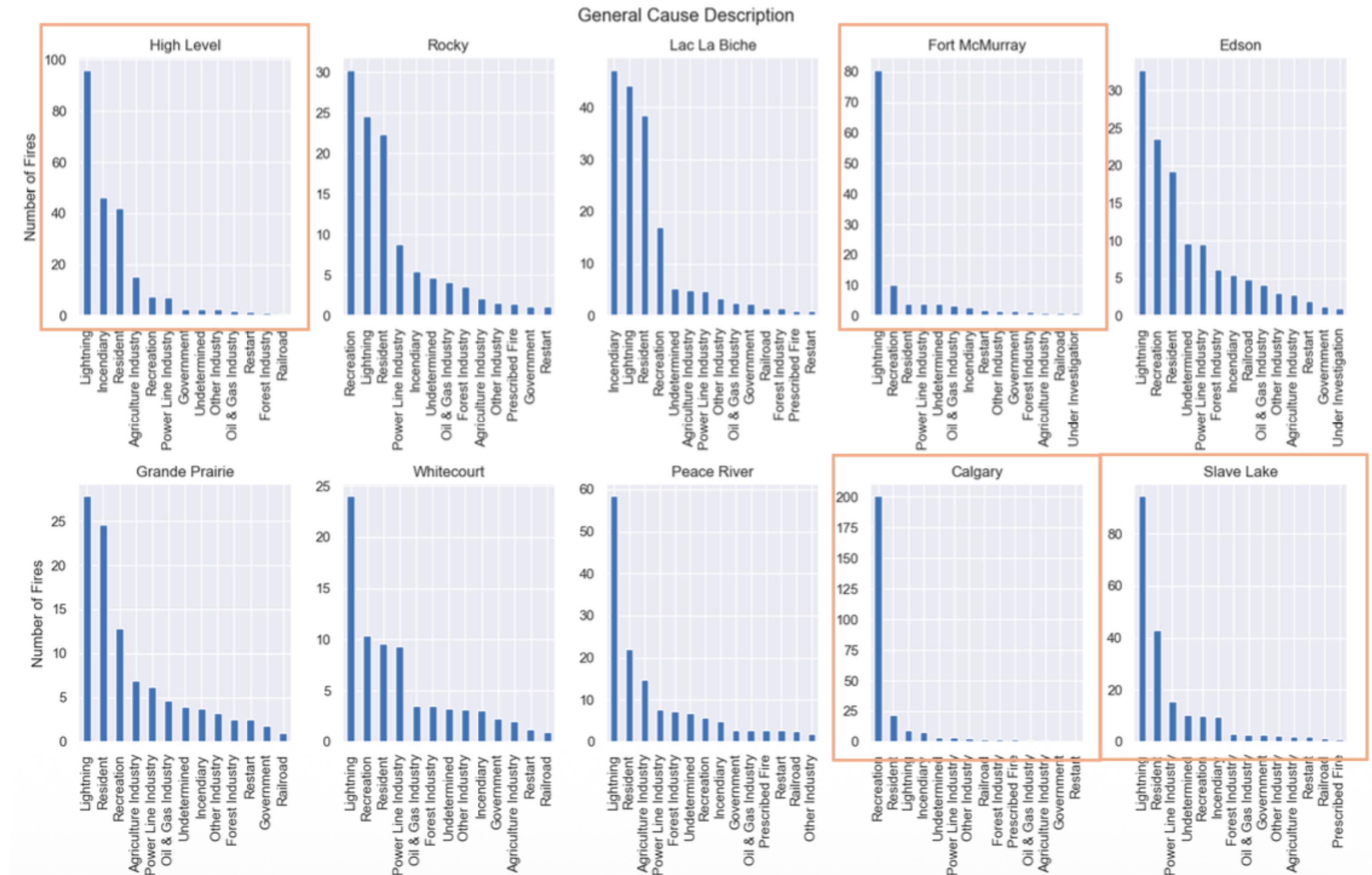
# Data Insights

- **Lightning** is an absolute leader of fire causes



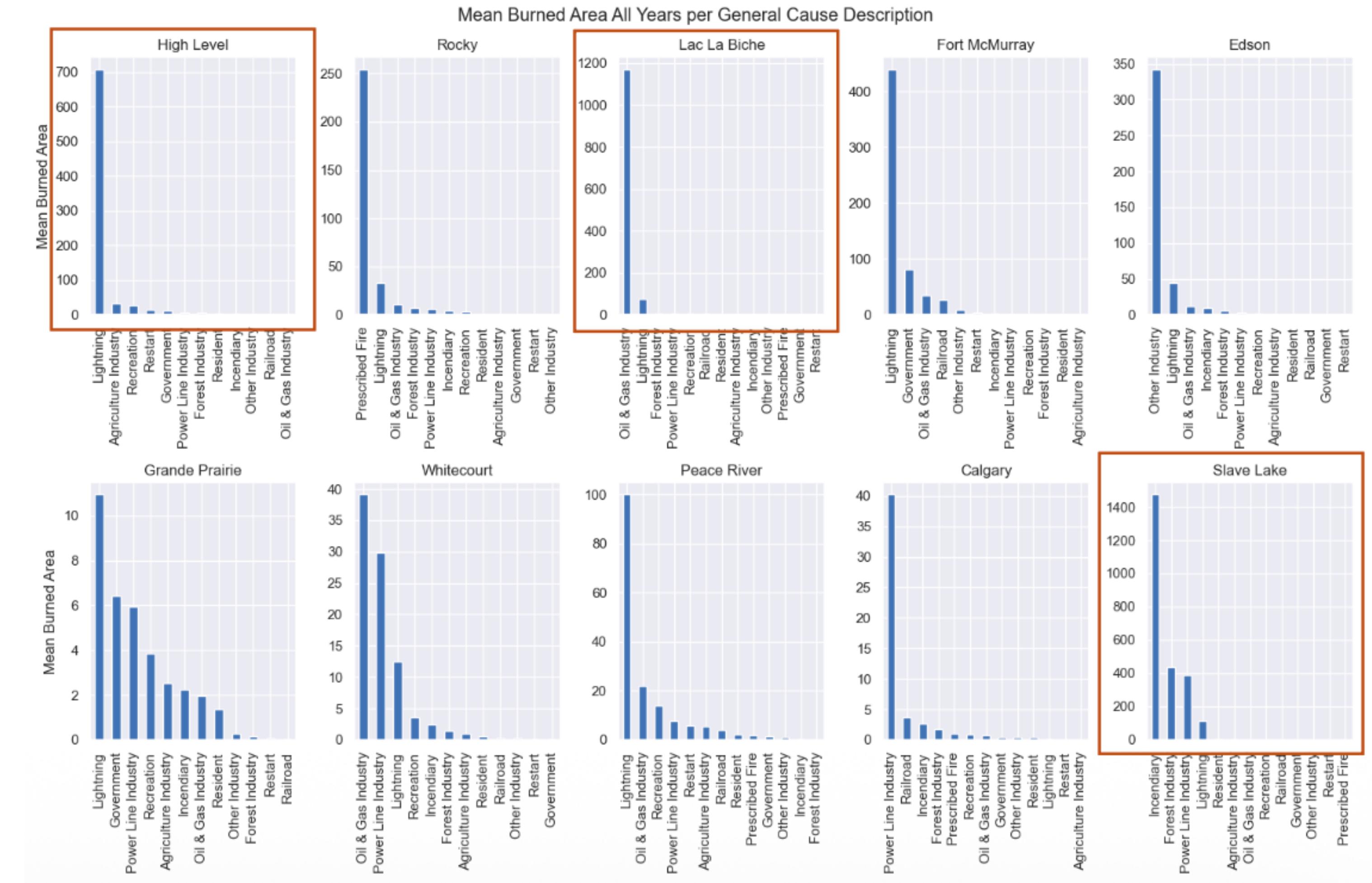
# Data Insights

- Top 4 regions which suffer from fire ignitions:
    - Calgary - Recreation
    - High Level - Lightning
    - Slave Lake - Lightning
    - Fort McMurray - Lightning



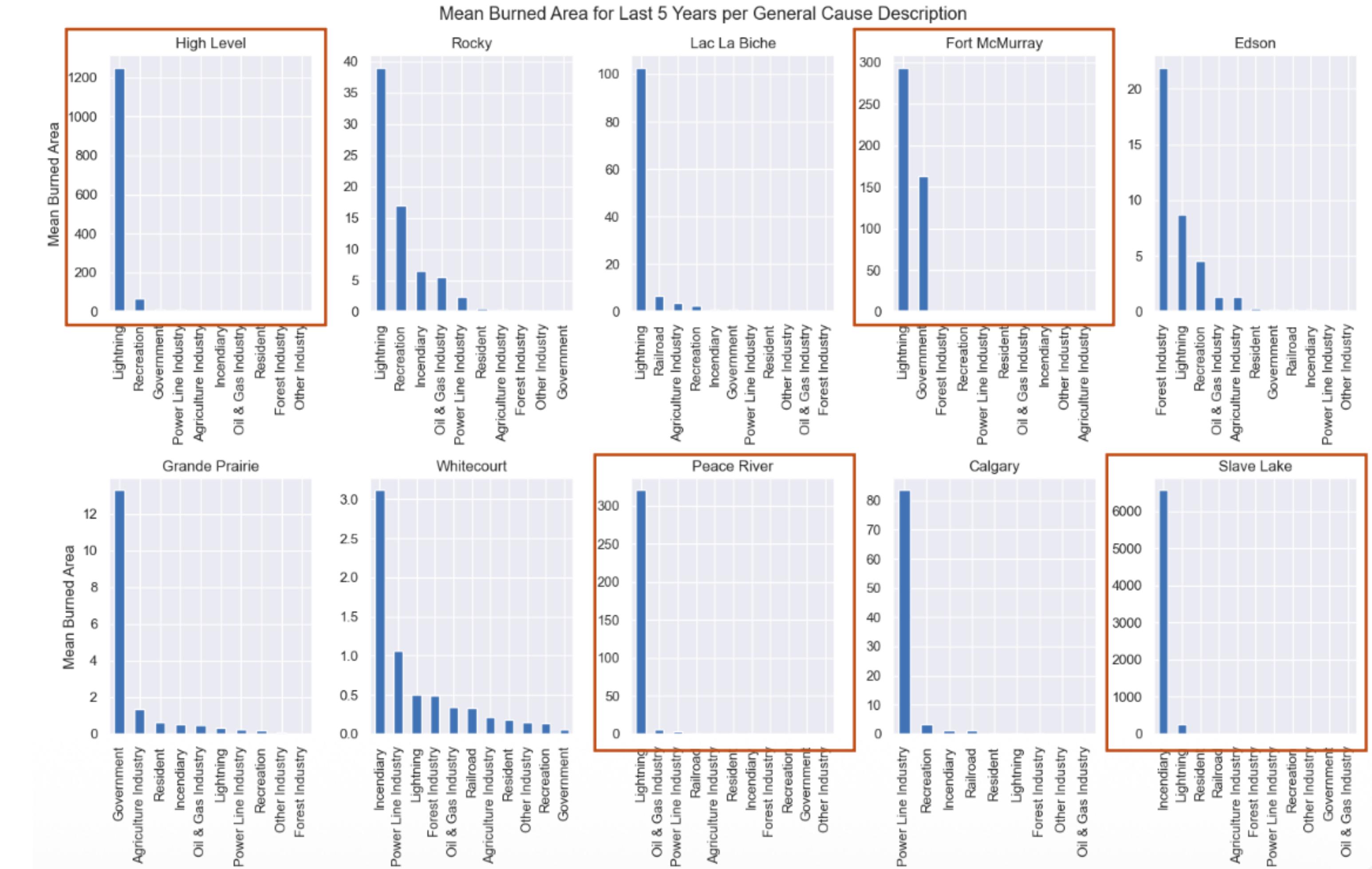
# Data Insights

- Top 3 regions on mean area burned (2006-2021):
  - Slave Lake - Incendiary
  - Lac La Biche - Oil & Gas
  - High Level - Lightning

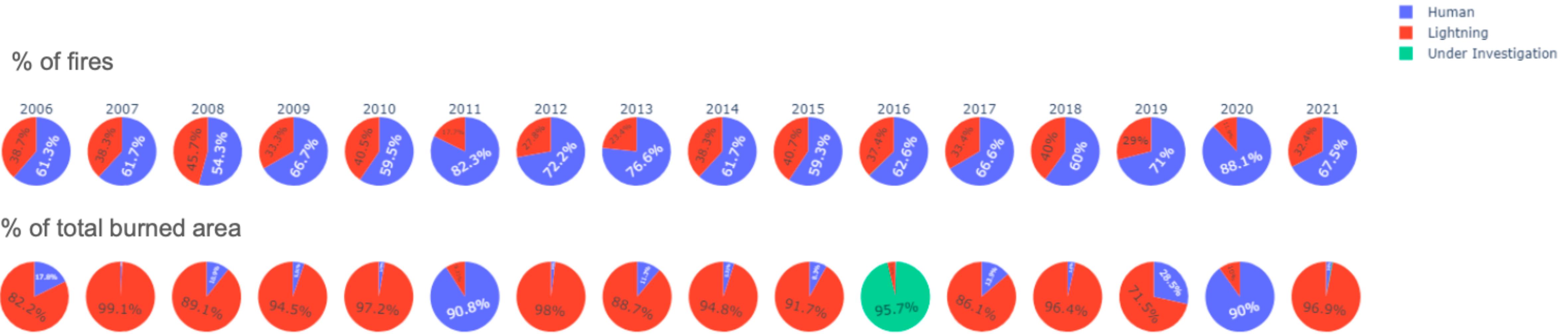


# Data Insights

- Top 4 regions on mean area burned for past 5 years:
  - Slave Lake - Incendiary
  - High Level - Lightning
  - Peace River - Lightning
  - Fort McMurray - Lightning



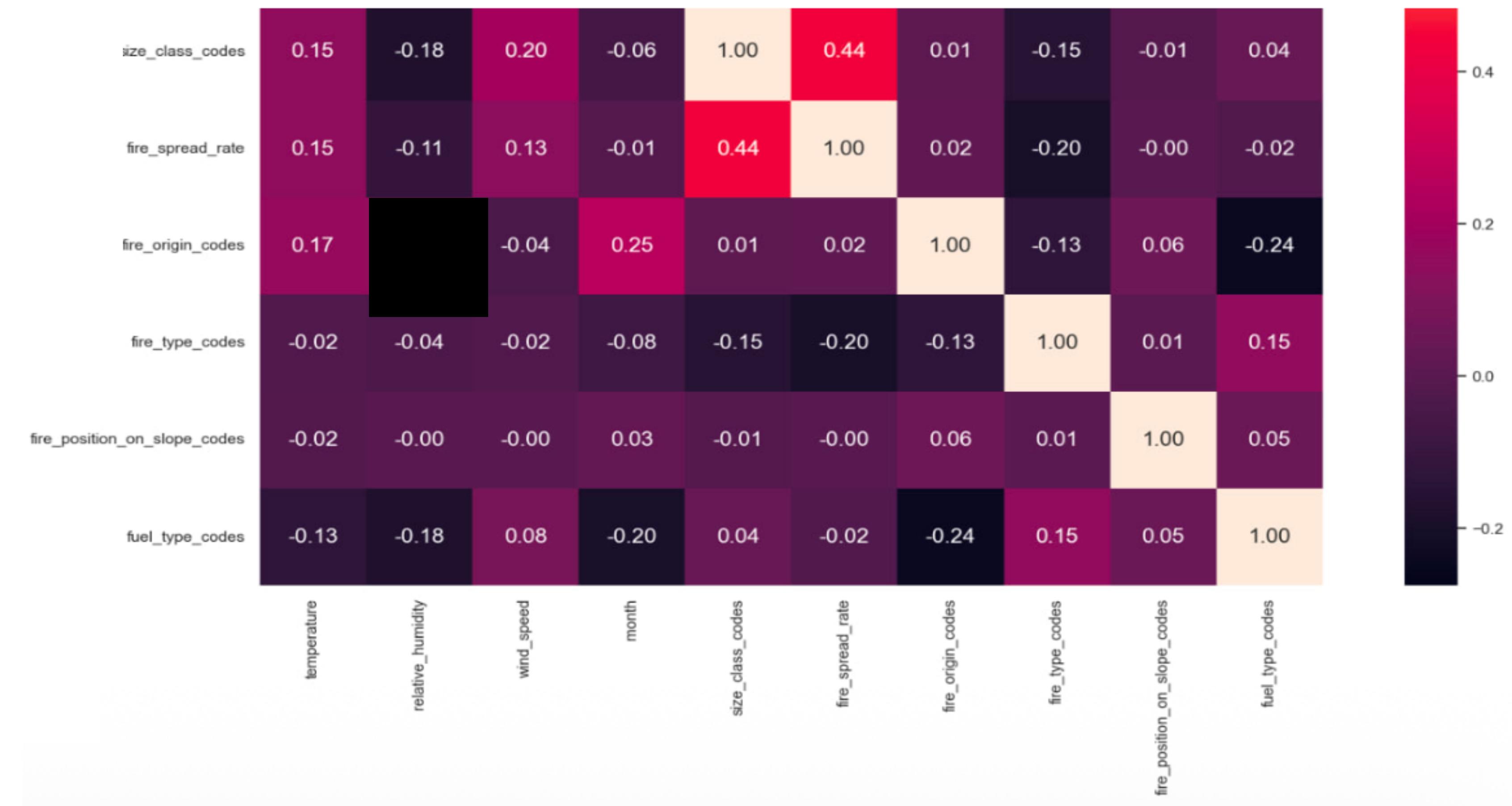
# Data Insights



- Human are leaders of causing fires (unsafe, abandoning, neglect)
  - But Lightnings lead the burnt hectares amount

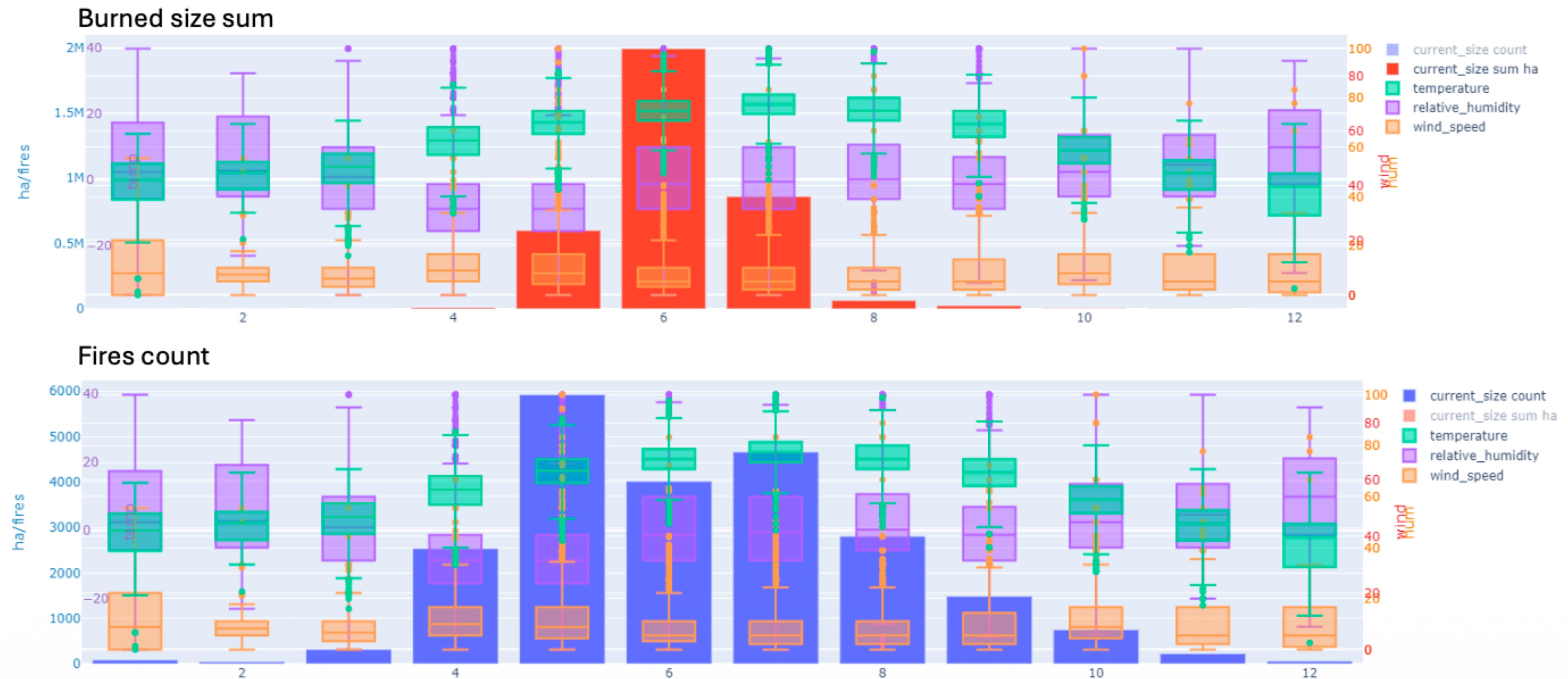
# Data Insights

- Fire class (size) depends on:
    - weather
    - spread rate
    - type of fire behaviour  
(crown/ground)
  - Spread rate depends on:
    - Behaviour
    - Weather
  - Fire Behaviour depends on
    - Soil (fire fuel)

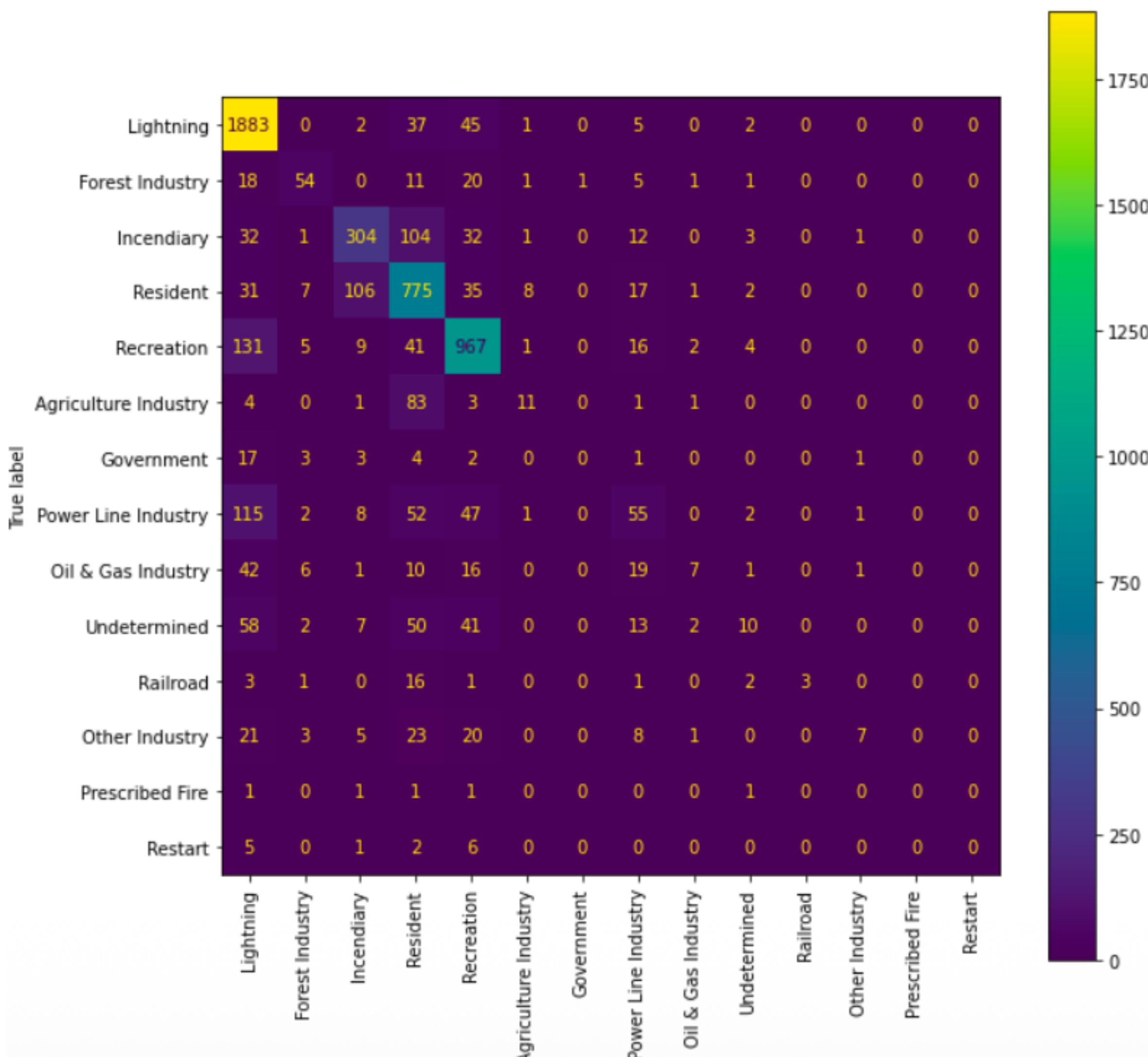


# Data Insights

## Seasonality



# Preliminary Analysis

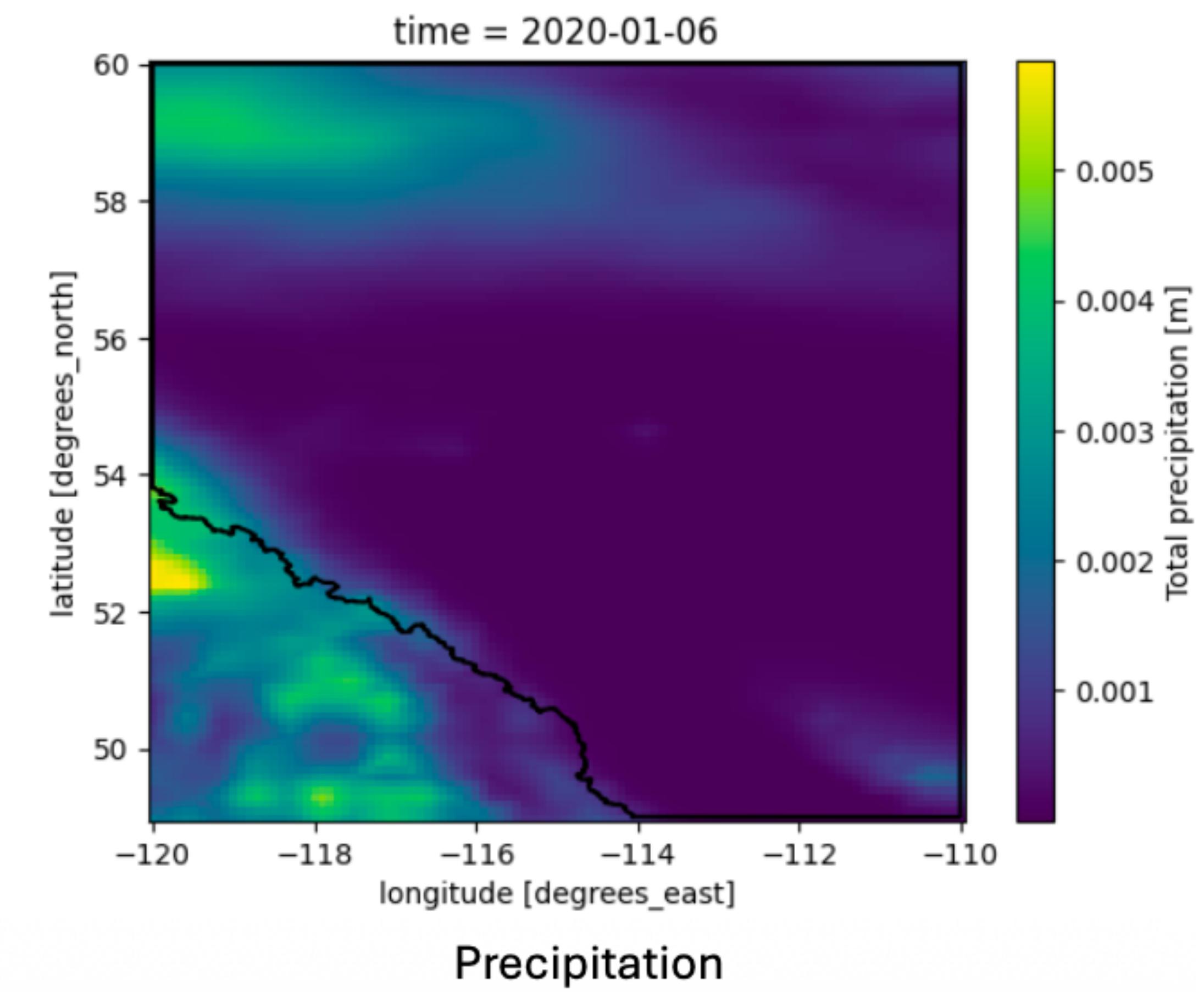
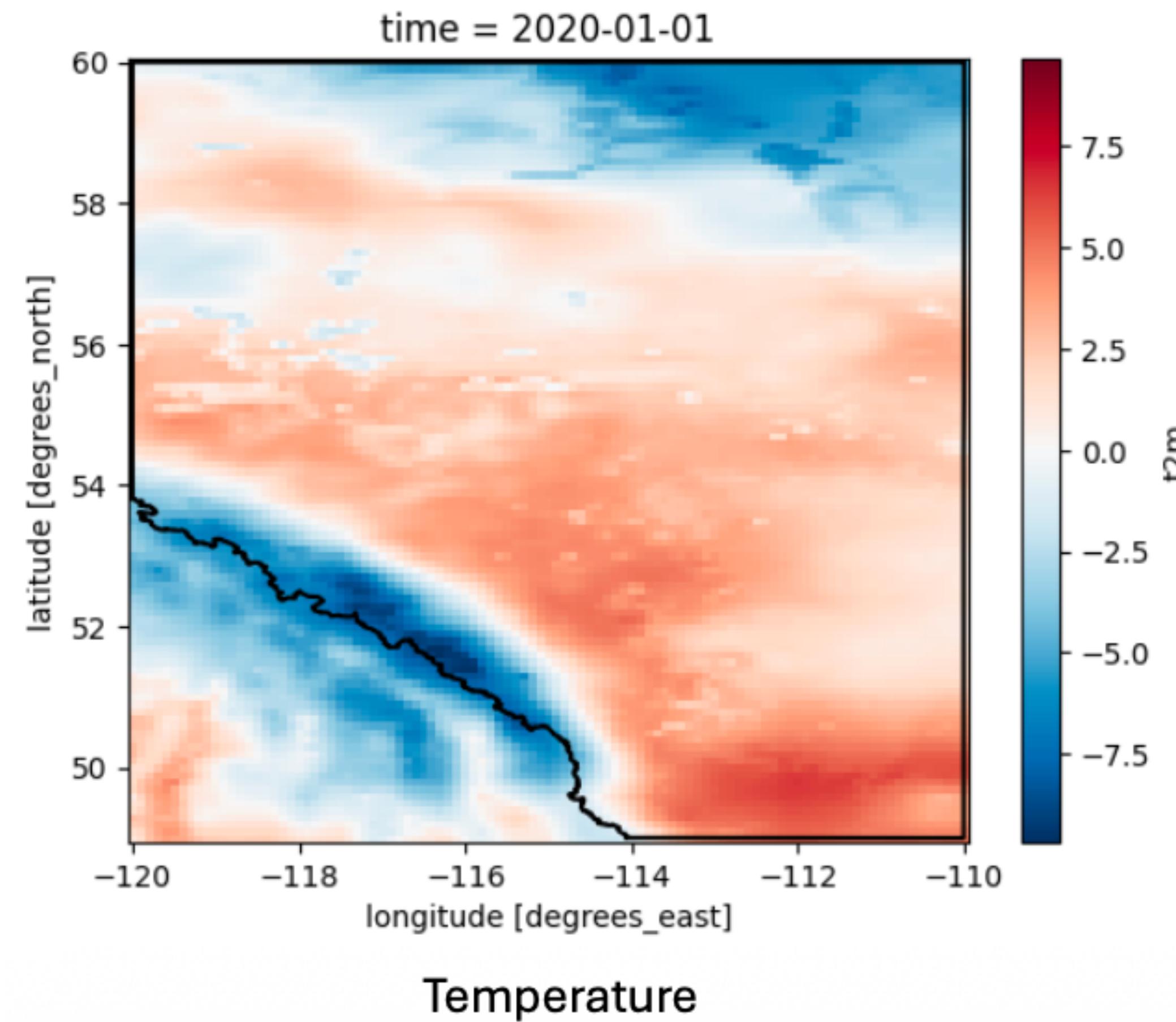


# Part I - Bird's Eye View

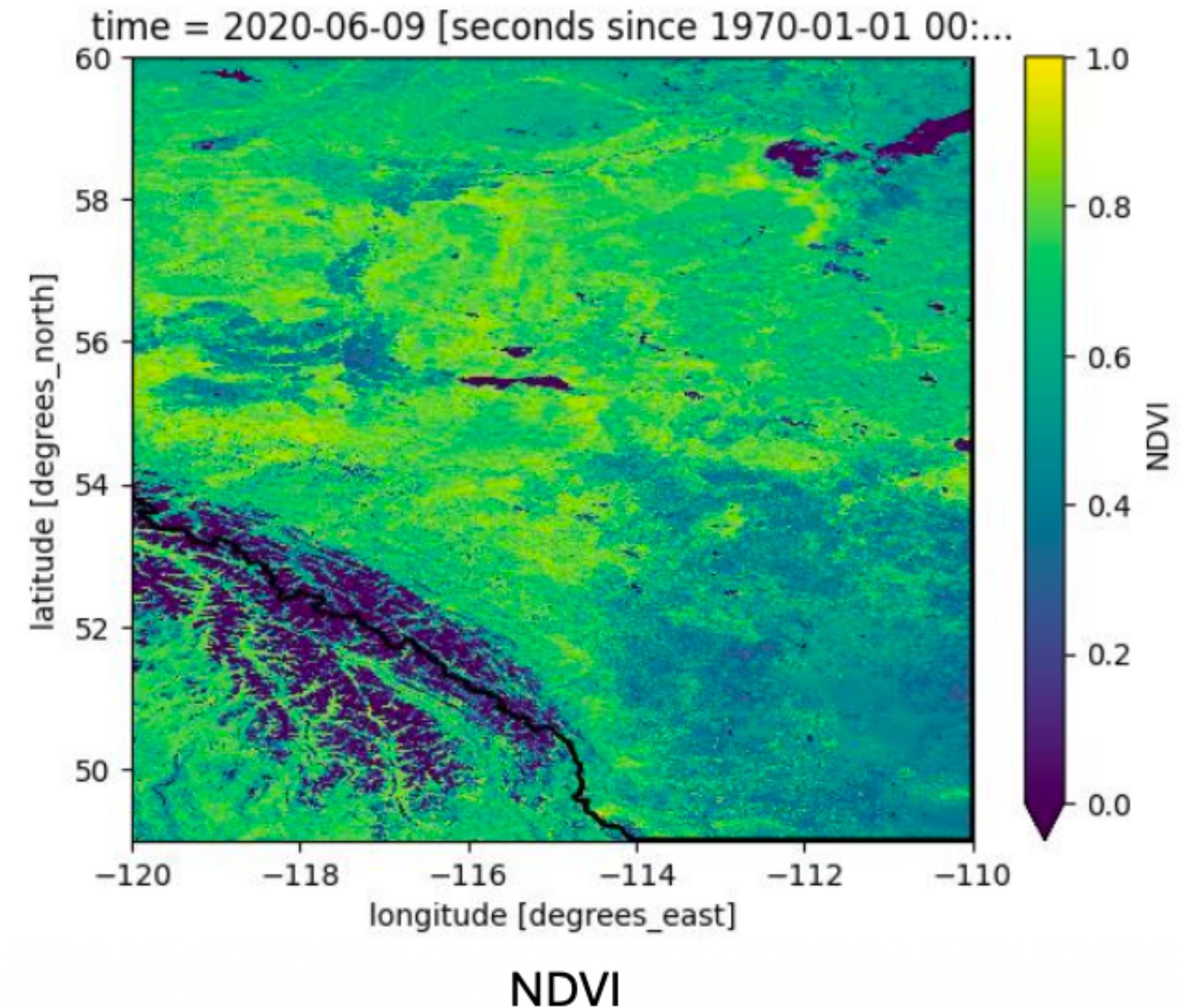
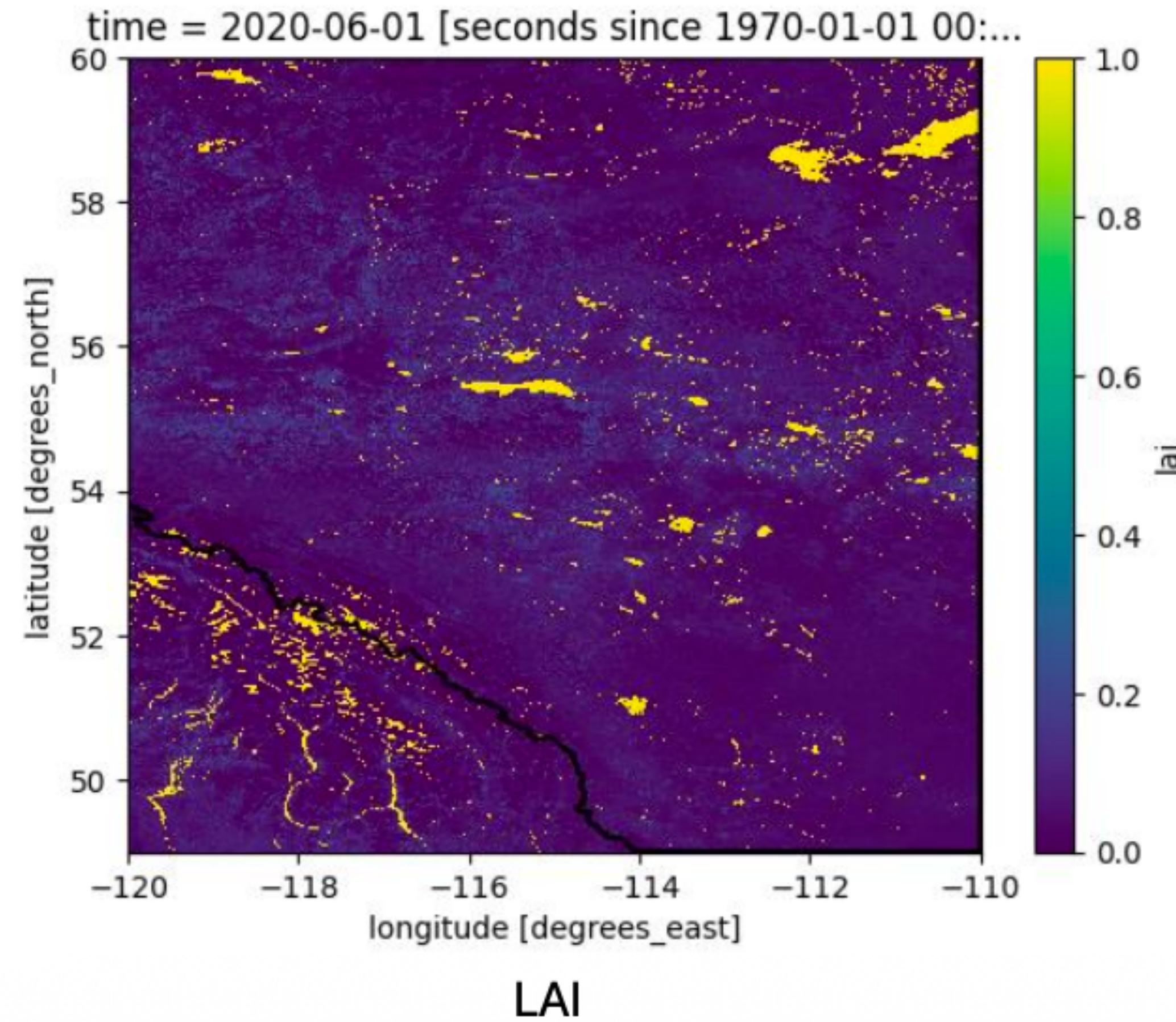
- Used Resources:
  - Total precipitation (ERA5)
  - Temperature (ERA5)
  - Dew-point temperature (ERA5)
  - Eastward wind (ERA5)
  - Northward wind (ERA5)
  - Lead Area Index - LAI (Modis)
  - Normalized difference vegetation index - NDVI (Modis)
  - Distance to roads ([worldpop.org](http://worldpop.org))
  - Population density ([worldpop.org](http://worldpop.org))
- Additional Datasets ([alberta.ca](http://alberta.ca))
  - Indian Reserve and Metis Settlement
  - Historical burned area polygons of Alberta
- Computed Variables:
  - Relative humidity
  - Wind Speed
  - Wind Direction



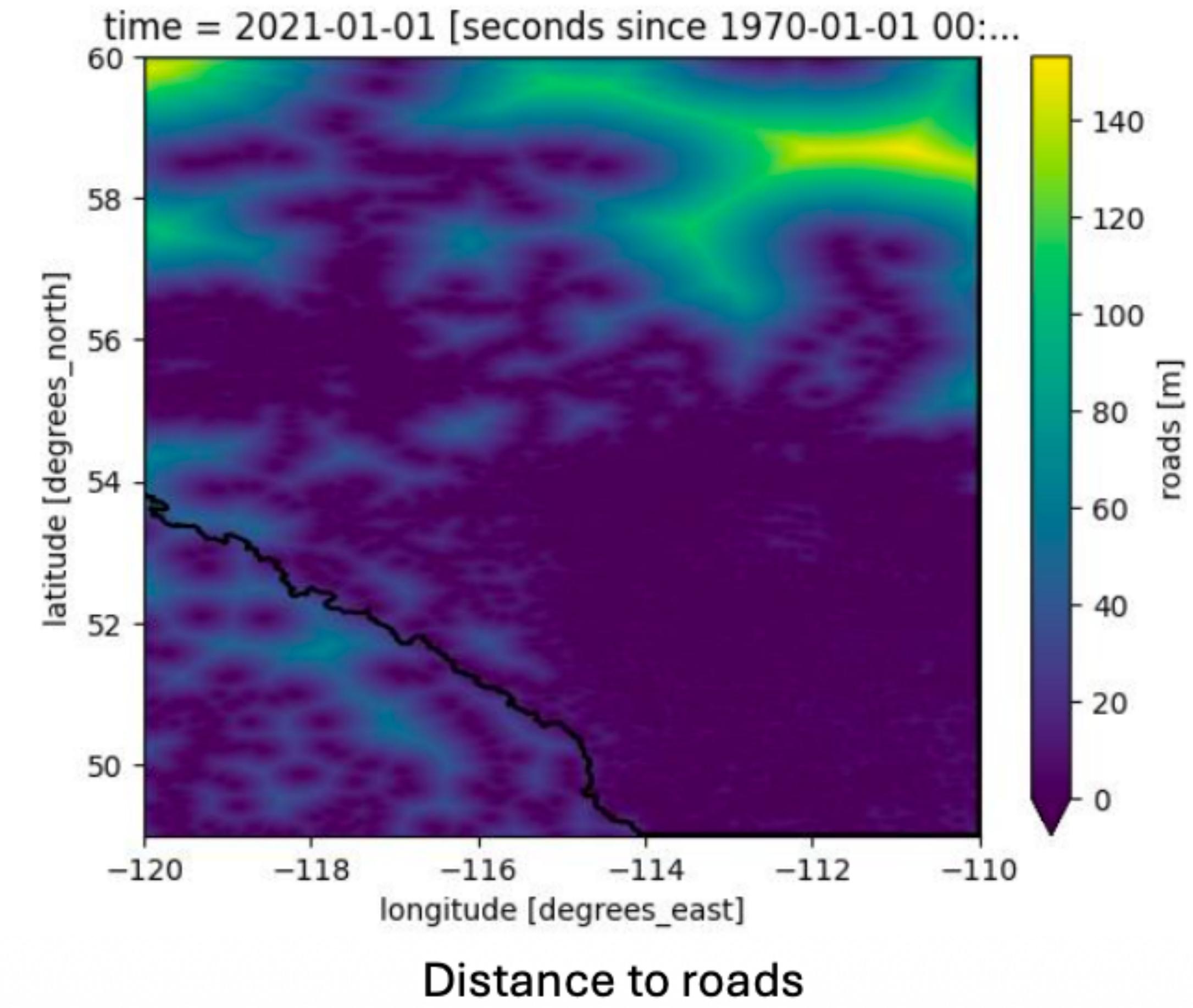
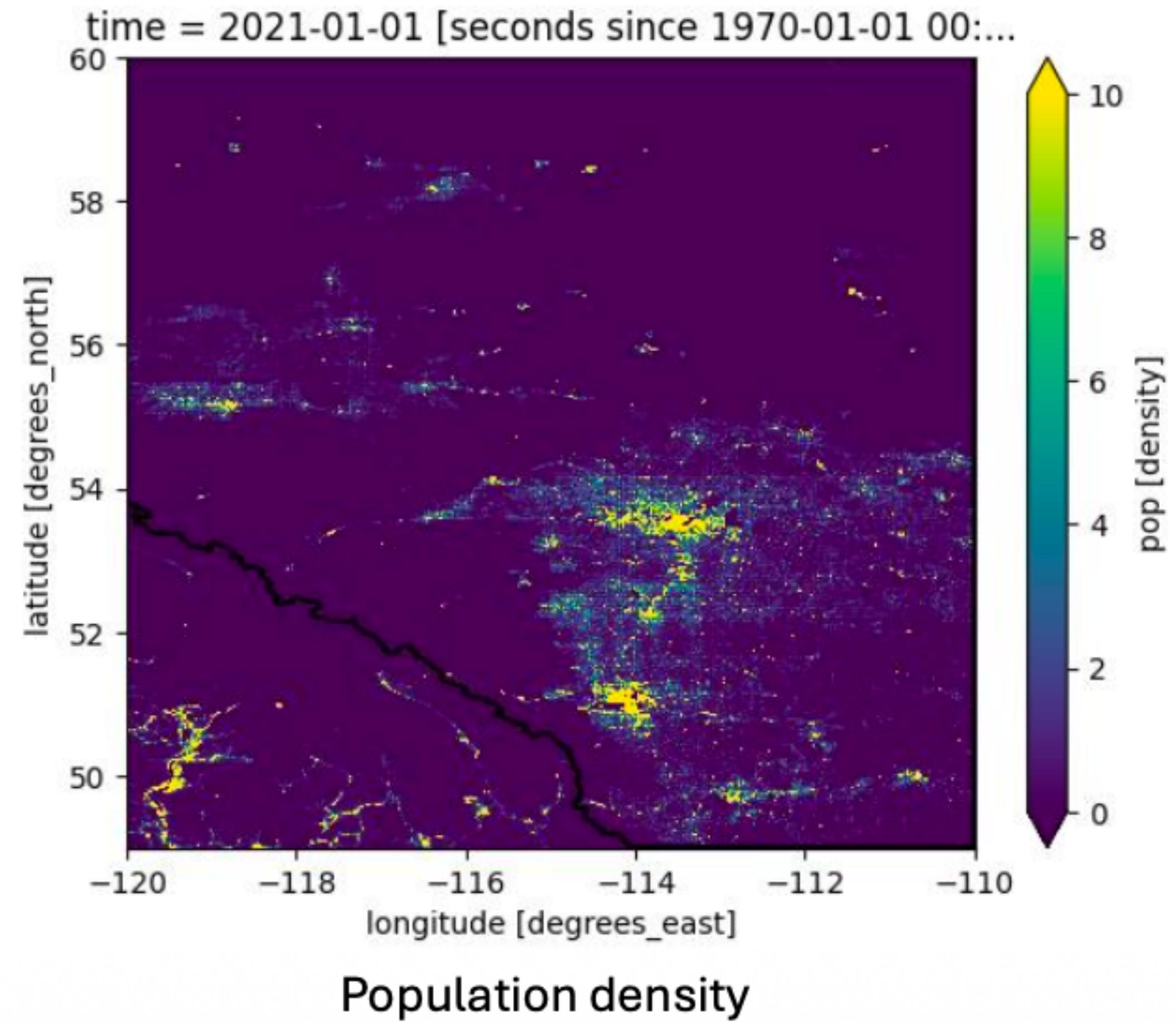
# Bird's Eye View Visuals



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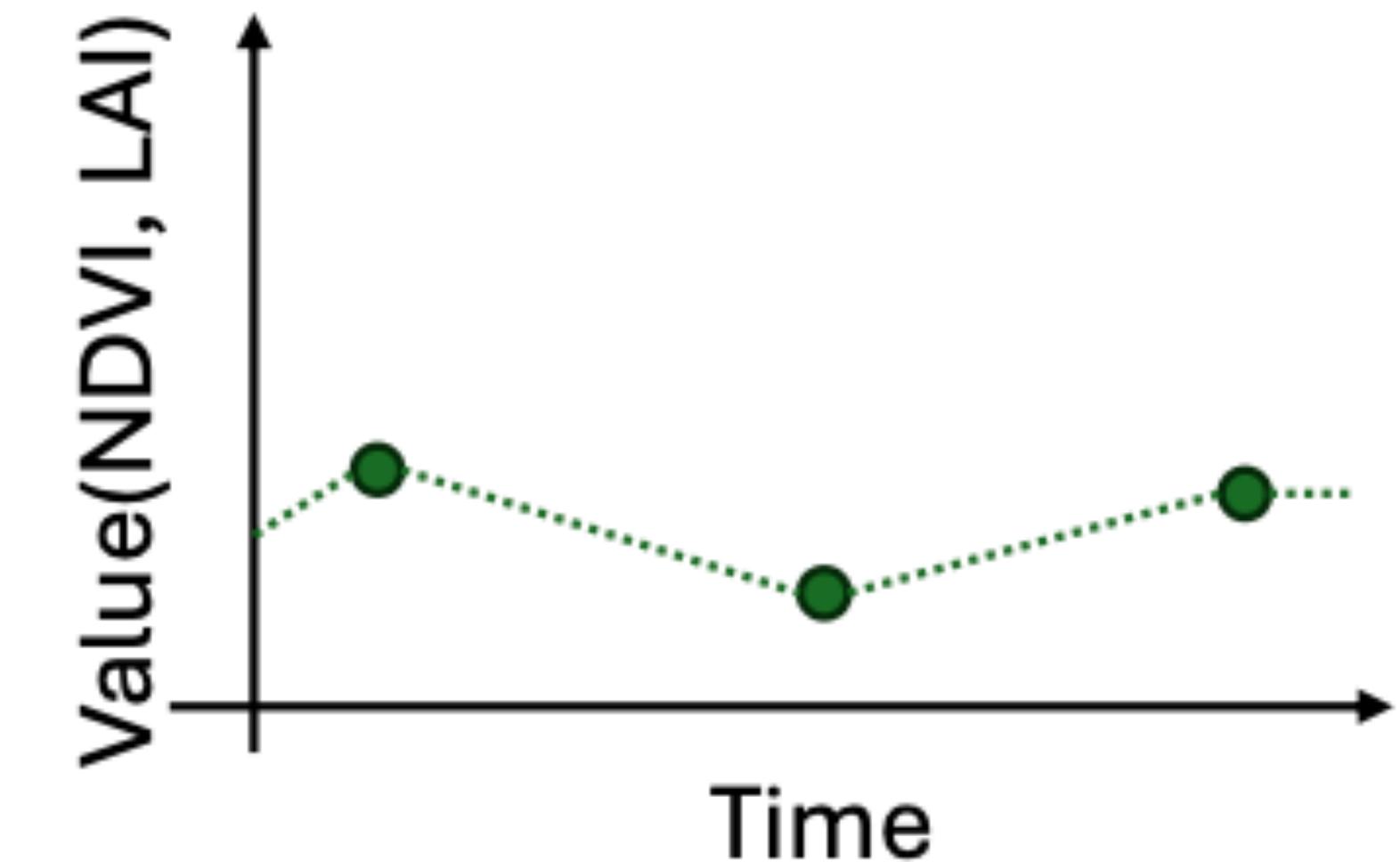


# Bird's Eye View Visuals

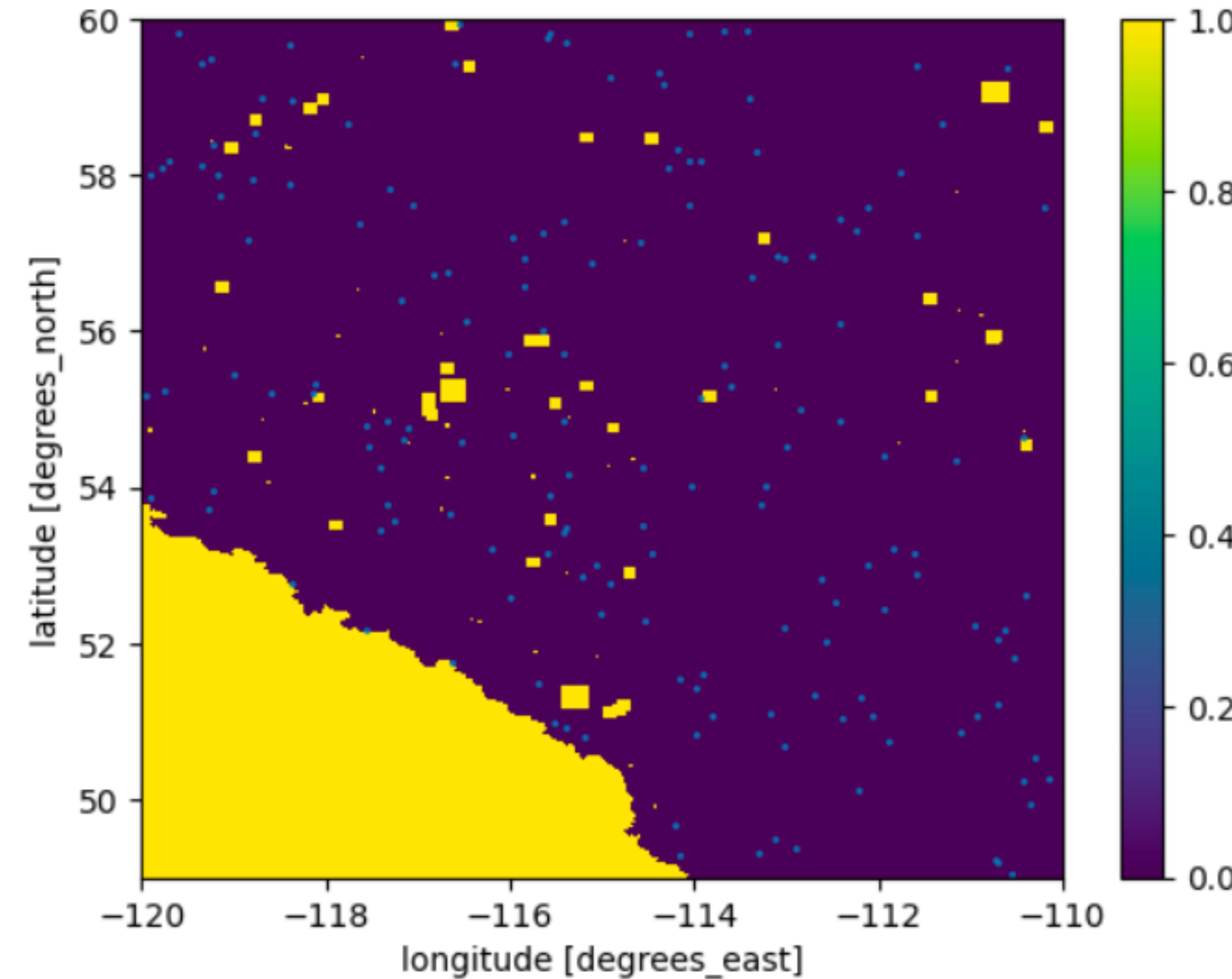


# +ive Samples

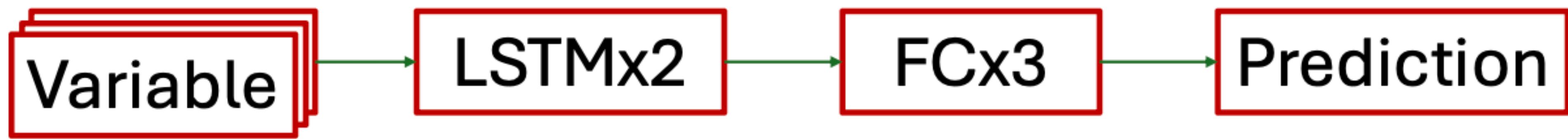
- Choose the fires with a high spread rate or big fires more than 0.1 ha
- If Incendiary or Debris Disposal should be bigger than 1 ha
- 32 days sequence before wildfire
- Interpolating satellite data
- Stack together: weather, satellite, static variables, day of year



# -ive samples



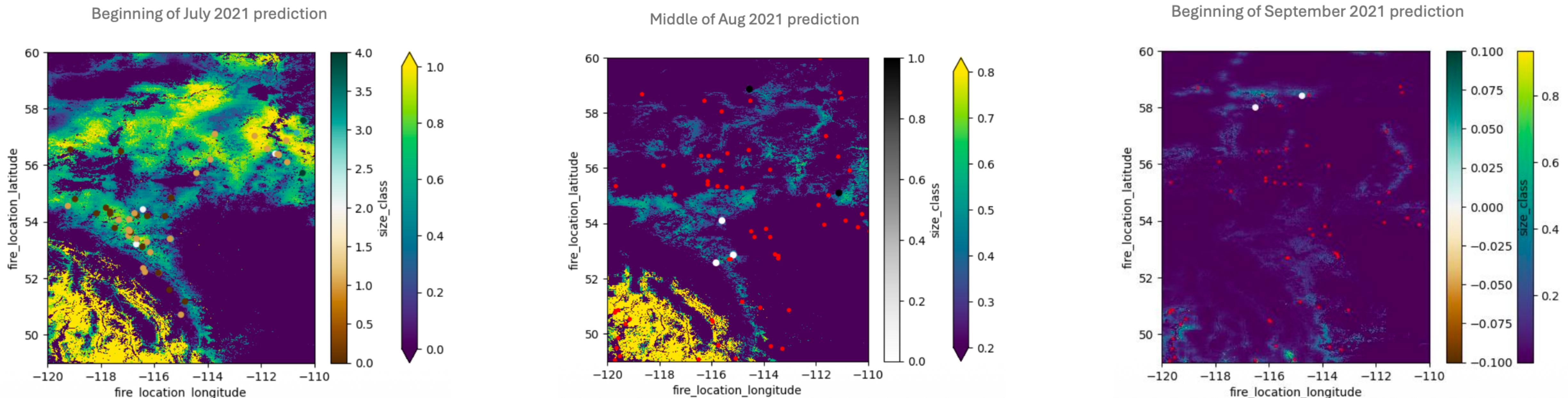
# Model



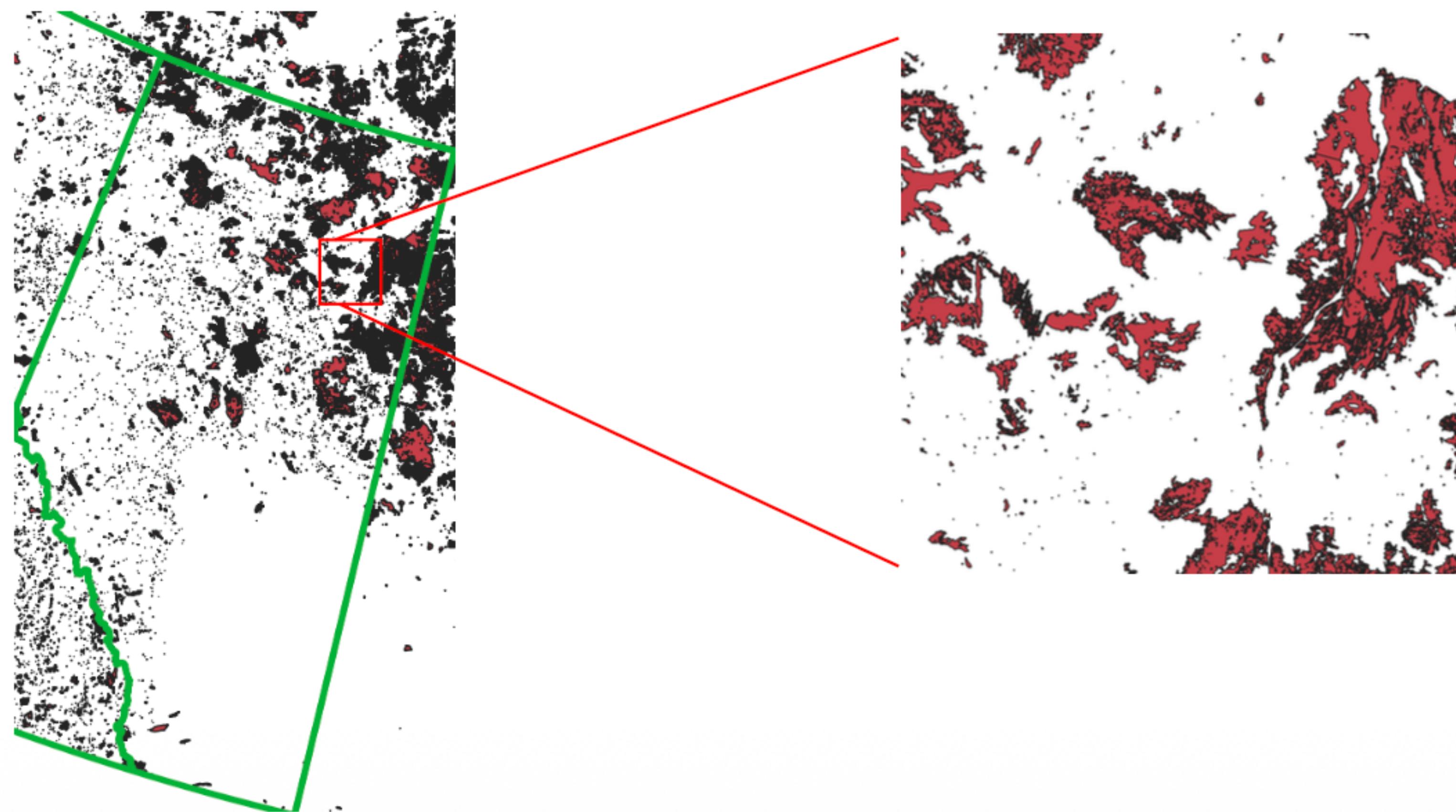
# Improvement

- 1 - is fire, 0 - no fire
  - F1-score: 0.615
- $w_i * BCE(\text{true}, \text{predicted})$  - is fire in point i, 0 - no fire
  - F1-score: 0.72

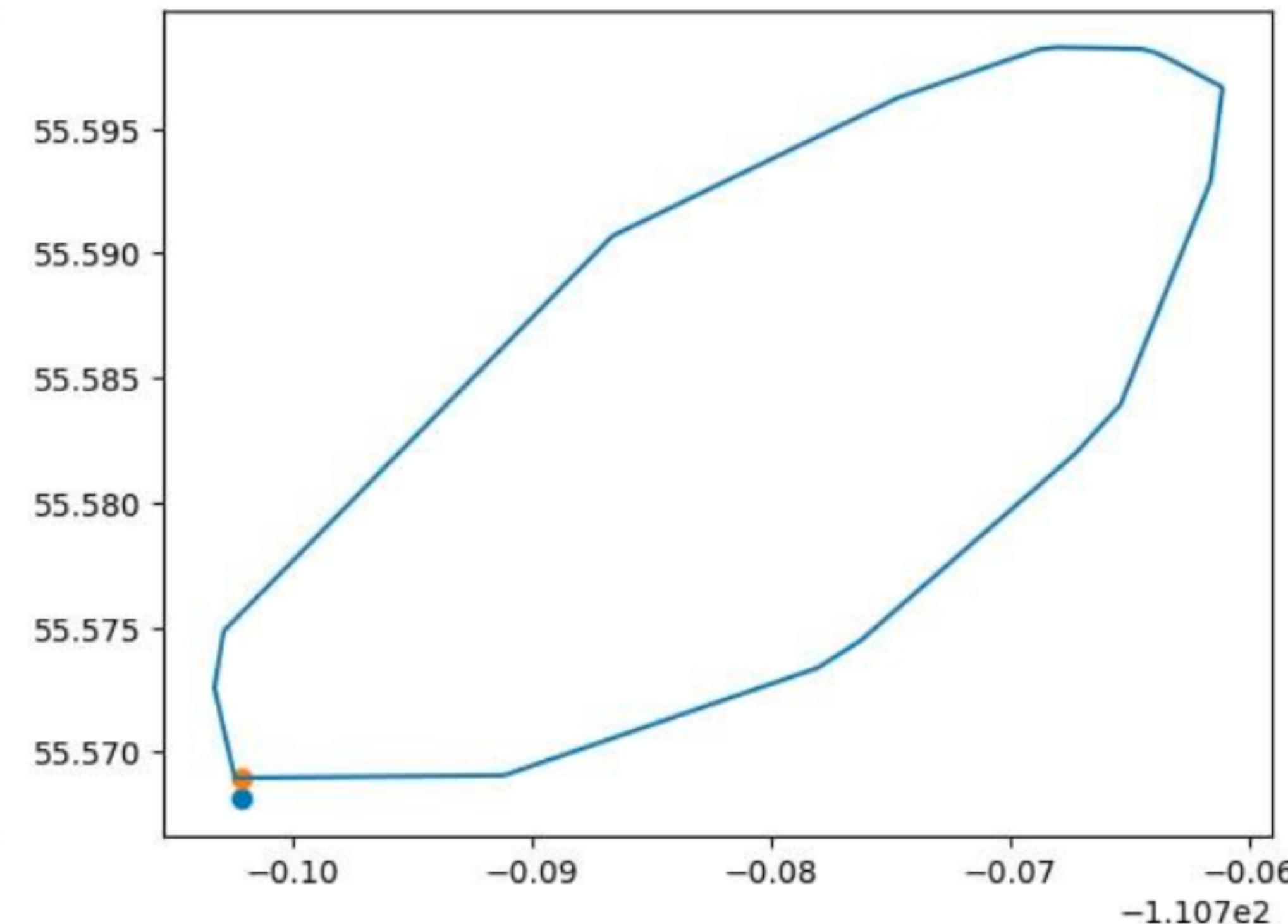
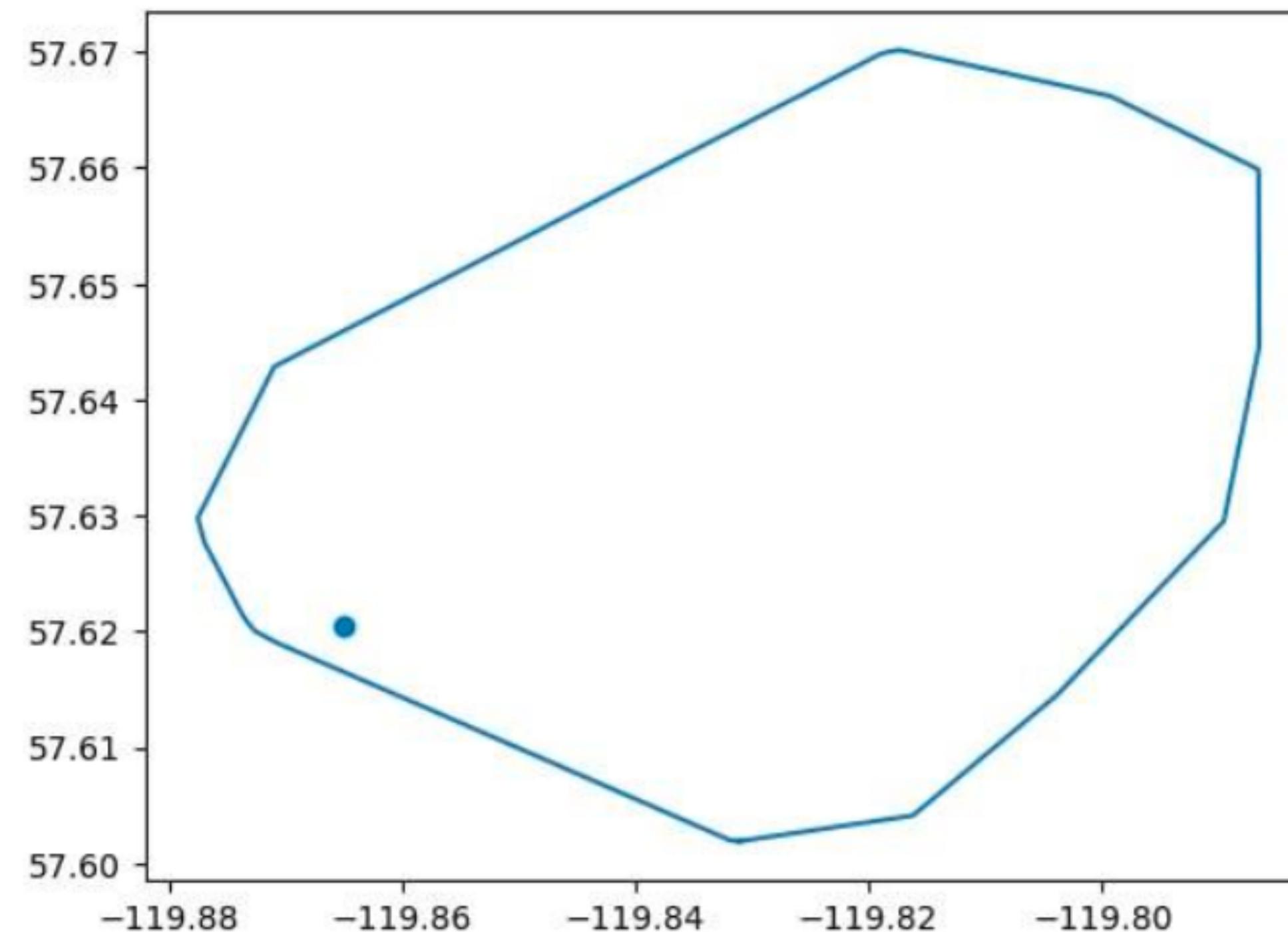
# Results



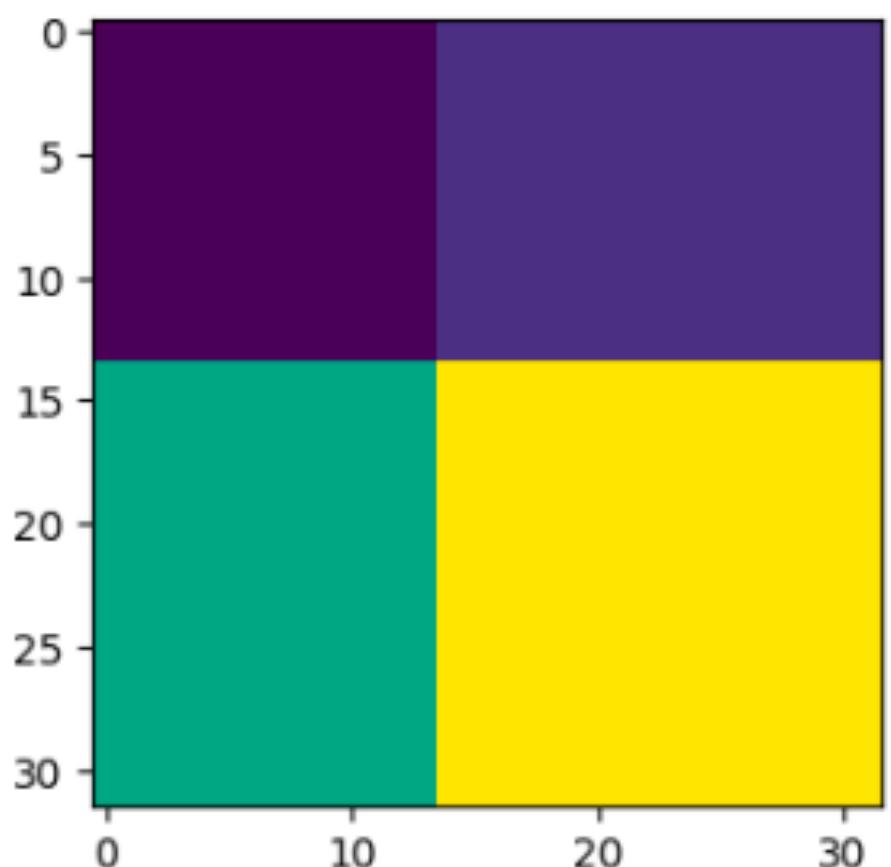
# Part 2 - Shape and Area Prediction



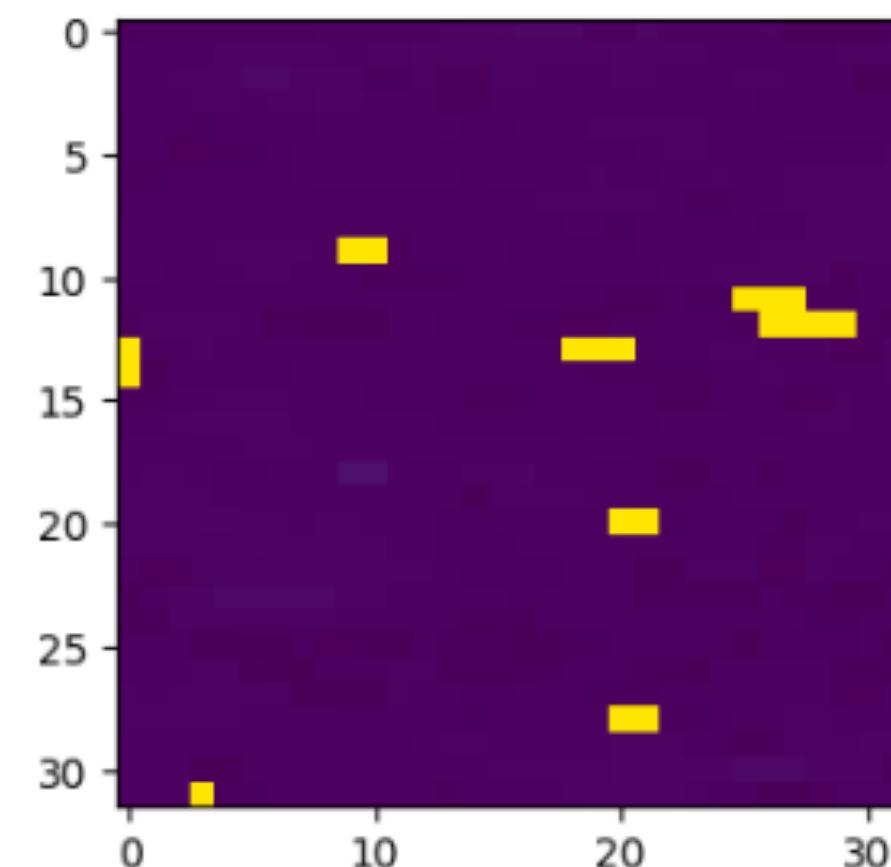
# Data



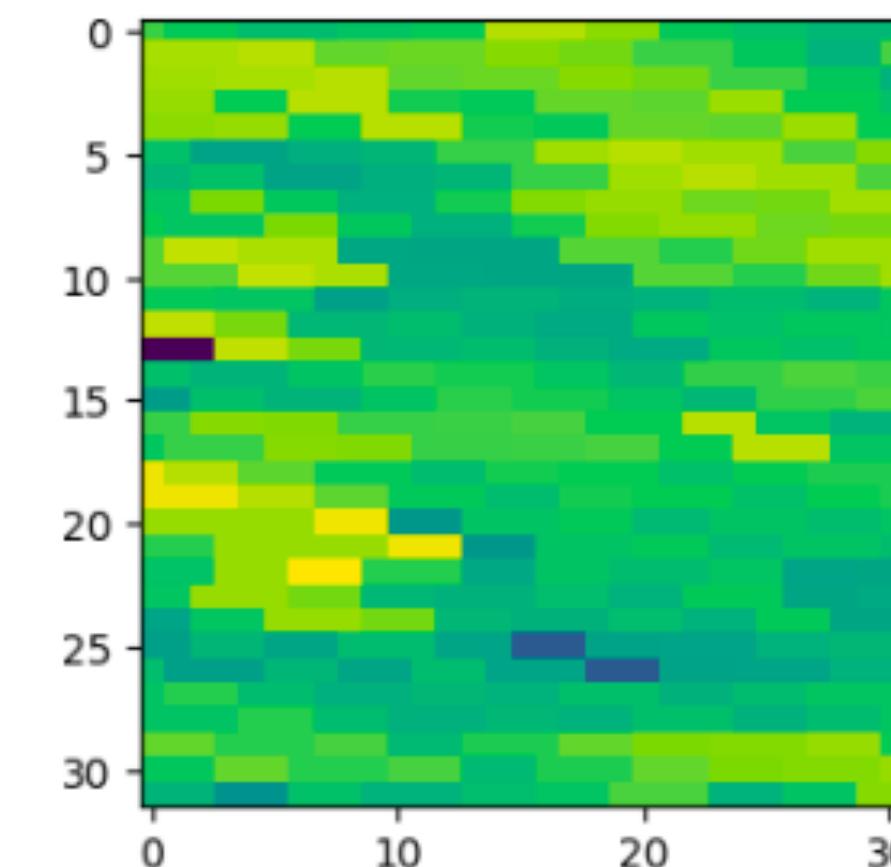
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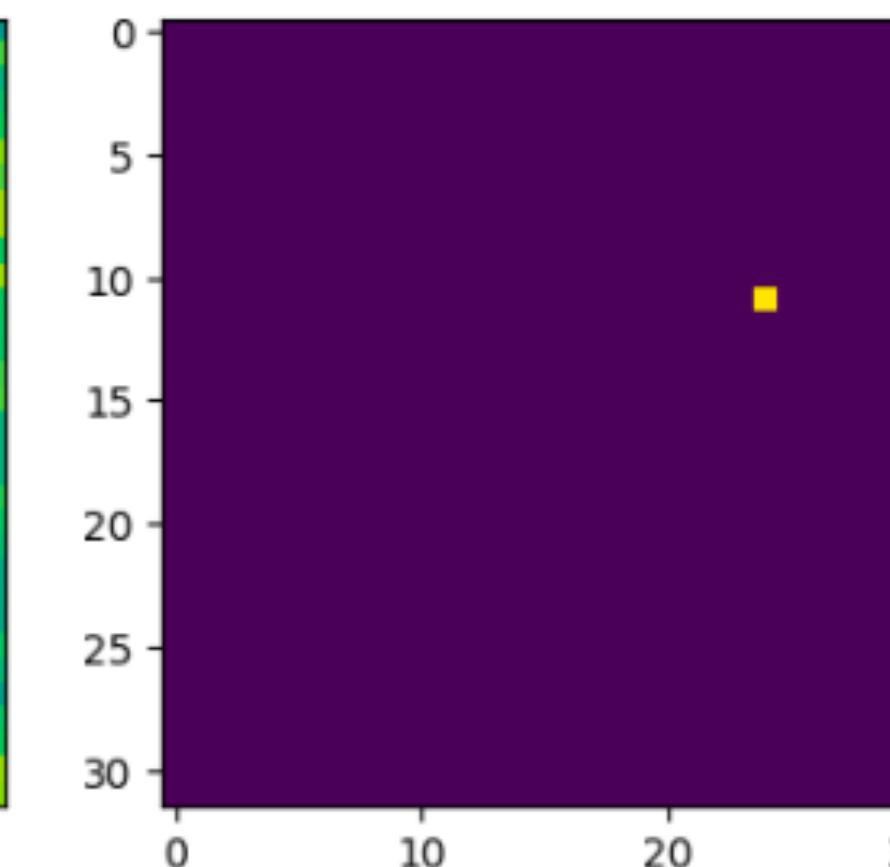
Wind speed



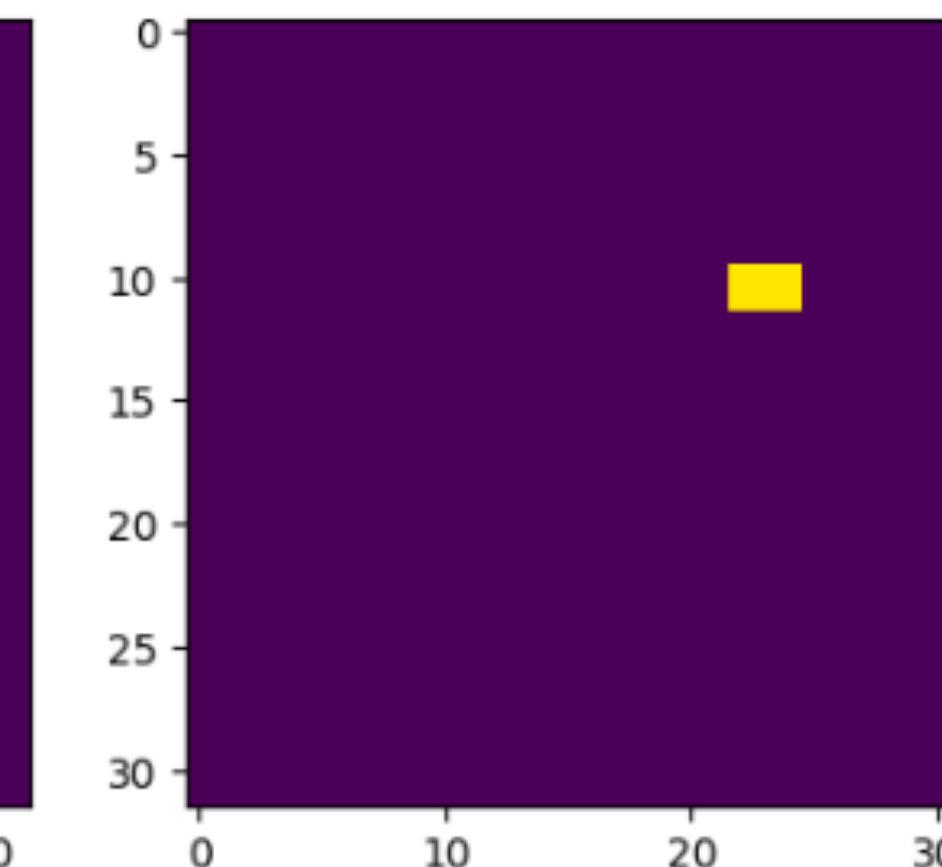
LAI



NDVI

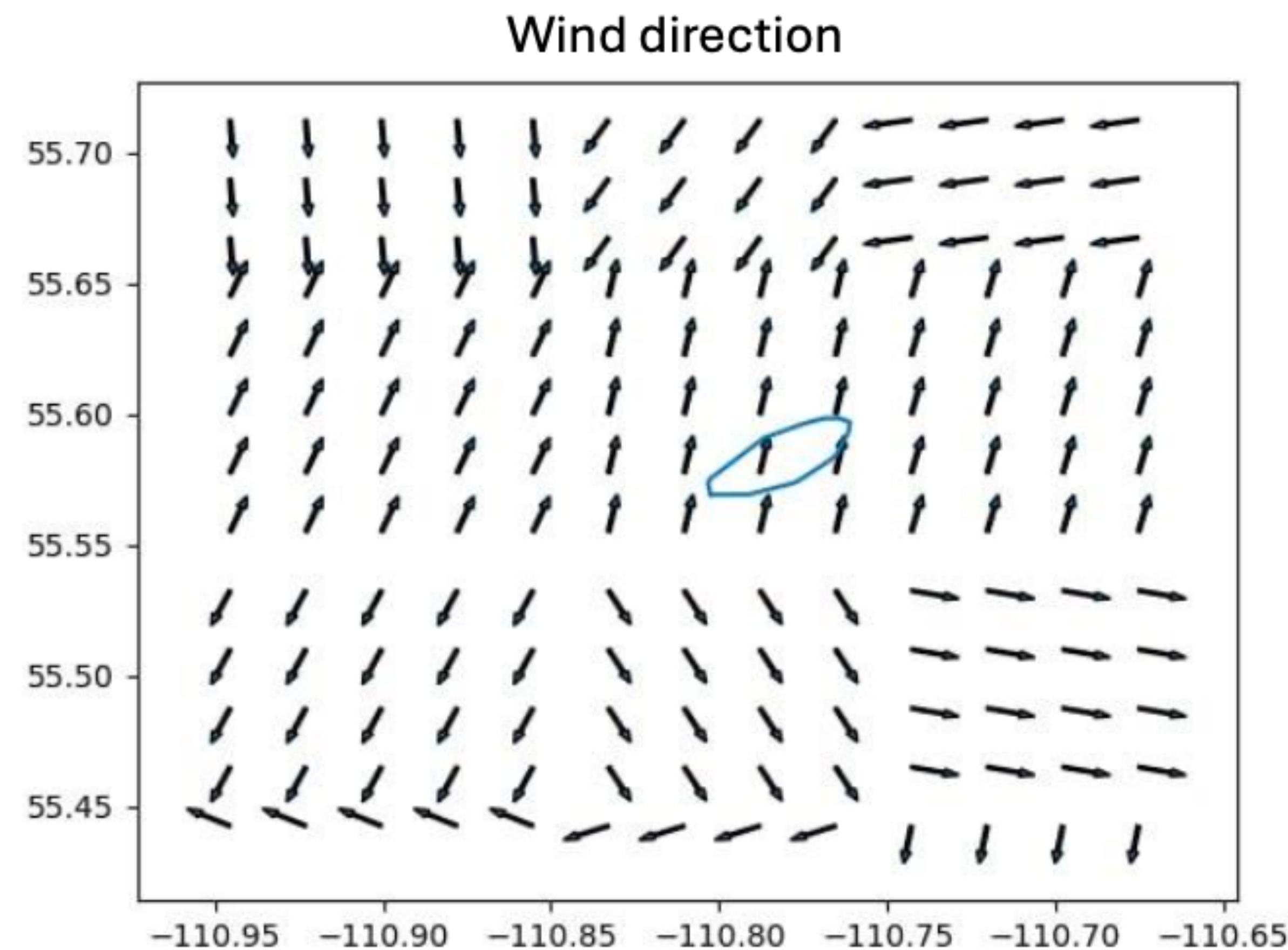


Ignition point

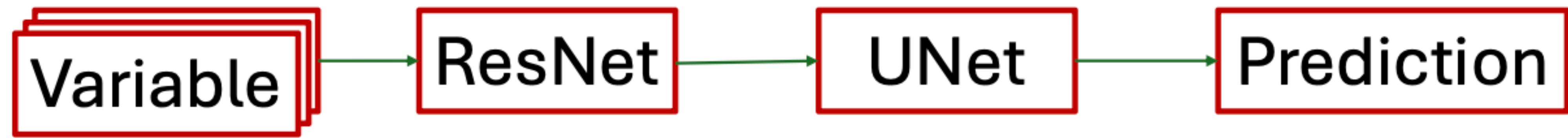


Burnt area

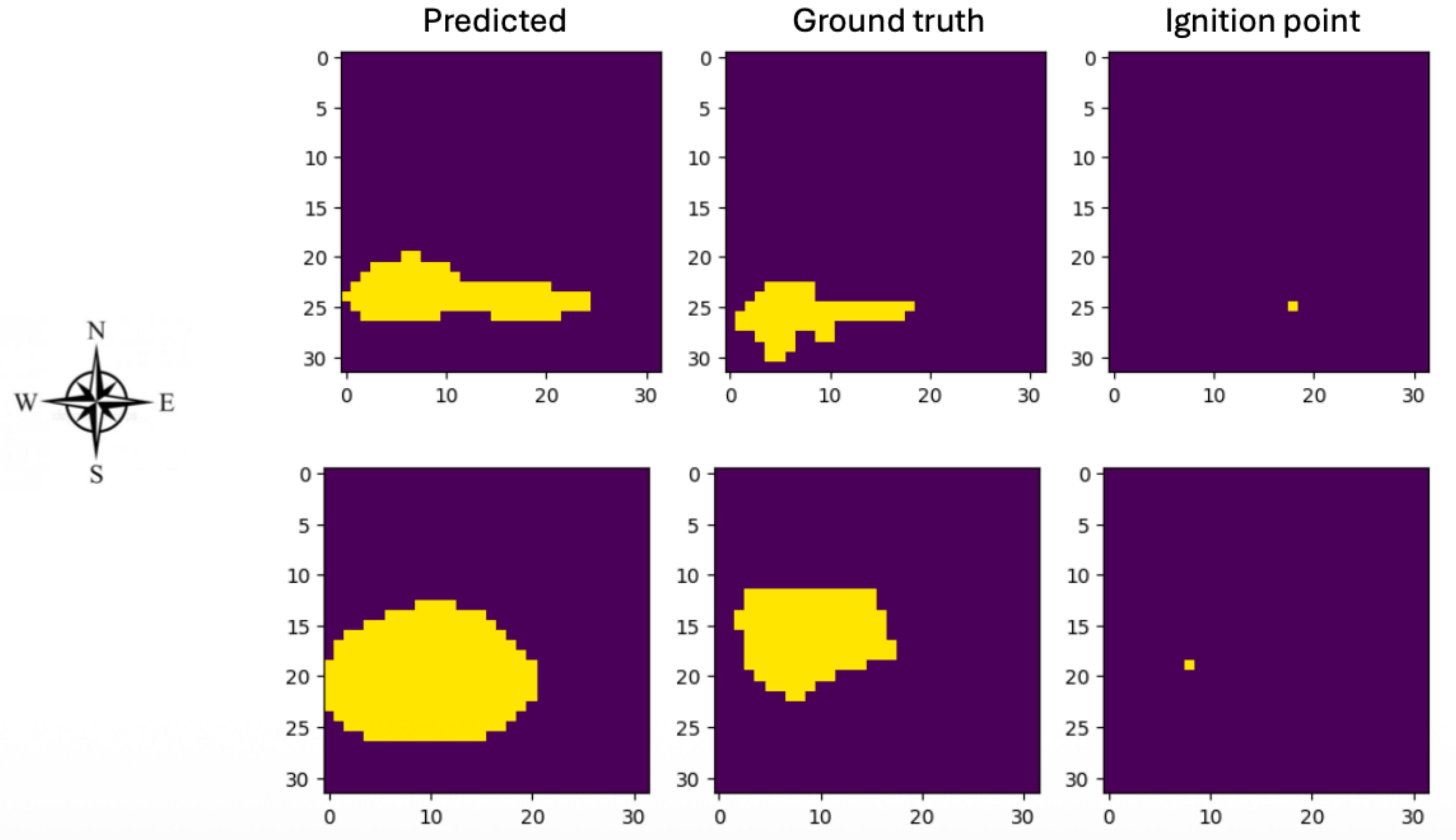
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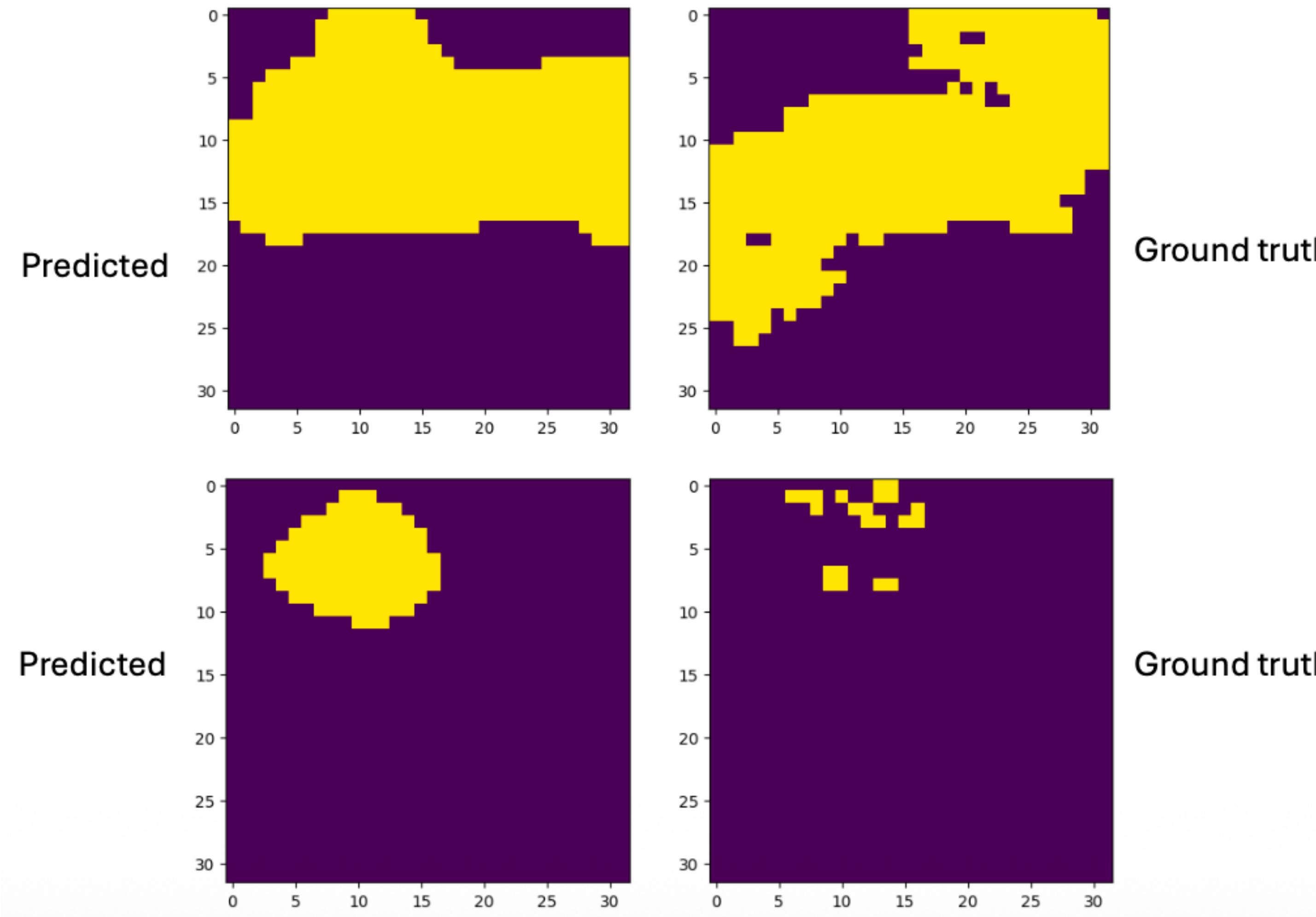
# Model



# Results

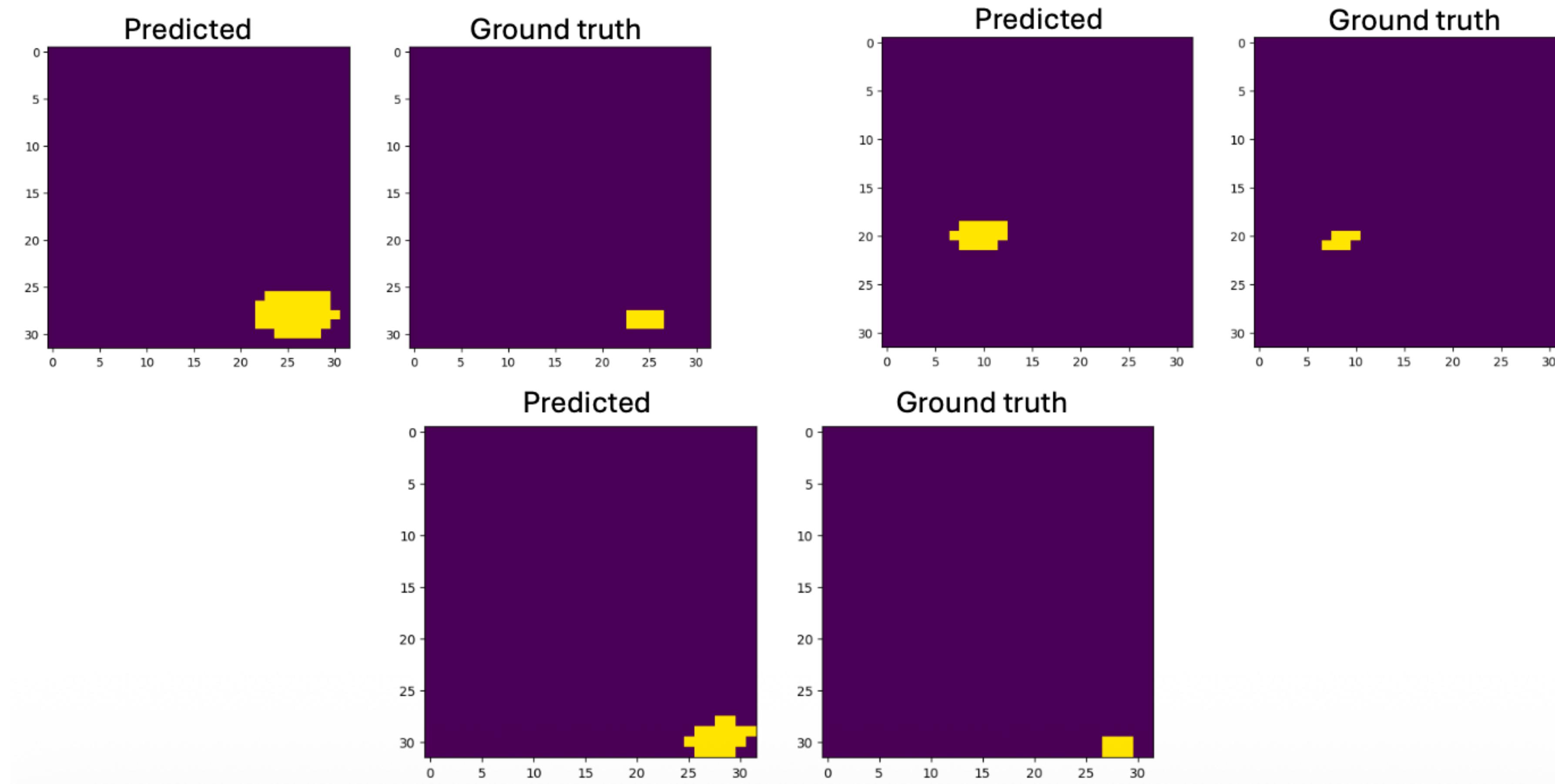


# Results



# Results

## Small Area



# Future Work

- Use more variables with better resolution:
  - carbon consideration
  - weather stations (advanced measurements)
- Incorporate Physics Equations
- Improve Models

# Conclusion

- Integrated diverse datasets including weather, vegetation, and demographics with ML techniques
- Created two-fold model strategy:
  - to identify high risk zones of fire
  - for estimating severity by predicting shape and area
- Made a tool to help decrease danger of wildfires and increase safety for residents and indigenous people