

# Scalable geospatial data generation with AlphaEarth

NeurIPS 2025

Tackling Climate Change with Machine Learning



# Agenda

- Motivation
- Project overview
- Methods
- Results
- Limitations & Takeaways



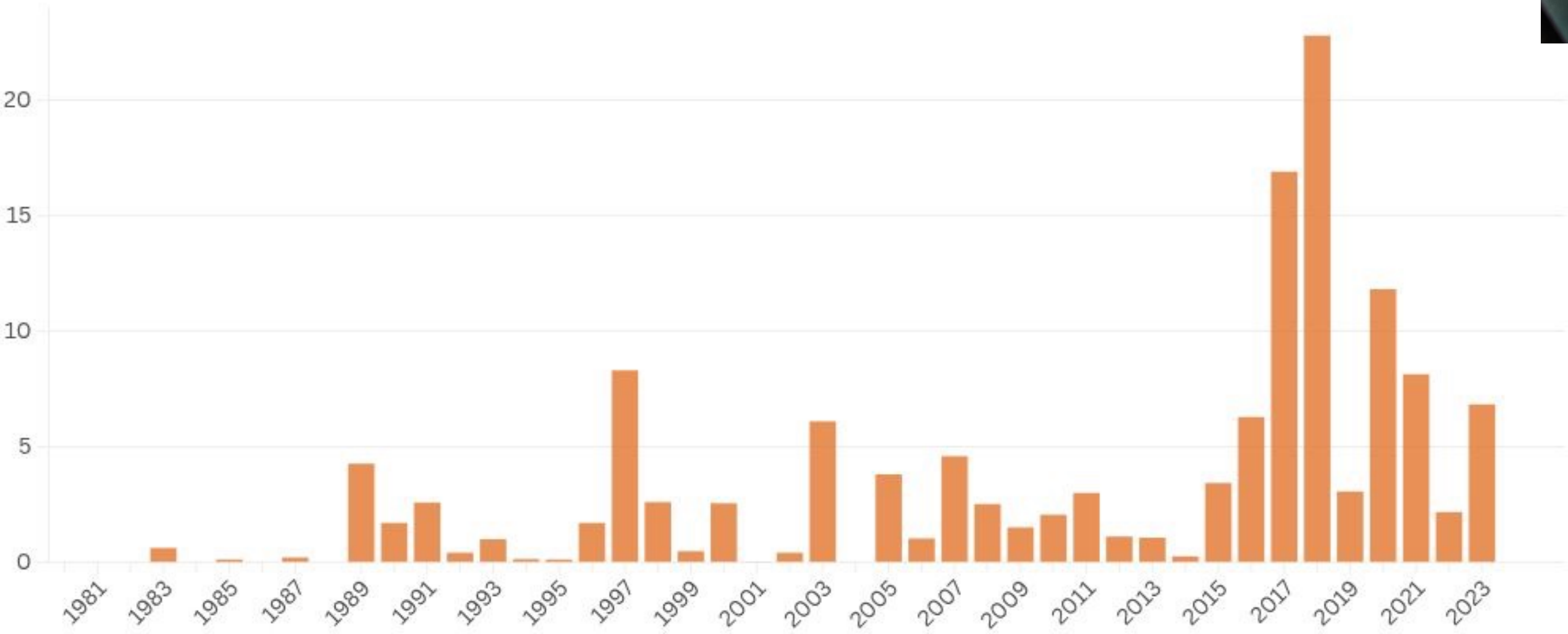
# Motivation

## Global damage costs from natural disasters, Wildfire, 1980 to 2024



Total economic cost of damages as a result of global natural disasters in any given year, measured in current US\$.

Damage Costs from Wildfires (Bn USD)



Source: [Our World in Data](#), EM-DAT, CREED / UCLouvain (2024).

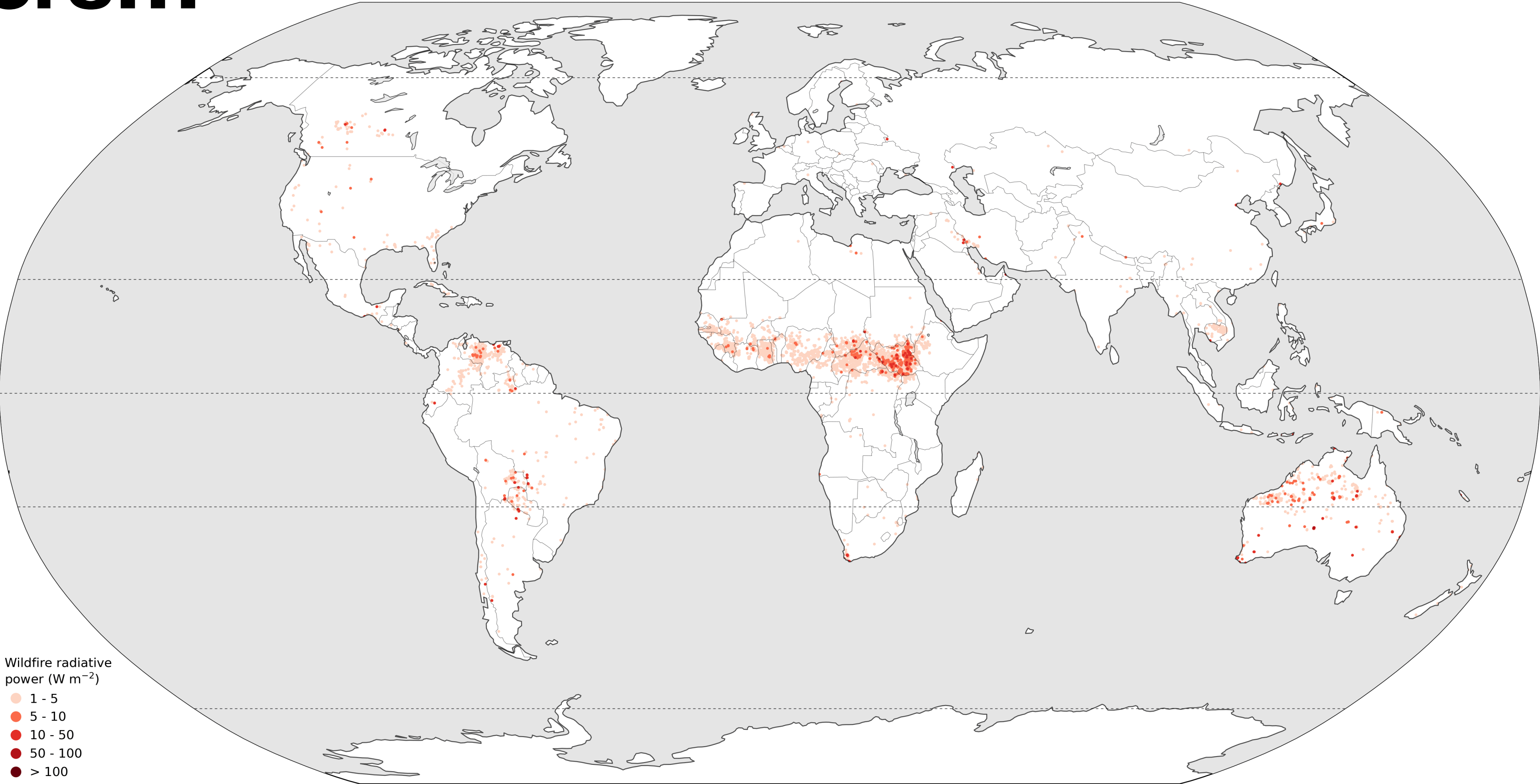
Note: Data includes disasters recorded up to April 2024





# Wildfires know no borders...

GFAS Total Fire Radiative Power - January 2024



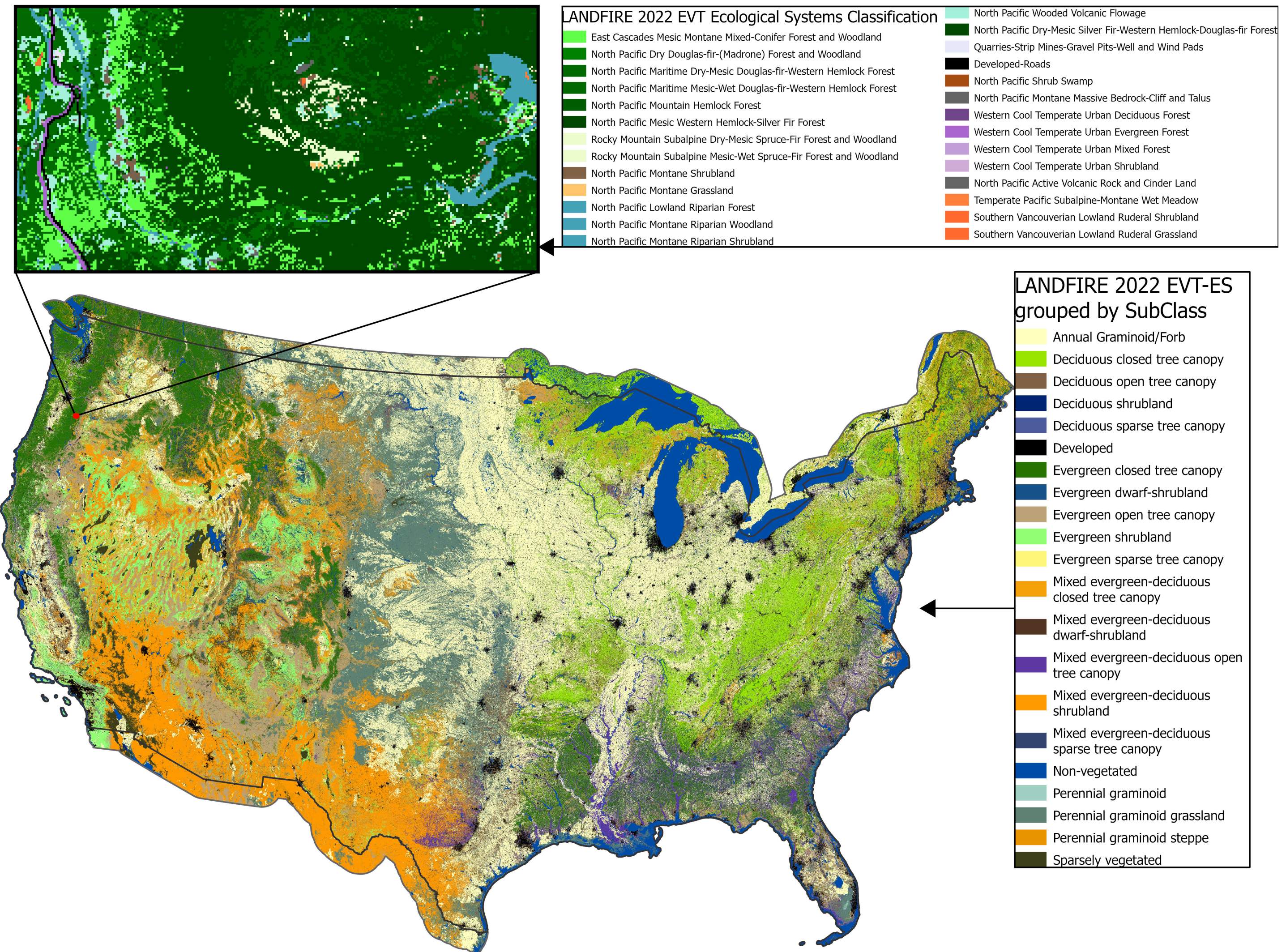
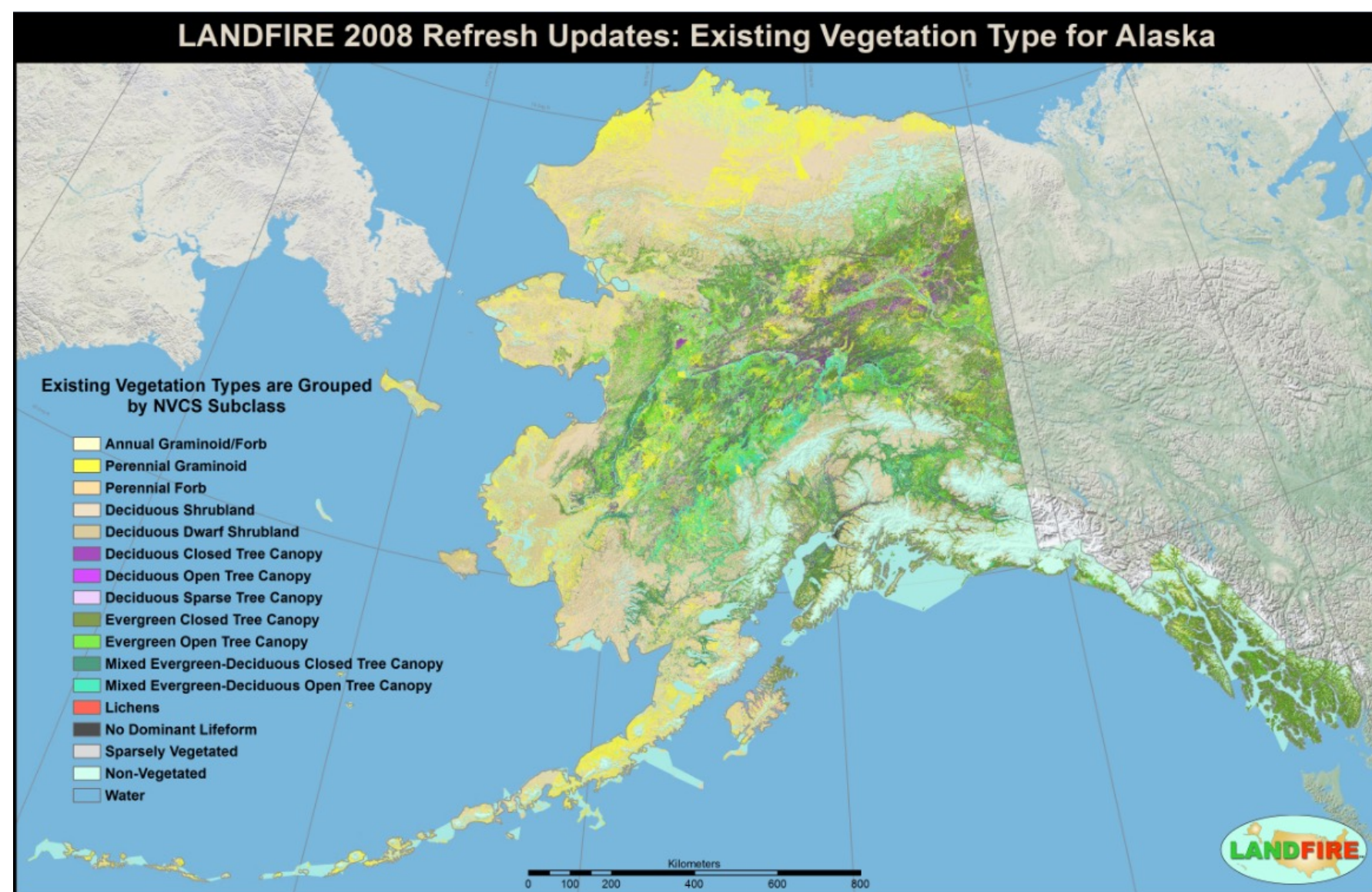
PROGRAMME OF  
THE EUROPEAN UNION





# ... But high quality vegetation datasets do !

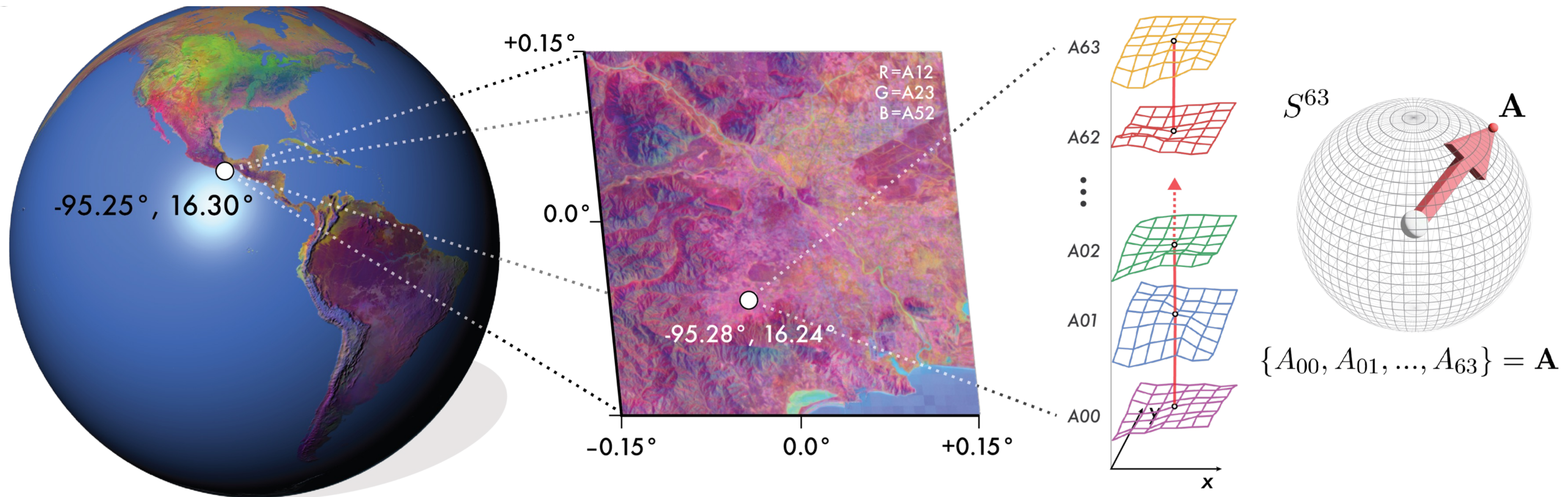
- LANDFIRE is an American cross-agency program
- Produces vegetation dataset in the US for fire management
- **EVT**: “Existing Vegetation Type”



“Landfire technical documentation.” (2023) Washington DC: US Department of the Interior, US Geological Survey



# About AlphaEarth Foundations (AEF)

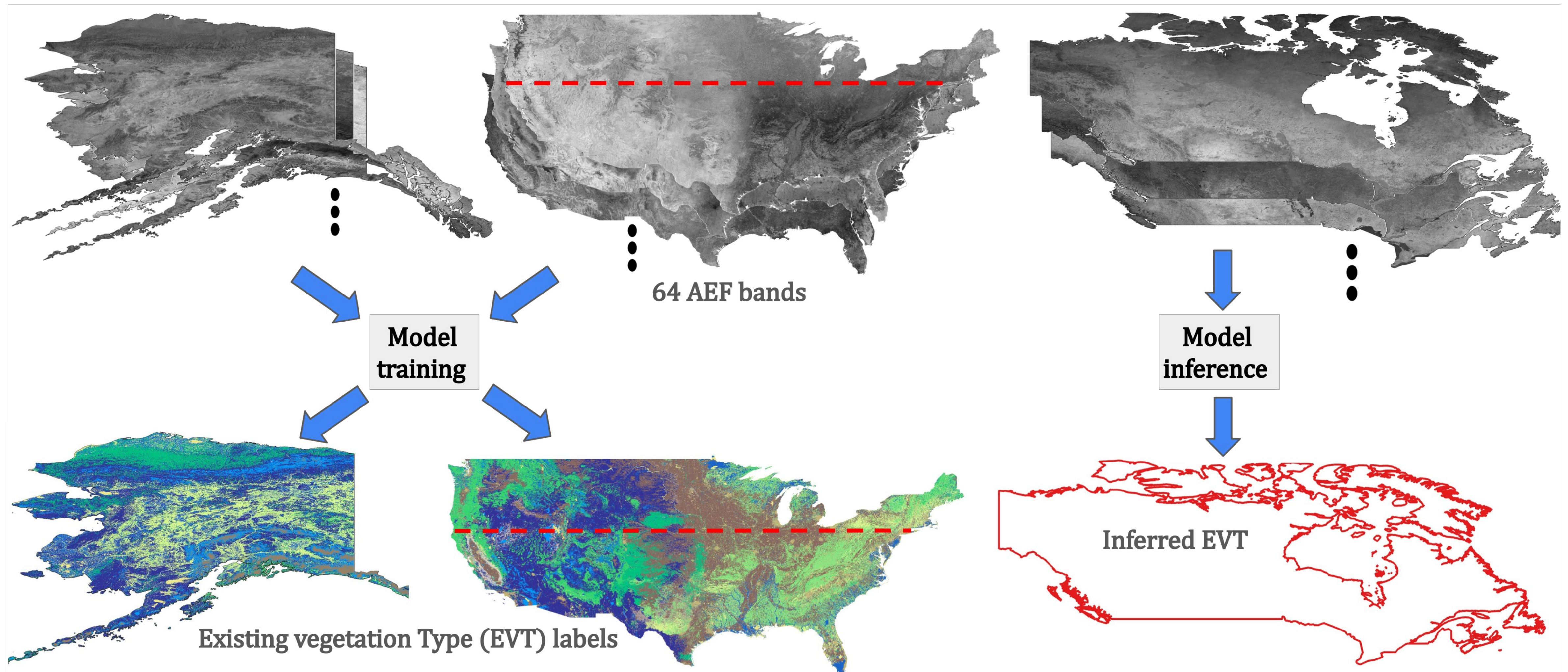


- Google Deepmind model-as-data publicly released on Google Earth Engine
- Model trained on wide variety of geospatial data (satellite optical + SAR, ERA5...)
- ‘General purpose’ embeddings provided as 64-dimensioned vectors

*Brown, Christopher F., et al. "AlphaEarth Foundations: An embedding field model for accurate and efficient global mapping from sparse label data." arXiv preprint arXiv:2507.22291 (2025).*



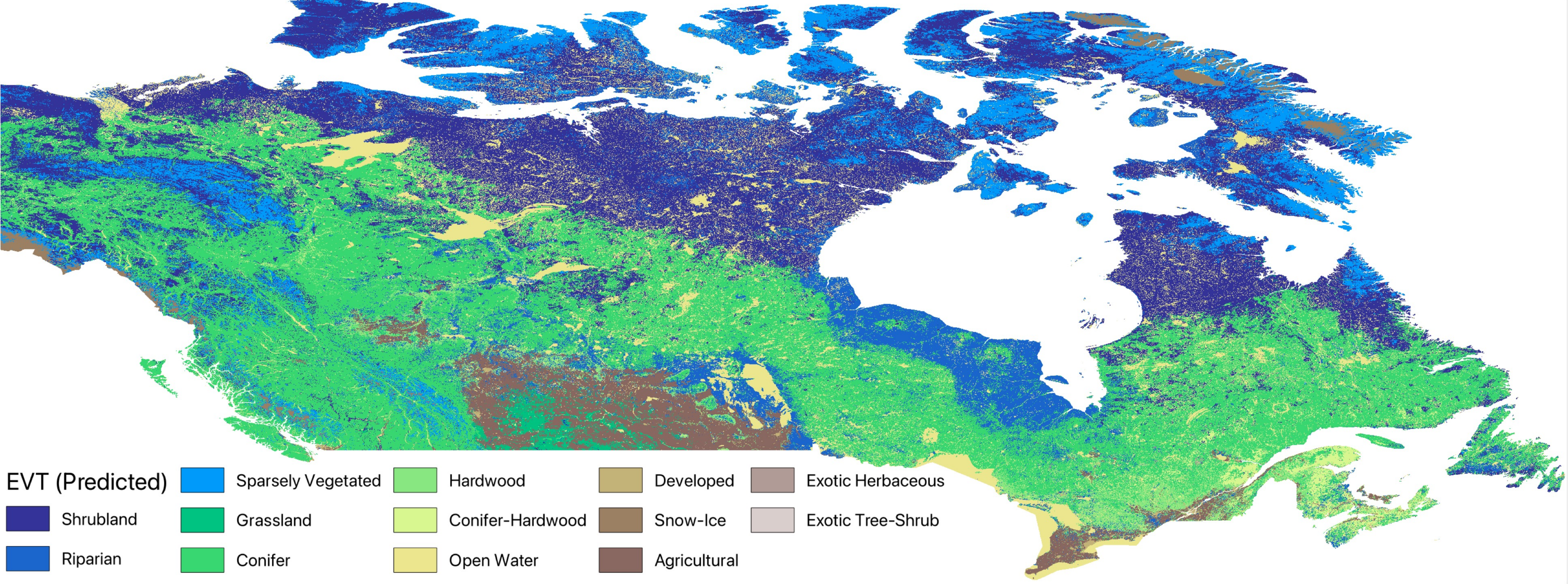
# Project overview





# Inference in Canada

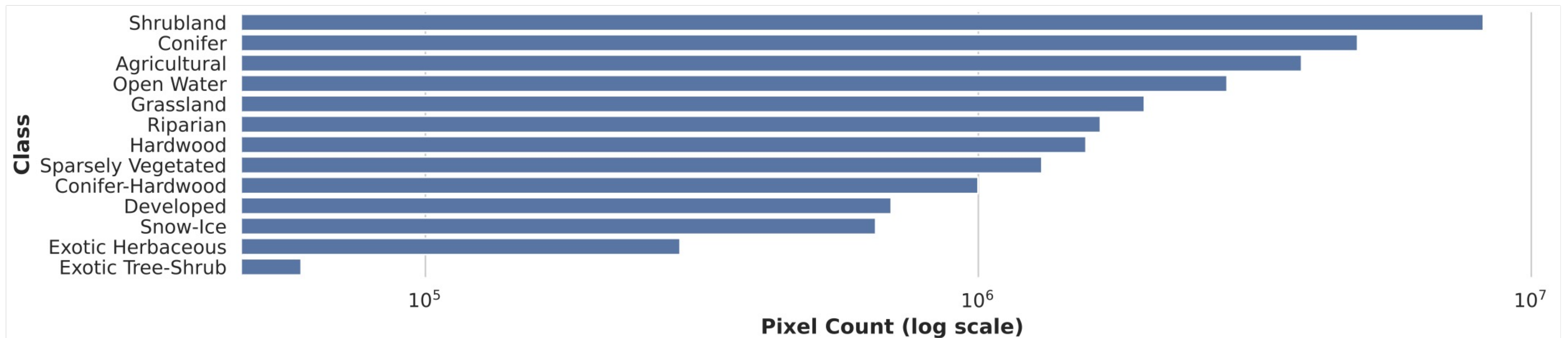
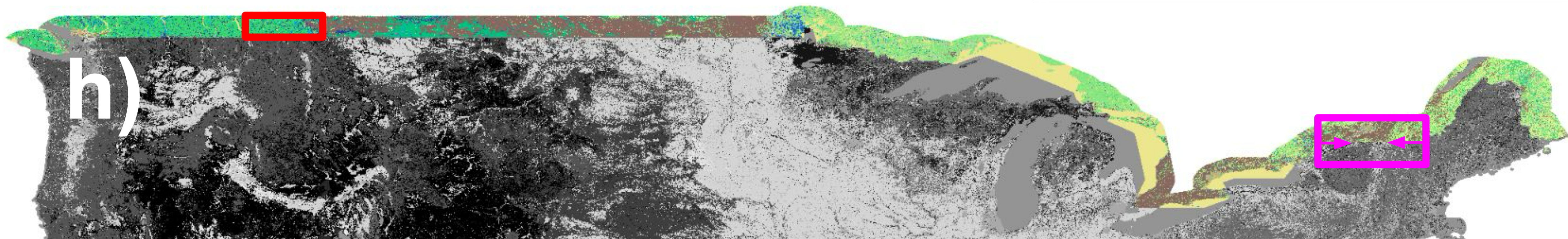
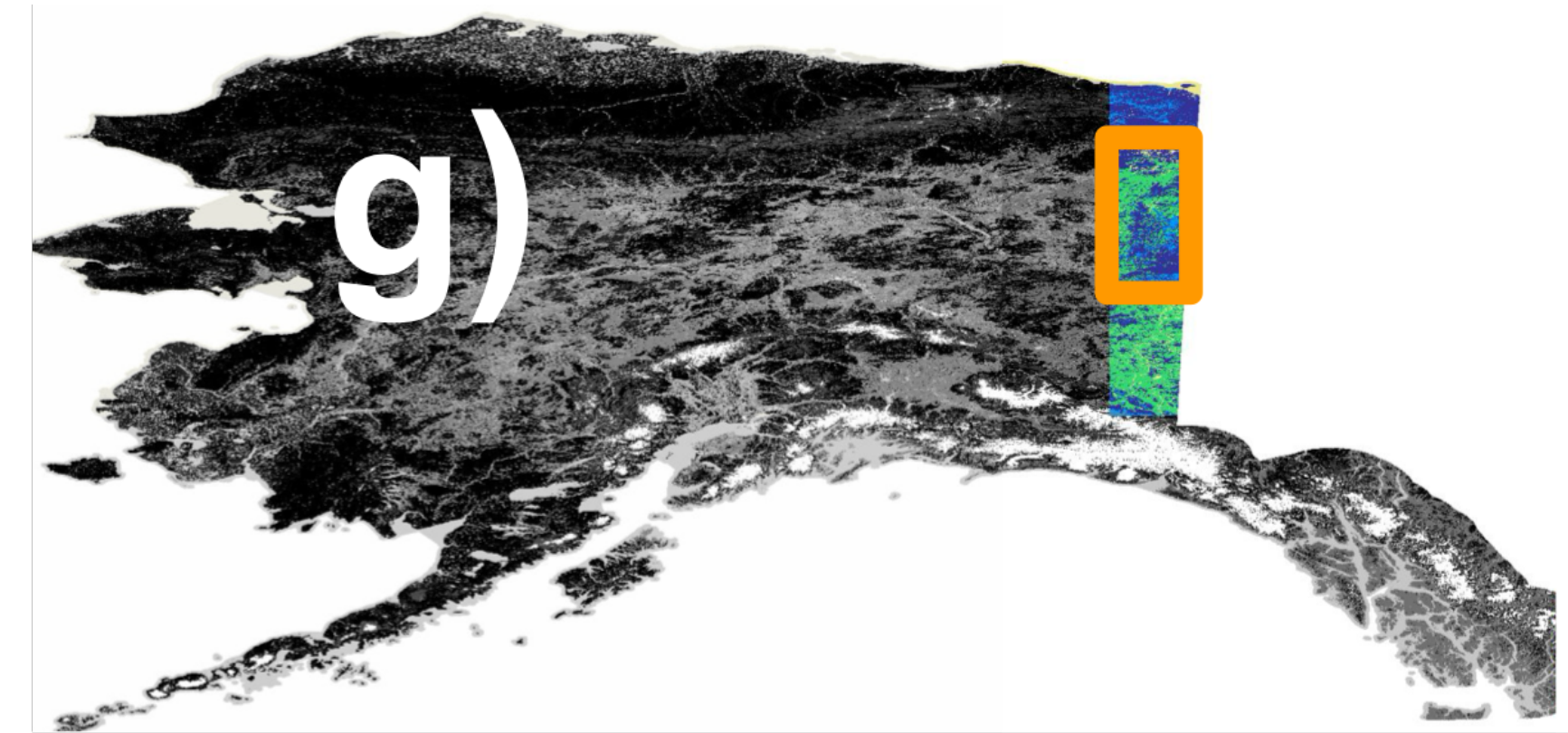
13 classes





# Methods

- 2 held out test areas to evaluate performance
- 4 different models investigated





# Training and testing

- Similar performance across models
- Drop in performance (a) in test regions and (b) as number of classes increases
- Over-performing random forest model in training

13 classes

|                               | Training |      |      | Validation |      |      | Test |      |      |
|-------------------------------|----------|------|------|------------|------|------|------|------|------|
|                               | ACC      | J    | F1   | ACC        | J    | F1   | ACC  | J    | F1   |
| <b>Logistic Regression</b>    | 0.77     | 0.48 | 0.60 | 0.77       | 0.48 | 0.59 | 0.71 | 0.39 | 0.51 |
| <b>Random Forest</b>          | 0.97     | 0.95 | 0.97 | 0.81       | 0.55 | 0.67 | 0.73 | 0.43 | 0.55 |
| <b>Gradient Boosted Trees</b> | 0.79     | 0.52 | 0.65 | 0.79       | 0.52 | 0.64 | 0.73 | 0.42 | 0.54 |
| <b>Segmentation Model</b>     | 0.79     | 0.50 | 0.63 | 0.79       | 0.51 | 0.63 | 0.73 | 0.42 | 0.54 |

80 Classes

|                               | Training |      |      | Validation |      |      | Test |      |      |
|-------------------------------|----------|------|------|------------|------|------|------|------|------|
|                               | ACC      | J    | F1   | ACC        | J    | F1   | ACC  | J    | F1   |
| <b>Logistic Regression</b>    | 0.60     | 0.28 | 0.40 | 0.60       | 0.27 | 0.39 | 0.42 | 0.11 | 0.17 |
| <b>Random Forest</b>          | 0.96     | 0.94 | 0.96 | 0.71       | 0.39 | 0.53 | 0.48 | 0.16 | 0.23 |
| <b>Gradient Boosted Trees</b> | 0.63     | 0.29 | 0.43 | 0.62       | 0.28 | 0.41 | 0.44 | 0.12 | 0.17 |
| <b>Segmentation Model</b>     | 0.65     | 0.28 | 0.40 | 0.66       | 0.29 | 0.41 | 0.48 | 0.15 | 0.21 |

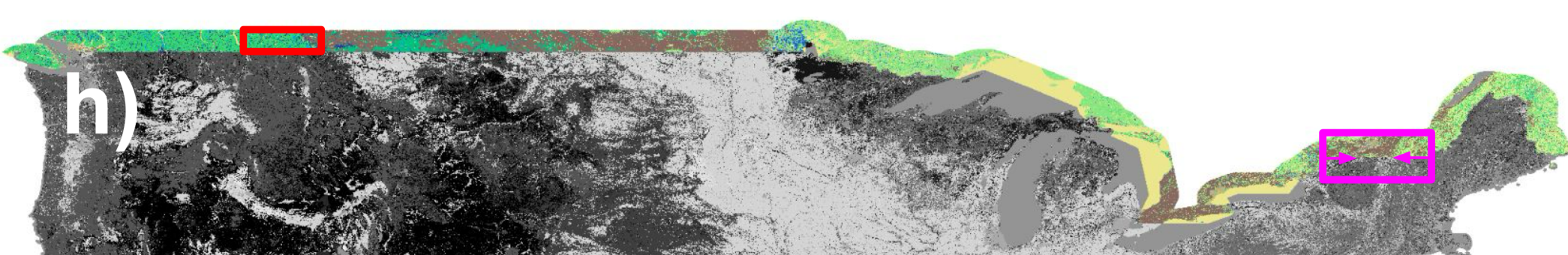
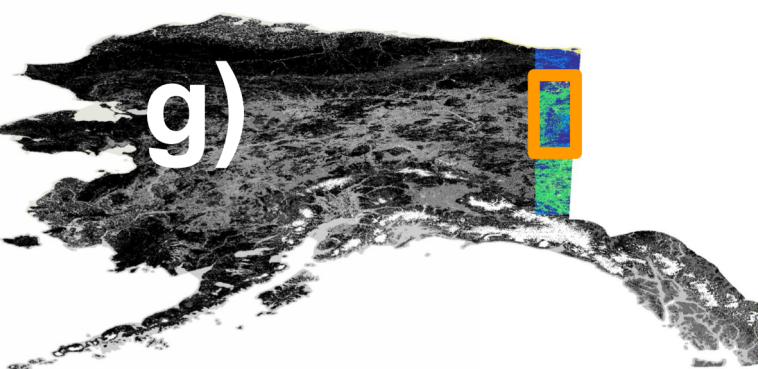
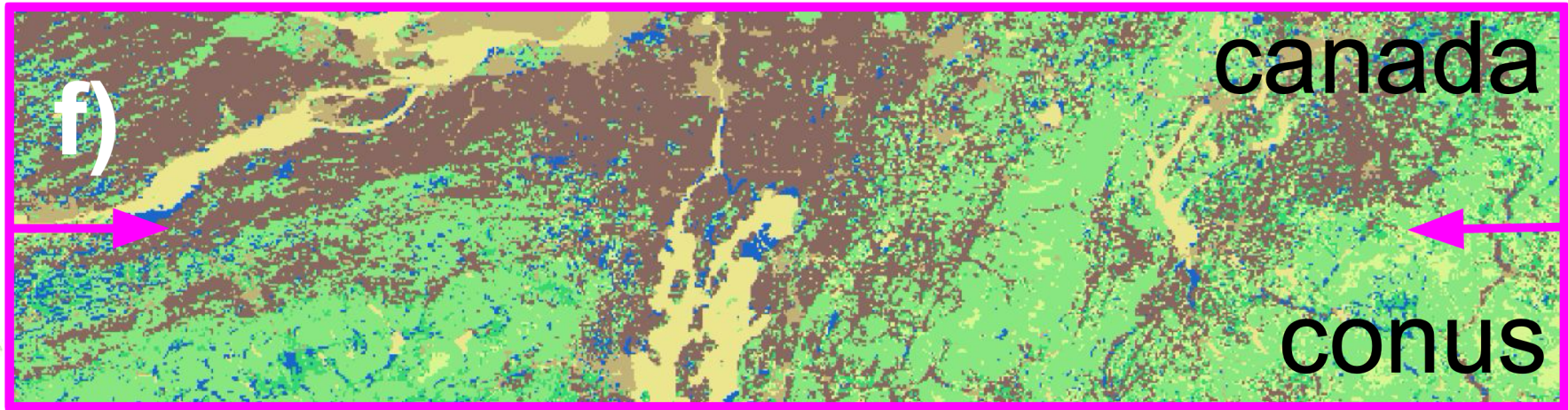
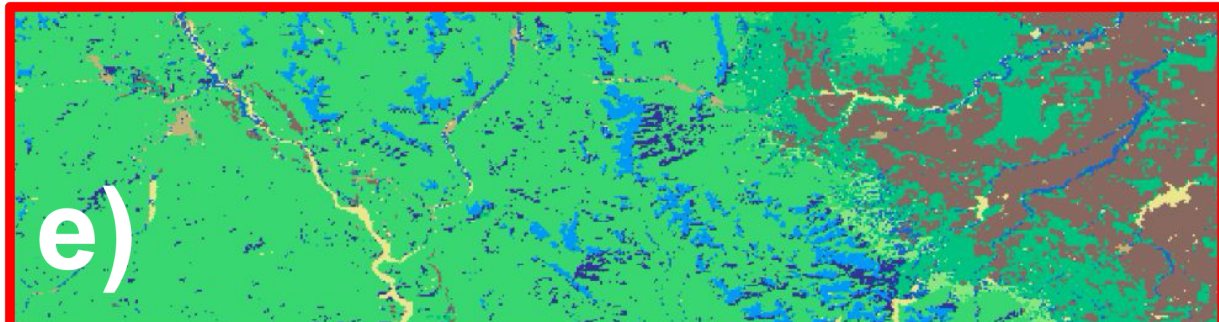
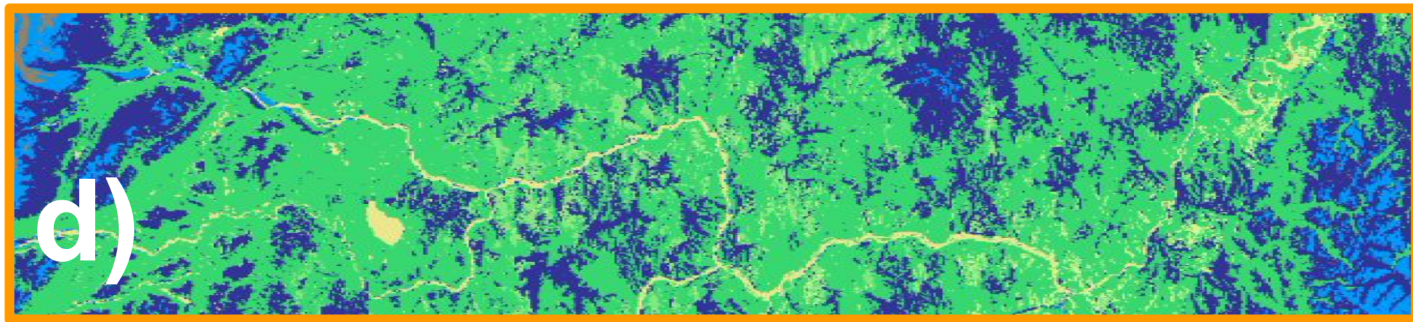
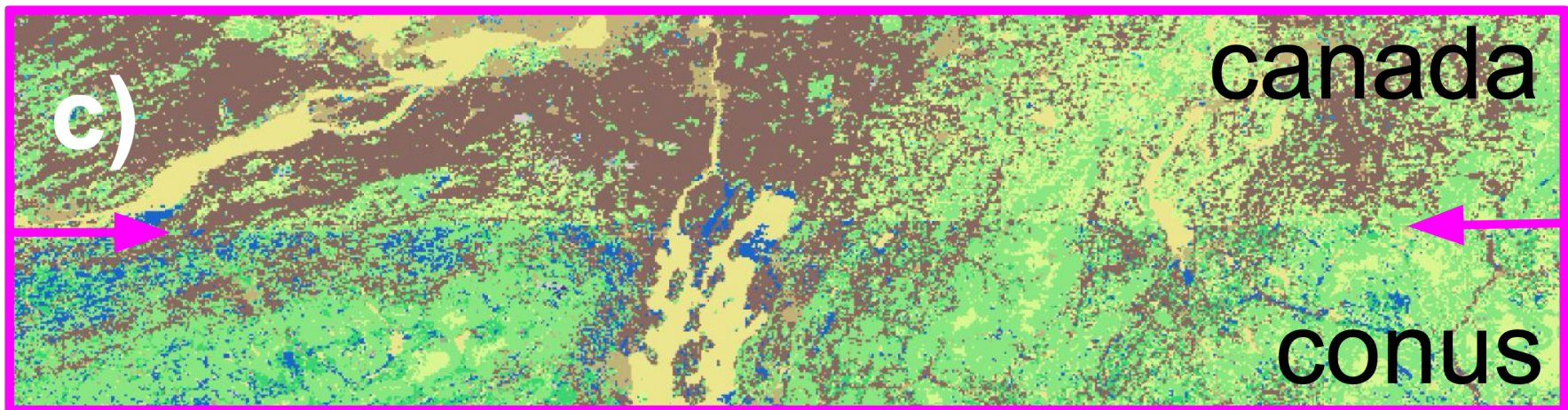
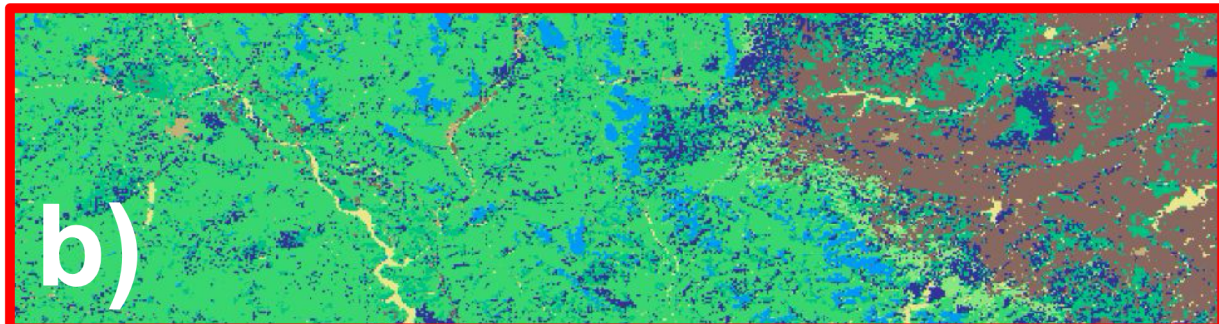
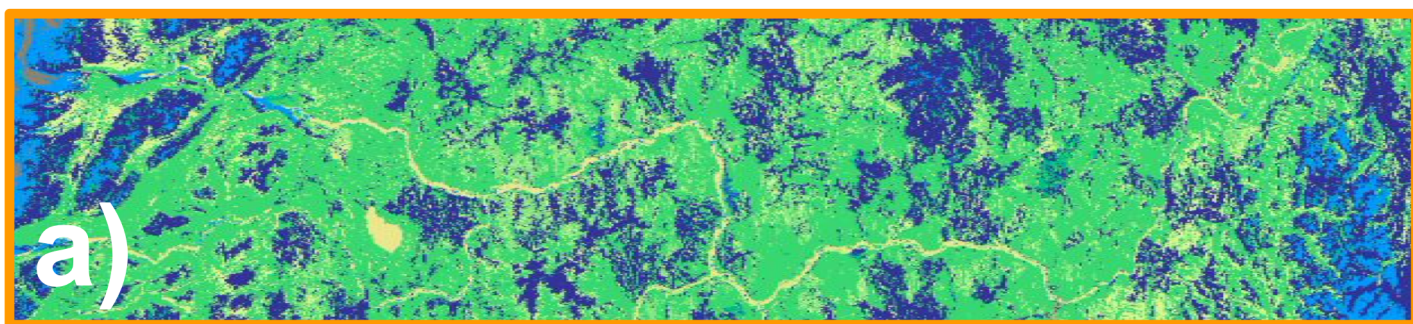


# Training and testing

- Large variations in performances across test regions
- Abrupt transition in LANDFIRE data could explain drop in performance

13 classes

|                        | Canada South |      |      | Canada West |      |      |
|------------------------|--------------|------|------|-------------|------|------|
|                        | ACC          | J    | F1   | ACC         | J    | F1   |
| Logistic Regression    | 0.67         | 0.31 | 0.41 | 0.82        | 0.35 | 0.42 |
| Random Forest          | 0.69         | 0.34 | 0.45 | 0.83        | 0.42 | 0.52 |
| Gradient Boosted Trees | 0.69         | 0.34 | 0.45 | 0.83        | 0.32 | 0.39 |
| Segmentation Model     | 0.69         | 0.34 | 0.45 | 0.83        | 0.37 | 0.45 |





# Limitations & Takeaways

- EVT is itself the output of a predicted model not a ‘true ground truth’
- Performance drops as a function of *distance* to labeled data
- Simple models can be used for this task with AlphaEarth Foundations
- This study can be extended to other use cases outside of vegetation types