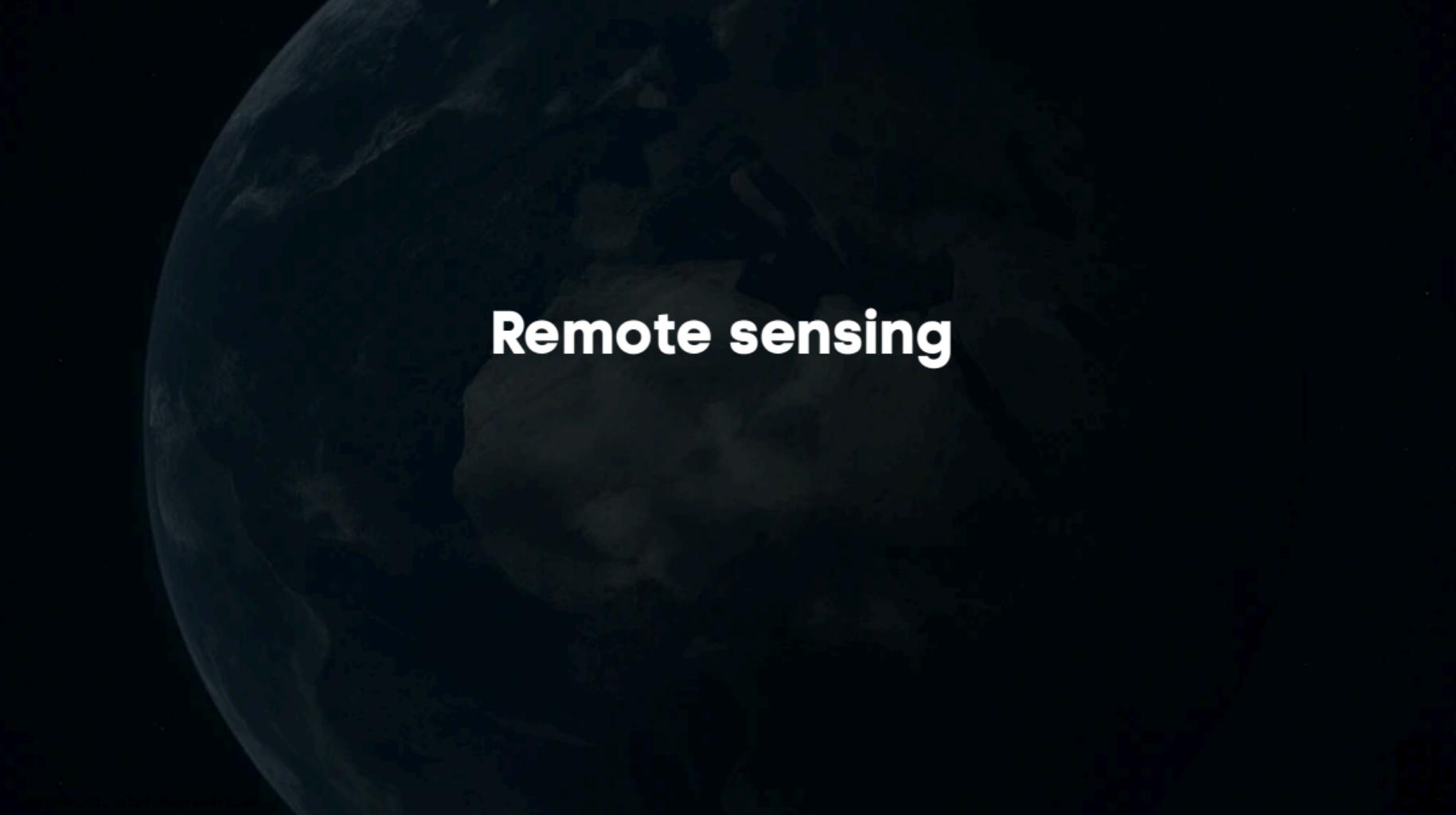




# **AI for environmental monitoring**

## **AI for environmental data, Uppsala University**

Olof Mogren, RISE Research Institutes of Sweden



# Remote sensing

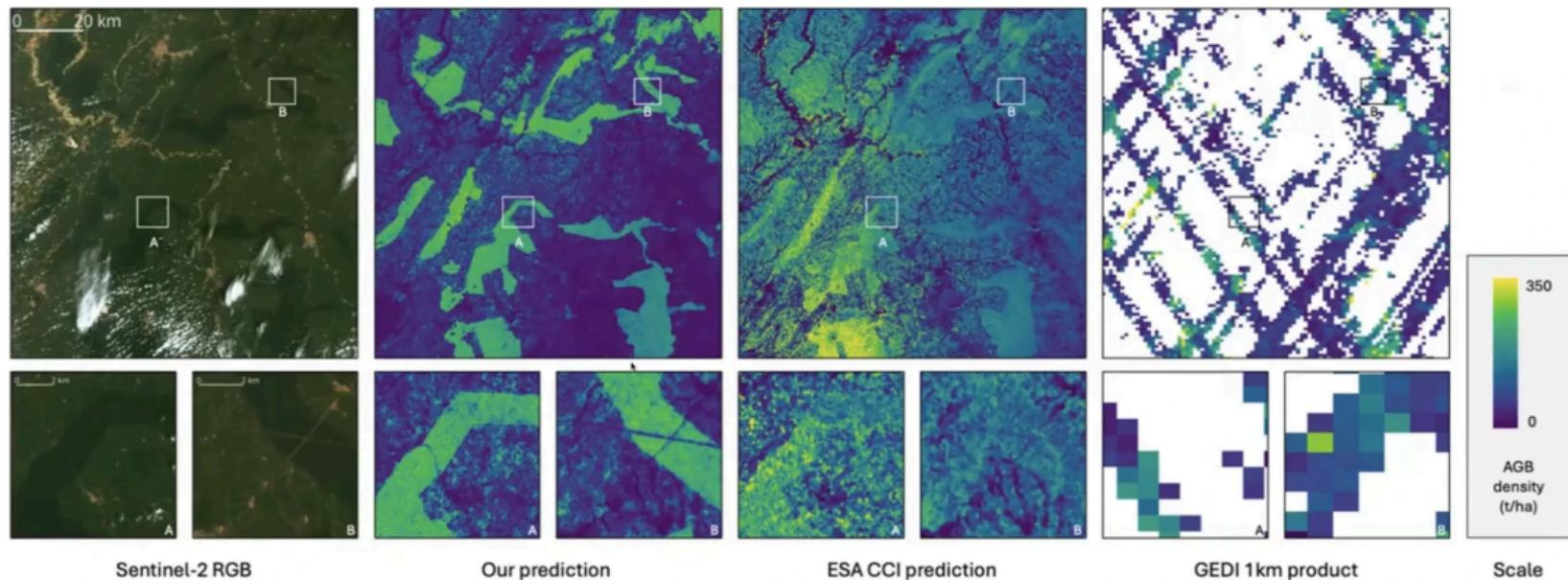


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S.E



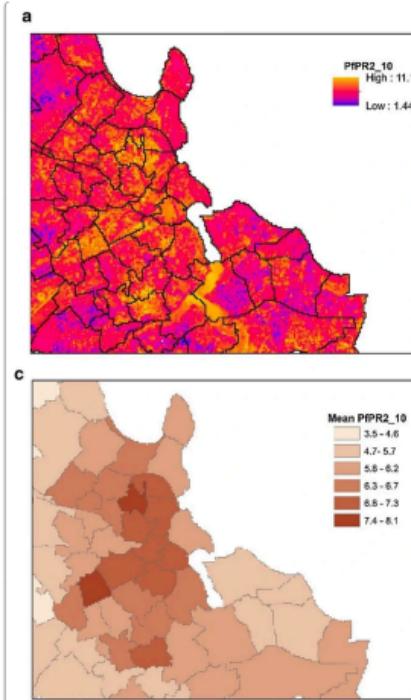
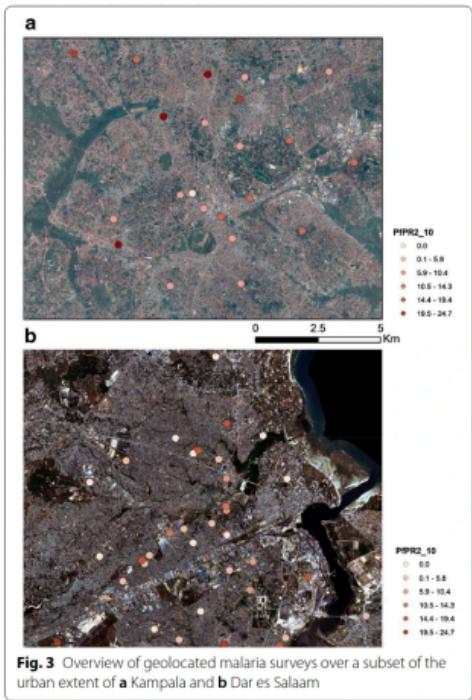
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# Above ground biomass estimation

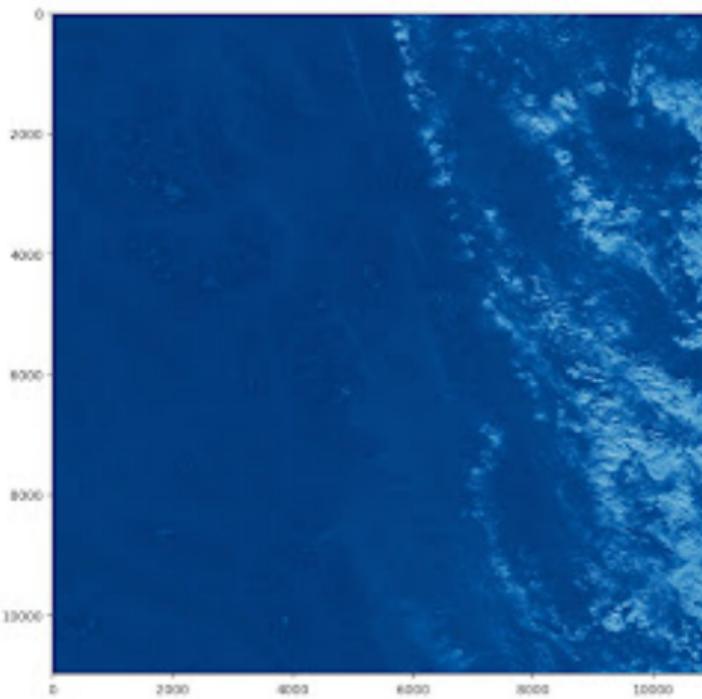
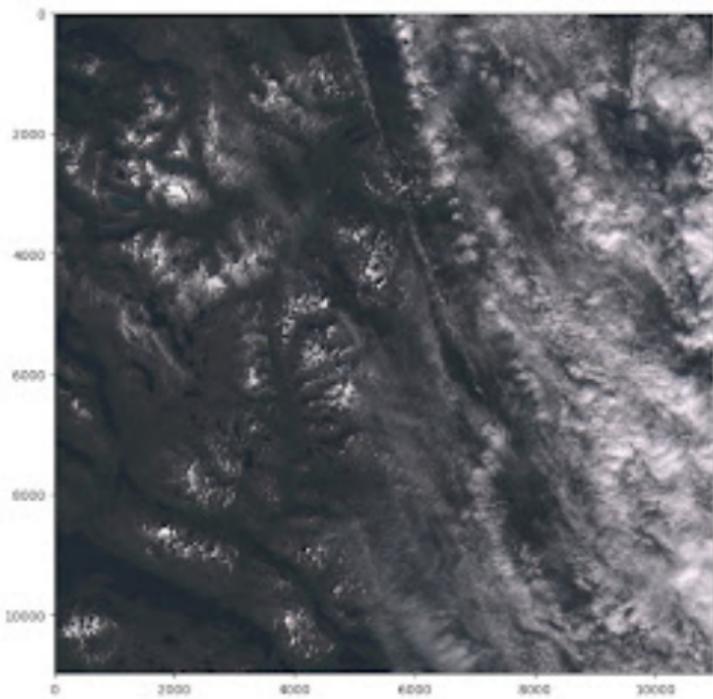


# Remote sensing for deprived urban areas

## Malaria mapping

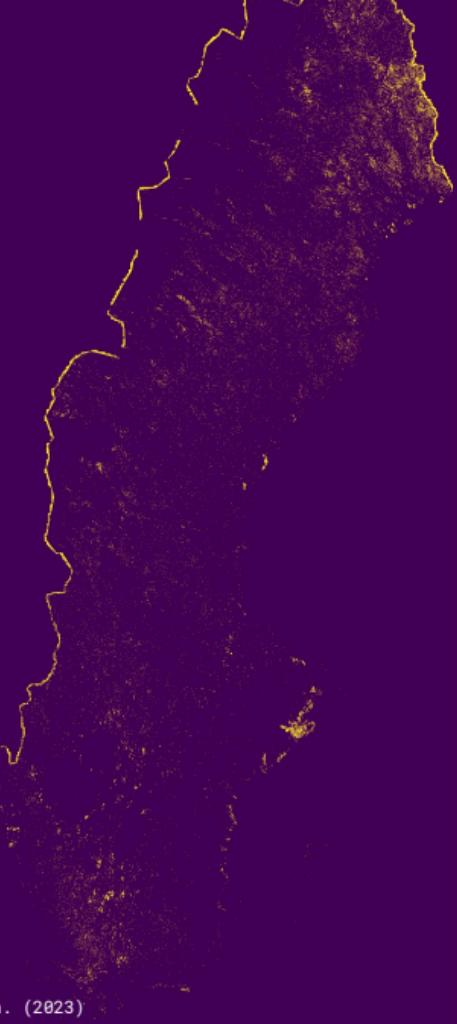


# Cloud thickness estimation



A wide-angle photograph of a wetland area. In the foreground, there's a body of water with many green lily pads scattered across its surface. The water is calm, reflecting the bright blue sky above. The middle ground is dominated by a lush, green marshy area with tall grasses and reeds. In the background, a dense forest of tall evergreen trees stretches across the horizon under a clear, blue sky with a few wispy clouds.

# Powerful carbon sink

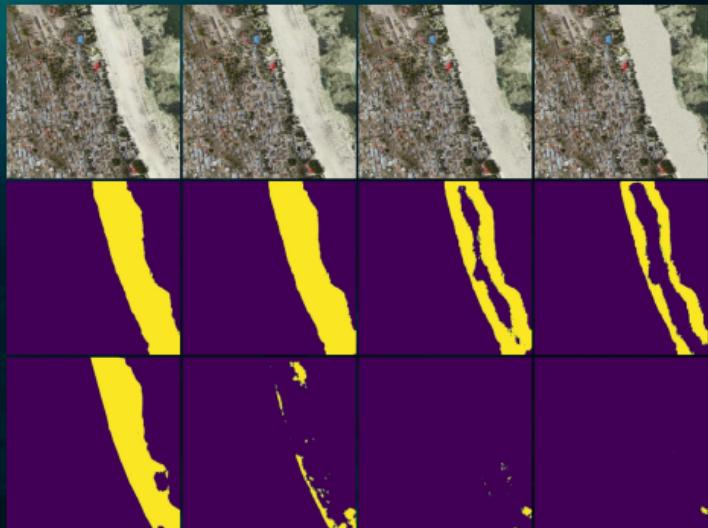


# Earth observation for wetland estimation

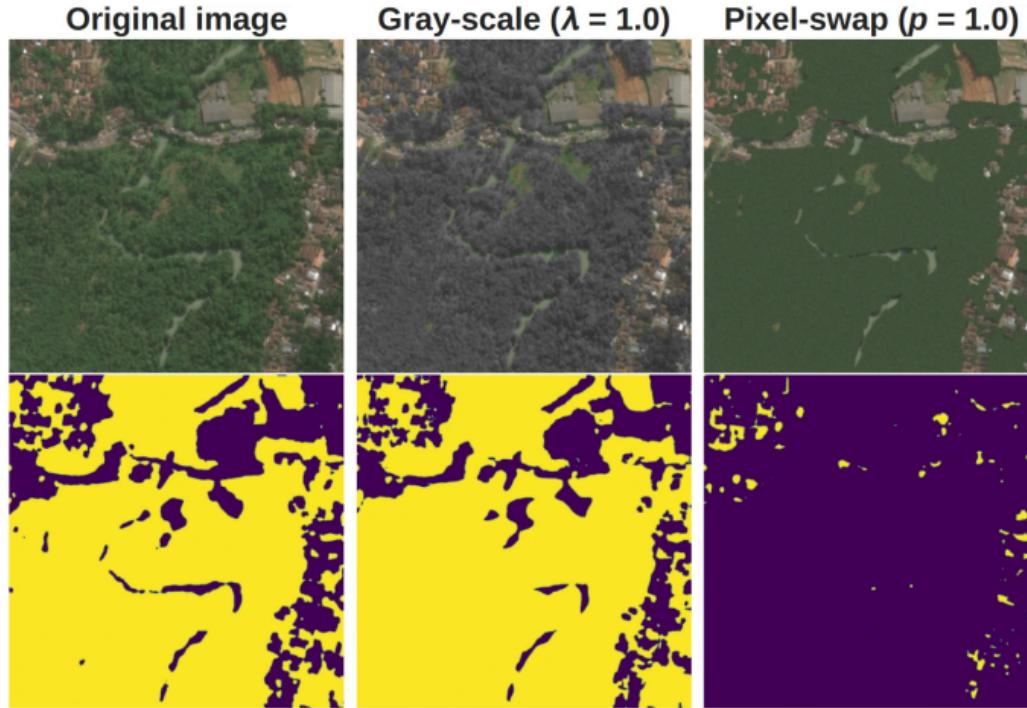
- Generated map, crucial for
  - Wetland restoration
  - Biodiversity
  - Climate adaptation

# Robustness in ML for remote sensing

- Existing state-of-the art models sensitive to pixel perturbations
- Relies on texture, context
- Not strong reliance on color
- Work published at ML4RS Workshop at ICLR 2024



# Robustness of state-of-the-art earth observation models



# Species distribution modeling

## Habitat suitability

- ~8.7M species, only ~100k have mapped ranges
- Traditional SDMs (e.g. MaxEnt, HMSC)
  - need environmental covariates
  - struggle at global scale
- Citizen science\*: >10 000 000 presence-only observations
- Can we predict species ranges with only locations (lat,lon)?

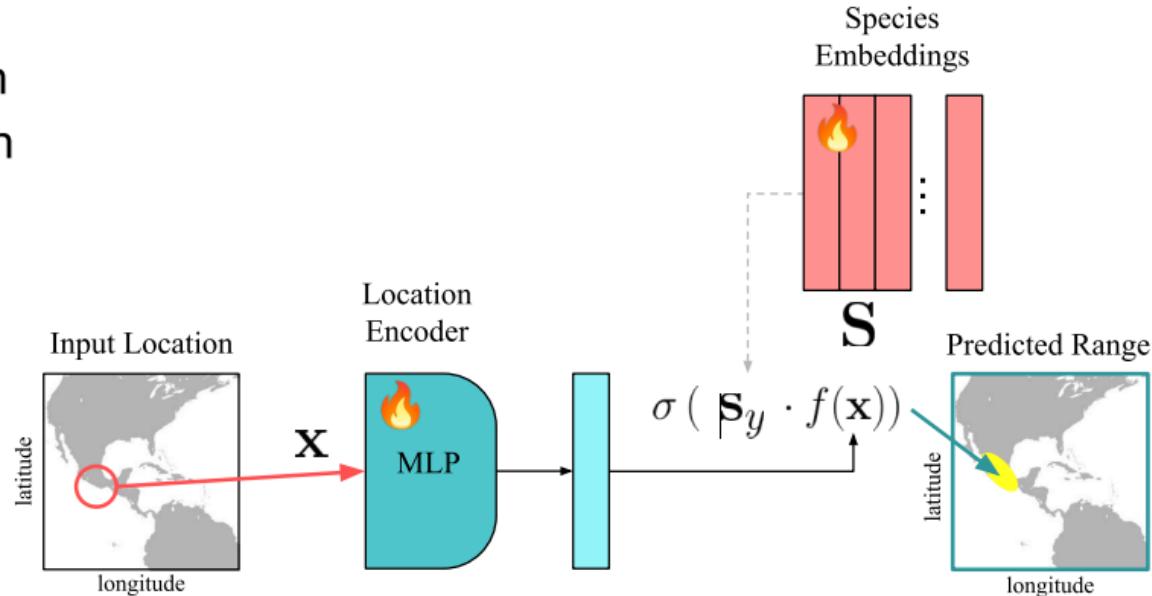
# Spatial Implicit Neural Representations (SINR)

Train this model on citizen science observations from iNaturalist

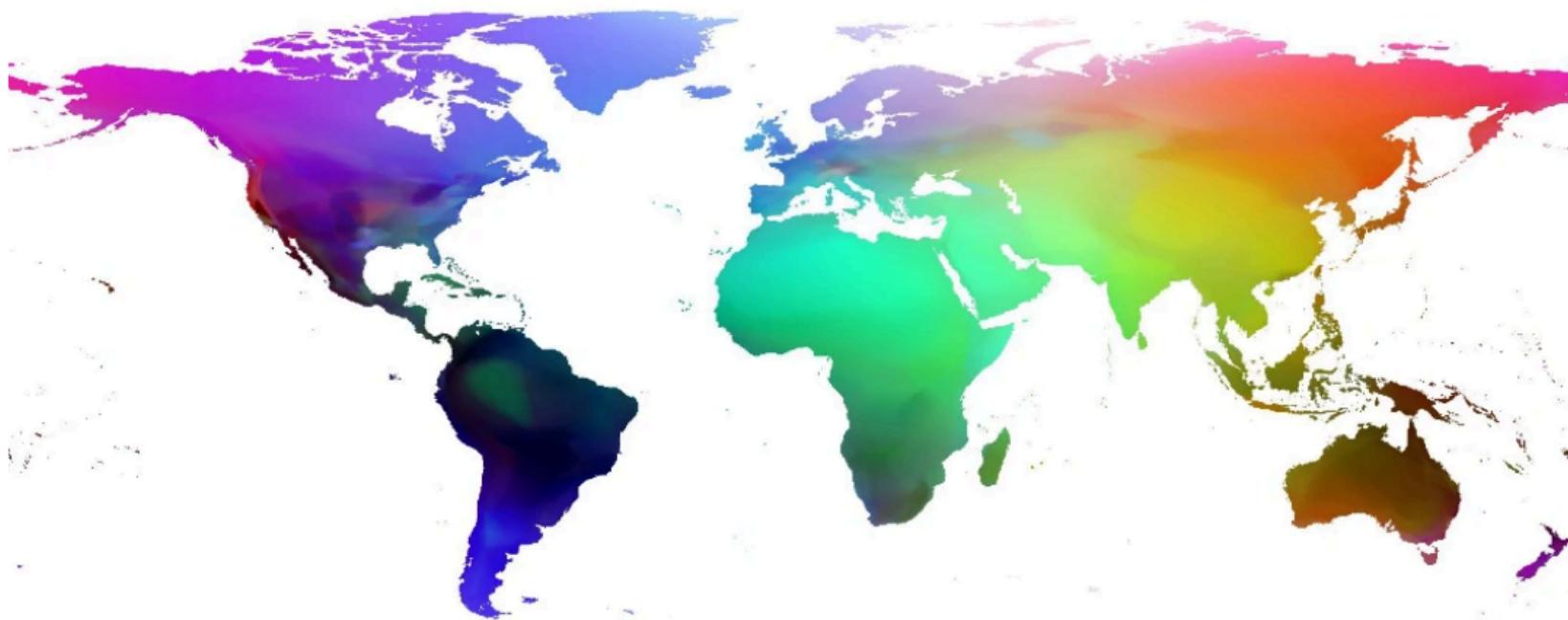
~50k species

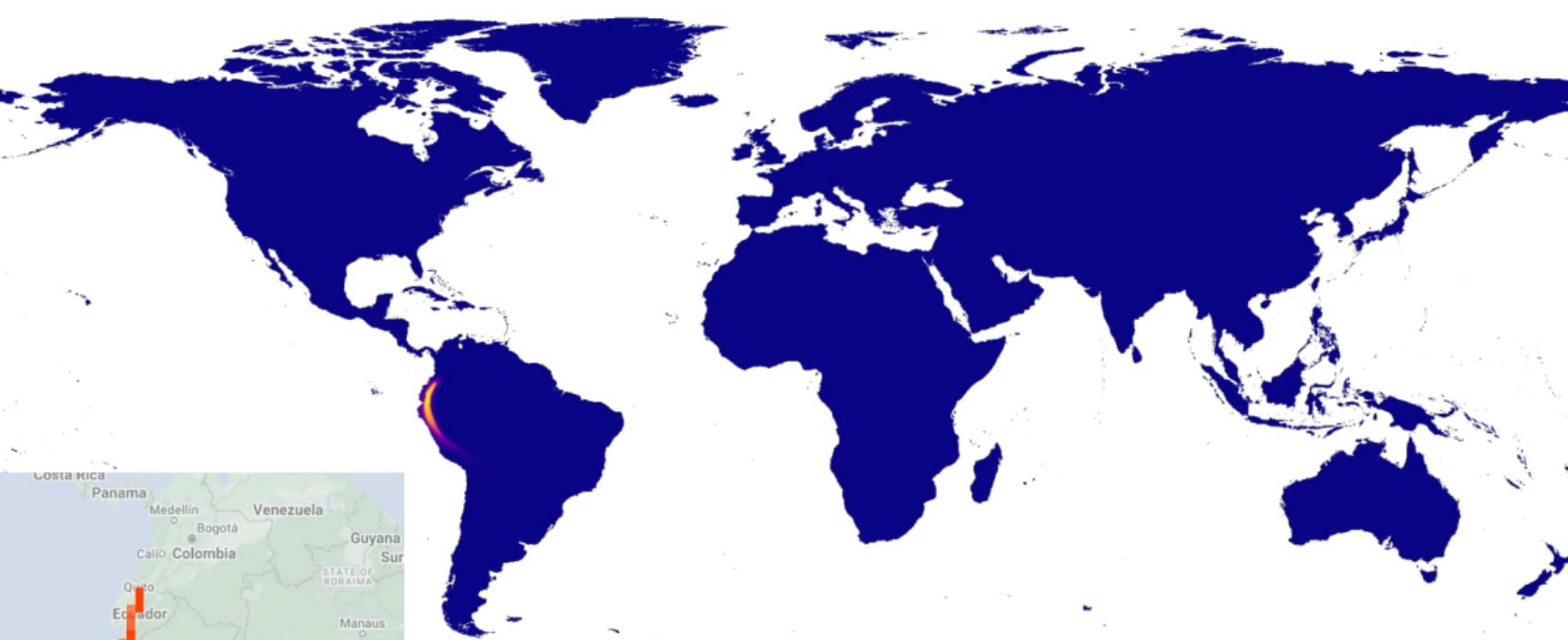
~35M observations

Model <100 MB



# Learned location embeddings





(*Oxyallagma dissidens*)

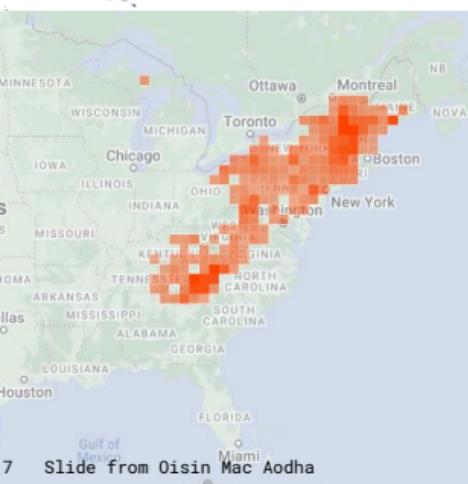
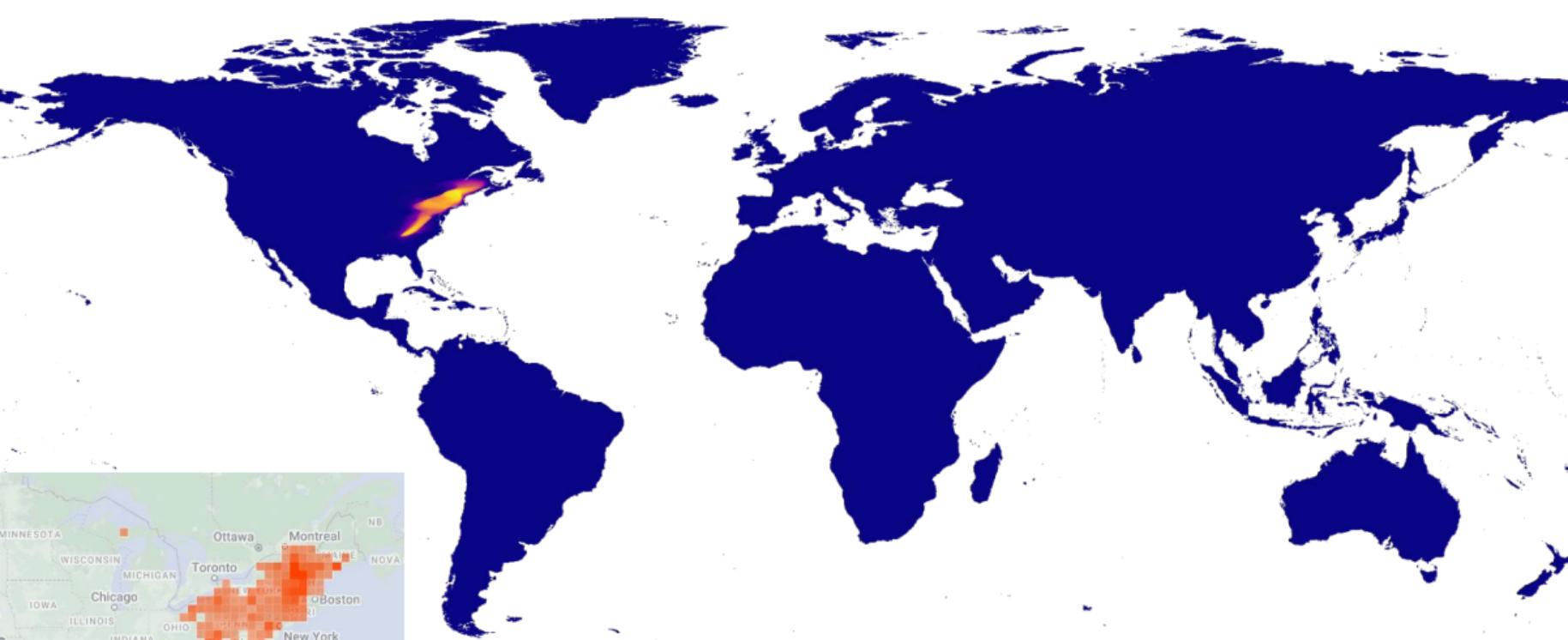


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Mangrove-leaved Daisy-Bush  
(*Olearia avicenniifolia*)





Round-leaved Violet  
(*Viola rotundifolia*)

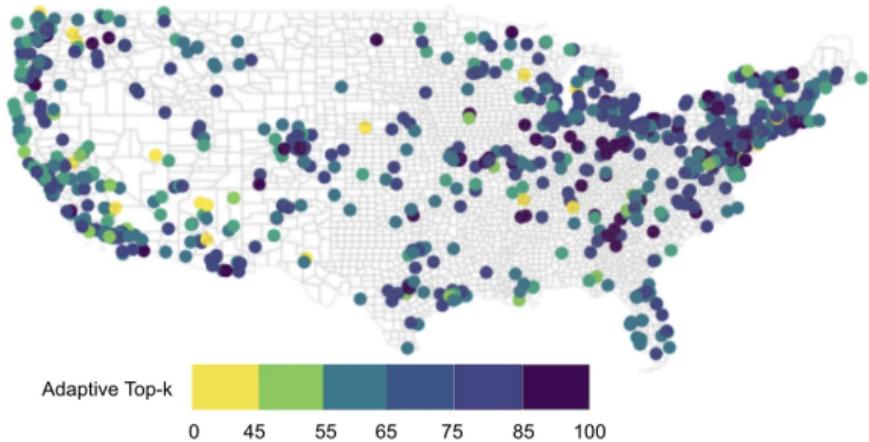


# Remote sensing for species distribution



# Remote sensing for species distribution

Satellite data + environmental variables  
better than either only sat or only env



A wide-angle, low-light photograph of a mountainous landscape. The foreground is filled with the dark silhouettes of numerous tall evergreen trees. In the middle ground, the dark ridges of mountains are visible, creating layers of depth. The sky above is a deep, dark blue, suggesting either twilight or early morning. The overall mood is mysterious and vast.

**Sensing, less remote**

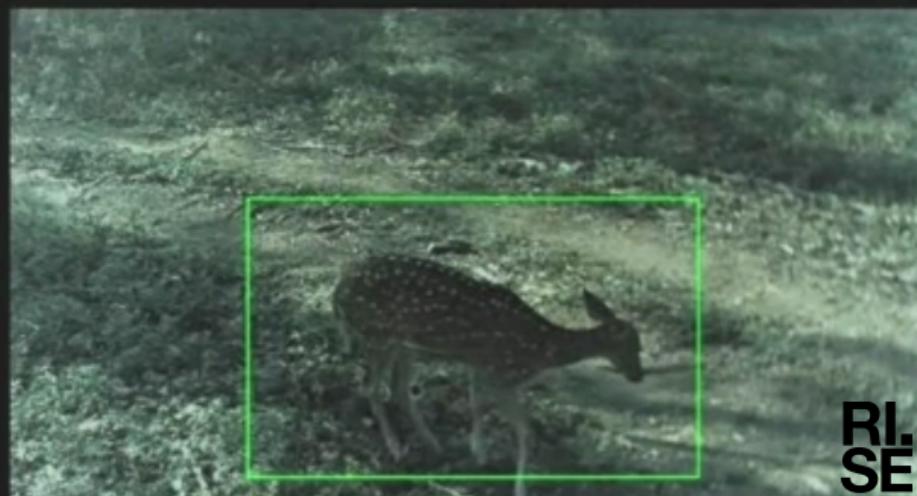
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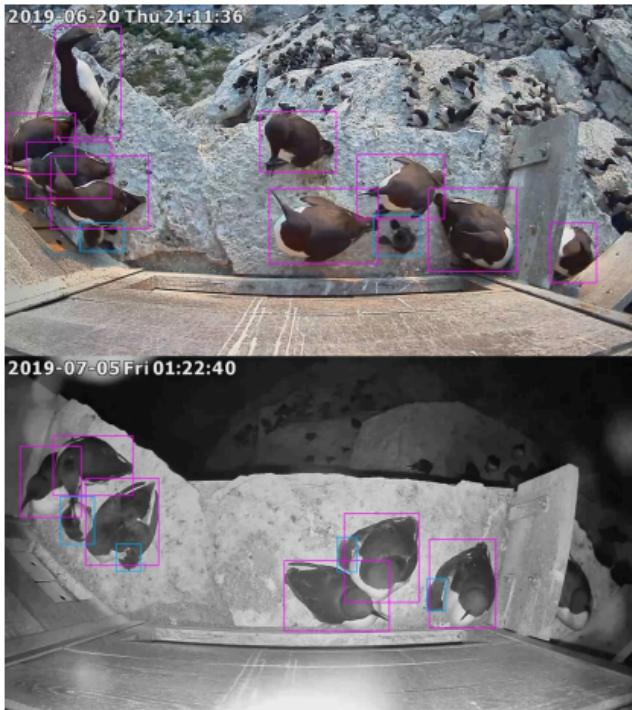


# Object detection for coffee berry disease

- Help detect infected plants
- Highly dependent on climate change and factors such as rainfall, humidity, and temperature
- Limited data
  - Few raw images **and** few annotations



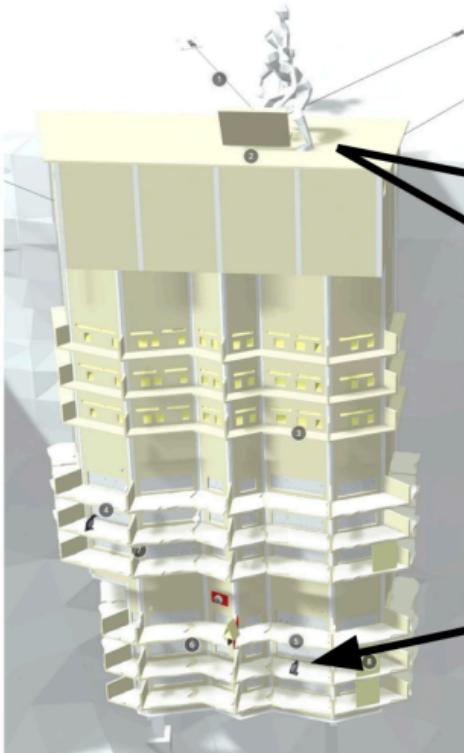
# Cameras for seabirds



**Jonas Hentati Sundberg**  
SLU

# Auklab

## Unique field site at Stora Karlsö



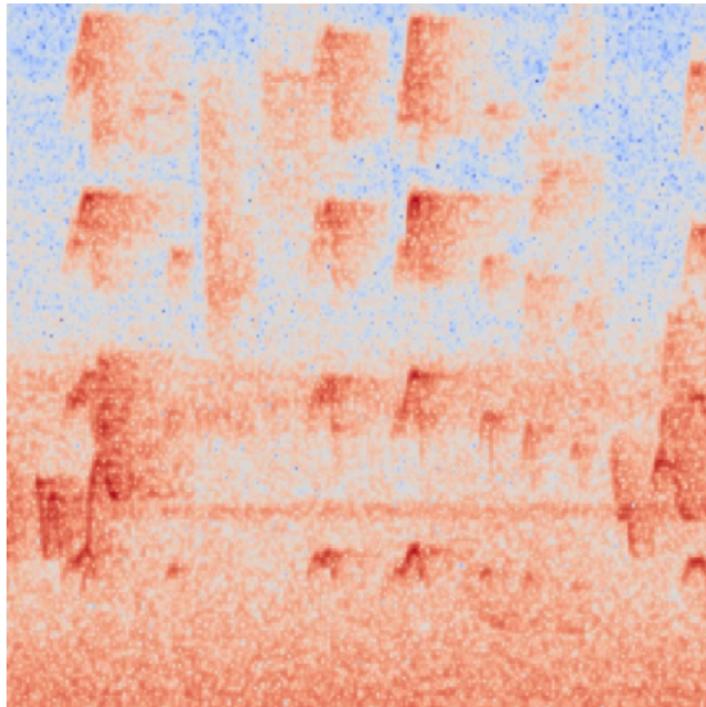
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# Soundscape analysis

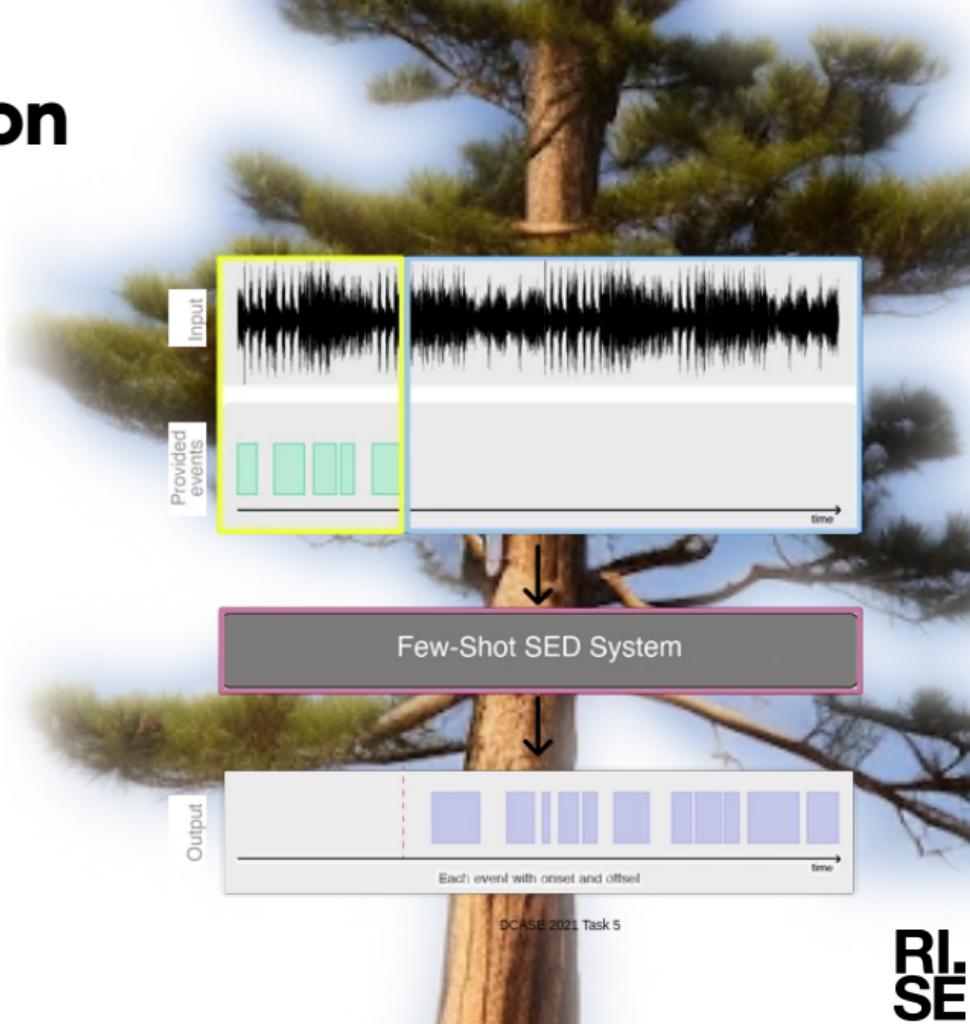
# Bird species identification

- Modelling sound using spectrograms and convolutional neural networks
- Altitude and location information improves results

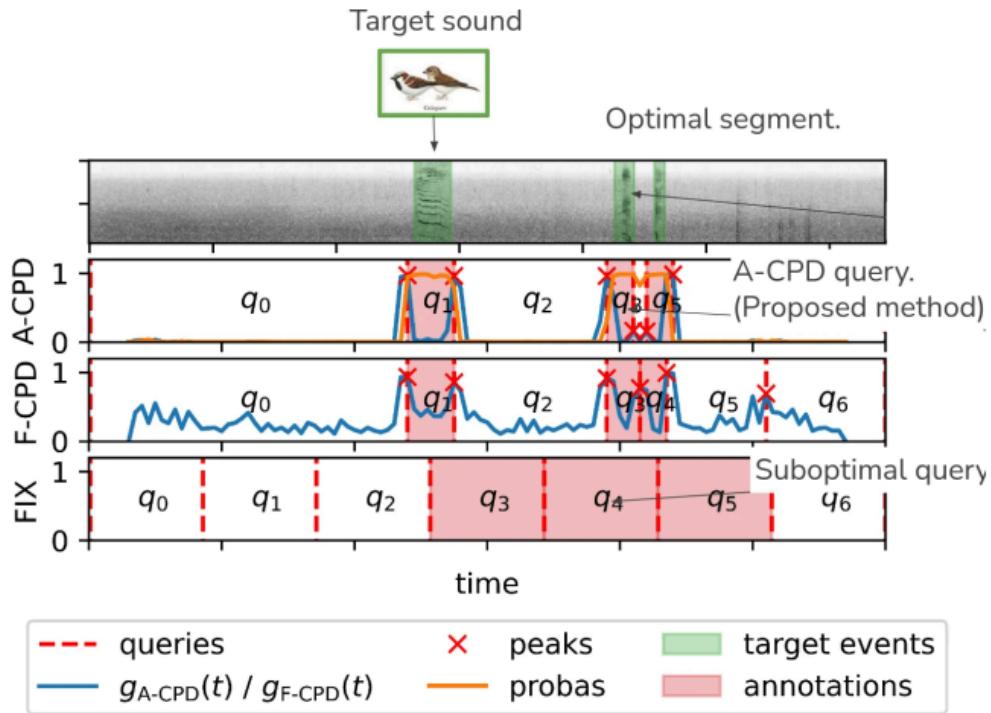


# Sound event detection

- Large amounts of data
- Labour intensive annotation
- Few-shot learning



# Active learning and active annotation



# Down the hatch



Extensive video monitoring for many years.

Other sensors such as thermal camera, weight scales, weather data.

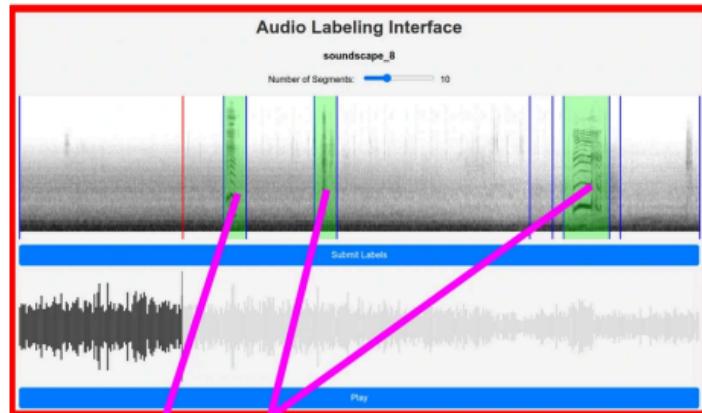
Unique long-term and seasonal multimodal dataset.



# Auklab

## recordings and video

- Guillemots indicative of overall ecosystem health
- Can dive more than 150 meters deep
- Linking audio and video events
- Deeper understanding, more granular data



# Letting data modalities inform each other

(Work in progress)

- Use **vision models** trained on synced video → provide event labels
- Transfer this knowledge to **audio-only recordings**
- Detect **events and behaviours** from soundscapes alone
- Reduce annotation workload by leveraging **cross-modal supervision**
- Unlock long-term monitoring where only **audio data** is available



# Schedule

## Yesterday:

- 10: Introduction to AI and Machine Learning
  - Olof Mogren
- 11: Introduction and Brief History of Natural Language Processing (NLP)
  - Murathan Kurfali
- 13: AI for Climate Adaptation and Mitigation
  - Olof Mogren
- 14: Exercises

## Today:

- 10: AI for Environmental Monitoring
  - Olof Mogren
- **11: AI for Prediction and Earth System Modelling**
  - Olof Mogren
- 13: Using NLP and Large Language Models: General Concepts and Climate Applications
  - Murathan Kurfali
- 14: Exercises

