

The Artificially Imaginative tide gauge observer

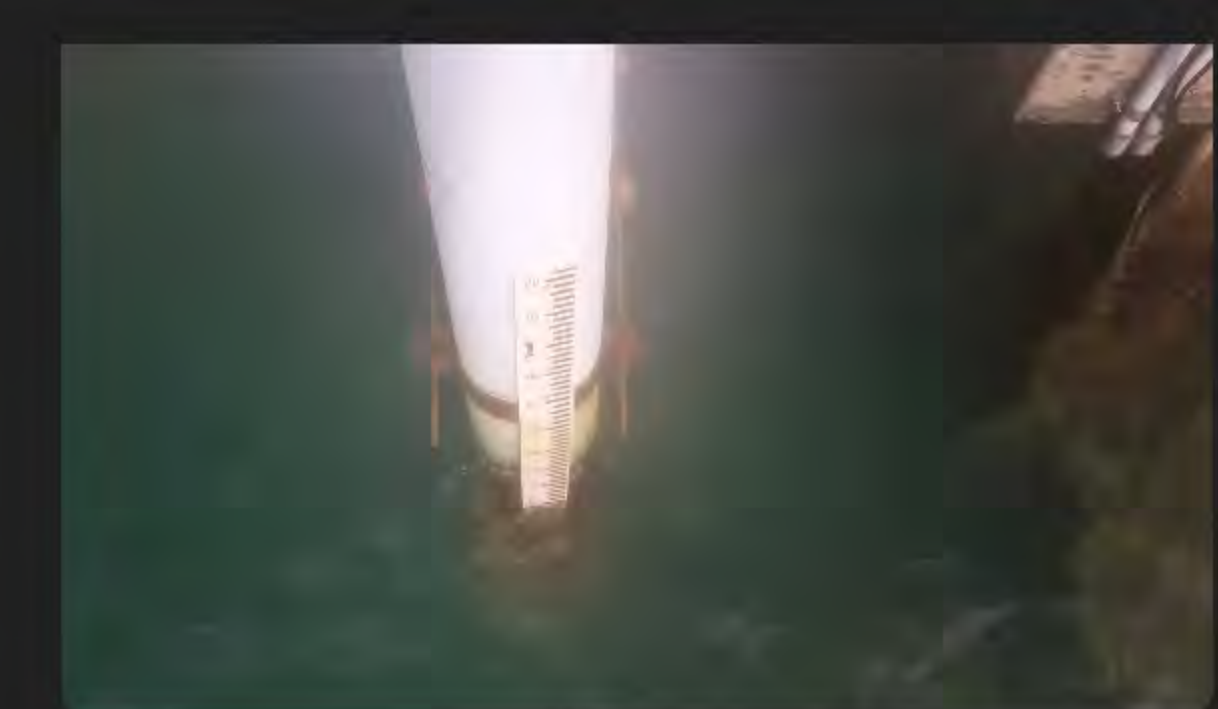
Motivation

- Human observers record water levels on tide staffs, which is tedious and error prone, but necessary to validate sensor measurements.
- Mechanical water level “switches” are an alternative (automatic) approach, until biofouling occurs.

AI offers opportunities for more reliable maintenance of water level sensor calibrations.

ChatGPT sees the tide staff.

What about reading it?



What is the water level?

From the image, the water level appears to be between 80 and 90 cm on the tide staff. A more precise estimate would be around 85 cm based on the visible marks on the gauge.

Equipment

Camera (\$25), computer (\$50), modem (\$150), and power (\$200)

- Raspberry Pi Camera module 3 (autofocus)
- Raspberry Pi Zero 2 (computer)
- Sixfab modem (with SIM card)
- LiFePO₄ w/ered/Pi+ battery (uninterrupted power)
- Solar panel and DC battery (not shown)



Camera software developed at UNC-Chapel Hill and NCSU

Camera facing tide staff



Approach

We developed an AI model that predicts water levels from coastal images

by preprocessing the data with temporal median filtering and cropping to focus on the tide staff. Using a fine-tuned MobileNetV2 architecture for regression, the model estimates water levels from images, and we employed Grad-CAM visualizations to interpret which image regions influenced the predictions.

--Described by ChatGPT o1-preview, which reviewed our software and produced this flowchart.

Transfer Learning and Image Regression (on Radar water level)

Model Building

Pre-trained Model: MobileNetV2 as base. Custom Layers: Add regression layers.

Computing on a small cluster of GPUs at UHSLC

Data Collection

Input: Images and water level measurements (Radar). Action: Collect and synchronize data based on timestamps.

Data Preprocessing

Remove invalid images (night time). Apply median filtering (30-minute running window). Crop (focus on Tide Staff).

Data Augmentation

Image transformations: Adjust brightness and move images (simulate noise)

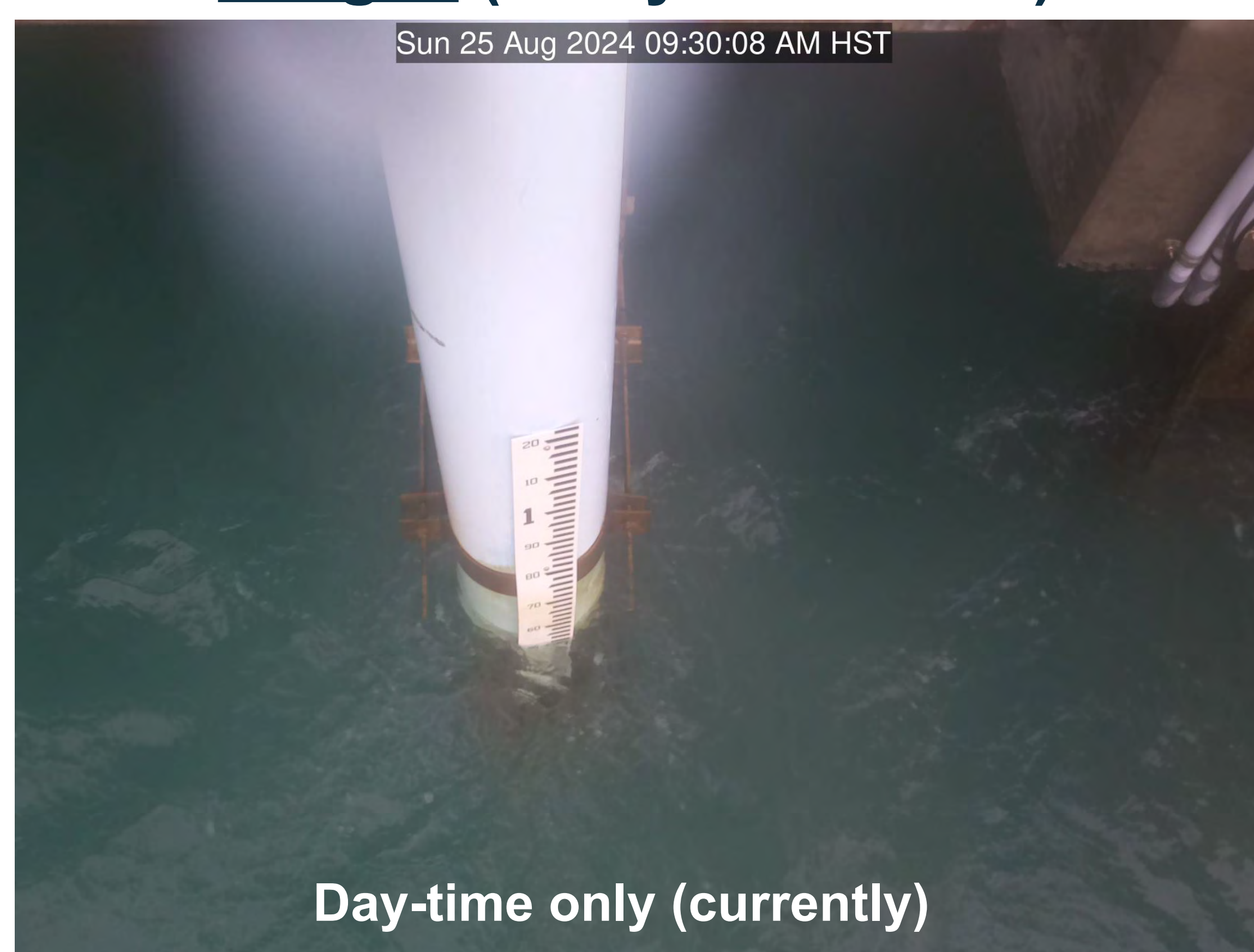
Model Training

Training Data: Use augmented images. Validation: Monitor performance on validation set.

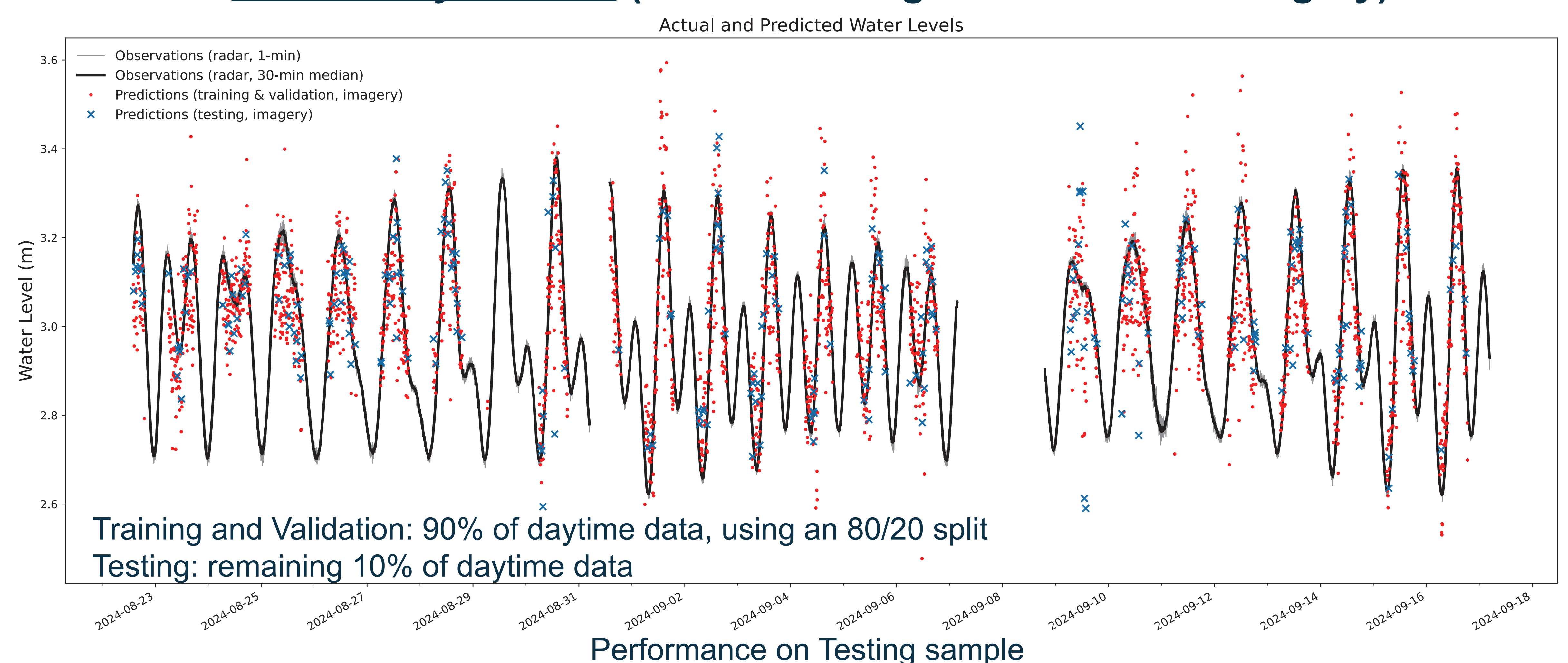
Model Evaluation

Metrics: Mean error. Visualization: Predictions vs. actuals. Interpretation: Grad-CAM to visualize focus areas.

Images (every 6-minutes)



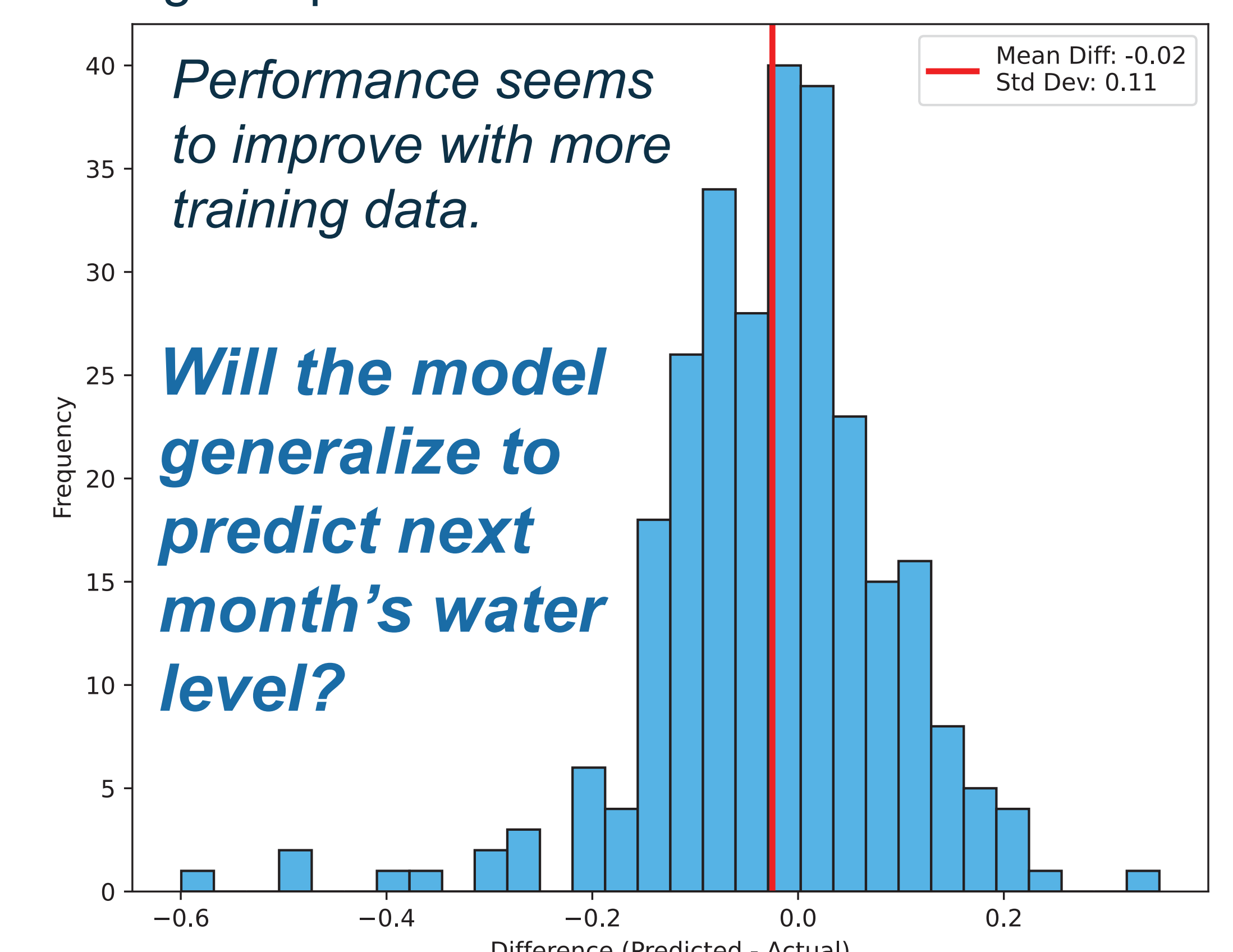
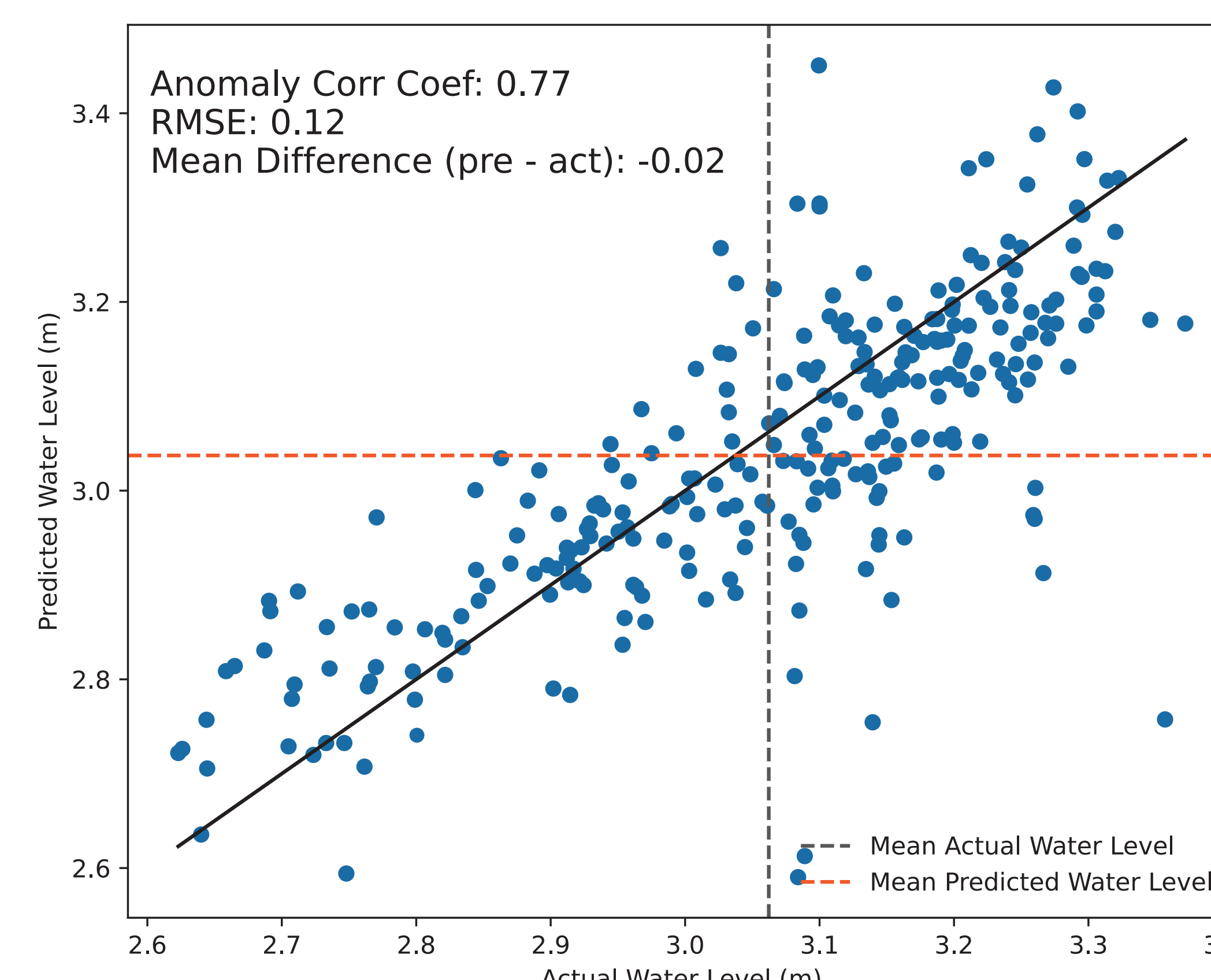
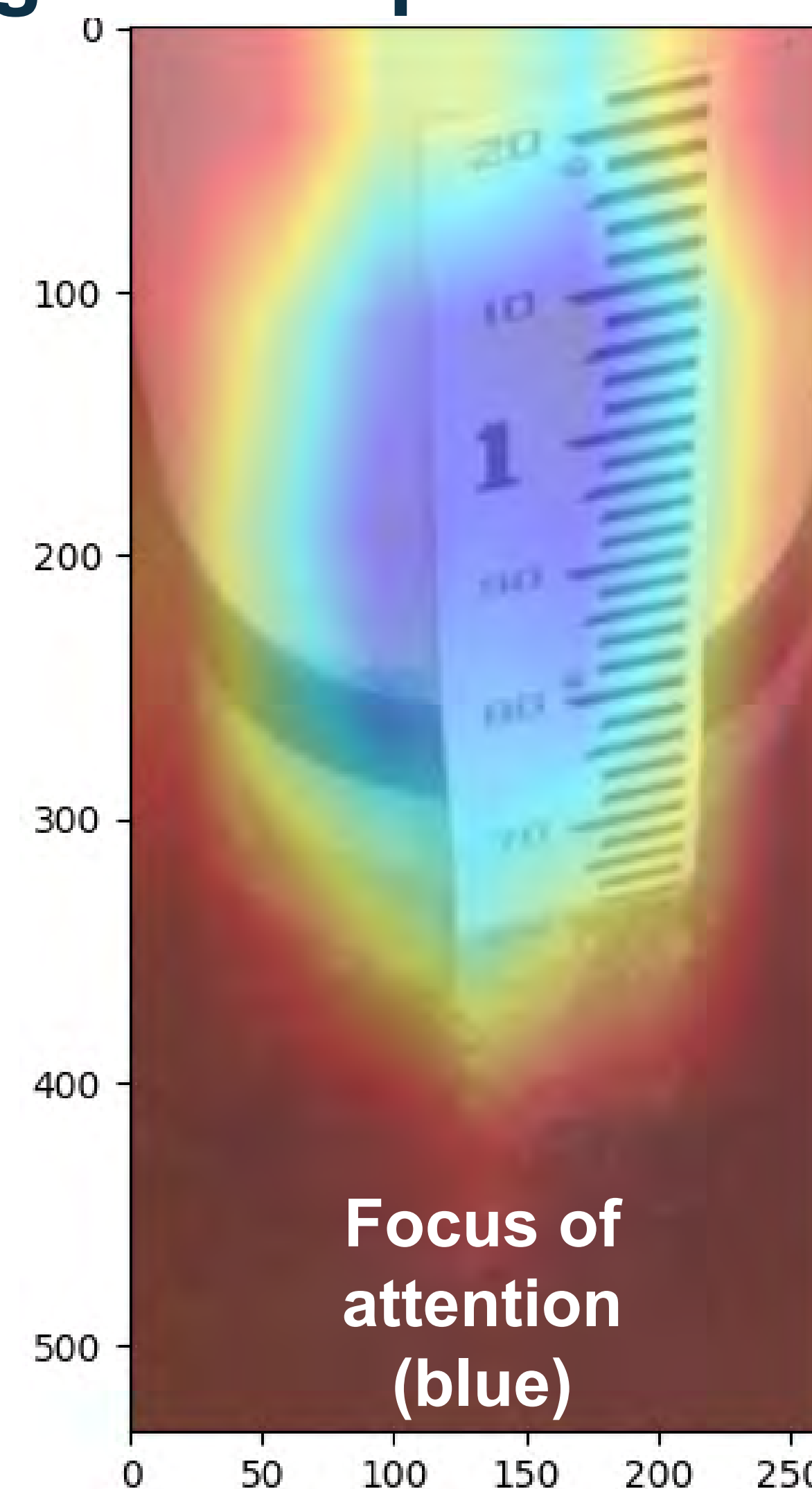
Preliminary Results (model training on 4 weeks of imagery)



Filtering and Cropping



Interpretation



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