EXPLAINABLE AI FOR SHORT-TERM LIGHTNING PREDICTION

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1. BACKGROUND

Utilizing GOES-16 Data to Predict Lightning

- Providing lead time before lightning strikes allows communities to prepare for hazardous weather.
- We train a deep learning model on infrared satellite imagery from the GOES-16 satellite and interpret the model's prediction using XAI methods.

2. METHODS

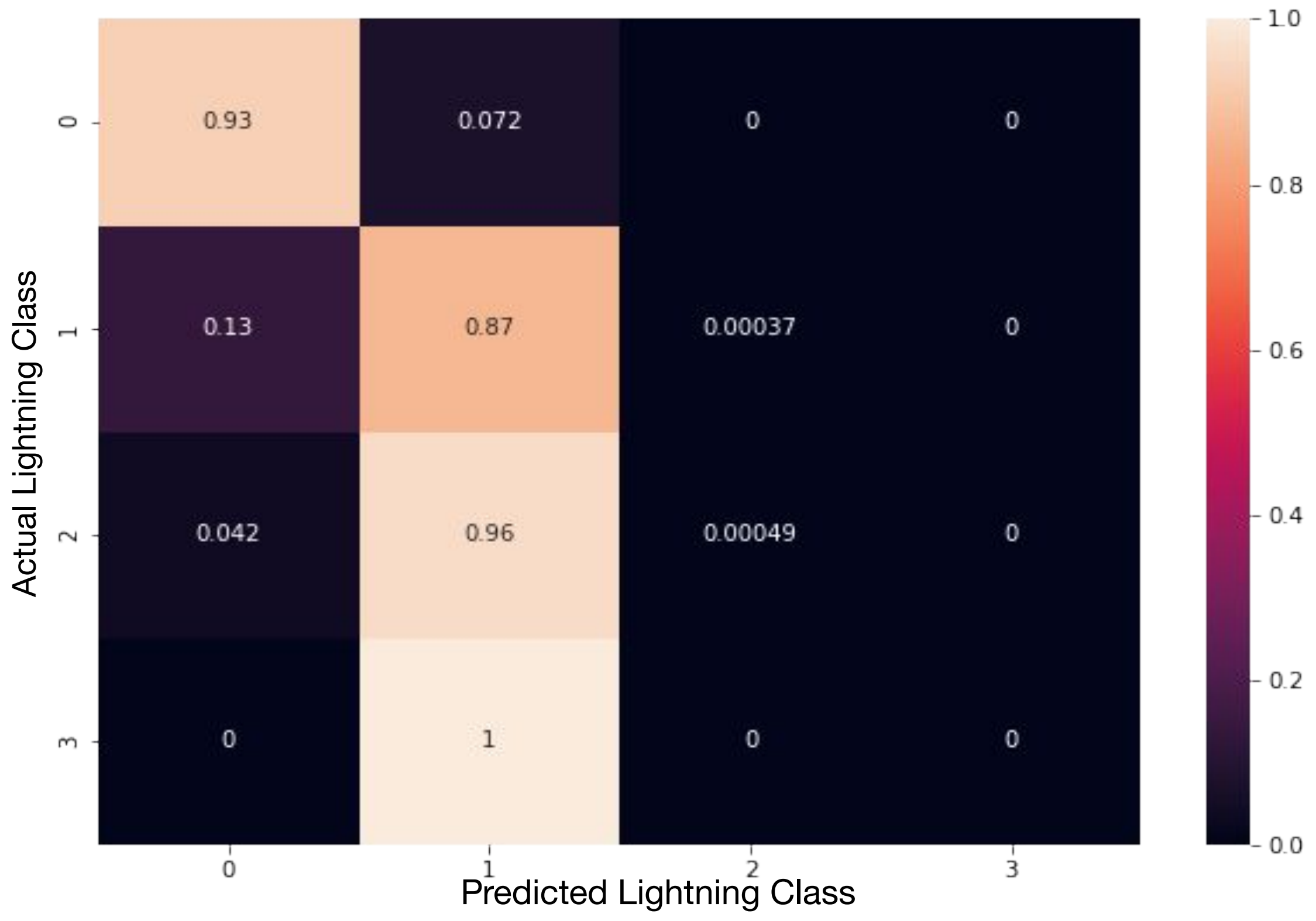
Data and Model Fitting

- Model Input: Infrared satellite imagery from water vapor (bands 8, 9, 10) and infrared infrared long window (band 14) bands of GOES-16 satellite
- Model Output: Binned Lightning Count (0, 1-10, 10-100, 100+ Lightning strikes)
- Used a pretrained ResNet18 architecture

XAI Methods

- Integrated Gradients (IG): Pixel-wise attribution method using average gradient from a reference
- Deeplift: Pixel-wise attributions method backpropagating model output to each input feature (similar to LRP)

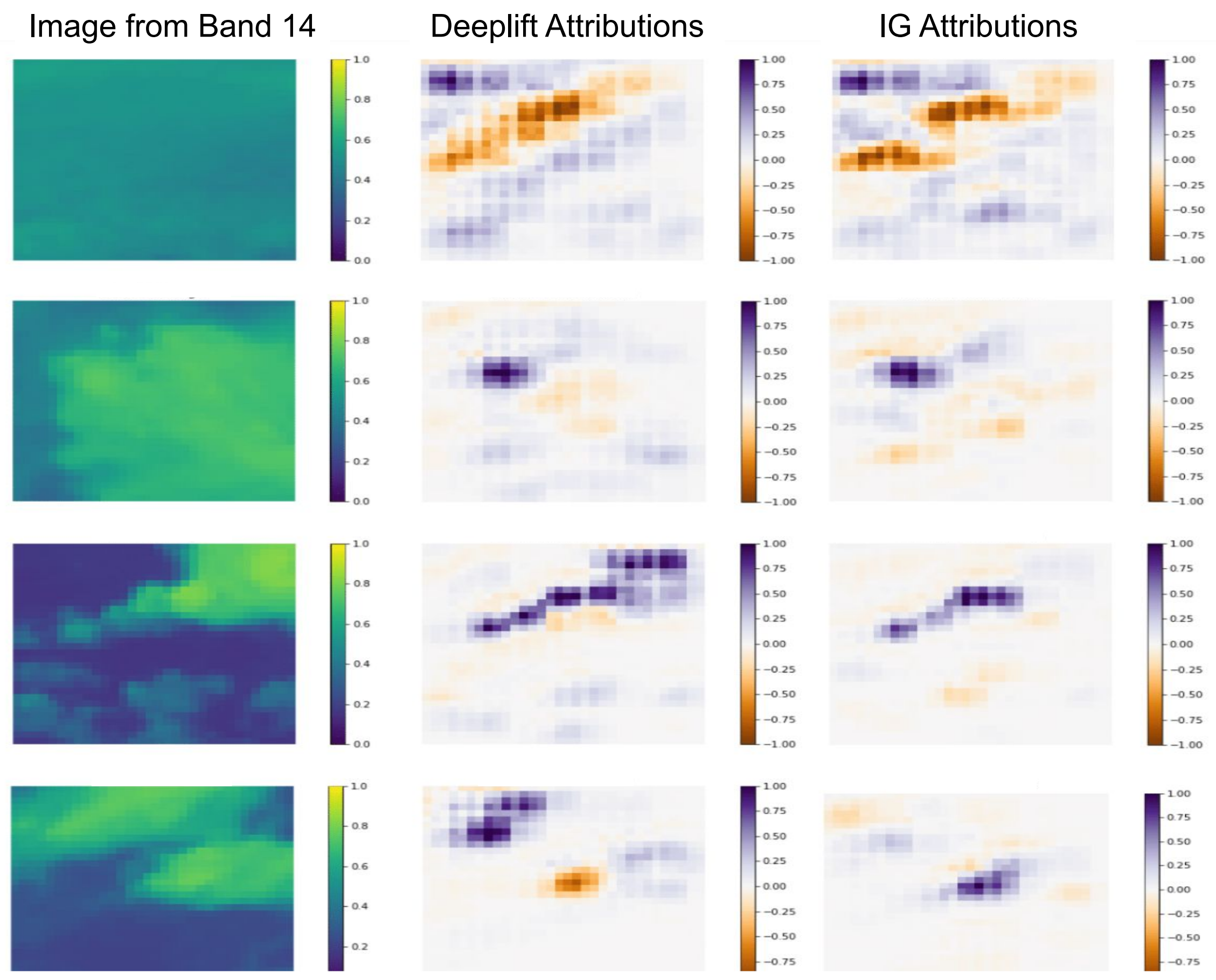
3. TRAINING RESULTS



- Model is 95% accurate at predicting lightning
- Unable to differentiate between lightning bins
- We can use XAI methods to interpret the model's predictions and reveal underlying phenomena

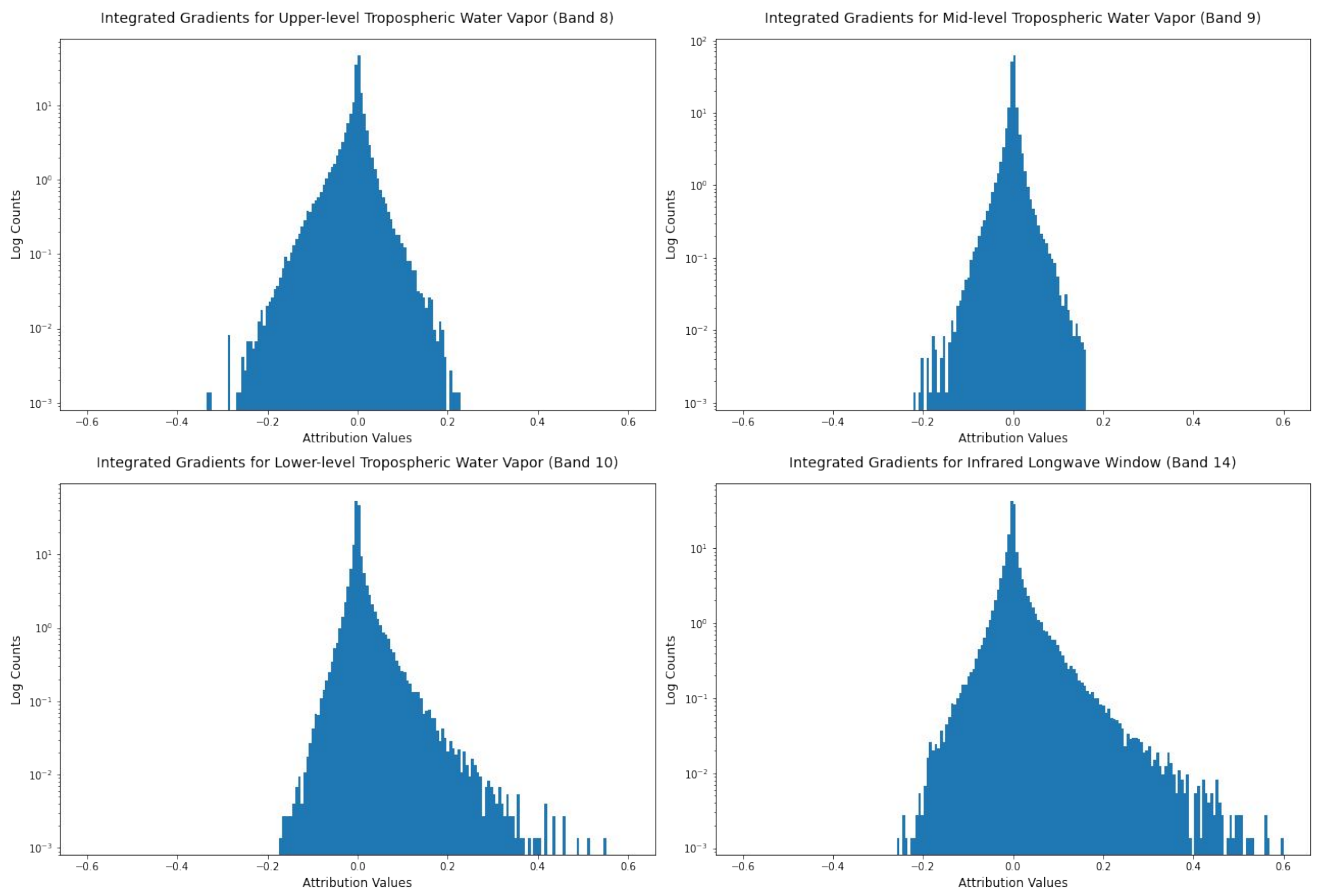
4. XAI RESULTS

1. Attribution Visualization



- Attribution heat maps from Deeplift and IG for one image from each class (0 lightning at top)
- Only band 14 is visualized since its attributions captured relevant features in the images

2. IG Attributions Across Channels

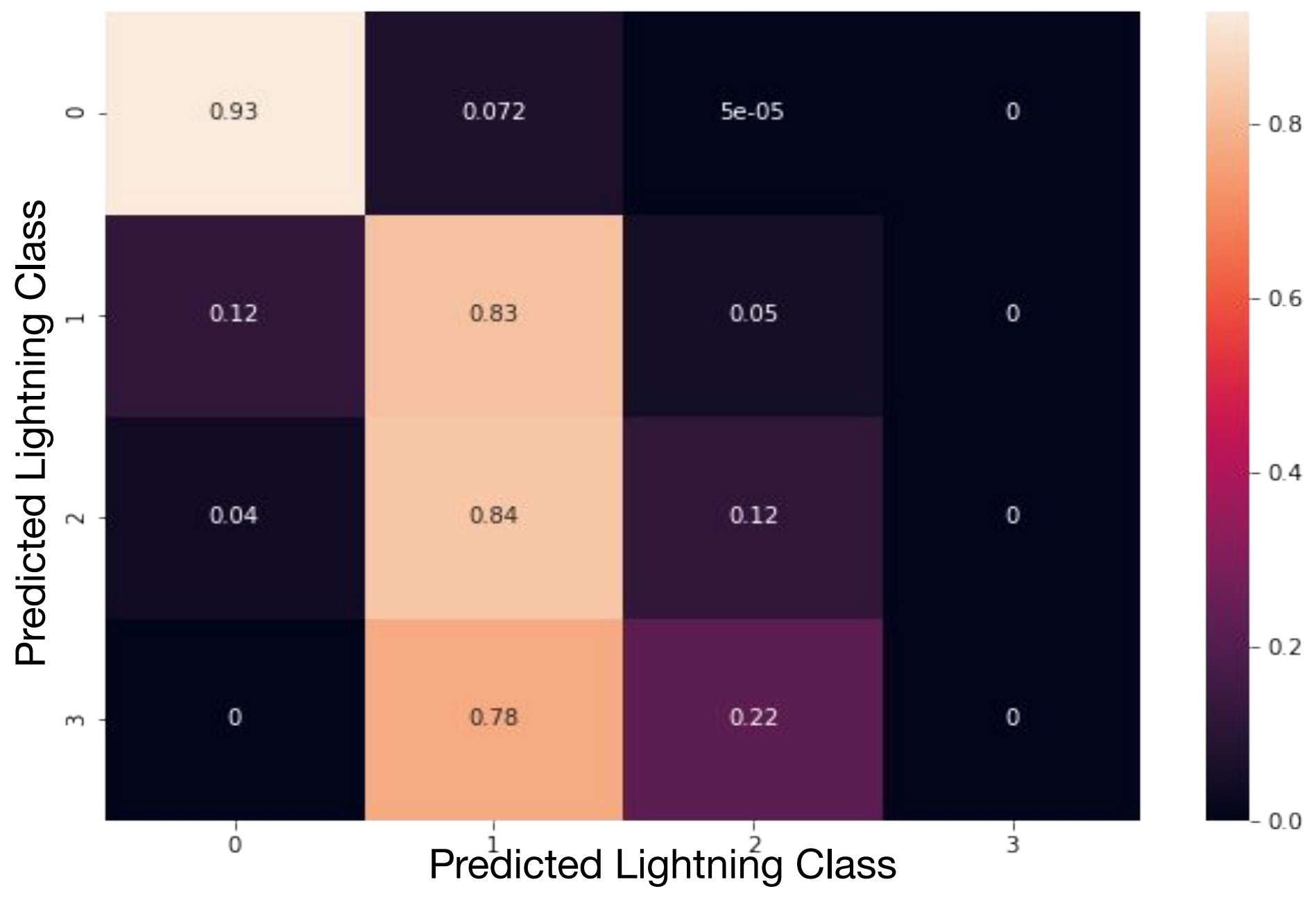


- Integrated Attributions across the four channels
- Water vapor bands (8, 9, and 10) tend to be more normally distributed

5. CONCLUSIONS

Infrared Longwave Window (Band 14) Contributes Significantly to Lightning Prediction

- ResNet trained on all 4 bands performs well at binary prediction
- Integrated Gradients and Deeplift both identify significant features (overshooting cloud tops) primarily in band 14 images
- Model trained on bands 14 and 9 achieves marginally better accuracy (shown below), while using only band 14 gives similar results to original



- In the future, we will explore the use of other 12 bands for lightning prediction

REFERENCES / ACKNOWLEDGEMENTS

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