FLORIDA ATLANTIC UNIVERSITY
I-SENSE

Deep Learning -Based Algal Bloom Prediction for Lake Okeechobee Using Multi -Source Data Fusion

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Harmful Algal Blooms (HABs)

- Overgrowth of algae
- Large accumulation of phytoplankton
- Eutrophication: excess nutrients
  - Rapid reproduction
  - Microcystis aeruginosa

(1) Cyanobacteria: “Blue-green” algae

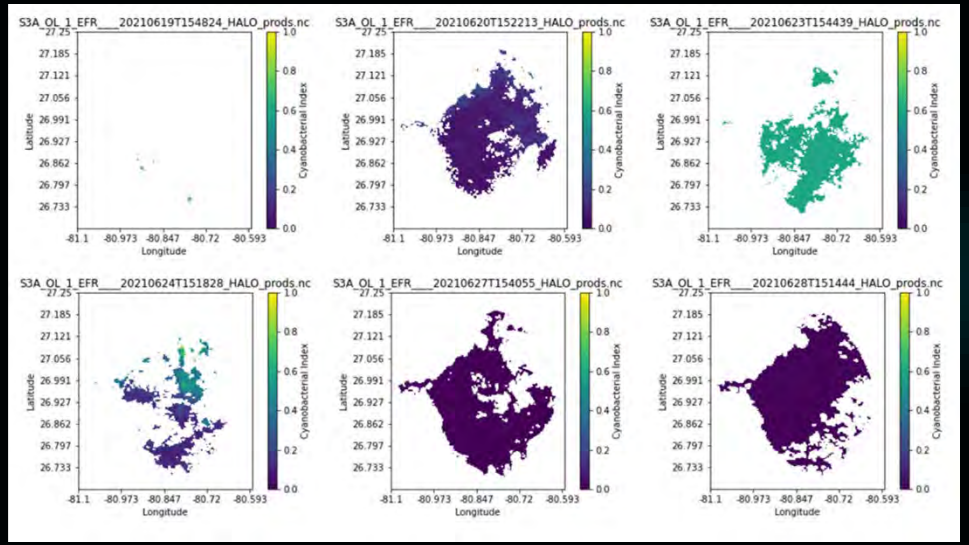
Economic & Ecological Impacts

- Microcystin: Hepatotoxin
  - Drinking water supply
  - Closed tourist locations
  - Marine aquaculture & fisheries
- Hypoxia - low O_2
  - Mammal mortality - dead zones

(2) Lake Okeechobee: 2nd largest freshwater lake

Satellite Sensors

- Used for remote sensing (RS) images
- Missing information - discontinuity
  - Dead pixels
  - Thick clouds
  - Sun glint
  - Water turbidity



(3) Lake Okeechobee RS images from satellites 3A, 3B

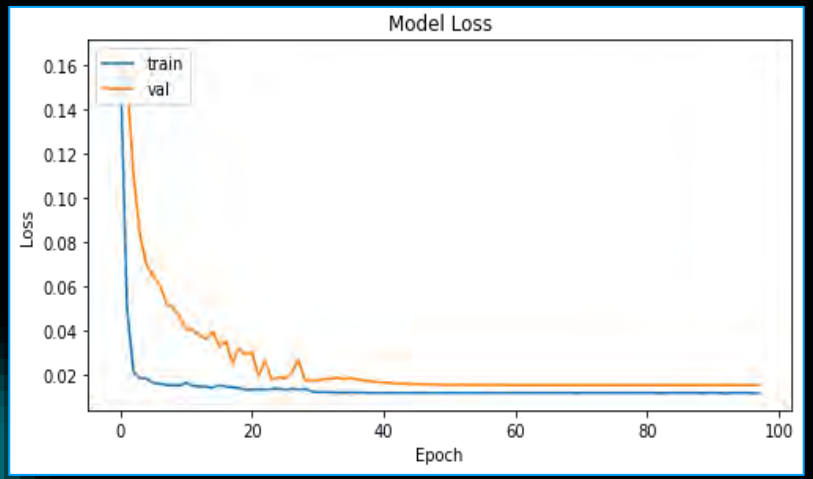
Multi -Source Prediction Model

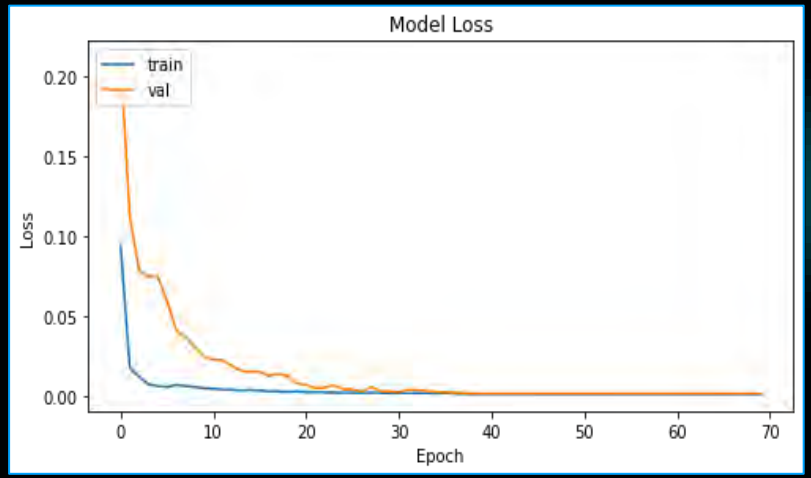
- Hybrid dataset
  - Satellites – RS
  - Simulated data
    - Hydrodynamic-biological model
- Forecasting prediction
  - Single-day
  - Rolling window

(3) True color RS images of central HAB

Advanced Deep Learning Model

- Convolutional Long-Short Term Memory (ConvLSTM)
  - Captures temporal & spatial correlations in data simultaneously
  - 14-14 & 14-1 predictions

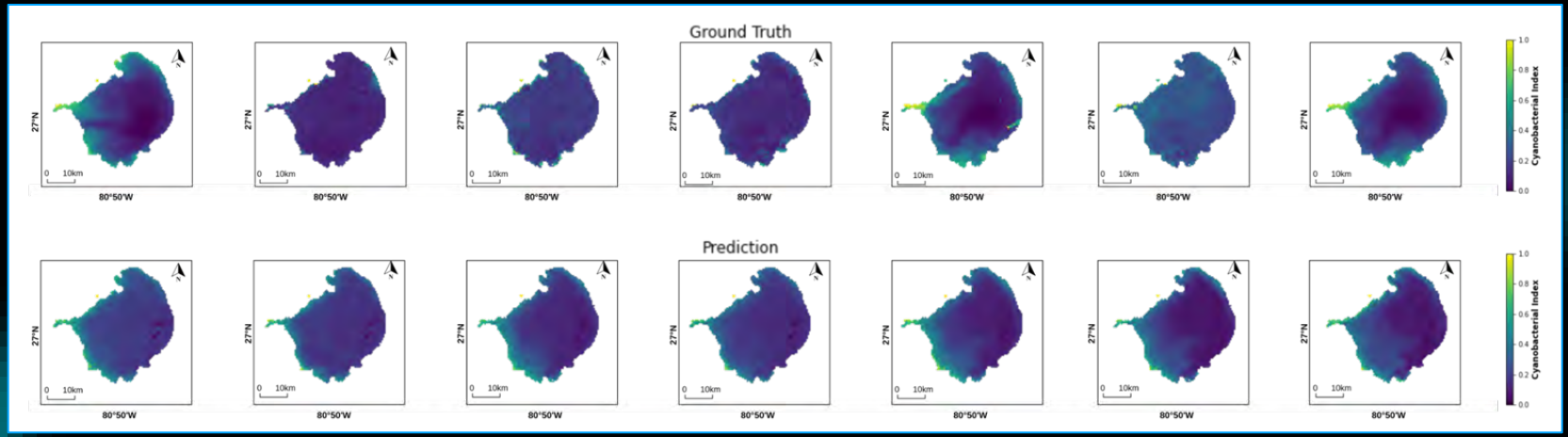




Training & validation loss for 14-14 and 14-1: Convergence is observed showing model is learning from data

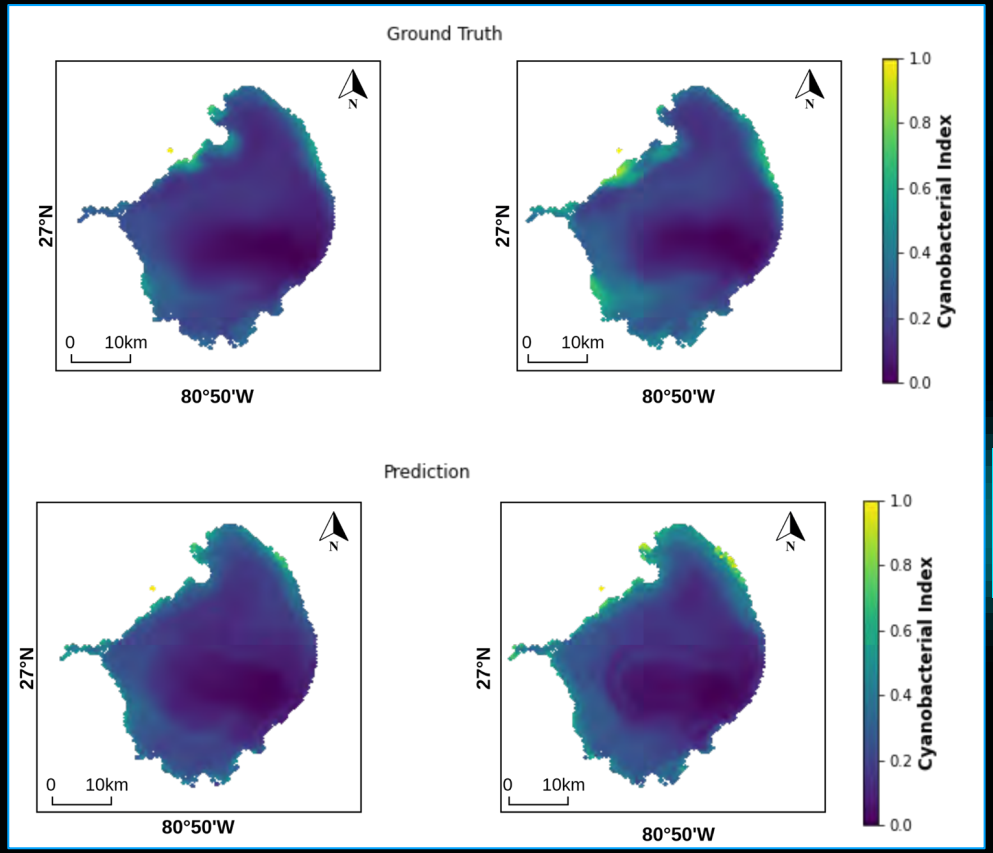
Prediction Results for 7 -7

- Root Mean Square Error (RMSE): 0.0033599667
- Peak Signal-to-Noise Ratio (PSNR): 49.47330001523929
- Structural Similar Index Measure (SSIM): 0.9916645337059432



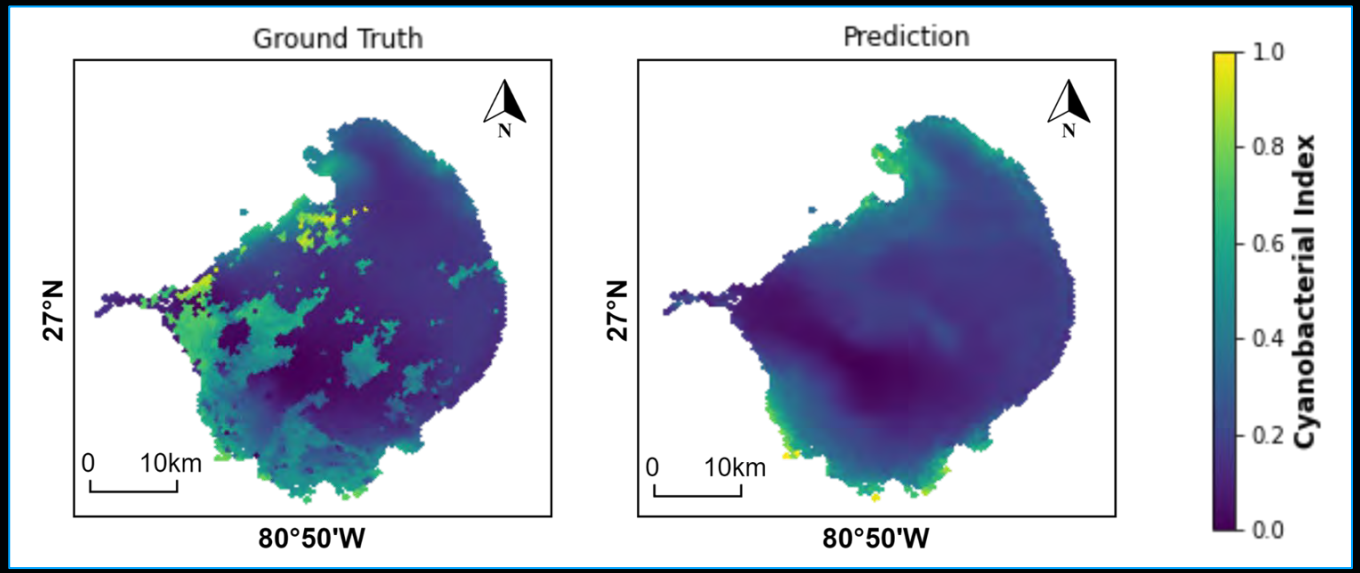
Prediction Results for 14 -2

- RMSE: 0.0029430606
- PSNR: 50.624015366344025
- SSIM: 0.9950491670550674



Challenges with HAB Model

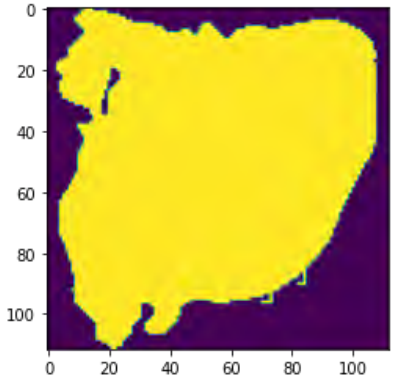
- Blurs in ground truth and prediction images
  - Model rolling prediction & downsampling
- Increase RS usable data
  - Patching & reconstruction



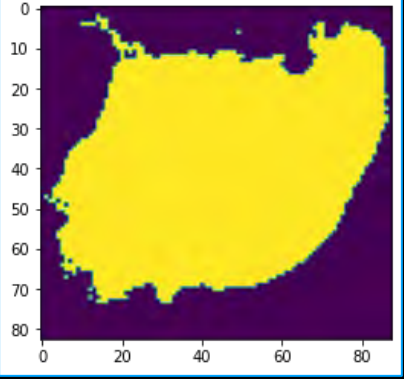
Future Work

- Paper being reviewed
  - IEEE Journal
  - Listed in acknowledgement section
- Yingqi changing mask
  - Match size for phys. and hybrid datasets
- Upload to website - forecasting

Phys. Dataset: (112, 112)



Hybrid Dataset: (83, 88)



THANKS!

Questions?

References

(1) Galoustain, G. (2020, August). FAU awarded $2.2 million to monitor algal blooms in Lake Okeechobee. *Florida Atlantic University*. https://www.fau.edu/newsdesk/articles/habs-lake-okeechobee.php

(2) Lake Okeechobee Aquatic Plant Management Interagency Task Force. (2021). *University Of Georgia - Center For Invasive Species And Ecosystem Health*. https://www.floridainvasives.org/okeechobee/about/

(3) Tang, Y., Feng, Y., Fung, S., Ruiz Xomchuk, V., Jiang, M., Moore, T., & Beckler, J. (2022, July). Deep learning-based algal bloom prediction for Lake Okeechobee using multi-source data fusion. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 1-13. *Under review*

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