Weekly Report

CIRA
STAR/NESDIS
National Oceanic and Atmospheric Administration (NOAA)

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Prepared by: CIRA and STAR contributors

Products and Applications

Publications (Citation: followed by a short **Summary:** (Why & so what)**, & detailed summary):**

"Identifying data sources and physical strategies used by neural networks to predict TC rapid intensification"
Weather and Forecasting
Ryan Lagerquist, John Knaff, Chris Slocum, Kate Musgrave, and Imme Ebert-Uphoff

TC rapid intensification, which we define as an intensity increase of ≥ 30 kt in 24 hours, is a difficult but important forecasting problem. Operational RI forecasts have considerably improved since the late 2000s, thanks largely to better statistical models including machine learning (ML), which mostly take scalar predictors from the SHIPS developmental dataset. More recent ML applications use convolutional neural networks (CNN), which can ingest full satellite images/videos and freely "decide" which spatiotemporal features are important for RI. However, two questions remain unanswered: (1) Does image convolution significantly improve RI skill? (2) What strategies do CNNs use for RI prediction – and can we gain new insights from these strategies? We use an ablation experiment to answer the first question and explainable artificial intelligence (XAI) to answer the second. Convolution leads to only a small performance gain, likely because, as revealed by XAI, the CNN's main strategy uses image features already well described in scalar predictors used by pre-existing RI models. This work makes three additional contributions to the literature: (1) CNNs with SHIPS data outperform pre-existing models in some aspects; (2) CNNs provide well calibrated uncertainty quantification (UQ), while pre-existing models have no UQ; (3) the CNN without SHIPS data performs surprisingly well and is fairly independent of pre-existing models, suggesting its potential value in an operational ensemble. Furthermore, we develop an XAI methodology – combining traditional XAI methods with eigenanalysis – that partly overcomes the subjectivity and sensitivity to pixel-level noise inherent in traditional XAI methods.

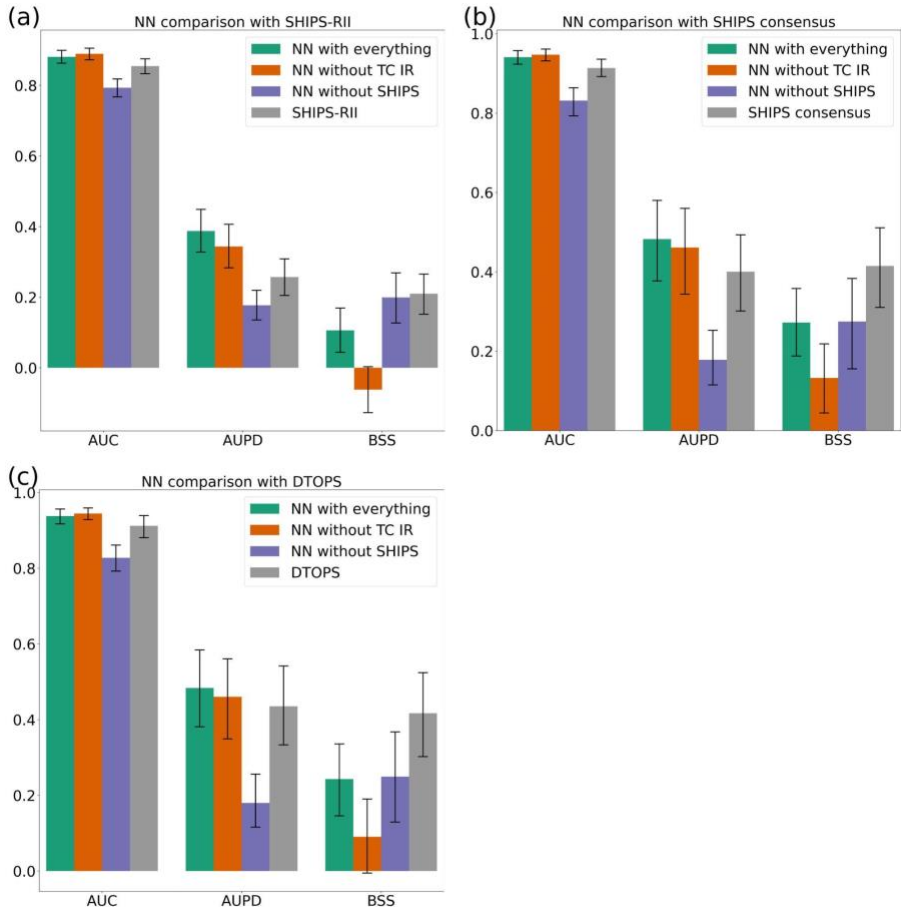

Figure 13: *Comparison of our neural networks – one trained with only the TC IR satellite data, one trained with only SHIPS scalars, one trained with both – to pre-existing RI models. Evaluation metrics (area under the ROC curve, area under the performance diagram, and Brier skill score) are positively oriented, meaning that higher is better. Error bars indicate 95% confidence intervals.*

Co-authored Publication

Regime shifts in satellite-derived chlorophyll within the Laurentian Great Lakes

Journal of Great Lakes Research, Available online 3 April 2025, 102573, In Press, Corrected Proof

Personalized share Link (50 days starting Apr-3-2025):
https://authors.elsevier.com/c/1ksxS_8fAfP6hZ

Nikolay P. Nezlin, SeungHyun Son, Christopher W. Brown, **Prasanjit Dash**, Caren E. Binding, Ashley K. Elgin, Andrea VanderWoude

The study analyzed 25 years (1997–2022) of remotely sensed chlorophyll-a (Chl-a) data from the OC-CCI dataset to detect ecosystem regime shifts in the Laurentian Great Lakes. STL

decomposition and STARS analysis identified significant shifts to lower trophic regimes, particularly in Lakes Michigan, Huron, and Ontario, where invasive *Dreissena* mussels were a key factor. This research provides valuable insights into the long-term impacts of invasive species and nutrient management on lake ecosystems. Additionally, it demonstrates the reliability of OC-CCI data for detecting regime shifts, supporting better management and conservation strategies for the Great Lakes.

Funding: NESDIS Environmental Application Team (NEAT)

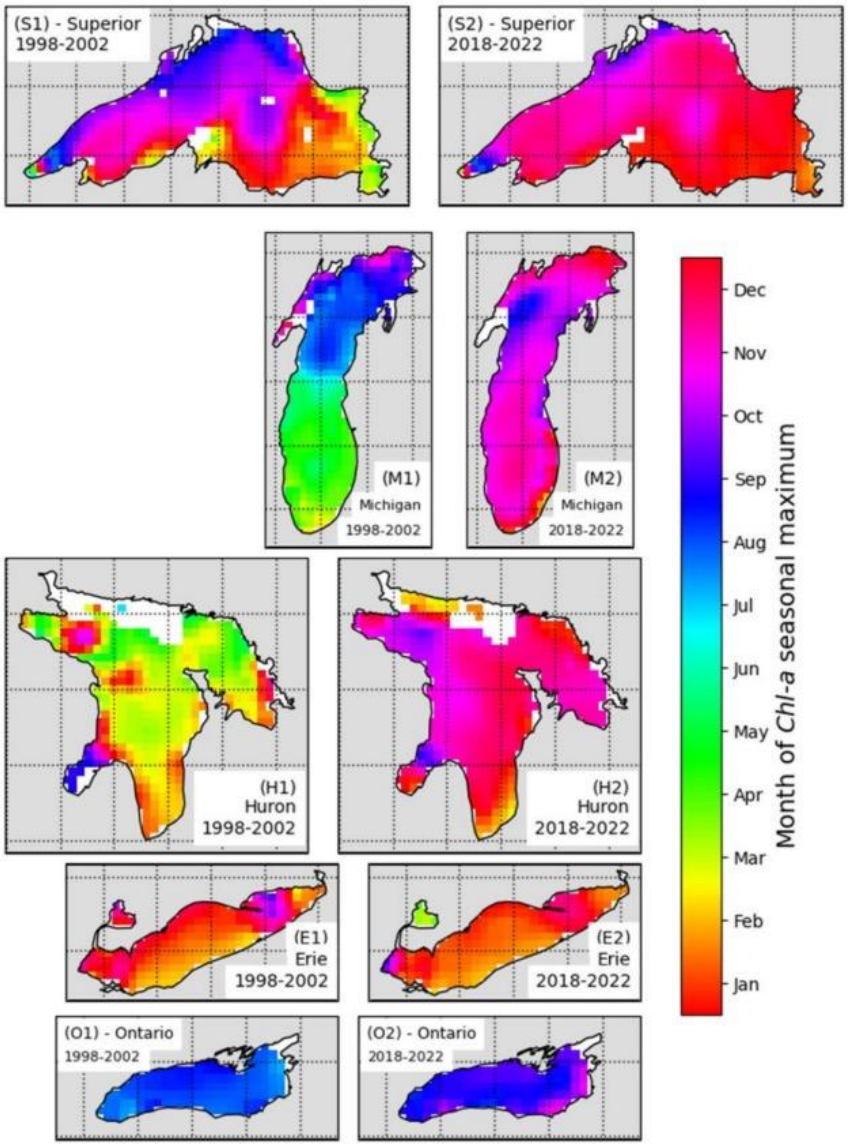

Fig. 10. Maps of the month of maximum monthly median chlorophyll concentration estimated by the "center of gravity" method for the 'starting' 1998–2002 (left column) and 'ending' 2018–2022 (right column) 5-year periods of the Ocean Colour Climate Change Initiative (OC-CCI) dataset in Lakes Superior (S1, S2), Michigan (M1, M2), Huron (H1, H2), Erie (E1, E2), and Ontario (O1, O2).

Awards and Recognition

Media Interactions and Request

Blog Posts and Social Media

Travel, Workshops, Conferences, and Meeting Reports

Training and Education activities

Future Meetings and Events (dates, meeting/event, location, staff involved)

Other

M. McGraw reviewed a manuscript for the Journal of Advances in Modeling Earth Systems. (POC: M. McGraw, CIRA, marie.mcgraw@colostate.edu)