Advanced machine learning approach for chlorophyll-a retrieval with SGLI/GCOM-C data

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Introduction

Chlorophyll-a (Chla) retrieval from satellite observations is crucial for assessing water quality and the health of aquatic ecosystems. Utilizing satellite data, while invaluable, poses challenges including inherent satellite biases, the necessity for precise **atmospheric correction (AC)**, and the complexity of water bodies, all of which complicate the establishment of a reliable relationship between **remote sensing reflectance (Rrs)** and Chla concentrations

Objectives

- Build a **Deep-Learning** model for **Chla estimation** using **GCOM-C/SGLI** on a global scale.
- Tune the model accuracy for different **water types**.
- Evaluate different **atmospheric corrections** and their effect on the model

Methods

- Model architecture is mainly based on the Bidirectional LSTM layers, followed by fully connected layers.
- Three models were trained for Low (0-20 mg/m3), Mid (10-50 mg/m3), and High (20-150 mg/m3) Chla concentrations.
- An attention mechanism is used to ensamble the three models.
- GLORIA dataset is combined with several field measurement and matchup SGLI data for training and testing.

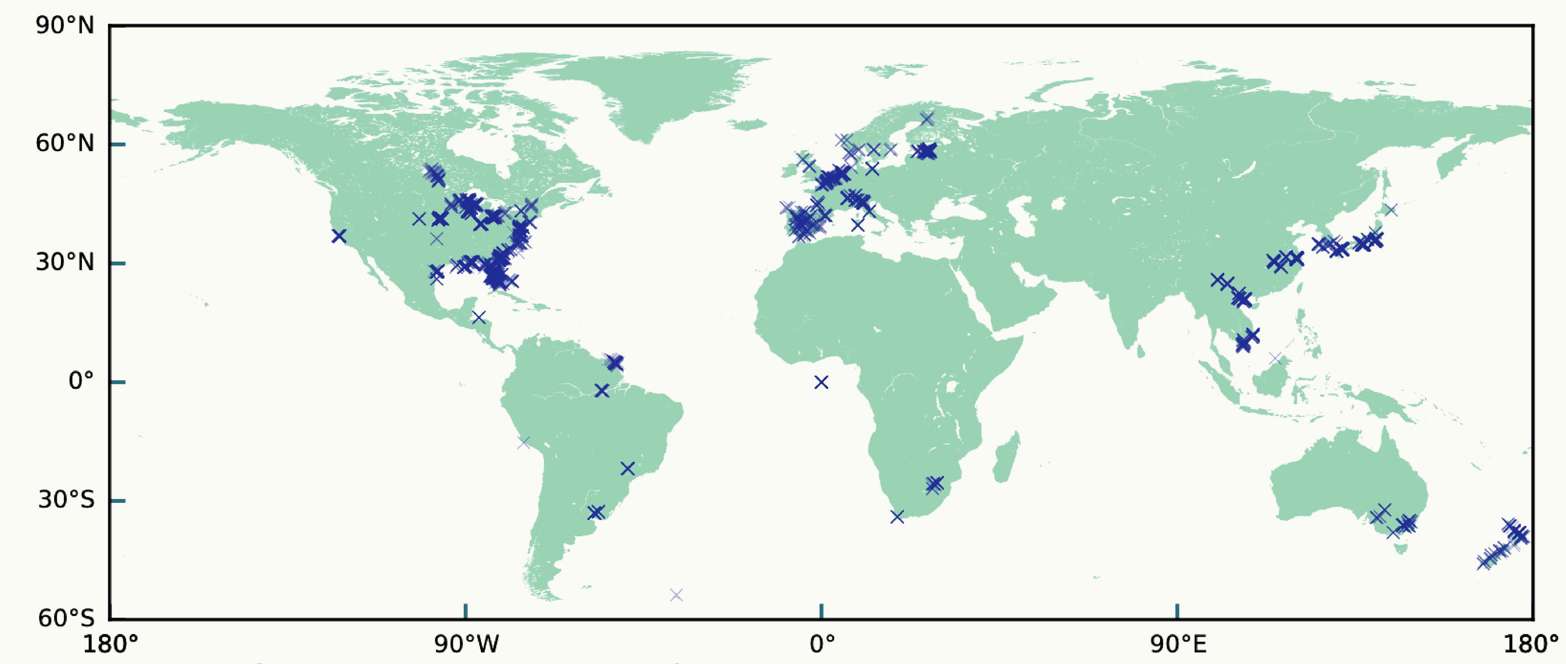

Figure 1. Global Distribution of the data used to train and test the model.

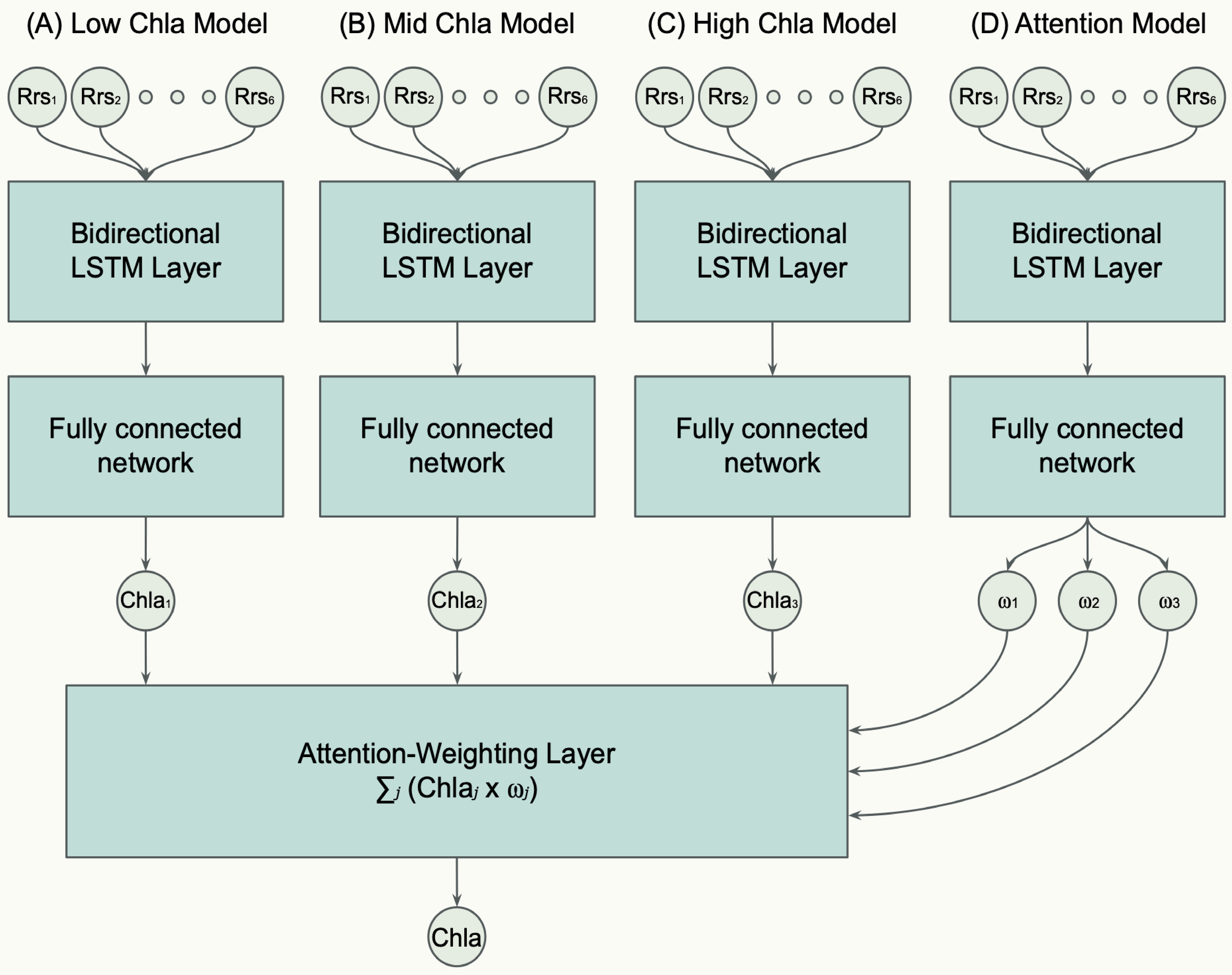

Figure 2. 3LATNet Model Architecture.

Results

- The models in this study were evaluated using in-situ and matchup SGLI data atmospherically corrected using Jaxa's standard AC and OC-SMART AC.
- 3LATNet shows superior results in every test setup.
- JAXA's Standard Atmospheric Correction provides more reliable results that OC-SMART atmospheric correction as depicted in Figure 5.

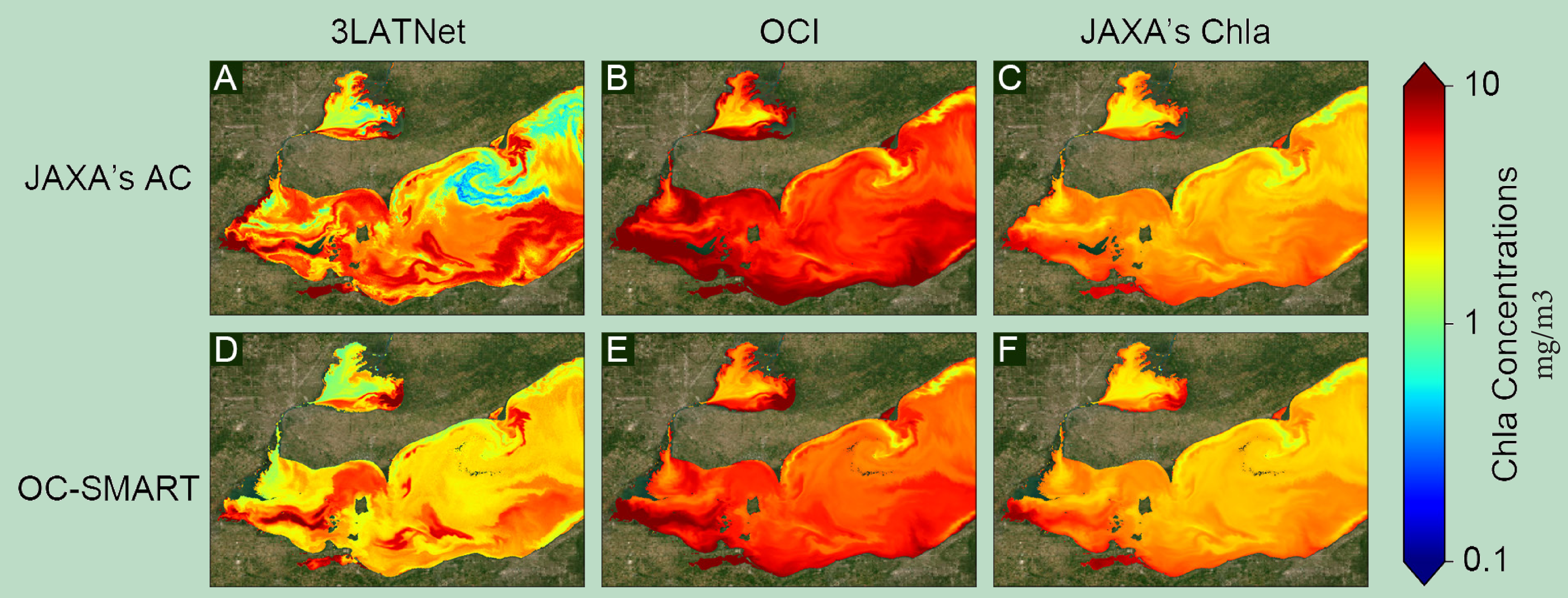

Figure 4. Chla Maps of Lake Erie on the 30th of April 2018.

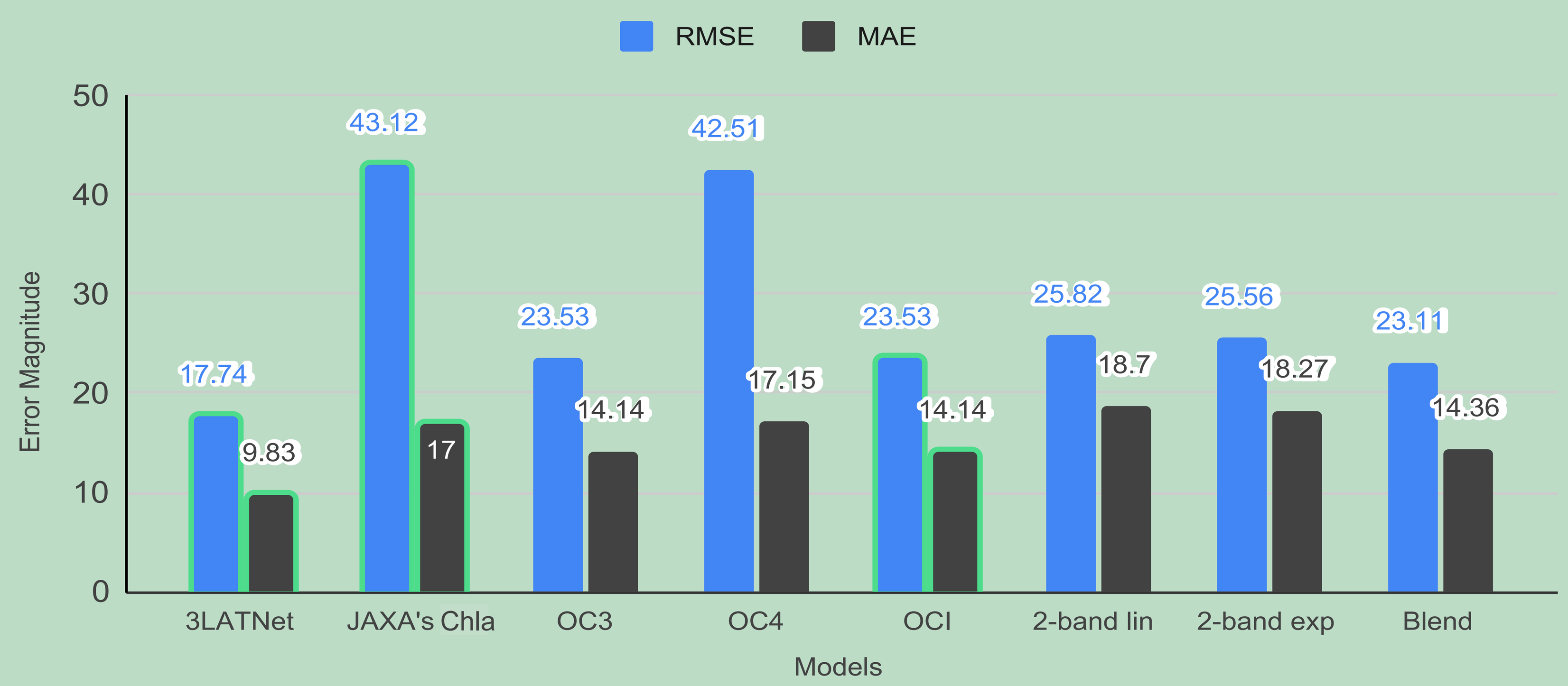

Figure 3. Absolute errors comparison using in-situ data over the full Chla range (0-150 mg/m3).

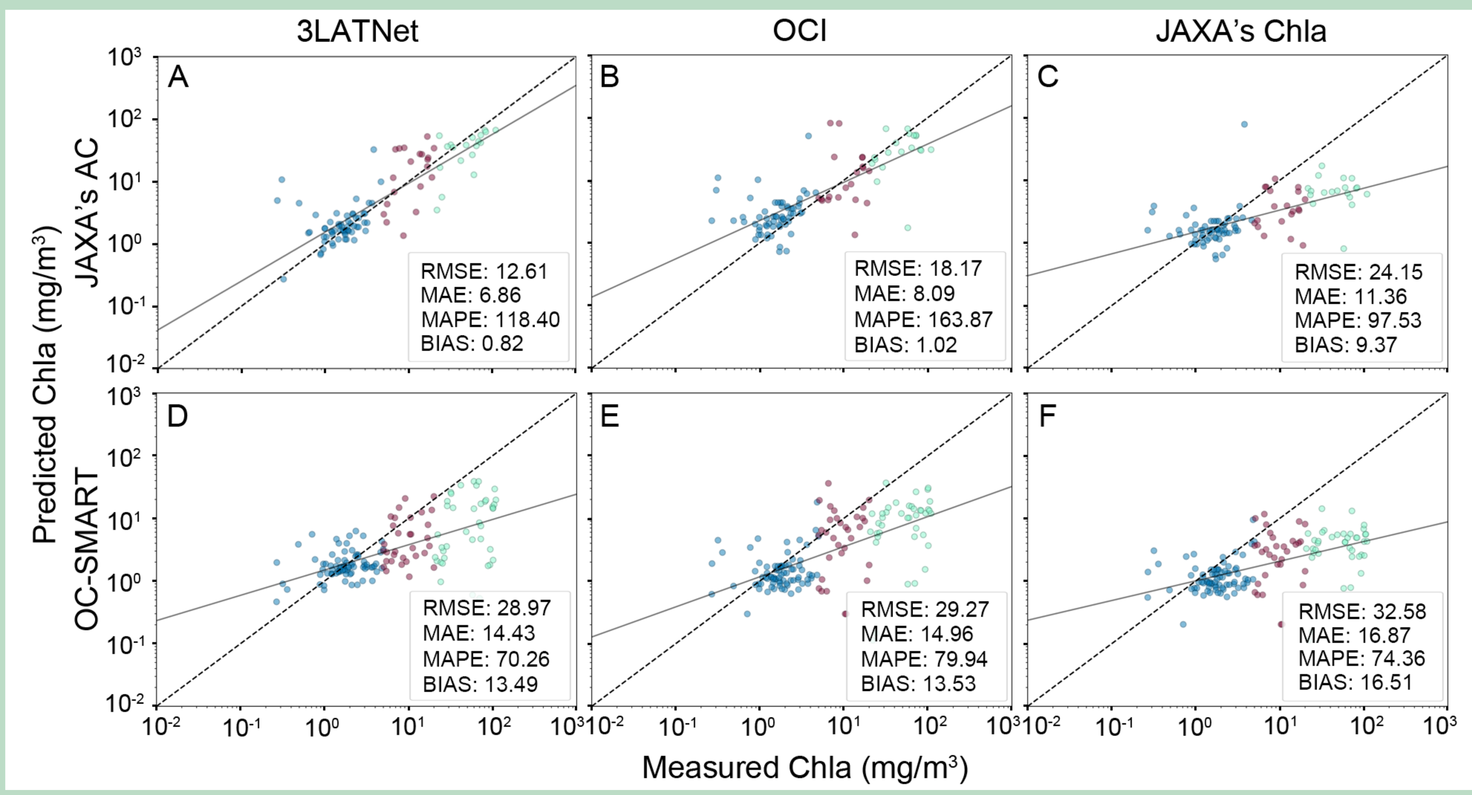

Figure 5. Scatter plots of matchup test sets using different atmospheric correction procedures.

Conclusion

- 3LATNet, surpasses traditional algorithms, achieving significant reductions in MAE (42.2%) and RMSE (58.9%) compared to JAXA's Chla algorithm.
- Notably, 3LATNet excels across the entire Chla concentration range, from low to high ranges. while JAXA's Chla algorithm only excels in the low and mid ranges.
- The comprehensive assessment includes a qualitative analysis of Chlorophyll-a concentration maps, showcasing 3LATNet's ability to capture distinct patterns in varying Chla concentration scenarios.
- Jaxa's Atmospheric correction is more reliable than OC-SMART and SeaDAS.

References

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