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Title: AI-Driven Global Sea Surface Salinity Retrieval from Ocean Color

Abstract: Sea surface salinity (SSS) is a key variable for understanding ocean circulation, freshwater fluxes, and climate variability. Despite its importance, reliable monitoring remains challenging, particularly in coastal and low salinity regions where variability is strong. L-band satellite missions such as Soil Moisture Active Passive (SMAP) provide global SSS observations but are constrained near the coast by coarse spatial resolution and land-related signal interference. While ocean color remote sensing offers superior spatial and temporal resolution, existing SSS retrieval methods have largely been developed as region dependent algorithms, and a globally applicable ocean color-based retrieval framework remains absent. This study proposes a global high resolution SSS retrieval framework that integrates ocean color observations with a two-step training strategy, using satellite derived and in situ SSS measurements as reference data to construct a sufficiently large and diverse training dataset. Our results demonstrated that global AI models outperformed conventional region-specific algorithms, providing improved accuracy in coastal domains. Evaluation against in situ measurements showed that the proposed model achieves higher performance (R^2 = 0.85; RMSE = 0.74 psu) than SMAP (R^2 = 0.80; RMSE = 0.82 psu). Comparisons with numerical models and level 4 satellite SSS products further show that the resulting high resolution SSS fields more effectively capture fine scale variability in coastal regions. This study demonstrates the feasibility of a globally applicable ocean color-based SSS retrieval framework, showing that data driven approaches can achieve consistent performance across regions and improved representation of coastal and low salinity variability compared to existing satellite observations and numerical models.

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