Assimilation of Satellite and In Situ Data for Ocean Storm Prediction and Storm Surge Monitoring to Enhance Community Resilience

Tropical storms and their associated storm surges pose significant threats to coastal regions worldwide. The northern Bay of Bengal, in particular, is a highly vulnerable area that recently experienced three major tropical storms: Mocha (May 2023), Hamoon (October 2023), and Midhili (November 2023), directly impacting the coastal regions of Bangladesh. In May 2024, storm Remal, despite having a wind speed of 111 km/h and a minimum pressure of 978 hPa, caused unprecedented damage due to prolonged storm surge inundation lasting nearly 40 hours. This extended inundation period was unparalleled in the region's history and led to widespread flooding, affecting not only Bangladesh but also parts of Nepal, Bhutan, and northeastern India. Given the critical need for robust and community-friendly ocean forecasting and early warning systems, this study aims to enhance tropical storm predictions and storm surge monitoring for the northern Bay of Bengal. This region is notably data-sparse, lacking in situ ocean observations. To address this, we employed satellite-based data assimilation techniques to improve storm prediction accuracy. Our study demonstrates that post-assimilation, the overall prediction performance improved by approximately 25 to 35%, with significant enhancements in statistical validation scores. A community-oriented storm surge model was developed, and corresponding inundation maps were generated to aid local communities and policymakers in disaster preparedness and mitigation efforts. The implementation of these improved forecasting products on public platforms is crucial for community resilience. Our findings emphasize the necessity for continuous improvements in the accuracy and reliability of these products. Acceptance and integration of these high-impact forecasting tools by the scientific community and civil administration can significantly enhance disaster management capabilities, offering a model that can be replicated in other data-sparse regions globally. Keywords: Tropical Storms, inundation, Ocean observation, coastal resilience.

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