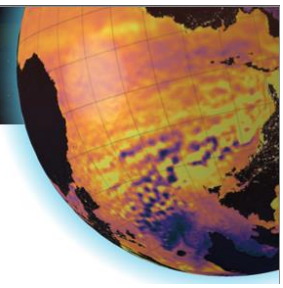

Strategy and validation for determining the location of ocean observation buoys

The deployment and operation of ocean buoys incur significant costs, necessitating a meticulous approach to site selection. Currently, ocean buoys operating in Korean territorial waters are primarily concentrated in shallow coastal areas, resulting in a significant decline in observation density towards the open sea. Consequently, this creates extensive observation gaps, highlighting the need for technical guidelines to prioritize the placement of new observation buoys. This study establishes a testbed in the South Sea of Korea and employs an optimization technique to determine the placement of new observation buoys in specific areas, considering the existing ocean buoy observation network operated by various relevant agencies. The validity of the placement is verified based on OSSEs (Observing System Simulation Experiments) and data acquired from the actual deployment of new observation buoys within these designated areas. To determine the optimal placement, a WSM-based BFO (Weighted Sum Method-based Brute-Force Optimization) is implemented to derive the optimal solution (new observation location) subject to several constraints. The optimal solution is represented by a set of Pareto-optimal solutions, which are non-inferior solutions that achieve the best possible efficiency while satisfying the objective function for each design criterion. These Pareto-optimal solutions are further categorized into five priority placement areas within the observation gap regions based on the weight assigned to each design variable. Furthermore, OSSEs were conducted to evaluate the performance of the designed observation network in capturing the spatiotemporal variability of oceanographic parameters. The OSSEs framework incorporated a realistic ocean circulation model and synthetic observations to simulate the data assimilation process. Two observation areas were selected for real buoy deployment based on the optimization and OSSEs design process. These areas were strategically chosen to capture the low-salinity water outflow from the Yangtze River, China, and the seasonal variability of the Tsushima Current. The two-year observation data collected from the deployed buoys was analyzed to evaluate the effectiveness of the observation network. The results demonstrated that the buoys successfully captured the targeted oceanographic features, supporting the design rationale. The observation data from these locations, as well as the conventional observation network, will be assimilated into KOOS (Korea Operational Oceanographic System) to assess the improvement in prediction accuracy. This study provides valuable insights into the validation of observation networks using

optimization, OSSEs, and real-time data collection, contributing to the design of effective ocean observation systems.

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