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Environment and Climate Change Canada

Development of an Ensemble-Based Ocean Data Assimilation System at ECCC

As part of Environment and Climate Change Canada's (ECCC) efforts toward the development of a fully coupled atmosphere–ocean–sea-ice data assimilation system for global numerical weather and ocean prediction, we present a new ensemble-based ocean data assimilation framework designed to replace the current deterministic operational system. The existing operational ocean analysis system consists of two components operating on different time scales. A daily component assimilates sea surface temperature (SST) information provided by an external SST analysis system, while a weekly component assimilates in-situ temperature and salinity profiles together with satellite-derived sea level anomalies. The first stage of the project focuses on transitioning these components from a deterministic to an ensemble-based data assimilation framework. This is achieved by forcing an ensemble of NEMO ocean models with atmospheric forcing derived from ECCC's Global Ensemble Prediction System (GEPS), thereby providing flow-dependent background-error statistics for both the daily and weekly analyses. The second stage consists of replacing the deterministic data assimilation algorithm used in the daily component with the same ensemble-based framework employed in ECCC's numerical weather prediction systems. The new ocean data assimilation system is implemented within the Modular and Integrated Data Assimilation System (MIDAS) and uses the Local Ensemble Transform Kalman Filter (LETKF) to produce ocean analyses in a manner consistent with the atmospheric ensemble data assimilation system employing the satellite-derived and in-situ SST observations directly. This presentation describes the methodology of the new ocean ensemble data assimilation system, the interaction and coupling between the daily and weekly analysis components, and the results obtained from preliminary experiments. The work also outlines the next steps toward a fully coupled atmosphere–ocean–sea-ice ensemble data assimilation framework, enabling stronger consistency between Earth system components and improved prediction skill across a wide range of temporal and spatial scales.