An Evaluation of the impact of ocean observations on a weakly coupled data assimilative Earth System Model – Developing NOAAs next reanalysis.

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A key objective of this effort is to quantify the impact of assimilating different ocean observing systems within a coupled data assimilation (DA) framework and to identify the observations that provide the greatest benefit for improving Earth system analyses and predictions. Through systematic evaluation of individual observing platforms, we aim to determine their contributions to the coupled system, identify critical observational gaps, and guide the development of future observing strategies. Particular emphasis is placed on in-situ ocean observations, including innovative observing platforms capable of improving the representation of shelf seas and historically undersampled regions, which remain challenging areas for global coupled simulations.

This work supports the development of NOAA's next generation of Earth system prediction capabilities, which are transitioning from single-component configurations (atmosphere, land, and ocean waves) toward fully coupled systems integrating the atmosphere, land, ocean, sea ice, and aerosols. A realistic representation of interactions among these components is essential for improving model fidelity, capturing key feedback mechanisms, and enhancing prediction skill, particularly for extended forecasts spanning the subseasonal-to-seasonal (S2S) timescale.

In this context, incorporating DA into fully coupled Earth System Models (ESMs) is computationally demanding but critical for constraining the state of each Earth system component and improving the physical consistency of analyzed fields. NOAA's Unified Forecast System (UFS) provides a comprehensive coupled modeling and DA framework to support this transition, enabling advanced initialization methods and reducing systematic biases through improved model physics and Earth system constraints.

To support this transition, the Physical Sciences Laboratory (PSL) is developing a coupled global reanalysis system that provides a physically consistent reconstruction of the Earth system and serves as a platform for scientific experimentation and development. We are currently conducting a scout-run using weakly coupled data assimilation, with horizontal resolutions of ¼° for the ocean and sea ice components and ½° for the atmosphere.