Exploring eddy-rich ocean models and surrogate initialisation techniques for medium-range coupled numerical weather prediction

Charles Pelletier, Kristian Mogensen, Christopher Roberts, Magdalena Alonso Balmaseda, Sarah Keeley, Eric de Boisseson, Philip Browne, Hao Zuo, Frederic Vitart

European Centre for Medium-Range Weather Forecasts, Bonn (Germany) and Reading (United Kingdom)

Abstract

ECMWF operational activities provide weather forecasts via the Integrated Forecasting System (IFS) at various time scales (from medium-range to seasonal), involving coupling to the NEMO ocean general circulation model. In parallel to its operational activities, as part of the Destination Earth (DestinE) initiative, the European Commission has mandated ECMWF to explore kilometer-scale modelling by building a global "Extremes Digital Twin" (EDT) of the Earth, for investigating weather-induced extreme events. One of the EDT's main specificity lies in its increased resolution. For its oceanic part, this implies running NEMO at a 1/12º nominal resolution, often described as an "eddy-rich" ocean model, in comparison to the currently operational "eddy-present" 1/4º version.

Ocean initial conditions are of crucial importance to skillful coupled prediction. Therefore, making a fair assessment of incorporating an eddy-rich ocean model requires comparable initial conditions across resolutions. For the operational 1/4º ocean configurations, ECMWF develops and maintains an ensemble ocean data assimilation (DA) system providing initial state. This system is tailored to the standard 1/4º resolution and cannot be directly transposed to the research 1/12º investigation, for which ECMWF does not have a data assimilation system.

We present two simpler alternatives to data assimilation offering more flexibility in terms of target ocean model resolution. Both methods rely of pre-existing ocean analyses: via simple nudging techniques; or via Incremental Analysis Update (IAU) as in data assimilation, but from fully 3D gridded ocean products. By construction, these methods cannot provide better initial conditions than the DA-based ocean (re-)analyses they are based upon. They are however more flexible in terms of target model resolution and thus offer a fair framework for assessing the benefits of an eddy-richer ocean model. In this presentation, we introduce these two surrogate methods along with associated results on ocean mean state and variability. We also present numerical weather prediction skill arising from medium-range coupled forecasts employing eddy-present vs. eddy-rich ocean configurations, with comparable initial conditions.