The role of the oceans for subseasonal prediction: insights from eddy-permitting and eddy-rich coupled forecast systems

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Abstract

The oceans play a fundamental role in Earth's climate system, redistributing heat and influencing global and regional climate variability and predictability across weather and climate timescales. The benefits of ocean-atmosphere coupling for initialised predictions depend on the balance between improvements associated with more realistic air-sea interactions and dynamics, and degradations arising from the development of systematic biases at the coupling interface. Here, we draw on recent developments in modelling and data assimilation at ECMWF to revisit the role of ocean-atmosphere coupling in subseasonal predictions. In particular, we evaluate the impact of ocean-atmosphere coupling in 46-day reforecasts produced with the ECMWF Integrated Forecasting System (IFS) and explore the potential for improvements through increased horizontal resolution and a better representation of the ocean mesoscale. We find that ocean-atmosphere coupling significantly enhances ensemble forecast skill in the tropics, with positive effects increasing at longer lead times. In particular, Madden-Julian Oscillation (MJO) forecasts are substantially improved, with forecast skill extended by approximately 5 days compared to the uncoupled configuration. In contrast, ocean-atmosphere coupling has a more limited impact on the extratropical atmosphere at subseasonal timescales, with marginal impacts on the predictability of major tropospheric and stratospheric circulation indices. Finally, we present selected results from an experimental eddy-rich coupled configuration of the IFS, with a horizontal ocean resolution of approximately 8 km. We find that a better-resolved representation of the ocean mesoscale has a limited impact on atmospheric forecasts at subseasonal lead times, which suggests that many of the known deficiencies of the eddy-permitting reference configuration are mitigated by accurate initialisation. Nevertheless, other factors may be important when considering the case for an eddy-rich ocean in coupled forecasts, including the potential for higher-resolution and more accurate ocean and sea ice forecast products, impacts on coupled data assimilation, and the influence on extreme weather events.