Seasonal-to-decadal variability and predictability of the Kuroshio Extension in the GFDL Coupled Ensemble Reanalysis and Forecasting system

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Abstract

The Kuroshio Extension (KE), an eastward-flowing jet located in the Pacific western boundary current system, exhibits prominent seasonal-to-decadal variability, which is crucial for understanding climate variations in northern midlatitudes. We explore the representation, predictability, and prediction skill for the KE in the GFDL SPEAR coupled model. Two different approaches are used to generate coupled reanalyses and forecasts: (1) restoring the coupled model's SST and atmospheric variables toward existing reanalyses, or (2) assimilating SST and subsurface observations into the coupled model without assimilating atmospheric data. Both systems use an ocean model with 1o resolution and capture the observed KE characteristics accurately. Assimilating subsurface observations improves the spatial structure of the KE oceanic front in the coupled reanalysis. We next demonstrate skillful retrospective predictions of the KE in SPEAR forecasts of monthly means (up to 1 year) and annual means (up to 5 years) in seasonal and decadal prediction systems, respectively. The skill varies seasonally, peaking for forecasts initialized in January and verifying in September due to winter intensification of North Pacific atmospheric forcing. We show that strong large-scale atmospheric circulation generates deterministic oceanic forcing (i.e., oceanic Rossby waves), leading to skillful long-lead KE forecasts. These curl anomalies also drive Ekman transports that form ocean memory by sequestering thermal anomalies deep into the winter mixed layer so that they can re-emerge in subsequent fall. The SPEAR forecasts detect the recent negative-to-positive transition of KE SSH anomalies and project a continued positive phase to 2022.

Keywords: Kuroshio Extension, Coupled reanalysis, Decadal and seasonal Prediction

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