A seasonal to interannual ensemble climate prediction system

A seasonal to interannual ensemble climate prediction system was developed, incorporating an ensemble optimal interpolation (EnOI) technique for ocean data assimilation of sea surface temperature, sea level anomalies, and ARGO profiling float observations. The atmospheric component employed a nudging data assimilation scheme that assimilated ERA5 reanalysis data. The ensemble members were initialized with sea surface temperature perturbations derived through a synergistic approach combining climate singular vector analysis and conditional nonlinear optimal perturbation methods. This innovative ensemble framework exhibited markedly enhanced predictive skill for high-impact climate phenomena, such as El Niño–Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD), outperforming traditional deterministic forecasts. Notably, the system accurately predicted the 2021 La Niña event with a five-month lead time, surpassing the capabilities of existing models. Furthermore, it demonstrated proficiency in forecasting the Madden–Julian Oscillation (MJO) up to 14 days in advance and successfully anticipated the transition to a negative phase of the Pacific Decadal Oscillation (PDO) one year prior to its 2020 occurrence. *Y*

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