Synchronization-asynchronization cycle of the Kuroshio and the Gulf Stream

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Recently, the sea surface temperatures of the Kuroshio and the Gulf Stream regions were reported to be synchronized, and named as the Boundary Current Synchronization (BCS). The BCS is believed to exert a widespread impact on midlatitude weather and coastal fisheries, but the synchronization is intermittent in the sense that both periods of large and small correlations were detected in observational records and outputs from high-resolution atmosphere-ocean coupled models. Therefore, in this study, to investigate why there exist periods of strong and weak synchronization, we perform a simple model simulation and data analysis.

As an idealized model of the BCS, we use a conceptual model of the mid-latitude atmosphere coupled to two oceans with western boundary currents. A series of simulations show that both variations in internal parameters, such as the deformation radius, and external stochastic noise can reproduce the non-stationary nature of the strength of synchronization.

Based on the aforementioned results, we define the Boundary Current Asynchronization (BCA) index as a measure of asynchronization. The regression map of sea surface temperature on the BCA index shows a strong signal in the eastern equatorial Pacific, and the Niño.3 index and BCA index peaked together in 2015/2016 boreal winter, suggesting that the El Niño Southern Oscillation interfered with the synchronization of the two currents. In addition, the regression map of sea level pressure on the BCA index exhibits opposite anomalies between the Aleutian Islands and around Iceland, suggesting that the so-called “Aleutian Low-Islandic Low Seesaw” variability may also contribute to the asynchronization in the two basins.

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