Press Releases

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JAMSTEC
The University of Tokyo

Parallel Worlds Could Exist in Ocean Circulations

-Ensemble experiments analyze interannual variability of the Kuroshio Extension-

Overview

A research team led by Dr. Masami Nonaka at Application Laboratory, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) and Dr. Hisashi Nakamura, Professor at the Research Center for Advanced Science and Technology, The University of Tokyo evaluated ocean interannual variability with ensemble experiments using the JAMSTEC's supercomputer, the Earth Simulator. The results showed existence of unpredictable intrinsic variability and potentially predictable wind-driven variability, both of which are contributing to the interannual variability in the mid-latitude ocean currents, including the Kuroshio and its eastward extension, Kuroshio Extension (KE) jet speed.

Applying ocean models on the Earth Simulator that can reproduce realistic ocean circulations, the research team's ensemble experiments demonstrated dissimilar phenomena of ocean circulations even under slightly changed conditions despite the identical wind-forcing variability. Specifically, potential predictability of interannual variability in the KE jet speed is limited substantially by intrinsic variability, of which magnitude is comparable to that of the deterministic wind-driven interannual variability.

These results suggest that parallel worlds could exist in ocean circulations, where dissimilar phenomena could be happening despite the same conditions while observations are only made in our world. Since it is not possible to predict what type of parallel worlds could be realized, it is necessary to take into accounts of such unpredictable intrinsic variability towards more sophisticated prediction. These findings suggest that multi-ensemble experiments are necessary also in the field of ocean current prediction as they are common in the area of atmospheric circulations such as weather forecasting. Introducing multi-ensemble experiments in prediction of ocean currents is expected to lead to much more sophisticated prediction of climate changes and the total catch of fish.

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Title: How potentially predictable are midlatitude ocean currents?
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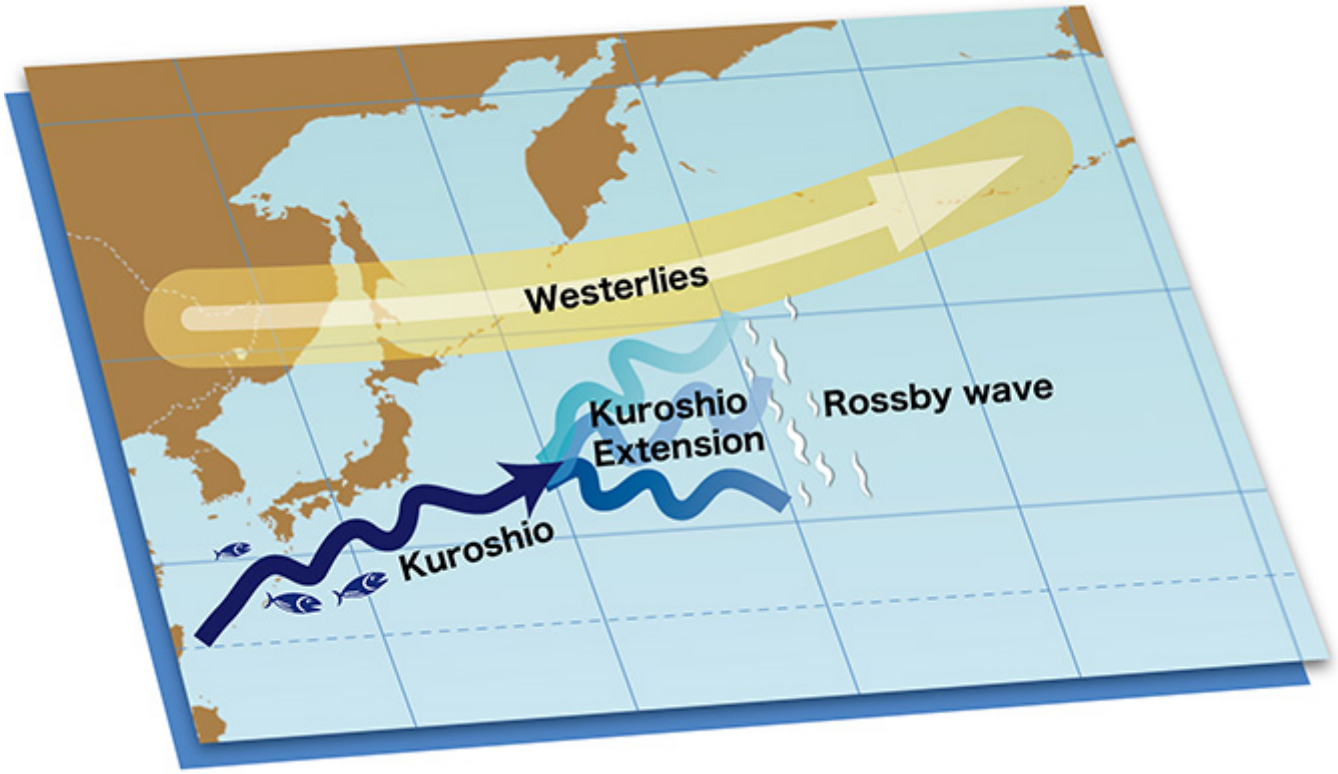

Figure 1: Kuroshio Extenion and interanual variability

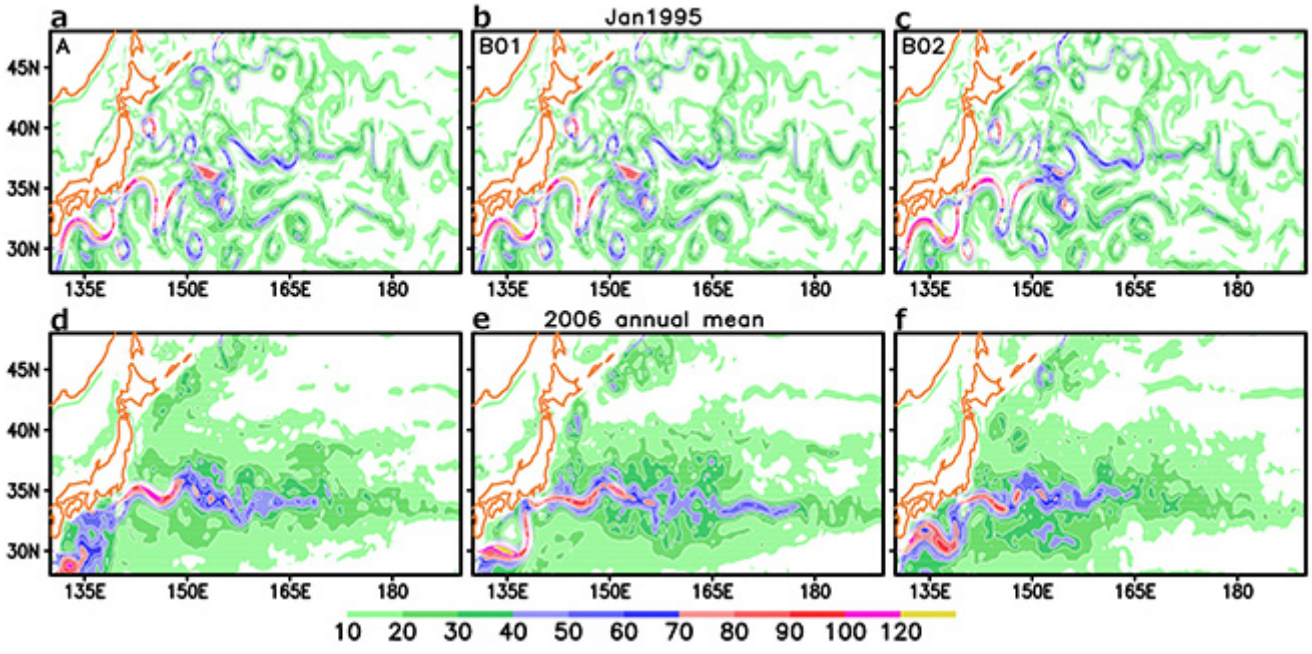

Figure 2:100-m depth current speed in hindcast experiments.
These three simulations were carried out each with slightly changed conditions but under identical atmospheric variability.
(a–c) Monthly means for January 1995. They showsed alomost the initial state, indicating mostly identical circulations.
(d–f) Annual means for 2006. To reduce impacts from ocean eddies and highlight

interannual variablity of current, annual means are shown here. Among three simulations, the KE jet differed notably in its strength and zonal extent.

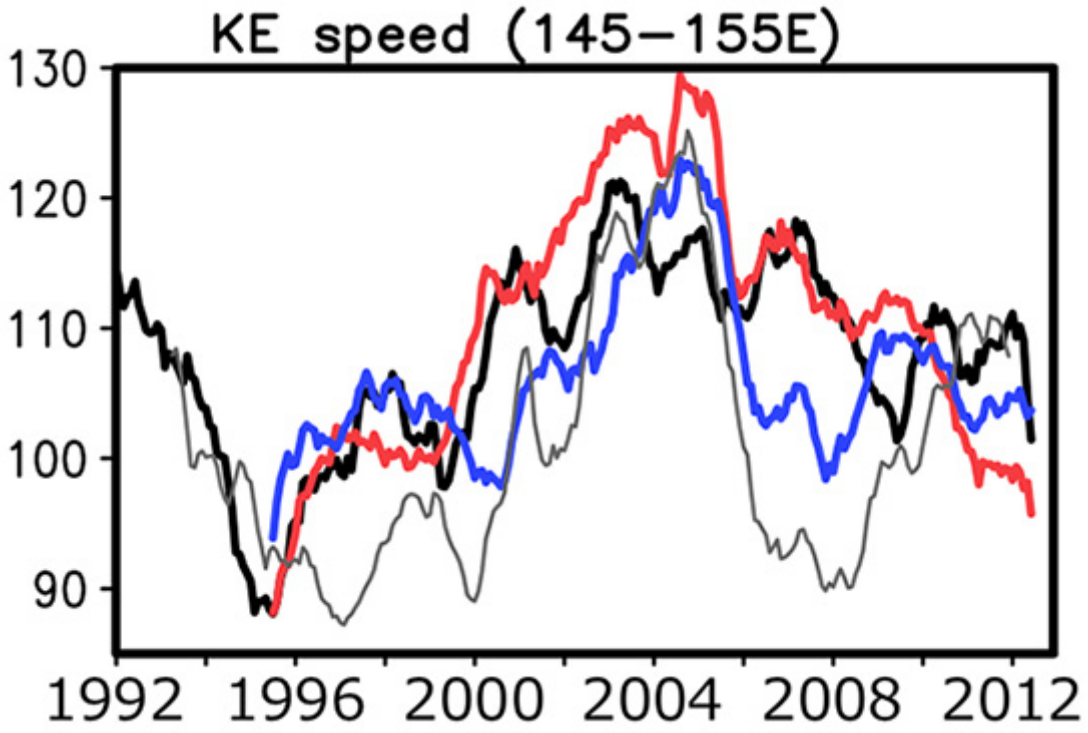

Figure 3: Time series of the Kuroshio Extension (KE) jet speed averaged over 145–155 °E, which was reprodcued in three simulations shown in the figure 1 (black line, red line, blue line). The gray line shows satellite observations. To reduce impacts from ocean eddies and highlight interannual variability of ocean currents, 13-month running mean is applied to the time series of the KE jet speed.
Roughly, a similar trend is shown in all simulations, in which velocity incerases around 2004 and then decreases. On the other hand, interannual variability of KE speed largely differs among three simulations. It indicates simulated ocean circulations vary greatly not only in 2006 as shown in the figure 2 but also in other years. In comparision with observation data, the simulation result shown in the blue line seems to be quite consistent with observations. However, there being no variance or difference in ocean models when compared to other two simulations (shown in black and red lines), it means consistency with observations is not related to ocean models but occurring incidentally and vice versa.

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