

# Prediction of Kuroshio Meander

## With JMA Operational Ocean Assimilation-Prediction System (COMPASS-K)

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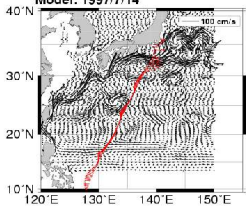
An ocean data assimilation system (COMPASS-K) has been operated in the Japan Meteorological Agency from 2001. The purposes of the system operation are understanding ocean variability in the western North Pacific as a local response to a global climate change with assimilated four-dimensional data sets, nowcasting and forecasting of ocean states, and a contribution to the GODAE project. The nowcasting product is delivered through Japan GODAE server (<http://godae.kishou.go.jp>).

Using COMPASS-K, 84 cases of 90-days prediction experiments are conducted to assess short-range (i.e., one month) prediction properties of the model with the operational system, from 1993 to 1999, for Kuroshio axis variability. Each prediction is started from an initial condition that is obtained in a reanalysis experiment. The predictions represent transition from straight to meander of the Kuroshio axis, and the results are analyzed according to mechanisms of the transition with eddy propagation and interaction that act as a trigger of the meander and self-sustained oscillation. The reanalysis shows the meander evolution by the eddy activity. Simulation (no assimilation) shows no meander state even with the same atmospheric forcing as the prediction. Therefore the initial condition contains the information of the meander and the system can represent the evolution. Mean (standard deviation) values of the axis error for all 84 cases are 13, 17, and 20 (10, 10, and 12) km, in 138.5E, in the 30-, 60-, and 90-days predictions respectively. Observed mean deviation from seasonal variation is 30 km. Then the predictive limit of the system is about 80 days. The gradual decrease of the amplitude in a stage from meander to straight axis is also predicted. The predictive limit is about 20 days that is shorter than the prediction of the opposite transition. We report also the real time prediction experiment that succeeded to predict the Kuroshio large meander in August, 2004.

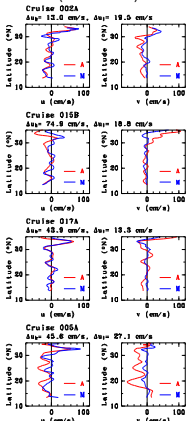
### 1. System & Performance (velocity field)

MRI OGCM (North Pacific, 1/4x1/4, L21)  
 4DOl (ship, argo, T/P)  
 Validation (e.g., Comparison with ADCP)

ADCP: 1997/7/12 - 1997/7/16 (005A)  
 Model: 1997/7/14



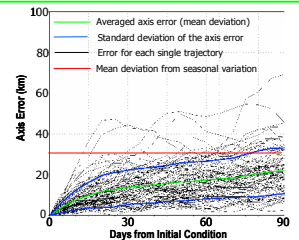
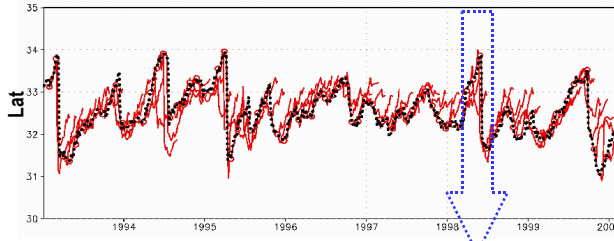
Distributions of velocity fields (mean value in 70-110m depth) of the reanalysis (black) and of ADCP observations (red arrows).



Latitudinal distribution of the velocity fields of the ADCP (red line) and of the reanalysis product (blue line). Left: east-west, right: north-south velocities.

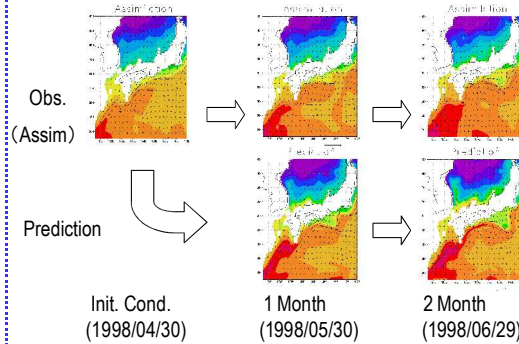
### 2. Hindcast Experiments

Time series of the latitude of the Kuroshio path in the reference (black dotted line) and prediction (broad solid line). Horizontal axis is time from 1993 to 2000.

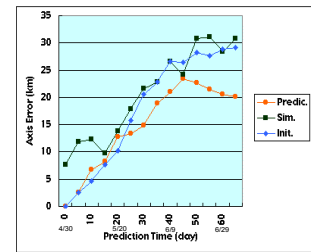


Time series of the axis error (mean deviation of the Kuroshio axis in 138.5E) of the all 84 cases of the prediction from 1993 to 1999.

Ocean State in 1998: Until 4/30 Straight path. 5/25-6/20: small meander to Kii-Peninsula. 6/25-: Meander evolves

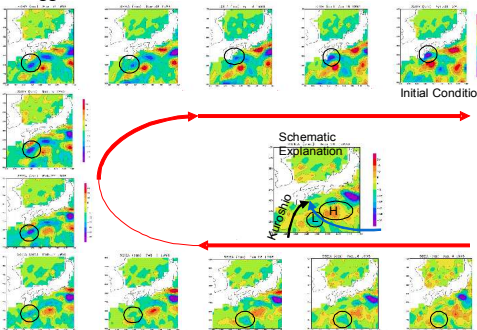


Prediction experiment from straight to meander path.



Time evolution of the axis error of the prediction (Predic.), model simulation (Sim.) and persistency (Init.). Horizontal axis is the number of days after the initial state (April 30).

Trigger: Eddy Propagation in 1998/1/8-4/28 (TOPEX/Poseidon SSHA every 10days)



<- (Left Fig.)

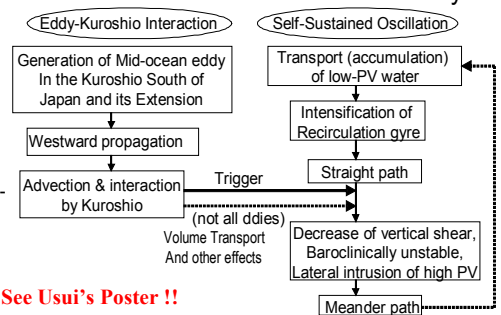
Time series of sea surface height anomaly derived from TOPEX/Poseidon altimetry. Each figure is drawn every ten days from January 8 to April 28 just before the initial condition, 1998. Time progresses along the broad arrow.

(Right Fig.) ->

Schematic diagram of a scenario of a relation of mid-ocean eddy and Kuroshio interaction and self-sustained oscillation. Unsolved process is shown by dotted lines (Kamachi et al., 2005). Thorough discussions are given by Tsujino et al. (2005).

### 3. Interpretation

### A Scenario for short term variability



See Usui's Poster !!

### 4. Operational Realtime Prediction in 2004

An example of operational prediction of Kuroshio Large Meander (2004)  
 Initial condition: 2004/06/04 to 08/03  
 Operational prediction experiment shows the large meander in this year.  
**It is the first time to predict the large meander successfully,**  
**and JMA had a press release in May 11th. !!!**  
 The nowcasting data are opened through the Japan GODAE server (<http://godae.kishou.go.jp>)

