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Water mass variability in the western North Pacific detected in a 17-year eddy resolving ocean reanalysis : Roles of the in-situ observations

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Abstract

We have investigated the sensitivity of including in-situ observations on the quality of the ocean reanalysis produced by a data assimilative eddy-resolving ocean model, with an emphasis on the Kuroshio frontal variability south of Japan. By increasing the number of the in-situ hydrographic profiles for the data assimilation (Fig.1), more enhanced Kuroshio front variations with approximately 20 days time scale were reproduced. The enhanced features exhibited the wavelike disturbances east of the Kii Peninsula with the wave length of 400 km and considerably affected coastal areas through the consequent warm water intrusion (Figs.2-5), which were consistent with the observed phenomena. This study suggests that the assimilaton of operational in-situ observations in coastal regions south of Japan is effective to capture the Kuroshio frontal variability.

Reference: Miyazawa et al.(2010), submitted to J. Geophys. Res.

The 17-year reanalysis data from 1993 to 2009 are available.

Access: http//www.jamstec.go.jp/frcgc/jcope/

Model and Data assimilation

- Modified Princeton Ocean Model with a generalized coordinate of sigma (Miyazawa et al.,2009,J. Oceanogr.)
  1. 1/12 deg., 47 sigma levels, 10.5-62N and 108-180E, daily-mean data
  2. Driven by NCEP/NCAR Reanalysis data
  3. Period: Jan. 1993 - Dec. 2009 (17 years)
- 3DVAR assimilation scheme using Temperature-Salinity coupling EOF modes (Fujii and Kamachi,2003,J. Oceanogr.)
  1. SSHA: TOPEX/POSEIDON, JASON-1,2, ERS-1, GFO, ENVISAT
  2. SST: NOAA/AVHRR
  3. T,S profiles: GTSPP, WOD05, FRA-DATA

Sensitivity Experiments:1993-1999

- Case-1 JCOPE2 : only assimilates GTSPP
- Case-2 FRA-JCOPE2 : assimilates WOD05 and FRA-DATA in addition to GTSPP

JCOPE2 FRA-JCOPE2

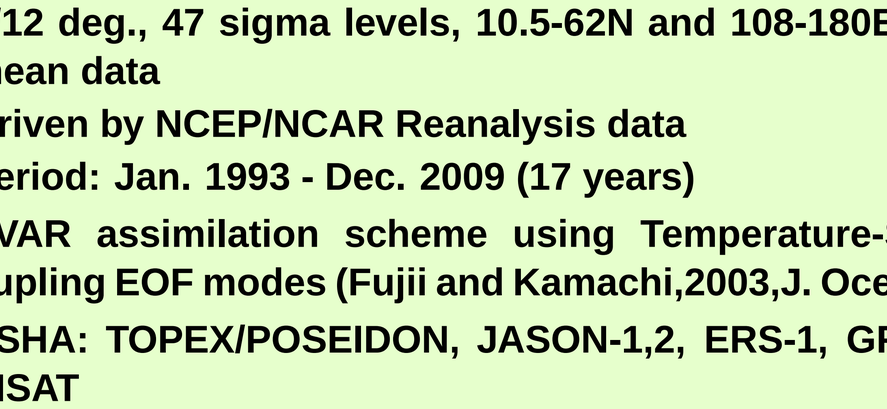

Fig.1. Monthly average numbers of in-situ temperature (upper panels) and salinity (lower panels) profiles assimilated into the reanalyses within 1° latitude-longitude boxes.

Enhanced Kuroshio frontal variability

JCOPE2 FRA-JCOPE2

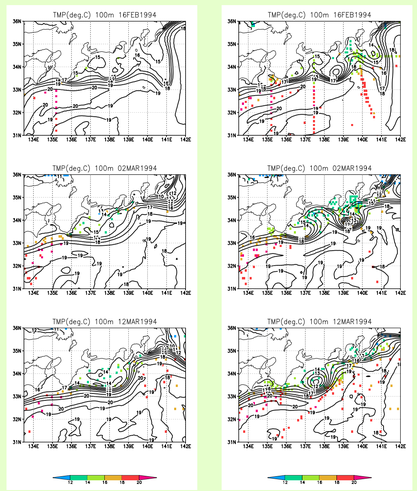

Fig.2. Time sequences of daily mean snapshots showing temperature distributions. Closed squares: Profile points.

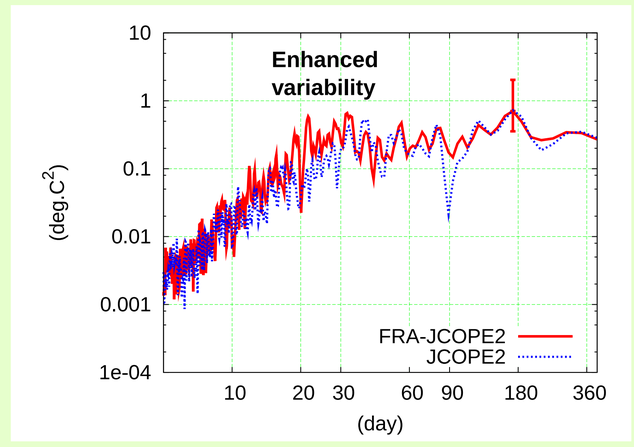

Fig.3. Power spectra obtained from the daily mean time sequences of the reanalyses temperature from 1 January 1993 to 31 December 1999 at 100m depth at 34°N, 138°E. An error bar: 95% level.

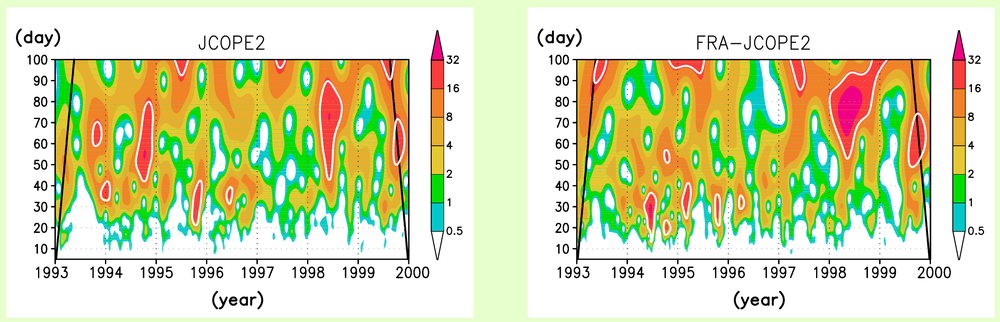

Fig.4. Local wavelet power spectra normalized by the average variance obtained from the same temperature sequences used in plotting Fig.3. The cone of influence is indicated in black lines. The white colored contour encloses regions of greater than 95% confidence.

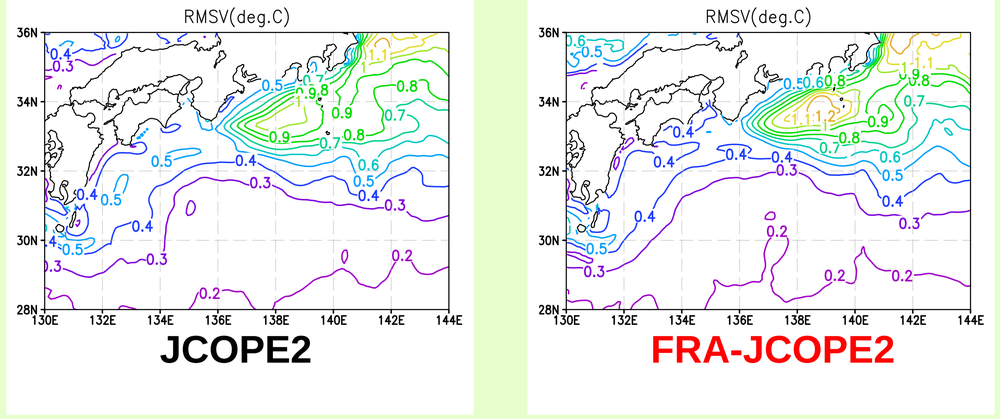

Fig.5. Root mean square variability (in °C) of the filtered temperature at 100m depth for the period from 1 January 1993 to 31 December 1999. The filter time scale is smaller than 35 days.

Impact of the in-situ data on the assimilation

JCOPE2 FRA-JCOPE2

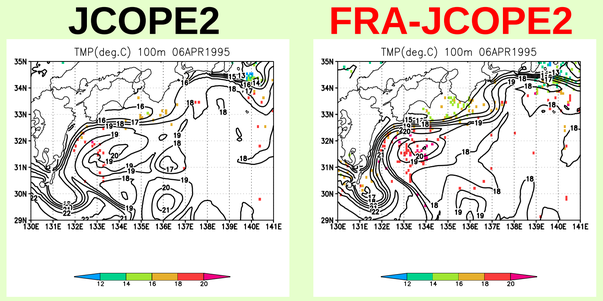

Fig.6. Daily mean snapshots showing temperature distributions. Closed squares: Profile points. FRA-JCOPE2(right) exhibits the intensification of the Kuroshio front.

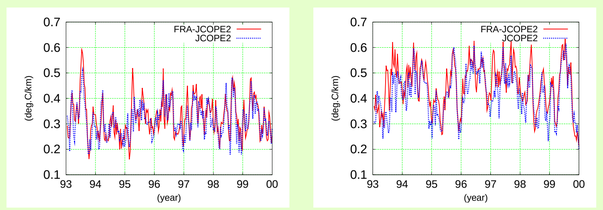

Fig.7. Daily mean sequences of average absolute value of horizontal gradient at 100m depth. Left: 31°-33°N, 131°-134°E. Right: 33°-35°N, 136°-141°E.

The general effect of the addition of the in-situ data is the intensification of horizontal temperature gradient related with the Kuroshio front. (Figs.6-7)

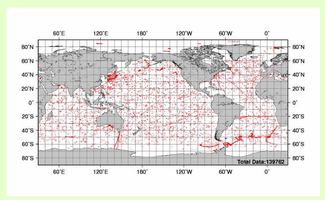

Fig.8. BATHY/TESAC data points reported in December 2009. (JMA website)

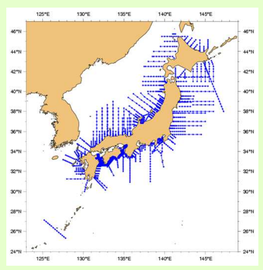

Fig.9. Typical distribution of the repeated hydrographic observation lines conducted by local fisheries research agencies in Japan (FRA-DATA).

At the present time, the dense real-time monitoring network has been established around Japan (Fig.8), suggesting the complemental role of the in-situ observations in the nearshore region (FRA-DATA; Fig.9) and in the open ocean (ARGO).