B2146

DEEP OVERFLOW THROUGH THE KERAMA GAP CONNECTING THE EAST CHINA SEA AND THE PHILIPPINE SEA

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1. INTRODUCTION

The East China Sea includes the Okinawa Trough (in part deeper than 2000 m) between the continental slope and the Ryukyu Islands (Fig. 1). In the Okinawa Trough, thermocline waters are exchanged with those of the Philippine Sea via the Kuroshio, while the deep waters below the thermocline can be exchanged only through the Kerama Gap with a sill depth of 1100 m. This study reveals temporal and spatial velocity-structures below the thermocline over the the Kerama Gap, mainly using data from moored current-meters in 2009/06–2011/05 and supplemented with outputs from a data-assimilated daily model provided by the Naval Research Laboratory.

2. MOORING OBSERVATION

PERIOD

1st deployment: 2009/06–2010/05

2nd deployment: 2010/06–2011/05

CONFIGURATION

See Fig. 2

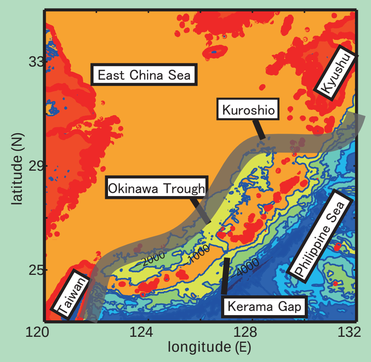


Fig. 1. The study area, showing bathymetry.

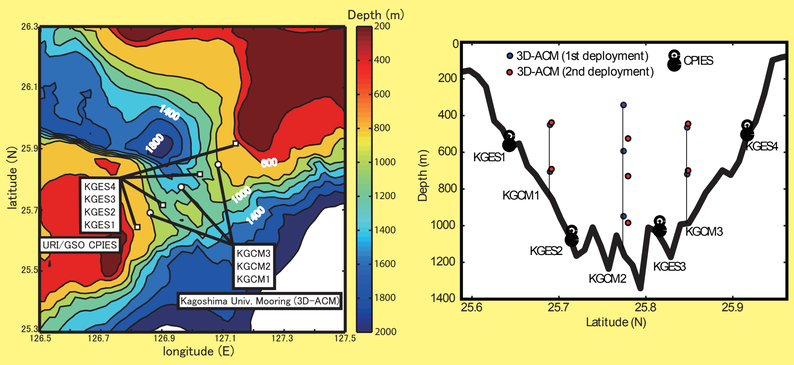


Fig. 2. Mooring configuration: (left) horizontal view and (right) cross-section.

Evidence of a steady deep flow into the Okinawa Trough

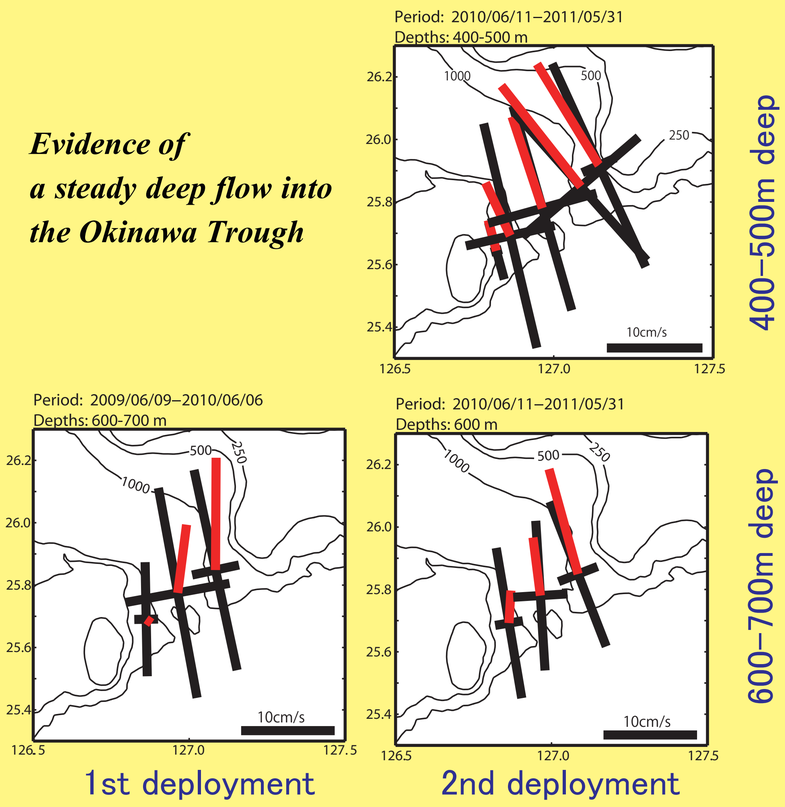


Fig. 3. Mean velocity vectors (red) and standard deviations of the velocity variations along principal axes (black); the length of each stick denotes twice the standard deviation.

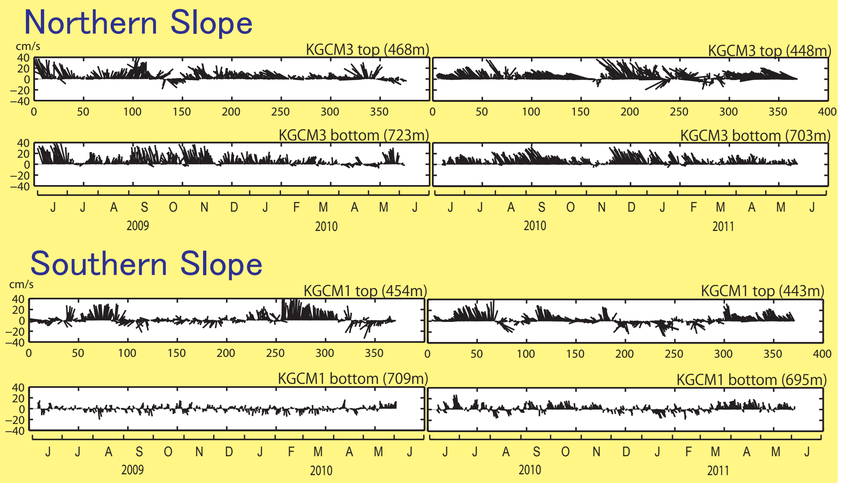


Fig. 4. Current vector time series (the north-south direction in ordinate)

Besides low-frequency variations due to unstable motions of the Ryukyu Current (see Figs. 9 and 12), clear high-frequency variations (period: about 10-d) are found on the southern slope.

Evidence of Hydraulic Control in the Kerama Gap, Based on ARGO Float Profile Data

(Fig. 5: see marked areas with the feature that dense water sinks into the deep Okinawa Trough)

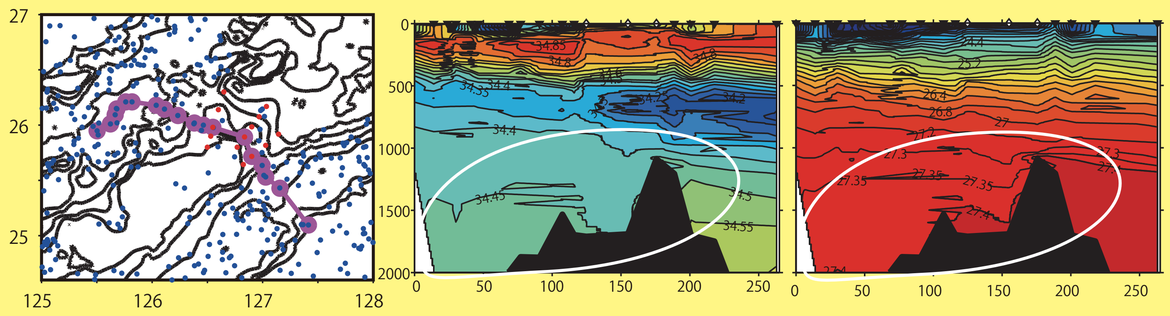


Fig. 5. Locations (purple circles) where ARGO floats observed temperature and salinity profiles.

Summary of Observation

1) A steady deep flow (> 10 cm/s) into the Okinawa Trough is clearly present on the northern slope of the Kerama Gap. 2) The volume transport thorough the gap is approximately estimated at 2.2 Sv in the depths below 300 m for the period 2010/06–2011/05. 3) The hydraulic control is evident on the sill of the Kerama Gap.

3. DATA-ASSIMILATED MODEL OUTPUTS

by Naval Research Laboratory

MODEL

1/12° global daily assimilation with HYCOM

TEMPORAL MEAN

See Fig. 9 and Fig. 10

TEMPORAL VARIATION

See Fig. 11, Fig. 12 and Fig. 13

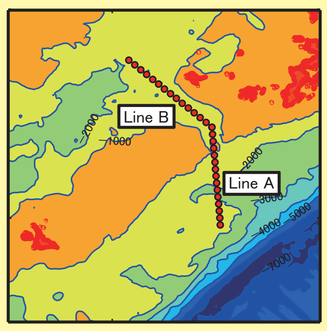
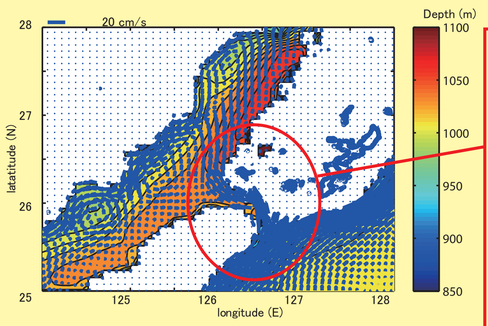


Fig. 8. Lines for Figs. 10 and 13.



Clearly shown that 1) the deep inflow on the northern slope is a branch of the Ryukyu Current, and 2) the 27.3 sigma-theta surface changes its depth at the Kerama Gap significantly.

Fig. 9. The 27.3 sigma-theta surface velocity along with the surface depth.

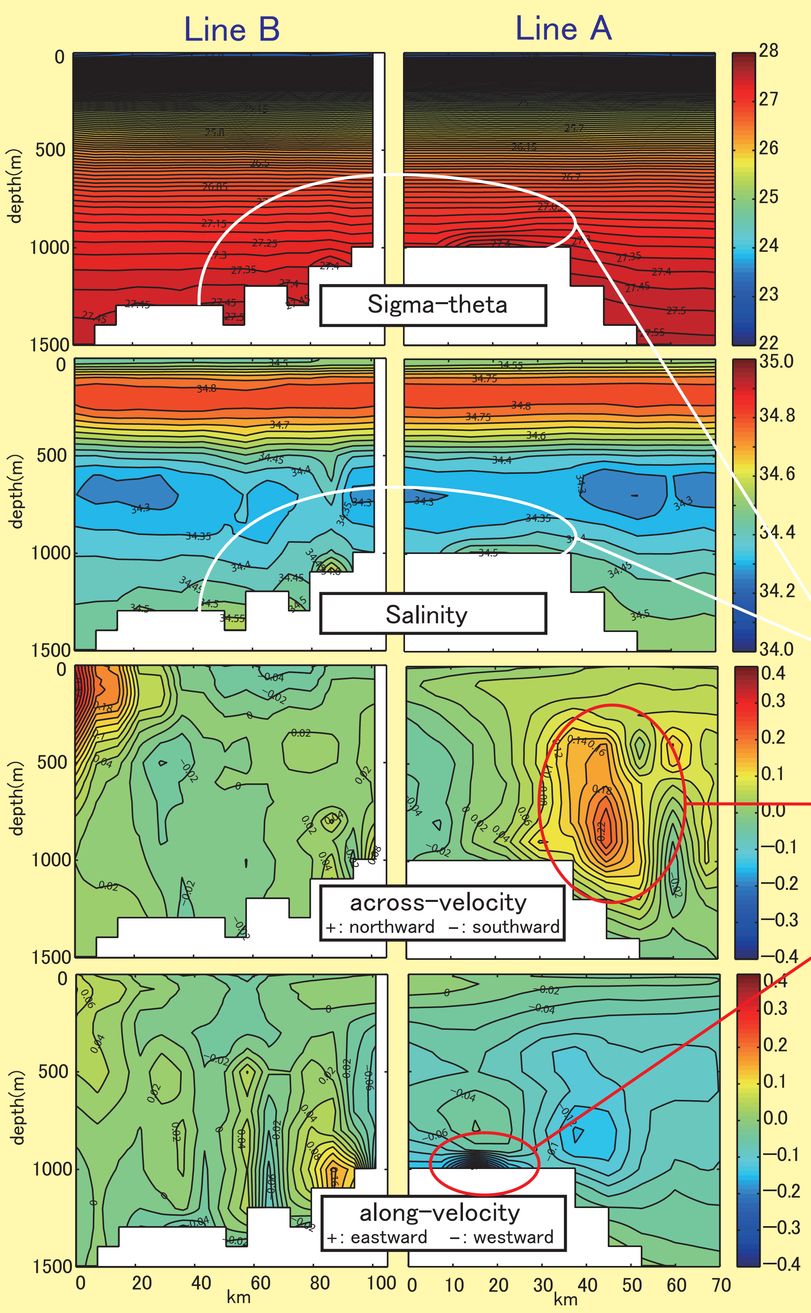


Fig. 10. Cross-sections along Line A (right) and Line B (left) (see Fig. 8 for the location of each line).

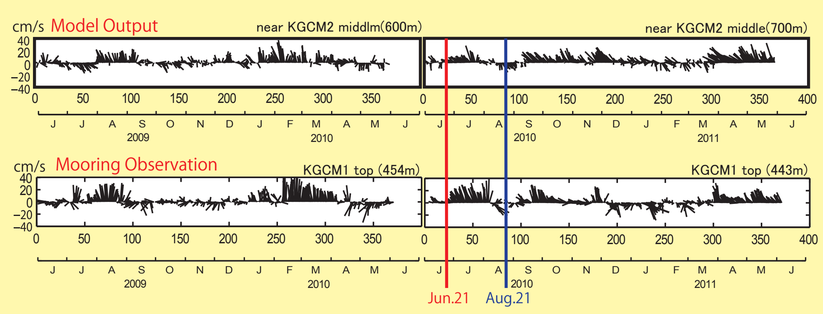


Fig. 11. Comparison between model output and mooring observation time series, showing the model represents observed temporal features. Red (Blue) line indicates the inflow (outflow) period shown in Figs. 12 and 13.

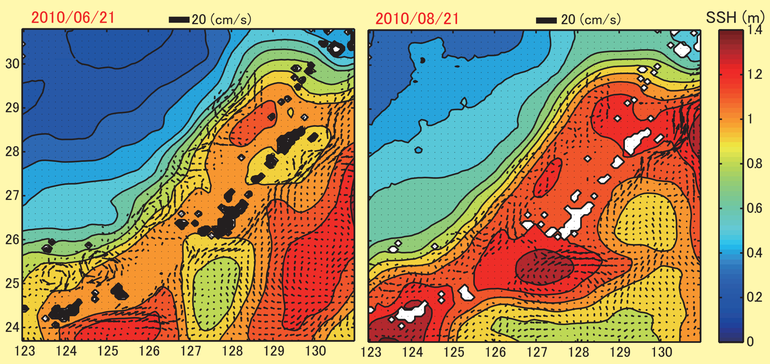


Fig. 12. Horizontal distributions of sea surface height (SSH) and velocity fields at 900 m depth: (left/right) inflow/outflow period on 21 June/21 August.

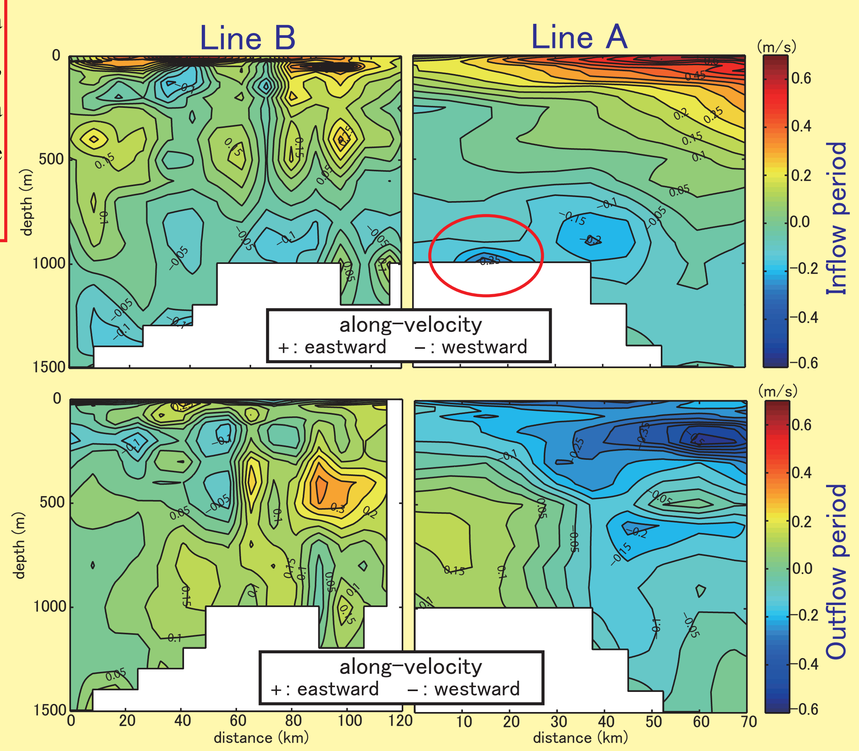


Fig. 13. Cross-sections along Line A (right) and Line B (left). Bottom intensified flow probably indicating the hydraulic section (see the marked area) is clearly shown in the two-layer ocean for the inflow period, while such a flow does not appear for the outflow period.

The model represents the feature that the dense water sinks into the deep Okinawa Trough.

The Ryukyu Current, which is a deep current flowing northeastward along the eastern slope of the Ryukyu Islands.

The bottom-intensified flow, which may be formed by hydraulic control.

4. CONCLUSIONS

1) A steady deep current, which is a branch of the Ryukyu Current, flows into the Okinawa Trough along the northern slope of the Kerama Gap.

2) The bottom water on the sill of the gap looks to sink into the deep layer of the Okinawa Trough, because of the effect of hydraulic control.