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13. SUPPLEMENTARY NOTES

14. ABSTRACT

Synoptic hydrographic and velocity data were obtained in the first meander crest and trough of the Kuroshio Extension (KE) from measurements aboard the R/V Soyo-maru in late May and early June 1998. Measurements indicated that the eastward flowing KE had significant (up to 20 cm/s) flow at 1400m depth and that a subsurface velocity maximum could be seen on the equatorward side of the current. Large salinity differences were found on potential densities from 26.2-27.2 kg m⁻³ that reflected cold, fresh waters of northern origin and warm, salty subtropical waters. Approaching the first meander crest, northward moving water was saltier than southward moving water at the same density on the downstream side of the crest, approaching the first trough. The velocity-salinity covariance was high and consistent with an eddy diffusivity of order 10⁴ m²s⁻². With an assumption of quasi-steady meanders, supported by altimeter results, density advection can be used to infer vertical velocities of 50-100 m/d in the meanders. Ascending water was found to be saltier than the descending water, especially in a potential density range about 26.8 kg m⁻³ within the core of North Pacific Intermediate Water (NPIW)). However, the two patterns of horizontal velocity-salinity covariance and vertical velocity-salinity covariance were not consistent with one another. The mixing of Oyashio and Kuroshio source waters, thought to be critical to the formation of NPIW, is clearly tied to cross-frontal flows within the meandering KE, with Kuroshio water ejected northward as water parcels approach the first meander crest and Oyashio water injected southwards into the flow as parcels approach the first trough.

15. SUBJECT TERMS
Proto-NPIW Flowing, Sea of Okhotsk, Boundary Currents of the NW Pacific, Kuroshio Extension, North Pacific Intermediate Water, Oyashio.

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FINAL REPORT
Grant No. N00014-98-1-0365
(WHOI Project # 13036500)

**Tracing the pathway and transport of proto-NPIW out of the Sea of Okhotsk
and into the boundary currents of the NW Pacific**

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Long-Term Goals

The long-term goal of this project was to understand the process of entrainment, mixing and subduction of low potential vorticity water in the Sea of Okhotsk as it evolved towards a major water mass of the North Pacific: North Pacific Intermediate Water (NPIW)

Objectives

Due to funding limitations, our objective was modified to make detailed measurements of hydrography and velocity from a cable-lowered system within the boundary currents, within the interfrontal zone between the Kuroshio Extension and the Oyashio Front, and within the first semi-permanent meander of the Kuroshio Extension.

Approach

Due to limited funds, our original plan of making extensive Seasoar surveys on a US research vessel was modified and instead we sampled from a Japanese Fisheries Research Vessel using a Lowered Acoustic Doppler Current Profiler (LADCP) in conjunction with a CTD in May/June 1998. The approach was to use these data to define the structure of the meander, estimate vertical motions within the meander, and correlate these with net fluxes of salinity across the front.

Tasks Completed

The LADCP data (WHOI) were combined with CTD data (Japan) and vessel-mounted ADCP data (Japan) and exchanged among all participants. One manuscript (Yasuda, lead author) was written and is under review at JGR Oceans for the combined data in the inter-frontal zone. A second manuscript (Joyce, first author, reference below) was submitted and accepted by JGR Oceans dealing with the Kuroshio Meander Region. It is now in press.

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Results

Using these data and also altimeter data from Topex/Poseidon, we established that the meander was quasi-steady during our shipboard survey. The LADCP and CTD data indicated that significant vertical motion and cross frontal fluxes of salinity were occurring near the meander crest and trough. These were prominent on density surfaces associated with large water mass contrasts and clearly related to NPIW formation by mixing between cold, low salinity water north of the Kuroshio Extension (and coming from the Sea of Okhotsk) and warm, high salinity water in the Kuroshio (of subtropical origin).

Impact for Science

The exchange across the front was localized at certain phases of the meandering flow as NPIW subducted across the Kuroshio Extension. This process is likely to play a prominent role in all mixing across strong currents/fonts in the upper ocean throughout the world ocean.

Relationships to Other Programs

Other efforts in the Gulf Stream (SYNOP) dealing with vertical motion and exchange in meanders are clearly related to our results and guided our analyses.

References

Joyce, T.M., I. Yasuda, Y. Hiroe, K. Komatsu, K. Kawasaki, and F. Bahr. Mixing in the meandering Kuroshio Extension and the formation of North Pacific Intermediate Water, *J. Geophys. Res.*, 106, 4397- 4404, 2001.