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14. ABSTRACT
We seek to understand shelf and shelf-edge phenomena associated with regional-scale currents, buoyancy forcing, wind forcing and mesoscale variability. We thus carried out a set of highly resolved physical oceanographic measurements off the northwestern coast of Australia during June-July, 2003. Among other sampling approaches, our primary sampling tool was the SeaSoar towed undulating platform which allows rapid, highly resolved sampling. During austral winter, winds were weak, but the air was dry and warm, so as to create very strongly evaporative conditions. Our measurements resolved a persistent and efficient means of transporting salty shelf water into the ambient ocean. Large scale and smaller scale surveys document a large scale alongshore salinity gradient (evidently caused by a combination of evaporation and alongshore advection), as well as unique eddy field at the shelf break that has two independent layers of small-scale eddies. Detailed surveys on the inner shelf elucidate cross-shelf exchanges driven by surface evaporation.

15. SUBJECT TERMS
shelf and shelf-edge phenomena, regional-scale currents, buoyancy forcing, wind forcing, mesoscale variability

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Dynamics of the Northwest Australian Shelf and Slope

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LONG-TERM GOALS

We seek to understand shelf and shelf-edge phenomena associated with regional-scale currents, buoyancy forcing, wind forcing and mesoscale variability. We are most concerned about the dynamically active "contact zone" between coastal and oceanic waters and how it is affected by phenomena both offshore and onshore.

OBJECTIVES

The shelf offshore of northwestern Australia has been chosen for the area of concentration. This region is particularly interesting because of the important role played by buoyancy forcing (evaporation, hence cooling and salinization: Shearman et al., 2007) over the shelf and because it is the believed to be the area in which the poleward-flowing shelf-edge Leeuwin Current forms (Holloway, 1995). An added level of interest is provided by the extremely high-amplitude M_2 tides that are found in this area (Holloway, 1984). An added level of interest is provided by the recent development of ideas on buoyancy arrest of bottom boundary layers (Trowbridge and Lentz, 1991) that invalidate the generally accepted ideas about dynamical balances within the Leeuwin Current (Thompson, 1987).

We thus carried out both observations and analysis activities that will lead to a new understanding of 1) mesoscale variability associated with the shelf-edge Leeuwin Current (Brink and Shearman, 2006; Brink et al., 2007), 2) how evaporative forcing affects variability and water mass composition (Shearman et al., 2007), and 3) the dynamical balances in the Leeuwin Current itself.

APPROACH

In-situ observations (Brink and Shearman), including currents, temperature and salinity, are used to characterize shelf and slope conditions during the austral winter (dry season) northwest of Australia. High resolution in both space and time were required in order to fully characterize structures in terms that include time variability and spatial scales

TASKS COMPLETED

During 2003, a 29-day cruise (Port Hedland to Darwin) then took place during June and July 2003 (roughly over 118-122° E, 15-20° S: figure 1). An ADCP mooring was deployed for 26 days near the 150m isobath north of Port Hedland (about 118° W), and an intensive 3-line CTD survey was carried out in order to establish regional scale structures. A regional scale SeaSoar survey (0-200m depth, or to within 10m of the bottom) was then carried out, followed by repeated mesoscale surveys near the mooring. Finally, Minibat surveys of temperature and salinity were made in shallower shelf waters in order to characterize the energetic small-scale (1-5 km) variability associated with surface cooling. Data processing and quality control are presently completed.

Data analysis and synthesis are completed, and manuscripts are either published (Brink and Shearman, 2006; Brink et al, 2007) or being prepared for submission (Shearman et al., 2007). Three coordinated presentations were given at the Fall, 2004 AGU meeting, and a poster presentation was made at the 2005 Gordon Conference on coastal oceanography. Seminars have been given on this work at Woods Hole and Oregon State.

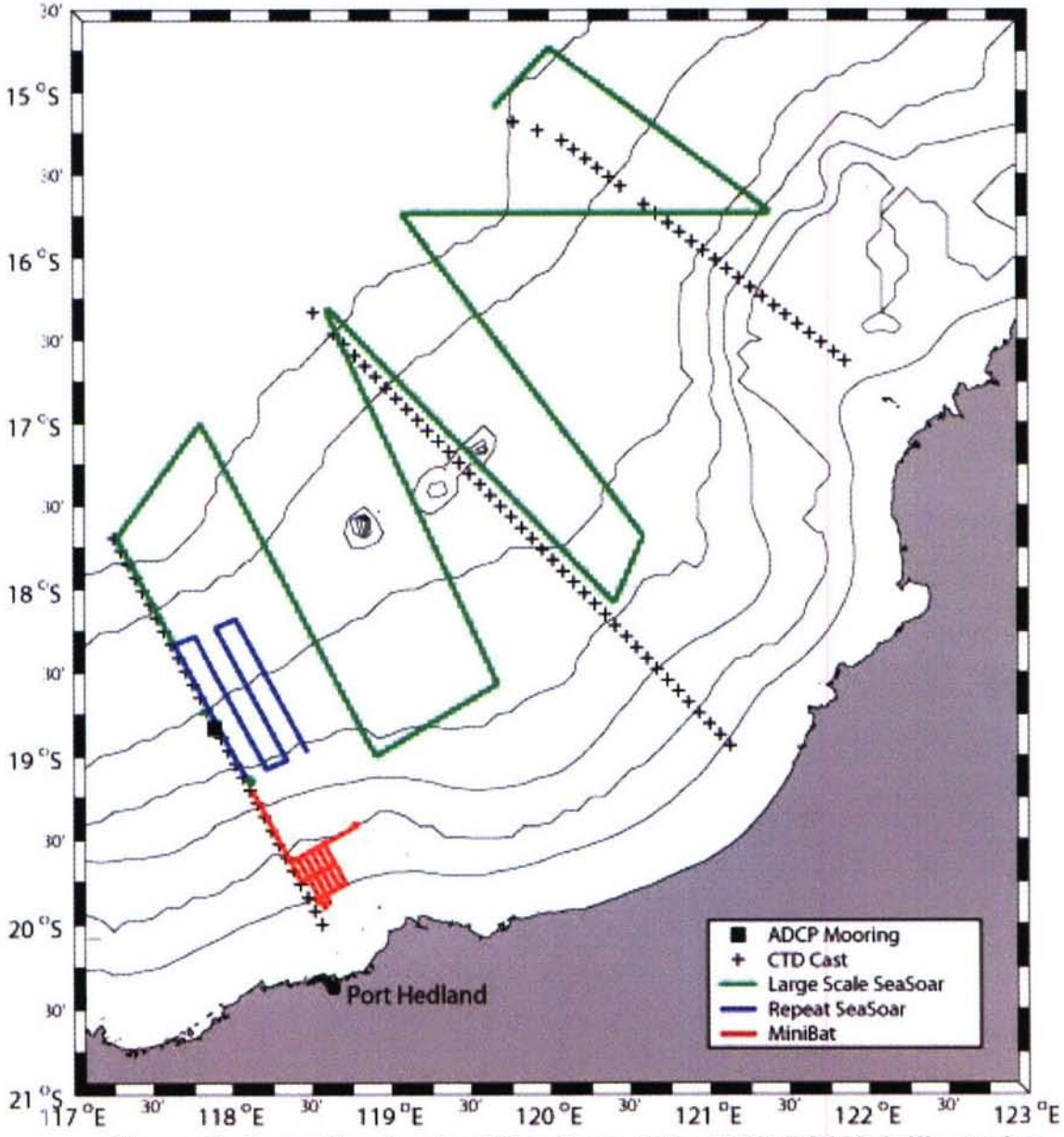

Figure 1: Sampling track of the June-July, 2003 R/V Melville cruise.
[Green and blue: SeaSoar sampling, red: Minibat, + : CTD stations, Black dot: Mooring]

RESULTS

Waters at all depths were found to become increasingly salty towards the west, and a shelf edge jet, identified with the Leeuwin Current, was found as far east as 122° E, but the system was subject to time variability. During repeated, shelf edge surveys, a bottom-trapped, meandering northeastward flow was found instead for 9 days. The direction of the alongshore flow appeared to control the bottom Ekman transport, hence the extent to which salty shelf waters extended offshore from the shelf break. It appears that the combination of evaporation-driven densification

and shelf bottom Ekman transport allows an important and efficient means for transport of shelf waters into the deeper ocean (Brink and Shearman, 2006).

Mesoscale variability near the shelf edge was energetic and persistent. Study of repeated surveys show that the observed eddy flows has a large ageostrophic component (Brink et al., 2007).

Intense evaporation over the inner shelf gave rise to cooler, saltier waters over the inner shelf and relatively deep (10s of meters) surface mixed layers at all locations. The inner half over the shelf was characterized by strong features on spatial scales of 5 km or less, including strong fronts (figure 2). These dynamical features appear to be consistent with those expected in a shelf region where surface buoyancy fluxes cause densification, as in high-latitude wintertime settings.

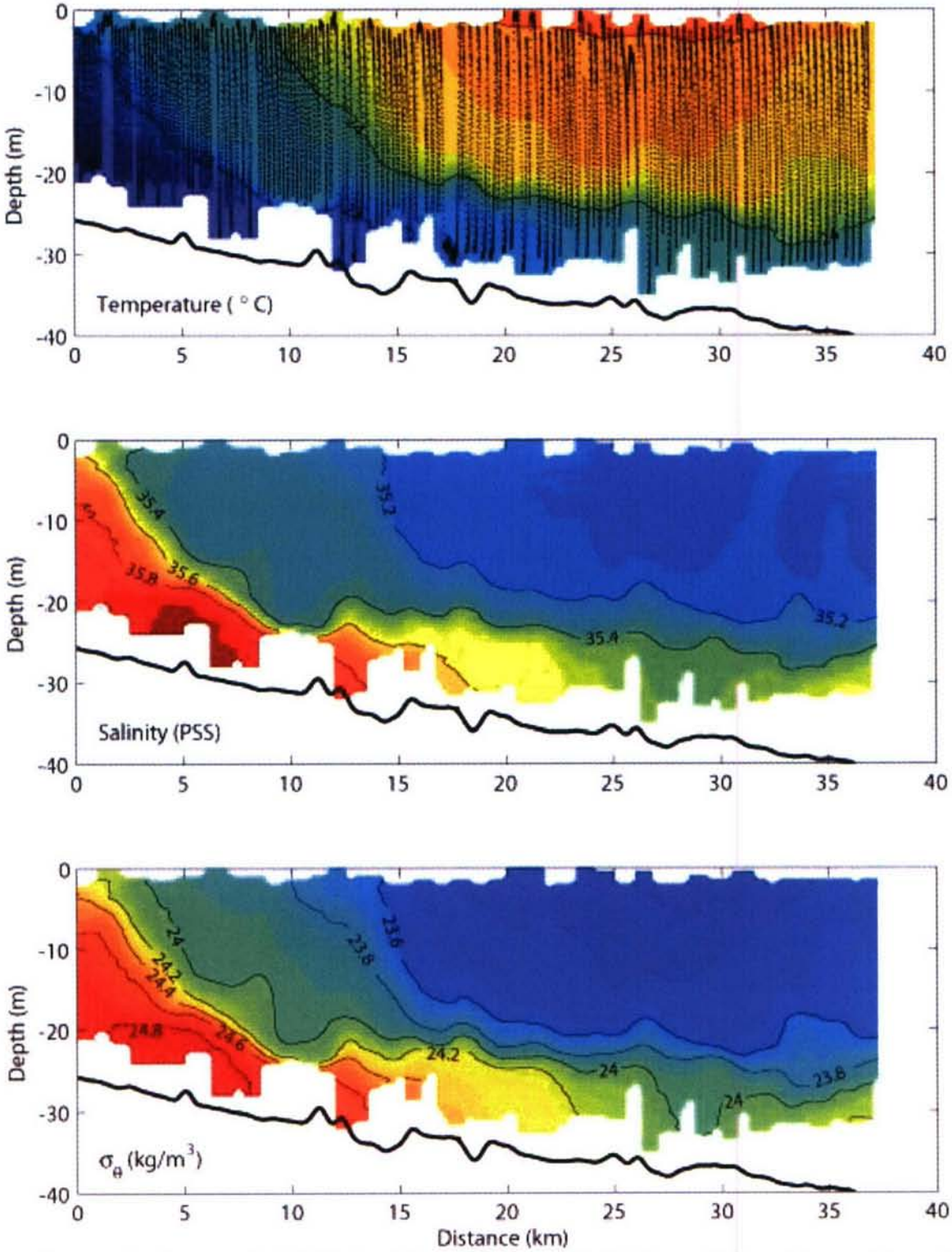

Figure 2: Cross-shelf Minbat Temperature, Salinity and Density sections from July 11, 2003 from the inner shelf (the red area in figure 1)

IMPACT FOR SCIENCE

We believe that our results regarding evaporative forcing are applicable to a number of continental shelves where surface fluxes make waters denser, such as adjoining desert regions (such as off the Arabian peninsula), and high-latitude settings. Our results with regard to shelf edge mesoscale variability are be applicable (or at least comparable) to a number of regions with broad shelves and shelf-edge currents such as the Mid-Atlantic Bight.

RELATIONSHIPS TO OTHER PROGRAMS

This work supplements the NSF-sponsored INSTANT program that studied the Indonesian throughflows (Dr. A. Gordon, LDEO, contact). Dr. Paula Coble's (USF) group participated in our cruise, studying colored dissolved organic material.

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