SHELF-BASIN EXCHANGE VIA BOUNDARY CURRENT INSTABILITIES

Robert S. Pickart and Albert J. Plueddemann, Woods Hole Oceanographic Institution, 360 Woods Hole Road, Woods Hole, MA 02543 USA; rpickart@whoi.edu, aplueddemann@whoi.edu

We are interested in the broad topic of ventilation of the interior ocean via boundary currents. This process is of particular interest in the Arctic where the halocline is presumed to be ventilated by exchange with water originating on the Arctic shelves. The problem is made difficult by the fact that the dynamics of dense water formation, say on the shelf or the upper slope, are intimately coupled to the dynamics of western boundary currents in general. Thus, in order to fully understand the issue of high latitude shelf/slope exchange, it will be necessary for the SBI program to consider various components of the system simultaneously, from the shelf to the deep ocean. Our specific interests involve the role of the ambient shelfbreak circulation, as well as deep slope currents, in driving cross-slope exchange between shelf and basin.

We feel that the lessons learned from the study of boundary current variability and ventilation at subtropical and subpolar latitudes can be applied to the Arctic shelf/slope exchange problem. Two issues seem to be of particular importance in enabling the boundary to communicate with the open ocean: variable topography and deep slope currents. For example, alongslope variations in bathymetry (say weakly convergent isobaths) can impact to first order the dynamics of shelfbreak jets, inducing secondary circulations that span the entire water column. This in turn influences the stability characteristics of the jet, and hence cross-slope exchange. Presently it is unclear how the process of dense water formation on the shelf dynamically impacts this type of exchange. For example the dense water may only play a passive role (e.g. such as a tracer), or it may play a central dynamical role (e.g. in establishing a seasonal shelfbreak frontal jet).

Another important aspect is the ability of deep-reaching slope currents, situated offshore of the shelfbreak, to drive cross-slope exchange. For example, it remains unclear if newly ventilated Arctic shelf water can escape the shelf "under its own power" (even with an ambient shelfbreak jet present). While models have been successful in generating dense water eddies, the models have not provided a mechanism for such eddies to propagate offshore---and hence populate the interior basins. Again observations from outside the Arctic provide useful insights. For example, instability of the deep slope current in the Labrador Sea couples with the shelfbreak circulation in forming boundary eddies that subsequently populate the interior Labrador basin.

The nature of the boundary current system in the Arctic is not well known. However, the evidence to date suggests that all of the components are there---shelfbreak frontal jets, deep slope currents, strongly varying topography---to drive exchange processes similar to those found in other shelf/slope systems. We are interested in pursuing the notion that topography, shelfbreak jets, and deep slope currents play a fundamental role in the shelf/open-ocean interactions of the Arctic. As dictated by our previous work, this will require measurements of high cross-slope resolution, both in space and time. Such an approach will benefit greatly from collaborative efforts.