SHELFBREAK PROCESSES AND ARCTIC SHELF-BASIN INTERACTIONS: TOWARDS A PAN-ARCTIC VIEW

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Shelf-basin interaction fundamentally involves exchange processes between the continental shelf and slope. A crucial area for exchange is the shelfbreak, where there is a large change in bottom slope, and may be large changes in stratification and currents. Exchange processes in many theories are dependent on gradients across the shelfbreak, which in turn are affected by changes on either the shelf or the slope. There are a wide variety of potential forcing mechanisms which affect the gradients and hence the exchange processes.

On the shelf side, throughflows, buoyancy inputs, and boundary layer processes affect cross-shelf exchange. Advective through-flows on the Barents Sea and Chukchi shelves can result in changes in the water mass properties over the shelf. A crucial aspect of these inflows is the strong degree of topographic control. Current systems tend to align along constant f/H contours, where f is the Coriolis parameter and H is the water depth. A striking example of this occurs in the Barents Sea where time-series of current motions near Novaya Zemlya are unidirectional (Loeng et al., 1993). For proper modeling of these shelves, a good knowledge of the bathymetry is crucial in defining regions which might be topographically isolated, such as banks and depressions, as well as giving insight into areas where currents may bifurcate (e.g. Gawarkiewicz and Plueddemann, 1995). Monitoring of key choke points, such as Bering Strait and Fram Strait, is clearly important in defining the role of advective inputs in generating shelf-wide temporal variability in water mass structure and current systems.

Second, the role of buoyancy inputs over the shelves is also important. River run-off and its subsequent cross-shelf transport is important in defining local stratification over the shelf as well as influencing surface mixed layer salinities offshore. Similarly, negative buoyancy inputs associated with coastal polynyas are important in generating saline water masses which contribute to various halocline water masses within the Arctic basins (e.g. Weingartner et al., 1998; Winsor and Bjork, 2000). The water mass contrasts resulting from the modified water masses over the shelves offers the possibility of frontal systems, including energetic frontal jets, and the generation of eddy fluxes.

Third, the shallow depths over many of the Arctic shelves means that frictional surface and bottom boundary layers are a significant fraction of the water column. This is particularly important at the shelfbreak, where lateral velocity shears generate boundary layer convergences and divergences that result in possible upwelling/downwelling zones.

Over the slope, the structure and temporal variability of the boundary currents should be an important factor in shelf-basin exchange. The maximum velocity and the width of the boundary currents are important in setting the stability properties of the flows at the shelfbreak (e.g. Lozier et al., 2000). The stability properties of the boundary currents are useful in helping to determine whether eddies composed of shelf water derive from shelf processes (such as local topography or coastal current instabilities, as in D'Asaro, 1988) or may derive from instabilities and eddy processes locally at the shelfbreak. The difference between local shelfbreak formation versus mid-shelf or coastal origin may have significant implications for biogeochemical sampling as well as carbon flux off of the shelves.

Finally, are there preferred sites for exchange? This is a fundamental question as we eventually try to scale results from individual process studies, which might be in a 100 km by 100 km area, to the entire Arctic shelf-basin system.

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