Abstract View

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The Formation and Maintenance of Density Fronts on the U.S. Southeastern Continental Shelf during Winter

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ABSTRACT

Density fronts on the U.S. southeastern continental shelf, during winter, am formed by (i) breakdown of the shelf-break front by Gulf Stream meanders or strong southward winds or both, (ii) shoreward intrusion of upper Gulf Stream warm water by persistent southward winds, and (iii) mixing of this warm water with continental shelf water cooled by cycles of cold air outbreaks. A cross-shelf and depth, time-dependent numerical model, which includes a model Gulf Steam and vertical mixing calculated according to a second-moment, turbulence closure submodel, was used to study physical process involved in the formation and maintenance of continental shelf fronts. Model results using somewhat idealized atmospheric forcings suggest that three or more winter storms are required to establish fronts on the midshelf. Otherwise, the front is situated just inshore of, and is sometimes indistinguishable from, the shelf-break front. Once formed, the front is maintained by southward winds, which transport warm water converging at the front and prevent frontal weakening by balancing seaward advection of cooler water at the foot of the front with downward turbulent diffusion of warmer water. Mean along-front flow is about 5 cm s^{-1} northward, opposing the wind, and should contribute to the persistent northward flow observed on the continental shelf during winter. Model results agree qualitatively with available hydrographic data.

One- and two-dimensional model simulators were performed for a two and a half month period during winter 1983/84 when wind, air and water temperature data available at a nearshore ocean station. Simulated circulation and density structures confirm the idealized run. Calculated temperature variations agree fairly well with observations, except for a discrepancy during a warm period from 1–18 December 1983, when incident solar radiation (minus longwave back radiation), neglected in the model, was significant.

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