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Cross-Front Mixing and Frontal Upwelling in a Controlled Quasi-Permanent Density Front in the Gulf of St. Lawrence

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ABSTRACT

CTD data obtained from three transects across a controlled quasi-permanent density front in the Gulf of St. Lawrence were analyzed for the purpose of investigating cross-front mixing, mechanisms for frontal convergence, secondary circulation induced by the front and relationship between surface mixed-layer properties and frontal structure. Water mass analysis indicates that mixing takes place mainly in the ambient water, from the lower boundary of the frontal layer down to ~ 100 m. On the side of heavier water, there is a region of low surface temperature. The water masses have a distribution suggestive of upwelling in the low surface temperature region. The thickness of the surface mixed layer varies across he front. Outside the frontal zone there is a well-developed mixed layer of a thickness of about 25 m. It disappears completely in the low surface temperature zone and is re-established in the frontal layer with a reduced thickness. Horizontal intrusions below the frontal layer and interleaving of thin layers in the intermediate cold layer (40–100 m) were observed. A cross-front circulation is proposed to explain the observations. Two mechanisms to generate the cross-front flow and upwelling, i.e. the centripetal acceleration of water parcels flowing along a curved density surface and suction of subsurface water by an internal Ekman flow beneath the frontal layer, are discussed.