Abstract View

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The Response of Intense Oceanic Current Systems Entering Regions of Strong Cooling

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ABSTRACT

The three-dimensional response of strong currents to cross-stream gradients of surface cooling is studied using numerical simulations. In particular, surface cooling is explored as a possible mechanism for explaining an observed 100 km southward shift in the mean position of the Gulf Stream during winter. The cooling increases in the downstream direction and in the direction of highest sea surface temperatures. In the immediate vicinity of the concentrated horizontal temperature gradient associated with the strong current system, most of the flow changes are induced by the cross-stream cooling gradient. The magnitude and direction of the cross stream circulation is highly dependent on whether or not a vertical mixing of momentum occurs when the water column convectively adjusts in response to the surface cooling. A weak cross-stream flow toward the higher sea surface temperatures occurs in the surface layer if momentum mixing does not occur, whereas a stronger flow toward lower sea surface temperatures results if momentum mixing does take place. In regions where the vertical shear is not large, the responses in the flow fields are due solely to the alongstream pressure gradient induced by the prescribed alongstream cooling gradient. The cross-stream response due to horizontal cooling gradient is not large enough to displace the Gulf Stream appreciably southward in any of the numerical simulations. By contrast, a moderate increase in the zonal wind stress is more effective in displacing the core of a strong current system than are very strong gradients in the surface cooling.