THE ROLE OF VERTICAL MOTION IN THE HEAT BUDGET OF THE UPPER OCEAN

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ABSTRACT

The heat budget of the upper ocean was studied to determine the importance of including heat changes due to vertical motion and divergence. In this study, bathythermograph observations in the eastern Pacific were used to form time series of monthly average thermal structure at ocean weather station November (30°N, 140°W) and various 5° and 2° squares between California and Hawaii. Correlations between heat content in a 250 m-thick layer and temperatures at various depths suggest that surface heat exchange, indicated by surface temperature changes, is at the mean annual time scale the most important factor in determining heat content changes. At the anomaly time scale, heat content changes are chiefly related to heat changes occurring at depth indicated by temperature changes at 200 meters. The heat changes at depth are caused by vertical motion which is related by continuity to horizontal flow divergence. A heat budget equation is derived that includes a term to account for heat changes due to vertical motion and hence divergence. The accuracy of surface heat exchange computations and the definition of heat content are considered. All the terms in the derived heat budget equation are computed, except the term representing horizontal advection. Correlations between the known terms show a stronger relationship between surface heat exchange and heat content change when the

heat changes due to vertical motion and divergence are included. The ratio of the mean square difference between surface heat exchange and heat content change to a similar difference between surface heat exchange and the heat content change including vertical motion shows about a 50% improvement when heat changes due to vertical motion are included.