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LAGRANGIAN FLOATS FOR DEEP CONVECTION

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LONG TERM GOALS

I aim to understand the process of deep convection in the ocean.

OBJECTIVES

Near surface water is mixed to great depth at a few high latitude locations, thereby forming the deep and bottom masses of the ocean. This proposal supports the development and deployment of neutrally buoyant floats which will accurately follow the three-dimensional motion of water parcels in these regions of Deep Convection, and the deployment of these floats in the Labrador Sea in the winters 1997 and 1998. During deep convection, the floats move vertically with the convective motions, thus directly measuring where, when, how and how fast the surface water is converted to deep water.

APPROACH

The floats to be used are a variant of existing instruments, but designed for longer duration and deeper depths. They accurately follow water motions through a combination of a density which matches that of seawater and a high drag. The density is matched to that of the ambient water by actively changing the float's volume and will stay matched, despite changes in pressure and temperature, through a combination of active control and a hull compressibility which is close to that of seawater. High drag is achieved through a large circular drogue attached to the float. The horizontal motion of the float is determined by acoustic tracking (RAFOS) and its vertical motion is determined from pressure. Data is relayed at the end of the 2 month mission via satellite (ARGOS).

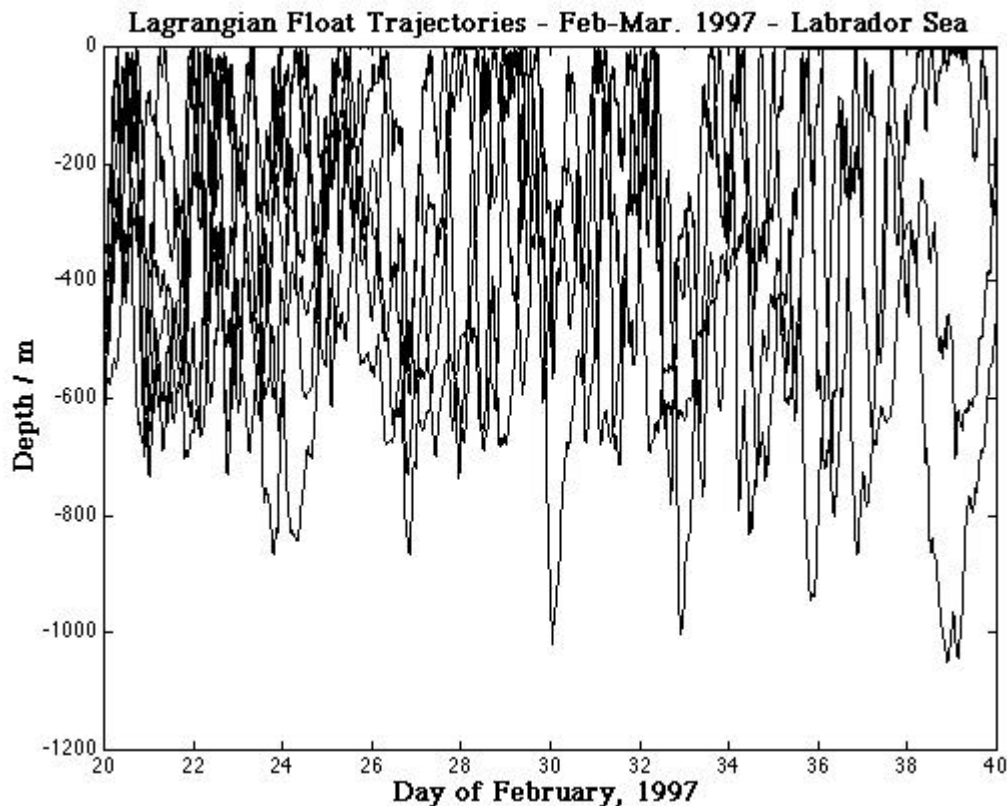
ACCOMPLISHMENTS

13 floats were deployed in February, 1997 in the Labrador Sea. Of these, 11 returned full data records. 3 floats were recovered, 2 by fishermen, and returned to APL for diagnosis. Overall, the floats worked very well. Several technical problems were found and we expect even better performance in the winter 1998 deployments.

SCIENTIFIC/TECHNICAL RESULTS

The Figure 1 shows depth/time data from all of the floats. A convectively mixed layer extending from the surface to about 700m is evident. For 20 days the floats cycle the floats cycle across this layer, with speeds often exceeding 10 cm/s. The depth of the convecting layer appears to be set by the intrusion of Irminger Sea water at this depth.

Occasionally, the floats descend through this barrier, reaching depths of about 1 km. Two



excursions to 1000 m occur. The rms vertical velocity of 2.3 cm/s is approximately that expected for convection with typical heat fluxes. Temperature measurements on the floats clearly show a vertical heat flux comparable to that expected.

Overall, the data clearly show strong mixing to 700m and intermittent mixing to 1 km. The mixing time, equal to the time for a float to traverse the layer, is about a day.

IMPACT FOR SCIENCE

These direct measurement of the vertical velocity and temperature fluctuations associated with deep convection will allow direct comparisons with theory and numerical models. The successful development of long-lived autonomous Lagrangian floats should allow similar measurements in a variety of strongly mixing regimes in both the Littoral and open ocean.

RELATED PROJECTS

These floats are close relatives of those used to study mixing in the Littoral zone and upper ocean mixed layer funded by ONR 322PO. Mixing processes in these various environments are similar in many ways and we learn the most by comparing and contrasting them.