Geophysical Research Abstracts
Vol. 13, EGU2011-4466, 2011
EGU General Assembly 2011

On the structure and dynamical features of interleaving in the Arctic Ocean

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Numerous CTD data obtained in the Arctic Basin are analyzed to describe structural features of intrusive layering. Special attention is paid to large intrusions (vertical size of 40-100 m) observed in upper, intermediate, and deep layers (depth range of 150-200 m, 200-600 m, and 600-1000 m, accordingly). The analysis of the intrusions is accompanied with descriptions of frontal zones where the layering was observed. Fronts in the Arctic Ocean were shown to be either purely thermohaline or essentially baroclinic ones, and the intrusive layering was characterized by a wide diversity of forms and length scales. Based on observations, detailed estimates of frontal zone parameters are presented.

Vertical profiles of temperature and salinity are stressed to have a well-defined “saw-tooth” or “cog” shape displaying a sequence of relatively thick, weak-gradient layers where temperature and salinity are decreasing with depth interleaved with relatively thin, high-gradient sub-layers where temperature and salinity are increasing with depth. Some hypotheses about causes responsible for cog structure existence are discussed.

Intrusive layering observed in regions stably stratified in both salinity and temperature are considered in order to estimate the effect of baroclinicity on the intensity of the interleaving. Intrusions with high amplitude anomalies in the vertical profiles of temperature and salinity are shown to be present at baroclinic fronts, and the layers dominated by intrusions can be as thick as 600-800 m. Two equally possible mechanisms for creating interleaving at the stable-stable stratification can be proposed: instability due to differential mixing (DM) or due to double-diffusive (DD) fluxes. Necessary condition of DM-instability is the existence of thermohaline fronts and some background of turbulence, which should not be too high. Presence of strong fronts, initial disturbances of finite amplitude and the lack or weakness of turbulent mixing is essential for DD-instability at stable-stable stratification.

In all cases of our observations it was concluded that warm and saline cold and fresh) intrusions crossing the front sink (rise) relatively to isopycnals.

Based on models of interleaving and data analysis the apparent vertical and lateral diffusivity in the frontal zones of the upper and deep ocean layers are estimated, and the slope of unstable modes relatively isopycnals is examined in the situation when both temperature and salinity are stably stratified.

In a view of weak internal waves activity, the small beta-effect and restricted interactions between ocean and atmosphere (due to ice cover) interleaving in the Arctic Ocean may be considered as an important mechanism for water mass exchange and mixing. It is slow, but always present.