Geophysical Research Abstracts
Vol. 19, EGU2017-12482, 2017
EGU General Assembly 2017

Dynamics of a vertical turbulent plume in a stratification typical of Greenland fjords: an idealized model of subglacial discharge

Erik Stenberg (1), Ekaterina Ezhova (2), Claudia Cenedese (3), and Luca Brandt (1)

(1) Linne FLOW Centre and SeRC (Swedish e-Science Research Centre), KTH Mechanics, Stockholm, Sweden, (2) Department of Physics, University of Helsinki, Helsinki, Finland, (3) Physical Oceanography Department, Woods Hole Oceanographic Institution, Woods Hole, USA

We the report results of large eddy simulations of a turbulent buoyant plume in a configuration providing an idealized model of subglacial discharge from a submarine glacier in stratifications typical of Greenland Fjords. We neglect a horizontal momentum of the plume and assume that its influence on the plume dynamics is small and important only close to the source. Moreover, idealized models have considered the plume adjacent to the glacier as a half-conical plume (e.g., [1]). Thus, to compare the results for such plume with the classical plume theory, developed for free plumes entraining ambient fluid from all directions, it is convenient to add the second half-conical part and consider a free plume with double the total discharge as a model. Given the estimate of the total subglacial discharge for Helheim Glacier in Sermilik Fjord [2], we perform simulations with double the total discharge in order to investigate the dynamics of the flow in typical winter and summer stratifications in Greenland fjords [3].

The plume is discharged from a round source of various diameters. In winter, when the stratification is similar to an idealised two-layers case, turbulent entrainment and generation of internal waves by the plume top are in agreement with the theoretical and numerical results obtained for turbulent jets in a two-layer stratification. In summer, instead, the stratification is more complex and turbulent entrainment is significantly reduced. The subsurface layer in summer is characterized by a strong density gradient and the oscillating plume generates non-linear internal waves which are able to mix this layer even if the plume does not penetrate to the surface. The classical theory for the integral parameters of a turbulent plume in a homogeneous fluid gives accurate predictions of the plume parameters in the weakly stratified lower layer up to the pycnocline.

[1] Mankoff, K. D., F. Straneo, C. Cenedese, S. B. Das, C. D. Richards, and H. Singh, 2016: Structure and dynamics of a subglacial discharge plume in a Greenland Fjord. *J. Geophys. Res.*, **121**, doi:10.1002/2016JC011764.

[2] Sciascia, R., F. Straneo, C. Cenedese, and P. Heimbach, 2013: Seasonal variability of submarine melt rate and circulation in an East Greenland fjord. *J. Geophys. Res.*, **118**, 2492-2506.

[3] Straneo, F., R. Curry, D. Sutherland, G. Hamilton, C. Cenedese, K. Vage, and L. Stearns, 2011: Impact of fjord dynamics and glacial runoff on the circulation near Helheim Glacier. *Nature Geosci.*, **4**, 322-327.