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Nordic Seas Water Property Evolution Robert W. Helber, David A. Hebert, Jay F. Shriver, and Alan J. Wallcraft Naval Research Laboratory, Code 7321, Stennis Space Center, MS

Abstract

Cold fresh water from the Arctic and warm salty water from the Atlantic oceans meet in the Nordic Seas where the vertical structure has been evolving in recent decades (Rudels et al. 2012). Because water properties are changing and seawater nonlinearities are stronger at low temperatures and salinities making dynamics subject to thermobaricity and cabbeling, numerical ocean forecasting is more complex. Using the Modular Ocean Model version 6 (MOM6) with both isopycnal layer and z-level coordinates and MIT General Circulation Model (MITgcm) in both hydrostatic and non-hydrostatic mode, we demonstrate a mechanism for watermass formation or modification.

Large Scale Context

Carmack (Deep Sea Research II, 2007): "'downhill' transport of Pacific Water (PW) into the Arctic Ocean and then North Atlantic" provides "supply of freshwater" ... "as intermediate water (IW) and deep water (DW) in "the Nordic Seas (Figure 1).



Figure 1. Carmack, E. C. (2007). "The alpha/beta ocean distinction: A perspective on freshwater fluxes, convection, nutrients and productivity in high-latitude seas." Deep-Sea Research Part II-Topical Studies in Oceanography 54(23-26): 2578-2598.

Thermobaric Instability

Envision an ocean condition where potential density is constant everywhere, but potential temperature and salinity are different above and below the wave interface.



The buoyancy force resulting from thermobaricity is unstable and largest for cold, fresh water. Thermobaric instability is more likely at high latitudes.









High Resolution Layer MOM6 is run with 256 horizontal grid points and 7 isopycnal layers.

Both MOM6 and MITgcm are run with 256 horizontal grid points and 320 vertical grid points in z-level. MOM6 solves the dynamical equations in layer formulation where as MITgcm solves them in finite difference formulation.



High Resolution z-level

Low Resolution z-level MOM6 is run with 64 horizontal grid points and 80 z-levels. distance, km distance, km -0.825 -0.925

References:

- Carmack, E. C. (2007) The alpha/beta ocean distinction: A perspective on freshwater fluxes convection, nutrients and productivity in highlatitude seas, Deep-Sea Research Part II-Topical Studies in Oceanography 54(23-26): 2578-2598.
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- Rudels, B., et al. (2012) The East Greenland Current and its impacts on the Nordic Seas: observed trends in the past decade, Ices Journal of Marine Science, 69(5): 841-851.
- **MOM6** is a layered model with Arbitrary Lagrangian Eulerian (ALE) capabilities originating from the Hallberg Isopycnal Model. See:
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