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The simulation of circulation in the Laptev Sea shelf zone using FVCOM

Model Setup

1. Region selection
- A part of the Laptev Sea
- No amphidromes in the vicinity of the open boundary
- Large enough to trace the distribution of Lena fresh water
- Convenient for modeling

2. GEBCO bathymetry data and NOAA coastline data are used to construct the coastline with the help of cubic b-splines
3. Triangulation of the domain based on the algorithm by Persson and Strang (2004), which allows one:
- To account for complexity of coastlines
- To refine mesh in particular regions
- To resolve bathymetry

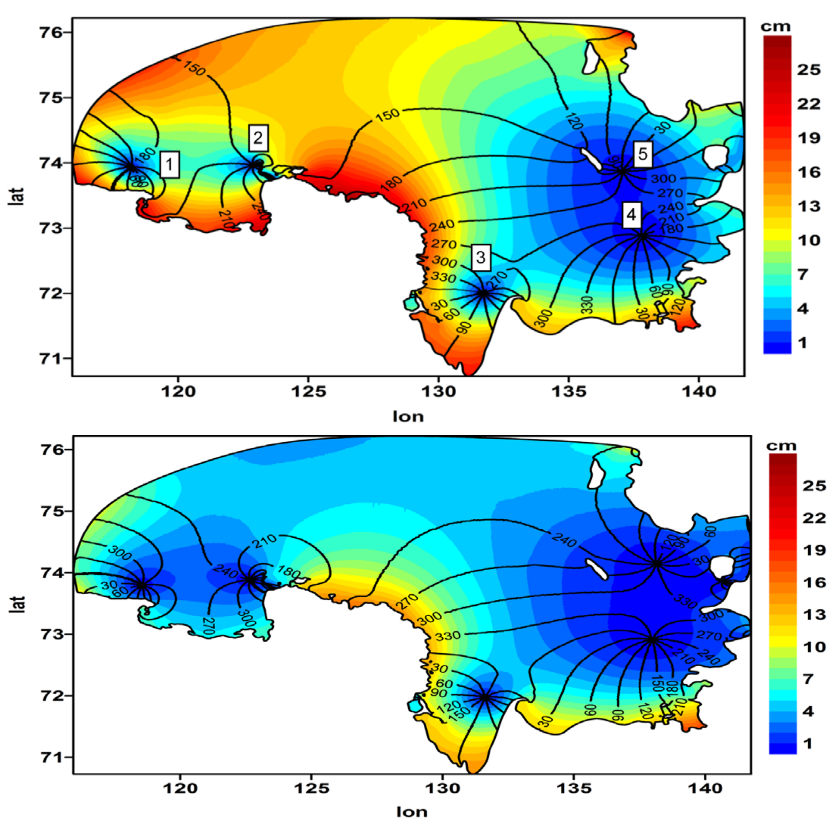
4. FVCOM setup
- 6 vertical sigma layers, 256479 nodes/per layer
- External/internal time steps are 4.6/46 s
- Open boundary: temperature/salinity time series nudging, sponge region for advection/diffusion

Input data

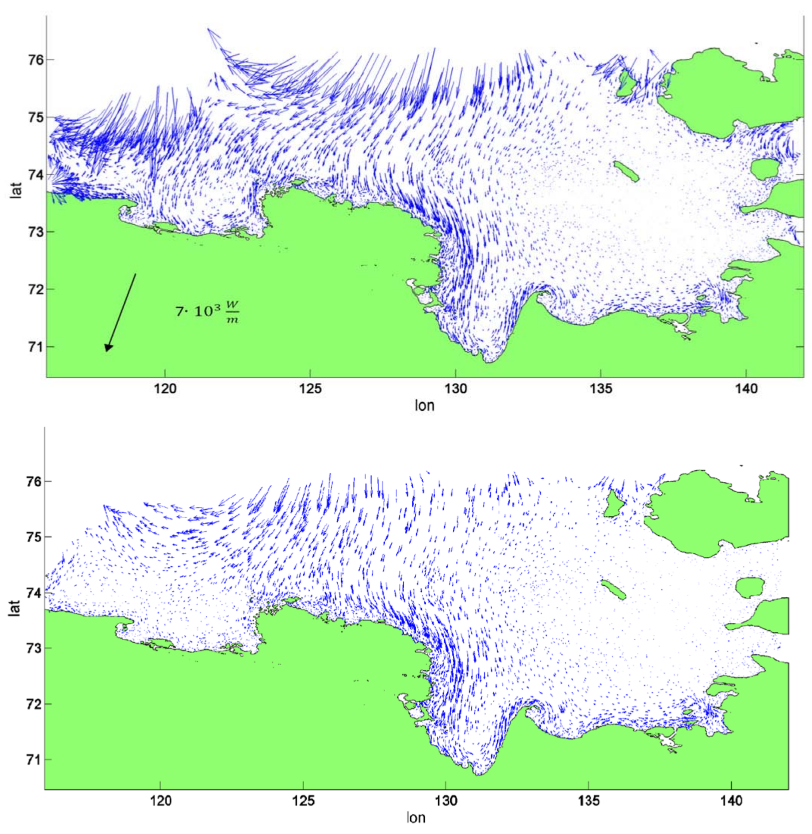
5. Input data
- Bathymetry and coastline data – NOAA, GEBCO and the digitized Soviet map
- Atmospheric data – COSMO model (University of Trier), NCEP Reanalysis 1,2 and ECMWF atmospheric model
- Initial salinity and temperature fields – a coupled Sea/Ice Ocean model (AWI Bremerhaven, R. Gerdes, C. Köberle, P. Itkin)
- Tidal elevation at the open boundary – TPXO6.2, TPXO7.1, AOTIM5 with corrections derived from tidal gauges
- Runoff data/Temperature of runoff – observational data from Kusur station
- Satellite images – MODIS, MERIS products (provided by T. Krumpen, B. Heim, S. Willmes)

Barotropic case

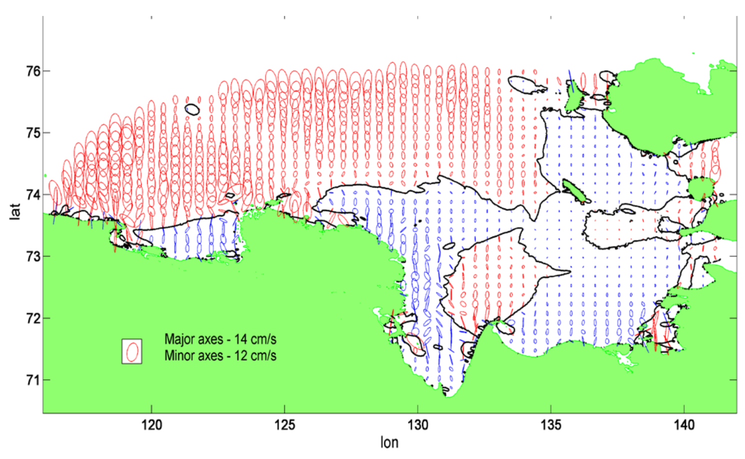
new tidal solution



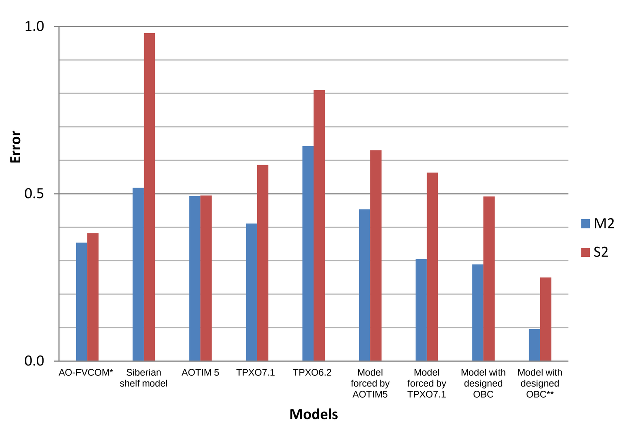
The tidal map for the M2(a) and S2(b) constituents. Simulations use optimal boundary conditions (with corrections).



The flux of tidal energy for the M2(a) and S2(b) constituents. The vectors are shown at every 90th point of the instructed grid.



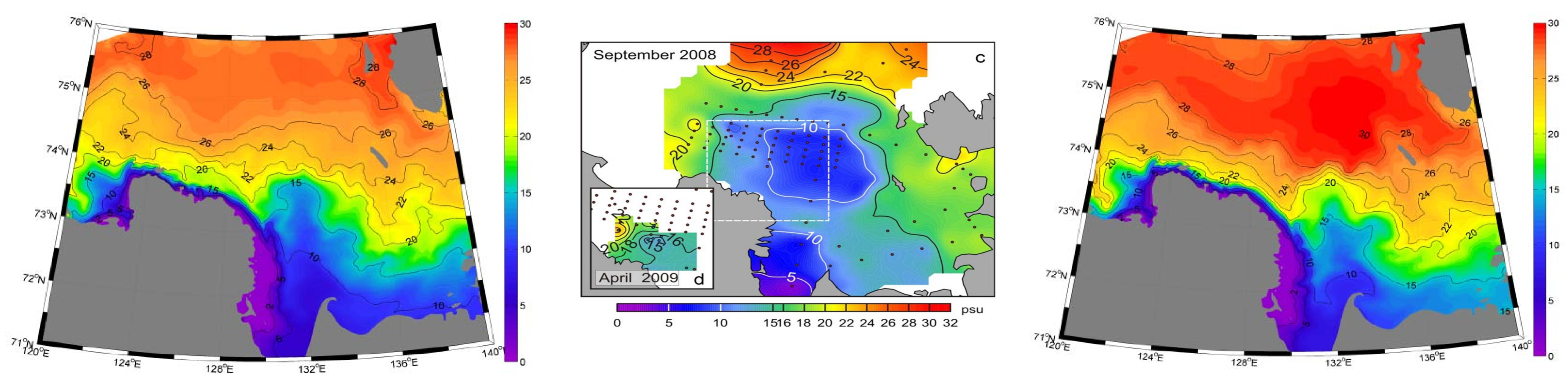
Ellipses of barotropic velocities for the M2 constituent, red/blue correspond to CW/CCW rotation. The parameters of ellipses are interpolated on a regular grid. The black line marks the change in the rotation direction. Simulations use optimal boundary conditions for tidal elevation.



The error of different models against coastal tide gauges for the M2 and S2 constituents. The single (double) asterisc indicates that points where the simulated results have been taken may deviate up to 40(20) km from the station positions provided in source organized by Kowalik and Proshutinsky.

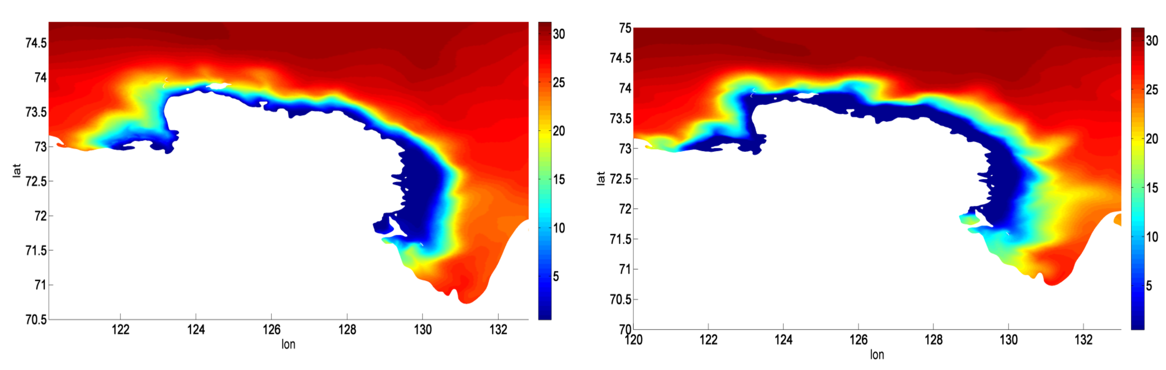
Baroclinic case

model verification

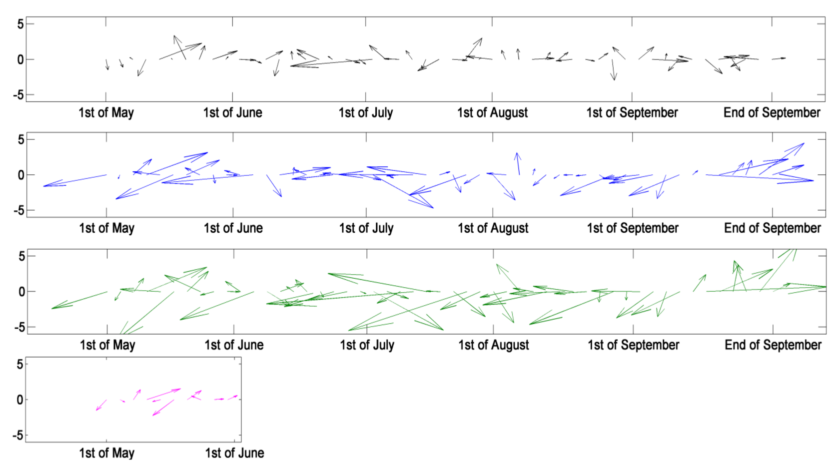


a) b) c)

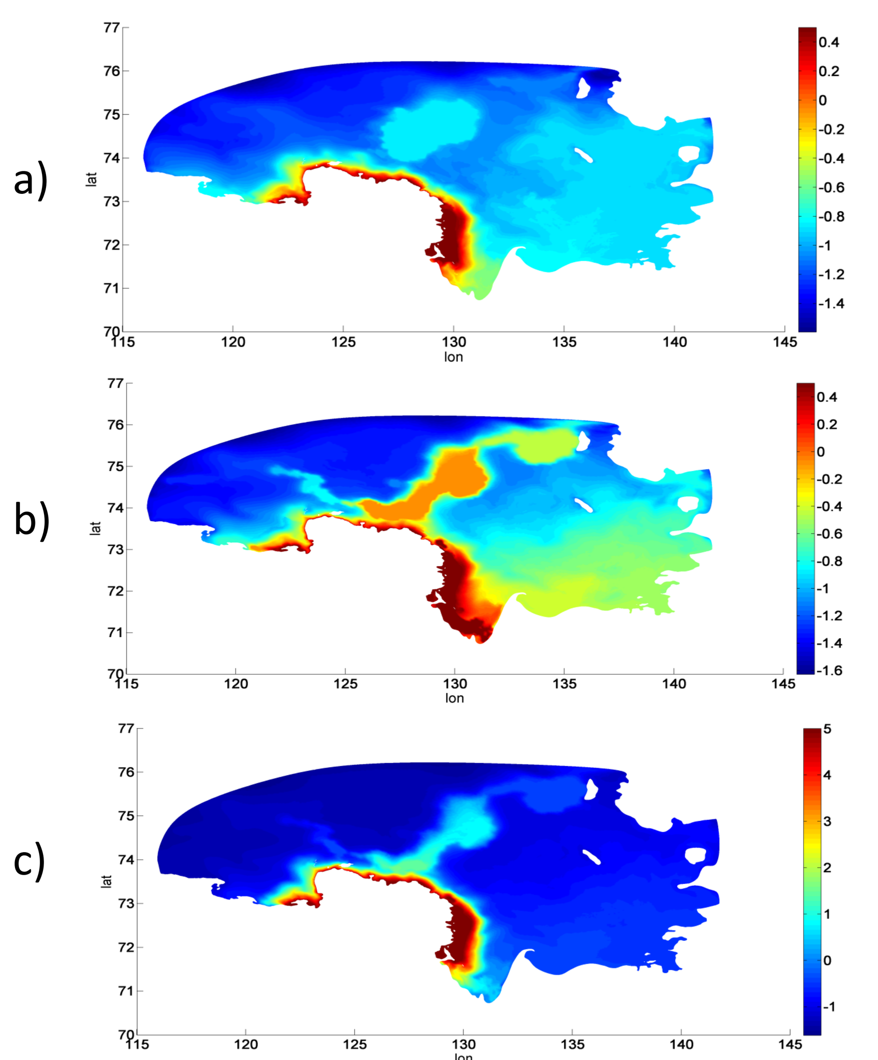
Surface salinity (at 2 m depth) in September 2008 in simulations a) and c), and observations b), adapted from Dmitrenko et al. 2010. Simulations are driven by the ECMWF forcing with a) and without c) the freshwater forcing caused by ice melting. Salinity is in practical scale.



Surface salinity distribution simulated at the end of May 2008. The runoff is implemented as boundary condition (left picture) and as distributed over some vicinity of the boundary (right picture). Salinity is in practical scale.



From top to bottom: the wind direction at the Tiksi hydrometeorological station and in ECMWF, NCEP-DOE Reanalysis 2 and COSMO data.



The surface temperature fields [°C] at the end of May, freshwater runoff input from the boundary:
a) atmospheric forcing from COSMO with polynyas closed by a thin ice layer, the runoff temperature is 0.5 °C;
b) same as in a), but with open polynyas;
c) same as in b) but for the runoff temperature of 5 °C.

References
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3. Rozman P., Hölemann J.A., Krumpen T., Gerdes R., Köberle C., Lavergne T., Adams S., Girard-Ardhuin F., 2011. Validating satellite derived and modelled Sea-ice drift in the Laptev Sea with in situ measurements from the winter of 2007/08. Polar Research 30 (7218).
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