MODELING SPITSBERGEN FJORDS BY HYDRODYNAMIC MIKE ENGINE

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ABSTRACT

Two Svalbard's fjords – Hornsund (on the western side of the most southern part of Spitsbergen island) and Kongsfjorden (also on the western side of Spitsbergen island, but in the northern part) are quite different – the first one is "cold" and second one is "warm". It is obvious that both of them are under influence of West Spitsbergen Current (WSC), which curry out warm Atlantic water and cold East Spitsbergen Current detaches Hornsund. But there is also freshwater stored in Spitsbergen glaciers that have strong influence on local hydrology and physical fjord conditions. Both, local and shelf conditions have impact on state of the fjord and there is no answer which one is more important in each of them.

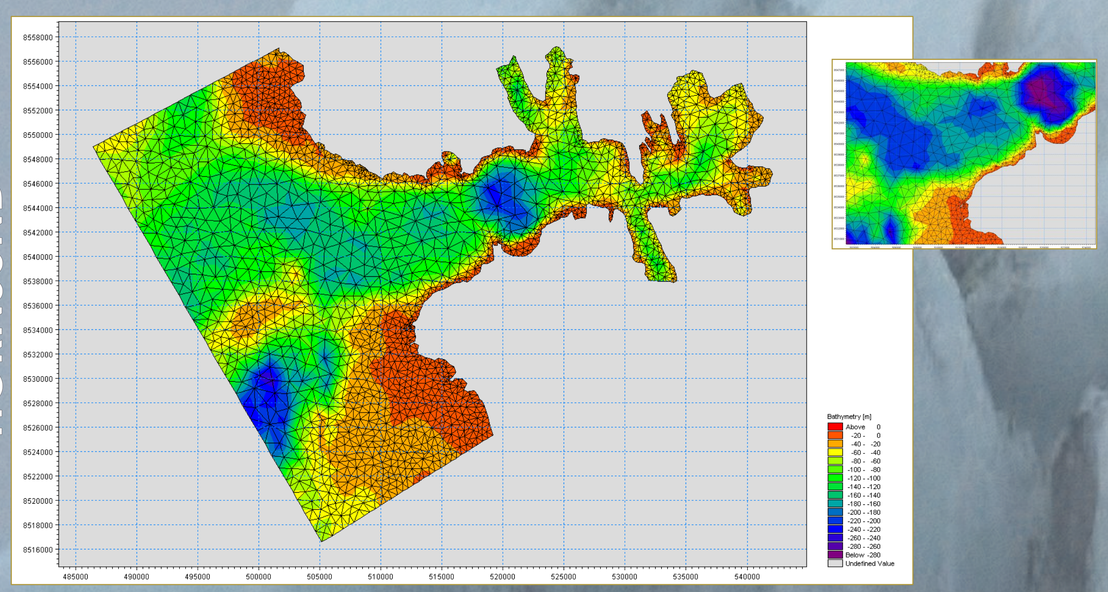
Hydrodynamic model, which main core is MIKE 3D engine has been implemented for both fjords. Mesh-grid of the each fjord has been extended for covering shelf area. External forces like tides, velocities at the boundary and atmospheric forces together with sources of cold and dens fresh water in the fjords will give reliable representation of physical conditions in Hornsund and Kongsfjorden. Calculations of balances between cold fresh water and warm and salty will provide additional information that could help to answer the main question of the GAME (Growing of the Arctic Marine Ecosystem) project - what is the reaction of physically controlled Arctic marine ecosystem to temperature rise.

MODEL DESCRIPTION

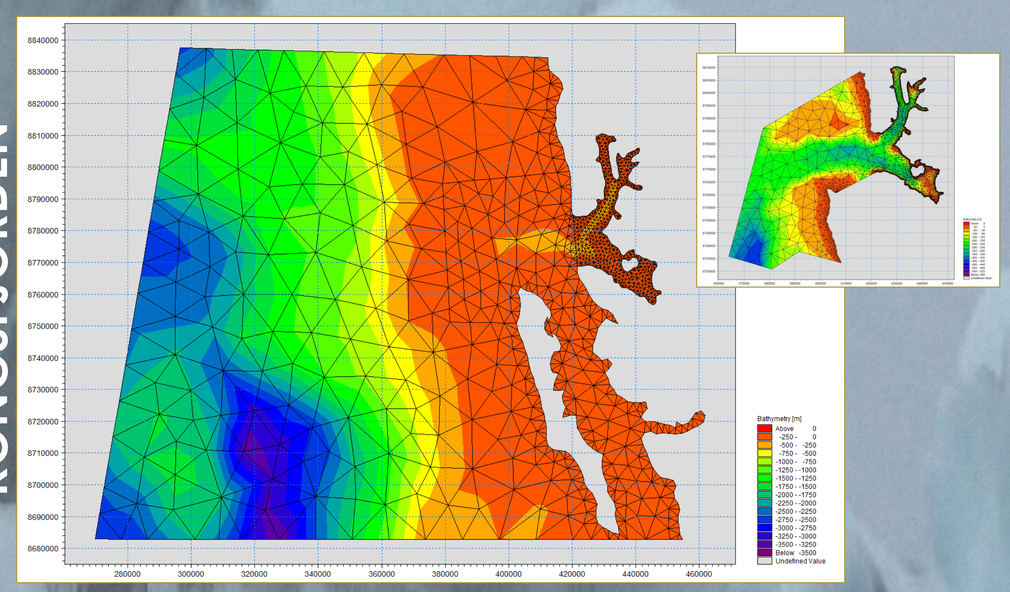
The first and very important step taken in modeling was to decide how to map the area that is not a fjord, but having a significant impact on the dynamics of the flow of water masses in the fjord. We have created three versions of each model for each modeled a different amount of shelf and deep ocean areas. As a next step we have selected revisions which is optimal in terms of accuracy of the solution and the required computation time. The shape of the open model borders was determined by the location of the model grid compute nodes TOPAZ4. With this model in the future it is planned to download the boundary conditions for our model in the form of temperature and salinity in order to maintain temperature balance and the actual amount of salt in the fjords.
The use of flexible mesh as a way of discretization the area of integration allowed for a detailed summary of the shoreline inside and outside of the fjords and prioryzation important areas of domains.
Aspects on which we pay special attention to faithfully reproduce the actual conditions affecting the hydrodynamics fjords are:

- Forced circulaspecific wind conditions.
- The interaction of tion of sea water in the fjords of West-Spitsbergen Current.
- Pay particular attention to areas of the shelf – increase grid density.
- Influence of the sea - ice.
- The influx of fresh water from the melting glacier.
- Mapping fjords gutter - drainage glacial origin.

HORNSUND



KONGSFJORDEN



Bathymetry and chosen variant of discretization for integration area in UTM-31 model coordinates.

MODEL CONFIGURATION

As initial conditions we asked the spatial distribution of temperature and salinity. These data obtained of the Ocean Circulation Laboratory fro m Institute of Oceanology Polish Academy of Science.

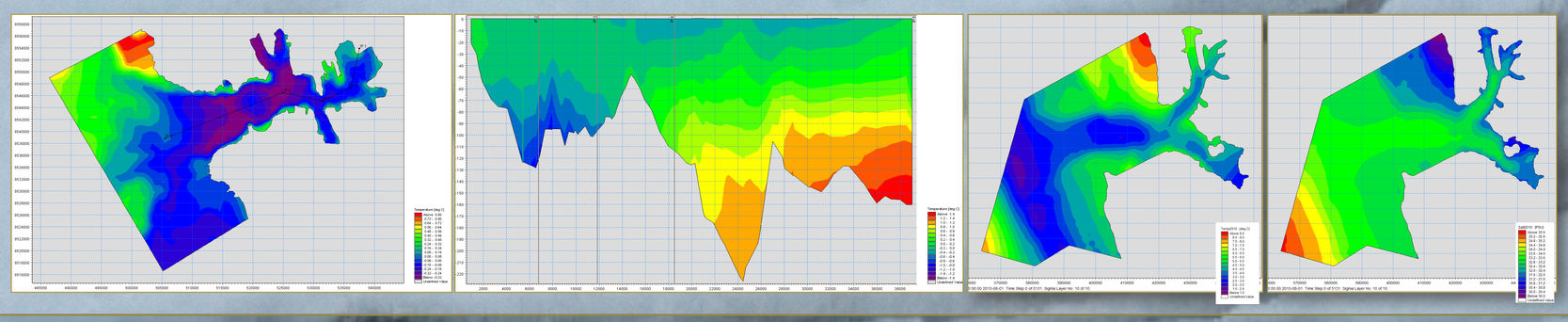
Flather's boundary condition (1976) let us to force the model with combined information. At the same time tidal ordinate and barotropic component of velocity that reflects the West Spitsbergen Current are implemented.

The Flather (1976) condition is very efficient in connection with downscaling coarse model simulations to local areas (Oddo and Pinardi (2007)).
Tidal forces heve been created using the Global Tide Model. The Global Tide Model data pepresents the major diurnal (K1, O1, P1 and Q1) and semidiurnal tidal constituents (M2, S2, N2 and K2) with a spatial resolution of 0.25 ° × 0.25 ° based on TOPEX / POSEIDON altimeters data.

For representation of the impact of West Spitsbergen Current on fjords, barotropic velocity component have been applied in the models.
It was assumed that background constant velocity is 7 cm/s for Hornsund and Kongsfjorden. Only velocity component along the shelf isobaths was taken into account for each fjord.

INITIAL CONDITIONS

Initial temperature and salinity (IOPAS)

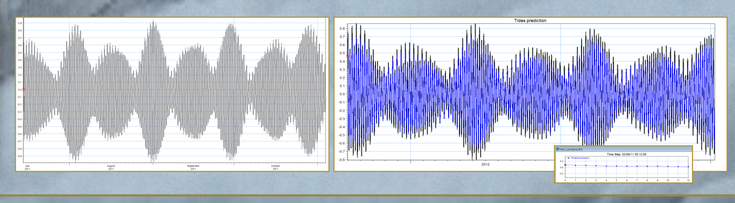


BOUNDARY CONDITIONS

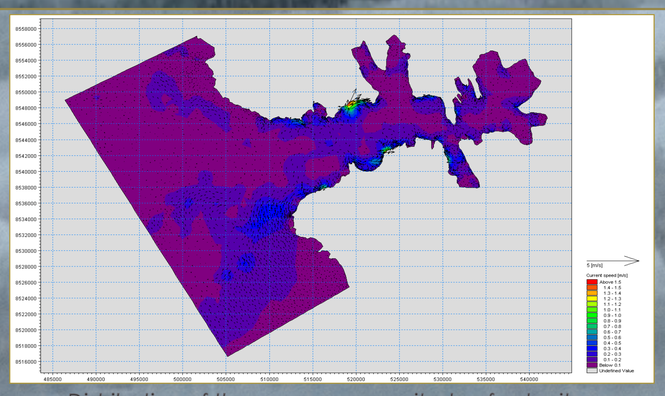
Flather conditions:

Velocity: Constant
- constant u-velocity: -0.035 [m/s]
- constant v-velocity: 0.06062178 [m/s]

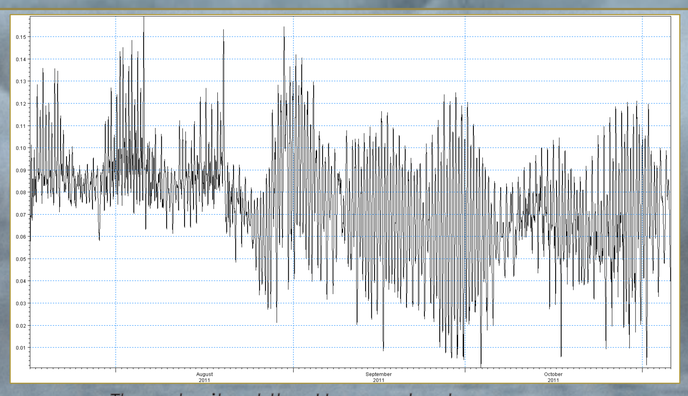
Level: TidesVaring in time and along boundary



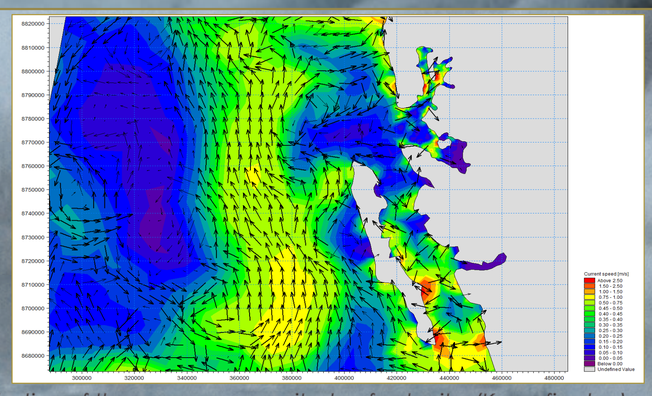
EXAMPLES OF PRELIMINARY RESULTS



Distribution of the average magnitude of velocity



The velocity at the Hornsund entrance



Distribution of the average magnitude of velocity (Kongsfiorden)

FUTURE WORK

Currently we present preliminary results and our work is in progress.
In the future we are planning to:

- Increase vertical resolution (more vertical levels)
- add rivers
- add influence of specific wind conditions
- try to implement influence of ice cover as a modified fluxes
- add fresh water discharge from the melting glaciers and other sources

GAME

Growing of the Arctic Marine Ecosystem