Data Descriptor

Long-term Hindcast Simulation of Currents, Sea Level, Water Temperature and Salinity in the Baltic Sea

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Abstract

This dataset contains the results of numerical modelling of currents, sea level, water temperature and salinity over a period of 50 years (1958–2007) in the Baltic Sea. A long-term hindcast simulation was performed using a three-dimensional hydrodynamic model (PM3D) based on the Princeton Ocean Model (POM). The spatial resolution was 3 nautical miles, i.e. about 5.5 km. Currents, water temperature, and salinity were recorded at depths of 0 m, 5 m, 10 m, 15 m, 20 m, 30 m, 40 m, 50 m and 60 m.

Keywords: hydrodynamic model, currents, sea level, water temperature, salinity, Baltic Sea

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Specification table (data records)

Subject area	physical oceanography, hydrodynamic model simulations
Type of data	multidimensional grid data obtained from the numerical model
Spatial resolution	3' latitude and 6' longitude, i.e., approximately 3 nautical miles (5.5 km)
Time resolution	currents: 3 hrs. sea level: 1 hr. water temperature and salinity: 12 hrs.
Data format	NetCDF (Network Common Data Form)
Data source location	MOST Wiedzy Open Research Catalog, Gdańsk University of Technology, Gdańsk, Poland
Conventions	CF-1.8, CF Standard Name Table v72

Data accessibility	These data are available free of charge under the Creative Commons license (CC BY-NC-SA 4.0, https://creativecommons.org/licenses/by-nc/4.0/)

Background

The reconstruction of long-term changes in circulation, sea level, temperature and salinity of the Baltic Sea is possible thanks to simulations using hydrodynamic models. A long-term hindcast simulation was performed using a three-dimensional hydrodynamic model PM3D (Kowalewski and Kowalewska-Kalkowska, 2017), a new version of the M3D model (Kowalewski, 1997). Previously, the M3D model was already used for a 44-years (1958–2001) simulation hindcast at a resolution of 5 nautical miles in the HIPOCAS (Hindcast of dynamic processes of the ocean and coastal areas of Europe) project (Jędrasik, et. al., 2008). The new, improved version of the model (PM3D) was used for a 50-year (1958–2007) hindcast simulation at a resolution of 3 nautical miles (Jędrasik and Kowalewski, 2019).

Methods

The model is based on the Princeton Ocean Model (POM) developed at Princeton University (Blumberg and Mellor, 1987). Like POM, the M3D/PM3D model uses the Mellor-Yamada turbulence scheme and sigma vertical coordinates. The simulation was carried out for the Baltic Sea area (Fig. 24.1) in a rectangular grid of 3' (latitude) and 6' (longitude) resolution. The spatial resolution was 3 nautical miles, i.e. about 5.5 km. An open boundary was located between the Skagerrak and the Kattegat along the parallel connecting Skagen and Göteborg, where the water exchange with the North Sea takes place. A radiation condition based on Somerfield's concept for velocities vertically averaged and normal to the boarder plane was applied. Atmospheric forcing for the period 1958–2007 was performed using the regional atmospheric climate model: REMO (REgional MOdel) which was based on the numerical weather prediction model: EM (Europa-Model) of the German Weather Forecast Service (DWD).

Data records

The eastward and northward components of surface currents and at a depth of 5 m, 10 m, 15 m, 20 m, 30 m, 40 m, 50 m and 60 m were recorded every three hours in the computational grid of the model in unprojected form: LatLong, WGS 84 (EPSG: 4326). Analysis of the Baltic Sea current data spanning five decades showed a higher stability of subsurface current eddies relative to the stability of ephemeral surface currents (Jędrasik and Kowalewski, 2019). The spatial distribution of water temperature and salinity was recorded twice a day, at the same depths and in the same projection as the currents. The sea level spatial distributions were recorded in the model's computational grid with an hourly time interval. Sea level values are expressed in metres relative to the mean level of

the Baltic Sea in the PM3D model. Example results of a long-term simulation are shown in Fig. 24.2.

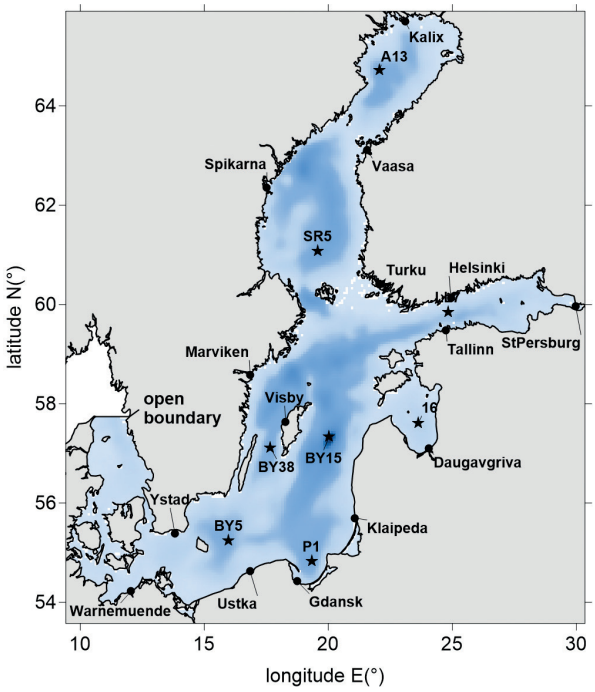

Fig. 24.1. Modelled area of the Baltic Sea and the location of open boundary, monitoring stations (stars) and tide gauges (circles) used for validation of the model results

Data quality

The modelled temperature and salinity distributions were validated for the period 1958–2007 (Jędrasik and Kowalewski, 2019) at selected depths for 8 monitoring stations (Fig. 24.1). The accuracy of the model results with respect to the level was evaluated at 15 sea level gauges, distributed evenly around the Baltic Sea (Fig. 24.1). The validation of the modelling results showed a root mean square error (RMSE) of the water temperature from 0.9 to 1.4°C, and in the case of salinity, the RMSE was from 0.16 to 0.5 psu for various stations in the Baltic Sea. The coefficients of correlation between the simulated and measured temperature ranged from 0.97 to 0.99. The validation of the sea level modelling results showed the RMSE of 7.2 to 18.7 cm and a correlation coefficient of 0.84 to 0.96 for different stations for various stations on the Baltic Sea.

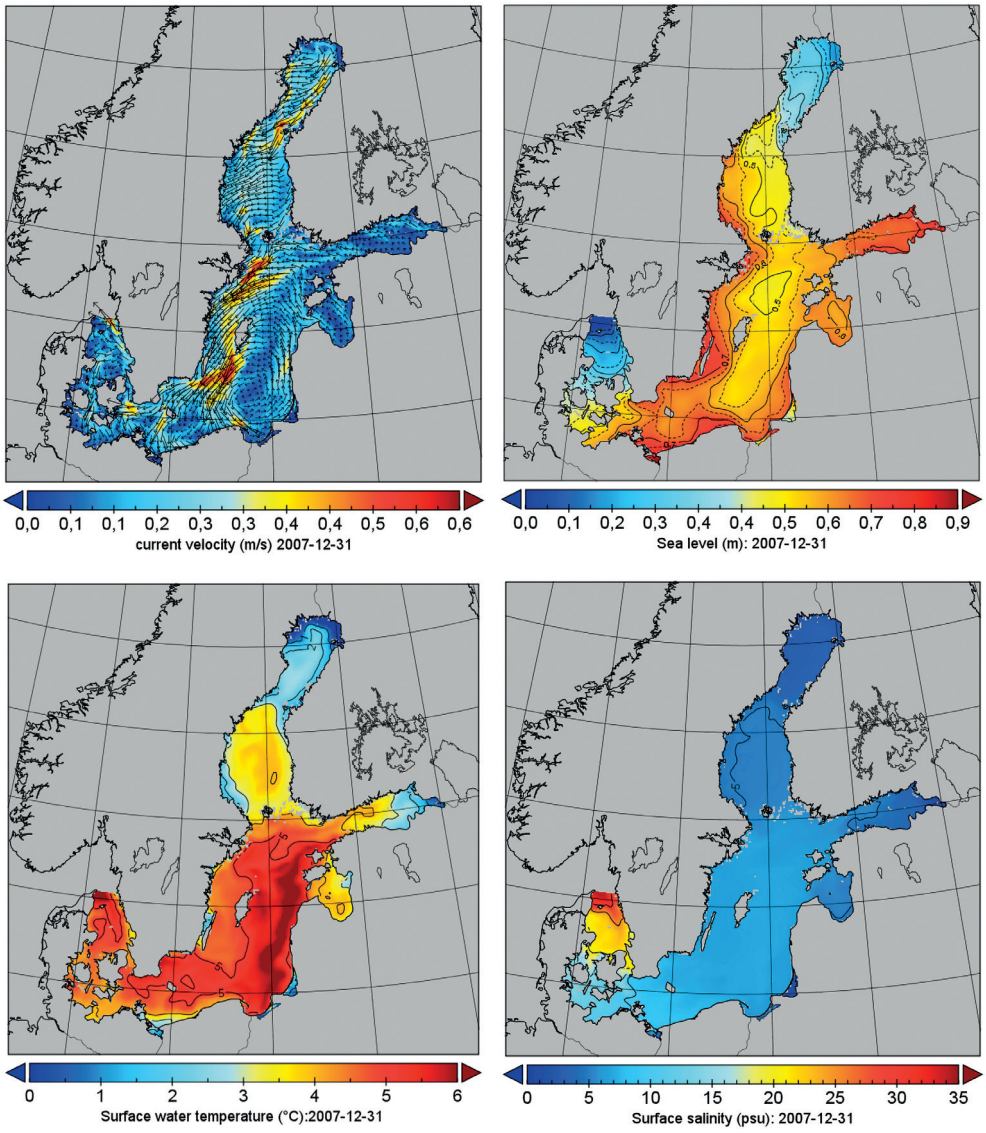

Fig. 24.2. Distribution of currents, sea level, water temperature and salinity in the Baltic Sea for the last day of the long-term simulation

Data availability

The dataset is available and is publicly and freely accessible for any research, educational and other non-commercial purposes under the Creative Commons license (CC BY-NC-SA 4.0, https://creativecommons.org/licenses/by-nc/4.0).

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10.34808/4tx1-0476
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10.34808/g7jm-8912

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