Data Descriptor

High-Resolution Wind Wave Parameters in the Area of the Gulf of Gdańsk During 21 Extreme Storms

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Abstract

This dataset contains the results of wind-wave parameter modelling in the area of the Gulf of Gdańsk (Southern Baltic). For the simulations, a high resolution SWAN model was used. The dataset consists of the significant wave height, the direction of the wave approaching the shore and the wave period during 21 historical, extreme storms. The storms were selected by an automatic search over the 44-year-long significant wave height time series.

Keywords: coastal zone; Gulf of Gdańsk hydrodynamics; SWAN model; wind-waves

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Specification table (data records)

Subject area	Physical Oceanography, Coastal Zone, Wind-waves
More specific subject area	Extreme storm conditions
How the data was acquired	Numerical modelling using SWAN
Data format	Text files
Data source location	MOST Wiedzy Open Research Catalog, Gdańsk University of Technology, Gdańsk, Poland
Data accessibility	The dataset is accessible and is publicly and freely available for any research or educational purposes

Background

The principal goal of the calculation performed is to gain some preliminary insights into the intensity of water movement generated by wind waves in the Gulf of Gdańsk (located in the southern Baltic Sea) during severe storms. Baltic storms appear to be important phenomena from several points of view: first, as threatening to the safety of human activity, and secondly, they may have beneficial effects on the natural environment causing oxygenating inflows from the North Sea and refreshing waters in deeper layers, and in particular, the bottom waters. The third point is that Baltic storms may set in motion sediment transport in the coastal zone and may induce sedimentation processes at the bottom (Cieślikiewicz et al., 2017).

In the area of the Gulf, the generation and transformation of waves is limited by an open water fetch distance and complex bathymetry. A sheltering effect in the Gulf reduces wave energy compared to open coast areas and protects the Gulf from storms (Cieślikiewicz et al., 2016).

This dataset contains the results of SWAN (Booij et al, 1999) modelling in the area of the Gulf during 21 extreme storms selected based on hindcast wind wave data in the period 1958–2001. The wind wave fields' characteristics over the Baltic Sea were taken from the 44-year hindcast generated within the framework of the HIPOCAS project (Cieślikiewicz and Paplińska-Swerpel, 2008) using the WAM model (WAMDI Group, 1988).

Methods

Wave parameters during 21 extreme storms (output from the WAM model running in coarse resolution), as well as wind parameters, were used as the boundary conditions for the SWAN model operating in a high resolution grid covering the area of the Gulf of Gdańsk. The SWAN numerical model allows the estimation of surface gravity wave parameters for a given seabed topography, wind field, sea state, and the current field. SWAN determines the generation of waves by wind and wave propagation in time and space, taking into account a number of physical phenomena determining the wave field. These are mainly shoaling, refraction, nonlinear interaction between waves, and wave energy dissipation caused by whitecapping. Additionally, it includes energy dissipation by friction of the bottom and refraction due to ocean currents (Urbański et al., 2008). The SWAN model simulation was performed in this study on a grid with a spatial resolution of 200m × 200 m, covering the entire Gulf of Gdańsk. Boundary conditions in the form of monochromatic wave parameters were set on the Gulf of Gdańsk's open border. This northern border of the computational grid of the SWAN model includes 11 WAM grid points. All of the analysed extreme storms occurred during similar wind conditions, namely with a similar wind speed of several metres per second from the northern direction. All of the SWAN simulations were performed in stationary mode, and the results are given for the peak of each storm. For the modelling, high-resolution bathymetric data provided by the Naval Hydrographic Office in digital form prepared by the Maritime Institute in Gdańsk was used.

Data records

The dataset contains SWAN model output in the form of text files: significant wave height, peak period and wave direction for 21 extreme storms (63 files in total). The significant wave height (Hs) and mean wave period (T) are integral wave parameters calculated from the wave spectrum. The physical meaning of Hs is the average of wave height taken over the given time interval, calculated from the highest one-third of all waves. The T parameter can be interpreted as the averaged time interval between two corresponding points on the wave, i.e. troughs.

Data quality and availability

The SWAN model has been successfully applied in extreme wave conditions but not in the Baltic Sea. Although there have been several studies focussed on the modelling of the wave field in this region, SWAN model was only applied in a few cases (e.g. Reda and Paplińska, 2002). These data are accessible in the MOST Wiedzy Open Research Catalog.

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References

Booij, N., Ris, R.C. and Holthuijsen, L. H. (1999) 'A third-generation wave model for coastal regions. Model description and validation', *Journal of Geophysical Research*, 104 (C4), pp. 7649–7666. DOI: 10.1029/98JC02622.

Cieslikiewicz, W. et al. (2017) 'Extreme bottom velocities induced by wind wave and currents in the Gulf of Gdansk', *Ocean Dynamics*, 67, pp. 1461–1480. DOI: 10.1007/s10236-017-1098-4.

Cieślikiewicz, W., Dudkowska, A. and Gic-Grusza, G. (2016) 'Port of Gdansk and Port of Gdynia's exposure to threats resulting from storm extremes', *Journal of Polish Safety and Reliability Association*, 7(1), pp. 29–36. Available at: http://jpsra.am.gdynia.pl/upload/SSARS2016PDF/Vol1/SSARS2016-CieslikiewiczDudkowskaGicGrusza.pdf (Accessed: 25th May 2022).

Cieślikiewicz, W. and Paplińska-Swerpel, B. (2008) 'A 44-year hindcast of wind wave fields over the Baltic Sea', *Coastal Engineering*, 55 (11), pp. 894–905. DOI: 10.1016/j.coastaleng.2008.02.017.

Reda, A. and Paplińska, B. (2002) 'Application of numerical wave model SWAN for wave spectrum transformation', *Oceanological Studies*, 31(1–2), pp. 5–21.

Urbański, J., Grusza, G. and Chlebus, N. (2008) 'A GIS-based WFD oriented typology of shallow micro-tidal soft bottom using wave exposure and turbidity mapping', *Estuarine, Coastal and Shelf Science*, 78(1), pp. 27–37. DOI: 10.1016/j.ecss.2007.11.025.

WAMDI Group (1988) 'The WAM model — A Third Generation Ocean Wave Prediction Model', *Journal of Physical Oceanography*, 18(12), pp. 1775–1810. DOI: 10.1175/1520-0485(1988)018<1775:TWMTGO>2.0.CO;2.