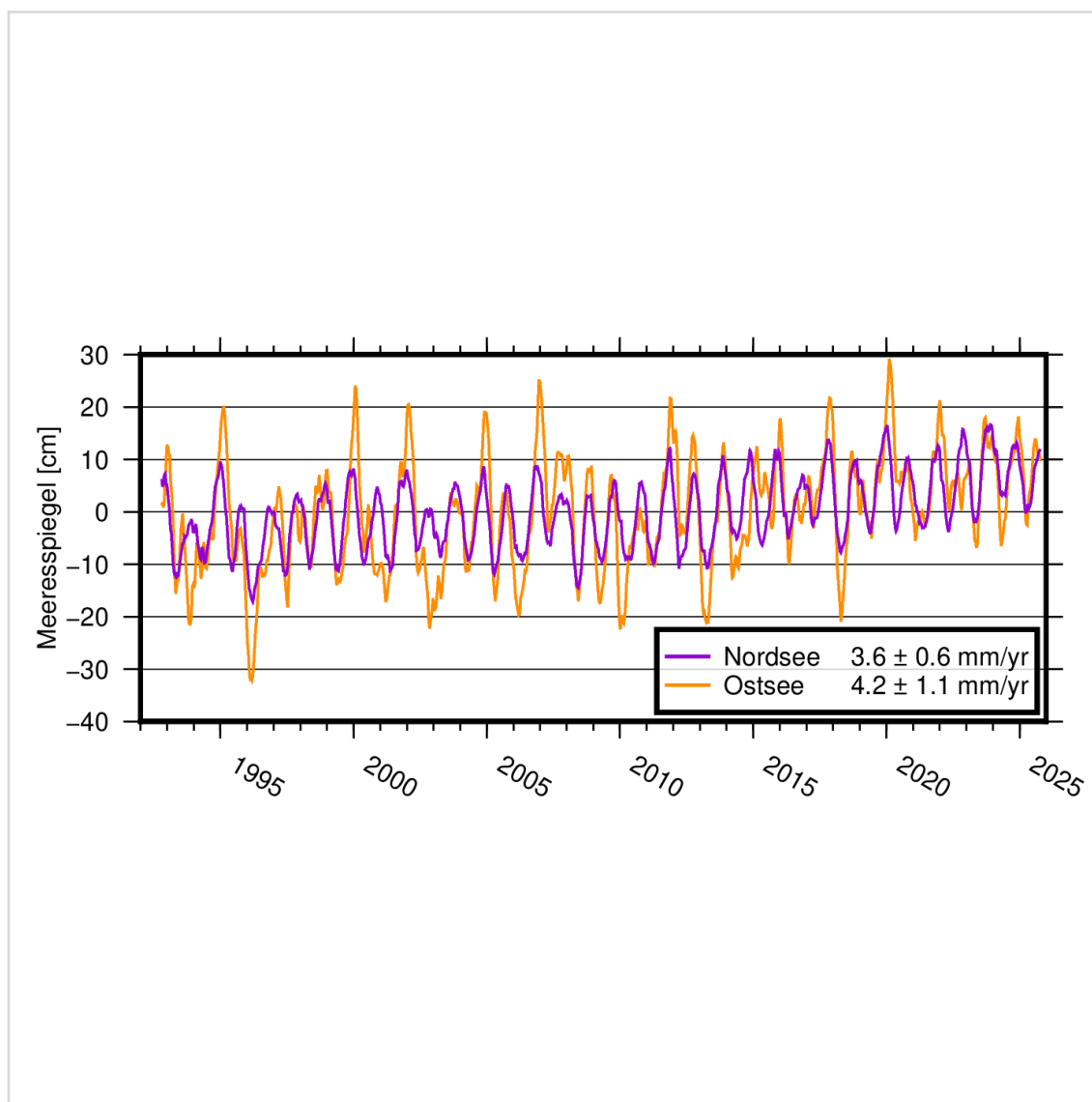




Documentation

Time series of sea surface height in the North and Baltic Sea (MS-Zeitreihe)

Product as of 11 2025



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1 Overview

Product:	Time series of sea surface height in the North and Baltic Sea
Content:	The time series of sea levels contain the average water level of an area and describe its temporal variations since 1992. They are derived from satellite altimetry measurements and have a temporal resolution of 10 days.
Area:	The entire North Sea and Baltic Sea area and corresponding sub-areas within the German exclusive economic zone (EEZ)
Spatial structure*:	Average time series for each of the areas: nsea: North Sea balt: Baltic Sea gbgt: German Bight swbs: southwestern Baltic Sea
Spatial reference*:	Position: EPSG:4326 (WGS84, ellipsoidal coordinates) Height: EPSG:7837 (DHHN2016)
Height accuracy:	2 – 4 cm
Currentness:	2025-11
Resolution:	10 days
Data formats*:	NetCDF, ASCII text file (CSV)
Data supply*:	Download
Data volume:	260 KB
Data source:	https://sgx.geodatenzentrum.de/web_public/gdz/datenquellen/datenquellen_ms-zeitreihe.pdf

* Please note that not all forms of delivery can be provided with each georeferencing and data format. If you have any questions, feel free contact the Service Centre (DLZ).

2 Description

2.1 Content and format

The product contains time series of sea levels in four different areas:

- entire North Sea (excluding Skagerrak and Kattegat)
- entire Baltic Sea
- German Bight (as defined by the maritime weather area)
- southwestern Baltic Sea (Kiel Bay to Arkona Sea)

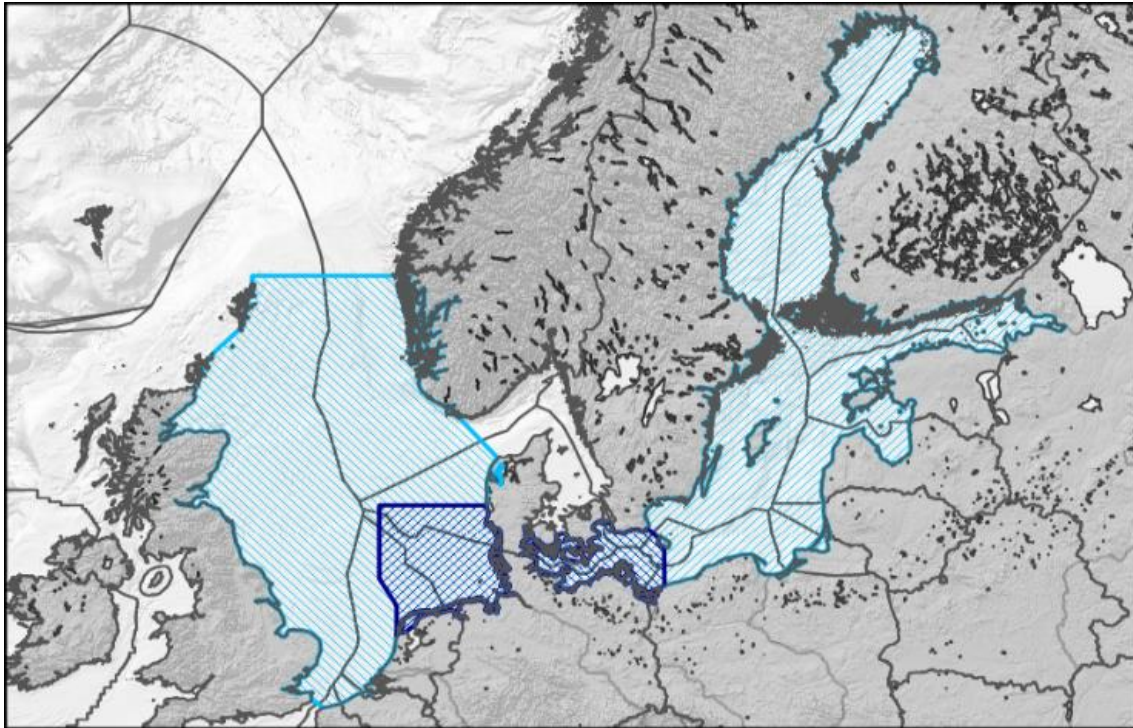


Figure 1: Definition of the area of the time series

The sea surface heights represent the average water level in the corresponding area over a period of 10 days. They refer to the geoid as the gravimetric height reference surface at the level of the official German height reference (further details in the product “Mean Sea Surface Height”). The time series are based on measurements from altimeter satellites (see data basis for satellite altimetry). The temporal resolution of 10 days is determined by the reference missions of satellite altimetry. Only after this period do the measurements from the altimeter satellites cover the observation area with sufficient density.

For each area, the data set contains:

- a) a high-resolution time series of sea level changes
- b) a smoothed time series of sea level changes

Further details on the calculation of the time series can be found at the end of the next section.

Time series of sea surface height in the North and Baltic Sea
MS-Zeitreihe

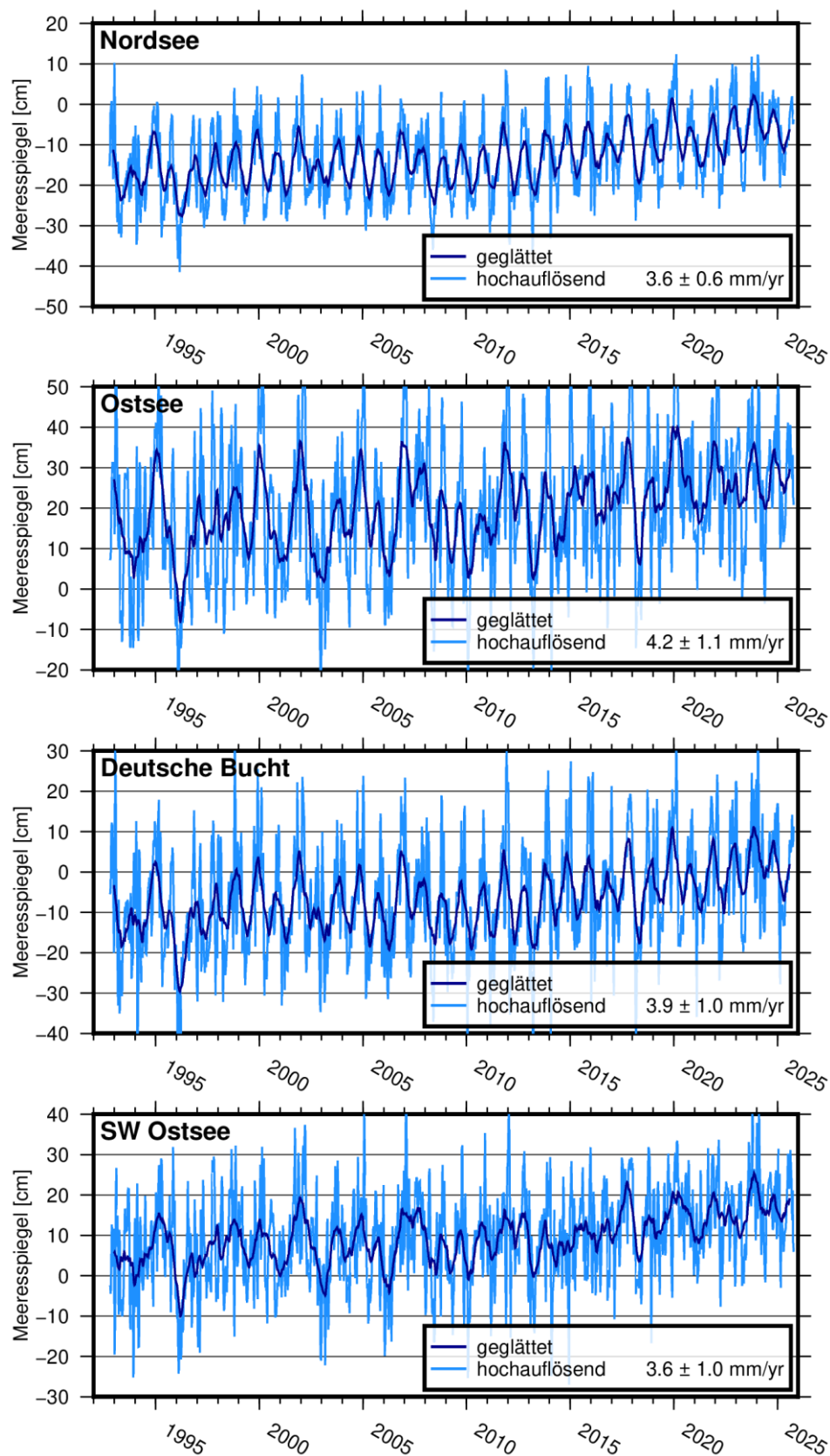


Figure 2: Time series for each area with corresponding estimated trend.

2.1.1 Data format

NetCDF

- common scientific binary data format
- all parameters in one file, readable e.g. with ncdump, ncview, Panoply, QGIS etc.
- format description via `ncdump -h sea_level_changes.balt.nc:`

```
dimensions:
    time = UNLIMITED ; // (1207 currently)
variables:
    double time(time) ;
        time:long_name = "time" ;
        time:calendar = "standard" ;
        time:units = "days since 1858-11-17 00:00:00.0" ;
    float adt_grav(time) ;
        adt_grav:_FillValue = NaNf ;
        adt_grav:long_name = "absolute dynamic topography" ;
        adt_grav:unit = "m" ;
        adt_grav:comment = "height above height reference" ;
    float adt_grav_filtered(time) ;
        adt_grav_filtered:_FillValue = NaNf ;
        adt_grav_filtered:filter_width_days = 183. ;
        adt_grav_filtered:long_name = "absolute dynamic topography" ;
        adt_grav_filtered:unit = "m" ;
        adt_grav_filtered:comment = "height above height reference" ;

// global attributes:
    :Conventions = "CF-1.6" ;
    :trend = 4.15032684559194 ;
    :trend_unc = 1.14233028083759 ;
    :trend_unit = "mm/yr" ;
```

ASCII text file

- easily readable format, e.g. with text editor / spreadsheet software
- Important metadata in the header
- Example:

```
# area: balt (Baltic Sea / Ostsee)
# unit: m
# trend: 4.15 +- 1.14 mm/yr
# time      adt      adt_filtered
1992-10-18  0.071    nan
1992-10-28  0.079    nan
1992-11-07  0.169    nan
1992-11-17  0.258    nan
1992-11-27  0.314    nan
1992-12-07  0.286    nan
1992-12-17  0.314    nan
1992-12-27  0.254    0.270
1993-01-06  0.135    0.262
...
```

2.1.2 Data basis satellite altimetry

The sea level products were derived from observations made by altimeter satellites since 1992. The satellite missions were and are operated by various organizations such as ESA¹, NASA², CNES³, and others. The RADS (Radar Altimeter Database System, Scharroo et al. 2013⁴) collects data from the various satellite operators and makes it available in a uniform format (see Figure 5). This data forms the basis for altimetry analysis at the BKG.

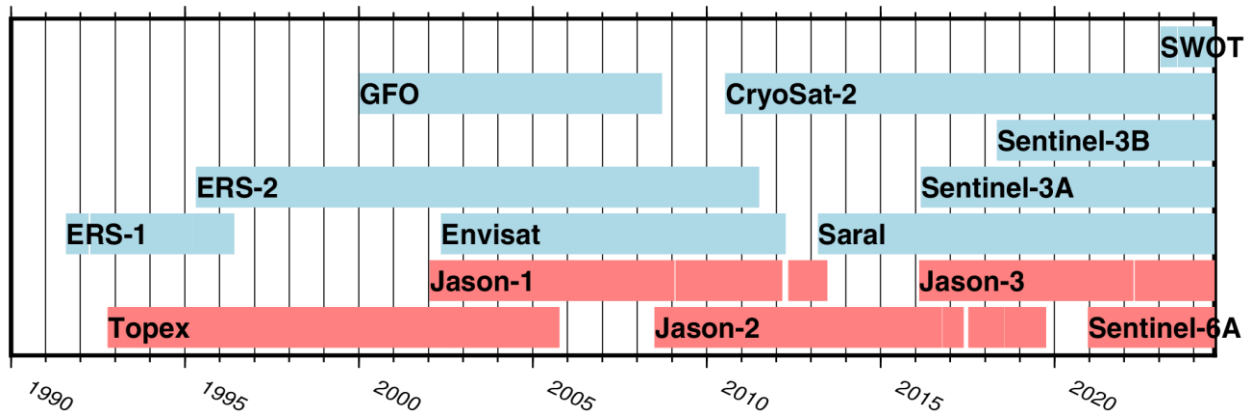


Figure 3: Observation periods of the satellite missions used. The reference missions (red) ensure continuous observations along the reference tracks. Additional missions (blue) supplement this data and improve spatial and temporal coverage.

BKG uses data from RADS and supplements this global dataset with the following regional models and data for the North Sea and Baltic Sea:

- New tidal model FES2022, which is particularly notable for its regional improvements in coastal areas
- Regional geoid models and comparable reference surfaces
 - GCG2016v2023 / BKG2016g geoid
 - BSCD2000 / FAMOS geoid
 - EGG2015
- Regional altimeter calibration:
 - Relative calibration of reference missions based on quasi-simultaneous observations during the tandem phases of the missions
 - Relative calibration of additional missions based on crossover points with the reference missions
 - Absolute calibration based on the Helgoland and FINO-2 offshore tide gauges

¹ European Space Agency

² National Aeronautics and Space Administration, USA

³ Centre national d'études spatiales, Frankreich

⁴ Scharroo, R., E. W. Leuliette, J. L. Lillibridge, D. Byrne, M. C. Naeije, and G. T. Mitchum, RADS: Consistent multi-mission products, in *Proc. of the Symposium on 20 Years of Progress in Radar Altimetry, Venice, 20-28 September 2012*, Eur. Space Agency Spec. Publ., ESA SP-710, p. 4 pp., 2013.

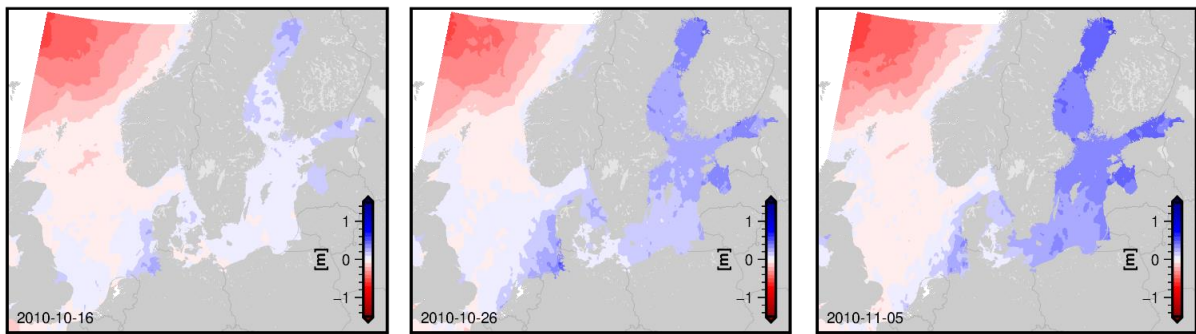


Figure 4: Examples of grids showing the average water level for three consecutive 10-day periods

The local mean water level was calculated from altimetric height measurements with a spatial resolution of approximately 10 km and a temporal resolution of 10 days (Figure 6). A Gaussian filter was used for this purpose (spatial sigma 40 km, temporal sigma 5 days). Higher-frequency sea level variations due to tides and weather influences were corrected in advance using models.

The time series data is calculated for a 10-day period (see Figure 4) from the spatial mean value of the grid cells in the corresponding area (Figure 1). The grid cells were weighted according to the cosine of their geographical latitude in order to correct for the effect of meridian convergence with increasing latitude. The sea level heights calculated in this way result in high-resolution time series. A temporally smoothed variant of this time series with a filter width of 6 months is also included in the product.

In addition, a trend over the entire observation period with a corresponding accuracy estimate (95% confidence interval) is provided for each of the time series. This trend was estimated together with a constant parameter and a regular seasonal variation (annual and semi-annual oscillation) from the high-resolution regional time series.

3 Further Information

Further information concerning the product are available at gdz.bkg.bund.de. In case of any questions, you are welcome to contact our service centre at dlz@bkg.bund.de.

General information regarding the Federal Agency for Cartography and Geodesy can be found on our homepage www.bkg.bund.de.