Deutscher Wetterdienst

The extreme storm in the south-western Baltic Sea in November 1872
A reanalysis of the wind fields for coastal protection purposes

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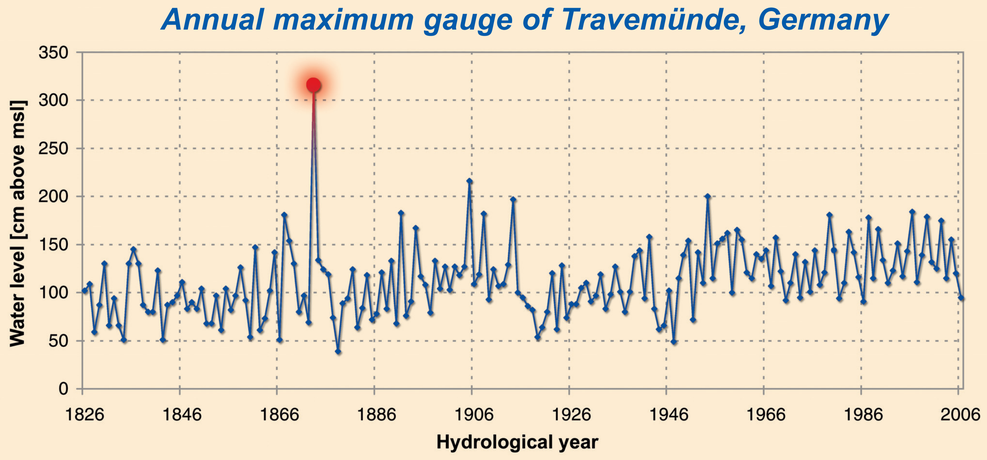
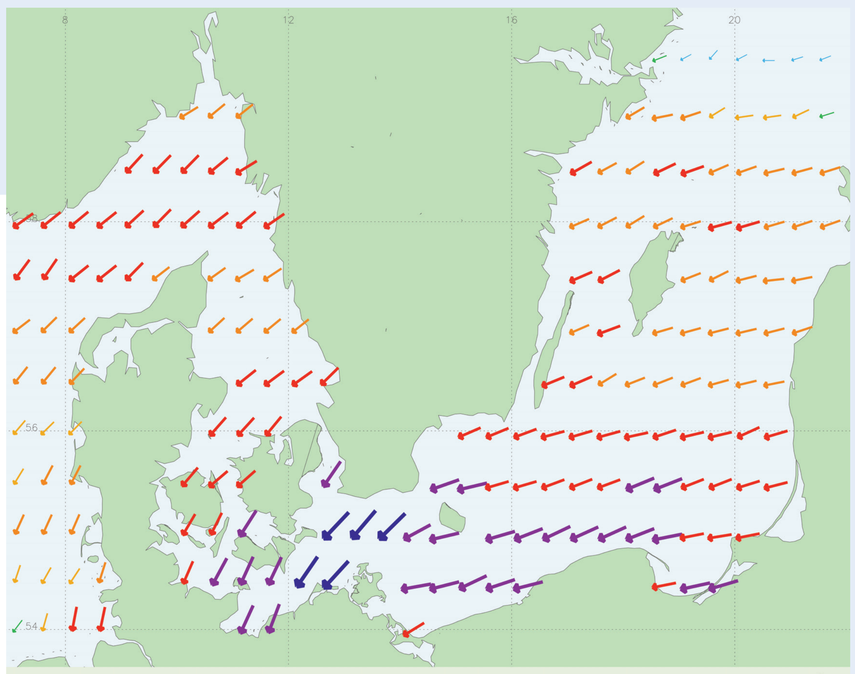
In November 1872, a devastating storm occurred in the south-western Baltic Sea. The most outstanding water levels by far since the beginning of instrumental registrations were recorded along the Danish and German coasts and since then, there has not been any situation like that.

Annual maximum gauge of Travemünde, Germany



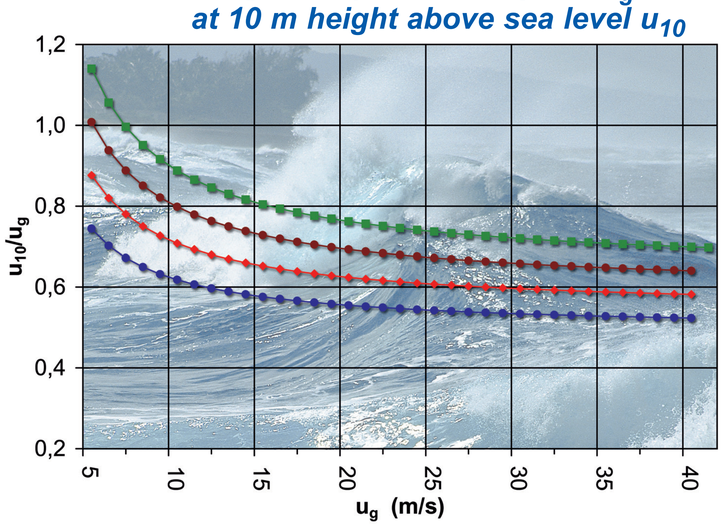
The sheer enormity gives reasons for special research. Of course, there is particular interest among coastal engineers and oceanographers to reconstruct the weather situation as exactly as possible using present-day methods. For better understanding the complex causes of this extreme event a comprehensive study was carried out aiming at reconstructing the wind fields in November 1872.

The Baltic Sea is a brackish inland sea. The only flow in and out occurs through the relatively narrow Danish straits. The mechanisms inducing high water levels differ from those at open sea. Air pressure, the filling level of the Baltic Sea, the seiche and the tidal influence have to be considered, however, the influence of the wind stress prevails by far. The filling level of the Baltic Sea is determined by the inflow from the North Sea during the preceding 2 to 3 weeks. Thus it was necessary to investigate the weather development in all northern Europe for a longer period before the storm surge event happened.



Wind speed at 10 m height above msl, 13.11.1872 06:00

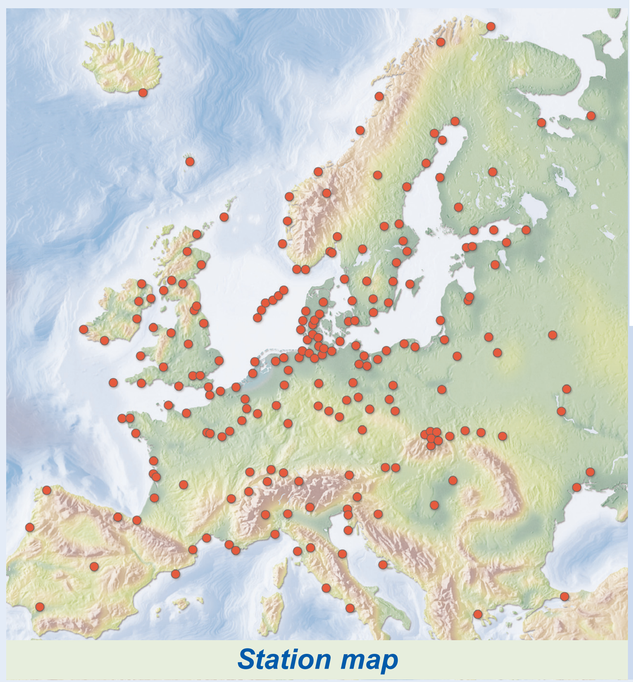
Conversion of geostrophic wind speed u_g to wind speed at 10 m height above sea level u_{10}



Dependency on height of the geostrophic wind speed and thermal stability (after Hasse)

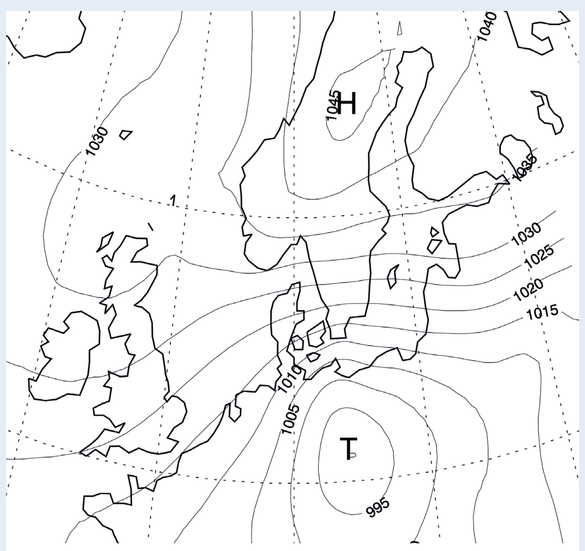
- ta-tw = -8 K
- ta-tw = -4 K
- ta-tw = 0 K
- ta-tw = +4 K

ta = air temperature
tw = water temperature

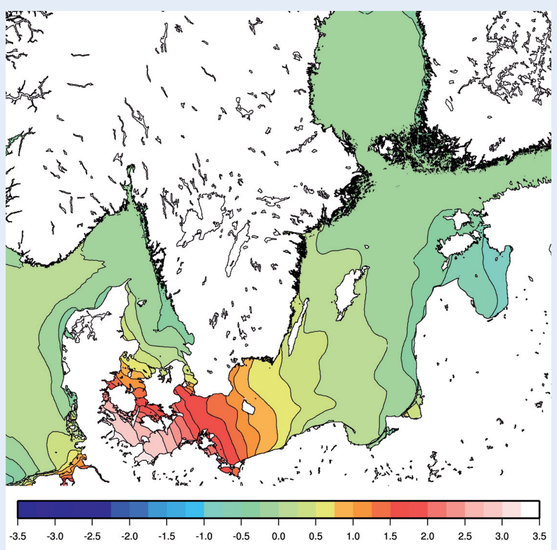


Station map

As there are insufficient wind data from those early days, the wind field was estimated indirectly by calculating the geostrophic wind from pressure readings. We succeeded in getting pressure readings of more than 175 stations from northern and central Europe with at least two readings per day. After a comprehensive data check as to status of reduction, unit, time, geographic position, height etc. the pressure fields of the period November 1 to 13 were analysed manually. The pressure fields were digitized and raster data for a 0.5 x 0.5 degree grid interpolated. These gridded pressure fields were used to calculate the geostrophic wind. Those data, in turn, were reduced to 10 m height above sea level with the empirical approximation of Hasse (1984) taking into account the thermal stability.



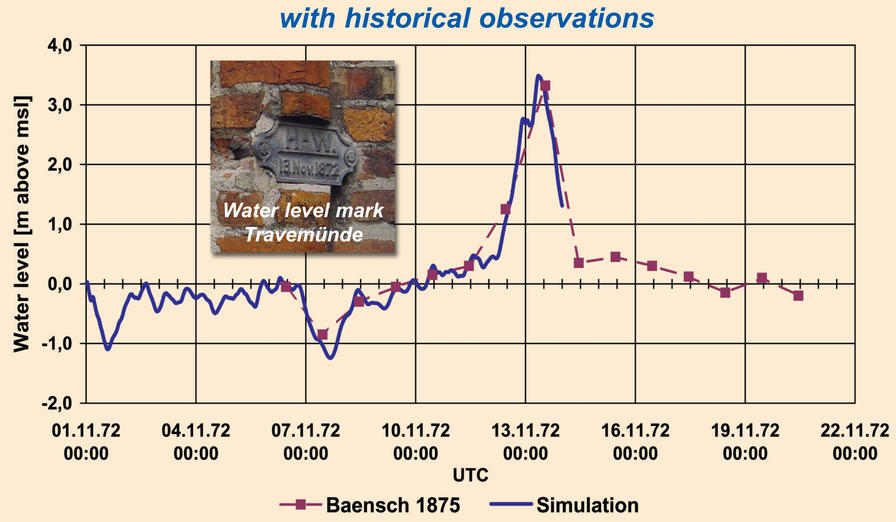
Reanalysis 13.11.1872 06:00



Water level above msl 13.11.1872 12:00 UTC

The operational water gauge model of Bundesamt für Seeschifffahrt BSH was driven by the calculated wind data. The comparison of the simulated water gauges shows excellent agreement with historical observations, as well spatio-temporally as to maximum values.

Comparison of simulated water gauges of Travemünde with historical observations



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