Departmental Research Programme
- National Meteorological Service in Germany (DWD)
- German Maritime and Hydrographic Agency (BSH)
- German Federal Institute of Hydrology (BfG)
- German Federal Waterways Engineering and Research Institute (BAW)

Validation of Geostrophic Wind Fields in ERA-40 and ERA Interim Reanalyses for the North Sea Area

A. Ganske, H. Heinrich, BSH, Hamburg, Germany,
G. Rosenhagen, DWD, Hamburg, Germany

Wind is the most important meteorological parameter for sea and coastal areas. This is especially true for the North Sea, which is extremely vulnerable to storm surges. As wind measurements are highly influenced by the surrounding and changes of observation techniques, time series of measured winds are inhomogeneous. However, it is possible to obtain information on long-term changes of wind speed from time-series of geostrophic winds, which are calculated from surface pressure measurements. Pressure measurements from ships, buoys and platforms are sparse and unevenly distributed in time and space. Distances between land-based measuring stations are often too large to describe small-scaled pressure gradients. Therefore the correlation between the resulting geostrophic wind and the 10 m wind is not always sufficient (Krüger and von Storch 2011). Because of this reason calculated geostrophic winds from reanalyses data is used instead.
For the south-eastern area of the North Sea, the geostrophic wind from the ERA - pressure output is validated with data calculated from sea level pressure measurements. The validation shows high agreement of geostrophic wind speeds from both Era-reanalyses to those from measured data. However, deviations of wind direction frequencies of reanalyses compared to those from measurements are considerable. As geostrophic wind speed fields, calculated with either ERA-40 and ERA Interim pressure data show high agreement in the North Sea area, both fields can be used for further research.

Comparisons of geostrophic winds from measured and reanalysed sea level pressure (SLP)

Geostrophic winds from SLP measurements for 1880 - 2012 have been calculated using SLP at three measuring sites, see Schmidt and von Storch, (1993). For the comparison of geostrophic winds from measured to ERA-40 and ERA Interim SLP three grid points of each reanalysis are chosen which are closest to the measuring sites (Fig. 1).

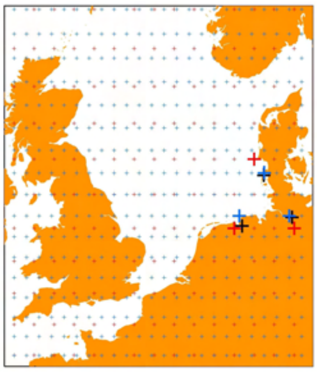

Figure 1: *Map of the North sea area with grid points of ERA-40 (+) and ERA Interim (+). Enlarged symbols: Grid points chosen for the calculation of geostrophic winds and position of SLP measurements (**+**).*

Fig. 2 shows the comparisons of time series of geostrophic wind speeds from measured and reanalysed SLP for corresponding times and both reanalyses. Means, root mean square errors (rmse) and standard deviations of the time series of ERA-40 and ERA Interim show high agreement to those calculated with measured SLP.

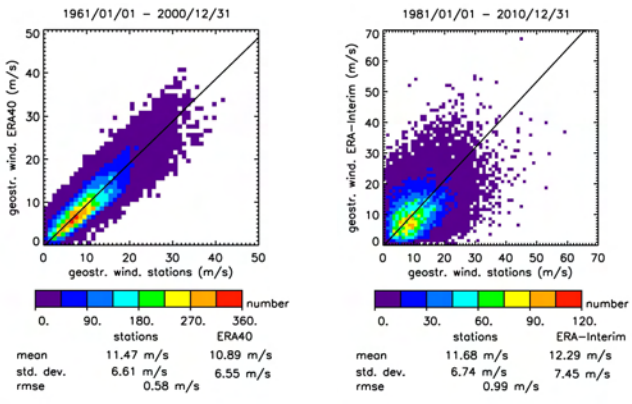

Figure 2: *Correlation of geostrophic winds calculated with measured and ERA-40 SLP from 1961 - 2000 (left) and with ERA Interim SLP for 1981 - 2010 (right). Also shown: best-fit line.*

Comparisons of 8 classes of directions of geostrophic winds in the south-eastern part of the North Sea are shown in Fig. 3. Highest frequencies are found for western and south-western wind directions. Deviations in frequencies of ERA-40 and ERA Interim winds compared to those from measured SLP are up to 4.3 % (ERA-40) and 7.7 % (ERA Interim). As differences are considerable, geostrophic winds should not be used for investigations, where wind directions are crucial, e.g. for the investigation of storm surges.

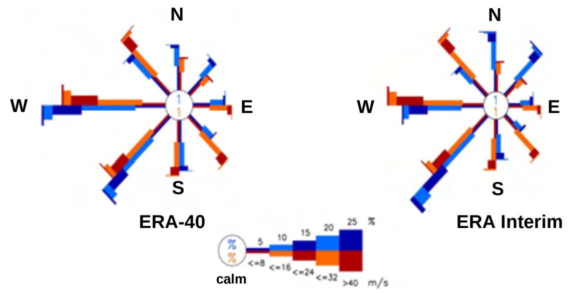

Figure 3: *Wind rose for geostrophic winds from measured data (orange) compared to ERA-40 for 1961 - 2000 (blue, left) and ERA Interim data for 1981 - 2010 (blue, right). Length of each branch is related to the frequency of occurrence of the respective wind direction, its width broadens with increasing wind speed range.*

Geostrophic wind fields, calculated from ERA-40 and ERA Interim pressure output

Geostrophic winds from reanalyses SLP fields are calculated for the whole North Sea region. Due to higher spatial resolution ERA Interim fields show larger variations than ERA-40 fields. Nevertheless, differences between ERA-40 and ERA Interim wind speeds are all smaller than 1 m/s over sea. Higher wind speeds as e.g. 99th percentile of frequency distribution also show similar spatial structures over the North Sea with deviations less than 1.5 m/s (not shown).

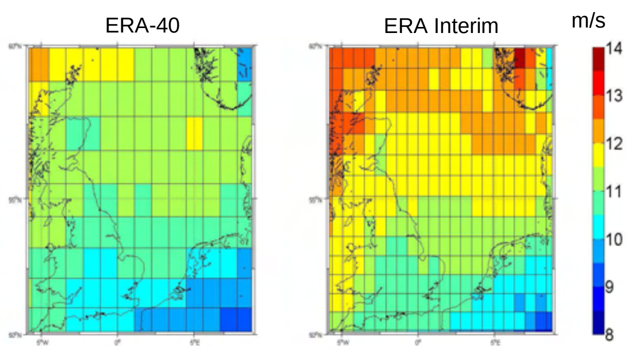

Figure 4: *Mean geostrophic wind speed from 1981 - 2000, calculated from ERA-40 (left) and ERA Interim SLP (right) .*

Literature:
Schmidt, H. and H. von Storch, 1993: German Bight storms analysed. Nature 365, p. 791.
Krüger, O. and H. von Storch, 2011: Evaluation of an Air- Pressure-Based Proxy for Storm Activity. J. Climate 24, p. 2612-2619.

Federal Ministry of Transport, Building and Urban Development

Contact: Dr. Anette Ganske, BSH
Bernhard-Nocht Str. 78
20359 Hamburg, Germany
Anette.Ganske@bsh.de