

Zentrum für Material- und Küstenforschung



On air pressure and past storm activity - an assessment of the informational value of proxies for past storm activity

Oliver Krueger Institute for Coastal Research, Helmholtz-Zentrum Geesthacht Hans von Storch





• Wind time series are often inhomogeneous and too short.



- Air pressure readings are usually homogeneous.
- At some sites long pressure measurements are available.



Are air pressure based proxies for storm activity

appropriate?



Multiple-station based proxies

• Quantiles of geostrophic wind speeds (pressure triangles)

Single-station based proxies

- Frequency of absolute local pressure changes exceeding a threshold over a certain time
- High percentiles of absolute local pressure changes over a certain time
- Number of deep low pressure readings
- Low percentiles of pressure readings





 Common assumption: The variation of the statistics of pressure proxies describes the variation of statistics of ground level wind speeds.

- Long and homogeneous data are needed.
- Ground level wind and surface air pressure fields from the spectrally nudged and NCEP driven REMO (coastDat) are made use of.
- The correlation between ground level wind speed statistics and the proxies is used to measure the informational value.
- Concentration on annual statistics, results also hold for seasonal statistics.

Multiple-station based proxies

- Daily geostrophic wind speeds are derived from a triangle of surface air pressure measurements and used to build yearly frequency distributions (Schmidt and von Storch, 1993).
- The variation of the statistics of strong geostrophic wind speeds describes the variation of statistics of ground level wind speeds.
 - Quantiles of geostrophic wind and atmospheric wind are positively linearly related.





Methodology



- Subset of randomly chosen triangles
- Annual and seasonal frequency distributions are determined from diagnostic 10m and geostrophic wind speed over one triangle
- Correlations between time series of specific seasonal/yearly quantiles (e.g. 95th %ile) of geostrophic wind and area maximum wind over triangles





Correlations between percentile time series of

geostr. and area max wind speeds





Every single correlation is tested at the 0.01-significance level.

The ratio of rejected local significance tests to the overall number is in agreement with the expectation that the proxy is valid in general.

Or in other words: The ratio is in agreement with rejecting the null hypothesis of a 0correlation in (for example) 99% of all the times.

Null hypothesis of a 0-correlation can be rejected in general. Triangle wind speed time series are positively linearly linked.

How do size and surface conditions influence the description of storm activity?





How do size and surface conditions influence the description of storm activity?



size

size







correlations between annual 99th percentiles of ground level wind speed and annual number of pressure observations below 980 hPa



correlations between annual 99th percentiles of ground level wind speed and...

number of p < 980 hPa	number of $\Delta p / \Delta t > 25 hPa / 24 h$	99th %ile of Δp/8h	1st %ile of pressure
0.198	0.228	0.395	-0.235

(thresholds from Bärring and Fortuniak, 2009)



Proxies barely exceed critical values in classical significance tests for a linear relationship (similar for all single-station proxies).

Weak informational value

Influence of proxy configuration:





HOWEVER

Albeit weak, we can at least show that there is a linear relationship in general by testing the sign (not the value) of the correlations.

For instance: 87% of annual deep low correlations are positive, which is in agreement with a general linear relationship between the annual number of deep lows and storm activity (via binomial distribution).

100.0% 50.0% 0% positive negative

General linear relationship between single-station proxies and storm activity.







- Pressure-based proxies and storm activity are linearly related.
- The informational value of single-station proxies is weak.
- The informational value of geostrophic wind speed statistics is superior to the informational value of single-station proxies.
- Geostrophic wind from sea triangles reflects storm activity better than geostrophic wind from land triangles.
- Small triangles lead to a better representation of storminess than bigger triangles.

see also:

Krueger and von Storch, 2011, Evaluation of an Air Pressure–Based Proxy for Storm Activity, Journal of Climate



- ➡ How do spectral- and wavelet-based proxies perform?
- Do single-station proxies represent storm activity in larger areas?
- How do measurement errors and other uncertainties influence the informational value?
- ➡ Is the informational content of proxies stationary?



Zentrum für Material- und Küstenforschung



Thank you.

Oliver Krueger oliver.krueger@hzg.de







Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung

