Evaluation of an air pressure based proxy for storm activity

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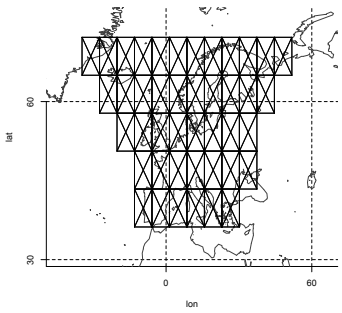
Motivation

Wind time series are often inhomogeneous and too short to assess past storm activity. On the contrary, air pressure readings are usually homogeneous. At some sites even long pressure measurements are available. Thus, the statistics of derived geostrophic wind speeds can be used as a proxy for past storm activity. It is commonly believed, however unproven, that the variation of the statistics of strong geostrophic wind speeds describes the variation of statistics of ground level wind speeds. This study evaluates this approach by examining the correlation between quantiles of yearly geostrophic wind speed and of atmospheric wind speed to determine whether the two distributions are linearly linked.

Dataset

- Diagnostic 10m wind and surface air pressure fields from the spectrally nudged and NCEP driven REMO (Weisse et al., 2009), known as coastDat, are made use of. The dataset covers Europe and the North Atlantic. The region is shown in the figure below.
- The period 1959-2005 is analysed.



Method

- Annual frequency distributions of area max 10m and geostrophic wind speed are determined over various and randomly chosen triangles of different size and location following Schmidt and von Storch (1993), Alexandersson et al. (1998), or Wang et al. (2009).
- This research concentrates on the examination of correlations between time series of specific quantiles (e.g. the 0.95-quantile).

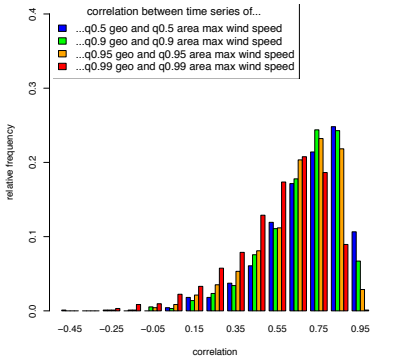
Are annual quantiles of geostrophic wind and atmospheric wind linearly related?

➡ Quantile time series are linearly related.

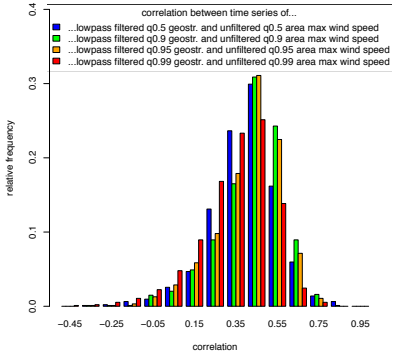
➡ The variation of ground level wind speed statistics are best reflected by the 0.5-quantile geostrophic wind speed. The correlations decrease for upper quantile time series.

➡ Lowpass filtering decreases the quality of the linear link.

correlation between...	0.05-quantile	median
...0.5-quantiles of geostr. and of area max wind speed	0.325	0.730
...0.9-quantiles of geostr. and of area max wind speed	0.300	0.724
...0.95-quantiles of geostr. and of area max wind speed	0.240	0.692
...0.99-quantiles of geostr. and of area max wind speed	0.112	0.593

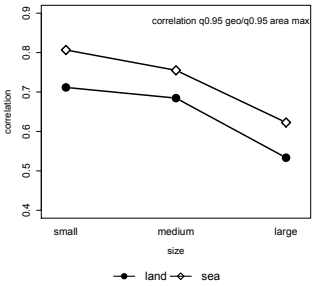


correlation between time series of...	0.05-quantile	median
... lowpass filtered q0.5 geostr. and unfiltered q0.5 area max wind speed	0.112	0.410
... lowpass filtered q0.9 geostr. and unfiltered q0.9 area max wind speed	0.137	0.452
... lowpass filtered q0.95 geostr. and unfiltered q0.95 area max wind speed	0.104	0.438
... lowpass filtered q0.99 geostr. and unfiltered q0.99 area max wind speed	0.014	0.369



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

- Size and surface conditions of triangles affect the correlations between quantile time series of geostrophic wind speed and of area maximum wind speed.
- In a two-way ANOVA it has been found that the effects of size and surface conditions are independent.
- The figure below shows mean correlations for the 0.95-quantiles.



➡ Geostrophic wind from sea triangles reflects storm activity better than geostrophic wind from land triangles.

➡ Smaller triangles lead to a better description of storminess than bigger triangles.

Differences in mean correlations between...	q0.5 geo/q0.5 area max	q0.9 geo/q0.9 area max	q0.95 geo/ q0.95 area max	q0.99 geo/ q0.99 area max
...small and large triangles	0.483	0.365	0.356	0.316
...sea and land triangles	0.178	0.189	0.159	0.113

Summary

➡ The variation of strong geostrophic wind speed statistics describes the variation of ground level wind speed statistics.

➡ Annual quantiles of geostrophic wind speed and of atmospheric wind speed are linearly related.

➡ Geostrophic wind from sea triangles reflects storm activity better than geostrophic wind from land triangles.

References

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