# Northeast Atlantic Storminess and its Uncertainty in the late 19th and 20th Century

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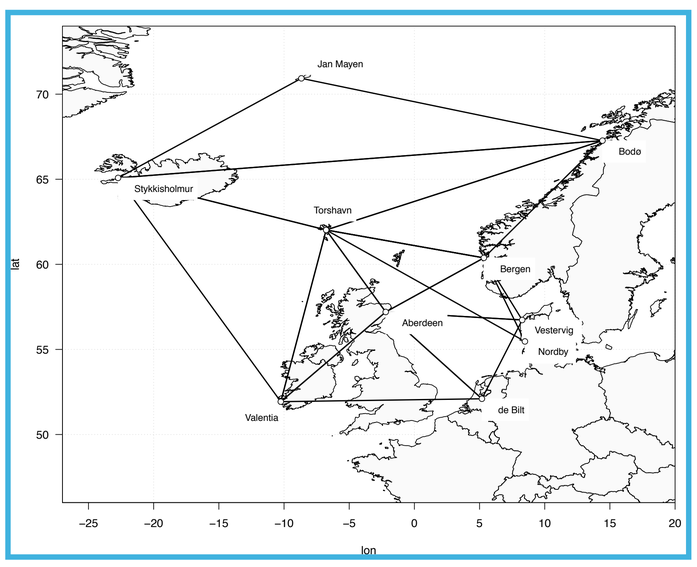
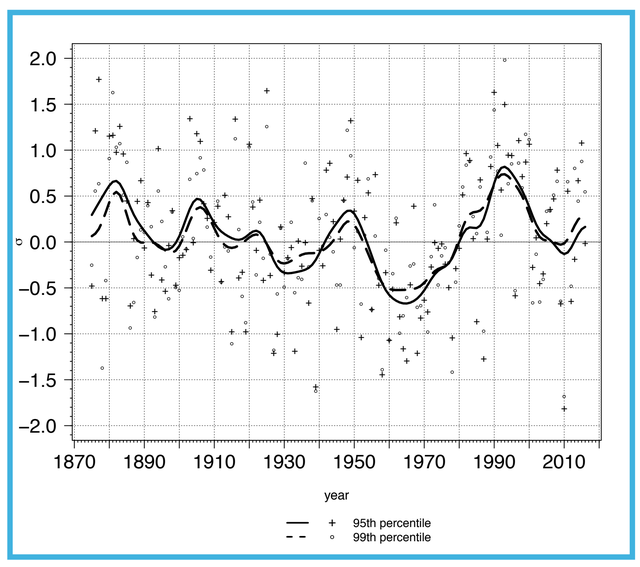
## Northeast Atlantic Storminess

Geostrophic wind speeds calculated from mean sea level pressure readings are used to derive time series of northeast Atlantic storminess following Alexandersson, et al. (1998, 2000). The technique of geostrophic wind speed triangles provides relatively homogeneous long-term storm activity data and is thus suited for statistical analyses. This study makes use of the time series of upper annual percentiles representative for northeast Atlantic storminess from 1875 until 2016 including uncertainty estimates.




Pressure observations from 10 stations have been used to derive geostrophic wind speeds from 10 triangles over northeast Atlantic and European regions.

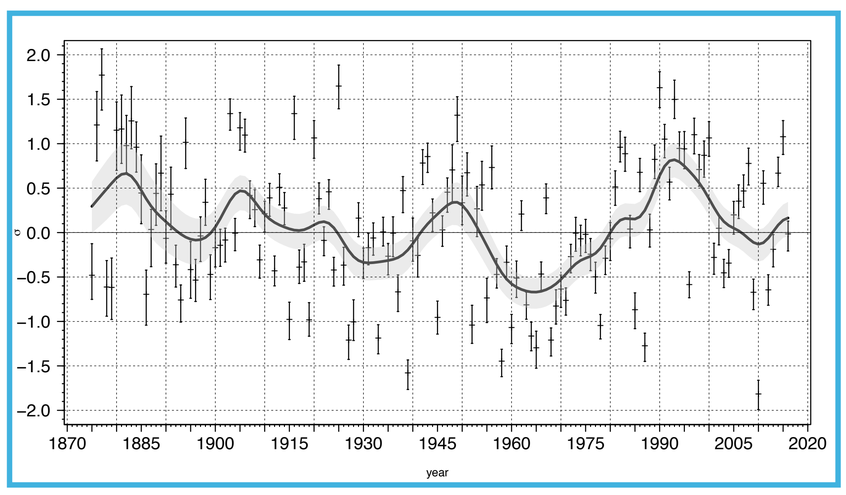



Standardized time series of annual 95th (plus-signs) and 99th (circles) percentiles of geostrophic wind speeds averaged over 10 triangles in the northeast Atlantic. Bold and dashed lines denote lowpass filtered time series.

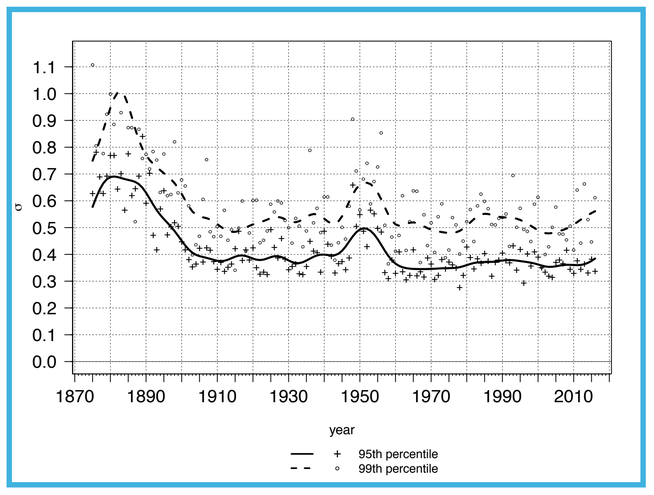
## Uncertainty

Uncertainty is considered through a bootstrapping approach, for which a yearly data availability of at least 80 % is assumed, thereby creating an ensemble of 100,000 yearly time series.

Sources of uncertainty include digitization errors, sampling errors, conversion errors, errors due to measurement routines. We use metadata of the Twentieth Century Reanalysis dataset 20CR to identify erroneous air pressure readings.




Uncertainty estimates for northeast Atlantic storminess time series based on annual 95th percentiles of geostrophic wind speed. Lines indicate Gaussian lowpass-filtered time series including a 95 %-confidence interval




Range of the 95 %-confidence interval of the annual uncertainty estimates for northeast Atlantic storminess time series for the annual 95th and 99th percentiles of geostrophic wind speed.

## Connection to the North Atlantic Oscillation

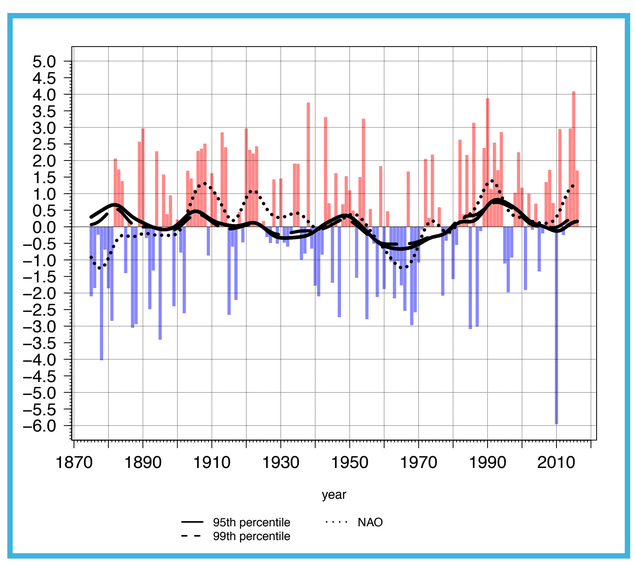
We make use of the annual and seasonal station-based NAO-indices and of annual and seasonal NE Atlantic storminess time series to gauge the link between the North Atlantic Oscillation and storminess over the northeast Atlantic.

The time series share common characteristics, such as the increase from the 1960s to the 1990s, or the interdecadal variability.

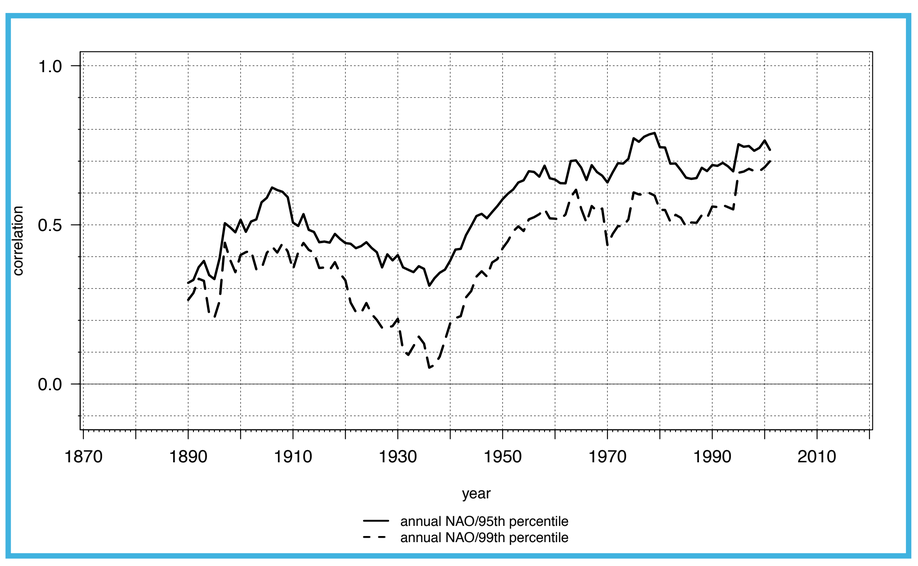
However, the link between the NAO and storm activity is not constant, likely indicating shifted centers of the NAO dipole or the presence of other modes of variability.

| correlation | MAM | JJA | SON | DJF | annual |
|---|---|---|---|---|---|
| 95$^{th}$ percentiles | 0.3814 | 0.2077 | 0.1210 | 0.5641 | 0.5191 |
| 99$^{th}$ percentiles | 0.2294 | 0.2046 | 0.0548 | 0.4051 | 0.4388 |

Simultaneous correlation between the NAO index and northeast Atlantic storm activity time series for annual and seasonal scales for the period 1875-2016.




Annual NAO index and lowpass filtered time series of the NAO index, 95th and 99th annual percentiles of geostrophic wind speeds averaged over 10 triangles in the northeast Atlantic.




Running correlation between the annual NAO index and 95th and 99th annual percentiles of geostrophic wind speeds averaged over 10 triangles in the northeast Atlantic. The correlation has been calculated in a moving window of 31 years.

- NE Atlantic storminess time series derived from upper annual percentiles of geostrophic wind speeds for the period 1875-2016.
- Uncertainty estimates derived through a bootstrapping approach revealing high uncertainty in the earlier years.
- NAO and storm activity share similarities, however results indicate that the link is not stationary.

References
- Alexandersson, H., H. Tuomenvirta, T. Schmith, and K. Iden, 2000: Trends of storms in NW Europe derived from an updated pressure data set. Climate Research, 14 (1), 71–73.
- Feser, F., M. Barcikowska, O. Krueger, F. Schenk, R. Weisse, and L. Xia, 2015: Storminess over the north atlantic and northwestern europe—a review. Quarterly Journal of the Royal Meteoro- logical Society, 141 (687), 350–382.
- Krueger, O., F. Feser, R. Weisse, 2018: Northeast Atlantic Storm Activity and its Uncertainty from the late 19th to the 21st Century", Journal of Climate, under review

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