

The most straightforward approach for detecting multidecadal changes in extratropical storminess would be to analyse wind time series recorded at weather stations or to examine the output of reanalyses. Unfortunately, both approaches suffer from a key limitation, namely that of a lack of homogeneity. On the one hand, because of modifications of the instrumentation, or of the surrounding of the weather stations and other artifacts. On the other hand, in the case of reanalyses, the density of the observational network and types of sensors, whose data are processed in the reanalysis, change over time. We provide examples for demonstrating this effect.

Two alternative, more indirect methods have been implemented in recent years. One is estimating statistics of **geostrophic winds**, based on triangles of air pressure readings, and the other is **dynamical downscaling of large-scale components of reanalyses**. Both systems may be used to derive multi-decadal homogeneous estimates of storminess at mid- and high-latitudes. The two methods, geostrophic wind and downscaling, provide consistent assessments, namely that a general increase in the number of storms cannot be detected until today.



A410-2812 - The challenge of detecting change in extratropical storminess

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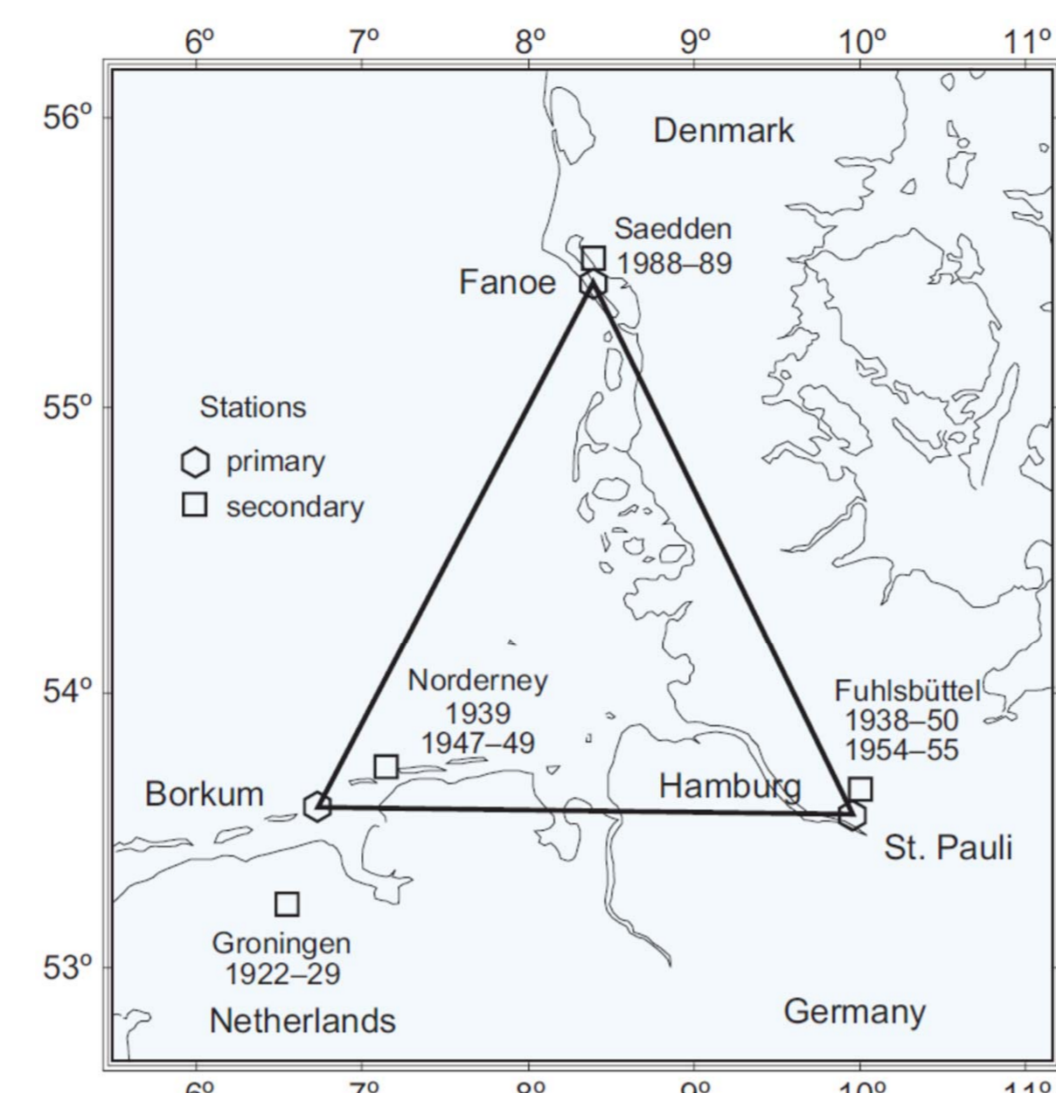


FIG. 1. Location of the meteorological stations from which pressure readings have been used to estimate geostrophic wind speed in the German Bight from 1876 to 1989.

- Air pressure readings are relatively robust and available for a long period of time.
- Variations of seasonal statistics of geostrophic wind, derived from triangles of local air pressure correlate well with such statistics of wind data in re-analysis.
- Thus changing geostrophic wind statistics are a good proxy for real wind stats changes.

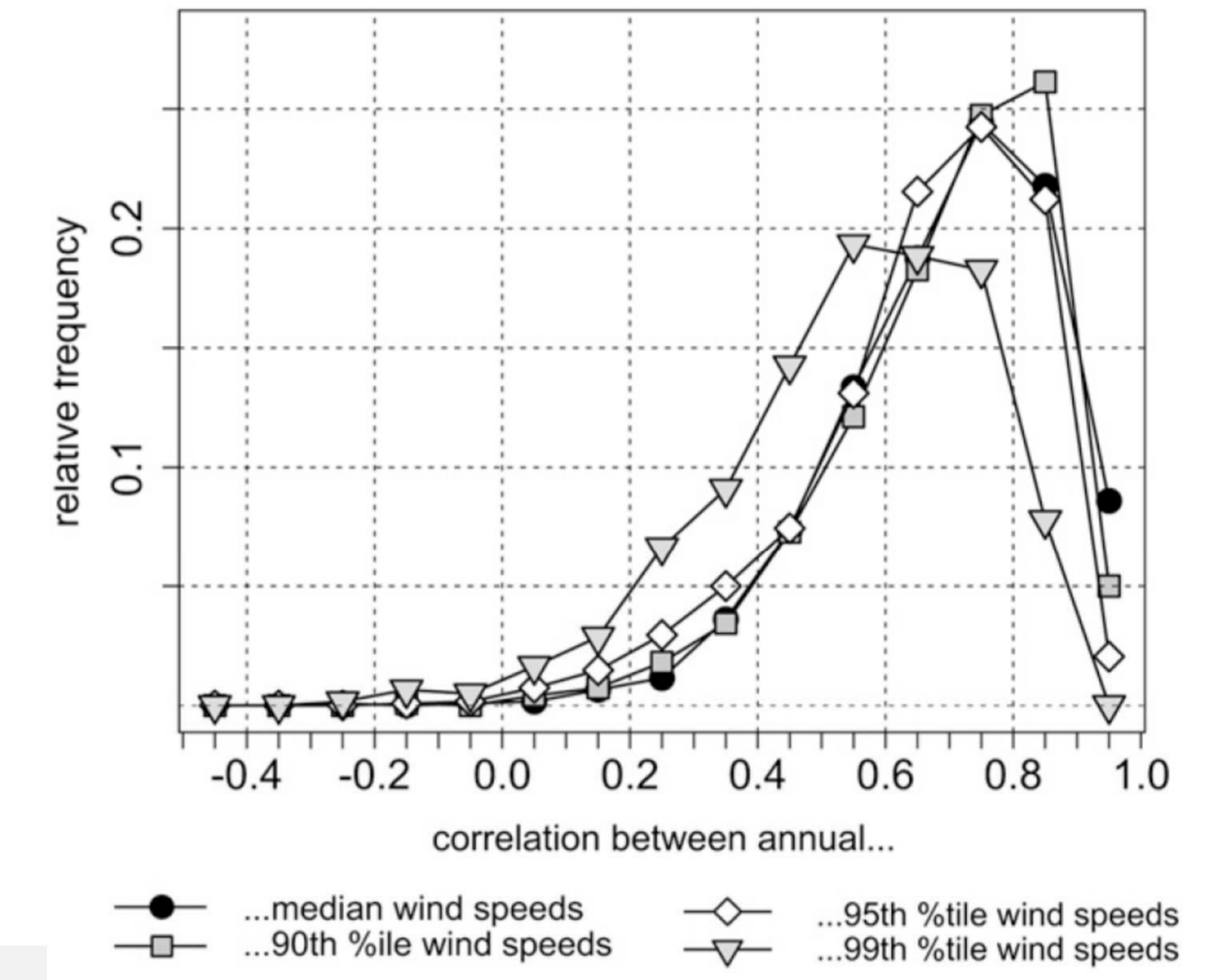
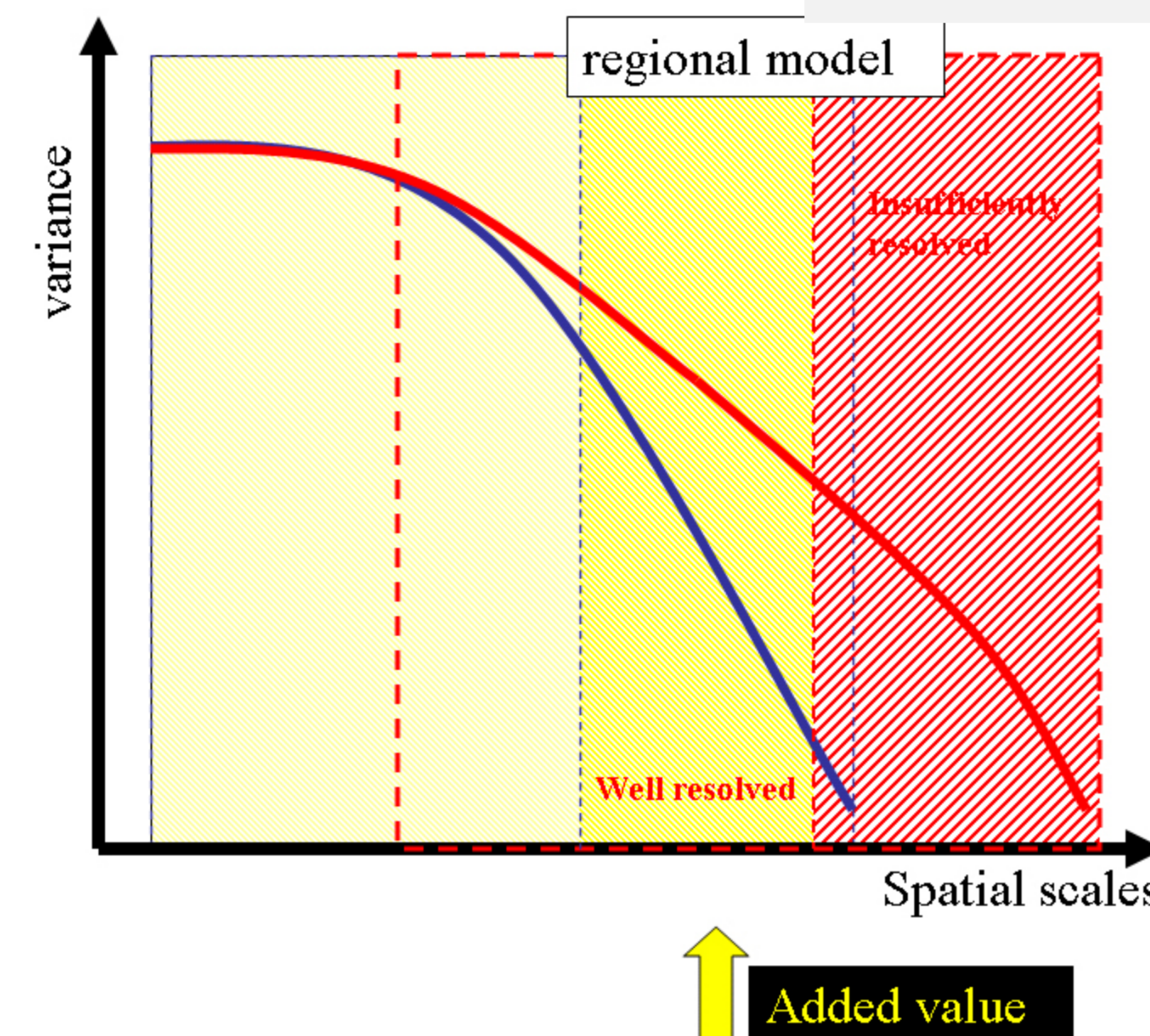
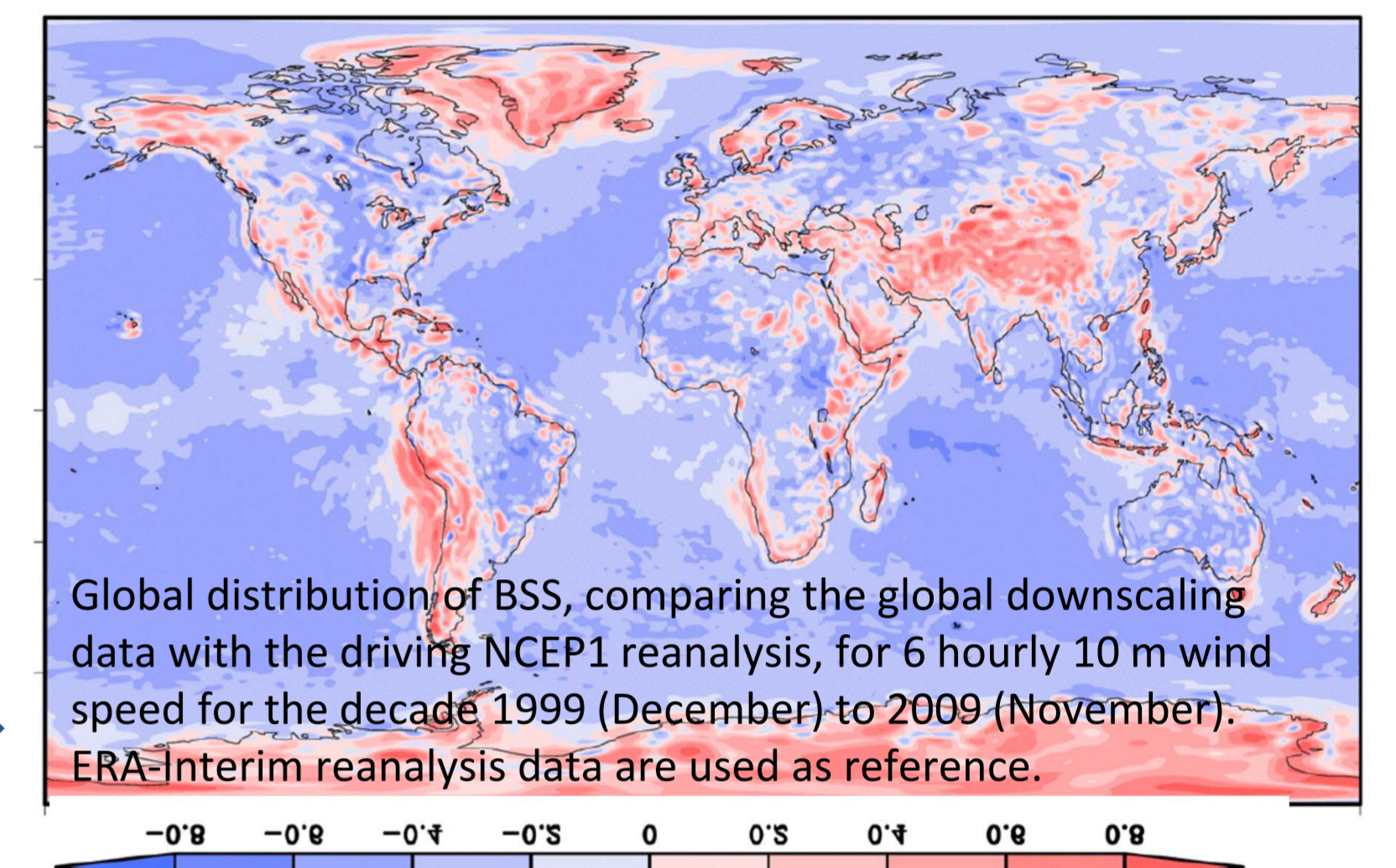


FIG. 2. Histograms of correlations between different percentile time series of geostrophic and of area-maximum surface wind speeds.



When constraining a global or regional model with large-scale re-analysis data (spectral nudging) small scale variations, including wind, are generated.



von Storch, H., H. Langenberg and F. Feser, 2000: A spectral nudging technique for dynamical downscaling purposes. *Mon. Wea. Rev.* 128: 3664-3673
von Storch, H., F. Feser, B. Geyer, K. Klehmet, Li D., B. Rockel, M. Schubert-Frisius, N. Tim, and E. Zorita, 2017: Regional re-analysis without local data - exploiting the downscaling paradigm. *J. Geophys. Res. - Atmospheres* 122, 8631-8649, DOI:10.1002/2016JD026332

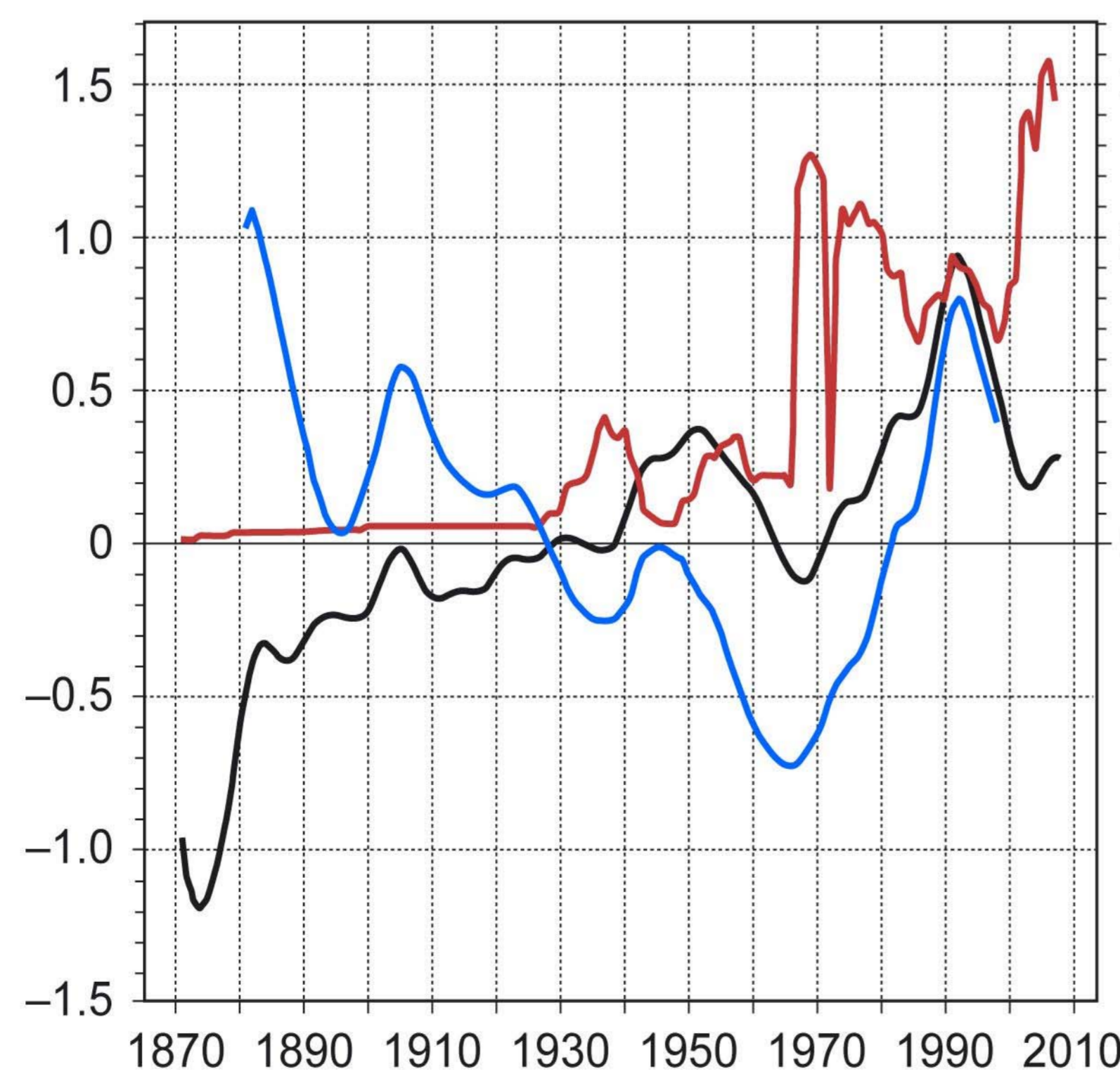
Krüger, O., F. Schenk, F. Feser, and R. Weisse, 2013: Inconsistencies between long-term trends in storminess derived from the 20CR reanalysis and observations. *J. Climate* doi: <http://dx.doi.org/10.1175/JCLI-D-12-00309.1>

Are re-analyses, which process available local data through the 20th century, returning estimates of changing storminess?

- Recently, attempts were made to extend the practice of reanalysis, by assimilating local data into GCMs, to the time before upper-air data were routinely available (about 1949): Only surface data could be assimilated.
- Different reanalyses result in a broad scatter of states (and trends).
- When extracting from the re-analyses local air pressure data, consistent geostrophic wind statistics can be derived and compared with those obtained from observations.
- After 1949 the geostrophic wind statistics derived from the re-analyses vary similar to those derived from observations, but prior to 1949 substantial differences emerge.

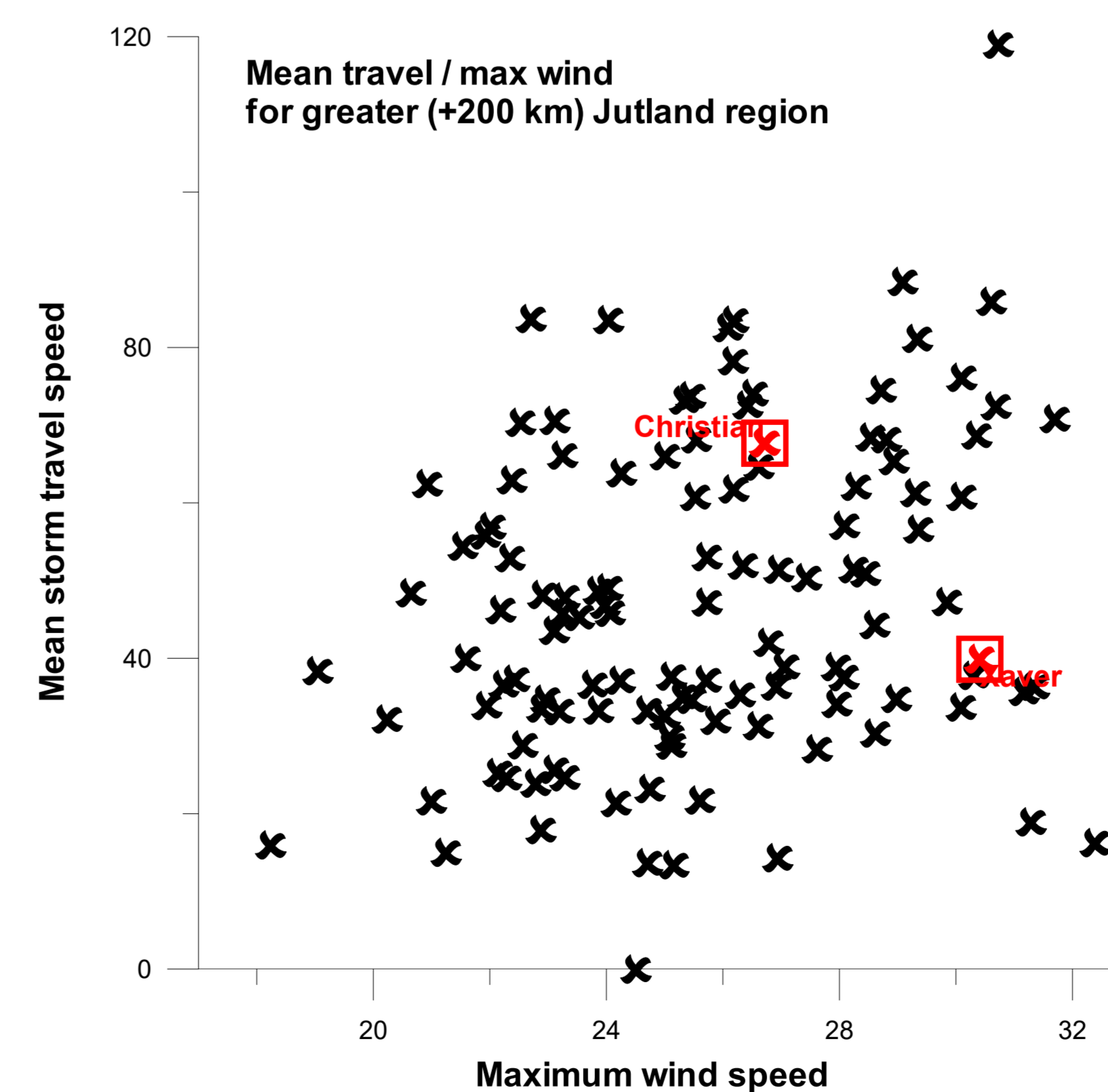
Thus, reanalyses based on local data sets with strongly varying densities are not suitable for reconstruction of storminess.

Example: Long-term NE Atlantic storm activity in one realization of the Twentieth Century Reanalysis dataset 20CR (black) and that derived from station-based geostrophic wind speed. Number of available data in red.



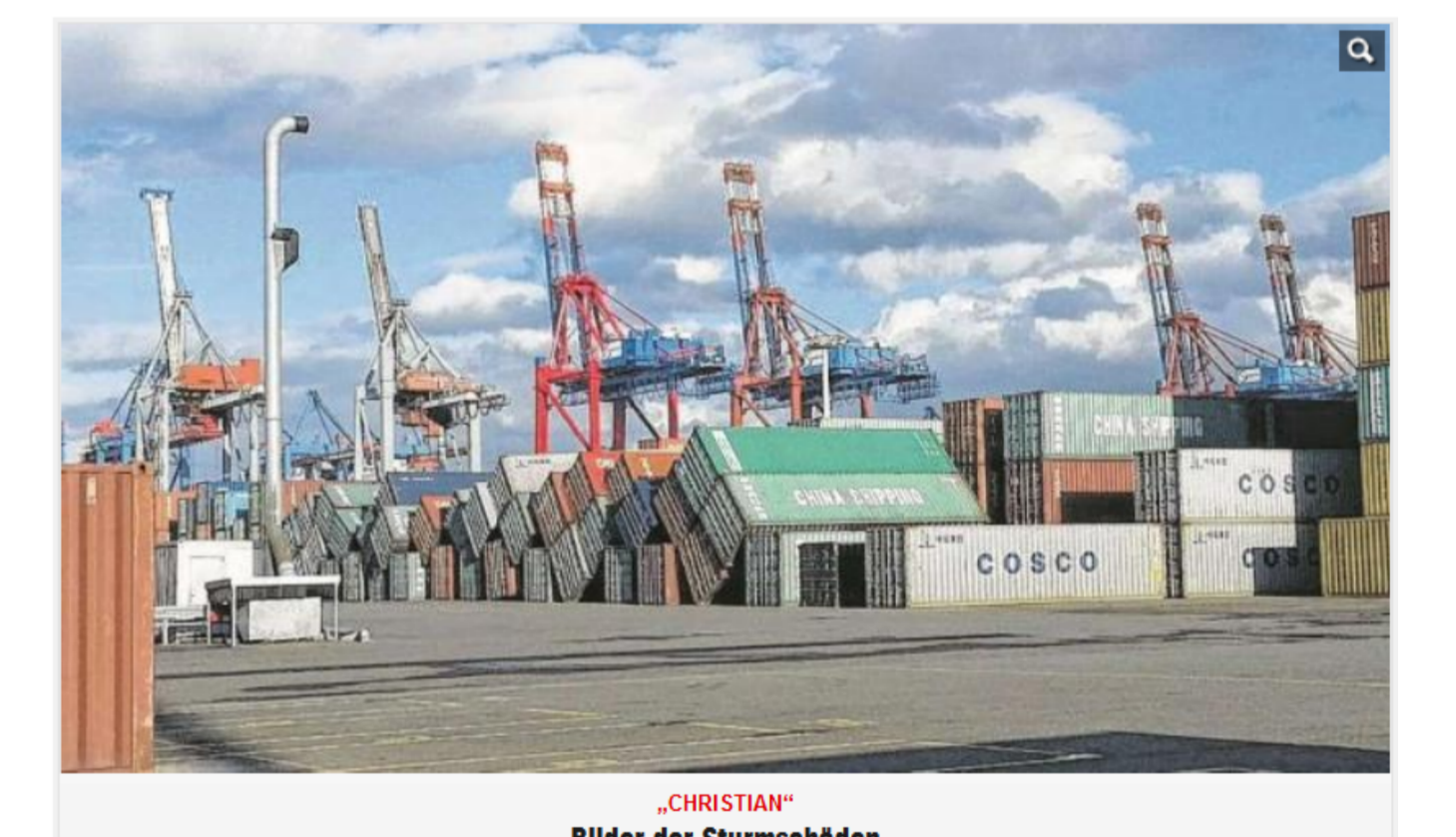
Were the recent storms “Christian” and “Xaver” really extraordinary or merely “rare” events?

- Long term wind statistics only available a for a limited time at some locations, with unclear issue of homogeneity.
- In downscaled high-resolution “re-analysis”, the storm is well reproduced.
- Compared to other storms in this “re-analysis”, both storms do not appear of being inconsistent with storms in the past 60 years, albeit rare.
- Same for earlier storm Xaver
- Thus, **no evidence for a claim of changing Northern European storms.**

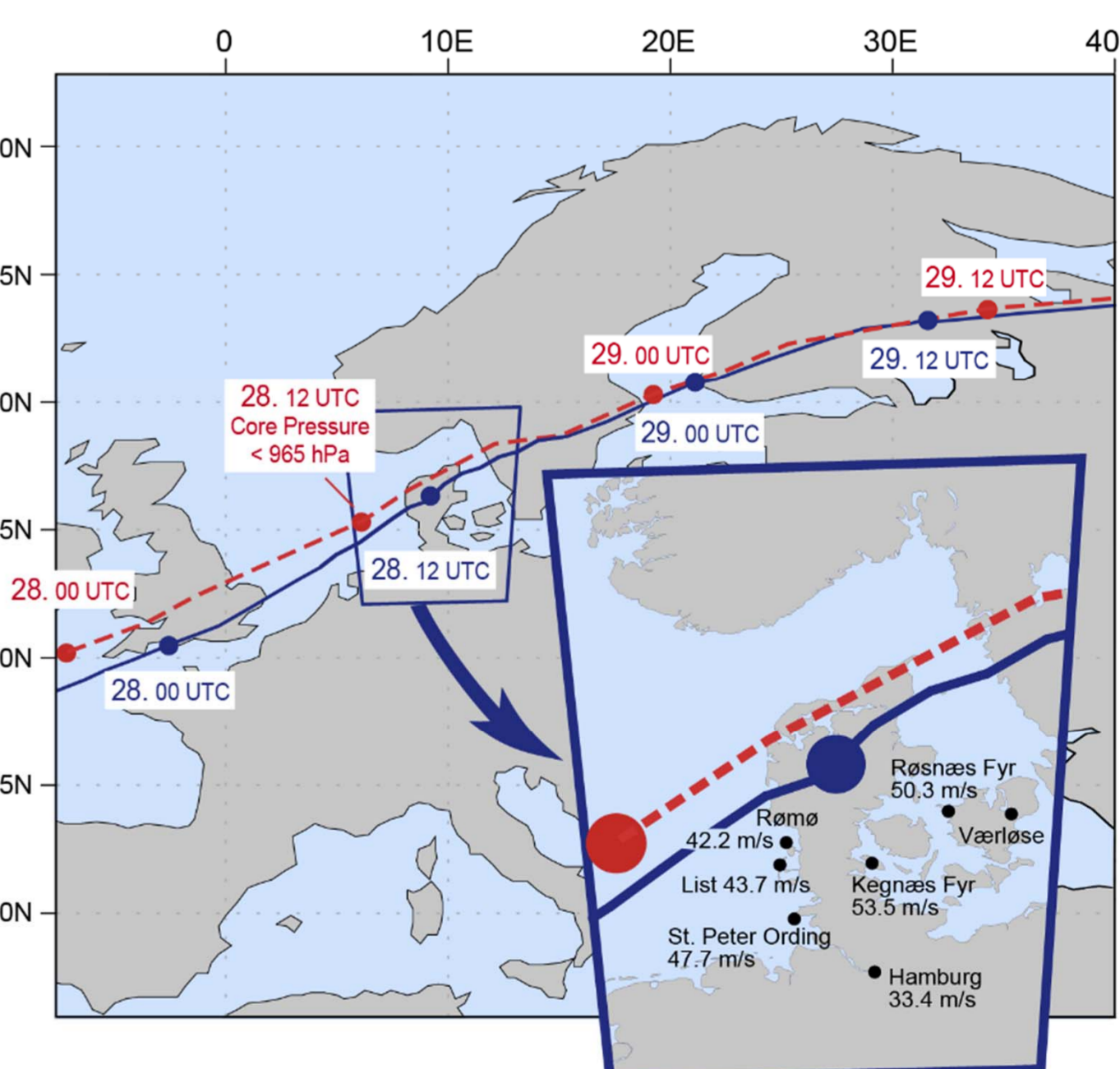


ORKANTIEF „CHRISTIAN“

Mega-Sturm pustet ganze Stadt ins Chaos



„CHRISTIAN“ Bilder der Sturmschäden



Track of the Christian/Allan storm according to an analysis by DWD (German National Meteorological Service) (red, dashed) and to the reconstruction in CoastDat (blue, continuous). The box, showing the mentioned stations with measured peak gusts, marks the area for the storm statistics.