EGU22-7828

HomogWS-se: A century-long homogenized dataset of near-surface wind speed observations since 1925 rescued in Sweden

Chunlüe Zhou[1,*], Cesar Azorin-Molina[2], Erik Engström[3], Lorenzo Minola[1], Lennart Wern[3], Sverker Hellström[3], Jessika Lönn[1], and Deliang Chen[1]

[1]RCG-GU, [2]CSIC, [3]SMHI,[*]chunluezhou@gmail.com

2022-05-27

Related Presentation: EGU22 -7366

CL5.3.5: Climate Data Homogenization and Analysis of Climate Variability, Trends and Extremes

Background

A joint project '**Assessing centennial wind speed variability from a historical weather data rescue project in Sweden (WINDGUST)**' (Grant #2019-00509) among the Swedish Meteorological and Hydrological Institute (SMHI), the University of Gothenburg, and the Spanish National Research Council, funded by Swedish FORMAS.

Objective 1: To rescue historical wind speed series available in the old weather archives at the SMHI for the 1920s-1930s. (*Work package 1*).

Objective 2: To quality control and homogenize rescued wind speed series from anemometer observations across Sweden. (*Work package 2*).

Objective 3: To assess and attribute centennial wind speed trends / variability in Sweden over centennial timescales (i.e., 1920-2018) never explored before (*Work package 3*).

Open Access Earth System Science Data

Zhou, C., Azorin-Molina, C., Engström, E., Minola, L., Wern, L., Hellström, S., Lönn, J., and Chen, D.: HomogWS-se: A century-long homogenized dataset of near-surface wind speed observations since 1925 rescued in Sweden, Earth Syst. Sci. Data, 14, 2167–2177, 2022.

HomogWS-se data set is publicly available at https://doi.org/10.5281/zenodo.5850264.

Background

- IPCC AR6 clearly stated that the ‘low to medium’ confidence in historical wind speed (WS) change and its causes is primarily due to the short duration and inhomogeneity of the observed WS series.
- The short duration of the current WS series typically does not cover a full cycle of multidecadal atmospheric modes with a periodicity of 60-80 years, e.g., North Atlantic Oscillation (NAO) for Sweden, leading to large uncertainties in detection and attribution of the recent WS stilling and recovery.
- Improving our knowledge of historical WS change and variability requires us to rescue early (1920s-1950s) WS measurements recorded in meteorological notebooks (Fig. 1).

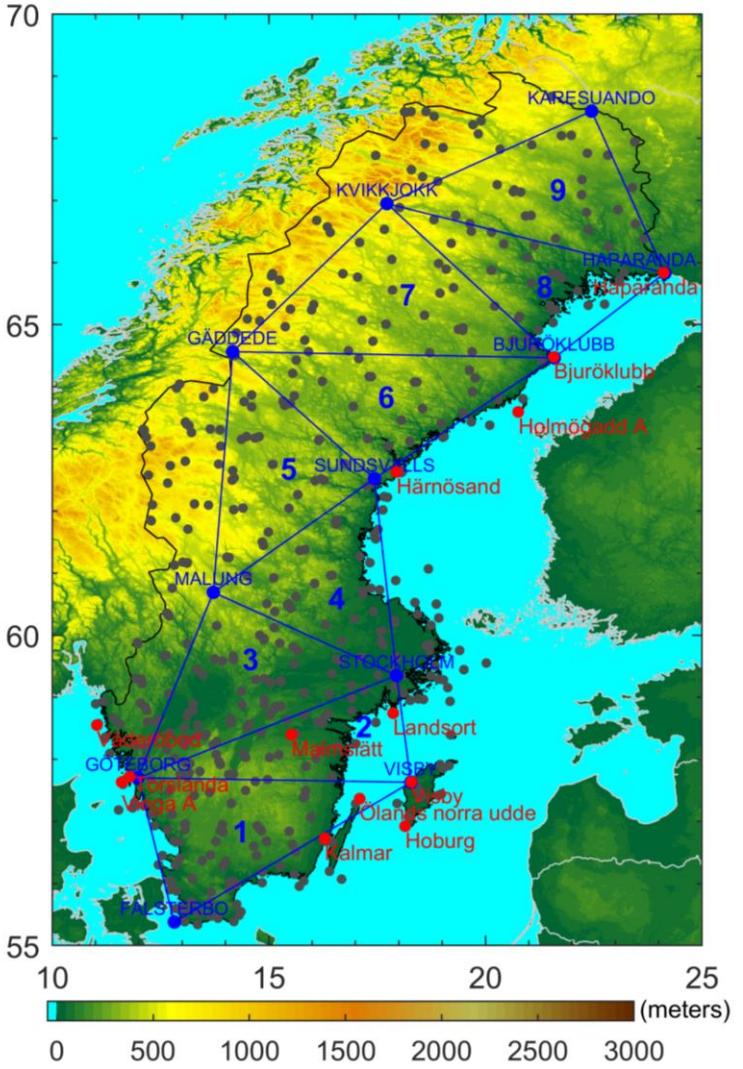


Fig. 1 Map of the 13 rescued stations (red); Nine pressure triangles (blue lines) for calculating geowind; Other stations with available data since 1950s (grey).

Background

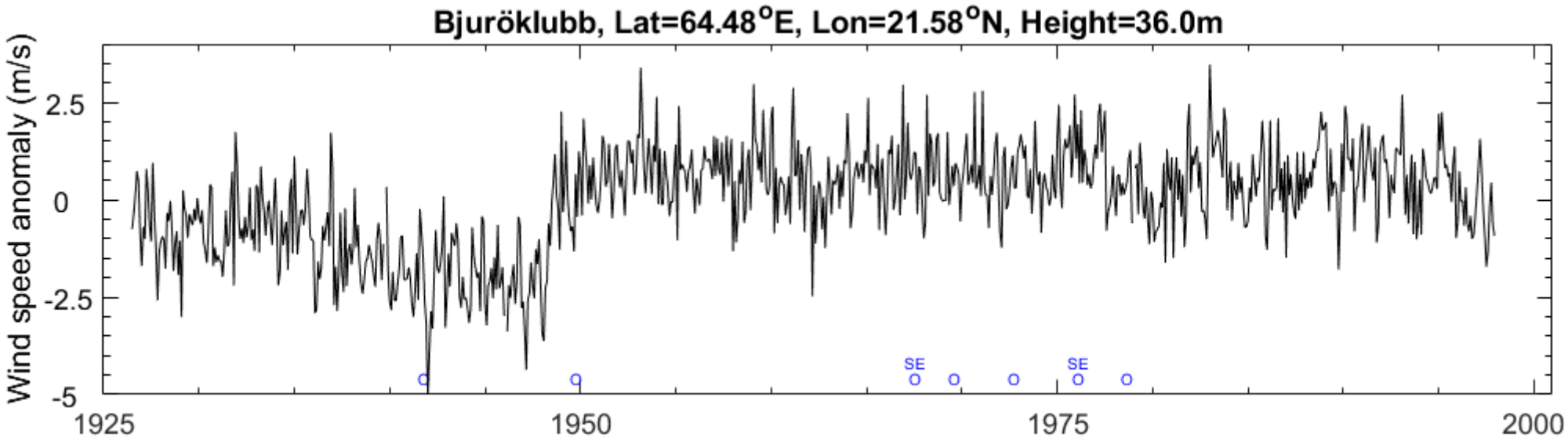


Fig. 2 One example of raw monthly wind speed anomaly series

Metadata events: ‘O’ represents a change in the observatory and ‘SE’ shows changes in the surrounding environments.

Four-step Homogenization Method

1. **Construction of the difference series with a reference series:** The monthly difference series (WS_{raw} - WS_{rea}) was created as the raw rescued wind speed (WS_{raw}) minus the reanalysis wind speed (WS_{rea}, from CERA-20C and ERA5 due to be homogeneous and good validity, Fig. 3).

2. **Detection of change-points:** We applied the PMF test at a significance level of 0.05 to the WS_{raw} - WS_{rea} series, for statistically detecting possible change-point dates. For comparison, the PMT test at a significance level of 0.01 was also applied.

3. **Adjustment of the discontinuities:** The mean-matching algorithm was applied to the WS_{raw} - WS_{rea} series to adjust the detected discontinuities. Up to 5 years of data before and after each change-point were used to adjust the discontinuities, with the last segment as the baseline.

4. **Creation of the homogenized series:** by adding the homogenized difference series and the WS_{rea} series.

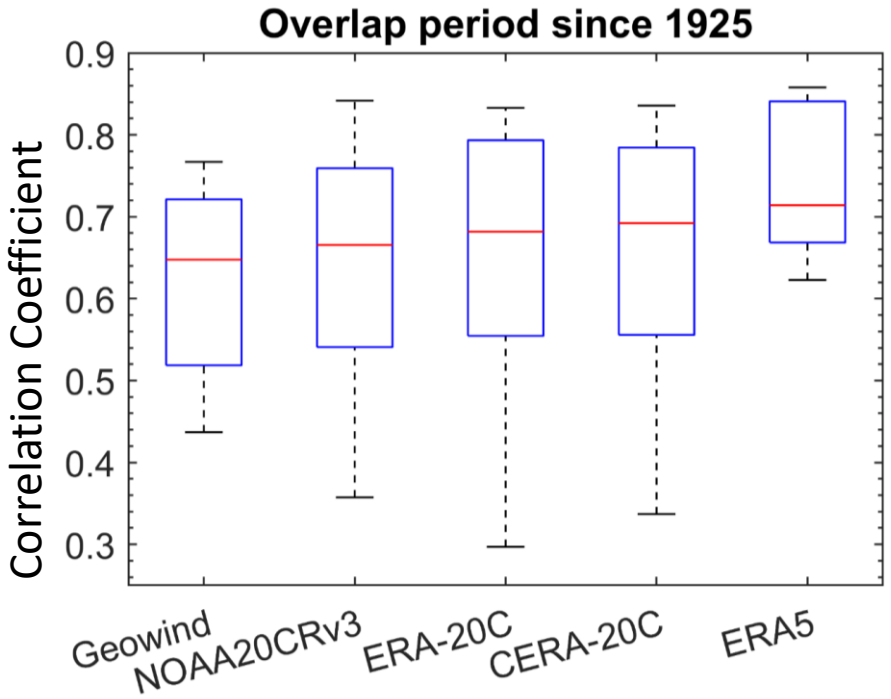


Fig. 3 Box plot for correlation coefficients of monthly WS anomaly series between the rescued data at the 13 stations and the geowind or reanalysis data at the collocated grids.

Changepoint Detection

- The PMF test at a significance level of 0.05 was applied to the WS_{raw} - WS_{rea} series to detect spurious change-points. The PMT test yielded similar results as in Fig. 4.
- Results identified 71 change-points in total for all the 13 stations, with a mean segment length of approximately 11.3 years. Histogram of years with detected change-points shows three peaks, i.e., 1935-1944, 1956-1964, and the 1985s.
- Approximately 38% of our detected change-points are confirmed by the known events recorded in the collected metadata.

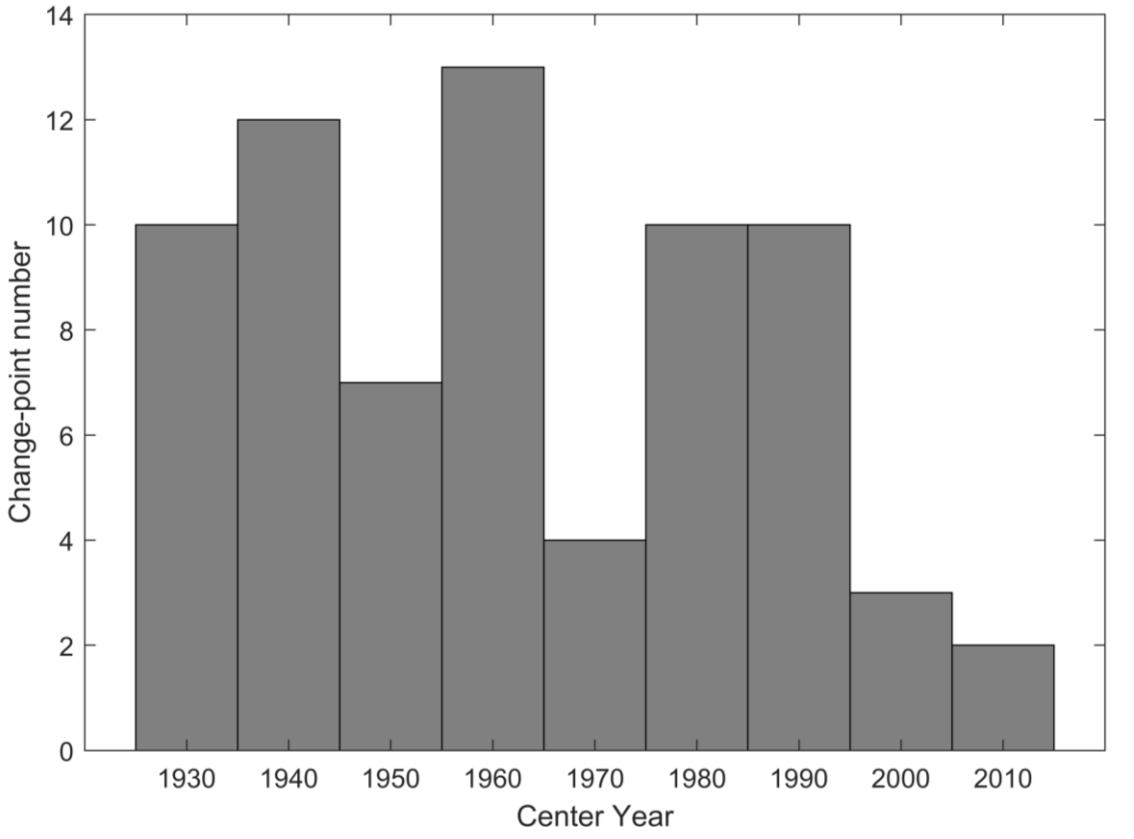


Fig. 4 Histogram of the years of the detected change-points.

Discontinuity Adjustment

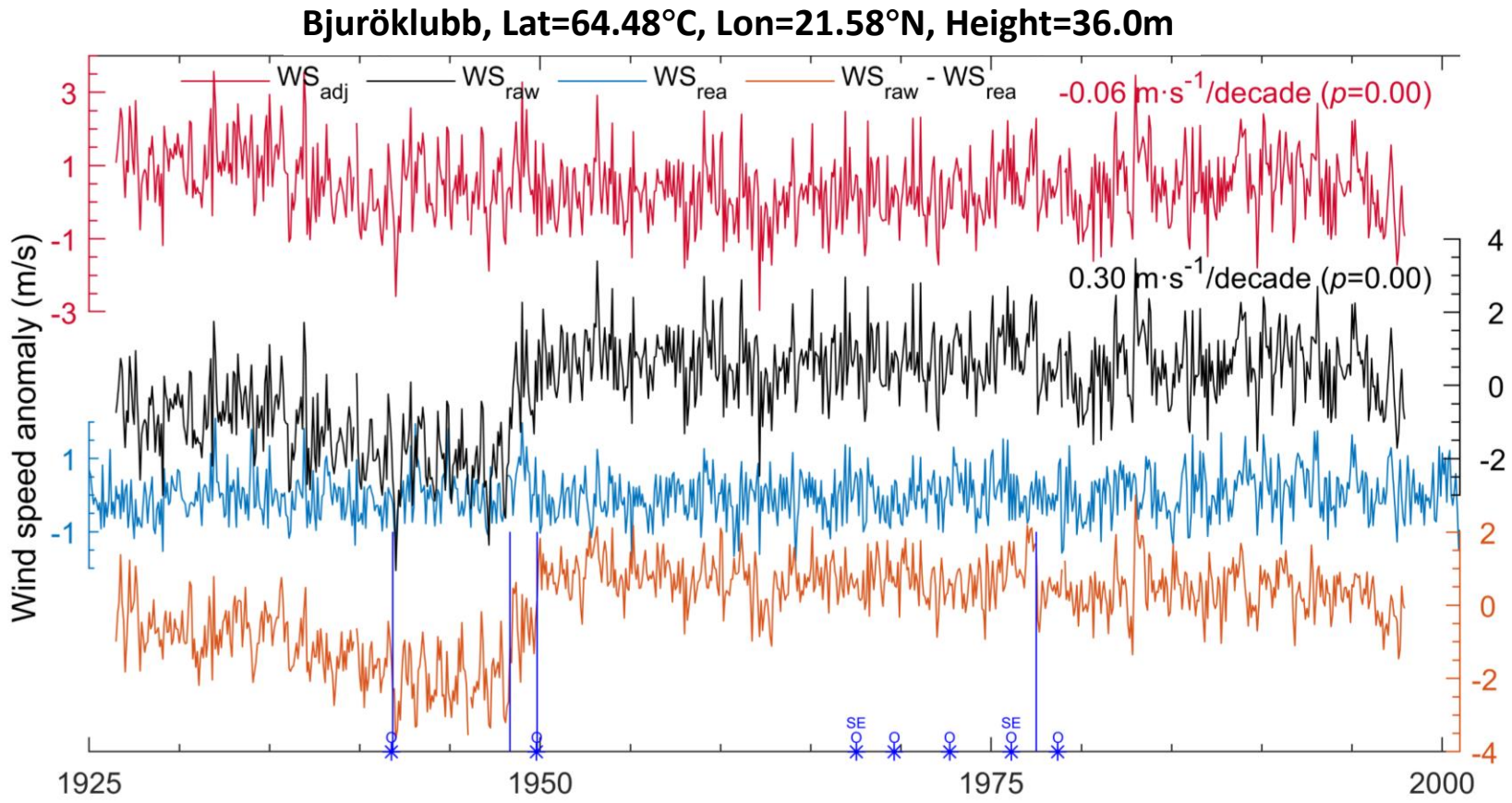
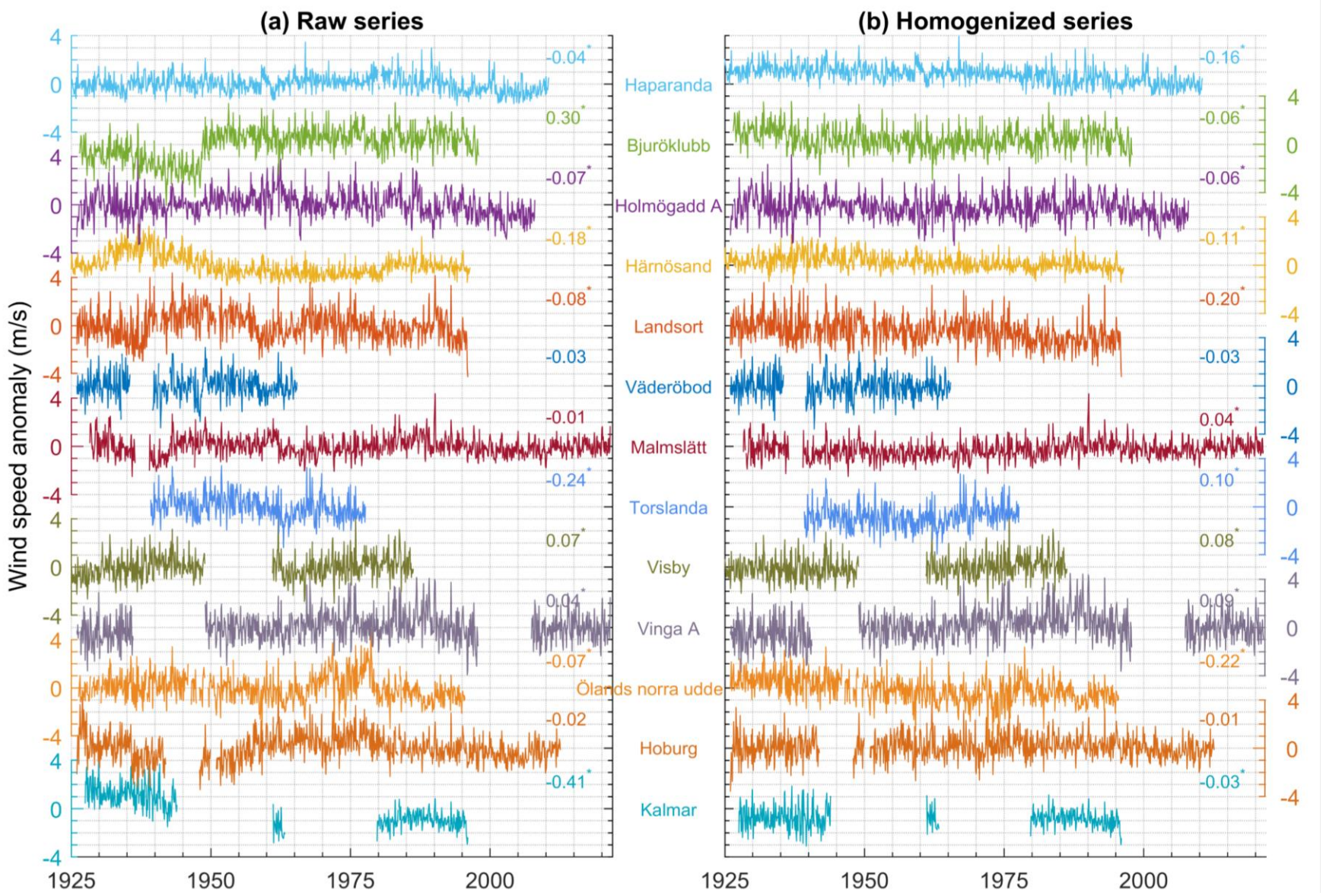


Fig. 5 One example to illustrate the homogenization process and result.

Black, blue and red lines are raw (WS_{raw}), reanalysis (WS_{rea}) and adjusted (WS_{adj}) series of monthly WS anomaly, respectively. Their WS trends are shown in the top right. Blue vertical lines show the detected change-point dates, and 'O' represents a change in the observatory and 'SE' shows changes in the surrounding environments.

Comparison of raw and homogenized wind speed series



Impacts of homogenization

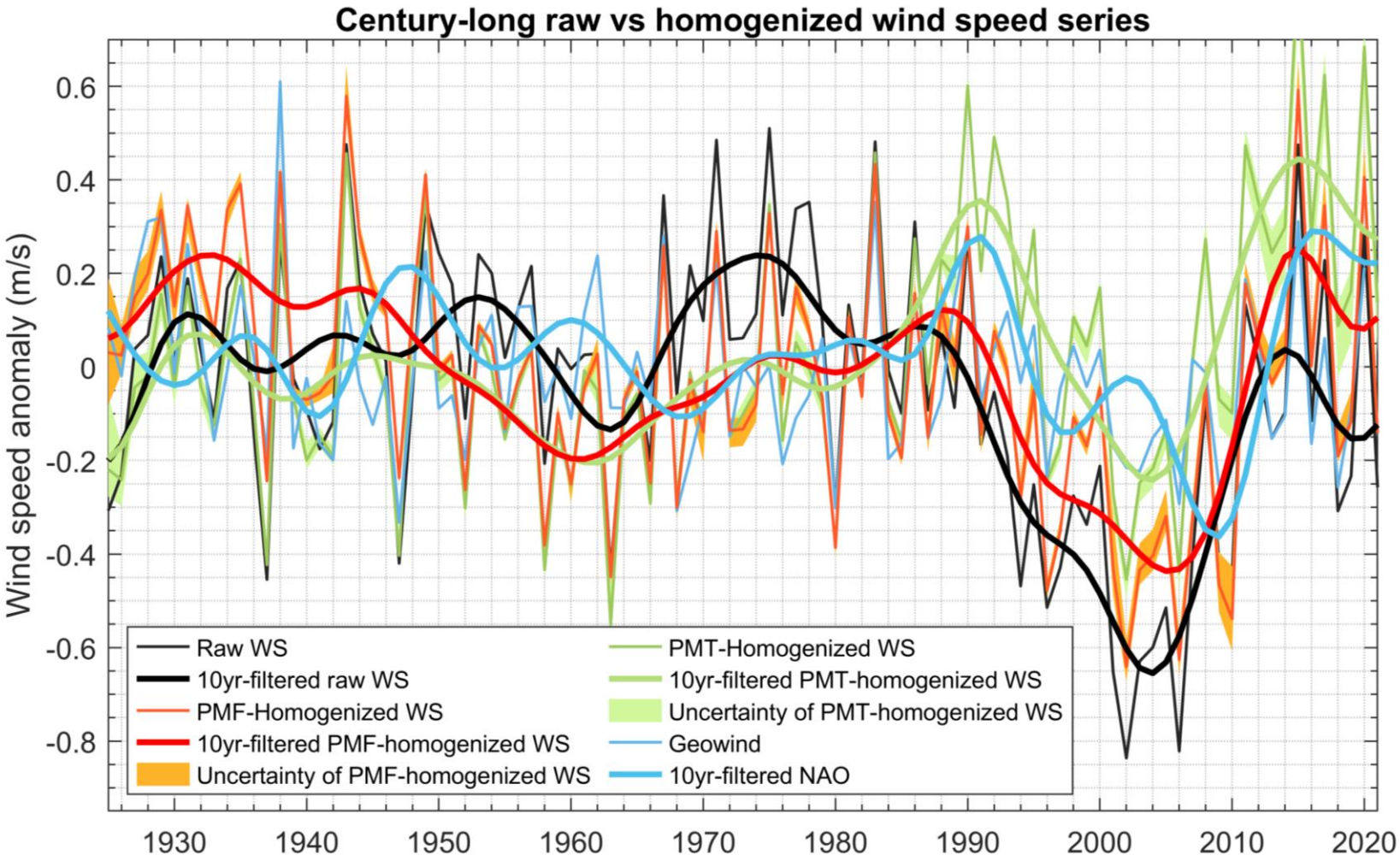


Fig. 7 Comparison of raw vs. homogenized WS series averaged at the 13 stations. Shadings are the uncertainties of the homogenized data. Geowind is shown on the North Atlantic Oscillation (NAO) to depict the signal of internal climate variability.

- Before and after adjustment, the signs and amplitudes of the multidecadal trends changed significantly, especially for early periods.
- During the period from 1990 to 2005, the magnitude of the wind stilling trend decreased by 25%, to -0.35 $m \cdot s^{-1}$/10a ($p < 0.05$), after adjustments.
- Decadal correlation between the NAO and WS series increased from 0.29 to 0.54 ($p < 0.05$) before and after adjustment.

Take-home message

- Creating a centennial homogenized wind speed observation dataset is essential for reliable detection and attribution of WS variability and change, evaluation and constraint of model simulations, and even various applications in energy industry, ecology and hydrology.
- The homogenized series presents an initial wind speed stilling and subsequent recovery until the 1990s, whereas the raw series fluctuates with no clear trend before the 1970s.
- The first 10-member centennial homogenized wind speed dataset in Sweden (HomogWS-se) is freely accessible at the Zenodo repository at http://doi.org/10.5281/zenodo.5850264.
- The proposed four-step homogenization procedure could help other countries or regions to rescue their early climate data and jointly build global long-term high-quality datasets.

EGU General Assembly 2022

Thank you for your attention!

Scan Me

Dr. Chunlüe Zhou
chunluezhou@gmail.com
https://www.researchgate.net/profile/Chunluee-Zhou

Open Access Earth System Science Data

Zhou, C., Azorin-Molina, C., Engström, E., Minola, L., Wern, L., Hellström, S., Lönn, J., and Chen, D.: HomogWS-se: A century-long homogenized dataset of near-surface wind speed observations since 1925 rescued in Sweden, Earth Syst. Sci. Data, 14, 2167–2177, 2022.

HomogWS-se data set is publicly available at https://doi.org/10.5281/zenodo.5850264.