An assessment of long-term variability in the NAO, Azores High, and Iceland Low using North Atlantic winds from historical whaling ship logbooks and reanalyses

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Highlights

- **Historical maritime weather data from whaling ship logbooks can be quantified for comparison with instrumental data**
- **Whaling data could thus improve reanalysis and understanding of climate variability in the 19th century**
- **Differences to 20th Century Reanalysis likely due to limited data, confined region, and/or differing horizontal resolution**
- **Past variability in the Azores High influence on North Atlantic winds highlighted**

Methods

Focus on North Atlantic: 90°W – 0°E and 0°N-75°N

Wind data (speed and direction) is extracted from New England whaling ship logbooks. Wind speed is converted to the Beaufort wind force scale. Wind direction is categorised into 12.5-degree boxes.

The 20th century reanalysis data (20cr; Compo et al., 2011) (monthly mean, daily, individual ensemble members) is used to determine the Azores High (AH) index, as well as to compare and validate the logbook entries. Therefore, it is also converted to the Beaufort wind force scale.

The North Atlantic Oscillation (NAO) index from Jones et al. (1997) is used.

AH index is calculated by determining the size of the AH in a fixed area (10°N-52°N and 60°W-10°E), big/small AHs are determined by taking the 20th percentiles of the AH's size during the whaling period (1826-1914). Winter is neglected for the NAO and AH analysis (Figure 5-9).

Background

Past: Few Observations
→limited knowledge about past climate / climate variability

Whaling Logbooks might help to fill this gap

They provide data for the period **1826 - 1914**

Approx. **11,110** entries are extracted providing information about the **North Atlantic** region

More data is available in **Summer & Fall** as the amount of data points varies seasonally

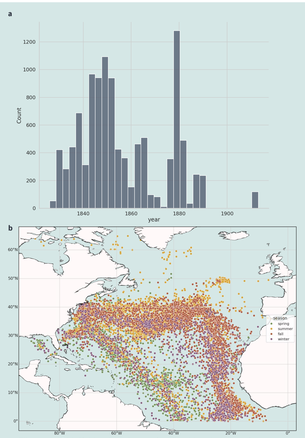

Figure 1 | Valid logbook entries for North Atlantic. **a**, over time. **b**, by season.

Results

20cr and logbook data generally agree in North Atlantic wind speed.

- Winds observed by the whalers reflect their preferred routes across the North Atlantic following the predominant wind patterns
- No higher wind speeds than 10 Beaufort recorded (possibly due to active avoidance of storm seasons and/or potential survivorship bias)

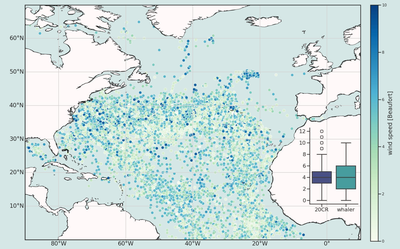

Figure 2 | North Atlantic datapoints, colours indicate windspeed. Box and Whisker plot shows wind speed distribution.

- All 20cr ensemble member data points are used, that match in location and time
- In first half of 19th century, differences between 20cr and whaling records are larger, while they match well post-1850.

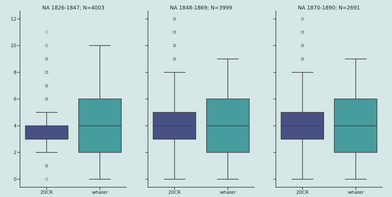

Figure 3 | North Atlantic (NA) wind speed distribution split into three intervals.

Generally expected North Atlantic wind patterns are reflected in whaling data.

- 20cr ensemble mean data points are used, that match in location and time.
- Boxes with a higher number of data points show generally higher agreement, than those with fewer values.
- Whaling data and 20cr generally agree on the wind direction.

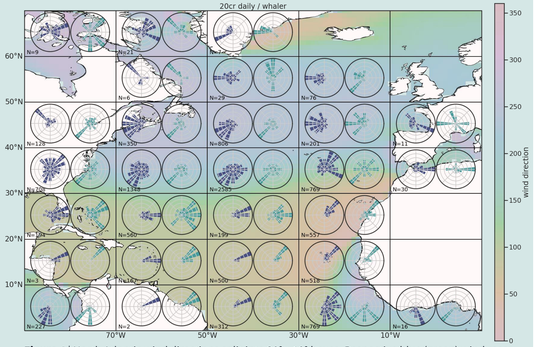

Figure 4 | North Atlantic wind directions split into 20° x 10° boxes. Respective blue (green) wind roses show 20cr (whaling) data. Background shading based on 20cr mean.

The number of big AHs increases with time.

The AH size is influenced by more than just the NAO state and can indicate various wind anomalies.

Figure 5 | **a**, Size of the Azores High Area (AHA). Red (green) line indicates the upper (lower) 20th percentile. **b**, number of big and small events per year.

Minor zonal mean wind differences are visible between big and neutral AH for both 20cr and whalers.

Figure 6 | **a**, whaling data during big AH events (scatter), wind anomaly compared to neutral events (shading). **b**, number of observations. **c**, zonal mean wind of whaling datapoints. **d**, same as c but for 20cr.

Whaling and 20cr data agree mostly during small AHs.

Figure 7 | same as Figure 6 but for small AH events.

Reasons for differences:

- Insufficient amount of whaling data available
- Datapoints are concentrated in an area, where a certain anomaly is expected
- 20cr ensemble mean only extends back to 1836

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More data is digitised, and new techniques for addressing data gaps are being developed.

The zonal mean winds during the positive and negative NAO phases strongly agree in regions with a sufficient amount of data.

Figure 8 | same as Figure 6 but for NAO positive phase.

Figure 9 | same as Figure 6 but for NAO negative phase.

Acknowledgements & References

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