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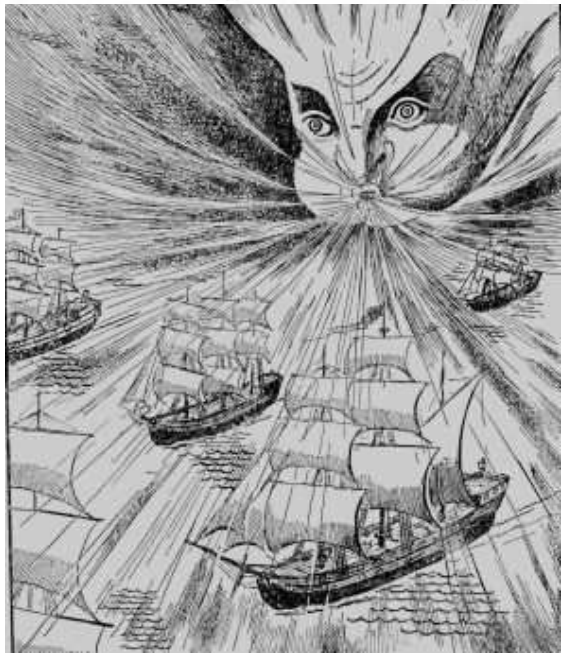

WESTERLY INDEX:

A quasi-instrumental climatic index for the North Atlantic westerlies (1685-2008)

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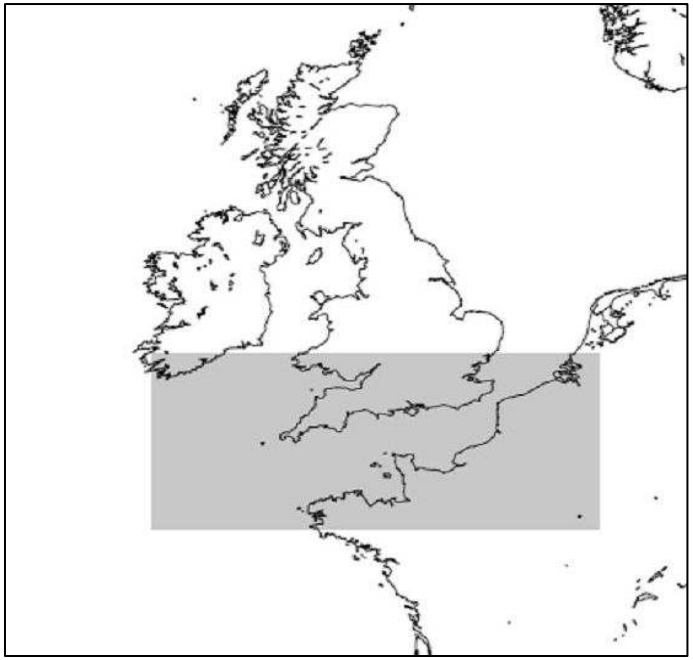
Introduction

How could we study the climatic effects of the westerlies' variability in the preinstrumental era without proxies?

Historical weather reports.

Ships' logbooks.

Area of Study

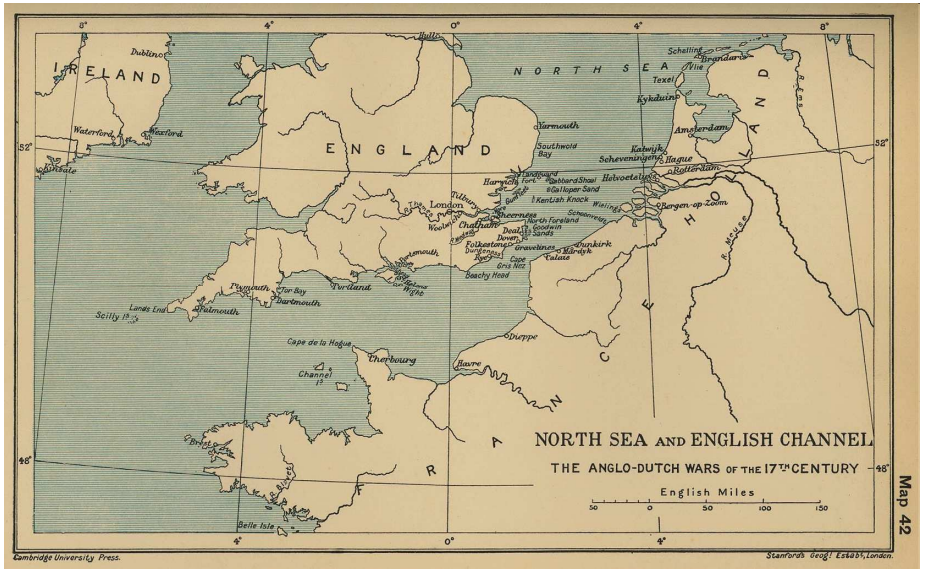


- English Channel was a strategically important area with intense maritime activity.

- In consequence, there is a large number of logbooks containing wind direction measures.

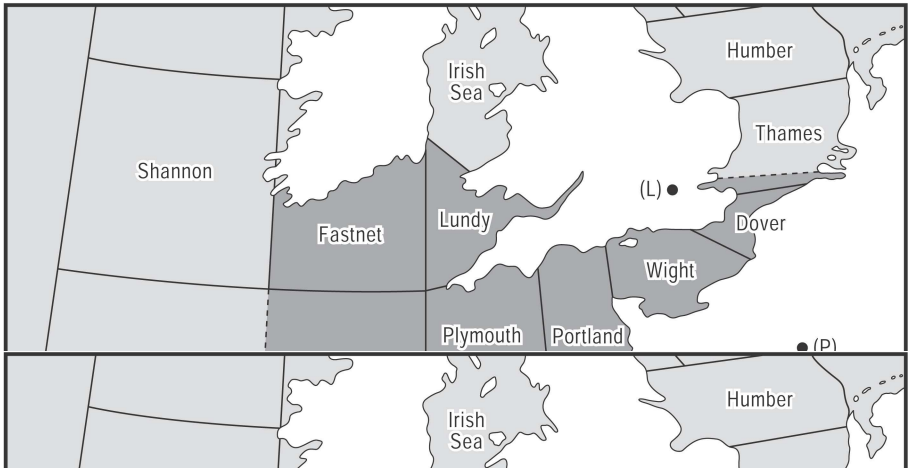
- To characterize the variability of the westerlies in the Northern Hemisphere in pre-instrumental times, the English Channel is a key zone.

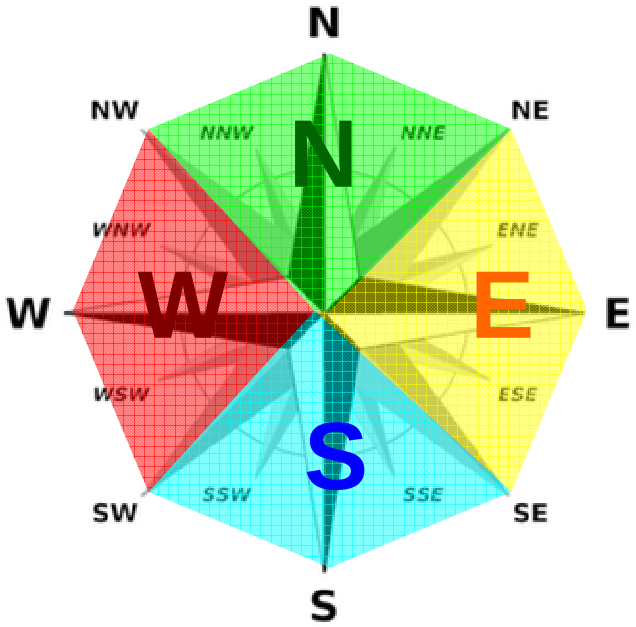
- Wind direction in this area provides a direct measure of the mid-latitude atmospheric circulation.



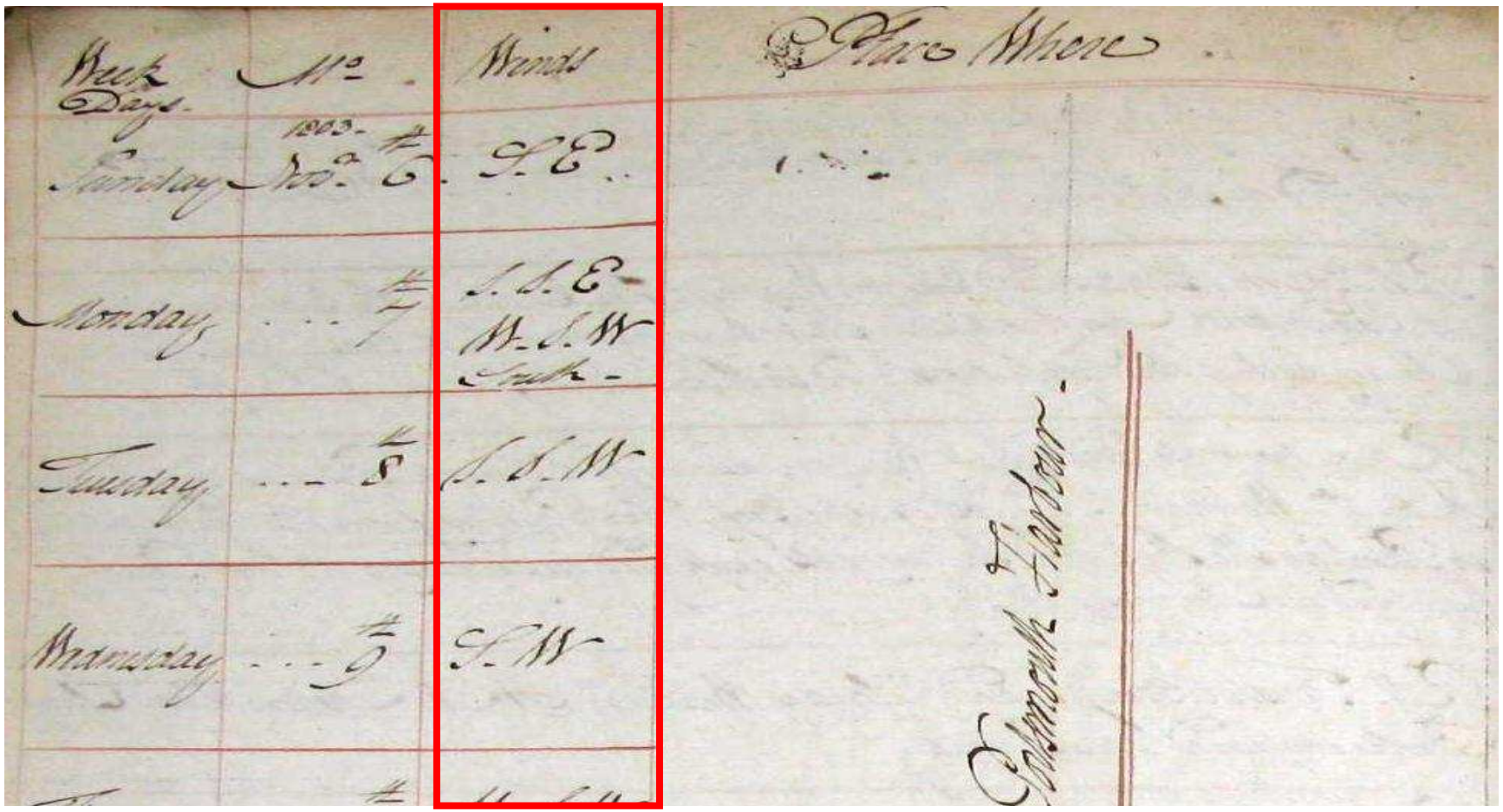
Defining the Index

- **Westerly Index (WI)** is defined as the proportion of days per month with prevailing wind coming from the west in a four point quadrant (wind blowing between 225 and 315 degrees) in the English Channel.



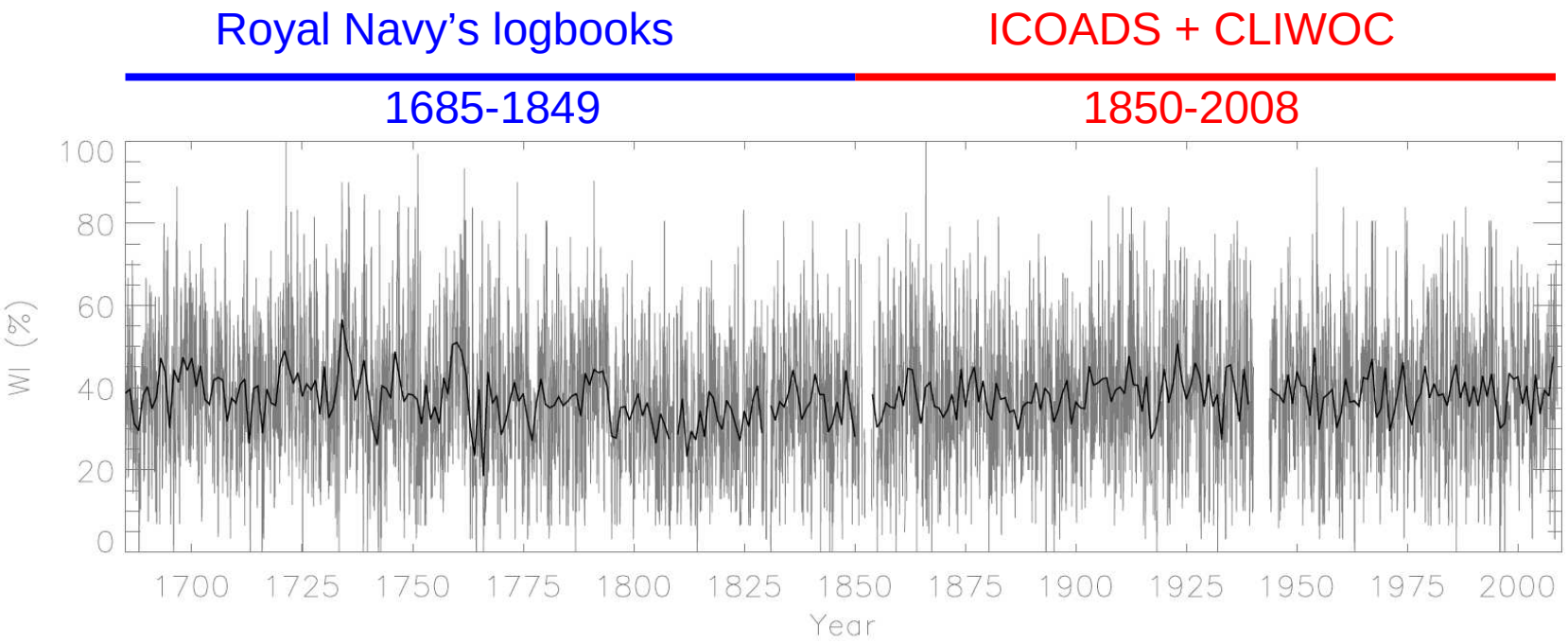


Defining the Index



The Westerly Index is based on wind direction measures and does not suffer from the transfer function problem that characterise the use of proxy data.

Defining the Index



Combining many logbooks and other sources, it has been possible to build a monthly Westerly Index (WI) back to 1685.

Data

ICOADS v2.1 and CLIWOC v1.5 databases provide a total of **3.392.640** records.

1850-2008

1685-1749

57,817 records of Royal Navy's Logbooks have been searched and digitized ad-hoc at The National Archives (UK).

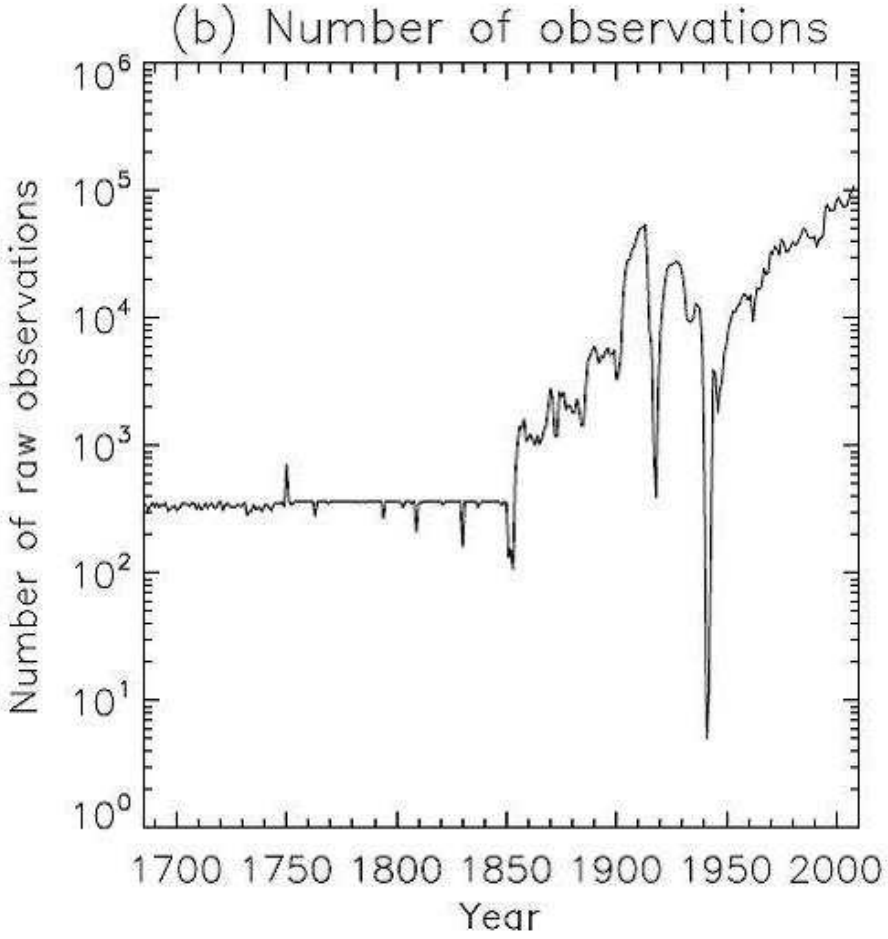
Data

Differences in data coverage density:

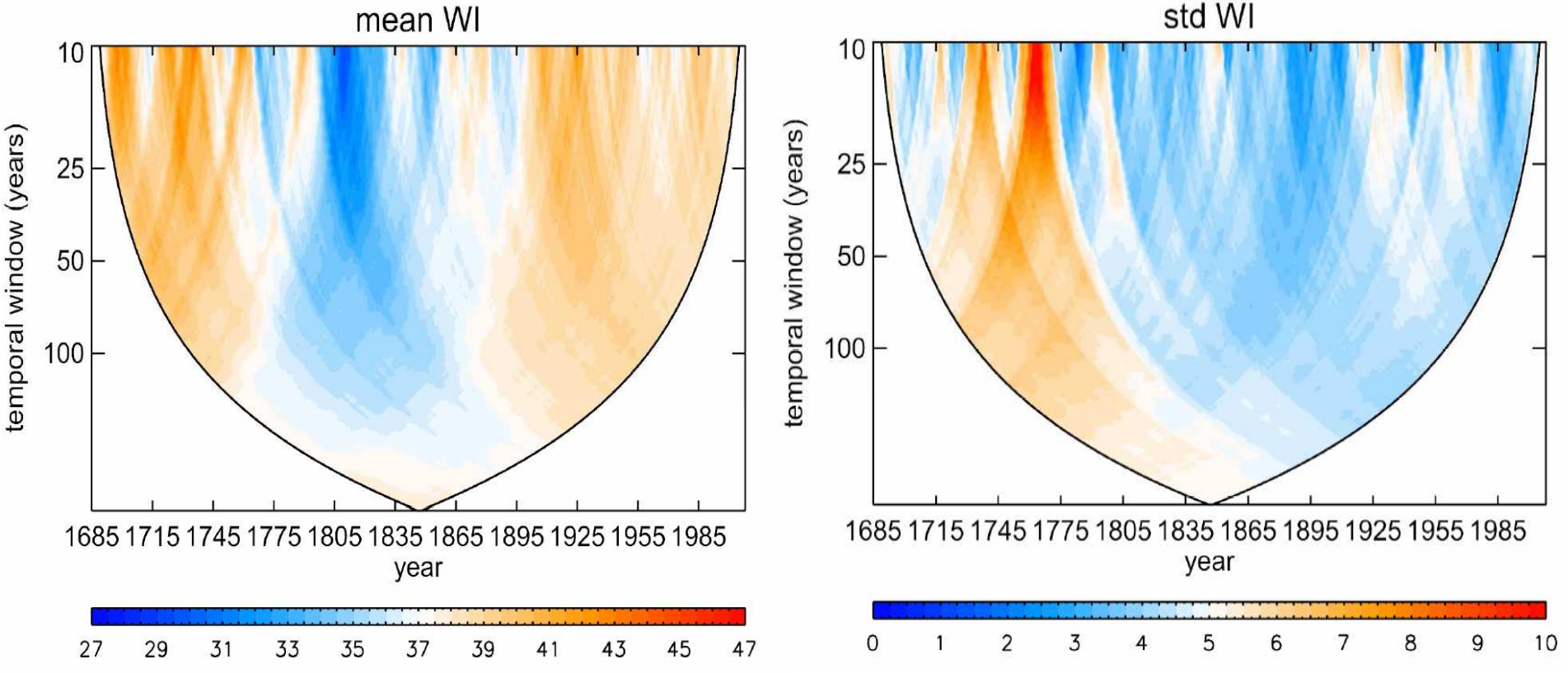
- Up to 1850: no more than one record per day.

- From 1850 to 1900: up to 20 observations per day are usually available.

- From 1900 on: the number of individual wind observations increases, reaching 100 records per day



Temporal Evolution



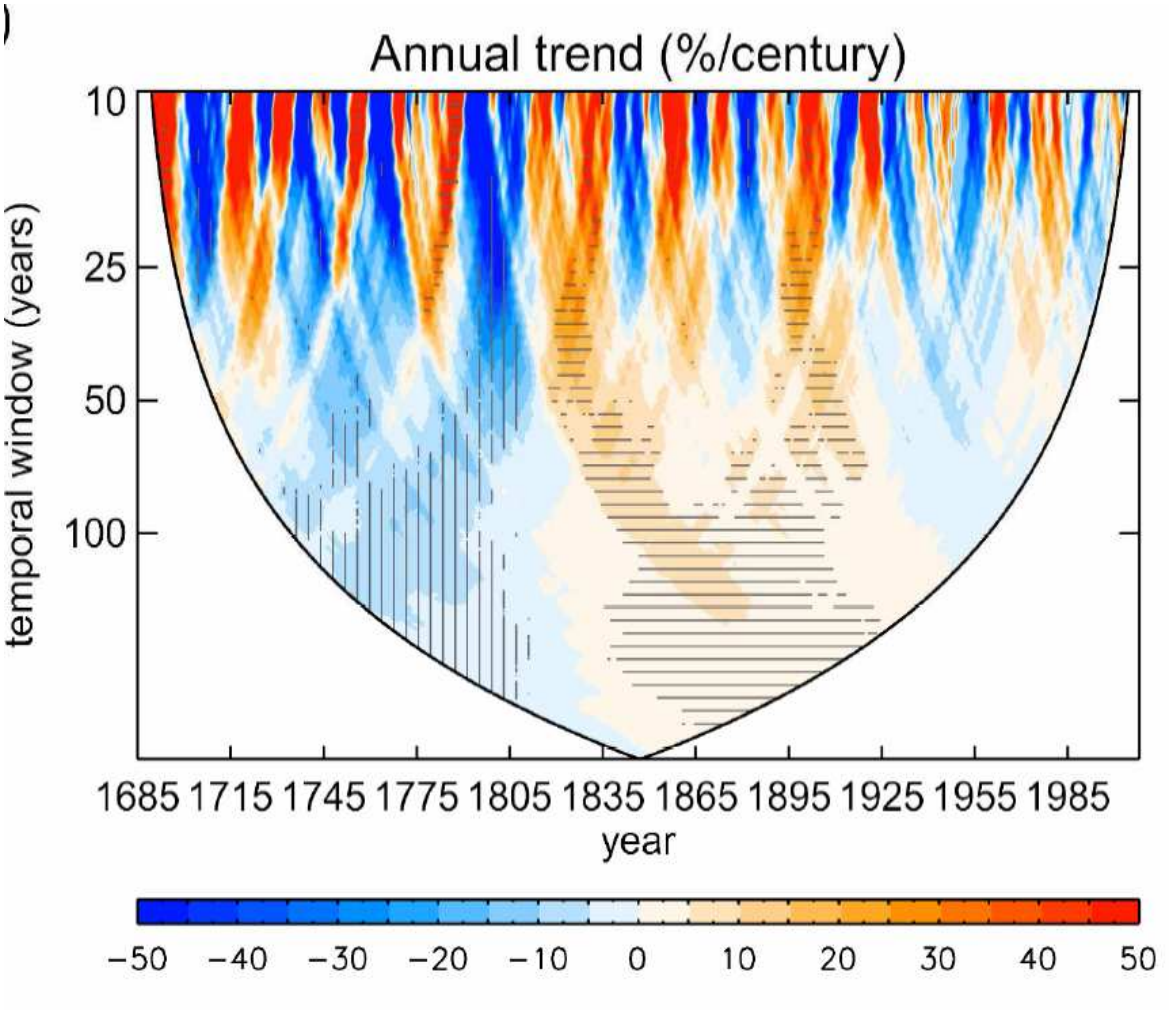
Figures with **mean and standard deviation**, showing different window widths in the vertical axis and temporal scale in the abscissa axis

- Apparently there aren't large fluctuations

- Stronger variability for small windows at the beginning of the series (from 1685 to 1775) and also during the first half of the 20th Century.

- For window widths of 25 and more years, the standard deviation shows a rather stable value around 5%.

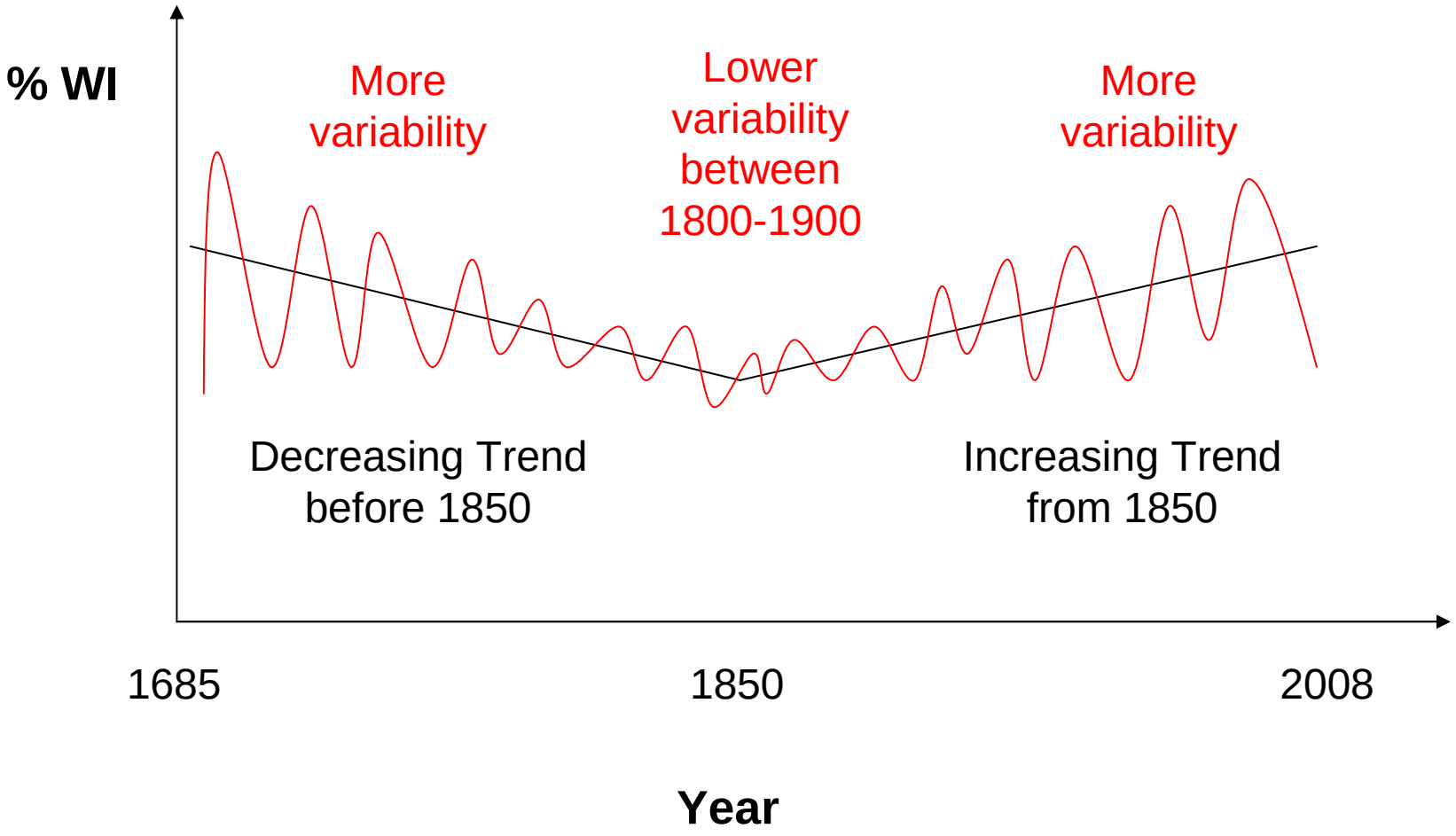
Temporal Evolution



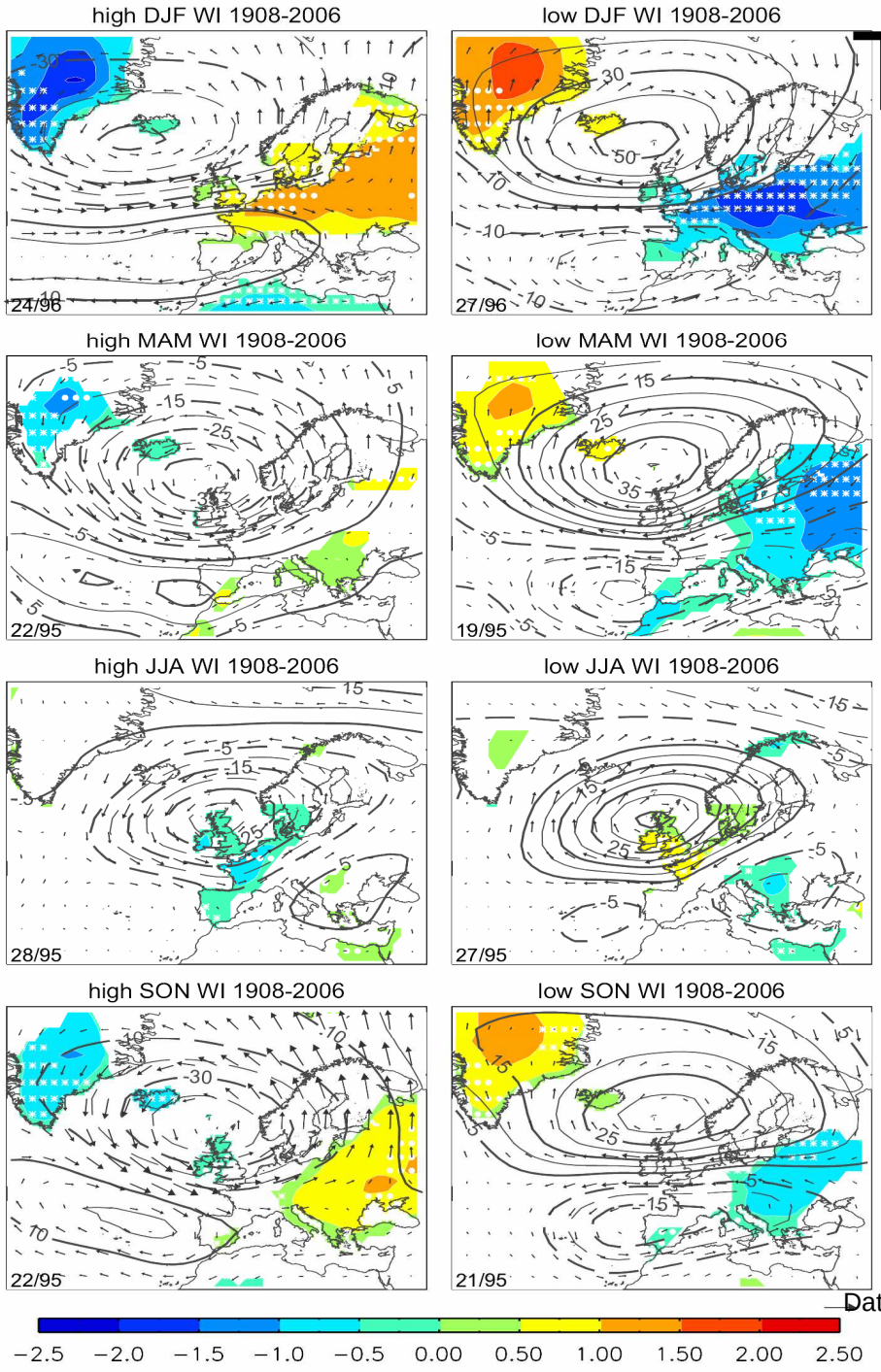
- Significant trends ($p<0.05$). Increasing trend from 1840 to 1930 and a relatively constant WI value from 1930 to present-day.

- At shorter temporal scales (window width between 10 and 25 years), alternating trends reflect regular fluctuations in annual WI averages that become stronger from 1685 to the beginning of the 20th Century, when they can reach absolute values up to ±40% per century.

Temporal analysis



Temperature



WI > 0 (left):

- Higher temperatures in central Europe (especially in Autumn and Winter) due to higher advection of air from ocean.

- In Summer, significant signal over the Iberian Peninsula (Low temperatures with positive index WI > 0)

WI < 0 (right):

signals are approximately opposite

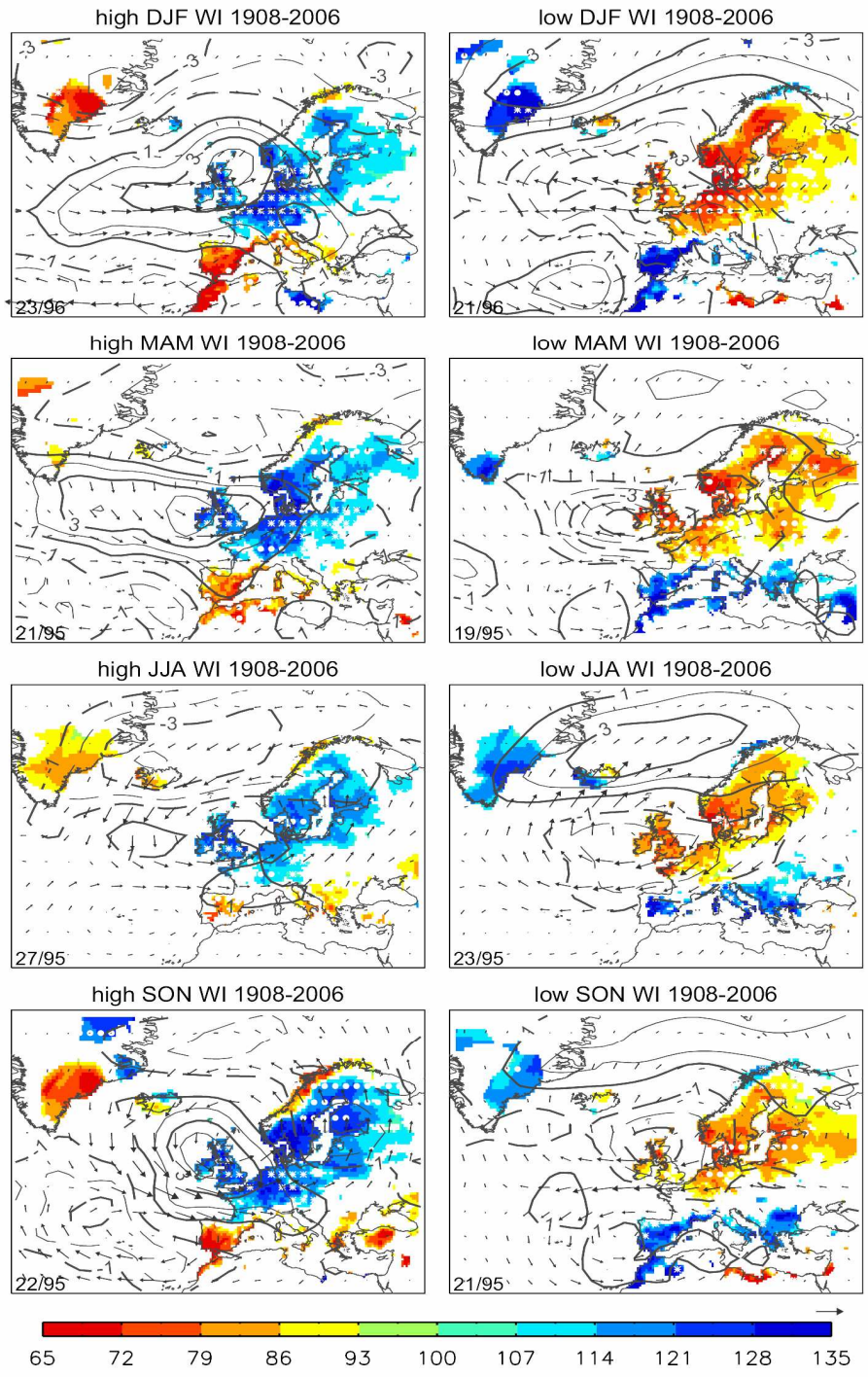
Figure:

Colors: surface temperature anomaly (º C)

Anomalies in temperature are due to wind shifts (bigger zonality with WI > 0)

White spots: Significative Areas with temperature advection at 500 hPa

Data from 20th century reanalysis project v2 (resolution 2ºx2º , period 1908-2006)



Precipitation

Clear dipole in precipitation.

WI > 0 (left):

- High WI values are characterized by drier than normal precipitation over the Mediterranean area an Southeastern Greenland and wetter climate for UK, Central Europe, and most of Scandinavia.

WI < 0 (right):

- Opposite anomalies are found for low WI values

Figure:

Colors: anomaly of precipitation in surface (% on average). Only the significant anomalies (p <0.1) are showed.

Lines: storm track anomalies (standard deviation of moisture at 500 hPa (p <0.1)

Precipitation anomalies are due to changes in the paths of extratropical cyclones, with higher (lower) moisture transport in Southern Europe with WI < 0 (WI > 0).

Data of precipitation with 1ºx1º resolution from GPCC, period 1908-2006

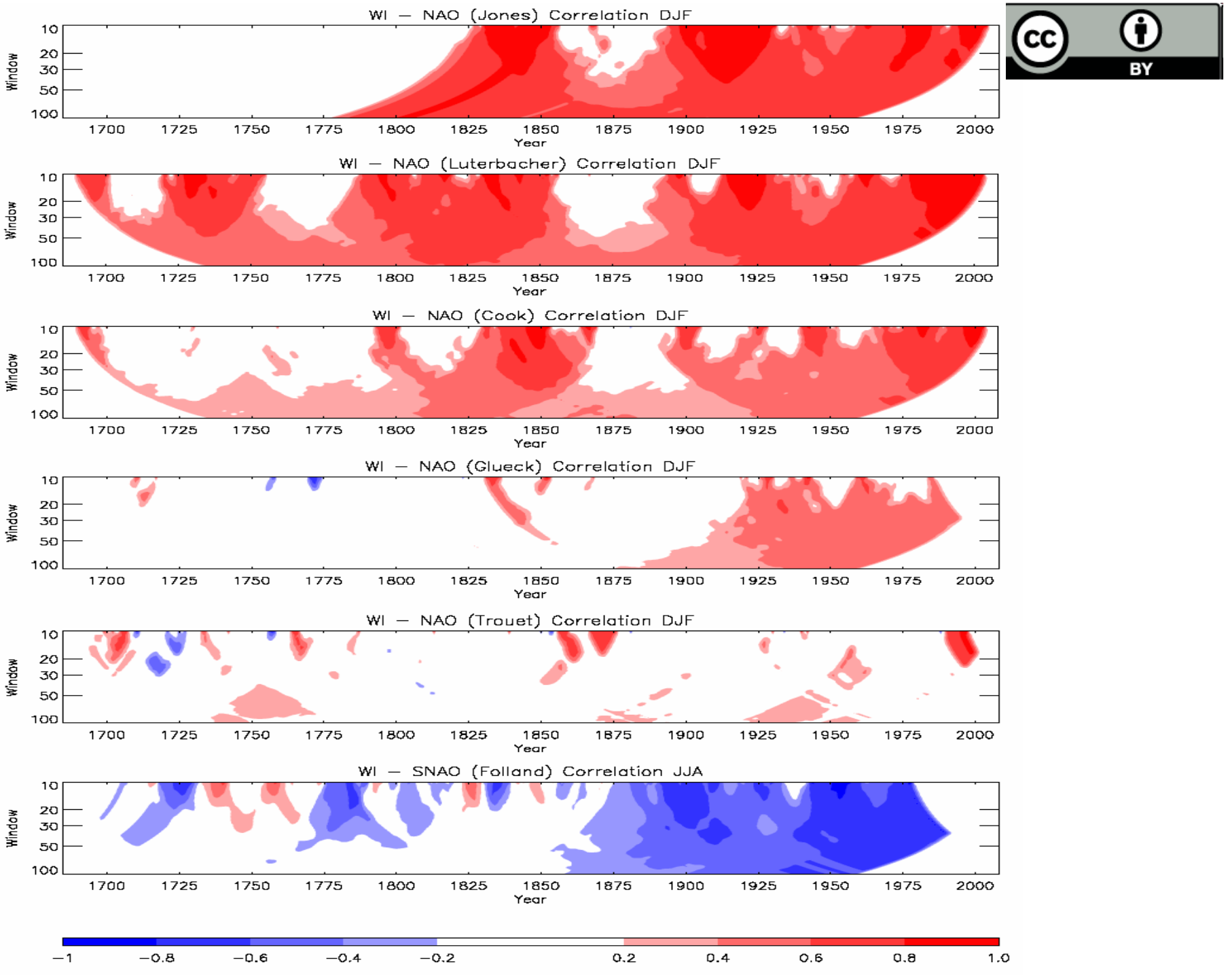
Correlation with NAO

- For more than a decade the high-frequency variability of the “true” NAO before approximately 1850 has persisted as an unresolved yet important issue.

- Because of their definitions, the WI and the NAO should be closely related (note that the WI is defined over an area of climatologically maximum Westerlies).

- However, it must be pointed out that they do not measure exactly the same aspect of circulation behaviour. The NAO accounts mostly for wind force and also for direction. WI exclusively deals with the frequency of Westerly flux.

- Therefore, a perfect correlation between both should not be expected, nevertheless is clear that during Winter the correlation should be positive (high NAO indices related to most frequent westerly).


WI — NAO (Jones) Correlation DJF
WI — NAO (Luterbacher) Correlation DJF
WI — NAO (Cook) Correlation DJF
WI — NAO (Glueck) Correlation DJF
WI — NAO (Trouet) Correlation DJF
WI — SNAO (Folland) Correlation JJA
Window
10
20
30
50
100
1700
1725
1750
1775
1800
1825
1850
1875
1900
1925
1950
1975
2000
Year
−1
−0.8
−0.6
−0.4
−0.2
0.2
0.4
0.6
0.8
1.0

Summary

- The WI provides a direct and non-proxy measure of the westerly winds in the English Channel for the period 1685-2008
- For the 20th century, the WI signature in precipitation and temperature is similar to NAO but with a stronger signal during the entire year, including Summer, and particularly in what concerns precipitation
- When several NAO reconstructions and the WI are compared, some good correlations are found with the exception of three periods of very low correlation.
- These periods are not coincident with the well-known cold (or warm) anomalous periods a conclusion that confirms the complex relation between the WI, the NAO, and their imprints on precipitation and temperature.
- Currently modeling work is underway to gain a deeper insight into the physical coherency, the cause and the climatic implications of the unconnected periods between all these variables found in this work.

Thanks for your attention!!!