NAO index values estimated from earth orientation functions

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Outline

- Motivation
- Technique
- Results
- Significance testing and Skill
- Conclusion

Motivation:

Calculate climate index from earth orientation functions
=> independent of climate model

Test case: rebuild well-known climate index from geophysical excitation functions
=>North Atlantic Oscillation (NAO) index

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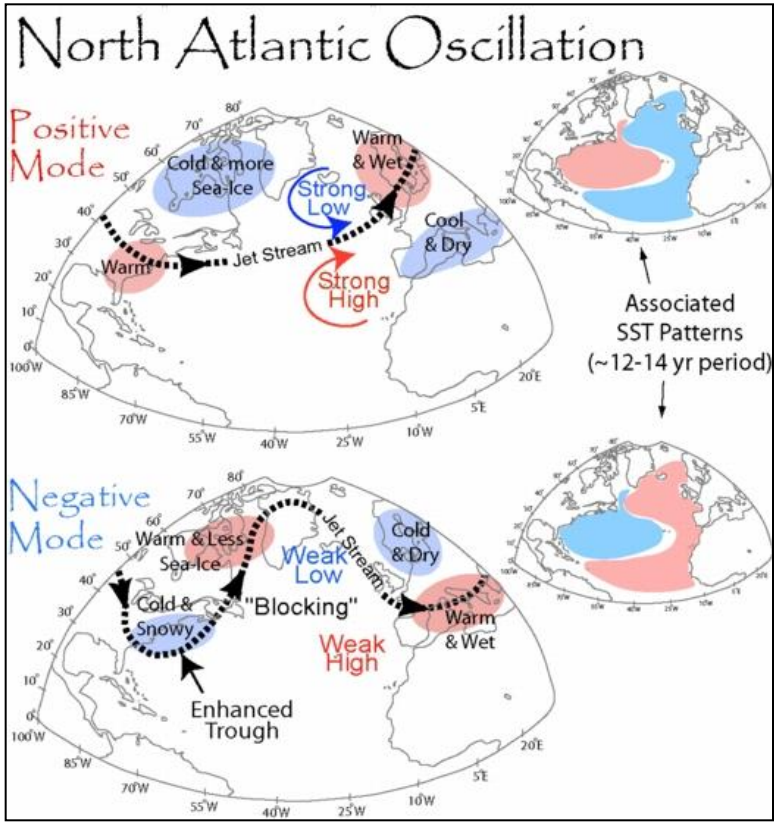

pressure pattern over North Atlantic
Icelandic low / Azore high
effects:

- pressure
- wind
- sea surface temperatures
- storm track
- precipitation
- oceanic transport

NAO influences all „subsytems“ relevant for AAMs / OAMs !

NAO influence on integrated, one-dimensional polar motion excitation functions ?

=> Use climate model to separate NAO influence

Model and Data used:

- Coupled Atmosphere/Ocean model ECHAM5/OM1
- 20th century run (IPCC AR4 – 20C_3 run)
- 1901-1999 („model years“)
- winter (DJF) mean only => annual data
- PC-based annual NAO index calculated via RPCA technique (rotated EOFs at 500 hPa)

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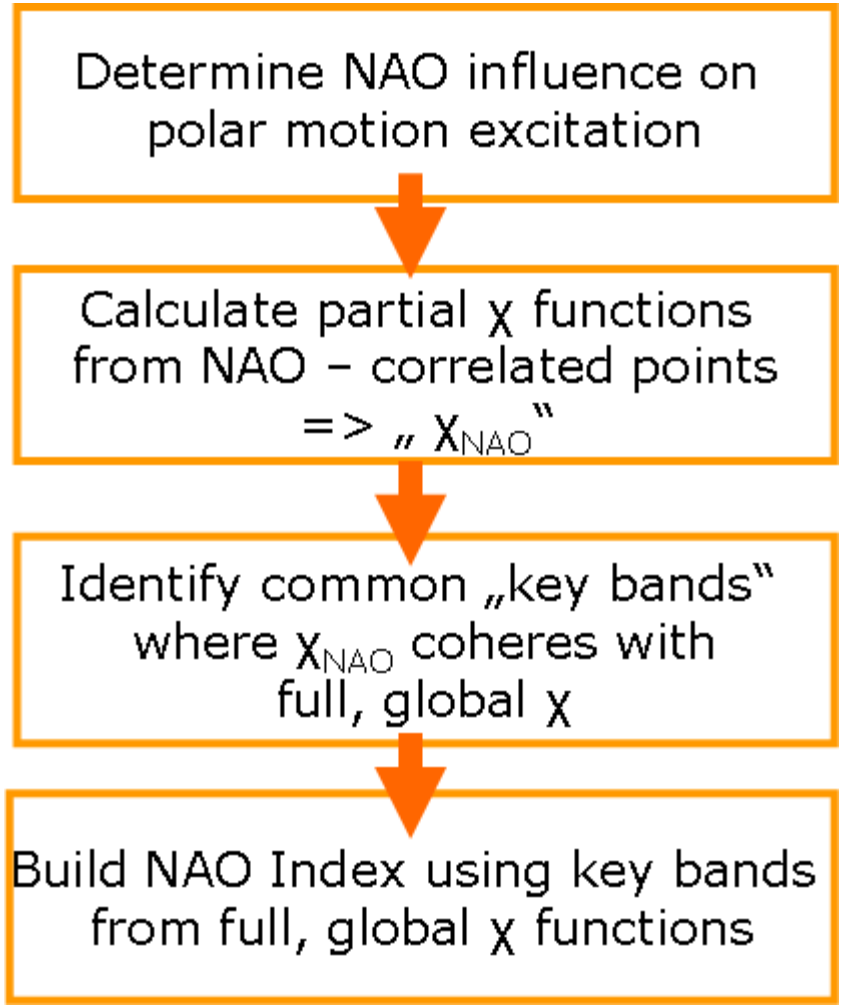

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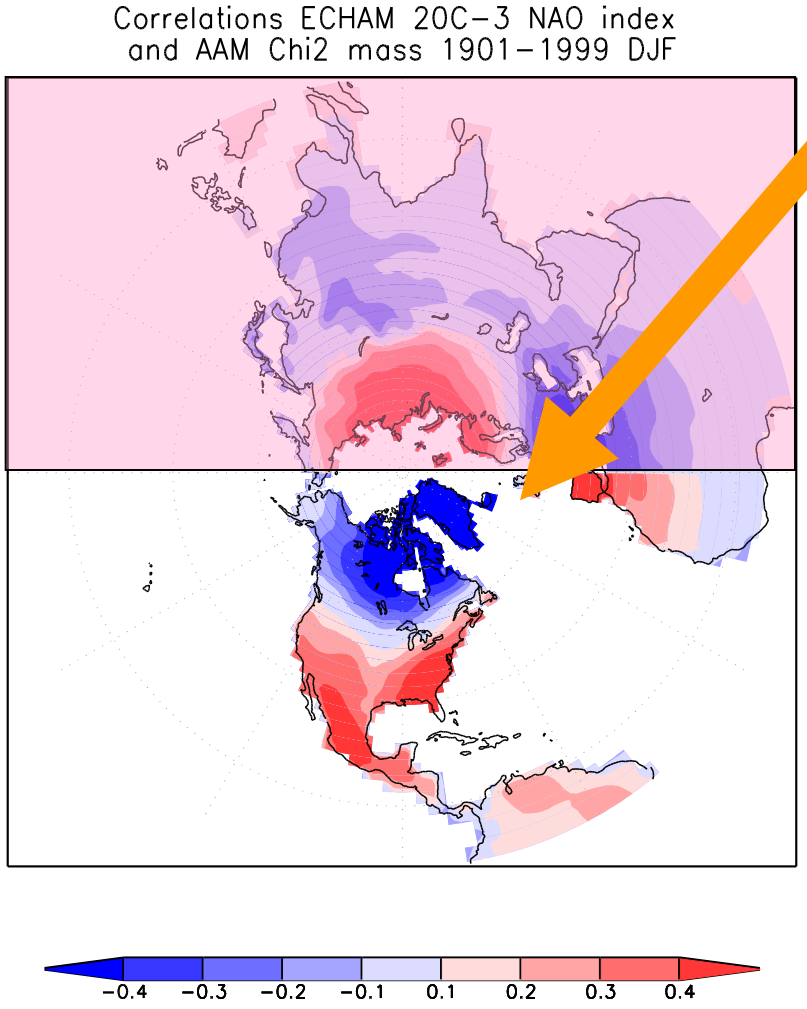

Icelandic low

NAO correlation with Chi2 AAM mass function

NAO pattern clearly visible

AAM pressure not meaningful over ocean for non-pressure-forced ocean model

Use only contributions from areas with cor > 0.25 (> 0.4 for AAM mass)
– highly significant > 99.99 *and* in accordance with known physical effects

Sum up to form partial, NAO-correlated excitation functions

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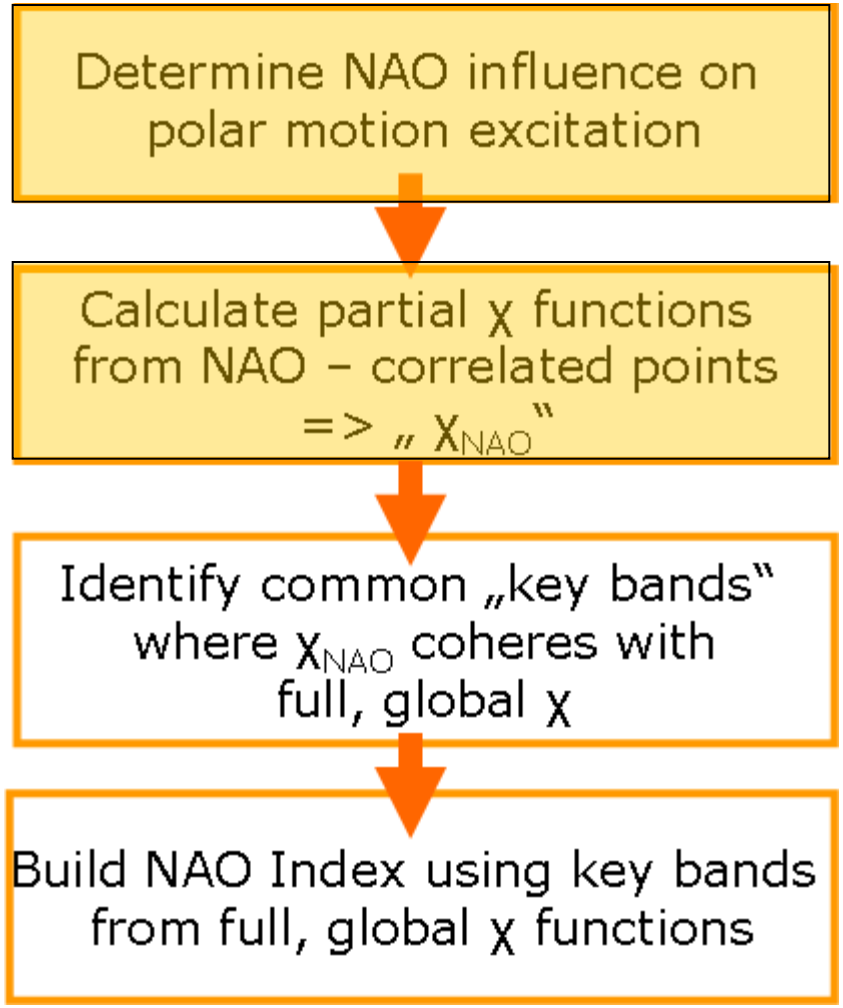

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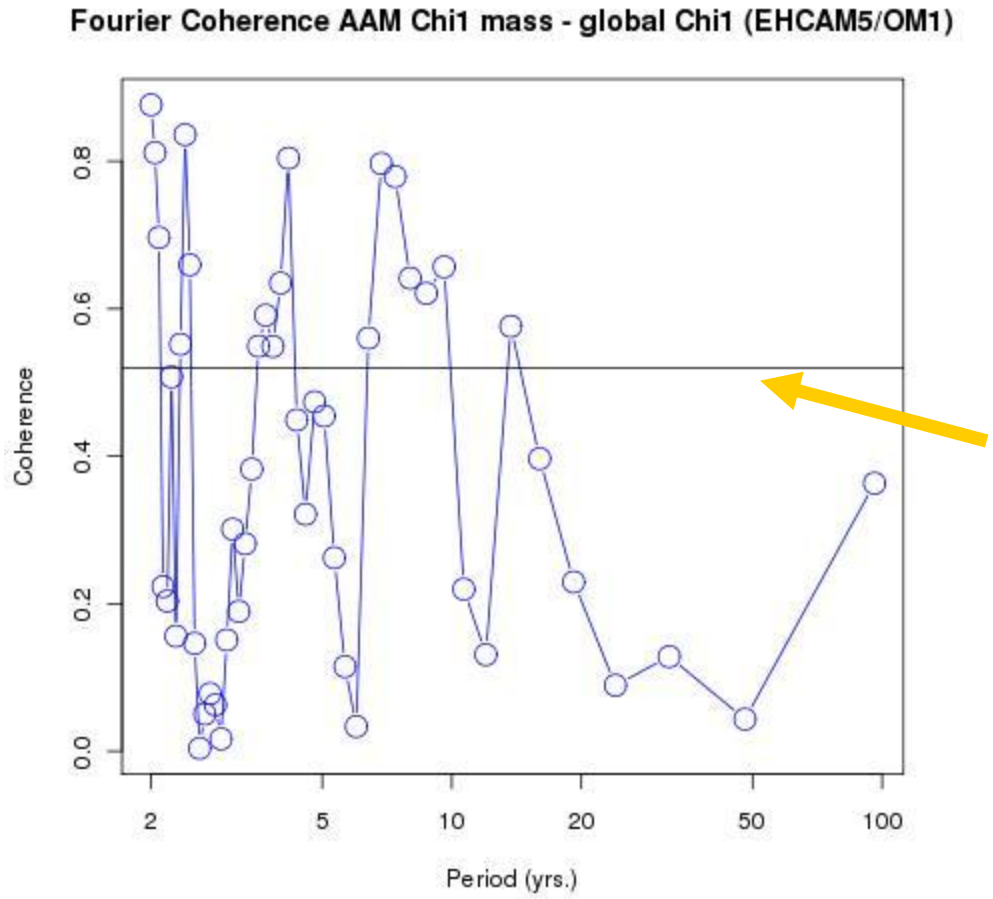

Fourier coherence between AAM / OAM mass and motion contribution and full, globally integrated Chi functions.

Significance threshold determined through bootstrap with 10^4 white noise time series

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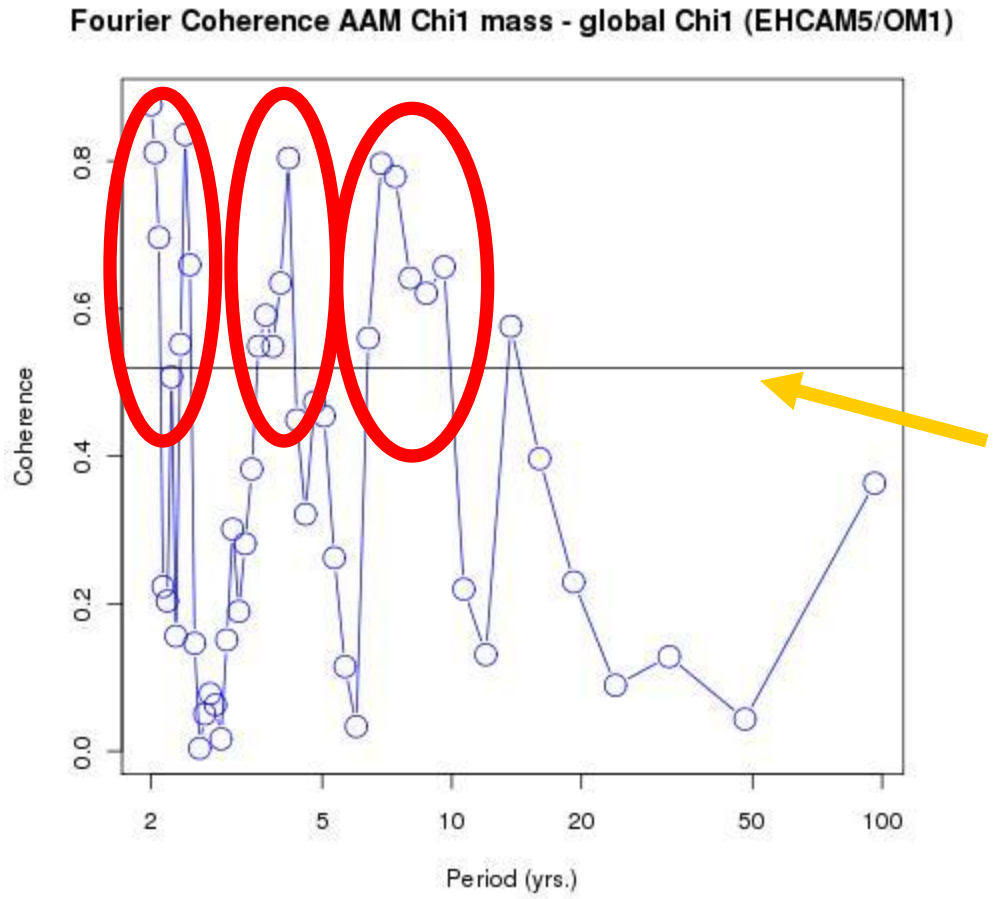

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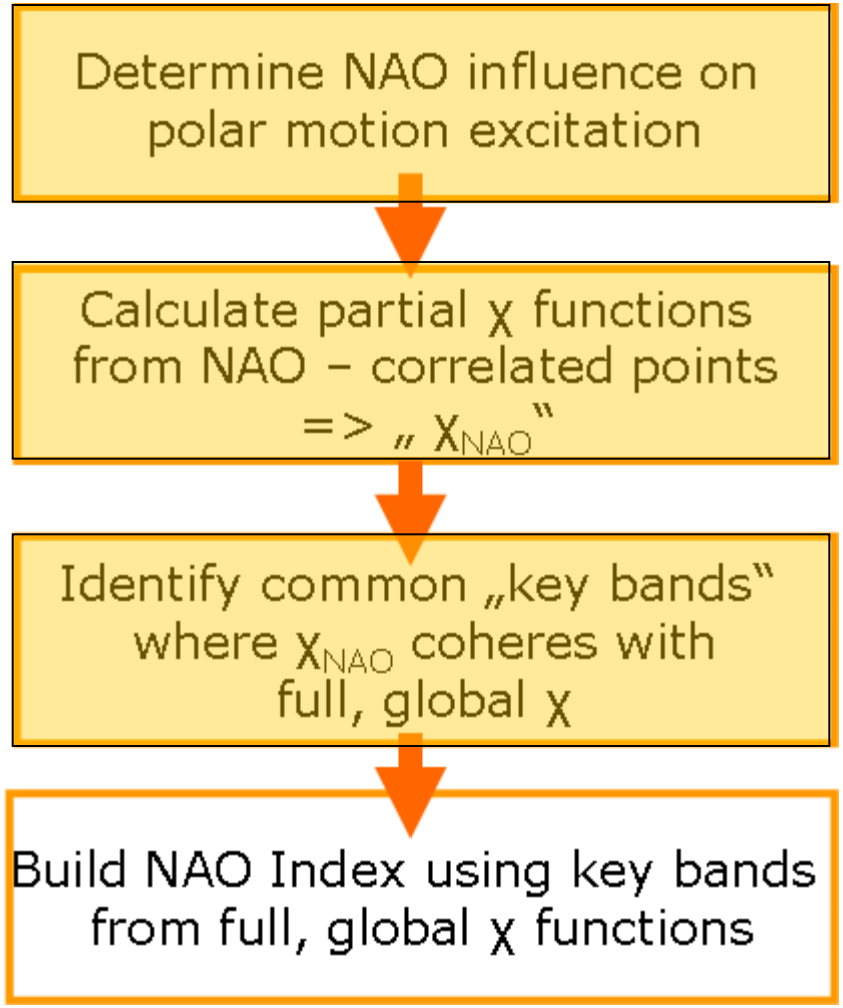
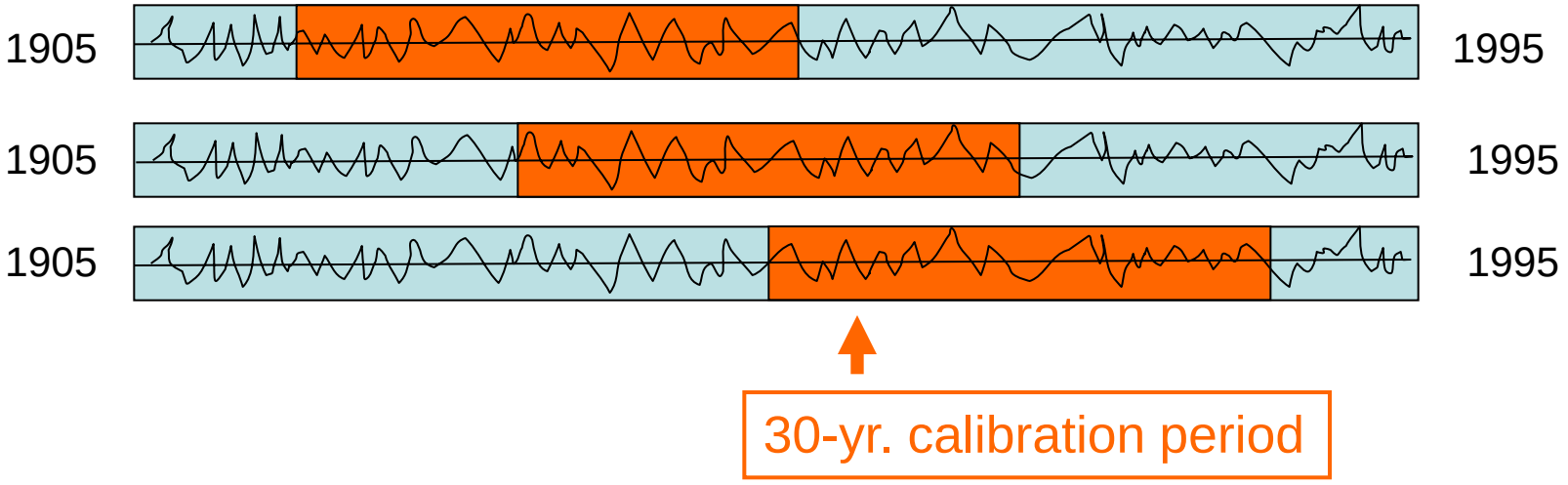


Extract relevant frequencies from Chi1, Chi2 (Butterworth filter)
Generalized Linear regression Model (GLM) with AIC minimization, using the atmospheric NAO index from the model

Significance and Skill:
=>rule out filter effects by testing against 10^4 white noise time series
⇒do not use whole set earth orientation data to estimate NAO index
⇒instead, use only 30 years for calibration and estimate the rest
⇒shift 30-year period by one year and calculate correlation and skill scores



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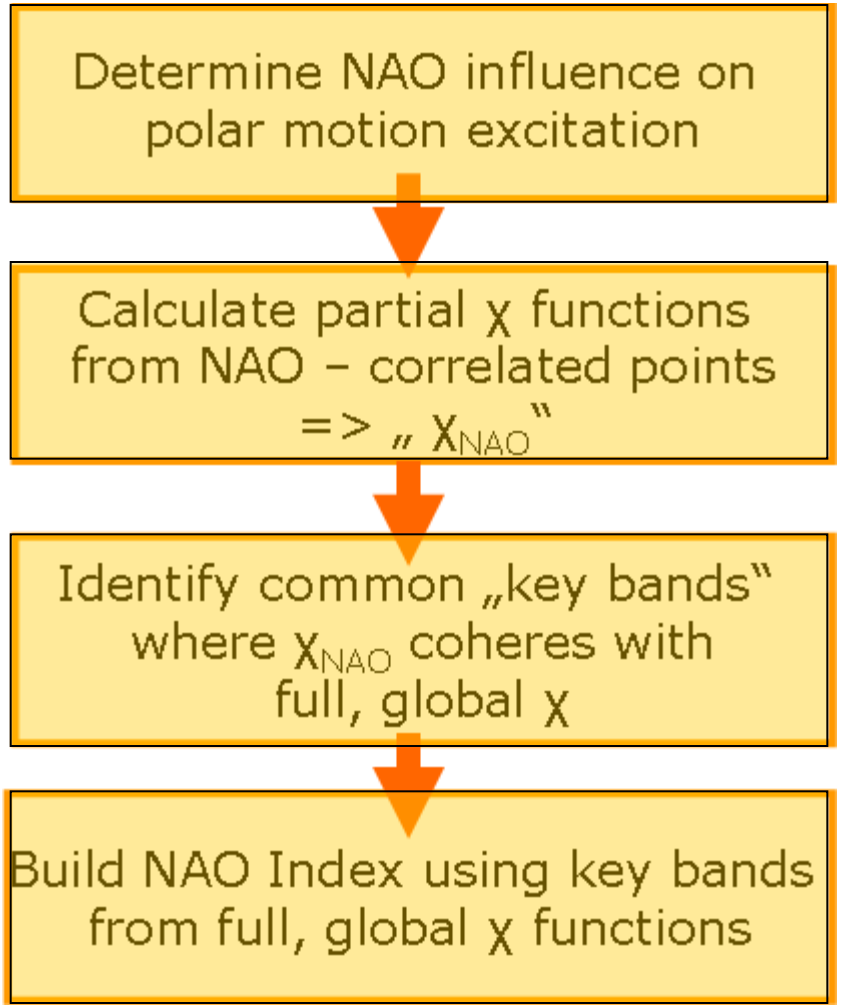

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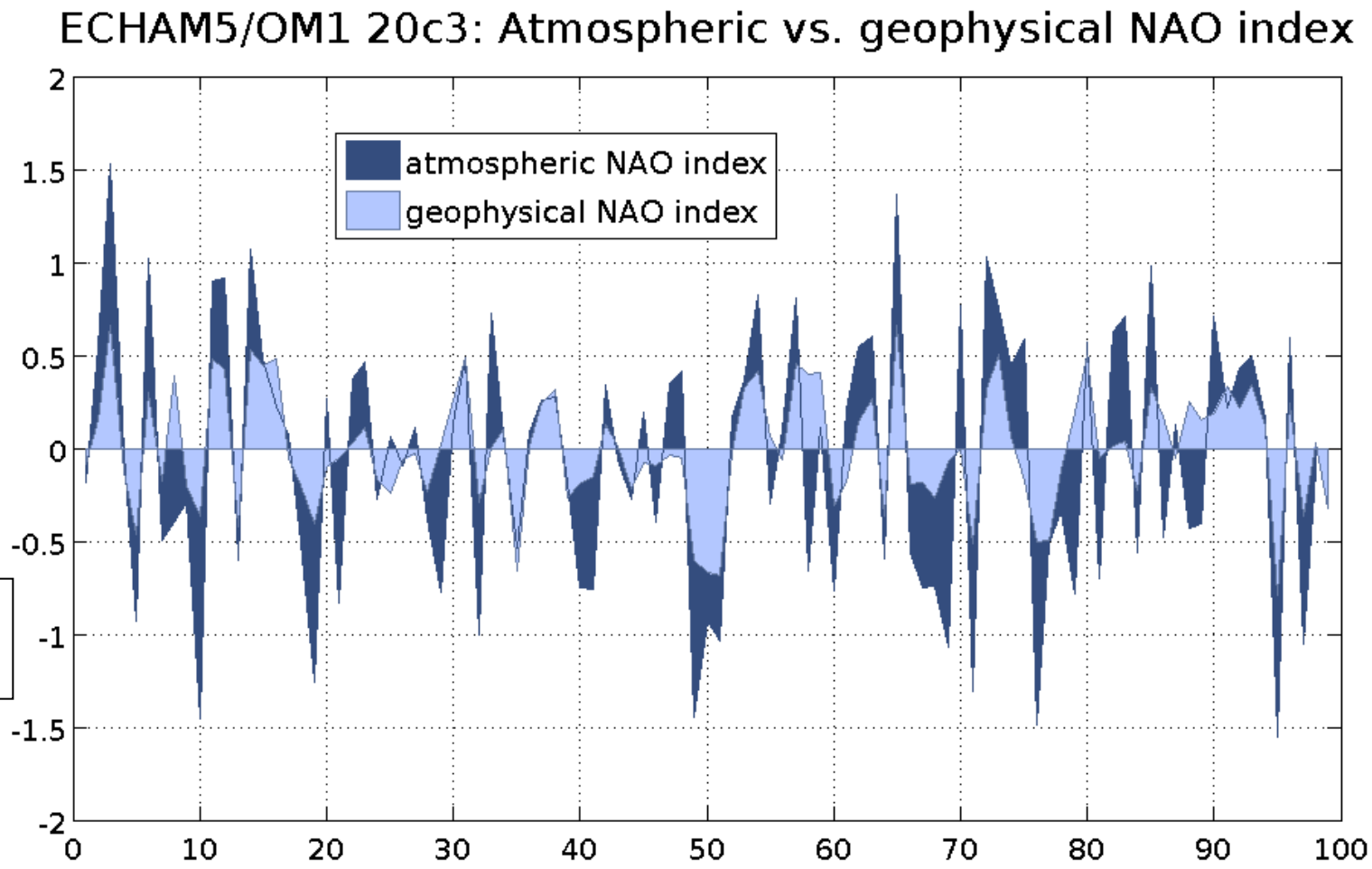

NAO index:
PC-based

Shown: best of all possible regressions using 30 % of the data available

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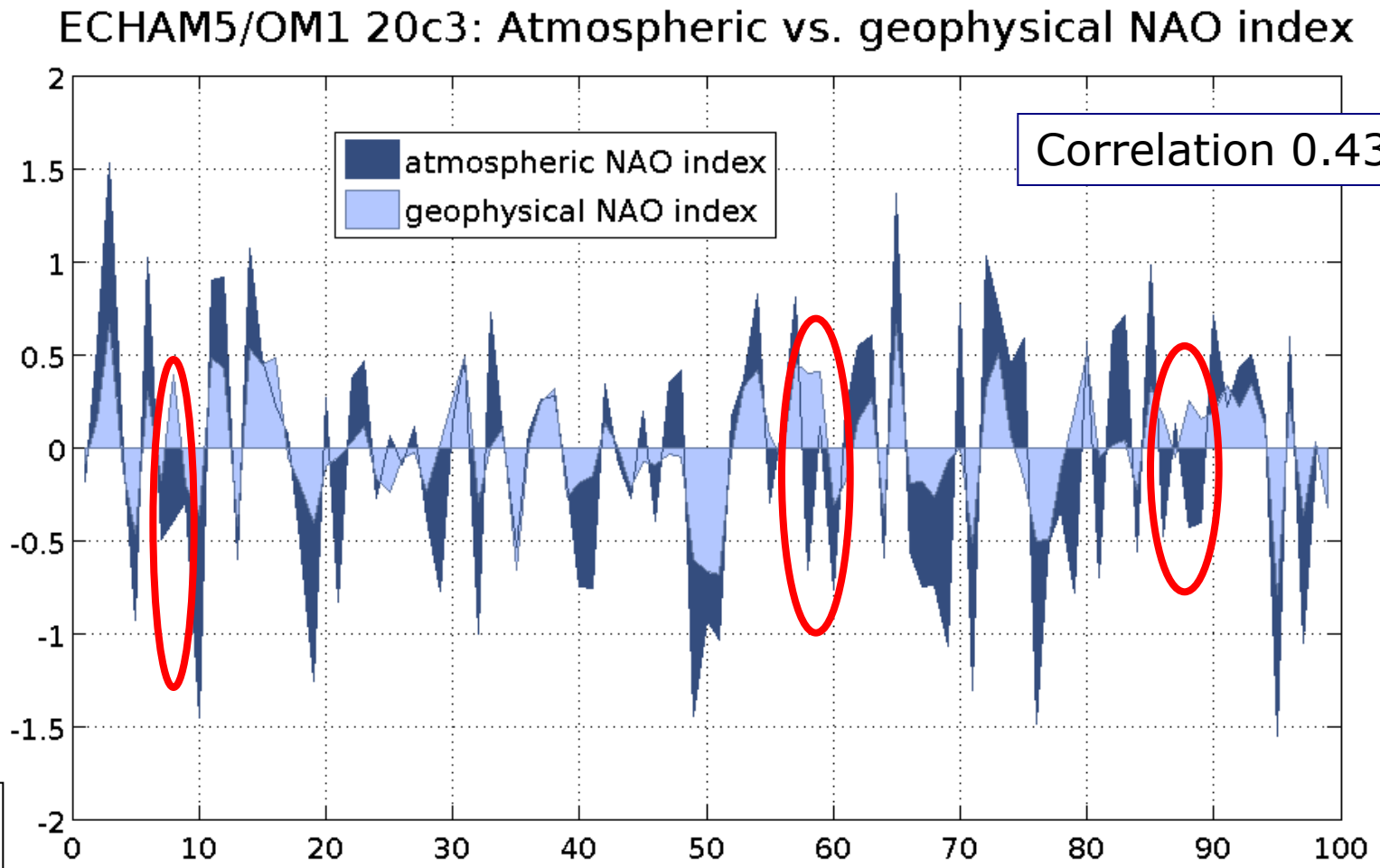

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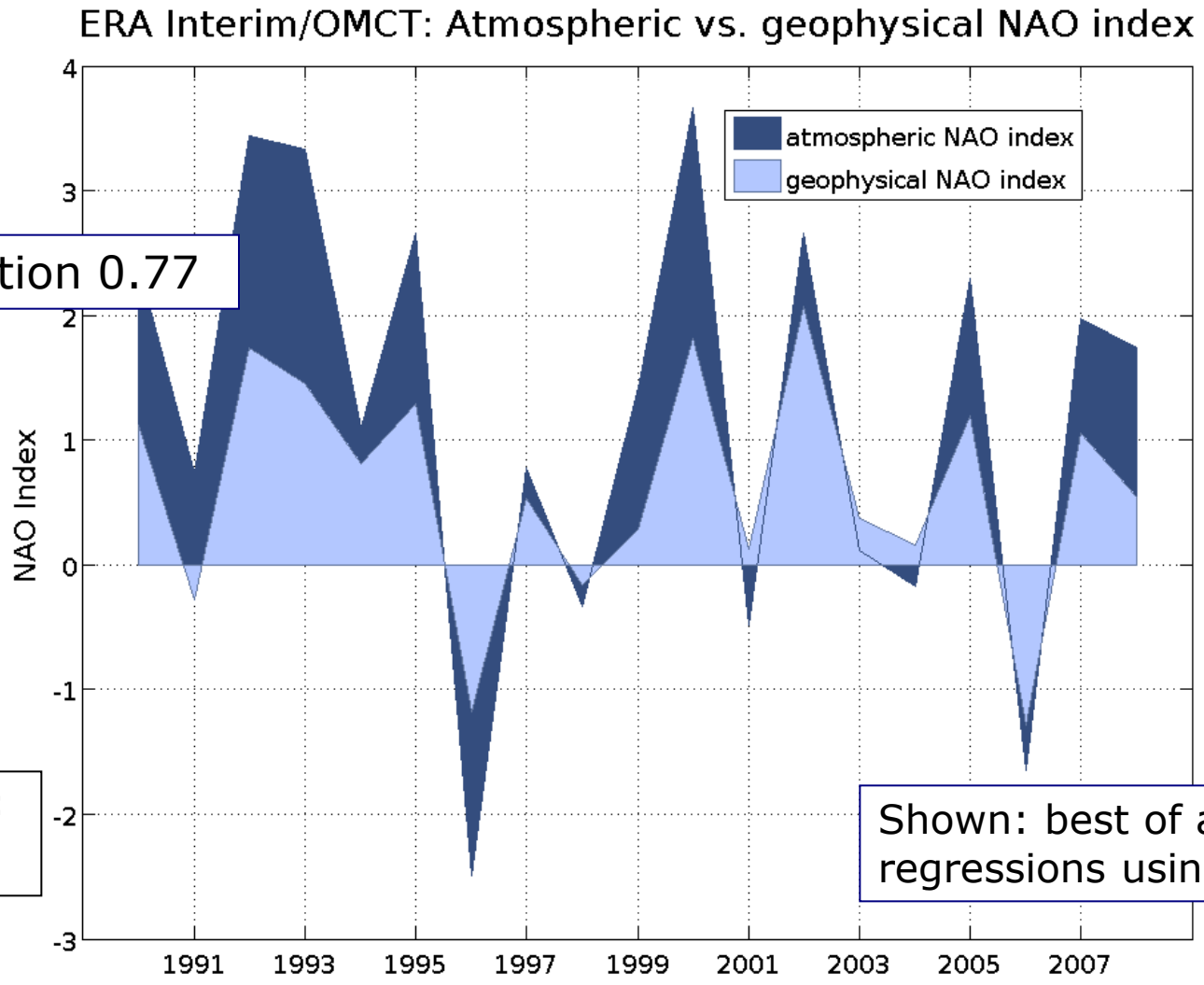

Correlation 0.77

NAO index:

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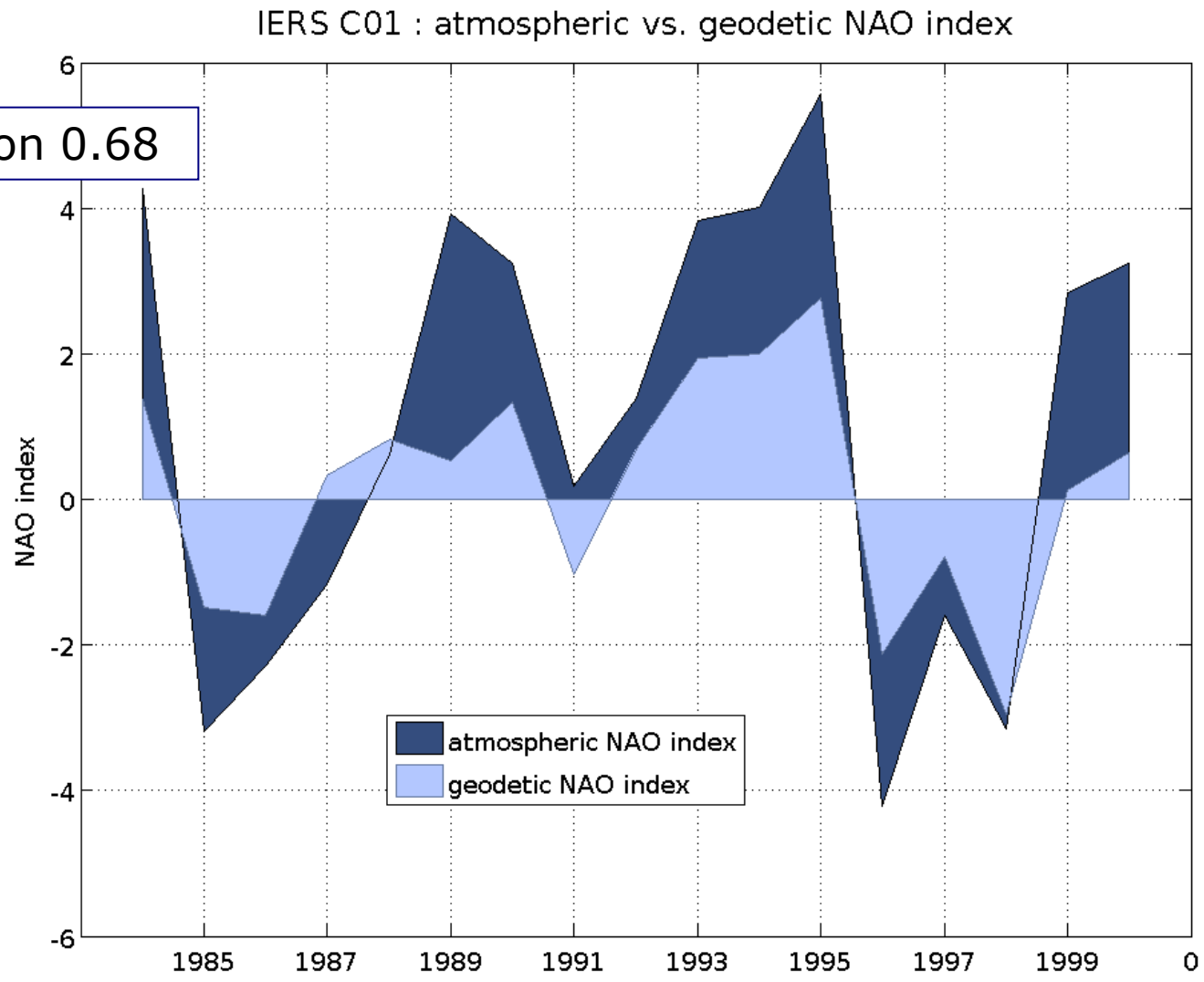
Correlation 0.68



NAO index:

Station-based

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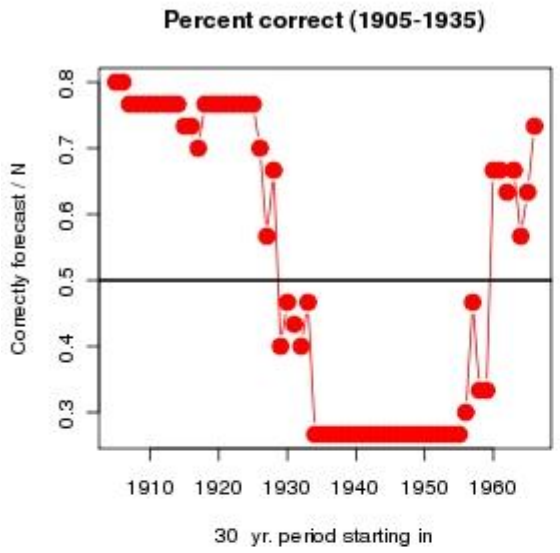

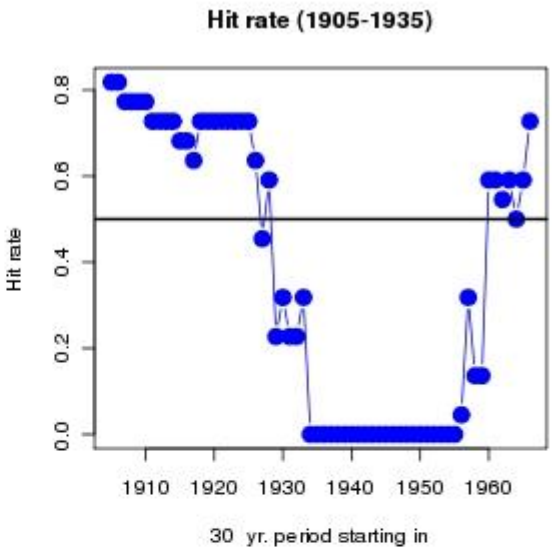

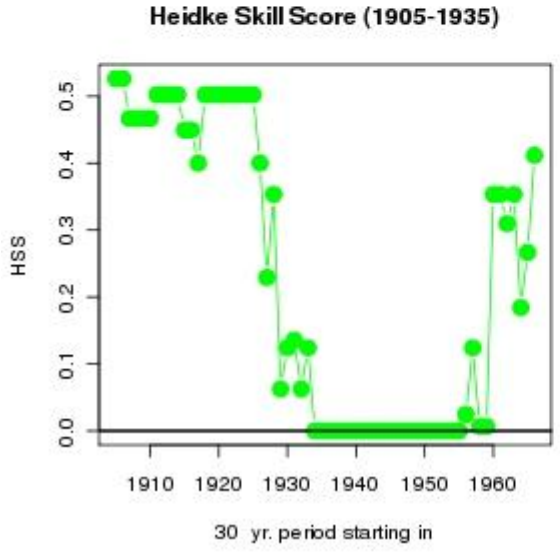

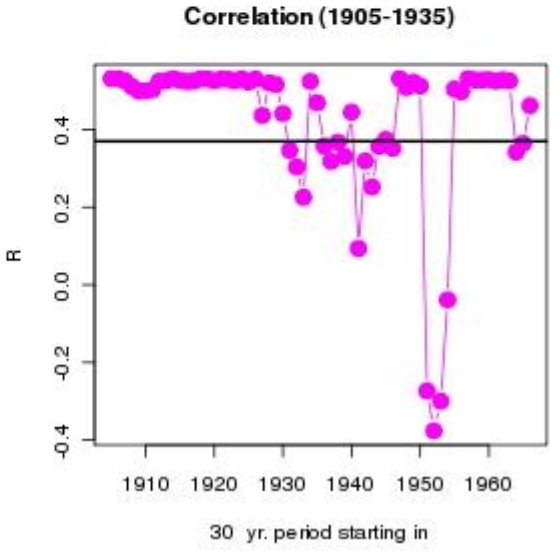

Significance testing:

Skill scores:

- PC (Percent corrrect)
- POD (hit rate)
- Heidke Skill score
- Correlation

Tested for
- different calibration lengths
- different data periods
- calibration period only
- forecast period only
- whole TS

Skill scores and correlation for IERS C01 1906-2000

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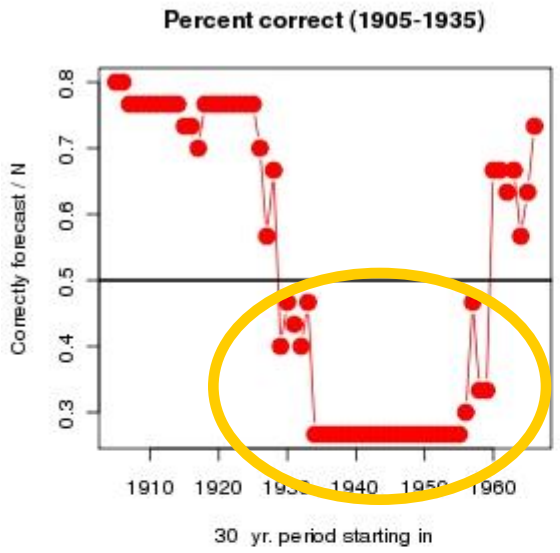

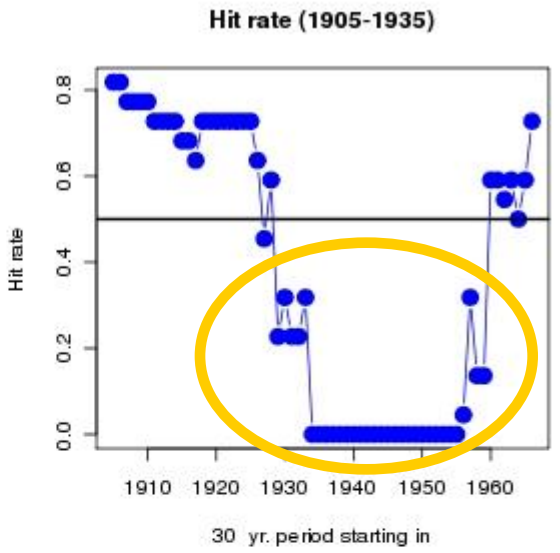

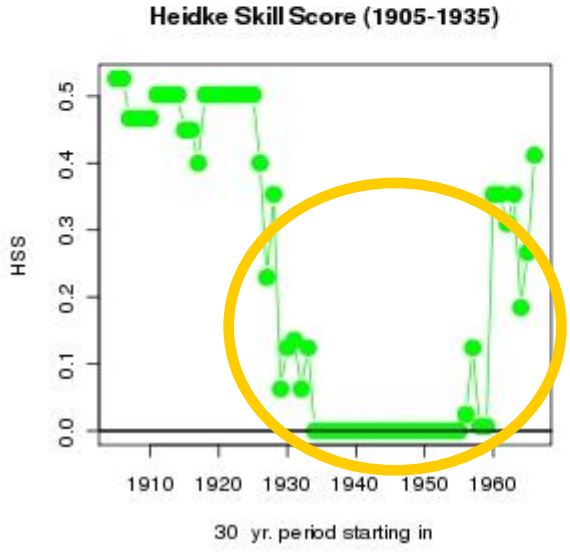

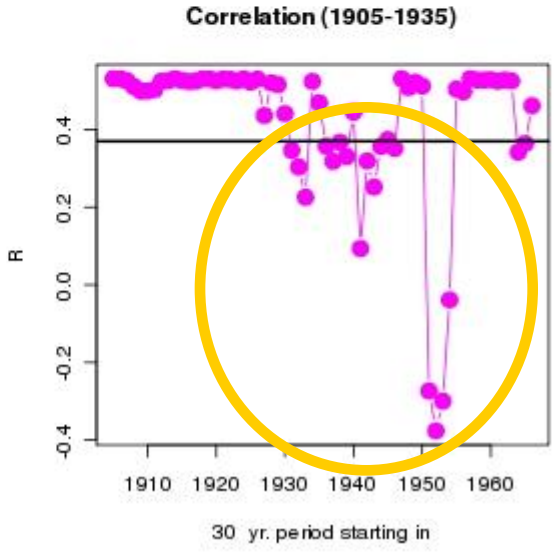

Significance testing:

Skill scores shows decreasing values for certain periods

=> independent of data quality

⇒ GCM model data shows similar structures

⇒ possible connection with PNA (Pacific North American Pattern)

Skill scores and correlation for IERS C01 1906-2000

Conclusions

- Index calculation from geophysical χ functions possible in coupled model ECHAM5/OM1

- very good results for ERAInterim/OMCT model and for observations (IERS C01)
- correlations > 0.7 (99.99 significance level)
- hit rates > 0.8
- also for early data periods

-NAO signal in earth orientation functions is disturbed at certain periods, possibly by strongly negative PNA signals

=> Combined NAO-PNA index ?

Thank you for your attention !