Renewable energy consultants

GL Garrad Hassan

A Statistical Review of Recent Wind Speed Trends in the UK

Bob Hodgetts

26th October 2011

GL GH experience in UK

We've been analysing wind farms in the UK for over 20 years

Of the present onshore installed capacity in the UK GL GH:

- Has conducted pre-construction energy predictions for over 70%
- Has conducted operational energy predictions for over 60%
- Provide short term forecasting for over 25%

Acknowledgements:

The work presented here has been compiled by the following team of GL GH experts:
Bob Hodgetts, Keir Harman, Andrew Strachan, Gemma Ebsworth and Andrew Beaumont

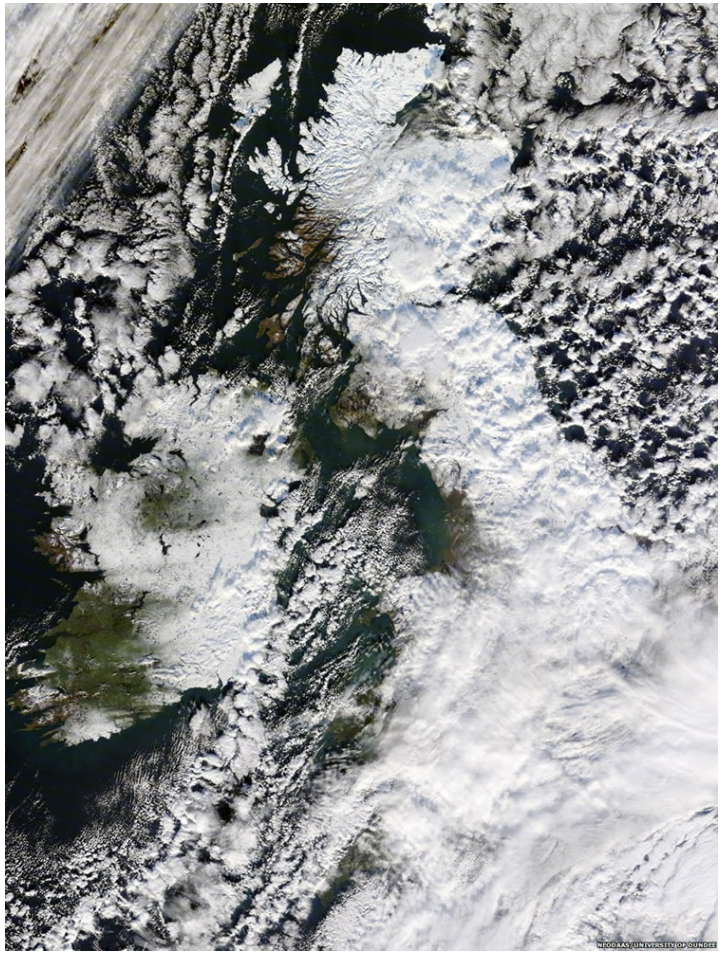
Wind speed variability in the UK

- General consensus is a standard deviation in inter-annual variability of ~6%
- Implies annual mean wind speeds up to ~14% higher or lower than the overall mean will occur at least once in 100 years
- 2010 was a low wind speed year

Common questions:

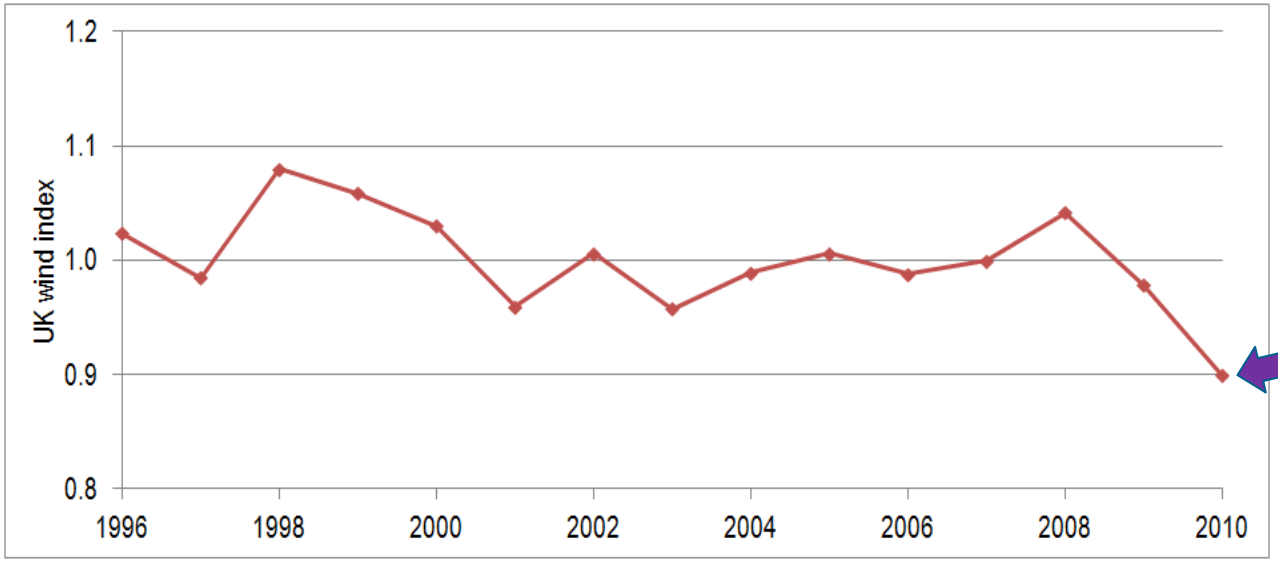
- How low was the wind speed in 2010?
- Will recent trends continue?
- Should 2010 be excluded when valuing wind farm projects?

December 2010



GL GH UK Wind Index

- Historical wind data from 1996 to 2011
- 50 meteorological stations spread across the mainland of the UK
- Each station has measured consistent wind speed data for 10 years or more
- Due to station consistency it is difficult to go further back than 1996

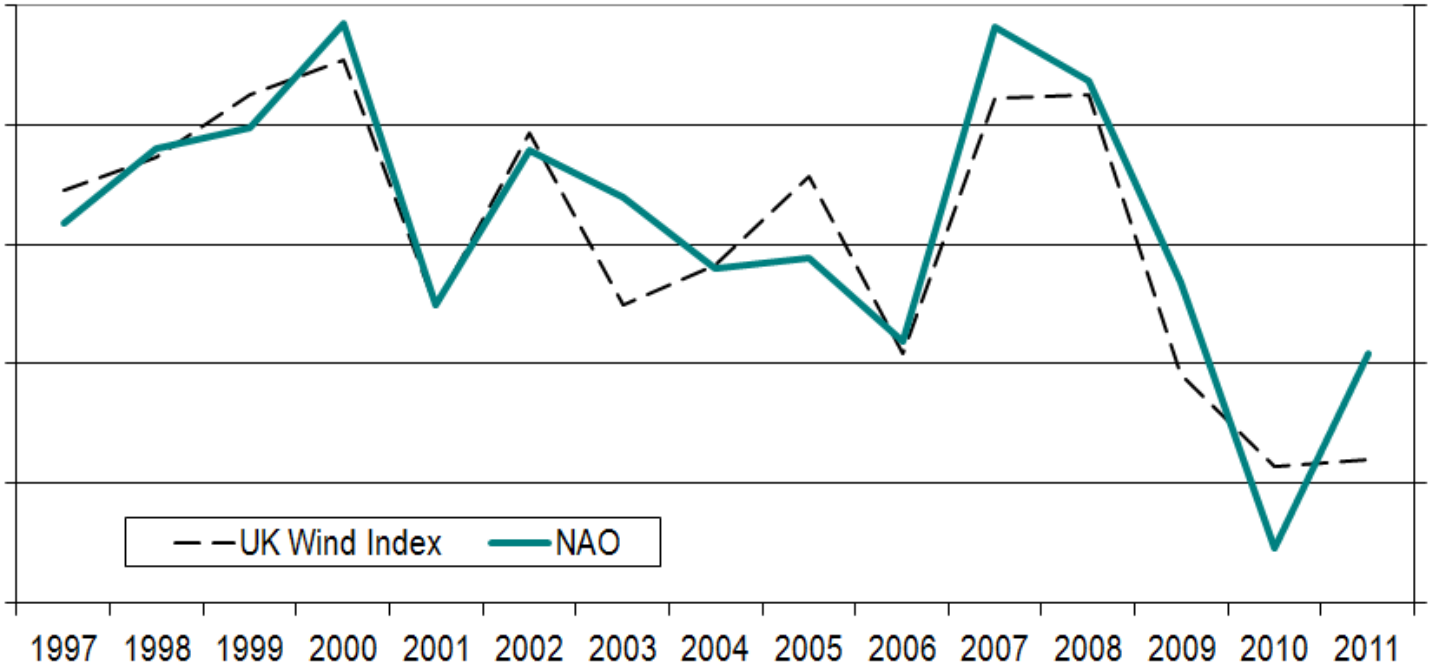


2010 was 10% below the 15 year mean

Comparison to the NAO

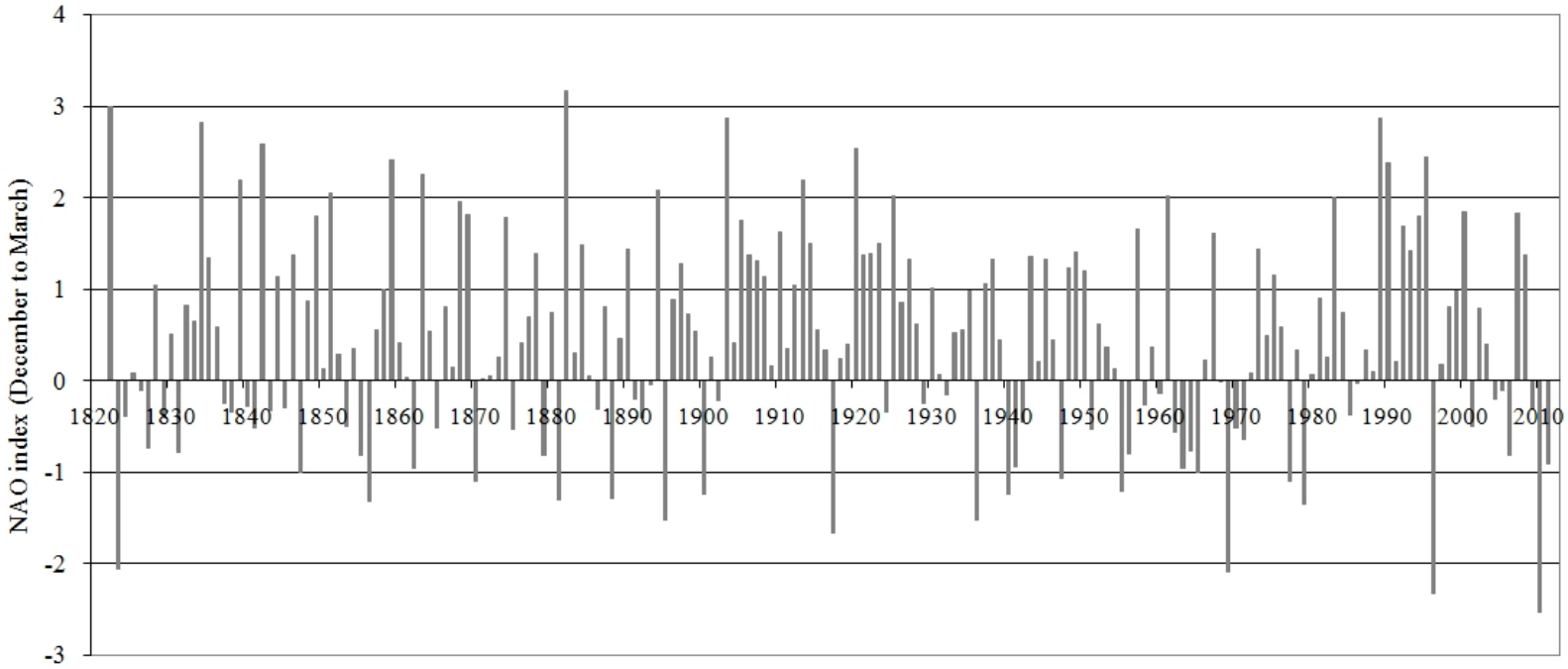
What is the North Atlantic Oscillation?

- Pressure difference between northern and subtropical Atlantic Ocean
- Reasonable proxy to wind speed, BUT only for winter months (Dec to Mar)



Historical NAO – the entire historical period

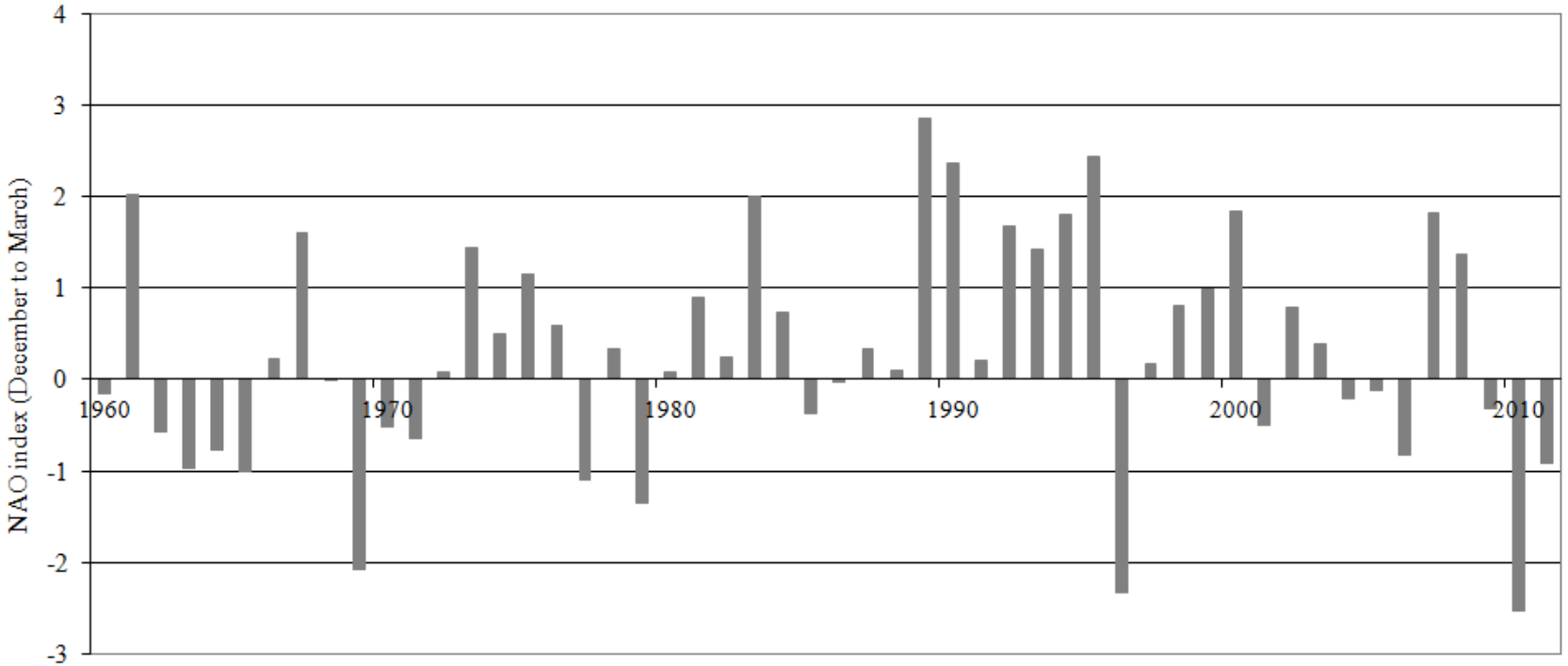
- It appears 2010 was an historical low
- Caution required as this only represents the winters



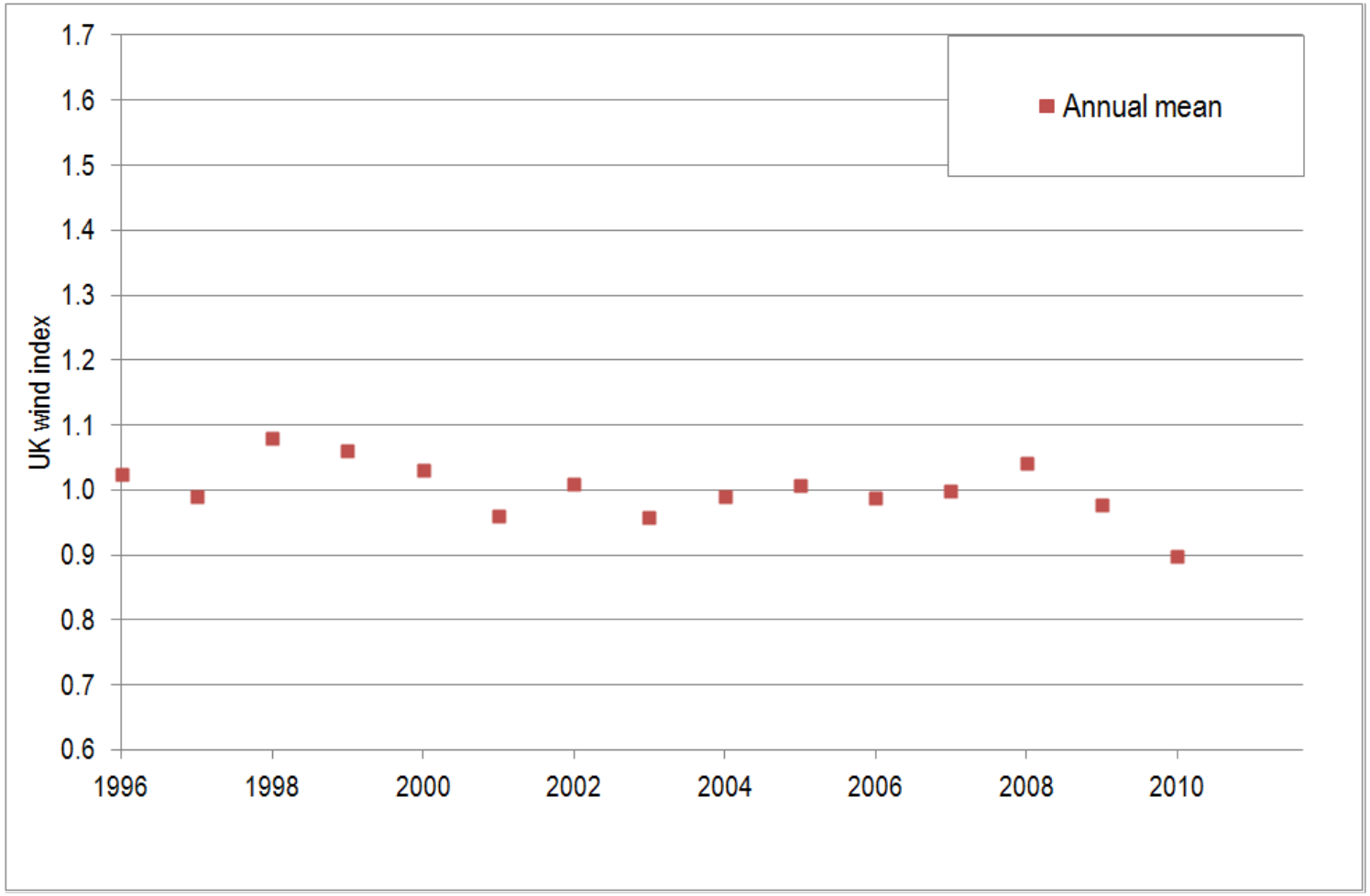
Is this consistent for 190 years?

Historical NAO – concentrating on last 50 years

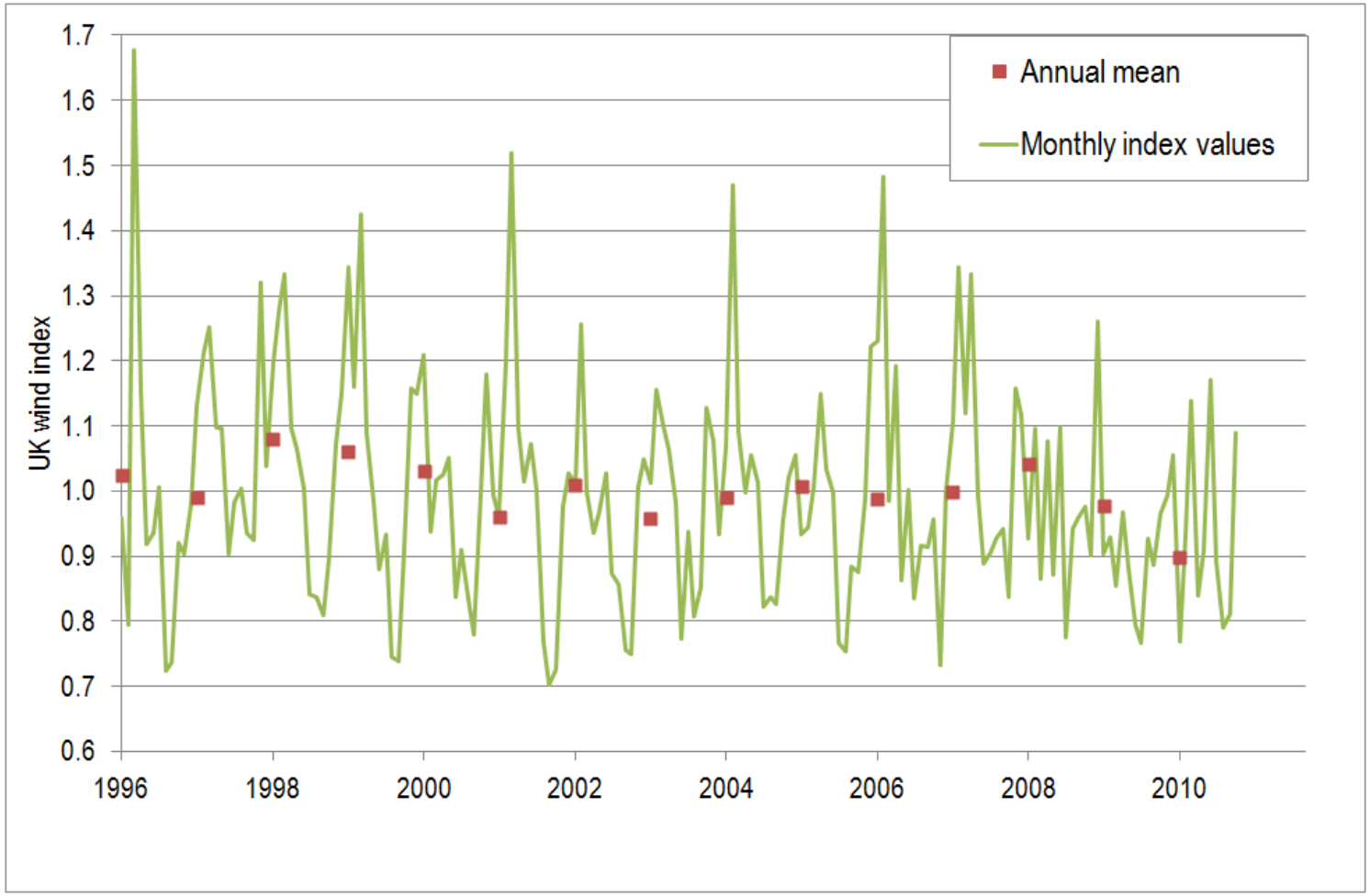
- It appears 2010 was an historical low
- Caution required as this only represents the winters



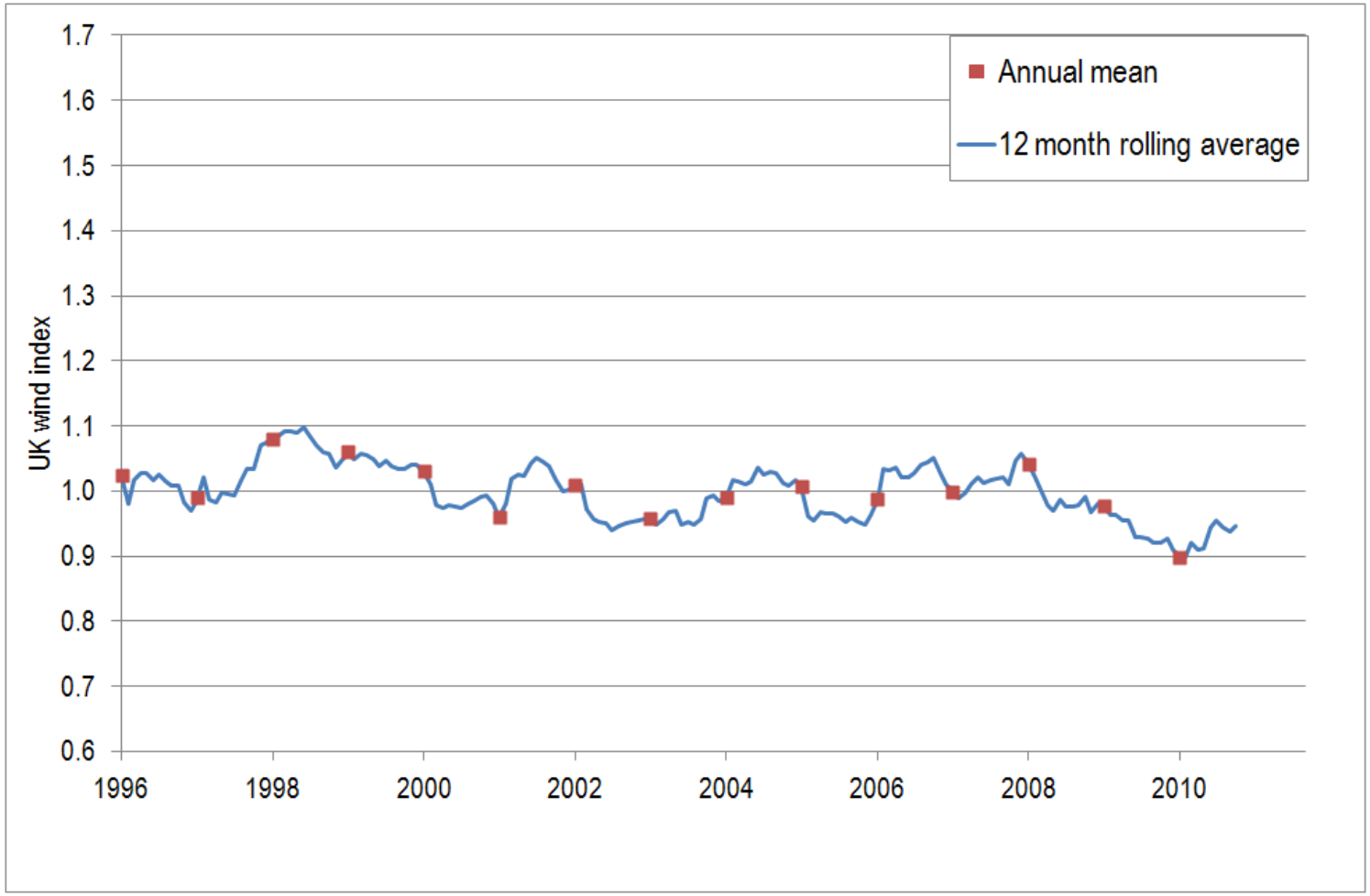
Take care looking at calendar years



Take care looking at calendar years



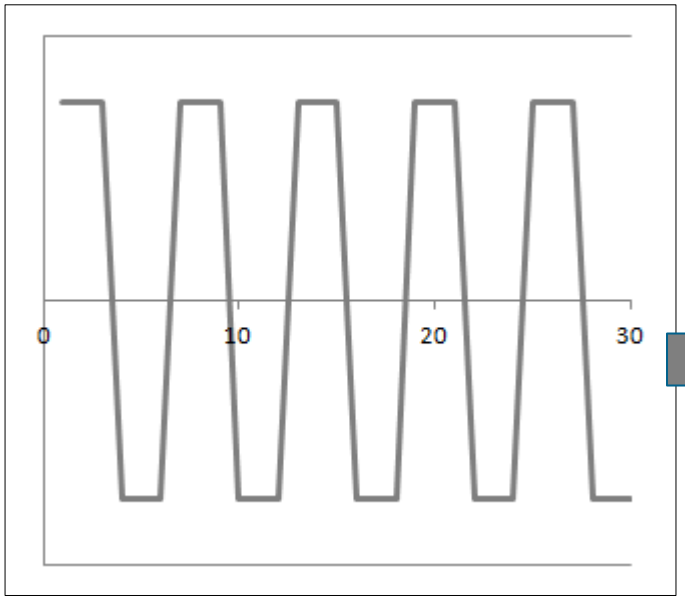
Take care looking at calendar years



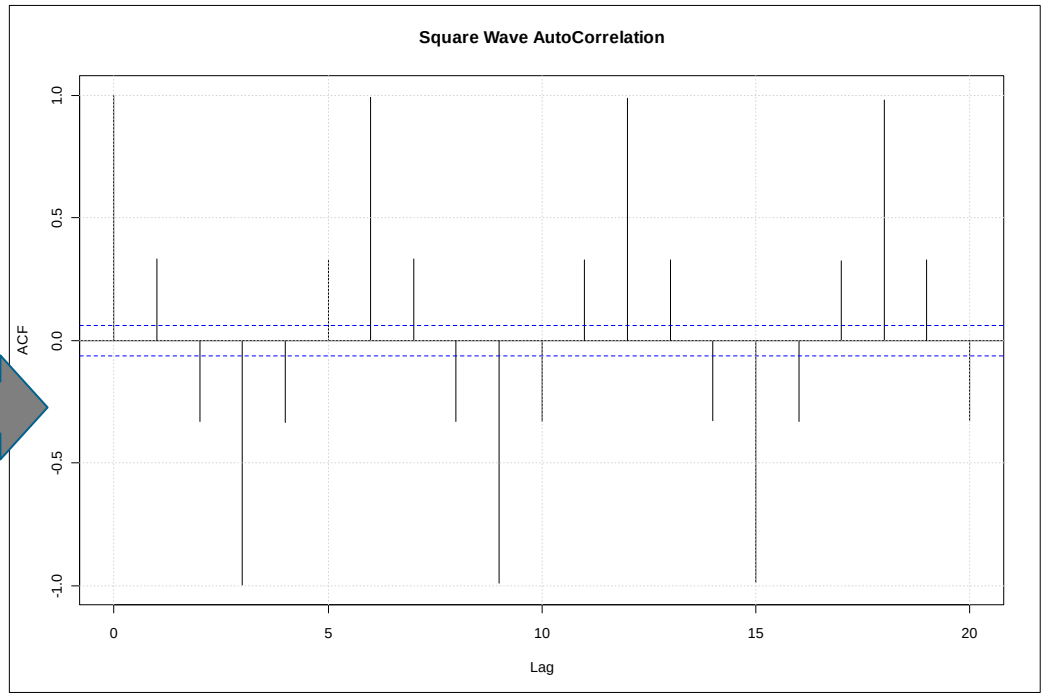
Autocorrelation – an example

Will the recent low wind speed period happen again next year?

Input data



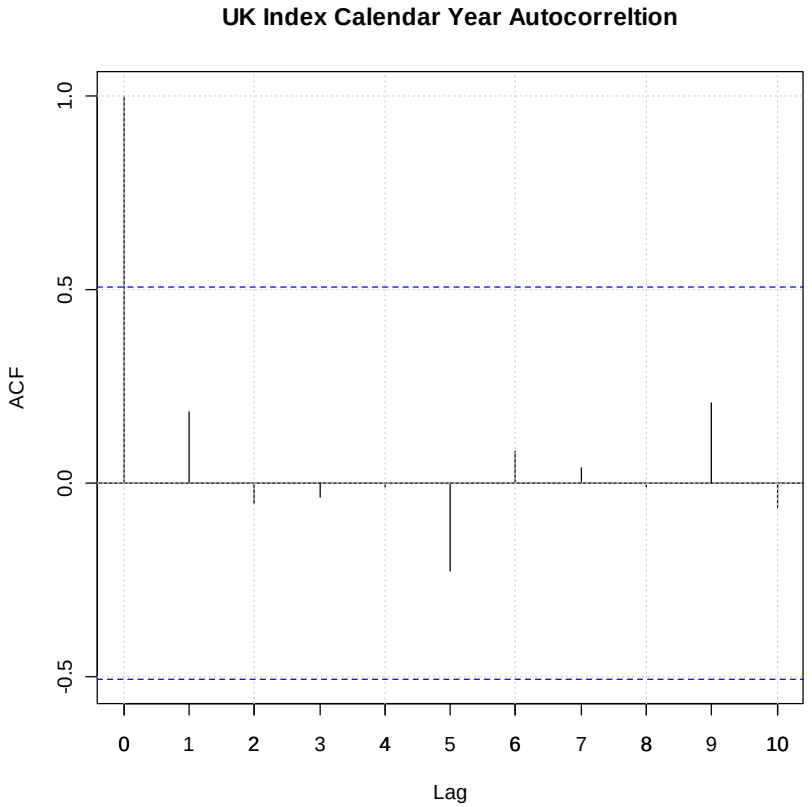
Autocorrelation result



Autocorrelation – the GL GH UK wind index

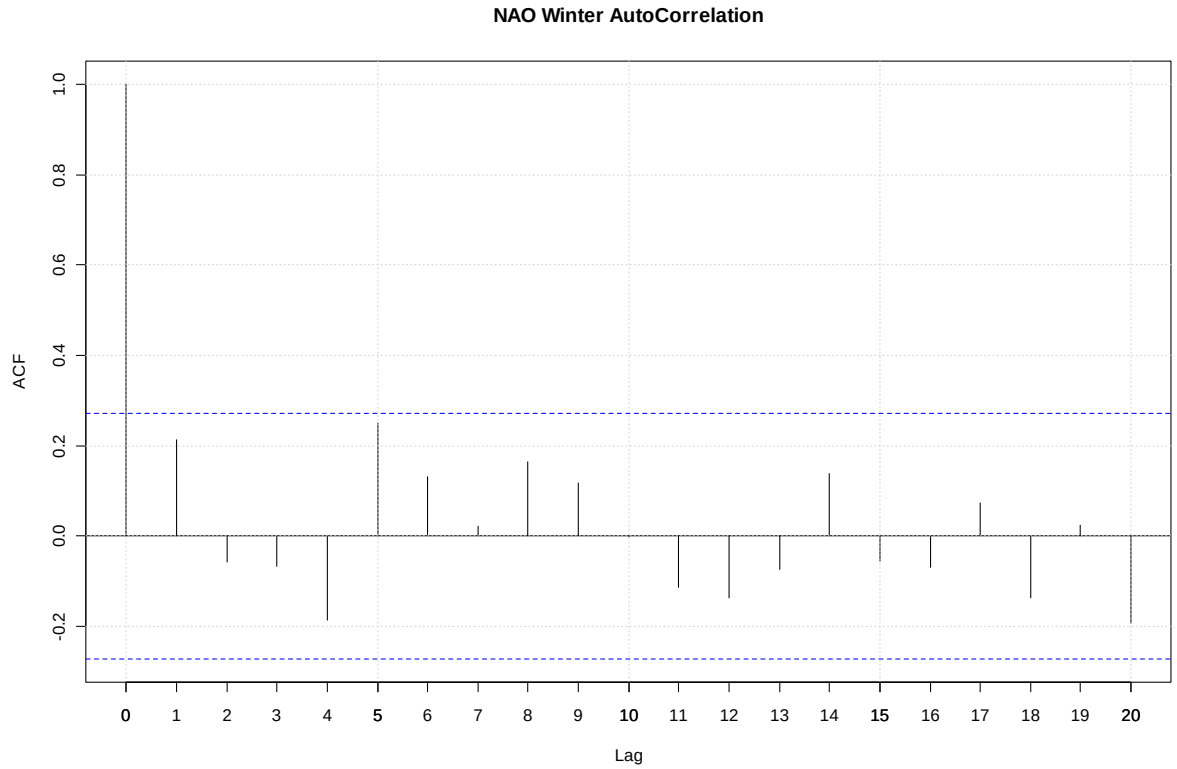
- *Will the recent low wind speed period happen again next year?*
- Autocorrelation of 12 month average data sets
  - Calendar years
  - Non-calendar years; June to July
- 15 year data set used
- Lag of up to 10 years investigated
- No significant autocorrelation at any lag

But what about even longer periods?



Autocorrelation – last 50 years of the NAO

- Autocorrelation of winter NAO values with lags of up to 20 years investigated
- No significant autocorrelation observed

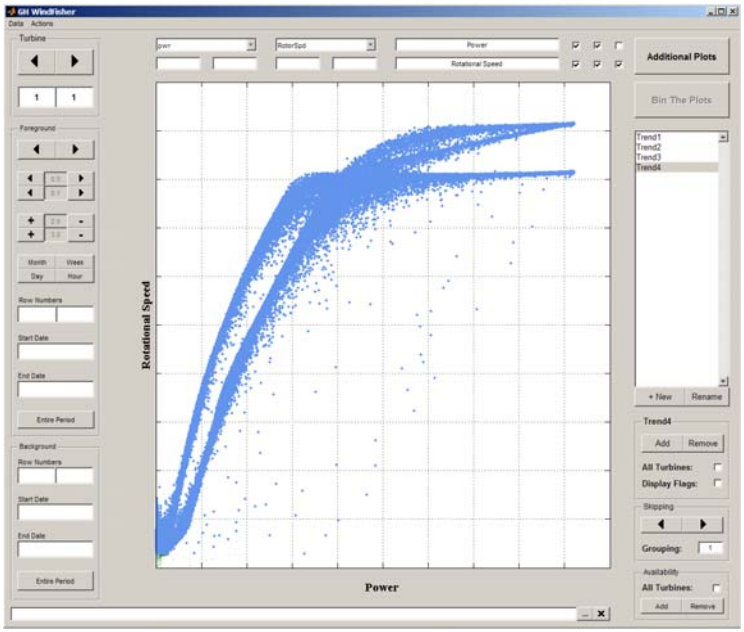


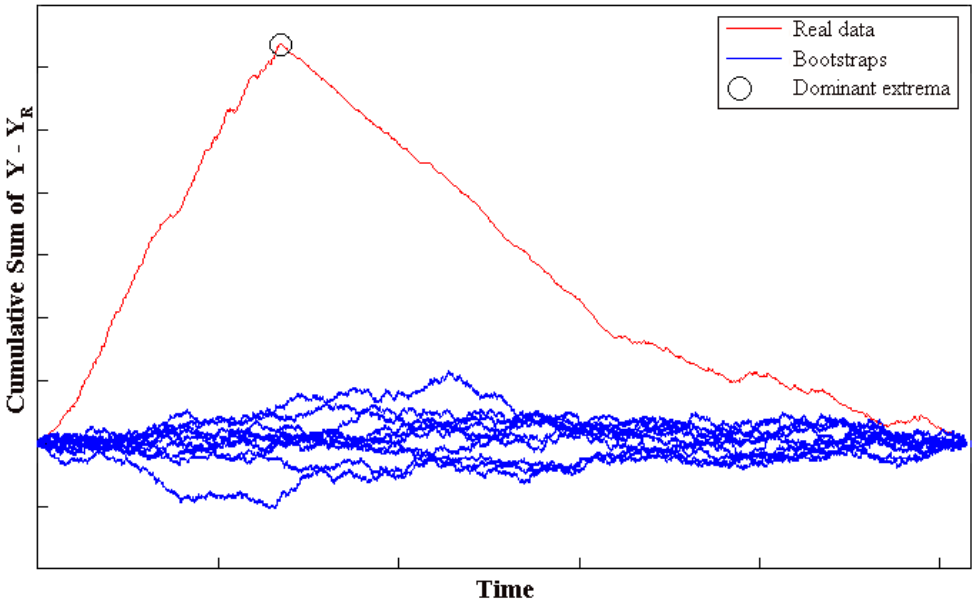
Conclusions:

1. Annual wind speed trends are essentially random
2. One year is not a good predictor of the next

Change Point Analysis – an example

- CPA aims to detect any change in the mean of a process in historical data
- Example below shows a CPA for a real turbine with a clear performance change

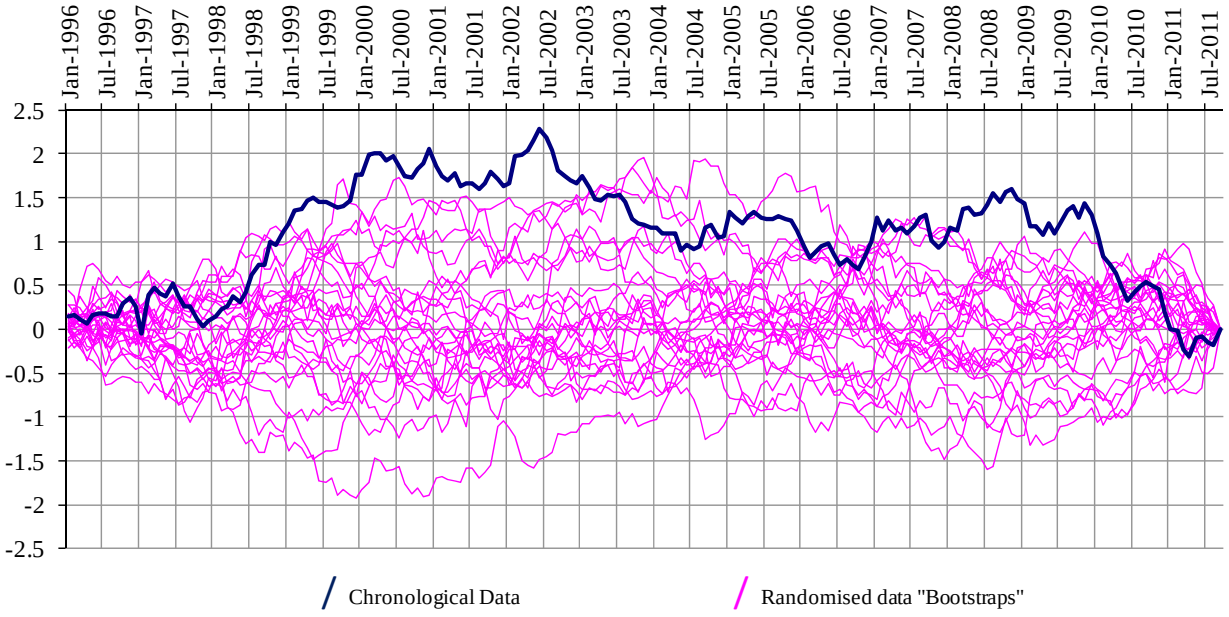




Further reading: http://www.variation.com/cpa/tech/changepoint.html

Change Point Analysis – the GL GH UK wind index

- *Does the recent wind trend signify a change in the way the wind "works"?*
- Analysis undertaken on UK index monthly values with a seasonal correction



Conclusion:

The recent low wind period has not been low enough, or prolonged enough, to be classified as a structural change in the data set

Conclusions

How low was the wind speed in 2010?

- Based on the UK wind index it was approximately 10% below the 15 year average
- 2010 is the lowest 12 month mean throughout the 15 year index
- Relative to the NAO it was an extreme event

Will recent trends continue?

- Statistical tests imply this is very unlikely
- Annual mean wind speeds are essentially random

Should 2010 be excluded when valuing wind farm projects?

- There is no evidence this is a new or different trend
- The annual mean wind speed for 2010 is within expectations for the assumed inter-annual variability

Thanks for listening

Bob Hodgetts
bob.hodgetts@gl-garradhassan.com

Visit us at Stand 49