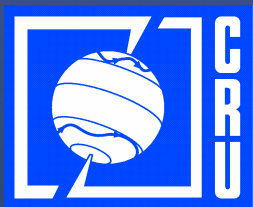


Predicting Future Changes in Wind



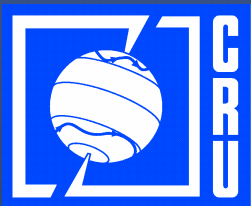
BETWIXT Workshop

13-14th May 2004



Presentation Outline:

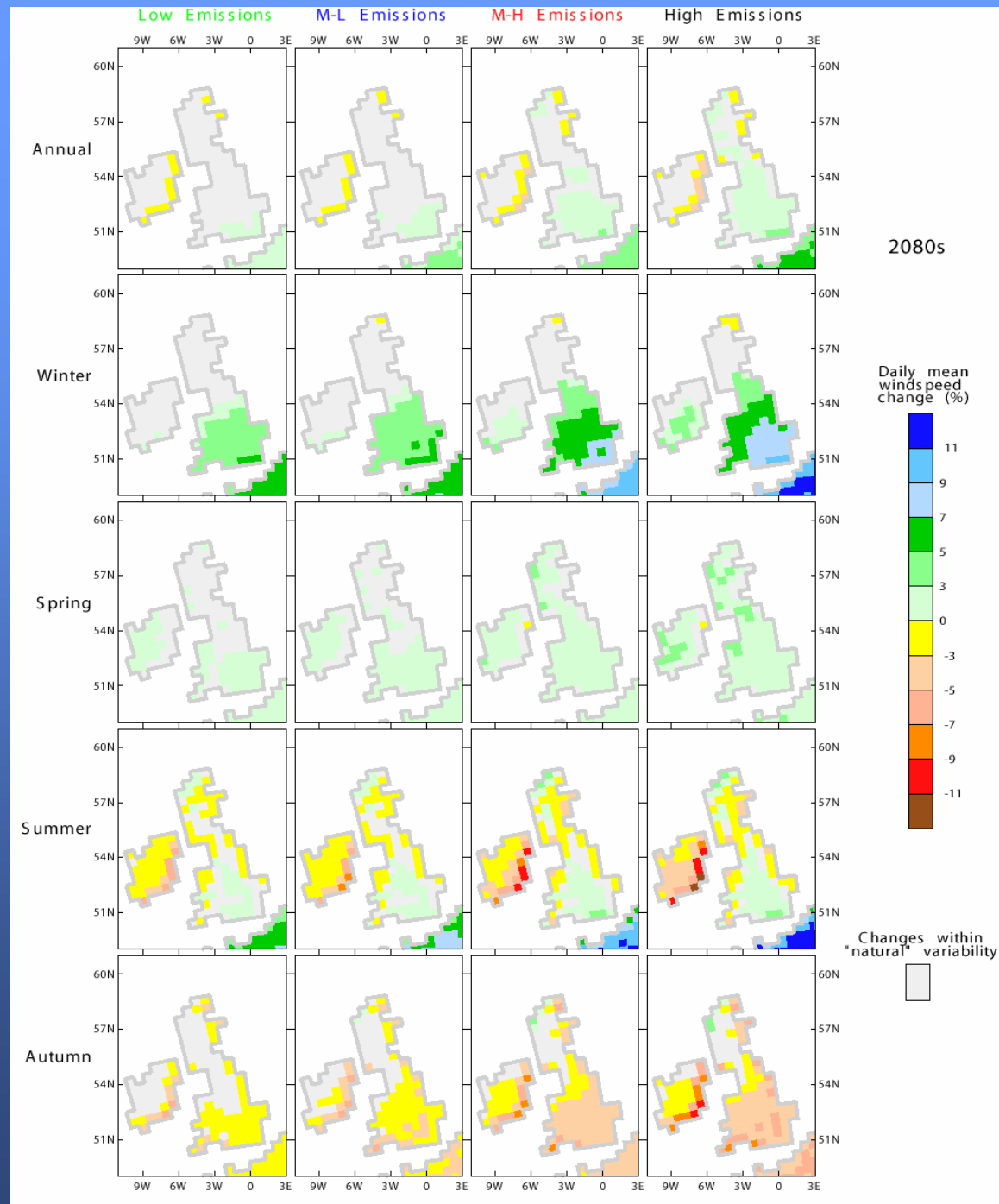
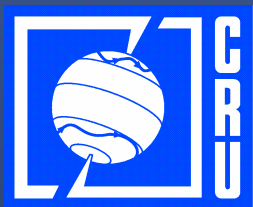
- What is the aim of this piece of research?
- Why are modelled winds unrealistic?
- How do modelled HadRM3H winds compare to station data?
- What do the Hadley Centre 3rd generation climate models tell us about the frequency and intensity of storms affecting the UK and Europe?



UKCIP02 Results

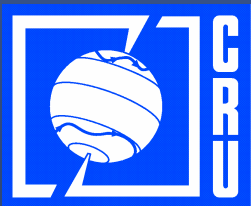
Change in Mean
Daily Wind
Speed - advise
the use of
empirical
relationships to
obtain statistics
at shorter
timescales

e.g., max. mean
hourly wspd =
30% greater than
daily mean wspd.



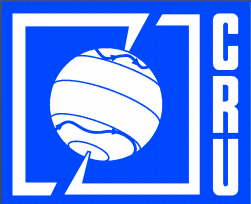
Aim:

- To apply a more physically-based approach to the development of wind scenarios based on information about storm track changes.
- These scenarios should be more reliable, particularly with respect to max. wind speed than those based on HadRM3H daily average wind data.



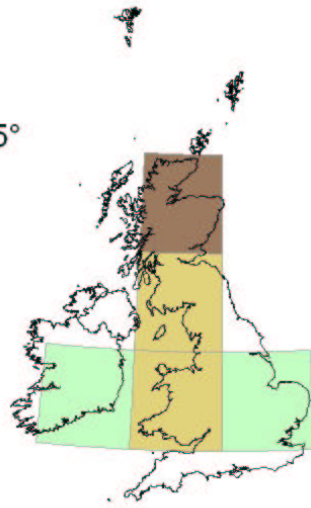
Reliability of Modelled Wind Data

- Climate models can generally model climate variables well e.g., mean temperature, mslp BUT they have a problem modelling wind speeds and direction.
- GCMs - coarse resolutions
e.g., HadCM3 $2.5^{\circ} \times 3.75^{\circ}$
e.g., HadAM3H $1.25^{\circ} \times 1.875^{\circ}$
e.g., HadRM3H 0.44° (UKCIP02 scenarios)
- Even the high resolution RCM is too coarse to model very small scale features of the circulation.
- Wind speed values are averaged over the grid box - at the highest resolution this is $\sim 50\text{km}^2$, and over time - average daily wind speed. Limited use in impacts modelling.

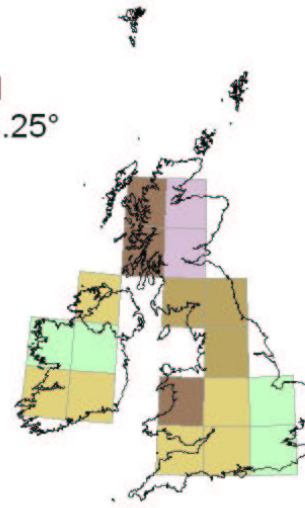


RCM/GCM grid

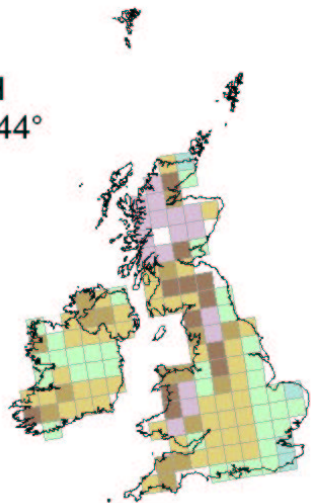
HadCM3
3.75° x 2.5°



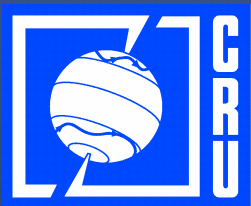
HadAM3H
1.875° x 1.25°



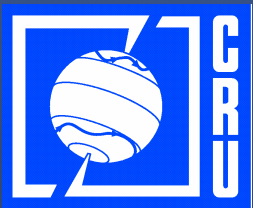
HadRM3H
0.44° x 0.44°



Elevation (masl)



Validation of HadRM3H mean daily wind speeds and direction across the United Kingdom

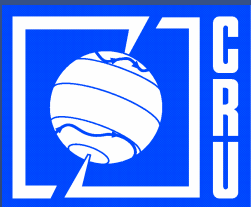


1) To have any confidence in future predictions, climate models need to be able to simulate current/historical behaviour of wind speed and direction

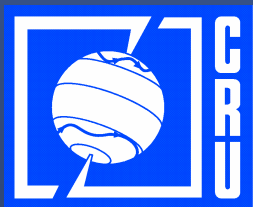
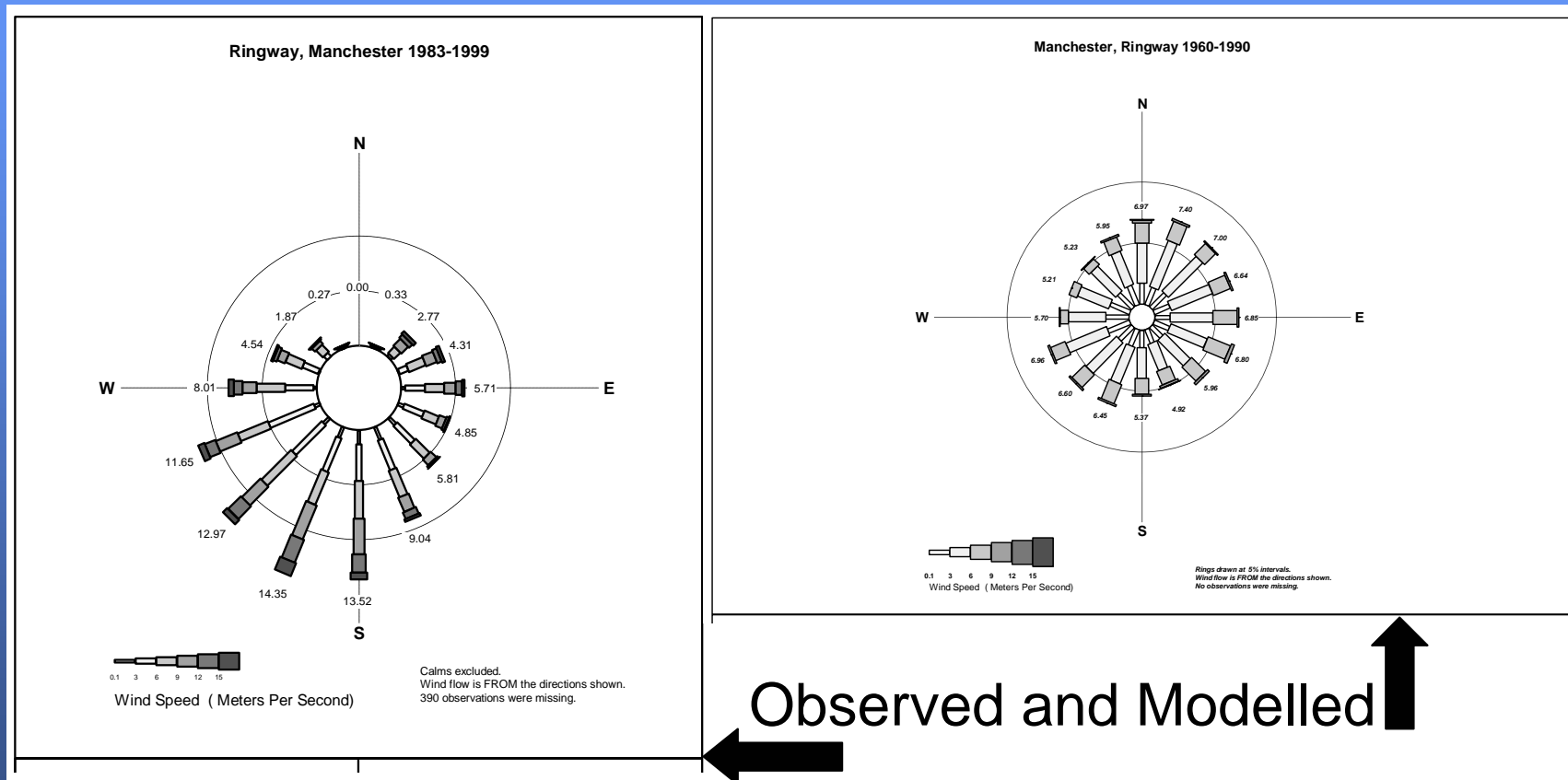
2) HadRM3H winds have been compared to data from nine meteorological stations

3) U and V wind components for the grid box within which a station is located were used to calculate wind speed and direction

4) Observed mean hourly wind speeds and directions were averaged to produce mean daily winds

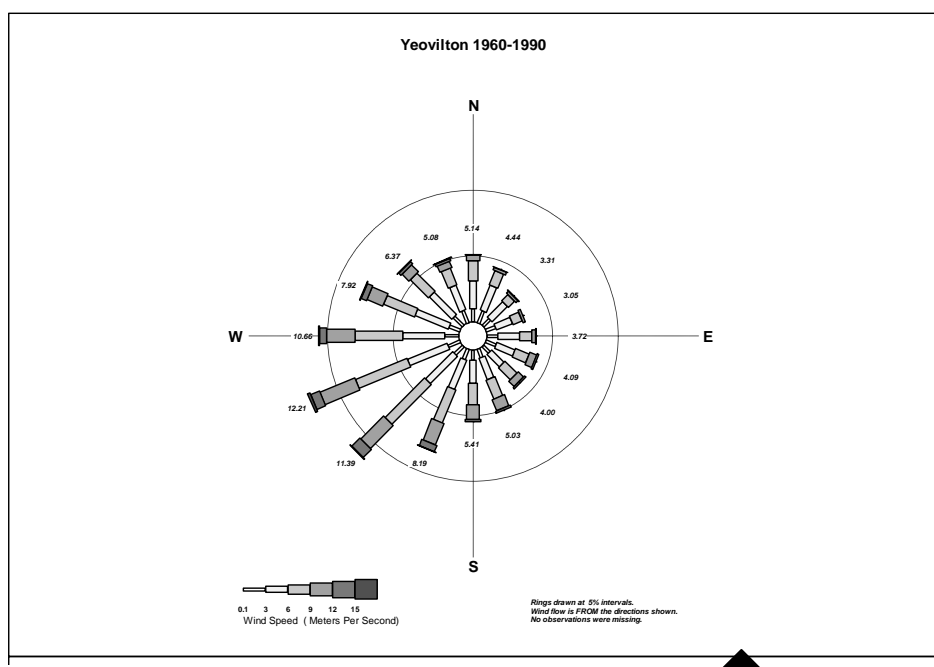
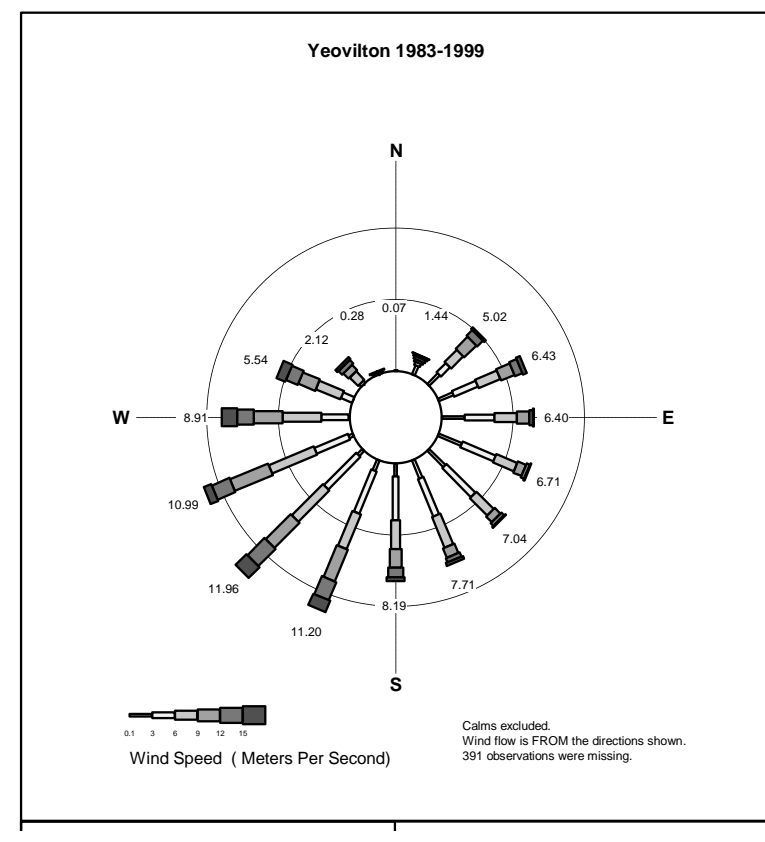


Two Examples: One poorly simulated (Manchester), one fairly well simulated (Yeovilton)



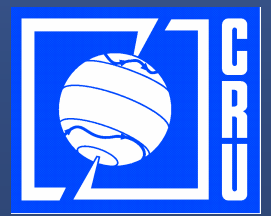
Manchester: Annual





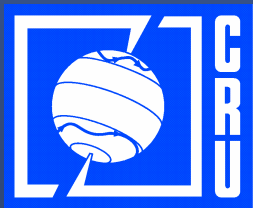
← **Observed and Modelled** →

Yeovilton: Annual

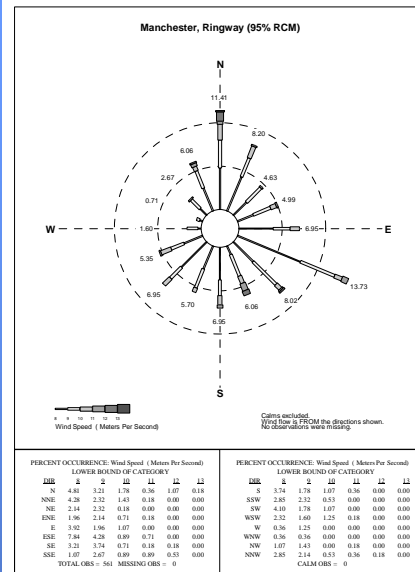


Analysis of Extreme Winds

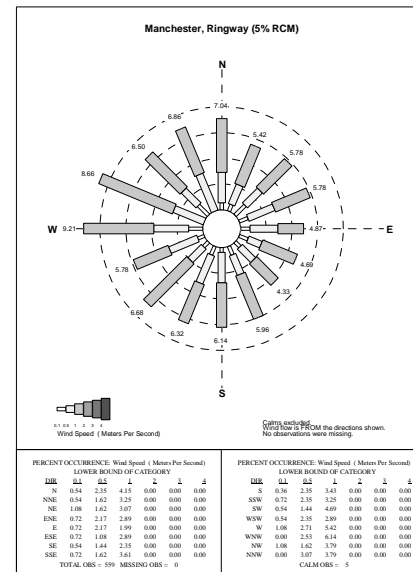
In order to examine the ability of the RCM to simulate the tails of the wind speed distribution the 5% weakest and the 5% strongest winds were analysed for the two stations.



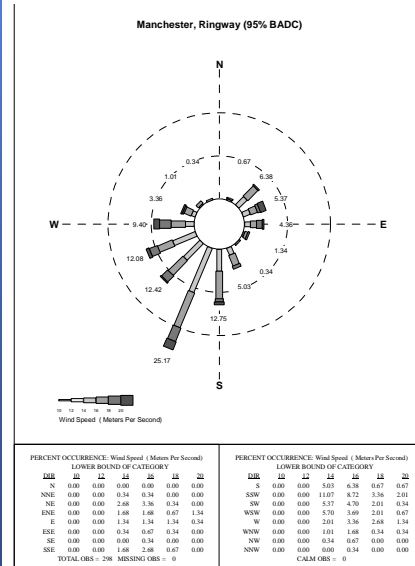
95th %ile
RCM



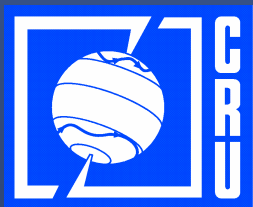
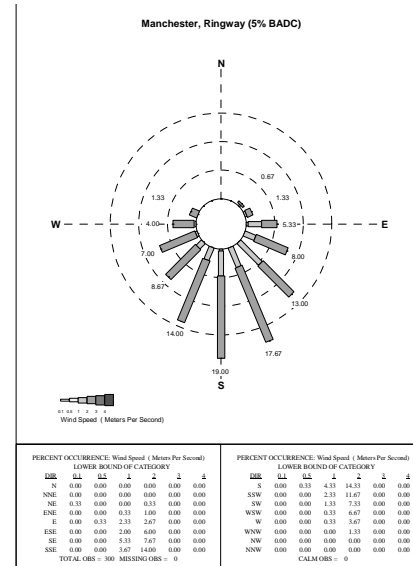
5th %ile
RCM



95th %ile
observed



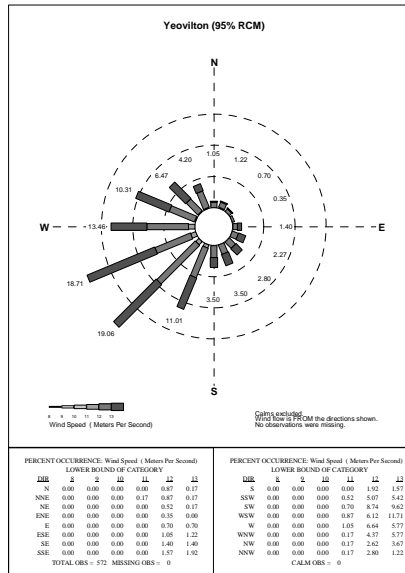
5th %ile
observed



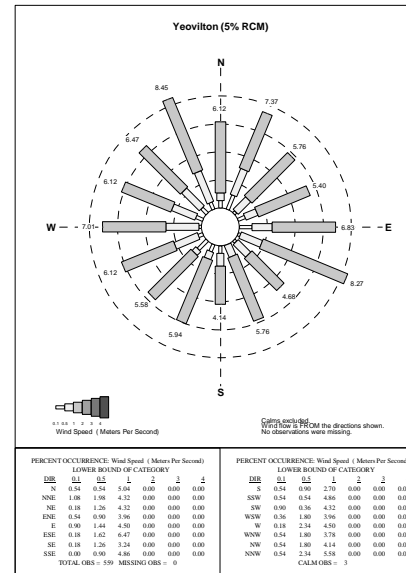
Manchester Extremes: Annual



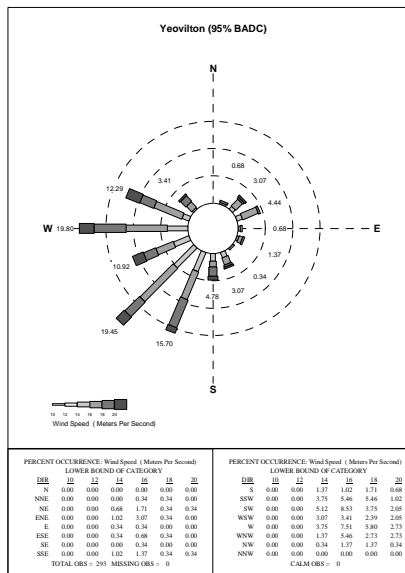
95th %ile
RCM



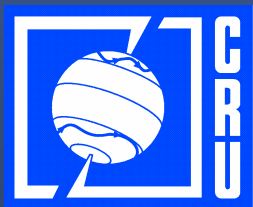
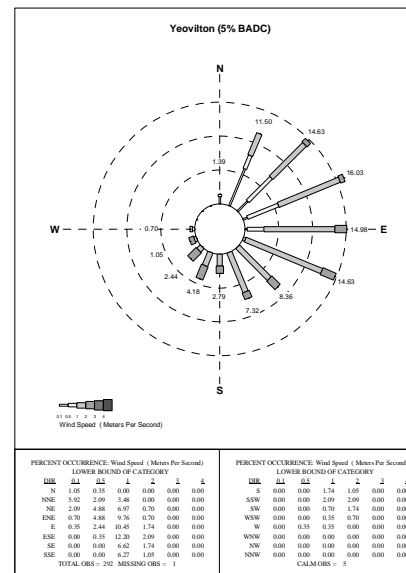
5th %ile
RCM



95th %ile
observed



5th %ile
observed



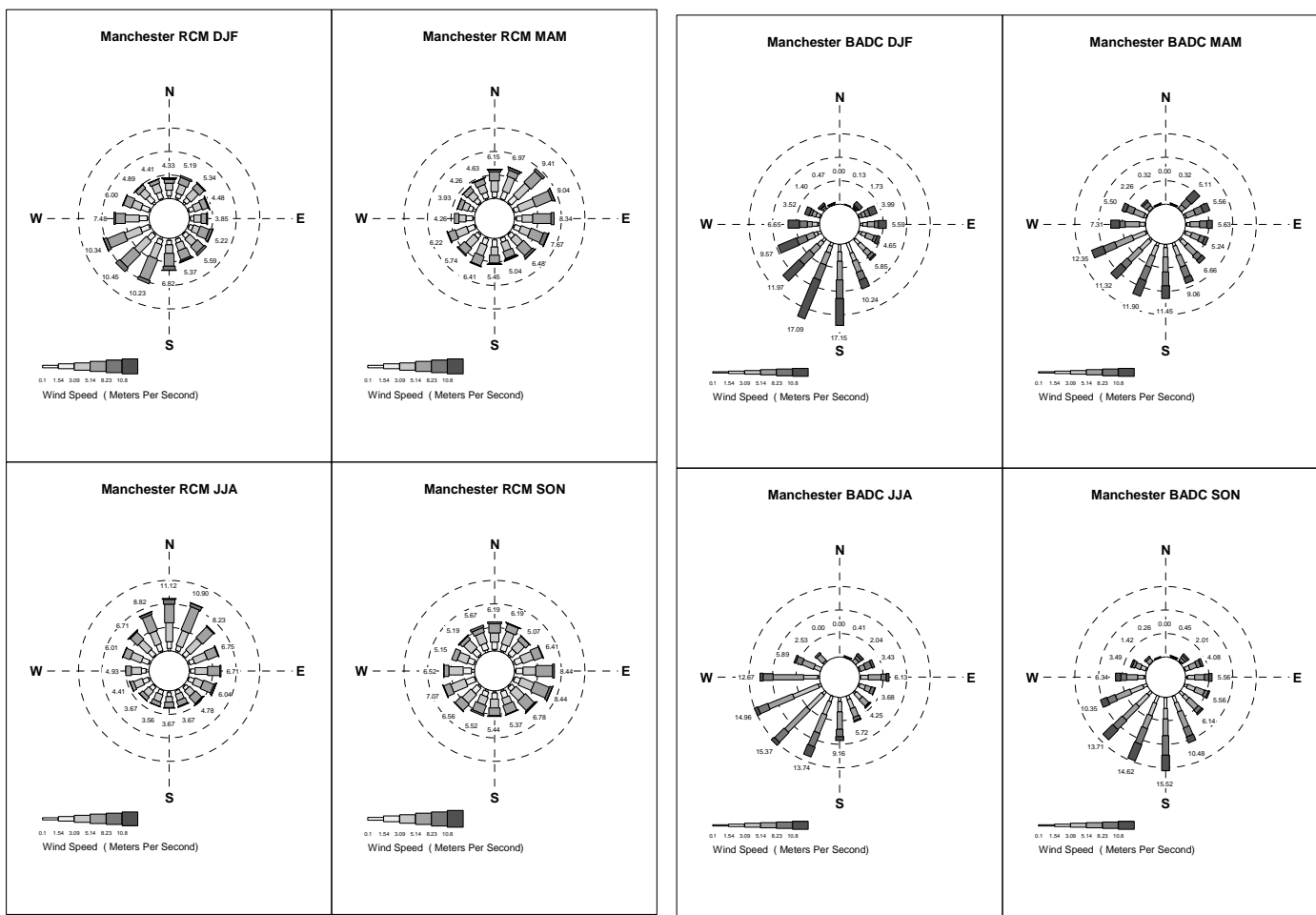
Yeovilton Extremes: Annual



Seasonal Analysis

RCM

OBS

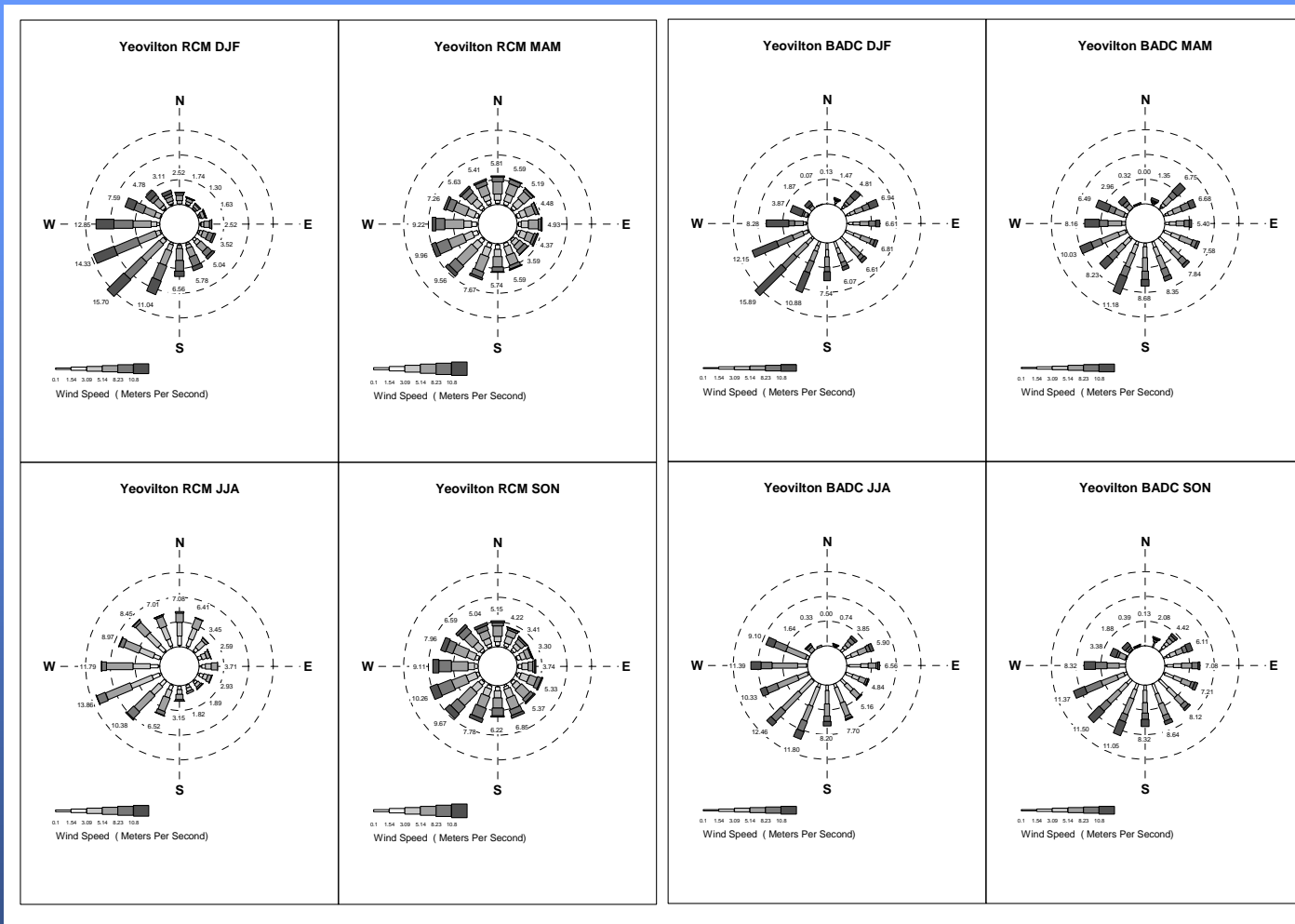


Manchester: Seasonal



RCM

OBS

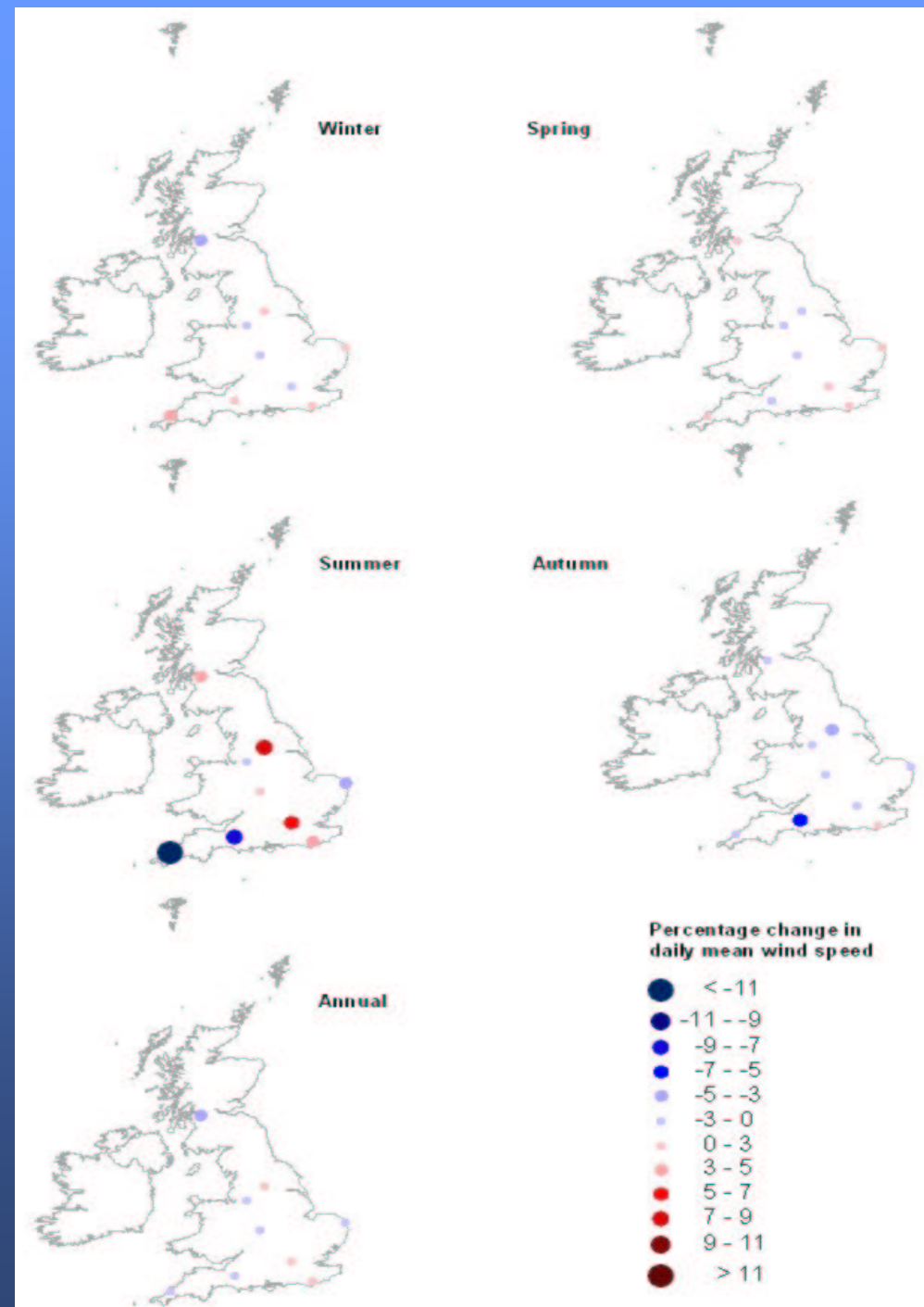
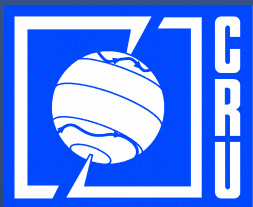


Yeovilton: Seasonal



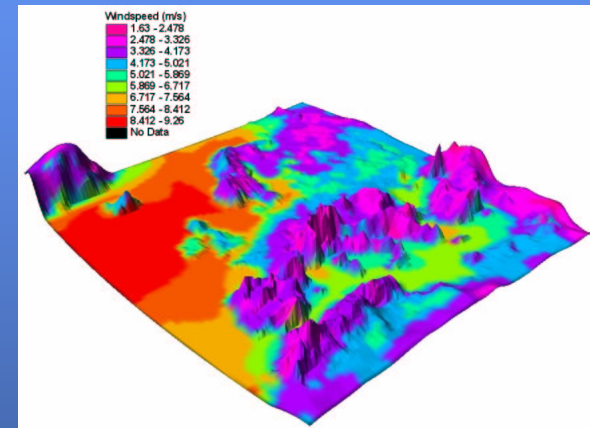
Future Changes?

- 1) For the future the RCM suggests no significant change in mean annual and seasonal wind direction.
- 2) Any changes in wind speed are in the order of a few tenths of a ms^{-1} only.
- 3) Changes are more noticeable at the seasonal level.
- 4) **HOWEVER**, the inability of the RCM to simulate historical winds means that little confidence can be applied to the future predictions of wind speed and direction.

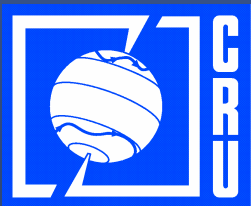


Why does the RCM have problems simulating wind speeds and direction?

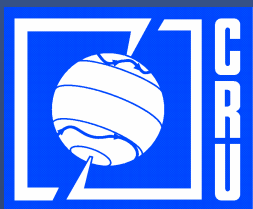
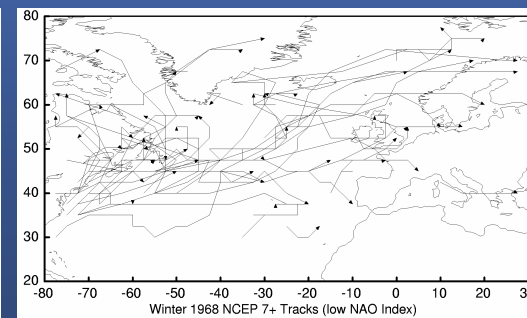
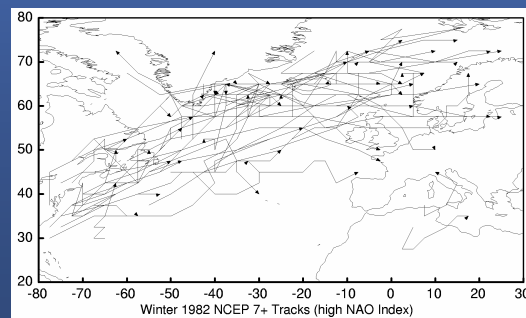
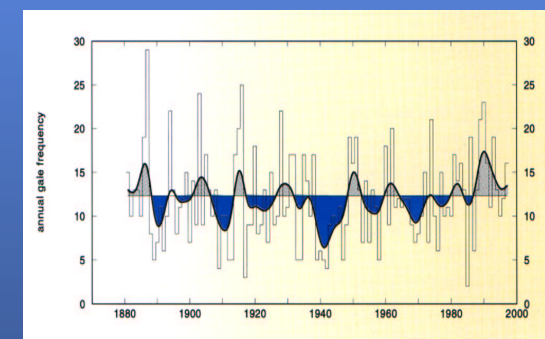
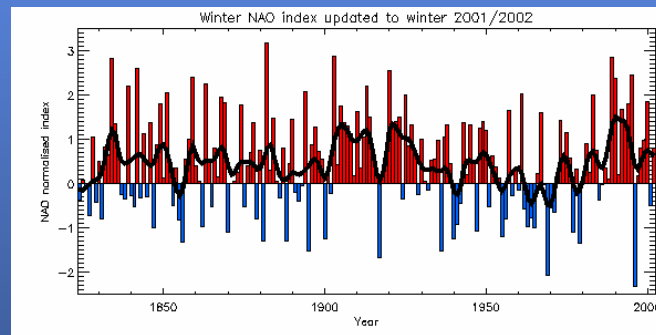
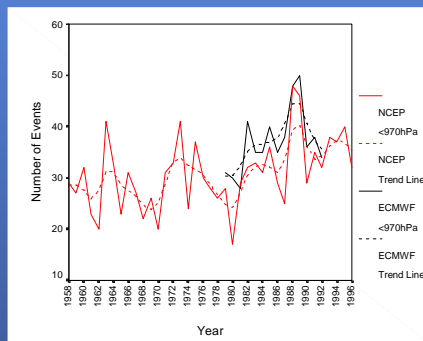
- 1 The simulation of changes in wind speeds with height. Modelled wind speeds decrease erroneously with height.
- 2 Small-scale and high intensity winds are sub-grid scale processes which cannot be modelled directly within the RCM.
- 3 The temporal resolution of the RCM winds also causes problems with the accurate modelling of speeds. The highest resolution is the daily average wind speed which is probably the cause of the modelled winds being so much slower than the observed winds.



Changes in wind speed with height. Annual average of mean daily winds produced by HadRM3H.

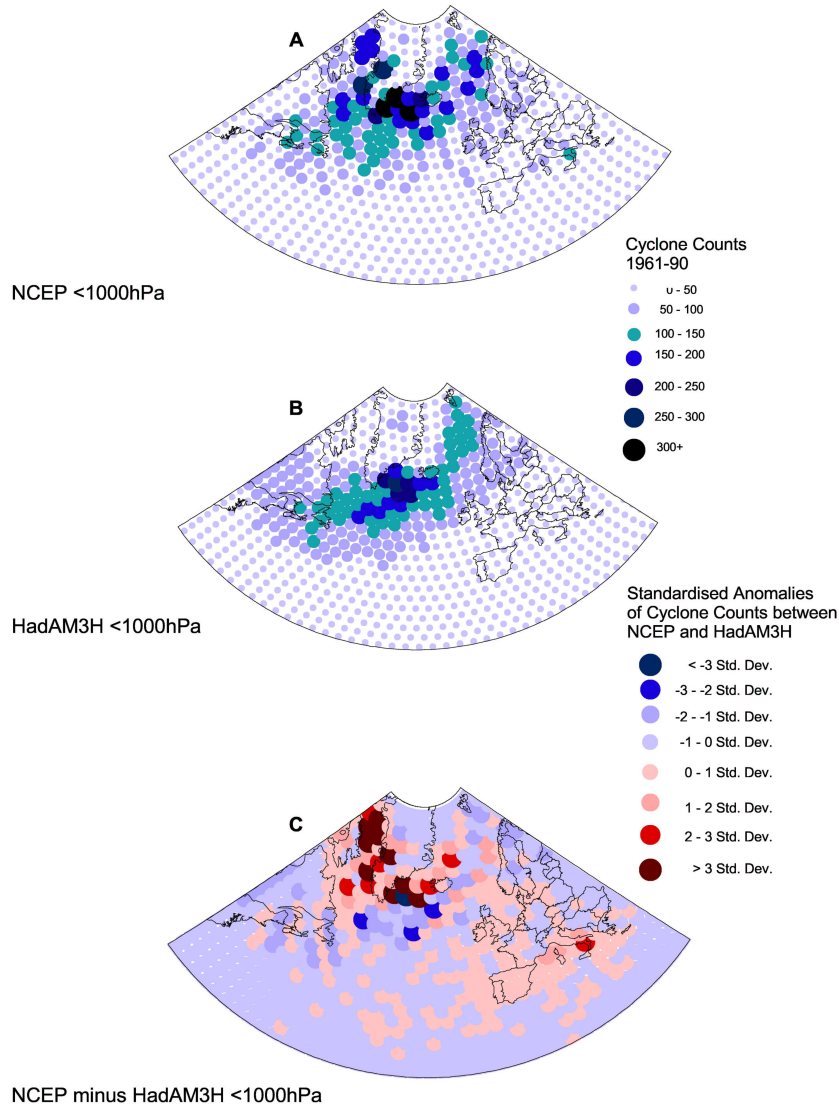


- If we can't rely on modelled wind speeds, what's the alternative?
- The NAO, cyclone activity and wind speeds are closely related.
- Hadley Centre models are amongst the most accurate in modelling the North Atlantic storm track.
- So what do they tell us about future cyclone activity?

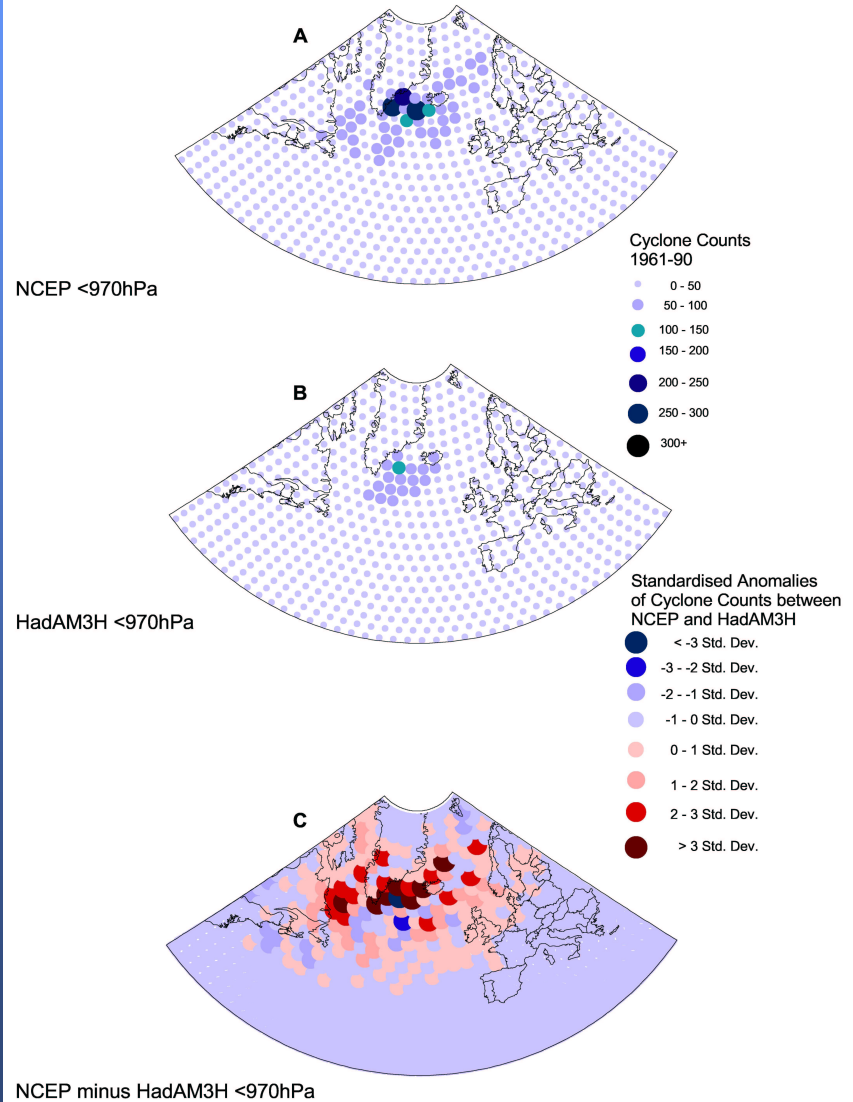


HadAM3H over the North Atlantic

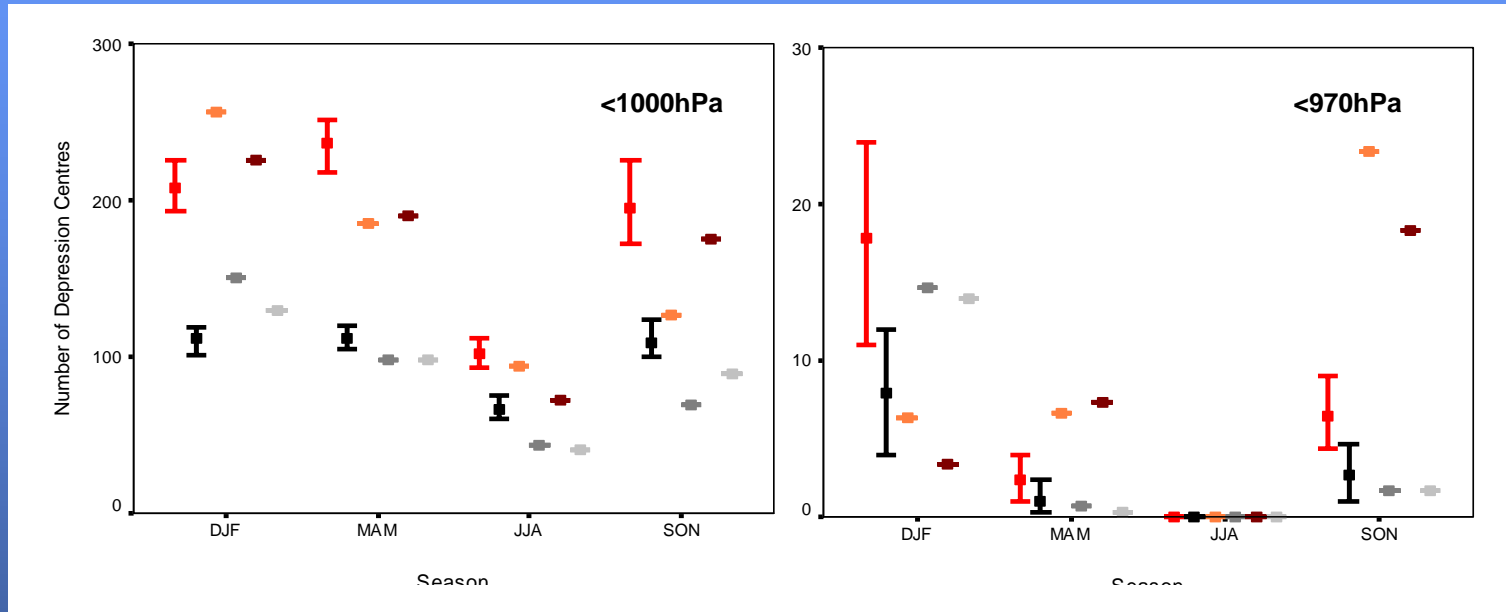
Distribution of Cyclones achieving at least 1000hPa minimum central pressure (1961-90)



Distribution of Cyclones achieving at least 970hPa minimum central pressure (1961-90)



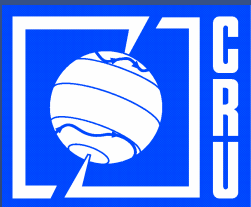
Seasonal Distribution over UK



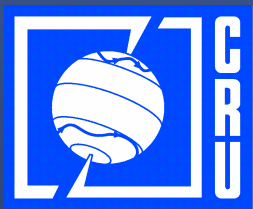
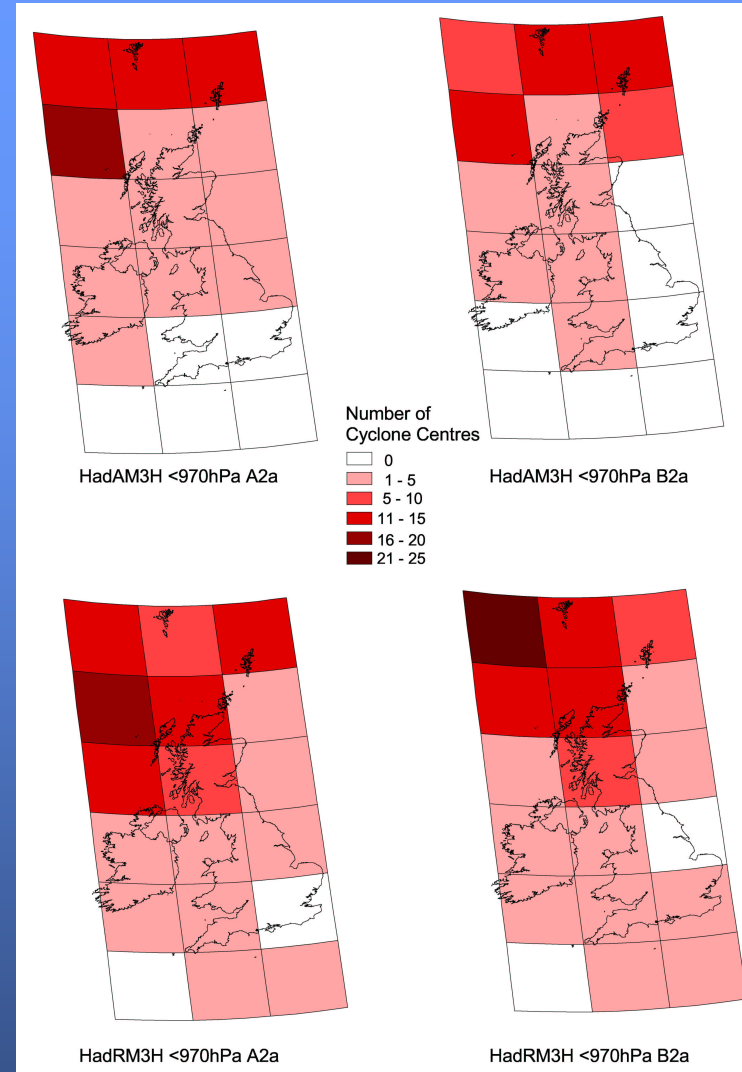
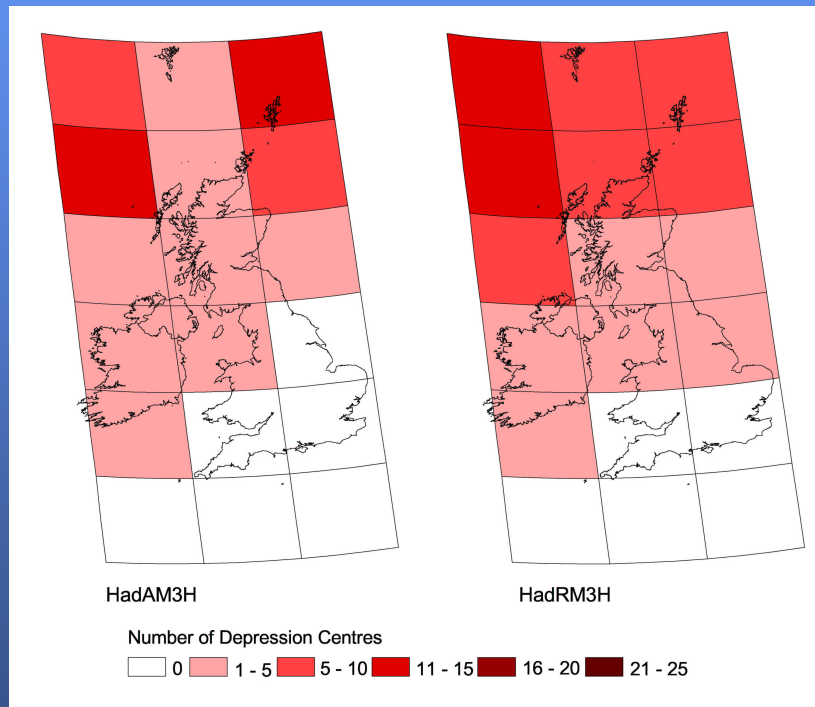
Red = RM3 , Black = AM3H

Orange/Dark grey = A2aF

Brown/Light grey = B2aF

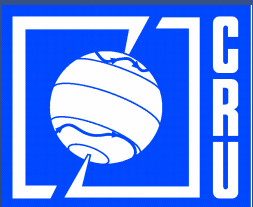


Present and Future Spatial Distribution



Conclusions:

- The GCM and RCM indicate no significant change in cyclone intensity, frequency or spatial distribution or wind speeds in the future.
- Reliability of the RCM in simulating wind speeds and directions is questionable BUT the cyclone simulation also indicates no significant change in the pressure field in the future.



Advice to BKCC:

- UKCIP02 conclusions about reliability of wind scenarios remain valid
- CRU weather generator provides wind time series which are consistent with other variables but may not encompass all relevant forcing factors

