

UKCP09 Storm projections

The following text summarizes the information available on storms in UKCIP02, UKCP09 and selected other sources. It must be emphasized that different publications can define storms differently and so readers must be clear how a storm is being defined within the resource they are reading.

The following text regarding UKCIP02 and UKCP09 is not referring to thunderstorms or convective activity, nor is it looking at storm surges. In terms of timescales, it is referring to storm activity up to the end of the 21st century.

UKCIP02 – What does it say about storms?

UKCIP02 defines storms as depressions or low pressure areas and notes that it is ambiguous since it can also be used to mean thunderstorms, quite a different phenomenon. The storms in UKCIP02 are depressions (cyclones) identified and tracked using mean sea level pressure data and TRACK which is an analysis program that automatically and objectively identifies depressions in time sequences of meteorological data (<http://www.nerc-essc.ac.uk/~kih/TRACK/Whatis.html>).

Within the headline messages it states that winter storms and mild, wet and windy winter weather are expected to become more frequent (low confidence).

The following section is taken from the UKCIP02 Science report, 'The weather of the UK is dominated in winter by depressions moving in from the North Atlantic. These are often called "lows", or even "storms", although storm is a rather ambiguous word since it is also used to mean thunderstorms, quite a different phenomenon. We identified and tracked low pressure areas using the pressure fields from the intermediate resolution global model - HadAM3H. A track with its lowest pressure below 1000 hPa was classed as a depression. The number of all such depressions crossing the UK in an average winter increases from about five for the present climate to about eight for the Medium-High Emissions scenario by the 2080s (Figure 51). This is mainly due to a shifting southward of the depression tracks from their current position, resulting in a strengthening of the winter winds over the south of England (cf. Figure 48). The probability of an individual low pressure system being a "deep" depression - defined when the central pressure is less than 970 hPa - does not change by the 2080s but, since there are more depressions overall, there are more frequent deep depressions. These "deep" depressions increase in frequency in winter by about 40 per cent for the Medium-High Emissions scenario by the 2080s. In the summer, the pattern is reversed, with depressions over the UK in the 2080s falling, on average, from five to four per season. There is little significant change in depression frequency or intensity in autumn or spring.' (UKCIP02 Science report, pg 51).

UKCP09 – What does it say about storms?

In UKCP09 there are two methods of exploring the nature of storms. The first defines storms using a band-pass filtered storm track that provides a measure of synoptic variability. The second method is similar to that used in UKCIP02 in that storms were identified and tracked using TRACK. A further difference between these two methods is that 850 hPa relative vorticity data was used in the first instead of mean sea level pressure.

There is no evidence within the UKCP09 projections of an increase in the frequency, nor intensity of storms in the UK. The following section is taken from Annex 6 of the UKCP09 Projections report, 'Future changes in storms and anticyclones affecting the UK', 'Useful information can be gleaned from examination of the present day and future synoptic-scale variability simulated by the Met Office ensemble of 17 HadCM3 experiments (described in Chapter 3, [Section 3.2.4](#)) and a multi-model ensemble consisting of 20 alternative coupled models, all using the same SRES A1B (UKCP09 Medium) emissions. Preliminary analysis of these ensembles suggests that the simulated future changes in storms, and their impact on mean climate conditions, are rather modest. Subtle shifts in the position of the N. Atlantic storm track are possible, but are inconsistent between different models and different model variants. The frequency and strength of storms remain relatively unchanged in the future simulations, as does the frequency and strength of blocking events. It must be borne in mind, however, that these two ensembles sample a smaller range of uncertainty than do the UKCP09 projections.'

Regarding a shift of storm tracks or the direction of storms, Annex 6 also states, 'The IPCC AR4 assessment concluded that the majority of current climate models show a poleward shift of the storm tracks, with some indication of fewer, but deeper, depressions. This can only be concluded when looking at the hemispheric scale; the UK is very much smaller than this scale and any climate change signal is swamped by natural variability and sampling uncertainty resulting in a lack of any robust signal of changes for the UK.'

UKCIP02 and UKCP09 – Summary

In HadAM3H (the climate model used in UKCIP02) there is an increase in the future number of UK winter depressions because there are more depressions overall and not because the probability of the most intense storms increases. This is attributed to a southward shift in the north east end of the North Atlantic storm track in this model giving more UK storms.

In HadCM3 (the climate model used in UKCP09) there is little change in the frequency of storms over the UK in winter. Although there is a southward shift in the North Atlantic storm track in this model the increase in frequency occurs to the southwest of the UK giving little change over the UK. There is also little change in the intensity of UK storms in this model.

There are uncertainties associated with both the position and strength of the present day storm tracks and these contribute to the large uncertainties in the future predictions of storms.

The different results between the two models illustrate the lack of any robust changes in UK storms, hence the [Annex 6.4 summary of the Climate change projections report](#) states:

"There is no consistent signal of change in either storms or blocking near the UK in either ensemble of Met Office models or the ensemble of alternative models. Such changes as are seen are relatively modest, and the potential for substantial changes appears to be small."

Wind data?

UKCP09 does not currently contain projections concerning wind. However, during 2010, it is planned that the Met Office will try to create probability distributions of wind speeds as part of the UKCP09 “extras” process. This attempt may not create projections that are considered to be robust, in which case these probability distributions will not be released.

The 11-member RCM, released as a by-product of UKCP09, provides projections of wind speeds. This information is available from the LINK project. It should be noted that these projections cannot be used in conjunction with the UKCP09 projections. The user must decide whether to use one of the other but not both together. Guidance on the 11-member RCM is available from the UKCP09 website at <http://ukclimateprojections.defra.gov.uk/content/view/1124/9/>

The weather generator does not provide any wind information because the future projections are generated using the UKCP09 probabilistic projections, which do not provide wind.

FAQ: Why are there no estimates of wind speed in the Weather Generator output but PET (which requires wind) is included?

<http://ukclimateprojections.defra.gov.uk/content/view/885/500>

Other sources e.g. IPCC - What do they say about storm projections?

IPCC

Definition:

Reference to storms in the IPCC refers to changes in the circulation of the atmosphere and in the mid latitudes is used with reference to extra-tropical cyclones (baroclinic low pressure systems that occur within the mid-latitudes of both hemispheres). Their potential for causing property damage, particularly as winter storms, is well documented, where the main interest is in wind and wind-generated waves. In place of direct wind measurement, that suffer from lack of consistency of instrumentation, methodology and exposure, values based on sea-level pressure gradients have been derived which are more reliable for discerning long-term changes.

More recently the IPCC has also included assessments of studies of storm tracks. This is a term originally referring to the tracks of individual extra-tropical cyclones, but now often is generalised to refer to regions where the main tracks of extra-tropical cyclones occur as sequences of low and high pressure systems.

What does the IPCC AR4 say about storm projections? Is there evidence of an increase in the number of storms?

Historical observations:

- Analyses of wind and significant wave height support reanalysis-based evidence for an increase in extra-tropical storm activity in the Northern Hemisphere in recent decades until the late 1990s. The IPCC also report that these worsening wave conditions in the north eastern North Atlantic during the latter half of the 20th century were connected to a northward displacement in the storm track.
 - During the period from 1950 to 2002, there has been a significant positive trend in significant wave height for regions to the west and south of the UK and for much of the North Sea and north of the UK (not to the northwest). For the winter, that positive trend continued up to the period considered by the IPCC AR4 (up until 2005).
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- The upward trend towards more positive NAO index in winters from the mid-1960s to the mid-1990s has been associated with increased wave heights over the northeast Atlantic. This evidence points towards more intense storm events and perhaps an increased number in winter, but not necessarily annually.

Future Projections

The IPCC AR4, assessment reveals that studies are showing that for many regions of the mid-latitude oceans, an increase in extreme wave height is likely to occur in a future warmer climate. This is related to increased wind speed associated with mid-latitude storms, resulting in higher waves produced by these storms, and is consistent with the studies that are showing decreased numbers of mid-latitude storms but more intense storms. The assessment refers to extreme wave height and does not discriminate as to the timing in the year (i.e. the extreme wave heights could all be occurring in the winter).

Is there evidence of increase in intensity of storms?

Model projections considered within the IPCC AR4 assessment suggest a general tendency for more intense but fewer mid-latitude storms averaged over each hemisphere, associated with a poleward shift of the storm tracks. It is suggested that these projections should be interpreted in light of the tendency for considerable variability in storminess that is characteristic of this region.

Recent research by scientists that has, and will be, further contributing to the IPCC within the AR5:

ENSEMBLES

The conclusion of a decreased number of “storms” as a result of a poleward shift was also reported within the ENSEMBLES project as was the increased intensity of the more intense “storms”.

Useful reference – this paper was produced as part of ENSEMBLES and reviews recent work on cyclones:

U. Ulbrich, G. C. Leckebusch and J. G. Pinto (2009) Extra-tropical cyclones in the present and future climate: a review Theoretical and Applied Climatology Volume 96, Numbers 1-2 / April, 2009 DOI 10.1007/s00704-008-0083-8 Pages 117-131

Environment Canada

Historical Observations

Environment Canada scientists document profound decadal or longer time scale fluctuations in storminess conditions in the Northeast Atlantic region (NEAR) over the past 130 years.

In this study, four scientists from Environment Canada look in detail at seasonal and regional changes in storminess in the Northeast Atlantic region over the period 1874–2007. Their analysis showed that decadal or longer time-scale variability in storminess is characteristic of this region, with considerable seasonal and regional differences. The most notable differences are between winter and summer, and between the North Sea area and other parts of the region. In particular, winter storminess shows an unprecedented maximum in the early 1990s, while the summer maximum occurred around 1880, in both cases in the North Sea.

In addition, winter storminess shows a steady upward trend in the north eastern region, and a decline in the western area and the Norwegian Sea, while summer storminess appears to have declined in most part of the NEAR, including the North Sea.

The authors note that the maximum winter storminess in the early 1990s is consistent with severe storms in the United Kingdom during the same period. Using the North Atlantic Oscillation (NAO) index, they found that storminess conditions in the NEAR are significantly correlated with this index in all seasons but autumn. This correlation is especially true in winter and spring where the higher the NAO index, the rougher the storminess conditions.

(Reference : Wang, X.L., F.W. Zwiers, V.R. Swail and Y. Feng, 2009, Trends and variability of storminess in the Northeast Atlantic region, 1874-2007, *Clim, Dyn.*, 33: 1179-1195)

Sources:

UKCIP02 Headline messages:

http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=237&Itemid=331

UKCIP02 Science report:

http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=353&Itemid=408

UKCP09 Projections report, Annex 6:

<http://ukclimateprojections.defra.gov.uk/content/view/2091/500/>

UKCP09 website FAQ: How do the storm projections for UKCIP02 and UKCP09 compare? Does UKCP09 show an increase in the frequency, intensity and severity of storms?

<http://ukclimateprojections.defra.gov.uk/content/view/542/500>



Wang, X.L., F.W. Zwiers, V.R. Swail and Y. Feng, 2009, Trends and variability of storminess in the Northeast Atlantic region, 1874-2007, *Clim, Dyn.*, 33: 1179-1195

IPCC, 2007: *Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., Qin, D., Manning, M., Marquis, M., Averyt, K. B., Tignor, M., and Miller, H.L., (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996pp.

TRACK web page:

<http://www.nerc-essc.ac.uk/~kih/TRACK/Track.html>