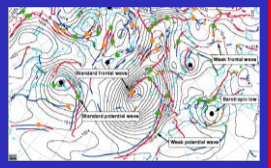
A Climatology of North Atlantic Cyclones

Helen Dacre and Suzanne Gray, The University of Reading, UK (h.f.dacre@reading.ac.uk)

The University of Reading



Introduction

Extratropical cyclones play a large role in determining the day-to-day weather conditions in western Europe through their associated wind and precipitation patterns thus their average characteristics are of great interest. In this study a climatology of extratropical cyclones is produced using an objective method of cyclone identification based on low-level gradients of wet-bulb potential temperature. The cyclone statistics are compared with previous climatologies and the spatial distribution of cyclone characteristics and the evolution of these characteristics are calculated in composite cyclones.

Method

• Cyclones are objectively identified from UK Met Office 12-h analyses, using low-level gradients of wet-bulb potential temperature (Hewson 1998), over a domain covering the North Atlantic (fig 1a).

• Individual cyclones are joined up into cyclone tracks using an automated system (Hodges 1994).

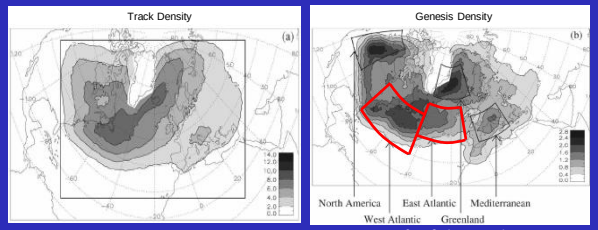
• Spatial cyclone characteristics are calculated by compositing the characteristics of all cyclones at their genesis point.

• The evolution of cyclone characteristics are calculated by:
i) centralising cyclone tracks around their time of max. vorticity
ii) grouping cyclones according to lifetime
iii) compositing cyclone characteristics at each 12-h interval

Cyclone Density Statistics

Track Density - the number of cyclone tracks within a 10^6km^2 area of a given point.

Genesis Density - the number of cyclone tracks first identified within 10^6km^2 area of a given point.



(a) Track density and (b) genesis density, units (10^6km^2)$^{-1}$month^{-1}. The cyclone-tracking region is marked in (a). Regions of maximum genesis are marked in (b), west and east Atlantic genesis regions are highlighted.

• The North Atlantic and Mediterranean storm tracks are identified.

• Cyclones that effect the UK and western Europe are generated in the west and east Atlantic genesis regions.

Cyclone Climatology Comparison

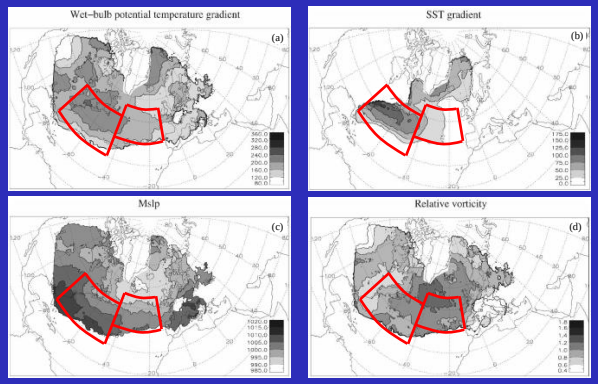
The density statistics were compared with previous climatologies. Differences are due to the variety of datasets, data periods, cyclone identification and tracking methods used to create the climatologies.

	Dacre and Gray (2009)
Spatial resolution of dataset	0.4ºx0.4º
Minimum lifetime threshold	36 hours
Identification method	Gradients of θ_w
Constraints on cyclone tracks	Tracks over Greenland removed
Area averaged for density statistics	10^6km^2
Seasonality of dataset	Annual

• The genesis densities in this study are higher than in previous studies with intermediate lifetime thresholds and annual datasets.

• This is due to a combination of a higher-resolution dataset and the thermodynamic method of cyclone identification that identifies weaker cyclones and cyclones at an earlier stage of their lifecycle (increasing the likelihood of satisfying the min. lifetime constraint).

Spatial Cyclone Characteristics



Characteristics of developing cyclones at their genesis point. (a) Wet-bulb potential temperature gradient at 1km (ºCkm^{-1}), (b) gradient of sea surface temperature (ºCkm^{-1}), (c) MSLP (hPa), (d) relative vorticity (s^{-1}) .

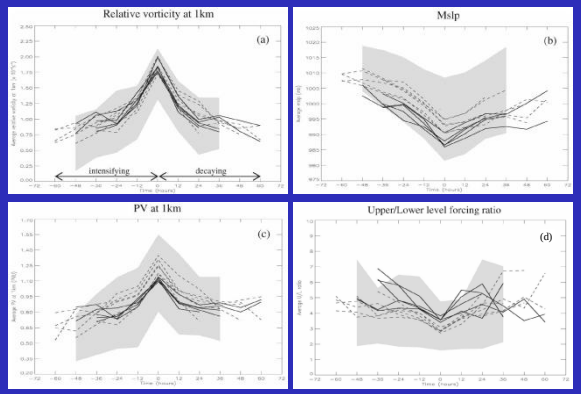
• West Atlantic cyclones form in an environment of stronger baroclinicity than east Atlantic cyclones.

• SST gradients are much stronger in the west Atlantic

• East Atlantic cyclones have higher relative vorticity and lower mslp at their genesis point than west Atlantic cyclones.

Evolution of Cyclone Characteristics

The composite evolution of west and east Atlantic cyclone is likely to be different as they develop in different environmental conditions.



(a) Average relative vorticity at 1km, (b) average MSLP, (c) average potential vorticity at 1km, (d) average ratio of upper- to lower-level qg forcing. West Atlantic cyclones (gray dashed) and east Atlantic cyclones (black solid) with lifetimes of 36-96h. Shading represents 1 sd from mean for 48h west Atlantic cyclones.

• East Atlantic cyclones develop faster than west Atlantic cyclones and have lower mslp, this may be due to the existence of a pre-existing parent cyclone in the vicinity of the cyclone.

• West Atlantic cyclones have higher low-level PV, this may be generated by friction in the boundary layer or latent heat release.

• The ratio of upper- to lower-level qg forcing is lower for west Atlantic cyclones due to a larger contribution from low-levels.

Conclusions

• The thermodynamic method of cyclone identification locates more cyclone features than previous methods.

• Most cyclones that reach the UK originate in the east Atlantic where baroclinicity and SST gradients are weak.

• East Atlantic cyclones have stronger relative vorticity and lower mslp at their genesis point, consistent with secondary cyclogenesis.

• East Atlantic cyclones develop faster, have very weak low-level forcing and strong upper-level forcing.

References

Dacre, H. F., and S. L. Gray, 2009. The spatial distribution and evolution characteristics of North Atlantic cyclones. *Mon. Wea. Rev.* 137, 99-115.
Hewson, T. D. 1998. Objective fronts. Meteorol. Appl., 5, 37-65.
Hodges, K. I. 1994. A general method for tracking analysis and its application to meteorological data. *Mon. Wea. Rev.*, 122, 2573-2586.