Report on temperature extremes – weatherlogistics.com

It is difficult to ascertain a specified weather event to climate change, since extremes of weather occur naturally. However there is strong evidence from observations that certain extreme weather events have become more common, as the global mean surface air temperature has risen[1]. Within the United Kingdom it is likely that a large amount of extreme weather is related to the dominating westerly flow of air across the North Atlantic Ocean in the form of the upper level winds known as the jet stream. Another cause of extreme weather is emerging ocean temperature anomalies. The ocean and the atmospheric circulation are coupled, and therefore ocean circulation changes result in changing weather patterns that in turn feedback on the ocean current. Most of this interaction relates only to the surface or sub-surface of the ocean, rather than the deep ocean circulation. Temperature anomalies that we observe in the ocean are dominated by changing global circulation patterns and especially weather systems that tend to reside in a particular location for a prolonged period of time. We focus here on a particular type of weather system that tends to resist the usual course of atmospheric and oceanic fluid flow at the surface and lower atmosphere. These features are commonly known as blocking weather systems. The most common form of blocking system that affects the weather of the UK is a northerly extension of the Azores high, and is continually monitored by the North Atlantic Oscillation index, relative to the sea-level pressure in Iceland.

Blocking weather patterns are characterised by a diverted course of the upper-level jet stream and disturbed flow of heat and moisture around the mid-latitudes. An increase in blocking high systems in the North Atlantic Ocean leads to a higher incidence of temperature extremes. Weather systems circulate the globe in the high latitudes, usually approaching the UK from the west, but can be diverted southward or northward before they make landfall. Since the observations of recent warming have been more pronounced over the land than the oceans, it is likely that the contrasts in temperatures at the ocean-continent boundaries are increasing. It is intuitive that a weak blocking systems are semi-permanent, often allowing some large-scale weather features to pass when the block shifts or weakens. Yet the block will divert the trajectories of many smaller-scale developments. The selective filtering of weather systems results in fewer days of precipitation, which tend to be more intense. A stronger blocking high characterised by a firmer and more permanent residence, will divert the course of many weather systems, increasing the prevalence of extreme weather. The period of extreme weather is likely to continue either until the responsible blocking system begins to weaken or shift from its usual position.

Within the UK, a warmer tropical air-stream carries moisture from the low latitudes to higher latitudes; this process is known as warm advection. The process of advection tends to cool the tropics whilst distributing some heat and moisture to our cooler climate. This moderates the higher latitude climates, particularly within Western Europe. The presence of water vapour in the atmosphere helps to heat the higher latitudes, because it is abundant in the atmosphere and is a strong greenhouse gas. Greenhouse gases resist the flow of longwave emission from the surface to space, helping to warm our planet. In a state of balance, the vertical temperature structure

between the surface and top-of-atmosphere is dominated by several factors: solar heating, cloud cover and height, but principally by the column of greenhouse gases within the thin-blue-line of atmosphere. Whilst the atmospheric temperature can rapidly respond to changes in the surface heating, the response of water vapour mixing ratio to surface conditions is limited by the hydrological cycle. Water vapour, unlike carbon-dioxide, is not well mixed in the atmosphere and on a regional scale fluctuates on daily and weekly cycles in relation to the changing weather patterns. The mass of water vapour in a column of atmosphere above the Earth's surface, known as the total column water vapour, dominates the day-to-day variability in temperature. One feature of a warming climate is a change in the transport of heat and water vapour poleward, known as the meridional heat transport.

The emerging blocking pattern towards mid-Atlantic blocking has on occasions led to some extremes of cold weather during Winter, since our climate is strongly dominated by the natural influx of moisture from the south-west. It is this moist flow of air, known as the tropical maritime air-stream, which gives the UK characteristic mild and wet winters. A continuation in blocking to the west of the UK is likely to bring extremes of both warm and humid weather, and cool dry weather. The longer term trend in our climate is one of warming in most regions over the globe.

I have developed a system for 1961-1990 climate averages back in 2002, placing these on the web to enable users to explore the weather conditions that cause extremes of temperature, and which are likely to become more accentuated with global warming. An indication to the expected daily maximum and minimum average temperatures can be found at the url:
http://www.onlineweather.org.uk/EXPECTEMPT/11.html

[1]*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., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA*

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