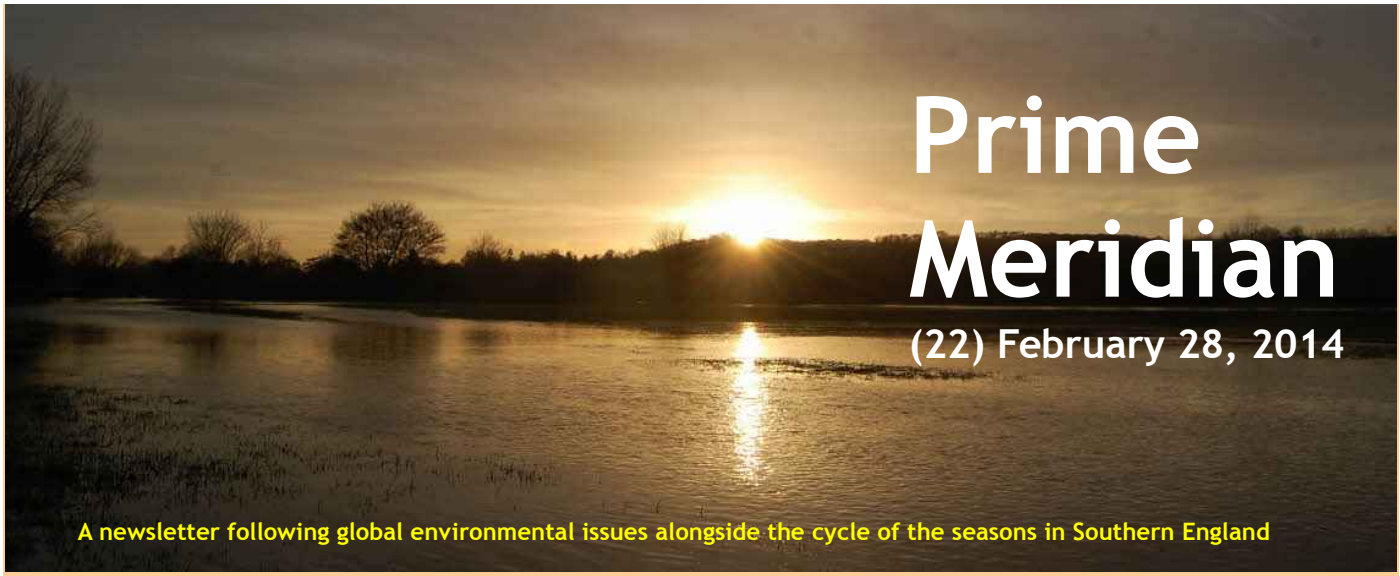


Prime Meridian

(22) February 28, 2014

A newsletter following global environmental issues alongside the cycle of the seasons in Southern England

Above: Feb. 3., 2014. Flooding around Horton Kirby, Kent, UK. Left: Looking across the Thames to the Tower of London on a rainy Jan. 31, 2014.

Battered by one freak storm after another . . . has Britain simply been unlucky in the weather lottery, or is it now experiencing the consequences of global climate change?

During the period December 2013 to February 2014, a remarkable series of storms swept across Britain, prompting the UK's Met Office (lead author Julia Slingo) and the Centre for Ecology and Hydrology (lead author Alan Jenkins) to publish a joint report looking at *The Recent Storms and Floods in the UK*.

"Although no individual storm can be regarded as exceptional, the clustering and persistence of the storms is highly unusual."

A few selected highlights drawn from this February 2014 report sum up the weather onslaught since late 2013.

January 2014 saw a record-breaking number of days on which it rained in southern England and: *"For England and Wales this was one of, if not the most, exceptional periods of winter rainfall in at least 248 years. The two-month total (December + January) of 372.2mm for the southeast and central southern England region is the wettest any 2-month period in the series from 1910."* The amount of water streaming down the Thames in 2014 was actually less than that during 14 earlier floods, but the flow (measured at Kingston, close to the tidal limit of the Thames), remained above 275 cubic metres per second for a longer time than in any flood since 1883. During January 2014, the Thames barrier had to be closed 13 times to protect London from the risk of flooding when high water flows down the River coincided with spring tides.

The storm of December 4/5 coincided with one of the year's highest tides and a storm surge hit the east coast. The events of 2013 have drawn comparison with the notable 1953 flood event, but the effects, although widespread, were were less disastrous. In 1953, floods engulfed 65,000 hectares and 24,000 properties, with a death toll of 307, but in 2013, thanks to improvements in flood defences, waters covered 6,800 hectares and damaged 1,400 properties. Lessons were learned from 1953 and improved warnings and procedures meant that there was not a single fatality.

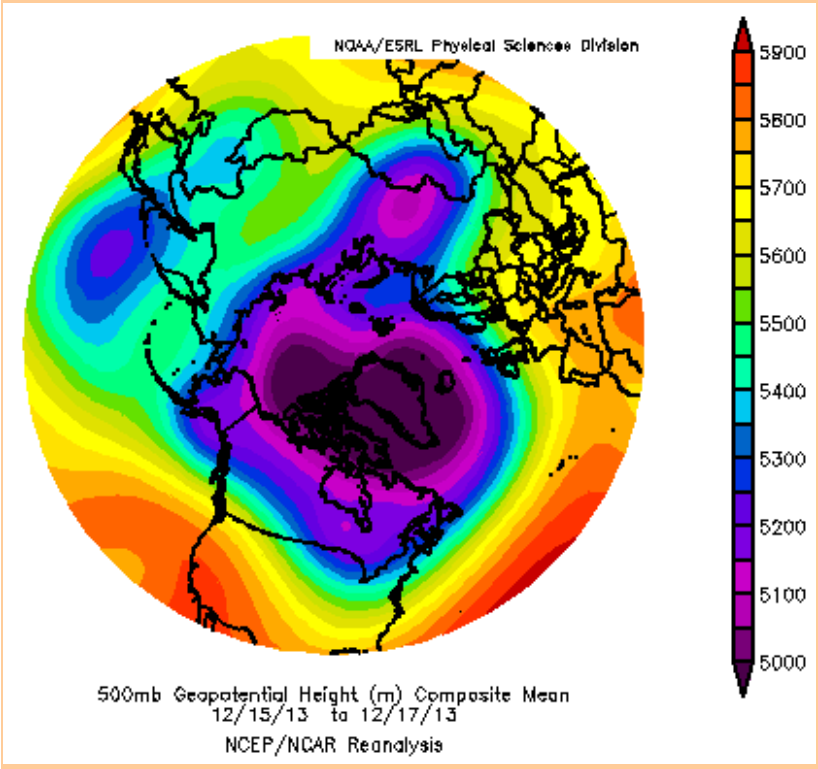
Above: The Thames Barrier was designed to protect London against the hazard of flooding. The risk is greatest when storm surges from the North Sea (the sea rises under low atmospheric pressure and waves rise with the wind) coincide with spring tides. Between 1982, when it was completed and February 2014, there were 174 closures of the Barrier. The period 2000/1 had seen the largest number of closures (24), but this last winter saw no less than 50. Environment Agency update. Image: Andy Roberts (Sept. 19, 2004). Creative Commons Attribution 2.0 Generic license).

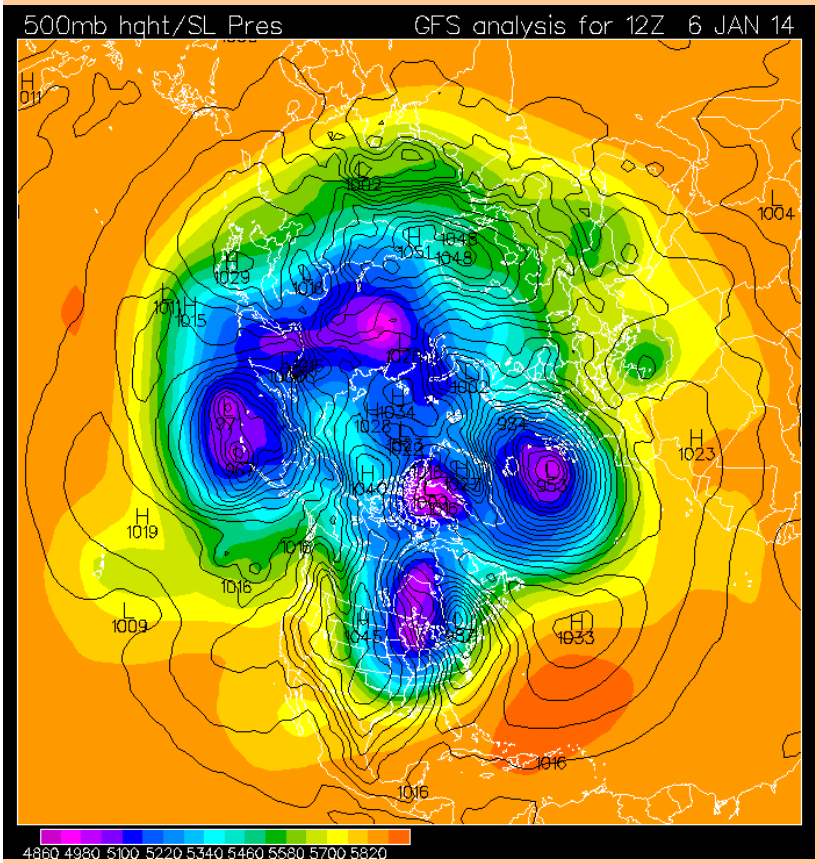
During the passage of an intense low on Dec. 24, 2013, Stornaway recorded an extreme pressure drop to 936 mb (the record is 925.4 mb at Ochtertyre, Perthshire on Jan. 26, 1884). A depression of rare size engulfed the entire North Atlantic on Jan. 5. On Jan. 6 and 7, stormy weather created huge waves of around 16m, and whilst there is nothing unusual about waves of this size in the NE Atlantic, the course of the storm was unusually far south.

Flooding in the Somerset Levels, South West England.

Left: The Landsat-8 satellite (image from NASA/USGS) revealed extensive flooding on the Somerset Levels on Jan. 23. The towns of Bridgewater is located at upper left and Taunton at centre left. Cyclone Anne (below left; NASA) on Jan. 3 and cyclone Christina (below right; NASA) on Jan. 5 not only brought rains, but low pressures enabled abnormal high tides, which together with strong winds damaged coastal defences and properties.

Below: Panorama from Burrow Mump above Burrowbridge, Somerset Jan. 14, 2014 (Image: Mike Smith. Creative Commons Attribution Share-alike license 2.0).





The UK was not alone in suffering extreme weather, it was experienced across the northern hemisphere.

Climate scientists explain this in terms of changes in the route of the polar jet stream, a high altitude ribbon of fast-moving air, which (generally) flows west-to-east in a meandering course at speeds of up to hundreds of km per hour. Jet streams develop along the boundaries between air masses of different temperature. The polar front jet stream snakes along the boundary between the cold polar air, which swirls around the pole from west to east (the so-called "*polar vortex*" that we have been hearing so much about) and the warmer air to the south. Jet streams can actually be quite complex, but this approximation is helpful.

Upper left: The jet's normal course (Dec. 15-17, 2013; images: ESRL/PSD) is shown as light blue. The chart shows the height in the atmosphere at which the pressure is about half that at the surface. Lower left: In early January 2014, the course of the jet stream became much more wavy. This allowed cold Arctic air to flow southwards and warmer air to penetrate into the Arctic and eastern Asia and eastern North America endured a cold spell that was dangerous in some regions and was felt as far south as Florida. According to Dr. Jim Overland of the Pacific Marine Environmental Laboratory: "*Whether this is normal randomness or related to the significant climate changes occurring in the Arctic is not entirely clear, especially when considering individual events, but less sea ice and snow cover in the Arctic and relatively warmer Arctic air temperatures at the end of autumn suggest a more wavy pattern to the jet stream and more variability between the straight and wavy pattern.*"

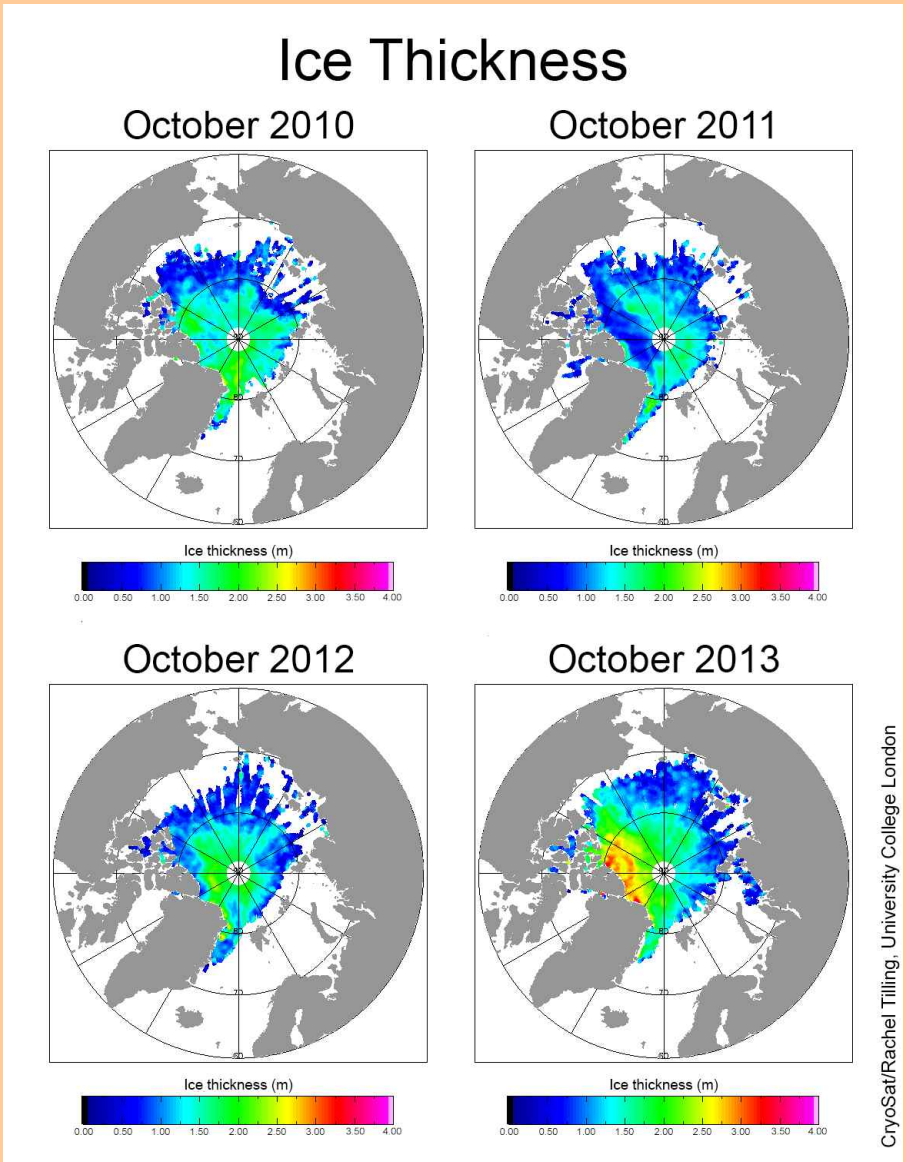
Discerning the relative contributions of natural variability and global climate change in the weather that affects communities worldwide is a vital research issue being pursued by the UK's Met Office.

The Met Office - Centre for Ecology and Hydrology report was cautious about whether the extreme weather in the UK was a symptom of global climate change. Looking at weather records for the period 1871 to 2010 (Wang *et al.*, 2012), the general Atlantic storm track (cyclonic storms are steered by the jet streams) appeared to have shifted poleward with time. To the north of the UK, there were more frequent and stronger winter cyclones, whilst the UK was exposed the same number of storms, but they grew stronger over time. *Wang et al. 2012*: Trends and low frequency variability of extra-tropical cyclone activity in the ensemble of twentieth century reanalysis. *Climate Dynamics* 40: 2775-2800.

The report acknowledged that: "*As yet, there is no definitive answer on the possible contribution of climate change to the recent storminess, rainfall amounts and the consequent flooding. This is in part due to the highly variable nature of UK weather and climate.*" Also: "*it is not possible, yet, to give a definitive answer on whether climate change has been a contributor or not.*"

It was noted that the Atlantic jet had been more intense and had reached back further into the tropical East Pacific than normal, which would by itself feed warmer and moister air into weather systems. Yet, at the same time, the sub-tropical Atlantic is known to have been getting warmer for some decades and that would also increase the supply of warmer, moister air. So far, then, events do appear to confirm the expectation of climate scientists that In a warmer world, the atmosphere could hold more water and there would be more power in weather systems, so daily rainfall amounts will rise.

Caveats noted, the opinion of Chief Scientist Julia Slingo, quoted in a Met Office information release, was that: "*all the available evidence suggests there is a link to climate change*."



Arctic sea ice was thicker last year, but the threat remains.

Climate scientists have been concerned not only about a general reduction in the *extent* of floating sea, but also about the amount of ice that survives from year to year to became thicker ice (which is more stable against summer melting).mmer). The National Snow and Ice Data Centre (USA) has reported that the Arctic sea ice has gained thickness. Measurements from the European Space Agency's CryoSat-2 revealed that the volume of sea ice had been 6,000 km^3 in Oct. 2012, but was 9,000 km^3 in Oct. 2013 – thanks to the survival of thick, multi-year ice around Northern Greenland and the Canadian Archipelago.

Unfortunately, this figure is still much smaller than the estimated 20,000 km^3 of October sea ice during the 1980s. Anxiety remains about the long-term trend.

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