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factsheet 4

Extreme weather events in Europe: preparing for climate change adaptation

Factsheet 4 Temperature extremes

Key messages

Observations show a trend towards more hot days, warm days and heat waves, and fewer cold days over most parts of Europe since the mid 20th century.

- Most places in Europe will very probably experience more hot and fewer cold extremes as global temperature increases.
- The magnitude of hot extremes is expected to increase and of cold extremes to decrease faster than mean temperatures over large parts of Europe.
- The probability of the occurrence of heat waves such as in 2003 in Europe or in 2010 in Russia is expected to increase substantially: a 1 in 50-year event may become 1 in 5-year event by the end of the 21st century.

Future hot and cold extremes

- More frequent, longer and/or more intense heatwaves or warm spells are expected in all parts of Europe.
- More frequent warm days and nights are projected, with the greatest increase in Southern and Central Europe and the smallest in Northern Europe.
- Decreasing frequency of cold days and nights is expected all across Europe, but with some intense cold spells possible even in the second half of the 21st century.

Heat waves in Europe are very likely to become more frequent and longer lasting, mainly following the increase in seasonal mean temperatures. In consequence, the probability of the occurrence of

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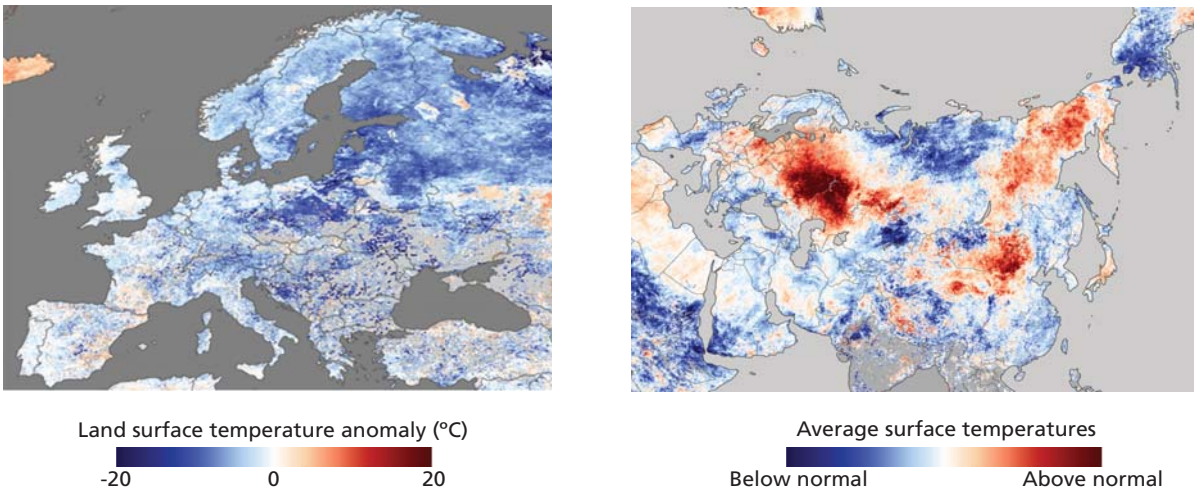


Figure 1 The temperature difference in Europe between 11–18 December 2009 and the 2000–2008 average (left), and the average temperatures for 20–27 July 2010 compared to the normal for the period (right)
Source: (left) http://en.wikipedia.org/wiki/Winter_of_2009–10_in_Europe; (right) http://blogs.agu.org/wildwildscience/2010/08/11/amazing-nasa-images-of-russian-heat-and-smoke (image from NASA Terra satellite).

events similar to the 2010 Russian heat wave would increase substantially, by a factor of 5–10 by mid century. Assuming expected levels of global warming, extremely hot summer temperatures like those in 2003 are projected to be exceeded in every second to third summer by the end of the 21st century.

The temperature departures during the hottest days are expected to warm substantially more than the corresponding mean local temperatures in Central and Southern Europe as a result of enhanced temperature variability at interannual to intraseasonal timescales.

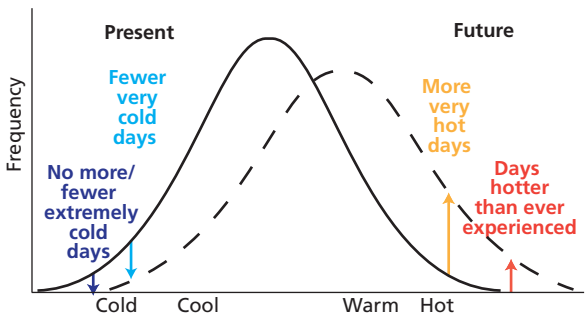
Cold extremes are also expected to warm more than the local mean temperatures as a result of reduced temperature variability related to declining snow cover and changing land-sea temperature contrast. Nevertheless, recent studies have suggested that in Europe some intense cold winter spells may still occur in the second half of the 21st century.

Past extreme heat and cold

- Observations show an increase in hot days and warm nights, heat waves and warm spells over most of the continent, particularly in the past four decades.
- Observations indicate a decrease in cold days and nights over most of the continent since 1950. In some regions the trend is only small or insignificant. However, in others it is large and significant.

Over recent decades the annual number of warm extremes has increased significantly as a result of an asymmetric pronounced warming of the upper tails of the temperature distribution. On average the length of heat waves has doubled and the frequency of hot days has almost tripled since 1880.

Figure 2 Potential changes in frequency and intensity of temperature and precipitation extremes in a changing climate
Current and potential future distributions are depicted by full and dashed lines, respectively.
Source: CH2011, 2011.



In particular, the frequency and severity of heat waves has been found to have increased in both the Eastern Mediterranean and in the west of Europe (Portugal), with trends towards longer periods of extreme heat and higher temperatures. The number of frost days has substantially decreased over the past six decades over most parts of Europe (Klein *et al.,* 2003; Frich *et al.,* 2002).

Description

Recent European summer heat waves and winter cold spells have had severe socio-economic and ecological impacts.

The record-breaking heat waves in 2003 in Europe and 2010 in Russia and Eastern Europe led to tens of thousands of heat-related deaths, crop shortfall, extensive forest fires and record-high prices on the energy market, among many other effects.

The cold winters of 2005/2006, 2009/2010 and 2010/2011 caused travel disruption, cold-related mortality and high energy consumption.

A change in the frequency and magnitude of such temperatures would have socio-economic and ecological impacts that go far beyond the effects of increasing mean temperatures.

Definition

Typically, a heat wave or cold wave is declared once it has been hotter or colder than a particular temperature for a number of days. The threshold is defined differently from place to place according to the magnitude of the expected impact.

The immediate causes of the 2003 and 2010 heat waves were persistent high-pressure systems in the atmosphere. Although such systems occur due to internal variability of the climate system, recent studies have demonstrated that human activity has 'loaded the weather dice' – anthropogenic influence on climate has increased the risk of an anticyclone causing a heat wave like that of 2003 by around a factor of four over what it would have been without further global warming.

Temperature extremes have always occurred and can result from natural variability. However, in a stable climate, the number of cold and warm extremes would be the same and the number of record-breaking cold and hot events would decrease in time.

This is clearly not the case: record-breaking warm extremes have become more rather than less frequent, and the frequency of cold extremes has decreased more rapidly than would theoretically have been expected without climate change.

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