The extreme summer of 2012 in Europe
Did climate change have a role to play?

The event

The summer of 2012 was marked by record-breaking temperatures in southern Europe and was anomalously wet in northern Europe. 2012 was the wettest summer in UK since 1912 and the driest in terms of summer rainfall in Spain since 1928.

Figure 1 illustrates the extreme warmth in the affected region and shows how summer 2012 compares to previous years. In contrast to sun-baked southern Europe, persistent rains drenched the north of the continent. As a result, the UK had its wettest summer in 100 years and suffered widespread flooding. These strikingly different conditions are typical of a characteristic state of the atmosphere that drives storms from the Atlantic across the British Isles and favours settled weather in the south. While this atmospheric pattern played a key role in the 2012 heatwave, attribution scientists also question whether man-made climate change is an additional driver that makes such events more frequent. Attribution science has developed a range of methodologies (see box) that exploit long records of weather observations and state-of-the-art climate models to estimate the probability of an extreme event at present, but also in a fictive world where humans have not influenced the climate.

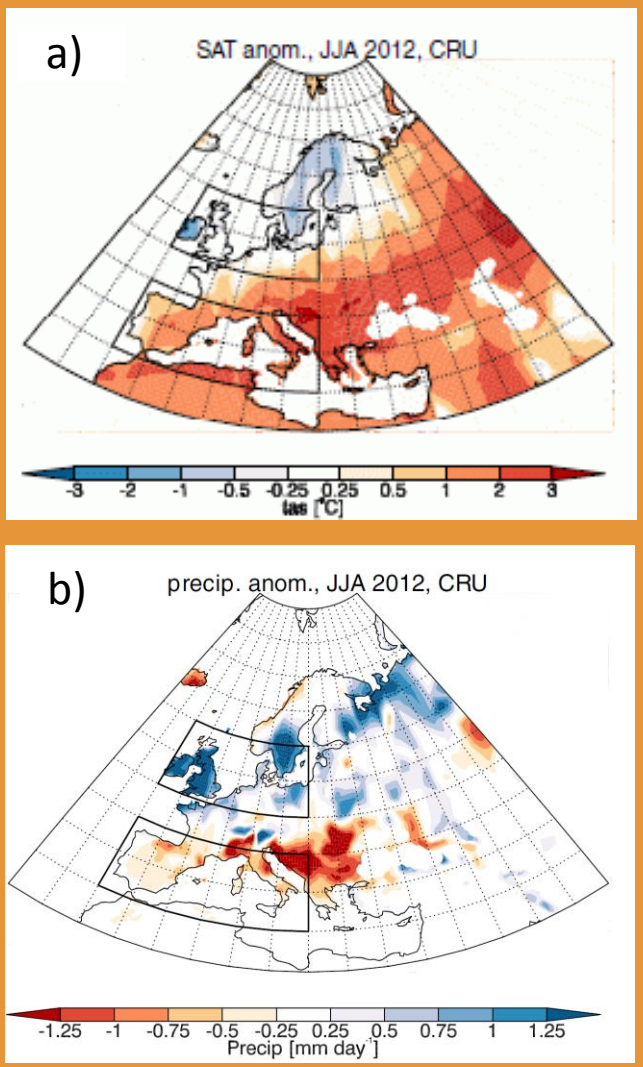

Figure 1. 2012 summer temperatures (a) and precipitation (b) anomalies with respect to the period 1960-2012.

The science of event attribution

Observation-based approaches to attribution use long data records to work out changes in the likelihood of observed events with time. For example, intense present-day heatwaves would be expected to occur less frequently in the colder climate of the early 20th century (but more frequently in a warmer future world). Scientists also try to identify "analogues" in the records, i.e. events with similar characteristics, to determine how similar types of events have changed.

Model-based approaches use a large number of climate model simulations of the "real world" and of a hypothetical "natural world" without human influence on the climate. Changes in the risk of extreme events because of manmade climate change are then estimated by comparing the number of events in these two types of simulations. Model-based approaches can be conditional, so that the change in the risk is estimated given a set of other possible drivers that might be at work when the event happens, or unconditional, which determines the change in the risk of the event under any possible conditions.

The effect of climate change

The average temperature in southern Europe during the summer of 2012 was 23.8 0C, or 2 degrees warmer than in the recent past (1960-2012).

Has the chance of such anomalously warm (in southern Europe) and wet (in northern Europe) summers increased under anthropogenic climate change?

To answer this question, scientists used different sources of data and methods.

Their analyses consistently show a significantly increased risk of hot summers in southern Europe. Exceeding the temperature of summer 2012 is found to be about 8 times more likely than in a world without human influence (Figure 2).The 8-fold increase in the risk applies to any given summer. However, changes in risk may also be calculated for summers that are more similar to 2012 with regard to the characteristic state of the atmosphere and/or the ocean.

For northern Europe, their analyses show no clear or robust indication of a change in the risk of wet summers due to human activities. Indeed, the atmospheric circulation in summer 2012 has favored the enhanced precipitations, but it is not found to be more probable under changing climate.

Without climate change **With climate change**

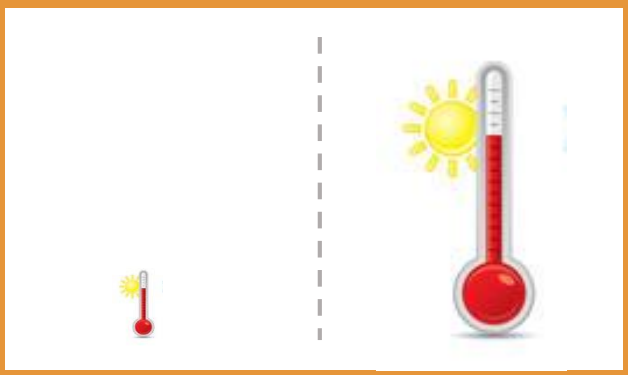

Figure 2. Anthropogenic climate change made it 8 times more likely to have temperatures at least as high as 2012 in southern Europe. This is the best estimate of the change in the risk, which has a possible range of values from 2.5 to 50.

Conclusion

In summary, 2012 was associated with a particular atmospheric pattern that produced much warmer temperatures in the south of the continent than in the north. Taking account of all possible atmospheric patterns, attribution studies show that although for northern European precipitation the climate change signal is difficult to detect, the chances of extremely warm temperatures in southern Europe has significantly increased due to anthropogenic emissions.

Looking forward

Climate models indicate that summers in southern Europe become increasingly warmer, a fact that may profoundly change the perception of extremes in the coming decades. The temperature anomaly of 2012 according to climate models is expected to become commonplace by the 2050s , while the event will be perceived as cold, or extremely cold by the end of the century.

For more information on the event:

https://link.springer.com/article/10.1007/s00382-017-3822-7

The Eupheme Project

Met Office · Royal Netherlands Meteorological Institute, Ministry of Infrastructure and the Environment · METEO FRANCE · Met Éireann · cnrs · cea · brgm · National Centre for Atmospheric Science, Natural Environment Research Council · CzechGlobe, Global Change Research Institute CAS

Funding ERA4CS JPI- Climate

ERA4CS European Research Area for Climate Services