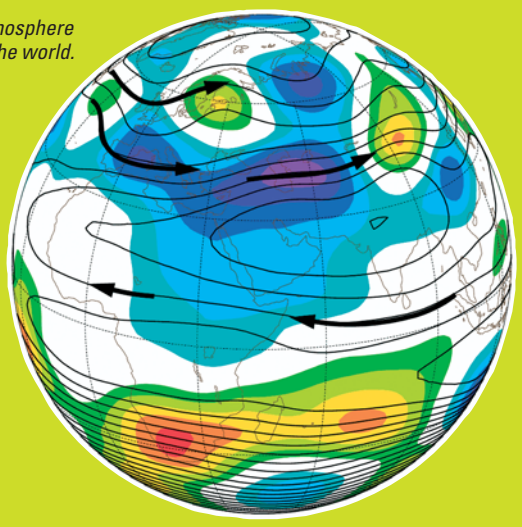

El Niño triggers patterns in the atmosphere which affect distant parts of the world.

2002 - a summer of floods and drought

Were the European floods, the drought in India and an El Niño developing in the Pacific connected? Mike Blackburn, Brian Hoskins, Pete Inness and Julia Slingo have investigated.

Summer 2002 saw severe flooding in central Europe, the worst monsoon failure in India for three decades and an El Niño developing in the tropical Pacific – three major climate anomalies all in one summer. Was it coincidence? Our studies of the large-scale atmospheric processes influencing European summer weather show that these separate events could be connected.

First, using global weather analyses and historical precipitation data, we identified the pattern most influencing summer rainfall over central Europe and the Mediterranean. This is a blocking high pressure system over Europe, which diverts the jetstream (the strong westerly winds 10km above the ground which blow around the Earth between the poles and equator) and its associated weather systems to the north and south. This leads to settled dry weather over northern Europe, but helps Atlantic weather systems move into the Mediterranean region, bringing rain. Such a situation lasted from mid-July 2002 until summer's end.

Next we come to the Indian monsoon. The monsoon rainfall generates a large region of relatively warm air between 5km and 10km above the surface, extending westwards over Africa and as far north as the Mediterranean. Using an idealised model of the atmosphere, Mark Rodwell and Brian Hoskins at the University of Reading proposed that the westerly winds above the Mediterranean descend as they meet this warm air, leading to the region's settled summer weather. By analysing historical data, we found that extended dry spells in the Indian monsoon tend to coincide with air descending more weakly over the Mediterranean, allowing more unsettled weather to develop there.

So it may be no coincidence that India received less than half its normal rainfall during July and early August 2002, while the Mediterranean suffered a very wet summer. At the end of the Indian drought, two weather systems each brought over 150mm of rain to central Europe, causing widespread flooding. The second system developed over the Mediterranean.

Our analysis of historical data also suggests a link with El Niños developing in the Pacific, which are believed to weaken the Indian monsoon. El Niños were developing in 2002 and 1972, the year of the previous most severe Indian drought.

The behaviour of the northern hemisphere's jetstream in early August 2002 revealed a third large-scale atmospheric process affecting weather in Europe. Over a week, a group of troughs and ridges in the jetstream over the central Pacific moved eastward over north America and the Atlantic. When it reached Europe, it led to the development of north-westerly winds over the UK and a deep trough over Europe. A weather system moved along this track into the Mediterranean, where it rapidly strengthened, a situation much more typical of winter than summer. It then moved northeast and brought the second period of torrential rain to central Europe, leading to widespread flooding along the major rivers.

The worldwide impacts of El Niño have been known for some time. In the last two decades, a combination of theory, studies using observational data and experiments using numerical models has revealed that El Niño triggers planetary-scale wave patterns in the atmosphere which affect distant parts of the world, a process of 'teleconnection'. The climate research community is identifying more such teleconnections, as our study of summer 2002 reveals.

We need to know how faithfully our weather prediction and climate models represent this family of teleconnections and their underlying processes, to increase both the skill of monthly and seasonal climate forecasts, and confidence in estimates of regional climate change and the future risk of extreme rainfall and flooding. Confident predictions of summer rainfall over Europe will require models that can predict European blocking highs, the Indian monsoon and El Niño, clearly a challenge!

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