Indian summer

A third of the world's population live in the shadow of the Asian monsoon. **Andrew Turner** explains what they can expect in the future.

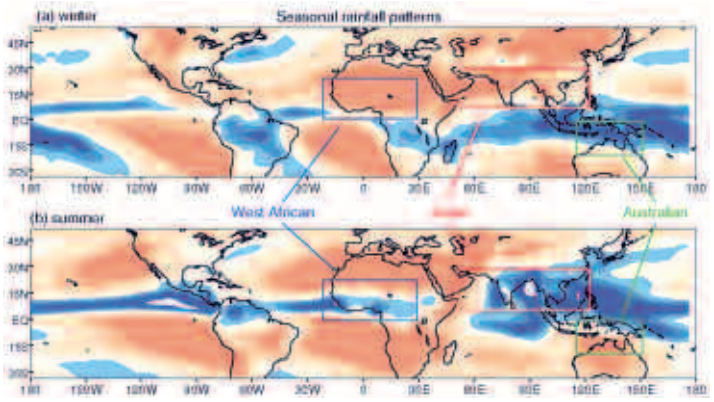
In South Asia scientists are concerned about the future of the monsoon: will it continue to exist in its present form, and if so, will floods or droughts be more common? Here at the National Centre for Atmospheric Science we are using computer simulations of the atmosphere and ocean to predict the behaviour of the Asian summer monsoon under future, warmer, planetary conditions. Our research shows that the people of Bangladesh, India, Pakistan and other Asian countries are likely to see heavier rainfall on average. They may also see wider variations, leading to more floods and droughts.

The Asian monsoon, like the West African and Australian monsoons, is characterised by remarkably regular changes in wind direction and associated with heavy rainfall during the summer months. As the sun progresses in the sky with the seasons, the land north of India is heated, drawing in moist air from the south-west across the Indian Ocean. Later in the year, the sun moves over the southern hemisphere, such that the Indian Ocean is now warmer and winds are drawn to it from the north-east, reversing their direction. Similar processes occur over West Africa and northern Australia.

The large scale of the phenomenon means that the Asian monsoon affects the lives of more than two billion people, a third of the world's population, in its timing, duration and intensity. Its year-to-year variation is quite striking: from the devastating and unforecast drought of 2002, which hit India's agriculture and economy hard, to the Mumbai deluges of August 2005, where more than one metre of rainfall fell in a single day.

While floods can cause complete crop failure, increase the spread of waterborne disease such as cholera, and damage roads and railways, droughts may impede the food supply and cause failures in hydroelectric power generation. These large variations in total seasonal rainfall are often related to weather in other parts of the world, such as El Niño, which is currently evolving in the Pacific Ocean.

Our research has tried to answer these questions using the Met Office Unified Model – a computer simulation of the physics behind weather and climate. This consists of atmosphere, ocean and land modules interacting with each other to generate a look into the future. Its output ranges from the data used in five-day weather forecasts issued to the UK media, to predictions of the climate expected on the other side of the world during the next century.



CMAP dataset, Climate Diagnostics Center, USA

Monsoons occur mainly in three locations around the globe: West Africa, Asia and Australia. Winds in the lower atmosphere change direction with the seasons in monsoon regions. Around India during northern hemisphere summer, they blow from the south-west, carrying warm moist air. Dramatic downpours are associated with the changing wind.

A simple method of looking at the future climate is to double the atmospheric carbon dioxide concentrations in the model from their pre-industrial revolution levels. We choose this starting point as it allows us to make comparisons between historical and recent observations, and the predicted future results. At current rates of fossil fuel emissions, we will see such carbon dioxide concentrations by the end of the century.

These models indicate Asia's summer monsoon will persist. Indeed, the average summer rainfall may increase by around five percent, increasing the water available for crop production, power generation and industry.

However, average conditions are simply a statistical measure of the weather experienced over many years. An individual summer may be very different from this average. In fact, measurement of this variation yields the important result that a warmer planet may feature increased extremes in monsoon climates. There could be a greater range between flood and drought conditions, both of which would be more severe.

So the Indian summer climate in the coming century looks to be wetter on average, together with flood and drought conditions occurring more often. What we still need to answer is how the daily patterns of weather may change during the future monsoon seasons. Could, for example, we see more short bursts of very heavy rain, like Mumbai in 2005, during flood years? Or will we just see a greater number of rainy days during the season? We are currently investigating such possibilities.

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