Aerosols and Australian rainfall

Aerosols may have a greater impact on patterns of Australian rainfall and future climate change than previously thought, according to leading atmospheric scientist, CSIRO's Dr Leon Rotstayn.

"We have identified that the extensive pollution haze emanating from Asia may be re-shaping rainfall patterns in northern Australia but we wonder what impact natural and human-generated aerosols are having across the rest of the country," Leon said.

Aerosols are fine particles suspended in the atmosphere. Sources of human-generated aerosols include industry, motor vehicles and vegetation burning. Natural sources include volcanoes, dust storms and ocean plankton.

Human-generated aerosols have long been known to exert a cooling effect on climate. This has partly masked the warming effect of increasing greenhouse gases. As aerosol pollution is predicted to decrease over the next few decades, unmasking of the greenhouse effect may lead to accelerated global warming.

However, in an address to the International Conference on Southern Hemisphere Meteorology and Oceanography in Melbourne, Leon said aerosols are much more than a "negative greenhouse gas" because they can actively force changes in winds and ocean currents by altering the distribution of solar heating at the earth's surface.

"Recent climate modelling at CSIRO shows that there may be important effects on Australian climate due to aerosol pollution from the Northern Hemisphere. These include an increase of rainfall in north-western Australia, and an increase of air pressure over southern Australia, which may have contributed to less rainfall there.

"New simulations with the CSIRO climate model also show big improvements in the simulation of El Niño and the associated natural rainfall variability over eastern Australia, when natural and human-generated aerosols are included in the model. Natural aerosol includes Australian dust, which may be the key factor that improved our simulation. A realistic simulation of natural rainfall variability is essential if a climate model is to be used to improve our understanding of Australian rainfall changes.

Leon said that further research into how aerosols are influencing climate and rainfall patterns across Australia is critical to scientists' ability to more accurately predict the longer-term effects of climate change.

"It is crucial to quantify the relative roles of different drivers of recent Australian rainfall changes. A rainfall decline attributed to natural variability will be a passing phenomenon, and changes forced by human-generated aerosols are likely to be more short-term than changes forced by increasing greenhouse gases. The implications for decision makers will be very different, depending on whether the drivers are long-term or short-term," Leon said.

Dr Leon Rotstayn.

THE IMPACT OF AEROSOLS

Aerosols, both natural and human produced, can cause significant changes to the climate, including to rainfall and temperature.

Natural sources of aerosols include wind-blown dust, volcanoes, marine biota and vegetation.

Anthropogenic (human-made) sources are mainly the burning of fossil fuels and vegetation.

Most aerosols exert a direct cooling influence on climate by reflecting sunlight back into space. They also have an indirect effect by acting as condensation nuclei to increase cloud formation.

Changing patterns

Observations of Australian rainfall and cloudiness since 1950 show increases over much of the continent, and especially in the northwest.

Dr Leon Rotstayn says that when anthropogenic aerosol changes were included in CSIRO's climate model, it showed increasing rainfall and cloudiness over Australia from 1951–96. The pattern of increasing rainfall was strongest over northwestern Australia, a pattern consistent with the observed trends.

Impact of Asian aerosols

'The strong impact of aerosols was predominantly due to the massive Asian aerosol haze, as confirmed by a sensitivity test in which only Asian anthropogenic aerosols were included,' Dr Rotstayn says.

'The Asian haze altered the north-south temperature and pressure gradients over the tropical Indian Ocean, thereby increasing the tendency of monsoonal winds to flow towards Australia.'

'Climate model simulations responding to increased greenhouse gases have generally not reproduced the observed rainfall increase over northwestern and central Australia.'

'Our results suggest that a likely reason for this failure was the omission of modeled responses to Asian aerosols, and that inclusion of these aerosols is essential in future modeling of Australian climate change,' Dr Rotstayn says.

FIGURE 1: Observed summertime rainfall trends across Australia (1951–96)