## Where there's smoke, there may be rain

A n international experiment to study how thick smoke affects the formation of rain-bearing clouds has challenged the theory that increased aerosol particles in the atmosphere decrease the likelihood of precipitation.

The experiment, known as PACE-5, took place in October 1997 over biomass burns near Katherine in the Northern Territory and in central Kalimantan, Indonesia. It drew together scientists from CSIRO Atmospheric Research, Japan's Meteorological Research Institute (MRI) and Indonesia's Meteorological and Geophysical Agency.

While in Indonesia, the group of researchers took airborne measurements of aerosol particles and trace gases such as ozone and carbon-monoxide, as well as temperature, humidity, winds, radiation and cloud properties.

For this purpose they used an F27 research aircraft owned by Adelaide company Australian Flight Test Services, fitted with Australian and Japanese instrumentation. The aircraft carried the largest load to date: 28 external and 12 internal sensors, two tonnes of equipment and a crew of 10 scientists and three pilots/engineers (seven Australians, four Japanese and two Indonesians). Over central Kalimantan, the team found a three-kilometre thick layer of dense smoke. Cumulus clouds were observed to pump this smoky air to much higher altitudes, making long-distance transport of the smoke more likely.

A CSIRO researcher on the project, Dr Jorgen Jensen, says the smoke was so dense over Kalimantan that no fires were observed visually; the typical visibility was 300 metres or less. The team had to rely on a sophisticated onboard real-time data analysis system to locate the fires and to fly around them, measuring the strength of the emission source, and the chemical composition of the new smoke air.

Jensen says precipitation formation is normally thought to decrease when many aerosol particles (smoke or natural) are added to air. This is because the available liquid water in a cloud becomes distributed across a greater number of smaller cloud drops. Small cloud drops are much less likely to collide and form rain drops.

But early results from the experiment seem to imply that the Indonesian smoke did not just have many small particles in the air. There was also an unusually high number of very large aerosol particles: the nuclei for rain formation. The high concentration of very large aerosol particles may help to offset the expected reduction in the clouds' ability to form rain. 'This appears to be one piece of good news among the many environmental aspects of the fires,' Jensen says.

The F27 was the only research aircraft to fly through the cores of the Indonesian fires. Its entry to Indonesia at short notice came after hectic work involving CSIRO, the Bureau of Meteorology and Geophysics (Jakarta), the Department of Foreign Affairs, the Australian Embassy in Jakarta, the Science and Technology Agency in Japan, Australian Flight Test Services and Showa Aviation (Japan). The work was jointly funded by MRI and CSIRO.

Contact: Jorgen Jensen, CSIRO Atmospheric Research, (03) 9239 4507, fax (03) 9239 4444, email: jorgen.jensen@dar.csiro.au

Below: The smoke air as photographed from four kilometres, one kilometre above the top of the smoky layer of air. Several cumulus clouds are seen to rise out of the smoke layer.

Inset: The F27 research aircraft, blanketed by dense smoke on the ground in Kalimantan.

