Avoiding volcanic clouds

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Dr Fred Prata (left) and Dr Ian Barton with a prototype of the AVADS volcanic ash detector. The instrument can be mounted on an aircraft wing or in the nose.

Ten kilometres above the Earth's surface, a commercial airliner flies serenely through thin streamers of cloud… and into a nightmare. Without warning, its jet engines begin to malfunction, then shudder to a halt.

The flight engineer tries in vain to restart the engines; the pilot and co-pilot wrestle with the controls and cabin attendants try to quell passengers' panic as the aircraft falls out of the sky. Suddenly, only 2600 metres from the ground, the engines roar into life again.

It may sound like the plot of a Hollywood melodrama, but the situation is alarmingly real to aviation authorities. And it's worryingly common: since 1973 at least 18 commercial aircraft have encountered just such emergencies, including near-fatal incidents during the Galunggung (Indonesia) eruptions in 1982 and the Mount Redoubt (Alaska) eruptions of 1989/90. In the latter case a KLM airliner carrying 245 passengers ran into an ash cloud and plunged 4000 m before the engines restarted.

Their all-but-invisible cause lies in clouds of volcanic ash, which in the case of large-scale eruptions can reach 40 km into the atmosphere and can continue to circulate at altitudes of 22 000–25 000 m for up to 3 years. Emergencies occur when tiny particles of the silica in volcanic ash melt as they are sucked into a jet engine, adhering to its turbine blades and forming a glassy coating that prevents air flowing through the engine. Researchers believe the rapid cooling that follows engine shut-off breaks up these silicate deposits, allowing the engines to be restarted — and avoiding disaster.

Until recently there was little a pilot could do to avoid such an emergency, since neither human eyes nor conventional radar can distinguish between volcanic ash clouds and those composed of water or ice.

Now, however, CSIRO Division of Atmospheric Research scientists Dr Ian Barton and Dr Fred Prata have developed AVADS — Airborne Volcanic Ash Detection System — a multi-channel infrared radiometer that utilises techniques and instrumentation based on satellite radiometers to discriminate between different types of clouds at distances of up to 100 km. The system offers instant read-outs on the composition and movement of cloud formations and, because it is especially sensitive to the low concentrations of ash at the edges of clouds, allows pilots vital minutes in which to take evasive action.

Radiometers measure the heat that radiates from all objects, including different types of clouds; in contrast, radar bounces microwaves off objects and analyses the returning signals. But AVADS (developed with financial assistance from the Department of Industry, Technology and Commerce) measures clouds' thermal radiation at a variety of infrared wavelengths, especially at 11 and 12 micrometres, where volcanic clouds — which contain high levels of silicates — differ most from water clouds.

It measures radiation levels in the appropriate wavelengths and alerts pilots to the presence of volcanic clouds ahead. Results of tests in Tasmania and, in March 1991, over Mount Sakurajima, an active volcano in southern Japan, confirmed theoretical and modelling studies.

The device is being patented around the world, and has generated a great deal of interest among aircraft manufacturers and in the aviation industry. According to Dr Prata and Dr Barton, AVADS will also be developed to detect clear-air turbulence, which is indicated by water vapour billowing upwards into the stratosphere (in other words, from 10 km altitude upwards) and which cannot be detected visually or by radar. Wind shear (a sudden downdraught of air at low altitude) is likewise invisible, but AVADS should be able to detect the large temperature differences close to ground level that indicate the presence of a phenomenon believed to have caused 35 aircraft crashes since 1965 in the United States alone.

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