Satellite images of volcanic ash clouds

Eruptions last year of Mt Galunggung in western Java choked the engines of two jet aircraft flying overhead, and passengers on board knew they had escaped catastrophe only when, at lower altitude, they heard the welcome sound of the engines restarting.

Airlines operating in the region now alter the course of their flights to skirt the danger area. However, the incidents prompted the Department of Aviation to ask Dr Frank Honey, a remote-sensing specialist in the CSIRO Division of Groundwater Research, and Dr Bill Carroll of the School of Electrical and Electronic Engineering at the Western Australian Institute of Technology if they could detect the ash clouds on satellite images.

Within 48 hours they had developed a technique for doing so, allowing early warning of an ash cloud's position to be given, even at night. More recently, Dr Honey has done further work on the dust-detection problem, and he has developed an aircraft-mounted unit that indicates if an ash cloud is ahead.

Ash clouds are, in general, not easy to detect. For the first few hours after last year's eruptions, the clouds appeared clearly on images recorded by the GMS-1 geostationary satellite, but later, as the clouds moved and dispersed, it was easy to mistake them for normal water-droplet clouds. They became completely invisible as the larger particles settled out and the finer ones, less than 5 micrometres across, remained at the altitudes traversed by jet airliners.

However, the polar-orbiting weather satellites NOAA-6 and NOAA-7, with their more sophisticated radiation-detection instruments, should provide enough information to allow the clouds to be picked out, reasoned Dr Honey.

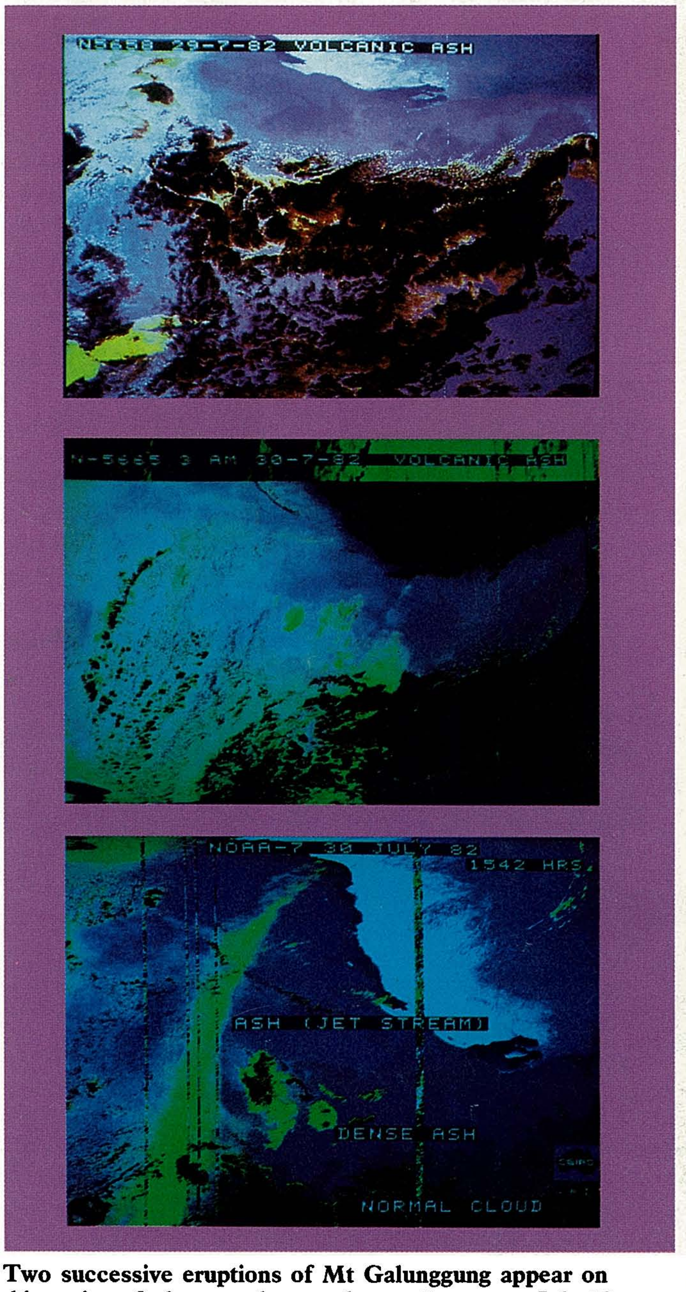
A receiving station at the Western Australian Institute of Technology in Perth, operated by the Institute and CSIRO, can track the NOAA spacecraft and receive its high-resolution pictures in five wavelength bands ranging from the visible to the far infra-red.

Although the ash clouds can't be definitely distinguished from normal cloud by use of the satellite's visible and reflected infra-red bands, the ash contains silicon dioxide, which has thermal properties that should affect the relative amounts of energy in two other far infra-red bands. Normal clouds don't influence these bands in the same way.

Based on this reasoning, computer processing of the satellite's signal by the CSIRO and WAIT team showed up a difference between the two bands that looked as though it might have been caused by the ash cloud.

To confirm that the feature identified was the ash cloud, Dr Honey rang up Anna Plains Station, a pastoral property lying within the boundaries of the patch. Yes, the station manager remembered seeing an unusual haze in the sky on that day, a day that was otherwise clear.

Subsequently, Dr Honey and Dr Carroll have recorded a set of three images (taken over a day, that night, and the next day) showing ash clouds from two successive eruptions. They are reproduced here, with ash clouds as greenish, and normal cloud as dark brown. The third photo shows ash smeared into a long, narrow trail — it's caught up in a jet stream.



Two successive eruptions of Mt Galunggung appear on this series of photographs — taken at 3 p.m. on July 29, 1982, 12 hours later, and 24 hours later. The third shows that ash from the second eruption has been entrained in a jet stream.

Dr Honey has gone on to develop an infra-red scanner that looks out ahead of an aircraft and determines, by day or night, the range, bearing, and elevation of any dust clouds. This information is displayed on the plane's weather-radar screen. He hopes the system will be manufactured commercially.

Andrew Bell

Observation of volcanic ash clouds using NOAA-7 AVHRR data. F.R. Honey and W. Carroll. *Remote Sensing of Environment*, 1983, 12 (in press).