Geophysical Research Abstracts
Vol. 13, EGU2011-4347, 2011
EGU General Assembly 2011

Challenges to an improved International Airways Volcano Watch in the moist tropics

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A move away from 'zero tolerance' for volcanic ash and aviation has been long known to be necessary for the International Airways Volcano Watch; the difficulty has been in defining an acceptable alternative. The Eyjafjallajökull eruption of April 2010 is serving usefully as a powerful catalyst for change, but a global revised warning system must work in all situations and not just in Europe.

The moist tropics have proven to be a particularly problematic region for the International Airways Volcano Watch during the 17 years of Darwin Volcanic Ash Advisory Centre operation:
1) The high tropical tropopause (17-18 km) allows meteorological cloud well above aircraft cruising levels (10-11 km) throughout the year, obscuring remote sensing during numerous eruptions. Long lived cirrus shields from deep meteorological convection, present for most of the year, are particularly problematic.
2) The moist convective environment also significantly enhances the potential for deep volcanic convection (to around tropopause height) for relatively weak or moderate eruptions, based on both observations and on 2D Active Tracer High Resolution Atmospheric Model (ATHAM) simulations. At the very weak end of the scale, the timing of 'volcanicCb' events is also influenced by the time of diurnal thunderstorm activity (usually mid-afternoon for convection over land, eg Pinatubo, Philippines, or early-morning for maritime environments, eg Manam, Papua New Guinea). An important implication of the influence of moist convective processes is that, within the moist troposphere, eruption strength correlates poorly with eruption height.
3) Moist air entrained into eruption columns will result in a relatively smaller proportion of fine ash in the umbrella cloud of a significant eruption compared to eruptions in a dry atmosphere , because of the role of hydrometeors in enhancing particle aggregation and removal. This, and the presence of ice/ash aggregates, makes remote sensing of ash much more difficult that in dry atmospheres, but also underlines the importance of estimating eruption mass flux and aggregation rates to avoid over-conservative warnings.
4) Conditions for ground observation are frequently extremely difficult. The lack of infrastructure across much of the tropics also makes volcanological and meteorological observations problematic.

Recent advances in ash and SO2 remote sensing show great promise in enhancing VAAC operations, but we do not yet have a solved problem. Encounters with apparently diffuse ash clouds have been shown to cause significant issues, and incidents such as the 2006 Gulfstream II twin-engine flameout over Papua New Guinea (thought to be from a cloud from Manam volcano) and the 2002 minor damage over Micronesia from an eruption cloud 20 days old were not warned for in real-time, and would most likely not be warned for using today's technologies and practices.

Careful warning system design will account for these challenges to the maximum extent possible. However, to support the next evolution of the International Airways Volcano Watch and implement current science advances, a major increase will be required worldwide in sustainable volcanological monitoring, in volcanological and meteorological cloud observation, and in international scientific cooperation.