5th INTERNATIONAL WORKSHOP ON VOLCANIC ASH

Santiago, Chile 22-26 March 2010

Convened by the *World Meteorological Organization*
In collaboration with the *International Civil Aviation Organization*
Hosted by *Dirección General de Aeronautica Civil de Chile*

Eruption of Chaiten volcano, Chile, 2 May 2008 (Carlos Gutierrez)

This is a high level summary of the meeting

Civil Aviation Authority

1. General Summary

The International Workshop on Volcanic Ash in Aviation workshop meeting (5th IWVA) is a regular 36-month event at which scientists report and collaborate on work intended to support the ICAO International Airways Volcano Watch (IAVW) system. The New Zealand Civil Aviation Authority hosted the last meeting, held in Rotorua in 2007.

The fifth workshop was held in Santiago, Chile, hosted by Dirección General de Aeronautica Civil de Chile, from 22 to 26 March 2010, and was attended by forty scientists and experts including representatives from eight volcanic ash advisory centres (VAACs), the International Air Transport Association (IATA), the International Union of Geodesy and Geophysics (IUGG), the World Meteorological Organization (WMO), US National Oceanic and Atmospheric Administration (NOAA), and scientists from Chile, United States, Australia, Spain, New Zealand, Norway, Argentina, France, Italy. Notably there was also representation from the US Naval Research Lab and Airbus Industries.

The workshop noted again that, so far, no fatal aircraft encounters with volcanic ash have occurred, arguably as a result of the efforts of the IAVW and its robust support from the scientific community.

The presentations given by the participants helped to identify areas of progress, but also those remaining questions that need to be addressed by both the scientific community and the operational users of the information.

2. Outcomes Summary

(a) The science behind the IAVW has advanced in many areas, including in satellite remote sensing, dispersion modeling, and eruption detection through lightning, infrasound and seismic networks. Two major 'special issues' of academic journals dealing with the volcanic clouds issue have been published since 2007.

(b) In general, the interaction between all IAVW participants is seen to have improved, and this is evident to users of IAVW products. The lack of major safety incidents during the major eruptions of 2007-2010 is seen as a highly significant testimony to the effectiveness of the IAVW, despite our ongoing concerns.

(c) There continues to remain no definition of a "safe concentration" of ash for different aircraft, engine types or power settings. In order to give a reliable and justifiable "all clear" once a plume has dispersed enough to be undetectable, clear limits of ash content are required from both the manufacturers and aviation licensing authorities.

(d) A two-year effort to establish a protocol for assigning eruption source parameters to dispersion models during eruptions, when real-time observations were unavailable, has been completed. The result is a table

of values, assigned to each of the world's volcanoes. The main limitation of the protocol is that it does not consider uncertainty at this stage.

(e) There needs to be a very co-operative and collaborative process in moving the science and new technology into the operational sphere and that management of such transfer needs to work carefully within the constructs of the safety management frameworks of ICAO, WMO and other international organizations.

3. Actions Summary

(a) Airbus agreed to write to the engine manufacturers asking if an answer is available on the question of safe particle size and concentration of ash that is sustainable by engines on its aircraft. Airbus will respond to IATA who will in turn inform the workshop and IAVWOPSG.

(b) A subgroup/working group of VAAC members should be formed to examine the use/provision of uncertainty forecasting and probabilistic information. The group should report back to the IAVWOPSG/6 meeting in Dakar in September 2011.

(c) It was recommended that a Volcanic Ash (VA) Science Steering Group (VASSG) be established under the auspices of the WMO, comprising no more than 5-6 key scientists representing the various science communities involved, and perhaps chaired by the WMO. The workshop agreed that this approach would provide a much more timely and dynamic method of co-ordinating the science developments with the changing needs of international aviation.

4. Findings Summary

(a) Discussion identified the importance of the engagement of researchers in the problems of the IAVW, even where direct funding is unavailable. Efforts such as the Support to Aviation for Volcanic Ash Avoidance (SAVAA) project in the European Union, demonstrate that third party funding (in this case from the European Space Agency) can be obtained for assisting in IAVW science problems.

(b) The integration of data between Volcano Observatories (VOs), Meteorological Watch Offices (MWOs), and VAACs was raised as a particularly important area to progress. Discussion on this point also outlined broader information sharing needs between Volcano Observatories and Meteorological Services for volcanic-related disaster risk reduction.

(c) It is becoming increasingly important to improve the capability of the Volcano Observatories to produce a pre-eruption probabilistic prediction scale that could be used in a qualitative assessment of the chances of an eruption occurring.

(d) The VAACs need for more frequent and higher resolution satellite imagery was recognized, with the European Meteosat Second Generation (MSG) satellite being recognized as current best operational source of geostationary data, particularly benefiting Europe and Africa. Analysis of the geostationary meteorological data stream shows that there is significant variation of coverage, with the Pacific Ring of Fire in particular being relatively poorly served. The advent of the US GOES-R geostationary satellite will help to answer these issues for the Americas. However, that is not expected until the 2014/2015 timeframe and will not assist all VAACs. Polar orbiting multi-spectral and hyperspectral data is becoming increasingly sophisticated and available.

(e) Recent work in Europe and the US has shown a greatly enhanced potential for improved volcanic cloud detection using multi-spectral and hyperspectral data, and using improved algorithms for sensing sulphur dioxide and other volcanic gases, volcanic ash, and mixed (ash, gas, water/ice) clouds. Particular improvements have also been made in volcanic cloud height assignment, using remote sensing and blended remote sensing / dispersion model approaches. Within 5 years, VAACs will have access to a new level of best practice techniques, greatly assisting operations.

(f) The universal implementation of these techniques is very important, noting that some of the improved algorithms for detection and cloud classification are designed to work with existing polar orbiting and geostationary data streams and to be essentially platform independent regardless of the variable quality of input data. The improved techniques will be very useful in addressing specific issues in remote sensing, such as for high altitude, ash-poor, ice-rich clouds in particularly warm and moist areas such as the Maritime Continent north of Australia, and also for reducing water-vapour effects on ash detection.

(g) The improvements coming in the next decade for satellite methodology will require re-education of VAAC users and offer a prospect of significant immediate improvements in the aviation safety applications. An international workshop especially for remote sensing of volcanic clouds could be held to help with this, or possibly this effort could be addressed at regional workshops at several sites around the world.

(h) There is a need for better ashfall modelling in and around airports in support of improved future warning protocols. This would include better predictive information on timing and amounts of ashfall. Uncertainty forecasting including probabilistic information is needed.

(i) There is still a requirement for a volcanic ash end-to-end system, which includes a capability for VAAC collaboration. It was noted that the Volcanic Ash Collaboration Tool (VACT) project was terminated in the U.S. without the project being completed. The intellectual capital and lessons learned from this effort should not be lost.

(j) VAACs must share best practices for plume height and volcanic cloud discrimination amongst one another, in support of consistent operational output and consistent competency-based training. In addition to the use of the WSO workshops for this purpose, this may be aided through posting to a common access web site, wiki, or by some other means to be determined.

(k) A trial of purpose-driven deployment of a portable Doppler radar by the USGS confirmed the system/technology is useful for all-weather confirmation of an event, cloud height estimation, eruption mass rate and proximal fall out characteristics.

(l) There is a need to encourage more use of radar systems which are near airports, but which are underutilized as volcanic cloud observation tools that could improve aircraft safety.

(m) Analysis of Worldwide Lightning Location Network (WWLLN) data indicates it works best on 'wet' eruptions, and in areas of low ambient noise. This appears to be very useful tool to add to the toolkit for confirming activity has occurred. Unlike most ground-based networks, it is tuned for cloud-cloud lighting and therefore is more likely to pick up volcanic lightning.

(n) Infrasound, including the International Monitoring System (IMS) Infrasound network, remains another tool that can be adopted to detect an explosive volcanic eruption. Uptake and use of this technique has been low and issues remain with correlation of plume height with signal amplitude.

(o) Recent USGS work has further explored the utility of correlating eruption height and seismic wave amplitude for remote eruptions, with promising results.

(p) There is a need to encourage data sharing especially of the growing variety of potentially useful satellite sensors.

(q) Remotely sensed ground-based measurements (imaging cameras, radar, scanning DOAS etc.) should be more widely used and better integrated with satellite data.

(r) A Volcanic Ash (VA) Science Steering Group (VASSG) will be established under the auspices of the WMO, comprising no more than 5-6 key scientists representing the various science communities involved.

5. Next Meeting

The next International Workshop on Volcanic Ash is expected to take place during the first half of 2013.