

Chapter 14

Volcanoes and the aviation industry

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There are over 1500 volcanoes around the globe. Of these, 247 have been active, some with multiple eruptions, since the start of commercial airline travel in the 1950s. Guffanti et al. (2010) provide a document on all the volcanic ash – aviation encounters from 1953–2009. They classify the level of encounter by a severity index of 0-5, with no encounters at level 5 and only nine at level 4. Several of the most significant encounters at level 4 occurred in the 1980s. The first two were from the 1982 eruption of Mt. Galunggung volcano, where a B-747 aircraft lost all four engines at an altitude of 11 km above sea level and approx. 150 km from the volcano (Hanstrum & Watson, 1983) and in 1989 from the Redoubt volcanic eruption, Alaska, USA, where another B-747 encountered an ash cloud approx. 150 km from the volcano, at 7.6 km above sea level (Casadevall, 1994).

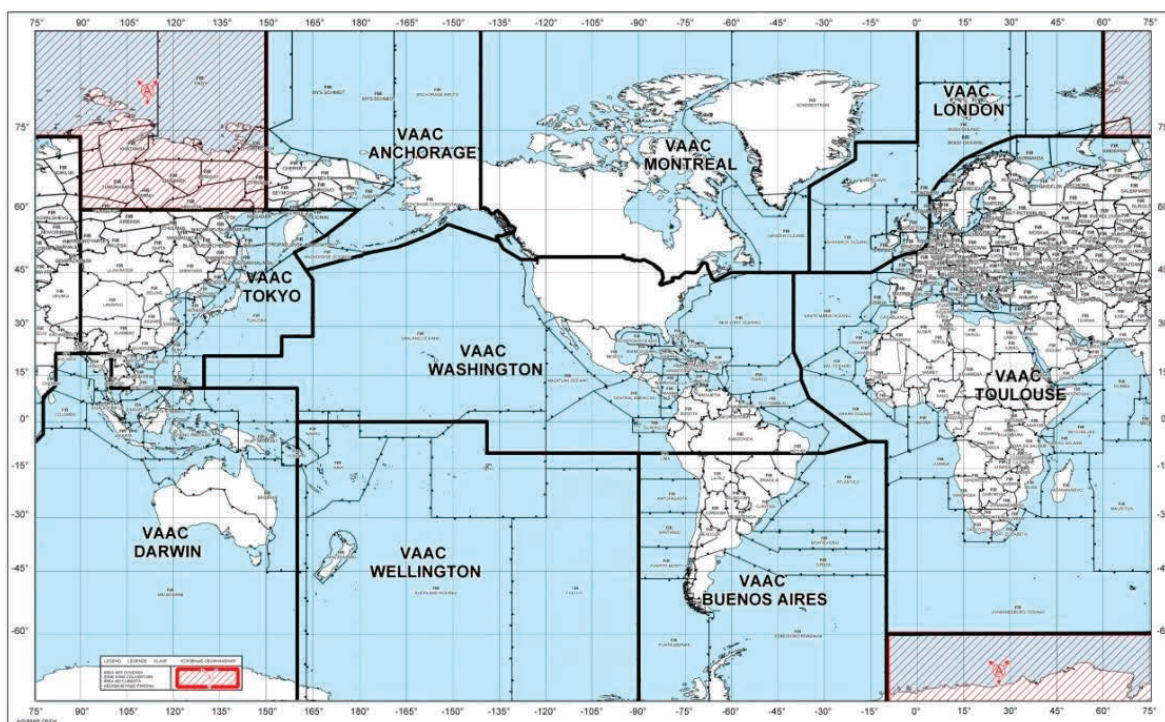


Figure 14.1 Volcanic Ash Advisory Center (VAAC) area of responsibility map, black lines represent the boundaries of each VAAC. For volcanoes in their area, each VAAC will produce the VAA and VAG for the aviation community. (International Civil Aviation Organisation).

Along with those from the 1991 eruption of Mount Pinatubo (Casadevall et al., 1996), lead the International Civil Aviation Organization (ICAO) to set up nine volcanic ash advisory centres or Webley, P.W. (2015) Volcanoes and the aviation industry. In: S.C. Loughlin, R.S.J. Sparks, S.K. Brown, S.F. Jenkins & C. Vye-Brown (eds) *Global Volcanic Hazards and Risk*, Cambridge: Cambridge University Press.

VAACs (International Civil Aviation Organisation ICAO, 2007). These nine centres each have own areas of responsibility, see Figure 14.1 and are maintained by the local weather service. The nine VAACs are: Anchorage, Montreal, London, Toulouse, Tokyo, Washington, Darwin, Wellington and Buenos Aires. Each of these produce volcanic ash advisories (VAA) and volcanic ash graphics (VAG) for the aviation community, see example in Figure 14.2, and link to the aviation industry through local meteorological watch offices, which produce the Significant Meteorological Information (SIGMET) statements for the aviation.

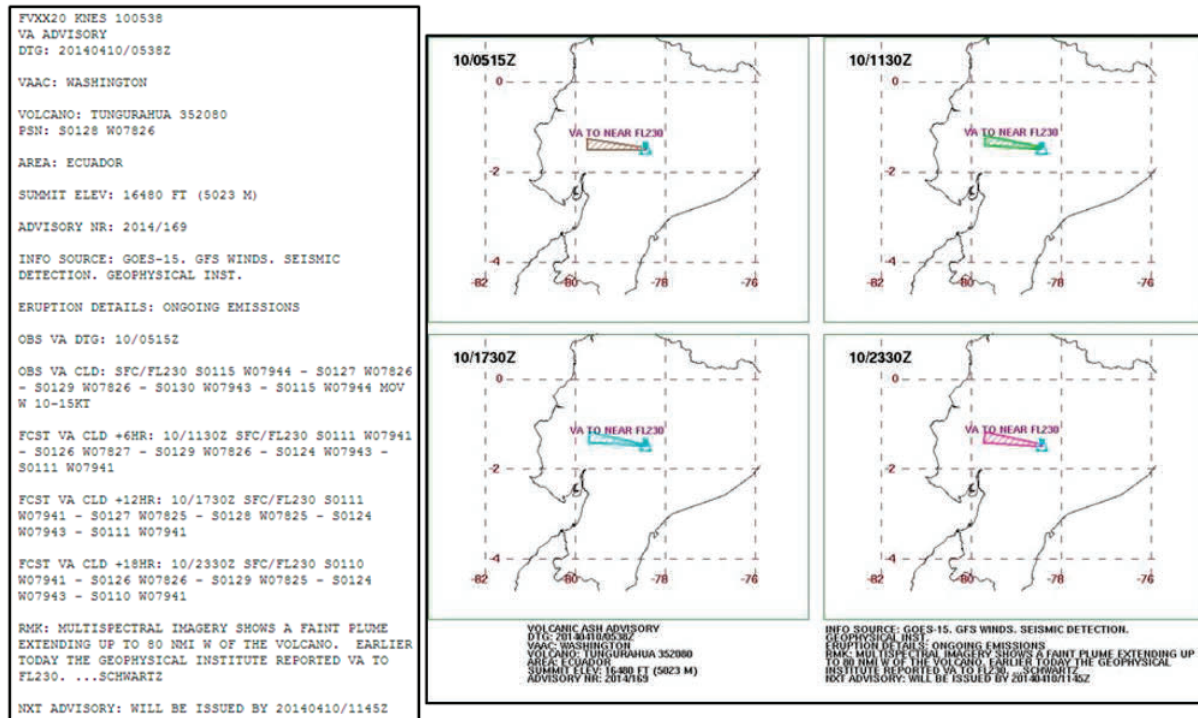


Figure 14.2 Example Volcanic Ash advisory (VAA) and volcanic ash graphic (VAG) for Tungurahua volcano on April 10, 2014 at 05:38 UTC (Z) as produced at the Washington VAAC. From NOAA Satellite and Information Service: NESDIS; <http://www.ssd.noaa.gov/VAAC/ARCH14/archive.html>

In addition to the VAACs, local volcano observatories (VO) have the role, as the state agency, to provide advice on the volcanic activity in their responsible region. VOs provide status updates on the level of activity at their volcanoes, often sending alert notifications and daily updates to the relevant agencies. This information can then be used by the VAACs to produce their VAA and VAG for the aviation community. There are several different alerting systems used worldwide, each with the aim to update those in local population centres close to the volcano and the aviation community.

One common system used is the United States Geological Survey (USGS) colour code system (Gardner & Guffanti, 2006). This uses a green-yellow-orange-red system for aviation alerts, which with its corresponding text, allows the aviation community to stay informed on the activity levels of the volcano, see Figure 14.3. The system in Figure 14.3 is in accordance with recommended ICAO procedures and is currently used by USGS led volcano observatories (USGS, 2014) as well as the Kamchatka Volcanic Eruption Response Team (Kamchatka Volcanic Eruption Response Team KVERT, 2014) and GeoNet in New Zealand (Geonet, 2014)

Volcano Alert Levels Used by USGS Volcano Observatories	
Alert Levels are intended to inform people on the ground about a volcano's status and are issued in conjunction with the Aviation Color Code. Notifications are issued for both increasing and decreasing volcanic activity and are accompanied by text with details (as known) about the nature of the unrest or eruption and about potential or current hazards and likely outcomes.	
Term	Description
NORMAL	Volcano is in typical background, noneruptive state or, after a change from a higher level, volcanic activity has ceased and volcano has returned to noneruptive background state.
ADVISORY	Volcano is exhibiting signs of elevated unrest above known background level or, after a change from a higher level, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
WATCH	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, OR eruption is underway but poses limited hazards.
WARNING	Hazardous eruption is imminent, underway, or suspected.

Aviation Color Code Used by USGS Volcano Observatories	
Color codes, which are in accordance with recommended International Civil Aviation Organization (ICAO) procedures, are intended to inform the aviation sector about a volcano's status and are issued in conjunction with an Alert Level. Notifications are issued for both increasing and decreasing volcanic activity and are accompanied by text with details (as known) about the nature of the unrest or eruption, especially in regard to ash-plume information and likely outcomes.	
Color	Description
GREEN	Volcano is in typical background, noneruptive state or, after a change from a higher level, volcanic activity has ceased and volcano has returned to noneruptive background state.
YELLOW	Volcano is exhibiting signs of elevated unrest above known background level or, after a change from a higher level, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
ORANGE	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, OR eruption is underway with no or minor volcanic-ash emissions [ash-plume height specified, if possible].
RED	Eruption is imminent with significant emission of volcanic ash into the atmosphere likely OR eruption is underway or suspected with significant emission of volcanic ash into the atmosphere [ash-plume height specified, if possible].

Figure 14.3 USGS volcanic activity alert-level notification system, with volcano alert levels from normal, through advisory and watch to warning and aviation colour code from green to red, adapted from Gardner and Guffanti (2006).

Additionally, to these operational groups, many other organisations have put together global meetings such as the World Meteorological Organization-International Union of Geology and Geophysics (WMO-IUGG) first and second workshops on ash dispersal forecast and civil aviation in 2010 and 2013 (World Meteorological Organisation WMO, 2013). Also, ICAO has assembled working groups and task forces such as the 2010-2012 International Volcanic Ash Task Force (IVATF) (International Civil Aviation Organisation ICAO, 2014). This task force was brought together as a focal point and coordinating body of all work related to volcanic ash being carried out by ICAO at global and regional levels.

Four meetings were held from 2010-2012, where members consisted of the VAAC's, aviation community, representatives for the volcano observatories and regulatory bodies. The IVATF provided a summary of recommendations (International Volcanic Ash Task Force IVATF, 2012) centred on science, airworthiness, air traffic management and international airways volcano watch coordination. These recommendations on aviation safety and volcanic watch operations will continue under the ICAO international airways volcano watch operations group (IAVWOPSG) (International Civil Aviation Organisation ICAO, 2014).

Globally, there can be many volcanoes active and potentially hazardous to the aviation industry. Therefore, the VAACs and local volcano observatories work closely together to provide the most

effective advisory system and ensure the safety of all those on the ground and in the air. Through the release of VAA, VAG and observatory information notices then timely advisories of the ongoing activity is able to reach the relevant organisation and reduce the potential hazard and provide the best tools to mitigate the risk to all.

References

- Casadevall, T. J. 1994. The 1989–1990 eruption of Redoubt Volcano, Alaska: impacts on aircraft operations. *Journal of Volcanology and Geothermal Research*, 62, 301-316.
- Casadevall, T. J., Delos Reyes, P. & Schneider, D. J. 1996. The 1991 Pinatubo eruptions and their effects on aircraft operations. In: NEWHALL, C. & PUNONGBAYAN, R. S. (eds.) *Fire and Mud: Eruptions and Lahars of Mount Pinatubo, Philippines*.
- Gardner, C. A. & Guffanti, M. C. 2006. US Geological Survey's Alert Notification System for Volcanic Activity: US Geological Survey Fact Sheet 2006-3139. Online at pubs.usgs.gov/fs/2006/3139
- Geonet. 2014. *Aviation Colour Codes* [Online]. Online. Available: info.geonet.org.nz/display/volc/Aviation+Colour+Codes
- Guffanti, M., Casadevall, T. J. & Budding, K. E. 2010. *Encounters of aircraft with volcanic ash clouds: A compilation of known incidents, 1953-2009*, US Department of Interior, US Geological Survey.
- Hanstrum, B. & Watson, A. 1983. A case study of two eruptions of Mount Galunggung and an investigation of volcanic eruption cloud characteristics using remote sensing techniques. *Australian Meteorological Magazine*, 31, 131-77.
- International Civil Aviation Organisation Icao 2007. *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds*. 2nd ed.
- International Civil Aviation Organisation Icao. 2014. *International Airways Volcano Watch Operations Group* [Online]. Available: www.icao.int/safety/meteorology/iavwopsg/Pages/default.aspx
- International Civil Aviation Organisation Icao. 2014. *International Volcanic Ash Task Force* [Online]. Available: www.icao.int/safety/meteorology/ivatf/Pages/default.aspx
- International Volcanic Ash Task Force Ivatf. 2012. *Summary of the accomplishments of the International Volcanic Ash Task Force* [Online]. Available: www.icao.int/safety/meteorology/ivatf/Documents/IVATF.Summary.of.Accomplishments.pdf
- Kamchatka Volcanic Eruption Response Team Kvert. 2014. *KVERT: Aviation Color Codes* [Online]. Online. Available: www.kscnet.ru/ivs/kvert/color_eng.php
- Usgs. 2014. *USGS Volcanic Activity Alert Notification System* [Online]. Available: volcanoes.usgs.gov/activity/alertsystem/
- World Meteorological Organisation Wmo. 2013. *2nd IUGG-WMO workshop on Ash dispersal forecast and aviation* [Online]. Online. Available: www.unige.ch/sciences/terre/mineral/CERG/Workshop2.html.