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INTERNATIONAL VOLCANIC ASH TASK FORCE (IVATF)

FIRST MEETING

Montréal, 27 to 30 July 2010

Agenda Item 6: Improvement of ash detection/avoidance systems (Science sub-group)
6.1: Ways and means to improve ground ash detection systems

IMPROVEMENT OF VOLCANIC MONITORING AND ADVICE

(Presented by World Organization of Volcano Observatories)

SUMMARY

This paper discusses a number of issues related to the scientific monitoring of volcanoes worldwide, including eruption prediction and detection, and possible actions that could be taken to urgently improve the volcanological input to the International Airways Volcano Watch in light of the Eyjafjallajökull eruption. Four specific actions are recommended for consideration by the science sub-group of the IVATF.

1. INTRODUCTION

1.1 The Appendix to this paper gives a special statement issued by the International Union of Geodesy and Geophysics (IUGG) in response to the Eyjafjallajökull eruption. The World Organization of Volcano Observatories (WOVO) endorses this statement, and notes in particular, and with a sense of urgency, the risk that, in seeking to implement an appropriate global response to the events of this year, it would be possible to overlook that Eyjafjallajökull is relatively well monitored by comparison to many others.

1.2 The remainder of this paper assumes that a proper response to Eyjafjallajökull must include efforts to significantly fill in gaps in volcanic monitoring where necessary in the world, and also to increase the overall quality of information flow between IAVW participants in response to enhanced ATM requirements stemming from analysis of the Eyjafjallajökull event.

2. DISCUSSION

2.1 Funding of volcano observatories

2.1.1 The task force will note that the fifth meeting of the International Airways Volcano Watch Operations Group (IAVWOPSG) called for the IUGG, (VONA) to continue its effort to educate volcano observatories on the use of the Volcano Observatory Notice for Aviation (VONA) via the World Organization of Volcano Observatories (WOVO) (IAVWOPSG Conclusion 5/6 refers). This was considered important to support of the timely notification on pre-eruptions and/or volcanic eruptions.

2.1.2 The WOVO welcomes the request to educate volcano observatories, but notes that, so far, the implementation of the VONA is extremely limited as discussed below. It might be considered that the implementation effort could be considerably accelerated if States were to implement appropriate sustainable funding arrangements, as noted in the IUGG Statement. As endorsed guidance on that matter now exists (*Guidance for State Volcano Observatories: The International Airways Volcano Watch*, available at www.wovo.org), the issue might be considered one of funding the encouragement and expertise for rapid implementation of these arrangements. Currently, different models are used in different countries. Most are funded as a public safety function of government; others are funded for scientific research, and a few are funded by users. Products of volcano observatories for aviation have the same diversity of funding.

2.1.3 *Recommendation 1*: Consistent with the guidance referenced above, WOVO does not recommend any single funding model, but does believe that it would be strongly in the interests of the aviation community to take whatever steps seem best in each particular country to promote contracts in which Volcano Observatories would provide volcanological information needed for aviation safety.

2.2 Secondment of volcano observatory staff to VAACs

2.2.1 In terms of the VONA itself, and in the context of the current non-uniform provision of volcano observatory information, WOVO supports both aviation colour codes and the VONA, both developed initially by the United States Geological Survey and implemented at the Alaska Volcano Observatory and promoted on the WOVO website (http://www.wovo.org/aviation-colour-codes.html; http://www2.icao.int/en/anb/met-aim/met/iavwopsg/IAVWOPSG%20Meetings/WP%2021.pdf). To date, only a small number of observatories are using VONA, despite generally positive feedback from users.

2.2.2 WOVO also notes the efforts of Australia, in coordination with the other VAAC provider States, IATA, and the IUGG, to create a uniform situational awareness briefing based around regular (daily) briefing for a geographical area rather than volcano by volcano (IAVWOPG conclusion 5/3 refers). A measure that could be taken in support of this or an alternative approach, in addition to rather than in lieu of VONAs, would be for each VAAC to ask all observatories within its domain to if possible "map" their own alert scheme into the standard 4-level ICAO volcano colour code. That way, VAACs could independently translate local codes into VAAC/ICAO colour codes.

2.2.3 An issue for ongoing discussion is remote sensing by and for Volcano Observatories: Relatively few volcano observatories presently use remote sensing as part of their daily operations, but that number is increasing. WOVO notes dramatic improvements in temporal, spatial, and spectral resolution of satellite-based remote sensing, and a variety of new ground-based methods as well. Uses of remote sensing at observatories include detection and quantification of thermal anomalies (using IR sensors, e.g., AVHRR, MODIS, ASTER, SEVIRI), detection and quantification of ground deformation (using C-X-, and L-band interferometric radars), and tracking of eruption phenomena including ash

clouds. Clearly, it is in the interest of volcano observatories to share remote sensing data with VAACs, and similarly for VAACs to share relevant meteorological remote sensing data and other information, as outlined in the IUGG Statement and also discussed at the WMO 5th International Workshop on Volcanic Ash in Santiago, March 2010.

2.2.4 In addition, volcano observatories need pilot reports and volcanic ash reports (VARs) in near- realtime. There has been improvement in this matter, but WOVO would like to see even more regular flow of information from VAAC's and others in the aviation community to volcano observatories.

2.2.5 *Recommendation 2:* To facilitate cooperation between volcano observatories and VAACs, it is recommended that appropriate volcano observatory staff be seconded to VAAC's, either on an ongoing, rotational basis, or as observatories see potential explosive eruptions approaching.

2.3 Availability of portable Doppler radars

2.3.1 In terms of volcanic source parameters for ash dispersion modelling, WOVO notes that Dr. Larry Mastin (Cascades Volcano Observatory) and others, in the *Journal of Volcanology* and *Geothermal Research* (also discussed at the IAVWOPSG), have proposed simplified source parameters for ash dispersion modelers, based on the likely eruptive style of each volcano worldwide. At the same time, WOVO notes with those authors that this is simply a starting point, not real-time information.

2.3.2 VAACs and others running dispersion models in real-time or near real-time need real-time estimates of magma flux rate and total eruptive mass, and their related quantities, plume height, particle size distribution with elevation. While satellite remote sensing can give some proxies, the best information will come from the volcano observatories. Cooperative, contract agreements between VAACs and Volcano Observatories will improve this process, and such contracts could specify products tailored to the VAACs needs (e.g., VONAs). WOVO notes that until the Volcano Observatories can provide source parameters for dispersion models in real time, forecasts of ash concentration will have high uncertainties.

2.3.3 The most direct and informative method for estimating eruption parameters in real-time uses Doppler radar, either fixed or portable, but the number of available radars is limited. Near real-time satellite-based remote sensing is also a key source. There was discussion in IAVWOPSG 5th Mtg (Lima) regarding a trial in Ecuador and Colombia of infrasound estimation of column height. Eruptions were detected, and signals of large eruption columns show some similarity, but additional validation is still needed. Longer period seismic waves and worldwide lightning signals are also being studied as a proxy for explosive eruption magnitude.

2.3.4 *Recommendation 3:* Noting that it would be unrealistic to expect every volcano observatory or every met office to have a Doppler radar available for ash cloud characterization, it would still be worthwhile for WMO and national met services to ascertain the locations and range of current installations of Doppler radar, for volcanologists to join this discussion to identify gaps relative to ash-producing volcanoes, and for all to explore possible mechanisms for making portable Doppler radars available on short notice for near-volcano characterization of eruption parameters.

2.4 Establishment of an office of volcanologists

2.4.1 Although ash dispersion modelling is largely outside WOVO's scope, a few WOVO observatories do routinely run ash dispersion models and a few individuals at observatories are working to improve available models. Volcanologists in the ash dispersion modeling community are responding

to the Eyjafjallajokull ash-aviation issue with calls for intercomparisons among existing models and improvements thereto. Dr. Costanza Bonadonna (Université de Genève) is organizing further discussions. WOVO simply notes the lively discussions between modelers and encourages intercomparisons and use of ensemble forecasts, using multiple dispersion models, and welcomes challenges from the modeling community to provide real-time input data for those models. WOVO also recognizes the value of coordination between volcanologists and meteorologists on this matter. Lastly, we recall that WOVO observatories have long recognized the benefit, on the ground, of having a consensus hazard map rather than multiple maps with varying assumptions. This requirement for consensus is of obvious relevance for any discussion re: standardization and/or ensemble use of ash dispersion models.

2.4.2 If the aviation community decides to adopt safe concentration levels, both modelers and users will need to know the statistical accuracy (significance) of the forecast. This is done routinely in the meteorological community. Each VAAC or other modeling group has its own model(s) and can then analyze the others. This will help when ash clouds track across VAAC boundaries.

2.4.3 The IUGG, and WOVO as a Commission of IUGG member IAVCEI, is a volunteer science organization; there is no UN based volcano monitoring organization equivalent to the highly effective specialist organizations ICAO and WMO. The TF may wish to consider whether it is necessary to suggest any changes to this situation.

2.4.4 *Recommendation 4:* The TF may wish to consider whether an office of volcanologists, under an international umbrella, should be established and tasked to promote improvements in volcano observatory products for aviation, improvements in communications between volcano observatories and the aviation community, and serve as a bridge to WMO and ICAO.

2.5 **Conclusions**

2.5.1 Given the discussion above, the TF is invited to consider the four abovementioned recommendations, and other actions to urgently improve and sustain volcanic monitoring for aviation purposes.

3. ACTION BY THE IVATF

3.1 The IVATF is invited to:

a) note the information in this paper; and

b) agree that the draft recommendations in this paper be referred to the science sub-group for further consideration.

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APPENDIX

STATEMENT BY THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS UNION GEODESIQUE ET GEOPHYSIQUE INTERNATIONALE

Volcanological and Meteorological Support for Volcanic Ash Monitoring

Adopted by the IUGG Bureau on 28 May 2010
This Statement follows the IUGG Statement of 20 April 2010 on Volcanic Ash Clouds

The eruptions of Eyjafjallajökull, Iceland, during early 2010, have highlighted the importance of a close understanding of the eruptive state of each of the world's active volcanoes, for the safety and health of local residents as well as for air traffic and other purposes. It has become increasingly evident during the eruption that accurate specification of the ash column height and the ash characteristics from the eruption are necessary for safe and efficient routing of air traffic. To be able to forecast ash clouds for the aviation hazards, the clouds' concentration, particle size and total mass is required in real time. The work of the volcanologists and meteorologists of Iceland, bringing together earth and atmospheric sciences, in support of the operations of the London Volcanic Ash Advisory Centre, has been critically important in this regard.

In improving the global response to volcanic clouds as aviation hazards, it must be understood that the great majority of the Earth's active volcanoes are located in less industrialized countries or in remote locations, and are not monitored to the standards of Iceland. Only about 50% of the World's volcanoes that currently threaten air operations have any sort of ground based monitoring. Also, less than 50 of the 1300 volcanoes with Holocene age eruptions (approximately the last 12000 years) worldwide are considered to be *well* monitored.

In this regard, the IUGG emphasises:

— The capability to understand, forecast and promptly report eruptions, based on thorough study and instrumentation of active volcanoes, remains vital for aviation safety, for residents exposed to local volcanic hazards, and also for assessing the magnitude and effects of volcanic emissions on our atmosphere and climate;

— An improvement in support for local volcano observatories would improve the timing, scope, and accuracy of information on volcanic activity;

— In meeting requirements from the International Civil Aviation Organization (ICAO) for States to provide volcanological information to aviation, the long term sustainability of such support for volcano observatories is an important consideration. ICAO, advised by the International Union of Geodesy and Geophysics and other organisations including the World Meteorological Organization (WMO), has prepared arrangements where a State may choose to recover reasonable costs for the provision of information to aviation from the aviation industry. A State could, alternatively, choose to support observatories

directly without such arrangements. Guidelines on these issues are now available as referenced below;

— Any volcanic crisis places high pressure on the responsible agency: support for aviation functions is typically only one of many aspects of a volcanic crisis that volcanologists must consider. International science protocols, prepared by IUGG constituent association, the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), already exist to assist in scientific cooperation during a crisis, and may be useful in the context of an aviation-focused volcanic crisis;

— Where observations exist (such as satellite data, pilot reports and meteorological radar coverage over a volcanic area), arrangements for multi-disciplinary observation sharing between all those concerned with the hazard assessment from the volcanic activity should be specified and followed to ensure the best possible use of observations.

In summary, increased support for the volcano observatories of the world, as part of the international science effort to improve volcanic cloud monitoring, is a necessary measure for improving volcanic impact management and aviation safety as well as for aiding natural hazard mitigation on the ground.

References:

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