

## **VOLCANIC ASH-RELATED ACTIVITIES**

*(Submitted by the WMO Secretariat)*

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### **Summary and Purpose of Document**

This document provides an overview of recent activities relating to volcanic ash, in particular summarising the outcomes of a conjoint WMO VAAC Best Practices workshop and WMO/IUGG Volcanic Ash Scientific Advisory Group meeting and a proposal for how to address volcanic sciences and applications in the future.

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### **ACTION PROPOSED**

The Management Group (MG) is invited to:

- (1) review the outcomes of the conjoint VAAC BP workshop and VASAG meeting held in November 2018;
  - (2) consider a proposal on how to address volcanic sciences and applications in the future; and
  - (3) offer comment and/or strategic direction in respect of (1) and (2) above.
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## **1. OUTCOMES OF CONJOINT SESSION OF VAAC BP AND VASAG**

1.1 A conjoint sixth Volcanic Ash Advisory Centre Best Practices (VAAC BP) workshop and eighth Volcanic Ash Scientific Advisory Group (VASAG) meeting was held at the Civil Aviation Authority of New Zealand (CAA NZ) and Meteorological Service of New Zealand Ltd. (MetService) in Wellington from 5 to 9 November 2018. The conjoint session was attended by 37 participants from 8 out of the 9 VAACs, VASAG members and other interested parties.

1.2 The conjoint session was a blend of joint and parallel discussions/presentations involving the VAAC managers/representatives and VASAG science experts. This was the first time that VAAC science and operations communities had been brought together in this way.

1.3 An executive summary of the progress and outcomes of the conjoint session, across the 20 topics discussed, is given at the [Annex](#) to this document.

1.4 As demonstrated, the conjoint session held discussions on a broad range of topics of direct relevance to VAAC science and operations. A number of the outcomes of the conjoint session fed as direct inputs to the ICAO METP WG-MOG (IAVW) and WG-MISD (VASD) that took place in the immediately following week.

1.5 All of the presentation materials (approx. 50 presentations in total) and a final report of the conjoint session are available via URL:

<https://www.wmo.int/aemp/VAAC-BP-6-VASAG-8>

1.6 In considering the benefit of holding a conjoint session in this way, the overwhelming consensus of opinion was that it had been tremendously productive *and* worthwhile. It was emphasized that bringing the two communities together, in person, was highly beneficial for exploring and exploiting research-to-operations opportunities, community collaborations, and closing gaps in knowledge and capability.

1.7 In respect of the next meetings or a conjoint session of VAAC BP and VASAG, the target timeframe is late-2020 to coincide with the proposed IWVA/8 (see item 15 in the table at the Annex). However, should there be a specific issue demanding special attention and a face-to-face meeting, consideration may be given to convening at an earlier point in time.

## **2. ADDRESSING VOLCANIC ASH-RELATED MATTERS IN THE FUTURE**

2.1 At present, the VAAC BP workshops are predominantly a best-endeavours effort facilitated by WMO without possessing any official status within the organization (e.g. they are not under the remit of CAeM nor any other technical commission). The VASAG meanwhile is similarly not a subsidiary body of the CAeM (nor any other technical commission) although it is, officially, a joint WMO and IUGG body. The VASAG was established by WMO at the 62<sup>nd</sup> Session of the Executive Council in June 2010 and fully supported by the Secretary General of the IUGG. The 67<sup>th</sup> Session of EC in June 2015 was the most recent occasion when the terms of reference of the VASAG were revised. The current VASAG terms of reference are available via URL:

<https://www.wmo.int/aemp/vasag>

2.2 Following on from the conjoint session held in November 2018, consultations have been held amongst the moderator of the VAAC BP workshops (Ian Lisk) and the co-chairs

of the VASAG (Andrew Tupper and Larry Mastin) to see if there is an opportunity to bring the two communities together as a single entity on a more permanent basis.

2.3 One idea that has been mooted is the establishment of an Expert Network on Volcanic Sciences and Applications (EN-VSA) [working title and acronym] under the auspices of the CAeM (or its successor<sup>1</sup>).

2.4 The combining of volcanic sciences and applications into one entity rather than separate VAAC BP workshops and VASAG meetings appears to be a desirable and necessary pursuit given the reported benefits that can be derived from such direct collaboration and interaction, particularly if one acknowledges the pace of scientific and technological advancement and the ever-advancing (aeronautical) user requirements. It would be a more efficient and effective use of the limited resources (within the AeM community of expertise and the secretariat) and would also, potentially, be an opportunity for regional and gender balance to be better realized, especially on the science side. Expertise from within the IUGG community of experts would continue to be assured too through, for example, the involvement of experts from State volcano observatories.

2.5 Given the non-intergovernmental nature of EN-VSA and the working groups of the ICAO Meteorology Panel (METP), there could also be merit, in time, to pursue the establishment of a joint working body/group with ICAO to address the volcanic ash and gases issue.

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<sup>1</sup> As noted under agenda item 3.4 of this meeting, WMO Reform will likely yield a new constituent bodies structure of the organization. This reform will, subject to the outcomes of the 18th World Meteorological Congress in June 2019, result in the dissolution of the CAeM and the establishment of a Standing Committee on Aeronautical Meteorology (SC-AeM) reporting to a Commission for Services and Applications (CSA) [working titles and acronyms].

**Executive Summary of the outcomes of the conjoint VAAC BP workshop and VASAG meeting held in Wellington, New Zealand from 5 to 9 November 2018**

(Full report [available here](#))

No.	Topic	Progress	Outcome
1.	<b>'Ins and Outs' modelling tables update</b>	<ul style="list-style-type: none"> <li>• Recurrent review on NWP errors/performance relevant to volcanic ash modelling</li> <li>• Similarities and differences across the 9 VAACs               <ul style="list-style-type: none"> <li>○ Opportunity to better understand the reasons behind why there are differences</li> <li>○ Opportunity to align modelling approach where necessary</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Update tables and review again in 2020</li> </ul>
2.	<b>VAAC strength of evidence checklists</b>	<ul style="list-style-type: none"> <li>• Operational trials of the checklists amongst some but not all of the VAACs over past year</li> <li>• Expert input/scientific advice from the VASAG</li> <li>• Integral component of QMS best practice               <ul style="list-style-type: none"> <li>○ Including utility in the event of any post-event analysis or aviation incident/accident inquiry</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Further iterative improvement of the checklists and trials across all VAACs</li> </ul>
3.	<b>VONA and the aviation colour codes</b>	<ul style="list-style-type: none"> <li>• VAAC↔SVO interactions non-uniform. Some good, other less so. Communication and collaboration challenges prevail in some regions</li> <li>• Identified mutual benefit of VAAC-SVO collaboration and improved service delivery (high quality, faster notifications)</li> <li>• Significant SVO deficiencies prevail – mainly but not exclusively in countries in the developing world</li> <li>• Most SVOs possess diligent, conscientious staff, but they simply lack resources to perform the aviation function</li> </ul>	<ul style="list-style-type: none"> <li>• Guidance, training and outreach/capacity development needs to be further improved to support the needs of the SVOs</li> </ul>

No.	Topic	Progress	Outcome
4.	<b>Volcanic hazard monitoring and observing capabilities</b>	<ul style="list-style-type: none"> <li>• Not insignificant challenges associated with forecasting, detection, characterization and communication of volcanic eruptions</li> <li>• Improved detection (e.g. sat. obs.) can help 'fill the void' cause by inadequate or missing ground-based monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• VAAC-SVO collaboration beneficial to build capacity and capability</li> <li>• 'SVO checklists' (similar to 'VAAC checklists') idea mooted</li> </ul>
5.	<b>Satellite inter-comparisons and discernible ash</b>	<ul style="list-style-type: none"> <li>• Comparisons between old and new generation satellite imagery</li> <li>• 'Step-change' in capabilities enhancement <ul style="list-style-type: none"> <li>◦ Spatial and temporal, multispectral</li> </ul> </li> <li>• Improved detection of smaller eruptions events and dissipating/distal ash cloud <ul style="list-style-type: none"> <li>◦ Able to see MORE ash in the atmosphere</li> </ul> </li> <li>• Operational side effects – increased VAAC workloads, more VAA/VAG issued, higher training need</li> </ul>	<ul style="list-style-type: none"> <li>• Continue satellite inter-comparison efforts between VAACs</li> <li>• Investigate feasibility for modelling inter-comparison</li> </ul>
6.	<b>Forecast verification and VAAC key performance indicators</b>	<ul style="list-style-type: none"> <li>• Trials of the VAAC KPIs first introduced in 2017</li> <li>• All VAACs close to achieving the KPIs <ul style="list-style-type: none"> <li>◦ Some uncertainty / ambiguity in the uniform application of the KPIs – initiation time, next issue time, 'sufficient evidence' or 'credible source', timeliness or compliance</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Fine-tune the timeliness KPIs</li> <li>• Seek advice on compliance KPIs expectations</li> </ul>
7.	<b>VAAC collaboration tools</b>	<ul style="list-style-type: none"> <li>• Basic functional requirements agreed</li> <li>• Single solution desired but not yet materialized</li> <li>• Excellent VAAC Tokyo (JMA) tool shows promise</li> <li>• Inspiration from other similar tools <ul style="list-style-type: none"> <li>◦ SIG-Coord. SE Asia, WAFC chatrooms, NWSchat, MetConnect Pacific</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Further development / improvement of the VAAC Tokyo tool</li> <li>• May lead to operational introduction for <i>all</i> VAACs</li> </ul>

No.	Topic	Progress	Outcome
8.	<b>IWXXM developments</b>	<ul style="list-style-type: none"> <li>• All VAACs to greater or lesser extent progressing with IWXXM <ul style="list-style-type: none"> <li>◦ Mainly as part of NMS broader responsibility for ICAO Annex 3 provisions</li> </ul> </li> <li>• Issues/problems identified with the IWXXM schema which require clarification/resolution</li> </ul>	<ul style="list-style-type: none"> <li>• Encourage continued development and implementation of IWXXM, incl. V3 RC2</li> <li>• Notify TT-AvXML of issues/problems with IWXXM schema for VA service</li> </ul>
9.	<b>Addition VAAC considerations</b>	<ul style="list-style-type: none"> <li>• Re-broadcasting of VAA/VAG</li>   <li>• VAAC backup arrangements, especially in respect of VAAC Washington's backup</li>   <li>• Holistic review of the IAVW</li> </ul>	<ul style="list-style-type: none"> <li>• Some VAACs not following Doc 9766 procedure at times</li> <li>• Agreement that ALL should follow 9766</li> <li>• Possible linkage with KPIs (additional indicator)</li>   <li>• Agreement to investigate more viable, more robust solution</li>   <li>• [In camera session]</li> </ul>
10.	<b>Eruption source parameter database for restless volcanoes</b>	<ul style="list-style-type: none"> <li>• Database continuing to mature as a web-based platform <ul style="list-style-type: none"> <li>◦ Alignment with Smithsonian numbering scheme</li> <li>◦ Field entry improvements</li> <li>◦ Data on new volcanoes added</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Encourage BGS to further develop to database (soft online launch)</li> </ul>
11.	<b>Aircraft volcanic ash encounter database and severity index</b>	<ul style="list-style-type: none"> <li>• Review of the severity index</li> <li>• Ongoing update database to include 2010-2016 data</li> <li>• Quality check on database against the 'new' SI</li> </ul>	<ul style="list-style-type: none"> <li>• Revised SI proposal developed</li> <li>• Encourage remaining activities to be completed soon (feed to ICAO Doc 9766 update)</li> </ul>
12.	<b>Satellite advancements</b>	<ul style="list-style-type: none"> <li>• Step-change improvements in capability c.f. older/previous generation of satellites</li> <li>• Inspiring new scientific initiatives <ul style="list-style-type: none"> <li>◦ E.g. VOLCAT (analysis toolkit)</li> </ul> </li> <li>• Inter-comparison of VA retrieval algorithms <ul style="list-style-type: none"> <li>◦ SCOPE-Nowcasting project – progress but challenges</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Further explore community collaborations on NRT experimental satellite products and model integrations</li> </ul>

No.	Topic	Progress	Outcome
13.	<b>Modelling advancements</b>	<ul style="list-style-type: none"> <li>• NWP and ATDM advancing               <ul style="list-style-type: none"> <li>○ Rapidly in some areas, more slowly in others</li> <li>○ Enabling improved ESP constraining</li> <li>○ Better model physics representation</li> <li>○ Quantitative satellite data integration leading to higher-quality, more accurate output</li> <li>○ Observations KEY to improving the NWP/ATDM</li> <li>○ But gaining access to the obs. data can be challenging</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Exploration of NWP/ATDM inter-comparison and validation studies</li> </ul>
14.	<b>Publications and outreach</b>	<ul style="list-style-type: none"> <li>• Improved outreach via a variety of scientific and non-scientific publications</li> <li>• Important to keep the VA issue in the spotlight</li> </ul>	<ul style="list-style-type: none"> <li>• Proposals for further outreach to be devised               <ul style="list-style-type: none"> <li>○ E.g. 10-year retrospective of the 2010 Eyja eruption?</li> </ul> </li> </ul>
15.	<b>Eighth International workshop on volcanic ash (IWVA/8)</b>	<ul style="list-style-type: none"> <li>• Concept note under development</li> <li>• Informal offer to host IWVA/8 in Iceland in 2020               <ul style="list-style-type: none"> <li>○ 10-year anniversary of Eyja eruption</li> <li>○ 100-year anniversary of IMO establishment</li> <li>○ Circa September 2020 (avoiding overlap with METP/5)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Mature the concept note for IWVA/8</li> </ul>
16.	<b>VAAC personnel competency</b>	<ul style="list-style-type: none"> <li>• All VAACs (their NMS) have some form of competency assessment framework in place for VAAC forecaster               <ul style="list-style-type: none"> <li>○ Some variance in approach, methodology applied, etc.</li> </ul> </li> <li>• Pace of scientific and technological advancement               <ul style="list-style-type: none"> <li>○ Challenging for VAACs to maintain staff competence</li> <li>○ Pull-through of R2O, S2S. Requires resource</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Initiate a review of top-level and/or second level competencies for AMF               <ul style="list-style-type: none"> <li>○ Adapt for VAAC usage</li> </ul> </li> </ul>

No.	Topic	Progress	Outcome
17.	<b>State volcano observatory skills, needs and capacity development</b>	<ul style="list-style-type: none"> <li>• Dependency between VAACs and SVOs</li> <li>• Sustainable CR mechanism or other funding stream for SVO often lacking               <ul style="list-style-type: none"> <li>◦ Even though crucial to build capacity, resilience, etc.</li> </ul> </li> <li>• Elevating VONA a step towards a more viable, more sustainable service delivery model for pre-eruptive information</li> </ul>	<ul style="list-style-type: none"> <li>• A review and update of (WOVO) guidance for SVOs to be initiated</li> </ul>
18.	<b>Volcanic sulphur dioxide</b>	<ul style="list-style-type: none"> <li>• Tens of hundreds of volcanoes emit SO<sub>2</sub> each year               <ul style="list-style-type: none"> <li>◦ Some significant, others lesser</li> </ul> </li> <li>• VA cloud and SO<sub>2</sub> cloud can overlap or be distinctly separate clouds</li> <li>• Records of a/c encounters with SO<sub>2</sub> <ul style="list-style-type: none"> <li>◦ But gaining access to the data can be challenging</li> </ul> </li> <li>• Effusive eruptions can produce discernible SO<sub>2</sub> for prolonged periods (months)               <ul style="list-style-type: none"> <li>◦ Implications on the service delivery model</li> </ul> </li> <li>• Proof of concept tools and techniques demonstrated</li> <li>• SO<sub>2</sub> impacts on airframe and engines is COMPLEX (more than VA)</li> <li>• Modelling SO<sub>2</sub> evolution in the atmosphere complex too</li> </ul>	<ul style="list-style-type: none"> <li>• Encourage cross-community sharing of information               <ul style="list-style-type: none"> <li>◦ Advance and expedite scientific and technological progress</li> </ul> </li> </ul>
19.	<b>Volcanic ash impacts on jet engines</b>	<ul style="list-style-type: none"> <li>• Dose approach (DEvAC) remains sensible approach</li> <li>• Slow uptake across other OEMs beyond Rolls-Royce</li> <li>• Demands knowledge of where and HOW MUCH ash in the atmosphere (quantification)</li> <li>• Advances satellite capabilities may demand a revisit of the "0.2 mg/m<sup>3</sup>" lower threshold of discernible ash.               <ul style="list-style-type: none"> <li>◦ (Subjectively at present) the threshold for discernible ash may be an order of magnitude too high</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Monitor developments</li> </ul>



No.	Topic	Progress	Outcome
20.	<b>Quantitative volcanic ash forecasts</b>	<ul style="list-style-type: none"> <li>• Current and foreseen future satellite capabilities characterization – continued progress</li> <li>• Advances in modelling (ESP, physics, NWP, coupling) – continued progress, some challenges</li> <li>• State of engine susceptibility – progress noted</li> <li>• Pull-through considerations – R20, S2S</li> </ul>	<ul style="list-style-type: none"> <li>• Support to revisit the quantification VA forecast issue</li> <li>• On proviso that the following is understood: <ul style="list-style-type: none"> <li>○ SCI and TECH developments demand sustained investment</li> <li>○ Uncertainty will always prevail (albeit general decrease over time)</li> </ul> </li> </ul>

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