SUMMARY

This paper presents a consolidated VAAC Management Report including sections on Operations, Key Performance Indicators, Significant Operation or Technical Changes, IAVW Implementation and Future Development or changes from VAACs Anchorage, Buenos Aires, Darwin, London, Montreal, Tokyo, Toulouse, Washington and Wellington. This report covers the 15-month period beginning around 1 July 2017 through 30 September 2018 in accordance with recommendation 5/15.

1. INTRODUCTION

1.1 During the last meeting in Tokyo (12-14 June 2017, Fifth Meeting of the Working Group of the Meteorology Panel Meteorological Operations Group (METP WG-MOG/5), the group agreed on a trial basis of a consolidated VAAC Management Report.

1.2 Introduction of World Volcanic Ash Advisory Centres:

Nine global Volcanic Ash Advisory Centres (VAACs) are mandated by the International Civil Aviation Organization to notify the 270 estimated Meteorological Watch Offices (MWOs), Area Control Centres (ACCs) and Flight Information Regions (FIRs) of the
presence of volcanic ash in the air by issuing Volcanic Ash Advisories (VAA) and Volcanic Ash Graphics (VAGs) for volcanoes that have erupted within their Area of Responsibility (AoR).”

2. DISCUSSION ON OPERATIONS

2.1 This section describes the operations of all VAACs in accordance with the IAVW in describing the issuance of Volcanic Ash Advisories (VAAs) and Volcanic Ash Graphics (VAGs), Key Performance Indicators (KPIs), Significant satellite and modelling operation or technical changes eruptions that influenced the performance of operations, changes in operational procedures or use of technology to enhance operational capability of the VAAC; issues

2.1.2 Issuance of advisories for Real Time and Exercise Events

<table>
<thead>
<tr>
<th>Volcanic Ash Advisory Centre</th>
<th>Volcanic Ash Advisory</th>
<th>Volcanic Ash Graphic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchorage</td>
<td>265</td>
<td>139</td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>1910</td>
<td>1910</td>
</tr>
<tr>
<td>Darwin</td>
<td>3855</td>
<td>Not Available</td>
</tr>
<tr>
<td>London</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>Montreal</td>
<td>12</td>
<td>1</td>
</tr>
</tbody>
</table>
2.1.3 **Key Performance Indicators**

An outcome of the most recent VAAC Best Practice and Met Operations Group (MOG) meetings (Tokyo, 5-9 June 2017 and 12-14 June 2017 respectively) was a commitment, from 1st January 2018, for all VAACs to adhere to certain Key Performance Indictors (KPIs) relating to the issuance of VAG and VAA products, as follows:

2.1.3.1 Following the collection of sufficient evidence of volcanic ash in the atmosphere within a VAAC’s Area of Responsibility, the Initial VAA/VAG product should be issued within 20 minutes on 95% of occasions.

2.1.3.2 Following the collection of sufficient evidence of volcanic ash in the atmosphere within a VAAC’s Area of Responsibility, the first forecast VAA/VAG product should be issued within 75 minutes on 95% of occasions.

<table>
<thead>
<tr>
<th>Volcanic Ash Advisory Centre</th>
<th>Initial Advisory</th>
<th>Forecast Advisory</th>
<th>Next Advisory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchorage</td>
<td>98%</td>
<td>100%</td>
<td>98.0%</td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>N/A</td>
<td>90%</td>
<td>91.4%</td>
</tr>
<tr>
<td>Darwin</td>
<td>100%</td>
<td>100%</td>
<td>Not Available</td>
</tr>
<tr>
<td>London</td>
<td>100%</td>
<td>88%</td>
<td>100%</td>
</tr>
<tr>
<td>Montreal</td>
<td>N/A</td>
<td>N/A</td>
<td>100%</td>
</tr>
<tr>
<td>Tokyo</td>
<td>100%</td>
<td>100%</td>
<td>98.6%</td>
</tr>
<tr>
<td>Toulouse</td>
<td>67%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Washington</td>
<td>100%</td>
<td>100%</td>
<td>98.8%</td>
</tr>
<tr>
<td>Wellington</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
</tr>
</tbody>
</table>
footnote: VAAC Wellington implemented KPIs in Aug 2018 and at this stage too few examples have occurred to draw any real trend

2.1.4 Significant satellite, modelling, operations or technical changes

2.1.4.1 GOES-16 was used at VAAC Washington in experimental mode starting in mid-June of 2017. The satellite replaced GOES-13 and became the official GOES-East satellite on December 18, 2017. Months of testing, hundreds of man hours took place for implementation at VAAC Washington and other programs within the Satellite Analysis Branch (SAB). The temporal, spatial and spectral resolution has been a significant tool in the monitoring of volcanoes. The same process is currently going on with GOES-17, but less time will be needed to meet needs and requirements based on what was learned in the GOES-16 transition. GOES-17 will replace GOES-15 as the official GOES-West satellite on December 10, 2018.

2.1.4.2 The change from GOES-13 to GOES-16 satellite was a challenge for operations. All the Buenos Aires VAAC forecasters were trained with a virtual course on GOES-16 and the Workshop "Analysis of typical situations affecting Southeastern South America" dictated by NOAA expert José M. Galvez in collaboration with local coordinators in November 2017. The images are received by PDA and a new ground station was installed. Both systems are working simultaneously at this moment. For operational purposes a new platform for the visualization of the new images was developed. For the ground station a Guide User Interface (GUI) named Proteus is working at this moment.

2.1.4.3 In addition to images received from the NOAA suite of polar satellites, and MODIS images from Aqua and Terra, VAAC Montreal is in the process of getting operational access to images from GOES-R, NPP and NOAA-20.

2.1.4.4 Observation data from the six Meteo-France aerosols LIDARs is now operationally used by the VAAC Toulouse, for volcanic ash monitoring from surface up to FL450. In addition, LIDAR data is steadily used for aviation weather forecast (bottom of clouds layers identification and sand dust or fire smoke monitoring).

2.1.4.5 Buenos Aires VAAC - FALL3D ash dispersion and deposition model is going to be operational in the next month. At this moment this model uses Global Forecasting System forecasts of 0.25° resolution. A FALL3D-GUI was developed at SMN so that the forecaster executes the model directly, and if necessary, produce a sequence of simulations to estimate and forecast numerically the state of long living plumes.

2.1.4.6 The horizontal resolution of the MOCAGE ACCIDENT model used to forecast volcanic ash dispersion has been increased to 0.1° (instead of 0.5°) in the inner regional domain (60°x 60°). This increase has considerably enhanced the description of the eruptive source term in the model.

2.1.4.7 The dispersion model used within the London VAAC (NAME) has been ported from standalone servers onto the main High Performance Computers (HPC). This was undertaken because increases in the resolution of the (Global) models used at the Met Office (GM resolution of ~ 10km) mean that data volumes have become increasingly
difficult to manage in a timely fashion, putting at risk the ability to provide dispersion modelling based on the most recent run of the atmospheric (meteorological) models.

2.1.4.8 Weekly testing of the operational response of VAAC Montreal to volcanic events continues as it has since February 2007. A second weekly test was added in January 2009. Each Tuesday (on both day and night shifts), the supervisor tests the operational Lagrangian transport and dispersion model (called MLDPn), the trajectory model issuance of VAAs or detection of ash in split-window imagery from satellites. These tests have allowed:

- Real-time detection of problems related to software, models, networks, transmissions of products, etc.
- Individual staff members to become more familiar and comfortable with procedures which they would be required to follow during an actual event.

2.1.4.9 VAAC Tokyo had improved its dispersion model and introduced it on 15 March 2018. The new model is able to assume volcanic ash emitted from sequential eruptions in calculations and provide more accurate forecast information when eruptions continue.

2.1.4.10 On 5 June 2018, JMA began the operation of its new supercomputer system. The system has 10 times more capacity in terms of numerical calculation than its predecessor. Thanks to the new system, VAAC Tokyo can calculate ash dispersion and provide VAA products in shorter time than before. VAAC Tokyo also plans to improve quality of VA products in the near future by further utilizing the new system.

2.1.4.11 VAAC Darwin has operationalised the VASEA. This is an enhancement to the current service and uses confidence-based assessment criteria to graphically represent the VAAC forecasters assessment of discernible ash. A VASEA is produced for every routinely issued VAA and distributed to industry via a registered user portal. The VASEA has been positively received by stakeholders and continues to be evaluated for further improvement. A more detailed account of the VASEA project outcomes is presented in a separate paper.

2.1.4.12 HYSPLIT GUI that runs on within the cloud was introduced for testing is expected to become operational in November 2018. The new cloud option will allow a VAAC forecaster to simulate an eruption for any volcano in the world, including for those situations where ash enters the Wellington VAAC from another area.

2.1.4.13 The World Wide Lightning Location Network (WWLLN) email alert trial started on the 26th July 2018. It has proved valuable for detecting low level eruptions in situations with significant stratiform cloud coverage. VAAC Wellington has taken this alerting capability a step further and incorporated it within the wider aviation alerting tool. If an eruption risk is reported from the WWLLN data, the forecaster is presented with a separate alerting message on their workstation screen, which then prompts them to look into a situation in more detail.
2.1.5 Social Media, Outreach, and Web:

2.1.5.1 VAAC Washington received official approval from DOC and NOAA for Twitter and Facebook accounts. Analysts are now able to post all VAA/VAG messages and satellite imagery to VAAC Washington Twitter page. This is important tool for disseminating information to our Central and South America users. An automated script is in the process of being created to post all messages and satellite imagery to the VAAC Washington account. It will be similar to the automated script that was already created to post all message by the analysts to NWS Chat accounts.

2.1.5.2 The VAAC Toulouse website has been re-designed to improve ergonomics and propose an access to an archive of any VAA/VAG issued by the VAAC from 2006. Volcanic ash concentration charts, satellite views with forecasters’ annotation (to assess the observation confidence) may be posted in real-time on the web site. This new website will open to users by the end of 2018.

2.1.5.3 VAAC Tokyo has conducted monthly VONA issuance drills with volcano observatories in the Philippines with PHIVOLCS; drills have contributed to appropriate VONA creation and issuance and smooth communication between PHIVOLCS and VAAC Tokyo.

2.1.5.4 Following discussions at the VAAC best practice workshop in June 2017 about Volcano Observatory Notice for Aviation (VONA), VAAC Montreal established procedures with colleagues at NavCanada, Natural Resources Canada and the Government Operations Centre of Public Safety Canada to ensure that VONA would be quickly and efficiently issued in the case of an eruption of a Canadian volcano. A distribution list for VONA was compiled by VAAC Montreal. It was agreed that VONA would be sent to recipients via NavCanada after being drafted by VAAC Montreal in coordination with the volcanologist on duty at Natural Resources Canada.

2.1.5.5 VAAC Darwin conducted an external stakeholder liaison visit to Papua New Guinea with visits including MWO's, ACC's and Airline and the Rabaul Volcano Observatory. All these stakeholders are an integral part of VAAC Darwin operations and it was very beneficial to learn how we fit into their operations and vice versa. With communication being a challenging area of development in PNG, the trip focussed on improving communications between all appropriate parties. The meetings were rich in information and have lead to improved communications. Another purpose of the visit was to update and share VAAC Darwin's service offerings and areas of development including the VASEA product and the GDAS (Graphical Daily Activity Summary) with our stakeholders. Figure 12 gives a snapshot of the engagement undertaken.

2.1.5.6 Close collaboration with GNS Science has continued, with the VAAC Wellington forecaster attending a Volcano Short Course in October 2017. Reciprocal visits continued in December 2017 and January 2018 with a goal to enhance utilization of remote sensing data. GNS provided valuable information from Aoba while visiting Ambae island in April 2018, following elevated activity across the region.

2.1.5.7 AAWU and VAAC Anchorage webpages: Recent changes to system management web pages has resulted in an effort to make significant changes to the VAAC Anchorage web
Due to a lack of IT resources at our office and in the NWS Alaska Region as a whole, many of these updates have been put on hold for the time being. Higher priority operational web issues are attended to first and foremost. Once sufficient resources are in place, the VAAC Anchorage webpage will be updated.

2.1.6 **Platform Changes**

VAAC Washington is currently in the exploration phase of looking into finding a new platform to produce VAA/VAG. VAAC Washington would like to thank VAAC Darwin, London and Wellington in providing live demos for the Visual Weather platform and other VAAC including Toulouse, Tokyo and Montreal in providing details of the platform they use in volcanic ash operations.

2.1.6.1: London VAAC is currently undertaking a change to the software that is used to produce the suite of Volcanic Ash forecast products, including VAG,VAA and VA supplementary products. The software is known as VAIT (Volcanic Ash Intervention Tool) and this change is expected to be complete by the early part of 2019. The current software is employed on a standalone system, but the new software will be part of the wider meteorologist visualisation software used at London VAAC.

2.1.6.2 Production of VAG and VAA is now possible with the new visualisation software of Météo-France (SYNOPSIS). This software developed at Meteo-France is more user-friendly – VAAC Toulouse.

2.1.6.3 The AAWU and VAAC Anchorage software known as Interactive Collaboration in Four Dimensions (IC4D) will be ported into the main NWS operational workstation knows as Advanced Weather Interactive Processing System (AWIPS). The tools used to create SIGMETs and VAAs may need to remain in IC4D until such time the NWS developed Hazard Services tool is completed and integrated into AWIPS. A decision will need to be made how we will bridge current operations into a time such that the Hazard Services tool is ready to be moved into operations. Several options are being discussed, although it is unclear at this time what the precise path will be.

2.1.7 **Future Developments**

2.1.7.1 A three-part collaboration is ongoing between VAAC Toulouse, CTBTO/IMS (Comprehensive Test Ban Treaty Organisation/International Monitoring System) and the French AEC (Atomic Energy Commissariat). Observations of infrasound waves detected by the CTBTO global observation network are collected and stored in the CTBTO International Data Centre (IDC). In the frame of the European projects ARISE (2012-2015) and ARISE2 (2015-2018), an objective of this collaboration is to establish correlations between these infra-sound data and the explosive activity of some volcanoes chosen in Europe and Africa. Two applications have been investigated for the VAAC purposes:

- in the far field (>500 km), for early detection of eruptive activity and possible ash emission by explosive volcanoes poorly instrumented;
- in the close field (<500 km), to enrich the description of the kinetic of the eruption and of the volcanic ash release.
2.1.7.2 Work at VAAC Montreal is ongoing to incorporate satellite imagery in real time into the in-house software used to perform operational responses. As well, work has begun on production of VAAs in XML format (according to the IWXXM format prescribed by the WMO).

2.1.7.3 A project for objective verification of VAA/VAG polygons for major eruptions based on remote sensing is under development by VAAC Buenos Aires research group as part of a research project in collaboration with some airlines.

2.1.7.4 In March 2018 a co-ordination meeting took place between representatives of the Met Office and Meteo-France, in order to work towards enhancing the close working relationship that exists between the two organisations. An outcome of this meeting was a commitment for the Met Office and Meteo-France to work towards providing a consistent supplementary VA product (VA concentration charts).

2.1.7.5 VAAC Tokyo has updated its system to generate VAAs in IWXXM version format; IWXXM advisories will be available on its webpage on a trial basis in the first half of 2019.

2.1.7.6 Building operational resilience through training of additional staff from the Bureaus National Operations Centre (BNOC) across the VAAC functions. We now have 14 competent VAAC forecasters. Additionally, Incident Manager training has been rolled out to Shift Supervisors and BNOC Management to strengthen surge capacity during high impact events.

2.1.8 Competency, Training and Education

2.1.8.1 VAAC Washington has gone a tremendous effort to retool operational and training procedures. The Standard of Procedures (SOP) was rewritten to make sure all operational aspects are included. A Volcanic Ash Pocket guide was created for the more pertinent operational procedures and information. A new training guide that sets out a clear objective for certification was created. The analysts will go through 6-8 weeks of training, must complete eight to ten COMET Modules and must complete a two day certification. After certification, analysts must be re-certified every two years. VAAC Washington certified five analysts from July, 1 2017 through September 30, 2018. A total of 10 analysts are currently certified and can perform volcanic ash duties along with other duties.

2.1.8.2 The VAAC London team that delivers the operational VAAC response for an eruption within London VAAC’s AoR is comprised of approximately 18 meteorologists (the team also perform a Space Weather function within the wider Hazard Centre of the Met Office Ops Centre). This team undertakes a three-yearly competency assessment to ensure their continued proficiency. In addition, the team attend a yearly VA Observation course to ensure that they are well-informed about the current state of observational techniques for detecting VA. Further, the software components that are part of the operational VA response are tested by the team on a twice-daily basis (each shift) to ensure continued familiarity, and to ensure that any IT issues that may arise with the software are identified and solved in a timely fashion.
2.1.8.3 VAAC Montreal staff training is ongoing. One new employee joined operations in the last year.

2.1.8.4 VAAC Buenos Aires competency assessment is planned to be on April 2019. The design of the competency guide was based on the documentation that VAAC London shared. Also, VAAC Buenos Aires plan to implement a refresh course on Volcanic Ash topics ranging from basic volcanology, remote sensing detection, numerical modeling to VAAC tasks.

2.1.8.5 The training protocol is reviewed yearly at VAAC Toulouse and published on the quality documents management website. Each forecaster has the obligation to realize two training sessions a year, at the minimum, in addition to the participation to the multiple exercises. A duplicated set of the operational tools are available for these trainings. The training protocol requires running the different models of volcanic ash trajectory and dispersion with a given scenario. Models outputs are then analysed to produce and publish on an internal website (mirror of the official VAAC webpage) VAGs, VAAs as well as concentrations charts, in compliance with the ICAO EUR/NAT Contingency Plan for Volcanic Ash.

2.1.8.6 All VAAC Wellington forecasters, as Aeronautical Meteorological Forecasters, meet the competency and qualification standards prescribed by WMO. VAAC Wellington forecasters run through thrice weekly tests (Monday, Wednesday and Friday) of the software platforms to ensure they keep familiar with the process and that our system is working. This becomes important when there are no eruptions within the area and is a way to catch any software bugs that could affect prompt issuance of live forecasts.

2.1.8.7 VAAC Anchorage has had a relative lull in volcanic ash episodes as compared to prior years. Due to relative low number of events during this period, the need arose to provide additional training. Our Science and Operations Officer developed forecaster training on a non-operational workstation to ensure that all of our forecasters have proficiency during an actual event. VAAC Anchorage has five lead forecasters, six journeyman forecasters, a Science and Operations Officer, and Meteorologist in Charge (VAAC manager) who are certified and can perform volcanic ash duties in addition to other aviation forecasting duties from the period July 1, 2017 to September 30, 2018.

3. **ACTION BY THE METP-WG/MOG**

3.1 The METP-WG/MOG is invited to:

a) note the information contained in this paper; and,

b) accept the combined VAAC Management Report as presented.

— END —