International Civil Aviation Organization

INFORMATION PAPER

Twenty-fourth Meeting of the Meteorology Sub-group (MET SG/24) of the Asia and Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG)

Web-conference, 16 – 20 November 2020

Agenda Item 5: Research, development and other initiatives

VAAC DARWIN MANAGEMENT REPORT

(Presented by Australia)

SUMMARY

The paper presents an IAVW Management Report for the VAAC Darwin and Wellington area of responsibility covering the period 1 July 2019 to 30 September 2020. It provides an update on current VAAC Darwin activities, significant operational changes, training and development, collaboration and stakeholder engagement.

1. INTRODUCTION

1.1 The report is contained in Attachment A. The discussion below contains a summary of the key topics.

2. DISCUSSION

Key topics from the report in Attachment A

2.1 VAAC Darwin issued 2590 and 665 advisories in financial years 2019/20 and the first quarter of 2020/21 respectively (Note: a financial year runs from 1 July to 30 June the following year). The most advisories were issued for Dukono and Sangeang Api in Indonesia. There were fewer high impact eruptions in the financial year 2019/20 compared to 2018/19.

2.2 The activity per volcano has been summarised in Figure 1 and 2 in Appendix A.

2.3 The high impact eruptions have been summarised with two particularly interesting cases for Mt Ulawun in Papua New Guinea. The first eruption went stratospheric reaching 63,000ft and spreading in all directions. There was a high sulphur dioxide (SO_2) content which was around for days after the eruption had ceased and the advisory was finalised. The second Ulawun eruption was from a newly formed vent or fissure near the base of the volcano which raised concerns about pressure within the volcano.

2.4 VAAC Darwin has transitioned to its new position in the Hazardous Weather Unit (HWU) under the new Melbourne Aviation Forecasting Centre (MAFC) in June 2020. The MAFC and VAAC Darwin now have 18 VAAC competent staff who rotate around the 3 HWU desks which gives the service added resilience. The forecasters have been able to support each other as everyone knows the right procedures for volcanic ash.

2.5 The VAAC is creating new ways to train and assess forecasters' skills while they are gaining their competency. The World Meteorological Organization (WMO) will be looking at a review of the current VAAC competency framework with support from VAAC Darwin and VAAC Montreal.

2.6 The VAAC and MAFC have been adapting to the ever-changing situation with COVID-19 affecting Australia. From March until now, the team has been looking for ways to continue the services and transition to work from home with no interruption to services. The current situation has the team split up into three different areas (Melbourne Office levels 5 and 11, and home-based work) but the communication and collaboration between the forecasters has been impressive and the response to high level eruptions has been as timely as ever.

2.7 VAAC Darwin and VAAC Montreal are still progressing with their back-up support for VAAC Washington. All VAACs will be aligning their back-up procedures due to previous issues with consistency and will now be notifying users with a message "*Issued by VAAC nnnnn on behalf of VAAC nnnnn"*.

2.8 VAAC Darwin is working on the ICAO Meteorological Information Exchange Model (IWXXM) schema version 3.0 for the Volcanic Ash Advisory (VAA), to be ready for dissemination by November 2020.

2.9 The Bureau has a new Dispersion Ensemble Prediction System (DEPS) which provides probabilistic forecasts for volcanic ash to help with more accurate advisories. This new tool helps move away from a deterministic approach, to better capture the uncertainties involved. DEPS will help with improved volcanic ash forecasts. It is also a step towards quantitative volcanic ash information such as ash concentration products or data as part of the international work from the ICAO Meteorology Panel (METP) Meteorological Information and Services Development (WG-MISD).

2.10 VAAC collaboration has strengthened between VAACs Darwin and Wellington as they look to harmonise services. The two VAACs have been working on operational processes and procedures, comparison of ash dispersion models, comparison of advisory and forecast creation, daily check-ins, and back-up services and exercises. VAAC Darwin will look to expand collaboration efforts with VAAC Tokyo in a similar way in the near future.

2.11 VAACs Darwin and Wellington conducted a standalone volcanic ash exercise to support Solomon Islands with their Air Navigation deficiency (AP-MET-23). The Solomon Islands Honiara Flight Information Region (FIR) is split between both VAACs so a volcano from each VAACs area of responsibility was used for the exercise. Outcomes will be provided in a separate report at this meeting

2.12 The WMO VAAC Best Practice and Volcanic Ash Scientific Advisory Group (VASAG) are working on consistency between the VAACs, the preparation of the next International Volcanic Ash Workshop, quantitative based volcanic ash information services, VAAC competency frameworks and SO_2 hazardous levels to pass on to the development groups.

2.13 The METP WG-MOG-IAVW has been focusing on: key performance indicators to enhance consistency and accuracy of forecasts; elevation of the Volcano Observatory Notice for Aviation (VONA) status and discussions around aviation colour codes; and progression of the Roadmap and ConOps documentation.

2.14 The WG-MISD work stream for sulphur dioxide and volcanic ash (VASD) is focusing on the first look at a potential operating capability for SO_2 services and having an initial operating capability (IOC) for the delivery of probabilistic quantitative volcanic ash information services.

2.15 The Asia/Pacific Volcanic Ash Exercises (VOLCEX) Steering Group has two exercises planned for each year. The exercise VOLCEX 19/02 was successfully conducted between Japan and Philippines which involved VAAC Darwin for ash cloud handover. VOLCEX 20/02 is in FY2020/21 but is included in this report. VOLCEX 20/02 was successfully conducted on 17 July 2020 in the Pacific region. The exercise has multiple aims and was conducted by VAAC Wellington, VAAC Darwin and VAAC Washington. During the exercise there was a back-up procedure test between VAAC Wellington and VAAC Darwin as well as coordinating with VAAC Washington as ash approached their boundary.

2.16 VAAC Darwin has contributed to other stakeholder engagement within the region as the international requirements will increase for training and coordination between VAACs and State Volcano Observatories.

3. ACTION BY THE MEETING

3.1 Note the information contained in this paper and refer to Attachment 1 for the full VAAC Darwin Management Report.

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Attachment A

1. INTRODUCTION

1.1. The Volcanic Ash Advisory Centre (VAAC) Darwin is responsible for monitoring the area from the Andaman Islands (India) eastwards to the Solomon Islands including the volcanically active Indonesian archipelago, Papua New Guinea and the southern Philippines. More than 150 active volcanoes lie within the area, some of which have given rise to the largest eruptions in human history. Areas within the region have poor communications and general infrastructure, incomplete volcanic monitoring and are characterised by moist tropical convection that makes remote sensing difficult for much of the year.

2. VAAC STATISTICS

VAAC	**Period of reporting**	**Total number of Advisories**	**High Impact Events***	
Darwin	1 July 2019 - 30 June 2020 1 July 2020 -30 September 2020	2590 665	Krakatau	10 April 2020
			Ibu	16 May 2020
			Merapi	14 October 2019 9 November 2019 2 March 2020 27 March 2020 10 April 2020 21 June 2020
			Semeru	16 May 2020
			Sinabung	10 August 2020 14 August 2020
			Ulawun	3 August 2019 30 September 2019

* Discernible or visible ash that is impacting or expected to impact aircraft cruising levels, international aerodromes, is of high media interest, or is deemed to be significant to aviation operations by a VAAC

2.1. A total of 2590 Volcanic Ash Advisories (VAA) and accompanying Volcanic Ash Graphics (VAG) have been issued for the Darwin area of responsibility this financial year (FY 19/20) thus far (Note: a financial year runs from 1 July to 30 June the following year). The beginning of the new financial year 20/21 from 1 July to 30 September has had 665 Volcanic Ash Advisories

2.2. Figure 1 shows the number of advisories issued by VAAC Darwin (reported by volcano) during FY 19/20 and start of FY 20/21. FY 19/20 has been a quiet period for high impact eruptions but has continued with low impact volcanic activity, compared to the busy high impact period of FY 18/19. In the VAAC Darwin area of responsibility (AOR), Dukono volcano, in northern Halmahera erupted almost continuously through this period with 1479 and 368 advisories issued for FY 19/20 and FY 20/21 respectively. Other volcanoes with sustained volcanic activity include Sangeang Api, in the Lesser Sunda Islands in Indonesia (479) in FY 19/20. Collectively, these two volcanoes were responsible for 68% of all advisories issued by VAAC Darwin for this period. The volcanoes which have had high impact eruptions include Merapi on Java in Indonesia and Ulawun on New Britain in Papua New Guinea. In order to provide context, Figure 2 features the total number of advisories issued by VAAC Darwin (by FY) since 1993.

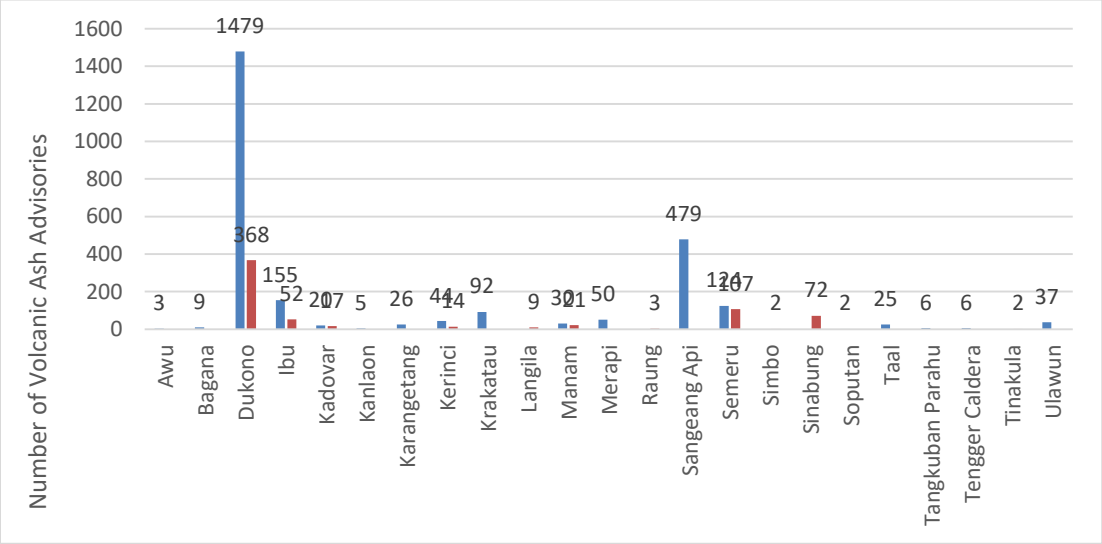

Figure 1 - Advisories by volcano for the VAAC Darwin area of responsibility for FY 19/20 (blue) and FY 20/21* (orange)

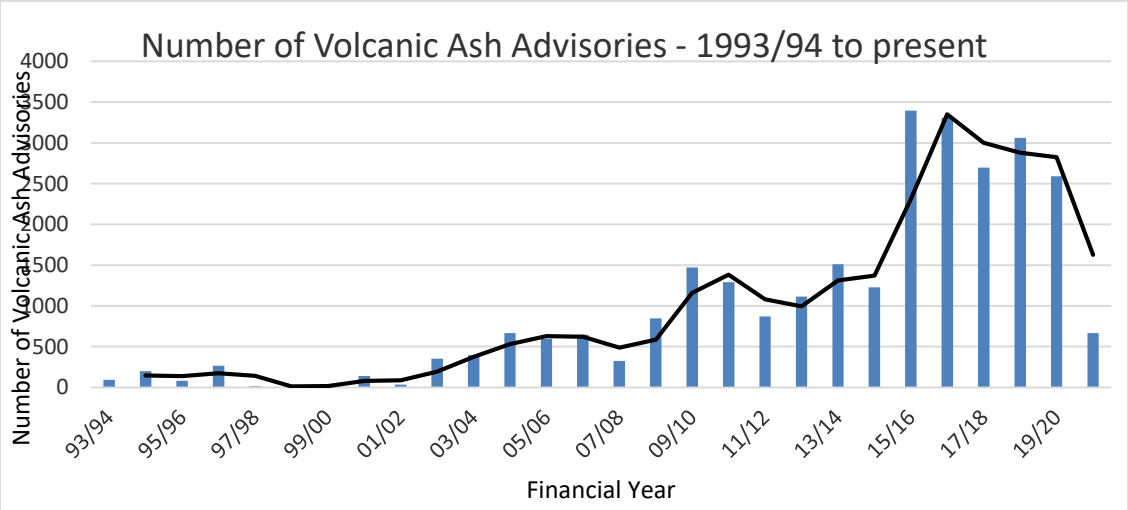

Figure 2 - VAAC Darwin: Number of advisories for Financial Years 1993/94 - 2020/21* (period 1 July 2020– 30 September 2020)

3. HIGH IMPACT ERUPTIONS

3.1. Ulawun, New Britain, Papua New Guinea – 3 August 2019 and 30 September

3.1.1. There was an increase in seismic activity recorded on the seismograms at Ulawun in the day leading up to the major eruption. The VAAC issued a one-off advisory to notify users of the increase of seismic activity and supporting guidance from Rabaul Volcano Observatory (RVO) for potential eruption. This advisory helps users adjust their flight planning around volcanoes which have increased activity and potential of major eruptions. The eruption occurred around 12 hours after the one-off advisory.

3.1.2. The eruptive intensity steadily increased as new eruptions occurred. Each new eruption was significantly higher causing the issuance of a new urgent initial. The eruption final height reached 63,000ft. The appearance on satellite was similar to the eruption on 26 June 2019, it was a massive mushroom cloud reaching into the stratosphere and causing it to spread quickly. The volcanic ash seems to stay near the vicinity of the volcano with a huge component of sulphur dioxide (SO_2). The advisory was finalised two (2) days after the initial eruptions; however, there was still SO_2 in the area with no evidence of volcanic ash.

3.1.3. The activity from Ulawun has been highlighting the better connectivity between VAAC Darwin and RVO.

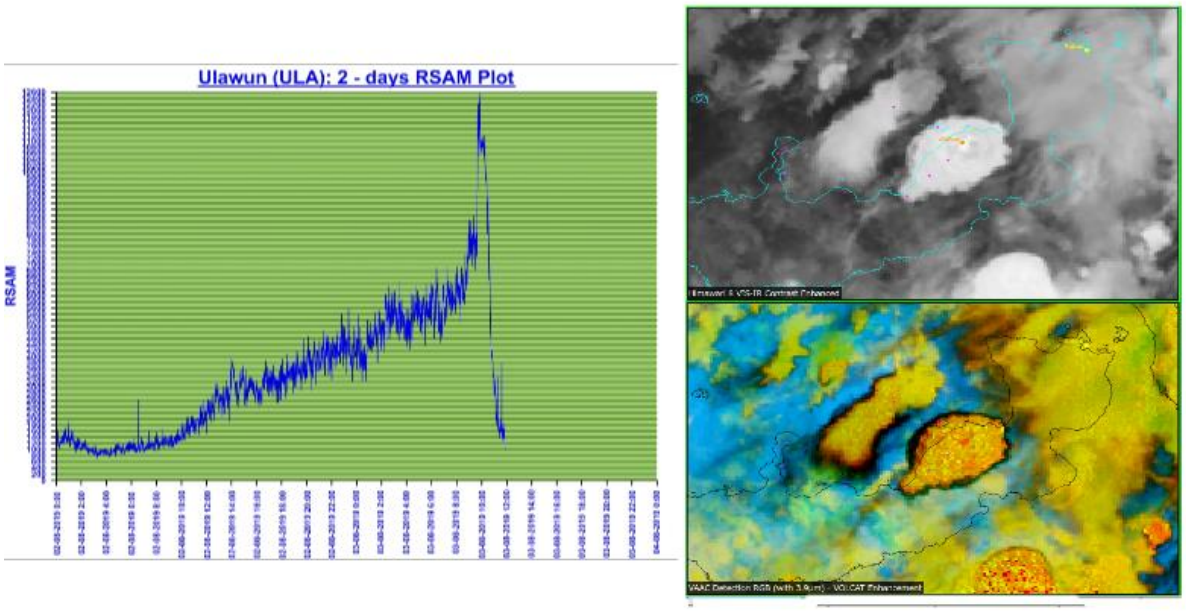

Figure 3. Mt Ulawun eruption on 3 August 2019 on the Island of New Britain in Papua New Guinea. The left image shows the massive increase in seismic activity during the event and the right image shows the beginning period for the eruption.

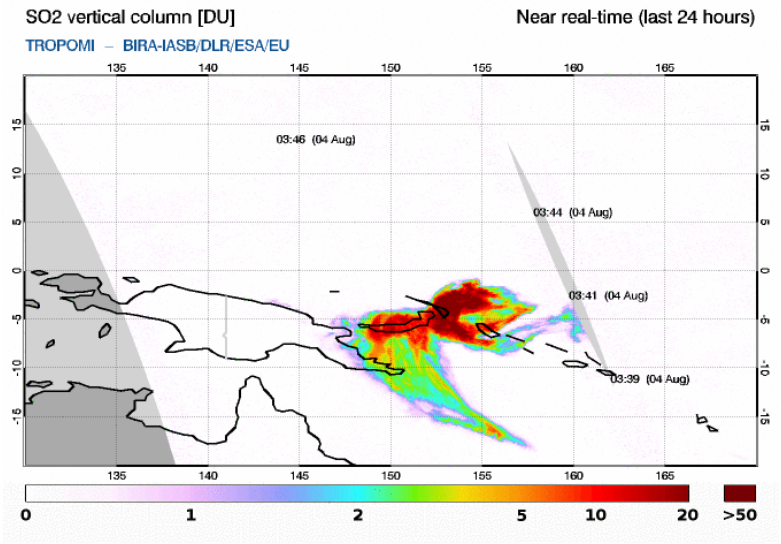

Figure 4. The SO_2 from the Ulawun eruption on 3 August 2019. Shows the spread and strength of the SO_2 signal.

3.1.4. On 30 September, Ulawun again experienced a massive increase in seismicity so the VAAC issued a one-off advisory. During the evening there was evidence of an eruption on satellite imagery prompting an urgent initial advisory to 15,000ft. Guidance from RVO was that an eruption was in progress. The eruption was not what the VAAC or RVO was expecting as the activity wasn't from the summit of the volcano but was from a new vent or fissure near the base of the volcano. The emission was increased to 20,000ft and continued for 4 days until it finally stopped; however, RVO are continuing to monitor the new vent.

Figure 5. Imagery of the eruption from the new vent at Ulawun. Image on left courtesy of RVO and image on right is courtesy of Air Niugini.

3.2. Manam, Papua New Guinea – 29 September 2019

3.2.1. On the 29 September there was increasing seismic activity at Manam which caused the issuance of a single one-off advisory. The seismic activity was volcanic related but there was no further activity from Manam due to this period.

3.3. Merapi, Java, Indonesia – Many discrete minor eruptions

3.3.1. On 14 October, there was a discrete eruption from Merapi on Java in Indonesia. The eruption was reported by ground observers and observed on satellite imagery to 19,000ft. The eruption was short-lived but in a highly populated area. On 9 November 2019 there was a second discrete eruption to 15,000ft. Merapi is located in the middle of Java next to many busy flight paths so minor eruptions can cause issues to air traffic but the volcano is known to have had large eruptions in the past.

3.3.2. There have been many discrete eruptions from Merapi in 2020. Most of these have been around 20000 to 30000ft and short-lived activity but have caused disruptions to flight paths. Merapi is one of the most highly monitored volcanoes in Indonesia by Centre of Volcanology and GeoHazard Mitigation (CVGHM). The VAAC has a great relationship with CVGHM and receives timely information to make sure that aviation is kept safe.

Figure 6. Merapi webcam imagery from CVGHM, Indonesia for the eruption on 14 October (left) and 9 November (right).

4. SIGNIFICANT OPERATIONAL CHANGES

4.1. VAAC Darwin transition to Hazardous Weather Unit

4.1.1. On 18th June 2020, VAAC Darwin moved from under the Bureau's National Operations Centre (BNOC) to its new home in the Hazardous Weather Unit (HWU) in the Melbourne Aviation Forecasting Centre (MAFC). All forecasters moving to HWU were required to have their VAAC competency (see section 4.2). Many months of work was conducted to guarantee that the software, technology and Melbourne servers were ready to accommodate the VAAC service to create a seamless transition and avoid service disruption.

4.1.2. The way the VAAC operates from a process point of view remains largely the same; the main change was the service transitioning to be under a new team with many of the staff moving across as well. However there are a number of other benefits to the VAAC service that have come with this transition. The greater number of VAAC-competent meteorologists in the HWU compared to previously increases the VAAC's flexibility and resilience, particularly in high end events. Under the new HWU, all forecasters working in the section are VAAC-competent. Over time, quality of service is likely also to benefit from the increased ability of the VAAC forecaster on duty to consult and seek second opinion from experienced VAAC-competent colleagues also on-shift at the time. This extra support also increases capacity in the VAAC to be responsive to high-impact events by redirecting more resources to VAAC services more quickly.

4.1.3. Additionally, in the transition to the HWU, significant work was completed on systems resilience and redundancy.

4.2. COVID-19 response

4.2.1. From March 2020, the Bureau of Meteorology has been adapting to the COVID-19 outbreak. There was a great effort across the whole of the Bureau to make sure the service could continue uninterrupted. Forecasters were provided equipment to test working from home capabilities and internet connections.

4.2.2. Currently the forecasting team is split into three different areas: Operations Centre 1 in Melbourne Office level 11, Operations Centre 2 in Melbourne Office level 5, and work from home set-ups. With the use of MS Teams and other technologies, the three desks under HWU can keep in constant contact with each other to discuss activity and screen share as if they were both at the same desk. During high level events, the forecasters are working closely while (on occasion) in different locations to provide the same level of service as before COVID-19 – but with increased risk management around the threat of the pandemic itself.

4.2.3. There are many procedures around handover and coordination to make sure that the staff are kept safe during the current situation. This provides added comfort for the two teams still working from the office as well as knowing there is a lower risk to the service if any staff are exposed to COVID-19.

4.3. VAAC Darwin Competency Program

4.3.1. VAAC Darwin has implemented a competency and training program for VAAC forecasters in line with quality management obligations and recent advancements in volcanic ash detection, monitoring and forecasting (i.e. next generation geostationary satellites, automated alerts (VOLCAT)), as well as implementation of improved strategies for

delivering aviation briefings which can be scaled up or down based on the impact an event and to meet the evolving needs of industry.

4.3.2. VAAC Darwin currently have 18 VAAC competent staff members. This has significantly increased the number of competent technical staff available and able to respond to high impact volcanic ash events. This increase has come about through the implementation of the Review of Aviation Weather Services (RAWS) over the course of the 2019/2020 Financial Year.

4.3.3. VAAC Darwin is developing in-house simulations and case studies to provide forecasters with a well-rounded training program so they can gain first-hand experience with many high impact eruptions.

4.3.4. The World Meteorological Organization (WMO) Expert Team on Education, Training and Competency (ET-ETC) will be updating the top- and/or second-level competencies for aeronautical meteorological personnel to accommodate the role of VAAC forecasters and VAACs Darwin and Montreal will be assisting with the process. We are hoping that with VAAC Darwin involvement we can have a consist competency framework between all the VAACs. The WMO ET-ETC have touched based with both VAACs with conversations to start later in the year.

4.4. VAAC Washington back-up

4.4.1. VAAC Darwin and VAAC Montreal are in consultation with VAAC Washington to continue working towards back-up support. VAAC Darwin are creating products for issuing VAAC Washington advisories, compiling important operational information such as contacts and AFTN addresses, working towards live dissemination tests once products and software are ready and preparing a Memorandum of Understanding for VAAC services between the two organisations.

4.4.2. Now that the back-up agreement is between VAAC Washington, VAAC Darwin and VAAC Montreal, the area has been split into two as VAAC Anchorage are unable to provide back-up support.

4.4.3. Darwin will back-up the area consisting of Central America, South America to 10°S, the Northwest Pacific which includes the Marianas Islands and sections west of Central and South America in the Eastern and Central Pacific (Figure 7, green area). VAAC Montreal will back-up the area consisting of the Continental US, Mexico, Caribbean, Eastern Atlantic and the Eastern and Central Pacific that includes Hawaii and west to 170°W. (Figure 7, yellow area).

4.4.4. Work is progressing towards these new back-up capabilities for VAAC Washington.

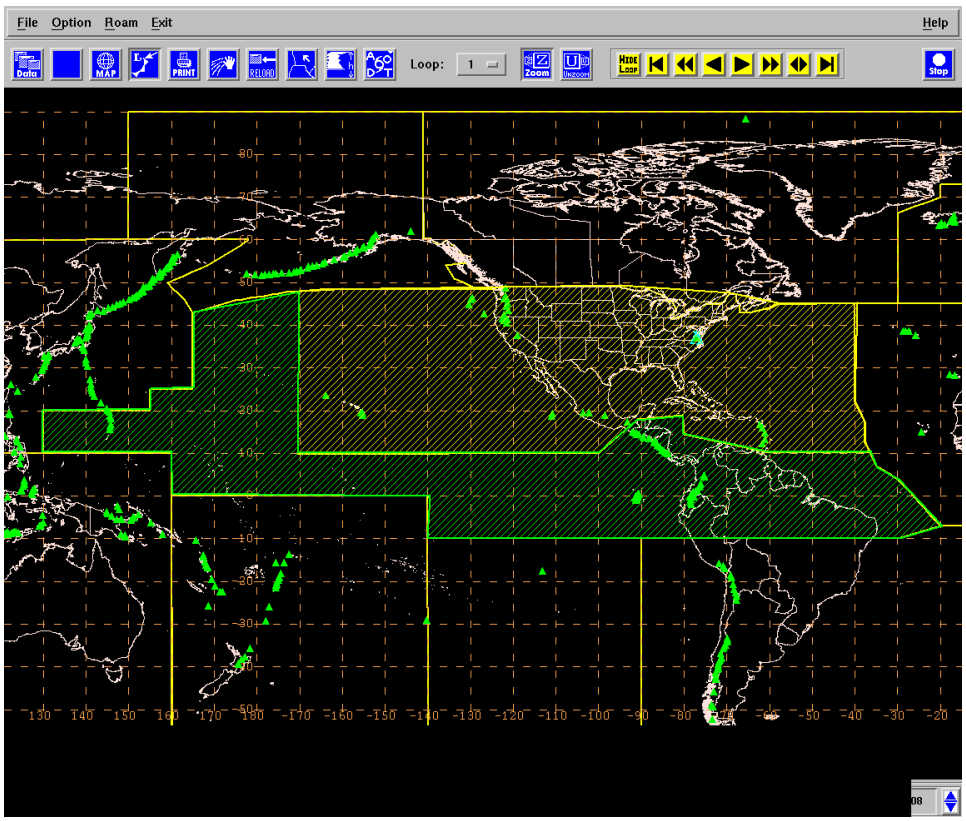

Figure 7. The VAAC Washington area split between VAAC Montreal and VAAC Darwin for back-up support.

4.5. VAAC Back-up testing

4.5.1. After recent changes at the ICAO METP WG-MOG, there will be a minor update to the VAAC back-up headers. The meeting decided:

> *That VAACS, when acting in a back-up capacity to another VAAC:*
>
> *Shall use the same product and location ID in the bulletin header as used by the VAAC they are backing up (with header number ii as appropriate), and*
>
> *Shall add a comment in the remarks section of the VAA when providing back-up to notify users in the form of "Issued by VAAC nnnnn on behalf of VAAC nnnnn"*

4.5.2. These changes will make sure the back-up procedures are consistent between all VAACs and that end users know which VAAC has issued the product.

4.5.3. The VAACs are required to conduct back-up tests at least once a year. The operational procedures will slightly change the back-up procedures with VAAC Wellington. We are hoping that these changes will rectify the issues experience during the back-up test last year. At this stage the date is to be announced as we discuss possible back-up test dates once changes have been implemented.

4.5.4. VAAC Darwin and VAAC Tokyo have postponed the back-up test until the second half of 2020 due to COVID responses. The back-up test will be conducted as per the Scheme of Cooperation between the two neighbouring VAAC regions.

4.6. IWXXM

4.6.1. VAAC Darwin is working towards issuing Volcanic Ash Advisories (VAA) in IWXXM format using schema version 3.0. It is planned to be implemented in the next major software upgrade. We will be able to conduct further testing on this in mid-late 2020 which should keep us on schedule for producing IWXXM VAA by November 2020 schedule.

4.7. Dispersion Ensemble Prediction System (DEPS)

4.7.1. In April 2020, the Australian Bureau of Meteorology transitioned its new dispersion model software which will give VAAC Darwin access to probabilistic forecasts for volcanic ash to help with more accurate forecasts in its advisories. The previous dispersion model capability was deterministic which provided a single output forecast for a volcanic eruption. The model could be run multiple times but still made many uncertainties involved.

4.7.2. The new system DEPS provides a probabilistic output which takes 18 current Numerical Weather Prediction (NWP) models and the previous 18 NWP models to create a lagged ensemble of 36 members. The output shows a probabilistic view of how many of the ensemble members suggest there is in any volcanic ash in a section of air space. Having an ensemble approach accounts for more of the uncertainties associated with the dispersion model process so it highlights that uncertainty in the output. This allows the VAAC forecaster to process the data and incorporate it into their advisories. It also puts VAAC Darwin in a good position to provide input into the international work by METP WG-MISD that is happening around quantitative volcanic ash by and the future of volcanic ash services.

5. VAAC COLLARBORATION

5.1. Volcanic ash evidence checklist

5.1.1. VAAC Darwin has been working on a volcanic ash evidence checklist to support VAAC operations for when to issue an advisory. Each VAAC issues a volcanic ash advisory when they have sufficient evidence that an eruption is imminent or underway. The evidence checklist is a way to visualise the information which will provide faster decisions and more timely advisories.

5.2. VAAC Wellington

5.2.1. VAAC Darwin and Wellington collaboration has been a major focus for the two VAACs to look at consistency and harmonisation of services. The VAACs have been considering coordination, quality, consistency, flexibility, and resilience. There are forecasters organising a number of activities which include looking into current capabilities and comparing ash dispersion models, looking into ways to incorporate daily collaboration activities, comparison of advisory and forecast creation, and including new information into

the evidence checklist to allow it to be used in multiple latitude, consistency in procedures for receiving different information.

5.2.2. We are having forecasters take on these responsibilities to further build up relationships between the two VAACs and to provide professional development for staff. We continue to work closing to organise, participate and review volcanic ash exercises to test out procedures and coordination.

5.2.3. VAAC Darwin and VAAC Wellington conducted a volcanic ash exercise to support Solomon Islands with Air Navigation deficiency (AP-MET-23). The Solomon Islands FIR 'Honiara' is split between both VAACs so a volcano from each VAAC area of responsibility was used for the exercise. Outcomes will be provided in a separate report at this meeting.

5.3. VAAC Tokyo Collaboration

5.3.1. VAAC Darwin and VAAC Tokyo are collaborating on a number of tasks to improve operational services and consistency between both centres. VAAC Tokyo have developed the JMA SIGMET Collaboration tool which will be expanded to include VAAC collaboration. It will be trialled during upcoming SIGMET coordination but was used during the VOLCEX 19/02 for coordination and volcanic ash cloud handover between VAACs Darwin and Tokyo.

5.3.2. Both VAACs are looking to incorporate the collaboration tool into back-up procedures as an easier way to communicate. We will begin trialling the collaboration tool for use with sharing forecast and dispersion runs for fictitious volcanic activity and real activity.

6. INTERNATIONAL STAKEHOLDER ENGAGEMENT

6.1. VAAC BP/VASAG

6.1.1. The combined VAAC Best Practice and VASAG where held in Washington DC in November 2019 and attended by VAAC Darwin representatives Jarrad Denman and Tristan King. The group is looking at the information exchange for operational volcanic ash practices, which includes monitoring and forecasting, technology, back-up services, new developments and ICAO compliance. There are a number of key actions that came out of the meeting which involve all VAACs or specifically VAAC Darwin:

- WMO are reviewing top- and/or second level competencies for VAAC forecasters and VAAC Darwin will be heavily involved in the updates for consistent VAAC competencies.
- All VAACs are contributing to the International Volcanic Ash Workshop being organised by the VASAG and committee.
- The VASAG is preparing for the eighth International Workshop on Volcanic Ash (IWVA) that was scheduled to be held in October in Reykjavik, Iceland 2020. The last workshop was held in 2015. The workshop is a chance for operational and scientific groups to talk about volcanic ash and the future. Next steps – to prepare agenda and finalise the concept note for the workshop. Due to COVID and restriction

on international travel by many countries, the group has decided to postpone the workshop to a tentative date of October 2021.

- Further VOLCAT development and dashboard for all automated alerts.
- All VAACs use evidence from different sources, but when do forecasters have enough information to issue a volcanic ash advisory? The group is looking at graphical representation of this information as a flow chart or pyramid of information to help forecasters make decisions. This will improve consistency between operations for each VAA
- The VASAG finalised the SO_2 recommendations based on guidance from World Health Organization on the level of exposure to SO_2 for different scenarios to pass back to the WG-MISD-VASD.
- The group is looking at quantitatively based volcanic ash information services.
- WMO is looking at emerging the VAAC BP and VASAG into one group called the Expert Team on Volcanic Sciences and Applications (ET-VSA)

6.2. ICAO Meteorological Panel Working Groups

6.2.1. The WG-MOG and WG-MISD meetings were held in Washington DC in November 2019 and attended by VAAC Darwin representatives Jarrad Denman and Tristan King.

6.2.2. The WG-MOG is responsible for operational oversight in the global system for volcanic ash, namely the International Airways Volcano Watch (IAVW). The IAVW work stream is working on the Concept of Operations to identify user needs, determining shortfalls, refining concept of operations, and defining functional and performance requirements for new information related to volcanic ash. The key action items for the WG-MOG include:

- Timeliness and accuracy key performance indicators to look at VAAC consistency, compliance and forecasts.
- Status of Volcano Observatory Notice for Aviation (VONA) and aviation colour codes.
- Progression towards quantitative volcanic ash information services as product or data.
- Looking towards the future with the roadmap for the Concept of Operations and IAVW.

6.2.3. The Volcanic Ash and Sulphur Dioxide (VASD) work stream of the WG-MISD is looking at the requirements of SO_2 reporting and the future of volcanic ash products including concentration charts and graphics. The MISD is the looking at SO_2 for the provision of a new service based on user requirements and input from world health organisation with an ad-hoc group tasked with developing a provisional first look at a potential capability. The potential capability will be presented at the next MOG meeting in 2020.

6.2.4. The VASD is gathering requirements and developing the initial operating capability for a probabilistic quantitative volcanic ash service as well as updates for Annex 3 to incorporate the new service. The group is aiming to have an operating capability developed and in service by 2023 to 2024 and amendments to be within Annex 3 to allow VAACs to

issue quantitative volcanic ash products and/or data. All nine VAACs are heavily involved in developing these capabilities.

6.3. Volcanic ash workshop in Indonesia

6.3.1. On 19 August 2019, BMKG hosted a volcanic ash seminar involving all users of volcanic ash products including State Volcano Observatories, VAAC, MWO, ATC, airlines and pilots. The discussion was around *"Understanding meteorological information in the event of volcanic ash in order to maintain safety, regularity and efficiency of aviation"* and the outcomes were:

- Brought all the key participants together to discuss products and how each section should interact – VAAC, SVO, MWO, ACC, NOF and airlines.
- Participants were able to ask viable questions to improve operations.
- Provide better understanding of the IAVW for all participants.
- Continuing collaboration between all sections to occur and grow.

6.3.2. The stake holder engagement allowed for discussions of current issues and sharing of new developments between the two countries.

6.3.3. With new changes to services and developments in the international space, all VAACs will need to keep up their stakeholder engagement and training for SVOs.

6.4. VOLCEX Steering Group

6.4.1. The VOLCEX steering group conducts volcanic ash exercises in the Asia Pacific region to maintain safety, regularity and efficiency of aviation during the event of a volcanic eruption.

6.4.2. VOLCEX 19/02 was conducted by Philippines and Japan for an eruption at Mt Kanlaon. This exercise had multiple objectives between many organisations including demonstrating appropriate responses by airports, appropriate coordination between VAACs and between MWOs. VAAC Darwin and VAAC Tokyo successfully conducted a handover of a volcanic ash cloud during the volcanic ash exercise using the JMA Collaboration tool. Reports from users is that it was easy to see when responsibility of the ash cloud was handed over between VAACs. The MWOs conducted VA SIGMET coordination between FIRs for observations and forecast SIGMETs. We are still awaiting the final report from the exercise, but it is expected to be presented at the VOLCEX-SG/7 meeting this year.

6.4.3. VOLCEX 20/02 was conducted in South-west Pacific/Tonga by New Zealand. The exercise is planned to affect multiple FIRs that don't experience a lot of volcanic ash. The exercises included participation from VAACs Darwin, Washington and Wellington. The primary VAAC issuing products was VAAC Wellington. As a first in APAC VOLCEX, there was a VAAC back-up test conducted during the exercise. VAAC Darwin provided back-up to VAAC Wellington to provide users with an added layer to the exercise. The outcomes will be provided in the VOLCEX 20/02 report at the next VOLCEX-SG/7.

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