WORLD METEOROLOGICAL ORGANIZATION

WMO VAAC “BEST PRACTICE” WORKSHOP 2015

WESTMINSTER, London, UK

5-8 May 2015

FINAL REPORT
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## ANNEXES

I. AGENDA

II. LIST OF PARTICIPANTS
1. VOLCANIC ASH WORKSHOP OUTCOMES (VWO)

(=Red text denotes a future project orientated activity.=)

VWO01 Volcanic ash AIREPS, in-situ, remote sensing and volcano monitoring information availability and dissemination processes need to be enhanced and better coordinated with associated guidance including operational application best practice updated/developed. ([IAVWOPSG ref 7/23, 8/3, 8/21, 8/22] – MET-P WG-MOG paper (Date TBC). Lead: WMO.

VWO02 Reaffirmation that VAA/VAG updates to be driven by availability of information/evidence not reflected in the current advisory (including no VA expected assessments) and not just by routine 6-hourly update cycle, Annex 3, Para 3.5.1 d) refers.

VWO03 All VAACs to work collaboratively towards the development (to include seeking and sharing of user feedback) of common/consistent VAG presentation and production content (including T+24 trial) based primarily on ‘agreed discernible ash techniques’ (including consideration of VA tops and bases) and use of approved annotation styles, terminology and formats and message issuance targets. ([IAVWOPSG ref 8/18, 8/19] – MET-P WG-MOG paper (Date TBC). Lead: VAAC London.

VWO04 Coordinated development of mechanisms (common website, chat room, exchange of process documentation BP and VAAC Ops subscription to volcanicclouds@yahoogroups.com ) for improved pull-through and sharing of volcanic ash science and information into operations. ([IAVWOPSG ref 7/22, 8/7] – MET-P WG-MOG paper (Date TBC). Lead: VAAC Montreal.

VWO05 All VAACs to review and update (email to Raul) Doc 9766 VAAC back-up table 4.3 and to then test back-up arrangements at least annually with OP MET databanks and MWOs feedback coordinated by VAACs rather than through the medium of a State letter. – MET-P WG-MOG paper (Date TBC). Lead: VAAC Darwin.

VWO06 VAAC ‘Ins and Outs’ Modelling tables (link to be added) to be reviewed, updated and shared every 2-years. – MET-P WG-MOG paper (Date TBC), Lead: VAAC London.

VWO07 All VAACs in coordination with the relevant NWP provider(s), to further investigate and report on NWP errors/performance (taking into account region specific issues e.g. tropics) relevant to volcanic ash modelling. – MET-P WG-MOG paper (Date TBC). Lead: VAAC Washington?

VWO08 All VAACs to review and share their processes, requirements and science for depicting re-suspended ash on VAA/VAG. – MET-P WG-MOG paper (Date TBC). Lead: VAAC Wellington

VWO09 Agreement that further research is required to better define potential SO2 service development requirements to inform resource requirements and pull-through of existing research-based SO2 monitoring and prediction capabilities into any new services to aviation. ([IAVWOPSG ref 7/34].

VWO10 VAACs to collaborate on development of a T+0 volcanic ash ‘confidence’ graphical product proposal, based on the Best Practice ‘Evidence Checklist’ to underpin a High or Low confidence assessment. ([IAVWOPSG ref 7/19, 7/20, 8/19] – MET-P WG-MISD paper (Date TBC). Lead: VAAC Darwin.

- 1 -
VAACs to collaborate on the development of a proposal for future ‘supplementary’ VA contamination level advisory products based on quantitative ash mass column loading thresholds. (IAVWOPSG ref 8/16) - IUGG/WMO VASAG paper (October) followed by paper to MET-P WG-MISD (2017). Lead: VAAC London.

Common understanding that jet engine damage impacts are a function of ash mass dosage as currently best summarised by the table below and that Doc 9691 chapter 4, list 4.2 should now be considered for updating. (IAVWOPSG ref 8/26) – MET-P WG-MOG paper (2016). Lead: ICAO.

All workshop participants to share any ideas of how to improve occurrence reporting with carsten.christmann@dlr.de e.g. a central ash encounter reporting system like the one presented by DLR at the workshop.

‘Themed’ VAAC BP Workshops to continue to be held every 12 months, hosted by a VAAC State (Proposals for Buenos Aires in May/June 2016 and Tokyo in 2017), in close coordination with the relevant 5-day MET-P volcanic ash related meetings. Lead: WMO.

WORKSHOP OPENING

WMO C AeM VP welcomes everyone on behalf of the WMO Secretary-General – thanks to the Met Office for hosting the workshop at their owning Government Department, BIS.
This workshop will discuss improved processes to achieve volcanic ash service delivery harmonization and follows on from the two previous 2-day Best Practice Workshops (kindly sponsored by IATA) in 2011 and 2012. The following VAAC ‘best practice’ statement was agreed at IVATF/4 in Montreal in June 2012:

**VAAC best practice is the expert evaluation of the best available sources of meteorological and volcanological information i.e.**

- Qualitative and quantitative satellite data;
- Model output;
- Ground and airborne based in-situ and remotely sensed observations;
- Pilot reports

...using (where possible) collaborative approaches to derive authoritative, high quality, evidence based and globally consistent analysis and forecasts.

The workshop will not make regulations and define requirements, that is ICAO’s role but the workshop’s agreed outcomes (see above) will demonstrate a collective commitment to continuous, harmonised improvements going forward.

**All presentations referred to in this report are available on the WMO AeMP website at** [https://www.wmo.int/aemp/?q=node/65](https://www.wmo.int/aemp/?q=node/65) **under Documents and Reports tab.**

**Workshop Objectives and scope (Agenda in Annex 1):**

- Harmonization and consistency of service delivery;
- Sharing of best practice;
- Forecast continuity based on best data;
- Confidence at T+0 and how to better define uncertainty in subsequent forecasts;
- Evidence we use to back up decisions we make – quality of evidence varies around the world;
- User needs – very important! – We have to better provide what the user needs, when they want it, how they want it. A big challenge and has to encompass how to better manage users’ expectations.

**Dimitar Ivanov**, WMO Chief of AeMP, unable to attend due to a clash with IATA meeting in Paris.

**Raul Romero, ICAO**, brief remarks on behalf of ICAO.

**Peter Lechner, Chair of the ICAO MET Panel (METP)**, brief remarks on behalf as Chair of the ICAO METP.
3. DELEGATES INTRODUCTIONS AND EXPECTATIONS

- Philippe Husson, VAAC Toulouse
- Jamie Kibler, VAAC Washington
- Donald Moore, VAAC Anchorage
- Dov Bensimon, VAAC Montreal
- Miriam Andrioli, VAAC Buenos Aires
- Yohko Igarashi, VAAC Tokyo
- Paula Acethorp, VAAC Wellington
- Emile Jansons, VAAC Darwin
- Anton Muscat, VAAC London
- Thomas Marmigere, VAAC Toulouse Forecaster
- Ian Lisk, Vice-president WMO CAeM
- Peter Lechner, ICAO METP Chair
- Raul Romero, ICAO
- Deborah Lee, Met Office
- Matthew Hort, Met Office (Wednesday to Friday only)
- Rory Clarkson, Rolls Royce (Tuesday and Wednesday only)
- Carsten Christmann, DLR (Tuesday only)
- Klaus Sievers, IFALPA (Tuesday and Wednesday only)
- Uta Reichardt, University of Iceland (Wednesday to Friday)
- Colin Hord, UK CAA (Tuesday and Friday)
- Thorgeir Palsson, IATA (Tuesday, Wednesday and Friday)

Apologies from BALPA, (last minute clash of meetings).
4. **ICAO METP/1 SUMMARY**

Presentations by Peter Lechner, Chair of METP and Colin Hord, WG-MOG Rapporteur.


A number of ICAO MET groups have been subsumed into an initial 4 new METP Working Groups (WFs). 12 ‘Job cards’ developed, defining the 29 recommendations, tasks and deliverables coming out from the ICAO-WMO METDIV meeting in July 2014.

1. MRI – MET Requirements and Integration
2. MISD – MET Information and Services Development
3. MIE – MET Information Exchange
4. MOG – MET Operations Group

Big changes – will be working in a more structured way, driven by the 12 activity ‘job cards’ – clear comms between aspects and clear requirements and objectives. Doing what did before but in a different way.

Legacy tasks from IAVWOPSG and new volcanic ash service development activities will be coordinated through WGs 2 and 4.
Colin – broader view and high level of interaction with people in the MET world.

Expectation is that the VAACs will be involved in both the WG-MOG and WG-MISD

CAeM VP – recognized at METP that VAAC BP good discussion forum.

Raul – METP established by the ICAO Air Navigation Commission in line with a “Panel Modernization” policy as a more joined-up way of doing things in ICAO. Expects METP will work very well, people involved have a lot of experience working previously in ICAO groups.

CAeM VP – 4 common themes with METP job cards:

- Requirements
- Developments (to ensure quality and pull-through)
- Regionalisation for all aspects of aviation meteorology service delivery is inevitable with associated focus on defining new governance procedures e.g. data policy and cost recovery
- Data – quality, interoperable data

MET Operations Group (MOG) – showed terms of reference, basically to provide what users need. E.g. “establish key performance indicators for the provision of services”, “determine financial and technical implications of all new developments to services”. Emphasized not just top-down approach but bottom-up approach too for proposing changes etc.

Task list – sets out where we are with different activities from IAVW etc – e.g. back up arrangements for VAACs – and references relevant IAVW Ops no. There will be a coordinator for each of the activity types – for IAVW this will be Emile Jansons.

First meeting of the METP WGs 2 and 4 likely in mid-late October 2015, venue still to be agreed but North America looks a strong favourite. Expectation is that METP will meet annually so ICAO Member States will have to think about how best to achieve appropriate expert representation on the WGs. Argentina, currently not represented on the METP will be invited to join as a VAAC Provider State.

5. VOLCANIC ASH USER AND SCIENCE PERSPECTIVES

IFALPA Pilots’ Volcanic Ash Perspectives Presentation by Klaus Sievers

Comments:

Anton – Request to clarify what the pilot wants? Klaus - wants real-time from briefing to engine shutdown but SIGWX updates are not yet routinely available in cockpit. How info gets to pilot is dependent on airline which raises the interesting issue about how long it can take for an updated VAA/VAG to get to the pilot.

Raul – IFALPA needs to raise new requirement proposals in an appropriate ICAO body (e.g. METP). Modelled volcanic ash concentration charts – IVATF (2010-12) concluded that the science that underpinned the production of modelled volcanic ash concentration charts was in the early stages of development and that the issuance of such charts to users should therefore be discontinued. Klaus - wants more pilot training material.
Jamie – How quickly do pilots know about a new eruption in mid-flight? Klaus - told quickly over radio.

Peter – SO2 still on back burner as there is no agreement on what tolerance levels are for public or aircraft i.e. so no requirements... yet.

Emile – data that comes back from pilots to VAACs through AIREPS is ineffective in many parts of the world and pilots are becoming increasingly reliant on AMDAR to disseminate ‘basic’ MET data in near real time. Peter and Raul – this remains a serious concern given that dissemination of AIREPS is classed as high priority and the VAACs need this information to validate and add value to their forecasts. VWO01 refers.

Ash Encounters Presentation by Carsten Christmann (DLR)

Comments:

Rory – there appears to be a gap in 5-level severity index between 4 and 5 – significant airworthiness impact e.g. loss of an engine.

Klaus – Suggestion to simplify to a 4-level system.

In terms of the severity index Carsten asked for feedback on the pros and cons of the 6-level index (amended by the missing criteria), 5-levels index (as ICAO) or a 4-level version (as per Klaus’ suggestion) and in terms of the occurrence reporting, would the DLR volcanic ash reporting system be supported by the participants? VWO13 refers.

Jamie – is reporting required or mandatory? Raul replied that it is mandatory. Peter – need to ensure information gets through – should make report and more detailed info at end of flight.

Emile - Reports getting a bit lost in the ‘chain’ – perhaps too many steps involved in the report handling and dissemination process?

Kelut Eruption Discussion led by Emile Jansons, VAAC Darwin

14th February 2014.

10 min geostationary satellite imagery was available during the early stages of the eruption.

Detection was also made using a new automated system. Pattern recognition was particularly valuable as the initial optically thick eruption cloud was not detectable using spectral techniques.

Follow-up (publicly available) report produced highlighting lessons learned and telecon with all stakeholders – standard procedure at Darwin if eruption goes above 20,000 FT or if affects international airports. Difficult for forecasters to take in all the scientific discussion so scientists called in to assist.

Looked at which model captured the meteorological situation best. Event timeline – records when alerts changed, when info received, when advisories sent and when airlines received it – sometimes an unexpected delay. Pro-active calls to airlines, CAA military etc when about to issue an advisory. If flights seen to be approaching a
volcanic eruption area (via flight tracker), AIREPS will be proactively requested. The fact that the Kelut ash encounter AIREP didn’t get to Darwin VAAC for 3 weeks highlights the need to investigate alternative means of disseminating VA observations.

Flight encounter with ash – likely the result of a combination of issues including SIGMET issuance and the fact that it was night-time demonstrates there are still some issues.

Some airlines requested concentration charts – raised expectation because of what is currently available in Europe (despite IVATF recommendations to the contrary)!

Review outcomes include VAAC forecast hourly updates where strength of evidence is considered to be LOW. Anton - London VAAC 6-hourly updates – thought of producing new forecast every one hour would be problematic and maybe impossible with everything else to do. Emile - half hourly – slices using mathematical formula comparing model and satellite image – when outside the box will issue new update.

From a VAAC perspective, Kelut is a reasonable success story and VAAC Darwin will look to build on progress and lessons learnt during future liaison visits to Indonesia. Height of the volcanic ash could be over and above top height capability of some models. Table in the document from the ‘VAAC Ins and Outs’ workshop 3 years ago now needs updating as some changes since. VWO06 refers.

Volcanic Ash and Gas Turbine Aero Engines Update Presentation by Rory Clarkson, Rolls Royce

Conclusions:

- Gradually the quantitative understanding of VA susceptibility is improving but still a lot not known. VWO12 refers.
- Some limited engine impacts research being undertaken, importance of safe to fly chart and keeping an eye on this – new data will allow updates e.g. VIPR III. Thorgeir – is there a choking effect? Rory – explained if reduce flow areas in the engine this stops the compressor working effectively, so related to mass of ash into the engine
- Still some confusion in relating current susceptibility understanding to operational guidelines particularly in Europe.
- New EASA regulations relating engine certification are now being reviewed.

Comments:

Klaus asked about duration – one spell or several over a few years. Rory – some of damage does self repair but some damage is non-reversible.
6. VAAC PRESENTATIONS (See also presentations on website.)

VAAC Anchorage, Don Moore

Volcanic Eruptions

From 2012 through April 2015, 5 volcanoes in Alaska have been active requiring volcanic ash advisories. The most active time period was 2013 through early 2014 where around 200 volcanic ash advisories were issued. The majority of the eruptions were low level with localized impacts to air travel. There were also 4 Russian volcanoes that were active in 2012-2014 that required VAAC Anchorage to take over responsibility from VAAC Tokyo. This has especially been the case from late 2014 through April 2015.

Service Changes

Service changes from VAAC Anchorage have mainly been internal, focusing on improving collaborative efforts with neighboring VAACs, Anchorage Air Route Traffic Control Center, and the U.S. Geological Survey Alaska Volcano Observatory. These efforts brought about improvements related to consistency of information and enhanced decision support services. Of particular interest, was the development of a new web based tool to analyze and collaborate volcanic ash hazards. VAAC Anchorage and VAAC Tokyo also jointly developed more formal documentation to hand over responsibility of volcanic ash advisories when volcanic ash is spreading from one area of responsibility to another. These efforts have resulted in improved and more consistent services, especially for larger volcanic eruptions.

Future challenges

Continuing to improve hand over procedures between VAAC Anchorage and VAAC Tokyo will remain a high priority for the two VAACs. The two VAACs also wish to more collaboratively work together on analyzing and forecasting volcanic ash. Utilizing tools, such as web-based chat software, will be one area of investigation to more effectively communicate. Incorporating new satellite data into operations, particularly from Himawari and GOES-R is another focus area. These new data sets will greatly improve detection of volcanic ash, with higher temporal and spatial resolution. Identifying ways for forecasters to effectively utilize these data sets and better communicate detailed volcanic ash hazards will be critical to improving services provided by VAAC Anchorage.

VAAC Buenos Aires, Miriam Andrioli

Volcanic eruptions

See table below related volcanic eruptions/issuance of VAAs, and VAGs (as of 2011) for the period 2006- April 15th, 2015.
Service changes

Better regionalized use of dispersion/concentration numerical model, FALL3D (Eulerian dispersion and concentration model for VA). Coupled to the local numerical model WRF-ARW on experimental basis and to the local operational version of ETA NMS meteorological model or the Global numerical model GFS, it provides ash concentration, ground load and deposition thickness. (The local version of the ETA SMN meteorological numerical model provides a better grid resolution).

Improved observations including a Global service for lightning activity; New Lidar network covering strategic areas at risk (Buenos Aires, Neuquén, Bariloche, Com. Rivadavia, Río Gallegos).

Interagency Volcanic Ash Information management protocol for Argentina. National Agencies involved: MinCyT, SEGEMAR, NMS; CONAE; CONICET; IGN; CIN; APN. Objective: to better articulate the scientific, technological and administrative capacities of all agencies involved for a better management of the hazardous situations posed by the presence of VA in the Argentinian territory.

Enhancing the variety of products and relation with users:
VAG T+24 (as of July 1st, 2014) and Graphic reports depicting VA deposits/re-suspended VA by cities.

Usage of the new International Volcano Database ID numbers for VAACs (as of October 1st, 2013; IAVWOPSG Conclusion 7/30).

Future challenges

Studies on the complexity of re-suspended VA events. The VAAC BA Research Group adapted and implemented three emission schemes originally developed for mineral dust in the FALL3D model to study its behavior when dealing with ash clouds. The simulations and evaluations were performed at the NMS of Argentina in collaboration with the Barcelona Supercomputing Center (BCS). Not operational.

Improve the performance of the short range forecasts of re-suspended ash for regions closest to the VA deposits and for which now, the adapted schemes of the FALL3D model tend to overestimate the plume concentration. Experiments with HYSPLIT activating the mineral dust component are also under way.
VORHISE volcanoes database. Design and develop a database of volcanoes VORHISE (Volcanes de la Región y su Historia Eruptiva), as well as to collect and validate its data. The information contained in VORHISE will include volcano location, ID number, type/height; and for each recorded eruption, the dates and/or the duration of the activity, height/s column/s eruptive/s, granulometric characteristics and parameters of shape of the ash emitted by volcanoes, explosivity index (VEI), volume, petrographic and geochemical characteristics of the material erupted, among other relevant data.

VA hazard maps. Create eruption/re-suspension VA hazard maps for the VAAC BA´s AoR. The maps will depict the probability of the presence of VA, its concentration in the atmosphere and the thickness of its ground deposits exceeding certain given thresholds.

Remote sensing. Evaluation and implementation of algorithms for qualitative detection and retrieval of volcanic ash following the work of Prata (Prata & Grant, 2001; Prata, 2011) and the developments of Pavolonis (2010) for the GOES R ABI.


Finalize the VAAC BA Operations Manual; the Competency assessment of VAAC BA personnel and QMS ISO 9001-2008 processes.

Lidar operation/interpretation training (Met. Observers/Forecasters), currently in process.

Real time processing, quality control and transmission on the WMO GTS of the automated air reports originated by Aerolíneas Argentinas and Lan Argentina´s aircrafts through AMDAR (Aircraft Meteorological Data Relay).

Ceilometers with VA detection capabilities and TOPAS, plans to enhance the present network.

VAAC London, Anton Muscat

Volcanic Eruptions

In the period 2012-2015 there has been relatively little volcanic activity within London VAAc’s area of responsibility, perhaps not too surprising given that two eruptions occurred in the recent past (2010 and 2011) and that the area sees an eruption occurring every 3-4 years on average. However, increased seismic activity beneath the Bardarbunga volcano did begin around the middle part of August 2014 and this led to a fissure eruption (lava fountains and SO2, but no Volcanic Ash) nearby from late August onwards, this continuing for a significant period of time, nearly 6 months, before ceasing towards the end of February 2015. At the beginning of this event, London VAAC did issue a VAG/VAA product to indicate that no VA was in the atmosphere, this to counter the (reactive) SIGMET issued by the Iceland Met Office to suggest that VA may be in the atmosphere. Otherwise, no VAG/VAA products have been issued in the period.
Service Changes

Over the last 4 years, London VAAC has seen a number of significant changes to the way that the Volcanic Ash service is provided, as follows:

1) The VAAC meteorologists have acquired, and regularly utilize, an Intervention Tool that allows dispersion model data to be modified on the basis of available observations (e.g. satellite, LIDAR) ensuring that the forecast provided is as accurate as it can be and guarantees consistency amongst the range of products provided.

2) New observational capabilities have been acquired, including a dedicated Met Office Civil Contingencies Aircraft (MOCCA) as well as enhanced LIDAR capabilities across the UK.

3) London VAAC has also introduced the concept of an annotated satellite image; issued to support any VAG/VAA or VA concentration chart products issued, this product would provide regular, real time verification of the forecast products as well as ensuring a detailed situational awareness of the situation for all users.

4) New satellite algorithms and imagery have been developed by the Satellite Applications team within the Met Office and who work alongside the London VAAC meteorologist. These new products allow the VAAC meteorologist to more clearly understand the extent of VA in the atmosphere, leading to more accurate forecasts.

5) In the event of an ongoing eruption, London VAAC personnel will provide a once-a-day WebEx briefing to users (including the CAA, Air Traffic services and airline customers) with the purpose of explaining the rationale behind the issued forecasts, basing this briefing on the annotated satellite images available and allowing questioning of the London VAAC team (meteorologists, modellers, satellite experts, etc.) in order to increase the confidence of the users in the forecast.

6) London VAAC has also extensively refreshed its web pages, providing an easier-to-utilize web site with more information.

7) A T+24 VAG product has been developed and is currently under trial, available through the London VAAC web pages.

Future challenges

There are two main challenges faced by London VAAC; firstly there is a desire by the VAAC to move from a VA Concentration product to a VA Mass Column Loading product. This change will ensure a more scientifically robust product that can be easily verified against available data (e.g. satellite imagery). This requires that the Intervention Tool used to edit the dispersion model data is extensively re-modified, and this will take a considerable amount of time and money. Secondly, the relative inactivity of the volcanoes within London VAAC’s area of responsibility means that ensuring operational readiness of the team is challenging. Regular exercises are undertaken (at least monthly) whilst the Intervention Tool is end-to-end tested each shift to ensure that IT is operating as it should. Undertaking collaborative work with other VAACs, during an eruption in their area of responsibility, is a way of improving operational readiness and this will be taken forward in the coming months.
VAAC Montreal, Dov Bensimon

Volcanic eruptions

VAAC Montréal has issued a total of 31 VAAs since the start of 2012. Twenty-six of these were retransmissions of VAAs issued by VAAC Anchorage and five were standard messages. These were mostly for volcanic ash originating from Sheveluch (Kamchatka), but also from Kliuchevskoi (Kamchatka) as well as from Katmaï (Alaska).

Service changes

A number have been implemented since the start of 2012. A new 24-hour volcanic ash graphic has been developed, as well as a new layout for displaying dispersion model output. This layout allows for the display of ash mass loading in an atmospheric column. The VAAC Montréal web page has undergone a number of changes destined to make it easier to use. VAAC Montréal has also increased its satellite coverage by obtaining images covering Kamchatka and Iceland in near real-time.

Future challenges

Changes made to the VAAC products website, including the capacity to animate model output maps, displaying a separate link for the 24-hour volcanic ash graphic and the capacity to sort VAA/VAG messages. Finally, work is being done so as to be able to ingest satellite images directly into the VAA production software so as to be able to more precisely specify where the VA is at T+0.

VAAC Darwin, Emile Jansons

Volcanic Eruptions

During the period 2012 to April 2015, VAAC Darwin has issued approximately 1300 advisories each year for 7 – 16 volcanoes; the majority of these eruptions have occurred in Indonesia with some eruptions also taking place in Papua New Guinea. Several major eruptions occurring during this period have resulted in widespread ash clouds and disruptions to aviation; some examples include: Kelud (February 2014), Sangeang Api (June 2014), Rabaul (August 2014), Soputan (2012, 2013, 2014) and Manam (2012, 2015).

Service Changes

VAAC Darwin operations have been significantly enhanced during in the last 3 years with the commencement of a 24 x 7 separate volcanic ash roster. VAAC staff is no longer responsible for any non-VA products or duties and are solely utilized for volcano monitoring and advisory production. This change has been driven by the high levels of activity that occur within the VAAC Darwin area of responsibility and the need to provide a more sophisticated level of service to aviation clients.

Another significant change has been the switch to a new Visual Weather based monitoring and advisory production system. The new system provides a more efficient satellite monitoring interface than the previous McIDAS based approach and allows for the seamless production of VAA, VAG and SIGMETs from satellite observations.
Future challenges

The flow of observations from State Volcano Observatories and pilots remains a significant challenge to VAAC operations. In order to supplement this information and promote the uptake of VONA, VAAC Darwin is becoming more engaged with social media platforms such as Twitter and Facebook.

Operational data from the new Japanese Himawari-8 satellite is due to become available during July 2015. The impact of high resolution 10 minute satellite imagery on the detectability of ash and the accuracy of forecasts is expected lead to a significant increase in the quality of VAA provided by VAAC Darwin; however, determining appropriate detection thresholds, products and operational procedures that will best exploit this data also presents significant operational challenges.

VAAC Tokyo, Yohko Igarashi

Volcanic Eruptions

From 2012 to April 2015, VAAC Tokyo issued advisories for 8 - 13 volcanoes each year; around half of which are volcanoes in Japan and others are those in Kamchatka Peninsula, Kurile Islands and the Philippines. More than 1,000 VAAs are provided every year in this region and some of the eruptions could be highlighted as a trigger for the enhancement of operations by relevant organizations and awareness-raising for volcanic ash-related phenomena. For examples, the eruption of Klyuchevskoi in 2013 realized us again of the importance of smooth and close cooperation between neighboring VAACs, and the eruption of Mt. Ontake in 2014 raised more attention on volcanic ash. Through these experiences, VAAC Tokyo has been improving its operations including handover procedures with VAAC Anchorage for the past few years.

Service Changes

Service changes from VAAC Tokyo vary widely, from internal to international as well as from system-related to operational matters. The most recent change is the update of its system for advisory creation and dissemination that was completed on 24 March 2015. During the period of 2012-2015, VAAC Tokyo focused on achieving more user-friendly advisory provision such as more frequent VAA/VAG issuances for significant eruptions and international coordination. As for the international coordination, two major changes have been conducted. One is the start of mutual back up cooperation with VAAC Darwin that also includes coordination with VAAC Wellington during back up operations. The other is the enhanced handover procedures with VAAC Anchorage in which the VAACs use a fixed form called HRS and make a phone call for confirmation. For both changes, the VAACs prepared documentations as a regulation or a guideline. These efforts have been collecting favourable user comments and improving the quality of services.

Future challenges

VAAC Tokyo will continue working on smoother communication and coordination with VAAC Anchorage. Not only the handover procedures but also the trial efforts for the collaborative decision analyses and forecast (CDAF) will be conducted. Currently the two VAACs are testing the effectiveness of a chat system for CDAF by discussing the estimation of volcanic ash extent based on a scenario prepared in advance. Similar tests will take place for a few more times to see if CDAF via chat can become operational.
It goes without saying that providing higher-quality information is an important task for VAAC Tokyo. Adding to the arrangement of phrases such as adding NOT PROVIDED and NOT AVBL to the existing NO VA EXP in VAAs, utilization of data from the new satellite Himawari-8, which will be operationally available this summer, is ongoing. The data with higher resolution as well as SO₂ detection with a sensor newly installed on this satellite will make it easier to identify volcanic ash from the imagery and the rapid scan will enable more timely advisory issuances. VAAC Tokyo is also expecting further verification of simulation results for ash extent using data from Himawari-8.

**VAAC Toulouse, Philippe Husson**

*Volcanic Eruptions*

From 2012 to 2015, VAAC Toulouse issued more than 200 operational VAA/VAG. Most of them were related to Mt Etna, Italy, but a number of advisories were issued for the Fogo eruption, in Cape Verde Islands. Etna eruptions were generally weak, some of them released however ash up to FL 200 or more, but due to their short duration, ash was not discernible after one to six hours after the eruption. The Fogo eruption, from 23.11 to 04.12.2014 released some ash very close to the volcano, and significant clouds of SO₂. During the eruption, the VAAC had regular contacts with Cape Verde volcano observatory, and occasional ones with civil aviation, and MWO.

*Service Changes*

Since a LoA was signed with INGV (Italian State Volcanologic Observatory), VONA have been regularly received at the VAAC with clear information on the presence/absence of ash in the released plume. A SHAPE (Southern Hemisphere Ash Propagation Exercise) was performed successfully in 2014 between Buenos Aires and Toulouse. Such exercises are intended to be run yearly. Three back-up exercises between London and Toulouse took place in 2104, two in 2015 and we intend to run them at least twice a year. Extended VAG production, with the mention of two confidence level (High and Low), was implemented in mid-2014 and is now issued on a routine basis.

*Future challenges*

The VAAC web page will be renewed – target is December 2015. It will present the operational products on two pages:

- ICAO products (VAA text, VAG in .png, VAG in .csv files, (to be replaced by XML in 2016) + possible experimental products such as Extended VAG;

- Additional products (Contamination charts, Satellite annotated images) in response to EUR/NAT requirements. dispersion model MOCAGE.

Current developments aim to improve of forecaster tool, to allow VAAC forecasters intervention on all kind of products (sat, contamination charts) and to improve Météo France dispersion model MOCAGE by assimilating aerosols data coming from Lidars networks and satellite.
VAAC Washington, Jamie Kibler

Volcanic Eruptions

From 2012-2015, the Washington VAAC issued advisories for approximately 29 volcanoes. Twenty of these volcanoes were within Washington VAAC boundaries. The majority of the eruptions were low to mid-level in height and low impact to the aviation community. The Washington VAAC issued advisories for nine volcanoes outside our VAAC boundaries that included ash moving into or near the Washington border. The 2015 year has been very busy so far with nearly 800 advisories and over 275 graphics issued with a forecast.

Service Changes

In the most part, service changes have included ways to increase the ability to know if eruptions are happening and how they are progressing in nature. In 2014, the Washington VAAC created a Twitter account that allows users to post volcanic ash events, provide updates on volcanoes and in general, provide useful information. This data has proved to be a valuable asset to the Washington VAAC. The addition of volcano cameras has played a major role in our operational duties. The Washington VAAC encompasses an area where communication and weather conditions are a large issue. We have continued to communicate with our users on the benefit of these cameras and it has paid off. Lastly, the CIMSS Volcanic Ash Alerts have played an important part in helping us validate current and ongoing eruptions. Although we do not have the full alert package and GOES imagery is not incorporated into the algorithm, they still help confirm what we see in imagery.

Future Challenges

The Washington VAAC is bringing on a new operational system, the Advanced Weather Interactive Processing System (AWIPS-II) in late 2015, possibly early 2016. Although the operational system is similar to our current, it does have some changes and analysts will need one to two full days of training. Another challenge is incorporating new satellite data into operations. Himawari data will be available for operations soon along with GOES-R in late 2016 and JPSS in 2017. The new data sets will provide greater spatial, temporal and spectral resolution and overall be a great benefit to volcanic ash detection and operations, but it will be a heavy load to ingest all of it. Lastly, building relationships with our users across Central and South America remains a high priority. Although we have made great progress in the last few years, it’s a continuing effort that will be a challenge due financial and technological reasons for our users.

VAAC Wellington, Paula Acethorp

Volcanic Eruptions

The Wellington VAAC had 9 volcanic eruptions to deal with during the period January 2012 until February 2015. On the NZ mainland, Tongariro erupted twice, while White Island erupted three times. We also had a sustained period of activity from Hunga Tonga during Dec 2014-Jan 2015, disrupting air traffic for Tonga's international airport. There were three separate Vanuatu volcanoes eruptions since 2012, none with advisories in force for more than a couple of days. We also had reports of Tofua in Tonga erupting in 2012, but this turned out to be a scrub fire.
Service Changes

We now have HYSPLIT running internally, and this will be used operationally when we go live with Visual Weather at the end of May 2015. We will also gain the ability to back up the Darwin VAAC when we go live with Visual Weather. Another recent change is that we now have funding from airlines for more volcanic ash forecasting resources, which is used for research and training when we have no VA events to deal with.

Future Challenges

In near future, we expect to start producing T+24 volcanic ash graphics and are also investigating implementing the ability to express a confidence on the T+0 ash forecast. We are also planning to implement the ability to refer to a lead VAAC on a cross-border VA event (we currently collaborate at the border). In the near future, we expect the data from Himawari-8 to produce challenges on ingestion as well as providing more information than we may be able to easily deal with. We plan to implement the ability to model ash from an existing ash or SO2 cloud in early 2017.

General Comments and Feedback on VAAC Presentations

CAeM VP – need to agree what doing as best practice in terms of depiction of ‘discernible ash’ using agreed techniques including model output when ash is obscured, e.g. by MET cloud – customers want consistency across VAACs.

Dov and Jamie – need to consider polygon points restrictions limitation on advisories – truncated if too much and covering too large an area to simplify the VAG will not be popular with airlines.

General discussion on roll-out of Anchorage ‘Chat room’ concept for all VAACs as well as the ‘operational’ use by all VAACs of other sources of scientific advice e.g. ESA SACS website and subscription to ‘Volcanicclouds’ email distribution list. VWO04 refers.

Dov asked about the drivers for a dedicated VAAC Darwin roster? Emile replied that a dedicated forecaster does a better job due to greater focus and more thinking time. In quieter times will work on developments and improvements, customer happy to pay based on underpinning business case.

Jamie – Is an up-to-date map of RA-III lidars available? VP has agreed to investigate further with WMO Global Atmosphere Watch (GAW) and WMO RA-III MG. VWO01 refers.

Miriam – Chile SVO provides volcanic eruption information, including the very recent introduction of the use of VONAs.

CAeM VP – What version of HYSPLIT is being used at VAAC Buenos Aires? Miriam and Jamie will follow-up post-workshop to ensure correct version is being used. VWO07 refers.

Matt – modelling from an existing cloud – model needs to have quantifiable amount of ash. Dov – forecasters can define a polygon as a source and look at a recent model run and picking one contour best matching the satellite.
Klaus comments on behalf of IFALPA – each centre has own speciality – good – T+24, hypothetical eruptions, happy with work of VAACs. IL T+24 – harmonized trial all VAACs agreed to do.

Thorgeir comments on behalf of IATA – seeing converging of ideas on how to best use information and capabilities – extremely useful, some problems still to solve – different approach in Europe with concentration charts but interested to see where the ash mass column loading proposal goes.

Rory – Very interested in the agreed techniques to underpin ‘discernible ash’ definition applications. VWO03 refers.

7. FORECAST CONFIDENCE, VERIFICATION AND SITUATIONAL AWARENESS

IAVWOPSG 7/13 refers – Situational awareness products

Wellington – only VONA (Volcano Observatory Notices for Aviation) used.

Montreal – no products, monitor situation. Have notification protocol, liaising with stakeholders (stakeholder note).

Anchorage – focus on conference calls – airline, Anchorage CWSU (Center Weather Service Unit), MWO, also use a ‘chat-room’ facility. Raul asked about collaboration tool – not really feasible for use by lots of stakeholders.

Washington – All products available on website, phone calls, messages chat. Post eruption daily telecons for larger eruptions to ensure that everyone is on the same page.

London – weekly communication from IMO, internal but can be forwarded externally as required. Annotated satellite image (not tested in a real eruption yet), daily Webex with CAA and airlines during eruption. Daily telecons with European NMS’s. NAME ESP (Eruption Source Parameters) are disseminated too. 5-day volcanic ash scenario charts are also produced for CAA, Government and MOD planning purposes.

Toulouse – Scenario charts produced for key stakeholders, pilot reports to display for users.

Buenos Aires – Has risk management meetings with stakeholders, media.

Tokyo – Lots of additional comms but no additional products. JMA, to which VAAC Tokyo belongs, also has volcano observatories in it and the necessary information for an eruption itself is provided by JMA.

Darwin – Proactively encourages the SVOs to use of VONA and has numerous briefings with key stakeholders.

Discussion

Emile – should there be formal process of telecons to introduce some structure to multiple stakeholder briefings e.g. set list of invitees airlines, regulators, SVOs etc with the added benefit of cutting down on number of individual briefings? Jamie – difficult to do this effectively outside of the US given language barriers and comms issues.
Darwin to produce a MET-P WG-MOG INF consolidating what the VAACs are doing in terms of additional products and stakeholder briefings. VWO04 (partly) refers.

IAVWOPSG 7/19, 7/20 and 8/19 refer – Confidence

Break-out groups discussions.

Group 1 User needs

High confidence – don’t need too much margin to fly around

Low confidence – add a bigger buffer

Need to understand what a low confidence assessment is based on.

Emile – need supporting guidance to help users interpret the High and Low confidence definitions. All VAACs also to adhere to the Melbourne Best Practice side meeting outcome to depict only High or Low confidence levels. VWO10 refers.

Group 2 and 3 - Quality of VAA/VAG and Validation Methods

Is quality purely accuracy or other factors? Feedback from users is key.

Consistency and continuity between products. Darwin overlays forecast products on satellite imagery as simple measure of verification. High confidence in ESP, NWP verification at T+0 as well as inter-comparison with forecast frames of other models is important. Agreement that the VAAC ‘Ins and Outs' Best Practice Workshop modelling table annexes, see:

https://docs.google.com/file/d/0B50bTmQtOwH6dUFkcjZzaG9UYlk/edit?usp=sharing&pli=1

should be updated every 2-years. VWO06 refers.

Quality assessment can take many weeks due to the non-operational nature of much of the observational information e.g. EARLINET lidar network in Europe.

Emile shows colour coded boundaries for T+0 – confidence in boundaries e.g. where cloud might be coming in on one side. Don asks about software and forecaster time.

Peter – will not make difference to regulators – still can’t go through area.

Raul – important to keep the message simple and consistent.

8. LEAD VAACs, ASH HANDOVERS & COLLABORATION

Common VAAC Website – IAVWOPSG 7/22 refers

There is a prototype for the website, currently limited only to the VAACs. Anton – very much based on RMSC model, looks very handy, could have been used e.g. for Calbuco. Emile suggests extra info on there. Usefulness vs. cost of maintaining needs to be balanced. ‘Chat room’ type concept on the website should be investigated. VWO04 refers.
Ash ‘handovers’ and collaboration tools – IAVWOPSG 8/5 and 8/7 refer

Lead VAAC and ash handover text submitted and is now included in handbook. Tokyo and Anchorage have done a lot of work over last couple of years to agree improved ash handover processes.

Yohko presents on handover documentation and guidelines focusing on best practice handling of large continuous plumes given that some areas may have better satellite imagery than others and the overarching objectives if consistency, continuity, quality and keeping the number of VAAs issued to a minimum.

Don – keep it simple – for different scenarios (single short duration, intermittent, continuous long duration etc), rules to deal with.

CAeM VP – how many of the ash handover processes are documented in line with QMS principles? METP – guidance related to this should be included in the future development of the ICAO PANS-MET document.

VAAC Backup arrangements

Raul confirms that IAVW Handbook Doc 9766 contains guidance material on VAAC back-up arrangements. Back-up discussions reveal that:

- London and Toulouse – VAAC back-up headers are changed (as per Doc 9766) to denote that a VAA has been issued by London VAAC on behalf of Toulouse.

- Wellington – VAA issued as if from Darwin – danger that organizations won’t get advisories if header is changed.

- All VAACs - Agreement that if the respective header designation processes are proven to work, ideally through regular testing rather than during a live event, then there is no need to align the two approaches.

- Darwin – announcement of exercises – Darwin have a formal procedure that requires the issuance of a State letter through the regional office. London is less formal and participating stakeholders are simply emailed. ICAO confirms that London’s more simple process is entirely consistent with Doc 9766 guidance.

- VAACs agree to ensure that their back-up centre is able to satisfy the necessary international air navigation Annex 3 requirements, to update Doc 9766 Table 4.3 and to test back-up arrangements at least once a year. VWO05 refers.

9. RE-SUSPENDED ASH DEVELOPMENTS

Buenos Aires - Extensive volcanic ash deposits to east of Chilean Calbuco (2015) and Cordon Caulle Volcanos (2011). Dry conditions and strong winds lift the ash (re-suspended) with the westerly winds then carrying the ash hundreds of kilometres across Argentina, visible as ‘haze’ in Buenos Aires and out into the South Atlantic Ocean with associated impacts on aviation (VAAs are issued) and air quality.

Models for the re-suspension of soil and sand make use of detailed models of the soil moisture as well as rainfall, wind speed, etc. The calculation of soil moisture is
dependent on soil type amongst other things. Volcanic ash re-suspension presents problems for such sophisticated models as the ash lays ‘over’ an existing surface and the ash characteristics such as drainage rates etc are currently not known. Buenos Aires continues to work on refining a modelling approach to underpin operational re-suspended ash forecasts and it was noted that London has developed a very simple approach that is used for daily air quality forecast in Iceland but not for VAAs – London does not currently depict re-suspended ash events on the VAA. NOAA also has a ‘dust’ capability that could be applied for volcanic ash. It was agreed that all VAACs should look to at least have access to such a re-suspended ash modelling capability (consistent with WMO VAAC Modelling ‘Ins and Outs’ Workshop (2012) IOWO01).

Model verification is based on existing air quality monitoring networks, ‘volcanic ash haze’ reporting and remote sensing retrievals from satellite and lidar-based systems.

Miriam summarized some further re-suspended ash research by a PhD student in 2011 looking at whether it is possible to infer emission sources from a set of observations – Matt Hort was a reviewer for this paper.

Anchorage – Deposits from a 1912 volcanic eruption continues to be re-suspended at times although winter snow pack does pose an extra challenge. Anchorage does issue a VAA, VAG and SIGMET for these events which usually last 1 or 2 days but only on the basis of observed re-suspended ash. Can go up to 10,000 feet if significant event. Not heard of any transportation impacts during these events but there are no major air transportation routes nearby.

Washington – generally very low level events with very fine ash, hard to see on satellite imagery, so advisories unlikely to be issued although a small number of advisories have been issued in the past for ‘significant’ events.

Wellington – need to investigate further. Peter Lechner has observed re-suspended ash when flying in NZ.

Tokyo – explored the issue of re-suspended ash a couple years ago and concluded that it would cause more confusion for users as they are not familiar with such situation and information. It also mentioned that re-suspension seldom occurs in Tokyo’s area of responsibility but if it finds necessity for information provision for re-suspension, it can reconsider. Anchorage highlighted a Kamchatka re-suspension event within the past year which Tokyo will now look to investigate further.

Darwin – Area of responsibility is the ‘wet’ and verdant tropics rain so re-suspended ash events are very rare. There is though a documented procedure for re-suspended ash, but would not issue an advisory without observational evidence.

Montreal – never had to issue an advisory for re-suspended ash. If it did, they do have the ability to run the model and issue VAA as necessary.

Toulouse – not observed any re-suspended events in the Toulouse area of responsibility – but if re-suspended ash was discerned a VAA would be issued based on steering winds and trajectories. MOCAGE would need to be further developed to model re-suspended ash events.

London – VAA not issued for Icelandic re-suspension events although a VA SIGMET was issued for a significant event in 2010. Processes need to be reviewed in consultation with the UK CAA.
CAeM VP – There is a requirement to generate a VAA/VAG whenever ‘discernible ash’ however it gets there, is dispersed into the atmosphere so each VAAC should review and take action as necessary. VWO08 refers.

10. VOLCANIC SULPHUR DIOXIDE (SO2) UPDATE

Matt Hort leads (see presentation on website)

Example of Grimsvotn 2011 during which SO2 dispersed to the north of Iceland and volcanic ash to the south.

Need to consider reactions – gas to sulphate – and model or make assumptions. NAME has chemistry mechanism.

UK interest – Laki eruption 1783-84. Fed into UK National Risk Assessment process. Volcanic SO2 impacts got added as a risk. Evidence base was weak so Met Office working with other partners e.g. British Geological Survey and Public Health England, was commissioned to do a probabilistic risk assessment. Used ensemble of meteorology over 10 years. SO2 and SO4, halogens. Used one eruptive sequence based on Laki. Results – SO2 risk has been reassessed one step down on the National Risk Register matrix but still a significant risk.

Bardarbunga – flood lava eruption – about 10 times less lava than Laki and SO2 about 100 times less than Laki. SO2 locally big issue in Iceland. Good opportunity to compare NAME with the NASA Ozone (and other aerosols) Monitoring Instrument (OMI). Also modelling shows SO2 and SO4 behaves quite differently. Looked at Infrared Atmospheroc Sounding Interferometer (IASI) and OMI comparisons – fairly good agreement so good resource to check against model. Concentrations µg/m3 - up to 500 in the UK. Issues with model not bringing SO2 down into boundary layer so further research needed.

Calbuco – Met Office Satellite Applications Group is using IASI to look at Calbuco SO2, being detected all way over to Australia!

Emile – If see SO2 detected above 20,000 ft will assume explosive eruption also including ash and will assume co-located initially. Reported that passengers on planes were quite distressed having smelt SO2 – thought they’d been through an ash cloud.

Raul – discussed by IVATF and IAVWOPSG with a particular focus on health risks to passengers but no requirements arising… yet. Should be an issue for ICAO METP WG-MISD to consider within its work plan.

Peter – need to consider psychological impacts as well. Darwin explains that advice is provided to airlines to brief on when to expect SO2 so that the airlines can brief passengers.

Don – Is it possible to determine the height of SO2? Yes, using conventional brightness temperature difference techniques and SO2 trajectory analysis

Dov – Montreal uses experience of previous eruptions - ash deposited after 5-6 days but SO2 remained for a long time and pilots still reporting. A ‘one off’ VAA was issued to acknowledge SO2 but to confirm no ash.
Jamie – what should VAACs do? CAeM VP – Nothing at this time but VAACs should look to be involved in any work to underpin the development of any requirements. VWO09 refers.

11. DISCERNIBLE ASH AND AIRCRAFT REPORTS

Further improvements to aircraft reporting to VAACs, IAVWOPSG 8/21 refers

Philippe – evidence of some improvement in AIREP reporting. VOLCICE exercises represent a good opportunity to test the flow of information. EUROCONTROL would like more AIREPs too to display on EVITA visualisation system. Toulouse will be coordinating VAAC inputs into report back to METP WG-MOG. VWO01 refers.

Aerosol observations exchange, IAVWOPSG 7/23 refers

Lots of activities going on around the world (satellite, aircraft-based, ceilometers, lidar etc) which now needs to be captured by WMO Observations Rolling Review of Requirements (RRR) process, in the case of aerosol observations, this is being looked after by the WMO GAW, VWO01 refers.

Agreed in-situ and/or remote sensing techniques for discernible ash, IAVWOPSG 8/3 refers (see also IAVWOPSG.8_WP39.4_Discernible_Ash on VAAC BP website)

Noting that the definitions of visible and discernible ash are now published in ICAO Doc-9691.

The IAVWOPSG recommendation 8/3... that an ad-hoc group consisting of members from all the VAAC Provider States, with the United Kingdom as Rapporteur, IATA, IUGG and WMO, be tasked to:

a) further review the conclusions and state of the science related to the development and use of —agreed techniques for remotely sensed and in-situ volcanic ash observations; and

b) develop associated proposed guidance material for a —Best Practices document rather than the Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds (Doc 9691) for consideration by the METP WG-MOG.

Workshop agrees that guidance related to ‘agreed techniques’ for discernible ash will need to be developed for inclusion in the proposed ICAO PANS-MET publication, VWO01 refers. In the meantime, the following conclusion from IAVWOPSG/8 WP39 should be used as the best top level reference material currently available:

Considering that the minimum detection threshold of Lidar and ceilometer systems is around 0.03 mg/m³, which is almost an order of magnitude below an approximation associated with the minimum satellite detection threshold, it is proposed that the agreed technique for these capabilities should be limited to clear skies evidence of no discernible ash i.e. Lidar and ceilometers systems should not to be used as evidence of discernible ash’ unless supported by other forms of observational evidence such as qualitative satellite imagery or ash concentration measurements of at least 0.2 mg/m³ derived from in-situ airborne or Lidar/sun-photometer measurements. Without traditional infrared satellite observations to the contrary, VAACs should treat areas having Lidar/sun-
photometer measurements less than 0.2 mg/m³ as an area without discernible ash.

What happens if it’s a remote volcanic eruption not detected by satellite but locals can see it? ‘Locals’ observations could be used on the basis of these being an agreed in-situ technique – should also cross-reference against Darwin’s evidence checklist document. What if the eruption was thought to be steam only? Initial advisory should be issued with “VA not identifiable” etc within remarks section (as per existent VAAC best practice). London – also produces a Volcanic Ash annotated satellite image in which a ‘low confidence’ assessment would be included if a VA PIREP was not backed-up by other evidence/observations.

Workshop agrees that satellite is ‘primary’ volcanic ash remote sensing technique with ash mass column loading detection threshold of 0.2 g/m², where available, recognised as the ‘best practice’ quantitative constraint used as a basis for defining the discernible ash envelope. VWO01 and VWO03 refer.

Don – what about new more sensitive satellite-based platforms which are likely to be able to detect ash at lower levels of ash mass column loading? Clearly this means that longer term we will need to consider quantitatively-based ash detection threshold levels. Key word is ‘agreed’ techniques, again VWO01 refers!

12. T+24 VAG TRIAL AND OTHER NEW PRODUCTS

IAWOPSG 8/18 and 7/20 refer

T+24 Trial

6 out of the 9 VAACs have so far been able to find the necessary resources to participate in the T+24 VAG (no requirement for VAA) trial with the opportunity also being taken to add H-L confidence statements to the product.

Feedback collated by Anton:

- Trial has not been well advertised. Peter suggests exploring the option of a NOTAM being issued to advertise.
- Four major airlines have seen and used the T+24 VAG – all want to see it continued.
- Could some form of discrimination be added to depict ‘already observed ash’ from ‘assumed eruption continuing ash?’ VAACs agreed that this added a level of complexity that would likely only serve to confuse!
- VAACs should indicate the data sources used to produce the VAG. VAACs agreed that data sources used to generate a T+24 are generally the same as for all forecast lead times albeit with an increasingly heavy weighting to ‘raw’ dispersion model output at longer forecast lead times.
- Don – T+24 much larger graphic almost implies more confidence – shouldn’t the T+0 be the largest one?
- Yohko – agree large T+0 panel then 4 panel for rest, but need 1-2 years to change software for this.
- Emile – T+0 first advisory needs to be out within 5 minutes of first eruption report.

Anton requested that any further feedback received to be sent to anton.muscatt@metoffice.gov.uk.

- Can be any image (London uses dust RGB) – Calbuco example used to demonstrate.
- Combines image with any other available obs.
- Allows VAAC meteorologist to provide a commentary and include a confidence level.
- Updated and posted to VAAC London website every 3 hours.
- Doubles up as a real-time verification tool and so inform confidence assessments for VAG also.
- If ash from known eruption not discernible by satellite, then 0.2 g/m² model ash mass loading output could be used to depict ash envelope, with appropriate commentary to justify low confidence assessment.

Comments:

Peter – Some concerns about possible litigation issues with use of this product.

Jamie – Important to ensure consistency with T+0 VAG. All agreed although it was pointed out that some detail differences are inevitable given the use of polygon points versus curved lines. Darwin supports the product concept but would have VAG polygons overlaid on satellite images to keep it simple.

Emile – How pilots use the information is dependant on whether confidence is based on presence of ash or confidence in location of ash.

Jamie - Some VAACs have a lot more advisories to produce than others making the timely production of quality additional products a significant challenge.

New products - Volcanic Ash Contamination Charts (see presentation on website)

Anton introduces a joint VAAC London - Toulouse proposal to replace the ICAO EUR/NAT Volcanic Ash Contingency Plan (VA CP) L-M-H supplementary ash concentration charts with an ash mass column loading-based product(s), see Fig 2.

Fig 2: ICAO EUR VA CP Volcanic Ash Contamination Chart proposal
In Fig. 2, outer line would be consistent with VAG line (discernible ash envelope), and has base and top e.g. 500/300.

Well known and accepted that despite their popularity with airlines, the IVATF concluded that the science underpinning the production of ash concentration charts is not yet mature enough to pull an ash concentration-based product into operations. There also remains the issue that there currently exist very few observational platforms that can provide accurate measurements of mass concentrations thus making it all but impossible to verify and amend (as necessary) such products in near real time.

Rationale for moving to an ash mass column loading-based product:

- The ICAO EUR VA CP requires a L– M– H ash contamination-based product(s) to inform the airline safety risk assessment requirements described in the CP.
- Model ash mass column loading values can be verified against data from the next generation of geostationary satellites e.g. Meteosat Second generation (already operational over the Atlantic), Himawari-8 (due to go operational over eastern Asia in late 2015) and GOES-R (due for launch in 2016, operational over the Pacific in 2017).
- Ash mass column loading thresholds can be used as a rough proxy for ash concentration by assuming a well mixed atmosphere and a 1000 metre thick layer of ash i.e. 0.2 g/m² as proxy for 0.2 mg/m³ low threshold and so on. Noting that, > 1000 metre ash thickness = lower concentrations, < 1000 metre ash thickness = higher concentrations but mitigation action in the unlikely event of such an encounter would be to climb or descend by 1000 metres.
- Ash top height estimations, verified against derived satellite imagery where high cloud cover permits, will result in better constrained ash top height forecasts.
- Ash base height estimations, verified against lidar and ceilometer data, where available and where low cloud cover permits will result in better constrained ash base forecasts.

Comments:

Emile – Please can a different acronym than VACC be used... too close to VAAC!? Much better than the ash concentration charts, but envisages this could ultimately replace the current versions of the VAA and VAG products. How to verify if no adequate satellite information available? Matt Hort – For EUR a product based on model output only would be issued.

Dov – Product is similar to what Montreal produce for their hypothetical scenarios.

Philippe – Also lobbying the European Air Navigation Planning Group Coordination Group (EANPG CoG) for the High contamination threshold level to be increased from 4 g/m³ to 20 g/m³ (proxy for 20 mg/m³).

Don – Sees this it as a good idea to spread around VAACs to try out internally. How are Toulouse and London ensuring that this product is addressing users’ needs? London – It is being presented and feedback encouraged at the relevant European meetings.
Peter – There is no ICAO requirement for this product but this proposal has potential – so the workshop should look at this as future product development with a working paper to go to a future ICAO METP WG-MISD meeting. VWO11 refers.

13. **DISCERNIBLE ASH AND AIRCRAFT REPORTS**
   *(with the aim of developing standardised SOP amongst the VAACs)*

The following is a list of operational VAAC issues that were discussed at the best practices workshop held in London from 5-8 May 2015 so as to come to a consensus in order to develop standardized SOP amongst the VAACs. The outcome of the discussion of each point raised is listed in bold and italics.

(a) When updating a VAA (either from the same VAAC or another one following a handover), it is suggested to use the previous T+6, 12, 18 and 24 as a starting point for the new T+0, 6, 12 and 18. These areas can then be adjusted as necessary before sending the VAA/VAG.

   There was general agreement amongst the VAACs that this is a good practice to follow as a starting point, but that adjustments are typically required to the previous forecasts when issuing an update to a previous advisory.

(b) Should a VAAC issue a retransmission VAA when VA is *forecast* to be within 555 km (5 degrees of latitude) of its area of responsibility?

   Most VAACs felt that a retransmission VAA should only be sent when VA is forecast (and only at short term, i.e. in 6 hours or less) in the area of responsibility of the non-lead VAAC, and not within 5 degrees of latitude of its area of responsibility. It should be noted that according to section 6a of Appendix C of the “Handbook on the IAVW” (ICAO document number 9766), a retransmission should be sent when “…an ash cloud is approaching (i.e. expected within 300 NM) the area of responsibility of another VAAC…” This wording seems to imply that even when VA is simply forecast within 300 NM (i.e. 555 km) a retransmission advisory should be sent. This being said, most VAACs seem to be comfortable with applying this only when dealing with a short-term forecast.

(c) Should a VAAC issue a retransmission VAA when the neighbouring VAAC is issuing the last advisory for a given VA cloud (i.e. there is a mention in the RMK section of "NO FURTHER ADVISORIES")?

   No consensus was achieved amongst the VAACs on this question.

(d) Should a VAG be issued when a retransmission VAA is sent? If so, perhaps VAACs should simply change header and re-issue lead VAACs bulletins. Otherwise, users may see an empty VAG, which is misleading.

   Most VAACs do issue a blank VAG when a re-transmission VAA is sent, but not all. As a result, no consensus was achieved amongst the VAACs on this question.

(e) Should a VAAC include the remark “responsibility is being transferred to VAAC no. 2” when VAAC no. 1 is issuing its last advisory? We have seen examples of retransmission VAs with this comment, and which thus had no VA forecast points. This leaves an ambiguity as to whether or not a VAA is really in effect, and if so, where the VA is. In such cases, it would be preferable to transmit the VAAVs from both VAACs at the same time to ensure users can have access to the latest forecasts of VA.
No consensus was achieved amongst the VAACs on this question. However, users’ feedback was shared as an example at handover between VAACs Anchorage and Tokyo in which transmitting the VAAs from both VAACs at the same time was found to be rather confusing. Users expressed a preference for only one VAAC to issue VAAs.

(f) It is suggested that the method of retransmitting VAAs should be the same for all VAACs. Some VAACs simply change the header of another VAA and transmit it, while others only send a partial VAA with a reference to the other VAA in the RMK section, and others still send a full VAA with a reference to the original VAA in the RMK section.

Most VAACs felt it was better to send a full VAA with a reference to the lead VAAC’s advisory. Simply changing the header of another VAA and transmitting it was not the preferred option, but this was deemed to be a good solution in some cases.

(g) For the element “AREA” in a VAA, is one supposed to mention the country in which the volcano is located, or the zone in which the VA is located?

No consensus was achieved, although most VAACs specify the country in which the volcano is located. A remark was made that using the country name was not always user-friendly: for example, an island name such as “Java”, provided as a sub-region name in the volcano database, would be better for Indonesia which consists of many islands covering a wide area. Marianne Guffanti of the United States Geological Survey indicated that one should use the sub region as mentioned in the xls file which is available from the Smithsonian Institution (http://volcano.si.edu/projects/vaac-data/).

(h) When issuing a retransmission, it is proposed to include the date, hour and minutes of the bulletin referred to, not just say “PLEASE SEE FVCN01 CWAO ISSUED BY VAAC MONTREAL”, but rather “PLEASE SEE FVCN01 CWAO 061540 ISSUED BY VAAC MONTREAL”.

No consensus was achieved on this point. Some VAACs were comfortable with including the date, hour and minutes in the reference, but others noted that when referring to a continuous or near-continuous eruption, it was preferable to simply refer to the general header of the lead VAAC.

(i) If no VA is observed, must mark “VA NOT IDENTIFIABLE FM SATELLITE DATA” and give WIND. What level is supposed to be indicated? At which point? Is this the wind at T+0?

It was generally agreed that the wind to be provided is the wind at the location of the volcano. One either picks a representative wind for the layer that was previously included in the advisory, or the wind at the top of the given layer. There is no hard and fast rule for exactly what vertical reference to use for the wind.

(j) Can two volcanic ash clouds from the same volcano be included in the same bulletin and graphic? Should they be in two separate bulletins?

It was generally agreed that two volcanic ash clouds from the same volcano should be included in the same bulletin, though exceptional circumstances could still warrant including them in two different messages.
(k) How do other VAACs coordinate with other MWO to send VA SIGMET and VAA at the same time with the same information? Can best practice be suggested for this?

Although efforts are made to coordinate with MWOs before sending out a VAA, the degree of coordination between VAACs and MWOs varies greatly from one centre to the next. Some are co-located; hence no coordination issues arise, while in other cases, MWOs may be hard to communicate with, leading to little coordination. Often, VAAs are sent out on circuit before SIGMETs, but the VAACs agreed that whenever possible, efforts should be made to coordinate with the MWOs.

(l) Should all VAACs put in "VA TEST" in "INFO SOURCE", "ERUPTION DETAILS" and "RMK"? Free text is permitted by Annex 3 for these lines.

It was agreed that this is a good practice to follow, and a number of VAACs already do so.

(m) Do the VAACs want to adopt a gradual cessation approach to ending VAAs? Gradual cessation implies that when the VA becomes too uncertain to forecast at T+24, only the forecasts at T+6, T+12 and T+18 are issued. Six hours later, when the T+18 forecast is too uncertain to issue, only T+6 and T+12 forecasts are included in the VAA, and so on.

There was general agreement that this was a good approach. However, the VAACs felt it may not apply to all cases. Therefore, it is not possible to adopt a gradual cessation approach for all events.

(n) Do the VAACs want to standardize including layers from the SFC to the reported height of the VA (i.e. exclude having layers starting from a level above the surface)?

The VAACs felt that it is NOT a good idea to standardize including layers from the SFC to the reported height of the VA. Although this is often what happens, a number of VAACs reported cases where there was high confidence that VA was only present aloft, in which case there is no need to extend the layer to the surface.

(o) Do the VAACs want to standardize the delay to issue a retransmission bulletin? For example, it might be agreed that a retransmission bulletin should be sent no later than 40 minutes after the original bulletin appears on circuit.

A number of VAACs have already adopted their own Quality Management Standard practices (QMS, e.g. ISO standards), but not all VAACs are QMS-certified and hence do not adopt a formal standard for the delays in transmissions. No consensus was therefore reached on this question.

14. FUTURE OF VAAC BEST PRACTICE (BP) WORKSHOPS

Workshop agreed to consider holding the next VAAC BP workshop being in Buenos Aires in May/June 2016 – Miriam Andrioli will investigate further which given that workshop outcomes will help to inform discussions at the METP meeting, likely in September 2016, would seem to make sense. Workshop agreed that close coordination is required and that in future possibilities should be explored for running BP workshops conjointly with relevant ICAO METP and/or WMO meetings. VWO14 refers.
Future BP workshops should be more focused with relevant papers in circulated in advance.

Workshop briefed on the WMO 7th International Volcanic Ash Workshop: ‘Science into Operations, Now and into the Future’ which will run 19-23 October 2015 in Anchorage, Alaska.

15. CLOSURE OF THE MEETING

After the customary exchange of courtesies, the meeting closed at 12:30 on 8 May 2015.
<table>
<thead>
<tr>
<th>Time</th>
<th>Tuesday 5 May</th>
<th>Wednesday 6 May</th>
<th>Thursday 7 May</th>
<th>Friday 8 May</th>
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<tbody>
<tr>
<td></td>
<td>Industry Perspectives</td>
<td>VAAC Activities</td>
<td>VAAC Innovation</td>
<td>Outcomes</td>
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<tr>
<td>1030</td>
<td>Registration</td>
<td>0900 Day 1 Review</td>
<td>0900 Day 2 Review</td>
<td>0900 Day 3 Review</td>
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<tr>
<td>1100</td>
<td>Opening – WMO, ICAO MET-P, Workshop objectives &amp; Intros</td>
<td>0930 VAAC Reports' Anc-Lon</td>
<td>0930 Re-suspended ash discussion (Bue)</td>
<td>0930 Agreement of Workshop Outcomes</td>
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<tr>
<td>1230</td>
<td>Lunch</td>
<td>1030 Break</td>
<td>1000 SO2 discussion (Lon)</td>
<td>1030 Break</td>
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<tr>
<td>1330</td>
<td>ICAO MET-P outcomes continued (CAA)</td>
<td>1100 VAAC Reports' Mon-Wel</td>
<td>1030 Break</td>
<td>1100 WMO VA Science Workshop update (Anc, WMO)</td>
</tr>
<tr>
<td>1400</td>
<td>IFALPA</td>
<td>1230 Lunch</td>
<td>1100 ‘Discernible’ ash &amp; A/C reports BP (WMO, Tou)</td>
<td>1130 Next steps – priorities &amp; timelines</td>
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<tr>
<td>1430</td>
<td>DLR</td>
<td>1330 Lead VAACs, ash handovers &amp; collaboration (Mon, Tok, Was, Anc)</td>
<td>1230 Lunch</td>
<td>1200 Workshop closing comments</td>
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<tr>
<td>1500</td>
<td>Break</td>
<td>1500 Break</td>
<td>1330 T+24 (chart intercomparison &amp; user feedback) &amp; other new products (Lon, Tou, WMO)</td>
<td>1230 Lunch</td>
</tr>
<tr>
<td>1530</td>
<td>Kelut case study (Dar)</td>
<td>1530 Forecast confidence, verification &amp; situational awareness (Dar, Wel)</td>
<td>1500 Break</td>
<td>1330 END</td>
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<tr>
<td>1600</td>
<td>'Safe to fly chart' (Rolls Royce)</td>
<td>1700 Close</td>
<td>1530 Other issues, VAG Best practice guidance &amp; regulatory status (WMO, Mon)</td>
<td>1700 Close</td>
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<td>1700</td>
<td>Close</td>
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*Outstanding IAVWOPSG conclusions included in Italics*
## PROVISIONAL LIST OF PARTICIPANTS

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