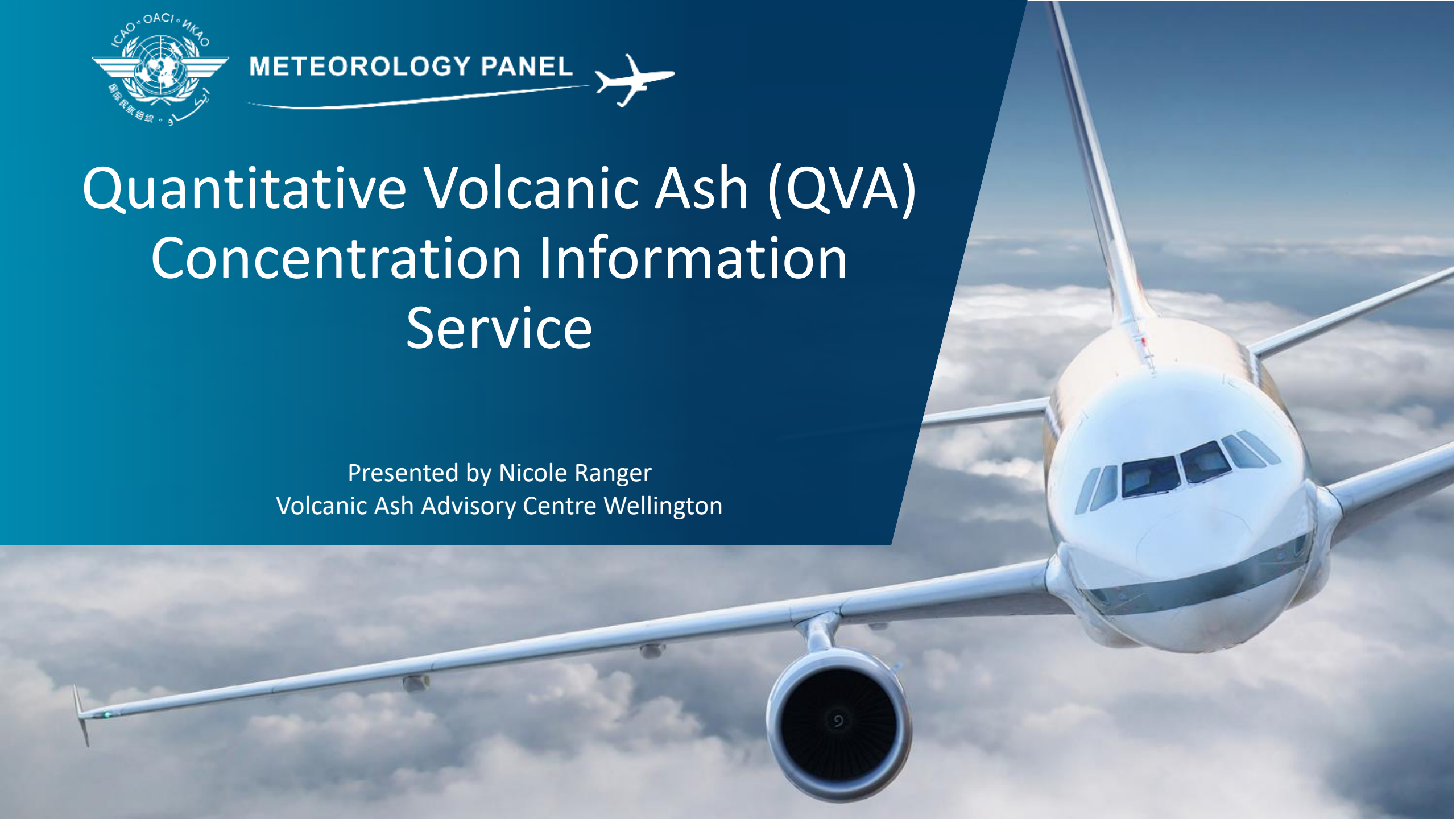
METEOROLOGY PANEL

Quantitative Volcanic Ash (QVA) Concentration Information Service

Presented by Nicole Ranger
Volcanic Ash Advisory Centre Wellington

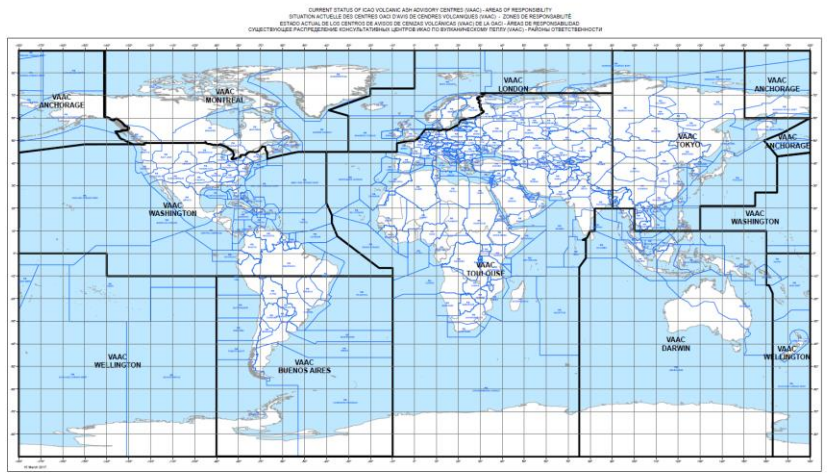


INTRODUCTION OF QVA Information Service

Proposed AMENDMENT 81 TO ANNEX 3

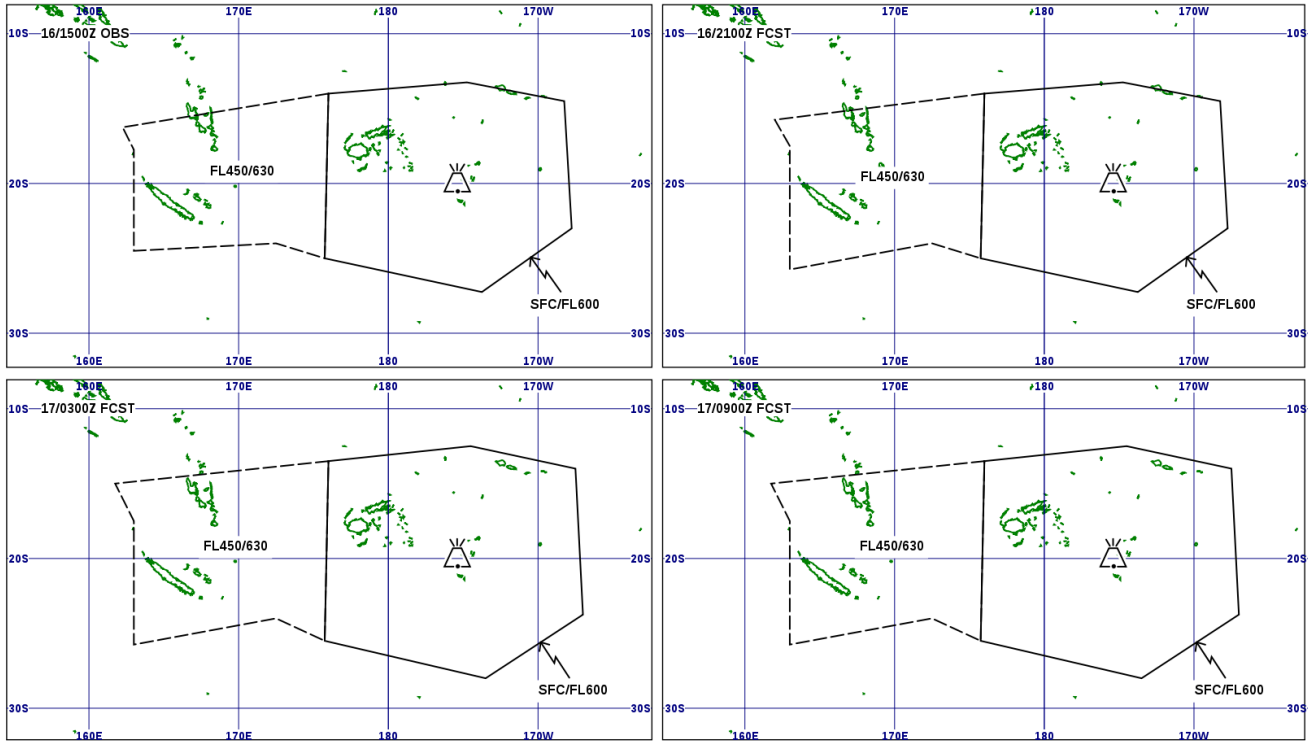
- Volcanic ash presents a significant hazard to aviation; particularly to aircraft in flight.
- International Civil Aviation Organization (ICAO) designated 9 centers as Volcanic Ash Advisory Centers (VAAC) in the 1990s.
- VAACs currently issue VAA/VAG (OBS/EST VA, and FCST +6, +12, +18hr)
- This information is qualitative, since the advisories do not include information on how **much** ash is expected at a given location.

Hunga Tonga-Hunga Ha'apai eruption, 20 December
Photo from aircraft and included in VONA from TMS



Examples of current Volcanic Ash Advisories & Graphics

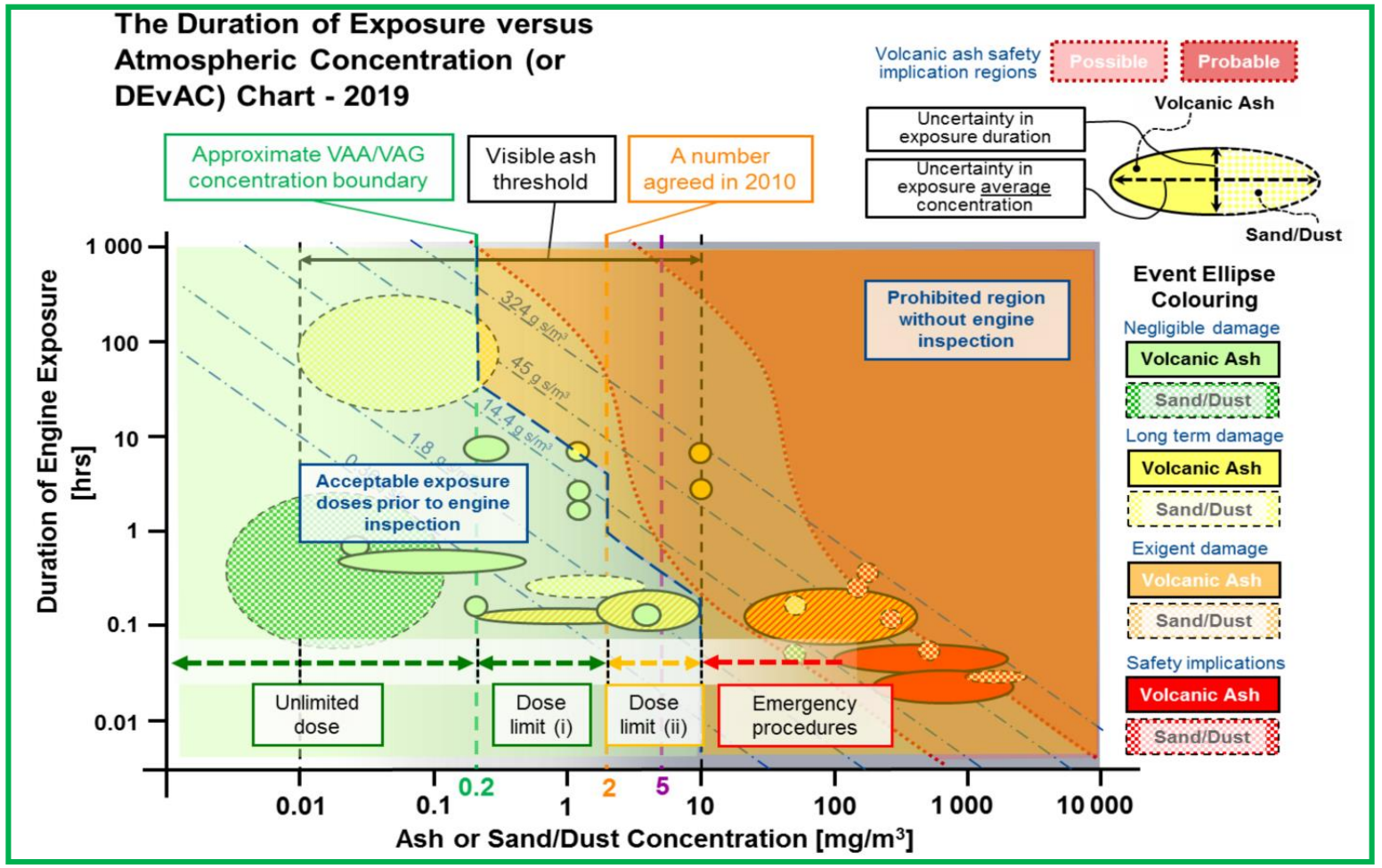
```
FVPS01 NZKL 161500
VA ADVISORY
DTG: 20220116/1500Z
VAAC: WELLINGTON
VOLCANO: HUNGA TONGA-HUNGA HA'APAI 243040
PSN: S2032 W17523
AREA: TONGA
SUMMIT ELEV: 114M
ADVISORY NR: 2022/27
INFO SOURCE: SATELLITE IMAGERY
AVIATION COLOUR CODE: RED
ERUPTION DETAILS: ERUPTION AT 20220115/0400Z LARGE ERUPTION
OBS VA DTG: 16/1500Z
OBS VA CLD: SFC/FL600 S2715 W17345 - S2500 E17545 - S1400
        E17600 - S1315 W17445 - S1430 W16815 - S2300 W16745 MOV S
        05KT FL450/630 S2500 E17545 - S2400 E17230 - S2430 E16300 -
        S1745 E16300 - S1615 E16215 - S1400 E17600 MOV W 30KT
FCST VA CLD +6 HR: 16/2100Z SFC/FL600 S2715 W17345 - S2500
        E17545 - S1400 E17600 - S1315 W17445 - S1430 W16815 - S2300
        W16745 FL450/630 S2500 E17545 - S2400 E17230 - S2545 E16300
        - S1730 E16300 - S1545 E16200 - S1400 E17600
FCST VA CLD +12 HR: 17/0300Z SFC/FL600 S2800 W17330 - S2530
        E17545 - S1330 E17600 - S1230 W17430 - S1400 W16730 - S2345
        W16700 FL450/630 S2530 E17545 - S2400 E17230 - S2545 E16300
        - S1730 E16300 - S1500 E16145 - S1330 E17600
FCST VA CLD +18 HR: 17/0900Z SFC/FL600 S2800 W17330 - S2530
        E17545 - S1330 E17600 - S1230 W17430 - S1400 W16730 - S2345
        W16700 FL450/630 S2530 E17545 - S2400 E17230 - S2545 E16300
        - S1745 E16300 - S1730 E16300 - S1500 E16145 - S1330 E17600
RMK: HIGH LEVEL VA EXTD W IN STRATOSPHERIC EASTERLIES. VA
        HEIGHT EST. SEE ALSO VAA FVAU01 ADRM ISSUED BY VAAC DARWIN
        WHICH DESCRIBES CONDITIONS TO THE WEST IN THE VAAC DARWIN
        AREA OF RESPONSIBILITY.
NXT ADVISORY: NO LATER THAN 20220116/2100Z=
```



VOLCANIC ASH ADVISORY

DTG:	20220116/1500Z
VAAC:	WELLINGTON
VOLCANO:	HUNGA TONGA-HUNGA HA'APAI 243040
PSN:	S2032 W17523
AREA:	TONGA

SUMMIT ELEV:	114M
ADVISORY NR:	2022/27
INFO SOURCE:	SATELLITE IMAGERY
AVIATION COLOUR CODE:	RED
ERUPTION DETAILS:	ERUPTION AT 20220115/0400Z LARGE ERUPTION
RMK:	HIGH LEVEL VA EXTD W IN STRATOSPHERIC EASTERLIES. VA HEIGHT EST. SEE ALSO VAA FVAU01 ADRM ISSUED BY VAAC DARWIN WHICH DESCRIBES CONDITIONS TO THE WEST IN THE VAAC DARWIN AREA OF RESPONSIBILITY.
NXT ADVISORY:	NO LATER THAN 20220116/2100Z=



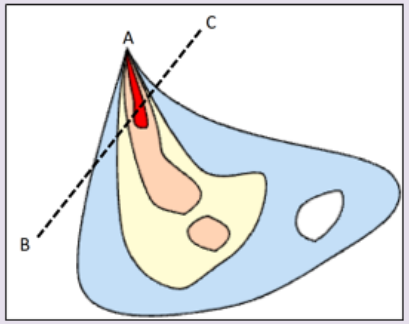
Dr Rory Clarkson and Harry Simpson – *Maximising Airspace Use During Volcanic Eruptions: Matching Engine Durability against Ash Cloud Occurrence*

QVA Format

QVA information will be provided in two file formats

Objects

Deterministic

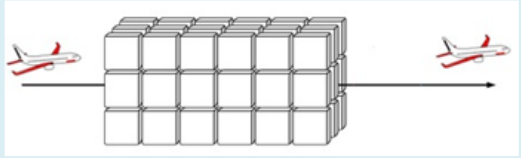


Illustrated Example of QVA

Forecasts of ash concentration to be provided in IWXXM format

Gridded Data

Deterministic



Each grid point has ash concentration value

Probabilistic

Very high

High

Medium

Low

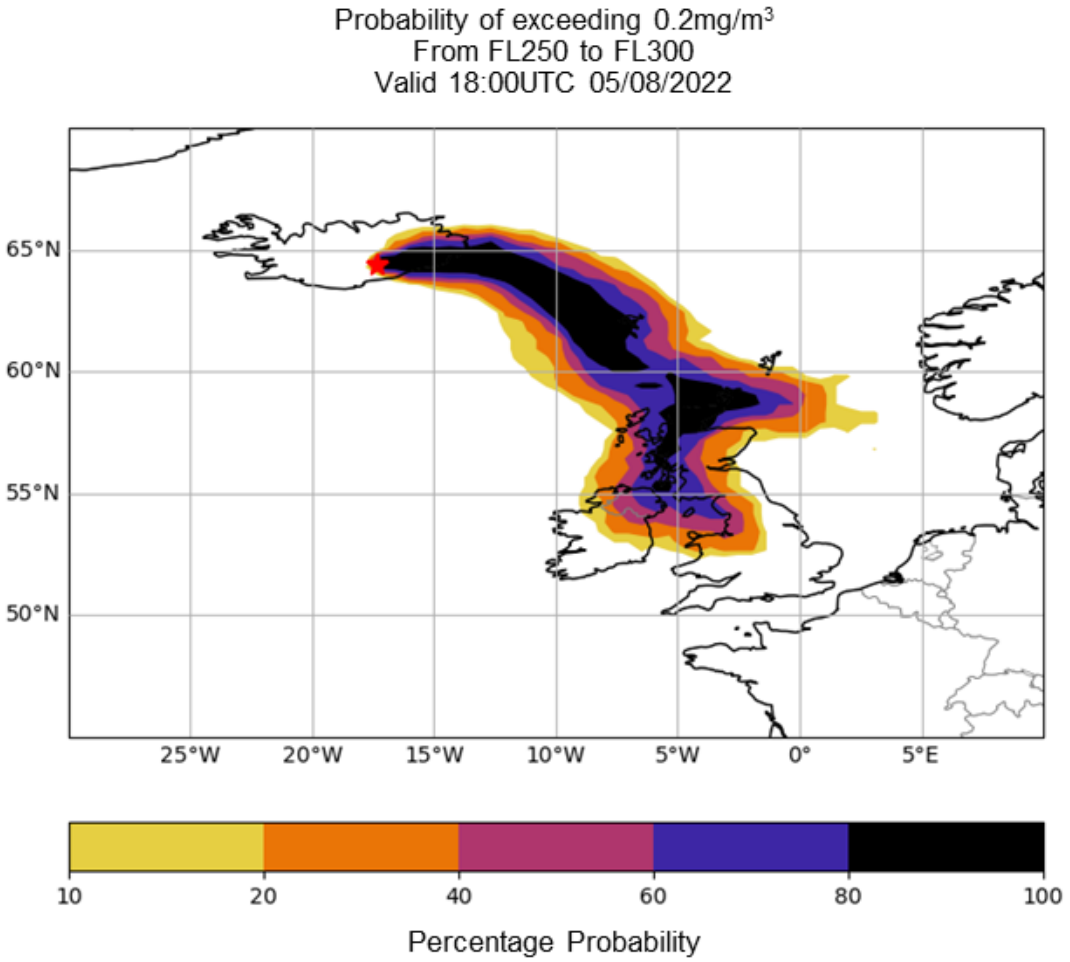
Each grid point has ensemble relative frequency of exceedance for volcanic ash concentration thresholds

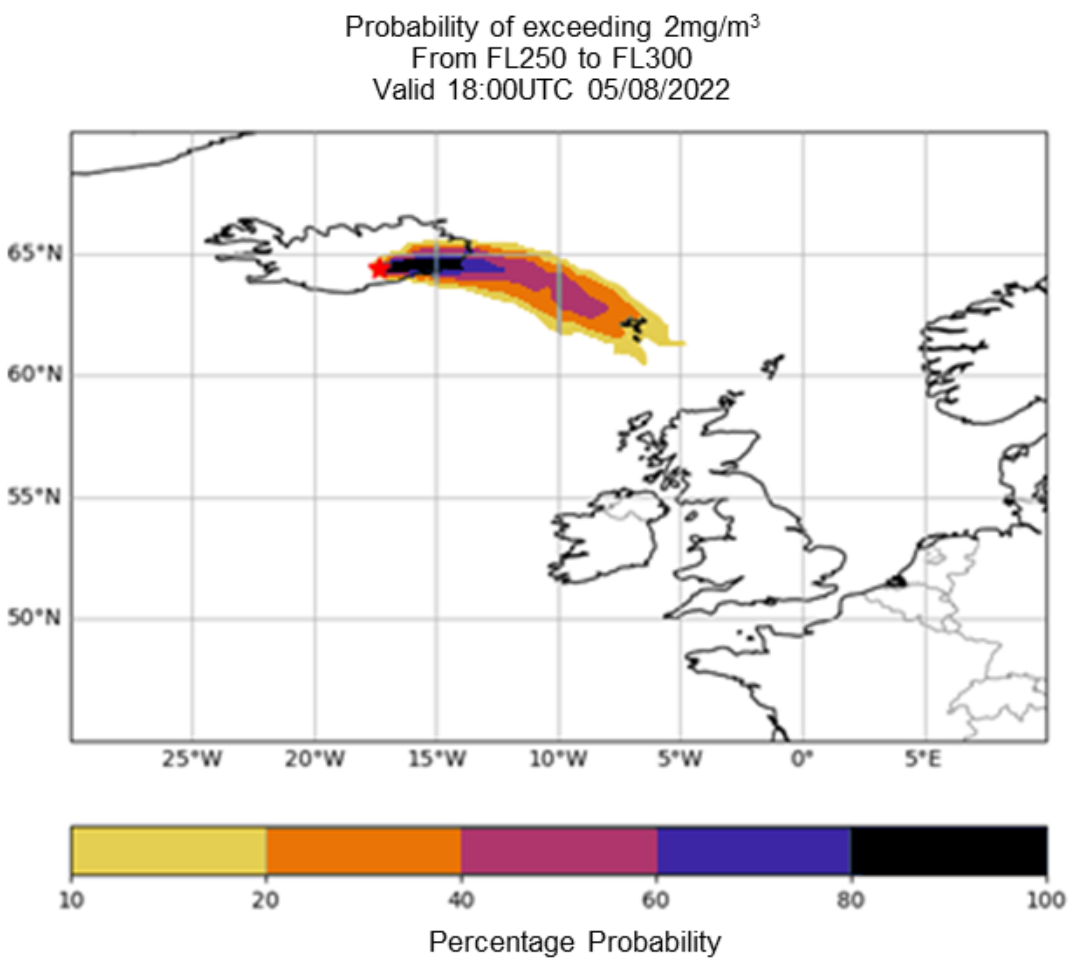
Intended for use in operator's flight planning, etc.
File format has yet to be determined but will probably be a binary format

QVA Thresholds and Resolution

	QVA Information	VAA/VAG
Concentration thresholds and ranges	Very high ≥ 10 mg/m^3 High ≥ 5 and < 10 mg/m^3 Medium ≥ 2 and < 5 mg/m^3 Low ≥ 0.2 and < 2 mg/m^3 Very low < 0.2 mg/m^3	N/A
Horizontal resolution	0.25 degrees lat/lon for gridded data	polygon vertices coordinates provided with 1-minute accuracy
Vertical resolution	5,000 ft (MSL to FL50, FL50 to FL100, ..., FL550 to FL600) for gridded data	N/A
Temporal resolution	3 hours (FT0, 3, 6, 9, 12, 15, 18, 21, 24)	6 hours (FT0, 6, 12, 18)
Update interval	at least every 6 hours	at least every 6 hours
Probabilistic forecast	ensemble relative frequency of exceedance for volcanic ash concentration thresholds	N/A
Format	Objects: IWXXM format Gridded data: TBD (probably in a binary format)	Text message, IWXXM format, PNG format
VA clouds for which information is issued	Significant VA clouds	All VA clouds

The probability of exceeding 0.2 mg/m^3 and 2.0 mg/m^3 for the FL250-FL300 level.





Visual illustrations of QVA IWXXM objects

Colour legend: White = <0.2mg/m³, Blue = ≥ 0.2mg/m³, Yellow = ≥ 2mg/m³, Orange = ≥ 5mg/m³, Red = ≥ 10mg/m³. Note that colours were randomly chosen and do not infer any visualization guidelines.

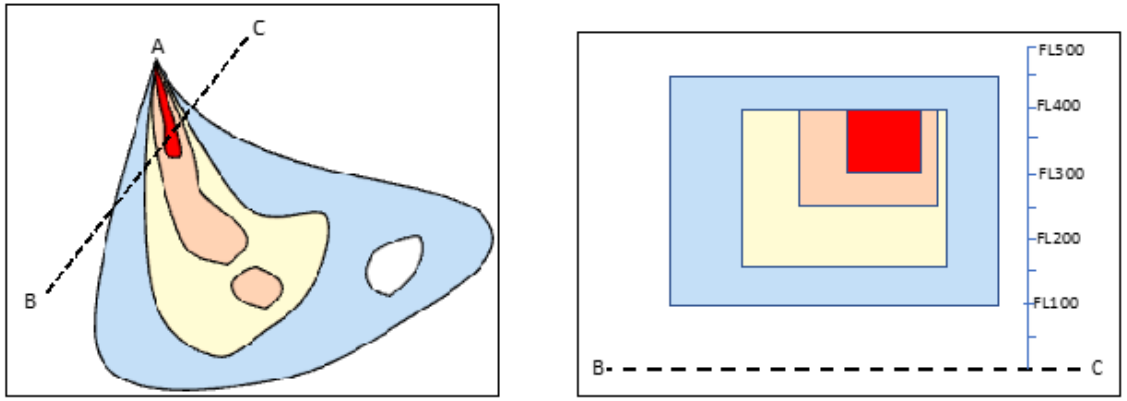


***Figure 1 (left)**. IWXXM objects showing all QVA thresholds depicted in the horizontal from a fictitious volcano located at A. The vertical depiction along line B-C is shown in **Figure 2 (right)**.*

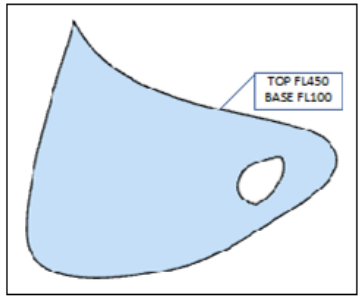


Figure 3.

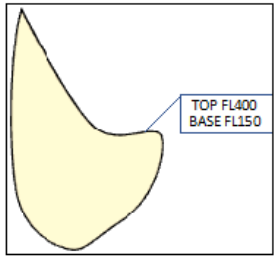


Figure 4.

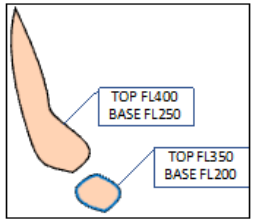


Figure 5.

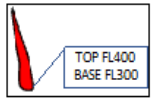


Figure 6.

Figures 3 through 6 depict the individual IWXXM objects from Figure 1. Figure 3 is IWXXM object ≥ 0.2mg/m³ (the "hole" is ash <0.2mg/m³). Figure 4 is IWXXM object ≥ 2mg/m³. Figure 5 is IWXXM object ≥ 5mg/m³. Figure 6 is IWXXM object ≥ 10mg/m³.

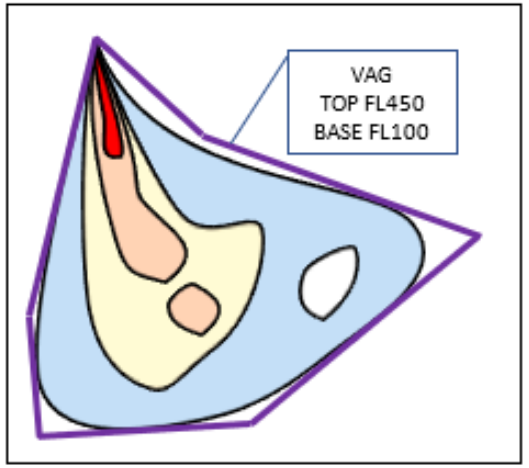


***Figure 7**. Same as Figure 1 but overlayed with the VAG (purple polygon).*

“Significant” volcanic ash clouds

- During the IOC, QVA information will be provided for “Significant” volcanic ash clouds – defined in Annex 3 as “*an ash cloud that poses a widespread impact to aircraft operations and air navigation*”.

- How ‘widespread impact’ will be defined is still being determined by the VAAC’s but may include:
  - an ash cloud with a certain vertical extent
  - an ash cloud within (or expected to move within) a certain distance of an airport
  - Impact of ash on aviation operations

- Guidance on widespread impact will be agreed between all VAACs, in consultation with users.

Data Distribution

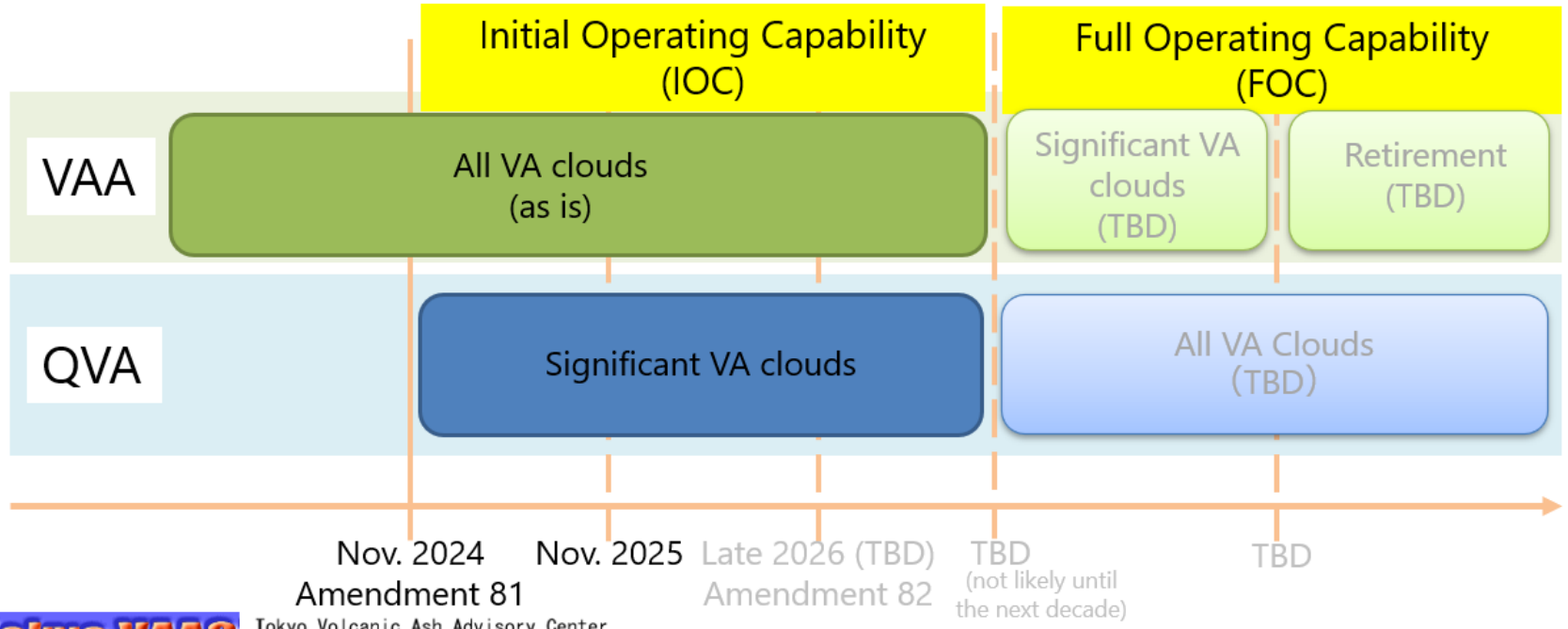
- VAAC's will provide a SWIM compliant API to allow access to the data.
- "publish subscribe" services (AMQP) suit the irregular nature of volcanic eruptions and it is expected that this will be used.
- It is hoped that the QVA service from each VAAC will offer the same capabilities and features.

Implementation Timeline

QVA implementation to be stipulated through ICAO Amendment Process of Annex 3

Date	Stipulated by	SARP	VAACs to implement QVA	Remarks
Nov. 2024	Amdt. 81	Recommendation	VAACs in a position to do so	Applicability date of Amdt. 81
Nov. 2025	Amdt. 81	Recommendation	All VAACs	
Late 2026 (TBD)	Amdt. 82	Standard	All VAACs	Applicability date of Amdt. 82

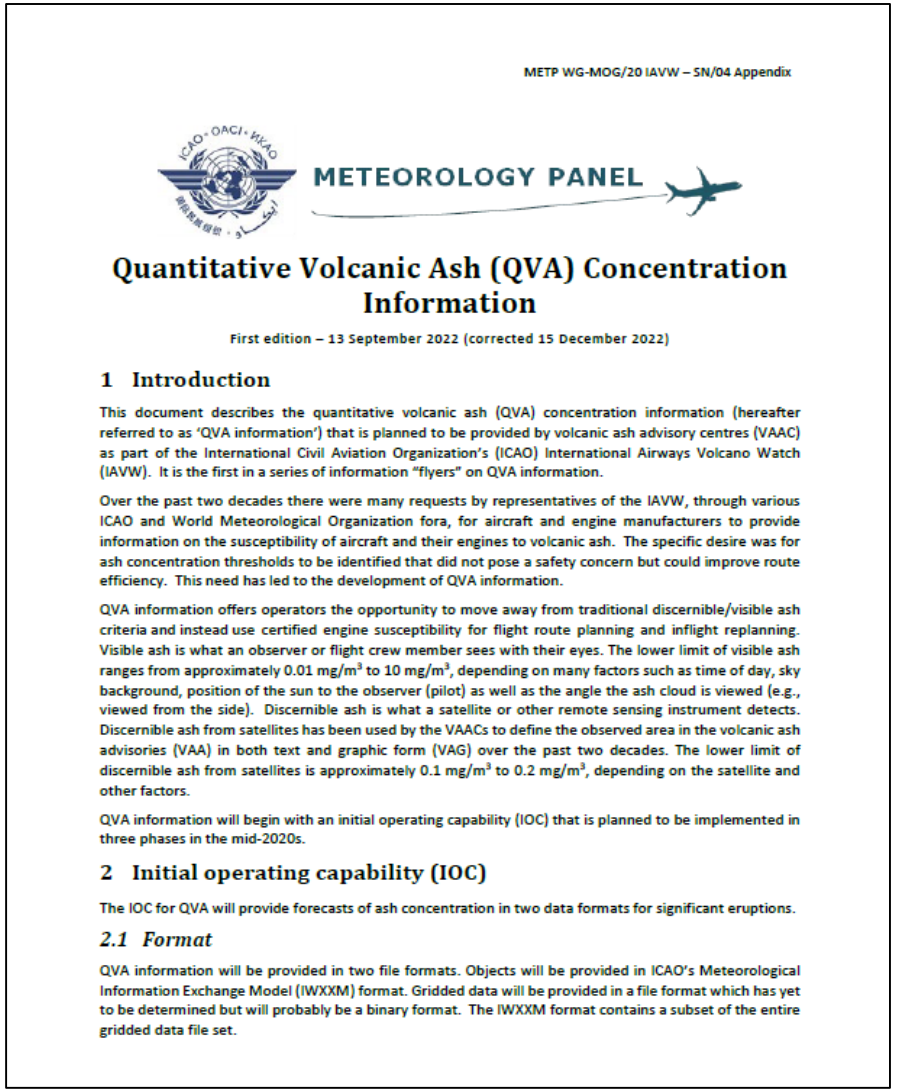
VA clouds for which VAA and/or QVA is issued



Tokyo VAAC
Tokyo Volcanic Ash Advisory Center
Japan Meteorological Agency

Using QVA

- User education material is expected to be developed that will provide flight crew and other users with information on the subtleties, uses and limitations of the QVA information.
- QVA information will likely have its greatest utility with ash cloud events that have a widely dispersed ash cloud with mostly lower levels of ash concentration.
- Probabilistic QVA information is intended for use in operator's flight planning and decision support systems. Operators will use probabilistic QVA information in conjunction with their safety management program to optimize airspace and plan more efficient routes during significant volcanic ash cloud events.
- Most of the material in this presentation is taken from a flyer that describes the QVA information service and that is available to anyone interested.



METP WG-MOG/20 IAVW – SN/04 Appendix

METEOROLOGY PANEL

Quantitative Volcanic Ash (QVA) Concentration Information

First edition – 13 September 2022 (corrected 15 December 2022)

1 Introduction

This document describes the quantitative volcanic ash (QVA) concentration information (hereafter referred to as 'QVA information') that is planned to be provided by volcanic ash advisory centres (VAAC) as part of the International Civil Aviation Organization's (ICAO) International Airways Volcano Watch (IAVW). It is the first in a series of information "flyers" on QVA information.

Over the past two decades there were many requests by representatives of the IAVW, through various ICAO and World Meteorological Organization fora, for aircraft and engine manufacturers to provide information on the susceptibility of aircraft and their engines to volcanic ash. The specific desire was for ash concentration thresholds to be identified that did not pose a safety concern but could improve route efficiency. This need has led to the development of QVA information.

QVA information offers operators the opportunity to move away from traditional discernible/visible ash criteria and instead use certified engine susceptibility for flight route planning and inflight replanning. Visible ash is what an observer or flight crew member sees with their eyes. The lower limit of visible ash ranges from approximately 0.01 mg/m^3 to 10 mg/m^3, depending on many factors such as time of day, sky background, position of the sun to the observer (pilot) as well as the angle the ash cloud is viewed (e.g., viewed from the side). Discernible ash is what a satellite or other remote sensing instrument detects. Discernible ash from satellites has been used by the VAACs to define the observed area in the volcanic ash advisories (VAA) in both text and graphic form (VAG) over the past two decades. The lower limit of discernible ash from satellites is approximately 0.1 mg/m^3 to 0.2 mg/m^3, depending on the satellite and other factors.

QVA information will begin with an initial operating capability (IOC) that is planned to be implemented in three phases in the mid-2020s.

2 Initial operating capability (IOC)

The IOC for QVA will provide forecasts of ash concentration in two data formats for significant eruptions.

2.1 Format

QVA information will be provided in two file formats. Objects will be provided in ICAO's Meteorological Information Exchange Model (IWXXM) format. Gridded data will be provided in a file format which has yet to be determined but will probably be a binary format. The IWXXM format contains a subset of the entire gridded data file set.

METEOROLOGY PANEL

Thank you for listening