

Hunga Tonga-Hunga Ha'apai Eruptions Review



PLUS FUTURE ICAO PLANS FOR VOLCANIC HAZARDS



**CIVIL AVIATION AUTHORITY
OF NEW ZEALAND**
Te Mana Rererangi Tūmatanui o Aotearoa

What I'll talk to you about...

- Overview of the HT-HH eruptions and the 15 January ash cloud evolution
- Outcomes of review of NZ aviation system response to eruptions
- Planned elevation of the VONA (2024)
- Planned introduction of quantitative volcanic ash information (2024)

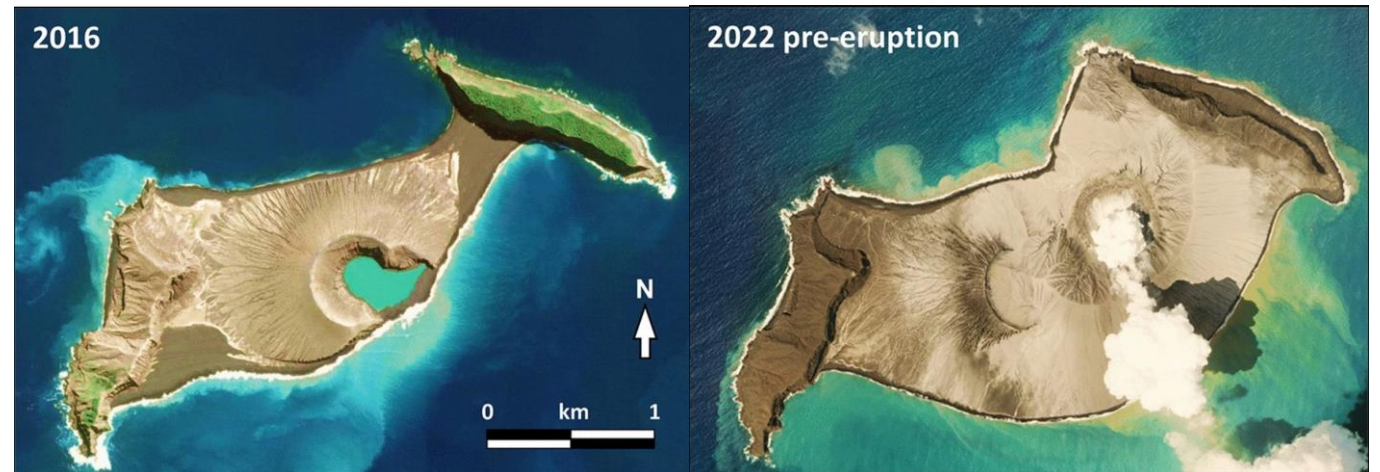
Reawakening – 20 December 2021



- VONA issued, followed by initial VAA.
- Determined to be steam, final VAA issued half an hour later.
- No SIGMET issued for this event.

21 Dec 2021 – 3 Jan 2022: Ash identified

- Ash emission confirmed by State volcano observatory – initial uncertainty as to whether water content was masking volcanic ash emission.
- Series of VAAs/SIGMETs (to FL400) issued 21 Dec 2021 until 3 Jan 2022, during several eruptive events.



Changes in the Hunga Tonga–Hunga Haʻapai volcano over time.
Credits for satellite images: CNES/Airbus and Maxar Technologies.

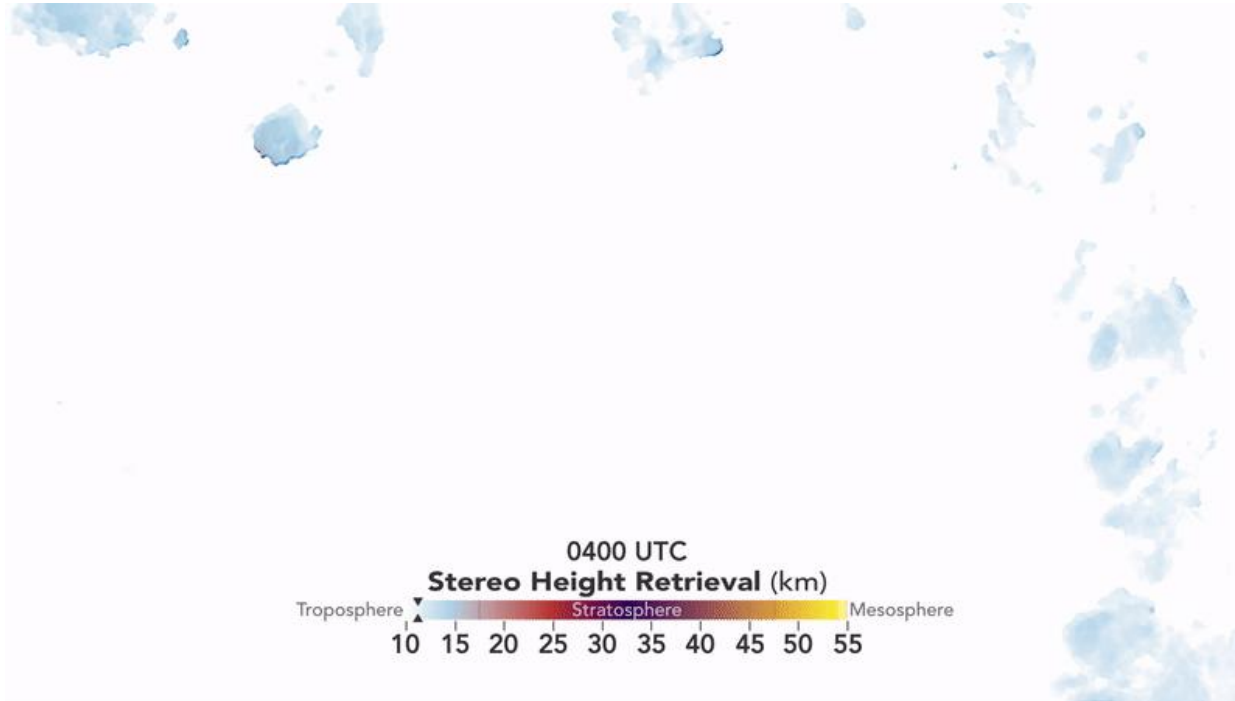
14 January – kicking up a notch



Photo courtesy Tonga Geological Services – “Note the 5km wide plume column of ash, steam and gas.”

- Eruption to FL500, abnormal tides, VA and sulphur smell at ground level.
- The Global Lightning Detection Network (GLD360) ground-based network detected 191,309 lightning events during a 21-hour period.

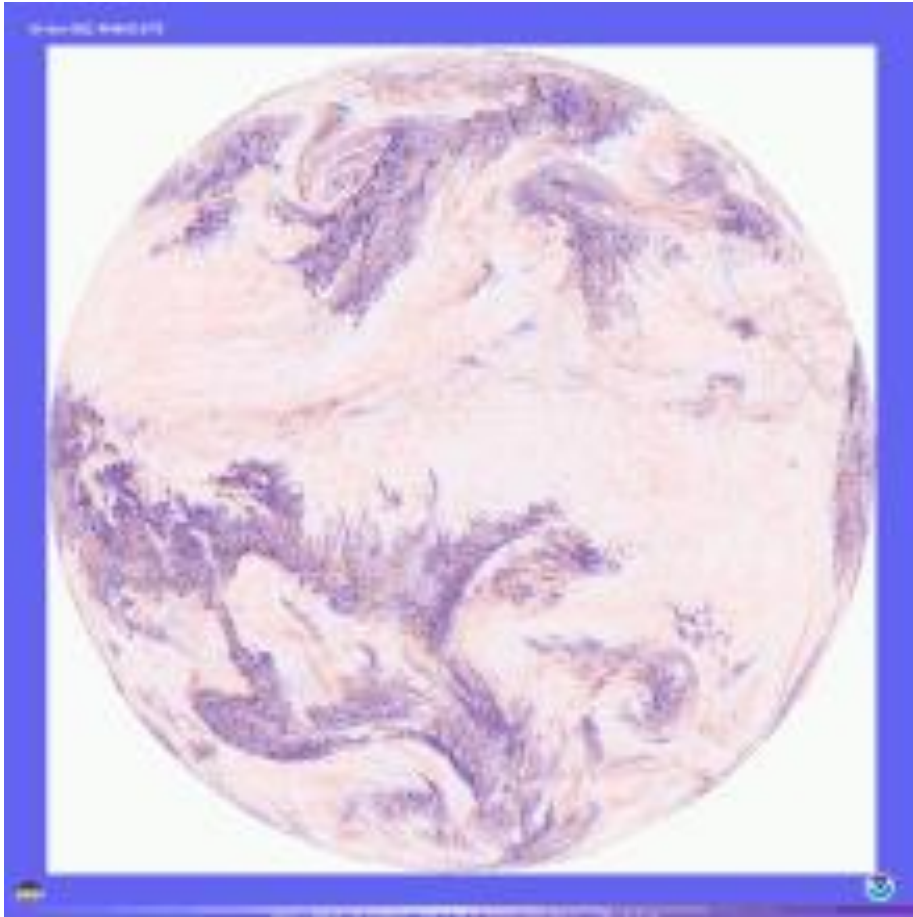
15 January – record breaking eruption



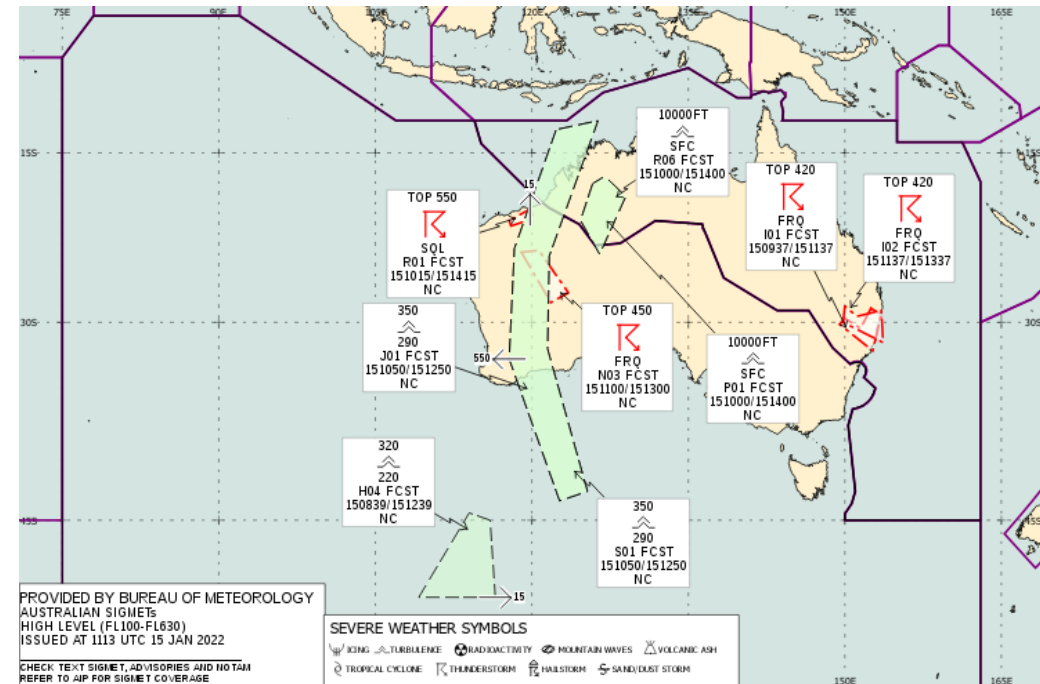
- At its highest point, the plume rose 58 km into the air, meaning it pierced the mesosphere – highest volcanic plume recorded by satellite. (Pinatubo 1991 – ~35km)
- GLD360 recorded almost 400,000 lightning events over a 6 hour period, with half of those during just one hour.

Image credit: NASA Earth Observatory/NASA
Langley Research Center/NOAA/NESDIS

15 January – volcanic shockwave

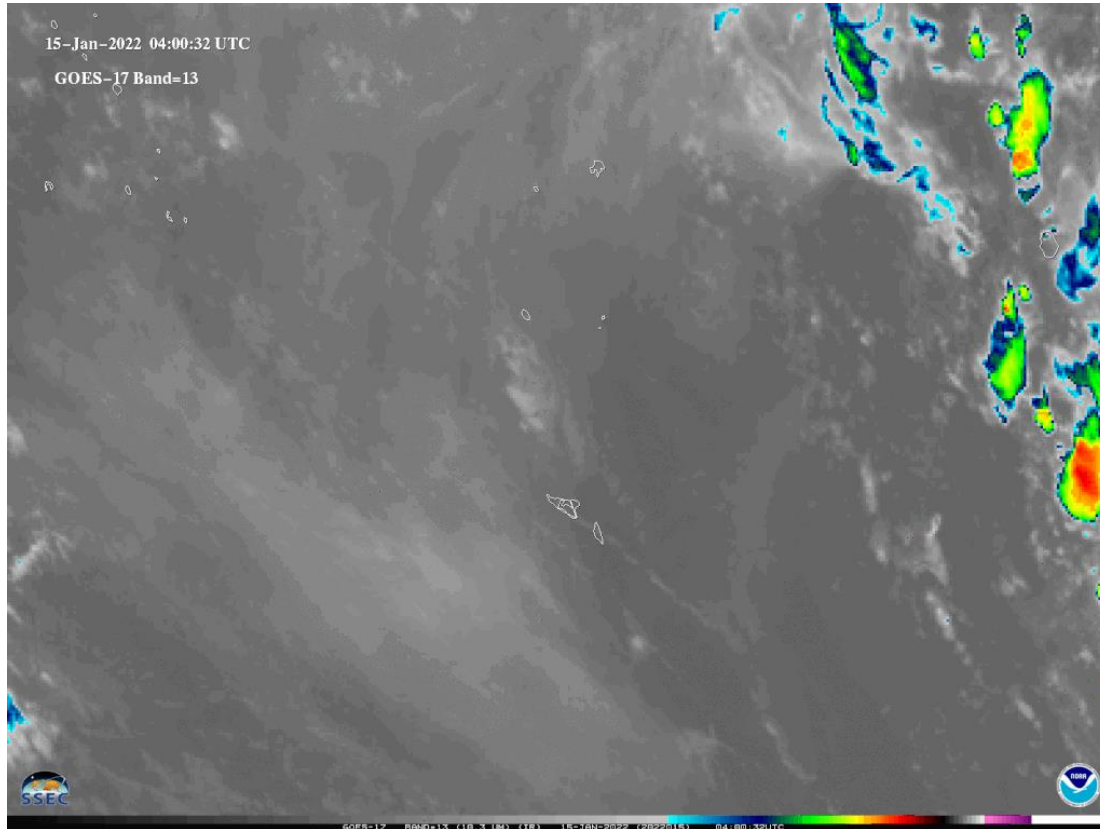


Shockwave from the Hunga Tonga eruption captured by GOES-17 satellite and shown using the Mid-level Water Vapour.



- Aus sev turb SIGMET – ‘MOV W 550KT’
- QNH spikes observed globally (4-5hPa in NZ, 2.5hPa in Switzerland)

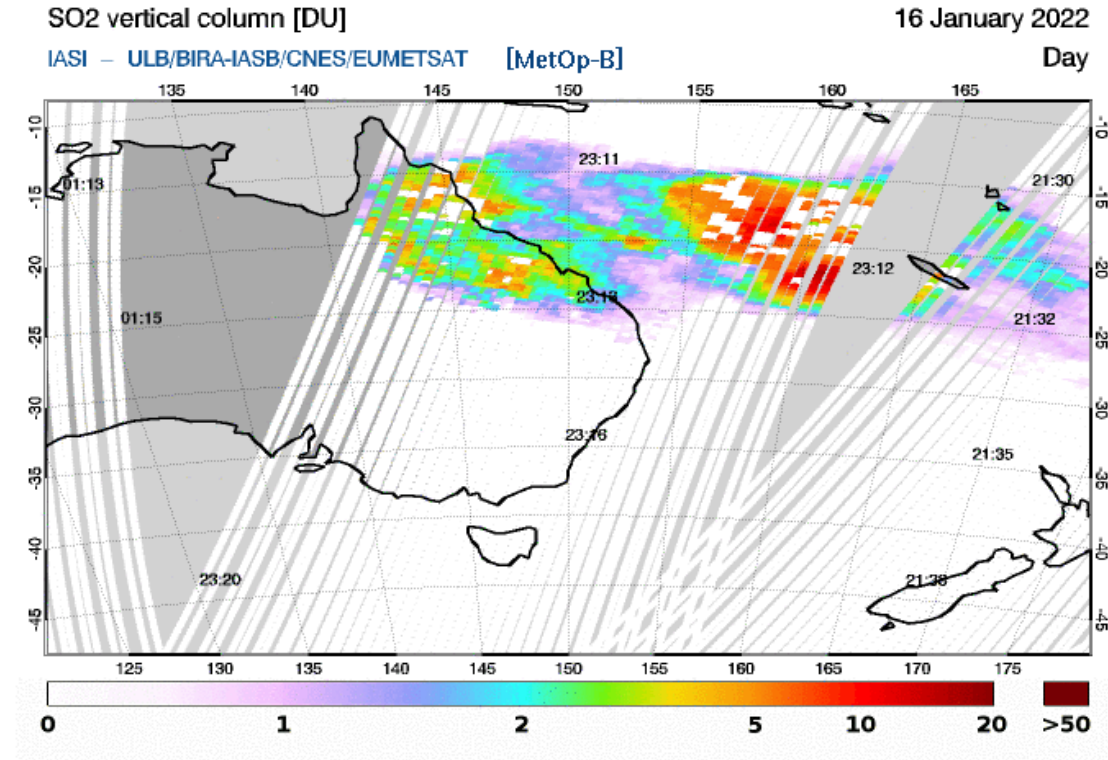
15 January – ash height challenge



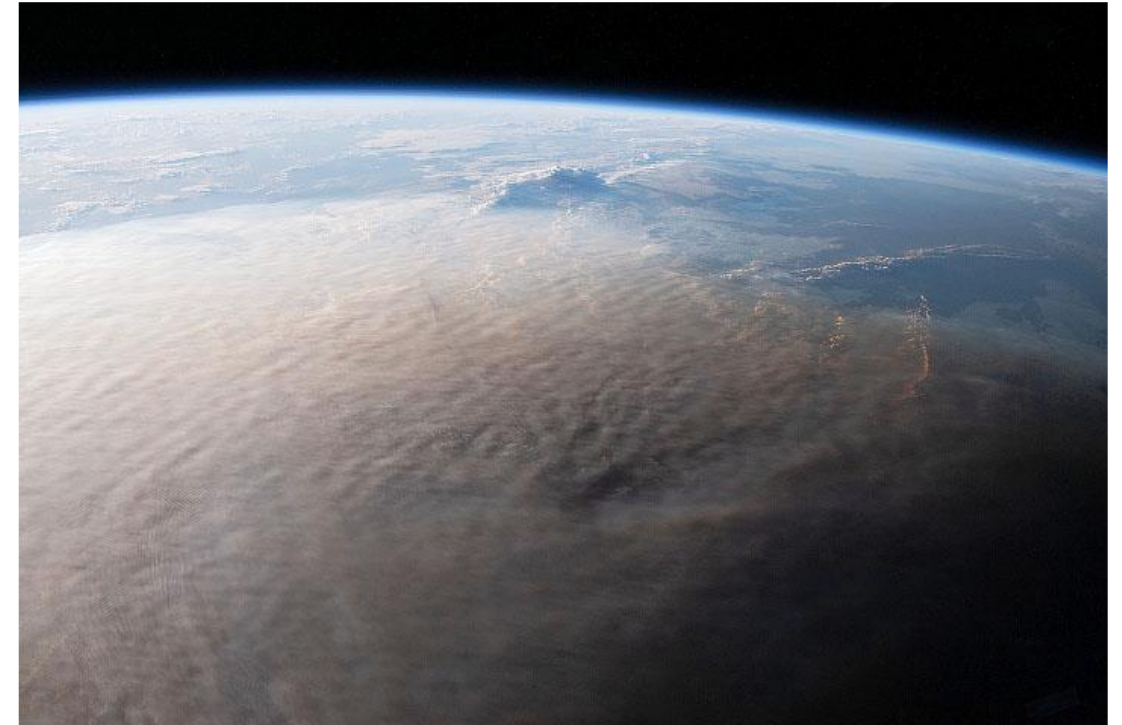
Relatively “warm” signature of ash in stratosphere initially indicated plume was much lower than it really was, but westward trajectory in satellite imagery gave the clue that it had reached the stratosphere.

A four-hour observation of the January 2022 eruption over the southern Pacific Ocean from the GOES-17 satellite.

16 January – heading west

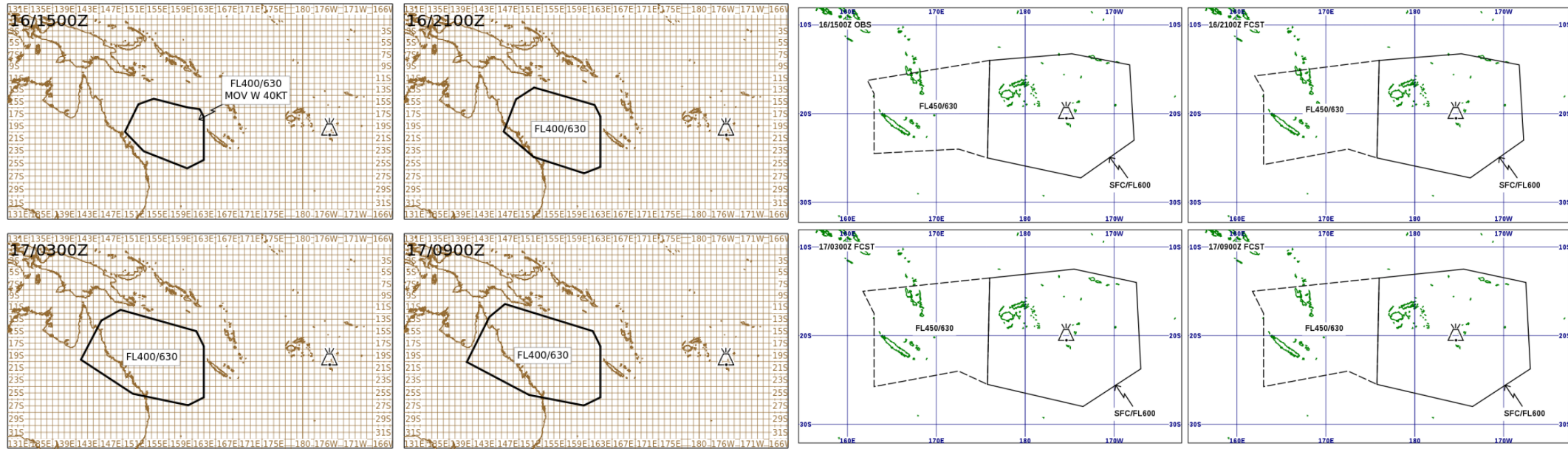


Daily IASI MetOp B SO2 detection from 16 January.



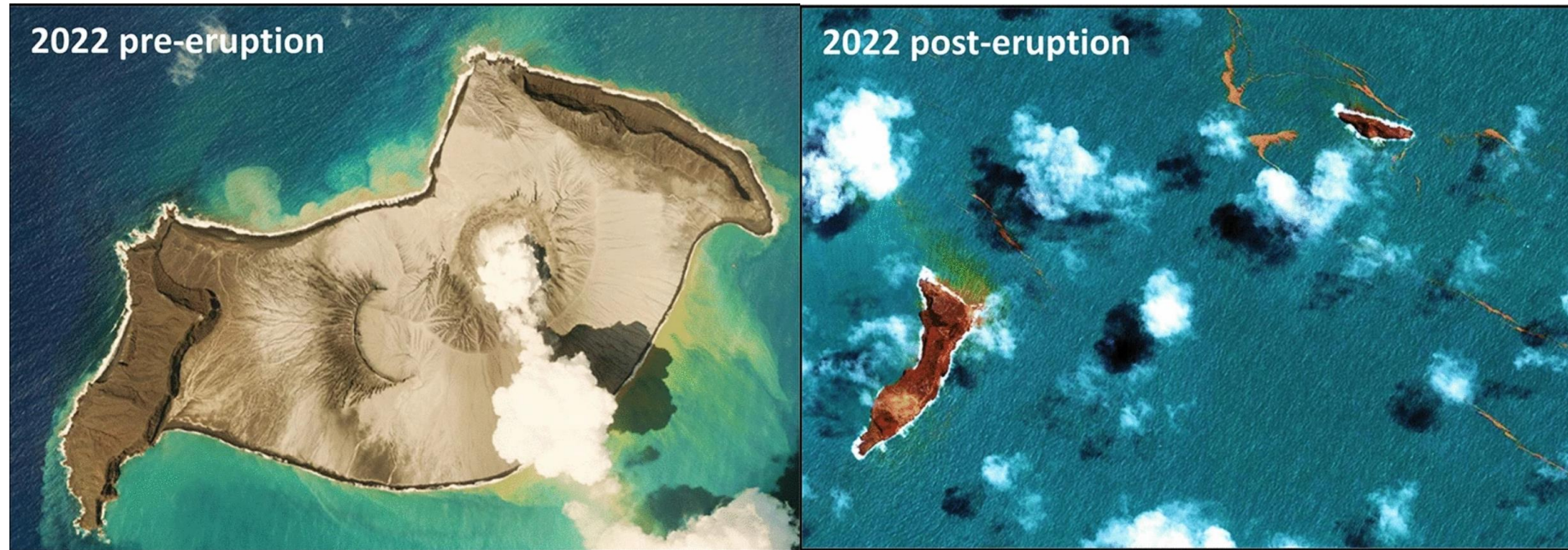
The stratospheric volcanic plume observed on 16 January, 2022 . Image courtesy of NASA Earth Observatory.

16 January – VAAC collaboration on VAAs



VAAs now issued separately as stratospheric ash extended across Australia. Cloud base difference due to lower tropopause height in Tasman Sea. VAAC Darwin took over entire cloud on 17 January, with the final VAA issued at 22/2320Z, nearly 6 days after initial eruption.

Back into the sea



The image in the bottom right is from 18 January 2022, three days after the most recent eruption. Credits for satellite images: CNES/Airbus and Maxar Technologies.

NZ review of eruptions – why?

By reviewing the NZ aviation sector response to the Hunga Tonga-Hunga Ha'apai eruptions, we could determine what worked well and where opportunities for improvement may lie.

These experiences could then be shared via appropriate forums (such as regional/global ICAO working groups, ISPACG etc) for others to consider and potentially learn from also.

Review process

- Held 18 March 2022 via Teams – with participants from VAAC/MWO Wellington, NZZO ATC, NZ NOTAM office, Airways policy team, Air NZ flight planning and CAA NZ.
- A consolidated timeline of the event including significant actions for each organisation was pulled together and shared ahead of the review meeting.
- Relevant outcomes from VOLCEX 20/02 were considered when reviewing the timeline during the meeting – in particular, were VOLCEX recommendations still relevant for a real high-level Tonga eruption?

Review outcomes – initial SIGMET

- Agreed that SIGMET is crucial tool for ensuring **all** users have awareness of eruption as soon as possible - not all receivers of SIGMET also receive initial VAA. (VOLCEX rec 3)
- Agreed that “initial” SIGMET process in place for NZZC FIR should be extended to NZZO FIR
 - SIGMET may only include volcano name/location and “eruption” – ash location and movement may still be being determined.
 - Even if it is determined plume is only steam, there is still value in alerting of elevated volcanic activity.

Review outcomes – initial SIGMET

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WVNZ21 NZKL 012232  
NZZC SIGMET 15 VALID 012237/020437 NZKL-  
NZZC NEW ZEALAND FIR MT RUAPEHU PSN S3917 E17534  
VA CLD OBS AT 2231Z S3917 E17534 =
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Note - the VA cloud observation location is a repeat of the volcano position.

The SIGMET would then be updated as soon as possible, using the full VAA, which would be issued when VA cloud horizontal extent and height is analysed and ash dispersion model is available.

Practice to be reviewed once VONA is widely available.

Review outcomes – situational awareness

- Tonga is responsible for initiating NOTAMs for the Tonga Sector of the NZZO FIR for volcanic activity
 - However, the request may be delayed or unable to be made due to impact of eruption (eg tsunami evac)
- Agreed that awareness of any new eruption in NZZO FIR would be useful and a “heads-up” call by VAAC/MWO Wellington would be appreciated. (VOLCEX rec 4, 6)

Review outcomes – unrest information

- Between eruptions ending early in January (final VAA at 02/1221Z and NOTAM cancelled at 05/2026Z) and the next eruption 13/1530Z, the only information regarded elevated unrest was the last VONA, issued 8 January – only required to be sent to VAAC, MWO and ACC/FIC.
- Need for elevated unrest information to be shared with airlines for risk management processes.
- Note – the Handbook on the International Airways Volcano Watch (IAVW) ICAO Doc. 9766 does advise NOTAM to be issued for significant pre-eruptive volcanic activity (section 4.3 refers).

Elevation of VONA to Rec. Practice

- Information on significant pre-eruptive volcanic activity or eruptions must be provided by State volcano observatories – but the format has never been formally defined.
- The Volcano Observatory Notice to Aviation (VONA) is a suggested format in the Handbook on the IAVW
- VONA is planned to become a ‘recommended practice’ in Annex 3 Amd 81 – expected applicability November 2024
- Disseminated in both traditional alphanumeric and IWXXM formats to their associated VAAC, MWO, ACC/FIC and now **NOTAM offices** and, by regional agreement, **regional OPMET databanks**.

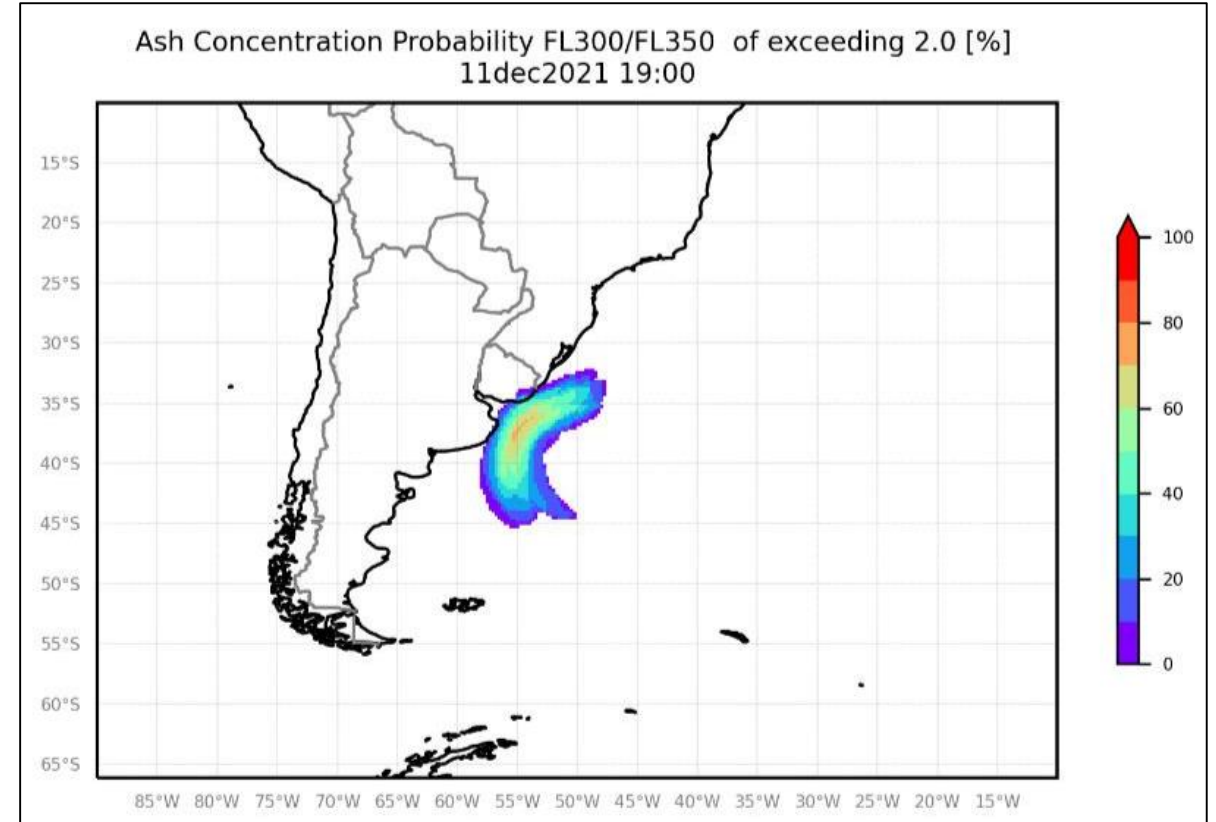
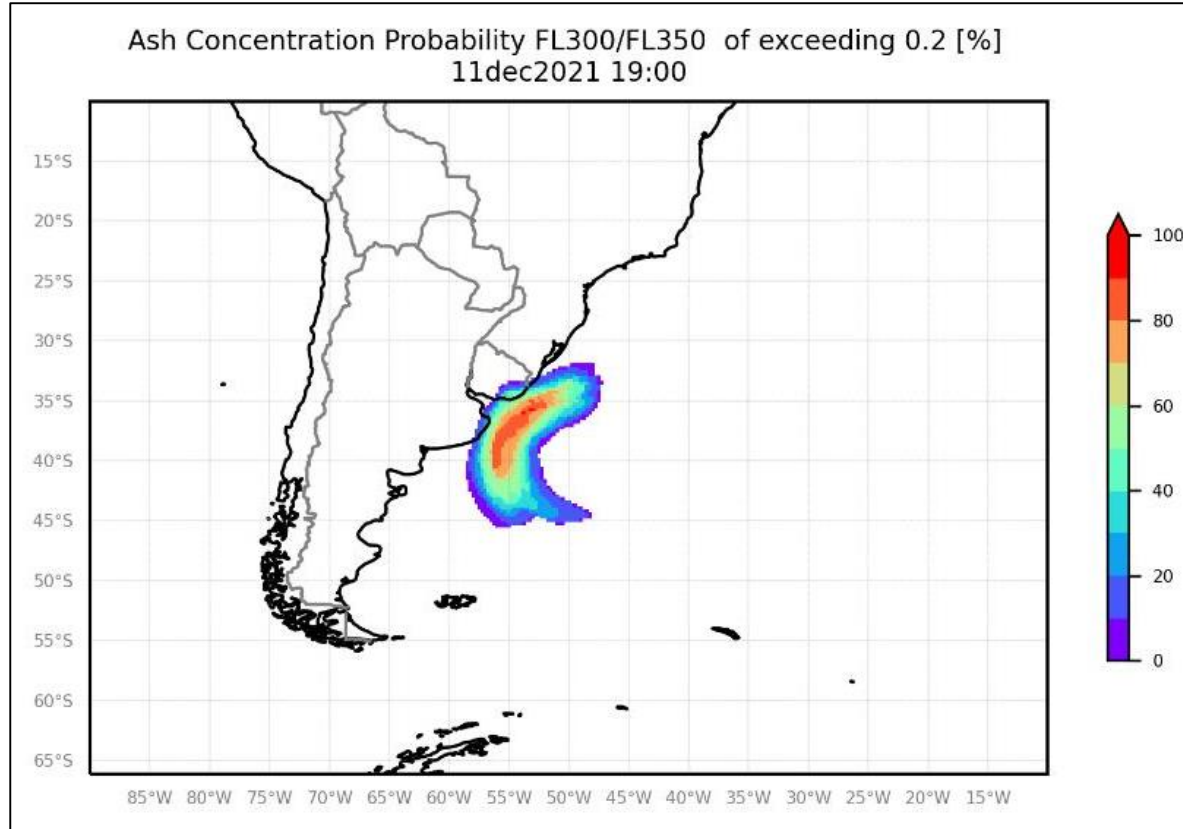
Quantitative Volcanic Ash (QVA) information

- 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 re-planning.
- Expected to be provided by **VAACs in a position to do so** for *significant* volcanic ash clouds from November 2024.
- “Significant” to be defined in the Handbook on the IAVW, expected to include proximity to international aerodromes, minimum vertical extent of cloud and by reasonable request of ATC/airlines – with exceptions for quality control assessment and discretion by the VAAC.

Quantitative Volcanic Ash (QVA) information

- QVA expected to be a recommended practice for **all VAACs** from 2025 and then a standard potentially from 2026.
- To be provided in NetCDF as a probabilistic gridded data set. Also to be provided as IWXXM objects (based on a minimum volcanic ash concentration).
- Intended to eventually be provided for all VA clouds and to replace VAA/VAG (and potentially also VA SIGMET) in coming years. There will be a need to extract information relevant for each user e.g. for an FIR.
- Flyer to be published early 2023 highlighting QVA information and plans.

QVA information – gridded data example



QVA information – IWXXM objects

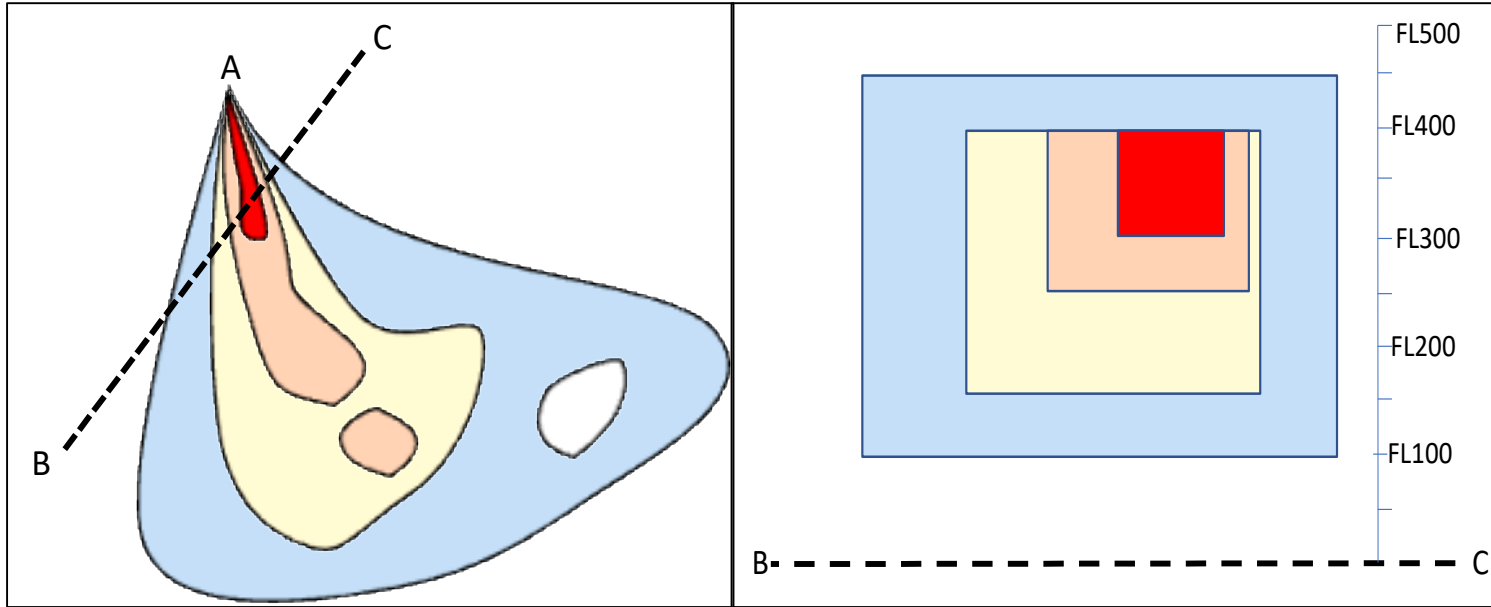
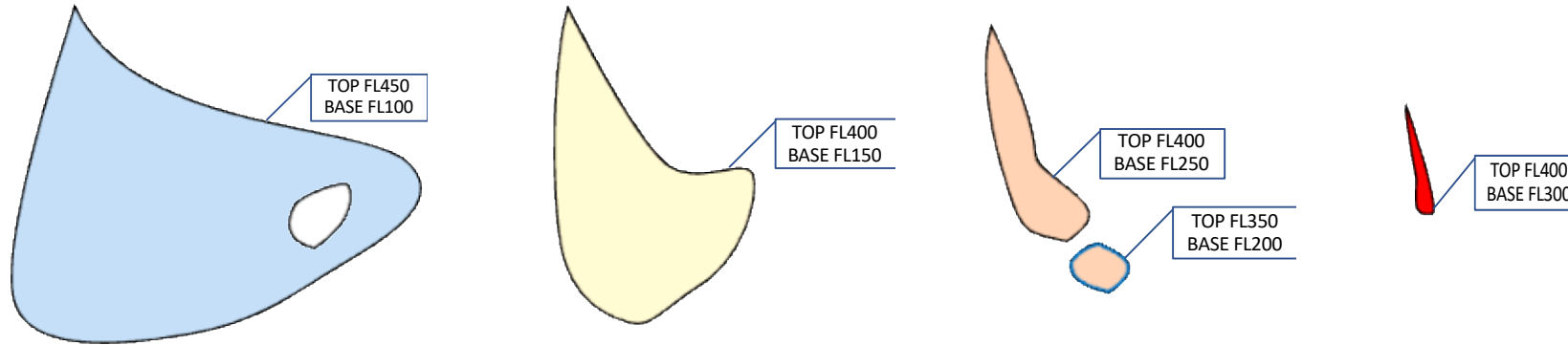


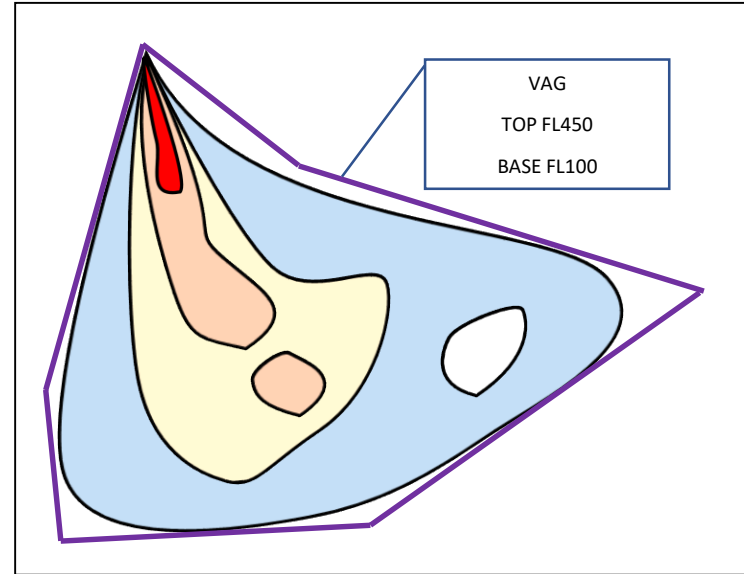
Figure 1 (left). IWXXM objects showing all QVA thresholds depicted in the horizontal from a fictitious volcano located at A. The vertical depiction along line B-C is shown in **Figure 2 (right)**.

QVA information – IWXXM objects



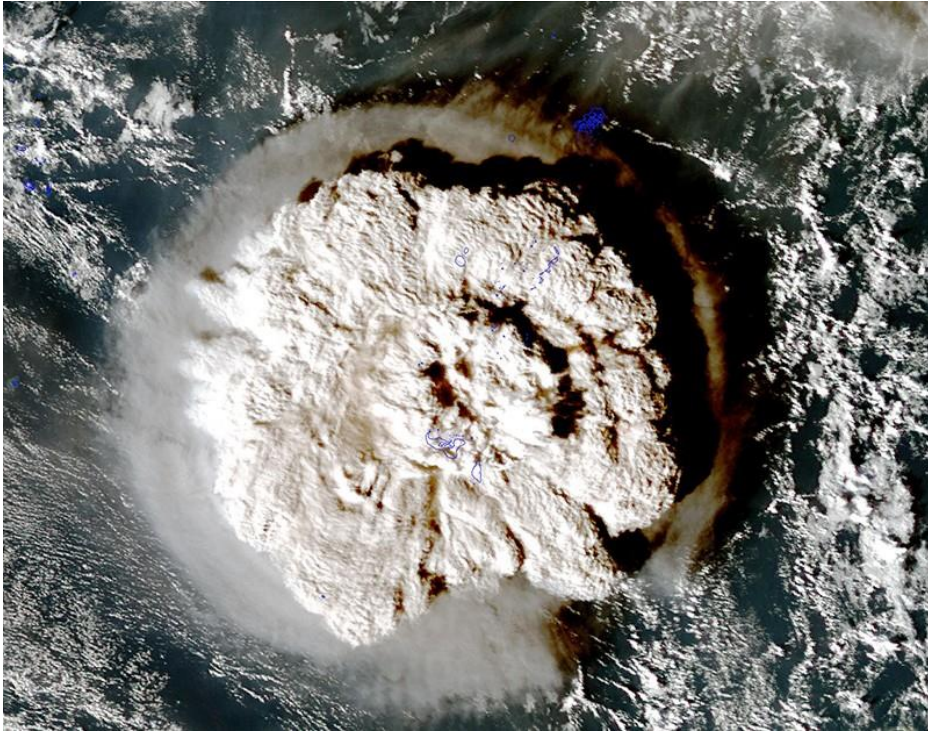
Figures left to right depict the individual IWXXM objects from previous slide, with increasing concentration (0.2, 2, 5 and 10 mg/m³). The “hole” is ash <0.2mg/m³.

QVA information – IWXXM objects



Visual illustration of QVA information IWXXM objects and volcanic ash advisory in graphic form.

Questions?



Himawari 8 satellite image of ash plume on 15 January 2022, provided by JMA.

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