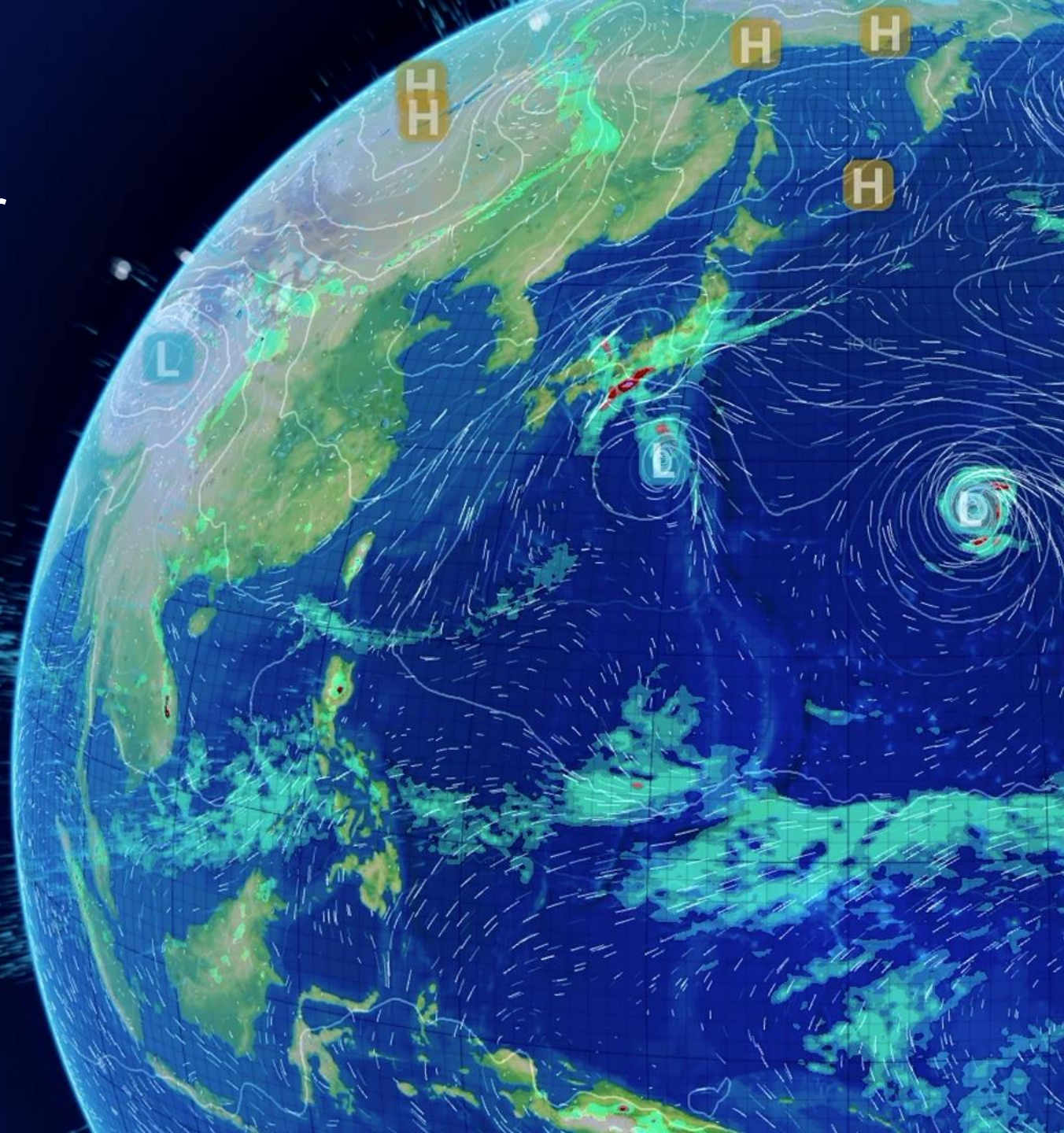
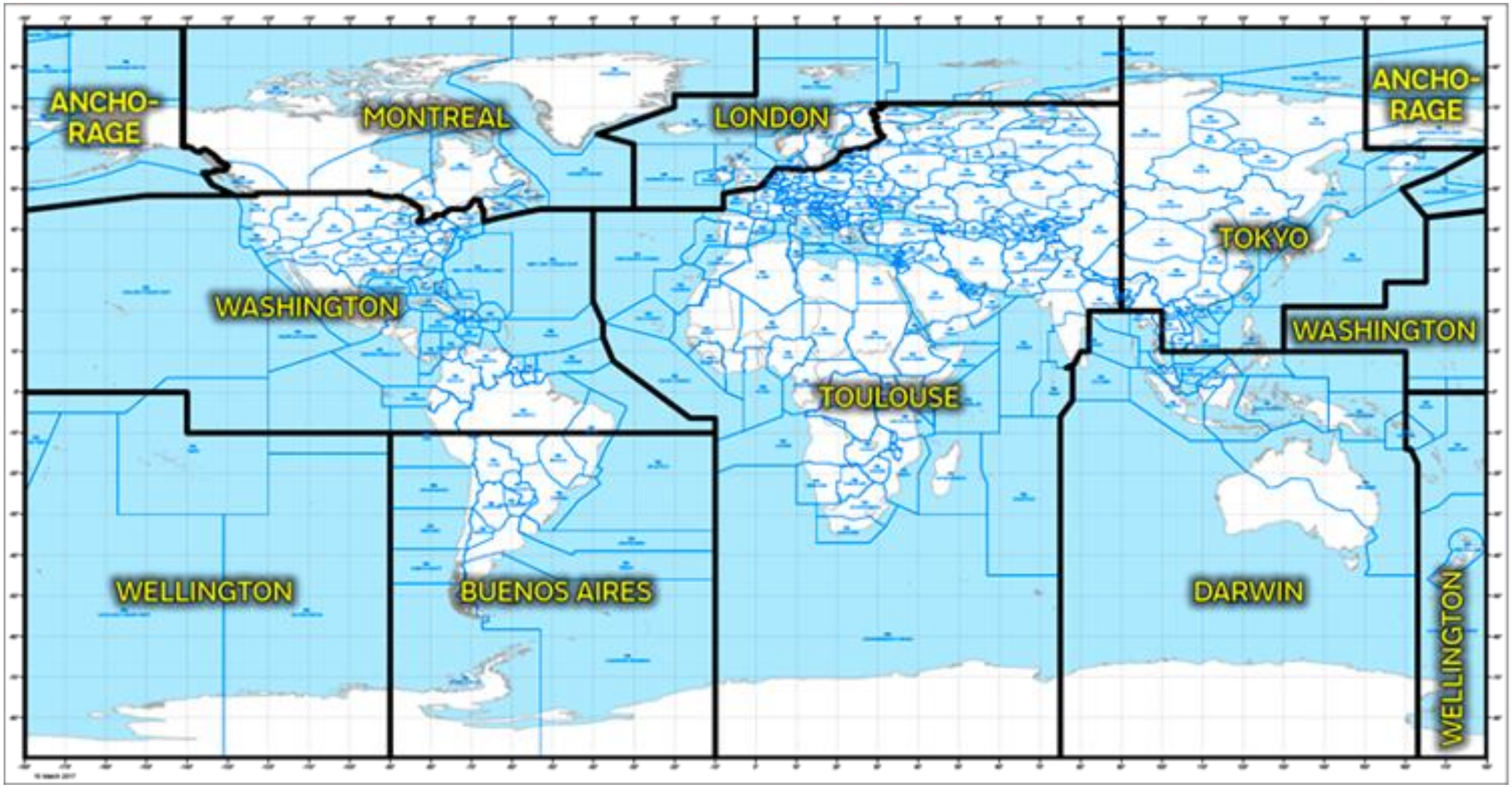
Quantitative Volcanic Ash Webinar



Met Office

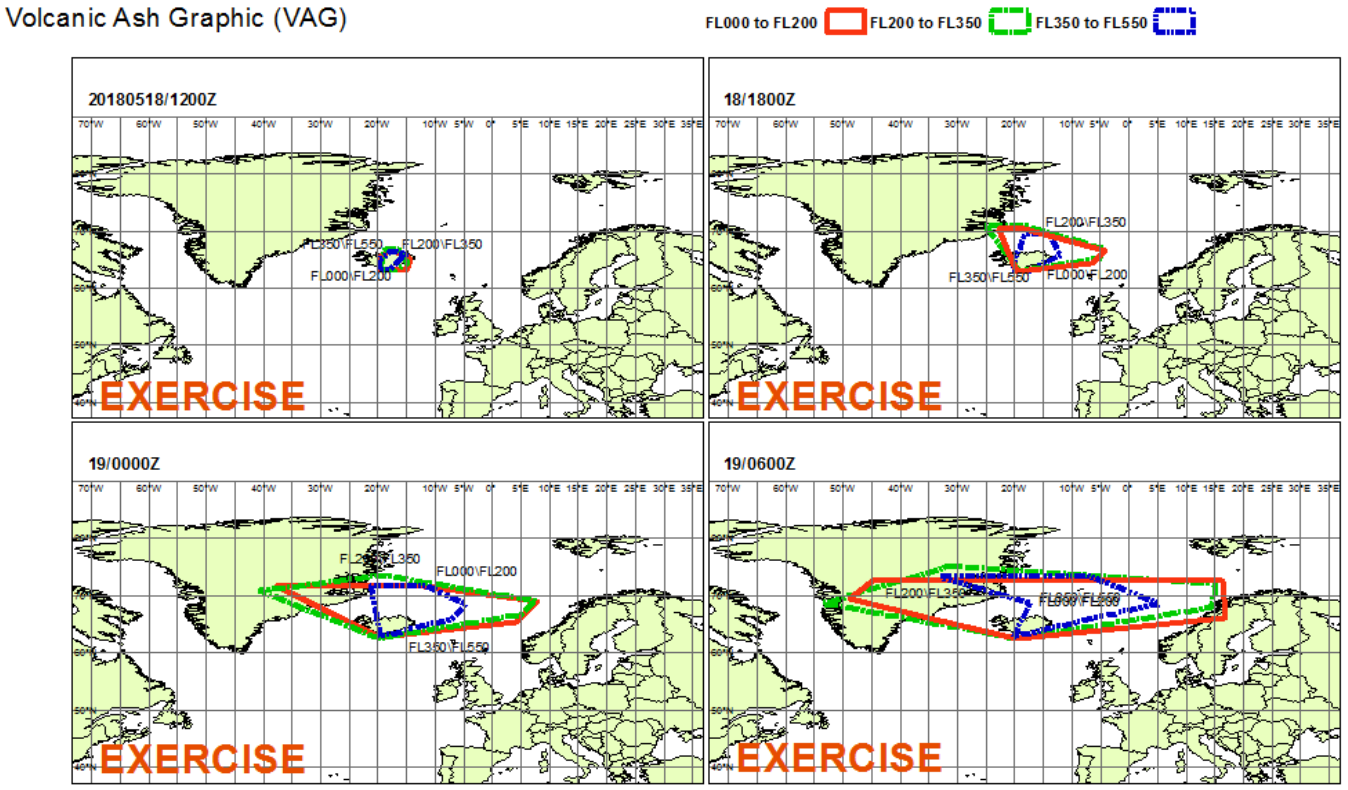
Volcanic Ash Advisory Centres (VAACs)



Met Office

Volcanic Ash Forecasts

At present, ICAO mandated Volcanic Ash forecasts are:

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FVXX22 KNES 180646

VA ADVISORY

DTG: 20231018/0646Z

VAAC: WASHINGTON

VOLCANO: REVENTADOR 352010

PSN: S0005 W07739

AREA: ECUADOR

SUMMIT ELEV: 11686 FT (3562 M)

ADVISORY NR: 2023/679

INFO SOURCE: GOES-16. NWP MODELS.

ERUPTION DETAILS: OCNL EM

OBS VA DTG: 18/0620Z

OBS VA CLD: SFC/FL150 N0001 W07743 - S0004 W07738

- S0006 W07741 - S0002 W07746 - N0001 W07743 MOV

NW 10KT

FCST VA CLD +6HR: 18/1230Z SFC/FL150 N0004 W07752

- S0004 W07738 - S0007 W07740 - S0000 W07755 -

N0004 W07752

FCST VA CLD +12HR: 18/1830Z SFC/FL150 N0005

W07751 - S0004 W07738 - S0006 W07740 - N0001

W07754 - N0005 W07751

FCST VA CLD +18HR: 19/0030Z SFC/FL150 N0004
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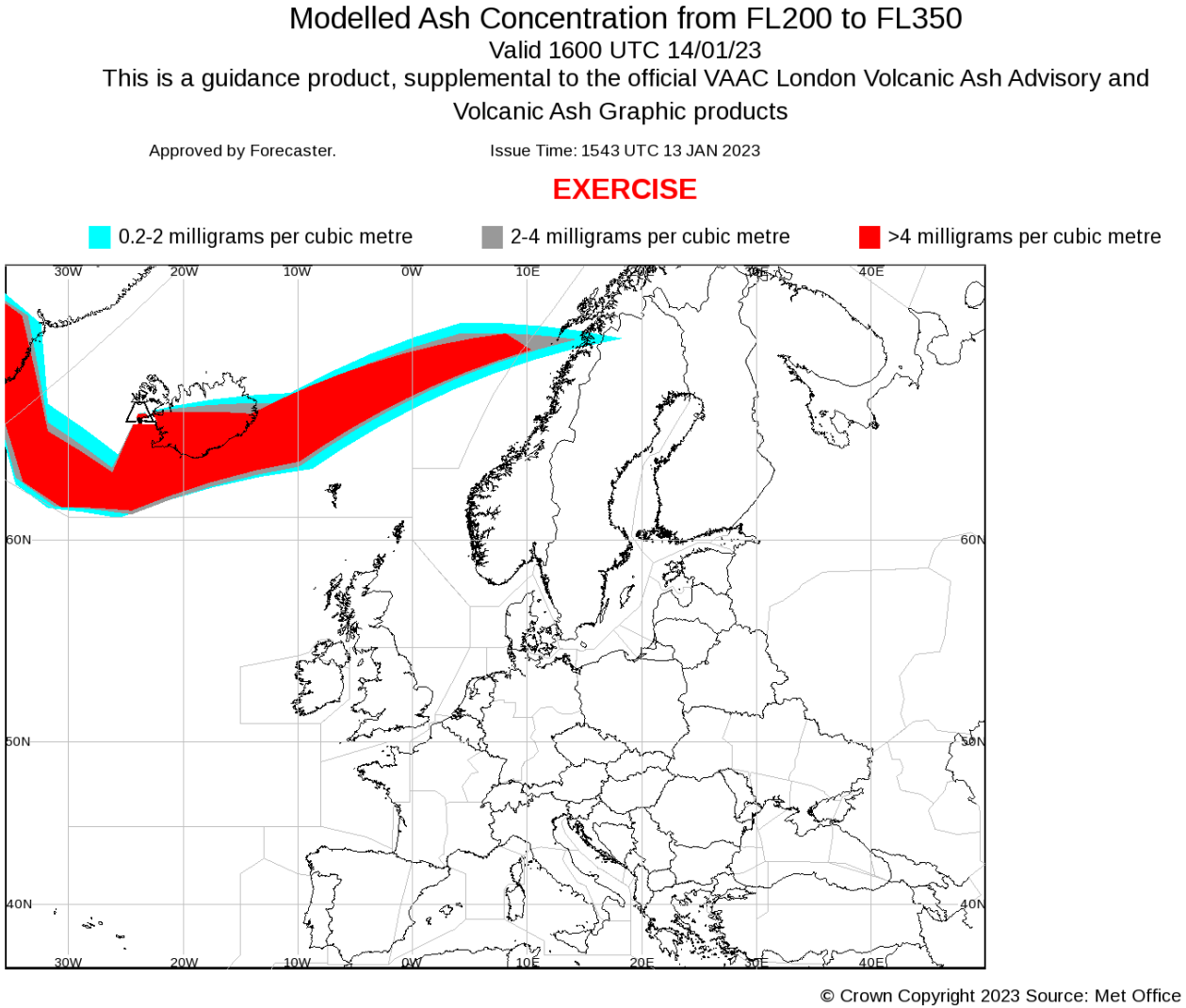
Volcanic Ash Forecasts

- Since 2010 VAAC London and VAAC Toulouse have provided ash concentration forecasts
- Data provided as charts, and simple data files



This product has three vertical levels, three concentration bands and four timesteps

How do we forecast volcanic Ash

Eruption information is provided to VAACs through a Volcano Observatory Notification for Aviation (VONA)

EXERCISE EXERCISE EXERCISE [NOT OFFICIAL/EXAMPLE ONLY]

(1) VOLCANO OBSERVATORY NOTICE FOR AVIATION — VONA

(2) Issued:20250702/0823Z

(3) Volcano: Eyjafjallajökull (372020)

(4) Current aviation colour code: RED

(5) Previous aviation colour code: GREEN

(6) Source: Icelandic Meteorological Office

(8) Volcano location: N6337 W01937

(9) Area: Eastern Volcanic Zone

(10) Summit elevation: 1651 M

(11) Volcanic activity summary:
The eruption in Eyjafjallajökull which started at 15:00 UTC on the 1st July is still ongoing

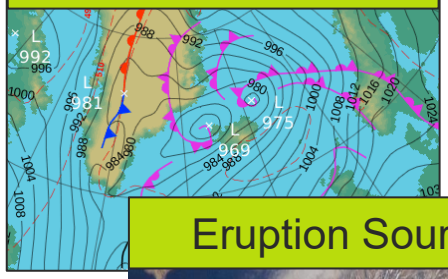
Etc Etc Etc……

Image from an eruption at Hekla volcano on 17th August 1980. Photo courtesy of Gudmundar Sigvaldason (Nordic Volcanological Institute), 1980, Image GVP-05165, Smithsonian Institute, Global Volcanism Program

How do we forecast volcanic Ash

Inputs → Model Simulation → Evaluation + Forecast Generation → Final Product

Weather Forecast

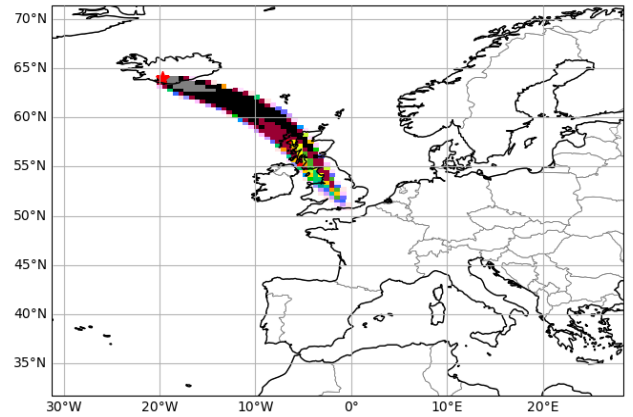


Eruption Source

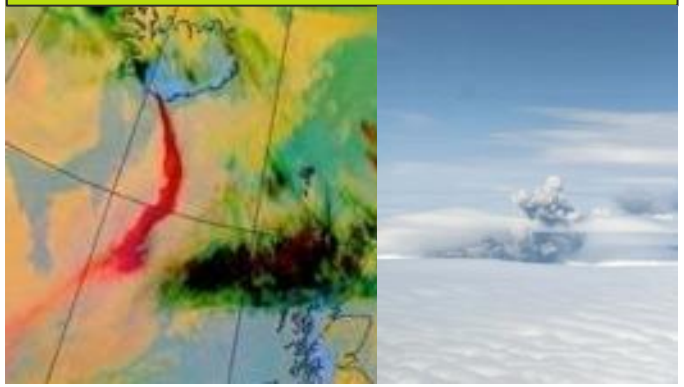
Observations

Dispersion Model

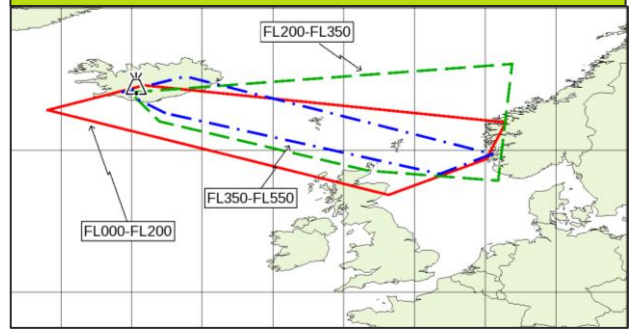
Model Output



Observations



VAG



Quantitative Volcanic Ash

Met Office

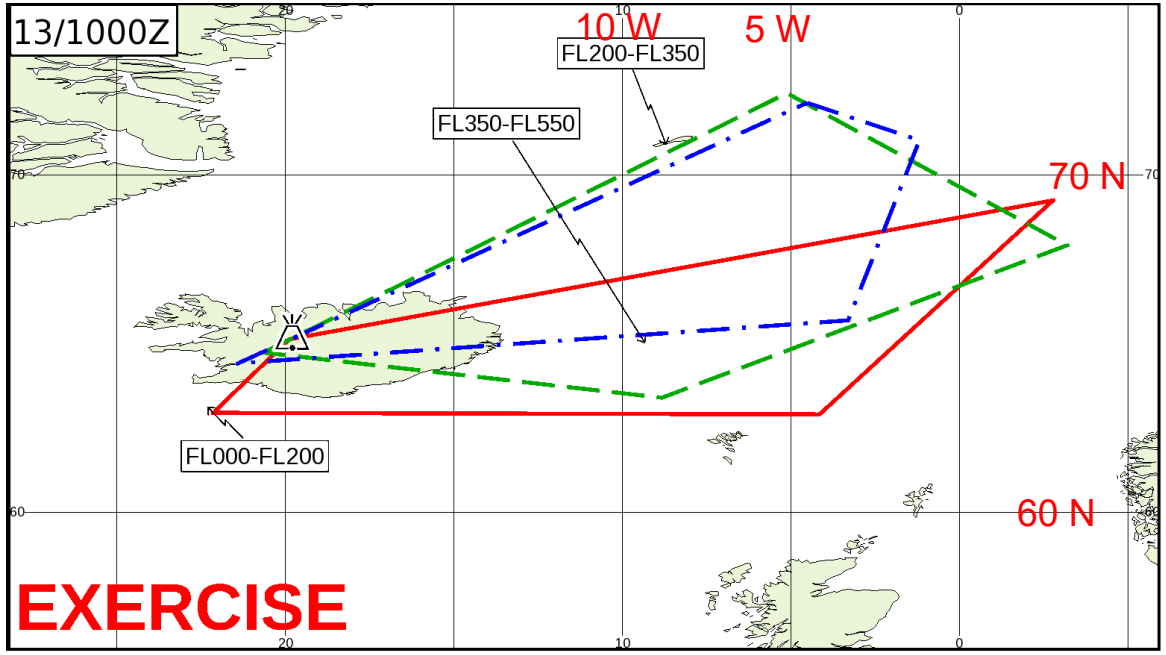
Quantitative Volcanic Ash (QVA)

- Builds on the extra data provided by VAAC London and VAAC Toulouse
- A work stream under the ICAO Met Panel has been defining the requirements for a new quantitative volcanic ash (QVA) information service. This group includes IATA, and aircraft engine manufacturers
- QVA information offers operators the opportunity to move away from traditional discernible ash criteria and instead use certified engine susceptibility for flight route planning and inflight replanning.
- The new provision is being introduced into Annex 3 with Amendment 82 and the new PANS-MET (First edition) on 27 November 2025

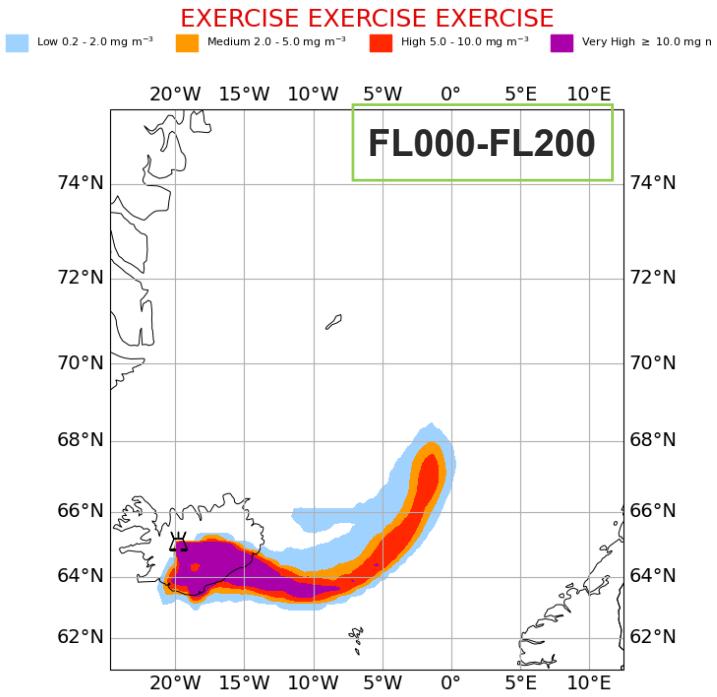
Met Office

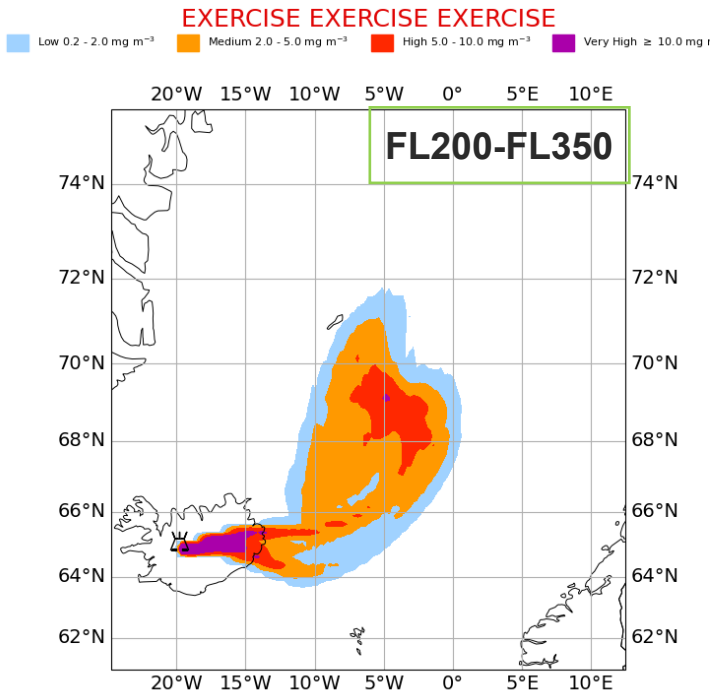
Quantitative Volcanic Ash (QVA)

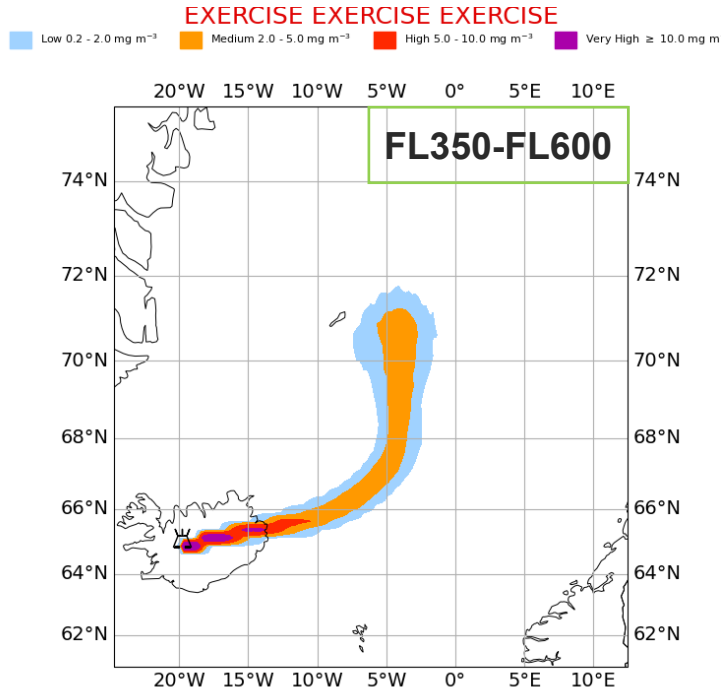
- QVA data has a higher resolution
- We can now create a probabilistic forecast of volcanic ash. This provides an indication of the confidence in the forecast.



QVA provides far more detail for decision making than the old VAA/VAG.







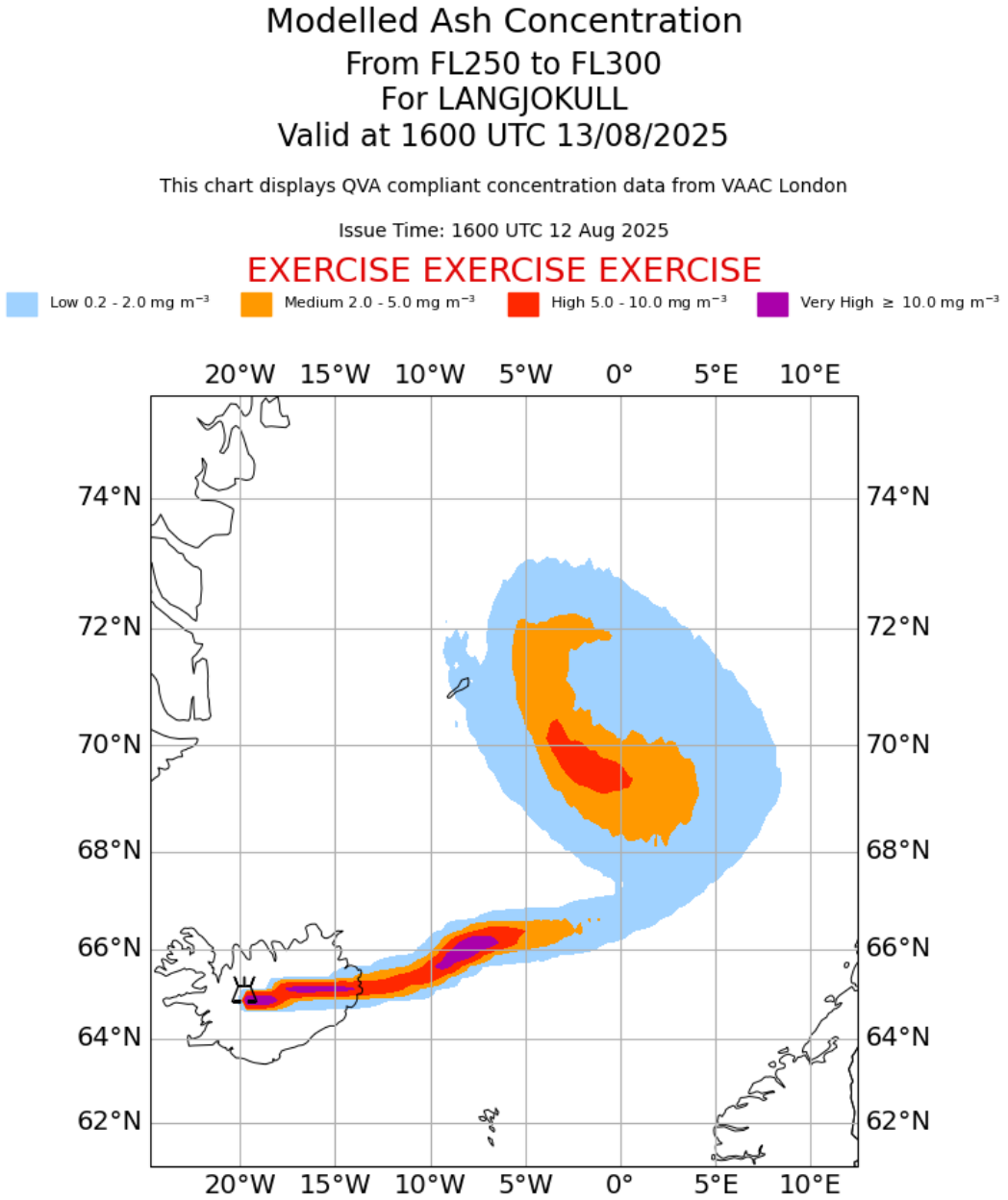
Quantitative Volcanic Ash data sets

What are the QVA data sets?

Deterministic gridded data

- Gives the expected ash concentration

Descriptor	Concentration thresholds and ranges
Very Low	<0.2 mg/m^3
Low	≥0.2 to <2 mg/m^3
Medium	≥2 to <5 mg/m^3
High	≥5 to <10 mg/m^3
Very high	≥10 mg/m^3



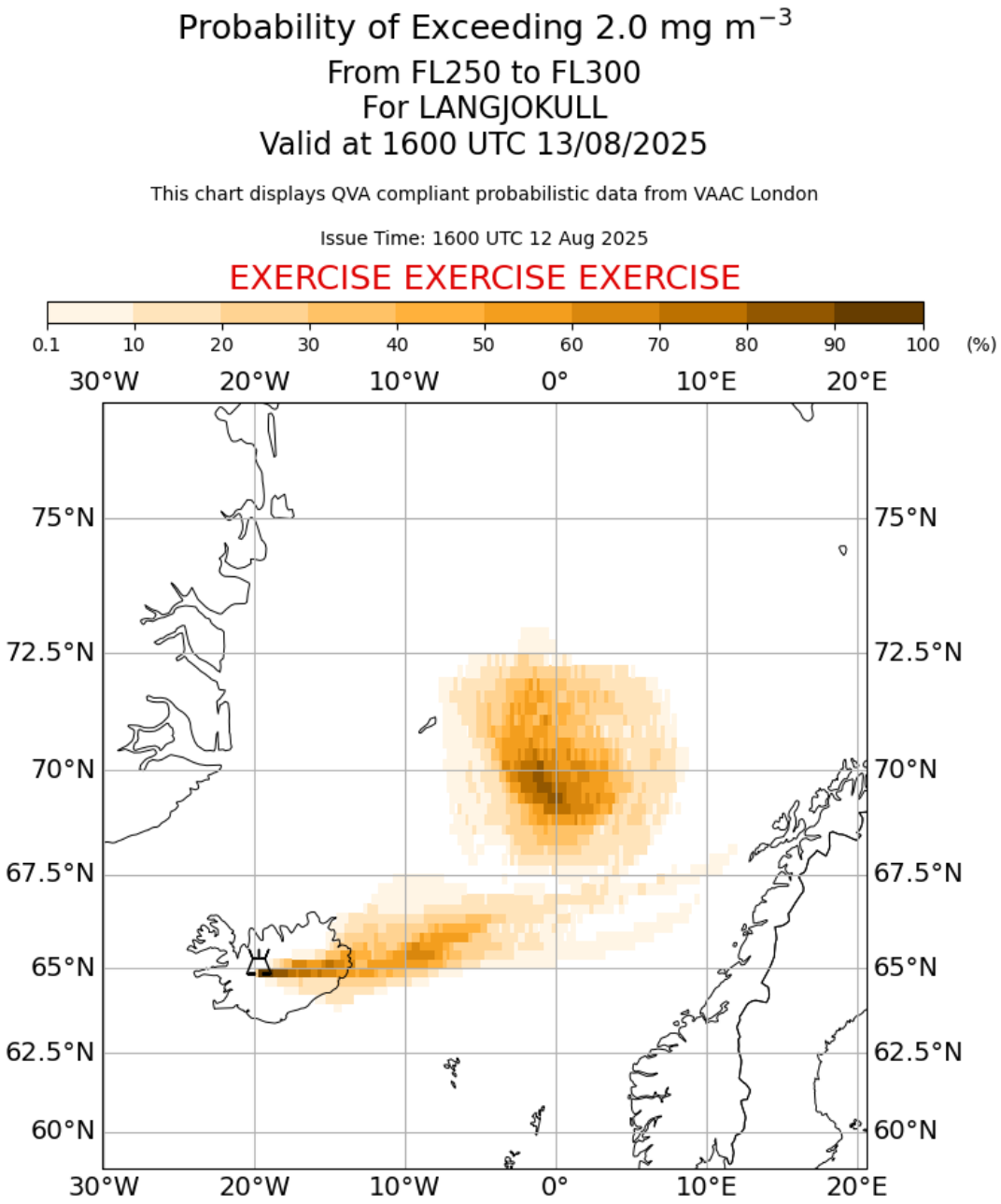
Existing VAA/VAG uses the ≥0.2 mg/m^3 threshold

What are the QVA data sets?

Probabilistic gridded data

- Gives the probability that the ash concentration these thresholds

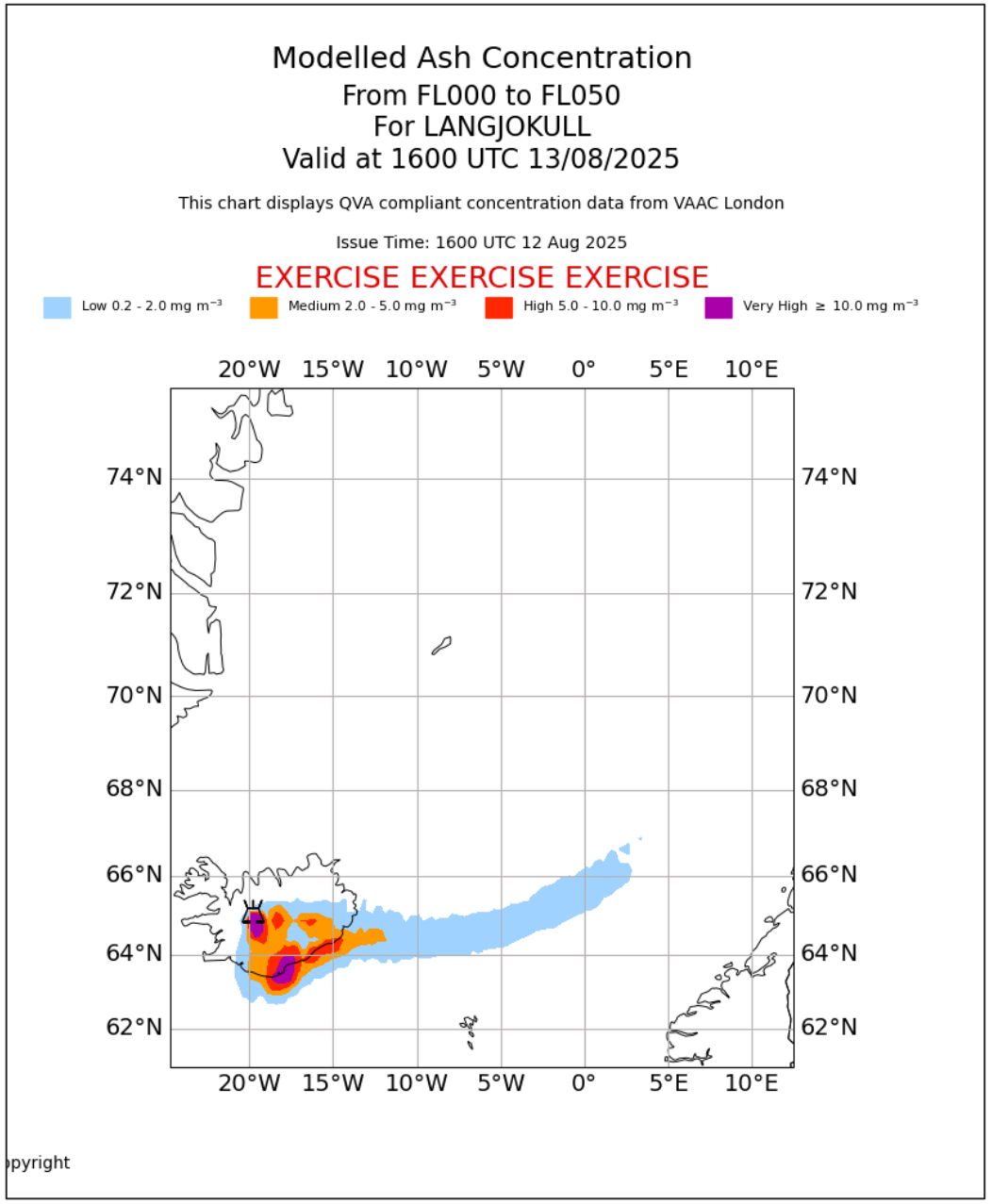
Concentration thresholds
≥ 0.2 mg/m^3
≥ 2.0 mg/m^3
≥ 5.0 mg/m^3
≥ 10.0 mg/m^3



What are the QVA data sets?

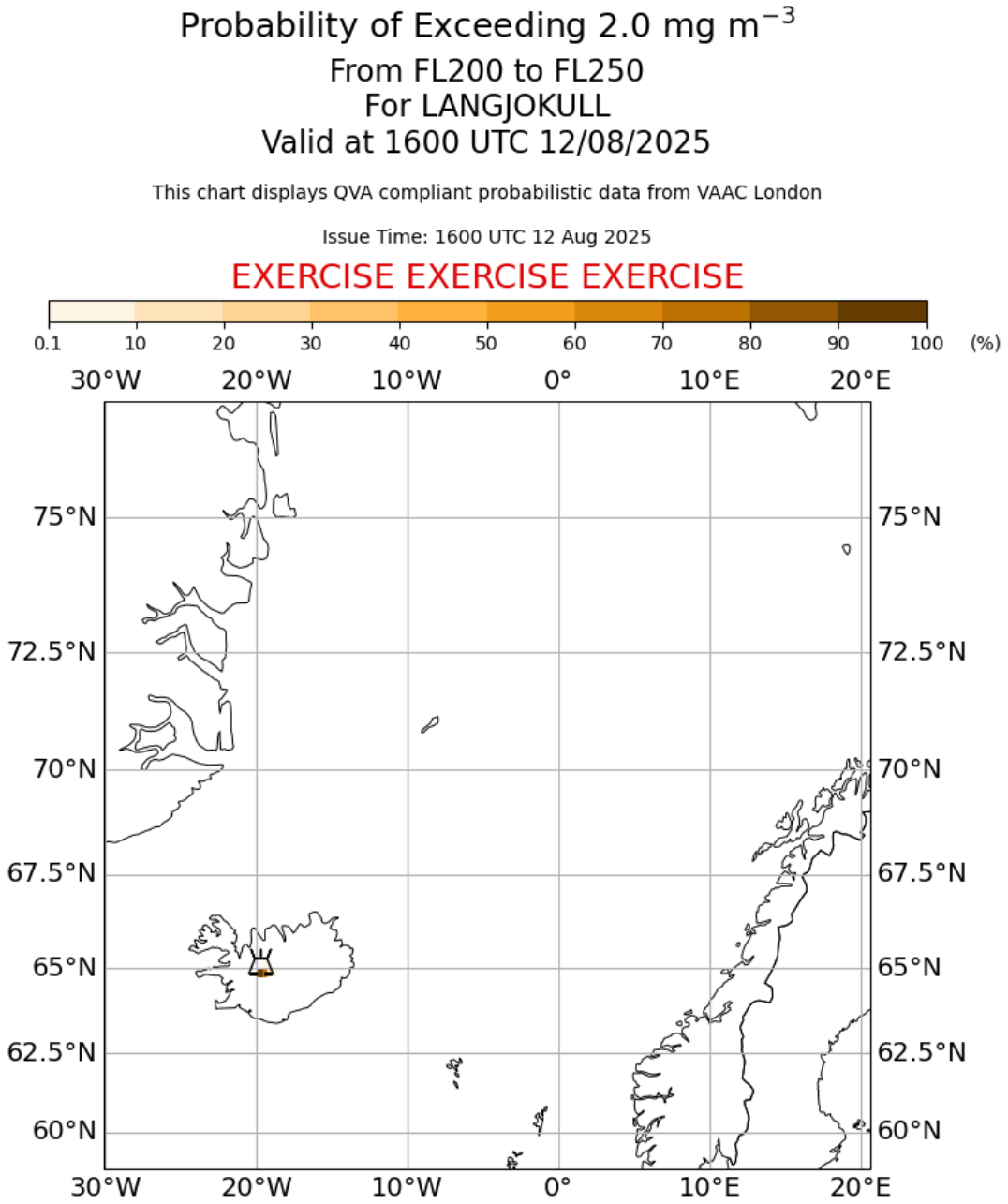
- Gridded data will be provided for 12 vertical levels (FL000 to FL600 at 5000ft intervals) at 0.25-degree latitude/longitude horizontal resolution

From mean sea level to and including flight level (FL) 50
Above FL 50 to and including FL 100
Above FL 100 to and including FL 150
Above FL 150 to and including FL 200
Above FL 200 to and including FL 250
Above FL 250 to and including FL 300
Above FL 300 to and including FL 350
Above FL 350 to and including FL 400
Above FL 400 to and including FL 450
Above FL 450 to and including FL 500
Above FL 500 to and including FL 550
Above FL 550 to and including FL 600



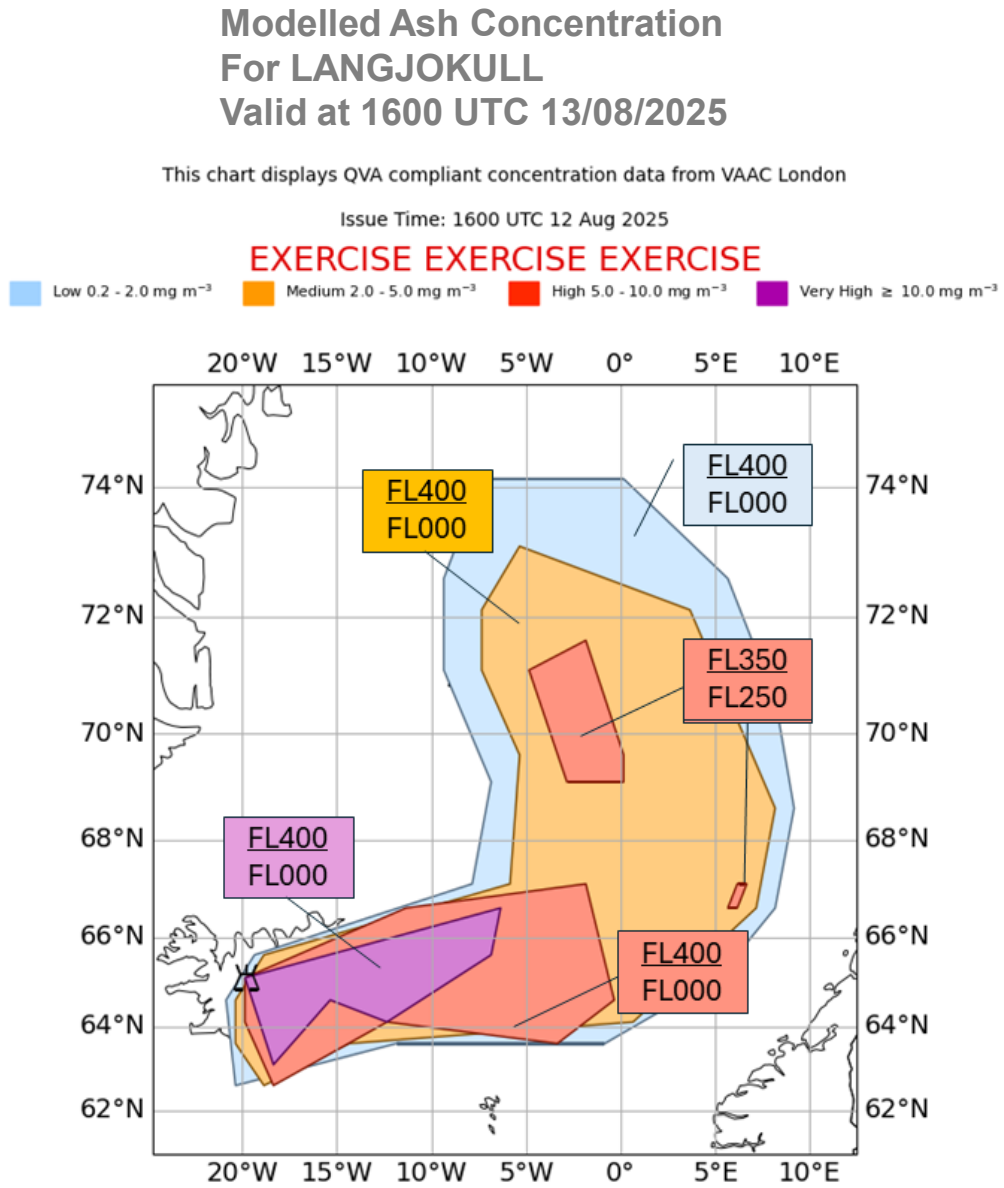
What are the QVA data sets?

- Timesteps: T+0 to T+24 at 3-hourly intervals



What are the QVA data sets?

- Ash polygons with attributes (a bit like WAFS SIGWX)
- Calculated from the deterministic QVA forecast, for ≥0.2, ≥2.0, ≥5.0 and ≥10.0 mg/m³
- Forecast vertical range covers FL000 to FL600
- Data in IWXXM format



Met Office

QVA data will be issued for “significant eruptions”

For a volcanic ash cloud to be deemed significant, and so prompting the provision of QVA, a VAAC will consider the following points (subject to VAAC assessment and workload):

- *Whether the volcanic ash cloud is impacting an international airport or a busy domestic airport.*
- *Whether the volcanic ash cloud is being transported a long way from the volcano and so impacting air routes.*
- *Whether there is a user request for QVA issuance*.

VAAC London expects to produce QVA forecasts for any eruption occurring on Iceland which is ejecting ash into the atmosphere.

Met Office

When and how will the QVA forecasts be provided?

- Forecast will be updated at 6 hr intervals during an ongoing eruption or if there is a significant change in the character of the eruption.

- The originating VAAC will cover the whole plume, however big it gets and wherever it goes.

- Data will be provided by each VAAC via API
- The VAACs have agreed to use a consistent technical approach, similar to what VAAC London has built. This is technically very similar to the SADIS API.

Common questions

Met Office

Why don't we call ash concentrations <0.2mg/m3 "nil":

Descriptor	Concentration thresholds and ranges
Very Low	<0.2 mg/m^3
Low	≥0.2 to <2 mg/m^3
Medium	≥2 to <5 mg/m^3
High	≥5 to <10 mg/m^3
Very high	≥10 mg/m^3

- We can model concentrations below 0.2mg/m^3
- Newer satellite instruments can now detect ash below 0.2mg/m^3
- Tiny concentrations of ash can be present that are very far from an eruption

Met Office

Ash concentrations <0.2mg/m^3 have minimal impact on aircraft

Paper titled " ***Maximising Airspace Use During Volcanic Eruptions: Matching Engine Durability against Ash Cloud Occurrence"*** *by Rory Clarkson @ Rolls Royce in 2017*

> (i) As indicated above, an engine's exposure to ash concentrations below 0.2 mg/m^3 can be neglected. Not only would exposure to such ash be very difficult to establish, there is considerable evidence that extremely large exposure times would be needed for significant damage to occur.

Met Office

4mg/m^3 vs 5mg/m^3 threshold

- The existing threshold (discernible Ash) used by the VAACs to denote areas of potentially hazardous ash (VAA/VAG), and reliably detectable by Satellite, was approximately equivalent to concentration of 0.2 mg/m^3.
- Additional thresholds of 2 mg/m^3 and 4 mg/m^3 were agreed in 2010 as acceptable thresholds that with suitable safety risk assessments and associated operational procedures could be used by airlines to plan for flights. These values were determined based on tactical thinking and with limited data.
- This was only adopted within the EUR/NAT ICAO areas due to significant disagreement amongst global experts and aviation stakeholders.

4mg/m^3 vs 5mg/m^3 threshold

- Since 2010 significant additional work to understand the damage mechanisms and susceptibility of aircraft engines has taken place. The key factor being it is not a spot concentration of ash encountered, but the duration of exposure to a concentration that is important.
- Research (by Rolls Royce) shows that engines operating in concentrations of 4 or 5 mg/m^3 would be able to operate for approximately 60 or 40 mins respectively without engine related safety margins being significantly affected. For 2mg/m^3 this would equate to 2 hours.

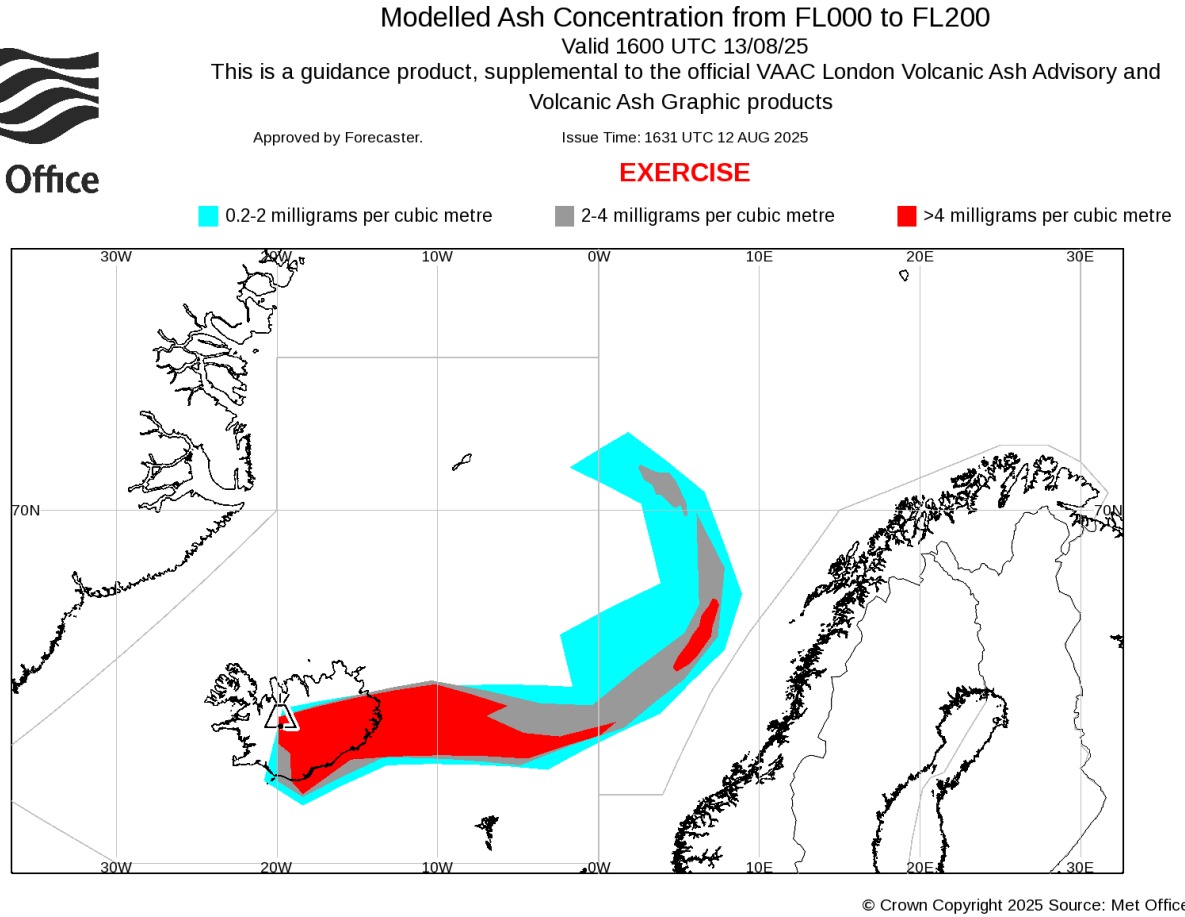
Met Office

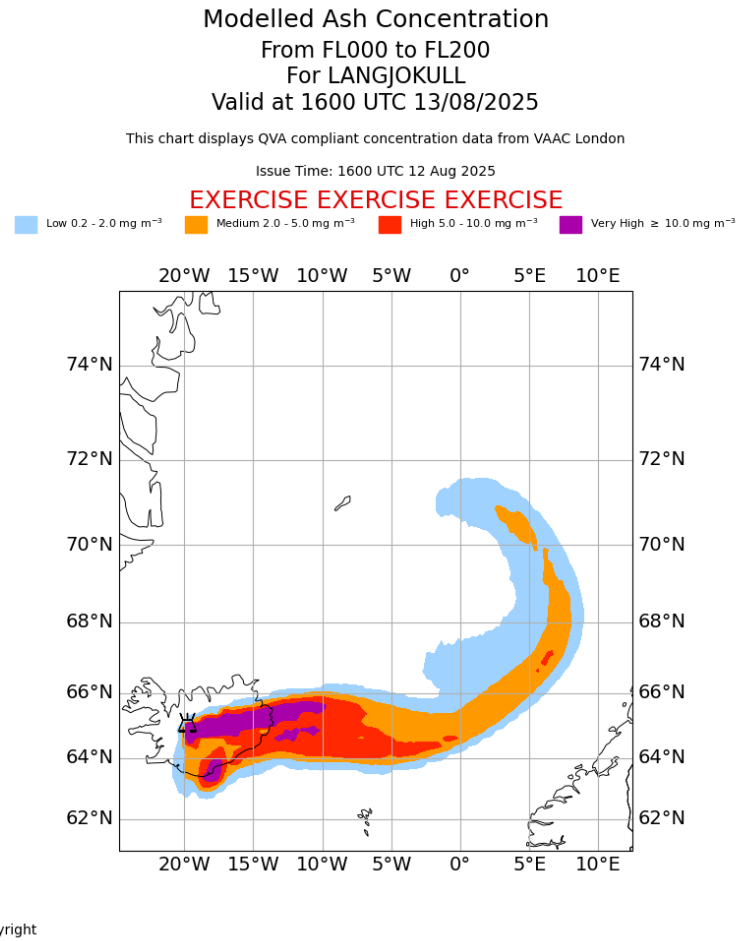
4mg/m^3 vs 5mg/m^3 threshold

- QVA thresholds discussed in great detail by ICAO Met Information and Service Development (MISD) volcanic ash work stream in 2019/2020
  - *inherent uncertainty in forecast accuracy means that being confident about the relative position of ash concentrations at 2 mg/m^3 and 4 mg/m^3 is difficult.*
  - *Differentiating between the relative position of ash at 2 mg/m^3 and 10 mg/m^3 is more reliable*

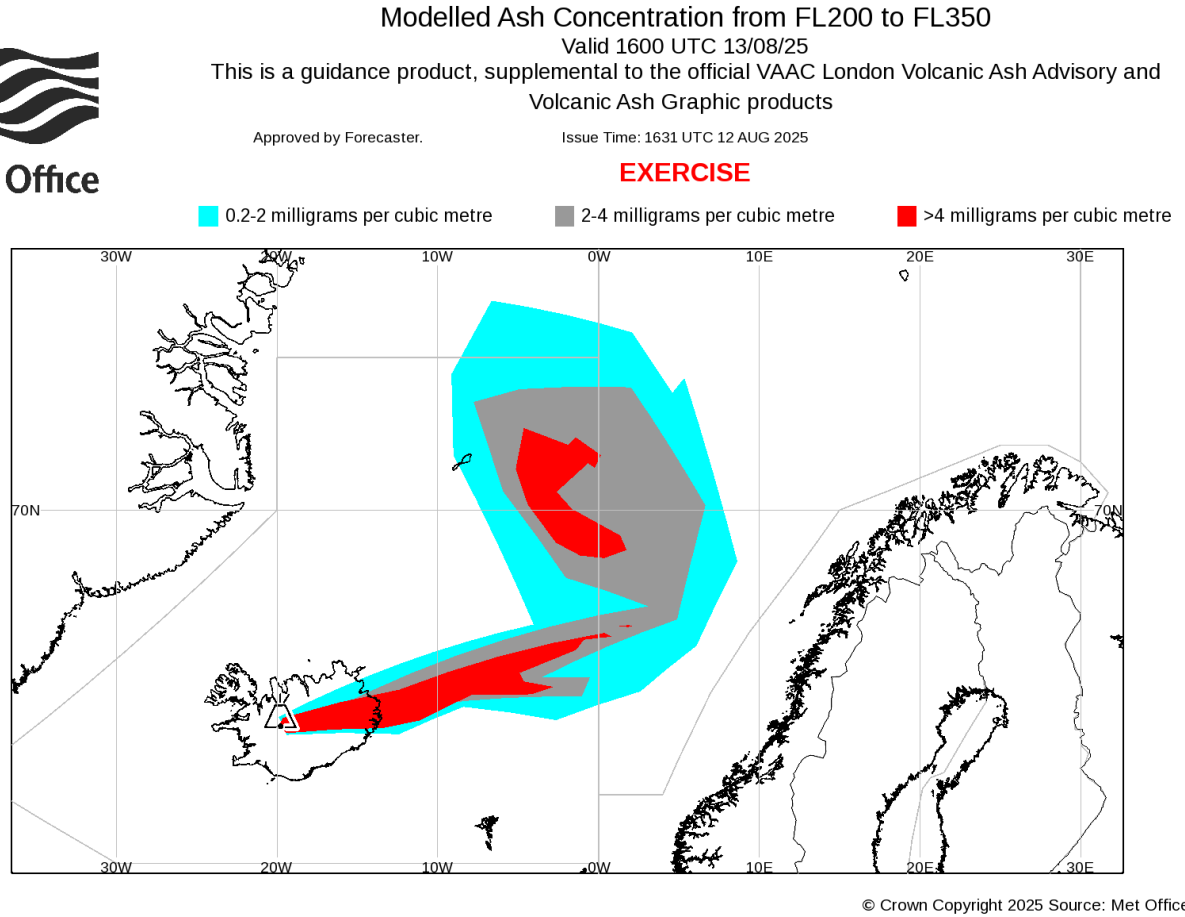
- The adoption of 5 mg/m^3 as a suitable intermediate concentration between 2 mg/m^3 and 10 mg/m^3 was agreed as a reasonable compromise between the ash susceptibility one OEM (Rolls-Royce) has defined and what is practical from the forecasters' perspective

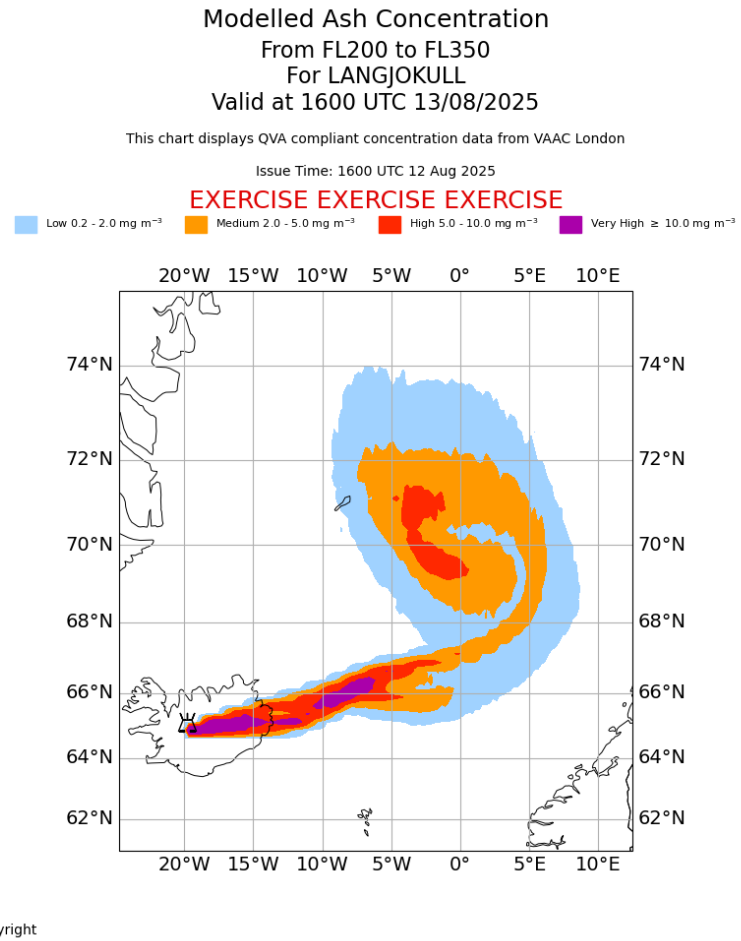
Comparison old “thick” layers vs new QVA projected the same way



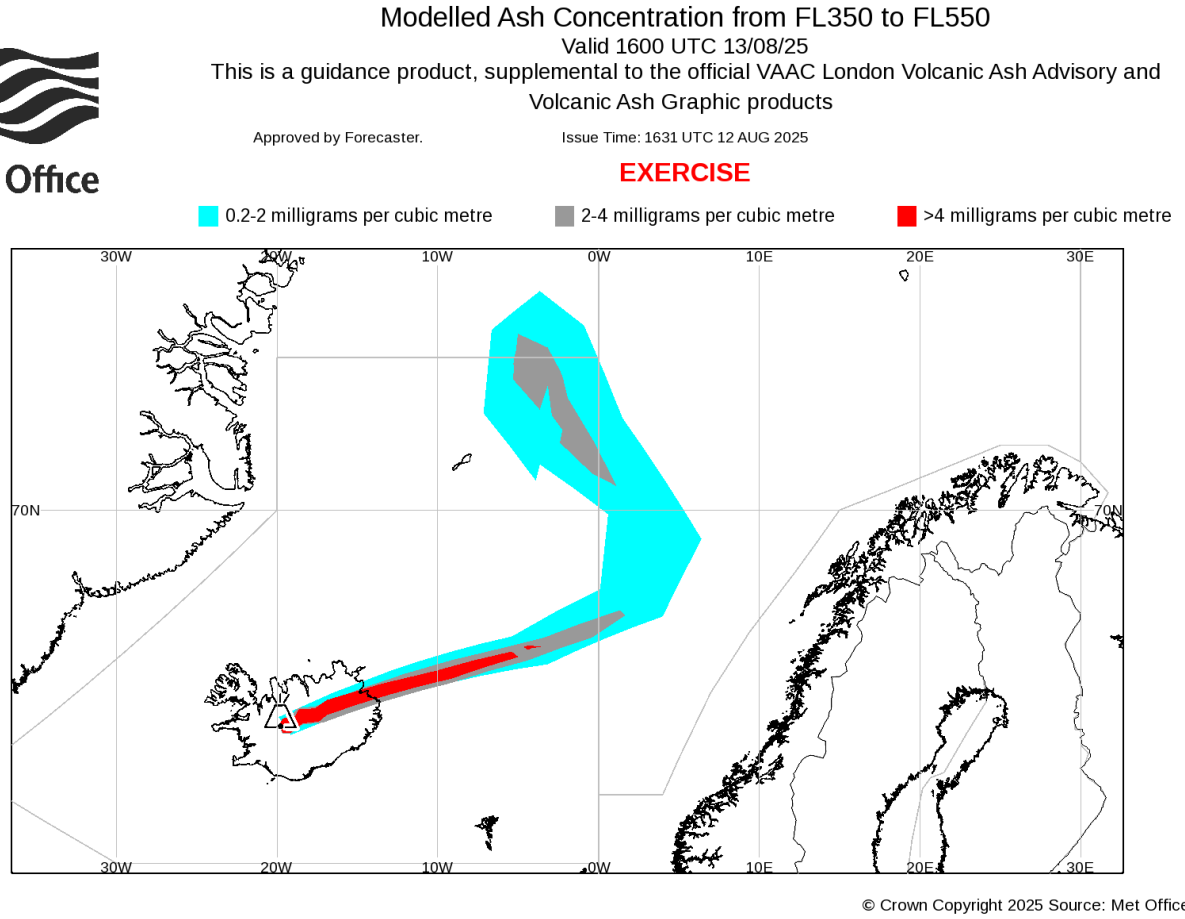


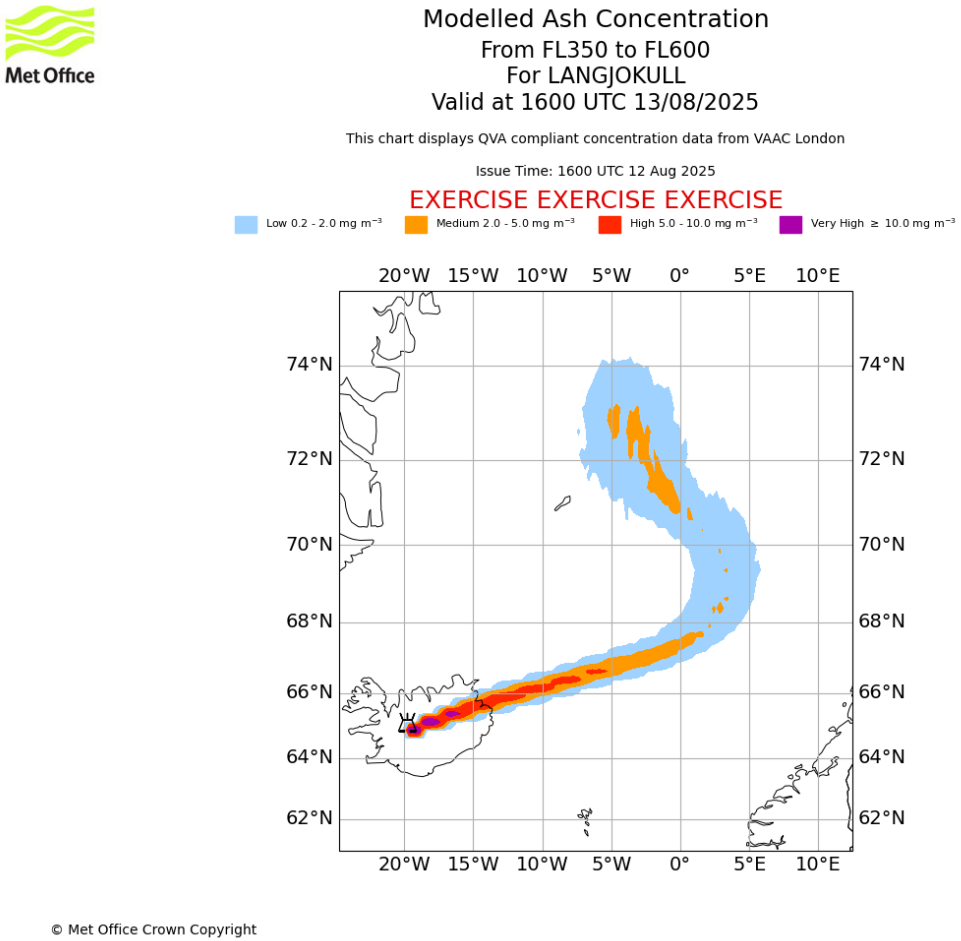
Comparison old “thick” layers vs new QVA projected the same way



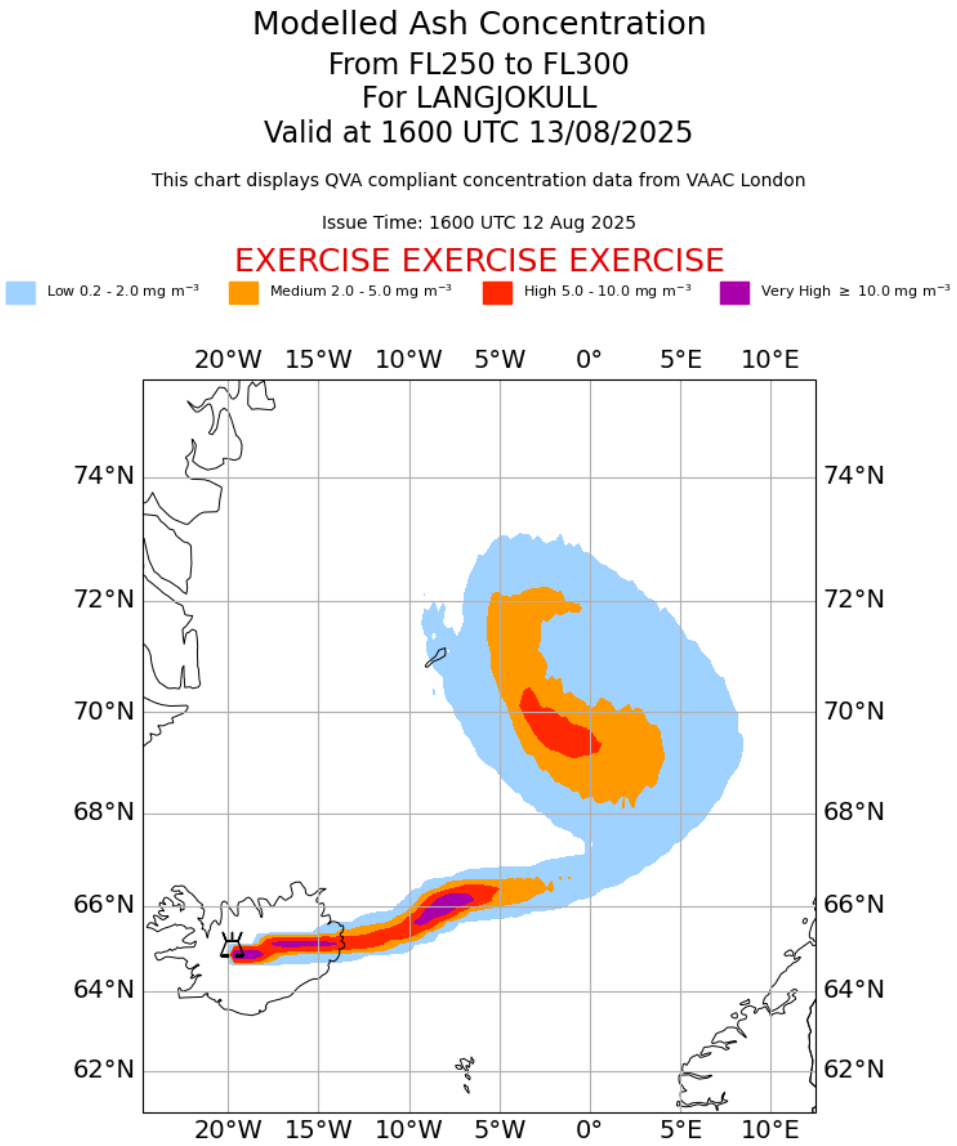


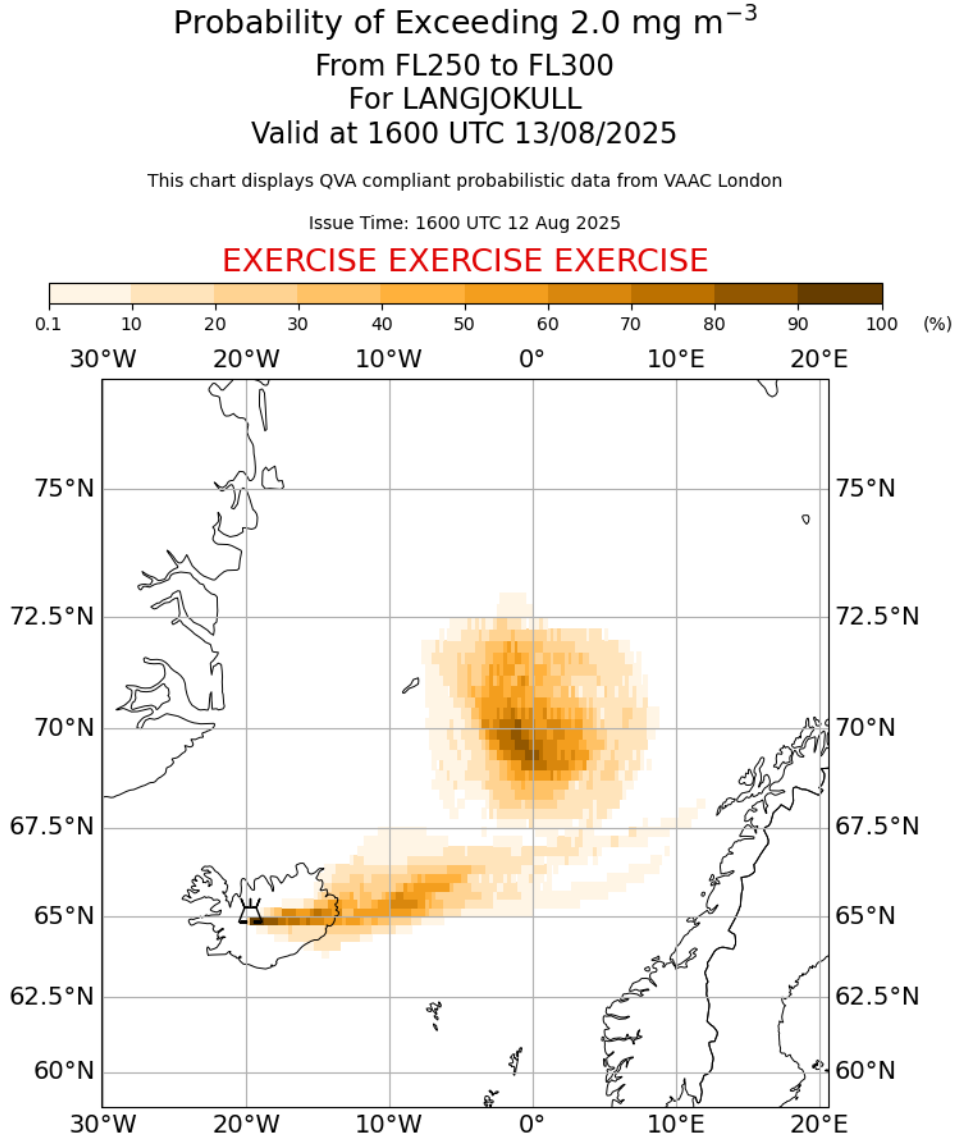
Comparison old “thick” layers vs new QVA projected the same way





How do you use the probabilistic data?



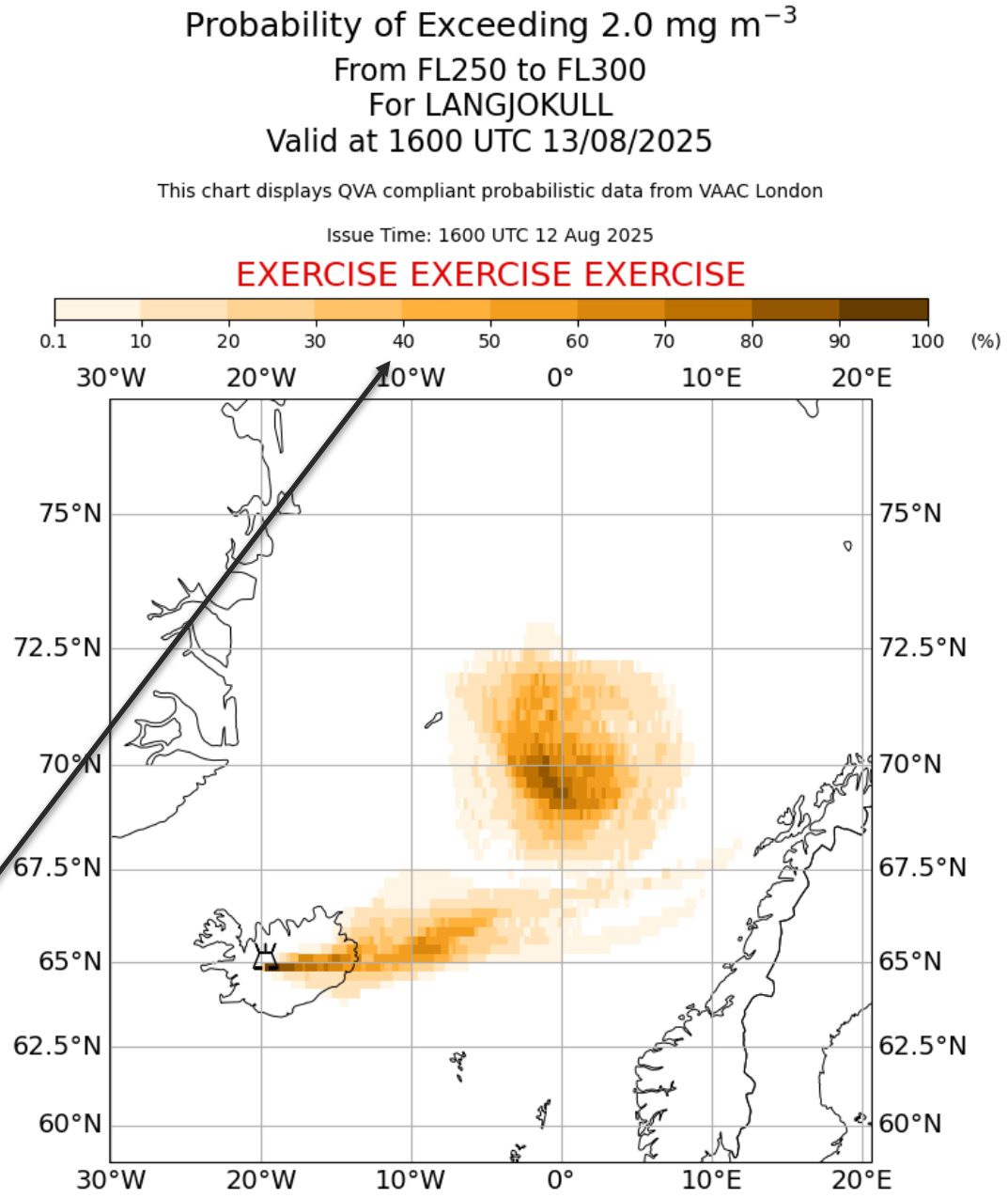


Met Office

How the Probabilistic Forecasts are generated + How to Interpret Them

- Multiple sources of uncertainty behind a forecast:
  - The Source (Plume Height + Release Rate)
  - Meteorological Data (weather forecast)
  - Observations
- London VAAC are generating probabilistic forecasts which represent our confidence in the weather forecast
- This leads to variability in the expected location and concentration of ash in the atmosphere
- All VAACs continue to develop capability to represent all sources of uncertainty

This is telling you that there is a 40% **chance** that volcanic ash will exceed concentrations of 2.0 mg m^{-3}



How do you get the QVA Data

Met Office

VAAC London QVA API

- Access to the VAAC London QVA API data will be granted to aviation industry users worldwide. It is free to use service.
- Registration involves accepting the service terms and conditions, and filling in a registration form. E-mail QVA@metoffice.gov.uk to start the process.

- Further information: https://www.metoffice.gov.uk/services/transport/aviation/regulated/international-aviation/vaac/qva/qva-api

Met Office

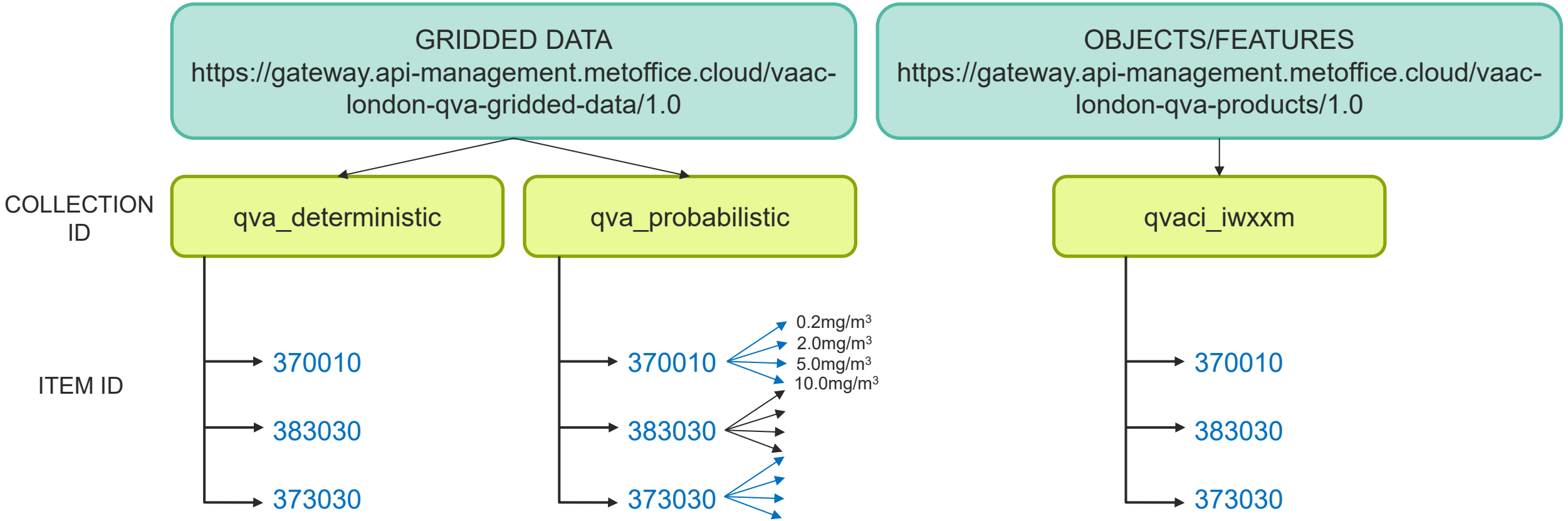
VAAC London QVA API

- The API confirms to the Open Geospatial Consortium Environmental Retrieval API standards and EUROCONTROL SWIM requirements
- Comprises of a REST API and notifications service

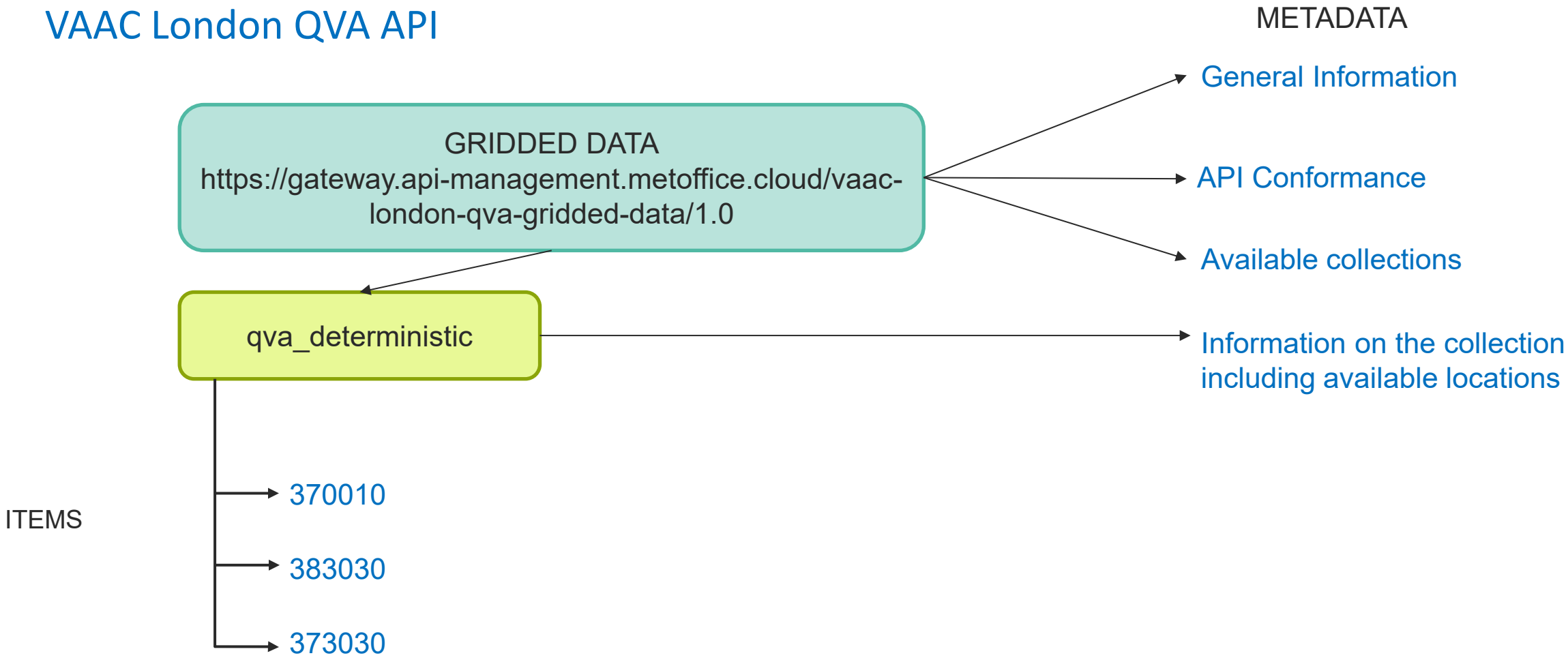
- No eruptions right now, so we are publishing daily test data sets (simulated eruptions)

Met Office

VAAC London QVA API



VAAC London QVA API



Met Office

VAAC London Notifications Service

- ActiveMQ Message broker with four topics that can be subscribed to.
- The Notification message contains the information on the volcano name, volcano number, publish time and the data (event) type and is sent each time new data sets are published.
- In addition a heartbeat (empty) message will be published every hour.

Met Office

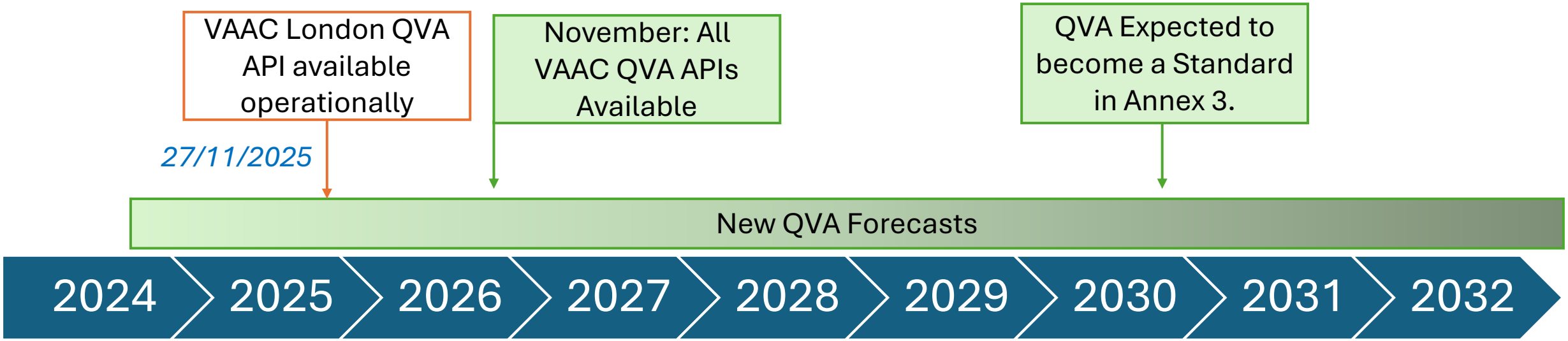
What if I can't use the API?

- Charts showing the QVA data on the Met Office website alongside other VA information

- https://www.metoffice.gov.uk/services/transport/aviation/regulated/international-aviation/vaac/quantitative-volcanic-ash

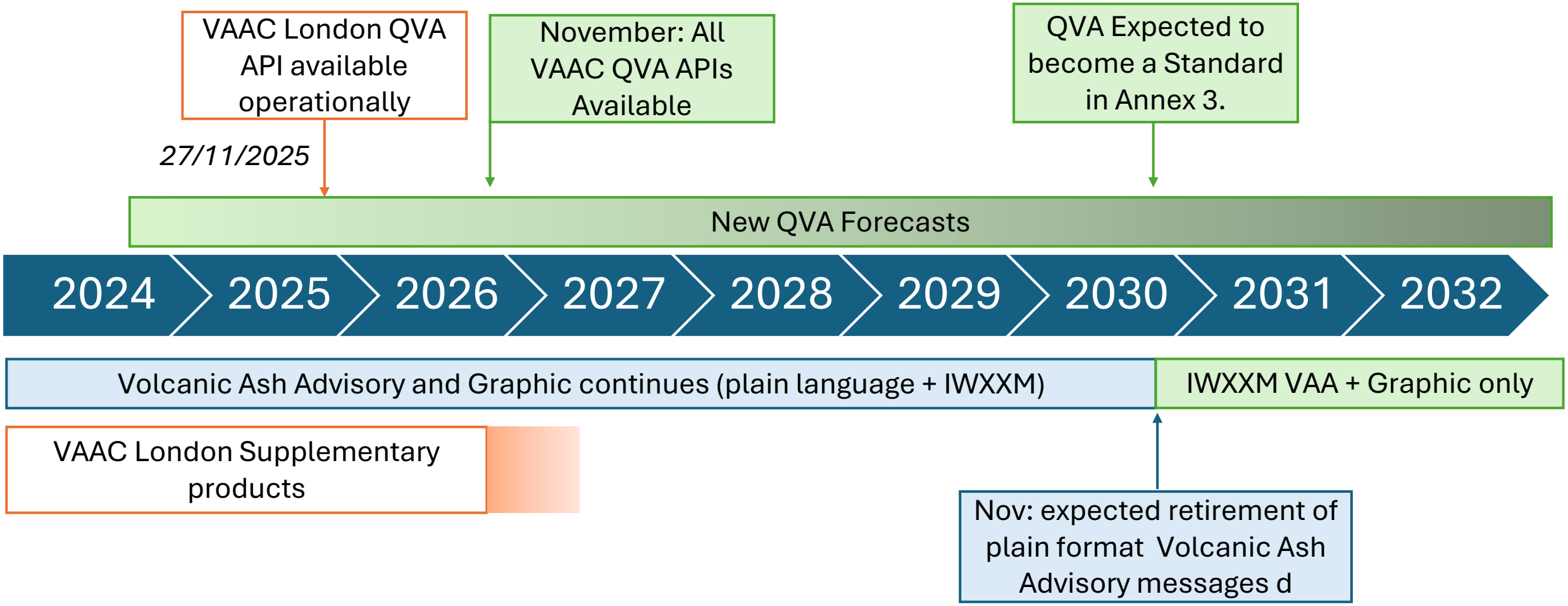
Note the chart viewer only populates when there is QVA data for a real eruption or when an exercise is run (2nd Tuesday of each month).

QVA Implementation timelines



- Annex 3 Amendment 82 says QVA will be provided by VAAC's "in a position to do so" from 27 November 2025. Only VAAC London and VAAC Toulouse meeting this.
- All VAAC's expected to provide QVA by November 2026, although VAAC Tokyo is likely to be in early 2027.
- This is the Initial Operating Capability. Future updates to the provision (e.g. increased resolution or more timesteps) will be determined in due course based on user requirements.

QVA Implementation timelines



Met Office

Thank you for listening

Question time

For further information contact:

QVA@metoffice.gov.uk