Quantitative Volcanic Ash Concentration Information Service (QVA) - Update

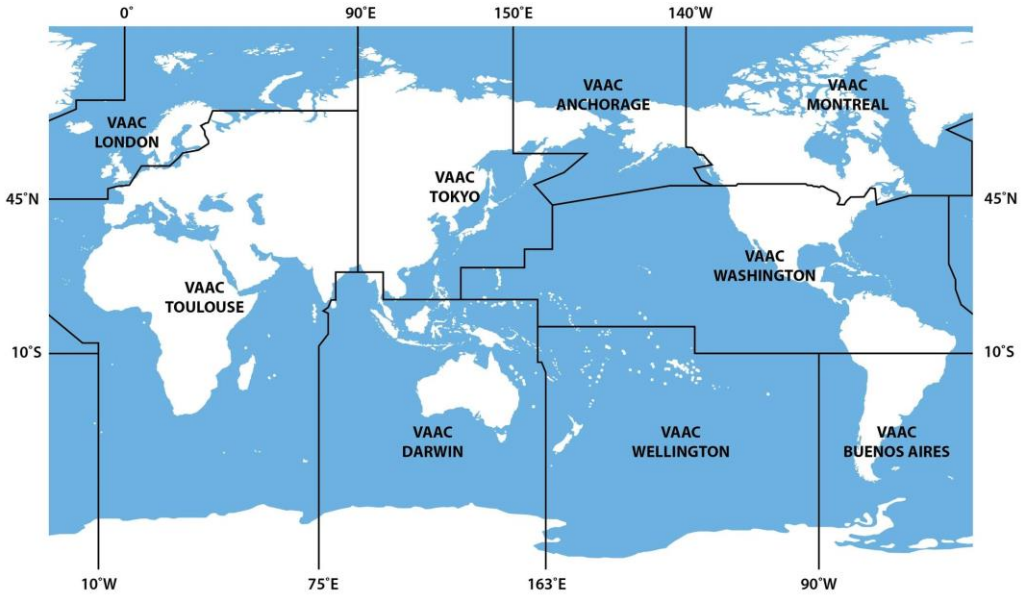
Nicole Ranger, Manager Aviation Weather Services

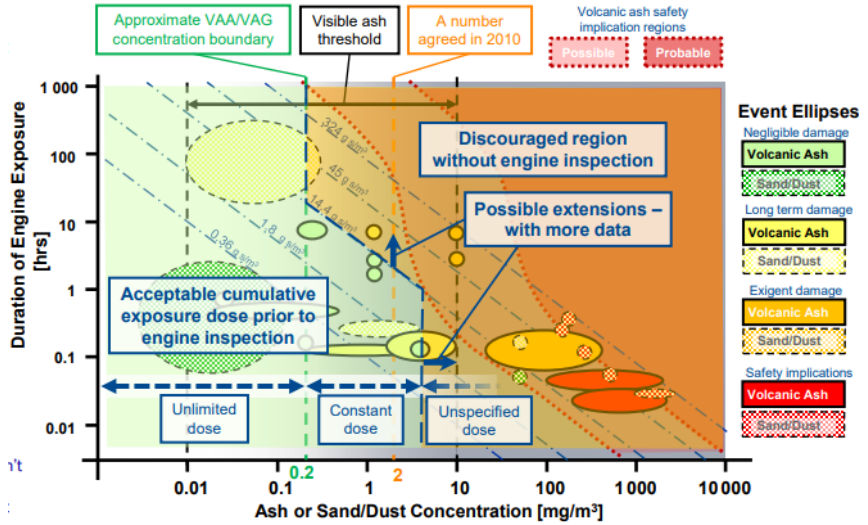
MetService
TE RATONGA TIRORANGI

QVA – Background Information

- MetService operates VAAC Wellington – 1 of 9 global VAACs
- Currently we produce VAA/VAG
- 2010 Eyjafjallajökull (Iceland) causes large flight disruption across Europe
- Industry request for Quantitative VA information
- Rolls Royce engine declares VA susceptibility
- Leading to the development of QVA

Eyjafjallajökull eruption in 2010



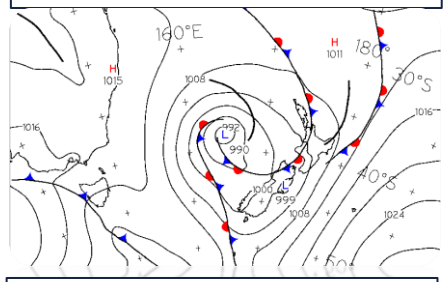


Rolls-Royce presentation at ICAO Meteorology Panel QVA Workshop 31st October 2024

How Forecasts are Generated

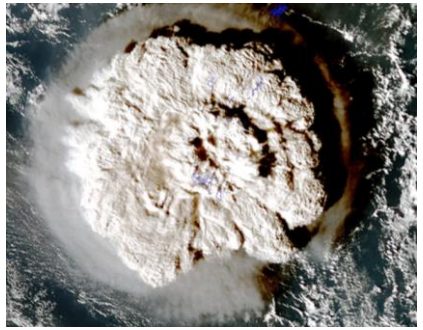
Inputs → **Model Simulation** → **Evaluation + Forecast Generation** → **Final Product**

Weather Forecast

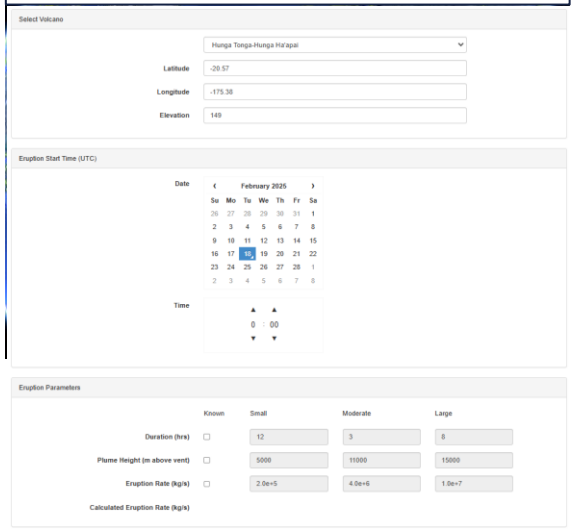


Eruption Source

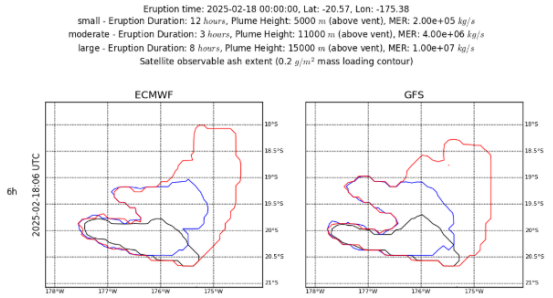
Observations



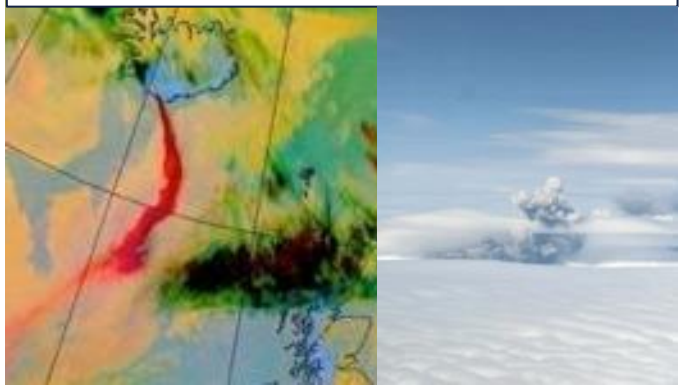
Dispersion Model



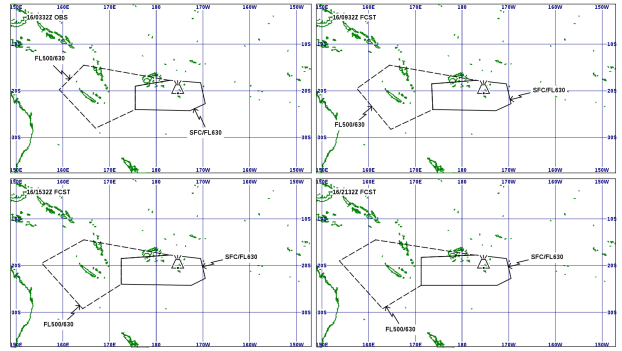
Model Output



Observations



VAA/VAG

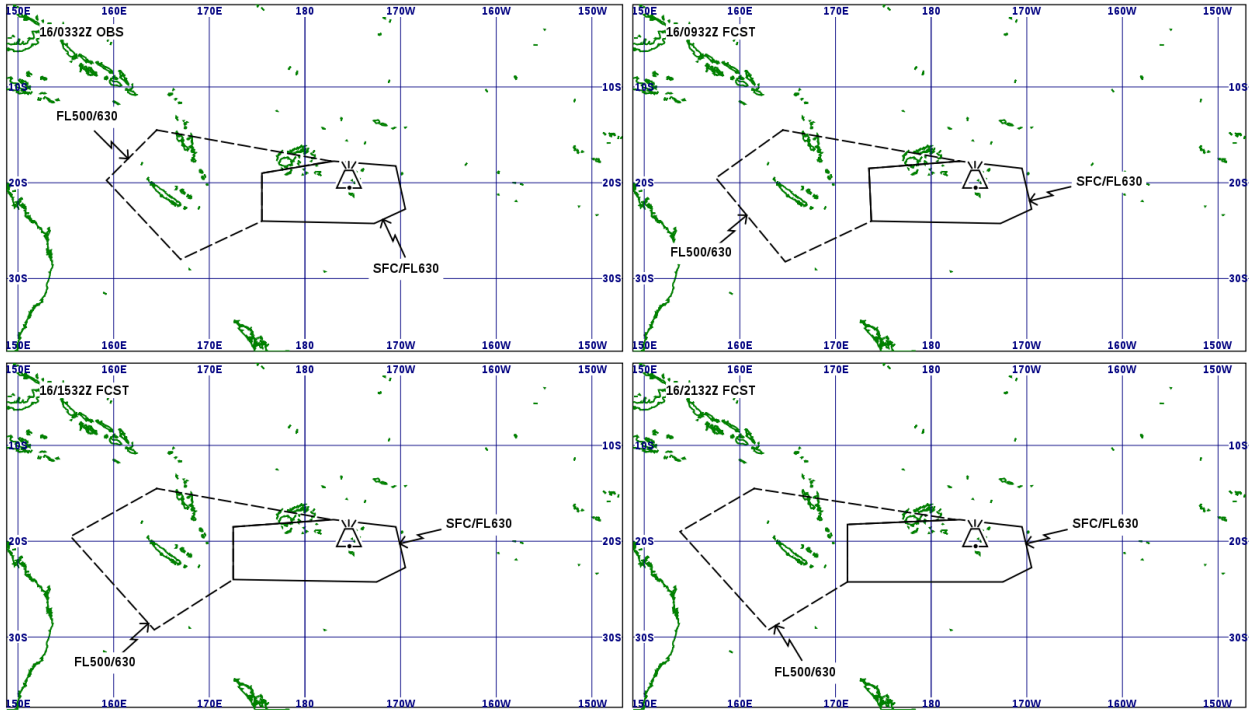



```
FVPS01 NZKL 160332
VA ADVISORY
DTG: 20220116/0332Z
VAAC: WELLINGTON
VOLCANO: HUNGA TONGA-HUNGA HA'APAI 243040
PSN: S2032 W17523
AREA: TONGA
SUMMIT ELEV: 114M
ADVISORY NR: 2022/25
INFO SOURCE: SAT IMAGERY, GROUND/PIREPS
AVIATION COLOUR CODE: RED
ERUPTION DETAILS: ERUPTION AT 20220115/0400Z LARGE ERUPTION
OBS VA DTG: 16/0332Z
OBS VA CLD: SFC/FL630 S1745 W17700 - S1815 W17030 - S2245
        W16930 - S2415 W17245 - S2400 E17530 - S1900 E17530 MOV W
        15KT FL500/630 S1745 W17715 - S1900 E17530 - S2400 E17530 -
        S2800 E16700 - S1945 E15915 - S1430 E16430 MOV W 50KT
FCST VA CLD +6 HR: 16/0932Z SFC/FL630 S1745 W17700 - S1830
        W17030 - S2245 W16930 - S2415 W17245 - S2400 E17345 - S1830
        E17330 FL500/630 S1745 W17700 - S1830 E17330 - S2400 E17345
        - S2815 E16445 - S1930 E15730 - S1430 E16430
FCST VA CLD +12 HR: 16/1532Z SFC/FL630 S1745 W17700 - S1830
        W17030 - S2245 W16930 - S2415 W17230 - S2400 E17230 - S1830
        E17230 FL500/630 S1745 W17715 - S1830 E17230 - S2400 E17230
        - S2915 E16415 - S1930 E15530 - S1430 E16430
FCST VA CLD +18 HR: 16/2132Z SFC/FL630 S1745 W17700 - S1830
        W17030 - S2245 W16930 - S2415 W17230 - S2415 E17115 - S1815
        E17115 FL500/630 S1745 W17730 - S1815 E17115 - S2415 E17115
        - S2915 E16300 - S1900 E15345 - S1430 E16130
RMK: ERUPTION TO VERY HIGH LEVELS WITH VA EXTD E IN
        STRATOSPHERIC EASTERLIES. AREA ON SATELLITE IDENTIFIED AS VA
        IN STRATOSPHERE NOW ADDED. VA HEIGHT EST FM PIREPS AND
        NOUMEA/NADI 00Z SOUNDING.
NXT ADVISORY: NO LATER THAN 20220116/0932Z=
```

Current VAAC Products

VAA/VAG http://vaac.metservice.com/

```
FVPS01 NZKL 160332
VA ADVISORY
DTG: 20220116/0332Z
VAAC: WELLINGTON
VOLCANO: HUNGA TONGA-HUNGA HA'APAI 243040
PSN: S2032 W17523
AREA: TONGA
SUMMIT ELEV: 114M
ADVISORY NR: 2022/25
INFO SOURCE: SAT IMAGERY, GROUND/PIREPS
AVIATION COLOUR CODE: RED
ERUPTION DETAILS: ERUPTION AT 20220115/0400Z LARGE ERUPTION
OBS VA DTG: 16/0332Z
OBS VA CLD: SFC/FL630 S1745 W17700 - S1815 W17030 - S2245
       W16930 - S2415 W17245 - S2400 E17530 - S1900 E17530 MOV W
       15KT FL500/630 S1745 W17715 - S1900 E17530 - S2400 E17530 -
       S2800 E16700 - S1945 E15915 - S1430 E16430 MOV W 50KT
FCST VA CLD +6 HR: 16/0932Z SFC/FL630 S1745 W17700 - S1830
       W17030 - S2245 W16930 - S2415 W17245 - S2400 E17345 - S1830
       E17330 FL500/630 S1745 W17700 - S1830 E17330 - S2400 E17345
       - S2815 E16445 - S1930 E15730 - S1430 E16430
FCST VA CLD +12 HR: 16/1532Z SFC/FL630 S1745 W17700 - S1830
       W17030 - S2245 W16930 - S2415 W17230 - S2400 E17230 - S1830
       E17230 FL500/630 S1745 W17715 - S1830 E17230 - S2400 E17230
       - S2915 E16415 - S1930 E15530 - S1430 E16430
FCST VA CLD +18 HR: 16/2132Z SFC/FL630 S1745 W17700 - S1830
       W17030 - S2245 W16930 - S2415 W17230 - S2415 E17115 - S1815
       E17115 FL500/630 S1745 W17730 - S1815 E17115 - S2415 E17115
       - S2915 E16300 - S1900 E15345 - S1430 E16130
RMK: ERUPTION TO VERY HIGH LEVELS WITH VA EXTD E IN
       STRATOSPHERIC EASTERLIES. AREA ON SATELLITE IDENTIFIED AS VA
       IN STRATOSPHERE NOW ADDED. VA HEIGHT EST FM PIREPS AND
       NOUMEA/NADI 00Z SOUNDING.
NXT ADVISORY: NO LATER THAN 20220116/0932Z=
```



VOLCANIC ASH ADVISORY

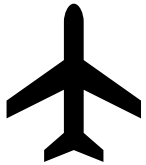
DTG:	20220116/0332Z
VAAC:	WELLINGTON
VOLCANO:	HUNGA TONGA-HUNGA HA'APAI 243040
PSN:	S2032 W17523
AREA:	TONGA

SUMMIT ELEV:	114M
ADVISORY NR:	2022/25
INFO SOURCE:	SAT IMAGERY, GROUND/PIREPS
AVIATION COLOUR CODE:	RED
ERUPTION DETAILS:	ERUPTION AT 20220115/0400Z LARGE ERUPTION
RMK:	ERUPTION TO VERY HIGH LEVELS WITH VA EXTD E IN STRATOSPHERIC EASTERLIES. AREA ON SATELLITE IDENTIFIED AS VA IN STRATOSPHERE NOW ADDED. VA HEIGHT EST FM PIREPS AND NOUMEA/NADI 00Z SOUNDING.
NXT ADVISORY:	NO LATER THAN 20220116/0932Z=

Why QVA?

Quantitative Volcanic Ash (QVA) - A new quantitative service has been agreed by ICAO

QVA Forecasts are higher resolution and more informative, representing improved scientific and technical capabilities, to provide a more useful and useable product for the industry



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

Operators with approval and procedures/practices will be able to use QVA information to fly more efficient routes in accordance with their safety management program

Operators will be able to use additional probabilistic QVA information in conjunction with their safety management program to further optimize airspace and plan more efficient routes during significant volcanic ash cloud events.

What is QVA?

Products required for significant eruptions:

- Ash concentration data sets
- IWXXM objects (polygons)
- Probabilistic data set
- *VAACs are also intending to provide supplementary graphics.*

Horizontal	0.25 degrees latitude and longitude.
Vertical	12 Levels, 50FL Depth, Mean sea level to FL600
Temporal	0, 3, 6, 9, 12, 15, 18, 21 and 24 hours

Descriptor	**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

Met office presentation at ICAO Meteorology Panel QVA Workshop 31st October 2024

What does this mean for VAACs

- All VAACs will be forecasting **how much ash** is expected to be in the atmosphere - not just its location
- Forecasts will be at a **higher resolution** – more time steps, vertical levels, and concentration thresholds
- IWXXM Objects - **sophisticated polygons** - will indicate low, medium, high and very high concentrations
- For the first time All VAACs will be generating **probabilistic forecasts**
- The raw **concentration + probabilistic data** will be provided to aviation customers for the first time

An Example of New London VAAC QVA Products

Scenario – Volcanic Eruption in Iceland

Volcano: Hekla

Eruption Start: 09:00 UTC 07/08/2024

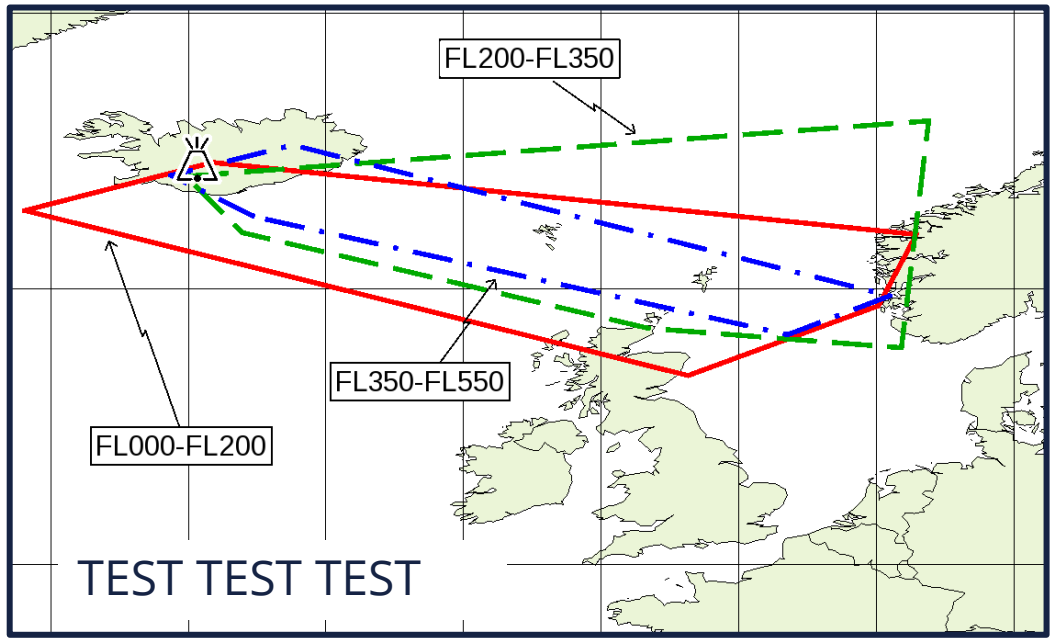
Plume Height: 15 km
Source Strength: 1.2 x 10^{12} g/hr

A moderate sized eruption at a known active volcano

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

London VAAC Forecasts

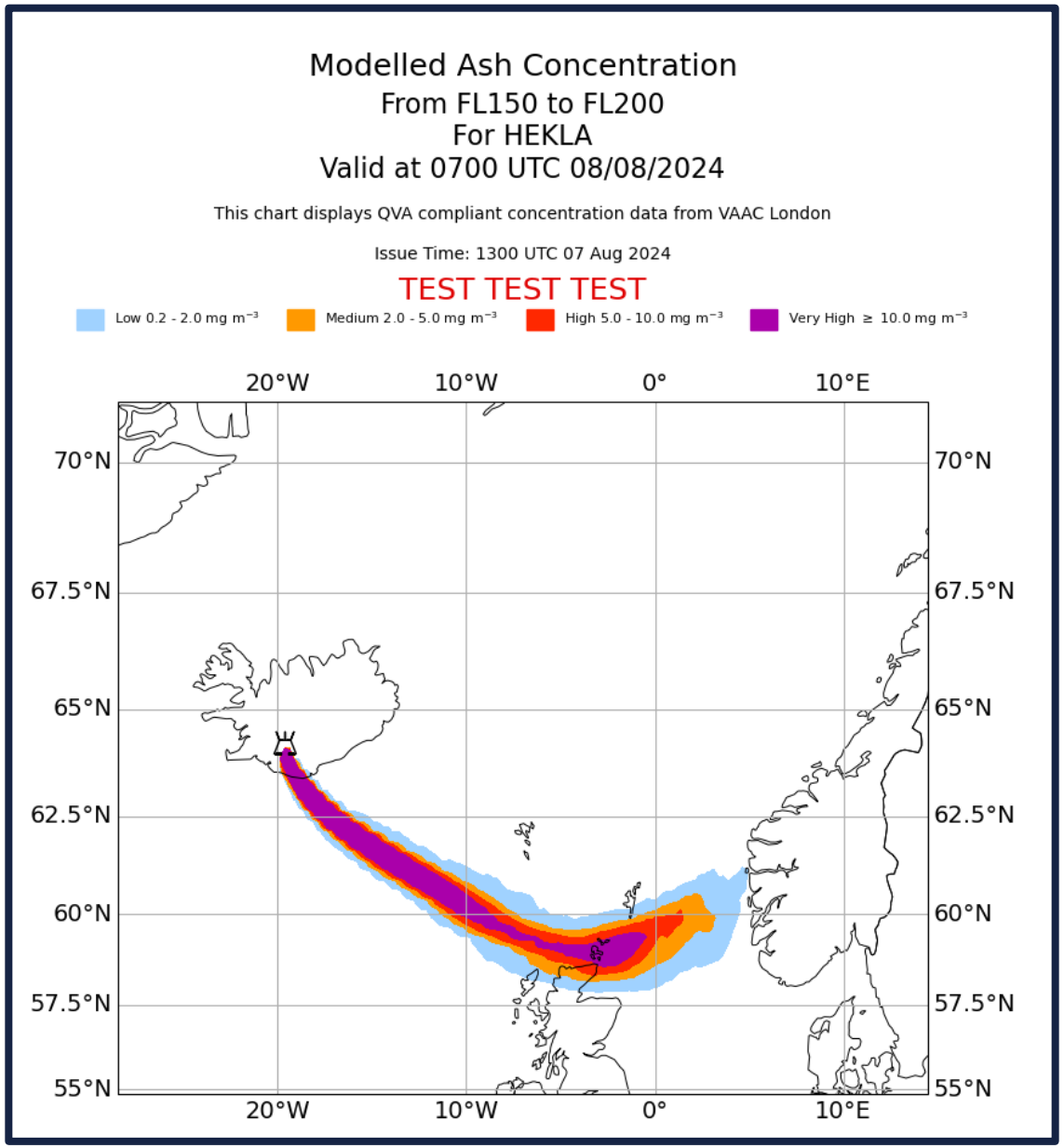
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

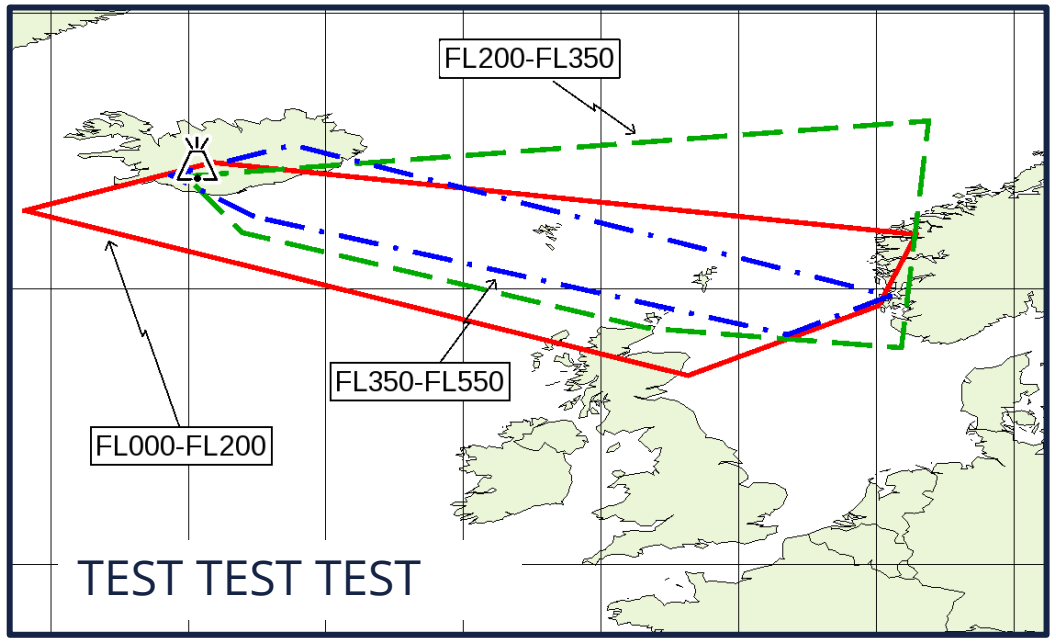
New QVA Product

Shows you variability in concentration



London VAAC Forecasts

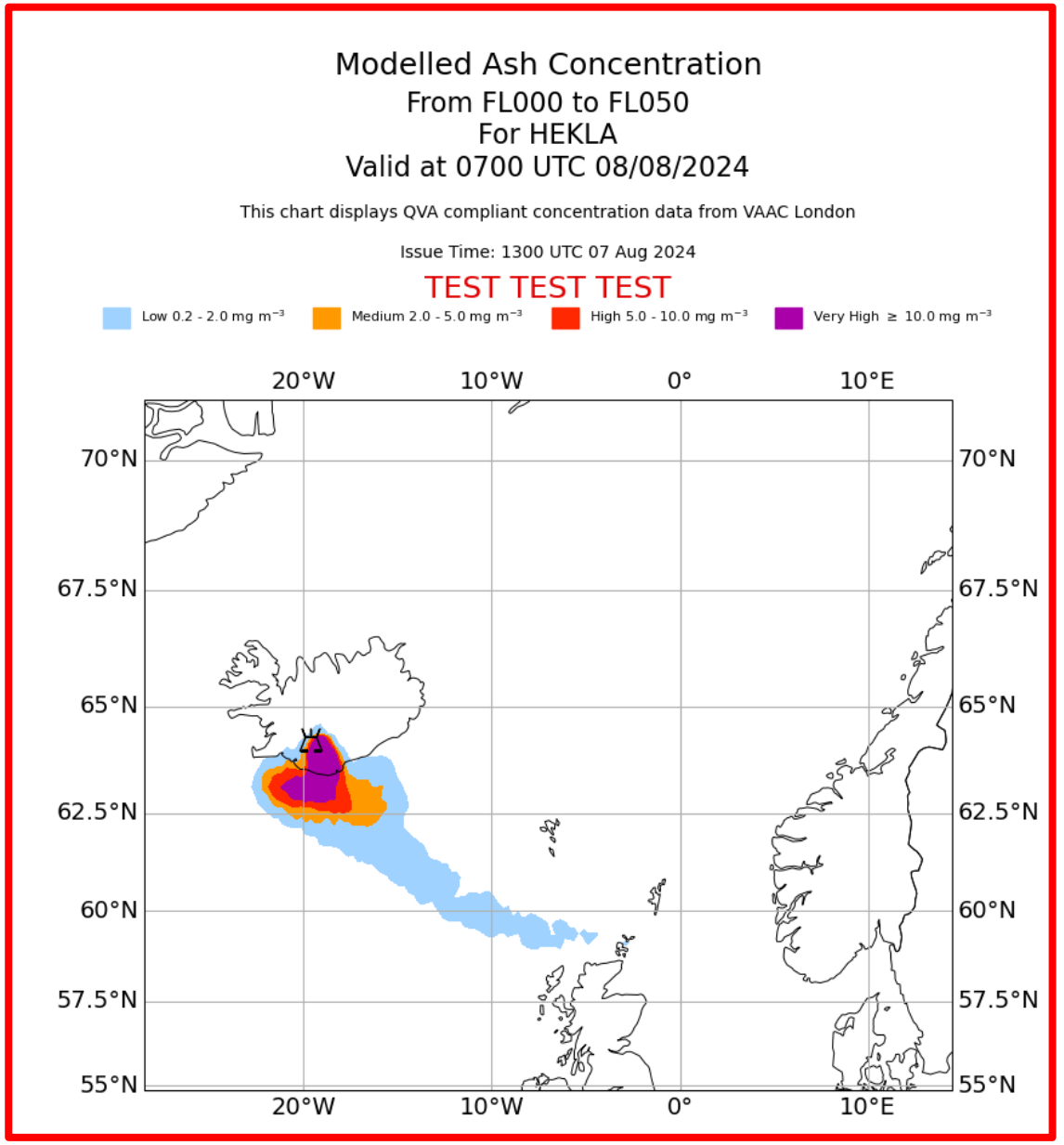
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

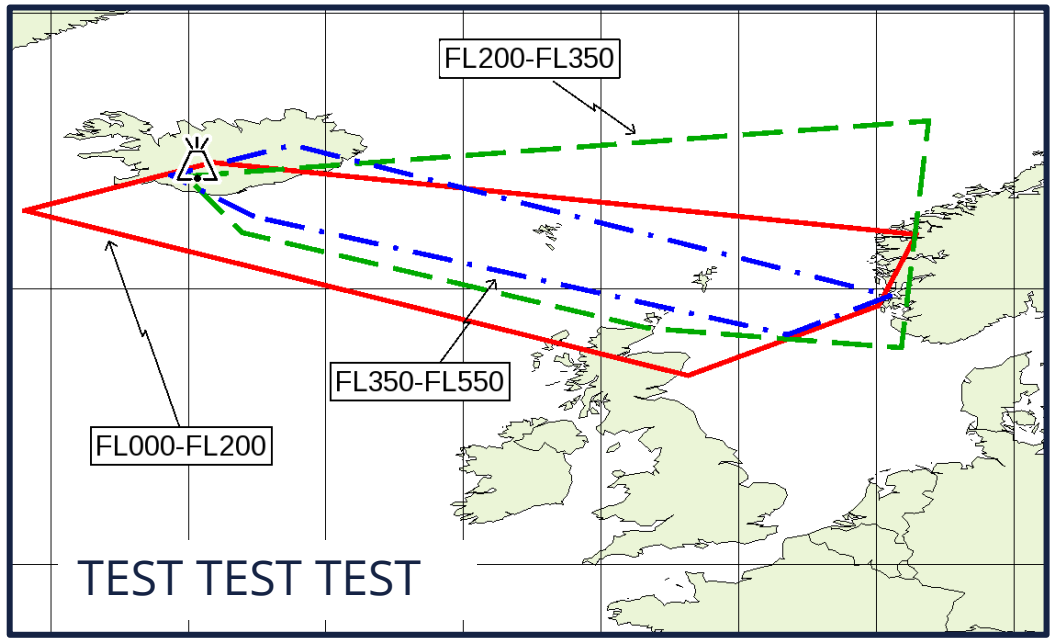
New QVA Product

Gives you the detail of where ash is in the vertical



London VAAC Forecasts

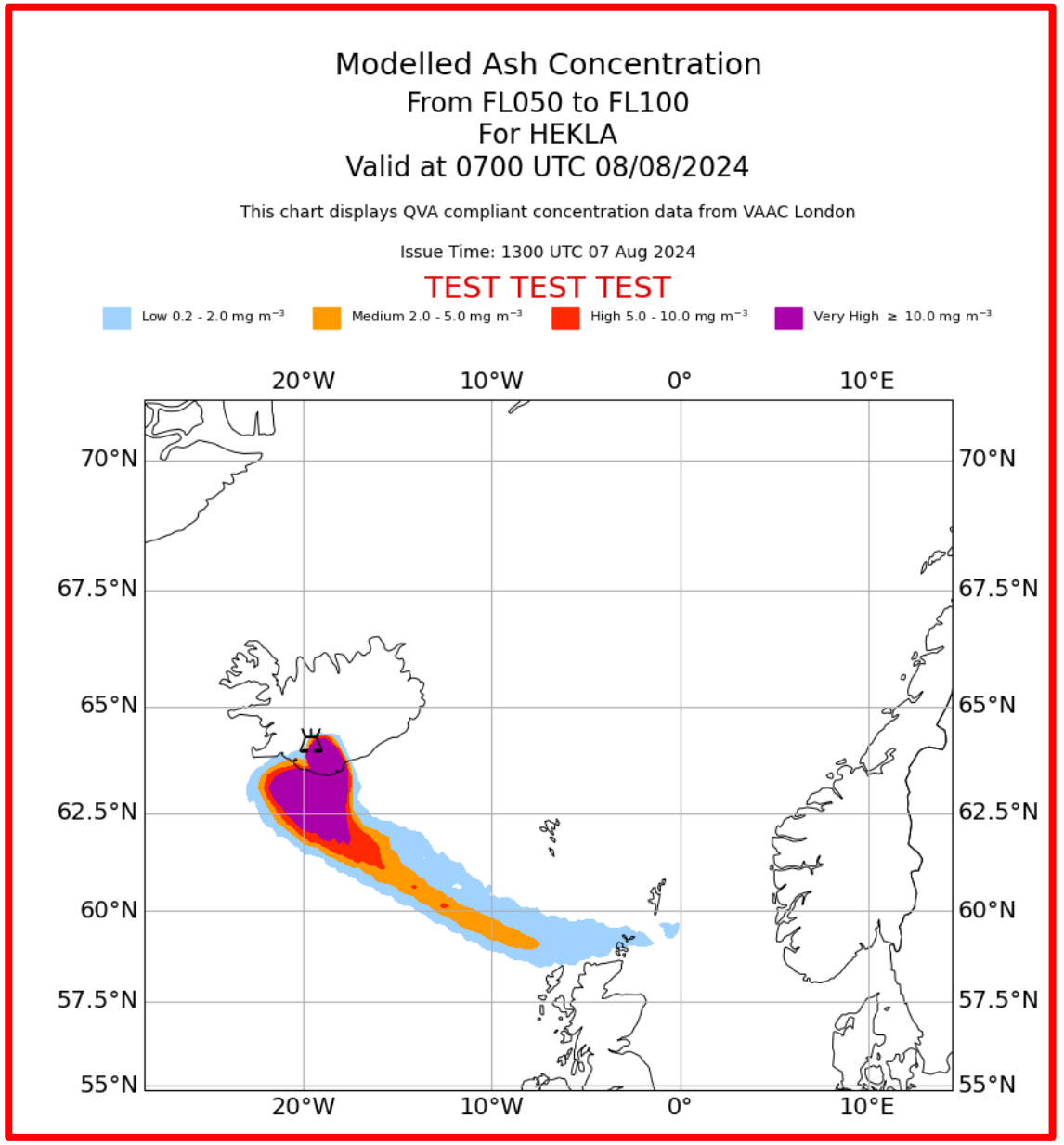
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

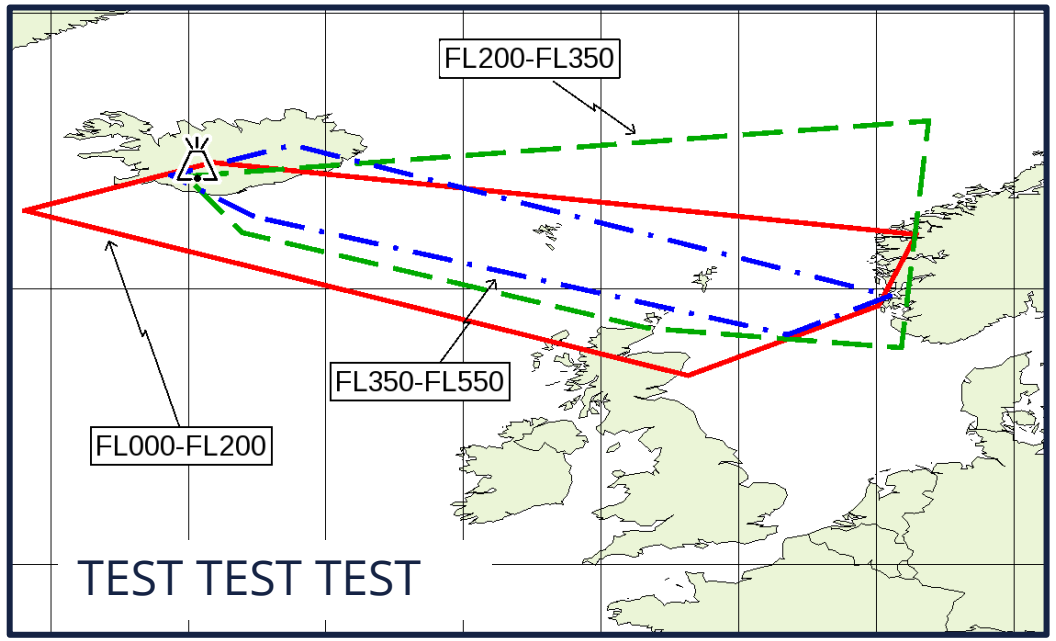
New QVA Product

Gives you the detail of where ash is in the vertical



London VAAC Forecasts

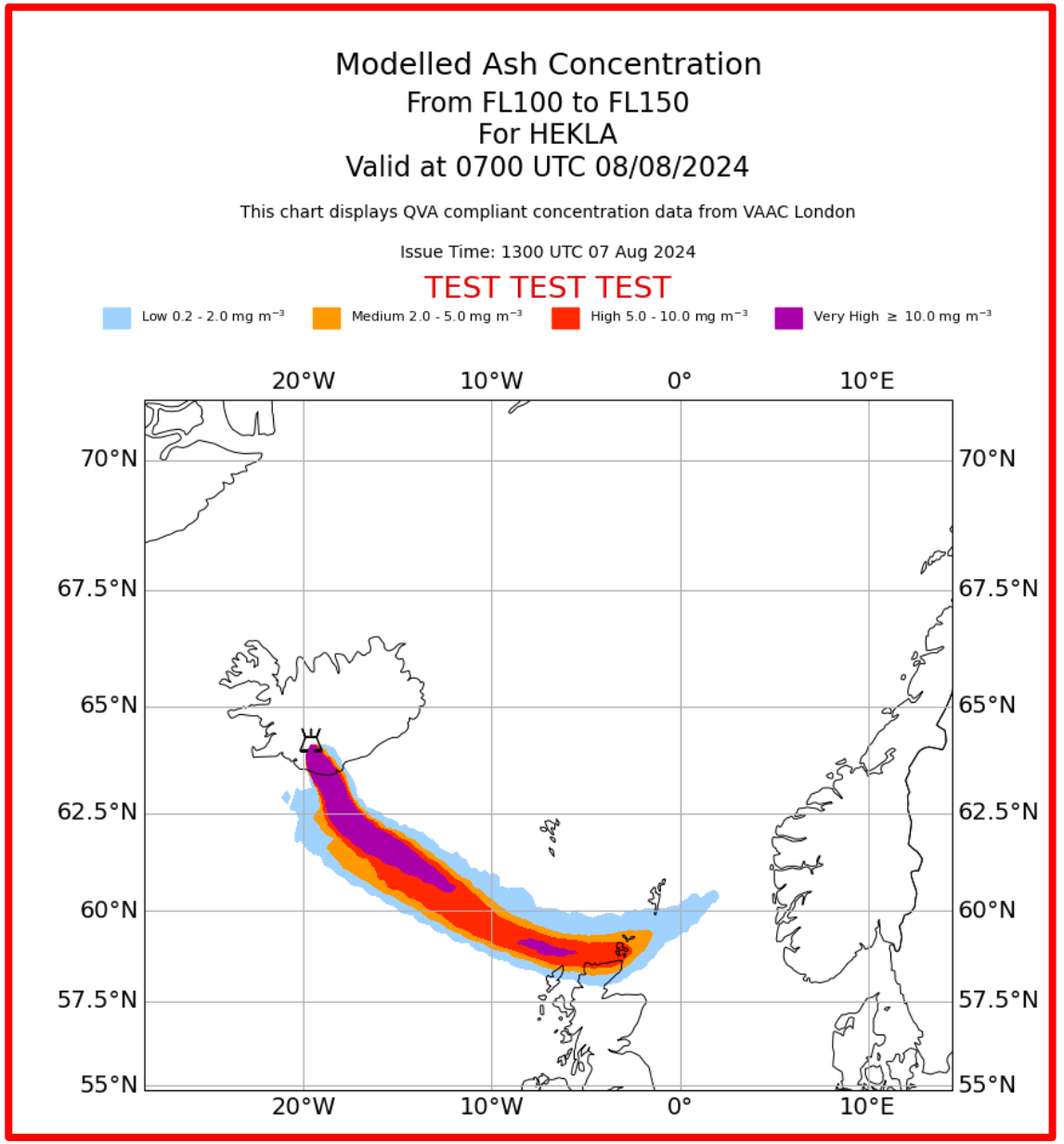
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

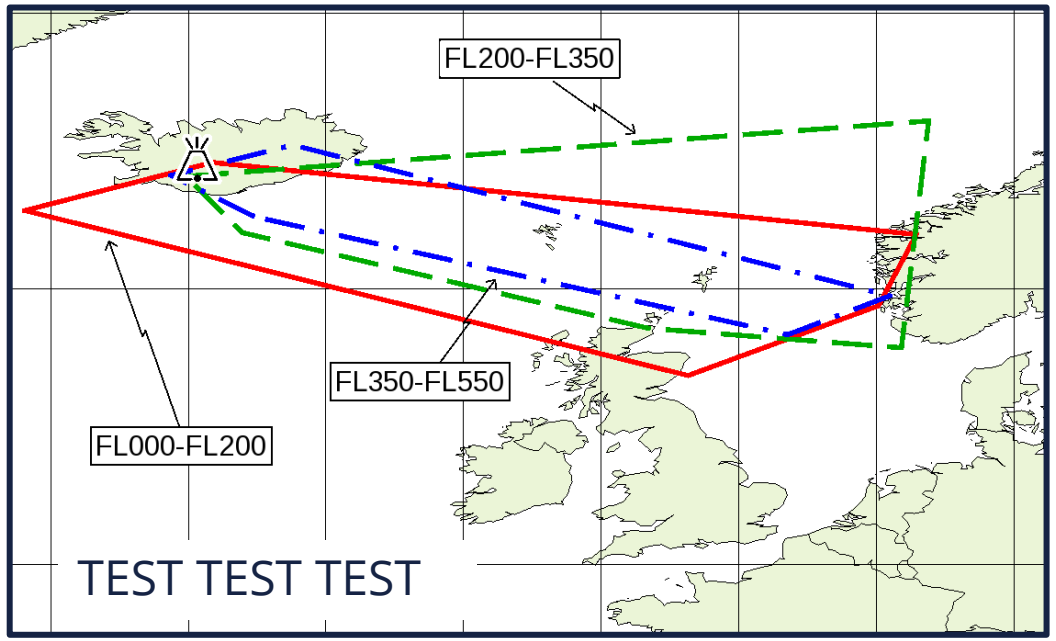
New QVA Product

Gives you the detail of where ash is in the vertical



London VAAC Forecasts

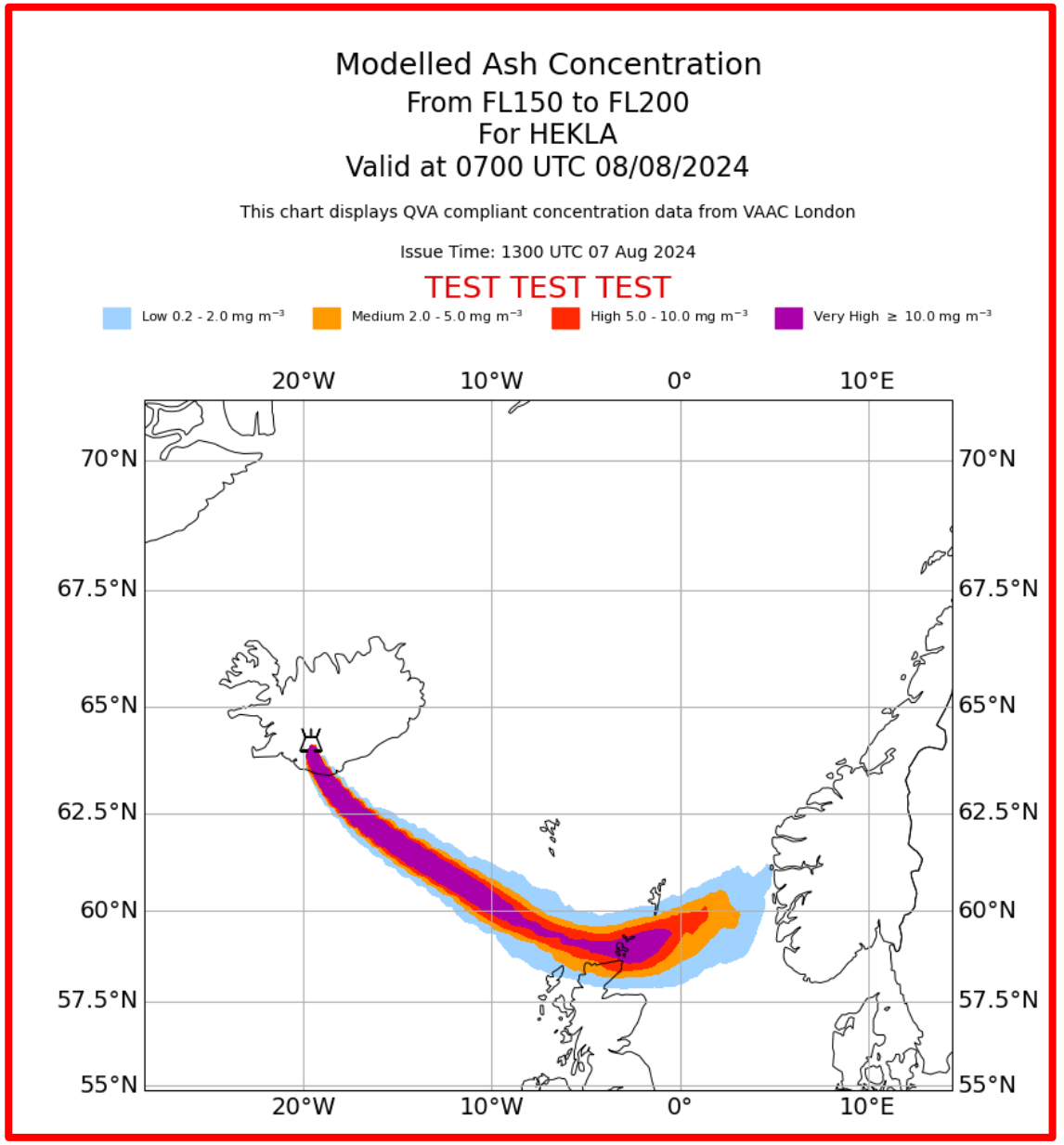
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

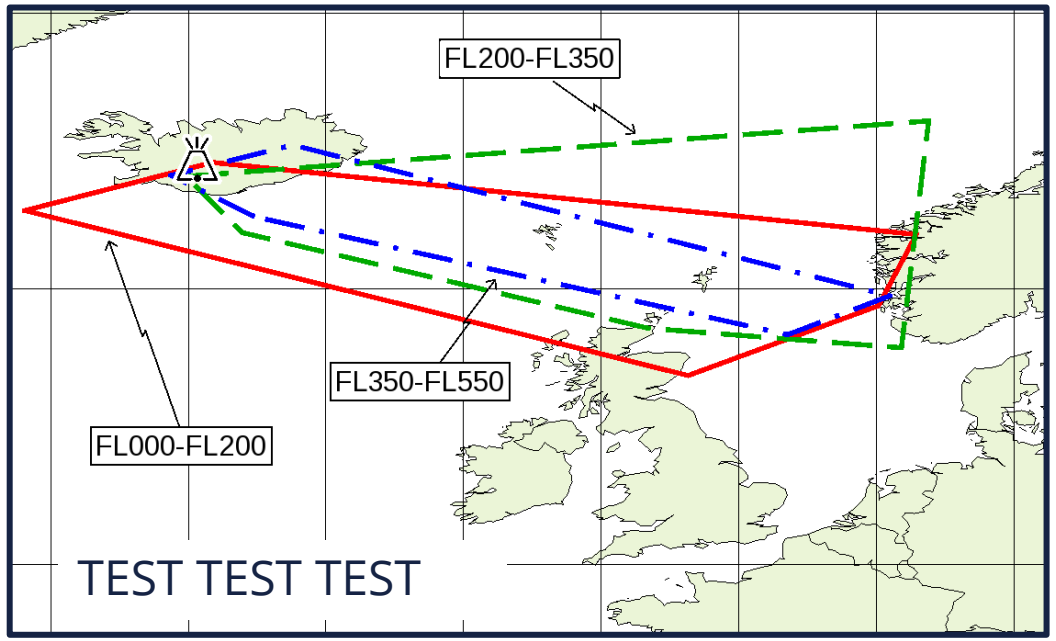
New QVA Product

Gives you the detail of where ash is in the vertical



London VAAC Forecasts

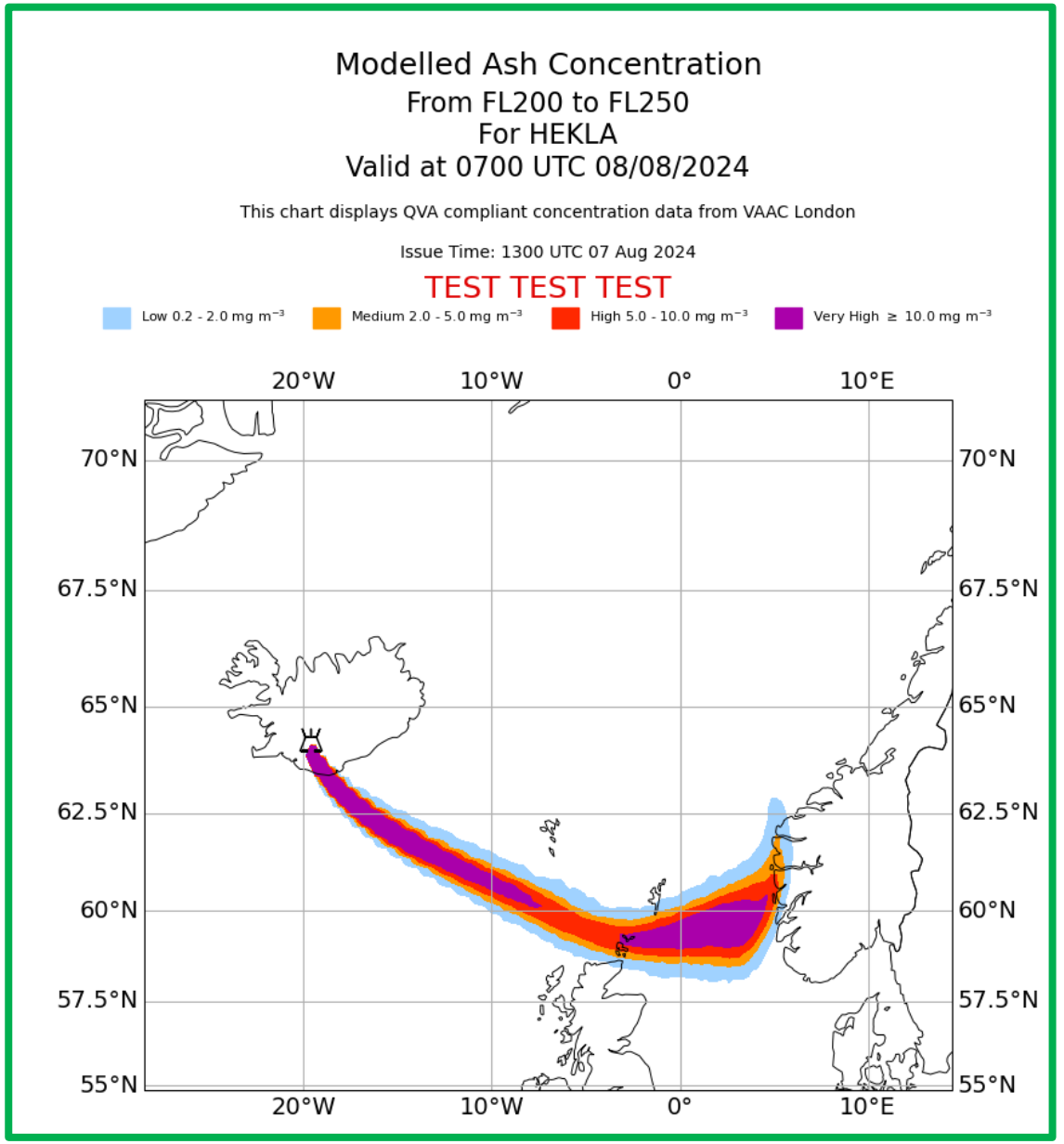
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

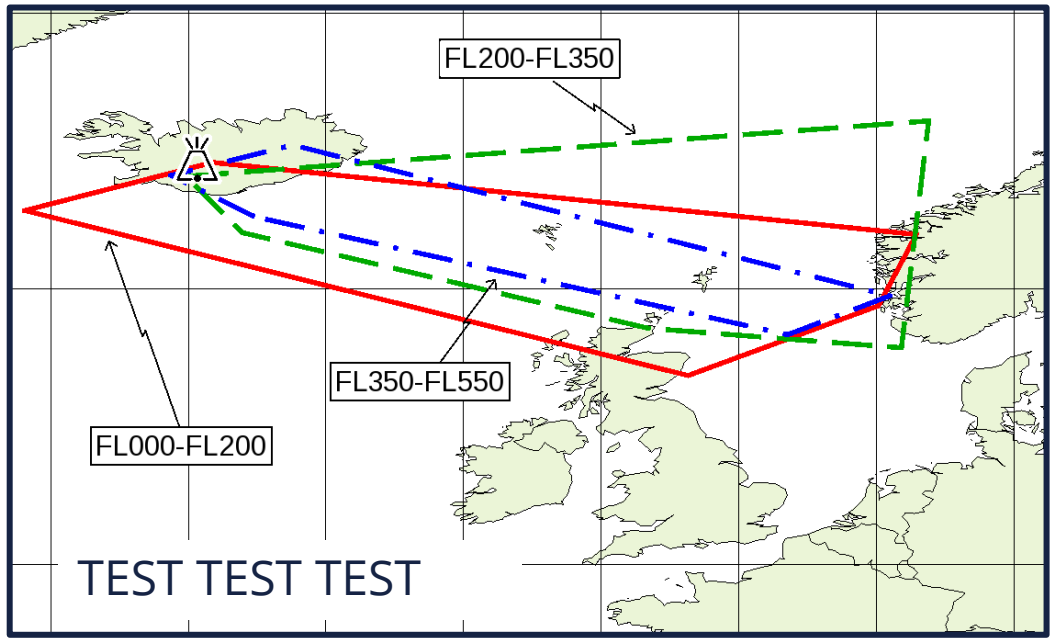
New QVA Product

Gives you the detail of where ash is in the vertical



London VAAC Forecasts

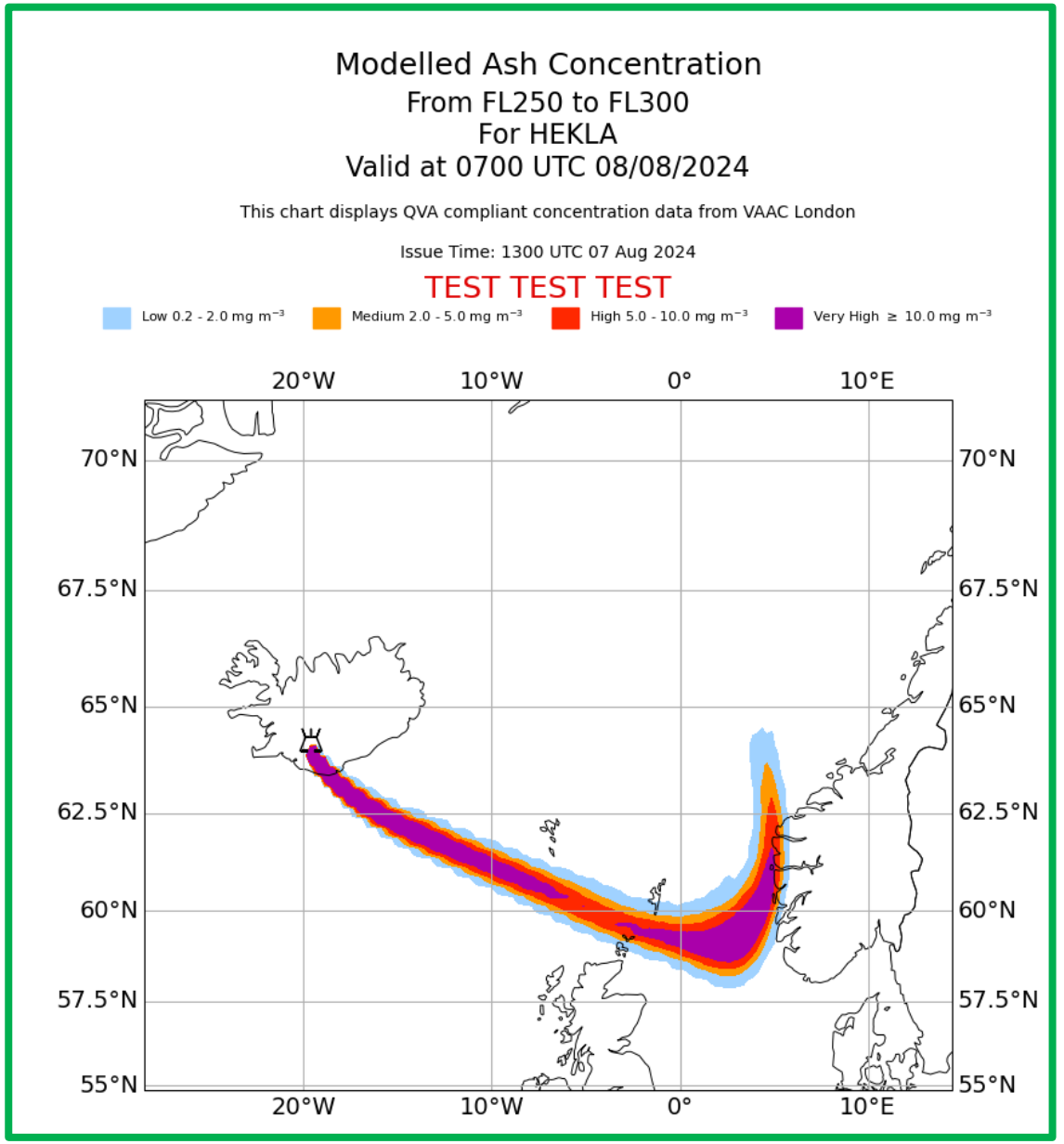
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

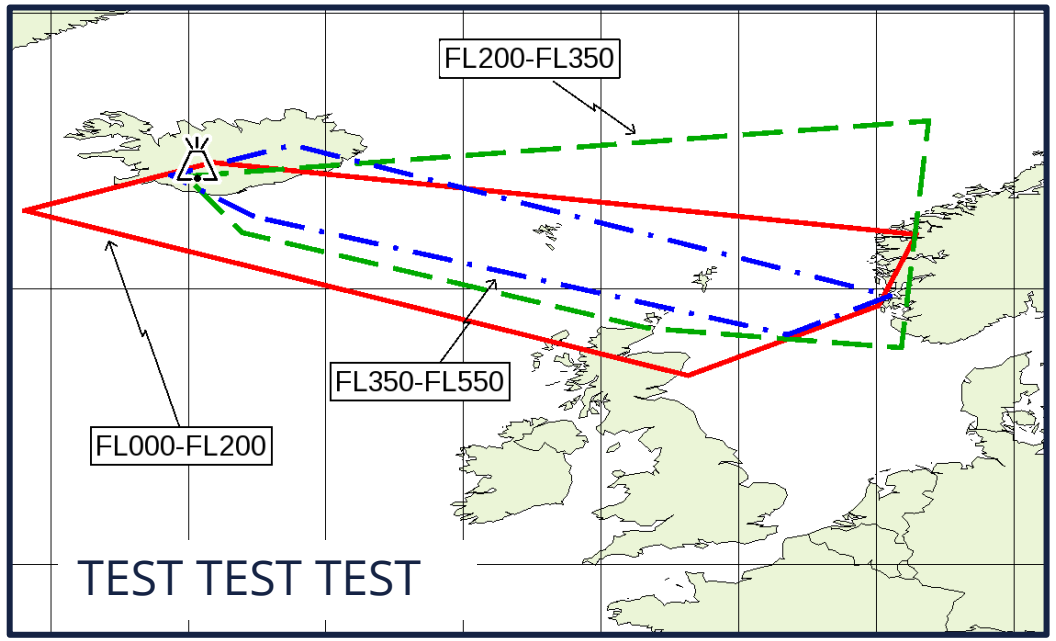
New QVA Product

Gives you the detail of where ash is in the vertical



London VAAC Forecasts

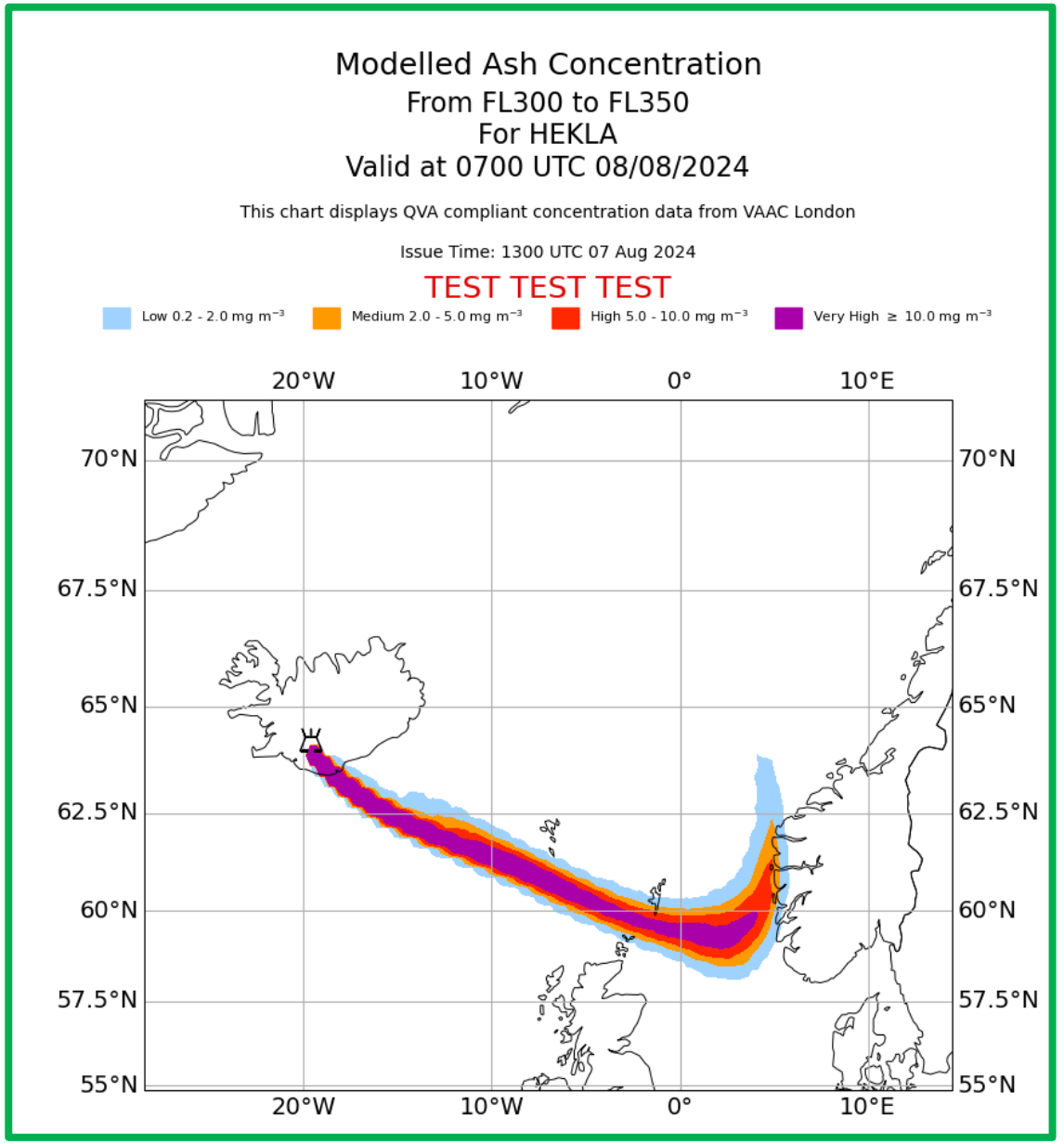
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

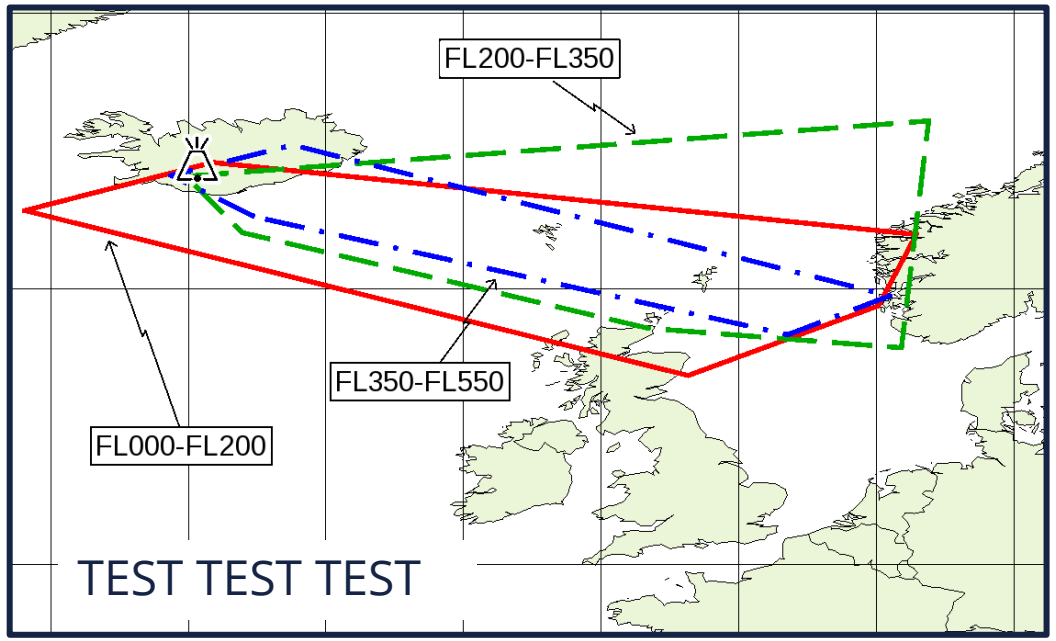
New QVA Product

Gives you the detail of where ash is in the vertical



London VAAC Forecasts

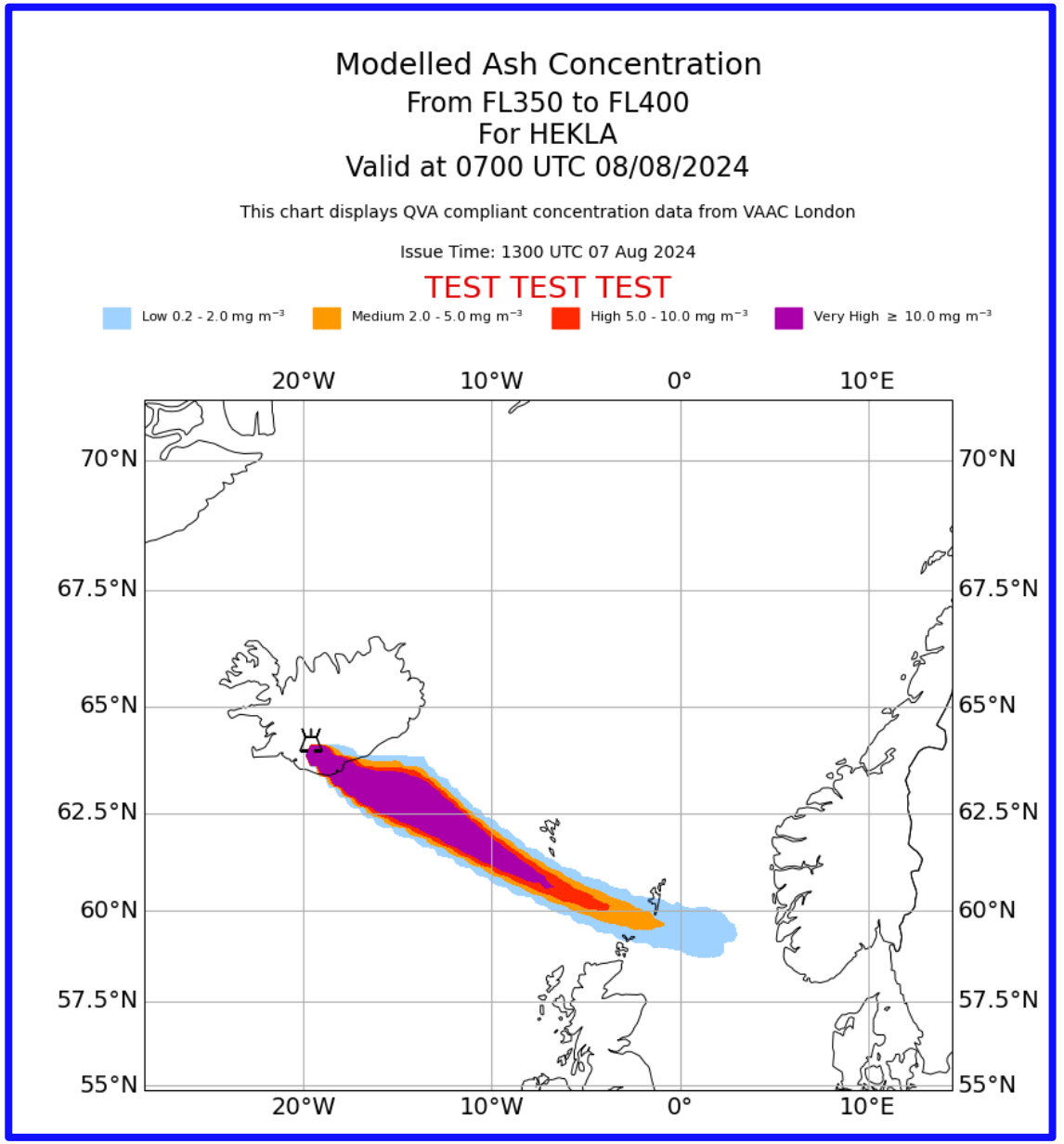
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

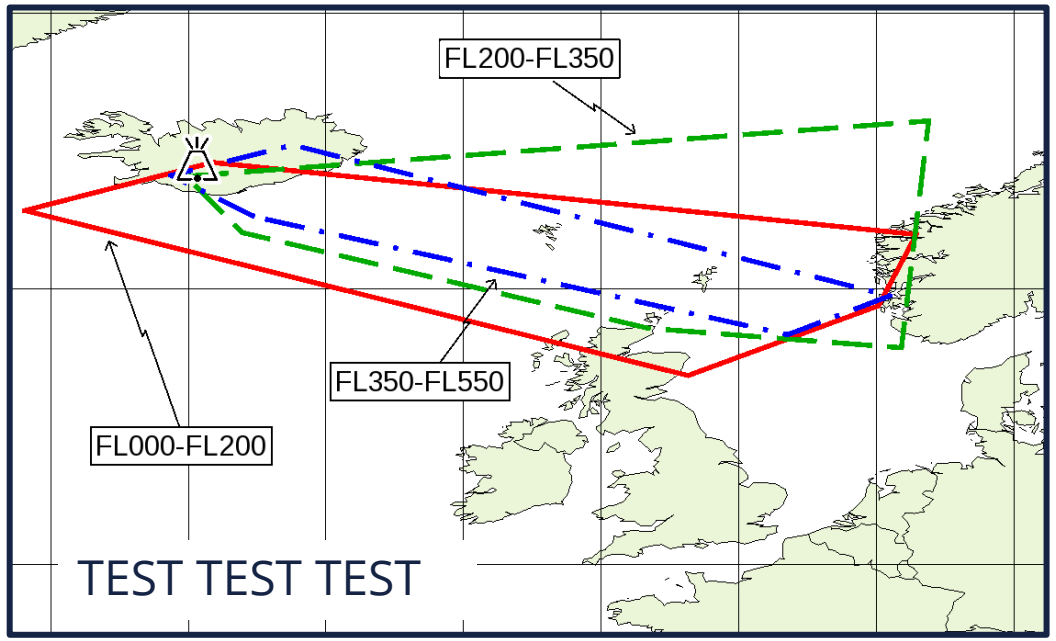
New QVA Product

Gives you the detail of where ash is in the vertical



London VAAC Forecasts

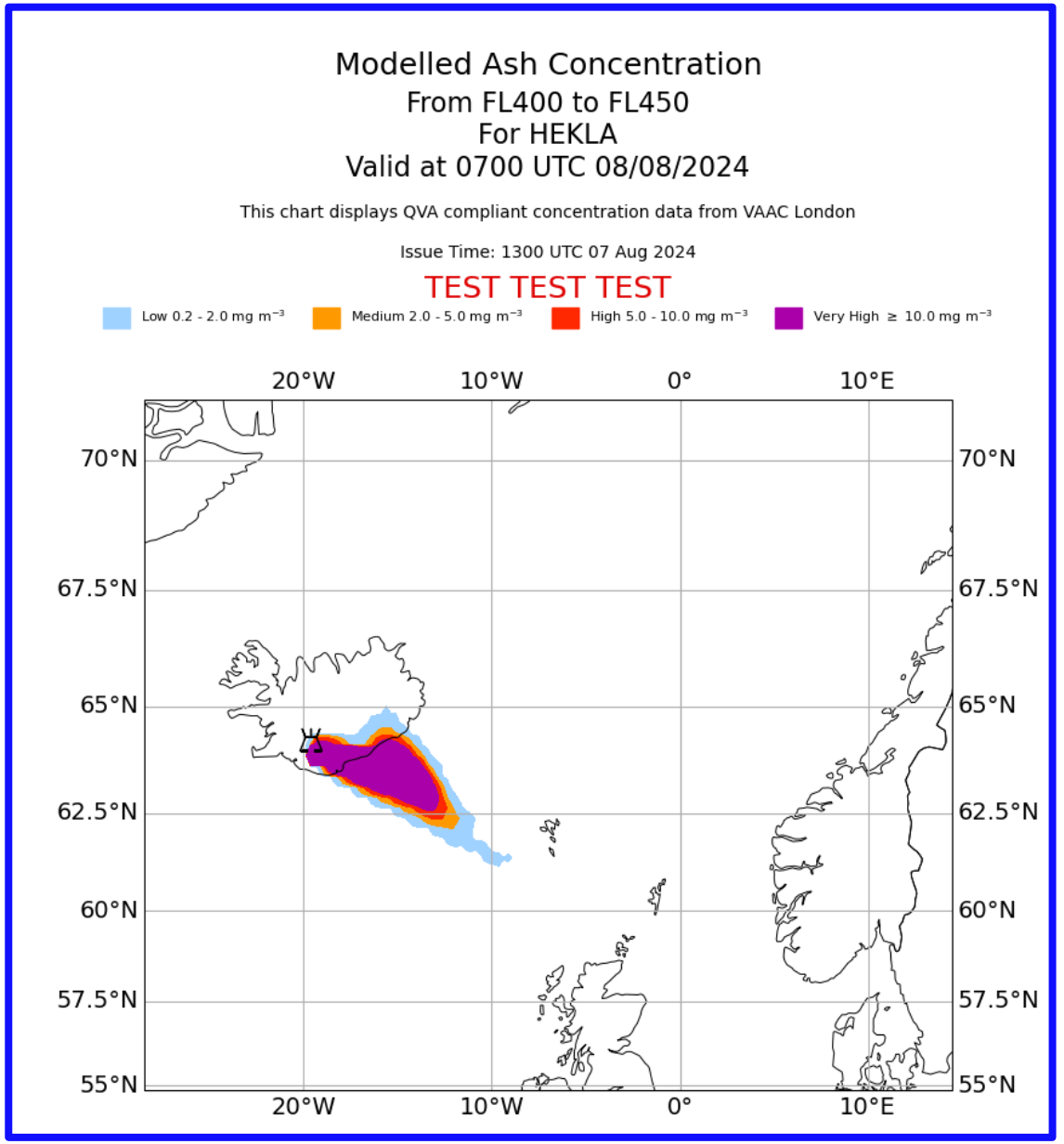
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

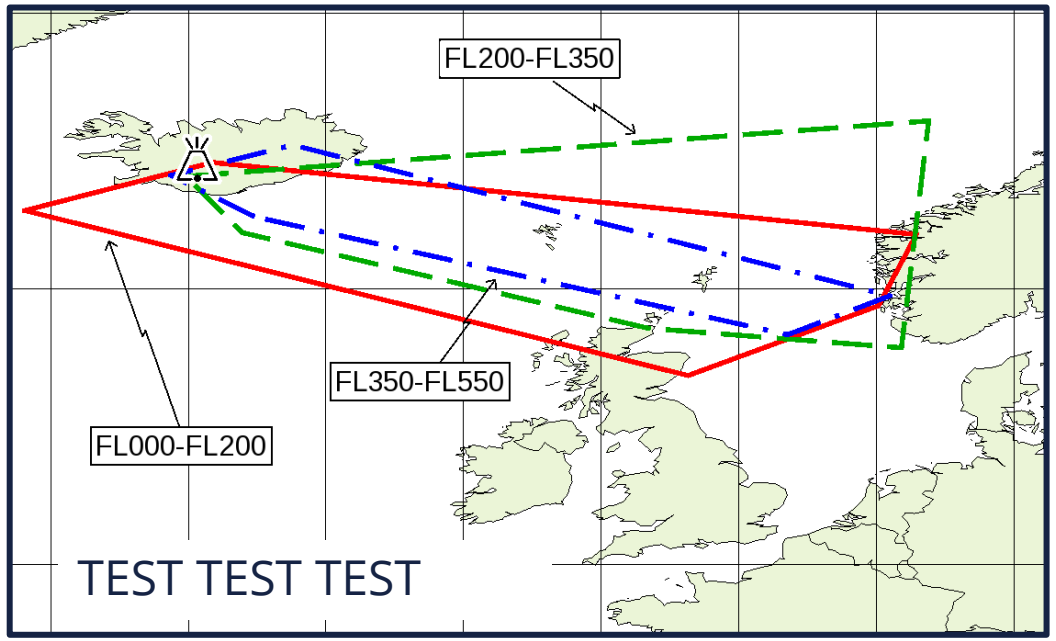
New QVA Product

Gives you the detail of where ash is in the vertical



London VAAC Forecasts

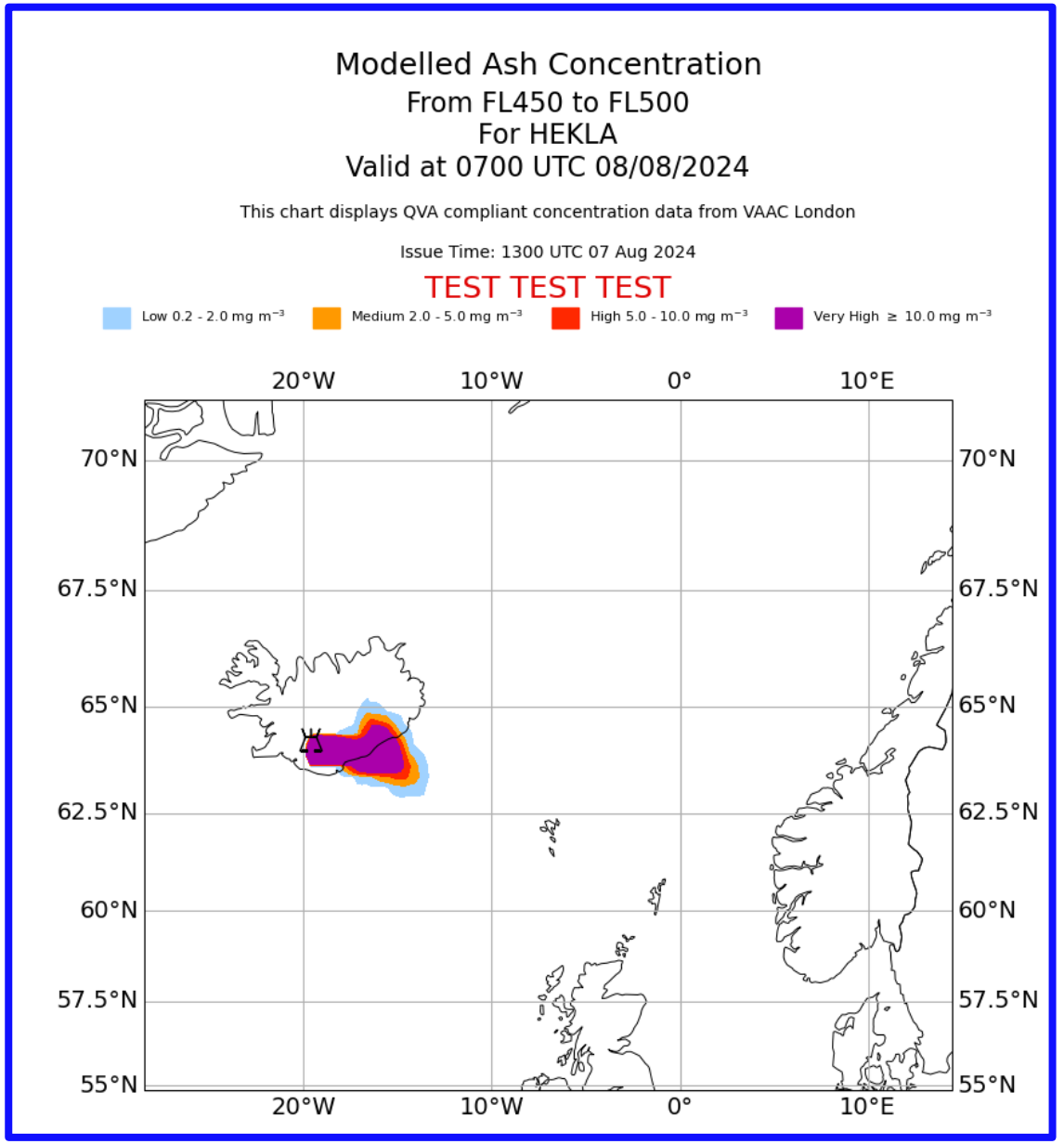
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

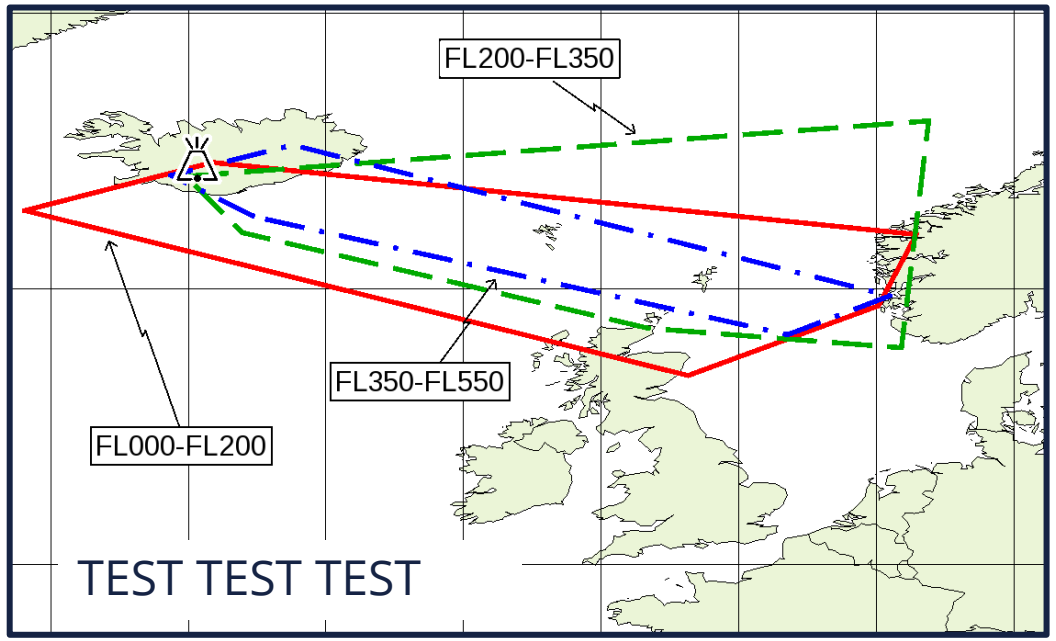
New QVA Product

Gives you the detail of where ash is in the vertical



London VAAC Forecasts

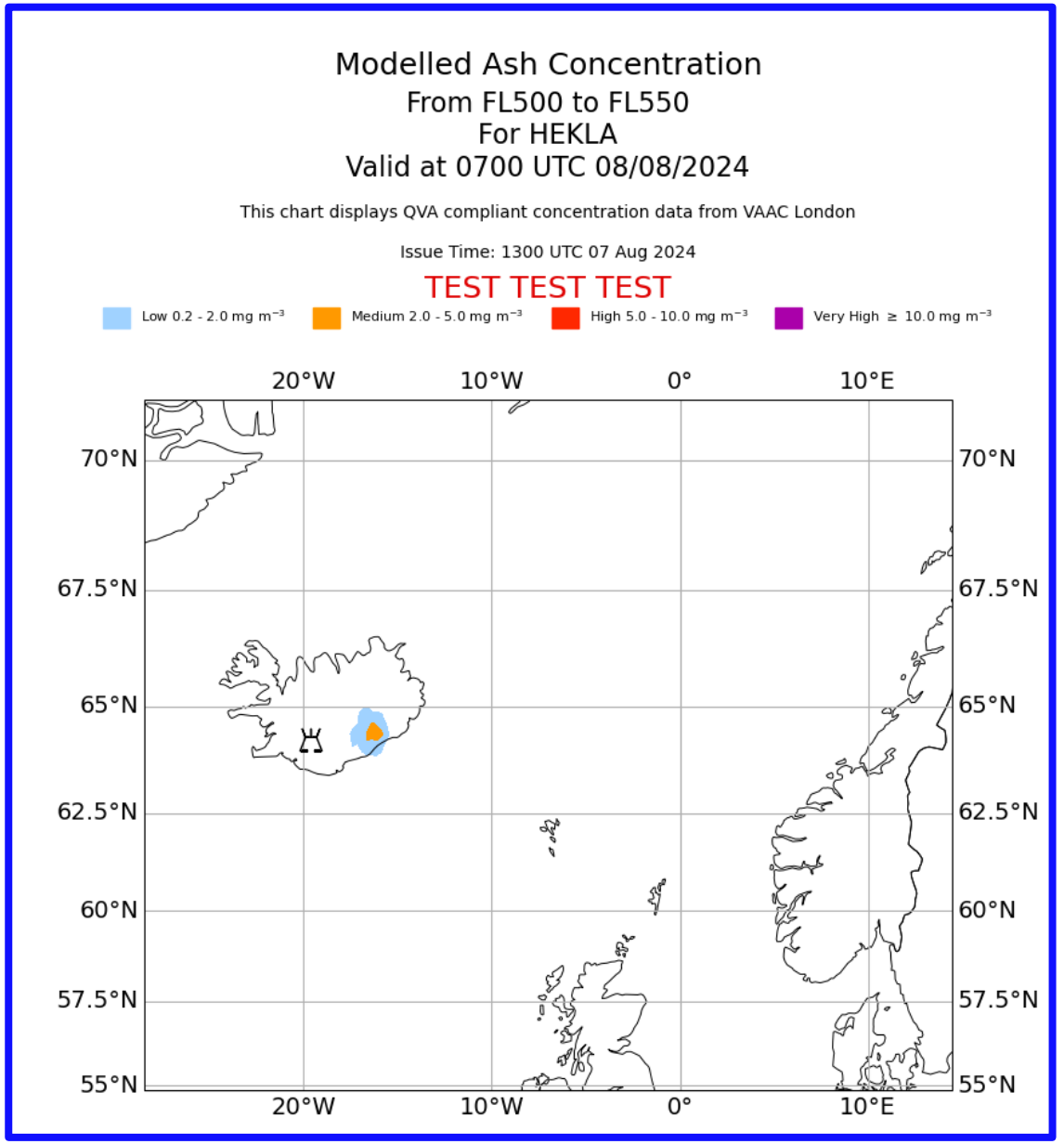
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

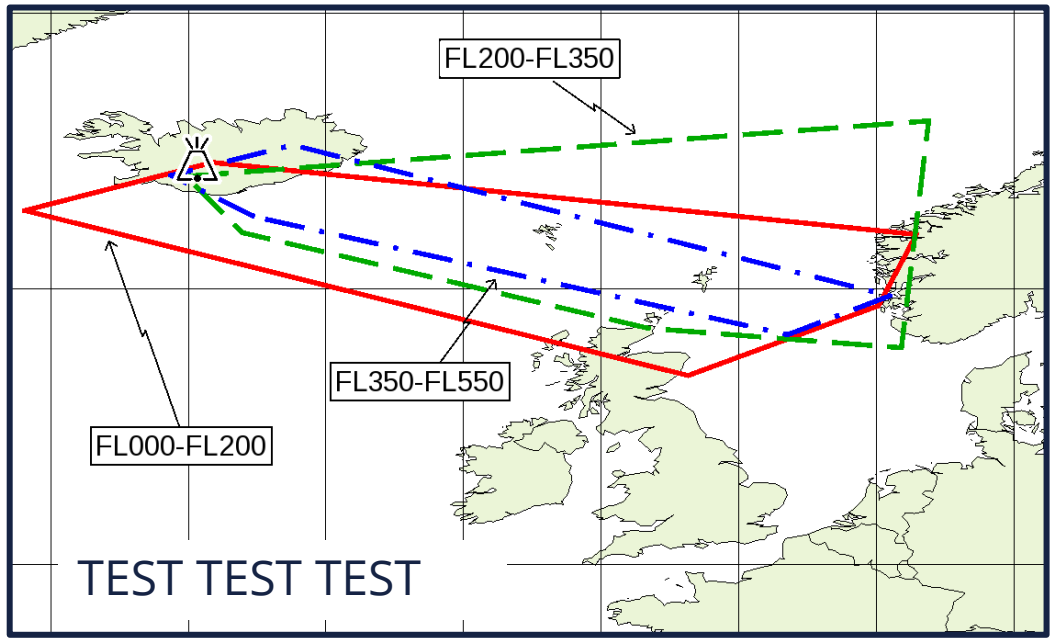
New QVA Product

Gives you the detail of where ash is in the vertical



London VAAC Forecasts

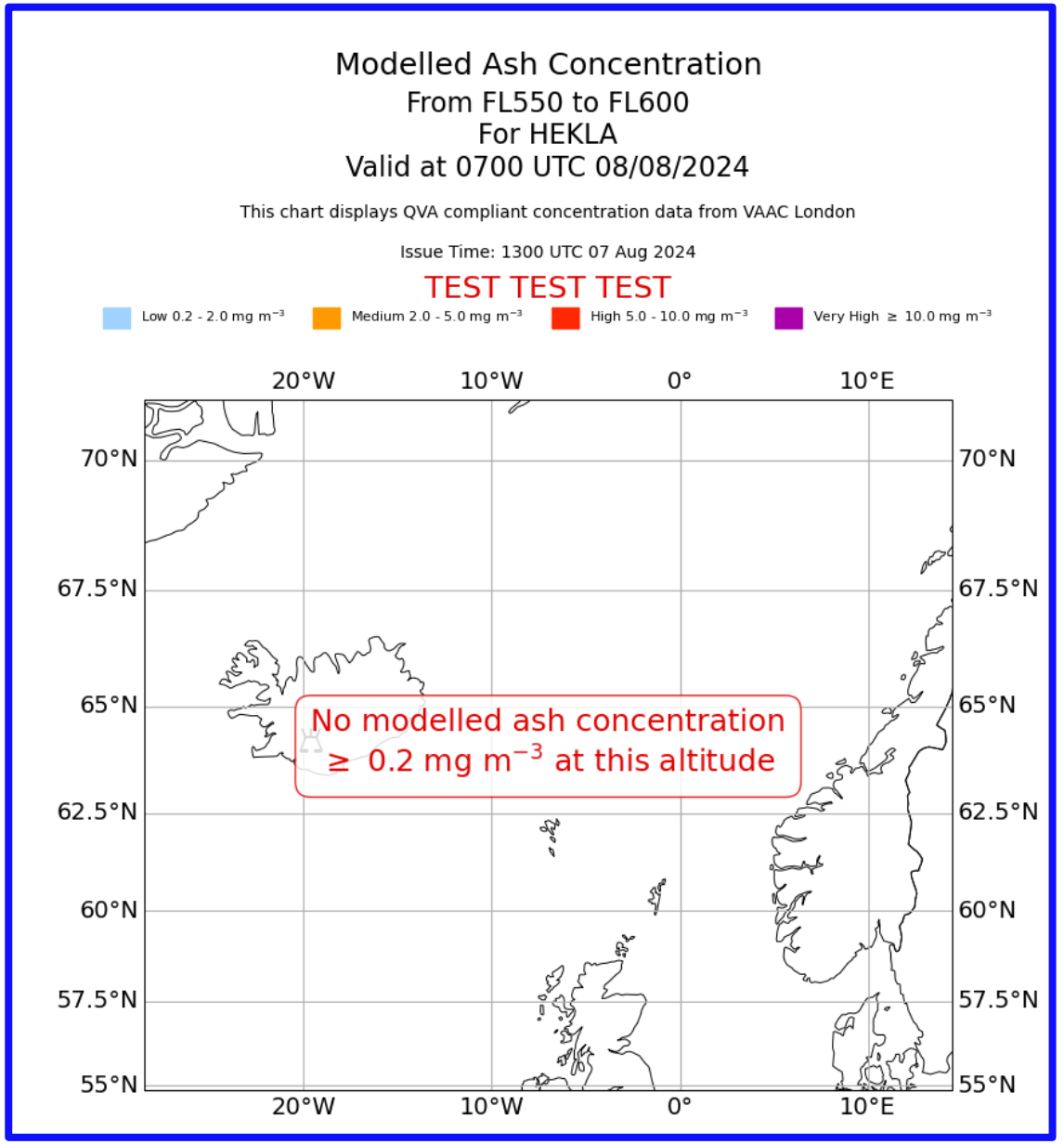
Volcanic Ash Graphic (VAG)



VAG is any ash above ~0.2 mg m^{-3}

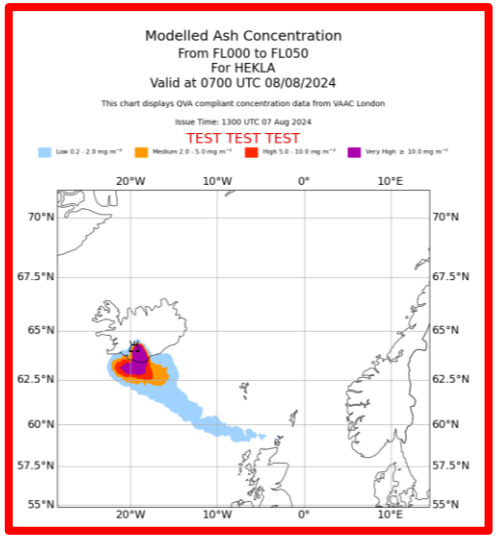
New QVA Product

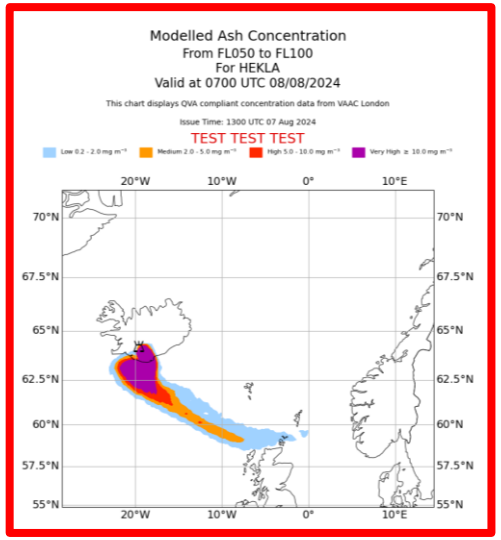
Gives you the detail of where ash is in the vertical

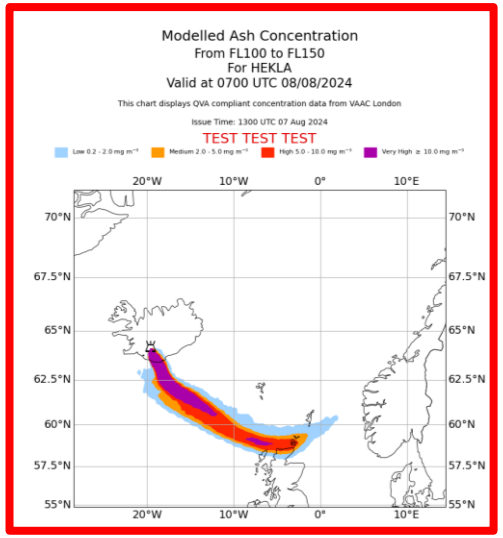


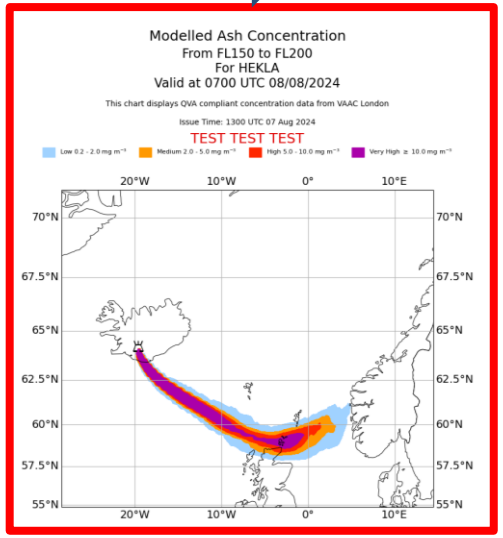
London VAAC Forecasts

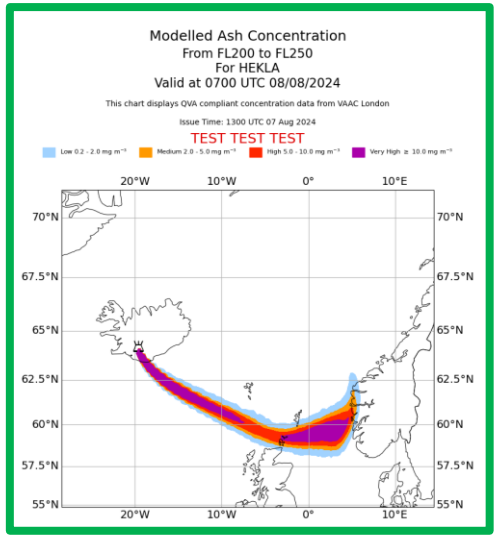
Height

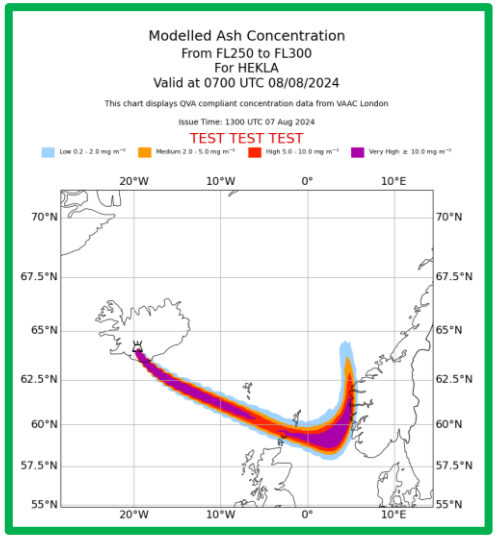


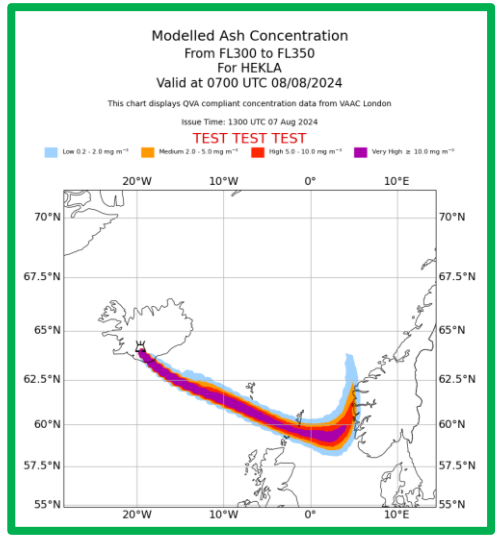


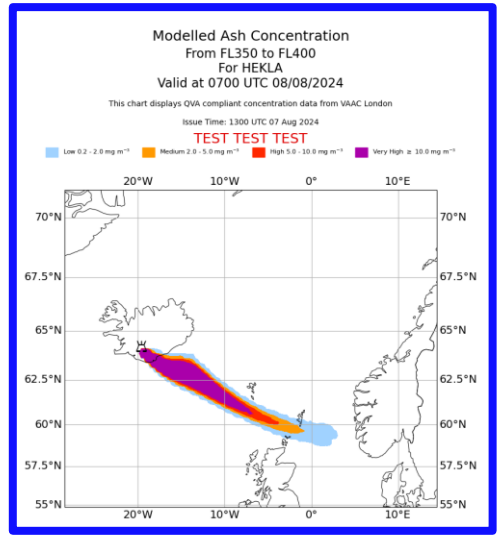


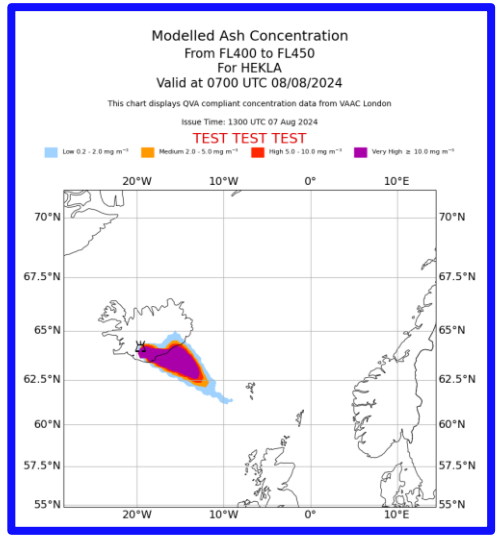


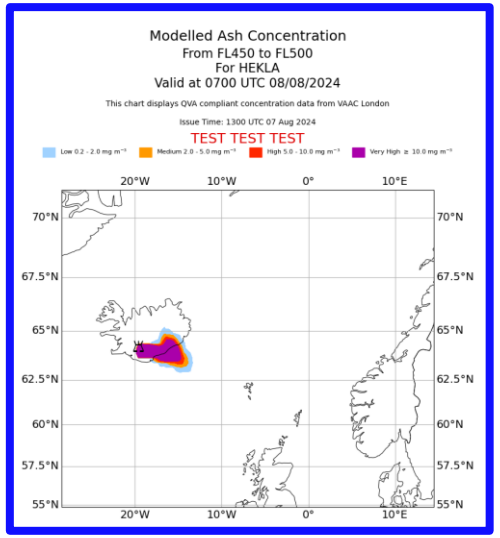








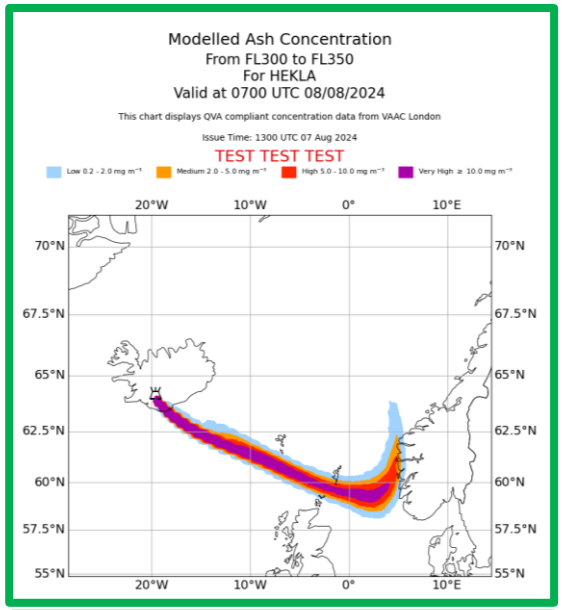


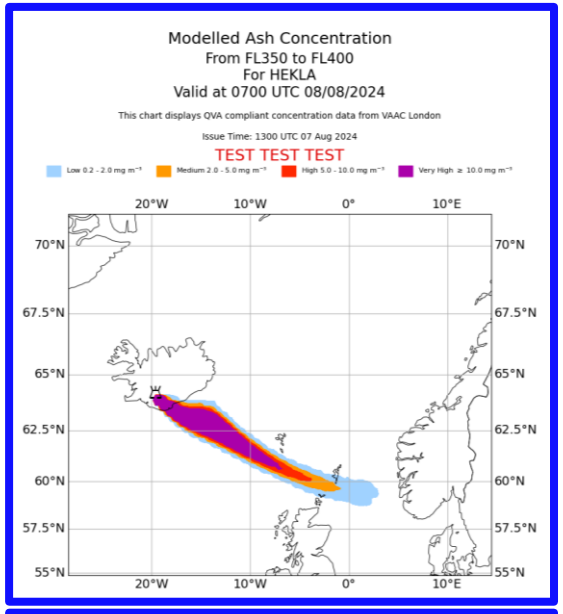


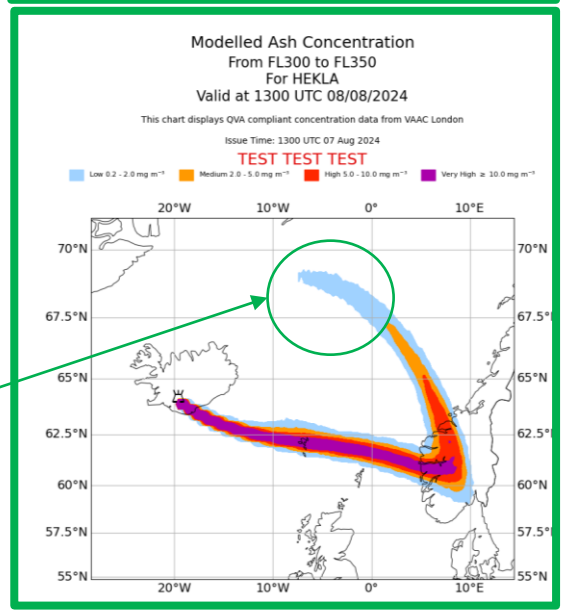
London VAAC Forecasts

Time

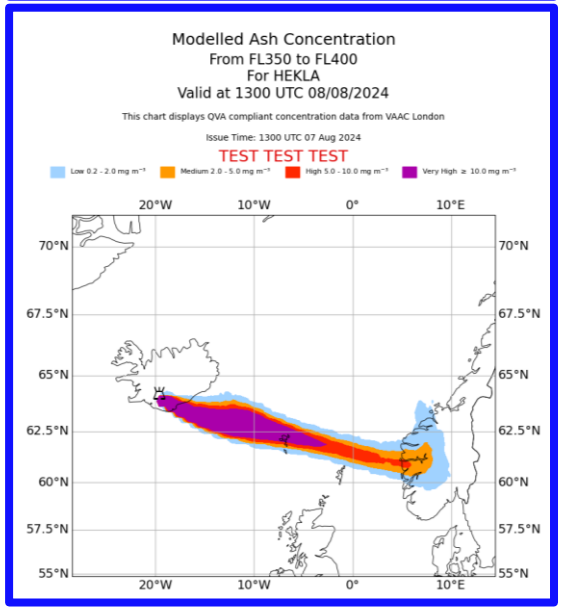
+ 6 h





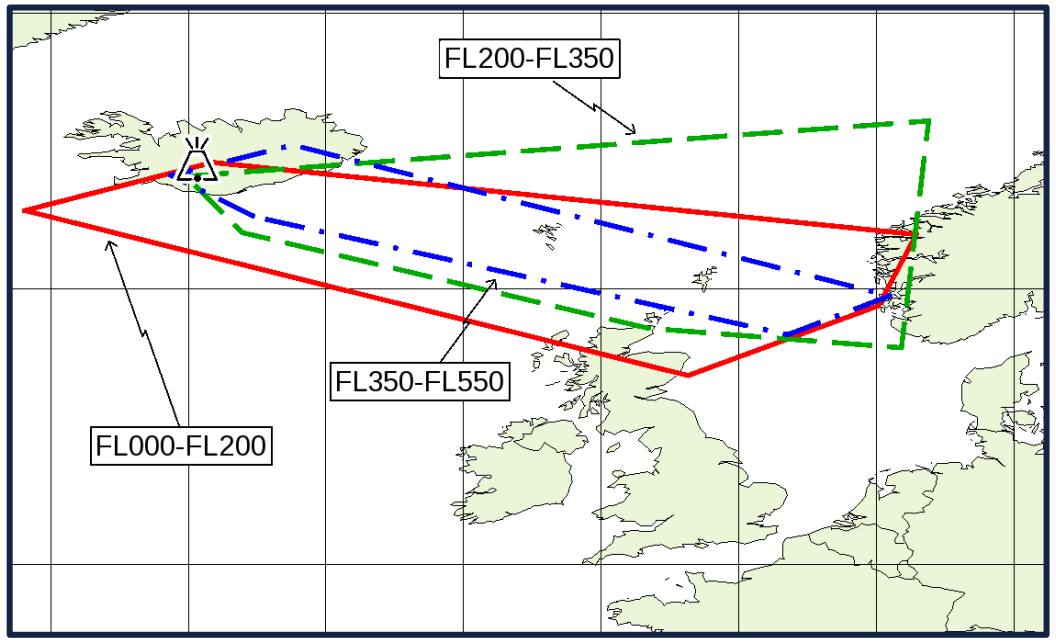


Here ash is less than 2 mg m^{-3}



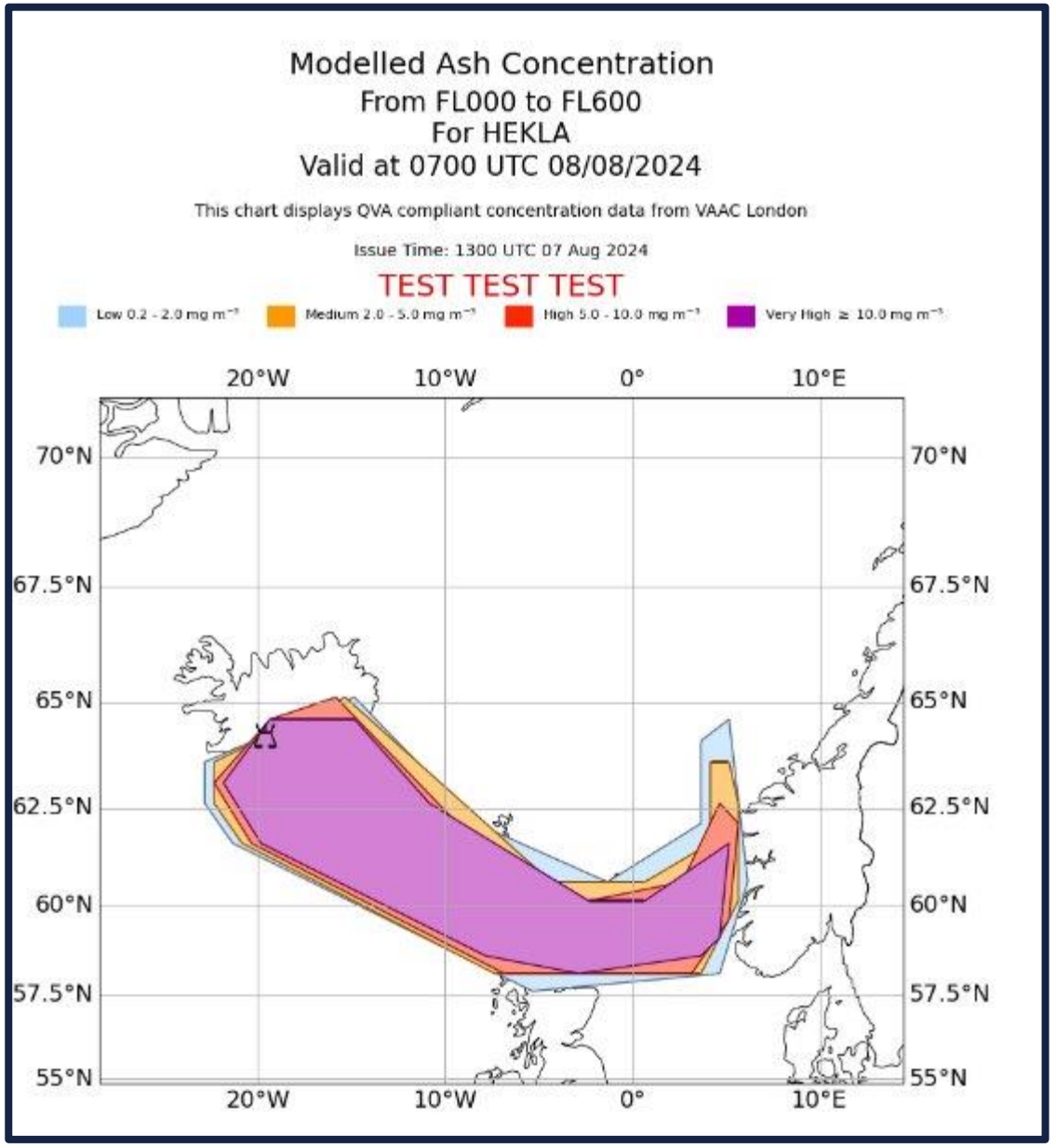
QVA IWXXM Objects

Volcanic Ash Graphic (VAG)



New QVA Product

Gives you more sophisticated polygons



Probabilistic Forecasts

How the Probabilistic Forecasts are generated + How to Interpret Them

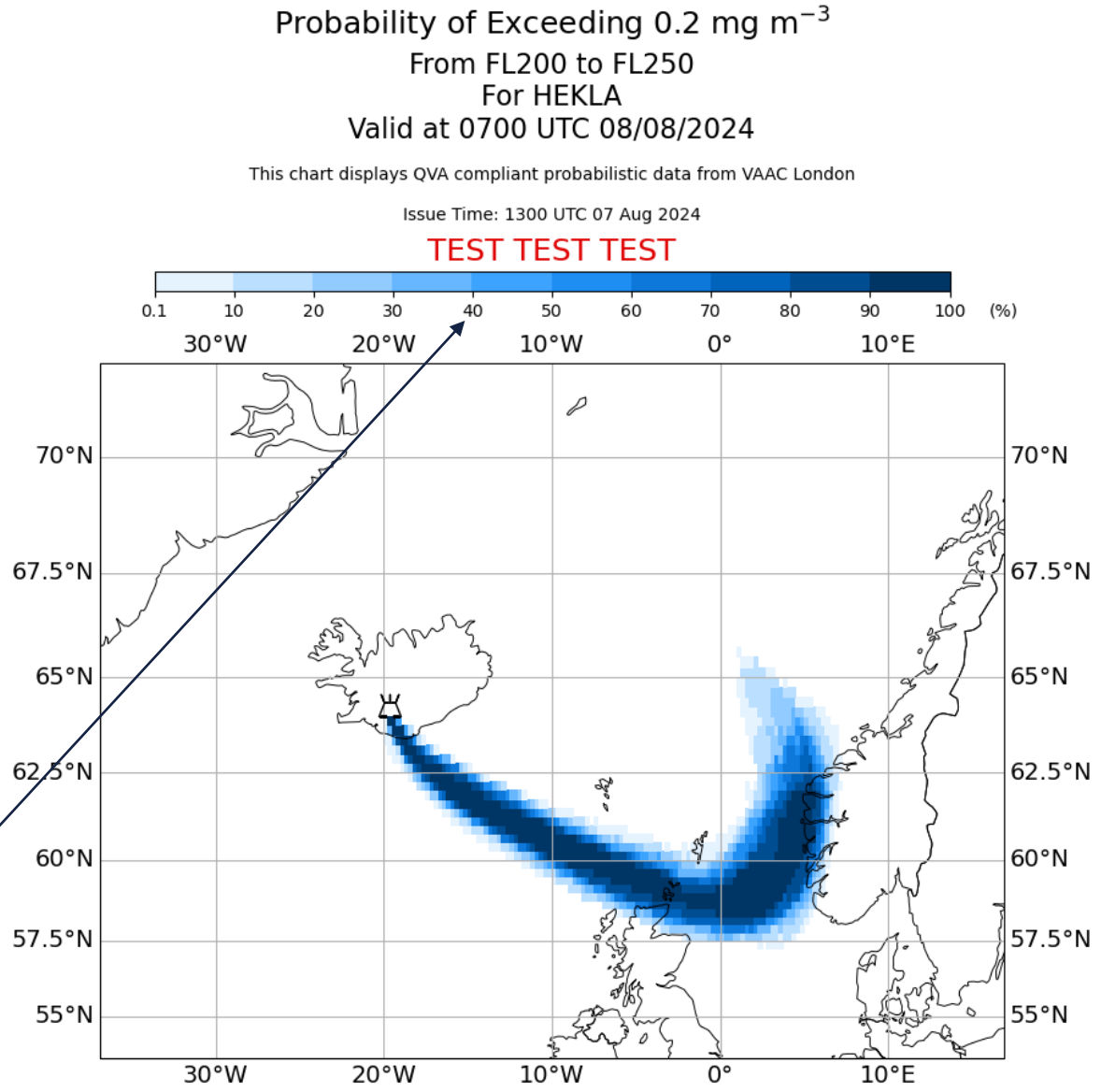
- Multiple sources of uncertainty behind a forecast:
  - The Source (Plume Height + Release Rate)
  - Meteorological Data (weather forecast)
  - Observations

- 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

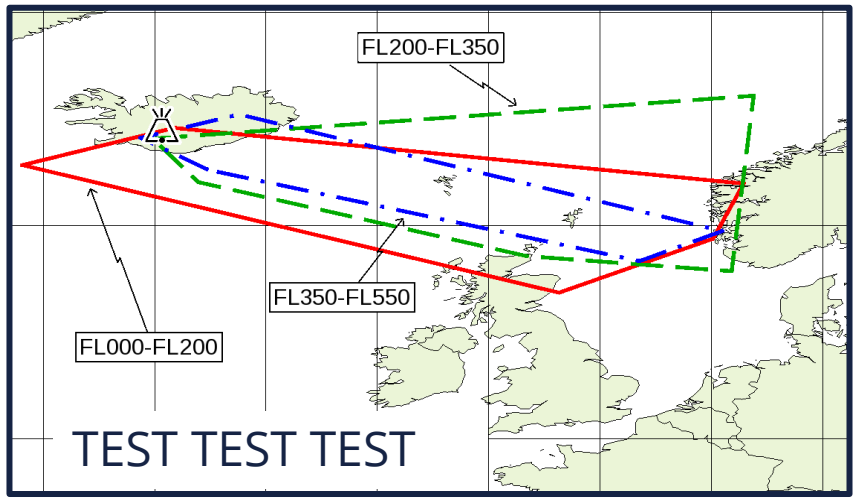
- All VAACs continue to develop capability to represent all sources of uncertainty

This is telling you that there is a 40% **chance** that volcanic ash will exceed concentrations of 0.2 mg m^{-3}



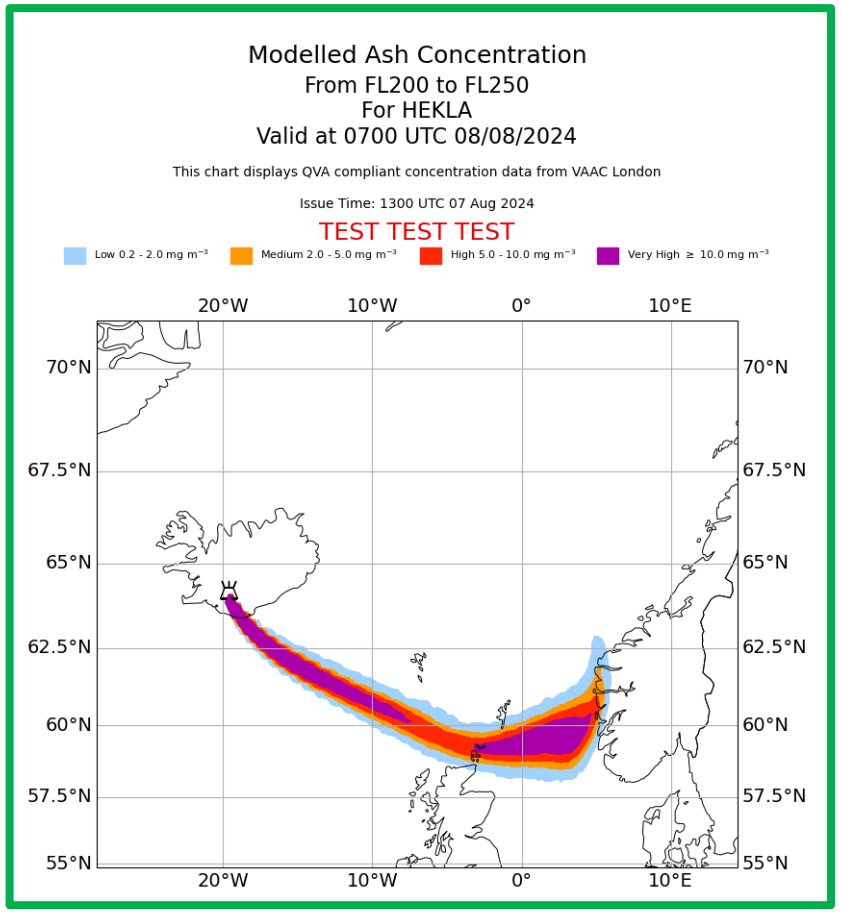
Probabilistic Forecasts

Volcanic Ash Graphic (VAG)

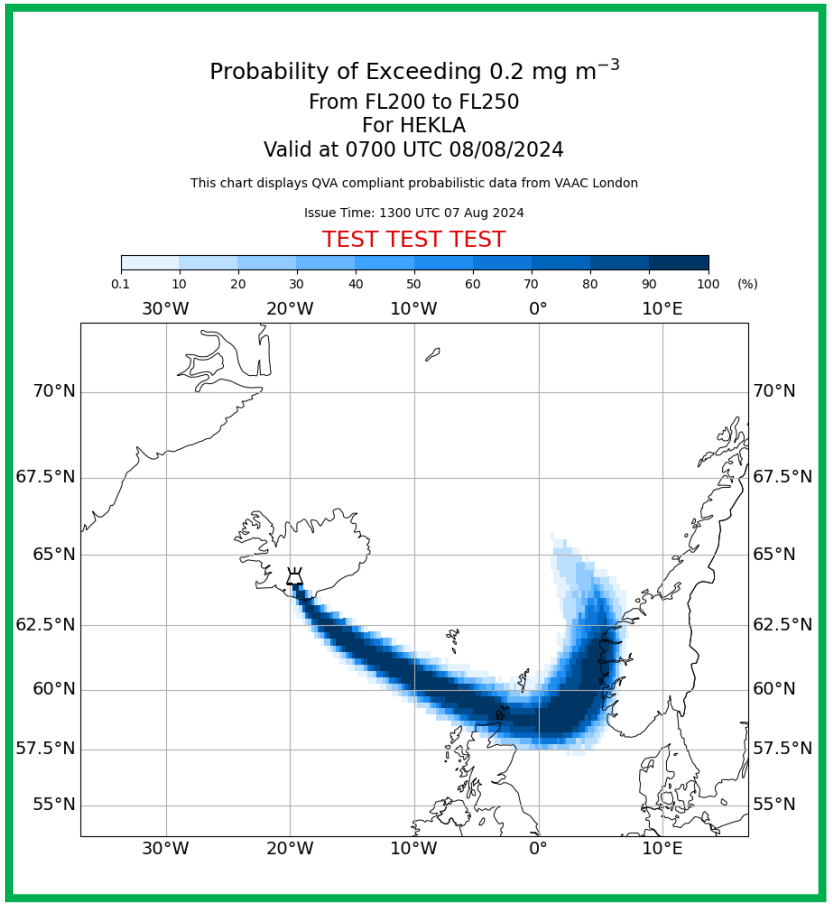


VAG is any ash above ~0.2 mg m^{-3}

New QVA Products

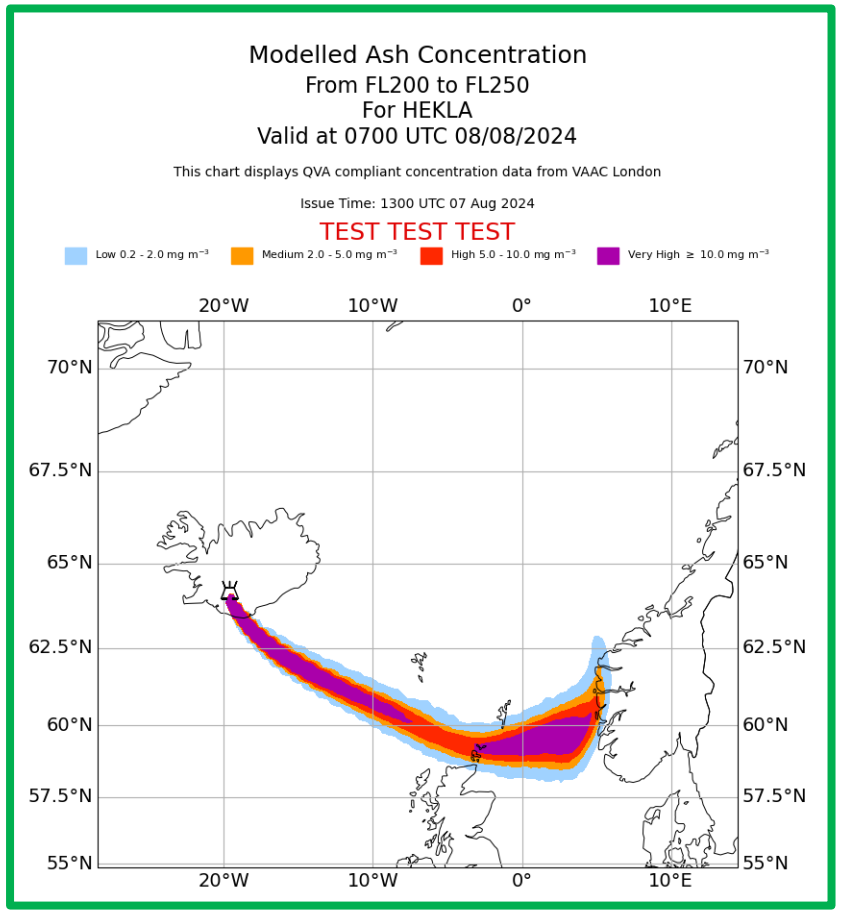


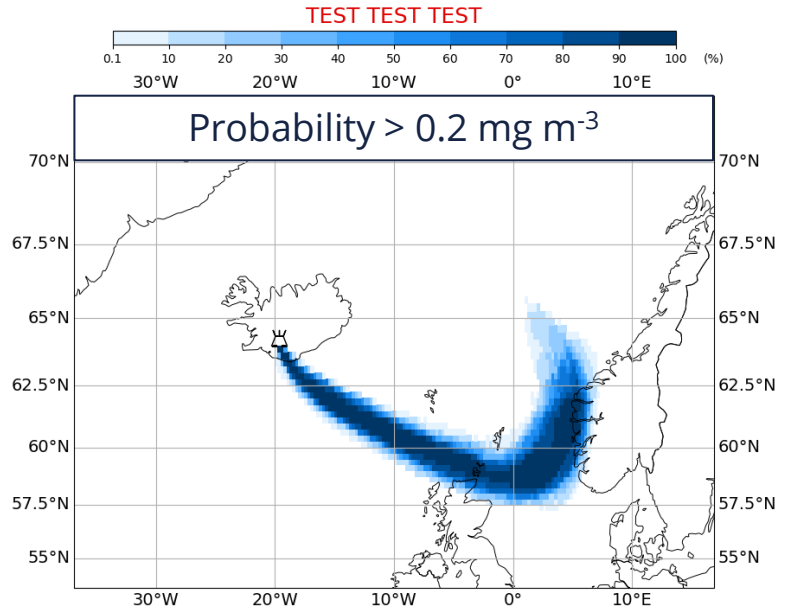
Concentration Forecast

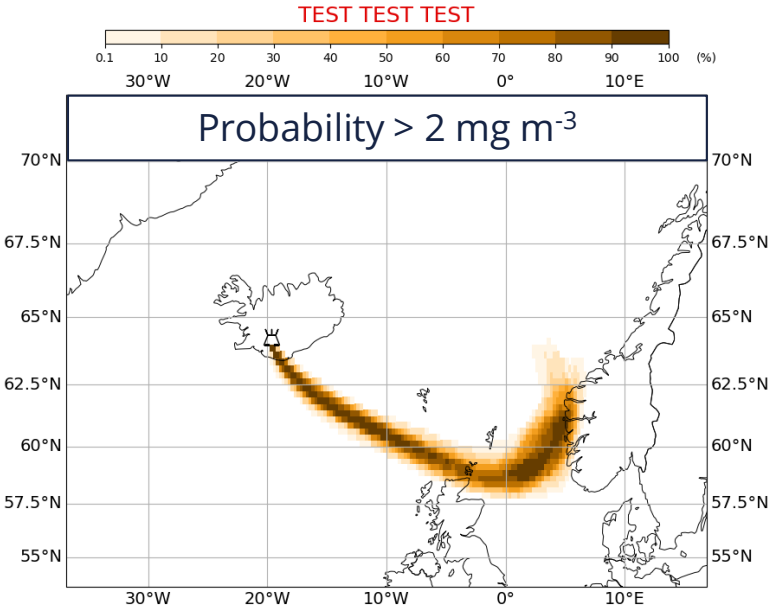


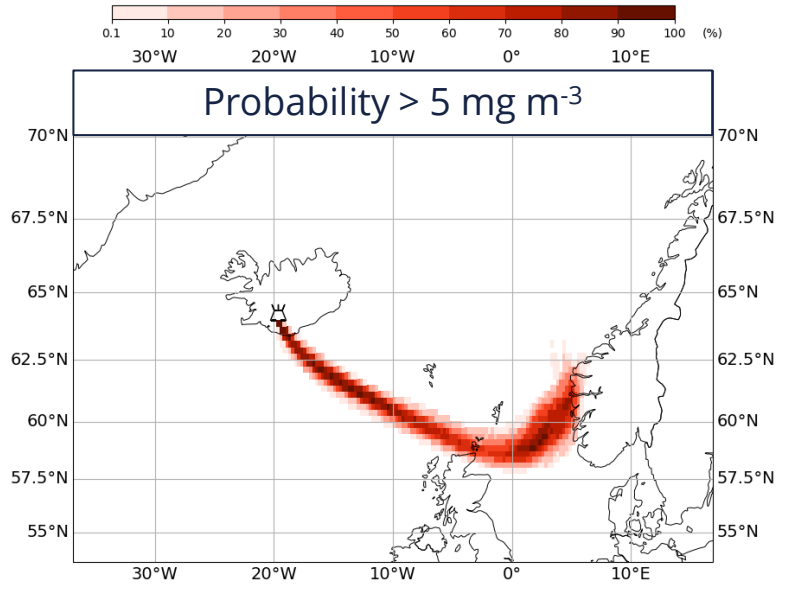
Probabilistic Forecast

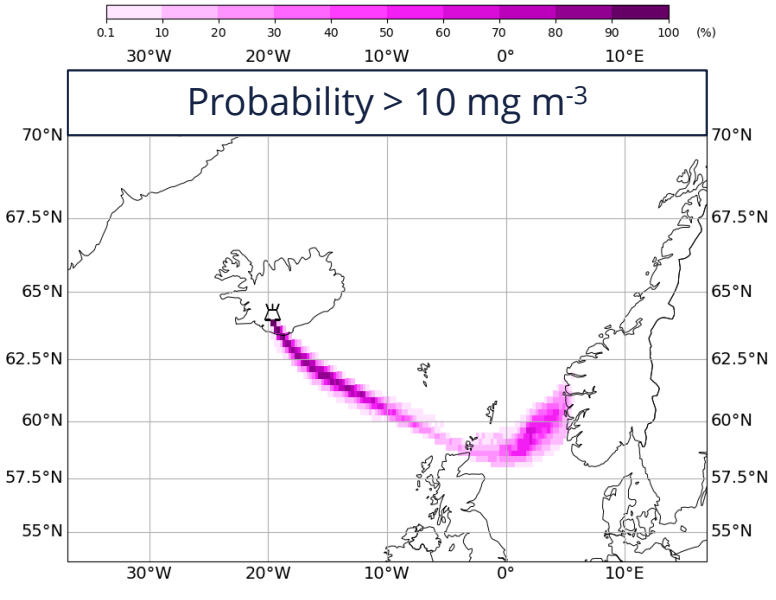
Probabilistic Forecasts











For FL200-250

Scenario – Volcanic eruption at Ruapehu.

Eruption Start: 12:00UTC 8 January 2025

Plume Height: 12.5km

Source strength: $8.8x10^4$ kg/s

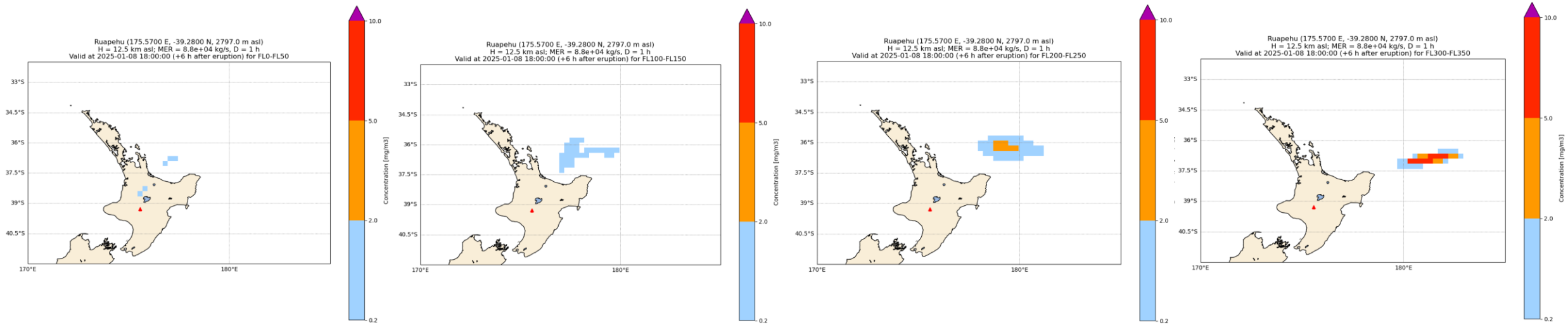
Eruption length: 1 hour

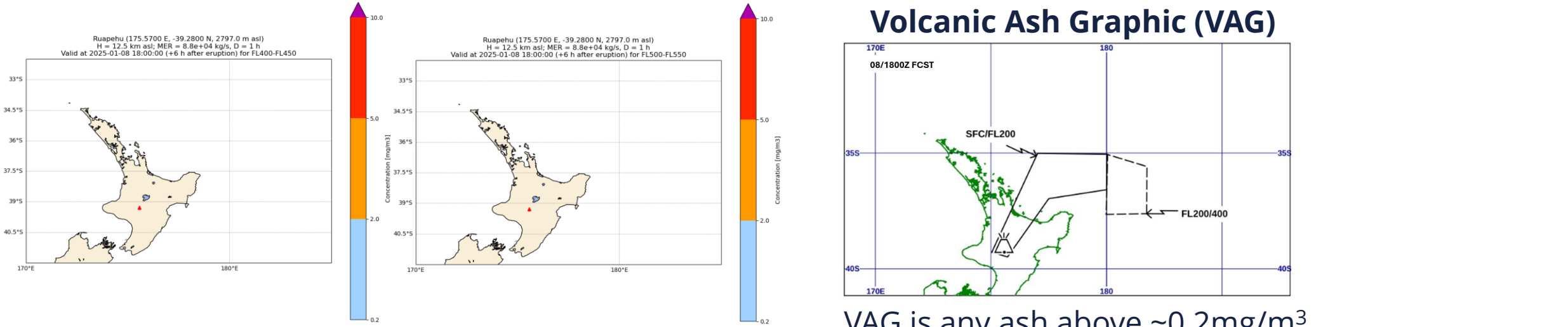
Note: The following example is based off the height of the 1996 Ruapehu eruption using weather modelled by GFS and GEFS at 12:00UTC 8 January 2025.

Impacts & Mitigation - Ruapehu 1995-96

Concentration graphic at +6h (from FL000-FL600, every 2 levels are plotted)

Increasing height

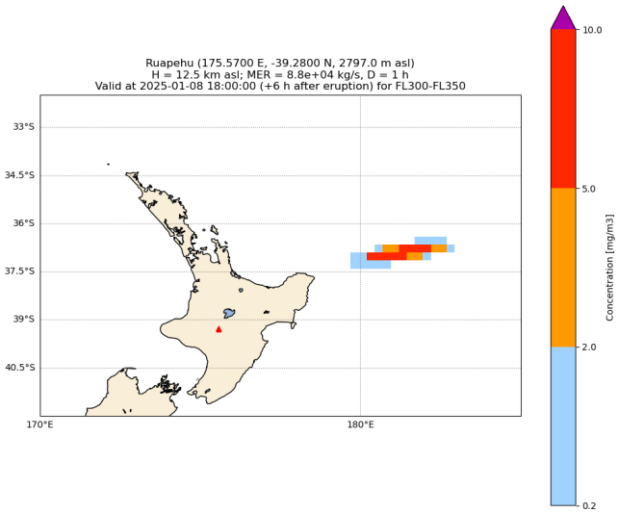




Volcanic Ash Graphic (VAG)

VAG is any ash above ~0.2mg/m^3.

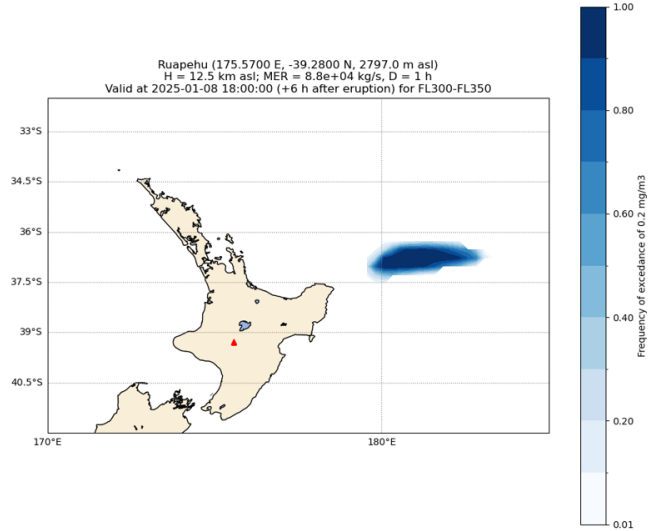
Concentration graphic at +6h for FL300-350

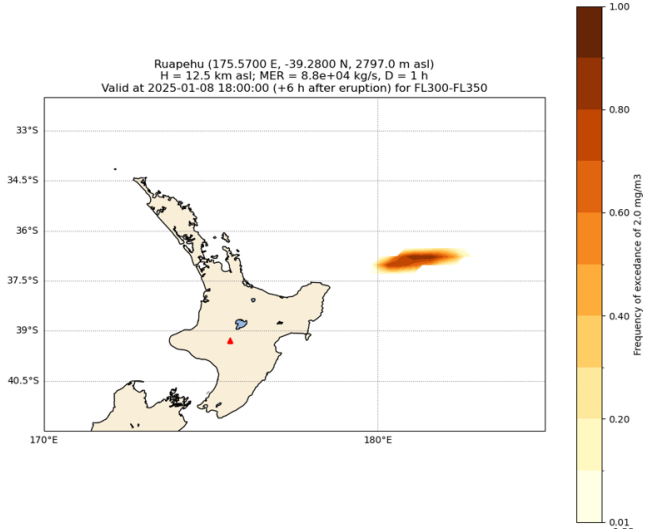


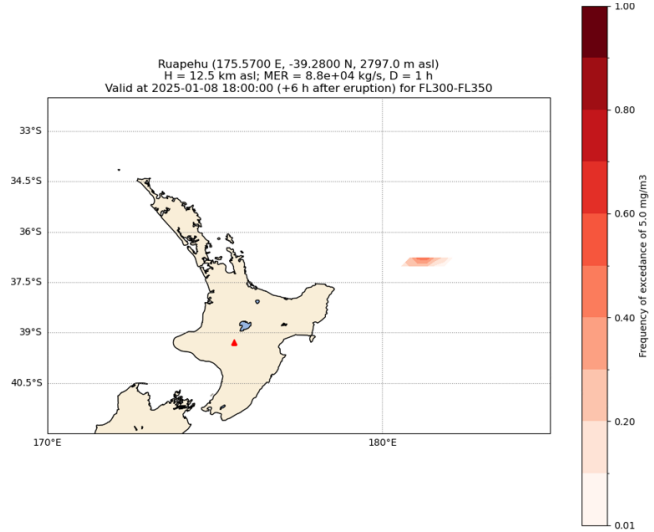
The forecaster will need to assess whether the eruption is significant and if the data is accurate data to proceed with issuing QVA data to the customer.

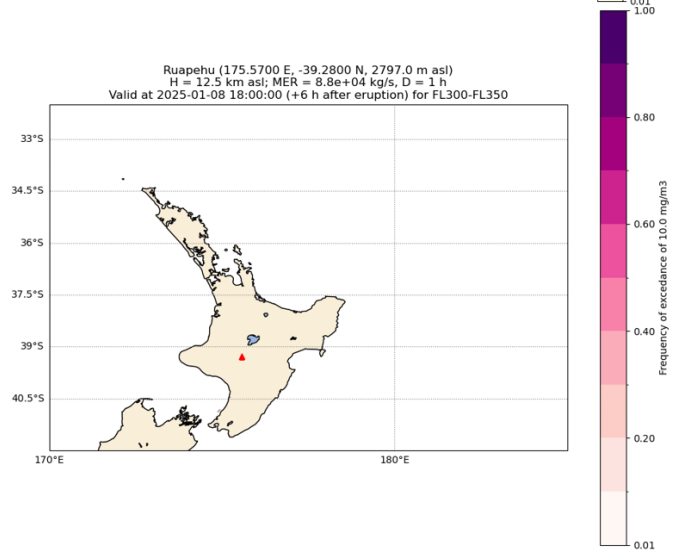
Probability of exceedance graphic at +6h from FL300-FL350

Increasing concentration

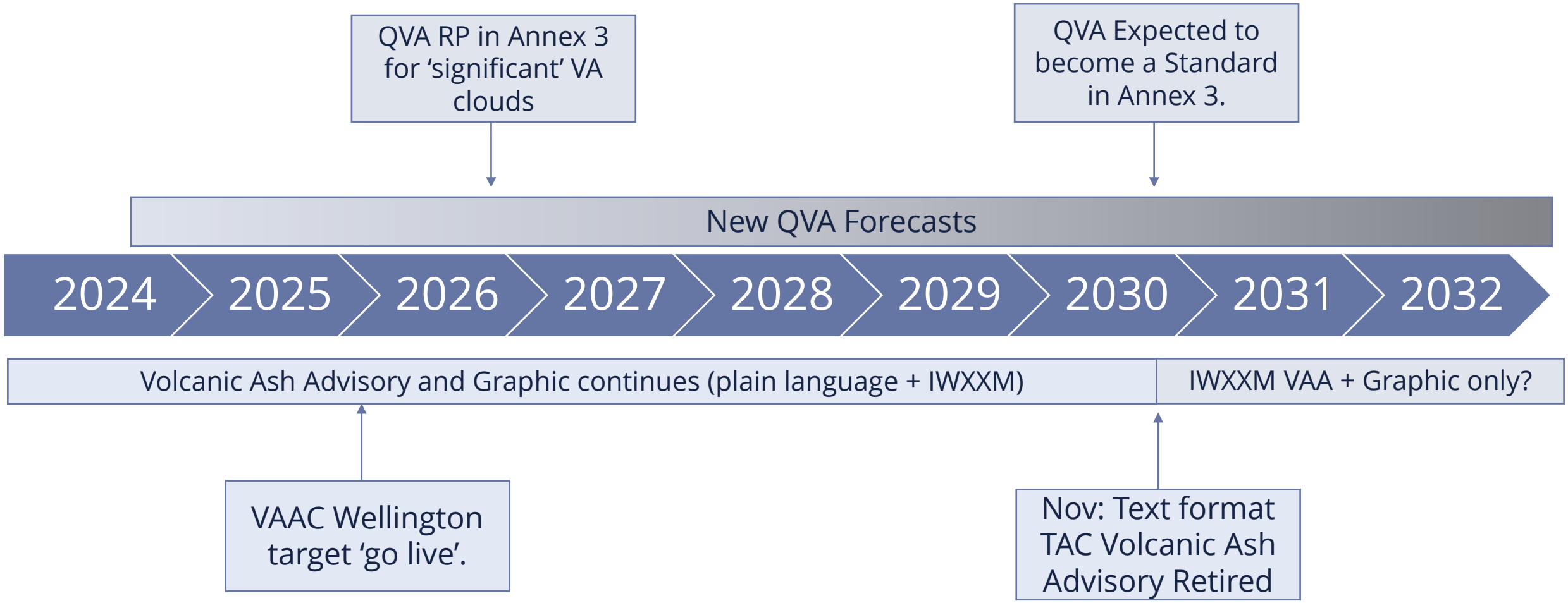






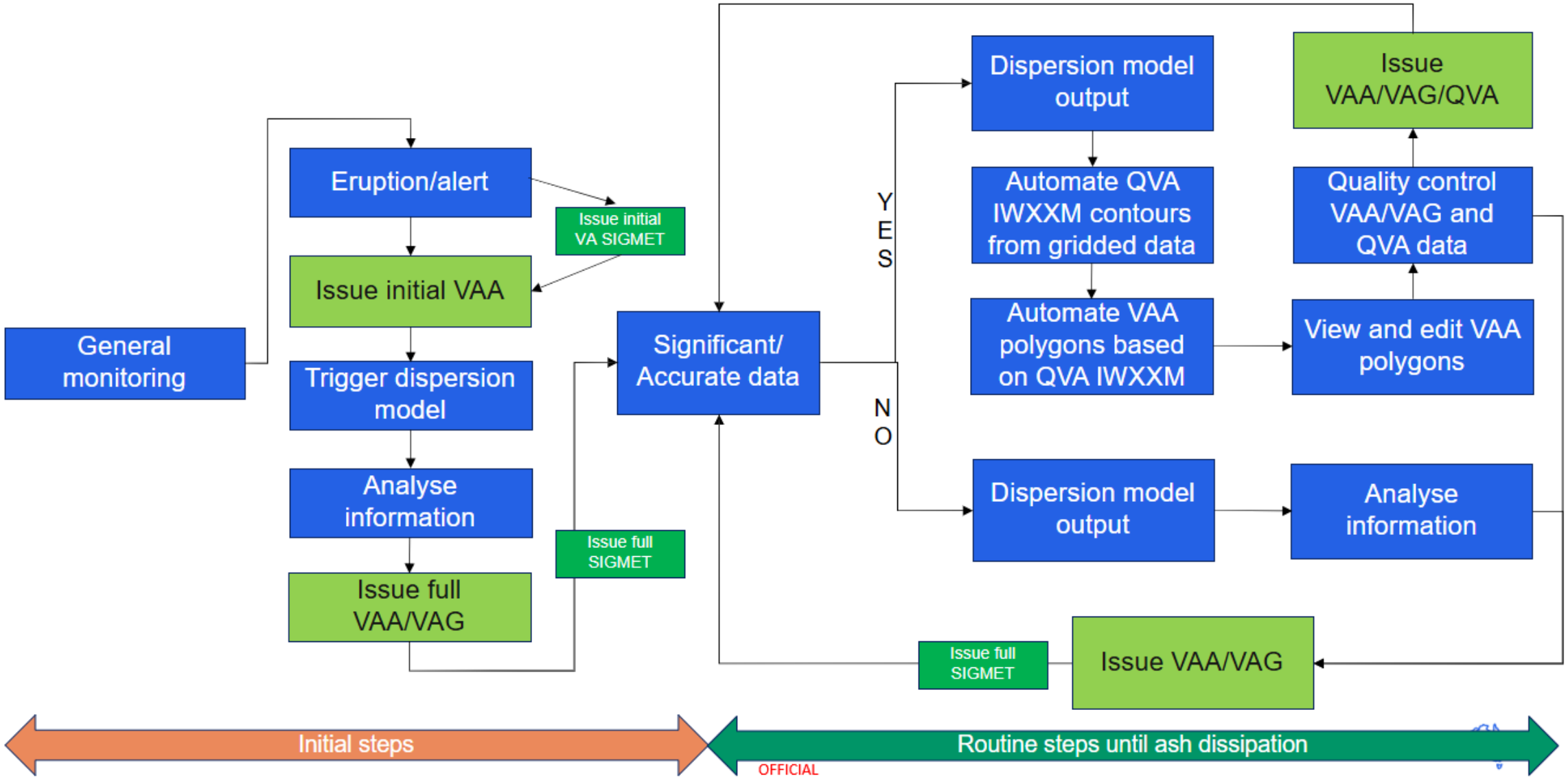


Timelines



From November 2026 the provision of a QVA for significant volcanic ash clouds will be a recommended practice

Proposed VAAC Forecaster workflow for QVA issuance



Modified from Bureau if Meteorology Australia's presentation at ICAO Meteorology Panel QVA Workshop 31st October 2024 to represent MetService's workflow.

Nicole.Ranger@metservice.com