Met Office User Forum 2024

Monday 25th November 2024

Housekeeping

Fire Alarm

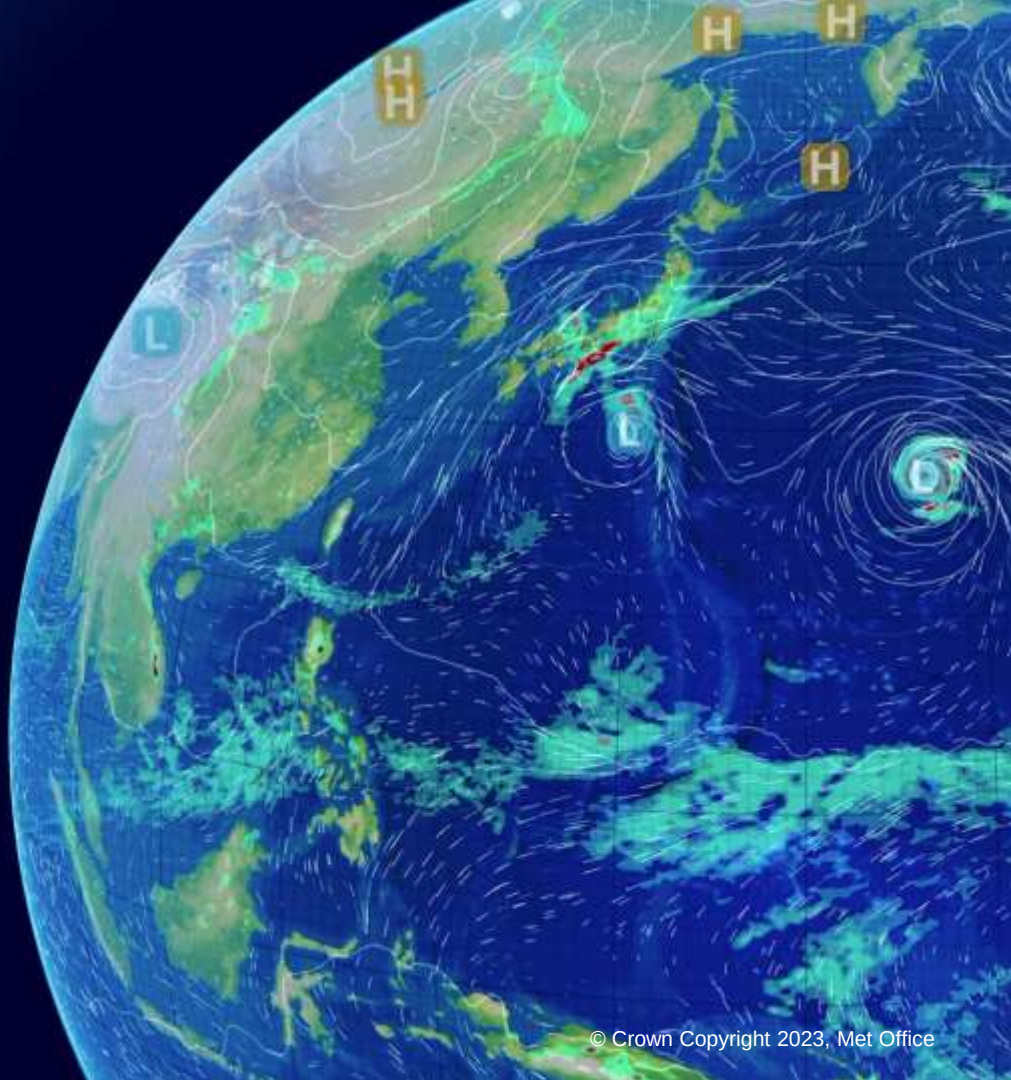
- In the event of a fire, a siren will sound, please obey the instructions given on the voice alarm.
- If evacuation is required, please follow your guide who will escort you safely from the building.
- In the interests of your safety, please remain with your guide at all times.

Photos

- Photos in the conference rooms, conference area balcony and outside the front of the building are permissible.
- No photos whilst on the tour please.

Met Office

Welcome and **Introductions** to **MOUF**



Today's Session:

11:00	Welcome and Introductions
11:15	International Activities
11:45	Finances
12:00	National Aviation Service
12:30	**Lunch & Ops Centre Tour – Photo Opportunity**
13:30	Aviation Research and Development
14:00	3-month weather outlook brief
14:20	Specific issues raised by members
14:50	Any other business
14:55	Date of Next Meeting

Today's Speakers:

Mark Gibbs Head of Transport

Lauren Donohue Aviation Manager

Piers Buchanan Aviation Science Manager

Andrew Creswick Aviation Scientist

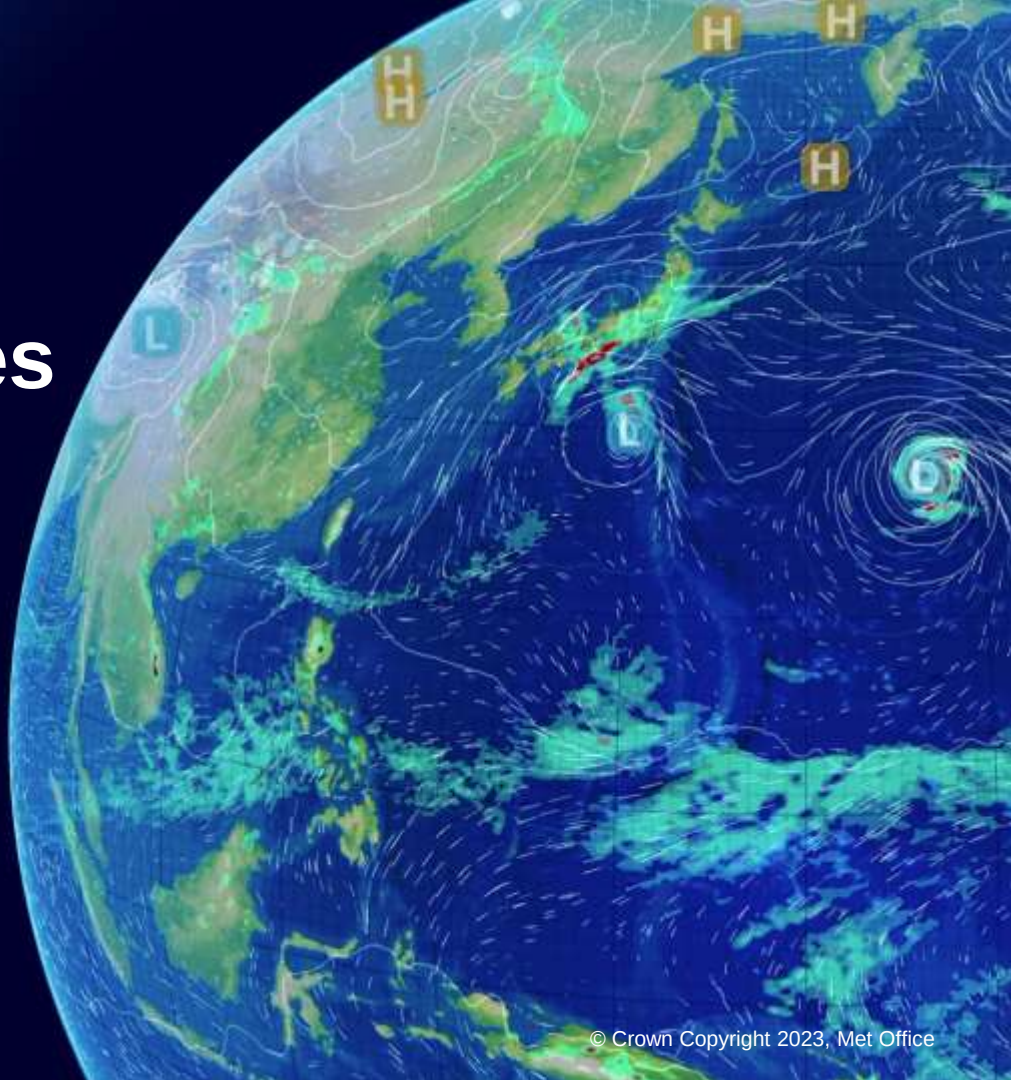
Graeme Anderson Aviation Senior Scientist

Dan Rudman Expert Operational Meteorologist

International Activities

Mark Gibbs

Head of Transport



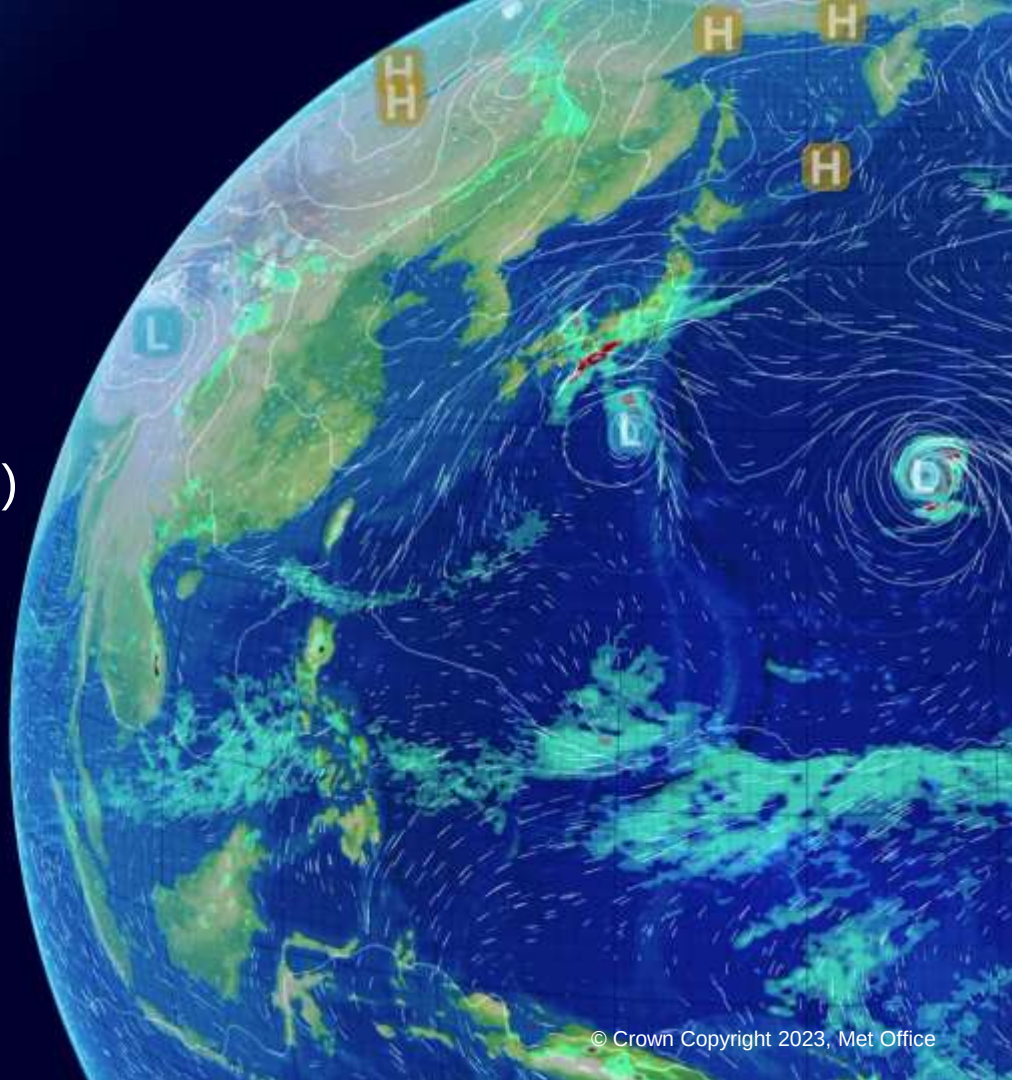
Content

World Area Forecast System (WAFS)

and

Quantitative Volcanic Ash (QVA)

Changes and upgrades



World Area Forecast System (WAFS)

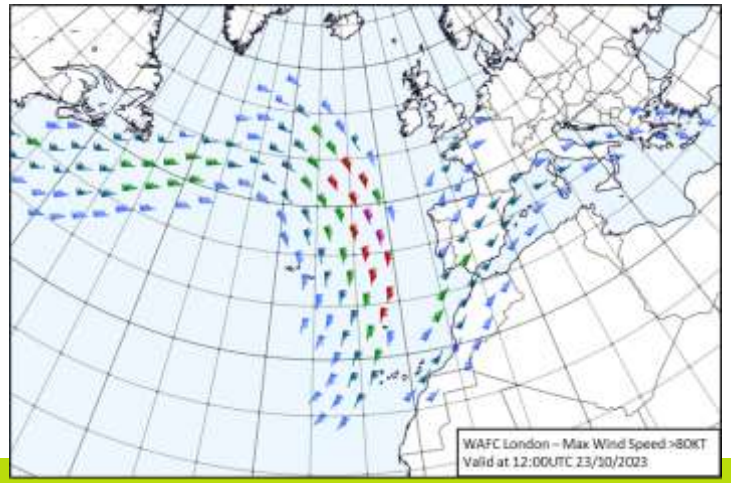
22nd November 2024 marked the 40th Anniversary of our WAFS provision under ICAO remit.

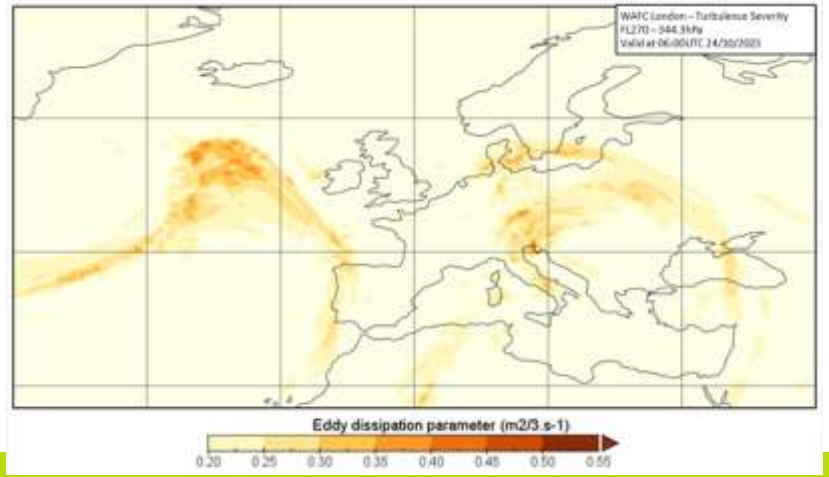
Throughout those 40 years we have been constantly evolving the service – and we are marking the anniversary with huge upgrades to our data sets, production platforms, and delivery systems.

19th March 2024:

- *New WAFS gridded data sets became operational.*
- *Entirely new back-end production system*
- *Introduction of new SADIS API system to deliver the gridded WAFS data and OPMET data sets.*

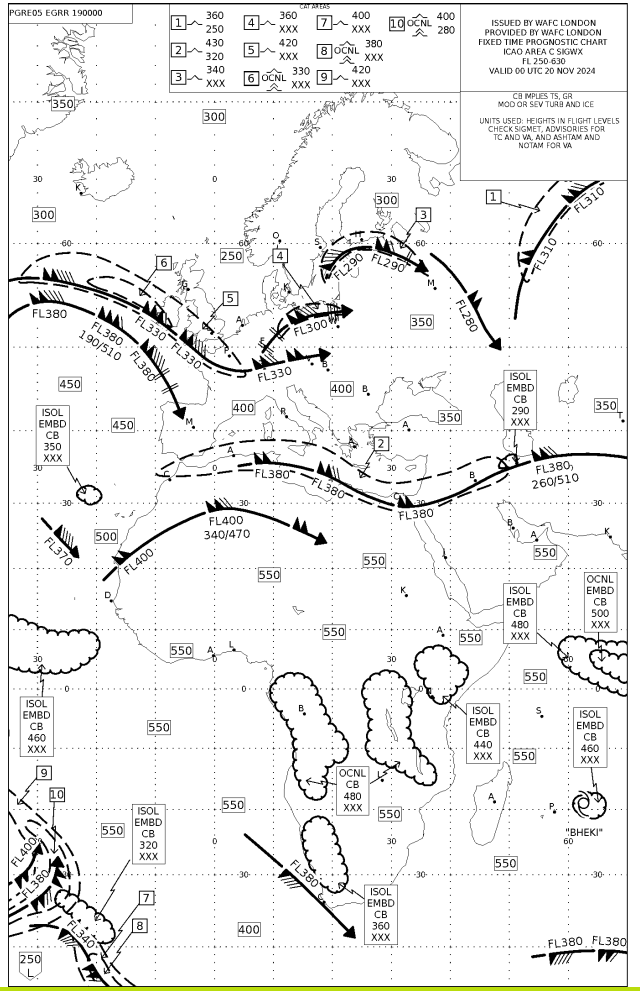
- 56 vertical levels for some parameters (was 17)
- Many more forecast timesteps with hourly data from T+6 to T+24 and stretching out to T+120
- Increased horizontal resolution for the wind temperature, relative humidity and tropopause data sets





23 January 2025:

- *Big changes to WAFS Significant Weather (SIGWX) forecasts*
- *Existing T+24 forecasts/chart production will be automated and their appearance/content will change*
- *New multi-timestep SIGWX forecasts covering T+6 to T+48 at 3-hourly intervals will be introduced (Feb 2025).*



Current SIGWX

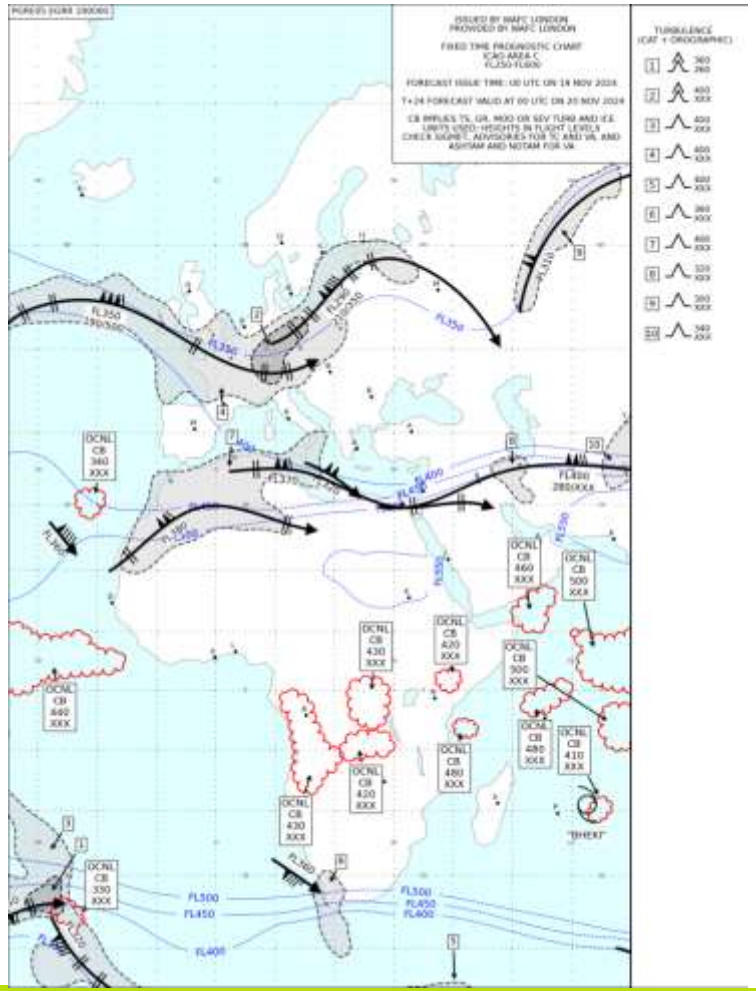
Met Office

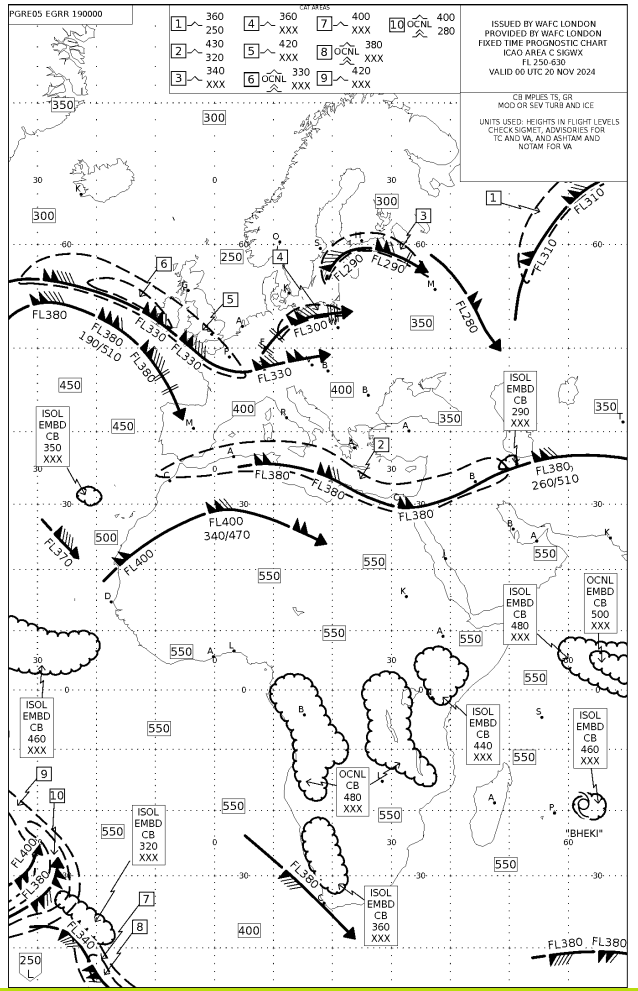
WAFC produced T+24 charts will be in colour!

Grey = turbulence areas

Red = Cumulonimbus areas

Blue contours = tropopause height



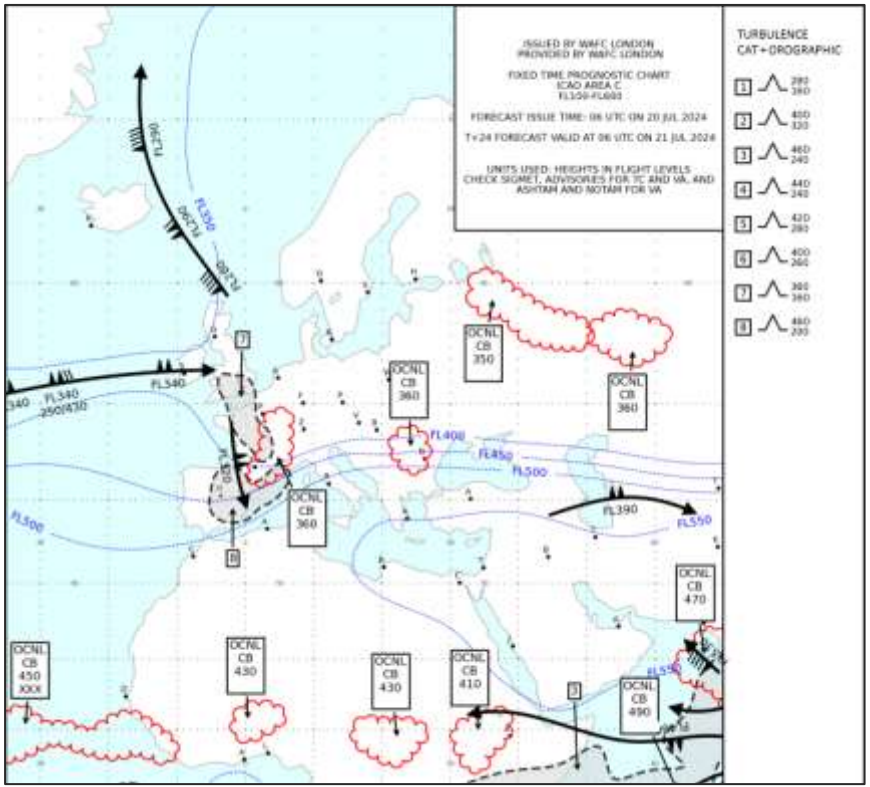


New Style SIGWX

Current SIGWX

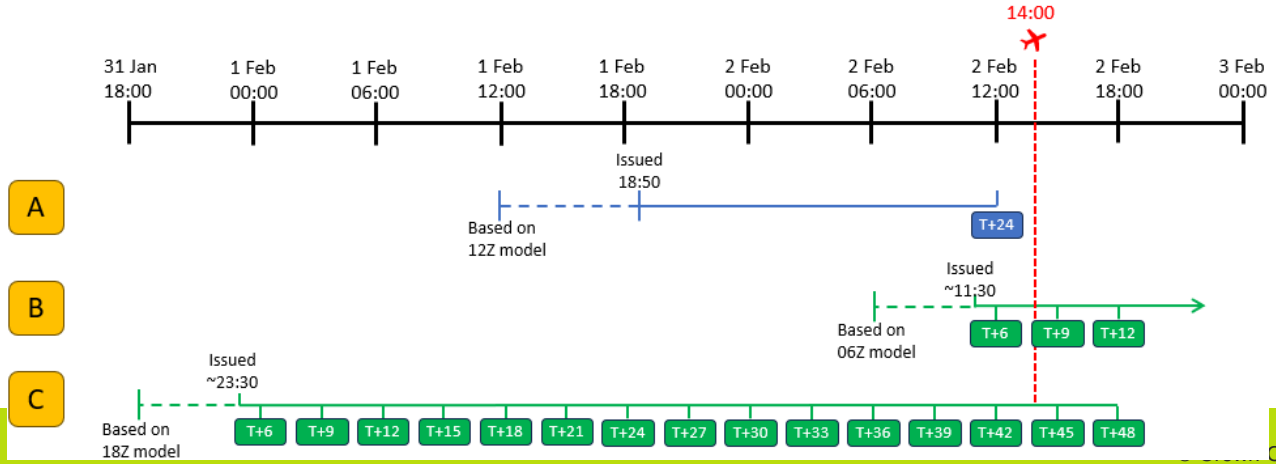
New multi-timestep SIGWX

- Spans FL100-FL600
- Tropopause height provided as contours
- Areas of occasional (OCNL) and frequent (FRQ) cumulonimbus (CB) and the flight level of the CB cloud tops
- Areas of moderate (MOD) and severe (SEV) “turbulence” areas will be forecast. This includes both clear air turbulence (CAT) and turbulence generated by mountains (orographic) turbulence types
- Global coverage icing forecasts
- New IWXXM format that users can turn into charts



Benefits of the new multi-timestep SIGWX

- Better suited to the needs of the aviation industry particularly for short haul and long-haul flights. SIGWX forecasts for a particular validity time will be available with a longer lead time and using more up to date model data.
- Consistency between WAFS gridded data and SIGWX
- Ability to see how features move and evolve



What about the existing T+24 SIGWX charts?

Medium and High level T+24 “Paper copy” (.png) charts will still be provided via SADIS FTP until 2028. There will be some change in their content and appearance:

- They will be provided in colour
- The high level SIGWX will change to span FL250 to FL600 (changing from FL250 to FL630).
- They will be produced earlier than they are now (by approx. 1 hr)

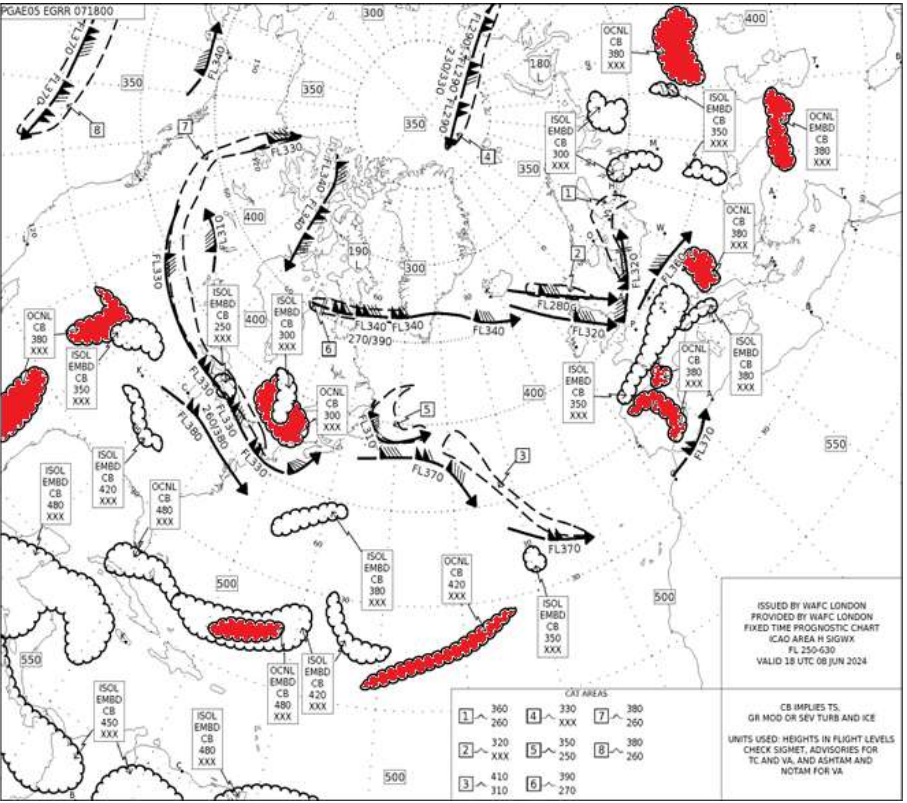
What will change in the T+24 SIGWX charts?

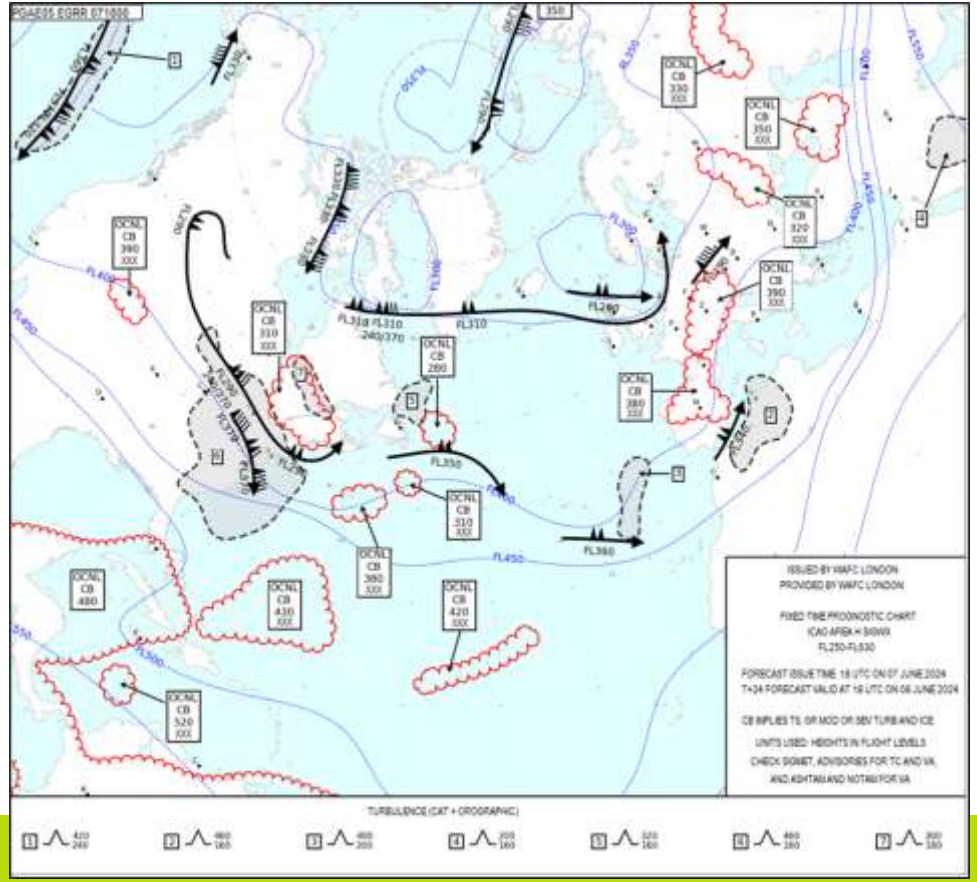
- Embedded cumulonimbus cloud will not be included.

This means that ISOL EMBD CB, OCNL EMBD CB and FRQ EMBD will not be shown.
Instead only OCNL CB and FRQ CB will be forecast.

There will be more areas of OCNL CB forecast than they are now.

Met Office


PGAE05 EGRR 071800
ISSUED BY WAFC LONDON
PROVIDED BY WAFC LONDON
FIXED TIME PROGNOSTIC CHART
ICAO AREA H SIGWX
FL 250-630
VALID 18 UTC 08 JUN 2024
CAT AREAS
CB IMPLIES TS, GR MOD OR SEV TURB AND ICE
UNITS USED: HEIGHTS IN FLIGHT LEVELS
CHECK SIGMET, ADVISORIES FOR TC AND VA, AND ASHTAM AND NOTAM FOR VA


PGAE05 EGRR 071800
ISSUED BY WAFC LONDON
PROVIDED BY WAFC LONDON
FIXED TIME PROGNOSTIC CHART
ICAO AREA H SIGWX
FL250-FL630
FORECAST ISSUE TIME: 18 UTC ON 07 JUNE 2024
T+24 FORECAST VALID AT 18 UTC ON 08 JUNE 2024
CB IMPLIES TS, GR MOD OR SEV TURB AND ICE
UNITS USED: HEIGHTS IN FLIGHT LEVELS
CHECK SIGMET, ADVISORIES FOR TC AND VA
AND ASHTAM AND NOTAM FOR VA
TURBULENCE (CAT + OROGRAPHIC)

What will change in the T+24 SIGWX charts?

- Embedded cumulonimbus cloud will not be included.

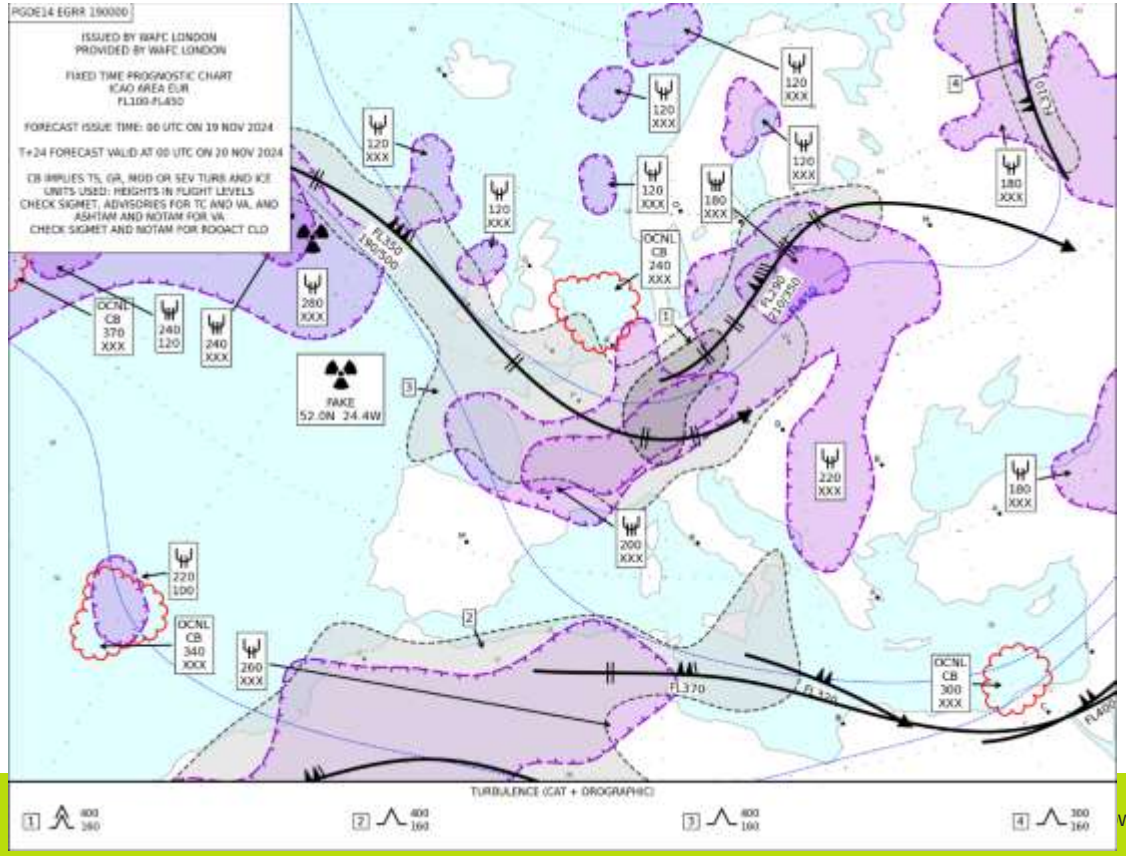
  This means that ISOL EMBD CB, OCNL EMBD CB and FRQ EMBD will not be shown. Instead only OCNL CB and FRQ CB will be forecast.

- Clear Air Turbulence (CAT) areas will become “Turbulence”. Moderate (MOD) and severe (SEV) turbulence areas include turbulence due to CAT and orographic turbulence types and if it is strong enough turbulence within non-convective clouds.

- On the medium level SIGWX the combined in-cloud turbulence and icing areas will change to only show icing intensity areas (MOD and SEV).

WAFC produced medium level SIGWX will look like this:

Purple = icing areas



SIGWX Verification

Satellite imagery, lightning observations and aircraft turbulence measurements have been used to ensure the new T+24 SIGWX is at least as accurate as the manually drawn SIGWX forecasts.

We aren't trying to make the new T+24 forecasts match the manually drawn T+24 forecasts as they aren't "the truth". We have tuned the new SIGWX forecasts to achieve highest forecast performance we can.

Both WAFC's are liaising with their State regulators to file a difference against the applicable Annex 3 provisions to notify airspace users of the changes to the T+24 SIGWX forecasts during the period 23 January 2025 to November 2025 (when Amendment 83 to ICAO Annex 3 - *Meteorological Service for International Air Navigation* becomes effective).

The UK CAA has issued an Aeronautical Information circular that regarding the upcoming SIGWX changes.
https://www.aurora.nats.co.uk/htmlAIP/Publications/2024-07-25/html/eAIC/EG-eAIC-2024-131-P-en-GB.html

More information:
https://www.metoffice.gov.uk/services/transport/aviation/regulated/international-aviation/wafc/upcoming-changes

Quantitative Volcanic Ash (QVA)

Met Office

At present ICAO mandated Volcanic Ash forecasts are:

VA ADVISORY
DTG: 20231018/1200Z
VAAC: TOKYO
VOLCANO: BEZYMIANNY 300250
AREA: RUSSIA
SUMMIT ELEV: 2882M
ADVISORY NR: 2023/38
INFO SOURCE: HIMAWARI-9
AVIATION COLOUR CODE: NIL

ERUPTION DETAILS: VA CONTINUOUSLY OBS IN SATELLITE IMAGERY
RMK: SOME PART OF VA OBSCURED BY MET CLOUD. VA HEIGHT UPDATED TO FL230 BASED ON SATELLITE DATA.
NXT ADVISORY: 20231018/1800Z

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

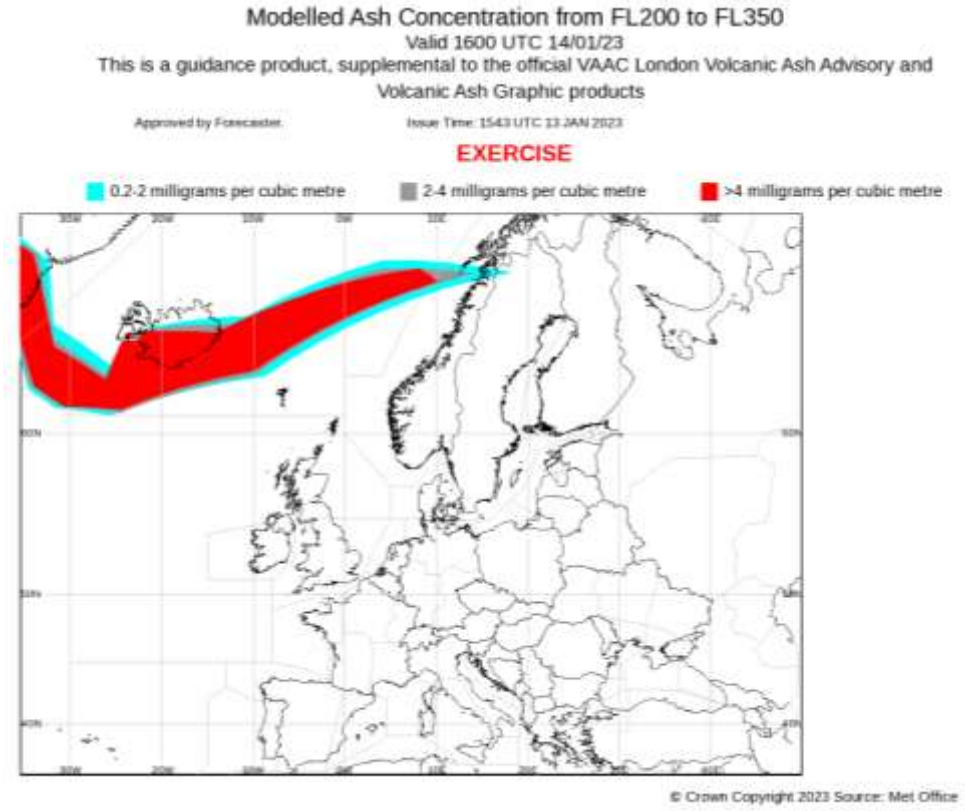
FCST VA CLD +6HR: 18/1230Z SFC/FL150 N0004 W07752 - S0004 W07738 - S0007 W07740 - S0000 W07755 - N0004 W07752

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

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

- Frustration for the customers/stakeholders outside of Europe where these products are not available.



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

Quantitative Volcanic Ash (QVA)

- New QVA ICAO provision builds on the concentration charts idea.
- VAACs meet regularly together with stakeholders (IATA, IFALPA, ICCAIA) and all have agreed to work towards this QVA approach. An Initial Operating Capability has been defined.

- QVA will comprise of three data sets
  - Gridded deterministic data set
  - Gridded probabilistic data set
  - An object/feature data set

QVA will be issued for “Significant” eruptions

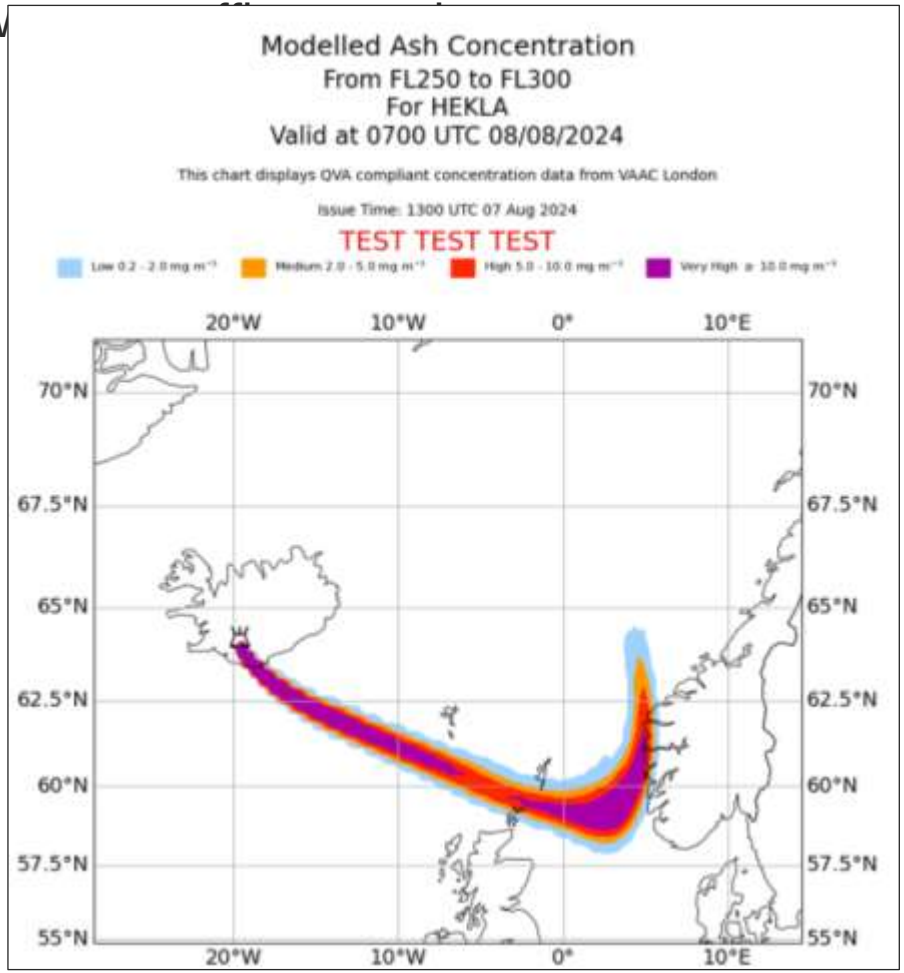
- ***1. A deterministic gridded output (expected concentration).***
-

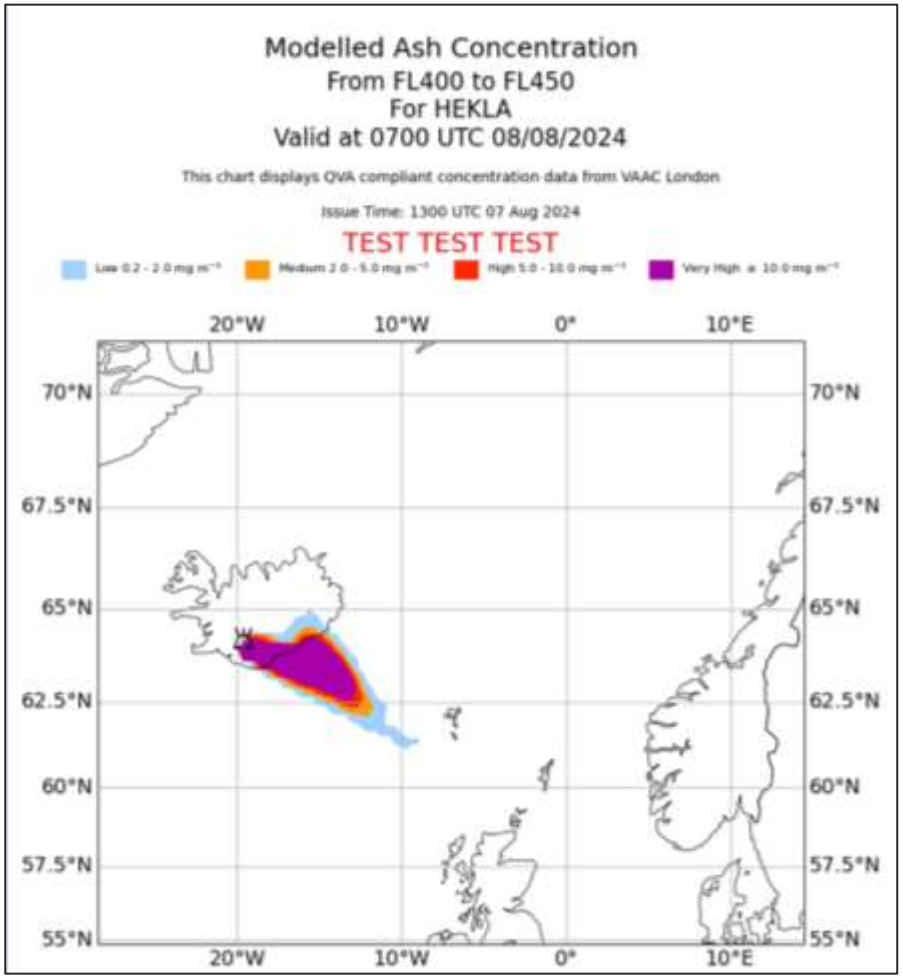
Descriptor	*Ranges*
Very high	Equal to or above 10 mg/m^3
High	Equal to or above 5 and below 10 mg/m^3
Medium	Equal to or above 2 and below 5 mg/m^3
Low[a)]	Equal to or above 0.2 and below 2 mg/m^3
Very low[b)]	Below 0.2 mg/m^3

a) 0.2 mg/^{3} is the agreed quantitative threshold for discernible ash.
b) Ash that may be detectable by more sensitive satellite and other remote sensing or in-situ monitoring capabilities.

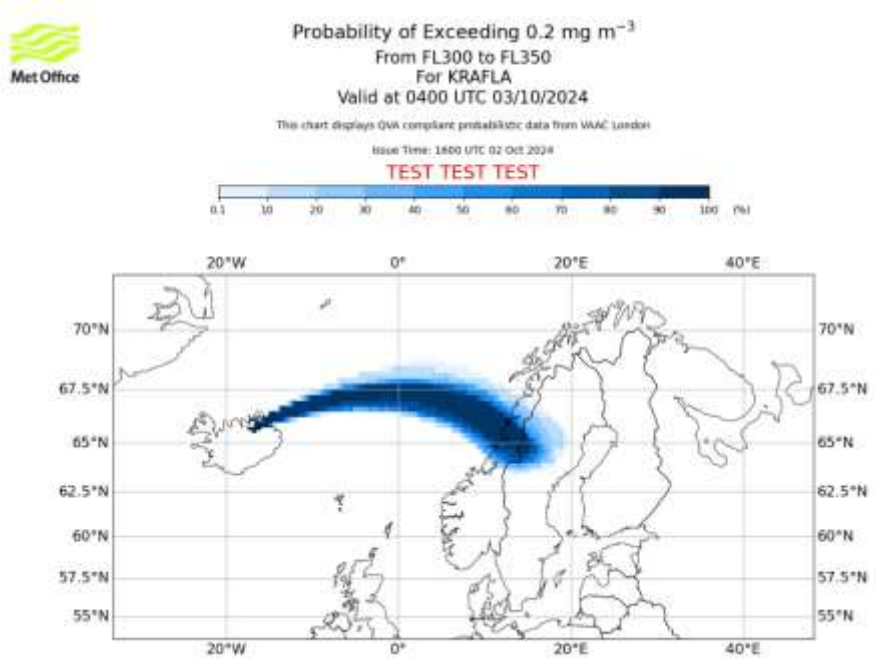
Descriptor	Ranges
High	>4 mg/m^3
Medium	2 – 4 mg/m^3
Low	$\geq$ 0.2 and < 2 mg/m^3

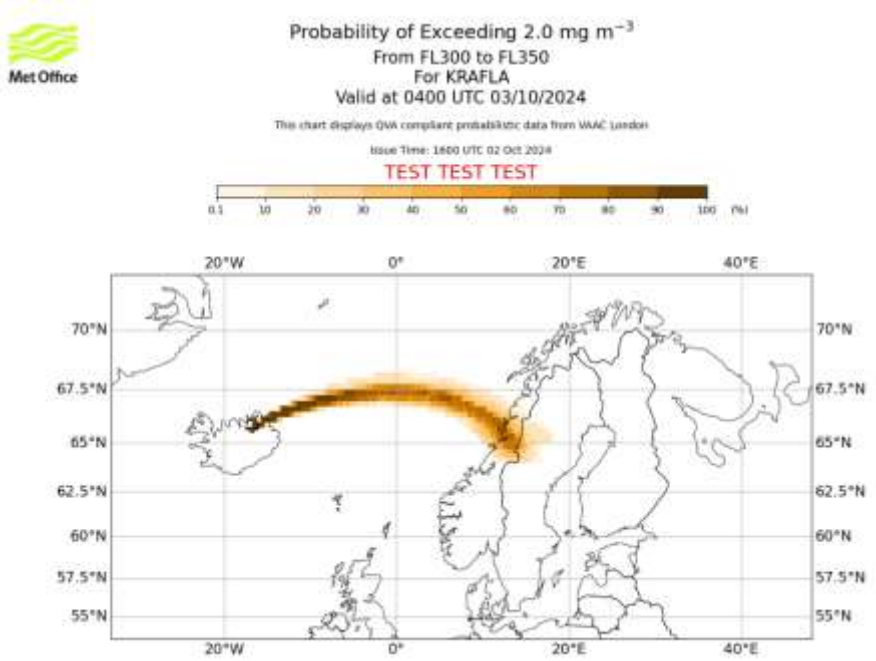
Current thresholds (being retired)





- ***2. Probability of exceeding four different concentration thresholds.***
-





Not shown: probability of exceeding 5mg/m^3 and probability of exceeding 10mg/m^3

- ***Probability calculation:***

- Meteorological Uncertainty: VAACs London will use its global ensemble model with 18 members
- Eruption Source Term Uncertainty: Some VAAC's may use this to cater for uncertainty in what is being throw from the volcano.

Gridded data will be provided at a 0.25-degree horizontal resolution and for 5000ft slices of the atmosphere between the surface and FL600.

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

Current vertical levels (being retired)

From mean sea level to and including FL200
Above FL200 to and including FL350
Above FL350 to an including FL550

Temporal Resolution?

- Currently we provide a temporal resolution of 6 hrs to T+18.
- QVA information will be provided in the following three hourly valid time increments: 0, 3, 6, 9, 12, 15, 18, 21 and 24 hours. QVA information will be updated as necessary but at least every six hours until the volcanic ash cloud is no longer considered a hazard.

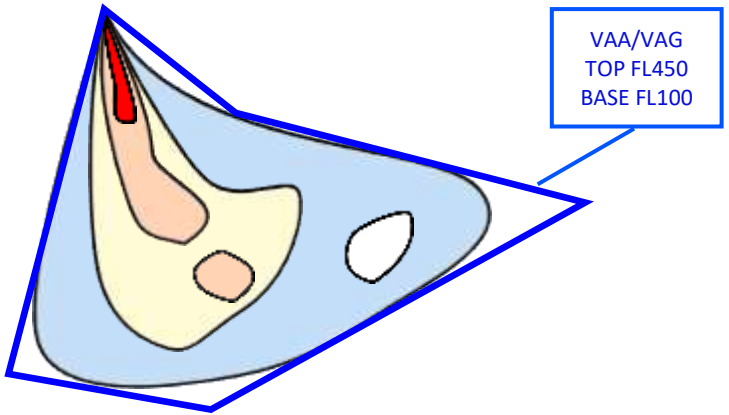
Data format

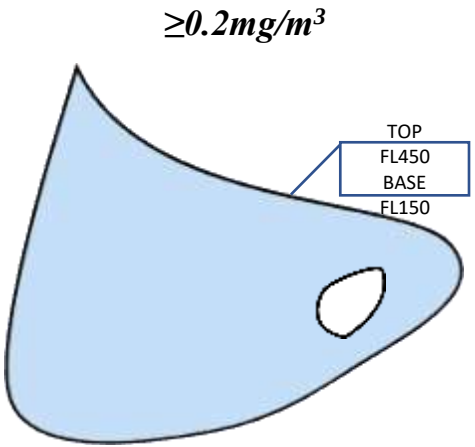
- Currently .csv (being retired)
- QVA will be provided in NetCDF format. The geographical extent will cover the entire plume from that volcano, however big that is.
- IWXXM format

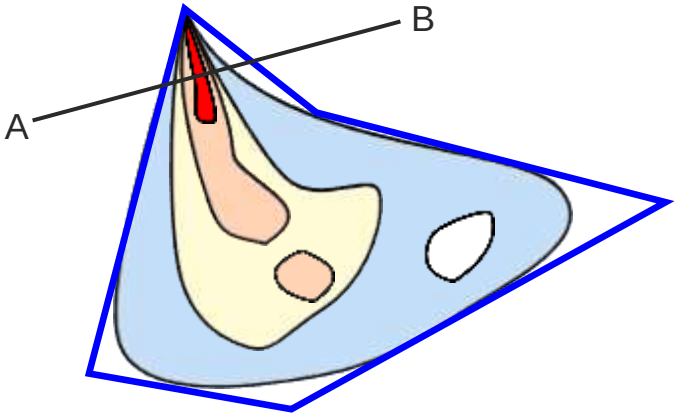
Object/feature data set

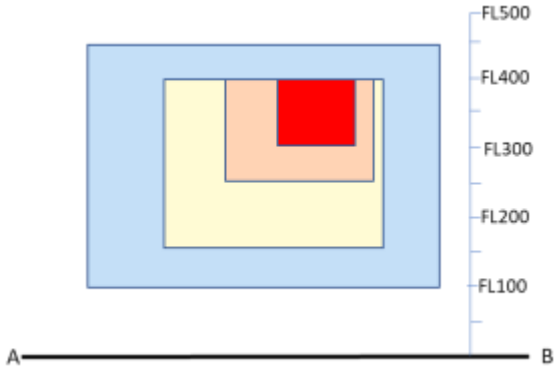
SIGWX like data set that can be used for situational awareness. They will be created from (and therefore will be consistent with) the deterministic gridded QVA data.

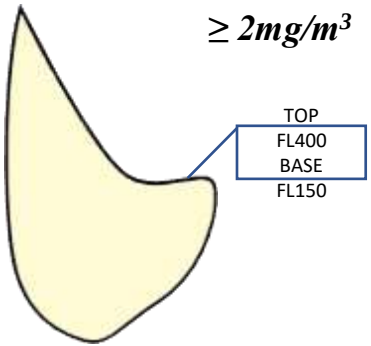
The data will be provided in ICAO's Meteorological Information Exchange Model (IWXXM) format

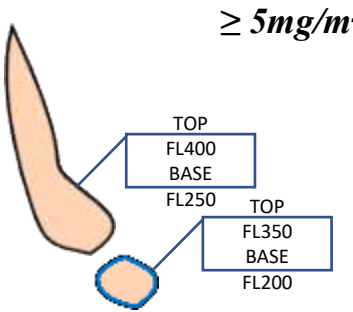


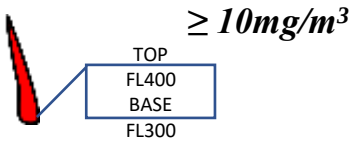




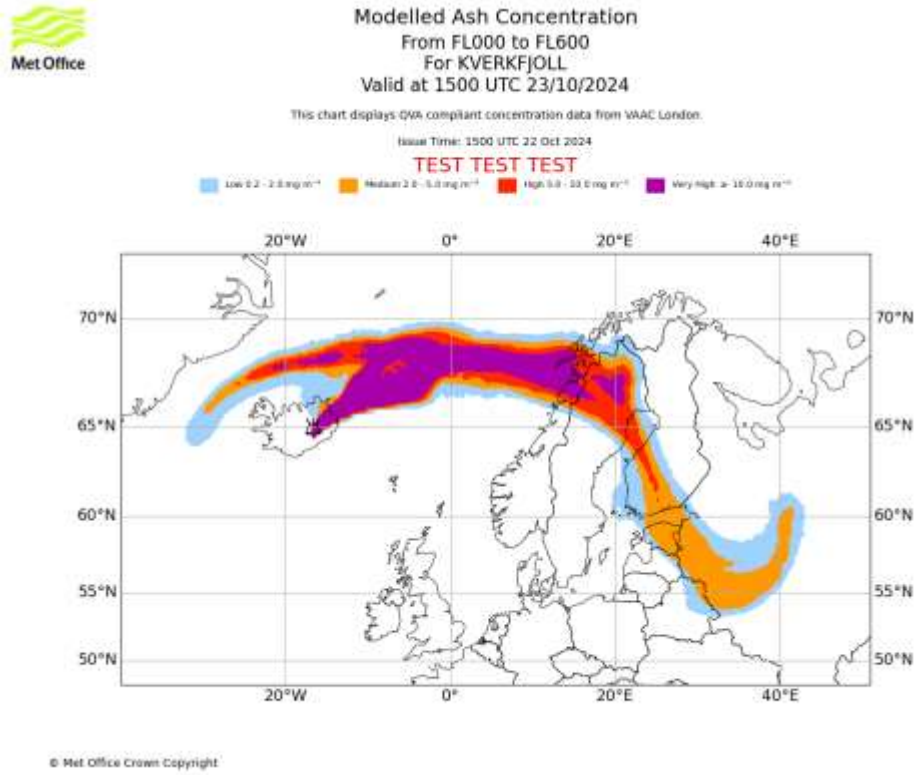


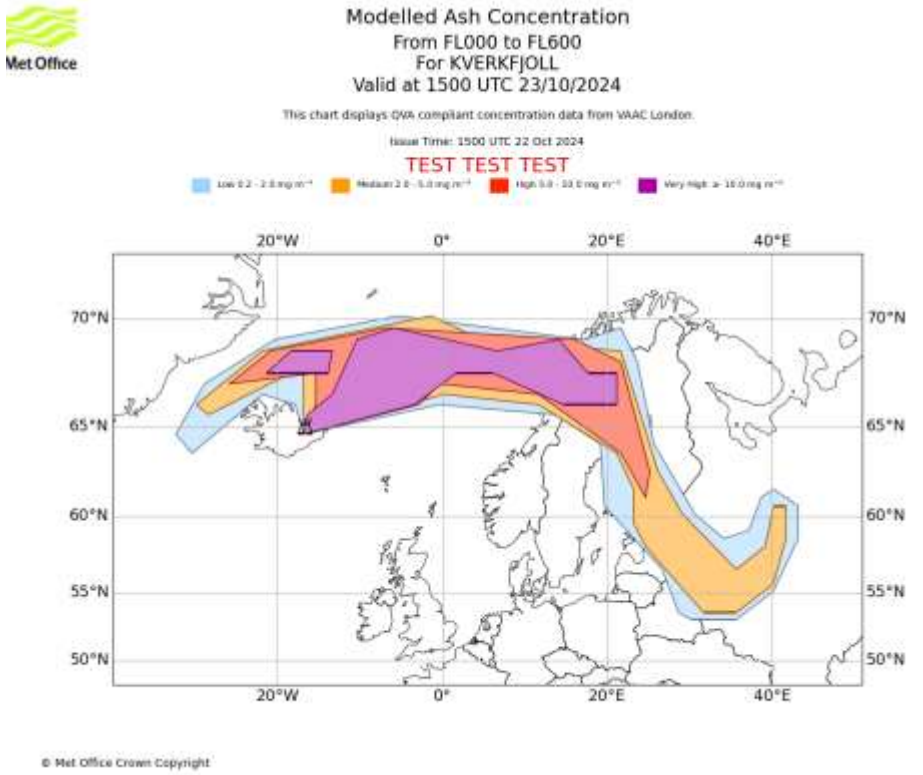






Met Office





How to get the QVA data

A VAAC London QVA API will be introduced in early June 2025

Data will be provided via an API, with an accompanying notifications system that users can subscribe to (to know when new data is published)

QVA implementation

- Test/exercise QVA data will be regularly published (in absence of a real eruption)
- Old concentration charts will be phased out (potentially end of 2026)
- Volcanic Ash Advisory messages and graphics will continue until at least 2030

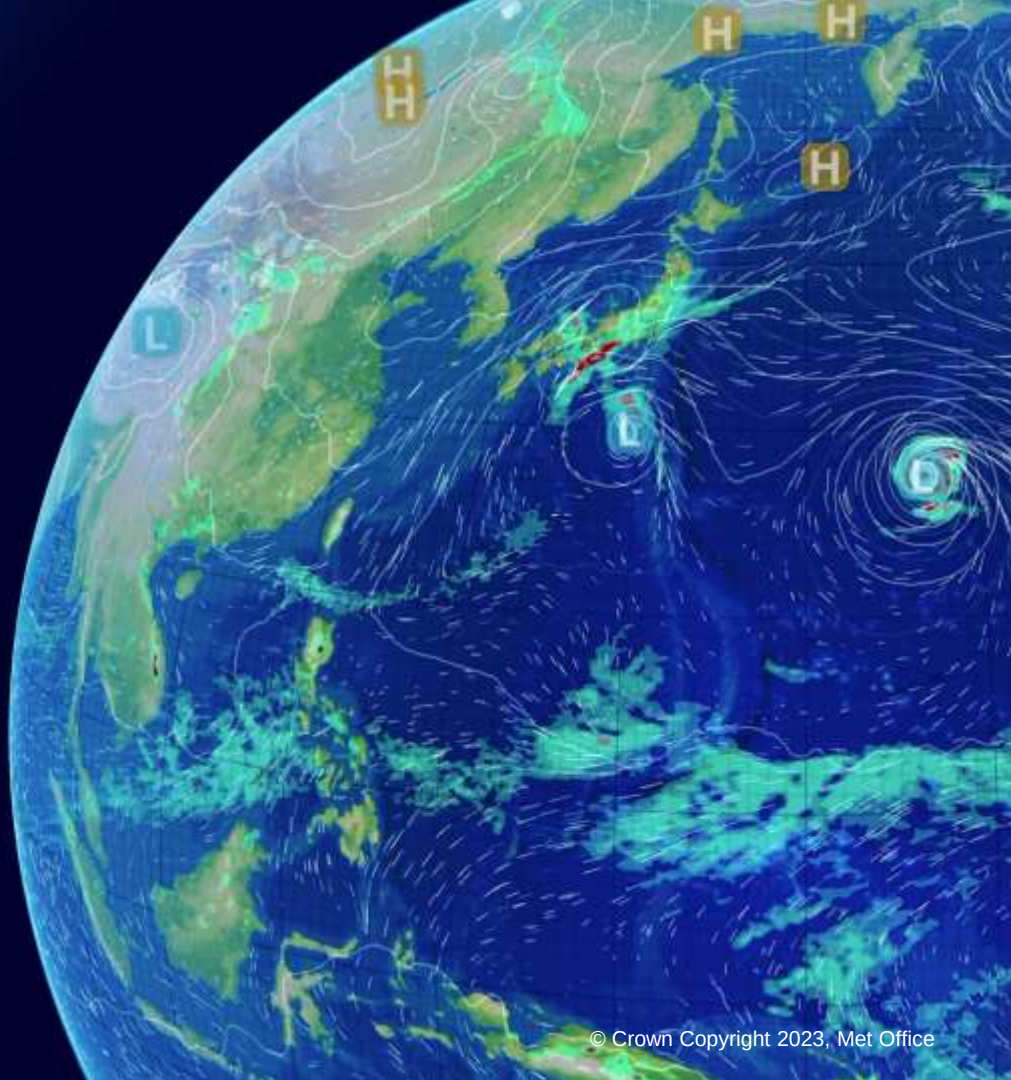
Met Office

Thank you for listening

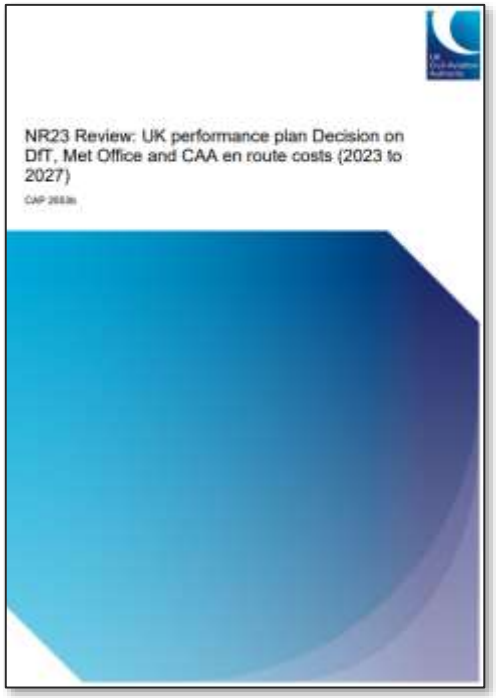
Update on **Finances**

Mark Gibbs

Head of Transport Business



NR23 Decision (CAP2553b)



Our Decision

2.10 For the reasons set out above and in our Initial Proposals, our Decision on Met Office Determined Costs for NR23 is as set out in Table 2.2 below.

Table 2.2 Met Office NR23 Determined Costs (nominal and 2020 prices)

£m	2023	2024	2025	2026	2027	NR23 Total
National Capability and International Subscriptions	19.2	23.6	25.8	25.9	26.4	
Aviation MET Service Delivery	8.2	8.1	6.8	6.7	6.6	
Aviation MET Service Development	7.6	7.5	6.7	6.6	6.8	
Total Determined Costs (nominal)	35.0	39.2	39.3	39.2	39.7	192.4
Total Determined Costs (2020 prices)	29.5	32.7	32.8	32.5	32.5	160.0

Source: Met Office

Met Office NR23 costs were originally set in 2022 prices. This means the updated inflation data has had a minor impact on both nominal and 2020 CPI prices.

2023 Actual v Determined cost

Met Office	Actuals		
£'000	2022	2023	both yrs
Staff	15,882	19,596	
of which, pension costs	2,879	3,540	
Other operating costs	8,318	8,725	
Depreciation	2,755	3,201	
Cost of capital	3,054	3,857	
Exceptional items	-	-	
Total costs	**30,009**	**35,379**	**65,388**
Determined cost	**31,632**	**34,980**	**66,612**
Act v determined	-5%	1%	-2%

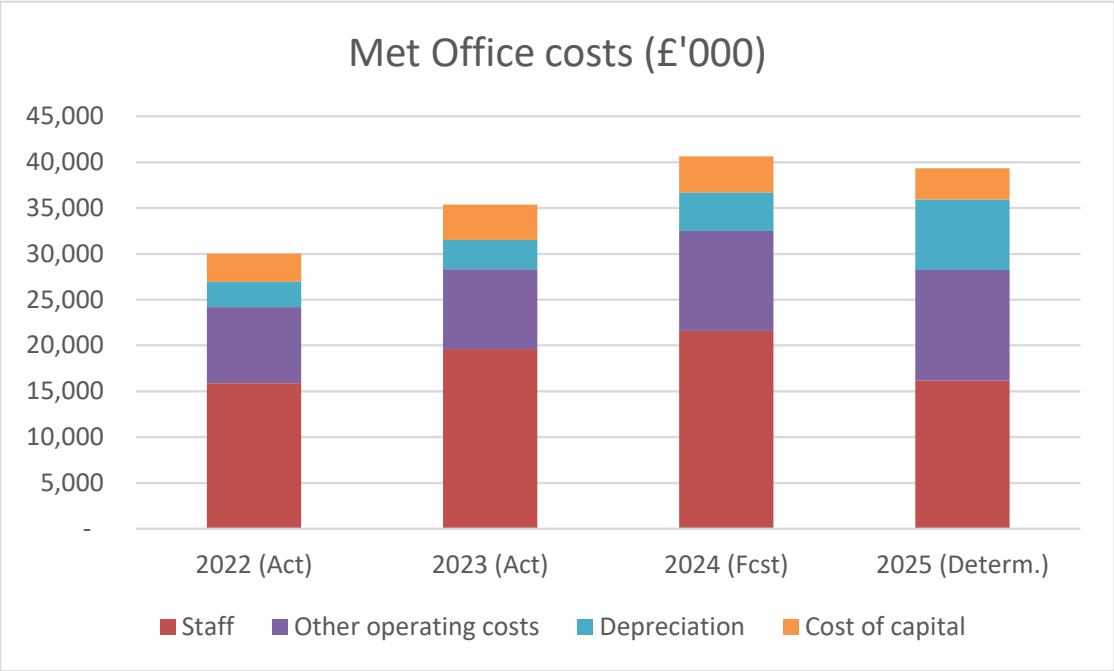
- Increase in line with original NR23 plan.
  - Recovery of work postponed during COVID
  - Transitioning of services from products to Information Services
  - Replacement legacy systems

Future costs

Met Office	Determined	Current fcst	Determined
£'000	2024	2024	2025
Staff	17,052	21,595	16,170
of which, pension costs	3,529	4,470	3,347
Other operating costs	11,919	10,904	12,066
Depreciation	6,646	4,201	7,703
Cost of capital	3,539	3,934	3,394
Exceptional items	-		-
Total costs	**39,155**	**40,634**	**39,334**

- Continued investment
  - development of Information Services
  - Lifecycling of legacy systems
- 2024 reduction in deprecation due to delay in EUMETSAT programme
- Any annual underspend is carried forward onto future years

Profile of spend 2022-2025



No requirement to change NR23 plans or unit rate

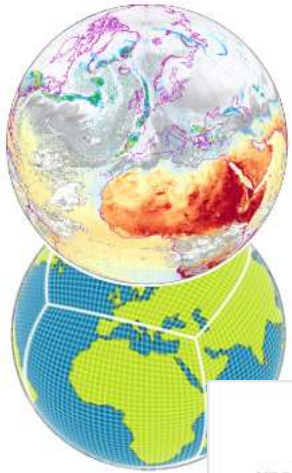
NR23 Plan

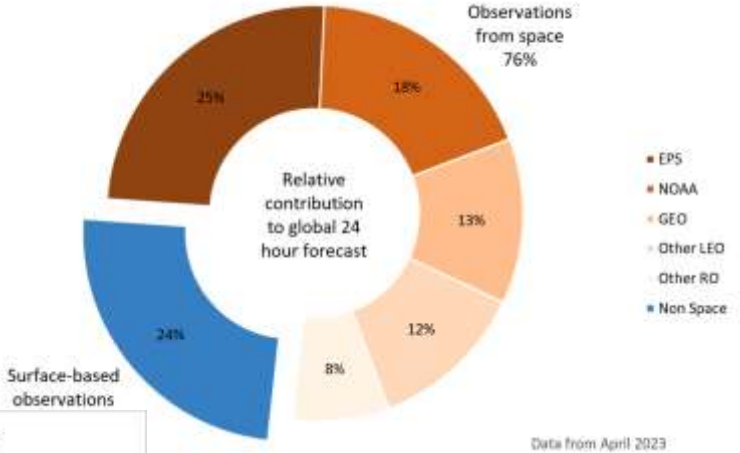
£,000	2023	2024	2025	2026	2027
National Capability & International Subscriptions	18,047	22,065	24,092	24,092	24,092
Designation Agreement Services	7,740	7,547	6,358	6,199	6,044
Additional Services & Development	7,173	6,965	6,253	6,087	6,187
Total	32,960	36,577	36,703	36,378	36,323

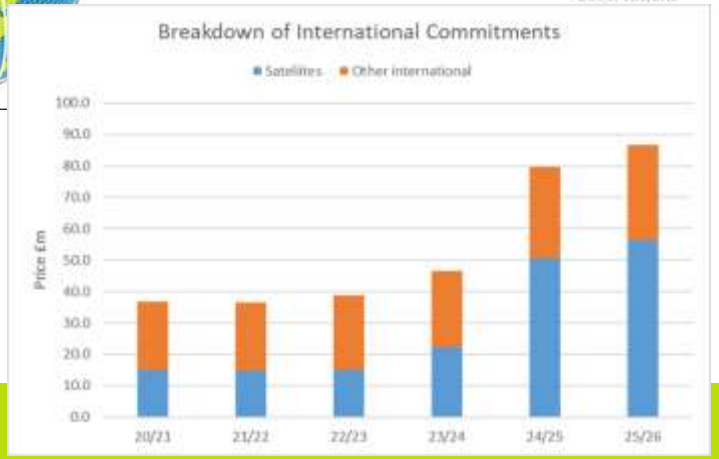
Annex 3 services

Service development

National Capability & International subscriptions

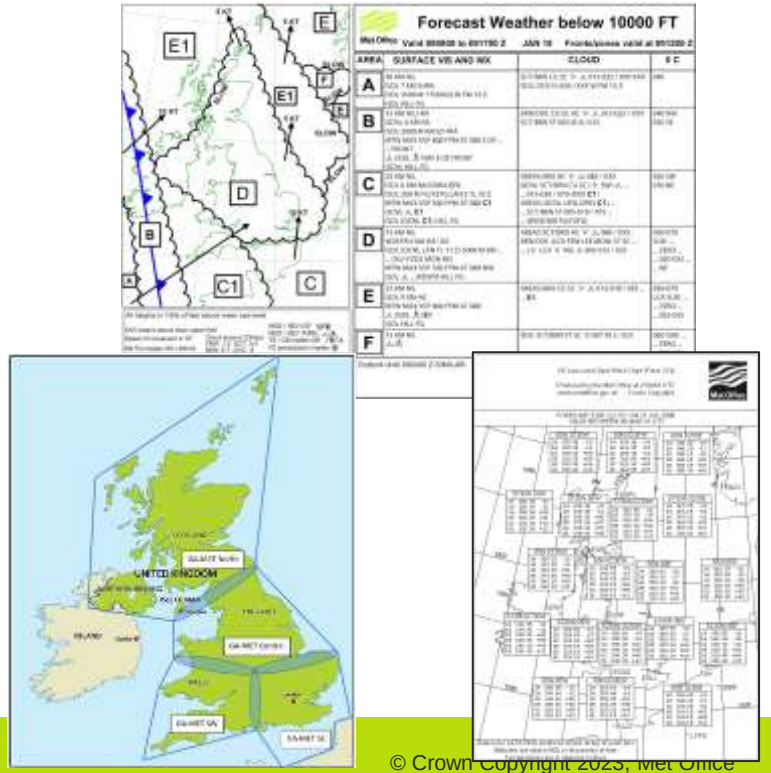






Designation Agreement Services

- Essentially Annex 3 products
  - 2.5% efficiency saving
  - WAFS – reduction due to SIGWX automation
- Other products:
  - TAFS
  - F214 & 215
  - Forecast QNH
  - GAMETS
  - Airfield Warnings



Additional Services & Development

Key 2024 activities

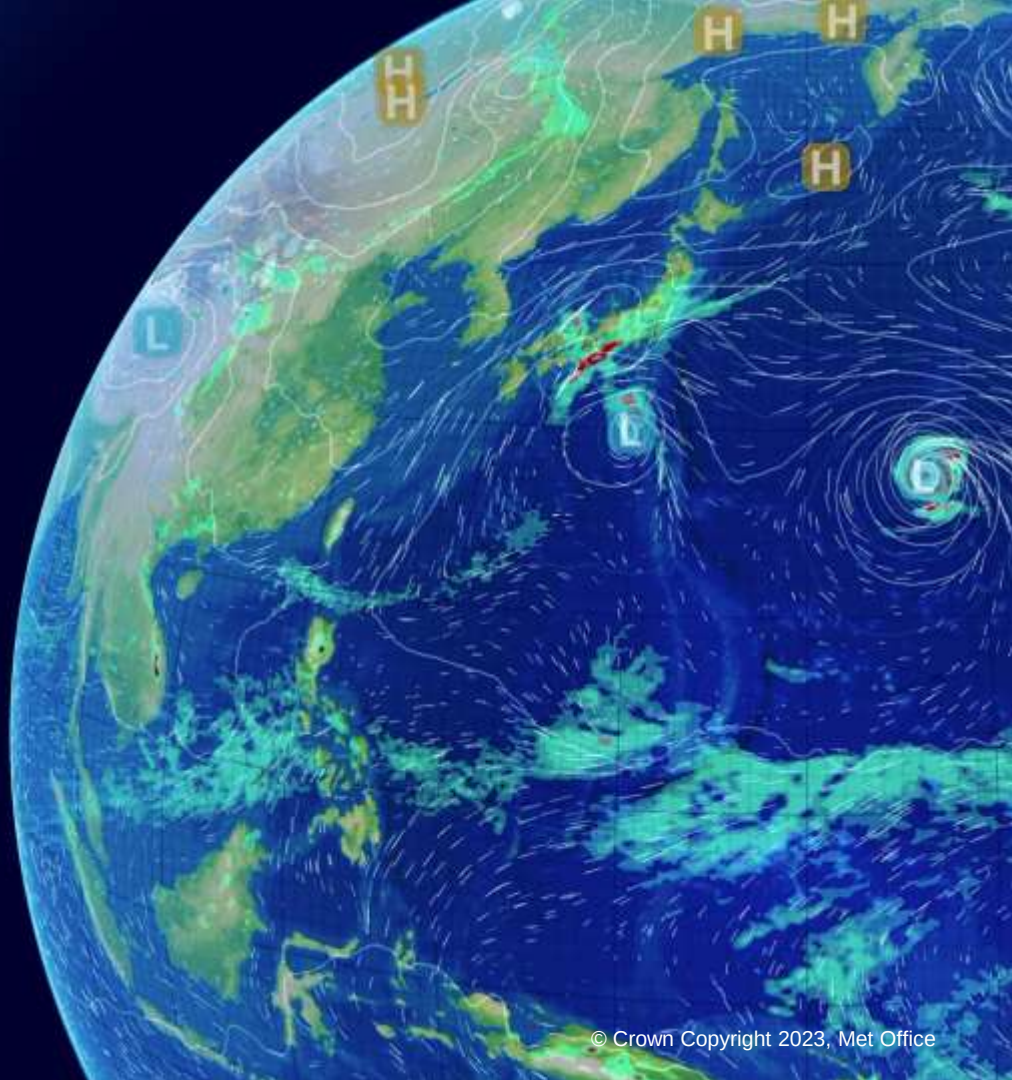
- WAFS & SADIS developments
- QVA development
- Embedded NATS team
- Re-development of Visualisation services – MAVIS
- Refurbishment of Volcanic Ash observing network (kick-off)
- Scientific Research & development

Met Office

Thank you for listening

National Aviation Services

Lauren Donohue



Met Office

NATS

UK Civil Aviation Authority

- 7 user specific tools
- Varying age of infrastructure and technology options
- New meteorological information services
- Ensure access to regulated and key information for decision making

Met Office

Met Office

Met Office Aeronautical Visualisation

Tiered access

All users eligible, most likely airports, airlines


NATS


Offshore helicopters


Emergency service helicopters

All users


GA (Private, recreational, work)


BizJet

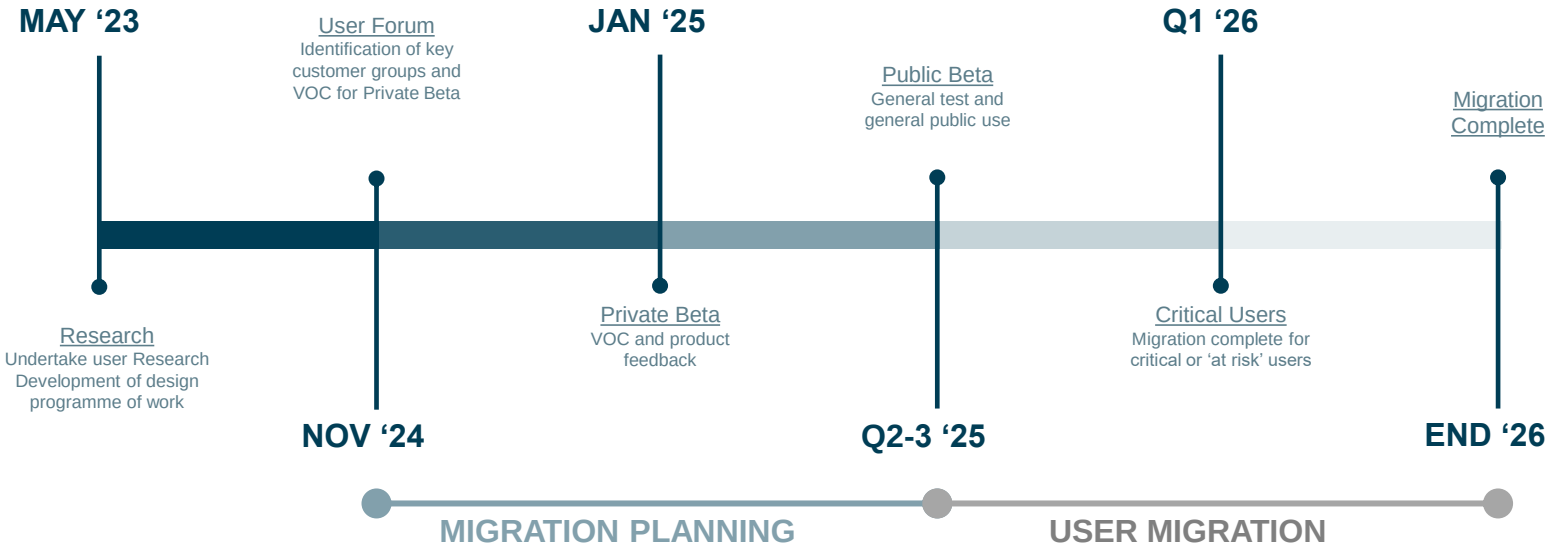

Airport


Airline


Commercial helicopters


ATS

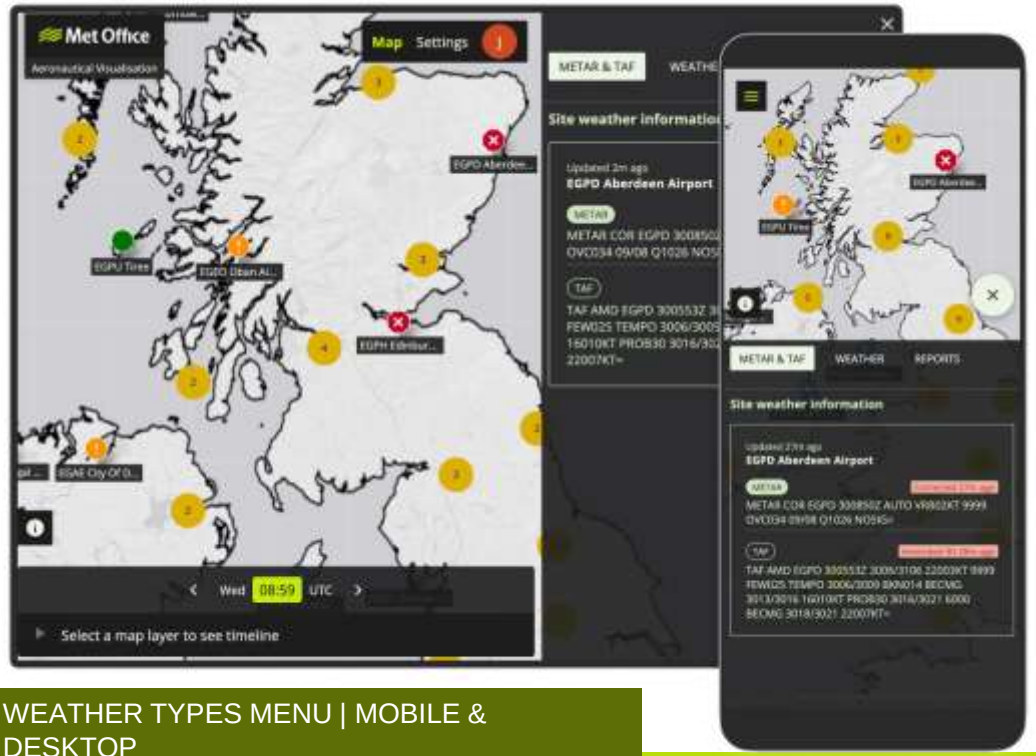
Milestones / Timelines



Designs

Basemap, Aerodrome Locations.

BASEMAP



WEATHER TYPES MENU | MOBILE & DESKTOP

Met Office

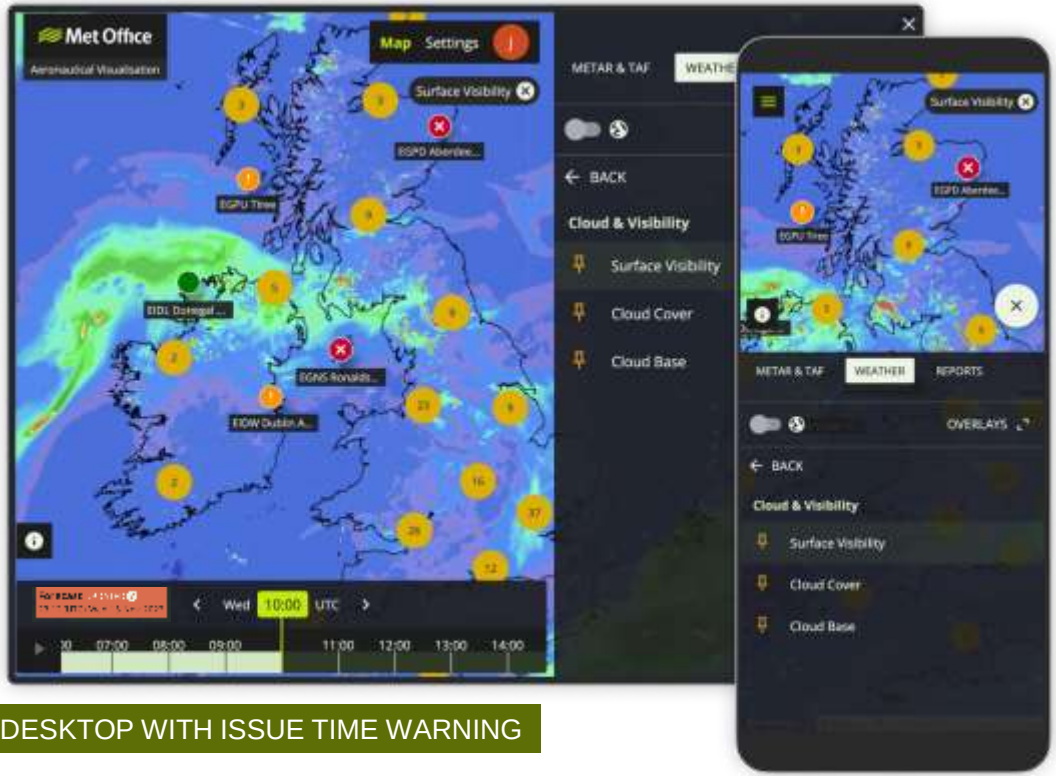
METARs, TAFs and warnings

SITE ICONS

SITE WEATHER

PINNED SITES

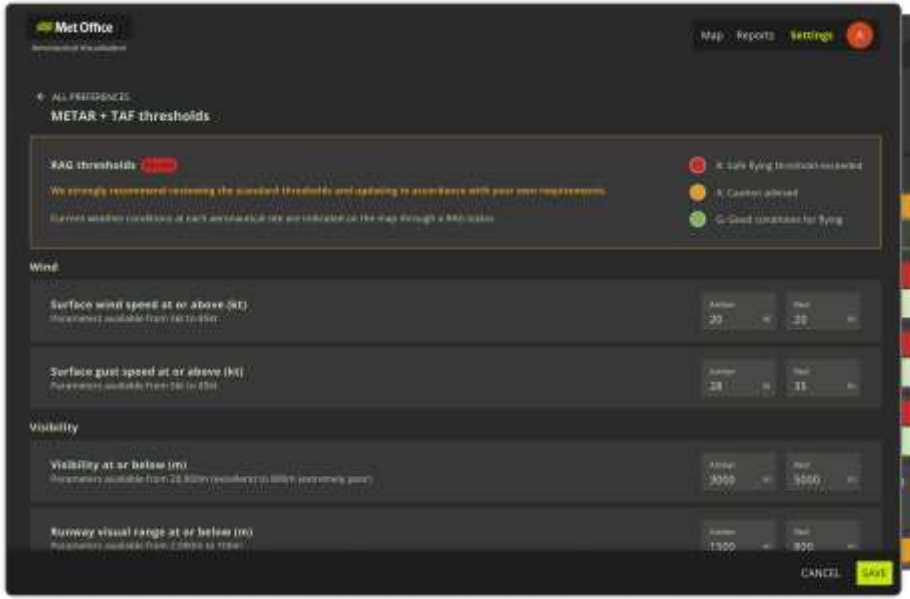
Timeline



DESKTOP WITH ISSUE TIME WARNING

PIN FAVORITE LAYERS

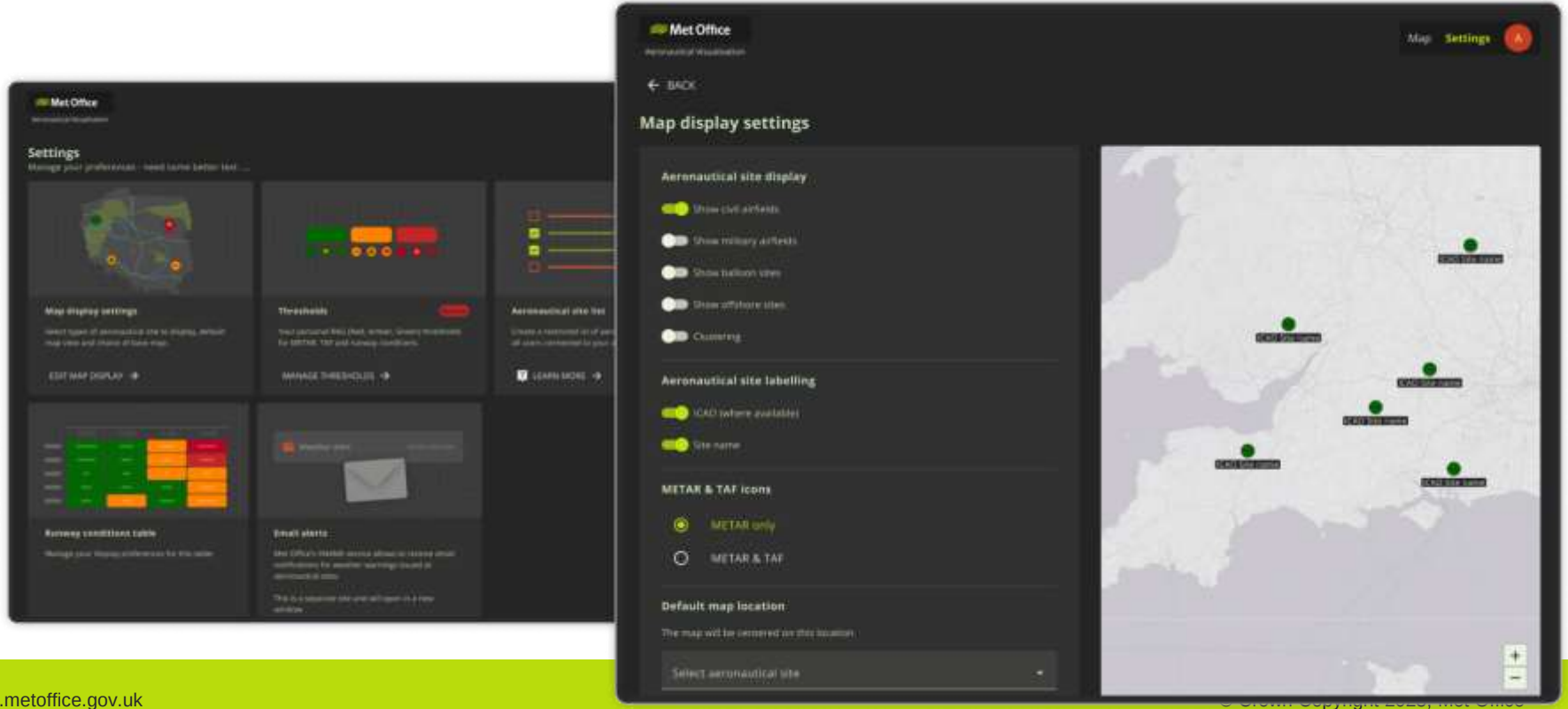
RAG thresholds



DEFAULT RAG THRESHOLDS

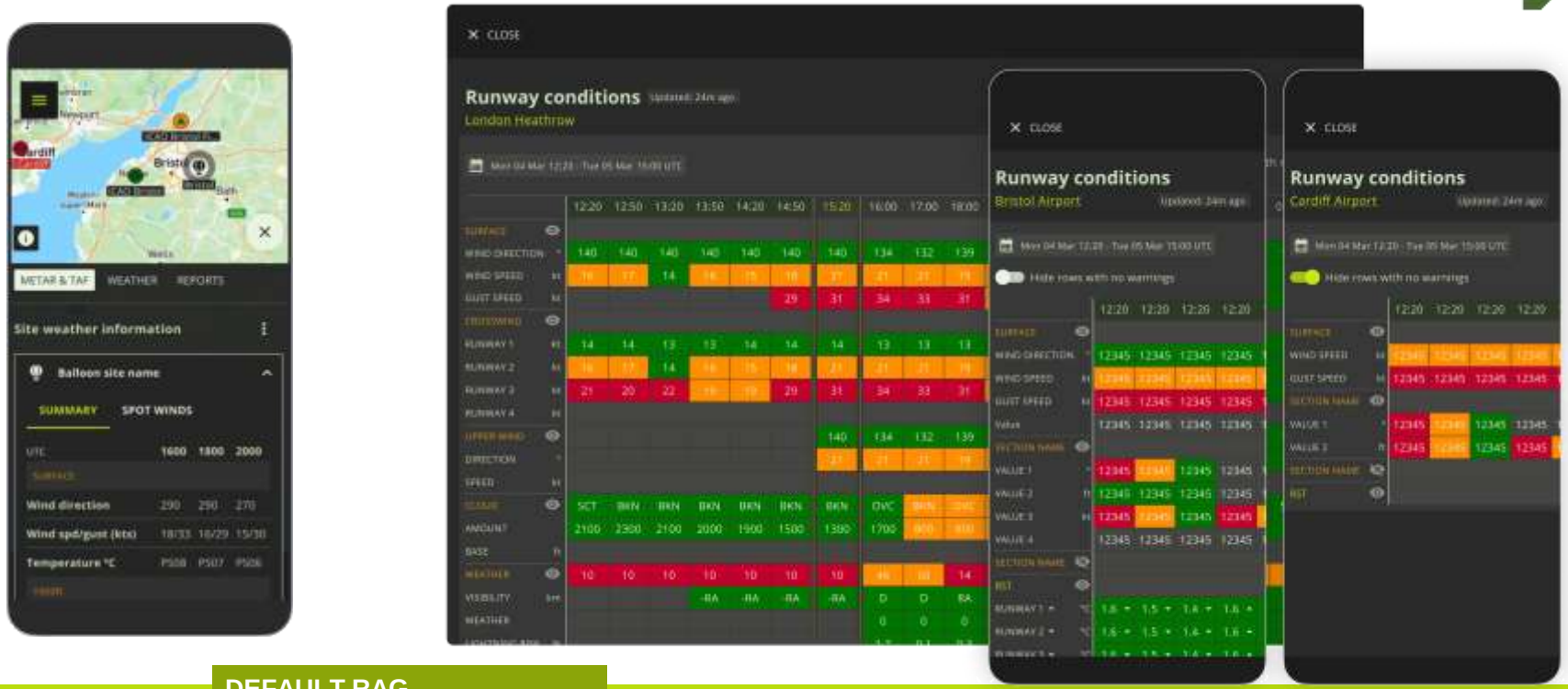
WEATHER PREFIX RAG

Individual site RAG thresholds



Met Office

Runway conditions



DEFAULT RAG THRESHOLDS

Met Office

Charts & reports

Your turn

Met Office Aeronautical Visualisation

https://mouf.ci.mavis.service.metoffice.gov.uk

Register via link. Will only work until 4pm today.

First impressions survey and sign up for user testing & research

https://forms.office.com/e/NLUT3XRuYE

https://mouf.ci.mavis.service.metoffice.gov.uk/

Lunch/Tours

1 group at 1230
1 group at 1300

Aviation R&D

Piers Buchanan, Graeme Anderson and Andrew Creswick

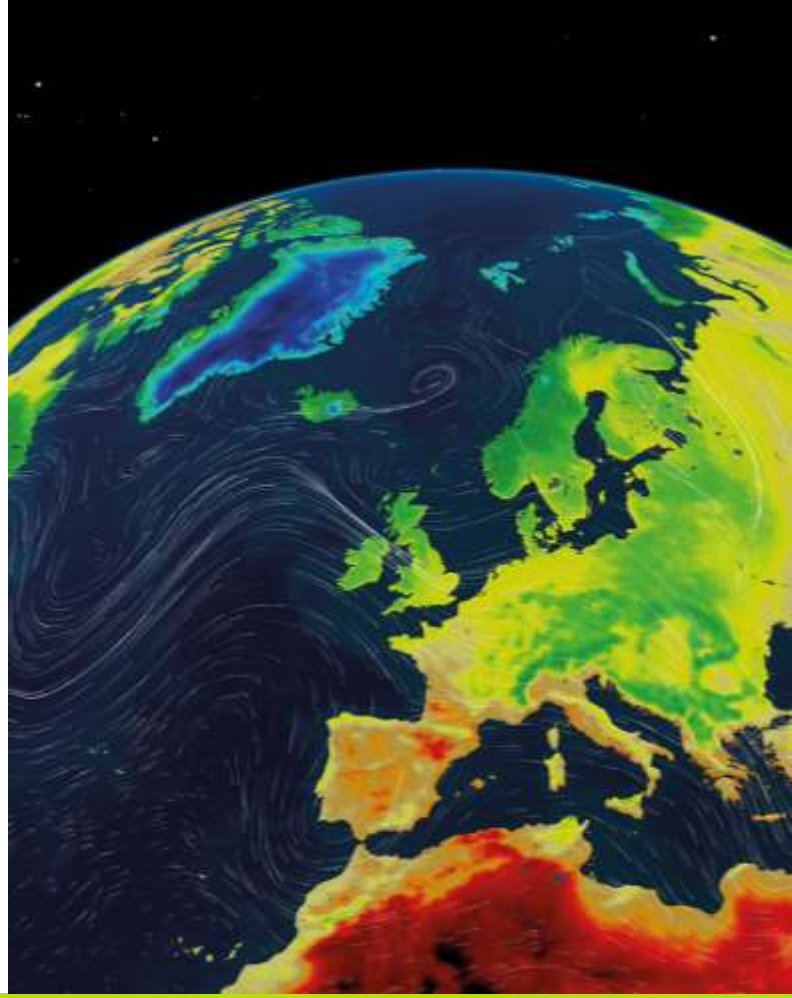
Aviation Applications Team

Talk Structure

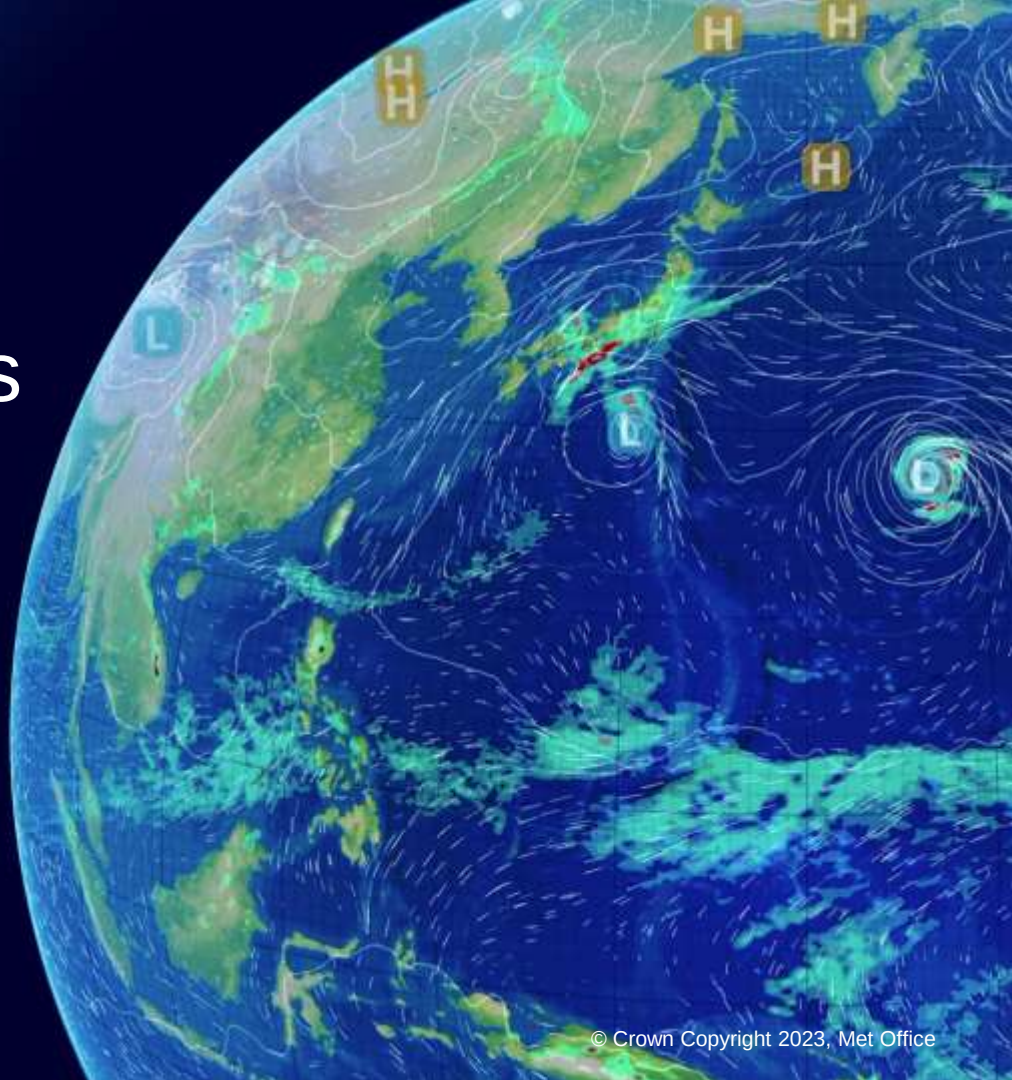
- R&D Updates
  - Andrew Creswick – Cb forecast updates
  - Graeme Anderson – SigWx implementation work
  - UK updates
- Future NWP plans

Purpose of global aviation R&D programme

- To support WAFS service with updated science.
- To monitor and improve WAFS datasets for Icing, Turbulence and Cb forecasts
- To develop ability to produce rapid multi-timestep Significant Weather Charts

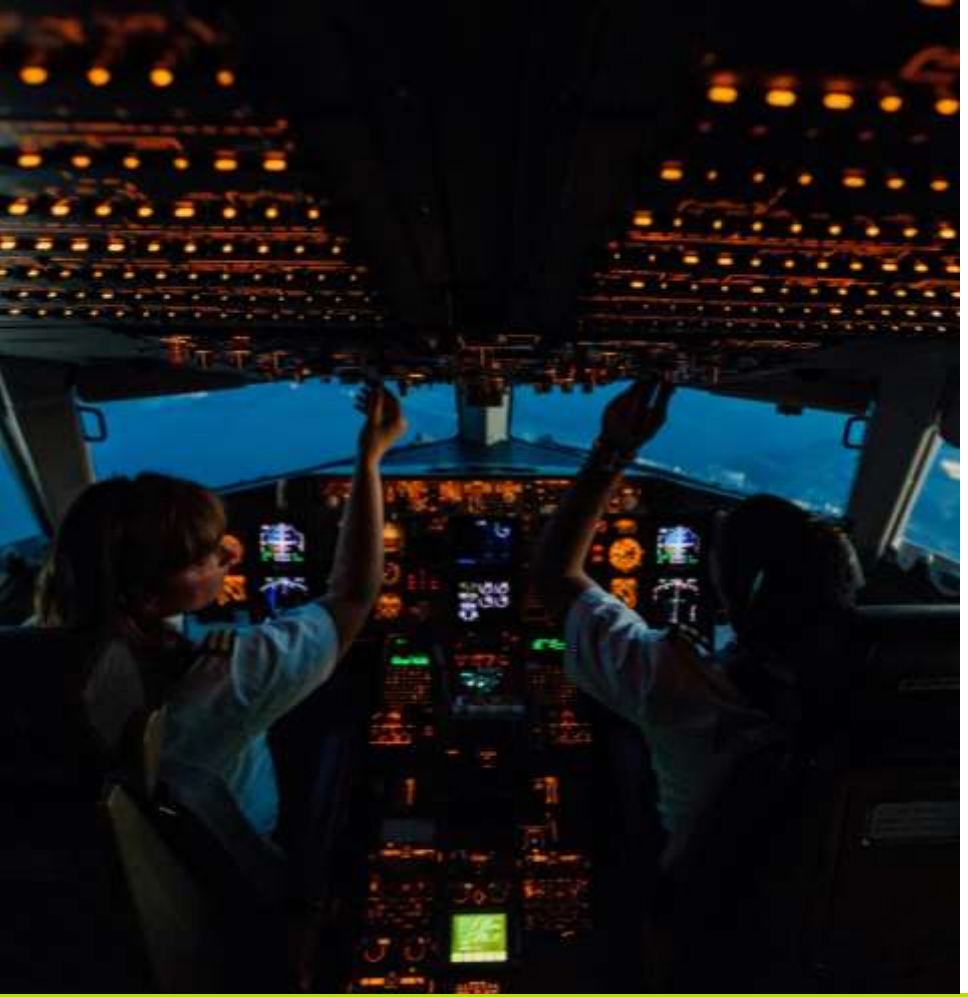


EPOCH Probabilistic Forecasts of Cumulonimbus Clouds



Met Office User Forum, Nov 2024

Andrew Creswick,
Aviation Applications Scientist



Future WAFS Upgrades

- Probabilistic forecasts of hazards.
- Probability of Cb top height exceeding 30,000 ft, 35,000 ft and 40,000 ft.
- 0.5 degree horizontal resolution
- T+6 to T+48 in 3 hour timesteps

EPOCH

- **E**nsemble **P**rediction **o**f **C**onvective **H**azards.

- Simple threshold tests determine Cb occurrence for each ensemble member.

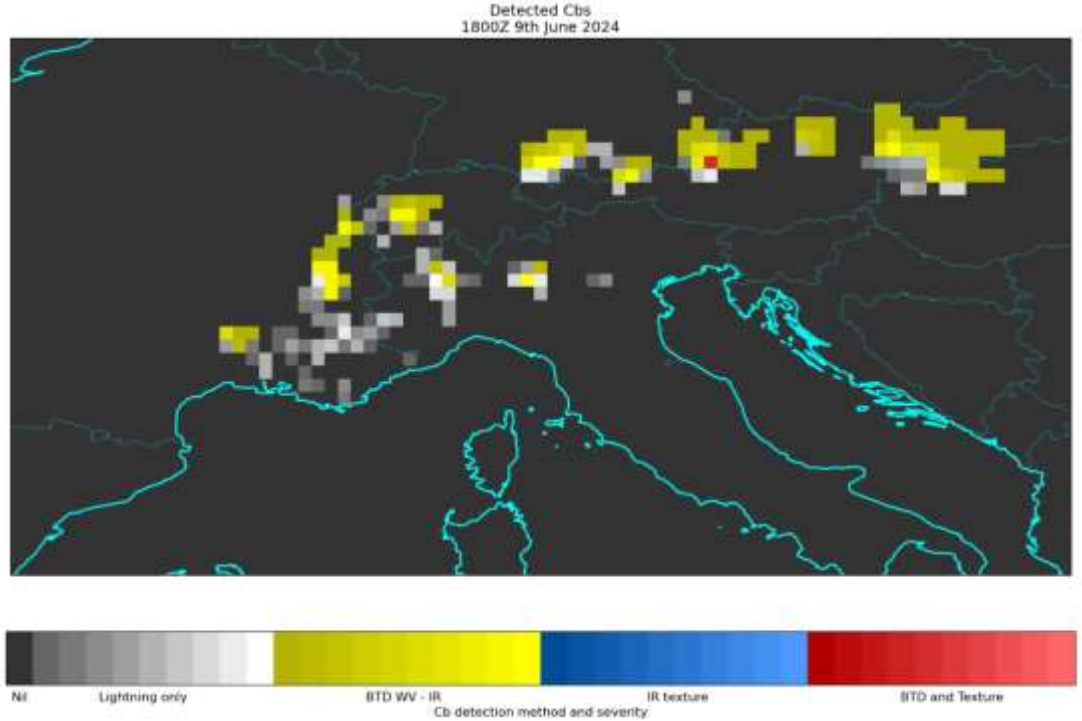
- MOGREPS-G and ECMWF global ensembles.

Photo: Stewart Turner

EPOCH thresholds

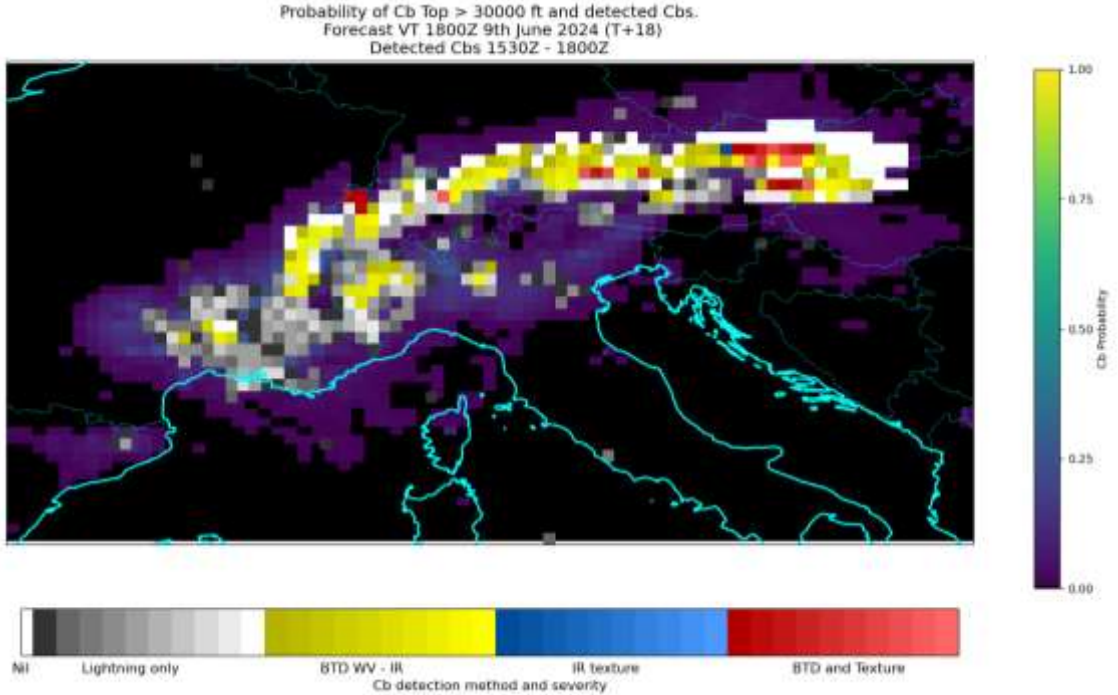
Most Unstable CAPE	200 J/Kg
Accumulated Precipitation from Convective Parametrisation	2 mm
Outgoing Longwave Radiation at Top of Atmosphere	• < 275 Wm^{-2} 30,000ft • < 235 Wm^{-2} 35,000ft • < 195 Wm^{-2} 40,000ft

Verification



- Satellite based Cb detection algorithm.
- Uses characteristics of overshooting tops in IR and WV channels.
- Input from lightning detectors.

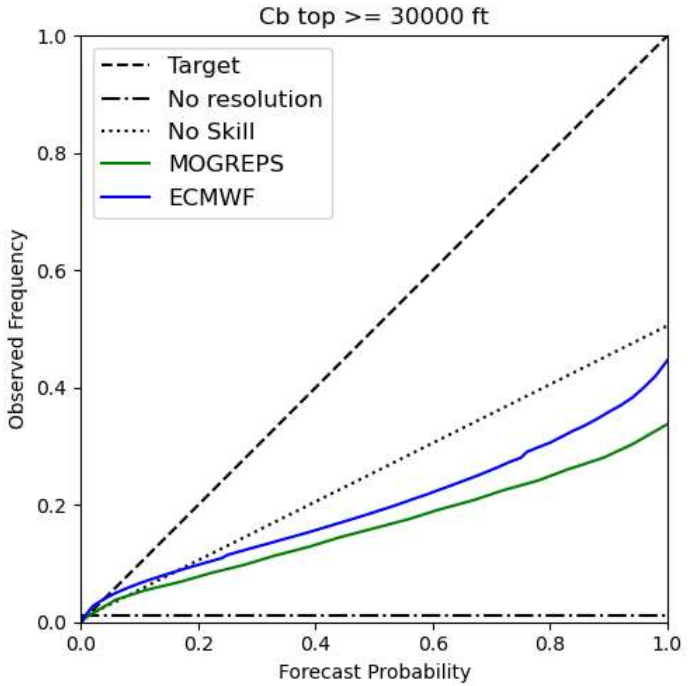
Construct Reliability Diagrams



- Compare forecast probability with max detected Cb severity in 3 hour window.
- Point-by-point.

Initial results show poor reliability

- January – June 2023
- Compares forecast probability to how often Cbs are observed.
- These match for a perfectly reliable forecast.
- The results would lie on the dashed line.



To improve reliability and resolution

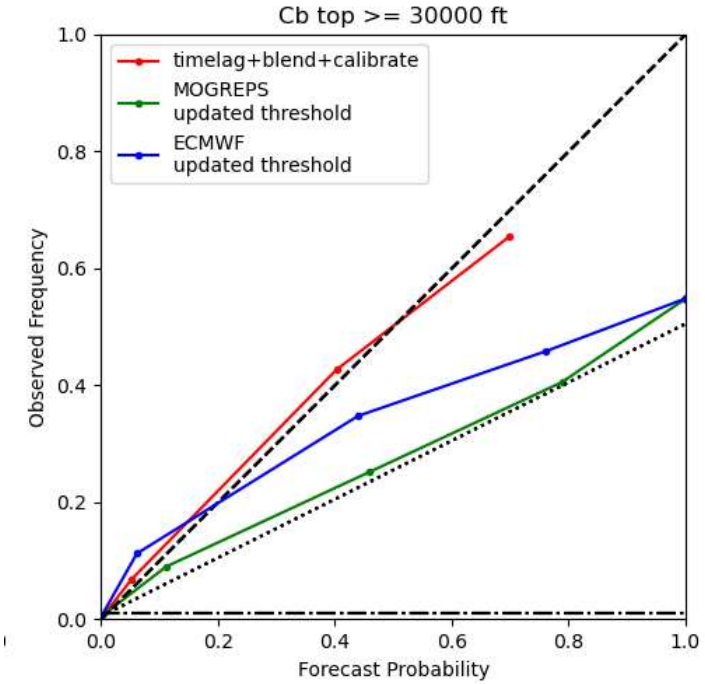
- Update EPOCH thresholds
  - Accumulated Precipitation from Convective Parametrisation - ~~2 mm~~ 6 mm

- Timelag over last 4 cycles.

- Blend MOGREPS-G and ECMWF forecasts

Improved reliability

- Updating threshold leads to some improvement in reliability.
- Combining different sets of forecasts and then calibrating the result gives further improvements.



Summary

- EPOCH produces global probabilistic forecasts of Cbs.
- Forecasts verified against satellite observations of Cbs.
- Post-processing steps and calibration improves statistical reliability.

SQ321 Case Study

Observations and comparison with EPOCH forecasts

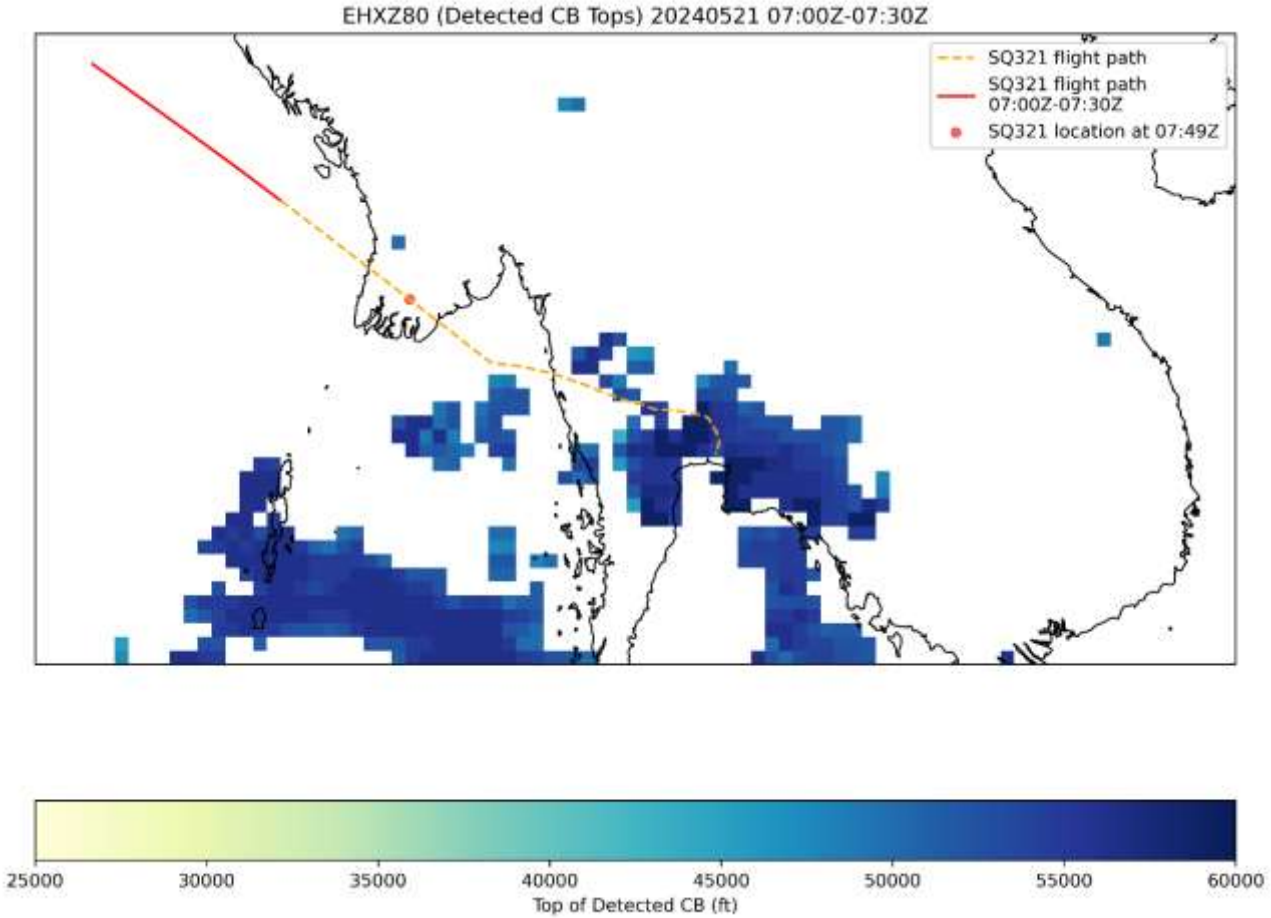
Met Office

Cloud Top Height for detected Cbs at 30 mins before incident.

N.B. uses a 30 minute window for detection.

Cb detection based on Overshooting Tops detection methods [1].

- IRW texture [2]
- WV-IR BTD [3]
- Lightning detection (LEELA)



[1] Francis and Batstone, 2013; [2] Bedka, 2010; [3] Schmetz, 1999

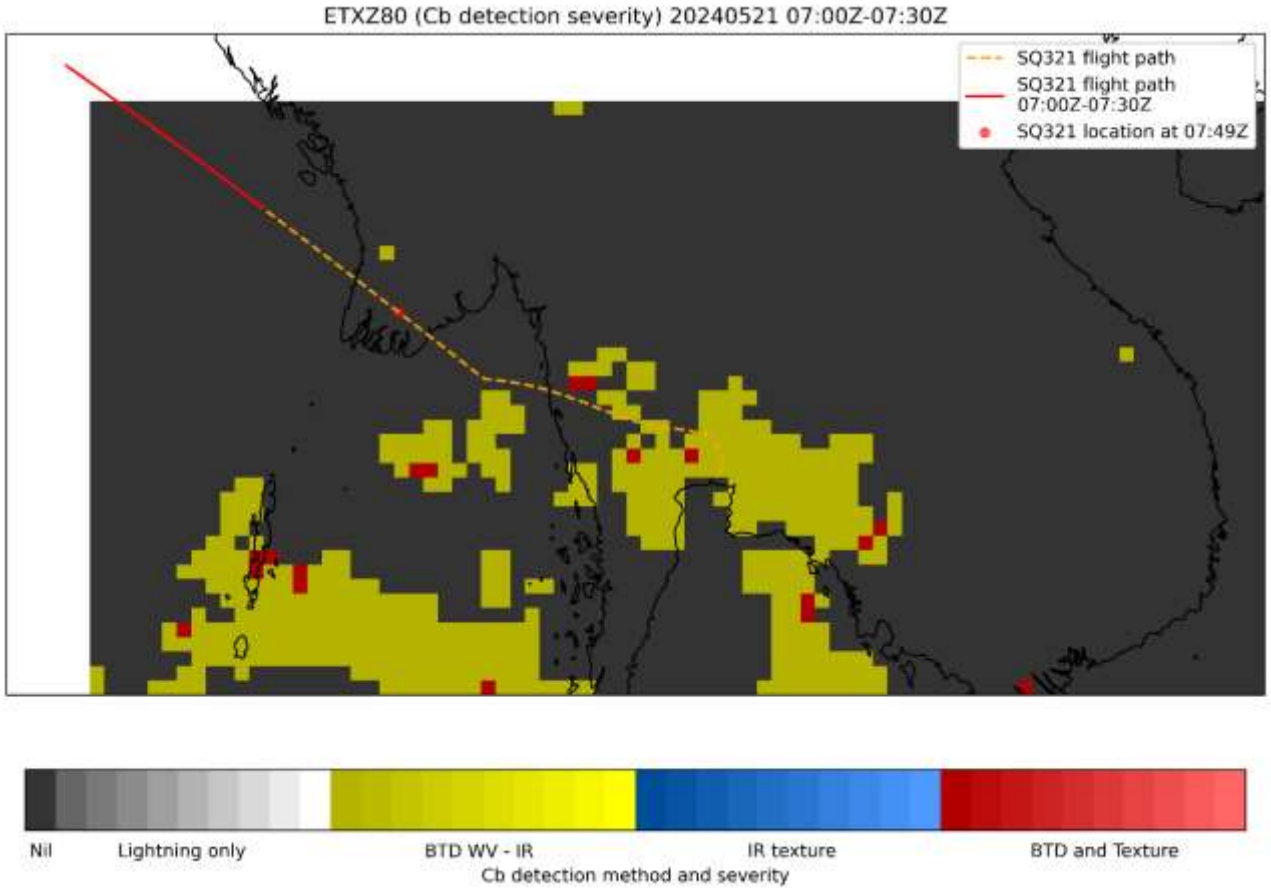
Met Office

Cb detection severity at 30 mins before incident.

N.B. uses a 30 minute window for detection.

Cb detection based on Overshooting Tops detection methods [1].

- IRW texture [2]
- WV-IR BTD [3]
- Lightning detection (LEELA)

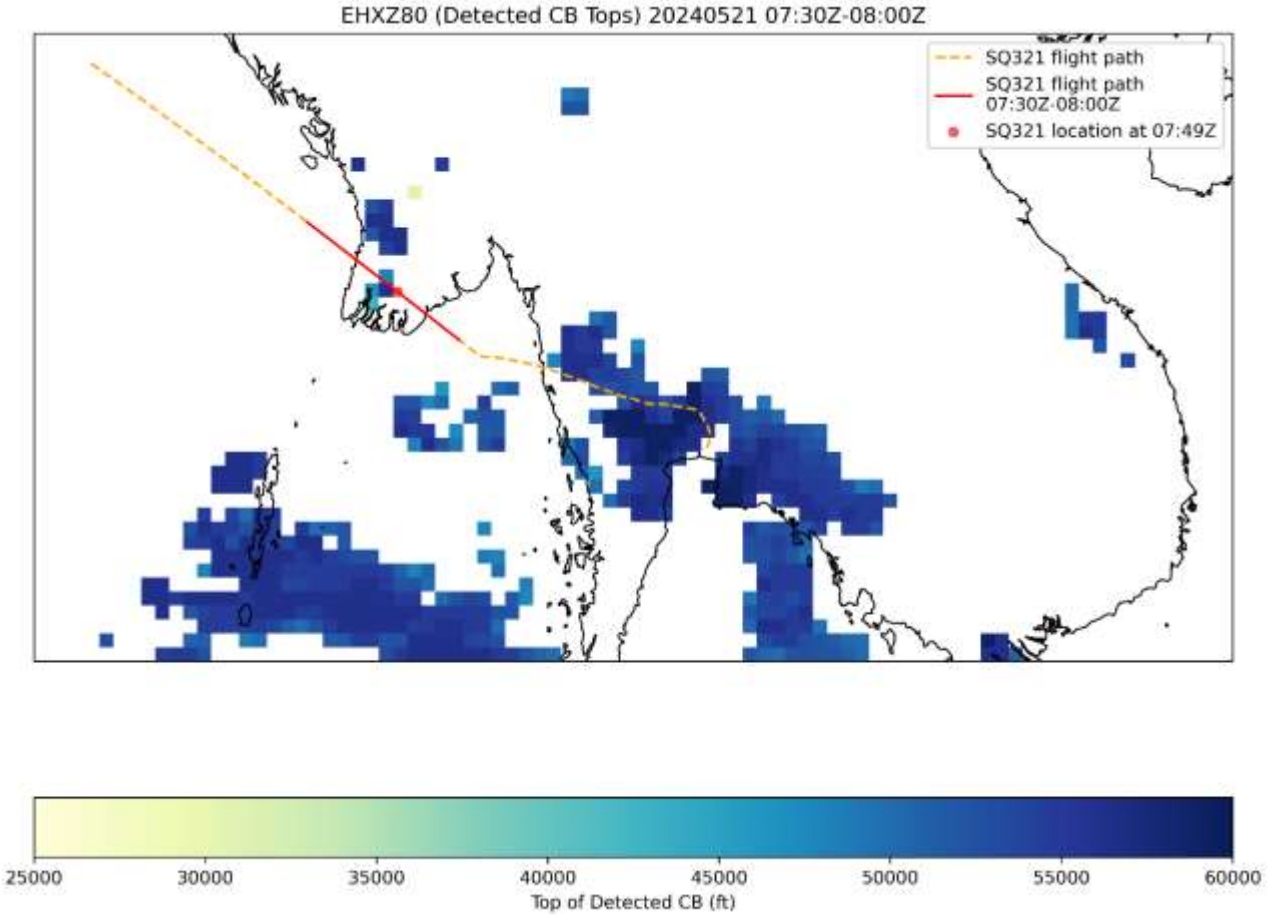


[1] Francis and Batstone, 2013; [2] Bedka, 2010; [3] Schmetz, 1999

Met Office

Cloud Top Height for detected Cbs at time of incident.

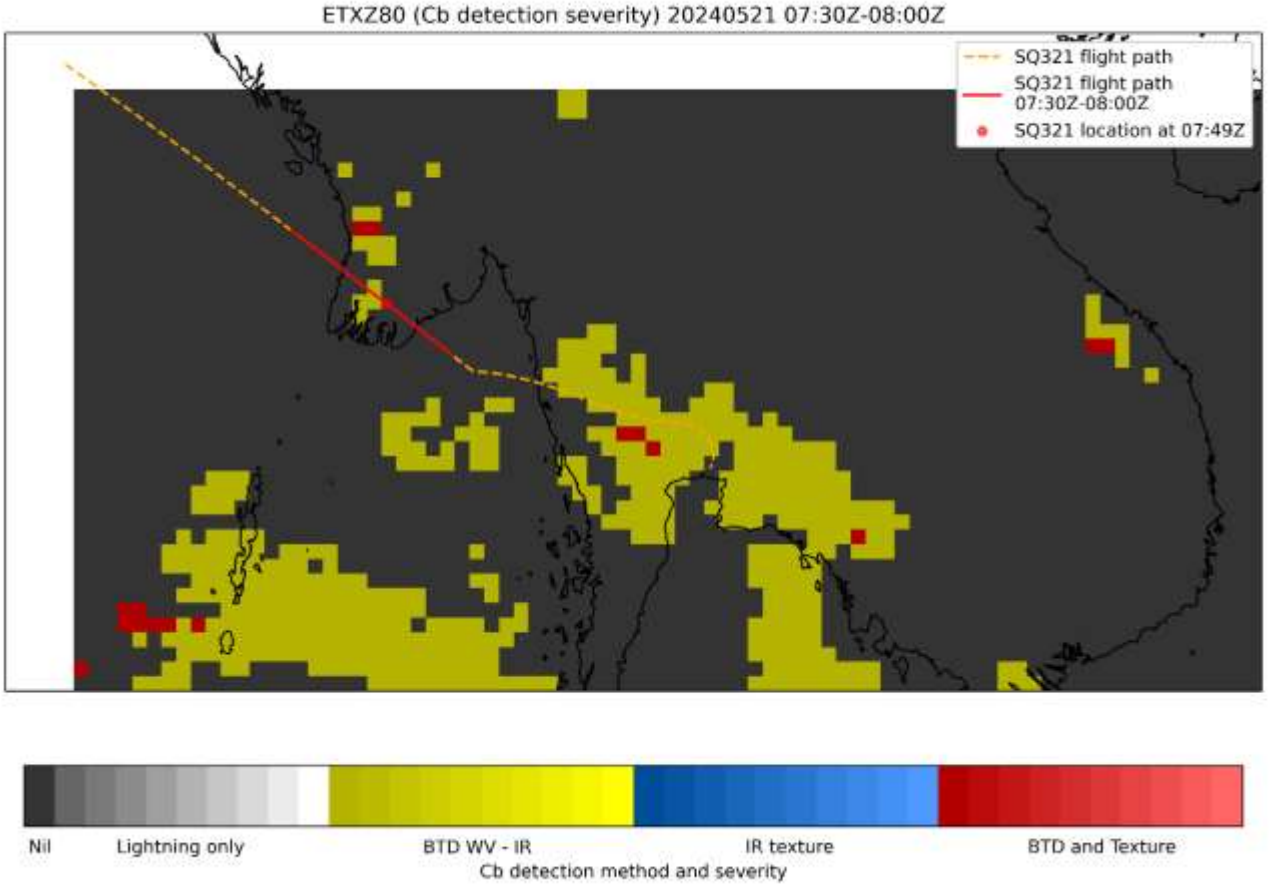
Shows Cbs detected in vicinity of incident in the time window that incident occurred.



Met Office

Cb detection severity at time of incident.

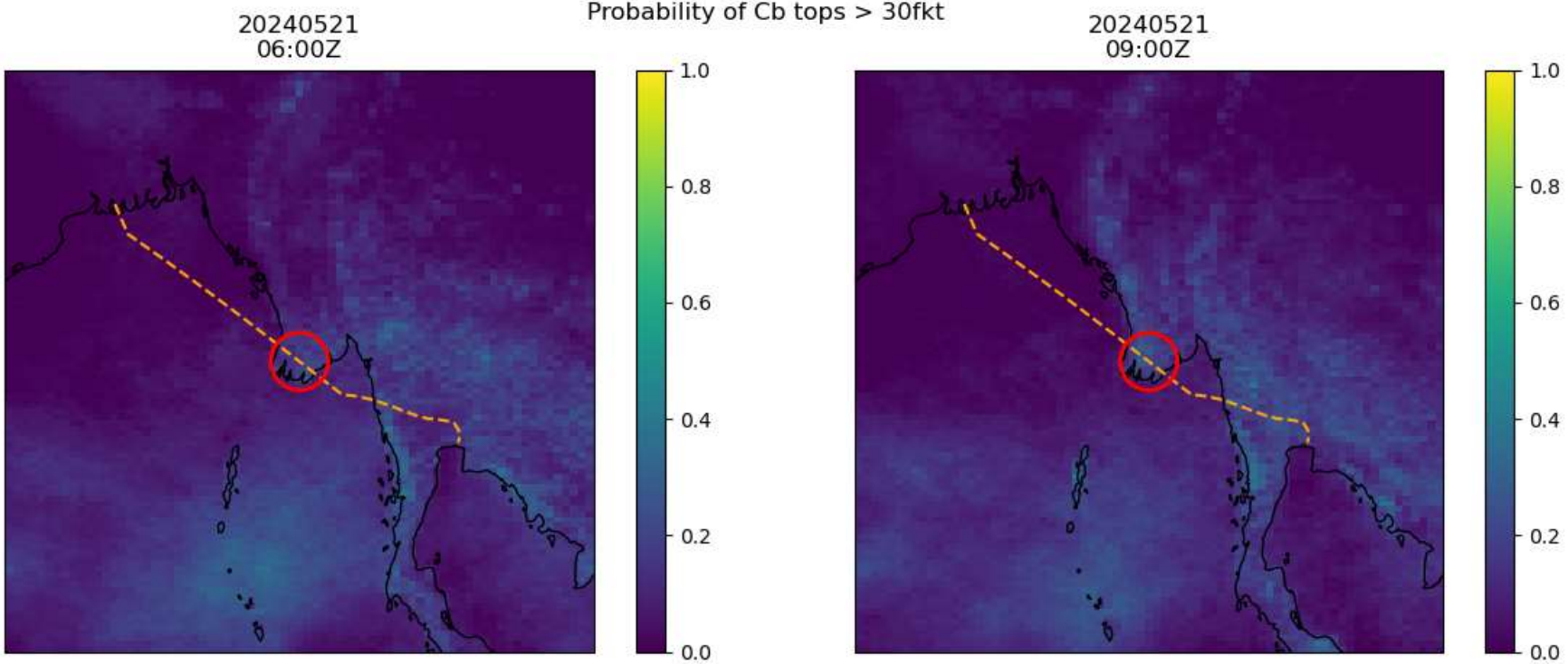
Shows Cbs detected in vicinity of incident in the time window that incident occurred.



EPOCH Forecasts

06Z run on 20th May

EPOCH forecasts (blend_calibrated) 20240520T0600Z
Probability of Cb tops > 30fkt



SIGWX Objects

Graeme Anderson

Met Office User Forum

25th November 2024

Met Office

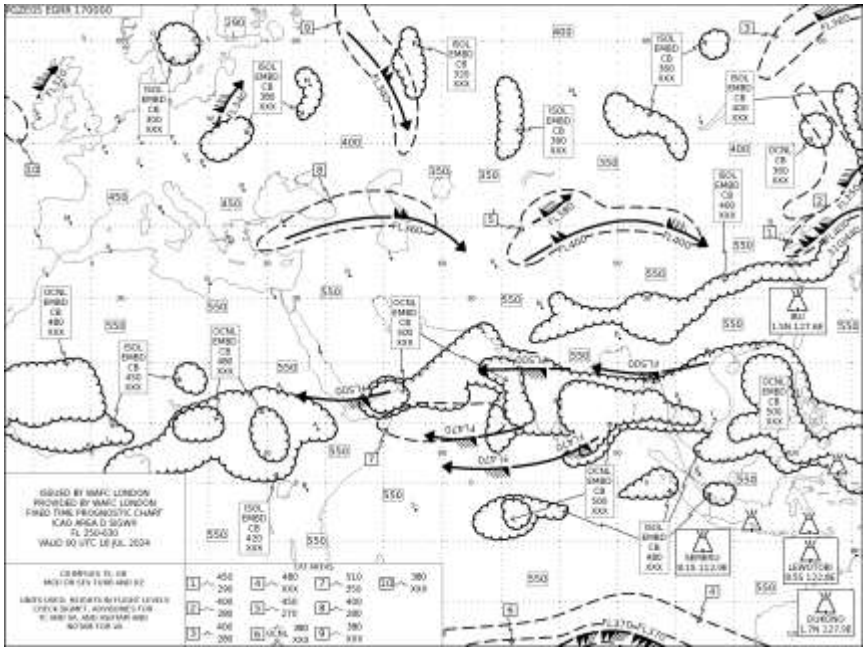
Contents

- SIGWX Charts
- Object Generation
- Plotting

Met Office

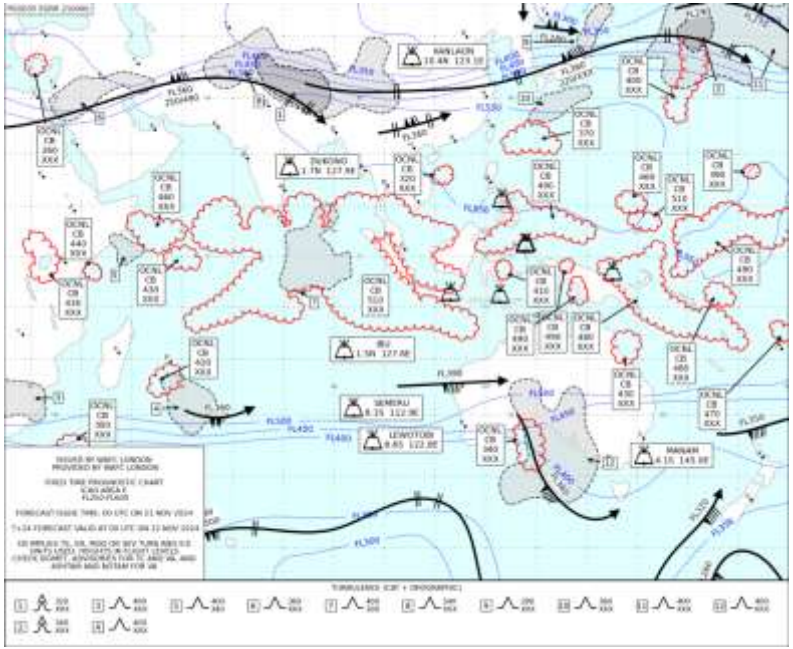
SIGWX Charts

SIGWX Charts



- Situational awareness charts
- Part of WAFS
- Manually produced
- T+24 only, every 6 hours
- FL100-450 and FL250-630
- Hazards:
  - Convection (CBs)
  - Clear Air Turbulence (CAT)
  - Jet streams
  - Tropopause height
  - Volcanic eruptions
  - Tropical cyclones
  - Nuclear releases

SIGWX Charts

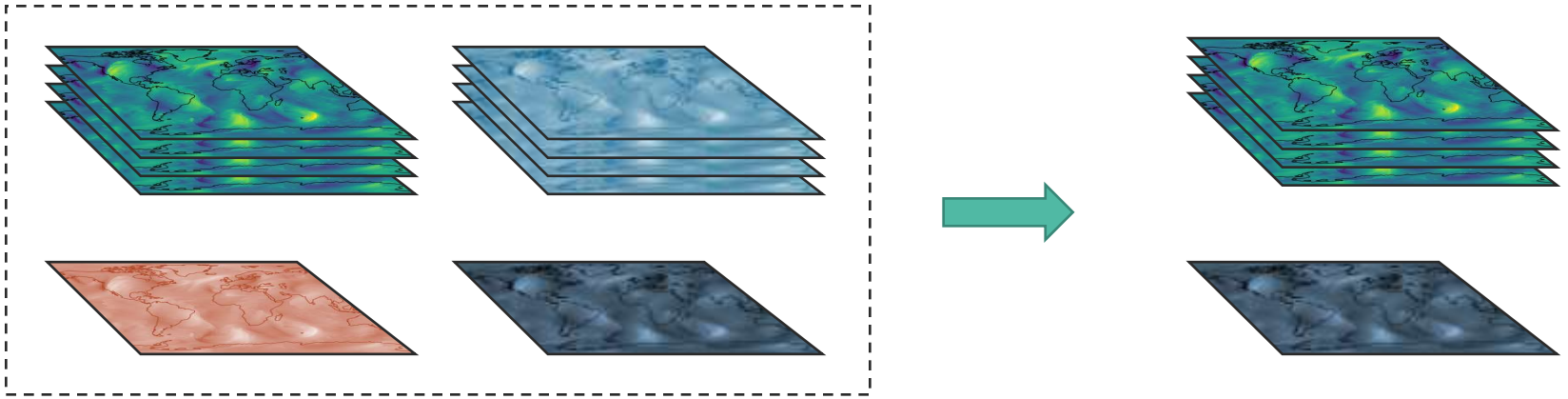


Met Office

Object Creation

Read Data

- CB, ICING, JET, TROP, TURB



WAFS gridded data file

Pre-process Data

- JET:

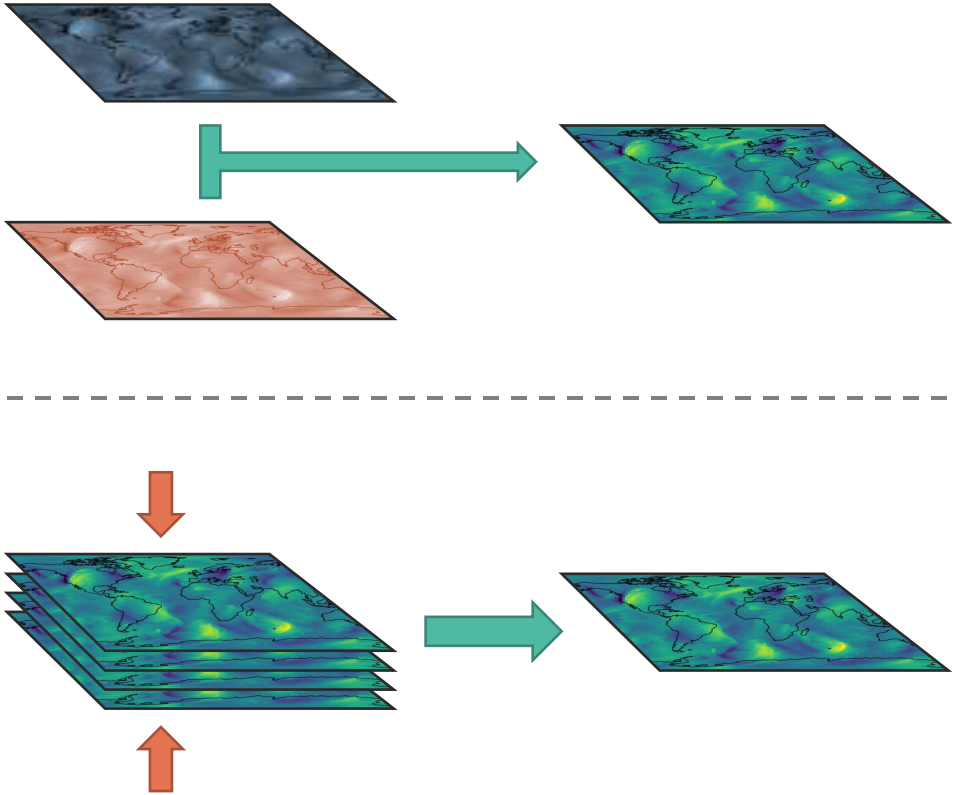
  Calculate speed and bearing

- ICING, TURB:

  Collapse 3D to 2D

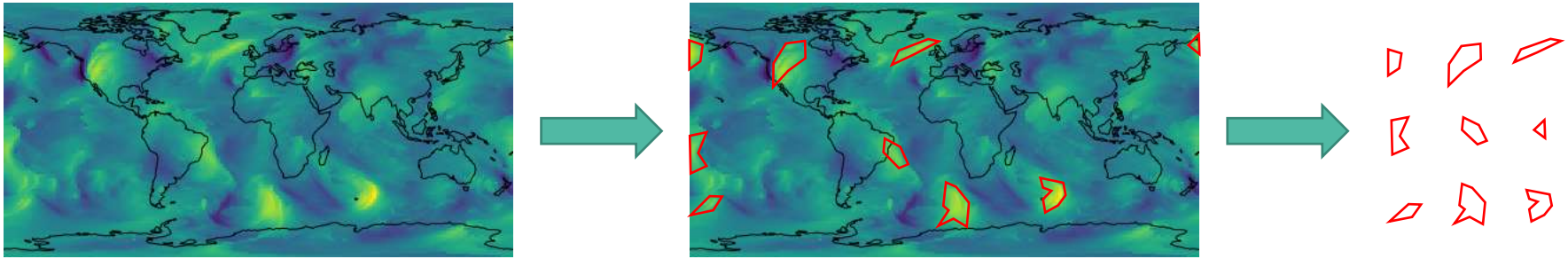
- CB, ICING, TURB, TROP:

  Smooth data



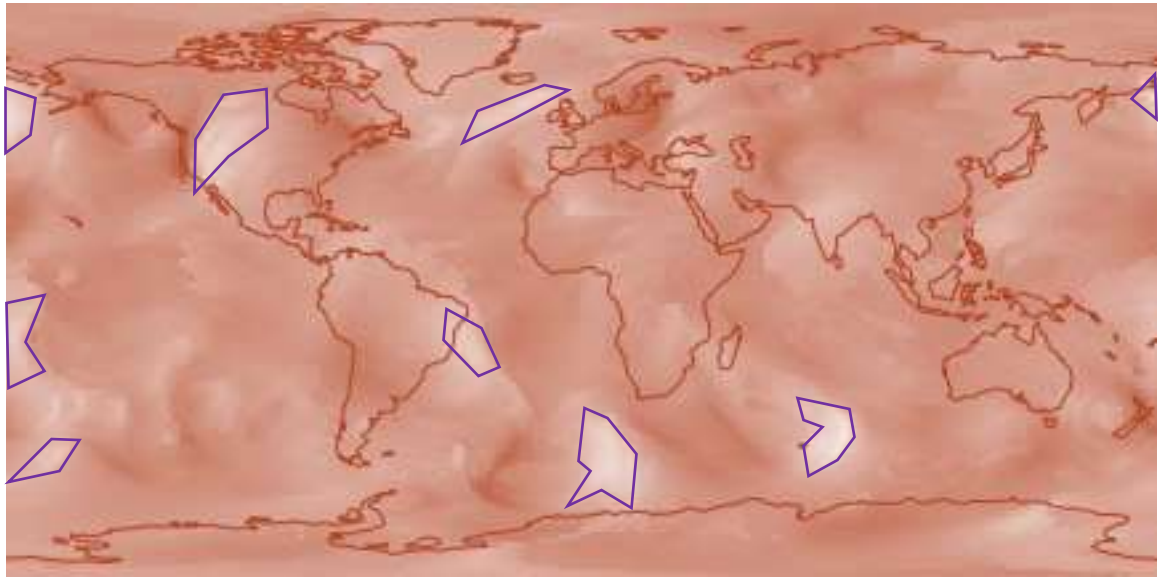
Met Office

Find Objects

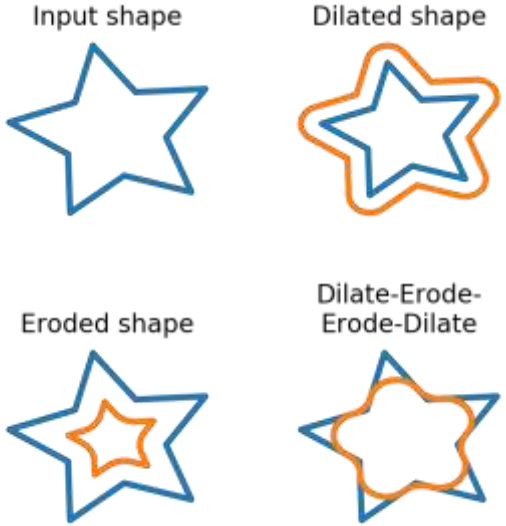


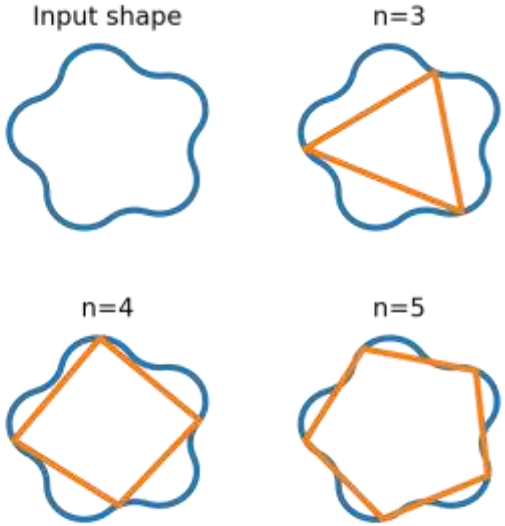
Met Office

Find Object Characteristics



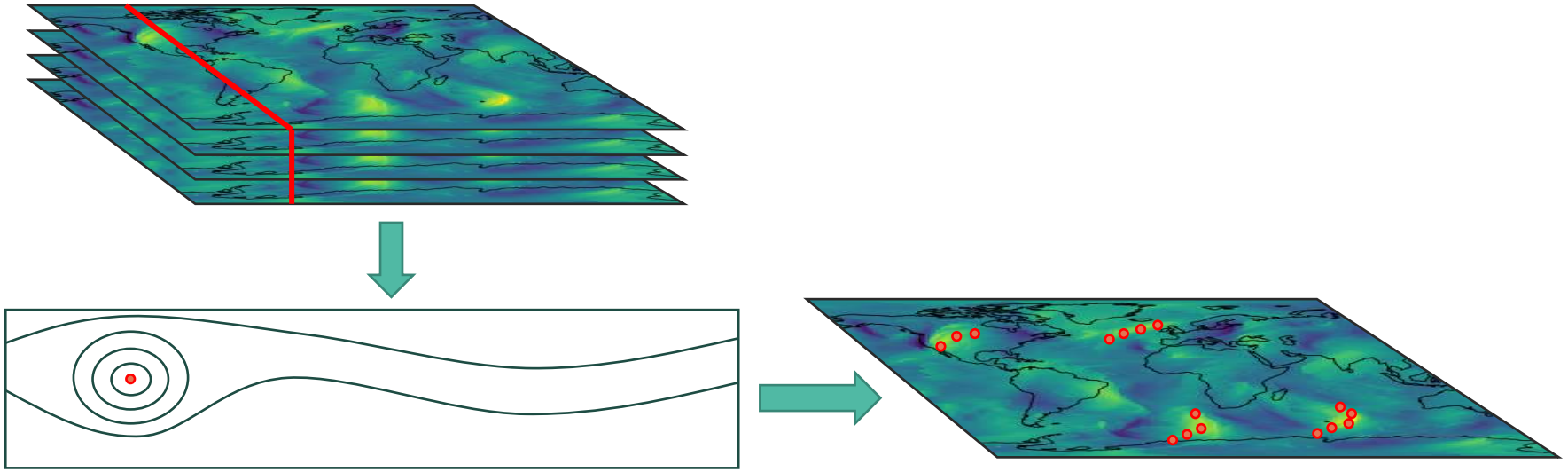
Smooth Objects



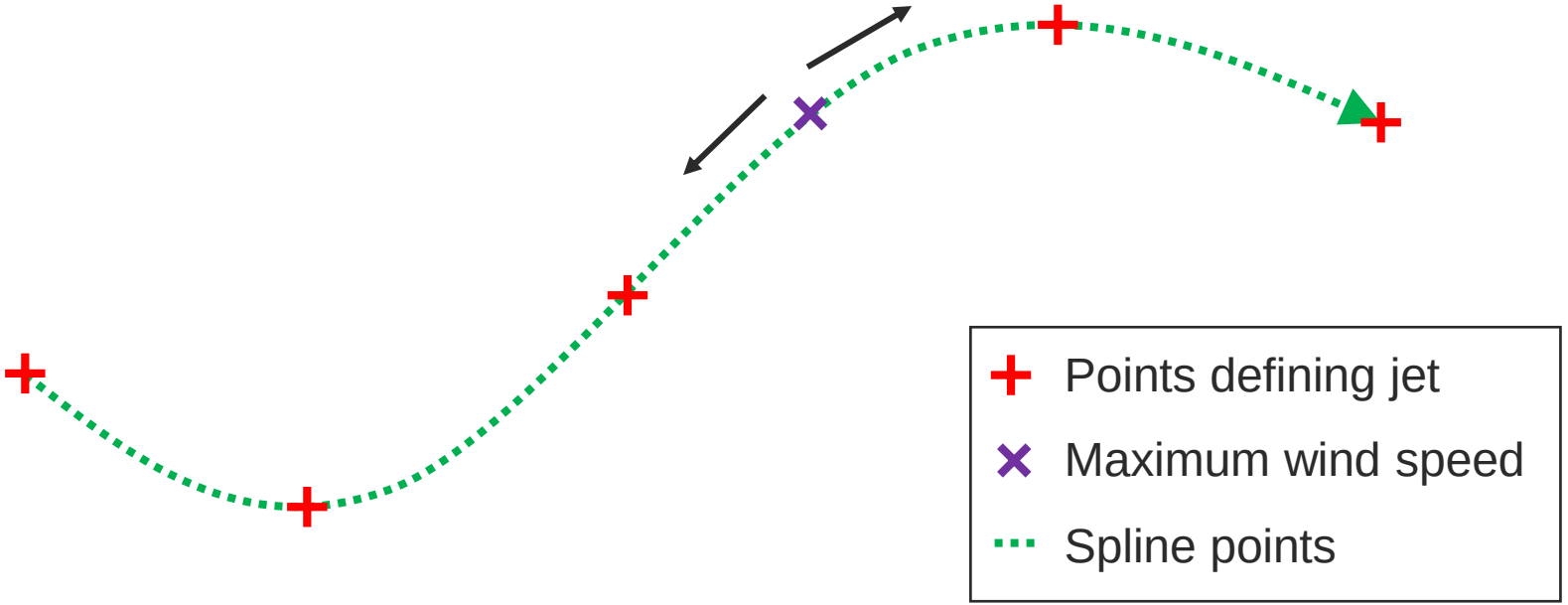


Met Office

Find jets

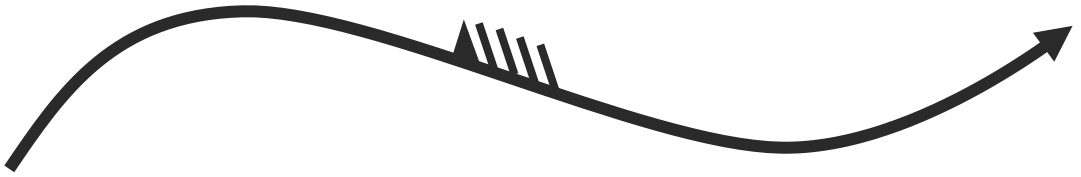


Find Fleches



Met Office

Write Data



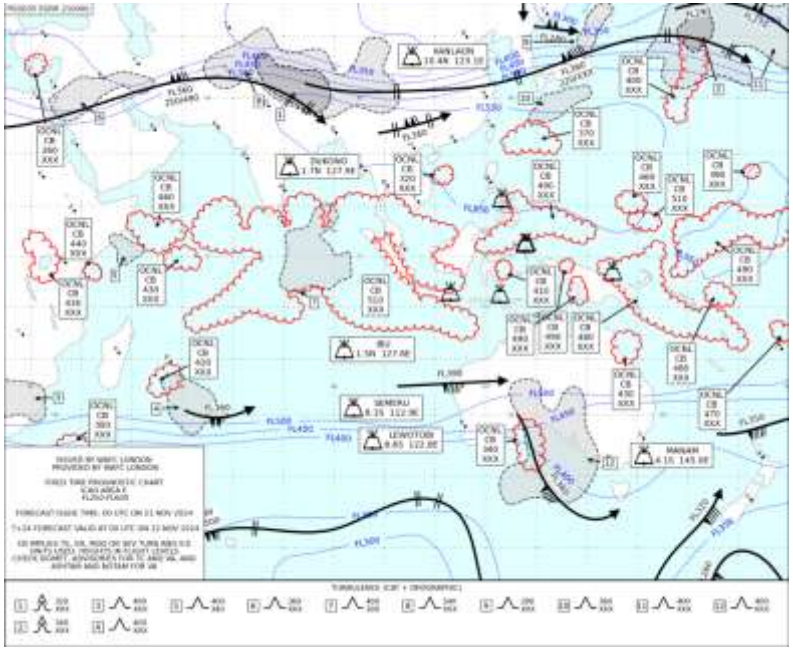
```
<!-- JET Object #1 -->
<iwxxm:feature>
    <iwxxm:MeteorologicalFeature gml:id="uuid.a0000000-0000-0000-0000-000000000000">
        <gml:identifier codeSpace="http://wafs/sigwxobj">a0000000-0000-0000-0000-000000000000</gml:identifier>
        <iwxxm:phenomenon xlink:href="http://codes.wmo.int/49-2/MeteorologicalFeature/JETSTREAM"/>
        <iwxxm:phenomenonGeometry>
            <gml:Curve gml:id="uuid.a0000000-0000-0000-0000-000000000000" srsDimension="2" axisLabels="Lat Long" srsName="http://www.opengis.net/def/ers/EPSG/0/4326">
                <gml:segments>
                    <gml:CubicSpline>
                        <gml:posList> -61.248572 175.399151 -62.874363 179.102867 -63.182597 180.457510 -64.582977 189.518028 …
                        </gml:posList>
                        <gml:vectorAtStart> -39.97667 53.92996 </gml:vectorAtStart>
                        <gml:vectorAtEnd> 48.93476 45.82039 </gml:vectorAtEnd>
                    </gml:CubicSpline>
                </gml:segments>
            </gml:Curve>
        </iwxxm:phenomenonGeometry>
        <iwxxm:phenomenonProperty>
            <iwxxm:WAFSJetStreamWindSymbol gml:id="uuid.a0000000-0000-0000-0000-000000000000">
                <iwxxm:location>
                    <iwxxm:ElevatedPoint gml:id="uuid.a0000000-0000-0000-0000-000000000000" srsDimension="2" axisLabels="Lat Long" srsName="http://www.opengis.net/def/ers/EPSG/0/4326">
                        <gml:pos> -62.66272 178.33860 </gml:pos>
                        <iwxxm:elevation uom="FL">300</iwxxm:elevation>
                        <iwxxm:verticalReference>MSL</iwxxm:verticalReference>
                    </iwxxm:ElevatedPoint>
                </iwxxm:location>
                <iwxxm:windSpeed uom="kn_i">90</iwxxm:windSpeed>
            </iwxxm:WAFSJetStreamWindSymbol>
        </iwxxm:phenomenonProperty>
    </iwxxm:MeteorologicalFeature>
</iwxxm:feature>
```

Met Office

Plotting

Examples


ISSUED BY WAFC LONDON
PROVIDED BY WAFC LONDON
FIXED TIME PROGNOSTIC CHART
ICAO AREA 5 SIGWX
FL 255/630
VALID 00 UTC 22 NOV 2024

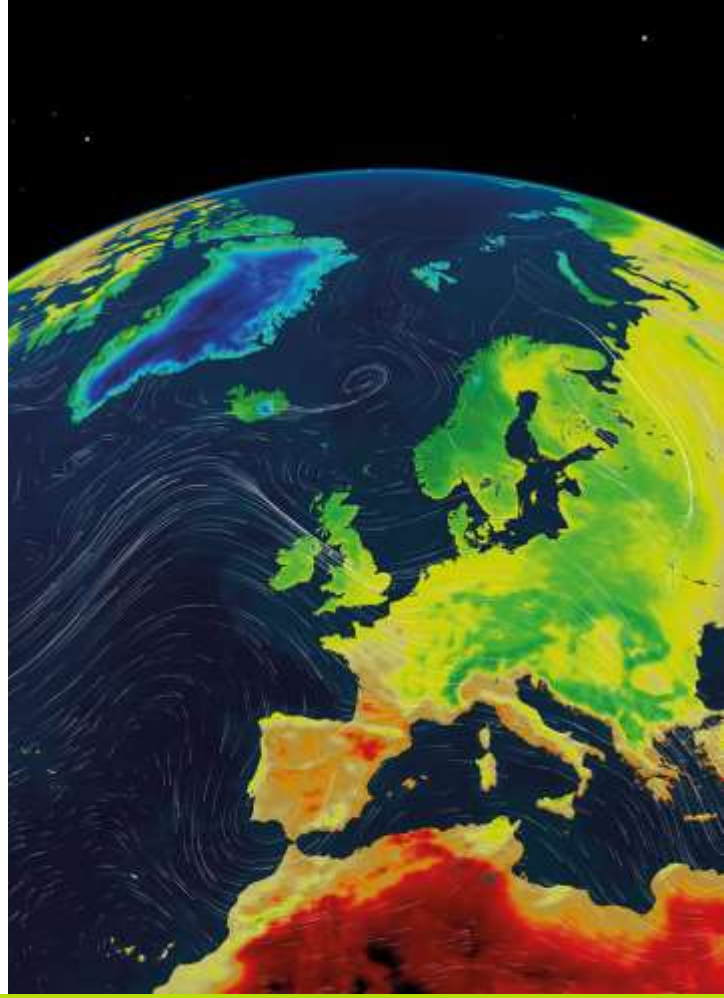


Summary

- Production of SIGWX charts has been automated
- Automation will improve timeliness, consistency and number of forecast timesteps available
- Due to go live January 2025

Purpose of UK aviation R&D programme

- Improving forecasting and understanding of convection, fog and low level cloud.
- Understanding ways to automate (and verify) forecasts currently produced manually.
- Improving weather forecasts for low level aviation.



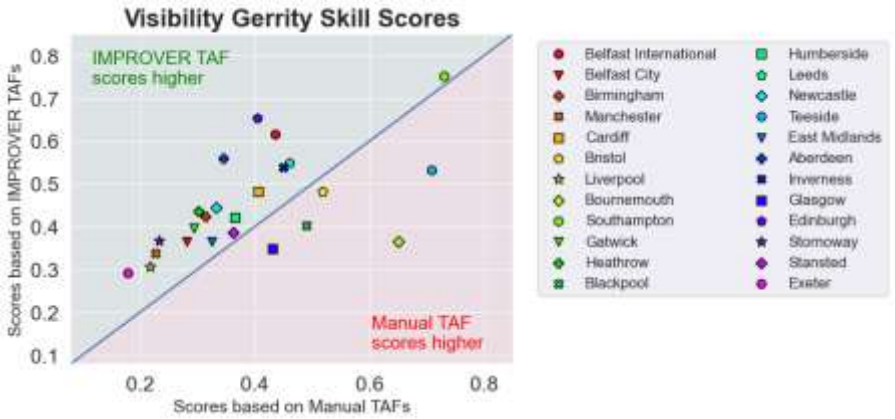
Andre Lanyon

Semi-Autonomous TAFs

IMPROVER TAFs

Norwich:

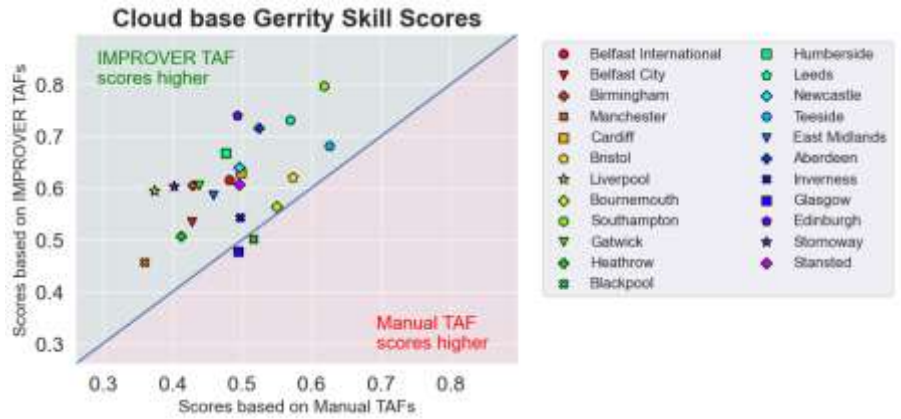
```
TAF EGSH 100800Z 1009/1018 25004KT 8000 FEW045
     PROB40 TEMPO 1013/1018 9999 BKN013=
```



Issued TAFs

Norwich

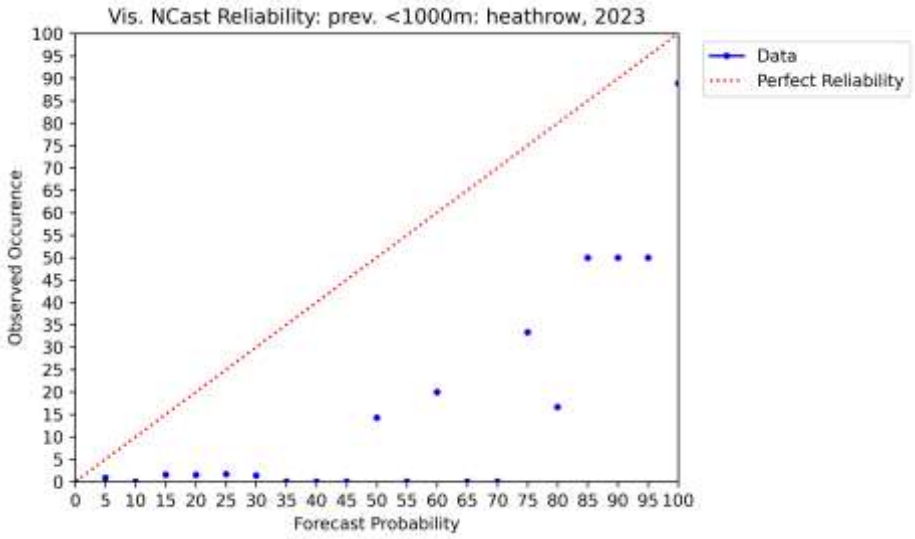
```
TAF EGSH 100756Z 1009/1018 26006KT 7000 BKN025
     TEMPO 1009/1018 6000=
```



Ultimate application of this work: Improve efficiency of TAF production

Lewis Davies

Machine Learning for Visibility Nowcasting



- Plot: Visibility Ncast compared against METAR observations of visibility
- Visibility Nowcast tends to over forecast
- Utilize machine learning to correct the nowcast output

Ultimate application of this work: Understand if we can improve airport visibility forecasting

Met Office

Piers Buchanan (if time)

WMO Aviation Research Demonstration Project Phase Two (AvRDP2)

- Successful third meeting in Exeter in September following on from meeting at NCAR, USA last year.
- Demonstration Project for the HKG to SIN route happening now.
- Enhanced prototype products for LHR-JBG route under development.

WMO AeroMetSci Conference 2024 (last one 2017)

- Successful conference in Geneva discussing aviation weather and climate issues
- Report in 2025 will have key recommendations of improvements / new developments.
- Machine learning important but only as **part** of an ongoing programme of work understanding weather and climate issues.

Met Office

Contrail Mitigation

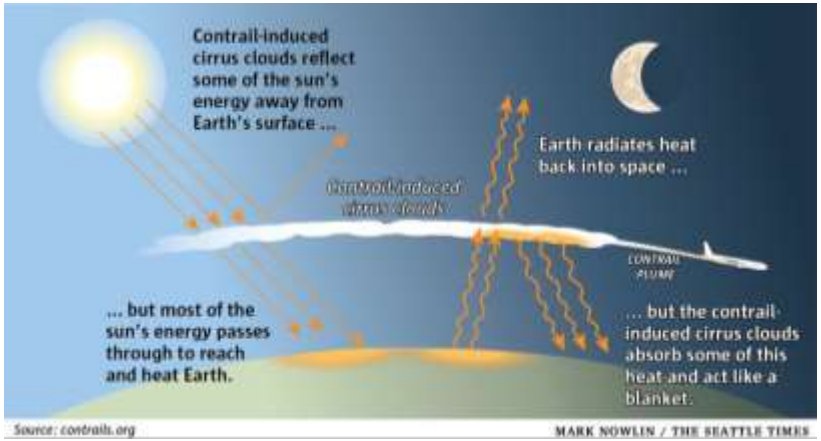
Mark Canning

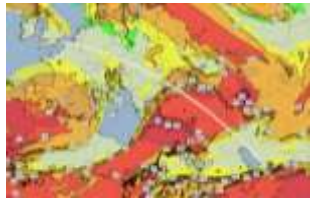
Aircraft exhaust emissions mix with environmental air → ice crystals

In cold and humid air they can persist and form clouds

~25,000 aircraft; only ~150 sensing humidity profiles, ~10 cruise humidity

Potentially solve with novel techniques / ML





[2]

Contrails are short-lived climate forcers

Climate impacts from contrails may be **greater** than from aviation CO_2 emissions[1]

Ultimate application of this work: Mitigate anthropogenic climate change

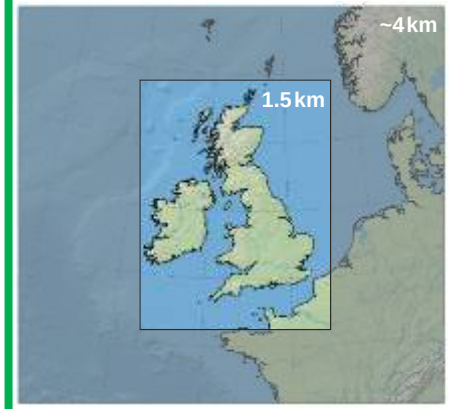
1 – IPCC AR6 WGIII
2 – T&E (2024)

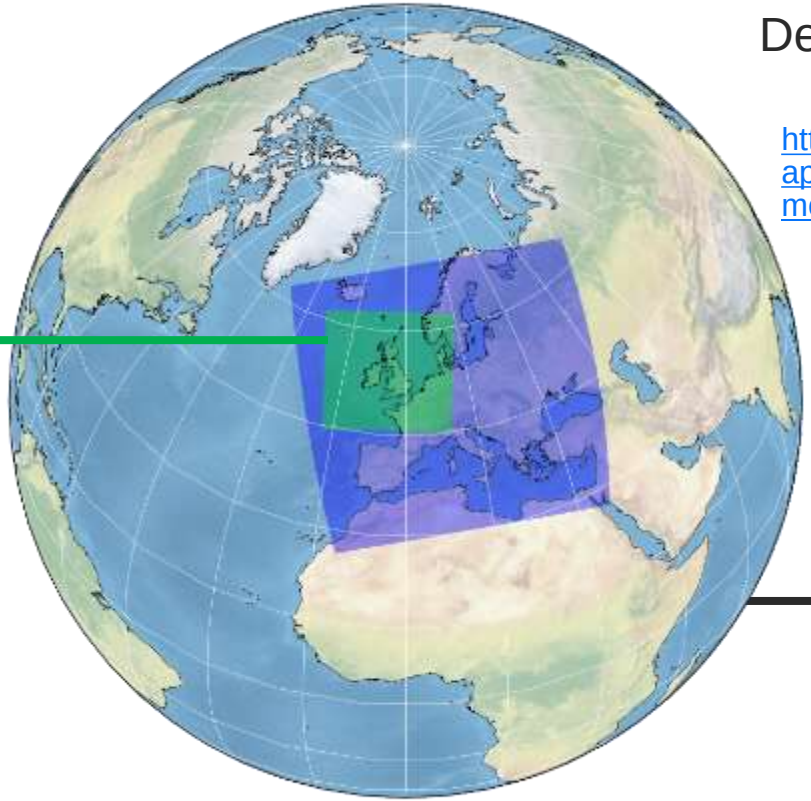
Supercomputer Update

Met Office Unified Model Configurations 2024

UK

1.5 km resolution (inner)
54 hour forecast (6× daily)
120 hour forecast (2× daily)
12 hour nowcast (hourly)
Ensemble 2.2km resolution to 5d, 18 time-lagged members, updated hourly.





Deterministic models

https://www.metoffice.gov.uk/research/approach/modelling-systems/unified-model

Global

10 km resolution
Up to 6 day forecast (4 × daily)
70 vertical levels (to ~80 km)
Initial conditions from a 44-member global ensemble
Ensemble 20km resolution to 7 days, 36 members

Global NWP Plans

- Increase global ensemble forecast range out to 14-days.
- Retire main deterministic global forecast.
- Upgrade to 10km resolution global ensemble forecasts.
- More frequent (3-hourly) global analyses.
- Continue to research 5−6km forecasts as first step towards a future km-scale global ensemble forecast system.

UK regional NWP

- Retire UKV forecasts beyond the T+12 “NWP nowcast”.
- Upgrade to 1.5km resolution UK ensemble forecasts.
- Introduce 300m resolution regional ensemble(s) to improve forecasts for urban areas and high-impact weather.

R&D highlights - Globally

MTG opportunities for aviation investigated.

WAFS Probabilistic trial analysed and vn1 finalised

Cb capability demonstrated via AVRDP2

R&D highlights - UK

Fog visibility forecasting role of machine learning better understood

Convection nowcast demonstrated in real time

Ongoing investigations about how to improve low level turbulence forecast

3-month Outlook

Dan Rudman
Expert Operational Meteorologist

Contents

- 1- and 3-month outlook headlines
- What is ‘normal’?
- Observations from recent years
- Forecast reasoning
  - *Teleconnections*
  - *Seasonal predictions*
- Key points

1- and 3-month outlook

The following forecast is for the average of the December to February period for the United Kingdom as a whole.

This forecast content is based on information from observations, numerical prediction systems from modelling centres around the world, and expert judgement.

1-month outlook (December) - Summary

Temperature	Precipitation / Wind
The chance of a cold month is close to normal Nevertheless, this level of likelihood is greater than typically seen in recent years	There is a slight increase in the chance of a dry month compared to normal There is an increased chance of a calm December compared to normal

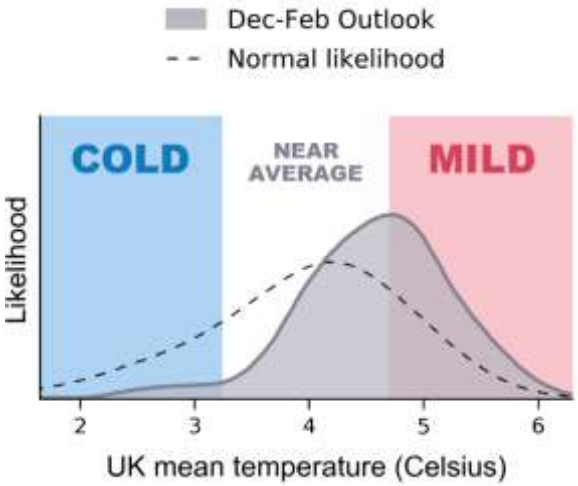
1-month outlook

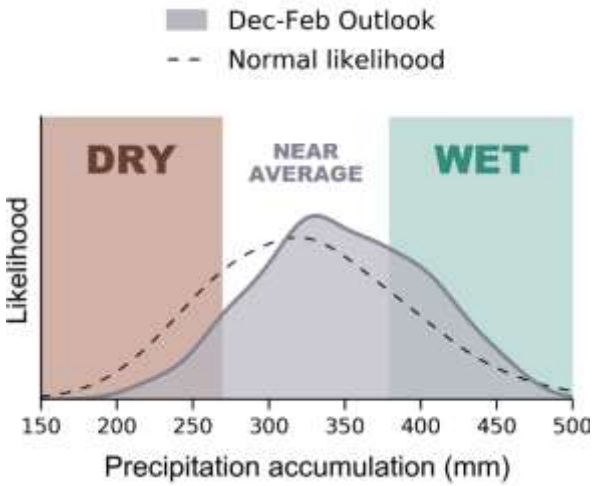
3-month outlook (Dec, Jan, Feb) - Summary

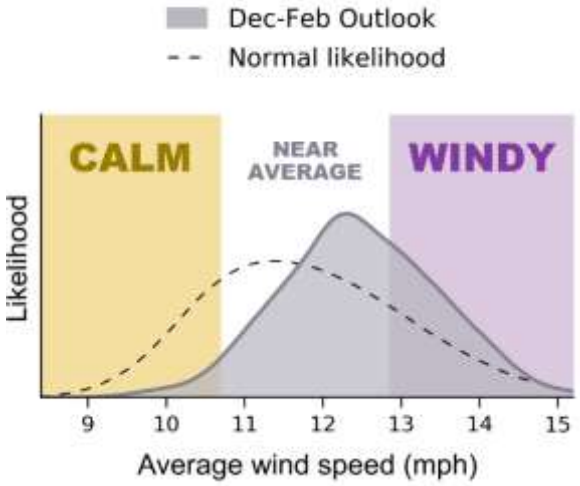
Temperature	Precipitation / Wind
Overall, the chance of the winter being cold is lower than normal This doesn't preclude some cold spells and related impacts	There is an increased chance of the winter overall being wetter and windier than normal Stormy conditions, and impacts from high winds, are more likely than normal

3-month outlook

3-month outlook - context



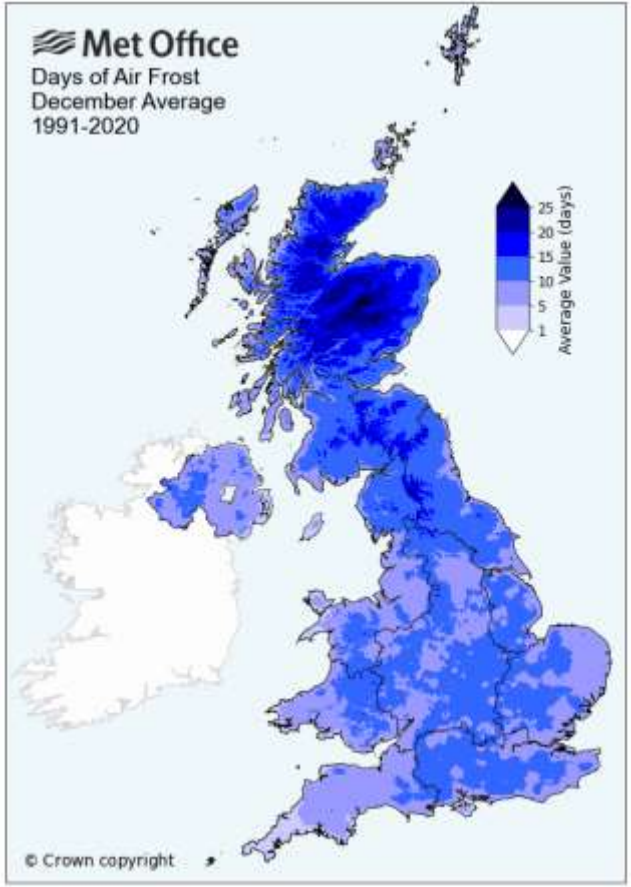


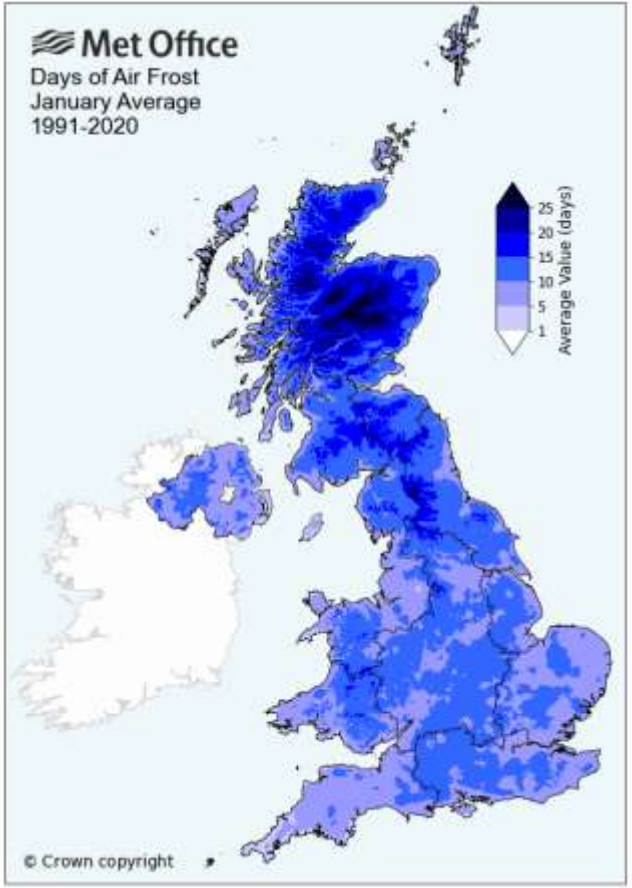


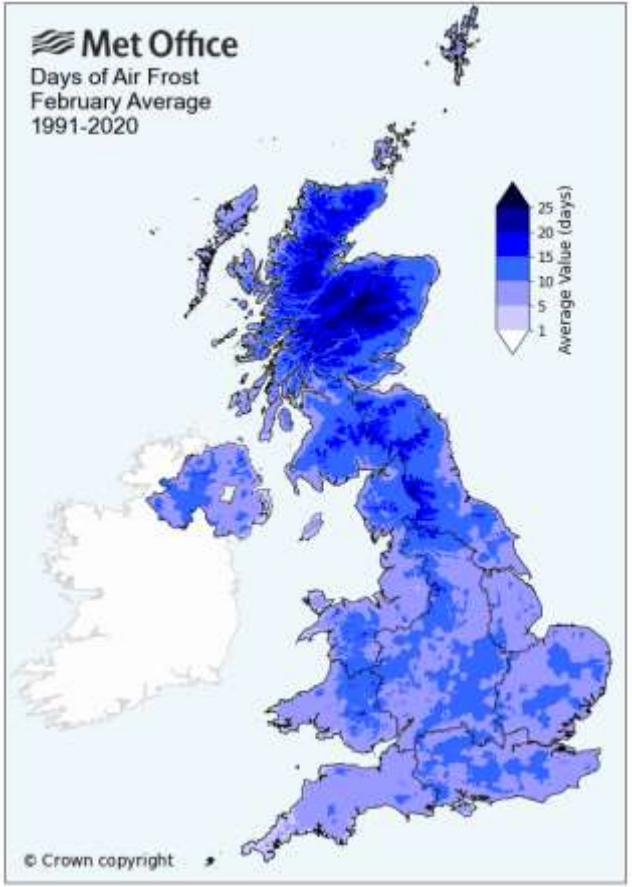
What’s normal?

A look at average conditions and a look back at recent years for the corresponding period

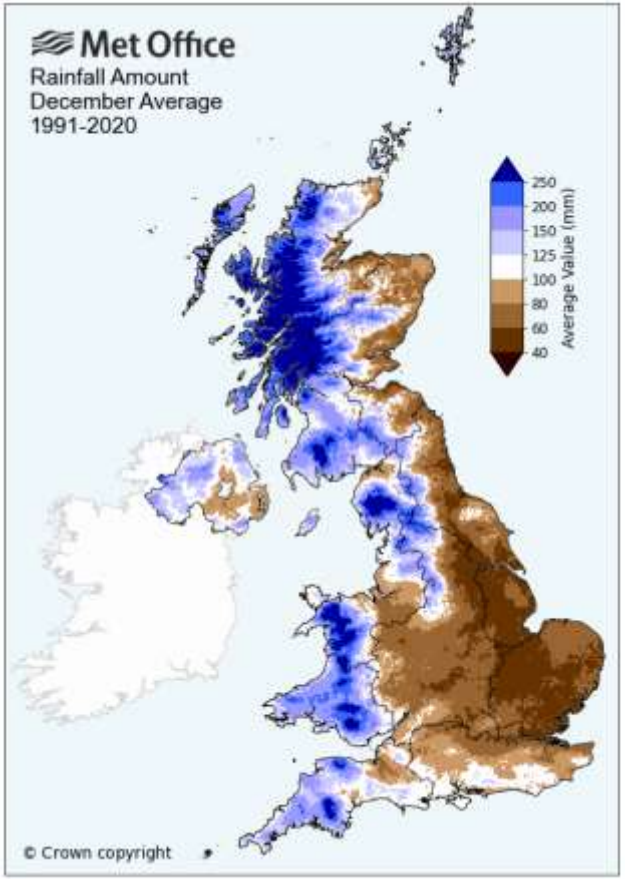
Met Office

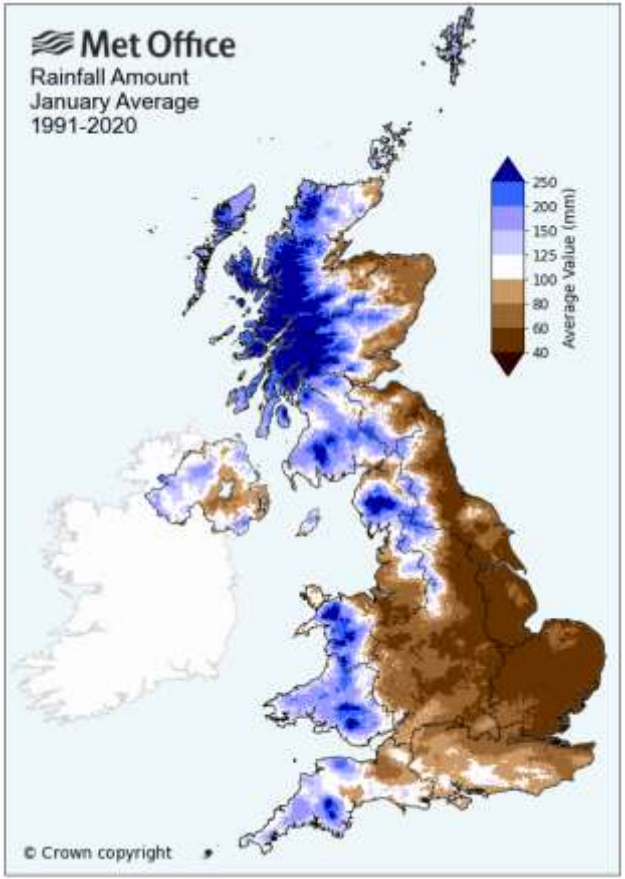


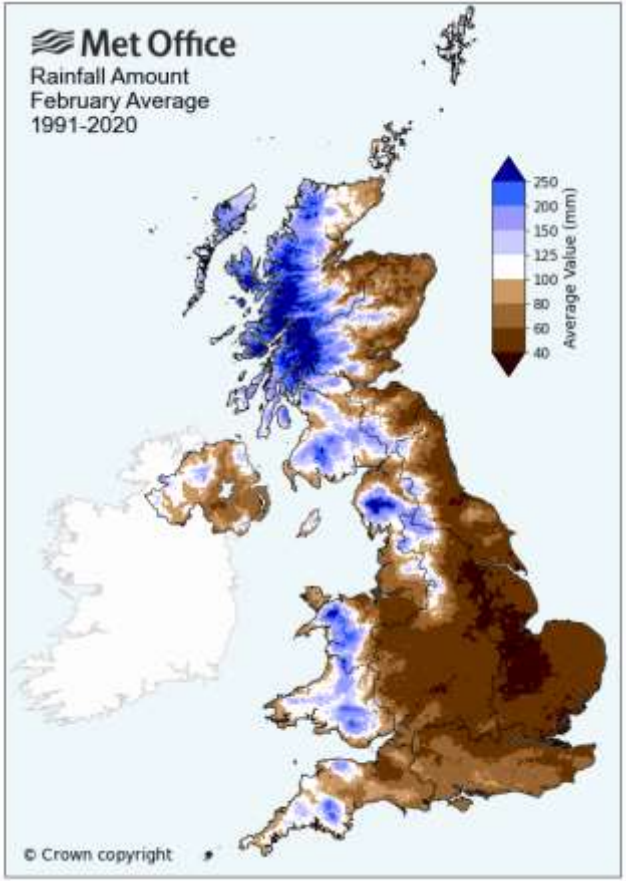




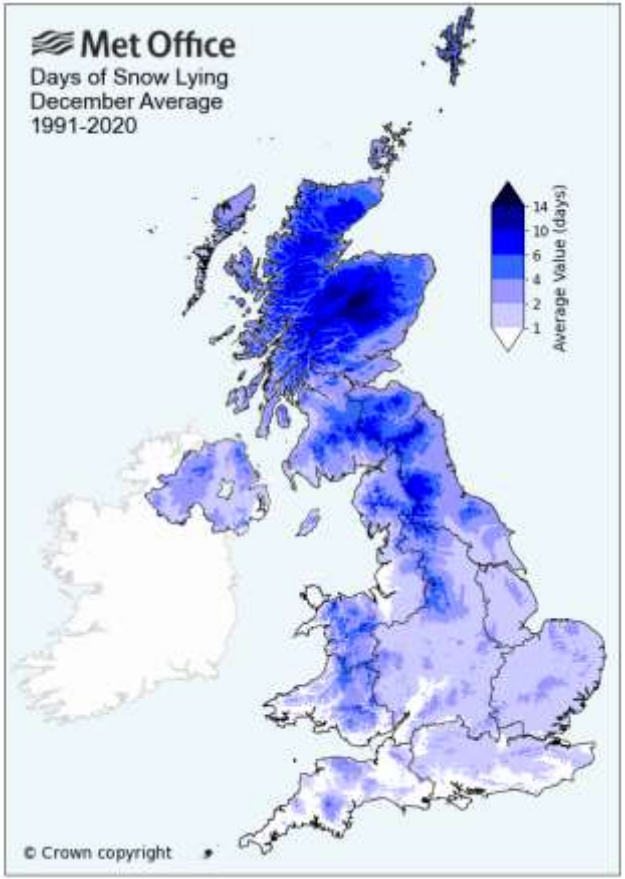
Met Office

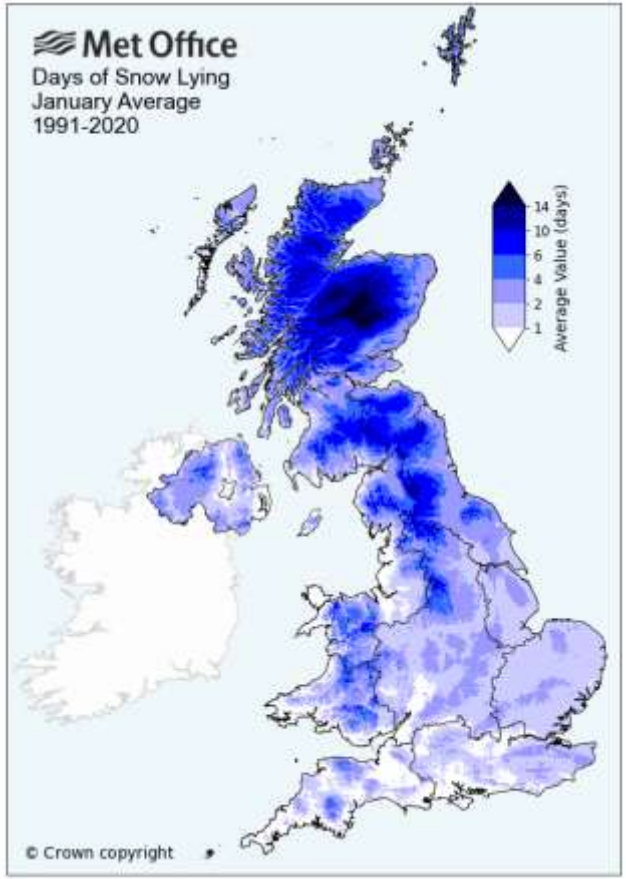


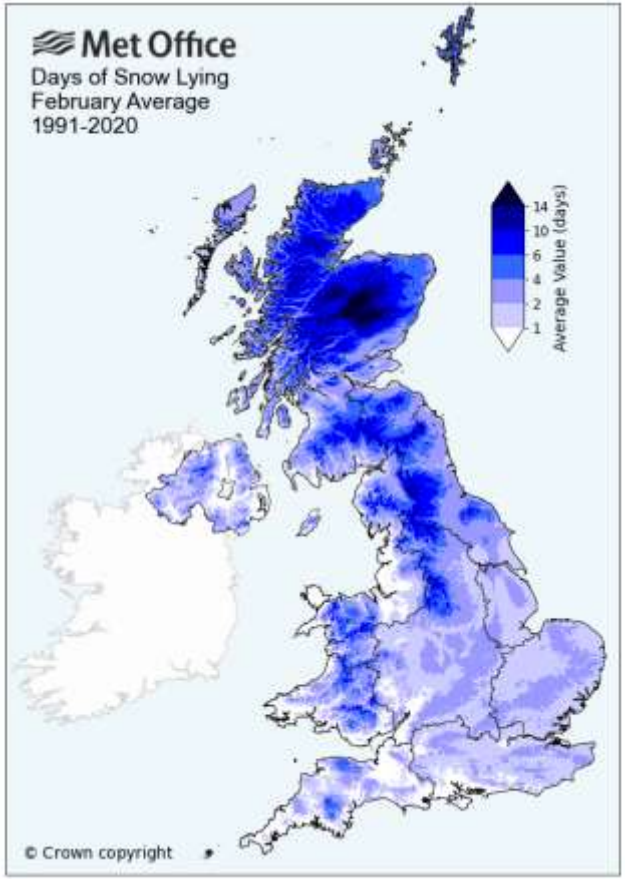




Met Office







Decembe r

2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
NEAR AVERAGE	MILD	MILD	NEAR AVERAGE	MILD	NEAR AVERAGE	NEAR AVERAGE	MILD	COLD	MILD
NEAR AVERAGE	WET	DRY	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	WET
NEAR AVERAGE	WINDY	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE

December-January-February

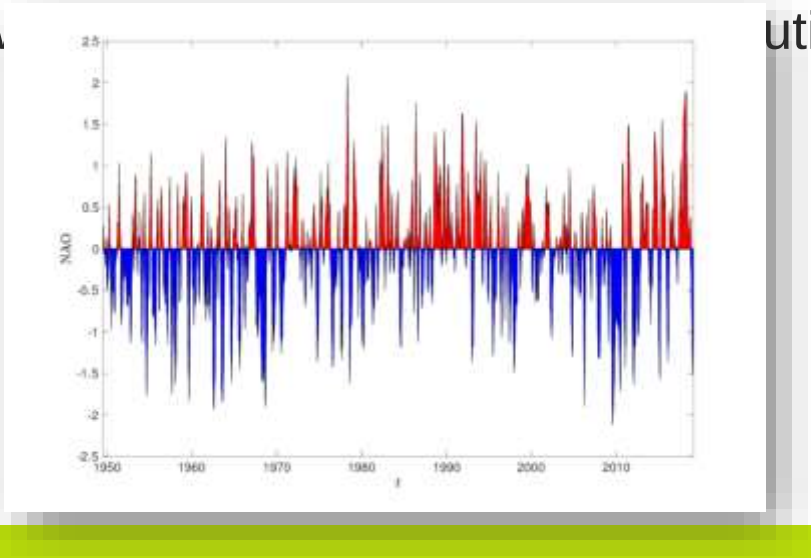
2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
NEAR AVERAGE	MILD	NEAR AVERAGE	NEAR AVERAGE	MILD	MILD	NEAR AVERAGE	MILD	NEAR AVERAGE	MILD
NEAR AVERAGE	WET	DRY	NEAR AVERAGE	DRY	WET	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	WET
NEAR AVERAGE	WINDY	NEAR AVERAGE	NEAR AVERAGE	CALM	WINDY	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE

Teleconnections and forecast reasoning

A look at the global drivers behind this forecast.

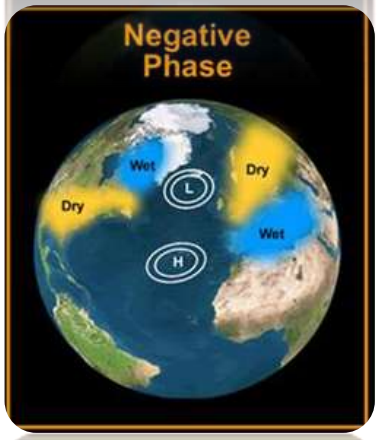
North Atlantic Oscillation (NAO)

- Explains much of the variability of the weather in the North Atlantic region, particularly during winter.
- The phase of the NAO affects v ution and the intensity and track of storm
- Seasonal prediction systems – such as the Met Office GloSea 6 system - have skill in predicting the NAO phase several months ahead.



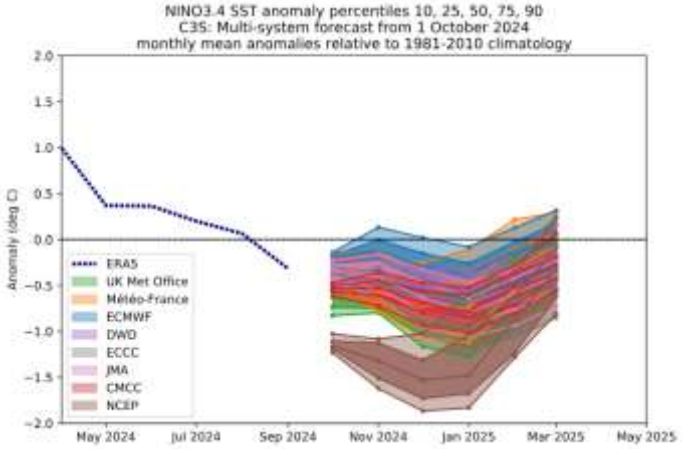
North Atlantic Oscillation (NAO)

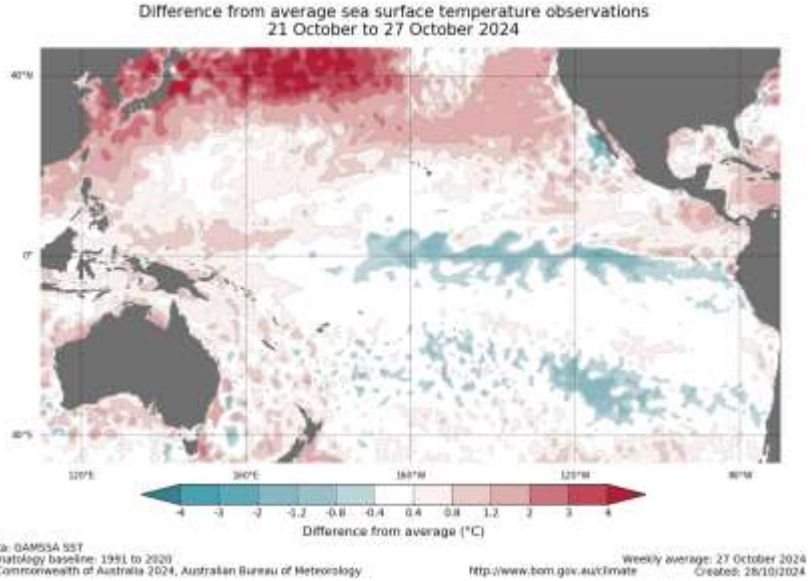
- Positive and negative phases of the NAO are defined by the differences in pressure between the persistent low near Iceland and the persistent high near the Azores.
  - Positive - enhancement of westerly winds leading to milder- and wetter-than-average conditions. Higher frequency of windstorms, but lower frequency of snow. (Winter 2013-14; 2015-16; 2019-20)
  - Negative - reduction in westerly winds leading to colder- and drier-than-average conditions. Lower frequency of windstorms, but higher frequency of snow. (Winter 2009-10; 2010-11)
- Many factors can influence the NAO phase including the stratospheric polar vortex, patterns of tropical rainfall and patterns of sea-surface temperatures in the Atlantic Ocean.



El Niño-Southern Oscillation

- Strongest driver of global weather patterns, influence greatest in the tropics but extends to the mid-latitudes in winter
- Moderate chance of La Nina over the next couple of months





Teleconnections summary

Positive NAO	Negative NAO
• *Possible La Nina (late winter)* • Westerly QBO	• *Possible La Nina (late autumn/early winter)* • MJO (sub-seasonal, late December)

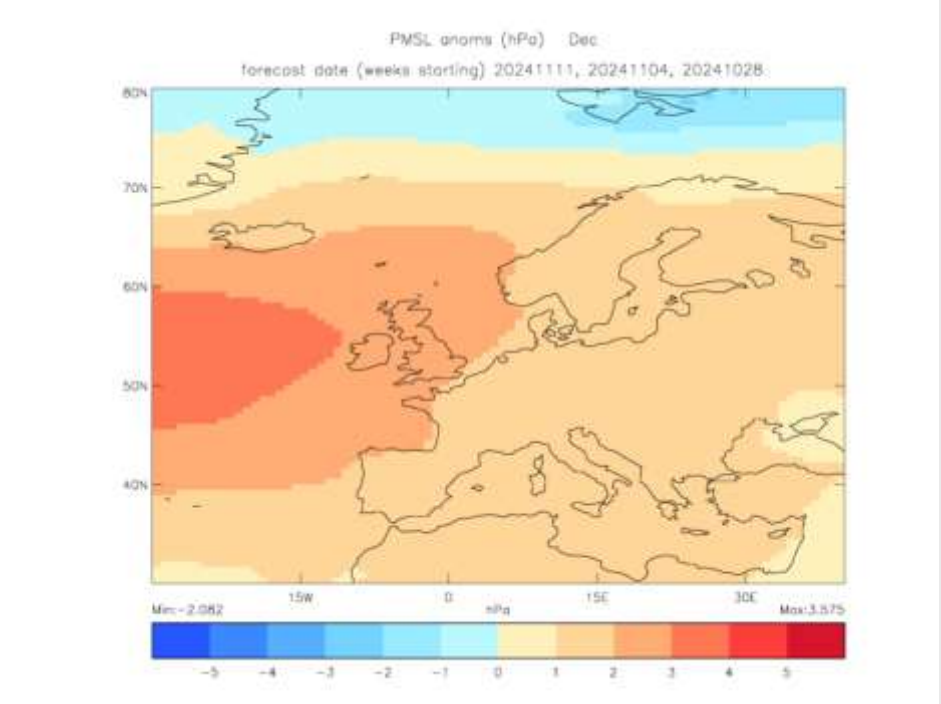
Seasonal Predictions

December-January-February

MSLP anomalies

December

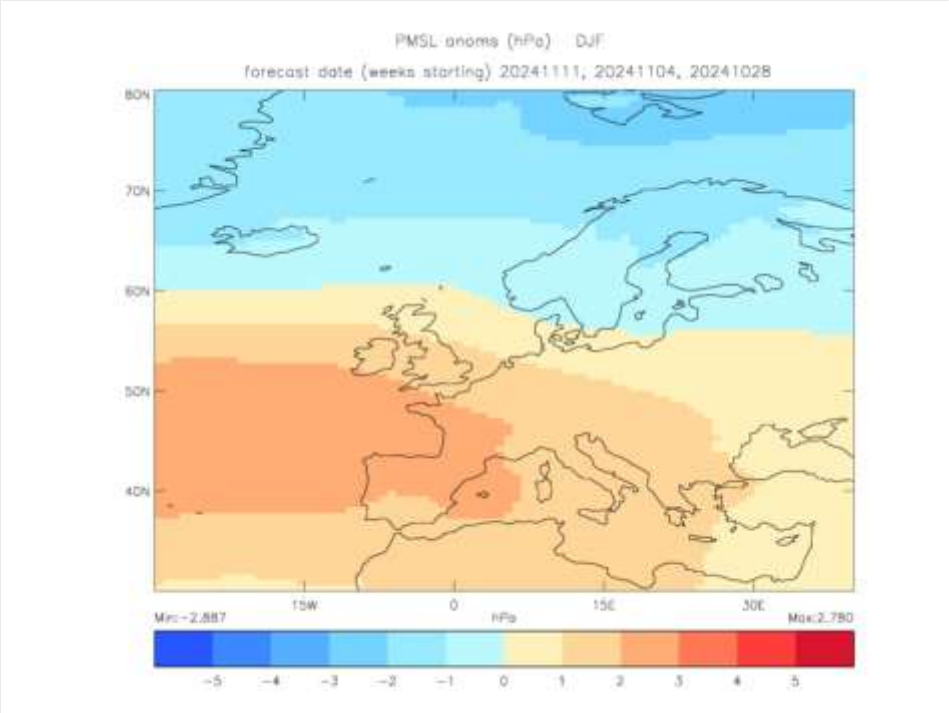
- Greater chance of blocking patterns than normal
- Increases the likelihood of spells of northerly or northwesterly winds



MSLP anomalies

December-January-February

- Patterns likely to change later in the winter
- Westerly winds favoured with a lower likelihood of blocking later in this period



Key points

- As during a typical winter, rain and wind likely to be hazards at times. However, may be more likely later in the winter.

- Signalled patterns for winter suggest rainfall more likely to above normal in northern and western areas.

- Consistent with our warming climate, the likelihood of the period as a whole being cold is very low.

- Cold spells and related impacts still likely at times.

Any questions?

Time to discuss:

- Any issues raised by attendees
- Any other business
- Date of Next MOUF

Stay in touch

Our you following our Aviation page on LinkedIn?

Read regular updates from the Met Office with an aviation angle.

General enquiries can be directed to:

transport@metoffice.gov.uk

Met Office

Opportunity for feedback

We value your feedback and would love to hear about your experience. Your input will help us improve and make future events even better.


Met Office
Thank you for attending the MOUF 2024 event
www.metoffice.gov.uk
© Crown Copyright 2023, Met Office