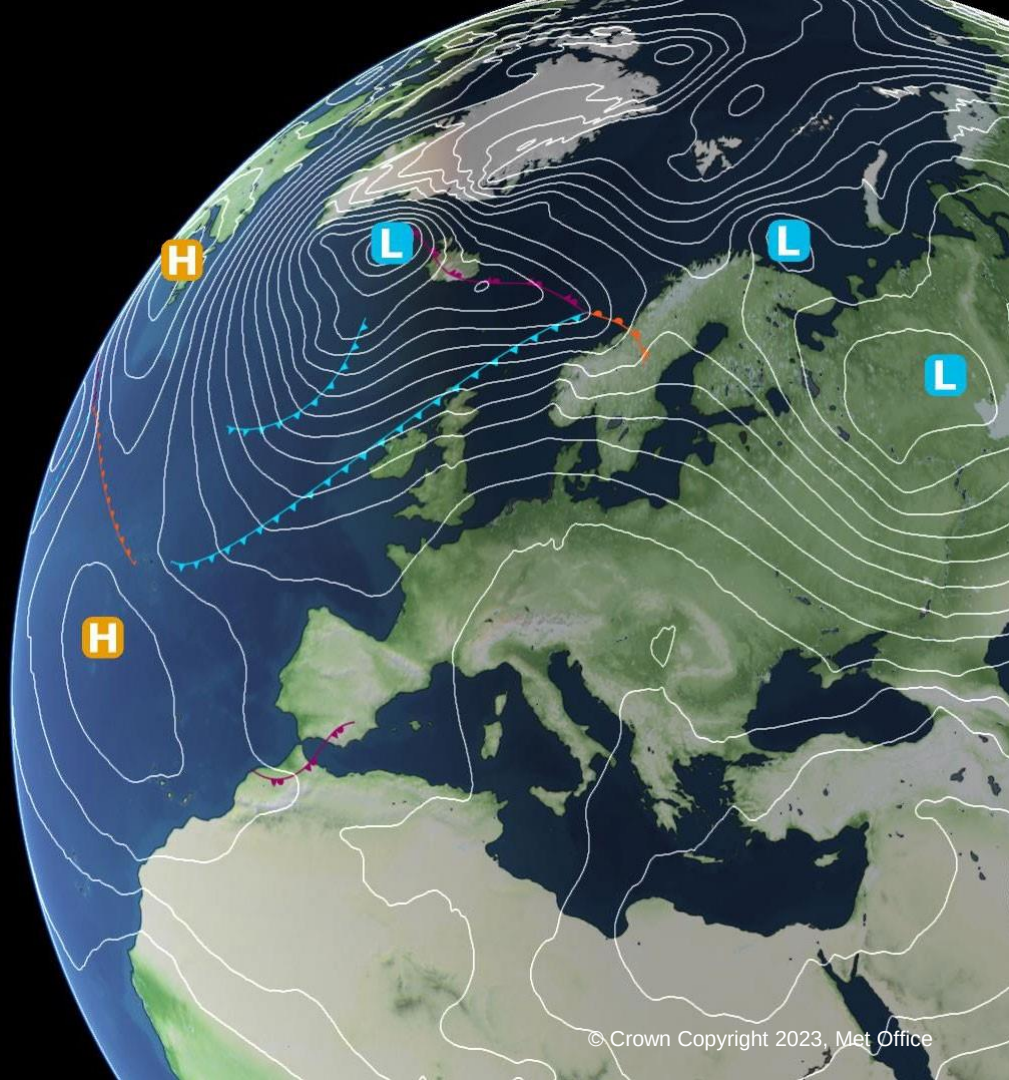
Met Office User Forum 2023

Thursday 9th November 2023



www.metoffice.gov.uk

Today's Speakers:

Mark Gibbs
Head of Transport

Darren Hardy
Snr National Aviation MET Advisor

Emma Corrigan
European Aviation Manager

Lauren Donohue
Aviation Business Manager

Piers Buchanan
Aviation Science Manager

Louise Bailey
Operational Meteorologist

Today's Session:

1. Welcome and Introductions
2. International Activities
3. Finances
4. National Aviation Service
5. SWIM services including SESAR & PCP

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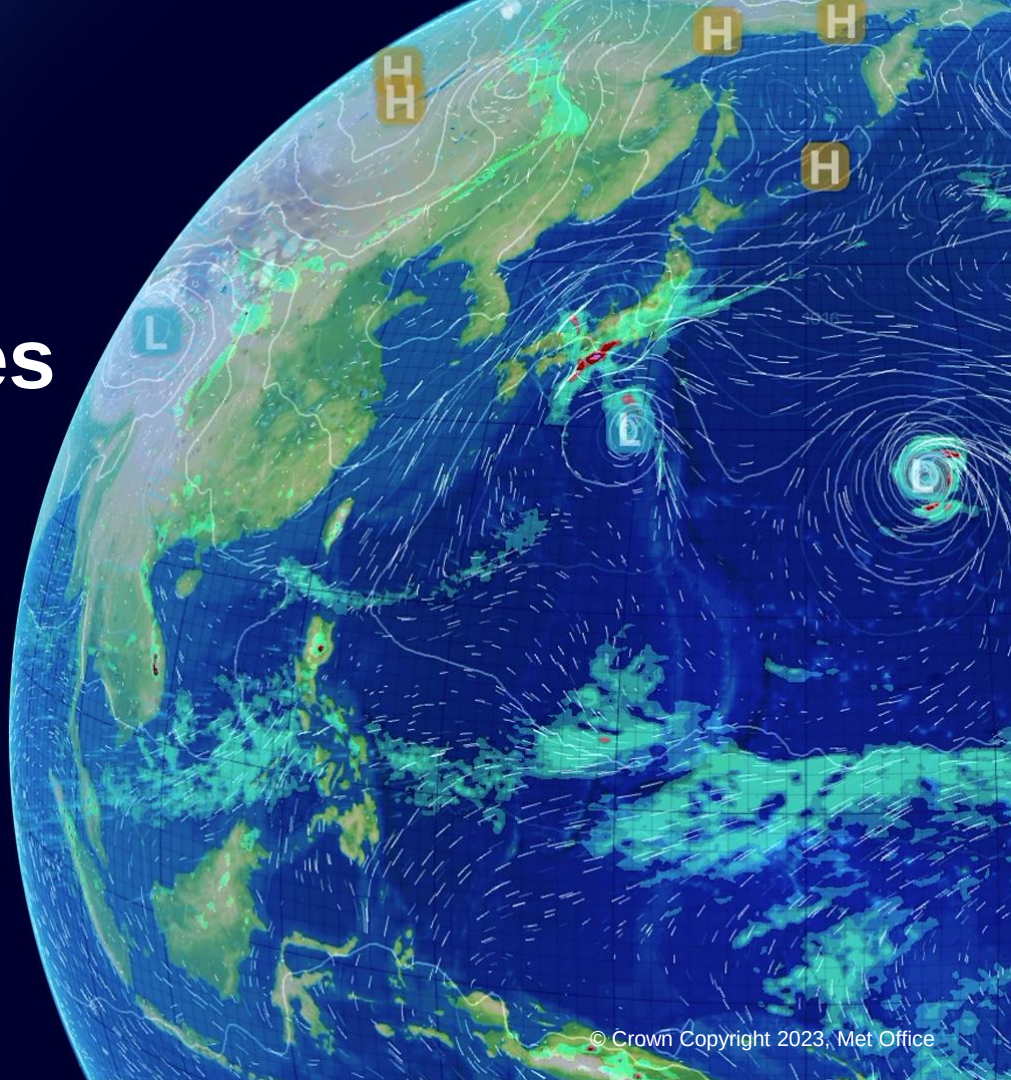
6. Aviation Research and Development
7. 3-month weather outlook brief
8. Specific issues raised by members
9. Any other business
10. Date of Next Meeting

International Activities

Mark Gibbs

Head of Transport



Content

1. World Area Forecast System (WAFS) upgrade
2. Volcanic Ash Advisory Centres (VAAC) changes
3. Secure Aviation Data Information Service (SADIS)

World Area Forecast System **(WAFS)** upgrade

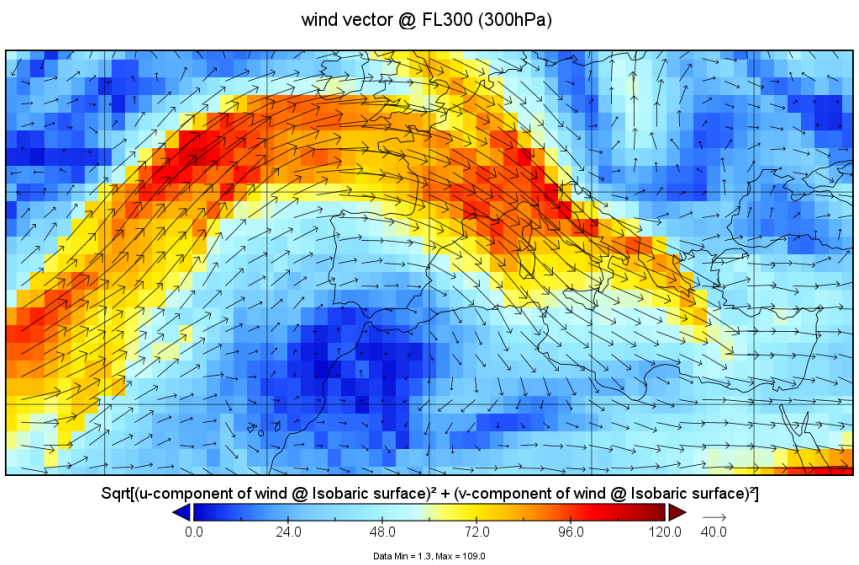
WAFS gridded data upgrade

- Many more vertical levels
- More timesteps
- Wind, temperature, relative humidity, geopotential height at 0.25 degree resolution

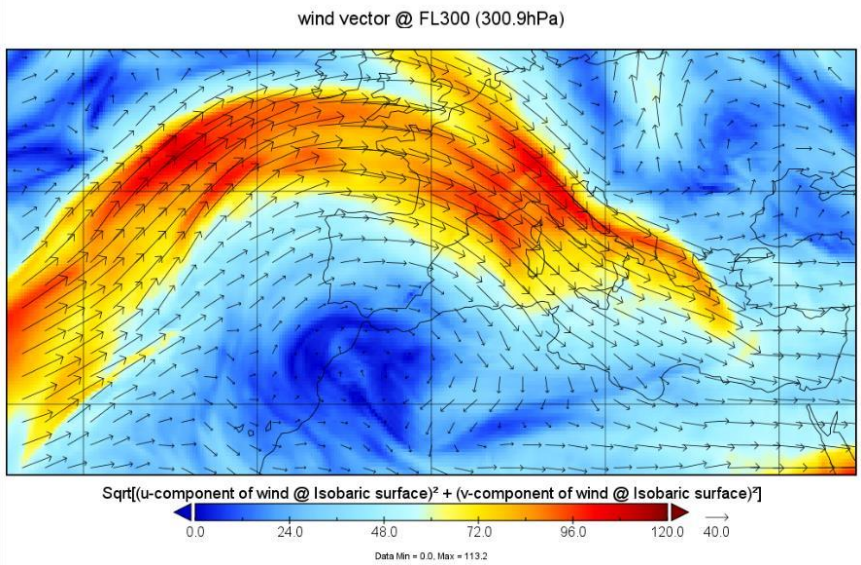
Upgrade is associated with Amendment 81 to ICAO Annex 3, effective November 2024 but we will have this new data available from end of 2023.

WAFS gridded data upgrade

Current 1.25 degree resolution



New 0.25 degree resolution



Vertical Levels

Flight Level	ICAO Standard Atmosphere pressure level (hPa)	Geopotential Altitude	Wind	Temperature	Turbulence Severity	Icing Severity	Humidity
FL050	843.1	X	X	X		X	X
FL060	812.0	X	X	X		X	X
FL070	781.9	X	X	X		X	X
FL080	752.6	X	X	X		X	X
FL090	724.3	X	X	X		X	X
FL100	696.8	X	X	X	X	X	X
FL110	670.2	X	X	X	X	X	X
FL120	644.4	X	X	X	X	X	X
FL130	619.4	X	X	X	X	X	X
FL140	595.2	X	X	X	X	X	X
FL150	571.8	X	X	X	X	X	X
FL160	549.2	X	X	X	X	X	X
FL170	527.2	X	X	X	X	X	X
FL180	506.0	X	X	X	X	X	X
FL190	485.5	X	X	X	X	X	
FL200	465.6	X	X	X	X	X	
FL210	446.5	X	X	X	X	X	
FL220	427.9	X	X	X	X	X	
FL230	410.0	X	X	X	X	X	
FL240	392.7	X	X	X	X	X	
FL250	376.0	X	X	X	X	X	
FL260	359.9	X	X	X	X	X	
FL270	344.3	X	X	X	X	X	
FL280	329.3	X	X	X	X	X	
FL290	314.9	X	X	X	X	X	
FL300	300.9	X	X	X	X	X	
FL310	287.4	X	X	X	X		
FL320	274.5	X	X	X	X		
FL330	262.0	X	X	X	X		
FL340	250.0	X	X	X	X		
FL350	238.4	X	X	X	X		
FL360	227.3	X	X	X	X		
FL370	216.6	X	X	X	X		
FL380	206.5	X	X	X	X		

FL390	39000	X	196.8	X	X	X		
FL400	40000	X	187.5	X	X	X		
FL410	41000	X	178.7	X	X	X		
FL420	42000	X	170.4	X	X	X		
FL430	43000	X	162.4	X	X	X		
FL440	44000	X	154.7	X	X	X		
FL450	45000	X	147.5	X	X	X		
FL460	46000	X	140.6	X	X			
FL470	47000	X	134.0	X	X			
FL480	48000	X	127.7	X	X			
FL490	49000	X	121.7	X	X			
FL500	50000	X	116.0	X	X			
FL510	51000	X	110.5	X	X			
FL520	52000	X	105.3	X	X			
FL530	53000	X	100.4	X	X			
FL540	54000	X	95.7	X	X			
FL550	55000	X	91.2	X	X			
FL560	56000	X	87.0	X	X			
FL570	57000	X	82.8	X	X			
FL580	58000	X	79.0	X	X			
FL590	59000	X	75.2	X	X			
FL600	60000	X	71.7	X	X			

Data shown in blue is what is currently available.

Note: Data will be produced for exact pressure levels e.g., 392.7hPa for FL240 instead of the current 400hPa

WAFS gridded data upgrade

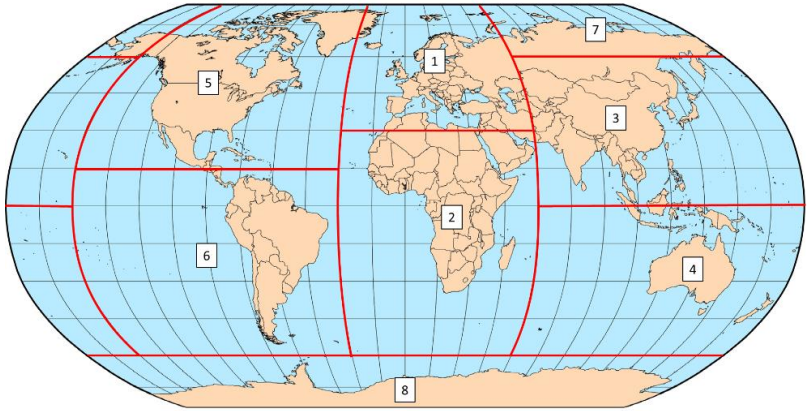
Forecast timesteps

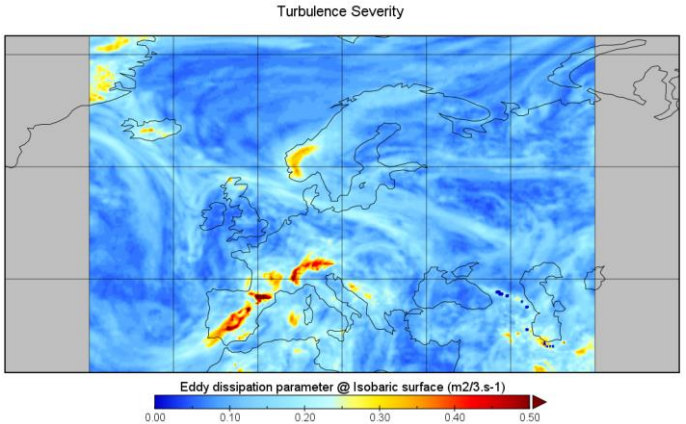
Upper-air grid point forecasts	*1-hourly intervals*	*3-hourly intervals*	*6-hourly intervals*
Wind, temperature , geopotential altitude	6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24 hours*	27, 30, 33, 36, 39, 42, 45 and 48 hours*	54, 60, 66, 72, 78, 84, 90, 96, 102, 108, 114 and 120 hours* Note data from 72hours onward will only be produced for two of the four daily model runs.
Flight level and temperature of tropopause			
Direction, speed and flight level of maximum wind			
Humidity			
Cumulonimbus extent, base and top	6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24 hours*	27, 30, 33, 36, 39, 42, 45 and 48 hours*	Not provided
Icing			
Turbulence			

Timesteps shown in blue is what is currently available.

WAFS gridded data upgrade

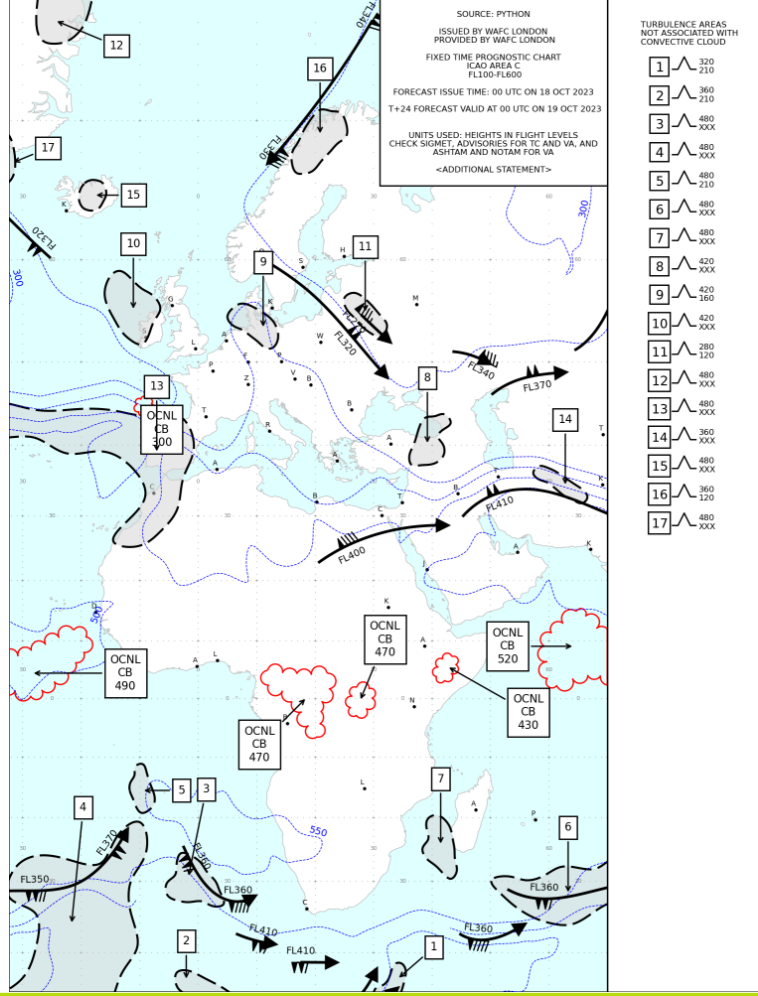
- New platform for the delivery of WAFS gridded data (SADIS API)
- SADIS API will be a SWIM compliant API that conforms to EUROCONTROL standards.
- Users will be able to take global coverage data or for preset areas (tiles)





WAFS SIGWX upgrade

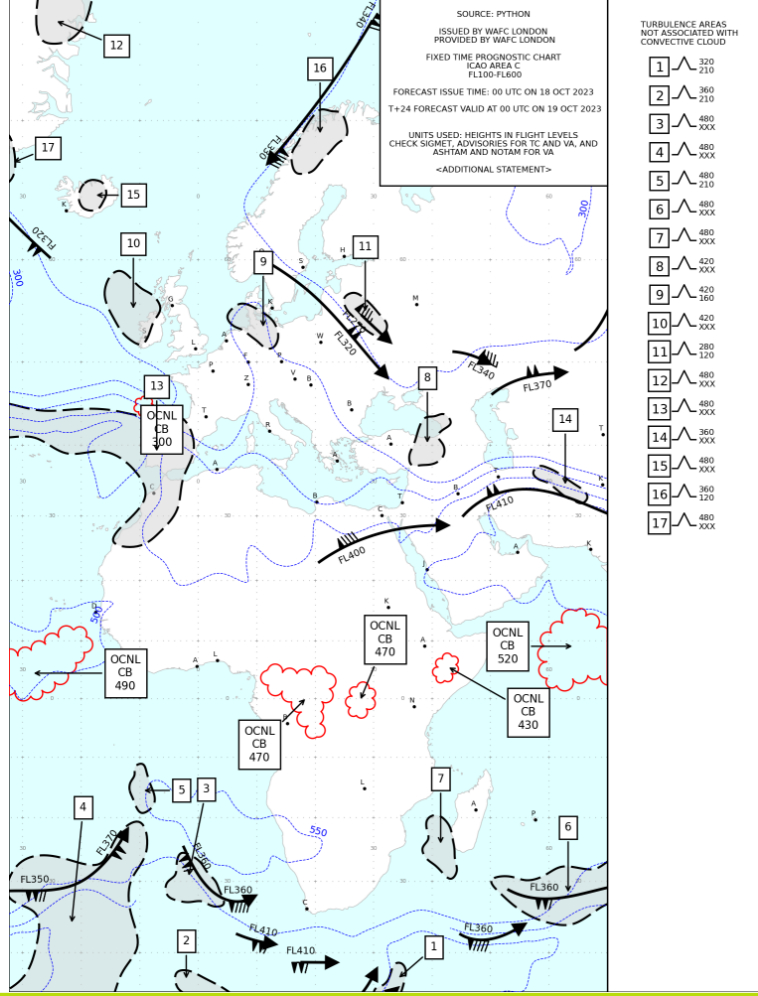
- Introduction of multi-timestep SIGWX forecasts
- Current SIGWX T+24 only. New SIGWX T+6 to T+48 at 3-hour intervals. Updated 4x daily.
- New SIGWX better suited for the needs of aviation, particularly short haul and ultra-long haul. Users will be able to easily see how SIGWX features evolve and move over time.



WAFS SIGWX upgrade

SIGWX content changes:

- Medium Level SIGWX retired. New SIGWX will span FL100 to FL600
- Tropopause height contours instead of spot heights
- Only OCNL/FRQ CB amounts
- Icing areas available for whole globe



WAFS SIGWX upgrade

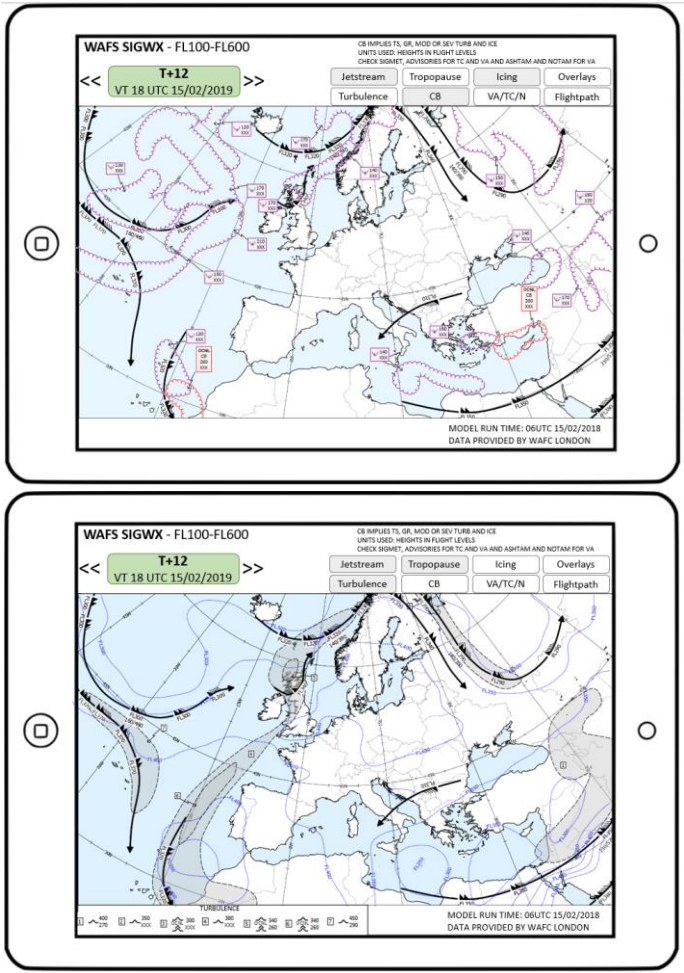
SIGWX content changes:

- New SIGWX format being introduced (IWXXM, a form of XML) which users will be expected to integrate into their systems to be able to visualise it in a way that meets their specific needs

  e.g., custom colour schemes, toggle layers on and off, change time-step, overlay other data)

- We won't provide briefing charts for the new SIGWX forecasts, apart from the legacy T+24 high level SIGWX map areas which will be retired in Nov 2028.

- The new SIGWX will be available on the SADIS API from January 2024 for testing/setup before it become fully operational in July 2024.



More information

November/December 2023

- WAFS gridded data upgrade
- SADIS API's for gridded data becomes operational

February 2024

- SADIS API for global OPMET (METAR, TAF, SIGMET etc) data becomes operational

July 2024

- Multi timestep SIGWX in IWXXM format introduced.
- SADIS API for SIGWX data becomes operational
- Retirement of medium level SIGWX

July 2026

- Retirement of BUFR format SIGWX

November 2027

- Introduction of probabilistic WAFS forecasts (hazards), made available through the SADIS and WIFS API's

November 2028

- Retirement of SADIS FTP including the T+24 "paper copy" charts

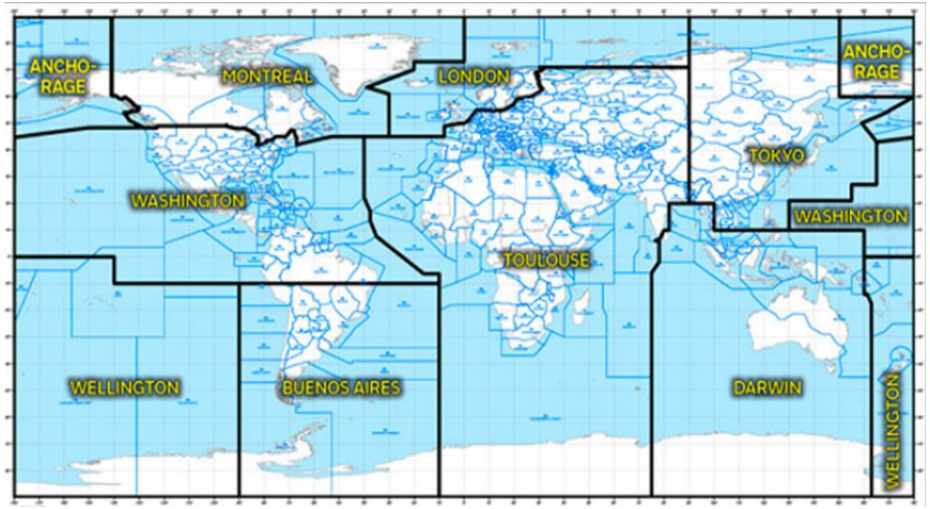
More information: https://www.metoffice.gov.uk/services/transport/aviation/regulated/wafs-2023

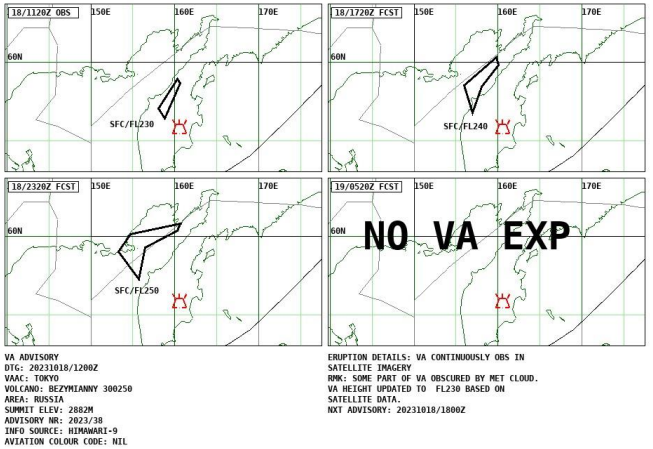
Volcanic Ash Advisory Centre **(VAAC)** Changes

Volcanic Ash Advisory Centres (VAAC)

Met Office is one of nine VAAC's which have been working on the next generation of volcanic ash forecasts.

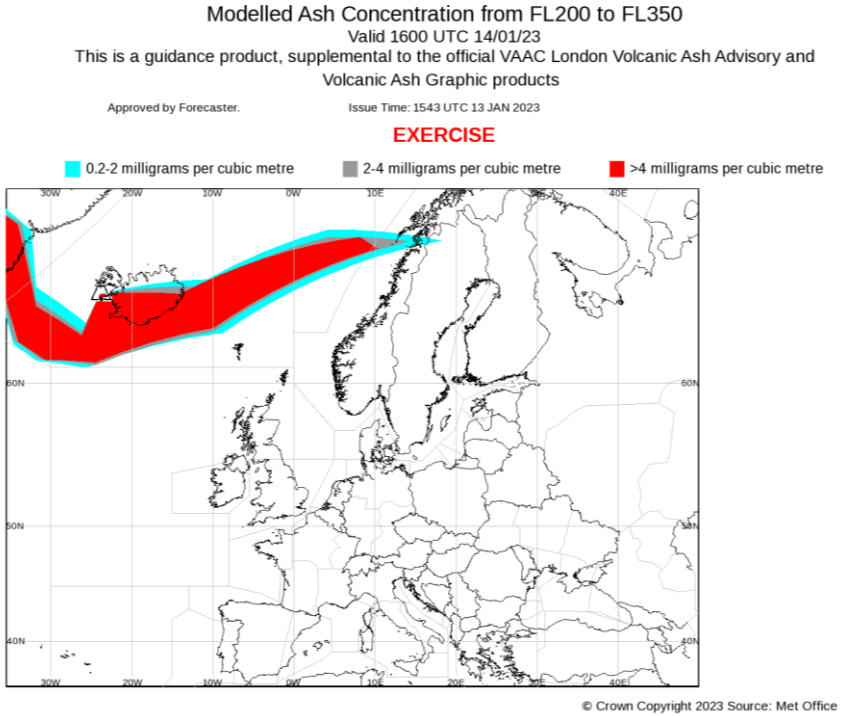
Iceland Met Office informs us if there is an eruption, and we issue Volcanic Ash Advisories and Volcanic Ash Graphics. These have a limited number of points and are only for "discernible ash"





Volcanic Ash Advisory Centres (VAAC)

New volcanic ash provision builds on the concentration charts that the Met Office has been producing since 2010.



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

Quantitative Volcanic Ash (QVA)

- Being introduced as a new provision into ICAO Annex 3 with Amendment 81(its next update)
- Recommendation for VAAC's "in a position to do so" to provide QVA forecasts in November 2024, then all VAACs by November 2025.
- Stakeholders (IATA, IFALPA, ICCAIA) helped to define the Initial Operating capability in conjunction with the VAAC's

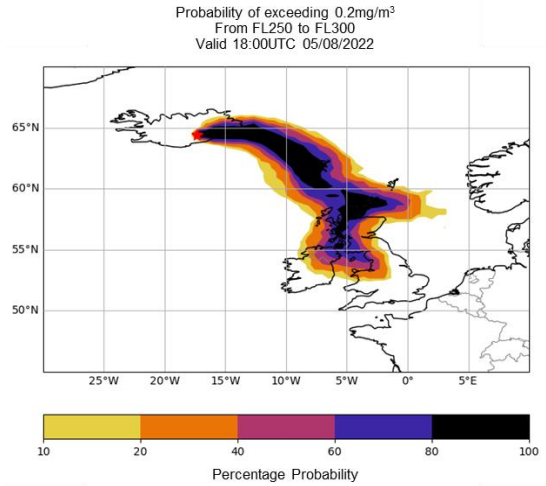
Quantitative Volcanic Ash

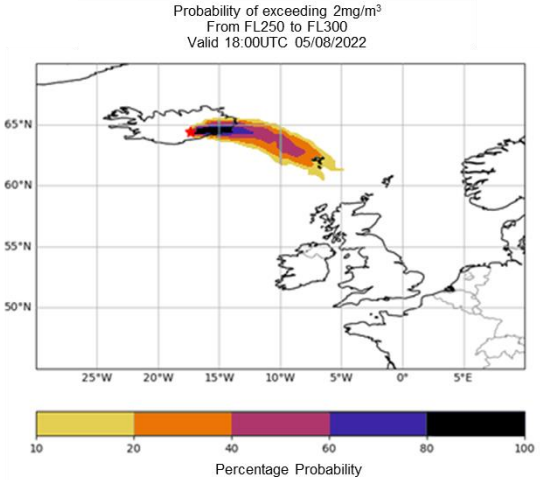
Data sets

1) A deterministic gridded data set
2) The probability of exceeding four different concentration thresholds

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.





Quantitative Volcanic Ash

Data sets

Vertical 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

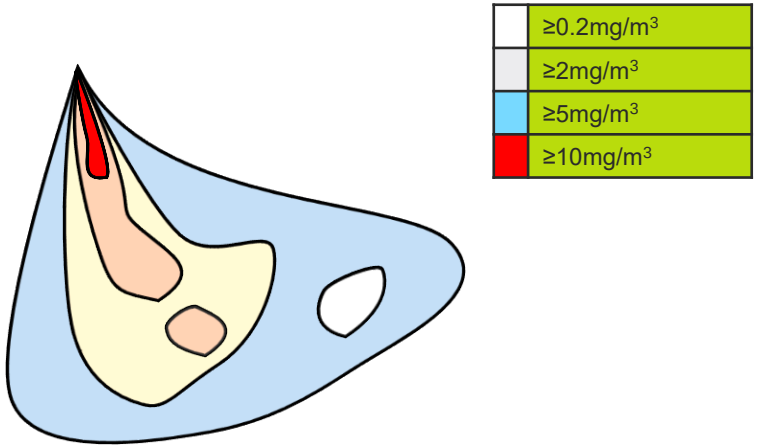
Horizontal resolution and forecast timesteps

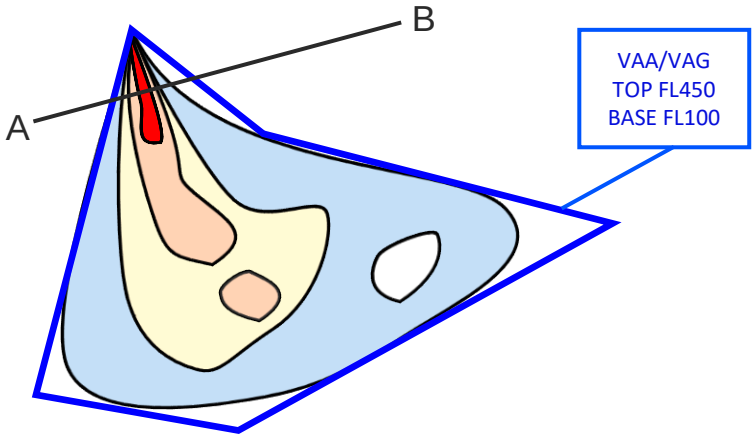
- 0.25-degree horizontal resolution
- QVA information will be provided in the following three hourly valid time increments: 0, 3, 6, 9, 12, 15, 18, 21 and 24 hours.

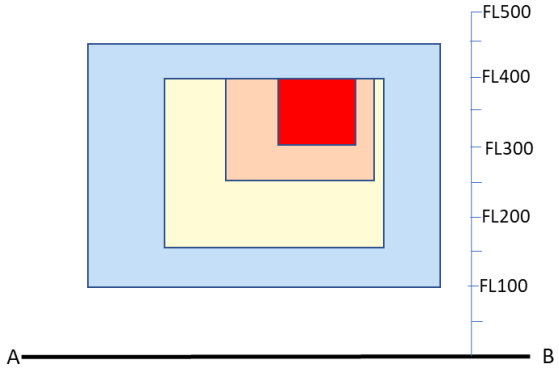
Quantitative Volcanic Ash

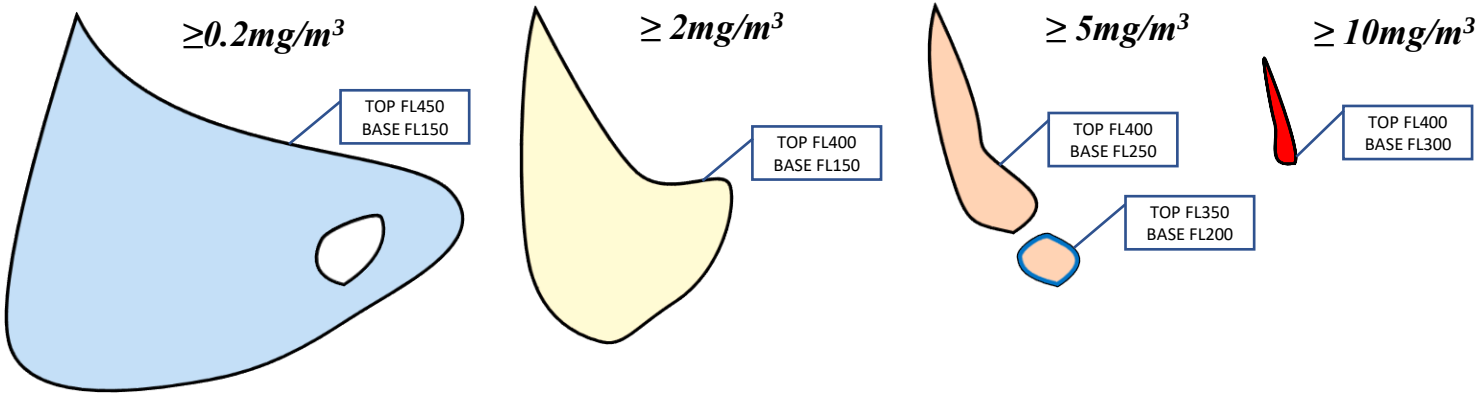
Data sets

3) A SIGWX like data set that can be used for situational awareness (will be created from the deterministic gridded data).









Quantitative Volcanic Ash

- QVA forecasts will be provided for “Significant” volcanic ash clouds
- Exact definition still being defined but is likely to include:
  - an ash cloud with a vertical extent to at least FL 300, and/or
  - an ash cloud within (or expected to move within) approximately 100nm of a commercial aerodrome

Quantitative Volcanic Ash

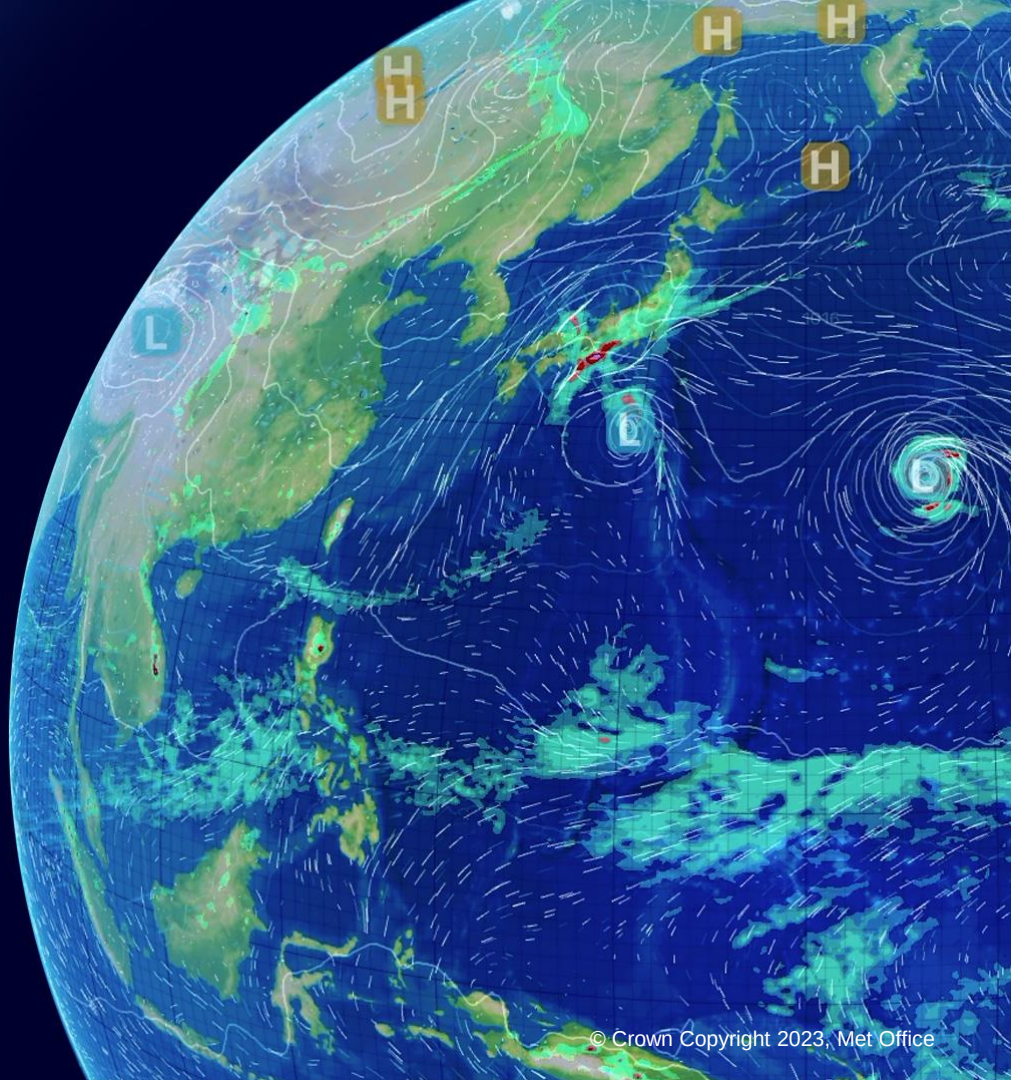
- QVA forecasts be distributed using a SWIM compliant API that conforms to EUROCONTROL standards.
- Alongside this there will be a notification system that users can listen to, which will alert to new QVA data being published.

- New QVA and the QVA API expected to go live in November 2024.

Update on **Finances**

Mark Gibbs

Head of Transport



Aims of the Met Office for Aviation Services

AVIATION FOCUS AREAS

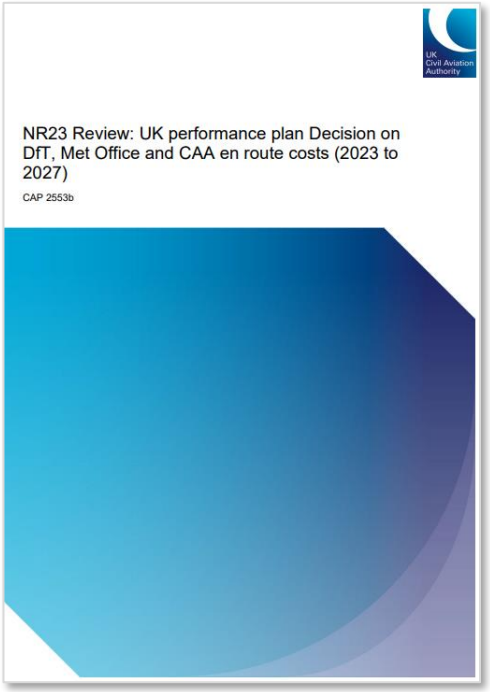
- Safety
- Performance
- Sustainability and efficiency

AREAS OF DEVELOPMENT

- Accuracy
- Access

Corporate target of net-zero by 2030

NR23 Decision (CAP2553b)



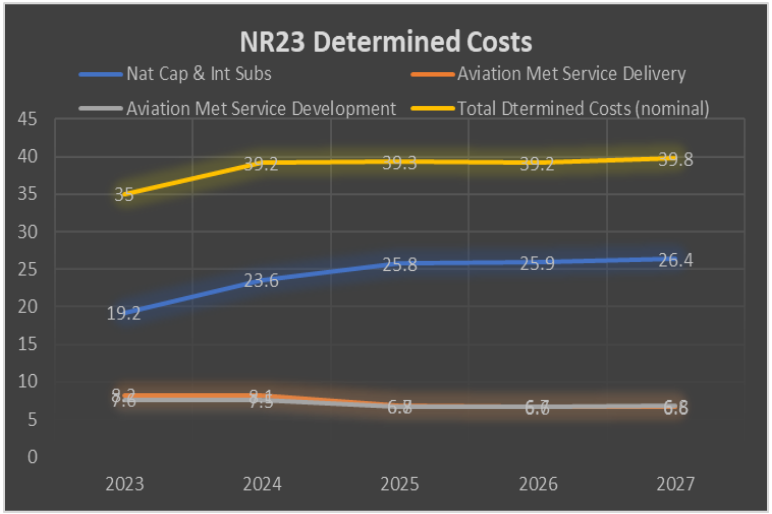
Our Decision

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)

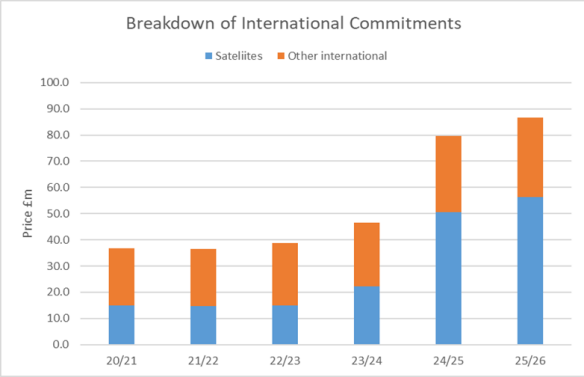
£m	2023	2024	2025	2026	2027	NR23 Total
National Capability and International Subscriptions	19.2	23.6	25.8	25.9	26.4	
Aviation MET Service Delivery	8.2	8.1	6.8	6.7	6.6	
Aviation MET Service Development	7.6	7.5	6.7	6.6	6.8	
Total Determined Costs (nominal)	35.0	39.2	39.3	39.2	39.7	192.4
Total Determined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

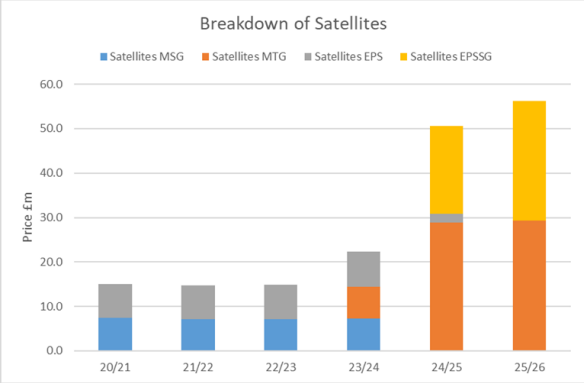
Source: Met Office

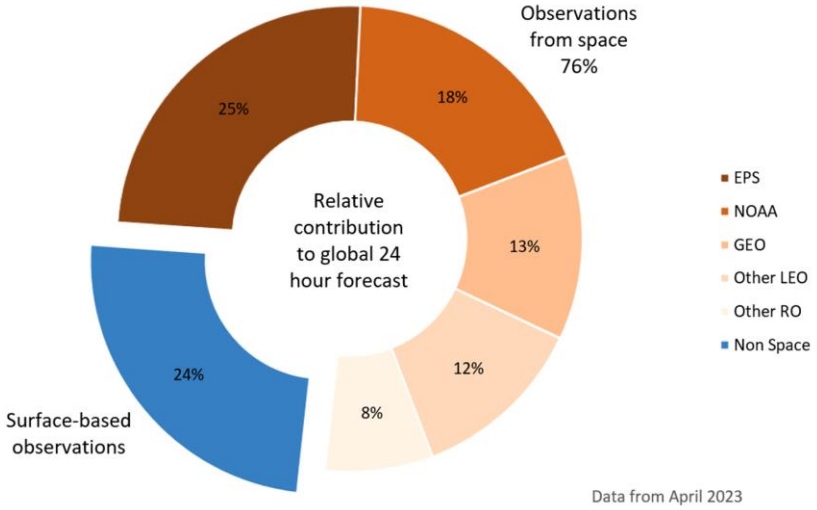


Met Office NR23 costs were originally set in 2022 prices. This means the updated inflation data has had a minor impact on both nominal and 2020 CPI prices.

National Capability & International subscriptions

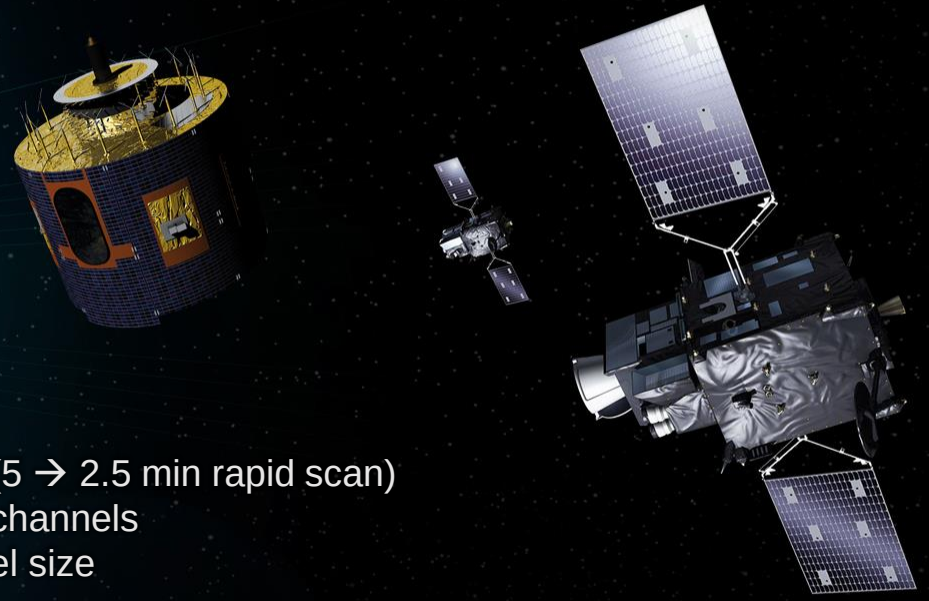






- An annualised charge to PWS recovers the total cost of EUMETSAT programmes over their life.
- The current EUMETSAT charge is artificially low as current programmes have had their lives extended
- 2025 cost is a better reflection of these costs.

Meteosat (geostationary) – From MSG to MTG

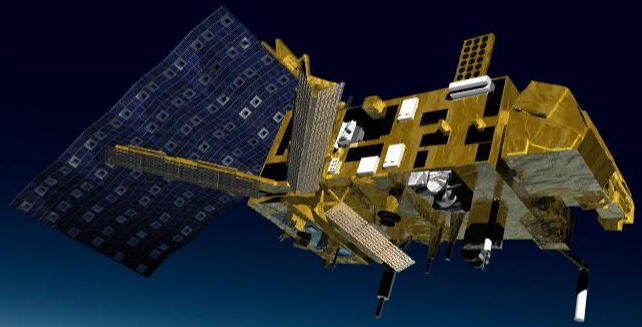


From 2024

15 minutes	→ 10 minutes (5 → 2.5 min rapid scan)
12	→ 16 spectral channels
1-3km	→ 0.5-2km pixel size

NEW	Lightning detection
NEW	Hyperspectral IR
NEW	UV sounding (Sentinel-4)

Metop (polar) – towards second generation



From 2025
More capable Imager, IR sounder, MW sounder, Scatterometer, GNSS radio occultation

NEW Ice cloud imager
NEW Microwave imager
NEW Multi-Viewing Multi-Channel Multi-Polarisation Imager

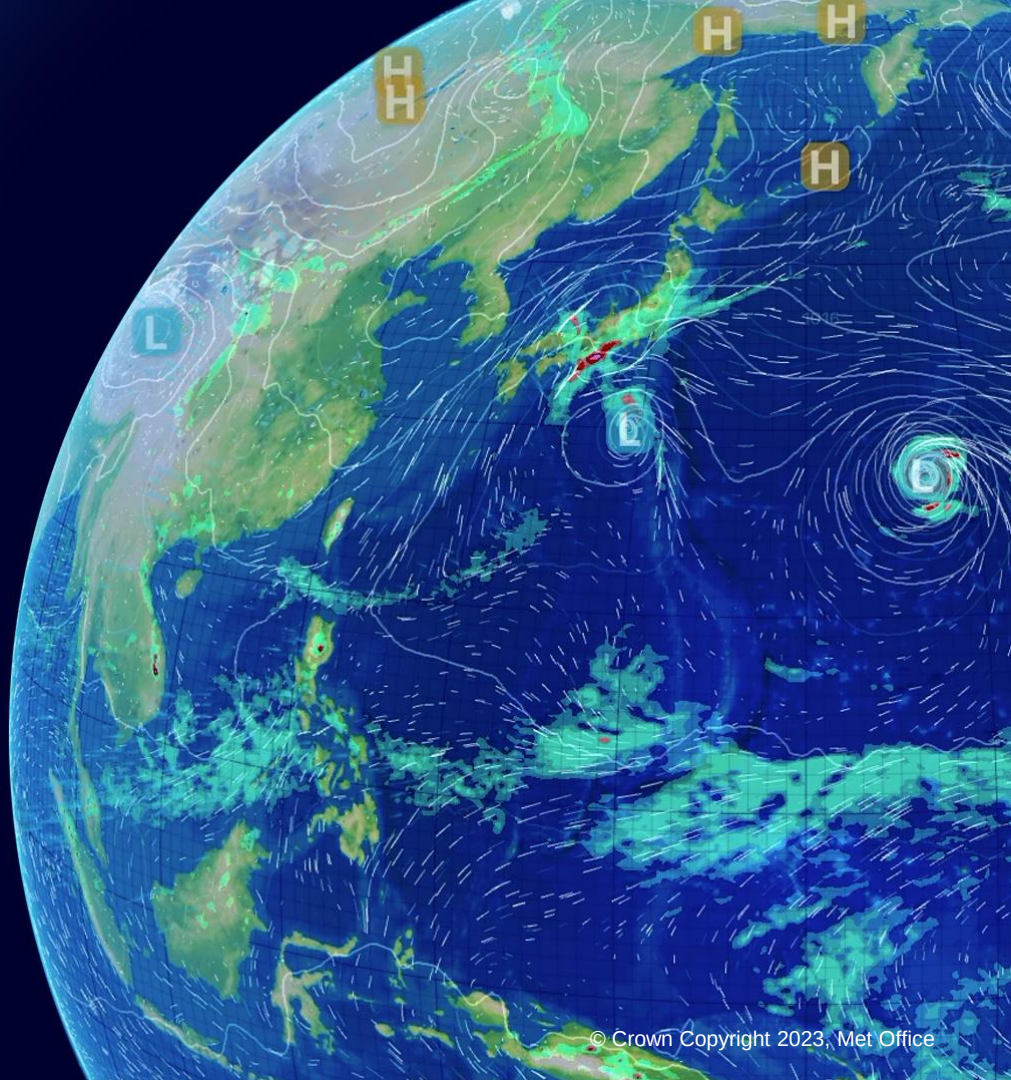
2023 Finances

- Determined cost £32.93m + CPI for CY2023 £35.0m
- Current forecast for 2023 £35.3m
  - Utilising underspend from previous years
  - Key variances
    - +£2.5m ADS development (AVS lifecycling)
    - -£1.1m VA monitoring (delayed to 2024)
    - -£1m National Met Programme

National Aviation Services

Darren Hardy

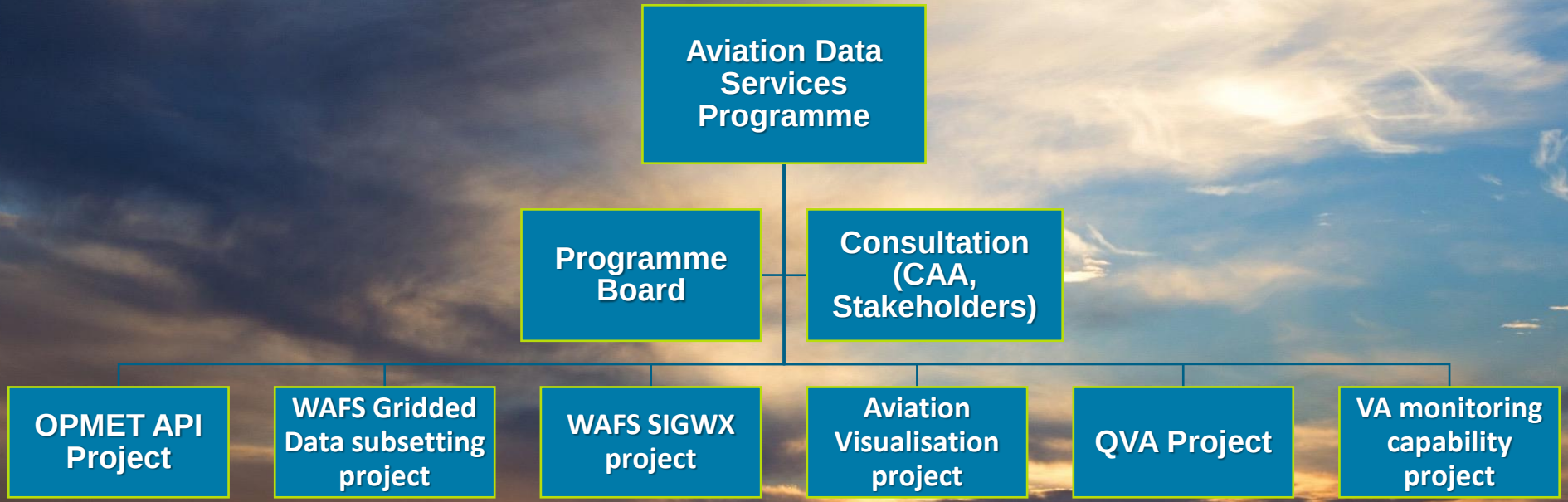
Snr National Aviation MET Advisor



Content

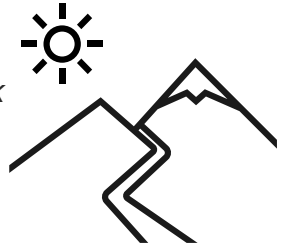
1. AVS Vision and Goals
2. Understanding the ‘As Is’
3. User Research Findings
4. ‘To Be’ Solution Options & Analysis
5. Roadmap timeline
6. Potential lifecycle enhancements
7. Future Data Services

Aviation Visualisation Service



AVS Vision & Goals

Determined following consultation within the NR23 programme of work



Vision and Goals for AVS

Why?

1. An unavoidable programme to re-platform services and **maintain regulatory operation**
2. Re platforming the services presents an opportunity to:

- **modernise** existing services
- **simplify** the services to reduce cost and so we can adapt to future user need
- Be more **user focussed**
- **Showcase** value of MO products

3. The services were designed and built in isolation of each other at different times so the experiences are inconsistent

Vision and Goals for AVS

The Vision
(what we want to achieve)

- To maintain the Met Office's commitment to **safety and regulatory compliance** with the associated **reputational** benefits.
- To build and run the service in the most **sustainable** and **cost-efficient** way ensuring **value to users**.
- Ensure **users** have a **consistent** experience, and they are engaged and **satisfied** with the services they use, **now** and in **the future**.

Goals
(how we will measure success)

1. We will keep and maintain the **strengths of current** services.

3. We will use a robust **technology** strategy & grounding.

2. We will ensure **user satisfaction.**

4. We will be able to **adapt** with the most appropriate implementation of future enhancements.

5. We will use **best practice** and **align across MO.**

6. We will improve visibility and quality of metrics & information (cost/risk/performance)

7. Aspiration to exit legacy technical dependencies by **March 2025.**

Further enhancements beyond that.

Understanding the ‘As Is’

Existing Estate Summary

Services

ABS

- A service used by the UK Aviation community to plan their flights up to 2 days in advance. 30,000 users.
- In general, users would like more data and an easier way to access the service.

NWR

- A service very similar to ABS used for situational awareness by airlines and airport operations.
- A more granular control version of the threshold settings would be valuable for a range of users.

OpenRunway

- Current commercial offering from Met Office mainly used by airports and airlines.
- Most organisations only use OR during the winter months.

HeliBrief

- Used by Emergency Service Helicopter Operators for constant awareness of weather and Offshore Helicopter Operators to plan flights.
- The service includes additional, specific information. Users need similar info to users of other services, but their requirements are especially time critical.

Design Approach

Workstreams	Output
Service Design • Assess holistic 'as-is' landscape by speaking to SMEs/stakeholders and conducting desk research • Support user research planning, facilitation and synthesis	Consolidated information to create an artefact which communicated the options and provide evidence for recommendation
User Research • Plan and conduct user research with participants from different user groups who use the various existing services • Synthesise raw findings	Created an artefact that communicated key insights, pains and opportunities for user groups and services

User Research findings

“It would be good if there is a hub, one place for a single service”

- Network Weather Resilience user

Overview of User Research

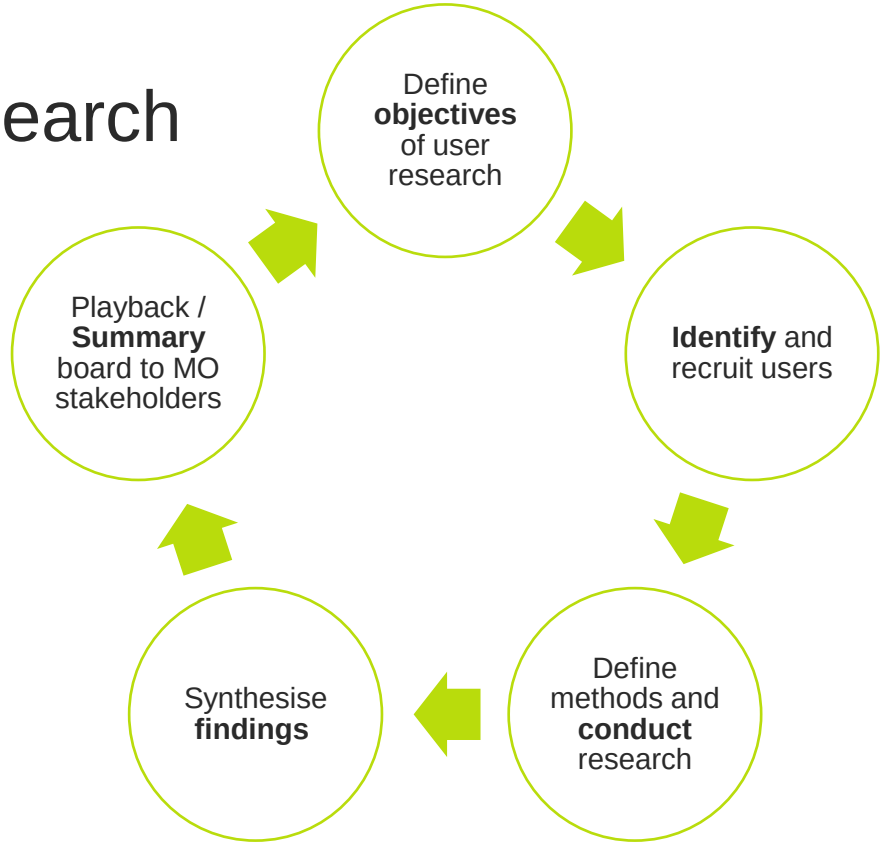
Aim of User Research

To better understand MO service user's role, needs and frustrations to understand how things work now and where things can be improved.

- Identify primary and secondary users of the services
- Understand how users are currently using weather information to make flight and operational decisions
- Identify what users are trying to achieve
- Learn about the different weather tools users use to make flight decisions
- Understand where/if services overlap or depend on each other (from a user perspective)
- Understand appetite for change
- Uncover pain points and opportunities

Our Approach to User Research

- 12 1-to-1 User Interviews
- Collected over 1316 responses to ABS survey
- Some In person visits



Key Customer Insights

These are just some of the high-level insights from the user research

As a user I need…	My pain points are…	Opportunities to address these are…
• to reduce unnecessary **operating costs**	• Information essential for work and safety is behind a **paywall** and some paid Met Office data is available for free on other apps • Some airports only use OR during key winter months	• If there is other data available on services, would be good to have the option to obtain relevant parts of what they have • Make premium service free
• a **visual display** of information • to understand important information **at a glance**	• Users rely heavily on weather visualisations across MO services for at a glance information, but **cluttered maps** and raw coded data adds mental processing • There's a **lack of customisation**, thresholding and colour coding in particular, which make it harder to gain a quick understanding and limit guidance for less experienced pilots	• Have a **customisable** list of airports for TAF, METAR and warnings and remove default of balloon sites showing • Be able to **set personal RAG thresholds**. Ideally for each site • **Personalised** homepage with info for quick overlay
• access to any information that can help make **safer flying decisions** • **information critical to operations** to be available (e.g TAFS, METARS, overlays)	• Some users were aware of more than one service and were surprised that different data was available in different services • People go to **other websites** to get information they feel they are missing • Short term forecasting: **missing detail**, no way to pick out any detail on it	• Emergency service pilots feel it would be good for people to have access to **more site-specific data** to support safer flying decisions • It would be good if there is a hub - one place for all information, **a single service** • Users suggested **consolidating** services (e.g Merge Helibrief and GA products into something coherent - GA map provides greater time resolution, but Helibrief shows METAR AND TAF data when an airfield is highlighted

Current View of Met Office Services

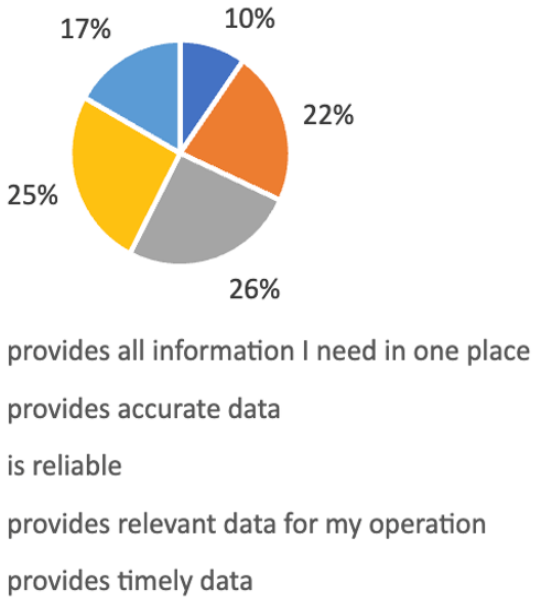
- There is a high level of trust for the Met Office brand and data.
- Weather visualisations are key for planning and decision making for all users.
- Some users are keen to adopt the Met Office's aviation weather visualisation services more widely in their organisation if they fulfil their needs better.

The ABS survey found only **10%** of users agree that ***'the service provides all the information they need in one place***'. Some users are looking at alternative weather visualisation services to get any additional information.

At least **15%** of people are **using another service to help fill information gaps, some of which are weather related**.

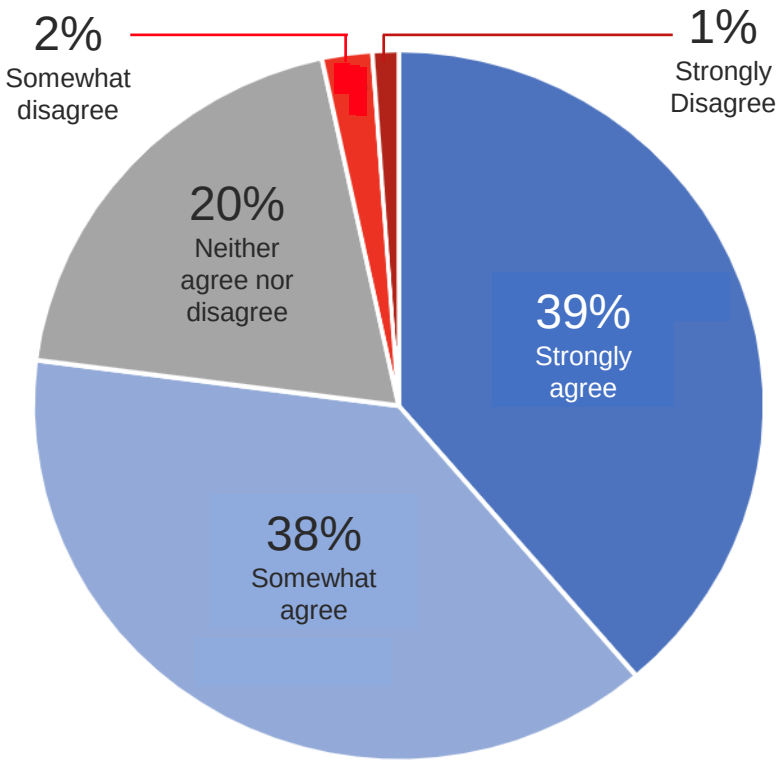
This strongly supports the idea of providing more weather data to more users in one place.

User's views on current Met Office services



Appetite for Change

- User Research suggests that users have a keen appetite to change
- **77%** of users from the ABS survey agreed that they were open to the idea of change
- **20%** of users remained **neutral**
- And **3%** were **not** open to change. However, feedback indicates that resistance to change may be due to previous digital service changes making the service harder to use and/or removing valuable information.



"I'm open to change" - **Helibrief** user

"Anything that improves communication is helpful" – **OpenRunway** user

"A change to the name wouldn't bother me" - **Helibrief** user

"If you make changes, do not lose anything that is available today, nor make it harder to access" - **ABS** survey

"Please don't mess with it. We must not lose any of its present functions." - **ABS** survey

"REINSTATE the 3-day forecast!" - **ABS** survey

‘To Be’ Solution & Analysis

‘To Be’ Solution Options

Option 1 (recommendation)

- One Aviation Service for all needs which is configurable to meet the needs of different user groups.
- **One** webpage to communicate purpose and features of service, **one** point of access, **one** consolidated (but customisable) landing page

Option 2

- Two Aviation Services: One exclusively for HeliBrief customers with specific data, and one for all other needs.
- **Two** webpages to communicate purpose and features of services, **two** points of access, **two** landing pages

Baseline option

- Rebuild **existing** 4 UIs on top of new architecture

Criteria for assessing options

- User Needs from User Research Sessions & Survey
- Met Office Needs and viability – for regulatory compliance and business benefits
- Technology feasibility and best practice, design principles and supportability
- Total Cost of Ownership
- Branding implications and impact on customers of change

Recommended 'To Be' Service – **Option 1**

Concept:

- **One** Aviation Service for all needs which is configurable to meet the needs of different user groups
- **One** webpage to communicate purpose and features of service, **one** point of access, **one** consolidated (but customisable) landing page

Key Points:

- We believe this option can meet a wide range of user needs (and empower them) through customisation and user type controlled access to specialised data sets
- This is the most cost-effective option as savings can made by building, maintaining and supporting one service
- It would be easier to adapt to future user needs as features could be rolled out to all users or an organisation
- Most efficient delivery sequence to re-platform and migrate users, and deliver tangible outcomes quickest

Access Model:

Premium Account
Manual Validation

Organisational Account
Manual Validation

Specific Access Account (Existing Helibrief users)
Manual Validation

Individual Account
Automated Validation

Recommended 'To Be' Service – **Option 1**

One Aviation Service for all needs which is configurable to meet the needs of different user groups.

AVS Project Vision

- **Aviation Visualisation Services** maintain the Met Office's commitment to **safety and regulatory compliance** with the associated **reputational** benefits. The services are built and run in the most **sustainable** and **cost-efficient** way ensuring **value to users**. **Users** have a **consistent** experience, and they are engaged and **satisfied** with the services they use, **now** and in **the future**.

We will keep and maintain the **strengths of current** services	We will ensure **user satisfaction**	We will use a robust **technology** strategy & grounding	We will be able to **adapt** with the most appropriate implementation of future enhancements	We will use **best practice** and **align across MO**	We will improve visibility and quality of metrics & information (cost/ risk/ performance)	Aspiration to exit technical dependencies by **March 2025.** Further enhancements beyond that.
Consolidating the services will incorporate the strengths of each service so that all users benefit.	Consistently refer back to user research insights (strongly indicate users satisfied with unified system)	Most cost effective for build (by 20%)	Having one service to update makes it easier and more cost effective to adapt and apply new beneficial features to the relevant users.	Single design system, user experience and shared, standardised components	Single source of user management for usage insights across all user groups	Most efficient delivery sequence to re-platform and migrate users, and deliver tangible outcomes quickest
RAG thresholds and opening on map from NWR	Continuously engage with users	Easiest and cost effective to maintain	A single source of truth of aviation data that is common for all users and maintainable	Recognisable standards will be used within the service	Easiest to track usage and get feedback on user needs to adapt service in future	
METAR/TAF lists from Helibrief (improved)	Users are fearful of change making the experience worse	Most sustainable			Complexity of attributing HB vs ANSP Funding allocation to one aviation service development	
	The satisfaction of HeliBrief users needs to be considered as they have had most input into their service					

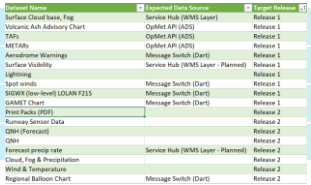
Roadmap Timeline

Roadmap

Shared with select users for feedback.
Additional data i.e., TAFs, METARs, Warnings, F215 & VAAC charts, some wx map data

Decommission existing services

Trying out different design solutions to issues learnt about during discovery.



HeliBrief
OpenRunway
Aviation Briefing Services
Network Weather Resilience

Parallel run, live user feedback and user migration

1 Dataset

Surface visibility map layer

CAA Demo - February

~ 10 Datasets

AVS Alpha

AVS Private Beta

AVS Public Beta Releases

AVS Public Beta Releases

AVS Live with Base Offering (achieves regulatory obligations)

AVS enhancements and premium features

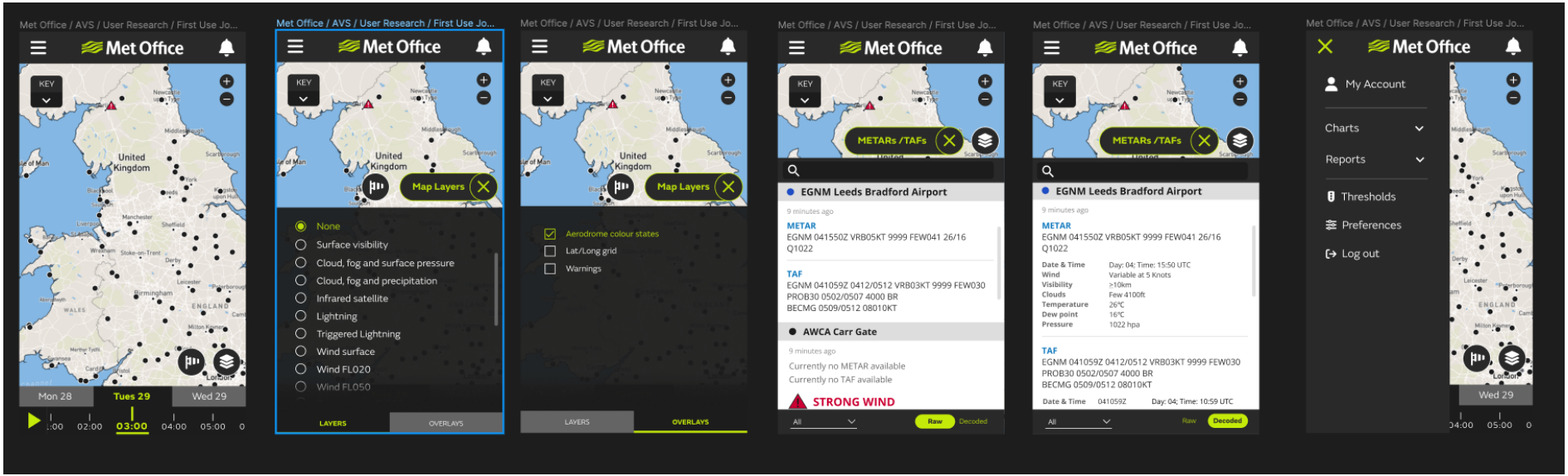
Q4 2023 | Q1 2024 | Q2 2024 | Q3 2024 | Q4 2024 | Q1 2025 | 2025

Product Team / Specialist Team for beta

Hurricane
Lancaster
Blackfire

Product Design

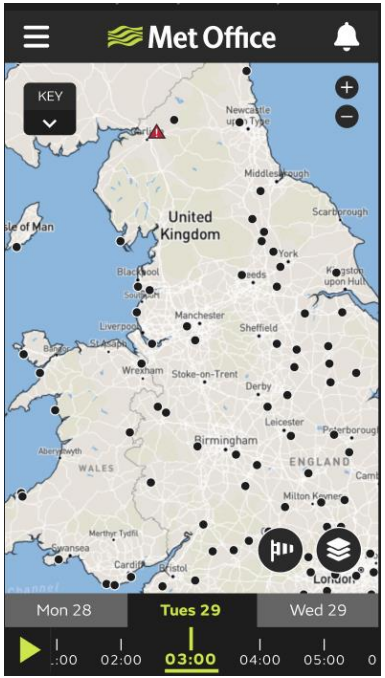
- **Web service, not an app but ‘Mobile first’**
- Have sought very initial user feedback on basic design
- Many more iterations and feedback engagements to follow



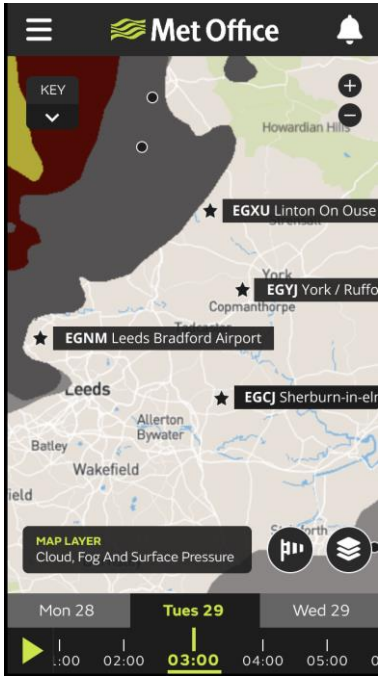
Product Design

Top level early insights:

- Overall appetite towards the new service was positive. All participants highlighted that the ability to customise the landing page adds value
- Several users expressed that they prefer the display of METARS and TAFS in other applications
- Too many touchpoints
- Emphasis on ensuring all data is relative to their operations
- Positive response to entering the service & landing on a base map
- **Let me know if you wish to be involved in testing!**



First use of service



Preferences set

Potential lifecycle enhancements

We've heard what users are asking for and it's on our radar for future enhancements…

Site specific observation data	Site specific model forecast data	Ingestion of 3rd party observation data	Customisable TAF/METAR colour coding	Customisable TAF/METAR lists (with colour coding)
Defence cross section forecasts	Integration of Monim data within HeliBrief (a 'one stop' shop)	Improved functionality of Weather map service	Webcam access	Probabilistic weather map layer(s)/data
Icing weather map layer	Metadata (Tide time data & aerodrome elevations)	Decoded TAFs/METARs	Ultra hi-res data (i.e. using 300 m model output once operational)	Temperature trends
Merged overlays feature	A 'timestamp' showing exactly when weather map layer data has been updated	Creation of a range of UK aviation data for 3rd party systems (APIs)	Access point for commercial aviation services	OR service enhancements

Future Data Services

Future data services

- A focus on API enabled data in response to feedback…
- **NR23** delivers evolving Aviation requirements

Features:
- Data held in the **cloud** (as an enabler)
- **Hi-res API** enabled data for 3rd party app providers (in-flight data, EFBs, flight following software)
- **Extensive data** (i.e., Aviation Briefing Service products and map layer data)
- Apply **Industry standards**
  - ✓An EU standard requirement for ATM data (inc MET)
  - ✓consistent data management
  - ✓Interoperable

This will:
- Improve the ability for users to discover and access Met Office data
- Allow users to take only the data they need (known as data **sub-setting**)
- We want to **engage** with Aviation community.

Future data services

Capabilities:

- **Web Coverage Services** will expose gridded data sets and enable flight planners/app providers to sub-set the data to select the levels, timesteps and area relevant to a specific application
- **Web Feature Services** enable the retrieval of four-dimensional trajectory information and corridor information applicable to specific flight routes
- **Web Map Services** will allow users to download georeferenced tile images that can be displayed on downstream systems.
- Provision of **weather objects/features** (e.g., areas enclosing hazardous weather)
- Provision of **spot data**
- Provision of aviation specific **charts and written forecasts**

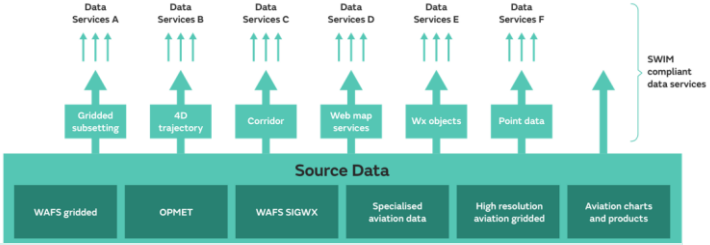


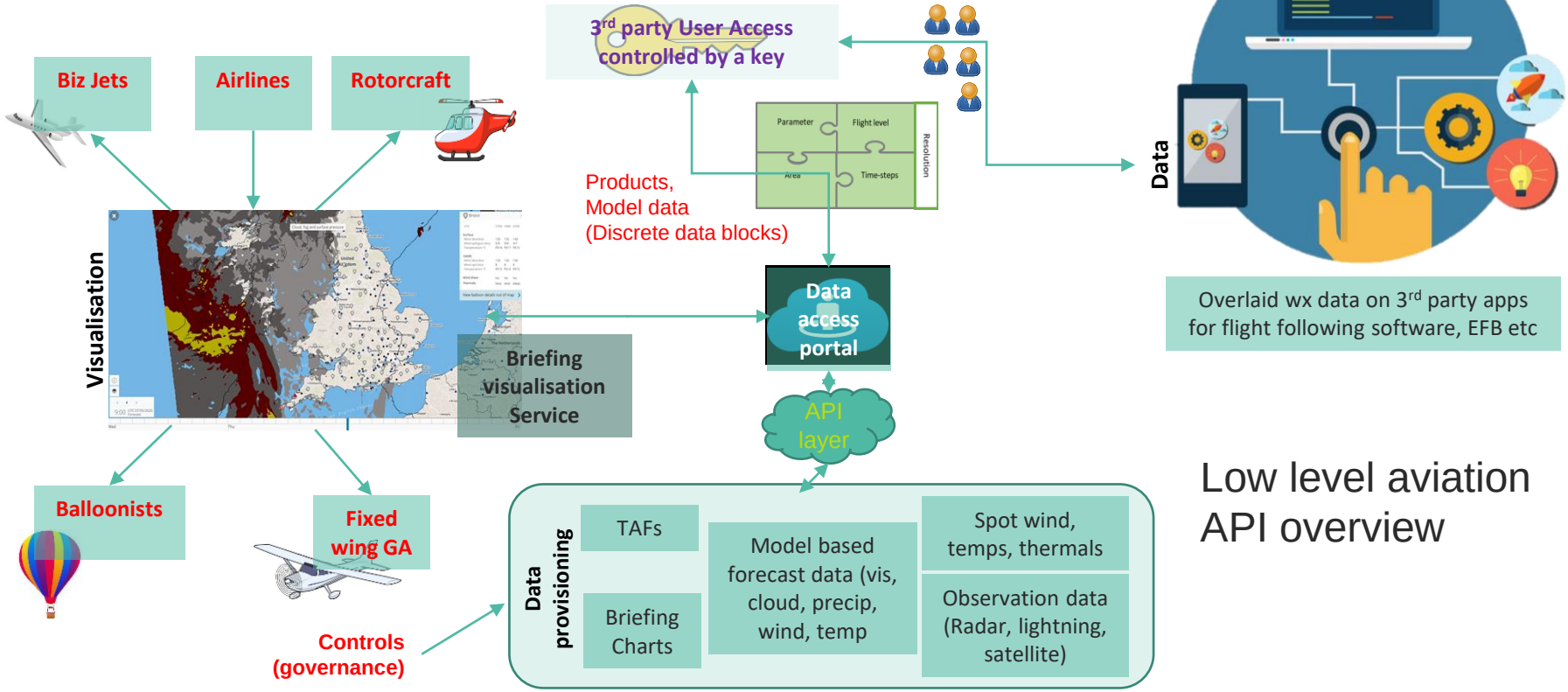
Illustration showing the variety of different source data and available formats for new aviation data services

Accessing these:

These capabilities will be accessed via a series of APIs, all recorded within the Eurocontrol SWIM Registry. Two main types of API will be provided:

- **Streaming API:** enables a user to subscribe to a particular data feed, and whenever new data becomes available, they will be notified and either provided with this data as a payload or directed to where to pick it up.
- **Request-Reply API:** enables ad-hoc requests for data to be made, and suits activities such as trajectory and corridor requests in which the route being flown changes each time

Future data services

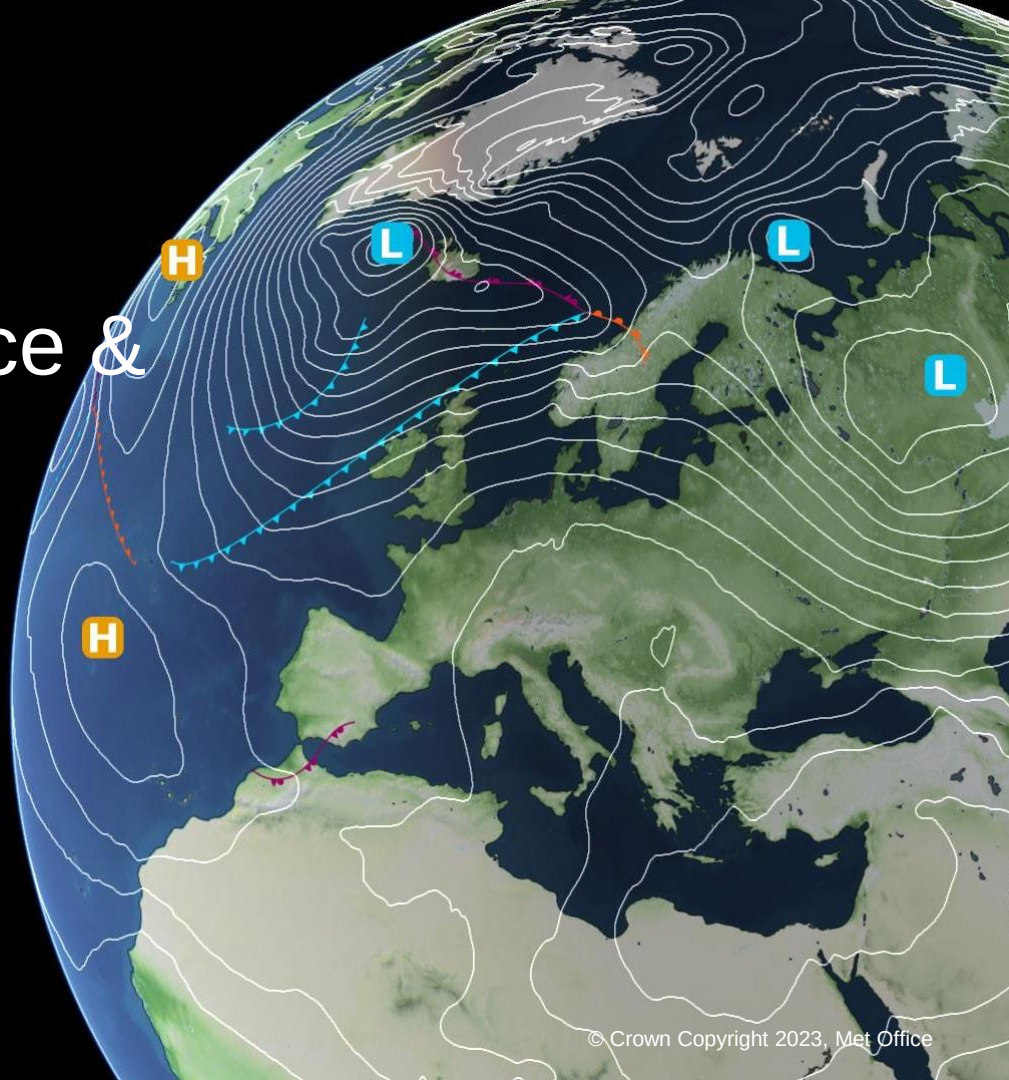


Low level aviation API overview

SESAR Services: Harmonised Turbulence & 3D Radar

Emma Corrigan

European Aviation Manager



Microsoft Teams

Recording for MOUF

2023-11-06 14:06 UTC

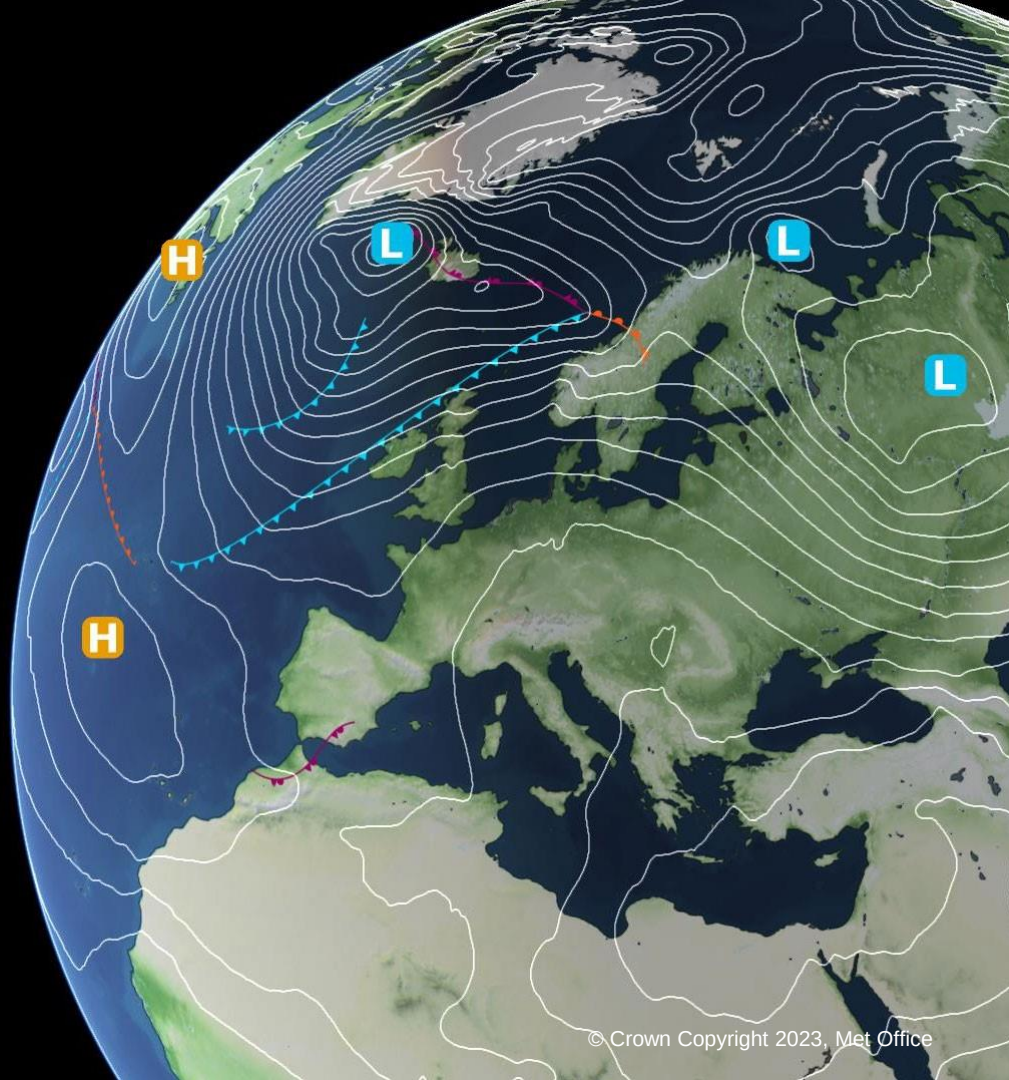
Recorded by
Emma Corrigan

Organized by
Emma Corrigan

SWIM services

Lauren Donohue

Aviation Business Manager



Why do these Services matter?

- Pilot Common Project evolved into the Common Project 1 (EU 2017/373)

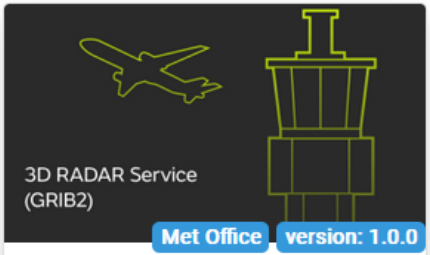
- While the Exit from the EU means that UK organisations are not bound by CP1, the UK does still have PCP in CAP779 and CAP1711.

- MET information (regardless how it is delivered) can be used to support operations. What decisions do you make that could have additional support?

Met Office

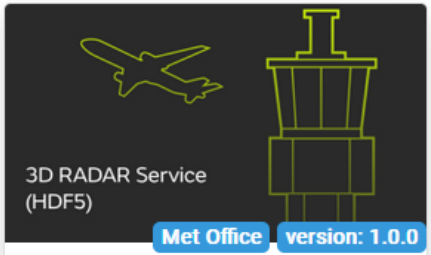
Registry SWIM

Service Descriptions



3D RADAR Service ...

The Pan-European 3D RADAR Service aims to provide a SWIM Compliant access point to high resolution R...



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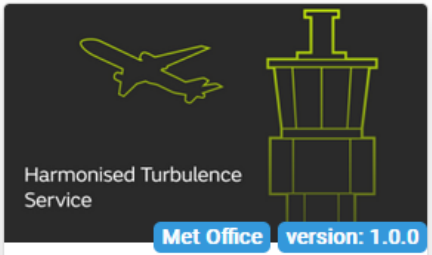
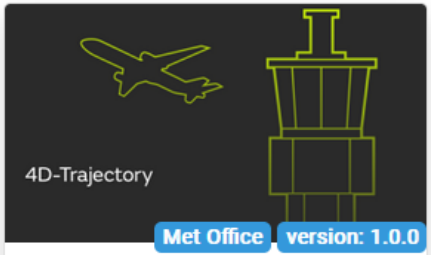


Harmonised Turbul...

The Harmonised Turbulence Service aims to provide a SWIM Compliant access point to harmonised turbul...

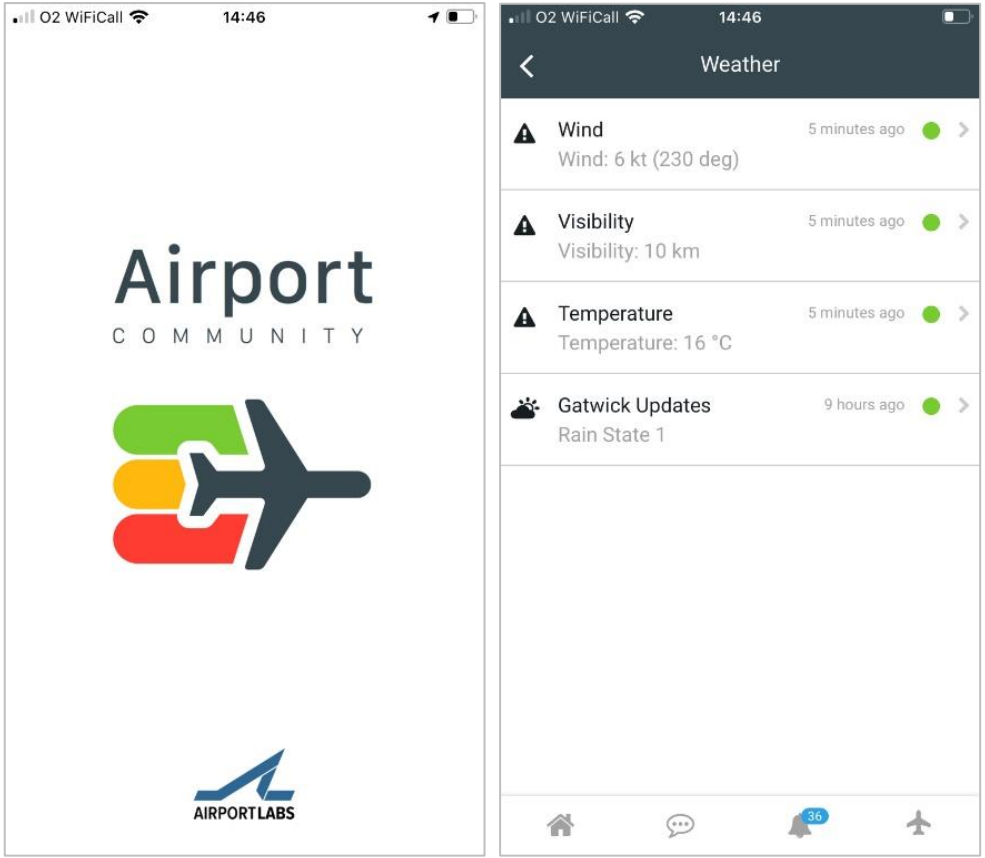


Met Office 4D-Tra...

The Met Office 4D Trajectory API service supplies global meteorological data for tailored flight tra...

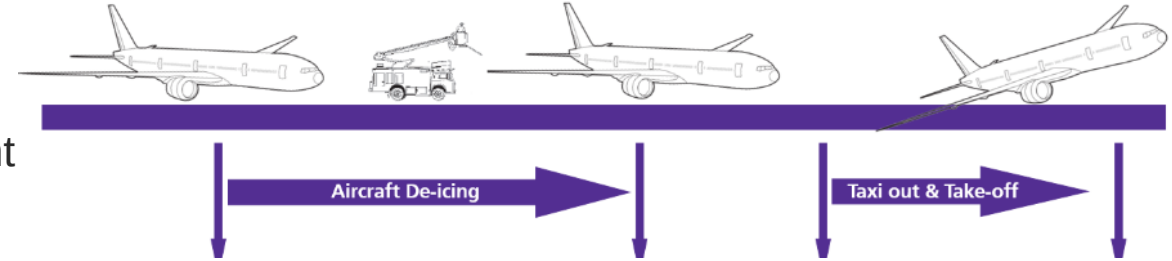
What additional MET information do you need to support?

- Airport Operations Plan
- Flight Planning
- Network Operations
- Air Navigation Services
- Air Traffic Flow Management



What additional MET information do you need to support?

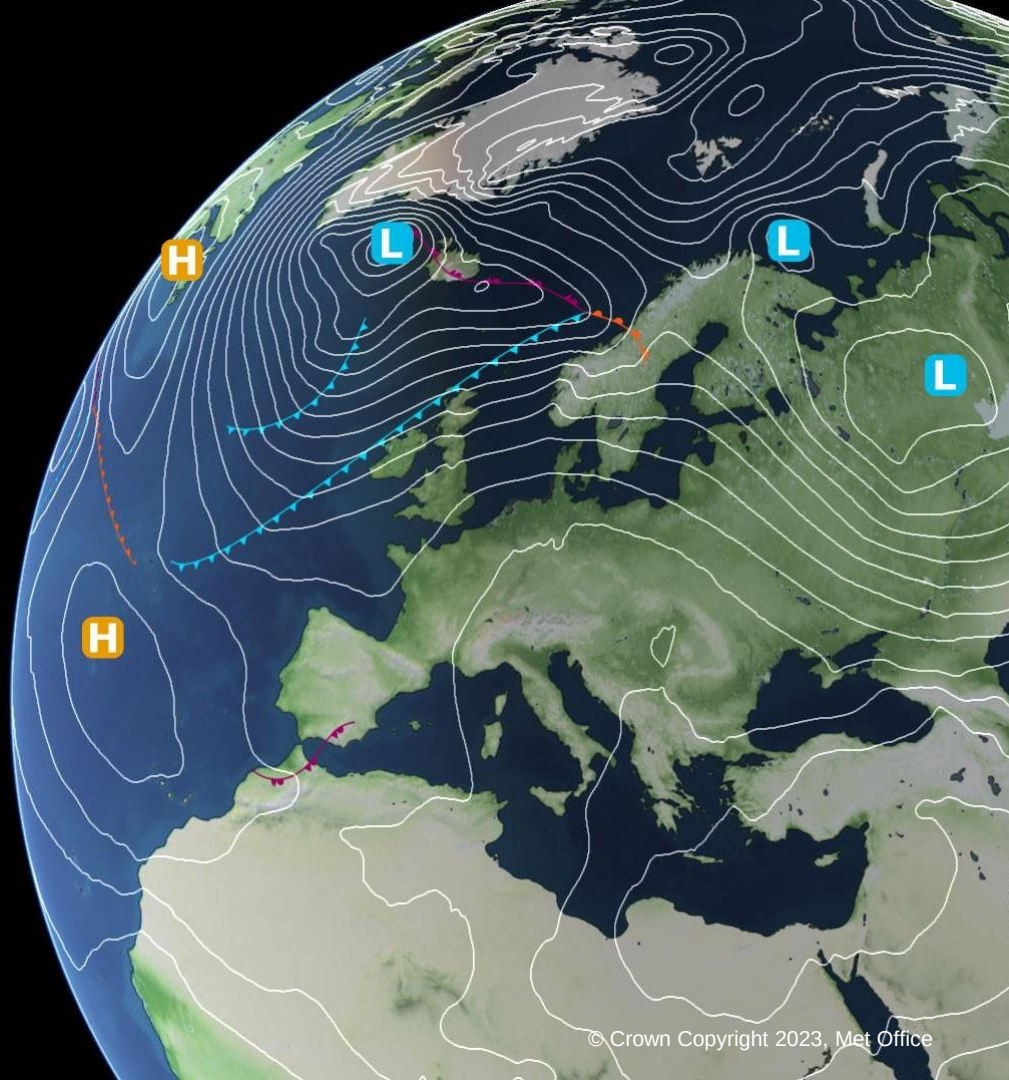
- Baggage
- Runway checks
- Travel to and from an aerodrome
- Choosing efficient flight paths/airspace
- Planning for peak periods in passengers or aircraft
- Risk for operations in inclement weather



Aviation R&D

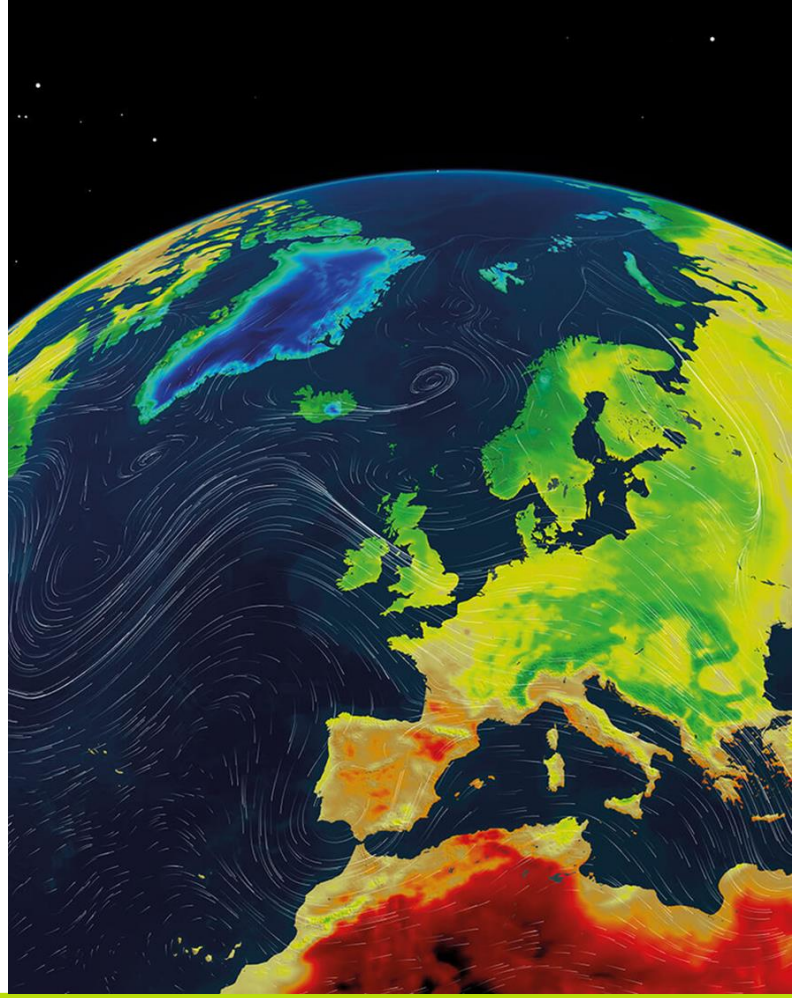
Piers Buchanan

Aviation Science Manager



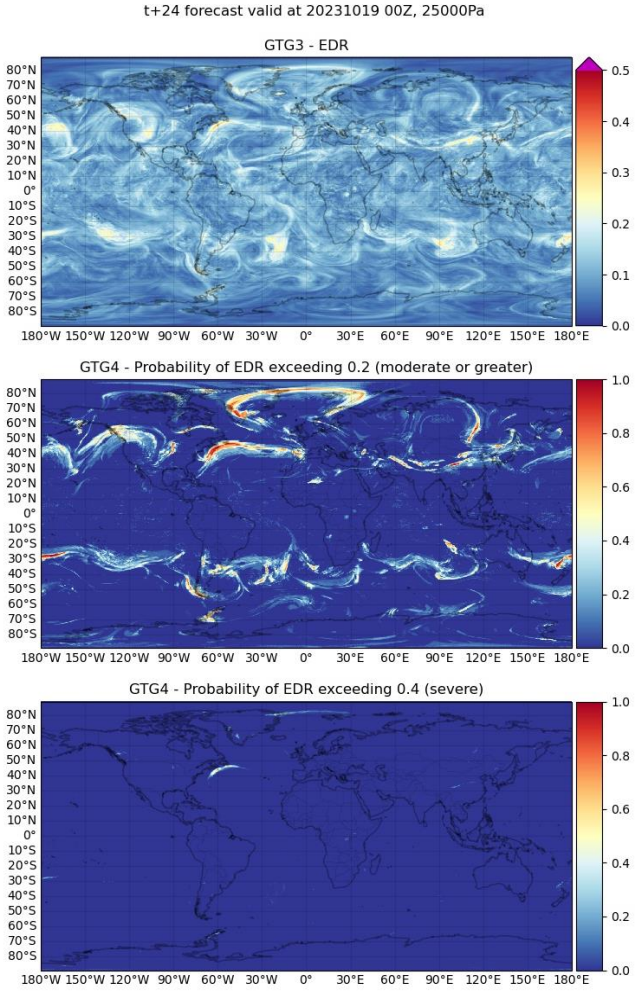
Purpose of global aviation R&D programme

- 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



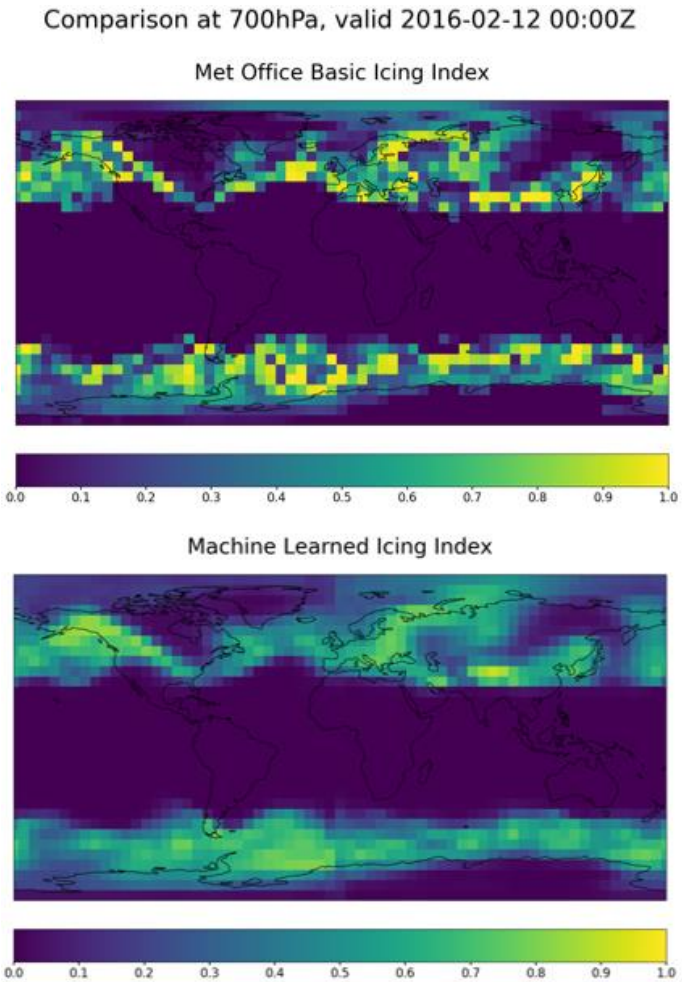
Probabilistic Turbulence Update

- In order to compute probabilities, we need to upgrade to latest version of GTG on new supercomputer.
- Probabilities of moderate or greater or severe turbulence are shown here.
- User outreach exercise for WAFS concluded this simple representation of probabilities is an excelle starting point for understanding how to use probabilities.



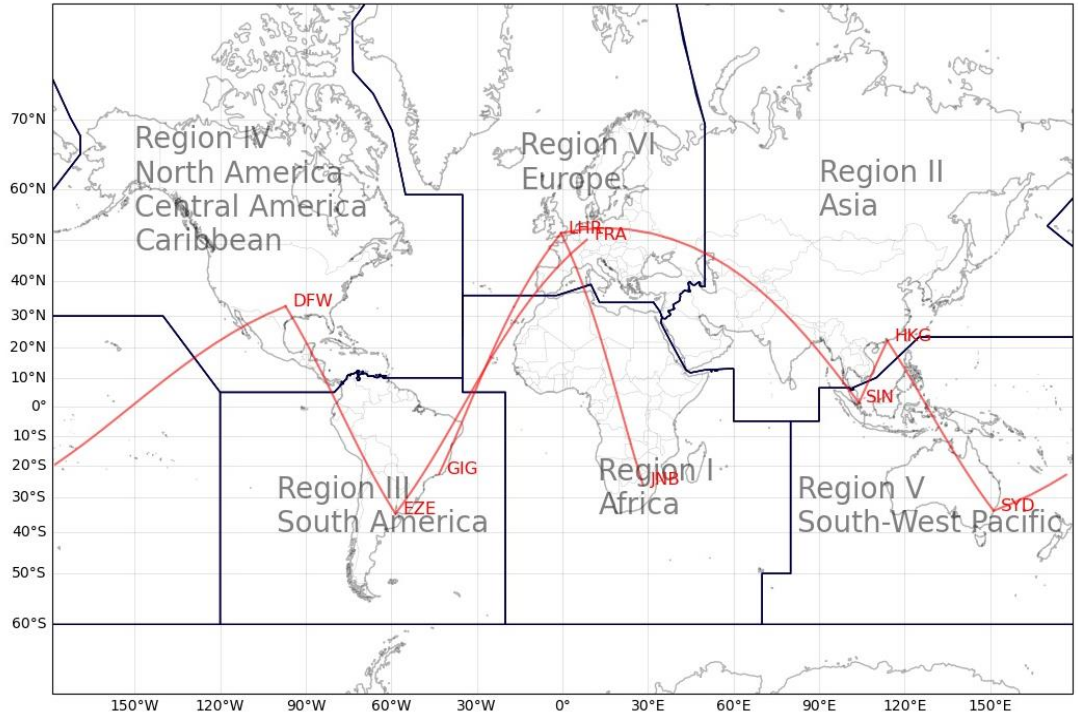
Machine Learned Icing Index

- Goal: to demonstrate a proof-of-concept icing forecast capability
- ERA5[1] reanalysis data used to train CNN[2] at low spatiotemporal resolution out to forecast range of 5 days
- Basic index with limited input parameters
  - Likelihood of icing (scale 0-1)
- Deterministic output generated
  - Demonstrates skill compared to persistence forecast
- Next step is to generate probabilistic output
- Future work
  - Further tuning to reduce ‘smoothing’
  - Increase resolution
  - Trial ‘live’ with analysis fields and compare to physics-based approach

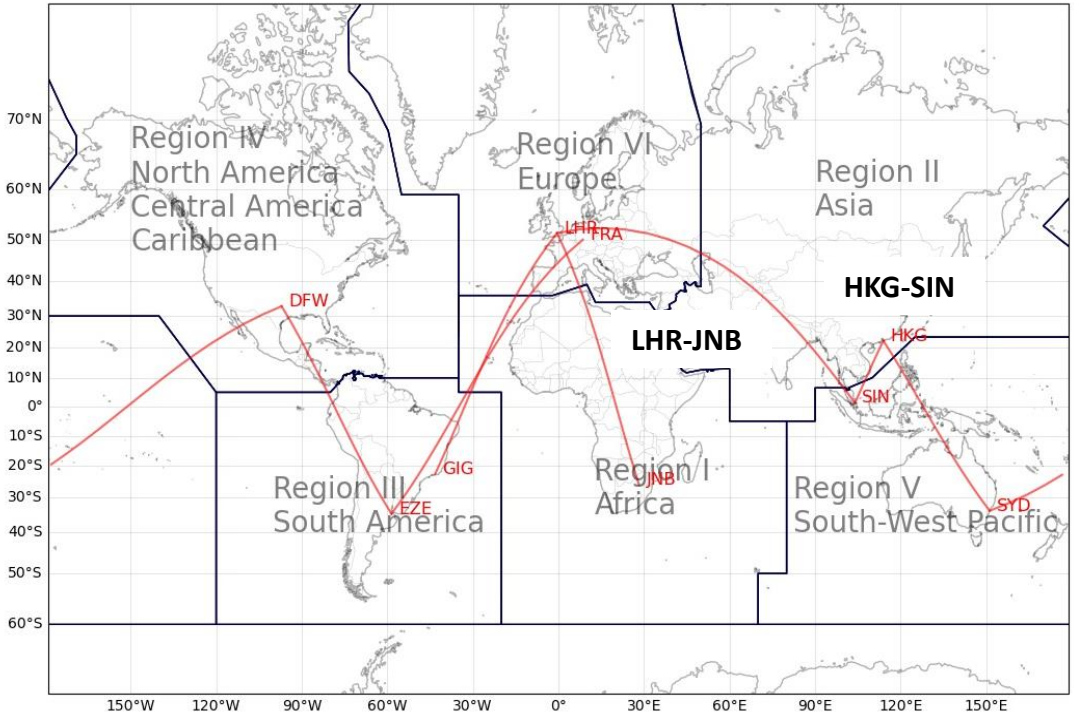


1 – ECMWF Reanalysis v5 (ERA5)
2 – Convolutional Neural Network

Global WAFS convection forecast.
AvRDP2 Project: Proposed Airport Pairs



Global WAFS convection forecast.
AvRDP2 Project: Proposed Airport Pairs

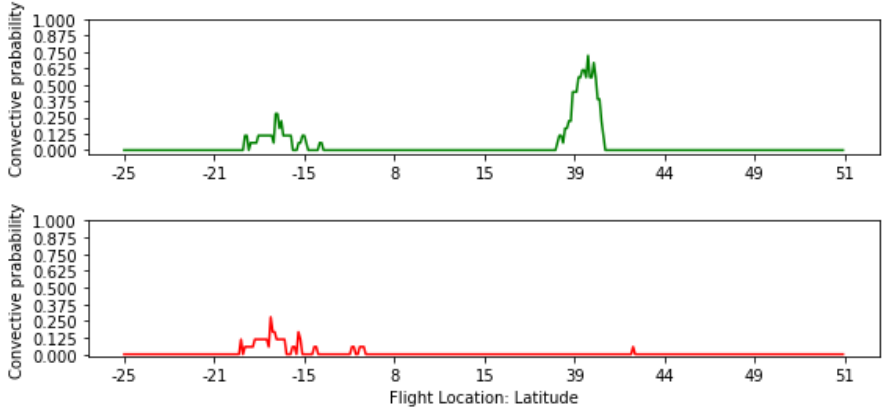


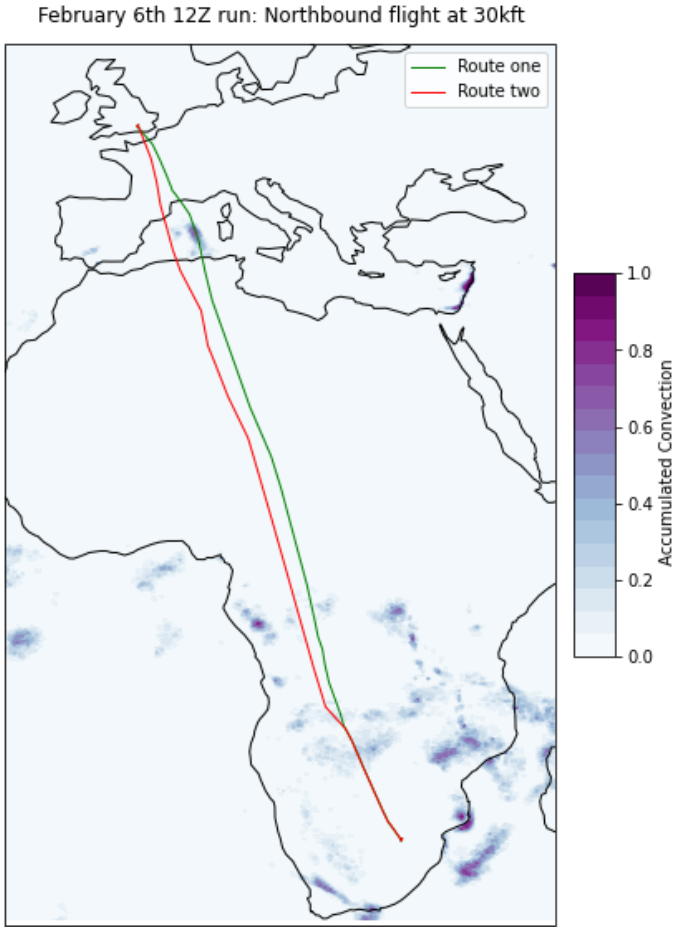
LHR-JNB Routing Product for Convection.

Example: comparing flight routes

Flight statistics: Johannesburg to London (North bound)

	Mean	Max	Distance (km)
Flight 1	0.034	0.722	1120
Flight 2	0.009	0.278	680

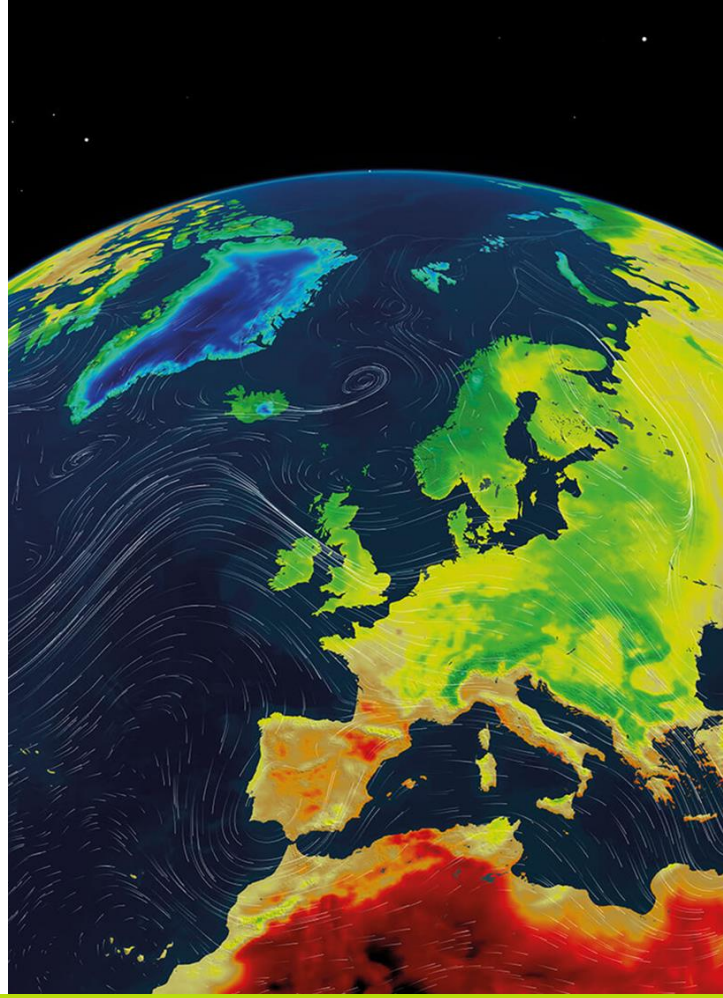




Victoria Vertrees, University of Reading MSc Student

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.



WesCon WOEST 5th June – 25th August 2023

Aircraft

- FAAM- 12 flights, >70 hours
- DIMONA - 16 Flights, >45 hours

Radars

- CAMRa, Kepler, NXPol1 & 2,
- Chilbolton, Lyeham, Wardon Hill
- 25+ Days scanning

Radiosonde

- Larkhill, Chilbolton, Ash Farm, Spire View, Reading.
- Extras: Camborne Herstmonceux Aberporth
- >350 in total

WxUAS

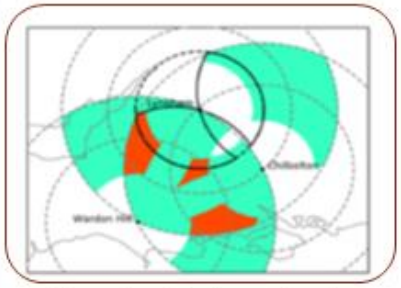
- Breach Hill, Heytesbury, Chilbolton, Wherwell Forest.
- ~120 flight hours.
- ~700 flights.
- First 2km BVLOS

Supersites

- Netheravon, Lyneham, Chilbolton
- Lidars,
- wind profilers,
- Microwave radiometers,
- Stereo cameras
- Masts

AWS sites

- 12 stations 24/7 operation



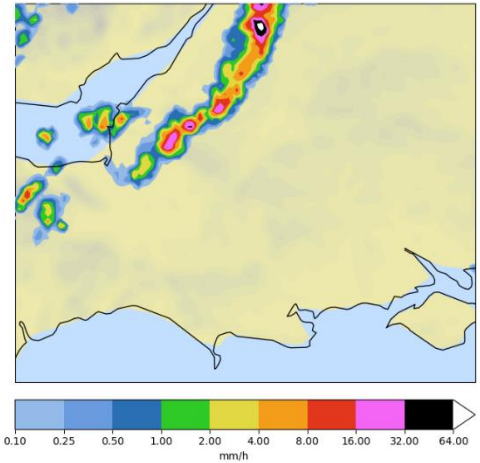
Doppler Radar network
Lyneham, Chilbolton, Wardon Hill

Long term observations and 30 Intensive Observations Periods

#WesCon2023

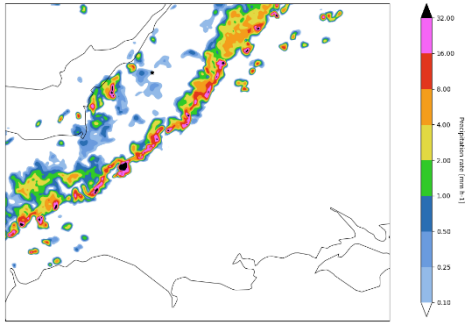
11 July 2023 15 UTC (T+21)

Radar composite

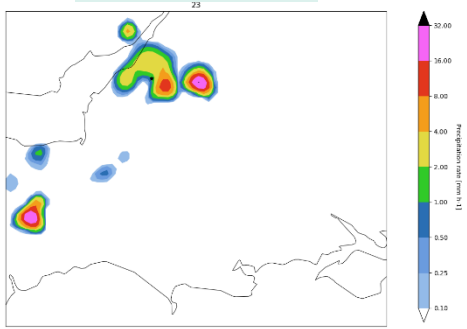


The WMV performs well for deep convection and is able to capture the organisation of features into bands/lines

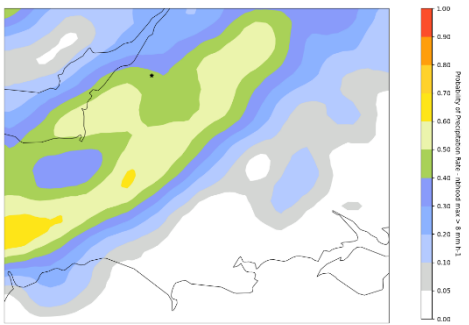
WMV Member 23

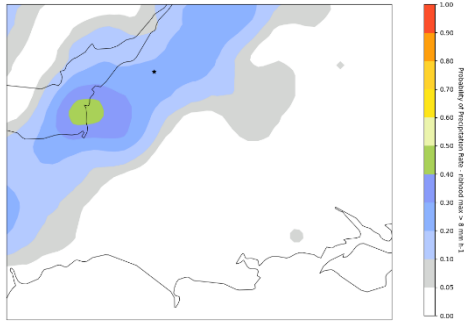


MOGREPS-UK Member 23



Neighbourhood max probability of ppn > 8 mm/hr





32. **For the probability of heavy precipitation (8+ mm/hr)**, using the radar observations, in terms of the extensiveness of the probabilities which gives better guidance?

More Details

WMV a lot	7
WMV a little	16
No difference	9
MOGREPS-UK a lot	3
MOGREPS-UK a little	3

In 61% of cases the WMV was viewed to give better guidance for the *coverage* of heavy ppn vs 16% of cases where M-UK was better.

34. **For the probability of heavy precipitation (8+ mm/hr)**, using the radar observations, in terms of the probability values, which gives better guidance

More Details

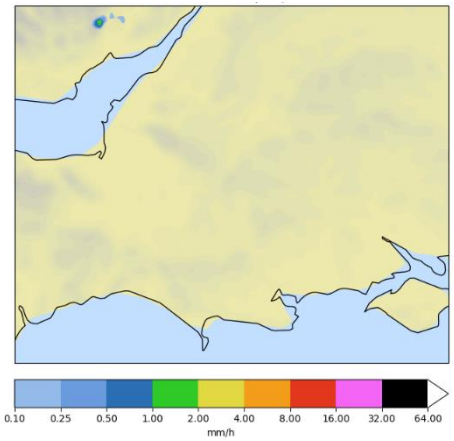
WMV a lot	5
WMV a little	19
no difference	8
MOGREPS-UK a little	2
MOGREPS-UK a lot	4

In 63% of cases the WMV was viewed to give better guidance for the *probability values* of heavy ppn vs 16% of cases where M-UK was better.

Based on questionnaire responses for 38 cases of heavy precipitation (8+ mm/hr)

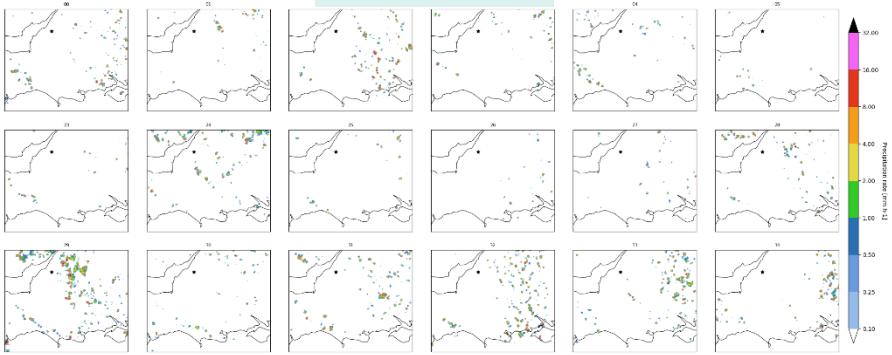
22 June 2023 12 UTC (T+18)

Radar composite

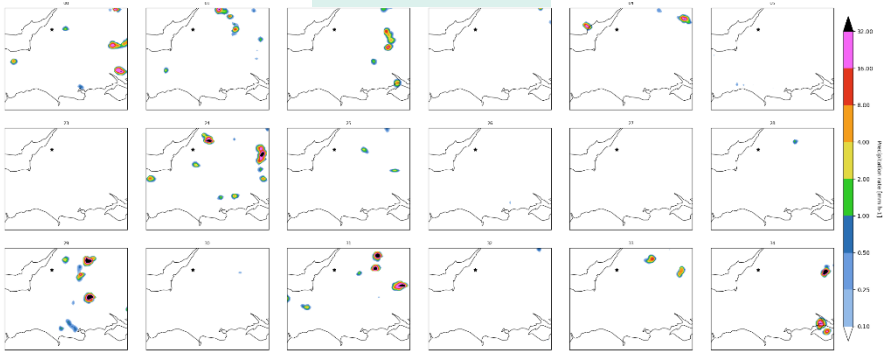


However, there is an issue with the WMV producing too many small precipitating showers in situations where there should only be shallow clouds. The WesCon observations will help us to better understand, and hopefully solve, this issue.

WMV



MOGREPS-UK



First Guess TAFs

- Uses BestData (deterministic and probabilistic)
- Wind and visibility completely included
- Compliant with ICAO rules so can be compared to operational TAFs
- Verified and compared to operational TAFs over 1 year
- Accuracy scores similar, but slightly lower for first guess
- Gerrity scores show more variation
  - Visibility scores generally lower for first guess
  - Cloud base scores generally higher for first guess
  - Large disparity in scores appears to be due to forecasting of rare events (e.g., fog)

Example of Output

First Guess

```
TAF EGNJ 161554Z 1618/1703 28005KT 6000 BKN003
     BECMG 1618/1621 SCT025
     PROB30 1618/1701 3000 BR
     BECMG 1621/1624 BKN003
     BECMG 1700/1703 BKN001=
```

Operational

```
TAF EGNJ 161702Z 1618/1703 VRB04KT 6000 SCT006 BKN030
    TEMPO 1618/1703 4000 -RA BR FEW002 BKN006
    PROB30 TEMPO 1618/1703 1200 RADZ BKN002=
```

Machine Learning Project

Use machine learning classifiers to predict when first guess TAFs would go bust

- E.g., for 0900 UTC on Tuesday 24th Jan 2023 for Heathrow for lead time T+3, the prediction might be ‘visibility too low’

- Adjust weather model data feeding first guess TAFs based on predictions
  - E.g., based on above example, model visibility for that time could be adjusted up by one TAF category

AIM 1: Reduce bust susceptibility in first guess TAFs

AIM 2: Improve main verification scores

Challenges

Data limitations

- Bias
- Availability
- Sparsity of observations

Explainable AI (XAI)

- Trusted by end users
- Tested under different situations
- Interpretable methods

ML Summer School 2020

Trustworthy AI

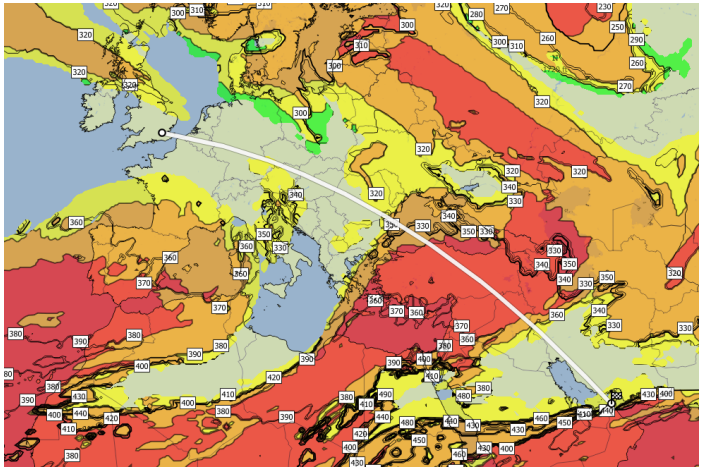
Representative AI

- Follows laws of physics
- Representation of extremes
- Uncertainty quantification

Research to Operations

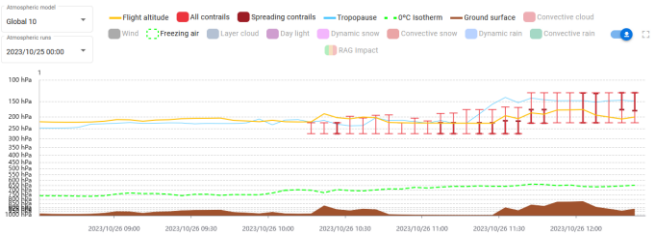
- Pull-through to operations
- Data pipelines
- Useful, usable and used

Non-CO_2 Emissions Contrails



- Climate impacts from contrails may be greater than from aviation CO_2[1] emissions
- Contrails are short-lived climate forcers
- Operational mitigation strategies could reduce the climate impact of contrails
  - ➢ Reduce time in prone formation regions
- Research is required to:
  - ➢ Improve current model prediction capabilities
  - ➢ Validate models with new observations

All contrails



Spreading contrails

1 – IPCC AR6 WGIII

R&D highlights - Globally

Paper on probabilistic icing forecast development

Monitor and continue to verify implemented SigWx Code

MTG lightning imager compared to our lightning observations.

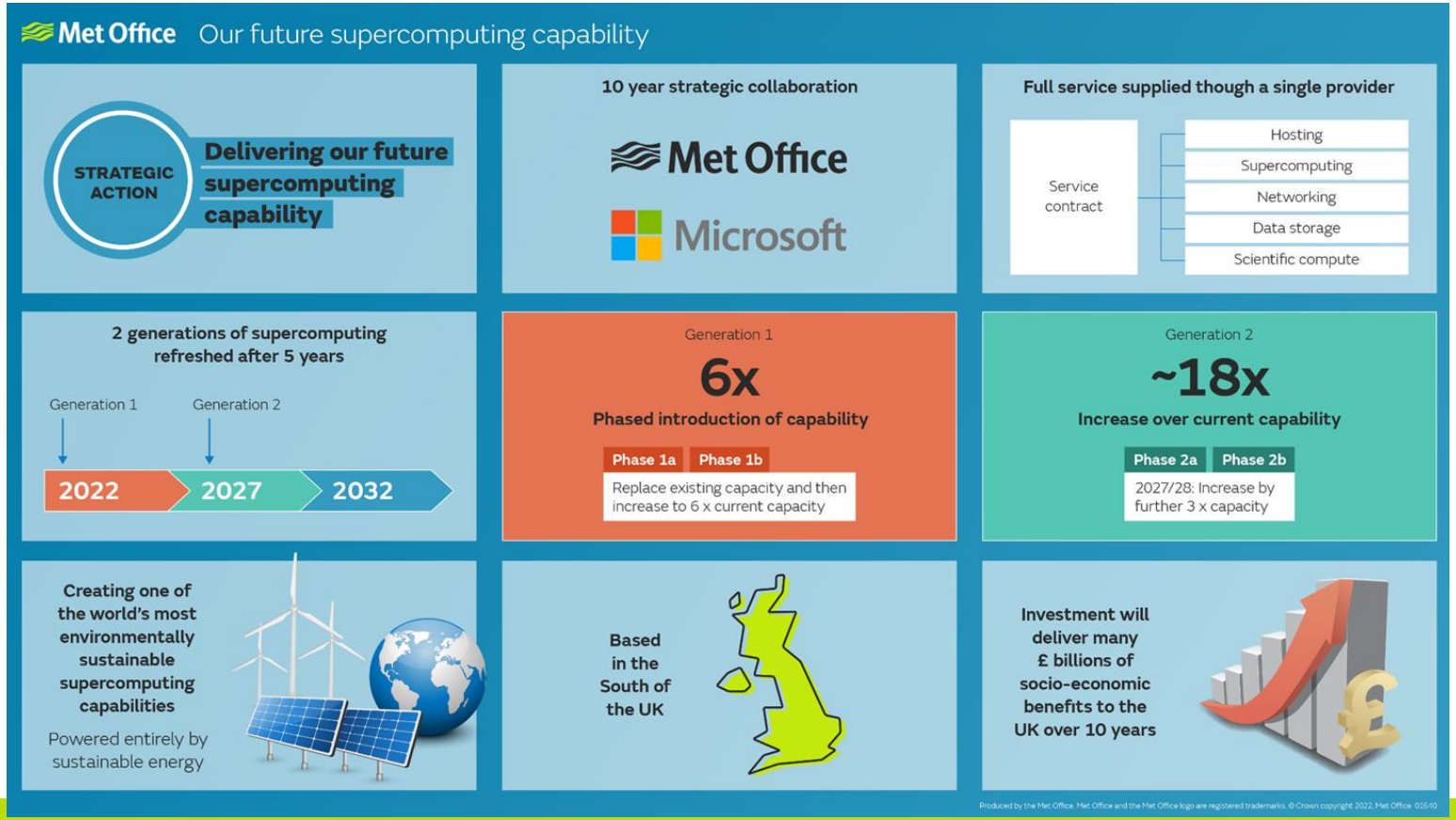
R&D highlights - UK

WesCon deep analysis of 333m model's ability to predict convection.

Understanding the benefit of existing fog diagnostics compared to new modelling capability.

Detailed report with options for improving low level turbulence forecast

Supercomputer Update



Global NWP

- 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.
- Introduce experimental 5−6km forecasts as first step towards a future km-scale global ensemble forecast system.

UK regional NWP

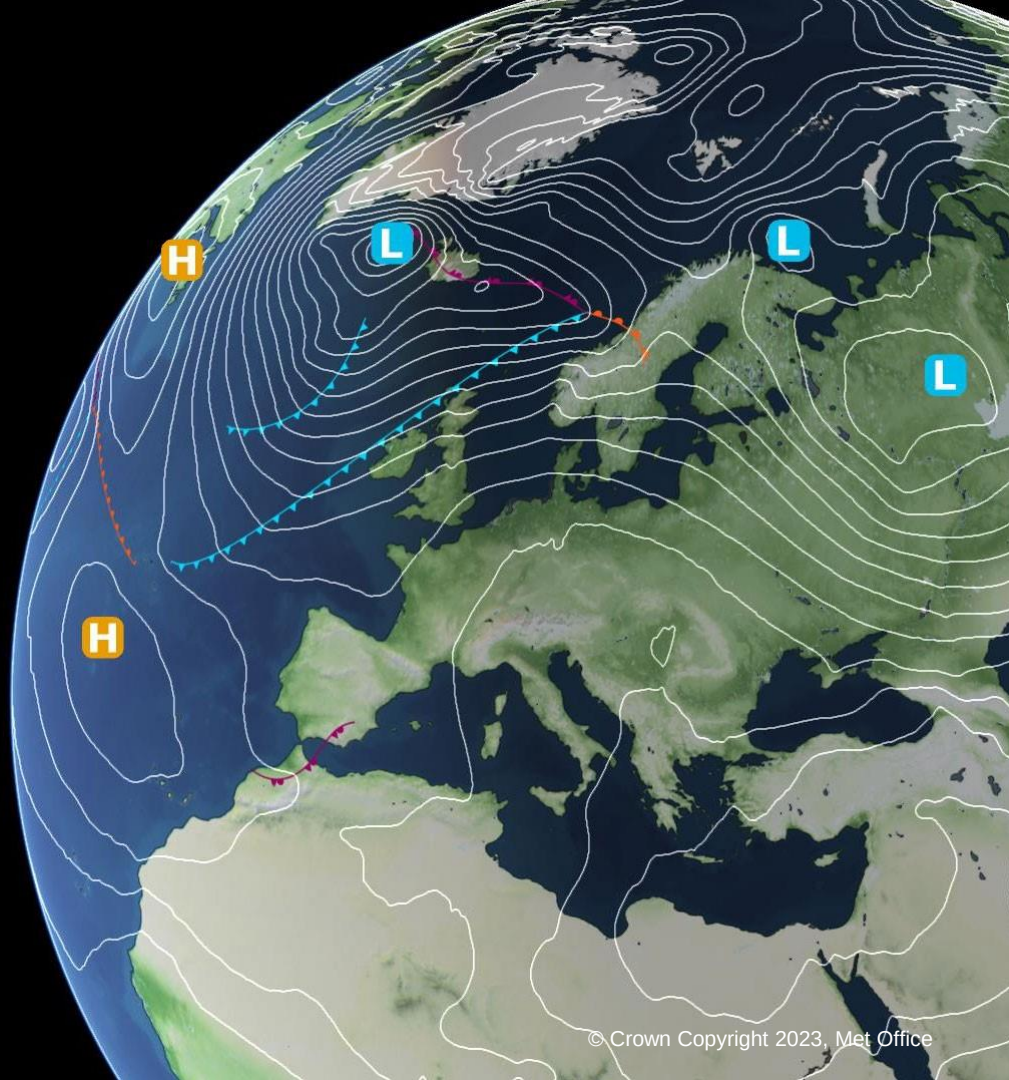
- Retire UKV forecasts beyond the T+12 “NWP nowcast”.
- Upgrade to 1.5km resolution UK ensemble forecasts.
- Introduce 300m resolution regional ensemble(s) to improve forecasts for urban areas and high-impact weather.

3-month Outlook

November–December–January

Louise Bailey

Operational Meteorologist



Understanding the outlook summaries

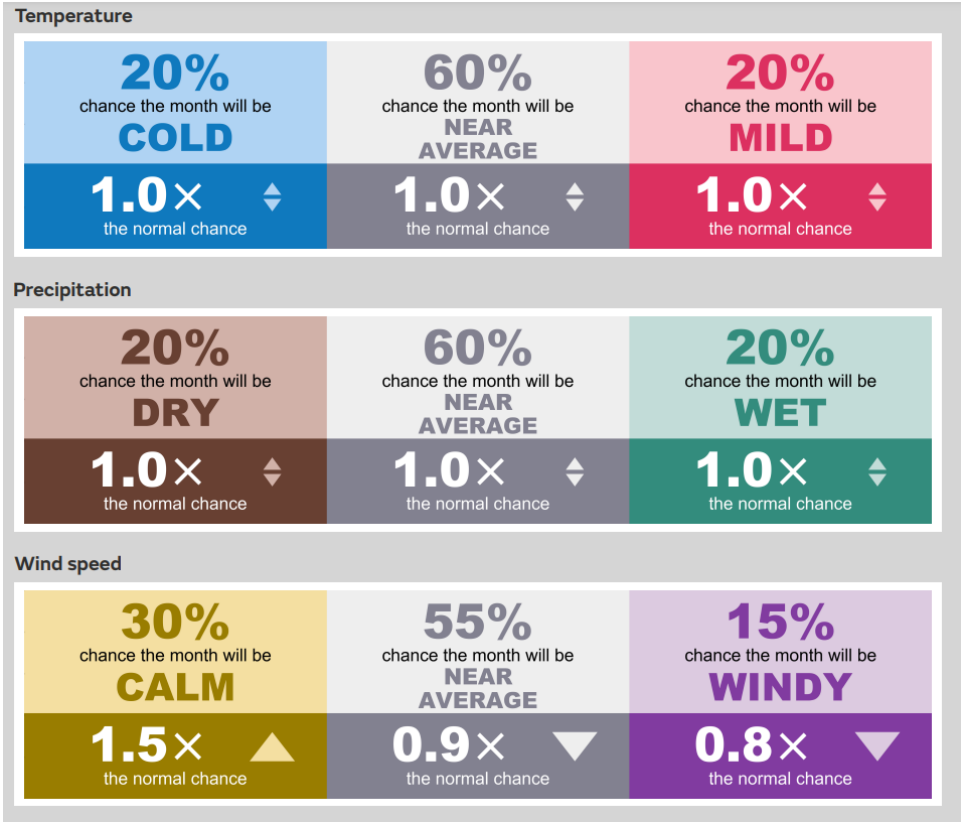
- The outlook uses 3 categories to mark expected conditions on 3 different parameters
  - Temperature: COLD, NEAR AVERAGE, MILD
  - Precipitation: WET, NEAR AVERAGE, DRY
  - Wind speed: CALM, NEAR AVERAGE, WINDY

- Linked to observed UK conditions in past years
- NEAR AVERAGE has a normal likelihood of 60%. Other categories have a normal likelihood of 20%
- Outlook shows how chances of occurrence differ from normal, based on global meteorological pattens. Does not identify which will actually occur

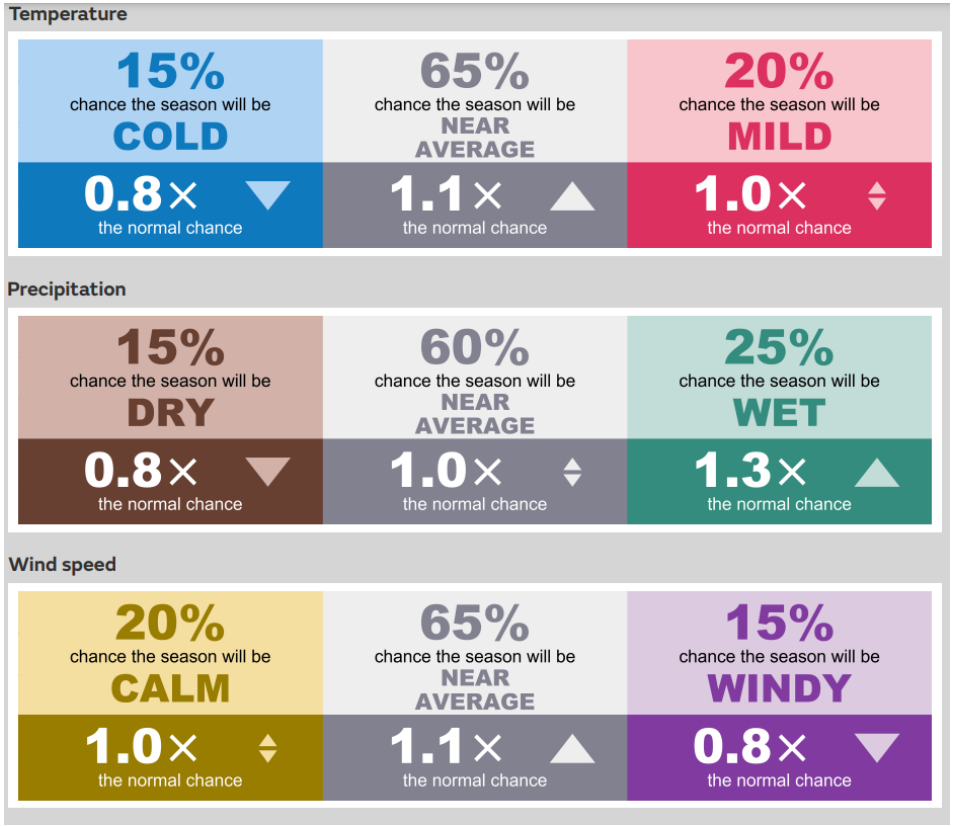
What factors go into the outlook?

- Warming of UK Climate consistent with wider global warming trends
- Global Weather patterns
  - **El Nino/ La Nina-** strong El Nino increases likelihood of mild, wet windy weather in late Autumn/early winter and dry, cold conditions in late winter
  - **Quasi-Biennial Oscillation-** easterly phase favours reduction in strength of W winds over UK
  - **Indian Ocean Dipole-** strong positive phase increases chances of SW winds during winter
- Agreement with other Met centres around the world

One Month Summary: November



Three-month summary: Nov Dec Jan



Same period over last 10 years

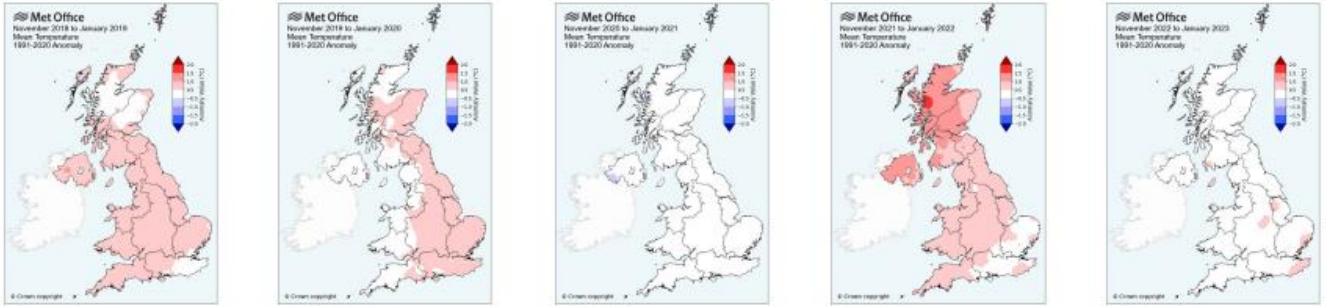
Same 1-month period over the last 10 years

2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
NEAR AVERAGE	MILD	MILD	COLD	NEAR AVERAGE	NEAR AVERAGE	COLD	MILD	NEAR AVERAGE	MILD
DRY	NEAR AVERAGE	WET	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	DRY	WET
CALM	CALM	WINDY	CALM	NEAR AVERAGE	WINDY	CALM	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE

Same 3-month period over the last 10 years

2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
NEAR AVERAGE	NEAR AVERAGE	MILD	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	MILD	NEAR AVERAGE
WET	NEAR AVERAGE	WET	DRY	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	DRY	NEAR AVERAGE
NEAR AVERAGE	NEAR AVERAGE	WINDY	CALM	NEAR AVERAGE	NEAR AVERAGE	NEAR AVERAGE	CALM	NEAR AVERAGE	NEAR AVERAGE

Last 5 years temperatures, difference from average (3-month)



Nov - Jan 2018/19 | Nov - Jan 2019/20 | Nov - Jan 2020/21 | Nov - Jan 2021/22 | Nov - Jan 2022/23

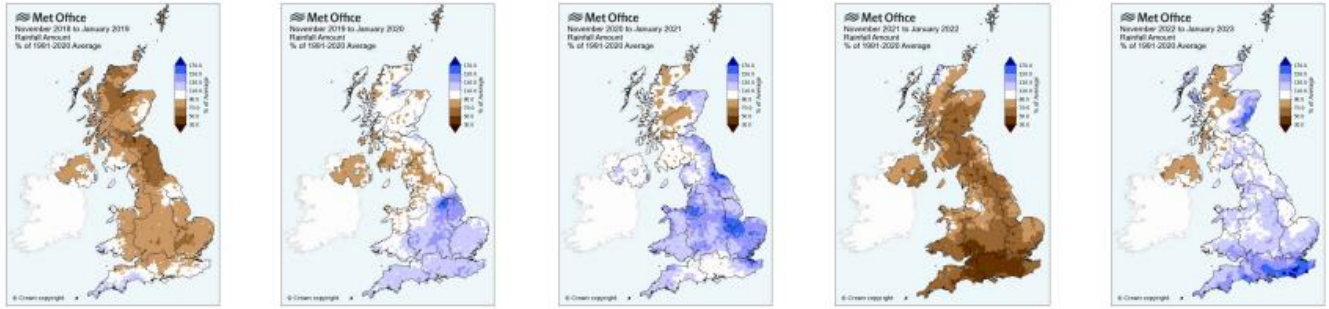
Anomaly (°C)

< -2.0	-2.0 to -1.5	-1.5 to -1.0	-1.0 to-0.5	-0.5 to 0.5	0.5 to 1.0	1.0 to 1.5	1.5 to 2.0	> 2.0

These maps show how November - January temperatures in the last five years differed from the long-term average temperatures shown above in the upper panel. Pink and red colours indicate milder-than-average conditions while blue shades indicate colder-than-average conditions. Detailed information on the climate of the UK is available at www.metoffice.gov.uk/climate.

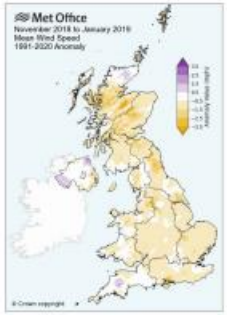
Met Office

Last 5 years precipitation, difference from average (3-month)

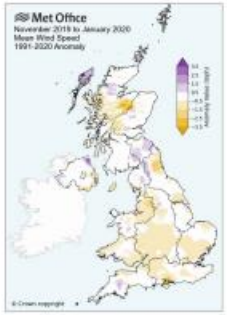


These maps show how November - January precipitation in the last five years differed from the long-term average precipitation shown above in the upper panel. Brown colours indicate drier-than-average conditions while blue shades indicate wetter-than-average conditions. Detailed information on the climate of the UK is available at www.metoffice.gov.uk/climate.

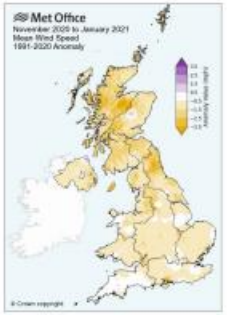
Last 5 years wind speed, difference from average (3-month)



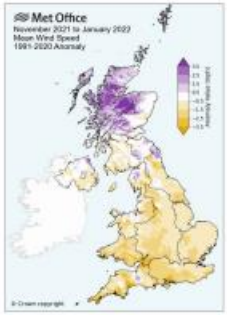
Nov - Jan 2018/19



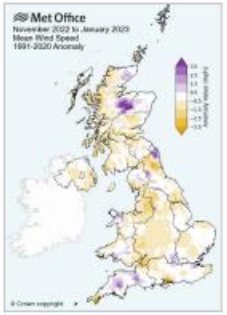
Nov - Jan 2019/20



Nov - Jan 2020/21



Nov - Jan 2021/22



Nov - Jan 2022/23

Anomaly (mph)

< -3.5	-3.5 to -2.5	-2.5 to -1.5	-1.5 to -0.5	-0.5 to 0.5	0.5 to 1.5	1.5 to 2.5	2.5 to 3.5	> 3.5

These maps show how November - January wind speed in the last five years differed from the long-term average wind speeds shown above in the upper panel. Yellow colours indicate calmer-than-average conditions while purple shades indicate windier-than-average conditions. Detailed information on the climate of the UK is available at www.metoffice.gov.uk/climate.

Stay in touch

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General enquiries can be directed to:

transport@metoffice.gov.uk