METEOROLOGY PANEL

ICAO MID Workshop on enhancing MET capabilities
(15 December 2025, ICAO MID Regional Office)

Agenda Item 2: Digital Transformation – SWIM and IWXXM Implementation

# Modernization of MET information to support future GANP - transition to MET-SWIM

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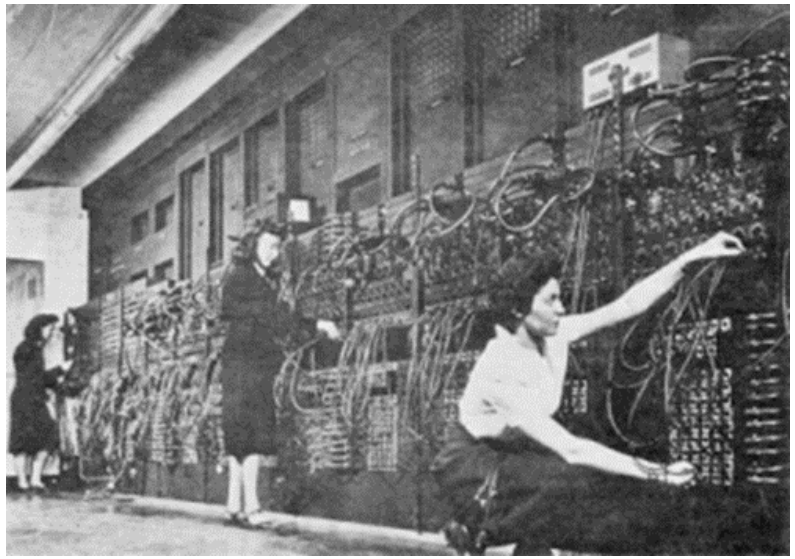
# Modernization of aeronautical MET service

# Where did we come from?

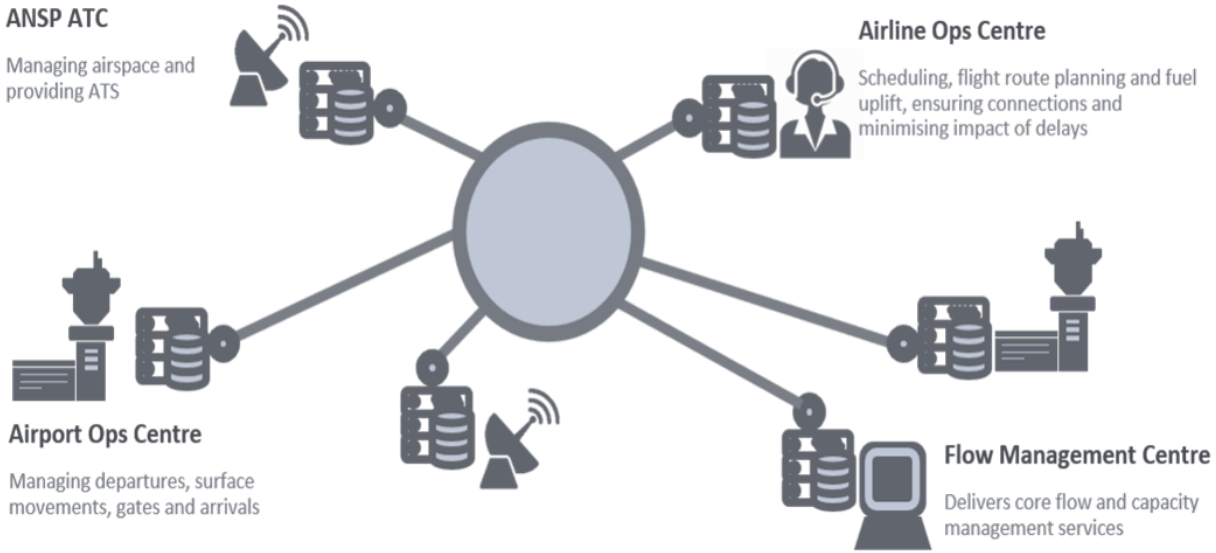
- Hand drawn analysis (isobars, nephanalysis, stability etc.)
- Teletype distribution of coded weather reports and forecasts
    - SA code (hourly code) in some places
- Use of dedicated “fixed” lines for aeronautical information
    - Transmission windows, intermediate data aggregators in some cases
- Graphical products sent by fax
- Observations almost all done by humans
- Counter briefings were commonly available
- Information included in State AIP

# Then and Now – Aeronautical MET Information Transmission

## Fixed Lines



## System Wide Information Management




Cirium Sky for SWIM
*Source: www.cirium.com/solutions/swim (16 January 2025)*

# Then and Now – Aeronautical MET Information Dissemination

## Teletype Machines

## Aviation Weather Display

Display at 2019 Air Traffic Controller Association Conference (Photo by Raytheon)
*Source: www.faa.gov/nextgen/programs/weather (16 January 2025)*

# Where are we now?

- Increased automation (observations and data analysis and assimilation)
- Significant increase in computing ability and remote observational  capabilities
- Internet distribution (e-mail, x400 with attachment). Increasing web distribution
- The core content of weather information remains code based
  - **Advantage –** it is understood, essentially globally used, and a useful abbreviated method to distribution information that is integrated into decision making criteria (often linked to regulations)
  - **Disadvantages –** requires code training, can be cumbersome (especially by voice) and is limited in its ability to provide additional useful information.

# However, we are still using codes

## METAR

CYOW 170100Z 17004KT 15SM -SN FEW040 BKN065 OVC120 M06/M09 A2974 RMK SC2SC4AC2 SLP081

## TAF

TAF CYOW 162340Z 1700/1806 18010KT P6SM OVC030
TEMPO 1700/1703 4SM -SN OVC020
FM170300 19008KT 1 1/2SM -SN SCT008 OVC012
TEMPO 1703/1705 4SM -SN OVC025
FM170500 18006KT P6SM -SN SCT012 BKN030
TEMPO 1705/1709 5SM -SN OVC020
BECMG 1705/1707 24005KT
FM170900 24005KT P6SM FEW003 BKN025
FM171200 24005KT P6SM SCT003 BKN020
FM171800 19007KT P6SM BKN025
FM172300 18008KT P6SM BKN015 OVC100 RMK NXT FCST BY 170300Z

## SIGMET

WSCN02 CWAO 162246
CZEG SIGMET E2 VALID 162245/170245 CWEG-
CZEG EDMONTON FIR SEV TURB OBS WI 60NM WID LINE BTN N5036 W11837 - N5053 W11455
- N5128 W11123 FL160/250 MOV SE 25KT NC=

# Current coded products are still constrained

## METAR/SPECI

- 4 RVR values
- 3 phenomena in present weather element
- 3 phenomena in recent weather element
- 3 phenomena in trend forecast

## TAF

- 4 cloud layers
- 3 phenomena in present weather element
- 2 temperature groups

## SIGMET

- 7 points in a polygon

## VA SIGMET

- 2 volcanic ash clouds (affecting the FIR concerned)

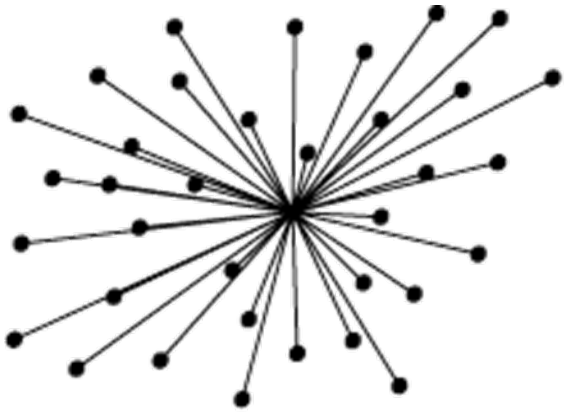
## TC SIGMET

- 2 centres (eyes) of tropical cyclones (affecting the FIR concerned)

## AIRMET

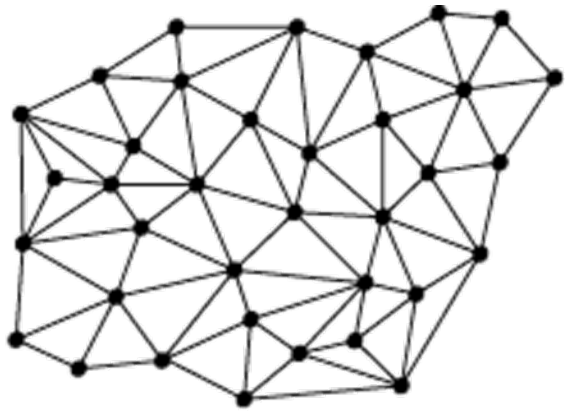
- 1 hazardous weather phenomenon

# Evolution of Dissemination Models



centralised

decentralised



distributed

**Past** **Present** **Future**

# AMET Modules

| AMET | /1 | /2 | /3 | /4 |
|---|---|---|---|---|
| **B0** | Meteorological observations products | Meteorological forecast and warning products | Climatological and historical meteorological products | Dissemination of meteorological products |
| **B1** | Meteorological observations information | Meteorological forecast and warning information | Climatological and historical meteorological information | Dissemination of meteorological information |
| **B2** | Meteorological observations information | Meteorological forecast and warning information | Climatological and historical meteorological information | Meteorological information service in SWIM |
| **B3** | Meteorological observations information | Meteorological forecast and warning information | Climatological and historical meteorological information | Meteorological information service in SWIM |
| **B4** | Meteorological observations information | Meteorological forecast and warning information | Climatological and historical meteorological information | Meteorological information service in SWIM |

# AMET Module

**AMET BBB:** Meteorological information provided to support operational efficiency and safety.

**AMET Block 0:** Global, regional and local meteorological information to support flexible airspace management, improved situational awareness, collaborative decision-making and dynamically optimized flight trajectory planning.

**AMET Block 1:** Meteorological information supporting automated decision process or aids, involving meteorological information, meteorological information translation, ATM impact conversion and ATM decision support.

**AMET Block 2:** Integrated meteorological information in support of enhanced operational ground and air decision-making processes, particularly in the planning phase and near-term.

**AMET Block 3:** Integrated meteorological information in support of enhanced operational ground and air decision-making processes, for all flight phases and corresponding air traffic management operations.

**AMET Block 4:** Integrated meteorological information supporting both air and ground decision making for all phases of flight and ATM operations, especially for implementing immediate weather mitigation strategies.

# AMET Module - AMET Bx/4 - Dissemination

**AMET B0/4: Dissemination of Meteorological Products**
Commencement of IWXXM, being the conversion of TAC using an IWXXM schema into XML/GML.

**AMET B1/4: Dissemination of Meteorological Information**
IWXXM form starts to replace TAC products. Human-readable products start to be derived from the IWXXM information (rather than the other way around). The introduction of web services allows for progressive replacement of fixed line dissemination systems.

**AMET B2/4: Dissemination of Information Services in SWIM**
Implementation of a data-centric MET information into a SWIM environment. User-defined products derived from meteorological information in IWXXM. Wider use of secure web services and decommissioning of fixed line and satellite dissemination systems. Commencement of the use of business-to-business services, allowing integration of MET information into ATM systems. Increased use of air-to-air datalink for transmission of upper air meteorological observation in near real-time.

**AMET B3/4: Dissemination of Information Services in SWIM**
Continued implementation of a data-centric meteorological information service into SWIM. Enhancement of IWXXM with further schemas and formats for meteorological information exchange. User-defined products automatically derived from meteorological information IWXXM form. Extensive use of secure web services, in particular business-to-business services that allows full integration of meteorological information.

# The Evolution of Aeronautical Meteorological Information

- From teletype, through e-mail, through dial up to WiFi, to the web, to EFBs
- Dramatic increases in computing and communications technology
- From limited coded messages to high fidelity information
- From fully manual processes to increased use of automation
- New means of observation (both airborne and remote)
- From set products to flexible information
- New types of information: Space Weather, Quantitative Volcanic Ash, probabilistic information, ultra long haul and both higher and lower altitude requirements etc.
- From past limits to future possibilities.

# Transition to MET-SWIM

# METP Plans for MET-SWIM

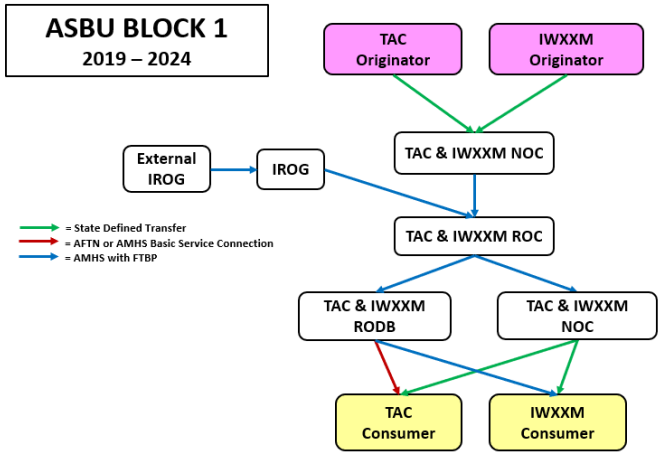
- Per the ICAO GANP, information service provision and consumption should commence within Aviation System Block Upgrade (ASBU) 2 (2025-2030)
- Roadmap for Meteorology in System Wide Information Management (MET-SWIM Roadmap) describes the transition plan and associated timelines for implementing MET-SWIM
- MET-SWIM Roadmap includes graphics for overarching information exchange across ASBUs 1-4, as well as transition plan for specific components of MET-SWIM (ex: communication protocols, information exchange services, data types, data addressing, etc.)

| ASBU Element | ASBU Element Description | ASBU | Timeline |
|---|---|---|---|
| AMET-B1/4 | Dissemination of MET Information | 1 | 2019 – 2024 |
| AMET-B2/4 | MET Information Service in SWIM | 2 | 2025 – 2030 |
| AMET-B3/4 | MET Information Service in SWIM | 3 | 2031 – 2036 |
| AMET-B4/4 | MET Information Service in SWIM | 4 | 2037 – 2042 |

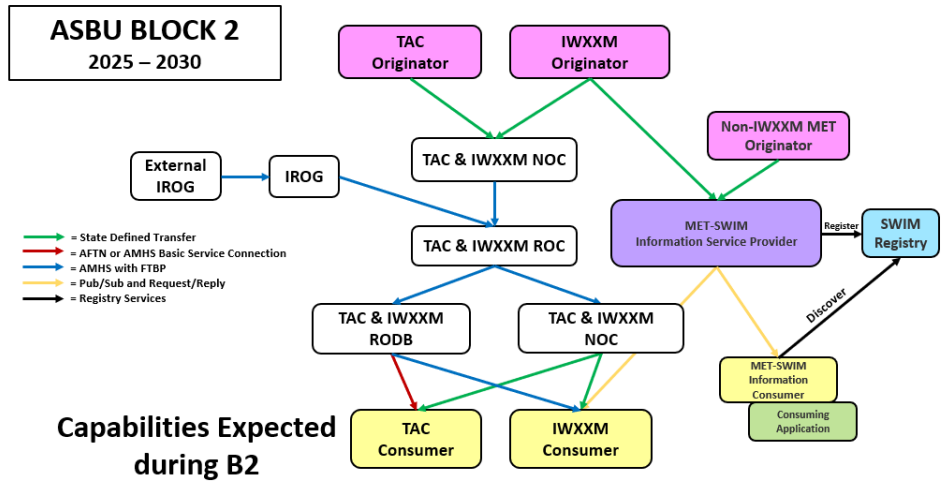
Source: *MET-SWIM Roadmap*, Table 1

# MET-SWIM Roadmap

## The Past

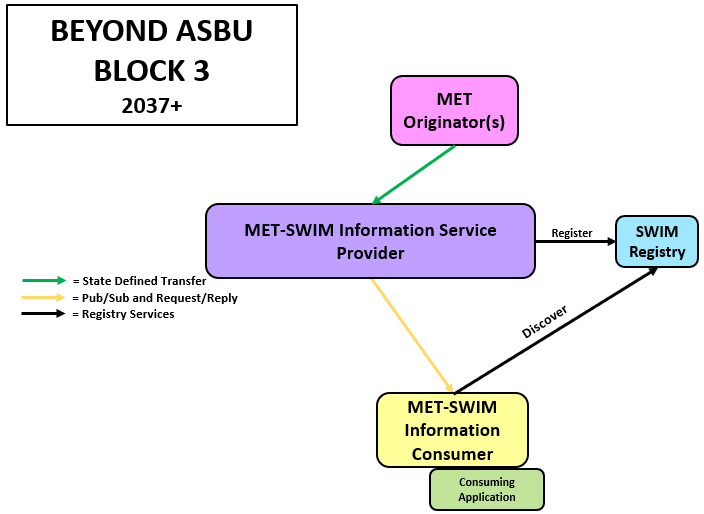



## The Present




Capabilities Expected during B2

## The Future




The provision of aeronautical meteorological information via SWIM-enabled information services will be one of the most significant developments in aviation in the last 30 years.

# Added value of MET information services – advantages over current “products”

- **Increased temporal resolution**
  - Weather observation information updated at shorter cycle (e.g., 5-minutes intervals)
  - Weather prediction model with finer temporal resolution and shorter update cycle
  - Future possibilities for “streaming” information services with very low latency
- **Increased spatial resolution**
  - High-resolution weather model data can be extracted in fit-for-purpose elements/areas/altitude levels
  - Severe weather phenomena captured more precisely than polygons or geographical reference points
- **Fit-for-purpose information services**
  - Tailored information services (e.g., regional information services developed in EUR) can be developed
  - More flexibility to respond to various local user needs
- **Free from legacy technical constraints**
  - No constraints on data volume — only minimum mandated information required for airspace users

# Added value of MET information services – challenges for implementation

- **Much larger data volume**
  - Systems need adaptation to manage data influx
  - Users should select only necessary data (e.g., avoid downloading the whole global model data set)
- **“No State left behind”**
  - Balancing innovation with realistic global standardization
  - Varied capabilities and progress across States and ICAO regions
- **Data Visualization**
  - Standardization of MET data visualization once data moves beyond TAC format

# Expected Initial MET-SWIM Services

## SADIS & WIFS API: Enhancing Aviation Data Services

- **Operational in 2024**:
  - **SADIS** (WAFC London) & **WIFS API** (WAFC Washington) provide access to key aviation data
  - Both are SWIM-compliant, based on the OGC Environmental Data Retrieval (EDR) API framework
- **Key Data Provided**:
  - Upgraded WAFS gridded data, METARs, TAFs, SIGMETs, WAFS SIGWX forecasts
  - Serves National Met Services, ANSPs, flight planning companies, airlines, and aviation software providers

## Quantitative Volcanic Ash Concentration Information (QVA)

- **Introduced in Amendment 82** to Annex 3 (effective 27 November 2025)
- **QVA information service (Amendment 83 to Annex 3, expected applicability in Nov 2027)**
  - All nine ICAO-designated VAACs to commence QVA data provision via SWIM-compliant information service

# Expected Initial MET-SWIM Services (Cont.)

## AMOIS (Aerodrome Meteorological Observational Information Service)

- Provides aerodrome observations with higher fidelity than METAR, SPECI, etc., in terms of representation, spatial/temporal accuracy, and coverage

## AMFIS (Aerodrome Meteorological Forecast Information Service)

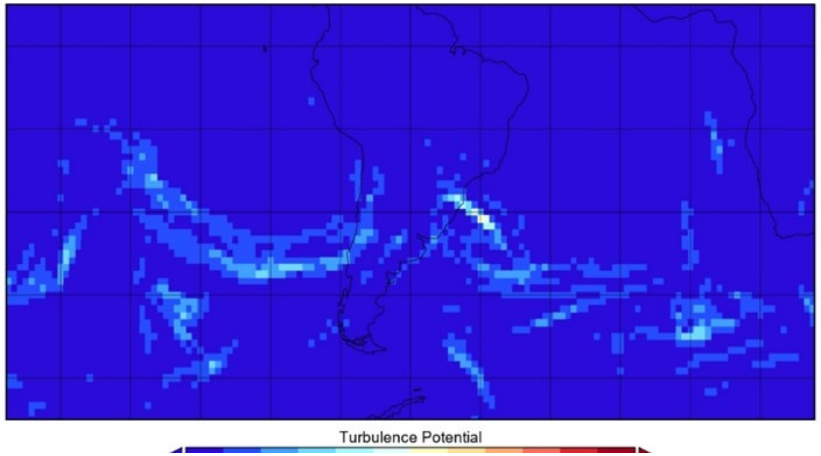
- Delivers aerodrome forecasts beyond the specifications of TAF, TREND, and other current aerodrome forecasts

## Implementation

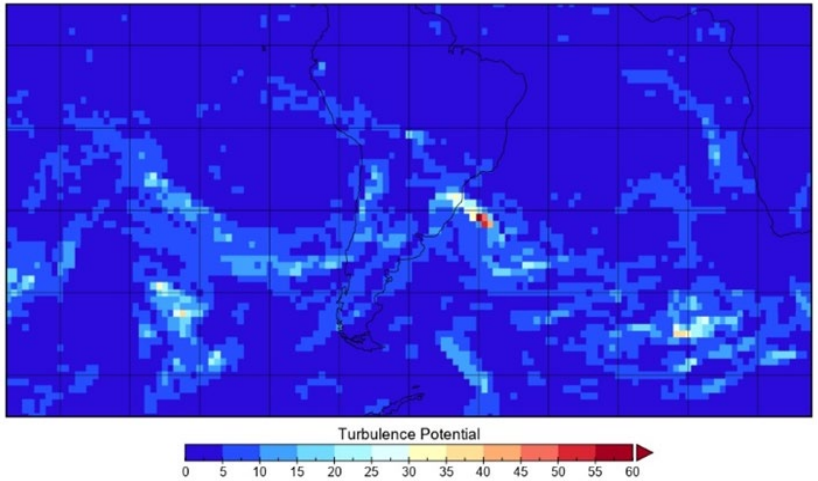
- Expected introduction as Recommended Practices in **Amendment 84** to Annex 3 and **Amendment 2** to PANS-MET, with applicability in **November 2030**
- Service providers must register and publish their services in a standardized format

# Higher Resolution Information

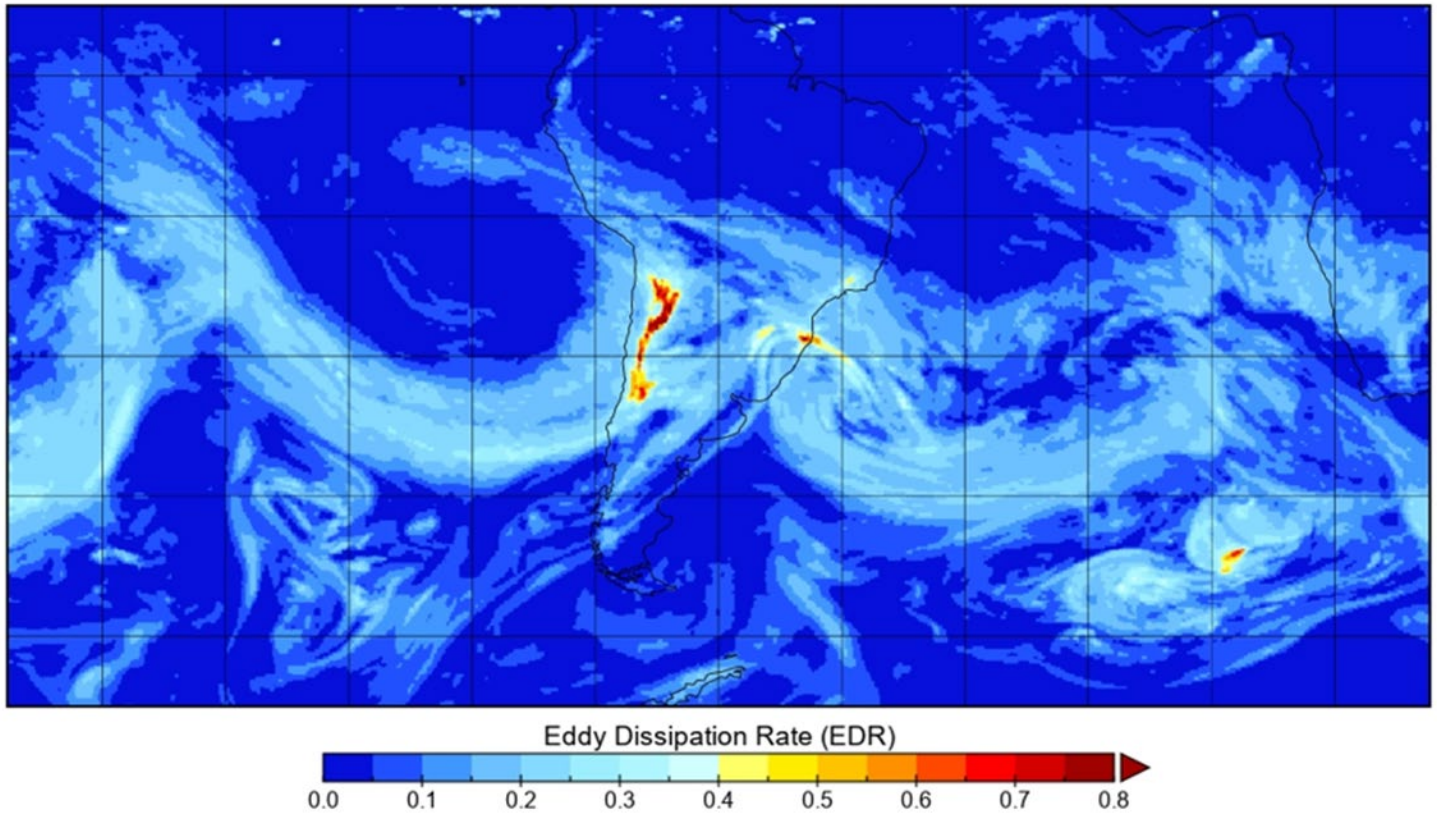
1.25 degree Clear air turbulence (CAT) Potential Average at 400hPa (FL240)




1.25 degree Clear air turbulence (CAT) Potential (Max) at 400hPa (FL240)

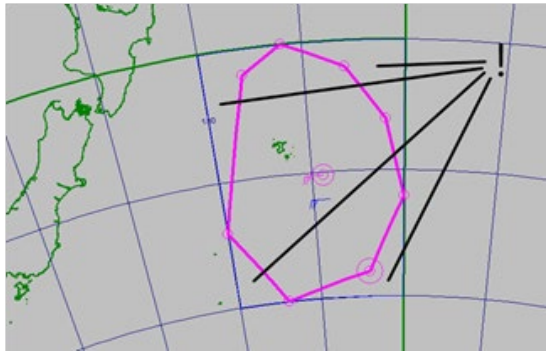



0.25 degree Turbulence Severity (GTG) at FL240 (392.7hPa)

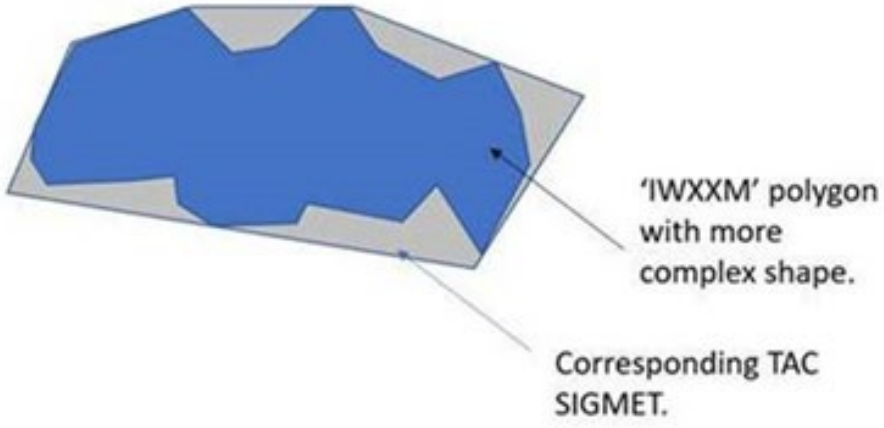


# Improving Hazardous Weather Information

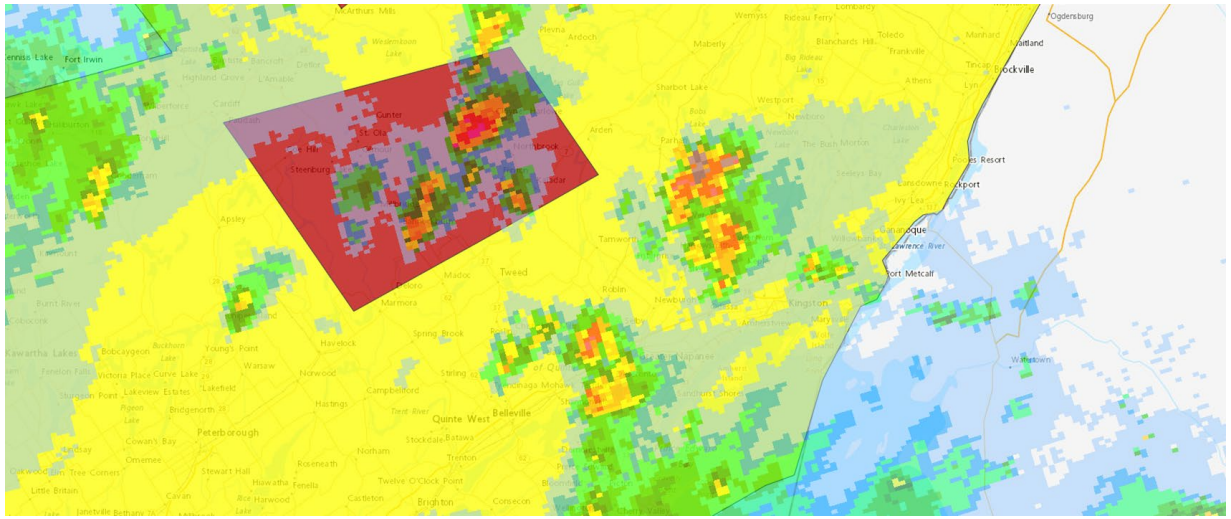
**Current constraints - SIGMET limited to 7 points**



**SIGMET in IWXXM – no constrains for the number of points**




**The future – Hazardous Weather Information Service**



# Collaboration Between METP and Information Management Panel (IMP)

**IMP** Develops provisions for information services and the SWIM concept

- ICAO **Annex 4**: Aeronautical Charts
- ICAO **Annex 15**: Aeronautical Information Services
- **PANS-ABC**: Abbreviations and Codes
- **PANS-AIM**: Aeronautical Information Management
- **PANS-IM**: Information Management

| ASBU Element | ASBU Element Description | ASBU | Timeline |
|---|---|---|---|
| SWIM-B2/1 | Information Service Provision | 2 | 2025 – 2030 |
| SWIM-B2/2 | Information Service Consumption | 2 | 2025 – 2030 |
| SWIM-B2/3 | SWIM Registry | 2 | 2025 – 2030 |
| SWIM-B2/4 | Air/Ground SWIM for Non-Safety Critical Information | 2 | 2025 – 2030 |
| SWIM-B2/5 | Global SWIM Processes | 2 | 2025 – 2030 |
| SWIM-B3/1 | Air/Ground SWIM for Safety Critical Information | 3 | 2031 – 2036 |

**PANS-IM includes procedures on**:

- Quality management, governance, metadata, and information exchange
- Information service publication, SWIM service registries, and information security framework

# Summary

# Summary – MET-SWIM transition to support GANP

- Meteorological information services play a critical role as essential enablers for the operational advancements required to achieve the future air traffic management (ATM), as outlined in the ICAO Global Air Navigation Plan (GANP).
- The successful implementation of new MET-SWIM information services is dependent on clear and coordinated timelines, which must be communicated across all ICAO Regions and States to ensure harmonized implementation and consistency in the global framework.
- In addition to the technical and regulatory alignment, effective stakeholder outreach is crucial. Engaging with relevant stakeholders—ranging from air navigation service providers (ANSPs) to operators, air crews, and aviation system/software developers—will be essential to facilitate a smoother and seamless transition and integration of enhanced MET information services.

# Expected timelines for MET-SWIM transition (In Summary)

Expected MET-SWIM information services*

**Amendment 83 (Applicable November 2027)**

- **WIFS & SADIS API**: Enhanced data access
- **QVACI**: Introduction of Quantitative Volcanic Ash Concentration Information
- **TAC Removal**: Standard for aeronautical MET data exchange (delayed to 2030)

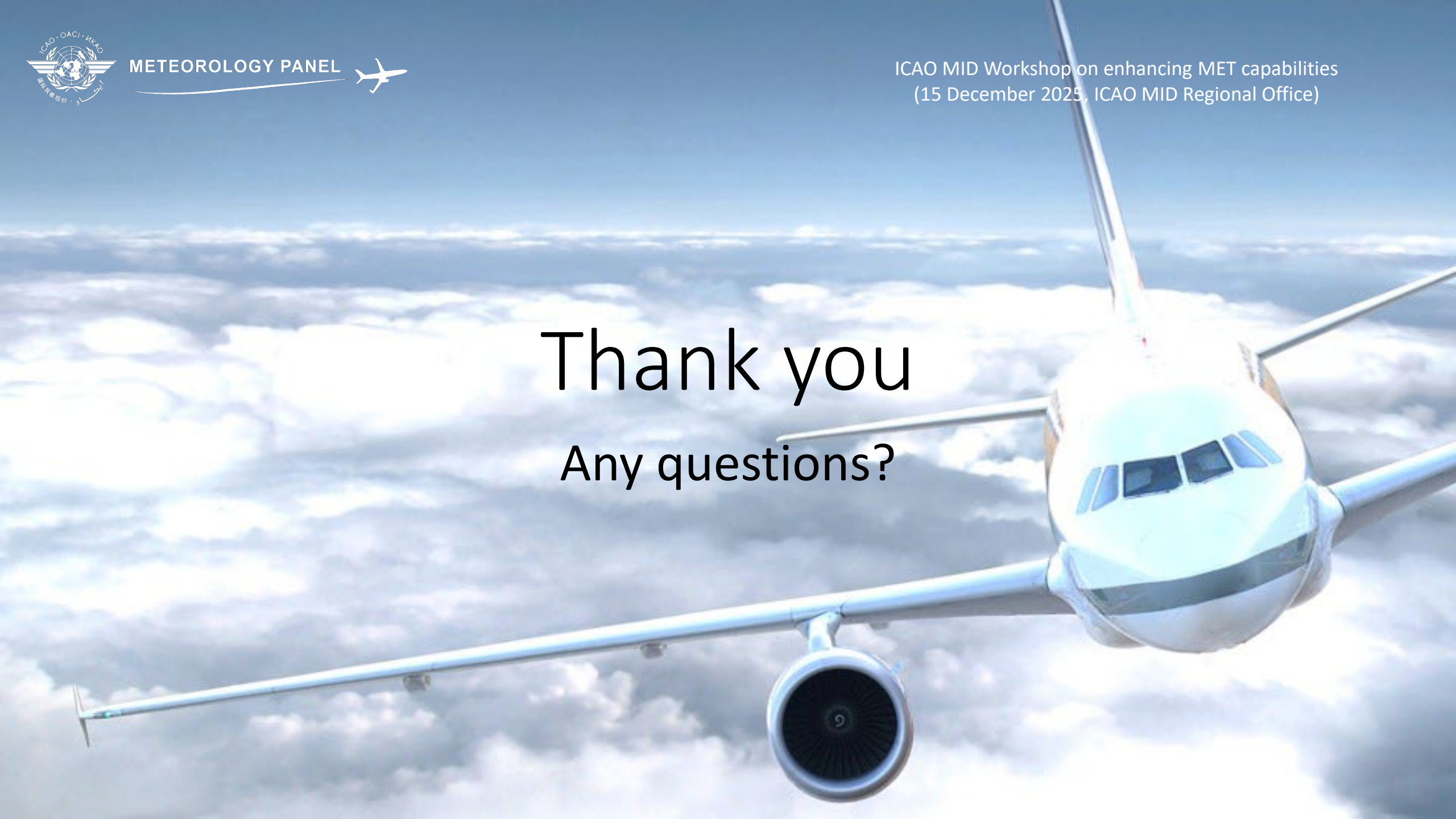
**Amendment 84 (Applicable November 2030)**

- **AMOIS**: Includes Local Routine Report, Local Special Report, METAR, SPECI, and optional data
- **AMFIS**: Includes TAF, Landing Forecast, Takeoff Forecast, and optional data
- **Space Weather Information Service (SWIS)**: Provided via SWIM

**Further beyond (TBD)**

- **Hazardous Weather Information Service (HWIS)**

***future timelines of ICAO SARPs are subject to review by the Air Navigation Commission (ANC), followed by the adoption by the Council.**



# Thank you

## Any questions?