ECA
European Cockpit Association

Enhancing Aviation Weather Information for Flight Safety

The pilot perspective

Weather as a critical safety factor

From the very first powered flights of the Wright brothers to today's highly automated and interconnected aircraft, weather has remained one of the most decisive factors influencing flight safety and operational efficiency. Adverse weather affects every phase of flight: strong winds, snow, and ice complicate ground operations; low visibility challenges take-off and landing; turbulence and icing threaten passenger comfort and aircraft performance; and large-scale phenomena such as convective weather systems, volcanic ash clouds, and tropical storms can fundamentally alter route planning.

From the flight deck perspective, weather is not an abstract forecast but a dynamic, time critical operational reality. Pilots must continuously assess evolving conditions, often balancing incomplete or outdated information against operational constraints, traffic, fuel margins, and safety considerations. Decisions related to route deviations, altitude changes, delays, or diversions are frequently made under time pressure, with direct implications for safety.

Over the past decades, meteorological science has made remarkable progress. Advances in numerical weather prediction, supercomputing, satellite observation, and climate modelling have significantly improved forecast accuracy and range. Despite this, much of the weather information available to pilots in daily operations remains fragmented, text based, static, or difficult to interpret. Traditional products such as METARs, TAFs, SIGMETs, and fixed charts are essential, but they do not fully exploit the capabilities of modern digital flight decks and connectivity. It is to be noted that recommendations given by EASA in the 2018's strategy paper "Weather informations to pilots" are yet to be implemented.

In this document, the European Cockpit Association (ECA) outlines its vision for a modern, pilot centred approach to aviation weather. The objective is to improve flight safety and efficiency by focusing on five key pillars: **connectivity, readability, coordination, space weather, and training.** These priorities are directed at airlines, regulators, air navigation service providers (ANSPs), and meteorological organisations, with the shared goal of ensuring that pilots receive timely, accurate, and usable weather information when it matters most.

Connectivity

Internet connectivity on board commercial aircraft is becoming increasingly widespread and represents a major opportunity to enhance flight safety. Using secure means, reliable connectivity allows flight crews to access real time or near real time weather information both before departure and throughout the flight. Weather data can be displayed on electronic flight bags (EFBs), integrated into the Flight Management System (FMS), or shared directly with airline operations and dispatch.

Live updates of aerodrome weather, en route conditions, turbulence, icing, and convective activity provide pilots with a far more accurate situational picture than static pre flight briefings alone. This capability supports better tactical decision making, particularly when weather conditions evolve rapidly.

Connectivity also enables more effective information sharing. Traditionally, pilot reports (PIREPs) have been used to relay weather observations, but this process has often been slow and limited. Modern connected systems allow for automated or manual transmission of turbulence, icing, or volcanic ash information, benefiting both other crews and meteorological agencies. This feedback loop improves forecasts and enhances collective situational awareness.

ECA considers that:

• New commercial air transport aircraft should be equipped with **secure and reliable flight deck connectivity**, and existing fleets should be retrofitted as far as reasonably practicable. Priority should be given to medium and long haul aircraft.

• Both **uplink and downlink** of data should be available to enable two way information exchange.

• Connectivity should provide **continuous access to relevant, real time weather information** on the ground and in the air, representing a significant improvement over static products such as TAFs that may already be several hours old.

• Weather information should be sourced both from ground based systems and from airborne reports, including pilot generated data. **Tools such as IATA Turbulence Aware should be widely implemented.**

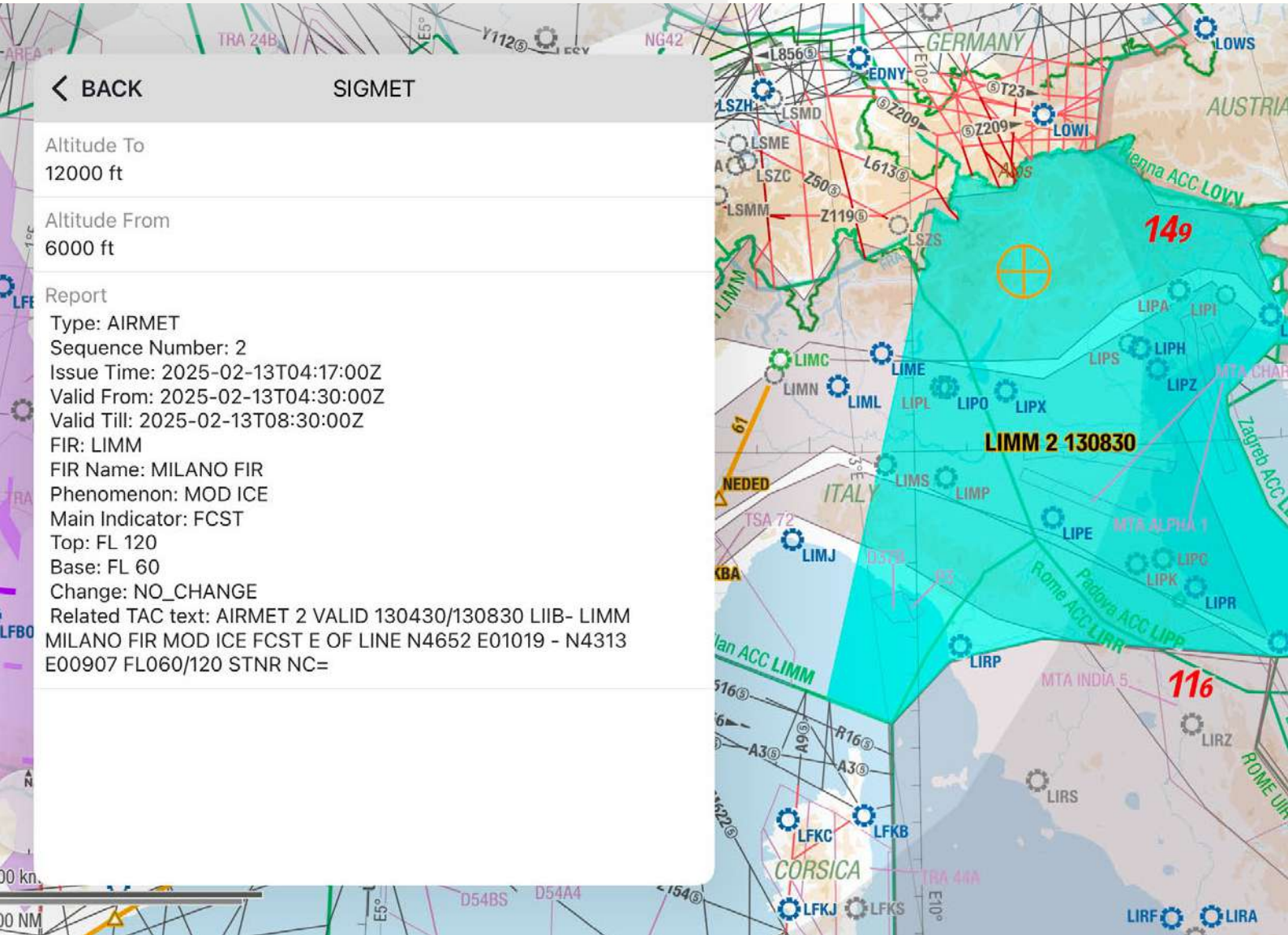
• While operators need to consider certified connected aviation weather applications, pilots should ensure that the digital commercial weather applications they sometimes use for flight preparation, beyond operator-approved or -provided tool, are appropriate for aviation operational use.

Readability

The usability of weather information is as important as its accuracy. Pilots frequently have to interpret complex charts, coded text, or coordinate based descriptions of significant weather areas that were produced hours earlier. This can result in increased workload and a higher risk of misinterpretation.

Modern digital devices offer extensive possibilities to improve the presentation of meteorological data. Moving maps displaying the planned route, real time aircraft position, selectable weather layers, and altitude dependent views can significantly enhance situational awareness. Ideally, all relevant weather information should be accessible through a single, intuitive, and integrated interface.

Highlighting weather-affected areas on a map greatly helps pilots. Simple text formats are less user-friendly.



ECA calls for:

• Weather information to be presented in a **clear, intuitive, and easily** interpretable format.

• Colour coding and standardised symbols to be used consistently to **enhance readability and reduce ambiguity**.

• Charts and graphics to display the lateral route and, where relevant, the vertical flight profile.

• Pilots to be able to select or deselect altitude bands and specific weather phenomena **according to operational needs.**

• When feasible, charts to show the real time aircraft position. Interactive displays and filtering options to be available both during flight preparation and in flight.

• The real time position and extent of SIGMETs to be **clearly visible on charts**.

• Displays to remain readable under both daylight and night time cockpit lighting conditions.

Coordination

Effective coordination between pilots, air traffic controllers (ATCOs), meteorologists, and dispatchers is essential for safe and efficient operations, particularly in complex and cross border airspace. Shared access to accurate, real time weather information ensures a common operational picture and supports consistent decision making.

Cross border forecasting tools, such as the EUMETNET Cross Border Convection Forecast (CBCF), play a crucial role in aligning traffic flow management, routing, and capacity planning with prevailing and forecast weather conditions. These tools should be supported, expanded, and harmonised across Europe.

ECA requests that:

• Pilots and ATCOs have access to the same **real time weather information across national boundaries**.

• Forecasting tools such as the **CBCF** are further developed and widely adopted by **ANSPs and airlines**.

• Meteorologists are available in Area Control Centres to provide expert input during significant weather events.

• TAFs are **reviewed and updated** frequently to ensure operational relevance and accuracy.

Space Weather

As aviation becomes increasingly dependent on satellite based navigation, communication, and surveillance systems, space weather has emerged as an operational consideration. Solar activity can disrupt GNSS signals, radio communications, and increase radiation exposure, particularly during high altitude and polar operations.

Although extreme space weather events are relatively rare, their potential operational impact can be significant. Awareness, monitoring, and clear procedures are therefore essential to mitigate associated risks. In Europe, space weather advisories are provided by the Pan European Consortium for Aviation Space Weather User Services (PECASUS).

Solar radiation can also produce spectacular effects, such as the northern lights.

ECA recommends that:

• Space weather advisories are included in briefing packages for all flights where they are operationally relevant.

• **Pilots receive training** to understand space weather information and its potential impact on flight operations.

• **Airlines establish clear procedures** for responding to space weather alerts, comparable to existing protocols for turbulence, volcanic ash, and tropical cyclones.

Training

Meteorological knowledge is a fundamental component of pilot competence, yet it is often undervalued once initial training is completed. While experience gained on the line is invaluable, structured, recurrent, and scenario based training is essential to maintain and deepen weather awareness.

Particular emphasis should be placed on the correct use and interpretation of onboard weather radar, EFB applications, and connected weather tools. Closer collaboration between pilots and meteorologists can further enhance mutual understanding and operational effectiveness.

More training on weather radar could help pilots interpret it more effectively, especially when using newer systems.

ECA considers that:

• **Airlines should invest** in comprehensive, practical weather training programmes for pilots.

• Training should focus on r**eal world decision making**, including the use of weather radar, interpretation of live weather data, and effective turbulence avoidance strategies.

• Regular workshops or briefings involving pilot representatives and meteorologists should be **encouraged**.

• Improved weather awareness and communication directly contribute to better decision making and enhanced flight safety.

Definitions

METAR (Meteorological Aerodrome Report): A standardised coded report providing current weather conditions at an aerodrome, typically issued hourly. It includes wind, visibility, runway visual range, present weather, cloud conditions, temperature, dew point, and pressure.

TAF (Terminal Aerodrome Forecast): A coded forecast describing expected weather conditions at an aerodrome for a defined period, usually 24 or 30 hours, used primarily for flight planning.

SIGMET (Significant Meteorological Information): A warning issued to inform pilots of hazardous en route weather phenomena such as severe turbulence, icing, volcanic ash, or tropical cyclones, typically valid for up to four hours.

ASHTAM: A notice providing information on volcanic activity that is, or is expected to be, operationally significant for aviation.

ANSP (Air Navigation Service Provider): An organisation responsible for providing air traffic management and related services, including communication, navigation and surveillance.

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