Since the days of the Wright Bros., pilots recognize the importance of weather to safe flying. Getting modern weather information for planning, with regards to enroute conditions to landing and final parking, is part of every professional pilot’s work. This information-set should include appropriate, modern, colourful weather info for print-outs, for the eFB, for uplink enroute. Information about turbulence, convection, cloud height and volcanic clouds is extremely relevant. Unfortunately, such information-sets are rarely available in airline practice.

Looking back, Meteorologists have concentrated on building ever more complex and capable meteorological systems on Earth and in Earth orbit. The Met Systems provide, transform and transport data: gigabits/second, multi-terabyte storage banks. We have a veritable glut of data, which will get pushed into the aviation data-systems of the future. Names like SWIM, IWXXM and 4D DATACUBE are in use.

Fig. 1: A huge amount of data is available, but too little of the needed information is reaching pilots.
So, data is available, information is available but the relevant rules and regulations, which are necessary to co-ordinate Met around the globe, have not been adapted to allow the practical use of much of the data. WAFS datasets are available several times a day, but visualisation of the data is left to the so-called private sector. Transmission of these data to aircraft in flight and display on an eFB is certainly possible – but the rules to allow this are neither flexible nor practicable. Transport of bits and bytes may get the occasional nod from a regulator, but getting approval for operational use of such data by displaying them to pilots is another matter entirely. Getting approval for any new product out of research is extremely difficult – and that would include even the approval for use of a paper printout of such information.

A symptom of the problem is, that in general, meteorologists don´t communicate with -airline-pilots on the expected weather anymore. The provision of weather in human-readable form, the promulgation of easily digestible graphical displays does not seem to be a high priority, although pilots need just that. Furthermore, the more challenging environment of today calls for the re-establishment of the knowledge transfer quality of a MET-briefing. Cortana, Siri or Alexa might assist selecting relevant information, and could even answer questions. Narrated movies and graphical displays could help.

Considering the very limited time available during briefing and in flight, meteorologists and especially regulators should make it their priority to engage in the improvement and provision of weather data on displays and printouts in human-readable form. The design of ´charts´, of easily digestible graphical displays needs to involve met experts, in order to avoid the risk of loss of meteorological information. R & D needs to move to operational use much faster, especially with regards to the development and standardization of graphical displays with the most effective in the transfer of information contained in the data to pilots.

Several providers are developing eFB applications. A path towards making these available to airline pilots within the regulatory framework is being built, but progress is slow. Matters are complicated, especially when a practicable form of usability/quality control for the applications is considered. Nevertheless, design guidelines for weather displays used by pilots need to be developed / improved, and guidance on colorful displays / printouts in a WMO Manual. Appropriate guidance, e.g. ICAO DOC 8896, Handbook of Meteorological Practice, and the ICAO DOC 10020, EFB Manual, needs to be enhanced.

Pilots have a limited amount of time during which to perform a prescribed curriculum of continuing education: aircraft systems, procedures, human factors. Met does not have a very high priority here, and a more active role of meteorologists would be very welcome. This engagement could take place not only at ICAO but also with the regulatory Civil Aviation Authorities to ensure they embed comprehensive Met curricula in their initial training rules and regulations. Additionally, program of continuing met education for pilots should be established within the regulatory framework.

Enhanced efforts are needed in the continued education of pilots about modern Met ideas (uncertainty, ensemble-forecasting, and decision support tools). Forecasts and displays need to be improved in line with the exponential growth of computing-power and observational capabilities, e.g. by satellites, ground stations or down-linked in-situ measurements by aircraft.
Meteorologists provide TAF forecasts, in TAC, traditional alphanumeric code, and information about future weather on SigWx charts. Nearly all the relevant information is available as data in some form, gridded or IWXXM or another format. Until now, there are no standards for the display of these data to pilots, and thus, research on such standards with the goal to improve the situational awareness of pilots by tailored forecasts, and tailored display formats needs to be done. Examples might be research the forecasting of CB, turbulence, the development and movement of all kinds of storms as well as their display in graphical form to pilots.

To summarize, data are available in large quantities, but little has been done to ensure that human users are receiving information that is easily ingested, understood and supporting decision-making in a clear, simple and unambiguous way. Near stagnation in the development of standardized information-displays and their transmission to pilots has taken place, although we would urgently need good, actionable information in modern form, available in the cockpit.

According to findings of the 2016/2017 CAeM global survey on aeronautical meteorological service provision, the CAeM Newsletter of September 2017, there is a very wide variety, globally, in the organisation of weather information provision. This variety should not hinder the flow of modern weather into the hands of pilots. It is, however, well beyond the means of any organisation like IFALPA to affect improvements uniformly on a global scale -it is hoped that the WMO, as a global organisation, can enhance standards and drive developments to ensure that the available Met-data can be visualized so that pilots can fly safer, with improved situational awareness.

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**Final thoughts**

- Met data that a pilot can not see is useless.

- Met is more than data – it’s about information, it’s about leveraging years of experience to gain an appreciation what’s probably going to happen.

- Met is about Mother Nature - and improving safety by accepting that she can be stranger and stronger than we can imagine.

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Fig. 2: We don’t need more supercomputers – we need modern, tailored weather information - in the hands of pilots.