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A weather awareness system supporting detection and forecasting of aviation hazards

Alessandra Lucia Zollo, Myriam Montesarchio, and Paola Mercogliano
CIRA - Centro Italiano Ricerche Aerospaziali, Meteorology Laboratory, Capua (CE), Italy

Awareness of weather conditions plays an increasing role in the aviation sector, which is very sensitive to meteorological conditions. In order to support pilots and flight management systems during flight, the CIRA (Italian Aerospace Research Centre) Meteorology Laboratory is developing an innovative system aimed to provide information concerning observed and forecasted (with different time range and spatial resolutions) meteorological hazards having potential not negligible impacts on the aircrafts. The present work describes the last enhancements in terms of new functionalities implemented in this system, continuously updated since 2014.
The system core is Meteo Service Centre (MSC), based on MATISSE (Meteorological AviaTIon Supporting SystEm), which gathers and consolidates observations provided by different sources (such as in-situ and remote sensing measurements) and forecasts provided as output of numerical weather prediction models and statistical methods. The system processes in near real time different formats of standard meteorological raw data, achieving more complex information useful for detection and forecast of hazards, and it stores them in a geodatabase for further applications. The main hazards currently considered are strong winds, heavy precipitation, icing conditions, lightning, clear air turbulence, cumulonimbus and their developing and dissolving phases. For each one, a specific tool for monitoring/detection and forecast is defined and implemented. In the nowcasting range, the tools are mainly based on satellite data, whereas on short and medium time range they are based on mesoscale limited area model COSMO-LM (for small specific domains, this model is adequately optimized at CIRA depending on the geographical area). COSMO-LM is developed also by CIRA since 2005 within the European COSMO consortium.
The system is designed to transmit weather data on-board, after performing an optimization process aimed to reduce data amount with a low reduction of the information content. This goal is achieved representing the areas affected by weather hazards by means of polygons, properly classified in terms of hazard severity (based on the analysis of historical dataset, stakeholders experience or literature works), allowing a simplified and intuitive visualization. This procedure is optimized taking into account the flight route requirements. More specifically, for the transmission on-board two options are under development. The first one is based on a data link from ground to the aircraft: weather data are transmitted by means of a binary message, reporting both the meteorological conditions of the reference airport and the hazards occurring over the flight area, following a well-defined protocol. The second option, instead, is based on a satellite communication system between the ground segment and the aircraft. In this case, weather data are optimized allowing to use cheap satellite communication systems. In both options, the transmitted weather information are managed on-board in order to allow the visualization in the aircraft.