Next Aviation Research and Development Project (AvRDP2)
A proposal (19 Jan 2021)

The joint WMO CAS/WWRP and CAeM Aviation Research and Development Project (AvRDP) successfully concluded in 2019. The Project resulted in the development and demonstration of new nowcasting and short-range forecasting capabilities and techniques for a range of meteorological conditions considered hazardous to aviation at 11 airports around the world with varying climatology. It demonstrated the importance of meteorological observations for nowcasting, forecast verification and calibration as well as the utility of probabilistic forecasts for the aviation community and essential need for close collaboration between the meteorological and aviation communities, in particular Air Traffic Management. In line with relevant EC decisions and resolutions, a scientific research proposal building on the success of AvRDP was submitted to the WWRP SSC-12 in October 2019 following coordination with the CAeM. The vision and mission of the proposed project, namely, AvRDP2, are as follows:

Vision: *"Leveraging advances in meteorological observing, nowcasting and forecasting research to enable the delivery of risk-based, hazard-impact information services that fully meet aviation users' needs."*

Mission: "*The overall mission of the Project is, through international collaboration, to develop, demonstrate and quantify the benefits of improvements to the forecasting of significant convection and* associated hazards*. The Project will also devote special attention on developing and demonstrating advancements in probabilistic forecasting and statistical methods (for providing confidence information and other assessments for the end-users), as well as on forecast verification and validation."*

Key research areas: In response to end-users' needs and feedback on AvRDP as expressed in various ICAO and WMO documents[1], AvRDP2 will focus on scientific advancement in observation, forecasting, warning of meteorological conditions considered hazardous to aviation[2] including capacity building, but not limited to:

(1) Hazardous Phenomena:
- Significant convection
- Convection-induced turbulence
- High Altitude Ice crystal icing
- Other phenomena including lightning, hail, heavy rain, high wind/windshear

(2) Improvement in observation and forecasting techniques:
- Advances in observing methods and use of observations
- Seamless forecast (blended nowcast and model forecast or innovative AI techniques along trajectory of city/airport-pair)
- Probabilistic forecast and statistical methods (for uncertainty/confidence assessment)

(3) Verification and validation
- Both scientific and user focus

(4) User focus:
- MET-ATM impact translation and Impact-based decision support modelling
- Capacity development for WMO Members providing new and enhanced aeronautical meteorological services and young meteorologists

[1] The ICAO and WMO documents reflecting the end-user needs and feedback on AvRDP include : (a) the ICAO Global Navigation Plan and its aviation system block upgrade methodology; (b) the outcomes of AvRDP I; (c) the outcomes of the AeroMetSci-2017 Conference; (d) the WMO Long Term Plan for aeronautical meteorology; and e) the ICAO White Paper on Future Meteorological Information Services.

[2] AvRDP2 is to focus more on addressing the delivery of the future risk-based, aviation hazard-impact information services.

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How: The Project is to demonstrate the concepts of research-to-operations and science-for-services with the full value chain through collaboration between Research Board, INFCOM and SERCOM. It would involve for example airport city-pairs to demonstrate the gate-to-gate use of advance aviation meteorological information in the future aviation operations environment. It would require seamless meteorological information from the take-off, ascent, cruising, descent, until landing phase to support the whole safe and efficient flight operations for the whole trajectory. It fits well with WMO's seamless earth system initiative, where "seamless" refers not just to the time-scales from minutes to days in this project, but across earth system domains spanning the whole value chain from observations to users' benefits. Opportunity would be taken to evaluate the impact of observation, including the benefits of additional observations in the terminal area. While weather hazard information from the World Area Forecast System (WAFS) is available for flight planning, this has to be supplemented by advanced nowcasting information for tactical and pre-tactical decisions. The project will study the blending of nowcasting information on the above-mentioned key meteorological hazards with global and regional models using advanced techniques such as the use of Machine Learning methodology. Special attention would be placed on the advancement of the use of ensemble techniques in probabilistic forecasting and statistical methods for assessing the uncertainly/confidence of the information, as well as on verification and validation. There is also a need to link with the Seamless-Global Data Processing and Forecasting System (S-GDPFS) concerning data availability and future modeling improvements. Close connection with the aviation users via, e.g., SC-AVI under SERCOM, would be required to ensure the outcomes are fit-for-purpose.

Who: It would be conducted collaboratively involving scientists from national meteorological and hydrological services specifically those providing aeronautical meteorological services, universities and research institutions, guided by a continuous and iterative consultation process with aviation stakeholders such as ICAO (representing regulators), IATA (airlines), IFALPA (pilots), ACI (airports), IFATCA (air traffic controllers), CANSO (air navigation service providers) and other relevant experts. This collaboration would be designed to facilitate better understanding of the impact (including "secondary impact") of meteorological hazards to aviation. This will ensure that the meteorological requirements for a range of decision-making horizons (time and space) and a range of aviation operations (airport, terminal area and enroute) will, due to the intrinsic variability of the atmospheric predictability of meteorological phenomena at different scales, be central to the Project.

Governance: It is proposed that the project be under the lead of WWRP under Research Board (RB) with SC-AVI under SERCOM as close partner and Infrastructure Commission (INFCOM) as the secondary partner. RB will take charge of the research element while SERCOM will serve as the channel linking WMO with the International Civil Aviation Organization (ICAO) and other aviation stakeholders to ensure the Project is steered towards the global air traffic management vision conveyed in the ICAO Global Air Navigation Plan (GANP) over the coming decade. A cross-cutting Task Team involving relevant WWRP/WGs, Core Projects, as well as SC-AVI/ET-MHS from SERCOM is to be formed to guide and oversee the Project. SERCOM and INFCOM will jointly contribute to the operation aspects especially on the R2O aspect.

When: The Project is expected to last 5 years from 2021 -2025 with periodic reviews of progress to be conducted after an Initial phase (around early to mid 2021) and at mid-progress around mid or late 2023. The next phase is the operationalization phase focusing on R2O (2023 till 2025 when the project will be concluded) (Suggestive Implementation Plan in Appendix A).

WHY (supplementary): Aeronautical meteorology is critical to the safe, efficient, regular and sustainable operation of the global aviation system and can help to reduce the environmental impact of flights. A key concept in the GANP is TBO which requires fit-for-purpose streams of observed and predicted data of high temporal and spatial resolution that are suitably updated, along the entire flight trajectory, from taxi and take-off, through ascent, en-route (cruise) and descent phases, to landing and gate arrival phases.

According to the global survey on aeronautical meteorological service provision conducted in 2016/17, majority of the services are provided by the national meteorological and hydrological services (NMHS). A long-term plan for aeronautical meteorology (LTP-AeM) prepared by CAeM and published by WMO in 2019 provides a framework for the progressive transformation from a conventional "product-centric" approach to a modern "information-centric" approach to MET service provision that is appropriate for risk management and other needs as articulated through ICAO's GANP and an ICAO 'White Paper' of 2018 titled 'Future Aeronautical Meteorological Information Service Delivery'. This project is intended to further the scientific advancement, and apply the scientific findings and new methodologies to service delivery ('science-for-services') to demonstrate the achievable benefits to aviation users.