Machine Learning in Aviation Weather Forecasting: Progress and Planning

Executive Summary

Machine learning (ML) is on the brink of revolutionising the way weather forecasts are delivered to the aviation industry. ML models have the potential to produce forecasts of greater skill than traditional numerical weather prediction (NWP) that can be delivered more cost-effectively and focus on specific aviation hazards and regions. This report outlines key milestones in the development and application of ML methods relevant to Met Office products and services for the CAA and considers their implications for future work. Over the past few years, the Aviation Applications team (AvApps) has been developing its ML capabilities and has produced several demonstrators and case studies. These include cumulonimbus cloud nowcasting, global convective forecasting and fog prediction; case studies spanning hazards, lead times, and scales using a range of ML techniques. These projects provide evidence of delivering measurable improvements in aviation hazard forecasting and importantly show the step to operationalising ML models is close. Both the Met Office and the CAA have developed AI and ML strategies, showing ambition to move towards new techniques for weather forecasting. The examples produced by the AvApps team show that this ambition can be realised in the near-future, and much sooner than the anticipated timeline laid out in the CAA's Strategy for AI in Aviation 2024. This development mirrors the progress being made across the Met Office and wider weather forecasting sector. ML forecasting is now being trialled at UK airports, including London City, and new methods are being developed by tech-giants (such as Google DeepMind)

and small data-driven start-ups. The Met Office and CAA should monitor emerging capability in the aviation weather forecasting domain and respond accordingly. Given the stringent regulatory environment of the aviation industry, it is essential to understand the implications of adopting AI methods and to ensure that new technologies meet high standards of safety and transparency. Therefore, the AvApps team has developed its ML model demonstrations using the principles of Trustworthy AI. This ensures that ML models are explainable, free from bias, and grounded in meteorological truth. The weather expertise that the Met Office has developed over decades, combined with the research to operations pipelines that the organisation continues to evolve, shows that the Met Office can provide reliable ML models to the aviation forecasting sector. Over the next 5 years the AvApps team will continue to grow its ML capabilities amongst its commitment to delivering projects laid out in NR23 (the regulatory period 2023-2027). It is highly likely that machine learning will play a key role in the next Regulatory Period (NR28 which covers 2028-2032), and we recommend how the CAA can support that development. The emergence of AI methods and applications is a pivotal moment for aviation sector. The AvApps team is developing approaches that are trustworthy, and customer focussed. Aligned with the Met Office's wider strategy

aims, future AvApps projects will consider choosing ML methods alongside other approaches for any future project, and where suitable, develop these ML methods in parallel or as a replacement to traditional methods.