

# Analysis and Design of Trajectory-Based Operations under Wind Forecast Uncertainty

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Abstract— The Trajectory-Based Operations (TBO) concept is a key part of the FAA's and EUROCONTROL's programs to make flight operations more efficient and predictable, while maintaining operational flexibility. TBO relies on four dimensional (4D) trajectories that are managed by specifying a sequence of metering points. Each metering point is associated with a controlled time of arrival (CTA) that must be met by the aircraft within a specified time tolerance. Although the TBO concept has been around for a while, prior literature has not addressed design aspects, such as identifying metering point locations and their impact on the system performance. In this paper, we show how a prior analytical model for TBO can be adapted to account for wind forecast uncertainty, and other operational constraints. We investigate the influence of different system parameters such as wind forecast uncertainty, distance between metering points, and CTA tolerance. The analysis reveals interesting trade-offs between various performance metrics such as throughput, fuel burn and delay. Based on this analysis, we propose a framework for locating metering points to satisfy traffic demand, while being fuel efficient.