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Super Ensemble-based Aviation Turbulence Guidance (SEATG) for Air Traffic Management (ATM)

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Super Ensemble (ensemble of ten turbulence metrics from time-lagged ensemble members of weather forecast data)-based Aviation Turbulence Guidance (SEATG) is developed using Weather Research and Forecasting (WRF) model and in-situ eddy dissipation rate (EDR) observations equipped on commercial aircraft over the contiguous United States. SEATG is a sequence of five procedures including weather modeling, calculating turbulence metrics, mapping EDR-scale, evaluating metrics, and producing final SEATG forecast. This uses similar methodology to the operational Graphic Turbulence Guidance (GTG) with three major improvements. First, SEATG use a higher resolution (3-km) WRF model to capture cloud-resolving scale phenomena. Second, SEATG computes turbulence metrics for multiple forecasts that are combined at the same valid time resulting in an time-lagged ensemble of multiple turbulence metrics. Third, SEATG provides both deterministic and probabilistic turbulence forecasts to take into account weather uncertainties and user demands. It is found that the SEATG forecasts match well with observed radar reflectivity along a surface front as well as convectively induced turbulence outside the clouds on 7-8 Sep 2012. And, overall performance skill of deterministic SEATG against the observed EDR data during this period is superior to any single turbulence metrics. Finally, probabilistic SEATG is used as an example application of turbulence forecast for air-traffic management. In this study, a simple Wind-Optimal Route (WOR) passing through the potential areas of probabilistic SEATG and Lateral Turbulence Avoidance Route (LTAR) taking into account the SEATG are calculated at z = 35000 ft (z = 12 km) from Los Angeles to John F. Kennedy international airports. As a result, WOR takes total of 239 minutes with 16 minutes of SEATG areas for 40% of moderate turbulence potential, while LTAR takes total of 252 minutes travel time that 5% of fuel would be additionally consumed to entirely avoid the moderate SEATG regions.