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Application of the Lighthill-Ford Theory of Spontaneous Imbalance to Clear-Air Turbulence Forecasting

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A new method of clear-air turbulence (CAT) forecasting based on the Lighthill–Ford theory of spontaneous imbalance and emission of inertia–gravity waves has been derived and applied on episodic and seasonal time scales. A scale analysis of this shallow-water theory for midlatitude synoptic-scale flows identifies advection of relative vorticity as the leading-order source term. Examination of leading- and second-order terms elucidates previous, more empirically inspired CAT forecast diagnostics. Application of the Lighthill–Ford theory to the Upper Mississippi and Ohio Valleys CAT outbreak of 9 March 2006 results in good agreement with pilot reports of turbulence. Application of Lighthill–Ford theory to CAT forecasting for the 3 November 2005–26 March 2006 period using 1-h forecasts of the Rapid Update Cycle (RUC) 2 1500 UTC model run leads to superior forecasts compared to the current operational version of the Graphical Turbulence Guidance (GTG1) algorithm, the most skillful operational CAT forecasting method in existence. The results suggest that major improvements in CAT forecasting could result if the methods presented herein become operational.

Reference

Knox, J.A., D.W. McCann, and P.D. Williams, 2008: Application of the Lighthill–Ford Theory of Spontaneous Imbalance to Clear-Air Turbulence Forecasting. J. Atmos. Sci., 65, 3292–3304.