

Trajectory model validation using newly developed altitude-controlled balloons during the International Consortium for Atmospheric Research on Transport and Transformations 2004 campaign

Emily E. Riddle, Paul B. Voss, Andreas Stohl, Daniel Holcomb, Darren Maczka, K. Washburn, and Robert W. Talbot

During the summer of 2004, five altitude-controlled tracking balloons were flown as part of the International Consortium for Atmospheric Research on Transport and Transformations (ICARTT) campaign. These Controlled Meteorological (CMET) balloons, newly developed at the University of Massachusetts, are notable for their light weight (1 kg mass), efficient altitude control, ease of launch, long-duration flight capability, and ability to perform repeated quasi-Lagrangian soundings. The balloons were embedded in urban plumes from New York and Boston which they tracked over New England, eastern Canada, and the Atlantic Ocean while maintaining a nearly constant altitude. The flights ranged from 10 to 111 hours and covered a maximum distance of 3000 km. Balloon flight tracks are used here to assess the accuracy of trajectory models during intensive aircraft sampling periods. A new method is presented for increasing the number of available reference trajectories by dividing the balloon flights into shorter segments for statistical analysis. For trajectory durations between 2 and 12 hours, mean trajectory errors are found to be approximately 26% and 34% of the flight distance for ECMWF-based and GFS-based trajectories, respectively. Anomalously large model errors observed during three of the flights are found to be the result of a narrow low-level jet (15 July) and synoptic-scale flow patterns (9 and 10 August). The results from this study should be useful to researchers evaluating the performance of trajectory models and chemical transport models during the ICARTT campaign. Complete CMET balloon and model trajectory data sets are available as a supplement to this paper.