

Improvements in the CMDL Trajectory Model

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For many years, CMDL trajectories have been produced using European Centre for Medium-Range Weather Forecasts (ECMWF) operational data and the use of an isentropic model. With the goal of improving the accuracy of trajectories, we are evaluating reanalysis data sets and the use of a 3-D model. Initially, comparisons were made using various input data sets and types of models. The difference between trajectory pairs was quantified by averaging the 3-D distances along the full length of the trajectories and then normalizing by the average distance traveled. The average elevation along the trajectories was also calculated. Three sources of trajectory differences have been quantified: input data, vertical assumption, and other model differences (advection scheme, time step, interpolation methods). Only minor differences (2-3%) were found between CMDL and NOAA Air Resources Laboratories (ARL) trajectories when the same input data and the same vertical assumption were used (Figure 1). Using different vertical assumptions caused average differences of 15%. Isentropic trajectories at CMDL Mauna Loa Observatory (MLO) had significantly lower elevations than the 3-D trajectories. Because of this, the 3-D trajectories often encountered higher wind speeds and hence were longer. A disturbing result was that the greatest source of trajectory difference was use of different input data sets. For example, isentropic trajectories using the ECMWF operational data differed from those using National Center for Environmental Prediction (NCEP) reanalysis data by 18%. However, the elevations of these trajectories did not differ greatly, indicating that the source of the difference is mostly due to the horizontal wind fields. This summer when the ECMWF reanalysis data set becomes available, it will be compared with the NCEP reanalysis data. The causes for systematic differences between isentropic and 3-D trajectories are being investigated. The goal is to determine under what circumstances trajectory uncertainty exceeds acceptable limits.

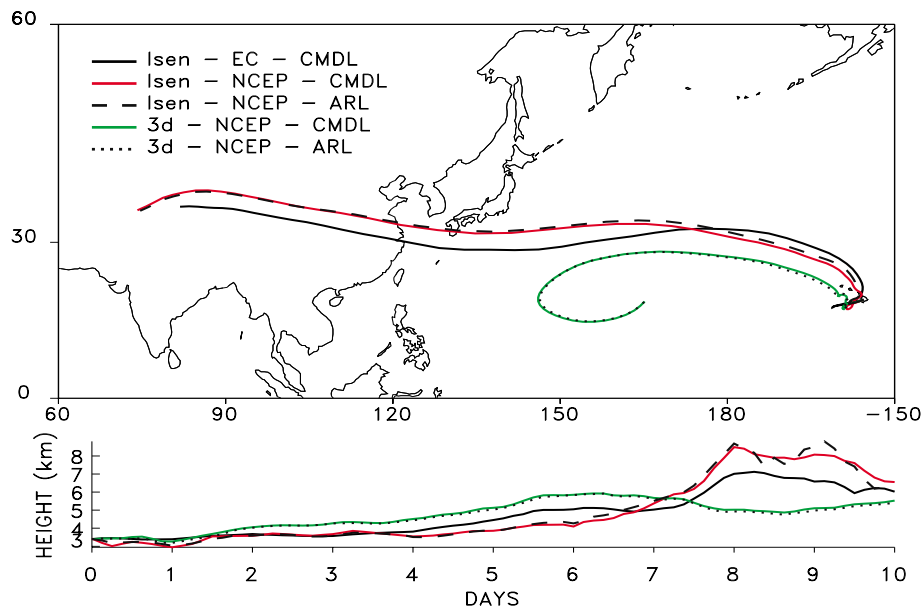


Figure 1. Five different trajectory types arriving at MLO on January 2, 2001, at 0000 UT. The source of the input data is indicated in the legend as "EC" for ECMWF operational data and "NCEP" for NCEP reanalysis data.