Backward Air Mass Trajectory Analysis for the First Cloud and Radiation Testbed Site at Lamont, Oklahoma

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The size distribution and composition of aerosols measured at a specific location depend on the origin and the trajectory of the air mass passing over it. Backward air mass trajectory analysis can be used to 1) identify the characteristics of an air mass and 2) help to determine which aerosol model should be used in LOWTRAN 7 for radiation calculations.

Examining the trajectory is not sufficient to characterize the aerosol composition of the air mass at the site. Additional analyses must be performed along the trajectory to understand how the original air mass has or has not been modified. Height analyses, precipitation events, the vertical temperature structure of the atmosphere, and the relative humidity field, as well as other physical parameters, are important for classifying an air mass after it has traveled for a few days.

The primary objective of this research is to characterize a climatology of air masses that pass over the Atmospheric Radiation Measurement (ARM) Program's Cloud and Radiation Testbed (CART) site at Lamont, Oklahoma. A three-dimensional air mass trajectory model and a method of analysis were developed at the Environmental Measurements Laboratory (EML). The classification of the air mass types (rural, marine, urban or desert) is used to decide which aerosol model is appropriate for calculations in a radiation model, such as LOWTRAN 7.

Trajectory Computations

Input data consisting of the analyses of the wind field, temperature, relative humidity, and precipitation at 12-hr intervals for the 1000-, 925-, 850-, 700- and 500-mb pressure level are used in EML's trajectory computer program. The data are received daily from the global circulation model of the U.S. Navy's Fleet Numerical Oceanography Center, Monterey, California. In this model, the horizontal grid interval is 2.5 degrees and covers a 33 by 19 horizontal grid matrix of the United States. The trajectories are computed backwards twice a day from the CART site, and the results are stored for further analyses. Trajectories reaching to the lateral boundaries of the matrix or 500-mb height are terminated.

Analyses

Horizontal and vertical cross sections of the trajectories are plotted to identify the origin and the path of the air mass. If an air mass travels over rural areas for a long period of time, it is designated as a "rural" air mass.

Vertical profiles of temperature and relative humidity along the trajectory are also plotted. These profiles provide information on the atmospheric stability, above or below the inversion height and the moisture content of the air mass and help to determine whether the air mass along the trajectory was modified. If an air mass travels below the inversion height and passes over a polluted city, it may be modified by urban emissions. In this case, the air mass arriving at the CART site would be designated as "urban."

A moist air mass coming from the ocean and traveling above the inversion height before descending to the CART site would be designated as "marine." In some cases, the air mass may be accompanied by rain before arriving at the site. The rain may modify the air mass by removing pollutants, therefore, the air mass is designated as "rural."

Future work

We will incorporate source emission inventory data (SO_2, NO_x and VOC, etc.) from the Environmental Protection Agency into our analyses. When the instrumentation to characterize the aerosol at the site is operational, the resulting data will help to improve air mass identification.