# Comments on "Characteristics of Plume Releases as Depicted by Balloon Launchings and Model Simulations"

JONATHAN D. KAHL

*Department of Geosciences, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin*

25 April 1990

The article by Stocker et al. (1990) is an interesting meteorological analysis of a balloon dispersion experiment conducted nation-wide by school children. One objective of the paper was to evaluate the ability of the ATAD trajectory model to simulate the mean transport of the balloons. I applaud the authors' interpretation of simulated and observed transport characteristics within different synoptic-scale meteorological regimes, however, I believe they underemphasized the role of upper-air interpolation in their assessment of model performance.

Several recent studies, some of which Stocker et al. cite, have shown that interpolation of existing upper-air network data leads to significant errors in trajectory model calculations. Errors in wind interpolation have been related to the spatial autocorrelation of upper-air observations (Kahl and Samson 1986, 1988a). Because subsynoptic scale motions and their resulting wind gradients cannot be fully resolved by the existing rawinsonde network, trajectory models are particularly sensitive to the spatial and temporal density of upper-air observations.

An earlier study of the ATAD trajectory model revealed a high degree of sensitivity to rawinsonde station density (Kahl and Samson 1988b). The study also demonstrated the importance of specifying the initial transport wind accurately. When comparing a single estimated trajectory with the mean transport of a number of balloons, it should be noted that a single meandering balloon will eventually be entrained into the mean flow, while an initial trajectory error (based on interpolated, sparse data) may amplify.

*Corresponding author address:* Dr. Jonathan D. Kahl, Department of Geosciences, University of Wisconsin—Milwaukee, P.O. Box 413, Milwaukee, WI 53201.

The effect of wind interpolation errors on ATAD trajectory estimates is shown in Fig. 1. The figure shows the 12 and 24 h endpoints of 1000 stochastic trajectories clustered about an analytical trajectory originating in southern Michigan. The wind field was defined as a homogeneous, time-invariant westerly wind of 5 m $s^{-1}$. Stochastic trajectories were generated by randomly perturbing the wind field to simulate spatial and temporal interpolation errors, with error statistics derived from the earlier analysis of Kahl and Samson (1986). The spreading cluster of trajectory endpoints is qualitatively similar to the balloon dispersion observed by Stocker et al. An ensemble of trajectories may thus be capable of describing the mean transport of a number of balloons, while a single member of the ensemble may not.

In conclusion, I believe that the inability of the trajectory model to accurately simulate the mean motion of the balloons is largely due to the inaccurate interpolation of sparse upper-air data. Because of the random nature of interpolation errors, the model is more reliable when used for long-term pollution studies.

## REFERENCES

Kahl, J. D., and P. J. Samson, 1986: Uncertainty in trajectory calculations due to low resolution meteorological data. *J. Climate Appl. Meteor.*, **25**, 1816–1831.

——, and ——, 1988a: Uncertainty in estimating boundary-layer transport during highly convective conditions. *J. Appl. Meteor.*, **27**, 1024–1035.

——, and ——, 1988b: Trajectory sensitivity to rawinsonde data resolution. *Atmos. Environ.*, **22**, 1291–1299.

Stocker, R. A., R. A. Pielke, A. J. Verdon and J. T. Snow, 1990: Characteristics of plume releases as depicted by balloon launchings and model simulations. *J. Appl. Meteor.*, **29**, 53–62.

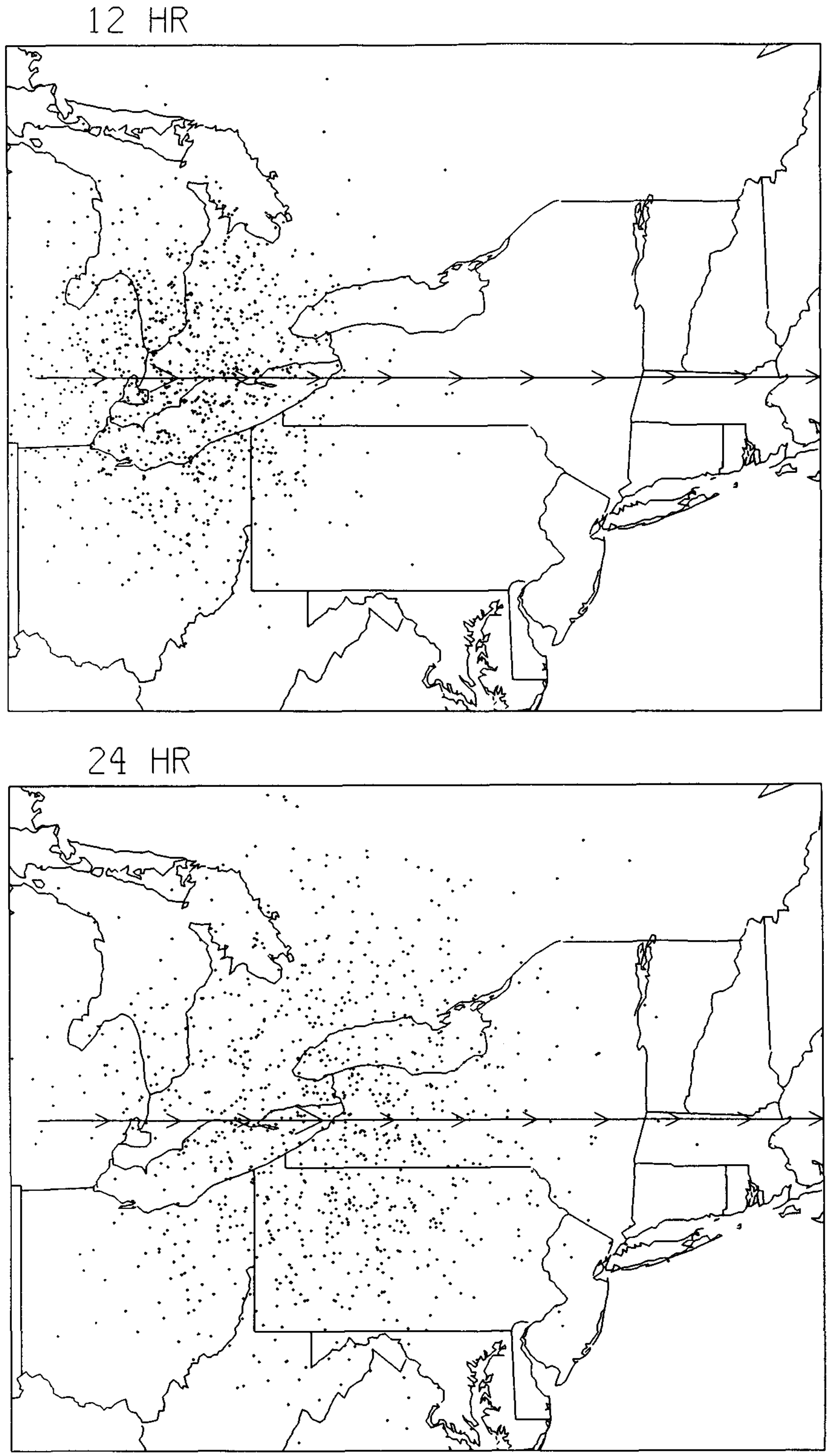


FIG. 1. Stochastic trajectory endpoints after (a) 12 h and (b) 24 h. The solid line is the analytical trajectory, with arrows drawn at 6 h intervals. The larger arrow indicates the true location at the indicated time.