Comments on "A Review of Relative Diffusion Analysis and Results"

A. D. KIRWAN, JR., AND W. J. MERRELL, JR.

Science Applications, Inc., Bryan, TX 77801

22 October 1979

The paper by Middleton (1980) is divided into three somewhat unrelated parts. Our comments are restricted to the last part, a criticism of one of a number of conclusions reported by Kirwan *et al.* (1978).

In essence Middleton claims that Kirwan *et al.* made a "serious error" in failing to state or test an assumption of stationarity in regard to some calculations of separation statistics. Critical to this argument is the assumption that the buoy motions are independent because the initial separations are much greater than "a typical mesoscale eddy diameter."

0022-3670/80/060994-02$04.50

If this diameter is interpreted as a turbulent length scale, then this assumption implies that the drifter displacement probability density functions are approximately normal. From this, using standard statistical techniques, Middleton establishes confidence intervals for the separation calculations. From the confidence intervals he infers that the separation rates for both the subtropical and subarctic gyres is not significantly different from the linear rate predicted for stationary, homogeneous turbulence.

We presented displacement calculations in the 1978 paper because we felt they were indicative of large-scale processes which are probably nonstationary. The rationale is that displacement statistics are interesting kinematic properties that are useful in describing aspects of the fluid motion. When coupled with a hypothesis such as stationarity the physical interpretation of the displacement statistics is greatly simplified. For reasons given by Kirwan *et al.* (1978) and summarized below, the data set was not treated as stationary. We believe that these reasons obviate Middleton's analysis.

As was shown in Kirwan *et al.* (1978) the buoy motions are not independent of the initial separations since any buoy once deployed in a gyre always remained in that gyre. Furthermore, there is nothing in the data base from this region of the North Pacific to suggest that mesoscale eddies behave as random turbulent eddies as implied by Middleton's analysis. Finally, a significant seasonal signal was observed in the data. Consequently, Middleton's critical assumption of normally distributed random variables is incorrect and his tests are not applicable to this data set.

Furthermore, even if the Gaussian assumption were correct, Middleton's test is not the most appropriate for establishing confidence limits for separation rates. A much stronger test for the latter would be to divide each data set into two or more parts and then test for statistical homogeneity of the regression statistics, especially the slope or separation rates. Then using the part of the data base appropriate for the large time asymptotic limit separation rate estimates could be made by least squares and their confidence limits determined by the Student's t test. However, such tests require the random variables to be normally distributed. Since this is obviously not true for our data it is inappropriate to discuss the results.

REFERENCES

Kirwan, A. D., Jr., G. McNally, E. Reyna and W. J. Merrell, Jr., 1978: The near surface circulation of the eastern North Pacific. *J. Phys. Oceanogr.*, **8**, 937–945.

Middleton, John F., 1980: A review of relative diffusion analysis and results. *J. Phys. Oceanogr.*, **10**, 992–994.