Comments on "An Iterative Algorithm for Objective Wind Field Analysis"

ROBERT E. ESKRIDGE[1]

Meteorology and Assessment Division, Environmental Protection Agency, Research Triangle Park, N. C. 27711

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In a recent paper, Liu and Goodin (1976) describe a technique for obtaining a divergence-free wind field using neither the calculus of variations nor a streamfunction.

However, there are some problems with the technique as given. First, the authors indicate through their notation in (9) [part of this equation shown below]

$$u^{n+1}_{p-1,q}=u^{n}_{p-1,q}-f_{p-1,q}\bar{u}^{n}_{p,q}h_{p-1,q}$$
$$u^{n+1}_{p+1,q}=u^{n}_{p+1,q}+f_{p+1,q}\bar{u}^{n}_{p,q}h_{p+1,q} \qquad (9)$$

and the statement "the velocities at the $(n+1)$th iteration will be the values at the nth iteration together with the velocity adjustments $\bar{u}^{n}_{pq}$ and $\bar{v}^{n}_{p,q}$," that there are two separate iteration levels. It is actually necessary to use the $(n+1)$ values as soon as they are calculated. To see that this statement is true suppose (p',q) is not near the boundary and the calculation is proceeding by increasing p' most rapidly. The algorithm states that $u^{n+1}_{p'-1,q}$ is to be solved using $u^{n}_{p'-1,q}$.

However, in the $(n+1)$ sweep through the grid a new value $(u^{n+1}_{p'-1,q})$ has been determined for this point when the index was $(p'-2, q)$. If $u^{n+1}_{p'-1,q}$ is ignored and $u^{n}_{p'-1,q}$ is used instead, the concept upon which the technique is based is violated; that concept being that equal adjustments are made at the $p'-1$ and $p'+1$ points and $q-1$ and $q+1$ points. Two separate iterative levels would yield a replacement at, say, the $p-1$ point, not an adjustment.

The second problem with the algorithms involves the use of a four-point approximation to the continuity equation such as (8) of Liu and Goodin when non-staggered grid systems are used. The problem is that as far as the iterative procedure is concerned there are two separate grids which do not interact or affect neighboring points at any time (see Fig. 1). This

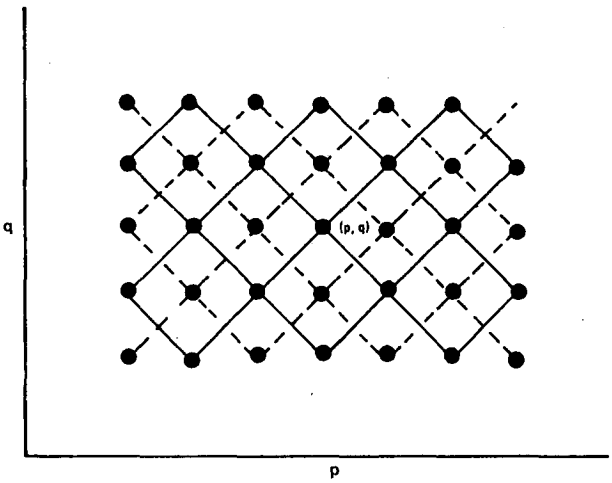

FIG. 1. A portion of the grid showing the two independent subgrids.

division of the grid into two independent subgrids will result in an analysis that can have a large oscillation. An examination of the computer code used by Liu and Goodin shows that they minimized this problem by setting the gradient at the boundary equal to zero. In other words, they connected the two independent grids at the boundary through common values. However, the larger the number of grid points used the more oscillation one would expect and, therefore, the four-point approximation must be used with care. The eight-point approximation to the continuity equation given by Liu and Goodin will not separate the grid into two disjoint subsets and, therefore, it is preferable to the four-point approximation.

[1] On assignment from NOAA, Department of Commerce.

REFERENCE

Liu, C. Y., and W. R. Goodin, 1976: An iterative algorithm for objective wind field analysis. *Mon. Wea. Rev.*, **104**, 784–792.