Reply

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Apart from being rather chagrined that I didn't think of the solution presented by Dr. Davies-Jones (pp. 2073–2075, this issue), I have no difficulty accepting his elegant formulation. In fact, I'm delighted to know that such a solution exists, as it allows all of us to explore further the ramifications of this model.

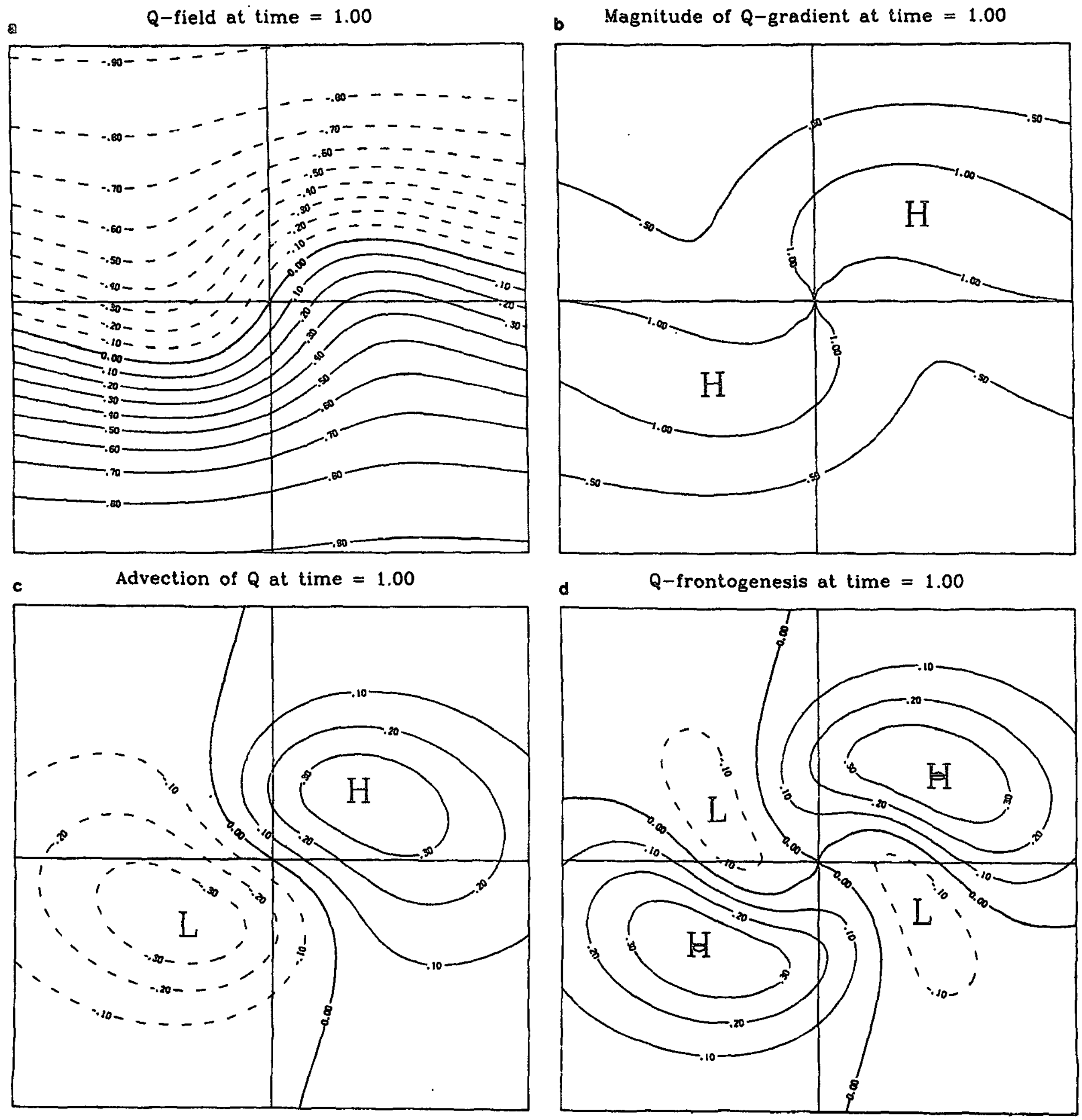

FIG. 1. (a) Solution for Q field at $t = 1.00$. Notation is essentially the same as in the original manuscript, (b) as in (a) except for Q-gradient magnitude field, (c) as in (a) except for Q-advection field, and (d) as in (a) except for Q-frontogenesis field.

I fear that my conditioning to accept the nonlinearity of the advection terms in more general situations was my undoing in this case. Once one recognizes that the flow field is fixed, the typical difficulty with such terms disappears. The removal of my self-imposed requirement for approximating the solution numerically also removes a reservation, expressed by one of the reviewers of my original manuscript, which was motivated by the temporal truncation errors in my approach.

Using his solution, I have redone the calculations on a microcomputer. I am providing revised figures as a means of illustrating how much of an error my approximations incurred and to show some more advanced (in time) calculations (Figs. 1–4). As Dr. Davies-Jones has suggested, the major problem is with the original calculation of the Q-gradient magnitude near the origin. Other adjustments are rather more subtle to the eye.

The times used in the revised figures (Figs. 1 and 2) do not correspond exactly to those originally used. In

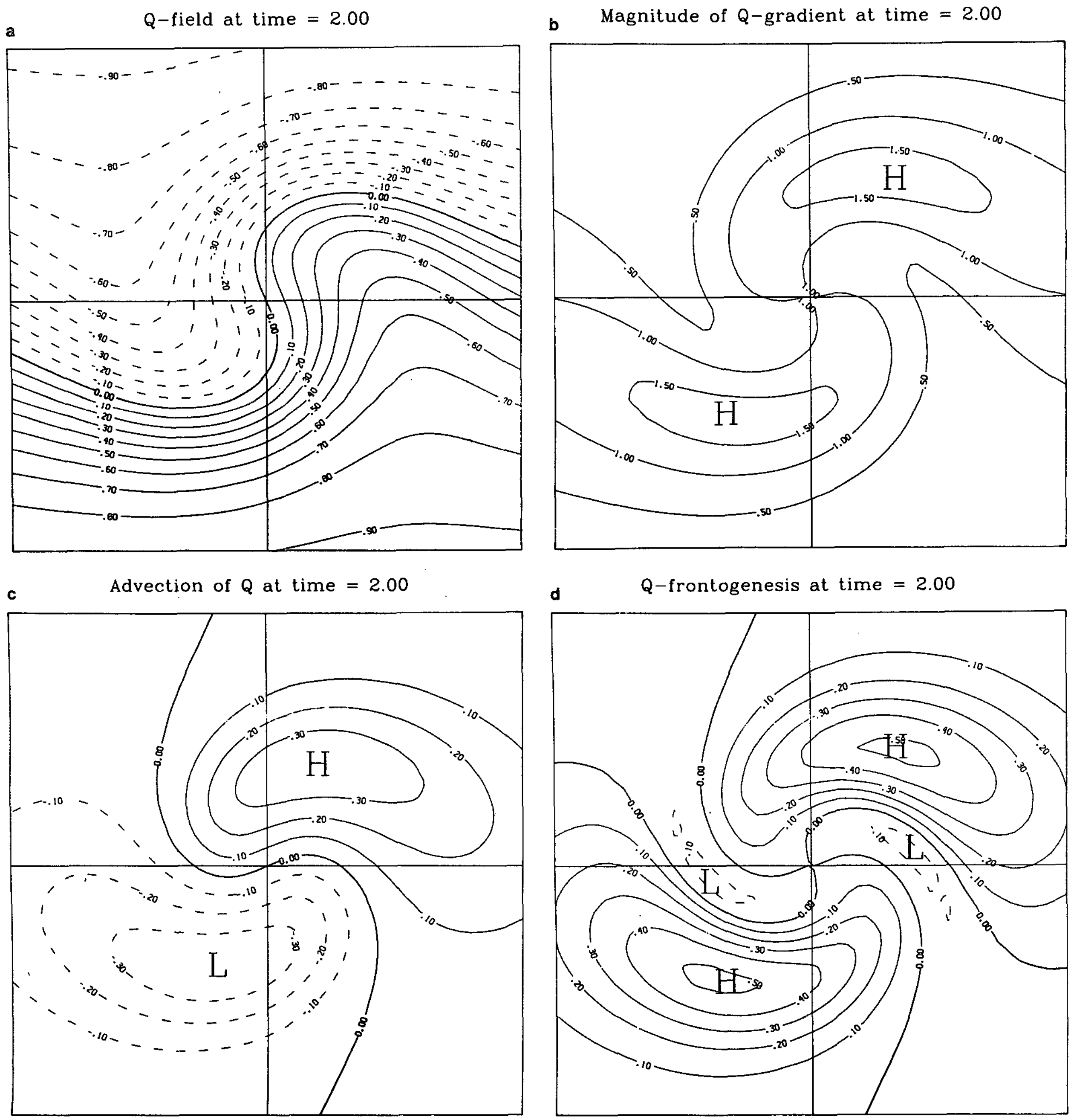

FIG. 2. As in Fig. 1 except at t = 2.00.

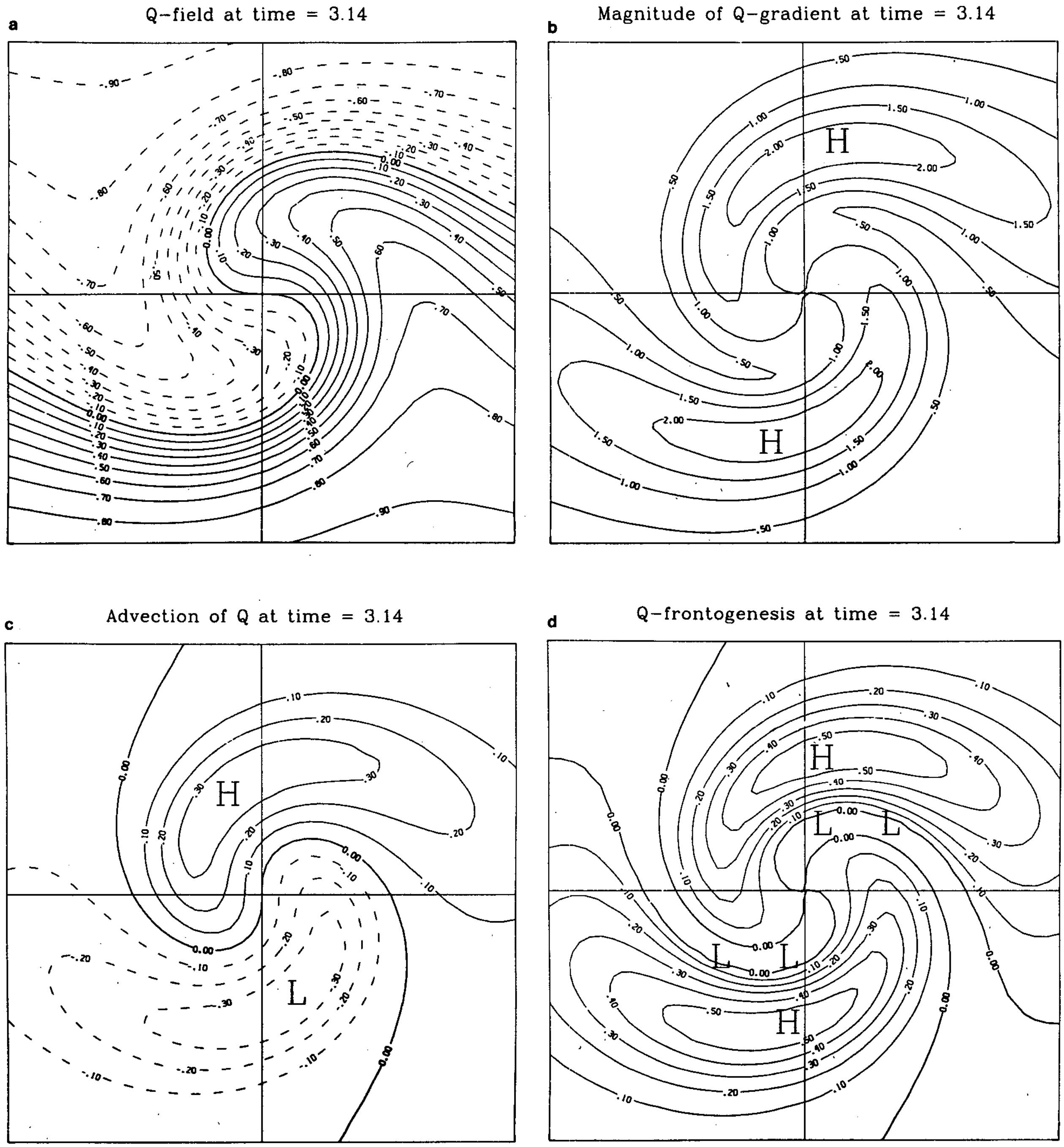

FIG. 3. As in Fig. 1 except at t = 3.14.

these figures, the nondimensional time is associated with the number of radians traversed at the origin. Since the model is purely kinematic, the actual time depends on the scale of the vortex under consideration. For an extratropical cyclone, t = 6.28 corresponds roughly to one day; for a mesocyclone, such a period is about 10 min; while for a turbulent eddy 100 m in radius, it is about one min. in duration.

Note the rather substantial increase in the magnitude of the Q-gradient, which increases more than fourfold by t = 6.28. With this analytic solution, it is possible to 1) vary the nature of the tangential wind with respect to the radius, 2) consider the detailed evolution of the fields near the vortex core (and also far from the core), and 3) follow the evolution as the wrap-up of the Q-field proceeds to large time values, to name only some of the possibilities. Note that when using a 31 × 31 grid, as I have, by t = 6.28 the deformations have re-

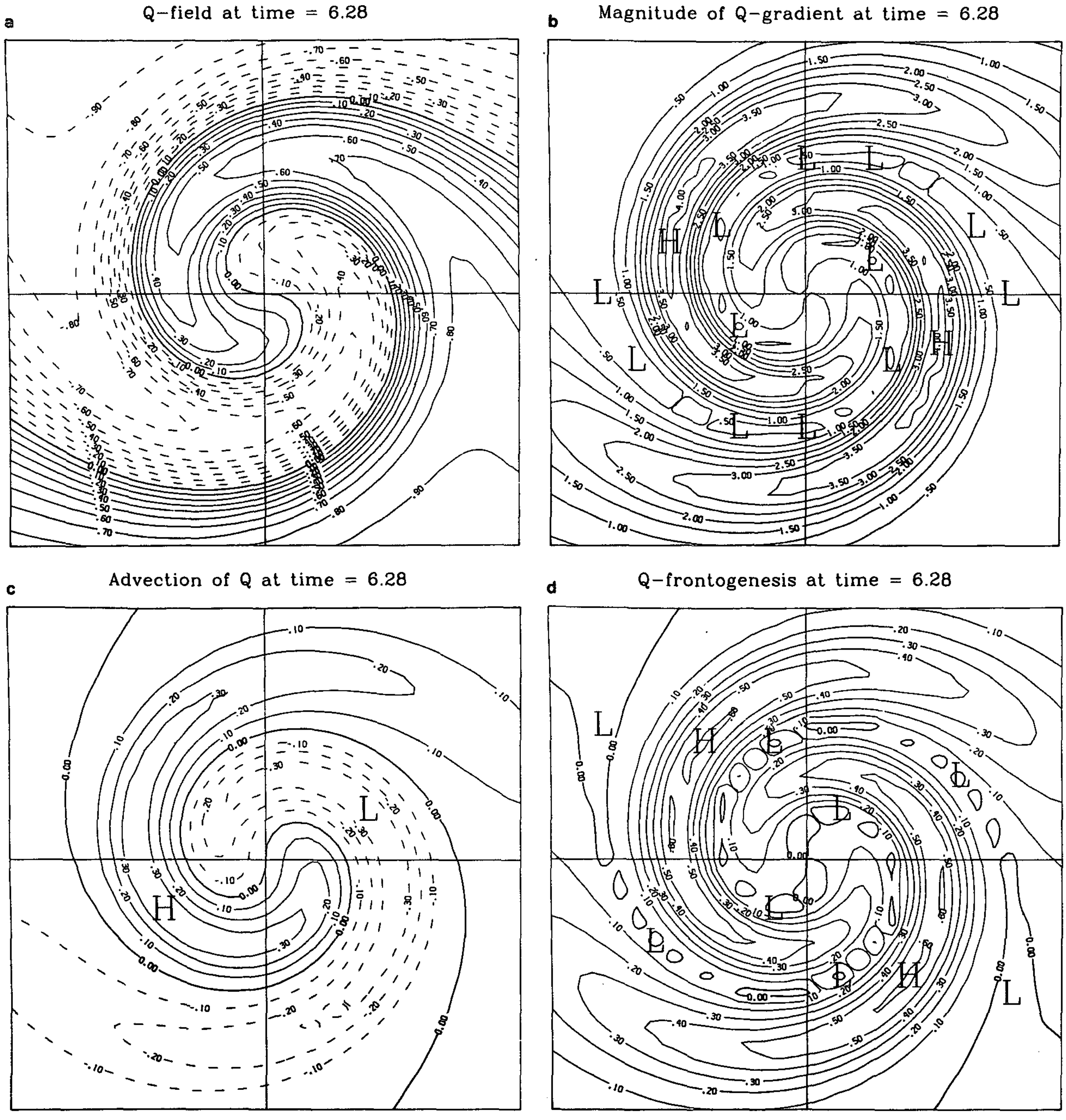

FIG. 4. As in Fig. 1 except at $t = 6.28$.

sulted in *spatial* truncation errors that are noticeable in some of the fields. This problem can be overcome simply by using a finer grid.

I have programmed the solution using a set of very short FORTRAN subprograms, allowing considerable flexibility. I will be happy to supply the source code to any interested readers who wish to explore this model on their own. I can copy them onto a personal computer-size (5¼ in) floppy disk in ASCII character format, if I am supplied with the diskette and a stamped, self-addressed mailer.

Acknowledgments. My thanks are extended to Mr. José Meitín, whose help in obtaining these graphical solutions has, once again, been extensive.