Reply

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13 January 1971

Peterson has demonstrated that conservation of mass when using the differentiated form of the continuity equation requires a constraint on the vertically-integrated divergence. The absence of such a constraint clearly results in errors in the numerical solutions, a point noted by Estoque (1961) in his original sea breeze paper. The question of how serious are these errors is not so clear.

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The reports of Estoque, and Magata (1965), both of whom employed the differentiated form of the continuity equation, give no indication of encountering difficulties so serious as that described by Peterson with the Moroz (1967) version of Estoque's model. Nor, in my calculations (McPherson, 1970), did I meet with such a devastating result. As it is unlikely that three independent investigators would commit the same programming error as Peterson uncovered, his experience appears to be unique. However, a recent paper by

Neumann and Mahrer (1971) indicates that errors associated with the use of this form of the continuity equation, while not so serious as Peterson suggests, may nevertheless not be negligible.

I remain reasonably confident that the conclusions expressed in my paper are not appreciably affected by errors arising from this source. In retrospect, however, it would have been preferable to employ some other means of suppressing or stabilizing the external gravity mode in the numerical solution. One such device is the semi-implicit integration scheme (Marchuk, 1965; Kwizak and Robert, 1971), which appears to be quite suitable for this purpose. Unfortunately, this technique was not widely known at the time my model was developed.

Peterson also notes that the exchange coefficient formulation is strictly valid only for steady-state flow over homogeneous terrain. While the flow in my model is non-steady, the exchange coefficient is a function of horizontal position only to the extent that stability varies horizontally. That is, the underlying surface was assumed to be flat and of uniform roughness and varying horizontally only insofar as land and water possess different heat capacities. It is difficult to assess quantitatively the impact of these departures from theory. When compared qualitatively to other assump-

tions made in the parameterization of the boundary layer, e.g., the assumption that the exchange coefficients for heat and momentum are equal, or the numerical approximations employed in blending the boundary layer formulation with that of the transition zone, they do not appear to be of major importance in this model.

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