Reply

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In the first part of his comments, Professor Reed, in effect, criticizes our assumption of geostrophic adiabatic flow. The restrictive nature of that assumption has already been emphasized in our paper. However, it does *not* rule out individual stability changes. In fact, from eq (3) and (7) of our paper, the individual stability change can be derived in the equivalent forms[2]

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[2] We are indebted to Mr. F. K. Ball for deriving the same result in a different manner.

$$\frac{ds}{dt} = \left(\frac{F}{g}\right) sW\left(k \times \frac{\partial W}{\partial z}\right) = \frac{s}{\Theta}\frac{\partial \Theta}{\partial t} = -\frac{s}{\Theta} W \nabla \Theta. \quad (1)$$

This disposes of Professor Reed's claim that differential advection "has no effect whatever on individual stability change."

As regards the Richardson number, Professor Reed queries our assumption of persistent wind shear which he replaces by that of constant slope of the isentropic surfaces. But the basic idea of hodograph analysis is that the existing wind structure determines the change in the thermal stratification. Hence, the wind structure must be assumed to persist for some time. The same type of assumption is made in numerical forecasting when computing the vorticity advection from the existing flow field.

Moreover, the slope of the isentropic surface (or, strictly, the difference between the slopes of the isentropic and isobaric surfaces[3]) is given by

$$\tan \alpha = \frac{\partial W/\partial z}{s}. \quad (2)$$

Hence, Professor Reed's assumption of constant α would require the wind shear to change in exactly the same manner as the stability—surely a far more artificial assumption than that of a quasi-persistent wind structure.

Thus, all of Professor Reed's doubts can, in our opinion, be discarded. However, the relevance of differential advection for clear-air turbulence of course requires further confirmation by observations, by using either Keitz's[4] method or hodograph analysis.

[3] Radok, U., and R. H. Clarke, 1958: Some features of the subtropical jet stream. *Beitr. Phys. Atmos.*, **31**, 107.

[4] Keitz, E. L., 1959: Differential advection as a factor in clear-air turbulence. *J. Meteor.*, **16**, 57–62.