Reply

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8 November 1974

We thank Dr. Pandolfo for pointing out our oversight in characterizing all of the turbulence parameterizations used in his paper (Pandolfo, 1971) as being explicitly height-dependent. His use of a local Richardson number dependence for the parameterization in Model I does permit variations in the depth of the planetary boundary layer which are not possible with the explicit height-dependent eddy coefficients used in the other parameterizations (in Models II–IV) described in his paper.

However, it should be emphasized that the philosophy behind our parameterization differs from Pandolfo's approach in that we do not use different eddy viscosity formulations to represent different convective behavior as Pandolfo does in his parameterization (Model I). Rather our formulation for the eddy exchange coefficients consists of a single formula involving local convective instability. This expression is applied over the entire model under all convective conditions with the calculated flow fields evolving with little damping until convective instability occurs and the local eddy coefficients increase to simulate strong turbulence generation. The resulting damping characteristics are particularly desirable for representing developing gravity waves (Orlanski and Ross, 1973) but are also shown to produce many realistic features in the diurnally-varying planetary boundary layer of a mesoscale model as shown in our paper (Orlanski *et al.*, 1974).

As regards Pandolfo's second comment, one would hope that the boundary layer functions ϕ_M and ϕ_H obtained from the model simulation would exhibit a similar behavior to data observed in the lower 10 m or so of the atmosphere. The distinction between the parameterized subgrid-scale turbulent fluxes and the total turbulent fluxes, both resolved and parameterized, is unimportant at this height in our mesoscale model [see Fig. 16 of Orlanski *et al.* (1974)] since the current resolution is insufficient to resolve eddies explicitly at this height above the surface. This does not mean that the comparison of ϕ_M and ϕ_H with observations in Fig. 21 of our paper is trivial since our eddy viscosity formulation was not derived from surface observations. Obviously a parameterization such as Pandolfo's which was obtained from observations in the surface layer will produce good agreement with such surface observations. However, this provides little assurance that such a parameterization will perform well in the upper part of the boundary layer.

REFERENCES

Orlanski, I., and B. B. Ross, 1973: Numerical simulation of the generation and breaking of internal gravity waves. *J. Geophys. Res.*, 78, 8808–8826.