Comments on "Diurnal Variation of the Planetary Boundary Layer in a Mesoscale Model"

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Orlanski *et al.* (1974) have described some interesting properties of a mesoscale model, in which eddy exchange coefficients in the planetary boundary layer are modeled as functions of stability.

However, in referring to previously proposed formulas they have apparently misinterpreted the approach of this investigator (Pandolfo, 1971) in their statement, "who used different parameterizations for different regions above the surface." In that paper, four alternative parameterizations were considered, three of which were refinements of the parameterizations used by Miyakoda *et al.* (1969), and one of which (Model I) is specifically the parameterization derived and used by Pandolfo in previous work cited in that paper. Model I uses a single set of parameterizing formulas at all heights above the surface, in which a key parameter is the local Richardson number Ri. Even though Ri is found to be dependent on height, one should no more describe the set of formulas used in Model I of Pandolfo (1971) as "differing for differing layers" than one should so describe the set (2.8) of Orlanski *et al.* (1974), because $\Delta\theta$ is found to be a function of height. The Model I set may be summarized from Pandolfo (1969) as

$$K_e=\begin{cases} f\,(\Delta\theta), & \mathrm{Ri}<\mathrm{R}_c \\ g\,(\mathrm{Ri}), & \mathrm{R}_c<\mathrm{Ri}\leqslant 0 \\ h\,(\mathrm{Ri}), & 0<\mathrm{Ri}\leqslant \mathrm{R}_e \\ K_0, & \mathrm{R}_e<\mathrm{Ri} \end{cases}$$

with $\mathrm{R}_c\approx -0.05$, $\mathrm{R}_e\approx 0.33$, $K_0\sim 10^4$ cm^2 s^{-1} containing four formulas for four differing, locally defined convective regimes.

The set (2.8) of Orlanski *et al.* (1974) may be summarized

$$K_e=\begin{cases} f'(\Delta\theta), & \Delta\theta<0 \\ K_0, & \Delta\theta\geqslant 0 \end{cases}$$

containing two formulas in two differing, locally defined stability regimes. These formulas are similar to those applied by Pandolfo in the extreme ranges of local Ri.

The simpler set of formulas may, quite adequately, simulate the diurnal variations of convective boundary layers over dry land, since observations show that local, near-neutral stratification, i.e.,

$$\sim -0.05<\mathrm{Ri} \quad \text{or} \quad Z/L<\sim 0.333,$$

is present for only brief periods in such cases. This situation is also evident in Orlanski *et al.*'s, model results (Fig. 21) which show very few computational points in this range of Z/L resulting from the model calculations. However, in the more general case, e.g., over moist land or water surfaces, near-neutral stratification is more prevalent, particularly at the lower levels, and a more complex set may well be required.

This characterization is important because the approach used in Model I of Pandolfo (1971), *a priori*, is as capable of simulating varying depths of the boundary layer with varying time of day, surface boundary conditions, etc., as is Orlanski *et al.*'s set (2.8). One could infer from the statement of Orlanski *et al.* that Pandolfo's approach is equivalent to the *a priori* specification of a boundary layer of fixed depth. Experimentally, the model has been found to produce such widely varying depths, including isolated elevated layers of strong mixing in some conditions.

Some assurance as to the validity of the Model I set in the upper portions of an observed convective boundary layer can be seen in Figs. 9 and 10 of Pandolfo and Jacobs (1972). The consistency of observed and computed vertical profiles in the layer below 500 m elevation is to be noted. The simulated case was one in which the convective layer extended up to the 500 m level, as is indicated by Fig. 1 of Pandolfo (1971).

At another point Orlanski *et al.* ascribe the discrepancy between the model-simulated wind-shear function ϕ_M and the experimental results of Businger *et al.* (1971) to the improper imposition of their lower boundary condition on vorticity in their work. Since the ratio ϕ_M/ϕ_H is by definition equal to the ratio K_T/ν_T (their notation), there is an interesting inference in their expectation of consistency between model-simulated and observed results. This is that parameterizations [e.g., those of Pandolfo (1971)] derived from such observations should be expected to be valid for both the subgrid scale, and explicitly defined convective systems in terms of their mesoscale model.

In some of their simulated results (Fig. 15), features with horizontal scale as small as 200 m are shown. Therefore, their expectation implies that systems of motion ranging in size from this smaller scale, up to the approximately 50 km scale of their overall model dimension, are adequately parameterized by the traditional empirical formulas in the case considered by them.

It would be of interest to many investigators, if Orlanski *et al.* would expand their discussion on this point, elucidating those aspects of their model results which confirm this expectation.

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