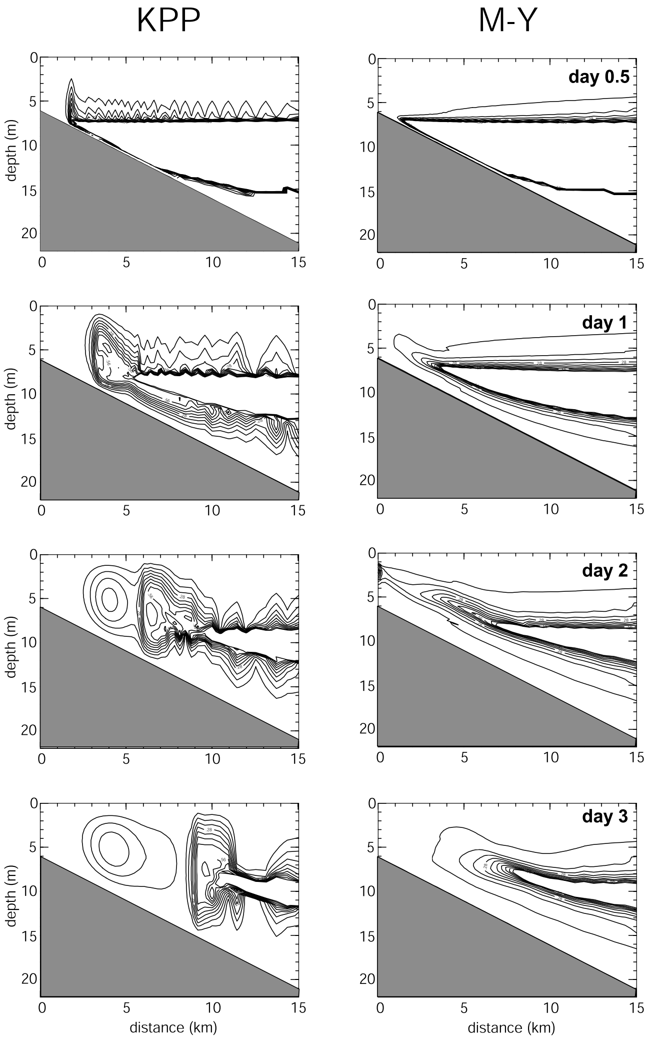

Figure 20. Sections of the gradient *Richdarson* number field for the two schemes at days 0.5, 1, 2, and 3.

than the original scheme. Rather it is the rate at which mixing diminishes under the influence of restratifying horizontal advection that determines the behavior.

7. Conclusions

[78] This study focuses on finding points of difference between two vertical mixing parameterizations applied to idealized coastal oceanographic settings. The two schemes that are compared were chosen because they represent alternative approaches to the closure problem which have both had some success. The Mellor-Yamada level 2.5 closure has been commonly used in regional continental shelf modeling. The K profile parameterization though tested in numerous open ocean settings, is found to have some shortcomings for application to coastal environments. In particular, the scheme as originally formulated, inaccurately represents mixing in bottom boundary layers and in nearshore regions where surface and bottom boundary effects interact strongly. To ameliorate this situation a bottom boundary layer parameterization modeled after that for the surface boundary layer is appended to the model. This modified formulation is compared with the M-Y scheme in a series of idealized experiments relevant to the coastal ocean. These include a test of the one-dimensional surface boundary layer response to wind deepening, the evolution of the pycnocline in one-dimension in shallow water when surface and bottom boundary layers are in close proximity, and a two-dimensional study of upwelling on a shallow continental shelf.

[79] In several instances the differences that are observed in the response of the two schemes are related to how each expresses the dependence of vertical mixing on the gradient Richardson number. In the surface boundary layer experiments the formulation of the KPP scheme which allows higher levels of mixing to exist at a higher gradient Richardson number, promotes greater entrainment and more rapid deepening when the stratification of the pycnocline is moderate to low. At low stratification, in the interacting boundary layer experiments the KPP scheme erodes the pycnocline significantly more quickly than M-Y, producing a well-mixed water column much earlier. This again is related to the stronger response to interior shear mixing in the parameterization. The suppression of turbulent production for $Ri_g > 0.21$ has been suggested as a weakness of the M-Y scheme. Several authors have modified it or developed other second-order closure schemes which formulate the relationship between Richardson number and mixing such that turbulence can persist at a higher value [*Kantha and Clayson*, 1994; *Burchard and Baumert*, 1995; *Mellor*, 2001; *Canuto et al.*, 2001]. They have argued that these formulations improve estimates of entrainment when compared to open ocean mixing experiments. It is likely that they also lead to mixing more comparable to KPP in the low-stratification one-dimensional experiments examined here.

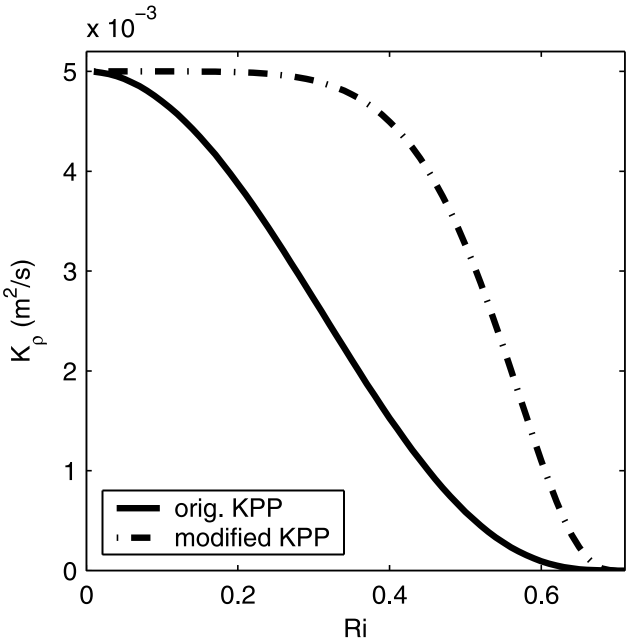

Figure 21. Relationship between gradient Richardson number and vertical viscosity coefficient for the regular KPP scheme and a modified version that shows behavior in the 2-D upwelling simulations more similar to M-Y.