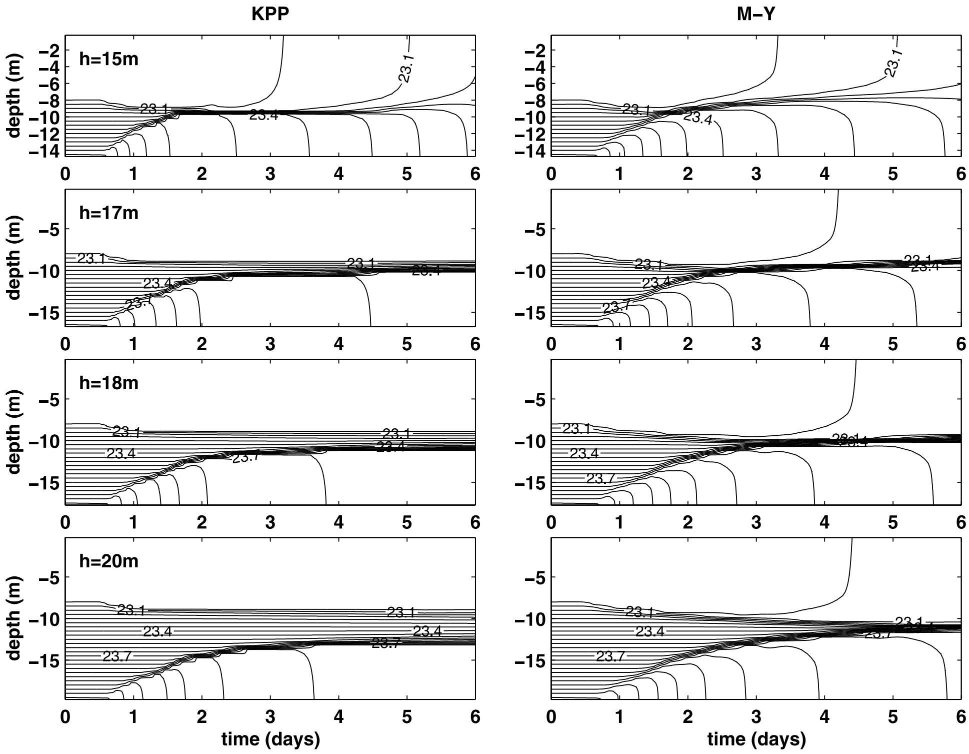

Figure 13. Time-depth contour plots of potential density displaying how the interaction between the boundary layers increases as the water depth decreases. Initial stratification below 7.5 m is set at the $N_o/10$ level.

result changes. Not only is there more stratification to build the intensified pycnocline, but the bottom boundary can also become thicker (with reduced shears) before impinging on the surface one.

[65] If the bottom boundary layer is not confined to a smaller vertical extent than the surface boundary layer, this response is not observed. Several experiments were tested where the model was initialized with a 7.5 m thick well mixed bottom layer with a pycnocline of several meters thickness between them. In these experiments the pycnocline intensified at middepth and never elevated as the boundary layers that developed were nearly identical.

[66] The KPP response in shallow water is different. The profile of mixing coefficient (Figure 14) for the 15 m depth case shows lower values than the M-Y parameterization throughout the bottom boundary layer for days 3 through 6, while it shows values nearly equal to or greater than M-Y for the 18 m depth case. The profile produced by KPP is only enhanced by increased bottom stress, increased boundary layer depth or an increased gradient in mixing coefficient at the interface with the pycnocline. The sharp onset of mixing with reduction in Ri_g specified by the shear generated mixing function ensures that the vertical mixing coefficient will change rapidly wherever a strong transition in stratification exists without adequate shear. This occurs in the 18 m deep simulation at the interface with the pycnocline of both the surface and bottom boundary layers. The gradient Richardson number changes from greater than Ri_o to close to zero over a single grid point resulting in the same slope at the interior edge of the boundary layer regardless of the particular thickness of the well mixed region. This conclusion holds if the boundary layer depth estimate from the bulk Richardson number calculation does not place the matching point so far into the stratified region that $\partial K_\rho/\partial z$ is close to zero there. This was not found to occur often in these studies.

[67] The profiles produced with KPP for the 15 m deep simulations show the vertical mixing coefficient diminishes more gradually approaching the pycnocline. In this case the pycnocline has become so thin that it extends over only two ρ grid points. The estimate for the vertical derivative of turbulent viscosity and diffusivity at the boundary layer depth is obtained by interpolating using the value of K_ρ at the three ω grid points (vertically staggered with ρ points) closest to it. For a very thin pycnocline one of these grid points may be in the surface boundary layer while another is in the bottom boundary layer. The net effect is that the estimates of $\partial K_\rho/\partial z$ for the base of the surface boundary layer can approach zero (because of the gradient at the bottom of the SBL and top of the BBL cancelling out). The estimate at the top of the bottom boundary layer, which uses the updated profile of K_ρ after the surface boundary layer profile has been determined, will also be reduced from the estimate that would be obtained were the pycnocline thicker or better resolved.

[68] At low enough stratification it would be expected that the enhanced shear that develops at the pycnocline between the surface and bottom layers would be adequate to locally generate mixing across the interface and lead to rapid disintegration of the density gradient. The interior shear mixing formulation of KPP has been utilized