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Effect of boundary layer on oceanfront

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Frontal developments in a baroclinically unstable environment are studied with a two-dimensional hydrostatic model with focus on the boundary layer effects on fronts over an ocean. The growth of the initial disturbance follows the Eady theory and a cold front forms following Hoskins and Bretherton due to nonlinear convergence focusing in the frontal zone. Without surface friction excessive winds develop and small scale gravity waves form above the front. The pressure of a K-theory planetary boundary layer substantially reduces the excessive wind speeds and leads to a more realistic frontal structure. Fronts simulated over an ocean have a much smaller horizontal scale than those simulated over land. This is partly caused by the fact that the roughness lengths are smaller over the ocean. However, even when the same roughness lengths are used over land, the ocean front still has a smaller scale. This difference is caused by the surface heat flux over the ocean. Most of the area behind the cold front has upward heat flux which causes more turbulent mixing which reduces the wind speed. However there is a small region with downward heat flux behind the cold front edge, which decreases the mixing process in that region. This causes stronger frontogenesis in that region which causes the more intense front that without the fluxes. Experiments with a constant added (subtracted) to the sea-surface temperature lead to weaker (stronger) fronts due to the influence on the surface heat flux.