SEMIGEOSTROPHIC ADJUSTMENT, SLOW MANIFOLD AND NONLINEAR WAVE PHENOMENA IN 1D ROTATING SHALLOW WATER MODEL

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We study the problem of nonlinear adjustment of localized front-like perturbations to the state of geostrophic equilibrium. By using Lagrangian coordinates within the framework of rotating shallow-water equations with no dependence on the along-front coordinate we first develop a perturbative in the cross-front Rossby number adjustment procedure and demonstrate splitting of slow and fast dynamical variables for non-negative potential vorticities. We show that wave-trapping is impossible and, thus, adjustment is always complete. We then give a nonperturbative proof of the existence and uniqueness of the adjusted state (slow manifold) for configurations with non-negative initial potential vorticities and show that 'retarded' adjustment may occur if quasi- stationary states decaying via tunneling across a potential barrier can exist on the background of the corresponding adjusted state. Shock formation is analysed and semi- quantitative criteria based on the values of initial gradients and the relative vorticity of initial states are established for wave-breaking and shock formation showing, again, essential differences between the regions of positive and negative vorticity.