On time-dependent, two-layer flow over topography. I. Hydrostatic approximation

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Baroclinic flows over topography are studied analytically and numerically in a time-dependent two-layer model. The governing equations are analogous to the shallow water wave equations, but differ from them in that the two-layer model includes terms of third order in amplitude. Numerical solutions also include dispersive effects. The analysis is based on the hydraulic theory because the numerical solutions show that the topographic interaction between the imposed barotropic flow and the resulting baroclinic flow is essentially hydrostatic. The baroclinic motion expressed in canonical variables (Riemann invariants or simple waves) clarifies the interaction and propagation process. The governing equations also lead to a non-linear radiation condition for simple waves, and to a hydraulic-jump speed that differs from those previously proposed. Solutions over step-like topography as an approximation to continental shelf edge, and over symmetric obstacles are discussed.

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