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Propagation of Shape-Preserving Solitons onto the Continental Shelf

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The propagation of shape-preserving solitons ('DJL' solitons, 'SECH2' solitons) [Lamb (2002), Shen and Evans (2004)] over a flat domain and onto the continental shelf were studied using the 3-D sigma-coordinate model EULAG [Smolarkiewicz et al (2001), Warn-Varnas et al (2007)]. The solitons were constructed over flat topography generated either using the DJL (Dubreil-Jacotin-Long) equation or analytic functions of the $sech^2$ type, consisting of one or two density depressions. In addition to idealized 2-D configurations, a particular 3-D geographical region was selected to test the simulations against data in the northwestern corner of the South China Sea The depth range was typically between 2500m to 110m. Most simulations used grid sizes of dx=139m (perpendicular to the slope) and dy=500m (parallel to the slope). As the depression solitons propagate up onto the shelf, they change to solitons of elevation, with the leading edge of the elevation developing a sharp front. The wave speed of the solitons slows down with decreasing depth, and the wave fronts acquire a curvature corresponding to the contours of the topography. Maximum vertical velocities range from 0.55 m/sec to .25 m/sec, and maximum horizontal velocities from 3.5 m/sec to 1.2 m/sec.