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Moving-boundary methods as a unifying approach to linked erosional-depositional systems

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One way to help reduce the persistent research divide between erosional and depositional systems is to develop modeling frameworks in which such divides are handled in a simple, natural way. Here we describe one such framework that we have used successfully to study the dynamics of systems comprising several linked transport subdomains: for example, an erosional region linked to a fluvial region linked via the shoreline to a shelf, etc. In typical numerical analyses, most of the attention is given to formulating the governing equations for each subdomain; of equal importance is how the subdomains are linked across their mutual internal boundaries. On long time scales, these boundaries migrate, and their trajectories in time must be found as part of the overall solution for the system evolution. The 'moving boundary method', widely used in heat transfer for modelling the dynamics of the solid-liquid front in a melting solid, provides a natural way of handling this problem. The moving boundaries are formulated analogously to ordinary boundary conditions at the edges of the domain, with a linking condition that specifies how the domains communicate. The linking conditions together with the evolution equations determine how the boundaries migrate. We illustrate the approach with examples from a model in which the moving erosion-deposition boundary is linked to several other important moving boundaries, stepping out to the deep sea, to provide a complete, if crude, model of a source-sink transport system.