# Linking sediment transport and geochemical processes in a numerical model with application offshore of the Mississippi River

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Sediment transport models that represent flood and storm sedimentation for coastal areas typically estimate grain size patterns and deposit thicknesses and are therefore disconnected from field data that rely on short-lived radioisotopic tracers to describe event bed character. Interpreting field data based on radioisotopes presents challenges that stem from the tracers' source terms, as well as confounding processes, including suspended transport and physical and biological mixing. We use a numerical sediment transport model capable of representing $^{7}Be$ and $^{234}Th$ profiles in the seabed to develop a quantitative tool that can be used to reconcile model estimates with observational studies, and better interpret field studies. The numerical model, built within the Community Sediment Transport Modeling System (CSTMS, see Warner *et al.*, 2008), accounts for multiple sediment types, suspended sediment transport, and erosion and deposition. It has recently been modified to also include cohesive sediment processes, and biodiffusion (Sherwood *et al.*, in prep.). To this framework, we have added a capability to represent particle – reactive tracers and used this to quantify radioisotopic activity for short-lived tracers within the seabed (Birchler, 2014).
A one-dimensional (vertical) model that includes two sediment classes and reactive tracers $^{7}Be$ and $^{234}Th$ was configured to represent a 50-m deep site offshore of the Mississippi River delta in the northern Gulf of Mexico, US, the "proximal" site previously studied by Corbett *et al.*, (2004). Though one-dimensional models typically neglect flux convergence and divergence, ours was configured to have sediment source and sink terms at the top of the model grid to produce deposition and erosion. The modelled sediment bed could then be subjected to deposition of riverine sediments and storm resuspension, with the input forcing based on time-series data of local wave conditions and Mississippi River discharge from the study period. The model estimates of radioisotopic penetration depth and activity matched field observations from the northern Gulf of Mexico made in April and October 2000 (Corbett *et al.*, 2004). These study periods differed in that the earlier time (prior to April, 2000) had higher wave energy than the later time period (prior to October, 2000).
Modelled radioisotopic profiles were similar to field observations, but the simulated profiles of $^{7}Be$ and $^{234}Th$ could be directly related to the flood and storm sequences used as model input to evaluate how the sediment bed tracers responded to individual discharge pulses and wave resuspension events. The model-estimated profiles were sensitive to the timing of $^{7}Be$ input, phasing of wave and current energy, and the intensity of biodiffusion. Deposition of riverine sediment, and seabed resuspension both typically produced fining upwards layers of grain size. Deposition of riverine – derived sediment increased the activities and inventories of both radioisotopes, while resuspension increased the activity and inventory of $^{234}Th$ only. Erosion events removed radioisotopes from the bed surface, reducing their total inventory, and winnowed the more easily suspended fine sediment from the bed.

**References**

Birchler J.J. 2014. Sediment deposition and reworking: A modelling study using isotopically tagged sediment classes. Master's Thesis. School of Marine Science, College of William & Mary, Gloucester Point, VA, USA. 164p.

Corbett D.R., B.A. McKee and D. Duncan. 2004. An evaluation of mobile mud dynamics in the Mississippi River deltaic region. Marine Geology 209:91-112.

Sherwood C.R., A. Aretxabaleta, C.K. Harris, J.P. Rinehimer, B. Ferré and R. Verney. (in prep.). Cohesive and mixed sediment model: extension of the community sediment transport modeling system. In prep. for Ocean Dynamics.

Warner J.C., C.R. Sherwood, R.P. Signell, C.K. Harris and H. Arango. 2008. Development of a three-dimensional, regional, coupled wave-, current-, and sediment-transport model. Computers and Geosciences 34:1284-1306. doi: 10.1016/j.cageo.2008.02.012.