New and Improved: Modeling Mixing Time Scales in the Altamaha River Estuary
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Abstract

Square-boxes is a 1-D box-modeling framework for estimating mixing times and nutrient transport in estuaries. An earlier Square-boxes model for the Altamaha River estuary was calibrated for flows ranging between 189 and 336 m$^3$/s, but could not adequately predict the higher salinities that occurred during the recent drought (1999-2002). We have now recalibrated the square-box model using data collected during the recent drought (1999-2002). We have also recalibrated the square-box model for the Altamaha River estuary for flows ranging from 50 to 110 m$^3$/s. The new model also extends our understanding of how the salinity distribution changes in the estuary response to changes in flow. This study expands on previous work by evaluating how transit times through specified salinity zones vary in the Altamaha River estuary.

Model Validation

Salinity: Predicted salinity distributions for 21 flows ranging from 50 m$^3$/s (1st percentile) to 928 m$^3$/s (90th percentile) compare closely with mid-side-averaged salinity observed at the flow (right). Salinity predictions are higher than observed for extremely high flows.

Transit Time: Model estimates of average transit time through each salinity zone were calculated independently from a long-term salinity data set using a freshwater fraction method (Alber and Sheldon, 1999).

Discussion

A potential application of these types of results is in conjunction with efforts by NOAA to address the potential problem of eutrophication in US estuaries. Their approach was to summarize concentrations of parameters of concern (chlorophyll, a, nitrogen, phosphorus, and dissolved oxygen) within broad salinity zones (NOAA 1996 and related reports), aggregate this information over all estuaries, and use “Export Potential” to assess the relative susceptibility of estuaries to increased nutrient loads (Bricker et al, 1999). Export potential, estimated as a combination of dilution and flushing effects, is a qualitative parameter that could be improved using actual flushing or transit times when available. Susceptibility assessment could also be improved by using data relevant to the most sensitive time of year (e.g. median summer flow) rather than average flow. The model responses at different flows can shift the polyhaline zone onto the continental shelf.

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