MODELING THE SPATIAL STRUCTURE OF ESTUARINE RESIDENCE TIME: EULERIAN AND LAGRANGIAN APPROACHES

by

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An Abstract

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This research provides numerical approximation of residence time for Tampa Bay. This calculation was done by coupling a Lagrangian particle tracking model to the Estuarine and Coastal Ocean Model Three Dimensional (ECOM-3D). Validation of model parameters was provided through comparisons with salinity, water level, velocity, and free floating drift buoys from three existing ocean monitoring systems in the bay. Comparisons of the Lagrangian method with an Eulerian passive tracer based approach, which is the typical modeling method for residence time, was performed.

Results show the following:

1) ECOM-3D captures the flow field in both the short and long term.

2) The Eulerian, passive tracer based, approach is overly diffusive.

3) The Lagrangian approach provides detailed structure by allowing for realistic particle movement.

4) Bay-wide estimates of of residence time from the Lagrangian and Eulerian method are similar (147 vs. 184 days respectively); however the spatial structure was quite different owing to the diffusion inherent in the Eulerian method.

5) Bay-wide bounds were determined from model runs for various changes in the forcing to the estuary (i.e., river discharge, wind stress, and tides) and are on the order of 2 to 9 months.

6) A theoretical function describing the bay-wide residence time was developed from an analogy with classic drain and fill problem, which suggests a strong, near linear response to variations in forcing at the low residence time end of the range.

In summary, the Lagrangian method is the logical choice of methods as it captures the bay-wide residence time as well as the spatial structure due to the fact that it does not suffer from the numerical diffusion inherent in the Eulerian approach. The two methods together help to identify specific regions in the estuary where processes controlling residence time differ, as well as to lend confidence to either approach in a bay-wide sense.

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