A Numerical Study of the Circulation, Stratification and Salt Fluxes in Delaware Bay Estuary

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Introduction

We present results of a numerical study of Delaware Bay using ROMS (Regional Oceanic Modeling System). Despite the prominence of this estuary it as received little attention among physical oceanographers. One of our main motivations to study Delaware Bay is to build a more complete picture of the physical aspects of this system. Here we provide a general description of the circulation, the salinity structure and salt fluxes in the bay. These modeling efforts are being augmented by ongoing shipboard surveys and moored observations. Preliminary results emphasize spring-neap variability in stratification that has not been previously documented in this system.

Numerical Model

- ROMS
- Fine Grid horizontal resolution:
- 20 vertical terrain following levels
- Forcing:
  - Tides at the boundaries
  - River input at Trenton 350, 650, 950, 1300, 1700, 3000 m³/s
- We defined 14 stations along the estuary

Results

Exchange flow and subtidal salinity structure

When the water column is stratified during neap tides, sediments are capped into the lower layer and phytoplankton at the surface has enough light to bloom. When the water column is well mixed during spring tides, sediments occupy the whole water column and as a consequence phytoplankton becomes light limited.

A factor that strongly influence estuarine stratification is the along channel salinity gradient which is directly related with the salt intrusion length.

Area integrated salt fluxes

The salt intrusion length in an estuary is regulated by the competition between two processes:
- seaward salt flux due to river output
- landward salt flux due to estuarine circulation and tides

Conclusions

- The exchange flow exhibits a transition between vertically sheared during neap tide to laterally sheared during spring tide. The subtidal salinity is vertically segregated on the main channel but vertically mixed on the flanks during neap tide and it is vertically well mixed through the entire cross section during spring tide.
- The system gains salt during neap tide and loses salt during spring tide. Nevertheless the system is close to steady state because the response time to changes in tidal mixing is much longer than the spring/neap cycle.
- Our 3D simulations reveal that across channel variations in bathymetry in Delaware Bay are a controlling factor of the salt fluxes in this system.