AGU, Washington D.C., Dec 10-14, 2018 Session OS21D Poster #1596 Abstract #449759

Sub-tidal Surface Current Variability in the Lower Chesapeake Bay

Teresa G. Updyke[1], Larry P. Atkinson[1]

[1]Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA, USA

Background

This poster presents analysis of a nine-year data record of high frequency radar observations in the lower Chesapeake Bay. The data from three 25 MHz CODAR SeaSonde® coastal ocean radar systems were combined using a least squares method to generate hourly surface current velocity maps on a two-kilometer spaced grid (Fig. 1).

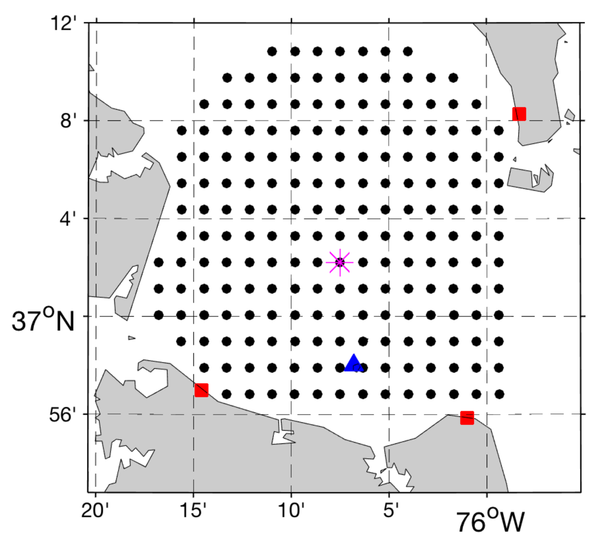

Figure 1. Chesapeake Bay radar stations (red) and grid points for total velocity maps (black). NOAA wind measurements [station 8638863] (blue). Mid-Bay location selected for time series plots in Figs. 7 & 9 (pink).

Figure 2. High frequency radar antenna at Ocean View Community Beach in Norfolk, Virginia.

- Time Period: June 1, 2009 to May 31, 2018
- Velocity vectors with Geometric Dilution of Precision (GDOP) error estimate >1.25 were removed from each map and replaced with spatially interpolated values.
- Temporal interpolation filled short (≤6 hour) gaps in the record.
- Analysis was performed at grid locations with 80% data availability.
- A 40-hour low pass filter was applied.

The surface current flow in the lower Bay is tidally dominated. The percentage of total current variance explained by the tidal component ranges from 70 to 85% over most of the grid (Fig. 3). Maximum tidal current speeds in the middle of the lower Bay are typically 40 to 70 cm/s.

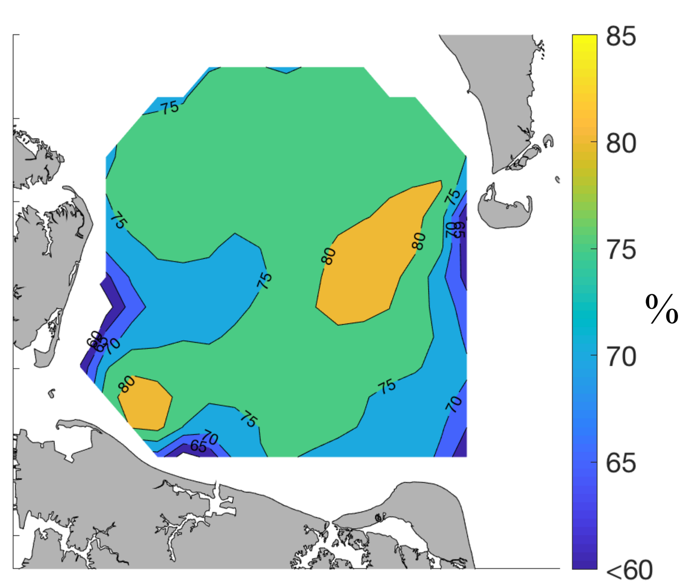

Figure 3. Percentage of variance along the major axis that is explained by the tidal component.

Sub-tidal Results

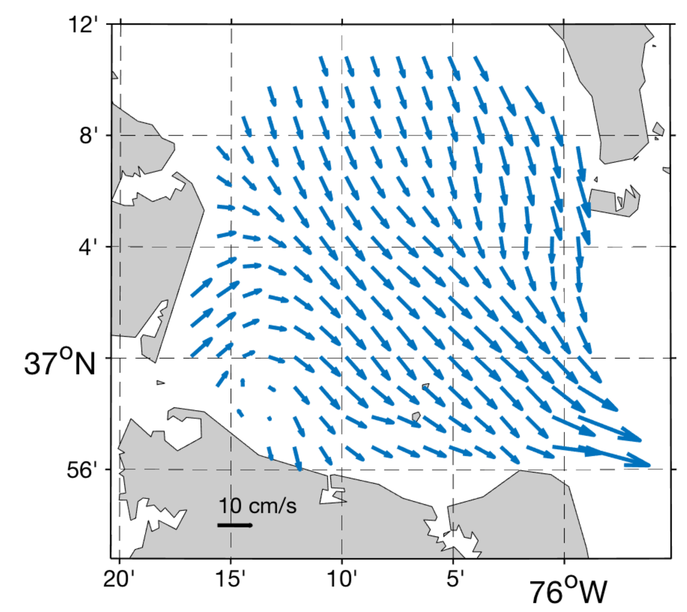

Figure 4. Mean current field (June 1 2009 – May 31 2018)

- Classic estuarine surface outflow
- Mid-Bay speeds averaging 8 cm/s
- Greater southward component of flow at the northern end of the Bay mouth
- Stronger eastward flow out of the Bay dominates near Cape Henry
- Circular clockwise pattern outside of the entrance to the James River

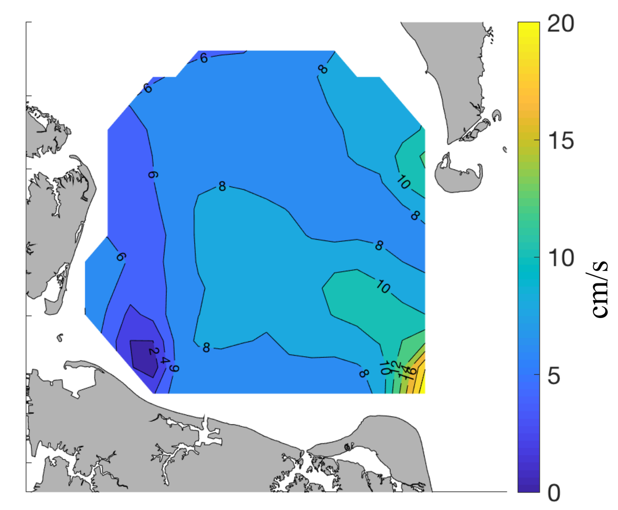

Figure 5a. Mean current speeds.

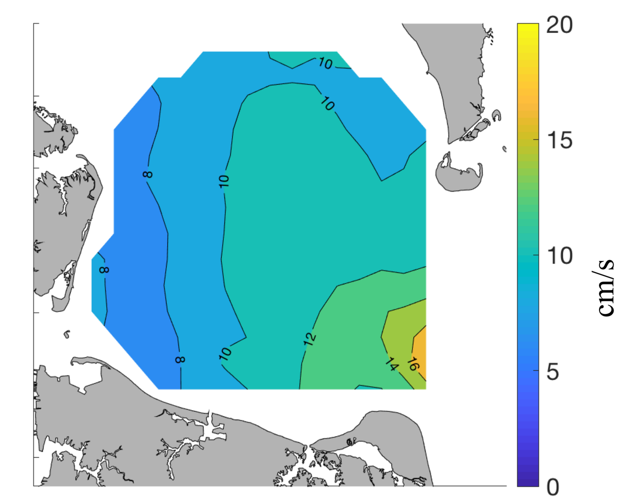

Figure 5b. Standard deviation of current speeds.

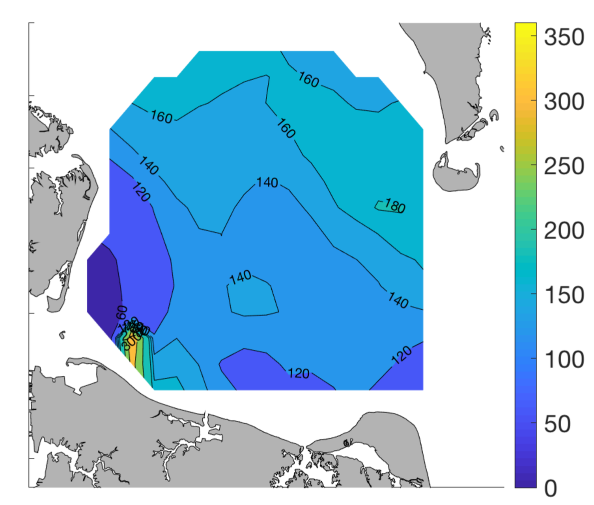

Figure 6a. Mean current directions.

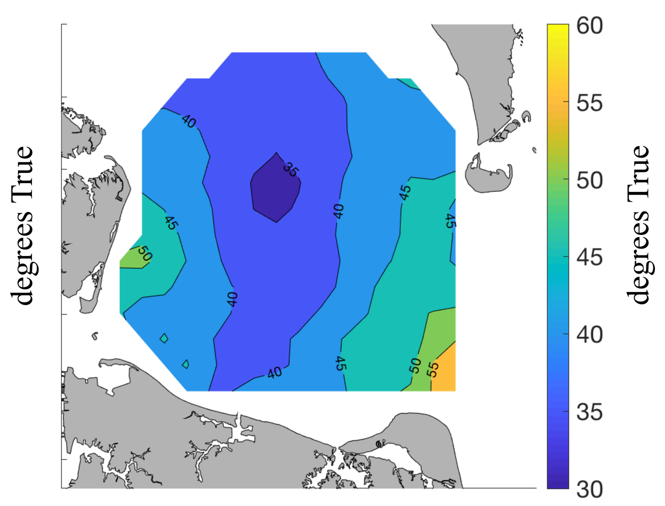

Figure 6b. Standard deviation of current directions.

- Mean sub-tidal current speeds are lowest in the southwestern area of coverage and highest (up to 18 cm/s) and most variable at the southern end of Bay mouth. (Figs. 5a & 5b)
- Mean directions are consistent with the coastal geography and along-Bay axis. (Fig. 6a)
- Directions are least variable (30-40º standard deviations) for an area running north to south down the middle of the Bay. (Fig. 6b)
- The most variable directions are near the southern cape with standard deviations up to 56º. (Fig. 6b)
- The "gyre" in the southwest is a persistent feature. This is supported by the modest standard deviations seen in that area. (Figs. 6a & 6b)

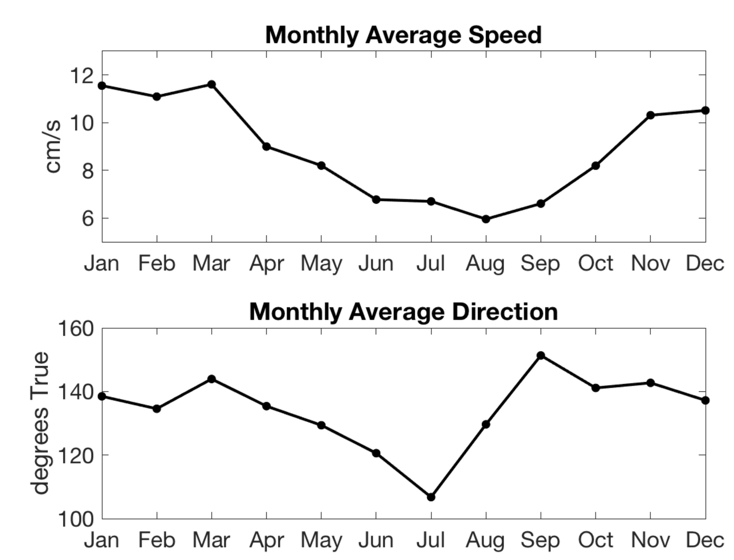

Figure 7. Monthly averages for currents at a mid-Bay location (shown as pink star in Fig. 1)

- Faster outflow in winter than in summer
- At mid-Bay location:
  - Average winter speed = 11.0 cm/s
  - Average summer speed = 6.3 cm/s

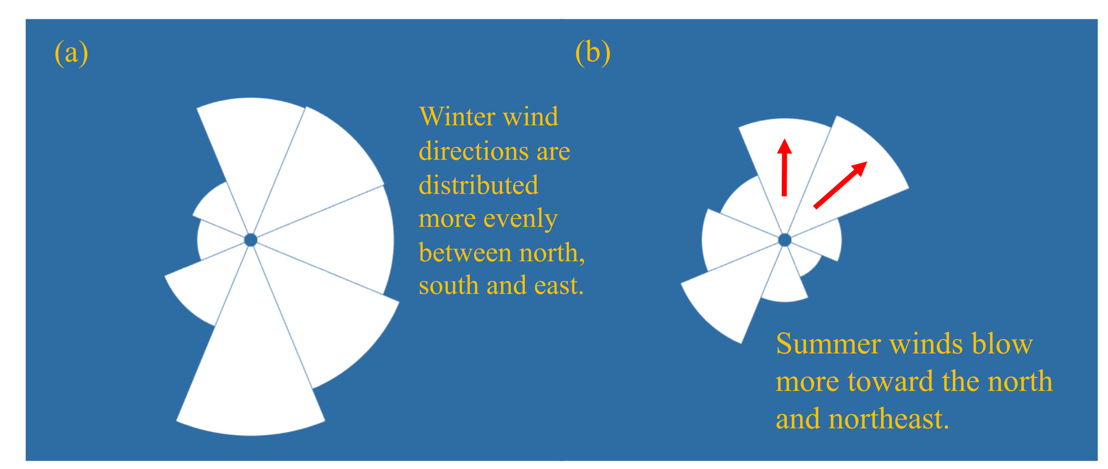

Figure 8. Wind roses for (a) winter (Dec-Feb) and (b) summer (Jun-Aug) winds at the NOAA Chesapeake Bay Bridge-Tunnel station. These charts use 2009 to 2017 data (2018 not available). Directional data is presented as wind blowing TOWARD a direction.

- Seasonal changes in wind direction may affect sub-tidal surface currents.
- Winds blowing to the north and northeast are more dominant in summer months.

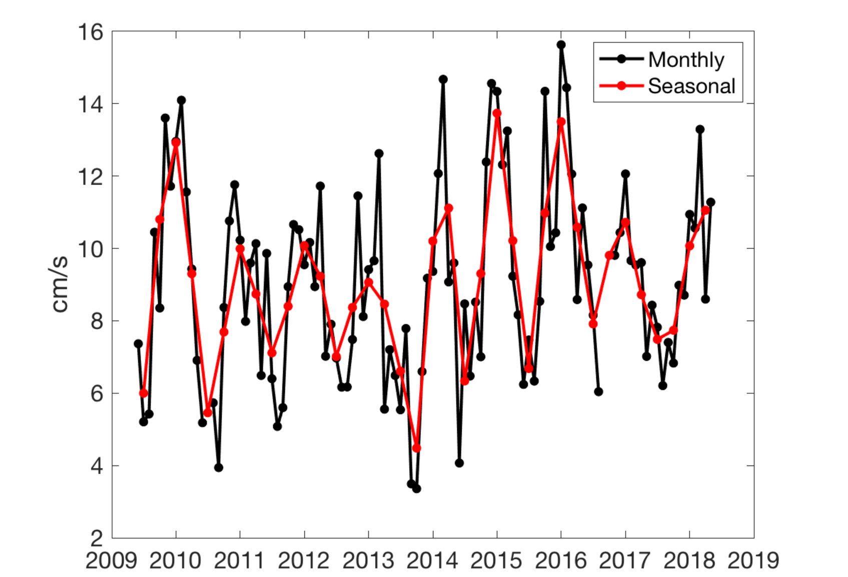

Figure 9. Monthly and seasonal averages for current speeds at a mid-Bay location (shown as pink star in Fig. 1)

- The annual/seasonal pattern in current speeds shows some interannual variability.
- Summer speeds range from 5.5 to 7.9 cm/s. and winter speeds range from 9.1 to 13.7 cm/s.

Conclusions

Analysis of a quality-controlled nine year record of high frequency radar surface current data in the lower Chesapeake Bay reveals seasonal variability of the sub-tidal surface circulation in an area where the exchange of coastal ocean waters and Bay waters is important for a variety of coastal processes. Patterns in variability and links to forcing mechanisms, such as winds, could be further investigated with an EOF analysis.

Further information is available at:
http://www.ccpo.odu.edu/currentmapping

For data access, please contact Teresa Updyke:
garner@ccpo.odu.edu.

This project is supported by NOAA's Integrated Ocean Observing System (IOOS) through the Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS).

OLD DOMINION UNIVERSITY
Center for Coastal Physical Oceanography

MARACOOS
Ocean Information for a Changing World

IOOS
Integrated Ocean Observing System