Relationship of Wind, Tides, Pressure, and Current Velocity in the Little Egg Inlet

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Introduction

Little Egg Inlet is a major connection point between shallow coastal bays of southern New Jersey and the ocean.

Previous analysis of circulation patterns found that coastal sea surface height, and to a lesser extent wind, are major drivers of flow through this inlet (Chant 2001).

The inlet is experiencing rapid sedimentation, and was dredged for the first time in winter 2018.

Our study collected observations of flow through one branch the inlet as a baseline prior to dredging.

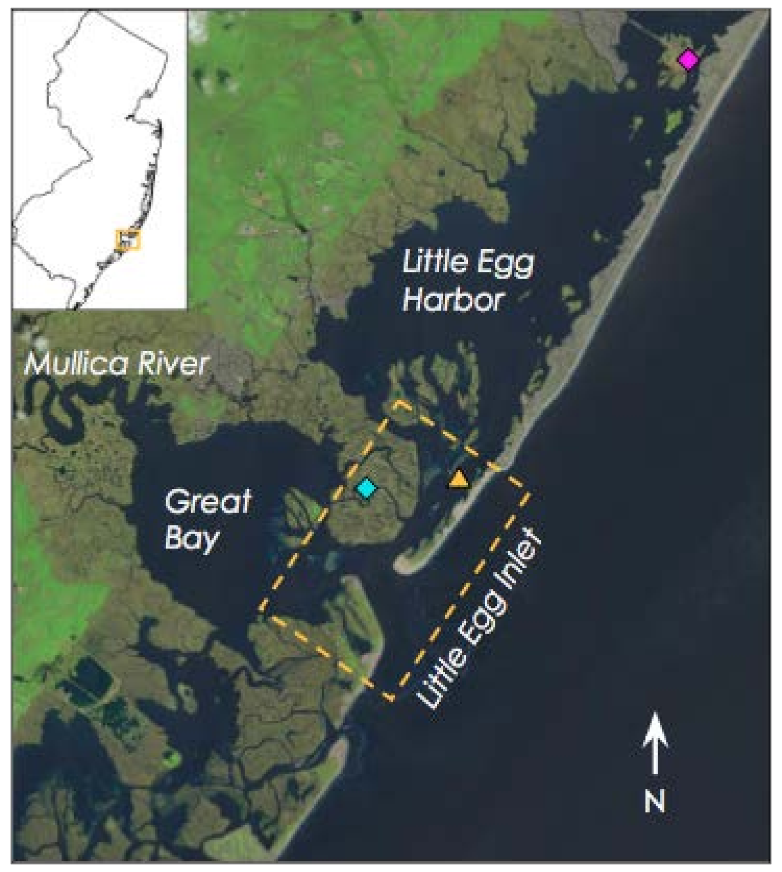

Figure 1. Map of study area near Little Egg Inlet, NJ with locations of ADCP (yellow), USGS tide gauge (magenta), and WeatherFlow wind data (cyan).

Methods

An Acoustic Doppler Current Profiler (ADCP) was deployed in the Little Egg Inlet from late August to mid September of 2017.

Velocity data were rotated to the principal component axes, representing along-channel and cross-channel flow.

A 33 hour low pass filter was applied to examine subtidal water velocities. These data were compared with low-pass filtered sea surface height and wind data.

Sea surface slopes were calculated from the ADCP pressure sensor to a USGS tide gauge data at Ship Bottom, NJ.

Wind data were obtained from a meterological tower in Tuckerton, NJ. Wind velocities were rotated in 5° increments to find the strongest correlation with water velocity.

Results

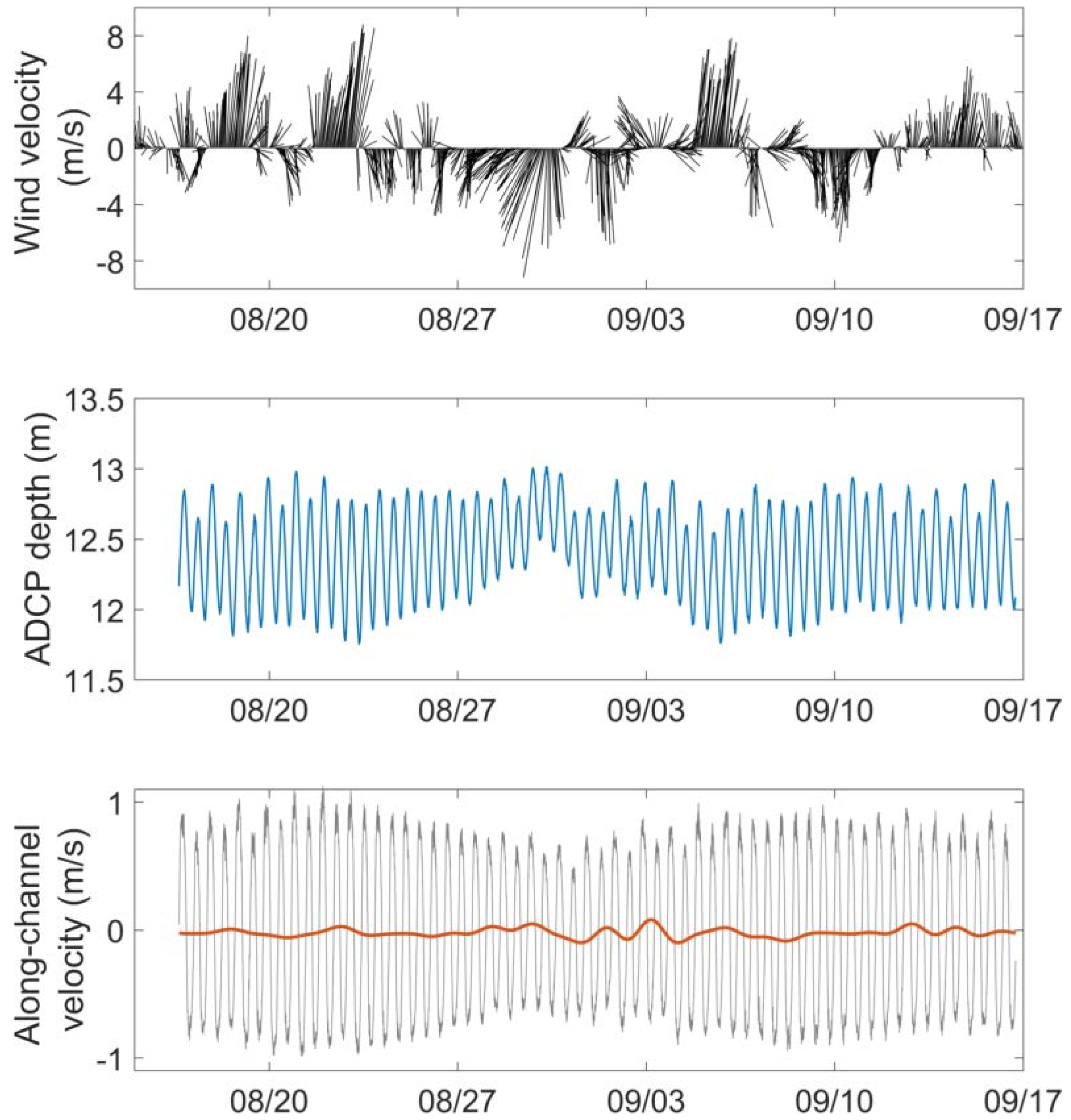

Figure 2. Comparison of (a) wind vectors, (b) water level above the ADCP, and (c) tidal and low-pass filtered velocity along the channel.

Peak tidal velocities were approximately 1 m/s.

Average subtidal flow in the channel was toward the south (out of estuary) but varied in direction over time.

Current velocity had a five hour lag in response to wind. A maximum correlation of the wind and current was found with the southeasterly wind component.

Wind and sea surface slope along the estuary axis were strongly correlated (R=0.85).

Correlation of the sea surface slope and depth-averaged velocity was weaker (R=0.4, 5.2 h lag)

Table 1. Correlation between water velocity and wind direction. Angle is the compass direction from which the wind came, lag is the time delay from wind to water velocity.

	Angle	Maximum Correlation	Lag
Surface Velocity	125°	R = 0.78	5.3 h
Bottom Velocity	120°	R = 0.77	5.2 h

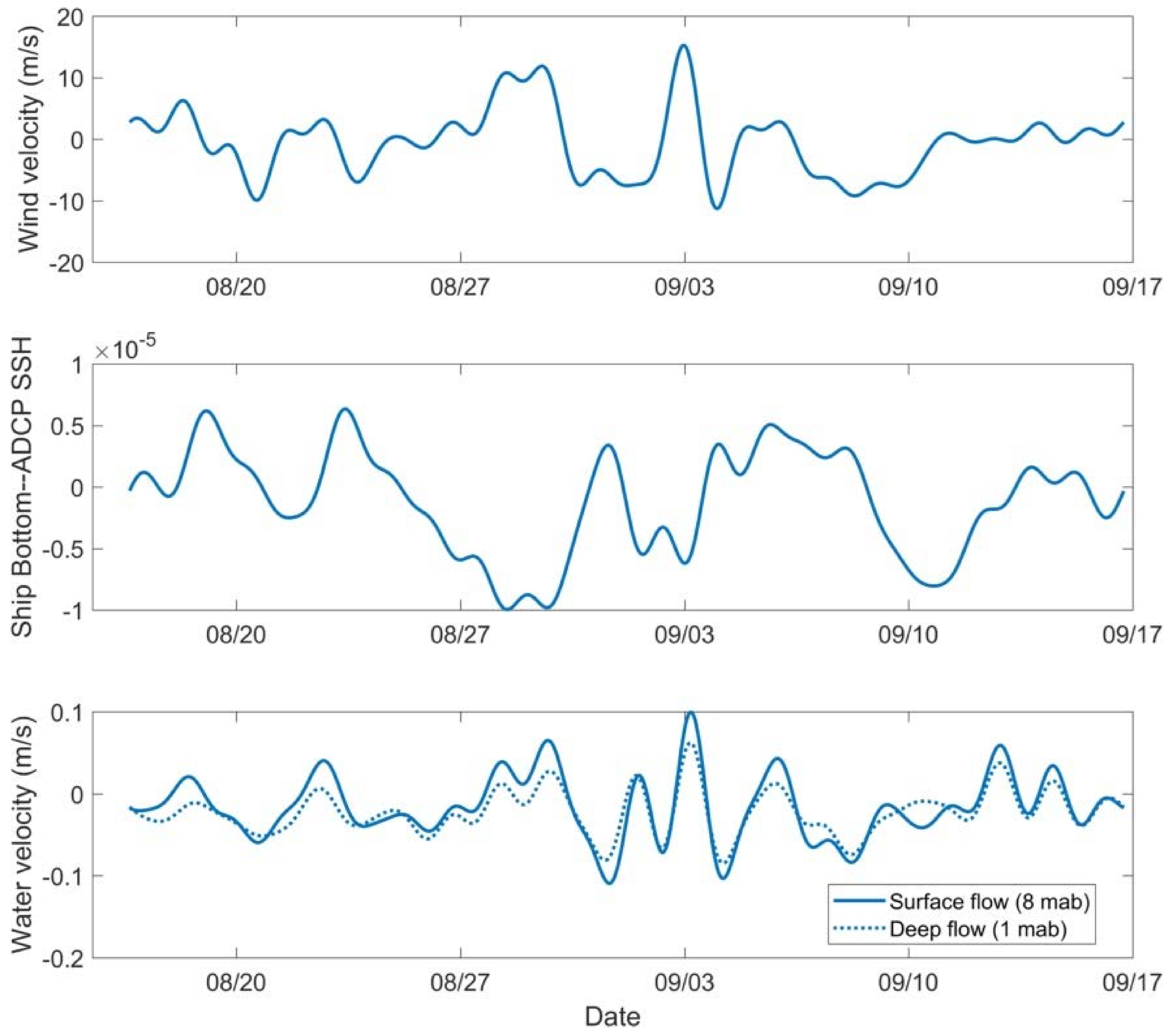

Figure 3. Low-pass filtered (a) wind, (b) sea surface slope along Little Egg Harbor, and (b) water velocity in the inlet.

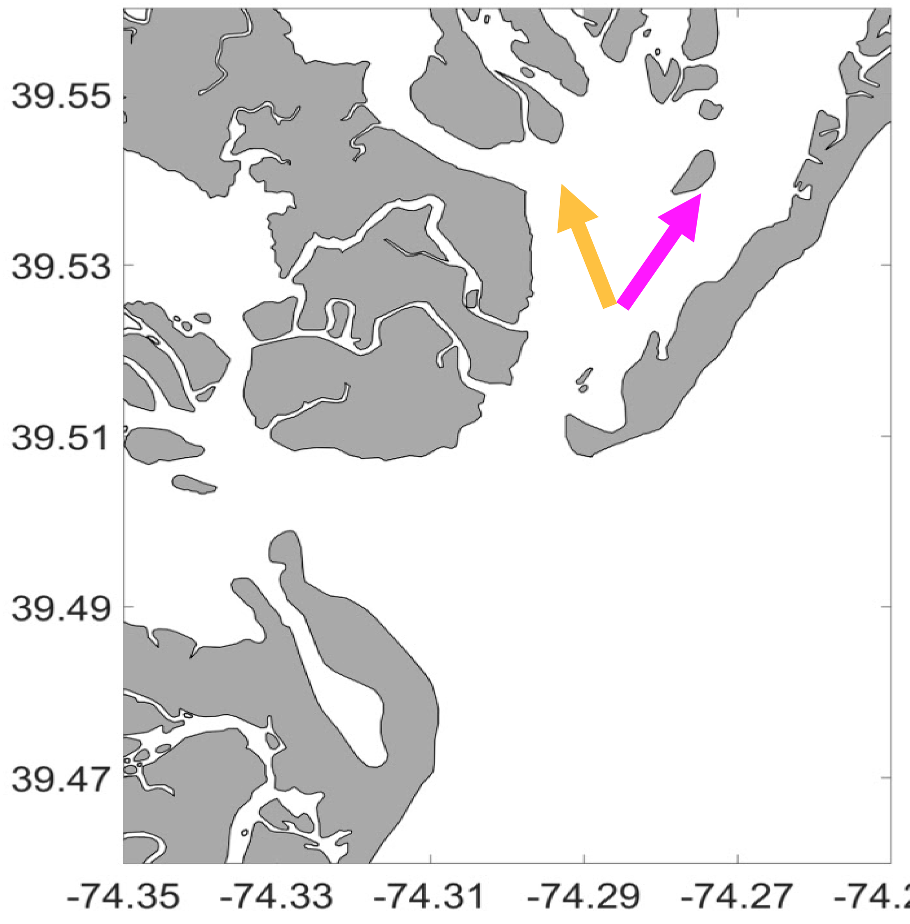

Figure 4. Arrows indicate the direction of wind most positively correlated with along-channel velocity (yellow) and sea surface height gradient (magenta).

Conclusions

Wind blowing from the southeast has the largest influence on the velocity through the inlet.

The lagged correlations indicated the elapsed time from wind forcing to water movement of approximately five hours.

The sea surface slope varied between positive and negative gradients. Sea surface slope in the bay appeared to respond strongly to wind, but water velocity was less strongly correlated to sea surface slope.

These baseline data will be the foundation of continued research on inlet circulation dynamics and the effects of dredging in particular.

Acknowledgements

We are grateful for field work assistance from staff of the Stockton University Marine Field Station and financial support from the Office of the Provost and School of Natural Sciences and Mathematics. We also thank the Rutgers University Marine Field Station for supplying wind data.

References

Chant, R.J. (2001). Tidal and subtidal motion in a shallow bar-built multiple inlet/bay system. J. Coastal Res. SI32: 102-114.

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WeatherFlow Rutgers University Marine Field Station. http://www.windalert.com/spot/148273.

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