Using Drones to Map Current Vectors in Narragansett Bay

Sokpearoun Lorn[1], Baylor Fox-Kemper, Ph. D.[2]

[1]Department of Electrical, Computer & Biomedical Engineering, University of Rhode Island

[2]Department of Earth, Environmental, and Planetary Sciences, Brown University

Abstract

The OSOM (Ocean State Ocean Model) simulates the Narragansett Bay by utilizing local ocean models and forcing data taken from the environment. To further constrain the OSOM's current velocity readings, vector maps are created using the CopterCurrents approach developed at Helmholtz-Zentrum Hereon as an alternative to Acoustic Doppler Current Profilers and other methods of data collection. A DJI Mavic drone was flown over the shore of the Save the Bay Center and Phillipsdale with the attached camera pointed in the nadir direction. Short duration footage of the waves is recorded at a variety of nearby sites, then run through the CopterCurrents program to create a vector map of wave direction, wavelength, phase velocity, and current velocity. Footage was taken of the two locations at high, low, ebb, and flow tides to account for a full tidal cycle. In total, 4-5 vector maps are produced for each location at each site. The vector data has been made available through the Rhode Island Data Discovery Center

Introduction

The OSOM is a workhorse model of the Narragansett Bay in development that uses the Rhode Island Data Discovery Center as a source of new and historical data to regulate the model. The RIDDC does not have data relating to surface currents, a physical variable that is affected by factors such as tides, river flow, winds, salinity, and temperature. In order to obtain this data, we explore a method of using drones to capture footage of the Bay's waterways as a cheaper alternative that can obtain data at a high resolution (Horstmann, Stresser, Carrasco, 2017). The method has a root-mean-square error of 0.09 m/s in current velocity (Streßer, Carrasco, Horstmann, 2017). Clear footage of the waves from above are recorded then interpreted by the CopterCurrents program being developed at HZG. This program derives the wavelength, period, and direction of the waves then compares them to their dispersion relations to create a vector map of the surface currents. Further information about the CopterCurrents program can be found at https://ms.hereon.de/coptercurrents/.

Materials and Methods

The drone used for the flights was the DJI Mavic Pro. Using the built-in camera and set to point downwards, footage was taken at 100m above ground level. Footage across the Seekonk river was taken, starting from Gulf Avenue to Phillipsdale, which is in close proximity to the Phillipsdale Buoy. The drone was programmed to stop 5 times during its flight path to record 12s of footage. The same procedure was used at the Save the Bay Center site, travelling directly across the Providence river, stopping a total of 4 times to record. This process was done for the high, low, ebb, and flow tides to provide as much variety in the datasets as possible.

Results

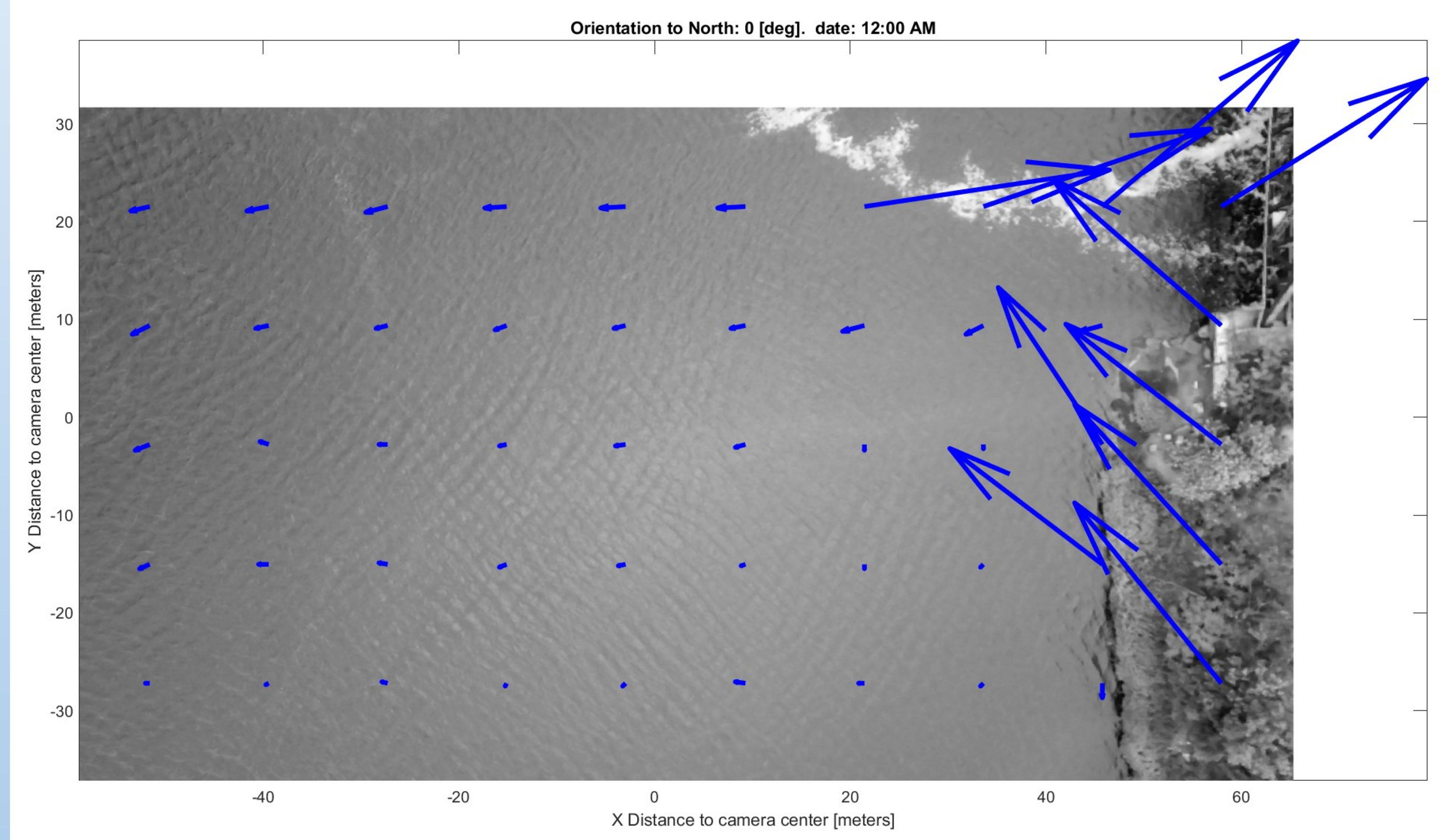
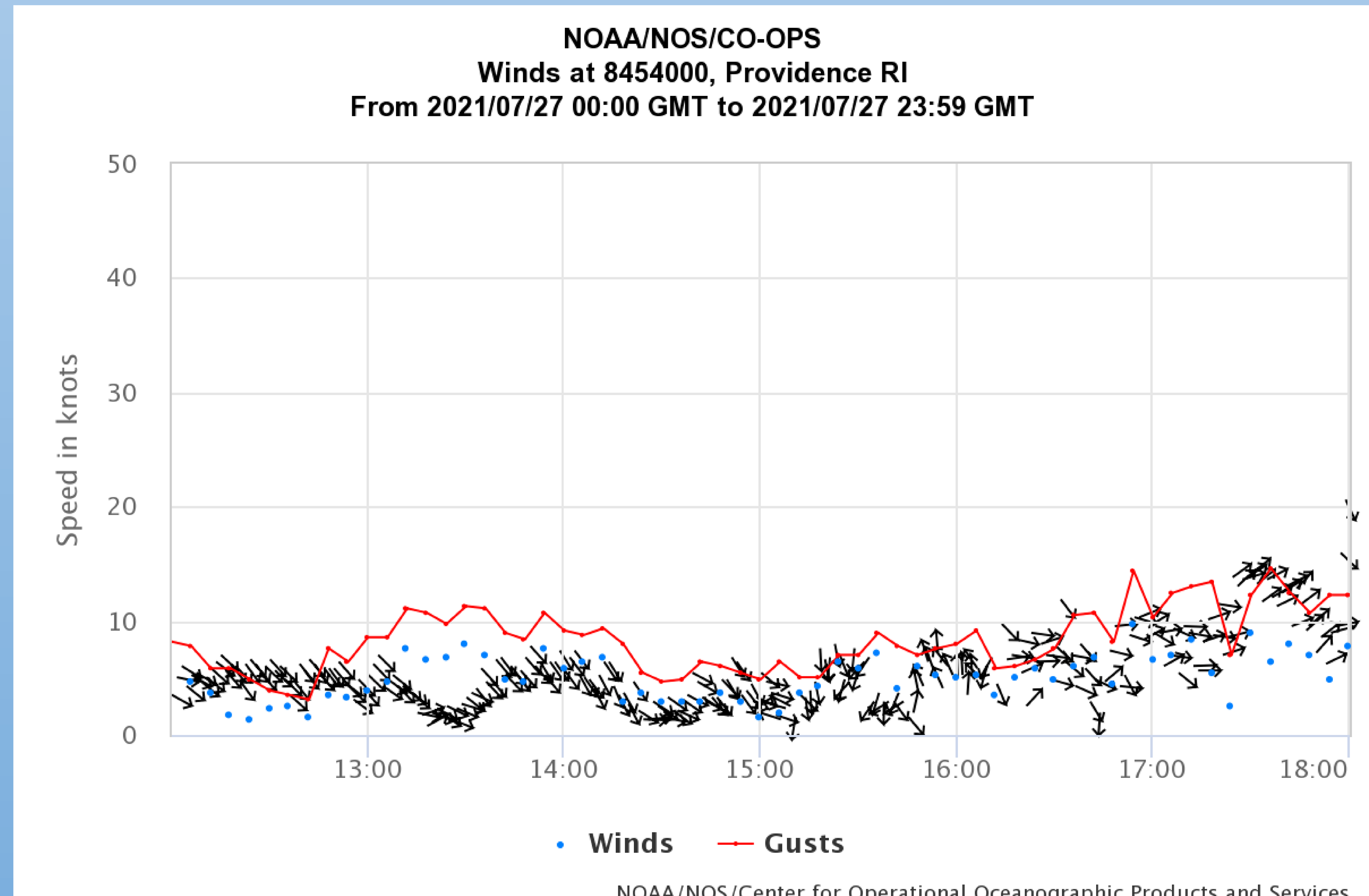


Figure 1. Resulting image from the CopterCurrents program. Footage taken during flow tide near Phillipsdale area. The current flowing from the river can visibly seen by the blue arrows. The large arrows are a result of noise observed by the program and can be ignored.



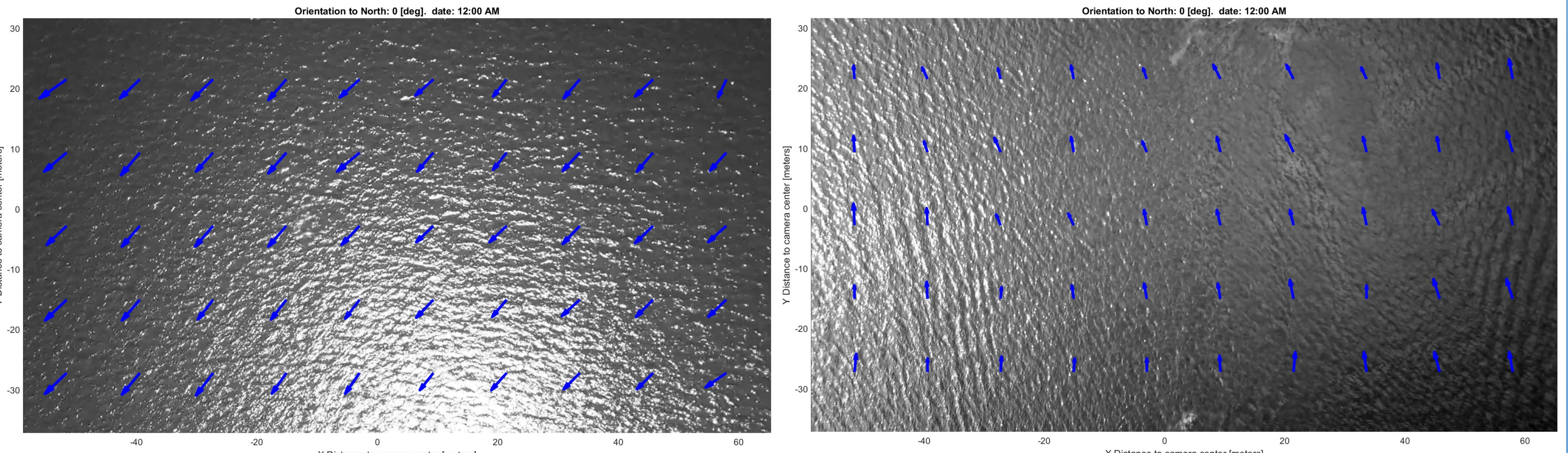


Figure 2. The bottom left vector map represents the Providence River near Save the Bay during ebb tide, taken at 12:27 PM. The bottom right represents the same location shortly after low tide, taken at 4:54 PM. The wind speed during low tide is much greater when compared to the snapshot at ebb tide. Similarly, the wind direction is different. The affects of tides, river flow, and wind on surface current velocity and direction can be inferred by the differences between the two maps.

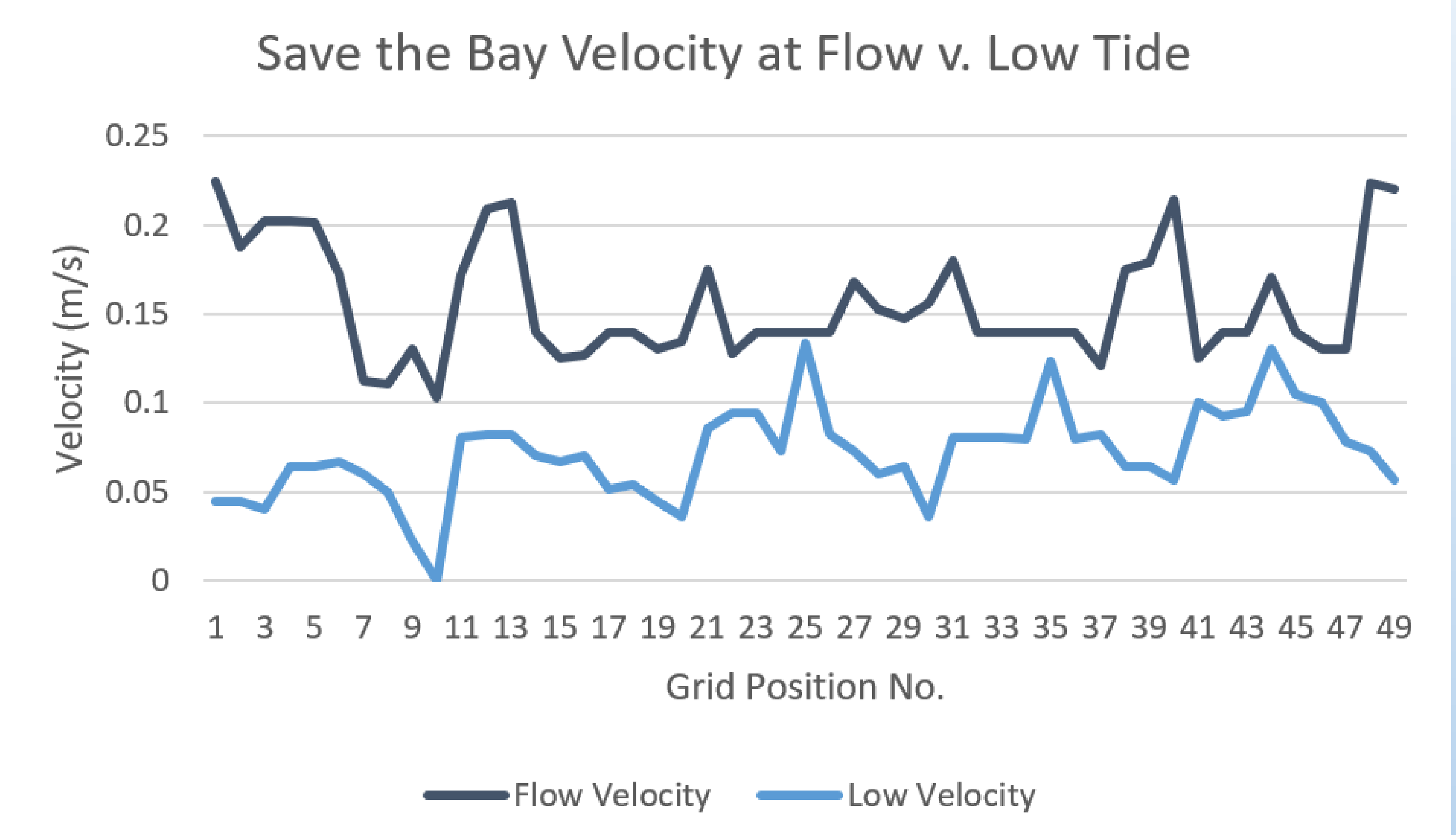


Figure 2. Velocity data retrieved from the CopterCurrents program of the Save the Bay shore. The differences in velocities represent behaviors that are typical for flow and low tides.

Conclusions

The usage of drones to observe surface current velocities has potential in obtaining low-cost high resolution data to help further develop the OSOM. However, some complications with the method are important to note. During the process of obtaining data across the two sites and four tidal stages, issues such as weather, lighting, winds, and water depth can affect the drone's ability to fly or collect accurate wave data. Similarly, any landmass or object viewed by the recording will cause the CopterCurrents program to return with unusable datapoints. Regardless, with proper conditions and planning, the method is capable of providing surface current data that corresponds closely to its local physical variables. Taking footage during the four tidal stages helped in illustrating the behaviors of the Providence and Seekonk at different water depths and weather conditions. Considering the effectiveness of the method in obtaining localized data, it has the potential of alleviating a major information gap in the OSOM, especially in narrower parts of the Bay that other methods of current detection cannot do. Future plans with this approach may include flights in more locations and across several tidal cycles to provide as much data possible for inclusion into the RIDDC and OSOM.

References

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