Surface Circulation Study of Waters near the Suwannee River, Florida

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1. Introduction

This report describes the use of acoustic drifters to study the surface circulation near the Suwannee river area. The purpose of the study was to observe circulation patterns when the ocean surface is predominantly forced by tides or wind. The results would be of importance to predict where the Suwannee plume extends and where its zone of influence is.

2. Study Area

The Suwannee River (Figure 1) is located North of Tampa Bay and flows from its headwaters in the Okefenokee Swamp to the Gulf of Mexico. The river is spring fed and receives runoff from the Alapaha, Withlacoochee, and Santa Fe Rivers and other tributaries. The river is 240 miles long and has an approximate drainage area of 9,640 square miles. The estuary provides a valuable habitat for birds, fish, mammals, and invertebrates, serves as a nursery for juvenile fish, and contributes nutrients to nearshore areas. The hydraulic response of the estuary, however, is poorly understood; and there is difficulty in gaging tidal flow by using traditional methods (*Tillis*, 2000).

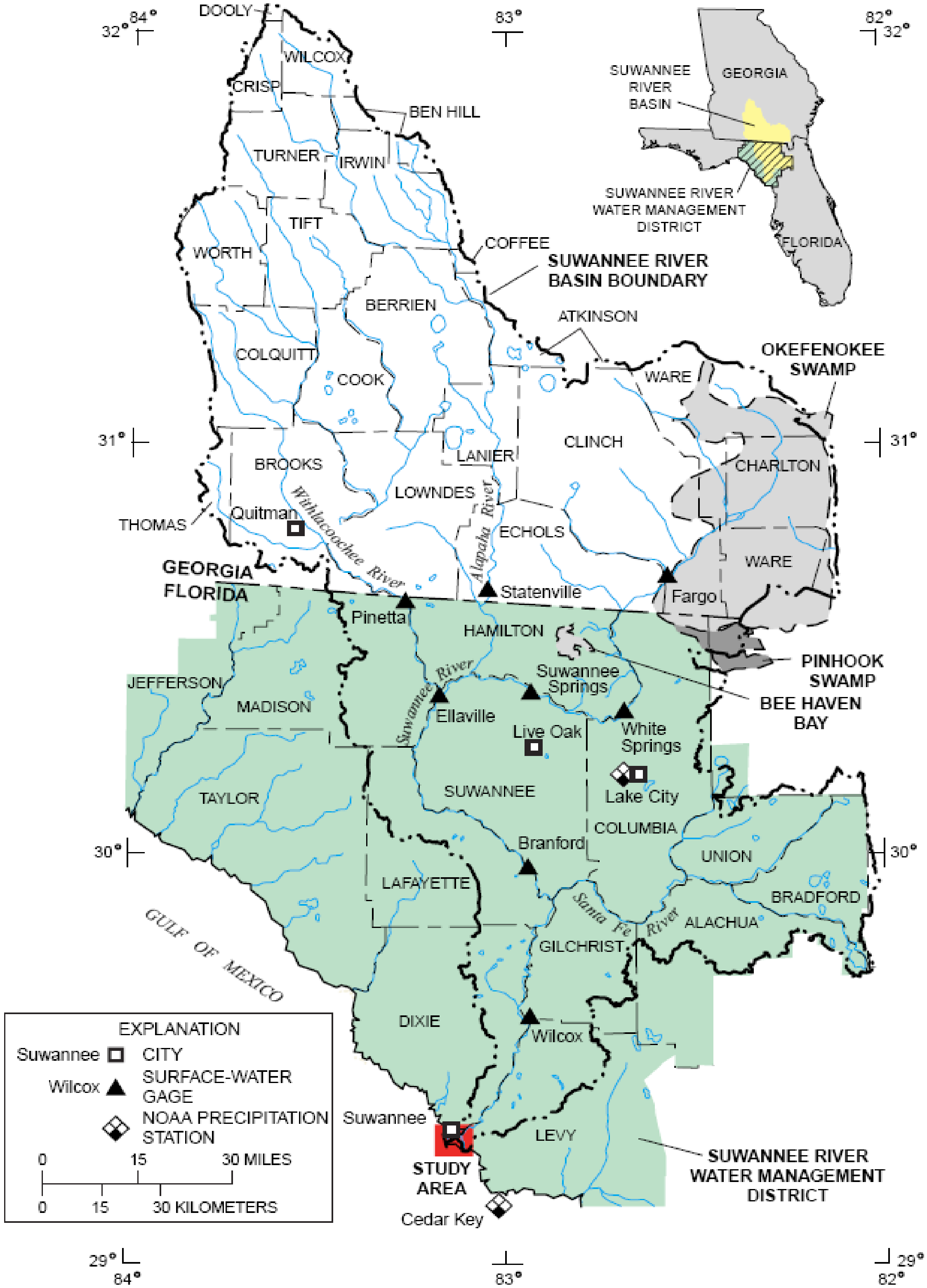

Figure 1: Location of the Study Area in the Suwannee River Basin, Suwannee, Florida (From *Tillis*, 2000)

3. Drifter

The drifters used in this study where designed by Peter Lazarevitch from the current meter facility. Those have been designed to measure currents over the course of several weeks with GPS fixes recorded every hour or better and transmitted by radio to a base station for real-time monitoring and recovery. This design relies upon three main components: a GPS receiver, radio transceiver, and a microprocessor controller, each available commercially as OEM components (*Lazarevitch*, 2007).

Eight drifters were used for the all study. The drifters were programmed to acquire a GPS fixed every two minutes, store the fix into memory, and then wake up at selected times and broadcast a radio message that included the last GPS fix made. The base station was programmed to constantly listen for these transmissions and output the messages via RS-232 for display on a computer.

The drifters were designed to be compact and low-profile in order to avoid being seen on the water by boaters. It was barely visible at 100 m. During field tests, it was found that the drifter was quite stable in the water, and that both the GPS and radio antennas remained slightly above the water line. This can cause problem in case of choppy water and an additional buoyant piece need to be add so the GPS module can still communicate with the base unit without being blocked from waves.

4. Observations

A total of 3 deployments were made: 1 in the Suwannee river the first day and two in the Gulf off shore. The first deployment would give a good idea on the tidal circulation inside the River itself, while the deployment offshore the second day is mostly forced by winds.

In the figures that follow, drifters' tracks from 2 deployments are plotted on Google Earth maps (using the Google Earth Matlab toolbox, *Davis*, 2007). Indeed, the second deployment the drifter did not stay in the water long enough. The figures show the deployment point as well as the recovery locations, and the 2-minutes interpolated position of the drifters. We also kept the Dinghy locations after the recovery (white solid line) while the phase of the tide is colored coded: the incoming tide is plotted in a blue solid line and the outgoing tide is the blue solid line.

4.1 Deployment at the Suwannee River, 09 May 2008

Four drifters were deployed at the same location and 15 minutes apart while the tide was outgoing. Since only one drifter has been recovered we have only one track showed by Figure 2. The deployment is showed by a cyan stars while the drifter recovery is showed by the pink stars. The drifter was on the water for 12 hours and grounded twice. First, the outgoing tide forced the drifter to go downriver until the low tide made the drifter grounded in some shoal. It is important to notice that the drifter was out of the river area. When the incoming tide was strong enough it pulled out the drifter again but grounded eventually after this and spend the night trapped in some vegetation.

The tidal signal is clearly visible and we can say that the drifter position was dominantly driven by the tidal forcing.

The rescued drifter velocities are computed at all 30-minutes interpolated position to avoid errors due to the geo-positioning system (Figure 3). The sample has a total of 445 records and the mean velocity is 0.065 m.s^{-1}. Figure 3 shows the end of the outgoing tides and the acceleration of the drifters due to the narrowing of the coastline. The maximum velocity is approximately 0.6 m.s^{-1}. Soon after, the drifter land on some grasses patch. The incoming tide can be seen 8 hours after the release but the drifter ground before it can come back to the mouth of the Suwannee River.

Figure 2: Drifter tracks for deployment at the Suwannee River the 9th April of 2008. Deployment and recovery sites are indicated with the green and cyan stars, respectively. The white lines indicate the drifter trajectories. Dots represent the 5-minute interpolated positions, and are all blue for an outgoing tide.

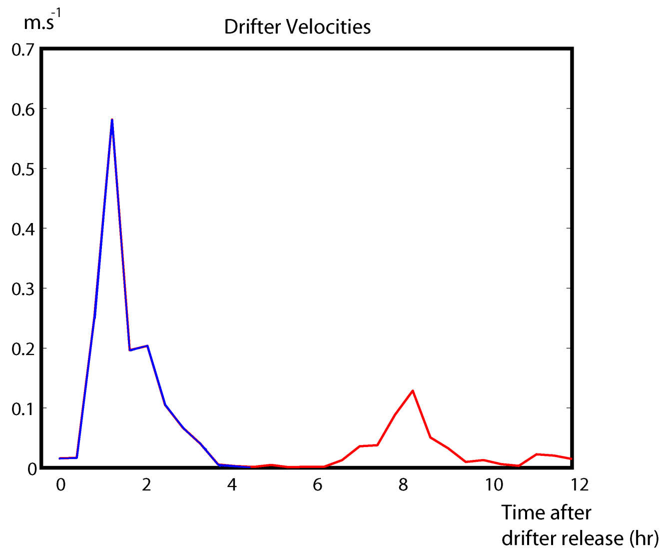

Figure 3: Drifter velocities. The x-axis is the time spent after the drifter release while the velocities (y-axis) are in $m.s^{-1}$

4.2 Deployment offshore of the Suwannee River, 10 May 2008

Four drifters were deployed offshore and were strongly driven by the wind forcing (Figure 4). The drifters were approximately 4 hours in the water and covered approximately 2 miles. Figure 5 shows the drifters' velocities histograms. It appears that the mean velocity is around $0.15 m.s^{-1}$. The drifters were dominantly floating in the northwest direction as the winds were southeast. The first release was drifter 1 and the velocities appear to be spread around the mean seen above with extremes at $0.05 m.s^{-1}$ and $0.35 m.s^{-1}$.The drifters 2 and 4 have more like a normal distribution center around this mean. This is in accordance with the total distance covered by the drifters in 4 hours.

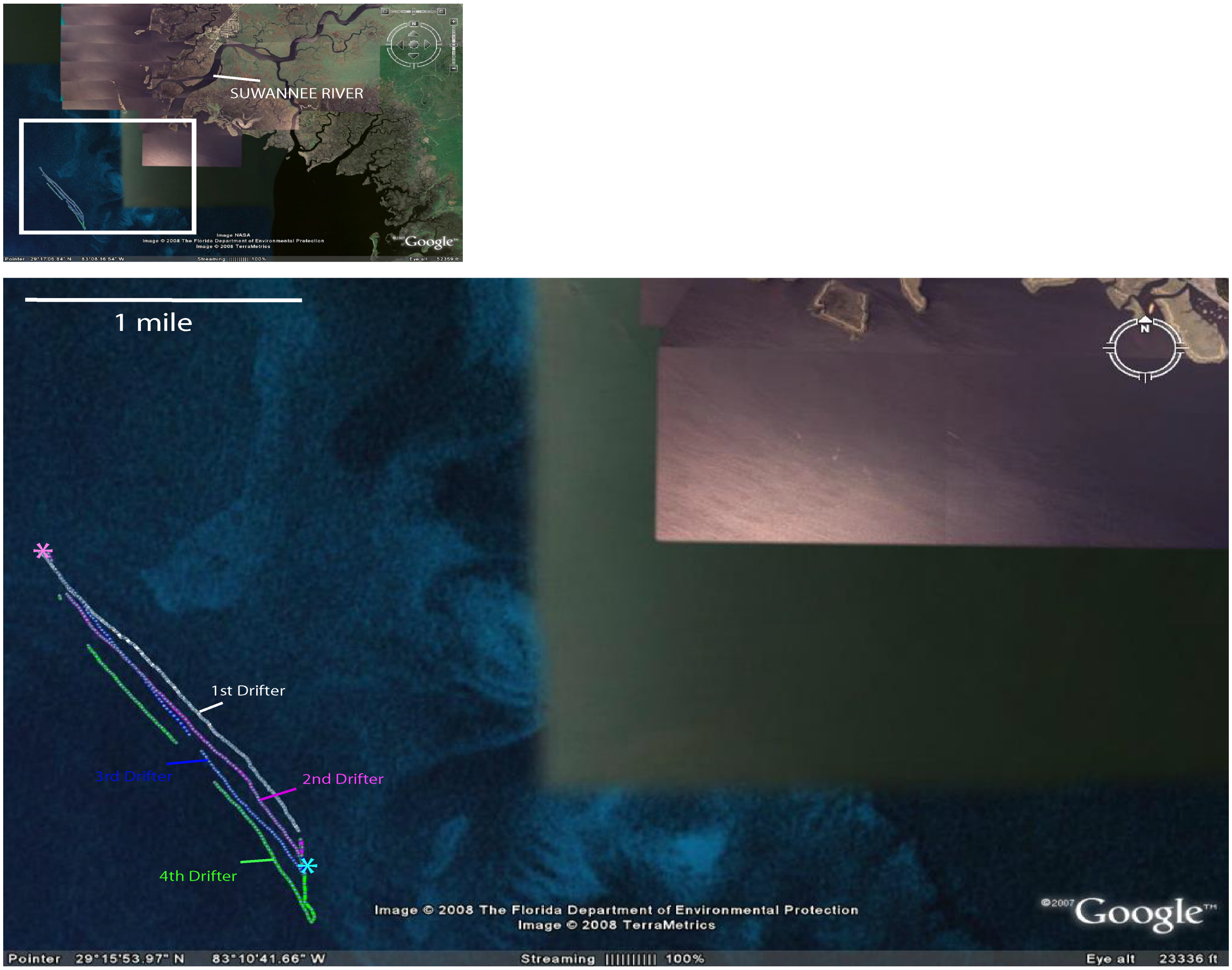

Figure 4: Drifter tracks for deployment at the Suwannee River the 9th April of 2008. Deployment and recovery sites are indicated with the green and cyan stars, respectively. The Drifters numbers are indicated on the graph.

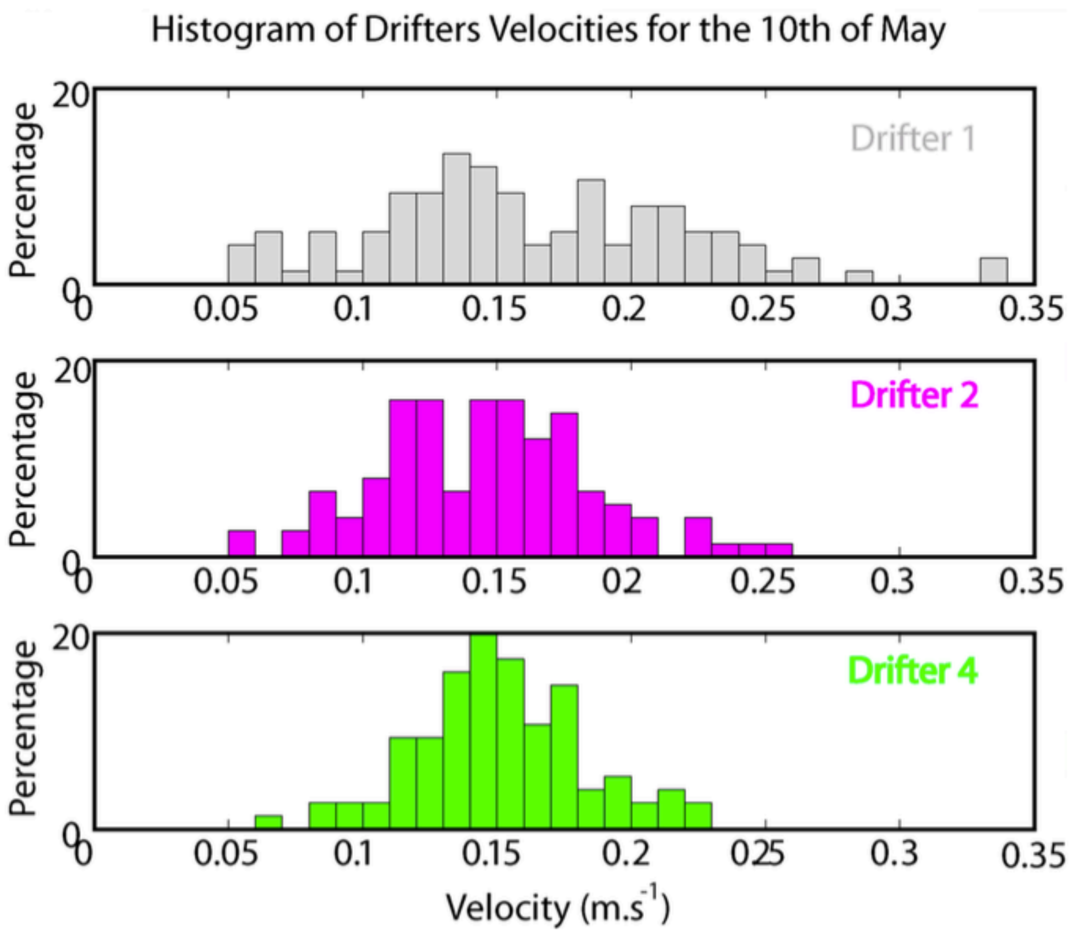

Figure 5: Histogram of drifters velocities during the deployment of the 10th of May. Top panel is for Drifter 1 (for reference see Figure 4, same colors for drifters), Middle panel is Drifter 2 and bottom panel is drifter 4.

5. Discussion and Conclusion

We were able to capture two different type of surface forcing: the tidal forcing and the wind forcing. It appears that near the Suwannee river mouth, the tidal circulation is quite strong, approximately $0.5 m.s^{-1}$. This is accordance with the papers from *Tillis* (2000) and *He and Weisberg* (2002) where they found similar tidal current velocities. The river plume is then strongly affected by the outgoing and incoming tide. Due to the drifter design and the coastline complex geometry it remains hard to have more than 2 tidal cycles as the drifter usually ground before.

The wind driven circulation results in velocities more spatially homogeneous but they are weaker, the mean being approximately $0.15 m.s^{-1}$. The wind was blowing at (?Nico?).

In conclusion, this study shows that near the river mouth, the tidal current plays a crucial role in the upper circulation and thus will have a strong impact in the plume dispersion.
As the plume goes off shore, the wind forcing drives the circulation, and while the velocities are weaker, they concerned a larger area and will disperse the plume over large distance compare to the locally tidal forcing.

References

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