Tampa Bay Response to Hurricane Irma

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Abstract

Hurricane Irma impacted Tampa Bay area during September 10-11, 2017. The Tampa Bay response to Hurricane Irma is analyzed using a combination of in situ observations and numerical model simulations. The observations include in situ wind and water level records. The model employed is the Tampa Bay Coastal Ocean Model (**TBCOM**) that downscales from the shelf to the estuary by nesting the unstructured grid FVCOM in the West Florida Coastal Ocean Model (WFCOM) that downscales from the deep ocean, across the shelf by nesting FVCOM in the Gulf of Mexico HYCOM. Both the observations and the model simulations show a rapid negative storm surge (set down of sea level) followed by positive surge associated with the change of in wind direction. This scenario implies massive exchanges of water between Tampa Bay and the adjacent continental shelf during the hurricane passage, which may have important ecosystem implications.

Model Grid and Storm Event

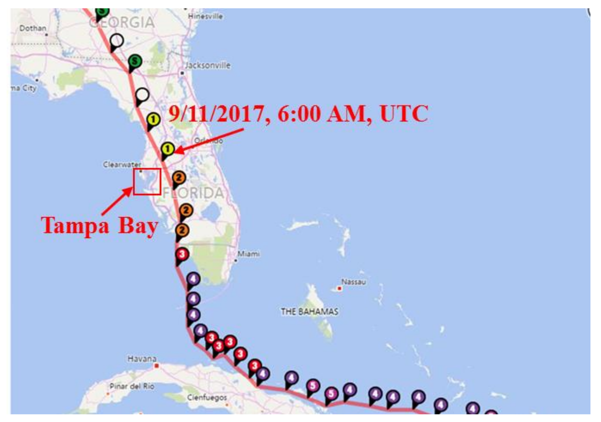

Fig. 1. The path of Hurricane Irma (by accuweather) and the location of Tampa Bay.

Tampa Bay is the largest of the Florida coastal plain estuaries, and it also contains the only deep water port on Florida's west coast. The eye of Hurricane Irma passed by the Tampa Bay region at about 6:00 am 9/11(UTC) when it was downgraded from Category 2 to Category 1 (Fig.1).

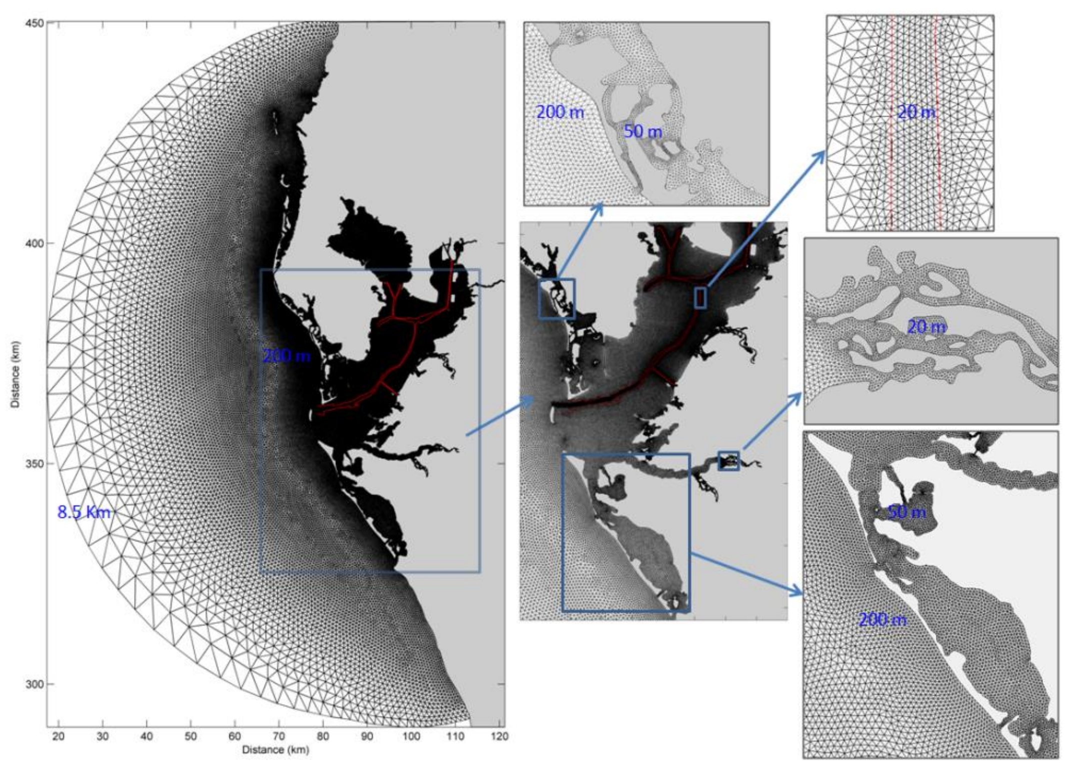

Fig. 2. Model grid of TBCOM and zoomed views of selected regions.

Tampa Bay Coastal Ocean Model (TBCOM)(Fig.2) nests FVCOM in the West Florida Coastal Ocean Model (WFCOM) (Fig.3) that nests FVCOM in GOM HYCOM. The TBCOM horizontal resolution gradually increases from ~ 8.5 km along the open boundary to ~ 200 m near the coast, and as fine as 20 m within Tampa Bay.

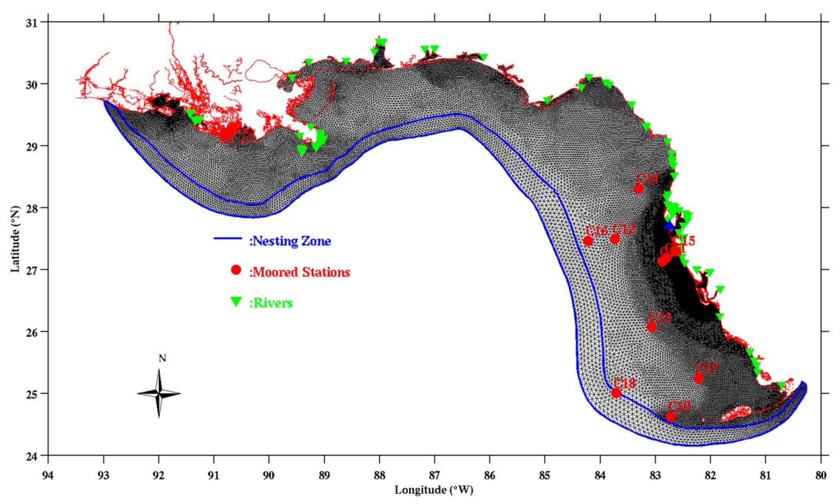

Fig. 3. Model grid of WFCOM.

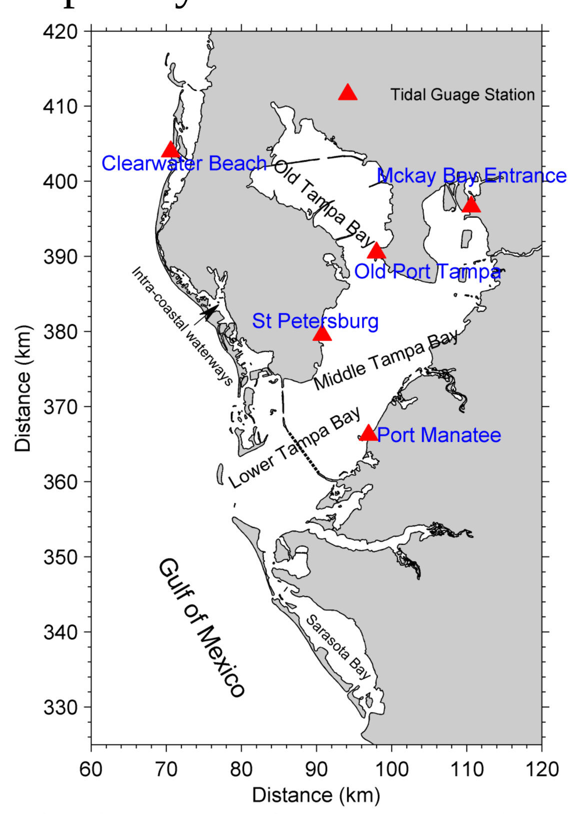

Fig. 4.The locations of Tampa Bay tide gauges.

Results

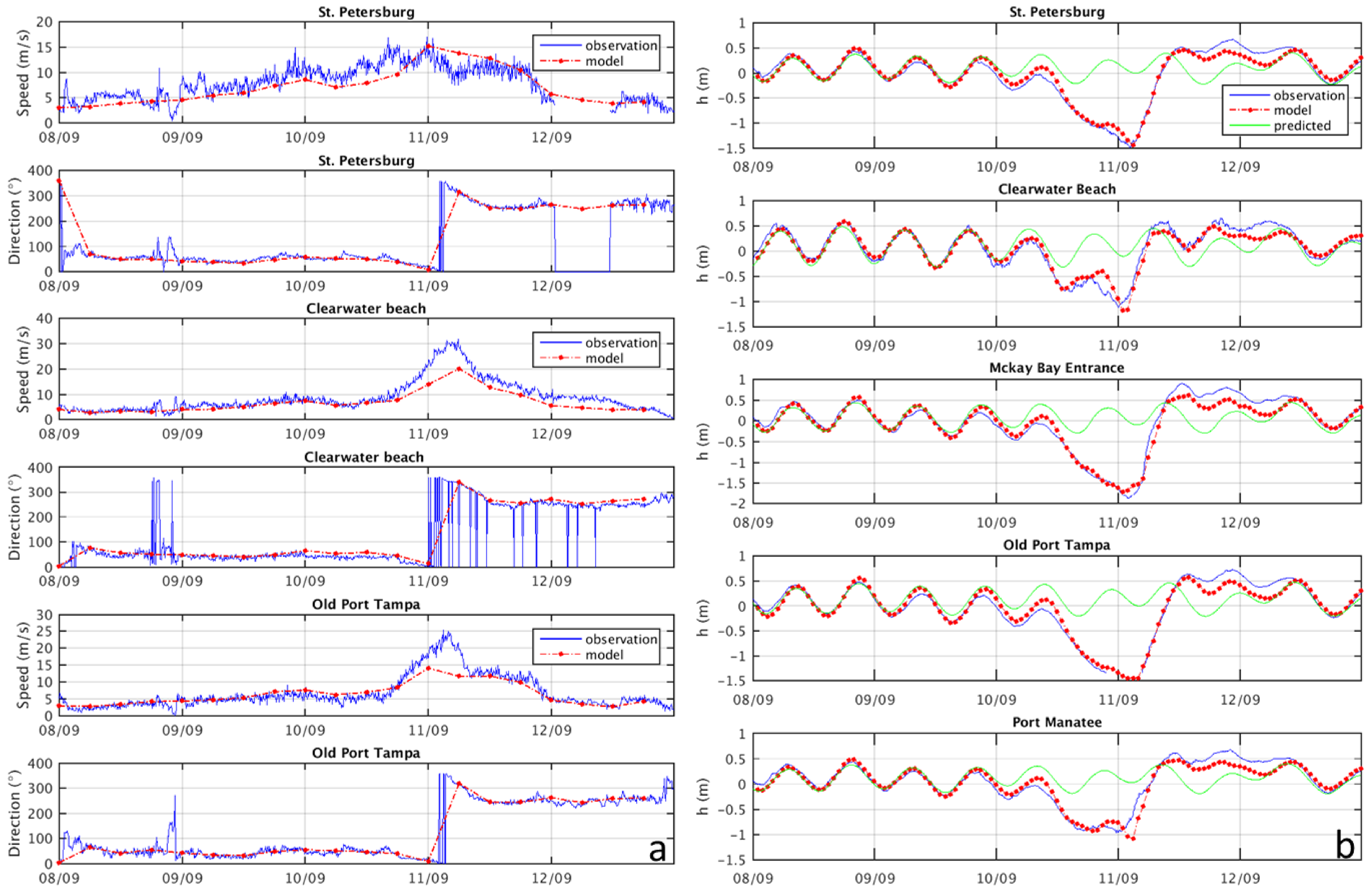

Fig. 5. (a) Wind speeds and directions observed and modeled (by NOAA) for stations (see Fig. 4). (b) Sea levels predicted by tides alone (by NOAA), observed (by NOAA) and modeled by TBCOM.

The NOAA modeled winds(Fig.5 (a)) used to force the TBCOM underestimated the Irma observed winds by a factor of 1.6 during the Hurricane. After adjusting the winds by a factor of 1.6 and rerunning the model in hindcast, the observed and modeled sea levels were in agreement. Sea level(Fig. 5(b) at St. Petersburg first decreased to ~ 1.5m below mean sea level, and then increased to ~ 0.5m above mean sea level, or ~ 2m overall. At some places, this difference was ~ 3m.

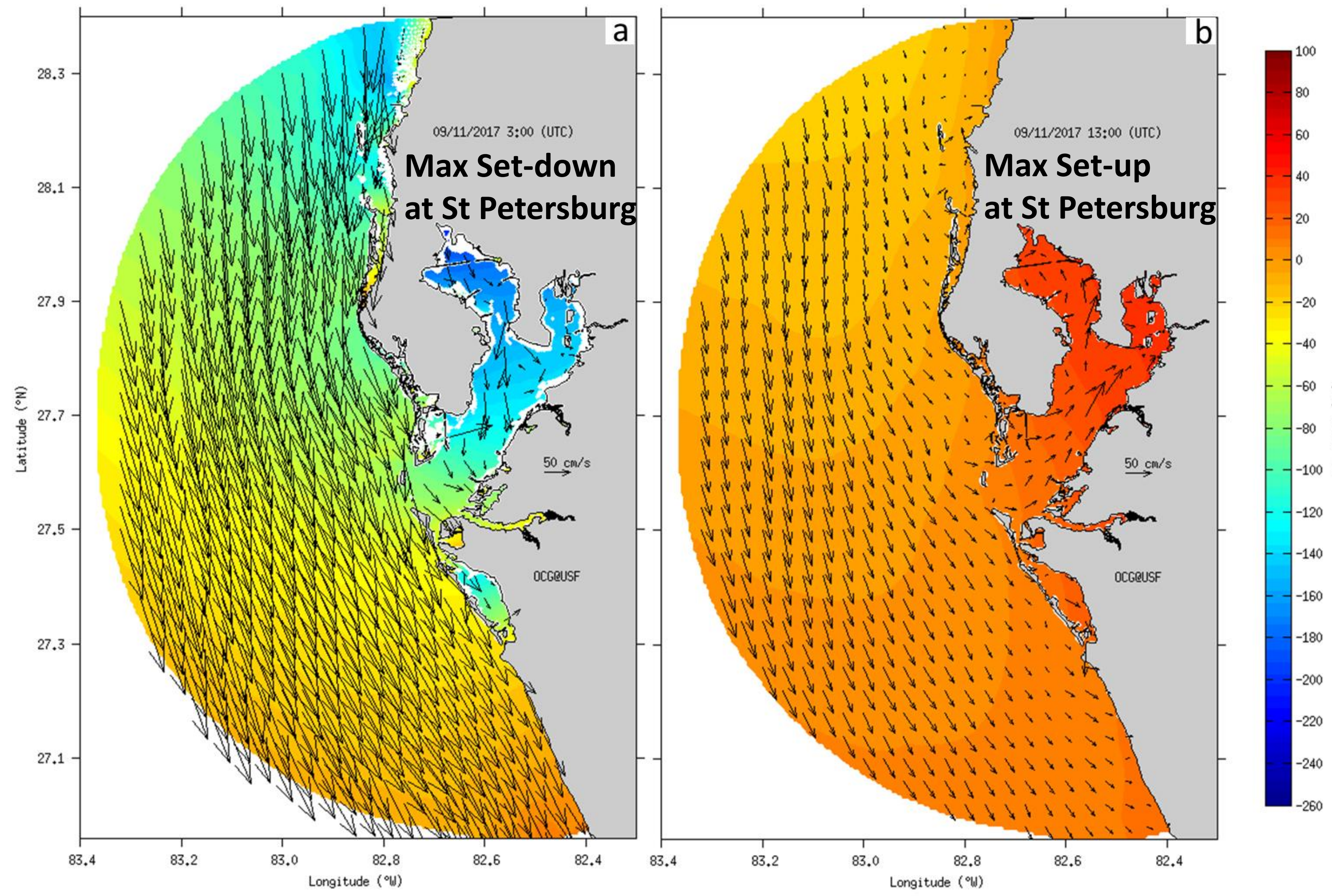

Fig. 6. TBCOM Simulated surface currents and sea level. The arrows represent current. The color coding is sea level, blue being low and red high. White areas are where the bay became dry.

Being able to track the water for a major event is important for determining where the water and properties such as larvae and nutrients came from and went to. Lagrangian Drifter Trajectories help to answer such questions.

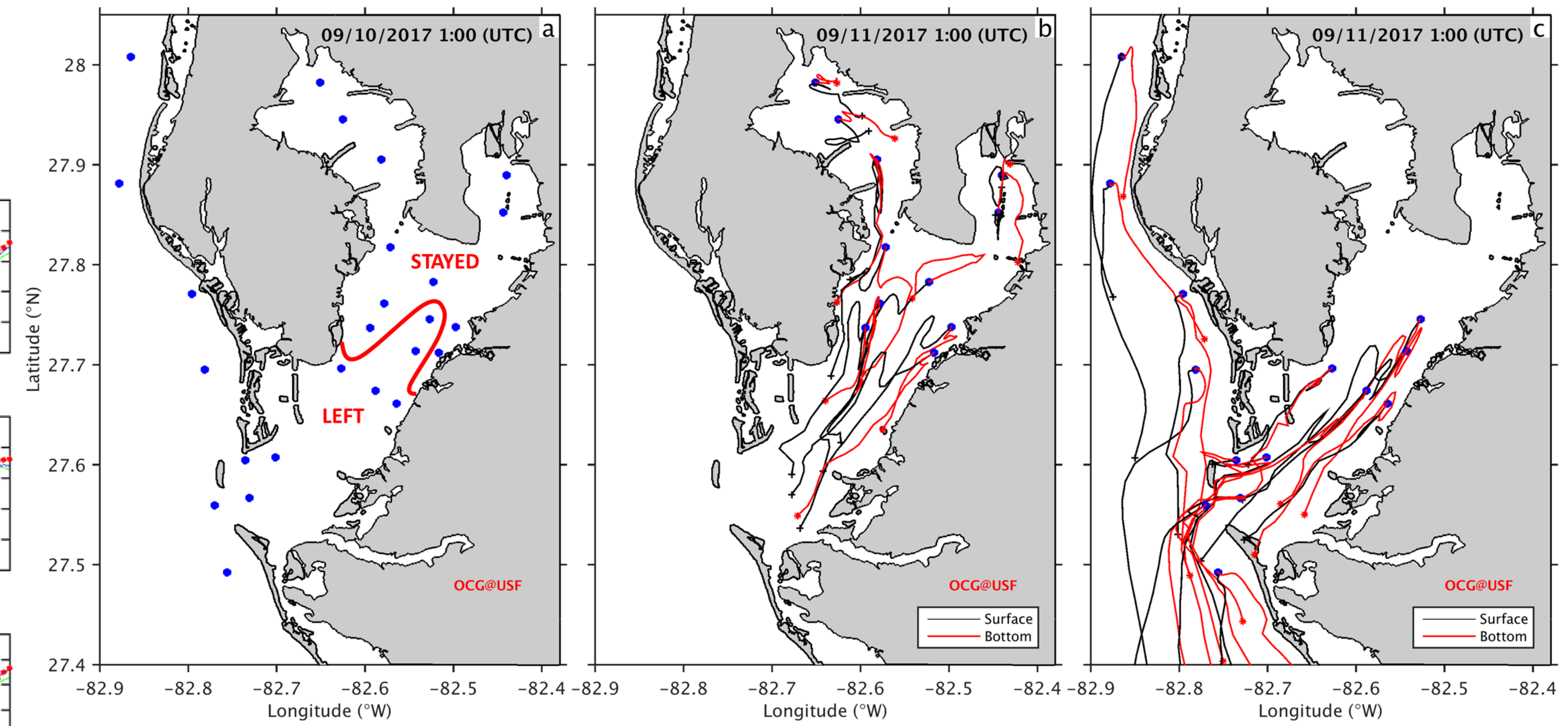

Fig. 7. Simulated Lagrangian drifter trajectories. (a) The blue dots represent the initial locations of the drifters. (b) The drifters which stayed in the bay. The **black lines** are surface trajectories, the red lines are bottom trajectories. (c) The drifters which left the bay.

From where did water leave the bay?

Answer: From the lower portion of Tampa Bay.

It turns out that water drained out of the bay really came from the lower portion of the bay(Fig.7(c)). The approximate boundary between the water which stayed and which left is the red line(Fig.7(a)).

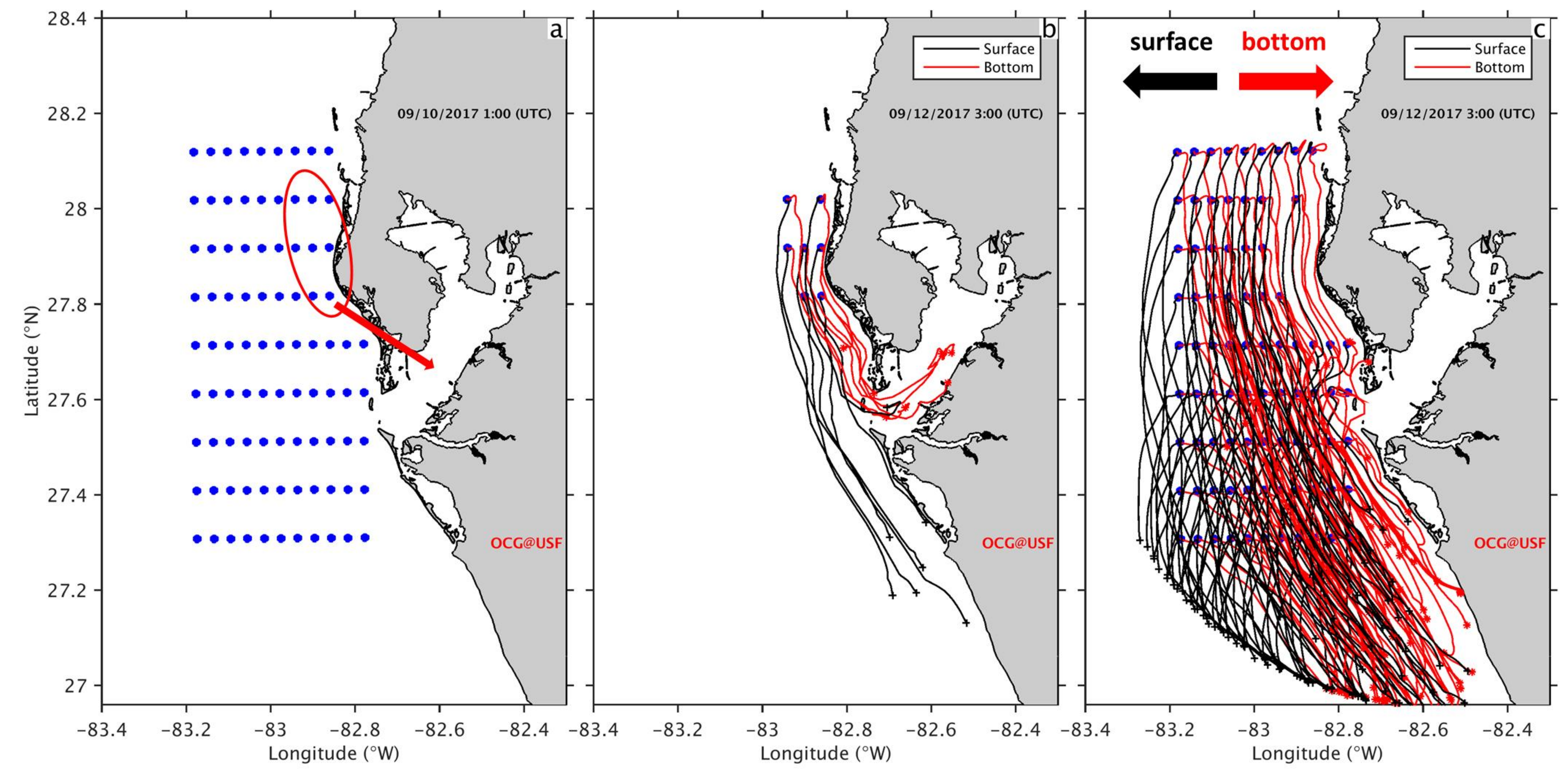

Fig. 8. Simulated Lagrangian drifter trajectories. (a) Those blue dots represent the initial locations of the drifters. (b) The drifters which went into the bay. The **black lines** are surface trajectories, the red lines are bottom trajectories. (c) The drifters which did not went into the bay.

From where did the new water enter the bay?

Answer: From nearshore of Indian Rocks Beach and Clearwater (red ellipse Fig.8(a)) and primarily from the bottom(Fig.8(b)).

During Hurricane Irma the surface drifters tended to go offshore, while the bottom counterparts tended to move onshore as expected for an upwelling response.

Conclusions

- TBCOM's first trial was Hurricane Irma for which it performed very well.
- Anticipated are TBCOM applications for recreational and commercial boating, fishing, search and rescue along with scientific studies.
- The emptying of water from Tampa Bay by Irma was primarily from the lower portion of the Bay. The water refilling the bay originated to the north near Indian Rocks Beach and Clearwater.
- Given this new TBCOM tool and its WFCOM counterpart we now have the capability to downscale from the deep ocean, across the shelf and into the local estuaries, providing opportunity for multidisciplinary studies of the shelf and its estuaries.