FLOW REVERSAL OBSERVATIONS AT RIO HONDO (MEXICO-BELIZE) INDUCED BY THE PASS OF HURRICANE ERNESTO

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Paper topic: Coastal waves, currents, tides and storm surges

1. Introduction

Currents (ADP's), CTD and surface elevation were measured at Rio Hondo during July to October 2012. The Rio Hondo forms the border between Mexico and Belize and the watershed drains from Guatemala, Belize and Mexico. The river flows in a northeasterly direction to Chetumal Bay on the Caribbean Sea. During early August hurricane Ernesto moving westward from the Atlantic reached its peak intensity as a category 2 as it made landfall on the eastern Yucatan Peninsula. From the 5 to 8 of August 2012, level data from the Chetumal Bay showed a gradual decrease in the sea water level of up to -1.07 m. A similar response was observed in the water level from the ADP pressure sensors deployed 10 and 20 km upstream the Rio Hondo. In few hours, after reaching the minimum there was a sudden increase in the water level up to 0.38 m. This sudden increase caused an opposite pressure gradient at the Rio Hondo inducing a reversal in the flow which was clearly observed up to 20 km upstream. Therefore, a description of the observed reversal is described and the observations are synthesized with a simple numerical model.

2. The Rio Hondo

The Rio Hondo is a river of Central America of approximately 150 km in length, which flows in a northeasterly direction to discharge into the Chetumal Bay on the Caribbean Sea. The Chetumal Bay is a shallow semi enclosed area with depths ranging from 2 to 5 m and connected in the southern part (70 km approximately) to the Caribbean Sea. Consequently, the Rio Hondo and the Chetumal Bay forms an estuarine system which seasonal patterns were described by Carrillo at al., 2009. Therefore, it has been observed that this estuarine system is strongly influenced by the dry and rainy season and meteorological events such as the presence of tropical storms or hurricanes.

3. Field measurements

Field measurements were carried out mainly during the rainy season. Measurements were aimed to determine quantitatively the discharges (Q) of the Rio Hondo and its tributaries. Along with, currents, water level and CTD were measured at Rio Hondo during July-October 2012. The Acoustic Doppler profilers (ADP's) were deployed on the river bed (in the central part the section) at approximately 10 m depth and at 10 and 20 km upstream the river mouth (Chetumal Bay). The ADP's recorded the vertical structure of the river current, temperature and water level. CTD casts were carried out along the river at different times. CTD data showed the presence of freshwater dominating throughout all the river to the mouth. So the river discharge was inhibiting the penetration of the salt wedge upstream the river. Finally, tidal data was measured from a station located in the Chetumal Bay. Tides are weak in the Chetumal Bay so changes in the sea level may be induced by changes in the coastal Caribbean current or mesoscale meteorological processes.

4. Conclusions

Environmental data was gathered during July to October 2012 at the Rio Hondo. Coincidentally,

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during that period the hurricane Ernesto made landfall in early August 2012 on the eastern Yucatan Peninsula, approximately 50 km north from the river mouth, where it enters into the Chetumal Bay. Data captured the impact of the hurricane on the water level and currents in the Chetumal Bay and Rio Hondo. Prior to the hurricane landfall a steady decrease in sea level was observed reaching up to -1.07 m and then increasing steeply to 0.38 m. Simultaneously, changes in the water levels induced, initially, the flushing of the Chetumal Bay and Rio Hondo with the normal and steady increase in the along stream current river velocity. However, the sudden and steep increase caused a reversal of the river water flow which was strongly observed up to 20 km upstream from the mouth of the Rio Hondo. This event was quite unique and was clearly observed since the hurricane was not accompanied of heavy rain which may inhibit changes in the water levels upstream and obscure the reversal of the river currents. Finally, field observations are synthesized by a simple numerical model to understand the response of the Rio Hondo to this particular storm surge.

Figure 1. Track of hurricane Ernesto during July-August, 2012.

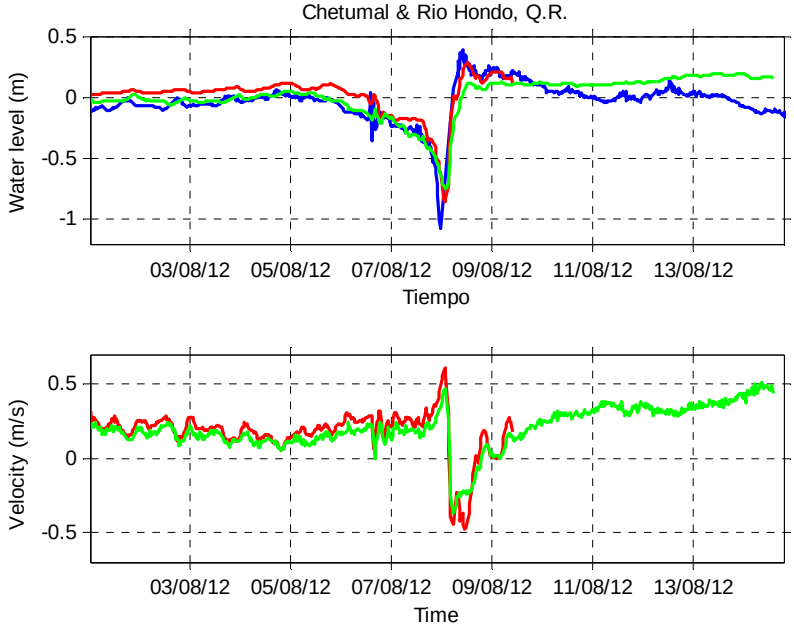

Figure 2. (Top) Water level of Chetumal Bay (blue line) and upstream the Rió Hondo (10 km = red and 20km = green line) during the pas of hurricane Ernesto on the eastern Yucatan Peninsula. Along stream velocity at Rio Hondo (10 km = red and 20km = green line).

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References

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