The Importance of Dynamic Density Compensation in Water Level Monitoring

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OBTAINING SUPERIOR WATER LEVEL ACCURACY IN COASTAL ENVIRONMENTS

In-Situ® Inc. water level instruments measure the sum of all pressures (atmospheric and hydrostatic) exerted on a pressure transducer and use that data to calculate water levels. Water density contributes to the total hydrostatic pressure. Saltwater has a higher specific gravity than fresh water. A standard column of saltwater exerts more pressure per square inch (PSI) on a pressure transducer than the same column of fresh water. Higher PSI levels are typically interpreted as increasing water levels, but many times are simply due to increasing salinity levels.

In environmental monitoring applications, typical water level sensors can not measure water density variations (due to salinity changes) over the course the monitoring period. The monitoring instruments report all pressure variations as changing water levels. More sophisticated water level sensors can compensate for different water density via input of a fixed, or static, specific gravity value. This compensation method, however, is only effective if the salinity levels do not change during the monitoring period. If not compensated for, changing salinity levels can impact water level accuracy by up to 2%.

Figure 1: Aqua TROLL® 200 instrument

The In-Situ Aqua TROLL® 200 instrument (see Figure 1) monitors and records water level, temperature, plus conductivity and salinity. The Aqua TROLL 200 instrument automatically and continuously corrects its depth and level parameters for changes in water density due to changes in salinity. This can dramatically improve the accuracy of depth and level measurements in estuaries and coastal waters where tides and rainfall continuously affect the local salinity.

Figure 2 contains data from a one-month deployment in Biscayne Bay, Florida–a shallow estuary protected by barrier islands on the southeast tip of Florida. The Bay is a productive ecosystem, where freshwater from the land mixes with saltwater from the sea to support a diverse mix of sea life including corals and sea grasses. Over the deployment, rainfall and tidal influences caused significant fluctuations in salinity and corresponding water density. Water depth and salinity were measured and plotted.

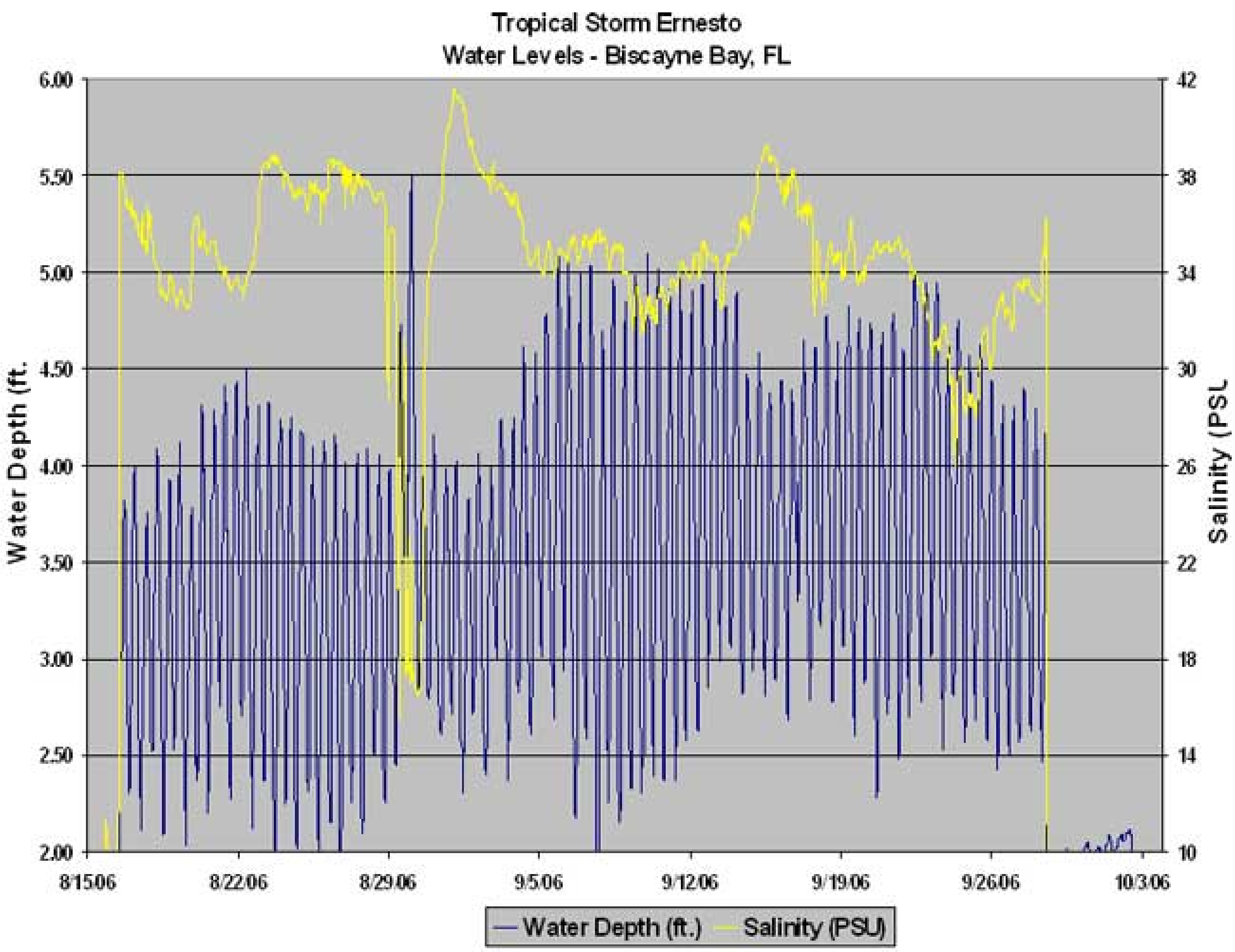

Figure 2: Water depth, temperature, and salinity were monitored and logged during a one-month deployment in Biscayne Bay, Florida. During Tropical Storm Ernesto, significant amounts of rainfall caused increased water depth and diluted the Bay's salinity levels.

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Figures 3 and 4 provide additional detail on Tropical Storm Ernesto's impact on salinity and water levels in Biscayne Bay. Due to fluctuations in salinity, water depth data could have shown up to a 2% error as indicated by error bars, if not compensated for dynamically. Under higher than average salinity conditions, a non-compensated sensor would report falsely high water levels. Under lower than average salinity conditions, like those occurring during Ernesto, a non-compensated sensor would report falsely low water levels. This error could ultimately have a drastic impact on future flood and storm surge modeling.

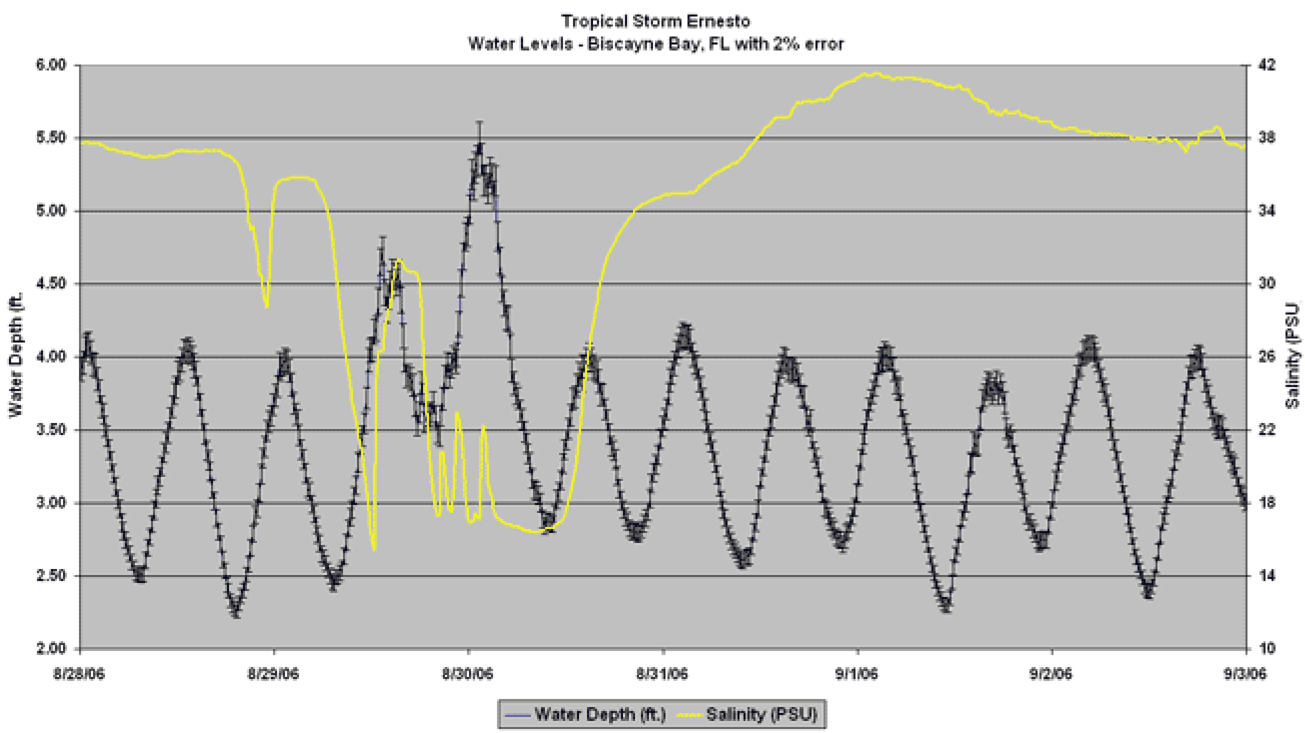

Figure 3: This figure shows water level measurements collected over a one-week period – before, during, and after Tropical Storm Ernesto. Had the water depth not been compensated dynamically via conductivity measurement, changing water densities could have resulted in error of +/-1.3" – over 10 times the accuracy specification of the instrument. Error bars represent this +/- 2% uncertainty.

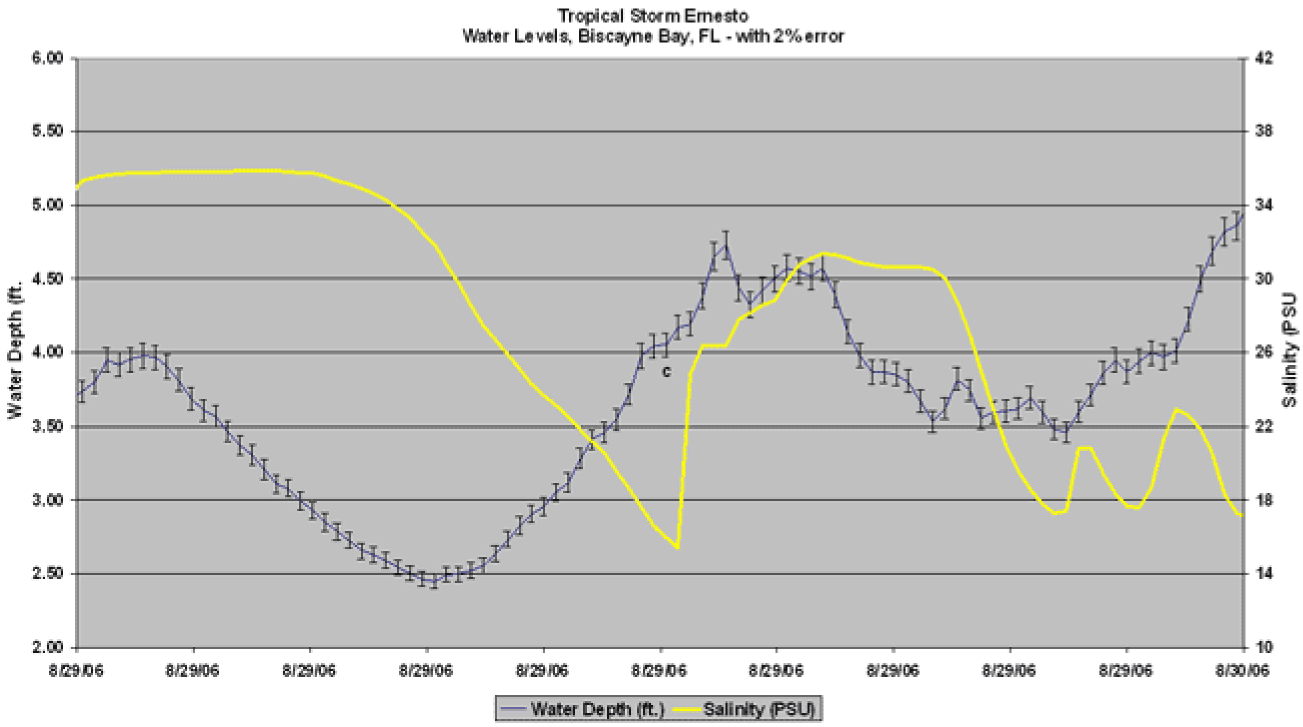

Figure 4: This figure shows data collected over the course of a day and shows the dramatic dilution of salinity levels in Biscayne Bay as Tropical Storm Ernesto made landfall. Error bars again represent the +/- 2% uncertainty of non-compensated depth readings.

When monitoring in estuaries and coastal zones, the Aqua TROLL 200 instrument's integrated conductivity sensor allows for dynamic density compensation and delivers water level accuracies better than +/- 0.1% of full scale over a full range of environmental conditions.

RESOURCES

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