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Oct 17th, 1:00 PM - 1:30 PM

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1. Introduction

One of the major challenges that we are facing in the northern Gulf of Mexico coastal area is the need of a better and reliable offshore met-ocean real time data collection system that supports the mission of Bureau of Ocean Energy Management (BOEM) and other federal and local agencies for coastal management, protection, and restoration, especially along the Louisiana coast. This area has a suite of environmental problems [1-6] that require the acquisition of real time data for immediate assessment or model−based assessment and predictions that rely on this kind of data. This need was demonstrated by the impact of hurricanes including 2005 Hurricanes Katrina and Rita, 2008 Hurricanes Gustav and Ike [7-30], 2008 and 2011 Mississippi River flood diversions [31,32], and 2010 Deepwater Horizon oil spill event. One such system providing this kind of data is managed by the Wave-Current-Surge Information System (WAVCIS, http://wavcis.sci.lsu.edu) at LSU.

WAVCIS, established in 1997, has been providing technical and operational services to one of the eleven regional associations of the US Integrated Ocean Observing System (IOOS) along the Louisiana coast, the GCOOS Gulf Coast Ocean Observing System (GCOOS). These services are well in line with the BOEM's mission as BOEM "must make decisions about the environmental risks and socioeconomic impacts of offshore oil and gas development in federal waters", which all require reliable information for weather and ocean conditions around the oil and gas production units. In addition, BOEM's Marine Minerals Program (MMP) manages non-energy minerals (sand and gravel) on the Outer Continental Shelf for coastal restoration. "BOEM ensures that the removal of any mineral resource is conducted in a safe and environmentally sound manner, and that any potentially adverse impacts on the marine, coastal, or human environments are avoided or minimized" (BOEM). For that purpose, offshore environmental data are crucial for the managers, engineers, and researchers.

WAVCIS has been an important component of BOEM's Marine Minerals Program providing observational data for wave modeling validations associated with predicting impacts to wave climate associated with excavating offshore sediments. In addition to hurricanes, more frequent but less severe winter storms can also introduce significant hydrodynamics response (e.g. [33-41]) and related sediment movement. The existing system, however, had been aging and the three working stations, even though the only such stations in the offshore area of the coastal Louisiana, Stations 3, 6, and 9, were constantly experiencing technical problems due to a lack of funding, antiquated electronic and data logging technology, and aging mechanical equipment. The present project was designed for the development of a new system using new technology that would be more economical to operate and at the same time, more reliable, with better sensors and data loggers as well as data transfer technology.

2. Station and Installation of Instrument

Originally, the site for the new station was selected to be at the old CSI 5 (Figure 1), which is an unmanned platform that was used by WAVCIS. It was later determined that this station would be too close to shore and far away from the area of interest (e.g. Ship Shoal) and a search of a proper site then began. For instance, we examined a possibility of using a platform from Block 84, 86, 87, or 99. The purpose was to select a relatively new site that would not be decommissioned soon, allowing us to collect adequate amount of data. We also examined a possibility of finding a wooden piling, which turned out to be very difficult. We identified a few locations which were all turned out to be unsuitable for the project: most of the potentially good sites were to be decommissioned soon. At one point, a Coast Guard lighthouse was identified as a potential site. It was later determined however that the condition of the lighthouse was not favorable and at the same time there was an issue of the ownership and associated procedure for permit of access. All these delayed the project for about a year. By November 2016, we had been working on boarding agreement with the owner (Fieldwood Energy) of the selected platform (Ship Shoal 91, 28.919ºN; -90.774ºW, Figure 1): we were in communication with people at Field Energy SS91, regarding a site visit before putting an ADCP with currents and wave sensors and CTD at the site.

Figure 1. Study site at SS91 and relevant stations.

The boarding agreement with Fieldwood Energy SS91 was approved by both LSU and the company on Dec. 12, 2016. After this, we were able to visit the site for measurements aimed at the design of the installation, and for the actual instrument installation after the manufacturing of the large clamps for fixing the conduit for cables.

The site SS91 at a shallow water of ~ 37' is ideal as it is on Ship Shoal where dredging of sand has been ongoing and there is a need for proper assessment of the fate of dredged pit under various weather and oceanographic conditions and the integrated effect over the years. A real-time station for continuous measurements of oceanographic conditions will be valuable. This site is close to the other WAVCIS stations (CSI 6 and CSI 9, Figure 1). This site is also in the coastal current zone in which the Louisiana-Texas coastal current goes through [42]. It is also in the area of the seasonal hypoxia. The data from this site can be very useful for coastal current model validation. This kind of models can be used for many purposes including the effect of severe weather, hypoxia, and oil spill, just to name a few.

Figure 2. Fieldwood Energy Ship Shoal 91 (SS91) A & B platforms (7 nm offshore)

Figure 3. Custom-made ADCP to reduce the effect of the rig legs by facing the transducer sideway. The blue color is antifouling paint that applied before the deployment.

To measure the current velocity profiles, we use the Nortek 1 MHz acoustic Doppler profiler (ADCP, Figure 3) – the 4-beam AWAC. The AWAC ADCP was *custom made* based on our request such that the four transducers are not symmetric – they are facing one side so that no beam would be interfered by the oil platform structure. The customization of ADCP heads allows for beams to gather data away from influence of rig structure. Traditional ADCP would have one beam influenced by the oil rig structure. To reduce biofouling, we painted the surface of the ADCP with blue color antifouling paint.

The ADCP has a SD card for up to 4 GB of data storage. It connects with the satellite transmission box (the AOS Iridium Nortek module).

This AWAC ADCP at the new WAVCIS station SS91 is a current profiler and a directional wave system in one unit. Traditional WAVCIS stations had ADCPs and separate pressure sensor which needed to be changed out yearly. Extra cabling was needed as well. The SS91 ADCP can measure the current speed and direction in 1-meter thick layers from the sensor depth to the surface. Waves of all varieties are measurable; this includes long waves, storm waves, short wind waves, or transient waves generated by local ship traffic.

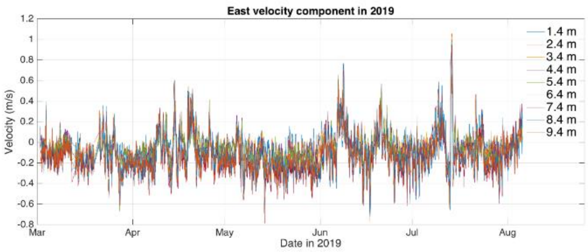

Figure 4. Example velocity data from the new station. East velocity component at various depths above the ADCP for March 2 – August 6, 2019.

The AOS data collection/transmission unit is designed for easy use and can handle harsh environments. The data collection unit is equipped with Iridium satellite communication modem for a truly global coverage. It is a very small and light unit – only 10 inches by 8 inches in dimension. Compared to the old WAVCIS antenna of 96 inches by 72 inches in dimension, this is a lot smaller and lighter. It takes much less deck space which is always very valuable on offshore platforms. In addition, since the old WAVCIS antennas are directional, they have to be precisely facing the direction of the geostationary satellite for reliable data transmission. When there is a severe weather, the antenna might be moved by the strong wind and data connection lost; whereas the AOS system is omnidirectional and it can be put in any orientation and thus not affected by strong wind during a severe weather. This makes the data transmission having better reliability and data quality is higher.

The old WAVCIS ADCPs were all powered by on site AC power from the oil and gas company provided at the platform. This new ADCP however is powered by a solar panel charged battery. This battery is securely housed in a weather-proof aluminum electronic box with an automated breaker that will click off when power surges or lightning strikes to stop the current going to the instrument that might cause damages. This kind of box has been used by the Department of transportation along the highway and very reliable for outdoor including offshore deployment. The ADCP is mounted at about 7 meter below the surface and looking upward so it can record velocity profiles at hourly intervals every meter in the water column above the sensor depth.

After all the preparations, and some delays due to weather and ship time scheduling issues, the new station at SS91 was finally finished with several trips and the AWAC – AOS system started recording real time data from August 23, 2018 up to the present. It should be noted that the instrument operated in real time from August 23 to Dec. 9, 2018 until which it stopped as we were working with the system to optimize it and testing for a better position for the AOS box. There were some issues involving the cable – it must be explosion proof, which was a new regulation implemented after our proposed work. All the cables had to be remade. After working with the company, fixing issues of data transmission, we boarded SS91 again on March 2, 2019 when we fixed the problem onsite and reactivated the real time data transmission since then for the AWAC ADCP. The data have been flowing real time since then (Figure 4). The data happened to have captured the influence of a few synoptic weather systems and Hurricane Barry which made its landfall in Mash Island Louisiana on July 13, 2019 with a Category 1 Hurricane wind force.

3. Conclusions

In this project funded by BOEM, we have selected a site at SS91, south of the Timbalier Bay for the installation of a real time ocean observing station. The station is at a shallow water of ~ 37' on the Ship Shoal where dredging of sand has been ongoing and there is a need for proper assessment of the fate of dredged pit under various weather and oceanographic conditions and the integrated effect over the years. This is a station based on an oil production unit owned by the Fieldwood Energy.

We have successfully installed an upward looking ADCP at this station for real time data transfer through Iridium Satellite Communications with an omnidirectional antenna. This system is a lot smaller than the old WAVCIS stations which used an onsite desktop computer that was subject to hacking and frequent unwanted system updates that were costly for data fees. The hacking and unwanted system updates caused interruptions in operation and costly repairs (ship time + labor costs). The new system doesn't use an onsite computer as some new technology is used and an internal processor and data logger replace the onsite computer. In addition, this system doesn't need the bulky cooling systems at each of the old stations. The old stations also needed heavy and large directional parabolic antennas which is now replaced by the omnidirectional one of a much smaller size.

Our intention is to keep the station running and provide the data to BOEM and Gulf Coastal Ocean Observing System (GCOOS). WAVCIS is part of the GCOOS. The data will be crucial for modeling studies and simulations of sediment transport and the fate of dredged pit off Louisiana coast to support the mission of BOEM/MMP in the OCS region. The data can also be used by researchers, students, including people at LSU and other institutions for studying the hydrodynamics and for numerical model predictions of the oceanic conditions that affect the fate of sediments and potential impact to any mineral resources.

Acknowledgement

We appreciate the assistance from Fieldwood Energy for providing access to the platform, for ship time scheduling, and diving operations; from the Field Support Cost Center at LSU for technical support and boat usage. We would like to thank M. Miner of the Water Institute of the Gulf, and J. Mallindine of BOEM for their assistance of the project at various stages. We thank the support of GCOOS. Study collaboration and funding were provided by the U.S. Department of the Interior, Bureau of Ocean Energy Management, Coastal Marine Institute, Washington, D.C., under Agreement M15AC00015.

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