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Data comparison between three Acoustic Doppler Current Profilers deployed in OBSEA platform in north-western Mediterranean

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***Abstract* – Three different Acoustic Doppler Current Profilers (ADCP) have been deployed in OBSEA platform, a 20 meters depth underwater observatory cabled with a 4 km mixt cable to Vilanova i la Geltru's coast. Two months of continuous data have been collected in order to confirm their proper operation and long term North current characteristic from the area.**

Keywords* – *ADCP, Doppler Effect, North current

I. Introduction to the Doppler Effect

The Doppler effect can be described as the change in wave frequencies perceived by an observer when there is relative motion between them and the waves. For example, an observer walking into the waves will see more waves in a given interval than someone standing still, and this will see even more than an observer moving away [1].

ADCPs use the Doppler effect by transmitting sound at a fixed frequency and listening to echoes returning from scatterers in the water. These scatterers are everywhere in the ocean and they float in the water moving on average at the same horizontal velocity as the water. So ADCP receives sound echoed from the scatterers and Doppler-shifted to a different frequency proportional to their movement. The angular motion causes no Doppler shift, only the radial one.

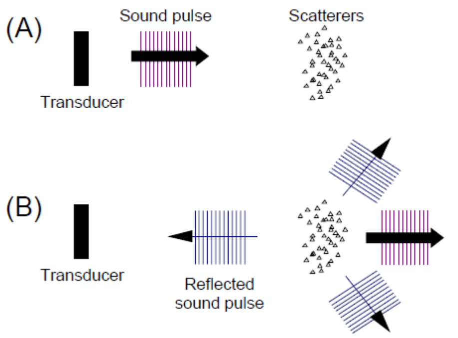

Fig 1. Backscattered sound. (A) Transmitted pulse; (B) A small amount of the sound energy is reflected back (and Doppler shifted), most of the energy goes forward.

ADCPs use multiple beams pointed in different directions in order to calculate different velocity components. With three beams, east, north and vertical velocity can be calculated and there's an extra one to estimate the validity of the sensor data.

II. OBSEA platform

OBSEA is an underwater observatory connected to the coast with a 4 km hybrid cable that provides power and data. It is placed at a depth of 20 meters in a fishing protected area near the coast of Vilanova i la Geltrú. The main advantage of the cable observatory is the capacity to feed the station from the land up to 3.6 kW and the high bandwidth communication link of 1 Gbps. This gives the opportunity to observe in real-time multiple marine environment parameters.

The main objective of OBSEA is to have a test bed for the development of oceanographic instrumentation while providing real time data to the scientific community.

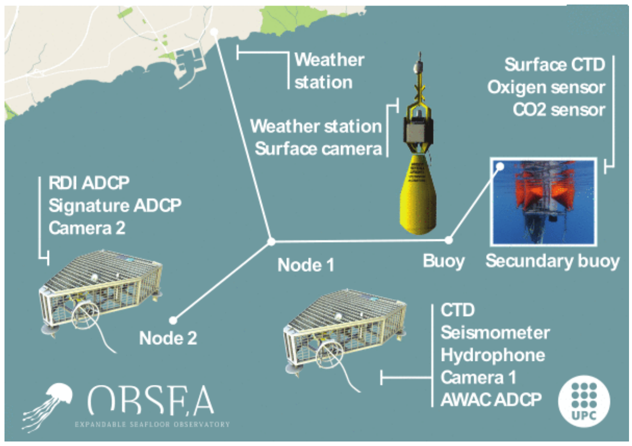

Fig 2. OBSEA platform distribution

This platform counts on two subsea nodes in series and one Buoy connected to the first one. Further, there's a secondary buoy connected to the first recently installed. Each has its own instruments such as ADCPs, CTDs cameras or a seismometer. The actual distribution of OBSEAs platform can be seen in figure 2.

III. ADCPs characteristics and set up

Three ADCPs have been deployed, two of them are Nortek technology and the third is from RD Instruments. The Nortek ADCPs are able to measure current profile and waves height and direction while the RDI ADCP only provides the current profile. In this paper only the current profile date will be considered.

The three ADCPs include the following sensors: tilt, pressure and temperature. All can be powered by batteries but are cabled to OBSEA nodes to provide real time data. This communication is through RS232 or RS422 in all cases. Each one has its personal software for communication.

Fig 3. AWAC [Nortek] ADCP

The first instrument installed was the AWAC ADCP from Nortek (figure 3). It was first deployed in March of 2013 and it works at 1 kHz. It is connected at OBSEA node 1, supported with a tripod at 10 meters and powered at 12 V. As it can be seen in figure number 3, it has 4 beams, 1 vertical and 3 at 25º. It was bought by CSIC (Consejo Superior de Investigaciones Científicas) for OBSEA's usage.

Fig 4. Sentinel [RD Instruments] ADCP

In April 2016 the RDI ADCP was deployed in node 2, fixed to the cage with brackets and powered with 48 VDC; the ADCP works at 600 Hz. It can be seen in figure 4 that it has 4 beams symmetrically distributed in angle. It is property of SmartBay and deployed under the funding of SMARTSEA project of FixO3. The objective of this project is to test SmartBay equipment in a real scenario (OBSEA) before the deployment in the Smartbay Observatory in Galway, to train SmartBay personnel on operational procedures and, finally, to compare data and exchange know-how.

The last ADCP deployed was the Signature from Nortek (figure 5). It works at 1 kHz and it's powered at 12 V. As the AWAC, it is supported with a tripod at 10 meters from node 2. This ADCP belongs to Nortek and it's in OBSEA under CISWE project funding from FixO3. The aim of CISWE is to execute a comparison of data between two Nortek currentmeters during a long period of time in order to perform the following: evaluation of the current speed estimations, evaluation of the current direction estimations and, evaluation of the power consumption. Differences between both instruments.

Fig 5. Signature [Nortek] ADCP

It is important to avoid interferences between instruments. For this reason, no ADCP has been deployed nearby with the same frequency. AWAC (1 kHz) is at node 1 and RDI Sentinel (600 Hz) and Signature (1 kHz) have been deployed at node 2. Additionally, magnetic interferences should be avoided to prevent errors in the compass side. It has been considered not to deploy instruments with magnetic materials in their supports. Both node cages are built with Stainless Steel.

All ADCPs have been set up with the same configuration so data comparison could be done. Considering OBSEA is at 20 meters depth, 20 beams have been stablished, each one 1-meter height. In RDI Sentinel ADCP only 19 cells were configured.

ADCP measures the velocity at different distances from the transducer by measuring the Doppler shift of the returning signal at different times. No measurements are made immediately in front of the transducer in what is referred to as the blanking region. This allows time for the transducers and electronics to recover from the transmit pulse. The blanking region has been used to place the beginning of the first cell in each ADCP at the same position. Considering that the height of tripods and node cages are different, different blanking height were set up in order to align cells between ADCPs.

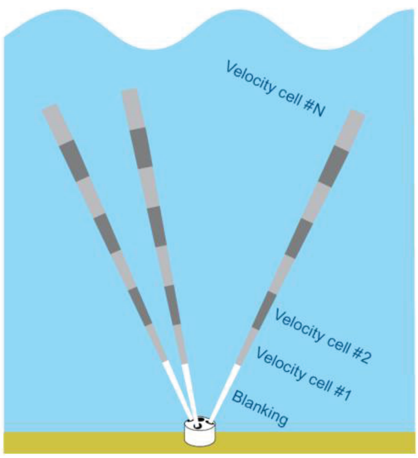

Fig 6. ADCP set up, Cells and Blanking

Finally, the sampling interval should be determined. It is not mandatory but setting the same in all ADCP is recommended.

IV. Data treatment

To validate the correct functionality of all ADCP two months of data have been collected. In each sampling moment, data of velocity in east, north and vertical components are collected for each cell in all current meters.

Getting data in a sample rate of 10 seconds, an hour average has been calculated for each velocity component (east, north, vertical). Multiplying this data per time we obtain the accumulated displacement of current for each cell and ADCP for an interval of time.

The cumulative displacement of water over a period of time has been plotted for the AWAC and RDI ADCPs in figures 7 and 8.

V. CONCLUSIONS

Figure 7 shows the displacement of water between 18-04 and 09-05 in 2016 in AWAC. As it can be seen water has moved about 30 km south and 120 km west (depending on the cell position). Although there are some days of turbulent movement, generally it has a south-west direction, parallel to the coast and following the North Current direction that describes the zone of north-western Mediterranean.

Figure 8 shows the displacement of water between 18-04 and 09-05 in 2016 in RDIs ADCP. The plot shows that water displacement components were 45 km south and 120 km west. In this plot can be seen, again, the characteristic North current because it has generally a south-west component, parallel to the coast.

ACKNOLEDGMENTS

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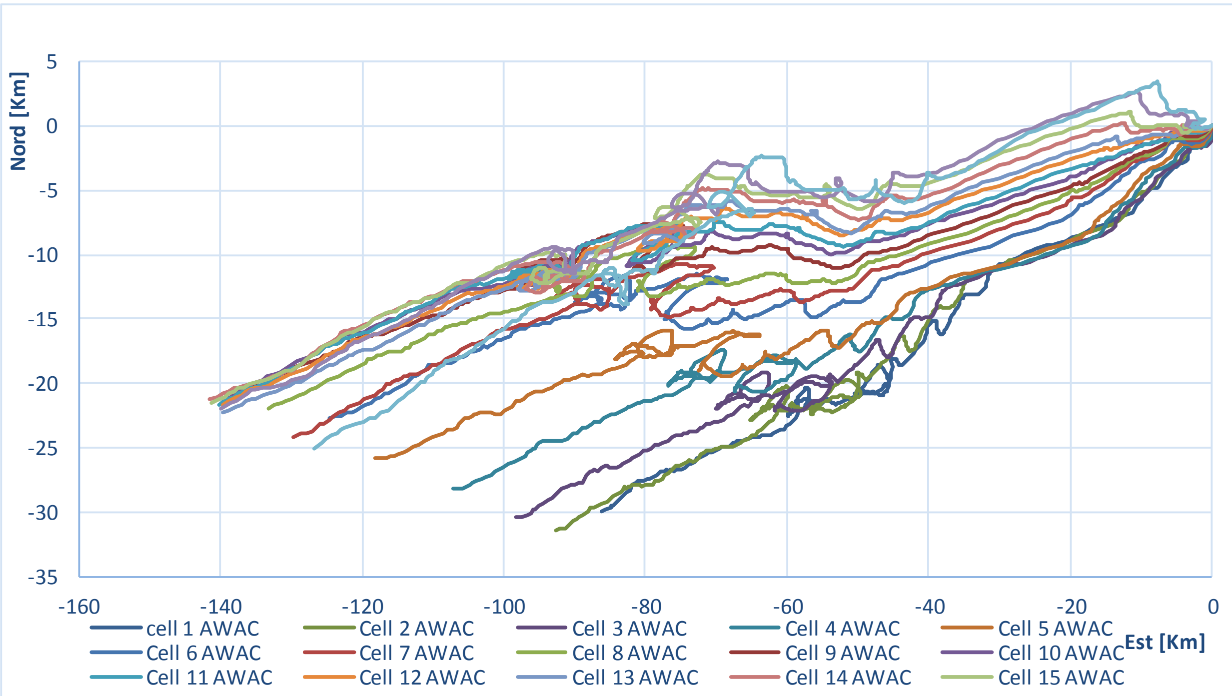

Fig 7. AWAC horizontal displacement of water

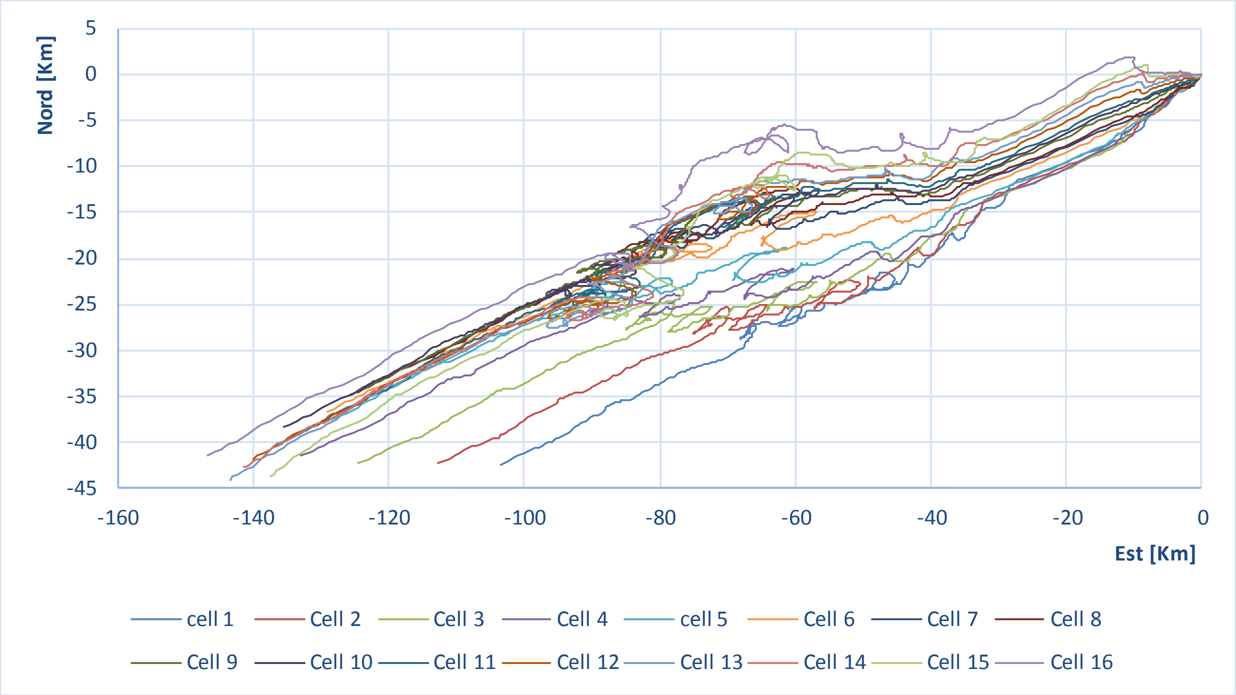

Fig 8. RDI horizontal displacement of water