ID01 RECORDING ACOUSTIC DATA IN THE TWILIGHT AND MIDNIGHT ZONES AT CLOSE RANGE

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Abstract

The twilight (200-1000 m depth) and midnight (1000-2000 m depth) zones are still nowadays one of the most unexplored places on earth, despite hosting one of the most diverse and biomass-rich environments. Active acoustics is one of the most employed techniques to investigate the twilight zone but vessel-borne echosounders are limited in depth due to signal loss with time. To overcome this limitation new acoustic devices are being progressively designed and deployed at depth. Since 2014, the Spanish Institute of oceanography (IEO-CSIC) and the Institute of Oceanography and Global Change (IOCAG-ULPGC) have been collaborating in the fine-tuning of a new acoustic instrument attached to the rosette able to endure pressures at 6000 m depth. A recent publication presented results from the initial surveys and some recommendations. This article provides further descriptions and recommendations.

Keywords - acoustics, vertical profilers, mesopelagic, bathypelagic.

INTRODUCTION

The twilight and midnight zones are inhabited by a large biomass of mesopelagic fishes targeted by many monitoring programs [1]. Recent advances in active acoustics have unveiled the existence of bathypelagic deep scattering layers that are hard to detect from a vessel echosounder [2,3]. Machine learning techniques such as unsupervised neural networks allow discerning general acoustic typologies [4] but are limited by the large volumes recorded far from the vessel at depth. A new acoustic device able to reach 6000 m of depth was presented in [5]. This article provides more technical and practical information useful for its deployment.

EQUIPMENT

The acoustic device (Acoustic Zooplankton Fish Profiler or AZFP, ASL) is a 50 kg, low cost device made up of a 0.17 m diameter x 1.0m length cylinder and transducers from 7 to 12 degrees (Fig. 1). Data is stored in a compact flash (special military cards resistant to vibrating platforms are recommended). Maximum ping rate is 1 Hz and thus slow rosette deployments are recommended to increase vertical resolution. A 3.3Ah rechargeable battery is inserted within the cylinder and allows short deployments such as rosette casts. A/D Digitization rates of 64, 40, or 20 kHz and pulse lengths of 100 to 1000 ms are available.

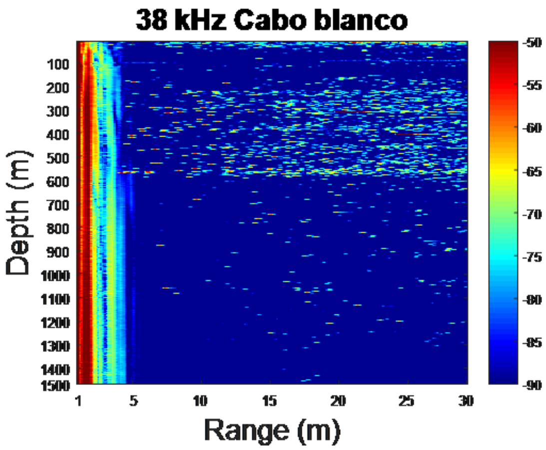

Fig 1.Above: Four transducers (38, 125, 200 and 455 kHz from left to right) of the and cylinder holding electronics and including the battery. Right: Echogram recorded at 38 kHz in Cape Blanc (Northwest Africa).

CHALLENGES

Vertical acoustic profilers are usually deployed with a vertical orientation [6], although horizontal deployments have been reported, particularly in rivers or lakes with shallow water columns [7,8]. While the side-recorded echogram provides a continuous image as well as information on avoidance derived from gradients with distance to the device [9], it also inherits acoustic uncertainty due to orientation variability. Acoustic devices need to be calibrated in the same conditions that are employed but the deployment of a calibration sphere on the side of the rosette at large depths is logistically complex. One of the challenges encountered in data processing was the elimination of noises and interferences. Although several published techniques are available [10], oblique bands of interferences caused by the altimeter are hard to eliminate [5]. Single beam transducers provide a mean scattering value that can be employed for dense layer analysis but do not correct the acoustic beam pattern and are thus less suitable for discrete target studies [11,12]. Platform vibration also introduces a 'ringing noise' area on the first meters of the echogram and may potentially increase avoidance.

FUTURE

While this instrument provides invaluable information on deep waters, the identification of the detected species requires some ground-truth data difficult to obtain from net samplers. High-resolution cameras seem to be the best potential combination but semi-transparent deep species are hard to identify. In order to reduce noise and avoidance, deploying the instrument on a small independent structure is desirable. A deepwater calibration facility is also highly recommended.

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ID02 A NEW COASTAL UPWELLING INDEX GENERATED WITH SURFACE CURRENT ESTIMATIONS FROM HIGH-FREQUENCY RADARS

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Abstract

Coastal upwelling has been extensively studied as it plays a critical role in the connectivity between offshore waters and coastal ecosystems, which has impacts on water quality, fisheries, and aquaculture production. Significant efforts have been devoted to the quantification of the intensity, duration, and variability of this phenomenon by means of coastal upwelling indexes (CUIs), derived from wind, sea level pressure, or sea surface temperature data. Although valuable, first-order descriptors, such classical indexes have been reported to present some limitations. As one of the major shortcomings is the omission of the direct influence of ocean circulation, this work introduces a novel CUI, generated from remotely sensed hourly surface current observations provided by a high-frequency radar (HFR). The consistency of the proposed index (CUI-HFR) is assessed in two different oceanographic areas during two distinct time periods: in the north-western Iberian (NWI) peninsula for 2021 and in the Bay of Biscay (BOB) for 2014. To this aim, CUI-HFR is compared against a traditional CUI based on hourly wind observations (CUI-WIND) provided by two buoys. Results revealed that HFR-derived circulation maps can be effectively used for the characterization of recurring upwelling and downwelling episodes and the noticeable agreement between CUI-HFR and CUI-WIND.

Keywords – HF radar, remote-sensing, upwelling, downwelling.

INTRODUCTION

High Frequency radar (HFR) has become an essential component of ocean observatories as this shore-based remote sensing technology collect, in near-real time, fine-resolution maps of the upper-layer flow over broad coastal areas, providing a dynamical framework for other traditional in situ observation platforms.

HFR-derived surface circulation is a reliable source of information for search-and-rescue operations and oil spill tracking, among other practical applications [1-2]. Equally, it can be used for a detailed investigation of upwelling and downwelling processes that modulate the connectivity between offshore waters and coastal ecosystems, which eventually has impacts on water quality, fisheries, and aquaculture production [3-4]. It occurs when alongshore winds and the Coriolis effect (due to Earth's rotation) combine to drive a near-surface layer of water offshore, a process referred to as Ekman transport [5]. Such cross-shelf transport is compensated for by the vertical uplift of cold and enriched waters that fertilize the uppermost layer. Conversely, during downwelling events winds induce net onshore displacement and subduction of surface coastal waters that foster the retention of organic matter and pollutants onto the shoreline with a subsequent impact on residence times and water renewal mechanisms.