Real-time monitoring of ocean sounds, meteorology and marine mammals from expendable profiling floats

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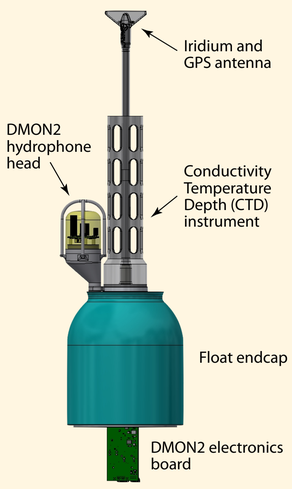
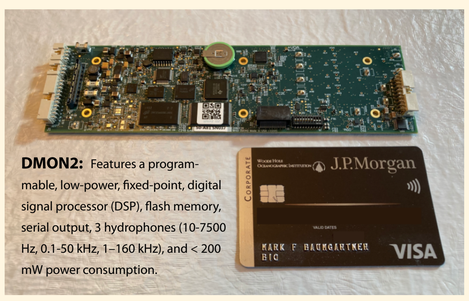
Introduction

Marine mammal occurrence and distribution in the world's ocean basins are difficult to observe because these areas are remote and rarely visited by visual survey vessels. Sustained passive acoustic monitoring is also difficult because archival recorders must be recovered and re-deployed from ships whose high costs are difficult to justify for long voyages. Long-endurance expendable profiling floats have been used by the physical oceanography community for the past two decades to measure ocean heat content throughout most of the global ocean (Argo program). These profiling floats operate at sea for years at a time, making them ideal platforms for access to remote ocean basins. To provide these expendable platforms with a passive acoustic monitoring capability, we integrated the low-power digital acoustic monitoring (DMON2) instrument in a commercially-available profiling float (MRV ALTO). After extensive bench and tank testing, the system was trialed during a recoverable mission south of Massachusetts, USA for 8 weeks during the summer of 2021.

Integration

The DMON2 was powered from the float's main batteries and transmitted/received data to/from the float using MRV's proprietary serial communication protocol. Every half hour, the DMON2 transmitted to the profiling float controller both ambient noise spectra (up to 30 kHz) and summary baleen whale detection information from the low-frequency detection and classification system (LFDCS)[1,2]. Upon surfacing, the float relayed these data to shore via Iridium short-burst data messages where they were displayed on a publicly accessible website in near real time (robots4whales.whoi.edu; marine mammal detection information from other DMON2-equipped platforms running the LFDCS[3,4] are also displayed at this site). The float signalled the DMON2 when it was ascending, descending, at the surface or parked at depth; the DMON2/LFDCS only collected and communicated acoustic information when the float was parked at depth.

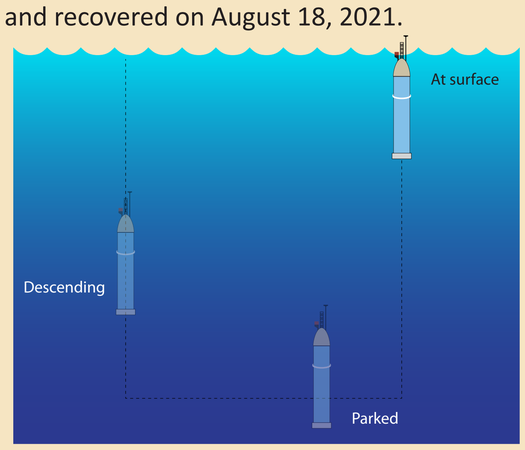


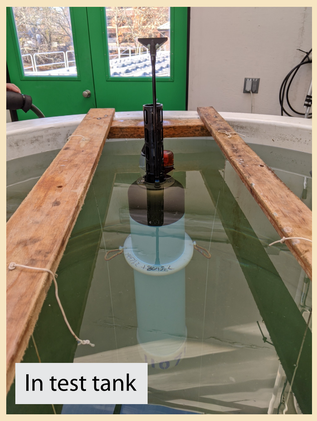


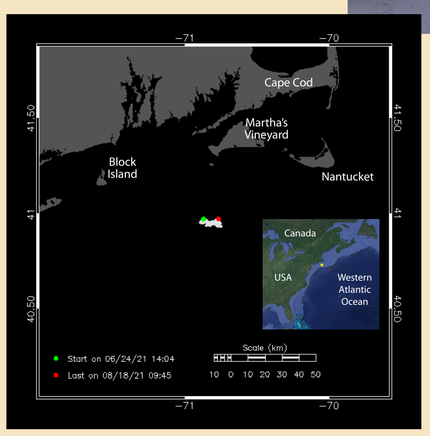
DMON2: Features a programmable, low-power, fixed-point, digital signal processor (DSP), flash memory, serial output, 3 hydrophones (10-7500 Hz, 0.1-50 kHz, 1–160 kHz), and < 200 mW power consumption.

Testing and field demonstration

The DMON2 firmware as well as DMON2-ALTO serial communications were bench tested to ensure reliable functioning, after which the integrated system was ballasted and tested repeatedly in a 10-m tall test tank at the Woods Hole Oceanographic Institution (WHOI). After sucessful tank testing, the system was deployed for a short (8-week) demonstration at sea south of Massachusetts, USA in waters of 55 m depth. The float was programmed to park near the sea floor to minimize lateral movement, and ascended to the surface once every 12 hours to transmit to shore both CTD and DMON2 data. These data were received and processed by a shore-side server at WHOI and immediately posted on a publically accessible website (robots4whales.whoi.edu). The float was deployed on June 24 and recovered on August 18, 2021.

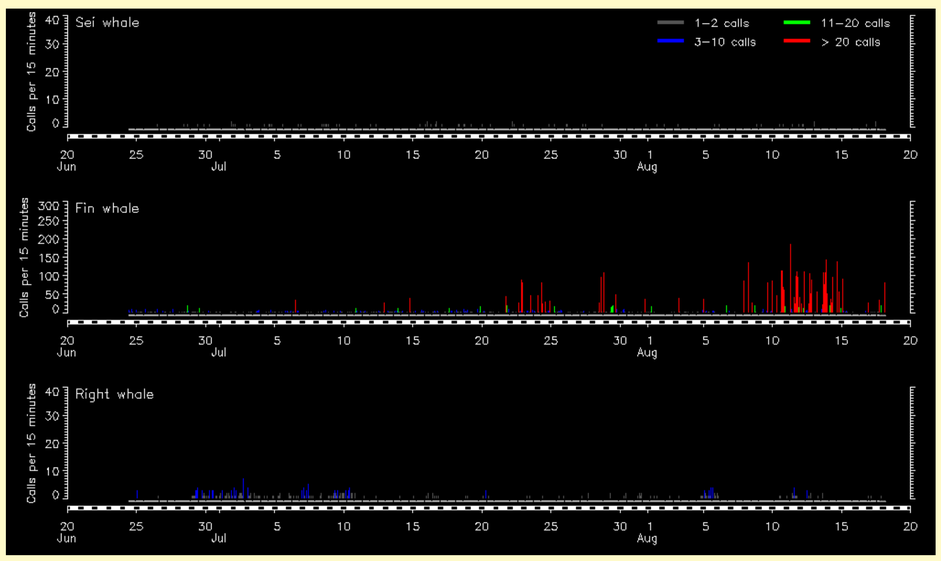


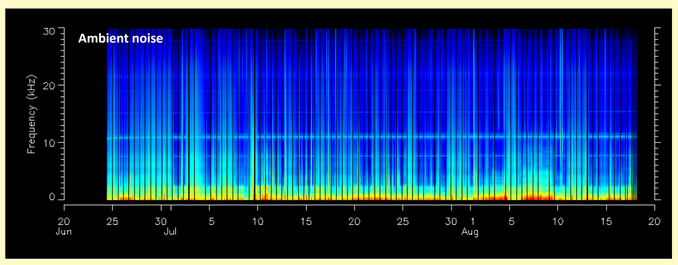


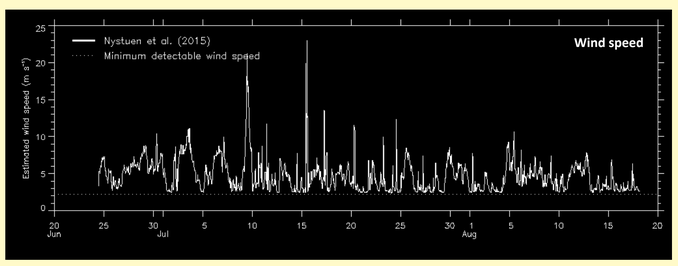


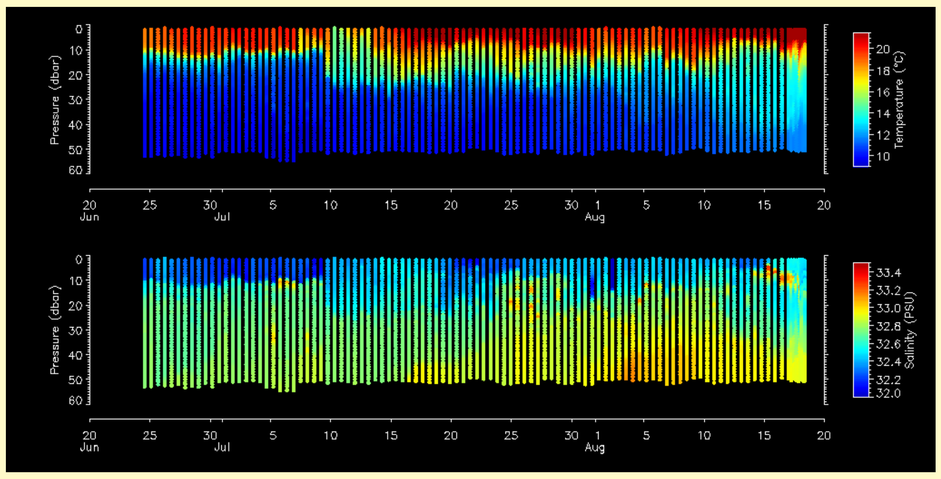
Preliminary results

The float successfully transmitted CTD and DMON2 data to shore during the 8-week mission. Although no verification of acoustic detections has been performed yet, there were numerous detections of fin whale 20-Hz calls consistent with previously observed fin whale acoustic presence in the area starting in mid-July. Background noise spectra revealed constant tonal noise likely attributable to either electrical or mechanical noise produced by the float. Background noise spectra were used to determine wind speed in near real time[5,6], which will be validated with observations from nearby meteorological stations.









Future work

We plan to (1) validate both the baleen whale detections as well as the wind speed estimates collected during the field demonstration to evaluate how the system performed, (2) investigate and hopefully mitigate platform noises, and (3) publish a journal article describing both the system and its accuracy. We are keen to deploy 2 floats in the central Atlantic for an expendable mission to demonstrate the long endurance capabilities of the system. We anticipate that the DMON2-equipped floats will operate for several years, providing an unprecedented observing capability for marine mammals and ambient noise for difficult-to-access oceanic regions.

References

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