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Profiles in ocean current measurements: RDI's Long Ranger ADCP

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Whether the application is acquiring high-resolution time-series of current structure in the open ocean for calibrating global circulation models, or remotely-monitoring the currents forcing offshore structures, the measurement standard used is the RD Instruments acoustic Doppler current profiler (ADCP). Deployment of thousands of RDI's Workhorse family of ADCPs have proven that, even in the world's most demanding environments, the Workhorse is up to task, providing sophisticated features that allow the unit to adapt to each situation.



The need: a history of creative breakthrough

Back in the early 1980s, RD Instruments revolutionised current measurement by developing the industry's first acoustic Doppler current profiler. At that time, the ADCP significantly altered the face of current measurement, as a single instrument was now able to remotely-profile the velocity and direction of currents throughout the water column, as opposed to capturing only an isolated point measurement. In essence, a single ADCP could now do the job of a full string of single-point current meters.



Over the past twenty years, RDI has continued the growth and development of its acoustic Doppler technology, resulting in a full line of Workhorse ADCP products

capable of precise velocity measurements in a wide array of environments – ranging from the shallowest stream to the deepest ocean.

The cornerstone of RDI's ADCP products, introduced in 1990, is the application of patented broadband signal processing technology, which allows for the collection of high-resolution data over an extended range, with reduced power consumption. To date, more than 6000 RDI ADCP products have been delivered for scientific, commercial and military applications around the globe, supported by a full staff of sales and field service professionals.

The Workhorse Long Ranger 75kHz ADCP was introduced in 1998, as the most powerful self-contained Doppler profiler available, and quickly became the standard, extended-range profiler for open ocean applications.

Deep ocean moorings – a case study

Daniel Torres of Woods Hole Oceanographic Institution (WHOI), USA, was responsible for the deployment

of a combination of ADCPs as part of the Shelf-Basin Interaction Experiment in the Beaufort Sea. One purpose of this multi-year, multi-institution project is to study the flow of Pacific waters from the Bering Sea onto the Chuckchi and Beaufort shelves, and their subsequent transferral into the deep Arctic basin.

Eight of the moorings were deployed by WHOI in a closely spaced 'picket fence' array to investigate eddy and frontal processes involved in transferring shelf water along and across the Beaufort slope. The three onshore moorings consist of bottom-mounted upward-facing RDI Sentinel Workhorse ADCPs along with WHOI coastal profilers (which travel up and down a wire held up by subsurface flotation measuring CTD data along their path). The next three slope moorings utilise RDI Long Rangers at the bottom with the same WHOI profilers on top. The ADCPs were all set for one-hour sampling and varying bin sizes (five to 20 metres) depending on bottom depth for the first 14-month deployment. The two deepest moorings use ACMs on the profilers for velocity measurement since they were too deep for a single Long Ranger

(800 and 1500 metres depth). According to Torres: "We chose RDI ADCPs for their excellent single ping standard deviation to low power consumption ratios. Specifically, we chose Long Rangers for the three slope moorings because they provided full water column range up to 605 metres."

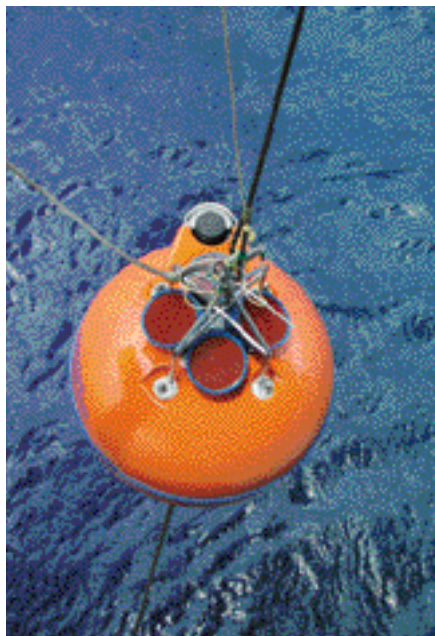
The early results from the first 14-month deployment show a velocity structure at a spatial and temporal resolution never before achieved in this region. We have been able to observe eddies propagate along the boundary current and even capture an upwelling event in its entirety. All moorings were re-deployed for another year. But for the first time, the ADCPs were all deployed using LADCP commands for tracking ice movement using water track pings at no additional disk space or power expense.

Offshore oil and gas platforms – a case study

RDI ADCPs are playing a key role at every stage in the development of hydrocarbon reserves. Even at the earliest stages of field development preliminary current studies are conducted, using moored systems, to understand the ocean forces that must be accommodated in offshore structure design. Once installed, deepwater rigs are now equipped with ADCPs to monitor the underwater and surface currents affecting the rig's safety and operations.

In the Gulf of Mexico, for example, powerful and persistent current features, called eddies, are spawned by the 'Loop Current' portion of the Gulf Stream. These eddies, resembling underwater hurricanes, routinely produce currents of up to three knots, extending hundreds of metres below the surface, and move about the Gulf for a period of months, impacting underwater structures. Current profile data have proved particularly useful in warning of these high currents, indicating when to make a precautionary shutdown, and later, when it is safe to resume operations.

In order to obtain current profiles throughout the water column in depths greater than 1000 metres, Shell Oil Company developed a real-time system which includes a rig-mounted ADCP 'looking' down through the water column, and a Workhorse Long Ranger ADCP looking up from a near-bottom buoy mounting (Oceans 2001, MTS0-933957-29-7). The rig-mounted ADCP feeds data directly to a computer aboard the rig. The bottom-mounted ADCP sys-



Long Ranger with modem.

tem collects current data and transmits it to the surface in real-time via an acoustic modem. In this way the extended range data of the upward-looking Long Ranger is combined with the downward-looking data to form a continuous, full-water-column current profile.

Using the upward-looking set-up at this site, the Long Ranger actually achieved significantly greater profiling range than typically expected. This case illustrates not only the capability of the Long Ranger, but also the utility of supporting systems such as the Linkquest, USA, acoustic modem and Flotation Technologies, USA, syntactic foam buoy mounting.

Ocean observatories – new challenges

Plans are now funded to construct integrated observatory networks that will provide the oceanographic research and education communities with a new mode of access to the ocean. The US National Science Foundation Ocean Observatories Initiative (OOI) has three elements: 1) a network of regional cabled observatories on the seafloor spanning multiple geological and oceanographic features and processes; 2) several re-locatable deep-sea buoys that could be deployed in harsh environments such as the Southern Ocean; and 3) new construction or enhancements to existing facilities leading to an expanded network of coastal observatories. Extended-range current measurements will be a fundamental aspect of ocean process characterisation.

VENUS, MARS and NEPTUNE

The Victoria Experimental Network Under the Sea (VENUS) is one of the first of the envisioned observatories. This cable-linked array of sensors will rest in the coastal waters off Victoria and Vancouver, British Columbia, Canada. The Monterey Accelerated Research System (MARS) cabled observatory will be located in Monterey Bay, USA, in the deep-sea offshore the Monterey Bay Aquarium Research Institute (MBARI). VENUS and MARS are taking the next step toward harnessing the promise of new power and communication technologies to provide a remote, continuous, long-term, high-power, large-bandwidth infrastructure for multidisciplinary, in situ exploration, observation, and experimentation.

Together, the two projects will serve as the test bed for a state-of-the-art regional ocean observatory, currently one component of the OOI. These first steps set the stage for the most ambitious project planned so far, the North East Pacific Time-series Undersea Networked Experiments (NEPTUNE). It will monitor the largest volume of ocean and seafloor of any observatory. A 3000-kilometre network of fibre optic cables will connect myriad sensors across the Juan de Fuca tectonic plate off the coast of Washington State and British Columbia.

As the observatory network expands, to include NEPTUNE, and other variations in ever deeper water, RDI will build on the success of the Workhorse Long Ranger ADCP to develop even longer-range current profilers to support those networks.

The development path: deep thoughts

For over 20 years, RDI Instruments has been leading the pace of innovation in current measurement. RDI pioneered techniques to service every current measurement application, including vessel surveys ranging from open-ocean to shallow streams, moored systems for benthic and coastal studies, and real-time monitoring systems for port and structure monitoring, including directional waves capability. Continuing in that tradition, new developments are planned to capitalise on newer technologies, like RDI's patented phased-array transducer, to achieve the maximum performance possible to service the evolving need to better understanding our most fundamental inner-space asset; the Earth's oceans. ■