

UnderwayCTD Application Note #2

UnderwayCTD Used on the Stratus Ocean Reference Station / VOCALS Cruises 2007-2010

Summary



As some of the first oceanographers to use the Oceanscience UnderwayCTD (UCTD) profiler, researchers at **Woods Hole Oceanographic Institution (WHOI)** have been able to gather hundreds of CTD casts while in transit and during dedicated UCTD transects during the Stratus and VOCALS cruises in 2007-2010. The cumulative number of underway casts now exceeds **1,050**. The WHOI experience has been crucial in developing the latest Series II UCTD, with feedback from three cruises used to drive design and operating procedure improvements. A recent WHOI investment in two upgraded Series II UCTD systems for future cruises, including the next Stratus cruise in 2011, will be rewarded by faster and deeper profiling capabilities.

Background

The Stratus Ocean Reference Station mooring at 20°S, 85°W off the coast of Chile provides oceanographic and meteorological data as part of an ongoing environmental observation program. The mooring is replaced and meteorological instrument calibrations are performed during an annual cruise on the NOAA research vessel Ronald H. Brown. In combination with the Stratus activities, researchers in the 2008 VAMOS Ocean-Cloud-Atmosphere-Land-Study (VOCALS) conducted a regional experiment in the area of the mooring to investigate ocean-atmosphere interactions, and atmospheric processes related to the region's stratocumulus cloud deck. Researchers have used both VOCALS and Stratus cruises to perform studies of upper ocean eddy variability

using techniques such as Vertical Microstructure Profiling (VMP), Acoustic Doppler Current Profiling (ADCP), and conventional CTD stations. In addition, participants from WHOI used the UnderwayCTD profiler, manufactured by The Oceanscience Group (CA, USA) to greatly expand the availability of upper ocean CTD profiles during cruises in 2007, 2008, and 2010, leading to a better understanding of important mesoscale oceanographic features. Cruise activities, research goals, and sampling achievements described in this Application Note are summarized from the following articles: Whelan et al. 2008¹, Whelan et al. 2009², Straneo et al. 2009³, Wood et al. 2010⁴, Bigorre et al. 2010⁵.

WHOI UnderwayCTD System

The Oceanscience Series I UnderwayCTD was used on four cruises on board the Ronald H. Brown (see Figure 1), with the system operated in both deep and shallow profiling modes. **Shallow mode** relies on the probe being deployed from the vessel and falling as deep as possible until most of the line is paid out from the winch on the ship, at which point the probe is recovered. To obtain deeper profiles, the researchers used the unique tail spool reloading system to enable line to be paid out simultaneously from the probe as it drops **and** from the winch on the ship for deep vertical underway CTD profiles in **deep mode**.



Figure 1. Series I UCTD Installed on R/V Ronald H. Brown.

When underway, shallow mode allows the fastest turnaround between casts and so minimizes the distance between profiles; deep mode offers deeper profiles but at the expense of horizontal resolution as the turnaround time is increased between casts. A mixture of deep and shallow profiling methods was typically used on these cruises. The first UCTD cruise in 2007 included Oceanscience's Senior Scientist and system developer, Jochen Klinke, who was on hand to provide training and help set up the system.

UnderwayCTD Activities and Results

2007: The Stratus cruise included over **300 UCTD casts**, with the profiler typically deployed every 30 minutes to a maximum profile depth of 200m. The ship speed was 12-13kts, which allowed profiles to be collected every 11-13km; the main section was approximately 1000km along 20S between 75W and 85W.

2008: The Stratus and VOCALS cruises were performed over two legs. In total **438 UCTD casts** were performed to a maximum depth of between 200m and 800m at a spatial resolution of 1 to 20km. The densely spaced profiles were obtained to help study specific eddy features; two transects between 75W and 85W were also conducted, one consisting largely of deep profiles and the other to shallower depths but at a higher spatial resolution.

2010: The Stratus cruise initially scheduled for 2009 was postponed to January 2010, and **about 350 UCTD casts** were accomplished. WHOI UCTD operators achieved a 250m

maximum profile depth at 11-12kts using thicker and more robust line for maximum probe safety. Four probes were taken on the cruise and all returned safely, thanks to the optimization of the UCTD line strength. Various comparison exercises were undertaken to compare the UCTD probes against each other and the ship's rosette-mounted CTD. The UCTD probes showed rather good agreement with the CTD, although some bias and salinity spiking was observed, both issues could be adequately explained or corrected.

UnderwayCTD System Development

The feedback from the WHOI researchers through the Stratus and VOCALS projects has been instrumental in continued development of the UnderwayCTD. The first configuration used was successful in gathering several hundred fast, deep profiles, but some UCTD probes were lost during operations. After increasing the strength of the line used on the UCTD, further probe losses were mitigated but the depth capability of the Series I system was reduced. The Series I winch clutch mechanism was also found to struggle at higher vessel speeds, increasing the probe recovery times.

In order to allow profiling to over 500m at 10kts with the new higher strength line, and eliminate mechanical issues highlighted by WHOI such as the clutch slip, the Series I UCTD was replaced with the new Series II design in 2009 (Figure 2). To enable deeper and faster profiling for the 2011 Stratus cruise, WHOI scientists decided to return both of their UCTD systems for a complete replacement with the Series II design.



Figure 2. Series II UCTD Installed on Rail Mount

Future UnderwayCTD Activities

With the newly upgraded Series II UCTD, researchers on the 2011 Stratus cruise will be able to attain substantially deeper profiles, as a result of the >50% increase in winch spool size. The faster probe retrieval also will improve spatial resolution, and mechanical improvements will afford a robust operation for long term use.

References

- ¹ S. Whelan, J. Lord, C. Grados, L. Yu, L. Morales, N. Galbraith, S. P. de Szoeki, M. O'Leary, R. Weller, P. Bouchard, T. Farrar, and F. Bradley, 2008: Stratus Ocean Reference Station (20°S, 85°W) Mooring Recovery and Deployment Cruise STRATUS 8. R/V *Ronald H. Brown* Cruise 07-09 October 9, 2007–November 6, 2007. UOP Woods Hole Technical Report.
- ² S. Whelan, J. Lord, N. Galbraith, R. Weller, J. T. Farrar, D. Grant, C. Grados, S. P. de Szoeki, C. Moffat, C. Zappa, M. Yang, F. Straneo, C. Fairall, P. Zuidema, D. Wolfe, M. Miller, D. Covert, 2009: Stratus 9/VOCALS Ninth Setting of the Stratus Ocean Reference Station & VOCALS Regional Experiment. UOP Woods Hole Technical Report.
- ³ F. Straneo, C. Moffat, and R. Weller, 2009: Eddies in the Southeast Pacific and Their Influence on the Upper Ocean. US CLIVAR Newsletter, pp9-11 (unpublished manuscript).
- ⁴ R. Wood, C. S. Bretherton, C. R. Mechoso, R. A. Weller, B. Huebert, F. Straneo, B. A. Albrecht, H. Coe, G. Allen, G. Vaughan, P. Daum, C. Fairall, D. Chand, L. Gallardo Klenner, R. Garreaud, C. Grados Quispe, D. S. Covert, T. S. Bates, R. Krejci, L. M. Russell, S. de Szoeki, A. Brewer, S. E. Yuter, S. R. Springston, A. Chaigneau, T. Toniazzo, P. Minnis, R. Palikonda, S. J. Abel, W. O. J. Brown, S. Williams, J. Fochesatto, and J. Brioude: The VAMOS Ocean-Cloud-Atmosphere-Land Study Regional Experiment (VOCALS-REx): goals, platforms, and field operations. *Atmos. Chem. Phys. Discuss.*, 10, 20769–20822, 2010.
- ⁵ S. Bigorre, R. Weller, J. Lord, N. Galbraith, S. Whelan, C. Zappa, W. Otto, J. Ram, R. Vasquez, D. Suhm: Stratus 10 Tenth Setting of the Stratus Ocean Reference Station Cruise RB-10-01 January 2 - January 30, 2010, Charleston, South Carolina - Valparaiso, Chile. UOP Woods Hole Technical Report.

