

UnderwayCTD Application Note #3

Impact of Typhoons on the Ocean in the Pacific (ITOP) Project Uses UnderwayCTD to Sample the Cold Wake of a Typhoon

Summary



In order to conduct a rapid-response upper ocean survey investigating the effect of a passing Typhoon in the Pacific Ocean, researchers from APL used the UnderwayCTD on a continuous basis during a 20 day cruise. This unique freefall profiler was the main instrument used to accomplish the October 2010 cruise goals, and was augmented by gliders, fixed CTD stations, and a Vertical Microstructure Profiler (VMP). Round-the-clock UnderwayCTD operations achieved a record-breaking **2,917 profiles**. Dozens of transects were completed, mostly at about 10kts with a spatial resolution of only 1km. The UCTD allowed high quality underway CTD profiles to be gathered at a lower cost, with less manpower than using larger towed systems.

Background

The **Impacts of Typhoons on the Ocean in the Pacific (ITOP)** program is a multi-national project with the goal of better understanding the effect of typhoons on the upper ocean in the western Pacific Ocean. The project goals include investigating the formation and dissipation of surface “cold wakes”, how ocean eddy features are related to typhoons, and how high winds affect ocean/atmosphere fluxes. An important component of the project was a cruise conducted on board the R/V Roger Revelle for 20 days commencing 17th September 2010 to specifically follow the evolution of a cold wake.

In order to gather data to investigate the relatively short-lived eddies and the cold wake, a rapid profiling CTD system was required as the principal component for the ship survey. Both high spatial resolution and a fast profiling rate were needed to allow the research vessel to cover large distances AND obtain a high number of CTD profiles. After considering some larger, more expensive, and more labor intensive options, researchers at the Applied Physics Laboratory (University of Washington, USA) selected the UnderwayCTD from Oceanscience to perform the critical Underway profiling duties. According to Luc Rainville (Co-chief Scientist), “The UnderwayCTD was the obvious fit for this study. We could not afford extra manpower to operate a large towed profiler, and the fast cycle time was ideal to allow us to get a very large number of profiles in the brief window after the typhoon passed”. On the uncertainty of the typhoon program, Luc continued “We could not afford a long setup time, and we were unsure of the time available or the wake size. The flexibility of the UnderwayCTD was a key factor in our decision”.

APL UnderwayCTD System

The Oceanscience Series II UnderwayCTD was installed on a post mount under the A frame on the aft deck, as shown in Figure 1. The UCTD was configured to offer either deep or shallow profiling modes. Shallow mode relies on the probe being deployed from the vessel and falling for a set time period as line spools off the winch; when it reaches a pre-determined depth, recovery is commenced. In this mode, very fast profiling cycles can be achieved to maximize spatial resolution in CTD surveys. To obtain deeper profiles, the

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ITOP UCTD was equipped with the unique tail spool reloading system to enable line to be paid out simultaneously from the probe as it drops *and* the winch on the ship. The tail spool reloading procedure can be seen in Figure 2, prior to an 850m cast. The tail spool seen on the rewinder is attached to the CTD probe using a special coupling prior to “freefall” deployment.



Figure 1. Series II UCTD Installed on R/V Roger Revelle, during probe recovery (Photo courtesy Luc Rainville).



Figure 2. Series II UCTD performing the tail spool reloading procedure (Photo courtesy Luc Rainville).

The cruise track and the location of the 2,917 UCTD casts can be seen on Figure 3. Typically UnderwayCTD profiles were conducted every 1km.

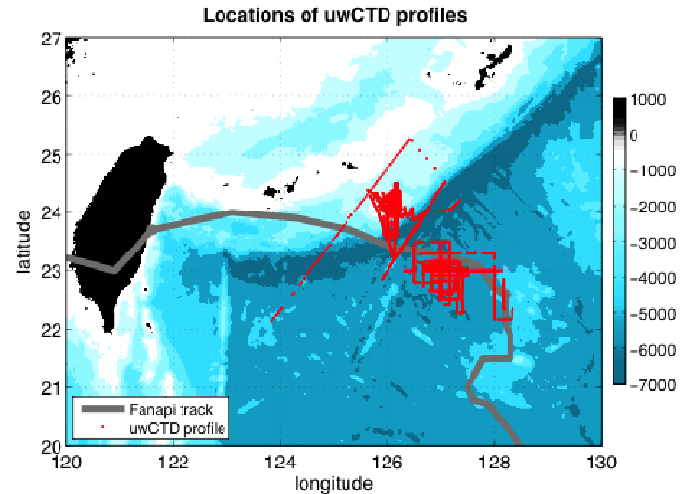


Figure 3. Bathymetric map of the study site, showing the storm track of typhoon Fanapi in gray and the location of the nearly 3,000 UnderwayCTD profiles.

UnderwayCTD Activities and Results

The cruise requirements dictated a very high spatial resolution in the CTD sections, so the shallow mode UCTD operation was the predominant method used. The profiling cycles achieved during the cruise were as follows:

- 2,827** casts to **160m** (6 min cycle time at 10kts)
- 82** casts to **400m** (18min cycle time at 10kts)
- 8** casts to **850m** (20min cycles at 0kts)

UnderwayCTD System Performance

Expecting bad conditions, the APL researchers ensured that three spare UCTD probes were taken on the cruise. All four UCTD probes were used on a continuous rotation. This method of operation allowed profiles to be downloaded

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periodically from each probe, via the Bluetooth link while the UCTD continued in action. Two probes were lost, probably as a result of the line being weakened by multiple days of continuous operation, or line snagging, while the other two kept providing good data despite sustaining damage from their heavy usage.

Based on the profiler replacement costs and other consumables expenses, the 2,917 UnderwayCTD profiles were obtained at a cost of only about **\$18 per profile!** This cost compares favorably even with expendable probes that cannot generate the data quality that UnderwayCTD offers.

After conducting more profiles in 20 days than typical UCTD users would achieve in five cruises, the winch and probe equipment was showing signs of wear towards the end of the cruise! "We knew we would be testing the system to the

limit, and we were pleased to get through to the end of the cruise with no data missing from major mechanical failures." On the profile success rate, Dr Rainville added "we performed over 3,100 casts in total, but because of some probe errors, user errors, or other failures, we achieved a 92% success rate. We are happy but we expect to improve on this next time."

This intensive test has identified some relatively straightforward improvements in system design and operation that can make the system even more robust. Principally, improved probe ruggedization has been added to the Oceanscience design team's goal for the next system revision in 2011. The entire winch system was returned to Oceanscience after the cruise, and a full service performed to ready the system for the next campaign. The high strength line was replaced, and probes replaced.

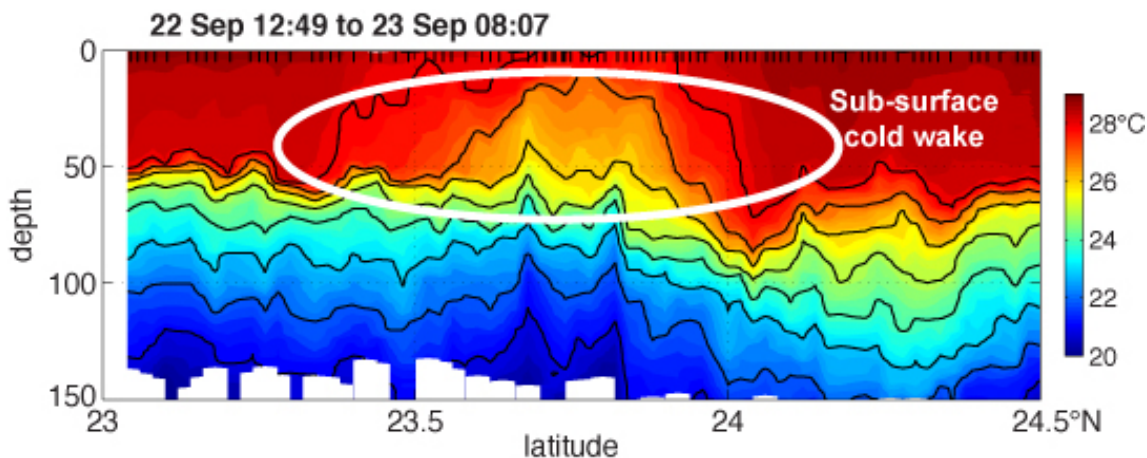


Figure 4. One of the UCTD transects, showing preliminary data from a temperature section across the cold wake 4 days after the storm. The 102 profiles in this section provide the extremely detailed mapping of the cold wake generated by typhoon Fanapi, offering a good indication of the possibilities for mapping oceanographic features in the upper ocean using the UCTD. Note that the upper few meters of the ocean were rapidly restratified by solar heating, but the sub-surface cold wake is evident.