# The CCAMLR-2000 Krill Synoptic Survey of Area 48

# CTD sampling protocol

## Introduction

These draft protocols are posted prior to agreement in order that their development will attract constructive criticism and input from qualified individuals.
It is recognized that the survey should collect data to World Ocean Circulation Experiment (WOCE) standards, however it is acknowledged that this may not be feasible for all participants. Notwithstanding this standard is recommended where possible. Participants are therefore directed towards the WOCE internet web site http://whpo.ucsd.edu/manuals.htm, in particular the pointers to CTD methods.

## Objectives

The main objective of sampling with a conductivity-temperature-depth (CTD) package is to identify environmental characteristics of the survey area, in particular the water masses which influence krill distribution and transport. A further objective of the survey is to identify the approximate geographic location of important fronts and to estimate geostrophic currents.

## Equipment

### Standard CTD

The preferred CTD unit for the CCAMLR Synoptic Survey is a Sea-Bird 911 plus. The nations (Japan, UK and the USA) currently participating in the survey each possess CTDs of this type. This CTD has three sensors; a series 410K-105 Digiquartz pressure transducer, a SBE 3 plus temperature sensor, and a SBE 4C conductivity sensor. In the standard configuration of the Sea-Bird 911 plus the SBE 3 plus and the SBE 4C sensors are connected to a SBE 5 T submersible high-speed pump.

The preferred mounting orientation of the CTD is horizontal, this is so that the flow of water within the rosette frame is as good as possible on both the down-cast and the up-cast.

## Accessory instrumentation

It is highly desirable that the CTD package carry a suitable means of independently verifying water temperatures at standard water bottle sampling depths, for example reversing thermometers or an SBE 35 Reference Temperature Sensor. For stations where the bottom of the cast is likely to be near the sea bed, a suitable means of detecting the bottom is required, for example an acoustic pinger (Japan and UK), or an altimeter (USA).

Such additional equipment, together with any other ancillary equipment mounted on the frame should not compromise water flow over the CTD sensors.

This CTD package should be fitted with adequate ballast to ease deployment in heavy seas.

## Water sampling equipment

The CTD should be mounted within a suitable carousel water sampler capable of carrying sufficient suitably sized sampling bottles. The bottles themselves should have external closure mechanisms, or internal Teflon-coated springs.

## Data acquisition

The CTD data should be logged via the SBE 11 plus deck unit to a suitable PC (Pentium or high-level 486) running Seasoft Data Acquisition Software (Sea-Bird Electronics Inc.).The preferred version is Seasoft version 4.221, or later, for DOS. Problems have been reported with Seasoft for Windows, though these may now have been fixed.

It is recognised that it is not possible to standardise the post processing software. Japan currently uses CONT3D (NRIFSF, Shimizu), the USA uses Ocean Data View version 4 (AWI, Bremerhaven) and the UK uses PEXEC (IOS, Southampton). Japan is currently considering changing to Ocean Data View.

## Auxiliary equipment

A suitable laboratory salinometer is required for determining water bottle salinities. Each of the participating nations (Japan, UK and USA) currently possesses a Guildline Autosal 8400B.

## Pre-cruise sensor calibration

All sensors on the CTD and on accessary, or auxiliary equipment should be laboratory calibrated both prior to, and following the cruise. The calibrations should be carried out by a professional laboratory appropriate to the task. Details of the calibrations should be archived for future reference. Any spare sensors should also be calibrated.

### Pre-survey software setup

Prior to the survey the current sensor calibration parameters should be set within the Seasoft SEASAVE module. This will only need to be carried out once, unless the sensors on the CTD are changed during the survey.

Various other SEASAVE options should also be set prior to data acquisition. It is recommended that the recording rate should be set to the maximum 24 scans for each channel per second. The header data should be kept to a minimum, but should include vessel name and cruise number. It is also suggested that the PC status line variables should be set to display pump status, pressure, temperature (IPTS-90), salinity, and density (?0), and that the display type should be set to be overlaid X-Y plots. It is recommended that the display should include pressure (Y-axis) versus each of temperature (IPTS-90), salinity, and density (?0) (X-axis). It is likely that the scale for these X-Y plots will require alteration throughout the cruise.

### Test deployment

A test deployment should be carried out prior to the main survey. This cast should be treated on a par with all survey stations. The test deployment should be to a depth equivalent to the deepest planned deployment in the survey. Water samples should be taken at pre-planned depths.

## Station protocol

### Pre-station preparations

Immediately prior to arriving on station, the water sampling bottles should be cocked and the CTD readied for launch. The depth to the sea bed should be monitored to see if it is necessary to use an acoustic pinger or altimeter. Communication should be established between the winch driver, the deck operators and the CTD laboratory.

Prior to data acquisition the PC clock should be synchronised with GMT. Local times and the time zone should also be noted.

The Seasoft module SEASAVE should be executed in preparation for data acquisition. Appropriate files should be setup in readiness for the cast. Although a common file naming convention is desirable, it is unlikely to be achieved, given the existing protocols on board each vessel. It is therefore paramount that station identification is possible from each national convention.

### On-station deployment

When the ship is settled on the station the CTD may be deployed. The exact latitude and longitude should be noted. The water depth and time (GMT) should also be recorded. As the CTD is deployed the SBE 11 deck unit should be turned on and the rosette firing mechanism should be armed. As the package enters the water the winch cable metering system should be zeroed, or the amount of cable out recorded. The CTD package

should be halted at approximately 8 metres depth, where it should be left to equilibrate. During this period the status of the SBE 5 T pump should be monitored to ensure that it switches on. After the equilibration period (dependent upon instrument load) the CTD package should be hauled to the surface after which the main deployment should commence. The depth and time (GMT) at the start of the main descent should again be recorded.

## The down-cast

The CTD package should be veered at a rate not exceeding 70 m min-1. Near the surface, this rate may be less to reduce problems associated with the heave of the ship. The CTD should be lowered to the desires depth and for stations where the cast will approach near-bottom the acoustic pinger or altimeter should be monitored. The CTD package should be lowered at the full speed until the sensors (wire-out, ships sounder, CTD pressure sensor, altimeter, acoustic pinger) indicate that the package is approximately 30 m above the bottom. At this point the veering speed should be reduced and the winch finally stopped with the CTD a safe height above bottom. The distance above the sea-bed will depend upon bottom topography, current speed, weather conditions, wire out, and a range of other factors specific to each deployment and platform. The maximum depth of each cast will depend upon one of two criteria: firstly, the available ocean depth, and secondly the default depth agreed for the survey (1000 m).

## At maximum depth

At the maximum depth the exact latitude and longitude should be noted, as should the time (GMT), depth and the amount of wire out. The first bottle should also be triggered. The package should remain stationary before and after the bottle is triggered, depending upon the thermal response time and the sampling period of any accessory temperature recording equipment.

Whilst at maximum depth any wire-washing equipment should be switched on.

## The up-cast

The CTD package should be hauled at a rate not exceeding 70 m min-1. All subsequent water sampling bottles are tripped during the upcast. Water should be sampled from pre-determined depths in order to allow independent salinity determination. Water should be sampled in regions of little vertical gradient, yet the samples should span the depth and salinity range of the water column. As other protocols (primary production, nutrient analysis etc.) may dictate that water is sampled from particular levels, care should be taken to ensure adequate samples are taken for salinity determination; these salinity samples should not be compromised.

## End of cast

After the last bottle is tripped the CTD should be brought on deck without stopping at the surface (although conditions may dictate that the winch operators require to stop at some point). The package should not be re-covered with bottles still cocked as they may trip accidentally during recovery.

As the package leaves the water the exact latitude and longitude should be noted, as should the time (GMT), depth and the amount of wire out. The SBE 11 deckunit should be turned off after noting instrument status.

# Post processing

## Salinity Samples

Salinity samples should be taken from all CTD casts at the bottle depths prescribed. The salinity samples should be taken in 200 ml glass medicine bottles (or suitable equivalent), with each bottle being rinsed three times before being filled to just below the neck. The rim of the bottle should be wiped dry with chlorine-free tissue, a plastic seal inserted and the screw cap replaced. The salinity samples should then be placed near to the salinometer for at least 24 hours before measurement. This will allow the sample temperatures to equalise with that of the salinometer.

The salinometer should be located in a room where through traffic will not cause disturbance to the ambient temperature, thereby ensuring a stable room temperature. The temperature of the room should be monitored and recorded.

The salinity samples should be analysed using standard seawater; the batch number should be recorded. One vial of standard seawater should be run through the salinometer at the beginning and end of each set of samples to enable a calibration offset to be derived and to check the stability of the salinometer.

## Reference temperatures

Where reference temperatures are available, for example from reversing thermometers or from a SBE 35 Reference Temperature Sensor, they should be used in the post-processing of the CTD data.

## The quality of the conductivity calibration

After applying the calibration coefficients and adjusting for the residual offset, the salinity of the bottle sample should be differenced with the derived CTD salinity. After rejecting outlying samples, the mean of the remaining samples and the standard deviation should be documented The residual offset applied to each cast after calibration should be documented.

## Data processing

It is recognised that CTD data are processed differently on each vessel. The downcast should be used as the principal data record. Initial processing will make use of Seasoft, however more detailed analysis is likely to require access to other software such as CONT3D (Japan), Ocean Data View (USA) pr PEXEC(UK). However, CTD data should be bin-averaged to 1 dbar. Data files should include all raw data such as conductivity, temperature (IPTS-90) and pressure, as well as derived data.

Hard copy data (log sheets, downcast plots and salinometer sample details) should be archived.

# Station sampling

## Proposed station sampling depths

It is proposed that CTD casts over continental self areas should sample to the near-bottom, that is within 10 m of the sea bed (depending upon conditions). A shelf station is arbitrarily defined as any station where the water depth is less than 1000 m.

It is proposed that CTD casts over the open ocean should sample to 1000 m. An open ocean station is arbitrarily defined as any station where the water depth is greater than 1000 m.

## Proposed depths for water bottle salinity sampling

In order to sample the water column for salinity calibration, the water sampling rosette should be triggered at the bottom of the cast, at 800 m, 600, 400 m, 200 m, 150 m, 100 m and at 30 m. Where additional depths are sampled (for accessory sensors) salinity samples may also be taken. Not all of the sampling depths will be possible over shelf areas.

# Proposed bottom depth

One of the principal water masses of the Antarctic Circumpolar Current (ACC) is Circumpolar Deep Water (CDW). This is divided into Upper CDW (UCDW) and Lower CDW (LCDW). UCDW has recently been shown to be an important defining factor in the southern extent of the ACC (Orsi et al., 1995). Consequently, sampling to encompass UCDW would be advantageous. It is suggested that the climatological level of UCDW should therefore be examined, so that the time overhead can be determined should sampling to these levels be agreed. A preliminary literature search (Peterson and Whitworth, 1989; Orsi et al., 1995) suggests that this overhead will be minimal.

# References

Peterson, R. G., and T. Whitworth III (1989). The Subantarctic and Polar Fronts in relation to deep water masses through the southwestern Atlantic. J. Geophys. Res., 94, 10817-10838.

Orsi, A. H., T. Whitworth III, and W. D. Nowlin (1995). On the meridional extent and fronts of the Antarctic Circumpolar Current. Deep-Sea Res., 42, 641-673.