CSIRO MARINE RESEARCH

CTD Processing Notes

R V Southern Surveyor Voyage SS2006/02

1 March - 15 March 2006

Data processing completed by Bernadette Heaney
March 2006

1. Summary

These notes relate to the production of QC'ed, calibrated CTD data from R V Southern Surveyor voyage SS 02/2006.

Data for 5 deployments was acquired using a Seabird SBE911 CTD, fitted with a 24 bottle rosette sampler. Pressures and preliminary conductivity values were computed using the Seabird-supplied calibration factors, and calibrations provided by the CSIRO Marine Research Calibration Facility were used to compute the water temperatures. The data was subjected to automated QC to remove spikes

The final conductivity calibration was based on a linear correction using a global fit to all salinity samples with obvious outliers removed. The quality of the resultant CTD salinity data is good with a standard deviation better than 0.003 PSU when compared to the sample bottle data.

Oxygen was calibrated by fitting the data to an Owens and Millard (1985) model of the Beckman-style oxygen sensor. This model does not quantify all factors affecting the sensor output, in particular hysteresis and start-up transients, which means that the CTD oxygen values should only be used for qualitative and semi-quantitative interpretation.

A Chelsea fluorometer was installed on the CTD's auxiliary A/D channels

The auxiliary channel data has been subjected to the same de-spiking as the standard CTD data, but it is essentially, uncalibrated.

2. Voyage details

2.1 Title

'Geological and biological investigations of the Murray Canyons Group'

(AUSCAN 2006 and PALEO-MURRAYS)

2.2 Principal Investigators

Professor Patrick De Deckker, The Australian National University, Canberra

For further details, refer to the Voyage Plan (De Deckker, 2006) which can be viewed on the CSIRO Marine Labs web site (http://www.marine.csiro.au/nationalfacility/voyage-docs/index.htm). The Voyage Summary report will also be published on this site, in due course.

3. Processing Notes

Data for 5 deployments were processed.

The data was acquired with CSIRO's CTD unit 20, a Seabird SBE911 with dual conductivity and temperature sensors, and an SBE13B, 'Beckman' dissolved oxygen sensor. A Chelsea AquaTrack Fluorometer was installed on one of the A/D channels. Water samples were collected using a Seabird SBE32, 24-bottle rosette sampler. 10 litre Niskin bottles were installed on the sampler; a total of 19 bottles in all.

The raw CTD data was converted to scientific units and written to netCDF format files for processing using the Matlab-based, procCTD package. procCTD is described in the *procCTD Procedures Manual* (Beattie, 2003).

procCTD applied automated QC and preliminary processing to the data. This included spike removal, identification of water entry and exit times, conductivity/temperature sensor lag corrections and the determination of the pressure offsets. It also loaded the hydrology data and computed the matching CTD sample burst data.

The automatically determined pressure offsets and in-water points were inspected.

The bottle sample data was used to compute final conductivity and dissolved oxygen calibrations. These were applied to the data, after which, files of binned, averaged data were produced.

3.1 Pressure and temperature calibration

Pressures were computed using the Seabird-supplied calibrations. The temperature sensors were calibrated on 16th March 2004 at the CSIRO Marine Research Calibration Facility. (Calibration reports 264T and 265T.)

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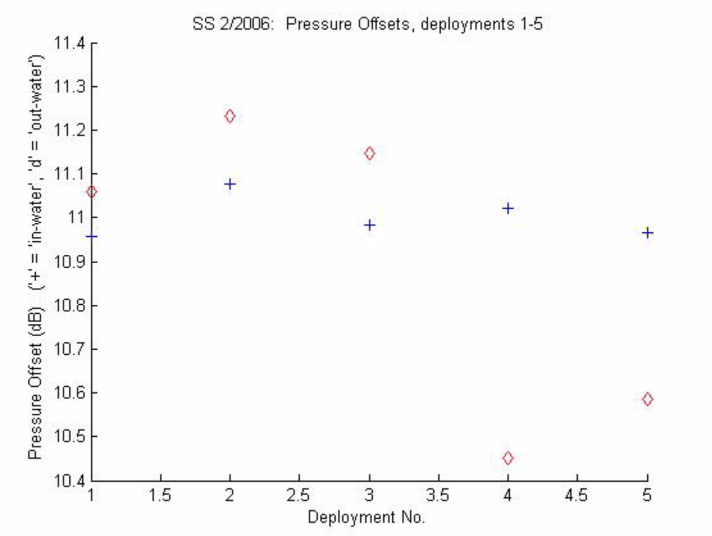
An additional pressure offset correction was computed for each deployment by assuming a linear drift between the pre and post-deployment, out-of-water pressures. These offsets are plotted in Figure 1(below).



The mean difference between the primary and secondary temperature sensors for each deployment are plotted in Fig. 2.

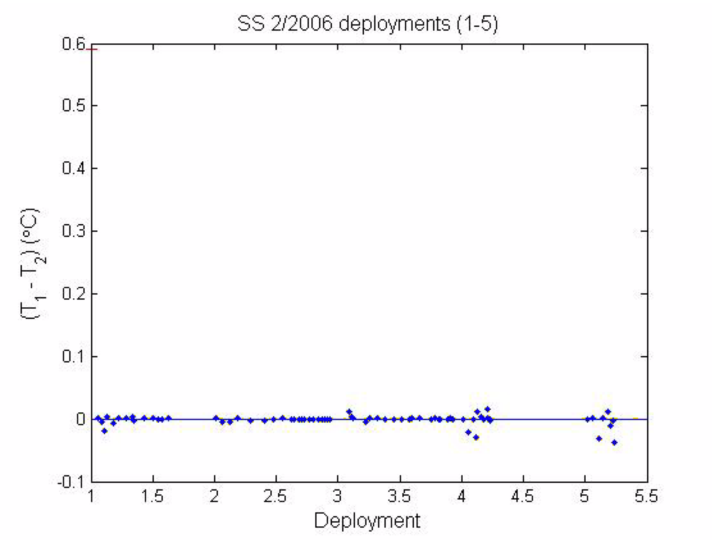


Figure 2. Mean temperature difference between the dual temperature sensors for each deployment.

The mean temperature differences indicate that there has been very little drift.

3.2 Conductivity calibration

- The calibration is applied in addition to the base calibration, rather than being applied to the raw data.
- The Seabird sensors are very stable, so it is assumed that no drift occurred during the voyage.

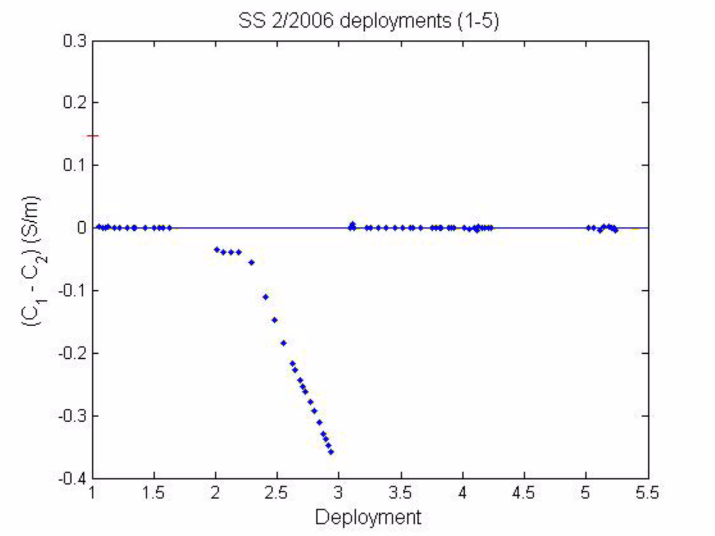


Figure 3. Mean conductivity difference between the dual conductivity sensors and for each deployment.

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The secondary conductivity sensor (2235) failed on station 2 and was replaced for station 3 (2598).

The base calibration for the primary conductivity sensor was the calibration derived from ss 7/2005. The base calibration for the new secondary sensor was the maufacturer's calibration.

For this voyage a single calibration, based on the sample data for all the deployments, was used for the primary conductivity sensor. The secondary conductivity sensor data was only applied to stations 3-5.

The results of the calibration can be summarised as follows:

Scale Factor (a1)	1.0003359	w.r.t. base calibration
Offset (a0)	-0.000245	
Calibration S.D. (Sal)	0.0031 psu	

for the primary conductivity sensor (2594) and were applied to stations 1 -5

Scale Factor (a1)	1.000508	w.r.t. M/facturer's calibration
Offset (a0)	-0.00016	ditto
Calibration S.D. (Sal)	0.0046 psu	

for the secondary sensor (2598) .

The above calibration factors were applied to deployments 3-5.

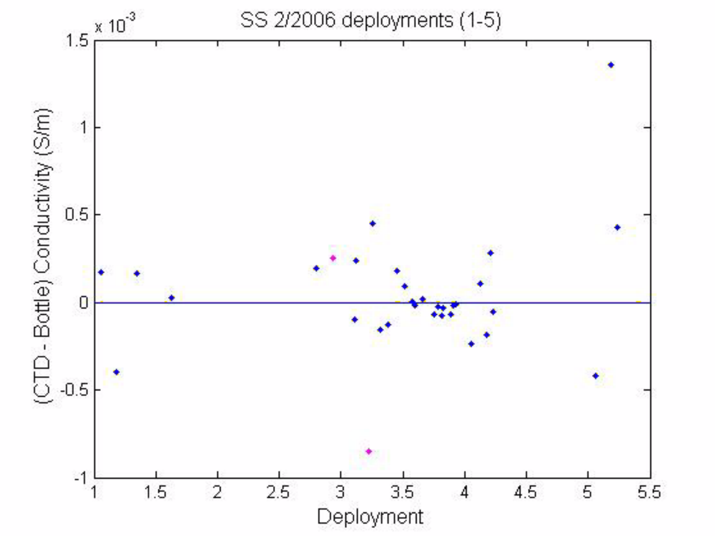

Figure 4. Difference between calibrated and derived bottle conductivities for each deployment using the primary conductivity sensor.

3.3 Dissolved Oxygen Sensor Calibration

3.3.1 Calibration procedure

Our model for the response of the Dissolved Oxygen sensor is based on Owens and Millard (1985). It uses an iterated, 6-parameter fit for the parameters:

Oxygen Current Slope (gain)
Oxygen Current Bias
Sensor Lag
Activation Energy
Reaction Volume
Temperature weight

In principle, the last 4 factors should be constant for the sensor type and geometry, with only the Slope and Bias changing, as the sensor becomes depleted. A slope and bias value was determined be fitting the data against all bottle samples.

The table below shows the calibration parameters.

	1-5
Current Slope	0.00020456
Current Bias	0.058137
Sensor Lag	30
Activation Energy	4699.2
Reaction Volume	-29.926
Temperature Weight	0.5674
Oxy Stnd. Dev (uM/l)	5.5547

The difference between the calibrated CTD and bottle dissolved oxygen is shown in Figure 6.

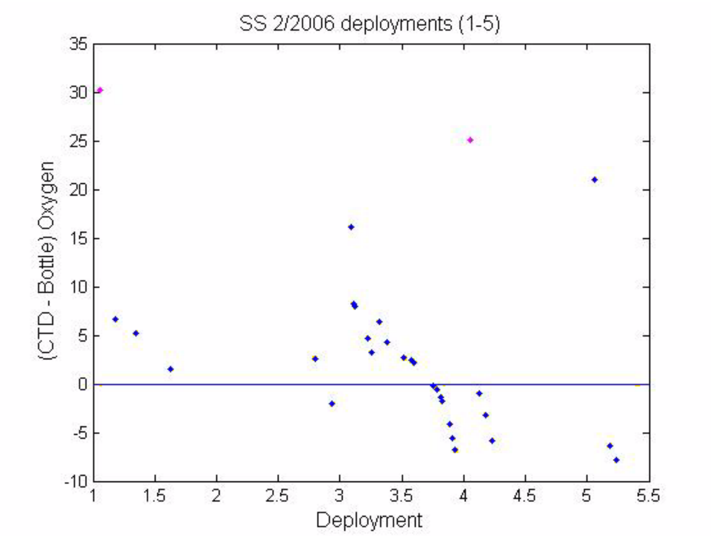

Figure 5. Difference between calibrated CTD and bottle dissolved oxygen data.

3.4 Other sensor

The Chelsea fluorometer was attached for all deployments.

3.5 Binned data files

The calibrated data was ‘filtered’ to remove pressure reversals and binned into 2dB averaged netCDF files. The binned values were calculated by applying a linear, least-squares fit to the bin data and using this to interpolate the value for the bin mid-point. This is more accurate than simply taking the mean of the data.

Each binned parameter in each bin is assigned a QC flag. Our flagging scheme is described in **http://www.marine.csiro.au/datacentre/ext_docs/DataQualityControlFlags.pdf**.

4. References

Beattie, R.D., 2004: procCTD CTD Processing Procedures Manual. http://www.marine.csiro.au/datacentre/ext_docs/procCTD.pdf. FrameMaker 7.0 source document: /net/fdcs/opt/fdcs/src/ctd/doc/procCTD.fm

Owens, W.B, and J.C. Millard Jr., 1985: A new algorithm for CTD oxygen calibration. J. Physical Oceanography, 15, 621-631.

Pender, L., 2000: Data Quality Control Flags. http://www.marine.csiro.au/datacentre/ext_docs/DataQualityControlFlags.pdf

