Meta Data for North Pole Environmental Observatory 2002 Aerial CTD-O_2 Survey

Measurements were made with a Seabird SBE-19 Seacat outfitted with an SEB43 O_2-sensor as part of the observational program of NPEO'02, following landing of either a ML8 helicopter or Twin Otter aircraft on the sea ice. Data from the SBE 43 dissolved O_2 sensor were generated for all of the casts. Individual dissolved sensor profiles generally appeared reasonable in shape, however, they exhibited hysteresis between the down and up casts and were all at least 1 ml/L less than the expected values. The O_2 sensor profiles tended to converge at about 500 m on a given day but were offset between days by amounts (0.5-1.0 ml/L) much larger than likely environmental variability. Obviously the sensor exhibited some type of problem.

Our initial working hypothesis was that degassing of the electrolyte resulted in bubbles behind the membrane. Such bubbles could cause divergence from the certified calibration parameters and hence offsets but not necessarily incorrect profile shapes. While this was a common problem with early serial numbers of SBE43 sensors, it was determined that ours was a later serial number that should not have been subject to this problem. Fouling or oil/grease contamination of the membrane can also diminish the sensitivity of the sensor but it seemed unlikely to us that this had occurred. After the 2003 deployment, we learned that the O_2 sensor contains a pressure compensation bladder and that Seabird had been filling this with distilled water through March 2003. It is likely that during shipment and/or deployment the contents of the compensation bladder experienced a hard freeze and so stretched the sensor membrane such that its sensitivity was diminished but not eliminated. Unfortunately, Niskin bottle O_2 samples taken in 2002 were not trustworthy. (For details, see bottle data results.) Thus the profiles were processed in a non-standard manner as follows.

CTD processing followed the SEASOFT recipe to minimize salinity spiking, with certain constants determined empirically. The CTD-O_2 package was set to acquire data at 2 scans/second. Conductivity and temperature were low-pass filtered with a time constant of 0.3 seconds, pressure was filtered with a time constant of 2.0 seconds and temperature was advanced relative to pressure by 0.7 seconds. Seasoft's thermal lag correction was applied with alpha=0.03 and tau=9.0. Potential temperature, depth and sigma-theta parameters were calculated according to EOS80 (Fofonoff and Millard, 1983).

Typically, data from downcasts are preferred since the water column can be disturbed by the wire and instrument package during the upcast. However, the upper portion of profiles in downcasts from the helicopter tended to be subject to ice interference in one or more of the sensors. Ignoring this portion of the profile, the best alignment of the adjusted in-situ temperature and O_2 voltages occurred for an O_2 advance of 5.0 sec. Comparison of processed up and downcasts shows that the O_2 sensor signals tended to converge below 200 m but showed varying degrees of hysteresis above 200 m. Accordingly, the following discussion is restricted to data from upcasts to 2 m below the surface for all sensors. Above 2 m the data are subject to artifacts related to the ice hole. The upcast data are available as ASCII files the title of which is the station identifier in

Table 1 below. Also listed are parameters relevant to the calibration of the O_2 data as follows.

Aligned oxygen voltage data were processed using a modified variant of the Owens and Millard algorithm (Owens and Millard, 1985) as described in the Sept 2002 Seabird Application Note No. 64:

$$O_2\ (ml/L) = \{S_{oc} * (V + V_{offset})\} * O_{2sat}(T,S) * e^{(Tcor * T)} * e^{(Pcor * P)}$$

where S_{oc} is the oxygen signal slope, V is the SBE43 temperature compensated output oxygen signal (Ox volts), V_{offset} is the voltage at zero oxygen signal, $O_{2sat}(T,S)$ is the oxygen saturation value in ml/L calculated using in-situ temperature and salinity following Weiss (1970), and T_{cor} and P_{cor} are residual temperature and pressure correction factors applied to in-situ temperature and pressure. Slightly varying calibration parameters S_{oc}, and V_{offset} for each profile are given in the table above. Values of $1.6x10^{-3}$ for T_{cor}, and $1.350x10^{-4}$ for P_{cor} based on the pre-mission calibration were applied to all of the profiles. The other calibration parameters S_{oc}, and V_{offset} were adjusted for each profile to give saturation in the surface mixed layer at the depth given in Table 1 and to bring concentrations at about 500m to 6.95 ml/L (Swift, et al., 1997). The specific depth adjusted to 6.95 ml/L for each profile is also given in Table 1. Spikes in the O_2 data were identified by visual inspection and eliminated though spiking was negligible except for portions of Helo-04 (cast 5). We estimate that the data have an uncertainty of about 0.2 ml/L. We have provided the aligned voltages, should anyone wish to undertake a different strategy in processing this data. *Obviously, the processed form of the O_2 data should not be used to examine issues related to surface saturation state nor small differences at depth where all the profiles were forced to fit a given value.*

The data are available in the form of tab-delimited ASCII files with the following 10 column headers: scan, depth m, press db, temp C, cond S/m, sal, pot temp C, sigma theta, O2 V, O2 ml/L. The name of file is the station name given in Table 1. Temperatures are expressed on the ITS-90 scale and salinities as PSS78. “O2 V” is the lag corrected oxygen voltage.

Table 1

Cast	Station	Latitude N	Longitude E	Date	Time UTC	S_{oc}	V_{offset}	sat depth m	"500" depth m
1	Helo 0	88º32.4'	087º53.6'	4/23/02	10:14	0.6198	0.9027	53.108	500.183
2	Helo 1	88º20.7'	113º03.0'	4/23/02	13:34	0.4894	0.4069	30.171	500.111
3	Helo 2	88º19.4'	123º21.0'	4/23/02	14:32	0.5371	0.5575	4.081	500.169
4	Helo 3	88º18.5'	131º59.0'	4/23/02	15:30	0.5052	0.4375	5.284	500.272
5	Helo 4	88º16.3'	140º51.7'	4/23/02	16:26	0.4907	0.3837	8.403	500.131
6	Helo 5	87º55.3'	153º50.9'	4/26/02	12:04	0.4144	0.1533	8.461	500.088
7	Helo 6	88º06.2'	148º05.5'	4/26/02	12:59	0.4288	0.2154	10.828	500.132
8	Helo 7	88º21.1'	118º23.7'	4/26/02	14:06	0.4761	0.4285	29.885	500.174
9	Helo 8	88º30.1'	071º14.1'	4/28/02	10:41	0.4521	0.3268	30.049	500.178
10	Hydro 1	85º10.7'	165º16.4'	4/27/02	14:33	0.4260	0.2021	12.776	500.075
11	Hydro 2	86º37.1'	164º59.5'	4/27/02	18:50	0.4141	0.1417	8.075	500.114

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For further information, please contact:

Dr. Kelly K. Falkner kfalkner@coas.oregonstate.edu (541) 737-3625
104 Ocean Admin Bldg
COAS, OSU
Corvallis, OR 97331-5503

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