Meta Data for North Pole Environmental Observatory 2004 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'04, following landing of the Twin Otter aircraft at the positions on the Arctic sea ice listed in the table below.

Cast	Station	Latitude	Longitude	Date
6	Borneo4	89°18.3'N	126°6.86'E	26-Apr-04
7	St85-170	85°0.72'N	166°36.9'W	27-Apr-04
8	St86-170	86°8.72'N	171°17.4'W	27-Apr-04
9	St87-180	87°16.3'N	178°53.1'W	27-Apr-04
10	St89-90W	89°4.11'N	87°19.0'W	28-Apr-04
11	St90N	89°57.7'N	113°9.00'W	28-Apr-04
12	St8840-180	88°41.1'N	179°35.0'W	28-Apr-04
13	St88-180	87°59.9'N	179°50.8'W	29-Apr-04
14	St87-90W	86°59.6'N	90°29.6'W	29-Apr-04

Additional casts (1-5) either didn't include the SBE43 or were problematic since we experienced a short in one of the connectors due to saltwater leakage. The complete suite of NPEO'04 CTD data has been archived separately at NSIDC.

The CTD-O_2 package was set to acquire data at 2 scans/second. Files provided in this archive are in a tab delimited ASCII format. Filenames include the station name in the table above and are preceded by "wpc" to indicate that for O_2 processing, Weiss (1979) saturation values and post mission calibration parameters were used (see below). The files each include the following 12 parameters from the downcasts defined by the same cut-off scan numbers that were used for the CTD-only archive:
Scan #, pressure in dbar, in-situ temperature T90 degC, conductivity S/m, Oxygen voltage, depth m, potential temperature T90 degC, salinity psu, sigma-theta, Oxygen ml/L, Oxygen-saturation ml/L and Oxygen mmol/m^3.

CTD processing followed the SEASOFT recipe to minimize salinity spiking, with certain constants determined empirically. Conductivity and temperature were low-pass filtered with a time constant of 0.5 seconds, pressure was filtered with a time constant of 2.0 seconds and temperature was advanced relative to pressure by 0.5 seconds. Potential temperature, depth and sigma-theta parameters were calculated according to EOS80 (Fofonoff and Millard, 1983).

Processing of the dissolved O_2 voltage was similar to NPEO 03 except that the membrane did not experience freezing and so held the calibration for the mission. Bottle samples taken for calibration purposes suffered from challenging field conditions such that none were trustworthy. Further details are provided with the archived bottle meta-data. Three sets of calibration parameters were available to us, pre-deployment (12Feb04), post deployment (20May04) and post deployment aimed at a revised algorithm (18Dec04). The post deployment calibration parameters generated results for the surface mixed layer closest to and nearly indistinguishable from saturation with respect to atmospheric O_2 for the majority of the profiles and so these values were used. A time constant of 6 seconds was used to align the down and up oxygen with the adjusted in-situ temperature. 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:

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

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) (Weiss, 1970), and T_{cor} and P_{cor} are residual temperature and pressure correction factors applied to in-situ temperature and pressure. Parameters S_{oc}=0.4223, V_{offset}=-0.4407, T_{cor}=1.4x10^{-3} and for P_{cor}=1.350x10^{-4} were applied to all of the profiles. We have provided the aligned voltages, should anyone wish to undertake a different strategy in processing this data. *Obviously, the processed from of the O_2 data should not be used to examine issues related to surface saturation state. Also, care must be taken in interpreting correlations between CTD-O_2 properties in layers less than 30 thick since the sensors have different response rates.*

It should be noted, that in consultation with Seabird, we are in the process of evaluating their new algorithm that explicitly takes into account the O_2-sensor response rate. We have determined via flow measurements that an advance of 1 sec should be applied to our oxygen voltage data with respect to the pressure to account for the physical separation of the sensors. The additional term accounting for the inherent response time of the SBE43 has yet to be finalized as of this writing. We also note that the data fitting procedure that Weiss (1970) used to create an O_2 saturation function has a form that deviates most strongly from the data at near freezing temperatures. Garcia and Gordon (1985) proposed an alternative that we prefer and intend to use in future CTD-O_2 data processing. Beware that the Garcia and Gordon publication has a number of typesetting errors and so anyone attempting to make use of it should check with the authors for corrections.

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