

# Observations and Measurements

## Field Names List

Parameter	Description	Units
deployment	For short-term deployments (1.5-3 days), the BATS cruise number from which the float was deployed. For long-term deployments, the serial number of the float (F033 or F034).	unitless
date	The UTC date at the completion of the ascent profile; yyyy/mm/dd	unitless
time	The UTC time at the completion of the ascent profile; HH:MM	unitless
pres	Pressure acquired with Sea-Bird Scientific SBE 41CP CTD. This is reported as the instrument output with the factory calibration applied.	dbar
temp	Temperature acquired with Sea-Bird Scientific SBE 41CP CTD. This is reported as the instrument output with the factory calibration applied.	Celsius
sal	Salinity acquired with Sea-Bird Scientific SBE 41CP CTD. This is reported as the instrument output with the factory calibration applied.	PSU
optode_therm_v	Oxygen sensor thermistor raw voltage; Acquired with Sea-Bird Scientific SBE 63 Optical Dissolved Oxygen Sensor. This is the raw sensor output.	volts
optode_temp	Temperature at dissolved oxygen sensor; Acquired with Sea-Bird Scientific SBE 63 Optical Dissolved Oxygen Sensor. Temperature at the dissolved oxygen sensor was calculated from the raw SBE 63 thermistor voltage by applying the factory calibration: $L = \ln(100000 * \text{thermistor voltage} / (3.3 - \text{thermistor voltage}))$ Temperature [deg C] = $1 / (TA0 + TA1 * L + TA2 * L^2 + TA3 * L^3) - 273.15$ See <a href="https://www.bco-dmo.org/dataset/728371">https://www.bco-dmo.org/dataset/728371</a> for calibration coefficients.	Celsius
oxy_phase	Oxygen sensor raw phase; Acquired with Sea-Bird Scientific SBE 63 Optical Dissolved Oxygen Sensor. This is the raw sensor output.	usec
	Dissolved oxygen; Acquired with Sea-Bird Scientific SBE 63	

Optical Dissolved Oxygen Sensor. Dissolved oxygen concentration [ $\mu\text{mol/kg}$ ] was calculated and corrected for salinity and pressure effects according to the 2016 Argo recommendations for processing of dissolved oxygen data (Thierry et al. 2016). As per these recommendations, an initial pressure correction was made to the raw measured oxygen phase delay  $\Phi$  [ $\mu\text{sec}$ ] according to Bittig et al.

2015:  $\Phi_{\text{adj}} = \Phi_{\text{raw}} + P_{\text{coef1}} * P / 1000$  where

$P_{\text{coef1}} = 0.115 \text{ usec}$  and  $P$  [dbar] is the collocated SBE 41CP CTD pressure measurement. The adjusted oxygen phase delay [ $\mu\text{sec}$ ] was then converted to voltage by

applying the factory conversion:  $V = \Phi_{\text{adj}} /$

$39.457071$  Uncorrected dissolved oxygen concentration

[mL/L] was calculated by applying the factory calibration:

$\text{Oxygen}_{\text{uncorr}} [\text{mL/L}] = \{(A_0 + A_1 * T + A_2 * V^2) / (B_0 + B_1 * V) - 1.0\} / (C_0 + C_1 * T + C_2 * T^2)$  where  $T$  is SBE 63 temperature [ $^{\circ}\text{C}$ ] and  $V$  is adjusted SBE 63 phase delay [V].

The oxygen calibration coefficients ( $A_0, A_1, A_2, B_0, B_1, C_0, C_1, C_2$ ) are provided in Table 1. Dissolved oxygen concentration [mL/L] was then corrected for salinity and

pressure effects according to the 2016 Argo recommendations.

$\text{Oxygen}_{\text{corr}} [\text{mL/L}] = \text{Oxygen}_{\text{uncorr}} [\text{mL/L}] * \text{Scorr} * P_{\text{corr}}$  where  $\text{Scorr} =$

$A(T, S, S_{\text{preset}}) * \exp(S * (\text{SolB}_0 + \text{SolB}_1 * T_s + \text{SolB}_2 * T_s^2 + \text{SolB}_3 * T_s^3) + \text{SolC}_0 * S^2)$   $A(T, S, S_{\text{preset}}) =$

$(1013.25 - \text{pH}_2\text{O}(T, S_{\text{preset}})) / (1013.25 - \text{pH}_2\text{O}(T, S))$

$\text{pH}_2\text{O} = 1013.25 * \exp(D_0 + D_1 * (100 / (T + 273.15))) + D_2 * \ln((T + 273.15) / 100) + D_3 * S$

$S_{\text{preset}} = 0$   $T_s = \ln[(298.15 - T) / (273.15 + T)]$   $T$

and  $S$  are the collocated temperature and salinity measurements from the SBE 41CP CTD, respectively.

Salinity correction coefficients are from Benson and Krause 1984 ( $\text{SolB}_0 = -6.24523\text{e-}3$ ,  $\text{SolB}_1 = -7.37614\text{e-}3$ ,  $\text{SolB}_2 = -1.03410\text{e-}3$ ,  $\text{SolB}_3 = -8.17083\text{e-}3$ ,  $\text{SolC}_0 = -4.88682\text{e-}7$ )

and  $\text{pH}_2\text{O}$  coefficients are from Weiss and Price 1980 ( $D_0 = 24.4543$ ,  $D_1 = -67.4509$ ,  $D_2 = -4.8489$ ,  $D_3 = -5.44\text{e-}4$ ). The

pressure correction factor  $P_{\text{corr}}$  is calculated as outlined in Bittig et al. 2015 as  $P_{\text{corr}} = 1 + (P_{\text{coef2}} * T +$

$P_{\text{coef3}}) * P / 1000$  with  $P_{\text{coef2}} = 0.00022$  and  $P_{\text{coef3}} =$

$0.0419$ . Dissolved oxygen concentration [mL/L] was

oxygen

$\mu\text{mol/kg}$

converted to dissolved oxygen concentration [ $\mu\text{mol}/\text{kg}$ ]:

Oxygen [ $\mu\text{mol}/\text{kg}$ ] = Oxygen [ $\text{mL}/\text{L}$ ] \* (44.6596  $\mu\text{mol}/\text{mL}$ ) / ( $\rho_{\theta}/1000$ ) where  $\rho_{\theta}$  is the potential density of seawater [ $\text{kg}/\text{m}^3$ ] at zero pressure and the potential temperature calculated from collocated SBE 41CP CTD salinity, temperature, and pressure measurements using the  $\rho_{\text{den}}$  function in the SEAWATER Matlab library (Morgan and Pender 1993). The value of 44.6596  $\mu\text{mol}/\text{mL}$  is derived from the molar volume of oxygen gas at standard temperature and pressure, 22.3916 L/mole (e.g., García and Gordon 1992). See <https://www.bco-dmo.org/dataset/728371> for calibration coefficients.

oxygen\_cal

Calibrated dissolved oxygen; The dissolved oxygen concentrations calculated above were corrected to dissolved oxygen concentrations measured by Winkler titration of bottle samples collected during concurrent Bermuda Atlantic Time-series Study cruises (available at <http://www.bco-dmo.org/project/2124> or <http://bats.bios.edu>). Linear regression yields the relationship: oxygen\_cal [ $\mu\text{mol}/\text{kg}$ ] = oxygen [ $\mu\text{mol}/\text{kg}$ ] \* 1.0331 – 6.9976;  $R^2 = 0.97$ . See <https://www.bco-dmo.org/dataset/728371> for bottle calibration data.

$\mu\text{mol}/\text{kg}$

chl

Chlorophyll-a; Acquired with WET Labs MCOMS Chlorophyll Fluorometer (excitation 470 nm/emission 695 nm). A dark offset was subtracted from the raw sensor counts and the result was multiplied by a factory-determined scale factor to obtain fluorometric chlorophyll-a concentration [ $\mu\text{g}/\text{L}$ ]. The dark offset was computed separately for each sensor as the mean of the deep-water minima measured during all profiles between July and September 2013 at BATS (<https://www.bco-dmo.org/dataset/728371>). Chl [ $\mu\text{g}/\text{L}$ ] = Scale Factor \* (Output - Dark Counts)

$\mu\text{g}/\text{L}$

chl\_corr

Corrected chlorophyll-a; The fluorometric chlorophyll-a values derived above were further corrected by removing the deep-water dependence of chlorophyll fluorescence on fluorescent colored dissolved organic matter (CDOM; see below) and a small residual deep-water sensor offset. The method of Xing et al. (2017) was applied. Briefly chlorophyll fluorescence in deep water was assumed to originate

$\mu\text{g}/\text{L}$

entirely from a combination of the above factors the dependence of the measured chlorophyll fluorescence on CDOM was determined through linear regression and the regression parameters were used to correct the entire chlorophyll profile. Profiles shallower than 200 m were corrected using the regression parameters of the subsequent float profile.

chl\_cal  
 Calibrated chlorophyll-a; Corrected fluorometric chlorophyll-a concentrations (chl\_corr derived above) were calibrated to chlorophyll-a concentrations measured by HPLC of bottle samples collected during concurrent Bermuda Atlantic Time-series Study cruises (available at <http://www.bco-dmo.org/project/2124> or <http://bats.bios.edu>). Linear regression yields the relationship:  $chl\_cal [\mu\text{g/L}] = chl [\mu\text{g/L}] * 0.4756 + 0.0064$ ;  $R^2 = 0.92$ . See <https://www.bco-dmo.org/dataset/728371> for bottle calibration data. ug/L

bbp700  
 Particulate backscattering coefficient bbp (700nm); Acquired with WET Labs MCOMS Scattering Meter with 700-nm wavelength and in-water centroid angle of 150 deg. See Table 3 in paper. The particulate volume scattering coefficient  $\beta_p$  was calculated as  $\beta_p(150 \text{ deg}, 700 \text{ nm}) [m^{-1} \text{ sr}^{-1}] = \text{Scale Factor} * (\text{Output} - \text{Dark Counts})$  using a factory-determined scale factor and a dark offset, computed separately for each sensor as the mean of the deep-water minima measured during all profiles between July and September 2013 at BATS (<https://www.bco-dmo.org/dataset/728371>). Particulate backscattering coefficient,  $bbp(\lambda) [m^{-1}]$ , is estimated as  $bbp = 2\pi\chi\beta_p(150 \text{ deg})$   $\chi = 1.13$  for 150 deg (from Boss and Pegau 2001). m<sup>-1</sup>

bbp700\_corr  
 Corrected particulate backscattering coefficient bbp (700nm); Depth profiles of particulate backscattering coefficient  $bbp(700 \text{ nm})$  were despiked using a running median filter (Briggs et al. 2011). Due to the size of the median filter window the initial and final six data points in each profile could not be despiked and appear as NaN. Park phase  $bbp(700 \text{ nm})$  data were not despiked because they were collected at a nominally constant depth. Despiked profile phase  $bbp(700 \text{ nm})$  and raw park phase  $bbp(700 \text{ nm})$  were further corrected by a float-specific deep-water offset. The m<sup>-1</sup>

minimum bbp(700 nm) measured during the long-term deployments was determined for each float (-2.0488e-04 m-1 for F033; -1.1139e-04 m-1 for F034) and subtracted from the bbp(700 nm) values derived above.

POC\_bbp

Particulate organic carbon derived from bbp (700 nm); The relationship between corrected bbp(700 nm) measured by the float backscatter sensor (bbp700\_corr derived above) and POC concentrations measured in bottle samples collected during concurrent Bermuda Atlantic Time-series Study cruises (available at <http://www.bco-dmo.org/project/2124> or <http://bats.bios.edu>) was utilized to predict POC concentration from corrected bbp(700 nm) for all float samples. Linear regression yields the relationship: POC [mg/m<sup>3</sup>] = bbp(700 nm) [m<sup>-1</sup>] \* 32020.0874 + 0.2973; R<sup>2</sup> = 0.86. See <https://www.bco-dmo.org/dataset/728371> for bottle calibration data.

mg/meters cubed

cdom

Colored dissolved organic matter; Acquired with WET Labs MCOMS CDOM Fluorometer (excitation 370 nm/emission 460 nm). A dark offset was subtracted from the raw sensor counts and the result was multiplied by a factory-determined scale factor to obtain colored dissolved organic matter concentration [ppb]. The dark offset was computed separately for each sensor as the mean of the surface minima (0 – 20 dbar) measured during all profiles between July and September 2013 at BATS (<https://www.bco-dmo.org/dataset/728371>).

ppb

trans\_counts

Transmissometer raw counts; Acquired with WET Labs c-ROVER 2000 transmissometer with 650-nm wavelength and 0.25-m pathlength. This is reported as the raw sensor output in counts.

count

beam\_c

Uncorrected particulate beam attenuation coefficient cp (650 nm); Acquired with WET Labs c-ROVER 2000 transmissometer with 650-nm wavelength and 0.25-m pathlength. Transmittance is calculated as:  
 Transmittance = (Signal - Dark) / (Cal Signal - Dark)  
 Signal = raw output in counts                      Dark = counts with beam blocked, factory supplied  
 Cal Signal = counts with Milli-Q water in sensor path, acquired prior to

m -1

deployment (<https://www.bco-dmo.org/dataset/728371>) The beam attenuation coefficient is calculated as:  

$$cp,uncorr(650\text{ nm}) = -\ln(\text{transmittance}) / \text{pathlength [m]}$$
 No correction for drift of the sensor over time (for instance, due to bio-fouling, see Estapa et al. 2013) has been applied. The maximum tilt value recorded during each sampling interval.

tilt		degrees
azimuth	The uncalibrated compass heading of the float.	degrees
ISO_DateTime_UTC	ISO formatted DateTime; UTC	unitless
float_id	The serial number of the float (F033 or F034).	unitless
prof_num	Number of float profile cycle.	unitless
lat	Latitude	decimal degrees
lon	Longitude	decimal degrees