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# Processing BGC-Argo CDOM concentration at the DAC level

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Argo data management
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# History of the document

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**Preamble:**

This document does NOT address the issue of CDOM parameters quality control (either real-time or delayed mode). As a preliminary step towards that goal, this document seeks to ensure that all countries deploying floats equipped with CDOM sensors document the data and metadata related to these floats properly. We produced this document in response to action item 30 from the $5^{th}$ BGC-Argo Data Management meeting in Tianjin (September 2016).

If the recommendations contained herein are followed, we will end up with a more uniform set of CDOM data within the BGC-Argo data system, allowing users to begin analyzing not only their own CDOM data, but also those of others, in the true spirit of Argo data sharing.

# 1 Introduction

In the open ocean, Colored Dissolved Organic Matter (CDOM) is the fraction of the total Dissolved Organic Matter (DOM), composed by a mixture of chemically complex algal degradation products that interact with light. CDOM absorbs solar radiation in the UV and visible ranges (Bricaud et al., 1981) and, if illuminated, re-emits light as fluorescence (i.e., FDOM; Coble 1996). These optical measurements can be used as proxies of CDOM concentration. Whereas CDOM absorption measurements are given by the entire pool of the organic matter, FDOM measurements detect only sub-fractions. Depending on excitation and emission wavelengths of the fluorometer, FDOM can represent the fresh-material produced by microbial degradation of phytoplankton cells and/or from zooplanktonic excretion, or aged humic substances (Stedmon and Nelson, 2015; Nelson and Gauglitz, 2016). Whereas CDOM absorption measurements require laboratory facilities, FDOM detection can be easily implemented on autonomous Biogeochemical-Argo profiling floats.

Though being only a small part of the DOM, CDOM (and FDOM) plays an important role in the ocean carbon cycle (Mopper and Kieber, 2002). Its distribution varies from the surface to the ocean interior and across world's oceanic regions (Nelson and Siegel, 2013). It can indicate presence of bacterial (Organelli et al., 2014) and zooplankton (Steinberg et al., 2004) activities, planktonic food-web interactions (Xing et al., 2014), or accumulate below the thermocline depending on water mass ventilation ages (Nelson et al., 2010). Relation between consumed oxygen and CDOM optical proxies is a consequence of this accumulation, and it can be linked to remineralization processes of marine organic particles in the deep ocean (Nelson et al., 2010; Nelson and Siegel, 2013). Knowledge of CDOM (and FDOM) spatio-temporal variability is also important for remote sensing applications as it can confound standard algorithms used for the retrieval of biogeochemical and bio-optical products from space (Organelli et al., 2016; Organelli et al., 2017).

FDOM sensors currently installed on BGC-Argo floats have excitation/emission wavelengths of 370 and 460 nm, respectively. Thus, FDOM measurements correspond to more aged refractory organic material (Nelson and Gauglitz, 2016). Hereafter, we refer to FDOM measurements as CDOM.

At the moment all fluorescence sensors implemented on floats are developed by the WET labs Company and are of the ECO serie. These CDOM fluorometers are not standalone sensors and combine the CDOM measurements together two measurements (ECO triplet) which generally are Chlorophyll-A fluorescence and backscattering at 700 nm. The present document is focused on the management of the CDOM fluorescence data flow acquired by those sensors (section 3). As soon as others sensors are implemented and successfully tested on floats, the present document would be accordingly updated.

# 2 Recommendations for addressing the CDOM concentration processing

The official BGC-Argo units for the CDOM concentration in sea water is ppb of quinine sulfate (hereafter ppb). Presently the fluorometers implemented on floats provide counts as a measurement. Here are the recommendations to address the CDOM concentration processing:

1. Store any data transmitted by the fluorometer with meaningful names. It is important to store those data, if changes occur in the calibration/conversion equations used to convert the sensor output in CDOM concentration data. The proposed name for the counts transmitted by the fluorometer is

   FLUORESCENCE_CDOM
   Raw fluorescence from coloured dissolved organic matter sensor (in counts)

2. Convert the counts in CDOM concentration

   CDOM
   Concentration of coloured dissolved organic matter in sea water (in ppb)

3. Fill properly the metadata to document the calibration, the conversions equations and the fields to identify a sensor. In the metadata file, the configuration parameters (excitation and emission central wavelengths, excitation and emission bandwidths) could also be filled in order to characterize as precisely as possible the fluorometer sensor.

As for the other sensors, the model number and serial number of the fluorometer sensor must be provided. This tracking way can be essential if a specific failure concerns all the sensors from the same batch for instance, or if the manufacturing process changes after a certain serial number.

Indications provided in the two following sections and the examples on how to fill metadata are valid as of the date of writing this document. It is very likely that changes in calibrations and conversions equations will occur in the future. Metadata will then have to be filled accordingly with the new procedures.

# 3 ECO sensor

In the following, we will focus on measurements performed with the Wetlabs ECO sensor.

## 3.1 Measurements and Data processing

Raw data from the ECO CDOM fluorometer are transmitted as counts. The basic equation allowing the retrieval of CDOM concentration from raw transmitted measurement is

**CDOM = (FLUORESCENCE_CDOM – DARK_CDOM) * SCALE_CDOM**

**or**

**CDOM = (FLUORESCENCE_CDOM – DARK_CDOM_O) * SCALE_CDOM**

where

**CDOM**= concentration of coloured dissolved organic matter of a sample of interest (in ppb)

**FLUORESCENCE_CDOM** = raw counts output when measuring a sample of interest

**SCALE_CDOM =** multiplier in ppb/counts

**DARK_CDOM =** dark counts, the measured signal output of the fluorometer in clean water with black tape over the detector from the manufacturer calibration sheets

Alternatively, DARK_CDOM can be replaced by

**DARK_CDOM_O =** dark counts, the measured signal output of the fluorometer in clean water with black tape over the detector performed by an operator before the deployment

## 3.2 Sensor METADATA and Configuration parameters

### 3.2.1 Sensor and parameter metadata

This section contains information about the sensors and the measured parameters by the profiler or derived from profiler measurements that need to be filled. All the reference tables can be found in the Argo user's manual.

| Sensor metadata | |
|---|---|
| SENSOR | FLUOROMETER_CDOM |
| SENSOR MAKER | WETLABS |
| SENSOR_MODEL | ECO_FLBBCD |
| SENSOR_SERIAL_NO | *To be filled* |

| Parameter metadata | |
|---|---|
| PARAMETER | FLUORESCENCE_CDOM |
| PARAMETER_SENSOR | FLUOROMETER_CDOM |
| PARAMETER_UNITS | count |
| PARAMETER_ACCURACY | |
| PARAMETER_RESOLUTION | |
| | |
| PARAMETER | CDOM |
| PARAMETER_SENSOR | FLUOROMETER_CDOM |
| PARAMETER_UNITS | ppb |
| PARAMETER_ACCURACY | |
| PARAMETER_RESOLUTION | |

### 3.2.2 Configuration parameters

In order to characterize precisely the fluorometer, some configuration parameters can be filled using the manufacturer documentation (if any) with the central wavelength and its bandwidth.

CONFIG_EcoCdomFluorescenceExcitationWavelength_nm

*Wavelength of ECO sensor for excitation of CDOM fluorescence measurements (in nanometer)*

CONFIG_EcoCdomFluorescenceEmissionWavelength_nm

*Wavelength of ECO sensor for emission of CDOM fluorescence measurements (in nanometer)*

CONFIG_EcoCdomFluorescenceExcitationBandwidth_nm

*Bandwidth of ECO sensor for excitation of CDOM fluorescence measurements (in nanometer)*

CONFIG_EcoCdomFluorescenceEmissionBandwidth_nm

*Bandwidth of ECO sensor for emission of CDOM fluorescence measurements (in nanometer)*

Fluorescence sensors do not collect data at the same pressure as the CTD sensors. We define a configuration parameter to illustrate the offset in pressure due to the difference of the vertical alignment between the Eco and the CTD. As the Eco is about 10 cm below the CTD:

CONFIG_EcoVerticalPressureOffset_dbar

*Vertical pressure offset due to the fact that the sensor is not exactly at the CTD pressure*

As an example:

CONFIG_EcoCdomFluorescenceExcitationWavelength_nm=370

CONFIG_EcoCdomFluorescenceEmissionWavelength_nm=460

CONFIG_EcoVerticalPressureOffset_dbar=0.1

## 3.3 CDOM data related parameters

During the ADMT13, the decision to separate data files for floats with biogeochemical sensors was taken. Then for biogeochemical floats, there are three files: one for P, T, and S; one containing P and intermediate parameters (b-file); and one merged file containing P, T, S and ocean state variables.

### 3.3.1 CDOM related parameters for the b-file

Raw data are given in counts from the ECO sensor (FLUORESCENCE_CDOM). These data will be stored in the b-file:

**PARAMETER** = "FLUORESCENCE_CDOM"

**PREDEPLOYMENT_CALIB_EQUATION** = "none"

**PREDEPLOYMENT_CALIB_COEFFICIENT** = "none"

**PREDEPLOYMENT_CALIB_COMMENT** = "Uncalibrated fluorescence from coloured dissolved organic matter sensor "

### 3.3.2 CDOM related parameters for the b-file and the merged file

The measurements of the CDOM concentration estimated with a fluorometer is considered as an ocean state variable and then will be stored in the merged file.

**PARAMETER** = "CDOM"

**PREDEPLOYMENT_CALIB_EQUATION** = "CDOM = (FLUORESCENCE_CDOM – DARK_CDOM) * SCALE_CDOM"

**PREDEPLOYMENT_CALIB_COEFFICIENT**=" SCALE_CDOM=0.0907, DARK_CDOM=51”

**PREDEPLOYMENT_CALIB_COMMENT**="No DARK_CDOM_O provided"

or

**PARAMETER** = "CDOM"

**PREDEPLOYMENT_CALIB_EQUATION** = "CDOM = (FLUORESCENCE_CDOM – DARK_CDOM_O) * SCALE_CDOM"

**PREDEPLOYMENT_CALIB_COEFFICIENT**=" SCALE_CDOM=0.0907, DARK_CDOM=51, DARK_CDOM_O=48”

**PREDEPLOYMENT_CALIB_COMMENT**=""

## 4 References


1. Bricaud, A., Morel, A., Prieur, L., 1981. Absorption by dissolved organic matter of the sea (yellow substance) in the UV and visible domains. Limnol. Oceanogr. 26 (1), 43–53.
2. Coble P.G. (1996). Characterization of marine and terrestrial DOM in seawater using excitation-emission matrix spectroscopy, Marine Chemistry, 51, 325-346.
3. ECO Fluorometers and Scattering Sensors Manual. eco170706-6 July 2017. http://www.seabird.com/sites/default/files/documents/manual-ECOMasterben.pdf
4. Mopper, K., Kieber, D.J., 2002. Photochemistry and cycling of carbon, sulfur, nitrogen and phosphorus. In: Hansell, D.A., Carlson, C.A. (Eds.), Biogeochemistry of Marine Dissolved Organic Matter. Academic, San Diego, Calif, pp. 455–507.
5. Nelson, N. B., and Gauglitz, J. M.: Optical signatures of dissolved organic matter transformation in the global ocean, Front. Mar. Sci., 2, 118, doi:10.3389/fmars.2015.00118, 2016.
6. Nelson, N.B., Siegel, D.A., 2013. The global distribution and dynamics of chromophoric dissolved organic matter. Annu. Rev. Mar. Sci. 5, 447–476.
7. Nelson, N.B., Siegel, D.A., Carlson, C.A., Swan, C.M., 2010. Tracing global biogeochemical cycles and meridional overtuning circulation using chromophoric dissolved organic matter. Geophys. Res. Lett. 37, L03610, http://dx.doi.org/10.1029/2009GL042325.
8. Organelli, E., Bricaud, A., Antoine, D., and Matsuoka, A.: Seasonal dynamics of light absorption by Chromophoric Dissolved Organic Matter (CDOM) in the NW Mediterranean Sea (BOUSSOLE site), Deep-Sea Res. Part I, 91, 72-85, 2014.
9. Organelli, E., Bricaud, A., Gentili, B., Antoine, D., and Vellucci, V.: Retrieval of Colored Detrital Matter (CDM) light absorption coefficients in the Mediterranean Sea using field and satellite ocean color radiometry: Evaluation of bio-optical inversion models, Remote Sens. Environ., 186, 297-310, doi:10.1016/j.rse.2016.08.028, 2016.
10. Organelli, E., Claustre, H., Bricaud, A., Barbieux, M., Uitz, J., D’Ortenzio, F., and Dall’Olmo, G.: Bio-optical anomalies in the world’s oceans: an investigation on the diffuse attenuation coefficients for downward irradiance derived from Biogeochemical Argo float measurements, J. Geophys. Res.: Oceans, 122, 3543-3564, doi:10.1002/2016JC012629, 2017.
11. Stedmon, C. A., and N. B. Nelson (2015), The optical properties of DOM in the ocean, in Biogeochemistry of Marine Dissolved Organic Matter, 2nd ed., edited by D. A. Hansell and C. A. Carlson, pp. 481–508, Academic, San Diego, Calif.
12. Steinberg, D.K., Nelson, N., Carlson, C.A., Prusak, A.C., 2004. Production of chromophoric dissolved organic matter (CDOM) in the open ocean by zooplankton and the colonial cyanobacterium Trichodesmium spp. Mar. Ecol. Prog. Ser. 267, 45–56.

13. Xing, X., Claustre, H., Wang, H., Poteau, A., D'Ortenzio, F., 2014. Seasonal dynamics in colored dissolved organic matter in the Mediterranean Sea: patterns and drivers. Deep Sea Res. Part I 83, 93–101.