Adjustment in real time (mode A) of the Coriolis Argo-O_2 floats ~~if no previous delayed-mode adjustment is available~~

Automatic procedure implemented at the Coriolis dac level

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Historic :

Date	Comment
Oct. 2020	Creation of the document
Jun. 2021	Evolution of the error propagation method (section 6)
Nov. 2021	Change scientific_equation_comment to be consistend with error propagation (memory lapse)
Jan. 2022	Add Method # 3 and reorganization of the document

I. Method # 1: Adjustment by comparison of in water float data to WOA based on PSAT or PPOX

Description of the method: gain estimated from the comparison between in water PSAT or PPOX from float and PSAT or PPOX from WOA climatology at most in the upper 20 dbar of the water column. WOA PPOX is computed from WOA PSAT and from TEMP and PSAL float data at the atmospheric pressure of 1 atm.

Coriolis procedure for the adjustment in real time of the ARGO-O2 floats

1. Scientific calibration equation

DOXY_ADJUSTED = DOXY .* G

G (gain factor) = median(gi)

with gi = (PPOX_woa/PPOX_DOXY_float)cycle i

PPOX_woa{PSAT_woa,TEMP_float,PSAL_float,Patm = 1atm}
PPOX_float{~~MOLAR_~~DOXY_float,TEMP_float,PSAL_float,Patm = 1atm}

N.B. As it is reported in the Argo Quality Control Manual For Dissolved Oxygen Concentration (Thierry, Bittig et al., 2018, http://dx.doi.org/10.13155/46542), DOXY_ADJUSTED = DOXY .* G is equivalent to PPOX_DOXY_ADJUSTED = G · PPOX_DOXY.

2. Parametrization

Climatology	WOA18 PSAT objectively analyzed mean
Climatology resolution	monthly
Climatology level	1 (depth = 0 m)

Profiles for G estimation: 5st ascending profiles from cycle 2 (and before cycle 20) with valid data and without :

- profiles in greylist
- profiles under ice
- profiles badly positioned

Raw data for PPOX_float: <DOXY> with QC flag different from 4,
<TEMP> with QC flag different from 3 and 4
<PSAL> with QC flag different from 4
<PRES> with QC flag different from 3 and 4
measured in the 10 first dbar (or 20 dbar is no available data)

Float data for PPOX_woa: <TEMP_ADJUSTED> and <PSAT_ADJUSTED> without QC 4 and measured in surface if sensor data mode is A or D.
<TEMP> without QC 4 and <PSAL> without QC 3 and 4 measured in surface if sensor data mode is R

3. O2 quantity conversion

O2 quantity is converted according to SCOR WG 142 recommendations (#RD5)

4. Go / No Go

Go / No Go threshold is equal to PPOX_ADJUSTED_ERROR, fixed at 10 mbar by default (cf. §6.).

Based on a internal study, we have decided to visualize all cycles for which

(1) Median Absolute Deviation > $MAD_{threshold}$ (=10 /ppox_woa_monthly)
(2) |median($PPOX\_clim_1$ – PPOX_adjusted)| > 10 in surface
(3) |median($PPOX\_clim_2$ – PPOX_adjusted)| > 10 in surface (if no data from $clim_1$)
(4) no data from $clim_1$ or $clim_2$ are available for comparison

Where $clim_1$ = the mapped O_2 product GlodapV2.2016b
$clim_2$ = the annual mapped O_2 product WOA18

These alerts are validated by comparison with GLODAPv2.2021 [Lauvset et al., 2021]. This "reference" data base should be completed with CARIMED (for Mediterranean sea) and "trusted" adjusted profiles (we should also define some criteria to decide how we select good floats and good profiles), and other regional data set of reference.

5. Gain application

Each validated gain is then propagated throughout the life of the float until <DOXY_ADJUSTED> parameter fails our internal adjustment quality test (cf. §III). ~~At that moment,~~ PI will be informed of the real-time adjustment of his float that he can (of course) contest by email return.

SCIENTIFIC_CALIB_EQUATION is filled with the common equation reported in the version 2.1 of the ARGO Oxygen quality control manual (#RD4)
SCIENTIFIC_CALIB_COMMENT is set according to Case 1_2 in DOXY_RT_adjustment Coriolis document.

A study will be carried out at the end of the first year to assess the relevance of each No GO and tools available to validate them.

6. Adjusted error

According to Thierry, Bittig et al. (2018), adjusted error is initially set up at 25mbar for AANDERAA OPTODE 3830, AANDERAA OPTODE 4330 regarding case 202_201_301, 202_204_#02, 202_205_#02 or 15 mbar for AANDERAA OPTODE 4330F regarding case 202_204_#03 and case 202_205_#03 or 10 mbar for other cases. The adjusted error ~~should be~~ is then propagated and converted into DOXY_ADJUSTED_ERROR like this :

PPOX_DOXY_ADJUSTED_ERROR = elast + 1 mbar year-1*(T – Tlast)
DOXY_ADJUSTED_ERROR =f(PPOX_DOXY_ADJUSTED_ERROR)

where T is the profile time, Tlast the time of the last profile with an adjustment, and elast the accuracy error estimate of this last profile.

II. Method # 3 : Adjustment based on last valid Delayed Mode adjustment

Description of the method: Adjustment information are provided by the last valid cycle with DM adjustment.

Coriolis procedure for the adjustment in real time of the ARGO-O2 floats

1. Scientific calibration equation

The scientific calibration equation is the common equation reported in the version 2.1 of the ARGO Oxygen quality control manual (#RD4).

PPOX_DOXY=f(DOXY)

PPOX_DOXY_ADJUSTED = (SLOPE *(1+DRIFT/100* profile_date_juld - launch_date_juld) /365) + INCLINE_T * TEMP)*(PPOX_DOXY + OFFSET)

DOXY_ADJUSTED=f(PPOX_DOXY_ADJUSTED)

Where the adjustment coefficients, SLOPE, DRIFT, INCLINE_T and OFFSET, are avalable in the SCIENTIFIC_CALIB_COEFFICIENT of the last DM.

In some cases, additional corrections beyond the common scientific equation could be recorded in the SCIENTIFIC_CALIB section by the expansion of the N_CALIB dimension. The SCIENTIFIC_CALIB_EQUATION stored by the PI is :

N_CALIB 1 DOXY1=DOXY*(1+C*PRES/1000)

N_CALIB 2 PPOX_DOXY = f(DOXY1);

PPOX_DOXY_ADJUSTED= (SLOPE*(1+DRIFT/100.

*(profile_date_juld-launch_date_juld)/365)+INCLINE_T *TEMP)*(PPOX_DOXY+OFFSET);

DOXY_ADJUSTED=f(PPOX_DOXY_ADJUSTED)

The sub method 3_2 takes into consideration the fine-tuning of the pressure correction coefficient as well.

Due to various reasons, SCIENTIFIC_CALIB_EQUATION could also be populated with equations that differ from the common equation reported just above. Nevertheless, the equations listed below are equivalent to the common scientific calibration equation if and only if OFFSET (or B) is equal to 0.

As we are not in a perfect world These equations are :

PPOX_ADJUSTED = OFFSET+(SLOPE*(1+DRIFT/100*(profile_date_juld-launch_date_juld) / 365)+INCLINE_T *TEMP)*PPOX

PSAT_ADJUSTED=A*PSAT+B

PPOX_ADJUSTED=A*PPOX+B

PPOX_ADJUSTED=OFFSET+(PPOX*SLOPE)*(1+DRIFT/100* (profile_date_juld-launch_date_juld)/365.)

2. Parametrization

- The last DM is defined as the ascending profile in delayed mode with the highest cycle_number.
- Last <DOXY> DM with PROFIL_DOXY_QC different from 'F'
- Except for SLOPE, mandatory coefficients are fixed to 0 by default.

3. O2 quantity conversion

O2 quantity is converted according to SCOR WG 142 recommendations (#RD5)

4. Go/No Go

Profiles are adjusted (GO) in real time using information provided by the last cycle in DM if :

- The quality of the last cycle differs from 'F'
- Equation filled in SCIENTIFIC_CALIB_EQUATION matches with conditions summarized in §II – 1
- Information filled in N_prof of SCIENTIFIC_CALIB_EQUATION and SCIENTIFIC_CALIB_COEFFICIENT are identical.
- SLOPE (or A) coefficient (cf. §II - 1) is filled in SCIENTIFIC_CALIB_COEFFICIENT.

5. Coefficient application

Coefficients for adjustment are then propagated throughout the life of the float until <DOXY_ADJUSTED> parameter fails our internal adjustment quality test (cf. §III). PI will be informed of the real-time adjustment of his float that he can (of course) contest by email return.

SCIENTIFIC_CALIB_EQUATION is filled with the common equation reported in the version 2.1 of the ARGO Oxygen quality control manual (#RD4). For Case 3_2_2, this equation is preceded by :

DOXY_COR_PRES=DOXY*(1+DO_COR_PRES*PRES/100)
PPOX_DOXY=f(DOXY_COR_PRES)

Where DO_COR_PRES (= C above) correspond to the fine-tuning of the pressure correction coefficient.

SCIENTIFIC_CALIB_COMMENT is set according to Case 3_2 or Case 3_2_2 in DOXY_RT_adjustment Coriolis document.

6. Adjusted error

The adjusted error is propagated and converted into DOXY_ADJUSTED_ERROR like this :

PPOX_DOXY_ADJUSTED_ERROR = elast + 1 mbar year-1*(T – Tlast)
DOXY_ADJUSTED_ERROR =f(PPOX_DOXY_ADJUSTED_ERROR)

where T is the profile time, Tlast and elast are respectively the time and the highest accuracy error of the last DM cycle used to get real time adjustment coefficients. If ppox_adjusted_error is empty, then we use the default value 5mbar.

III. Quality of the RT adjustment over time

A test checking the quality of the real time adjustment has been set up in the framework of the Copernicus Marine Service and in collaboration with Coriolis expert, all alerts are scrutinized. A message is sent to PI (and/or DM operator) when its floats fail the adjustment quality test n cycles. To be confident with the O_2 quality on the GDAC, the float should push into the grey list when it fails the adjustment quality test n*2 cycles.

1. Description of the adjustment quality test

adjusted_gain = PPOX_WOA18_monthly / PPOX_DOXY_ADJUSTED
ERROR = (1-adjusted_gain).* PPOX_WOA18_monthly

Test is failed if ERROR > PPOX_DOXY_ADJUSTED_ERROR of float (cf. §6 for each previous session).

2. Parametrization

An Alert is sent if float fails the test n=10 cycles.

IV. REFERENCE

Lauvset, S. K., Lange, N., Tanhua, T., Bittig, H. C., Olsen, A. C., Kozyr, A., Àlvarez, M., Becker, S., Brown, P. J., Carter, B. R., Cotrim da Cunha, L., Feely, R. A., van Heuven, S., Hoppema, M., Ishii, M., Jeansson, E., Jutterström, S., Jones, S. D., Karlsen, M. K., Lo Monaco, C., Michaelis, P., Murata, A., Pérez, F. F., Pfeil, B., Schirnick, C., Steinfeldt, R., Suzuki, T., Tilbrook, B., Velo, A., Wanninkhof, R., Woosley, R. J., and Key, R. M.: An updated version of the global interior ocean biogeochemical data product, GLODAPv2.2021, Earth Syst. Sci. Data Discuss., 2021, 1-32. doi:10.5194/essd 2021 234. 2021.Lauvset