SUPPORTING INFORMATION A

The BGC-Argo database used in this paper relies on *in vivo* chlorophyll fluorescence measurements as a proxy for the chlorophyll *a* concentration (Chl*a*). The calibration of the chlorophyll fluorescence signal into Chl*a* is challenging because the fluorescence-to-chlorophyll ratio shows large variability (*Falkowski and Kiefer*, 1985) depending on several factors, including sensor characteristics as well as environmental conditions and biology (e.g. phytoplankton photophysiology, taxonomic composition) (*Cleveland et al.*, 1989; *Geider et al.*, 1997; *Dubinsky and Stambler*, 2009). Despite those limitations, *in vivo* fluorescence represents an easy, cost-effective way for measuring Chl*a*. It can be measured over broad ranges of space and temporal scales from small fluorometers installed on a variety of platforms such as BGC-Argo floats.

The advent and increasing use of BGC-Argo floats led the community to develop standard procedures, recognized at an international level, to be applied for the calibration and qualification of the bio-optical proxies measured by the floats (*Schmechtig et al.*, 2014, 2016). Recently, however, *Roesler et al.* (2017) have reported a systematic overestimation in the calibrated Chl*a* values derived from WET Labs ECO-series sensors (i.e. identical to those installed on BGC-Argo floats), and recommended a correction factor of 2 to be applied globally at the user level. This recommendation was based on the analysis of a match-up database of HPLC Chl*a* determinations and calibrated *in situ* fluorescence observations from WET Labs ECO fluorometers. Their results were further supported by comparisons of calibrated fluorescence observations with Chl*a* values derived from other techniques, e.g. radiometric measurements (*Xing et al.*, 2011), light absorption line height (*Roesler and Barnard*, 2013), experiments on algal cultures.

The study of *Roesler et al.* (2017), deals with two distinct issues that have to be independently considered. On the one hand, the global correction factor of 2 addresses an instrumental bias and allows a better correction of the WET Labs ECO-series fluorometers. On the other hand, this correction factor may vary regionally as a result of natural variations in the fluorescence-to-chlorophyll ratio. *Roesler et al.* (2017) proposed regional correction factors from the analysis of the database of paired HPLC-determined Chl*a* measurements and calibrated *in situ* chlorophyll fluorescence observations. The regional factors were computed for 10 of the *Longhurst* (2006) biogeographic regions where data were available. In addition, for 16 Longhurst's regions where BGC-Argo floats collected radiometric data, the authors computed regional correction factors based on a comparison of the Chl*a* values obtained from the fluorescence observations calibrated using either the standard procedure or the "radiometric" calibration method of *Xing et al.* (2011). In brief, this method is based on a bio-optical relationship that links the Chl*a* values to the diffuse light attenuation coefficient (K_d) as derived from the downwelling irradiance (E_d) measurements acquired by BGC-Argo floats (*Morel et al.*, 2007a).

First, we looked at the impact of these different regional correction factors on the distribution of the computed errors in the b_{bp}-to-Chl*a* ratio. We analysed the relative error in the b_{bp}-to-Chl*a* ratio computed following the method described in Section 2.2.3 of the manuscript using the global as well as the regional HPLC- and radiometry-based correction factors (Figure A1). The results suggest similar distribution of the b_{bp}-to-Chl*a* relative errors regardless of the factor applied to correct the Chl*a* values at a statistical significance level of 0.01.

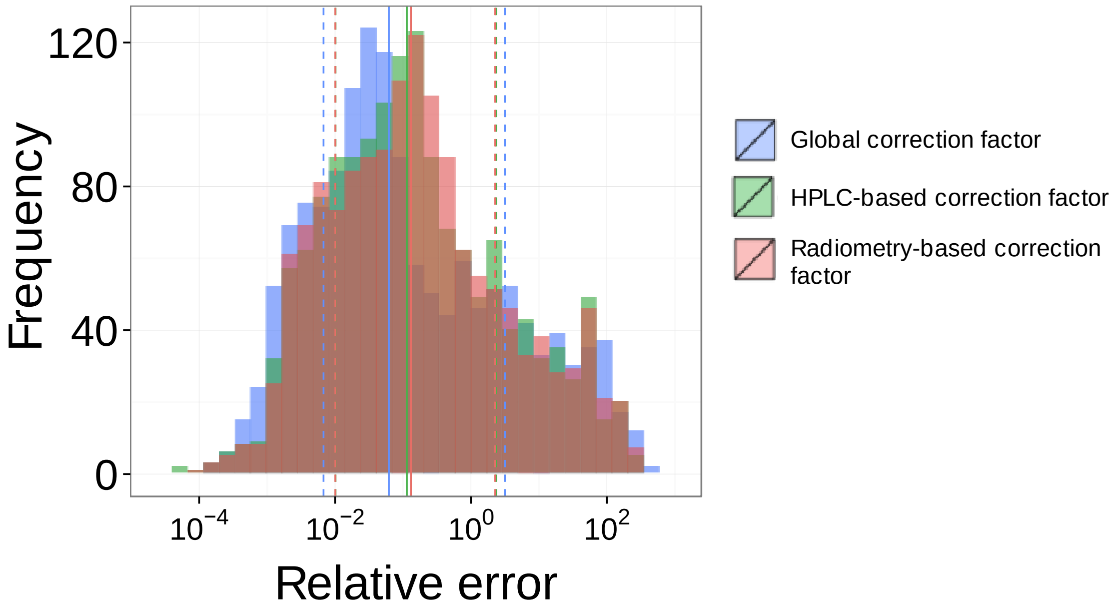

Figure A1: *Histogram of the distribution of the relative error in the* b_{bp}*-to-Chla ratio for the 0-*Z_{pd} *layer; the plain lines indicate the median error and dotted lines the 20% and 80% quantile.*

It appears that correcting the fluorescence-based Chl*a* values of the database with regional factors compared to a global factor does not significantly affect the distribution of the computed errors in the b_{bp}-to-Chl*a* ratio.

Second, we performed an analysis of the sensitivity of the b_{bp}-to-Chl*a* relationship to *Roesler et al.* (2017) regional correction factors. At a regional scale, we tested the influence of applying the regional HPLC- and radiometry-derived correction factors, compared to the global factor of 2, on the variability of the b_{bp}-to-Chl*a* ratio. The regional HPLC-based factors are available for four regions of our database: Icelandic Basin of North Atlantic Subpolar Gyre (ICB_NASPG), Indian Sector of the Southern Ocean (IND_SO), North-western Mediterranean Sea (NW_MED) and Levantine Sea (LEV_MED). Those factors were, respectively, 2.6±0.78, 3.46±0.35, 1.62±0.28 and 1.72±0.23. The radiometry-based factors for the same regions were, respectively, 2.49±0.31, 4.13±0.65, 1.47±0.12 and 1.80±0.11. In the

ICB_NASPG and IND_SO, the Chl*a* values are underestimated when the global factor of 2 is applied compared to the regional factors (>2). In contrast, the Chl*a* is overestimated in the NW and the LEV_MED. Figure A2 shows the seasonal variability of the b_{bp}-to-Chl*a* ratio with the Chl*a* originating from the global correction factor or from the regional HPLC- or radiometry-based factors. Because the regional factors are constant over a given region, our regional interpretation of the b_{bp}-to-Chl*a* ratio seasonal variations remains essentially unchanged (Figure A2).

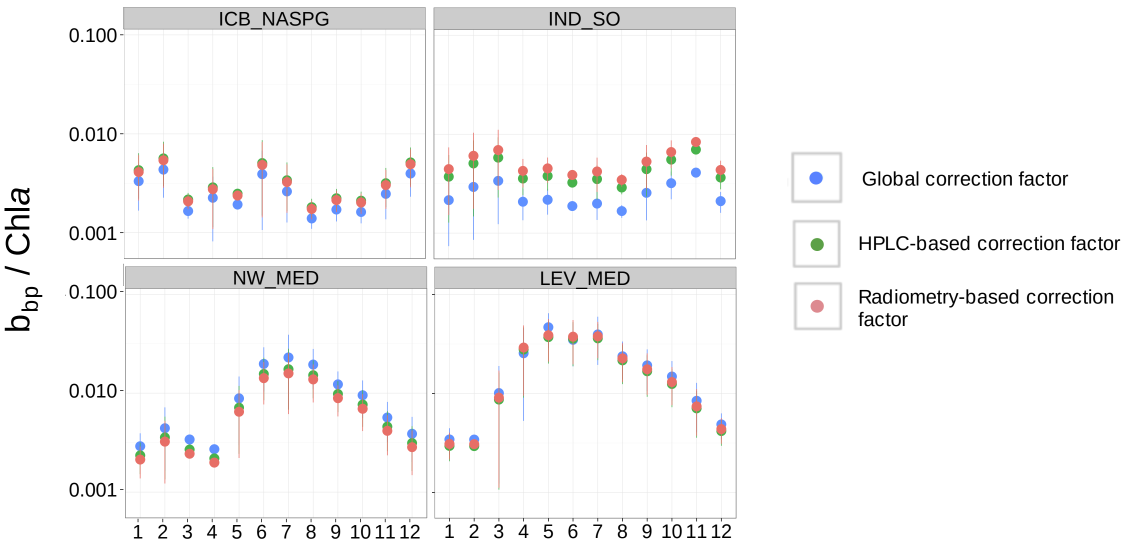

Figure A2: *Monthly climatology of the b_{bp}-to-Chla ratio within the surface layer (0-Z_{pd}) for the four regions where regional HPLC- and radiometry-derived correction factors are available.*

At a global scale, we examined the impact on the b_{bp}-to-Chl*a* relationships in the different layers of the water column, of the application of the global factor of 2 *versus* the regional radiometry-based factors. This global-scale analysis has been conducted using the radiometry-based factors that were available for 20 of the 24 regions of our BGC-Argo database. It could not be performed with the HPLC-based factors, available for only 4 regions of our database. The results are presented in Figure A3 and Table A1; Figure A3 is similar to Figure 3 of the manuscript but uses the regional radiometry-based factors instead of the global factor of 2. The radiometry-derived correction factors do not significantly alter the b_{bp}-to-

Chl*a* relationship in the different layers of the water column as suggested by the results of a significance test (mentioned in Table A1). The most noticeable change shown in Figure A3, compared to Figure 3 of the manuscript, is observed for the Southern Ocean. This region of the global ocean has been reported to have an atypical bio-optical status (*Organelli et al.*, 2017a), so that the regional radiometry-derived factors may be questionable. The Southern Ocean is also the largest High Nutrient Low Chlorophyll (HNLC) region of the global ocean, with large spatio-temporal variability in iron stress (e.g., *Boyd et al.*, 2000; *Blain et al.*, 2007). The potential impact of iron limitation on the fluorescence-to-chlorophyll ratio (*Behrenfeld et al.,* 2006) should be investigated further in the Southern Ocean and in other HLNC regions such as the Subequatorial or North Pacific.

For the other regions of our database, the trend and scattering of the data points observed for the different layers of the water column remain similar regardless of the considered global or regional correction factors. The statistical indices R^2 and RMSE are only slightly modified and the slopes and intercepts of the b_{bp}-to-Chl*a* relationships remain almost identical (see Table A1).

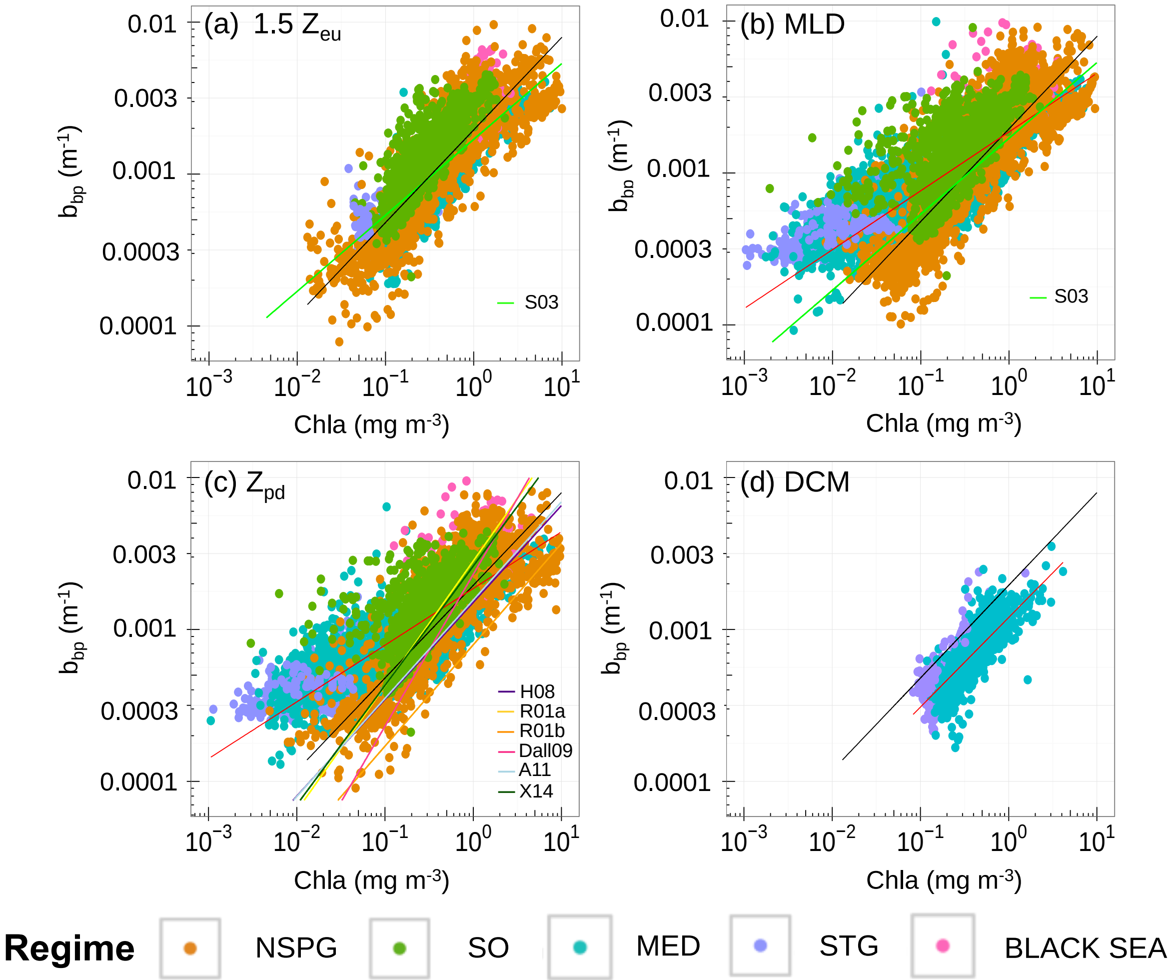

Figure A3: *Log-log scatterplot of the particulate backscattering coefficient at 700 nm (b_{bp}) as a function of the chlorophyll a concentration (Chla) corrected using the regional radiometry-derived factors of Roesler et al. (2017) within (a) the productive layer comprised between the surface and 1.5 Z_{eu}; (b) the mixed layer; (c) the surface (0-Z_{pd}) layer and (d) the DCM layer. The color code indicates the regime where the BGC-Argo data were collected. For each plot, the black line represents the relationship calculated over the productive layer (0-1.5 Z_{eu}) while the red line represents the regression model calculated over the considered layer.*

Table A1. Comparison of the coefficient of determination R^2, Root Mean Squared Error (RMSE), intercept and slope associated to the b_{bp}-to-Chl*a* relationships with the Chl*a* values resulting from the application of either the global correction factor of 2 or the regional radiometry-derived factors of *Roesler et al.* [2017].
The relationships are not statistically different at a significance level of 0.05 (Wilcoxon test).

Water column layer	Statistical index	Relationship obtained with the global factor of 2	Relationship obtained with the regional radiometry-based factors
0- Z_{pd}	Intercept	0.00174	0.00186
	Slope	0.36	0.373
	RMSE	0.000942	0.000921
	R^2	0.6311	0.6485
0- MLD	Intercept	0.00171	0.00186
	Slope	0.373	0.387
	RMSE	0.000932	0.000969
	R^2	0.6167	0.6339
DCM	Intercept	0.00147	0.00119
	Slope	0.753	0.5894
	RMSE	0.00104	0.000184
	R^2	0.5667	0.7061
0- 1.5 Z_{eu}	Intercept	0.00181	0.00195
	Slope	0.605	0.61
	RMSE	0.000967	0.000781
	R^2	0.7443	0.7399

Finally, our analysis indicates that the choice of the correction factor induces minor changes to the b_{bp}-to-Chl*a* relationship and little impact on the interpretation of our results. It also has to be noted that regional HPLC- or radiometry-based correction factors shows some limitations. The regional HPLC-based correction factors, which are potentially the most robust, are for example, not available for, and therefore cannot be applied to all the regions of our BGC-Argo database. BGC-Argo profiling floats sample the water column autonomously, over long time periods and across different environments, likely impacting the fluorescence-to-Chl*a* relationship. HPLC-based calibration established at the time of float's deployment, might be therefore less accurate over the float's lifetime. In contrast, the regional radiometry-based correction factors may be applied to any BGC-Argo data provided that downwelling irradiance measurements are available. However, they rely on a general empirical relationship (*Morel et al.* 2007) that has been established for the surface layer only and, more critically, implies that all of the world's open ocean regions show analogous bio-optical behaviour, which is known not to be the case (e.g., *Organelli et al.*, 2017a). Therefore, the two sets of regional HPLC- and radiometry-based correction factors proposed by *Roesler et al.* (2017) provide a strong basis for examining the impact of the correction factor and of the natural variability in the fluorescence-to-chlorophyll ratio on the results of our analysis. They nevertheless suffer from the above limitation and thus deserve to be addressed more thoroughly, especially by the collection of additional (HPLC) data set. Yet, at this stage, we believe that the global correction factor is the most relevant for the present dataset.

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