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# *Interactive comment on* "The seasonal cycle of $\delta^{13}C_{DIC}$ in the North Atlantic Subpolar Gyre" *by* V. Racapé et al.

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Anonymous Referee #2 Received and published: 20 October 2013

REFEREE: This paper presents new 13C data set in subpolar Atlantic region, bringing new information about recent d13C temporal variation in this region with both seasonal and interannual scales. I think the final conclusions deduced from the observed data are almost true, but method of data analysis, at least description of that, contains many inaccuracy and sloppiness. I recommend the Author to make substantial revision for this manuscript, paying more attention to input enough information so that the reader can understand what the authors actually did. specific commnets:

[1]about formulation of Dd13Cbio(W-S) First of all, I believe that the equation (2) ap-



peared in this manuscript has mistype. This equation should, at least, be as follows: Dd13Cbio(W-S) = r(c:n) x dC13org(S) x [NO3(S)-NO3(W)]/DIC(s) x d13Ccarb [Alk(s)-Alk(w) + NO3(S)-NO3(W)]/2DIC(s) [eq.A] Second, when based on the original equation of Dd13Cbio in Gruber [1999], the above equation should be as follows: Dd13Cbio(W-S) = d13C x [C*(s)-DIC(s)]/C*(s) +r(c:n) x dC13org(S) x [NO3(S)- NO3(W)]/DIC(s) x d13Ccarb [Alk(s)-Alk(w) + NO3(S)-NO3(W)]/2DIC(s) [eq.B] Eq.[B] can be approximated to Eq.[A] only when C*(s) nearly equals to DIC(s). The author should specify that they made this assumption, if they actually adopt Eq. [A]. However, I doubt validity of this assumption. As C*(s) nearly equals to DIC(w) in this case, the value of the first term in the right side of Eq.[b] becomes around 0.02 (i.e., 1.0 x [2150-2100]/2150 ) when using the data read from Fig. 2. This value is roughly same order of d13Cphy(W-S) for "climatological seasonal cycle" in Table 2. In another words, the author's estimation of d13Cphy(W-S) in Table 2 is biased, to a greater or lesser, by the author's assumption in choosing Eq.[A] instead of Eq.[B].

RESPONSE: You are totally right. There was an informatic typo that I couldn't see before publication. The good equation send to BGD is

$\Delta\delta$13Cbio(w to s) = [ $\delta$13Corg * rc:n * $\Delta$NO3 / DICs ] + [ $\delta$13Ccarb * ($\Delta$Alk + $\Delta$NO3) / 2DIC ]

Instead of

$\Delta\delta$13Cbio(w to s) = [ $\delta$13Corg * rc:n * $\Delta$NO3 / (DICs + $\delta$13Ccarb) ] * ($\Delta$Alk + $\Delta$NO3) / 2DIC

In more detail, we have:

[$\Delta$DIC]w to s = [$\Delta$DICbio]w to s + [$\Delta$DICphy]w to s

[$\Delta$DIC($\delta$13CDIC)]w to s = [$\Delta$DICbio($\delta$13Cbio)]w to s + [$\Delta$DICphy($\delta$13Cphy)]w to s

We can express this as,

$\delta$13CDIC(s) = (DICw / DICs) * $\delta$13CDIC(w) + ( [$\Delta$DICbio($\delta$13Cbio)]w to s / DICs ) + ( [$\Delta$DICphy($\delta$13Cphy)]w to s / DICs )

Where,

[$\Delta$DICbio($\delta$13Cbio)]w to s / DICs = $\Delta\delta$13Cbio(w to s) , biological processes contribution

[$\Delta$DICphy($\delta$13Cphy)]w to s / DICs = $\Delta\delta$13Cphy(w to s) , physical processes contribution

As

$\Delta$DICbio ($\Delta\delta$13Cbio) = $\Delta$DICorg ($\delta$13Corg) + $\Delta$DICcarb ($\delta$13Ccarb)

We have :

$\Delta\delta$13Cbio(w to s) = [ $\delta$13Corg * rc:n * $\Delta$NO3 / DICs ] + [ $\delta$13Ccarb * ($\Delta$Alk + $\Delta$NO3) / 2DIC ]

$\Delta\delta$13Cphy(w to s) = $\delta$13CDICs – ( $\delta$13CDICw * DICw / DICs + $\Delta\delta$13Cbio(w to s) )

Winter to summer DIC change due to both physical and biological processes (up to 100 $\mu$mol kg-1) are lower than mean DIC concentration observed in surface water of this region (between 2050 and 2150 $\mu$mol kg-1) so much so that DICw/DICs is close to 1.

The last equation and sentences will complement the manuscript.

REFEREE [2]Section 3.1 The authors claim in this section that d13C decreases from 2005-2006 to 2010-2012 while DIC increases during this period. However, I find difficulty to detect this signal from Fig.2, especially in the case of DIC. In addition, I cannot decide this DIC increase signal to the anthropogenic effect, because DIC can also increase only if SSS has been increased during this period. I thus recommend the authors to change Fig.2 to show temporal variation of NDIC instead of DIC, or add graphs of salinity temporal variation.



RESPONSE: Fig. 2 has been revised considering your comments and those from the first referee. 1) We have replaced the arrow by a box to show the selected region. 2) We have changed the picture order to make them easier to comprehend (as DIC increase) 3) We have added a graph of salinity temporal variation to inform about a potential natural impact on DIC increase. As salinity was not measured in April 2006, we have a preference for this graph (salinity alone) instead of normalized DIC graph which has been however included in table 1 in order to have all available information.

To conclude, we agree with you on the DIC increase signal which could be attributed to SSS change. This information has been included in the text, especially in section 3.1 and 3.2.

REFEREE [3] Section 3.2 Here the authors show that the d13C-DIC relationship has same slope in both period of 2005-2006 and 2010-2012, introducing the results of "t-test". However, t-test can only say that "we cannot say that two slopes are different." Indeed, the similarity of two slopes have important information. It means that there is little physical effect to both the DIC and d13C temporal variation, and that there is little change in r(c:n) during this relatively short perod. I thus want to distinguish whether the obtained slopes are truly same with high precision, or simply we cannot say about the difference due to the large error bar. We can distinguish these two if you directly show the error bar of each slope estimation in Eqs. (4) and (5).

RESPONSE: For Eqs. (4) and (5), error bar associated to the two slopes are close to 3*10-4 ‰($\mu$mol/kg). Considering the comments of the second referee, we have estimated 2 additional linear regressions for the following periods: From July 2005 to June 2006 and from Aug. 2010 to March 2011, reported here:

(1) From July 2005 to June 2006, $\delta$13CDIC=-0.0108*[DIC]+24.10 ($r^2$=0.94, error slope= 3.3*10-4) (2) From Aug. 2010 to March 2011, $\delta$13CDIC=-0.0074*[DIC]+16.6 ($r^2$=0.94, error slope= 3.1*10-4) (3) From March 2011 to Sept. 2012 $\delta$13CDIC=-0.0108*[DIC]+23.81 (Eq. 5 in the first version of tour manuscript), ($r^2$=0.95, error slope=

2.9*10-4)

There is no significant difference between the slopes of regression (1) and (3) according to t-test and slope error. As a result, the slope of Eq (2) is significantly different from the other two and suggests that additional mechanisms also contribute to DIC and $\delta$13CDIC distributions, thus changing their relationship.

REFEREE #p14522, l23: "higher DI13C" =>"lower DI13C" ? RESPONSE: it is a typo, we have removed higer DI13C by higher DI12C.

REFEREE[4]Section 3.3 I feel that many passages of this section is ambiguous. Please polish the sentence to make the authors' argument clear. RESPONSE: We have presented all the hypotheses done to explain the relationship observed during these 3 periods (2005-2006, Aug. 2010-March 2011, and March 2011-Sept 2012) and rewritten the sentence.

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Interactive comment on Biogeosciences Discuss., 10, 14515, 2013.