Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2019-338-RC1, 2019

Biogeosciences Discussions
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EGU

Interactive comment on "Physical drivers of the nitrate seasonal variability in the Atlantic cold tongue" *by* Marie-Hélène Radenac et al.

Anonymous Referee #1

Received and published: 15 November 2019

This paper examines the physical processes that influence the nitrate seasonal cycle in the equatorial Atlantic cold tongue region using observations (PIRATA/EGEE cruise and PIRATA mooring data) and a numerical model (NEMO + PISCES run for the tropical Atlantic). The biogeochemical results are very interesting to this physical oceanographer, and the paper reads very nicely and is well organized. In particular, I found the results about the role of vertical processes in controlling the seasonal evolution and spatial distribution of nitrate and the interplay between the low frequency advection and advection due to tropical instability waves and eddies most fascinating. The results presented here are important and with some minor revisions this paper will be suitable for publication.

Abstract: The abstract text about the different role of horizontal advection (extends and

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shapes the bloom off equator, brings nitrate low water below mixed layer, EUC brings low-nitrate water but still rich enough) on lines 19-23 seems a little contradictory and some wordsmithing could be applied to make clear the competing roles of zonal and horizontal advection. In contrast, the description of vertical advection and diffusion were clear.

Figure 1. Possibly enlarge Figure 1 and/or make SST contours darker/thicker so that they are easier to read.

Line 49: Suggest “1960s, as well as satellite measurements since the 1980s” instead of “60s and satellite measurements”

Line 79 (and elsewhere): Suggest acronym “TIWs” instead of “TIW”

Line 83: It is important to note here or elsewhere in the paper that TIWs exhibit seasonal variability similar to the nutrient seasonal cycle (specifically they are present with peak variance in May-July and sometimes re-emerge and there is a secondary peak in variance in the fall). This is in response to seasonal changes in the winds and the background circulation (which is drive the low-frequency vertical advection signal) but might also be contributing to the eddy vertical advection signal. Might be good to cite a study or two that shows evidence of this reemergence of TIWs in the tropical Atlantic (Caltabiano et al. 2005 OS, Athie and Marin, 2007 JGR; Perez et al. 2019 JGR, . . .)

Line 85 (and elsewhere): wording “low productive and productive seasons” is unclear, and you could perhaps switch the order or use something like “low productivity and high productivity seasons”

Line 90: Here do you mean “equatorial upwelling” instead of “equatorial divergence” since you are specifically referring to vertical processes in the parentheses?

Line 133-134: Perhaps indicate here or in Table 1 which years you include in the “low productive”/”no upwelling” averages and the “productive”/”upwelling” averages for Figure 2a-c. Are they cruise transect composites for years which productive vs. not pro-

ductive but in the same season?

Line 135: Suggest “1970s and 1980s” instead of “70s and 80s”

Line 181: Suggest “three-dimensional” instead of “three-dimension”

Line 192: The second term on the right hand side in equation (2) is just the eddy part of the advection rather than the residual (sum of three terms involving an eddy term) that you describe using in the text.

Line 196: Suggest “residual” instead of “residue”

Line 202: Please identify which term in equation 1 corresponds to the “entrainment term” either on this line, or earlier in the discussion of equation 1 terms.

Line 224: “Too elevated” reads awkwardly. Please consider rewording.

Figure 4: Panel e makes it easier to compare Z20 and ZEUC between model and observations. Could a similar line plot be used to compare depth of the nitracline and DCM between model during the “no upwelling season”? It could be a panel f and fill the white space.

Line 261: There is compensation between zonal and meridional advection. Question: Which term wins and during which time of year? Which term is most responsible for bringing nitrate low waters to the cold tongue area, presumably zonal advection?

Line 281. In December, is the compensation between meridional and zonal advection different than in July? How do they contribute to the secondary maxima?

Line 310 Suggest “as an interplay” instead of “as interplays”

Line 331: Don’t you mean zonal advection (rather than horizontal advection) removes nitrate all year long? Meridional advection seems to add nitrate in the mixed layer, at least in Figure 7e. You do say this later, but the statement on line 331 is in conflict with that.

Line 322-340: Some of Figure 7 labels are shifted (e.g., Fig. 7c instead of Fig. 7d) in the text in these 2 paragraphs.

Lines 358, 360. Two sentences begin with “Its” and “It” and I’m not 100% whether “It” means the EUC or nitrate concentrations or something else.

Line 447-449: The sentence beginning with “Although. . .” is a bit unclear as written.

General question that pertains to the last two sections in the text: How strong or realistic are the TIWs in the model? In the real ocean, do you think the eddy contribution to advection will be basically the same as what you found in the model?

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