Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2019-340-RC1, 2019

Biogeosciences Discussions
Open Access
EGU

Interactive comment on "A New Characterization of the Upper Waters of the central Gulf of México based on Water Mass Hydrographic and Biogeochemical Characteristics" *by* Gabriela Yareli Cervantes-Diaz et al.

Anonymous Referee #1

Received and published: 12 October 2019

General Comment Based on hydrographic and biogeochemical measurement obtained during five oceanographic cruises, this article proposes a redefinition of water masses over the upper ocean in the central Gulf of Mexico. A new water mass for the most surface layer that considers the effects of fresh water from precipitation and river runoffs is introduced. The data sets used in this research are interesting, as they captured the seasonal variability in hydrographic and biogeochemical properties over the Loop Current (LC), anticyclonic mesoscale eddies that separated from the LC, and cyclonic mesoscale circulations such as the Bay of Campeche Cyclone, and some frontal LC

Printer-friendly version

Discussion paper

cyclones. The attempt to eliminate overlaps between some of the water masses, and the introduction of the new surface water mass, is appreciated. However, the justification on the need to change the conventional ranges for the gulf's water masses is not convincing, and the way the water masses were defined is weak. Below, I am including a number of scientific issues that need to be addressed for making a more convincing case, and for improving the presentation and readability of the manuscript.

Specific Comments 1. The definition of water mass FISW does not satisfy conventional approaches to name the body of water and delineate its properties. a) Note that a water mass is defined as a body of water with a common formation history. Given that 'FISW' is under the continuous action of highly dynamic and variable forcing (wind stress, insolation, air-sea fluxes, precipitation, and mesoscale eddy dynamics), is it possible to attribute a common formation history to this body of water? b) Since the name of the water mass usually relates to its major area of residence, the name FISW is not appropriate for this potentially new water mass. c) A water mass is often found in regions well beyond its formation region. Is this condition satisfied in the case of FISW? I do not think so. This condition is difficult to be verified. d) A water mass can be identified away from its formation region because its elements retain its properties, in particular its potential temperature and salinity. Given that FISW extends over surfaces waters where irreversible vertical mixing is continuously changing the temperature of the body of water (diabatic turbulent process), temperature is not a conservative property over these surface body of water. Note that classical water masses that form in the surface usually sink into deeper waters away from surface forcing, which allows them to retain its original properties for long periods of time over grate distances. e) In order to accurately define a water mass, it is necessary to include information about its standard deviation; some water masses only require a single combination of T-S and its standard deviation, while delineating other water masses may require defining a T-S relationship and an envelope for the standard deviation. This requirement must be satisfied in the definition of FISW (no information is given about its standard deviation). Is its standard deviation small enough?

Printer-friendly version

Discussion paper

2. The definitions of water masses presented here need to be compared against historic definitions that are well established in the scientific community. Modifying table 2, and creating a new figure showing the different ranges of the water masses reported in the literature, will help in evaluating whether we need a new definition of the Gulf's water masses.

3. Why is the overlap between CSW and GCW a big deal? There is always a transition region between water masses in every ocean (that is why we need a standard deviation in trying to isolate the dominant characteristics of the water mass). In order to justify the idea that we need to get rid of this overlap, this manuscript needs to quantify the error related to the conventional and new definitions, including a quantification of the effects on the density field. Are these errors significant, or are both at the noise level? If errors from both definitions are at the noise level, no new definition is needed. The manuscript is missing an in-depth review of the-state-of-the-art on the formation of GCW.

4. It is not clear how the LC cycle can be used to eliminate the overlap between CSW and GCW since the LC does not transport GCW. This is an important issue in the approach presented here. Also note that Caribbean anticyclones can also make it into the Gulf transporting CSW. Moreover, atmospheric forcing could erase the CSW signature in winter over the Gulf. Some misleading statements regarding this issue are: a) This explanations in 455-459 and 553-554 are convoluted. Since the LC does not transport GCW (water mass originated in the GoM), and the CSW is presumably only found in the LC, how the CSW ends up on top of GCW? Something does not make sense here. b) Too much emphasize is put on the idea that the "weakening" of the LC is associated with the absence of CSW in the GoM(423). However, previous studies (cited in the present article) claim that the absence of CSW is becasue this water is continuously transformed in the GoM by wind forcing. Since the latter idea weakens the hypothesis that the LC cycle can be used in dealing with the overlap between CSW and GCW, this issue needs to be addressed in detail. Is CSW absent

Printer-friendly version

Discussion paper

in winter in both the GoM and Caribbean Sea? If it is missing also over the Caribbean Sea, then atmospheric processes control the variability of this water mass over both the Gul and the area of formation. c) In lines 428-430 it is claimed that there is a salinity contribution to CSW in the GoM. Is not supposed that CSW acquires its distinctive high salinity values over the Caribbean Sea? A local addition of salinity within the GoM is against the conventional definition of water mass.

5. I understand that water masses formed at the surface at higher latitudes retain its DO because they sink and move away from regions of intense atmospheric forcing. However, in the case of water masses that remain in the surface, is it valid to use DO for characterizing their properties? I am not sure about this, since intense vertical mixing acting over these bodies of water makes them diabatic (their properties are non-conservative). Note that DO is a function of temperature, and temperature is non-conservative in water parcels over the ocean mixed layer and upper thermocline. Also note that the LC cycle is not needed to have the variability in DO documented here (562-564). It needs to be shown the variability in DO is not caused by atmospheric forcing in surface water masses; otherwise, it cannot be used in characterizing surface water masses.

6. An important analysis and methodology for redefining the water mases are given in Fig. 4 and appendix A. These approaches can be significantly simplified by satisfying the conditions listed in item 1 above; using the standard deviation can be particularly helpful.

7. What are the source of nitrite and DIC contained in FISW? Is the seasonal variability in these properties related to vertical mixing (and cooling of the sea surface), since these two chemicals depend on temperature? Because these properties reflect the dynamic and variable characteristics of surface waters (409-412), can they be used in delineating water masses? They are clearly impacted by the seasonal cycle of insolation and vertical mixing over the upper ocean, and likely also by local biogeochemical processes.

Printer-friendly version

Discussion paper

8. Where is the analysis of the Brunt-Vaisala frequency (345-247) being shown? Rather than buoyancy alone, it is the criticality of the Richardson number (Ri<1/4) that is used to identify periods of vertical mixing. In addition to the buoyancy frequency, measurements of horizontal current vertical shear are also needed in the computation of Ri.

9. Another possibility for explaining the seasonal change in the nutricline and carbocline (387-390), is that these properties are a function of the seasonal cycle of the wind stress and insolation since these properties clearly are a function of temperature as per Fig. 8.

10. The vertical exchange of chemical properties between water masses discussed in 484-486 can occur by diffusion (very low time scale), or by diapycnal mixing that requires vertical mixing and water mass transformation. What is the more likely mechanism for explaining this conundrum? Again, the introduction is needs an in-depth discussion on the formation of GCW.

11. Note that the Mississippi River plume (508-510) also extends southward into the LC and associated eddy field; this plume can also leave the GoM through the Florida Straits. This topic needs a review of the state-of-the-art, since river runoff can be an important contribution to FISW.

Technical Comments 1. The article is too long, which makes difficult to finish reading it. Maybe it should be divided in two parts (assuming that the specific comments listed above are addressed satisfactorily), one for the definition of water masses, and another for the discussion of the effects of the water masses on biogeochemical properties. This should also take care of the too long discussion section.

2. A substantial review of English grammar is needed; there are too many sentences that need revision as to be listed here.

3. line 122: Do you mean surface waters in the interior GoM?

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2019-340, 2019.

Printer-friendly version

Discussion paper