Comment on bg-2021-269
Anonymous Referee #3

Referee comment on "Wintertime process study of the North Brazil Current rings reveals the region as a larger sink for CO₂ than expected" by Léa Olivier et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-269-RC1, 2022

Overview

The authors conduct a case study on the air–sea flux in the equatorial Atlantic. They collected pCO₂ measurements from several cruises in the under sampled December-February period. They characterise the different water masses they sampled. They develop a relationship to calculate regional pCO₂ fields which they use to calculate the regional flux. They identify the flux as being an order of magnitude greater than the Landschützer estimate. They identify the key processes contributing to this flux. This was a really nice paper to read and I found the results interesting. I would suggest publishing this paper following minor revisions.

Major comments

Throughout – At the moment many of your figures are too small. All axis ticks and axis labels need to be much bigger. There are a lot of different colour schemes throughout the figures, e.g. Figure 1 has three different colour schemes. Can they be standardised? Otherwise it is less clear when the colours refer to the regions in figures 4 and 5.

Title – It would also be nice for the title to reflect the main finding of the paper. At the moment you don’t say what the main result was. For example something along the lines of - pCO₂ measurements made in the North Brazil Current rings in February 2020 reveals the region as a larger sink for CO₂ then predicted by pCO₂ climatologies”. I am not suggesting using this title but hopefully it points you in the right direction.

Abstract – The abstract needs a bit of work. You have identified the key processes but it
isn’t clear when and where they are important. This information is in the text but the abstract needs to stand up on its own. You also need 1 sentence at the beginning saying the wider context of the problem, 1 sentence explaining what these eddies are/ how they form and 1 sentence saying how they might impact the flux. Or something along those lines. I would advise using the nature abstract template as a guide on how to improve this section. https://unl.libguides.com/c.php?g=51569&p=2633458

**Introduction** – A well written introduction. The thing I feel is really missing here is a full size schematic of the region. You need to label all the currents (with arrows) and locations you mention in the introduction. Unless the reader is extremely familiar with the region they will not be able to visualise anything. This becomes important later when you start discussing the cruise track. On a read through it would be great for you to at least label the following North Equatorial Counter Current, NBC retroflection region, the Caribbean, Lesser Antilles, Amazon River plume, Trade wind region, Eddy Boulevard. Currently figure 1 is not that helpful. You show these fields but without a schematic of the circulation/currents it isn’t particularly useful. Please add a locations/ currents map as a large subplot to figure 1 at least.

**Methods** – You need to provide a date for the data, at the moment you state January and February. Either as another subplot by day of year or state them in the text and figure cation. As it stands we don’t know how far apart the measurements were made from each other, they could be 1 week or 8 weeks. Figure 2a - c are very much results, so move them there. Perhaps have a cruise track by DOY here instead. Then move Figs 2a-2c to the results. Section 2.2 is nicely written. I feel there is some missing detail here on justifying the choice of datasets though, you need to rationalise why you have used SMAP over ESA CCI SSS for example. In section 2.3.2 you verge into results and begin to discuss them. Be careful of doing this. See lines 214 to 226. I realise you use fig 3 to get the relationship you use to generate your maps but consider moving it to the results.

**Results** – If you talk about Figure 1 here bring it down to results. Figure 4 and 5 are really great. It would be nice if you had a table describing the criteria for each of the 6 water masses. This will make it easier to quickly reference backwards and forwards. Please number and or define the water masses as you introduce them. It isn’t clear whether lines 290 to 203 describe some of these water masses. Section 3.3,3.4,3.5,3.6 are nicely done. Figure 10 is also really nice, maybe you can discuss this further.

**Discussion** – Section 4.1 seems out of place. Combine with section 3.2 at the start of the results where you define the water masses. In lines 477 and 478 you say that the inter annual signal can’t explain the entirety of the differences, this is a really important point but you don’t back this up with hard evidence. Did you try to do an extrapolation for any other years? The appendix figure and table are proof of the method working and I feel justify their place in the main manuscript. The appendix figure is not clear, there doesn’t appear to be anything superimposed on it? What is missing is a 10 year timeseries of the winter pCO2 fields using your relationship, it would be nice to visualise the interannual flux variability as a bar chart (maybe split by your 6 regions).
Minor comments

- Line 1 - The title should read as “The” Impact of North Brazil Current rings on air-sea CO2 flux variability in winter 2020.
- Line 13 – this should just be pass
- Line 19 – factor of 10 might be changed. You could also say underestimated by 1 order of magnitude. You also need to be clear this is WRT to L20 climatology.
- Line 22 – is this 20% of the -1.7Tg month? May say the size as well as the percentage?
- Line 23 – The spatial distribution of
- Line 23 – ‘On the other hand’ is not really the right term here. You mean ‘in contrast’. Where is the detrital material acting as a CO2 source?
- Line 24 – It is not clear why 12 degrees north is an important threshold from the abstract
- Line 30 – “retroreflects” is a term I’ve never heard before. Be aware that some readers even with a strong oceanography background may not be familiar with this. I strongly recommend explaining it here or using another description like “doubles back on its self”
- Line 35 – Is the NBC retroreflection region where the rings pinch off or where they travel across?
- Line 37 – For something extensively studied is there not more recent literature? A 2002 reference predates satellite salinity.
- Line 52 – please edit this, the way it is written makes it sound like the ocean is causing ocean acidification.
- Line 54 – remove “continuously”. It is technically not correct as there is a seasonal signal each year that reduces atmosphere global pCO2.
- Line 71 – edit needed. “The minimum plume extend occurs”. Please be careful when referring to seasons near the equator, it may be better to do month X–month Y.
- Line 109 – why is this separate paragraph. You can merge it with the paragraph before.
- Line 127 – Should this not reference Takahashi 1993?
- Line 128- Can you state the style so the reader doesn’t have to look it up e.g. showerhead, membrane, bubble?
- Line 133/134 – You need to describe the methods here. At least one reference to another paper is required.
- Line 141 – 142 – Can you provide a reference here please
- Line 145 - replace “inferior” with “less than” . Also was this comparison at the same time? Hours apart days?
- Line 154 – How did you check this? Please add the details here or the supplement
- Line 170 – convention to not use PSU or pss. Please check throughout for this
- Line 243 – Would be really nice for you to give the relationship here. Other researchers may want to use it.
- Line 258 – it is hard to visualise this grid without drawing it on a map
- Line 264- Comparisons with the Landschützer product would be best saved for the discussion.
- Lines 265 -268 and 274-275– This is introductory material. Why is it in results?
- Line 302 – Can you change your dates to mmm-dd. Some American readers are confused by dd/mm.
- Line 507 – Are there really only 4 cruises over this time period?