Comment on bg-2021-269

Peter Land (Referee)

This is a thorough and well-presented analysis of a multi-ship campaign measuring waters north of Brazil containing two large eddies (rings), combined with satellite data (including a novel SSS product) to estimate the February air-sea CO2 flux in the region and the contributions due to the rings and other water masses. It describes a method for estimating flux that could be extended to other years, and validates this using previous cruise data with good agreement. I consider the work novel and important and the argument convincing, and I recommend publication. I have two main issues plus detailed comments.

SST is a fundamental component of your method, albeit with relatively low variability across the region, and is often referred to in the text, but we only ever see SST in TS plots and cruise tracks. I would like at least a February 2020 SST composite so readers can see how features described in the text manifest spatially in SST. You could go further and expand other figures to include maps of SST alongside SSS and chla. Speaking of maps, I second Referee #3’s request for a geographically-labelled map, including Bermuda, Trinidad & Tobago and any other geographical features mentioned in the text.

In Section 4.3 and Appendix A, you appear to get to a point where you can address a crucial question, which is whether 2020 was a flux outlier, but you don't present any results! I couldn’t understand why that was, the paper would be much better with this information. Are you saving it for another paper? I wouldn’t blame you, but then Appendix A seems largely redundant as well as unfair on your expectant readers! You successfully validate in other years with cruise data but you don’t go on to process all years since 2010 and present summary statistics on at least the headline regional flux figure.

I18-9 This could use more neutral language, eg ‘a factor of 10 greater than previously estimated’
I22 causes
I139 Different families of rings exist... (a little more explanation of the families would be nice here for ignorant folks like me, e.g. are they all anticyclonic? I would have thought so, but the next phrase kind of suggests a secret world of cyclonic eddies undetectable by altimetry - maybe I'm letting my imagination get the better of me!)
I158 CO2-undersaturated
I172-3 The climatology of difference...
I178 ...due to onshore winds as it travels... (as it stands it sounds like winds ambiguously perpendicular to the coast are travelling NW!)
I183 Later you only refer to the western one as a filament and to the eastern one as a plume - be consistent please
I124 Temperature and salinity...
I133-4 At what depth? If similar to the intake, one thing these might be used for is to shed further light on the fCO2 comparison (or muddy the waters!) by calculating fCO2.
I169 Was the extra data only used to fill gaps, or were all data from the three passes averaged? If the latter, for consistency I’d be tempted to treat all days the same, and either use 6AM the next day all the time or not at all. Could the two missing days be recovered by using 6PM from the previous day? If so, again I’d be tempted to do the same throughout.
I203-4 Brief comparison stats could be included here, eg bias and RMSE.
I220-1 This sentence doesn’t make sense - my guess as to your meaning would be something like ‘Chl-a is hard to distinguish from terrigenous detrital material using ocean colour where both are present as they have similar spectral effects’ or similar. Phytoplankton produce their own detritus, the effect of which is included in satellite chl-a algorithms.
I225 ...prevents oscillations...
I237 ...is ~4 uatm (or is 4 uatm if the ‘of’ was just a typo)
I248 ...over... It might be interesting to check the sensitivity to these extrapolations by calculating the mean fCO2 and/or flux without the extra points, equivalent to setting pixels outside the in situ range to the mean so they don’t affect the result.
I255 Rather vague and irreproducible with different data as it stands. Did you have a threshold of coverage? Given that in the end you average over all days, why do you not average all valid fCO2 values in a given pixel, regardless of coverage? If there’s a specific reason (e.g. strong, consistent temporal gradients of gap location, which could bias the results), please state it clearly along with your exclusion criterion. Alternatively, how about doing it both ways, the difference suggesting a lower limit to uncertainty?
I284 I agree with Referee #3. This amounts to a 3D classification of your data, and there are many ways to achieve this. How did you do it? Manually? How did you arrive at 6 classes? What are the thresholds? Some are scattered through the text, but not in sufficient detail for me to be able to uniquely assign a (S,T,C) triplet to a class (or none). A simple table or a decision tree would suffice to make them reproducible. Do you have any interpretation at all of the grey data, which constitute a large proportion of the warmer waters?
I297 You should refer to this as simply ‘NBC’ rather than surface-intensified. It took me awhile to work out that this wasn’t ‘modified NBC’ with a different name. Or rephrase along the lines of ‘The NBC, intensified at the surface,...’
I334 was it likely to be affected by topography in this area?
I345 ...processes are...
I355 SSS<34.5 appears to be the only necessary criterion in Fig 4b - is the chla limit a threshold or an observation?
I366-7 please quote the background silicate for comparison
I371 ...and modifies...
I380 Are you confident it’s both? I don’t think you have any independent measurements. If not, I suggest ‘and/or’.
I386 ...A2’s westward...
I387 from Fig 4b it looks like SST goes down to about 26.8C. Which of these are
thresholds and which observations?
1399 ...CO2 flux maps... Are these calculated from mean dfCO2 and everything else daily?
1400 Oddly vague - what is the resolution?
1407 (and abstract) personally, I consider /month to be a mangled unit, especially since your data comprise a subset of February! Why not quote /day, valid over the day range used for the calculation?
1411 Not Feb but Feb 2-19
1420 ditto
1424 The two NBC...positive air-sea CO2 flux average in early to mid-February.
1427-8 ...over 18 days
1430 ...on average in early to mid-February...
1441 ...in early to mid-February
1456-7 ...associated with...
1459 Is this how you did it? I thought it was T, S and C thresholds!
1464-8 It would be easy to calculate overlaps between your water masses and the relevant Longhurst provinces, e.g. 90% of the pixels we classify as NASW are in the NATR province.
1471 ...presents...of air-sea CO2...
1472 ...and in February 2020 we estimate the 5-16N, 59-50W domain to be a...
1473 ...large-scale...
1475 ...considerably smaller in...
1476-8 can you quantify this?
1481 ...and is...
1491 ...current...
1496 ...due both...
1551 ...filaments...
1554 ...plume, water...
1558 ...regimes...
1560 ...in early to mid-February...
1561 You quote 10 times smaller earlier, which is it?
1561 ...contributes most... or ...is responsible for...
1564 ...contributes almost... or ...is responsible for almost...
1574 ...than those of temperature and...
1588 ..., sampled daily on a 25 km x 25 km grid,...