Herewith we submit a revised version of the manuscript entitled "Mg/Ca, Sr/Ca and stable isotope from planktonic foraminifera *T. sacculifer*: testing a multi-proxy approach for inferring paleo-temperature and paleo-salinity". We appreciate the effort the reviewers put into our manuscript, which greatly benefitted from their comments. Each of their comments is addressed separately below.

Answer to anonymous referee 1:

Comment 1: This text is of very high degree of interest for everyone who works on salinity reconstruction and understanding oxygen isotope/element ratio/salinity/temperature relation-ship. As said line 511, the authors "have the perfect data set at hand"!

One very important point is missing: the reader does not understand at which ontogenic stage foraminiferal specimen were chosen for Mg/Ca and δ18O measurements. Are the studied specimen of *T. sacculifer* without SAC (in the paper called "kummer- form") considered as adults or pre-adults? so, do the author consider that *T. sacculifer* is adult when the SAC is built?

Answer:

Due to the very specific sampling strategy and as described from line 125 to 130: "In our samples (collected between 0 and 10 m depth), *T. sacculifer* specimens have not yet added the Mg-enriched gametogenic calcite, which generally occurs deeper in the water column just prior to reproduction. Therefore, only the trilobus morphotype without GAM calcite is considered in this study (230µm to 500µm), which limits the environmental, ontogenetic and physiological variability between samples and should be taken into account when compared to other calibrations based on core top and/or sediment trap collected specimens."

As described in this section none of the foraminifers considered in our study have GAM calcite nor a so called 'SAC-like chamber'.

Recently Poole and Wade (Journal of Systematic Palaeontology, 2019) published: "Many studies on extant forms group all morphospecies of the *T. sacculifer* plexus as *T. sacculifer,* or discern only between *T. sacculifer* 'with-sac' (i.e. *T. sacculifer* sensu stricto) and *T. sacculifer* 'without-sac' (i.e. *T. trilobus, T. immaturus* and *T. quadrilobatus*). In particular, palaeoceanographical studies utilizing *T. sacculifer* often avoid specimens possessing a sac-like final chamber as they may have different geochemical signatures or add variability (e.g. Spero & Lea 1993). **Equally, *T. sacculifer* sensu stricto is often used to denote only *T. sacculifer* (i.e. only forms with a sac-like final chamber), whilst *T. sacculifer* sensu lato refers to all four morphospecies of the *T. sacculifer* plexus (regardless of whether a sac-like chamber is present or not)**."

There is only one genotype of this species, now denoted *T. sacculifer*. The exact description of the different morphotypes (e.g. *sensu lato*) of *T. sacculifer,* is still a subject under discussion Therefore, we purposedly only described the sampling strategy and the samples that were analysed. It can be safely assumed that the analysed specimen are indeed pre-adult, without GAM calcite. As GAM calcite is produced **after** chamber formation has finished (including a final sac-like chamber or a "kummerform" chamber) it can be inferred that we only analysed normal, (trilobus form) pre-gam specimens.

Same topic: the specimen size selected for measurement (cited line 316), is never explained - which test size the authors are talking about? The reader has to wait until line 393 to know this information. So, the description of the species and its ontogenic stages (chapter 2.2) should be a bit more precise.

Answer:
Selected test size fraction is described as early as line 128, but it is correct that the reason of the size selected for measurement is only explained line 316. To accommodate this comment, we have modified section 2.2 as follow:

Line 127-131…."Therefore, only the trilobus morphotype without GAM calcite is considered in this study, which limits the environmental, ontogenetic and physiological variability between samples even if a rather wide size fraction (230 to 500µm) was selected due to sample size limitation. This should be taken into account when compared to other calibrations based on core top and/or sediment trap collected specimen."

The problem of the calcification depth of the last chamber of the selected individuals should also be addressed. In this paper, I feel like the authors follow an inverse reasoning (hypothetical causes form the basis of conclusions about reality). In Line 327-328, it is written: "This is confirmed by the strong correlation (R^2=0.87) observed between our Mg/Ca reconstructed temperature vs. measured surface temperature." I would write it (and think it) the other way around. The data set used for this paper is so nice, that the authors should start by the beginning = OK we don't know very well where the *T. Sacculifer* calcifies its test => first see how the correlation between "Mg/Ca reconstructed temperature" vs. "measured surface temperature" is. It is very strong. Conclusion => T. *Sacculifer* calcifies its last chamber at the sea surface (around 10m depth) !!!

Answer:
We understand the reviewer's comment and for clarity the statement line 323-334 was modified as follow:
"The specimens considered in this study were collected between 0 and 10 meters depth, and in agreement with measurements on specimens from culture experiments (Dueñas-Bohórquez, 2009), Mg-rich external surfaces (GAM calcite) were not observed in our samples. This indicates limited vertical migration (see section 2.2. for reproduction cycle), reducing therewith potential ontogenic vital effects responsible for inter-chamber elemental variations (Dueñas-Bohórquez, 2010) and, limited, if any, GAM calcite precipitation (Nürnberg et al., 1996). If the exact calcification depth of the last chambers of our *T. sacculifer* specimen can still be questioned, the lack of GAM-calcite, together with the strong correlation observed between measured surface temperature vs. Mg/Ca-reconstructed temperature, support the idea that calcification of the last chamber of our specimen occurred around 10 meters depth. It should be noted that Lessa et al. (2020) recently confirmed that *T. sacculifer* calcifies in the upper 30 m."

The statement given line 448 and following (differences between Mulitza et al., (2003) equation and this study . . .. could possibly be due to a difference in studied size fractions) strengthens my opinion that sizes and associated ontogenic stages are of primary importance in the conclusion of this study. It would have been best to normalize the element ratio and Oxygen isotope data with

the corresponding individual test sizes.

Answer:
Our sampling strategy (underway pumping from ca. 10m depth), drastically reduced the 'possible' ontogenic stages at which our foraminifera were collected, which is confirmed by the complete absence of GAM calcite in our samples. This is, of course, not the case for studies based on foraminifera from surface-sediment, or sediment trap, where all ontogenic stages can be found, in abundance and therefore narrow size fraction can be considered.

However, the size fractions used by Mulitza et al. (2003) are even wider than ours. They state: "…. and includes measurements of various size fractions of foraminifera larger than 150 µm." They further state: "Since our data agree with regression equations derived from culture experiments (Bemis et al., 1998; Spero et al., 2003), in which pH is controlled to be close to present-day surface waters, it is likely that the pH of calcification is the reason for the deviations."

The reviewer is right that normalizing the element ratio and oxygen isotope data to corresponding size fractions would have been preferable. Although not discussed in the current manuscript, this problem was considered during the elaboration of the paper, and Mg/Ca ratios determined on the last chamber of *T. sacculifer* tests, were reported against foraminifera test size, and are summarized in the table below. In this table, it appears that in our samples, varying size fractions do not have any clear impact on Mg/Ca ratios per station. Again, this is largely explained by our sampling strategy implying the collection of foraminifera that are seemingly all at the same "ontogenic" or "growth" phase, no matter what their variation in size might be (variation in size that can then be attributed to variation in temperature, light intensity and food availability). We are therefore confident that our results are not biaised by the sizes and associated ontogenic stages of the analyzed foraminifera. While answering this comment, we also corrected an error that occurred in line 165, as it is not 5-8 specimens that were analyzed per station, but a minimum of 5 to 8 specimen. The sentenced has now been corrected as follow: For each station 5-13 specimen were analysed.
For oxygen isotope data however, and because a minimum of 2 to 3 foraminifera were necessary to obtain enough material for analysis, it was impossible, due to limited sample size, to only measure foraminifera within a more restricted size fraction.

Mg/Ca data measured per specimen per size fraction

Size fraction	25		29		31		35		38		40		42		46		49		52		56		62		66	
<212																					1	2,86				
212-250	1	2,93					1	5,85	3	4,10	4	4,09													1	1,69
250-300	3	3,11					3	5,38	5	4,36	4	4,05									2	3,03			5	1,65
300-350	3	3,65	3	3,92	2		1	5,53					1	3,92							1	3,56	2	2,12	1	1,62
350-425	2	3,38	2	3,84	3	5,04	1	5,26					6	3,68			3	2,93	2	2,69			3	2,25		
425-500	2	3,22	1	3,62	1	4,55							2	4,05	3	3,94	2	3,07	2	3,20						
>500			7	4,28	4	4,70									4	4,36			2	3,04	1	4,05	1	2,18		
Total number of specimen analysed/station	11		13		10		6		8		8		9		7		5		6		5		6		7	
Total Mean Mg/Ca per size fraction per station		3,26		3,92		4,76		5,50		4,22		4,07		3,88		3,75		3,00		2,98		3,15		2,18		1,66
Total mean Mg/Ca per station		3,22		4,01		4,77		5,46		4,31		4,07		3,79		3,92		3,19		2,96		3,31		2,20		1,66

Mg/Ca ratios measured on the last chamber of T. sacculifer tests per station. In grey columns are reported the number of foraminifera analyzed per size fraction per station. In white columns are reported the mean measured Mg/Ca values per size fraction per stations. In the bottom lines are summarized the mean Mg/Ca values per station as an average of size fraction mean values per stations. Below are reported mean Mg/Ca values per station.

In all calculations, I did not understand if the author have taken into consideration the precision error for in situ salinity measurements. Did the author estimate the quality of salinity data from the ship instrument (that effectively measures conductivity) by sampling sea waters for calibration purpose?

Answer:
As described line 103, temperature and salinity of surface seawaters were continuously recorded by the ship's systems, no extra samples were taken for calibration purpose, but yes the precision error for *in situ* salinity measurements (±0.05) were taken into consideration.

See the attached pdf for details

Please also note the supplement to this comment: https://www.biogeosciences-discuss.net/bg-2020-208/bg-2020-208-RC1- supplement.pdf

All the extra comments listed within the manuscript have been incorporated in the final version.

Answer to the additional comments within the text:

-All exponents were properly written in the original manuscript, but when the article got transformed for the online version, exponents got changed. We'll pay attention to that before publication.

-The considered size fraction of our specimen is already given line 128.

- As suggested by the reviewer 'The last chamber' is now precised earlier in the manuscript: line74.

We thank reviewer 1 for this constructive review