Interactive comment on "Sea surface salinity and temperature in the Southern Atlantic Ocean from South African icebreakers, 2010–2017" by Giuseppe Aulicino et al.

Anonymous Referee #1

This paper describes new measurements of sea surface salinity that are very valuable for the scientific community working on the Southern Ocean, and in particular for validating satellite salinity. Very few in situ measurements are available in the Southern Ocean which makes this unique data set particularly interesting. Data quality seems to have been carefully checked. Nevertheless, more details need to be given before accepting this manuscript for final publication.

We are glad that the referee appreciated our efforts in providing a valuable and carefully checked SSS product for the Southern Ocean. Following the excellent suggestions provided by Referee #1, we improved the manuscript in order to address all highlighted criticisms.
A point by point response (in Italics) follows.

My main concerns are that:

-Criteria for sorting out bad data are rather vague

We went through the text in order to provide additional information about QC. See following comments for detailed answers.

-Figures and statistical indicators are limited to a few cruises and need to be extended to the whole data set.

In the first version of this manuscript we opted for providing only typical figures which referred to few cruises. Nonetheless, we provide statistics for the whole dataset in order to assess its quality in the revised version. The way we improved the paper is described in the following detailed comments.

-It is unclear where SST and SSTH are measured and how they are used for deriving SSS.

This information is provided at lines 91-92. However, text has been improved to clarify this concept. See following comments for detailed answers.

- The depth of the measurement is not given. Even if it probably varies depending on the sea state conditions, an approximated range should be indicated.

The inlet sits at 5 m below the waterline. This information is now included at lines 72-73.

-Comparisons with other fields (section 3) is very interesting but the interest of this new data set (e.g. for detecting sharp latitudinal gradients) could be better enhanced.

We improved the discussion in section 3 in order to stress the usefulness of this dataset for several scientific purposes (e.g., detecting sharp latitudinal gradients in proximity of ACC fronts, studying the Agulhas current and its rings, etc.) as already summarized in the conclusions.

Detailed comments:

Line 17: explicit SA

We changed vessels names to S.A. Agulhas and S.A. Agulhas II because those are listed as official names (see https://www.marinetraffic.com/en/ais/details/ships/601048000 and http://www.sanap.ac.za/sanap_agulhas.html).

Line 40: though salinity AND TEMPERATURE values

That's right of course. Text changed as suggested.

Line 51: meaning of 'the correspondent sector of the Southern Ocean' is unclear

Text changed. Sentence reads "Despite their oceanographic and biological importance, the southern sector of the Atlantic Ocean and the Southern Ocean are among such areas".

Line 52: this sentence is unprecise: strickly speaking, the calibration applies on satellite raw measurements, not on salinity retrievals; change in e.g.: improve the satellite calibration, SSS retrievals algorithms and better validate them in these regions.

We agree. Text changed as suggested.

Lines 60-78: This part would better fit within data and methods section.

We agree. This information is now reported in Data and methods section.

Lines 63-65: It is unclear what is the interest of the temperature cell as, according to Figure 1, it does not measure the temperature of the water analyzed in the conductivity cell (it is not within the TSG), nor the hull temperature. The monitoring of the temperature in the conductivity cell is necessary to ensure a precise salinity, but this is not mentioned. On another hand, oceanographers are interested in the density of the in situ sea water, so I would expect it is the hull temperature that is of interest for computing density.

We apologize if this information was not clear. Actually, temperature is measured twice, i.e. at hull (SSTH) and inside the TSG cell (SST). The thermometer placed directly at seawater intake on the hull provides the actual sea surface temperature that should be used for computing density. The thermistors placed inside the TSG cell are used to monitor the temperature necessary for ensuring the precise salinity. This information was partially provided at lines 91-92 where one can read "As for temperatures, please note that SST is the temperature of the water volume inside the TSG while SSTH is the temperature of the ocean at the water intake". However, we went through the text to improve the description of these measurements (e.g., line 72, lines 91-96, Figure 1 and Table 3) and clarify this concept to the reader .

Lines 89-92: It is unclear where SST and SSTH are given these sentences and Figure 1 (see also my previous comment). It would be useful to indicate SST and SSTH on Figure 1.

Following the previous comment, we have improved Figure 1 with this information.

Lines 97-98: what are the chosen threshold values?

Generally, the chosen thresholds range between 2.5 S/m and 5.5 S/m (conductivity); 32.0 and 36.0 (salinity). As for temperature, different thresholds were considered according to the specific cruises and the different sub-regions monitored in specific time of the year. This information has been included in the revised version of the manuscript. Furthermore, de-spiking is also applied at this stage.

Line 109: are the cruise reports publicly available?

No the reports are DEA publications which are only available to cruise participants and DEA executive post cruise.

Lines 104-111: Criteria for eliminating episodic quick decreases of conductivity associated with air bubbles and harbour data and observations collected when sailing into icefields are vague. I understand that some of the sortings is probably somewhat subjective but it needs to be done in a repeatedly way from one cruise to another and the magnitude of possible remaining contamination has to be indicated based on the criteria used for sorting out bad data. This would help to interpret the validation done in next section.

For all the cruises, TSG observations collected when sitting or sailing into a harbour were flagged to bad data simply using latitude/longitude information provided through cruise reports. The same for (few!) observations collected when sailing into icefields (generally TSG pumps are turned off before entering the icefield in order to reduce the potential damages to the TSG system and the possible acquisition of bad data). This detail has been included in the revised version of the manuscript (lines 113-114).
As for air bubbles, information included in the cruise reports was carefully analyzed to be aware of these events and other suspicious malfunctioning of the system in order to discard bad data. Nonetheless, this was not enough to avoid the presence of episodic quick decreases of conductivity associated with problems not noticed during the cruise. The salinity deduced from TSG measurements decreases to underestimated value which can range from the order of 0.1 (in case of small bubbles) to several units (in presence of severe sea conditions). The actual SSS value is recovered within a few minutes. Most of these altered data are already discarded during the QC-1. However, further analysis are developed during QC-2 and applied to the entire dataset in order to identify and discard residual contaminated data. Considering that these events are really evident in terms of salinity and conductivity quick decrease, they are easily identified and removed. In particular, subsets showing sharp gradients in terms of conductivity (salinity), and/or a decrease greater than 0.1 between subsequent data, are identified, checked and eventually discarded. Hence, possible remaining contamination is very low, do not depend significantly on the chosen values in QC-2 and do not affect the reliability of the dataset.

Line 115, Lines 177-178: what is the expected sea ice contamination? Presence of ice cristals in the TSG? Or actual local low SSS values linked to ice dilution?

We refer to the presence of ice crystals which could cause a bad functioning of the pump system and, consequently, a slowing down of the seawater flux (see also lines 82-83). In order to avoid these problems, usually "the TSG pumps are turned off before entering the icefield in order to reduce the potential damages to the TSG system and the possible acquisition of bad data" (lines 83-84). Nonetheless, scattered presence of seaice when sailing out of the icefield should be considered during QC. Following referee's suggestions, lines 177-178 have been completed mentioning ice crystals when describing seaice contamination.

Lines 121-123: I would expect each SSS to be given together with the conductivity and SST used to derive it: isn't it the case?

Yes, it is the case. All SSS are given together with COND and SST measurements (they are deducted from). Nonetheless, few COND and/or SST data (about 8%, see Table 2) were not readable when analyzing the raw data. Considering that SSS values were absolutely reliable and consistent with expected values, we opted for providing these products anyway and informing the reader about this issue. Hence, data users can decide if keeping or excluding this piece of SSS information when taking advantage of our dataset.

Lines 135-136: Figure 3 and Figure 4 only show comparisons for a given cruise. This is not enough to assess the quality of the whole data set. A compilation of the results obtained with all cruises should be given, for instance the mean and standard deviation of the difference per latitudinal bin, as well as a table indicating for each cruise, the mean bias and standard deviation between bottle and TSG SSS.

A larger compilation of the results obtained through the bottle validation is now provided in the revised manuscript including men bias and standard deviation between bottle and TSG SSS.

Lines 164-182: Again, only examples are illustrated on Figure 5 and 6, a compilation of the results obtained for all the cruises needs to be given.

Examples on Figures 5 and 6 have been completed through the new Table 4 that reports the results (bias and standard deviation) obtained for all the analyzed cruises in comparison to the three reference dataset. As already discussed into the manuscript, BIAS are generally within 0.1, STD being within 0.1-0.2, except for particularly large deviations along subtropical front signatures and close to ice edge (i.e., in January 2012 and second half of December 2014). Despite that, BIAS are very much commensurate with internal agreement among the reference dataset. Please note that the comparisons in Table 4 were limited up to the end of 2015 - the last available year with complete reanalysis data for all the reference datasets.

I don't understand Figure 6: on Figure 6a, TSG SSS are much less scattered than on Figure 6b: which smoothing or filtering is applied? The text indicates a very good agreement between bottle samples and TSG SSS: this is not evident at all from figure 6b. As suggested previously, statistics for each cruise describing bottle-TSG comparisons should be given.

We removed figure 6b and we opted for showing statistics concerning the comparison between the reference datasets and the entire TSG SSS data presented in this study (as suggested by referee, see previous comment). However, we would like to clarify that differences between Figure 6a and 6b (as reported in the original version of the manuscript) are due to difference in the number of data reported in the two figures. In particular, Figure 6a presented only a subset of the entire campaign (reliable continuous southward TSG measurements), while all data (southward / northward legs and those acquired during scientific activities in-between) were showed in figure 6b in order to give information about the comparison with bottle data.

Units harmonization: in previous sections SSS was given without unit, here it is given in pss

Done.

Table 3: Again description of SST measurement is unclear: SSTH, the hull SST, should not be called TSG SST as the measurement is made outside the TSG. Is SST a measurement done within the TSG or outside (as suggested by Figure 1); a TSG delivers a conductivity measurement, not a salinity. In the text, SSS are given without unit (it is indicated in the introduction that they are given on the pss scale), not in psu.

Table 3 has been corrected following referee's comments about SSTH and SSS. Furthermore, SST and SSTH description has been improved as described above.

Legend of Figure 2: need to indicate units of bathymetry.

Figure 2 has been changed since it was incomplete. Legend has been also improved including units of bathymetry.

Legend of Figure 6: remove 'Another comparison of'

Done.