

**Review of Shadwick et al. “The Southern Ocean Time Series: A climatological view of hydrography, biogeochemistry, phytoplankton community composition, and carbon export in the Subantarctic Zone” submitted to EGU sphere (manuscript #egusphere-2024-3887)**

The paper describes the seasonal climatology of several monitored ocean parameters (physics, carbonate system, nutrients, phytoplankton and export flux) based on the decades-long time-series maintained at the SOTS (Southern Ocean Time Series) site in the Australian sector of the circum-global Subantarctic Zone (SAZ).

The paper is well-written, informative and provides a broader context for the myriad of papers that have been written about the SOTS site over many years on a range of oceanographic topics, including air-sea flux, trace metal chemistry and zooplankton. It provides a summary of mean climatologies for the selected parameters while also highlighting the associated knowledge gained from these other focussed studies.

One comment is that the paper needs to highlight that novelty of the climatological approach within the context of the wealth of other data generated by the time-series programme, which is almost the focus of the Discussion. Furthermore, the paper would benefit from analysing the interpretations of the SOTS data as presented with respect to other HNLC regions, such as the subarctic North Pacific and other regions of the SAZ. This would require an additional section to be added to the Discussion section.

It was good to see the efforts of the SOTS stalwart, Tom Trull, recognised in the Acknowledgements as the persistence of certain people is often the gel that enables such valuable datasets to be generated over the required timeframes to account for the inherent variability of ocean parameters over a variety of space and temporal scales.

Except for the recommendation of an additional section in the Discussion to place the SOTS data in the context of other HNLC regions, this review only has minor comments on the manuscript as detailed below:

- (1) In several places, “time series” should be hyphenated. Similarly, “mixed-layer depth”. The authors should ensure consistency throughout the text.
- (2) Lines 69-70: how were the RAS samples preserved for the different parameters that were measured? Were the phytoplankton identifications, in particular, affected by the use of mercuric chloride as intimated in the caption for Figure A4?
- (3) Lines 74-75: it is not clear if the instrumentation measuring “subsurface temperature, salinity and dissolved oxygen” were at different depths to measure surface mixed layer processes or if the measurements were just made at static (surface, 30m or 50 m depths) as for some of the other instrumentation on the SOFS mooring.
- (4) Lines 78-79: “McLane” has a capital “L”. What model of PARFLUX trap was used on the SAZ mooring over the years? Did it change? How were the sequential sediment trap samples preserved?
- (5) Lines 95-96: a definition is provided for the STF. Should one also be provided for the SAF? Is there any variability in the location of the SAF that could affect the surface ocean parameters at the SOTS site?
- (6) Lin 123: “ $p\text{CO}_2$ ” should have the “p” italicised. Correct in many other places in the text.
- (7) Line 127: how “far north” of the SOTS site was deemed “to far” too be included in the climatologies?
- (8) Line 133: shouldn’t “PULSE” be capitalised?

- (9) Lines 135 and 146-147: Looking at Figure 5b there seems to be some correlation between deep mixed-layer depth formation in autumn and winter and the southernmost position of the STF, especially within the small SOTS box. Yet, in the last lines (148-149) in the paragraph, the sentence states that deep mixed-layer depths autumn and winter are related to the STF being further north. Please comment as this doesn't appear to be the pattern shown in Fig. 5b (unless the scales are precluding close enough scrutiny).
- (10) Lines 150-151: "summer maxima of 15°C ..... (Fig. 5b)". This is not apparent in the climatology presented in Fig. 6, presumably due to variability – this figure suggests the summer climatological maxima at the site is only 12-13°C. Please comment further on these observations.
- (11) Line 154: "Subtropical" should be capitalised as for "Subantarctic" later in the sentence.
- (12) Line 161-179 "Deep-ocean observations at the SOTS site": It is unclear of the relevance of this section as the implications of these deep-water observations are not discussed further in the Discussion.
- (13) Lines 203-204: over what depths does "deep (Alk-rich) waters" refer to? Similarly, "shallow depths" later on in the sentence.
- (14) Line 205: As mentioned previously, "Subtropical" should be capitalised, plus perhaps amended to "Subtropical surface waters" in the context discussed here.
- (15) Line 214: last part of sentence should read: "... through to June (winter) in most years". Adding "(winter)" will assist Northern Hemisphere readers to orient themselves to the Southern Hemisphere seasonality.
- (16) Lines 216-218: Is a reference needed at the end of the sentence here where "regenerated nutrients" are discussed when these are not reported on by the paper.
- (17) Line 220: spell out "foraminifera", rather than "forams" as for the other groups of organisms.
- (18) Line 231: add semi-colon (";") between "... SOTS site" and "however", rather than a comma (",").
- (19) Lines 232-234: isn't the apparent non-seasonality in silicoflagellate abundance (Fig. 13) also warranted some discussion here?
- (20) Lines 249-251: why are no values provided for the flux "transfer efficiency".
- (21) Lines 254-257: Long sentence – consider re-writing.
- (22) Line 261: "... interannual variability" of what specifically?
- (23) Line 261-262: "do you mean "... multiple linear regression analysis and ..." ?
- (24) Line 266: add "(NCP" after "Net community production".
- (25) Line 272: "The seasonal succession away from a phytoplankton-dominated community" – not sure what this actually means and how this can be "elucidated on the basis of chlorophyll and backscatter data" – please comment.
- (26) Line 273: "ship board" is written as "shipboard" (preferred) and "ship-board" in other places in the text. Similarly, "time scales" (e.g., line 324). Please ensure consistency.
- (27) Lines 276-275: no PAR data are shown in the paper yet Fe and Mn are inferred as seasonally co-limiting. Is light also a factor, especially in winter with such deep mixed layers?
- (28) Line 279: "cocolithophores" is missing one of the "c"s.
- (29) Line 280: "there is a seasonal depletion" – when?
- (30) Line 281: "silica" should be "silicate" as it refers to the macronutrient, not the mineral.

- (31) Line 281: “similar to the global median” – what is this value? Should be stated here for ease of reference.
- (32) Line 283: add “carbon” between “biological” and “pump”.
- (33) Line 301: “an independent measure of particle export” – was this at the SOTS site or in the SAZ in general?
- (34) Lines 305-316: the work by Wilks et al. on diatom fluxes and species identifications at SOTS is not references here.
- (a) Wilks, J. V., et al. (2017). "Biogeochemical flux and phytoplankton succession: A year-long sediment trap record in the Australian sector of the Subantarctic Zone." Deep Sea Research Part I: Oceanographic Research Papers **121**: 143-159.
  - (b) Wilks, J. V. and L. K. Armand (2017). "Diversity and taxonomic identification of *Shionodiscus* spp. in the Australian sector of the Subantarctic Zone." Diatom Research **32**(3): 295-307.
- (35) Line 306: not sure what “modern and historical properties of diatoms” means.
- (36) Line 310: need space between “*huxleyi*” and “is”.
- (37) Lines 325-337 “Links to Higher Trophic Levels”: how do these studies relate back to the climatology work presented in the paper? As outlined here, it appears that this discussion is just outlining other studies without reflecting on the relationships to the new research that is the core aspect of the paper.
- (38) Line 334: do you mean “particulate organic carbon”? Also, “low surface (chlorophyll or plankton) biomass” later in the same sentence?
- (39) Lines 335-337: the last sentence seems to be somewhat tacked on but does emphasise the other co-benefits of sediment trap records with respect to plankton species identifications.
- (40) Line 354: “... future impacts.” – of what? On what?
- (41) Line 364: “... RV *Investigator*” should be italicised.
- (42) Line 420: species name should be italicised.
- (43) Line 425: missing the opening speech bracket from the title.
- (44) Line 489: extra comma after “... A. S.,”. Similarly on line 493.
- (45) Lines 490, 498 and 501: species names should be italicised.
- (46) Lines 513-517: do all the authors need to be listed here (Sathyendranath et al.)? Maybe list first 10 and then add “et al.” Similarly, lines 549-552 (Bates et al.) and lines 554-557 (Takahashi et al.).
- (47) Figure 1: could the mean circulation patterns and main surface water masses be also shown on this figure, especially for international readers not familiar with this region?
- (48) Figure 2: by showing the climatologies of the various fronts on this figure raises questions about how variable the SAF and PF are? In particular, do shifts in the location of the SAF affect the SOTS site?
- (49) Figure 3: does “sensor” mean shipboard “CTD” or moored “CTD” data or something else? Are these data from the SOTS site only rather than from other deployments in the wider SAZ? State this in the caption.
- (50) Figures 5b and 6: what is the definition that is used to define the “mixed-layer depth” calculations?
- (51) Figure 7: is there any way of clearly showing the variability associated with the CTD data?
- (52) Figure 8b: Why are there no data from 3900 m shown?
- (53) Figure 8c: the pressure differences shown here suggest the sensors were moored at slightly different depths. So, did this affect other moored data collected at the same

time or were the moorings adjusted to account for the slight depth variations between mooring deployments?

- (54) Figure 9: Axis labels are too small to read. Consider adding labels to each of the plots for ease of clarity.
- (55) Figure 9: are all of these climatologies generated from within the mixed layer or from a specific water depth?
- (56) Figure 10: Axis labels are too small to read. Consider adding labels to each of the plots for ease of clarity. Can  $r^2$  values be ascribed to the linear relationships in the Alk v S plot?
- (57) Figure 11: Axis labels are too small to read. Consider adding labels to each of the plots for ease of clarity. What production models do the green and orange plots, respectively, in Figure 11c refer to?
- (58) Figure 12: the colour scale on these plots, especially 12b, make it very difficult to see the difference in phytoplankton community composition as described. Please adjust.
- (59) Table A1: add “°S” and “°E” to the last two table columns, respectively.
- (60) Figures A1 and A2: nice to see these detailed mooring schematics but the small font sizes make it difficult/impossible to read any of the details.
- (61) Figure A3: What water depths were these T and S climatologies from? In Figure A3b, what are the bottom red dashes – extreme outliers or artefacts?
- (62) Figure A4: what water depth were these SEM samples collected from? Presume they were collected using the RAS, which needs to be specified here, presuming they are from the SOTS site and not elsewhere in the SAZ? What was the effect of the mercuric chloride preservation on the ease of phytoplankton IDs?