This manuscript presents analyses of CTD data taken in and over deep ocean trenches by GO-SHIP repeat hydrographic cruises (incorrectly referred to as WOCE cruises in the manuscript) and by full-ocean-depth landers. This is a revision of an earlier manuscript, and is much improved over that earlier version. It contains interesting new information, and should be suitable for publication following revision. Specific comments follow, indexed by line number, L, where applicable.

Thank you for the positive comment. Replies and revisions responding to each comment are in red.

1.Title. Consider deleting "Examining baseline" in the title.

Thank you for the suggestion, this has been changed.

2.L15. Consider changing "Increases in salinity patterns" to "Salinity increases with increasing depth".

Changed to “Salinity increases with increasing depth for profiles over 10,000 dbar, with potential causes…”

3. L20-110 and discussion section. The potential effects of geothermal heating on halal trench mixing (e.g., van Haren, 2023, Dynam. Atm.& Oceans) as well as T-S evolution (e.g., Joyce et al., 1986, Deep-Sea Res. A) and stability should be introduced here and then incorporated into the discussion. Even the weak bottom heating in trenches will tend to cause convective turbulence in a (possibly quite thick) bottom mixed layer, working against establishment or maintenance of stabilizing deep salinity gradients potentially caused by other mechanisms.

Thank you for this comment. The third paragraph of the introduction has been changed to reflect these comments and it has been included throughout the disucssion.

“The extrapolation of hydrographic conditions to the broader physical oceanographic context of a trench system has been notably underrepresented in research. However, regional studies have provided insight into these depths but with some bias towards the *Challenger Deep* in the Mariana Trench (Greenaway et al., 2021; Mantyla and Reid, 1978; Taira et al., 2005; van Haren et al., 2017, 2021; Taira et al., 2004), and neighbouring trenches (Kawagucci et al., 2018; Taira, 2006). Long-term temperature sensor deployments have shown the impact of internal tidal waves and turbulent spurs due to warm waters pushed from above the trench on the de-stagnation of the water below 6000m. These examples of turbulent mixing, excluding horizontal advection, may reduce the stratification on a similar order as geothermal heating (convective turbulence) (van Haren, 2023). Considering this, turbulence can be ten times higher in the upper hadopelagic (6,500 – 8,500 m) compared to the bottom of the hadopelagic (10,300 – 10,850 m) (Huang et al., 2018). Local cyclonic circulation over trenches has been identified over the Philippine Trench (Zhai and Gu, 2020; Tian et al., 2021) and the Mariana Trench (Huang et al., 2018), with both circulation patterns informed by bottom water circulation. “

4. L22. Consider changing "basins" to "a few deep basins".

Changed

5. L25. Consider changing "cool" to "cold", and is light penetration really "limited" at 6000 m? This reviewer would have thought it was effectively zero, although they are admittedly not an optical oceanographer.

Changed to “cold temperatures and no light penetration..”. Yes, there is no light therefore abyssal and hadal

6. L28-29. This sentence is confusing and needs to be rewritten, perhaps split into two. "The 2-dimensional-area of the seafloor with depths greater than 1% (Harris et al., 2014)." is fine. However, what is meant by the second clause? Volume and depth are treated as somehow equivalent, which is confusing dimensionally and conceptually. At any rate, that second clause needs rethinking.

Changed to “Over 6,000 m, the volume is approximately 0.21% of the total ocean, however, it is 45% of the ocean's total depth range (Jamieson 2015).”

7. L50. Change "between" to "among".

Changed

8. L128. There is a grammatical error here that needs to be fixed so that readers can understand the meaning of this sentence.

Changed to “"The Kermadec Trench connects at the southern end of the Tonga Trench within the same convergence system in the central South Pacific, separated only by the subducting Osborn Seamount (Jamieson et al., 2020). Deployments were made in the Tonga Trench (~23˚S / 174˚W) to a maximum depth of 10,823 m, 9,986 m and in the Kermadec Trench (~32˚S / 177˚E)."

9. L137. Add a comma before the last and in the series.

Added

10. L177-181. The WOCE field program ceased circa 1998, 2000 at the latest. Repeat Hydrographic sections collected along historical WOCE lines within ±4 years of the lander expeditions would have been completed under the auspices of GO-SHIP (e.g., Sloyan et al., 2019, Frontiers in Marine Sci.). It would probably be useful to the reader to cite the years of the GO-SHIP sections used at each WOCE historical site. Also, how were the offsets determined? The optimal way would be to use conservative or potential temperature as the independent variable, and adjust the lander salinity to match the GO-SHIP CT-SA relation in a relatively stable portion of the water column (e.g., small lateral gradients and relatively slow circulation - likely the "oldest" deep waters rather than the more recently ventilated and presumably more variable bottom waters).

Yes, some have been incorrectly labelled as WOCE observations, while they are GO-SHIP observations. WOCE lines are included within the paper. The distinction between the two has been made clearer including the appropriate referencing. The method you describe is how the offsets were calculated, this is detailed within the supplementary information. We have added a sentence in the methods for clarity as well.

11. L203-15. OMP analysis typically takes advantage of a non-negativity constraint and requires the water mass fractions to add up to unity, both of which make the calculation better determined. It is not clear from this description that this was done. It probably should be, otherwise OMP should not be invoked. In Matlab the function lsqnonneg in the optimization toolbox would be useful for adding the non-negativity constraint. Also, was any weighting used, as customary in OMP? If not, please note that, and if so, please note what it was. If this is all too much, it would be fine to reframe the problem as simple end-member mixing in CT-SA space with two end-members, and not OMP at all, since it could be simplified to that if desired.

Thank you for this comment and suggestions. A non-negativity constraint was considered, however not applied since our results did not have any non-negative values. Weightings from 1-1, 5-1 and 10-1 were tested, typical of OMP analysis for CT-SA. However, the difference in the AABW fraction from using 1-1 to 10-1 was 0.0001, hence we omitted using weighting in our results. Additionally, the exclusion of a weighting tends to the problem being a simple end-member mixing in CT-SA space as you have suggested. We have made this methodology and decision making clearer in the paper.

12. L227 and following. The discussion here mostly quotes gradients from 4000 dbar to the bottom of the profiles. This practice mixes the regions above and below the sill of the trench. Readers might be more interested in gradients from the sill depth (which should be estimated for each trench) and the bottom. This would allow a focus on trench processes and dynamics, rather than mixing trench and deep water processes and dynamics.

Thank you for this comment. We have modified this throughout to emphasis the rate of change in temperature and salinity over 6000 dbar. In the theta-S figures we have included 4000 dbar and deeper. Additional gradients are identified for the deeper trenches to show the rate of S_A increase.

13. L239 (and elsewhere?). Change "monotonously" to "monotonically". ;-)

Changed

14. Figures 2-8 and discussion. It is interesting that almost all the lander CTD profiles (with the exception of in the Japan Trench) exhibit increasing salinity with increasing pressure at high pressures (salty tails) with various amplitudes, whereas the GO-SHIP data "tails" are either absent or small (the P08 "fresh tails" are implausibly statically unstable, and are nearly within the ±0.002 PSS-78 instrumental uncertainty). All of the GO-SHIP cruise CTD data would be calibrated to bottle salinity data. In general that calibration would include a conductivity cell compressibility coefficient that was determined by least squares fitting along with other calibration coefficients for each co sensor used on that cruise (but maybe the P08 calibration didn't include that term?). So the correction would be specific to the cruise and the sensor. It would often be different from the nominal correction (based on the compressibility of glass) that Seabird Scientific provides. Certainly the CTDs used on Deep Argo floats have exhibited a noticeable artifact owing to this issue (Kobayashi et al., 2021, Prog. Oceanogr.) In addition, it seems possible that under the truly extreme pressure experienced by the lander CTDs, some nonlinearity in the interaction between the glass co cells and their plastic protective jacket could come into play. So without careful (e.g., done to GO-SHIP standards) bottle salinity analyses with multiple samples collected at a variety of pressures (from the trench sill to the bottom) this reviewer is quite skeptical regarding the salinity increases with increasing pressure reported by the lander CTDs. They could be real, but a more likely explanation is that they are an artifact owing to an incorrect coefficient, or even an inadequate model (e.g., linear when it perhaps should be non-linear), used to correct for conductivity cell compressibility. The discussion should probably reflect this perspective.

Thank you for this inciteful comment. Yes, we were also sceptical that this increase was real, however given the findings of van Haren et al. 2021 we thought to discuss the possibility that this was a true increase. Notwithstanding, we have added the details you have provided, particularly details from Kobyayshi et al. 2021 and reflected this information more clearly in the discussion.

15. L339-340. There is a repeated phrase in here. Please edit to remove the repetition.

Removed

16. P369 and elsewhere. Practical Salinity is reported on the dimensionless Practical Salinity Scale of 1978 (PSS-78) and Absolute salinity has "units" of g/kg. There is no such thing as "psu". Please revise the manuscript throughout accordingly.

This is a typo. Throughout we are referring only to Absolute Salinity and not Practical Salinity. This has been removed and changed to g/kg

17. L378. The varying rates of salinity increase with increasing pressure could easily be solely due to instrumentation. The same co sensor used on different cruises can require different compressibility correction coefficients as it ages.

This has been reflected throughout this paragraph, also encompassing the points you have made above in no 14.