We would like to thank the reviewers for their careful and constructive evaluation of our manuscript. Their comments and suggestions have helped us improve the clarity, transparency, and scientific robustness of the manuscript. We have carefully considered all comments and have revised the manuscript accordingly. In particular, we have clarified the distinction between the monthly and daily-derived climatologies, provided additional information on the validation and uncertainty of the reconstructed fields, and further discussed the spatial and temporal limitations of the observational dataset.

Below, we provide a point-by-point response to each comment.

Reviewer 1 :

Referee Report - Manuscript essd-2026-42

Manuscript Title: Climatology of the Sea Temperature from Long-Term In Situ Observations:

Northern Chilean Patagonia.

Authors: Pujol et al. 2026

1. General assessment

This paper presents a four-dimensional temperature climatology for Northern Chilean Patagonia, covering the period 1948–2023 at approximately 900 m horizontal resolution and 32 depth levels between the surface and 400 m. The interpolation is performed with DIVAnd, a well-established variational tool that accounts for bathymetric constraints and data uncertainties. The work compiles roughly 3.3 million in situ observations drawn from several public repositories and regional monitoring programmes, merging them into coherent monthly and daily-derived gridded fields.

The topic is of genuine scientific relevance. Northern Chilean Patagonia is a poorly instrumented region where persistent cloud cover and complex fjord geometry limit the utility of satellite products, and where the expansion of aquaculture makes an accurate thermal baseline increasingly important. To my knowledge, no previous study has produced a spatially continuous, in situ-based climatology for this entire region at the resolution reported here, and the potential applications listed by the authors, from model validation to marine heatwave detection, are realistic and well motivated. The manuscript is clearly written, the figures are informative, and the discussion places the results appropriately within the existing literature on Patagonian oceanography. I have a number of concerns that I believe should be addressed before publication. Most of them relate to documentation and transparency rather than to the scientific substance of the work, and

I am confident they can be resolved without difficulty. I recommend minor revisions.

2. Main concerns

2.1 Undocumented difference in depth coverage between the two products

The monthly and daily-derived climatologies differ substantially in their vertical coverage: the monthly product spans 32 depth levels from 0 to 400 m, whereas the daily product covers only 14 levels from 0 to 100 m. This distinction is correctly reflected in the Zenodo repository metadata, but it is never stated in the manuscript. The abstract and conclusions describe the study as producing a product with "32 vertical levels" and coverage "from the surface to 400 m" without clarifying that these specifications apply only to the monthly file. A reader who downloads the daily file expecting full-depth coverage will find it limited to the upper 100 m. The manuscript should clearly state, at the first description of the daily product (Section 2.3) and in the abstract, that the daily-derived climatology is restricted to 14 depth levels between 0 and 100 m, and should briefly explain the rationale for this choice.

Response: Done. Added to abstract, mat & mat and conclusion

2.2 Absence of subsurface validation

The validation presented in Table 4 is limited to the sea surface (0–1 m depth). While this is the layer with the most observations, the product extends to 400 m, and a user intending to employ the climatology as background for subsurface assimilation or model comparison has no quantitative basis for assessing its reliability at depth. The authors do show profile comparisons in Figure 8, which is helpful, but the comparison is qualitative. I would expect, at minimum, summary validation statistics (correlation, RMSE, bias) for a representative set of depth levels, or a reference to the validation procedure for depth. If a fully stratified validation is not feasible given the data sparsity at depth, the authors should be explicit about this limitation and note the depths below which the climatology should be used with caution.

Response: We thank the reviewer for highlighting the importance of assessing the reliability of the subsurface fields. We agree that the surface validation alone does not directly quantify the accuracy of the climatology at depth. We chose not to apply the same 5% withholding procedure at depth because the number of observations decreases substantially with depth, and removing an additional 5% would further reduce the already limited observational constraint and could disproportionately affect the reconstruction. Instead, we now provide DIVAnd relative analysis error fields, which quantify the remaining analysis uncertainty relative to the background and account for the spatial distribution of observations. We have added these fields to the material and methods, Results (section 3.2.3) and discuss them as a complementary assessment of observational constraint rather than as an independent validation of accuracy. We have also clarified this distinction in the discussion.

2.3 Spatial sampling bias

Table 2 reveals that 76.8% of all observations come from Comau Fjord alone. The authors acknowledge this but do not assess its impact on the resulting climatology. The concern is whether DIVAnd's spatial smoothing adequately compensates for the extreme undersampling of other basins, particularly in the southern part of the domain (Elefantes Channel: 0.32%, Chonos Archipelago: 0.95%). The validation in Table 4 does not distinguish spatially between well-sampled and data-sparse regions, so it is not possible to tell whether the performance metrics are dominated by Comau Fjord. I would encourage the authors to provide at least a regional breakdown of the validation statistics, or to test the sensitivity of the climatology in data-sparse areas by, for instance, comparing the full climatology with one produced excluding Comau Fjord data.

Response: Although some regions account for a relatively small proportion of the total number of observations (e.g. the Chonos region, which represents 0.95% of all observations), they are nevertheless supported by a substantial number of measurements (approximately 31000 observations in the case of Chonos). Comau Fjord clearly influences the overall statistics because of its disproportionately high sampling density, however, the other regions remain well sampled. For the interpolation, a correlation length of 50 km was used, meaning that the influence of the particularly dense sampling in Comau Fjord is spatially constrained and is expected to extend primarily towards Ancud Gulf. This is also consistent with the observed hydrographic connectivity of the region. For the surface validation, we additionally calculated the statistical metrics independently for the different regions, rather than relying solely on statistics calculated over the entire study area. These results are presented in the section 3.1.

2.4 Temporal representativeness

The data span 75 years in principle, but the authors note that 99% of observations post-date 1990 and 55% post-date 2010 (lines 130–131). The climatology is therefore predominantly a representation of recent thermal conditions rather than a true long-term mean, which has implications for its use as a baseline against which to measure trends or anomalies. This is not necessarily a fatal limitation, but the authors should discuss it more explicitly, for example, whether the product is better described as a climatology of the 1990–2023 period with historical anchor points, and how the underrepresentation of earlier decades might affect the mean state.

Response: we added a sentence in the material and methods (section 2.2) " The resulting climatology should therefore be interpreted as a climatological reconstruction based predominantly on recent observations (last three decades), rather than as an equally weighted 75-year climatological mean. "

and we added a paragraph in the discussion "The temporal distribution of the observations represents an important consideration when representing the climatology. Although the dataset spans 1948-2023, the observations are strongly concentrated in recent decades, with 99% collected after 1990 and 55% after 2010. The resulting product

should therefore not be interpreted as an equally weighted representation of the mean thermal state over the entire 75-year period. Rather, it primarily reflects the thermal conditions captured by the more densely sampled recent period, while earlier observations provide historical constraints that extend the climatological reconstruction back to 1948. Consequently, the climatology is best considered a multi-decadal reference field based on observations spanning 1948-2023, rather than a strict baseline of the 75-year period. "

3. Minor concerns and technical corrections

3.1 Inconsistencies in the manuscript text

Line 199 contains the placeholder “see Table XX for details”,

Response: done

Line 319: “4-dimentional” should read “4-dimensional”.

Response: done

Line 373: “Chacao Channal” should read “Chacao Channel”.

Response: done

Line 390: “associated wit harmful” should read “associated with harmful”.

Response: done

3.2 Very high NaN fraction at depth

At 400 m, approximately 94% of the monthly grid cells contain NaN, meaning that fewer than 6% of the domain has valid interpolated values at maximum depth. This is not in itself a problem, it reflects the narrow geometry of the fjords and the rapid increase in land fraction with depth, but it is worth noting explicitly so that users are not surprised. A brief statement or a figure showing the spatial coverage as a function of depth would help.

Response: Thank you for that important comment. We choose not to put a dedicated figure but we add a small paragraph in section 3.2.2 “The proportion of the study domain covered by interpolated values decreases progressively with depth, reflecting the bathymetry characteristics of the fjord environment. The interpolation covers 100% of the domain at the surface and remains relatively high in the upper 100 m, with more than 65% of the domain containing valid interpolated values. Coverage then decreases substantially with depth, reaching approximately 30% at 200 m and only 14% at 400 m. At 400 m, the interpolated area is primarily confined to the Peru-Chile Trench west of Chiloé Island and a few deeper-micro-basins within the fjord system. ”

3.3 File format and Zenodo deposit structure

The manuscript never explicitly states the format of the distributed files (NetCDF3-Classic, as confirmed by inspection). This should be stated in Section 2.3 and in the data availability statement, along with the coordinate reference system (WGS84, assumed). Users would also benefit from a note about recommended software for reading the files and, ideally, a short code snippet or Jupyter notebook in the Zenodo repository.

Response: format added to both section 2.3 and data availability. We also provided on the same Zenodo deposit two script (MATLAB and Python Jupyter Notebook) for easy data handling and visualisation. The scripts were mentioned in the code and data availability and in section 3.1.

The Zenodo description also notes that the cited deposit (zenodo.18255999) is a subset of a larger deposit (zenodo.14845077) containing the full dataset, including the in situ observations used to construct the climatology. The manuscript does not mention this parent deposit, which seems relevant: readers who wish to access the underlying observational data should be directed to it. I recommend that the data availability statement reference both DOIs and clarify what each contains.

Response: The larger deposit does not contain the in situ observations used to construct the climatology. These observations originate from datasets provided by other organisations, which have made them freely available through their respective repositories. We therefore do not want to redistribute these datasets through our own Zenodo repository.

The larger deposit was originally associated with a previous manuscript that has since been rejected, with the recommendation to split the work into two separate studies: one focusing on the development and description of the climatology, which is the aim of the present manuscript, and a second focusing on the application of the climatology to marine heatwave detection, which will be addressed in a future paper. The larger deposit was therefore originally linked to the corresponding preprint.

We initially retained the reference to this larger deposit because it had already been disseminated online in association with the climatology. However, we agree that its inclusion may cause confusion.

We propose to remove the reference to the larger deposit from the Zenodo record.

4. Recommendation

This is a solid piece of work that will be a useful resource for the oceanographic community working in Chilean Patagonia. The methodology is sound, the regional context is well described, and the presented results are consistent with previous knowledge of the area. The concerns raised above relate primarily to documentation and transparency rather than to the scientific substance, and I expect them to be resolved without difficulty. I recommend minor revisions.

Response: Thank you.