

Answer to Review #2 for “15 Years of Satellite, In Situ and Reanalyzed Salinity Data: Insights into Sea Surface Salinity Trends, Variability, and Water Cycle Links”

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We thank the reviewer for their careful reading, detailed suggestions, and positive feedback. We have carefully considered these comments and provide below a point-by-point response to the issues raised.

General comments

This paper investigate SSS trends in different kinds of up-to-date products based on either in situ data, satellite data, or both, combined with a model or not. While not groundbreaking as it builds on other studies of SSS trends and do not deeply investigate processes at work, it provides a very interesting comparison of short-term trends for which satellite data allow unprecedented monitoring, and long-term SSS trends that only historical in situ observations can capture. Moreover it gives a good overview of the different kind of products available through Copernicus, and therefore fits perfectly within the State of the Planet report.

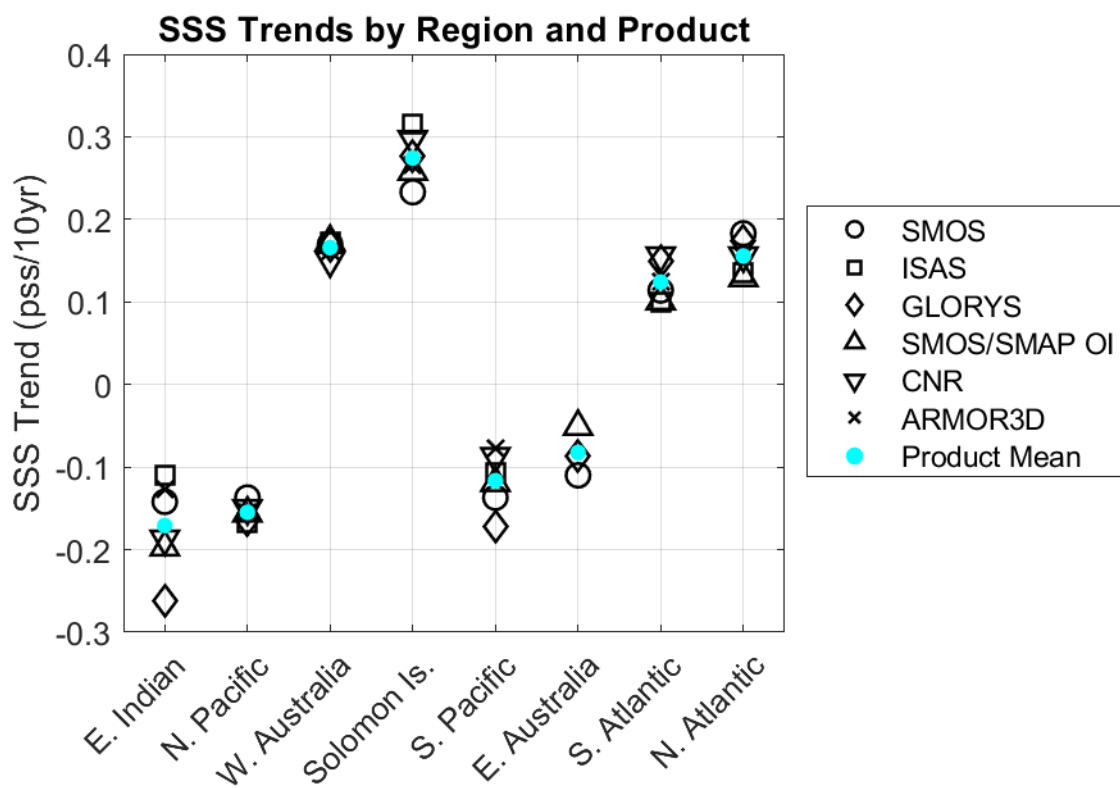
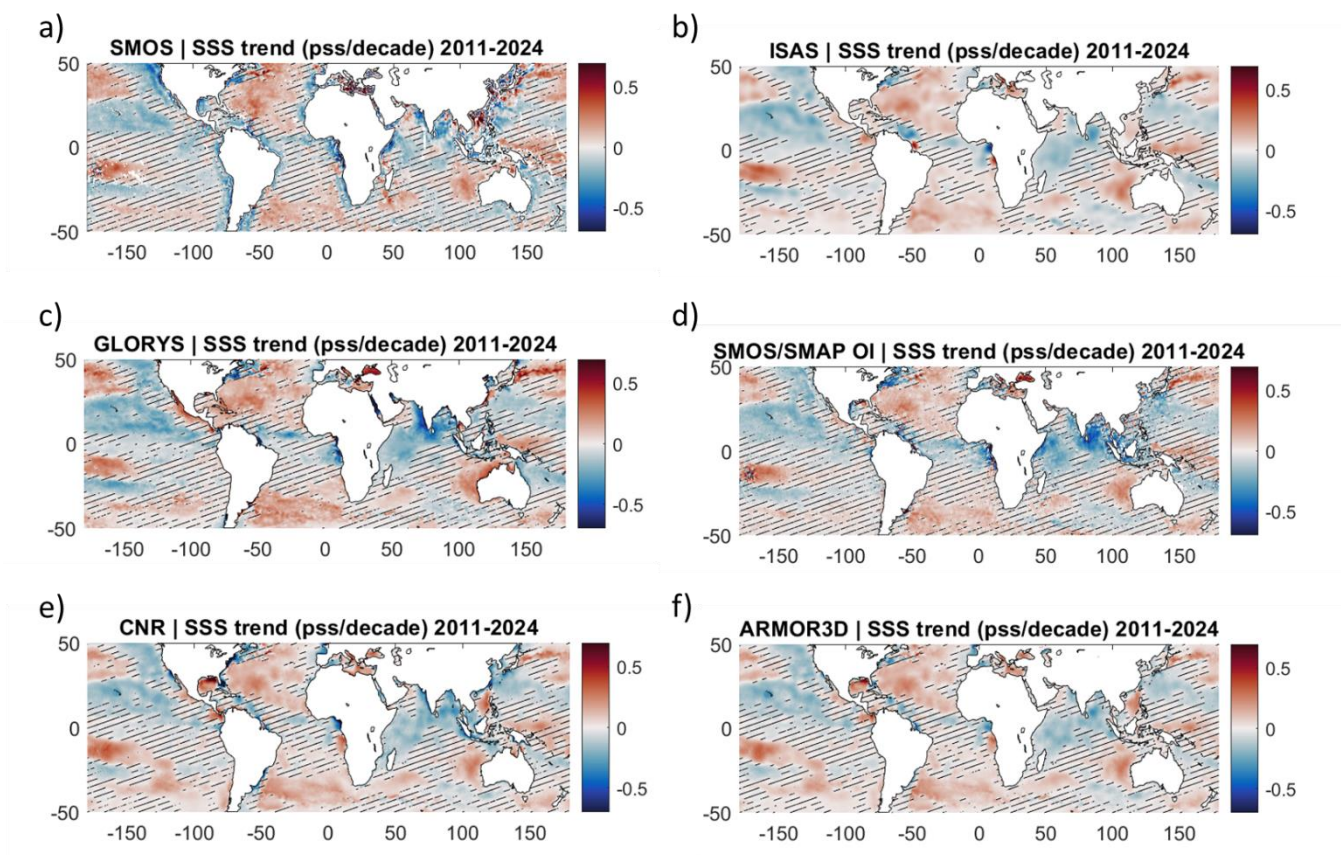
The multi-product analysis is done rigorously, the writing and figures are of very good quality. My main recommendations are to always present the different products in the same order in the figures and tables throughout the paper to improve the reading flow, and to check that all references are in the end list as I found that some of them missing.

In the revised version, the products have been presented in the same order in the figures and papers. The missing references have been added.

We now follow the following order for the products and the following abbreviations used throughout the paper:

1. SMOS
2. ISAS
3. GLORYS
4. SMOS/SMAP OI
5. CNR
6. ARMOR3D

This order and names have been used in the Tables, the Figures and the Legends of some of the figures. For example:



I recommend to accept the paper, while I provide below a number of minor comments (mostly typos, rephrasing) that should help to polish it before publication.

Minor comments

L39 by saltier regions getting saltier L54 is probably of anthropogenic origin rather than due to natural variability

Done.

L63 least-damped

Done.

L76 there is now at any time around 4000 Argo floats in the global ocean, so the cumulative number of floats deployed since the early 2000s is certainly higher. Please rephrase

Thank you for catching this. We have corrected it to “Since the early 2000s, there has been a large increase in near-surface and subsurface salinity data sampling at a global scale, with the deployment of around 20 000 Argo floats in the global ocean. Over 4000 Argo floats are currently in operation, each providing at least one salinity cast every 10 days in a three-degree cell in the top 2 km of the water column (Thierry et al., 2025).”

L100 remain

The subject “15 years” is treated as singular when referring to a single period of time, so it should be “remains”. But to avoid confusion, we replaced it with “is”.

L104 in remote sensing of SSS

Done, but added “satellite” before “remote sensing”.

Table 1 Information on the spatial resolution of these products is lacking, is it similar from one product to the other and have they been interpolated on a similar grid ? Also it would be good to give the available period for these products, even if only the period common to all is later used in the analysis. I suggest to give the short name of each product in a separate column for more visibility, and used « SMOS L3G » rather than « L3G » (both are used, depending on the figures, better to be consistent). Also it seems some QUID and PUM references are missing in the reference list (e.g. Tarot, 2024 ; Verbrugge, 2023), please verify and complete.

When making the table, we were following strict guidelines from the OSR team, so the organization of the table and the columns used were not up to our choice. However, as suggested by the reviewer, we have replaced “Product ref. no.” with “Product ref. no. and abbreviation” and we use this same abbreviation throughout the text, figures and tables, avoiding the inconsistencies pointed out. In addition, following your suggestion we have added an additional table with the information on each product’s resolution, available time period, and auxiliary data. The datasets were not interpolated to the same grid, they were computed at the grid of the resolution indicated in Table 2.

The references have been added.

Table 1, Product 2 : Kolodziejczyk

Done.

L115 Theil, 1950; Sen, 1968 : missing in the references list

These references have been added.

L131 « SMOS L3G (product 1) and Glorys (product 5) » It would be more intuitive to present the maps in Figure 1 in the same order as the products are presented in Table 1. Also I suggest to present in that order : in situ-only product, satellite-only product, hybrid products.

For the revision, the product order has been made consistent throughout. We have ordered the products starting from satellite-only, in-situ only on top (SMOS and ISAS respectively) and then mix of in-situ and satellite. We decided to order satellite-only first, because the satellite data is the one with the shortest available period, and hence is driving the main period chosen for this study. It was also one of the goals of the paper to show that satellite products are able to capture SSS trends, so the satellite-only product, SMOS, was the one used in a lot of the comparisons (for instance, in the bottom panel in Figure 2 and in Figure 3a). This order also allows for an easier comparison between independent datasets: SMOS, ISAS and GLORYS, as well as between dependent datasets, like ISAS and SMOS/SMAP OI, and CNR and ARMOR3D at the bottom. The organization will now look like this and we hope the reviewer find it suitable:

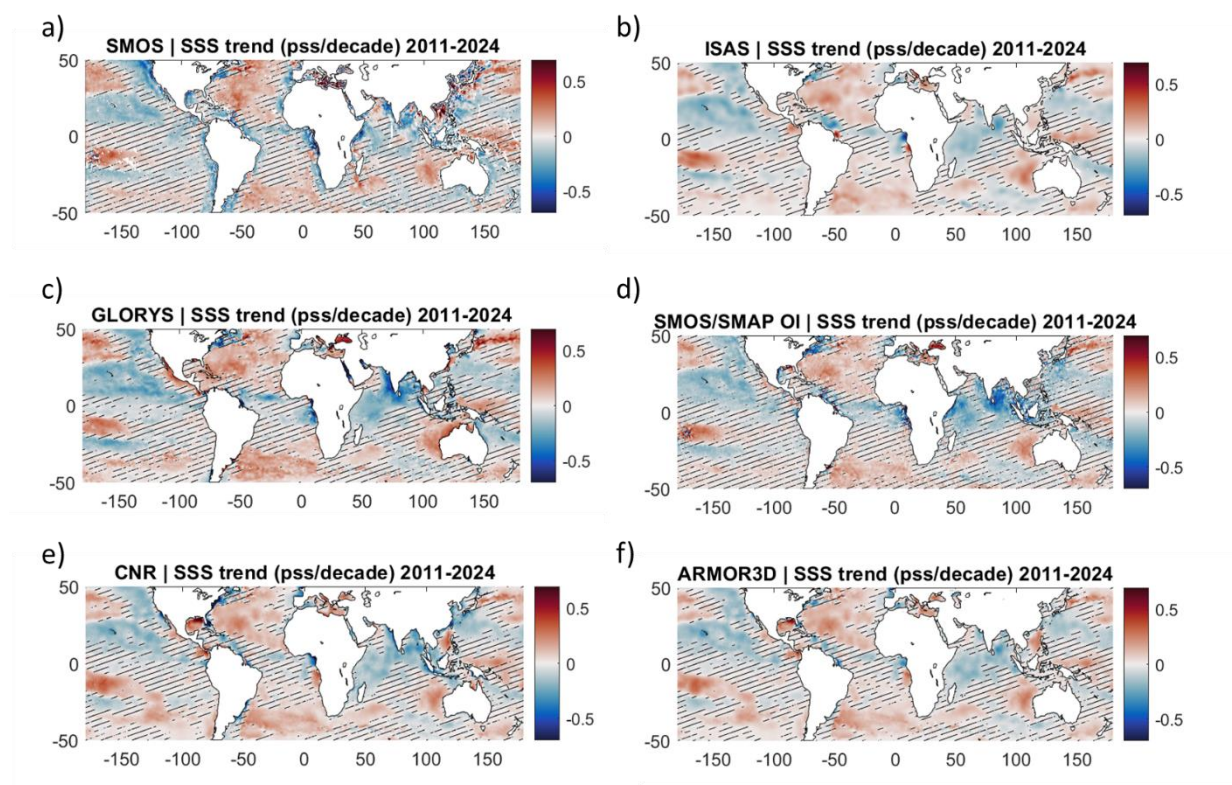
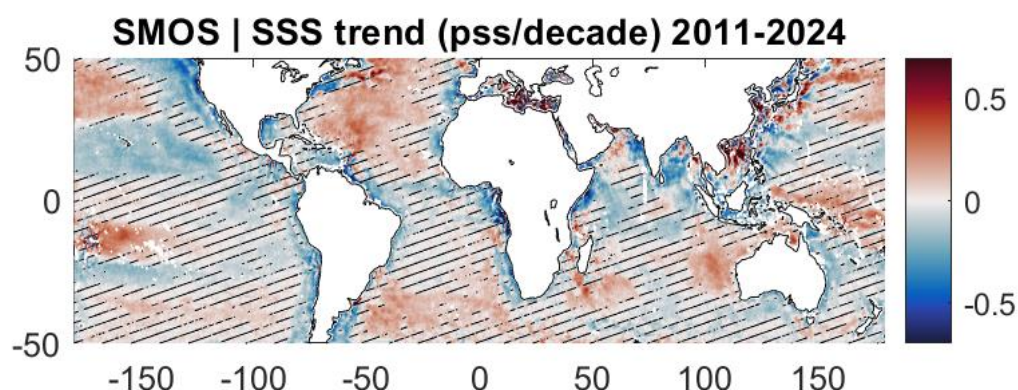


Figure 1 « SSS trend (pss/decade) 2011-2024 » is common in all subplot titles while the name of the product is only included as a subscript. I suggest to rather put forward the name of the products in these titles.

Thank you for this observation. The name of the products has been put forward: first in line and not in subscript. For example:



L135 Which areas of higher variability that are distinct from river plumes do you refer to ?
Red areas in Figure 2d are all associated with river plumes, it seems. Could you clarify ?

The sentence has been rephrased to: “There are also differences between the products in smaller regions, such as river plumes (e.g. of the Amazon and Congo rivers), which are areas of higher variability.”

L154 SSS trends obtained from the 6 products.

Done.

L167 When maps of the mean salinity trends estimated from the 6 products (Figure 2a) and SSS climatology (Figure 2c) are compared

Done.

L172 are found in the Indian Ocean east of India (where a fresh region shows a freshening trend)

Done.

L183 The link between the Pacific ENSO/PDO modes and the Amazon flow is not so direct, can you add a reference ? Which different periods and different techniques to estimate trends are you referring to ? Please clarify.

This refers to the paper cited earlier in the paragraph, Nardelli and Iudicone (2025). The citation was made clearer.

Figure 3b The order of products used in the legend is again different from the order in Table 1 or Figure 1. Please keep consistent.

This has been corrected so that the order of the products is the same, and also the order of the regions are consistent with the other Tables and Figures.

Table 2 I do not see the underlining of non-significant trends mentioned in L200. Again products seem to be presented in random order.

The underlines have been added.

L233 « mooring etc » : it would be worth knowing if this product includes underway SSS measurements from thermosalinographs. Also details on this product should rather be moved to the data section.

Thank you, the IAP dataset has been added to Table 1 and an additional table with the information on each product's resolution, available time period, and auxiliary data have been added to make this clearer.

L241 There is an inconsistency between the periods given in the legend and in the subplot titles, please correct.

The legend has been corrected.

L246 Figure 5d).

Done.

L253 « trends in salinity are not linear » : it is right but by definition you here discuss differences in linear trends, and it is difficult to see trends otherwise on the short period Figure 3b. Thus I would recommend to rephrase with something like « In addition, when looking at such a short period as 15 years, interannual and interdecadal variability have a strong influence on the estimation of a linear trend (as seen in time series of Figure 3b) ».

Thank you – we have replaced the sentence with your suggestion.

L256 Vinogradova and Ponte (2017) is missing in the references list

The reference has been added.

L258 compared to

Done.

L263 saltening ?

We replaced it with “increasing salinity of the”.

L270 up-to-date products derived from satellite data on one hand, and from in situ data on the other hand

Done.

L274 Glorys (a model reanalysis which assimilates only in situ salinity). L282 showed that the intensity

Done.

L283 salinity sensors

Done.