# Authors’ Response to Reviews of

## An ensemble-based coupled reanalysis of the climate from 1860 to the present (CoRea1860+)

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*Earth System Science Data,* `Manuscript ID: essd-2025-127`

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**RC:** ***Reviewers’ Comment***, AR: Authors’ Response, ☐ Manuscript Text

**RC:** ***This paper presents a new and interesting contribution to the ocean reanalysis landscape with the development of CoRea1860+, a long-term coupled ocean reanalysis that assimilates only sea surface temperature (SST) observations. By avoiding the assimilation of subsurface data, which is more sparse in space and time, the product is designed to maximize temporal consistency, making it particularly well suited for studies of climate variability on decadal and longer timescales. The manuscript provides a clear and thorough evaluation of CoRea1860+, demonstrating how it compares with both existing ocean reanalyses and observational datasets. The approach is novel and complementary to other reanalyses that rely on more comprehensive data assimilation strategies.***

AR: We sincerely appreciate the reviewer’s positive evaluation of our manuscript as a clear and thorough description of the dataset available at `https://doi.org/10.11582/2025.00009`, and we thank the reviewer for the thoughtful comments and constructive suggestions to improve the manuscript. We have carefully addressed the reviewer’s concerns and revised the manuscript accordingly.

Below, we present each comment from the reviewer (Reviewer Comment, **RC**) followed by our response (Authors’ Response, AR) and, where applicable, the corresponding changes made to the manuscript (highlighted within the black box ☐).

Please find our detailed, point-by-point responses below. Again, we thank the reviewer for his/her valuable time and effort in reviewing our manuscript.

**RC:** ***I recommend minor revision, primarily to encourage the authors to expand their discussion and analysis in a few areas where the strengths of CoRea1860+ could be further leveraged—for example, by using its extended temporal coverage to explore decadally paced modes of variability or by more explicitly investigating the ocean-forced atmospheric variability. These two aspects are already well acknowledged in the paper, but could benefit from deeper exploration to further highlight the utility of the dataset.***

AR: We thank the reviewer for this thoughtful and constructive suggestion. We fully agree that the extended temporal coverage of CoRea1860+ and its explicit representation of ocean–atmosphere interactions present valuable opportunities for studying decadal variability and ocean-forced atmospheric responses. As noted by the reviewer, these aspects are acknowledged and partially explored in the manuscript. To better align with the reviewer’s recommendation, we added a new analysis of the North Atlantic Oscillation (NAO, Figure R1), a key atmospheric mode of climate variability, which offers further insight into the capability of CoRea1860+ to represent ocean-forced atmospheric decadal variability. The new content was included in Section 4.4.3 (L580-590) and the conclusions section (L668-670) as follows:

> The North Atlantic Oscillation (NAO) is a predominantly atmospheric mode of climate variability and represents one of the most prominent patterns of climate fluctuations over the North Atlantic and

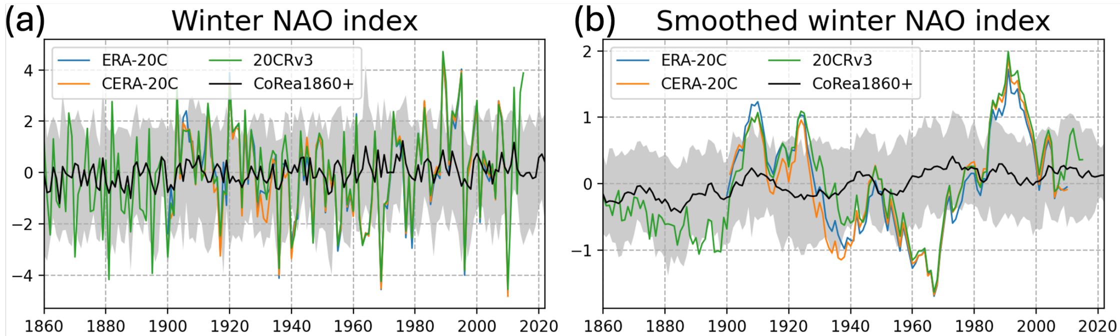


Figure R1: (a) Winter (December-March) station-based index of the NAO. (b) 10-year running average of the winter NAO index.

> surrounding regions (e.g., Hurrell, 1995). Following the definition in Hurrell (1995), we calculate the winter (December–March) NAO index as the difference between normalized SLPs at Lisbon and Stykkisholmur (Figure 12). The NAO indices from ERA-20C, CERA-20C, and 20CRv3 show strong agreement, reflecting the constraint provided by the assimilation of surface pressure observations (Figure 12a). In contrast, CoRea1860+, which assimilates only SST observations, exhibits weak interannual variability in the ensemble mean and a relatively large ensemble spread. The correlations between the NAO indices from CoRea1860+ and those from the reference reanalyses are all below 0.16. This indicates that SST assimilation alone is not sufficient to synchronize the NAO's year-to-year fluctuations with those in the other reanalyses. Nevertheless, CoRea1860+ shows the NAO's decadal variability (Figure 12b), suggesting a potential oceanic influence on longer timescales. This highlights an area of interest for future investigation, particularly in exploring how ocean-atmosphere coupling may contribute to low-frequency NAO variability.

> CoRea1860+ does not capture the year-to-year fluctuations of the NAO in phase with the other reanalyses. Nevertheless, it shows a weak NAO's decadal variability, suggesting a potential oceanic influence on longer timescales.

A more in-depth exploration of decadal variability and ocean-forced atmospheric dynamics is indeed of high scientific interest and will be a key focus of future studies. To briefly clarify this intent, we added a forward-looking paragraph to the conclusions section of the manuscript (L671-680):

> While the present study focuses on describing and evaluating the CoRea1860+ dataset, its extended temporal coverage is well-suited for studying long-term climate variability and the slower modes of the climate system over the historical period. For instance, we have been contributing a prospective paper on AMOC variability and predictability. Furthermore, the direct constraint of the ocean component in CoRea1860+ enhances its suitability for investigating the ocean's role as a primary driver of interactions within the climate system. We have been investigating whether the ocean drives the decline in Antarctic SIE from 1940 to 1980. The relatively large ensemble of 30 members offers possibilities to study teleconnections over the entire historical period. CoRea1860+ can also be used to initialize climate predictions over much longer periods than normally considered (e.g., 1960-present in CMIP6 Decadal Climate Prediction Project, Boer et al., 2016), and can provide more reliable estimates of multi-annual

> prediction skill. We have performed a set of decadal hindcasts starting each year from 1873 to 2020 initialized by CoRea1860+ and have been investigating the modulation of decadal prediction skill.

## 1. Specific comments

**RC:** ***Line 10: Change "areas" to "aspects".***

AR: We revised the text (L10) as:

> It then provides a comprehensive evaluation of the reanalysis across four key aspects

**RC:** ***Line 27: Change "Retrospective analysis... is" to "Retrospective analyses... are".***

AR: Done. The revised text (L28-30) is as follows:

> Retrospective analyses (i.e., reanalyses, Kalnay et al., 1996; Wang et al., 2023) are a comprehensive four-dimensional reconstruction of the historical climate system achieved by combining observational data (i.e., observations) with a numerical physical model through data assimilation (DA, Evensen, 2003; Carrassi et al., 2018; Penny et al., 2017).

**RC:** ***Line 66: Rephrase "and the discard of the first two years of each streamline" to "from which the first two years are discarded".***

AR: Thanks for the suggestion. We revised the text (L65-68) as

> its production process involved the parallel generation of 14 ten-year production streams (initialized from the uncoupled ERA-20C and ORA-20C reanalyses) from which the first two years are discarded to produce the final climate reconstruction for the period 1901–2010, leading to discontinuities in the ocean variables (see Figure 10 in Laloyaux et al., 2018).

**RC:** ***Lines 76-78: It is not very clear what distinguishes semi-coupled from fully-coupled assimilation. Could you elaborate a bit more?***

AR: Sorry for the confusion. For clarity, we modified the text (L76-84) as follows:

> Coupled DA can be classified into two types: semi-coupled DA and fully-coupled DA. In semi-coupled DA, observations are assimilated into their respective components (Counillon et al., 2016; Kimmritz et al., 2019). For instance, when assimilating atmospheric and oceanic data in semi-coupled DA, the atmospheric data are only used to update the atmosphere component and the oceanic data are solely used to update the ocean component. Semi-coupled DA still allows for constraints on the other components through the model's coupling of the components, making it valuable for studying specific component interactions within the climate system. In fully-coupled DA, all components are directly constrained by observations (Fujii et al., 2009; Laloyaux et al., 2016). Again, for example, when assimilating atmospheric and oceanic data, the atmospheric data are used to update not only the atmosphere component but also the ocean component and the oceanic data are used to update both the ocean and atmosphere components.

**RC:** ***Lines 87-89: The way it is introduced, it seems that the problems of full-field initialization (e.g. model drift) are specific to uncoupled reanalyses. This is misleading as I would actually expect uncoupled reanalyses to be less subject to model drift due to the anchoring effect of the boundary conditions. Since full-field initialization is also used in coupled reanalyses, I would introduce it as a standalone concept that is opposed to anomaly initialization.***

AR: We agree with the reviewer that the statements were misleading. For clarity, we revised the text (L92-96) as

> The full-field assimilation directly uses the actual value of observations and corrects both the model state and variability (de Boisséson et al., 2018; Slivinski et al., 2021). However, this approach can lead to persistent model drift, where the coupled system repeatedly moves away from observations toward its biased state (Carrassi et al., 2014; Weber et al., 2015). This drift introduces inconsistencies in the coupled reanalysis, particularly in unobserved variables and regions such as the deep ocean when observational data are sparse.

**RC:** ***Line 113: Change "reconstruction" to "reconstructions".***

AR: As suggested, the text (L117-119) was rewritten as

> NorCPM is a physics-based numerical model (scientific software) developed for performing climate reconstructions (Counillon et al., 2016; Wang et al., 2022) and predictions on different timescales (Wang et al., 2019; Bethke et al., 2021; Nair et al., 2024; Xiu et al., 2025).

**RC:** ***Lines 147-150: Could you comment what impact this discontinuity in the assimilated product is expected to have in your reanalyses? Could you also motivate the choice of this reference dataset and explain in particular why you didn't consider HadISST1 which extends up to present?***

AR: HadISST2.1 has ten realizations of monthly gridded SST. The standard deviation between the ten realizations, which varies with time and space, is designed to reflect its uncertainties - one key quantity for data assimilation (Evensen, 2009). However, HadISST1 does not provide uncertainties. OISSTV2 provides weekly SST and weekly observation error variance, in addition to monthly SST. In our assimilation system, the observation error variance of the monthly data is estimated as the harmonic mean of weekly error variances provided by OISSTV2 (Bethke et al., 2021).

HadISST2.1 is our preferred dataset, but it is only available until 2010. During the preparation of the Decadal Climate Prediction Project (DCPP) experiments for the sixth phase of the Coupled Model Intercomparison Project (CMIP6) (Bethke et al., 2021), we verified through a separate reanalysis covering the period 2006–2010 that the transition from HadISST2 to OISSTv2 does not introduce any noticeable discontinuities in the coupled reanalysis.

**RC:** ***Lines 312-313: I wouldn't say that the total error is stable as it shows a clear decreasing trend over time.***

AR: We agree with the reviewer and revised the text (L324-326):

> The total error (red line in Figure 1) is about 0.6 °C with a slight decreasing trend before 1982 and about 0.5 °C after 1982. Its shrinkage in 1982 is mainly because of introducing the satellite observations.

**RC:** ***Figure 2 and paragraphs in Lines 356-376: Can you motivate the choice of the two polar regions as regions that deserve specific validation? Is it because they have been more poorly observed before the satellite era?***

AR: As suggested, we added one paragraph into Section 4.2.1 (L351-355):

> We evaluate three ocean regions: the open-water ocean $[60°S, 60°N]$, the Arctic Ocean $[60°N, 90°N]$, and the Southern Ocean $[60°S, 90°S]$. In each region, we assess OHC in both the upper 0–300 m and 0–2000 m layers. The two polar regions are of particular interest, as they are critical for climate studies but were poorly observed before the satellite era. Moreover, SST data in areas covered by sea ice are not assimilated, making it especially valuable to evaluate the system's performance under sea ice conditions.

**RC:** ***Lines 359-360: I don't see why having more data available should traduce in higher variability. Isn't the higher variance in this region with respect to the global ocean explained by the polar amplification phenomenon?***

AR: We agree with the reviewer that the statements were misleading. For clarity, we modified the text (L366-368) as

> It should be highlighted that the hydrographic profile data availability at high latitudes is higher. Over the period 1980-2010, EN4.2.2 depicts a higher warming trend in the Arctic than in the open-water ocean ($[60°S, 60°N]$), which confirms the polar amplification phenomenon.

**RC:** ***Lines 362-363: The apparent good agreement after the 1950s might be artificial, as this is the period that you chose to compute the anomalies. If you choose a different one (the early 20th century or the whole dataset, the periods of agreement/disagreement might be very different.***

AR: Using another period as the climatology period would shift up or down the timeseries of different datasets. But their temporal variability is still the same. As we mostly focus on the temporal variability evaluation in this study, we revised the sentence (L371-372) as follows:

> From the 1950s onward, all datasets are in good agreement in temporal variability, while EN4.2.2 shows higher variability amplitude than the other products.

**RC:** ***Lines 400-401: How much of this good agreement is because of the long-term trends. Have you recomputed the correlations with detrended timeseries?***

AR: In the manuscript, we have computed correlations for the anomalies including the trends (Figure R2, i.e., Figure 3 in the manuscript). To address the reviewer's comment, we computed correlations for detrended anomalies (Figure R3). Comparing Figure R3 to Figure R2 demonstrates that the agreement between CoRea1860+ and the reference datasets is mostly due to the synchronization of the yearly variability. Long-term trends do contribute to the ACC maps, which are relatively weak. We added the following statement to the manuscript (L426-427):

> Note that interannual variability in OHC contributes much more to the computation of ACCs than the long-term trend (not shown).

**RC:** ***Section 4.2.2: It is important to point out that CoRea1860+ cannot describe the observed Ekman-driven component, as it doesn't include any wind forcing. That might explain some of the year-to-year discrepancies with the other reanalyses. It might be worth repeating the comparison but removing first the Ekman component (e.g. as in Baehr et al 2004).***

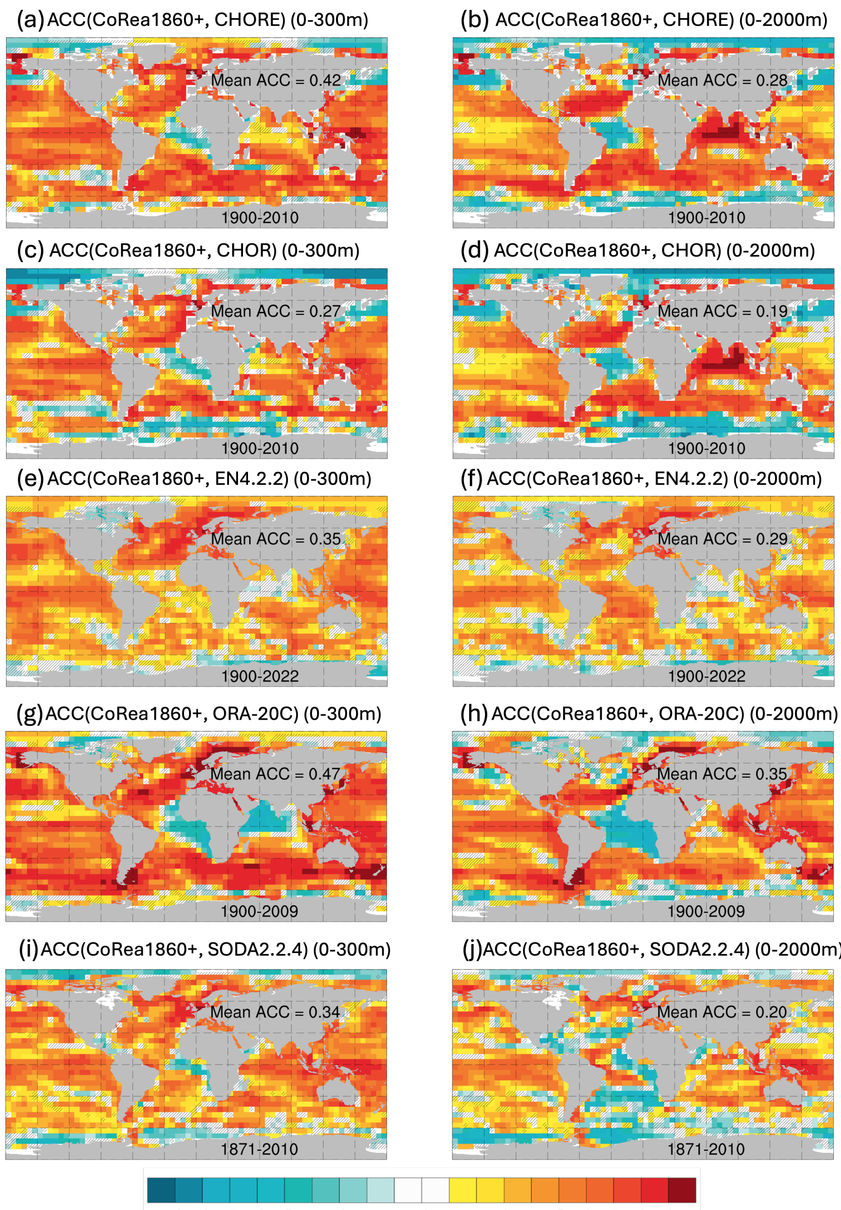


Figure R2: ACC of yearly OHC in 0-300m or 0-2000m of CoRea1860+ against different reference datasets. Grids that fail the significance test are marked with a slash. The period used to compute ACC corresponds to the overlapping period between CoRea1860+ and the specific reference dataset and is shown in Antarctica. The spatially averaged ACC is shown in Eurasia.

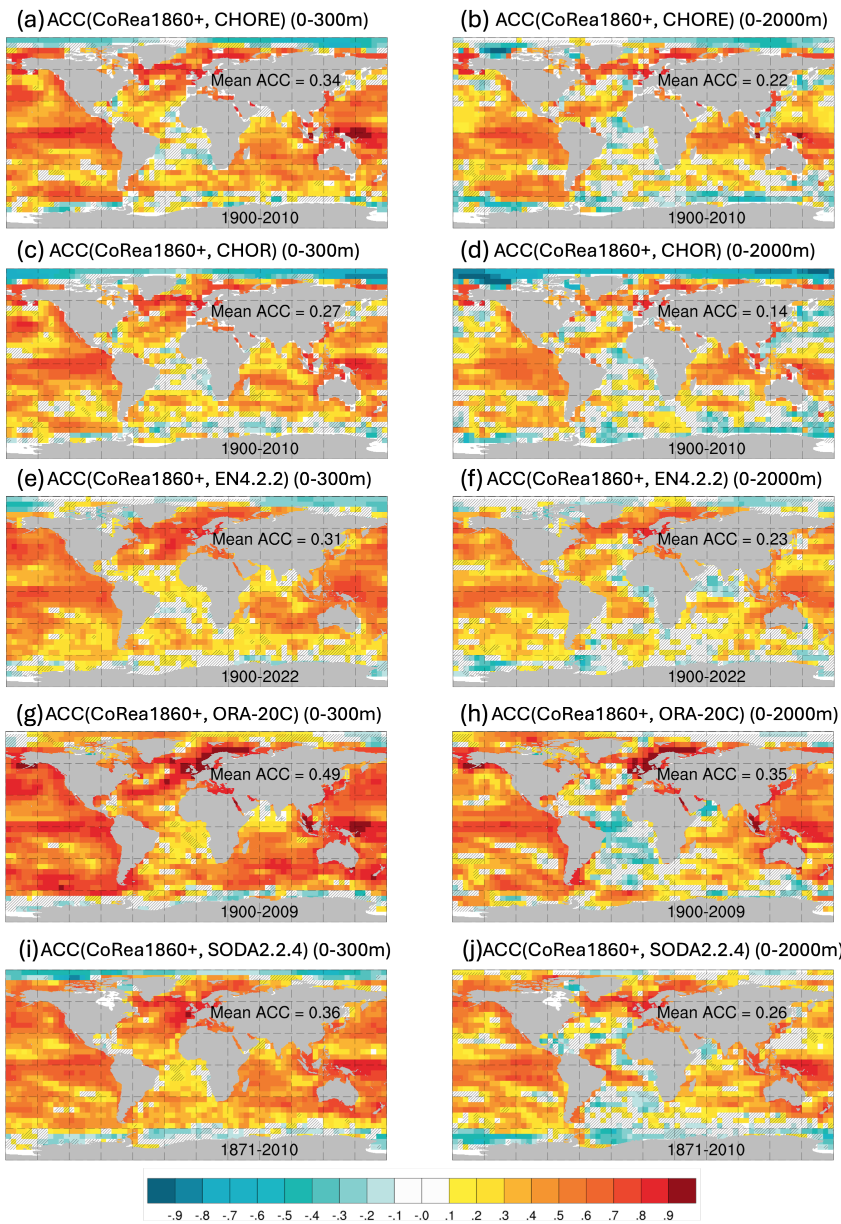


Figure R3: Same as Figure R2 but for detrended yearly OHC.

AR: We thank the reviewer for this insightful suggestion. We acknowledge that in CoRea1860+, the wind forcing is not synchronized with the observed wind fields due to the assimilation of only SST observations. As the Ekman component present in the AMOC of each ensemble member is not synchronized, we expect its contribution to the ensemble-mean AMOC shown in Figure 4 of the manuscript to be minimal.

We agree that removing the Ekman component from the other reanalyses and RAPID data would likely provide a fairer basis for comparing the interannual variability of the AMOC. However, this section primarily focuses on the long-term trend and multidecadal variability, rather than the high-frequency variability. To clarify this point for readers, we revised the text of the manuscript (L436-441):

> In the following, we focus on time series of the anomalies of the maximum AMOC transport at 26° N (Figure 4) and discuss the long-term trend and multidecadal variability of the AMOC. Note that the contribution of the Ekman component to the ensemble mean AMOC in CoRea1860+ is expected to be minimal due to the lack of wind synchronization in the assimilation system. We do not remove the Ekman component from the other reanalyses and RAPID; however, a fairer comparison of interannual variability across datasets would require doing so.

**RC:** ***Line 425: Another relevant paper that compares the AMOC mean state and variability across different ocean reanalyses is Jackson et al (2019).***

AR: Thanks for the suggestion. We added Jackson et al. (2019) into the manuscript (L457-458):

> Disagreement among reanalysis products is consistent with previous findings (Karspeck et al., 2017; Jackson et al., 2019).

**RC:** ***Lines 429-432: I wouldn't say that CoRea1860+ compares well with the other reanalyses after 2005, as the year to year variations are completely off (for the reasons explained above). Interestingly, it does show a good agreement with RAPID.***

AR: We agree with the reviewer and modified the text (L460-463) as:

> All datasets including CoRea1860+ consistently capture the rapid decline in the AMOC from 2005 to 2010, which is in agreement with the RAPID array observations. Importantly, CoRea1860+, despite not assimilating ocean subsurface data, demonstrates AMOC variability comparable to RAPID since 2005. This consistency underscores the robustness of CoRea1860+ and lends confidence to its AMOC reconstruction before the availability of extensive subsurface observations.

**RC:** ***Line 440: Change to "Superimposed on this decline there is"***

AR: As suggested, we revised the text (L471-472):

> Superimposed on this decline, there is notable multidecadal variability, which reflects the internal variability of the climate system (Delworth et al., 2016; Omrani et al., 2022).

**RC:** ***Line 442: You should mention that the decline in the early 20th century is not captured in HadISST2.***

AR: As suggested, we added the following text into the manuscript (L475-477):

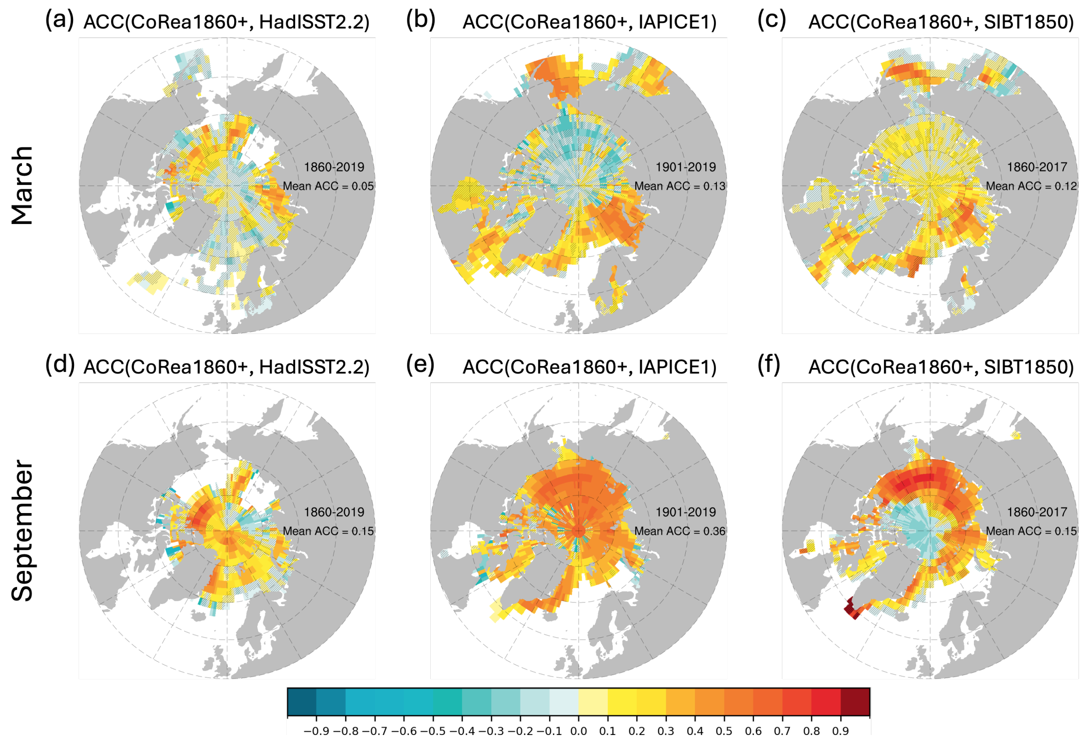


Figure R4: ACC of Arctic sea ice concentration in March or September of CoRea1860+ against HadISST2.2, IAPICE1, and SIBT1850. Grids that fail the significance test are marked with a slash. The period used to compute ACC corresponds to the overlapping period between CoRea1860+ and the specific reference dataset and is shown in Eurasia. The spatially averaged ACC is also shown in Eurasia.

> HadISST2.2 is characterized by strong interannual variability but does not show comparable multi-decadal variability and the decline in the early $20^{th}$ century observed in the CoRea1860+ reanalysis.

**RC:** ***Line 451: What is the agreement (i.e. ACC) when the trend is removed? Also, to me it doesn't look like the datasets agree so much. The areas of significant correlation values change from one dataset to another, and the values are not so high. That's an indication of high observational uncertainty across the different records.***

AR: To address this comment, we plotted ACC for the detrended timeseries of sea ice concentration (Figure R5). Comparing Figure R4 (Figure 6 in the manuscript) and Figure R5, we found that when the trend is removed, the spatial patterns remain similar but with slightly reduced ACC values. For clarity, we added a new sentence to the manuscript (L499-500):

> Note that interannual variability in sea ice concentration contributes much more to the computation of ACCs than the long-term trend (not shown).

Indeed, the areas of the significant ACC vary with the reference dataset and the region. The results with IAPICE1 and SIBT1850 agree better than with HadISST2.2, likely due to missing data in HadISST2.2. These

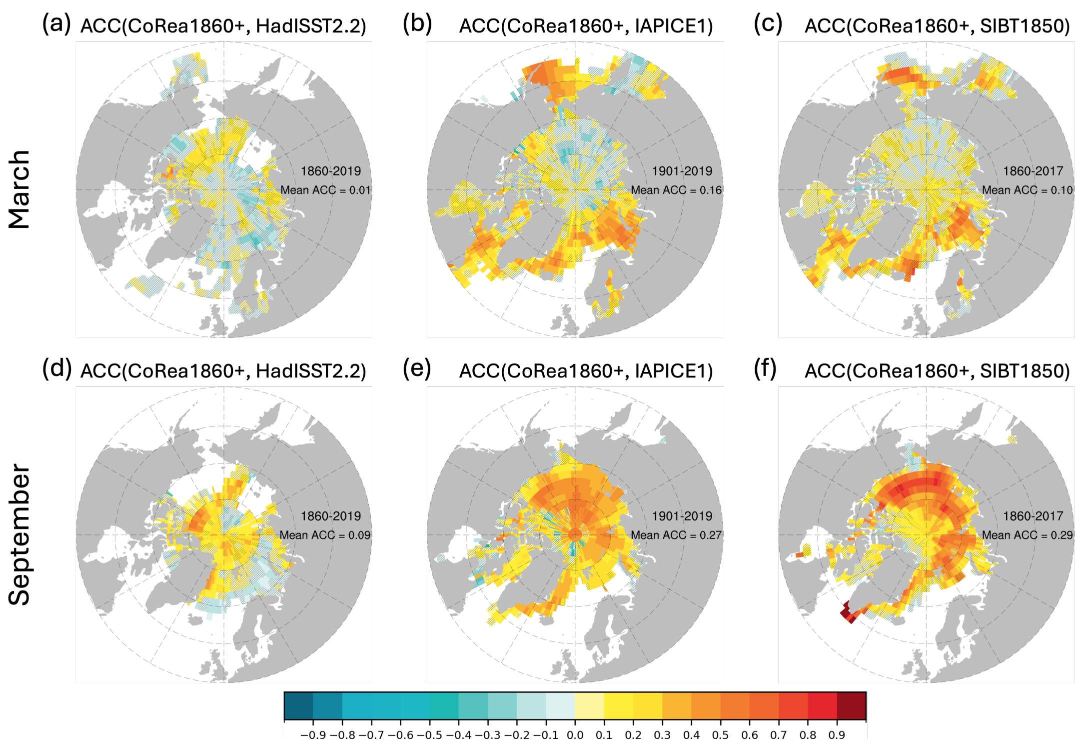


Figure R5: Same as Figure R4 but for detrended timeseries.

have been documented in the manuscript (L485-488):

> CoRea1860+ aligns with SIBT1850 and IAPICE1 in marginal ice regions, such as the Bering, Labrador, Greenland, and Barents Seas, while it shows agreement with HadISST2.2 in the Kara, East Siberian, and Beaufort Seas. Notably, the spatial coverage of ACC with HadISST2.2 is significantly lower compared to that with SIBT1850 and IAPICE1, maybe due to using climatological data before 1900 and in the 1940s when missing data (Figure 5).

**RC:** ***Figure 6: Could you indicate what the gray hatched areas indicate? Is it a lack of statistical significance? And how is that significance computed? Note that to make a fair assessment the effect of the time-series autocorrelation on the effective sample size needs to be corrected (Bretherthon et al 1999). Also, the color scale assigning white colors to the -0.1-0.1 range is a bit misleading, as it doesn't distinguish areas (e.g. the Okhost Sea in panel a) of low correlation from areas with no sea ice.***

AR: The hatched areas represent grids that fail the significance test. We have described our significance test approach in Section 3.2 (L289-295):

> For the significance test of ACC, we use the significance level of $\alpha = 0.1$ and follow the methodologies of Yeager et al. (2018) and Bethke et al. (2021). A bootstrap technique is employed to generate a probability distribution function of ACC accounting for uncertainties arising from both temporal sampling and the limited ensemble size. Specifically, we generate 1000 bootstrapped ACCs for each tested ACC by resampling the data using $x$-$y$ pairwise sampling with replacement in 5-year blocks and resampling ensemble members (also with replacement). In cases where the fraction of bootstrapped ACCs with an opposite sign to the tested ACC is larger than $\alpha$, the tested ACC is assumed to not differ significantly from zero. Grids that fail the significance test are marked with a slash on the ACC maps.

We replotted Figures 6 and 7 of the manuscript with a new colorbar as Figures R4 and R6 and added the description of the hatched areas to their caption.

**RC:** ***Line 509: To me the agreement over land areas is much less clear than for the ocean, with some areas like North America, Russia and Argentina with low and even negative correlations.***

AR: In North America, while ACCs are positive and significant in most areas in winter, they are low or significantly negative in summer. In Russia and Argentina, ACCs are low or significantly negative in both winter and summer. However, in many other land regions, in particular tropical regions, ACCs are positive and significant. We modified the text (L544-547) as

> CoRea1860+ exhibits consistency with ERA-20C, CERA-20C, and 20CRv3 in ocean regions and some land regions (Figure 9). The spatial patterns of ACCs are highly consistent across the reference datasets, with spatially averaged values ranging from 0.50 to 0.66. The highest mean ACC is obtained with CERA-20C, which is also a coupled reanalysis. In both boreal winter (DJF) and summer (JJA), ACCs are generally higher over oceans than over land where the oceanic influence is reduced.

**RC:** ***Line 529-530: How do you explain this better agreement in winter than in the summer? In winter, the Arctic is largely covered by sea ice so the direct influence on evaporation (and through it on precipitation) is expected to be reduced.***

AR: The better agreement is located mostly in the Greenland Sea and the Barents Sea, which are the downstream regions of the Norwegian Current (a branch of the North Atlantic Current and bringing warm water from the south). We added a short explanation to the manuscript (L567-568) as

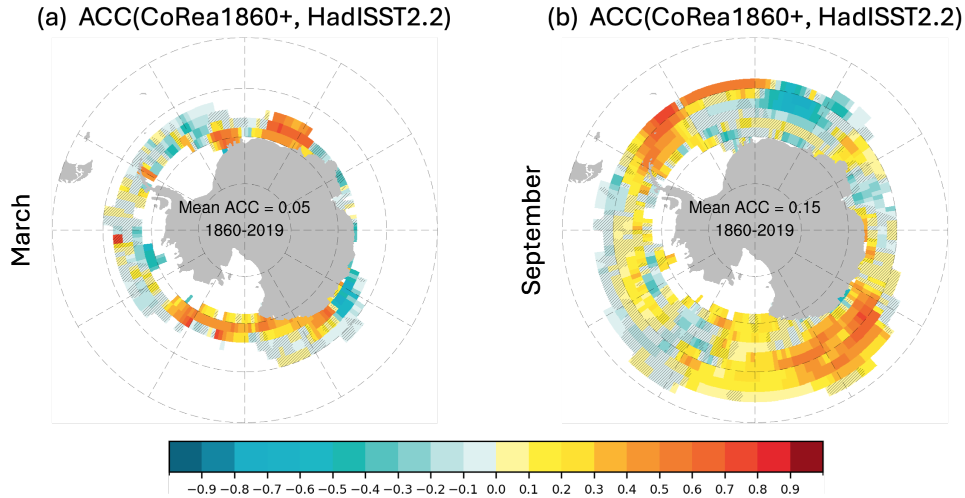


Figure R6: ACC of Antarctic sea ice concentration in March or September of CoRea1860+ against HadISST2.2. Grids that fail the significance test are marked with a slash. The period used to compute ACC corresponds to the overlapping period (i.e., 1860-2019) and is shown in Antarctica. The spatially averaged ACC is also shown in Antarctica.

> In the Arctic, ACCs in DJF are higher than in JJA, particularly in the Norwegian-Barents Seas, primarily due to the relatively stronger influence of the Norwegian Current in winter (e.g., Wang et al., 2019).

**RC:** ***Line 533: The correlations are not high and significant everywhere, so I would directly say which regions show a good agreement and which ones don't.***

AR: As suggested, we removed the leading sentence of this paragraph (L572-576) as

> For SLP in both boreal winter (DJF) and summer (JJA) (Figure 11), ACCs are particularly high in the tropics, especially over the tropical Pacific, due to the strong influence of ENSO and its teleconnections (e.g., Luo et al., 2005). In contrast, ACCs are lower in the mid-latitudes compared to the tropics, especially in regions such as North America, the North Atlantic, and North Asia. ACCs are low in the Arctic during both DJF and JJA. However, in the Antarctic, ACCs are relatively high during DJF but notably low during JJA. The spatially averaged ACCs are between $0.30$ and $0.35$ in DJF and between $0.20$ and $0.27$ in JJA.

**RC:** ***Lines 556-558: Given the suitability of CoRea1860+ to look at both long-term climate changes (e.g. trends) and the slow modes of internal climate variability, I miss some analyses in the paper that assess both aspects. One example would be checking to what extent the low-frequency changes in the North Atlantic Oscillation have been forced by the ocean, by verifying if CoRea1860+ is able to reproduce them.***

AR: As we demonstrated in Figures R2, R3, R4 and R5, the long-term climate changes (e.g., trends) over the whole period have contributed to ACC plots, which vary in region and are much weaker than the interannual variability.

As suggested, we added a new analysis on the NAO in the manuscript (L580-590) as follows:

> The North Atlantic Oscillation (NAO) is a predominantly atmospheric mode of climate variability and represents one of the most prominent patterns of climate fluctuations over the North Atlantic and surrounding regions (e.g., Hurrell, 1995). Following the definition in Hurrell (1995), we calculate the winter (December–March) NAO index as the difference between normalized SLPs at Lisbon and Stykkisholmur (Figure 12). The NAO indices from ERA-20C, CERA-20C, and 20CRv3 show strong agreement, reflecting the constraint provided by the assimilation of surface pressure observations (Figure 12a). In contrast, CoRea1860+, which assimilates only SST observations, exhibits weak interannual variability in the ensemble mean and a relatively large ensemble spread. The correlations between the NAO indices from CoRea1860+ and those from the reference reanalyses are all below $0.16$. This indicates that SST assimilation alone is not sufficient to synchronize the NAO's year-to-year fluctuations with those in the other reanalyses. Nevertheless, CoRea1860+ shows the NAO's decadal variability (Figure 12b), suggesting a potential oceanic influence on longer timescales. This highlights an area of interest for future investigation, particularly in exploring how ocean-atmosphere coupling may contribute to low-frequency NAO variability.

**RC:** ***Line 571: Can you rephrase it? It's not clear what you mean by depiction of AMOC variability in the context of the first part of the sentence.***

AR: For clarity, we modified the sentence (L621-622) as

> CoRea1860+, which assimilates SST data, captures the temporal variability of the OHC across different regions and the AMOC.

**RC:** ***Line 576: What do you mean by open-water regions?***

AR: Here we have wanted to say the oceans [$60°$S, $60°$N] that are mostly not covered by sea ice. For clarity, we revised the text (L629-631) as follows:

> For both OHCs in the 0–300 m and 0–2000 m, CoRea1860+ aligns more closely with the comparison datasets in the oceans [$60°$S, $60°$N] and the Arctic Ocean than in the Southern Ocean, particularly after the 1950s.

**RC:** ***Line 587: The authors repeatedly use the expression "reasonable variability" throughout the manuscript, which is ambiguous. I recommend using more precise terminology. Additionally, providing some quantification—such as the correlation coefficient and its p-value—would enhance clarity and support the interpretation.***

AR: We appreciate the reviewer's suggestion regarding the use of the term "reasonable variability". We acknowledge that this expression can be ambiguous without further clarification. In the revised manuscript, we carefully reviewed and revised the relevant sentences. Where possible, we replaced the term with more precise language or added supporting quantitative information, such as the spatially averaged ACC.

**RC:** ***Line 610: It would be beneficial for the article to conclude with a prospective paragraph on the intended use of the CoRea1860+ at NERSC/UoB, also highlighting potential applications for other research groups to encourage its adoption.***

AR: In response to this comment, we added one prospective paragraph in the manuscript (L671-680):

While the present study focuses on describing and evaluating the CoRea1860+ dataset, its extended temporal coverage is well-suited for studying long-term climate variability and the slower modes of the climate system over the historical period. For instance, we have been contributing a prospective paper on AMOC variability and predictability. Furthermore, the direct constraint of the ocean component in CoRea1860+ enhances its suitability for investigating the ocean's role as a primary driver of interactions within the climate system. We have been investigating whether the ocean drives the decline in Antarctic SIE from 1940 to 1980. The relatively large ensemble of 30 members offers possibilities to study teleconnections over the entire historical period. CoRea1860+ can also be used to initialize climate predictions over much longer periods than normally considered (e.g., 1960-present in CMIP6 Decadal Climate Prediction Project, Boer et al., 2016), and can provide more reliable estimates of multi-annual prediction skill. We have performed a set of decadal hindcasts starting each year from 1873 to 2020 initialized by CoRea1860+ and have been investigating the modulation of decadal prediction skill.

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