Response to reviewer 2 Comments

General comments:

The Saharan Heat Low (SHL) is one of the important drivers of summer-time precipitation over the West African Monsoon. The authors discussed the performance of two state-of-the-art seasonal forecasting systems SEAS5 (ECMWF) and MF7 (MeteoFrance) in forecasting the Saharan Heat Low (SHL) against ERA5 reanalysis data for the period 1993-2016. SEAS5 and MF7 show opposite biases and both models under-estimate the interannual variability of the SHL. Statistical bias correction methods reduce biases; however, they do not add much in terms of skill beyond 1 month. A lot has been done, but there are several critical issues that hamper the suitability of the current MS for its publication in WCD. Below are some points both major and minor that Authors should consider during their revision.

We first thank the reviewer for his/her availability and interest to evaluate the work.

Some points are (major and minor):

- Introduction can be organized better.

Line 19: poor precipitation forecast skill is for what seasonal? Subseasonal? The reference provided showcased 1-5 day precipitation skills.

We clarified this point by adding the following sentence in the manuscript:

{" In the Sahel region, food security for populations depends on rain-fed agriculture which is conditioned by seasonal rainfall (Durand, 1977; Bickle et al., 2020), characterized by a strong convective activity in the summer, associated with a large climatic variability (local- and large-scale forcings), generally leading to poor precipitation forecast skills at sub-seasonal and seasonal time scale in tropical north Africa."}

Thanks to the reviewer for this remark.

Line 37: Adding a demographic map will be good mentioning names of countries etc.

According to the reviewer's suggestion, we integrated a demographic map of the Sahara region with the names of countries.

Line 41 to 50: the references mentioned are from CMIP5 models, these may be fine, but not much relevant in the current research – this paper is concerning with initialized models aka seasonal forecasting system, so suitable references are those that utilized such models for SHL analysis.

We followed the suggestion of the reviewer and replaced the references using the climate models by the following references :

The old references :

{ " Roehrig et al. (2011) studied the link between the variability of convection in the Sahel region and the variability of the SHL at intra-seasonal time scale using National Center for Environment Prediction (NCEP-2) reanalysis data. They showed that the onset of the monsoon is associated with strong SHL activity when the northerlies coming from the Mediterranean (sometimes called ventilation) are weak. Conversely, they revealed that the formation of a strong cold air surge over Libya and Egypt and its propagation toward the Sahel lead to the collapse of the SHL, which inhibits the WAM onset. Lavaysse et al. (2016) analysed the variability of the SHL at intra-seasonal time scale using reanalyses and Atmospheric Models Intercomparison Project simulations from 15 climate models performed in the framework of the 5^{th} Coupled Models Intercomparison Project (CMIP5). They observed a high variability in the temporal trends of the SHL for the 15 climate models. They also found large discrepancies between reanalyses and climate model simulations regarding the spatio-temporal evolution of the SHL. Dixon et al. (2017) investigated the representation of the characteristics of the SHL in 22 global climate models from CMIP5. They highlighted large biases in the CMIP5 models in terms of intensity and location of the SHL compared to reanalyses. They noticed that the CMIP5 models tend to develop weaker climatological SHLs than the reanalyses. "}

The relevant references are now given in the new paragraph:

{" Lavaysse et al. (2009) monitored the seasonal evolution of the West African Heat Low (WAHL) using ERA-40 reanalyses and brightness temperature from the Cloud Archive User Service (CLAUS). They found a north-westward migration of the WAHL from a position south of the Darfur mountains in the winter to a location over the Sahara between the Hoggar and the Atlas mountains during the summer. They also estimated the climatological onset of the SHL occuring around the 20th June (from the period 1984-2001) some days before the climatological monsoon onset date. This highlights strong links between the SHL and the monsoon flow. Chauvin et al.

(2010) assessed the intraseasonal variability of the SHL and its link with midlatitudes using National Center for Environment Prediction (NCEP-2) reanalysis data. They found a robust mode of variability of the SHL over North Africa and the Mediterranean which can be decomposed into two phases generally termed as east-west SHL oscillations. The west phase corresponds to a maximum of temperature over the coast of Morocco–Mauritania, propagating southwestward, and a minimum of temperature between Libya and Sicily, propagating southeastward. The east phase corresponds to the opposite temperature structure which propagates as in the west phase. Roehrig et al. (2011) investigated the link between the variability of convection in the Sahel region and the variability of the SHL at intra-seasonal time scale using NCEP-2 reanalysis data. They showed that the onset of the monsoon is associated with strong SHL activity when the northerlies coming from the Mediterranean (sometimes called ventilation) are weak. Conversely, they revealed that the formation of a strong cold air surge over Libya and Egypt, and its propagation toward the Sahel lead to a decrease of the SHL intensity, which inhibits the WAM onset. "}

Line 51: Mentioning the "Climate Models", in "above studies", these are IPCC models, and Author mentioned seasonal forecasting models, so valid reference should be provided, if no reference available, just relying on OBS studies might be enough. Authors should take this concern, as it could avoid a lot of confusion present in the current MS.

We agree with the reviewer and clarified this point as follow :

the old formulation:

{" As detailed above, previous work has evidenced the limits of climate models in reproducing SHL variability and characteristics; but they have also shown the importance and the role of the SHL on the West African climate. One may legitimately wonder how seasonal forecast models represent the SHL since they rely on numerical climate models? "}

the new formulation:

{" As detailed above, previous work has evidenced the importance and the role of the SHL on the West African climate. These studies are based on a climatological view of the SHL using mostly reanalysis data. One may legitimately wonder how seasonal forecast models represent the SHL evolution? "}

Line 56-60: rewrite, these are confusing and not clear.

We reformulated the sentence for the sake of clarity as the reviewer suggests.

The old formulation was : { " The seasonal forecast is a long-term probabilistic forecast which is very useful by allowing an anticipation of seasonal trends. The use of ensemble forecast for seasonal forecasting provides a range of forecasts and gives information about the spread associated with the forecast of a specific parameter. Ensemble forecasts can be processed differently depending on the tasks assessed by using the (mean/median/unperturbed/ensemble)-member. This is not the case with deterministic forecasts which provide a unique forecast. Probabilistic forecast tends to increase the predictive skills of the models (Haiden et al., 2015;Lavaysse et al., 2019). "}

The new formulation is the following :

{ " A seasonal forecast is a long-term forecast which is very useful by allowing an anticipation of seasonal trends. The use of ensemble forecasts for seasonal forecasting provides a range of forecasts and gives information about the spread associated with the forecast of a specific atmospheric variable. Ensemble forecast models lead to an improvement of the predictive skills of some atmospheric variables (Haiden et al., 2015; Lavaysse et al., 2019). The evaluation of the SHL behaviour in seasonal forecast models has not been addressed yet. Provided that the SHL characteristics (i.e. the east and west pulsations of the Heat low, its intensity and its interannual variability) are well captured in seasonal forecast models simulations, they can be used as predictors for rainfall in the Sahel area.

"}

Line 60: remove "some".

we removed "some" as suggested by the reviewer, and the new sentence is the following:

{" The goal of this article is: i) to investigate the representation and the forecast skills of the SHL in two seasonal forecast models and ii) to evaluate the added value value of bias correction techniques on raw seasonal forecasts."}

Line 61: Climate models or seasonal forecasting models?

We clarified this point by replacing " climate models " by "seasonal forecasting models", thanks to the reviewer. The new sentence is the following :

{ " Bias issues are very frequent in seasonal forecast models, by correcting them with statistical methods, it can improve the predictive skills of the seasonal models and obtain a better representation of some atmospheric variables. " }

Line 63: Prediction skill is for SF models.

Yes we agree with the reviewer, we have clarified it in the previous comment.

Line 62-63: Rewrite.

We reformulated the current sentence according to the reviewer suggestion:

The old sentence {'' Bias issues are very frequent in climate models, by correcting them with statistical methods, one can improve the predictive skills of the models and obtain a better representation of some atmospheric variables. This task has not been addressed yet for the seasonal forecast of the SHL.'' } has been replaced.

The new sentence now writes : { " Bias issues are very frequent in seasonal forecast models. By correcting them with statistical methods, the predictive skills of the models can be improved in order to provide atmospheric variables that better fit the characteristics of the observation. " }

Line 64:

Need more details about this, by looking at this one can observe the low skill in SHL in current state-of-the-art SF models, how SHL then can be used as a predictor for the rainfall?

It has been shown that the SHL is a key component of the WAM system at synoptic scale (Sultan and Janicot, 2003,; Parker et al., 2005; Lavaysse et al.,2009, among others). Provided that the SHL characteristics (i.e. the east and west pulsations of the Heat low, its intensity and its interannual variability) are well captured in seasonal forecast models simulations, they can be used as predictors for rainfall in the Sahel area.

"Seasonal models" must be seasonal forecasting models.

We replaced " seasonal models" by "seasonal forecasting models" as suggested by the reviewer.

{ “ To reach this aim, we firstly study the SHL variability modes in seasonal forecasting models and reanalyses; secondly we estimate thebiases between the forecasts and reanalyses. “}

- Line 75: Add topography figure as mentioned above.

We added a topography map as mentioned by the reviewer.

- Line 80-85: 30E must be 30 N, here and others as well.

Yes the reviewer is right, we rectified as he suggested. Thanks to the reviewer for this remark.

{ “ the Sahara area between 10◦W - 20◦E and 20◦N - 30◦N;

the central SHL here denoted as ”CSHL”, is located between 7◦W - 5◦E and 20◦N - 30◦N;

the Western SHL here denoted as ”WSHL”, is located between 10◦W - 2◦W and 20◦N - 30◦N;

the Eastern SHL denoted as ”ESHL”, is located between 0◦E - 8◦E and 20◦N - 30◦N. “ }

- Boreal summer is JJA. A study considering June to September, and some places June to November. Be consistent

To be more consistent in our study, we replaced “boreal summer “ by “JJAS” and the modified sentence now writes: { “ Those four sub-regions have been chosen based on previous works. The ‘central SHL’ region is the location where Lavaysse et al. (2009) have detected the SHL with an occurrence of more than 70% during the JJAS period, the ‘Sahara box’ is highlighted in climate studies (Lavaysse, 2015; Taylor et al., 2017), and the ‘Western SHL’ and ‘Eastern SHL’ boxes are defined to highlight the East and West phases of the SHL (namely an east-west oscillation of the location of the maximum low-layer temperature at synoptic scale (Roehrig et al., 2011). “}

- Related to above, Figures 2 and 3, captions say the computation for SHL is performed for June to November period. While text section 2.3 (Line 113) says June to September period. Which one is right?

This is an important remark from the reviewer, it is a mistake in the captions on figures 2 and 3. For all our analyses, we focused on the JJAS period except for the analysis of the drift and the monthly climatological bias. We corrected this information in the manuscript to be clearer.

{" Figure 2. Climatology of significant days: significant days here refer to days with spectral power signal greater than 1. Red, blue and black curves and bars represent respectively SEAS5, MF7, ERA5 number of days and spread over: a) central SHL box and b) Sahara during the period 1993-2016. The computation was made just using the unperturbed member of the ensemble forecast models launched from the 1st of June for the JJAS period. The Y-axis represents significant days and the X-axis the duration of propagation in days``}

{ " Figure 3. Inter-annual variability of significant days: significant days here refer to days with spectral power signal greater than 1. Red, blue and black curves represent respectively SEAS5, MF7, ERA5 number of days over: a) - c) central SHL and d) - f) Sahara. The values on red and blue boxes refer to the correlation respectively between SEAS5 and ERA5, MF7 and ERA5, respectively. [0,10],]10,22], and]22,32] are the different classes of days identified for the present study. The computation was made by using only the unperturbed member of the ensemble forecast models launched from the 1st of June for the JJAS period. The Y-axis represents significant days and the X-axis the time of year. "}

- Line 95: Be specific, Is this 2m temperature?

We thank the reviewer for this relevant comment. We have clarified this point by explaining that we use the daily temperature at 850 hPa. We added this information in the text to be more explicit.

{" The ERA5 atmospheric variable studied here is daily temperature at 850 hPa with a spatial resolution of 0.25° x 0.25° downloaded from the climate data store website: https://cds.climate.copernicus.eu/. "}

- Native SEAS5/MF7 is 36/37 KM, and ERA5 is 0.25, then why remap at 1x1.

The remapping process allows us to get the same spatial resolution in all the products. Furthermore, as computations of spatial mean are made on large boxes, the impact of resolution of the products is negligible.

- Line 108: SEAS5 forecast is for 0.5 to 5.5. What you mean by "for a period of 6-12 months for SEAS5"

Thank the reviewer for this comment, by “for a period of 6-12 months for SEAS5” we want to specify that the forecast period of SEAS5 is at least 6 months. We clarified it accordingly in the text:

{“ The re-forecasts are released on the first day of every month for a period of 6 months for SEAS5. “}

- Line 115 to 120: Organize intro well, otherwise readers will remain in the state of constant confusion. Provide a reference/references that use either NWP or SF models.

We already took this comment into account. Please see the previous modifications.

- Line 134: Since T850 hPa is used, I would recommend using this term instead of simply saying temperature.

Thanks to the reviewer, we adopted this notation. We replaced temperature by “T850 hPa” in the text.

- Line 135: If no detection is performed, better to use a different heading for 2.4.1.

As we didn’t perform a detection of the SHL, we changed the title of this section according to the reviewer comment. The new title is the following :

{“ Saharan heat low evaluation metric.“}

- Line 154: The period of the analysis is also the same for OBS. Make it clear. Are you focusing June to Sep or all 6-months?

For this analysis, we focused on all the 6-month from June to November. We clarified it in the text as follows :

{“ The wavelet analysis has been applied separately on the re-forecasts and the reanalyses for an initialisation of the seasonal forecast models on the \$1^{st}\$ of April, May and June for a 6 months period; but we extracted only the signal on the JJAS period to conduct our analyses on variability modes. “}

- Line 158: “reservoirs” may be better replaced by being components.

Thanks to the reviewer for this suggestion, we adopted it :

{ " Climate models provide a numerical representation of the earth and the interactions between its different components. " }

- Section 2.4.3: Bias correction depends upon the data. You can consider other OBS datasets as well, matching your analysis window, and may add this OBS sensitivity as supplementary material.

We agree with the reviewer that bias correction depends on the data used as reference, but the sensitivity analysis required by the reviewer is out of the scope of this study. Indeed these sensitivity tests are particularly important for the developers of bias correction methods. In the present study other observations will change the final debiased products (depending on the observation used) but will not bring pertinent additional information according to our objectives.

Line 211: Which "previous analysis"???

This previous analysis was a benchmark of the evaluation of the predictive skills of ensemble forecast models using probability scores (not published but will be integrated into another study).

We clarified this point in the manuscript as follow:

{" A preliminary study was conducted to benchmark the skills of the seasonal forecast models using different scores, namely Continuous Ranked Probability Score (CRPS), Brier Score, Roc Area Curve, Rank Histogram, Reliability Diagram (not shown). Based on this, we have only focus on the CRPS for the present work."}

Line 215: Provide the definition of CRPS, that it is a quadratic measure of the difference between the forecast CDF and OBS CDF.

Thanks to the reviewer for providing the definition of the CRPS score. we added to the text :

{ " The CPRS is a quadratic measure of the difference between the forecast CDF and observation CDF. It quantifies the relative error between the model forecasts and the observations. It is a measure of the precision of an ensemble forecast model. The closer the CRPS is to 0, the better the forecast. "}

- Line 225: This agreement is in terms of OBS and models? Or just in terms of observation. Better to rewrite this sentence.

We want to mention the fact that the strong intensities of the SHL are found in the same box as in Lavaysse et al. ,2009. We clarified this by reformulating the sentence as follow: { " For both seasonal models and ERA5, the strong intensities of the SHL are located over the central SHL (CSHL) location; this is in agreement with Lavaysse et al. (2009) who identified high activities of the SHL in the same location using ERA-40 reanalysis."}

- Line 229: SEAS5 should be ERA5.

Thanks to the reviewer for this remark, we corrected directly in the text :

{" Through a wavelet transformation, we compared the variability modes in the forecast products (SEAS5, MF7) with respect to ERA5 over central SHL location and Sahara (boxes indicated in Fig. 1) (see [Fig. S1] in supplemental material). "}

- Line 240: "similar behavior" in SEAS5 and MF7? Rephrase this sentence.

Not exactly, by " similar behavior in all products", we mean here in all the datasets used for the study: the reanalysis ERA5 and the seasonal forecast models (SEAS5 and MF7). We clarified that point in the manuscript to avoid confusion:

{" We observe a similar behaviour in ERA5, SEAS5 and MF7 in terms of significant days with an increasing number of days with periods up to 10 days followed by a quite steady activity for longer periods."}

- Line 260: Move this to the Methods section.

We moved this sentence to the method section according to the reviewer's suggestion.

- Line 265: The analysis period is from June to September when SHL is active. Why did you add here other months? Is there any reason? And you used Lead-0 in this case. This is strange to see a contrasting behavior in models at Lead-0.

Yes we agree with the reviewer but the analysis of the monthly bias is not performed exclusively on JJAS. By computing the bias over each month of the year, we are able to check if the biases in the seasonal forecasts models are constant or specific to the JJAS period. Yes, we used lead time 0 for the estimation of the monthly bias over the period 1993-2016.

{ " The bias is computed for each month at lead time 0 during the season from January to December for the period 1993-2016. This allows us to check if the biases in the seasonal forecast models are constant or specific to the JJAS period." }

- Line 273: Hot may be replaced by warm.

Thanks to the reviewer for this suggestion, we replaced in text :

{ " This warm bias tends to develop from March to September and affects the whole Sahara. It is more intense during the monsoon phase and is located over the eastern part of the Sahara "}

- Line 275: What is "observed bias". Rewrite for clarity.

The " observed bias" refers to the bias between MF7 and ERA5. We clarified it in the text :

{ " The bias between MF7 and ERA5 tends to decrease in intensity during the retreat of the monsoon in October. "}

- "hotter trend", What does this mean? Confusing? Rewrite.

We rewrote this sentence to avoid confusion to the reader.

{ " MF7 is hotter than ERA5 and overestimates the spatial evolution of the SHL over the Sahara."}

- Line 270 to 280: Why two models show completely opposite bias? Authors must provide some plausible reason for these opposite behaviors in these models? Please also use other observations for a comparison. Maybe adding RMSE is also valuable here.

We would like to thank the reviewer for this valuable comment.

Both models exhibit strong and opposite biases over the Sahara indeed.
The investigation of mechanism causing the biases is a long-term subject for which a large set of sensitivity experiments is needed. The origins of these biases are way beyond the scope of this article. They are likely associated with global biases like ocean drift and / or biases in the representation of continental surfaces. The strength of the biases over Sahara is not really mentioned in the litterature, especially in the not-so-large literature about seasonal forecast systems. It is partly explained by the use of anomaly relative to the hindcast to apply a 1st order debiasing.

We added a more precise comment in the text to underline the scope of the paper which is to provide a regional evaluation of the skill of both seasonal forecast systems and a debiasing methodology to allow application developpement.

We add a few contextual points to allow the reviewer having a more complete view on these biases. Like ocean-atmosphere coupled climate models, seasonal forecast systems have the same difficulties to represent a proper ocean-atmosphere coupling, which is sensitive to the way the ocean is initialized. For instance, MF7 has the core of CNRM-CM6 (Voldoire et al. 2019) with different ocean initialisation. MF7 uses NEMO v3.6 ocean model initialized with MERCATOR ocean data while SEAS5 uses NEMO version 3.4 initialized with the Global Ocean Data Assimilation System (NEMOVAR-OCEAN5) data. It has a global impact as shown on Figure1 for both models.

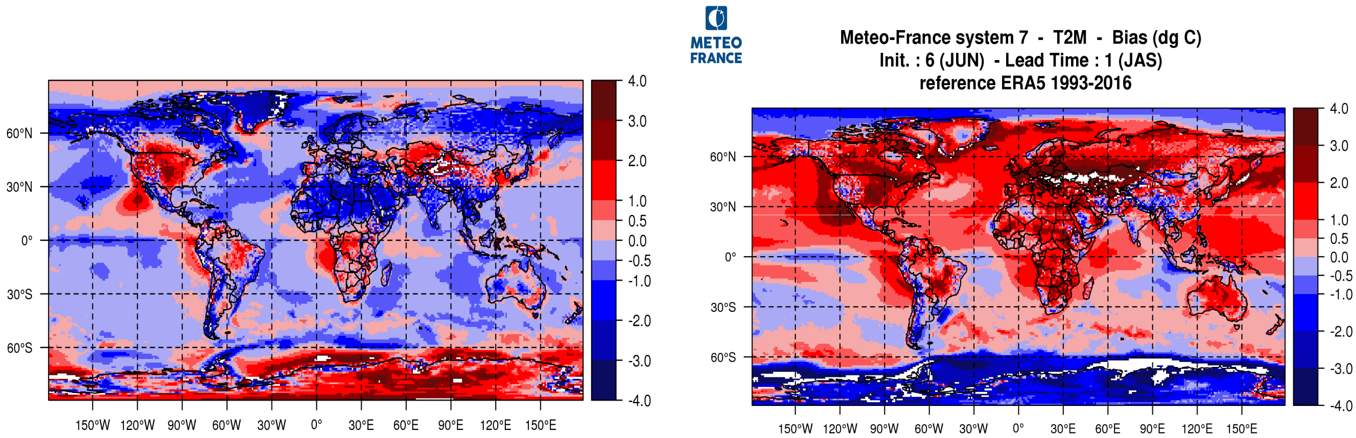

Figure 1 : 2m-temperature bias for SEA5 (left) and MF7 (right) with reference to ERA5 on the period [1993-2016]. June initialisation is considered for JAS forecast.

The biases are of opposite signs over the Sahara but of the same signs over the USA and southern Africa. Strong oceanic biases develop quickly after the initialization and might be responsible for persisting biases during the forecast but continental surface representation, radiative effect of aerosol and low-level advection can be valid potential explanations of these biases. In a more general framework, various european research projects have shown the difficulty of attributing a specific bias to a specific parameterization over West Africa, including the SHL (Martin et al. 2017).

The cold bias in SEAS5 is consistent with previous global studies (Jonhson et al. 2019, Fig.10, Haiden et al. 2021) although the continental surface parameterisation of ECMWF is known to produce relatively cold surface compared to other forecast systems. The hot bias in MF7 is in agreement with a previous analysis carried out at Meteo France on the 2-meter temperature (Figure2) comparing MF7 forecasts to ERA5 reanalyses.

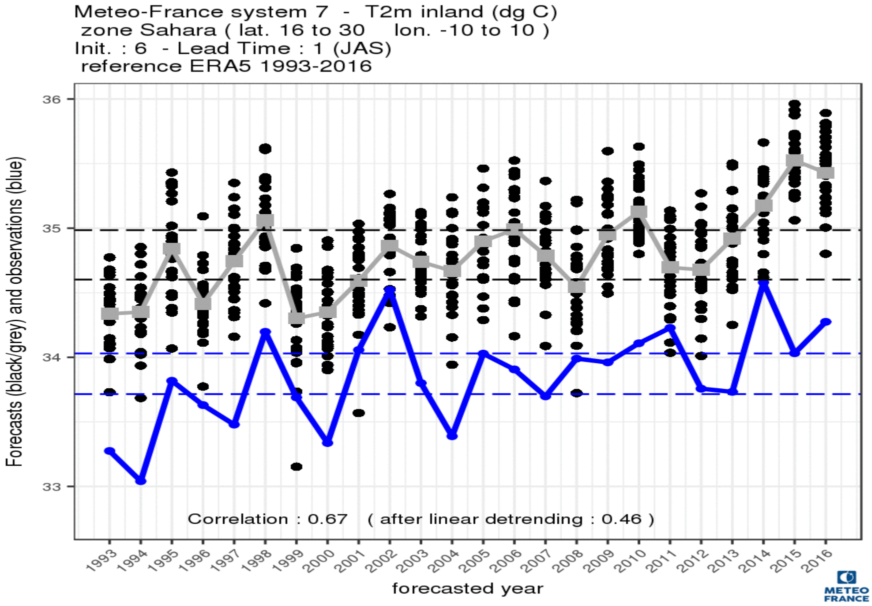

Figure 2 : Sahara box-avered 2m temperature for ERA5 (blue) and MF7. The gray line shows the ensemble mean and the dots correspond to each member. The correlation to the reanalysis is indicated at the bottom.

We added some information about this point in the manuscript as follow:

{ "Without sensitivity tests, it is difficult to clearly identify the reasons for these opposite behaviors between the models. Nevertheless, because of the spatial and temporal variabilities of the results (warm bias for MF7 over Libya) we can suspect a misrepresentation of air advection in the seasonal forecast model. These results are in agreement with previous studies which show a warm/cold bias over the continents with MF7/SEAS5 (Jonhson et al. 2019, Haiden et al. 2021). In a more general framework, various european research projects have shown the difficulty of attributing a specific bias to a specific parameterization over West Africa, including the SHL (martin et al 2017)."}

References :

"NEMO ocean engine",
Gurvan Madec and NEMO System Team,
Scientific Notes of Climate Modelling Center (27) – ISSN 1288-1619,
Institut Pierre-Simon Laplace (IPSL)

Johnson, S. J., Stockdale, T. N., Ferranti, L., Balmaseda, M. A., Molteni, F., Magnusson, L., Tietsche, S., Decremer, D., Weisheimer, A., Balsamo, G., Keeley, S. P. E., Mogensen, K., Zuo, H., and Monge-Sanz, B. M.: SEAS5: the new ECMWF seasonal forecast system, Geosci. Model Dev., 12, 1087–1117, https://doi.org/10.5194/gmd-12-1087-2019, 2019.

T. Haiden; M. Janousek; F. Vitart; Z. Ben-Bouallegue; L. Ferranti; C. Prates; D. Richardson Evaluation of ECMWF forecasts, including the 2020 upgrade 01/2021 , ECMWF technical memorandum, https://www.ecmwf.int/en/publications/technical-memoranda

Martin, G. M., Peyrillé, P., Roehrig, R., Rio, C., Caian, M., Bellon, G., Codron, F., Lafore, J.-P., Poan, D. E., and Idelkadi, A. (2017), Understanding the West African Monsoon from the analysis of diabatic heating distributions as simulated by climate models, J. Adv. Model. Earth Syst., 9, 239– 270, doi:10.1002/2016MS000697.

According to the reviewer comment we added the MERRA reanalyses. Please see the new intercomparison of MERRA-ERA5 in the supplementary materials (Fig.S1 and Fig.S2) and the new figures (Fig.2, Fig.6 and Fig.7) that integrate the new set of data. As shown in the new results, behaviors and differences among the seasonal forecast models remain very similar to those obtained with ERA5.

According to the reviewer's suggestion, RMSE has been calculated and discussed (see Fig . S11 in supplementary materials).

- Line 301: Avoid “trend”, when explaining bias analysis. This is confusing.

We removed “trend” and reformulated the sentence as follow: { “The bias evolution is quite similar over the two periods (see [FigS2]/[Fig4-a)]); but we notice in SEAS51 a smaller cold bias compared to SEAS52. “}

- Line 330-335: Move this to the Method section.

We do not totally agree with the reviewer's suggestion here. This part is useful for the introduction of bias correction analyses.

- Line 335: Not clear.

We reformulated this sentence for the sake of clarity:

{ “ In our case, the bias correction is first applied separately on the ensemble members, in order to correct the forecasts of each one of the 25 members of the seasonal forecast models (SEAS5 and MF7). A second methodology has been tested by applying a bias correction on the ensemble mean .”}

- Line 364: AEJ is defined already. Please check for this and others.

Yes “AEJ” has been already defined previously, so we reformulated the sentence as follow:

{ “ Strong SHL activity contributes to the reinforcement of the monsoon flow over the Sahel along the eastern flank of the SHL. It also modulates the intensity of the AEJ and generates wind shear over the region.” }

- What is DACCIWA?

We provided the definition of DACCIWA in the text:

{ “ We evaluate the method using the LLAT approach and the automatic detection of the SHL barycenter (Lavaysse et al., 2009) used during the H2020 DACCIWA (Dynamics-Aerosol-Chemistry-Cloud Interactions in West Africa) project (Knippertz et al., 2017), which aims to evaluate the seasonal location of the SHL with respect to its climatological position. “ }

- Line 406: All datasets mean both SEAS5 and MF7?

By “All datasets”, we refer to the reanalysis ERA5 and the seasonal forecast models. We clarified it in the text: { “ First, it is worth noting that the East Sahara is climatologically hotter than the West Sahara in ERA5, SEAS5 and MF7. “}