Changes in extreme precipitation patterns over the greater Caribbean and teleconnection with large-scale sea surface temperature

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Reply to reviewer #1

We sincerely thank reviewer #1 for his thorough review and insightful comments. Below are our responses to the comments. Responses are shown in blue, comments in black.

1. Page 1, line 14: the phrase “the greater Caribbean” is used, What is this? I suggest the authors to clarify this.

   The Greater Caribbean comprises all the states and territories with coastlines on the Caribbean Sea. These include the Greater Antilles and the Lesser Antilles. The term "la grande cariabe" has therefore been used to present the region from which the study area has been extracted. However, in line 14, the term "La grande Caraibe" could mean that the work was carried out over the whole region. To clarify, a correction has been made in the text by adding the following: "the greater Caribbean, particularly the Greater Antilles".

2. Page 1, line 22: the phrase “Northern Oscillation Index (NAO)” is used, I highly recommend using “North Atlantic Oscillation” instead.

   This correction will be taken into account in the revised version of the document.

3. Page 3, lines 95-96 “They have a monthly rainfall cycle characterized by two peaks: the first in May and the second between September and November” This should be cited.

   Chen and Taylor(2002), this citation will be added to the revised version of the paper.

4. Page 3, lines 96-98: “North Atlantic anticyclone” better use “North Atlantic subtropical high (NASH)“. Here adding more information about the Caribbean low-level Jet (CLLJ, Amador, 1998) and the Mid-Summer Drought will improve the text since both features are quite important in the climate of the region.

   This paragraph will be added to the revised version:

   The term North Atlantic subtropical high (NASH) has been substituted for North Atlantic anticyclone in the text. Also, to improve content on the low-level jet in carabids, we've added the paragraph below:

The low-level jet (CLLJ), which is characterized by two maximums; the first in January and the second in July (Amador, 1998; Cook and Vizy, 2010), plays a very important role in transporting moisture to the Caribbean (Mo et al., 2005). Also, the July peak is associated with a short dry season (Wang and Lee 2007).

5. Page 3, lines 101-102, "The total annual precipitation in the Greater Antilles depends on land-sea interactions (breezes) and topography (fig.1a)" This should be cited.

Two citations will be added to the revised version of the paper: Cantet(2007) et Moron et al. (2015)

6. Satellite data section. Due to complexities in estimating rainfall, for example, gridded products exhibit a very wide range of accuracy levels across regions worldwide. These products are developed at relatively high resolution or using sophisticated procedures, but even though, despite advances in estimating precipitation from satellite data, this option is limited by temporal sampling and algorithm errors that lead to advantages and limitations of each product. Why did the authors consider only using satellite data instead of other datasets? Why do the authors use only two products, when the use of more available products could lead to more robust results? According to the results, could the authors mention how these errors in satellite data could affect their results?

Thanks for the interesting questions. In fact, at first, we wanted to use data observed on the ground. We used NOAA's Global Surface Summary of the Day (GSOD) databases. However, given the high percentage of missing data in the time series, we opted for satellite data. As you mentioned in the comments, satellite data have limitations due to algorithm errors during estimation. So, before using these products, it is important to evaluate their performance. In the area, the study by Bathelemy et al (2022), in which several satellite products were evaluated, revealed that CHIRPS satellite data reproduce rainfall seasonality very well and perform well in estimating heavy rainfall in the Caribbean, particularly the Greater Antilles. Although other satellite products were used, such as MSWEP, for which good performance was also observed, CHIRPs was the most judicious choice because of its high resolution (5kmx5km) compared with other satellite products.

It should also be noted that Chirps underestimates rainfall in dry seasons and overestimates rainfall in wet seasons (Fig.7, Bathelemy et al. (2022)). Although these discrepancies are not significant, when interpreting the results, we consider them to be borderline.

7. Page 4, lines 116-118: "TRMM 3B42v7 satellite product is used to calibrate and reduce the bias in the estimates". Could the authors be more specific? A bias correction method was applied. Why do the authors use this Tropical Rainfall Measuring Mission product instead of the integrated Multi-satellite retrievals for Global Precipitation Measurement (IMERG)?

The work of Funk et al. (2015) revealed that the TRMM 3B42v7 satellite product was used to calibrate the Chirps data. As in the given section of this study, a description of the CHirps satellite product was made, to this effect, we added the TRMM 3B42v7 satellite product to complete this description by referring to the work of Funk et al. (2015). However, in relation to the question on the IMERG satellite product, this is an interesting one. We wonder whether this one concerns us directly in the context of this study.

8. Check every time CHIRPS is mentioned, first appeared as CHIRPSv2 and after as CHIRPS, please select one.

In the revised version, CHIRPS will be replaced in the text by CHIRPSv2.

9. Page 4, lines 120-121 "evaluated over certain regions of the Americas, has demonstrated 121its ability to reproduce the mean climate as well as its capacity to estimate extreme precipitation events" Please add cites.

Dans la version révisée, on ajoutera cette citation : Rivera et al.(2019)

10. In general in the Satellite data section, I highly recommend adding the following reference "Centella-Artola A, Bezanilla-Morlot A, Taylor MA, Herrera DA, Martinez-Castro D, Gouirand I, Sierra-Lorenzo M, Vichot-Llano A, Stephenson T, Fonseca C, et al. Evaluation of Sixteen Gridded Precipitation Datasets over the Caribbean Region Using Gauge Observations. Atmosphere. 2020; 11(12):1334. https://doi.org/10.3390/atmos11121334". These will help to improve your research.

In the revised version, we will add this citation.

11. Why the NOAA DOISST (Daily Optimum Interpolation Sea Surface Temperature version 2.1) data is used?

The NOAA DOISST choice is justified in the above graph:
Sea surface temperatures (SST) are very important for monitoring and assessing climate change (IPCC 2013). They can be derived either from observations from floating or moored buoys (Smith et al. 1996), from satellite observations (Merchant et al., 2014), or from a mixture (in situ + satellite) (HadSST, Rayner et al., 2003; Reynold et al., 2007, DOISST). Given that NOAA DOISST(Reynold et al., 2007, Huang et al., 2021) has been widely used for climate assessment and monitoring, notably as part of the reanalysis of the NOAA/NCEP climate prediction system(Saha et al., 2010). Also, work by Huang et al.(2021a) has revealed that NOAA DOISST performs well in terms of bias compared with buoy and Argo observations, as well as with the eight SST products.

12. Page 5, lines 150-155, I highly recommend to rewrite this paragraph.

This paragraph will be rewritten in the revised version with more detail on the influence of Atlantic (Pacific) Ocean SSTs on precipitation in the Caribbean. Also, the term precipitation variability will preferably be replaced by precipitation has been influenced by SSTs.

13. More discussion should be added on why the use of Spearman correlation instead of Pearson for example.

A few lines of discussion I'd like to add to the revised version:

Analysis of the relationship between two variables is often of great interest for data analysis in research. It generally consists in characterizing the form and intensity of the link (relationship) between variables by means of a correlation coefficient. For two variables, X and Y, this coefficient is interpreted as : i)linear linkage, the correlation coefficient is positive when X and Y values change in the same direction, i.e., an increase in X leads to an increase in Y; ii)linear linkage, the correlation coefficient is negative when X and Y values change in the opposite direction, i.e., an increase in X leads to a decrease in Y (or vice versa); iii) non-linear monotonic linkage, the correlation coefficient is positive when X and Y change in the same direction as in (i), but with a small slope (Lewis-Beck, 1995; Sheskin, 2007; Gibbons).

In the literature, Pearson's and Spearman's correlation coefficients are often the most widely used to measure the strength or degree of linkage between two variables. In this study, we used Spearman's non-parametric rank correlation coefficient (rho) to assess the interannual link between extreme precipitation over indices and global SSTs indices. This non-parametric method was chosen because it does not require a normal distribution for the variables. Also, Spearman outperforms Pearson's linear coefficient in the case of outliers. On the other hand, linear trends can be detected using Pearson or Spearman tests, but the latter is preferable for monotonic non-linear relationships (Gauthier, 2001; Von Storch and Zwiers, 1999).

14. Page 5, lines 156-162, I highly recommend to rewrite this paragraph.

The few contents #13 will allow me to improve this paragraph in the revised version.

15. Page 6, lines 166-169, What is the meaning of “whether the two variables are correlated or not”? If the trend or correlation is not statistically significant, then that means you cannot reject the null hypothesis (i.e., that there is no trend or correlation).

Two variables are correlated when an increase in one variable leads to an increase in the other, or a decrease(increase) in one variable leads to an increase(decrease) in the other. However, when analyzing data, statistical tests are available in the literature to determine whether there is indeed a statistically significant correlation (or not) between two variables. The correlation is statistically significant if the null hypothesis is not verified. On the other hand, if the null hypothesis is verified, the correlation is not statistically significant.

16. If the acronyms for the extremes were previously defined, please use them to reduce the text. Please check this.

This correction will be considered in the revised version.

17. Page 6, lines 176-179, I highly recommend to rewrite this sentence.

Thank you, in the revised version this correction will be considered.

18. Page 6, lines 181-184, I highly recommend to rewrite this sentence. Besides, are these results related to a very active hurricane season, or are caused but something else?

For lines 181-184, this correction will be considered in the revised version. For this question relating to cyclonic seasons, unfortunately in this study, the results do not take cyclonic seasons into account.

19. Page 6, lines 185-196, I highly recommend to rewrite this paragraph

Thank you, this correction will be considered in the revised version.

20. Page 7, "Variations in extreme precipitation indices under the influence of variables such as NAO, SOI, TSA, and SST-CAR were analyzed over the Greater Antilles. The influences of large-scale variables were classified as positive, negative, positive, significant, negative, or significant, as shown in Figure 4." Could the authors explain the meaning of this?

The term influence used here refers to the correlation between SSTs and precipitation indices. As explained in answer #13, the variables can be either varied in the same direction or in the opposite direction. Hence the need to associate signs (positive, negative) to characterize the direction of variation. On the other hand, once the direction of the correlation has been determined, a statistical test is needed to determine the significance of the sign. In other words, whether this positive (negative) correlation is statistically significant or not.

21. Page 7, lines 209-210: based on what the authors made this comment? In Figure 4 I can not see this statement since significant correlations are barely seen.

Significant correlations are the correlation coefficients in Figure 4 with the symbols *. This symbol is placed to the left of the correlation coefficient.

22. Page 7, lines 210-213: this is impossible to see since the quality of the figures is low and one or two * did not make a difference.

Thank you for your comments, the quality of the figures will be improved. As these figures have been produced on Python, we will use a python package(searbon) to improve the quality of the figures.

23. I can not follow this discussion (figure 5-8) if the supplementary material is not available, besides the writing should be improved for better understanding.

There is no supplementary material for this section. However, we promise that the writing will be improved to facilitate comprehension in the revised version.

24. Page 8, lines 249-253: please improve the writing.

This correction will be considered in the revised version.

25. The reference format should be revised.

This correction will be considered using the format proposed by ESD in the revised version.

26. All the figures' quality must be improved, Figure 3 revised the caption and the information on the figure does not coincide.

We're going to use another python package (seaborn) to improve the quality of the figures.