Review of the manuscript entitled "A 20-year satellite-reanalysis-based climatology of extreme precipitation characteristics over the Sinai Peninsula" by Soltani et al. In this paper, the authors try to characterize the synoptic conditions of extreme precipitation events over the Sinai region. They use the satellite-derived GPM daily precipitation and meteorological fields from the NCEP-NCAR reanalysis data during the 2001 - 2021 period. I have several concerns over the methods used by the authors in this study. Therefore, I suggest the manuscript should undergo a major revision.
We appreciate your time and consideration. The respected reviewer's comments/recommendations are clarified and addressed below.

Specific comments:
1. The authors claim that threshold precipitation of >= 10 mm/day is required to define the wet and dry periods over the Sinai region. I fail to understand the logic behind choosing this arbitrary threshold. Why don't you choose a percentile-based threshold rather than an arbitrary one? The 10 mm/day threshold also suggests that 9 mm/day is considered as dry. Is it correct? I think that you need to have separate thresholds for wet and dry events.
Response: We experimentally (but not arbitrary) used a threshold of ≥10mm precipitation, after testing other thresholds like ≥5mm and ≥20mm, to define the overall wet-period and dry-period on a monthly basis in the Sinai Desert. For this, Figure 3 was our major reference determining the wet-months and dry-months, which is estimated based on the *frequency occurrence* of the precipitation events (but not precipitation amount only) with a threshold of ≥10mm/day for the period of 2001-2020 (7305 days).

Indeed, we are particularly interested in to determine months with the lowest frequencies of precipitation in the Sinai. This is because, the current study is an initiative to the follow-up major Sinai's research, which is to examine the regreening impacts on the local/regional hydrometeorological process (such as precipitation recycling) in the Sinai that is currently a desert. Due to the poor Sinai's literature, this study aims at, among others, determining the months/periods with minimum -or no rainfall amount/frequency throughout the year in the Sinai in order to select the driest months to address the above-mentioned goal; particularly, estimating the rate of enhanced precipitation recycling under a vegetated-surface scenario during a naturally-dry-period of the year over the Sinai's water-limited environment.

In addition to the threshold of ≥10mm precipitation (Fig. 3b, see below) determined in this study, we now did estimate the precipitation frequencies with thresholds of ≥9mm/day and ≥11mm/day (Figure 001), as test cases; this figure is attached below -- *but will not be added to the manuscript/supplement*. It is clear, their results (≥9, ≥10, ≥11 mm/day) are almost identical; so, it is not much about thresholds with ±1mm/day with respect to frequencies to be defined as dry -or wet at a monthly basis. However, it will be different for much higher thresholds like ≥5mm -or ≥20mm in the Sinai, as shown in the supplement. Therefore, a threshold of ≥10 mm/day looks logical to define the wet -and dry periods in the case of Sinai Desert.

However, following your suggestion (and also the other respected reviewer to use standard deviation to better understand the rainfall variations), in addition to the frequency-analysis with a threshold of ≥10 mm/day, we now did estimate the monthly 90th percentile and standard deviation of the precipitation as well. So, in the revised manuscript, we now developed a multi-statistical-approach using three statistical measures based on percentile, frequency and standard deviation to determine/split wet -and dry months in the Sinai region -- as the results obtained from these statistical methods are in very good agreement in time and space (see Fig. 3 below).

So, in the revised manuscript, we now added a new subsection at the beginning to explicitly explain our approach developed in this study as follows:

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2.3 Data analysis approach

2.3.1 Determining the Sinai's wet and dry periods

In this research, we are particularly aimed at, among others, determining months with the lowest (-or no rainfall) and the highest amounts/frequencies of the precipitation events throughout the year in the Sinai Peninsula. This is mainly because, it is planned as the follow-up Sinai's research, to assess regreening impacts on the local/regional hydrometeorological process such as precipitation recycling in the Sinai Desert under a vegetated-surface scenario during a naturally dry period of the year. Thus, herein we developed a multi-statistical-approach to split the wet -and dry months of the year in the Sinai's water-limited environment for the period of 2001-2020. This is achieved via a combination of the results obtained from three statistical measures: i) monthly 90th percentile of the daily precipitation (Fig. 3a), ii) an experimentally-based precipitation frequency occurrence with a threshold of ≥10 mm/day (Fig. 3b) – after examining other thresholds such as ≥5 mm/day and ≥20 mm/day (see Figs. S1 and S2), and iii) monthly rainfall standard deviation SD estimates (Fig. 3c). These methods were calculated using a set of statistical functions, described in the follow-up subsection (see Table 1). Therefore, using the above-mentioned approach developed in this study, the Sinai's wet months are determined from October to March, defined as wet-period, and its dry months from April to September, defined as dry period.

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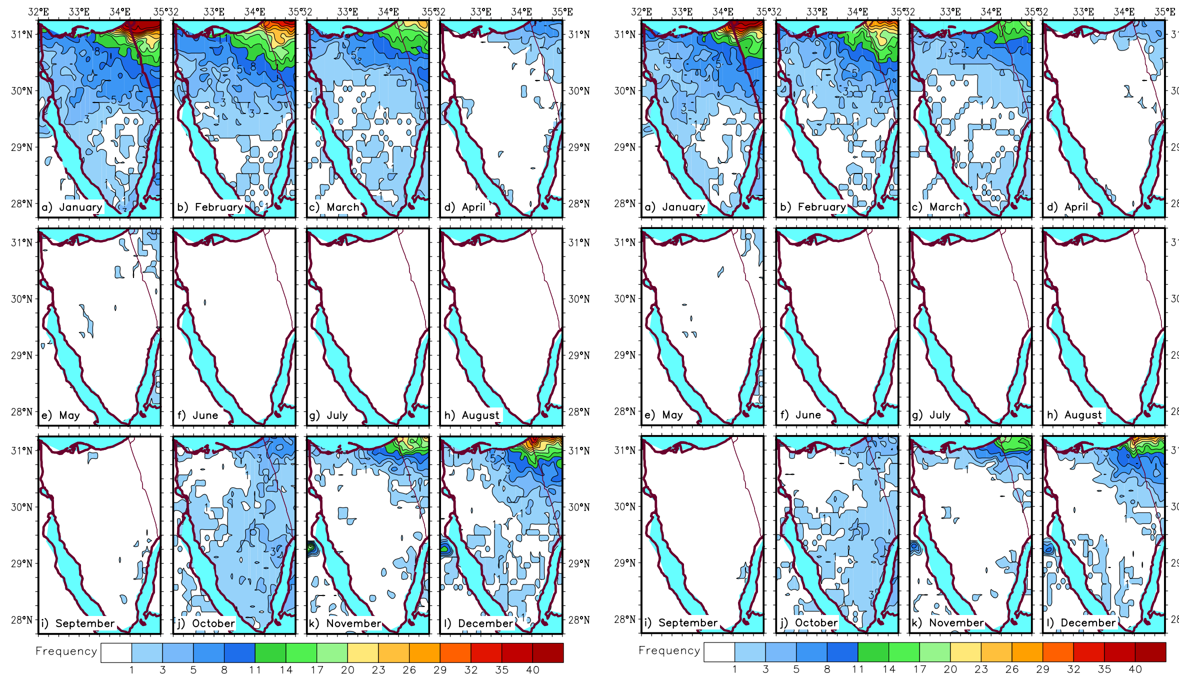

Figure 001. Frequency occurrence of the monthly precipitation events for the climatology period of 2001-2020 (7305 days) over the Sinai Peninsula: **left)** with a threshold of ≥*9 mm/day*, **right)** with a threshold of ≥*11 mm/day***.** Units are frequency in days.

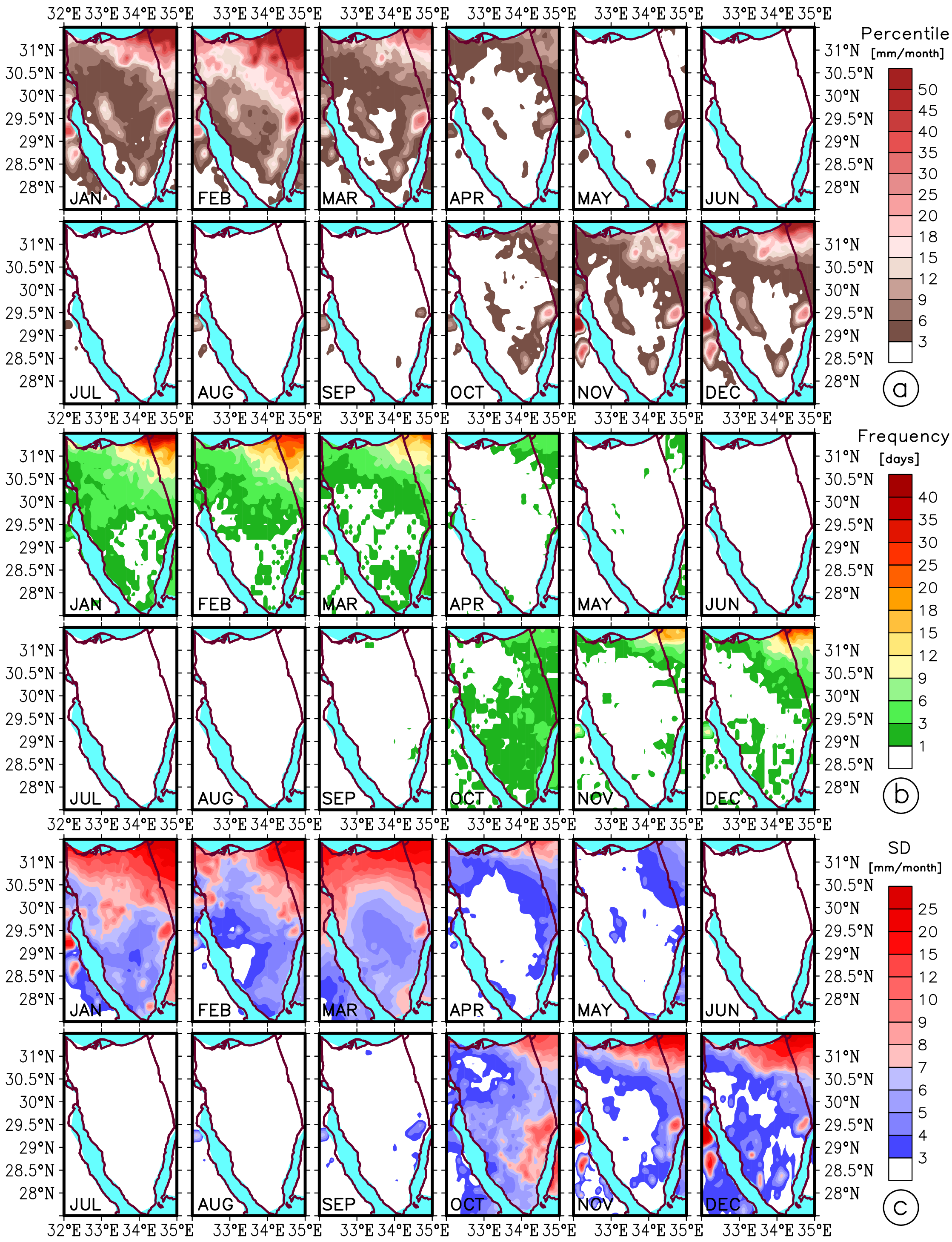

Figure 3. A multi-statistical analysis of the precipitation in a monthly basis: a) the 90th percentile of rainfall climatology, b) frequency occurrence of the rainfall events with a threshold of ≥10 mm/day, and c) grid-based standard deviation SD estimates of the rainfall for the period of 2001-2020 (240 months) over the Sinai Peninsula.

2. Cyclone Tracking: From the description, the cyclone tracking method is not clear. How did they identify the genesis and lysis of cyclones? If multiple cyclones are present, how did they identify each of them at the subsequent time steps? Did the authors use an automated algorithm? In that case, it should be mentioned explicitly. There are several cyclone tracking algorithms available. The authors can compare their technique with some of the other tracking techniques.

Response: The approach we used for the cyclone tracking was not an automated algorithm, but a manual approach developed in this study. Each method, however, has its own pros and cons. For example, the available algorithms (in case of being freely accessible for the public) might be convenient for users to use, but need several inputs, and are still suffering from a low-accuracy/precision in identifying/tracking cyclones (and yet, mostly focused on the tropical cyclones). This could be a critical challenge to be used in heterogeneous landscapes with a complex atmospheric PBL in mid-latitudes like the Mediterranean region. As such, the performance of those algorithms remains challenging for several reasons mentioned above -and also outlined in e.g., Raible et al., 2007; Flaounas et al., 2014; Prantl et al., 2021. However, our developed manual method might be a bit time-consuming, but possesses a higher degree of precision in identifying/tracking the cyclones (and also anticyclones) – as explained below.

Also, we would like to mention that the manual approach developed in this study outweighs the available automated algorithms for the Sinai's case; apart from the above-mentioned issues for using automated algorithms, we were merely interested to identify/track those rainy-systems (cyclones) that precipitated ≥10mm over the Sinai – some cyclones/lows may not necessarily make rainfall at all especially with a given threshold over a given domain. And yet, as you mentioned correctly, multiple cyclones might be presented simultaneously that is an additional challenge. So, in our case this is even further challenging to use such algorithms for cyclone tracking over the Sinai, as a small-region from a synoptic/dynamical perspective.

In the revised manuscript, we now added further details to explicitly explain our approach developed for the cyclone tracking analysis in this study as follows:

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2.3.5 Cyclone tracking

In line with the synoptic analysis, the daily trajectories of the rainy-systems precipitated over the Sinai region were tracked and plotted for the wet -and dry periods using a manual approach developed in this study. In our approach, we merely aimed to detect and track cyclones precipitated with ≥10mm in the Sinai. This however is challenging for an automated algorithm to a large extent, to detect a low-pressure-system (sometimes with multiple centers, cyclones) that may -or not has generated a rainfall with a given threshold over a given domain. Yet, its performance is not error-free in particular over heterogeneous regions with complex atmospheric PBL like the Mediterranean region (e.g., Raible *et al.,* 2007; Flaounas *et al.,* 2014c; Prantl *et al.,* 2021). Our manual-based cyclone-tracking approach developed in this study consists of three major steps as follows:

i) first, a set of daily total precipitation patterns over the Sinai was produced using GPM data separately for the wet -and dry periods; by doing so, a total number of 156 events (out of 7305 days) were identified, for which precipitated ≥10mm over the Sinai Peninsula. Accordingly, synoptic-scale daily composites of SLP, and 850-hPa RV and streamflow were produced using the reanalysis data for the entire study-period (2001-2020, 7305 days). Here, 850-hPa RV and streamflow were used along with SLP to better identify the lows (Flaounas *et al.,* 2014c). *ii) second*, to identify the cyclogenesis/lysis of the selected events, the composite maps of SLP, RV and streamflow for several days before -and after the Sinai's rainfall events were monitored and tracked with care. Every daily movement (X-Y coordinates) of the corresponding cyclone was recorded from the beginning (where the low system was born, cyclogenesis) until it was disappeared (cyclolysis). This process was carried out one-by-one for all156 cases with rainfall ≥10mm. All the events were classified into five categories based on the rainfall magnitude as follows: category 1 (10-20mm), category 2 (21-30mm), category 3 (31-40mm), category 4 (41-50mm) and category 5 (>51mm). *iii) third*, finally the cyclone tracking charts for the wet -and dry periods were produced using the information obtained from the former steps.

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3. Statistical significance of the trends: The authors should do a significance test (ideally, a non-parametric test) for the trends presented in Fig. 2 and report it in the caption.

Response: The statistical tests for significance of the regression model/trends are typically performed for the time-series dataset (between two variables), which can be determined by e.g. r^2-values along with the p-values (or t-test). As such, if r^2 is typically >0.6 with $p <0.05$ in regressions, then the trend is regarded as statistically significance and meaningful. However, our trend of slope (Fig.2: now Fig. S8 in the revised supplement) is estimated using an *anomaly-based approach* (not timeseries in a regression model). Here, we detected the precipitation anomalies (annual/seasonal) with a *Mean* function, meaning that the long-term mean (average) of each rainfall data was calculated; then it was subtracted from each year/season precipitation values to estimate the anomalies (i.e. anomaly equals individual values of each year/season minus long-term mean value), and finally the trend of slopes of those anomalies was drawn using the common least-squares fitting process. Therefore, our trend of slope represents the rate at which change occurs over time. If the slope has a positive value, the rainfall rate is increasing (-or the wetter condition). If it is negative, the rainfall rate is decreasing (-or the drier condition). In that figure, we interpreted the trend of slope to mean that, on average, the rainfall rate is changed by the slope value each year/season over the past two decades (2001-2020). Therefore, we deliberately avoided to use the terms such as ''significant trend'' -or ''statistically significance'', related to that figure.

Indeed, for the anomaly-based approach and its trend of slopes it is not feasible to perform any kind of statistical significances like Bootstrapping; however, we did perform *Bootstrapping Confidence Interval* for the original datasets of seasonal and annual precipitation climatology (20-years) on the selected sites across the Sinai. The results are given in Table S1 in the revised supplement – also attached below.

However, since we now applied the EOF-based analysis (Fig. 4 in the revised manuscript, also shown below) suggested by you, we decided to move the temporal site-scale anomaly-based analysis/figure into the supplement data (Fig. S8). It is good mentioning that, the results of the site-scale anomaly-based analysis are in good agreement with those of the grid-scale EOF-based spatiotemporal analysis in the Sinai Desert.

Table S1. The 95% and 99% bootstrapped confidence interval (CI) for the Mean and Median values of the original dataset (mean seasonal and annual for 20-years: 2001-2020) for the selected sites across the Sinai (anomaly-based analysis in Fig. S8), see Fig. 1 for the locations. For this analysis, 300 bootstrapped samples were generated each with a sample size of n=10.

	North-site			**Middle-site**			**South-site**		
	Winter	Autumn	Annual	Winter	Autumn	Annual	Winter	Autumn	Annual
Average precipitation (mm)	***68.6***	***18.5***	***28.4***	***22***	***6.1***	***9.3***	***9.1***	***4.8***	***5.1***
95% bootstrapped CI for **Mean** value of original dataset	79.8	24	31.9	30.8	9.1	11.2	14.3	9.4	6.9
99% bootstrapped CI for **Mean** value of original dataset	85.5	26	33.4	35.4	10.3	12	16.2	10.8	7.3
95% bootstrapped CI for **Median** value of original dataset	88.3	26.1	31.4	23.9	7.5	10.5	11.7	5.3	7.5
99% bootstrapped CI for **Median** value of original dataset	90.4	29.1	36.1	29.1	9.7	12	17.5	8.2	8.3

4. Fig. 4: I don't understand the logic behind this analysis. Why do you need to compare the annual mean precipitation with the wettest month and wettest day precipitation? The color scales of all the plots should be the same for comparison. There are better ways for understanding spatio-temporal variability. E. g. an EOF analysis.

Response: The reason is to demonstrate how precipitation is *spatially* distributed across the Sinai, not only in the climatology map (20-years -or 240 months -or 7305 days) (Fig. 4: now Fig. 2a in the revised manuscript) but also in a single month (Fig. 2b) -or day (Fig. 2c). This study focuses on extreme events; thus, the most extreme cases of the wet month/day are presented as well, and more extreme cases of the rainiest months (Fig. S3) and wettest days (Fig. S4) are represented in the revised supplement data. All panels in Figure 2a-c clearly show that northern (southern) parts of the Sinai *always* receive the highest (lowest) amount of precipitation regardless of time-period *either* in long-term climatology *or* a single month/day-event. However, we now re-structured the associated subsection to (*3.1.1 The precipitation spatial patterns and extreme indices*) in the revised manuscript. Please also note that Figure 6 (climate extreme indices) is now attached to Figure 2d-f, due to the new subsection added – see Figure 2 below.

We needed to use two separated legends for the panels *a* and *b-c* in Figure 2 due to large differences in the rainfall magnitudes. In case of using a single legend, the distribution of rainfall values in panels *b* and especially *c* will become almost constant/flat, thus unclear.

Thanks for a good suggestion. We now applied the Empirical Orthogonal Function (EOF) analysis to better understanding the spatiotemporal variability of the Sinai's precipitation climatology. This analysis -and its results for both the annual and seasonal (wet -and dry periods) have been added to the revised manuscript (Fig. 4) and supplement data (Figs. S6 and S7) -- these figures are shown below also.

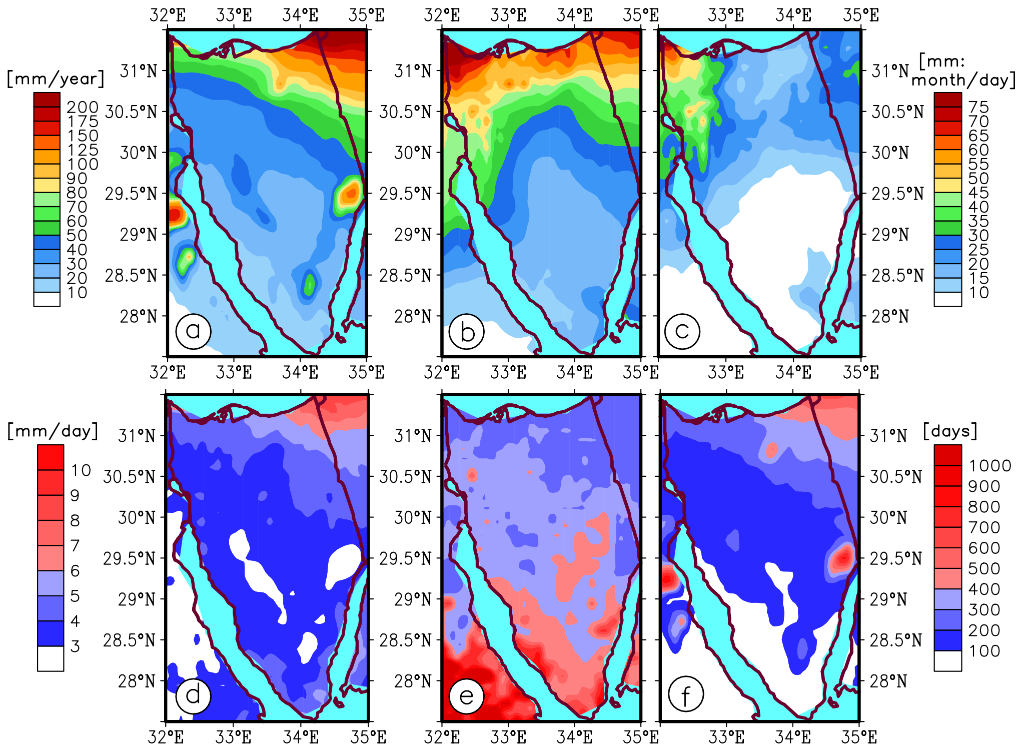


Figure 2. The precipitation spatial patterns and extreme indices: a) climatology map of mean annual precipitation (2001-2020); b) the wettest month i.e. March 2020 (out of 240 months), c) the wettest day i.e. March 12, 2020 (out of 7305 days); as well as extreme daily precipitation indices with a threshold of ≥1mm/day: d) simple daily intensity index (SDII), e) consecutive dry days (CDD) and f) wet days index (RR1) for the period of 2001-2020 over the Sinai Peninsula.

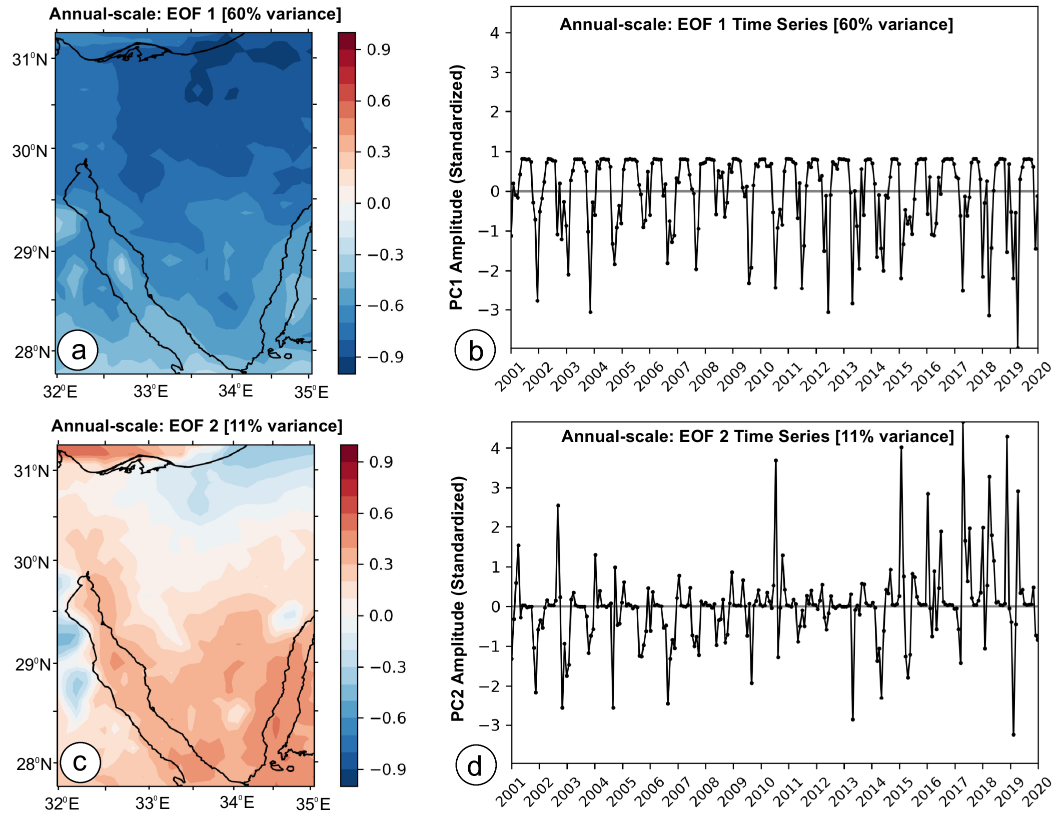
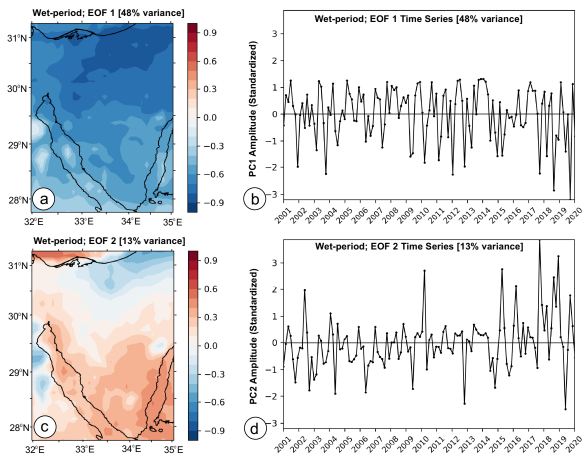
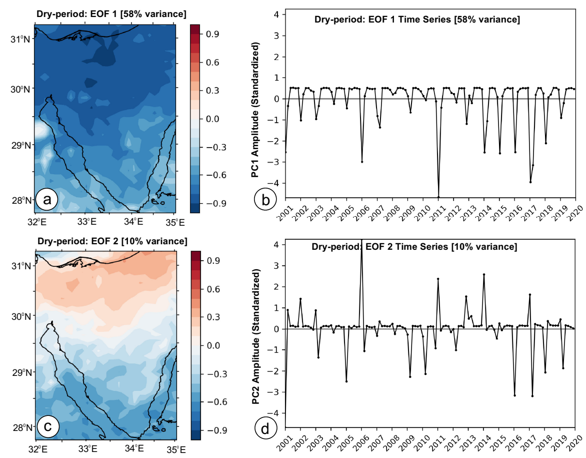


Figure 4. The two leading EOF spatial patterns (a and c) and the associated timeseries (b and d) of the monthly mean precipitation dataset (**at annual scale**) for the period of 2001-2020 (240 months) in the Sinai Peninsula. The values of EOFs (a and c) are expressed as correlation coefficients.





Left: Figure S6. Same as in Fig. 4, but for the wet-period (October-March). **Right: Figure S7.** Same as in Fig. 4, but for the dry-period (April-September).