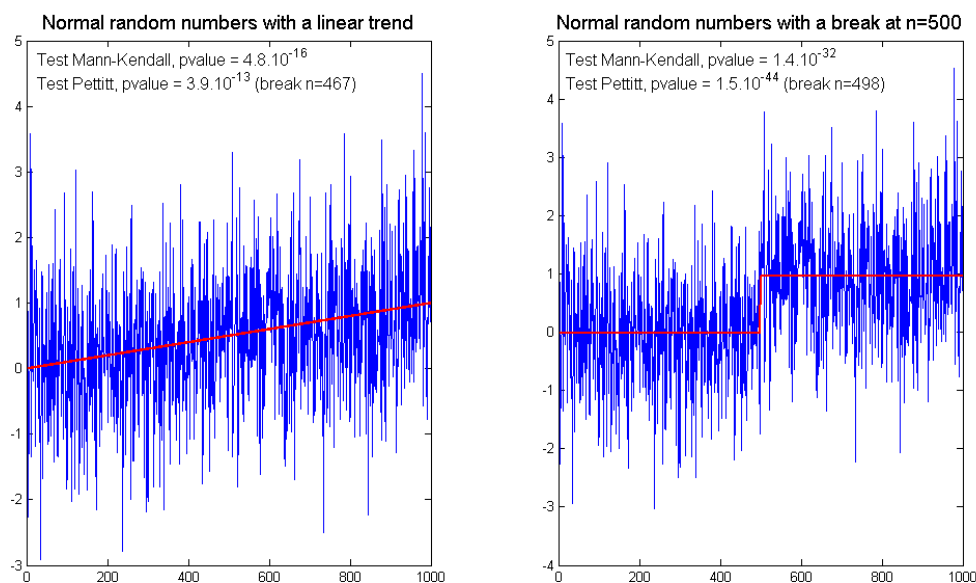


We would like to thank **the reviewer** for his constructive comments about our manuscript.

**The only main comment is on the application of the detection procedure for the identification of potential break points (inhomogeneities). The removal of the (estimated) trend component seriously affects the results of the detection procedure.**

We fully agree with this statement. We would like to emphasize that not removing the trends would also seriously affect the change-point detection procedure, at least using standard tests such as the Pettitt test used in our study. As shown in the example below, we added either a trend (left) or a change point (shift in the mean) (right) in random numbers generated from a normal distribution. If applying the Mann-Kendall test for trends and the Pettitt test for change points to these two synthetic datasets, both tests rejects the null hypothesis. In the left panel, it is clear that there is no change point, nevertheless a change point is detected by the Pettitt test ( $pvalue=3.9 \cdot 10^{-13}$ ). This shows that in the presence of trends (or autocorrelation), a nonexistent shift could be detected by the Pettitt test (Beaulieu et al., 2012, in the reference list, Guerreiro et al., 2013). This is the reason why statistical tests should not be applied blindly and there is the need to test for trends prior to the change point detection procedure. There is also a need to check the presence of change-points when testing for trends, on the right panel it can be seen that the Mann-Kendall test rejects the null hypothesis in the presence of a change point. Indeed, an abrupt change is a limit type of a generic monotonic trend (Guerreiro et al., 2013).



To tackle these issues some more advanced statistical models have been proposed in the recent years (Ehsanzadeh et al., 2011; Beaulieu et al., 2012; Villarini et al., 2013), however in our study we have chosen to apply carefully some widely used methods in the literature, in a similar fashion as Guerreiro et al. (2013).

#### References:

Ehsanzadeh, E., Ouarda, T. B. M. J. and Saley, H. M. (2011), A simultaneous analysis of gradual and abrupt changes in Canadian low streamflows. *Hydrol. Process.*, 25: 727–739. doi: 10.1002/hyp.7861

Guerreiro S., Kilsby C.G., Serinaldi F. 2013. Analysis of time variation of rainfall in transnational basins in Iberia: abrupt changes or trends?", International Journal of Climatology, doi:10.1002/joc.3669.

Villarini, Gabriele, James A. Smith, Gabriel A. Vecchi, 2013: Changing Frequency of Heavy Rainfall over the Central United States. J. Climate, 26, 351–357.  
doi: <http://dx.doi.org/10.1175/JCLI-D-12-00043.1>

**Furthermore, detection procedures should be applied in a “relative way”, i.e. by using a reference series, to allow a correct attribution of the change point.**

As we wrote page 3633 line 5, There is no homogeneity correction method specifically designed for daily precipitation time series and no consensus about the best method to use (Beaulieu et al., 2007; Toreti et al., 2010). A wealth of information about homogenization of climate time series can be found on the ACTION COST-ES0601 website = <http://www.homogenisation.org/>

Indeed, the ideal case would be to apply change point detection using neighborhood reference stations. However in North Africa, as in many developing countries, the density of the monitoring networks is lower by comparison to Europe or North America. Therefore in many cases only absolute tests are used (see Donat et al., 2013). In our case, since we are focusing only on stations with long records, the number of available stations is very small by comparison to the area of interest, therefore it is impossible to use neighboring stations since the smallest distance between two stations is approximately 50km.

**Indeed, it is worth to highlight that a change point could be caused by either climatic or non-climatic factors (in the latter case, the change point is named break point or inhomogeneity).**

This is precisely why we wrote page 3633, line7:”If the monotonic trends are likely caused by long term climate change, step changes in precipitation series may be considered doubtful and possibly caused by station relocation or changes in the station instrumentation.”

**3627, 17-18: This sentence sounds odd.**

Replaced by:

“Therefore, daily precipitation data is an interesting proxy, by comparison to river runoff, to analyze long terms trends and variability of precipitation that are causing floods or drought periods”

**3629, 18: large scale circulation indices.**

Added

**3629, 25: I suggest to revise this sentence, e.g. “Here, we consider ...”**

Changed by:

“Here we consider the long daily precipitation series maintained by the governmental hydrological services of Algeria, Morocco and Tunisia, who are in charge of dams and all the water regulation structures”

**3630, 10: underwent.**

Changed

**3630, 25-27: I suggest to rephrase this sentence.**

Changed by:

“Therefore it is important to check the presence of trends in the precipitation records, since the stationarity hypothesis is often assumed for the management of water resources..”

**3631, 17: I suggest**

**“Several precipitation indices, similar to those of ETCCDI (...), are considered.”**

Changed

**3633, 19: I think there is no need of explaining the null hypothesis of the Mann-Kendall test.**

For consistency, we prefer to mention the null hypothesis behind each statistical test we used.

**3634, 14: ditto 3636, 14: Please note that you have intrinsically assumed the isotropy of the space**

Added:

“(Assuming the isotropy of the space)”

Indeed with a greater station density it would have been possible to include the local effects, such as the topography, to better represent the spatial variability.

**3638, 9: I suggest to write “estimated slope”**

Changed to:

“However, in several stations there is a negative Sen slope estimated for these indices...”

**3638, 22-25: please give**

**some details on the detrending procedure. Have you estimated and subtracted a linear trend?**

Yes. It must be noted that our results are not strongly different if performing a non-linear detrending, see our response to the comments of M. Donat. The trend in NAO and MO indices has been previously reported in several studies (Hurrell 1995; Mariotti and Dell’Aquila, 2012, in the reference list). Here since some indices exhibit a long-term trend, it would not make much sense to compute a correlation coefficient between a precipitation index with a trend and a NAO or MO index which show also a trend (in that case it is very likely that the correlation will be significant just because of the trends).

### **3639, 8: local or global significance?**

Changed by=

“The PRCPTOT and R1mm indices and to a lesser extend SDII, CWD and CWDm, show field-significant correlations with NAOi, MOi and WEMOi. For PRCPTOT and R1mm the correlations with NAOi or MOi are significant in almost half of the stations if considering the local or global significance level”

### **3639, 24-25: I suggest to highlight that heavy rainfall are caused by an interaction of several factors acting at different spatiotemporal scales.**

Added line 17:

“Only a few field-significant correlations with the NAOi are detected for these indices, mainly for stations located Morocco (Larache, Mjaara, Bab Ouender) as previously reported by Trambly et al., (2012) or Donat et al. (2013). Heavy rainfall events are caused by an interaction of several factors acting at different spatiotemporal scales: it is likely that large-scale circulation indices alone are not sufficient to characterize the variability of these extreme events.”

### **Table 2: Confidence intervals should be added**

In table 2 are reported the Sen slopes estimates only if a significant trend was detected by the Mann-Kendall test. It would be somewhat redundant to give the confidence intervals of the Sen slope estimates and would make the table hard to read. Please note that the Sen slope is the median slope joining all pairs of observations, it is expressed by quantity per unit time, in the original unit of the different precipitation indices. This is the reason why several values of the Sen slopes appear very small for some indices.

The table caption has been modified to:

“Sen slope estimates for each station and each indices, only in cases when the Mann-Kendall test detected a significant trend at the local 5% level”

### **Figure 6: I suggest to write “estimated slopes”**

Changed to=“...Sen slopes estimated for the full length...”