

Authors' response to comments from Referee #1

The authors gratefully acknowledge the anonymous referee for his positive review and remarkable insight proposals. In what follows in *Italic* are the comments provided by the Referee, and in **bold** fonts the authors' response. Changes to the manuscript are quoted and reported in "***bold italic***" font. Please consider that text here reported is still undergoing for the check from a professional native English speaker.

The first is about the assumptions made in this work as their significance with respect to natural phenomena; e.g. the non-stationary model accounts only for the variability of mean in time (which should be explicitly shown for the sake of clarity by reporting the theoretical expressions of the three first order moments a functions of the parameters), yet in nature the non-stationary behavior could imply also a variability in terms of the second order moment. Further, natural time series often depict dependence in time, which significantly affects the power of statistical methods for non-stationarity detection, as also recognized by the Authors themselves. I generally suggest the Authors to improve the discussion on practical limitations of those tests and of the conditions analyzed in their work, yet this is only a personal suggestion to improve the completeness of the discussion.

Authors wish to thank the reviewer for these useful suggestions. We introduced in section 2.4 the theoretical expressions by Muraleedharan et al. (2010) of the three first order moments as functions of the parameters. We enlarged the discussion regarding general limits of statistical methods for detection of non-stationarity in both the introduction and the conclusive sections. In particular we specify, also dealing with the final remark from Referee #2, that our purpose here is to show that, in some cases, even a weak linear trend in the mean suffices to reduce power to unacceptable values, then, we decided to limit the investigation to variability of mean in time. Nevertheless, when dealing with natural series, a number of potential other sources of uncertainty, including variability in time of the second order moment, should be considered as we have remarked in the conclusions of the revised manuscript.

As main changes to the manuscript, in the introduction the following lines were introduced:

"The use of null hypothesis significance tests for trend detection has raised concerns and severe criticisms in a wide range of scientific fields as outlined by Vogel et al. (2013). Serinaldi et al. (2018) also provided an extensive critical review focusing on logical flaws and misinterpretations often related to their misuse."

and later,

"Nevertheless, as claimed by different authors (Milly et al. 2015, Beven, 2016, among others) the importance of power in earth system sciences fields has been largely overlooked in years while a strong attention is always given to the level of significance (i.e. type I error). As pointed out by Vogel et al. (2013) "a type II error in the context of an infrastructure decision implies under-preparedness, which is often an error much more costly to society than the type I error (overpreparedness)".

For changes to conclusions please see response to final remark from Referee #2.

Second, I would like to see a deeper comparison with previous literature works on the same topic; e.g. the Authors mention in the conclusion section the paper from Serinaldi et al. (2018), without giving further details. I believe that the comparison with previous literature results could help strengthen the general discussion presented in the conclusion section

We accepted this suggestion, we decided to move the comparison with previous literature in the introduction. This includes a more specific reference to the work from Serinaldi et al (2018) and also a more general discussion about the use of statistical power for trend detection in hydrology (see response to point 5) of Referee #3 for changes to manuscript).

Moreover, in the conclusion section, we introduced some final remarks about the lack of ergodicity to be considered when dealing with nonstationary stochastic process (see response to final remark of Referee #2 for changes to manuscript).

Finally, the Authors should spend some efforts to improve the readability of the figures, e.g. by making the lines thick, by increasing the character size etc.

Suggestion accepted.