Review of the manuscript egusphere-2025-2181: "A non-stationary trans-Gaussian model for daily rainfall over complex topography" by Lionel Benoit, Matthew P. Lucas, Denis Allard, Keri M. Kodama, and Thomas W. Giambelluca

The authors are investigating the ability of non-stationary trans-Gaussian to simulate rainfall over an area with a complex topography. Using a parametrisation that accounts for spatial non-stationarity in the covariance function improves the quality of the rainfall simulation by better accounting for the orographic effects. Even though the work in this paper is of interest, it needs some additional analysis and clarification before it can be published.

Major comments:

I/- There are other ways to introduce non-stationarity in a Gaussian process. It would be nice to have some brief insight into different ways to introduce non-stationarity and provide some argument why your choice of using this parametrised covariance better suits your target.

II/- To make the paper easier to read, it would be better to introduce the data, the climatic regions and the rain clusters before describing the components of the models. Indeed, there are instances where rain climatology, climatic regions and clusters are mentioned before being introduced and understanding that there is one model per cluster/region earlier would be nice.

III/- What are the modelling differences between the model developed in this paper and the benchmark model? It can be presented as a table in the paper (Appendix).

IV/- Before assessing the spatial pattern, is it possible to look at the seasonal and inter-annual variability for a sub-sample of stations (section 3.3)?

V/- Can we see some evaluation of correlation /auto-correlation for all pairs of stations in addition to the correlation spatial pattern, conditionally to one location given in Figure 4.

VI/- It seems that there are non-negligible correlations (>0.5) in the observation between different climatic regions for the three examples given in Figure 4(c) between regions 12/11 (top), 9/11 (middle) and 8/12 (bottom). Limiting the covariance estimation to climatic regions seems to cause this. Why not estimate one non-stationary covariance function for the whole island (at least to compare)?

VII/- I also suspect the results would be very similar with an anisotropic stationary covariance function estimated for each climatic region. I would like to see the result with the stationary version of your covariance.

VIII/- What is the purpose of performing conditional simulations? Are the unconditional simulations not enough? How would it be necessary for hydrological simulations?

Minor comments:

- In the introduction, it is not fully clear that the paper only tackles spatial non-stationarity; please clarify this.
- I do not see the contrast between paragraph lines 45 and 50. Indeed, the authors mention in lines 47-49: "non-stationary geostatistical models tend to have a large number of parameters [...] focus on one aspect of non-stationarity, the choice of which is driven by the problem at hand.". How are you handling the high number of parameters in your "fully non-stationary trans-Gaussian geostatistical model?"
- line 145: spectral simulation? Is that what the authors do?
- Can you give the total surface of Hawai'i in section 3.1
- Appendix A: Since α iteratively determined for each dry station, how big N_{iter} needs to be?
- Appendix B: Can you precise how $\mathbf{Y}_{f,sim}$ is obtained, in particular how is it initialized?
- In Figure 4: Are the simulations with the non-stationary model unconditional? Can you clarify this?
- line 502 & 511: Appendix A (not 1).