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Comment on se-2021-79

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Referee comment on "Change-point detection in seismic double-difference data: application of a trans-dimensional algorithm to data-space exploration" by Nicola Piana Agostinetti and Giulia Sgattoni, Solid Earth Discuss., <https://doi.org/10.5194/se-2021-79-RC2>, 2021

The authors provided an automatic and data-driven approach to pre-process seismic data and applied their method to the Katla volcano data to define the change-points. The aim is clear and the method is suitable. My major suggestion is that the way how they present their method and its application is hard to follow and can be re-organized so that the idea can be clearly conveyed and understood. I have the following suggestions and comments:

1. The authors give a clear basic background introduction to 'double-difference data' and 'Bayes theorem'. However, besides introducing the background, this part should also serve the following sections or the whole paper. For example, one of the main focuses of the paper is to construct the covariance matrix of the error, which is only simply mentioned in the introduction part. If the introduction part can be more specific, say focus on the methods used in the paper, the readers are more clear how these methods fit in the current Bayes theorem, and the following parts can also be much easier to be understood.
2. Following #1, I also found that the Data and Method parts seem to be somehow mixed. Maybe first clarify the methods and then talk about their application would be better, especially for a method-focused paper.
3. As for the inconsistency when compared with the cross-correlation (CC), my understanding is that this paper's method can reflect the similarities/differences between any traces (because the covariance matrix is used), however, the CC is calculated according to one major event. I wonder, what if you calculate the CC within each window, instead of with the largest event? Whether the comparison will be more consistent or not?
4. As for the inconsistency when compared with the seismicity rate, I think it might be dangerous to draw the conclusion that 'the time-history of the seismicity rate should be

carefully evaluated', based on the current comparison and evidence. From my understanding, the data the authors used are the individual traces, and the time-related information, also in the data, is not considered (e.g., what is the time interval between two traces). If this is the case, in my opinion, the authors are looking at 'different parts' of the data from the people who study seismicity rates. For example, assuming a synthetic case (two time periods) with a constant subsurface elasticity but with a different stress/strain field. The waveforms in these two time periods should be exactly the same (therefore no changepoint is defined from this paper's method), but the seismicity rate can be different. Therefore, the discussion on seismicity rate needs more considerations.

5. A minor question about the terminology. From my understanding, when there is one event and one station, and we compare the differences between the observed data and the synthetic data, this can be valued as 'single-difference'. And when there is a station- or event-pair, this is called 'double-difference'. But in this paper, only the observed data (observed travel time) is mentioned. I wonder if it is still suitable to call it double-difference data when the synthetic data part is not involved in?

6. Some of the typos:

Line 100: Such solution have (has)

Line 108: where $p(m|d)$ represent (represents)

Line 173: we compute compute (delete one of the compute)

To conclude, I think the aim of this paper is clear: how to find changepoints of the data, and their method should be suitable. However, the current structure prevents readers from fully understanding what is and how to exactly use their method. I think a major revision, especially on the structure (how to better present the method), is needed to make it a better paper. The method should be easier to be understood, rather than harder, through the authors' re-construction. Then, the following-up applications and the scientific findings behind have the chance to be addressed, as it is cleared mentioned at the beginning.