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The Cryosphere Discussions

Interactive comment on "Passive seismic recording of cryoseisms in Adventdalen, Svalbard" *by* Rowan Romeyn et al.

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Comment from Referee 1

"I feel that the events location method used in the paper is very similar to the Match Field Processing (MFP) described by Sergent et al. (2020) (adapted from previous sources). The advantage of the MFP is that its methodology is clearly defined both theoretically and practically. It is also quite adaptive with several tunings that can make it very high resolution. I wonder why the authors did not try this approach with their arrays which are very well designed for that. Could you comment on that and perhaps compare the different methods?"

Response:

This was a useful comment from the reviewer. We had not considered the MFP technique in this context initially, having been motivated to develop a method that is completely blind to specification of the velocity structure of the study site. We have now tested the specific MFP implementation described in Walter et. al. (2015) that is also referred to in Sergeant et al. (2020). In our implementation, we omit the ensemble averaging over multiple seismic noise windows since we are dealing with large amplitude, distinct microseismic events. Similarly to Walter et. al. (2015), we neglect amplitude information and match only the wave phase.

The additional constraint provided by specifying a model of the medium velocity means that the MFP method performs very well. Azimuth and range localisation was very reliable for highly idealised synthetic test data, when the medium velocity was accurately specified. We used the dominant A0 mode trend to specify the dispersion curve of the medium. Usefully, the medium velocity can also be estimated for real data via the simple azimuth scanning technique of Park et. al. (1998) to approximately locate the source azimuth and build a dispersion image. The MFP method that can then be used to estimate the source range and refine the source azimuth estimation. This approach may provide a way to overcome the challenge of relative offset invariance that occurs when the source is located far from the array and that limits the maximum range to which our trace sorting method is useful.

We have also tested the MFP method on our catalogue of microseismic events, where we find that source localisation is equivalent to our trace sorting method. The MFP method appears to be robust to the presence of random noise, but we still have the impression that our trace resorting method performs very well despite the challenges of receiver positioning uncertainty, non-stationary and non-uniform noise that we encounter in real data.

Actions for revised manuscript (1) The MFP source localisation results for our catalogue of microseismic events will be added to Figure 5. This will provide an additional benchmark that helps the reader set the source positioning results using our trace sort-

ing method in context. We include the revised figure also here as an attachment to this comment. (2) We will acknowledge throughout the text that our trace sorting method is an alternative to the existing MFP methodology that is also capable of resolving both azimuth and range of unknown seismic sources, under the additional constraint of a modelled medium velocity.

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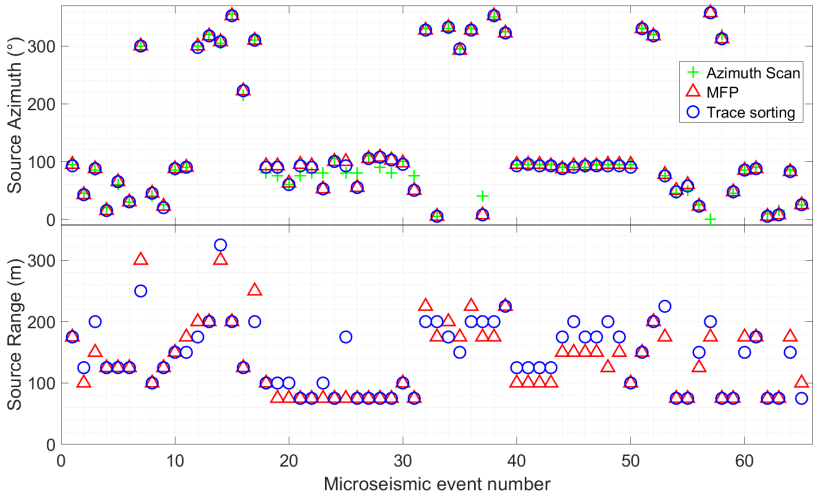

Fig. 1. Comparison of source localisation using Azimuth Scanning, (green crosses), Matched field processing (red triangles) and our trace re-sorting approach (blue circles)