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

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Comment from Referee 2

"The differences in Spring vs Autumn dispersion curves (Figures 14 and 15) is intriguing and at a quick glance suggests significant changes in the surface material properties, presumably related to the changing thermal environment, however on closer inspection it's more difficult for a reader to interpret precisely what is happening. The interpretation presented by the authors is of a thin (3.5-4.5 m) high velocity layer over a thicker (30 m) low velocity layer, which is quite thin compared to the presumed topography of the survey site and the source locations appear to have distinct regional variations. This needs to be accounted for in interpreting the differences between the

dispersion curves. A straightforward way to do this would be to see a direct comparison between one or two specific pairs of closely spaced individual events (Autumn, Spring) to see how much they vary with one another. This is especially important as the footprint of the recording nodes is slightly different between Spring and Autumn. It would also be helpful to see the actual model and it's range of variation plotted out."

Response:

It is a good point that spatial variation in ground properties should be considered in addition to temporal variation and this has not been sufficiently discussed in the manuscript. It would not be unexpected that the true ground structure varies according to a complex spatiotemporal pattern. It is rather difficult to resolve these effects from our limited catalogue of microseismic events and we agree that the varying receiver footprint further complicates the interpretation of these effects. However, we are confident that the varying receiver footprint does not play a significant role for a laterally homogenous, horizontally layered medium (based on tests with synthetic test data). One might anticipate that a complex interplay between spatially varying ground properties and the slightly varying footprint of the receiver array could manifest as a false temporal signal. On the other hand, the dispersion images for spatially dispersed events over short time windows (24-48 hrs) are highly consistent, which points towards a ground structure that is (relatively) homogeneous in space. We therefore infer that the slightly varying geometry does not play a major role and that time varying ground structure best explains the observed variation in dispersion images.

As suggested by the reviewer, we have analysed subsets of events that cluster spatially while being dispersed temporally. In this case we still observe the same trend as illustrated in Figure 15, i.e., that there is significant variation between events that occur at different times of the year while events occurring around the same time are very consistent. As long as our argumentation holds that the varying receiver geometry doesn't play a significant role, we are still left with the conclusion that the ground structure is varying temporally.

We will update the manuscript to include a more nuanced discussion of spatial versus temporal effects and the varying receiver geometry. We feel that is not worth including additional figures to illustrate subsets of events that cluster in space but are dispersed in time (or vice versa) since the reader will be presented with essentially the same trend that is already illustrated in Figure 15. These figures are however included as attachments to this comment for reference.

Actions for revised manuscript:

(1) Include a more nuanced discussion of spatial versus temporal effects and the potentially confounding factor of varying receiver geometry. We will describe the variation we observe for sets of events that cluster in space and disperse in time (and vice versa) to make it clearer to the reader why we think that temporal variation in ground structure best explains the observed variation in dispersion images for our catalogue of microseismic events.

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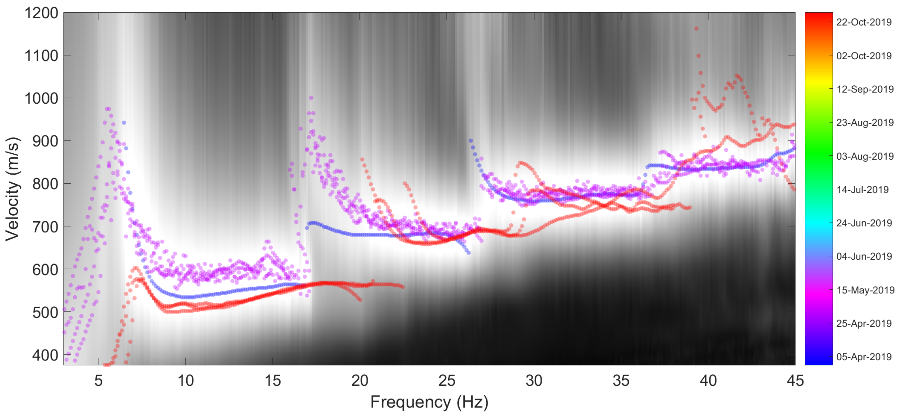

Fig. 1. Dispersion trends for a spatially clustered subset of microseismic events. We observe significant variation between spring and autumn events.

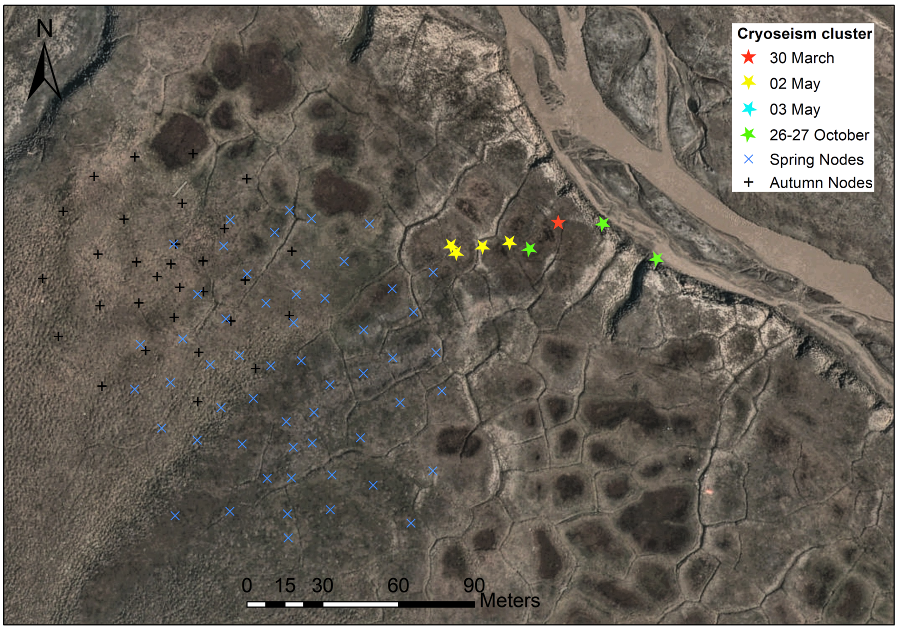

Fig. 2. Map view illustrating the source positions of the events from Fig. 1

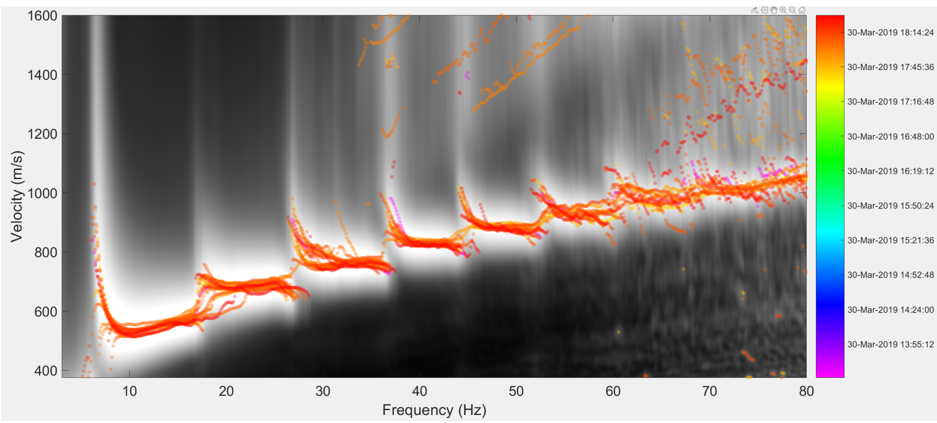

Fig. 3. Temporally clustered events that are dispersed in space (see Fig. 11 in manuscript for locations) display a highly consistent dispersion pattern.