**The Cryosphere
Discussions**

Interactive
Comment

Interactive comment on "Seasonal variations of glacier dynamics at Kronebreen, Svalbard revealed by calving related seismicity" *by* A. Köhler et al.

A. Köhler et al.

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We appreciate the very constructive review of Shad O'Neel. In the following we will refer to his comments one by one.

RC: I think that icequake seismologists would benefit from an additional section in this paper, namely a description and interpretation of the direct observations. A discussion of the nominal size, style and character of calving at Kronebreen would substantially help to place the interpretation of glacier dynamics into context of existing work (e.g. Columbia Glacier, Bering Glacier, Icy Bay, Greenland etc : Walter, Amundson, West, O'Neel, Stuart, Qamar, Wolf and Davies).

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AC: We added a short description of the estimates for iceberg volume in Section 2.2 from the scale relationship as defined in a different study and direct the reader to this study: "For a detailed description and discussion of this direct observational dataset, we refer to Chapuis (2011). " We agree that a detailed section about the characteristics of Kronebreen calving would be interesting for this paper. However, our objectives are to present the autonomous methods to detect seismic related calving, rather than calving itself. Therefore, we prefer to refer the readers to at least two articles in a PhD thesis available online that describe this direct observational dataset in great detail.

RC: A figure summarizing the observational record, and showing the relationship between seismicity and observations is essential.

AC: A new figure has been added showing calving observations and seismicity in the calibration periods in 2009 and 2010 (Figure 5).

RC: Similarly, a description of the waveforms associated with calving (duration, impulsiveness, freq. content, presence of phases etc) should come before the description of classification. A discussion of how these signals compare to other papers that have used seismicity as a tool to monitor calving is also needed.

AC: We modified Section 5.2: We discuss and compare the waveform characteristics with previous studies, though a direct comparison of our seismic signals from the low-sensitive geophone with those of broad-band instrumentation is limited due to the bandwidth of the instrument. See also comments in response to Amundsons review. We describe the results of classification before discussing the signal waveforms because we follow the "philosophy" of an unsupervised pattern recognition approach. As described in the paper, consideration of domain knowledge to characterize recognized clusters/classes automatically is done after the training phase. This is different to supervised classification, where a manually identified class is used to train a recognition algorithm. We therefore think it is better to keep the order of describing the results of the clustering first and then do the interpretation with respect to glacier seismicity.

RC: In agreement with Jason's review I would appreciate better connections between this work and existing literature. Some of the references in this paper are can be elucidated much better using other papers. Missing references that should be included – O'Neel et al., 2010; Walter et al, 2010; Amundson and Truffer 2010

AC: We added new references (including the suggested ones) and included a more detailed discussion and comparison with previous studies.

RC: Minor comments: Title: Add hyphen between calving and related.

AC: Done.

RC: p.3293 L9 – reference to Ahn and Box w re to calving is strange as their work is focused on detecting changes in velocity. While time-lapse imagery may reveal changes in front position associated with flow or a calving event or series of events between photographs (which may be separated by hours of darkness), the technique is not generally suitable for analysis of individual events.

AC: The reference has changed to Amundsen et. al., 2008 who show a series of pictures for individual calving events. Nonetheless, although techniques for generating a calving-proxy from time-lapse imagery has not been developed yet, it does not exclude the feasibility of using it for calving detection, especially in the arctic where darkness is not a problem during the summer. In addition, time-lapse photography may be quite helpful for single event studies as long as the repeat photo rate is high enough to capture the event.

RC: p.3295 L4: Specify the response of the sensor – what is the peak frequency?

AC: The natural frequency is 10 Hz (SM-4 geophone). Information was added.

RC: p.3305 Section 5.4 should precede 5.3 as it defines the assumptions used to construct the time series in 5.3.

AC: We changed the order of those sections as suggested.

RC: p.3306 L15: What is a large event at Kronebreen? See the larger comments above.

AC: Size 4 and more are a pretty large calving events at Kronebreen which correspond to a volume of about 1000 m3 and more. See the new reference Chapuis (2011) (PhD thesis).

RC: p.3306 L25 data set should be plural

AC: Done.

RC: p.3307. What happens in between the measurement periods? Does the terminus re-advance? Are the relative position reference lines the same for both years?

AC: We added the information to the caption of Figure 6 that the reference lines are different for both years and that the front advanced during the winter 2009-2010.

RC: p.3307-08. Why are the years so different?

AC: We mentioned that site conditions are slightly different (coupling, position) which could introduce a bias. However, noise levels seem to be similar on average in 2009 and 2010. Furthermore, decreased seismicity in 2010 seems to be consistent with visual observation of glacier activity for that year. In 2009, 463 events have been counted per day on average. In 2010 it was 256 events per day. Information was added. We do not have enough data to discuss why the glacier seems to be more active in 2009.

RC: p.3308 L20-25. The claim that there are first and lower order controls on calving has been made by several authors (reviewed by Benn). Can you frame your results more in context of the existing literature, especially the O'Neel and others 2010 paper that analyses a 2 year dataset similar to this one.

AC: We have re-written section 5.5 according to the above and to the review by J. Amundson. Thanks for the suggestions!

RC: p.3310 L4: Reference to a in prep paper on such a large statement seems inappropriate. There are existing references that should be included here

AC: We added existing references.

Interactive comment on The Cryosphere Discuss., 5, 3291, 2011.