Thanks for your helpful comments! Our responses are **bolded**.

- When you attempted to cross-correlate the seismograms, did you use the entire seismogram (e.g., similar to what is shown in Figure 2) or just some subset of the seismogram? If the former, one issue that might cause problems is that calving events often involve the detachment of multiple icebergs. I would guess that the calving events shown in Figure 2 involved 2–3 icebergs. If the latter, how did you determine what subset to pick? Also perhaps show what section of data you are using, or refer to Figure 12 when describing the section of data that you used. Its not clear exactly what data you are using.
We cross-correlated the snippets like those in Fig. 12, which were manually chosen by looking at sharp peaks in the spectra. We required that all four stations had clear peaks (so that we could identify lags) – in some cases this was not possible. We have added text to clarify that we are using the windows in Fig. 12 in the cross-correlation.

- I understand that cross-correlating the seismograms did not give satisfactory results for the calculating the time delay. Did you also consider cross-correlating the envelope of the waveforms? I'm wondering if there is a more robust way of calculating the time constant that doesn't rely on an empirical constant.
Our reviewer #1 suggested just to manually pick out the lags due to the small sample size. We were not wanting to do it fully manually due to the inherent subjectivity. Cross-correlating the envelopes would lose the resolution of the lags as the envelope is of order 5 s (in Fig. 6) but we have lags of order 1-3 s or so and even a 0.5 s shift would dramatically change the hyperbola. We were unable to think of a truly automated way of calculating the lags – we could also do a STA/LTA method but all methods require manual checking to see if the results are sensible (like for cross-correlation, we found implausible lags). Do you think it would be better just to concede that even our most automated method requires manual verification, and to just scrap our emperical values and do the localization manually?

- This study focused on large, full-thickness calving events that occur on weekly timescales. These are events that, at least for focused studies on individual glaciers, can often be located using time-lapse or satellite imagery (as stated in the paper). Smaller calving events clearly occur more frequently. Admittedly, these smaller events may be insignificant for the total mass loss from glaciers like Helheim and Jakobshavn, but understanding the variability of these smaller events may provide insights into processes driving calving. If you decrease

the STA/LTA threshold, can you detect and locate more events? If so, what sort of patterns emerge?
The biggest issue here is that the lower-amplitude events have a smaller slope (because they have a lower amplitude change in more-or-less the same time time step) and so our automated lag detector is much less accurate. Moreover, as the peaks are less sharp, it's also harder to manually identify them. However, if there is relatively low noise around the signal, and there is a short, sharp burst (like at 03:06 in Fig A3 below), then our method does converge. But because calving signals are emergent, we don't have these short sharp bursts during the main calving event. So we are unlikely to be able to localize the main calving signal for small events, but we may be able to localize nearby secondary signals from these events – though this probably would not localize the calving event itself.

- Another way to expand the applicability of this method is to show that it works for regional seismic data. Full-thickness calving events at Jakobshavn Isbrae are detectable at ILULI (50 km away), SFJD (250 km away) and sometimes SUMG (400? km away), even when the calving events don't generate classic "glacial earthquakes". Have you tried incorporating regional seismic data into your method? Can a regional seismic network such as GLISN be used to detect and locate large calving events around Greenland (besides those that generate glacial earthquakes) using your methodology?
Kira Olsen presented a poster at AGU 2015 that looked at locating glacial earthquakes using GLISN (using an azimuthal method), though due to the distance of the seismometers, this localization was limited to identify which glacier calved and not where on each glacier the calving occurred. We do not believe our method easily scales up to regional arrays, as a key assumption (that the surface velocity is constant in all directions) is no longer valid with different travel paths from the epicenter – this means the locus would no longer be a hyperbola, but rather some (more complex) other shape. Also, at higher distances, the error in v_eff would make the localization too imprecise (likely over most of the glacier). Though, the main limitation is the lack of a constant v_eff. Another test for the validity of our method is to look at calving fronts and to see if our localization matches – and our method does hold (Figure A2 below).

A few more minor questions:
- The authors state that calving at Helheim preferentially occurs on the north side of the glacier. Is this where the glacier is thickest/fastest? Is this statement really just saying that full-thickness calving events only occur in that region?

This is where the glacier is thickest (Fig A2), by about 200 m.

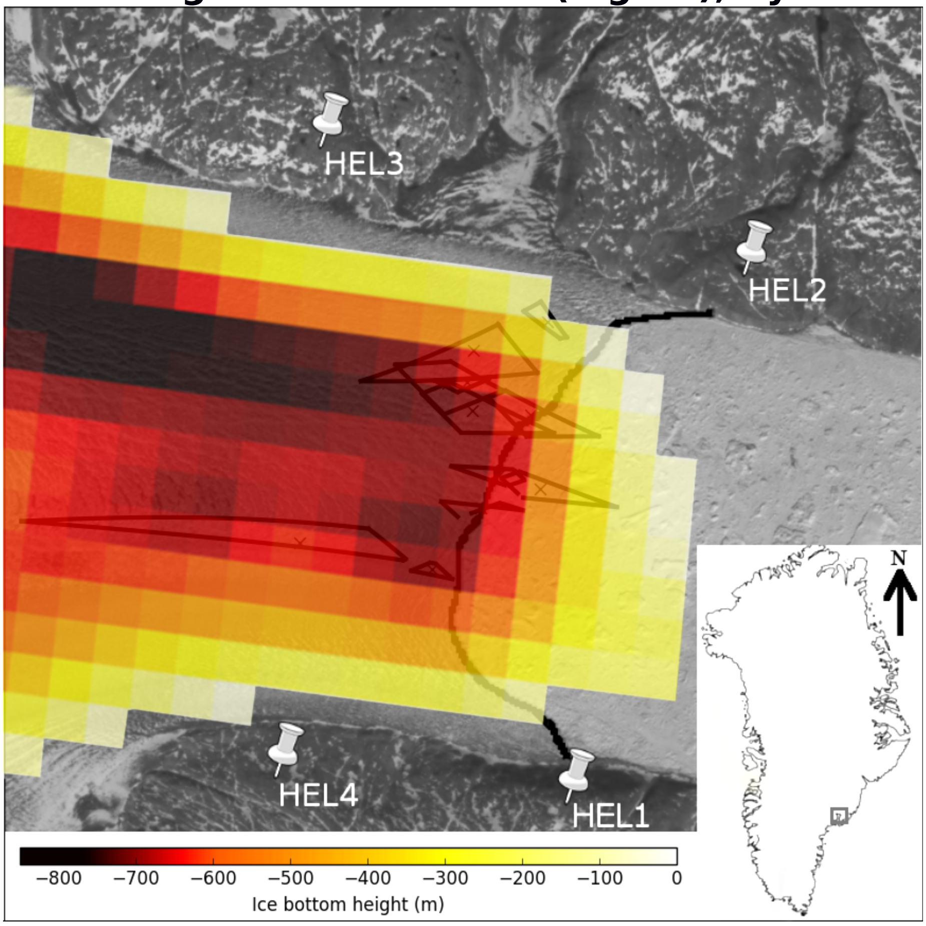

Fig A1. Topography of the rock below Helheim Glacier, taken from NSIDC McORDS flights collated between 2008-2012.

- What is the date on the googleearth imagery used in the figures? Perhaps it makes sense to use newer imagery that was captured closer to the time of study (e.g., from Landsat 8)?
Yes – we have now updated this (Fig A2) to use a Landsat image from July 2015, and we use three other images to also show the progression of the calving front (at the suggestion of reviewer #1).

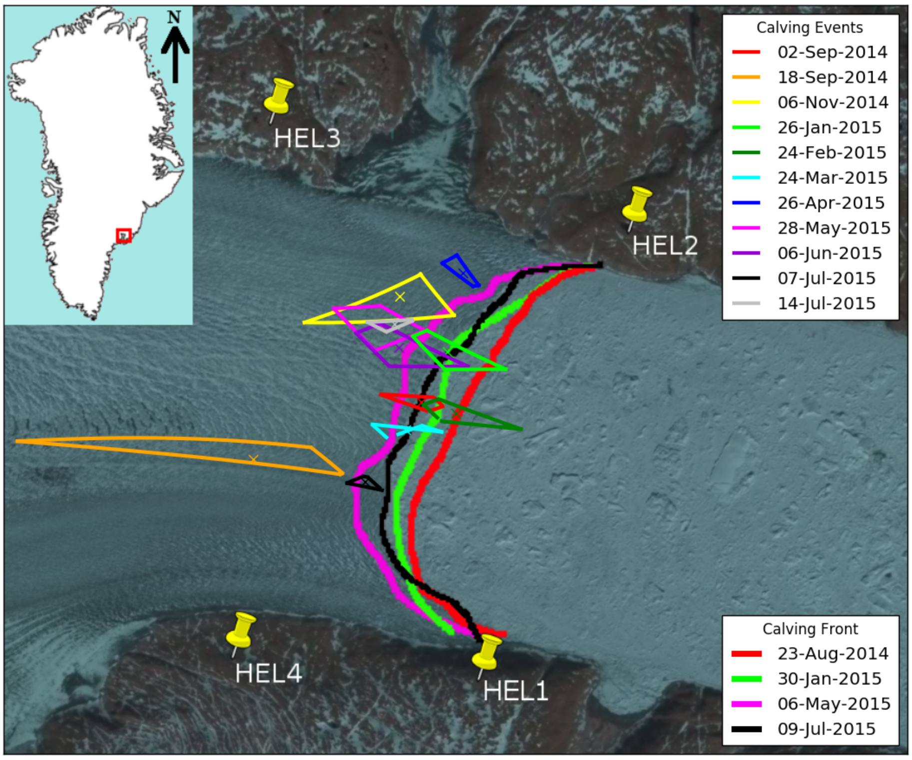

Fig. A2. Updated calving catalog showing locations and the movement of the calving front.

- I would guess that two or three icebergs calved during the events that appear in Fig. 2. What happens if you analyze each of the peaks in seismicity separately? Do you see calving propagating upglacier or across the glacier face?

The calving event Fig. 2 is from August 2014, when only two seismometers were available, so unfortunately we are unable to localize those events. However, we found another multiple-calving event (June 6 2015) which we treated the peaks separately (Fig. A3). It looks like the calving progression in that figure goes Red, Yellow, then it splits in two directions and goes Blue-Purple and Green. The estimated calving localizations all touch the calving front of June 5 (from Landsat), which is good. Do you think this plot is worth adding to the manuscript? This event is part of the calving catalogue from the manuscript you already saw, but only the "main" event (i.e. the highest peak at 2:30) is used. The plot may be a bit misleading because the shapes may suggest calving magnitude, which is not the case here (the biggest area in purple actually represents the smallest amplitude signal).

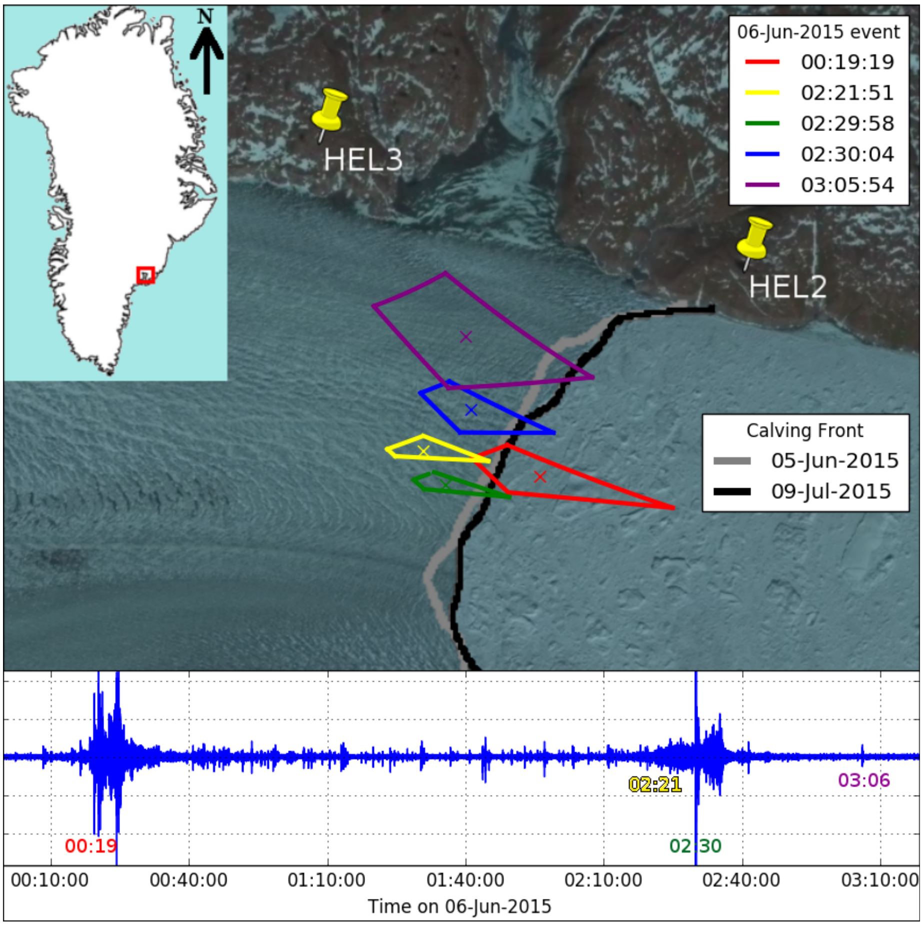

Fig A3. Multiple-iceberg calving event on June 6 2015.

- page 9, equation for radius of a circular fault: the equation contains beta_0, but the text describing the variables only refers to beta. Should these be the same thing?

Yes – thanks.