

Interactive comment on “Cornice dynamics and meteorological control at Gruvefjellet, Central Svalbard” by S. Vogel et al.

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General comments:

Observational studies like this are particularly valuable because they serve to better document and record snow behavior, and often result in new and unexpected insights. This study also demonstrates simple, rugged observational technology that appears to be well-suited to harsh environments.

Arctic studies are particularly useful, as most avalanche studies are done in lower-latitude mountain ranges that may have much different conditions.

Communities and industrial developments will continue to require careful siting and mitigation, and when factors like limited land availability or presence of mineral de-

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posits force development in avalanche zones, this kind of study has direct practical application.

Specific comments:

1.) I agree with Kalle Kronholm that the focus of study could be made clearer.

Though avalanches triggered by partial cornice collapse are mentioned, it appears that these are relatively small and non-threatening, so their mechanism of release is not the primary concern. Since these smaller cornice breaks are common triggers of sizable avalanches in other regions, it would be good to include some clarification in the introduction. It appears that avalanches triggered by the entire cornice releasing along the cornice crack are the focus, and the main source of threat to the settlement. It would be helpful to compare the size and number of non-cornice-triggered avalanches, those triggered by partial cornice breaks, and those triggered by full cornice collapses.

It would also be good to have some description of how many of these cornice falls are triggering slab avalanches, and how many are simply triggering and entraining loose snow, if known.

Also some discussion of non-cornice-triggered avalanches would be useful in the introduction. Are the slabs triggered by wind-loading, rain, or other mechanisms an important threat?

A brief discussion of historical avalanches affecting the settlement area, and their causes, might be appropriate; with the understanding that remote areas often have little historical information available, and that there is little evidence left behind from historical avalanches in areas without trees.

2.) In the abstract, I would add to the comment on "induced by pronounced air temperature fluctuations" an indication of whether those fluctuations included temperatures above the freezing point.

3.) If large cornices dropping are the primary threat to settlement, it seems that jet

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roofs, drift fencing, or other cornice-reduction methods might be more useful than forecasting and evacuation, given the forecast accuracy limitations with a time window of weeks for cornices to drop after first showing visible signs, and that not all cracks resulted in releases and not all releases were preceded by cracking.

Annual return for slides capable of damaging housing is certainly high enough to merit consideration of structural approaches. Brief discussion of possible mitigation approaches based on the study's results, including studies that might refine forecasting accuracy, would add value.

4.) The two winters studied yielded a sufficient number of events for analysis, but is there any information available on how representative a sample those two winters were of the typical range of variability for weather and avalanche activity? A brief comparison with long-term weather records and any known climate cycles would be great.

5.) Page 2281 - In the introduction, it might be more descriptive to refer to cornices as being shaped like a breaking wave, rather than just as "wedge-shaped".

6.) Page 2291 - The problem of creating a reference point to measure snow motion is common to cornice, creep, and glide crack studies. Stakes as used are a simple and robust solution, but they can move in the snow under wind, creep, or melt, and the motion of the part of the snow mass they are connected to may or may not represent the movement of the cornice overall.

We have considered but not tried using surveyors' laser rangefinder reflectors, which could allow precise remote measurement but would likely be delicate in an Arctic ridgetop environment, and easily buried and lost.

We also have considered using short lengths of white plastic pipe buried horizontally as deadmen, with marked low-stretch synthetic cord from them to our measurement points. These could allow measurement at different depths. Until we have tiny micro-GPS sensor pucks we can embed and track, these have been our best ideas.

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7.) Page 2292, line 23 - I am curious as to the range of these "increasing air temperatures", and would like more detail here. How close to freezing? Above or below? If above, for how long?

8.) Page 2294 - The finding that the cornice size is the key variable determining the threat from the slide is very useful. It is the best argument here for cornice prevention or reduction as the best-targeted solution, and helps to answer concerns in my comment 1.) above.

9.) Page 2295 - The information on critical wind speeds for cornice accretion and scouring in this environment is new and very useful.

10.) Page 2297 - Good discussion; very thought-provoking! Discussion of previous research and possible mechanisms is useful and points the way for further studies.

11.) Page 2298 - Intriguing finding that snow and increasing temperatures initiated cracking but not collapse. Useful understanding of process. How about smaller breaks; were they more common during storms, or were they obscured by cornice-building and drifting snow that made them hard to detect visually?

12.) Page 2299 - The observation that rock buttresses on the sides supported some cornices suggests that in situations where an excavator could be brought to the ridge-line, and where the rock is loose enough for digging, the topography might be reshaped into smaller basins with buttresses shaped to wedge cornices in place.

It sounds like the rock at this site may be too hard for easy excavation, but in the Alaskan Arctic, frost action is so intense that many rock outcrops are shattered and have more rubble than solid rock. Re-contouring the ridgeline above settlements or developments could be a practical mitigation solution in some locations.

13.) Typos:

Page 2281 - line 11, comma and space after Svalbard

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Page 2300 - line 24, where the temperature conditions?

Page 2300 - line 25, insulation or isolation? Also freezing onto might be better usage than onfreezing, though if that is a technical term I don't know, no problem. (If not it could be a useful one to coin!)

Interactive comment on The Cryosphere Discuss., 5, 2279, 2011.

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