Point-By-Point Reply to Editor's Comments

Thank you very much for your manuscript revision. As you will see there is variety in opinions from the reviewers. In general the concerns from the previous round have been addressed. There remains an issue that this has parallels with earlier research around wind tunnel experiments. However, this is such an understudied topic that I consider publication of these experiments is worthwhile. Please bear this point in mind and strengthen the discussion around how this manuscript changes the scientific discourse as you address the remaining comments from the reviewers.

Response: We would like to thank the editor for taking the time and patience in review process. We sincerely appreciate your effort in giving us valuable comments and encouragement, which helped us in improving this manuscript.

To strengthen the discussion around how this manuscript changes the scientific discourse, we added lines 334-336 in the conclusion: "Overall, this study is a step forward in understanding the mechanism of cornice formation with detailed measurements and controlled environmental conditions. We also present progress in the methodology of observing snow cornice formation. In the future, this may lead to improvements in cornice-fall avalanche predictions". In the meantime, we also added lines 14-17 in the abstract: "Based on the physics of drifting snow, our results provide new insights into snow cornice formation and improve understanding of cornice processes that can influence avalanche activity. The experimental results and the conceptual model can be used in future snow cornice simulation and prediction work for cornice-induced avalanches."

Point-By-Point Reply to Referee #2's Comments

General comments:
Thank you again for the opportunity to review the revised version of this manuscript. The current version of the manuscript, in my opinion, represents a considerable improvement in terms of readability and the ease in which it allows the authors' work to be understood. I particularly appreciate the authors' efforts to expand the literature review in the introduction and more explicitly address previous work by Naito and Kabayashi in this version of the manuscript. Additionally, the inclusion of the notation section and the reworking of the results and discussion section – together with Figure 7 and the conceptual model for cornice formation – makes this version considerably more accessible to a broader audience.

This work utilizes repeatable, controlled laboratory experiments to improve our understanding of snow cornice processes. In particular, this work provides a solid theoretical and numerical foundation which can help inform and improve future field studies and serve as a basis for additional modeling efforts. Accordingly, I believe this work will appeal to a relatively broad scientific audience interested in snow processes and also potentially to practitioners working with snow avalanche and cornice hazards.
Response: We would like to thank you for your endorsement of our work! We appreciate your efforts and expertise that you contribute to improving this manuscript.

Certain sections of the work suffer from decreased readability due to language issues. In most cases these issues will be easily resolved with an additional editing session, but in a few cases I found language issues to impede understanding of the scientific concepts being described. I've included these minor issues in the specific comments and have also tried to include some of the more noticeable technical corrections.
Response: Sorry for the language issues in the manuscript. We will pay more careful attention in revising it and make it readable.

***Specific comments*:**
Line 8: I think you should define ū here.
Response: To keep this sentence concise, we revised this sentence in lines 7-8 to "The results show that cornices only appear under a moderate wind speed range (1-2 times threshold wind speed)."

Line 14: Consider briefly specifying how this work can contribute to improved snow avalanche forecasting (maybe via improved understanding of cornice processes which can influence avalanche activity?).
Response: Thank you for this important comment. We have added this to lines 14-17: "Based on the physics of drifting snow, our results provide new insights based on the physics of drifting snow into snow cornice formation and improve understanding of cornice processes that can influence avalanche activity. The experimental results and

the conceptual model can be used in future snow cornice simulation and prediction work for cornice-induced avalanches."

Lines 43-44: I think "daily observations" better describes the temporal issues you allude to here rather than "average observations."
Response: We have revised the sentence in lines 45-47 to: "However, cornices often grow through relatively discrete events in the field (Vogel et al., 2012; van Herwijnen and Fierz, 2014; Naito and Kobayashi, 1986; Hancock et al., 2020). Daily observations therefore only incompletely characterize cornice growth conditions."

Lines 44: do you mean the compromises necessary to acquire these field observations?
Response: Yes, I mean some uncontrollable factors for example weather that can affect the continuity of the field observations.

Lines 51-52: The language in this sentence is a bit confusing and should be revised, but from a content perspective do they find fresh snow with an irregular dendritic shape needs to be available for wind transport for cornices to form? It would help the reader to be a bit more specific about "fresh snow with an irregular dendritic shape."
Response: Sorry for the misunderstanding we made in this sentence. They also observed that fresh snow in an irregular dendriform shape is more appropriate for the cornice formation than the aged round snow, which might because of their larger contact surface. In order to express more clearly, we revised this sentence in lines 54-55 to: "Their results show suitable conditions for cornice growth include the air temperatures of -20 ^{o}C to 0 ^{o}C, wind speeds 4 m s^{-1} to 8 m s^{-1}, and irregular dendritic-shaped snowflakes with larger contact surface."

Line 53: mainly occurs through snow redistribution processes?
Response: I agree with you. It is more proper to use "redistribution" here. We have revised this word.

Line 54-55: Gauer (2001) could reproduce cornice formations numerically due to poorly understood physical formation mechanisms?
Response: To avoid misunderstanding, we revised the sentence in lines 56-58 to "Moreover, the locations such as cornice-like deposition at the ridge are well predicted in the numerical simulation using Alpine3D (Lehning et al., 2008) and ARPS (Mott et al., 2010), but the cornice shape cannot be represented."

Line 85-86: the SSA provided here is for snow stored for a few days up to a week?
Response: Sorry, in here we made a mistake, we have revised this sentence in lines 87-88 to "The specific surface area (SSA) was about 40-60 mm^{-1} for the snow that was stored a few days up to a week (Schleef, 2014)."

Figure 3: Nice!
Response: We thank the reviewer for a positive comment.

Line 170-171: Here are you describing that collection efficiency refers to temporary storage of the snow particles under transport? I am struggling to understand this description as it is currently written.

Response: The collection efficiency is the ratio of permanent storage of snow particles to mass flux of airborne particles, and its calculation formula is shown as equation 9. Here, we mean that the cornice growth rate is not only dependent on the collection efficiency, but also determined by the mass flux.

Line 185: Cool! This is a super useful result.

Response: We thank the reviewer for a positive comment.

Line 208: I am unsure what "sticking particles at the edge" refers to here?

Response: Sorry for the misleading. Here, we mean that the particles stopped at the edge. We revised this sentence in lines 212-213 to: "The first stage can be assumed as a formation of a 1-2 particle diameters thick snow slab composed of particles sticking horizontally at the edge (see Fig. 3a and b). "

Technical corrections:

Line 3-4: consider "This is particularly true with respect to the wind conditions which favor cornice formation" to make this a complete sentence

Response: Thank you for pointing this out, we have corrected this sentence in lines 3-4 to "This is particularly true with respect to wind conditions which favor cornice formation."

Line 23: infrastructure

Response: Thank you for pointing this out, we have corrected the word.

Lines 28-29: Montagne et al. (1968)

Response: Thank you for pointing this out, we have corrected the name.

Line 29: measured a wind speed range between 7 and 15 ms-1 for cornice formation

Response: Thank you for pointing this out, we have corrected the sentence.

Line 30-31: consider "identified wind speeds between 4 to 8 ms-1 as suitable for cornice formation at 1 m above…"

Response: Thank you for pointing this out, we have corrected this sentence in lines 33-34 to "Naito and Kobayashi (1986) identified wind speed between 4 to 8 m s^{-1} as suitable for cornice formation at 1 m above the snow surface in the field and at the center (0.5 m height) in the wind tunnel"

Line 37: these discrepancies

Response: Thank you for pointing this out, we have corrected the word.

Lines 38-39: under moderate to strong winds
Response: Thank you for pointing this out, we have corrected the word.

Lines 48-50: This sentence should be rewritten as two sentences.
Response: Thanks. We have corrected this sentence in lines 52-53 to "They described snow cornice formation as a process in which drifting snow particles adhere one after another at the leeward edge. The formed thin snow slab elongating leeward then hangs down under its weight."

Lines 51-52: maybe "Their results show suitable conditions for cornice growth include air temperature between -20 deg C and 0 deg C, wind speeds between 4 and 8 ms-1, and"
Response: Thank you for pointing this out, we have corrected this sentence in lines 54-55 to "Their results show suitable conditions for cornice growth include the air temperatures of -20 to 0 ^{o}C, wind speeds 4 to 8 m s^{-1}, and irregular dendritic-shaped snowflakes with larger contact surface."

Line 171: This value only reflects
Response: Thanks. We have corrected the word.

Line 173: remove "the" before Section 3.3
Response: Thank you for pointing this out, we have removed the word "the" before Section 3.3.

Line 206: a snow cornice
Response: Thank you for pointing this out, we have added the word "a" before snow cornice.

Line 209: can be assumed to be a repeated process.
Response: Thank you for pointing this out, we have corrected this sentence in lines 214-215 to "The second stage can be assumed to be a repeated process of length growth - thickness growth."

Line 265: Hancock :)
Response: We are very sorry to make an incorrect spelling by mistake. We have corrected the name to Hancock.

Line 313: do you mean field data here?
Response: Yes, for better illustration here, we revised this sentence in lines 325-327 to "Based on the field observation data, such as roughness length, the threshold wind speed, and the local surface snow conditions, this model can be applied to field conditions to predict the cornice length growth rates and the suitable wind speed range."

Line 316: remove of from before threshold wind speed

Response: Thank you for pointing this out, we have revised this sentence.

Line 316: field.
Response: Thank you for pointing this out, we have revised this word.

Line 320: observational data
Response: Thank you for pointing this out, we have revised this word.

Line 321: and measurements of other relevant parameter
Response: Thank you for pointing this out, we have revised this sentence.

Point-By-Point Reply to Referee #3's Comments

In this paper, the authors reproduce the development process of snow cornice by wind tunnel experiments in cold room, then constructed a conceptual model using the experiment results. They also applied their conceptual model to actual field observations to verify the practicality of the conceptual model.

As they showed in their paper, although snow cornice is one of the factors that cause avalanches, our understanding of its development process is still insufficient. Therefore, snow cornice role in the avalanche is not sufficiently taken into account in avalanche prediction. For this point, their study may contribute to the avalanche prediction thorough the modeling of the developmental process of snow cornice.
Response: We thank the reviewer for a positive view on the importance of our study.

On the other hand, as noted in their paper, wind tunnel experiments and field observations of snow cornice have been conducted as previous studies, although they are few in number. Previous studies have reported that snow cornices develop under moderate wind conditions.

The results of their experiments show similar results. In this sense, the present study can be positioned as an example of wind tunnel experiments on snow cornice development, and it must be said that the results of the experiments themselves have little scientific impact.
Response: We agree with you on the point that previous studies have reported that snow cornices develop under moderate wind conditions which had been addressed in the Introduction section in last round revision. Our experiments agree well with the previous research on this point, as a basement results. The main contribution in this paper is that we explained this phenomenon from physical mechanism. Moreover, we developed a concept model that can be used as prediction model for the field. Therefore, we still cannot accept the point that this study just has little scientific impact because it shows the similar results as before.

Their advantage should be that they made more detailed measurements, but it is not clear how their results play a significant role in the interpretation of what has already been reported. For example, they only mentioned that the difference between their result and previous one is caused by wind tunnel size difference, they did not discuss concretely from the scientific view. Therefore, under the present, it is difficult to find the scientific role of their detailed measurements to develop understanding snow cornice development. The comparisons between their conceptual model calculations and actual field observations are only a qualitative comparison due to the limitations of the conceptual model.
Response: Thanks. In the calculation of collection efficiency (Eqn. 9), we replaced the particle density by using the cornice density. As the revised results shown in the Figure

5, our experiment results are in the same order of magnitude as that in N&K86's study.

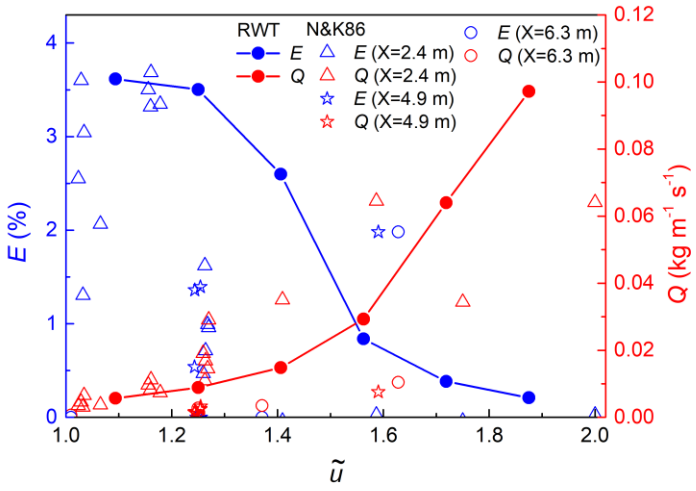

Figure. 5 Collection efficiency E (in blue) and snow transport rate Q (in red) under different non-dimensional wind speeds $\tilde{u}$. X represents the distance from the snow particle feeding point to the mass collection pits where the cornice grows. Lines are for ring wind-tunnel experiments, and hollow scatters are for N&K86. N&K86 represents the experiment results of (Naito1986).

Our measurements do provide more details than the previous study of N&K86. In N&K86's study, only very little raw data and environmental condition are reported. Therefore, we could barely do a deeper comparison between the two works. For readers clear this fact, we revised the sentences in lines 172-174: "Our measured values for the collection efficiency are in the same order of magnitude as in N&K86. Due to the limited data and unpublished details in the study of N&K86, we could not make a deeper comparison."

For these reasons, it must be said that, at this stage, the scientific value of their study is insufficient for publication in the TC.
There is no doubt that a lot of hard work went into this study. The experimental results have sufficient credibility. The manuscript itself is also well described, including the description of the methodology.
Before resubmitting the manuscript, I strongly recommend that the authors reorganize the manuscript to clarify what new scientific findings they have derived from this study and how their finding contribute to advance the scientific topic of the developmental process of snow cornice.
Then they should concretely clarify their scientific contribution in the manuscript.
Response: We thank the reviewer for the approval of the work volume, credibility, and the description. To make concretely clarify our scientific contribution, we added lines 334-336 in the conclusion: "Overall, this study is a step forward in understanding the mechanism of cornice formation with detailed measurements and controlled environmental conditions. We also present progress in the methodology of observing

snow cornice formation. In the future, this may lead to improvements in cornice-fall avalanche predictions". In the meantime, we also added lines 14-17 in the abstract: "Based on the physics of drifting snow, our results provide new insights into snow cornice formation and improve understanding of cornice processes that can influence avalanche activity. The experimental results and the conceptual model can be used in future snow cornice simulation and prediction work for cornice-induced avalanches."

Point-By-Point Reply to Referee #4's Comments

The manuscript has been well-revised. The authors referred to similar experiments made by Naito and Kobayashi (1986) then succeeded in quantitatively showing the formation process of snow cornices governed by the balance of growth and erosion rates. This study will provide an important contribution to the observation method of snow cornice and snow cornice-induced avalanche forecasting. I would recommend it for acceptance after the minor points listed below are addressed.

Response: We thank the reviewer for pointing out many important comments, which are very helpful in improving our manuscript.

L125

The formulation of Eq. (7) seems not described. More explanation from Eq. (6) to Eq. (7) should be given.

Response: Thank you for this important comment. It is our mistake that didn't describe enough on the transfer from Eq. (6) to Eq. (7). We have added the explanation in the new version manuscript in line 125: "The transport mass flux profile can be described by an exponential law (Nishimura and Nemoto, 2005; Sugiura et al., 1998):"

Section 4.2.1

The threshold wind speed (ut) is set as 10 ms-1, however, this can give the misleading impression that ut is too much higher than the wind tunnel experiments.

In the reply to referee #1's comments, the authors estimated the friction velocity and concluded that this wind speed value is comparable to the threshold wind speed in previous literature. This quantification process should be introduced here.

Response: We agree with you. To avoid this misleading impression, we added this quantification process in lines 244-249: "It should be noted here that by analyzing the time series of wind speed data from Gruvefjellet meteo station (2022), the corresponding averaged wind speed is found to be 7.37± 0.97 m s^{-1} when the maximum wind speed is in the range of 10.5 to 11.5 m s^{-1}. Thus, the friction velocity is 0.29 m s^{-1} assuming a roughness length $z_0 = 10^{-4}$ m. This value is comparable to the threshold wind speed in previous research (Sugiura,1998; Jdoorschot,2004; Clifton, 2006), considering the harder snow surface in Gruvefjellet (Eckerstorfer2013)."

L123

··· Φp(z) is the mass concentration calculated by Eq. (1) …

Eq. (5)?

Response: Sorry for this mistake we made, and we have corrected it to Eq. (5).

L265

Hancoko et al. (2020)

-> Hancock

Response: Sorry for this mistake we made, and we have revised the name.

L346
Kosugi, K., … Sato, A., and Prevention, D.
Prevention, D. seems not a human name
Response: Thank you for pointing this out, we have revised the citation here.

L364
Naito and Kobayashi
-> Naito, A. and Kobayashi, D.
Response: Thank you for pointing this out, we have revised the citation here.