We thank the reviewer for their helpful comments that will help improve the manuscript. Based on their concerns and those of the second reviewer we have undertaken a reorganisation of the manuscript. The reviewer's comments are highlighted in blue with our response and how corresponding changes to the manuscript below in black.

Major concerns.

My main concern is the need to improve the quality of this manuscript. The authors have used non-scientific language, such as 'almost certain' and 'roughly', when drawing conclusions. Additionally, I have noticed that many introductory contents are misplaced in later sections, such as 4.3, 7.1, 7.5, etc. I suggest that the authors rewrite the introduction as well as these sections. Overall, there are several redundant paragraphs in this manuscript that could be significantly shortened.

We thank the reviewers for their feedback and along with a similar comment from Reviewer 2 we have reworked the manuscript to improve the scientific language and the general structure.

Regarding the numerical experiments, particularly the mesh resolutions experiments, it is conventionally recommended to test at least 4 different points of each variable in order to draw conclusions related to convergence. These points should span at least 1/2 and 2 times the control resolution.

We have conducted extra experiments in order to fulfil the requirement to have four different points for each variable spanning half and two times the control resolution.

The significant impact of non-physical parameters on the no pinning point cases appears to be closely related to the CD calving law. I suggest that the authors add a comparison experiment with a rate-based calving law to identify the reason for this strong dependence.

Yes, the reviewer is correct the crevasse depth (CD) law determines the state of the glacier in the two setups. We have added a supplementary experiment with a rate-based law to distinguish the difference between the method and the CD law.

I fully agree that the authors should focus on the key methodological choices and model capabilities. However, as a whole paper, the manuscript should be self-explanatory without requiring readers to read the supplementary materials.

The reviewer notes correctly that the manuscript has a large supplementary text. Complete documentation of the algorithm requires a large amount of detail that would be accessible to a only small number of the glaciological community interested in complexities of remeshing. On the other hand, as noted by Reviewer 2, it is important that full documentation is available to allow other glacier modellers to implement the new calving method. We feel that the best compromise was to confine description of the detailed model algorithm and model setup to the supplement, and to focus the main text on outlining the main features and capabilities of the algorithm, thus allowing the paper to be comprehensible without being burdensomely long.

Detailed comments.

We thank the reviewer for their careful reading of the text. All minor and specific changes requested have been made to the manuscript. Comments that required a fuller explanation are below.

Section 4.2, in general, this section need a bit more work.

We have reworked this section as the reviewer suggests.

l132-141, I'm a bit confused about this paragraph. What boundary condition is apply at the fjord wall? If the velocity is solved with a Dirichlet boundary condition parallel to the fjord wall, then the velocity component in the direction of the fjord wall is automatically constrained. Shouldn't the velocity solution be constrained first, instead of fixing the displacement?

The reviewer is correct the velocity is constrained first and then the displacement fixed along a predefined set of fjord walls. We have updated this paragraph for to improve the clarity.

l148-149, 'the model has the …. lateral margins', could you explain a bit more in details, what are the 'boundary elements' and where is the lateral margins? Are these at the calving front, or at the fjord wall?

The lateral margins are those present on the fjord wall so those on the side of the glacier. Boundary elements within the 3D domain are triangular elements present on a particular boundary. The identity of the boundary (and corresponding conditions) enforced on the element are determined using a boundary tag associated with the element. Each boundary element corresponds to a parent tetrahedral element present on the bulk (3D element forming part of the domain). Here, when the glacier advances the Lagrangian movement of the terminus of the glacier mean the calving front can come into contact with the predefined fjord walls. If this occurs, the model transfers the assigned boundary identity of the element from the terminus to the lateral (right or left) boundary. This changes the boundary conditions applied at this element from those present on the terminus (Eqs. A9 and A10) to the lateral boundary (Eqs. A15 and A16) which has a non-penetration condition. We have rewritten this section to provide additional clarity.

l153, is the normal to the element faces, or to the nodes?

Normal to the nodes based on the mean normal of adjacent elements.

l159-161, I'm a bit worried about the melting applied at the corner element, as the normal direction is not going to parallel to the wall, which add additional 'leak of mass' at the side wall boundary

Melt is accounted for prior to terminus advance being reprojected along the side wall boundary. The resultant vector of the velocity vector minus the melt normal vector is constrained along the predefined fjord wall. The change in mass from melt is usually small compared to the velocity being projected along the fjord walls. Changes in mass from either are insignificant on a glacier scale and when compared to changes in the domain from the Hausdorff distance associated with remeshing.

Overall, it would beneficial to have a schematic plot of the boundary at the corner between ice front and fjord wall, and refer to the items in the figure when explaining the implementations

There is a figure in the detailed supplement that explains the algorithm in detail but we can move this into the main text as the reviewer would find this beneficial.

l210-211, what is 'level set implementation fails across the range of input parameters provided'? Give a concrete example. Why 'calving cannot occur' then?

Given the complexity of remeshing a new internal boundary failure can occur. In order to increase the robustness of the model multiple remeshing parameters can be specified on the model input file allowing several attempts at remeshing and increasing the change of success. This is shown in Figure 4. We have reworked this paragraph to improve clarity.

l219, how is the new solution checked, to ensure not to use unrealistic velocity?

An additional solver that checks the convergence of the velocity solution, the maximum velocity and the divergence from the previous timestep is used. We have added a sentence to describe this process.

l227, why 'plus one second'? Does this mean one has to always use time step at one second?

Yes, as the reviewers note this is currently hardcoded but could easily be changed so this additional time can be user specified. This functionality was included because when an unrealistic velocity is produced the timestep needs to be rerun. However, because of some internal workings in Elmer the time-dependent solvers cannot be rerun with the exact same starting time. One second is insignificant time span when considering the usual time stepping using glacier models. If the reviewer thinks it is particularly important to allow this time to be user defined we can update the code.

Figure 4, row 5, the center box 'Success? Mesh quality sufficient?' has two 'Yes' arrows, which way should 'Yes' go?

Yes, goes two ways. The output calving statistics are only calculated upon successful remeshing. The other 'yes' is the continuation of the algorithm to redistribute the mesh.

l269-274, I could not fully agree with the author's arguments here. Every numerical method for time dependent problem has numerical errors associated with the time scheme. No matter what type of calving law, the errors are due to the approximation of the time derivative in the time dependent equations. In this case, it comes from the free surface equations. I agree the way no-physical rate-based law update the ice geometry is different from rate-based law, but this does not lead to the conclusion that it is time step independent.

We thank the reviewer for this insight. We agree with the reviewer's conclusion that ultimately even rate based laws can be timestep dependent. However, we were trying to emphasise the clear distinction that the CD law predicts attractor positions towards which the terminus will migrate, and consequently is sensitive to the choice of timestep when the glacier is in a transient state (moving between attractors). This consideration is not an issue for rate-based laws. We have reworked this paragraph to reflect the reviewers comments.

section 6.2, after reading this section several times, it is still not clear to me what adaptive time stepping method is used in this study. To me understanding, adding small timesteps is just a safeguard after the adaptive time stepping. I suggest the authors to rewrite this section, and spend the first few paragraphs to explain what adaptive time stepping method they used in this work.

l303-306, in most numerical models, the common reason to use adaptive time stepping is to improve efficiency of the transient simulation, while maintaining desired accuracy. In general, adaptive time stepping method is more efficient than constant time stepping in terms of getting the final solution of a long term simulation. I would strongly recommend to revise this section.

We thank the reviewer for the above two comments which provide us with us the chance to improve the clarity of the description of the adaptive time-stepping implemented in the model. Firstly, as the reviewer correctly notes the time is reverted if the velocity solution is inadequate. This is not what we describe as 'adaptive time stepping'. The adaptive time stepping is instead a method to better simulate rapid ice loss from a glacier. If a large calving event occurs the new geometry can potentially be unstable. In order to capture secondary calving the time step size is altered if calving occurs over a given threshold. If the calving volume is below the given threshold normal time stepping is resumed. Importantly, this is independent of remeshing and numerical requirements.

Remeshing failure (including that of inadequate velocity solution) suppresses calving so normal time stepping must be resumed. Therefore, if remeshing failure occurs it prevents potential calving cascades from being simulated. We have rewritten this paragraph to improve the clarity of this method.