Dear Olivier,

Thank you very much for considering our manuscript for publication in 'The Cryosphere' and for your helpful comments. Please find below our replies (in italics) to each of your points (in bold).

Kind regards,

Sebastian Rosier and Hilmar Gudmundsson

- line 80: flexural ice- softening -> flexural ice-softening

Done

- line 90: what is h in Eq. (4)-(6) should be specified as from Fig. 1 it seems to be the ice thickness at the front, whereas in the analytical solution it is the mean(?) or local(?) thickness. Also, it is mentioned line 113 that this solution is derived for an infinitively long ice-shelf (which I guess means with periodic boundary conditions in the x direction), which seems in contradiction with a constant thickness gradient along x? How the assumption that h is not constant departs from this assumption should be discussed (or at least clearly mentioned).

Ice thickness (h) is now defined in the figure caption and the relevant portion of text.

Ice thickness 'h' in our analytical solution refers to local ice thickness and a thickness gradient exists which contributes to the driving stress 'F_d'. Our analytical solution provides u(y) at some point downstream of the grounding line for a particular ice thickness at that point and the magnitude of bending stresses varies with the ice thickness.

The beam equations we use are 1-dimensional and in the past have been used in the context of a floating ice tongue protruding outwards perpendicular from the coast. We focus on the across-channel bending stresses, so our wording is admittedly poor because in this case the equations are only strictly correct for an infinitely <u>wide</u> ice shelf. This is not due to a periodic BC but due to other BC's which must be satisfied and are outlined in Appendix B. In our geometry, ice thickness is a function of x but not y and so, as long as we focus on a region sufficiently far from the GL that 2-D effects are negligible, the thickness gradient in x does not matter. In Appendix B we demonstrate that, although our geometry is not infinitely wide and so the BCs are not the same, the equations are still a good approximation for a sufficiently wide ice shelf such as is found at the outlet of Rutford Ice Stream. So it is only the beam equations (from which we obtain bending stresses) which were derived for an infinitely long ice shelf, we show that they still work for our geometry and do not make this infinitely long assumption anywhere in our analytical solution. We have reworded things in a few places to hopefully make all of this clearer.

- line 92: the GL that the -> the GL so that the(?)

Changed to "the GL such that the…"

- line 122: w_a is noted W_a in Fig. 1 (make it consistent). The Poisson's ratio is usually \nu?

Fixed w_a and replaced all instances of \mu with \nu for Poisson's ratio.

- line 143: s is the surface elevation, b is the bed elevation

Done

- Equation 18: why not u_shift instead of n_shift (which looks like a ratio of velocity, not a velocity)?

We prefer to continue calling this "n_shift" because it emphasises that it is the nonlinearity arising from "n" that contributes to the increase in velocity due to tidal bending.

- Caption Fig. 2: in table 3 -> in Table 3

Done

- line 198: Then I don't understand because it is mentioned above that only the non linear viscous term is conserved and that elasticity is neglected? Did I miss something? There is no E in Eq. (18)? Which value for A has been used? It should be mentioned in Table 1.

In order to calculate the stresses generated by tidal bending we use elastic beam theory, these stresses are then used in the purely viscous analytical solution which is possible because of the Maxwell rheological model that we use, in which elastic and viscous stresses are equal. Thus, E enters in Eqs. 4, 5 and 6 which define the stresses. The wording is probably confusing though and so we have changed it to make this clearer.

The value used for A is now mentioned in Table 1.

- line 248: \rho_i should be \rho

Done

- line 250: similarly to reviewer #1, I don't understand what is an elastic foundation. Are you just applying a normal stress equals to the water pressure on that surface? If yes, why do you need to introduce this concept of "elastic foundation"? Or is it more complex, like the "viscous spring" term in Eq. (15) of Durand et al. (2009)? Then it should be mentioned.

The elastic foundation BC that we implement in our FE software is mathematically exactly equivalent to applying a normal stress to the face of the element. We choose to apply the ocean pressure in this way because it requires less iterations to converge than directly applying a normal stress, by reformulating the force to be a function of the unknown ice shelf base position. No additional dampening terms (as in Durand et al. 2009) are needed to aid stability. We reworded this slightly and added a citation to Gudmundsson (2011), where this is described in more detail.

- Figure 3: margin till -> margin BC?; ice stream till -> ice stream BC?

Done

- line 330: no space after MS_4

Done