Dear Authors,

The main goal of the manuscript is to infer heat source locations, strength and spatial distributions beneath an ice cap using ice flow model and glacier surface data. The idea and the novelty of the method in this region are laudable and of interest, as direct measurements of geothermal heat sources are impractical. However, I have some main concerns. At this stage, the manuscript needs some major edits.

My first concern is if the authors have made a global search during step (I) to step (III) in section 2.3 for all the potential positions (*CX, CY*), the peak outflow velocity and the heat source width *R*. You take *UZ0*=−1250 m/year in step (I), and you get an optimized location, which is used as input for step (II). If you take a different value of *UZ0* in step (I), you would possibly get another different optimized location, which may have impact on the subsequent results. From Table 1, run 06-09, we can see that for a fixed location of (*CX, CY*) and changing *UZ0,* the resulting RMSE is sensitive to the change of *UZ0.* Therefore, global search for optimized values in the space of 3 parameters are needed. I cannot see how the present scheme in the paper to do so.

The numerical model in Section 2.2 is not completely or correctly described. I have a few questions. (1) The boundary condition for the ice flow model is not completely described. Do you assume zero Cauchy stress at the ice surface? Your domain is a part of the ice cap. What is the lateral boundary for the side walls? (2) You take the outflow velocity as basal ice velocity, right? (3) Is it a steady state simulation or prognostic simulation? It is not very clear. As you move the ice surface, I assume it is a prognostic simulation. Then what is the timestep used in Eq. (3)? In Line 88-89, 'a predefined time step (cf. sect 2.3)', but I do not see the predefined time step in section 2.3. Maybe you refer to sect 2.4. And how many timesteps do you use? (4) The steps shown at the end of section 2.2 is not a cycle. What will you do after step 4 when you find bad match between the modelled ice surface geometry with reference data? Will you change the more iterations to make a better fit? (5) The outflow velocity is a vector (see Eq. (1)). However, when you mention it in section 2.3, it becomes a scaler, for instance, *UZ*=−130 m/year. It is wrong. It is not consistent. I guess *UZ* is only the vertical component of outflow velocity? You need describe it correctly.

The surface elevation change is caused by the surface mass balance (SMB) and the ice motion (Eq. (2)). Have you compared them? It would be helpful to show them. You used two approaches to calculate the SMB. How does the spatial distribution of SMB and its uncertainty compare with the elevation change caused by ice flow transportation? From Fig. 2, we can roughly guess the surface lowering caused by surface velocity is 3-6 m/year (blue area in Fig. 2). Could you make a plot of SMB distribution? Then we can know what role they play in surface elevation change.

I also have some detailed comments as below.

1) The ice flow model is named Elmer/Ice, see its website. So please change all the Elmer-ICE to Elmer/Ice.

2) Line 59, as I understand, you assume the ice is temperate everywhere, so you used a constant value for Glen's rate factor. If so, you did not consider the coupling between stokes model and heat transfer equation, it is just Stokes equation, you cannot say you solve the Full-Stokes equations.

3) Line 71. I got confused. It is said here that "Hence spatial variation in heat flux can be simulated". What do you mean? The heat flux is given or simulated? It should be an input data for an ice flow model. Forward ice flow model cannot simulate heat flux.

4) Line 82, Eq. (3), the second plus symbol should be times $\times$.

5) Line 94. What is 'the cauldron', K5 or K6? Pleaser clarify it.

6) In Table 1, the *UZ* in the 1st row should be *UZ0*. They are different, see Eq. (4). The abbreviation of sim. nr. should be defined somewhere.

7) Figure 2 and its caption need to change or improve. Is the scale bar for both plots? In the caption, you need mention the domain of left plot is the modelled region, and refer to Fig. 1a for its location. You can change the background to white rather than grey. It is better to change 'velocity z' on the colorbar to 'vertical velocity'. The right plot is the vertical outflow velocity at the base. It is not basal outflow velocity distribution as written in the caption, which is 3D. Please change the caption. The caption is not complete. Please also add the location information of the basal outflow velocity distribution. Please consider to add a plot for the horizontal basal outflow velocity. Besides, please consider to add a subplot to how the modelled basal velocity for the whole study area – as the left plot. Also add marker for K6 and K5. What is run 004? The number is not consistent with Table 1.

8) Figure 3 caption. Please refer to Fig. 1a for the domain you show here. Is it modelled area or focused area? Please add a marker for K6. Similar for Fig. 4, 5, 6.