Manuscript Evaluation Criteria

Scientific Significance:
Does the manuscript represent a substantial contribution to modelling science within the scope of Geoscientific Model Development (substantial new concepts, ideas, or methods)?

Yes: Excellent (1)

Scientific Quality:
Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)? Do the models, technical advances and/or experiments described have the potential to perform calculations leading to significant scientific results?

Yes: Excellent (1)

Scientific Reproducibility:
To what extent is the modelling science reproducible? Is the description sufficiently complete and precise to allow reproduction of the science by fellow scientists (traceability of results)?

Yes: Excellent (1)

Presentation Quality:
Are the methods, results and conclusions presented in a clear, concise, and well-structured way (number and quality of figures/tables, appropriate use of English language)?

Yes: Excellent (1)

In the full review and interactive discussion the referees and other interested members of the scientific community are asked to take into account all of the following aspects:

1. Does the paper address relevant scientific modelling questions within the scope of GMD? Does the paper present a model, advances in modelling science or a modelling protocol that is suitable for addressing relevant scientific questions within the scope of EGU?

The Authors present a robust method for obtaining balance velocities that is not subject to the usual grid-size dependence, nor does it require a heuristic routing algorithm. The use of a stabilized Finite Element Method adds to the strength of this method, since all of the usual convergence criteria of the FEM can be relied upon.

2. Does the paper present novel concepts, ideas, tools, or data?

The most novel aspect of this paper is the use of FEM as the basic numerical tool. FEM has the advantage of accepting unstructured grids, internally specified known InSAR velocities, and the ability to incorporate critical longitudinal stress gradients in addition to the primary driving stresses. To this add the SUPG stabilization scheme, which as the authors point out, is probably why this method has not been used before. The authors demonstrate the grid-size independence of their method, as well as an adequate display of the dependence of their results on the one unconstrained parameter, l, the number of ice thicknesses over which longitudinal coupling should act.

3. Does the paper represent a sufficiently substantial advance in modelling science?

Yes.

4. Are the methods and assumptions valid and clearly outlined?

Yes.

5. Are the results sufficient to support the interpretations and conclusions?

Yes.

6. Is the description sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? In the case of model description papers, it should in theory be possible for an independent scientist to construct a model that, while not necessarily numerically identical, will produce scientifically equivalent results. Model development papers should be similarly reproducible. For MIP and benchmarking papers it should be possible for the protocol to be precisely reproduced for an independent model. Descriptions of numerical advances should be precisely reproducible.

Yes.

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution?

Yes.

8. Does the title clearly reflect the contents of the paper? The model name and number should be included in papers that deal with only one model.

Yes.

9. Does the abstract provide a concise and complete summary?

Yes.

10. Is the overall presentation well structured and clear?

Yes.

11. Is the language fluent and precise?

Yes.

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

Yes.

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?

No. I would like to see Figure 2 in a larger format, or perhaps with zoome-in boxes for the critical ice stream regions. My review copy was at such a resolution that I could not blow it up sufficiently to see how well the comparisons matched the InSAR velocities.

14. Are the number and quality of references appropriate?

Yes.

15. Is the amount and quality of supplementary material appropriate? For model description papers, authors are strongly encouraged to submit supplementary material containing the model code and a user manual. For development, technical and benchmarking papers, the submission of code to perform calculations described in the text is strongly encouraged.

I would hope that the authors would provide as supplementary material an appropriate format (netcdf perhaps) of their results for Greenland. This would be very useful to ice sheet modellers.

Minor Typos:

Page 5186 - Line 14: “and estimate” should be “an estimate”