Review of “Non-linear retreat of Jakobshavn Isbræ since the Little Ice Age controlled by geometry” by Stieger et al., submitted to The Cryosphere

Summary: The authors use a width- and depth-integrated flowline model that includes a parameterization to account for lateral ice fluxes to test the sensitivity of Jakobshavn Isbræ’s long-term retreat to variations in geometry under a variety of environmental forcing scenarios. The model results suggest that the non-linear retreat of the glacier is likely due to along-flow variations in fjord width and basal topography. The time series of grounding line and terminus retreat deviate from the observations for all the prescribed climate change scenarios, likely indicating that the simple linear climate forcings used here do not capture the complexities of the actual climate change during the observation period. However, the focus of the manuscript is on the importance of geometry in modulating the response to climate change and I think the paper clearly demonstrates that geometry exerts a strong first-order control on the timing and magnitude of dynamic change.

Specific Comments:
There are a few points that I feel should be slightly expanded on in the text for the sake of clarity and transparency in methodology.

1) It would be helpful to include an equation to clearly show how the height of basal crevasses is estimated from tensile deviatoric stresses and the height above buoyancy. There is presently no reference provided and it is up to the reader to search for an appropriate reference and equation therein that would relate these variables.
2) The transition height for the SMB parameterization is not listed in Table 1.
3) I do not see how it is possible that the ice thickness can be uniformly decreased due to submarine melting seaward of the grounding line without introducing an artificial step decrease in ice thickness across the grounding line. Is the time step sufficiently short that the step reduction in thickness at any given time is minimized? Or is submarine melting applied orthogonal to the floating ice so that it essentially ablates ice horizontally at the grounding line? Both Motyka et al., J. Geophys. Res. doi:10.1029/2009JF001632, 2011 and Enderlin et al., J. Glaciol., doi: 10.3189/2013JoG12J049, 2013 provide modern estimates of submarine melting beneath Jakobshavn’s floating tongue. How do your melt rates compare? This should be stated in the text.
4) Where is the lateral influx prescribed? Is it evenly added along the lowermost 80km or is the flux weighted so that it increases or decreases in the along-flow direction? What velocity data are used for the initial parameterization? Is the average annual velocity at each grid point bordering the main trunk used to estimate lateral flux variability along flow? Please elaborate.
5) You state that a crevasse water depth of 160m during the LIA may be exaggerated but I think you should at least say it is “likely” exaggerated because it is highly unlikely that crevasse water depths are anywhere close to that deep, especially given that there is no visible water in crevasses immediately inland of the modern terminus.
6) At the bottom of page 14 you state that geometry can delay the response of glaciers to climate change. The influence of geometry on the timing and magnitude of dynamic

change was also discussed in Enderlin et al., The Cryosphere, doi:10.5194/tc-7-1007-2013, 2013 and should be cited here as support for the importance of geometry on dynamic change (albeit using simple, synthetic glacier geometries).