## Review of a manuscript "Persistence and Variability of Ice Stream Grounding Lines on Retrograde Bed Slopes" by A. A. Robel, C. Schoof and E. Tziperman.

This is a revised version of a previously submitted manuscript. The authors have addressed most of the major reviewers comments, however, there are a few left. Though, these issues are not crucial, and do not preclude the manuscript publication, their clarification would certainly benefit the manuscript.

The first issue is the negligence of the internal heating due to ice deformation. The authors refer to a study by Suckale et al. (2014) that found that this term *is* (not "may be") important in shear margins. A model used by Suckale et al. (2014) assumes that ice thickness is constant across an ice stream and that the vertical velocity, which determines the vertical advection, is scaled linearly with the surface accumulation. Both assumptions are violated in the shear margins. For the present study, it would be more straightforward to perform an extra simulation that includes the internal heating term and compare it with a simulation without that term. Presumably, the model runs are fairly fast. A quantitative estimate of the effect of internal heating on the model behaviour would make the presented results more robust.

The second issue is extremely narrow range of the accumulation rate, 6 mm/yr, that results in the hystereses (p. 9, line 14). It is likely, that inter-annual variability of the surface accumulation rate of the present-day ice streams is larger than this value. Although, It is difficult to prove it, as both, the observational errors of the current accumulation rate, and instrumental and methodological errors of the past accumulation rates inferred from radar observations are substantially larger than this very narrow range of the critical accumulation rates. The manuscript would benefit from some discussion what are physical implications of such a narrow range and how realistic the obtained hysteresis behaviour.

**Minor comments**

Abstract: line 4 "numerical" is unnecessary.

Introduction: p.1 lines 11-12: The first two sentences are unnecessary.

Eqn (1): should be $\rho_i$ instead of $\rho$ and it should be defined after this equation.

Model preliminaries: p.3 line 26: "Vertical shear of horizontal velocity is assumed to arise independently..." is (a) unclear (arise independently of what?), and (b) does not sound right - vertical shear is deformation, which is determined by the vertical structure of horizontal velocity. But it is not a property or characteristic of velocity.

P. 4, line 2: what does "$x-z$ mass continuity" mean? Simply saying that $w$ is determined by the vertical integration of the mass-continuity equation would remove ambiguities.

P. 4, line 8: no need to repeat that the melt rate is neglected. It is already stated on line 4.

P. 5, line 16: what does "self-consistently" mean? What are "activation waves"?