

## ***Interactive comment on “Mechanisms leading to the 2016 giant twin glacier collapses, Aru range, Tibet” by Adrien Gilbert et al.***

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Reviewer: Irina Rogozhina, MARUM, University of Bremen/NTNU

This paper presents a model-based interpretation of temporal changes in the internal dynamics, basal friction and stress states of two glaciers in western Tibet to explain their catastrophic collapses in 2016. The inversion method used to derive glacier model results is rather unusual – in this I agree with reviewer 1 – but it seems to yield rather good results. I still think that this method should be validated on a glacier that has measurements of horizontal velocities, vertical surface changes and ideally bedrock topography to make the case that it is operational. There are quite some examples of such glaciers, especially in the European Alps. Inversion methods can be quite tricky,

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since they derive whatever one wants to obtain, especially when multiple parameters are estimated in parallel. Nevertheless, this study is an impressive contribution to the state-of-the-art understanding of the glacier dynamics and addresses the challenge of the glacier model initialization in a neat manner, even though it has a significant overlap in terms of motivation and conclusions with the paper featuring the same authors (Kääb et al., 2018). The language is quite remarkable, as reviewer 1 has pointed out, and I am rather surprised to see so many experienced co-authors – including native speakers – who do not seem to have read the paper. With this review I encourage them to have a look at it. I believe that this paper will merit publication in TC after moderate revisions.

**MAJOR POINTS:** 1. As I mentioned in my summary, the authors should prove that their inversion method is operational by validating it on a glacier with more measurements (see above). 2. I absolutely agree with reviewer 1: All the points he has raised are valid and I am looking forward to seeing responses to his concerns. In addition, I feel that his specific point 2 needs further exploration: It would be worth looking at how friction angle in equation 4 (in addition to friction coefficients) changes over time leading to the collapses of the glaciers. In addition to showing how the subglacial till changed its properties in response to warming and increased meltwater supply, this experiment will provide an estimate of the yield stress needed to enable such a failure. A very useful exercise for the future diagnostic experiments that will empower predictions of similar glacier failures and an important exercise to support the conclusions of this study. 3. I don't believe much in the climate forcing provided by ERA-Interim in such high-topography, steep-gradient environment, especially after I learned from this paper that the precipitation rate had to be multiplied by a factor of 4. Could the authors compare ERA-interim fields with High Asia Refined (HAR) analysis (Mausson et al., 2014)? I suggest that the authors perform sensitivity tests to assess the uncertainties in their results coming from the mass balance estimates using HAR.

**MINOR POINTS:** The methods section is sloppy. For example, I am missing a table with model parameters. In general, the methods have to be more detailed. This is

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not a Nature paper, there is space for the description of methods. The supplementary materials are not accessible through the online system. There are some citations of materials in the supplement, which I cannot access. Page 7, lines 13 – 14: Cannot it be influenced by a larger error in the bedrock estimate? Page 9, line 9 – 13: This requires a proof. Page 9, line 27: “from temperate to cold basal conditions” - the other way around? Page 10, section 5.3: The field data are only available for Aru 1. Are the authors sure that Aru 2’s bed has the same lithology? Page 11, lines 4 – 5: Any evidence from the little ice age glacial moraines to support this statement?

References: Kääb, A., Leinss, S., Gilbert, A., Bühler, Y., Gascoin, S., Evans, S. G., Bartelt, P., Berthier, E., Brun, F., Chao, W.-A., Farinotti, D., Gimbert, F., Guo, W., Huggel, C., Kargel, J. S., Leonard, G. J., Tian, L., Treichler, D. and Yao, T.: Massive collapse of two glaciers in western Tibet in 2016 after surge-like instability, *Nat. Geosci.*, 11(2), 114–120, doi:10.1038/s41561-017-0039-7, 2018. Maussion, F., D. Scherer, T. Mölg, E. Collier, J. Curio, and R. Finkelburg: Precipitation seasonality and variability over the Tibetan Plateau as resolved by the High Asia Reanalysis, *J. Climate*, 27, 1910-1927, doi:10.1175/JCLI-D-13-00282.1, 2014.

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