

Interactive comment on “Geometric changes and mass balance of the Austfonna ice cap, Svalbard” by G. Moholdt et al.

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GENERAL COMMENTS: This paper provides a comprehensive summary of recent surface elevation changes of the Austfonna Ice Cap using a variety of data sources (e.g., ICESat, GNSS, airborne laser altimetry). The methods and results are clearly explained, and it is good to see a comprehensive presentation of the errors associated with the different measurement techniques. This provides confidence that the reported changes are real and well constrained, and improves our understanding of recent glaciological changes in Svalbard.

SPECIFIC COMMENTS: My comments are generally minor in nature, but there are a few areas that would benefit from attention. Page and line numbers from the original text are used for reference:

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P860, L19: You need a reference or two here to back up your statement that the ice cap is stagnant (e.g., Dowdeswell et al., 1999). It would also be useful to describe the ablation stake velocity measurements that you allude to on p876, L21 (and possibly plot the velocities on Figure 1d). However, I believe that it is incorrect to say that the ice cap is truly stagnant. This would mean that there is no surface velocity, while it is clear that there is at least some in most places. Hence I would recommend changing 'stagnant' to 'slow-moving' throughout the text.

P861, L5: You should state at what elevation the weather stations are at, and it would also be useful to plot their location on Fig. 1 (in Fig. 1d?)

P865, L1-L8: Your methodology here seems to be a bit circular (or perhaps needs more explanation). You state that you use ICESat data to measure changes in elevation over time, with interpolation between different tracks being undertaken with a surface DEM potentially produced from the same ICESat data. If this is the case, then the problem arises that you can't distinguish whether surface elevation changes are from (1) mass balance changes over time (what you are trying to measure), or (2) surface elevation changes across space (related to the interpolation). Could you add some explanation to address this issue? For example, if only ICESat data from one year was used to produce the DEMs, then this wouldn't be a problem.

P868, L21: Is your given firn density (500 kg m^{-3}) actually based on field measurements from Austfonna, or is it just a generic value? The argument for using this value would be stronger if it was based on actual field data (e.g., shallow boreholes).

P873, L8: I don't think that your older data is accurate enough to really say whether the rate of change at Austfonna has sped up between the two measurement periods

P878: In the Conclusions it would be useful to refer to studies that have found similar patterns of interior thickening and marginal thinning on other glaciers and ice caps recently (i.e., not necessarily related to the surge cycle). For example:

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Arendt, A.A., Luthcke, S.B., Larsen, C.F., Abdalati, W., Krabill, W.B., and Beedle, M.J. 2008. Validation of high-resolution GRACE mascon estimates of glacier mass changes in the St. Elias Mountains, Alaska, USA, using aircraft laser altimetry. *Journal of Glaciology*, 54(188), 778-786.

Luthcke, S.B., Zwally, H.J., Abdalati, W., Rowlands, D.D., Ray, R.D., Nerem, R.S., Lemoine, F.G., McCarthy, J.J., and Chinn, D.S. 2006. Recent Greenland ice mass loss by drainage system from satellite gravity observations. *Science*, 314, 1286-1289.

Fig. 1: - The current Fig. 1d would seem to be better placed as Fig. 1a. - The grey lines showing the data tracks in the current Fig. 1a & 1c are hard to distinguish from each other. - In the figure caption, the parts for each figure (a, b, c, etc.) should be given at the start of each description, not at the end of it

Fig. 4: It would simplify the caption to change 'Glacier area per meter elevation for the...' with 'Hypsometries for the...'

Fig. 7: It would be useful to add a line to this figure that shows the total error, in addition to the individual errors

TECHNICAL COMMENTS:

P858, L2: 'deviate' should be 'deviates'

P859, L17: 'water equivalents' should be 'water equivalent'. Also: is the figure of 0.36m an annual rate? If it is, it should be stated as such.

P860, L15: delete 'the' from 'the Nordaustlandet'

P860, L26: '11 km²/yr' should be '11 km² y⁻¹'. It would also be useful to state what the total area of Austfonna is here to put the loss rates in perspective

P861, L7: 'during summer' should be 'during the summer'

P863, L8: 'part of data' should be 'part of the data'

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P863, L15: what are you referring to here - 'the best spatial coverage of'? Ice depths?

P864, L14: can you state how deep the shallow ice cores were drilled to?

P864, L19: 600 kg/m³ should be 600 kg m⁻³

P869, L13: 'equal the' should be 'equal to the'

P870, L24: when you say two neighbour ICESat points, I assume that you are referring to ones on the same orbit? It would be useful to state this for clarification.

P873, L2: When you refer to Figure 1 here, I think that you are really only referring to parts 1a and 1b.

Fig. 6 caption: m/yr should be m y⁻¹

Interactive comment on *The Cryosphere Discuss.*, 3, 857, 2009.

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