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The Cryosphere Discussions

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

**G. Moholdt et al.**

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Thank you for useful comments and suggestions. You are right that the surface mass balance is the key to understand the observed elevation changes at Austfonna. However, it is not straight forward to compare these two types of data (Fig. 3 and Fig. 5) because of the differences in spatial and temporal sampling (Fig. 1). For example, the elevation change data sets have a relatively higher weight of data from the southeast where the ELA is lower due to a higher accumulation rate (Taurisano et al., 2007; Schuler et al., 2007; Dunse et al., 2009). The most appropriate way to investigate the link between surface mass balance and elevation change is to compare these two measures locally along the stake transects. Figure 1 below, which is an update of Fig. 5 in the discussion paper, shows the southern and northern mass balance curves



along with corresponding elevation changes derived from repeat track GNSS profiling in spring 2004 and spring 2008. The elevation changes vary at a local scale along the profiles, but the overall change trends follow the surface mass balance curves.

Replies to the other comments:

858-17: Ok.

859: Contour labels will be included in the final paper.

861-16: The 1986-1998/99 average mass balances from shallow ice cores (Pinglot et al., 2001) can now be directly compared to the 2004-2008 period in Fig. 1 below. The high elevation surface mass balance has not changed significantly between the two periods.

861-20: This is thoroughly discussed by Kohler et al. (1997). The reference will be added.

861-22: The magnitude of annual winter accumulation varied by a factor of two between the minimum year in 2004 and the maximum year in 2008 (Fig. 6). A note will be added.

864: Annual ELAs for the Eton-/Winsnesbreen basin are provided in Fig. 6. This is the only stake transect that has been measured each year between 2004 and 2009. A comparison of surface mass balance and elevation change along two transects is included in Fig. 1 below. The transition from thickening to thinning occurs approximately at the same elevation as the ELA.

873-7 and Fig. 1c: The reason why we do not discuss differences between 1983-2007 and 2002-2008, is the low precision and poor spatial sampling of the 1983 and 2007 RES ice thickness comparison. The 1983-2007 data set indicates predominant low elevation thinning and high elevation thickening over the period, but it is not suitable for quantitative studies.

Fig. 3d: See the previous two comments.

Fig. 5: Yes. See the caption of Fig. 1 below for an updated description.

References:

Dunse, T., Schuler, T. V., Hagen, J. O., Eiken, T., Brandt, O., and Høgda, K. A.: Recent fluctuations in the extent of the firn area of Austfonna, Svalbard, inferred from GPR, Ann. Glaciol., 50, 155-162, 2009.

Kohler, J., Moore, J., Kennett, M., Engeset, R. V., and Elvehoy, H.: Using ground-penetrating radar to image previous years' summer surfaces for mass-balance measurements, Ann. Glaciol., 24, 355-360, 1997.

Pinglot, J. F., Hagen, J. O., Melvold, K., Eiken, T., and Vincent, C.: A mean net accumulation pattern derived from radioactive layers and radar soundings on Austfonna, Nordaustlandet, Svalbard, J. Glaciol., 47, 555-566, 2001.

Schuler, T. V., Loe, E., Taurisano, A., Eiken, T., Hagen, J. O., and Kohler, J.: Calibrating a surface mass-balance model for Austfonna ice cap, Svalbard, Ann. Glaciol., 46, 241-248, 2007.

Taurisano, A., Schuler, T. V., Hagen, J. O., Eiken, T., Loe, E., Melvold, K., and Kohler, J.: The distribution of snow accumulation across the Austfonna ice cap, Svalbard: direct measurements and modelling, Polar Res., 26, 7-13, 2007.

Caption to Fig. 1:

The continuous lines are second order polynomials fitted to averaged point observations of annual net mass balances between fall 2003 and fall 2008 in the southern and northern basins (Fig. 1d). The 1986-1998/99 average net mass balances from shallow ice cores are included for comparison (Pinglot et al., 2001). The dotted lines show the average water equivalent elevation change rates between spring 2004 and spring 2008 along two repeat track GNSS profiles. The southern GNSS profile runs from the



summit to the Braasvellbreen basin along the mass balance stakes, while the northern GNSS profile runs from the summit to the stakes in the Etonbreen basin (Fig. 1d). The GNSS change curves were smoothed using a running mean filter over 2 km distances, and we used the density of ice to convert elevation changes into water equivalent rates.

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

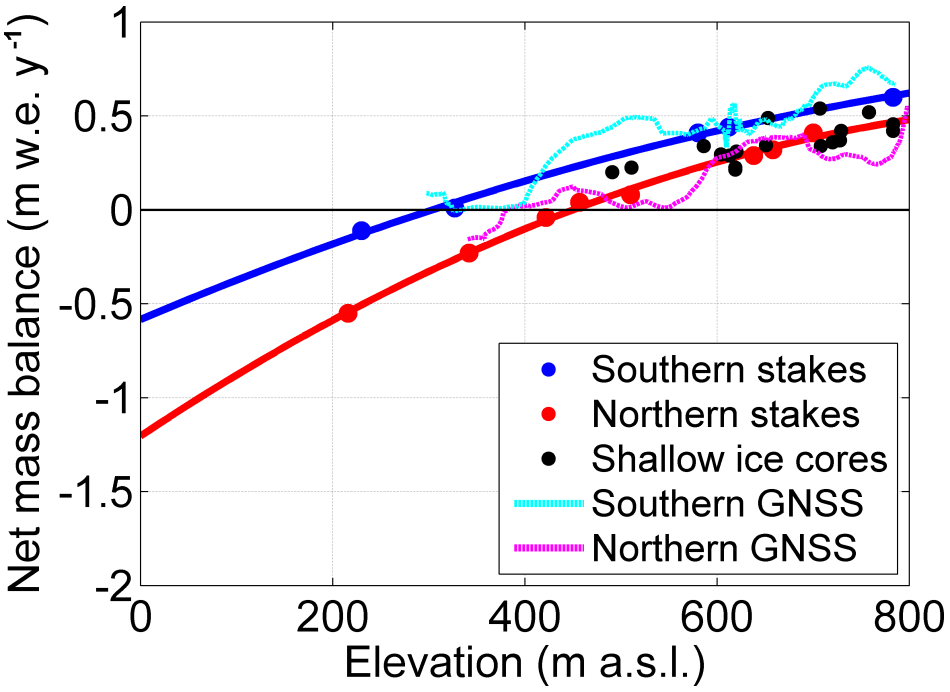


**Fig. 1.** This is an update of Fig. 5 in the discussion paper. See above for the full caption.