

## ***Interactive comment on “Comparison of direct and geodetic mass balances on a multi-annual time scale” by A. Fischer et al.***

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Dear Mauri Pelto, Thank you very much for your very helpful suggestions.

1158-22: Provide a reference here this has been examined and quantified by several authors. Pay close attention to the J of Glaciology correspondence section 42(142) from 1996. Yes, I will do that, and also include a Citation to the work of Meier in the 1960s.

1161-17: Table 3: Maybe the most important point to reexamine is the 1967 and 1969 bgeo for HEF. This is a positive period for all Austrian glaciers and the negative -3.9 versus bdir in three years is clearly in error. The following period also has an anomalous +4.5 m for the bgeo versus direct. The obvious conclusion, though those are not always

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correct is that there is an error in the 1969 map or analysis. If we just look at the 1967-1979 period the record looks much better. You must either explain this discrepancy or not utilize the 1969 geodetic product for HEF. The basic idea of the comparison was to use all available DEMs for the comparison, even in case they might show different accuracies. I do not want to exclude one of the DEMs because it does not seem to 'fit in' the picture, since that would imply to neglect the possibility that such a DEM will be included in an analysis, when no direct data is available. But of course, I should make more comments on that, as you suggest above, and add some additional data (which is cited, but not included).

1161-26 and Figure 6-10: A quantitative measure of the change in area for KWF or at least an area of the glacier would give the reader an idea of the magnitude of change due to crevasse closure. Though this maybe a separate study and paper. After crevasse closure surface area exposed for ablation is also reduced. Either Figure 6 or 10 could be eliminated. A single comparison vertical shot of a section of a glacier with differential crevassing would be better. Ok. Maybe I could include that detailed study in the paper on HEF in preparation, and include a reference and the corresponding numbers in this paper.

1164-5: A further figure of a mass balance map including measurements sites for one glacier would be useful, to include in discussion. This could include the geodetic points of 1893 if the EHEF or KWF is used. An idea that cannot be expected but visually would be compelling is to prepare a map to show areas of crevasse changes, densification on the map, and high basal melt for a that specific glacier. The position of the stakes in a single year can be included here. A map of crevasse zones and its changes can be easily included in the paper in preparation mentioned above. Recently, we finished detailed investigations on basal melt, so this topic will be covered by that publication in preparation in detail..

1165-19: Miller and Pelto (1999) discuss the reduction in internal accumulation in the 1998 winter snowpack as ice lenses did not form due to a warmer snowpack, this leads

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to a slightly less dense snowpack, not a process that would be the main one when the snow layer thickness is actually much reduced. The tendency of mass balance losses to lead to densification is an excellent point. The reduction of ice lenses is also a very interesting point. We did not observe that on Hintereisferner or Jamtalferner, and the snow pack is still quite cold during the winter. We also observed the formation of superimposed ice in nearly every year I will have a closer look at that.

1166-13: Can this be illustrated better by focusing on a specific actual point location on a specific glacier, such as on HEF for the years shown in Figure 11? The retained snow depth at the end of the past few accumulation seasons is known and the densification from Ambach (1995) for older snow could be applied. Yes, I planned to that with LIDAR data on the stake locations on KWF, on a shorter time scale, but not within this paper.

1167-14: The lowering cannot all come from ablation it is true. How much can be explained by ablation measurements, which due exist? Also how much would a slow of inflow contribute? The detailed answer is coming soon, supported by a number of DGPS surveys on Hintereisferner and Mittelbergferner.

1168-26: Both the South Cascade and Lemon Creek Glacier have the opposite trend to HEF. On this same point Krimmel (1999) points out that the error is believed to be in the direct methods. This should be mentioned and also the reasons for this error. The idea is that the surface mass balance is too negative on South Cascade Glacier is supported by it having by a significant margin the most negative mean annual balance of any of the 13 glaciers measured within 150 km of it, though it has a very high correlation coefficient 0.80 and higher with all of these (Pelto and Riedel, 2001). Further and Miller and Pelto (1999) point out the errors in Lemon Creek Glacier mass balance assessment are mainly near the terminus. This manifests itself in negative balance years as terminus retreat is greater and we do not measure the terminus areal extent changes each year, they are multi year extrapolations and our ablation data is less accurate the further from the snowline you get. Yes, I will mention that. I investigated the effect of not doing any area correction for Hintereisferner (mass balance of 2003 on

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the area of 1953), to investigate that error for the HEF data (Fischer 2010, Glopacha, and it was smaller than I expected.

Figure 1-2: The captions are much too brief to fully explain. Yes, I will improve the explanations.

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Interactive comment on The Cryosphere Discuss., 4, 1151, 2010.

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