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Open Access Earth System Science Data Discussions

Interactive comment on "Long-term records of glacier surface velocities in the Ötztal Alps (Austria)" *by* Martin Stocker-Waldhuber et al.

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The paper presents a data-set of surface flow velocities measurements on 4 glaciers in Austria ranging from more than 100 years of observations on Hintereisferner to a decade on Gepatsch- and Taschachferner. Velocity fluctuations are interpreted in terms of glacier wide mass balance and length fluctuations.

General comments:

Indeed, ice flow is an important property of glacier and this parameter has got surprisingly low attention in monitoring programs. Ice flow velocity depends on ice thickness and surface slope. So ice thickness change is most suitable for interpretation of velocity variations. I do understand that surface elevation was measured as long with the posi-

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Discussion paper

tion of the flow markers, and thickness change can be determined (as an example see Fig 5.3 of the latest Glaciological Report http://doi.org/10.18752/glrep_137-138). Sure the surface topography is a result of mass balance but with some dynamical response and local ice thickness is more appropriate than glacier wide balance quantities. Moreover, I would recommend - if shown - to plot the cumulative mass change rather than annual values.

The method sections suffers from two shortcomings. (1) A systematic bias results when calculating a mean of a variable number of measurements. I see two potential alternatives - central or maximum value as well as average of a constant, fixed subset of measurements. (2) Although the difference of emergence/submergence and the vertical component of the velocity vector are introduced in detail, throughout the paper (e.g. Fig.5) a misleading terminology of vertical velocity for the emergence/submergence motion. Vertical velocity is only valid with regard to a fixed coordinate system. Emergence/submergence is the motion relative to the surface resulting as a an apparent vertical displacement.

The effect of melting in and tipping over of flow markers is not addressed. Important with regard for the accuracy/uncertainty is the fact that vertical movement is one order of magnitude lower than the horizontal component and moreover of the same order as the counteracting processes of mass balance and thickness change. So any uncertainty of any of these may affect all.

Your interpretation and discussion makes extensive use of length variation. It would be more convincing for the reader if you would plot this information - at least for some glaciers (e.g. HEF)

General quality of the Figures is relatively poor and therefore hard to read. Probably this is just a minor problem of Figures generated in vectorized format that have been transformed with a poorly resolved raster format when inserted to the manuscript? Labels are all fuzzy, rather small and gradients between different lines difficult to separate.

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Checking of the online data-set prepared for download on pangea.de was not possible, because access was denied. I made several unsuccessful attempts.

Detailed/minor points (indicated by page.line):

1.12: Ice age theory was earlier established by Agassiz (Alps) or Lyell (UK) already back in the first half of 19th century. Penck & Brueckner may have confirmed the theory later on.

1.18: I miss proper references of first systematic ice flow measurements in the Alps in the 1840s on Unteraargletscher and Mer de Glace (Agassiz, 1847; Forbes, 1846).

1.21: I recommend to use the official spelling of 'Rhonegletscher' to be consistent with all the other mentioned glaciers

1.21: Berthiere -> Berthier

2.10: I do not agree this paper presents 2 long-term series and 2 series of only about a decade.

2.11: Acronym ALS was not yet introduced

3.14: Acronym DGPS not introduced

5.2: rod level -> level rod

7.3: Unclear what is the 'expected inverse process'? Surface elevation change may result from both processes melting or a dynamic adjustment.

7.11-12: This statement is not correct - velocity variation is a direct response to thickness change as a result of the climatic forcing where as the terminus fluctuations is delayed and damped by the dynamic adjustment. Both are sensitive!

7.31-32: The reason for summer speed-up has been well investigated e.g. Iken, 1978 or Gudmundsson, 2002

Fig.1: Replacing the GI 1, GI 2 and GI 3 labels with the respective years would be more

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15.5: pint mass balance is the right terminology for delta_a and more appropriate.

Fig.3: are you sure that the individual, extremely high value of 1919 is correct? Are there any arguments against an outlier?

Fig.7: awkward ticks / tick interval -> using quarters would be easy to read

References:

Agassiz (1847), Système glaciaire ou recherches sur les glaciers, leur mécanisme, leur ancienne extension et le rôle qu'ils ont joué dans l'histoire de la terre. Première partie: Nouvelles études et expériences sur les glaciers actuels, leur structure, leur progression et leur action physique sur le sol, V. Masson, Paris.

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