

Decay of a long-term monitored glacier: the Careser glacier (Ortles-Cevedale, European Alps) (TCD 7, 3293, 2013)

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The paper is a comprehensive account of surface mass balance measurements between autumn 1966 and autumn 2012 at Careser Glacier in the Italian Alps. The principal product of the paper is a table of glacier-wide annual values of winter B_w , summer B_s , and annual B_a surface balance. The paper should note that these are evolving-surface values, not reference-surface values; see Elsberg et al. (2001).

In addition to recording those annual values, the paper reports results of geodetic determinations over six multi-year periods spanning 1933-2006. The good agreement between the geodetic values and the sum of the surface measurements over each period at Careser Glacier is often not the case for other glaciers.

The paper deals with surface mass balance and should state this clearly. See page 7 of Cogley et al. (2011) concerning other components. It also provides glacier area and hypsometry obtained from each of the seven aerial surveys bracketing the six geodetic determinations, as well as glacier length on about 30 dates between 1897 and 2012.

Notably lacking is any information about uncertainties in the tabulated glacier-wide balances. The cumulative B_a values in the table should be augmented to show the width of the uncertainty band as it grows from 1967 to 2012.

An evolving-surface mass balance series convolves effects of climate with effects of changing glacier geometry. A possible way of separating these effects and obtaining a series containing mainly climate effects would be to construct a $b_a(z)$ profile for each year and interpolating in it at the same altitude every year. The paper gives very little information on the spatial distribution of point values of b_a , so it is hard for me to tell whether this is feasible. If so, such values would be a valuable addition to Table 2. Whether or not it is feasible, the paper would be improved were it to give more details on the distribution of original balance measurements.

The paper is well written, and the English is exceptionally good.

The following detailed minor comments are identified here by page, line number in the 5 July 13 manuscript.

Because the bed topography is known under only part of the glacier (3303,14) the statements implying that it is known for the entire glacier (3295,8 and 3307,16 and 3312,8) should be reconsidered.

3293,3 Current glaciological usage would be 'Careser Glacier' not 'the Careser glacier'

3295,10 *adding to the mass balance record* into the past using the geodetic method, because the geodetic method does not provide *direct* observations.

3295,12 Mass losses were 1.5 and 2.0 m w.e. per year, not -1.5 and -2.0 because a negative loss is a gain.

- 3296,6 Clearly variations of glacier length are an indirect and delayed response to climate variations, but how they enhance the signal is not clear.
- 3296,15 Continuation of these series depends on financial and organizational circumstances, not on rapid environmental change.
- 3297,21 I know no precedent for referring to non-contiguous regions as a single glacier.
- 3297,26 Should Fig. 1 show an outlet from Careser Lake whereby the Rio Careser drains into the Noce River?
- 3299,14 Could the exact dates of the surveys be given in Table 1, not just the year?
- 3299,17 *too little accuracy*
- 3299,26 Should UTM coordinates be shown on Fig. 1?
- 3300,12 Δt would be better than t to denote the length of a time interval, following the use of Δ for changes to other variables.
- 3301,25 The paper should describe the method and accuracy of using the "index values", which has been shown to be successful for other glaciers (see, for instance, Rasmussen and Andreassen (2005) *J. Glac* **51**(175) 601-606).
- 3302,24 'consisted of' not 'was comprised of'
- 3303,9 'maximum accuracy' would be better stated in terms of the error or uncertainty.
- 3303,14 The area of the subglacial topography determined by GPR should be stated. From Table 2 the total glacier area at the time of the surveys appears to be about 2 km².
- 3304,29 'deglaciation' would be better than 'consumption of'
- 3305,9 The 3.82 km² loss since 1933 implies that the area in 2012 was 1.63 km². If the area-altitude profile cannot be shown in Table 2 for any years after 2006, at least the total area can be.
- 3305,19 'emergence'
- 3307,16 This implies $V(1933) = 324 \times 10^6$ km², which should be stated.
- 3307,21 'Holocene' in English.
- 3308,10 Briefly define *drainage glacier* and *reservoir glacier*, neither of which is in Cogley et al. (2011).
- 3309,15 Better than comparing it with the mean would be comparing its difference from the mean with the standard deviation of the set of 111 glaciers.
- 3310,4 In Eqn (3) it is the mass balance rate b_t that appears, not the mass balance gradient, so the relevance of the gradient is not apparent.

- 3310,13 A reference on the LIA in the Alps should be supplied.
- 3311,10 Switching back and forth between 'elevation' and 'altitude' is distracting and might make some readers wonder whether a distinction is being made. Of the two terms, I prefer the one contained in the term area-altitude profile.
- 3311,15 How the projections to 2020, 2040, 2060 were obtained should be described more clearly.
- 3312,10 The 1959-1980 period would be better described as having only slightly negative balance (Fig. 8b) instead of having reduced imbalance.
- 3312,28 It would be useful here to say how many programs are longer than the one for Careser Glacier.
- 3320 Table 1 would be enhanced were it to have one more column giving the mean value over each interval, numerical expression for the values shown in Fig. 8a.
- 3322 The quantities in the first three columns of Table 3 are glacier-wide averages of *surface* mass balance: winter, summer, and annual (not net). See Cogley et al. (2011) regarding terminology. The meaning of "index" values should be briefly explained in the caption. An uncertainty band is needed for the last column.
- 3325 Panel a) shows snout *position* relative to its 1897 position. Panel b) shows variation of area since 1933. The caption should say that the length in 1897 was 3.8km (3308,8).
- 3330 The caption should say that in the lower panel, which should be labeled b), the curves are defined to have zero value when they begin, 1933 for the geodetic and 1969 for the direct. Plotting the direct curve so that it began in 1969 with the interpolated value of the geodetic curve then would emphasize similarity between the two curves after then.
- Larger tick marks every ten years would make Fig. 8 more readable.
- 3334 Instead of labeling the middles of the intervals 2675, 2725, ..., 3325 it would be better to label their endpoints 2650, 2700, ..., 3350. This would not only be graphically less cluttered, but also it would avoid the subtle implication that the quantity applies to a single altitude rather than to an altitude interval.