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Interactive comment on "Air temperature variability over three glaciers in the Ortles-Cevedale (Italian Alps): effects of glacier disintegration, intercomparison of calculation methods, and impacts on mass balance modeling" *by* L. Carturan et al.

Anonymous Referee #2

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The paper addresses the amplification of glacier melt while glaciers start to disintegrate and tries to explore a potential way to quantify this effect. This is definitely of interest for e.g. estimating rates and duration of melt water production in catchments where glaciers are about to disintegrate. At the same time, if going beyond simple parametrizations of gross amounts of melting, this is a non-trivial endeavor.

The authors try to make use of an unusual data set, collected from 8 different weather stations both off and on the glaciers of the rapidly disintegrating ice bodies of the Careser-La Mare basin. The data availability and the interesting question are definitely motivational and, hence, the authors try to (i) improve mass balance modeling by (ii) developing a generally valid temperature transfer function from a measurement site to a glacier surface, based on (iii) analyzing the effects of glacier disintegration on near surface temperature distributions from the available records. Unfortunately, the authors fail to reach any of these targets due to incorrect assumptions and consequent misconceptions. I here only address the gross problems of the paper which lead to the recommendation of rejection. I will be happy to discuss details if a future draft overcomes the principle weaknesses.

Both the “glacier cooling” and the “glacier damping effect” over melting glacier surfaces, as compared to the environmental temperature, are the result of the melt rates. This is the principle of why positive degree day (PDD) type models function so successfully and the reason why they should only be used with temperatures measured outside the influence of the glacier. The sum of positive (above 0°C) Celsius temperatures measured outside the glacier stands for the environmental energetic potential for melting ice. Using on-glacier temperatures (being permanently close to the 0°C of the melting ice surface) can only weaken the potential of a PDD approach. There is, consequently, no reason for knowing the near ice surface temperature beyond the interest in the dynamics of katabatic winds and the respective role in a fully process resolving energy balance study. Extrapolating from environmental temperatures to near glacier surface temperatures in order to feed an empirical statistical model, such as PDD day models of any degree of complexity, for estimating melt rates means weakening the potential of such a model. The centrally cited authors Greuell and Böhm (1998), who have explored the temperature distribution on a glacier surface with great care, state this very clearly when they say:

“. . . if a constant lapse rate is used to compute 2 m temperatures above the glacier from temperatures recorded at climate stations or predicted by atmospheric models, the sensitivity of ablation to variations in atmospheric temperature will be overestimated.

The ideal solution to this problem is to use the temperature outside the thermal influence of the glacier as forcing and to compute melt by coupling a melt model to a mesoscale atmospheric model. The latter should extend beyond the thermal influence of the glacier and resolve details of the structure of the boundary layer above the glacier."(Greuell and Böhm, 1998)

In other words: only if the structure of the boundary layer above the glacier is resolved in appropriate detail it makes sense to compute and use the 2m above the glacier surface temperature and Greuell and Böhm (1998) also make clear that any computation of the near ice temperature from off-glacier temperatures is different from case to case. A generalizing solution can only be found in a model that accounts for and resolves all potential influences on air temperature changing from an off-glacier site to a glacier site. Such models could be found in the limited area atmospheric simulation approaches and by including the full dynamics of boundary layer meteorology. Yet, related degrees of freedom are usually far beyond the availability of data for the respective variables.

This said, none of the targets envisaged in the presented draft can be reached: 1. The "effects of glacier disintegration on (near glacier surface) temperature variability" can only be studied by a full resolution of all processes acting between the free atmosphere and the complex surfaces of a glacierized mountain basin including high spatiotemporal resolution of boundary layer dynamics. This requires both a powerful model and respective data input considerably beyond what is available from the 8 weather stations. 2. For the same reasons, the search of a generally valid equation for linking off-glacier temperatures with on-glacier temperatures and, finally for calculation lapse rates above the glacier surface must fail. An "inter-comparison of calculation methods" is, thus, only of value per se but cannot lead to a generally valid solution. In particular, the parameter settings for the presented transfer models must be calibrated for each site and for each case individually. Again, a full process resolution approach would be the only promising one but cannot be reached with the proposed methods and the available data. 3. As a consequence, mass balance modelling cannot be improved from the available data and with the proposed approach.

I suggest the authors to find another use of the interesting data but I have, unfortunately, to recommend rejecting the present paper.

Reference: Greuell, W. and Böhm, R., 1998: 2 m temperatures along melting mid-latitude glaciers, and implications for the sensitivity of the mass balance to variations in temperature. Journal of Glaciology, 44(146): 9 - 20.

Interactive comment on The Cryosphere Discuss., 8, 6147, 2014.