Correspondence

The Editor,
Journal of Glaciology

SIR,

Comments on "The use of planimetric surface area in glacier mass-balance calculations: a potential source of errors" by Jacobsen and Theakstone

Two of the major conclusions of this paper are: (1) the true area of a glacier surface is not the same as the area of its projection onto a horizontal plane (the planimetric area), and (2) the true surface area should be used in computing average mass balance from point measurements. The first statement is correct but trivial, because it follows from the most basic trigonometry that an element of planimetric area can be obtained from an element of surface area by multiplication with the cosine of the local surface slope angle. The second statement is incorrect if the point measurements are made in the vertical direction, which to our knowledge is always the case, whether one uses poles, aircraft altimetry or even sequential mapping. Average mass or volume change is computed from these data by integration over the planimetric area, not the surface area, as outlined by Paterson (1994), for example. Use of the true surface area will lead to error in average mass balance which is on the order of 15% (depending upon the geometry), as the authors compute.

The point seems quite basic. We caution against the uncritical use of the results of this paper.

Geophysical Institute,
University of Alaska,
Fairbanks, Alaska 99775-7320,
U.S.A.

BERNARD RABUS
WILLIAM D. HARRISON
KEITH A. ECHELMEYER

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Comments on "The use of planimetric surface area in glacier mass-balance calculations: a potential source of errors" by Jacobsen and Theakstone

Geo-information systems (GIS) provide "triangulation irregular network digital terrain models" (TIN DTMs) as routines for many purposes. These include the determination of "true" rough surface areas in order to improve the results one obtains from the traditional glaciological mass-balance method (Hoinkes, 1970), where mass and volume changes are obtained from point measurements which are extrapolated to areal values. (1) These "true" surface areas are not at all true, and (2) even if they were true, their use for the calculation of mass balance and related topics (e.g. energy balance) would be wrong by definition.

(1) The value of a rough surface area is mainly a function of scale, similar to the determination of the perimeter of an island. Zooming continuously into larger scales, it becomes longer and longer, even up to orders of magnitude (e.g. Penck, 1894). If Jacobsen and Theakstone (1995) went to even larger scales than 1:2000 they would obtain "true" areas which become larger than the projected area not only by 10–20%, but finally by orders of magnitude if the scale is chosen large enough. These rough surface areas are neither wrong nor true. However, it is impossible to define them exactly.

(2) If one looks at the calculation of the mass balance of a glacier along a longitudinal cross-section, one has to deal with the surface area of a rhombus which has two vertical and two inclined sides. The surface area of such a rhombus, corresponding to changes in the volume of a glacier, is calculated by multiplying the arithmetic mean of the vertical sides by the arithmetic mean of the horizontal projections of the inclined sides. Therefore, as long as specific mass- as well as energy-balance terms are measured vertically, they must be related to the horizontal projection of the corresponding surface area which is, moreover, well defined. Using mass-balance values and energy fluxes which are directed normal to the surface would again lead to a scale problem (normal to which surface with which inclination?), in addition to measuring problems, and would not improve the results objectively.

The problem of serac areas is well known but there is no realistic way to solve it. Not only for this reason it has to be noted that not every glacier is suitable for mass-balance studies, and "mass-balance glaciers" should be chosen very carefully (e.g. Østrem and Brugman, 1991, p. 9).

Institut für Geographie,
Universität Innsbruck,
Innrain 52,
A-6020 Innsbruck, Austria

GEORG KASER

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