

Comments on “Deglaciation of the Caucasus Mountains, Russia/Georgia, in the 21st century observed with ASTER satellite imagery and aerial photography”, by M. Shahgedanova et al., submitted to *The Cryosphere Discussions*

Graham Cogley, September 2014

General Comments

This paper reports on an analysis of area changes of nearly 500 glaciers in the central Caucasus and on Mount Elbrus between 1999 and 2012. Rates of terminus retreat are also investigated for the longer period 1987–2010. Although suitable weather stations are hard to find, the paper seeks to interpret the observed shrinkage rates in the context of temperature and precipitation records from three stations. The shrinkage rates exceed the measurement uncertainties, which the authors have examined carefully. Nevertheless, the rates are of the order of $-0.05\% \text{ a}^{-1}$ or slightly less, which is rather small by comparison with rates in other mountain ranges, the Alps in particular, at similar latitudes. Terminus retreat was more than twice as fast in 2001–2010 as in 1987–2001. These glacier changes are found to be generally consistent with the evolution of temperature at the weather stations, with due allowance for changes of precipitation.

I have relatively few substantive comments, and those relatively minor, to make about this paper. It is a careful and thoroughly competent study and presents valuable glaciological information in a reasonably clear way. It should be accepted for publication subject to consideration of the points made below.

Substantive Comments

P4161

L17-20 Perhaps it would be prudent to mention here two other strong contributors to area measurement error: sensor resolution and glacier size.

P4163

L14-16 These critical remarks should probably be omitted here. That about “the use of snow-covered areas” is not mentioned in section 6, and the other two are details that are best left until later. My impression as a reader is that Holobaca’s results are “OK”, but if they are compromised by inadequate correction for seasonal snow that should be documented more thoroughly.

P4164

L16-18 Oops! The Randolph inventory simply took the Caucasus outlines from GLIMS on the assumption (evidently wrong) that they covered the region completely. This will be corrected in future versions.

L4167

L9-10 I do not know what an “interactive” ground control point is.

P4166

L28 Mention the number of surging glaciers that were excluded, and possibly the criteria that were used to identify them. And if the number is significant, it would be of interest to know roughly how this paper’s area changes might have been affected by their inclusion.

P4168

L13 Increasing the buffer width on debris-covered parts of glacier margins is a common practice, but it may not address the real problem, which is that the debris creates a risk of gross error (mistakes many pixels wide).

L15 Donguz Orun: Figure 3 is a superb illustration not just of what “debris-covered glacier” means but also of where the debris might come from. A remark would be appropriate to explain that the debris derives (or is presumed to derive) from the headwall by avalanching.

L18-20 For how many glaciers was the error due to debris cover calculated? Change “the overall majority of” to “most”. (Here, as in most of its other occurrences in scientific writing, “overall” is meaningless.)

P4170

L8-9 The Baksan, Kuban, Inguri and Kodori catchments should be delineated in Figure 1.

P4171

- L23 I suggest “0.1–1.0” and “1.0–5.0”. Everybody would know what you mean, and you would avoid awkward questions about glaciers with areas of 0.105 and 1.05 km².
- P4175
L2 Debris cover of 3–25%: this conflicts with the statement of the extent of debris on Donguz Orun Glacier on P4168.
- L10-12 The discussion is rather hard to follow here. I suggest writing a separate sentence about the valley glaciers.
- P4176
L1-7 As suggested at P4163 L14-16, this discussion should be either reduced or extended. The inclusion of seasonal snow, for example, ought to be either documented with examples or dropped.
- L11 Change “on glacier tongue” to “near the glacier terminus”.
- P4184
Table 2 The errors of the areas are not retrievable from the errors of the area changes. If finding space for them is difficult, they are probably more important than the (admittedly convenient) percentages, which could be sacrificed. The same comment applies to Table 4, where space could certainly be saved by putting a line break between “Number” and “(Fig. 4)”.
- P4193-4194
Tables 6, 7 The lines in these graphs ought not to be smoothed.

Stylistic Comments

- P4160
L2 “located on”.
- L12 “and 2000/01–2010”.
- L15 “terminus retreat”, here and in the remainder of the text. When used as an adjective, the noun should be in the singular, not the plural.
- L23 “of mountain”.
- L24 Delete “was”.
- L25 “decades in”. Comma after “record”.
- P4161
L4 “Dyurgerov”.
- L6 “to the global”.
- L7 Comma after “1998–2008”.
- L10 “have been conducted”.
- L12 Commas after “imagery” and “respectively”.
- L18 “of single-glacier area change”.
- L27 “glaciation”.
- P4162
L1 “have examined”.
- L3 “on repeated”.
- L13-14 “reported average”.
- L16 “assess”.
- L17 “very similar”. (“close” should become “similar” in some other places as well.) “on field”.
- L25 “shrinkage” would be shorter than “reduction in the glacier area”.
- P4163
L3 “with the exception”. No comma after “period”. Comma after “1980s”.
- L24-25 “with the exception”.
- P4164
L6 “intervals. Nor do we analyze data from ...”.
- L15 “Randolph”.
- L22 “A characteristic”.

P4165
L2 “1000 m”.
L5 “Elbrus. A number ... glaciers have individual”.
L6 “Cirque glaciers”.
L10 “glacierized”.
L16 “of the SWIR”.
L19 Comma after “1 km²”.
L25 “and a Landsat”.

P4166
L1 Commas after “2000” and “ASTER”.
L2 “an ASTER scene”.
L13 “under [nearly]”.
L23 “the ASTER”.
L25 “Kienholz”. Make this change throughout.
L26 “were used”.

L4167
L13 Delete the unnecessary “value”.
L14 “than the size of an ASTER pixel”.
L17 “the average ratio of ... to”. Comma after “increment”.
L20 “using a similar”.
L28 “glacierized”.

L4168
L2 “field”. Comma after “work”.
L4 “Debris cover ... is”.
L9 Change “The overall majority of” to “Most”.
L14 “debris was extensive”. (“debris” can be plural in the original French, but is always singular in English.)
L16 “cover”. Delete “map area”.
L26 “of the termini”.

P4169
L5 Comma after “signal”.
L11 Delete “further in the text”. (Or change it to “below”.)
L15 “were digitized”.
L17 Delete “the”.
L21 “conceptually” might be better than “traditionally”. Or say “position can be understood as”.
L24 Surely “length” should be “width”?
L28 Change “the pixel value of” to “the pixel size of the”.

P4170
L6 End the sentence at “m a.s.l.”, and begin a new one with “Their monthly”. Perhaps insert “(Pass)” after “Pereval”.
L19 “The differences between”.
L20-21 Delete “It appears that”.

P4171
L4 “catchment. They experienced”. Comma after “types”.
L6 “with 2001”.
L7-8 “There are no ... differences”.
L17 Delete “further in the text”.
L20 “with 2001”.
L21 Change “and” to a semi-colon.
L22 “another 36”.
L23 “change. Glaciers within”.

L25 “with 2000”. Same at L27.
P4172
L3 “2012. Their”.
L15 “rocks on the”.
L15-16 “Azay” should be “Azau” and “Garabashy” should be “Garabashi”.
L21 “Dzhikiugankez”.
L27-28 “The area losses of ... and of Glacier No. 319”.
P4173
L2 “eastern (5.0%)”. That is, use the same number of decimal digits in each parenthesis.
L7 Delete “rates of”.
L9 Delete “overall”. Same at L11. (If the idea is to refer to the combined time spans, “total” would be clearer.)
L10 “Bolshoi”.
L11 Comma after “500 m”.
L14 Delete “overall”, or substitute “in total”.
L14 Decide between “Dzhankuat” and “Djankuat” and be consistent. (The same choice needs to be made for “Dzh/Dj-ikiugankez”.) My preference would be for “Dzh”; nobody would think of writing Zhitomir as Jitomir or Zhuravlev as Juravlev.
L15-16 Commas after “subdued” and “slope”. Change “were” to “where”.
L21 Comma after “respectively”.
P4174
L7-8 Comma after “precipitation” and “level”.
L9 Comma after “period”.
L11 “a positive”.
P4175
L2 Comma after “small”.
L13-14 “lower than in the north positive anomalies”: garbled; clarify.
L15 No need to hyphenate “westernmost”.
L19-20 Commas after “precipitation” and “2002”. I would change “two-three” to “2-3”.
L21 Comma after “mid-1990s”, and delete “as”.
L23-24 Delete “overall”.
L25-27 Commas after “(2012)” and “2.5 m”. Delete “overall”.
P4176
L3-4 “the total glacier wastage may”. Change “inclusion” to “interpretation”.
L5 “glacierized”. (Or if you want to spell it with an “s”, do so consistently throughout the text.)
L15 “1990s”.
L20 Delete “on”.
L21 “twice the long-term average”, or preferably give the period (1984 to current). Perhaps say “in the El Niño year of 1998”.
L22 Subsequently to what?
L27 “11%”.
P4177
L5 “glacierized”.
L9 “this estimate exceeds the uncertainty”.
L10 “lost a similar”.
P4179
L10 “Kienholz”.
P4180
L16 “Gidrometeoizdat”.
L26 “50(53)”. It is necessary to give the issue number for Annals volumes 50 and later, because pagination begins anew with each issue.

L30 “54(63)”.
P4182
L6 “50(50)”.
L11 “glaciation”.
P4185
Table 3 Try to do a better job of aligning the columns.
Table 4 Provide two decimal digits for the area changes in rows 17 and 19.
P4188
Table 5 Insert “average” before “error terms”.