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Interactive comment 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.

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Deglaciation of the Caucasus Mountains, Russia/Georgia, in the 21st century observed with ASTER satellite imagery and aerial photography by Shahgedanova et al. 2014 TCD.

General comments

This study reported glacier area changes of 498 glaciers located in the Main Caucasus Ridge and on Mt. Elbrus using multispectral ASTER and panchromatic Landsat im-

agery. Decadal changes in recession rates of glacier snouts between 1987–2001 and 2001–2010 were also investigated using aerial photography and ASTER imagery for a sub-sample of glaciers. This study interpreted glacier recession rates with temperature and precipitation records from three stations and provided comprehensive picture on glacier recession and climate change. However, area and length changes are delayed response of glaciers as compare to mass balance. This information is somehow missing in manuscript (introduction and discussion part). Minor changes in structure of results are required for more understanding of subject (see following suggestions). This is interesting finding that recession rate of glaciers of southern slope of the central MCR has tripled during study period. There is need to provide possible reasons of these higher recession rate.

Specific comments

P 4160, L 6: Include no of sub-sample was investigated using aerial photography and ASTER. P 4160, L 8-10: Include the total area out which the loss and recession has been analyzed. P 4160, L 15: What is the possible cause of tripled rate of increase in glacier termini retreat on the southern slope? Describe in 1-2 sentences. Several studies in northern hemisphere also found (e.g. Bhambri et al. 2011) higher recession rate on southern slopes. P 4161, L 1: There are several peer-reviewed references on temperature increase. So, use peer-reviewed reference instead of website. P 4162, L 14-15: ' Stokes et al. (2006) reported the average glacier termini recession rates of 8 ma−1 between 1985 and 2000.' Shift these sentences on line 7 before the 'Panov's (1993) analysis of the field measurements and data derived.....' and make change accordingly. P 4162, L 14-15: Show on fig 1 subdivided parts of western, central and eastern sectors of greater Caucasus for the more understanding of region. Similarly P 4165, L 12-14 areas of 498 glaciers were mapped of which 174 and 304 were located in the central and western sectors of the MCR respectively on both northern (Russia) and southern (Georgia) slopes and twenty on Mt. Elbrus. P 4164, L 21: Include exact number instead of 'several'.

P 4164, L 25-27: Not understandable. Improve the sentence.

P 4165, L 15-21: Glacier outlines..... was 0.02 km2. Shift these lines in 3.1 Satellite imagery and glacier mapping as these belong to glacier mapping. Delete 'procedures'. Glacier mapping is sufficient here. I would suggest authors can merge 3.3 Assessment of changes in positions of glacier termini using aerial photographs with this section. P 4165: Describe the procedure of debris-covered glaciers tongue in section 3.1 Satellite imagery and glacier mapping. P 4167: Section 3.2 quantification of errors. This section only considered error estimation for area changes and errors related with terminus changes reported in other 3.3 section. Generally, papers on glacier area and length changes (e.g. Bolch et al. 2010, Bhambri et al. 2013) included error estimation in a single section. I would suggest that authors should include error estimation of terminus and area changes in single section. P 4169, L 1-3: These lines related with introduction, so shift in introduction and add length area changes are indirect response of glaciers. P 4169, L 11: Describe scale of aerial photographs if possible. P 4169, L 25: 'five measurements were taken across the length of each glacier terminus along flow lines and an average value was calculated.' cite here Koblet et al., 2010; Bhambri et al. 2012. P 4170, L 4-5: Location of meteorological stations show on fig 1. P 4170, L 8-10: Include period of used meteorological data. P 4170: Section 3.4 Meteorological data. Non-parametric test performed in this study to observe the significance of climatic trends. This information should be presented in this section. P 4170: 4 Results, there is confusion in structure of result section. I would suggest to change the structure of results. 4 Results, 4.1 Area change, 4.1.1 The Main Caucasus Ridge, 4.1.2 Mt. Elbrus, 4.2 Terminus retreat, 4.3 Climatic variability. P 4170, L 20-25: Long phrase. Split it. P 4171, L 4-5: Define here glaciers of other types. P 4171: Section 5 Climatic variability, Include this section in results section as suggested above. P 4171: Section 5. For the interest of readers mention in this section magnitudes of the climatic trend by linear regression analysis. P 4173, L 7: 'rates of" typo error. P 4173, L 13: 'two periods' respectively. What periods? P 4174: Section 6 Discussion and conclusions. Both sections are important. Arrange in two different sections. I would suggest authors

should see role of elevation range, slope, aspect on glacier retreat results and discuss in discussion (e.g. Bolch et al. 2010, 2011, Bhambri et al. 2011). P 4184: Table 2 Include region wise no. of glaciers with combined area in table. P 4188: Improvement is needed in Fig 1 for more understanding of region. Location of Fig 2, 3, 4 and 5 include in fig 1. Location of climatic stations also show in fig 1. P 4189: Fig 2, P 4190 Fig 3. Include year/date of photography. P 4189: Fig 4 and 5, Include details/type of satellite images (date).

References Bhambri, R., Bolch, T., and Chaujar, R. K.: Frontal recession of Gangotri Glacier, Garhwal Himalayas, from 1965–2006, measured through high resolution remote sensing data, Curr. Sci., 102, 489–494, 2012. Bhambri, R., Bolch, T., Kawishwar, P., Dobhal, D. P., Srivastava, D., and Pratap, B.: Heterogeneity in glacier response in the upper Shyok valley, northeast Karakoram, The Cryosphere, 7, 1385-1398, doi:10.5194/tc-7-1385-2013, 2013. Bolch, T., Yao, T., Kang, S., Buchroithner, M. F., Scherer, D., Maussion, F., Huintjes, E., and Schneider, C.: A glacier inventory for the western Nyainqentanglha Range and the Nam Co Basin, Tibet, and glacier changes 1976–2009, The Cryosphere, 4, 419– 433, doi:10.5194/tc-4-419-2010, 2010. Koblet, T., Gärtner-Roer, I., Zemp, M., Jansson, P., Thee, P., Haeberli, W., and Holmlund, P.: Reanalysis of multi-temporal aerial images of Storglaciären, Sweden (1959–99) – Part 1: Determination of length, area, and volume changes, The Cryosphere, 4, 333–343, doi:10.5194/tc-4-333-2010, 2010.

Interactive comment on The Cryosphere Discuss., 8, 4159, 2014.