Review of paper on "Changes in glacier Equilibrium-Line Altitude (ELA) in the western Alps…" by Rabatel et al.

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General comments

Antoine Rabatel and colleagues present time series of end-of-summer snowlines derived from satellite images between 1984 and 2010. They use the end-of-summer snowline altitudes (SLA) as a proxy for the annual ELA and investigate spatio-temporal change patterns with respect to summer temperature, winter precipitation and morpho-topographic parameters. They present a statistical variance decomposition model to reconstruct spatio-temporal ELA fluctuations based on morpho-topographic and climatic drivers.

This is a generally well presented study based on and extending earlier work by Rabatel and colleagues. The results are not too surprising but are an important step towards scaling detailed mass balance measurements at few glaciers to entire mountain ranges using satellite-based (snow line) observations. I recommend publishing this paper in The Cryosphere after a moderate revision based on the specific comments below.

Specific comments

Note: More substantial comments are marked in bold.

Title: shorten, e.g. to: "Changes in glacier equilibrium-line altitude in the western Alps from 1984-2010: evaluation by remote sensing and modelling of morpho-topographic and climatic controls."

Page 2249, Line 8, update: "..on around 260 glaciers worldwide…"

Page 2249, Line 11, update: WGMS (2012)

Page 2250, Lines 1-12: The paragraph following "Here, we…" shall provide the aims of the study. Further detail your aims (Lines 1-3) and move the other text bits (i.e. Lines 4-12) to the introductory paragraphs above.

Page 2250, Lines 13-22: delete. There is no need for a description of each section in a short paper.

Page 2251, Lines 4-5; relates also to Page 2256, Lines 10-11 and Fig. 4**:** The first selection criterion (i.e. only glaciers with high enough maximum elevation) might lead to a bias in your sample. Many glaciers experienced ELAs above their maximum elevation in the past two

decades, with extreme values in 2003 (Zemp et al. 2005, DGS; Schär et al. 2004, Nature). Add a corresponding section to the discussion: Is this a limitation of your approach? Is there a workaround?

Page 2251, Line 10: delete the URL here but keep it in the Acknowledgements.

Page 2251, Line 18: avoid acronyms in title.

Page 2252, Line 7: avoid acronyms in title.

Page 2252, Lines 14-16: You investigate the classical selection of simple morpho-topographic parameters which is OK. What about testing some 'new' ones which allow considering the sensitivity to hypsometry (e.g., above/below median or mean elevation area ratio)?!

Page 2252, Lines 17-24: The study by Paul and Haeberli (2008; GRL) showed that elevation differences can be >100m in the ablation zones of Swiss glaciers between 1980s and 2000s. Your approach might, hence, introduce a bias in years of low SLAs. Check and add a corresponding remark here or add a section in the Discussion.

Page 2253, Lines 10-26: What is the need for filling observational gaps? Which results are based on the original and which on the completed sample? These issues become somewhat clearer later on but it might be helpful to clarify this point here.

Page 2255, Lines 22-26, Page 2256 Lines 1-3: Setting SLA equal to ELA is a major assumption and certainly not of general validity. Hence, I recommend (i) adding ELA values to Fig. 3 or adding a figure showing SLA versus ELA (maybe as an inset) for the tree glaciers with mass balance measurements and (ii) not using the term ELA for SLA.

Page 2256, Lines 20-27, Fig. 5: I agree that 2003 might mark a breakpoint in the time series. The extreme heat wave resulted in a reduction, or even complete loss, of the firn area and, hence, introduced a positive feedback on glacier mass balances after 2003. This issue might be further detailed in the discussion section. Optionally, you might show average SLAs before and after 2003 in Figure 5.

Page 2258, Lines 14-15: "…about 300 m higher than the average for the whole period (in fact above many glacierized summits), …"

Page 2259, Lines 14-19: delete.

Page 2260, Lines 15-18: I do not agree that glacier size of 2010 represents the average ELA of the period 1984-2010 – most Alpine glaciers are too large for current climate (cf. Mernild et al. 2013, TCD).

Page 2264, Lines1-19: It might be interesting to compare your results to those from more other studies, e.g. by Kuhn (1981, IAHS), Braithwaite and Zhang (2000, JG), Oerlemans (2001, Balkema Publishers), Zemp et al. (2007, GPC). Maybe add an additional table.

Pages 2263-2270, Section 4.3: this section is way too long and combines methods, results and discussion. Split and distribute the text to the corresponding sections. Also, better motivate/emphasize the benefit of this additional statistical exercise.

Pages 2272-2276: The reference list is slightly francophone. It might be worth supporting and discussion your findings in view of other Alpine studies.

Page 2275, Line 30, replace WGMS (2011) by WGMS (2012): WGMS: Fluctuations of Glaciers 2005–2010, Volume X, edited by: Zemp, M., Frey, H., Gärtner-Roer, I., Nussbaumer, S.U., Hoelzle, M., Paul, F., and Haeberli, W., ICSU(WDS)/IUGG(IACS)/ UNEP/UNESCO/WMO, World Glacier Monitoring Service, Zurich, Switzerland, 336 pp., publication based on database version: doi:10.5904/wgms-fog-2012-11, 2012.

Page 2279, Table 2: You may delete this Table and add the key information to the text.

Page 2282, Fig. 2: This figure nicely shows some important issues of the SLA selection which might be worth to be discussion in more detail: somewhat arbitrary definition of the glacier system/catchment and selection of the snow line for SLA calculation. How different are the manually derived SLA (including expert knowledge) from those derived from automatic approaches (e.g., Huss et al. 2013, AG)?

Page 2283, Fig. 3: Add ELA values. See comment above relating to Page 2255.

Page 2284, Fig. 4: The caption is hard to understand without reading the text section. It might help to indicate where to find the corresponding information.