Changes in glacier Equilibrium-Line Altitude (ELA) in the western Alps over the 1984-2010: evaluation by remote sensing and modeling of the morpho-topographic and climate controls

(TCD 7, 2247-2291, 2013) by Rabatel, Letreguilly, Dedieu, Eckert

The paper employs an analytical perspective that will probably be unfamiliar to most glaciologists. A reviewer prepared to evaluate the statistical analysis could probably suggest how the authors could make the paper more accessible to a broader range of readers. The paper uses factor analysis, which occurs only seldom in the glaciological literature, for instance, but devotes not a word to describing it.

The paper does not reflect a broad awareness of the glaciological literature dealing with analysis of ELA variation, such as Braithwaite, Raper (2009, *Ann. Glac.* **50**(53) 127).

The English is very good.

The following detailed comments (identified here by page, line number in the 5 June 13 manuscript) might be useful to the authors in preparing any subsequent versions.

2248,5 A quantity that varies in space or time is a variable, not a parameter. This indicates a change that is needed in numerous other places. Especially objectionable are *climate parameter* and *meteorological parameter*.

2251,6 *glacierized* is needed here and in many other places instead of *glaciated.*

2252,24 Presumably the point here is that the 20-m difference is small compared with variation of the ELA.

2253,24 α_i would be better called the long-term mean over the period of record. It seems that α_i and β_t should be defined right after (1), and that $\epsilon_{it} = \alpha_i + \beta_t - \mathrm{SLA}_{it}$, where α_i and β_t are formed as stated and SLA_{it} is the observed SLA.

2254,19 Presumably standard deviation of the measured SLAs is meant, not their RMSE.

2254,23 The remarkable fact that records from each of 21 weather stations are used for exactly two glaciers (Table 1) and from one other station for one glacier is worthy of spelling out in the text or in the caption of the table.

2255,6 Presumably two stations in Switzerland were used in addition to the 20 mentioned to get the 22 listed in Table 1. If so, the paper should be more specific by saying two stations in Switzerland instead of additional stations in Switzerland.

2256,3 That mass balance correlates well with the SLA does not mean the SLA is the ELA. If glacier-wide mass balance correlates well with mass balance at a point near the middle of the altitude range of the glacier, which is the case for most mid-latitude glaciers, the mass balance at that point is not the ELA and that altitude is not necessarily the ELA. Moreover, the SLA and ELA coincide only in the absence of superimposed ice.

2258,1 The two effects of higher temperature in the south should be distinguished in the text. How much is due to enhanced ablation and how much might be due to shifting of precipitation from snow to rain?

2258,7 It is an increasing trend but it is not a linear trend.

2258,12 Sublimation should be mentioned, only if to say that all ablation is assumed to be due to melting.

2258,16 It would be appropriate here to cite Beniston (2004, *GRL* **31**) or Beniston, Diaz (2004, *Glob. Planet. Change* **44**)

2258,24 Standard deviation after 2001 appears to be larger than half of before 2001.

2260,6 How the average altitude is calculated should be explained. Is it the width-weighted average or is it just half the sum of the highest and lowest altitudes? See Cogley, McIntyre (2003, *AAAR* **35**(4) 482), which should be cited.

2260,14 The sentence needs to be recast for it implies that the ELA is the independent variable upon which the geometric properties depend.

2260,24 What is meant by *meridional effect* should be explained.

2262,10 Fig. 4c shows winter P.

2262,24 How the seasons are defined should be stated, particularly if it is meant that the entire year is partitioned into just winter and summer. That is, there are no transitional seasons during which both accumulation and ablation might occur (as they might also occur, in vastly unequal amounts, in both winter and summer.)

2263,4 Units of CPDD are °Cd, not °C. Here $115\mathrm{m}\,°\mathrm{C}^{-1}$ is said to be sensitivity to CPDD, whereas at 226,11 it is correctly called sensitivity to summer temperature. The Fig. 9 caption also ascribes the wrong units to CPDD.

2264,6 Why spatial and temporal variables are called *covariates* should be explained.

2264,16 How standardized variables are reduced should be explained.

2265,5 *poorly informative priors* is an example of statistical jargon in the paper that few glaciologists will comprehend.

2266,6 It is not clear why Eqn (15) is denoted $R^2_{\text{time/space}}$ when its numerator contains only the temporal term.

2266,7 The notation would be more compact were the denominators of Eqns (15,16) written as $\mathrm{VAR}(\mathrm{ELA}_{it}) - \sigma^2$.

2266,15 *lower level* should be defined.

2267,2 If $\epsilon_{it} \sim N(0, \sigma_\epsilon^2)$ (as stated at 2253,25) would not $\Sigma \epsilon_{it}$ be very small? The disparate expressions for σ_t in Eqns (17 and 19) are worthy of comment, as also are the two for σ_i in Eqns (18 and 20).

2267,11 What is the MCMC sequence?

2267,16 The first five mean R^2 values in Table 4 do add to 1.00, so the statement about being very close but not fully equal to 1 should be made quantitative. Maybe to more decimal places they add to something such as 0.997.

2270,23 How the 170-m increase was determined is unclear. Was it the difference between the 43-glacier mean ELA in 2010 and the 43-glacier mean ELA in 1984? If so, it is irrelevant, although interesting, that the 26-year variation of the mean is nearly linear

2271,23 The full variability might be well approximated but the *full* variability is not reproduced.

2277 Fig. 1 would be better were it to show locations of all 22 weather stations, not just 14 of them. An alternative would be to give latitude and longitude in Table 1 for all stations and all glaciers.

2284 The meaning of *spline regression* should be explained. Apparently, smoothing splines are fit to the 27 values in each panel, but nothing is said about the criteria of the fits, such as weights or boundary conditions or the polynomial degree or the order of continuity. A reference should be supplied.

2288 Writing $r(\text{ELA}, T)$ and $r(\text{ELA}, P)$ follows conventional notation for correlation between two variables, whereas $\text{ELA} - T$ and $\text{ELA} - P$ denote differences.