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## ***Interactive comment on “A minimal model for reconstructing interannual mass balance variability of glaciers in the European Alps” by B. Marzeion et al.***

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Received and published: 4 December 2011

Marzeion et al. (2011) presents a unique method for reconstructing mass balance and assessing its variability in the Alps. This method has promise and is worth both publication and further examination. At present the paper requires several points of clarification, and a more detailed verification on Hintereisferner in order for the reader to be able to assess the potential with confidence. I do not disagree with the particular model choices or the methods of validation. I simply need a better explanation of choices and presentation of validation on Hintereisferner and in production of a reasonable balance gradient. The detailed discussion of the model to the entire Alps is

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not useful without a better verification of the method.

Key Comments: 2804-4: Why is the temperature at the terminus used in the equation? This is partly raised because equation (4) requires an adjustment to the terminus anyway. Why not use the ELA where we know mass balance=0. 2804-24: Where is the evidence that this method improves the estimate of accumulation?

2807-13: The scaling functions  $a_{\text{optimized,cross}}$  and  $\mu_{\text{optimized,cross}}$  should produce a reasonable balance gradient that can be compared to mean gradients for the Alps from Greis, Hintereisferner, Vernagtferner etc. If this cannot be done than the model output results cannot be robust. It seems vital to devote a figure to a reconstructed balance gradient.

2813-11: Figure 10 is offered as an exemplary case for testing the model. This figure is not convincing as constructed for this purpose. The time span used far exceeds that for which glacier mass balance data exist. The time span presented is too long for detailed examination of accuracy and potential bias of the model. The contention is that the model provides reasonable annual results. This needs to be carefully examined with respect to the 50 year long Hintereisferner annual mass balance record. This graph should focus just on the 1953-2003 period. After this verification provides a view of the model output versus observation in a detailed manner, than Figure 10 is fine for illustrating the long term reconstruction and the impact of temperature and precipitation on the above, as is done in part in Figure 13. The skill scores and correlation coefficient reported are quite good, but do not illustrate the annual variations. For example is mass balance using the model underestimating the mass balance more during years with particularly low mass balances as Figure 3 would suggest, or for Hintereisferner is the situation different.

2816-18: It is concluded that “Doing so increased the mean rmse of the model, indicating that our model’s implicit distinction between liquid and solid precipitation over the glacier surface is more accurate than the more global, i.e. less glacier-specific,

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estimate of the solid fraction of monthly precipitation contained in the HISTALP data.” This may be the case, but the case is not made strongly here. How much did the mean RSME improve? How accurate is the HISTALP solid fraction? Is this the HISTALP solid fraction determined for terminus elevations?

Specific Comments: 2801-9: Surface mass balance is more closely related to the atmospheric forcing than changes in glacier length.

2801-18: A better reference than the weak Roe and O’Neal, 2009, should be used.

2801-26: Is the long term data series for mass balance from Sarennes warrant inclusion here?

2803-17: reword to “The model is established for a glacier. . . . .”

2805-5 : The amount is proportional to what temperatures specifically?

2805-20: Why is mse insensitive to  $T_{melt}$ ? This is a crucial point to identify.

2807-11: spelling- interval

2807-16: good use of cross validation

2808-11: How many were rejected and what was the basis for rejection, just the number of values?

2809-9: Why does Sarennes for example have such a high a-optimized?

2809-Section 2.3: I am not clear on why the SSC model is used here, given the adjustments described that limits its advantages from the original application.

2811-1: The reduced effectiveness due to more model parameters is obvious, however, what if those parameters are more accurately known as they are in the original Oerlemans and Reichert, (2000).

2813-2: Split this sentence into two parts.

2815-13: The support of the statements in this paragraph are weak.

2820-10: Oerlemans in his Minimal Glacier Model (2008) noted that it is remarkable that the sensitivity of glaciers to temperature change can be estimated by just two parameters: the mean slope and the atmospheric temperature lapse rate. Contrast this with your statement at the beginning of this paragraph

Figure 5: Is this necessary given Fig. 6-8 and Table 1?

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Interactive comment on The Cryosphere Discuss., 5, 2799, 2011.

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5, C1455–C1458, 2011

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