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Interactive Comment

Interactive comment on “Statistical modelling of the snow depth distribution on the catchment scale” *by* T. Grünewald et al.

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1) We moved the section on the HRU (P3250, L12-24) directly to the description of the Lehning et al. approach and we also shortened the paragraph. We still mention the "manual" approach as performed by Lehning et al. 2011 and also provide the link to HRU, as this approach was the starting point for our analysis and we belief that it is an interesting finding that both methods yield very similar results. This is also the justification for applying the automatic procedure rather that the more subjective one.

"...The length scale of these subareas was approximately 500m. Such an aggregation follows the concept of hydrological response units (HRU), which has successfully been applied for semidistibuted hydrological models (Kite and Kouwen, 1992; Rinaldo et al., 2006; Pomeroy et al., 2007) and is consistent with the concept of stratified snow sampling (Steppuhn and Dyck, 1974) where landscape units were defined to minimise within-unit variance of SWE and maximise difference in SWE between units. The facets applied by Daly et al. (1994) for the calculation of precipitation gradients or to the concept of snow accumulation units outlined by Hopkinson et al. (2012) are also similar approaches. The second method..."

As suggested by Referee 3 we have added one sentence to link to the REA concept:

"The approach is similar to the concept of representative elementary area (Wood et al. 1988, Bloeschl et al. 1995), which aims to identify ideal scales for hydrological modelling applications.

2) The smallest N applied in this study is 29 for LAG (model: SL, dE) followed by 35 for WAN (model: SL, dE, No), which is in our opinion a sufficient number for a robust model with two respectively three parameters (Table 2). We will change N> 20 to N∼>30 in the text (p3251 L6). Nevertheless we agree that models with a 200m grid would also have been a possible choice. As discussed in the text, the effect of a smaller grid is - in most cases - only that the explanatory power of the models decreases, model parameters remain the same. For the single-catchment models (Table 2), the range of reduction of R2 is 0.01 to 0.14 when changing from 400 to a 200 m grid. This effect is illustrated in Fig.5b for WAN and would look similar for the other data sets.

We have added one sentence to p3254 L17: "Choosing a 200 m grid instead of the 400 m would result in very similar models but with lower performance: While the model parameters remain the same, the model R2 would be reduced by 0.01 to 0.14 for the respective models of the single investigation areas . For example for WAN R2 would decrease from 0.73 to 0.59 (Fig. 5b). Moreover a 400 m grid is a similar...."

The inter-annual consistency will depend in a similar way on the resolution as the comparison between areas. Therefore, the quantitative information on the correlation between years will be affected but not the finding on a high consistency, which is also reported in earlier studies (e.g. Deems et al. 2008, Erickson et al, 2005; Schirmer et al. 2011).

3) Calculation procedure for the regression models: - We calculated all possible 2 and 3 parameter models (without factor combinations) - We selected the best possible, physically meaningful model and checked if all parameters and the overall model were significant - if 2 parameters performed similarly as 3 the model with the 2 was chosen. For almost all data sets a stepwise approach (starting with no variable included) would have resulted in the same model. - then we added all possible factor combinations (e.g. dE*SL, dE*NO and NO*SL for a model with initial parameters dE, SL, NO) and tested if the combinations improved the model and if they were significant. This results in final models with up to 3 initial parameters complemented by up to 3 factor combinations. In our option this calculation procedure for the regression models is already well described in the text (p3252 l26 - p3253 L9).

We agree that a validation of the models with an independent data set would improve the evaluation of the model quality. There are two options for such a validation: The fist is to sub-sample the single data sets. This requires relatively large areas or data from different years. Only HEF and NUR are large enough for such a sub-sampling (see also the discussion above on the minimum number of regression points). But NUR is a very diverse data set and our attempts to do a reasonable sub-sampling were not successful. For HEF, the data set is governed by the large glacier, dividing it into sections was not found to be meaningful. A validation with multi-temporal data was possible for WAN and HEF and is presented in section 3.2.3 and Fig 7. of the paper. The second option is to compare neighbouring or similar datasets. Similar data sets (ARO and HEF) have been compared in section 3.2.3; For the other data, a direct validation of one model by applying its regression model for other regions has been tested but did - as expected - not give reasonable results.

4) "leave-one-out cross validation" (p3253, L 22) and "cross-validation" (L 27) (replaced by "validation"), p3258 L14 (replaced by "analysis of the inter-annual consistency"),

Table 5 (replaced by "inter-annual consistency") were removed from the text.

5) It is well true, that a comparison with neighbouring valleys would be very interesting but no such data set was available. We also agree that climatic conditions and their interaction with the terrain might differ from site to site. Some physical based interactions of snow cover and terrain might nevertheless have universal validity (e.g. less snow in steep slopes). We therefore think that it is very interesting to investigate if such "universal rules" can be found in the data sets, and even if the model with slope and elevation "only" explain slightly more than 20% of the variability, it is still 20%. And we think that the result of a limited universality is very important and interesting to the hydrological community. We therefore did not remove section 3.2.2 as suggested by the reviewer.

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