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# *Interactive comment on* "A statistical approach to refining snow water equivalent climatologies in Alpine terrain" *by* S. Jörg-Hess et al.

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General comments:

The article presents a method for the preparation of SWE climatologies based on station data of snow depth in Switzerland. The authors explain the relevance of this topic and exemplarily show possible applications and benefits for hydrological studies. The presented approach makes use of a recently developed statistical density model which allows the conversion of snow depth into density and SWE. Such easy-to-use models, which are based on linear relations between snow depth and snow bulk density, proved their applicability in recent works in Switzerland and other regions. The presented usage of SWE estimates is a novel application of this technique and provides an added value to the field of snow hydrology. The resulting gridded SWE-maps make this study

very valuable since spatially distributed SWE data are still very rare but this type of data is of high importance for various scientific tasks (hydrology, climatology) but also for non-scientific aspects such as water resources management.

Therefore, this work is clearly within the scope of TC. Scientific methods are valid and accurately described and the authors properly reference related work. Overall the manuscript is (in most sections) clearly written and the analysis is logical. Nevertheless, some sections (especially parts of the methods and results sections) need revisions and restructuring which will hopefully result in a better reading flux. Besides some minor technical corrections I first state some points I missed. To add some of this recommendations may improve the paper.

Specific comments:

There is a large potential for applications of the resulting gridded SWE-maps (examples in chapter 5). Howev-er, it remains sometimes difficult to assess the accuracy of the presented SWE-maps. The authors put a lot of effort in comparing the different resulting SWE-maps (map110 vs. map203). However, the whole article would benefit from detailed comparisons of model results with measured data. First of all, I suggest to cite results from Jonas et al. (2009; e.g. table 3) in order to get an idea of the general accuracy of the SWE estimates (e.g. in the introduction or methods section). Some of the stations, from which snow depth is used for the preparation of the maps and which also provides measurements of SWE (e.g. one of the locations where bi-monthly density and SWE are available), could be used for comparison with the estimated SWE (e.g. in a figure comparably to Fig.7 but plotting estimated SWE and observed SWE). After reading the article two times I am still not sure if the data which is used in 4.4.1 are SWE estimates or observations of SWE. However, I am quite sure that a comparison between estimated and observed SWE on the point-scale will emphasize the quality of the SWE data which is used for the interpolation of the maps.

For the resulting gridded SWE-maps comparisons with spatial distributed data such as



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satellite-based snow cover data would be preferable. This is not a demand since the authors have already put a lot work in this study. However, to strengthen the value of the presented results, e.g. MODIS snow cover data or NOAA-AVHRR data could be used for a spatial evaluation of the gridded SWE maps. The authors cite several applications of satellite data for snow hydrology in the introduction. According to the description on page 4244, line 25, the work by Foppa et al. (2005, 2007) provides real-time snow cover maps for Switzerland which are based on snow depth measurements and satellite data. Zappa (2008; Objective quantitative spatial verification of distributed snow cover simulations – an experiment for entire Switzerland. Hydrolog. Sci. J., 53(1): 179-191.) applies several functions for the spatial evaluation of modelled SWE based on satellite snow cover data. Such comparisons would be beneficial for quantifying uncertainties related to the placement of the snow borderline (page 4262, line 28-29) but do not allow to evaluate the accuracy of SWE. For the latter case MODIS fractional snow cover data would be a good choice since binary snow cover data may not be accurate in vegetated areas.

The model presented by Jonas et al. (2009) is designed for a monthly resolution. The according description in the method section lacks details from the enhanced version of the model which is mentioned. Does the enhanced version include daily resolution regressions parameters? How can settling and melt be distinguished if only HS is used?

A non-linear trend of SWE over elevation is the basis for the mapping of SWE. How does the trend of SWE over elevation look like? Is it influenced by the station elevations? SWE generally increases with elevation but does the used function/ chosen resolution of the maps account on the often observed decrease of SWE in the ridge zone?

Technical corrections:

The methods and results sections need some revisions. Several descriptions of meth-



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ods are spread over the results section (e.g. 4.3, 4.3.1) Therefore it is hard to follow the line of argumentation in the results section. The authors should move the first sentence from chapter 4 to chapter 3.3. The assumption that map203 is used as reference data should be mentioned in 3.3. The cross validation and the comparison with station data (Fig.3) should be explained in section 3.3. This may also clarify one of my points of criticism from above.

Especially in the results section, I would recommend to use fewer abbreviations. For instance, I would not use CP and TP (write out!) in 4.4.1 and 4.4.2 where you first use it and later describe it once again.

The descriptions of Fig. 15 (actually presented in the conclusions section) should be presented in the results or discussions sections.

Minor corrections:

Page 4245, line 7: considerably x 2, delete one.

Page 4251, line 11: 1 km x 1 km grid.

Page 4251, line 20: a relative measure could help.

Page 4252, line 19: "The SWE height trend. . ." ?? Do you mean SWE-elevation?

Page 4257, line 6: "...which can generally only be verified against runoff." This is not true, rewrite this sentence. There is definitely a lot of work going on with spatial data in hydrological modelling.

Page 4257, line 8: delete "therefore" in this sentence!

Page 4257, line 21: "true SWE" is misleading, since it refers to map203 (a model result). Change into, e.g. "likely".

Page 4257, line 24: VS (left), AR (right) is wrong – AR is plotted on the left side of Fig. 12.



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Page 4258, line 5: ... considered “as” the...

Interactive comment on The Cryosphere Discuss., 7, 4241, 2013.