The Cryosphere Discuss., 8, C1743–C1746, 2014
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The Cryosphere
Discussions
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Interactive comment on "Elevation dependency of mountain snow depth" *by* T. Grünewald et al.

Anonymous Referee #2

Received and published: 6 September 2014

General Comments

This manuscript is a unique contribution to our understanding of snow distribution across elevation gradients. The authors describe an extensive data set of fine-scale, photogrammetry and LiDAR derived, snowdepth with terrain measurements collected over large areas. The main findings show a positive elevation-snowdepth relationship that reverses trend at the highest elevations, with some finer scale variations of this pattern. These are compelling findings that support an emerging understanding of the relationship between elevation and snowdepth. The work is suitable for publication after addressing the following comments and revisions.

The introduction suggests orographic precipitation processes may account for the observed dependences between elevation and seasonal snow depth. However, the authors do not discuss this in light of their observations or reconcile their comparisons

of precipitation, a flux (L/t), with cumulative seasonal snow depth, a single component of SWE. I agree the comparison is a valid proxy, as suggested in the introduction, but this needs to be developed further, along with addressing orographic response, in the discussion.

While the role of local gravity and wind driven snow redistribution is a plausible explanation for decreasing snow depths at higher elevations there may be other reasons rooted in atmospheric physics that should be considered see (Roe and Baker 2005). The exhaustion of precipitable water in ascending air masses and the reduced lift from leveling or descending terrain may reflect upon these results as well.

Please provide an overview of the processing of photogrammetry and ALS and how differences in their uncertainties may affect your analysis.

How might "rocky areas" with high surface roughness impact the DEM creation and the bare earth minus snow surface calculation?

While intuitive the definition and classification method for "level of rocks" is not sufficiently outlined for a reader to recreate the results.

Please report the point return density for the ALS data sets?

Section 5.2 presents an elegant method for comparing disparate snow depths

Specific Comments:

3666; 20, should be "ascend mountain slopes"

3667; 9, confusing sentence

3667; 26-, Please distinguish wind saltation and re-suspension from orographic effect.

3668; I suspect sublimation would be more prevalent at high elevations where temperatures are lower and turbulent flux is higher.

3668; 16 should be "particularly at"

3669; 1, another published LiDAR dataset is Harpold et al. 2013

3669; 6, It's not clear why other studies have not been "systematic" but this one has. There are many earlier studies considering elevation and snow distribution over large areas, from climatic, seasonal and synoptic perspectives, as the authors have noted. The uniqueness of this study seems to be the fine-scale snowdepth measurements over large regional elevation gradients, which distinguishes it, and Grünewald and Lehning (2011), from the previously mentioned works. However, there are other examples of this also (e g. Deems, Fasnacht, Elder, 2006; Trujillo, Ramirez, Elder, 2007; Kirchner et al., 2014).

3671 Please state if these data sets are published and or publically available if so include citation and electronic source

3673;24 What is the classification method used? Please provide sufficient information or a citation that would allow a reader to recreate your results.

3678;20 figure does not match description, a and b seem to be mislabeled in caption

3681:23-25 I do not understand this sentence.

3690 figure is unnecessary the specific viewing angles could be stated in the text.

3691 Please provide a figure(s) that show the location of all the study sites, left should be replaced with "right" in caption

3694 figure b is missing gridlines.

3695 consider using different symbol and color schemes but the same elevation scale to aid the reader with interpretation of these figures.

References

Roe G. and Baker, M,; Microphysical and Geometrical Controls on the Pattern of Orographic Precipitation, Journal of Atmospheric Sciences, 63, 2006

Harpold, A.A., Q. Guo, N. Molotch, P. D. Brooks, R. Bales, J.C. Fernandez-Diaz, K.N. Musselman, and T.L. Swetnam, P. Kirchner, M. Meadows, J. Flanagan, R. Lucas, LiDAR-derived snowpack data sets from mixed conifer forests across the Western United States, Water Resources Research 50, 2014

P. B. Kirchner, R. C. Bales, N. P. Molotch, J. Flanagan, and Q. Guo, LiDAR measurement of seasonal snow accumulation along an elevation gradient in the southern Sierra Nevada, California, Hydrology and Earth System Science Discussions,11, 5327-5365, 2014

Interactive comment on The Cryosphere Discuss., 8, 3665, 2014.