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Interactive comment on "Snow cover reconstruction methodology based on historic in situ observations and recent remote sensing data" *by* A. Gafurov et al.

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This paper discusses a straightforwards approach to quantitatively predict historical daily maps of binary snow cover status at 500m resolution over a watershed in Central Asia by exploiting statistical relationships between current colocated MODIS binary snow cover maps , in-situ snow depth measurements and digital elevation models. The approach is assessed with four binary snow cover maps derived from application of the MODIS algorithm to relatively cloud free Landsat TM imagery. Agreement rates range from 84% to 86.4% leading the authors to conclude that considering teh ∼92% accuracy of MODIS maps over the region the historical approach is reasonable and

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should be applicable.

The paper has some novelty in that it provides a repeatable approach for spatially extrapolating snow cover using station data.

The paper is mathemathically rigorous but suffers somewhat by introducing new notations for simple probability theory.

The paper does make generalizations and over simplifications in the use of satellite imagery and needs to provide more details on both the in-situ data and results.

Much more care is required in presenting information related to the limits of this method. Especially accuracy and uncertainty during transition seasons and at edges of the snow field.

The conclusions are too broad - the study is for an ∼120 x 120km region with specific land cover and climate conditions. I am not sure if the paper is applicable to this journal if it's scope if limited but it is sufficiently novel that with some addition uncertainty information it should be of interest to readers.

My verdict: The paper should be revised and re-reviewed.

I have five major review comments that should be addressed and then some minor ones.

1. The title of the paper suggests a generic methodology without caveats on the areas it is designed to be suitable (and areas it has been tested over). I strongly suggest the study be cast in terms of an approach applicable to mountainous areas that are relatively above the tree line , e.g. alpine regions (as I think applies to this study area). This is especially true considering a. the MR statistic used really only identified higher elevation areas, compared to a station, as being snow covered and lower elevation areas as being 'snow free' - but in areas with different land cover conditions the presence/absence of snow may be related to factors other than elevation. 2. The study suggests that because there was a ∼85% agreement rate with 4 landsat images the

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method and modis only provides 92% agreement the method is good. This is misleading. Snow cover mapping outside of melt periods tends to have large areas that are easy to classify and then transition zones that are problematic. For example, figure 9 shows that it is in the transition areas that the step 5 approach was being used for mapping and that this provided most of the uncertainty. If we interpret this conservatively from Table 4 about 50% of the area is mapped using step 5 but this contributes most of the uncertainty. In a sense the accuracy of mapping 50% of the area using step 1-4 is very good (>95%) and for the rest much worse ($\sim$70%). This should be noted - basically the approach is good in about 50% of the areas where step 5 is not used but is not competitive to mapping approaches in the other areas. 3. There is historical snow cover data from AVHRR at >=1km available. AVHRR imagery can also be used to map snow cover. I understand you may not have it over your region at present but it exists and should be noted as an option. 4. It is not clear you validated during either melt or onset season when snow cover may be harder to map from MODIS itself and hence your accuracy will be lower. Please find and add a test for each of these seasons. 5. If snow cover is ephemeral I figure you will have a lower MR since the station and MODIS maps may be seeing different snow cover. Can you provide an image of the range of MR across the annual period (and more importantly when step 5 is being used to map a region for the worst/best case dates) since when MR<1 the method is far less accurate.

Minor comments

1. I would be more comfortable if much of the math was phrased in terms of conditional probabilities rather than new terms such as 'MR'. The 'MR' is just the conditional probability a modis pixel is snow covered (or snow free) if a station is snow covered (or snow free). 2. The confidence in the MR will change with the number of cloud free MODIS estimates at a pixel. This should be factored in and modelled using binomial sampling theory. 3. Since the MR estimate is essentially a binomial probability you can model the confidence interval of MR when it is not equal to 1. For example, say

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the true probability a modis pixel says 'snow' if a snow station says 'snow' is 0.8. Say then we sample 10 cloud free years over the pixel and find 6 of 10 years say 'snow'. Then the probability the modis grid cell is snow covered based on the station being snow covered can be directly modelled using a binomial distribution. 4. I am not opposed to using elevation zones and some sort of buffer to make monthly climatologies but I would rather the potential for a shift in snow covered area for a month be directly checked using modis time series. 5. I found the use of a neighbourhood filter to change snow cover status (test 4) too arbitrary to be useful and potentially dangerous - what about areas with lakes, open areas and forests, hollows where snow gathers etc. I suggest it may work in your region but would definitely mask these areas and use them only with some additional test to verify land cover and topography is relatively constant in the filter window. 6. Figure 3 should show the study area outline. 7. Figure 1 should show the study area in the lower panel as an outline only - we need to see the higher resolution dem. 8. I like FIgure 1 it convinces the reader that in your region there is some robustness to your approach but please refer to my point 2 since I feel that the transition zone that covers 50% of the area seems to have most of the errors. 9. The Landsat map is based on the MODIS algorithm as is the MODIS snow cover maps used to calibrate similarity indices - you should caution there could be some potential for bias in your validation due to this fact. 10. Brown 1999 did not use remote sensing imagery to map snow cover. 11. You need to provide more details on the snow depth measurement especially a. if it also records no-snow conditions b. what threshold depth is used for snow c. what do you do if there are trace measurements?

Interactive comment on The Cryosphere Discuss., 8, 4645, 2014.