# Replies to the comments of Anonymous Referee #1

**Authors' replies are in BLUE color.**

## Interactive comment on "Variability in snow cover phenology in China from 1952 to 2010" by C. Q. Ke et al.

**Anonymous Referee #1**

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CONTENTS

The paper presents the climatology of snow several snow variables (snow cover days, onset and end date of snow cover), their spatiotemporal evolution, extreme years and trends from 1952-2010 in China for a prey large number of stations. The relation to temperature variables and climate patterns (Arctic Oscillation, AO) is also discussed.

A good relation between temperature indices and snow pack is found (shortening of snow season), for some regions also with the AO. Trends are not as clear as on the northern hemispheric scale.

RECOMMENDATION

The paper gives a good overview of snow climatology of China with a lot of snow stations included. It also discusses the spatiotemporal evolution of several snow variables and analyses the relation with temperature and a major climate pattern. By discussing first the climatology of the mean, then the extremes and finally the trends gives the paper a good structure in my view. It is worth to be published but some major clarifications and "more consistency" in the presentation is needed before final acceptance.

**Replies:** We have read your comments carefully. Thanks for your detail comments, and we have made amendments to the article according to your recommendations. You can see detail replies below.

MAJOR COMMENTS

Abstract L18-19: "the AO has the maximum impact" not the "AO index". An index has no impact, it is the process behind the index.

**Replies:** We change the 'AO index' to 'AO'.

2.2 Methods: There is no validation of the gridding procedure applied to your SCD, SCOD and SCED data (Fig. 2, 4 and 7). Please provide some results on how good the procedure works (e.g. by doing some kind of cross-validation).

**Replies:** We add a new Table to illustrate this point, and also provide some description in the revised manuscript.

Table 1 Prediction errors of cross validation for the spatial interpolation with the universal cokriging (UCK) method

| PE | MS | RMSS | RMS | ASE |
|---|---|---|---|---|
| SCD | -0.0078 | 1.1729 | 10.3351 | 9.3710 |
| CV | 0.0027 | 0.8236 | 56.7797 | 70.9203 |
| SCD in 1957 | -0.0001 | 1.1430 | 11.6712 | 10.1066 |
| SCD in 2002 | 0.0170 | 1.2862 | 7.9122 | 5.7430 |
| SCD in 2008 | 0.0008 | 1.0627 | 7.3988 | 6.8352 |
| SCED in 1957 | 0.0050 | 1.0112 | 14.8384 | 14.7432 |
| SCED in 1997 | 0.0026 | 1.1420 | 19.5960 | 16.9098 |
| SCOD in 2006 | -0.0035 | 1.0396 | 16.2315 | 15.4075 |
| SCOD | 0.0037 | 1.1001 | 15.3312 | 13.8313 |
| SCED | -0.0038 | 1.1376 | 19.9136 | 17.1397 |

(Note: PE for Prediction Errors, MS for Mean Standardized, RMSS for Root-Mean-Square Standardized, RMS for Root-Mean-Square, ASE for Average Standard Error)

3.1.2: L13-15: Is there an explanation on why the winter on the Tibetan Plateau is so scare of snow? My first guess is, that it is too cold and dry in order to produce enough snow. Can this be shown in your data?

**Replies:** Yes, your guess is right. Mean temperature and precipitation in winter for Dangxiong station are -7.73 °C and 7.92 mm, respectively, and these for Qingshuihe station are -15.8 °C and 16.3 mm. Therefore it is too cold and dry in order to produce enough snow (Hu and Liang, 2014), and we also cite reference to support this.

3.1.2: L24: you speak of a nation-wide “snowstorm”. Do you mean one event or an annual anomaly here? Please be precise here. Normally the word “snowstorm” is used for one certain event of a few days length.

**Replies:** We change the ‘snowstorm’ to ‘SCD anomaly’.

Fig. 5 and elsewhere in text: you use the terms advanced and postponed. Wouldn't it be better to used "earlier" and "later" everywhere? Especially "advanced" is a strange word to be used here in my view.

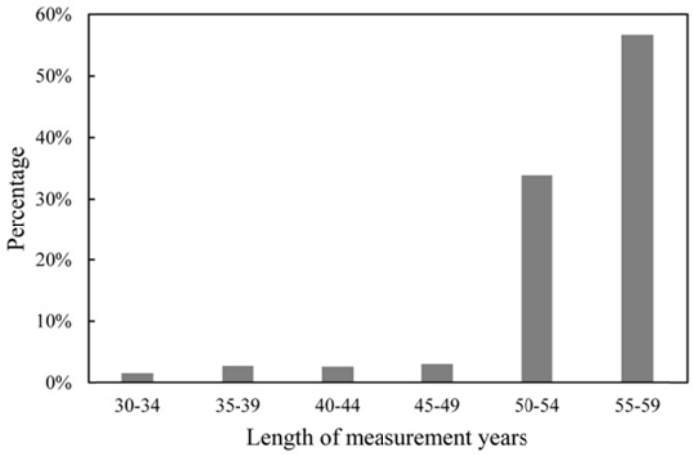
**Replies:** We change the 'advanced' and 'postponed' to 'earlier' and 'later' everywhere in text, respectively.

Section 4.2: In my view you could omit one of the analyses with MAT or TBZD. The two seem to have the same effect. I would shorten 4.2 to one sentence at the end of section 4.1. Very similar results are found for MAT.

**Replies:** We change the section 4.2 to one sentence 'Very similar results are found for MAT' at the end of section 4.1 as you suggested.

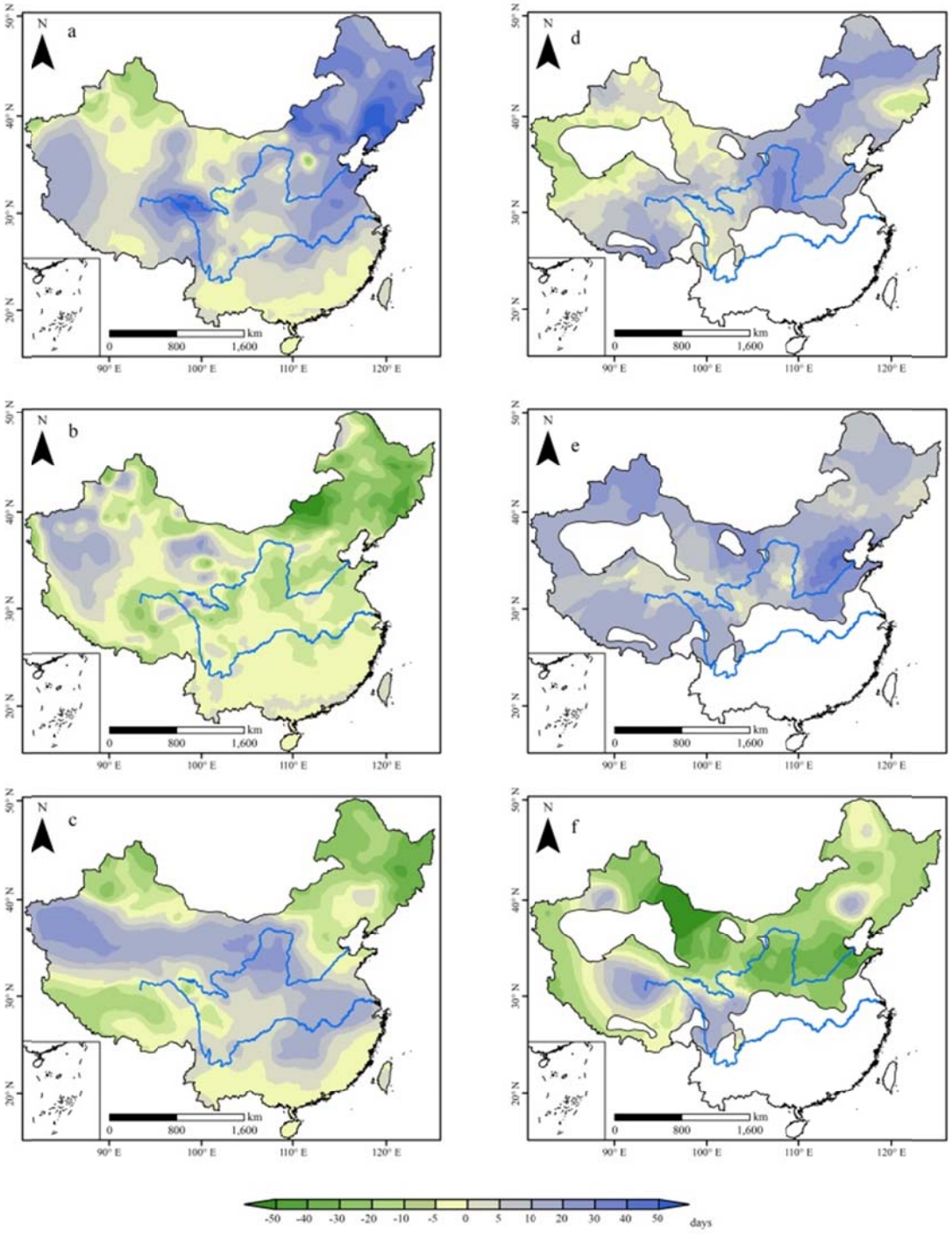
An additional table with the length of measurements for the different stations and probably a figure with the distribution of the lengths of the snow series would be very helpful in my view.

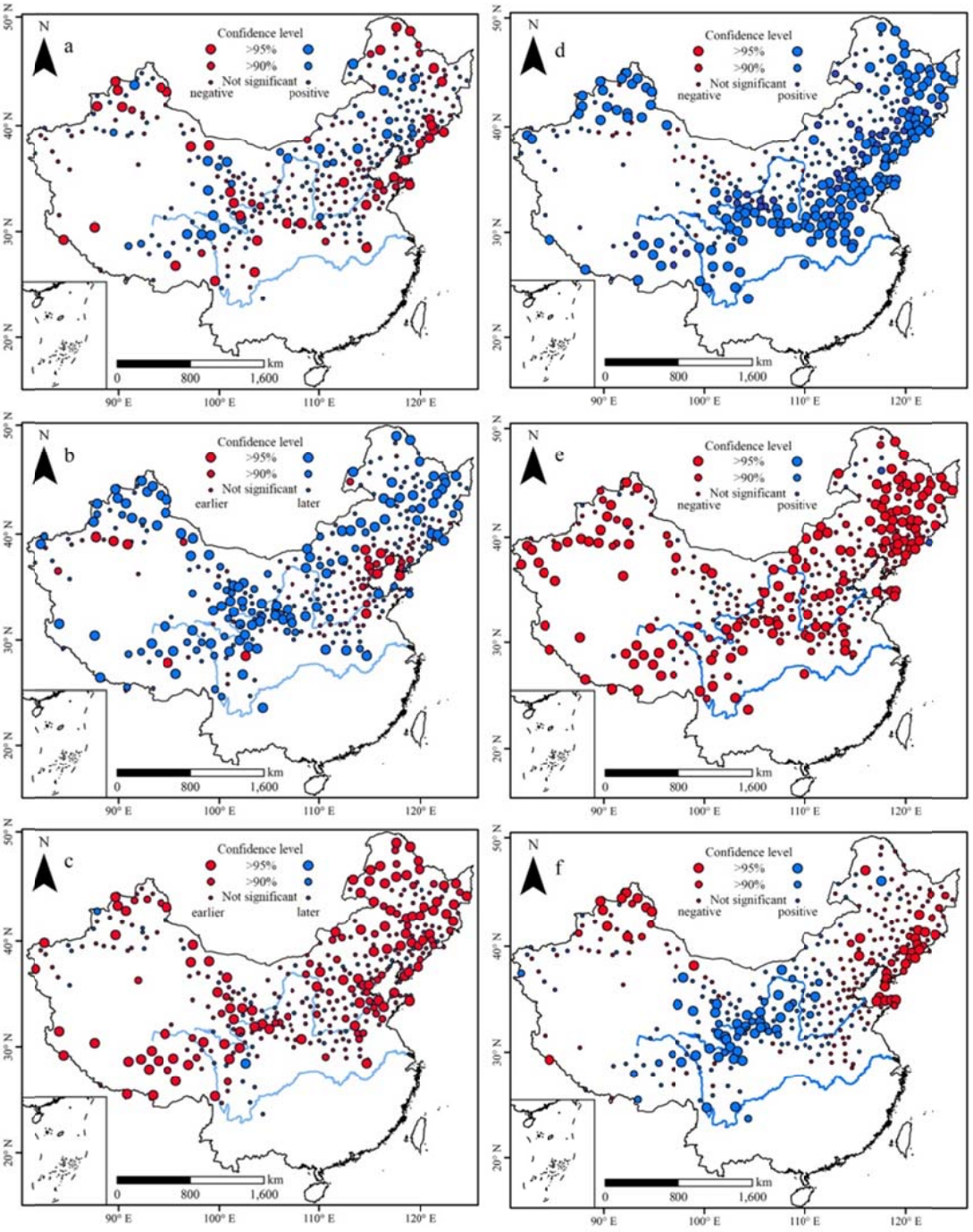
**Replies:** We add a figure to show this.




The colour tables you use in Fig. 4 and 5 are not optimal and not intuitive. Fig. 4: I suggest to use a scale that goes from green or brown to blue. Blue is often associated with lots of snow, brown and green with no snow. Fig. 5: Panel a: positive trends should be blue, negative ones red. Panel c: earlier should be red, later blue. Panel d: Use blue for positive correlation. Use earlier instead of advanced in Fig. 5 and text everywhere!

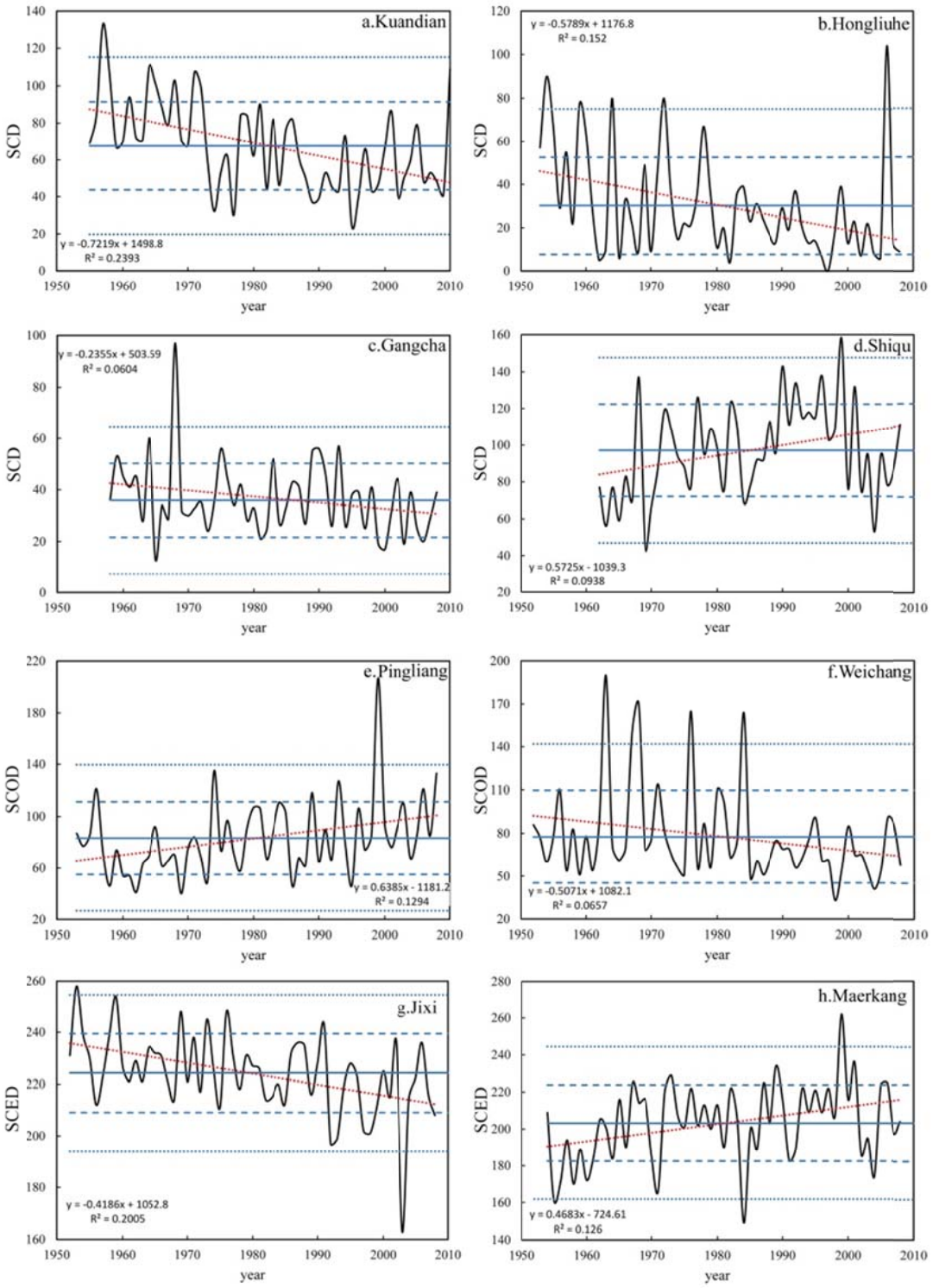
**Replies:** According to your suggestions, we change the colour tables in all figures, and use 'earlier' instead of 'advanced', 'later' instead of 'postponed' everywhere in text.

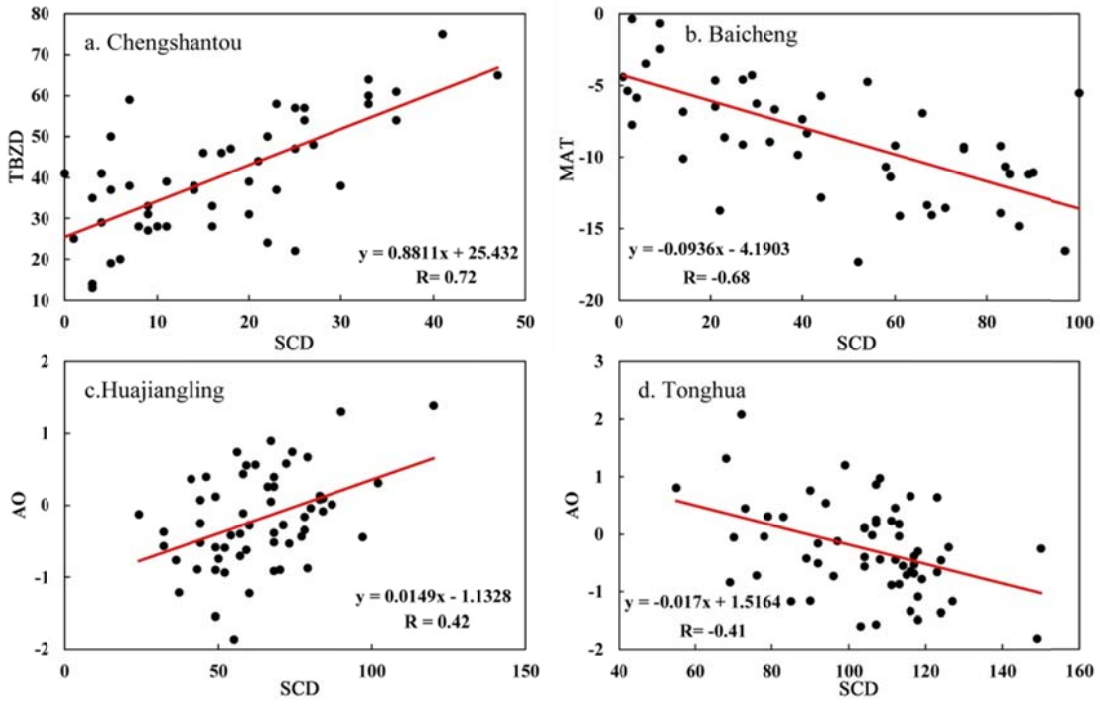

a
b
c
d
e
f
N
50° N
40° N
30° N
20° N
90° E
100° E
110° E
120° E
0
800
1,600
km
-50
-40
-30
-20
-10
-5
0
5
10
20
30
40
50
days




Use consistent panel labelling in all Figs., i.e. top left a, top left b etc: : :(as in Fig. 6) or left column down (a,b,c) as in Fig. 5. Do not mix them as in the current version.

**Replies:** We use consistent panel labeling in all figures in the revised manuscript.


a.Kuandian
y = -0.7219x + 1498.8
R² = 0.2393
SCD
year
b.Hongliuhe
y = -0.5789x + 1176.8
R² = 0.152
SCD
year
c.Gangcha
y = -0.2355x + 503.59
R² = 0.0604
SCD
year
d.Shiqu
y = 0.5725x - 1039.3
R² = 0.0938
SCD
year
e.Pingliang
y = 0.6385x - 1181.2
R² = 0.1294
SCOD
year
f.Weichang
y = -0.5071x + 1082.1
R² = 0.0657
SCOD
year
g.Jixi
y = -0.4186x + 1052.8
R² = 0.2005
SCED
year
h.Maerkang
y = 0.4683x - 724.61
R² = 0.126
SCED
year




The data in Fig. 6f looks very suspicious. Can you explain the strong changes in variability when comparing the 1962-1985 period with the one after 1985? (station relocation, other inhomogeneity?)

**Replies:** We check some reference, and explain as: the strong change of SCOD in Weichang is resulted from station relocation and urbanization.

MINOR COMMENTS

P 4473 L9: Decreases in snow pack have also been found for the European Alps in the last 20 years of the 20th century (e.g. Scherrer et al. (2004)). But: very long series of snow pack suggest large decadal variability and overall weak long term trends only (cf. Scherrer et al., 2013).

**Replies:** We add the sentences above and cite the two references in the revised manuscript.

P 4474 L23: Another study confirming the large influence of large scale atmospheric circulation: Scherrer and Appenzeller (2006).

**Replies:** We cite and add the reference.

P 4476 L14: change to “to identify possible breakpoints”

**Replies:** We change them as suggested.

P 4477 L19: change to “of climate series”

**Replies:** We change them as suggested.

P 4478 L 19: explain what you mean with annual periodicity and no annual periodicity

**Replies:** We explain as following:

with annual periodicity, every winter there is definitely snow.

without annual periodicity, not every winter there is snow, especially there is no snow in a warm winter.

We add the sentences mentioned above in the revised manuscript.

P 4480 L10-11: You could also add Scherrer et al. (2004) here.

**Replies:** We cite and add the reference.

Fig. 3: Can you give numbers for the seasons winter, Autumn and spring also. Please put a box around the legend or place it outside the figure.

**Replies:** We give numbers for each season beside the circle.

Fig. 6: Are the curves somehow smoothed? If so, I would prefer a direct connection between the years and no smoothing on the edges.

**Replies:** The curves are original, not smoothed.

REFERENCES

Scherrer SC, Appenzeller C. 2006. Swiss Alpine snow pack variability: major patterns and links to local climate and large-scale flow. Climate Research 32(3): 187–199. http://www.int-res.com/articles/cr_oa/c032p187.pdf

Scherrer SC, Wüthrich C, Croci-Maspoli M, Weingartner R, Appenzeller C (2013) Snow variability in the Swiss Alps 1864-2009. Int. J. Clim, 33(15), 3162–3173. doi: 10.1002/joc.3653.