

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2021-363

Holt Hancock (Referee)

Referee comment on "Synoptic control over winter snowfall variability observed in a remote site of Apennine Mountains (Italy), 1884–2015" by Vincenzo Capozzi et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-363-RC2>, 2022

General comments:

I appreciate the opportunity to review this very interesting and generally well-written work related to snowfall in Italy.

This study uses a unique snowfall record from the Montevergine Observatory in Italy's Apennine Mountains to investigate snowfall variability over the winter months (DJF) between 1884 and 2015. Via cluster analysis, the authors identify six synoptic atmospheric circulation patterns conducive to snowfall in the Apennine Mountains and link observed snowfall variability in their time series to changing frequencies in these synoptic types. Finally, the authors analyze the relationship between the synoptic types identified in this work and five teleconnection patterns important for winter weather in Europe. The findings from this study indicate synoptic-scale atmospheric variability largely controls snowfall variability at the Montevergine Observatory.

This work falls squarely within TC's scope. The unique snowfall time series presented here provides snow information from a lesser-studied region and is particularly noteworthy and interesting for its broad temporal coverage and daily resolution. By combining this record with analyses of synoptic-scale atmospheric circulation, this study contributes valuable climatic information and knowledge about the mountain cryosphere which will be of interest to a broad audience.

I found the manuscript enjoyable to read and generally well-written. Grammatical errors do occasionally hinder understanding or serve as a distraction to the authors' overall message (see examples under Technical corrections) – however, I believe the authors can quickly correct most of these errors. Similarly, figures are relevant and mostly readable, although I have made some suggestions for improvements in the specific comments below. The organization of the manuscript made sense to me, but I think a discussion of

the results should be more explicitly highlighted either via the addition of a Discussion section or via individual discussion subsections throughout Sections 3 and 4.

My main concerns with the manuscript relate to the analyses of the snowfall timeseries (Section 3.1) and the section analyzing synoptic type variability in time (Section 3.3). In these sections, the combination of the subjective sub-period time interval selection and the visual time series inspections impede result robustness. A more objective method for analyzing variability in the time series – I like the other review's moving window suggestion – would mostly resolve my concerns in these sections by eliminating the subjectivity in the sub-period selection. If the authors wish to continue using the sub-periods as presented in the current manuscript, the rationale behind the sub-period selection should be specifically addressed in Section 2 (Materials and methods). In this case, employing some statistical time series analyses in addition to the visual time series inspections would be necessary.

Specific comments:

Line 160 – On Figure 3, it appears several HNSd values exceeded the 35 cm threshold and would actually have been detected by the gap check? Am I misinterpreting what you have done here in terms of identifying outliers?

Lines 226-227 – a sentence or reference justifying the selection of your domain would be helpful here

Line 237 – here the HNSd threshold to determine NSD is 3 cm, but in Lines 331-332 related to Figure 5 you state that the right panel of Figure 5 includes days with over 1 cm of snow. Why do you display different data in Figure 5 than you use to determine the snow days for synoptic typing? Since Figure 5 is the only location where the total NSD is displayed as a time series (e.g. Figure 8 does not include a panel showing aggregate snow days from all synoptic types), I think it is important the NSD in Figure 5 match the 1986 days used in the cluster analyses.

Lines 336-340 – I appreciate the plain-language labelling of the synoptic types here, but these names are not used consistently throughout the remainder of the work. I'd recommend sticking with just one of the naming conventions, e.g. either ST1 or Arctic Maritime, or including the plain language name parenthetically as in Table 2.

Section 3.2 – This section would really benefit from discussion comparing the synoptic types you have identified with other synoptic work related to snowfall in Europe. I realize you only included snow days in your analyses, but I am also curious about the prevailing synoptic conditions which do not result in snowfall in the Apennines. Even just a couple sentences about this in a discussion would be helpful.

Lines 397-400 – Are these differences statistically significant?

Figure 5 – See the comments above related the number of snow days in the right panel. If you elect to continue with the sub-periods, please delineate the time periods in the graph to help the reader.

Figure 8 – If you elect to continue with the sub-periods, please delineate the time periods in the graph to help the reader. Please also consider including a panel showing the total NSD, if the data in Figure 5 are different.

Technical corrections

Line 39 – the mid-1970s

Line 43 – the Castilla y Leon region

Line 54 – few studies extended their analyses further back (?)

Line 61 – to provide

Line 89 – emphasized

Line 93 – to point

Line 155 – ascending order

Line 280 – where the air pressure is lower than

Line 428 – I would write XX as 20th here.

Line 479 – to inspect

Line 557 – left for future studies

Figure 2 – is there any way to increase the resolution of the photo? I can't really read it even zooming in and would really like to see what the records look like!

Figure 3 – it's pretty hard to find the panel labels in this figure.

Figures 6 and 7 – Beautiful. Is it possible to project these data so the higher latitude portions take up less of the map? I understand this can be a huge headache, however.