Revision of

"Historical snowfall measurements in the Central and Southern Apennine Mountains: climatology, variability and trend"

RC (X) = Referee comment (number X)
AC (X) = Authors' reply (number X)

REVIEWER #2

RC: Dear Authors, dear Editor,
Thank you for proposing this study. The topic is interesting and timely, the methods used are sound, and the focus on the Appenine area is a valuable complement to pre-existing work and snow data analyses.
Therefore I find the presented work very valuable and worth publishing - but naturally, I have some suggestions to try to improve it.
AC: Dear Referee, we are very grateful for the positive evaluation of our manuscript and for the comments and the suggestions, which help us to improve our paper. Here we provide a point-by-point response to his/her comments. All required changes will be included in the new manuscript version.

RC (1): I join referee one in his/her concern that the data should be made openly accessible (for instance via a doi associated to the present paper) to comply with Copernicus guidelines.
AC (1): Following this valuable suggestion, we have deposited the dataset that supports this study in the Zenodo open data repository (CERN). The dataset can be accessed through the following link: https://zenodo.org/records/12699507

RC (2): As also assessed by referee 1, "Number of days with Snow" / NDS is too vague (notably L55) and the description comes too late in the paper. As I understand from L 183 it could be formulated as Number of days with fresh snow accumulation on the ground.
AC (2): In the new manuscript version, "Number of days with snow" will be replaced by "Number of days with snowfall". In addition, following your valuable comment, we will introduce more clearly this parameter at Line 55.

RC (3): The Standard Normal Homogeneity Test procedure is barely understandable the way it is currently presented without reading further reference. I suggest to explain the general philosophy underlying the test.
AC (3): Thank you for the suggestion. We have introduced the following brief description. Note that the changes with respect to the original manuscript version are highlighted in yellow.

"Climatol has been employed in this study also to check for homogeneity of the investigated time series. The use of this toolbox for the homogenisation of snowfall data has been explored, with encouraging results, in some recent works (Buchmann et al., 2022; Buchmann et al., 2023). As described in detail by Guijarro (2018) and by Kuya et al. (2022), the Climatol homogenization method is based on the Standard Normal Homogeneity Test (SNHT; Alexandersson, 1986) for the identification of the breaks and on a linear regression approach for the adjustments (Easterling and

Peterson, 1995). The SNHT falls within homogenization procedures that are able to identify an inhomogeneity without knowing a priori the time of the break point in the time series and that can also estimate the magnitude of the detected break. The basic idea underlying this method consists in using neighbouring stations as a reference to identify inhomogeneities in the station being tested (the candidate station). Such assumption requires the existence of a sufficient correlation level between test and reference stations. More specifically, SNHT uses normalised series of the ratios/differences (hereafter, *Q*) between e.g. precipitation/temperature at candidate station and neighbouring reference stations. The test is based on the null hypothesis that the *Q* series has a constant mean level, i.e. that the candidate series is homogeneous, and the alternative hypothesis that the mean level of the *Q* series changes abruptly from one level to another at some time. For each point of the time series, a test value, based on a comparison between the means of the two subsamples before and after the potential breakpoint, is computed as described in detail in Alexandersson and Moberg (1997). The null hypothesis is rejected if the maximum test value of all dividing points in the *Q* series is greater than a predefined critical level. In Climatol, the SNHT is applied to the anomalies time series previously introduced in the description of the tolerance test."

References

Alexandersson, H., & Moberg, A. (1997). Homogenization of Swedish temperature data. Part I: Homogeneity test for linear trends. International Journal of Climatology: A Journal of the Royal Meteorological Society, 17(1), 25-34.

RC (4): More generally, the use of the terms "snow" is sometimes misleading throughout the paper, as illustrated in the expression "number of days with snow" . We don't know wether this is atmospheric snow (snowfall) or ground covering snow. Please be more specific.

AC (4): Ok, thank you for the suggestion. In the new manuscript version, we will specify it.

RC (5): Both the title and the abstract draw the focus on snow *precipitation* or *snowfall*. However, based on the variables analyzed (snow cover duration, number of days with snow, total height of new snow) the focus is at least equally on snow on the ground as on snowfall. This should be revised in order to convey a more precise message.

AC (5): Thank you for this valuable suggestion. To avoid ambiguity, we will revise the title of our manuscript, replacing "snowfall" with "snow". The term "snow" may be considered more general and inclusive of different types of data (e.g. snow cover, snow precipitation amount and snow frequency of occurrence) than "snowfall". As an example, Scherrer et al. (2013) have used a similar title ("Snow variability in the Swiss Alps, 1864-2009"), in a work that considered different snow indicators, such as new snow sums, maximum new snow and days with snowfall.

Therefore, in the new manuscript version we'll use the term "snow" to generally mention all the snow variables employed in our study and we will replace it with "snowfall" when referring a specific parameter, such as the "Number of days with snowfall".

References

Scherrer, S. C., Wüthrich, C., Croci-Maspoli, M., Weingartner, R., and Appenzeller, C.: Snow variability in the Swiss Alps 1864–2009, Int. J. Climatol., 33, 3162–3173, https://doi.org/10.1002/joc.3653, 2013.

Minor comments :

RC (6): L 43-44 : please aknowledge recent work that expands in time the MODIS time-series through the use of older satellite archives or reanalyses, and machine learning

Dumont, Z. B., Gascoin, S., & Inglada, J. (2024). Snow and cloud classification in historical SPOT images: An image emulation approach for training a deep learning model without reference data. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing.

Gascoin, S., Monteiro, D., & Morin, S. (2022). Reanalysis-based contextualization of real-time snow cover monitoring from space. Environmental Research Letters, 17(11), 114044.

AC (6): Ok, we will follow this suggestion. Thank you.

RC (7): L 172 : snow-to-liquid equivalent : the proper name of this quantity is snow water equivalent (SWE). See the International Classification of snow (Fierz et al., 2009) here: https://unesdoc.unesco.org/ark:/48223/pf0000186462

AC (7): Ok, thank you for the suggestion. In the new manuscript version, we will modify it.

RC (8): In one of the authors' previous work mentioned in the Introduction, a recent recovery of snow cover duration, HN and NDS is mentioned in the Southern Appenines (L 67 68). Unfortunately the present study ends by 2000 while the recovery at Montevergine Observatory appears after 2000. Would it be possible to bridge the gap between both studies and mention this in the discussion, enlightening the dependence of trends to timeframe/period length, and also the connection with AO/NA that was seen in this previous study but found not relevant in the present one?

AC (8): Ok, thank you for this suggestion. In the Discussion section, we will mention that previous studies on the Apennine region highlighted a recovery in snow cover duration, snowfall amounts and number of days with snowfall after 2000 and that this rebound in snow indicators is closely linked to the trend of Arctic Oscillation (AO). About the connections between AO and time series employed in this study, it is important pointing out that this aspect has been analysed only means of Cross Wavelet Transform. We feel that additional analyses are necessary to better assess the relationship between this relevant atmospheric mode and snow variability in the study area. It may speculate that non-negligible differences might exist between western and eastern sectors of Apennines (the first one might be more “sensitive” to the AO variability). In the Conclusions section, we will add a sentence about this future investigation.

Edits :

RC (9): L61 : clear -> clearly

AC (9): Ok, thank you.

RC (10): L 106 : ad -> an

AC (10): Ok, thank you.

RC (11): L 115 : southwest -> south east

AC (11): Ok, thank you.

RC (12): L 223 : quote -> quite
AC (12): Ok, thank you.

RC (13): L 263 : use -> uses
AC (13): Ok, thank you.

RC (14): L 355 : scree -> screen
AC (14): Ok, thank you.

RC (15): L 511 : second "in" -> and
AC (15): Ok, thank you.

RC (16): L 539 one word is missing (likely "to" before "contextualize").
AC (16): We are sorry for the error. We will add the missing word.

RC (17): L 559 : stations -> station
AC (17): Ok. Thank you.

RC (18): L 689 : means -> by means
AC (18): Ok, thank you.