Anonymous Referee #2

General Comment: Based on nearly 100 tree cores of Korean pines and climate data between 1956 and 2017, the study reconstructed 270-year precipitation for the northeastern region of China. The manuscript is not very well prepared. Some necessary technical details are missing (e.g., the specifics of the detrending functions, characteristics and the spatial resolution of the APVI), whereas parts of the manuscript are repetitive. Since the intent of the manuscript is to understand soil moisture conditions (drought and wet periods), I recommend that the authors should consider directly reconstructing a drought index based on precipitation data alone, e.g., SPI or SPEI (based on simply Tmax and latitude). A drought index may better serve the purpose of the study. The two indices can be easily derived as the authors already have all the necessary information.

Reply: We are very grateful for your constructive comments and suggestions. We have carefully revised the manuscript according to your suggestions. If we missed anything or if there are things we need to further clarify, please let us know. We will be happy to work with you and the editor to further improve the manuscript as needed.

According to your suggestion, we have added more details regarding the data and methods, including more details about the polar vortex intensity index in Lines 176-214, as well as the detrending method of the tree-ring chronology construction in Lines 145-148. In the Discussion section, we also presented the map to show the relationship between our reconstruction and the SPEI (Fig. 6A). As you suggested, there is a strong relationship with SPEI. However, the reconstruction of precipitation provides the advantage of examining a single climatic factor, which made it easier for us to explain the mechanisms of the interannual variation patterns. In the Lesser Khingan Mountains, snow accumulates in mid-fall and winter and melts after the 17th of April (Zhu et al., 2016). The snow accumulation can insulate the soil and contribute to keeping warm soil temperatures in winter. Additionally, rapid water absorption by the roots in the following spring and early growing season contributes to enhanced growth rates (Fritts 1976?). Therefore, while no monthly precipitation from previous October to current May is significantly correlated with the tree-ring chronology (probably because of relatively small and irregular amounts of precipitation in the individual winter and spring months), the total precipitation during these months has important effects on the tree-growth in our study area. Therefore, we decided to reconstructing the PPTp10-c6.

Specific comments:

1. From Fig. 2, I suspect that the monthly precipitation was only the amount of monthly rainfall. Please clarify whether the precipitation data include the amount of snowfall.

Reply: The precipitation data from the meteorological station include both snowfall (as water equivalent) and rainfall and we have clarified this in the manuscript (Line 164).

2. For spectral analysis, I would recommend that the authors should consider using multitaper spectral analysis against a red noise background. What does the blue line in Fig. 8A represent? 95% significance level? Also, without information about what different colors represent (power or statistical significance), Fig. 8B by itself is meaningless.

Reply: We did spectral analysis using multitaper against a red noise background using matlab software. We have changed the Fig. 8 and clarified the different lines representing the

confidence levels.

3. The statistics in Table 3 suggest that the regression functions in the 1956-1986 and 1987-2017 periods may have different slopes (temporally unstable). Fig. 5B suggests this may be true. The authors should test the homogeneity of regression slopes to see whether that is the case. I would also like to see a simple sentence states that the residuals of all three regressions met the regular assumptions, given that the residuals indeed met the assumptions.

Reply: Fig. 5B shows the observed and reconstructed p10-c6 precipitation (PPTp10-c6) for the full calibration period 1956-2017. Different slopes may exist for the regression lines, but the purpose of split validation is to mainly make sure that the relationship is statistically significant without large biases for the two independent time periods. Of course, the optimal results should be consistent regression models. What is important is that the model based on the entire calibration period was robust as this one was used for the reconstruction. The results of t-test indicated that the regression functions in the 1956-1986 and 1987-2017 periods have same slopes. The residuals of all three regression models met the regular assumptions of regression: the residuals are all tested as random variables; and the histograms below indicated that the residuals were likely to be normally distribution (Fig.1). We have added the statement regarding the residuals and assumptions of regression analysis in the revised manuscript (Lines 340-343).

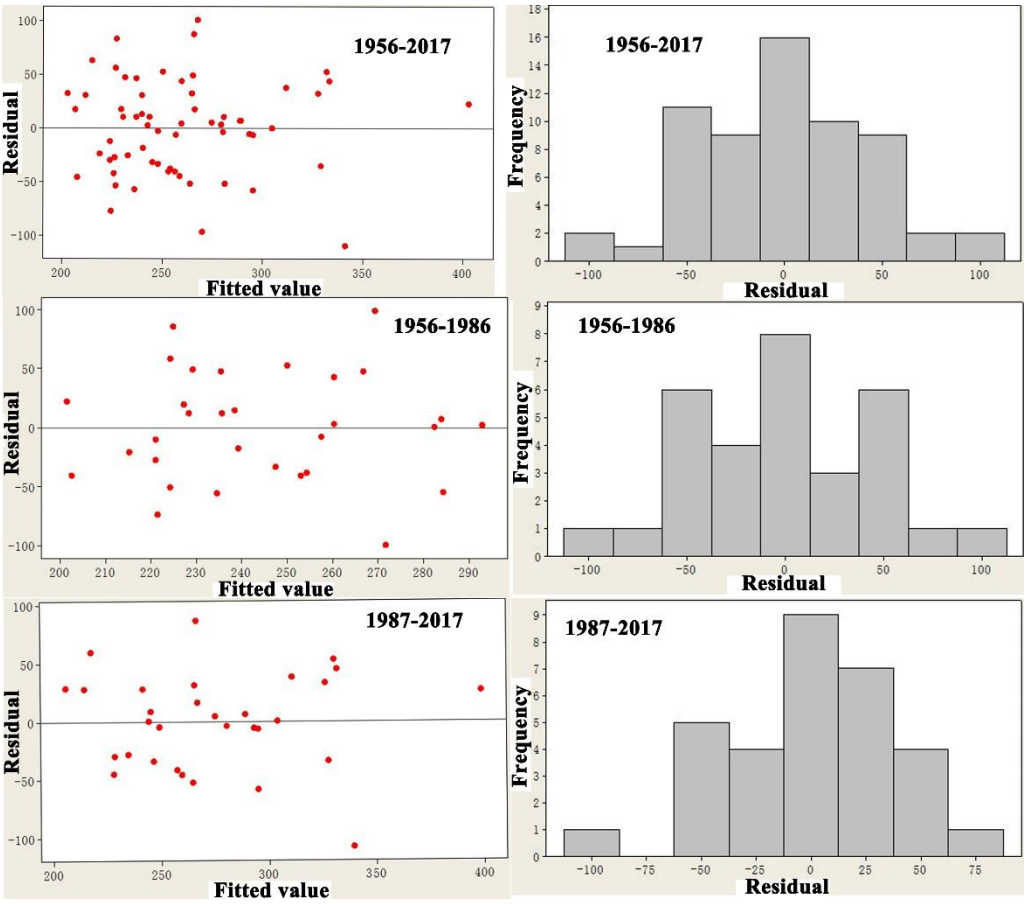

Fig.1 the scatter plots between residuals and fitted values, and histograms of residuals for different validation periods.

4. The authors should explain what the black solid and dotted lines represent in Fig. 5C. They

should also explain how they derived their 95% CI.

Reply: We have added the explanations about the black solid and dotted lines in the graph title. Since the calculation of CI of regression model estimates is a rather standard procedure in regression analysis, we would like to refer to a textbook of statistical methods as the reference in the figure caption (Ott, 1988, p. 356).

Ott, L. 1988. An Introduction to Statistical Methods and Data Analysis, 3rd ed. PWS-Kent Publishing Co. Boston, USA. 835 pp.

5. The correlations between the reconstructed precipitation and the reconstructed NAO index they used are quite low and statistically not significant. I fail to see the main point of their arguments. Also, please plot the running correlation (e.g., using a 40-year window perhaps) over the common period between the two, so we can see how the correlation evolved. Furthermore, please provide a plausible explanation as to how NAO and the study area's precipitation are correlated.

Reply: We originally included NAO as a possible factor of regional circulation of our study region because of its broad impact across the northern Eurasia continent. Our results showed that May-June NAO is positively correlated with May-June APVI, while the latter is negatively correlated to May-June precipitation. We added the explanation to the connection between APVI and precipitation in the revised manuscript (Lines 499-503). Because the mechanisms of how NAO influences weather conditions in northern Eurasia are complex and not fully understood (Schlichtholz 2019) and its correlation with precipitation is low, as you pointed out, we now have deleted the related content.

Schlichtholz, P. 2019. https://www.nature.com/articles/s41598-019-51019-w

6. The authors examined the relationships of observed (and reconstructed) precipitation and several large-scale atmospheric-oceanic circulations. After reading the manuscript, however, I still do not have a clear picture of what natural climate drivers are important to the study area's soil moisture conditions. Another index that the authors may want to look at is the East Asian Winter Monsoon index (use the one developed by Wu and Wang, 2014, An intensity index for the East Asian winter monsoon. J. Clim. 27, 2361–2374.).

Reply: Since NAO, PDO and ENSO did not show strong correlations, we have decided to delete the discussion about these large-scale atmospheric-oceanic circulations, and just focus on the correlation between the APVI and precipitation in our study area. According to your suggestion, we calculated the correlation between precipitation and the EAWMI, but the correlation coefficient is low and not statistically significant, $r = -0.121$ ($p=0.174$). Apparently, the East Asian Winter Monsoon is more of a factor of winter and spring temperature, and does not have a significance effect on precipitation in our study area.

Technical comment: Please read through the manuscript again. Remove repetitive information and re-structure the manuscript.

Reply: We made editorial changes throughout the manuscript to improve language usage and removed repetitive information.