We are very grateful for this thorough and constructive review.

In general, Reviewer 1 requested

- More background and citation of the detection and attribution literature.
- Clearer separation of methods from results.
- Expanded explanations of the approach: selection of proxy observations for the D&A exercise
- A clearer conclusion, not “only assumptions”.

Our answers to the reviewer comments are highlighted in bold below.

General comments (Reviewer 1)

The paper addresses the relevant scientific questions related to the evaluation of model simulations and observed data, and within the scope of CP. Only one citation Hegerl and Zwiers, 2011 is not enough and even was discussed earlier in IPCC 2001 Detection of Climate Change and Attribution of Causes — IPCC. Reports TAR, Climate Change 2001, 2013 AR5 Climate Change: The Physical Science Basis Detection and Attribution of Climate Change: from Global to Regional.

We will add further introduction to the development and evolution of D&A research, including a set of key references at the end of the first paragraph of the introduction. We also will note that detection and attribution of climate change has been discussed and summarized in every IPCC WG1 assessment report to date. An exhaustive review of such work is beyond the space available in the present manuscript, but is published elsewhere as cited (Hegerl and Zwiers, 2011).

Some parts of the methodological approaches are mixed up with results. The authors often avoid clarifications and explanations, which can be helpful. There is no clear conclusion, only assumptions. It is not clear how TRW chronologies were pre-selected, which method of standardization was applied. Moreover, all chronologies have different age trends, periods, site-specific, and species-specific differences. All uncertainties can be related to the methodological approaches and pre-selection procedure.

We will provide further clarifications and explanations in the revised manuscript, including: TRW chronology selection and most importantly, validation of the TRW simulations we perform. We also

refer the reader to Breitenmoser et al (2013), which addresses these questions directly, and on whose data compilation our study was based and builds upon.

Specific comments

L. 29 Starting from the first sentence - brings confusion between different forcing and factors. The main research question/hypothesis in the article can be better formulated. It is not clear if the main focus is irradiative forcing before /after volcanic eruptions or in general forcing or any other forcing factors or mechanisms that will be taken into consideration. It should be clearly formulated.

We regret not more clearly stating the goal of the study in the abstract. We will revise the relevant sentences in the abstract to:

"Here we perform a D&A study, modeling paleoclimate data observations as a function of paleoclimatic data simulations. Specifically, we model tree ring width (TRW) observations as a linear function of on TRW simulations which are themselves forward modeled from realistic singly-forced and cumulatively forced climate simulations for the period 1401-2000."

This reflects the statistical model for the detection and attribution study (equation 1) as well as the specific properties of the problem, which are defined in Figure 1 and Section 2.

L. 80 unclear which time period (past 600 years from xx to xx?). Which grid net was used (lat, alt)? TRW observations – common period? Which chronologies, citations, how many chronologies n=? Pre-selection high latitudes, mid-latitudes? Please provide citations and refer to Fig 1.

We will clarify the period "1401 to 2000 C.E.", number of chronologies, the focus on extratropical northern hemisphere because of the availability of the particular target observational data set, and added citations to sources for all of these elements. Additionally, Fig. 1 will be revised to provide additional information about the spatial grid we used to compare observations to simulations. All of these elements are determined by the results of Breitenmoser et al (2014), whose attributes we now provide in summary for the reader in Section 2.1.

L.89 no citation ." to prior studies", which one? Please cite. …" of reconstructed surface temperature"? Summer temperature? Annual temperature? Please specify.

We will revise the text to refer here to the studies of Schurer et al (2013, 2014) and refer to the use of northern Hemisphere annual mean surface temperature reconstructions in that work. One advantage

of the approach we take to the D&A problem is that we do not explicitly require, nor assume, the particular season or climate variable which is most likely reflected in the TRW observations (section 1: "It has the potential advantages of circumventing assumptions required in the reconstruction process...") Additionally, we will clarify in section 2.1 that by the nature of the observational data type, the temporal resolution is one observation per growing season: ("For every point in time, which is explicitly resolved as one value per growing season each year,…").

L.101 – historical temperature. Is it reconstructed temperature? If yes, please provide the period. If not, please clarify.

We will clarify that we use gridded instrumental temperature and precipitation product CRU TS3.23, 1901-1970 period, for the development of VSL parameter estimates.

Subsection 2.1 It will be good to provide more details about the TRW database used for analysis, e.g., time period, regions, species.

We will add details about the used tree-ring width data set, including number of species, data from all continents and information about the detrending and standardization. For further information we also refer the reader to Breitenmoser et al (2014), and note that many of the reviewer's concerns were shared by those authors, who attempted to develop a homogeneous data set free of biases arising from the factors noted by the reviewer.

Subsection 2.2 Please explain what T and M mean. "Parameters T1, T2, M1 and M2.

We will revise the text to better introduce the tuned parameters, as follows:

"Parameters T1, T2, M1 and M2 describe the onset of growth (1) and point above which climate is no longer a limiting factor (2) for temperature (T) and moisture (M), respectively (Tolwinski-Ward et al., 2011a, 2013)."

The development and validation of this model is described in Tolwinski et al (2011a, 2013) with reference therein to the more complex Vaganov-Shashkin model (Vaganov et al 2006, 2011) from which VSL is derived.

L. 160 please clarify why a 71-year high-pass LOESS filter was applied.

Besides the previous explanation that centennial scale variability is not preserved in many records in the tree-ring data set, citing Franke et al 2013 in support, we will also note that the period of study is

relatively short for analysis of centennial timescale variations to be statistically significant. This need for additional process replicates is stated in the Introduction as a motivation for paleoclimatic D&A studies, and its value is illustrated in the results (e.g. Table 2 and Fig 4). Should future studies be able to access a longer time interval of both realistically forced climate simulations and paleoclimatic observations, this restriction might be usefully relaxed, and we now note this in the Conclusion.

L. 194 this description should be provided earlier in Figure 1 legend

This description is already inside Figure 1.

L. 210-220 info about TRW chronologies, length, sites should appear earlier in section 2, subsection 2.1

We will describe the TRW observation network in more detail in section 2.1.

L. 262 it is unclear based on which criteria the 12 largest volcanic events were pre-selected (VEI?) and which one (names). Please clarify.

We will clarify that we use the 12 largest (above 95th quantile) volcanic event between 1401 and 1970, following Crowley and Unterman (2013). There event size is measured in stratospheric Atmospheric Optical Depth (AOD). This forcing is the same which is used to force the HadCM3 model simulations used in this study (Schurer et al 2013). Additionally, we use the more recent inferred Global Volcanic aerosol Forcing (GVF, in W/m2) by Sigl et al (2015). We included a table with the years of the 12 strongest eruptions in both forcing data sets. We did not add the names of the volcanos because some are still unknown.

Figure 5. It is unclear why annual temperature and annual precip. are considered? In legend VOLC – volcanic forcing, in Table 1 – V. Please select one abbreviation through the whole manuscript.

The detection and attribution analysis in Figure 5 is between annually resolved TRW simulations and observations (see also equation 1 and section 2.4), not between annually averaged temperature and precipitation. Because the TRW modeling indicates that the observations may be distinguished as either temperature or moisture limited, however (section 3.1; Figs 2-4), and also because the radiative forcings are applied only at annual resolution in the underlying climate simulations (Schurer et al 2013), we perform the D&A exercise for these subsets of TRW observations and simulations at annual resolution, respectively. A map figure showing the distribution of these subgroups by TRW observational location will be added to the manuscript.

Technical corrections

All points without a reply below will be corrected exactly as suggested.

L.16 Abstract: tree ring width replace with tree-ring widthL.42 – references are not in the correct order. Please correct.

L.43 instrumental period of observations, please specify the period. For many stations outside Europe the instrumental period of observations for precipitation is rather short (ca. 50 years).

The previous sentence explains the broad range of climatic variables, which have been used in D&A studies. The density and time period covered by each of these variables differs. Explaining all details is not our concern here in the paleoclimatic context. We want to focus on the additional gains of using a period much longer than any instrumental record. Therefore, we decided to leave this sentence more general.

Figure 1. Abbreviations should be clarified in the Figure legend. E.g., optimize S/N ratio. Please clarify numbers (B14)? Please check abbreviations and provided an explanation in scheme precipitation or precip.,) in the text L. 101 (PREC). Please be consistent.

L. 105 – Eq. 1 is not in Section 2.4. Firstly, it was mentioned p.2. It should be Eq. 2. Please correct the numbers.

L. 110 consider revision .. “is constructed is illustrated”

Polson et al, (2013), replace with Polson et al. (2013),

L. 176, 178 – please check (is/are)

L. 203 GT, GM – please clarify what is what.

Fig 3, x-axis please write Year (CE)

Fig. 3 in plot – edf and citation edf – please clarify

edf stands for “effective degrees of freedom” and is already described in the figure caption, with citation of Hu et al (2017) for further details.

L. 232 replace to "..a 11-year.."

L. 341 AOD – please clarify.

L. 342 please add a citation.

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