Reviewer #1:

Original comments are given in normal fonts, the reply is set in bold. New revised text in red.

The manuscript is rather long, perhaps too long for one paper, as analysis for the Holocene and for the last millennium (including temperature response to changes in total solar irradiance) could be split into two papers.

We agree that the manuscript is long, but believe that it is valuable to document the entire change from radiocarbon production, solar modulation, TSI, to simulated global mean air temperature in a single manuscript.

There is just one major issue that I see with the paper: The model description is incomplete. The handling of 14C in the LPX model is not documented since the Scholze et al. publication that the authors cite only deals with 13C.
I have seen the original implementation of carbon isotopes in LPJ, and here 14C is dealt with in a very similar way to 13C, with two exceptions: Obviously, radioactive decay of 14C is implemented, but for photosynthesis the model does not discriminate against 14C, instead setting the Δ14C of assimilated carbon (GPP) to the Δ14C of atmospheric CO2. Since discrimination against 14C should be double the discrimination against 13C, this would obviously introduce a small bias in the atmospheric Δ14C. Not having seen the LPX code, I do not know whether the implementation in LPX is identical to the original implementation of C isotopes in LPJ, or whether this was corrected. Either way, it needs to be documented in the paper.
I assume the bias in atmospheric Δ14C introduced by the non-discrimination against 14C during photosynthesis (if this actually is the case in LPX) would be so small that it is already covered by the uncertainty range the authors specify for the land C pools.
^{14}C was implemented in LPJ in Bern and may differ from the version that is available to the reviewer. In our version, ^{14}C is subject to discrimination during assimilation. The following text is added in the model description paragraph in the manuscript:

"^{14}C is implemented following the implementation of ^{13}C Scholze et al. (2003) and taking into account radioactive decay using a mean life time of 8267 years. Fractionation is twice as large for ^{14}C than for ^{13}C. Fractionation during assimilation depends on the photosynthesis pathways (C3 versus C4) and on stomatal conductance. No fractionation is associated with the transfer of carbon between the different pools in vegetation and soils."

Another issue arises from Fig. A3. Here it appears as if the total error is larger than the ΔTSI signal for some of the time. This begs the question whether the ΔTSI reconstruction is meaningful at all. This would need to be discussed in the text.

It is true that the total uncertainty range of TSI exceeds ΔTSI in certain periods. However, it should be noted that the total uncertainty range include systematic and random errors. The TSI time series still contains valuable information as

only a minor part of the error is random (i.e. uncorrelated). The random error arises from the uncertainties in the tree ring radiocarbon data. We added the following text on page 1201, line 20:

" More than half of the uncertainty in TSI is of systematic nature and related to the Φ-TSI relationship (Figure A3, panel c). More specifically, the slope of the linear relationship between the interplanetary magnetic field and TSI (Equation 4) is with 0.38± 0.17 units highly uncertain. A lower slope would correspond to correspondingly lower amplitude variations in TSI and a larger slope to larger amplitudes in TSI, while the temporal structure of the reconstruction would remain unchanged. To distinguish between random and systematic errors, we provide the uncertainty related to the random uncertainty in the radiocarbon data and the total uncertainty arising from both systematic and random errors in panel d) of Figure A3

Page 1167, lines 16-20: This* is the most important sentence in the introduction since it shows what is new in your study. One needs to read it a number of times in order to understand it - I'd suggest adding a "However" at the beginning and then to split up the sentence into at least two.

** "A quantitative assessment how the climate-carbon cycle changes over the last glacial termination, Holocene and last millennium climate variations, ocean sediment and dynamic vegetation and soil changes affect atmospheric ^{14}C and inferred Holocene ^{14}C production and solar activity is yet missing."*

We changed the sentence which now reads:

" However, a quantification how past changes in climate and the carbon cycle affect reconstructions of radiocarbon production and solar activity is yet missing. Aspects neglected in earlier studies include (i) changes in the climate-carbon cycle system over the last glacial termination (∼18 to 11 ka BP) (ii) variations in Holocene and last millennium climate (iii) changes in ocean sediments, and (iv) changes in vegetation dynamics and in anthropogenic land use."

Page 1168, line 24: Most readers will be familiar with the half-life of radioactive isotopes, but the average life time is not so well known - a sentence explaining how the two relate to each other would be a help to the uninitiated reader.

We changed the corresponding sentence which now reads:

" It enters the ocean-sediment and the land biosphere and is removed from the climate system by radioactive decay with an average lifetime of 8267 year or a corresponds half-life of 5730 yr (8267 yr × log(2)) and to a minor part by seafloor sediment burial. "

Page 1171, line 8: The motivation for applying sinusoidal perturbations only becomes clear in section 3. A sentence here would make things easier for the reader.

We changed the corresponding sentence which now reads:

"In the results Sect. 3, we apply sinusoidal variations in atmospheric ^{14}C with frequencies between 1/(5 yr) to 1/(1000 yr). The results characterize the model response to a given radiocarbon time series as any time series can be described by its power spectrum using Fourier transformation."

Minor corrections/typos

Minor details were corrected as suggested by the referee

References:

Scholze, M., Kaplan, J. O., Knorr, W., and Heimann, M.: Climate and interannual variability of the atmosphere-biosphere 13CO2 flux, Geophys. Res. Lett., 30, 1097, doi:10.1029/2002GL015631, 2003.