Clim. Past Discuss.,
https://doi.org/10.5194/cp-2017-158-RC2, 2018

Climate of the Past Discussions

Interactive comment on "High latitude Southern Hemisphere fire history during the Mid-Late Holocene (750–6000 yr BP)" *by* Dario Battistel et al.

Anonymous Referee #2

Received and published: 9 February 2018

This manuscript describes the first long-term record of levoglucosan from Antarctica. Levoglucosan, a specific biomarker of biomass burning, was measured from 750-6000 yr BP. The levoglucosan record was compared to Kbb of the same ice core. The authors conclude that the Kbb record supports the Levoglucosan record and for the interpretation rely on the Levoglucosan record. The authors compare the levoglucosan record to charcoal records and demonstrate the greatest correlation to Patagonia charcoal. The authors propose that in general, the levoglucosan record demonstrate a linkage between climatic changes in Patagonia and biomass burning. Lastly the authors focus on a peak in Levoglucosan centered at ∼2,000 yr BP.

In general, I found this manuscript interesting to read and the manuscript is well written. I appreciate that this the first long-term ice core record of levoglucosan from Antarctica.

I recommend the authors do not focus the manuscript on the individual spikes observed in their records as these spikes have not be replicated in other Antarctic ice cores and therefore the spikes may be driven by degradation/transport rather than changes at the source. I think the manuscript would benefit from removing repetitive sections in Section 3 while adding additional discussion in other parts of the manuscript. In addition, this manuscript would benefit from a clearer explanation of the climatic mechanisms driving the observed correlations.

Specific comments: Introduction: It is worth noting on page three that while few Levoglucosan records exist in Antarctica, several studies on the monitoring of biomass burning byproducts (Hu et al., 2013 Scientific Reports; Pereira et al., 2006; Weller et al., 2013; Wolff and Cachier, 1998; Fiebig et al., 2009; Hara et al., 2010) have been conducted in Antarctica. In addition, other biomass burning proxy records have been published from Antarctic ice cores (ex. Pasteris et al., 2014; Bisiaux et al., 2012; Arienzo et al., 2017) and are also worth mentioning here.

Section 2.1: How was LoQ determined?

Section 2.2: What are the errors on the ages at this depth in the ice core? Since Kbb is introduced in this section, I would suggest moving equation 1 and the explanation here.

Figure 2: I found figure 2 very confusing in particular since the X-axis and Y-axis vary per plot. I would recommend plotting the fluxes on the same X axis and possibly changing the color of the lines to indicate the different data being plotted. I would also include accumulation rate in this plot to demonstrate that the levoglucosan and Kbb flux records are not dominated by variations in accumulation. Lastly, in both A and B a LOWES smoothing is shown with two varying SPAN parameters. I don't understand why the red curve in panel A is lower frequency and the red curve in panel B is higher frequency (when compared to the black cure in each panel). I also noticed that in figure 3, a different SPAN is used and then in figure 4 a 250 year average window is shown.

I would recommend choosing one smoothing parameter and showing the results using that smoothing in all figures. This allows the reader to easily compare between the various plots.

Section 3.1: In this section, the authors demonstrate at the end of page 5 to the second paragraph on Page 6 that there are significant uncertainties associated with interpreting the spikes observed in the Levoglucosan record. This provides the justification for removing the large spikes when discussing the overall trend of the Levoglucosan record. However, later in this section and in other parts of the manuscript the authors discuss the spikes as potential evidence of specific fires. I would caution the authors about interpreting the spikes observed in the record as changes in the source area, considering that there are very few that agree between the levoglucosan and Kbb records and that transport is potentially a large driver of the spikes.

Section 3.3: I suggest renaming this section "Biomass Burning Sources" I appreciate that the authors discuss the potential for other biomass burning sources in this section (lines 19-29, p. 9). However, I would encourage the authors to preface this with a discussion of the comparison between the Patagonia and the TALOS record as several differences and similarities exist. For example at 4.5 kyr the TALOS Levoglucosan begins to increase, while the Patagonia record is decreasing at this time. This could then be followed by a discussion of other possible biomass burning sources. Lines 26 to 29 p. 9 would be more appropriate in section 3.4. Section 3.3 addresses the potential sources of biomass burning, not the impact of climate on the charcoal records. Lines 19-26 are relevant as they explain the heterogeneity of fire in Australia so maybe something like "Similar heterogeneities are not observed in Patagonia (Ref)" would be more appropriate instead.

Section 3.4: I would rename this section "Drivers of biomass burning" This section overlaps with section 3.6. I would consider merging the two sections to make one section that very clearly states what the proposed drivers of biomass burning and the mechanisms driving these changes are. Also reorganizing would allow the authors to

discuss figure 4 in its entirety in one section.

Section 3.5: Given the uncertainties in the sources of levoglucosan and transport variations I would be cautious about attributing the spikes in the Levoglucosan record to specific fire events within charcoal records.

Section 3.6: As stated above, the overall discussion of climate/fire linkages would be much stronger if this section was merged with section 3.4. For example, P.11 line 14 the authors state that "variable and generally wet conditions prevailed in South America after 4000 yr BP" which would very nicely flow with the discussion in section 3.4. While this section includes a very nice statistical comparison to various climatic indicators, the mechanistic linkages between the climate and biomass burning (and hence Levoglucosan) are unclear. For example, what climatic mechanism would link 30 degree solar radiation in December to Patagonia biomass burning/Levoglucosan? Additional discussion with references would strengthen this section of the article. In the discussion about ENSO, is there evidence in the modern for an impact of ENSO on burning in Patagonia? It might be worth noting, other proxy biomass burning records from Antarctica (ex Bisiaux et al., 2012, ACP) demonstrate a modern relationship to ENSO. In the discussion of the drivers of the peak Levoglucosan (P. 12 lines 1-7), I appreciate the discussion here.

Conclusions: The statement "Potassium was analyzed in order to provide a more complete biomass burning record through the comparison with another fire proxy" should be reworded. I would suggest instead "The comparison between levoglucosan and the multi-sourced Kbb suggests that Kbb is best used in conjunction with other biomass burning markers."

Technical/minor comments: Page 5, line 16: This would be appropriate in the background.

While changes in the westerly wind belt would have changed climate in Patagonia, is it possible that changes in the regional scale winds would also have impacted transport

of Levoglucosan to Antarctica?

Why is the levoglucosan record compared to Southern Hemisphere charcoal (page 10 line 27-28) when in section 3.3 the source was determined to be most likely Patagonia?

P. 11 lines 10-12: this sentence is unclear.

P.11 line 16: “This 1000-year peak in levoglucosan. . .” I would encourage the authors to define the age range of the peak referenced here.

A reference is needed to support the statement “the cooling period coincides with a shift to drier conditions in South America (page 12 line 6-7)”.

Figure 2: The Y axis for plot 2B does not have a complete label. The caption in missing a parentheses.

Figure 4: This plot would be clearer if the y-axes were labeled rather than having the labels floating within the plot. Does the 250 yr average window include the spikes? This is unclear since the spikes are plotted.

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2017-158, 2017.