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Climate of the Past Discussions

Interactive comment on "A 2700-year annual timescale and accumulation history for an ice core from Roosevelt Island, West Antarctica" *by* Mai Winstrup et al.

Anonymous Referee #1

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Review of Winstrup et al. 2017: A 2700-year annual timescale and accumulation history for an ice core from Roosevelt Island, West Antarctica

Overview: WINSTRUP et al. present a 2700 year annually resolved timescale for the Roosevelt Island Climate Evolution (RICE) ice core constructed by identifying annual layer in multiple impurity records and synchronized to WAIS Divide ice core using methane and volcanic signal. The work is motivated by the effort to provide the best accurate timescale for the upper 344 m about 2700 yr. This paper is used for the datation of the accompanied paper submitted to Climate of the past discussion by Bertler et al., CP2017-95.

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An accurate timescale is prerequisite for any paleoclimatic reconstruction. The important effort to reconstruct the timescale of RICE ice core must be supported. While the main result is of interest this manuscript suffers from a number of flaws. The manuscript is poorly written, too long with several repetition redundant, several contradictions between the same paragraph or other paragraphs, the data and the result are inaccurate present (see example tephra layers). The methods chapter are not well structured with several information reported two three times and not in the appropriate chapter as result and discussion. Most of the information about the methods is reported in the supplementary material, where are more clearly presented. The manuscript must be completely revised and shortening significantly. Some references are uncorrected or mismatched. Five accompanied papers of RICE core are submitted or in preparation, but their result are used to validate or as source of the result of the manuscript (ex. Lee et al., in preparation). To make this manuscript a significant contribution to the literature, the authors need to better justify their time scale and snow accumulation records.

In particular:

Clarify the use of the WAIS volcanic signal and methane with RICE17 chronology, in the text look like that is use as synchronisation (see 3.3.1.3), but several point is stressed that the accuracy is low and it is use only at posteriori as validation. All the process of comparison between RICE and WAIS must be clarify, it is repeated several time in different way. If the two records are synchronised by volcanic the age error must be the same closer the tie points, between one tie point to other can increase. The process must be revised.

The tephra layers where used to fix the chronology, but it is not reported the analysis of tephra particles (Raboul 1964 CE and Pleaide 1252 CE) and the analysis on WAIS ice record (up to now never published on my knowledge), that can be permit an unequivocal attribution.

The explanation because nssSO4 signal or acidity peak of major eruption reconnaissance in WAIS (Tambora, Unknow etc.) are not recorded in the RICE records is questionable, but Authors have attributed as unknown more than hundreds chemistry signal to volcanic eruption (123 event Table 2) and those are not observed in WAIS or others ice core in Ross Sea (Siple Dome, Taylor Dome, Talos Dome). Why RICE records is able to record 193 volcanic event, with all the problems pointed out in paragraph 3.3?

Black Carbon, on the base of figure 4 does not appear the best proxies of seasonal signal, H+ appear more conservative and less misleading of BC.

Authors report strong gradient in snow accumulation spatially ranged from 0.09 to 0.30 m we/yr and migration of the dome from 500 to 900 m. Can the Authors exclude any impact on the snow accumulation history due to migration of the dome ? and/or on thinning function?

Paragraph 5.3 “Current mass balance. . .. “does not report any new valuable information for the mass balance of the RIS

In detail: Pag 3 line 44-47, How could explained stable ice divide flow with a migration of the ice divide position of around 500 -900 m?

Pag 4 Line 33-34 RICE could be representative of East Ross Sea, not of Victoria Land, see accompanied RICE paper (Bertler et al., submitted)

Chapter methods This part is too long and inappropriate as method chapter and most of the text must be moved to result chapter. The does not provide information about the sample resolution along the core and the analysis performed and at which resolution ice (cm) and sample per year. Percentage of missing record of CFA example must be reported and show. Most of the information about methods is relegate in the supplementary info.

Pag 6 Line 21-24 This paragraph present contraindiction in several points, along the entire text, correlation between RICE and WAIS “volcanic event” are used or not to tune

the RICE scale? Ex. See line 29-30 of pag 6

Pag 6 line 24 The Raoul tephra is a unequivocal volcanic event or not?

Pag 6 line 31-32 The layer counting stops at 343.72 because the annual layer is to fine (<6 cm), to identify seasonal signal needs at least 10-12 sample per year, a graph showing the number of sample analysed per year must be show, from the surface to the 344 m.

Pag 6 44-46 The record of overlap section must be shown to see the ratio noise/signal in the two cores.

Pag 7 line 10 “Several other records also displayed annual variability, but much less reliability” Why do use BC instead of H+ or both?

Pag7 line 11-16 The peak of proxies seasonality are quite different in time (isotope versus sea ice proxies, or photolysis) and most depend from the occurrence of snow fall. The use of ERA model does not look appropriate and the reference is still not published.

Pag 8 line 17-21 Geochemical composition of the tephra at RICE-WAIS and source must be show before any attribution of a tephra never reported in Antarctica before (Raoul 1964).

Pag 8 Line 21-36, it is not clear why some sulphate deposition is attributed to eruption and other no, and correlated to WAIS.

Pag 8 Analysis of comparison between manual and automated annual layer counting must be performed and show.

Pag 9 line 14-15. BC is used to date the 90% of the core analysed, but on the base of fig 4. is not the best proxies of seasonality, also as reported by Author pag 7 line 10. At line 26-27 is reported different use of the proxies the Authors contradict themself.

Pag 9 line 39-40. The geochemistry is not show; Pleiades volcano is not West Antarc-

tica, but in Northern Victoria Land; Kurbatov et al., 2015 is not reported in reference, and it is not present in any database as reference for tephra layer reported; the 1252 tephra attributed to The Pleiade was iscovered the first time at Talos Dome and dated at 1254+- 2 by Narcisi et al., 2001; on my knowledge the analysis of the tephra at WAIS is still not published.

Pag. 10 line 5-18 RICE site is farer than other cores (WAIS-Byrd-Siple Dome, Taylor Dome and Talos Dome) from "many active volcanoes", it is very difficult to understand why RICE record is able to identify volcanic eruption those are not identified in the ice cores of the region with much lower ratio in noise/signature due to marine biogenic sulphate emissions.

Pag 10 line 19-25 Methane gas synchronization less precise than volcano matching, after 4 line "but methane it is better than volcanic matching", clarify.

Paragraph 3.3.1.1 The use of acidity and ECM to detect the volcanic signal is not a new tools. Hammer have used H+ in 1980 as proxies of volcanic signal.

Pag 10 line 43 a resolution of 9.5 cm (about 4 sample per yr) is very low to observe the seasonal variation, but enough to detect the important volcanic signal like Tambora, Kuave etc present a signal for 2-3 yr in Antarctic cores (from 8 to 12 sample).

Pag 10 line 25-32 On the base of figure 7a and Table 2 the volcanic events identified in RICE at 158.15 m and 160.77 m do not present any clear evidence in ECM, H+, due to the high background of ssSO4 at RICE. It is very difficult to understand why a site with this high noise/signal ratio could record local eruption sulphate does not observed at other site core. Paragraph 3.3.1.2 The Pleiades tephra horizon is discussed in several part of manuscript (parag 3.2.1, 3.2.4 and 3.3.1.2), but without provide any evidence on the base of geochemistry analysis. This tephra layer was reported for the first time in Talos Dome 1996 ice core and dated by Narcisi et al., 2001 at 1254+-2 and attributed as source to Melbourne Volcanic Province, probably "The Pleiades", located about 250 km from Talos Dome. This tephra was than identified in Siple Dome and Taylor Dome

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by Dunbar et al., 2003. Moreover, Narcisi et al., 2012 pointed out that at TALDICE (a core drilled from 2004 to 2007) is present the tephra of 1254 as TD87a (86.20 m depth) close in composition to the previous of found in the ice core on 1996. However a subordinate set of glass shards (TD87b) is also trachytic but with a chemical signature inconsistent with The Pleiades products. Mount Berlin could thus be a suitable source of ash (Narcisi et al., 2012). Moreover an other tephra layer TD85 at 84.37 m depth younger than 25 yr has been reported by Narcisi et al., 2012 and the suggest source is Mt Melbourne volcanic province. Without any geochemistry analysis is impossible attribute unequivocally the tephra found in RICE.

Pag 11 Line 41-42 If the tephra layer identified is 1252+-2 yr, why use 1252+-13 for this horizon in RIC17? Pag 12 line 9-18 see above, more than 170 volcanic event most of them never see in closer core.

Pag 12 line 19-42 Volcanic event and Methane records are used for Synchronization or validation?

Pag 13 line 9-10 Which is the gas-age at RICE ? and compared to closer site as Siple and WAIS?

Pag 13 Line 24-29, What is the source of surface temperature of -22°C? Why is used this instead of -27.4°C, this value is also proposed in accompanied paper of Bertler et al., submitted. Why do you use a warmer temperature of 5.4°? Which implication on density and thinning model using 5.4° warmer?

Pag 13 line 30-40 Kingslake et al, 2014 instead of Raymond

Pag 13 line 40-41 The recent migration of ice divide, could be attributed to change in snow accumulation variability at ice divide? Due to the snow accumulation variability between the flank of the ice divide, which is the influence have on snow accumulation record and thinning function of RICE core? Kingslake et al., 2014 report that near-surface strain rates are compressive at ice divide than in the flanks 90% higher at

RICE. The migration of the ice divide respect to Raymond Bump position indicate a role of temporally changing in spatial snow accumulation distribution, as well as the role of along-ridge flow is un-clear and hampers a solid interpretation about thinning function and snow accumulation records.

Fig 8 The pRES measurement (Kingslake et al., 2014) was at ice divide and does not follow the Raymond bump features as reported in figure 8b.

Pag 14 line 11-20 On the base of which data the Authors construct a vertical velocity profile along the Raymond Bump?

Pag 15 line 14 “control point . . .. . .of atmospheric oxygen isotope” at page 12 “Given the stability of the δ18Oatm record over the last millennia, the synchronization was solely constrained by the observed variability in the methane records” as in several other part of the text none coherence exist between the paragraphs and some times also in the same paragraph.

Pag 15 Along all the paragraph it is not clear the process of adjustments of the counting layer respect to matching between RICE and WAIS.

Pag 16 line 13-16 High internal-annual variability in snow accumulation is normal issue (see eg Eisen et al., 2008 and reference within), 1.3% is a very low value.

Pag 16. Line 40-45 The three accumulation record of snow accumulation must be shown in the overlap time, the correlation coefficient of 0.85 and 0.87 indicate that the RICE annual are representative, but at pluriannual scale (see Eisen et al., 2008; Frezzotti et al., 2007). The comparison of the three cores can confirm only the stability of snow in the overlap time, not at secular or millennium scale.

Paragraph 4.3.2 and 4.3.2 The inflection point in accumulation of fig 9 with a trend in decrease is closer to age of the hypothesis of the stabilization of the ice divide at present position 1450 EC (Pag 14). The uncertainty of change in accumulation must be taking in account also the spatial variability at ice divide. The topography position

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of ice divide is probably linked also to spatial variability of snow accumulation in a feedback mechanism (see Drews et al., 2013; King et al., 2004; Matsuoka et al., 2015; Lenaerts et al., 2014). The uncertainty due to age scale and thinning function and ice divide migration must be tacking in account when is analysed the trend, uncertainties is not small amounts.

Pag 17 line 36-46 the interpretation of the reason of trend in accumulation differ from that hypothesis reported by Bertler et al., submitted paper.

Pag 18 line 1-4 the decrease of 6.6 cm/yr per century is not agree since 1950 with the paragraph 5.3 “Clausen et al. (1979) estimated the current (1954-1975) accumulation rate at the summit of Roosevelt Island to be 0.20 m w.e yr-1, whereas we here find the current accumulation rate (average of the last 50 years) to be 0.22$\pm$0.06 m w.e yr-“

Paragraph 5.1, Most of points reported are repetitions already pointed out in Methods and Result, see above for the comment, in particular for “we noted several strong volcanic imprints that seemingly have no counterpart in the WAIS Divide ice core data, and thus most likely originate from local West Antarctic volcanoes.”

Pag 18 Line 31-44 The dipole effect change during the time, see Bertler paper, are this occurs in correspondence with presence or absence of RICE-WAIS volcanic event synchronization?

Pag 18 Line 38 “Absence of sulfate in RICE” with a higher background of 200 ng/g, exactly the opposite.

Pag 19 line 1-7 The tephra number of RICE is not unusual as presence compared to TALDICE or west Antarctic core, as the Authors have written few line after. Moreover, RICE present “several strong volcanic imprints that seemingly have no counterpart in the WAIS Divide ice core data, and thus most likely originate from local West Antarctic volcanoes.”, but not tephra, this is very unusual if the volcanic event reported in Table 2 are true.

Page 19 line 3 “Only one exists within the last 2700 yr”, but on the base of manuscript the tephra are two: Raoul 1964 and Pleiade 1252

Pag 19 Line 22 “longer-term trends are significantly different between the two locations” the text after describe similar trend with higher accumulation in the past respect to the present and change trend close at secular scale.

Paragraph 5.3 The result of RICE does not provide new information for the mass balance of RIS, taking in account the previous cores with similar SMB value and the high spatial variability of the rise and RIS.

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