The Cryosphere Discuss.,
doi:10.5194/tc-2016-160-RC2, 2016

The Cryosphere Discussions

Interactive comment on "Radiocarbon dating of glacier ice" *by* Chiara Uglietti et al.

Anonymous Referee #2

Received and published: 7 September 2016

Radiocarbon dating of glacier ice is an important asset to ice core sciences in mid-latitudes when classical methods to derive age-depth models (layer counting, ice flow modelling, tephra-chronology) fail. However, suitable material for radiocarbon dating of macrofossils is sparse in the ice making it desirable to date other organic carbon compounds. Water-insoluble organic carbon (WIOC) has been shown to be a suitable candidate for radiocarbon dating of mid-latitude ice. Uglietti et al. review the efforts to develop the analytical methodology for radiocarbon dating of WIOC in ice, and test its accuracy. The group of Bern/PSI has been instrumental in developing the method so it seems only natural that they provide a review thereof and is certainly a valuable contribution to the literature of this topic. The paper is generally well written, thorough, suitable for the Cryosphere, and should be published. However, I have some comments that the authors might want to consider for the sake of clarity in the paper and some details the authors may want to check before publication.

1. My main comment is that in the context of analytical precision, I find it slightly misleading to discuss calibrated ages instead of 14C ages or fraction modern. The calibration of radiocarbon dates is a second methodology, introducing additional uncertainty due to the uncertainty of the calibration curve itself. Hence, 2 significantly different radiocarbon ages may lead to statistically indistinguishable calibrated ages. However, if the radiocarbon dates and their uncertainties are reliable, then 2 different radiocarbon ages are indicative of different calendar ages. This applies for example to table 2 and 3 and figure 1. These experiments refer to analytical accuracy of radiocarbon preparation and measurement, independent of the calibrated age and it is hence worth discussing (and showing) the differences in 14C years or F14C instead of calibrated years. A comparison of the 14C measurement results could for example be indicative whether the pure analytical precision does reflect the true uncertainty of the method. I would assume that the true uncertainty is somewhat larger, due to the inhomogeneous distribution of WIOC over an ice sample. This can for example be seen in Table 3 where the samples JUV 0_5/6 as well as JUV 0_7/8 yield significantly different radiocarbon ages, despite being from the same ice block. This questions whether these samples can be summarized to an error weighted mean and standard error as done in table 3. The final uncertainty of $\pm$9 14C yrs for JUV 0_3-8 seems very small given the scatter of the individual measurements. A reduced Chi2 statistic of the sample pools in table 3 could be used to assess and discuss whether the uncertainties of single measurements are realistic. In a second step, it can then be discussed whether these uncertainties matter in terms of the absolute chronology, given that the calibration adds additional uncertainty.

2. Please check the data in the tables. I was confused seeing that the samples Bel2_THEODORE and Bel2_Sunset yield significantly different F14C values while their 14C ages agree. Using an F14C of 0.425 for Bel2_THEODORE I obtain a radiocarbon age of 6874 14C BP, as compared to 7329 14C BP given in table 2. So unless I missed something either the F14C or the 14C age of this sample is erroneous which might also impact on the calibrated ages shown in figure 1. Please check.

3. Throughout the manuscript the term “conventional” 14C dating is used to describe the dating of macrofossils. However, in the radiocarbon literature “conventional” 14C dating refers to 14C measurements using liquid scintillation and gas proportional counting techniques as opposed to AMS measurements. Please either use a different term than “conventional” or add a sentence defining how it is used in this paper.

L 45: please replace “nuclear” with “radiometric”

L 179-182: This is a very long sentence and a little unclear. Maybe divide it up into 2 sentences. Are the sample background corrected using OxII? I suppose the standard is used for normalization and not background correction? Please rephrase.

L 183: Please insert “relative” before deviation, as the samples are normalized to the standard.

L 183: “BP” is not explained at this point yet, but only in line 185. Please explain it here instead.

L 227-228: Are the uncertainties given in 14C years here? If so, please write “14C yrs” instead of years to be clear.

L 249 and following: See comment number 3. Please either define what you mean by conventional or use a different term throughout the manuscript instead.

L 252: This may be nitpicking, but AD 1258 – AD 1050 = 208 years, not 200 years.

L 259-271: Several times it is stated that the WIOC dates “agree well” with the macrofossil dates, while the 14C ages are indeed significantly different. I am not arguing against the general agreement but it would be great if you could add 1-2 sentences to make this more precise. Are the differences due to sampling differences (i.e., different ice layers have been sampled for macrofossils and WIOC)? If so, are the results in stratigraphic order?

L 351: Please write “climate wiggle matching” instead of just “wiggle matching” which

could also refer to the wiggle matching of radiocarbon dates.

L 357: Please add a reference to [Godwin, H. 1962. Nature, 195 (4845)] for the half-life of radiocarbon.

Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2016-160, 2016.