

## General comments :

I would strongly advise to reorganise the paper in separated sections for more clarity. The way it is now, you continuously go back and forth between the sites and methods.

I would suggest the following organization:

Introduction, Field sites and analytical methods (-> presentation of your sites and the measured data in the field and in the lab + analytical uncertainties), Age models (-> choice of tie-points and chronological uncertainty propagation for both TG and TD), Results ->  $\Delta$ age and Discussion. Your manuscript would gain in clarity and would guide the reader toward your results and interpretations.

You should avoid the listing of sites and data in the text and instead propose tables summarizing the data/sites information you need. This is particularly true for the blue ice sites you cite in the text and the different measurements performed on your cores.

## Specific comments & Technical corrections :

### ABSTRACT:

- line 24: "Taylor Glacier (Antarctica)"
- line 27: "low SNOW accumulation WITHIN the Taylor..."
- line 31: replace "Taylor Dome" (already used in the sentence) by "this area"

### INTRODUCTION:

#### Page 1:

- line 36: missing references for past atmospheric composition and a list of trace gases
- lines 40-41: This statement is not true, close to bedrock folding can happen, disrupting the order of ice/gas layers, as seen for the bottom part of NEEM ice core in Greenland for example.
- line 41 "precise distance-age"-> from which reference is the distance measured?

#### Page 2:

- line 12: remove "with fast access to age information"
- line 13: as precise as what? The previous method?. Replace "have" by "present"
- paragraph 3: it would be easier for the reader if you summarize all in a table (site, location, period covered, references) and refer to it in the main text. Such a listing is difficult to follow with too many commas.
- line 29: replace "expands" by "extends" and replace "by developing ice and gas chronologies spanning" by "back to"
- Line 31-32: remove "the across-flow transect"
- Line 34-36: "paleoarchive FROM TAYLOR GLACIER, where it was previously thought to be absent". Remove "larger context of". Replace "into" by "within". Replace "at Taylor Dome" by "of this region"

### FIELD SITE AND ANALYTICAL METHODS:

#### Page 3:

- line 5: if you are not citing an acronym, ice sheet is written without capital letters
- line 6: "northERN"
- line 7: "ice EQUIVALENT accumulation"

- line 15: "80 km LONG ablation zone", and you already said it in the previous paragraph
- line 16: need rewording. I suggest the following: "Water stable isotopes obtained from an along-flow transect just below the equilibrium line"... "revealed uncontinuous ice covering the last glacial period"
- line 20: "revealed continuous records of ice from the Holocene to the last ice age, with ice of the last interglacial and older found..." references for this statement?
- line 22: "the most COMMONLY USED archive" instead of utilized
- line 27: Reference for the previous ice core study. Where was taken this new ice core compared to the previous study? Need more precision. What was the sampling problem with the previous record?
- lines 30-33: need a reference
- line 36: replace "in" by "of"... "CH4 variations similar to those ASSOCIATED WITH DO19" or "corresponding to"
- line 37: "CH4 CONCENTRATION increase"

Page 4:

- line 3: replace "work" by "analysis", replace "spanning" by "section"
- line 4: need rewording, proposition: "...CH4 and CO2 concentrations, which confirmed the MIS 4/5 transition record in the gas phase"
- line 6: spanning not properly used
- lines 7-11: it would help to make a table for all the analyses performed on the different cores, with specification of the proxy measures, where, the time coverage of samples (or portion of core) and the method used for measurements, analytical uncertainty...
- line 24: "resulted in a good agreement of our measurements with other..."

Page 5:

- line 19: "... on archived Taylor Dome ICE CORE samples..."
- line 22: "(~10g OF ICE, ...)"

## RESULTS AND DISCUSSION

### 3.1 AGE MODEL

Page 5:

- line 28: "synchronized to" not correct, more likely "presented on"
- line 29-33: need rewording, not clear
- line 33: need more precision, here a proposition: "We constructed our gas age scale based on the alignment of our CH4 and d18Oatm data with the EDML CH4 and NGRIP d18Oatm records on the AICC2012 chronology."

Page 6:

- line 10: 'CO2 CONCENTRATION decrease", again later
- line 11: remove "and"
- line 13: value of the offset?
- line 15: need rewording, a proposition: "...younger ages. Therefore, we refrain from further align the CO2 rises together for better consistency."
- line 17: why not use the d18Oatm of Vostok or TALDICE instead of NGRIP? You would have a complete record over your period of interest on AICC2012, but potentially with a lower resolution.

-line 23: replace “has” by presents”

-paragraph 3: I am not very much convinced by value matching for dating. We do not really understand the usefulness of the -380 core data until the idea of similar firn conditions. This and the following argument are important for your interpretation later. This paragraph needs rewording.

Page 7:

-paragraph 2: not useful, could be removed.

### 3.2 ANALYTICAL AND AGE MODEL UNCERTAINTIES

Page 7:

-line 18: “is likely”

-lines 19-22: not clear. You say that you consider the 2015-2016 data as uncontaminated, but as the same record differ from the lab, in the end you do not interpret the data... but you did later in the text...

Moreover, you did not discuss the reasons that could explain why the records are so different. I would possibly keep the tuning, but associate it with a much larger uncertainty than the other points due to the mismatch with the lab data. Then only use the CH<sub>4</sub> data in grey area for dating purposes and no more.

The discussion about the analytical uncertainty should be following the presentation of the analytical methods.

-paragraph 4: I am not convinced about your argument for the confirmation of data. From the looks of the data presented on Figure 2, I would say that your choice of markers is not convincing, I would have chosen differently... From your Figure 3, I understand that your choices were made in order to align together the records you cite as confirming your alignment (e.g. nssCa). I would recommend to change the way you presented your figure 2 to make the reader see by himself why you choose these tie-points and not others.

You should focus more on this aspect, which is the base of your discussion later, it would strengthen your work. Not necessarily in the main text, it could be an appendix.

Page 8:

-lines 3-4: “20 cm = 300 years”, based on what? Which chronology?

Lines 5-8: This is not a proper argument. If you say that both CH<sub>4</sub> data from TG and EDML are similarly smoothed in the firn column, you are implying that they have similar firn conditions (i.e. accumulation rates, firn depth...). Is it the case?

-lines 8-9: Analytical noise... why is that? What is the measurement uncertainty of your method?

-lines 9-12: Please, when using a chronology as reference, make sure of the uncertainty values you cite... What you wrote is not correct. The AICC2012 chronology uncertainty over your period of interest (i.e. ~65-74 ka) at EDML is ranging between 1500 years and 1400 years (cf. supplementary material of Veres et al., 2013). The values you have indicated correspond to the uncertainty of the ice and gas chronology at the orbital scale, prior to the last interglacial.

-Following all this discussion of uncertainties, what are the uncertainties associated with your ice and gas chronologies for TG? You never gave a value and I do not see them on your figures. The same for your revised TD chronology.

### 3.3 $\Delta$ AGE AND COMPARISON TO TAYLOR DOME

Page 8:

-line 7: Temperature and accumulation are not the only factors influencing  $\Delta$ age. All factors acting on the firnification process do as they impact on the firn depth variability. What about insolation of wind stress affecting the snow metamorphism into ice?

-line 19: remove "on the order of hundreds of years", it is given by the lower limits just before. Change "smaller" in "smallest"

-line 21: replace "at" by "for"

-lines 26-27: ok for the two sources of uncertainties, but you forgot to take into account the absolute uncertainty of the ice and gas chronologies. You have ~1500 years uncertainty from the AICC2012 age scale, consequently the uncertainty of your new chronology should be around ~1600 years for the gas age, and ~1530 years for the ice age (I took one random range from your choice of tie-points).

Then your maximum and minimum  $\Delta$ age should be obtained from the (ice age - 1sigma)-(gas age + 1sigma) and (ice age + 1sigma)-(gas age - 1sigma). You should give an approximate value of the  $\Delta$ age uncertainty for the reader to have an idea of the significance of your  $\Delta$ age values later.

-line 30: "10 ka" +/- ??? uncertainty needed.

-line 33: then why is it so different? Replace "high" by "large"

-line 34: now you talk of the influence of wind, but not before...

Page 9:

-paragraph 1: I do not think that the last sentence is necessary, you should delete it.

-paragraph 2: You should gather together in one section the chronology construction for your two sites, with the proper calculation of their respective uncertainties.

-line 13: "in the same manner AS described"

-lines 17-19: You should then directly give a 0 value. Note then the uncertainty associated to the  $\Delta$ age is then not gaussian..

-line 21:  $\Delta$ age of 2.5 ka, but p8 line 20 you cited an extrema value of 12 ka with reference to Baggentos et al., in review... why are the values so different?

-lines 22-25: I disagree with this statement. It comes too soon. For TG, not located on a dome, ice thinning and ice flow are very important factors that could affect the depth-age relationship. For TG you cannot interpret directly your variations on  $\Delta$ age in terms of accumulation. To distinguish between the major influences of thinning and accumulation, you need an ice flow model. If your ice flow model indicate that there are no significant thinning variations, then and only then you can interpret it in terms of accumulation. Moreover, you give absolutely no justification for your favour toward accumulation changes, and you do not explain why you disregarded the thinning influence.

-last paragraph: you should give the modern values of accumulation measured at these two sites. It would give an idea of how much your prior assumption of all differences are due to accumulation changes is valid for modern times.

Page 10:

-lines 14-18: give values for the LGM reconstructed accumulation at both TD and the virtual sites. This gradient is reverse from yours. Why do you use it then? The useful result from this study to you is only “the opposite accumulation gradient (decreasing from south to north) for ice older than 60ka”.

-lines 18-26: bring nothing more, just show support for the LGM gradient that is different from yours. I would advise to remove these sentences.

-last paragraph: remove the first two sentences, you are only rewording your results.

Page 11:

-line 4: need a reference for this statement.

-paragraph 2: the MIS 4 gradient is similar to modern conditions. Are modern conditions in agreement with your proposed hypothesis?

FIGURES & TABLES:

-Figure 1: I would advise to change the organization: a-Antarctica map, b-landsat imagery, c-simplified map of TG.

-Figure 2: The way the data are presented now, one can strongly argue your chosen tuning points. The scales are too small to see the consistency between the associated variability. I am not at all convinced about your tie-point between the  $\delta^{18}O_{ice}$  of EDC and TG, records present different variability. I would advise to remove from the legend the last two sentences.

-Tables 1&2: You should add some indications on your figure 2, on the reference records, to directly make the link between the tables and your chosen points (e.g. DO19...). In Table 2 legend, remove the sentence “Ice phase...”

Figure 3: I would say that there is absolutely no point in plotting together records that were tuned together, or if you really want to, it should be in an appendix. You already use some other untuned records to validate your chronologies. I would leave here only 1 gas, 1 ice records, and then the (b) part of the figure. You should extend the lines for the identification of MIS limits to the bottom of the figure for more clarity. In the legend your last sentence is not necessary, you could delete it.

Figure 4: Same comments as for Figure 3. You should keep consistent the colours of curves from one figure to another. Why didn't you remove the three points in questions and simply state it in the measurement section?