

## ***Interactive comment on “Archival of the water stable isotope signal in East Antarctic ice cores” by Mathieu Casado et al.***

### **Anonymous Referee #3**

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#### Summary

The manuscript of Casado et al. (tcd-2016-263) presents an analysis of the post depositional modification of the oxygen isotopic composition in East Antarctic snow using various types of isotope dataset including water vapor, precipitation, surface snow, and buried snow. The interesting point of this study is that documents seasonal and inter-annual variations in oxygen isotopic composition of precipitation and surface snow at the far inland of the Antarctic continent. The work shows that the seasonality of the surface snow does not correspond to that of the precipitation, but is linked to the seasonal change in grain index which is an indicator of coarsening of snow at surface. While more work needs to be done to quantitatively interpret the post-depositional effects, the work described here is pioneering and the implications will doubtless be fleshed out in future work. I list some minor comments in below.

## Primary comments:

1. There is some disconnect between isotopic variability of surface snow and the post depositional process. The metamorphism of surface snow is not only factor controlling the isotopic variability of surface snow, but the precipitation amount also influences to the inter-annual variations of summer isotopic peaks because the depth of sampling layer is fixed. For example, Figure 4 shows that the summers with relatively higher oxygen isotopic peaks (2012 and 2014) are accompanied with relatively heavy snowfall events in summer. In contrast, the years with weak snowfall events are characterized by lower oxygen isotope peaks. These results suggest that inter-annual variations of summer oxygen isotopic values would reflect the relative contribution of summer precipitation to the samples. Hence, inter-annual variability of snowfall amount has to be considered before discussing the influence of metamorphism.

2. The conclusion that the sublimation/condensation cycle occurs in closed system at Dome C site seems to be exaggerated. Fig 6 shows that the increasing trend of oxygen isotopes in water vapor does not perfectly correspond to the decreasing trend of those in surface snow. When air temperature begins to rise at 18:00 UTC, the isotopic value of water vapor also starts to increase, but the decreasing trend does not. And, I have another question as for frost formation process. Generally, frost formation occurs when surface temperature becomes cooler than the atmosphere. Fig 6, however, shows that frost formation starts after the surface temperature rises above the 3-m temperature. How do you explain this contradiction?

3. A recurrent multi-year cycles, corresponding to 20cm cycles in this study, can be seen in the snow pit collected at Dome Fuji (see Fig 5 in Hoshina et al., 2014). They explained the multi-year cycles reflect the multi-year cycles of large precipitation events. Please discuss if this theory works for the 20cm cycles in this study. I think the authors seem to overestimate the role of post depositional effects.

Hoshina, Y., et al. (2014) Effect of accumulation rate on water stable isotopes of near-

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surface snow in land Antarctica, 119, 274-283, doi:10.1002/2013JD020771.

4. This manuscript includes various types of oxygen isotope dataset. To distinguish them, why don't you use the symbols shown in Fig 2? For example, oxygen isotopic composition of precipitation can be represented by  $\delta^{18}\text{O}_p$ . I think that the word of "precipitation isotopic composition" is not popular. Generally, we describe as "isotopic composition of precipitation" or the  $\delta^{18}\text{O}$  of precipitation.

5. Please do not use italic letters in the text. All symbols and units should move out from math mode. For example, not  $\delta^{18}\text{O}$ , but  $\delta^{18}\text{O}$ .

Other minor comments:

P5; L15: I can't understand this mean; "picked provided".

P8; L13: "sastruga" -> "sastrugi"

P8; L26: "precipitation isotopic composition variations based on" -> "variations of  $\delta^{18}\text{O}_p$  using"

P8; L26-P9; L2: These sentences are repeated in the following subsections. Hence, I recommend to omit them.

P12; L1: Please replace "standard deviation" to "difference between two samples". At least three more samples are necessary to calculate standard deviation.

P12; L6: "Van Den Broeke (1998)" -> "Van den Broeke (1998)"

P13; L13: "isotopic composition seasonal variations" -> "seasonal isotopic variations"

P13; L31: "isotope exchange" -> "isotopic exchange"

P14; L1: "in parallel with . . ." Repeated sentence.

P14; L8: What is the mean of "frontal perturbation"? Do you mean the passage of frontal system?

P14; L11 – P15; L3: “In addition to the isotopic composition. . . (Goff and Gratch, 1945)”  
This sentence is grammatically incorrect.

P15; L28: Which temperature do you use? Surface temperature or 2m-temperature measured by AWS?

P16; L8: “From the 16th of December . . .” SSA decreases do not correspond to the increases of the difference of delta 18O between surface and subsurface snow. Fig 7 shows that the large isotopic difference occurred a few days ago before SSA decreasing.

P17; L7: “is indicating” -> “indicates”

P17; L7: “in the case of SSA” -> “in contrast, for SSA”

P17; L22: “varriations” -> “variations”

P19; L7: “not necessary capture” -> “not necessarily capture”

P20; L8: Section 4.1 I can't understand the logics of this section. I wonder why the authors used the MCIM results to discuss the influence of the patchiness of the accumulation and precipitation intermittency. What is the physical mean of delta 18O of snow – surface temperature plots in Figure 9b and 9c? Did you pick up the samples only precipitating days? Please explain your strategy more specifically.

P23; L31: “surface snow isotopic composition variations” -> “variations of delta 18O of snow”

P24; L10-L15; I think these sentences are meaningless.

P25; L14: “focus in particular oin” -> “focus, in particular, on”

Figure 2. There is no explanation as for “phase X”. Please add the explanation for each symbol shown in Figure 2.

Figure 4. Please add surface air temperature from the ERA-Interim.

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Figure 6. Please add Local time

Figure 7. Although temperatures are expressed by degree C in previous Figures, this Figure uses Kelvin unit. Please unify the expression of the unit for temperature.

Figure 9. Did you use daily average temperature when you take surface snow samples?  
Are all data including sunny days plotted in Figure 9b and 9c?

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Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2016-263, 2016.

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