

Interactive comment on “Post-coring entrapment of modern air in polar ice cores collected near the firn-ice transition: evidence from CFC-12 measurements in Antarctic firn air and shallow ice cores” by M. Aydin et al.

Anonymous Referee #2

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Review comments follow. Capitals are used for emphasis or to suggest wording changes.

Review of Aydin et al., “Post-coring entrapment of modern air. . .” ACP November 2009.

This manuscript provides evidence for POTENTIAL contamination of shallow ice core samples with air after the core has been drilled. Overall the manuscript is of moderate interest, though to a specialised readership, and provides evidence of the shallow sample problem in a more systematic and complete way than the scattering of evidence

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that exists in the literature.

It has been known for a while by ice core researchers that measurement of enclosed gases can be problematic near close off. MacFarling Meure et al. mention rejection of samples based on evidence of significant residual open pore space in the shallow ice samples in their 2000 year record of several gases, which extended up to shallow depths and very recent years. But they also found no evidence of SF₆ and C₂F₆, tracers not unlike CFC-12, in samples selected away from shallow and partially closed off material. It has also been known that firn and ice formed from summer accumulation has a lower density than adjacent layers (Martinerie et al., EPSL, 1992) and that the layers need to be treated independently where possible, and selected on that basis, especially near close off. See Etheridge et al., Tellus, 1992. Trudinger et al., JGR 2002 and Fabre et al., GRL 2000 also distinguish between the closed porosity of shallow ice at the scale of a prepared ice sample compared to that of the ice sheet where the sample was extracted. These observations are pertinent to the findings of this manuscript and help in understanding it. They also show how the problem of shallow, partially closed samples has been approached in the past and, importantly, how it has generally not influenced ice core measurements of gas composition. For example, the Law Dome records of CO₂, CH₄ and their isotopes show overlapping links of measurements from atmosphere, firn air, shallow ice and deeper ice, consistent with the atmospheric record, which is confirmation that the shallow ice they selected contained negligible contamination (Etheridge et al., JGR 1996; 1998; Francey et al., Tellus, 1999; Ferretti et al., Science, 2005). I suggest that this evidence is considered and mentioned in this manuscript.

I also find the manuscript title misleading. The entrapment is not generally in polar ice, rather in SOME SHALLOW ICE CORE SAMPLES, after drilling and storage. This is a significant and important difference and must be emphasised so not to confuse with the vast majority of ice core samples which have clearly been demonstrated to reliably trap and preserve atmospheric composition for decades to hundreds of thousands of

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years. This also needs addressing in the last few sentences of the abstract and the last sentence of the introduction, to avoid a quick scan of the manuscript leading to a wrong conclusion. The reliability of the ice core record needs reiterating in the conclusion and a careful distinction made between those “shallow” (definition needed) samples that might be affected and those samples which generally make up the ice core record. I would think there is ample evidence that post drilling entrapment ALMOST CERTAINLY has no impact on records from ice samples as near as 10 m or less from the close off region when they are carefully drilled, stored, selected and prepared for gas analysis.

The manuscript would also be more enlightening if the following points were considered:

How much of the observed contamination and its variation between samples and sites is simply due to sample storage time in different environments, the packaging of cores (sealed bags etc) and the amount of ice removed during cleaning and the duration of pumping on a prepared sample?

Some deep drilling projects in the past used CFC's as drilling fluid. What is the chance that some of the contamination found, particularly in the Siple Dome samples (which have levels higher than ambient modern air), was from cores, samples, equipment or storage environments used for those projects?

It would be very useful if the concentrations of other gases were measured in the ice core samples. This would help confirm the estimates of percentage of the gas that was entrapped after drilling, perhaps with more certainty than for the CFC-12 approach, since this gas can have highly variable backgrounds in the environments where the cores are stored and handled. Is there information on this, or is it planned to be done?

Sturrock et al., JGR, 2002, also produced a record of CFC-12 from firn air spanning the entire atmospheric history of this gas. This should be mentioned and perhaps used in the analysis because their firn air had very fine resolution in time, was also from the southern hemisphere and the uncertainties in the reconstructed record were

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estimated.

Other minor points include:

Section 1. para 2. “diffusive permeability”. I assume what is meant is diffusivity. Permeability is another quantity (related to pressure gradient, not concentration gradient).
Para 5. . . . THE CFC-12 mixing ratio

Table 1. Deepest firn AIR sample?

Section 3.1, para 2. How do you know that the microcracks have been eliminated? Are they visible, to a certain depth? For all cores? 3.1 last para. The use of an isotopically distinct measurement needs better explanation. . . .original INTENTION. . . . Section 3.3. Spell out “SS”. Coupled with either ECD or? . . .THE ECD response. . . . Section 4 last para. Mention Sturrock et al., JGR 2002. Section 5.1. para 2. how high is “unusually”? Section 6. The yield of gas versus depth: are the yields in mol per sample or per ice sample mass?

With these changes made, including clarifications about what the findings here might mean for ice core records of the atmosphere in the light of existing evidence for the ice core record not being contaminated, the manuscript might be suitable for publication.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 1631, 2010.

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