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Interactive comment on "Physical properties of shallow ice cores from Antarctic and sub-Antarctic islands" *by* Elizabeth Ruth Thomas et al.

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ORIGINALITY

The manuscript reports glaciological field studies conducted as a part of the Antarctic Circumnavigation Expedition during the 2017 austral summer. Here the authors present depth profiles of density and melt layers from short (14-24m) firn cores extracted from three sub-Antarctic islands and two coastal domes. Short radar surveys in the vicinity of the cores are also presented. The study is a reconnaissance to evaluate potential ice-core sites that preserve records of past climate and atmospheric circulation in this important, data-sparse region.

SCIENTIFIC QUALITY

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Discussion paper

Concerning eqn.1, does ph denote density at depth h? Is model parameter "a" equivalent to the "Zero-depth intersection (m)" given in Table 3? Is model parameter "b" also given in Table 3?

How does the presence of melt layers affect the Herron and Langway age-density model? How do you estimate the age uncertainties given in Table 3? How might annual or decadal variations in accumulation impact the age-scale? A more rigorous analysis of uncertainties is needed.

Detailed measurements of stable isotopes, ions, and organic chemistry from the Bouvet Island core have been previously reported and interpreted (King et al., 2019). The 14.2m core was dated using annual cycles in deuterium and calcium. Assuming data shown in Fig. 11 are correct (see comments below about inconsistencies), the core from Bouvet Island appears to be the least affected by melt layers. However, Fig. S1 in King et al. (2019) shows the isotope and chemistry signals are strongly attenuated near the bottom of the core.

I see (line 309) that annual layer counting of the other SUBICE cores has not yet been completed. Is it in progress? The paper would be much stronger if measurements of isotopes and chemistry and an associated age scale for the other cores are included. An age scale for each core is needed to validate the use of the ERA-5 derived accumulation rates, and to establish the fidelity of the age-scales.

Apart from identifying a possible basal reflection at Bouvet Island, it is not clear how the discussion of the radar profiles support the focus of this study.

At 400MHz reflections are more sensitive to changes in density than changes in chemistry. In this case, one might expect that shallow radar reflections (where the background density is less that ~700kg/m3) might correspond to melt layers. However as presented, it is difficult to determine if there is such a correspondence. As mentioned in the text, the radar system records the two-way travel time (TWT time) to a reflector. For matching radar layers with the core stratigraphy, rather than using an average wave speed (as implied in Table 2) it would be best to use an appropriate depth profile of the dielectric constant to estimate variations in the wave speed through the firn.

Further, it would be informative to show the location of the core site directly on the radargrams, and to evaluate the mismatch between radar-detected layers and the melt stratigraphy in the cores.

SIGNIFICANCE

This reconnaissance study identifies several potential sub-Antarctic ice-core sites that contain a centennial-scale climate record. All sites contain melt layers, but progress has been made dating cores in sub-polar and maritime climates (e.g Abram et al., 2013; Neff et al 2017). Although perhaps more logistically challenging, it may also be possible to find suitable sites at higher elevations on Bouvet Island, Mount Siple or South Georgia.

PRESENTATION QUALITY

Are columns “melt frequency”, “average thickness” and “maximum thickness” given Table 2 derived from “visualization of the radargrams” or are they derived from the cores?

Results shown and discussed in the text, Table 2, and Fig. 11, are inconsistent. For example, Table 2 indicates the thickest ice layer at Mt Siple is 61cm, while Fig. 11 indicates that it is about 12cm, and at Peter 1 Island the thickest layer is 8.1cm, but Fig 11 suggests it is >30cm. Text (line 303ff) states: The average melt layer thickness in the Bouvet core is 0.3 cm, observed at a frequency of five layers per meter; with the largest measured melt layer just 3.98 cm (Table 2). . ...., in contrast, Table 2 shows values 0.69cm, 6.5 layers/m, and 3cm for the largest melt layer.

Section 2.2.5 It is not clear why the two cores from South Georgia are mentioned here since they . . ."do not provide contemporary climate information". However interestingly, Mayewski et al (2016) presented results of an initial reconnaissance for an ice core site

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on South Georgia and suggested that annual stratigraphy might be preserved at sites with elevations above 2000m.

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