

Interactive comment on “Radio-frequency probes of Antarctic ice birefringence at South Pole vs. East Antarctica; evidence for a changing ice fabric” by D. Besson et al.

Anonymous Referee #4

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In this paper the authors use polarimetric radar sounding to characterize the Antarctic ice sheet at South Pole. Since they are cosmic ray physicists, Besson et al. use specialized radio equipment that differs somewhat from that normally used for glaciology.

An interesting aspect of the ice which the authors have been able to probe is fabric, or a preferred orientation of the c-axes of the ice grains. The authors have detected birefringence correlated with ice flow direction, though they point to the synchronicity of radio echoes from the top half of the ~ 2850 m ice sheet as evidence against any appreciable birefringence there. As the authors point out, reorientation of fabric typically occurs over tens of meters. However, ice grain size can vary considerably over

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only centimeters, which can affect fabric development. Fabric can also depend on the specifics of the ice flow, for example, whether the flow is convergent or divergent. South Pole is an unusual and potentially intriguing study site since it is not an ice dome or an ice divide. It isn't too surprising to find different fabric at South Pole than at Fuji since SP is "off-axis" and Fuji is a dome. The ice at SP is thought to be in convergent flow and undergoing uniaxial extension, so a vertical girdle fabric would be expected at intermediate depths. The typical transition to vertical single pole which the authors mention may not happen until the deepest 10% or so of the ice sheet, which would be in the echo free zone of radio. The ice at the WAIS Divide site is also in pure shear and exhibits a vertical girdle fabric, with c-axis orientation nearly random for the first 1000 m before developing into a strong girdle, and then into vertical single pole indicative of simple shear in the bottom 15% (Don Voigt, pers. comm.).

The authors mention "implied" depths based on reflection times, why not include this information for the reader? Where do the authors get temperature at depth for the temperature-weighted velocity?

In their conclusions the authors claim to see cross-polarized signals which exceed co polarized ones and that this suggests some curious effects may be going on in the ice. It isn't clear from the paper that the authors have eliminated all systematics and put forward clear definitive evidence of this, so some additional material would seem warranted on this point if it is going to be a bullet in their conclusions.

An intermediate depth (1500 m) ice core is being planned at South Pole. Unfortunately the azimuth of the core will likely not be preserved; this is technically challenging and not considered high enough priority to justify the extra trouble when designing coring drills.

Small points...

page 4697, line 1: "..work in this subject has been done based..." is awkward.

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page 4698, line 12: there is no Fujita reference from 1996.

page 4703, line 10: synchronousness → synchronicity, simultaneity

page 4706: "index-of-refraction of refraction"

page 4708: parallel not perpendicular

pg. 4708 line 11, should be "propagation parallel (i.e. along z)"

Interactive comment on The Cryosphere Discuss., 6, 4695, 2012.

TCD

6, C2715–C2717, 2013

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