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New insights into polar ice crystal fabrics from radar polarimetry

Carlos Martin (1), Alex Brisbourne (1), Jonathan Kingslake (2), Robert Mulvaney (1), Julius Rix (1), Catherine Ritz (3), Keith Nicholls (1), Reinhard Drews (4), Katrin Lindback (5), and Kenichi Matsuoka (5)

(1) British Antarctic Survey, Physical Science Division, Cambridge, UK, (2) Lamont-Doherty Earth Observatory, Columbia University, New York, US, (3) University Joseph Fourier, Grenoble, France, (4) University of Tübingen, Germany, (5) Norwegian Polar Institute, Tromsø, Norway

Ice is one of the most anisotropic natural materials but it is common knowledge in our community that anisotropy in ice is: a) a second order factor that can be ignored, b) easily assimilated into isotropic models by tuning certain parameters, or c) so complicated that it is better to ignore. Interestingly, any measurement of anisotropy in polar ice shows that ice develops crystalline preferred-orientation fabrics that produce strong mechanical, optical and dielectric anisotropic properties. Here, we look in detail at polarimetric radar measurements in different regions of East and West Antarctica. We use a ground-based phase-sensitive frequency-modulated continuous-wave radar (ApRES) and a matrix-based model to study the radio-waves depolarization and anisotropic scattering (Fujita et al, 2006). We find that anisotropy is widespread and an excellent archive of past ice flow conditions. We use it here to extract details of the recent deglaciation of the Ross and Ronny ice shelves over the last thousands of years. Also, because the length of the record is related to the advection time of the ice flow, we use our method to show that a candidate ice core location near Dome C, for the Beyond Epica Oldest Ice Core project, has been under steady ice-flow conditions over the last million years or so.