Spatial variations in ice-crystal alignments deduced from englacial radar polarimetry, central West Antarctica

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We present results of polarimetric ground-based radar surveys at 19 sites in a 100 km by 300 km area near the WAIS Divide that separates ice flow toward Ross and Amundsen Embayments. The measurements were made using 60-MHz and 179-MHz co-polarized, pulse-modulated radar. At each site, the orientation of the radar polarization plane is changed by 15-degree increments, so that depth variations of the radar returned power is collected at 12 polarization planes. We found alternations of 200~400m-thick ice bands with different degrees of the anisotropy. In strongly anisotropic band, the magnitude of the anisotropy is more than 20 dB. The most distinct polarimetric feature is uniaxial (180^o periodic), while a weaker 90^o-periodic feature is also found. These two patterns are predicted as effects of anisotropic reflectivity and birefringence caused by alignments of ice crystals (ice fabrics). Thus, we interpreted these polarimetric signatures in terms of ice fabrics. At almost all sites (regardless of the distance from the current ice-flow divide), ice fabrics are developed significantly to make anisotropic reflections as shallow as 200-500 m depths. A principal axis of the ice fabrics near the surface is consistent with the local fall line, which is consistent with GPS-measured flow direction or stretching axis at most sites. The principal axes of the ice fabrics vary with depth, suggesting a complicated flow history in the past or depth-variable flow patterns which are presumably caused by rough bed topography.