Densification of layered firn of the ice sheet at Dome Fuji, Antarctica

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In order to better understand the densification of polar firn, firn cores from three sites within approximately 10 km of Dome Fuji, Antarctica, were investigated, using surrogates of density: dielectric permittivities ε_v and ε_h at microwave frequencies with electrical fields in the vertical and the horizontal planes, respectively. Dielectric anisotropy $\Delta\varepsilon$ (= ε_v - ε_h) was then examined as a surrogate of the anisotropic geometry of firn. We find that layered densification is explained as a result of complex effects of two phenomena that commonly occur at the three sites. Basically, layers with initially smaller density and smaller geometrical anisotropy deform preferentially throughout the densification process due to textural effects. Second, layers having a higher concentration of Cl^- ions deform preferentially during a limited period from the ice sheet surface until smoothing out of layered Cl^- ions by diffusion. We hypothesize that Cl^- ions dissociated from sea salts softened firn due to modulation of dislocation movement. Moreover, firn differs markedly between the three sites in terms of strength of geometrical anisotropy, mean rate of densification, and density fluctuation. We hypothesize that these differences are caused by textural effects resulting from differences in depositional conditions within various spatial scales.