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Formation and metamorphism of stratified firn at sites located under spatial variations of accumulation rate and wind sp

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The initial stage of postdepositional metamorphism in polar firn was investigated at sites located under spatial variations of accumulation rate and wind speed along the East Antarctic ice divide near Dome Fuji. A better understanding of this process is important for interpreting local insolation proxies used for astronomical dating of deep ice cores. Three 2-4 m deep pits were excavated and physical properties, including density, grain size D, reflectance R of near infrared light and microwave dielectric anisotropy, were investigated at high spatial resolution. We found that dielectric anisotropy ranges between 0.028 and 0.067 and that such high values occur in the surface ˜0.1 m. In addition, short scale variations of density are correlated with those of dielectric anisotropy, and inversely correlated with those of D, confirming contrasting development of initially higher density layers and initially lower density layers. Moreover, postdepositional metamorphism makes these contrasts more distinct with increasing depths. Both the contrasts and dielectric anisotropy for given values of density are higher under lower accumulation rate conditions and under less windy conditions. Insolation efficiently causes evolution of strata of firn at the ice sheet surface under such conditions. Under more windy conditions, the strata contain more wind-driven hard layers with higher density and dielectric anisotropy and thus have larger fluctuations of density and dielectric anisotropy. We suggest that the initial variability of density at the surface and the duration of exposure to diurnal and seasonal temperature gradients play sequential roles in determining the physical/mechanical properties of firn, which is retained throughout the densification process.

Keywords: Antarctica, ice sheet, firn, metamorphism, accumulation rate, wind speed