Metamorphism of layered firn at Dome Fuji, Antarctica: Evolution of relations between Near-infrared reflectivity and the other textural/chemical properties

Shuji Fujita, 1,2,
Kumiko Goto-Azuma, 1,2
Motohiro Hirabayashi, 1
Akira Hori, 3
Yoshinori Iizuka, 4
Yuko Motizuki, 5
Hideaki Motoyama,1,2,
Kazuya Takahashi, 5

1National Institute of Polar Research, Research, Organization of Information and Systems (ROIS) 10-3 Midori-cho, Tachikawa, Tokyo 190-8518, Japan
2Department of Polar Science, The Graduate University for Advanced Studies (SOKENDAI), 10-3 Midori-cho, Tachikawa,
Tokyo 190-8518, Japan
3Kitami Institute of Technology, Kitami, Japan
4Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan
5RIKEN Nishina Center, Wako, Japan
Correspondence: S. Fujita <sfujita@nipr.ac.jp>

Evolution of polar firn was investigated at sites at Dome Fuji, to better understand signals of deep ice cores. Using samples from a 4-m-deep pit and a 122-m-deep core, relations between major textural and chemical properties, such as Near-infrared light reflectivity R, density ρ, microwave dielectric anisotropy $\Delta\varepsilon$, and concentration of major ions, were investigated at a depth range of 0 – 122 m, with high spatial resolutions. At the near-surface depths, we found: (i) Fluctuations of R, ρ, and $\Delta\varepsilon$ are positively correlated; (ii) $\Delta\varepsilon$ ranges 0.03 – 0.07 immediately below the snow surface at ~0.1 m depth; (iii) These properties of R, ρ, and $\Delta\varepsilon$ are not correlated to major ions. With increasing depths during reported phenomena of density crossover, the positive corrlation of R to $\Delta\varepsilon$ persistently remains with a slight decrease. Besides, R becomes weakly negatively correlated to concentration of Na^+ which is the sea salt marker. These facts suggest that textural features of the near-surface depths are preserved in both R and $\Delta\varepsilon$ at a depth range immediately below bubble-close-off, being weakly affected by reported softening of ice by Cl^- ions. We therefore suggest that optically layerd features in ice cores are directly linked to the metamorphism.