An ice-flow modeling study for evaluation of sites for and oldest ice core around Dome Fuji, Antarctica

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The recovery of a new Antarctic ice core to cover one million years will advance our understandings of the Quaternary climate. Previous ice flow modeling studies indicate that such old ice may exist in inland areas of the Antarctic continent, where horizontal ice flow is slow, the ice is thick, accumulation rate is low, basal temperature is well below the pressure melting point (Pattyn 2010; Fischer et al. 2013). We have been analyzing the field data taken by 59th Japanese Antarctic Research Expedition (JARE 59, 2017-2018) and conducting ice flow modelings as the essential parts of the site selection activities. In the present study, we show results of ice flow modeling to estimate the temperature and age of ice, and age resolution of the ice near the bed at a dome of the ice sheet. We use an one-dimensional ice flow-thermodynamic model, in which the vertical velocity of the ice is parameterized with empirical functions applied to the area near ice sheet domes. At first, the calculated age and temperature profiles of the ice are compared with depth-age profile of the Dome Fuji ice core and borehole temperature at Dome Fuji to assess the model performance for our purposes. Next, we investigate the influence of parameters (ice thickness, accumulation rate, geothermal heat flux, profile of vertical velocity of the ice) on the age of ice especially in the lowest few hundred meters. The results indicate that a fine resolution of oldest ice (~age of 1.0 Ma before present) is expected from a thick ice and a low accumulation, but the thick ice increases the chance of basal melting. The one-dimensional model is applied to the vicinity of Dome Fuji along the transect of JARE 59 surveys, using estimated ice thickness and simplified pattern of surface mass balance and geothermal heat flux. The calculated distribution of the age of ice are compared with internal layers of the ice (isochrone) derived from ground radar surveys. The calculated age of ice roughly follows observed internal layers of ice, and a smaller accumulation near NDF compared to Dome Fuji increases the agreement between calculated age of ice and internal layers of ice.

Keywords: Antarctic ice sheet, ice core, modeling, Dome Fuji

