

## Features of the ice sheet radio-echoes from deep internal layers and ice/bed boundaries observed with radars of the Japanese Antarctic Research Expedition: a summary

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For deep ice coring projects in polar ice sheets, it is essential to collect glaciological information from within the ice sheet, before locating exact drilling site. Integrity of the climate signals with well-layered condition of the ice sheet is a prerequisite. In addition, we should know various physical conditions such as temperature, presence/absence of basal melting. Since 1980's, the 2<sup>nd</sup> highest dome in Antarctica, namely, Dome Fuji is one of areas where the Japanese Antarctic Research Expedition (JARE) had its focus on the glaciological investigations. So far, JARE have collected several shallow (100~200-m-long) ice cores as well as two very deep cores known as 2503-m-long DF1 ice core and 3035-m-long DF2 ice core. The latter core covers back in time ~720 k-years. Scientists in the Dome Fuji Ice Coring project have their next scope to drill the 3<sup>rd</sup> very deep ice core covering age more than 1 million years, to better understand climate systems and climatic history.

Ground-based radar sounding has been a powerful method to collect information from deep within the ice sheet. The Dome Fuji Ice Coring project started ground-based radar sounding near Dome Fuji already in 1980's using a VHF pulse-modulated radar operating with a frequency of 179 MHz. Since then, ground-based radar surveys were repeated in 8 austral summer and/or winter seasons, in 1993/1994, 1997/1998, 2000/2001, 2006/2007, 2007/2008, 2012/2013, 2017/2018 and 2018/2019. A brief history is as follows. Mountainous topography beneath the ice sheet was already found at ~40 km south of Dome Fuji in the survey of 1993/1994. In the 1997/1998 season, the survey team made a 150-km-long trip to the south and they discovered that significant layered scattering of the electromagnetic waves within the deepest few hundred meters above the subglacial mountains at approximately 45-65 km south from the Dome Fuji. They identified that the subglacial mountain area could be a candidate location for future deep ice coring. In the 2012/2013 season, further survey was done at a location centering a site which we called as New Dome Fuji (77.801 °S in latitude, 39.040 °E in longitude, 3761 m in elevation and 2157 m in ice thickness). In the 2017/2018 season, the team made a radar survey with high gain antennas along about 2,990 km, with major spacing of the lines 5 km, covering total area of 20,000 km<sup>2</sup>. In the 2018/2019 season, the team investigated along 2,700 km in an area of about 1,000 km<sup>2</sup>. The latest spacing between survey lines varied between 0.5 km and 0.25 km. In this 2018/2019 season, we also made a collaborative international survey with University of Alabama, University of Kansas and Norwegian Polar Institute (See, for example, presentation by Tsutaki and others in this session). Overall, efforts over more than 30 years made the NDF area with very high-density coverage of the radar measurements.

In this talk, we will first talk about historical aspects, how the observations have proceeded with what kinds of radars. And then, we will explain how we have extracted ice thickness and features of internal layers, from the data of the Japanese pulse-modulated radars. Finally, we will discuss how we will cooperate with (i) the team-efforts with the state-of-the-art radars developed by University of Alabama and University of Kansas, and (ii) team-efforts of the ice sheet modelling.

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