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Electrical signal layering of ice sheet at Dome F, Antarctica

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Ice core records can reveal climate history over time-scales of up to 10^6 years. By resolving ice core records, we can extract information on past climate such as temperature, precipitation rates, atmospheric composition, chemical components, and solid material transported to polar regions. In ice core studies, researchers are often interested in annual or seasonal-scale variations as well as far longer-scale variations such as glacial/interglacial cycles. Detection of such variations from typically km-long samples is time-consuming work that often requires 10^3-10^5 samples.

Usually, measurements on electrical properties are done first because such methods are relatively fast and can quickly locate positions of climatic events on the ice cores. In addition, electrical measurements give high spatial resolution. Historically, several methods from DC to microwave frequencies were tested to ice cores. Electrical properties respond to components such as hydrogen ions, sulfuric acid, chloride or ammonium. Also, crystal orientation fabrics and density are major factors controlling the electrical properties. Therefore various electrical measurements provide not only information on climate but on the physical layering structure of polar ice sheets.

Since 1992, the Japanese Antarctic Research Expedition has conducted a deep ice-coring at Dome F, the second highest dome summit in East Antarctica. The location is 77°19'S, 39°40' E, and 3810-m above sea level, and the ice thickness is 3028 ± 15 m. They recovered ice down to 2503 m, which contains climatic data back 320 kyr or more. Electrical measurements were extensively done along the entire ice core. Here, based on the measurements, I focus on presenting a view of physical/electrical structure of the ice sheet. First, general tendency of the electrical profiles and its relations with various climatic signals are presented. Second, relations between electrical layering and electromagnetic scattering detected by VHF radars are discussed. Third, by combining ice core signals at the coring site and radar sounding data covering wide areas, a view of physical structure of the ice sheet from the dome summit to coastal region is presented.