Formation processes in the Antarctic snow and superficial firn

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The stratigraphy of snow and firn in Antarctica is a complex product of depositional and metamorphic processes. The depositional process is dominated by frequent re-deposition and rare atmospheric precipitation. Metamorphism is a ubiquitous and significant process occurring at the near surface of snow and firn. Relatively little is known about how snow metamorphism affects the physical and mechanical properties of snow in Antarctica, and observations are difficult by traditional means. One reason for the lack of knowledge is that depositional and metamorphic processes occur concurrently. Near-infrared photography, quantitative translucent profiles, high-resolution penetrometry, micro-tomography and computerized polarization microscopy are modern methods capable to improve knowledge of Antarctic snowpacks. These instruments gather detailed stratigraphic information at multiple scales. We applied these methods at two different sites in Antarctica: Pointe Barnola and Kohnen Station. The characteristic stratigraphy and microstructures found at these locations is presented and interpreted. The new methods are very efficient to reveal the complex structures and to characterize layer thickness and variability. Based on our observations, we show that alternating temperature gradient metamorphism, which is the dominant type of metamorphism at the surface and to a depth of about 3 m, has a strong effect on the re-mobilization of the hard snow surface during austral summer, and temperature gradient metamorphism is important during winter. Large erosional events, removing multiple years of deposition, can occur, and have a marked impact on stratigraphy.