Antarctic Ice Sheet and Radar Altimetry

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Abstract

Altimetry is probably one of the most influential technique for ice sheet observation. Our revelation of the Antarctic ice sheet has been deeply altered since the launch of the ERS1 satellite in 1991. With the launch of ERS2 and Envisat, the series of altimetric observations now provides 19 years of continuous and homogeneous observations that allow monitoring of the shape and volume of ice sheets. The topography deduced from altimetry is one of the relevant parameters revealing the processes acting on ice sheet. Moreover, altimeter also provides other parameters such as backscatter and waveform shape that give information on the surface roughness or snow pack characteristics. The Antarctic ice sheet has uneven bedrock, almost entirely covered by ice. Antarctica with a surface of 14 million km², and an average ice thickness of 2,200 m, represents 90% of the terrestrial ice and if melted could lead to an equivalent sea level rise of up to 60 m. The snow accumulation rate in Antarctica is less than a few centimeters per year in the interior and a few tens of centimeters near the coast [3]. That represents approximately 2,200 Gigatons each year or the equivalent of 6 mm of global sea level rise. A slight imbalance may then contribute to significant sea level changes. Monitoring and understanding the Antarctic ice sheet are of great interest to address key scientific issues ranging from past climate conditions to potential future sea level rises. Among all the remote sensing techniques applied to ice sheets, radar altimetry is particularly useful since it provides valuable information for meteorological studies, ice dynamics constraints and mass balance estimations. The aim of this paper is to give a review on the major glaciological progresses made thanks to this sensor. In this context, radar or laser altimetry plays a crucial role. Indeed, among parameters, surface topography is probably the most relevant. From a dynamic point of view, surface topography can be used to constrain ice flow models, to test or initialize them. Ice physical processes often have a specific signature on the ice surface. Note that for ice dynamics study, the bed topography is also crucial. From a balance point of view, monitoring the surface elevation changes inform us about volume variations, we have now 19 years of continuous measurements. Here we will focus on radar altimetry because time series are longer and because it also provides subsurface information. Indeed, due to the penetration of the microwave within the snowpack, radar altimetry has the peculiarity of giving information not only on surface but also subsurface state that can be related to meteorological and climatic parameters.

Keywords: Altimetry Observation, Backscattering, ERS2 and Envisat Satellite and Volume and Shape of Ice.