Geophysical Research Abstracts,
Vol. 11, EGU2009-9804, 2009
EGU General Assembly 2009

On the use of GPR energetic reflection coefficients in glaciological applications

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In this paper we analyse the suitability of Ground-Penetrating Radar (GPR) energetic reflection coefficients for glaciological applications, with focus on glacier hydrology. Standard coefficients such as the internal reflection power (IRP) and bedrock reflection power (BRP), or normalised versions of them, are first analysed in order to point out their weaknesses. Alternative versions of them, such as the internal reflection energy (IRE) or the bedrock reflection maximum (BRM), or normalised versions of them, are then introduced, aimed at overcoming the weaknesses of the standard definitions.

Examples are shown using field data from radiophysical investigations made at Hansbreen, a polythermal glacier in Spitsbergen, in July-August 2003 and in April 2004. These investigations, aimed at studying the glacier hydrology, included repeated radar profiling (20 and 25 MHz) along a transverse profile, repeated common mid-point measurements, continuous radar measurements during 8 days at a fixed site, meteorological observations, and continuous ice surface velocity monitoring by differential GPS.

The repeated GPR profiles are interpreted in terms of variations in the amount of water at the ice-bed interface, and also in terms of variations of melting at the ice surface, which decreases the power transmitted into the ice.

The spatial variations of the internal reflection coefficients correlate with the changes in thickness of the cold ice layer and the occurrence of a drainage and crevasse systems. The comparison of internal and bedrock coefficients allow us to suggest different styles of hydraulic connection of either isolated crevasses, or complex moulin and crevasse systems, with the underlying bedrock. A good hydraulic connection between surface and bed seems to be responsible for the increase in basal sliding, and thus surface velocity, immediately following high surface melting events.