Estimating englacial radar attenuation using depth profiles of the returned power, central West Antarctica

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We analyzed depth patterns of geometrically corrected returned power P_c from within the ice of central West Antarctica to develop a proxy for englacial radar attenuation. The depth patterns of P_c at individual sites were first approximated with least-square vertical gradients of the local-mean P_c for five depth ranges. Variations of these gradients along radar tracks show identifiable trends but have local anomalous features over distances less than ~5-10 km that are caused by smaller reflection from tilted internal layers above steep beds and other factors. Consequently, extraction of an attenuation proxy from the returned power requires mitigation of reflectivity variations. Next, returned power was synthesized only from bright layers assembled over distances much wider than the local anomalous features. Individual data ensembles have a clear upper envelope in P_c and the envelope decreases with depth monotonically between ~500 m and ~1600 m. With the aid of attenuation and reflectivity modeling, we concluded that the upper-envelope gradient can be an attenuation proxy in the isothermal ice, which is expected in the upper half or more of central West Antarctica. The estimated attenuation rate in the upper ~1600 m varies 5 dB/km (one way), equivalent to lateral temperature variations of about 2^oC or chemistry variations of up to a factor of 2. This range indicates that the attenuation variations may alter dependable delineation of bed wetness on the basis of contrasts in power returned from the bed.