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Phase-sensitive radar on thick Antarctic ice – how well does it work?

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Phase-sensitive radar (pRES) has become one of the mostly used tools to determine basal melt rates as well as vertical strain in ice sheets. Whereas most applications are performed on ice shelves, only few experiments were conducted on thick ice in Greenland or Antarctica.
The technical constrains on an ice shelf to deduce basal melt rates are less demanding than on inland ice of more than 2 km thickness. First, the ice itself is usually only several 100s of meters thick; and, second, the reflection coefficient at the basal interface between sea water and ice is the second strongest one possible. Although the presence of marine ice with higher conductivities might increase attenuation in the lower parts, most experiments on shelves were successful.
To transfer this technology to inland regions, either for the investigation of basal melt rates of subglacial hydrological networks or for determining vertical strain rates in basal regions, a reliable estimate of the current system performance is necessary.
To this end we conducted an experiment at and in the vicinity of the EPICA deep ice core drill site EDML in Dronning Maud Land, Antarctica. That site has been explored in extraordinary detail with different geophysical methods and provides an already well-studied ice core and borehole, in particular with respect to physical properties like crystal orientation fabric, dielectric properties and matching of internal radar horizons with conductivity signals. We present data from a commercially available pRES system initially recorded in January 2015 and repeated measurements in January 2016. The pRES data are matched to existing and already depth-calibrated airborne radar data. Apart from identifying prominent internal layers, e.g. the one originating from the deposits of the Toba eruption at around 75 ka, we put special focus on the identification of the basal reflection at multiple polarizations. We discuss the potential uncertainty estimates and requirements to unambiguously identify the basal melt rate on thick grounded ice in Antarctica.