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Ice thickness mapping on active volcanoes using airborne radar systems

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Snow and ice volume storage on ice-capped volcanoes is an important parameter to determine the volume to be potentially melted during eruptive events generating lahar mudflows. In order to estimate glacier water equivalent volumes, we have developed two airborne ground penetrating radar (AGPR) systems, capable of measuring cold, polythermal and especially, temperate ice, commonly found on active volcanoes and Andean mountain glaciers. AGPR permits a fast and efficient survey, of large, remote, crevassed and steep glacier areas. Both systems use a hanging metal structure as an antenna, which needs to be transported by helicopter as a hanging load. One of the radars works with a central frequency of 20 MHz, with a transmitter of 3.2 kV and an antenna weight of 350 kg. This system is designed to be used at low altitude (~2000 m a.s.l.) temperate glaciers or in tephra-covered glaciers such as those in Villarrica volcano, Southern Chile, where high signal attenuation is expected. With this system we have reached a maximum penetration range of near 850 m of temperate ice in Campo de Hielo Patagónico Sur. The second AGPR is a light version of the first system, with less penetration capacity, which uses a central frequency of 50 MHz, a transmitter of 2.4 kV and the antenna structure weighs only 150 kg. This system is designed to be used at high altitude (~4000 m a.s.l.) where cold or polythermal ice is more likely found. With these two airborne radars, we have surveyed a wide range of ice-capped volcanoes of Chile, including Villarrica, Nevados de Sollipulli, Lautaro, Tupungatito, Marmolejo and Palomo volcanoes. A description of the system and examples of the resulting radargrams will be presented.