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An attempt to monitor liquid water content in seasonal snow using capacitance probes

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Liquid water dynamics in snow are a key factor in wet snow avalanche triggering, in ruling snowmelt runoff timing and amounts, and in remote sensing interpretation. It follows that a continuous-time monitoring of this variable would be very desirable. Nevertheless, such an operation is nowadays hampered by the difficulty in obtaining direct, precise and continuous-time measurements of this quantity without perturbing the snowpack itself. As a result, only a few localized examples exist of continuous-time measurements of this variable. In this framework, we tried to get undisturbed measurements of liquid water content using capacitance probes. These instruments were originally designed to obtain liquid water content data in soils. After being installed on a support and driven in the snow, they include part of the medium under investigation in a LC circuit. The resonant frequency of the circuit depends on liquid water content, hence its measurement. To test these sensors, we designed two different field surveys (in April 2013 and April 2014) at a medium elevation site (around 1980 m a.s.l.). In both the cases, a profile of sensors was inserted in the snowpack, and undisturbed measurements of liquid water content were obtained using time-domain-reflectometry based devices. To assist in the interpretation of the readings from these sensors, some laboratory tests were run, and a FEM model of a sensor was implemented. Results show that sensors are sensitive to increasing liquid water content in snow. Nonetheless, long-term tests in snow cause the systematic development of an air gap between the instrument and the surrounding snow, that hampers the interpretation. Perspectives on future investigation are discussed to bring the proposed procedure towards long-term applications in snowpacks.