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Spectral Induced Polarization monitoring of the groundwater physico-chemical parameters daily variations for stream-groundwater interactions

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During the last decades, geophysical methods have been attracting an increasing interest in hydrology and environmental sciences given their sensitivity to parameters of interests and their non-intrusive nature. The Spectral Induced Polarization (SIP) is a low frequency electro-magnetic method that allows the characterization of the subsurface through its complex electrical conductivity. It reports the modulus of the conductivity and the phase between an injected current and a measured voltage over a rather large frequency range (from few millihertz to few tens of kilohertz). The real part of the conductivity is sensitive to lithological (porosity, specific surface area) and hydrological (water saturation, water salinity) parameters, while the imaginary part is linked to electrochemical polarizations, that have been shown to be largely influenced by the chemistry of the pore water.
In the present contribution, we aim at better characterizing the exchanges between a stream and the surrounding groundwater using the SIP method and its sensitivity to pore water changes over time. Two sites from the OZCAR Research Infrastructure (French Critical Zone observatories) have been chosen for this study: the Houay Pano catchment (Laos) and the Orgeval catchment (France). These two sites have a good existing infrastructure and have been already studied extensively in terms of hydrology, geophysics, and hydrochemistry. They constitute perfect experimental sites to develop novel methodologies for the assessment of stream-groundwater exchanges. We propose to obtain a vertical description of the changes in complex electrical conductivity with depth based on SIP soundings undertaken with the multi-channel system SIP Fuchs III. We conducted a high-frequency monitoring close to a river stream (one vertical profiles every 30 min). In parallel, a high frequency monitoring of the physico-chemical parameters (temperature, conductivity, ionic concentrations) in the river stream has been performed. Relating the daily fluctuations of the groundwater complex conductivity and the river physico-chemical parameters could therefore establish a new proxy to characterize stream-groundwater interactions.
In parallel to the field measurements, laboratory experiments have been conducted on soil samples from the two sites. These measurements provide a better understanding of the complex conductivity signature of the samples submitted to saturation and pore water physico-chemical changes. This work is in progress but the first results already show that the method has a real interest for the monitoring of daily variations of the physico-chemistry properties of the groundwater and their relations to those of the stream.