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Assessment of local and regional climate signals in water stable isotopes and chemistry records from new high resolution shallow ice cores in Adélie Land, Antarctica

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Documenting climatic variations in Antarctica is important to characterize natural climate variability and to provide a long-term context for recent changes. For this purpose, ice cores are unique archives providing a variety of proxy records. While water stable isotopes are commonly used to reconstruct past temperatures, their variability may also reflect changes in moisture origin and evaporation conditions. Further information on the origin of air masses can be obtained from aerosols, through the chemical analyses of ice cores. In high accumulation regions, such as the coastal Adélie Land area, the combination of water stable isotope and chemical records is crucial to date ice cores by annual layer counting and assess the associated uncertainty on annual accumulation rates, but may also help to unveil past changes in regional atmospheric circulation.

In order to document accumulation in the area from Dumont d'Urville station to the central Antarctic plateau, towards Dome C, the Agence Nationale de la Recherche ASUMA project (Improving the Accuracy of the Surface Mass Balance of Antarctica, 2014-2018) initiated new field campaigns and was successful in obtaining a network of new shallow ice cores in a previously undocumented region.

Here, we will present new results from two shallow ice cores drilled in Adélie Land, the S1C1 ice core (67.71 °S, 139.83 °E ,279 m a.s.l.) drilled in January 2007 and the TA192A ice core (66.78 °S, 139.56 °E, 602 m a.s.l.). We have dated the ice cores by combining multi-parameter annual layer counting using major ions and δ18O, as well as reference horizons. This allowed us to estimate very contrasted accumulation rates (respectively 21.8 $\pm$ 6.9 cm w.e. y-1 and 73.38$\pm$21.9 cm w.e. y-1), averaged respectively over the period from 1946 to 2006 and from 1998 to 2014 . As a result, we have reconstructed annual accumulation rates, isotopic and ion time series, and investigated their characteristics (mean values, trends and periodicities). The high accumulation rates enables us to compare the ice core seasonal variations in δ18O and deuterium excess with outputs from the ECHAM5-wiso atmospheric general circulation model equipped with water stable isotopes and nudged to ERA reanalyses.

We have investigated through statistical analyses the relationships between inter-annual variations in our new ice core records with local climatic parameters (near-surface temperature, wind speed and direction, local sea-ice extent), and with large-scale modes of variability (ENSO and PSA2).
The first results rule out any significant multi-decadal trend and evidence decadal periodicities already documented in instrumental records. Remarkable years identified in one shallow ice core do not coincide with those identified in the other ice core. No significant correlation with local or regional climate parameters is identified. This suggests that either the ice core signals are dominated by changes in regional atmospheric circulation or that they are strongly affected very local effects of deposition and post deposition, in an area marked by strong katabatic winds.