Optimized determination of ^{17}O-excess in Antarctic snow using cavity ring-down spectroscopy

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Recent developments in laser-based analytical techniques have achieved a measurement of ^{17}O-excess ($^{17}O_{xs} = \ln(\delta^{17}O+1) - 0.528 \cdot \ln(\delta^{18}O+1)$) in water with a precision better than 10^{-5}. We optimized a routine method for the $^{17}O_{xs}$ measurement using wavelength-scanned cavity ring-down spectroscopy (WS-CRDS; L2140-i, Picarro). Based on the precision evaluated from repeated injections of a snow-melt solution (1σ of 17 per meg (10^{-6})), the optimal number of injections was determined. Taking into account the memory effect across different solutions, analyses of the first eight injections were shortened through modifying the original Python codes to save time and were excluded from the result calculation. The VSMOW and SLAP solutions were analyzed to calibrate the $^{17}O_{xs}$ results to the VSMOW-SLAP scale. A Monte-Carlo approach was used to estimate the integrated precision of results according to the injection numbers of the standards and a sample. The modeled precision agreed well with the measured ones with GISP and an in-house working standard, and the injection numbers were adjusted so that the external reproducibility is better than 10 per meg (1σ). The optimized method was applied to two shallow ice cores obtained from the coastal regions of East Antarctica and proved to be sufficient to resolve temporal variations in $^{17}O_{xs}$ characterized by the strong seasonality high in winter and low in summer.