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Online compound specific Radiocarbon analysis (CSRA): Analytical challenges

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With the recent developments in accelerator mass spectrometry (AMS) and online radiocarbon (14C) gas measurements, it has become possible to analyze samples as small as 5 μg C. However, it is crucial to test the reproducibility of data at small sample size and respect proper blank assessment for constant contamination correction. Low abundance and multiple-step during purification procedure are the most demanding analytical challenges for compound specific 14C analysis (CSRA). So far, the majority of compound specific analysis in earth sciences have been measured offline using a vacuume line for tube combustion and subsequent 14C analysis with a cracker system. Compared to online measurements this is a time-consuming and expensive method. In this study, we document processing blanks from different classes of compounds such as n- alkanes, amino acids, alkenones and n-fatty acids using an elemental analyzer (EA) directly coupled with an AMS at ETH Zurich. Comparison with previously measured sample blanks and processing blanks prepared with a vacuum line and measured by cracker system is favorable. Furthermore, it was investigated how reproducible and robust the results are when dealing with compounds smaller than 10 μg and low in concentration (> 15 ka). Finally, the protocol for sample preparation for each class of compound prior to AMS measurement is discussed with the aim of reducing the amount of extraneous carbon.
The presented data from online measurements show that blank values from processed and non-processed blanks are very similar to the values obtained from offline measurements making EA-AMS a promising alternative to offline measurement for CSRA. However, the magnitude of uncertainty has to be carefully considered in order to provide meaningful information and avoid misinterpretation of data. Regardless of the specific application, in the case of small compound sample sizes (< 10 μg C) with low concentration duplicate measurements are important, as the magnitude of uncertainty derived from error propagation during data processing can be very high. This remains a big challenge in some class of compounds.