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Progress in the analysis and interpretation of N_2O isotopes: Potential and future challenges

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In recent years, research on nitrous oxide (N_2O) stable isotopes has significantly advanced, addressing an increasing number of research questions in biogeochemical and atmospheric sciences [1]. An important milestone was the development of quantum cascade laser based spectroscopic devices [2], which are inherently specific for structural isomers ($^{15}N^{14}N^{16}O$ vs. $^{14}N^{15}N^{16}O$) and capable to collect real-time data with high temporal resolution, complementary to the well-established isotope-ratio mass-spectrometry (IRMS) method. In combination with automated preconcentration, optical isotope ratio spectroscopy (OIRS) has been applied to disentangle source processes in suburban, rural and pristine environments [e.g. 3, 4].

Within the European Metrology Research Programme (EMRP) ENV52 project "Metrology for high-impact greenhouse gases (HIGHGAS)", the quality of N_2O stable isotope analysis by OIRS, the comparability between laboratories, and the traceability to the international isotope ratio scales have been addressed. An inter-laboratory comparison between eleven IRMS and OIRS laboratories, organised within HIGHGAS, indicated limited comparability for ^{15}N site preference, i.e. the difference between ^{15}N abundance in central (N*NO) and end (*NNO) position [5]. In addition, the accuracy of the NH_4NO_3 decomposition reaction, which provides the link between ^{15}N site preference and the international $^{15}N/^{14}N$ scale, was found to be limited by non-quantitative NH_4NO_3 decomposition in combination with substantially different isotope enrichment factors for both nitrogen atoms [6].

Results of the HIGHGAS project indicate that the following research tasks have to be completed to foster research on N_2O isotopes: 1) develop improved techniques to link the ^{15}N and ^{18}O abundance and the ^{15}N site preference in N_2O to the international stable isotope ratio scales; 2) provide N_2O reference materials, pure and diluted in an air matrix, to improve inter-laboratory compatibility. These tasks will be addressed in the upcoming European Metrology Programme for Innovation and Research (EMPIR) project "Metrology for Stable Isotope Reference Standards (SIRS)" starting in June 2017.

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