Towards SI traceability for CO_2 isotope ratios: Identifying sources of error in optical spectroscopy measurements

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In order to properly characterise the increasing greenhouse gas concentrations in the atmosphere, there is a clear need to distinguish between anthropogenic and natural contributions. A valuable discriminant for such determination is stable isotope analysis, which can provide information on the origin of a gas species. Through technological advances, it is possible to make such measurements with field-capable optical spectrometers. However, with numerous monitoring stations around the world, and with different instrumentation often employed, it becomes crucial to establish a traceability chain to allow accurate comparisons between measurements, both in time and between different monitoring locations.

European metrology research projects, such as the recently completed Metrology for High Impact Greenhouse Gases (HIGHGAS), and the newly commenced Metrology for Stable Isotope Reference Standards (SIRS), have moved to address the need for metrological impact on optical isotope ratio spectroscopy. The goals of these projects cover a range of topics, including the development of static and dynamic reference materials for CO_2 in air, the development of validation routines to provide recommendations on the best practice for monitoring networks, and the development of traceable field-deployable spectrometers which can meet the WMO compatibility goals. To achieve these goals requires the development of significantly stable instrumentation, as well as extremely careful instrument characterisation.

Preliminary work on the development of a metrologically characterised optical spectrometer for the determination of $\delta^{13}C\text{-}CO_2$ and $\delta^{18}O\text{-}CO_2$ will be presented. Issues related to measurement uncertainty, such as temperature, pressure and matrix effects, and their resulting effects on $\delta^{13}C\text{-}CO_2$ and $\delta^{18}O\text{-}CO_2$ values, will be covered.