Improving inter-laboratory compatibility of atmospheric carbon dioxide and methane isotope measurements.

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Around the world laboratories that are part of the Global Atmospheric Watch (GAW) community conduct atmospheric trace gas measurements under the auspices of the World Meteorological Organisation (WMO). The GAW-WMO defines the inter-laboratory compatibility goals for these measurements, that is the maximum tolerable bias these measurements may have in order to still be useful for modelling and flux studies. The GAW-WMO network compatibility goals for \(\delta^{13}\text{C} \)- and \(\delta^{18}\text{O}\)-CO\(_2\)(atm) measurements are 0.01 ‰ and 0.05 ‰ respectively, and for \(\delta^{13}\text{C} \)- and \(\delta^{2}\text{H}\)-CH\(_4\)(atm) measurements they are 0.02 ‰ and 1 ‰, respectively. It has to be noted that these goals are very ambitious and at the precision limit of current analytical techniques. Nevertheless, in particular the isotopic measurements of atmospheric methane have suffered from considerable inter-laboratory biases of up to 0.5 ‰ and 13 ‰ for \(\delta^{13}\text{C} \)- and \(\delta^{2}\text{H}\)-CH\(_4\)(atm) measurements in the past (Umezawa et al., 2018).

These inter-laboratory measurement biases have been, and still are in part due to the different standardisation strategies that are used in different laboratories. In order to tackle this problem the stable isotope laboratory at the Max-Planck-Institute for Biogeochemistry (BGC-IsoLab) developed the Jena Reference Air Scale (JRAS-06) that has been in use since 2006. JRAS-06 is the scale realisation of the VPDB-CO\(_2\) scale, and its use is recommended by the GAW-WMO community to standardise \(\delta^{13}\text{C} \)- and \(\delta^{18}\text{O}\)-CO\(_2\)(atm) measurements. The JRAS-06 scale is based on CO\(_2\) in air standards where the CO\(_2\) is evolved from standard calcium carbonates (e.g. NBS 19). Using an example dataset of \(\delta^{13}\text{C} \)- and \(\delta^{18}\text{O}\)-CO\(_2\)(atm) measurements we show the improved inter-laboratory compatibility that results from using the JRAS-06 standards and scale at two laboratories, the stable isotope laboratory at the Institute of Arctic and Alpine Research (INSTAAR) and BGC-IsoLab.

The BGC-IsoLab is now collaborating with the National Institute of Water and Atmospheric Research (NIWA) in New Zealand in order to develop standards and a unifying scale for \(\delta^{13}\text{C} \)- and \(\delta^{2}\text{H}\)-CH\(_4\)(atm) measurements analogous to the JRAS-06 scale realisation. Here we show the first results of this collaborative effort towards a JRAS-M(ethane) scale that aims to improve the inter-laboratory compatibility and closely link \(\delta^{13}\text{C} \)- and \(\delta^{2}\text{H}\)-CH\(_4\)(atm) measurements to the international VPDB-CO\(_2\) and VSMOW scales, respectively.