Investigation of adsorption / desorption behavior of high pressure small volume cylinders and its relevance to atmospheric trace gas analysis

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A critical issue for the long term monitoring of atmospheric trace gases is precision and accuracy of the measurement systems employed. In order to achieve a globally integrated and well established greenhouse gas observation network, the World Meteorological Organization (WMO) has recommended compatibility goals for measurements of trace gases within its Global Atmosphere Watch (GAW) programme [1]. These challenging limits can only be achieved by regular calibration with standard gases of known composition. However, standard gases may not be stable throughout a measurement period due to diffusion, leakage, regulator effects, gravimetric fractionation and surface processes [2, 3]. The latter, which encompasses adsorption / desorption, is also dependent on temperature, pressure and surface properties. Currently there exists only limited data and a few attempts to quantify these surface processes [4, 5].

For this study, high pressure small volume measurement chambers were produced which enable to investigate trace gases and their affinity for adsorption / desorption on various surfaces over a set of temperature and pressure ranges. The presented experiments are designed to investigate the filling pressure dependency up until 40 bars, and temperature dependency up until 50°C for these prototype cylinders of steel and aluminum. Here, we focus on measurements of CO_2, CH_4, CO and H_2O using a cavity ring down spectroscopy analyzer. Moreover, a theoretical adsorption isotherm is used to explain the changes in the measured concentrations for both pressure and temperature variations.

References

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