High-precision, Continuous and Real-time Measurement of Atmospheric Oxygen using Cavity Ring-down Spectroscopy

J. Boulton

Picarro Inc., Santa Clara, CA 94054; 408-962-3946, E-mail: jboulton@picarro.com

Oxygen (O_2) is a major and vital component of the Earth atmosphere representing about 21% of its composition. It is consumed or produced through biochemical processes such as combustion, respiration, and photosynthesis and can be used as a top-down constraint on the carbon cycle. The observed variations of oxygen in the atmosphere are relatively small, in the order of a few ppm's. This presents the main technical challenge for the measurement since a very high level of precision on a large background is required. Only few analytical methods including mass spectrometry, fuel, ultraviolet[1] and paramagnetic cells are capable of achieving it.

Here we present new developments of a high-precision gas analyzer that utilizes the technique of Cavity Ring-down Spectroscopy to measure oxygen concentration and its oxygen isotope ratio $^{18}O/^{16}O$. Its compact and ruggedness design combined with high precision and long-term stability allows the user to deploy the instrument in the field for continuous monitoring of atmospheric oxygen level. Measurements have a 1-σ 5-minute averaging precision of 1-2 ppm for O_2 over a dynamic range of 0-50%. We will present comparative test results of this instrument against the incumbent technologies such as the mass spectrometer and the paramagnetic cell. In addition, we will demonstrate its long-term stability from a field deployment in Switzerland.

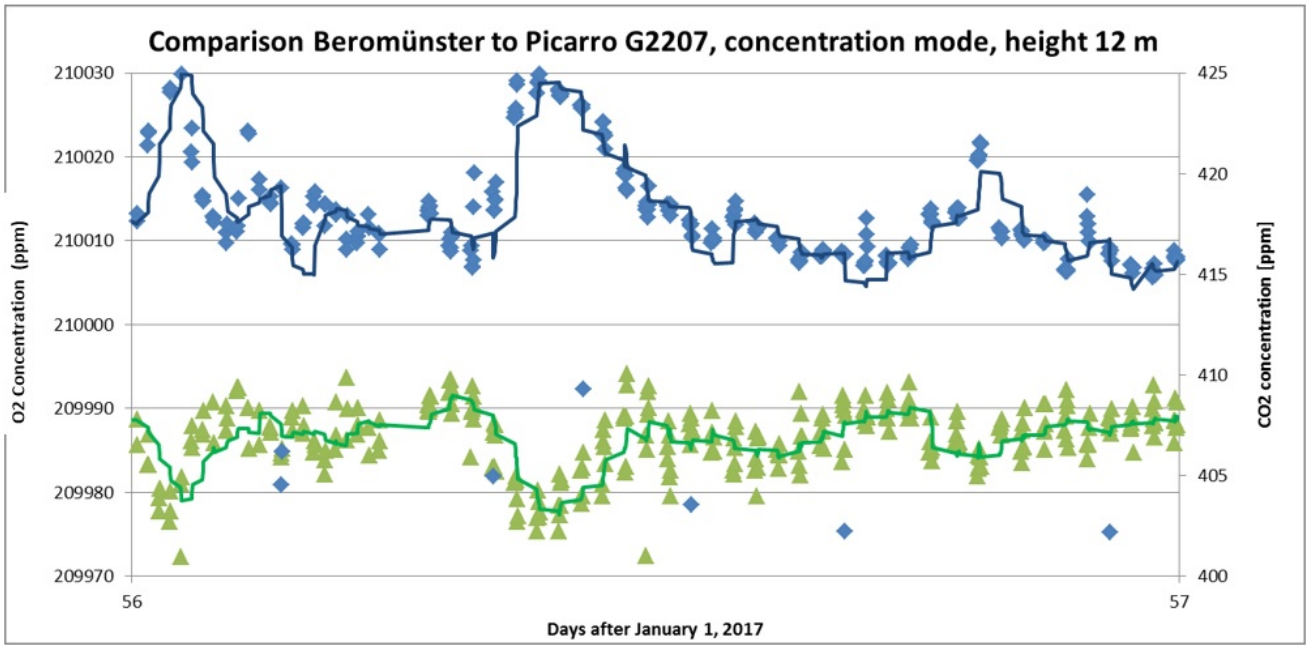

Figure 1. Concentration mode measurements at Beromünster tall tower, in blue CO_2 concentration by a Picarro 2401 instrument and in green O_2 values for the inlet at 40 m height, six minute switching. The dark blue and the light green lines correspond to a 10 point running mean of the 30 seconds means, i.e. 5 minute running averages over one day.