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High Precision Continuous and Real-Time Measurement of Atmospheric Oxygen Using Cavity Ring-Down Spectroscopy

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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 18O/16O. 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.