Adaptation of a commercial greenhouse gas analyser for airborne measurements with expanded altitude range and application on the ORCAS and ATom campaigns

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The commercial availability of the Picarro cavity ring down spectrometer (Crosson 2008) has advanced our community's ability to make highly stable and precise measurements of CO_2 and CH_4 mixing ratios in the atmosphere. We have expanded the Picarro's operating altitude range through a software modification to lower its cell pressure set point. This approach for airborne applications eliminates the need for significant engineering of auxiliary systems, such as upstream sample pumping or pressure control. The concept of a flexible cell pressure set point, without significant reductions in pressure control or measurement precision, opens up new possibilities for continuous greenhouse gas measurements on airborne platforms with minimal ancillary engineering and operational requirements.

We evaluate the behavior of a Picarro analyzer with a modified pressure set point through a series of laboratory tests and controlled field tests, and describe its performance on two aircraft campaigns that sampled at altitudes up to 14 km (150 hPa). We compare Picarro measurements on the ORCAS and ATom campaigns to those made by several other measurement systems, including a high-precision laser spectrometer (QCLS, Santoni et al. 2014), a non-dispersive infrared spectrometer (LiCor/AO2, Stephens et al. 2003), and two flask-based systems (Medusa from Scripps and Programmable Flask Packages from NOAA). We present an empirical uncertainty analysis of the Picarro measurements that accounts for short-term measurement precision, stability in the analyzer response during individual flights and for a campaign duration, the analyser-specific empirical water vapor correction that is applied to the undried measurements, and the traceability of reported values to WMO scales. By this methodology total average uncertainty is approximated for 1-second measurements as 0.1 ppm for CO_2 and 0.7 ppb for CH_4 (1-sigma) for these two campaigns.

References

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