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Atmospheric Measurement Techniques Discussions

Interactive comment on "Tracking isotopic signatures of CO_2 at Jungfraujoch with laser spectroscopy: analytical improvements and exemplary results" *by* P. Sturm et al.

Anonymous Referee #2

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Presented are outcomes of more than three years of observations of carbon dioxide concentration and 13C and 18O isotopic ratios, using a laser spectroscopy instrument at a high altitude location in the Alps. The outcomes are compared to a dispersion model simulation to help interpret diurnal and seasonal variability by a correlation to clustered source areas.

The authors document the changes made to their instrumental setup during the monitoring period in detail, both in technical (e.g., improved temperature stabilization) as well as procedural (calibration, post-processing) aspects. This is supported by benchmark statistics, showing improvement over previous work. The combination with model simulation is a good case study, but the depth in which this is discussed suggest that the main contribution of this ms is an update to the instrumental state of the art. That alone would be of interest to ATM readership, but open questions on the comparison with the simulation outcomes may leave the reader wishing for more.

Comments:

1. The authors are brief in their discussion and interpretation of the model comparison. What new insights do the isotopic data add? Isotopes are introduced as 'ideal tracers of sources and sinks' (p2,l22) in natural systems, yet the presented research is focused on anthropogenic emission in winter, for which mostly the concentrations provide the information, less so the isotopes. For instance, it would be interesting to learn if the detailed isotopic data can tell us if the relative contribution of fuel/wood combustion contrast clusters representing warmer (south, cluster 1+5) or colder synoptic weather (Atlantic and continental land mass; cluster 2,6,8). Instead, the authors conclude 14C information is needed instead (p19l7–l13). Thus, we are shown that it is possible to have a highly detailed isotopic record of 13C and 18O of carbon dioxide for high altitude sites, but not offered a very strong argument for its relevance.

2. With the presented study and previous experience, the authors could more prominently discuss the implications of the standards set by WMO (p3l2) for interlaboratory compatibility when using state-of-the-art spectroscopic instruments. Can this be achieved at field sites in challenging conditions? If not, what are the options for more tuning of the setup or further technical improvements?

3. The authors have given much thought to the schedules of calibration and measurement time. The trade-offs can lead to complications that are not discussed in much detail. For instance, a 120 s average for a reference gas is used as a benchmark for 10' averages (p12l26) and shows SDs that are higher than the reported performance. This gives a somewhat misleading image of the measurement data quality, for which the benchmark values at any time will lie between the Allan variance statistics and the variability of the 2' averages. Please explain why the measurement of reference gas was not made for a duration that is aligned with the optimal 10' averaging period for the measurements. Would periodic change from 2' to 10' make a more useful benchmark or do you advise against it (and why)?

Minor comments:

1. p7l1: 'traceability of the isotope data remains a challenge' what exactly do you mean?
2. p7l7: Manufacturer of the carbon sources gases?
3. p8l7: are these causes in order of importance?
4. p13l14: Would regression (slope, R2) not be a better indication of how these estimates correlate then their mean difference?
5. p18,l7: What defines remote? A remote location could still be one with a laboratory environment, stable mains power and temperature regulated by heating (for readers not familiar with the site). The challenge seems to have been the high-altitude, low pressure conditions.
6. Title: 'Exemplary results' The data are extraordinary, but is the qualification 'the best of its kind' justified in the title? Do you mean 'case study' or 'result highlights'?

7. Title: 'Jungfraujoch' may not be known well enough to be read as synonym for 'high elevation' site.
8. Fig.1. The temperature stabilization in the diagram suggests heating of the sample/gas inlet tubes. The text mentions stabilization of the optics (p6l7). Please clarify.
9. Fig.2. This was determined at the Jungfraujoch site? Not mentioned in the text.
10. Fig.7. Please add statistics to these means
11. Offset correction: "one-point (offset) calibration, drift cylinder, reference gas, drift standard, cylinder B or C" Please check if this can be simplified. Several terms are used for the same thing and it is not always clear from the text (maybe cited works) if a correction is made to the carbon dioxide concentrations only, or also the stable isotope ratios.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 423, 2013.