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Interactive comment on "Evaluating the performance of commonly used gas analysers for methane eddy covariance flux measurements: the InGOS inter-comparison field experiment" *by* O. Peltola et al.

Anonymous Referee #2

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General Comments

This paper presents the results from a two weeks field test of eight fast response methane analysers that were used in an eddy covariance (EC) setup in order to calculate the turbulent exchange of methane between a grassland site and the atmosphere. The data analysis covers the instruments' performance in terms of precision, necessary spectral and density corrections and consistency of calculated fluxes. The manuscript is very well written, the high quality data are thoroughly analysed and despite its complexity the paper is well structured and thus easy to read and to understand.

The available techniques to measure atmospheric methane concentrations at high frequencies – and the number of available sensors – have developed rapidly during the last years. Sharing the results from a systematic field comparison between the most promising of them is therefore highly relevant and useful for the scientific community. A particularly useful and novel aspect is the detailed analysis of the necessary density corrections due to simultaneous water vapour fluxes, which is not straightforward if the water concentrations are not measured in the same cell as the methane concentrations are. This is the case for some of the older instrument versions, and the corresponding uncertainties and biases have often been neglected in earlier EC studies.

Therefore I consider the manuscript as a suitable contribution to "Biogeosciences" and I expect that it has the potential to become a much cited reference paper. A problem I have with the paper is nevertheless the short duration of the field experiment that does not exactly allow wide-ranging conclusions about the sensors' performance in continuous EC studies. Therefore I recommend that the authors be encouraged to make a few clarifying changes to the text and to at least one table before a decision about publication in "Biogeosciences" can be made. The recommended minor revision should refer to the following specific comments and questions:

Specific Comments

Page 800/801: The second paragraph of the Introduction section raises the issue of long-term measurements at remote sites and the need to assess the suitability of gas analysers for such purposes. However, this question is not really answered in this paper because it contains only a very short data record (< 1 month) – in contrast to an earlier Peltola et al. (2013) paper in BG. The suitability of the analysers will actually depend on their stability, for example in terms of CRD time or corresponding indices, and the required maintenance work (filters, mirrors etc.). For instance, the necessity to clean mirrors every second day (section 4.1) would rule such an instrument out for certain setups. Please make absolutely clear what kind of conclusions can be expected from this paper and which questions it can NOT answer.

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Page 804: Please explain whether the changes in the measurement frequency of the DLT-100 and the FMA2 were done accidentally or on purpose.

Page 814 bottom: How was the unusual threshold of u_star > 0.08 m/s identified? Please explain whether this was an arbitrary choice or a decision based on data analysis.

Page 816 bottom: Why is the observation of a missing influence of CRD time on the noise "surprising"? I would leave this word out. As long as CRD time is above a certain threshold it will no longer affect the noise which would instead be dependent on other limiting factors such as the sensor's general resolution limit or pressure fluctuations in the cell.

Page 817 bottom: Was the low measurement frequency, the resulting artificial (linearly interpolated) 10 Hz data and the corresponding slow response time of the G2311-f (Fig. 6) in fact the reason for the - apparently - very low noise in the "raw" methane concentrations (Fig. 5) of this sensor? This should be discussed on page 825, line 25.

Page 825: The discussion on long-term applications of the sensors is not sufficient. It appears as if data gaps, for example caused by rain for open-path analysers, would be the only issue with respect to an analyser's suitability. Actually, this short-term study cannot judge about the analysers' long-term performance. Please add a sentence or two about what else we would need to know to make a statement about which analyser(s) to choose for long-term applications.

Table 1 (and corresponding text on page 804): Here I am missing some very important information about the setup: What was the cell pressure in the analysers? Were the vacuum pumps able to keep it constant or did it vary during the experiment (and if yes, how much)? Did the pumps (Edwards vs. Varian) in combination with the respective filter settings perform equally well? This is important because the noise and the magnitude of the measured methane concentrations will depend on how well the target pressure in the cells could be maintained.

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Looking at Fig. 1 I wonder why there were two additional sonic anemometers mounted on the tower – did they have any connection to the experiment described here?

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