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Atmospheric Measurement Techniques Discussions

Interactive comment on "Fine-scale turbulence soundings in the stratosphere with the new balloon-borne instrument LITOS" *by* A. Theuerkauf et al.

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Reply to anonymous referee #2

We would like to thank the referee for the comments and for the extensive linguistic editing.

(a) From the title, we expect to see turbulence soundings from the surface to the stratosphere (or, at least in the stratosphere), so I would suggest to elaborate on

the magnitude of epsilon, its variation (i.e., turbulent versus non-turbulent regions) and the sharp boundaries observed between the two regimes of stratospheric turbulence. The topics of turbulent versus non-turbulent regions and the sharp boundaries separating them have been barely discussed.
According to the comment of the referee we changed the title of our paper to: "LITOS - A new balloon-borne instrument for fine-scale turbulence soundings in the stratosphere". With the new title we want to emphasize that this paper should address mainly the technical aspects of the new instrument LITOS and the results of the laboratory measurements as it is the scope of the journal. Based on an example of a turbulent layer in the stratosphere we demonstrate the procedure to quantify the energy dissipation rate. More geophysical analysis and profiles of the energy dissipation rate, its magnitude and variations will be aspect of a subsequent paper. For this reason we just shortly discuss the topic of turbulent versus non-turbulent reason and the sharp boundaries between them. However, to confirm our statements we replaced Figure 5 and 6 with a new Figure showing a longer data sequence including boundaries between the turbulent layer and the non-turbulent regions.

Also, since it is claimed in the abstract that balloon launches provide high resolution turbulence soundings up to 35 km altitude, it would be nice to see a vertical profile of epsilon from the surface to the stratosphere.
In this first paper we focussed on the description of the instrument, the results of the laboratory measurements and a first case study of turbulence in the stratosphere. For clarification we changed the sentence 3456L15-16 in the abstract to: "A first case study in the stratosphere allows..." Nevertheless, the instrument enables the quantification of epsilon from the surface up to the stratosphere. Those observations and vertical profiles of epsilon will be part of a subsequent paper, as the geophysical interpretation requires some elaboration on e.g. layer thickness, layer distances, turbulence strength and turbulence origin.

(b) I find that the description of the technique, in particular Sect. 2, could be shortened. For example, Eq (1) is presented in appendix A, so remove it in the text.
The referee is right, that Eq. (1) is unnecessarily presented twice. Instead of removing the equation in the text we decided to remove it from the Appendix A. We want to clarify already in the description of the CTA system that the heat balance is a sum of four different heat fluxes. Thus we want to indicate why it was necessary to perform the laboratory measurements described in the following section.

Furthermore, the technique of estimating epsilon from hot-wire anemometry has been previously used in the troposphere, therefore I consider the presentation of your technique not as novel. Please see at least these two papers: Balsley, 2008 "The CIRES Tethered Lifting System: a survey of the system, past results and future capabilities" Acta Geophysica, 56(1), 21-57. This paper shows that hot-wire anemometry has already been used to estimate epsilon in particular. Frehlich et al., 2003 "Turbulence measurements with the CIRES Tethered Lifting System during CASES-99: calibration and spectral analysis of temperature and velocity" J. Atmos. Sci., 60, 2487-2495. This paper is worth referencing.
With respect to your comment we add both papers to our reference list. It is true that Frehlich et al., 2003 used also hot-wire anemometry for the retrieval of epsilon values. By using a Kite-System and a tethered balloon they estimated energy dissipation rates for the atmospheric boundary layer. Our main goal is the estimation of energy dissipation rates in the stratosphere. Therefore we are using hot-wire anemometry on balloons and this has never been done before. Several aspects of using CTA in the stratosphere like the heat transfer with decreasing air density, calibration issues etc. are different from the usage of CTA in the laboratories or in the boundary layer and therefore need to be considered. Despite the experimental aspects we are using

another procedure for the calculation of energy dissipation rates. Frehlich et al., 2003, applied a maximum likelihood estimation of the spectral level to derive the energy dissipation rate from the spectrum. Whereas we apply the least mean square method to determine the inner scale of the spectrum which is directly related to the energy dissipation rate. This method was introduced by Lübken 1992 and Lübken 1993 and we have adapted it for the first time to our data of relative voltage signals from velocity fluctuations. Thus we would maintain the statement that our paper presents a new technique for the estimation of energy dissipation rates in the stratosphere.

(c) I would also suggest combining figures such as: - Put Figs. 3 and 4 together as (a) and (b) (under one figure number) - Same thing for Figs. 5 and 6 - Same thing for Figs. 7 and 8
We put together Figure 3 and 4 as well as Figure 7 and 8. Instead of the Figures 5 and 6 we added a new figure showing the sharp boundaries between a turbulent layer and the non-turbulent regions.

In general, please see the marked-up paper (attached) for numerous suggested edits.
We thank the referee for the extensive editing of the manuscript. We took the comments carefully into account.