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Interactive comment on "Consumption of atmospheric methane by the Qinghai–Tibetan Plateau alpine steppe ecosystem" *by* Hanbo Yun et al.

Anonymous Referee #1

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Yun et al. present in this paper eddy covariance based observations of land-atmosphere methane exchanges in concert with environmental data, such as climate and soil temperature or water content. The data shows that the site at the Tibet plateau is a net annual methane sink, which is an important finding for better constraining bottom-up estimates of the methane balance. Most semi-empirical models so far do not allow any methane sink but assume a methane source of soils. Interestingly, this ecosystem, if uniform in soil properties and vegetation, seems to act as methane source during winter and spring while acing as a methane sink in summer and autumn.

These findings are interesting and important, and the paper is in general well written.

Still, I do have some questions and comments that should be addressed thoroughly prior to any publication.

i) This is a good introduction into the topic and knowledge gap. However, I request to state the research questions addressed here more precisely. I can see at least three questions: - What is the long-term annual methane budget of the study site? - What is the seasonal methane budget of the study site? - Which environmental factors control the seasonal methane budget and why? - Is a classical vegetation productivity based definition of growing season useful for defining the methane flux seasonality? The manuscript tries to address all these questions but it is useful to state them precisely in the introduction, and then they can be addressed with respective methods and presentation of results.

ii) Cryoturbation is a collective term for many soil transport processes based on freezing and thawing that lead to a subduction of topsoil horizons down to the transition zone. This term is wrongly used in this manuscript. I think what the authors mean is freezing and thawing instead. Please, correct this.

iii) In addition to eddy covariance based observations of methane fluxes, this study presents a lot of observations of environmental factors, such as climate and soil properties. This is really interesting because this allows addressing the question on why do we see this strong seasonality with methane sources (summer, autumn) and sinks (winter, spring). However, the data presented does not explain these seasonal differences. The attempts of explanation in the discussion section with several hypotheses are important but please include into this discussion how these hypotheses could have been proven by your data or which other measurements were required.

In general, the temporal differences in eddy cov CH4 time series could have been due to either temporal differences in soil processes or spatial differences of the footprint. I strongly suggest to first rule out the latter case before discussing all kind of soil processes leading to the seasonality of methane fluxes: Are there more wet or dry soil

areas in the footprint and do we see methane flux dynamics due to changes in the footprint? Please, analyze wind direction and wind speed together with methane fluxes in Fig. 5. Also, the main wind direction can be displayed in color scale in fig 9.

One more idea that could be tested is the importance of vegetation activity for an oxygen flux into the soil. You could analyze your GPP data from the tower in concert with methane fluxes to prove this hypothesis.

Minor comments - I would place fig 13 and 14 directly after fig 5. Fig 14 should have the same order of seasons than fig 13 and a uniform y-axis scale. - Most of section 3.2 should be part of the methods section.

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