Review of egusphere-2026-2644: “Methane in the Asian Monsoon Anticyclone and global UTLS behavior observed in ACE-FTS satellite data“ by You Yi et al.

The manuscript by You Yi and colleagues addresses the impact of the Asian Summer Monsoon (ASM) on the distribution of methane in the upper troposphere and lower stratosphere (UTLS). For this the authors use satellite data from ACE-FTS to describe the vertical and horizontal distribution of methane as well as the seasonal cycle of methane in this region. They show that methane has its maximum at higher altitudes than a comparable tracer, CO, and that the decrease of methane concentrations into the stratosphere starts at higher altitudes than for CO. This is attributed to the longer lifetime of methane. Their results are supported by in situ observations from AirCore and aircraft measurements. Together with data for surface methane emissions, they can also demonstrate the effectiveness of the lifting process within the ASM – while emissions peak during summer, the peak methane concentrations in the UTLS occur in autumn. The authors also analyze trends based on the ACE-FTS data which are in line with previous findings.

Methane is a highly relevant constituent in the atmosphere with increasing importance in discussions centered around climate change. Analysis of the global distribution and sources of methane are of relevance and fit well into the scope of ACP. The manuscript addresses an interesting question, particularly based on observational data. Such data is often required to validate chemistry climate models and might also be relevant for trend studies. Therefore, the paper will be a great addition to the scientific literature. In my opinion, the manuscript is overall already in a good shape. The scientific reasoning is sound, the figures are appropriate and fit to the story. The overall thematic flow of the paper is clear and comprehensible. However, this is the case if the reader is already in an expert in the topic. For all others, I think the manuscript would benefit from more information and extended discussion at several points. This is also my main concern on which I will give some examples below. Otherwise, I think the paper is on a good path to be published and I recommend a publication after minor revision. I choose minor revision here because my comments are mainly about providing more information and not about a new or extended analysis or about reasoning.

My major concern is that although all relevant information is touched upon in each section, the often very brief presentation of the content gives the impression that the authors have reduced the material too much. Since this occurs in many places throughout the manuscript, the overall impression is that important information necessary for understanding and proper contextualization is missing or treated too superficially. Some examples are given below:

- In the introduction I am missing a sentence or two about methane sources, especially in South-East Asia to emphasize why this region is so important for the global methane budget not only from a transport perspective but also from an emission perspective. This could be part of the first paragraph (l. 28ff) or of the paragraph starting in line 43.
- Since CO is also widely discussed throughout the manuscript, it might deserve a small introductory paragraph, at least to contrast it to methane in the introduction.
- The paragraph about ACE-FTS (l. 47ff) would benefit from some references. There are several statements in this five lines which could be filled with references. Also it

would be good to inform the reader about other methane (and CO) related studies with ACE-FTS to put the results from this study more in perspective.

- Line 62: What is the wavenumber 0.02 cm-1? Please specify.
- Line 68: Here you mean effective *horizontal* resolution? What is meant with oversampled at 1 km?
- Is there a specific reason why no measurement error is given for the AirCore data? (section 2.2.1).
- Figure 1: the lapse-rate tropopause shown in this figure is derived from which data? Does this lapse-rate vary much between the individual flights? I asked whether I would like to know whether the differences between methane and CO which are discussed here might become even more prominent when all profiles would be plotted in a tropopause relative coordinate system.
- In section 3 it is often mentioned that ERA5 data has been used. Since this occurs at multiple occasions, I would suggest to include a small subsection in Section 2 about the ERA5 data used in this study.
- In Figure 3 the black lines show a stream function, how is this calculated? Which years are used, which values of the stream function are shown her and does this explain why the lines are only evident in the region of the ASM?
- Also in Figure 3 it is not fully clear to me why 16.5 and 14.5 km have been chosen here for methane and CO? The text says that the maximum of CH4 is around 16 km, and for CO 14 km. From Figure 4 would follow that the maximum for CH4 is more 15.5 km and for CO 13.5 km to 14 km.
- The lapse rate tropopause in Figure 4: has this been calculated by yourself? If so how and on which ERA5 data (pressure level, model level, monthly mean, daily, hourly data, horizontal and temporal resolution)?
- In Figure 5, the gray lines show the stream function: what is meant with composite here? Do I assume correctly that the data source is again ERA5? And did you calculate the vertical wind from the Lagrangian tendency of the pressure (omega)? Why are there only gray lines between ~15°N to 60°N? And finally, I would have expected that th the upwelling (tropics) and the downwelling (extratropics) would be evident in the stratosphere, but the arrows along the streamlines all point upward. Is this related to the region and time?
  The blue line is again the ERA5 lapse-rate tropopause? And the contour lines for the horizontal wind show magnitudes of +10 m/s and +20 m/s (solid) and -10 m/s and -20 m/s (dashed)?
- In Figure 7, OLR data is shown? Where does this come from and what exactly is shown here? At some places it seems that multiple lines are evident and not just one line for 220 K.
- For the discussion around and the data in Figure 8, the region is extended to 15°S-30°N and the entire zonal direction. How well does this represent the ASM region?
- Also for Figure 8 and the surface emission data: Can you include some more information about this surface data set, so that is not necessary to go the Saunois et al. paper.
- Is the LOTUS regression model the one available here on this web page: https://usask-arg.github.io/lotus-regression/. Can you provide further details about the model in your text, especially, on your setup (proxies and input data).
- Figure 10 b): which bin size has been used here for this plot (in delta z and delta lat)? And could you provide potentially one sentence why the trend is larger at the tropical tropopause than above? Is this upwelling related or has this to do with the strength of lateral mixing?
- ERA5 data should be listed in the Data availability section.