Review of the manuscript "Analysis of regional CO_2 contributions at the high Alpine observatory Jungfraujoch by means of atmospheric transport simulations and $\delta^{13}C$"

General remark:

The data set presented in the manuscript is unique and valuable due to its long period, precise measurements and the remoteness of the station. Therefore, the presented rigorous analysis the data set is important. The analysis comprises measurements and model simulations, which are combined in a reasonable manner. The manuscript is well structured. Some of the passages are rather descriptive and could be refined. I recommend publication in ACP after some additional revisions concerning the following remarks:

Specific comments:

- Line 22: The authors comment that n R^2 of 0.4 is "remarkable" for the Alpine topography. However, a more objective description would rather be "acceptable" or "according to expectations".
- Line 69 – 85 and 114-125: This is much detail on other tracers, which are not investigated in the paper, and makes the paper lengthy and more diffuse. I recommend skipping or at least shortening discussion on CH4, CO, N2O, ^{18}O-CO_2 and ^{14}C as they are not the scope of the paper.
- Line 300: "And overall agreement within the extended compatibility parameters of the WMO". The extended goals reflect the less stringent requirements for urban and regional studies. However, as Jungfraujoch station is a remote station with only small influences of pollution, the authors should not reason with the extended WMO goals here. In the contrary, they should argue why not reaching the WMO goals for clean sites does still allow the analysis in this manuscript.
- Line 388: The authors describe the "fair-weather-effect", but they do not outline why this effect may be inadequately captured in the models.
- Line 395ff: As VPRM fluxes dominate the measured regional CO_2 signal (especially in summer), an estimation of uncertainty of VPRM fluxes would be very valuable. The authors make some qualitative statements about VPRM, but leave the reader without a clue on the uncertainty of these biogenic fluxes.
- Figure 6 and Line 529ff: The general pattern of $\delta^{13}C$ is captured by the models. However, small changes in $\delta^{13}C$ smaller than 0.1 ‰ may have a significant impact on the source signature. This is the case if the CO_2 discrepancy do not "match" the $\delta^{13}C$ discrepancy. The authors state that the discrepancies in CO_2 may contribute to the mismatch, but not why and to what degree. An analysis how the discrepancies could influence the source signature is needed. Especially as in Fig. 10 the measured source signature is compared to the model source signature.
- Table 4 and Figure 6: Instead of Table 4, an additional panel in Figure 6 showing the differences in modelled and observed $\delta^{13}C$ would be helpful. That way also phase differences and annual patterns would be visible.
- Fig 10 panel a: The authors derive the source signature by applying the moving Keeling plot method to their $\delta^{13}C$ and CO_2 measurements. They compare the source signature to the model to evaluate different filter criteria. However, it cannot be taken for granted that the model and measurements will show the same source signature. Especially, as no absolute agreement between measured and modelled $\delta^{13}C$ was achieved, any conclusion on filtering based on this comparison is not valid. A better test of filter criteria would be to apply the filters to the simulated $\delta^{13}C$ and CO_2 records to check if the model source signature can be obtained by the applied method.

- Line 783ff: The conclusion is missing a statement on how useful continuous isotope measurements actual are for the understanding of the carbon cycle at Jungfraujoch. In the manuscript, the authors use $\delta^{13}C$ qualitatively, but do not quantify biogenic or anthropogenic contributions. No significant additional information could be obtained from analyzing the continuous isotope measurements. I think the manuscript would benefit from a discussion on if and under which circumstances continuous $\delta^{13}C$ data can be useful for understanding the carbon cycle.
- Figure A1: The mean monthly discrepancy between E2 and E3 is very large. Ideally the authors would actually pinpoint the origin of this discrepancy by having an additional run with COSMO fields with a spatial resolution close to that of ECMWF.

Technical correction:

There are still some typos, comma and grammar mistakes in the manuscript.