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Comment

Interactive comment on “Large-scale European source and flow patterns retrieved from back-trajectory interpretations of CO₂ at the high alpine research station Jungfraujoch” by C. Uglietti et al.

Anonymous Referee #1

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General comments:

In this paper continuous CO₂ and O₂, respectively APO, records at the station Jungfraujoch are interpreted using back-trajectory analysis. Source and sink areas are identified by an analysis of the footprints for specific events. The events were classified according to their CO₂ and APO concentration and the correlation between the tracers. The authors interpret the typical CO₂ and APO (or O₂) of the events together with the associated footprint maps in terms of most likely source/sink processes and travel path of the air mass.

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Back-trajectory analysis as a tool to interpret measurements of trace gases at Jungfraujoch and identify their source and sink regions has been applied already in a large number of studies. The authors apply the method here to CO₂ and O₂ time series, which is new and potentially interesting. The authors should point out more clearly what the added value of their study is and not already known from previous studies. Fortunately, the authors restrict themselves to a description of the source/sink patterns and processes and do not attempt to estimate source/sink strength.

The title of the paper is misleading because it could imply that this study will determine flow patterns in Europe from CO₂ measurements at Jungfraujoch. On the contrary, flow patterns known from other sources (like meteorological data) are used to interpret the CO₂ time series. In fact, back-trajectories rely on the known flow pattern.

In general, the paper is quite well structured and well written. Data, method and results are well presented. However, the description of the data treatment to separate background, long-term trend, seasonal cycle, and short-term variations would profit from a clearer structure. The conclusions section is simply a summary. It could be condensed substantially and focused on unique findings.

Specific comments:

p. 814, l. 20: O₂ uptake by dry summer soils is just one possible explanation and it is not shown in the paper that this is the major reason. Therefore it is not supported enough to be mentioned in the abstract.

p. 815, l. 27: Briefly explain the carbonate buffering system and its effect on atmospheric CO₂.

p. 816, l. 23: Although this is not relevant for the results of this study, please specify exactly which version of EDGAR was used, EDGARFT2000 is only available for 2000.

p. 817, l. 5: Is this for the European part of Russia?

p. 818, l. 10-12: Moreover, . . . This information is not relevant in this context.

p. 820, l. 19: Although at least 0.25 degree apart some of the trajectories could start within the same grid box of the meteorological fields. Is this a problem? Are these trajectories different?

p. 821, l. 3: Is PBL height directly available in the 3 hr ECMWF forecasts and analyses? Or is it calculated offline? Please specify explicitly.

p. 821, l. 12-14: Specify the resolution of the footprint maps. Are they on 1 x 1 degree like the meteorology or on a finer grid?

p. 821, l. 23: Can you expect to identify air masses transported to Jungfraujoch by convection in summer although convection is neglected in the trajectory model (p. 820, l. 7)? Please comment.

p. 823, l. 19-21: What are background data, how are they determined? The definition is only given later in the manuscript. Please consider to rearrange the sections describing the way in which trend, seasonal cycle and short term variations were separated in the time series. Otherwise the statement at p. 824, l. 9-10 seems contradictory.

p. 824, l. 18-23: Does this background include the seasonal variations? Is this the same background as mentioned in p. 823, l. 21?

p. 827, l. 17: Explain the color scale of the relative footprint map.

p. 827, l. 6: Explain briefly what South Foehn events are, what is the meteorological situation.

p. 828, l. 16-20: The argument why it is better to use CO₂ vs. APO instead of CO₂ vs. O₂ is difficult to follow, needs clarification, give a more physical explanation.

Section 4.2: The terms 'negative CO₂' and 'negative APO' are not fully correct. 'Negative ΔCO₂' or 'negative ΔAPO' would be better terms to denote a negative deviation from the background. As this might be confused with the nomenclature in the definition of APO in the introduction, the term 'low CO₂' could also be considered. In any case,

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use low/high and negative/positive consistently in text and figures.

p. 829, l. 5-6: The seasonal cycle indicated in Fig. 9 is contradictory to the description of subset 5 (winter and spring) and subset 6 (winter). It seems that there is not such a clear seasonal cycle as suggested with Fig. 9.

p. 829, l. 26: Is really more O₂ used in respiration or less O₂ produced by photosynthesis?

p. 830, l. 17-20: Some more explanation is needed why the patterns suggest a cyclonic path.

p. 830, l. 20-21: That the upward transport was connected with fronts in the case studies should be explained in detail already in 4.1.1 and 4.1.2

p. 832, l. 16: This is not consistent with Fig. 9

Figures: Please indicate in all maps the location of Jungfrauoch. Please indicate subset number in the legends of Figures 10-15.

Fig. 1: EDGAR 3.2 Fast Track emissions are for 2000 not 2005.

Fig. 8: 'South Foehn situation drawn by Meteo Swiss' Please give a proper reference for the meteorological map.

Fig. 10-15: Add explanation of the histograms in the legend.

Fig. 11-15: Use high/low or positive/negative consistent with text.

Fig. 2, 7-15: Better use the original grid instead of color-filled contours, which produce artificial diamond shaped structures.

Technical corrections:

p. 815, l. 12 : Do you mean $\delta(\text{O}_2/\text{N}_2)$ or $(\delta\text{O}_2)/\text{N}_2$?

p. 815, l. 15: Van der Laan-Luijckx

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p. 816, l. 11: you probably mean 'consumption'

p. 817, l. 11: Balzani Lööv

p. 819, l. 7: acronym SIO needs to be explained

p. 827, l. 14: concentrations ...were also...

p. 829, l. 25: ...because of CO₂ increases due...

p. 831, l. 3: There is something missing in this sentence.

p. 832, l. 6: ... are consistent...

p. 833, l. 4: ...relatively high...

p. 833, l. 10: Van der Laan-Luijkx

p. 838, l. 26: Balzani Lööv

Fig. 6: 'All' instead of 'Both' records.

Fig. 7: According to the text this is not the south foehn situation.

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