Atmospheric
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Discussions

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Interactive comment on "On the diurnal, weekly, seasonal cycles and annual trends in atmospheric CO_2 at Mount Zugspitze, Germany during 1981–2016" *by* Ye Yuan et al.

Anonymous Referee #2

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General Comments

This paper outlines a set of CO2 data records collected over >30 years at locations within the German alps, specifically the methods used and trends observed. These long-term continental records, although more complicated to interpret than coastal records, are important. As such details of these records, like those given in this paper, should be published and the records themselves made publicly available. Unfortunately, there is a distinct lack of detail when it comes to the calibration approach used, in particular for the older data records. This needs to be rectified before publication. The paper also has a number of sentences which are confusing to read and would

benefit greatly from the Copernicus copy editing service or the help of a native English speaker. I have attempted to note these in the technical corrections section and offered some suggestions for how they could be clarified. I feel that only with the addition of significant detail in relation to the calibration approach and a revision of the language used should the paper should be published.

Specific Comments

Abstract

Examining weekend-weekday variability in order to comment on which fluxes are driving CO2 signals is a powerful tool. This, along with the outcomes of such a study should be highlighted in the abstract. At the moment the reference to it is rather vague, "indicating potential CO2 sources", and could easily be strengthened.

2.1 Measurement sites

There needs to be a description of the sampling method. Was there a small mast at these locations with an intake cup or were the instruments just measuring the air around them?

2.2 Data processing

If you're presenting data from the first two time periods then you need to give information on how that data (or wasn't calibrated). If they weren't calibrated then say so, and in the discussion provide an estimate of the size of the error that this will drive in the data. The GC calibration method is unclear to me. From the description it appears that you have a single working standard, the concentration of which is adjusted based on the station standards, and that this working standard is measured once every 15 mins. This will account for instrumental drift but does that mean you're assuming a linear detector response? Using GC to measure CO2 is usually a more linear approach than many other CO2 measurement techniques but it's not exactly linear. The effect of this non-linearity needs discussed and outlined in the text. There is no information on the

CRDS calibration process. If CRDS data is presented in the paper (it's not clear if it is) then this information needs to be provided.

2.3 Offset adjustment

The offset noted between ZPT and ZUG is very large – typically 6ppm – and concerning. However, it's difficult to comment on the offset adjustment used to correct for this as no information is given on how these sites are calibrated. Without further information it is impossible to know whether the offsets are driven solely by the use of CO2 in N2 calibration standards or other issues. It's also possible that, considering that they are different locations, that they were measuring air of different composition and part of this offset was true signal. Was any data filtering (e.g. wind speed/direction) completed prior to the comparison?

Technical and editorial corrections

The below comments are made in reference to specific areas of the text identified as page no./line no.

1/17 In this context there is no need for the definite article before "Mauna Loa" and "global means". This error occurs throughout text. For example "in good agreement with the Mauna Loa station and the global means" should read "in good agreement with Mauna Loa and global means"

1/18 It's important to include some estimate of the variability of the seasonal amplitude to give an indication of how stable it is.

1/20-22 This sentence is confusing and vague.

1/31-2/1 Please change "Apart from the sites located either in the Antarctica or along coastal/island regions, continental mountain stations also offer excellent options to observe the background atmospheric levels due to high elevations that are least unaffected..." to "Along with sites located in Antarctica or along coastal/island regions, continental mountain stations offer excellent options to observe background at-

mospheric levels due to high elevations that are less affected..."

2/2-4 This sentence is superfluous, please remove. "Presently, there are 31 Global Observatories coordinated by the Global Atmosphere Watch (GAW) network, focusing on monitoring the physical and chemical state of the atmosphere on a global scale."

2/7 Please change "lidar" to "LIDAR" it's an acronym.

2/15 Change "...what extend that elevated..." to "...what extent elevated..."

2/33 Confusing "Weekly CO2 periodicities were evaluated with the diurnal cycles for the Mount Zugspitze sites". Do you mean that the weekly periodicity was evaluated by examining diurnal cycles or that the weekly periodicity was evaluated and diurnal cycles were also evaluated? I think the former but it could be read both ways.

3/1-2 Again "In addition, we perform an atmospheric CO and NO case study together with the amount of passengers at Zugspitze in 2016 as potential indicators for weekday–weekend influences." is confusing. I'm guessing you mean "A case study combining atmospheric CO and NO measurements and records of passenger numbers was used to examine weekday-weekend differences"?

3/8-11 This is confusing. Please change "The measurements were collected at a southward-facing balcony in a pedestrian tunnel (Reiter et al., 1986) from the summit of Mount Zugspitze to the Schneefernerhaus (ZPT, 47°25âĂš N, 10°59âĂš E, slightly below the summit), which was a hotel until 1992 when it was rebuilt into an environmental research station. From 1995 until 2001, a new set of measurements began at the summit (ZUG, 47°25âĂš N, 10°59âĂš E, 2960 m a.s.l.) at a sheltered laboratory on the terrace using a URAS-3G device." to "The measurements were collected at a southward-facing balcony of a pedestrian tunnel (Reiter et al., 1986) which joined the summit of Mount Zugspitze to the Schneefernerhaus situated Xm below the summit (ZPT, 47°25âĂš N, 10°59âĂš E). The Schneefernerhaus was a hotel until 1992 when it was rebuilt into an environmental research station. From 1995 until 2001, a new set

of measurements were made at a sheltered laboratory on the terrace of the summit (ZUG, 47°25âĂš N, 10°59âĂš E, 2960 m a.s.l.) using a URAS-3G device."

3/15-18 This section ("Zugspitzplatt, a glacier . . . shown in Fig 1. (Gantner et al., 2003)" interrupts the flow of the site descriptions. It's also unclear why it's included – I'm guessing to highlight that there are visitors nearby? Please move it to the end of the paragraph and provide more context.

3/20-21 Confusing. Were the CRDS measurements made as well as the GC measurements i.e in parallel? Or instead of due to the instrumental failure? It's unclear.

4/3 What were the concentrations of the working standards? I don't need the exact value for each cylinder but a general description would be useful. E.g. "near-ambient"

4/5-6 Confusing. The GC data acquisition system doesn't "produce" the calibration values. By their very definition acquisition systems can only acquire data. Do you mean that using the GC system chromatograms were measured every 5 minutes with the working standard measured every third chromatogram?

4/8 What is a "pollution list"?

4/8 "Simultaneous measurements of identical gas" Do you really mean that you have simultaneous measurements of CO2 made using another instrument at the same location? If so how were they made and why aren't they reported here?

4/12 If the working standard is measured every 15 minutes how often was the second target measured?

4/18 This is a really large offset, typically 6ppm. Please give the mean offset here so that readers don't have to look in the supplementary.

5/1-2 It would be useful to refer to this 36-year data record as a "compound" data record as it's actually composed of data collected at three different locations. Using this terminology would make later sections of paper clearer.

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6/11 Was this done on the raw data or the ADVS filtered data?

6/23 Change "over the entire 36 year period" to "of the 36-year compound record"

6/25-26 "In general, the mean annual growth rates over the entire 36 year period at all sites agree within a range of 1.8 ppm yr–1". Which sites are you referring to here? The Zugspitze sites don't cover a 36-year period e.g. ZPT is only 16 years long. If you're referring to SSI, MLO and the global mean as referenced in the previous sentence than this sentence is redundant please remove it.

7/1-2 Please change "Möller (2017) also mentioned that growth rates at both German stations and the MLO from 1981 to 1992 were identical." To "Möller (2017) also mentioned that 1981 to 1992 growth rates at both German stations and MLO were identical."

7/8 Please change "that minimize in August" to "that reach a minimum in August".

7/10-11 Please change "Sampled air is more frequently mixed with air from lower levels, which is characterized by lower CO2 concentrations that also minimize in August." To "As such, in Summer sampled air is more frequently mixed with air from lower levels, which is characterized by lower CO2 concentrations, enhancing the August minimum."

7/17 Please change "The MLO is" to "Mauna Loa data are" or "The Mauna Loa CO2 record is"

7/18 Please change "which agree" to "which agrees"

7/18-19 Please change "Moreover, global means exhibited the lowest seasonal amplitudes of 4.33 ppm (NOAA) and 4.76 ppm (WDCGG)." To "Global means exhibited the lowest seasonal amplitudes, 4.33 ppm (NOAA) and 4.76 ppm (WDCGG)."

7/19-23 I know what you're trying to say but this section really isn't written clearly. Please correct it.

7/27-28 Please change "Apart from this, significantly higher levels of CO2 at ZSF from

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January to March and lower levels from July to September cannot be neglected." To "However, significantly higher levels of CO2 are evident at ZSF from January to March and lower levels from July to September."

8/6-7 I'm confused. You state that there are an abnormally high percentage of validated data points for the year 2000 but then say there are only 4634 points but there are 15000 for the other years. Do you mean 15000 total for the remaining years or 15000 per year? If it's per year then that's seems wrong.

8/11-12 In figure 4b please colour code the sections of the compound Mt Zugspitze record for the different sites to make it easy to identify which years are ZPT, ZUG or ZSF. This would make relating this section to the figure far easier.

8/20 Please change "can also be illustrated for" to "are also evident in"

11/1-2 "Seasonal amplitude at . . .. compared with global sites" This sentence doesn't make sense. Please correct.

Figure 2 Please plot the data from the different sites as different colours in the bottom left hand plot to make it clear which site is being used at which time.

Figure 4 – Please add the abbreviations used in the text e.g. SSI or WNK to the titles of the plots to make comparisons between the text and the figure easier. Please colour code the sections of the compound Mt Zugspitze record for the different sites to make it easy to identify which years are ZPT, ZUG or ZSF.

Figure 5 – Match the site colour coding from figure 4 to this figure.