

Answer to Referee 2

General comment:

I cannot fully agree with the title of the paper because its main value is not the GC system, similar to which has already been described elsewhere, but the results of the analyses of the measurement data.

R: we changed the title:

“Three years of semi-continuous greenhouse gas measurements at Puy de Dôme station (Central France)”

I feel as if the paper would be consisted of separate independent parts. One of them, the first part of the manuscript (description of the GC system, comparison with other analyzers), is a detailed, purely technical paper, while the last part is a modeling work. The middle part could be an illustration to the operation of the measurement system but it may also be considered as an independent data analysis. Some sort of smooth logical connection among the parts would be desirable to get a consistent paper.

R: Based on your specific comments and on those given by Referee 1 and Referee 3, we tried to make our manuscript more consistent.

The authors compare the calculated fluxes to the official emission inventory of Auvergne region. However, they do not discuss how much the catchment area of the monitoring site overlaps with Auvergne region, how much the data are comparable at all.

R: we have added a few sentences in the manuscript in order to clarify this. Please, see our answers to your specific comments.

Specific comments:

Page 3123, line 8: Units to all numbers should be given.

R: It has been formatted as it by the journal. We agree that we should give all the units and we have corrected this.

Page 3123, line 9-11: The sentence is not clear. Do you mean the accuracy/repeatability criteria? To check its fulfillment you do not need to compare instruments.

R: As recommended by the referee 1, we deleted this sentence and we gave more explanation about the WMO recommendation in the manuscript.

Page 3124, line 9: UNFCCC was signed in 1992 and entered into force in 1994.

R: corrected

Page 3124, line 12: ‘six main long lived GHGs’ – in fact, significantly more than six, because HFCs and PFCs are groups of several gases. Usage of past tense (‘aimed’) might be better because the commitment period (2008-2012) is already in the past.

R: we removed “six” and we used the past tense in the sentence.

Page 3125, line 24: The correct name of the program is ‘Global Atmosphere Watch’.

R: corrected

Page 3126, line 3: Fourier (capital F), in my opinion, because Fourier is a name.

R: corrected

Page 3126, line 6-7: 'on the order of Hertz' is not clear. Hertz is a unit, not a number. Do you mean the order of 1 Hertz?

R: yes, order of 1 Hertz. This has been corrected.

Page 3127, line 19: What is the region for which these land cover data refers to? Is it a circle of a certain radius around the station?

R: we modified the sentence: "According to the French national institute of statistic and economic studies (INSEE – <http://www.insee.fr>), the ground cover of Auvergne region (26,013 km²) consists mainly of meadows (36.4 %), forests (33.4 %) and arable land (17.6 %), Puy de Dôme station being located in the center of this region."

Page 3128, line 12: I would prefer 'aerosol particles' to 'aerosols' because the first one is the correct term.

R: corrected

Page 3128, line 24-25: Is there any reason while PBL data were not evaluated for 2013 when the GC system was also operational? Why do you chose 575 m altitude if the station is located at 1465 m?

R: the 2013 data from ECMWF were not ready when we extracted them. The main purpose of showing the PBL height is to show statistically when the station is within the free troposphere or in the PBL. In fact, we obtain the same results than the study of Venzac et al., 2009 which presents the diurnal cycles of the PBL calculated from ECMWF from 2003 to 2007.

The main purpose of this extraction was to retrieve the PBL height. The volcano on which the station is located can be considered as a high singularity in a plateau of approximately 575m asl.

Page 3129, line 3-4: Such a correction is rather questionable. Did you distinguish between the situations concerning the correction method when both 575 m asl and 1465 m asl are within the PBL and when 575 m asl are within the PBL but 1465 m asl is above it?

R: We have not did such a distinction. An other reason for our choice is that the wind direction given by the meteorological sensor show a clear shadow area due to the telecommunication antenna (89 m height) located on the military base. We added this explanation in the manuscript. That is also why we did not make a distinction between the two situations.

Page 3129, line 8-10: Are these data derived from the ECMWF data at 575 m asl, from the original Puy de Dome measurements at 1465 m asl or from the PUY corrected ECMWF data?

R: We used the wind speed from the sensor (PUY) and the wind direction from ECMWF. In order to clarify we deleted the beginning of the sentence : "~~Regarding meteorological parameters~~".

Page 3129, line 25-29: Are you mean only those days/trajectories when the station was within the PBL between 14:00 and 16:00 UTC (above the PBL between 22:00 and 06:00 UTC) or all days/trajectories independently form the actual PBL elevation during the periods? Separation of the situations (if it has not done) may give a clearer picture. (The question also regards to page 3141, line 12-14.)

R: We wanted to present the nighttime footprint versus daytime footprint and show that the footprint is clearly larger at night when the station is in the free troposphere. We did not separate the situations as, except in winter, the station is statistically in PBL from 14:00 to 16:00 and above it between 22:00 and 06:00.

Concerning the calculation of the background between 22:00 and 06:00 UTC, the Puy de Dôme station is high enough compare to the plateau to be in the free troposphere between 22:00 and 06:00 UTC,

even in summer. This is also confirmed by the study of Venzac et al., 2009. We deleted the word “usually” page 3141 line 14.

Page 3130, line 1: Why do not you use your own trajectory analysis presented in this paragraph, why do you refer to another work in this case?

R: the air masses repartition calculation was not straightforward from the footprint calculation. The air mass repartition having been already studied by Boulon et al., 2011, we preferred used their values.

Page 3132, line 28-29: I suggest reformulating the sentences because CO₂ itself cannot be detected by FID.

R: We deleted the end of the sentence: “to allow CO₂ molecules to be reduced to CH₄ to enable CO₂ detection by the FID”.

We also modified the following sentence according to referee 1: “Hydrogen is also used for CO₂ catalysis by the nickel catalyst-CO₂ reduction over the Ni catalyst.”

Page 3133, line 6-7: Numbering of the valves and EPCs are not consequent for this paper. In the paper you cannot use a numbering scheme compiled for another purpose, which is not logical in the given context.

R: As explained in the manuscript part 3.1.2., the valves are controlled by the internal and external events output GC connectors. We kept the numbering code given by Agilent for each of these outputs. Also, the EPC-Aux 3, 4, 5 are each specific for the carrier tanks and the atmospheric sample and are so named by Agilent.

Page 3133, line 25: What does ‘over several days’ means? How long was the measurement sequence and what followed its end? Restart of the whole system? Some sort of maintenance of the system?

R: We gave more precision on that.

“A sequence is designed for lasting three days by a sequential arrangement of methods which enable the automatic selection of ambient air and calibration gas measurement. The created sequence is run in a loop mode.”

Page 3137, line 20: ...a 6 m LONG strait metal tube...

R: added

Page 3138, line 13-14: Usually, you need to calibrate an NDIR analyzers much more frequently. Is there any documents on the temporal shift of the scale traced e.g. by target gas measurements? How long was the analyzer flushed before starting the signal integration? (It is the same question concerning page 3138 line 17-18.) For me the order of words ‘analyzing for 10 minutes for 30 times’ seems less understandable than ‘analyzing 30 times for 10 minutes’ but it may be a question of taste.

R: There was not enough full calibration. However there is also a regular calibration of the instrument with the REF measurements which enable to correct for short-term variation

Page 3139, line 25 and onward: How the measurements of the different instruments producing data of different temporal resolution were compared?

R: for the in-situ comparisons, we added this sentence

“These differences are calculated from the hourly mean measurements.”

For the comparison with the flasks, we added the following:

“The two GC measurements bracketing each sampled flask are linearly interpolated in order to match the time of the flask sampling.”

Page 3141, line 20-22 and page 3168: Presentation of the diurnal variations relative to the daily averages may be more logical supposing you do not want to present/discuss the seasonal variations.

R: An estimation of the seasonal variations are implicitly shown in figure 5 (mole fractions per season) and they are also discussed later, pages 3142 and 3143.

Page 3145, line 4-5: Schauinsland is significantly farther from the ocean than Puy de Dome. I would suppose that there are less air masses at Puy de Dome spending 3 days over the continent than in the case of Schauinsland.

R: according to reviewer 1, we changed this part to make it more clear:

The term in brackets in Eq. 1 corresponds to the radioactive decay correction factor. For a continental mountain site like Schauinsland, Schmidt et al. (2003) determined that the mean residence time for air masses over the European continent before reaching the station is between 2 and 4 days, leading to a net effect of radioactive decay varying from 16 % to 29 %, respectively.

Page 3147, line 19 and onward: What is the size of the catchment area for which these flux values are representative? How much is it comparable with the extension of Auvergne region for which the CITEPA data are given? During the night, when the station is above the PBL, the region in the immediate vicinity of the station but within the PBL (small/big (?) part of Auvergne region) may have only limited influence on the measured mixing ratios.

R: fig1 shows that during the night, the grid cells contributing the most to the signal measured at the station cover an area of approximately 300*300 km, centered on the station. The Auvergne region covers an area of approximately 150*250km also centered in the station. Nevertheless, the neighboring regions are also rural area with roughly the same land cover. The CITEPA estimates a CH₄ emission of 6.3 t km⁻² yr⁻¹ and a N₂O emission of 345 kg km⁻² yr⁻¹ in the Limousin region which is located west of the Auvergne region. These fluxes are close to those estimated for Auvergne (6.0 and 320 respectively). We added the following comment in page 3148:

“Following Fig.1, the grid cells contributing the most to the signal measured at the station at night cover an area of approximately 300*300 km. The Auvergne region covers an area of approximately 150*250km also centered in the station but the neighboring regions are also rural area presenting roughly the same land cover and similar GHG fluxes which allows a direct comparison between the fluxes estimated by our atmospheric approach and those estimated by the CITEPA for the Auvergne region.”

Ideally, we should use the back trajectories to have better estimates of the footprint for each period (perspective to improve the method).