

Interactive comment on “Influence of meteorology and interrelationship with greenhouse gases (CO₂ and CH₄) at a sub-urban site of India” by G. Sreenivas et al.

Anonymous Referee #2

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Long-term measurements of greenhouse gases are valuable, particularly in regions where data may be sparse. Understanding the range of processes that affect levels of GHGs in the atmosphere is increasingly important. The scope of this study is relevant and a good match to the journal. However, in my view, the presentation of this work and analysis of results are not of sufficient standard to merit publication in ACP. I therefore recommend the current manuscript be rejected.

General comments

This ambitious study considers a range of mechanisms affecting CO₂ and CH₄ concentrations over the course of a year. Given the range of mechanisms involved, the

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approach needs to be far more systematic and the analysis more robust. In many places, the discussion does not relate closely enough to the data – results are presented and then an explanation is suggested based on literature, without any testing or demonstration of its relevance to this dataset. It is often not clear to the reader why a particular plot or grouping of data has been chosen. As many of the findings are not clear-cut, this leads the reader to question whether the results are robust or whether the conclusions would be different if data had been analysed slightly differently. In some places, there seems to be a very large jump between the data presented and the conclusions drawn. One key issue is the relative importance of the various mechanisms considered. In each subsection (of Section 4) the mechanism under consideration is used to explain the results as presented in that subsection, while the other processes (some of which have been shown to be major controls) are generally ignored.

In terms of the methodology, important information is missing about the study area in particular. It is often unclear how data have been averaged and why. The paper needs restructuring so that the reader understands the aims, approach and decisions taken by the authors.

The manuscript also has several typographical errors and language issues (not all detailed here).

Specific comments referring to particular lines are given below.

Introduction

The Introduction needs restructuring and developing. A clear outline of objectives is needed. A summary of the various mechanisms that will be examined in the rest of the paper would improve readability. Previous work that is relevant to this study should be discussed.

Pg 34207 Line 12-5: It is not clear why this sentence appears here. It would fit more naturally in Section 3.2.2.

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Pg 34207 Line 16-23: This meaning of this paragraph is unclear.

Study area

More information about the study area is required. Figure 1a is not very informative and the scale is difficult to read. An aerial image, map or photograph of the study area would be far more helpful. What is the land use and land cover? Please provide some information about the characteristics of buildings and/or vegetation. Please provide some context for this study compared to other similar studies. How large is the study area?

Pg 34208 Line 3: The site is described as 'rural' here but 'suburban' in the title.

Pg 34208 Line 4: Population density would be more useful to facilitate comparison with other sites.

Pg 34208 Line 9: What is meant by 'near'? Please quantify.

Data set and methodology

Pg 34208 Line 23-5: This paragraph does not communicate very much. It may be more informative to provide a brief summary of which variables are being measured or modelled and why here, before moving on to the subsections giving the details of each. Currently, the reader does not have a clear overview of the campaign.

In-situ observations

More details are required about the experimental setup. Where are the sensors located (in terms of their surroundings and measurement height)?

It is not clear how the data have been averaged. What is meant by 'diurnally averaged' (Pg 34209 Line 19)? What temporal resolution was used in Fig 2? In Fig 2a-b are these monthly averages and variation of daily values or hourly values or something else? What about in Fig 2c-d? What do the error bars represent?

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In general, more detail is needed in the figure captions.

In Fig 1b-e are the data monthly averages? Indicate the data are for 2014.

Please also put y-axis ticks at more intuitive intervals on all plots (e.g. 50, 60, 70, 80% in Fig 1d).

In Fig 3 and 4 what does each point represent? How have the data been averaged?

Results and discussion – the presentation and analysis of results needs significant improvement throughout this section. The discussion is often unclear and does not fully address the trends seen in the results. The explanations are often vague and, although processes are mentioned, they are not convincingly linked to the results of this study. The references used should be expanded here if relevant to this dataset, or used in the Introduction if they are useful as background instead.

Seasonal variations

Monthly averages are presented in Fig 2a-b but results are discussed in terms of seasons (consisting of 2, 3 or 4 months according to Section 2). Note it may be helpful to indicate the different seasons on Fig 2a-b.

For CO₂, the seasonal averages are very similar to each other, so it does not make sense to provide seasonal values and then talk about differences between behaviour in each season. Fig 2a suggests there may be relatively high CO₂ near the start of the monsoon season, although the period of missing data and considerable variability means the picture is not especially clear. If 1-week or 2-week averages were used in Fig 2a instead, is the overall result the same? If the data are grouped according to the actual onset of the monsoon (rather than monthly approximations), are the results any more conclusive? The discussion and explanation (Pg 34212 Line 4-13) does not give a clear overview of the processes involved, how they impact the CO₂ concentration and when or why each process is most significant.

Pg 34212 Line 4 'loss of carbon' from what?

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For CH₄, again, consideration should be given to the robustness and suitability of using monthly/seasonal averages. The analysis is vague and does not adequately explain the results. In particular, 'associated with the Kharif season' (Line 20) is vague and needs further explanation. Is the rate of change really highest during post-monsoon (OND) and winter (JF) (Line 26-7)? The final sentence in Section 4.1 does not explain the results; please state and explain precisely what is meant (rather than 'This may be...').

Diurnal variations

Pg 34213 Line 5-7: The meaning of this sentence is unclear. Could you provide an example specific to this dataset?

Pg 34213 Line 14-6: Referring to other studies is helpful, but are the sites in those studies similar, i.e. are the same processes relevant? More detailed discussion needed.

Pg 34213 Line 16-20: Needs more explanation. Do boundary layer dynamics affect CH₄ concentrations as well? How does consideration of boundary layer height impact the findings from the previous subsection?

Influence of prevailing meteorology

Fig 3 – what does each point represent? Pg 34214 Line 2 mentions 'monthly mean wind speed'. Daily or hourly averages may be most suitable, bearing in mind the diurnal cycles seen in Fig 2.

Pg 34214 Line 8-15: Wind direction and source area seem to be a very relevant consideration and should be addressed in more detail (again a map and some quantitative information would be useful).

Pg 34214 Line 16 - Pg 34215 Line 6: It is very difficult to relate the correlations discussed here to Figure 4, which leaves the reader rather unconvinced of the results. The analysis presented here does not seem sufficient to draw the conclusions reached in this section. Where other studies are used to try to explain potentially relevant pro-

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cesses, they are linked too vaguely to the results and there seems to be little evidence that these processes are actually relevant to the data shown here.

Pg 34214 Line 20: Is there any diurnal cycle in wind speed that should be accounted for? Do the findings change significantly if daily/hourly averages are used for wind speed/temperature/humidity?

Influence of boundary layer height on GHGs mixing ratios

The figure, discussion and conclusion do not give a clear picture of how the boundary layer height influences the mixing ratios.

Methane sink mechanism

Most of Section 4.5 would be better in the Introduction (which would also help the reader in Section 3 when the various datasets are described). Might the high CH₄ readings be due to the highway and railway directly? The dependence on OH seems like a hypothesis which can be neither supported nor rejected based on the analysis presented here.

Influence of vegetation

Pg 34218 Line 22-3: 'NDVI showed inverse relationship with CO₂, mainly due to change in vegetation which affects the CO₂ concentrations.' Both halves of this sentence effectively say the same thing without explaining the process.

To summarise, Section 4 contains too many different mechanisms without consideration of how they impact each other or a clear systematic structure to the analysis. Perhaps the relationship with NDVI should be moved closer to the start of the section where seasonal variations are discussed. Looking at the monthly ratio (Fig 6) may also be more useful earlier on. The high CH₄ readings in Fig 7 may need to be discussed alongside source area analysis in Section 4.3.

Are there other sources or sinks of GHGs which have not been considered in this

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analysis? How might they impact the results?

Conclusions

The conclusion should draw together the findings and provide an insightful summary of the research. Many statements are vague (e.g. Pg 34221 Line 7-8: 'This clearly indicates the seasonal variations in source-sink mechanisms of CO₂ and CH₄ respectively.' What are the source-sink mechanisms and how do they differ for CO₂ and CH₄ with season?) What new findings have emerged from analysis of this dataset?

Minor comments

Throughout: Change GHG's to GHGs

Pg 34206 Line 11-2: Sentence not clear – please rephrase.

Pg 34206 Line 16-7: Sentence vague and not clear– please rephrase.

In many places spaces are missing, e.g. Pg 34206 Line 22: '(GHG),particularly'; Pg 34206 Line 24: 'emissionsand'; Pg 34207 Line 8: 'andecosystems' ; Pg 34207 Line 9: 'reflector'

Pg 34206 Line 26: What is the significance of May 2013? A longer-term perspective that extends to the present may be more useful (i.e. to indicate May 2013 is not an exception).

Pg 34209 Line 3: I would mention 'Los Gatos Research' here rather than in the Abstract and Introduction.

Pg 34209 Line 5-7: Reference would be useful here.

Pg 34209 Line 20-1: Give exact dates.

Pg 34209 Line 25: Correct brackets.

Pg 34211 Line 24: Better to define mean and standard deviation here rather than in the Abstract.

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Pg 34212 Line 3-4: Change to '... ppm in winter, pre-monsoon, monsoon and post-monsoon, respectively'

Pg 34213 Line 22: Change 'place' to 'plays'

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 34205, 2015.

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