

## ***Interactive comment on “Gap-filling strategies for annual VOC flux data sets” by I. Bamberger et al.***

### **Anonymous Referee #2**

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This manuscript analyzes several different gap filling strategies for VOC flux data sets. VOC fluxes have significant effects on atmospheric chemistry and contribute to the net ecosystem carbon balance. In order to assess these impacts, flux information on seasonal to multi-annual time scales is needed. Long-term flux data sets are scarce, however, particularly for VOCs other than isoprene. Validated gap filling strategies can be useful in completing existing data sets so that cumulative fluxes and net exchange can be evaluated. The authors conclude that, for data obtained during the growing season, the mean diurnal value method has significantly lower errors and is therefore superior to the other tested methods. All tested gap filling methods were less effective (had greater associated errors) during winter periods, after cutting events, or for longer gaps. The authors call for more wintertime measurements to reduce uncertainties in the cumulative VOC flux during this time period.

The methods for gap-filling VOC flux data sets presented in the paper are novel and

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important and warrant publication. I recommend the paper be accepted following minor revisions as indicated below.

P 17791, lines 21-22: “Half-hourly VOC flux values passing the quality control were retained, while not quality approved flux values were termed as missing values.” Please revise this sentence for clarity. For example, “Half-hourly VOC flux values passing the quality control were retained, whereas flux values that did not pass were termed as missing values.”

P 17799, lines 3-14: “Unlike the errors for individual VOCs, both, the absolute and relative error for the sum of the VOCs, which was introduced by the gap-filling, was lower in 2011 (root mean square errors between 2.8% and 6.0%) compared to 2009 (24.2%–60.7%). In addition to the continuous emission of methanol, monoterpenes showed considerable deposition fluxes only in 2009 (Bamberger et al., 2011) resulting in a lower VOC carbon sum in 2009 and a lower second main error source regarding the absolute error in 2011. Although the percentage of missing data was equal or, on a daily scale, even lower than during 2009, the composition of gaps was different with a tendency towards data gaps which span several days in 2011. The lower errors for the individual VOCs in 2009 show that the filling of several shorter gaps (with a larger number of measurements in between) introduces considerably lower errors than the filling of the same percentage of longer-lasting gaps.”

Suggest revising this paragraph. The first two sentences discuss errors in the sum of the VOCs, which had higher errors in 2009 than 2011. The last two sentences compare errors for individual VOCs, which in most cases were lower in 2009 than 2011. Combining both of these ideas in the same paragraph is confusing. I would suggest dividing it into two separate paragraphs. It might also help to change the order (moving the paragraph containing the last two sentences before the one with the first two sentences), since errors in individual VOC fluxes are discussed earlier in the section.

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P 17799, lines 16-18: “The time series of measurements exhibited no extended ( $> 2$  h) data gaps during management actions of the grassland (cutting and fertilization) and this effect was also excluded from the gap-filling simulation for Table 1.” I would suggest revising this sentence for clarity, for example, “The time series of measurements exhibited no extended ( $> 2$  h) data gaps during management actions of the grassland (cutting and fertilization), HOWEVER, THESE PERIODS WERE excluded from the gap-filling simulation for Table 1.

P 17799, lines 20-21: “. . . was simulated exemplarily for the year 2009 and is presented in Table 3.” Also used in the Table 3 caption and Fig 3 caption. ‘Exemplarily’ can mean ‘as an example’ but is more commonly used to mean of notable quality or commendable. To avoid the second meaning, which seems unintended in this case, I would suggest rephrasing, such as, “. . . was simulated for the year 2009 as an example and is presented in Table 3” (or similar) in the text and “Example shown for the year 2009” in the table caption.

#### Section 3.2.4 and Table 2

It's unclear to me what time period the cumulative fluxes for the winter data (shown in Table 2) are summed over. Is it the number of snow-covered days in the sample? If so, then the number of days in the sum is quite different for the two years and the cumulative values are not comparable. I would suggest adding a column for the daily average total C flux or the cumulative flux over all winter days. This would facilitate evaluation of the estimated flux for the full winter season and comparison of the predicted flux and associated errors with the values for the growing season. This is particularly needed so that the reader can reconcile the cumulative fluxes given in the tables (in which the winter period seems like it could be a significant contributor, depending on the time period the cumulative flux represents) with the annual budget presented in Figure 4 (in which the wintertime fluxes seem to be quite small.) (It's possible the cumulative flux given in the table is summed over all winter days of the year, which would lead to a very different interpretation of the values presented in Table 2. A more thorough explanation

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is needed.)

### Section 3.4: Annual VOC Budget

Along the same lines as the previous comment, it is not clear how the wintertime data was filled for the annual budget estimate. Section 2.3.3 discusses 3 approaches for winter gap filling, but it is not stated which was used in the annual budget calculations shown in figure 4. Section 3.4 says the MDV method was used for the annual budget estimate – does that apply to the wintertime period as well? More detail on this aspect of the analysis would be helpful.

P 17804, lines 19-21: “. . . a lot lower than the complete annual exchange of carbon (between 6.2–12.5 gCm<sup>-2</sup>) estimated above a ponderosa pine plantation (Bouvier-Brown et al., 2012).” I believe the authors mean that this is the observed annual exchange of carbon in the form of VOCs (not the complete exchange of carbon, which would include CO<sub>2</sub>). I would suggest rewording to clarify this point.

Fig 2 (bottom panel) axis label: C<sub>12</sub>H<sub>16</sub> should be changed to C<sub>10</sub>H<sub>16</sub> for monoterpenes.

Table 3 is presented and discussed before Table 2 in the text. Suggest reversing the order of the tables.

Fig 4: Is it possible to include an error estimate for the cumulative flux due to gap filling in the figure for illustration purposes?

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