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Biogeosciences Discussions

Interactive comment on "Regional carbon dioxide and energy fluxes from airborne observations using flight-path segmentation based on landscape characteristics" *by* O. S. Vellinga et al.

Anonymous Referee #1

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The authors introduce a method which will help to estimate regional fluxes of sensible and latent heat as well as carbon dioxide for heterogeneous landscapes by using airborne measurements. Segments for the flux calculation were derived by taking land use, soil types and relief properties into account. Land use classes captured by the flight segments were estimated with averaged footprint length derived from a footprint model.

While reading the manuscript some methodological questions arose which first need be answered before the paper can be published, further more minor problems concerning graphics and details need to be handled.

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Interactive Discussion

Discussion Paper

Major points

1) P10487 ll. 7-11 A stationarity test with two windows which can differ between 0.3 and 1.7 compared to the mean does not seem like an appropriate test for stationarity. For example the mean covariance of sensible heat of a flight segment is 450 W/m^2 the first half window can have a value of 135 W/m^2 and the second half of 765 W/m^2. I'm aware that that the stationarity criteria can't be as tight as for ground based measurements but this does not seem appropriate at all. My suggestion would be a 'classical' stationarity test. The flight segment should be divided into 4 parts and for each segment the mean covariance is calculated. If the deviation from the covariance of the total segment is less than 50 % for all 4 parts the segment can be assumed to be stationary.

2) P10487 ll. 24-29 One should not take an average of all footprint lengths to determine the land use that is influencing the measured fluxes. It would be more suited to calculate the footprint length for each pass along each segment, determine the corresponding land use, and then average the land use for all passes over one segment. This takes the different atmospheric conditions into account that prevailed during each pass and the corresponding land use.

3) P10488 ll. 1-3 Even though wind speeds were only around 2 m/s there must be a displacement of the footprint to the direction of the mean wind direction (as described in P10887 l. 29f). It can't be assumed that for all segments the footprint is symmetrical to both sides of the flight track.

4) P10488 ll. 6-8 There are major differences between the land use sampled by the flight track and the land use classes in the flight domain. MG is overestimated by $\sim$13 % (2 times more than in the full domain) making it the most dominant land use class for the flight track but in the full domain it is just the 4th important land use class. WM is underestimated by $\sim$9 % making the most dominant land use type in the full domain to the 4th important one for the flight tracks. Even though the 5 most important land use classifications are the same for the flight tracks and the full domain their contribution

BGD

6, C3330–C3335, 2009

does not match.

Furthermore many minor land use classes are not sampled at all. This not a problem but it should be mentioned since they account for approximately 10 % of the land use in the full domain. Are these differences negligible if one wants to estimate a regional flux?

5) P10494 ll. 15-21 The method of forcing three flux segments into segment 8 raises different questions:

1. Is a certain part of the adjacent segment used for two flux calculations? Or is this part removed from the flux calculation of the adjacent segment?

2. Is the land use inside the footprint area of the neighboring segment included into segment 8?

3. If the high error bars are a result of this method than a comparison between this method and just using two 2 km segments will show that.

4. Why are the high error bars just present in IOP1?

6) P10495 ll. 10-24 The explanation of the differences between IOP1 and 2 for segment 6 ignores some important aspects:

1. Why is the photosynthetic activity of the plants inhibited? 74mm rainfall in the 2 week before IOP 1 assure sufficient water supply and the high LAI indicates a high potential transpiration which is underlined by the high evaporative fraction (IOP1 0.6 / IOP2 0.4).

2. Before IOP2 only 7mm rainfall was detected. 3. This is contradictory to P.10491 ll. 27ff 'This corresponds with the higher LAI and evaporative fractions found for IOP 1 as photosynthesis is coupled to plant transpiration and both are also a function of leaf area.'

During IOP2 the LAI is reduced, the Bowen ratio is higher, and the evaporative fraction

BGD

6, C3330–C3335, 2009

is lower for segment 6 than during IOP1 4. The error bar might be the highest but compared to segments 9,10 and 11 it is not significant more. And segment 10 and 11 mainly consist of one kind of land use (WC 94 % and 87 %)

5. Compared to IOP1 all error bars of IOP2 are comparatively small.

7) P10496 ll. 22-24 Would a comparison of the airborne and the ground based fluxes be possible only for segment 10 and 11? If so why is the CO2 flux of the airborne data just one third of the ground based data?

Minor points

8) How were the error bars calculated? Is it the standard deviation of the single passes for one segment or is the variability inside the passes also included?

9) P10487 l. 5

'The results hereafter are based an averaging length. . .'

The results hereafter are based on an averaging length. . .

10) P10487 ll. 24-29 The footprint model used for the estimation of the source area was not tested for measurement heights over 20 m above ground level and roughness length of more than 0.1 m (at least not in the paper you referred to (Hsieh et al., 2000)). I don't think this is a real problem since no ideal footprint model exists for airborne measurements but this information needs to be given to the reader.

11) P10488 ll. 11-12 'Largest differences between segment areas and full domain are found in classes MG (23 %), WM (11 %), and WC (16 %).' The difference of WC is 1-2 % whereas the difference for CCP/WC is 3-4 %. The value inside the bracket should be the difference of the full domain and the flight track instead of the value from the flight track.

12) P10489 ll. 13-15 Were the segments with no averaged flux data included into the land use extraction and the comparison of the full domain and the flight track? If there

BGD

6, C3330–C3335, 2009

are no flux data they should not be included.

13) P10491 ll. 3-7 Since water is the limiting factor of photosynthesis is it not possible that the difference of the precipitation also has an effect on the carbon dioxide fluxes?

14) P10491 ll. 3-7 What is CV? Change in radiation?

15) P10496 ll. 22-24

'. . .one of many models (e.g. Schmid, 2002), uses a constant roughness length (z0) . . .'

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16) Flight track 7 is not in one direction to the mean wind direction (change in flight direction of approximately 330°) what happened with the data during the 'curve', how is the quality, is there a difference in flying in two directions to the mean wind direction (compare Desjardins et al., 1989). Same applies to track 9 but not so extreme.

17) Table 1 The abbreviation FR (Fronton?) is not explained but all others.

18) Table 1 Flight height above ground level should have a standard deviation to it. It indicates how leveled the ERA flew above ground level. This applies also for P10486 l.6.

19) Table 1 Did you mean UTC instead of LT for Time Period? There is a contradiction to P10489 ll. 7-9.

20) Table 2 If an averaged footprint length is used to calculate the source area, why are the fractions of the length and the area of different segments so different?

21) For all figures the axis labels should be bigger many are hardly readable if not magnified.

22) Figure 2 A legend with major land use types is missing (maybe just the 5 most

BGD

6, C3330–C3335, 2009

important ones). The map should be colored (also just the 5 most important land use classes) there are too many gray shades.

23) Figure 2 It would be helpful to show the river as well as the river valley. With the information derived from Figure 3 it is not possible estimate the stream course compared to flight track. Not only crossing the river may have effects on the flux measurements but also flying parallel to the river.

24) Figure 3 The line between loam and clay must be bigger such it can be seen without magnifying the figure to 150 %.

25) Figure 3 Is the flying altitude just a single flight (exemplary) or the mean flying altitude of all flights?

26) Figure 8 For this figure the first flight begins at 11:50. In the text before it says that segments are just used between 12:00 and 14:00. It should be consistent throughout the text. The difference to Table 1(13:45 [UTC]) is no problem since it means the departure time of the aircraft, as I assume.

27) Figure 8 and 9 What is the meaning of the green labels with the number inside? Also needs to be bigger.

Literature

R. L. Desjardins, J. I. MacPherson, P. H. Schuepp and F. Karanja; An evaluation of aircraft flux measurements of CO2, Water Vapor and Sensible Heat; Boundary Layer Meteorology 1989; Volume 47, Numbers 1-4

Hsieh, C. I., Katul, G., and Chi, T.: An approximate analytical model for footprint estimation of scaler fluxes in thermally stratified atmospheric flows, Adv. Water Res., 23, 765–772, 2000.

Interactive comment on Biogeosciences Discuss., 6, 10479, 2009.