Biogeosciences Discuss., 4, S2276–S2280, 2008
www.biogeosciences-discuss.net/4/S2276/2008/

Biogeosciences Discussions

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Interactive Comment

Interactive comment on "Dependence of CO_2 advection patterns on wind direction on a gentle forested slope" *by* B. Heinesch et al.

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Received and published: 2 January 2008

General Comments

This manuscript provides us with more evidence that CO2 advection due to slope flows is a highly complex problem, very site-specific, and often difficult to diagnose. While there is a wealth of information in the data the authors have collected, there are a few issues with the interpretation and the format that will need to be addressed before this can be moved from Discussions into the final resting place. In its current form, the paper is somewhat confusing unless the reader is familiar with previous publications of this group.

What bothered me first was that no clear evidence of the slope flow itself (i.e. downhill)

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presented, in the form of a graph or a table. I know this has been shown in previous publications, but this paper needs to be able to stand on its own two feet. At least the authors should clearly explain (in section 2.4) what quantitative criteria are used to separate out "gravitational events".

In this paper, everything is related to winds above the canopy (except Fig.4), and those are apparently usually perpendicular (i.e. NE and SW) to the direction of the slope (NW). No in-depth explanation is given to physically relate these wind directions aloft to what may be happening below; in fact, the subcanopy flow is assumed to be completely disconnected from the flow aloft (see Fig. 2). On the other hand, relationships between w(h) and subcanopy flows are investigated throughout the manuscript. This is a bit confusing and needs to be more carefully discussed 8211; if these flows are independent, can we safely relate w in the flow aloft to divergences in the subcanopy?

I have a hunch that a lot of what you see in your forest may be driven by along-valley flows (which appears to slope down towards the WSW), not only by the local slope at the tower. I was hoping that the authors would at least speculate on what makes the NE flow scenario physically so different from the SW scenario; why does one produce a T profile inversion and the other one does not? On the local scale, and as stated by Dr. Eugster (and mentioned in your manuscript in 3.2) the step-change in canopy characteristics at your site may have a lot to do with what you observe at the site. The estimated advection magnitudes show that things are probably more complicated than assumed. It is unfortunate that you only have measurements down the slope and not perpendicular to this line; also, given that so much of the advection probably happens rather close to the ground, it would have been good to have anemometer measurements below 3m. Things to keep in mind if you intend to continue your measurements there, as I hope you do!

There are also many instances in this manuscript where things are not explained as clearly as they easily could be. One example: caption of Fig 4; vertical velocity above the canopy. Why not indicate the exact height (i.e. 40m)? If you can be specific, you should do so. Another: the NEE estimate in Fig 10 - how was that calculated? These are things that are surely very obvious to you, but to the reader who has not read your other papers this should also be transparent. I am wondering whether reading Aubinet (2007), which I have not seen, would explain much that has been left out, but again, this manuscript needs to be able to stand on its own feet.

In my opinion this manuscript will be acceptable for publication once all the specific comments of the other reviewers and mine are addressed, and more attention is paid to exploring and explaining the possible physical links between what goes on aloft and the flows near the ground.

Specific Comments

1. repartition: not sure whether this is recently adopted terminology; if so, I missed that. Just "partition" will do [4231L19, 4246L12]

2. 4233L15-19 Please clarify that you only used data for which the near-ground (3 or 6m) flows were parallel to your slope transect (if I understand this correctly!). It may be worth mentioning that this obviously makes calculating a divergence more justifiable but you are only looking at a selected fraction of all possible cases and therefore will end up with biased results. As mentioned, this can be fixed by setting up a lateral transect for future measurements.

3. 4234L5 should be "departures of the instantaneous values from the average"

4. Eq (1) and (2) have been discussed by the previous reviewers; nothing to add to those semantics.

5. 4236L10-12 I like the way you formulate the separation of dependencies to set up the scale factor approach. Very elegant - I wish I had thought of that!

6. 4237L8 as mentioned by another reviewer, it would be good to show data to support your u profile.

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7. Eq(5): you should more clearly define uoref due to its importance in what follows. It is hard to figure out what the reference height is, and it should be shown in Fig 2.

8. 4238L9 you state the uncertainty on k, but not the mean!

9. 4238L13 replace "more simple" with "simpler"

10. 4240 L5: traducing - do you mean "producing"?

11. 4241L3: where does that angle (1.7deg) come from?? Is that the average slope for NE flows? I thought the slope angle was 3deg.

12. 4241L5: do you mean "braking"?

13. 4242L2: missing a few articles: air circulating in the gravitational flow layer, and it helps to dilute the CO2.

14. 4243L3: going from -0.05 to -0.1 is a decrease by definition.

15. 4243L78: I think you are talking about delta c, not gradients; but either way, the units (umol/m) are wrong.

16. 4243L16: how was the NEE in Fig. 10 calculated? This is not explained anywhere; obviously not from Eq (1). I presume you used a simple soil temperature model, but please be specific.

17. 4245L18 gravitational layer top: where is this? Please be specific. You may have noticed that if you assume linear w all the way up to h (40m), i.e. dw/dz = w(h)/h, you get du/dz = 0.002 s-1, which isn't far off your direct estimate. Food for thought (about the depth of the slope flow, and relevant scales etc.)

18. Fig 1: Reverse a) and b). On slope diagram, indicate the NW direction, and the distance between main tower and transect

19. Fig 2: mark the "gravitational layer top"; and the reference height, and make sure it's all English (avec => with)

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20. Fig 3:Wouldn't you expect w to be negative for all wind directions between 45 and 225o (looking at the topography)? For a perfect 2D slope you'd expect a sinusoidal function. Unless we're already looking at some form of rotated w? If that's the case, please make that very clear. Also indicate that these are wind directions at 40m.

21. Fig 4: define "surface velocity" - what height?

22. Fig 6: Apparently these are temperatures relative to 40m, but you need to specifically state that

23. Fig 7: move the x-axis down to the bottom

24. Fig 9: replace "delta" with its Greek symbol; maybe put NE and SW above the graphs to make it easier for the reader to figure out

25. Fig 10: make f) the same size as the other panels

26. Fig 11: not sure whether this is worth a figure on its own; maybe add the integrated divergence to make it more interesting

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Interactive comment on Biogeosciences Discuss., 4, 4229, 2007.