

# ***Interactive comment on “Energy balance closure on a winter wheat stand: comparing the eddy covariance technique with the soil water balance method” by K. Imukova et al.***

## **Anonymous Referee #1**

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### **1 General comments**

The present paper aims to elucidate the nature of the energy gap for winter wheat stands in Southern Germany. The authors focus on comparing two retrieval methods for the latent heat flux: by eddy-covariance and by soil water balance. They also reach conclusions about limitations of the second approach.

The paper addresses relevant questions and presents novel data. The scientific methods in the paper are generally clear enough and the referencing is usually fine. The paper is well-structured. The article appears reproducible, except (for me) the error

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Discussion Paper



estimation of the soil water balance method. The abstract is concise and well-written except for the untelligible grammar of its last sentence. I do have problems with one sentence (6784/3, see below).

Nevertheless, I would like to see a more elaborated site-specific discussion (as far as possible with the present data) which could lead to some additional conclusions. To me the first part of the title seems to suggest that all aspects of the energy balance closure were investigated, and likewise the abstract promises: “The *present study elucidates the nature of the energy gap* of EC flux data from winter wheat stands in southwest Germany.” However, in practice the focus of the paper lies on the second part of the title. In the discussion section (6802/3) I can only find “Other fluxes or storage terms must account for closing the energy gap” and in the conclusions (6803/11) “*the gap . . . was not made up by latent heat*”. There are a great many possible general reasons for the non-closure listed from the literature, but the authors do not really go into specifics for their site. Therefore I would suggest the authors add a small discussion about the other components of the surface energy balance applied to their site. That there is no universal approach for determining the energy balance non-closure and that the residual is site-specific is not a new conclusion (it is certainly good to repeat that here but preferably to supplement a site-specific conclusion) and **I certainly do not expect the authors to draw general conclusions from the study of one site, but a more detailed discussion and summary of the possible causes of the non-closure for their specific site would be welcome** (see main questions). When this is provided, I can recommend the article for publication.

Principal criteria	Excellent	Good	Fair	Poor
Scientific significance		×		
Scientific quality			×	
Presentation quality			×	

**Although the article contains valuable material, I think the authors should revise their manuscript. The necessary changes are not very large but I nevertheless**

C2443

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recommend to resubmit for a review.

## 2 Specific comments

### 2.1 Main questions

1. The discussion section contains a lot of review material about related articles. It is good that the authors make the reader aware of the existing literature, but I think it would be good if the authors complement this by applying the general ideas to their own site. Barring experimental errors from the instrumentation, the two major schools of thought in EC can be summarized as storage versus heterogeneity effects (advection/secondary circulations). Which site-specific arguments would support one or the other, or both? With some six OPs available for two sites, can a distinction be made between local storage effects and heterogeneity effects and the relation with the EBR of the OPs?
2. The paragraph of the error estimation for the soil water balance method is rather formal (e.g. that  $\frac{\partial y}{\partial x}$  is the derivative of  $y$  with respect to  $x$  is self-explanatory in my regard and can be omitted) but it does not give a clear understanding of the practice: does  $y$  represent the bimodal Van Genuchten model, or  $\Delta S$ , or something else? In my understanding there were 16 observations, so is  $\sqrt{n} = 4$  or does the number of observations refer to another quantity? Furthermore, how high was the variability between the 16 observations, i.e. how well is the footprint-weighted average of these 16 samples over a whole field site representative for the real average? Did the authors try a semi-variogram to check the spatial variability? What would be the uncertainty on the measurement related to the limited sampling? (e.g. right now the error associated to the WB method is of the same order of that of the EC method, would that still be the case?)

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12, C2442–C2449, 2015

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3. Table 3: why has OP-4 the worst closure? Because it was earlier in growing season (the meteorological conditions seem fine) or is there a relation to its lower Bowen ratio? Can the authors connect this to the commonly cited causes in the literature?

## 2.2 Minor questions

4. 6789/20: Why do the orientations of the two anemometers differ?
5. 6786/16: “Large eddies can be formed at the boundary of areas with different land use.” This is slightly imprecise. I understand that their formation is linked to the presence of different land use types (and hence related to the presence of boundaries) but the (large) eddies would not be restricted to the boundary region. The authors declare that because the large eddies “do not touch the land surface, their transport of heat, water or gas is not detected by the EC station”. Can the authors improve these sentences? One could argue that the large eddies do not *directly* touch the land surface, but this is unrelated to being undetectable by a single EC tower. (The reason for that would be that they’re quasi-stationary.) Finally, the authors say that the large eddies are non-uniformly distributed: but distributed over what?
6. 6785/15: how much can it help (answer here in general)? Please be more specific. How much would it matter for the study sites? (the latter answer in the discussion)
7. 6787/16: In this study (with its apparent focus on the latent heat flux) there would be no distinction with respect to the H post-closure. So I’m not convinced why it has to be mentioned at all. Was there an advantage of using the raw energy fluxes in those studies that has implications for the present study? If so, please clarify.

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8. 6792/7: this was an average over the three classes or there were 3 averages, each for one stability class. How was the weighing done?
9. 6800/15: how high was the correlation?
10. 6802/1 and 6803/11: make “most periods” more quantitative.

### 3 Technical corrections etc

#### 3.1 References

11. In many cases the authors of the references are incorrectly specified in the manuscript, e.g. often an “et al” is missing, or only one author is named when there are in fact two authors. The authors should check their reference list and correct this. Simultaneously, the pronoun “he” is often used when it should be “they”.

#### 3.2 Formulas

12. Formula (3) is placed between two paragraphs without connection to the preceding sentence. The formulas can be read more fluently when they form (even when placed on a separate line) part of the sentences. (In that case also the punctuation has to follow standard spelling.)
13. 6790/25: The EC ET units  $\text{kg m}^{-2}$  and  $\text{mm} = \ell \text{ m}^{-2}$  are technically speaking not equivalent. The numerical values in these units will of course correspond when  $\rho_{\text{H}_2\text{O}} = 10^3 \text{ kg m}^{-3}$ .
14. Units are missing in equation (6).

15. 6795/23: I believe the notation  $\theta_V$  was not introduced.
16. In my opinion Gaussian error propagation is much more basic than the Akaike information criterion, so formula (11) is not needed. As mentioned in the main questions, the problem of this paragraph is not the theory, it's that the precise application is not clear (at least to me).

### 3.3 Structure and content

17. (An outline of the paper is missing at the end of the introduction, but the structure of the paper is also clear enough without.)
18. In Table 2 the data should be added because OP-0 appears in Figure 7.
19. 6794/11: Perhaps add the values for the Akaike information criterion of the tested models to highlight the selection of the preferred model. (As of now a number of models is simply listed but only one is chosen, so I don't see why naming all the other models is relevant. In my opinion this could be omitted.)

### 3.4 Other

20. 6791/10: it's of course completely equivalent here, but why not use as unit Kelvin instead of degrees Celsius
21. 6792/10: I believe the installation height was mentioned in 2.2.1 and was 13 cm higher there.

### 3.5 Language suggestions

Suggestions in order of appearance in the text, not in order of importance. Correct at least the two clear mistakes (comments in bold).

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22. 6784/4: I prefer “energy imbalance” or “energy budget non-closure” instead of energy gap, the latter reminds of energy supply and solid state physics.
23. 7: please write both  $H$  and  $LE$  slanted (or all upright) throughout the manuscript
24. 23: “vegetation period” could be replaced by the more standard “growing season”
25. 24: **a verb is missing**
26. 6785/9: the ground heat flux
27. 21: in this context, I would prefer the term “energy balance ratio”  $EBR$  instead of the energy balance closure  $EBC$
28. 6786/3: during the night when fluxes are low
29. 14: concluded instead of discussed
30. 17: analyzed instead of performed
31. 19: quantified instead of measured
32. 6787/9: in this context I would prefer “residual” instead of gap
33. 6788/3: in the region Kraichgau
34. 8: and the landscape consists of gently sloping hills
35. 18: surrounded by other agricultural fields
36. 6789/15: the fluctuations of the two quantities
37. 20: the Licor, the CSAT3

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38. 6791/6: perhaps put brackets around “using the mean of [. . .] the plates” to make the sentence more clear
39. 6792/13: Matrix/matric potential can both be used, but in other uses it is one **matrix** and two **matrices**. Occurs elsewhere in the text as well.
40. 6794/15: of the two
41. 6796/1: The latter two periods. (the last could also mean OP-5 and OP-6)
42. 6797/17: during instead of over

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