Biogeosciences Discuss., 7, C1692–C1695, 2010
www.biogeosciences-discuss.net/7/C1692/2010/

Biogeosciences Discussions

Interactive comment on "Sensitivity and predictive uncertainty of the ACASA model at a spruce forest site" *by* K. Staudt et al.

Anonymous Referee #2

Received and published: 6 July 2010

General Comments: The paper deals with a sensitivity and uncertainty estimation study of the ACASA model using the Generalized Uncertainty Estimation (GLUE) method. The ACASA model uses a third order turbulence closure scheme to concern higher moments of micro-turbulent exchange which are temporary relevant inside forest canopies. This approach is state-of-the-art, and so I recommend in principle to publish this paper. But some questions and "problems of understanding" should be clarified before a final publication of this paper (listed in the special comments below):

Special comments:

1. The authors discussed in the introduction the advantages of higher-order closure turbulence schemes in contrast to first order closure schemes based on K approach and flux gradient relationships. They substantiate this thesis by older citations. Refer-

ring to several new comparative papers (e.g., Pinard and Wilson, JAM, 2000) I must contradict this general statement. The advantage or disadvantage of the different closure schemes depends strongly on the quality of input data and the aim of turbulence simulations. The theoretical advantage of higher-order closure schemes (to simulate counter gradient fluxes, for example) is "given away" in practical applications, when, for example, time-averaged turbulent fluxes at a special forest site should be reproduced (as presented in the paper). In that case the large natural variability of crucial model input parameters, as for example drag coefficient (cd) and plant area densitity (pai), which are essential to parameterise the additional plant-specific source term in the basic equation of motion (cd*pai*u^2, see, e.g., Meyers and Paw U, BLM, 1986, p. 301 or Wilson and Shaw, JAM, 1977, p. 1200), leads to uncertainties of simulated results. In the present paper the typical spectra of variability of pai in a forest is not adequately represented by the 5 measured profiles (Fig. 1). Furthermore, I miss any information about the quantity and variability of cd. These parameters were also not included in the GLUE method which was the main method applied by the authors. So, there exists an inadequacy between the complexity of the turbulence modelling and the quality of data input. Finally, it is difficult to discuss the results of uncertainties satisfyingly if the natural variability of essential model input parameters is not represented realistically.

2. A prominent disadvantage of models using higher-order closure turbulence schemes is the limitation of vertical model extension. Authors of early papers suppose a limit of about 100 meters, and the ACASA model has a vertical boundary (as typical for SVAT) of few multiples of vegetation height. This concept is working well as long as the SVAT is part (sub-model) of a meso- or large scale meteorological model (as, e.g., coupling of ACASA with MM5, Pyles et al., JAM, 2003). In this case there is an aerodynamic coupling to the complete atmospheric boundary layer and to the free atmosphere. In the presented paper the ACASA model is working "stand-alone" to reproduce turbulent fluxes at an experimental site. Because of the strong vertical limitation of ACASA a realistic aerodynamic coupling to the complete boundary layer, which is essential at a forest site (see, e.g., Pinty et al., Agformet 61 (1992) or Martin, Agformet 49 (1989)),

cannot be reproduced. Because the measurements of turbulent fluxes include the effects of aerodynamic coupling, a methodical problem occurs when measurements and simulations are compared. Finally it was not clear what is the reason for the uncertainties: the variability of the 24 input parameters of ACASA, the insufficient inclusion of crucial input parameters of turbulence modelling (cd and pai) – or the insufficient description of aerodynamic coupling.

3. Regarding to more actual references I suggest a comparison of the ACASA simulations with simulations using a K approach (models with first order turbulence closure). In contrast to the remarks from the authors in this paper, models using a K approach do not must be worse “per se” in relation to models using higher order closure principles. This is especially the case when time-averaged fluxes are simulated for comparison with measurements above the canopy (e.g., half-hour means - as in the paper presented, see also Zeng and Takahashi, Agformet, 2000 or Pinard and Wilson, JAM, 2000). In this layer the flux-gradient relationship (FGRS) is valid in most cases, and the advantage of models using higher order closure schemes - to simulate fluxes against FGRS – becomes less important.

Referring to the remarks made in 1. to 3. a clear specification of advantages and disadvantages of the closure scheme used in ACASA, with focus to the model application in this paper, is recommended.

4. Finally I miss clear statements to the uncertainties of measurements. One of the main problems in comparison of ACASA results and turbulence measurements is due to the fact that neither the ACASA model using third order turbulence closure scheme nor measurements using eddy covariance techniques can reproduce the complete turbulence spectra. So it could be assumed that one part of uncertainties is caused by the lack of information from the turbulence spectra. Of course, this problem is well known regarding to the measurements - but it should be discussed more detailed in the conclusions.

5. To reproduce the complete variability of turbulent fluxes at the experimental site Waldstein-Weidenbrunnen a longer measurement period for analyse is recommended. Otherwise, the reason the restriction to one short period should be explained.

Special comments p. 4244, 25: Please specify the favoured direction of uncertainty. In most cases there is an underestimation of fluxes because of the loss of a part of turbulence spectra during the turbulence measurements. p. 4246, 10: What CPU time did you need for all simulations? p. 4250. . .: Please add more actual references referring to the applications of models at forest sites using different turbulence closure schemes. p. 4270: Fig. 7 and 8: The uncertainties of measurements should be added.

Interactive comment on Biogeosciences Discuss., 7, 4223, 2010.