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Geoscientific Model Development Discussions

Interactive comment on "Validation of 3D-CMCC Forest Ecosystem Model (v.5.1) against eddy covariance data for ten European forest sites" *by* A. Collalti et al.

Anonymous Referee #2

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The manuscript by Collalti et al. presents the developments recently implemented into the 3D-CMCC Forest Ecosystem Model, which relies on the concept of Light Use Efficiency for carbon assimilation. It also presents an evaluation of the Gross Primary Production (GPP) flux simulated by the 3D-CMCC Forest Ecosystem Model against in-situ data at 10 European forest sites, from daily to multi-annual time scales. Additional simulations are also presented in order to test if a more in-situ based representation of the forest characteristics can improve the model performances.

Overall, the manuscript contains the information needed for understanding the model structure, the simulation set-up and the model evaluation. However, I would suggest to re-shape the model description section and to provide more information on the model

initialization at site level. I have also some serious concerns about the time series analysis performed. These points are developed here below.

Model description section: Most of the model features are described in the Appendix A. Because model development is the main scope of GMD, I would suggest to move the model description in the body of the manuscript, in the 'Materials and Methods' section. It is mentioned that information regarding model initialization at site level was taken from the BADM database but this information is not reported in the manuscript. It would be valuable to specify all these initial values that are site-specific (DBH, tree height, age and density) and to put these values in an appendix, for instance.

Time-series analysis: You attend to analyse the GPP at different time-scales (day, month and year) but the way you do it is not appropriate to my opinion. Your daily signal contains information at lower frequencies especially at monthly time-scale (seasonal). Indeed, the largest variations of the daily signal are the seasonal variations, in such a way that the correlation of the daily signal with observation is very similar to the one you get for the monthly time-series (top panels of figure 1). For the bias, by definition, based on equation (3), the model scores are the same for both daily and monthly time series, except that one is expressed per day and the other per month (compare bottom panels of figure 1). I think working with inter-monthly (IMV) and inter-yearly variabilities (IAV) as you did goes in the right direction but based on equation (4) this is not done properly. When defining IMV, it will be more appropriate to subtract the mean annual value (for each year) from the monthly GPP time-series instead of subtracting the long-term mean (over all the available years, as you wrote). By that way, you do not account for the biases at annual time-scale when analysing the IMV. There are sophisticated time-series decomposition techniques that have been applied to terrestrial carbon flux analysis (for instance, Mahecha et al., 2007) but there are also simple ones that I encourage you to use (for instance see equation (2) of Zhao et al., 2012) in order to perform your analysis on these flux anomalies, only. I would also suggest that you use the Mean Absolute Error (MAE) instead of the mean error for the Bias metric, in such

a way that you do not compensate for errors of opposite signs when averaging.

Based on the legends of figure 1 and table S1, I'm expecting to find in the figure 1 the same values than those reported in Table S1 for the correlation, NRMSE, MEF and Bias for daily and monthly time-series. But it is not the case for many sites and metrics, among others: at BE-Bra, MEF and Bias values of the daily GPP flux differ between Figure 1 and Table S1 and the Biases of the monthly time-series are also different at this site. NRMSE of the monthly time-series differ at FR-Hes. In addition, the Bias values reported in Table S1 and Table 3 do not match at IT-Ren (2L_2C) for both the daily and monthly time-series. All this is very confusing. Are there problems in the values that you report on the plot or in the tables, or problems in the legends in case the figure and the tables do not represent the same information?

Other comments

You present results in terms of GPP but describe how the model computes autotrophic respiration and other processes not directly linked to GPP calculation. I would suggest you to be consistent by either keeping the description of the respiration flux and showing results in terms of NPP or removing the paragraphs where other processes than C assimilation are described.

Page 6899 lines 7-8 you write that "the C/N stoichiometry is constant and depends on species, unfortunately, the model still lacks of an interactive C-N cycle". Based on this information, I don't think it is appropriate to write that 3D-CMCC FEM models nitrogen allocation and represent nitrogen pools.

In the results section, you never try to compare your results with other modelling studies. Other models based on LUE (or not) have also used some of the sites you studied for analysing the GPP flux, like you. It would be good - where possible - to compare your results with these studies, for instance: Balzarolo et al. (2014), Ogutu et al. (2013), Zhao et al. (2012), Yuan et al. (2007)

When discussing the results in terms of IAV and the capacity of the model to get the right sign of the IAV, be more critical on your results especially when writing that 'model reproduced well the timing of anomalies in more than half of cases' (page 6883 line 29), keep in mind that with a random selection process you catch the sign of the anomalies in half of the cases, already. Do other models perform better than 3D-CMCC FEM in terms of IAV?

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