

Our response to Larisa Timofeeva comments on 28.01.2022 (<https://doi.org/10.5194/bg-2021-294-CC2>)

*Title of the manuscript:* Improving the stomatal resistance, photosynthesis and two big leaf algorithms for grass in the regional climate model COSMO-CLM.

*Interactive comment on “Improving the stomatal resistance, photosynthesis and two big leaf algorithms for grass in the regional climate model COSMO-CLM” by Evgenii Churiulin et al.*

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The international group of authors shares the findings of their research on improving several algorithms included in COSMO-CLM. They have applied the model as a flexible tool for taking into account land-atmosphere fluxes and phenological properties, which can change due to global warming. The authors' idea is new (at least to me). The interdisciplinary core of the research makes it especially worth-while and up-to-date.

However, to help readers to understand quite complex content the authors have to pay more attention to details and relevant explanation of principal matters. In my opinion, the following terms need clarification in Abstract to attract more readers, who are not experts in plants.

**C3 vs. C4 plants** (first met in Line 13)

It would be useful to address the main differences between the two types of plants, which are due to their ability and manner to fix carbon dioxide in cool and warm seasons. Please provide some examples of “C3 grass plants in Germany” just to make the picture more vivid and realistic.

*Answer:* Ok, we agree with the reviewer. The sentence with the differences between C3 and C4 plants was added to the manuscript.

**One-big leaf vs. two-big leaf approach** (first met in Lines 14-15)

The difference between these two approaches is critical. Implementation of a two-big leaf approach means dividing vegetation into sunlit and shaded portions. This has complicated calculating dramatically and is worth highlighting, even though the approach is explained in subsection 2.4.2.

*Answer:* Thank you for this comment. Yes indeed, the modernization required a lot of additional work for the implementation of this approach. However, it is a programming and technical work and more information about the modernization of the model code can be found in the GitHub repository, appendix A and in the official documentation for COSMO and CLM models. Also, we are working on the special documentation where all these changes will be displayed. Nevertheless, additional changes (corrections) were added to the text. We hope, these changes help to explain the new implementations in more detail.

**Dry leaf calculations** (first met in Line 21)

What parameter do the authors imply? Please explain. I could not find either definition or equations in the paper.

*Answer:* Ok, we agree. The text of the manuscript was corrected. The name of this parameter was changed from *dry leaf calculations* to *the calculations of transpiration from dry leaf surface*. The detailed answer to this question (with equations and more detailed description) is presented in our answer to Sibylle Schaphoff questions and comments (<https://doi.org/10.5194/bg-2021-294-CC1>).

There are other points in the paper that need to be improved to enhance its readability.

**Line 10.** “Climatic changes towards warmer temperatures” can be replaced with a more common term “Global warming” that looks suitable in the context.

*Answer:* Ok, we agree. The text was corrected. *The new sentence is:* The simplified vegetation algorithm of the regional climate model COSMO-CLM is not capable of modelling complex processes depending on dynamic biophysical, environmental, soil water conditions and CO<sub>2</sub> concentrations especially relevant in the context of global warming.

**Line 65.** The full definition of LAI (the Leaf area index) should be placed before the abbreviation.

*Answer:* Ok, we agree. The text was corrected. *The new sentence is:* Moreover, the leaf area index (LAI) does not respond to water stress and depends on vegetation parameters.

**Line 95.** Equations 7 and 8 look the same. Please check.

*Answer:* Thank you for this clarification. The equations were corrected.

**Line 264.** “The focus of the research was on statistical analysis of the summer months” has no sense, since not months but certain parameters can be analysed, which are listed in the next sentence.

*Answer:* Ok, we corrected the text of the manuscript according to this comment. *The new sentence is:* The focus of the research was on validating values of the output COSMO-CLM parameters (near-surface temperature, latent and sensible heat fluxes, fluxes of water evaporation and transpiration, and stomatal resistance) during the period when the vegetation is in active phase.

**Lines 303-304.** There is a statement that the absolute error for precipitation is 4.45%. It must be corrected, since the absolute error cannot be in %.

*Answer:* Ok, thank you for noticing this mistake. The unit of the error was corrected from % to mm.

**Line 357.** It is not clear where in North America is situated the region for which the published in-situ stomatal resistance data were found. This is important to decide if the data can be used for validation of the results.

*Answer:* Ok, we added the information to the manuscript. The region is situated similar climate conditions and the data can thus be used for our analysis.

**Line 372.** Table 3. I find myself doubtful what CTR stands for. Besides, the word DATE seems strange in two columns between v3.5 and v4.5e.

*Answer:* We thank you for this comment. The header of the table 3.1 was corrected. The word DATE was deleted, the new header is v4.5.

**Line 486.** “Evapotranspiration plays an important role in determining the component of energy balance”. What component do the authors mean?

*Answer:* Ok, we agree. The sentence is corrected. The new one is: Evapotranspiration is an important component in the energy balance equation.

Moreover, I have noted a number of issues that need rewriting. In my opinion, too many punctuation marks are used, such as dash, colon, and brackets. Besides, spelling of the word “parameterization” and use of articles are not consistent. I should confess English is not my native tongue; moreover, the authors’ vocabulary and writing style might differ from mine. However, some English language flaws

are obvious and should be corrected. I consider the shortcomings noted by me might be consequences of the authors' urgent willing to share their latest findings.

*Answer:* Ok, thank you for these comments. We agree with them. The text of the manuscript is adjusted to the comments. We also send our manuscript to a professional editing service.

I have also paid attention to the fact that several references, explaining basic foundations, were made to modern resources instead of appropriate older ones. One example is in Line 34, de Noblet-Ducoudre and Pitman, 2021. There is classic research on the role of soil and its parameters in land-atmosphere interaction, starting from Dokuchaev. All of all, the Reference list includes a wide range of resources, which are accessible via the links provided. This is only one of the numerous strengths the paper has.

*Answer:* Ok, thank you for this information, it is a good idea. We added this classical research paper to our manuscript.

To begin with, the paper is perfectly structured. Each section logically presents all the information announced in Abstract. In section 2, the changes implemented in the TERRA-ML and COSMO-CLM models are described. These noticeable changes have made applying COSMO even more time and resource consuming than it usually is. The modified algorithms are quite detailed described in the text and in Appendix A. Codes as a Python package and data are available via the links provided. All this proves that the authors are experienced data scientists and programmers.

*Answer:* Thank you for this comment. We appreciate it.

Thorough statistical analysis of a number of modelled characteristics was carried out based on the relevant parameters, including the Kling-Gupta Efficiency index, which has become quite popular recently. The choice of different validation datasets seems to be convincing.  
Ok, we thank the reviewer for this comment.

What I miss is a more detailed discussion in terms of botanic.

Ok, the reviewer raises a good point. We added more discussion in terms of botanic. For example, in the introduction was added information about C3 and C4 grass. The methods were expanded by the more detailed information about the vegetation parameters. Stomatal resistance section: the new sentence about the role of  $V_c$ , max in Ball-Berry approach added to the manuscript.

I would like to highlight that the authors reasonably evaluate perspectives of possible future research; they will try to implement new algorithms, which will enable accounting carbon uptake rate, changes in temperature and different growing seasons.

We thank the reviewer for this thoughtful comment.