Discussion of "Divergent response of evergreen needle-leaf forests in Europe to the 2020 warm winter"

Gharun et al.

Reviewers' comments are in italic. The Author's responses are marked in blue.

Author Response to Referee 1

1. General comments

The theme holds significant importance, as they aim to assess the impact of a warm winter on CO2 fluxes through the examination of flux tower data. The findings indicate that winter warming triggers a divergent ecosystem response. Additionally, observations reveal that in colder locations, daytime Net Ecosystem Productivity (NEP), primarily driven by photosynthesis, decreases with warming air in winter. Conversely, in warmer sites, daytime NEP increases with soil warming. However, the paper exhibits several big issues:

The introductions lack clarity and a well-organized structure. Introductions should avoid incorporating captions.

Thank you for your feedback. We appreciate your insight regarding the clarity and organization of the introduction. We will take your comments into careful consideration and make necessary revisions to improve the overall structure and coherence of the introduction. Specifically we will improve the clarity of the paper by re-writing the Introduction entirely in this structure:

1) Introducing the main challenge which is understanding the response of forest CO_2 fluxes to changes in the temperature and why this understanding is needed,
2) the impact of temperature and radiation on the CO_2 flux components (NEP, GPP and RECO),
3) differences in temperature sensitivity of CO_2 fluxes in different regions,
4) the extent of reported warming in winter 2020 across different sites
5) the objectives and hypotheses of this study.

The introduction lacks logical coherence, for example, Lines 78-83 dedicates excessive space to elaborating on physiological responses, which is not the primary focus of this study.

We will remove text related to ecophysiological responses from the Introduction, and instead add an introduction section about the influence of different environmental factors on the components of NEP (i.e., GPP and ecosystem respiration) and NEP in general, to maintain the focus of the paper.

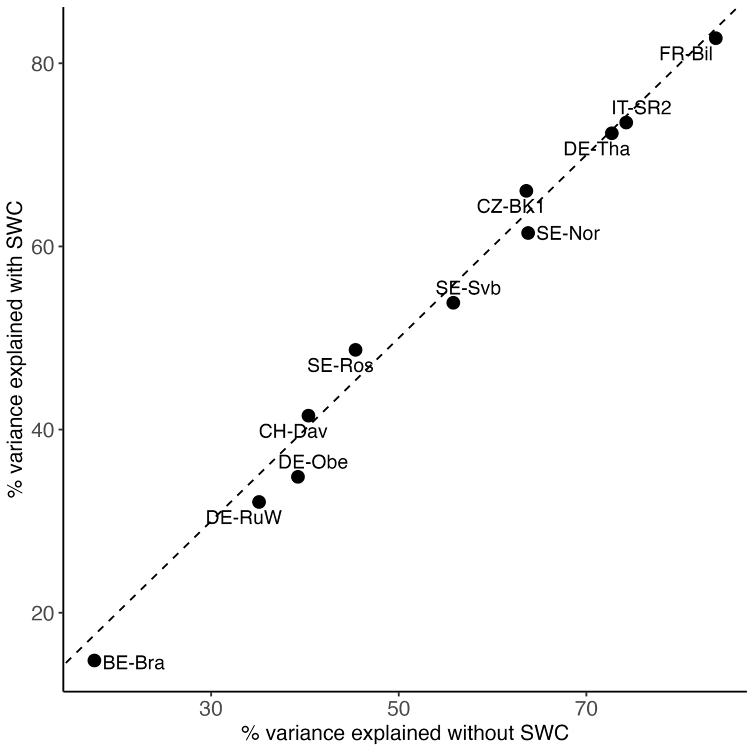
Table 3 could be presented graphically.

After revising our research questions we saw necessary to remove this table, as it no longer fits our objectives.

The analysis focuses solely on solar radiation and temperature, neglecting the consideration of moisture limitations. RF model should also consider moisture variables.

Soil water content (SWC) was removed from the drivers analysis 1) because of its negligible effect on the overall model (see more details below), 2) since not all sites had complete measurements throughout the study period, 3) and because generally soil water content measurements should not be trusted at freezing soil temperature levels, and we saw that for several sites soil temperature in winter remained near or below zero (see Figure 5).

The effect of soil water content on the RF model was negligible as we had compared the random forest results once with and once without including SWC. The difference in the variance explained was less than 3% (negligible improvement in results based on the %variance explained of the model).The figure below shows the comparison of the importance of SWC in the random forest model for the 11 sites that had SWC measurements. The dashed line shows the 1:1 comparison of the model with, and the model without SWC.



We will add this information to the Methods section.

Furthermore, the potential collinearity between soil temperature and air temperature can impact the accuracy and reliability of the model results.

One of the characteristics of the random forest regression is its robustness against multicollinearity of predicting variables. Decision trees in a random forest model are constructed based on impurity measures known as Gini impurity. When selecting the best split at each node for constructing the decision tree, the algorithm chooses the feature that maximizes the information gain (or minimizes the error), which is a measure of how much the split reduces mse (mean square error) in the target variable. Therefore, even if two correlated variables are available for splitting, the algorithm chooses the one that results in the lowest error metric (e.g., MSE), which then gives an indication of the importance of the variable (or variable importance) (Breiman 2001). Therefore, random forest is not affected by multicollinearity as much. Furthermore, in this study we do not use the random forest regression model to make predictions, but to understand variable importance by estimating 'conditional variable importance' which calculates variable importance taking into account the collinearity of the predictors (thus 'conditional').

We will add a brief description in the Methods section to clarify this point.

To enhance the manuscript, a concerted effort should be made to streamline the content, maintain logical progression, and incorporate necessary elements for a thorough analysis.

Thank you for your feedback.

We will revise the Introduction section thoroughly to improve the logical flow (see our response to an earlier comment please), and will add the missing information in the Methods and Results section (in response to the comments posted by the second reviewer also) and re-write the Discussion section accordingly.

In order to improve the data analysis we will add a section on the analysis of the temperature sensitivity of CO_2 fluxes. For this part, we will bin the data by mean air temperature and average CO_2 flux for the respective bins. In this way we will compare winter GPP/NEP/Reco with Rg/Tair/Tsoil during a reference winter (2014-2019) and compare that with winter 2020. More details are provided in response to the comments from the Reviewer #2.