Reply on RC1

General comments

Although the article does not introduce new scientific methods, the methods used are fully sufficient for a detailed analysis of the specific phenomenon under investigation.

The language and the interpretation of the results are clear, and it shows very well the influence of LAI on atmospheric parameters produced by MAR. In addition to the objectives of the article, it also clearly shows the role of forests in the natural environment.

Nevertheless, here are some points for possible amendments and explanation.

-the title does not fully reflect the content of the manuscript as the vegetation dynamic is represented exclusively only by one parameter - LAI. Therefore, LAI should be reflected in the title. Further to that, the role of LAI in vegetation dynamics should be briefly discussed in text.

Thank you for this relevant comment. We agree that vegetation dynamics in our study are represented exclusively through LAI, which is a central aspect of the manuscript. Accordingly, we propose the following revised title:
"Assessing Regional Climate Model Sensitivity to Vegetation Dynamics Using Spaceborne Remote Sensing-derived Leaf Area Index."

In addition, we will include a short paragraph in the LAI data section clarifying the role of LAI in representing vegetation dynamics

Line 174 will be changed to : "As explained in Section 2.1, the vegetation cycle in MAR is externally prescribed. In this case, MAR uses as primary information the Leaf Area Index (LAI), that represents the one-sided green leaf area of a canopy per unit ground area, influencing processes like photosynthesis, and energy exchange at the vegetation-atmosphere interface (Chen and Black, 1992). Because carbon and water exchanges between vegetation and the atmosphere occur at the leaf scale, LAI is closely linked to land-atmosphere fluxes and is therefore a key variable in climate modelling (Rogers et al., 2021). In addition, LAI is strongly associated with major phenological stages such as leaf expansion, maturity, and senescence, making it a direct indicator of seasonal vegetation dynamics (Richardson et al., 2013)."

-the finding that increased LAI leads to increased evaporation is somehow surprising. Does it have any physical explanation, or could it rather be attributed to MAR procedure?

The increase in evaporation is indeed induced by the MAR physics. The evaporation in MAR combines the evaporation of open water, water in the first centimeters of soil and water intercepted by the leaves. As MAR tends to quickly make the water drain below

the modelled soil depth, the water reaching the ground tends to reach depth at which it is no longer considered for the surface soil evaporation. Thus by increasing the LAI, more water is intercepted by the leaves and thus more water is evaporated.

Definitions of evaporation and evapotranspiration will be provided in the text.

-it should be clarified what data entered the comparison in Sec. 3.1. The terms „observational-modelled data“ (row 255) and „observed data“ (row 259) should be defined/described.

Thank you for this comment. “Observed data” in line 259 is indeed a typo.

Line 255 will be revised to:
“To evaluate the simulations, we compared the daily averaged model outputs against datasets directly derived from observations.”

Line 259 will be revised to:
“[…] perform a statistical comparison between the model and observation-based data.”

In this manuscript, we define observation-based data as data derived directly from observations that have undergone post-processing prior to their use in the analysis.

-the sensitivity test in section 3.4 should be supported by some numeric or graphic interpretation.

Thank you for this suggestion. We did not initially include numerical or graphical interpretations of the sensitivity test results because the differences were not statistically significant. However, to improve clarity and completeness, we will include an additional table in appendix (Table C1), similar to Table 3, presenting seasonal daily average values of surface air temperature, soil moisture content, and albedo, as well as cumulative mean daily rainfall and evapotranspiration for summer (JJA) and winter (DJF) over the 2015–2024 period.

Table C1 : Daily average values of surface air temperature, soil moisture content, and albedo, along with cumulative daily rainfall and evapotranspiration, for summer (JJA) and winter (DJF) during 2015–2024, as simulated by $MAR_{MODISclim}$ (using the MODIS LAI climatology) and MAR_{sector} (using the MODIS LAI climatology corrected for MAR subpixel).

	Temperature (°C)		Soil moisture		Albedo		Rainfall (mm/day)		ET (mm/day)	
	DJF	JJA	DJF	JJA	DJF	JJA	DJF	JJA	DJF	JJA
MAR$_{MO}$	3.8	18.4	0.65	0.63	26.3	23.8	194	232	6	156

DIS										
MAR$_{sector}$	3.8	18.6	0.65	0.63	26.2	23.5	190	227	6	158

-the statement „...that changes in LAI influence the distribution of rainfall events (Fig. 8(a)) sounds like LAI is influencing the raifall events didtribution.The above fact is rather attributed to the seasonal distribution of both LAI and rainfall events. Explain please, if not.

Thank you for pointing out this ambiguity. We agree that the seasonal co-variation of LAI and rainfall should not be interpreted as a causal influence of LAI on the temporal distribution of rainfall events. In our simulations, changes in LAI do not modify the temporal distribution of rainfall events, but only the magnitude of some extreme rainfall enhanced by local (inside MAR integration domain) evapotranspiration.

To avoid any confusion, lines 391–392 will be revised as follows:
“Examining the frequency of rainfall events based on their hourly intensity across the different experiments ($MAR_{+-x\mu}$, MAR_{ref}, and $MAR_{MODISclim}$) reveals that changes in LAI influence only the magnitude of some high-intensity rainfall events (Fig. 8(a)).”

Typos

There are very few typos in the text. Nevertheless, one more check for typos, like in rows 31 and 465 is recommended.

The authors would like to thank Dr Nejedlik Pavol for identifying typographical errors. The text will be reviewed and the typos will be changed accordingly.

-row 31 . n response, ... (In response,...)

-row 465 ...a led to... (skip a), ...LAI compared to s static one,... (change to s to a)

Formal notices

-the areas marked with a thin dashed line in Fig. 1 should be defined in the legend to Fig. 1.

Thank you for this remark. The areas marked with dashed lines correspond to forested regions within the studied domain. The figure 1 caption will be revised to include the following sentence:

“Forested (or partially forested) regions of Ardenne and Campines are indicated with black dashed outlines.”

-it should be stressed that 10 years of phenological data is quite a short time to compute useful climatology (row 193). The word „averages“ instead of „climatology“ should be rather used.

Thank you for this important remark. We agree that a 10-year period is relatively short to establish a true climatology. Accordingly, the term “climatology” will be replaced by “average” throughout the manuscript when referring to the MODIS dataset. For example, line 192 will be revised to:

“From the 8-day MODIS product, we computed an annual daily average using all available images over the period 2012–2022.”

$MAR_{MODISclim}$ will also be renamed $MAR_{MODISavg}$

-it is difficult to distinguish some of the lines in Fig, 4a.

We agree that $MAR_{MODISsector}$ and MAR_{-0} are difficult to distinguish. The colour palette will be revised to improve visual contrast and readability.

-terms MAR_{m2m} and MAR_{2m} (row 382) should be clearly defined.

We thank the reviewer for noting the inconsistent terminology. The terms MAR_{m2m}, MAR_{2m}, and $MAR_{MERRAclim}$ correspond to earlier naming conventions and will be replaced by the experiment names used in Table 1, namely $MAR_{-2\mu}$, $MAR_{+2\mu}$, and MAR_{ref}, respectively. The entire manuscript will be carefully reviewed to ensure consistency between text, figures, and tables.

-rows 468 and 469. ... maximum daily air temperature (Fig. 11a) and daily average evapotranspiration (Fig. 11b). Figs 11a and 11b show the ET and Tmax in reverse order from that listed in the text.

We thank the reviewer for identifying the mismatch between the text and the figure order. The text will be corrected so that maximum daily air temperature (Fig. 11b) and daily average evapotranspiration (Fig. 11a) are described consistently with the figure. The text will be reviewed to ensure consistency between the text and the figure/tables.

-Fig. 11. The description in the legend and in the figure itself should be identical. $MAR_{MERRAclim}$ is shown in the figure while MAR_{ref} in the legend.

Following precedent comments, $MAR_{MERRAclim}$ corresponds to earlier naming conventions and will be replaced by the experiment names used in Table 1 namely $MAR_{ref.}$

-row 353. There is no Appendix A1. There is Appendix A, Table1.

The reference to Appendix A1 is incorrect and the line 353 will be changed to ”A more detailed table of the changes can be found in table A1 in appendix A”

Bibliography

- Chen, J. M. and Black, T. A.: Defining leaf area index for non-flat leaves, Plant, Cell & Environment, 15, 421–429, https://doi.org/10.1111/j.1365-3040.1992.tb00992.x, 1992.

- Richardson, A. D., Keenan, T. F., Migliavacca, M., Ryu, Y., Sonnentag, O., and Toomey, M.: Climate change, phenology, and phenological control of vegetation feedbacks to the climate system, Agricultural and Forest Meteorology, 169, 156–173, https://doi.org/10.1016/j.agrformet.2012.09.012, 2013.

- Rogers, C., Chen, J. M., Croft, H., Gonsamo, A., Luo, X., Bartlett, P., and Staebler, R. M.: Daily leaf area index from photosynthetically active radiation for long term records of canopy structure and leaf phenology, Agricultural and Forest Meteorology, 304-305, 108 407, https://doi.org/10.1016/j.agrformet.2021.108407, 2021.