Referee comments to *Fire Weather Compromises Forestation-reliant Climate Mitigation Pathways*

Referee #2:
https://egusphere.copernicus.org/preprints/egusphere-2024-15#RC2
General:

2.0 This paper investigates the feedback mechanisms between climate change and forest carbon sequestration across five integrated assessment models (IAMs), where wildfires play a significant role in influencing the accumulation of carbon within forests. The Canadian Fire Weather Index (FWI) is a pivotal metric to assess potential fire risk. The subject matter is particularly intriguing for discussion, given that contemporary research tends to concentrate more on either afforestation efforts or the impacts of exacerbated wildfire weather conditions. Several minor points need to be addressed to elucidate the central concept more effectively.

Thank you for acknowledging both the relevance of our perspective as well as its interdisciplinary approach.

2.1 The introductory section outlines the advancements and constraints of current research, but seems inadequacy to explicitly establish strong relationships among these various aspects.

Thank you for this feedback, which agrees with the comment of referee #1 (1.1.1). In response we will enhance the links within our literature-based introduction.

2.2 In Section 3, the authors employ FWI instead of alternative fire impact metrics due to its dependency solely on atmospheric conditions, rendering it more resilient. Moreover, FWI exhibits a positive interannual correlation across various forested regions. However, it is confusing that the calculated weighted mean value does not provide adequate support for the role FWI plays in serving as a proxy for wildfire potential. To improve this, it would be beneficial if the authors:

- Conduct a comparative analysis between FWI and other existing fire weather index systems.
- Concentrate their focus on forest areas that display notably high correlations.

Thank you for this comment. Local FWI cannot fully represent fire risk, because vulnerability and exposure of the forest would matter as well. However, the same issue remains with alternative fire weather indices. Nevertheless, the FWI, as other fire indices, are useful to assess the physical hazard of changing weather conditions. Supported by extensive literature on the robust links between fire weather and fire occurrence (e.g. Abatzoglou et al, 2018; Bedia et al, 2015; Jones et al., 2022), we are confident that assuming constant and homogeneous vulnerability globally allows for conclusions on the globally aggregated level for overall relative trends.

Regions, where the correlation between FWI and BA is high, offer analysis with higher confidence. Following your advice we will give key indicators not only for global aggregation but also for aggregation across high correlation regions.

Abatzoglou, J. T., Williams, A. P., Boschetti, L., Zubkova, M., and Kolden, C. A.: Global patterns of interannual climate–fire relationships, Global Change Biology, 24, 5164–5175, https://doi.org/10.1111/gcb.14405, 2018.

Bedia, J., et al.: Global patterns in the sensitivity of burned area to fire-weather: Implications for climate change, Agricultural and Forest Meteorology 214-215, 369-379, https://doi.org/10.1016/j.agrformet.2015.09.002, 2015.

Jones, M. W., Abatzoglou, J. T., Veraverbeke, S., Andela, N., Lasslop, G., Forkel, M., Smith, A. J. P., Burton, C., Betts, R. A., van der Werf, G. R., Sitch, S., Canadell, J. G., Santín, C., Kolden, C., Doerr, S. H., and Le Quéré, C.: Global and Regional Trends and Drivers of Fire Under Climate Change, Reviews of Geophysics, 60, e2020RG000 726, https://doi.org/10.1029/2020RG000726, 2022.

2.3 Several studies (ref1, ref2) have demonstrated that anticipated changes in fire weather and ongoing wildfire activities can drive long-term shifts in forest species composition and lead to significant transitions from woody vegetation cover to less dense vegetative types such as scrubland and grassland. In this context, I am interested to know how the IAMs in this paper address or account for these vegetation dynamics and their implications on the ecosystem.

In some IAMs, vegetation dynamics and PFT composition are only modelled by separate vegetation models like LPJmL. In others, simpler, static vegetation maps and parameters are used (see Appendix C for overview). While REMIND-MAgPIE does includes LPJmL data in an offline mode, IMAGE simulation runs include LPJmL vegetation dynamics coupled to other socio-economic processes annualy. Advanced processe like aridity limiting post-fire recovery has not been assessed with LPJmL. However, with its modeling structure it is generally capable to model landscapes and vegetation composition responding to disturbance (e.g. Ostberg et al., 2015).

It is important to contextualize that the land model components of IAMs are land use models optimizing the allocation of land use and land cover change according to optimization of internalized profits and costs. Shifting vegetation suitability therefor rather is a boundary condition than a driver of the projected land cover changes (compare Table 1 and lines 145 – 152, see also Schaphoff et al., 2018 and Braakhekke et al., 2019).

Ostberg, S., Schaphoff, S., Lucht, W., and Gerten, D.: Three centuries of dual pressure from land use and climate change on the biosphere, Environmental Research Letters, 10, 044 011, https://doi.org/10.1088/1748-9326/10/4/044011, 2015.

Schaphoff, S., Bloh, W. V., Rammig, A., Thonicke, K., Biemans, H., Forkel, M., Gerten, D., Heinke, J., Jägermeyr, J., Knauer, J., Langer-wisch, F., Lucht, W., Müller, C., Rolinski, S., and Waha, K.: LPJmL4 - A dynamic global vegetation model with managed land - Part 1: Model description, Geoscientific Model Development, 11, 1343–1375, https://doi.org/10.5194/gmd-11-1343-2018, 2018.

Braakhekke, M. C., Doelman, J. C., Baas, P., Müller, C., Schaphoff, S., Stehfest, E., and Vuuren, D. P. V.: Modeling forest plantations for carbon uptake with the LPJmL dynamic global vegetation model, Earth System Dynamics, 10, 617–630, https://doi.org/10.5194/esd-10-617-2019, 2019.

2.4 In figure 5, the value between -0.5 and 0.5 was set to the same group in the color bar, demonstrating very little information.

Thank you, as requested also by referee #1 (1.2.4), we will alter the color bar such that we keep transparency high close to zero change.

Ref1. Mekonnen, Z.A., Riley, W.J., Randerson, J.T. et al. Expansion of high-latitude deciduous forests driven by interactions between climate warming and fire. Nat. Plants 5, 952–958 (2019). https://doi.org/10.1038/s41477-019-0495-8

Ref2. Baudena, M., Santana, V.M., Baeza, M.J., Bautista, S., Eppinga, M.B., Hemerik, L., Garcia Mayor, A., Rodriguez, F., Valdecantos, A., Vallejo, V.R., Vasques, A. and Rietkerk, M. (2023), Increased aridity drives post-fire recovery of Mediterranean forests towards open shrublands. New Phytol, 239: 2416-2417. https://doi.org/10.1111/nph.19012