RC1

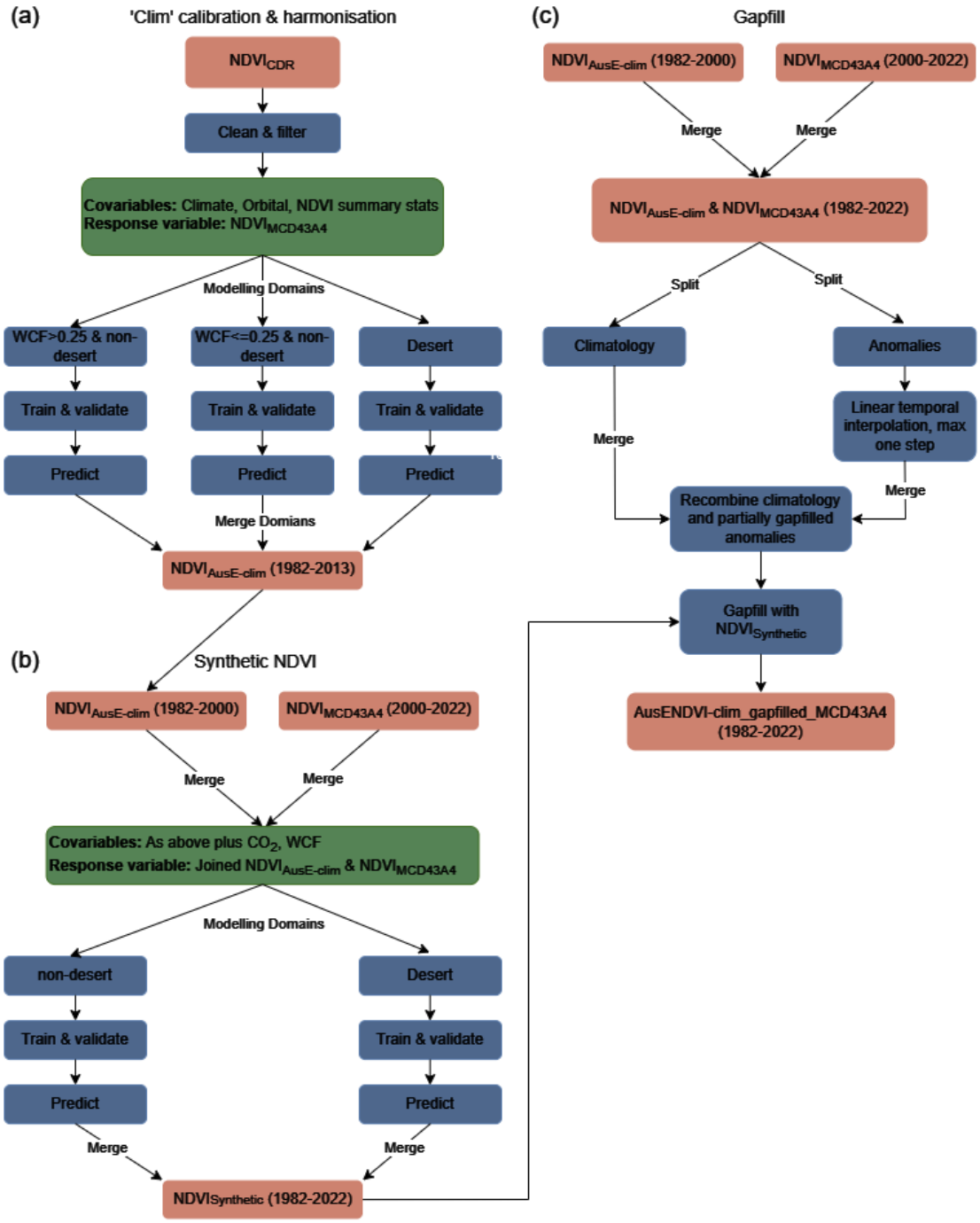
This study proposed several versions of AusENDVI and these NDVIs can be used for studying Australia's changing vegetation dynamics and carbon, and water cycles. The paper is generally organized. The new data set would be useful for the Earth system science studies. However, I still have questions about the structure of the article. Considering these and due to the following major concerns and suggestions, I would recommend it with major revision and to determine whether to accept a revised version.

Major concern:

RC1-1: I think the article needs a flowchart to show each step, which helps the reader understand the importance of the data processing process. So far I found in the section 'Data and Code Availability' that the author lists each version of AusENDVI, but in fact, I am confused about which step each version of the data is obtained through.

We thank the reviewer for noting the need for a flowchart to clarify the methods. We agree that a flowchart would increase understanding, especially since the modelling is broken up into several domains that can get confusing to follow. We had neglected to include one originally in the interests of keeping the number of figures to a minimum but are now convinced, as per your suggestion, that there is a need for it. The flowchart below will be edited into a revised manuscript with the following caption:

Figure 1: Flowchart describing the methods of calibration and harmonisation (a), and the development of a synthetic NDVI (b) for gap filling (c). a) Shows the method for the 'clim' model type, the methods for 'noclim' are the same but climate variables are removed from the covariables and 'noclim' is not gap filled. Red coloured boxes denote datasets, blue boxes denote processing steps, and green boxes describe the response variables and covariables used for modelling.



<u>RC1-2:</u> I don't think 'Quality of existing NDVIs' is the key part of the article, this part of the results could be replaced by comparing the performance of AusENDVI with other NDVIs, e.g. by adding on the performance of AusENDVI in Figure 2, and then transforming this part into the second part of the results.

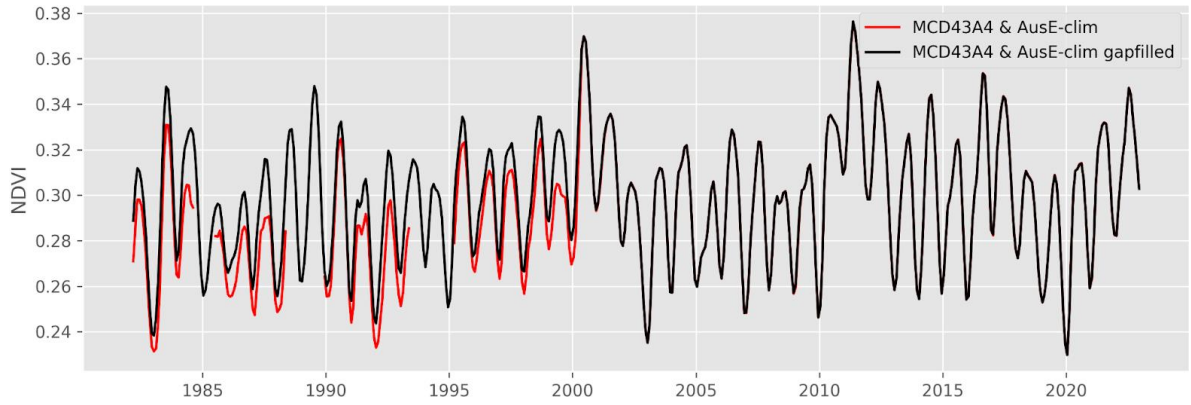
We respectfully disagree that the section examining the quality of existing NDVI products over Australia is not crucial to the article. We feel it is necessary firstly to help establish the underlying scientific need to develop an Australian-specific long-term NDVI, and secondly to help educate potential users of both AusENDVI and other global NDVI products on the limitations and advantages of these datasets. Of course, there are many ways to structure the article, and your suggestion may increase the overall efficiency of

the article by including more results in the same figure set. However, we argue this would reduce the emphasis on the intercomparison and thereby lessen one of the objectives of the study i.e., to determine the suitability of existing NDVI products for long-term vegetation monitoring in Australia.

<u>RC1-3:</u> I think the first part of the results could be to highlight the results of each step, especially 'before and after the calibration and harmonization' and 'before and after gaping fill'. Of course, these are already in the results, but they should be in the same section to highlight the results of each step of the enhancement.

We believe it is necessary for the results of the calibration and gap filling to be in different subsections as there are two distinct modelling efforts occurring here. In the first instance (section 3.2), we report the results of harmonising AVHRR to MODIS, and in section 3.3 we report the results from the creation of a synthetic NDVI for gap filling. The creation of a synthetic NDVI is a different enough process from the harmonisation that we argue it requires its own subsection (different models, modelling domains, and input data). Note also that the two sub-sections immediately follow each other so narratively the current structure of the article is similar to your suggestion. We hope the inclusion of a flowchart will also help clarify this and make more obvious the need to separate the results of the two different steps.

We also aim to include the plot below into Figure 7 to show the 'before and after' results of gap-filling. As missing data tends to be in the higher NDVI regions (wet, cloudy, forested regions), gap filling has the tendency of increasing NDVI when averaging over the continent. Figure A4 in the current manuscript also shows the time series of CDR-AVHRR before and after the calibration/harmonisation, averaged across all of Australia and broken down by bioclimatic region. We are open to including this in the main part of the manuscript at the editor's discretion.



<u>RC1-4:</u> Is it possible to find field measurements of NDVIs in Australia to provide absolute accuracies for individual NDVIs, and if so, this would be an important support for demonstrating the accuracy of AusENDVIs.

In short, no. There are no in-situ field measurements of NDVI that are comparable to the spatial and temporal scales of AusENDVI (the area of pixels in AVHRR are ~25 km^2). However, note that MODIS MCD43A4 surface reflectance data (from which we calculate NDVI as the response variable for the harmonisation) is a well calibrated and validated remote sensing product, and the validation performed in our study is based on random pixels selected from MODIS. We also included a comparison with the Digital Earth

Australia Landsat surface reflectance product as this product has all the same types of corrections (atmospheric, BRDF etc.) (Byne et al. 2024) as MODIS MCD43A4 and is therefore a fair and independent inter-comparison dataset.

RC1-5: The discussion is too lengthy, my suggestion is that it could be broken up into subsections.

We will revise the manuscript to include subtitled sections in the Discussion, and where possible we will edit for clarity and brevity.

RC1-6: As with 'Trends in peak-of-season phenology', I would suggest that the authors do the same study again, using the available NDVIs, do a trend analysis of annual averages, and then compare it to the results in the literature, to sidely bolster the credibility of these data.

We appreciate the reviewer's suggestion here and below we have assessed the annual-average NDVI trends across Australia for the different NDVI products to see how they differ. AusENDV-Clim closely reproduces the observable trends in MODIS and GIMMS3g (coefficients: AusECLIM=0.00058 NDVI yr^{-1}, MODIS=0.00066 NDVI yr^{-1}, GIMMS3g=0.00061 NDVI yr^{-1}). Trends in the two GIMMS-PKU products are less than half those of MODIS and GIMMS3g. This result reinforces our previous assertions that no pre-existing AVHRR-based NDVI product both reproduces close agreement with the MODIS record while simultaneously reproducing satisfactory results in the pre-MODIS era. We aim to include this analysis in a revised manuscript.

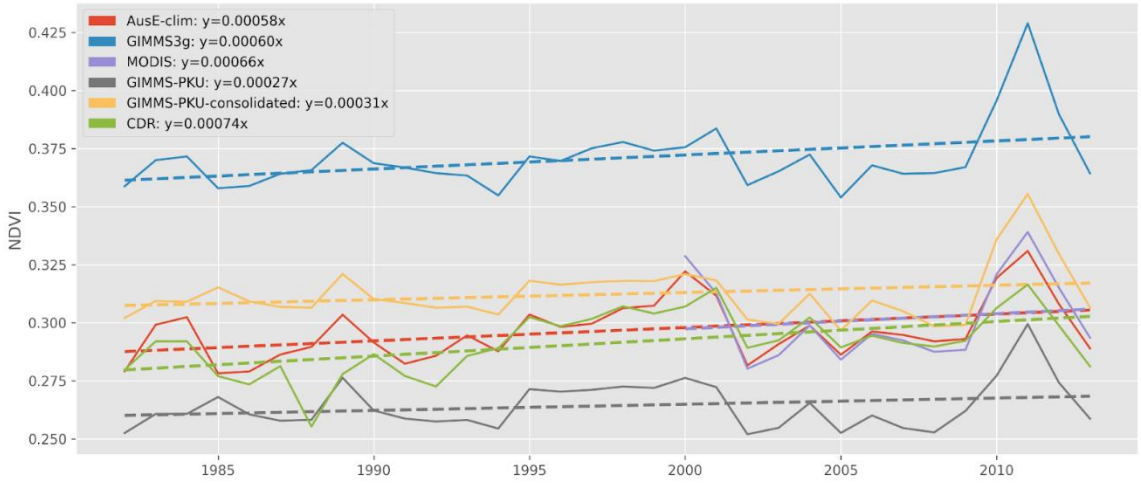


Figure: Annual average NDVI trends summarised over Australia for the overlapping period of 1982-2013. All data gaps have been matched between datasets, and datasets have been reprojected to match the resolution of GIMMS3g. Trend lines have been fitted using ordinary least-squares regression and coefficients are expressed in terms of NDVI yr^{-1}.

References

Byrne, G., Broomhall, M., Walsh, A. J., Thankappan, M., Hay, E., Li, F., ... & Denham, R. (2024). Validating Digital Earth Australia NBART for the Landsat 9 Underfly of Landsat 8. Remote Sensing, 16(7), 1233.