

## ***Interactive comment on “The influence of vegetation on the ITCZ and South Asian Monsoon in HadCM3” by M. P. McCarthy et al.***

**M. P. McCarthy et al.**

mark.mccarthy@metoffice.gov.uk

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### **General comments**

**We thank the reviewer for their useful comments. Particularly for taking to time to do so and demonstrating the value of the open review process that this journal provides. The original review comments are copied below, and our response is in bold. The methods, results, and overall conclusions are unchanged, but we have undertaken substantive revisions to parts of the manuscript to improve the presentation and address common points raised by all the reviewers. Therefore the responses below will make reference to the appropriate sections in the revised manuscript**

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M. P. McCarthy and colleagues present a sensitivity study of the HadCM3 climate model to different reconstructions of vegetation. More specifically, they consider 9 transient experiments, covering the period 1959 to 1989 AC, initialised from previously published experiments covering the periods 1859 and 1989. Out of the 9 experiments, 8 use vegetation reconstructions meant to represent the pre-industrial vegetation cover (it is not entirely clear whether this is pre-industrial or pre-industrial potential vegetation), but obtained differently, either based on previously published surveys or on experiments with the TRIFFID vegetation model developed on purpose for HadCM3. The 9th experiment uses an estimate of extra-tropical vegetation at year 2100 obtained with TRIFFID, but maintains the tropical (or Southern Hemisphere?) vegetation of year 1859, in order to emphasise the effects of northern extratropical vegetation changes on the atmospheric circulation.

### **The redrafting of the experiment description will hopefully make this clearer**

A series of graphics are presented (Fig. 2, 3, 4) showing the effects of these vegetation differences on different atmospheric quantities, including temperature, precipitation, zonal wind and monsoon seasonal indices. The conclusion summarises nicely the objective of the authors: they “demonstrate a sensitivity of HadCM3 tropical climate to extratropical vegetation [...] consistent with numerous previous studies both with HadCM3 [...] and other GCMs. This study does not offer any new insight(s) into these teleconnections processes [...] but it serves to demonstrate how the representation of vegetation [...] can have significant implications. ”

This quote shows that the objective of the authors is to illustrate the climate-modelling uncertainties associated with vegetation land cover, not to investigate deeply the atmospheric teleconnection mechanisms, which have already been amply addressed elsewhere. Implicitly, it may be understood that the interest of the study lies in comparing these uncertainties with other sources of uncertainties, e.g., uncertainties associated with the uncertain parameters of the model, forcing and interannual variability, which are being sampled in the ensemble approach at the core of the QUMP2019

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(Quantifying Uncertainties in Modelling Prediction) project. Unfortunately, such a quantitative comparison is missing in the present article.

**A brief quantitative comparison of this type is now included in the revised section 3.3 to demonstrate that the difference between the TRIF and WHS experiments are outside the range of the perturbed physics ensemble of Booth et al. 2011, and that the difference of the alternative "observed" datasets is of a similar magnitude to the spread of the perturbed physics ensemble**

It must be said that the discussion of mechanisms is being difficult by the nature of the experiment design. Changes in vegetation result from different modelling assumptions or different literature sources, rather than from a controlled alteration of vegetation patterns that would have been specifically chosen to study extratropical-tropical connections. In this sense the ensemble of experiments presented here is truly an ensemble of opportunity.

**That is correct**

Namely, the authors observe that the weakening of the Tropical Easterly Jet further indicates a perturbation to the dynamical South Asian monsoon system rather than through vegetation feedbacks over India", but how can one exclude that vegetation feedbacks over India force the weakening of the Tropical Easterly Jet?

**While it is true that this manuscript cannot completely rule that out, the large-scale responses and sensitivity to northern hemisphere extra-tropics pulled out from the experiments does provide strong evidence of a remote rather than local feedback to the large-scale tropical dynamics. This point is made clearer in the revisions to sections 3.1 through 3.3 and is consistent with other studies such as Osborne et al. 2004 discussed in the introduction**

Keeping this in mind, one wonders whether the numerous plots presented in Figures 2 and 3 are the optimal way of presenting the information relevant for the present study.

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The reader is easily confused (implicit labelling of dashed, dotted and full solid curves does not help) given the complexity of vegetation changes (Figure 1) that have to be associated to temperature and precipitation changes (Figures 2 and 3). Furthermore, the plots do not provide much insight about which differences should be judged as significant as regards the other sources of uncertainties (in particular, parametric uncertainties).

**The plots have been significantly simplified to improve clarity as suggested, with additional useful but not essential panels moving to supplementary material**

The article may also gain in readability by considering the following comments about style. Introductory / review material tends to be intermingled with result discussion.

**The discussion of some aspects of the wider literature are included in the results section where they are of particular importance to the processes under discussion**

The conclusion comments a bit surprisingly on the problematic of land use classification schemes, surely an important topic but which has not been addressed earlier in the article. It finishes on a quite general sentence that, arguably, is not very informative.

**I would disagree, the manuscript is very much concerned with the problems associated with land use classifications, because these results demonstrate how plausible uncertainties in existing datasets markedly change the simulation of tropical climate in the widely used HadCM3 model. This point is now made in the introduction as well as the conclusions.**

The phrasing is confusing at places: the experimental setup has to be read several times, and shadows persist, as to the differences between TRIF1 and TRIF2, why TRIF1 and TRIF2 were used distinctly to run IGBP1, IGBP2 and WHS1 and WHS2, the difference between IGBP1 and IGBP2 being phenology fixed, while both TRIF1 and TRIF2 have phenology.

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**The discussion of the experimental setup has been significantly altered to make for clearer presentation. While the alternative set of experiments were initially conducted to separate the effects of phenology this has minimal impact and so the experiments are paired to provide 60 year samples.**

which anthropogenic disturbances of vegetation are being taken into account?

p. 94 l. 2 : with and without tropical vegetation : what does it mean exactly?

**It would be beyond the scope of this manuscript to go into the experimental detail of the Osborne et al. study**

p. 94, l. 14 : intrinsic variability : the authors probably mean the atmospheric variability

**Modified as suggested**

by only perturbing the Northern Hemisphere: must one understand that the fraction of the tropics belonging to the northern hemisphere is being perturbed?

**In the TRIFut (formally called TRIF3) land areas north of 20N are altered, this point is made more clearly in the modified experiment description**

how are TRIF1 and TRIF2 (and likewise, IGBP1, IGBP2 etc.) being considered together.

**This point is now made more clearly in the revised section 2.3**

When the acronym TRIFFID is being re-introduced p. 97 l. 12, is it a typo for TRIF ?

**TRIFFID refers to the model and TRIF a shorthand for the experiments utilising vegetation cover simulated by the TRIFFID model This section has been revised for clarity**

p. 101 :is therefore expected to have a positive impact on the strength of the South Asian Monsoon in that simulation. The experiment was actually performed, isnt it? so cant the authors be more affirmative here?

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**Yes, amended**

p. 98 l. 4; p. 93 l. 14, p. 101 l. 15: grammatical errors

**Amended**

In conclusion, the article has some potential as an interesting contribution about the effect of vegetation on climate but the purpose of the study has to be more consistently addressed, in particular by quantifying uncertainties that are meant to be considered here with respect to other sources of uncertainties quantified in the QUMP effort, and choosing figures more carefully, in line with this objective.

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Interactive comment on Earth Syst. Dynam. Discuss., 3, 91, 2012.

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