Response to Reviewer 2, 02/08/2020

Our response is given in standard typeface, with the original review in italic.

The manuscript "GIR v1.0.0: a generalised impulse-response model for climate uncertainty and future scenario exploration" present a simple climate model, that consists of six equations, that can easily be implemented in other models regardless of code language and also used in software such as Excel. The potential use of the model can therefore be widespread.

We thank reviewer 2 for their careful review of the manuscript. We will attempt to address each comment below, our responses are written in blue. We will either agree and make a suitable change to the manuscript, or offer an explanation as to why we disagree with the suggestion.

I have only minor comments to the manuscript as follows:
L 8. It could be highlighted more the tunable nature of the model. In other parts of the manuscript it is nicely written e.g. : "Here we emphasize that the models themselves are not systematically biased either low or high - it is the parameters used, and how these are selected, that determines the model response. " This could be emphasized even more in the abstract.

Agreed. Abstract changed to include sentence discussing this point.

L33. The differences between SCMs and ESMs here are runtime and lines of code. Complexity should also be mentioned. SCM: only global, global mean temperature, while ESMs three dimensional, gridded, large set of variables, not only temperature Etc.

We have amended the text in line with this comment.

Figure 1: It could be useful if R, T, G, S, etc. could be defined in the figure caption.

We have amended the caption in line with this comment.

Figure 2: Here, and elsewhere in the manuscript, references are written without a year. E.g: "from Meinshausen et al. concentrations". Add "(CMIP6 historical)" to the figure caption. Indicate end year in the figure. Or mention in the caption. I am not familiar with the use of TgN2O-N2. Better to use TgN instead? (same for L401)

We have amended the text in line with this comment. We have altered to use the more familiar TgN.

Figure 3: Unit on the y-axis are missing.

We have amended the figure in line with this comment.

Table 2: In the table caption, add which indirect forcing effects that are included in f2.

We have amended the figure in line with this comment.

L245: Any reference to the high correlation for total ozone and CH4 concentration?

We have slightly adjusted the ozone forcing calculation in line with a parameterisation from Ehhalt (2001).

L 371: typo

We have corrected this.

L 385: "While this harmonization procedure may not exactly match the one used in the database scenarios" Do you mean the harmonization procedure that are used in the SSP database? A set of the scenarios are harmonized to historical emissions in the SSP database. Why did you not use them? And related to L387, isn't these harmonized emission scenarios in the SSP database what you ask for?
Also, regarding the scenarios, there are many ssp scenarios available, generated by different models. Please specify which ones you have used. I guess it is the unharmonized marker scenarios?

We have chosen to mitigate against this confusion over what data sources we use by using emission scenario data from the RCMIP dataset to simulate future scenarios with GIR. This data source has the advantage of being complete, in a single location, and has been used by other simple modelling groups such that we can be certain that their output is directly comparable to ours. We will be explicit about which specific scenarios we have used in the revised text.

Figure 4, 5 and 6, there are more than hundred SSP scenarios. Replace a "range of SSP scenarios" with "three SSP scenarios"?

Replaced in the text.

Figure 4: Add in the figure caption why the dashed and dotted lines are not included in CH4 and N2O figure? Add what the shading and error bar in the figure represent.

For the 4th figure, the dotted and dashed lines show the model derived concentration timeseries for each of CO_2, CH_4 and N_2O. We haven't calculated CH_4 and N_2O concentration timeseries using MAGICC6 and FaIRv1.3 because they both require an estimate of background emissions from natural sources. We pulled MAGICC6 timeseries from the IIASA database of scenarios contributing to the IPCC SR15 report. Only CO_2 concentrations are available here, and so this is what we plot. Thanks to the RCMIP effort, we will be able to provide comparisons for all variables for all models in the revision. Shading represents the central 5th-95th percentile range, and error bar shows the median and 5th-95th percentile range in 2100 (added to caption).

Figure 5: In figure caption concentration is written. Replace by ERF. Also here indicate what the shading represents.

We have replaced concentrations with ERF in the caption, and now indicate what the shading represents..

L 447: To fully emulate the CMIP6 ensemble, aerosol ERF must also be tuned. This is not mentioned in the text. Please discuss how this can be done.

We agree that this has not been discussed in enough detail, and will expand in the revised text.

In the conclusion section, first differences to FaIR v1.0 is presented, while later results are compared to FaIR v1.3. In the first part of conclusion, also present the differences to FaIR v1.3.

We agree with this comment. We chose to refer to FaIR v1.0 when discussing the difference in carbon cycle from FaIR, as while FaIR v1.3 introduced many new features, the carbon cycle had remained the same. However, we will ensure to make consistent comparisons throughout in the revised text.