Atmospheric
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Discussions

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Interactive comment on "A modified impulse-response representation of the global response to carbon dioxide emissions" *by* Richard J. Millar et al.

Richard J. Millar et al.

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As an example of the ability of the FAIR model structure to reproduce the ESMs and EMICs shown from Joos et al (2013) we here include an example figure of model comparison. We would incorporate a version of this figure in a revised version of the manuscript.

In figure 1 (of this comment) we fit parameters in FAIR to individual models in a two stage process. Firstly, we fit parameters to minimise the total sum of squares residual in both the PD100 and PI100 experiments for the multi-model mean. Free parameters used are the coefficients partitioning the emissions into different timescale carbon pools (a_i in equation 1 of the discussion paper), the r_0 parameter and pro-

portional variations in the r_C and r_T parameters (therefore maintaining a fixed ratio of $r_T/r_C = 225$GtC/K as in the discussion paper) whilst keeping the τ_i's (timescales) fixed at the AR5-IR model values. The temperature timeseries is taken as given in the model output to focus the fitting exercise solely on the carbon-cycle behaviour. The best fit to the multi-model mean (dashed black line in figure 1 of this comment) selects a_i parameters that are different to the AR5-IR parameters due to the differing model formulation.

Now fixing the a_i parameters at these new values from the multi-model mean fit, we then attempt to fit the individual models from Joos et al (2013) using just two degrees of freedom: r_0 and proportional variations of both the r_C and r_T parameters (again leaving the ratio fixed). As can be seen in figure 1 of this comment, a diverse set of model responses can be emulated within the FAIR structure by changing just two important degrees of freedom in the parametrisation of changes in $iIRF_{100}$, namely the pre-industrial magnitude of the carbon-cycle response (r_0) and the total size of the feedbacks. A single set of parameters of the FAIR model successfully captures the response in both the PD100 and the PI100 experiments for individual models.

We hope an expansion and discussion of this figure in a revised version of the manuscript would address several of the comments of both reviewer 1 and reviewer 2 with regard to model evaluation and comparison to ESMs.
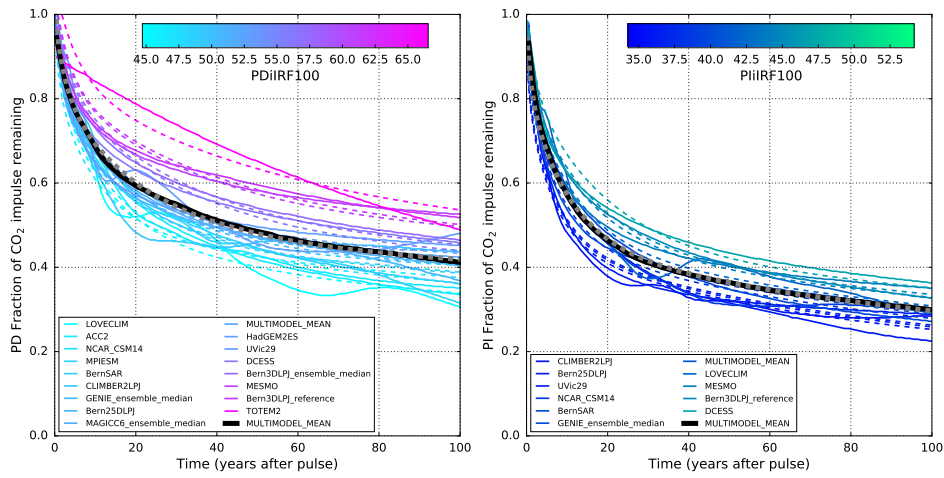
Fig. 1. Fits to the EMICs and ESMs from Joos et al (2013). Solid lines represent the raw model data and the dashed lines the FAIR fits in each case. The lines are coloured by their iIRF100 values.