Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2019-90-AC3, 2020

Earth System Dynamics
Discussions

Interactive comment on "What could we learn about climate sensitivity from variability in the surface temperature record?" *by* James Douglas Annan et al.

James Douglas Annan et al.

jdannan@blueskiesresearch.org.uk

Received and published: 11 May 2020

Thank you for the useful comments. Here we present some initial responses which describe proposed changes to the manuscript.

General comments:

Figures

We thank the reviewer for the suggestion to combine figures, and have combined figs 2 and 6 in a manner that we hope indicates the shapes and compares the spreads (5-95% range, and location of maximum). Figs 3, 7 and 8 are also combined in a similar

manner. We attach one figure to illustrate the proposed approach. We agree with the reviewer that a line and dot is adequate for summarising the information, especially with some distributions still being shown in full. Figure captions and legends will be improved.

However, for figures 1 and 5 it rapidly became messy to plot all of these data on one figure, especially with us now including two different CMIP ensembles on Figure 5 (sufficient data from CMIP6 are available and it seems a useful validation through being published subsequently to our analysis). We will make sure to emphasise their similarities and differences in the text, eg that they are broadly similar albeit with the 20th century simulations generating slightly higher values for psi than the unforced two-layer simulation in Figure 1.

We have also included a brief mention of the HadCRUT data and two CMIP model ensembles in the methods section.

Specific comments

Abstract: citations in the abstract are deprecated by the journal but we will change the wording a little to the deliberately less specific "trends in observational time series" and expanded the introduction "the focus has been on the long-term energy balance as constrained by the warming trend in surface and ocean temperatures"

l15 : done as suggested

Kirk-Davidoff results will also be discussed in relation to ours.

l21: Citation will be added but additional discussion is retained for later section. Given their original theory was based solely on the single layer unforced model we think it is appropriate to focus initially on this situation.

Section 2: Brief description of HadCRUT and two CMIP ensembles added

p3 l 20: epsilon does not play a significant role here; we include it primarily because

this is the standard version of the model that is widely used to mimic GCM behaviour. We now make this point in the manuscript. It is not quite correct to say that it epsilon can be subsumed into the gamma parameter, as its effect on energy balance is more akin to an additional feedback into space, the strength of which depends on the degree of disequilibrium. As for the references here, while the Held et al reference is actually clearer as to the formulation of the model (see their equations 9 and 10) they did specifically cite Winton et al as the origin of this approach. We will try to clarify this in the text.

p3 l26 Agreed

l27-9 Will expand. Aim is not to specifically emulate a particular GCM ensemble but just to cover a reasonable range wherein we believe reality could plausibly lie.

p5 l11 agreed (yes we did look at this briefly).

l23-29. Detrending the unforced runs made very little difference. We thought it was more in the spirit of the original derivation to not do this in the main analysis, as the stated purpose was to remove the forced trend which we know to be zero in this instance. Their ordinary least squares analysis makes no assumption of heteroscedasticity, and we believe they must just have been lucky in their set of models (combined to some extent with optimising the parameters of their analysis).

p6 l31-2 this will be reworded.

Figure legends will be added/improved.

p11 26 This scaling considers larger aerosol forcing (alpha >1) just as likely as smaller (alpha <1) and the 95% range is 0-2x the standard value.

p12 l2 noted and text will be improved.

p13 l1 will change to historical

p13 l18 "Data and methods" section will be included as suggested.

Interactive comment on Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2019-90, 2020.

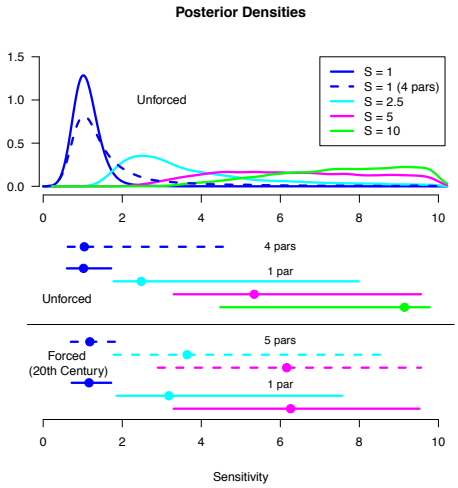
Posterior Densities
1.5
1.0
0.5
0.0
Unforced
S = 1
S = 1 (4 pars)
S = 2.5
S = 5
S = 10
0
2
4
6
8
10
4 pars
1 par
Unforced
5 pars
Forced
(20th Century)
1 par
0
2
4
6
8
10
Sensitivity

Fig. 1.