Atmos. Chem. Phys. Discuss., 12, C2879–C2881, 2012
www.atmos-chem-phys-discuss.net/12/C2879/2012/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Precipitation response to regional radiative forcing" *by* D. T. Shindell et al.

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Received and published: 23 May 2012

We thank the reviewer for their constructive suggestions on the paper. Please note that in our specific replies below, figure numbers refer to those in the ACPD submission.

Specific comments:

1. We have expanded the description of how trends and uncertainties are calculated, as suggested.

2. We have added a new figure showing the imposed heterogeneous forcings as suggested.

3. The reviewer raises a good point about the amplitude of the normalization varying between the different perturbations. In response to reviewer 1, we've now stated that the scalings were chosen to give forcings of at least 0.2 W m-2 locally. The scalings

had to be larger in areas with less forcing, in particular in the Arctic. So it's interesting that the three cases noted as 'noisy' in Figure 1 are in fact all cases where forcing was fairly large (0.5-0.6 W m-2) and substantially larger than the lowest local forcings of ~0.25 W m-2. This suggests to us that these particular forcings cause patterns of response with substantial structure, though we note that the response to globally uniform CO2 forcing (Figure 1a) also has a great deal of structure. As shown in later figures 3 & 4, the responses are sometimes not statistically significant, but no more so for these particular forcings than for any others.

4. We thank the reviewer for pointing out these useful references. We have included them in the new section on Physical Mechanisms.

5. In the new Physical Mechanisms section, we now assess the impact of the various forcings on circulation. For the Asian Monsoon region, we find that the response is more closely tied to anomalous meridional circulation, consistent with the study of Bollasina et al. (2011) and less so with zonal anomalies (though we also find the forcing is closely tied to more localized changes in pressure systems). So while we agree that the location of the forcing boundary at 30N could potentially influence the results, we believe that it is unlikely to be a large factor in this case. We also note that the response to the combined 30S-90N BC and sulfate forcings is quite similar to the sum of the separate band forcing responses, suggesting that edge effects are not terribly large. Furthermore, as the new forcing figure shows, the gradients in sulfate and BC forcing are extremely large in many places, and are typically not changed very much by imposing zero forcing in a neighboring band relative to using the full pattern of modeled forcing using the boundaries we selected. For example, there are very large gradients across 30N when we impose sulfate or BC forcing throughout the world and these gradients are nearly as large as those when we only impose the forcing in the band just below or just above 30N. While this is not the case for ozone, which is more mixed, we believe the bands were well-chosen for aerosols to minimize any edge effects, as demonstrated by the added figure. We have also examined the upper level

zonal winds, as suggested, but find no particular anomalies near the region boundaries or over South Asia in general.

6. As in 5 above, we now address this issue in the new Physical Mechanism section. For the NW US, we find that wind responses are not particularly zonal, but instead are closely linked to changes in the strength of the North Pacific high pressure system. And again, the response to the combined 30S-90N BC and sulfate forcings is quite similar to the sum of the separate band forcing responses, suggesting that edge effects are not terribly large for the NW US either. However, as forcing is smoother across the 60N parallel, we agree that it would be worth further study of how the imposed gradients affect the results at higher latitude regions in general.

Technical comments:

1. Revised as suggested.

2. Suggested reference added - thank you.

3. We have revised the caption to try to improve its clarity. More substantially, we have greatly expanded the opening paragraph to the section Comparison with Historical Trends, where Figure 4 is first presented, by adding a description of what's shown and what the point is of the various quantities included in what is admittedly quite a complex figure.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 5015, 2012.