

Interactive comment on “The net climate impact of coal-fired power plant emissions” by D. T. Shindell and G. Faluvegi

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Received and published: 4 February 2010

We thank the reviewer for their constructive comments and suggestions.

In our revisions, we have attempted to clarify to readers what is new in our paper. As the reviewer points out, the masking effect of aerosols has been known for a long time, and so we have clarified that what's new here is that we show the spatial and temporal variation of the masking effect. Among other things, we point out that even when the global average forcing is zero due to a complete cancellation between aerosol masking and CO₂ warming, due to the different lifetimes of these species their spatial extents are quite different and so regional forcing is still quite strong. We also show how the timing of air quality pollutant controls has a substantial effect on the rate of warming, although the removal of aerosol masking leads to only a small temperature difference

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in the long term. This is clearer in the revised abstract, and we have substantially revised the last paragraph of the introduction to put the work into context with prior studies more clearly and to better clarify what's new in this study. The reviewer asks how the results differ from simple linear regression between existing scenarios. Such scenarios include simultaneous changes in multiple emission sources, so the role of a single activity such as coal-fired power plants can't be identified. We also now note in the text that while the influence of coal-fired power plants has been studied before (e.g. Hayhoe et al), prior work discusses only the global mean impact while we show here that regional differences are quite important.

In the second comment of the review, the reviewer points out that we consider only added power plants and not emissions from current plants. We agree that this left a rather incomplete story, so have added in the effect of emissions from current plants, both their prior emissions and future emissions. Hence we now consider emissions from the current plants in USA (and elsewhere), and we discuss the effects of potential growth outside China and India though those are expected to account for the majority of future emissions.

The reviewer wonders if Climatic Change might've been more appropriate. We agree that that journal might also have been appropriate, but felt that as we concentrated in our study on only the physical climate impacts and not economic, health, or policy, the study was not terribly multidisciplinary, though there are obvious implications for those other areas. We feel that following the reviewers' suggestions, the revisions have made the paper much clearer and so the paper will be useful and interesting to ACP readers.

Specific comments:

Figures – We have corrected the colors in the figures.

p 21259, L 6-7 - While coal reserves in the US are large and energy demand is projected to grow, and hence there is potential for growth in power plants, mainstream projections are for only very slow growth in the US (US Dept. of Energy's Energy Infor-

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mation Administration, 2009). We state in section 2 that “China and India since they are projected to account for 80% of the growth in coal-fired power generation over coming decades (EIA, 2009)”, and in section 6 that “US power plants, which are projected to grow at 1.1%/yr (EIA, 2009)”, to make these points clear.

p 21259, L18-19 – We thank the reviewer for pointing out these studies. We have revised this text to put our new work into context with prior studies more clearly, adding the suggested references and also the earlier work of Charlson et al and Taylor and Penner.

p 21260, L 16-17 - We have added a comparison with our projections of total coal usage for power generation with those in the SRES scenarios as suggested at the end of the first paragraph of section 2. Documentation on the new RCPs has not yet been published.

p 21263, L1 – We now clarify in the text that the AIE is used in all calculations.

p 21263, L 19-25 – It’s definitely the case that initial forcing for existing plants is negative because emissions before 2000 are not considered. We have revised to make this even clearer. We do emphasize the role of future emissions in the paper, but discuss both the role of past emissions, future emissions from current plants (added in the revisions), and emissions from new plants. We highlight the future, as suggested, and have added constant current worldwide emissions (Figure 1), which we feel is even more useful than adding US constant emissions. We agree that it is interesting to see the effects of constant CO₂ emissions but decreased SO₂. In the revised paper, we have broken down the forcing from current emissions into its component parts (Figure 1). With that information, it’s clear what the effect would be of removing SO₂ (eliminating the negative forcing from sulfate), which we now discuss in section 6, at the end of the 3rd paragraph.

p 21264, L 5 – We have revised this line to clarify that rather than providing an estimate of the ‘effects’ of emissions, we are providing an estimate of the ‘instantaneous RF’.

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As the reviewer points out that we discussed later on, the emissions growth rate is also important for the effects on climate.

Figure 2 – Colors corrected.

P 21265, L 2 – We’ve revised this sentence to be clearer about what’s new and what’s not surprising here.

P 21265, L 9 and 23 – We do not believe there are other published results for the spatial distribution of the RF due to coal-fired power plants. We have added references to already published studies when we discuss the global mean results, however.

P 21266, L 2 – We now show in Figure 1 both the forcing from current plants in China and India and also plants worldwide. Combined with the figures showing future emissions we can either examine total emissions or only those from plants that might be constructed in the future depending on our interest. We’ve added discussion of the influence of each of these on the total temperature response in the 3rd paragraph of section 6.

P 21267, L 5-13 – We now discuss the impact of constant current emissions as well (3rd paragraph of section 6).

P 21270, L 27 – No, we meant faster in time rather than faster than another part of the globe. We’ve rewritten this sentence.

P 21272, L 15-16 – Citations added.

P 21272, L 19 – Currently, coal plants emit about 2 GtC, while global emissions are ~7 GtC. Hence the role of coal emissions would grow under our scenarios for coal if all else followed the SRES scenarios (as happens in some of the SRES scenarios). The relative growth rates of coal usage itself in our scenarios vs the SRES is given in section 2.

P 21273, L 15 and 19 – We found additional discussion in an EPA publication, and

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have added a reference to that.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 21257, 2009.

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