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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Response of shortwave cloud radiative effect to greenhouse gases and aerosols and its impact on daily maximum temperature" *by* Tao Tang et al.

Anonymous Referee #2

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The paper is interested in GCM-produced summertime changes in the maximum land temperatures of the NH under perturbed conditions, namely doubled CO2, 10 times more black carbon aerosols and 5 times more sulphate aerosols (subject to model interpretation). Results come from a somewhat outdated database (CMIP5 era models) and the focus is on the SW effects of clouds at the surface (at least initially, later when a prediction model is built LW is added too). I'm not clear what we learn from the analysis. The general consensus since AR5 has been that low clouds provide a positive feedback under CO2 doubling (or quadrupling for that matter), so SWCRE at the surface is expected to be weaker (less cooling at the surface). So, this part is not so new, although I guess one can focus on the effect of this reduced radiative cooling

on Tmax. Then there is the aerosol: aerosol changes can change the environment, the circulation, etc, so they can change cloudiness. But they can impact the clouds "faster" through alteration in microphysics (lifetime, optical thickness changes) and this part is not discussed until the conclusions. In any case, the effect of aerosol on (low?) clouds and therefore on land Tmax is not clear-cut since there is also the direct radiative dimming or brightening part that works in conjunction or competition with the cloud effect. So, it's kind of interesting to see results about this, although I imagine people have previously looked at that too. I guess the most intriguing result is that Tmax changes can largely predicted by LOCAL RADIATIVE changes; it was somewhat unexpected to me that this works as well as it does since temperature is also affected by turbulent fluxes and advection (non-local effects). I suggest the authors make a bigger deal of this finding.

Here are my main issues with this paper: (1) LW and indirect cloud effects are not discussed until the concluding section.

(2) Since the SWCRE effects are mostly attributed to CF changes, the LW downwelling to surface changes should also be broken to clear and LWCRE effects; I mean basically the LW should be treated as the SW and not lumped into a single term in the regression.

(3) Why are only CF changes considered and not changes in other cloud properties? Optical thickness changes can have impact in SWCRE.

(4) Only CF changes for low clouds (and the corresponding RH) are considered (if I understand correctly), but for SW cloud at any altitude in the in the atmospheric column can have strong SWCRE effects

Some minor issues: (1) Clarify from the start (including the abstract) that SWCRE refers to surface.

(2) Define changes in SWCRE more formally. For this SWCRE itself has to be defined more formally, i.e., difference between net all-sky and clear-sky fluxes where net

= down-up flux. Then you have to take a difference between baseline and perturbed conditions. Just saying that a positive SWCRE change means less cooling is unsatisfying.

(3) I find the discussion between fast and slow feedbacks a bit superficial. Land responds to fast feedbacks, but for slow feedbacks the SST responds as well and that's what will drive circulation changes. For slow feedbacks it makes more sense to look at TOA quantities. When it comes to direct radiative effect of aerosol, TOA and SFC changes are distinct for absorbing (BC) vs non-absorbing aerosols (sulphate).

(4) Why not use the same colorbar in Fig. 2 for normalized forcing change and cloud fraction change to make comparison easier (of course range of values can be different)?

(5) By showing only MMM results and nothing about model spread we have no idea how much the models diverge in predictions. Not sure there is an easy way to convey that.

(6) I imagine the radiative treatment of aerosol differs widely among models. Not discussed. When you change emissions instead of concentrations directly, divergence is introduced too.

(7) I also imagine that the base state of the models is quite different too. Care to comment?

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