Reply to RC2

We thank the reviewer for the encouraging and very helpful comments. Below please find the point by point reply to the comments.

> This manuscript describes global model simulations to assess the impact of dust pollution interactions in cloud liquid and ice water content and direct and indirect aerosol radiative effect. The design of numerical simulations is appropriate and methodology to delineate various terms is reasonable. The results indicate dust aerosol interaction will reduce the negative cooling effect of aerosol. The result is quite interesting and worth publication. However, some clarifications of the methodology are required to facilitate better understanding.
> P3, L28-29, The sentence reads awkward.

We have rephrased the sentence.

> The methodology section, it would be better to move the description of four experiments with ('0', 'dust','Anthropogenic','Full') first. Then describe the 16 ensemble simulations and the nudged simulations for each experiment.

We have changed the order as suggested.

> Table 1-2 and 3S-4S caption, I am very confused here. The Mineral dust and Anthropogenic pollution by their definition, either only contains dust or pollution and there should be no dust pollution interaction, why do these simulations include the interactive term? Shouldn't 'Mineral dust' effect be simply Xdust – Xo and "Anthropogenic" effect be Xpol – Xo and the last term computed with Eq. 2?

$x_{\mathrm{pol}} - x_0$ yields the effect of the pollution, but in the absence of mineral dust (or ignoring the dust-pollution interactions). Due to the dust-pollution interactions this differs from the pollution effect in the presence of dust, $x - x_{\mathrm{dust}}$. We chose to present the latter because it represents the change from preindustrial times to the present day, wheras the dust free case is only a hypothecial scenario. However, the interaction term $\Delta_{\mathrm{int}}x$ provided in the last column immediately relates both effects, as $x - x_{\mathrm{dust}} = x_{\mathrm{pol}} - x_0 + \Delta_{\mathrm{int}}x$. Consistently, we also present the dust effect in the presence of pollution, $x - x_{\mathrm{pol}}$.

> P5 L23-24. What do you mean by neglecting 'aerosol-radiation-interaction'? Do you mean by excluding the aerosol contribution in the radiation calculation? That should not be termed as "aerosol-radiation-interaction".

We used the term "aerosol-radiation interactions" (ari) consistently with AR5 for the scattering and absorption by aerosol particles. Ignoring these interactions corresponds to excluding the aerosol contribution in the radiation calculation (but still including the result of the aerosol-cloud interactions (aci)). To avoid any confusion with other interactions subject of this article we now explicitly refer to "scattering and absorption by aerosols".

P5 L28. How do you compute the total radiative forcing? Do you mean "total aerosol radiative forcing"?

Yes, we have revised to "total aerosol radiative forcing". More details on the forcing calculation have been included in the preceding paragraph.

Section 5. How do you define the TOA radiative forcing in SW and LW? Is this simply the difference of reflective SW and outgoing long wave (LW)? What direction is considered positive, into the Earth or out of Earth?

We follow the convention to define incoming (downward) radiative fluxes to be positive and outgoing (upward) fluxes to be negative, which we now mention in section 3. The forcings correspond to the change of the net flux, the sum of incoming and outgoing fluxes. The SW forcing only includes in- and outgoing SW radiation, the outgoing LW radiation is included in the LW and the total forcing. We have clarified the second sentence of the section.

P7 Last paragraph and Figure 4: it contains a lot of calculations that are not straitforward to readers. It took me a while to figure out (hopefully I got them correct!). Better to spell out how each term is calculated. For example, Xp – Xo represents total aerosol effect without dust and X – Xo represent total aerosol effect with dust (blue + green). The green part is computed from the difference of two calls of radiative transfer code with or without aerosol contributions. Then the blue part is total minus the green part. The red bar should be result of Eq. (2). Why is this number different from the global total in Figure 3?

We now provide the terms used for "With dust" and "Without dust" in the caption and have expanded the description of the forcing calculation in section 3. Figure 4 shows the effective radiative forcings (ERFs) obtained from the SST simulations, Fig. 3 shows results from the nudged simulations.

I haven't understood the rational for using maps from nudged simulations while global averaged effect (Table 1 and 2) from SST simulations in the main article. Could you explain how each of these simulation configurations contrast and complement with the story you which to tell?

By definition, the effective radiative forcings are obtained from SST simulations which we now explicitly mention in section 3. Also in section 3, we discuss that due to statistical variability the SST results are not suited for regional analysis and we have to resort on nudged simulations for that purpose. Still, we provide global averages from the nudged simulations to show that SST and nudged results are largely consistent.