Author response

Anonymous reviewer 1

Thanks very much for your responses. I am ok with the revised version. I have only one comment: in line 40, you should add the corresponding references with dust radiative forcing depending on the altitude of the dust within the atmosphere, the time-of-day, the season, the surface albedo, and the precise mineralogy and optical properties of the dust.

Many thanks for your comment. We have added several references to support this statement in the introduction.

Anonymous reviewer 2

Most of my concerns proposed in the first round have been addressed, and the authors have revised the manuscript accordingly. However, some issues still need to be addressed before it is acceptable for publication.

Firstly, the main conclusion of this study is that dust aerosol from the Aralkum desert has a cooling effect both at the surface and in the upper atmosphere. However, the uncertainty (standard deviation of DREs) is larger than the average value by one order of magnitude, which makes the conclusion less convincing. The authors revised the manuscript and added section 4.2 to demonstrate that the contrast to other findings is due to the scattering property of the dust aerosol from the Aralkum. However, the authors still need to analyze and discuss the uncertainty in a more decent way.

It is true that the standard deviations on the average DREs are typically larger than the mean values, although not quite as much as an order of magnitude. However we would argue that these means contain both positive and negative numbers, dragging the mean values closer to zero than the standard deviations.

In response to the editors' comments, we have added more discussion on the SW and LW components of the overall DREs, explaining the contributions of these to the DRE patterns which underpin the overall numbers. We have also added quantitative information on the TOA DREs, and further discussed probable lagged responses to the DREs, which may not be accounted for in the instantaneous DREs quoted in the manuscript.

Secondly, the quality of multiple figures is out of standard. I proposed some issues in the first round, but the authors did not make any revisions. The black grid lines need to be removed in Figures 2,5,6,7,10, which do not help for the geolocation as there are already lat/lon values in the x/y-axis and national boundary lines. Moreover, the text size in many figures is too small to read and needs to be improved.

We concede that the grid lines did make these maps a bit too heavily cluttered, and so we have removed them, making use of the lat/lon ticks and the country borders for geolocation. We have also added the Aralkum box to more of these maps, to define the study region.

Meanwhile we have also increased the font sizes in many of the figures and we hope that this makes them more legible.

Editor's report:
The atmospheric cooling needs to be better justified. A separation on shortwave and longwave contributions on the atmospheric cooling would be useful.

We thank the editor for this comment, and recognise that adding more information on the SW and LW contributions is important. To this end we have added an extra figure at the beginning of Section 4.1 to depict the SW and LW contributions to the DUBLT_PRESENT SFC and ATM DREs plotted in Fig. 8 of the previous version of the manuscript (in relation to the DOD, SZA, and season). This new figure is now Fig. 8, while the previous Fig. 8 becomes Fig. 9. Meanwhile Table 1 has also been expanded to include the SW and the LW contributions alongside the net values.

In addition, at the end of p. 20, the following sentences have been included in relation to Table 1:
"The competing SW heating and LW cooling effects on the atmosphere result in a net cooling of the atmosphere to a value of -0.62±2.9 W m^{-2} on the yearly timescale (j), with daytime SW heating of the atmosphere of +3.21 W m^{-2} (k) being outweighed by the cumulative daytime and nighttime LW cooling (l). During the daytime there is a net heating of the atmosphere by +1.24 W m^{-2} due to the greater intensity of the SW effect compared to that of the LW."

Furthermore, we thank the editor for additional helpful comments that he has made during the review process. To this end, we have included the TOA values in Table 1 and we have also added an extra paragraph on p. 21 to comment on the likely consequences of lagged radiative effects and associated temperature adjustments, which are not explicitly considered on the instantaneous timescale. These are also discussed further in the fourth paragraph of the conclusions.