REPLY TO REVIEWER #1

We thank the reviewer, Prof. Jérôme Brioude, for the constructive comments and suggestions, which have helped us to improve our manuscript. We have provided responses to the comments; the comments appear in *red italics*, our response in **bold face** below the respective comments and we have used *green italics* to quote the changes in the revised manuscript.

General comment: the paper presents new results on large scale processes that control the interannual variability of the dust concentration above the South Asia. The authors used satellite measurements from 2001 to 2018 to analyse the frequency of days (over a month, called $DA_{\%}$) when the dust optical depth above South Asia is high. Using NCEP/NCAR reanalysis, they found that an increase in $DA_{\%}$ was associated to an increase in SST in the mid-latitude North Atlantic, and a cooling in the Subtropical North Atlantic between 2011 and 2018. The authors presented a detailed analysis, based on NCEP reanalysis and CEMS simulations, of anomalies in the wind fields and SST to explain the link between the SST variability in the Atlantic Ocean and the dust emission over South Asia. The correlation was linked to large scale transport pattern anomalies and a weakening of the South Asia monsoon.

The paper is well written and the results are of interest for the community. I will accept this paper for publication after addressing the following comments:

We thank the reviewer for the summary evaluation and positive recommendation. Our responses to the specific comments follow.

Specific comment:

1) *Section 3.3 is a bit long and probably needs some reorganisation. Figures 6 and 7 discuss the capabilities of CESM to simulate dust and precipitation in South Asia, and not so much the mechanisms that link dust activity to North Atlantic SST. I'm wondering if figure 6 and 7 should go in section 2.2 instead, and leave figures 8 and 9 in section 3.3. That way you will only discuss anomalies in section 3.3, which will help to follow the arguments of section 3.2.*

This is indeed a helpful suggestion and we have complied with this. Figures 8 and 9, along with the relevant texts are now moved from Section 3.3 and placed under a separate Section 2.3 titled as "Model Validation". All the figure numbers in the manuscript are revised accordingly. The following sentences are added in the beginning of Section 3.3 to link it with the new Section 2.3:

As discussed in Section 2.3, although there are certain limitations, CESM can reproduce the main aspects of atmospheric circulation and the spatial and temporal characteristics of dust over South Asia quite well. This gives us confidence in using the model for our present study.

Please see L423-425 in the modified manuscript.

2) introduction: you don't mention the impact of the indian ocean dipole (IOD) and its impact on the monsoon and potentially on the dust emission. Please add references and comments.

Thanks for this suggestion. We have now added the following sentences in the introduction to elucidate the possible role of Indian Ocean Dipole on monsoon and dust:

The Indian Ocean Dipole (IOD) is the other teleconnection that influences atmospheric circulation over this region, with the positive phase of IODs counteracting the impact of El Nino on precipitation over South and Southwest Asia (Ashok et al., 2001; 2004). This can reduce the magnitude of anomalies of dust over Southwest Asia due to an El Nino event (Banerjee and Prasanna Kumar, 2016).

Please see L49-52 in the revised manuscript.

Technical comments:

figure 5 top: the coast lines need to be enhanced.

Complied with. Please note that the Figure number has been changed in the revised manuscript to Figure 7.

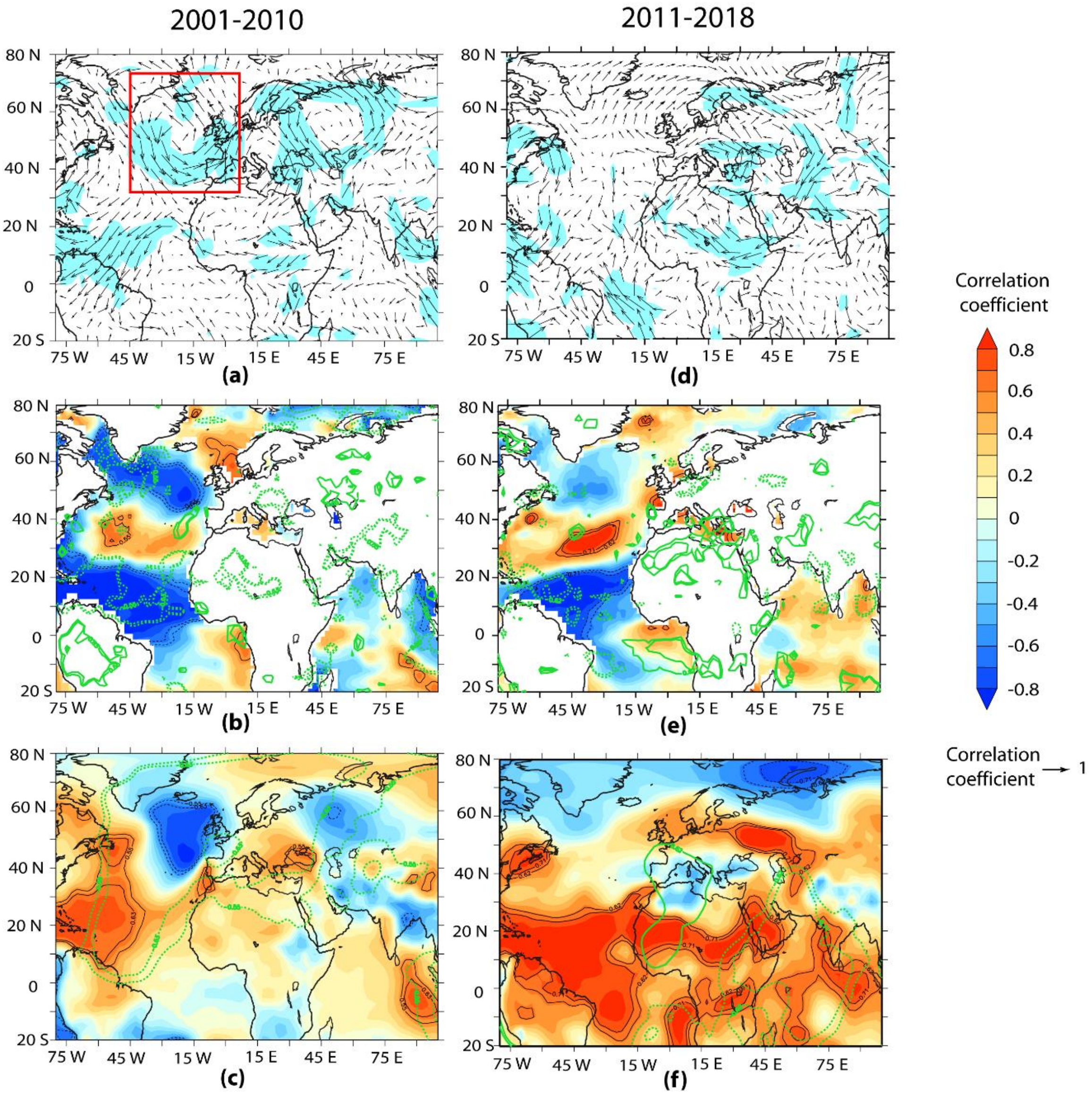

Figure 7: Correlation between the April-June North Atlantic Difference Index (NADI) and different meteorological parameters from NCEP/NCAR Reanalysis averaged for May-September for (left panels) 2001-2010 and for (right panels) 2011-2018. (a) and (d) Arrows show correlation between NADI and wind vectors averaged between 850 and 700 hPa pressure levels. Light blue shade highlights the regions where one of the components of the wind vector is significantly (95% confidence level) correlated with NADI. (b) and (e) Shading shows correlation between NADI and SST and the green contours enclose the regions where significant correlation exists between NADI and precipitation. Black contours indicate the regions where correlation between NADI and SST are significant. (c) and (f) Shading shows correlation between NADI and sea level pressure and the green contours enclose the regions where significant correlation exists between NADI and velocity potential at 850 hPa pressure level. Black contours indicate the regions where correlation between NADI and sea level pressure are significant. For all the panels continuous and dashed contours are indicative of significant positive and negative correlations respectively; inner and outer contours of a particular colour indicate 95% and 90% confidence levels respectively.

abstract: you should rephrase lines 22-23 to better explain what you mean by 10% (20%) and 30% (50%).

We have rephrased these lines as follows to make the meaning clearer:

Simulations with an earth system model show that the positive phase of the North Atlantic SST tripole pattern is responsible for 10% increase in dust optical depth over South Asia during May-September; with increases as much as 30% during the month of June. This increase is mainly due to transport by the westerlies at 800 hPa pressure level, which on average increases dust concentration at this pressure level by 20% during May-September and up to 50% during June.

Please see L21-25 of the revised manuscript.

References

Ashok, K., Guan, Z., *and* Yamagata, T.: Impact of the Indian Ocean dipole on the relationship between the Indian monsoon rainfall and ENSO, Geophys. Res. Lett., 28, 4499–4502, https://doi.org/10.1029/2001GL013294, *2001*.

Ashok, K., Guan, Z., Saji, N. H., and Yamagata, T.: Individual and combined influences of ENSO and the Indian Ocean Dipole on the Indian Summer Monsoon, J. Climate, 17, 3141–3155, https://doi.org/10.1175/1520-0442(2004)017<3141:IACIOE>2.0.CO;2, 2004.

Banerjee, P., and Kumar, S. P.: ENSO Modulation of Interannual Variability of Dust Aerosols over the Northwest Indian Ocean, *J. Climate*, **29**, 1287–1303, https://doi.org/10.1175/JCLI-D-15-0039.1, 2016.