

Response to referee #2

We would like to thank the referee for her/his encouraging remarks. We agree with the referee on the issues raised by her/him in “general comments” that have potential to be a separate individual research question. We would specifically like to comment on the question, to quote the referee “do we have to recalibrate aerosol global distribution and strength from passive remote sensing?” The retrievals of aerosol properties from passive sensors typically use clear-sky pixels, thus bypassing the overlap events. This is mainly due to inherent limitations of these sensors to detect such events. However, as we show in the present study, we are potentially missing the detection of many aerosol layers during overlap events globally. Since the CALIOP sensor allows detection of these overlying aerosol layers together with information on their macrophysical properties and optical depth, we have the first real possibility to evaluate global radiative impact of these overlying aerosols and to understand if we are missing something that is “radiatively significant” (while considering both direct and indirect effects). The need to recalibrate aerosol global distribution from passive sensors and the need to include aerosol overlap in global climate models will depend on the results from such studies. As a first step, the statistics presented in our study (and few other previous studies) implies that the impact of overlapping events is most likely to be non-negligible (at least regionally).

Few specific comments raised by the referee are addressed below.

- 1) The presence of optically very thin cirrus will not have any impact on our results due to the following reason. In a given collocated profile, we first look to aerosol layer (rather than cloud layer). If it is present, we then proceed and search for underlying liquid water cloud layer. However, if the lidar signal is saturated because of optically thick cirrus (with optical depth in the order of 2-3), then in such situations, the retrievals of aerosol layer below, if detected at all, will most likely be carried out with the lower degree of confidence. Such situations will be screened out, which may potentially lead to an underestimation of overlap frequency.
- 2) Although most of the biomass burning in the DJF months occurs over the Sahel region and around the equatorial belt of Africa, very little amount of the low level liquid clouds is observed over these regions (Fig. 1). A fraction of smoke aerosols from these regions are transported southwards along the southwestern coast, where such clouds are predominantly present during the DJF months, thus leading to higher overlap frequency away from the source regions.
- 3) It was necessary to partition data into six latitude bands to squeeze in multidimensional information into 2D plots, and to simultaneously show seasonal variations without increasing number of figures by four-fold. These six latitude bands represent three distinct regions with different weather regimes in both hemispheres, namely the tropics, mid-latitudes and the polar regions.