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Atmospheric Chemistry and Physics
Discussions

# *Interactive comment on* "Long-term study on coarse mode aerosols in the Amazon rain forest with the frequent intrusion of Saharan dust plumes" *by* Daniel Moran-Zuloaga et al.

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We appreciate the very positive comments by Referee #1. We addressed his/her comments as outlined below. [1.1] Referee comment: In section 1) Section 2.5, Fig S2 The comparison between the gravimetric and OPS derived aerosol concentrations is made for periods in dry season, where majority of the coarse mode particles is expected to be of primary biogenic origin with densities close to 1g/cm3. Would it be possible to compare the OPS derived and gravimetric mass concentrations also for the wet season or specific LRT episodes? Or at least estimate the implications of the densities of both major contributors to the long range transported coarse aerosol - dust and sea



salt - being substantially higher than 1 g/cm3? Author Response: Although a gravimetric validation of the OPS results during the wet season and, in particular during the LRT episodes, would have been very useful for the study, no gravimetric results were available for these periods, unfortunately. We have added the following statement to the experimental part (page 9, line 22) to clarify this explicitly: "No corresponding gravimetric results were available for the wet season and LRT episodes." With respect to the requested estimate of the implications of substantially higher densities for e.g. Saharan dust or sea salt for the OPS-based aerosol mass retrieval, we added the following statement in page 9, line 27: "This implies that during substantial influence of dust and/or sea salt, which are characterized by higher aerosol particle densities ($\sim$2 g cm-3, see table S1), no one-to-one agreement between OPS-based mass retrieval and gravimetry can be expected. In fact, the OPS-derived aerosol mass would underestimate the actual mass. The influence of different densities on the aerosol mass concentration is addressed later in this study in more detail (refer to Table 2)." [1.2] Referee comment: 2) Page 15, lines 16-29. Is the precipitation along the back trajectories considered at ground level or 3D? Do you take into account the option of the dust plume transport above the rain clouds followed by downwards mixing? Author Response: The referee brings up important aspects and we agree that this is not sufficiently clarified in the manuscript. With respect to the first question (precipitation at ground level or 3D): The HYSPLIT model provides the precipitation in the grid cells independent of altitude and, thus, not in 3D. To clarify this aspect, we have added the following statement in the experimental part (page 10, line 28): "Note that the HYSPLIT precipitation output is provided "at the grid cell where the trajectory is located and does not depend on the cloud value at the height of the trajectory" (comment by G. Rolph at https://hysplitbbs.arl.noaa.gov/viewtopic.php?t=577, last accessed 15 Mar 2018)." Furthermore, a second aspect (dust plumes being transported over the rain clouds), we modified the following original paragraph (page 15, line 16): " Relating to (3): Wet deposition is the dominant aerosol loss mechanism in tropical latitudes because of their intense precipitation (Huang et al., 2009; Martin et al., 2010a; Abdelkader et al., 2017). According to Fig. 1c, comparatively small scavenging rates are expected for most of the dust's transatlantic passage (i.e., north of 03° N), whereas precipitation rates (on average) increase instantaneously when the air masses meet the ITCZ rain belt. As a measure for the extent of scavenging rates that the air masses experience in the NE Basin, we calculated the cumulative precipitation along the 3-day BT tracks, PBT , (shown as daily averages). In other words, the intense precipitation in the NE Basin defined if and to what extent the LRT plumes reached the ATTO region. The PBT time series shown in Fig. 2d and its comparison with M1-10 in Fig. 2e clearly underlines this relationship: Virtually all M1-10 pulses correspond with relative minima in the PBT time series. This shows, expectedly, that the dust burden that arrived at the ATTO site was inversely related to the cumulative amount of rain that the corresponding air masses received. In other words, only dust plumes that survived the intense rain-related scavenging had a chance to arrive in the ATTO region. Good examples for this relationship (among many others) are the dust pulses around 18 February 2014 and 06 April 2015." to the following revised version to explicitly address and clarify the aspects brought up be the referee: "Relating to (3): Wet deposition is the dominant aerosol loss mechanism in tropical latitudes because of their intense precipitation (Huang et al., 2009; Martin et al., 2010a; Abdelkader et al., 2017). According to Fig. 1c, comparatively small scavenging rates are expected for most of the dust's transatlantic passage (i.e., north of 03° N), whereas precipitation rates (on average) increase instantaneously when the air masses meet the ITCZ rain belt. A direct comparison of the cumulative precipitation, PBT, for 3-day vs. 9-day BTs shows that most of the rain (on average ∼75 %, see Fig. S6) occurred during the last 3 days of the air mass journey, underlining that the region of the ITCZ belt is most important for aerosol wet deposition. Along these lines, the daily averages of PBT along the 3-day BT tracks represent a measure for the extent of scavenging rates that the air masses experience in the NE Basin. The intense precipitation in the NE Basin defines if and to what extent the LRT plumes reached the ATTO region. The PBT time series shown in Fig. 2d and its comparison with M1-10 in Fig. 2e clearly underlines this relationship: Virtually all



M1-10 pulses correspond with relative minima in the PBT time series and vice versa. This shows, expectedly, that the dust burden arriving at ATTO was inversely related to the cumulative amount of rain that the corresponding air masses experienced. In other words, only dust plumes that survived the intense rain-related scavenging had a chance to arrive in the ATTO region. Good examples for this relationship (among many others) are the dust pulses around 18 Feb 2014 and 06 Apr 2015. Note that the HYSPLIT precipitation output, which is calculated per grid cell, does not depend on altitude and cloud cover (see sect. 2.7). Thus, this analysis does not exclude that dust is transported at high altitudes over the precipitating clouds and mixed downwards in the ATTO region. However, the clear inverse relationship between the PBT and M1-10 variability underlines empirically that PBT can be used as a simple but reliable proxy for the extent of rain-related scavenging." [1.3] Referee comment: Page 3, line 10 – correct to "focused on " Author Response: Thanks for pointing out this typo. We have changed it from "focused of" to "focused on". [1.4] Referee comment: Page 15, line 9 – correct "this study clearly shows" Author Response: We also corrected this typo from "this study clearly show" to "this study clearly shows".

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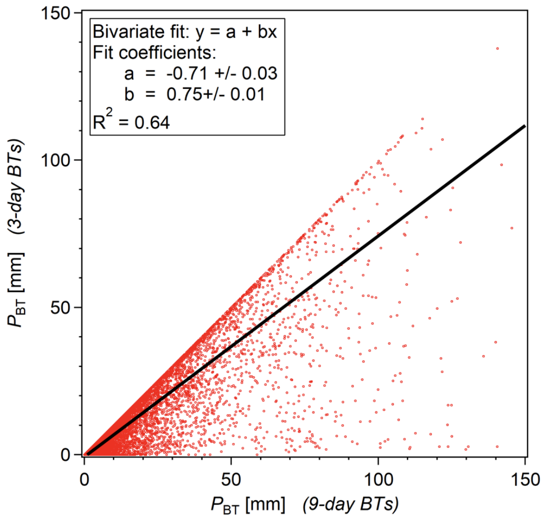


**Figure S6.** Scatter plot of cumulative precipitation, $P_{BT}$, (daily averages) along 3-day vs. 9-day back trajectories. Trajectories within the time period from 01 Jan 2014 to 31 Dec 2014 are analyzed here. Comparison shows that (on average) 75 % of the rain that the transported air parcels receive occurs during the last three days on their way to ATTO.

**Fig. 1.**