Response to Anonymous Reviewers #1 and #2 to manuscript TC-2020-55

Title: Giant dust particles at Nevado Illimani: a proxy of summertime deep convection over the Bolivian Altiplano

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This document shows a point-by-point reply to comments from both reviewers (RC1 and RC2). It is followed by a marked-up version of the manuscript showing the changes we have made. All line numbers correspond to the marked-up manuscript.

RC2, Specific Comment #1: L 101-104: Ice layers in the core. The other reviewer pointed this out in the first round of reviews, and the authors added a sentence or two in response (and a very general figure in the supplementary material). I think their analysis falls far short of what is required to justify interpreting the particle record as a purely climate signal. The author's claim that "these features indicate few events of meltwater percolation" (line 104) is not backed up by any analysis. I would need to see some sort of analysis of the various core proxies vs. the ice layer record to have any confidence in that statement. One obvious question - what is the effect of melting on the particle size distribution? Is the depth variability of the giant particle concentration simply a function of surface concentration during melting?

[Answer]: *We changed the figure in the supplementary material (Fig. S1). Now it shows the depth variability of GPPnb and δD, and also the depth intervals where we observed ice/crust layers. This figure points to no clear relationship between ice/crust layers and these proxies. Therefore, we assume that meltwater percolation had little influence on our record. The text in Line 101 has been changed to improve this discussion.*

RC1, General Comment #1: The statistical treatment is still poor. With a mean RSD for GP of 45% also the percentage has a large uncertainty (error propagation). I wonder if the correlation of the GPPnb percentage with delta D is statistically different from the correlation between total particle number concentration and delta D. Since this is the main finding, it should be better supported.

[Answer]: *We improved the statistical treatment. First, we isolated the random components of our records by removing their seasonality and outliers. Then, we tested the distribution of the random components. Based on this test, we performed the Spearman correlation analysis. Finally, we determined the confidence intervals for each correlation, using a block bootstrap resampling method followed by the Fisher's transformation. This procedure allowed us to observe that the correlation between GPPnb and δD is statistically higher than the correlation between total particle number concentration and δD. These procedures and discussions were included in the new subsection 2.6 (Correlation evaluation), and in Line 282.*

RC2, Specific Comment #2: Lines 133 (and throughout): The use of GPPnb as a proxy. The authors present a time series of particle concentration (Fig. 3) and interpret the seasonal pattern of both total and giant particle deposition. In this figure, and lines 224-225, the authors clearly show that giant particle concentrations are highest in the dry season, and much lower (by at least a factor of 2) during the wet season during convective activity. I would argue that this (giant particle concentration) is the most accurate measure of giant particle deposition at the site (after, of course, the authors answer the post-depositional modification question). Yet, the authors then proceed to move to a relative measure of giant particles (giant particle percentage GPP). Unfortunately, that measure conflates two uncertain measures - both fine and giant particles. What if atmospheric processes were affecting the two differently, such that GPP is being altered primarily by fine grain processes? At the very least, I would have to see both measures (GP concentration and GPP) statistically compared vs. the other core parameters and meteorological variables. I suspect (and could of course be wrong) that the correlations with GPP could be non-existent or even absent when run with GP concentrations.

RC2, Specific Comment #3: Figure 3 is not relevant to the author's argument. The overall correlation through the entire record (which the authors have still not quantified) has no bearing on the wet season convective activity. A much more useful figure would be wet season dD, wet season giant particle concentration AND wet season GPPnb vs. year. Similarly, Figure 6 needs to include giant particle concentration for dry and wet seasons vs. dD (not just GPPnb).

[Answer]: *We have observed no significant correlation between the number concentration of giant particles (GP) and both δD and the meteorological variables. The reason for this is that we believe the effect of convection on GP is twofold. Giant particle suspension is favored by convective activity, on the other hand, GP increases during dry conditions by increased source strength and reduced accumulation. Conversely, GPPnb seems to provide the overbalance between turbulence and source strength/accumulation. We added this discussion to the text (Line 368). Then, we included an indication of the wet seasons in Fig. 3. This figure introduces the GPPnb time series and its relationship with δD.*

RC2, Specific Comment #4: Dust provenance - I'm still confused as to what the dust provenance work is supposed to show. The focus here is on the giant particles, and the question that remains to me is - are these particles simply local (in the Illimani massif) or from some farther source? The simplest explanation seems to be that these giant particles are simply local transport and thus do not require a complicated convective activity explanation. But that can only be proved if the dust provenance geochemistry clearly shows the giant particles are not of local origin. The sample choice and data do not seem to be able to shed any light on this issue - wet vs. dry season geochemistry on bulk samples provides no specific information on the provenance of the giant particles. The giant particles could be from right next the the drillsite, and deposited with a background, fine fraction dust matrix that is from a remote location.

[Answer]: *The dust provenance section shows that source areas are local/regional during both wet and dry seasons. Deviations in dust mineralogy and geochemistry seem to be associated with increased scavenging during wet seasons due to heavier precipitation. Although we have no specific data for the giant particles provenance, these conclusions support the influence of local/regional convective activity on GPPnb variability. We added to Line 333, an improved conclusion for the dust provenance section.*