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The Cryosphere Discussions

Interactive comment on "Influence of the Tungurahua eruption on the ice core records of Chimborazo, Ecuador" *by* P. Ginot et al.

Anonymous Referee #3

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General Comments:

Very good. This paper presents a valuable comparison study of shallow tropical ice cores to test the impact of volcanism on preservation of chemical stratigraphy. Such repeated ice core studies on tropical glaciers are rare and offer an important check on post-depositional processes. The merit of this paper is thus in providing empirical data to test the robustness of ice core records and the preservation of data used to interpret climate variability. The results apply more generally to any ice core location potentially impacted by volcanism. Moreover, there is reason to believe that volcanic deposition in the tropical latitudes is a particularly important impact given the more intense solar radiation regime, and resulting control over mass balance.

The analyses are largely qualitative in describing relative trends, and the intercompari-

son of the cores requires some tuning so raw data are not shown. Likewise, interpretations of patterns are necessarily selective, and certain questions about processes are raised and not answered. Nevertheless, the dataset and demonstration of selective elution by volcano induced meltwater are worth publishing, and perhaps could inform future hypotheses to test.

Specific Comments:

The overall organization of text is somewhat confusing, as much intercomparison and discussion of both cores and the adjustments made before Fig. 2 all in section 2.2. It might be best to have an observations section discussing both cores together, and then discuss the meaning/interpretation of the observations in the discussion section, that could include the ionic ratios. Also, a methods section before observations would help clarify by explaining the "adjustments" made to the core that are foundational to all interpretations. In the current form, we are only shown the post-adjusted depth trace of the isotopes and ions in Fig. 2. And it is not until describing Core B on P1348 we are told so or how. And even then, it appears the whole trace of core B was "stretched-shrinked" to do so. How? Were upper layers compressed differentially more to account for firn densification? We're only told the entire length of record is compressed 10% as a result.

With only depth recorded on the isotopes and ion traces (Fig. 2), it is not possible to verify the presence or absence of a "bimodal peak" referred to P1347,L18 but then heavily relied on subsequently as the explanatory factor for other ionic variations. This begs the question of how was the ice core record dated? Is it an assumption that there are 2 peaks in isotopes per year? Explain this clearer in text (not just by ref to Ginot et al. 2002) and/or include age/depth relationship.

The isotopic records coincide after just over a meter depth. Yet the magnitude of lighter isotope is diminished significantly in the year between cores, so that the d18O value at 0.5 m in 1999 is the most negative of entire records from both years. This disappears

by 2000. What happened? Is this resulting from fractionation as meltwater percolated? How does this challenge (or not) the initial assumptions about the isotopes being least affected by surface melting (P1348), with percolation not subjected to refreezing?

The way it is presented here, penitents (should this be spelled "penitents"?) and hoarfrost are caused exclusively by volcanic ash. Yet this is a qualitative assessment by visible contrast of the ice cap surface in successive years (Fig. 1). Moreover, the authors use the net accum in w equiv to estimate a big deficit due to melt. There obs of a deep melt layer is fairly convincing, but are there any corroborating independent measurements of precipitation/accumulation?

Some discussion of species is selective, or features ignored, or else generically noted to feature "some discrepancies." This is perhaps inevitable when no explanations are thought of, but it should be noted. For example, why is formate included? It is cursorily correlated to ammonium only in Core A, but there is no attempt to address the large peaks in Core A at 3 and 4 m depth that disappear in Core B.

Other subtle contrasts in interpretation of presence/absence of seasonality. For example, the authors mention a lack of expected bimodal peaks in Na+ and K+, and this is certainly true for Core B, but there is better variability in Core A, comparable to the SO42- that the authors acknowledge as seasonally varying (P1350). This is unclear.

Technical corrections:

P1345, L4: should be "the Chimborazo summit glacier"

P1345, L6: Delete "The" before Chimborazo

P1345, L22: change to "is far from trivial."

P1346, L15: is verano "summer" and "little summer" what the dry seasons are called?

P1346, L24: incorrect use of "analyzes". Probably should be analyzed.

P1356, L26: delete "pure"

P1347, L1-2: citation for info on volcano emissions? How was this information determined?

P1347, L9: change "form" to "from"

P1347, L13: it is not clear what this means: "the definition of the adequate ionic ratio indicator related to the ice core evolution." Explain this in clearer terms.

P1347, L18: include "annual" precipitation

P1347, L20, 21: precipitation is singular

P1350, L21: edit: "persisting down to 3.3 m weq depth was completely removed"

P1351, L1: aren't the authors actually referring to Core B?

P1351, L12: replace "than" with "to"

P1351, L13: delete "already"

P1351, L21: replace "than" with "as"

P1352, first sentence of second paragraph is convoluted and needs re-written as two sentences.

P1352, L13 and L19: "allover" is two words

P1354, L2: change "much concentrated" to "highest concentration"

P1354, L18: change "reports" to "features"

P1354, L24: change to "reached" and "covered" (past tense)

P1354, L25-27: edit to ". . .both ice cores permits an evaluation of. . .and an investigation of. . ." delete "involved" on L27.

P1355, L1: change "from" to "of" and "isotopes" to "isotope"

P1355: other grammatical roughness...

Fig. 2: (a) any way time can be expressed? (b) the accumulated deposition flux is awkward, since it starts at surface (0-depth).

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