The Cryosphere Discussions

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Comment on tc-2021-186

Anonymous Referee #1

Referee comment on "Relationships between Andean Glacier Ice-Core Dust Records and Amazon Basin Riverine Sediments" by Rafael S. dos Reis et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-186-RC1, 2021

This paper tries to establish linkages between dust deposition on the Quelccaya Ice Cap (QIC) in Peru, its grain size distribution and tropical Atlantic and Pacific modes of variability. In my opinion the paper fails to convincingly do so. The entire analysis is exclusively based on correlation analyses, without providing a causal mechanism that could support and explain the suggested relationships. The abstract alone lists 6 r-values, yet does not include a discussion as to why these correlations occur. Discussing correlation coefficients is fine, but in the end scientific inquiry requires understanding or at least investigating the mechanisms that underpin these statistical relationships. The paper falls short in this regard and the proposed relationships remain conjecture. There are other problems with this paper as well, including the seeming lack of awareness of prior work, or inadequate statistical methods employed, that further lower the quality of this study. I can therefore not recommend this paper for publication, but I have tried to outline a few avenues for improvement that may help the authors to reconfigure their analyses.

The discussion of prior studies in section 2 focused on snowfall and climate on QIC is inadequate. There is a lot of work that has been performed understanding snowfall and related circulation mechanisms on the QIC, yet most recent studies are ignored. For example, Hurley et al. (2015) analyzed snowfall on QIC and related atmospheric circulation mechanisms and tied snowfall events to cold air incursions. Perry et al. (2017) also analyzed snowfall events at the same site and tied them to northerly and easterly airflow using back-trajectory analyses. Hurley et al. (2019) compared the climatic conditions on QIC during Pacific cold and warm events and documented through which pathways tropical Pacific SST influence climate on QIC. All these studies are highly relevant for the work presented here, yet none of them are even mentioned in the paper.

Line 62-63: Rabatel et al. (2013) make no such statement that all glaciers will disappear in the tropical Andes by the end of the 21st century.

Lines 128-132: The influence of ENSO on QIC is indeed profound but it manifests itself in changes of the mass and energy balance, rather than direct retreat of the ice margin, as large ice sheets such as QIC respond with some delay in adjusting their extent to climatic forcing.

Lines 150-152: I don't understand the rationale for defining the hydrological year as April-March. April still very much belongs to the prior wet season as snowfall on QIC usually ends by the end of April or in early May (see Fig. 3 in Hurley et al., 2015). Defining the hydrologic year from July to June would therefore make much more sense.

Calculation of dust concentrations. There is no discussion of how snowfall amount and snow loss due to sublimation and wind scour (both of which are significant on QIC) factor in when calculating the actual dust flux. Concentrations are sensitive to both dilution by snowfall and increasing in concentrating via snow loss. This aspect requires a thorough discussion, but is completely ignored in this paper.

Statistical approach in Figs. 5&7: I have serious concerns about the statistical relationships and their significance derived from only twelve data points. The PDO is a slowly evolving multi-decadal index and establishing relationships with this mode of variability would require much longer time series, that cover at least one full warm and cold phase (i.e. at least 50 years). Furthermore, both the FPP and the GPP show clear trends in their data. For a robust statistical comparison these trends would have to be removed prior to the calculation of correlations, as otherwise the relationship may simply hinge on common trends in the data, rather than reflect actual year-to-year causal mechanisms. The same comment also applies to Madeira River sediments and runoff in Figure 7.

How exactly the ice core chronology was determined, needs to be explained in much more detail. The year 2015/16, for example, was marked by an extreme El Niño, with almost zero net accumulation on QIC. Yet the chronology presented in Fig. 2 assumes a normal year with ~ 1.5 m weq snow accumulation, which is hard to reconcile with on-site accumulation measurements for that year (see Fig. 1c in Hurley et al., 2019)

Fig. 6: These correlations are strongly influenced by one outlier. You should repeat this analysis using only data that fit a normal distribution (i.e. without the outlier) to confirm that your relationship still holds.

Minor edits:

Line 32: there are no ‘atmospheric oscillations in the QIC’

Line 79: It is a ’Stampfli’ drill (not ‘Stampli’)

Line 117: “Atmospheric circulation over the Amazon basin’ may be influenced by, but does not ‘come from the tropical Atlantic Ocean’

Lines 202-203: This sentence is incomplete: “To explore the relationship between total dust concentration in different size ranges (Figure 4)”.

Line 375: capitalize ‘Cordillera Vilcanota’

Lines 400-403: You reference a discussion paper that was rejected after peer-review. Please delete this reference and refrain from citing it in the text.

References cited in this review

Hurley, J.V., et al., 2015: Cold air incursions, $d^{18}O$ variability and monsoon dynamics associated with snow days at Quelccaya Ice Cap, Peru. J. Geophys. Res., 120, 7467-7487, doi:10.109/2015JD023323.

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Perry, L.B., et al., 2017: Characteristics of precipitating storms in glacierized tropical Andean Cordilleras of Peru and Bolivia. Ann. Amer. Assoc. Geogr., 107(2), 309-322, doi:10.1080/24694452.2016.1260439.

Rabatel, A., et al., 2013: Current state of glaciers in the tropical Andes. A multi-century perspective on glacier evolution and climate change. The Cryosphere, 7, 81-102, doi:10.5194/tc-7-81-2013.