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Interactive comment on "Influence of regional precipitation patterns on stable isotopes in ice cores from the central Himalayas" *by* H. Pang et al.

Anonymous Referee #1

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Interactive Comment

Comments on "Influence of precipitation patterns on stable isotopes in ice cores from the central Himalay" by N. Pang et al

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1 General comments

The paper aims at explaining why the $\delta^{18}O$ records from the Dasuopu and East Rongbuk glaciers are interpreted differently. This is an interesting aim. Beyond the interpretation of these specific ice cores, this aim is of interest for a broader community since it may help better understand the relative effect of temperature and precipitation in controlling $\delta^{18}O$ in tropical ice cores.

The paper is well written.

However, I'm not sure I understand how the authors get to their conclusion, it looks like several steps in the reasoning are missing and in contrast I don't understand how some parts of the paper relate to the reasoning. The take-home message and the reasoning to get there should be explained more clearly as explained in specific comments.

I think the paper is relevant to the Cryosphere but needs revision.

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2 Specific comments

2.1 Clarify the goals and the different steps of the reasoning

- **Clarify the take-home message**. Based on what I understand of the paper, the take-home message of the paper is that Dasuopu gets more precipitation from moisture advected by the westerlies, which makes it more sensitive to temperature, whereas East Rongbuk gets more precipitation from moisture advected by the ISM flow, which makes it more sensitive to precipitation amount. If this is not your take-home message, then it really needs clarification. Below my comments assume that I understand the take-home message correctly.
- p 1880 l 21 to 1882 l 2: **why use OLR anomalies rather than precipitation anomalies?** What is the goal or added value of using OLR? If the goal is to show spatial covariations in precipitation variability, why not just use precipitation?
- **What is the use of section 5.2 on seesaws?**
  - What are the implications of the existence of North-South and West-East seesaws for the interpretation of ice core records? Does this have any role on the relative proportion of moisture from the westerlies or from the ISM? Section 5.2 looks useless and may be removed unless its link with the goal of the paper is clarified.
  - To relate to the goal of the paper, it would be more interesting to investigate the link between these seesaws and the ice core records, e.g. calculate correlations between indexes of the North-South and West-East seesaws on the one hand and accumulation rate and $\delta^{18}O$ at ER and Dasuopu on the other hand. If $\delta^{18}O$ at ER does record one or both of these seesaws whereas Dasuopu does not, then it supports your conclusion.

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- The discussion on the causes of the seesaws is interesting, but how useful is it to address the question of the interpretation of stable isotopes in ice cores? I'm not sure this discussion belongs to this paper unless understanding the causes of these seesaws is really useful to understand the ice core records. Otherwise, this discussion should be moved into another paper.
- Some of the discussion is on intra-seasonal time scales. How relevant is it for precipitation variability at the inter-annual time scale? Also, clarify for each process or for each model of variability whether it is involved in intra-seasonal or inter-annual time scales.
- Have the ISM seesaws any influence on the relative influence of the Westerlies and of the ISM on precipitation falling on the ice cores? May some of the inter-annual variability in $\delta^{18}O$ at ER or at Dasuopu be associated with variations in this relative influence?
- I think the core of the paper is in section 5.1: that's where you argue for the difference of moisture origin on the 2 cores. The relevance of sections 4.2 and 5.2 is not clear. Again in conclusion: p 1889 l 10-25: how does it contribute to answering your initial question?

• The authors investigate the variability in ISM precipitation, because they argue that variability in ISM precipitation influence $\delta^{18}O$ at ER. But **why focusing on only one half of the problem**? They argue that winter westerlies and/or temperature influence $\delta^{18}O$ at Dasuopu: **why not investigating the inter-annual variability in the westerlies and/or temperature**, with as much detail as investigating the ISM precip? Why going in more details for the controls at ER than for the controls at Dasuopu?
p 1890 l 19: "spatial patterns of ISM precipitation should be taken into account": and what about the spatial patterns of the westerlies, don't they need to be taken into account as well?

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- The authors discuss the different moisture origins and the ISM modes of variability. But **an important step is missing before we can understand the $\delta^{18}O$ signal: for a given moisture origin and in the context of given modes of variability, what does $\delta^{18}O$ record?**

  - Even if ER receives most of its precip from the ISM and that the ISM varies at the inter-annual scale according the seesaws, is it proven that $\delta^{18}O$ records variations in ISM precipitation? Does your record or data published in the literature support that? And if so, the precipitation where and when, by what mechanisms?
  - Even if Dasuopu receives moisture from the westerlies, is it proven that $\delta^{18}O$ will record temperature? And if so, the temperature when and where, at what time scales?

  For the interpretation of both ice cores, it would be useful to check the link between $\delta^{18}O$ at ER and ISM precipitation/seesaws and between $\delta^{18}O$ at Dasuopu and temperature in a region and season to be defined.
  You can also refer to previous studies. For example, daily isotopic data has been collected and analyzed to try and better understand $\delta^{18}O$ at the process scale (e.g. Gao et al. (2011)).

2.2 What are the implications of this work?

- What are the implications of this work **for the interpretation of Dasuopu and East Rongbuk records**? What do you conclude from the $\delta^{18}O$ trends in terms of trends in temperature or in ISM precipitation? What do you conclude from the inter-annual variability of $\delta^{18}O$ in terms of inter-annual variability of temperature and ISM? Can some of the signal at one of these sites reflect the varying contribution of moisture from the westerlies and from the ISM?

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If for example you are able to link the trends, inter-annual variability or some specific events of ER $\delta^{18}O$ to a seesaw of the ISM, then the analysis of the causes of these seesaws in section 5.2 may become relevant, because in this case you could attribute the ER $\delta^{18}O$ variations to various factors or forcings.

- What are the implications of this work **for the broader debate on the relative effect of temperature and precipitation in controlling $\delta^{18}O$ in tropical ice cores**? Can this study be extended to other tropical ice cores? For example, for a given ice core, can we assess the relative effect of temperature and precipitation controls based on a study of the origin of air masses? Can all tropical ice cores be classified into ER-type (recording precip) and Dasuopu type (recording temperature), and if so on what criterion would you do this classification?

2.3 Miscellaneous

- p 1872 l 11: "The north–south and west–east seesaws of the Indian Summer Monsoon (ISM) precipitation are primarily responsible for precipitation falling at the ER site": do you mean "responsible for the inter-annual variability of the precipitation falling at the ER site"? Modes of variability cannot be not responsible for a precipitation amount, rather for a precipitation variability. Generally, I think this awkward wording reflects a confusion throughout the paper between the origin of precipitation and the sources of precipitation variability.
- p 1872 l 5: "interpreted" -> "interpreted in the literature" or "interpreted in previous studies".
- It's not clear what is your contribution in this paper: are you bringing new data? Or are you just reviewing previous studies and your contribution is to make new connections between them?

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- p 1873 l 27-28: “the large-scale circulation at the two sites are the same”: really? I thought one of your conclusion was that ER was more influenced by the westerlies...
- p 1875 l 16 and l 21: start new paragraph
- p 1876 l 13 to 1877 l4: this is not about seasonal distribution, this should be in an earlier subsection of 4.
- 1878 l 7: “spatial variability on intra-seasonal to inter-annual scales”: Do you mean rather “temporal variability”? Normally spatial variability can be seen at different spatial scales (meso, regional, continental) whereas temporal variability can be seen at different temporal scales (intra-seasonal, inter-annual...)
- throughout the paper, it would be useful in the discussion to **separate the effects of trends and the effect of inter-annual variability**. Do the correlations hold after detrending the time series?
- p 1887 l 7-8: “larger accumulation rate ... indicator of the different precipitation seasonality”: I don’t understand, there is no a priori link between precip amount and precip seasonality.
- p 1887 l 24 “higher elevations ... low latitude source regions” but p 1888 l 4-8: “high elevations ... winter time precipitation ... western disturbance” -> inconsistent? So is the ISM expected to have more influence at high or low elevations?
- p 1888 l 20: “restricted by convection height of the ISM”: there is nothing like a convection height of the ISM. In the context of the ISM, there are some convective systems that have some height. And I cannot see the link between the height of these convective systems and “monsoonal precipitation amount” “in the high elevations of Himalayas”. The rain that is falling on the Himalayas does not come from convective systems that shower the mountains from above. There are

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plenty of convective systems that appear and disappear everywhere where there is enough moisture and convective instability, and this leads to rain at the surface whatever the height of these convective systems. I would remove this argument.

- p 1888 l 15: “more observations on moisture transport ... are needed”. **Specifically, what kind of data do you need?** Moisture transport is not directly observable. Do you need reanalysis data to calculate moisture budgets (e.g. review byGimeno et al. (2012))? Model simulations with water tagging diagnostics (e.g. Yoshimura et al. (2004))? Do you need water vapor measurements to give information on the moisture origin (e.g. Lee et al. (2012))? If so, this is already available and it should be highlighted as precious information to exploit in future work. If you need more data that are not yet available, it’s a good opportunity to encourage such data collection, but in this case you need to be specific.
- p 1890 l 19-20: how should they be taken into account? What is the strategy? For example, if a map of the proportion of precipitation coming from the westerlies and from the ISM was available, would it be enough to know how to interpret any Himalayan ice core? Or what specific information do you need to interpret an ice core properly?

3 Technical corrections

- p 1882 l 7: “variations and trends” -> “variations in trends”?
- p 1889 l 3: “implying” -> “suggesting”

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