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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 #2

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General comments

Influence of regional precipitation patterns on stable isotopes by H. Pang et al raises a very interesting issue (i.e., different interpretation of ice core δ^{18}O retrieved from nearby glaciers on the Himalayas). The study tries to address the issue, and come up with possible mechanisms leading to those different interpretations. Tremendous efforts have been devoted to the atmospheric circulations patterns and atmospheric physics likely functioning in the process. The authors should be commended for their scientific and innovative spirits in delving deep to extract possible factors at play in ice core stable isotopes at different locations on the Himalayas.

However, for ice core sites so close to each other, the authors may need to look into their unique geographical locations and differences before introducing climatological

differences. Otherwise, both sites are expected to experience the same large-scale (e.g. monsoon and westerlies) and/or meso-scale circulation systems. Besides, the much lower elevation of the ER than Dasuopu may subject the former to wind scouring and re-deposition of snow. Thus the ice core information in ER may not be directly affected by large-scale atmospheric circulation, but rather by local and secondary effects.

The paper in its current form is not easy to follow, due mainly to the diverse interpretation and mechanisms introduced to understand the issue. There is also a lack of comparison with previous studies regarding the proposed interplay between the westerlies and Indian monsoon. The authors proposed reverse evolution of the westerlies and Indian summer monsoon as the mechanisms for different interpretation of ice core δ^{18}O for Dasuopu and ER, and suggest a weakening westerlies and intensifying summer monsoon due to global warming. Is such an indication consistent with studies as An et al. 2012 and Yao et al., 2012? A brief graph, or sentence is needed here to summarize the comparison and propose some causes for the differences, if any.

In general, I opt for major revision for this paper. Before looking at the large-scenario for causes of the ice core δ^{18}O differences at both glaciers, the authors are suggested to first study the local geomorphology and potential local effect.I think in situ observation in nearby areas may be more convincing evidences for the verification of ice core δ^{18}O climate significance. Thus field observation of precipitation patterns on different slopes may supplement the understanding, and continuous sampling of precipitation in the region for stable isotope analysis is also conducive to understanding the problem.

Specific comments

3. Data
Introduction of the ice cores should follow the times series, i.e., Dasuopu first, and followed by ER. It should also follow the relevance of those data to understanding the issue, i.e., how the appearance of those data is arranged throughout the paper. Thus

ice core information should be followed by regional precipitation data, and then by instrumental rainfall data over India, and finally by the reanalysis data.

Besides, elevation information of the ice coring sites should be mentioned, as it directly influences the accumulation and climate significance in ice core δ^{18}O .

The motivation to compare with rainfall in India is missing. Maybe the authors take the rainfall in India as Indian monsoon index, and that in different part of India as resulted from contributions of different moisture trajectories? Such a rationale is needed for the introduction of the Indian precipitation and its spatial pattern.

4. Regional precip. . ..
The presentation of long-term monthly distribution of precipitation at the four stations along the Himalayas is informative. The authors should clearly define "western" and "eastern" Himalayas as some stations are pretty close to each other, e.g., Dingri and Nylam.

The study would also benefit from correlation analysis of precipitation δ^{18}O with climatic parameters in modern precipitation at those stations, if available.

Otherwise, the study clearly depicts the different regional precipitation patterns, with the western Himalayas characterized by bimodal whereas the eastern Himalayas characterized by uni-modal. Such precipitation spatial feature suggests possible difference in atmospheric circulation systems at play in the Himalayas, which offers an insight in the different mechanisms driving precipitation δ^{18}O variation at those two drilling sites. However, the paper then turned to analyze the impacts of regional precipitation patterns in the Indian peninsular on ice core δ^{18}O, followed by atmospheric circulation systems over the region, and detailed study of meteorological parameters including OLR, mid-upper troposphere summer mean temperature, and sensible heat flux. I find those analyses not very relevant and compelling, as I was at loss as to what those atmospheric analyses intend to prove.

5. Potential mechanisms. . .
In this section, the authors seem to have proposed possible mechanisms behind different δ^{18}O variations at those two ice coring sites, in terms of, respectively, geographical features, and synoptic scenarios.

Subtitle for section 5.1 is better renamed as "Unique geographical features associated with different precipitation seasonality along the Himalayas".

In Section 5.2, the north-south seesaw is associated with the seasonal shift of the ITCZ, while the east-west seesaw is mainly related to a latest discovery by Wu et al (2012) about the importance of the Iran Plateau in triggering this feature. The IOD is also touched upon to understand the east-west seesaw pattern in precipitation over India. Those seesaw patterns and related synoptic scenarios and underlying mechanisms, however, seem to have been well documented in the atmospheric circle. In other words, the authors may need to shorten this part by highlighting some major concepts and mechanisms potentially functioning behind the different δ^{18}O features at those two ice coring sites.

The current description of those seesaw patterns in ISM precipitation is a bit verbose, and somewhat far-fetched from the scientific question addressed in the study.

6. Discussion
The authors proposed one more possible factor in the different precipitation seasonality of East Rongbuk (ER) and Dasuopu ice coring sites, i.e., higher elevation of Dasuopu than ER, which offers an innovative insight. But the citation about high elevations (>3000 m a.s.l) receive up to 40% of annual precipitation during winter may not be proper, as both ER and Dasuopu are higher than 3000 m a.s.l., therefore should yield little difference here.

Besides, the discussion of topographic condition as possible mechanism for the precipitation seasonality, therefore different ice core δ^{18}O signals at those two sites should go with the section 5. In fact, this section is better integrated with section 5 as section

5.3. In my view, this part is more relevant to different δ^{18}O signals at those two sites.

The authors seem to indicate that Dasuopu in the western Himalayas is influenced more by the westerlies, while East Rongbuk in the eastern Himalayas is influenced more by the summer monsoon. In this case, the increasing accumulation in East Rongbuk versus decreasing accumulation in Dasuopu reflects increasing monsoon versus decreasing westerlies in the past 200 years. Have you compared this finding with other studies about the interplay between the westerlies and Indian monsoon?

Technical corrections

P1873 L6, ER and Xixiabangma are considered in the high central Himalayas, but P1877, ER and Xixiabangma are considered as the Eastern Himalayas and the western Himalayas, respectively. Which one is right?

P1874 L6-10,"Precipitation patterns. . .and accumulation rate records" can be deleted, as the data will be elaborated in Section 3. Besides, the introduction of data here without a scientific background for transition appears abrupt.

P1875 L3, please give reference to "Western Disturbances"
L8, remove "annually-dated", 'cause it is said later in L13 that "..ice core was annually dated to . . ."

P1877 How is the western and eastern Himalayas divided? How do you define the central, western and eastern Himalayas? As Dingri and Nylam stations are very close to each other. If such a division is provided with some reference, the readers will be more convinced of the content.

P1879 L11-12, "In order to further decipher the relationship between. . .and . . .and. . ., correlation coefficients between. . .and. . .and. . .are included in Table 2"

L26-29, "The above correlation analysis results suggest that the relationship between. . . and . . . and . . .exists, but the relationship is vague for the Dasuopu core". Description of the relationship is a bit confusing. By looking at Table 2, I think the au-

thors are talking about ". . .the relationship between and among. . .". Or please rephrase to clarify "the relationship".

P1881 L27-28, ". . .convection activity is stronger over the western ISM region. . ."

P1882 L5 remove "both"
L7 "pronounced"

P1890 L 16, delete 'that' at the beginning of the line;

L16-18, what does 'all Indian summer monsoon region and its sub-regions' refer to? Why is 'the middle-northern India' not a 'sub-region' of the Indian summer monsoon. Please rephrase the sentence.

Figures:
Figure 3 precipitation seasonality should be based on the same duration to ensure the same climatic background. I think the period from Jan, 1973 to Jan, 2011 would suffice to yield climatology.

Figure 4 solid circle should be marked with a different mark. The current presentation is likely to be merged with the grey shadows.

Figure 5 please rephrase the caption as the current one is hard to comprehend.

Figure 6 The data source is unclear here. In the text, the authors first indicated that the "sensible heat net flux" is downloaded from NOAA/ESRL PSD. While later in the text, the authors indicated that the "sensible heat net flux. . ..was computed using the . . .reanalysis data. . ." Are they of the same parameter? How is the sensible heat net flux computed, please specify?

Additionally, figure captions are not consistent throughout, and some legend may need reorganization to ensure readability and avoid ambiguity.

Sometimes the subtitles are before the subject, while other times they are placed after the subject. Please be consistent in organizing the caption in one paper.

The usage of brackets is ambiguous. In most cases, it intends to explain and/or supplement the word before. While in other cases, it goes parallel and is replaceable with the word before. For the latter case, I suggest using slashes.

Interactive comment on The Cryosphere Discuss., 7, 1871, 2013.