

## ***Interactive comment on “Glacio-archaeological evidence of warmer climate during the Little Ice Age in the Miyar basin, Lahul Himalaya, India” by Rakesh Saini et al.***

### **Anonymous Referee #2**

Received and published: 6 March 2017

The main goal of this ms is to present detailed mapping of ruins within a moraine complex high in the Miyar basin in the Indian Himalaya, and to show that new 14C dates from the ruins indicate continuous human occupation from 1170-1730 AD. As the moraine complex is 200 m above the highest cultivation at present, the authors conclude that their data demonstrate that the LIA there was warmer than present. This would be an unusual conclusion.

The research team has clearly done detailed mapping within the moraine complex and documentation of the ruins, the crop fields and the irrigation techniques used by the former inhabitants. This looks very solid. However, I have some reservations on the format of the ms.

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I have several questions and some suggestions on how to improve the ms.

Continuous line numbers for the ms would be very helpful, rather than starting over every page

Abstract

Avoid passive text "is described" and superlatives "Impressive"

Organization

The ms has elements of a major review of Holocene glaciation in the Himalaya, and also elements of a very detailed local study which is, I think, the major contribution. I suggest the authors remain focused on their own study and limit overview text to their own region. An overview of what is known of the LIA in general for the Himalaya would be fine. I have suggested below an alternative organizational structure.

Geochronology

The main focus of my concern is the dating, which is the key element of their contribution. Given the difficulty of locating appropriate organic material for dating, it is good to see some new ages. However, the authors' treatment of the dates needs to be expanded. Table 1 needs to include the Conventional  $^{14}\text{C}$  ages and the Calibrated Ages. They have not correctly calibrated their dates. It is simply not possible to have the very small 1 sigma uncertainties for ages less than 400  $^{14}\text{C}$  years that are listed in Table 1; this is very clear from their own Figure 5, where they appear to have included the results of the calibration, showing vastly greater uncertainties for the younger samples.

I suggest the authors provide details of the collection for each of the radiocarbon samples. This is not given in the text, and also how they interpret them. Was the laboratory able to extract collagen from the bones? Are the horns and bones collected on the surface or in stratigraphic section? If from the surface do they represent casual animal presence?

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The large discrepancy between the hearth charcoal dates and the animal dates is thought provoking. Where did the inhabitants obtain wood for fires? Is it "fossil" wood. . .that is wood that is long dead and so has an "old" 14C age? Are the charcoal dates on a single discrete piece of charcoal or on many pieces?

How do they interpret their "soil" dates? I assume these are "bulk" dates as opposed to dating a discrete item. Soils are always time integrators.

What is the context of the dated wood? Is it part of the structures of the ruins, or from or just lying on the surface? Why is it there? Was it to be used for firewood?

Very little information is provided on these important aspects, which the reader requires as the primary conclusions are all based on the 14C dates.

Line 26-28 p. 6 " The important point to note is that all of these samples were obtained from locations within and on the end moraine complex, in comparatively close proximity to the terminus of Tharang glacier." From their Fig. 2 it seems to me that the end moraine complex containing the ruins is far from the terminus of the glacier, in fact from Fig. 2 it is 5 km and around the corner (although in the conclusions they say it is only 3 km to the snout; which is it?)

Lines 4,5 p.7 "The dates from these three sites indicate that the oldest and longest occupied settlements, in order of antiquity are: Tharang, Patam, and Phundang. " is certainly not justified from the data. There is only one date listed from both Patam and Phundang, although the text on p. 6 says two of the dates are from Phundang. It is not possible to draw such a conclusion.

I suggest giving all 14C ages (Conv and Cal) in years AD; it will be much easier to follow the text that way,

## Discussion

This lengthy section includes a long discussion that while interesting seems more of a review than of relevance to their primary dataset and the focus of this paper.

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A few key points:

Neoglaciation has a formal definition and it includes the LIA. The authors must change their terminology. The advance called the "Historical Advance" within the interval the authors state is the LIA, but is nevertheless separated from the LIA in their tables. This makes no sense to me. They discuss periods of both greater and lesser precipitation during the LIA on p.8 yet say the LIA had little glacier response because there was less precipitation even though there was apparently greater precipitation from 1700-1900 AD, clearly during what is still the LIA. I think the authors must consider the "Historical Advance" to be a LIA phenomenon.

The authors argue that the moraine in which the ruins are situated in from middle Holocene. This might be true, but is there any evidence for a 6 ka age? How do they know it is not a recessional moraine from regional deglaciation at the end of the last ice age? The ruins provide only a minimum age. Their statement (p.8) " The study . . . . clearly indicates that this area had restricted glacier during this period [occupation], i.e., Tharang glacier terminated up-valley beyond the moraine complex" seems oddly out of place as they had already argued it was mid Holocene in age and had not cited anyone else arguing it was LIA in age. They go on to argue that an increase in precipitation in the late 19th Century caused crop failure (p.8), which is also odd, since the region is moisture limited for crops. It would have to be either less precipitation or colder summers to cause crop failure.

### Conclusions

This should be a summary of their key findings (the dates and what they mean) and the climate interpretations. Their statement " the glacier either terminated close to its current position or further up- valley during the LIA" seems not to be supported by their Fig 2 that indicates an "Historical (which is LIA) Advance", but that figure is very difficult to understand. Finally, the authors imply in the conclusions that the dominant control on the mass balance of Tharang Glacier is summer temperature, when in this region

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precipitation has to be a major contributor.

Figures: Captions need far more explanation.

Fig. 1 Not possible to see where the field area is or what the small inset figures mean

Fig. 2 requires a lot of guess work; not possible to fully understand; two advances mentioned but not clearly labeled which is which

Fig. 3 OK

Fig. 4 Not particularly helpful

Fig. 5 OK (NH Temp Anomaly not cited. The sites of these records need to be located somehow. The Dasuopu record seems most relevant and suggests precip control on Tharang glacier?

Fig. 6 should not be included. Save this for a review paper. It's not possible to interpret it in its current format

Plates are not helpful. I was hoping to get a sense of the 14C samples but you can't tell from the plates

Recommendation

The team has clearly done a lot of work in the Tharang Glacier region. However, in its current form, the ms is not appropriate for Climate of the Past. All the conclusions are derived from the 14C dates, but the calibrations as given in Table 1 are incorrect, which causes incorrect conclusions. A revision could be acceptable if the authors can provide more secure detail on the stratigraphic settings for each of their dates, correctly calibrate them (especially the true uncertainties) and consider the balance between precipitation and temperature on the glacier mass balance. They need to accept that any advance before 1900 AD and after 1250 AD should probably be considered a LIA advance. They should present evidence for the age of the moraine on which the ruins are located. . .are they sure it is a mid Holocene advance or could it be an LGM

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recessional moraine. Not too important for their main story, but if there is evidence that it is 6 ka, this would be of interest to the readership.

Possible alternative Outline for a revised paper

Abstract

Introduction

Study area location and climate

Methods

Field Mapping

Ruins

Glacial Features

Radiocarbon Dating

Results

Holocene glaciation of the Miyar Basin

Radiocarbon Dates

Details of each collection

Interpretation of each date

Interpretation

Human occupation of the moraines: This should be a discussion on how robustly can they conclude continuous occupation of the ruins by humans. What is age of this moraine?

Climate control on late Holocene glaciation: Here we need a discussion of the balance between precipitation and melt to control glacier mass balance. Is the lack of a LIA

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advance due to aridity and NOT warmer temperatures? What do we actually know about Tharang Glacier mass balance? Is it likely more sensitive to precipitation or temperature?

Discussion

I think focus on LIA evidence from the nearest regions

Conclusions

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Interactive comment on Clim. Past Discuss., doi:10.5194/cp-2016-101, 2016.

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