We thank Somnath Baidya Roy for editing our manuscript, and we thank the two reviewers for their careful reading of our initial manuscript as well as for their constructive suggestions and notes that considerably helped to improve the revised manuscript. We have addressed all points below.

Responses to Reviewer 1

(1) **Comment:** While the topic is very interesting and the analyses have been carried out very carefully, it is a bit of a pity that that authors do not provide a clear conclusion as to what could explain the observed discrepancy between meteorological records and local peasant's observations. The reader is left somewhat in limbo at the end, wondering who is correct, the meteorological data or the local observers.

Response: We thank the reviewer for pointing out the missing of a statement on this important question. We actually had discussed the issue (somehow controversially) in our writing team several times. Overall, we think that the observed discrepancy between meteorological records and local peasant's perception is result of:

a. Different knowledge systems: The discrepancy can be explained by the different types of knowledge systems (epistemologies) from which the information – meteorological data and peasant's perceptions – were generated. Both contain uncertainties, due to the lack of high spatiotemporal resolution of meteorological data on one side, and because of memory failures and gaps on the other. Thus, the mentioned discrepancy may in reality not be as large as the data suggest.
b. Discursive embeddedness of peasants' perceptions: As local ecological knowledge of peasants is a result of continuous iteration between individual and collective perceptions, practices and believes (see Section 3.1), the accounts of peasants must be understood as a result of (1) individual experiences under increasingly difficult circumstances for agricultural production and (2) arguments of regional discourses on global climate change as a potential reason for the increased difficulties.

We have extended the discussion of this topic at the end of Section 5.

(2) **Comment:** Were the peasants queried as to what they perceive or believe to be the cause of the changes they identified in the interviews? If any information on this aspect were available it would be nice to include more discussion of it.

Response: Peasants consider climate change as a result of both environmental degradation and industrialization in "the First World" on a global level and air pollution through mining and other industry on the regional level. They raise the question of environmental justice when they think about the reasons of their suffering under climate change conditions without having the benefits of industrialization. Once again this can be understood as reproduction of global climate change discourses and the positioning of peasant groups within these discourses (see answer to comment 1).
We added information about this topic at the end of Section 3.3.

(3) **Comment:** Figure 1 could be improved a bit. Much of the text is written in extremely small font (also true for Figure 2) and the setting of the study site within the Rio Santa and within central Peru are not very clear. Finally the darker rain-fed areas are hard to distinguish from the dark

satellite backdrop. It might be better to use an actual map, rather than a satellite image as a basis for this Figure.

Response: We increased the size of all fonts in Fig. 1 and Fig. 2. In Fig. 1 the "Study Site" is now written in the same way in the two insert maps. We also increased the brightness of the background image to enhance the contrast between the background and the features. By doing so we received better visibility than with a topographic map as a background layer. We also slightly extended the caption of Fig. 1.

(4) **Comment:** Figure 3: same comment as above: if possible, please improve readability of the text in the legend.

Response: We have increased the size of all fonts in Fig. 3.

(5) **Comment:** Onset of the dry season. I wonder whether this chosen criterion is optimal. From simple visual inspection of Figure 3, it appears that the end of the wet season is often characterized by long dry spells, which would suggest that the dry season may actually start earlier (i.e. the length of the wet season may be overestimated). Indeed a wet season in this region that extends to mid-May is somewhat inconsistent with reported precipitation seasonality in the literature from this region. Indeed Fig 4a shows a wet season around 250 days. That is too long for this region. I would suggest that the authors try and find a more stringent measure for defining wet season (there are plenty of them floating around, for example in the South American monsoon literature that could be adapted to this region). Usually such measures are defined based on end of the wet season, rather than beginning of dry season metrics.

Response: We spent quite a while in developing and testing different algorithms (also more sophisticated ones than the applied one) to approximate the end of wet season. Due to the relatively irregular transition from wet to dry conditions in the different years in around 1/3 of the years there would be at least two possible dates (typically an early and a late one) for the start date of the dry season. At the end we choose a conservative criterion by taking an agricultural viewpoint (dry seasons should only start if there is only very little or no precipitation for soil moistening available). From a climatic/statistical viewpoint other criteria (e.g. Marengo et al., 2001; Nieto-Ferreira and Rickenbach, 2011) would likely yield earlier onsets of the dry season but they would miss the fact that in some years still frequent precipitation events in May could prevent the soil from totally drying out.
We extended the respective discussion in Section 4.2, description of feature 6. Overall, we think that it is almost impossible to find one universal algorithm for both sites that yields perfect results for the entire time series. To allow further insights in the basis of our decisions we are totally open to share e.g. data or figures in workable format that allow a closer look into individual years.

(6) **Comment:** Dry spells also could probably be defined more narrowly. Figure 4 shows that in some wet seasons there are more than 100 dry spells. How is this possible? Dry spells by definition are periods that must extend over several days (otherwise it is not a spell). Are you maybe counting several days that form part of the same dry spell individually rather than as one and the same dry spell? In any case it might be worthwhile to compare your estimates with other numbers from the literature on dry spells in the Peruvian Andes, which usually only lists a few dry spells per wet season (e.g. Sulca et al., J. Hydrometeorol., 2015-in press, although their wet season is based on only 3 months).

Response: As mentioned in Section 4.2 (Description of feature 4), a dry spell in this paper should mark a period in which plants might start to suffer from water scarcity, independent from the

statistic properties of the precipitation time series (as e.g in the climatologically motivated approach chosen in Sulca et al. 2015). Overall, our choice for our definition is determined by two considerations, providing the agricultural perspective and allowing for a year-to-year comparison of the number of dry spells. Thus, it is important to note that dry spells are allowed to overlap and that each dry spell has the same length (7 days). Another option used in the literature to define dry spells would have been to work with dry spells of different length but any year-to-year comparison would again require calculating the number of affected days. Nevertheless, motivated by this review comment we added information on the max/mean length (in days) of dry periods (defined as consecutive dry spells) during the wet season (Section 4.3 and Fig. A1). Working on that issue, we also corrected the date until which dry spells are counted in Fig. 4 from May 1st to April 23rd (earliest onset of the dry season at both sites). The effect of this correction on the results is minimal.
To account for this comment in the manuscript, we extended the description of feature 4 in Section 4.2 and added information in Section 4.3 (referring to Fig. A1).

(7) **Comment:** The boxplots in Figure A1b, A1c need a bit more explanation in the Figure caption. What do the red crosses indicate and why are they shown only for some months?

Response: We have extended the description of Figure A2b and A2c (former Figure A1). Following this description, the reason for missing or less frequent outliers in the wetter months is the much wider range of values between the 25% and 75% quantiles, thus relatively higher/lower thresholds for outliers compared to dry months.

(8) **Comment:** The statement that freezing levels remained constant since the 1980s is inconsistent with data shown in Bradley et al. (Geophys. Res. Lett., 2009) and Rabatel et al. (2013, the Cryosphere) and also with observations that suggest continued warming at high elevations in the Andes over the period 1981-2010 (Vuille et al., 2015, J. Geophys. Res.). I think this statement needs to be a bit more balanced, given all the evidence suggesting otherwise.

Response: We thank the reviewer for pointing out this mistake. Schauwecker et al. (2014) referred their freezing line trends exclusively to days with precipitation. We corrected the respective paragraph in Section 5.

(9) **Comment:** Page 1883, line 7: 'affects' (not 'effects')

Response: We thank the reviewer for this correction.

Responses to Reviewer 2

(1) Comment: Perceptions and group-level sociocultural differences. On one hand, the paper acknowledges the role of "societal processes…. contingent upon and characterized by the different interests, positions, and vulnerabilities of affected groups" (p. 1864) and the research framework is designed explicitly to include different groups in the interview sample (p. 1865). This acknowledgment and design are well-chosen and correspond to other scientific studies of the climate perceptions of peasants and other sociocultural groups in the Andes, including works that could potentially be drawn upon to strengthen the parts of this study that concern peasant perceptions of precipitation (see Comments 6, 7, and 8, especially the first item in 8). Equally or more important is that the paper being commented upon here possesses the potential to extend and strengthen its analysis of perceptions to include the group-level differences that it acknowledges and is designed to consider, but that, in the current version, do

not appear here in the results, discussion, or conclusion. As a result the analysis of the realm of perceptions gives the impression that significant differences do not exist among the groups interviewed. If so that is an important result and, in this reviewer's opinion, should be presented and discussed. If there is the finding of differences of climate perceptions among groups that result also is also of importance and should be presented and discussed in order to strengthen and extend analysis.

(2) Comment: Continuing the above comment to an additional point I think one of the main reasons I'm excited and supportive of this study and its publication is because I think it does have the potential to address the issue being addressed in this comment #1. While the authors would need to discern potentially testable hypotheses based on their data and insights my readings and ongoing research on these issues in the Andes suggest at least a couple possibilities that could be relevant and feasible: (i) potential differences of precipitation perceptions among peasants and non-peasants in the interview sample; and (ii) potential differences among peasants with irrigation access and without, or alternatively (since the paper describes the disabling of an irrigation canal), the potential differences among peasants in the higher elevation community and those of the lower elevation communities. These kinds of hypotheses are based on existing scientific works on peasant climate perceptions elsewhere in the Andes (see Comments 6, 7, and 8 below) and there may also be findings in existing studies of the Callejón de Huaylas that would also support such hypothesis construction and testing.

Response on Comments 1&2: We thank the reviewer for pointing on the topic of differences on group and individual peasants' levels respectively. In fact, there exist differences on group level in the peasants' reports about changing circumstances for agriculture. They depend on the location and the altitude of the affected plots as well as on the characteristics of the planted crop types. In contrast, the peasants' perceptions about precipitation changes vary very little within each group (individual level) because of the collective knowledge production and discourse (re-)production.
Regarding reports of peasants versus non-peasants such as NGOs and public institutions, the general statements on precipitation/climate change show little difference, but non-peasant actors don't mention the importance of the Puspa rain and tend to simplify impacts on agriculture while speaking more generally about difficulties of traditional peasant agriculture (commercial and market-oriented agriculture are hardly ever mentioned in this context).
Concerning potential differences between peasants' regarding irrigation versus rain-fed plots we have to mention that only very few plots are irrigated. Thus, even families with irrigated plots mainly practice rain-fed agriculture and everyday work of all families is dominated by rain-fed farming.
Furthermore, the following problems affect the few irrigable plots: (1) the traditional channel system is deteriorating due to emigration or disinterest of young people. Their contribution is missing in the communitarian maintenance work. (2) The water of the Rio Auqui is contaminated with heavy metals (Baraer et al., 2012), making the water unsuitable for irrigation. (3) The city of Huaraz is constructing a large channel for urban water supply with a water extraction site above the rural communities in the Cuenca Auqui. It is currently not clear how much river water will be available in future.

Overall, motivated by comments 1 and 2, we have added further information at the end of Section 3.3 and also included references to studies relevant for this topic (thanks for indications). Within upcoming studies we think it would be desirable to further investigate differences in perceptions depending on e.g. the applied agricultural practices, social status or availability of irrigation. In our collected reports, indicated explanations of reasons of climate change and potential solutions diverge. Neither of these questions was in the focus of our study but we see the need for further investigating climate change discourses in the region (entanglement of global, national and local discourses).

(3) **Comment:** The reporting of results about "Peasants' reports about changing precipitation patterns" should give percentages of the interviewees reporting each of the 4 findings presented. Also, the wording of the section title should be reconsidered since 2 of the findings, which are important, do not concern precipitation patterns per se.

Response: We see the interest in expressing percentages but as our methodological focus lies in qualitative approaches we have conduced individual narrative interviews as well as interrogations in collective meetings and discussions in the communities. The obtained information can hardly be separated in clear and "equally weighted" categories that can be quantified. For quantitative analyses more standardized questions and a higher number of interviews would be needed. Concerning the section title we agree that ground frost is, at the first glance, not directly related to precipitation patterns. However, considering the climate of the region, increased ground frost occurrence would have to coincide with less humidity (and presumably less precipitation) in the atmosphere: Only clear nights can produce ground frost in the tropical mountain climate. Nevertheless, we changed the title of Section 3.3 to "Peasants' reports about changing precipitation and weather conditions".

(4) **Comment:** The introduction to findings on peasant accounts of changing precipitation (p. 1868), which is generally quite good and presents valuable original insights, describes perceptions as part of local knowledge that is "modified by specific political and discursive dynamics." This statement raises a point that is relevant, important and accurate. But in my review of the paper I do not see results or discussion on this point. It would be helpful to either present the relevant results and discussion on this point or, alternatively, mention how and why there were no findings on this point.

Response: We now present information on that topic in Section 3.3 and have extended the discussion (end of Section 5). Please also see our response to the comments 1&2.

(5) **Comment:** Similar to #4 above the paper introduces the findings section (p. 1868) by stating that "The derived information represents a snapshot of the broad local knowledge about environment, society, and history." This statement is relevant, important and accurate. But the findings per se (pp. 1870-1872) do not present information on the social or historical aspects of peasant perceptions of climate and precipitation. Here too—similar to #4 above—it would be helpful to either present the relevant results and discussion on this point or, alternatively, mention how and why there were no findings on this point.

Response: With the word "snapshot" we want to indicate that for this study we were not able to assess details on the impact of the societal processes or historical events beyond climate issues (e.g. the agrarian reform 1969 or the terrible 1970 earth quake) on peasants' perception. However, being fully aware of these issues we aim to develop kind of a historic timeline along which potential impacts from natural, political and social changes on small scale agriculture are combined.

(6) **Comment:** With regard to scientific studies of peasant perceptions, knowledge, and social dynamics of climate and climate change in the Andes—including ones outside the immediate area of the Callejón but still quite relevant to the context of the paper being commented upon—it would be well worth considering the works of Sietz (e.g., Sietz et al. 2012 in Regional Environmental Change) in the southern Peruvian Andes and elsewhere in Peru and, also, Postigo (e.g., J. Postigo et al. 2008).

(7) **Comment:** Similar to #6 it is worth considering incorporating and using works that focus on sociocultural dynamics of peasant perceptions of climate and climate change in the Andes such as Orlove (potentially Orlove et al. 2008 or Orove and Caton 2010).

(8) Comment: Building further on preceding points it is relevant to consider incorporating and using works that focus on group-level differences in peasant perceptions of climate in the Andes (Zimmerer 1993 in Economic Geography) and the role that the seasonality of precipitation plays in the social dynamics of water use among Andean farmers whereby poorer tail-end irrigators are often most affected and aware of precipitation seasonality and potential climate change impacts (Zimmerer 2010 in Professional Geographer and 2011 in Global Environmental Change).

Response to Comments 6-8: We thank the reviewer for all the useful hints regarding relevant literature and apologize for some missing references that definitely should be cited in the respective contexts. We now have integrated some of the missing contents and the respective references in our manuscript.

(9) Comment 9: The design and framework of this study resemble, perhaps even quite closely, the approach of ethnoscience featuring the comparison of Western scientific knowledge and the knowledge systems of non-experts. If so it would be worth mentioning this similarity in the paper's introduction to the research framework and maybe to mention one or two relevant ethnoscientific studies "of climate or other knowledge systems" conducted with Andean peasant people and their perceptions.
Response: Many thanks for this comment. We integrated relevant studies in Section 1.

(10) Comment: Returning finally to the paper's documented loss of an important irrigation canal among peasants in the study communities (also referred to above in Comment #2) I would pose the question if that reduced access has sharpened or accentuated peasants' perceptions of the increased seasonality of precipitation since they no longer have access to an important water source that previously would have buffered the seasonality of precipitation.

Response: The irrigation channel shown in Fig. 1 has never been in operation yet. Since 2014 it is in reconstruction to improve urban water supply.We have added this missing information in Section 2.

Finally, we once again thank both Reviewers for the constructive and helpful feedback. We hope we have fulfilled most expected improvements and/or are now able to better explain motivations/reasons for our approaches. Overall, as indicated in the responses, we think this study is just one step that may help to motivate for a comprehensive multidiscipline effort towards better understanding the interaction of social and environmental changes as well as individual and collective response to the (perceived) changes.

Literature

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