

## ***Interactive comment on “Climate changes of hydrometeorological and hydrological extremes in the Paute basin, Ecuadorean Andes” by D. E. Mora et al.***

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The authors thank for these comments. These were of high support to improve the quality of this paper.

About the referee comment “Although the downscaling approach is technically accurate and commonly applied in hydrologic studies, it is, from a climate dynamics standpoint, ill suited for this region. GCM have large errors in simulated precipitation over this region of complex topography and using GCM precipitation as input into the downscaling procedure will lead to a propagation of this error”, it is true that GCMs have larger er-

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ror due to the poor spatial scale. As the referee states, this can lead to large errors in regions of complex topography. In addition, the use of the delta approach, taking only an average signal of change, would not be enough to represent the properties of climate variables at local scale, including extreme conditions. For that reason, this study is considering not only the results of GCMs but also the available RCMs in the region. Despite that Buytaert et al. (2007) state that RCMs do not necessarily give better simulations for precipitation when compared to observed series, the RCMs Precis Echam and Precis Hadley were also considered in this study. However, only 2 RCMs are available for the region, and their resolution is still too coarse for the hydrological impact scale considered in this study. That is exactly where the statistical downscaling method comes to play as an approx. solution as long as higher and more regional RCMs are not available.

About the referee's comment “Statistical-empirical downscaling, taking advantage of observed relationships between precipitation and the large-scale circulation aloft, and then deriving these circulation-indices from future scenarios in GCMs would almost certainly yield much more realistic results. GCMs are capable of realistically reproducing the large-scale circulation for the region, but not regional-scale precipitation. As such I have little faith in the projected changes in rainfall”, the aim of the statistical downscaling methods is to transfer the large scale climate signals, mainly greenhouse gas (GHG) scenario driven, to the local scale changes (mainly driven by local scale topography, which is considered to not change under climate change). The referee might be right that it might be better to apply the statistical downscaling to the GCM circulation outputs than to the GCM rainfall outputs. However, the GCM precipitation simulations are also based on the circulation results by a given parameterization that is physically based but at the coarse spatial scale. The additional step of converting the coarse spatial scale precipitation to the local scale, making use of local observations (which intrinsically reflect the effect of local, small scale conditions, mainly topography driven) is done by the statistical downscaling method. This motivation is now added to the paper.

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About the referee's comment "The English grammar needs some improvement. While generally OK, in many instances sentences are unclear or the wrong use of words makes the interpretation of sentences ambiguous. Examples such as: 'temperature is despicably lower' or 'highest monthly temperature values are experimenting lower changes' make it difficult to discern what the authors meant to say". The English grammar was checked and improved along the article. The syntax of sentences was improved and the length of sentences was reduced.

About the referee's comment "Table 2, Figure 5 and discussion in the text: temperature changes in % are not very useful nor indicative. Please provide results in common units (deg. C or K) throughout. This is also important to verify whether the projected (absolute) temperature changes are indeed larger at higher elevation, consistent with reports in previous studies. Figure 5: more description is needed to explain what is shown. For example which scenarios belong to which Figure?", as motivated above, temperature and rainfall results are now indicated in absolute values instead of relative changes. This will clarify the interpretation of the results, especially when comparing changes in temperature at different locations along the study area. Figure 5 was updated to indicate the scenario and the impact indicator.

About the referee's comment "The paper suffers from an unequal weight given to methods and discussion of actual results. The methodology is explained on six pages, while the results are discussed on only three (with one page left for conclusions). It would make the paper much more appealing to a broader audience if more emphasis was given to discuss the results and their implications in more detail. For example the authors mention the stronger increase in maximum as compared to minimum warming or the larger warming rates projected for higher elevations. Why is this the case? A lot of interesting results emerge from the study, but they are not put into a useful regional and thematic context. It is very strange that the projected temperature increase is higher in A1B than in A2, given the lower radiative forcing. Why is this the case? After all CMIP3 models show larger warming in the A2 than in the A1B scenario (not just globally av-

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eraged, but also over the Ecuadorian Andes)." Several sections of the article were rewritten. As replied above in response to the first referee, changes were made to the structure of the article and to the concepts within it, especially in the methodology to evaluate the impacts of climate change, and therefore, also in the reporting of results and the conclusions. More discussion was added explaining the differences in results as the referee suggests.

Section 2.6 "Impact indicators" was modified. This section now describes the proposed concepts given by the referee. This is first considering separately the changes obtained from the GCM-RCM simulation results without downscaling, then describing the spatial and temporal variability on observed series, and finally comparing the changes obtained directly from GCM-RCM outputs with the changes resulting from the perturbed observed series. This comparison leads to a better understanding of the impact of the statistical downscaling technique and clarifies the influence of the described local properties involved in the downscaled technique. It also gives a clearer interpretation of results in the analysis of the spatio-temporal patterns. The impact indicators and the description of the local properties of observed series was based on: i. yearly and monthly magnitudes, ii. frequency of wet/dry events (for rainfall) and iii. events at different quantiles.

The changes made to section 2.6, leads to corresponding updates in the section 3, Results. This section was divided in three subsections: i. Spatio-temporal patterns in observed series, ii. Impact indicators obtained directly from the GCM-RCM outputs, and iii. Impact indicators obtained from the downscaled series. This was followed by the discussion of the results.

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