Responses to Referee comments on manuscript ESDD-5-1-2014

General author response/commentary:

We thank the reviewers for their constructive and insightful commentary which will help us to improve our final manuscript.

i) Response to Referee M. Disse [5, C580-C581, 2014]

[i.C1] (p. 1120 / line 6-11) *"…What is the benefit compared to classical bias correction?"*

[i.R1] The assertion that there will be a benefit to bias correction, or more precisely, bias characterisation relates to the aggregation of biases calculated for individual grid cells or point locations into more general assessments of gridded dataset performance. Our contention is that the defined climate zones are rational, object geographic zones (spatial units) within which one ought to be able to expect consistent gridded dataset performance. The converse assertion is that aggregating bias statistics which lump climatically dissimilar zones could lead to masking of biases, e.g. averaging cool biases over deserts with warm biases over mountains to conclude near neutral mean bias.

[i.C2] (p. 1122, line 9-12) *"Please explain how the objective climate classification will improve the inter-comparison of gridded dataset performance in the sub-regions. Which new approach will be provided?"*

[i.R2] This answer is linked to the previous response (i.R1). We assert that our findings demonstrate that an objective basis is required to group individual observation sites into subsets for coherent, consistent characterisation of the biases of gridded datasets. As an illustration, if stations from across the South Asian or Central Asian domains were lumped as a single set, important differences in performance between climate zones, e.g. the Central Asian deserts and the Ganges-Brahmaputra Delta.

[i.C3] (figures and tables) *"In order to get a quick understanding of the figures and tables, I would suggest to explain all abbreviations of the respective figures / tables."*

[i.R3] We will make the following changes to tables:

Table 2. Variables used for Himalayan region climate classification.

Variable	Season	Physical importance
Precipitation	Annual Total	Humid vs arid climates
	ONDJFM ("rabi")	Westerly (extra-tropical) weather system climate influence
	AMJJAS ("kharif")	Monsoonal weather system climate influence
T_{avg} daily mean near surface air temperature	DJF	Indicator of precipitation state (solid versus liquid) and available energy to drive hydrological processes (meltwater generation) and crop growth (transpiration); as such indicator of hydrological regime (pluvial, nival or glacial)
	MAM	
	JJA	
DTR diurnal temperature range	DJF	(inverse) Indicator of moisture conditions, i.e. relative humidity and cloud cover, as both suppress DTR; as such proxy for cloud cover further informs regarding circulation influences
	MAM	
	JJA	
SW_{net} net downward shortwave radiation at the surface	DJF	Indicator of land surface state (snow covered or bare) and available energy to drive hydrological processes (meltwater generation) and crop growth (transpiration) ; as such indicator of hydrological regime (pluvial, nival or glacial)
	MAM	
	JJA	

Table 5. Variability of primary Himalayan region climate zones (8 clusters) area in the Hadley Centre downscaled perturbed physics ensemble, Regionally Quantify Uncertainty in Model Predictions (RQUMP), for South Asia.

We intend to modify the figure captions to read as follows:
Figure 1. Geographic context of the – Himalayan arc and adjacent plains – study area including elevation and areas with > 33% under irrigation (hashed). Data sources include the United Nations Food and Agriculture Organisation (FAO) and the United States Geological Survey Global 30 Arc-Second Digital Elevation Model (GTOPO30).

Figure 2. Ensemble precipitation climatology and normalised comparison of individual contributions from reanalyses used in this study. ONDJFM is the abbreviation for the period from October to March, referred to regionally as “Rabi.” AMMJJAS is the abbreviation for the period from April to September, referred to regionally as “Kharif.”

Figure 3. Ensemble energy input (temperature and radiation) climatology and normalised comparison of individual contributions from reanalyses used in this study. SW_{net} is net downward shortwave radiation at the surface. T_{avg} is daily mean near surface air temperature. DTR is diurnal temperature range. DJF is the (Winter) period December through February. MAM is the (Spring) period March through May. JJA is the (Summer) period June through August.

Figure 4. Comparison of the first three principal components (PCs) from each of the reanalyses used in this study. PCs are calculated from the Principal Component Analysis (PCA) input standardised variables using the PCA output weighting factors. PCs are thus dimensionless and values are expressed in standard deviations.

Figure 5. Comparison of climate classifications resulting from the use of 8, 12 and 16 clusters (k) on principal components from the individual reanalyses. Large units in the legend refer to zones for the k=8 case.

Figure 6. Ensemble spatial statistics for annual cycles of precipitation (left) and DTR (right) by climate zone (8 clusters). DTR is diurnal temperature range.

Figure 7. Ensemble spatial statistics for annual cycles of Tavg and SWnet by climate zone (8 clusters). SW_{net} is net downward shortwave radiation at the surface. T_{avg} is daily mean near surface air temperature.

Figure 8. Comparison of climate classifications resulting from the use of 8 clusters on principal components of the control period (1970 to 1999) from the individual members of the Hadley Centre RQUMP perturbed physics ensemble downscaled over South Asia.

[i.C4] (Figure 4) *“The unit of the legend is not clear (-5 to +5).”*
[i.R4] As also stated in the previous response, we are adding the following text to the figure caption: PCs are calculated from the Principal Component Analysis (PCA) input standardised variables using the PCA output weighting factors. PCs are thus dimensionless and values are expressed in standard deviations.

[i.C5] (Figure 6 and 7) *“The quality of the figures should be improved. Is the printing resolution sufficient to distinguish the differences? Can you add some (general) statistics in order to evaluate the differences of the four reanalysis datasets (e.g. test statistics for common mean value)”*
[i.R5] With regards to the figure quality, we have review the files we supplied for article submission, and the problem appears to have occurred during generation of the pdf file as the original figure was of far greater

resolution. In any case we will coordinate with editor and journal production staff to ensure that the graphics are both of the highest possible quality and meet the standards of the publisher.

With regards to evaluation of the differences between the reanalyses, we consider the evaluation of differences between individual reanalyses to be beyond the scope of the present work. We are of this opinion because central to the interpretation reanalysis data in general is understanding that both data assimilation and forecasting models used to generate the datasets and the fixing of mean surface elevations at coarse spatial resolution introduce biases. We consider that it would be of greater interest to compare statistics between derived climate zones from a single reanalysis although in our opinion step would also be out of scope. If the editor, however, is of the opinion that this would be an essential addition to the paper, we are willing to generate the additional table(s) and add accompanying text to the table. We will await specific instruction from the editor before make these changes.