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Interactive comment on "Spatial Extent of Future Changes in the Hydrologic Cycle Components in Ganga Basin using Ranked CORDEX RCMs" *by* Jatin Anand et al.

Anonymous Referee #2

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This paper presents a case study in which a hydrological model is forced with the output of CORDEX RCMs to obtain spatially-explicit information about future changes in some hydrological variables across the Ganga basin. The manuscript is quite difficult to follow and could be substantially reduced in length. There are some structural changes which could be made in order to help readers. In addition, the authors must provide better arguments for some of their decisions. For example, what are the reasons for using SWAT? Why was RCP4.5 used? Why were the RCMs evaluated on the basis of streamflow and not precipitation?

The hydrological model has been calibrated with discharge measurements at various

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points on the Ganga and its tributaries. However, this river system is both highly regulated by surface water infrastructure and strongly influenced by anthropogenic activities within the basin. Clearly the assumption that such factors are stationary is false (as the authors acknowledge), which leads me to question the validity and utility of projections of surface runoff using this approach. This should be discussed in more detail. Further, the authors do not really justify their choice of SWAT. Why not a process-based, distributed model such as VIC, which has previously been used to assess hydrological change in the Ganga basin (e.g. Chawla and Mujumdar (2015), who also consider land use change)? What is the reason for choosing to rank RCMs according to surface runoff? In my opinion the performance of RCMs should be evaluated using precipitation. Do the same three models perform best if you use precipitation, not surface runoff, for evaluation purposes?

Throughout the manuscript the authors attribute some of the change in surface runoff to changes in snowmelt. While snowmelt is undoubtedly an important factor in the Himalayas, I cannot imagine the relative contribution in, say, Farakka is very high. Maybe I'm wrong, but in any case the authors must first quantify the contribution of snowmelt to surface runoff and place any discussion of the impact of changes in snowmelt in this context. Since the aim of the paper is to assess the spatial extent of future changes in hydrology it should quantify the relative contribution of various hydrological processes to streamflow at different points in the basin. This would be an interesting study. Presently, however, readers are left with little understanding about the reason for the spatial variability in surface runoff apart from the precipitation pattern.

Some more specific comments are listed below:

Page 2, line 18: "The imbalance between the water demands and water supply has been increasing of late due to change in climate" - what evidence is there for this? Is climate change more or less important than other factors such as population and economic growth? Page 2, line 34: This is the first mention of objectives. Perhaps they could be stated explicitly beforehand. Page 4, line 1: "Furthermore, the Ganga river

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basin is highly governed by snowfall accumulation and snowmelt processes within the catchment" - This may be true in the Himalaya region but once the river enters the Gangetic plains I can't imagine that snowmelt contributes much to the overall flow. The following claim, that "snowmelt processes provide most of the surface water during non-monsoon season" is at best misleading and should be explained further. Is it the case that discharge at Farukka during winter months is predominantly snowmelt? What is the role of groundwater? Page 4, line 25: "The primary sources of water in the river are precipitation, base flow, and snowmelt water from the Himalayas" - again, this statement fails to recognise that the relative importance of these sources changes as the river moves downstream. Meltwater may well be an important component of discharge in Rishikesh or Haridwar, but in Patna or Farukka, say, I would imagine it's contribution would be very small. In any case the contribution of the various hydrological processes should be quantified. Page 4, line 19: This section essentially repeats what you have said in the final paragraph of the Introduction, and could be removed. Page 6, Table 1: Use consistent units for spatial resolution (e.g. SRTM @ 3 arc second, soil @ 5 arc minute, etc.) Page 6, line 5: Explain why RCP 4.5 was chosen. Page 7, Model description: Explain why SWAT was chosen. For example, why not choose a spatially distributed model for the analysis, given that the expressed aim of the paper is to assess the spatial extent of changes to the hydrologic cycle? Page 7, line 3: Why is it relevant that the model is computationally efficient? In fact these first two sentences does not fit very well and the paragraph would make more sense if it started with the third sentence. Page 7, line 10: Not sure what is meant by 'vivid methods' - perhaps 'various methods' would be more appropriate. Page 7, line 13: 'The SWAT model is used to assess the impact of land use changes...' would be more clear. Moreover it would help readers if you provide some references to back up this assertion. Page 7, line 7: Given the study aims to provide spatially explicit insight, it would be helpful if at this stage a figure was provided to show how SWAT is spatially discretised. Page 7, line 17: The Methodology does not include any description of the hydrological modelling. I see that you describe the model set-up in the section 6.1 – would it not make

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more sense to put this in the methodology? Page 11, line 23: See previous comments about the relative contribution of snowmelt to baseflow. Why is baseflow attributed to snowmelt? What is the relative importance of groundwater? Page 11, line 24: It's not clear what is meant by 'intrinsic nature' - consider rewording. Page 21, Fig. 9: The x-axis represents discrete locations so the points shouldn't be joined.

References:

Chawla, I. and Mujumdar, P. P.: Isolating the impacts of land use and climate change on streamflow, Hydrol. Earth Syst. Sci., 19, 3633-3651, https://doi.org/10.5194/hess-19-3633-2015, 2015.

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