We would like to thank the reviewer for her/his thoughtful comments. We believe that they have substantially improved the manuscript. Please find attached the responses to the reviewer's comments.

Interactive comment on "Intercomparison of different uncertainty sources in hydrological climate change projections for an alpine catchment (Clutha River, New Zealand)" by Andreas M. Jobst et al. Anonymous Referee #1 Received and published: 29 November 2017 >

General comments: The study evaluates different sources of uncertainty in hydrological projections with focus on the impact of the snow model. The experiments were carried out for a subcatchment of the Clutha River, New Zealand. It is nicely demonstrated that the snow model contributes to the uncertainty of seasonal variations and high inter-annual variability. Despite that the choices of the global climate model, emission scenario, and bias correction method generally have more impact on the total uncertainty, the results show that the uncertainty linked to the snow model should not be neglected in alpine catchments. It is a compact study with a good structure. The manuscript is clearly written, and I enjoyed reading it. Some minor comments might be considered to clarify a few parts. Including:

(1) Study area: The studied area is called the "Clutha catchment" and is introduced as a "major" and "large-scale New Zealand catchment". But – according to Chapter 2.1 – the analysis was carried out only for the most north-western sub-catchment (outlet Chards Rd). To clarify the whole study, the authors should please rephrase those parts of the manuscript (see also technical corrections) which lead to the misunderstanding that the results represent the whole Clutha catchment.

Response: *In the paper we now state more clearly that a hydrological model was developed for the entire Clutha (as described in Jobst 2017) and that this paper focuses on the unmanaged north-western part of the Clutha. Outflow of the Kawarau sub-catchment (focus of this study) is highly correlated with the other unmanaged headwater tributaries and as most of the central Clutha catchment is characterised by a dry climate (with comparably little additional streamflow generated) the results for the Kawarau can be considered broadly representative of the main stem of the Clutha (including the outlet Balclutha, Figure 1).*

However we agree that the main focus of this study is on the Kawarau sub-catchment and therefore "Clutha catchment" has been replaced with north-western sub-catchment or similar in most parts of the document. Corresponding changes were made to the following lines in the paper:

-P1 L12
-P3 L5, L10, L11, L23-24, L27-28 and L30-32
-P6 L22
-P8 L16
-P11 L12

Further, Figures 5,6 and 9 (note old figure number plus 1) were updated as they showed data for the entire Clutha catchment. They now show averaged data for the sub-catchment (Chards Rd) only. The relative signals shown in the updated figures are very similar to the previous ones for the entire Clutha and therefore only minor edits had to be added to the results sections of this document.

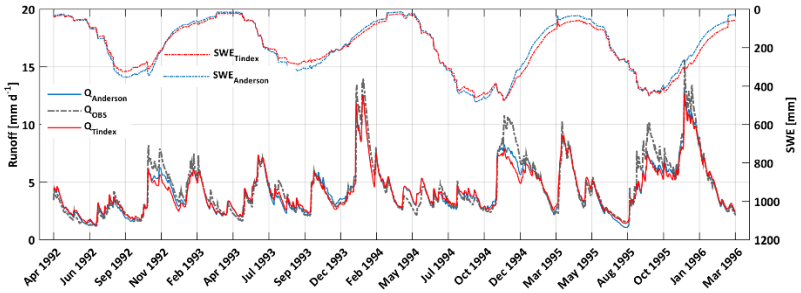
(2) Catchment characteristics: Please provide some information about i.e. elevation range, glacier extent, vegetation of the sub-catchment (outlet Chards Rd).

Response: *The requested statistics and catchment characteristics have been added to the document (P3 L32 – P4 L4)*

"Most of the Kawarau sub-catchment is covered by indigenous tussock grassland followed by low producing exotic grassland and indigenous forest. The elevation of the sub-catchment ranges between 300 and 2800 m with an ice cover of approximately 84 km^2 which corresponds to 55% of the Clutha catchment's ice cover (New Zealand's Land Cover Database v3.0 as published by Landcare Research in 2012)."

(3) Snow models: The study focusses on snowmelt uncertainty for hydrological projections and should therefore give more details about the two types of snow models used here. For example, it would be helpful to know if all snow is gone after the summer (except for glaciers) or if snow accumulates from year to year.

Response: *A new figure has been added that shows the seasonal variation of SWE and how some of the snow persists over summer and into autumn (Figure 3).*



Some more details about the snow models have been added to 2.2 (P4 L15-19)

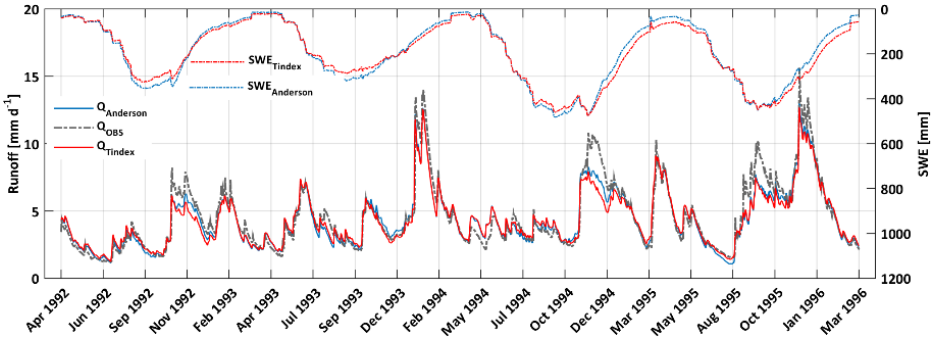
"The Tindex model calculates the melting rate via a degree-day factor multiplied by the difference between actual temperature and the melting point temperature. The Anderson model is more complex as it computes four separate melt fractions and accounts for radiation by using a seasonal melt factor. Further the Anderson approach also models the refreezing of liquid water stored in the snow pack if the actual temperature is below melting point."

(4) Baseline: Please introduce the baseline model in "Data and methods". How has it been calibrated?

Response: *We decided not to add any more detail on this matter because of the following reason. The calibration of the hydro model has already been described as part of 2.2 (P4 L20-31). The baseline simulations presented in 3.1 were not calibrated per se but are the product of WaSiM being forced by the bias corrected and downscaled meteorological variables of the RCM simulations.*

(5) Results – Baseline simulations: Apart from the graphs, values of model efficiency would strengthen the results.

Response: *A new figure has been added (Figure 3) showing daily simulations of discharge forced by the observed meteorology during the validation period. A new table (Table 2) with more NSE values was also added to the document. Also see second Reviewer's comment 3.*



River	Gauge	Cal (1.4.2008-31.3.2012)			Val (1.4.1992-31.3.2008)		
		NSE	NSE_{log}	NSE_{mo}	NSE	NSE_{log}	NSE_{mo}
Dart	The Hillocks (1996-2012)	0.77 (0.77)	0.77 (0.78)	0.92 (0.92)	0.64 (0.65)	0.64 (0.68)	0.78 (0.79)
Shotover	Peat's Hut (1996-2012)	0.64 (0.65)	0.67 (0.70)	0.81 (0.82)	0.60 (0.62)	0.65 (0.70)	0.76 (0.79)
Kawarau	Chards Rd	0.87 (0.88)	0.88 (0.87)	0.89 (0.90)	0.87 (0.85)	0.86 (0.86)	0.89 (0.87)
Matukituki	West Wanaka	0.67 (0.67)	0.64 (0.65)	0.80 (0.80)	0.62 (0.62)	0.72 (0.72)	0.83 (0.82)

(6) The climate change signals: Please clarify in the text (and legends) “temperature signal” / “change in Tmean”.

Response: *Mean air temperature has been abbreviated with Tmean throughout the document*

(7) Streamflow signal: Some parts could better be included in the discussion.

Response: *To avoid unnecessary repetitions and to keep this paper concise we would like to leave section 3.3.1 as it currently is. Adding individual sentences to the discussion would require reintroducing the figure and what the data points depict.*

> Technical corrections:

(8) P.3, l. 4 : makes it

Changed as suggested

(9) P.5, l. 13 : runoff regime

Changed as suggested

(10) P.6, l. 11 : Clutha catchment or north-western sub-catchment?

Changed as suggested

(11) P.6, l. 30 : most striking transformation for the 2090s

Changed as suggested

(12) P.7, l. 18 : Clutha catchment or north-western sub-catchment?

Changed as suggested

(13) P.8, l. 28 – 32 : see (7)

See comment under (7)

(14) Table 1 : provide units to the reader

Units were added to the table as suggested

(15) Figure 1b : increase the size of the coordinates and the catchment border

Changed as suggested

(16) Figure 1c : show the sub-catchments used for the calibration of the snow model

Changed as suggested

(17) Figure 3 : rescaling of the y-axis (2 to 6mm/d) and different colors for the single lines would help the reader

Changed as suggested. As the focus is on the groupings (i.e. A1B and A2 emission scenario runs) the same colors are supposed to be used for each grouping, while different colors for the individual lines would make these figures even harder to read.

(18) Figure 5 : see point (6)

Caption changed to: "mean temperature (Tmean) signal"

(19) Figure 8 : provide a legend for the different shapes

The different shapes are shown in Figure 8a to make this more obvious "The legend corresponding to all eight subplots is shown in Figure 8a." has been added to the caption.

(20) Figure 9 : Please increase the size of the circles and/or change the colors since it is really hard to distinguish between the colors.

Changed as suggested and we have also adjusted the layout of the figure