Supplement to Natural climate variability is an important aspect of future projections of snow water resources and rain-on-snow events

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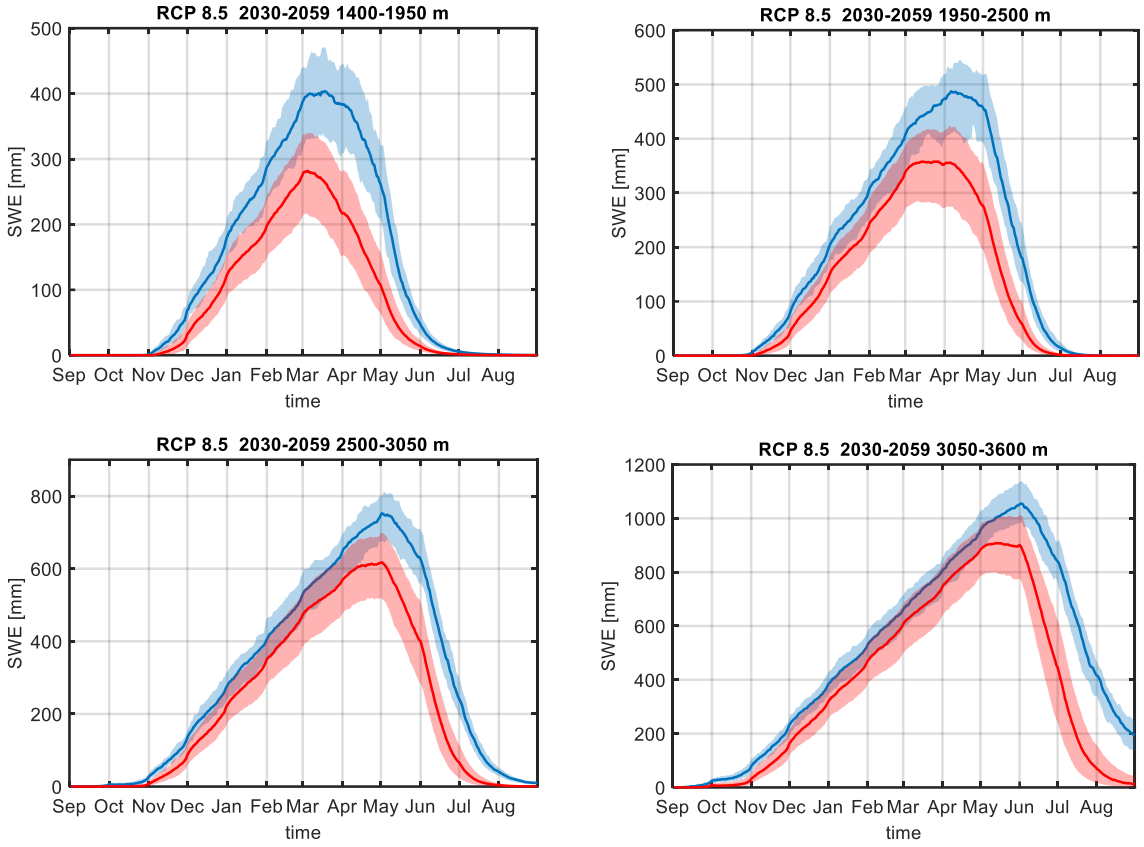
Table S1. Climate model chains and their abbreviations used in this study. *) This model chain was used with two different realizations.

RCM	Driving GCM	Abbreviation
CLMcom-CCLM4-8-17	ICHEC-EC-EARTH	CLMCOM-CCLM4-ECEARTH
CLMcom-CCLM4-8-17	MOHC-HadGEM2-ES	CLMCOM-CCLM4-HADGEM
CLMcom-CCLM4-8-17	MPI-M-MPI-ESM-LR	CLMCOM-CCLM4-MPIESM
DMI-HIRHAM5	ICHEC-EC-EARTH	DMI-HIRHAM-ECEARTH
MPI-CSC-REMO2009	MPI-M-MPI-ESM-LR	MPICSC-REMO1-MPIESM *)
MPI-CSC-REMO2009	MPI-M-MPI-ESM-LR	MPICSC-REMO2-MPIESM *)
SMHI-RCA4	ICHEC-EC-EARTH	SMHI-RCA-ECEARTH
SMHI-RCA4	IPSL-IPSL-CM5A-MR	SMHI-RCA-IPSL
SMHI-RCA4	MOHC-HadGEM2-ES	SMHI-RCA-HADGEM
SMHI-RCA4	MPI-M-MPI-ESM-LR	SMHI-RCA-MPIESM



20 **Figure S1: Areal mean seasonal SWE development under the current (blue) and future climates (red) for different elevation ranges, but only emission scenarios RCP 8.5 and mid of the century. Plotted are the 5, 50, 95 percentiles of climate period mean values stemming from 50 (current climate) and 500 climate periods (future climate with 50 realizations of 10 climate models).**

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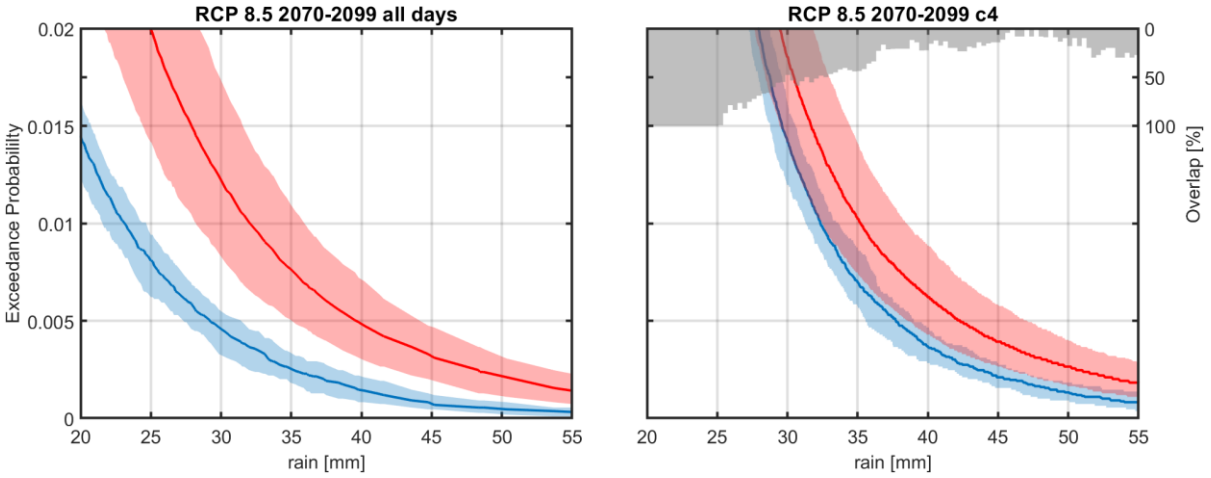

Figure S2. Yearly exceedance probability of total area-averaged rain for all days (a) and contribution areas averaged during ROS conditions with criterion 4 (b) for current climate (blue) and RCP 8.5 end of the century (red). Plotted are the 5, 50, 95 percentiles of climate period mean values stemming from 50 (current climate) and 500 climate periods (future climate with 50 realizations of 10 climate models). The overlap indicates how much of the current climate natural variability is overlaid by the future climate uncertainty range.

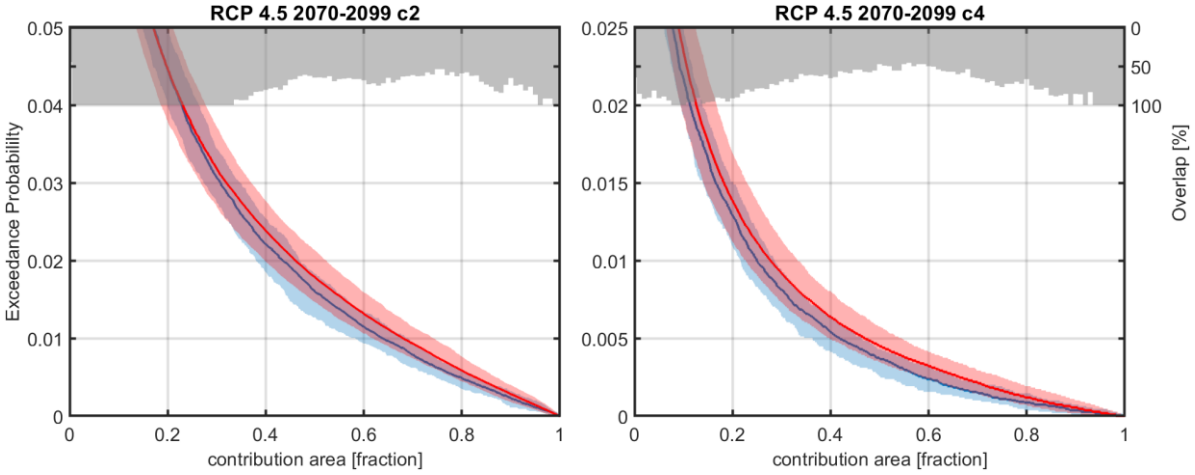

Figure S3. Yearly exceedance probability of the contribution areas of ROS events for current climate (blue) and RCP 4.5 end of the century (red) for criteria 2 (a) and 4 (b). Plotted are the 5, 50, 95 percentiles of climate period mean values stemming from 50 (current climate) and 500 climate periods (future climate with 50 realizations of 10 climate models). The overlap indicates how much of the current climate natural variability is overlaid by the future climate uncertainty range.

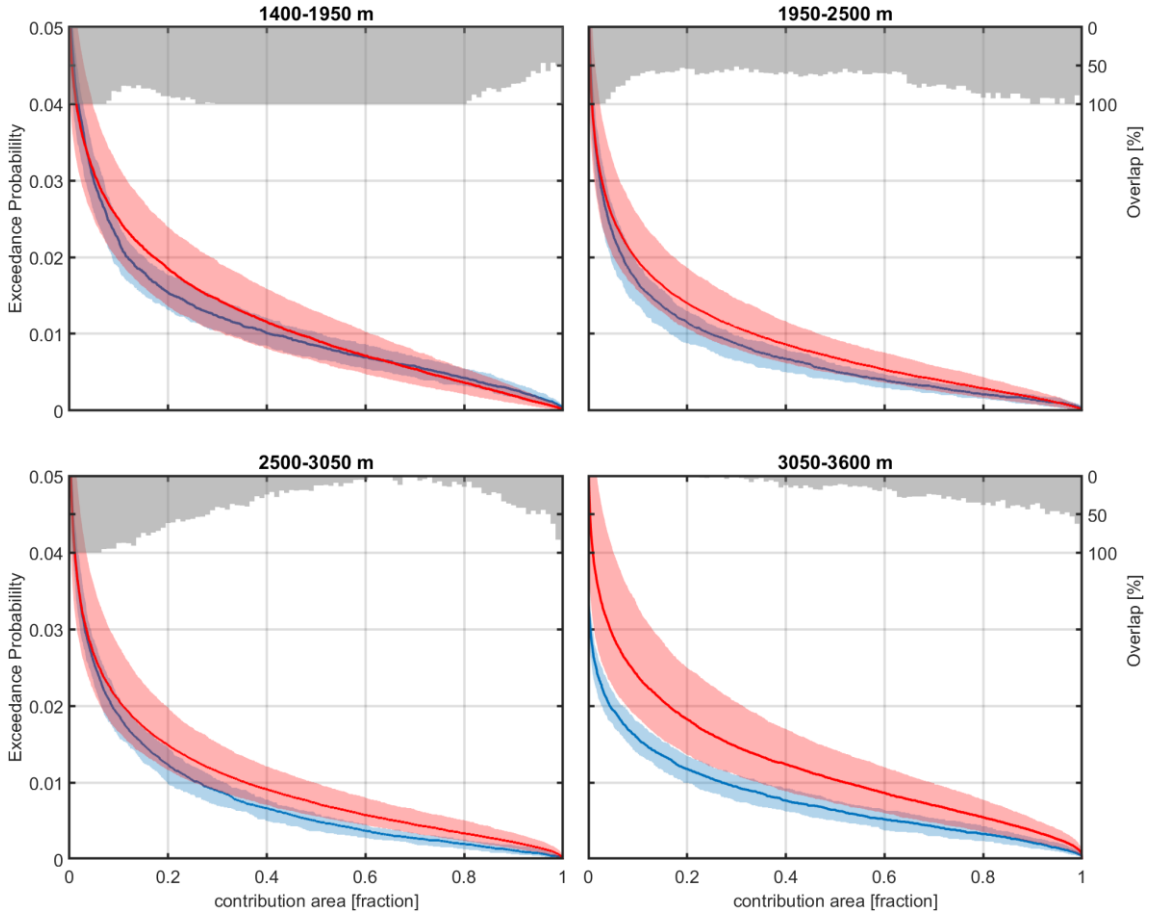

Figure S4. Yearly exceedance probability of the contribution areas of ROS events for current climate (blue) and RCP 8.5 end of the century (red) for criterion 4 in four elevation ranges. Plotted are the 5, 50, 95 percentiles of climate period mean values stemming from 50 (current climate) and 500 climate periods (future climate with 50 realizations of 10 climate models). The overlap indicates how much of the current climate natural variability is overlaid by the future climate uncertainty range.

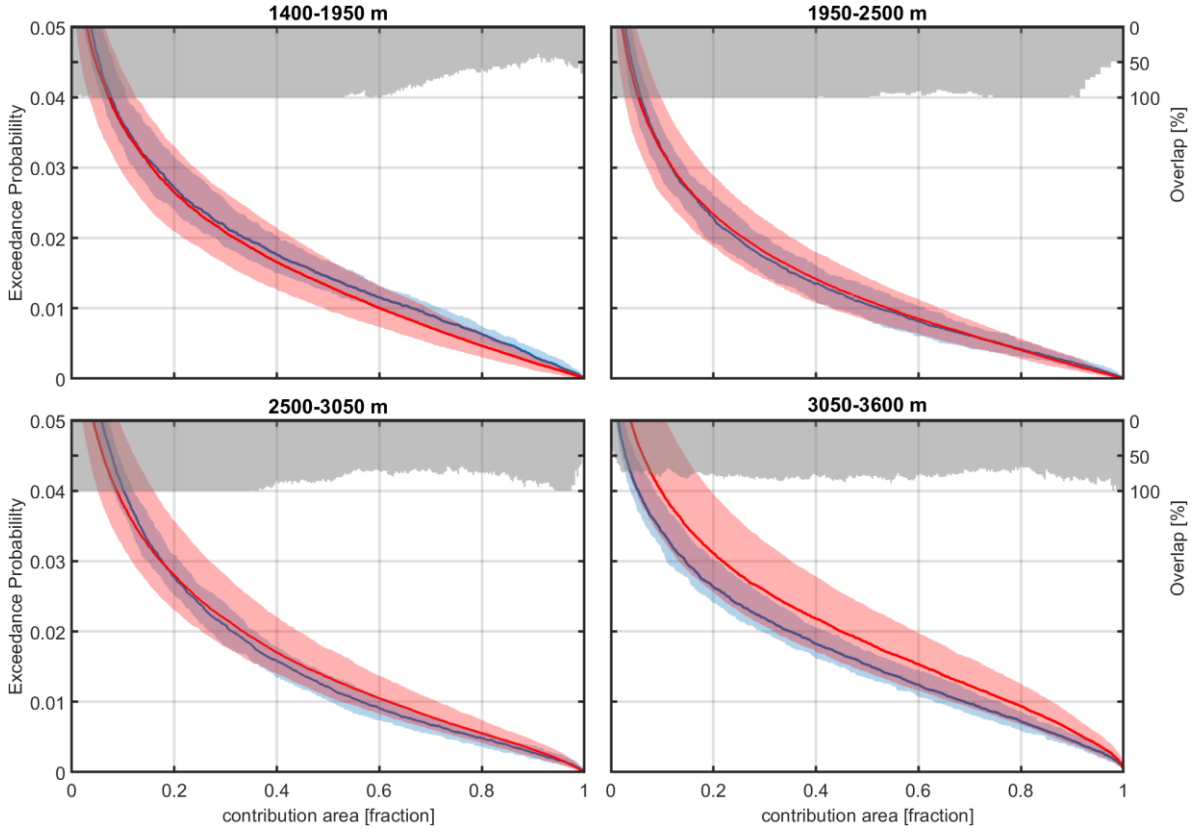

Figure S5. Same as Figure S4 but with criterion 1.

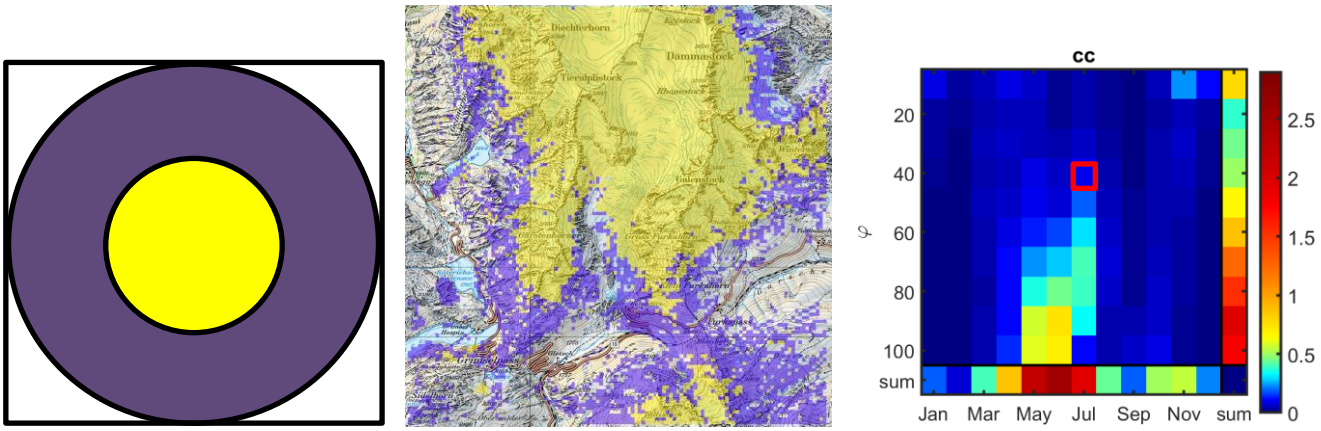

Figure S6. Conceptual (a) and modelled (b) example of a ROS event showing areas satisfying criterion 1 (purple) and criterion 2 (yellow and purple), and copy of Figure 9a in the main manuscript (c). The modelled example is at the beginning of July under current climate conditions. Following criterion 2 (yellow and purple), this ROS event has a contributing area of 63% of the total area, φ is 37%, i.e. the ratio of pixels obeying criterion 1 over pixels obeying criterion 2, and would therefore add to the red marked class of ROS events in (c). This event is characterised by relatively dry and cold snow conditions as it would be typical for this time of the year.

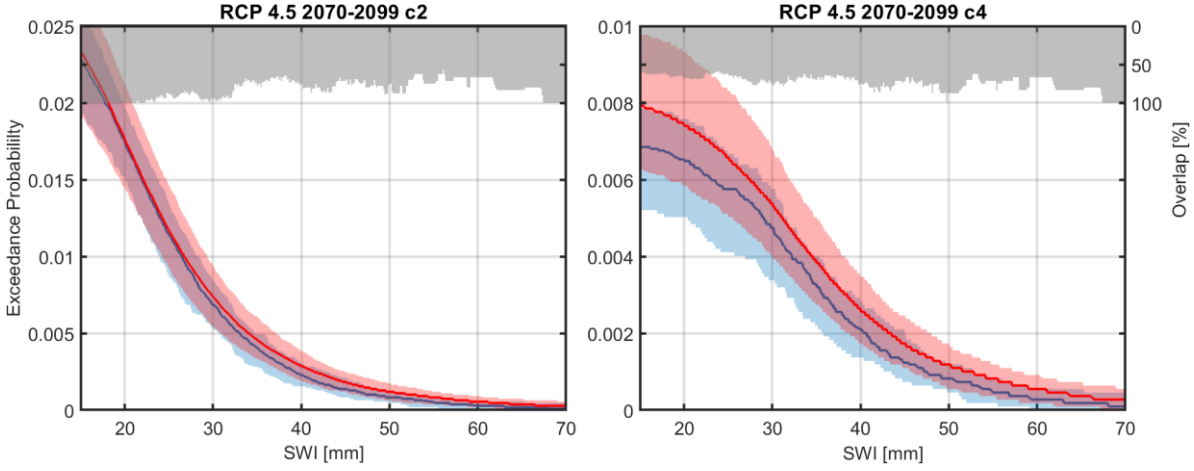

Figure S7. Yearly exceedance probability of total area-averaged SWI of ROS events for current climate (blue) and RCP 4.5 at the end of the century (red) for criteria 1 and 4. A contribution area >1/3 of the total area was chosen to define a ROS event. Plotted are the 5, 50, 95 percentiles of climate period mean values stemming from 50 (current climate) and 500 climate periods (future climate with 50 realizations of 10 climate models).

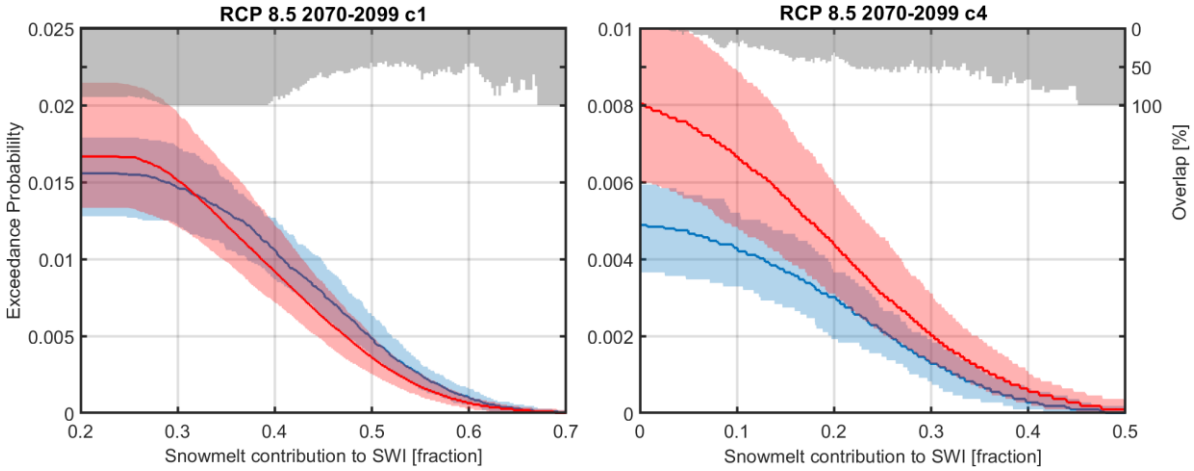

Figure S8. Yearly exceedance probability of contribution area-averaged snowmelt contribution to SWI of ROS events for current climate (blue) and RCP 8.5 at the end of the century (red). A contribution area >1/3 of the total area was chosen to define a ROS event. Plotted are the 5, 50, 95 percentiles of climate period mean values stemming from 50 (current climate) and 500 climate periods (future climate with 50 realizations of 10 climate models).

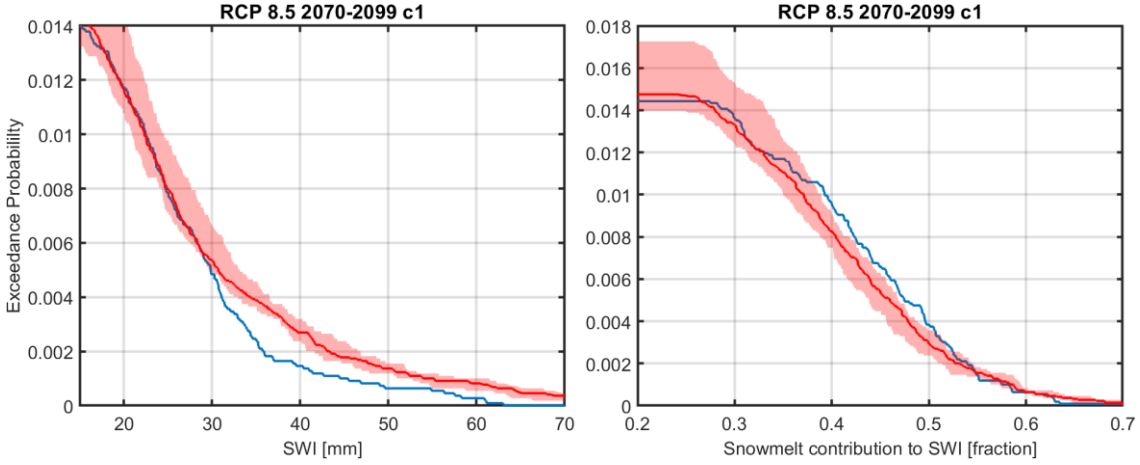

Figure S9. Yearly exceedance probability of total area-averaged SWI (a) and contribution area-averaged snowmelt fraction of ROS events for current climate (blue) and RCP 8.5 at the end of the century (red) for criterion 1. A contribution area >1/3 of the total area was chosen to define a ROS event. Plotted are climate period mean values are from the first realization of a climate period (blue) and the 5, 50, 95 percentiles of climate period mean values stemming from 10 climate models (red) from the first realization of a climate model period. These figures relate directly to Figs. 9a in the manuscript and S8a.