Quantifying projected changes in runoff variability and flow regimes of the Fraser River Basin, British Columbia

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Supplementary Tables and Figures

1 **Supplementary Table 1:** List of the 21 CMIP5 models used in the present study.

Institution	Model Name	Resolution (Lon.° × Lat.°)
Commonwealth Scientific and Industrial Research Organization (CSIRO) and Bureau of Meteorology (BOM), Australia	ACCESS1.0 ACCESS1.3	1.8 × 1.2
Beijing Climate Center, China Meteorological Administration	BCC-CSM1.1	2.8 × 2.8
College of Global Change and Earth System Science, Beijing Normal University, China	BNU-ESM	2.8 × 2.8
Canadian Centre for Climate Modelling and Analysis, Canada	CanESM2	2.8 × 2.8
National Center for Atmospheric Research, U.S.A.	CCSM4	1.2 × 0.9
Centre National de Recherches Météorologiques/Centre Européen de Recherche et Formation Avancée en Calcul Scientifique, France	CNRM-CM5	1.4 × 1.4
Commonwealth Scientific and Industrial Research Organization in collaboration with Queensland Climate Change Centre of Excellence, Australia	CSIRO-Mk3.6.0	1.8 × 1.8
LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences; and CESS, Tsinghua University, China	FGOALS-g2	1.8 × 1.2
NOAA Geophysical Fluid Dynamics Laboratory, U.S.A.	GFDL-CM3 GFDL-ESM2G GFDL-ESM2M	2.5 × 2.0
Institute for Numerical Mathematics, Russia	INM-CM4	2.0 × 1.5
Institut Pierre-Simon Laplace, France	IPSL-CM5A-LR IPSL-CM5A-MR	3.7 × 1.9
Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute and National Institute for Environmental Studies, Japan	MIROC-ESM	2.8 × 2.8
	MIROC5	1.4 × 1.4
Meteorological Research Institute, Japan	MRI-CGCM3	1.1 × 1.1
Max Planck Institute for Meteorology, Germany	MPI-ESM-LR MPI-ESM-MR	1.8 × 1.8
Norwegian Climate Centre, Norway	NorESM1-M	2.5 × 1.9
<i>All model outputs are for RCP 8.5, are statistically downscaled and bias-corrected using BCCAQ2 (Sec. 2.2), and are regridded to a common horizontal resolution of 0.25° to facilitate the VIC model simulations.</i>		

3 **Supplementary Table 2:** 30-year runoff mean and interannual variability (estimated by standard deviation). Values are
4 calculated for each individual CMIP5-VIC simulation and are averaged to get the MME annual mean. The inter-model spread in
5 runoff mean and its interannual variability is indicated as uncertainty ranges ($\pm$) estimated by a 5-95% confidence interval.

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Basin	Mean and interannual variability of Runoff [mm yr ⁻¹]					
	1990s (1980-2009)		2050s (2040-2069)		2080s (2070-2099)	
	Mean	Variability	Mean	Variability	Mean	Variability
Rocky Mountains	790 $\pm$ 9	129 $\pm$ 10	798 $\pm$ 25	128 $\pm$ 9	796 $\pm$ 32	133 $\pm$ 7
Interior Plateau	220 $\pm$ 3	41 $\pm$ 3	228 $\pm$ 7	41 $\pm$ 3	236 $\pm$ 10	42 $\pm$ 3
Coast Mountains	1250 $\pm$ 10	158 $\pm$ 8	1364 $\pm$ 25	177 $\pm$ 12	1410 $\pm$ 33	206 $\pm$ 14
UF	554 $\pm$ 55	120 $\pm$ 15	548 $\pm$ 58	121 $\pm$ 15	535 $\pm$ 60	123 $\pm$ 14
QU	551 $\pm$ 7	110 $\pm$ 8	550 $\pm$ 19	109 $\pm$ 8	545 $\pm$ 23	112 $\pm$ 6
TN	347 $\pm$ 4	72 $\pm$ 5	349 $\pm$ 11	69 $\pm$ 5	347 $\pm$ 14	74 $\pm$ 4
CH	417 $\pm$ 5	65 $\pm$ 4	461 $\pm$ 10	70 $\pm$ 5	493 $\pm$ 12	74 $\pm$ 5
LF	358 $\pm$ 4	58 $\pm$ 4	369 $\pm$ 11	58 $\pm$ 4	376 $\pm$ 13	61 $\pm$ 3

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Supplementary Figure 1: Spatial patterns of change (%) in (a, c) mean and (b, d) interannual variability of CMIP5 models precipitation in 2080s relative to 1990s. Panels (a-b) shows annual changes and panels (c-d) are for cold season only.

14 **Supplementary Figure 2:** CMIP5-VIC simulated daily runoff (a, d, g, j) mean, (b, e, h, k) variability and (c, f, i, l) 7-day
15 moving average variability for the UF, QU, TN and CH sub-basins. Black, blue and red curves represent the MME mean for the
16 1990s, 2050s and 2080s respectively. Shading represents inter-model spread as represented by 5-95% confidence intervals.

Supplementary Figure 3: (a) Sensitivity coefficient between changes (%) in cold season gridcell averaged runoff variability and elevation in the Fraser River Basin (FRB), Rocky Mountains (RM), Interior Plateau (IP) and Coast Mountains (CM) geoclimatic regions. Bars outlined in black are significant at $p < 0.05$. Univariate linear regression is used to explore changes in runoff variability at different mean gridcell elevations. (b) An example of a scatter plot for the CM used to calculate the slopes estimates in panel (a).

32 **Supplementary Figure 5:** CMIP5-VIC simulated cumulative flow departures for the 1990s, 2050s and 2080s for all sub-basins.
33 Thick lines are for the MME mean and shading indicates the 5-95% confidence interval
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