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Supplement of

Benchmarking historical performance and future projections from a large-scale hydrologic model with a watershed hydrologic model

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Table S1. List of GCMs from the CMIP6 experiment used in this study together with time periods SSP2-45 and SSP5-85 simulations of the GCM reach 1.5 to 4.0 °C global warming level (GWL) above the preindustrial period 1850-1900. GWL calculations are performed with respect to 1995-2014 by considering 0.85 °C warming between 1850-1900 to 1995-2014. NA means that the GCM simulation do not reach the specified GWL by the end of the simulation.

GCM name	Primary reference	SSP	GWL 1.5	GWL 2.0	GWL 3.0	GWL 4.0
Australian Earth System Model, version 1.5 (ACCESS-ESM1.5)	Ziehn et al. (2020)	2-45	2019-2038	2035-2054	NA	NA
		5-85	2017-2036	2029-2048	2050-2069	2068-2087
The Canadian Earth System Model version 5 (CanESM5)	Swart et al. (2019)	2-45	2011-2030	2023-2042	2051-2070	NA
		5-85	2011-2030	2021-2040	2037-2056	2050-2069
Centre National de Recherches Météorologiques and Cerfacs, Earth System Model version 2.1 (CNRM-ESM2.1)	Séférian et al. (2019)	2-45	2021-2040	2038-2057	2074-2093	NA
		5-85	2018-2037	2031-2050	2049-2068	2063-2082
European Community Earth System Model version 3 (EC-Earth3)	Döscher et al. (2022)	2-45	2014-2033	2036-2055	2078-2097	NA
		5-85	2015-2034	2026-2045	2048-2067	2064-2083
Geophysical Fluid Dynamics Laboratory Earth System Model, version 4.1 (GFDL-ESM 4.1)	Dunne et al. (2020)	2-45	2024-2043	2050-2069	NA	NA
		5-85	2023-2042	2037-2056	2061-2080	NA
Model for Interdisciplinary Research on Climate version 6 (MIROC6)	Tatebe et al. (2019)	2-45	2024-2043	2050-2069	NA	NA
		5-85	2022-2041	2037-2056	2062-2081	2080-2099
Max Planck Institute Earth System Model High Resolution version 1.2 (MPI-ESM1.2-HR)	Müller et al. (2018)	2-45	2027-2046	2053-2072	NA	NA
		5-85	2023-2042	2039-2058	2064-2083	NA
Meteorological Research Institute Earth System Model version 2.0 (MRI-ESM2.0)	Yukimoto et al. (2019)	2-45	2017-2036	2035-2054	NA	NA
		5-85	2013-2032	2025-2044	2052-2071	2071-2090

Table S2. Comparison of the goodness-of-fit (GOF) metrics for VIC and CWatM SWE results. Summarized metrics include Nash-Sutcliffe coefficient of efficiency (NSE), Kling-Gupta coefficient (KGE) and % volume bias (VB) for the available data, the stations correspond to Fig. S1.

	VIC			CWatM		
Station	NSE	KGE	VB	NSE	KGE	VB
BCE-4D14P	0.80	0.84	-6.2	0.61	0.74	10.4
SCD-YT056	0.73	0.78	-8.2	0.68	0.80	12.1
YK-10AD-M1	0.62	0.77	13.5	0.68	0.77	10.4

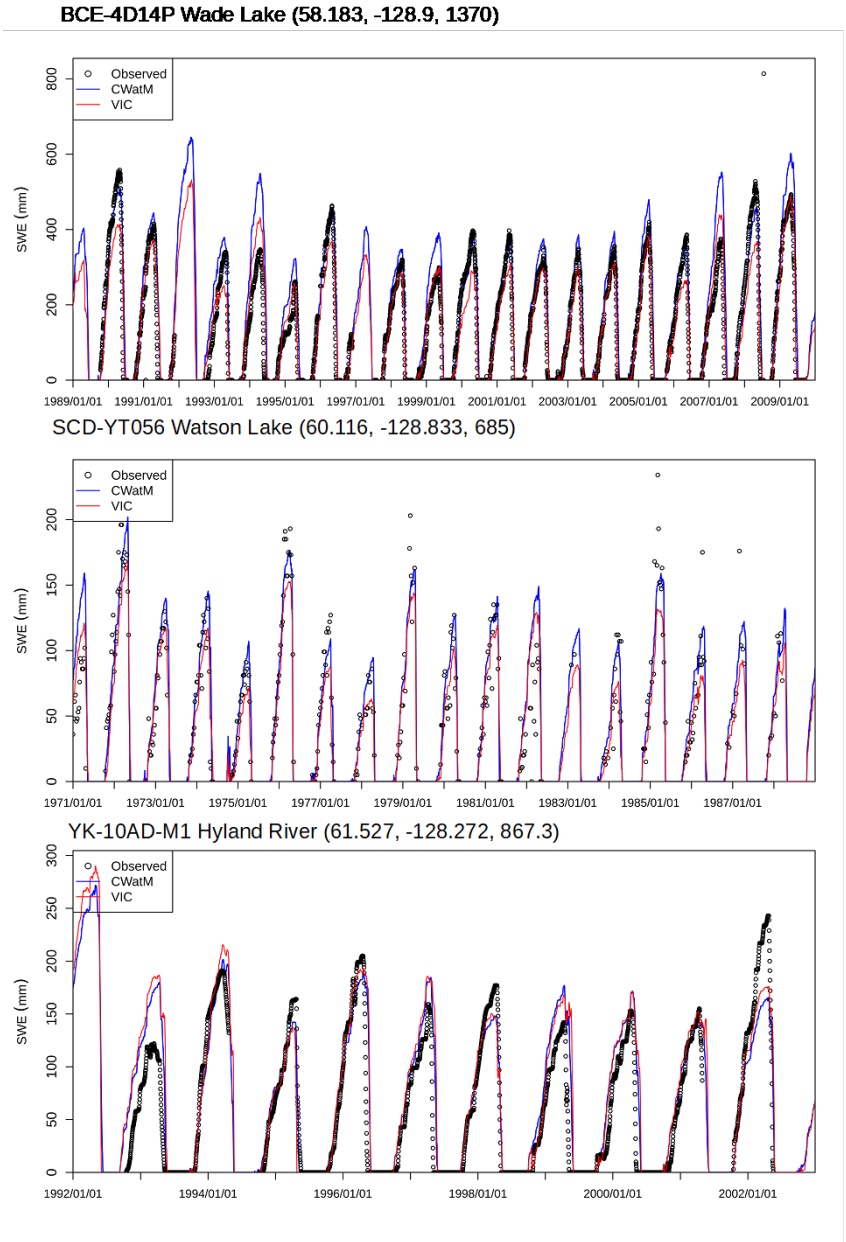
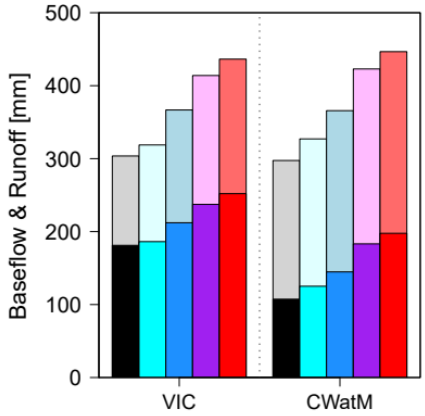
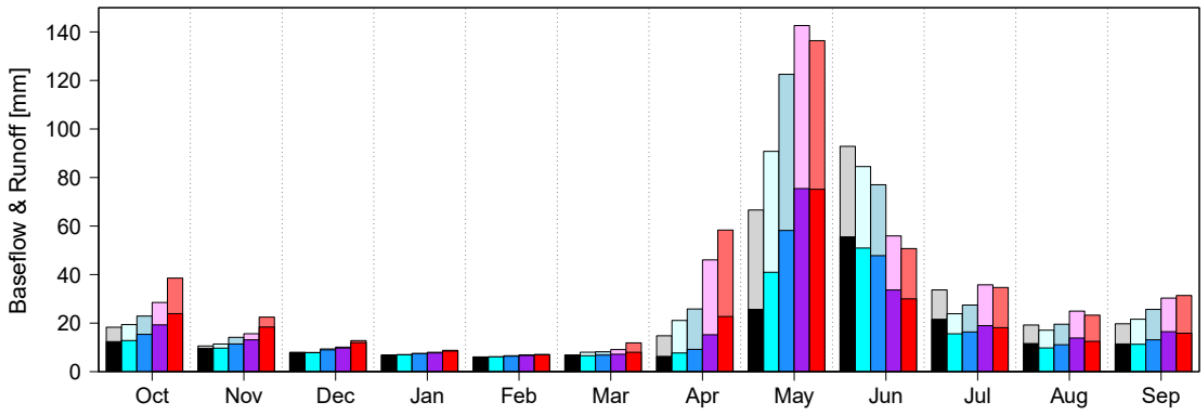


Figure S1. Observed vs. simulated SWE from CWatM and VIC models for three stations with highest numbers of observations.

a) Annual baseflow and runoff



b) Monthly baseflow and runoff from VIC



c) Monthly baseflow and runoff from CWatM

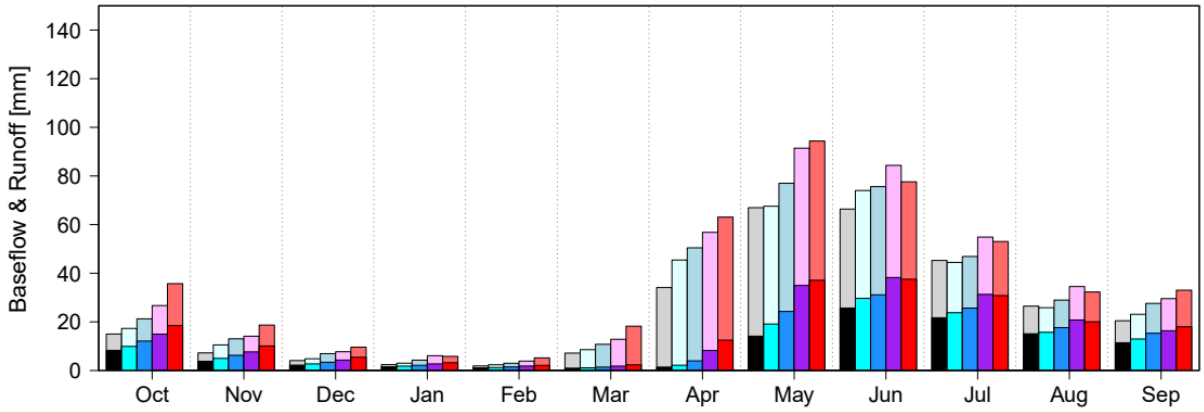


Figure S2. Sample annual and monthly runoff distribution obtained from CanESM5 GCM driven VIC and CWatM runs for historical (1971-2000) and 1.5 to 4.0 °C GWLs. The upper and lower portions of the bar plots show surface runoff and baseflow, respectively.

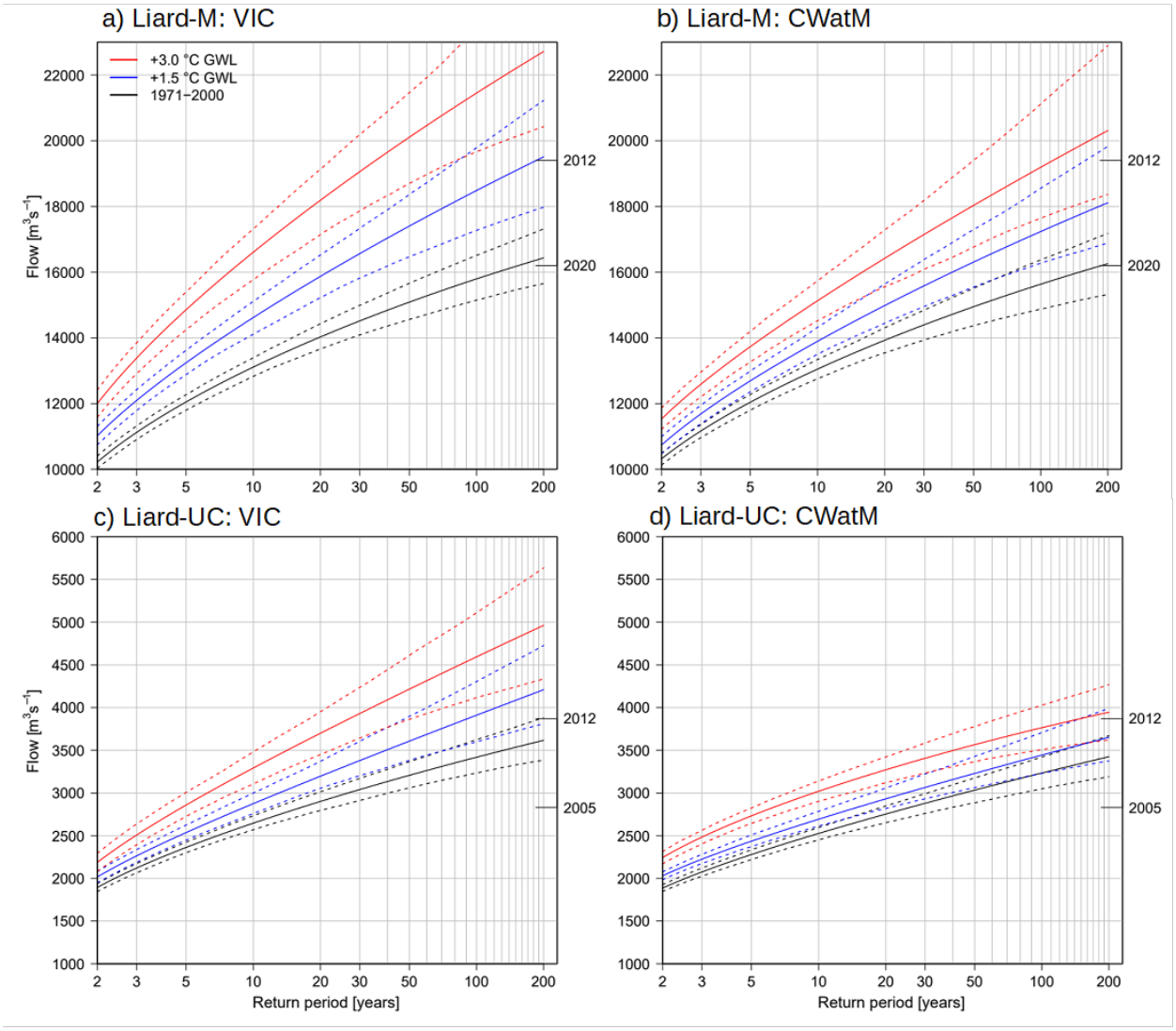


Figure S3: Flood frequency plots of annual maximum flows obtained from the model simulations driven by the GCM ensembles: a) VIC for Liard-M station, b) CWatM for Liard-M station, c) VIC for Liard-UC station, and d) CWatM for Liard-UC station. The results are shown for the historical period (1971-2000) and 1.5 and 3.0 °C GWLs. Dashed lines show the 95% confidence intervals. The years on the right axes of each plot indicate the two highest recorded historical flood events.

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