



Supplement of

Propagating meteorological uncertainty in physically based mountain snow modeling

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1 Supplement

2 S1 Snakemake Workflow Example



Figure S1: Autogenerated Snakemake workflow image example depicting static input data generation for GPEP. The workflow orchestrates a series of preprocessing steps to prepare gridded and meteorological station input data.

3 S2 Predictor Screening for Chena and Tuolumne

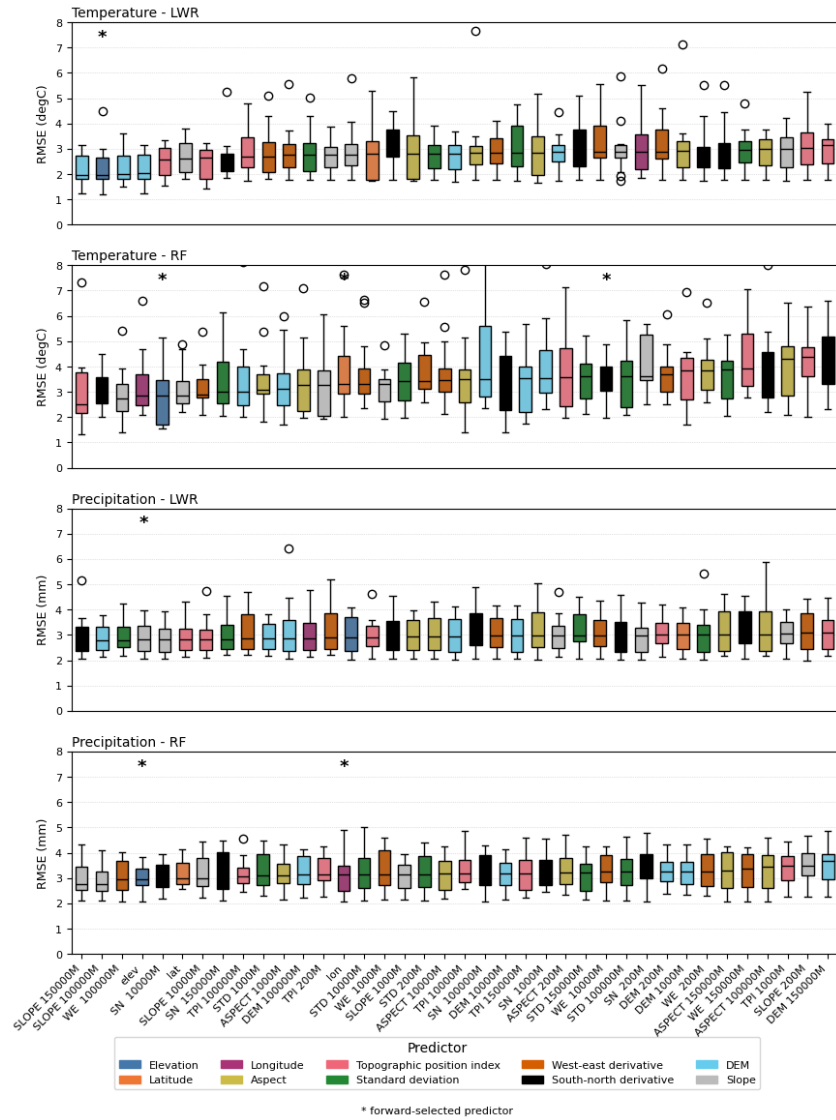


Figure S2: Static predictor screening showing single predictor cross-validation results for the Chena. Topographic descriptors and their smoothed variants (200 m, 1000 m, 10,000 m, 100,000 m, 150,000 m) are evaluated to assess cross-validation RMSE for Temperature and Precipitation using Locally Weighted Regression (LWR) and Random Forest (RF).

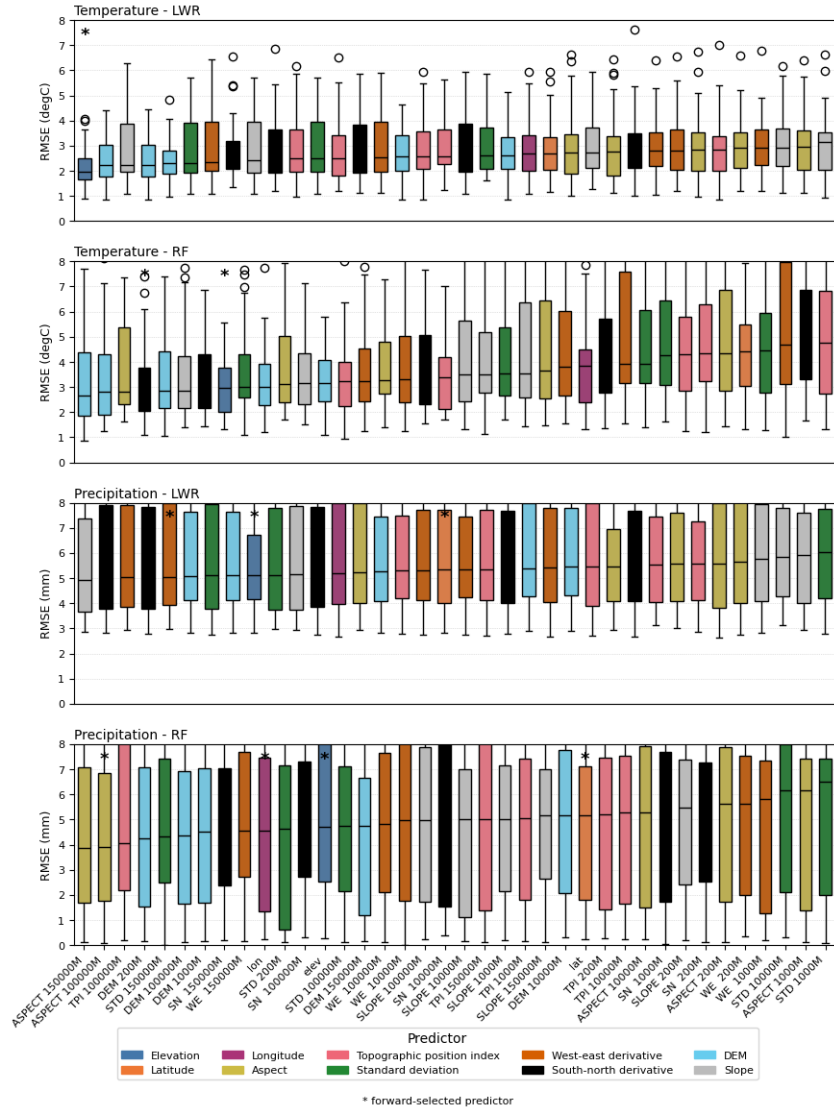


Figure S3: Static predictor screening showing single predictor cross-validation results for the Tuolumne. Topographic descriptors and their smoothed variants (200 m, 1000 m, 10,000 m, 100,000 m, 150,000 m) are evaluated to assess cross-validation RMSE for Temperature and Precipitation using Locally Weighted Regression (LWR) and Random Forest (RF).

4 S3 Surface Meteorology Inputs to SUMMA

Variable	Description	Units	CASR v3.1 variable	ERA5 variable
time	Time	s	time	time
precip	Precipitation rate	$\text{kg m}^{-2} \text{ s}^{-1}$	A_PR0_SFC	pptrate
airtemp	Air temperature	K	P_TT_1.5m	airtemp
SWRadAtm	Downward shortwave radiation	W m^{-2}	P_FL_SFC	SWRadAtm
LWRadAtm	Downward longwave radiation	W m^{-2}	P_FB_SFC	LWRadAtm
windspd	Wind speed	m s^{-1}	P_UVC_10m	windspd
airpres	Air pressure	Pa	P_P0_SFC	airpres
spechum	Specific humidity	kg kg^{-1}	P_HU_1.5m	spechum

Table S1: Summary of surface meteorology data input requirements for the SUMMA energy balance snow model, with corresponding CASR v3.1 and ERA5 variable names.

5 S4 Model Calibration Parameter Ranges

Parameter name in SUMMA	Lower	Upper	Transformation	Units
tempCritRain	272.16	274.16		K
tempRangeTimestep	0.5	5		K
frozenPrecipMultip	0.95	1.05		
albedoMax	0.7	0.95		
albedoMinWinter	0.4	0.6		
albedoMinSpring	0.35	0.5		
albedoDecayRate	100000	5000000		
albedoRefresh	1	10		
Fcapil	0.01	0.1		
mw_exp	1	5		
z0Snow	0.0001	0.03	log10	m

Table S2: SUMMA snow parameters used in the Large Sample Emulator (LSE) calibration approach as well as the lower and upper bounds for parameter search.