

## Supplementary Materials

**Table S1.** Summary of default physical options in Noah-MP model

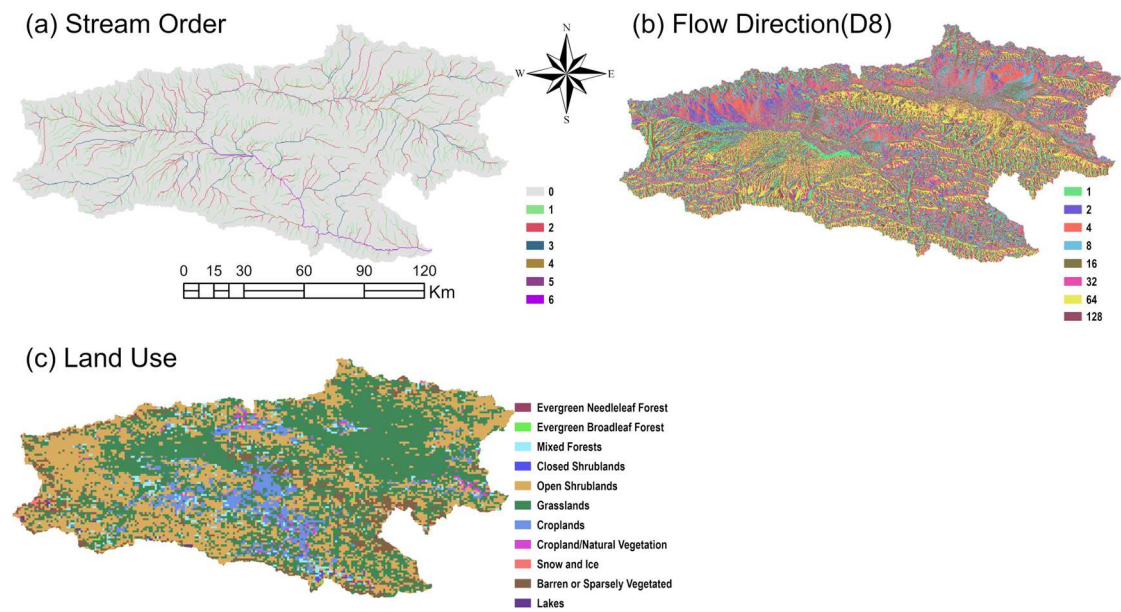
Noah-MP namelists	Options	Option Description
Dynamic vegetation Option	4	Use table LAI and maximum vegetation fraction
Canopy stomatal resistance option	1	Ball-Berry
BTR option	1	Noah
Runoff option	3	Original surface and subsurface runoff
Surface drag option	1	M-O
Frozen soil option	1	Linear effects, more permeable
Supercooled water option	1	No iteration
Radiative transfer option	3	Two-stream applied to vegetated fraction
Snow albedo option	2	CLASS
Partitioning precipitation into rainfall and snowfall	1	Jordan
TBOT option	2	Noah
Temperature time scheme	3	Semi-implicit
Glacier option	2	Ice treatment more like original Noah
Surface resistance option	4	Sakaguchi and Zeng for non-snow; rsurf = rsurf_snow for snow

**Table S2.** Scores of sensitivity tests of Noah-MP options, the options chosen for each test are listed in the names.

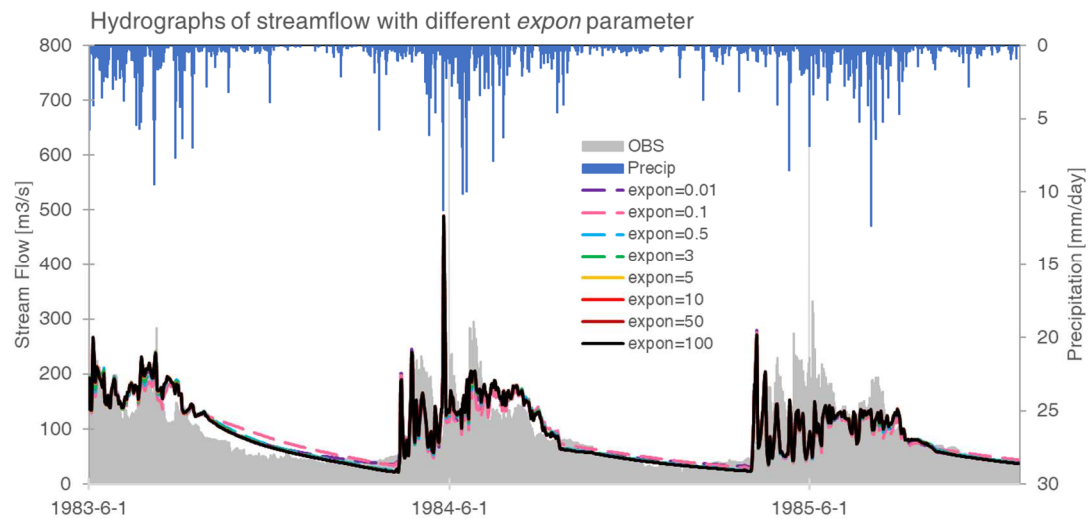
Name	CC	BC(m <sup>3</sup> /s)	RMSE(m <sup>3</sup> /s)	NSE
run1_pcp1_gla1_res1	0.42	-25.88	67.08	0.18
run1_pcp1_gla1_res2	0.44	7.21	57.10	0.19
run1_pcp1_gla1_res3	0.51	25.77	57.59	0.26
run1_pcp1_gla1_res4	0.38	-13.92	63.25	0.14
run1_pcp1_gla2_res1	0.42	-25.88	67.10	0.18
run1_pcp1_gla2_res2	0.44	7.21	57.12	0.19
run1_pcp1_gla2_res3	0.51	25.77	57.61	0.26
run1_pcp1_gla2_res4	0.38	-13.92	63.27	0.14
run1_pcp2_gla1_res1	0.42	-26.20	67.34	0.18
run1_pcp2_gla1_res2	0.44	6.93	57.18	0.19
run1_pcp2_gla1_res3	0.51	25.46	57.50	0.26
run1_pcp2_gla1_res4	0.38	-14.15	63.42	0.14
run1_pcp2_gla2_res1	0.42	-26.20	67.37	0.18
run1_pcp2_gla2_res2	0.44	6.93	57.20	0.19
run1_pcp2_gla2_res3	0.51	25.46	57.52	0.26
run1_pcp2_gla2_res4	0.38	-14.15	63.45	0.14
run1_pcp3_gla1_res1	0.44	-27.83	67.78	0.19
run1_pcp3_gla1_res2	0.46	4.91	56.61	0.21
run1_pcp3_gla1_res3	0.52	23.55	56.22	0.27
run1_pcp3_gla1_res4	0.40	-16.55	63.78	0.16
run1_pcp3_gla2_res1	0.44	-27.83	67.80	0.19
run1_pcp3_gla2_res2	0.46	4.91	56.63	0.21
run1_pcp3_gla2_res3	0.52	23.55	56.24	0.27
run1_pcp3_gla2_res4	0.40	-16.55	63.80	0.16
run2_pcp1_gla1_res1	0.51	29.02	62.63	0.26
run2_pcp1_gla1_res2	0.52	38.53	65.18	0.27
run2_pcp1_gla1_res3	0.60	51.72	69.77	0.36
run2_pcp1_gla1_res4	0.50	34.81	64.60	0.25
run2_pcp1_gla2_res1	0.51	29.02	62.66	0.26
run2_pcp1_gla2_res2	0.52	38.53	65.20	0.27
run2_pcp1_gla2_res3	0.60	51.73	69.79	0.36
run2_pcp1_gla2_res4	0.50	34.81	64.62	0.25
run2_pcp2_gla1_res1	0.50	28.81	62.67	0.25
run2_pcp2_gla1_res2	0.52	38.33	65.18	0.27
run2_pcp2_gla1_res3	0.60	51.50	69.67	0.36
run2_pcp2_gla1_res4	0.50	34.61	64.62	0.25
run2_pcp2_gla2_res1	0.50	28.81	62.70	0.25
run2_pcp2_gla2_res2	0.52	38.33	65.20	0.27

run2_pcp2_gla2_res3	0.60	51.50	69.70	0.36
run2_pcp2_gla2_res4	0.50	34.62	64.65	0.25
run2_pcp3_gla1_res1	0.52	26.50	61.69	0.27
run2_pcp3_gla1_res2	0.54	35.91	63.75	0.29
run2_pcp3_gla1_res3	0.61	49.27	67.67	0.37
run2_pcp3_gla1_res4	0.51	32.16	63.34	0.26
run2_pcp3_gla2_res1	0.52	26.50	61.72	0.27
run2_pcp3_gla2_res2	0.54	35.91	63.78	0.29
run2_pcp3_gla2_res3	0.61	49.27	67.69	0.37
run2_pcp3_gla2_res4	0.51	32.16	63.36	0.26
run3_pcp1_gla1_res1	0.73	-6.06	42.53	0.54
run3_pcp1_gla1_res2	0.74	21.96	45.58	0.54
run3_pcp1_gla1_res3	0.78	40.49	54.49	0.61
run3_pcp1_gla1_res4	0.74	4.58	40.20	0.55
run3_pcp1_gla2_res1	0.73	-6.06	42.54	0.54
run3_pcp1_gla2_res2	0.74	21.96	45.59	0.54
run3_pcp1_gla2_res3	0.78	40.49	54.50	0.61
run3_pcp1_gla2_res4	0.74	4.58	40.21	0.55
run3_pcp2_gla1_res1	0.74	-6.43	42.46	0.54
run3_pcp2_gla1_res2	0.74	21.62	45.37	0.54
<b>run3_pcp2_gla1_res3</b>	<b>0.78</b>	<b>40.12</b>	<b>54.16</b>	<b>0.61</b>
run3_pcp2_gla1_res4	0.75	4.26	40.11	0.56
run3_pcp2_gla2_res1	0.74	-6.43	42.47	0.54
run3_pcp2_gla2_res2	0.74	21.62	45.38	0.54
run3_pcp2_gla2_res3	0.78	40.12	54.17	0.61
run3_pcp2_gla2_res4	0.75	4.26	40.12	0.56
run3_pcp3_gla1_res1	0.73	-7.87	43.35	0.54
run3_pcp3_gla1_res2	0.73	19.82	44.95	0.54
run3_pcp3_gla1_res3	0.78	38.50	53.14	0.61
run3_pcp3_gla1_res4	0.74	2.21	40.56	0.55
run3_pcp3_gla2_res1	0.73	-7.87	43.35	0.53
run3_pcp3_gla2_res2	0.73	19.82	44.96	0.54
run3_pcp3_gla2_res3	0.78	38.50	53.15	0.61
run3_pcp3_gla2_res4	0.74	2.21	40.57	0.55
run4_pcp1_gla1_res1	0.66	-25.28	63.03	0.44
run4_pcp1_gla1_res2	0.59	11.05	55.89	0.34
run4_pcp1_gla1_res3	0.63	30.81	56.75	0.39
run4_pcp1_gla1_res4	0.58	-13.28	62.78	0.34
run4_pcp1_gla2_res1	0.66	-25.28	63.07	0.44
run4_pcp1_gla2_res2	0.59	11.05	55.93	0.34
run4_pcp1_gla2_res3	0.62	30.81	56.78	0.39
run4_pcp1_gla2_res4	0.58	-13.28	62.82	0.34
run4_pcp2_gla1_res1	0.66	-25.60	63.34	0.44
run4_pcp2_gla1_res2	0.58	10.76	56.00	0.34

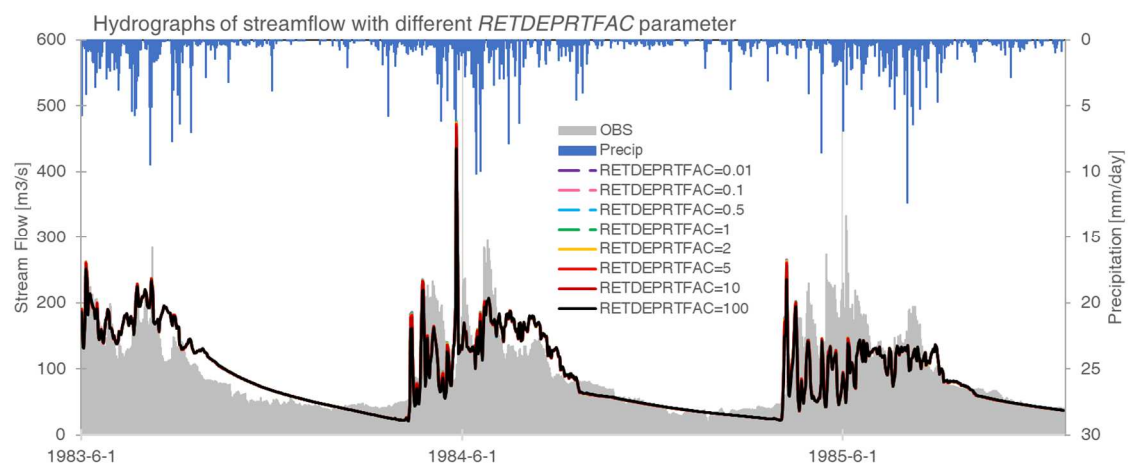
run4_pcp2_gla1_res3	0.62	30.51	56.69	0.39
run4_pcp2_gla1_res4	0.58	-13.53	63.02	0.34
run4_pcp2_gla2_res1	0.66	-25.60	63.38	0.44
run4_pcp2_gla2_res2	0.58	10.76	56.03	0.34
run4_pcp2_gla2_res3	0.62	30.51	56.72	0.39
run4_pcp2_gla2_res4	0.58	-13.53	63.06	0.34
run4_pcp3_gla1_res1	0.66	-27.20	64.61	0.44
run4_pcp3_gla1_res2	0.59	8.77	55.85	0.35
run4_pcp3_gla1_res3	0.63	28.63	55.68	0.40
run4_pcp3_gla1_res4	0.59	-15.91	64.12	0.35
run4_pcp3_gla2_res1	0.66	-27.20	64.64	0.44
run4_pcp3_gla2_res2	0.59	8.77	55.88	0.35
run4_pcp3_gla2_res3	0.63	28.63	55.71	0.40
run4_pcp3_gla2_res4	0.59	-15.91	64.15	0.35



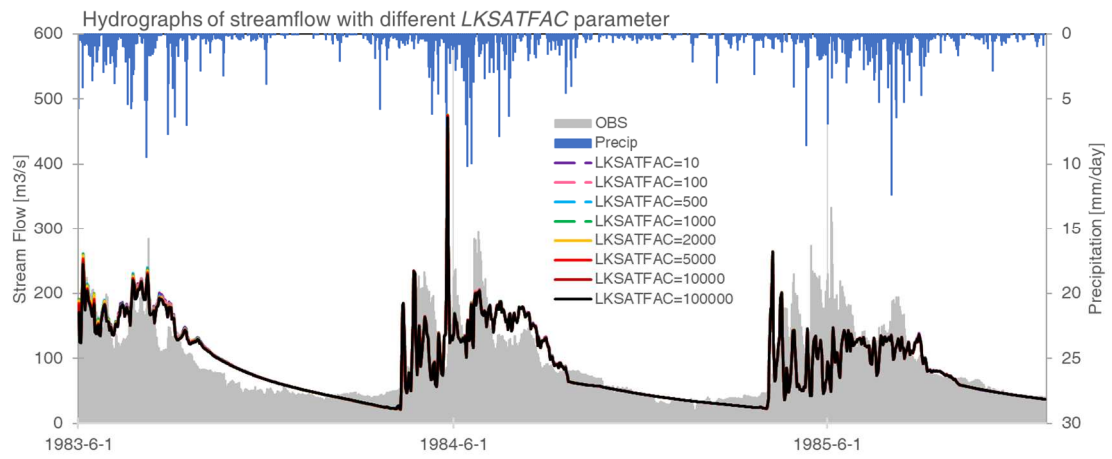
**Figure S1.** Stream order (a), flow direction (b) and land use (c) of the study area.



**Figure S2.** Simulated hydrographs with the sensitivity tests of *expon* ranging from 0.01 to 100. The precipitation and observed streamflow are shown in blue and gray bars, respectively.

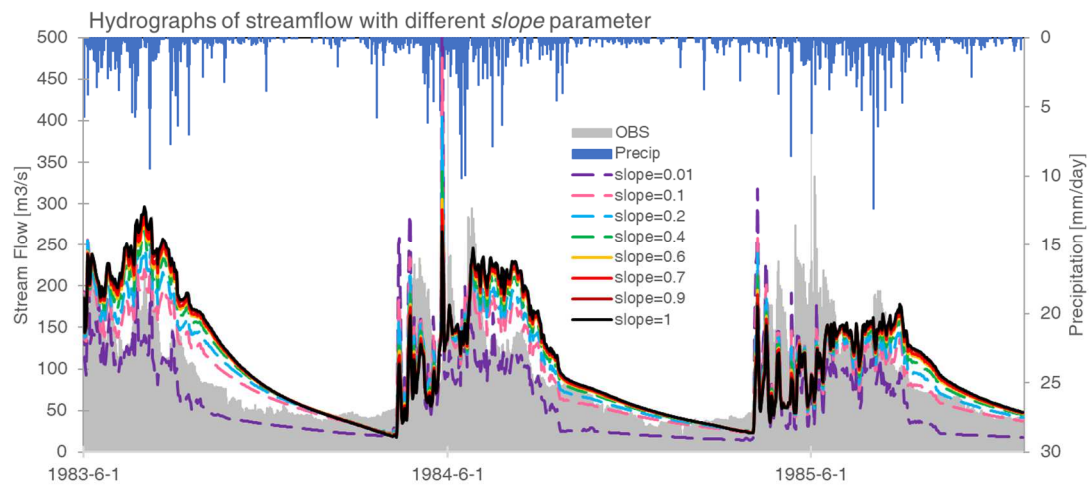


**Figure S3.** Same as Figure S2, but for the sensitivity tests of *RETDEPRTFAC* parameter ranging from 0.01 to 100.

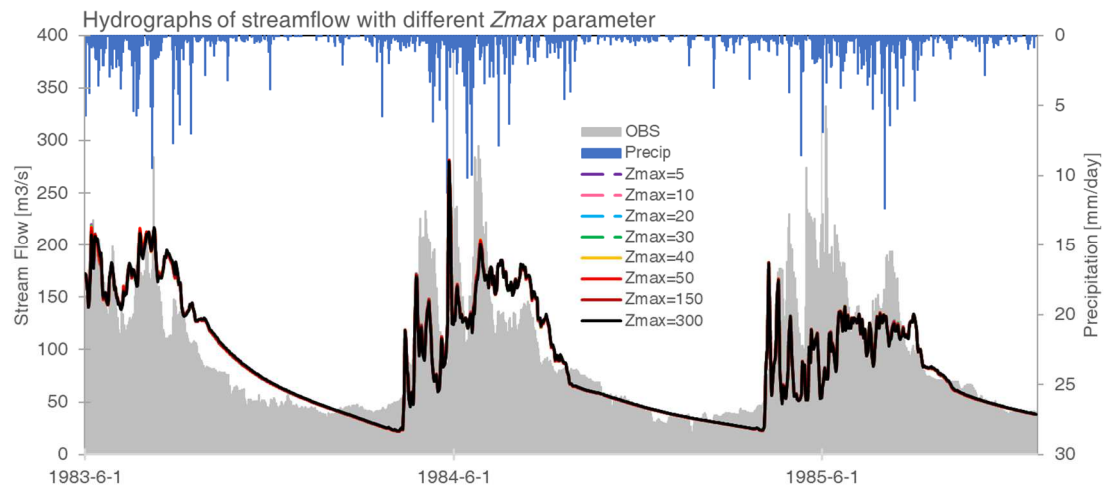


**Figure S4.** Same as Figure S2, but for the sensitivity tests of LKSATFAC parameter ranging from 10 to 100000.

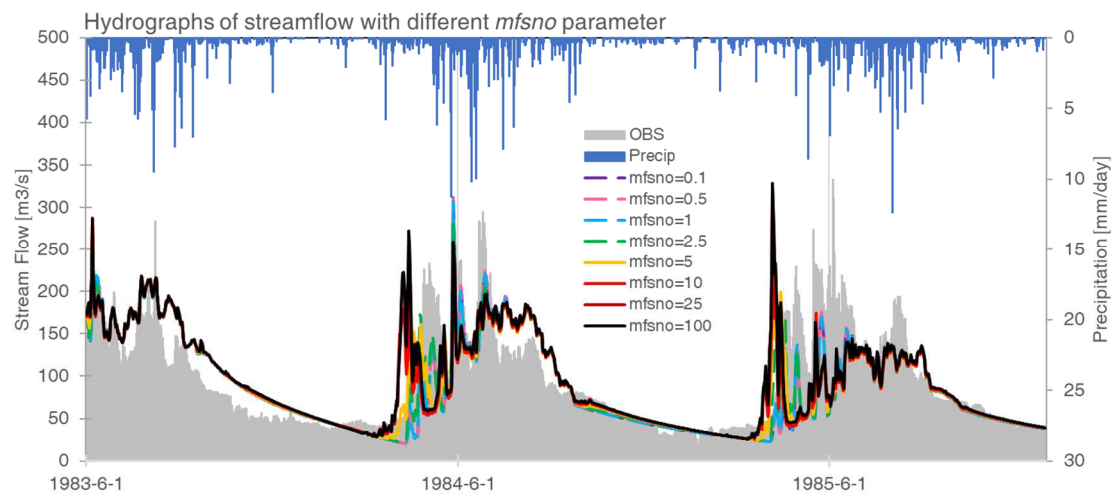




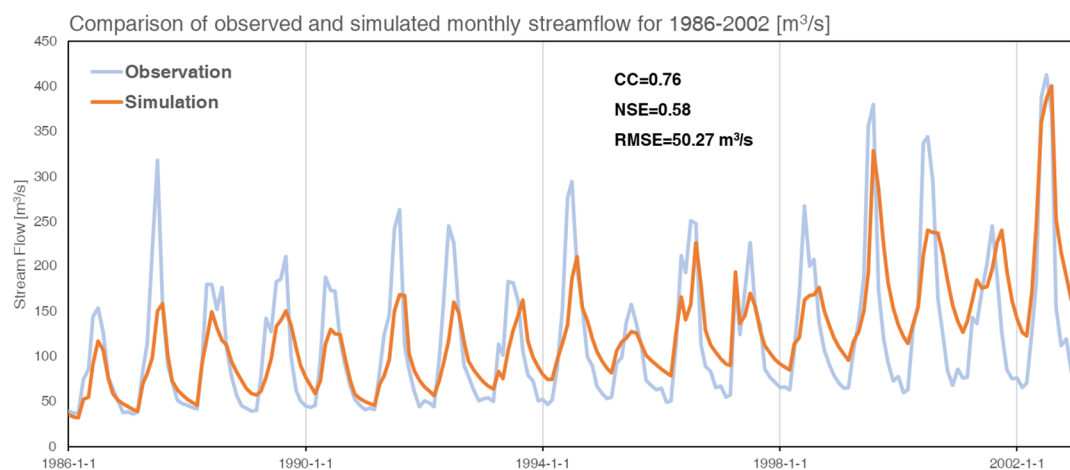
**Figure S5.** Same as Figure S2, but for the sensitivity tests of slope ranging from 0.01 to 1.



**Figure S6.** Same as Figure S2, but for the sensitivity tests of  $Z_{max}$  parameter ranging from 5 to 300, the calibration factor is multiplied.



**Figure S7.** Same as Figure S2, but for the sensitivity tests of *mfsno* parameter ranging from 0.1 to 100.



**Figure S8.** Comparison of observed and simulated monthly streamflow during the evaluation period.

