Supplementary Material

to

Mitigating the impacts of climate non-stationarity on seasonal streamflow predictability in the US Southwest

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Table S1: Streamflow gages used in the paper. Column "No." refers to the numbering in Fig. S1.

No.	Gage name	State	USGS ID	SNOTEL stations used for forecast
1	Rio Grande nr Del Norte	CO	08220000	624, 327, 580, 762
2	Saguache Creek nr Saguache	CO	08227000	762, 701
3	Conejos River nr Mogote	CO	08246500	431, 874, 840, 580
4	San Antonio nr Ortiz	NM	08247500	532, 431, 580
5	Los Pinos nr Ortiz	NM	08248000	532, 431, 580
6	Rio Grande nr Lobatos	CO	08251500	624, 327, 580, 762, 431, 874, 840, 580
7	Red River below fish hatchery, nr Questa	NM	08266820	665, 715
8	Rio Chama below El Vado Dam	NM	08285500	394, 532, 316, 431
9	Rio Grande at Otowi Bridge	NM	08313000	624, 327, 580, 762, 431, 874, 840, 665, 715, 394, 532, 316
10	Taylor River below Taylor Park Reservoir	CO	09109209	380, 680, 542
11	East River at Almont	CO	09112500	737, 542, 680, 380
12	Gunnison River nr Gunnison	CO	09114500	737, 542, 680, 380
13	Tomichi Creek at Gunnison	CO	09119000	762, 701
14	Lake Fork at Gateview	CO	09124500	701, 713, 538, 629, 762, 327
15	Uncompaghre River at Colona	CO	09147500	713, 538, 589
16	Gunnison River nr Grand Junction	CO	09152500	701, 737, 762, 542, 680, 380, 618, 682, 713, 538, 589
17	San Juan River nr Carracas	CO	09346400	840, 431, 580, 394
18	Piedra Rive nr Arboles	CO	09349800	839, 624, 843, 797
19	Animas River at Durango	CO	09361500	632, 797, 713, 629, 327, 780
20	San Juan River nr Bluff	UT	09379500	624, 797, 843, 839, 840, 431, 580, 394, 632, 713, 629, 327, 780

Table S2: Seasonal prediction models used for the temperature forecast. Note that we just use the ensemble mean of each model in this study.

Model	**Hindcast period**	**Ensemble members**	**Reference**
CFSv2	1982-2016	24	Saha et al. (2014)
CMC1	1982-2016	10	Merryfield et al. (2013)
CMC2	1982-2016	10	Merryfield et al. (2013)
GFDL	1982-2016	10	Zhang et al. (2007)
GFDL FLOR	1982-2016	12	Vecchi et al. (2014)
NASA	1982-2016	10	Vernieres et al. (2012)
NCAR CCSM4	1982-2016	10	Kirtman and Min (2009) for CCSM3
ECMWF System 4	1982-2016	51	Molteni et al. (2011)

Table S3: Forecast skill improvement, stratified by skill metric and forecast issue date. For each forecast issue date, the first column gives the fraction, in %, of gages (total of 20 gages) that show an improvement in the respective skill metric, while the second column gives the fraction, in %, of these improved forecasts that are significant at the 95% level. See Section 3.4 for details on the significance test.

	Jan 1		**Feb 1**		**Mar 1**		**Apr 1**		**May 1**		**Total**	
Correlation	100	100	100	100	100	100	95	100	100	100	99	100
rRMSE	100	100	100	100	100	100	95	95	100	100	99	99
BSS	55	100	65	100	70	93	45	89	75	93	62	95
CRPSS	100	100	100	95	100	100	95	95	100	100	99	98

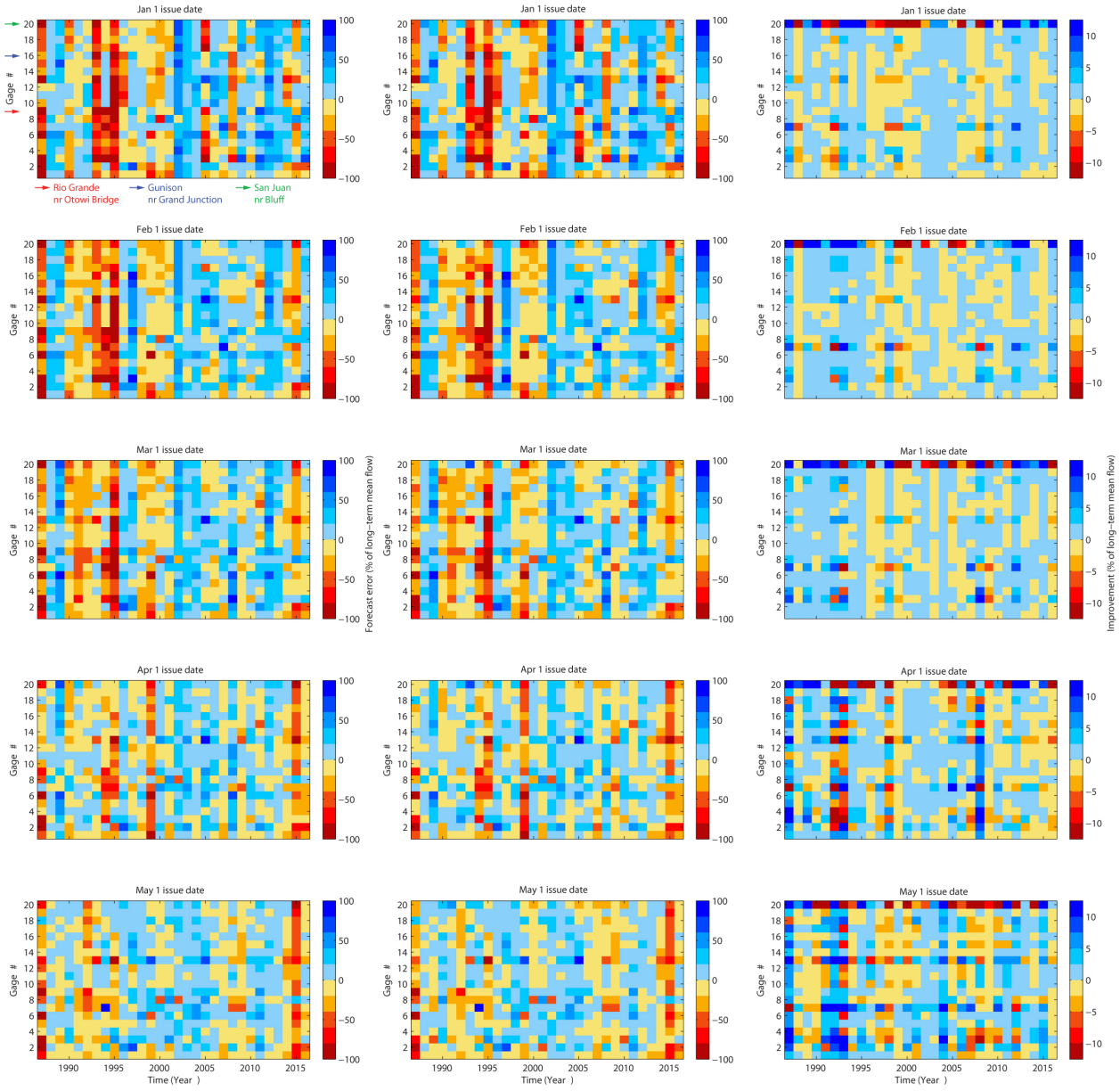

Figure S1: Forecast error, expressed in percent of the long-term mean flow, for each gage, issue date, and year. (Left column) Baseline forecast, (middle column) temperature-aided forecast, (right column) improvement between temperature-aided and baseline forecast, i.e., blue colors mean the forecast accuracy has been improved. The three gages highlighted in Figure 1 of the main text are marked in the top left panel.

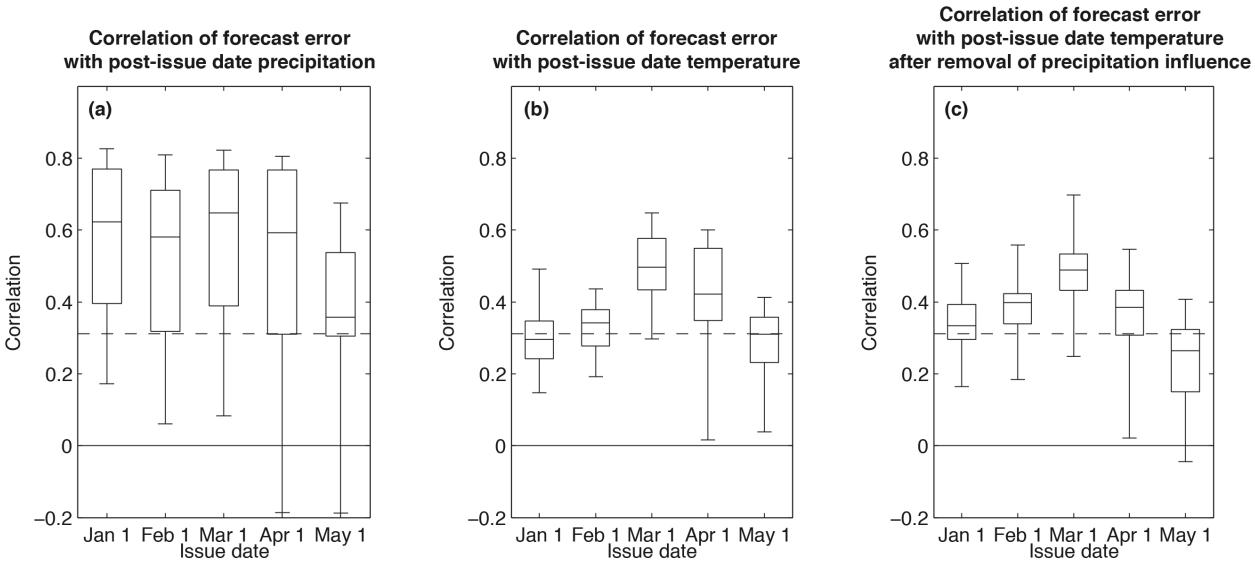

Figure S2: Correlation between streamflow forecast error of the 'baseline forecast' and (a) summed precipitation anomalies post-forecast issue date, (b) averaged temperature anomalies post-forecast issue date, and (c) averaged temperature anomalies post-forecast issue date after regressing out the influence of precipitation on temperature on a monthly basis. The boxplots (minimum, 25th, 50th, 75th percentile, maximum) encompass the correlations of all 20 streamflow gages. Correlations in (a) have been multiplied with -1 to have the same sign as (b) and (c). Correlations are derived from 1987-2016 and the dashed line indicates the 95% significance level. For precipitation and temperature, the same datasets and regions as in Fig. 1b have been used.

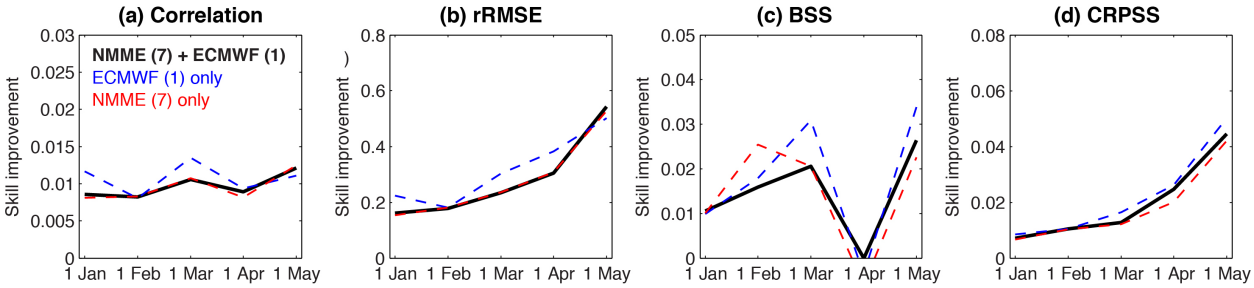

Figure S3: Absolute skill improvement relative to the 'baseline forecast'; shown is the median across all gages as a function of issue date for (a-d) the four different skill metrics. The black lines are the same as the black solid lines in Fig. 3b in the main paper. The blue and red lines are the skill improvements when only using ECMWF and NMME temperature forecasts, respectively.

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