

Spatial mode-based calibration (SMoC) of forecast precipitation fields from numerical weather prediction models

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Introduction

This supporting information presents additional illustrations of SMoC calibrated ensemble forecasts (Text S1, Figures S1-S3, and Animations S1-S3), and a few more forecast evaluation results based on new treatments on the EOF expansion coefficients when establishing the SMoC model (Text S2, Figures S4-S5, and Table S1).

Text S1.

In addition to the displayed SMoC calibrated ensemble members that are selected based on a set of quantiles of basin average values in the paper, here we display 100 SMoC calibrated ensemble members of the whole research basin for each forecast

example, as shown in Animations S1 to S3. We also provide a set of grid cell-scale quantiles of SMOc calibrated ensemble members for the three selected forecast examples, as shown in Figures S1 to S3.

Text S2.

We investigate a few more treatments on the derived EOF expansion coefficients (ECs) to compare with the treatments used in the SMOc model (i.e., the selection of ECs from the first 10 EOF modes and the standardization of ECs). Specifically, we conduct two more experiments, with one selecting ECs from different numbers of the first few EOF modes, and the other removing the standardization. Results of CRPS skill score and PIT alpha index for calibrated forecasts from the two experiments are shown in Figure S4 and Table S1, respectively. As a supplement, we also present how the explained proportion of variance changes with the number of EOF modes in Figure S5.

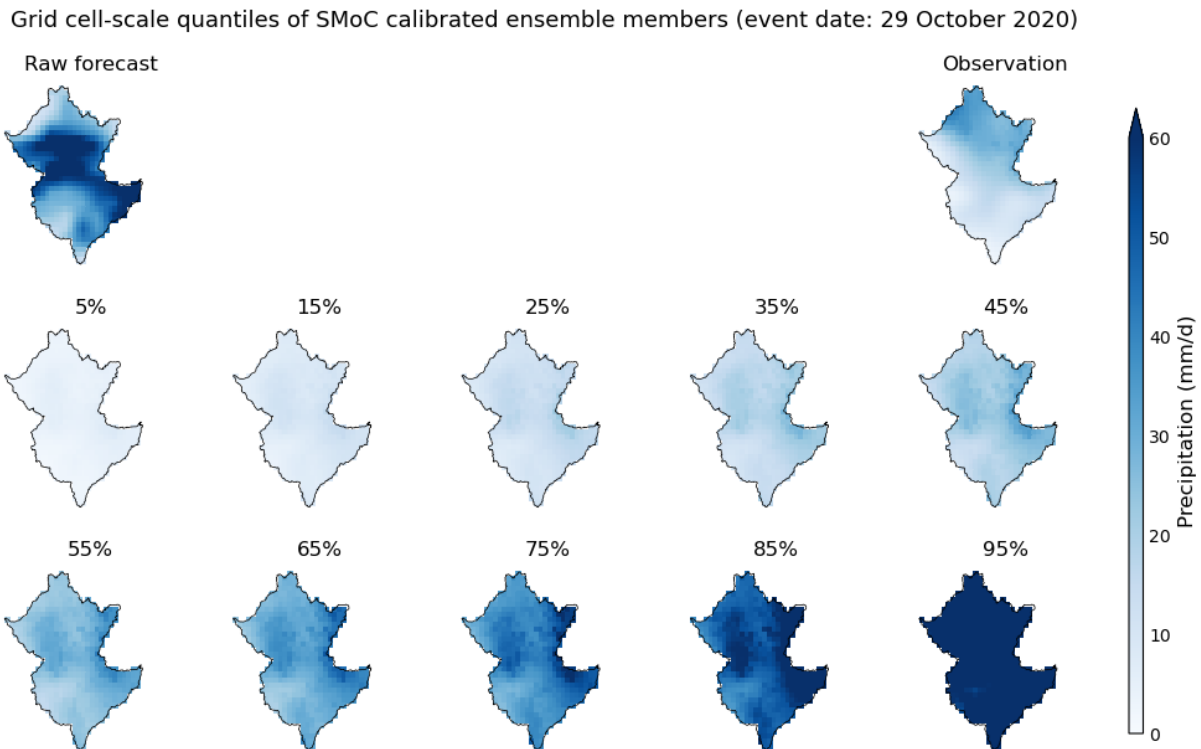


Figure S1. Spatial precipitation plots based on a set of grid cell-scale quantiles of SMOc calibrated ensemble members for a substantive precipitation event on 29 October 2020. Extreme precipitation is present in the raw forecast but not in the observation for this event.

Grid cell-scale quantiles of SMOc calibrated ensemble members (event date: 19 January 2021)

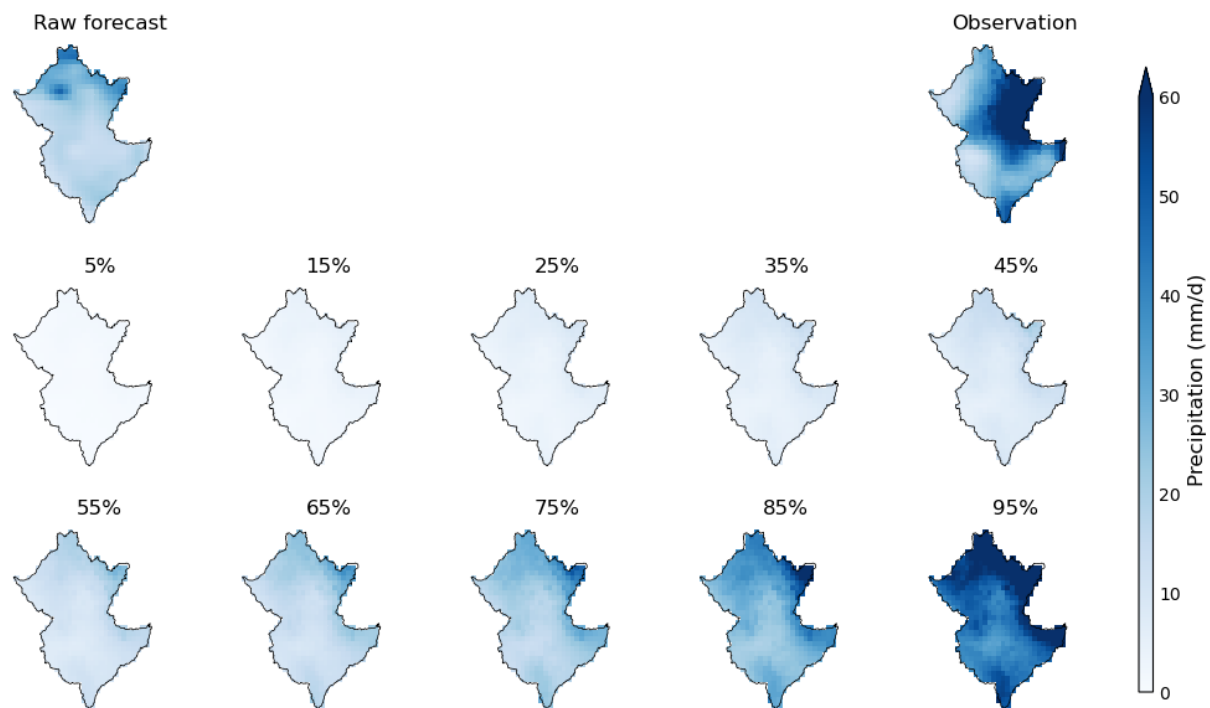


Figure S2. Spatial precipitation plots based on a set of grid cell-scale quantiles of SMOc calibrated ensemble members for a substantive precipitation event on 19 January 2021. Extreme precipitation is present in the observation but not in the raw forecast for this event.

Grid cell-scale quantiles of SMOc calibrated ensemble members (event date: 14 December 2020)

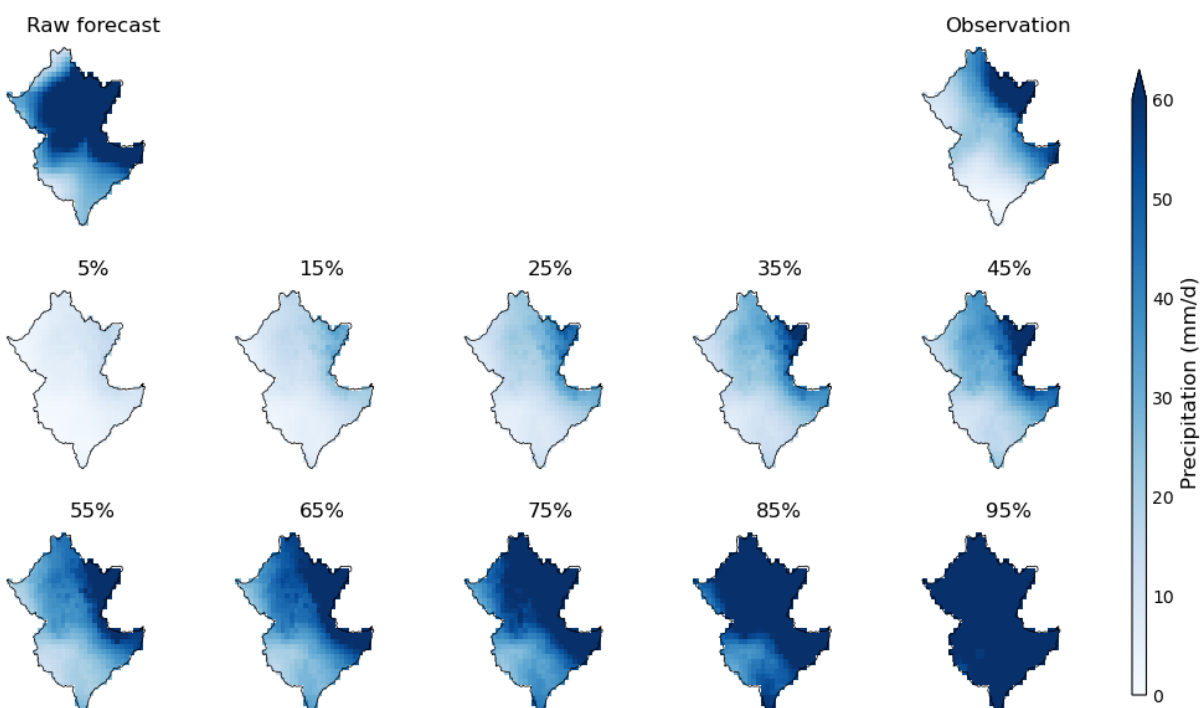


Figure S3. Spatial precipitation plots based on a set of grid cell-scale quantiles of SMOc calibrated ensemble members for a substantive precipitation event on 14 December 2020. Extreme precipitation is present in both the raw forecast and the observation for this event.

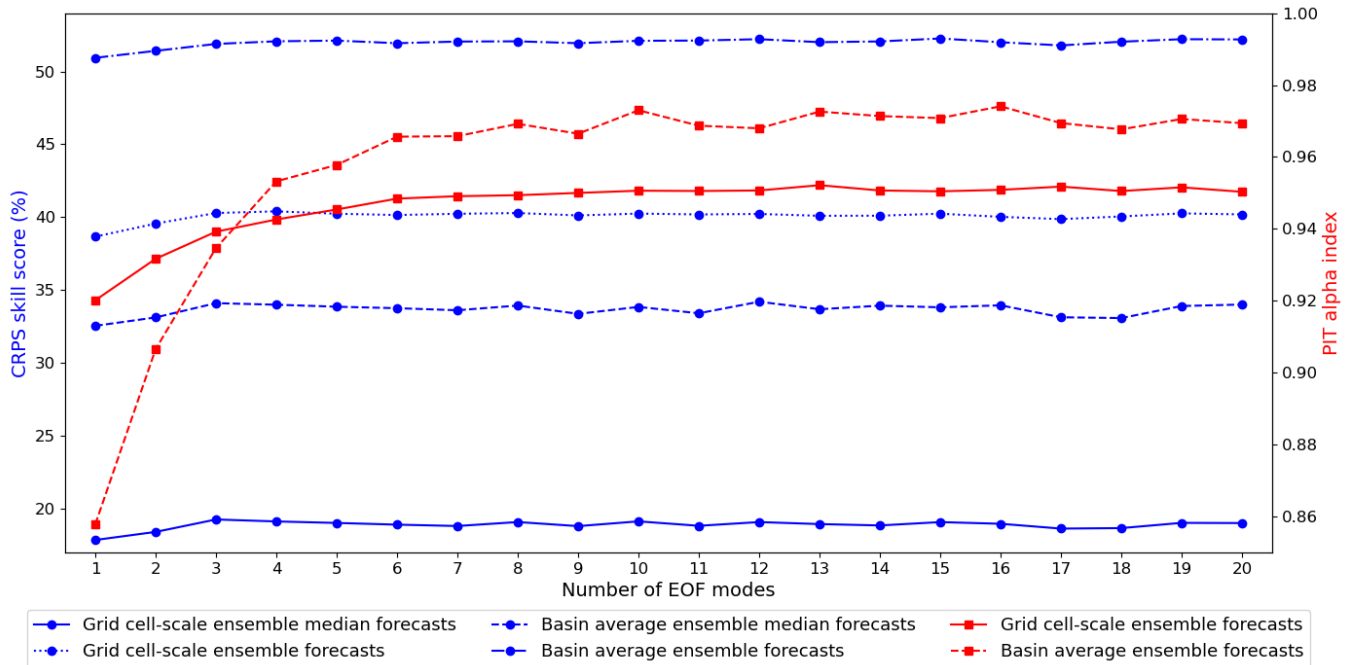


Figure S4. CRPS skill score and PIT alpha index verifications of SMOc calibrated forecasts with different numbers of selected EOF modes for substantive precipitation events in the research basin during the 3-year forecast period. Blue lines with dots respectively represent average CRPS skill score values of grid cell-scale ensemble median forecasts and grid cell-scale ensemble forecasts, as well as CRPS skill scores of basin average ensemble median forecasts and basin average ensemble forecasts. Red lines with squares respectively represent average PIT alpha index values of grid cell-scale ensemble forecasts and PIT alpha index values of basin average ensemble forecasts.

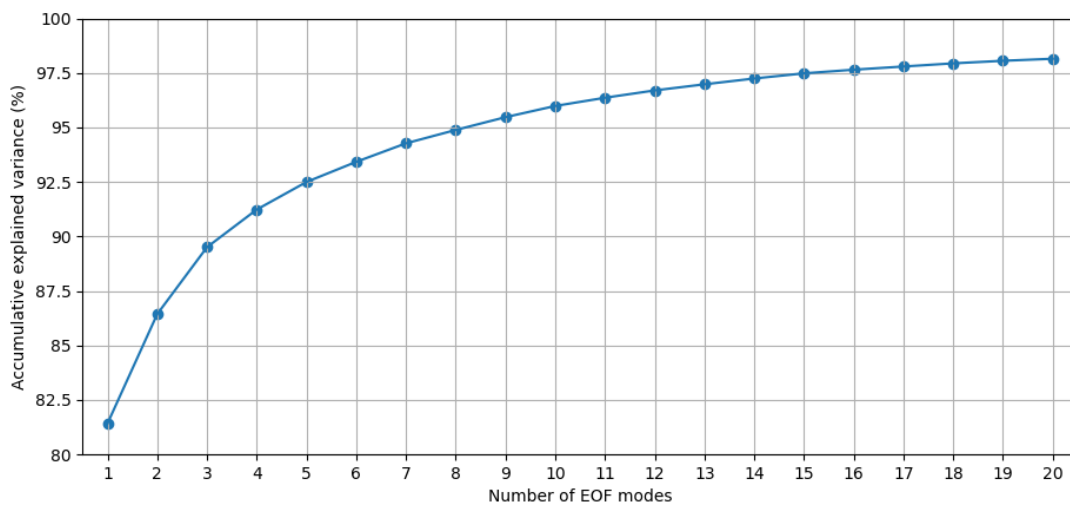


Figure S5. Accumulative explained variance against the number of EOF modes.

Table S1. CRPS skill score and PIT alpha index verifications of SMoC calibrated forecasts with (without) EC standardization. These verifications are provided at both grid cell and basin scales for substantive precipitation events in the research basin during the 3-year forecast period. The average of grid cell-scale evaluation results is calculated to give an overall verification for all of the grid cells in the whole basin.

	Average of grid-scale evaluation			Basin average forecast evaluation		
	CRPS skill score		PIT alpha index	CRPS skill score		PIT alpha index
	Ensemble median	Ensemble		Ensemble median	Ensemble	
Calibrated forecasts with EC standardization	19.16%	40.27%	0.9491	33.83%	52.14%	0.9692
Calibrated forecasts without EC standardization	17.46%	39.36%	0.9467	32.53%	51.24%	0.9755

Animation S1. Animation of 100 SMoC calibrated ensemble members of the whole research basin for a substantive precipitation event on 29 October 2020. Extreme precipitation is shown in the raw forecast but not in the observation for this event.

Animation S2. Animation of 100 SMoC calibrated ensemble members of the whole research basin for a substantive precipitation event on 19 January 2021. Extreme precipitation is shown in the observation but not in the raw forecast for this event.

Animation S3. Animation of 100 SMoC calibrated ensemble members of the whole research basin for a substantive precipitation event on 14 December 2020. Extreme precipitation is shown in both the raw forecast and the observation for this event.