Effective calibration of precipitation forecasts across Australia using the Seasonally Coherent Calibration (SCC) model

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Introduction

Statistical calibration of forecasts from numerical weather prediction (NWP) models aims to produce forecasts that are unbiased, reliable in ensemble spread, and as skillful as possible. We suggest that the calibrated forecasts should also be coherent in climatology, including seasonality, consistent with observations. This is especially important when forecasts approach climatology as forecast skill becomes low, such as at long lead times. However, it is challenging to achieve these aims when data available to establish sophisticated calibration models are limited. Many NWP models have only a short period of archived data, typically one year or less, when they become officially operational. To address this issues, we developed the seasonally coherent calibration (SCC) model for working effectively with limited archived NWP data. This model has been evaluated at the site scale (Wang et al., 2019). In this study, we apply it to the continental scale to enhance precipitation forecasts in Australia.

Methods and Data

➢ *Methods*

The SCC model is developed to resolve three issues:

- constructing a calibration model that is sophisticated enough to allow for seasonal variation in the statistical characteristics of raw forecasts and observations.
- bringing climatology that is representative of long-term statistics into the calibration model.
- reducing the number of model parameters through sensible reparameterization to make the model workable with short NWP dataset.

➢ *Data*

In this study, precipitation forecasts for Australia produced by the ACCESS-G2 model are calibrated. The raw forecasts have a spatial resolution of 25km and a forecast horizon of 10 days. We calibrate daily forecasts for a period of three years during 4/2016-3/2019 to 5km resolution. We use the Australian Water Availability Project (AWAP) precipitation data during 4/1990-3/2019 for model fitting and assessment.

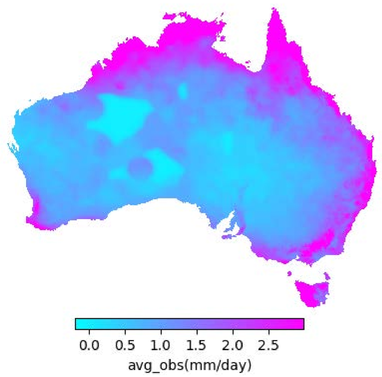

Figure 1. Average precipitation (mm/day) of AWAP during 4/2016-3/2018

Results and Discussion

➢ *Evaluation of SCC calibrated forecasts*

❖ **Bias in raw and calibrated forecasts**

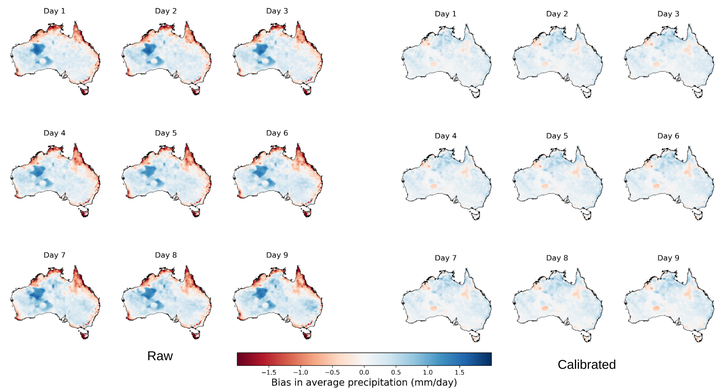

Figure 2. Bias in average daily precipitation of raw and calibrated forecasts (closer to zero is better)

❖ **Wet day in raw and calibrated forecasts**

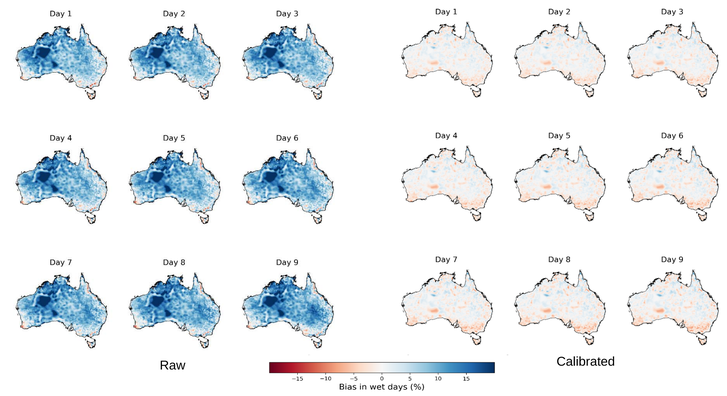

Figure 3. Bias in percentage of wet days of raw and calibrated forecasts (closer to zero is better)

❖ **Skills of raw and calibrated forecasts**

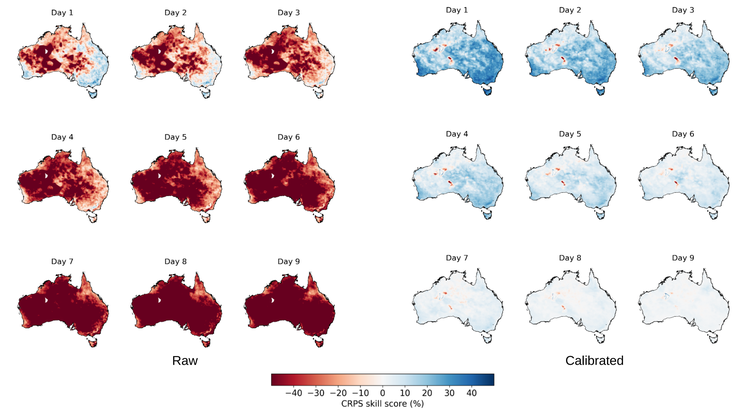

Figure 4. CRPS skill score of the raw and calibrated forecasts (higher is better)

❖ **Reliability of calibrated forecasts**

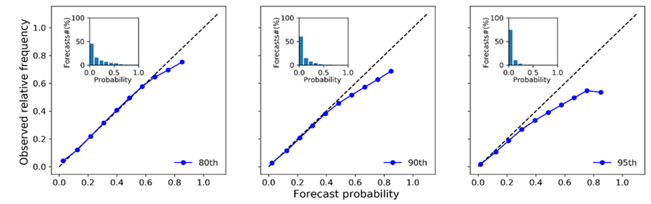

Figure 5. Reliability diagrams of calibrated forecasts during 4/2016-3/2019 using 80th, 90th, and 95th percentiles of observations as the thresholds

❖ **Precipitation seasonality in raw and calibrated forecasts**

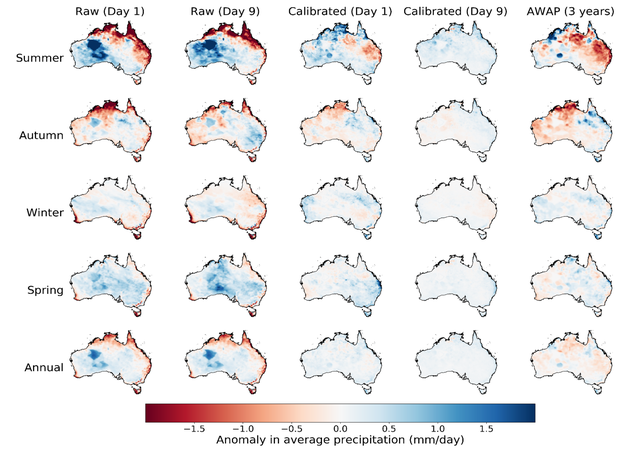

Figure 6. Anomalies of average precipitation in raw and calibrated forecasts and the 3-year (4/2016-3/2019) observations at the seasonal and annual scales relative to the 20-year (4/1999-3/2019) AWAP data.

Conclusions

- The SCC calibrated forecasts show substantial improvements relative to raw forecasts and are reliable in ensemble spread.
- The processing methods can be easily adapted to future NWP models, and can be used to process other NWP variables such as temperature, wind, vapor pressure, radiation, and reference crop evapotranspiration.
- The processing will benefit a broad range of forecast users by providing well-calibrated ensemble forecasts in high spatial resolutions across Australia.

Reference

Wang, Q.J., Zhao, T., Yang, Q., Robertson, D. 2019. A Seasonally Coherent Calibration (SCC) Model for Postprocessing Numerical Weather Predictions. Mon. Weather Rev. 147, 3633–3647.

Yang, Q., Wang, Q. J. and Hakala, K.: Achieving effective calibration of precipitation forecasts over a continental scale, J. Hydrol. Reg. Stud., 35, 100818, doi:10.1016/j.ejrh.2021.100818, 2021a.