Calibrating 2-m Temperature Forecast for the Regional EPS at CMA

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Abstract

The nonhomogeneous Gaussian regression (NGR) approach is applied to calibrate the 2-m temperature forecasts from the regional EPS (REPS) at CMA, and the minimum continuous ranked probability score (CRPS) estimation is used to fit the regression coefficients of the calibrated PDF. The experiment results are evaluated using Talagrand diagram, brier score, area under relative operating characteristic (ROC) , and the CRPS. It can be found that compared with the raw ensemble output the NGR method can greatly improve the reliability attribute and forecast skill of the 2-m temperature forecast. The experiments also are performed to investigate the impact of the training length in the NGR method, and results show that calibrated results are insensitive to the training length. Furthermore, the preliminary comparison between NGR and the time-decaying average bias correction method is performed, and the results show that the NGR method not only seems to have advantages of reducing ensemble mean bias and increasing ensemble spread, but also improving the 2-m temperature forecast skills in terms of probabilistic scores.

1. NGR Calibration Method

The statistical distribution of 2-m temperature forecast follows the Gaussian distribution, therefore the PDF of 2-m temperature forecasts from the REPS could be modeled through the nonhomogeneous Gaussian regression (NGR) approach:

$$PDF = N(a + b\mu, c + d\sigma^2)$$

Here, μ is ensemble mean ,σ is variance (ensemble spread), a,b,c and d are regression coefficients needed to be found, which determine the bias (a and b), and spread-skill relationship (c and d).

The approach based on the minimization of the CRPS (continuous ranked probabilistic score) is used to estimate the regression coefficients (Gneiting et al. 2005; Kann et al. 2009) .

$$CRPS(P, x_a) = \int_{-\infty}^{\infty} [p(x) - p_a(x)]^2 d_x$$

Analytically described CRPS by fitting coefficients

$$CRPS_{train} = \frac{1}{k}\sum_{i=1}^{k}(c + d\sigma_i^2)^{1/2} \times \{Z_i[2\Phi(Z_i) - 1] + 2\phi(Z_i) - \frac{1}{\sqrt{\pi}}\}$$

Φ : CDF; φ : PDF
K : the training length
Y i : observation at day i
μ: the ensemble mean at day i

$$Z_i = \frac{Y_i - (a + b\mu_i)}{(c + d\sigma_i^2)^{1/2}}$$

Fitting coefficients a,b ,c and d through minimization iteration method

Q: quantile function

$$ENSmem(i) = Q(p(i))(c + d\sigma^2) + (a + b\mu)$$

2. Verification of Calibrated REPS forecasts during B08RDP

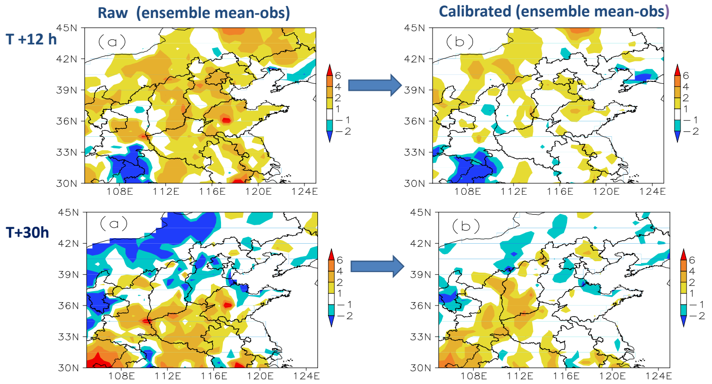


Figure 1 : The raw and calibrated ensemble mean error of 2-m temperature at 12UTC 20 July 2008, +12 and +30 h lead time. Simulation domain was B08RDP common domain.

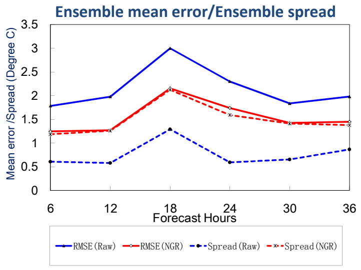


Figure 2 : Ensemble mean error and ensemble spread of 2-m temperature from raw and calibrated REPS forecast. Verification period: 20 July to 20 August 2008.

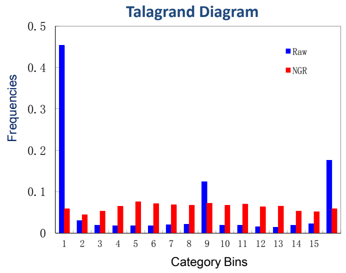


Figure 3 : Talagrand diagram of 2-m temperature from raw and calibrated REPS forecast at 12 h lead time. Verification period: 20 July to 20 August 2008.

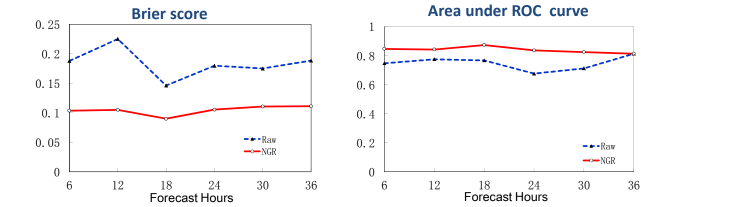


Figure 4 : The Brier score (BS) and area under ROC curve for 2-m temperature anomaly > one standard deviation. Verification period: 20 July to 20 August 2008

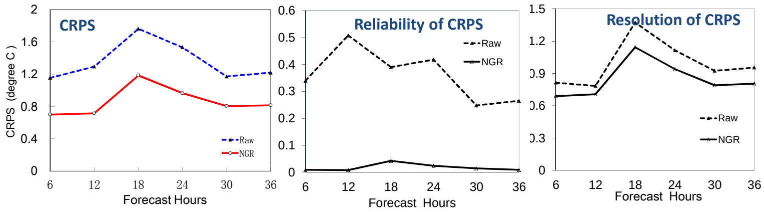
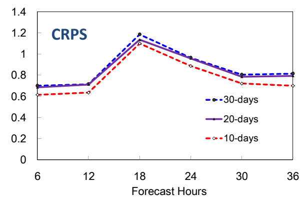


Figure 5 : CRPS and its decomposition (reliability and resolution component) of 2-m temperature from raw and calibrated REPS. Verification period: 20 July to 20 August 2008

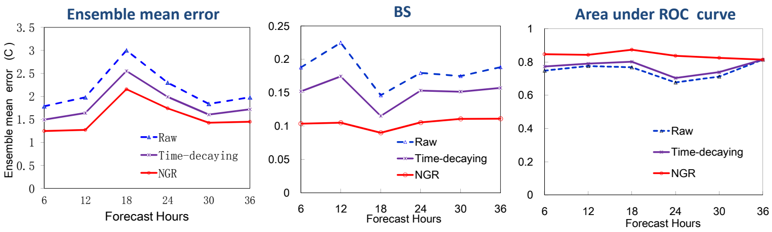


Three training periods (10, 20, and 30 days)are tested to evaluate the sensitivity of NGR method to training length.

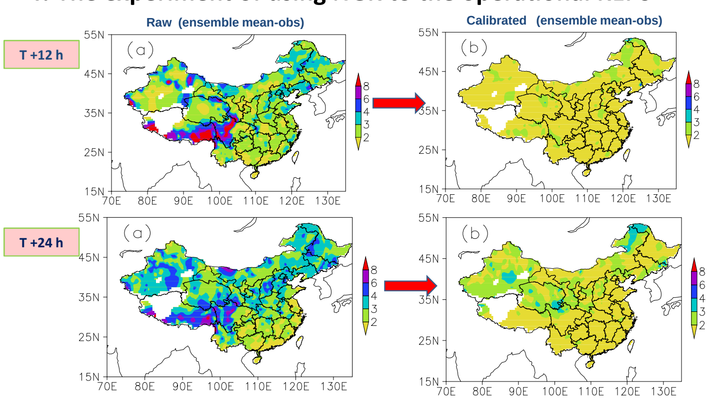
Figure 6 : CRPS of calibrated REPS 2-m temperature with different training lengths.

3. Comparison of NGR and time-decaying bias correction method

The time-decaying bias correction method (Cui et al. 2012) is compared with NGR method for 2-m temperature from REPS during the verification period 20 July to 20 August 2008.



4. The experiment of using NGR to the operational REPS



The raw and calibrated ensemble mean error over the operational REPS domain . Verification period: 1 to 25 Oct 2011.

5. Conclusions

- NGR method can effectively calibrate the biases in ensemble mean and improve ensemble spread of 2-m temperature forecasts from the REPS .
- NGR method is not sensitive to the length of training data, even with the shorter training data, the calibration results are still significant.
- Compared with time-decaying bias correction method, the NGR method not only has advantages of reducing the ensemble mean bias and increasing ensemble spread, but of improving the forecast skill in terms of probabilistic scores.