Meteorological and Environmental Research 2025, 16(2): 59 – 61

An Objective Method for Temperature and Wind Forecast at the Venues of the 14th National Winter Games

Xuefeng YANG, Sitong LIU*

Hulunbuir Meteorological Bureau, Hulunbuir 021008, China

Abstract According to the demand for weather forecast at the venues of the 14th National Winter Games, based on the data of the fine grid model of the European Centre (EC) and RMAPS model, as well as the real-time observation data of the competition fields, a dynamic optimal correction method was proposed to improve the accuracy rate of temperature and wind speed prediction. Through techniques such as deviation correction and univariate linear regression, mathematical models applicable to different competition regions were constructed, and the effective correction of objective forecast products within 0 – 120 h were realized. The results show that this method significantly improved the accuracy rate of the prediction of temperature, wind speed and extreme wind speed, and the effect was more obvious especially when the model performance was unstable. Meanwhile, terrain and climate background had a significant impact on the correction effect. This study provides new technical support for mountain meteorological forecast.

Key words Temperature forecast; Wind speed forecast; Objective correction; Dynamic optimum; Mountain meteorology

DOI 10.19547/j.issn2152 – 3940.2025.02.014

The meteorological services for the 14th National Winter Games have extremely high requirements for the spatial and temporal resolution of forecast, and precise hourly forecast of multiple stations should be provided. However, the competition venue is located in a complex mountainous environment. The direct prediction of numerical models (such as EC and RMAPS) have large errors, and there is a lack of historical data, so it is difficult to conduct manual correction. One of the problems that must be solved in precise precise forecast is to create a periodic and quantitative temperature. At present, the release technology of numerical prediction products is regarded as an effective way to improve the level of temperature prediction, and many effective and practical objective release methods have been explored, such as BP neural network method[1], decreasing average method[2–3], multiple regression method[3], and Kalman filter[4]. Therefore, this study aims to improve the accuracy of forecast through an objective correction method based on real-time data and model output, so as to provide reliable meteorological support for events.

1 Data and methods

1.1 Data sources The two-meter temperature and 10-meter wind field data of the EC fine grid mode from November 2018 to March 2019 included the data of all the stations during the 14th National Winter Games. The observation data of temperature, wind speed and wind direction at each station of the 14th National Winter Games venues were sourced from Inner Mongolia Tianqing.

1.2 Research methods During the correction process, through attempts at different correction methods, the correction method with the highest accuracy rate within 3 d was selected from multiple methods according to the selection principle of dynamic optimality, so as to correct the model and then determine objective correction results.

The two-day average error method takes the average of the errors of a model in the previous two days at this station and this time as the new error for model correction. The model is very useful when it is relatively stable and there is no weather change. It represents the average state of the model error, and its accuracy rate is relatively high under the same weather background. However, when the weather changes, the accuracy rate drops rapidly, and it is easy to cause forecast values to extend towards extreme values.

The five-day average error method takes the average of the errors of a model in the previous five days at this station and this time as the new error for model correction. The model error over a longer period of time is selected for averaging, which results in better averaging. Moreover, the weather and climate background within 5 d change little, so it can better represent the average state of the model error. However, it is not sensitive enough to the correction when the weather process occurs, which may cause the correction value to shift towards the average, resulting in a smaller absolute value of the correction.

The univariate regression method means performing linear regression on the errors of the previous two days, so as to predict the error of the new pattern based on the slope and intercept of the trend line. This method is more suitable for processes such as continuous heating or cooling, and its application effect is relatively good. As the weather fluctuates, its prediction effect is extremely poor, and it is very easy to cause the forecast value to be larger.

By using the objective correction method and based on the latest numerical prediction products, the prediction products in

Received: March 14, 2025 Accepted: April 20, 2025

* Corresponding author.

each time period were corrected to form the objective correction products within 0 – 120 h finally. According to the pre-set threshold, if there is a time limit that has reached the threshold was checked, and then the time and location where it is located can be judged and output. The prediction model is as follows:

$$Yi = Fi + Bi + B0$$

$$B0 = Mi + Bi - S$$

In the formulas, Yi is the predicted value; Fi is the model value; Bi is the average deviation of the background field; $B0$ is the corrected deviation; Mi is the mode value on the previous day; S is the actual value.

2 Verification and analysis of correction results

2.1 Objective correction effect of temperature In the correction results of temperature prediction from 08:00, the correction method had a very good correction effect for Hailar Ice Sports Training Center and Yakeshi Fenghuangshan Ski Resort. The accuracy rate of the corrected objective products rose by more than 10% in most stations, and the increase was up to nearly 20% in some stations. However, for the Jinlongshan Ski Resort, the correction effect was not particularly obvious, or there was almost no increase in the accuracy rate. In the correction results of temperature prediction from 20:00, the accuracy rate rose more significantly compared to that of temperature prediction from 08:00. For Hailar and Yakeshi Fenghuangshan Ski Resort, the accuracy rate increased by 25%, and the increase reached 30% in most stations. However, the correction effect for Jinlongshan Ski Resort was still not satisfactory, and it contributed little to the improvement of accuracy rate.

From the distribution of data, there was only a slight difference between the original data of the model were not particularly significant at Yakeshi Ski Resort and Jinlongshan Ski Resort. From the correction results of urban forecast, it can be seen that the correction effects of Zhalantun and Yakeshi were similar. From the correction results of stations of the 14th National Winter Games, it is found that there was a big difference between Jinlongshan Ski Resort and Fenghuangshan Ski Resort, because their terrains are completely different. There are obvious differences in their terrain distribution. Firstly, the altitude of Fenghuangshan Ski Resort is relatively low, and the slope is gentle. Although the terrain is slightly undulating, all the stations can receive sunlight, which is basically the same as a flat ground. Secondly, the terrain of the station in the Hailar Iceberg Sports Center is also relatively platform, with no obvious obstructions or buildings around. This is also quite similar to the environment of urban forecast stations. Therefore, the effect of empirical correction using average error was relatively ideal, and the accuracy rate of temperature prediction increased significantly. However, the terrain of Jinlongshan Ski Resort is unique. Firstly, the horizontal distances between the various stations of Jinlongshan Ski Resort are relatively close, but there are significant differences in the vertical direction, with a height difference of nearly 200 m. Secondly, Jinlongshan Ski Resort is located on the shady side of the mountain range and the leeward side, so that it is impossible for the sunlight to fully cover the ground in most times. Merely considering the influence of average error is insufficient to make up for the effects brought by terrain, lighting, cloud cover, *etc*. Therefore, the correction effect was not obvious. Based on practical working experience and the forecast experience during the previous test events, when prediction was conducted at each station in Zhalantun, it is necessary to fully compare the differences in cloud cover and wind between the two days. The correction effect was better according to the idea of average error.

2.2 Objective correction effects of average wind speed and extreme wind speed For the correction of wind speed, the municipal bureau mainly focuses on finding the error of the model system. Generally, it looks for the model error of the previous time, and uses it as a reference for the correction of the error of the current time. By following the same idea as the temperature correction direction and using the idea of average error, the average state of the model systematic error is found. Through the statistics of the correction effect of wind speed over a period of time, it is found that the correction effect of the average error idea on wind speed was relatively obvious in some stations, but was average in other stations. As seen from the correction effect, the objective correction method increased the accuracy rate of extreme wind speed more obviously than average wind speed, and was also more applicable to stations. It is found that in station C7426 of Zhalantun, the increase in the accuracy rate of extreme wind speed was the most obvious, reaching nearly 20%. This station has the highest altitude and no obstruction around. Therefore, the forecast value of wind speed based on the model here was relatively small. However, the objective correction method combined some real-time information, so the accuracy rate of extreme wind speed was significantly improved. The athletes set off from this station, so the forecast of wind speed in this station is also very important.

The objective correction effect of wind speed prediction from 20:00 was significantly better than that of the prediction from 08:00. Firstly, the correction effect of average wind speed rose significantly, with more than five contributing stations, and the increase of accuracy rate was also relatively obvious. Secondly, most stations played a role in the increase in the accuracy rate of extreme wind speed. Especially for all the stations in Zhalantun, the accuracy rate of maximum wind speed rose very significantly, with an increase of more than 10%, so the correction effect was very ideal.

In conclusion, the objective correction method played different roles in the correction of wind speed and extreme wind speed at different prediction times. In the correction of the numerical forecast starting at 20:00, the objective correction method played a very significant role, and the correction effect was good. Especially for the correction of extreme wind speed, it played a very significant role in the improvement of the correction effect. However, the correction effect of the objective correction method on wind direction was generally not ideal. The reason is that wind direction is a vector, and a simple deviation correction method cannot accurately correct it. The correction effect may be relatively ideal within a certain period of time, but the correction effect on wind direction was not as good as that of model forecast from the perspective of the long-term average state. In practical work, the model should be simply corrected in combination with the current situation, and the correction scope should not be too large, because the simple correction method does not have an ideal correction effect on wind direction.

3 Conclusions

Based on the data of the fine grid model of the European Centre (EC) and RMAPS model, as well as the real-time observation data of the competition fields, a dynamic optimal correction method was proposed. The following conclusions are obtained through practical tests.

(1) The mathematical models constructed for different competition areas by techniques such as deviation correction and univariate linear regression are feasible, and can achieve effective correction of objective forecast products within 0 – 120 h.

(2) Through the research on the forecast methods of temperature and wind in fixed stations at the venues of the 14th National Winter Games, it is found that the objective correction method had a better improvement effect on the EC model in terms of temperature, wind speed and extreme wind speed. However, the objective correction method had different effects in various regions. Especially when the model performance was poor or unstable, the effect of the objective correction method would be better.

(3) 2-day average deviation correction, 5-day average deviation correction, and univariate linear regression deviation correction schemes were similar to the ideas of forecasters in urban forecast, but there were slightly fewer influencing factors to refer to. However, they still had a good correction effect. Especially through the selection of a dynamic optimal correction scheme, it also had a significant effect on the improvement of the forecast performance. However, this primary correction scheme was not sufficient to enhance the accuracy rate, especially when the mode performance was relatively good.

(4) The objective correction effect of wind direction was poor. The main reason is that wind direction is a vector, and the simple linear correction scheme had no obvious effect on it. Therefore, the correction effect was comparable to or slightly worse than that of the model itself. A better correction scheme should be sought to objectively correct wind direction.

References

[1] LI Q, HU BH, WANG XZ, *et al.* Multi-model integration forecast experimentation for regional temperature based on BP artificial neural network [J]. Journal of Arid Meteorology, 2011, 29(2): 231 – 235, 250.

[2] WANG D, HUANG SN, GAO HY, *et al.* Analysis on errors of SCMOC refined guidance temperature prediction corrected by the decaying averaging method in Shaanxi Province[J]. Journal of Arid Meteorology, 2016, 34(3): 575 – 583.

[3] TONG H, GUO PW, ZHU YJ, *et al.* Bias correction and statistical downscaling meteorological parameters forecast technique based on large-scale numerical model products[J] Meteorological Monthly, 2014, 40 (1): 66 – 75.

[4] WANG ZW, ZHENG ZF, CHEN M, *et al.* Prediction of meteorological elements based on nonlinear support vector machine regression method [J]. Journal of Applied Meteorological Science, 2012, 23(5): 562 – 570.

[5] MA XL, SHI Y, HE J, *et al.* The combined descending averaging bias correction based on the Kalman filter for ensemble forecast[J]. Acta Meteorologica Sinica, 2015, 73(5): 952 – 964.