EGU General Assembly 2022

北京师范大学地理科学学部
Faculty of Geographical Science BNU

Statistical downscaling of temperature and humidity for snow-quality risk forecasts for Beijing 2022 Winter Olympics

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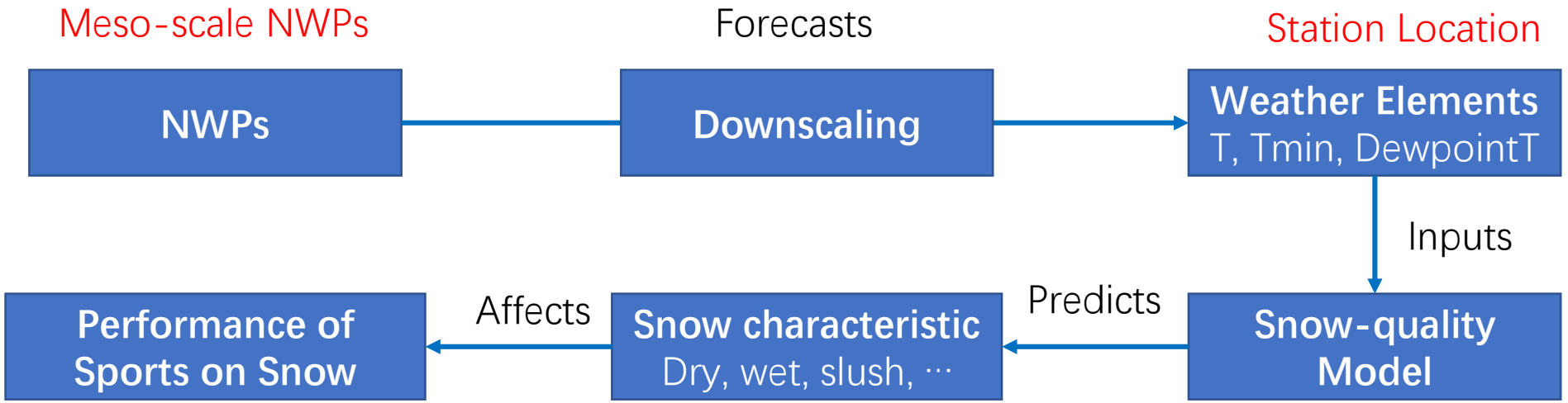
Introduction



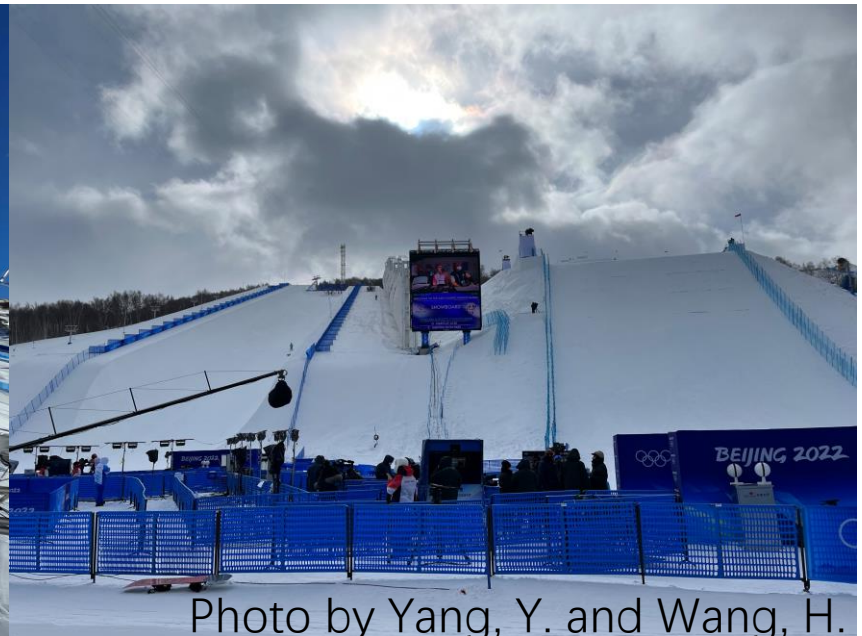
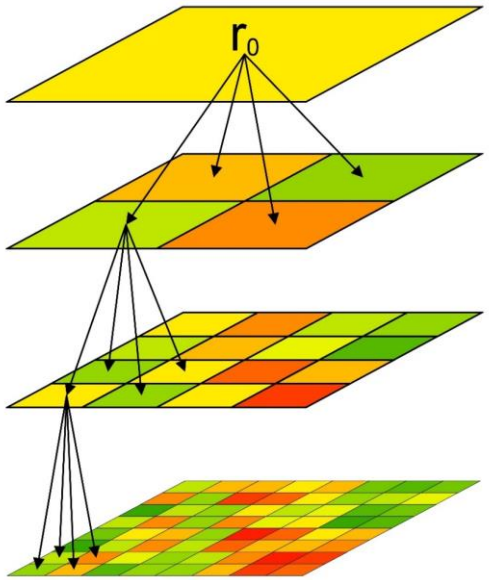


Photo by Yang, Y. and Wang, H.

Introduction



I don't know if we each have a destiny or if we're all just floating around accidental-like on a breeze. But I think maybe it's both. Maybe both get happening at the same time.

---- Forrest Gump

- **Dynamical downscaling**
  - Following the physical principles
  - Computationally expensive
- **Statistical downscaling**
  - Require fewer computational resources
  - Require long duration historical data

Introduction

Objective

- Downscaling the hourly temperature (T), minimum temperature (Tmin), and dewpoint temperature (DT) at station points in Zhangjiakou Competition Zone

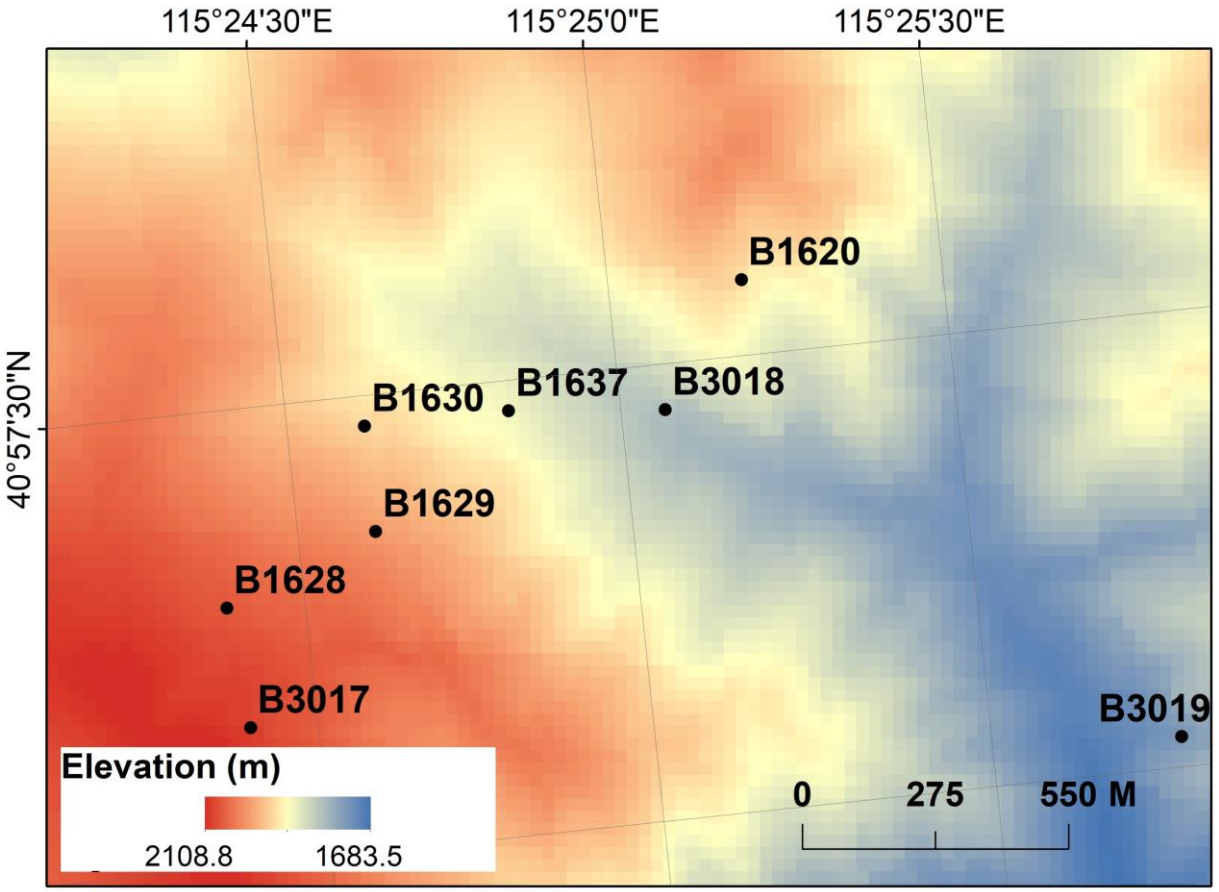
- Evaluating the improvement of the downscaling for snow-quality risk forecast

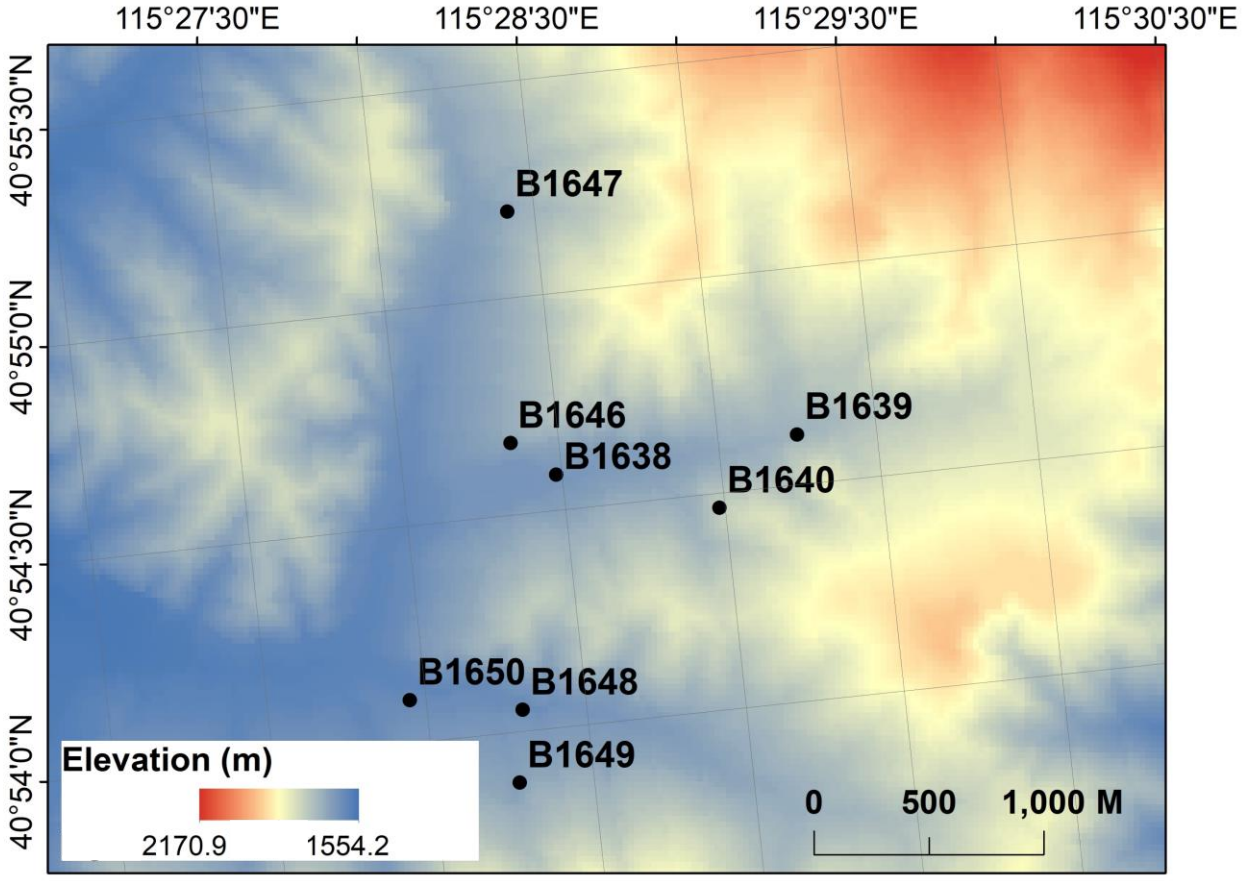
Introduction

A: Cross, Halfpipe, Slopestyle, Parallel Giant Slalom Alt. 1800~2100m

B: Cross-Country Skiing, Nordic Combined, Biathlon Alt. 1600~1800m

Data & Methods

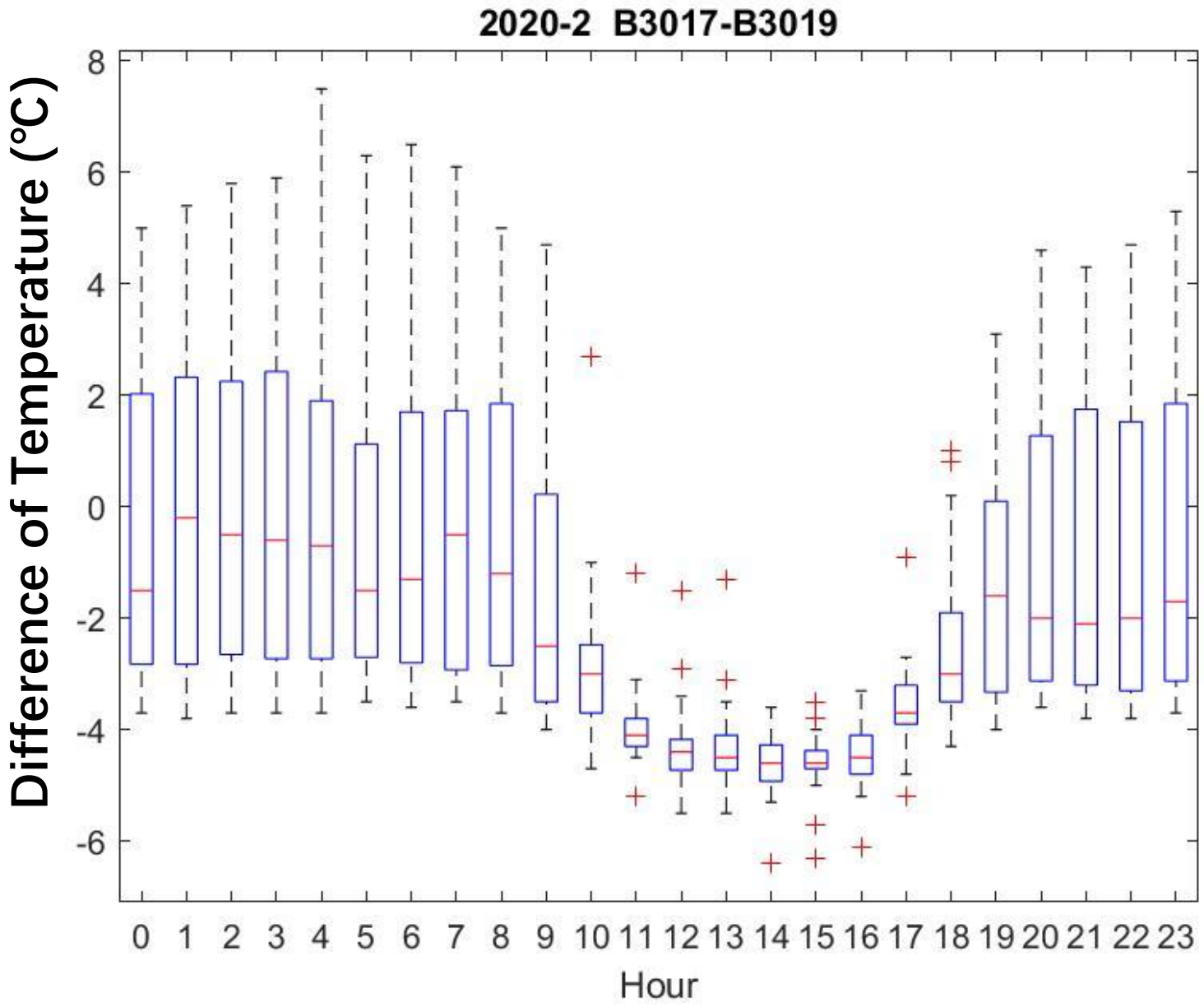




16 meteorological stations with **hourly T** (temperature), **Tmin** (minimum temperature) and **DT** (dewpoint temperature) observations.
Year: **2019-2020**, Months: **JFMA & OND**

Data & Methods

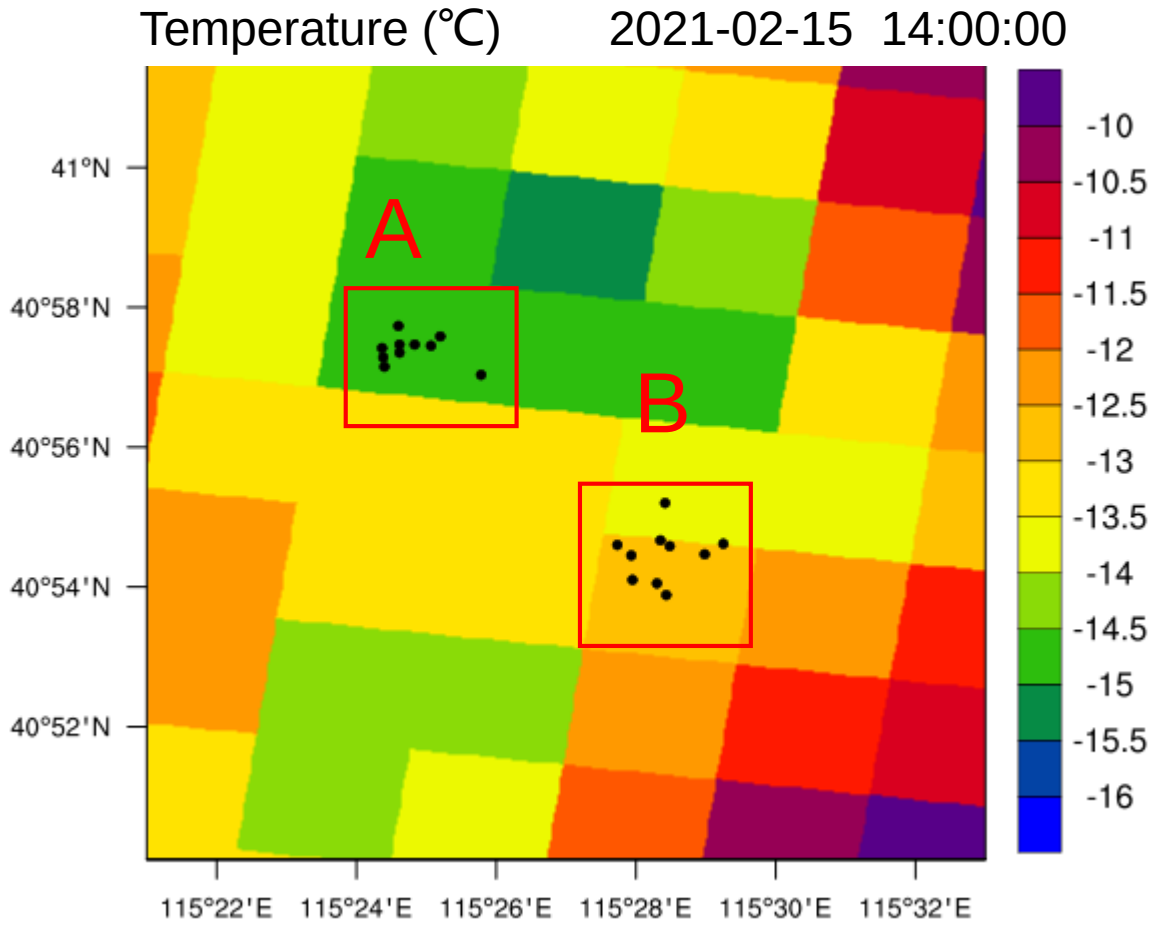
About 4℃ difference between the highest (B3017) and the lowest (B3019) stations during the daytime in Region A



Data & Methods

RMAPS (Rapid-Refresh Multiscale Analysis and Prediction System)
developed by the Beijing Institute of Urban Meteorology

- Run 8 times daily:
  (**0000** 0300 0600 0900
  1200 1500 1800 2100 UTC)
- 0~48h hourly forecast
- 3 km × 3km
  (2 grids in each region)



Fan, S., Tong, W., Zhong, J., et al. Rapid-Refresh Multiscale Analysis and Prediction System (RMAPS) in North China-STv2.0[C]// Annual meeting of Chinese Meteorological Society. 2018.

Data & Methods

Decaying Averaging (Cui, 2012)

Applied by NCEP to calibrate global ensemble forecasts in 2006

a. Bias estimation

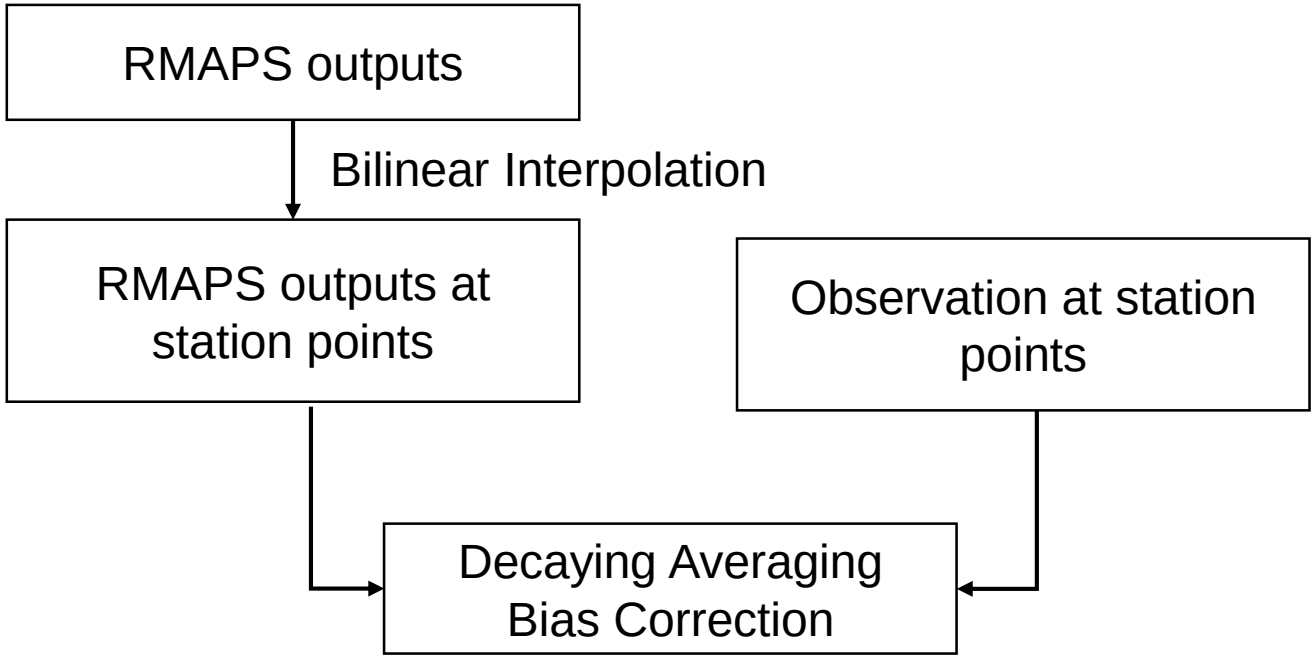
$$b_{i,j}(t) = f_{i,j}(t) - a_{i,j}(t)$$

b. Decaying average

$$B_{i,j}(t) = (1 - w)B_{i,j}(t-1) + wb_{i,j}(t)$$

c. Bias correction

$$F_{i,j}(t) = f_{i,j}(t) - B_{i,j}(t)$$



2019 for calibration (w_optim, minimize the RMSE)
2020 for validation

Cui, B., Z. Toth, Y. Zhu, and D. Hou, 2012: Bias correction for global ensemble forecast. Wea. Forecasting, 27, 396–410.

Data & Methods

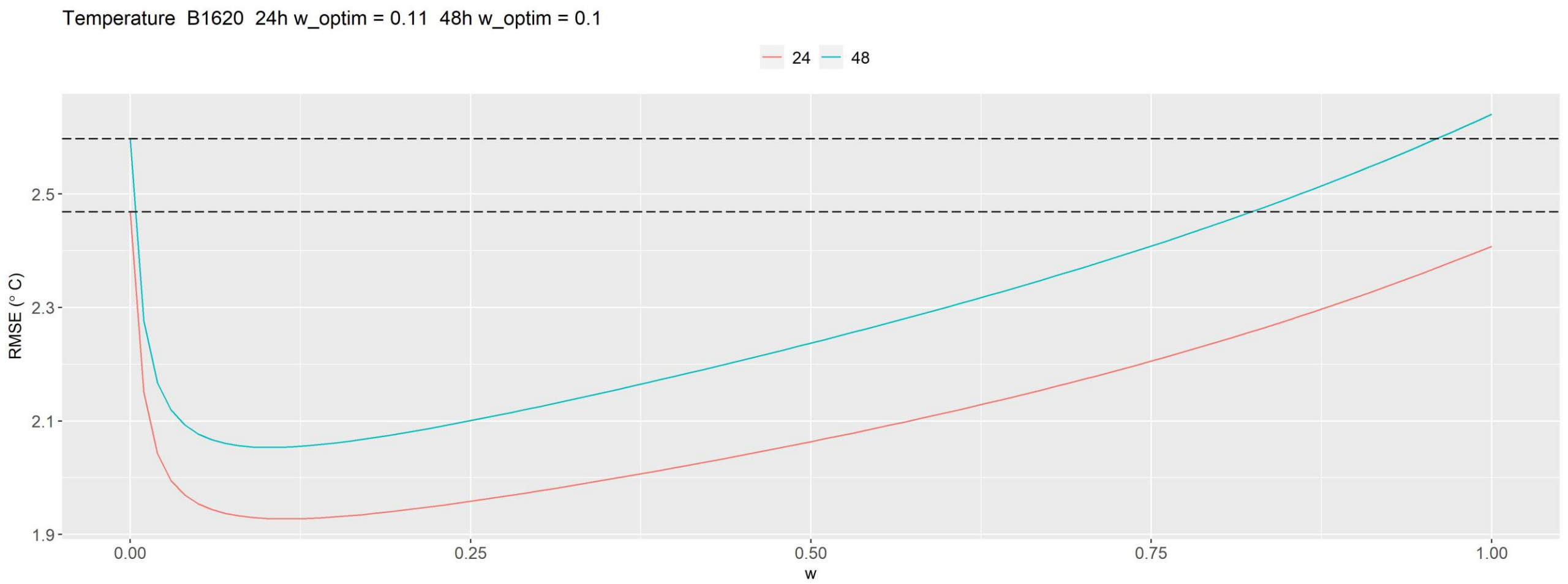
Snow-quality risk classification model

Developed by the Climate Centre of Hebei Province, China

Classification	Indicator	Characteristic
No risk	Tmin≤-7.35℃	Dry snow; Moisture content=0%
Low risk	Tmin>-7.35℃ & T≤-4.48℃	Slight wet snow; Moisture content=0.2%
Medium risk	Tmin>-7.35℃ & -4.48℃ <T<5.0℃ & DT<-3.3℃	Slight wet snow; Moisture content>0.4%
High risk	Tmin>-7.35℃ & T>-4.48℃ & (DT≥-3.3℃ or T≥5.0℃)	Slush snow; Moisture content>3%

Results – Optimization of Parameter w for each station

w_optim: 0.04~0.13 (Minimize the RMSE)

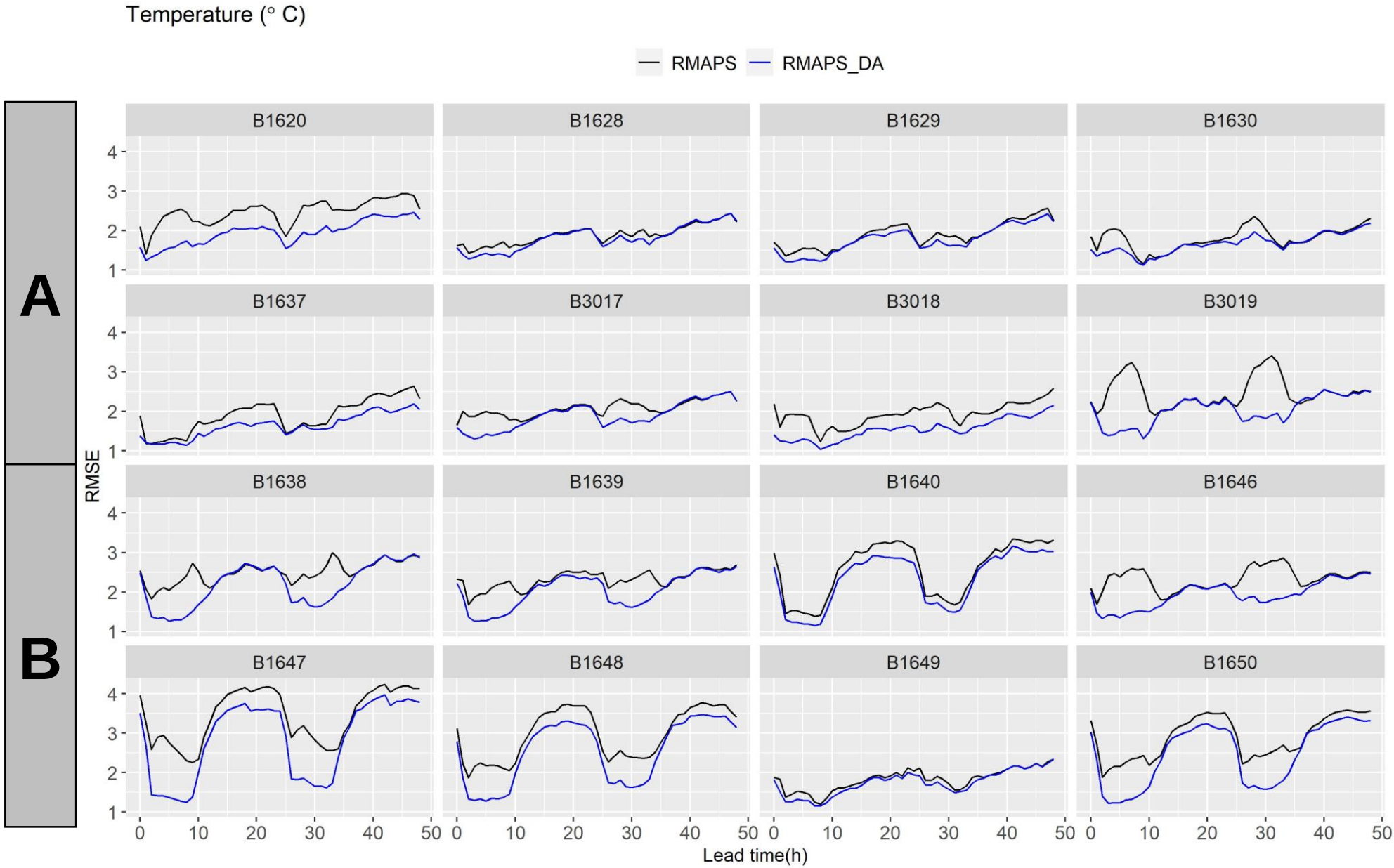


Results – Evaluation of Downscaled Temperature

Improvement of RMSE

0~2℃

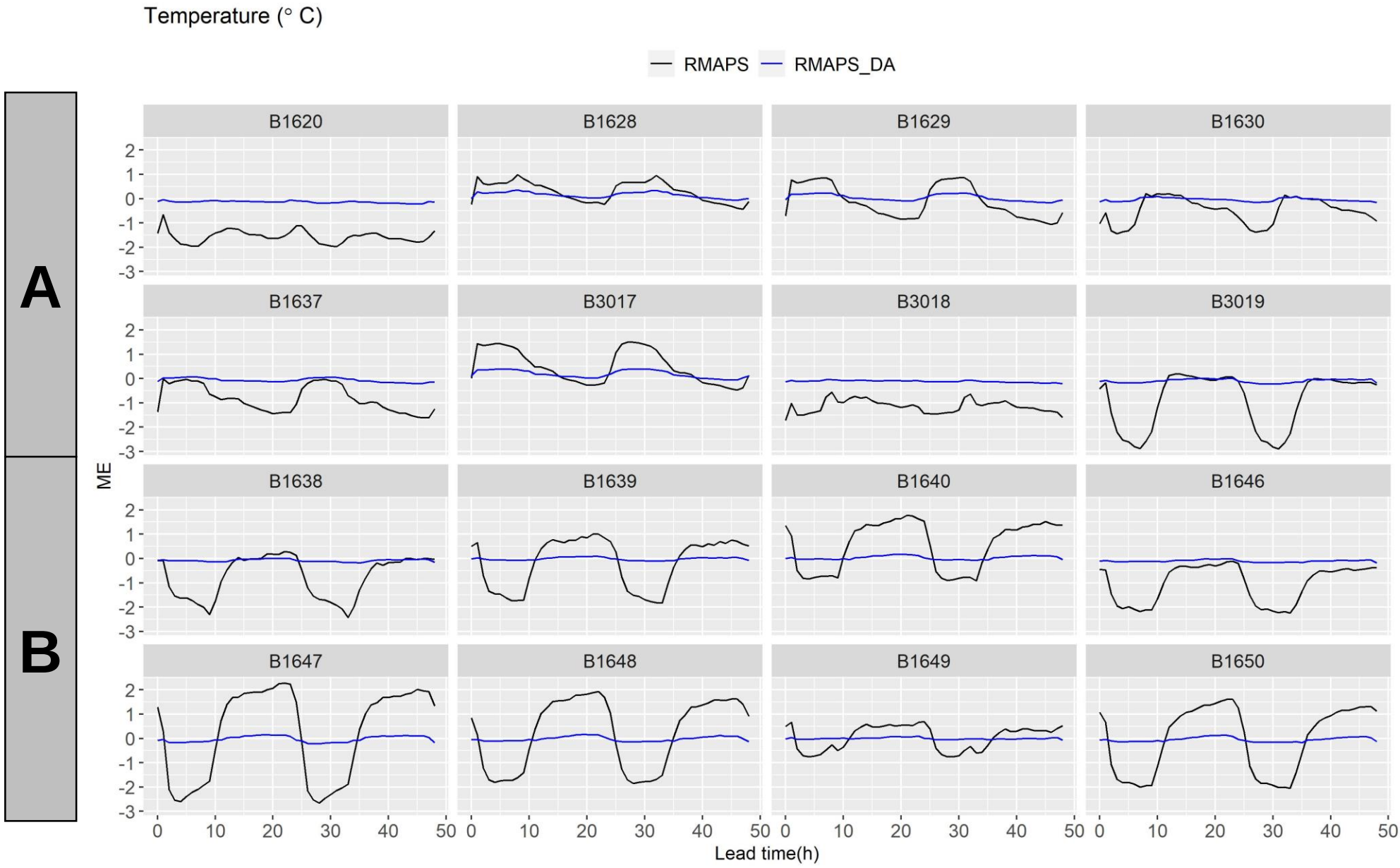
More noticeable during the daytime



Results – Evaluation of Downscaled Temperature

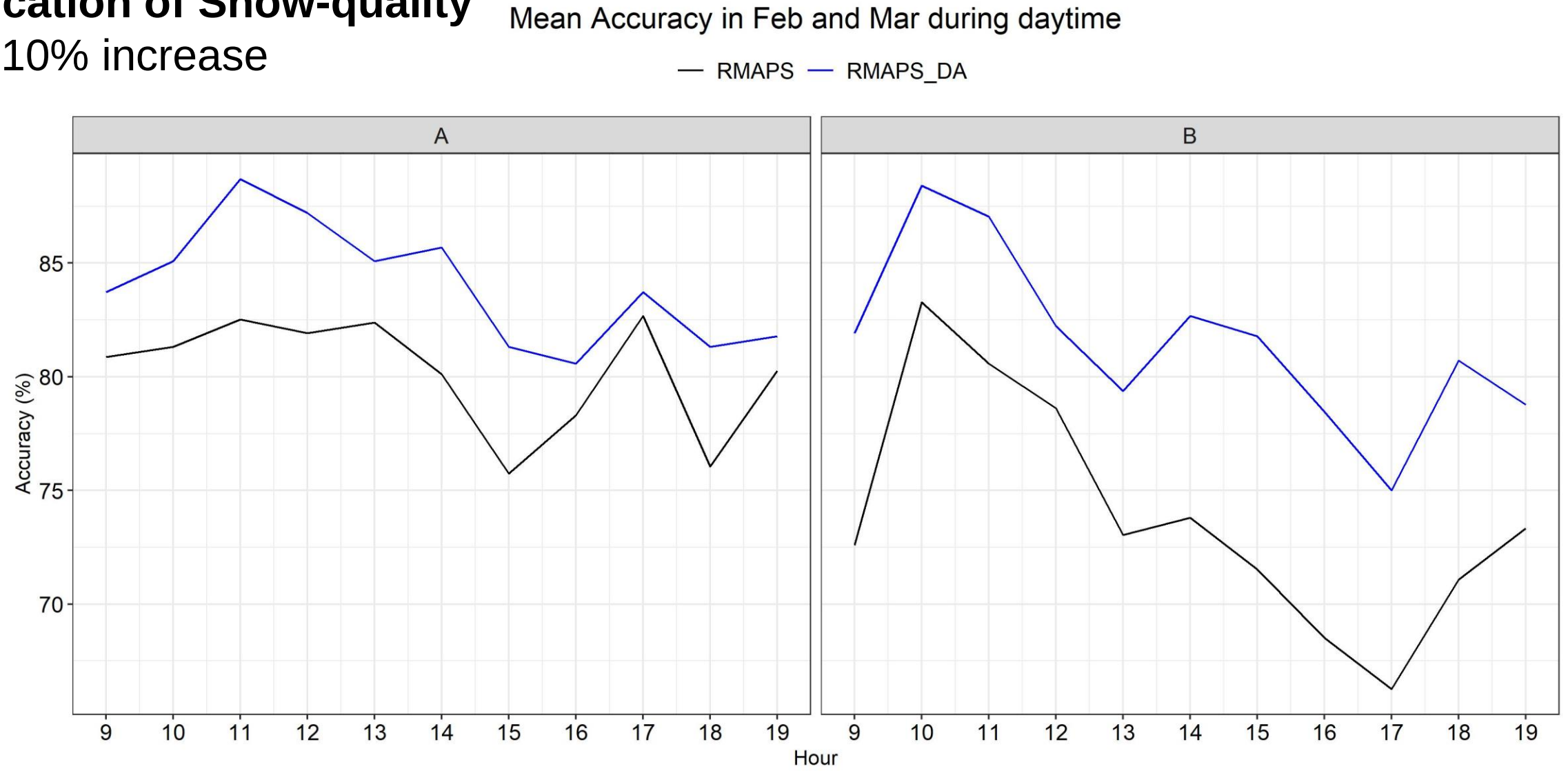
Improvement of ME

From ±3 ℃ to almost 0



Results – Evaluation by Snow-quality risk ranking model

Improvement of Accuracy of the Classification of Snow-quality risk: 2~10% increase



Conclusions

- Decaying Averaging can reduce the systematic errors of the RMAPS forecasts
- For the temperature, the RMSE decreased by 0~2 ℃, and the improvements were more noticeable during the daytime
- The accuracy of the classification of snow-quality risk increased by 2~10% during the daytime in Feb. and Mar.

Further improvement:

- Add biases from some small-scale weather processes, which are affected by circulation patterns and local topography to the bias correction procedure

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Thank you for your attention