An Introduction to Week-2 Forecast Guidance of Temperature Extremes of Central Weather Bureau

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Introduction

This study applied statistical post-processing techniques in week-2 forecasts of temperature extremes in order to provide more reliable, skillful, and practical forecast guidance for users in Taiwan. Ensemble Kernel Density Model Output Statistic (EKDMOS) technique (Glahn et al. 2009) was used to perform bias correction and downscaling for National Centers for Environmental Prediction (NCEP) Global Ensemble Forecast System (GEFS). For operational week-2 forecast guidance of temperature extremes at the Central Weather Bureau (CWB), one product is daily probabilistic forecasts of temperature extremes, and the other one is providing daily information on the most likely regions and the less likely but still possible areas of temperature extremes in week 2.

Forecast and Observation Data

Forecast data：
NCEP GEFS 20 members
(2.5 deg * 2.5 deg)

Observation：252 stations
(auto + manned stations)

Training period：2012 – 2015
Forecast period：2016 – 2019

Winter (Nov – Apr)
Summer (May - Oct)

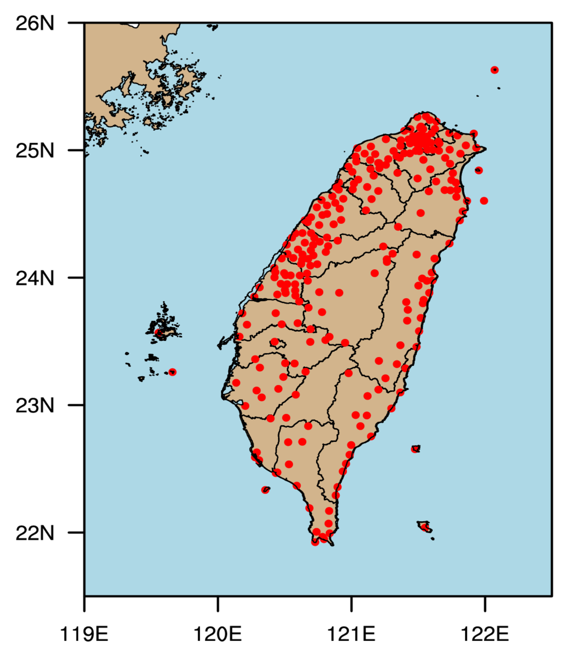
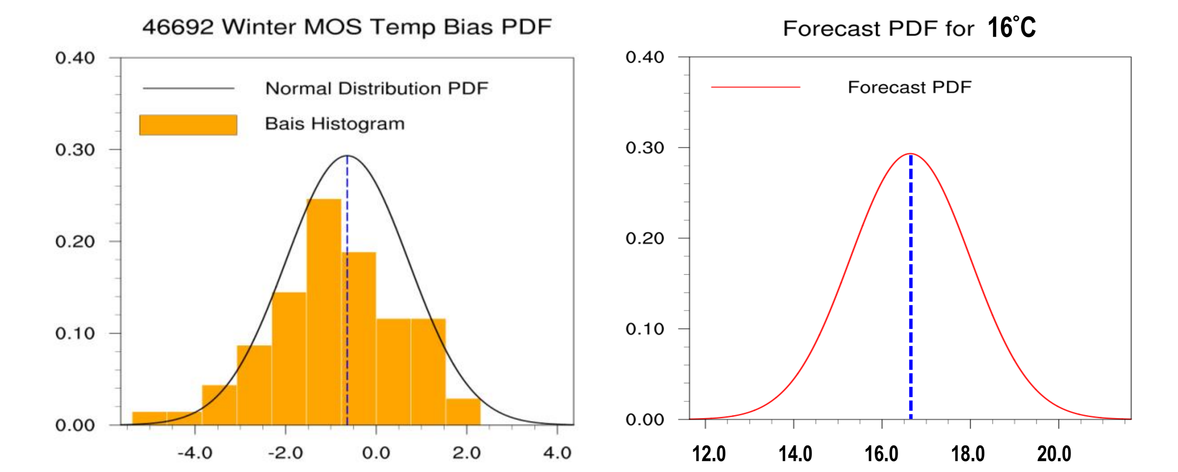


Figure 1. Meteorological stations (red dots) used for the EKDMOS.

Methodology

Ensemble Kernel Density MOS (EKDMOS)

1. Error histogram → error PDF (normal distribution) → forecast PDF of each member
2. Apply every member with equal weight to compose the final forecast PDF→ forecast probability of temperature extremes.



Different stations have different error PDFs and thus different forecast PDFs.

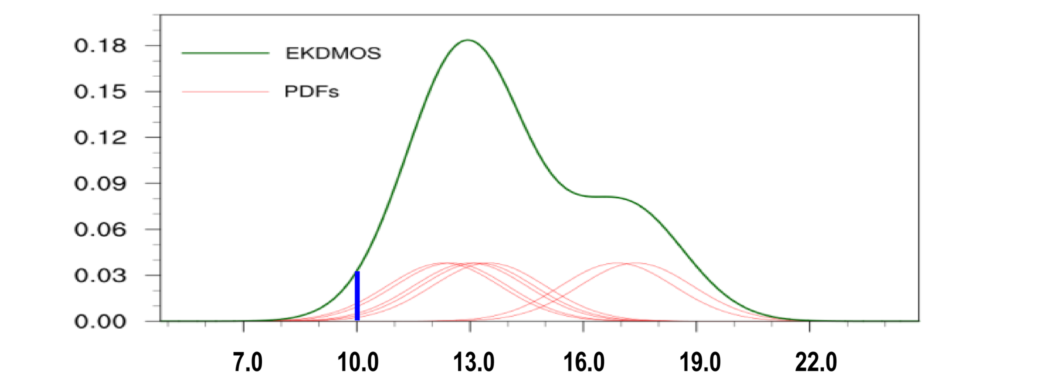


Figure 2. Schematic diagram illustrating how to produce probabilistic forecasts of daily minimum temperatures being less than a threshold using the EKDMOS.

Temporal Relaxation (Chang et al. 2017)

A temporal relaxation of one day

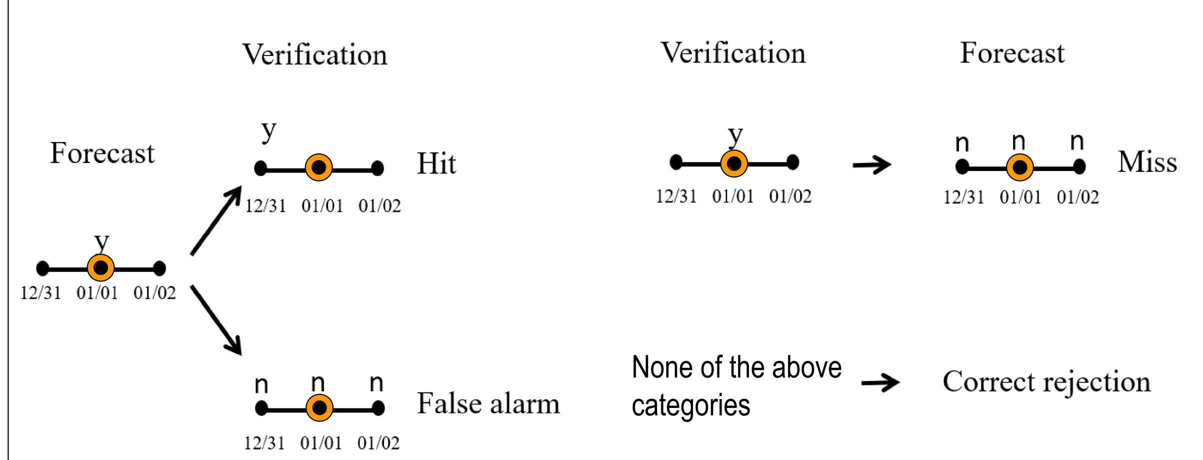
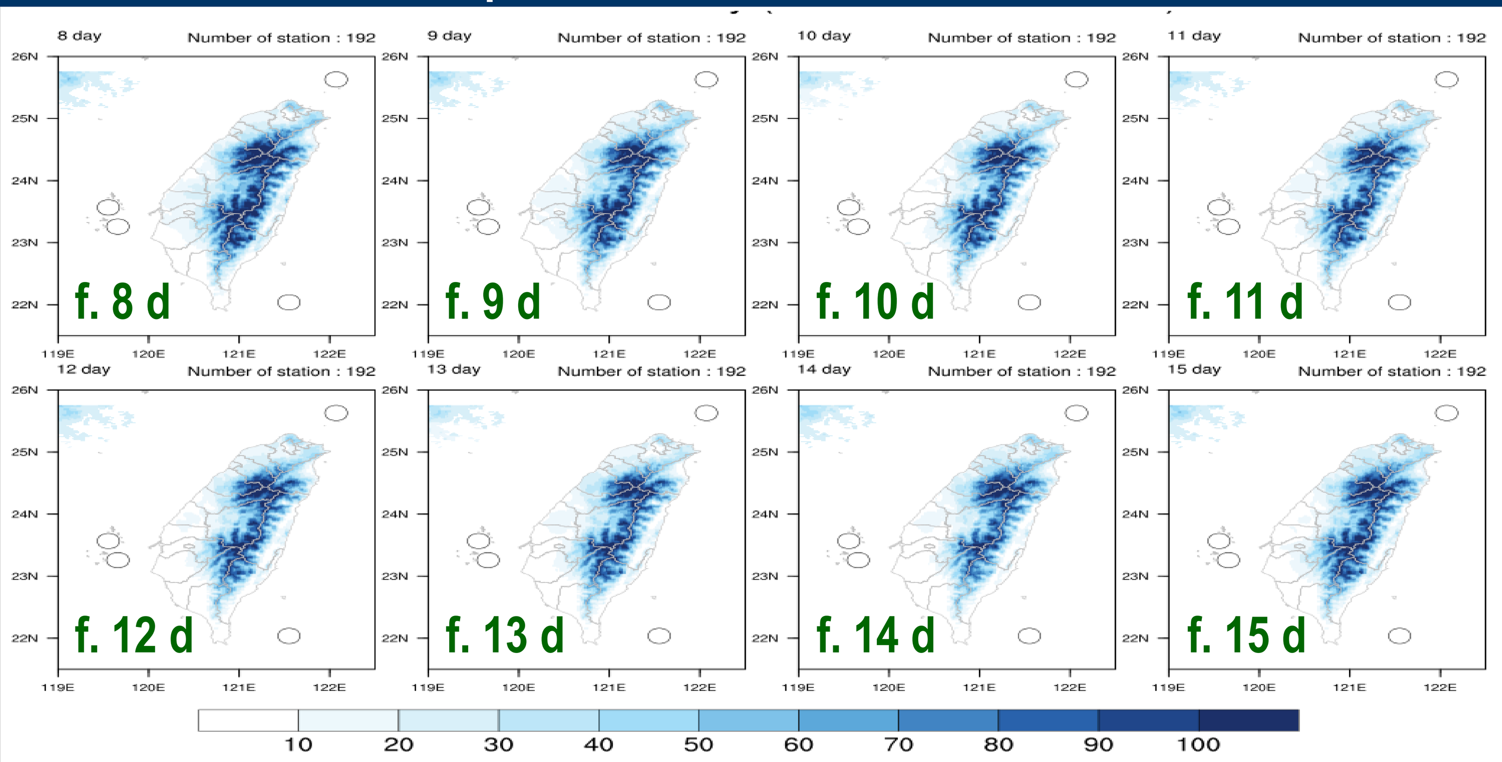


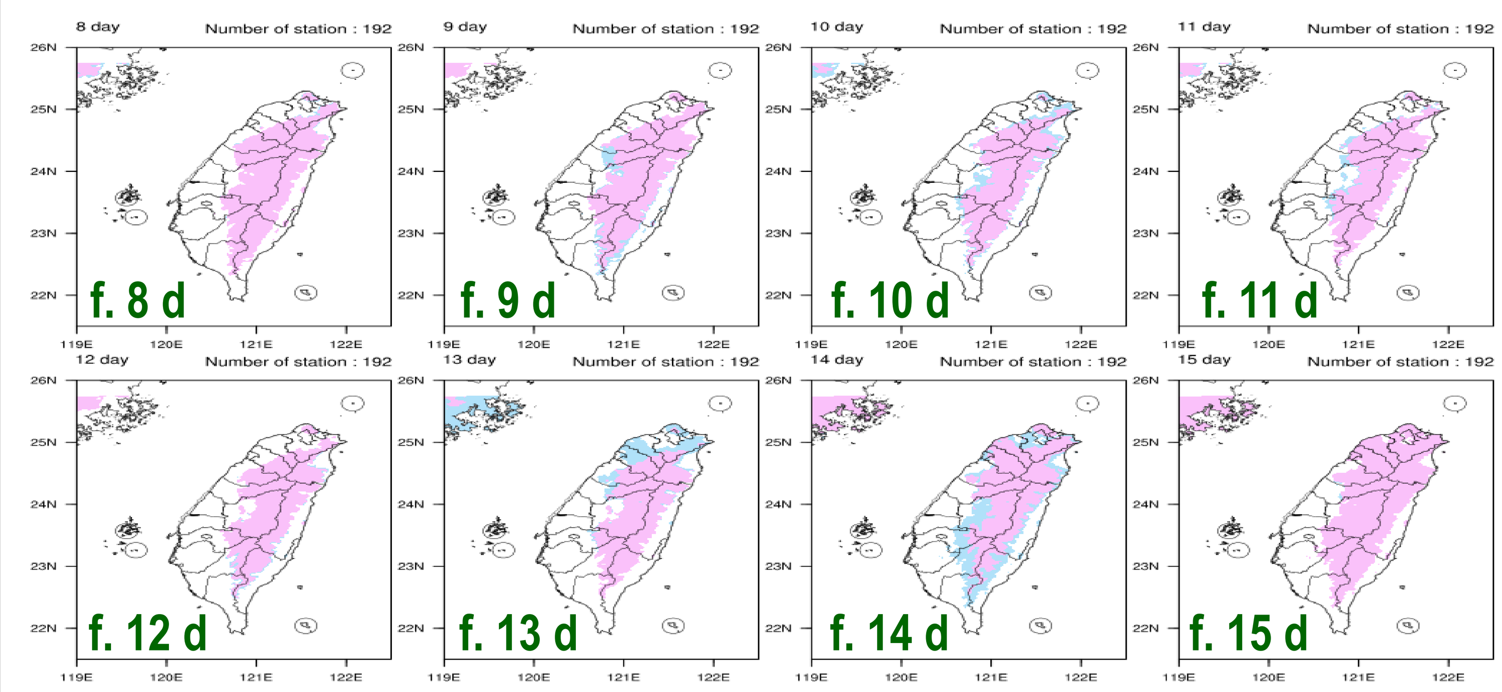
Figure. 3. Schematic diagram for a temporal relaxation of 1 day, which means a temporal shift of 1 day is an acceptable tolerance for week-2 forecasts of temperature extremes.

Operational Week-2 Forecast Guidance of Temperature Extremes



Daily probabilistic forecasts of cold extremes

Figure 3. Daily probabilistic forecasts of daily minimum temperatures (T_{min}) being less than a threshold (10 ℃) during week 2 in winter. This threshold could be a specific temperature value or a percentile, and it is adjustable based on users' requirements. In addition, this kind of product for daily maximum temperatures (T_{max}) exceeding a threshold is also provided in summer.



Daily forecast guidance of cold extremes

Figure 4. Daily forecast guidance of cold extremes (T_{min} < 10 ℃) during week-2 in winter. The pink shading shows the most likely regions for cold extremes, and the blue one shows the less likely but still possible areas of cold extremes. In addition, this kind of product for warm extremes is also provided in summer.

Results from Verification

Reliability Diagram

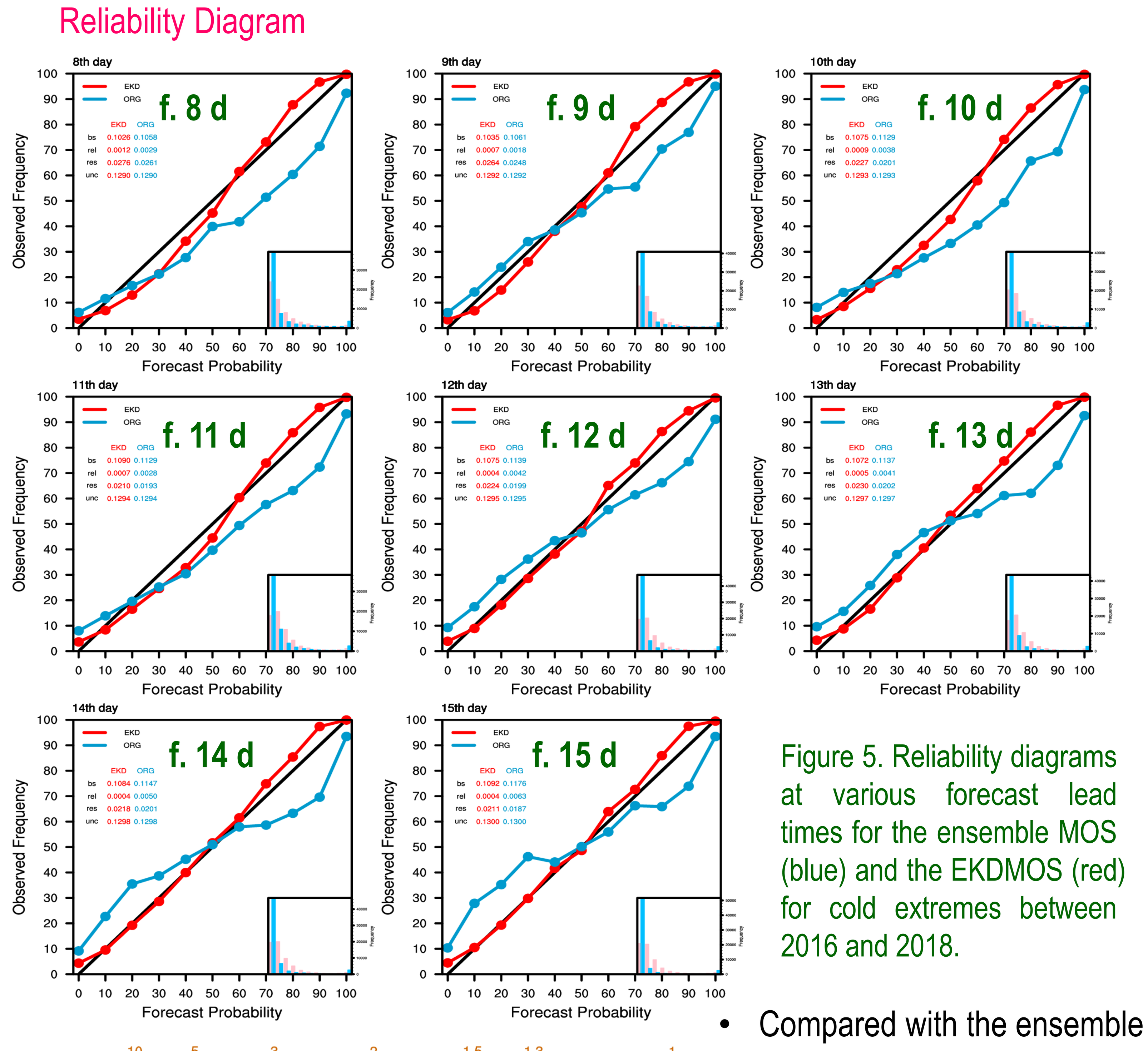


Figure 5. Reliability diagrams at various forecast lead times for the ensemble MOS (blue) and the EKDMOS (red) for cold extremes between 2016 and 2018.

Relative Operating Curve (ROC)

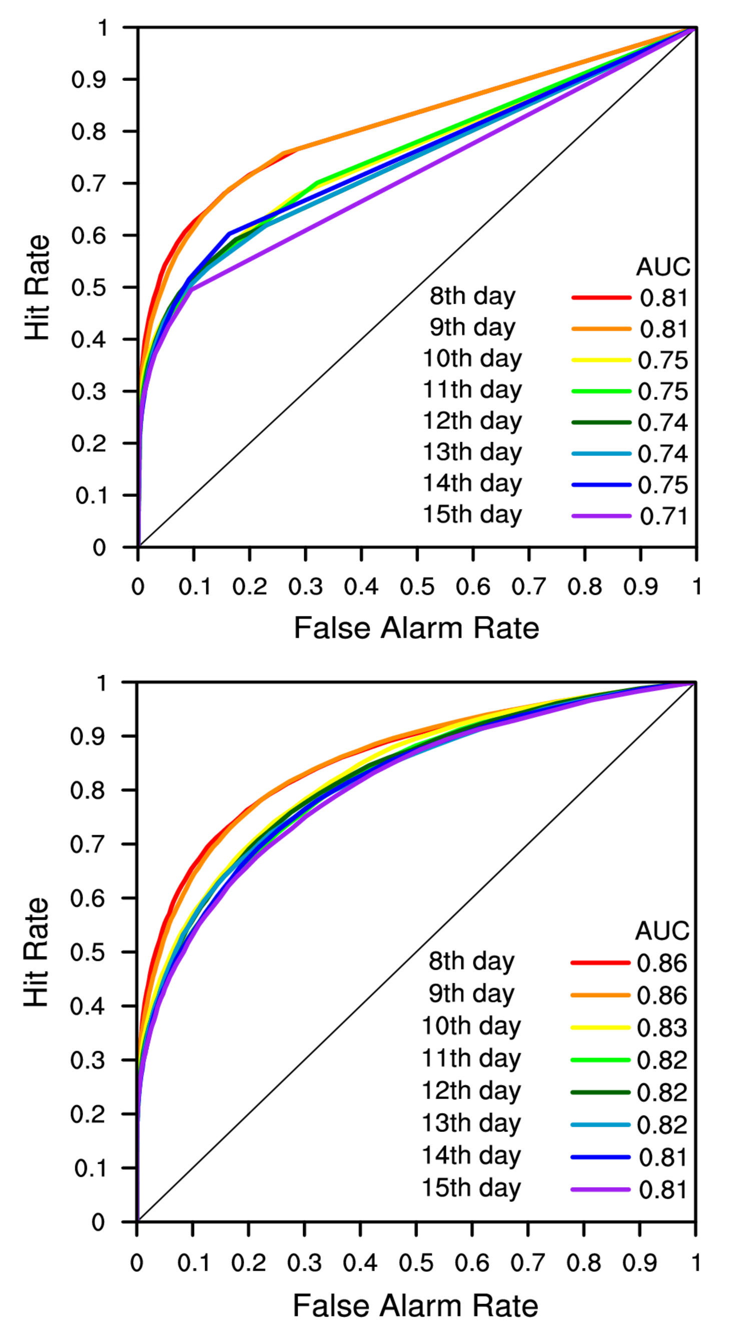


Figure 6. ROC curve and area under ROC curve (AUC) at various forecast lead times for the ensemble MOS (upper) and the EKDMOS (lower) for cold extremes from 2016 to 2018.

- Compared with the ensemble MOS, the EKDMOS provides higher reliability and better discrimination for probabilistic forecasts of cold extremes.

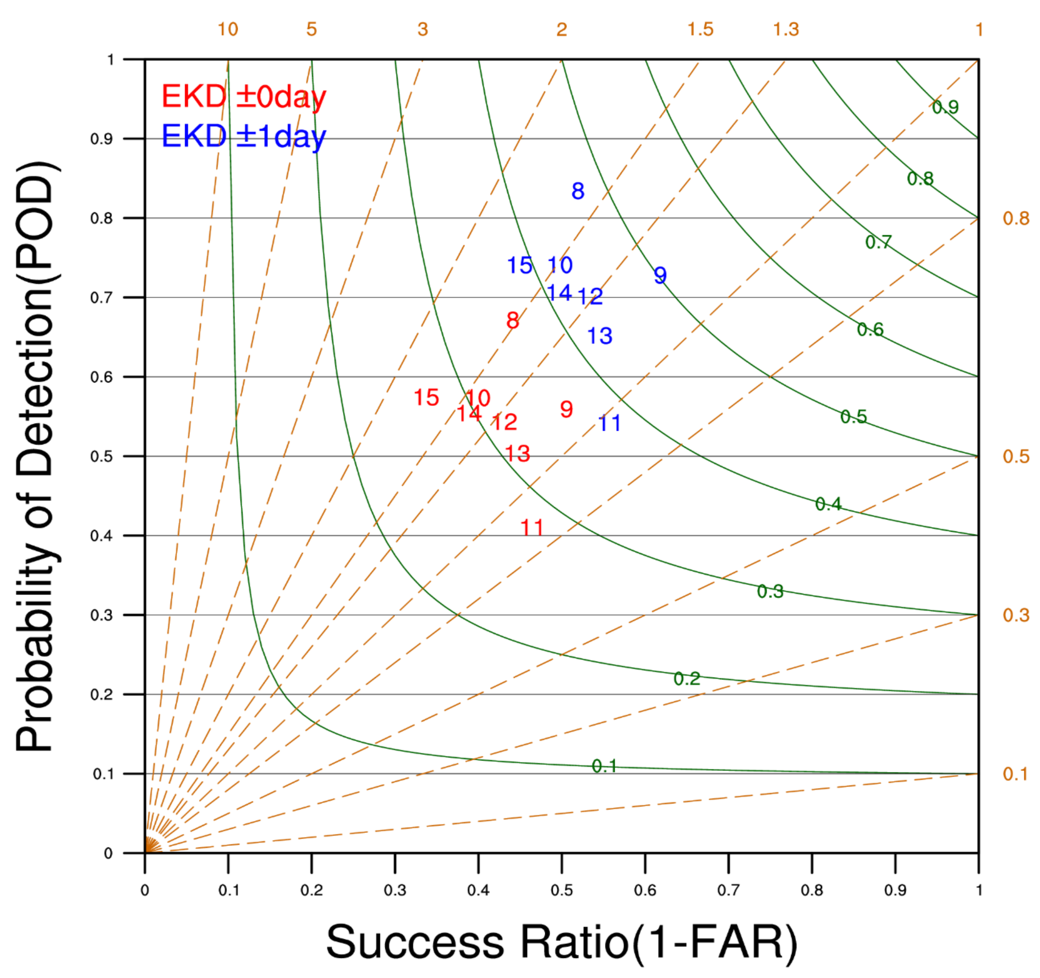


Figure 7. Performance diagram for the forecast guidance of cold extremes without (red numbers) and with (blue numbers) a temporal relaxation of one day. Different numbers indicate different forecast lead times (day).

- When a temporal relaxation of one day was applied, the forecast guidance of cold extremes displays moderate accuracy (TS：0.38-0.5), a high probability of detection (POD：0.65-0.85), a moderate success ratio (SR：0.45-0.62), and an acceptable degree of over-forecasting (Bias：0.99-1.6).

Conclusions and References

- Compared with the ensemble MOS, the EKDMOS has higher reliability and better discrimination for probabilistic forecasts of cold extremes.
- Under a temporal relaxation of one day, the forecast guidance of cold extremes displays moderate accuracy, a high probability of detection, a moderate success ratio, and an acceptable degree of over-forecasting.

Glahn, B., M. Peroutka, J. Wiedenfeld, J. Wagner, G. Zylstra, B. Schuknecht, and B. Jackson, 2009：MOS Uncertainty Estimates in an Ensemble Framework, *Mon. Wea. Rev.*, **137**, 246-268.

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