中国气象局地球系统数值预报中心
CMA EARTH SYSTEM MODELING AND PREDICTION CENTRE

The CMA-GEPS extreme forecast index for temperature and verification on the extreme high temperature forecasts for the summer of 2022

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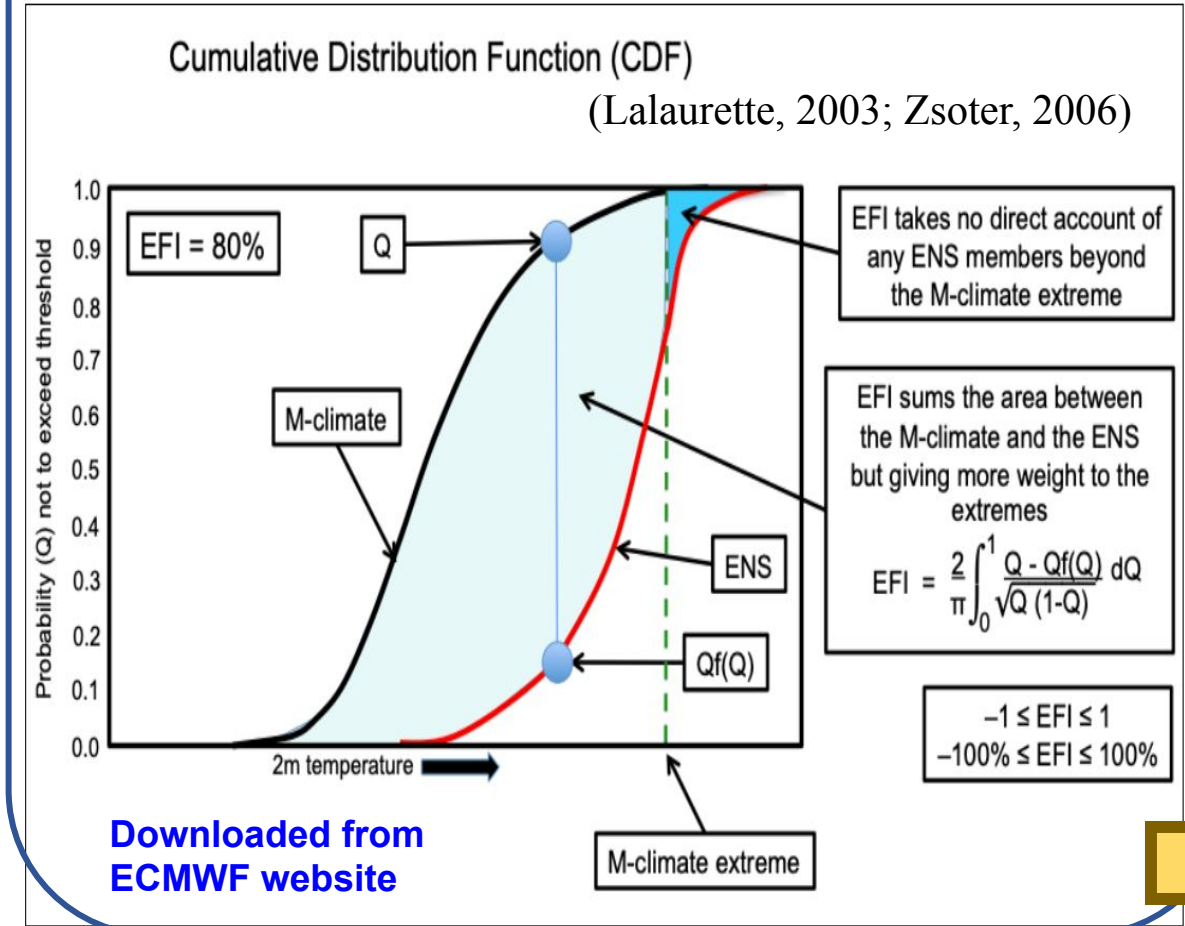
Extreme Forecast Index (EFI)

$$\mathrm{EFI} = \frac{2}{\pi}\int_0^1 \frac{p - F_{f(p)}}{\sqrt{p(1-p)}}\,dp \quad (\mathrm{EFI} \in [-1, 1])$$



Downloaded from ECMWF website

CMA-GEPS

(China Meteorological Administration (CMA) global ensemble prediction system)

Implementation	Operational Version
2018.12	CMA-GEPS V1.0
2020.05	CMA-GEPS V1.1
2021.11	CMA-GEPS V1.2
2022.09	CMA-GEPS V1.3

- Focusing on the extreme high temperature events occurring in the summer of 2022 over the Northern Hemisphere, the forecast skills of the CMA-GEPS EFI will be evaluated and discussed.

• Parameters for CMA-GEPS V1.2

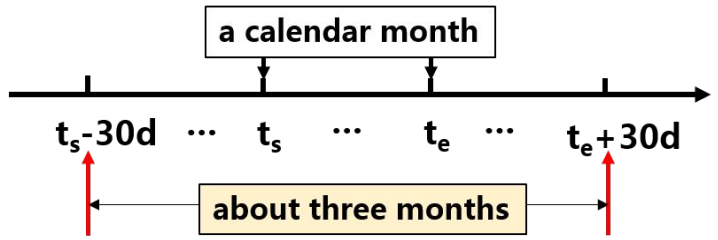
Item	Configuration
The forecast model version	CMA-GFS V3.1
Model horizontal resolution	0.5°×0.5°
Model vertical levels	87 (at a 0.1-hPa top)
Members	31
Initial perturbations	Singular vectors
Model perturbations	SPPT, and SKEB
Forecast range	15 d

✔ **CMA-GEPS V1.2 was run in operation from Nov 2011 to Sep 2022. Compared with its previous versions, both model dynamics and physics were changed. So was the model climate, especially for 2-m temperature (t2m).**

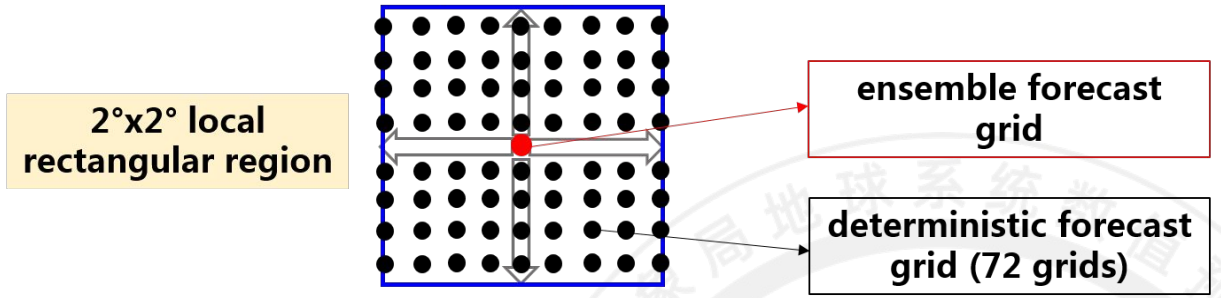
✔ **Reforecasts were not implemented.**

• Establishments of the model climate for EFI

(1) The method to extend samples in time



(2) The method to extend samples in space



✔ **To build the model climate consistent with the ensemble forecast model version (V1.2), operational forecasts of the CMA global higher-resolution (0.25 degree) deterministic model from June 15 2020 to July 22 2022 (more than 2 years) were used via extending forecast samples in both time and space.**

Methodology, data and study region

✔ **For observations:**

- The extreme temperature events were **defined by the 95th percentiles** of the observed climate.
- **Taking ERA5 as "observations"**, t2m from 1989 to 2021 was used to construct the observed climate, and t2m in the summer of 2022 was used to identify the extreme temperature events.

✔ **For forecasts:**

- An extreme high temperature events is predicted to appear when **the EFI is greater than or equal to a pre-specified critical threshold (e.g., 0.3)**.
- The EFI values of 0, 0.05, 0.1, …, 0.95 are used as the thresholds, respectively.

- threat scores (**TS**), hit rates (**HR**), false alarm rates (**FR**), and bias (**BIAS**), relative operational characteristic curve (**ROCV**) and **economic value (EV)**

(1) the middle and lower reaches of the Yangtze River in central-eastern China (**MEC**; 26.0ºN-35.0ºN, 105.0ºE-121.5ºE)
(2) North China (**NC**; 35.0ºN-42.5ºN, 110.0ºE-120.0ºE)
(3) Western Europe (**WEU**; 43.0ºN-51.0ºN, 0.0ºE-10.0ºE)
(4) Central Europe (**MEU**; 54.5ºN-63.0ºN, 36.5ºE-50.0ºE).

- **Four blue rectangles in the following figure highlight the four study areas.**

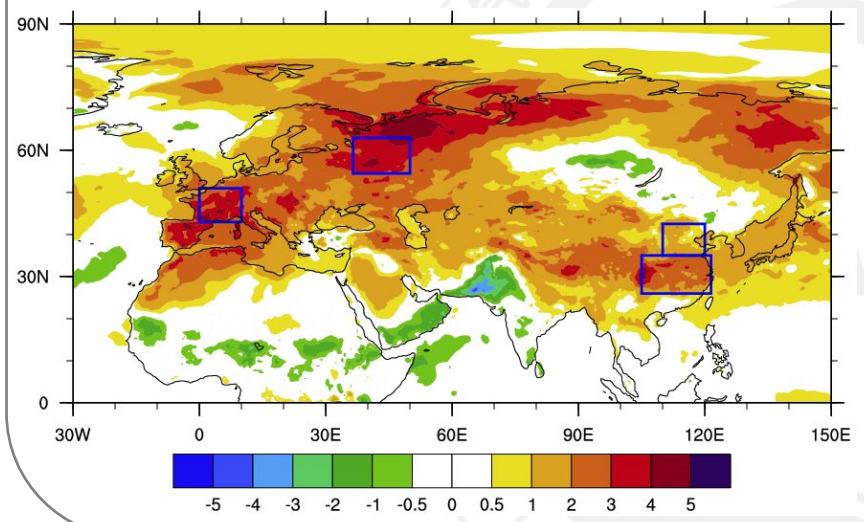
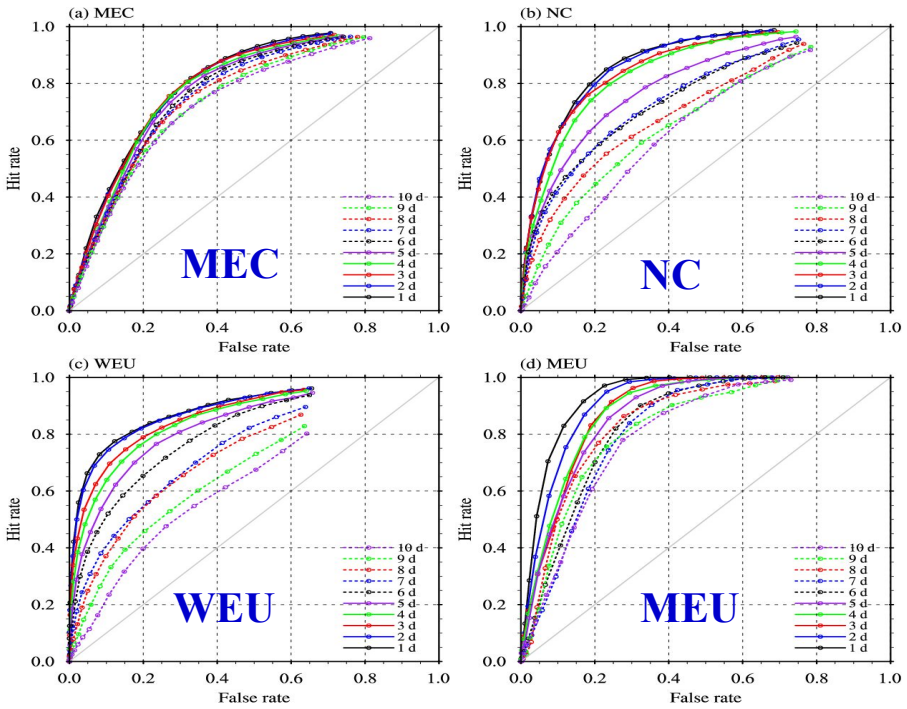


Figure. **t2m anomalies** averaged for the summer of 2022.

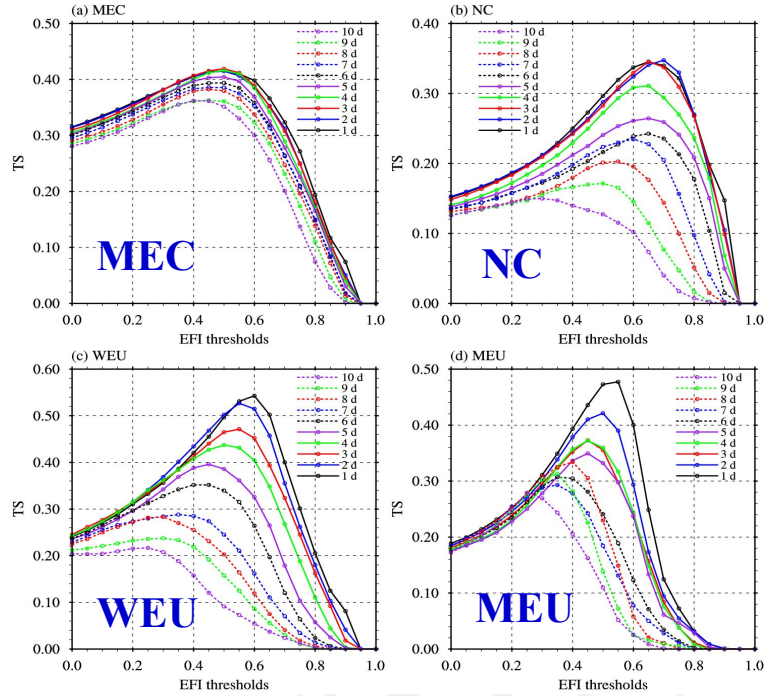
Verification results

ROCV



- ✔ **The CMA-GEPS EFI had the ability to discriminate extreme high temperature within the short- and medium-range forecast lead times of 1-10 days.**
- ✔ **The EFI forecast ability was decreased with the forecast lead time, which was related to the ability of the CMA-GEPS in capturing the synoptic systems that caused the extreme high temperature.**

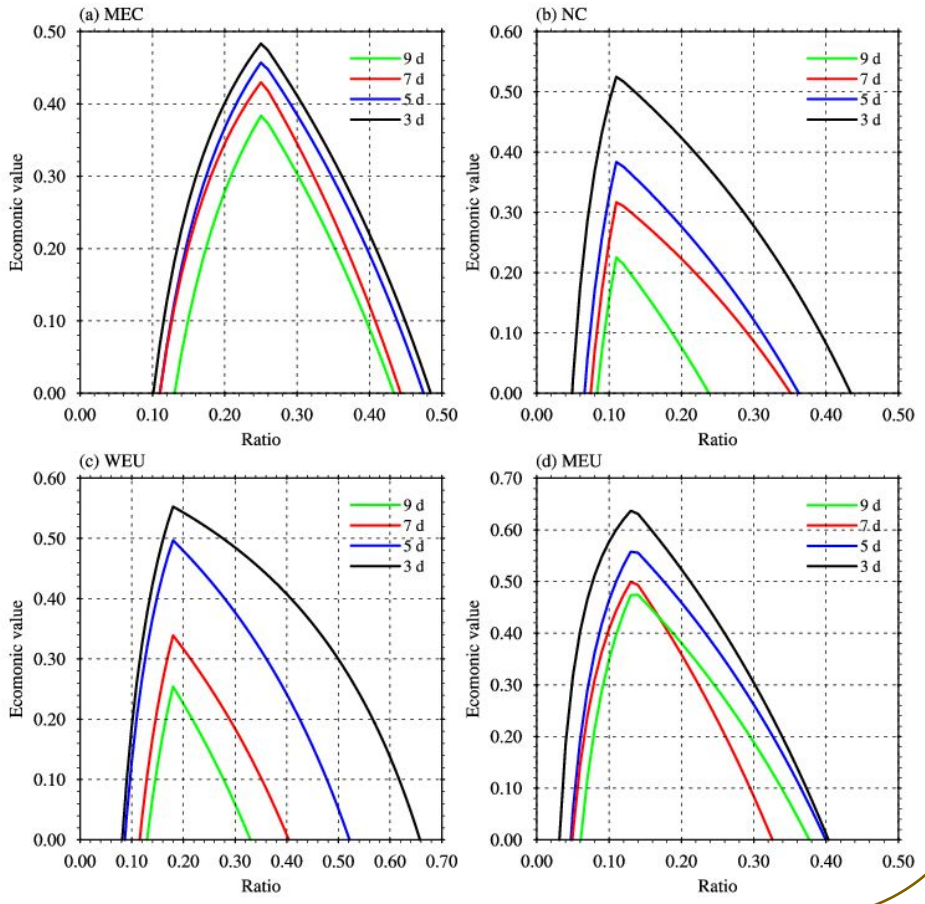
TS



- ✔ **The forecast performance of the CMA-GEPS EFI was linked to the applied EFI thresholds.**
- ✔ **The EFI values corresponding to the maximal TS scores varied with the study regions. For a specified study region, the EFI values corresponding to maximal TS scores decreased with the increase of forecast lead time.**

Economic value as a function of cost/loss

Positive economic values are indicative of reductions in the economic losses due to the occurrences of extreme events.



- Through the economic value model, it was revealed that **risk decisions based on the EFI forecast information owned certain economic value and reference value**.
- Analysis results from case study further demonstrated that the CMA-GEPS EFI could provide early warnings for extreme high temperature in the medium forecast range.

A case study on 12 UTC 20 August 2022

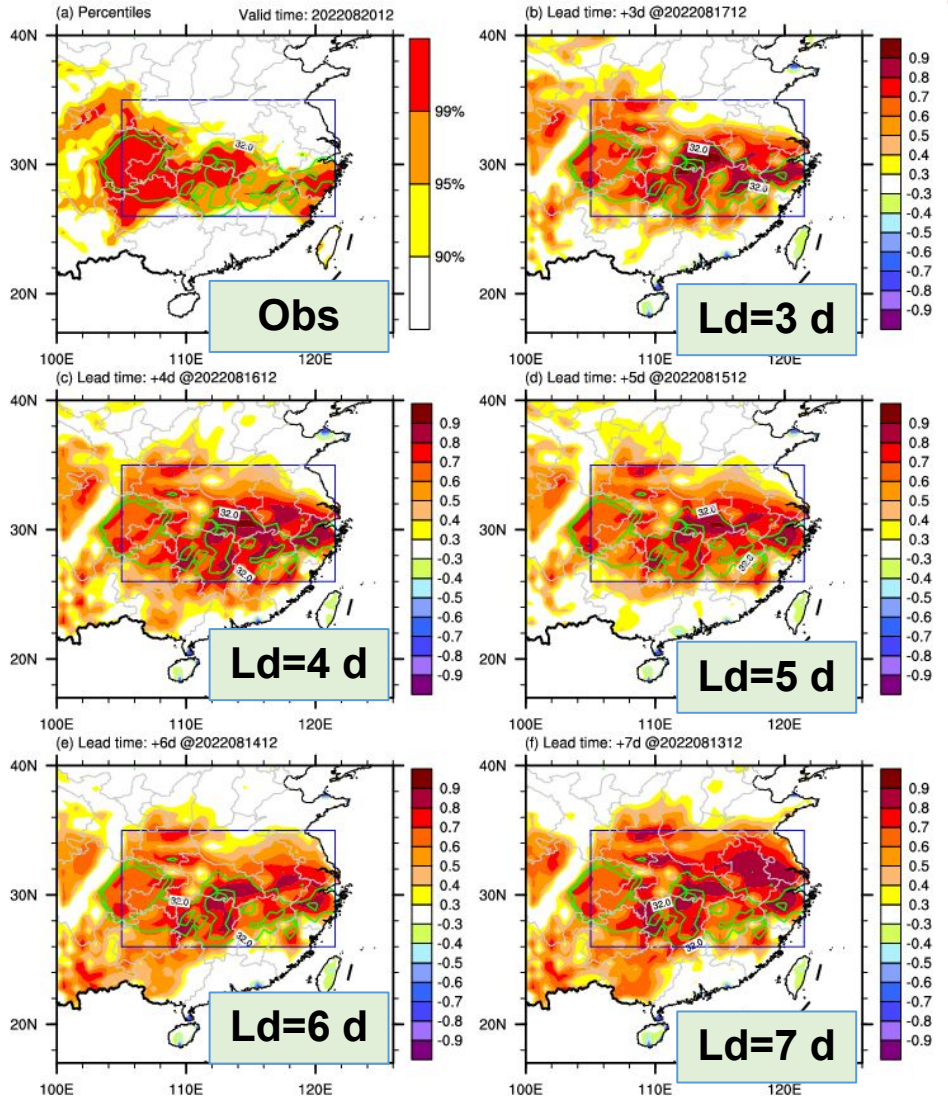


Figure. t2m from the ERA5 reanalysis on 12 UTC 20 August 2022 (green contours) in the MEC region and its percentiles accounting for the observed climate distributions (a, shaded) as well as the corresponding EFI at the lead times of 3 d (b, shaded), 4 d (c, shaded), 5 d (d, shaded), 6 d (e, shaded) and, 7 d (f, shaded).

THANKS !

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