A study on evaluation method for predictability of persistent heavy rainfall events over East Asia based on ensemble forecast

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1. Introduction

- The Persistent Heavy Rainfall (PHR) is the most influential extreme weather event in Asian summer monsoon season, which has attracted intensive interests of many scientists.

- A new verification method applied to evaluate the predictability of PHR is investigated. By use of operational global ensemble forecasts from China Meteorological Administration (CMA), a metrics called Index of Composite predictability (ICP) based on Equitable Threat Score (ETS) of 24h accumulated precipitation and Root Mean Square Error (RMSE) of height at 500hPa is established to identify “good” and “poor” forecast from ensemble members.

- Moreover, by using ICP, two PHR events that occurred in Yangtze river region were analyzed. By identifying two members with the best and worst forecast performance and comparing the differences between initial condition errors, its growth, and the key weather systems impact on PHR, the rationality and reliability of ICP are analyzed. This research would lay a foundation for the assessment of predictability of PHR and mechanism of error growth in NWP model.

2. Data and Methodology

2.1 Data the two PHR events

- This T213-based ensemble prediction system includes 15 members with the horizontal resolution of 0.5625°.

- The observations are the precipitation observed from 2412 stations offered by National Meteorological Information Center of China.

Two of the longest events are selected from the PHR events which are not affected by typhoon systems in Huaihe river basin between 2009 and 2011. The integrated intensity of Event I is the third among the PHR events in Huaihe River Basin from 1950 to 2010, which makes it an excellent representation of PHR events.

2.2 Methodology of ICP

To evaluate and compare the ensemble members’ forecast ability during the two PHR events, we defined ICP (Index of Composite Predictability) based on the ensemble forecast. Specific mathematical process is as follows:

1) Consistency processing of verification index. The purpose of this step is to unify two types verification index. Make it the greater NIV value, the better the forecast.

\[
NIV = \begin{cases} 1 & \text{if score value is the first type} \\ 1 & \text{if score value is the second type} \\ \end{cases}
\]

2) Compare the NIV of individual ensemble member to the average NIV of all members each time.

\[
\bar{A}V = \frac{\sum NIV / M}{M}
\]

3) The definition of ISV (Index of Composite Predictability). By the definition of ISV (Avm), it may have diverse results by choosing different verification index for a particular ensemble member.

\[
ISV = \frac{\sum \text{ETS}_v}{\text{IET}}
\]

4. ICP model for the persistent heavy rainfall events. For persistent heavy rainfall (PHR), choose two verification indexes to construct ICP model for this weather event.

\[
ICP = \begin{cases} I \text{SIV}(ETSV) + I \text{SIV}(RMSE) & \text{ETSIV}(RMSE) \geq 0 \\ 0 & \text{else} \end{cases}
\]

According the rank of ICP, it is easy to see the “good member” is member 10 and “poor member” is member 1.

3.2 The Predictability for PHR events

By using the “good member” and “poor member” identify difference from ICP scores, the predictability of large scale general circulation, mesoscale weather systems and the prediction on precipitation intensities and locations will be analyzed.

3.3 The initial error growth of “good member” and “poor member”

Accurate forecasting of heavy precipitation is the key to the prediction on the genesis and development of rainfall events, which is closely associated with the precipitation on the genesis and development of mesoscale systems.

4. Conclusions

- A metrics called Index of Composite predictability (ICP) based on ETS and RMSE is established.

- The maximum and minimum value of ICP corresponds to the best and the worst performance of members respectively.

- The forecasts between the “good member” and “poor member” differed greatly in terms of the large scale circulation, mesoscale systems and precipitation.

- Accurate forecasting of heavy precipitation is the key success factor for the prediction of persistent heavy rainfall events, which is closely associated with the precipitation on the genesis and development of mesoscale systems.

- The comparisons of the error growth between “good member” and “poor member” reveal that most of the temperature errors exist in the high latitudes and polar areas and grow rapidly with time, especially the errors on the trough.

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