Categorized correction forecast for accumulative precipitation of heavy rainfall processes based on optimal probability (OPPF) in medium-extended-range forecast time

RUOYUN NIU

National Meteorological Center, CMA, Beijing, China.

1. The introduction and example of the 3 OPPFs Methods

The overall route: A heavy rainfall process (HRP) is predicted by the current real-time model with initial time $YYYY_0MM_0DD_0HH_0$ and the start and end forecast time of the HRP t1 and t2 respectively. The firstly, the episodes of observation sample for the corresponding periods in past 5 years is selected (Fig.1) and the initialized time of forecast sample with the same start and end forecast time (t1 and t2) are detected for every episodes of observation sample. The accumulative precipitation are respectively calculated for above observation and forecast samples (OFSs) by taking the ensemble prediction data(EPD) from ECMWF and the observations data of precipitation in China. The secondly, the critical values of optimal probability ($OPCV_k$) at the different forecast grades (k) of the accumulative precipitation are obtained with the maximum of TS based the above OFSs. The finally, the categorized correction forecast (CCF) for accumulative precipitation of the HRP are obtained based on OPCV and the current real-time EPD. The 3 calculation schemes of OPPFs (namely OPPF1, OPPF2, OPPF3) are designed according to overall technical route.

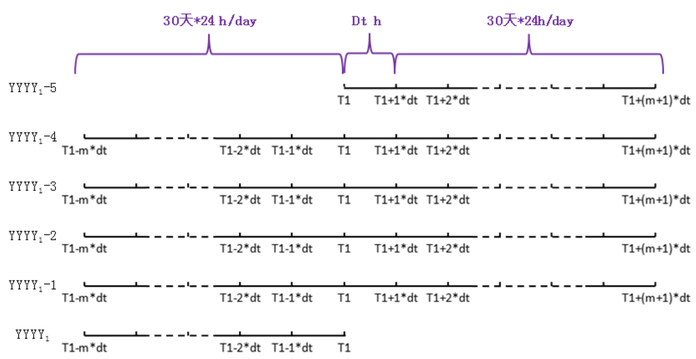

Fig.1 The sketch map of episodes of observation sample for the corresponding periods in past 5 years. (YYYY1MM1DD1HH1: the start time of heavy rainfall processes derived by the current real-time model forecasting. T1:MM1DD1HH1. t1 and t2 is the start and end forecast time (unit: h)，dt=t2-t1, m*dt≤30day*24h/day＜(m+1)*dt

k	1	2	3	4	5	6
G_k（mm）	0.1	10	25	50	100	250
$OPCV_k$（%）	80.39	41.18	21.57	9.8	3.92	1.96

Table.1 The critical values of optimal probability ($OPCV_k$) at the different forecast grades of the accumulative precipitation between 96 ～144 forecast lead time initialized at 1200 UTC 29 July 2015 derived by the scheme of OPPF1

k	1	2	3	4	5	6
G_k（mm）	0.1	10	25	50	100	250
$OPCV_k$（%）	31.37	45.1	27.45	23.53	9.8	3.92
G_{kL}（mm）	2.9	9.4	22.8	35	71	175

Table.2 the $OPCV_k$ and their calculating forecast grades (G_{kL}) derived by the scheme of OPPF3, The other is same as in table 1

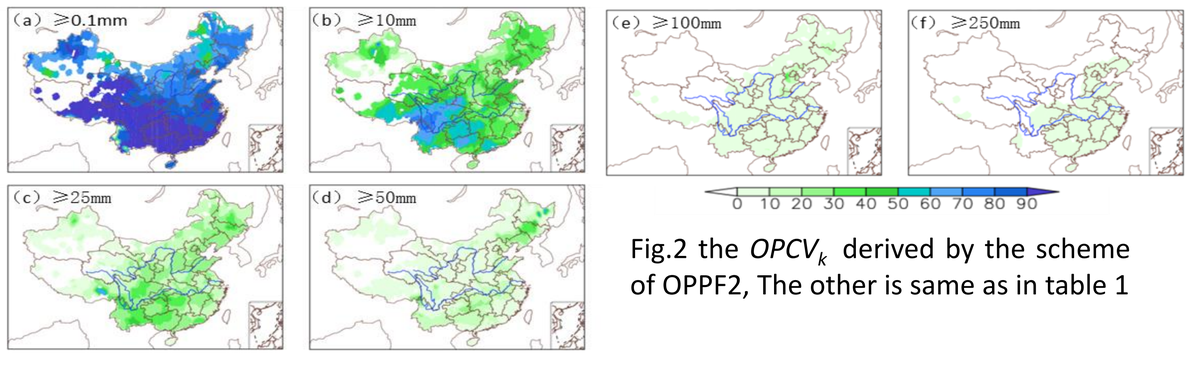

Fig.2 the $OPCV_k$ derived by the scheme of OPPF2, The other is same as in table 1

The difference of the 3 OPPFs: For every forecast grades (G_k), there is the only $OPCV_k$ at all station in China in the scheme of OPPF1 (Table 1) and OPPF3 (Table 2) and is respectively $OPCV_k$ at every station in China in the scheme of OPPF2(Fig.2). Moveover, the CCF values in the scheme of OPPF3 are assigned as G_k based the probabilities of accumulative precipitation of EPD above G_{kL} exceeding the $OPCV_k$

2. the forecast performance of OPPF3 produced by the reforecast test

In the medium-extended-range forecast time (96～360h), the performance of the 3 OPPFs are better than that of EMPF and CTPF for heavy precipitation forecast and clear-rain forecast. The performance of OPPF1 and OPPF3 is better than that of CTPF and close to that of EMPF for precipitation above Moderate intensity or larger intensity.

Among the 3 OPPFs, the forecast performance of OPPF3 is slightly better than that of OPPF1 in overall. Meanwhile the forecast performance of OPPF3 and OPPF1 is better than that of OPPF2.

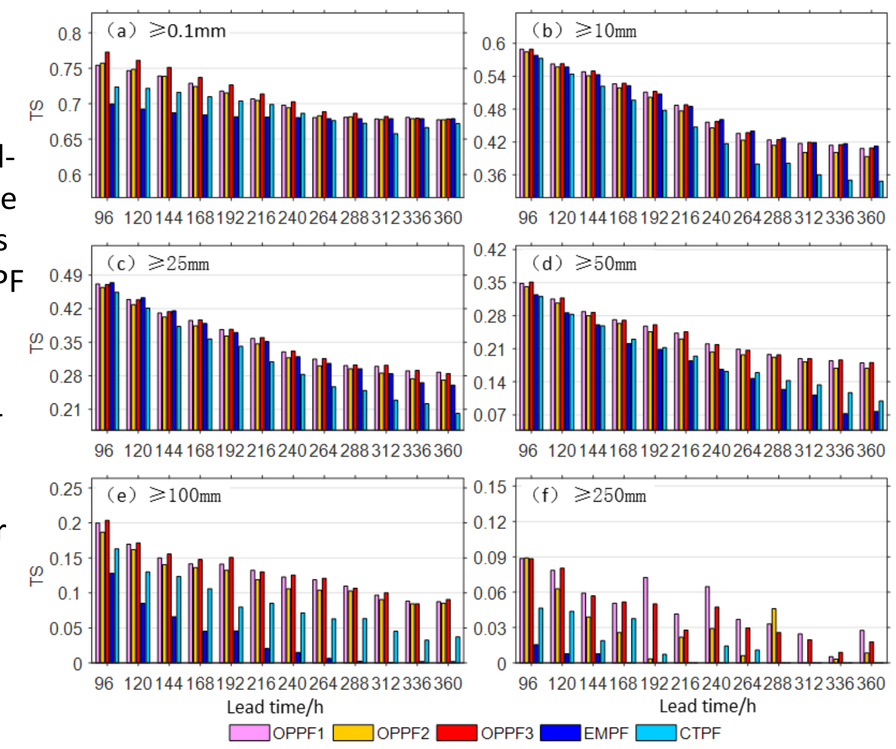

Fig.3 The TS in medium-extended-range forecast time of the three OPPFs and EMPF and CTPF for the accumulative precipitation of 91 heavy rainfall processes from May to September during 2015 to 2017 in China

There are obvious regional differences in forecast performances. TS in southern China are higher than in northern China, and the performance of OPPF3 for heavy precipitation is better than that of EMPF in southern China. During 96～240h forecast time, the performance of OPPF3 for heavy precipitation is also better than that of EMPF in eastern part of Northeast China.

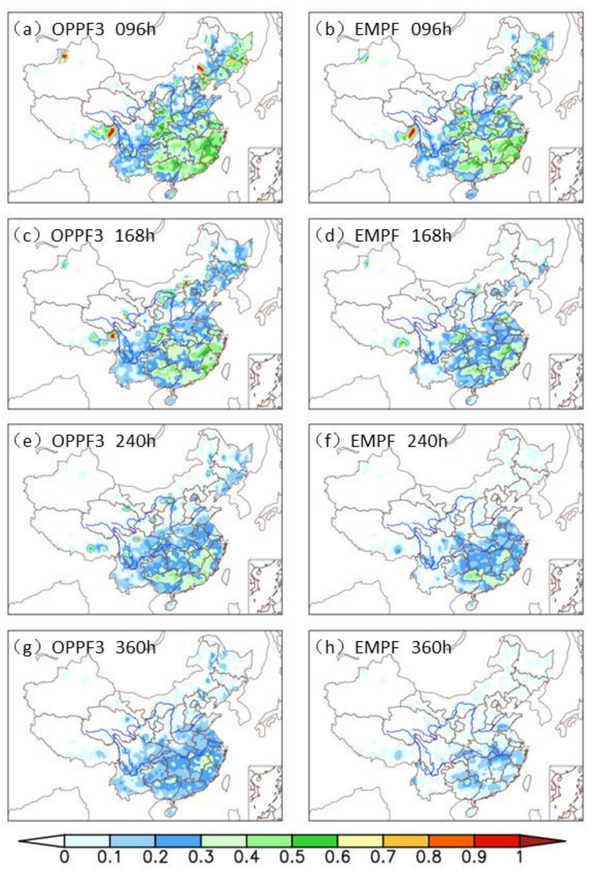

Fig.4 The TS distributions at different forecast time of OPPF3 and EMPF for accumulative precipitation above 50mm of 91 heavy rainfall processes from May to September during 2015 to 2017 in China

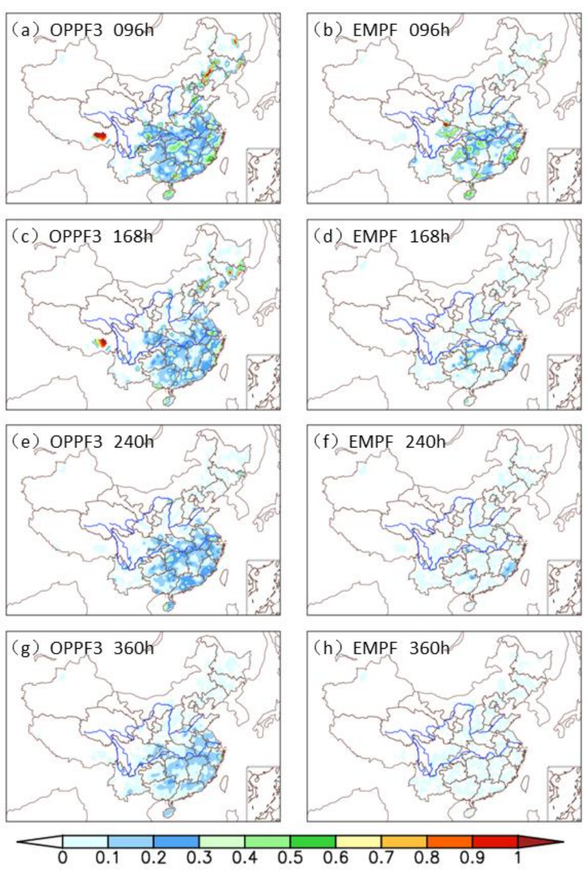

Fig.5 The other is same as in Fig.3, but for accumulates precipitation above 100mm

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