Verification and intercomparison of QPFs and PQPFs from TIGGE over East Asia

Xiang Su* and Huiling Yuan

Key Laboratory of Mesoscale Severe Weather/Ministry of Education, and School of Atmospheric Sciences
Nanjing University, Nanjing, 210093, China * e-mail: dg1228010@smail.nju.edu.cn

This poster participates in OSP
Outstanding Student Poster Contest

Abstract ID: EGU2013-80
Session: AS1.4/CL2.11/HS12.1

Motivation

- Evaluate the precipitation forecast quality of the typical operational Ensemble Prediction Systems (EPSs)
- Use different metrics to see different aspects of quantitative precipitation forecasts (QPFs, here refers to the ensemble mean precipitation forecasts) and probabilistic QPFs (PQPFs)
- Monitor the performance changes of the EPSs due to model upgrades

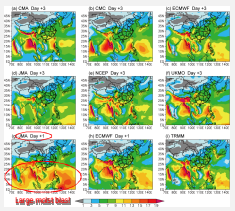
Data

- The 24-h precipitation forecast data of the selected six operational EPSs from the THORPEX Interactive Grand Global Ensemble (TIGGE)
- The Version 7 advanced TRMM satellite based rainfall product 3B42 (TRMM 3B42 V7), 0.25° × 0.25° ,3-hourly, 50° S-50° N
- All data was linearly remapped onto the 1.0° × 1.0° grid for verification
- Tropics: 0-20° N, Extratropics: 20-49° N

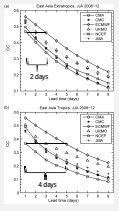
Center	Base time (UTC)	No. of ensemble members	Horizontal resolution archived	Forecast length (day)	Initial perturbation method	Model uncertainty	Major model upgrade time
CMA (China)	00/12	14+1	0.56° × 0.56°	0-10	BVs	-	-
CMC* (Canada)	00/12	20+1	1.0° × 1.0°	0-16	EnKF	PTP+SKEB	17 Aug 2011
ECMWF* (Europe)	00/12	50+1	N320(~0.28°) N160(~0.56°)	0-10 10-15	EDA-SVIM	SPPT+SPBS (Multi-physics)	26 Jan 2010
JMA* (Japan)	12	50+1	1.25° × 1.25°	0-9	SVs	SPPT	16 Dec 2010
NCEP* (USA)	00/06/12/18	20+1	1.0° × 1.0°	0-16	ETR	STTP	23 Feb 2010
UKMO* (UK)	00/12	23+1	0.83° × 0.56°	0-15	ETKF	RP+SKEB	9 Mar 2010

*The CMC EPS was upgraded to version 2.0.2 on 17 August 2011.
*The ECMWF EPS used a horizontal resolution of N200(~0.45°) for 0-10 day forecast and N128(~0.7°) for 10-15 day forecast before 26 January 2010. EVO-SVIM was used as the initial perturbation method before 22 Jun 2010. The SPBS method has not been used to account for model uncertainty until 9 November 2010.
*The JMA EPS began to take account of model uncertainty with the SPPT method on 16 December 2010.
*The NCEP EPS began to take account of model uncertainty with the STTP method on 23 February 2010.
*The UKMO EPS used a horizontal resolution of 1.25° × 0.83° before 9 March 2010.

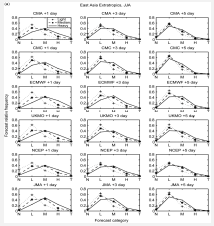
Verification of QPFs



Average summer (June-August, JJA) precipitation during 2008-2012

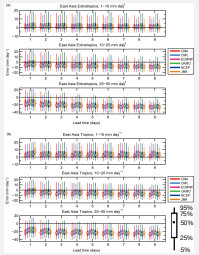


Spatial correlation during 2008-2012 JJA



Discrimination diagrams of QPFs in East Asia Extratropics. The ordinate shows the forecast relative frequencies of observed light rain (1-10 mm day^{-1}, dotted lines), moderate rain (10-25 mm day^{-1}, dash lines), and heavy rain (25-50 mm day^{-1},solid lines) against five forecast categories: no rain (N, <1 mm day^{-1}), light rain (L, 1-10 mm day^{-1}), moderate rain (M, 10-25 mm day^{-1}), heavy rain (H, 25-50 mm day^{-1}) and torrential rain (T, >50 mm day^{-1}). The diagram in East Asian Tropics is similar and not shown here.

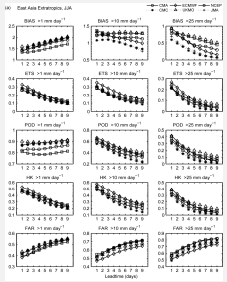
Forecasts gradually lose the ability to distinguish different rain events



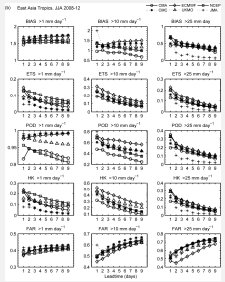
Forecast error during 2008-2012 JJA

- Overestimate light rain events and underestimate heavy rain events
- The discrepancies of ETS and HK skill are more obvious in the Tropics

JMA and CMC tend to produce less extreme forecasts

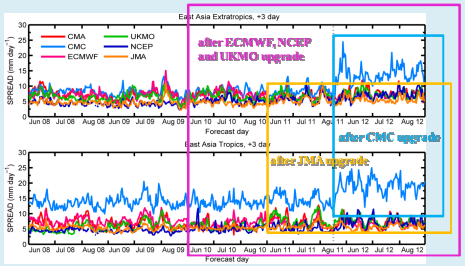


Scores for binary forecasts in East Asian Extratropics



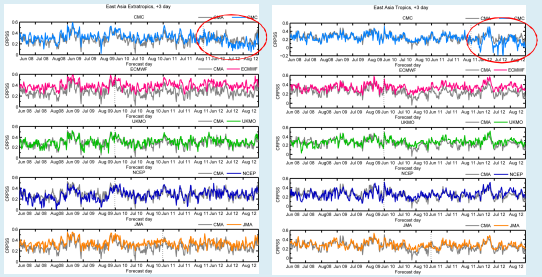
Scores for binary forecasts in East Asian Tropics

Performance changes due to upgrades



Time series of ensemble spread during 2008-2012 JJA

The CMC EPS added more ensemble spread after upgraded to version 2.0.2.

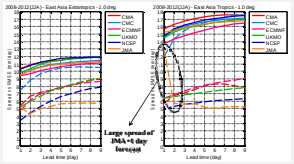


Time series of CRPSS in East Asian Extratropics

Time series of CRPSS in East Asian Tropics

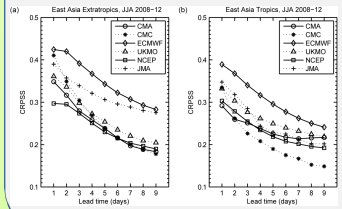
- Use the CMA EPS as the benchmark
- After upgraded to version 2.0.2, the PQPFs of CMC EPS became worse than before
- The ECMWF EPS, UKMO EPS and NCEP EPS became better after upgrade
- The performance change of the JMA EPS is not obvious

Verification of PQPFs



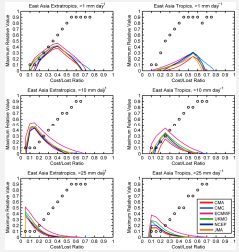
Ensemble spread (mm day^{-1}, dotted lines) and RMSE of ensemble mean forecasts (mmday^{-1}, solid lines)

- All EPSs suffer from severe deficiency of ensemble spread except CMC
- The large ensemble spread of CMC is due to its use of multi-physics to account for model uncertainty



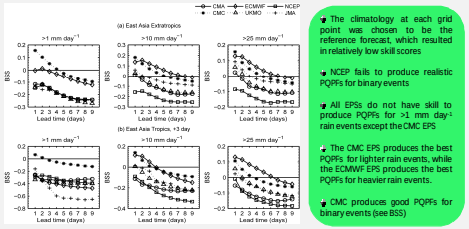
Continuous ranked probability skill score (CRPSS)

- CMC performs good for the +1 day forecasts, but the CRPSS drops very quickly with forecast lead time.
- Though CMC produces good PQPFs for binary events (see BSS), it produces poor PQPFs for continuous forecasts (see CRPSS). This is caused by its large ensemble spread.



Maximum relative economic value for +3 day PQPFs at different precipitation thresholds. The circles indicate the probability thresholds for taking action to achieve the maximum relative economic value among the six centres as a function of different Cost/Loss ratios.

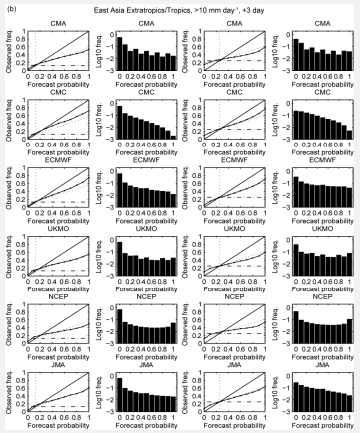
- Generally the ECMWF EPS produces the largest potential economic value.
- The CMC EPS performs better only for high Cost/Lost ratios at the >2.1 mm day^{-1} threshold.



Brier skill score (BSS)

- The climatology at each grid point was chosen to be the reference forecast, which resulted in relatively low skill scores
- NCEP fails to produce realistic PQPFs for binary events
- All EPSs do not have skill to produce PQPFs for >1 mm day^{-1} rain events except the CMC EPS
- The CMC EPS produces the best PQPFs for lighter rain events, while the ECMWF EPS produces the best PQPFs for heavier rain events.
- CMC produces good PQPFs for binary events (see BSS)

All EPSs show a dry bias at the low end and a wet bias at the high end
The CMC EPS is most reliable but least sharp
NCEP is most sharp but least reliable



Reliability diagram (also called "Attribute diagram") at 10 mm day^{-1} threshold

Conclusions

- JMA and CMC tend to produce less extreme forecasts.
- All EPSs suffer from severe deficiency of ensemble spread except CMC. This is due to CMC's use of multi-physics to account for model uncertainties.
- Though CMC produces good PQPFs for binary events, it produces poor PQPFs for continuous forecasts. This is caused by its large ensemble spread.
- CMC is the most reliable but least sharp EPS, and NCEP is the most sharp but least reliable EPS.
- CMC became worse after model upgrades, while others became better except JMA.

References

Jolliffe, I. T., and D. B. Stephenson (2003), Forecast verification : a practitioner's guide in atmospheric science, xiii, 240 p. pp., J. Wiley, Chichester, West Sussex, England ; Hoboken, NJ.
Richardson, D., B. R., and R. Hagedorn (2005), Final report of the 1st Workshop on the THORPEX Interactive Grand Global Ensemble (TIGGE), in WMO TD No. 1273, WWRP-THORPEX No. 5., edited.
Wilks, D. S. (2006), Statistical methods in the atmospheric sciences, 2nd ed., xvii, 627 p. pp., Academic Press, Amsterdam; Boston.
Su, X., and H. Yuan (2013), The TIGGE ensemble predictions of Northern Hemisphere summer precipitation during 2008-2012, to be submitted to J GEOPHYS RES-ATMOS

Acknowledgements

This project received the support from Natural Science Foundation of China (41175087), the R&D Special Fund for Public Welfare Industry (meteorology) (GYHY201206005), and the Priority Academic Program Development of Jiangsu Higher Education Institutions. Also appreciate the graduate school of Nanjing University for the support of graduate studies.