

# Electronic Supplementary Material to: System of Multigrid Nonlinear Least Squares Four-dimensional Variational Data Assimilation for Numerical Weather Prediction (SNAP): System Formulation and Preliminary Evaluation\*

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**Table S1.** Cumulative precipitation thresholds.

Times (h)	Light rainfall (mm)	Moderate rainfall (mm)	Heavy rainfall (mm)	Rainstorm (mm)	Torrential rainfall (mm)
12	≥ 0.1	≥ 5.0	≥ 15.0	≥ 30.0	≥ 70.0
24	≥ 0.1	≥ 10.0	≥ 25.0	≥ 50.0	≥ 100.0

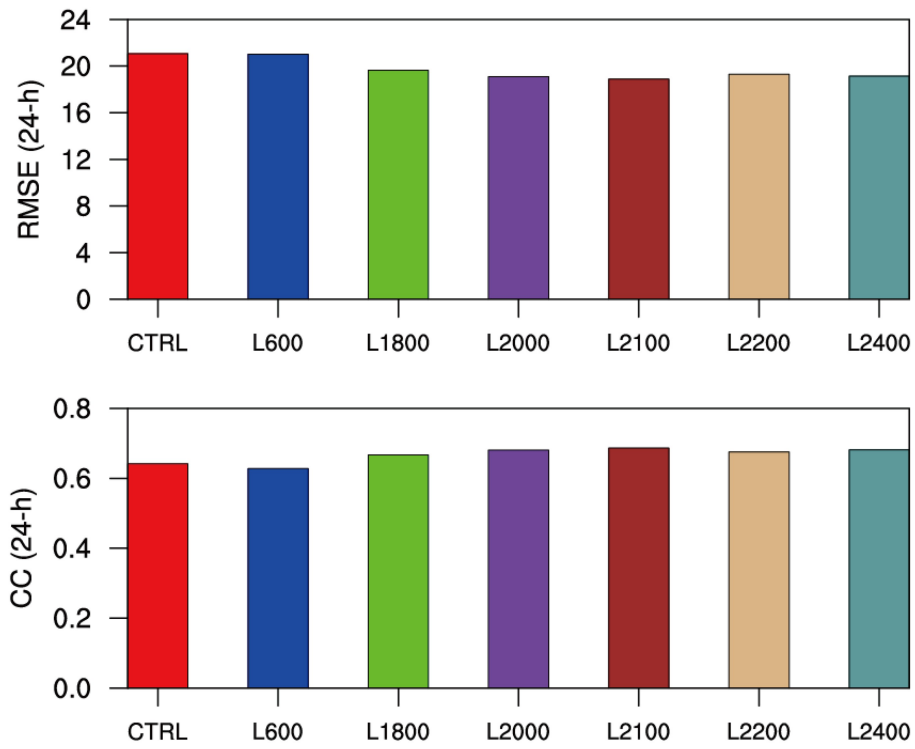
**Table S2.** Relationships between precipitation forecasts and observations ( $a$  is the number of correct hits,  $b$  is the number of false alarms, and  $c$  is the number of misses;  $d$  refers to the number of stations in which both the prediction and observation were below a certain threshold).

Precipitation forecast	Observation	
	Yes	No
Yes	$a$	$b$
No	$c$	$d$

**Table S3.** TS of 24-h precipitation forecasts corresponding to different localization radii and CTRL.

Radius (km)	CTRL	Localization radius (km)					
		600	1800	2000	2100	2200	2400
≥ 0.1	0.7957	0.8045	0.8028	0.7998	0.8038	0.8019	0.7990
≥ 10.0	0.6945	0.7005	0.7065	0.7074	0.7076	0.7060	0.7136
≥ 25.0	0.5647	0.5255	0.5630	0.5734	0.5856	0.5685	0.5839
≥ 50.0	0.3922	0.3434	0.3478	0.3279	0.3279	0.3242	0.3370
≥ 100.0	0.05	0.05	0.0	0.0	0.0	0.0	0.0

\* The online version of this article can be found at <https://doi.org/10.1007/s00376-020-9252-1>.



**Fig. S1.** The RMSE and CC values of 24-h cumulative precipitation observations and forecasts corresponding to different localization radii and CTRL.