

Timely Event Attribution of Extreme Precipitation in Japan: An Example of Heavy Rainfall in July 2020

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The supplemental material provides additional figures (Figs. ES1 and ES2) and tables (ES1–ES3) to elucidate the main text.

Time series of regional mean precipitation from 31.9–32.4N,129–132E

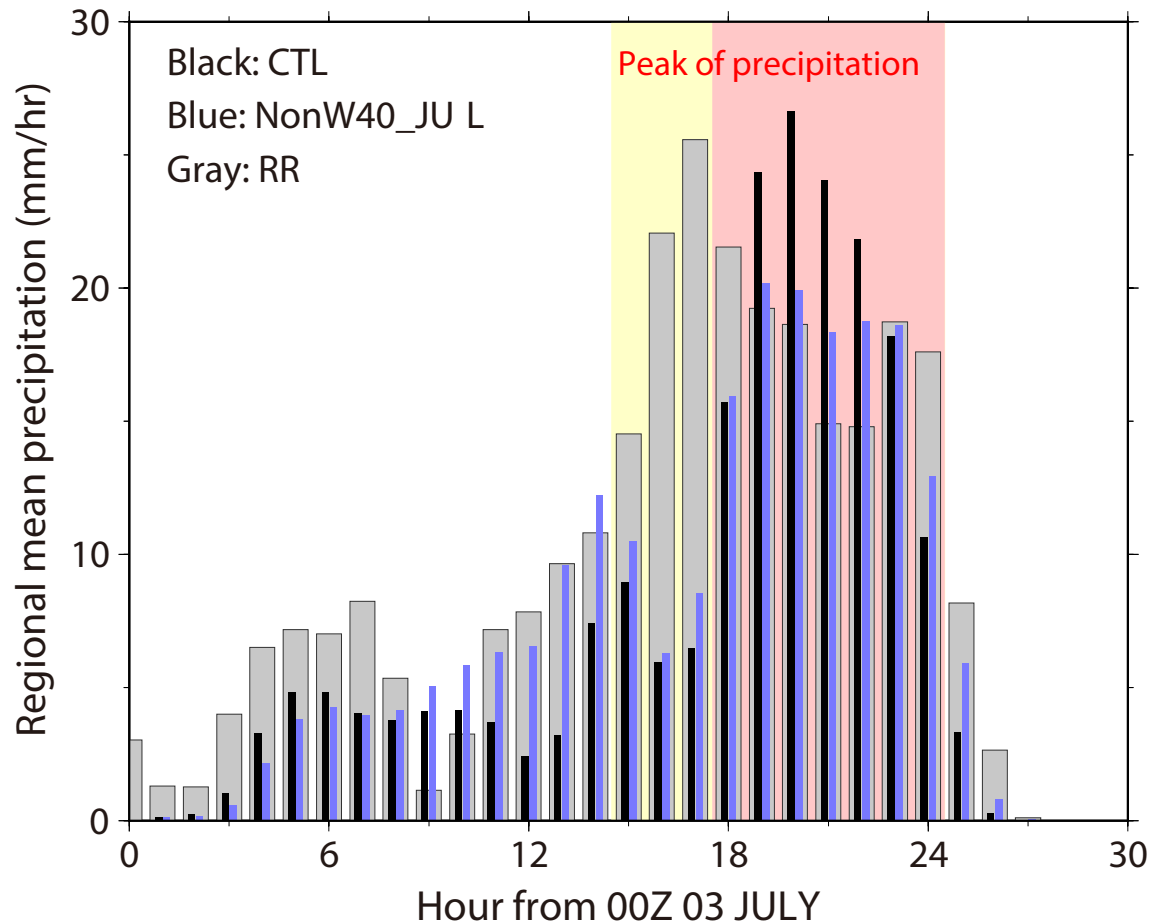


Fig. ES1. Time series of regional mean precipitation over 31.9°–32.4°N, 129°–132°E from 0000 UTC 3 Jul 2020. Black, blue, and gray bars represent CTL, NonW40_JUL, and RR respectively. Light red shading show the peak of precipitation simulated by the NHM. The duration of observed heavy precipitation is longer than simulated ones (yellow and red shadings).

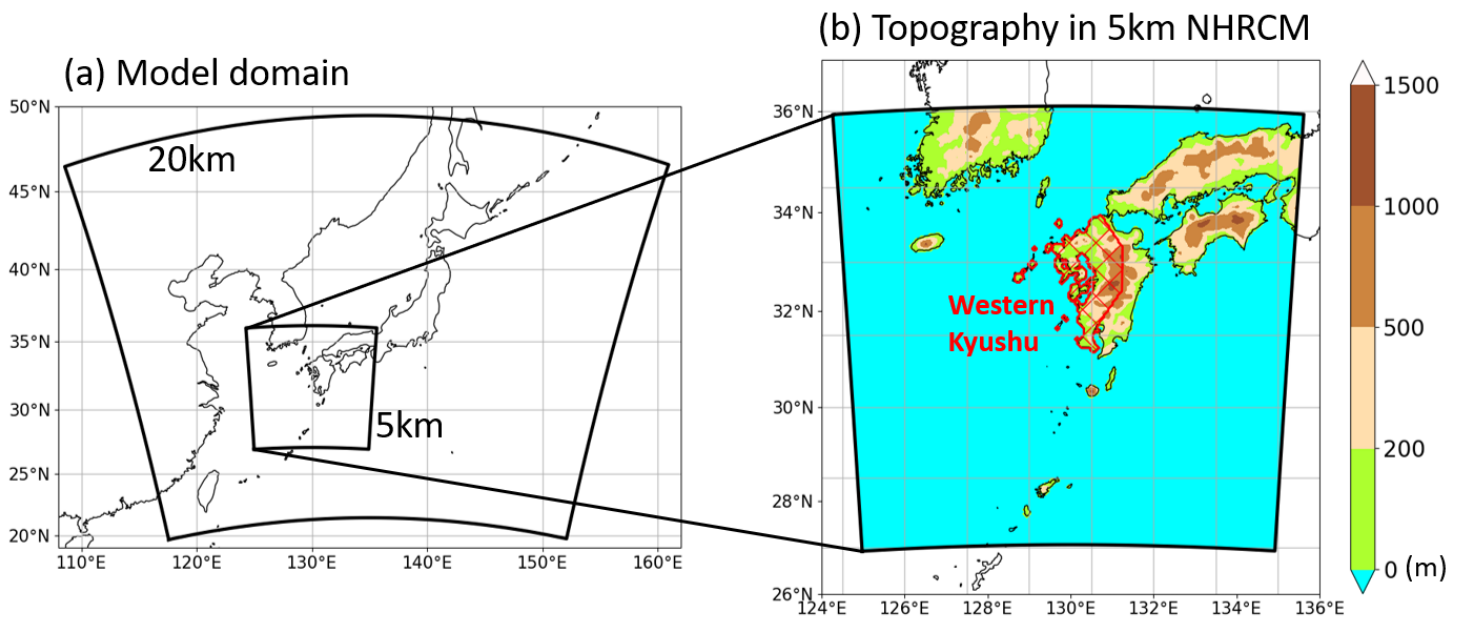


Fig. ES2. Model domains and topography. (a) Model domains of 20-km mesh NHM in d4PDF and 5-km mesh NHM. (b) Topography in 5-km mesh NHM. The red-hatched area represents western Kyushu, where the number of ES-MCS is calculated.

Table ES1. Specification of NHM for the storyline approach.

Grid No.	400 × 200 × 50 for 5-km mesh NHM, 500 × 400 × 50 for 1-km mesh NHM
Height to model top	20 km
Physical process	
Cloud microphysics	Bulk-type cloud microphysics (Ikawa et al. 1991)
Convective precipitation	Kain–Fritsch convective parameterization (Kain and Fritsch 1993) for 5 km-NHM only
Radiation	Clear-sky radiation (Yabu et al. 2005) Cloud radiation (Kitagawa 2000)
Boundary layer	Improved Mellor–Yamada–Nakanishi–Niino (MYNN) Level 3 (Nakanishi and Niino 2004)

Table ES2. Experimental designs. The improved MRI/JMA Simple Biosphere (iSiB) updated from Hirai and Oh'izumi (2004). Non-warming experiments in d4PDF are forced by COBE-SST2 (Hirahara et al. 2014) in the 1900s and the concentration of greenhouse gases in 1850.

		Storyline approach			Risk-based approach	
Experiment name		CTL	NonW40_JUL	NonW40_JJA	HIST	NonW-d4PDF
Regional model		NHM			NHM including land surface model	
Initial and lateral boundary condition		JMA mesoscale analysis data (MA)	MA without recent 40-yr temperature trends in July	MA without recent 40-yr temperature trends in JJA	Historical experiments (d4PDF 20 km-mesh RCM) (Imada et al. 2020)	Non-warming experiments (d4PDF 20 km-mesh RCM) (Imada et al. 2020)
Initial date	5 km	0000, 0300, 0600, 0900, 1200, 1500, and 1800 UTC 1 Jul 2020			0000 UTC 20 Jun 2017 0000 UTC 20 Jun 2018	
	1 km	1200 UTC 2 July 2020 (in each 5-km experiment)			—	
No. of ensemble members		7 (initial date ensemble)			100 (SST perturbation ensemble) (Mizuta et al. 2017)	
Analyzed term		1800 UTC 3 Jul–0000 UTC 4 Jul 2020			1–30 Jul 2017 (30 days) 1–30 Jul 2018 (30 days)	

Table ES3. Regional mean 9-h total precipitation simulated CTL, NonW40_JUL, and NonW40_JJA with 1-km grid spacing. Narrow and wide areas are the black and red boxes in Figs. 1d and 1e, respectively. Prec = precipitation; Std = standard deviation.

	Narrow region		Wide region	
	Prec	Std	Prec	Std
CTL	153.88	3.25	81.55	1.01
NonW40_JUL	139.54	2.86	70.37	1.23
NonW40_JJA	141.88	1.94	70.76	1.09

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