Supplementary materials

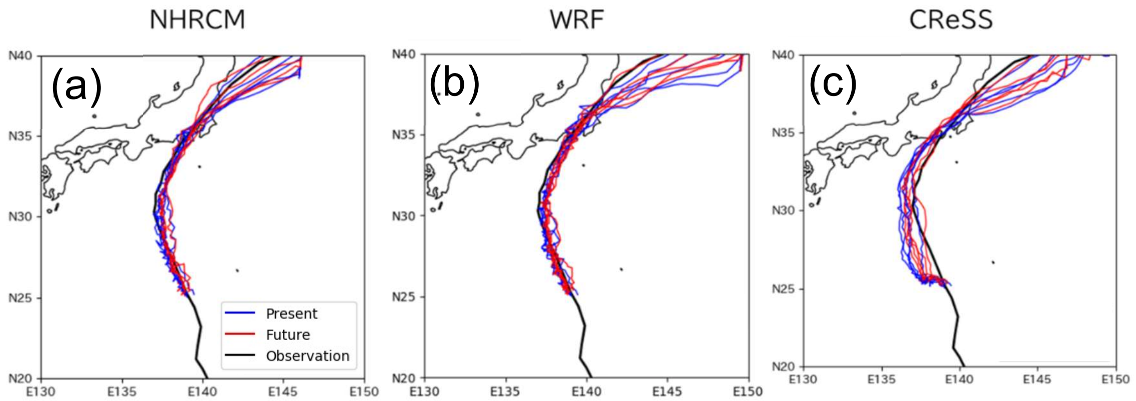


Figure S1 The track of Typhoon Hagibis as reproduced by (a) NHRCM02, (b) WRF, and (c) CReSS models. The blue (red) lines indicate the track from five present (future 4K) ensemble experiments and black line is best track.

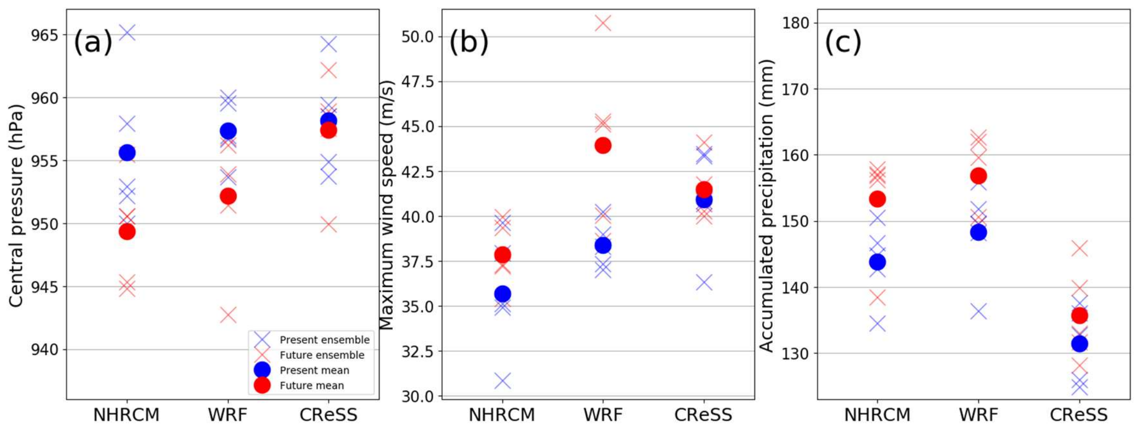
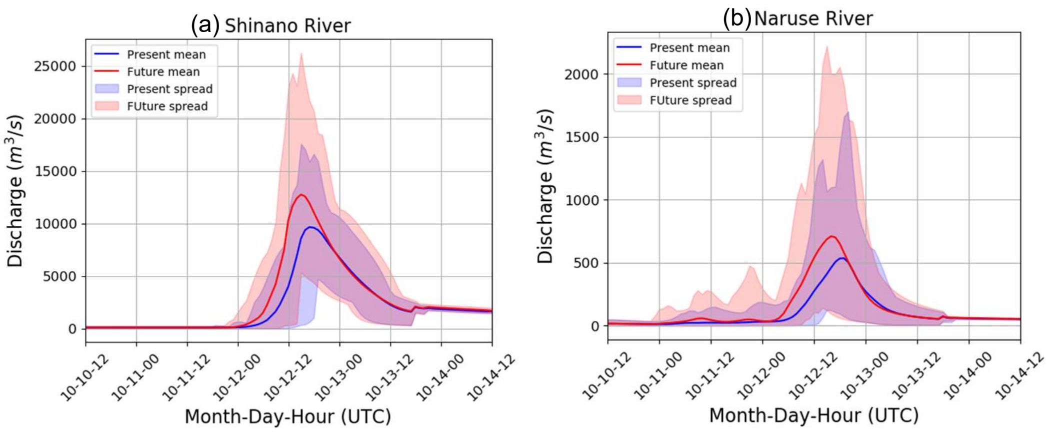


Figure S2 Same as Fig. 4, except for the results from the 2K experiment.



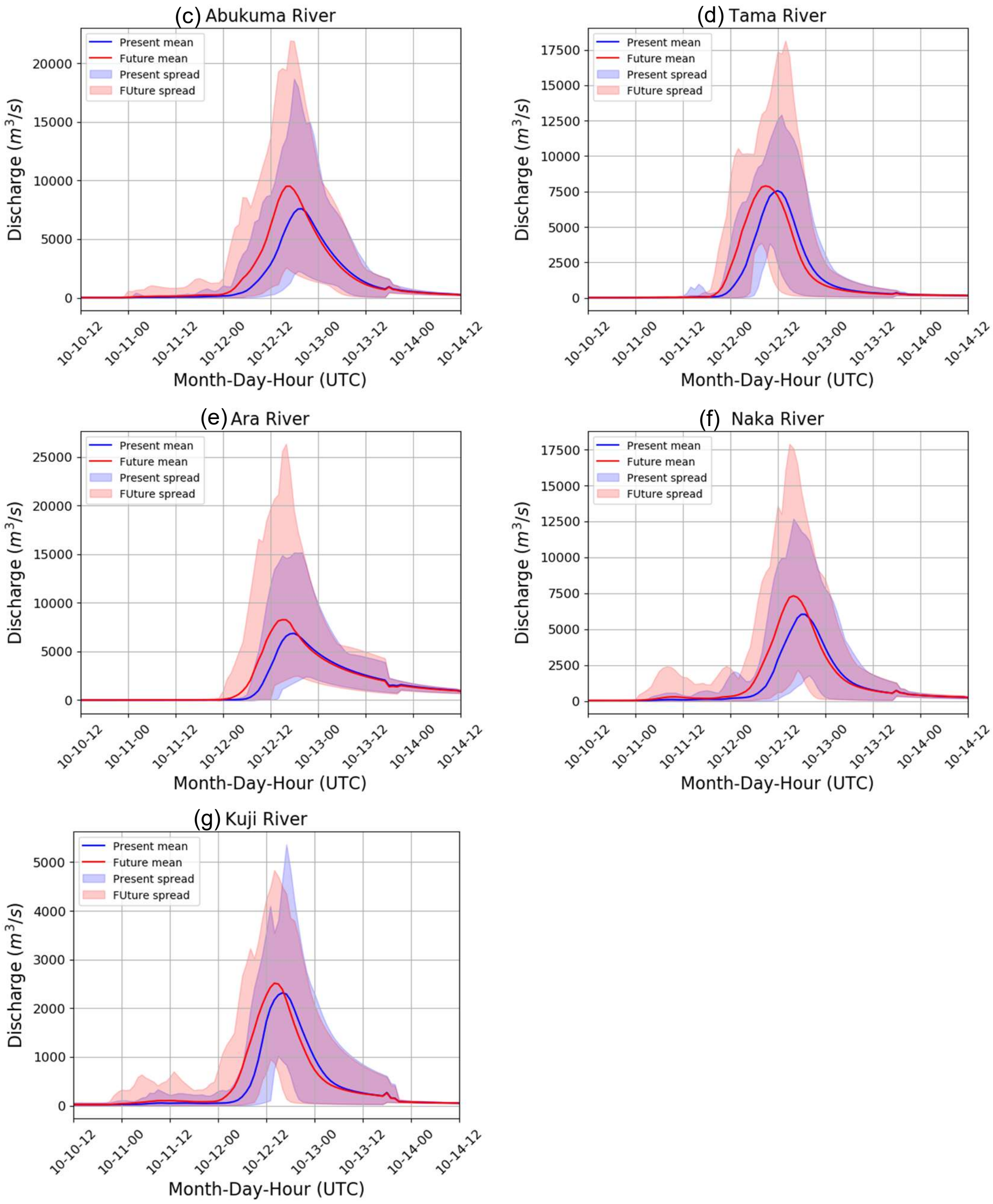


Figure S3 Same as Fig. 5, except for the results from the other 7 observation sites.

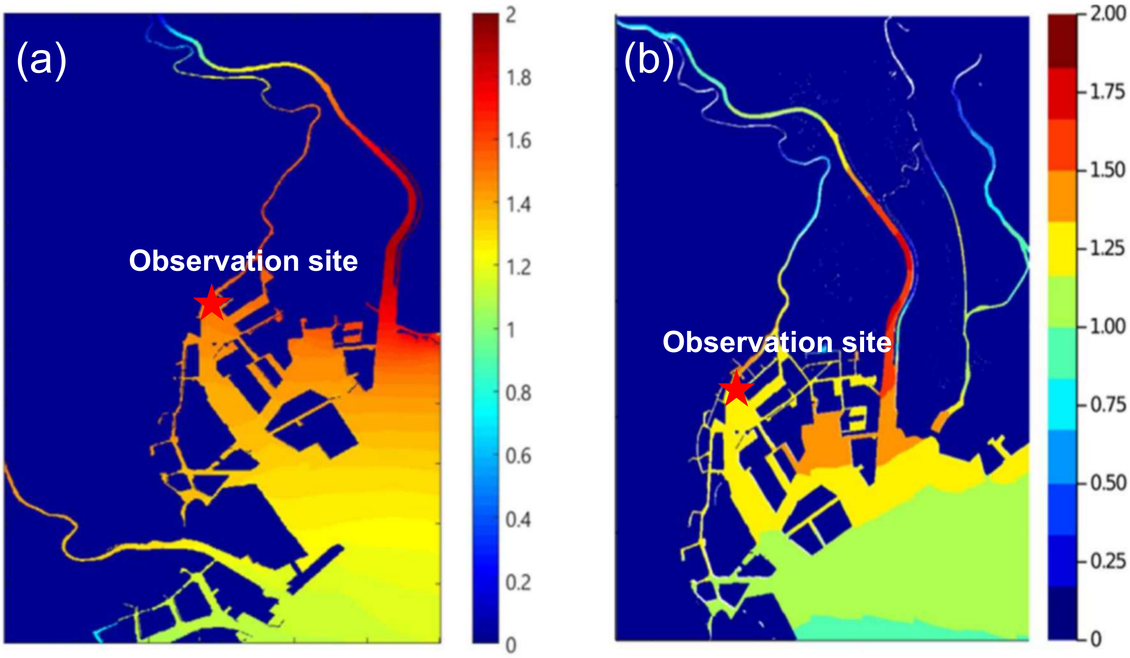


Figure S4 Spatial distribution of maximum tidal level deviation by storm surge models, (a) SuWAT and (b) GeoClaw based on 4K warming experiments with NHRCM using an initial condition.

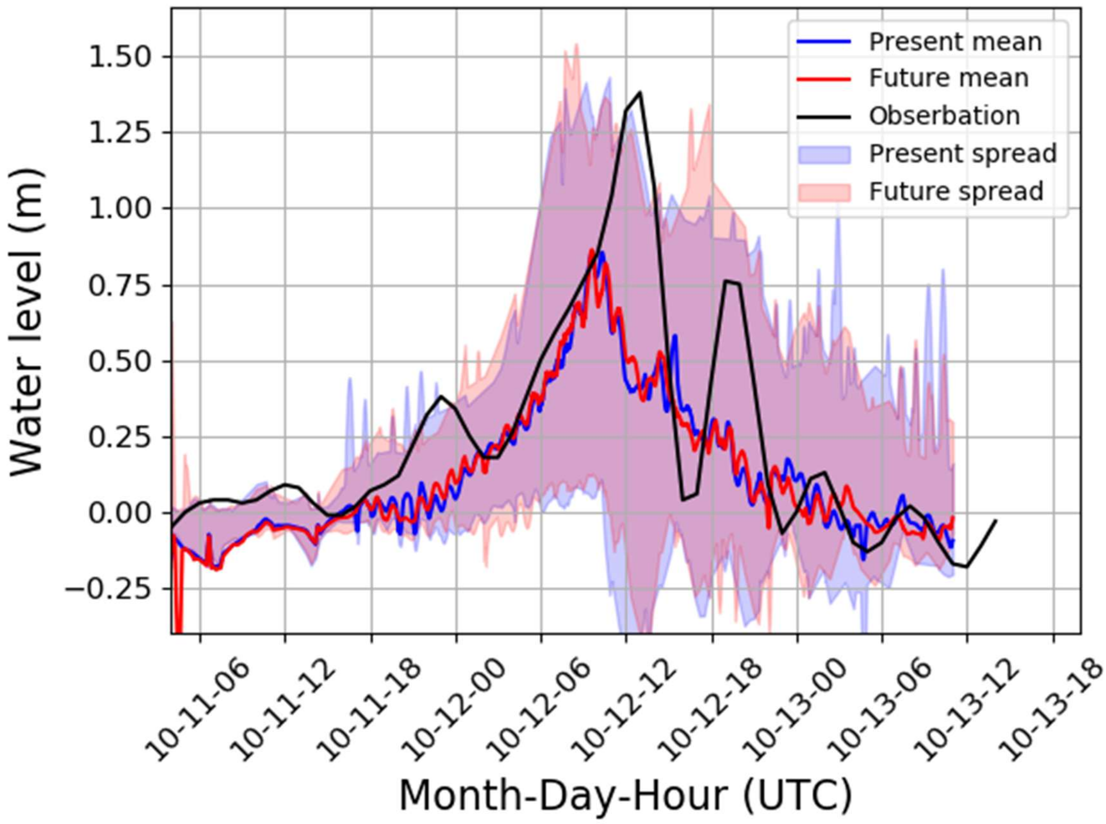


Figure S5 Same as Fig. 8, except for the results from the 2K experiment.

Table S1 Overview of the three meteorological models

	NHRCM	WRF	CReSS
Governing equations	Non-hydrostatic fully compressible model	Non-hydrostatic fully compressible model	Non-hydrostatic fully compressible model
Time Step	10s	10s	2-5s
Mapping	Lambert conformal	Lambert conformal	Lambert conformal
Vertical layer	Generalized hybrid (Ishida 2007)	Terrain-following, mass-based, sigma-pressure vertical coordinate	Terrain-following vertical coordinate
Vertical levels	50	56	50
Cumulus scheme	Kain-Fritsch scheme (NRCHM20 and NHRCM05) and None (NHRCM02)	None	None
PBL scheme	Improved Mellor-Yamada Level3 (Nakanishi and Niino 2004)	Yonsei University nonlocal	Deardorff
Microphysics	Bulk-type microphysics scheme with an ice phase (Lin et al. 1983; Murakami 1990)	WRF single-moment 6-class microphysics scheme	Simple two-moment three-ice bulk scheme
Ocean coupling	Fixed SST	Fixed SST	Slab ocean model
Land surface scheme	MJ-SiB (Hirai and Oh'izumi 2004)	Five-layer thermal diffusion	Bulk scheme by Sagami et al. (1989)
Radiation scheme	Clear-sky radiation scheme (Yabu et al. 2005) Cloud radiation scheme (Kitagawa 2000)	New Rapid Radiative Transfer Model	Tsuboki and Sakakibara (2002)
Spectral nudging	Yes	Yes	No

Table S2 Overview of the three River Models (1K-DHM, RRI, and MATSIRO-CaMa-Flood

	1K-DHM	RRI	MATSIRO-CaMa-Flood	
			MATSIRO	CaMa-Flood
Boundary	Rainfall	Rainfall	Rainfall/Surface	Runoff

condition			pressure/Surface air temperature/Relative humidity/Wind velocity/Downward short and long waves	
Resolution	30 sec	5 sec	60 sec	60 sec
Topography	HydroSHEDS	J-FlwDir	-	J-FlwDir
Flood control	Considered	Considered	-	None
Inundation	None	Overflow	-	Overflow
Slope scheme				
Subsurface runoff	1-D kinematic wave equation with a q-h relationship proposed by Tachikawa et al. (2004)	2-D Diffusive wave equation with a q-h relationship proposed by Tachikawa et al. (2004)	MATROF composed of baseflow, Dunne runoff and Horton runoff (TOPMODEL) and 1st soil layer runoff	-
Infiltration	-	Green-Ampt model	Richards equation	-
Soil moisture	Variable in q-h relationship	Variable in q-h relationship	Variable in MATROF	-
ET	-	Optional (unused)	Considered in MATROF	-
River scheme				
River scheme	1-D kinematic wave equation	1-D diffusive wave equation	-	1-D local inertial equation with the cumulative distribution function of elevation
River section	Rectangular	Rectangular/Real section	-	Rectangular??

Table S3 Overview of the two storm surge models (SuWAT and GeoCla)

	SuWAT	GeoClaw
Governing equations	nonlinear shallow water	nonlinear shallow water

Discretization	Finite difference method, staggered mesh	finite volume method
Numerical method	fixed grid, multi domain nesting	adaptive mesh refinement
Lateral boundary	Radiation	Radiation
Spatial resolution [m]	2430, 810, 270, 90, 30	~38
Forcing	SLP, U10, V10	SLP, U10, V10
Bathymetry	Chubo (Central Cabinet) data	Chubo (Central Cabinet) data
Coastline	10-meter mesh data provided by the Chubo (Central Cabinet), and levees were not taken into account	10-meter mesh data provided by the Chubo (Central Cabinet), and levees were not taken into account

Hirai, M., and Oh'izumi, M.: Development of a new land-surface model for JMA-GSM, Extended abstract of 20th Conference on Weather Analysis and Forecasting. In 16th Conference on NWP. P (Vol. 2), 2004.

Ishida, J.: Development of a hybrid terrain-following vertical coordinate for JMA non-hydrostatic model, Mon. Wea. Rev, 134, 1266-1298, 2007.

Kitagawa, H.: Radiation processes, Separate vol. ann. rep. NPD, 46, 16–31 (in Japanese), 2000.

Lin, Y. L., Farley, R. D., and Orville, H. D.: Bulk parameterization of the snow field in a cloud model, Journal of Applied Meteorology and climatology, 22(6), 1065-1092, https://doi.org/10.1175/1520-0450(1983)022<1065:BPOTSF>2.0.CO;2, 1983.

Murakami, M.: Numerical modeling of dynamical and microphysical evolution of an isolated convective cloud The 19 July 1981 CCOPE cloud, Journal of the Meteorological Society of Japan. Ser. II, 68(2), 107-128, https://doi.org/10.2151/jmsj1965.68.2_107, 1990.

Nakanishi, M., and Niino, H.: An improved Mellor–Yamada level-3 model with condensation physics: Its design and verification, Boundary-layer meteorology, 112, 1-31, https://doi.org/10.1023/B:BOUN.0000020164.04146.98, 2004,

Sagami, H., Lennarz, W. J., and Ogura, K.: The biosynthesis of dehydrodolichyl phosphates by rat liver microsomes, Biochimica et Biophysica Acta (BBA)-Lipids and Lipid Metabolism, 1002(2), 218-224, https://doi.org/10.1016/0005-2760(89)90290-7, 1989.

Tachikawa, Y., Nagatani, G., Takara, K.: Development of stage-discharge relationship equation incorporating saturated-unsaturated flow mechanism, Proceedings of hydraulic engineering, 48, 7-12, 2004.

Tsuboki, K., and Sakakibara, A.: Large-scale parallel computing of cloud resolving storm simulator. In

International Symposium on High Performance Computing (pp. 243-259), Berlin, Heidelberg: Springer Berlin Heidelberg.FF, https://doi.org/10.1007/3-540-47847-7_21, 2002.

Yabu, S., Murai, S., and Kitagawa, H.: Clear sky radiation scheme, Sep. vol. ann. rep. NPD, 51, 53–64 (In Japanese), 2005.