



Supplement of

Disentangling atmospheric, hydrological, and coupling uncertainties in compound flood modeling within a coupled Earth system model

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Content of this file

Figure S1~S11

Table S1

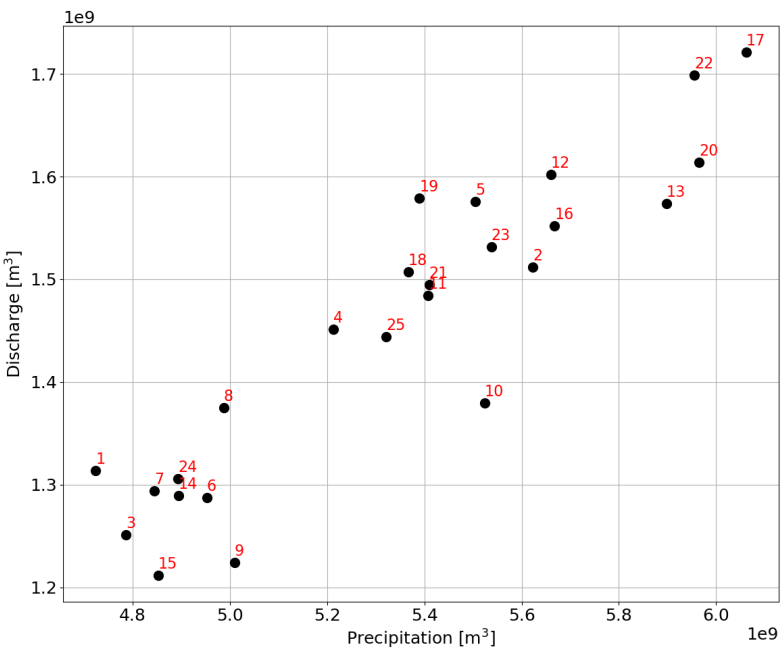


Figure S1 The accumulated precipitation against discharge during Irene for the 25 ensemble simulations.

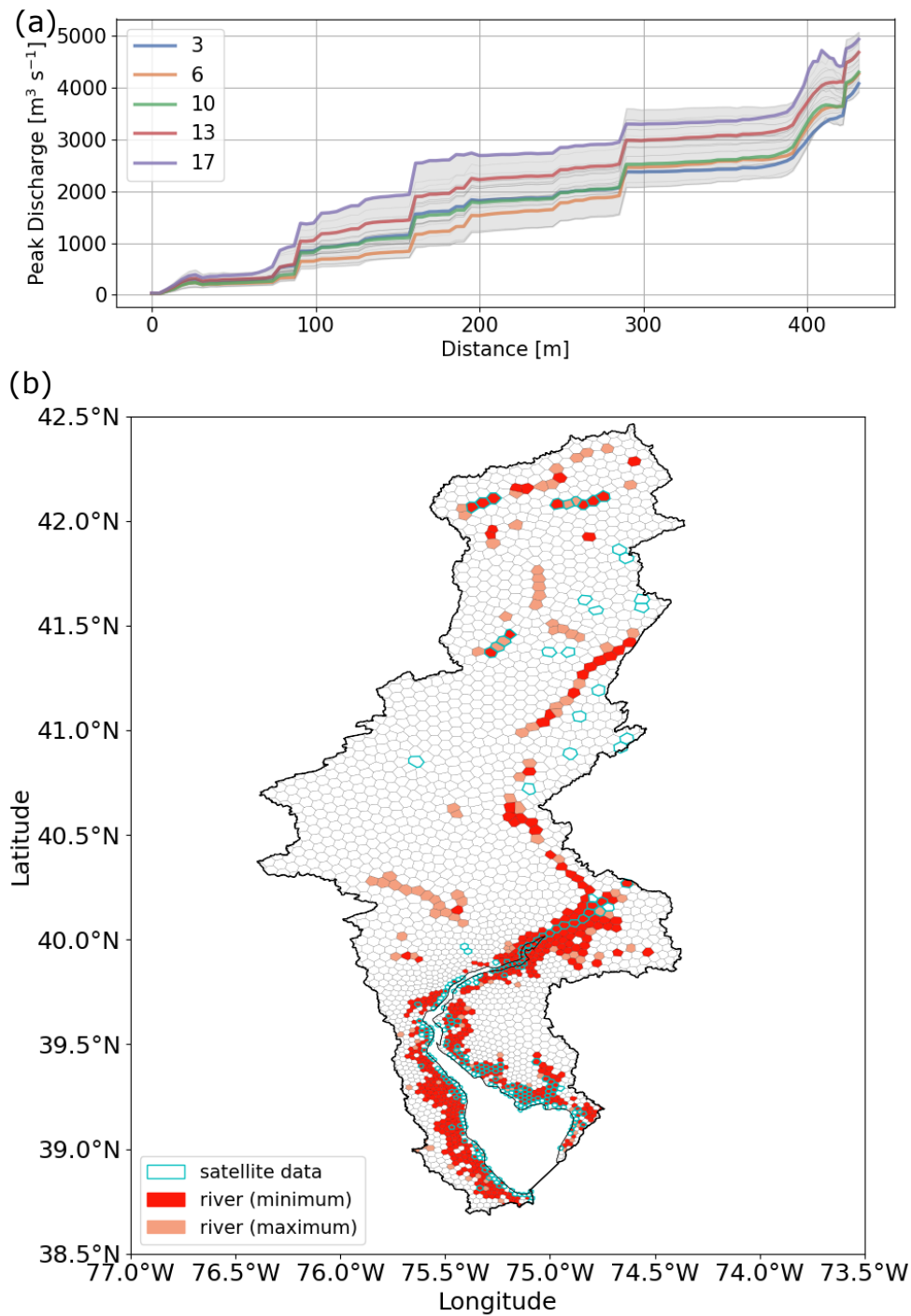


Figure S2: (a) Peak discharge along the Delaware River mainstem modeled using the five selected atmospheric ensemble members. (b) The corresponding riverine inundation extent. Darker and lighter red colors indicate the minimum and maximum inundation extent, respectively, among the five ensemble members.

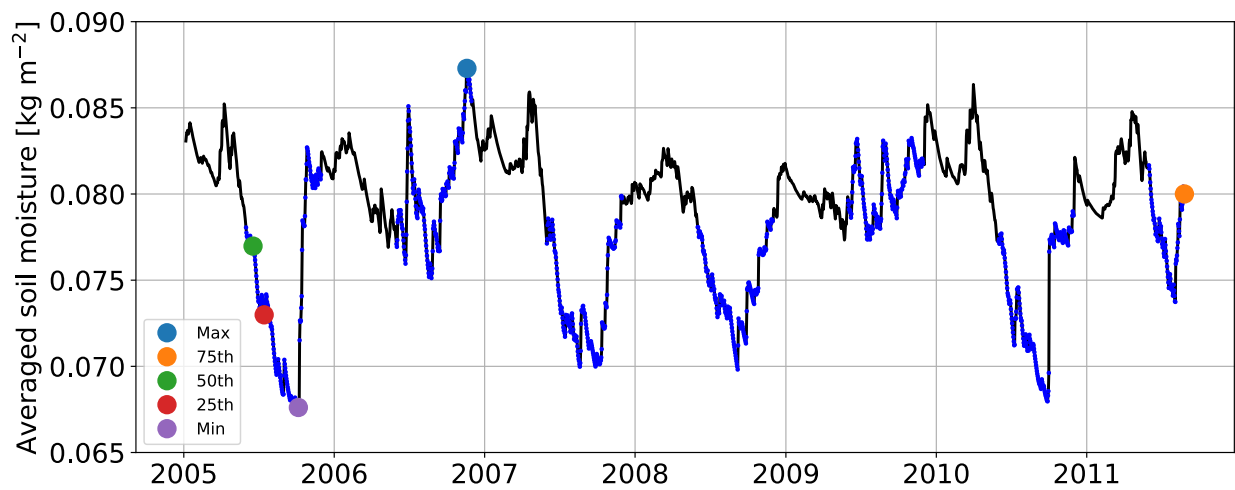


Figure S3: Time series of soil moisture averaged in Delaware River Basin (DRB) obtained from a historical ELM simulation forced by the Global Soil Wetness Projects version 3 (GSWPv3) climate forcing data set (Kim, 2017) running on the same mesh as Irene simulations. The hurricane seasons are highlighted by blue. The colored circles represent the selected quantiles used to generate the enhanced simulation ensemble.

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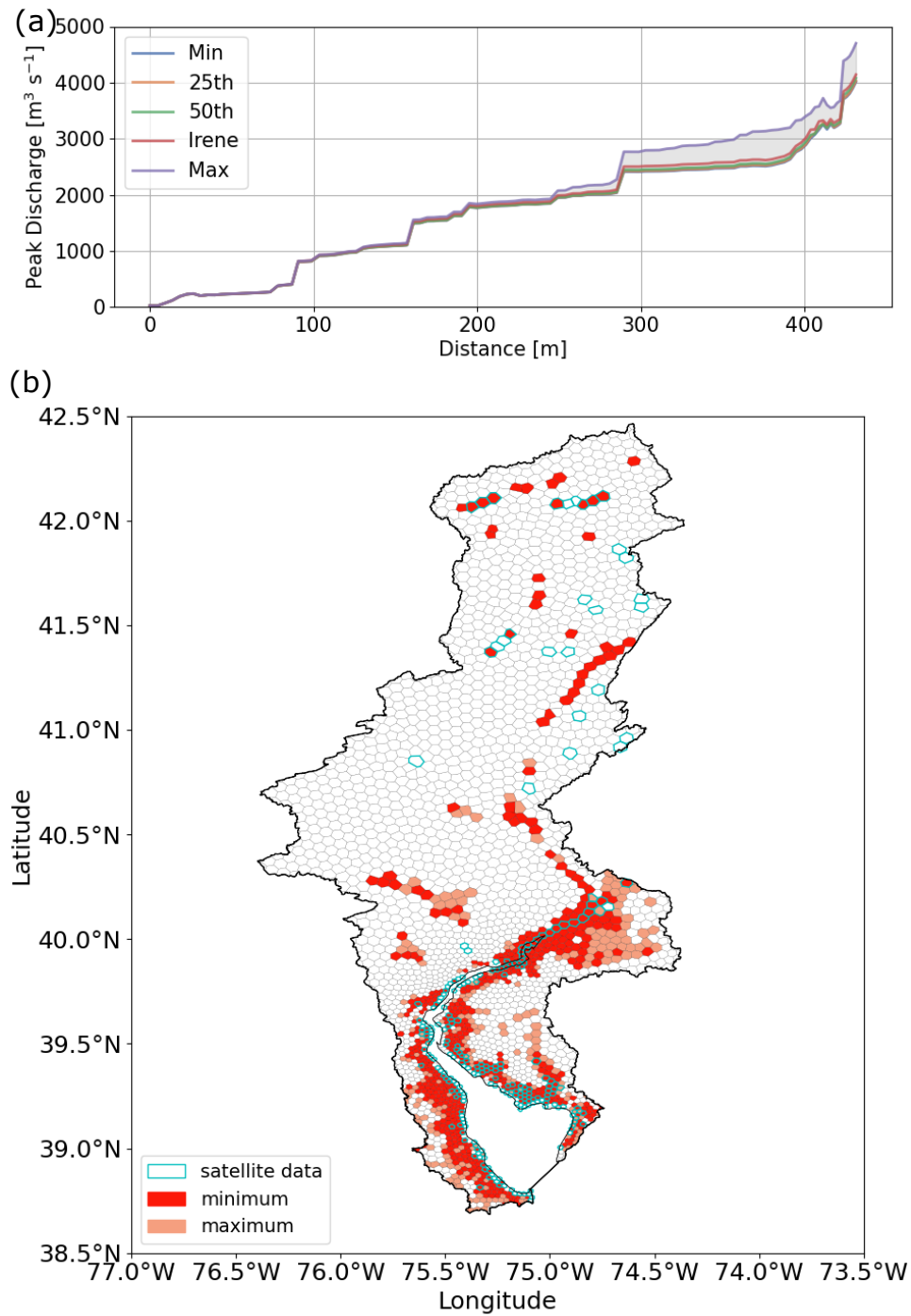
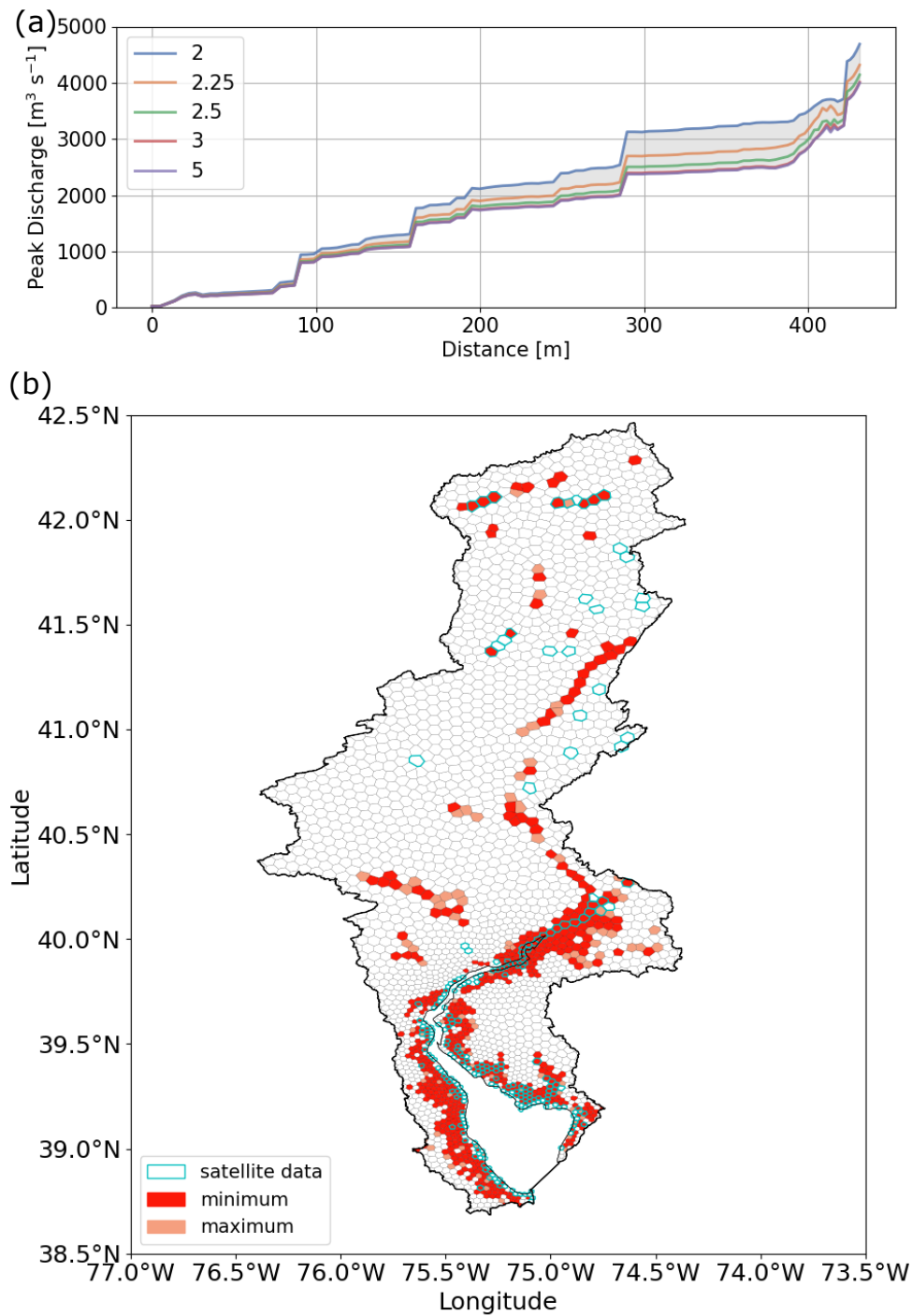


Figure S4: (a) Peak discharge along the Delaware River mainstem modeled from the simulations with five antecedent moisture conditions (AMCs) selected in Figure S3. (b) The corresponding riverine inundation extent.



30 **Figure S5: (a) Peak discharge along the Delaware River mainstem modeled from the simulations using five values of f_{drain} (i.e., 2, 2.25, 2.5, 3 and 5). (b) The corresponding riverine inundation extent.**

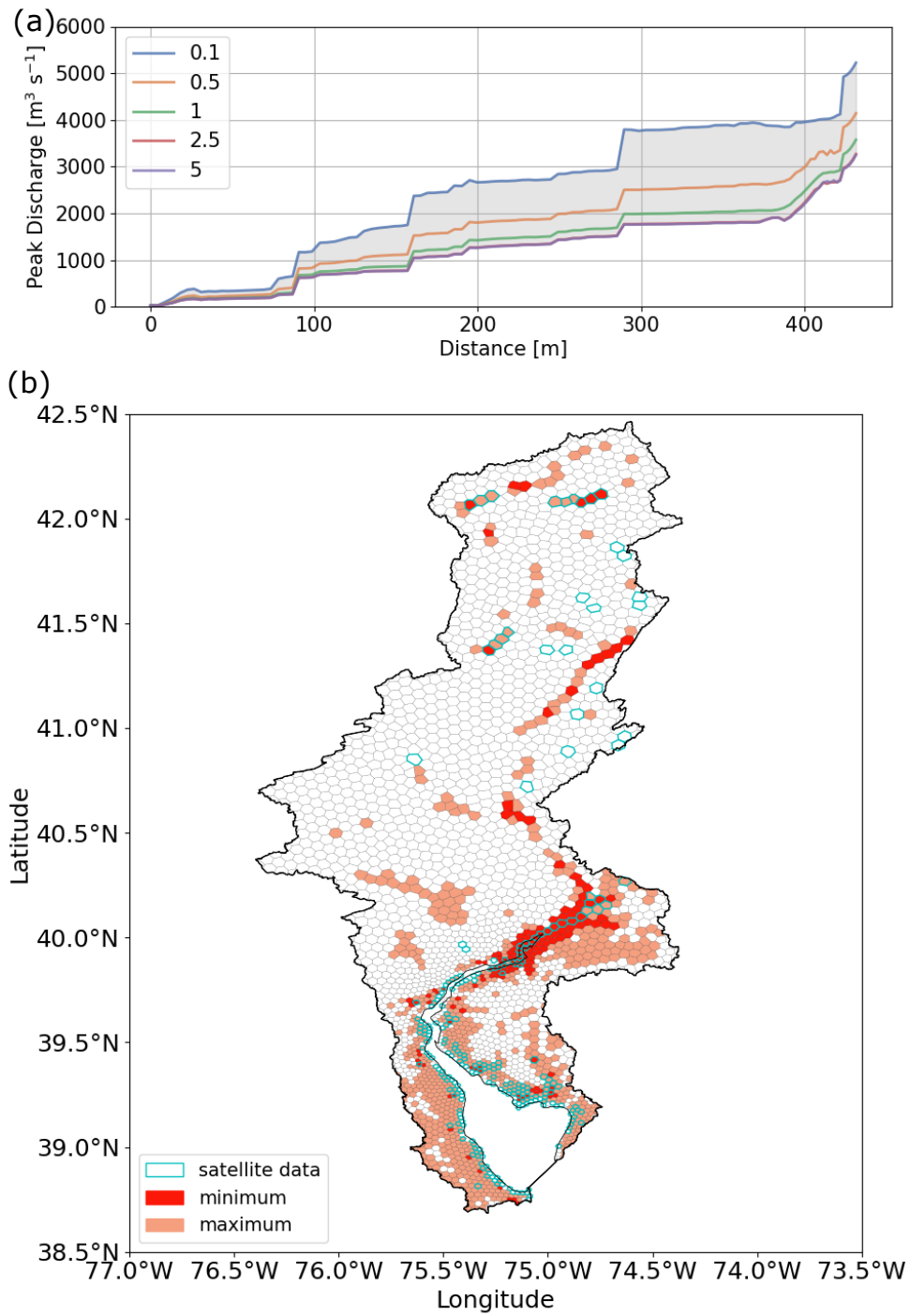


Figure S6: (a) Peak discharge along the Delaware River mainstem modeled from the simulations using five values of f_{over} (i.e., 0.1, 0.5, 1, 2.5 and 5). (b) The corresponding riverine inundation extent.

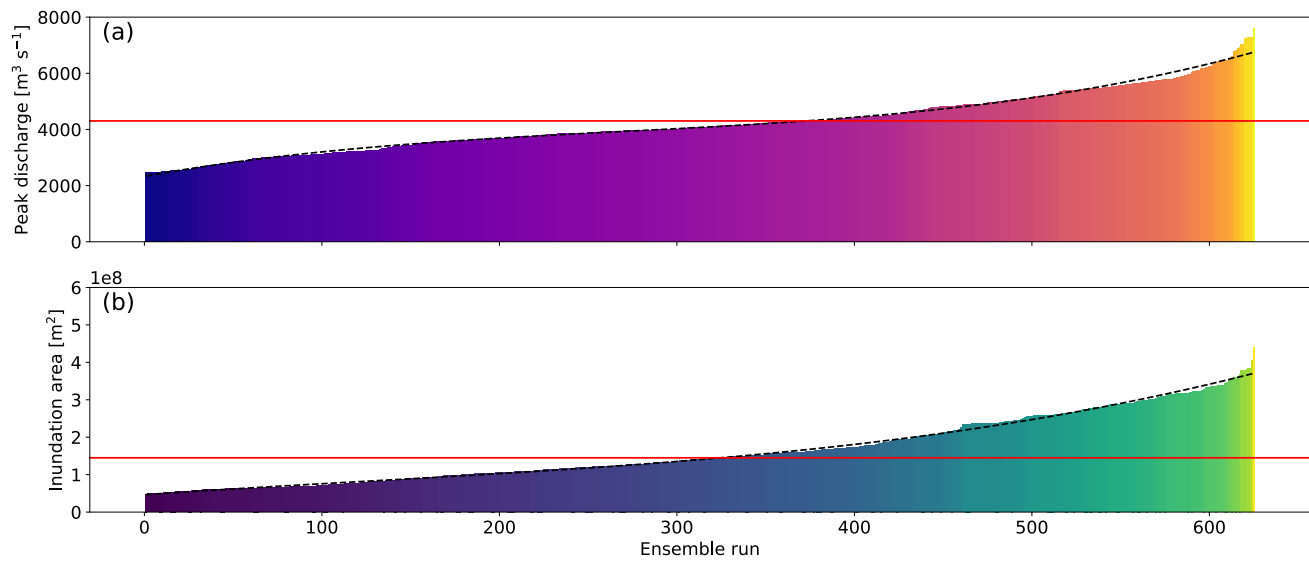


Figure S7: (a) Peak discharge and (b) riverine inundation area of the 625 ensemble simulations. The red lines represent the results of the simulation that best describes Irene.

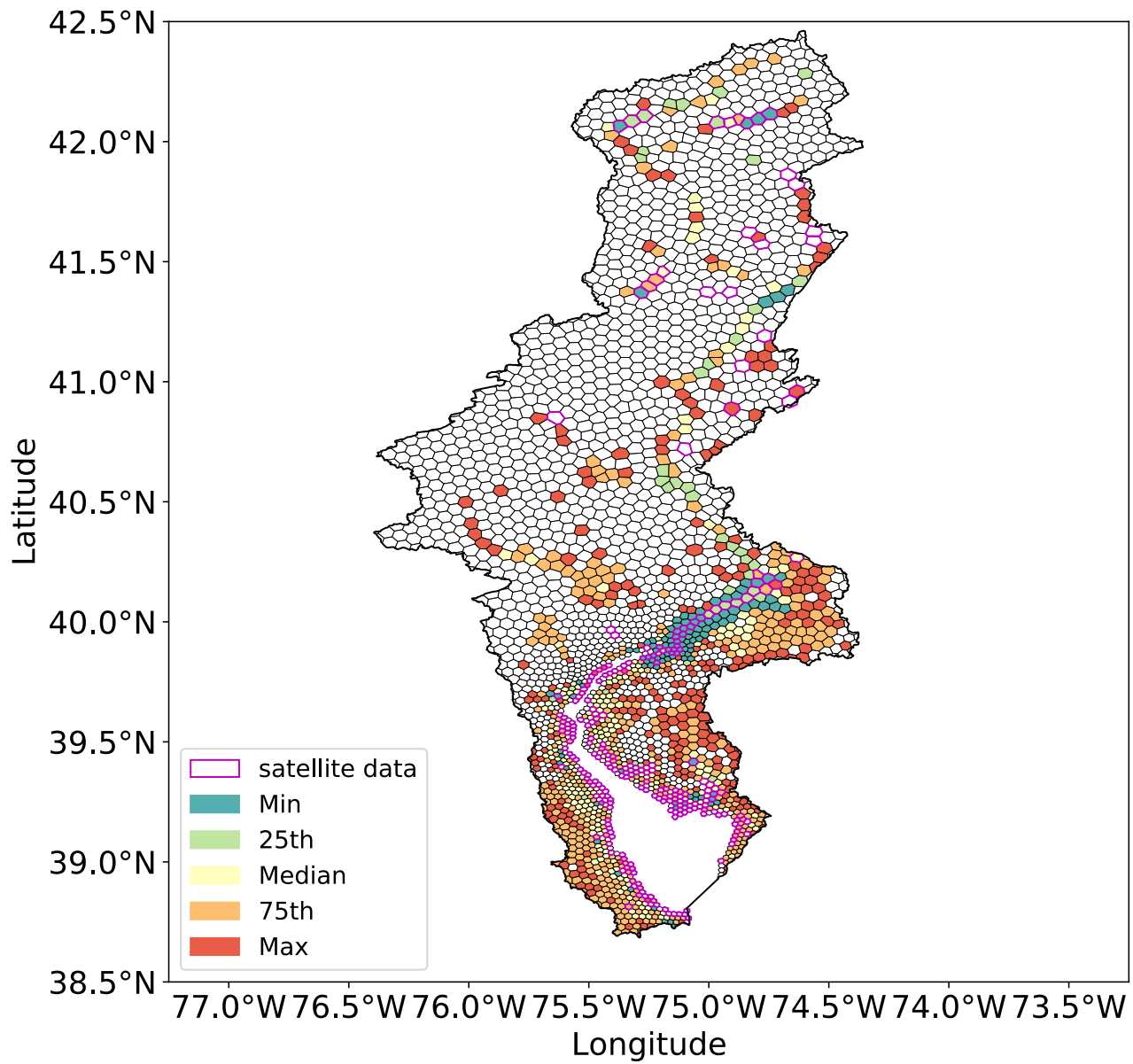
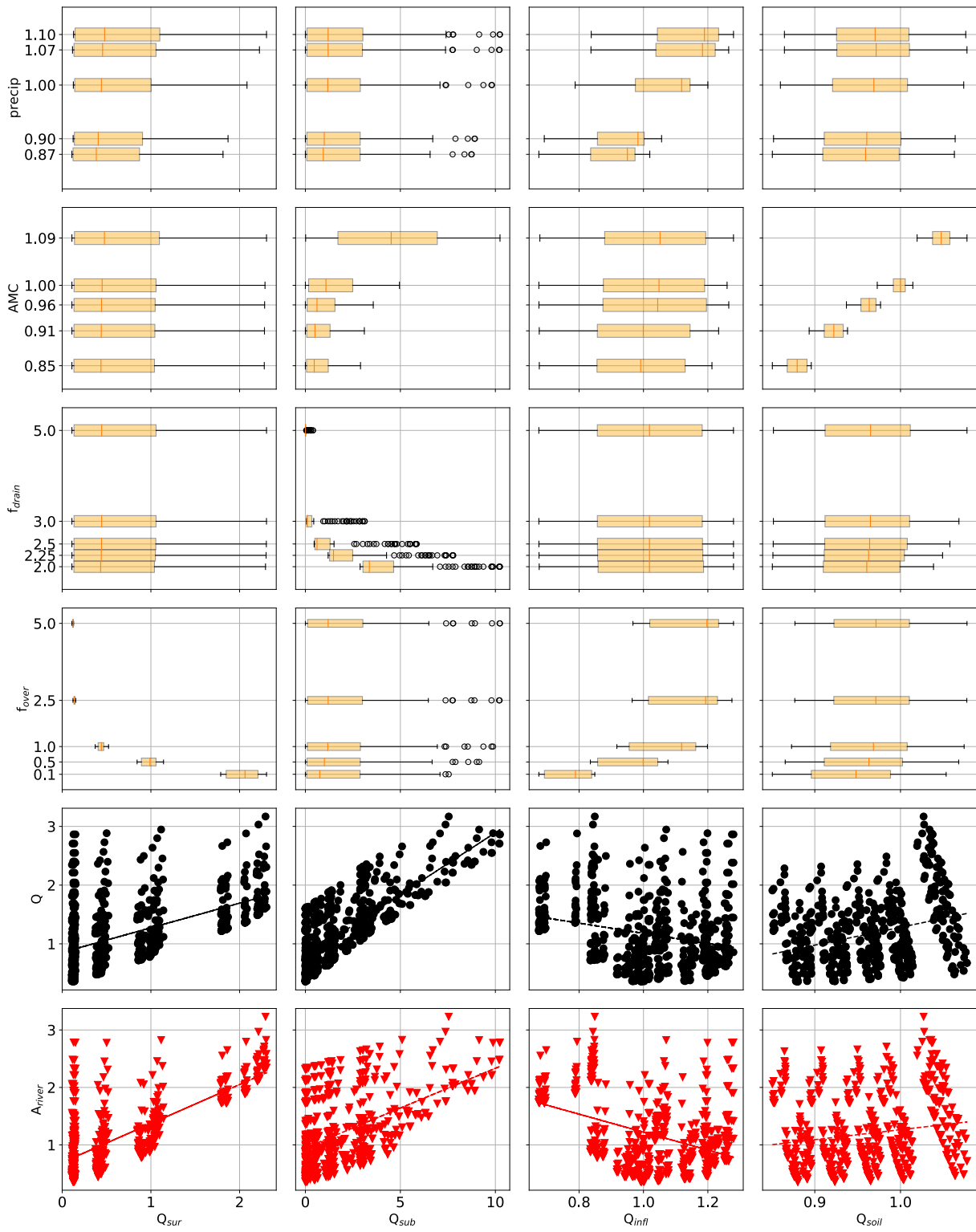


Figure S8: The plausible outcomes of inundated extent in DRB with the five colors representing the minimum, 25th percentile, median, 75th percentile and maximum inundation from the 625 ensemble runs. The magenta boxes represent the flood extent of the satellite data.



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Figure S9: The top four rows are bar plots of the perturbation parameters (Y-axis) against the four hydrological drivers (X-axis). The bottom two rows are scatter plots of river discharge and riverine inundation area (Y-axis) against the hydrological drivers (X-axis). The data are from the 625 ensemble simulations. All variables except f_{drain} and f_{over} are normalized with respect to their maximum values.

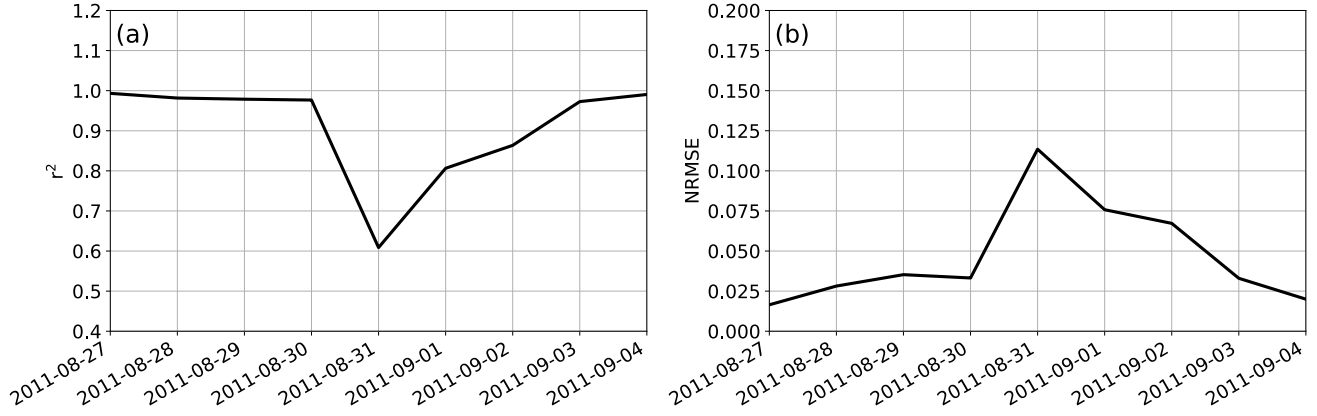
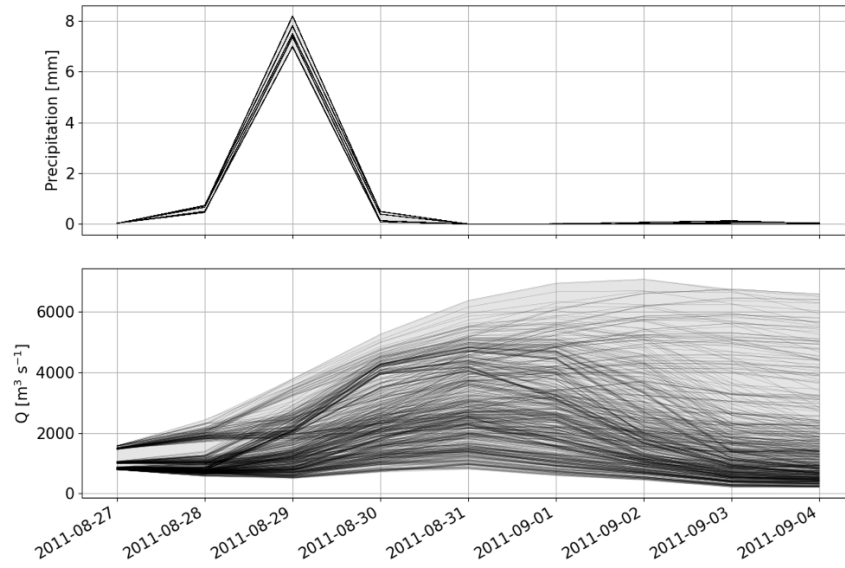


Figure S10: Time evolution of (a) r^2 and (b) NRMSE, for the ANN trained from daily data in corresponding to Figure 10.



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Figure S11: Time series of DRB-averaged precipitation and river discharge (Q) at the outlet corresponding to Figure 10.

55 **Table S1 Comparison of uncertainty in flood and discharge metrics due to model coupling and atmospheric forcing. Coupling-induced uncertainty is represented by the difference in the metrics between Experiments 2 or 3 and Experiment 1, averaged across ensemble simulations. Atmospheric uncertainty is quantified as the standard deviation of metrics across ensemble members in Experiment 3.**

Uncertainty source	HR	FR	SI	FA [$\times 10^7\text{m}^2$]	Q [m^3/s]
Two-way land-river coupling (riverine flooding) (Exp 2 – Exp 1)	-0.076	0.007	-0.020	-6.186	-124.342
Two-way river-ocean coupling (riverine flooding) (Exp 3 – Exp 1)	0.015	-0.004	0.005	2.480	1641.695
Two-way river-ocean coupling (riverine&coastal flooding) (Exp 3 – Exp 1)	0.346	-0.098	0.129	54.185	
Atmospheric forcing (standard deviation in Exp 3)	0.015	0.014	0.01	8.500	326.094

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Kim, H.: Global soil wetness project phase 3 atmospheric boundary conditions (experiment 1), (No Title), 10.20783/dias.501, 2017.