Supplementary information for Disentangling Atmospheric, Hydrological, and Coupling Uncertainties in Compound Flood Modeling within a Coupled Earth System Model

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Figure S1~S9

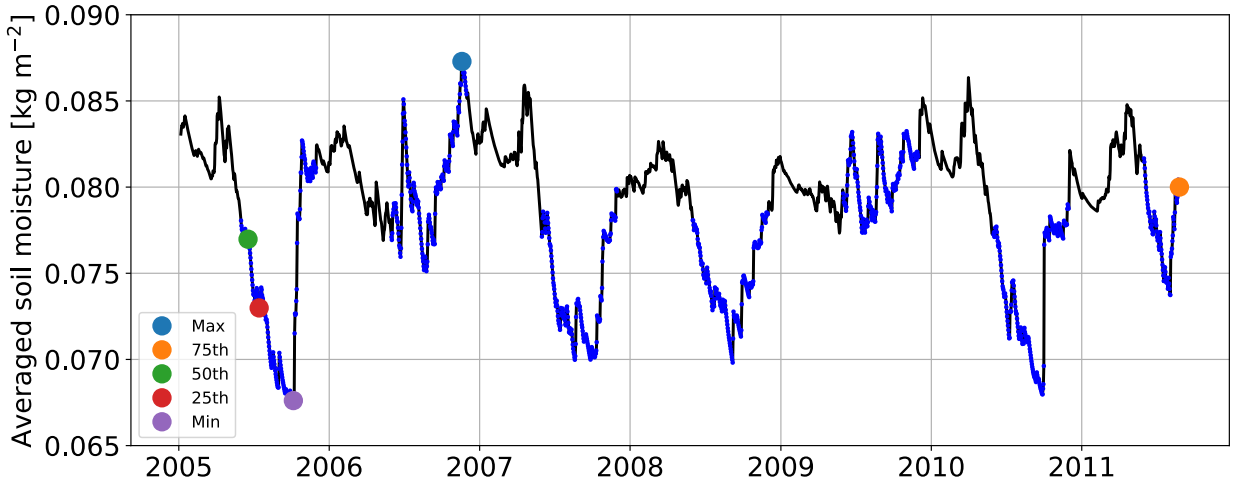

Figure S1: Time series of soil moisture averaged in Delaware River Basin (DRB). The hurricane seasons are highlighted by blue. The colored circles represent the selected quantiles used to generate the enhanced simulation ensemble.

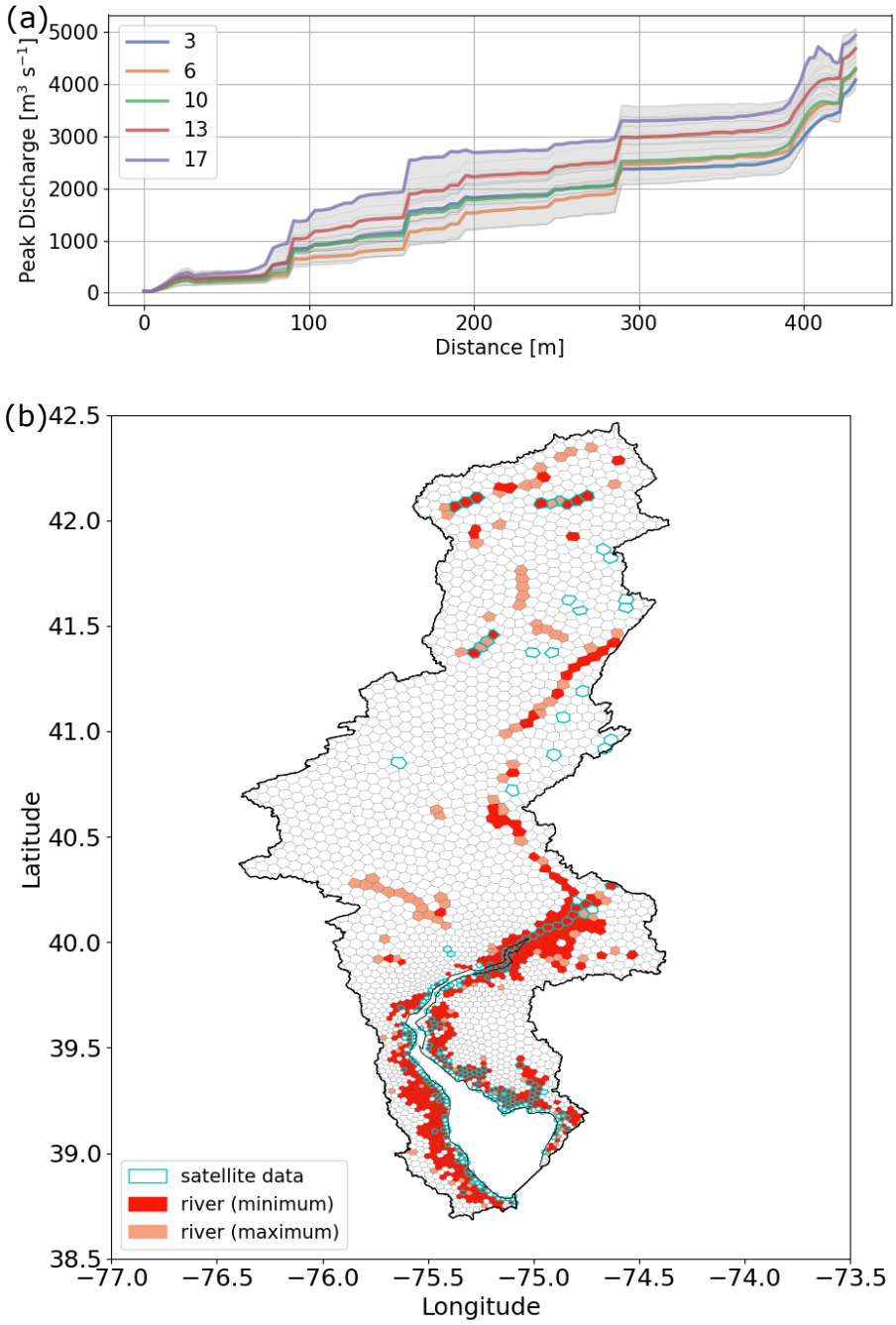

Figure S2: (a) Peak discharge along the Delaware River mainstem modeled using the five selected atmospheric ensemble members. (b) The corresponding riverine inundation extent. Darker and lighter red colors indicate the minimum and maximum inundation extent, respectively, among the five ensemble.

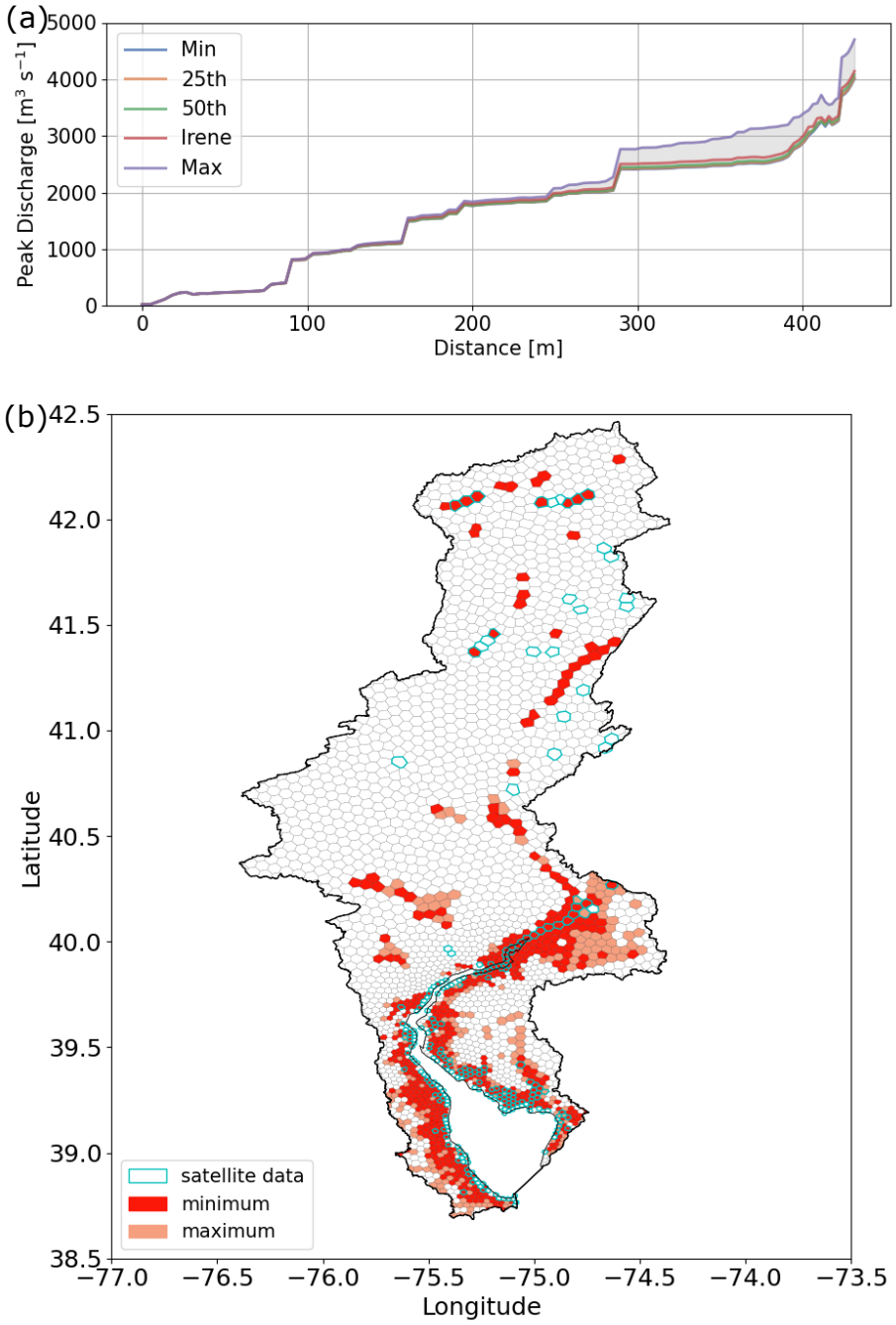

Figure S3: (a) Peak discharge along the Delaware River mainstem modeled from the simulations with five AMCs selected in Figure S1. (b) The corresponding riverine inundation extent.

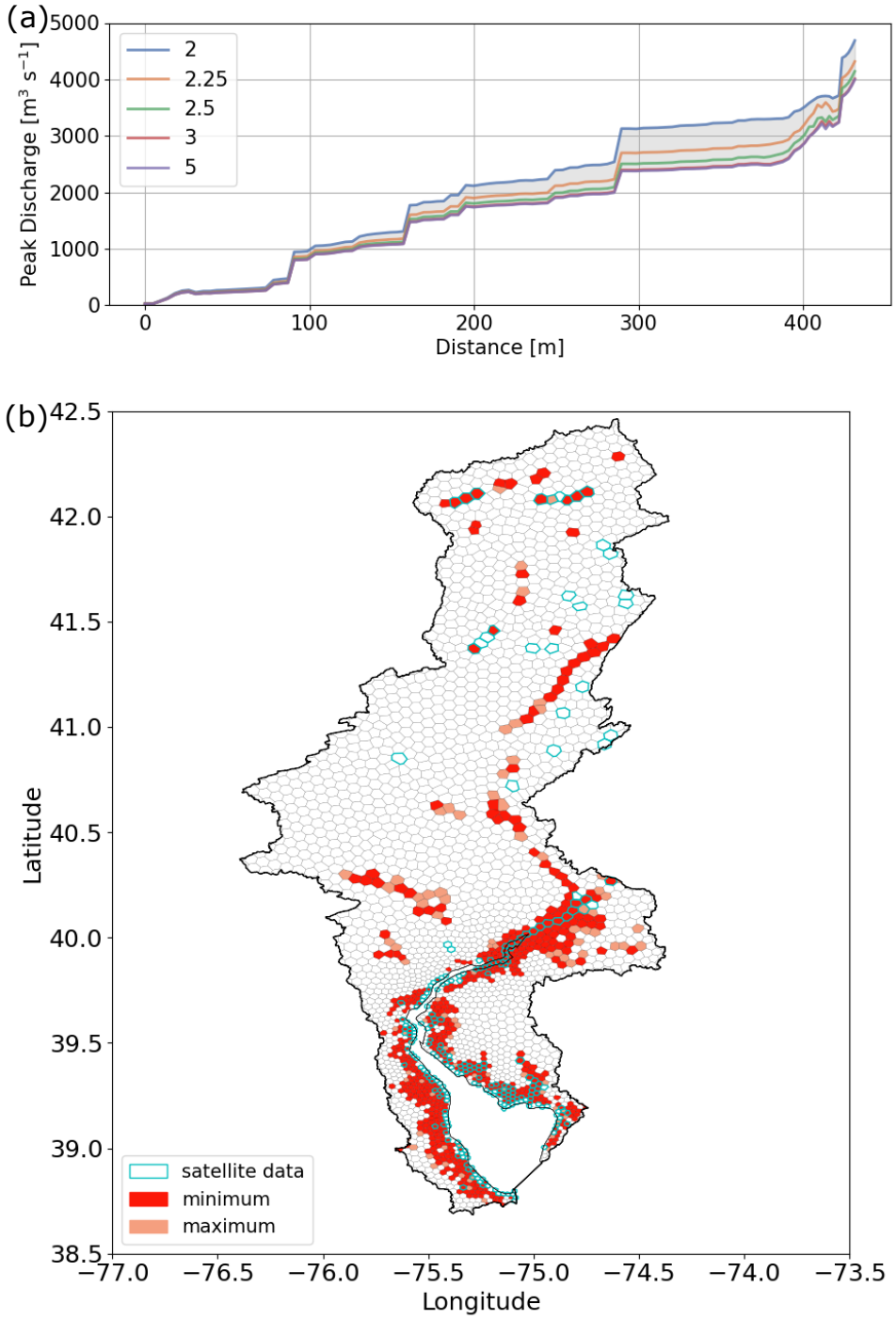

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Figure S4: (a) Peak discharge along the Delaware River mainstem modeled from the simulations using five values of f_{drain} (i.e., 2, 2.25, 2.5, 3 and 5). (b) The corresponding riverine inundation extent.

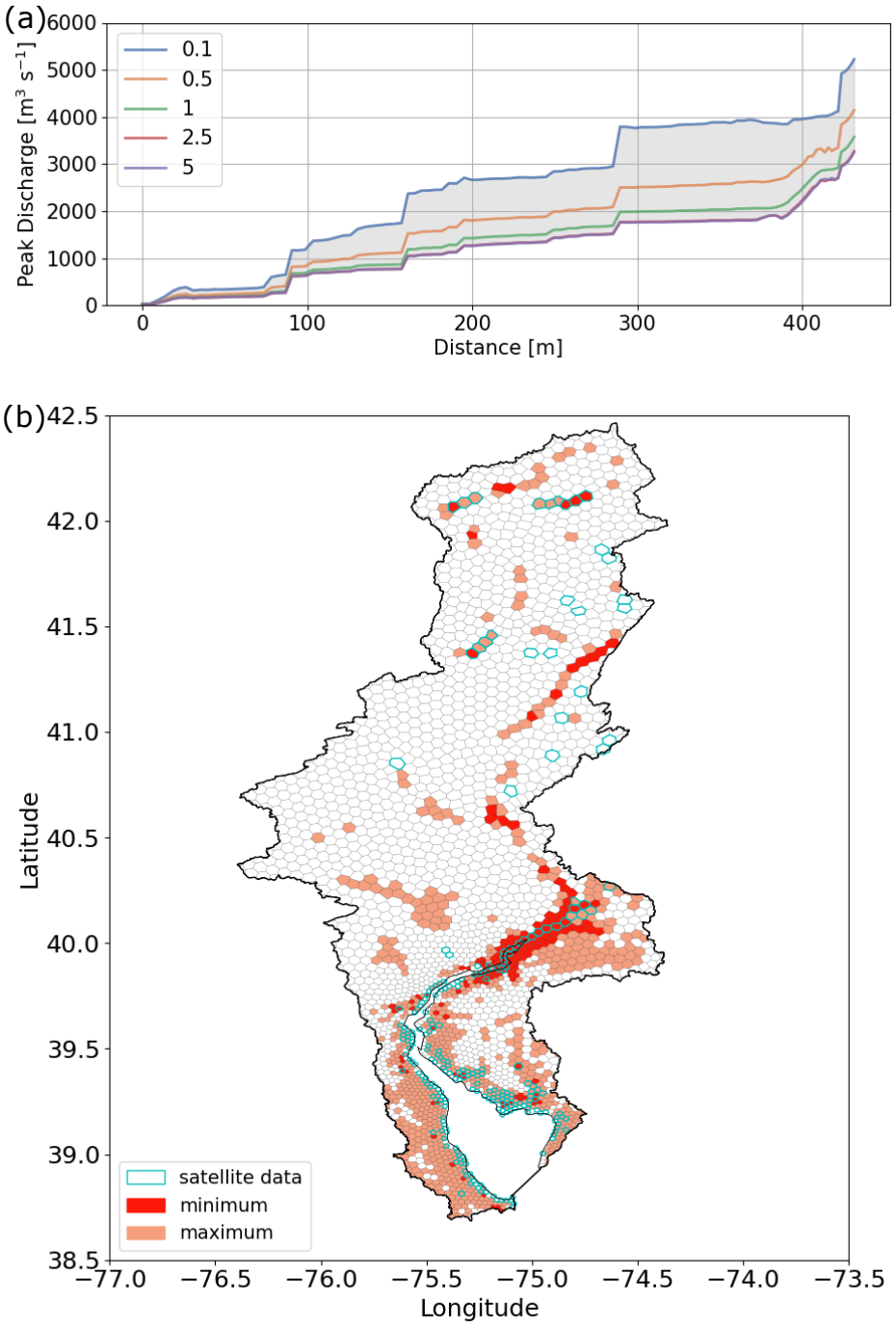


Figure S5: (a) Peak discharge along the Delaware River mainstem modeled from the simulations using five values of f_{over} (i.e., 0.1, 0.5, 1, 2.5 and 5). (b) The corresponding riverine inundation extent.

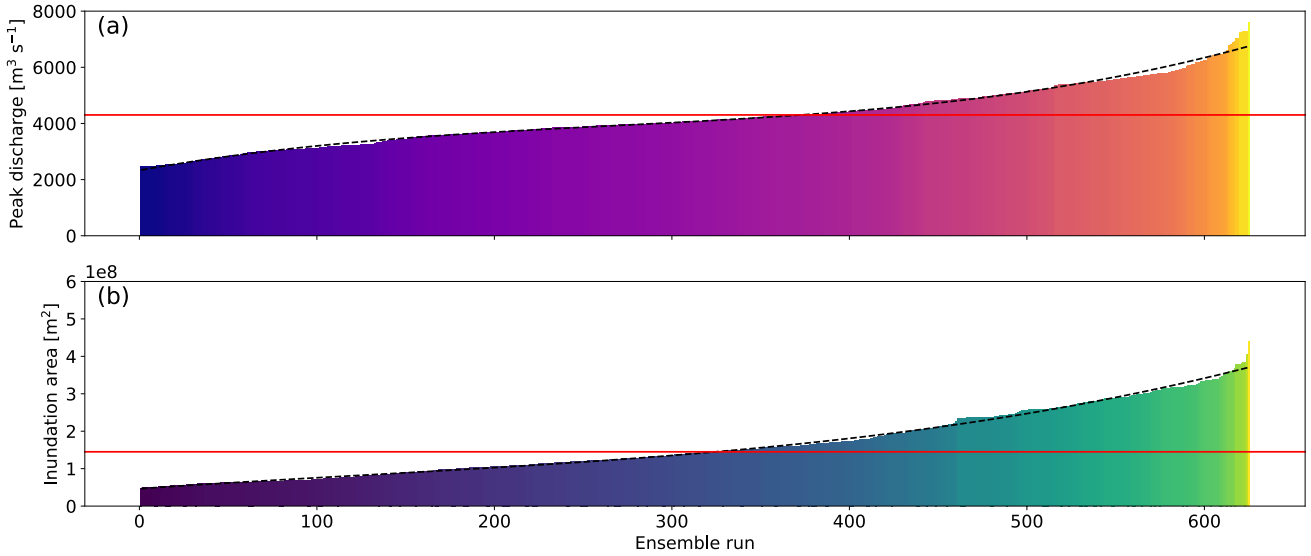
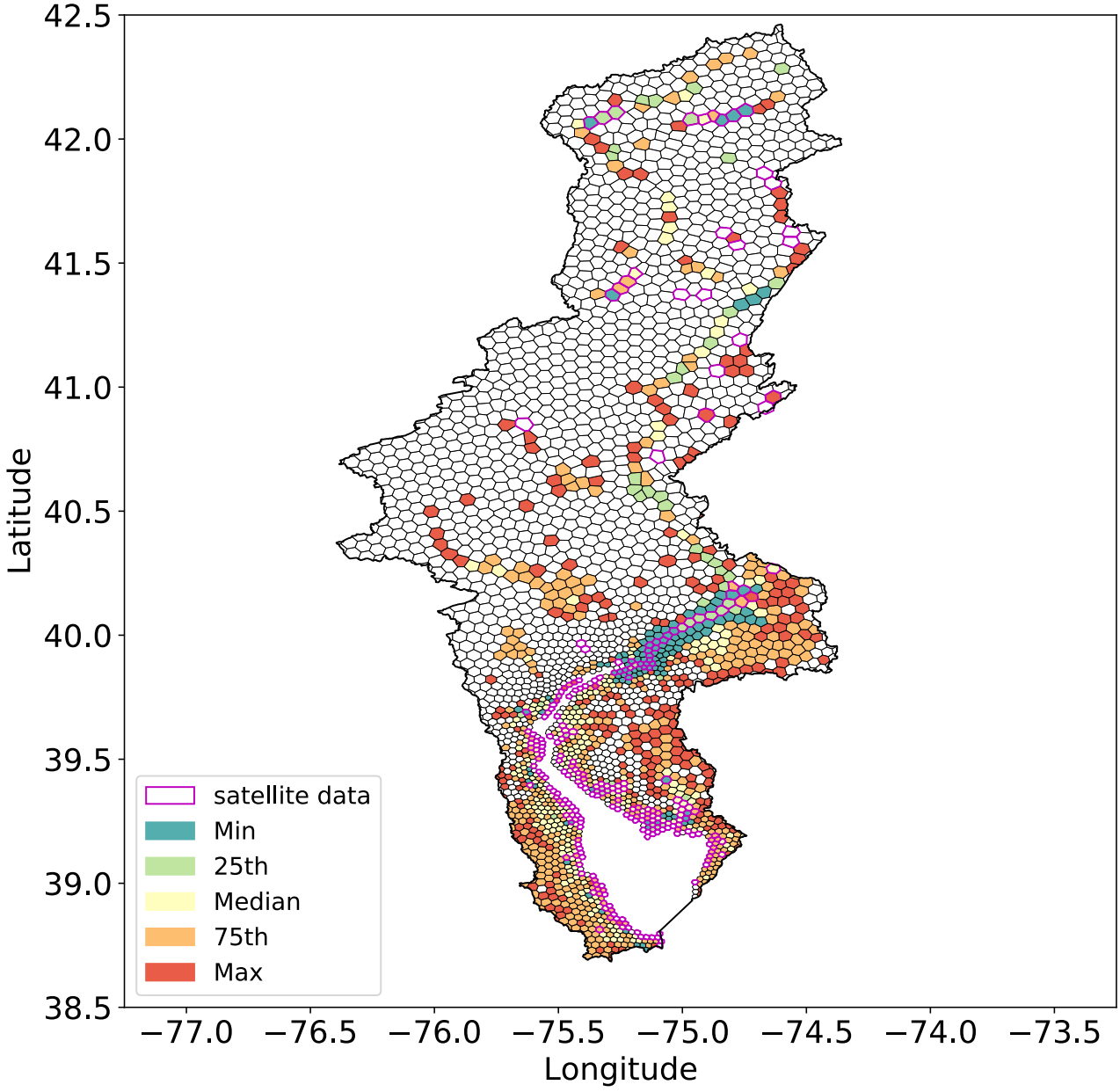


Figure S6: (a) Peak discharge and (b) riverine inundation area of the 625 ensemble simulations. The red lines represent the results of the simulation that best describes Iren



35 **Figure S7: The plausible outcomes of inundated extent in DRB with the three colors representing the minimum, Irene and maximum inundation from the 625 ensemble runs.**

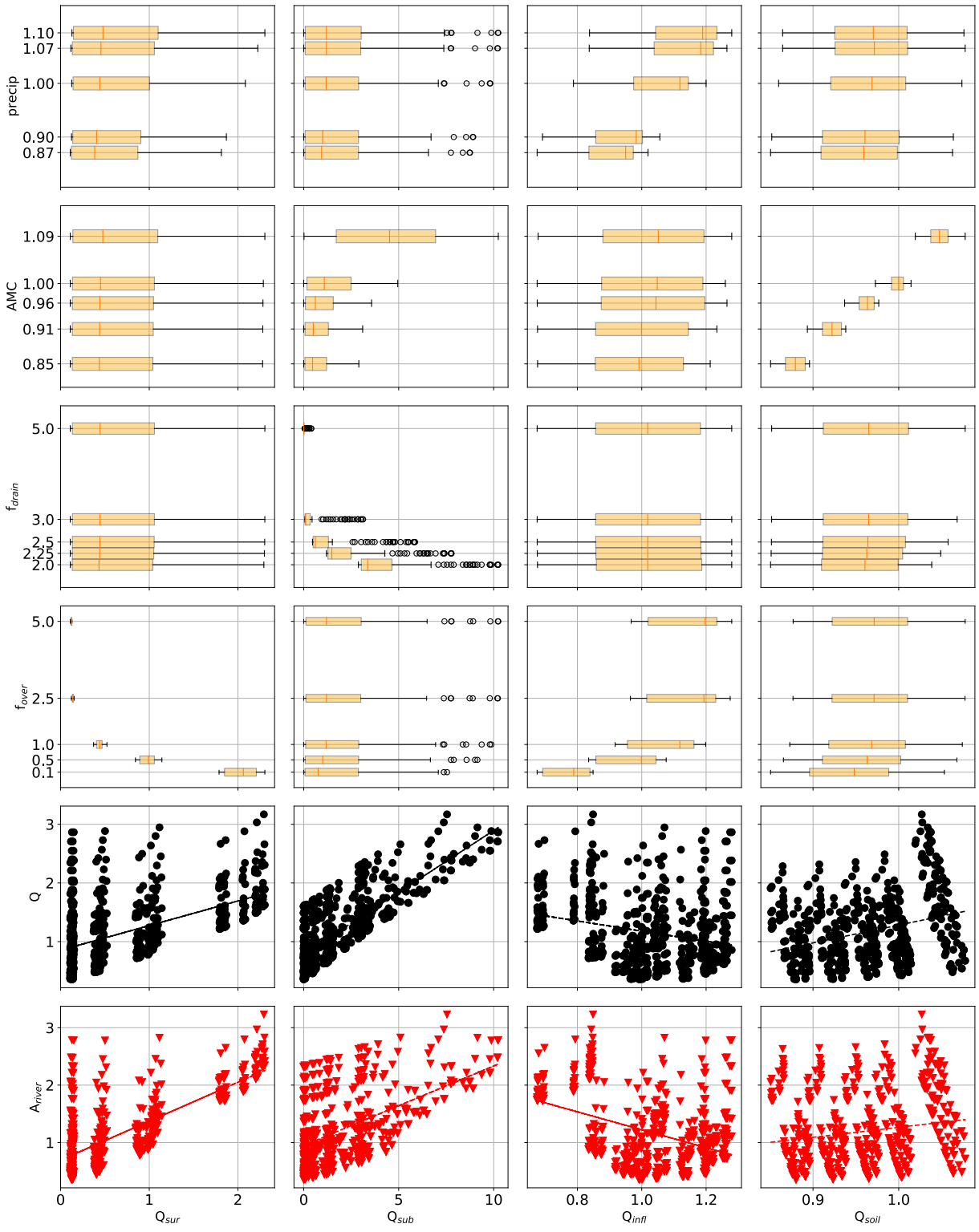

precip
1.10
1.07
1.00
0.90
0.87
AMC
1.09
1.00
0.96
0.91
0.85
f_{drain}
5.0
3.0
2.5
2.25
2.0
f_{over}
5.0
2.5
1.0
0.5
0.1
Q
3
2
1
A_{river}
3
2
1
0
1
2
Q_{sur}
0
5
10
Q_{sub}
0.8
1.0
1.2
Q_{infl}
0.9
1.0
Q_{soil}

Figure S8: 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.

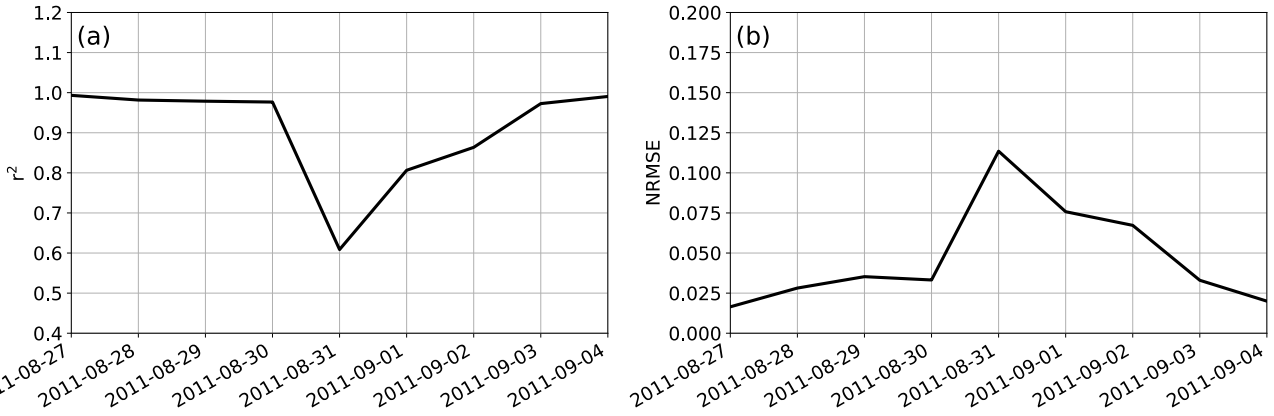


Figure S9: Time evolution of (a) r^2 and (b) NRMSE, for the ANN trained from daily data in corresponding to Figure 10.