Supplement of Nat. Hazards Earth Syst. Sci., 24, 2461–2479, 2024
https://doi.org/10.5194/nhess-24-2461-2024-supplement

Natural Hazards and Earth System Sciences
Open Access

Supplement of

Estuarine hurricane wind can intensify surge-dominated extreme water level in shallow and converging coastal systems

Mithun Deb et al.

Correspondence to: Mithun Deb (mithun.deb@pnnl.gov)

Hurricane case selection: Case A from Ensemble E1 and Case B from E2

One of the main objectives of this study is to demonstrate how estuarine wind fields can exacerbate hurricane-driven coastal and riverine flooding. To illustrate this, we chose two cases from the different ensembles of hurricanes E1 and E2 that can provide a more straightforward explanation of the variation in along-channel peak water surface elevation (WSE) from the interaction of surface wind stress inside the estuary, tide, and geometry, shown in Figure 2c. In Figure 2c, between SJS and RP (close to 80 km from the bay entrance), we can notice a higher peak WSE for E1. This location is near the open bay, far from the influence of river discharge, and the remote- and estuarine-wind-generated surges primarily dominate the flooding. Because of the largest bay WSE there (in Figure 2c), we compared the time series of WSE between all members of E1 (shown in Figure S1) and observed that member/case 35 produced the highest WSE. Hence, we picked this event from E1 and called ``Case A" (which has a primarily northerly wind) to further assess the role of the estuarine local wind.

Compared to E1, E2 has more inland-oriented tracks (primarily southerly wind) and generates a much higher range of surges, especially in the mid-bay. To explain the role of the estuarine local wind in E2 surges, we tried to rank the members that have negligible influence from river discharge on WSE, have a similar magnitude of wind speed, time scale (translation through the bay), and WSE at the bay entrance compared to Case A from E1. Identifying such an event from E2 can easily demonstrate the role of the southerly estuarine wind in surge amplification. Figure S2 compares Delaware River discharge at the model flow boundary where we identified four members, 42, 22, 8, and 14, that produced the lowest fluvial discharge. Subsequently, we also examined the wind speed and direction from these E2 members with Case A from E1 (shown in Figure S3; the red and blue wind vectors represent the southerly and northerly wind, respectively, and they are scaled using the wind speed) and observed that E2 Case 14 generated a relatively similar wind speed and time scale than others. Before choosing Case 14 from E2 for further analysis, we also compared the WSE at the bay entrance. While we did not compare the root-mean-square of the four members from E2 with Case A because of the phase lag between E1 and E2 members, from Figure S4, we can see that Case 14 has the closest peak WSE to Case A among them and the difference is around 0.27 m. Ultimately, based on all these different comparisons, we picked E2 Case 14 as ``Case B" to demonstrate the role of estuarine southerly wind direction in elevating the surge-induced flooding in Delaware Bay and River compared to northerly wind direction or ``Case A".

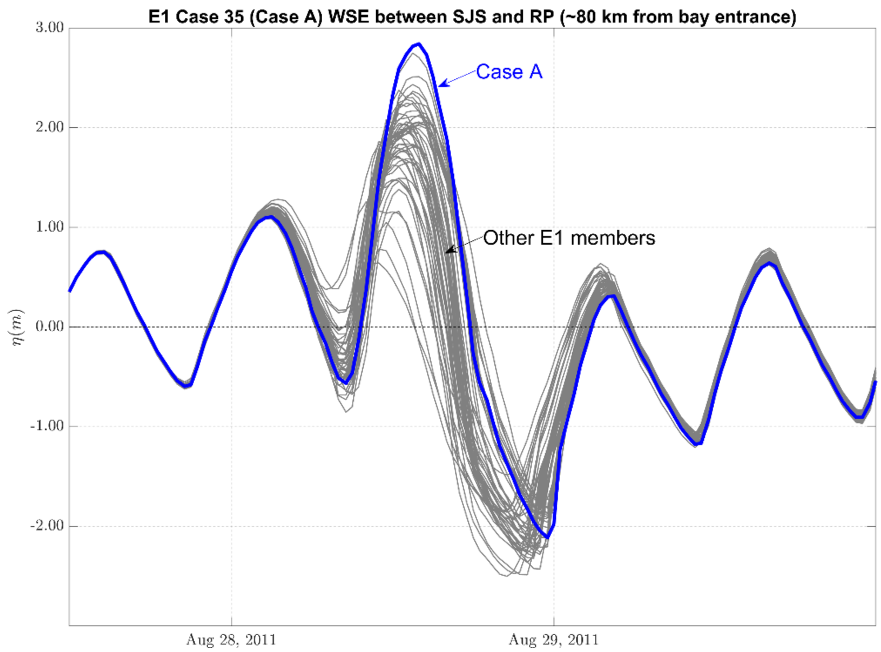

Figure S1: Water surface elevation at a point location (between SJS and RP in Figure 1c) in the Delaware Bay and River, approximately 80 km from the bay entrance. The water surface for Case A (Case 35 from Ensemble 1) is shown using a solid blue line. Variation in water surface for other cases from the same Ensemble 1 is represented using solid gray lines.

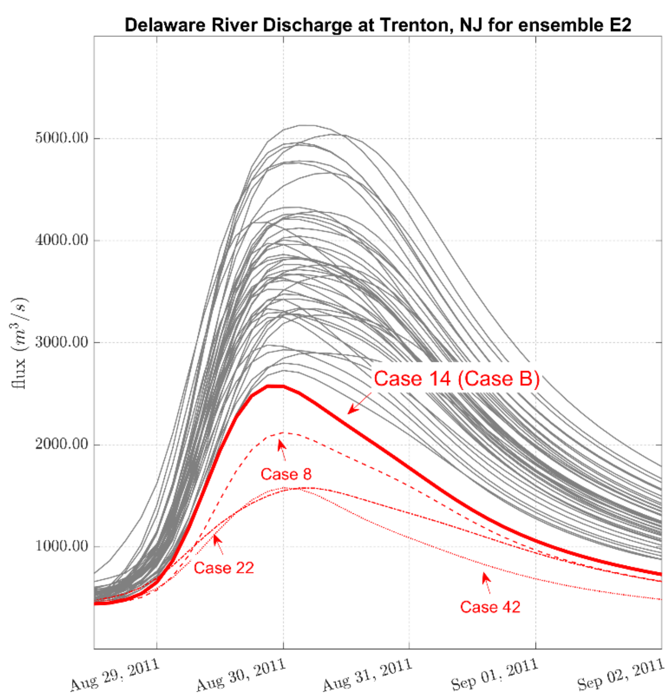

Figure S2: DHSVM-simulated river discharge at the hydrodynamic model flow boundary near Trenton, NJ, for different cases of Ensemble 2. Red-colored dotted, dash-dotted, dashed, and solid lines represent the river flux for cases 42, 22, 8, and 14, respectively.

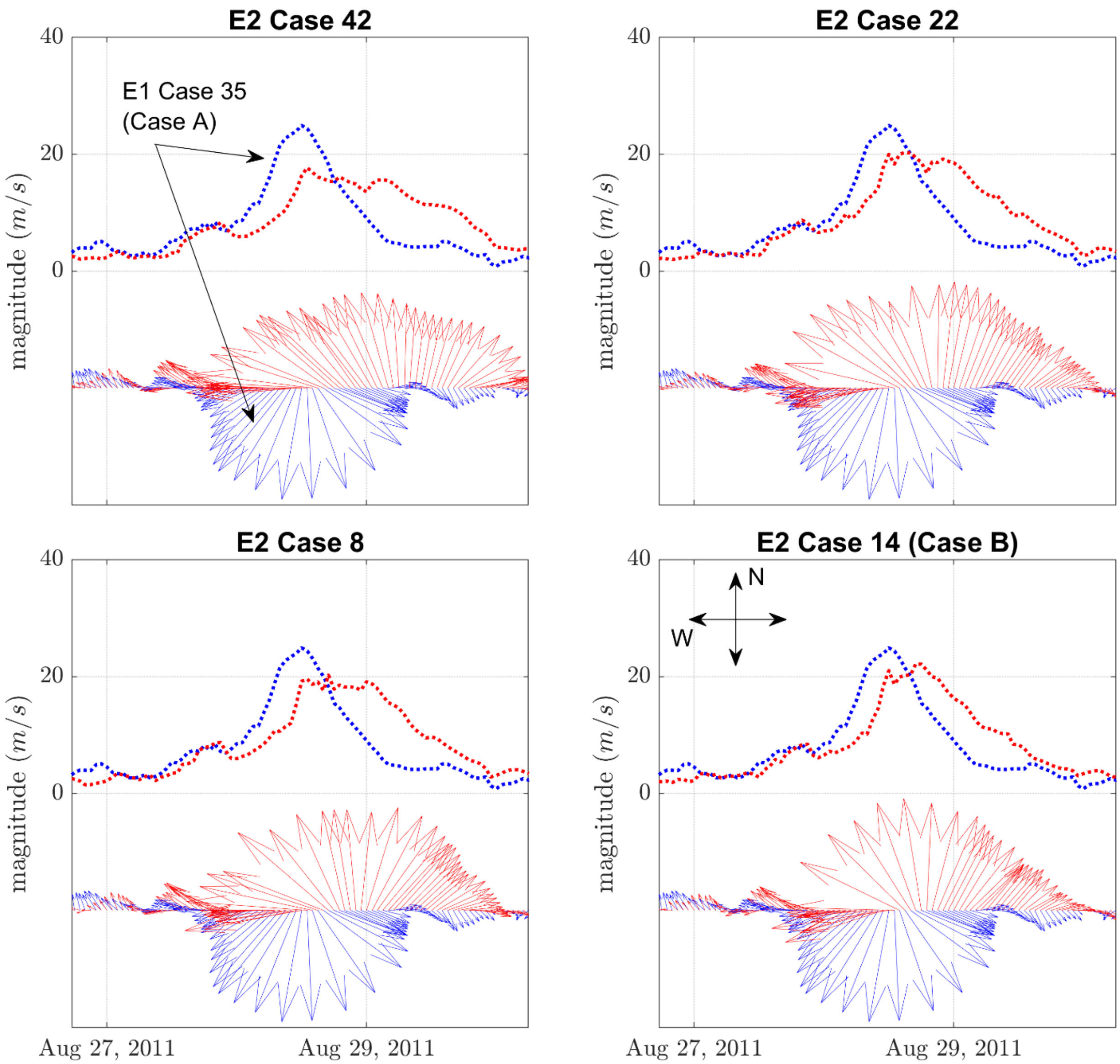

Figure S3: Comparison of hurricane wind speed and direction of four cases with the smallest river discharge from Ensemble 2 (red color; also shown in Figure S2) with Case A (blue color).

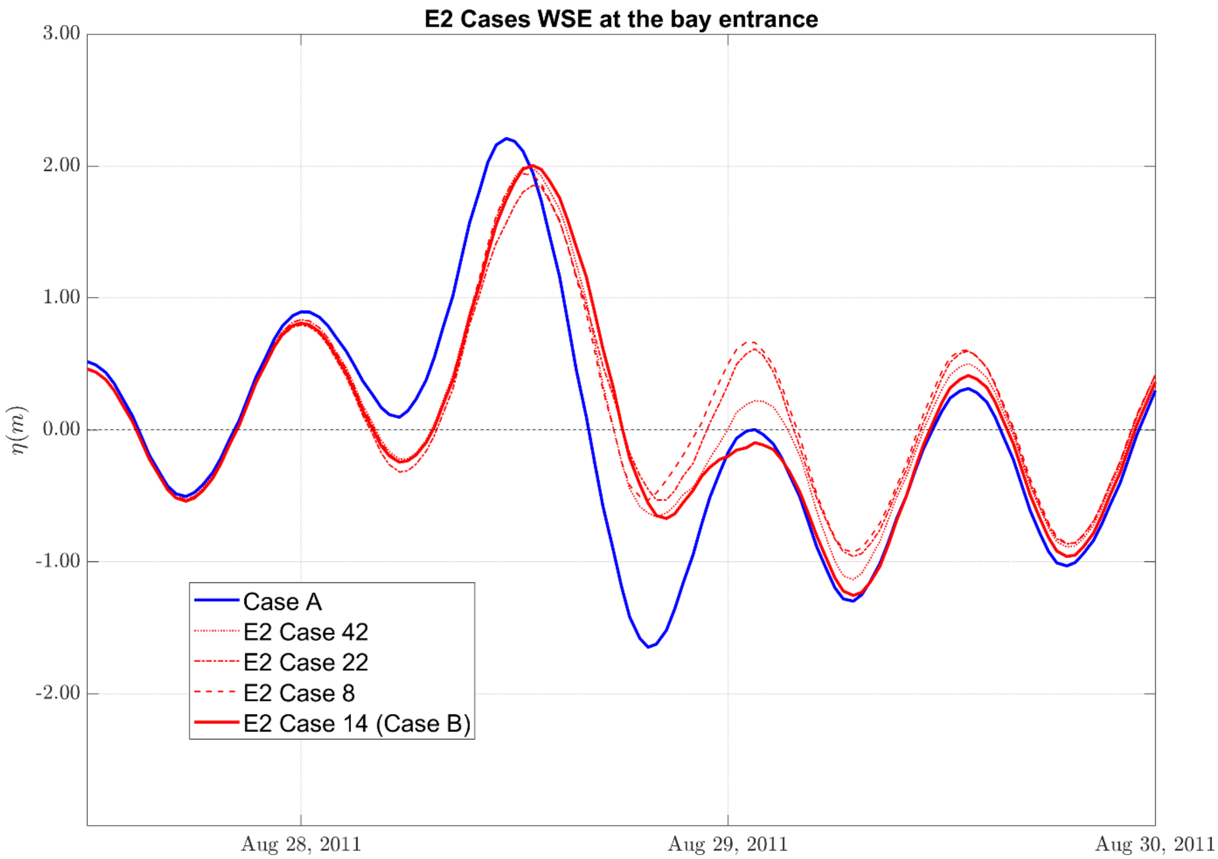

Figure S4: Comparison of water surface elevation at the bay entrance of four cases from Ensemble 2 (red color; also shown in Figure S2) with Case A (blue color).