frontiers

Supplementary Material

1.1 Supplementary Figures

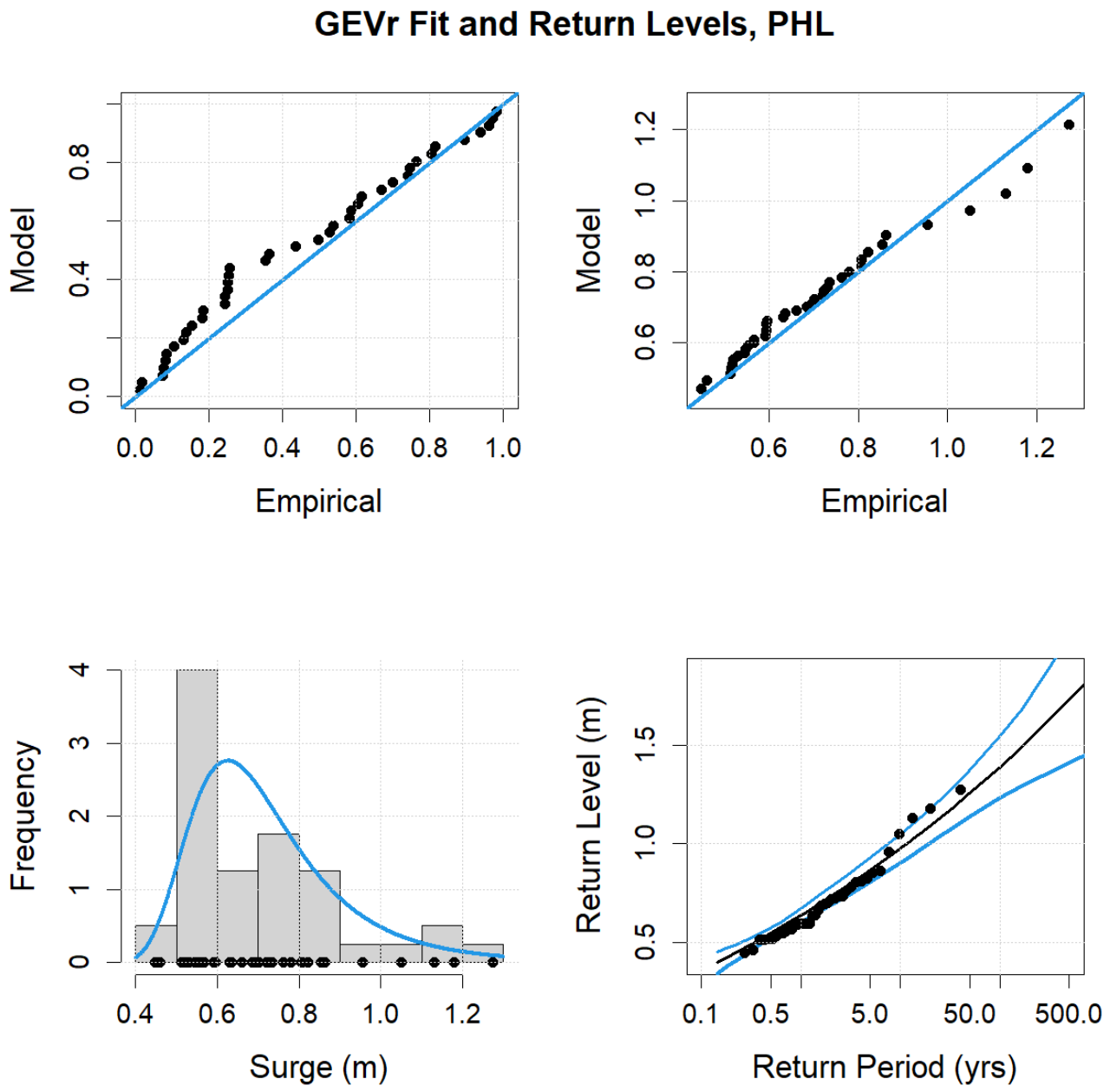
The following 24 figures represent diagnostic plots for the extreme value distribution model fits of skew surge for each tide gauge. The first set of 12 show results of the BM/GEVr approach using the optimizied value of r, while the second set show results of the POT/GP approach using the optimized threshold. Details on the model fit optimization can be found in the main manuscript sections 2.3 and 2.4. Each figure is composed of four diagnotic plots, in the following layout:

Top left – Probability-Probability plot. Each data point's empirical probability is plotted on the x-axis while it's corresponding probability based on the hypothesized model is plotted on the y-axis. Generally, the closer the points are to the 1-to-1 line, the better the fit.

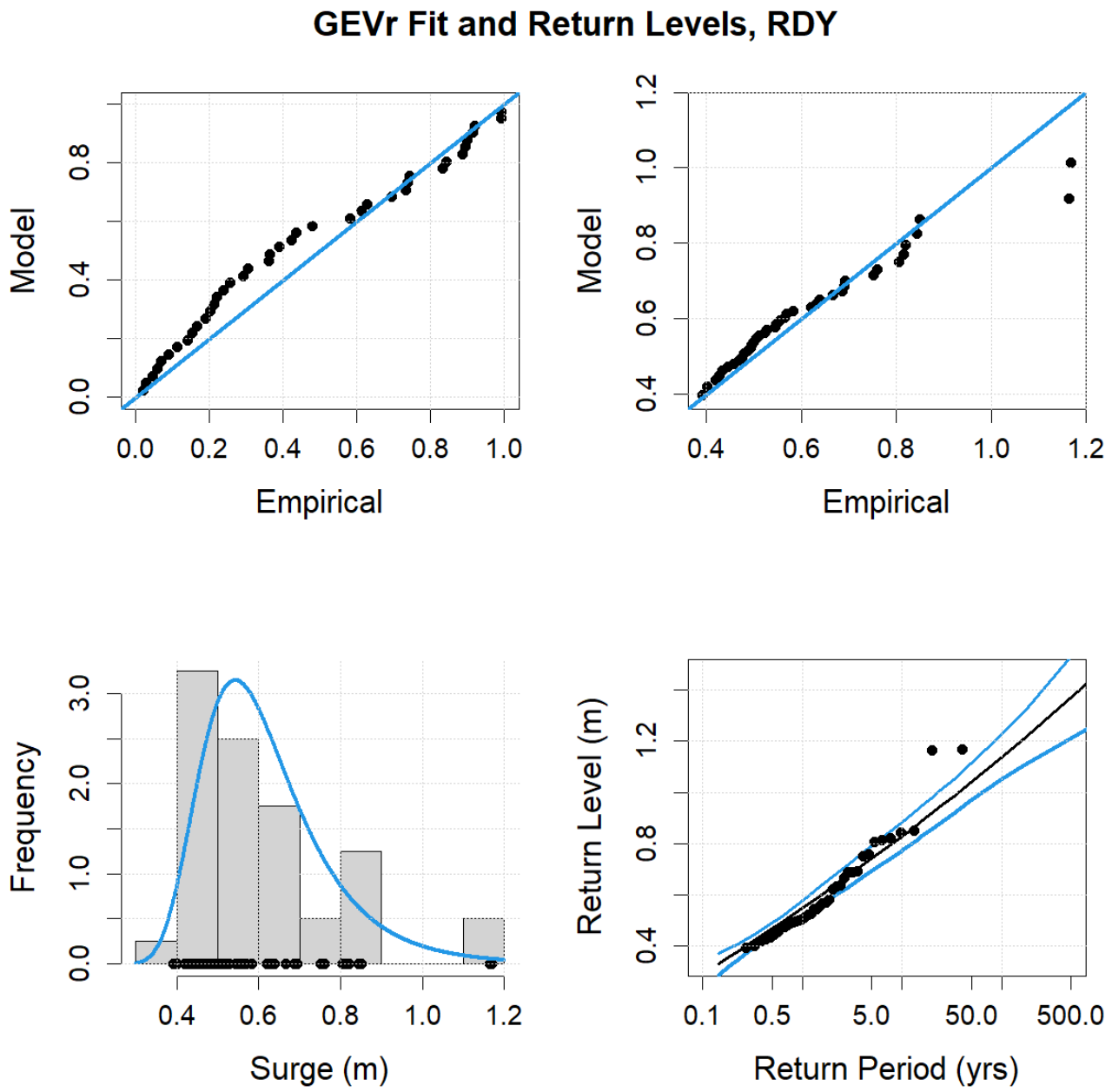
Top right – Quantile-Quantile plot. Each data point's empirical value is plotted on the x-axis while its hypothesized value based on it's empirical quantile, is plotted on the y-axis. Similar to the probability-probability plot, points along the 1-to-1 line represent a better model fit.

Bottom left – Histogram and Probability Density Function (PDF). The histogram shows the frequency distribution of the data points. When fitting to the GP, the values are exceedances over the selected threshold. The PDF curve represents the extreme value distribution PDF with estimated model parameters (location, scale, and shape for GEVr; scale and shape for GP.) Data point empirical values are plotted based on the magnitude along the x-axis to provide a more exact location of where the points fall within each bin.

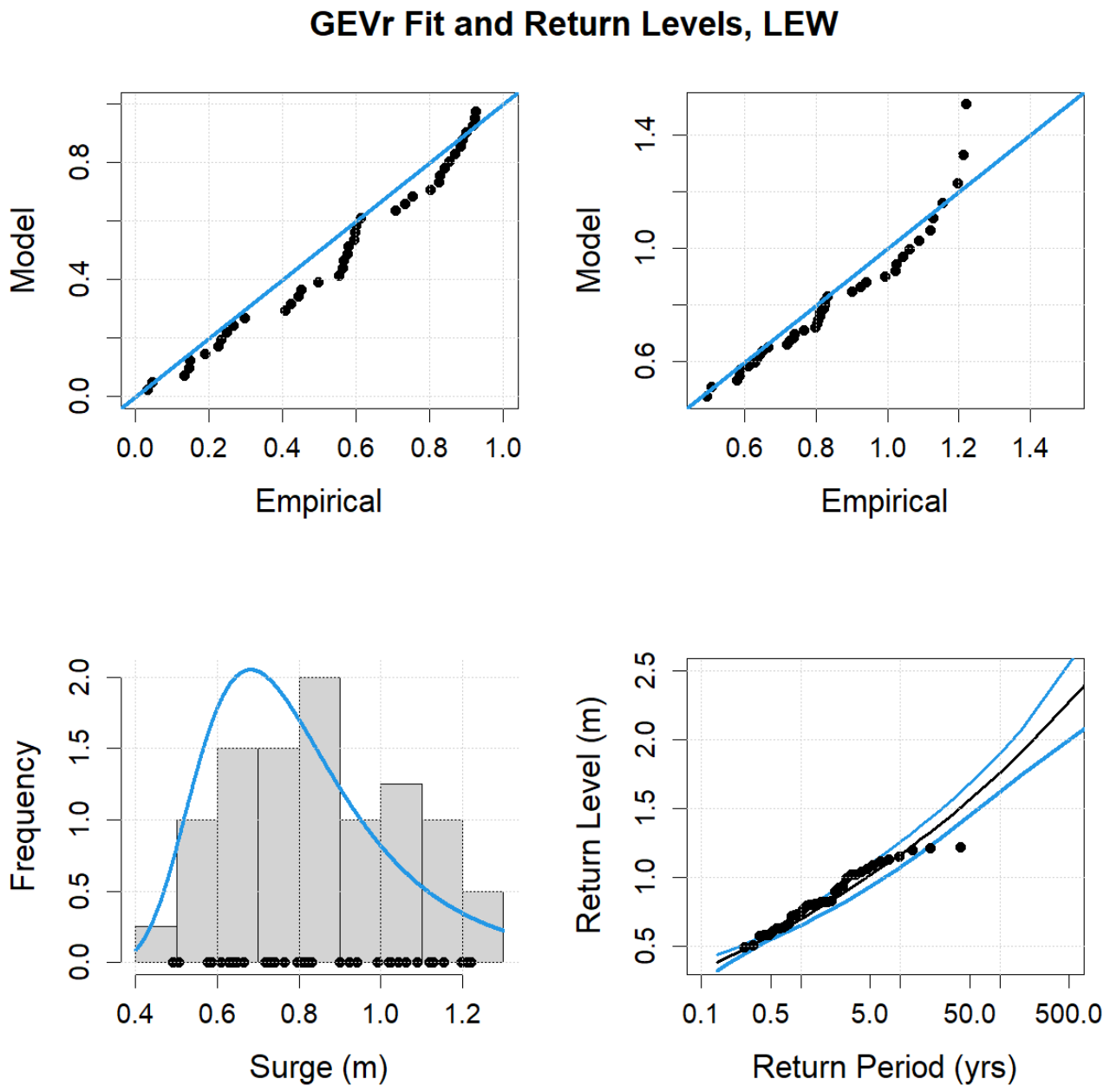
Bottom right – Return Level plot. Skew surge return levels are plotted on the y-axis and return periods plotted on the x-axis. The x-axis is plotted on a logarithmic scale up to 500-year return period. For a return period of 100 years, the corresponding return level has a 1% probability of occurring in any single year. The 90% confidence interval is also plotted, widening for increasing return periods. Since only 40 years of data were compiled to produce the model fits and corresponding return level estimates, the furthest (maximum) empirical data point along the x-axis should lie near the 40-year return period. The more narrow the confidence interval, the more robust the central estimate. As well, the more data points that fall within the confidence intervals, especially if narrow, the more closely larger data points match with the longer return period estimates.



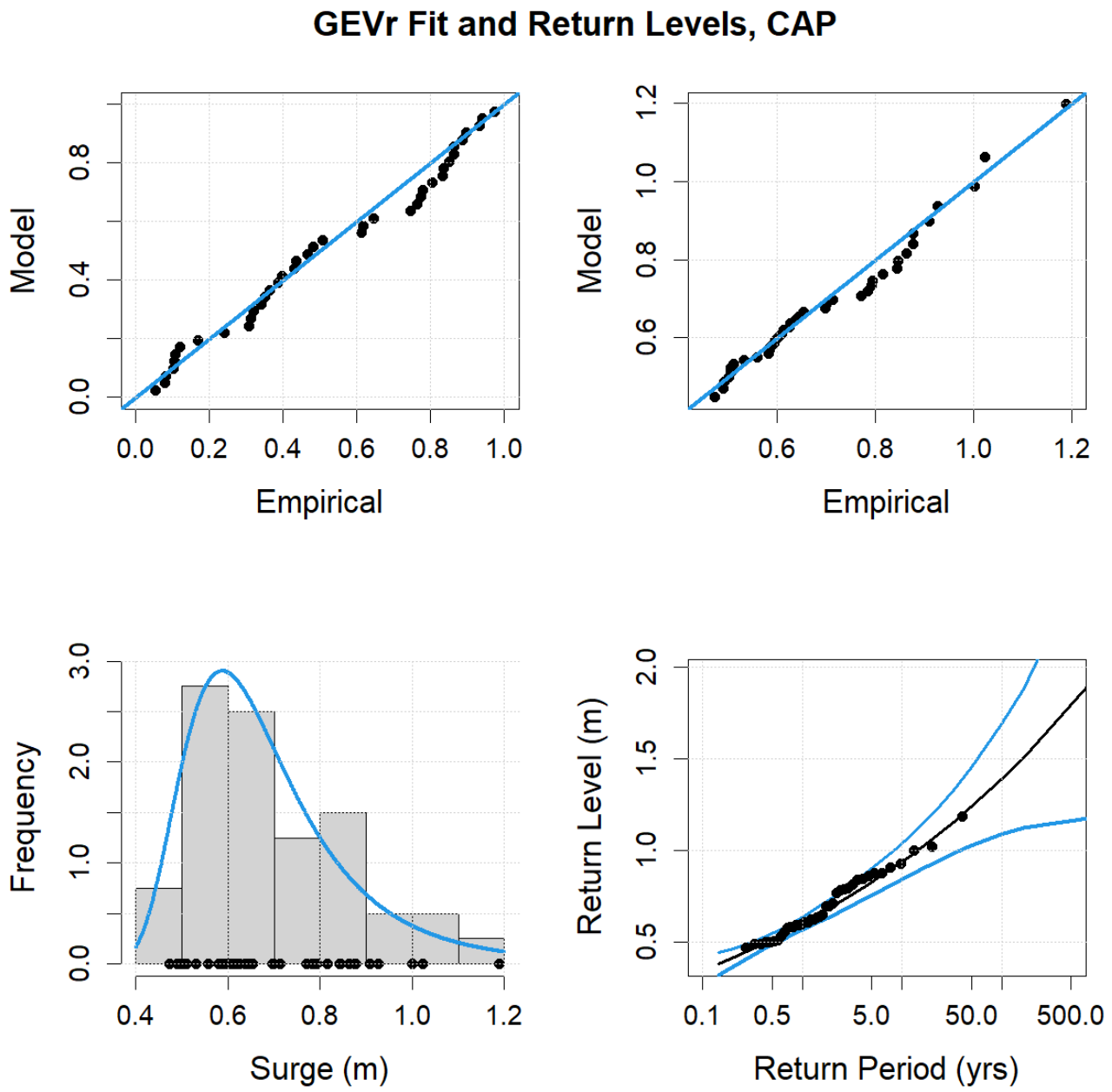
Supplementary Figure 1. Diagnostic plots for extreme skew surge fit to GEVr model at Philadelphia NOAA tide gauge (8545240) in the Delaware River/Bay. (see introduction to this supplementary doc for explanation of plots.)



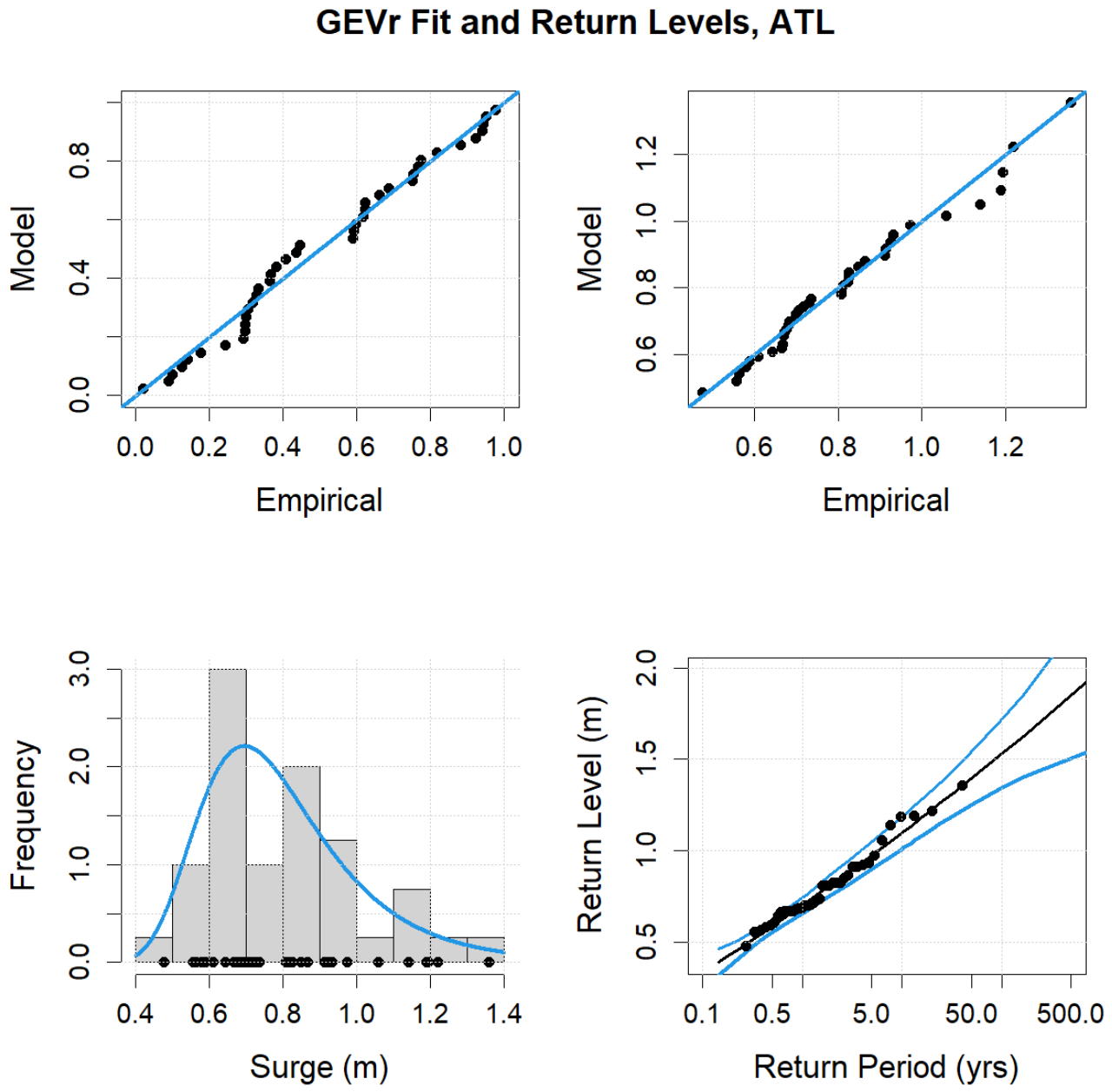
Supplementary Figure 2. Diagnostic plots for extreme skew surge fit to GEVr model at Reedy Point NOAA tide gauge (8551910) in the Delaware Bay. (see introduction to this supplementary doc for explanation of plots.)



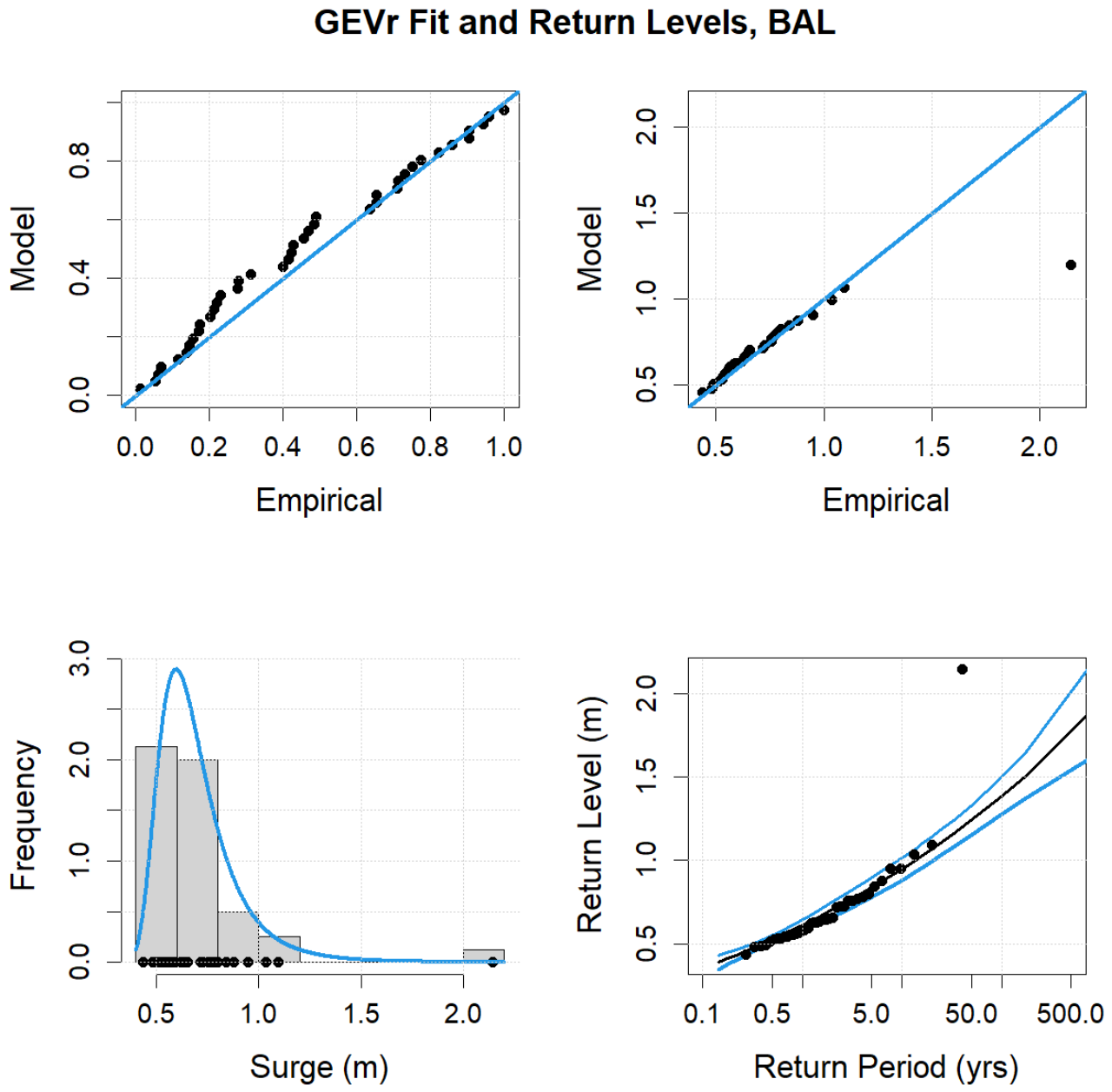
Supplementary Figure 3. Diagnostic plots for extreme skew surge fit to GEVr model at Lewes NOAA tide gauge (8557380) in the Delaware Bay. (see introduction to this supplementary doc for explanation of plots.)



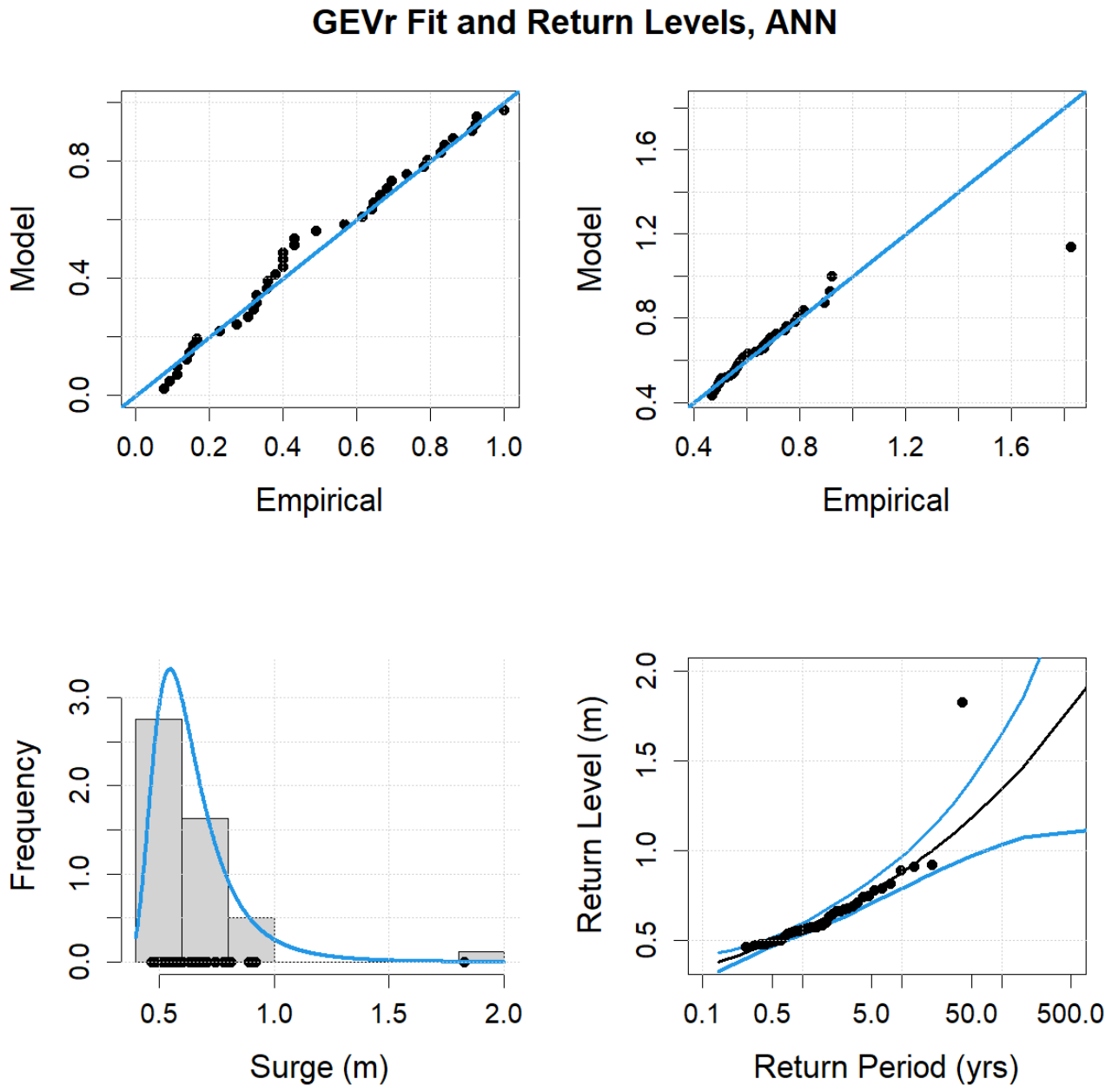
Supplementary Figure 4. Diagnostic plots for extreme skew surge fit to GEVr model at Cape May NOAA tide gauge (8536110) in the Delaware Bay. (see introduction to this supplementary doc for explanation of plots.)



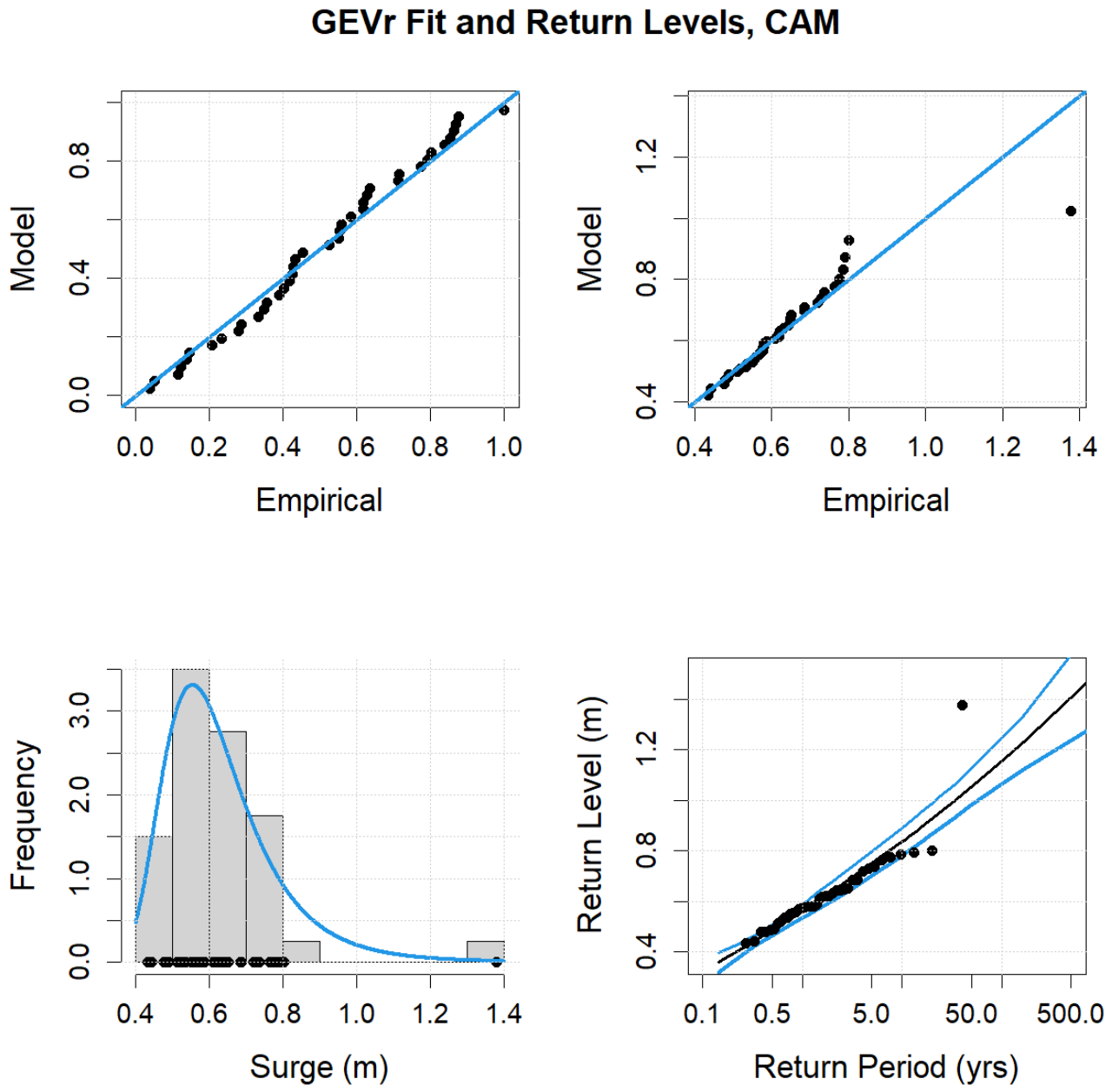
Supplementary Figure 5. Diagnostic plots for extreme skew surge fit to GEVr model at Atlantic City NOAA tide gauge (8534720) near the Delaware Bay. (see introduction to this supplementary doc for explanation of plots.)



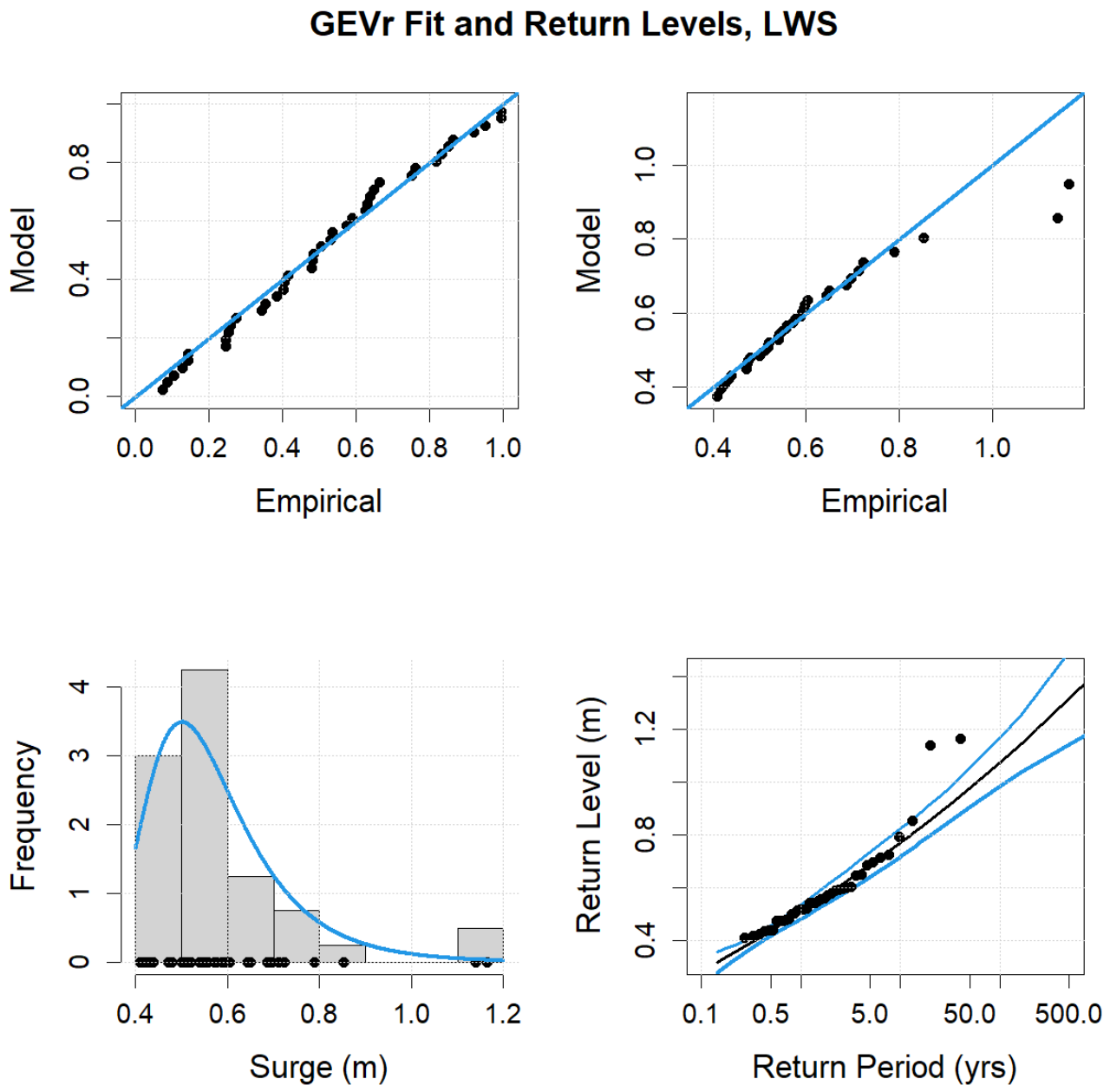
Supplementary Figure 6. Diagnostic plots for extreme skew surge fit to GEVr model at Baltimore NOAA tide gauge (8574680) in the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



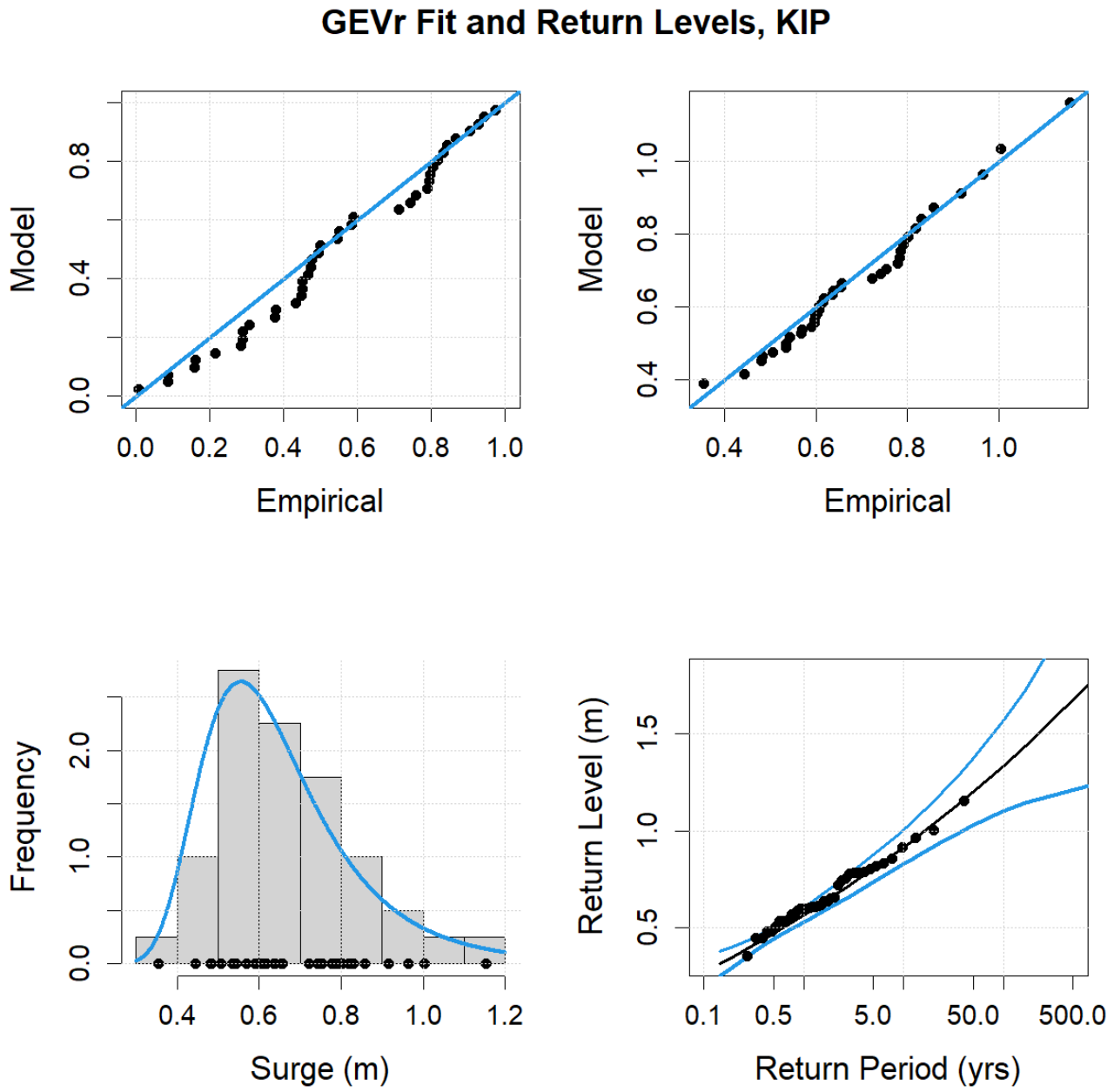
Supplementary Figure 7. Diagnostic plots for extreme skew surge fit to GEVr model at Annapolis NOAA tide gauge (8575512) in the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



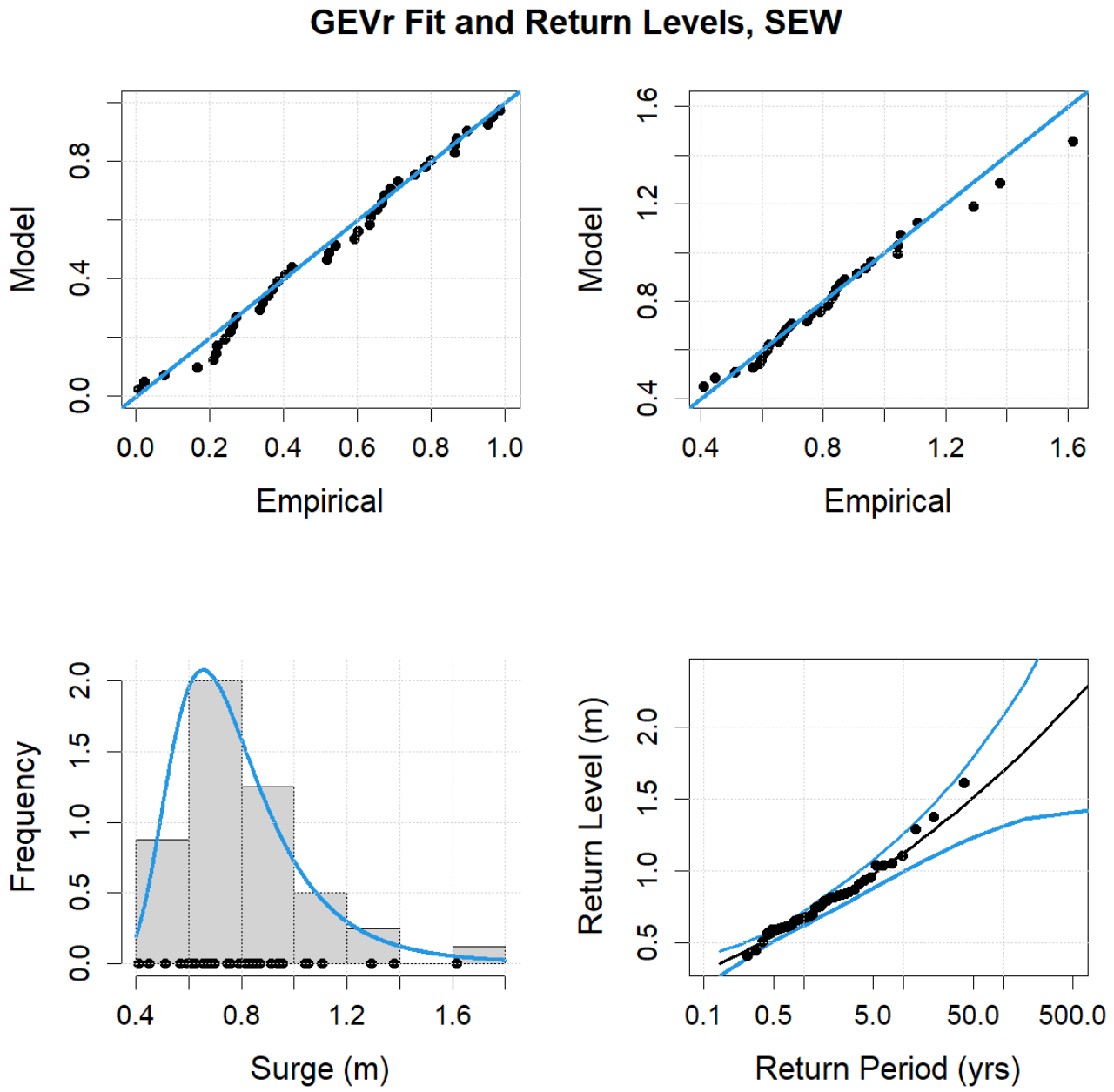
Supplementary Figure 8. Diagnostic plots for extreme skew surge fit to GEVr model at Cambridge NOAA tide gauge (8571892) in the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



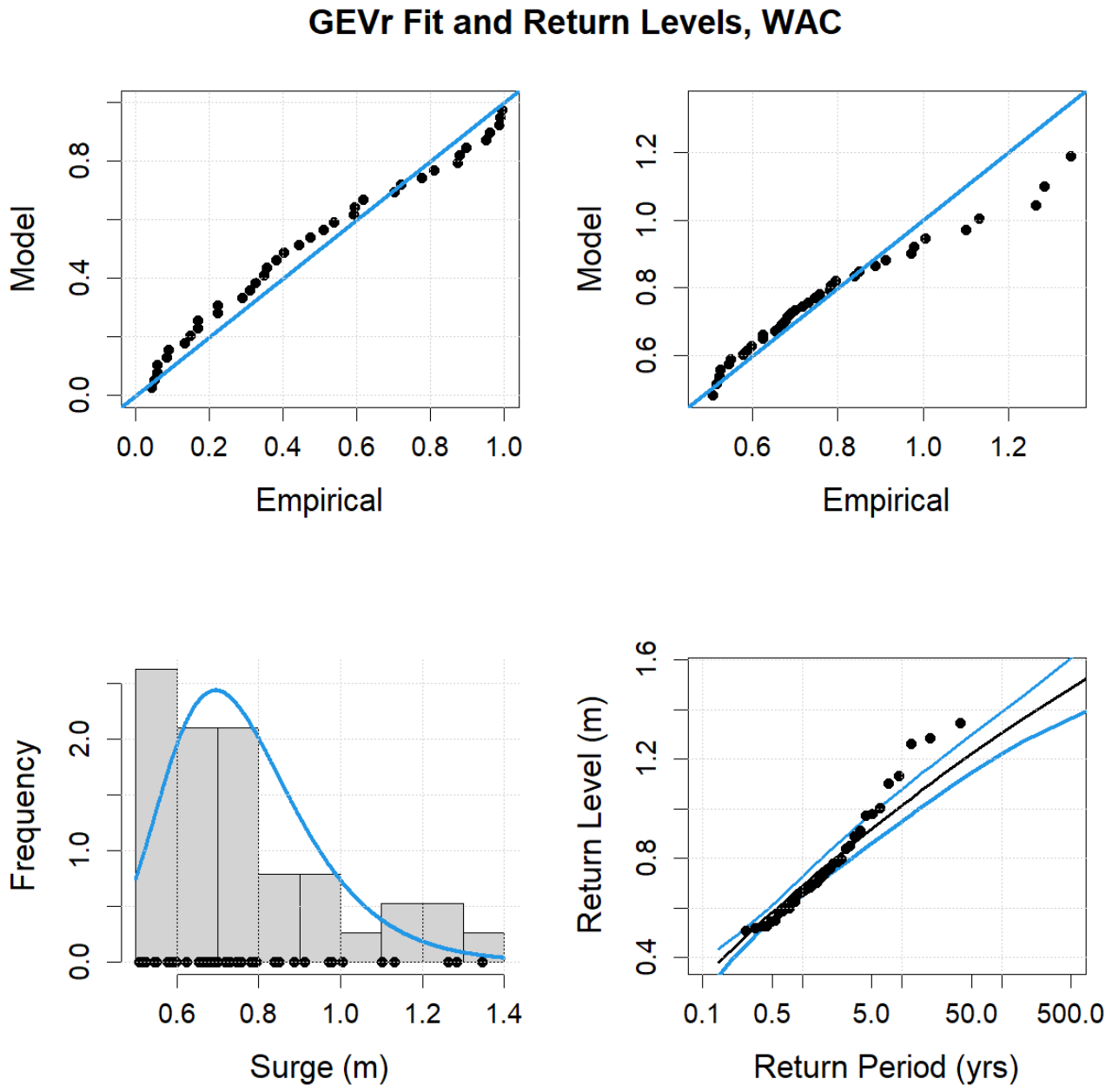
Supplementary Figure 9. Diagnostic plots for extreme skew surge fit to GEVr model at Lewisetta NOAA tide gauge (8635750) in the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



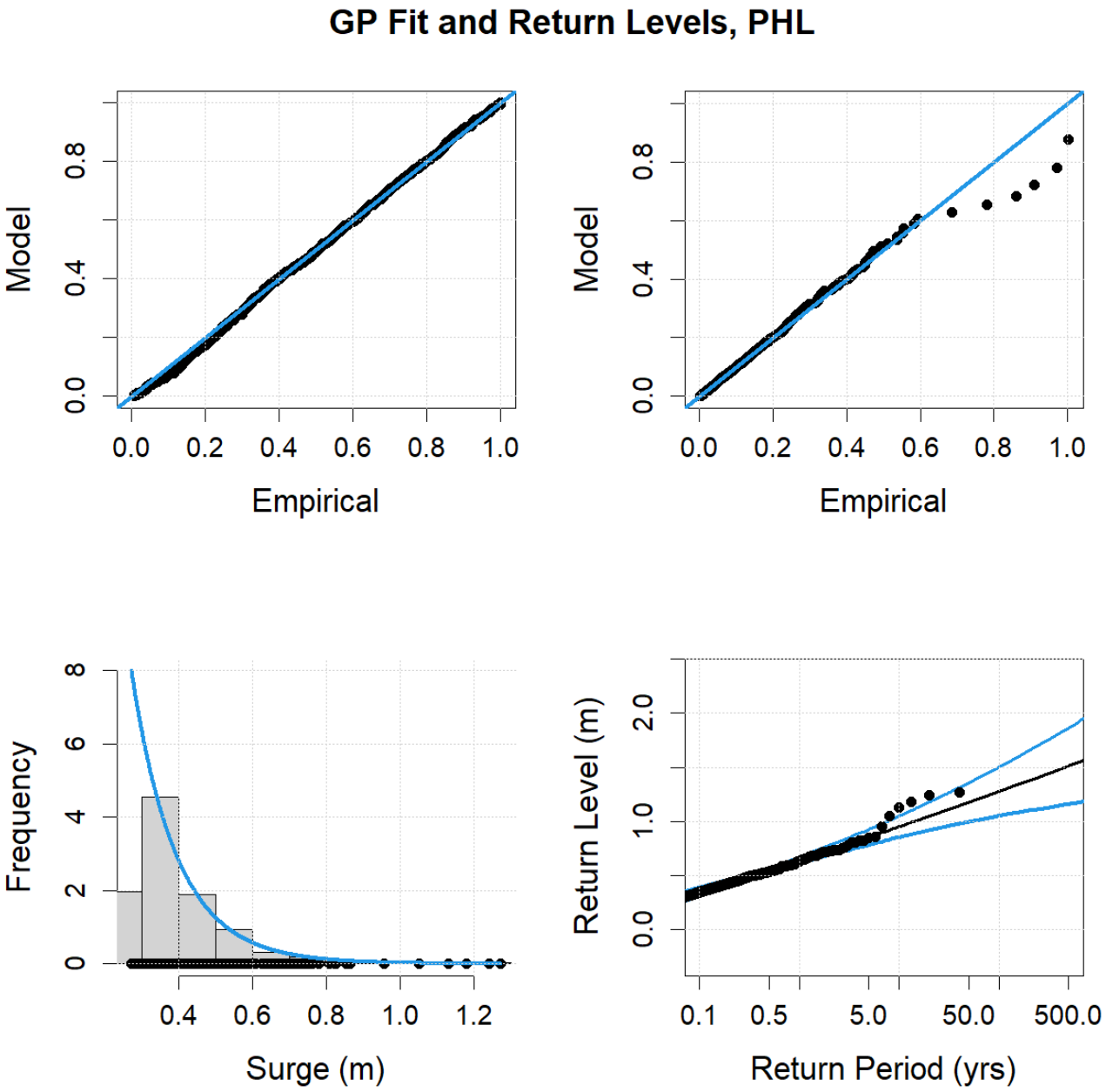
Supplementary Figure 10. Diagnostic plots for extreme skew surge fit to GEVr model at Kiptopeke NOAA tide gauge (8632200) in the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



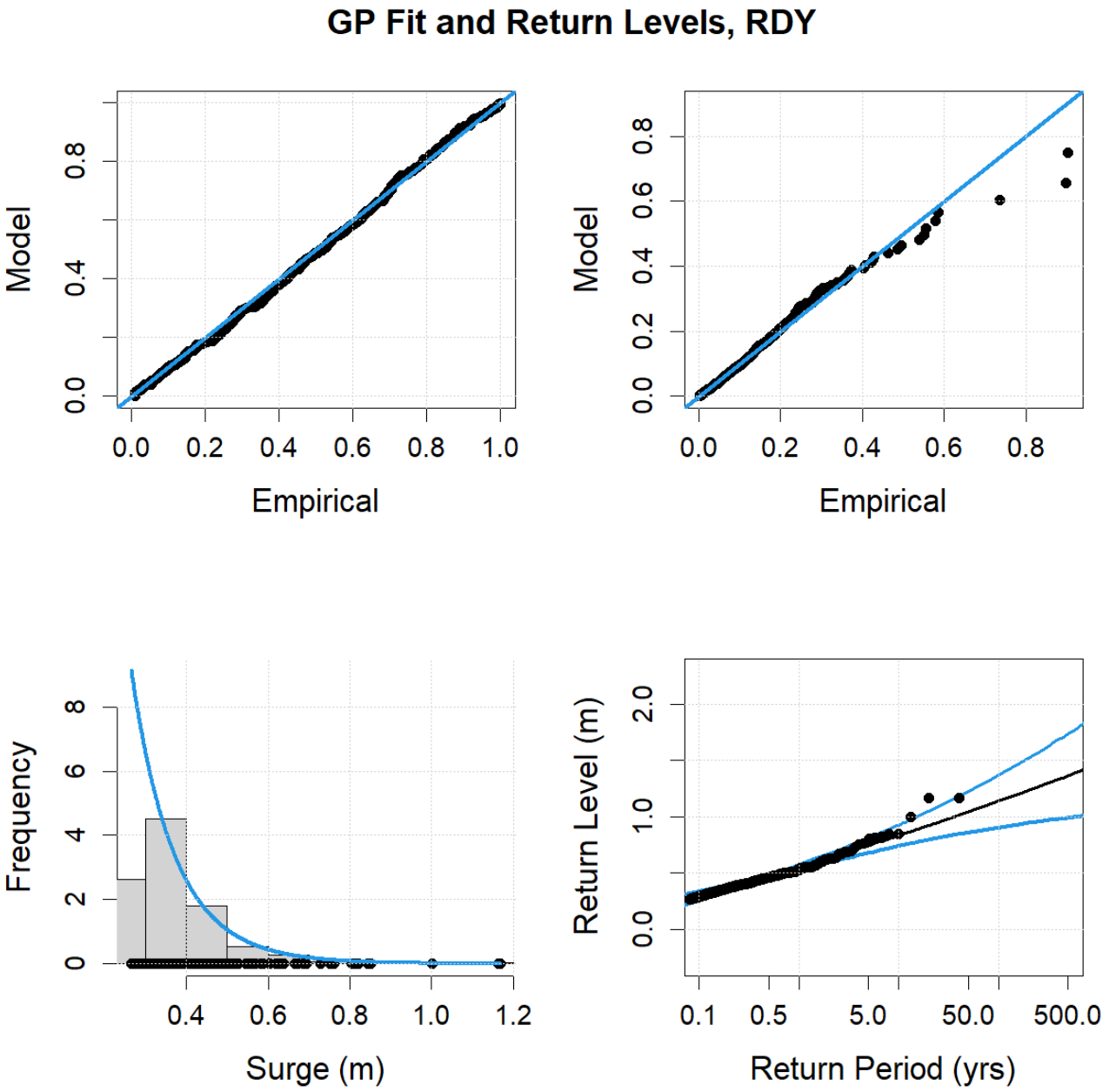
Supplementary Figure 11. Diagnostic plots for extreme skew surge fit to GEVr model at Sewells Point NOAA tide gauge (8638610) in the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



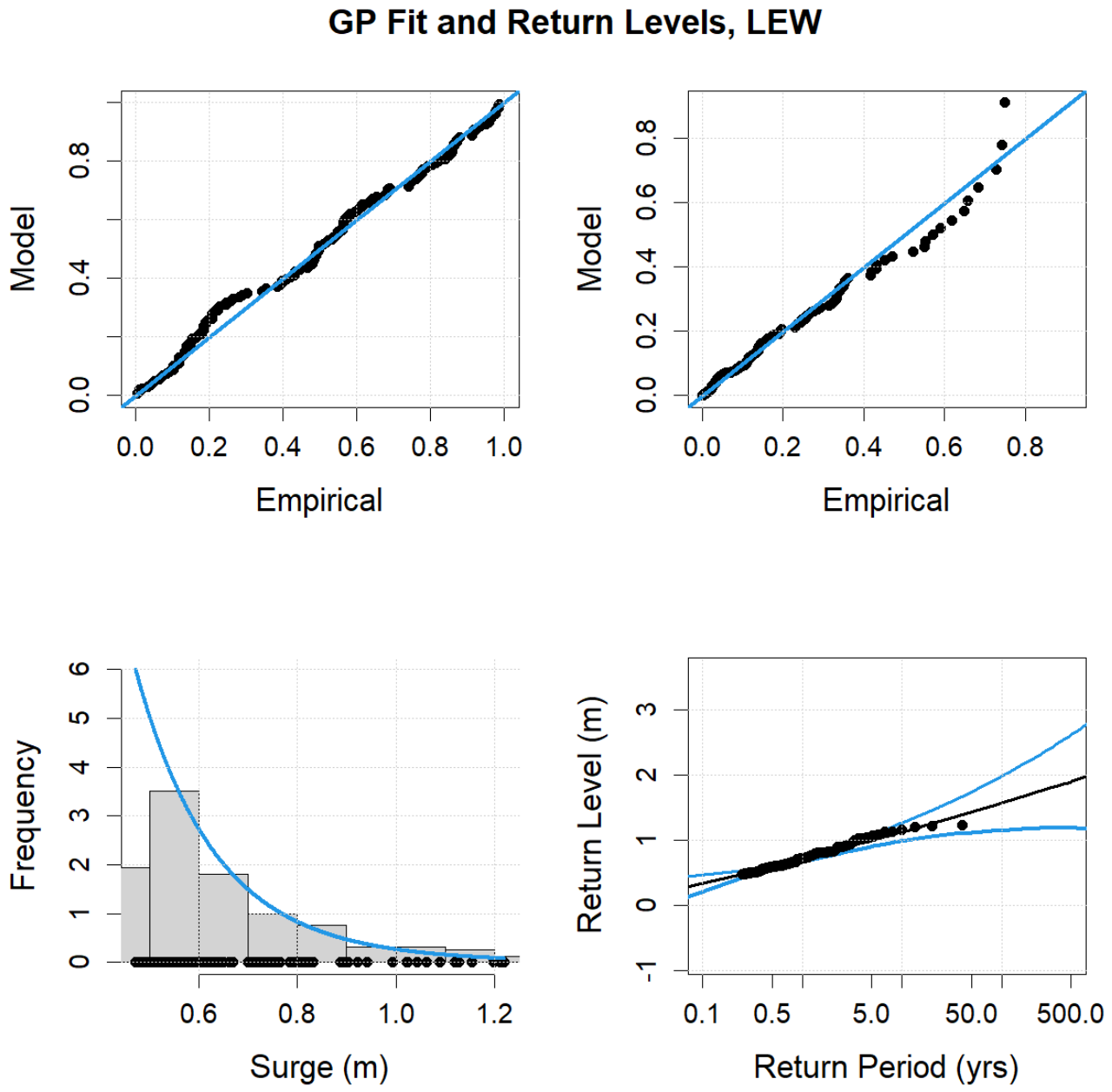
Supplementary Figure 12. Diagnostic plots for extreme skew surge fit to GEVr model at Wachapreague NOAA tide gauge (8631044) near the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



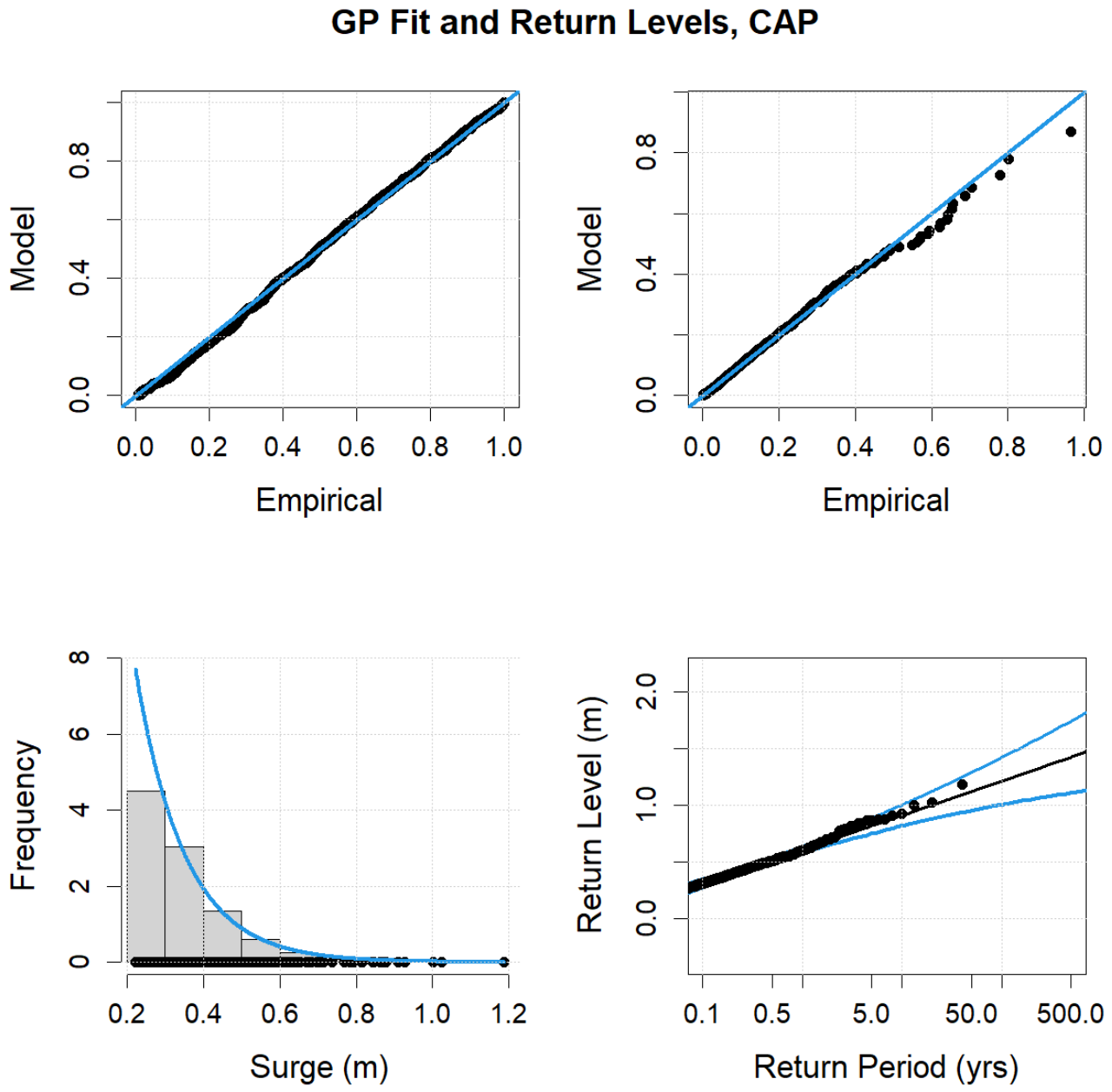
Supplementary Figure 13. Diagnostic plots for extreme skew surge fit to GPD model at Philadelphia NOAA tide gauge (8545240) in the Delaware River/Bay. (see introduction to this supplementary doc for explanation of plots.)



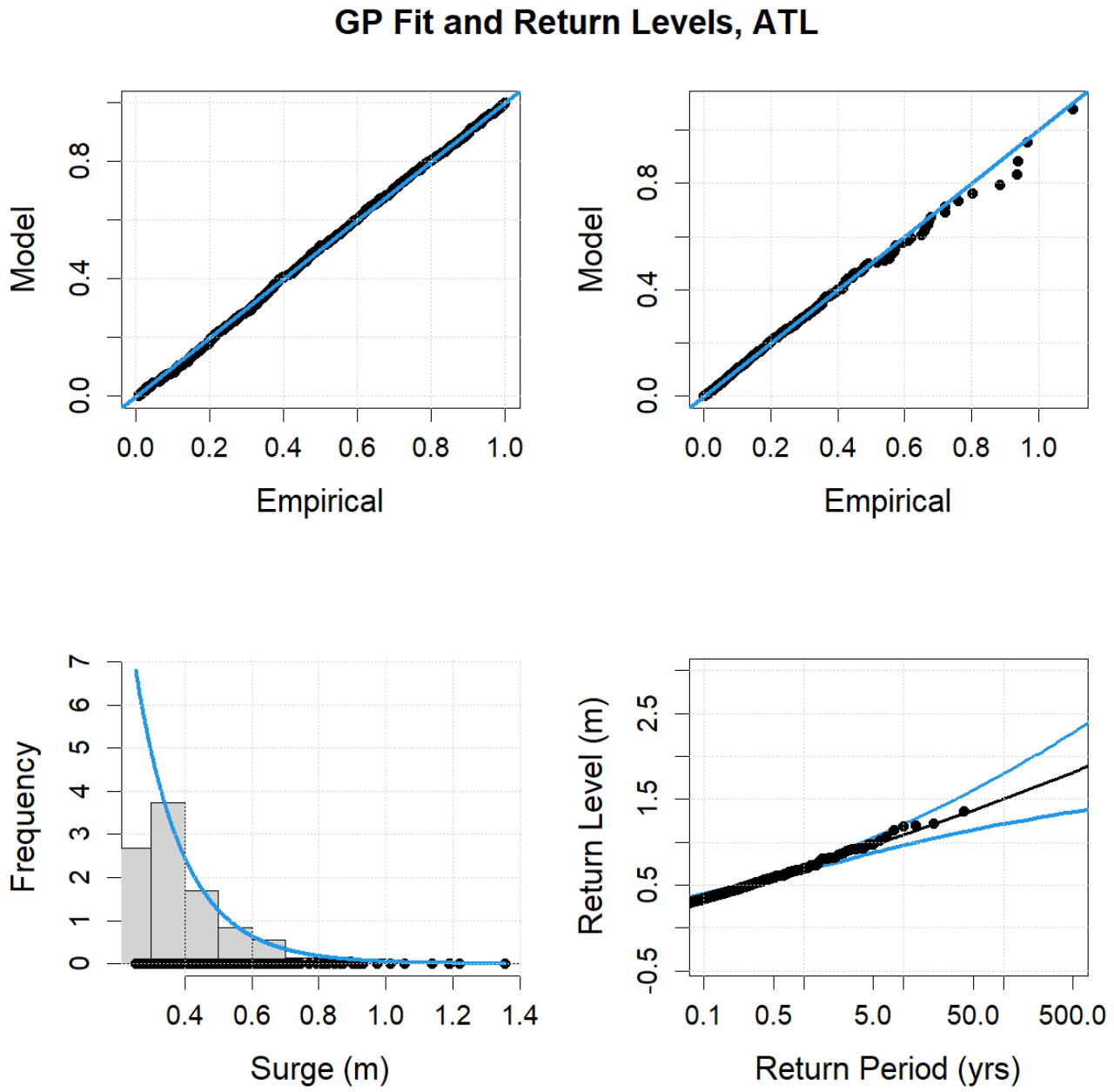
Supplementary Figure 14. Diagnostic plots for extreme skew surge fit to GPD model at Reedy Point NOAA tide gauge (8551910) in the Delaware Bay. (see introduction to this supplementary doc for explanation of plots.)



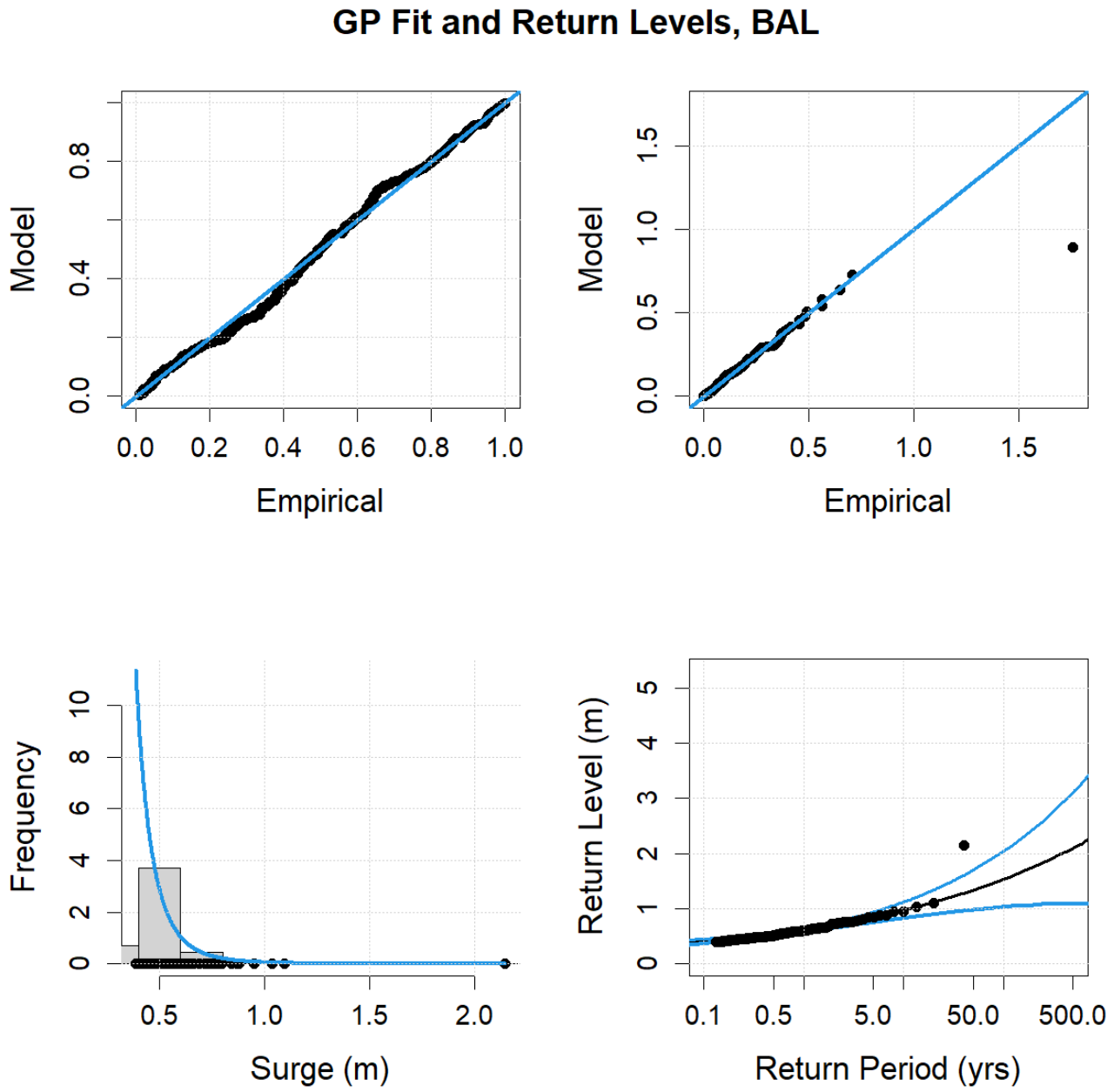
Supplementary Figure 15. Diagnostic plots for extreme skew surge fit to GPD model at Lewes NOAA tide gauge (8557380) in the Delaware Bay. (see introduction to this supplementary doc for explanation of plots.)



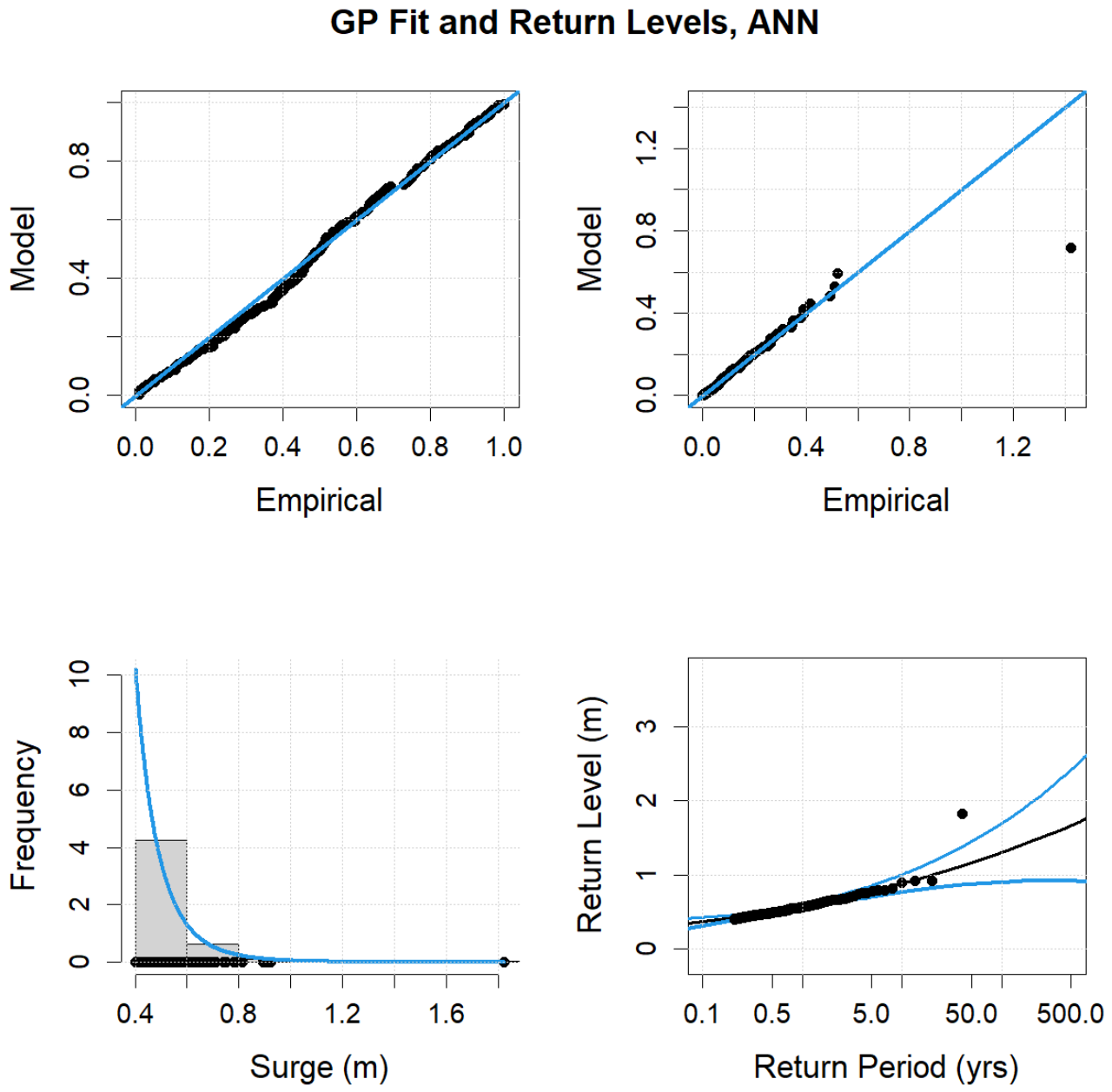
Supplementary Figure 16. Diagnostic plots for extreme skew surge fit to GPD model at Cape May NOAA tide gauge (8536110) in the Delaware Bay. (see introduction to this supplementary doc for explanation of plots.)



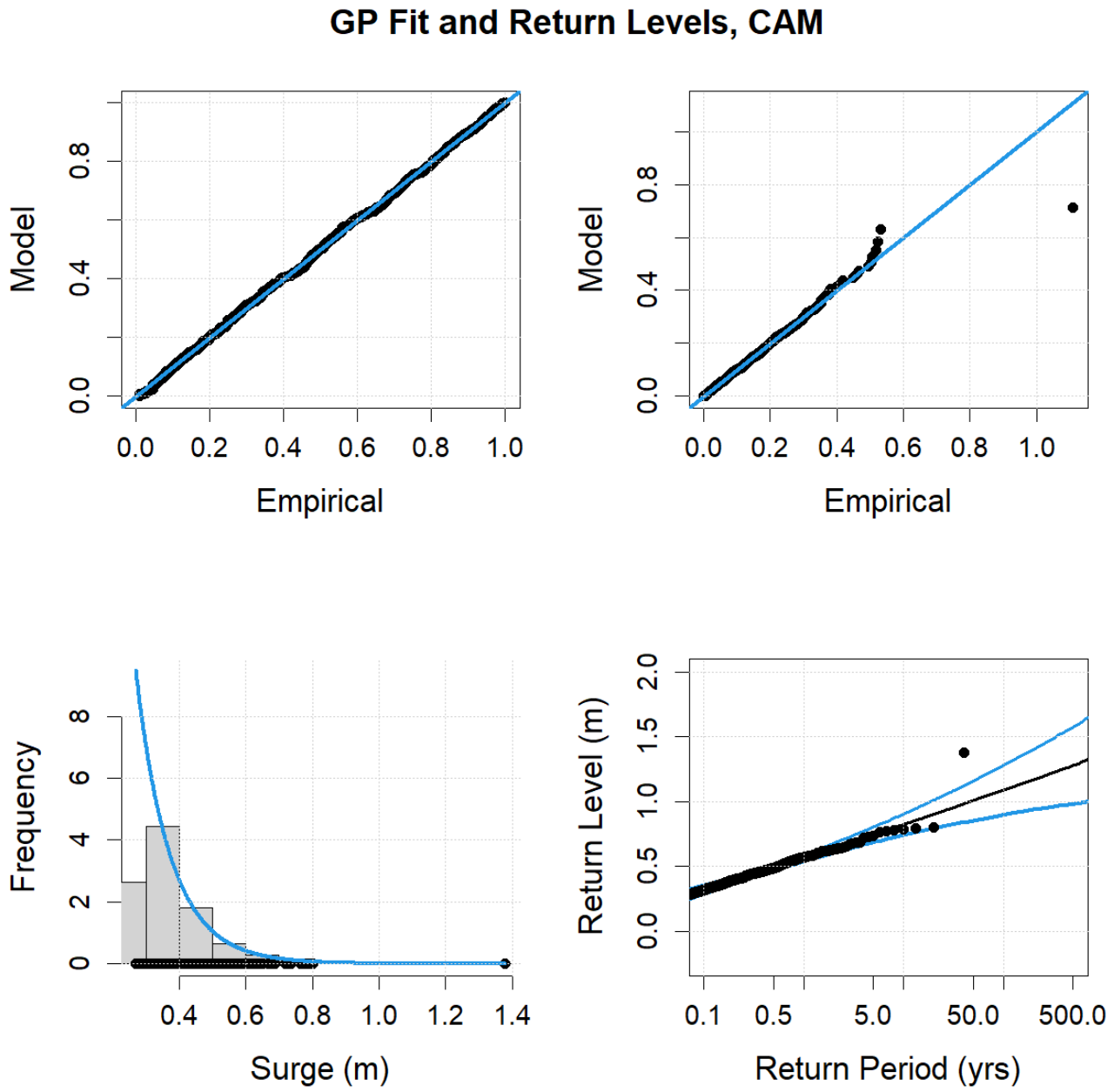
Supplementary Figure 17. Diagnostic plots for extreme skew surge fit to GPD model at Atlantic City NOAA tide gauge (8534720) near the Delaware Bay. (see introduction to this supplementary doc for explanation of plots.)



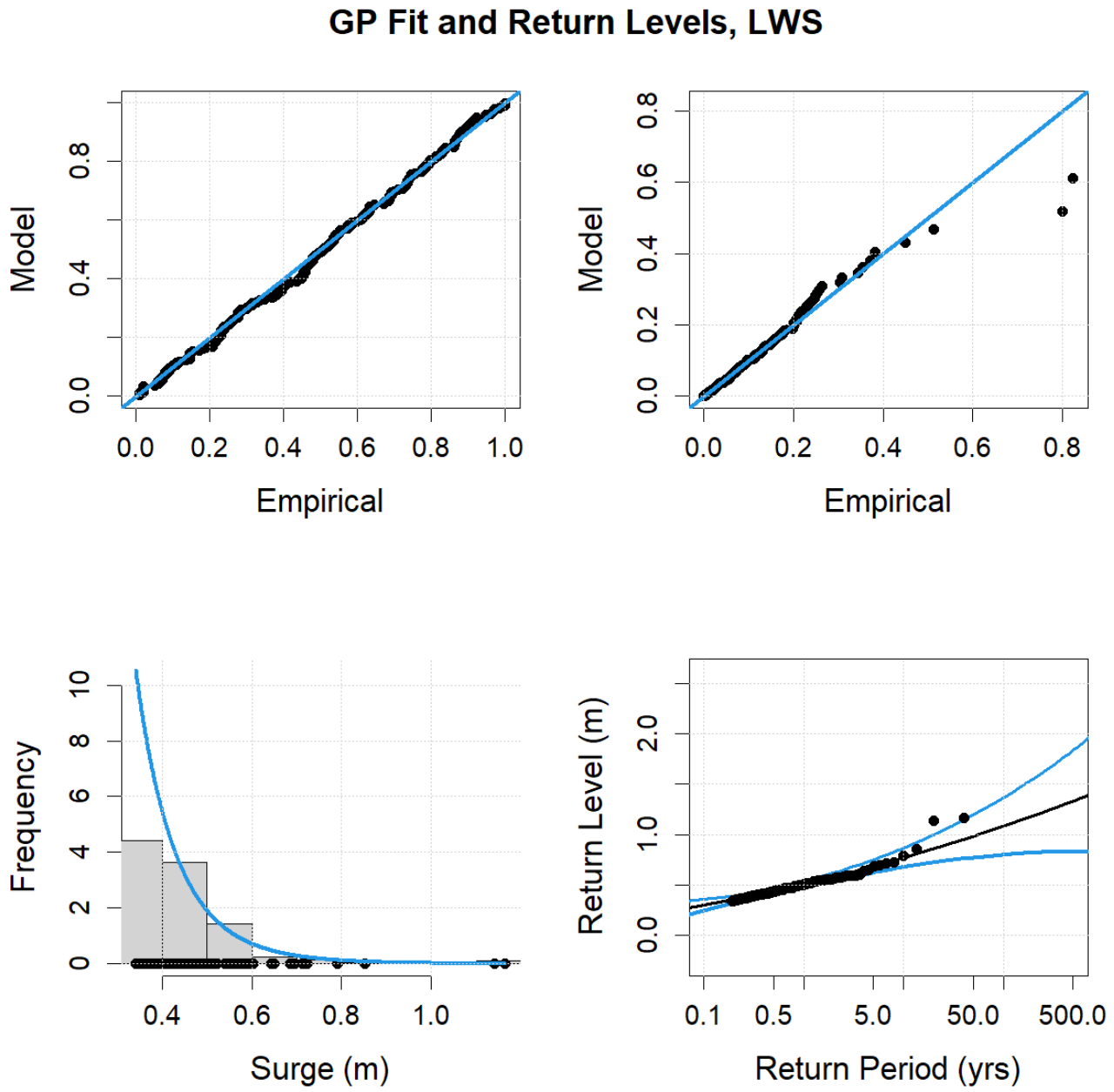
Supplementary Figure 18. Diagnostic plots for extreme skew surge fit to GPD model at Baltimore NOAA tide gauge (8574680) in the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



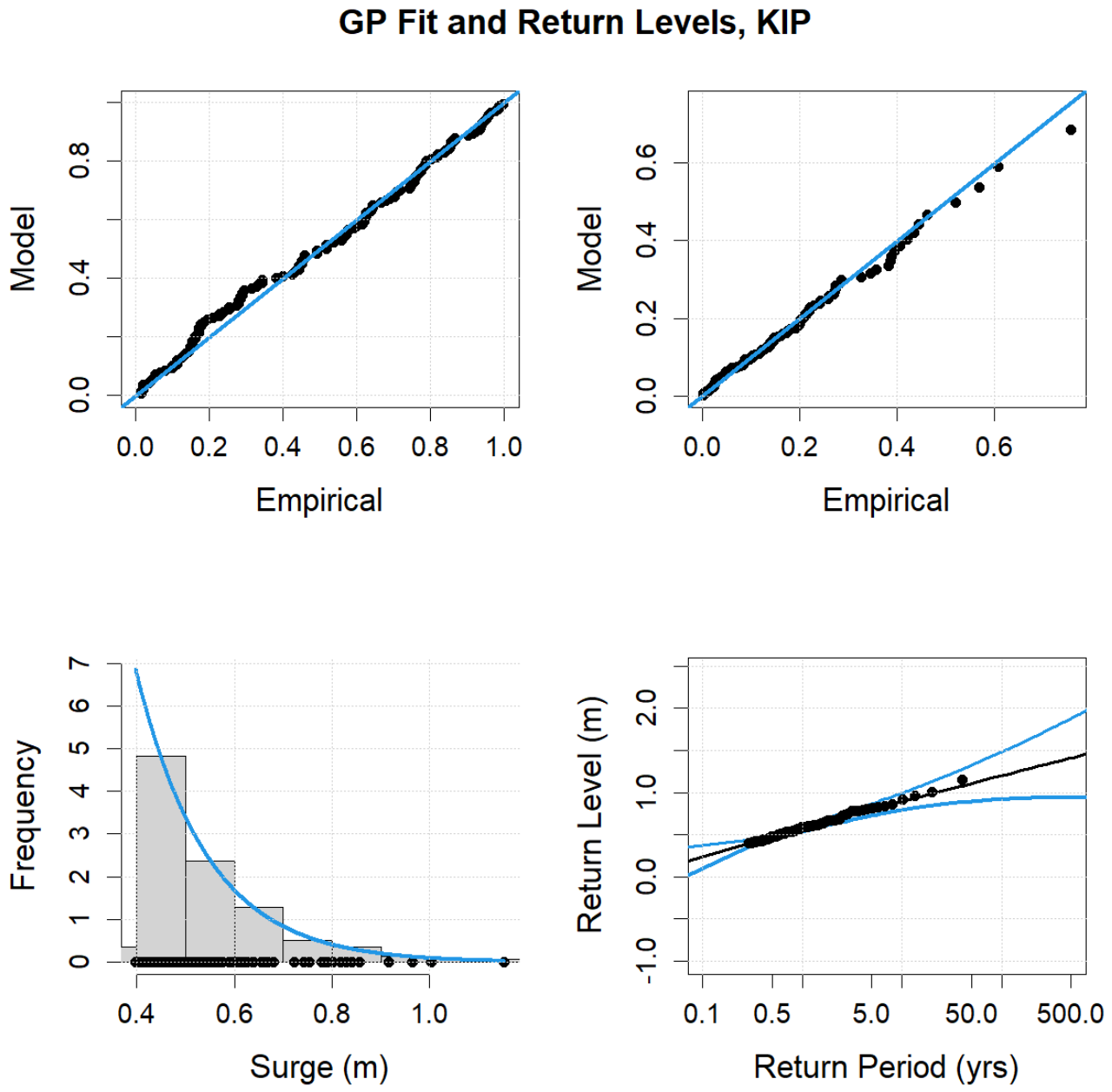
Supplementary Figure 19. Diagnostic plots for extreme skew surge fit to GPD model at Annapolis NOAA tide gauge (8575512) in the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



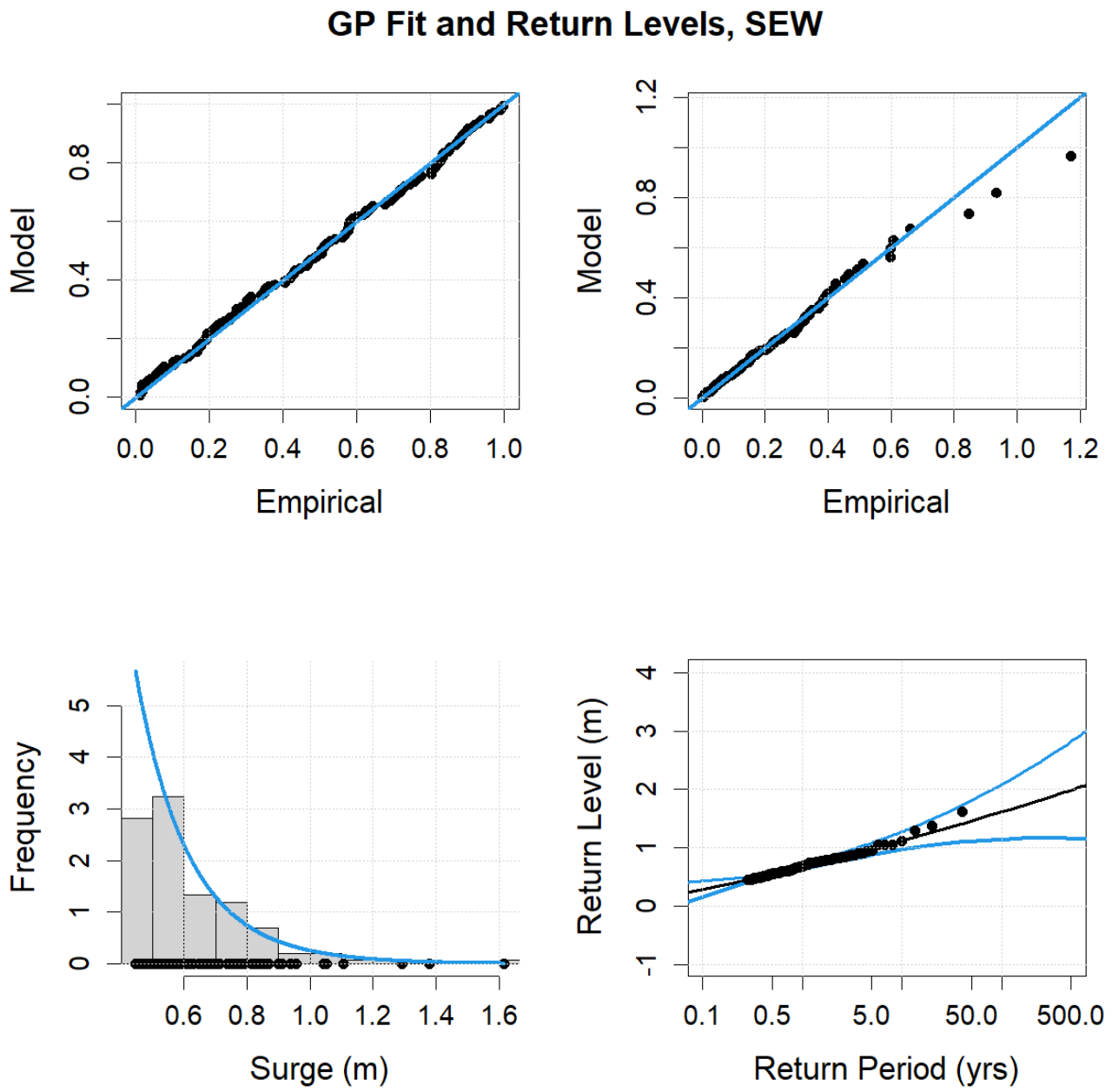
Supplementary Figure 20. Diagnostic plots for extreme skew surge fit to GPD model at Cambridge NOAA tide gauge (8571892) in the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



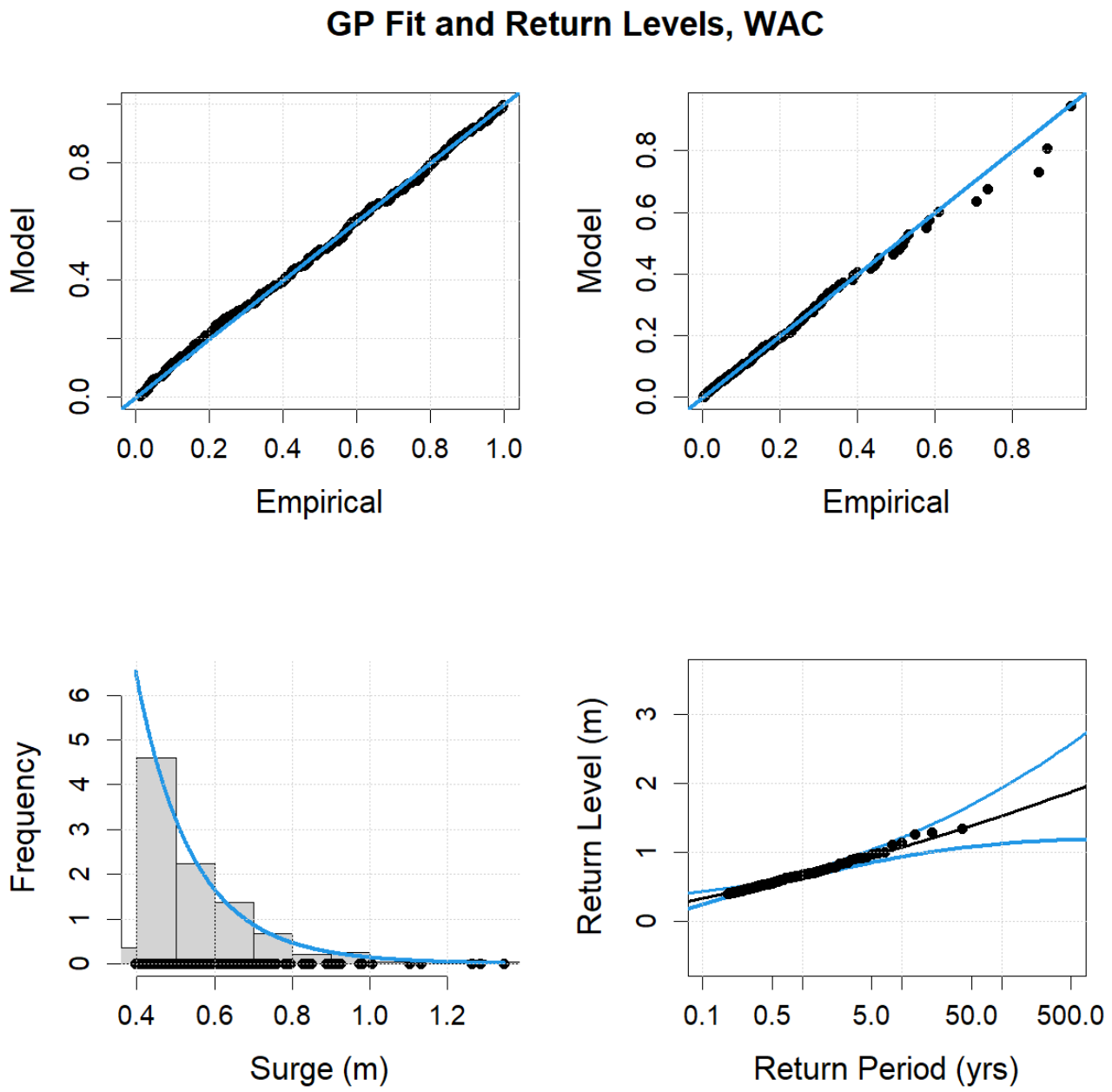
Supplementary Figure 21. Diagnostic plots for extreme skew surge fit to GPD model at Lewisetta NOAA tide gauge (8635750) in the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



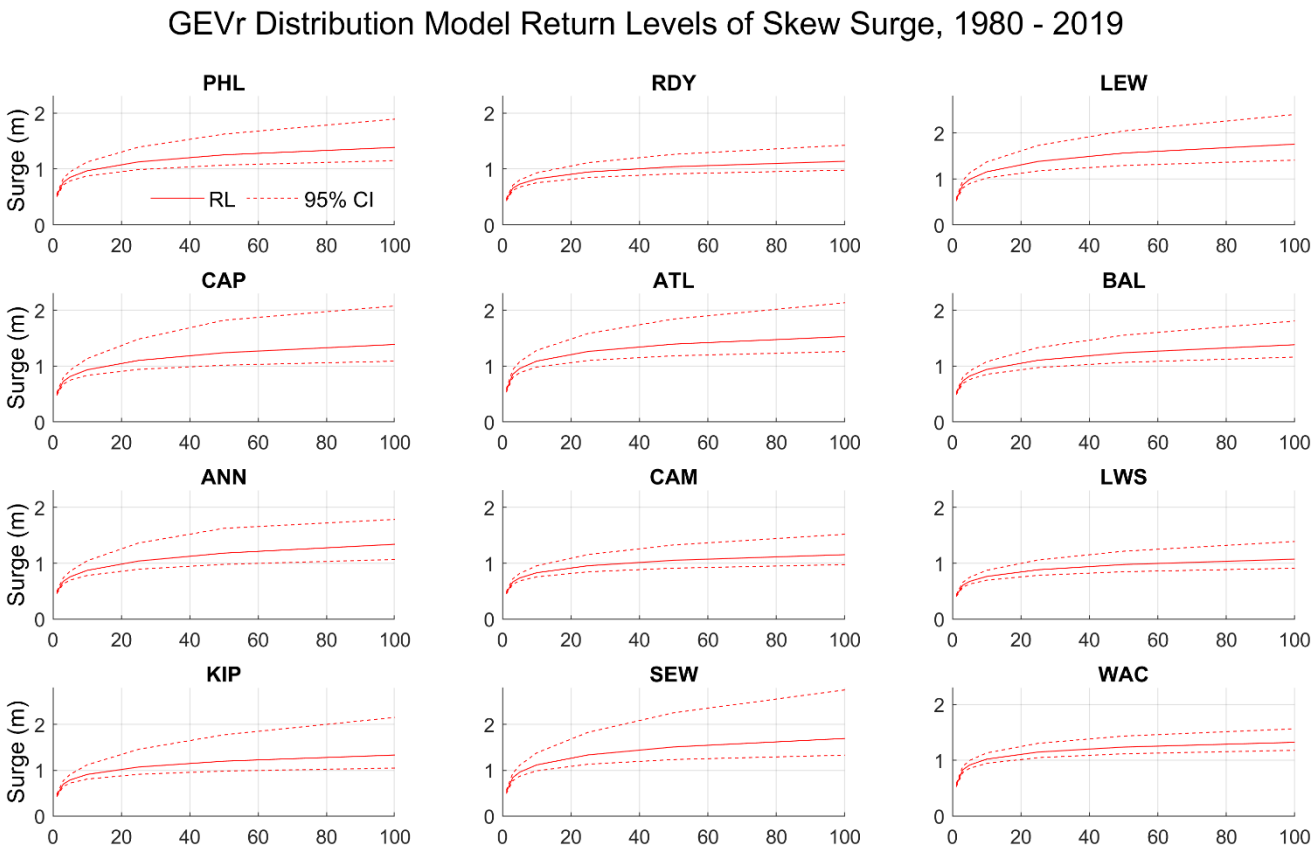
Supplementary Figure 22. Diagnostic plots for extreme skew surge fit to GPD model at Kiptopeke NOAA tide gauge (8632200) in the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



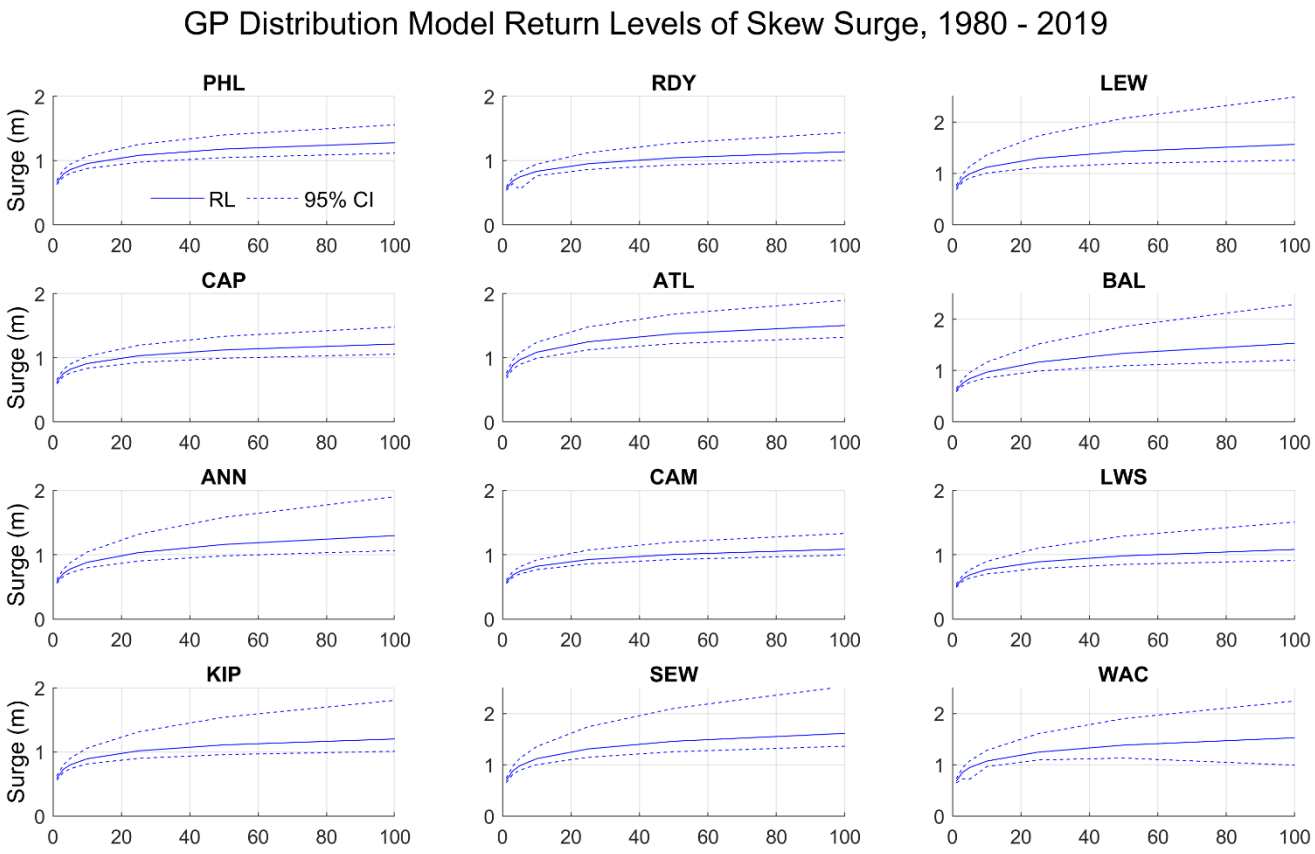
Supplementary Figure 23. Diagnostic plots for extreme skew surge fit to GPD model at Sewells Point NOAA tide gauge (8638610) in the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



Supplementary Figure 24. Diagnostic plots for extreme skew surge fit to GPD model at Wachapreague NOAA tide gauge (8631044) near the Chesapeake Bay. (see introduction to this supplementary doc for explanation of plots.)



Supplementary Figure 25. Estimates of skew surge for 1.1, 3, 5, 10, 25, 50, 100-year return periods using BM/GEVr approach for tide gauges in the Mid-Atlantic region, 1980 – 2019. Dotted lines represent upper and lower bounds of 90% confidence interval.



Supplementary Figure 26. Estimates of skew surge for 1.1, 3, 5, 10, 25, 50, 100-year return periods using POT/GP approach for tide gauges in the Mid-Atlantic region, 1980 – 2019. Dotted lines represent upper and lower bounds of 90% confidence interval.