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Supplement of

Tide–surge interaction observed at Singapore and the east coast of Peninsular Malaysia using a semi-empirical model

Zhi Yang Koh et al.

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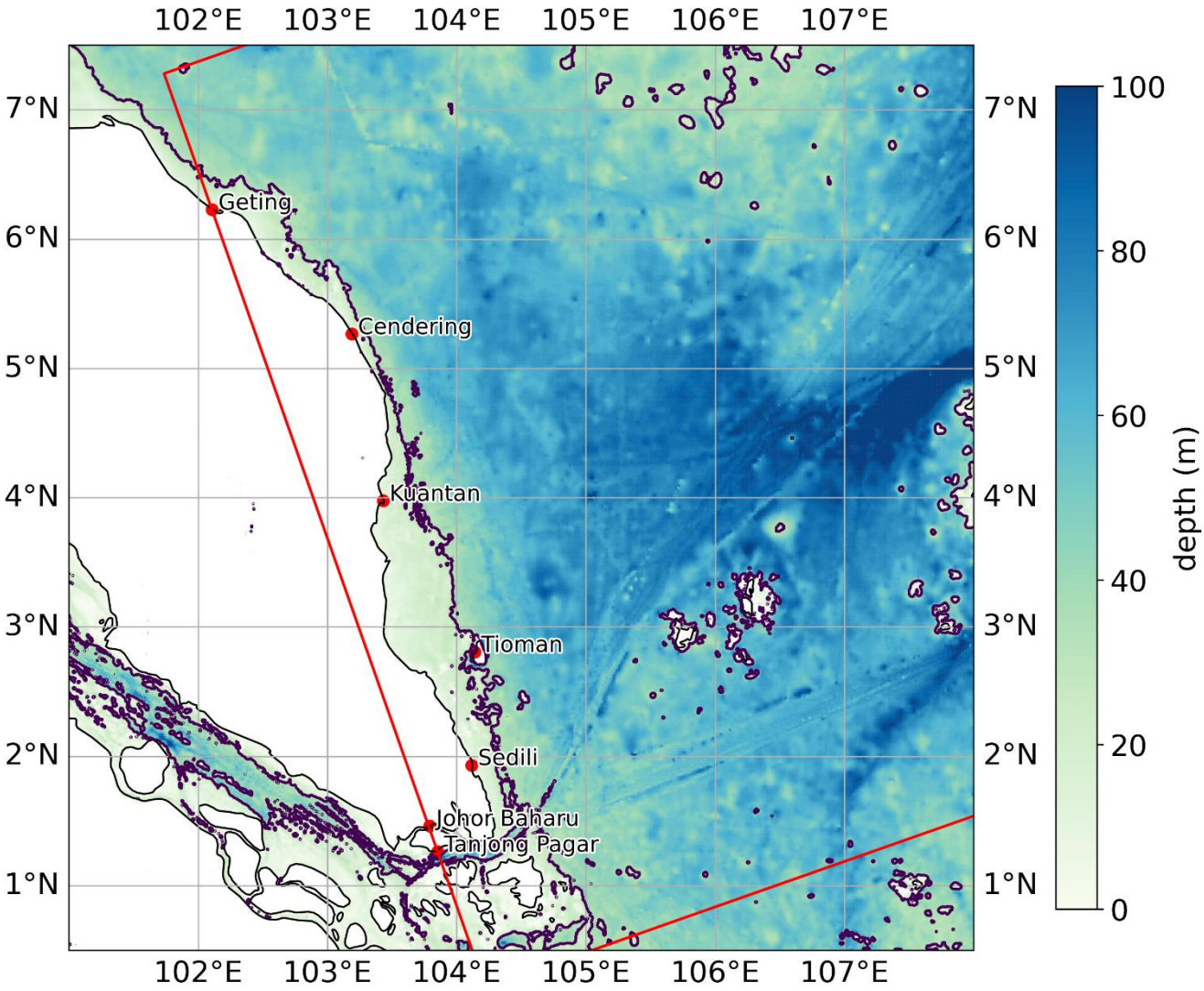


Figure S1: Bathymetry (in m) near the seven tide gauges, obtained from GEBCO, the General Bathymetric Chart of the Oceans (GEBCO Compilation Group, 2023). The seven tide gauge stations are marked in red circles. The red rectangle denotes the region where 10 m winds and mean sea level pressure are considered when calculating R_{surge} (Sect. 3.4). Contour lines at a depth of 30 m are drawn in purple, beyond which we find a relatively steep descend.

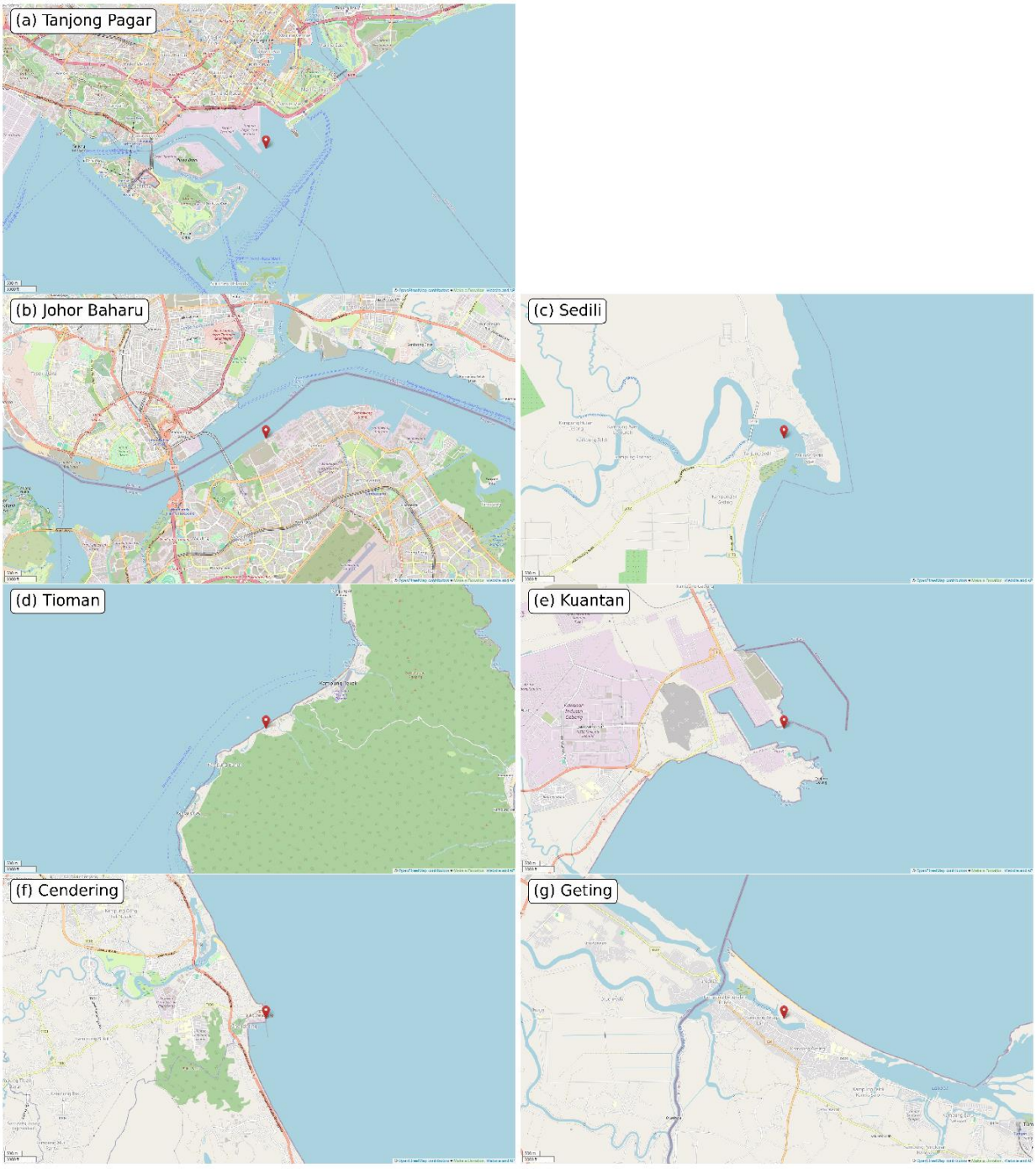


Figure S2: Local characteristics near the seven tide gauges (OpenStreetMap contributors, 2017; Caldwell et al., 2001). © OpenStreetMap contributors 2017. Distributed under the Open Data Commons Open Database License (ODbL) v1.0.

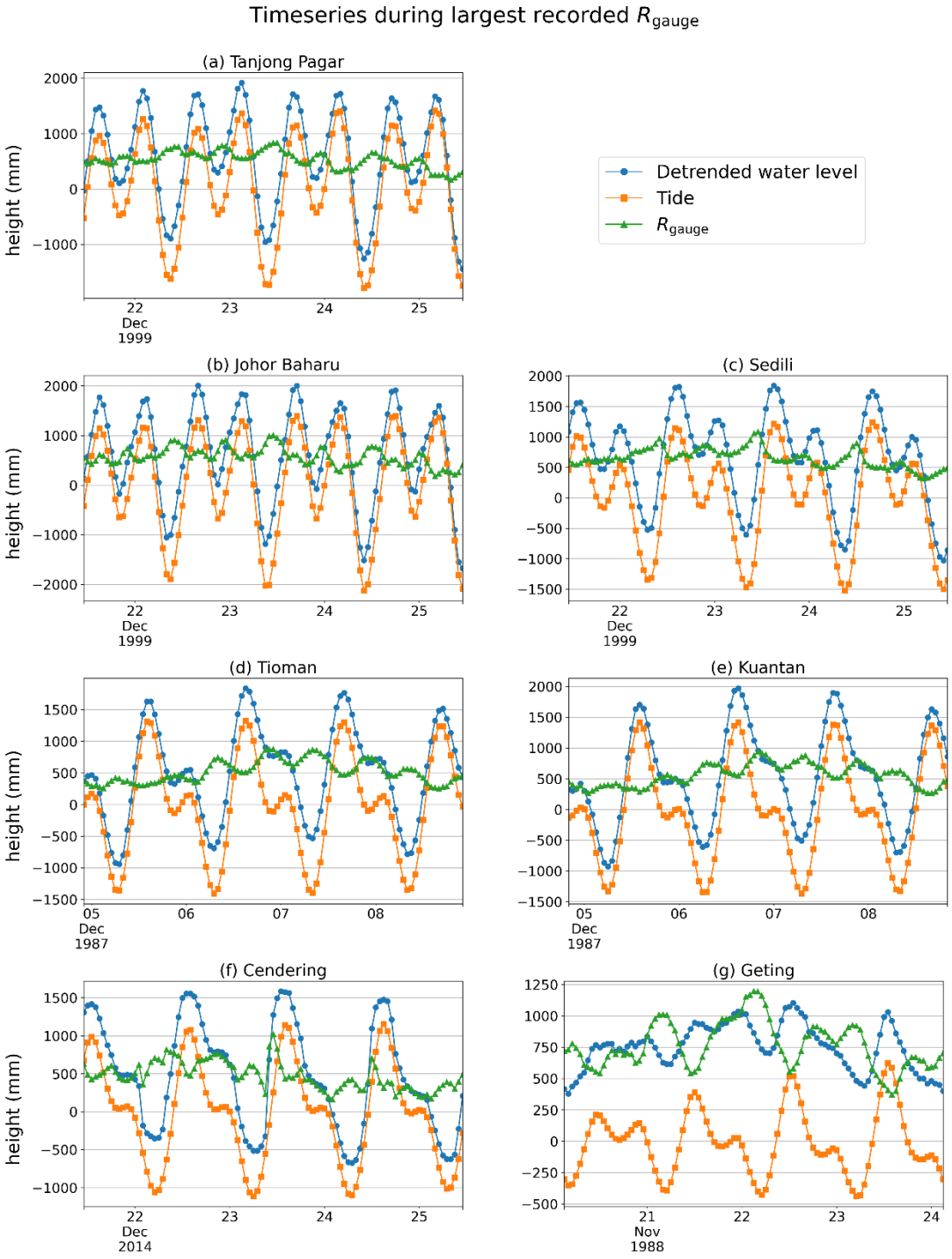


Figure S3: Timeseries at each tide gauge location two days before and after the largest observed non-tidal residual, R_{gauge}.

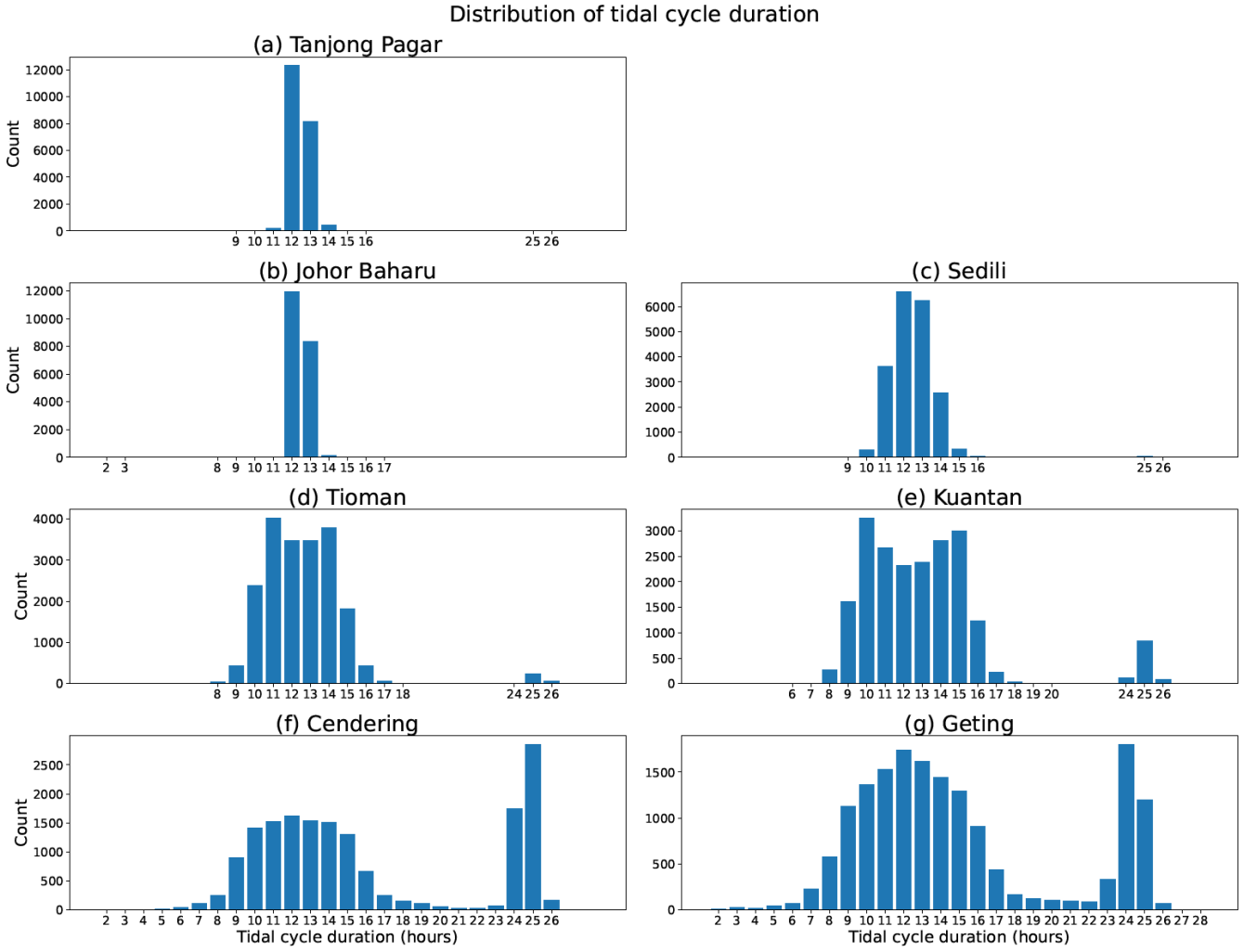


Figure S4: Histogram of the duration of tidal cycles at each tide gauge location. Tidal cycles are defined as the duration from one local minima in the hourly tidal level to the observation immediately preceding the next local minima (Sect. 3.2). Tidal cycles at Tanjong Pagar and Johor Baharu are often 12–13 hours long, while the tidal cycles at the other locations are less consistent.

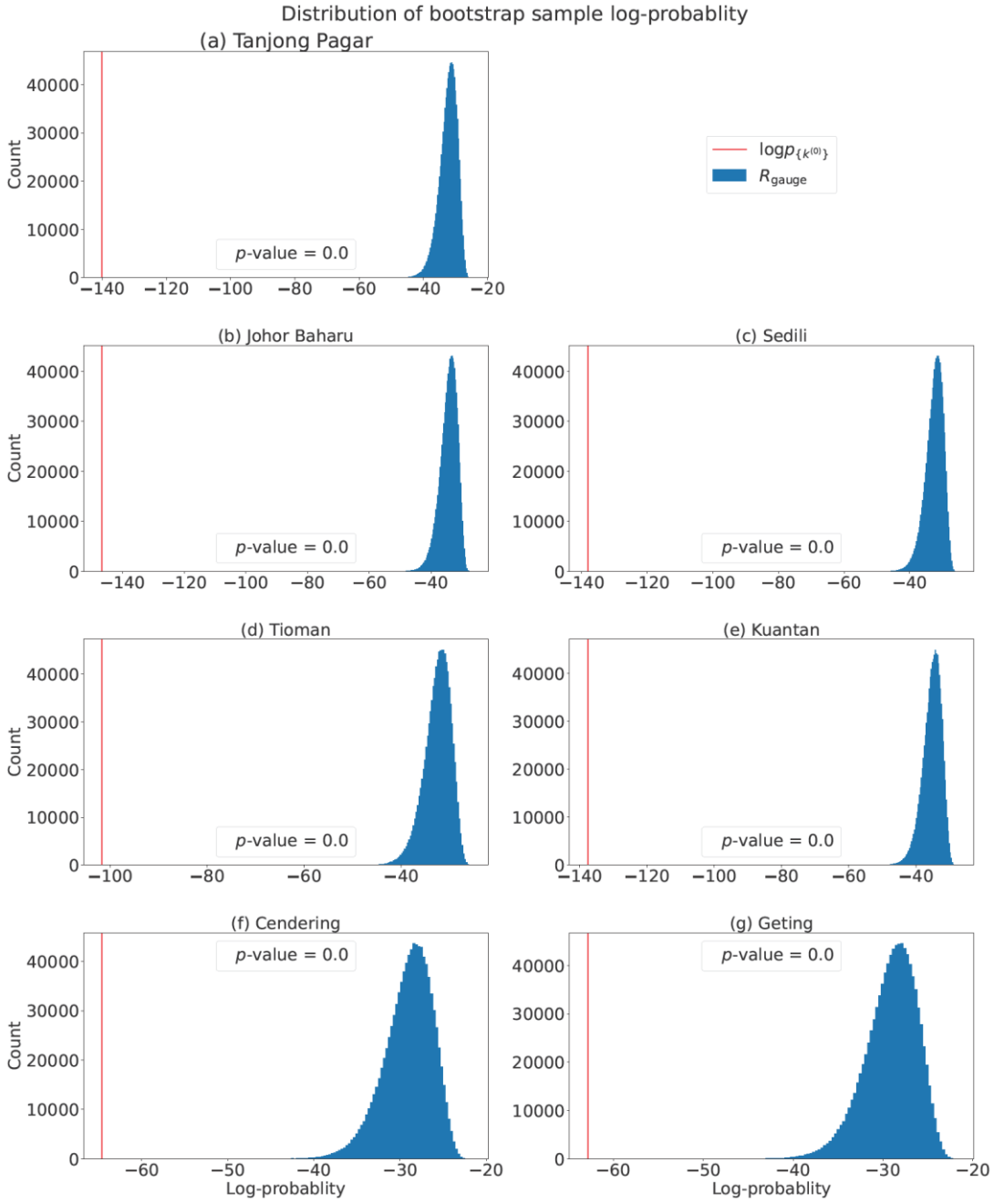


Figure S5: Histogram of 1,000,000 log-probabilities of obtaining a randomly generated bootstrap sample from the normalized No-TSI distribution p_h of R_{gauge} during semidiurnal tidal cycles. Red vertical lines indicate $\log p_{\{k^{(0)}\}}$, the log-probabilities of obtaining the frequency distribution $k^{(0)}$ from p_h. p-values are obtained by taking the quantile of the $\log p_{\{k^{(0)}\}}$ within the 1,000,000 log-probabilities of bootstrap samples.

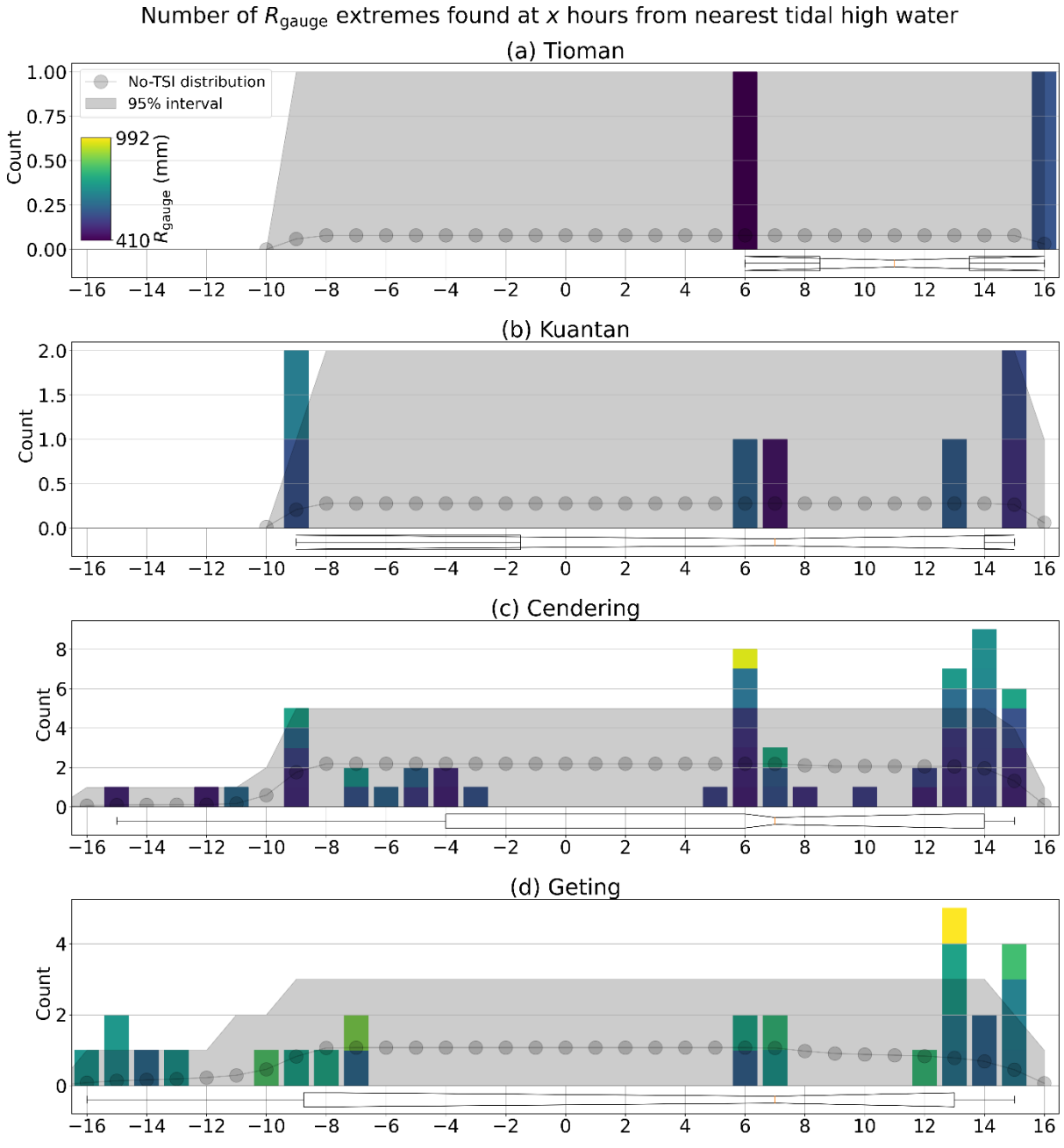


Figure S6: The frequency distribution for extreme values of R_{gauge} and the No-TSI distribution during diurnal tidal cycles, truncated at ±16 hours from tidal high water. The frequency distribution is compared to the No-TSI distribution to determine the presence of tide-surge interaction. Summary statistics of the frequency distribution are shown using the horizontal notched box plot, where orange lines indicate the medians, notches indicate the 95% confidence interval of the medians, notched rectangles indicate the interquartile range (IQR), whiskers indicate a range that extends up to 1.5×IQR from the limits of the IQR, and black circles (if present) indicate outliers outside this range.

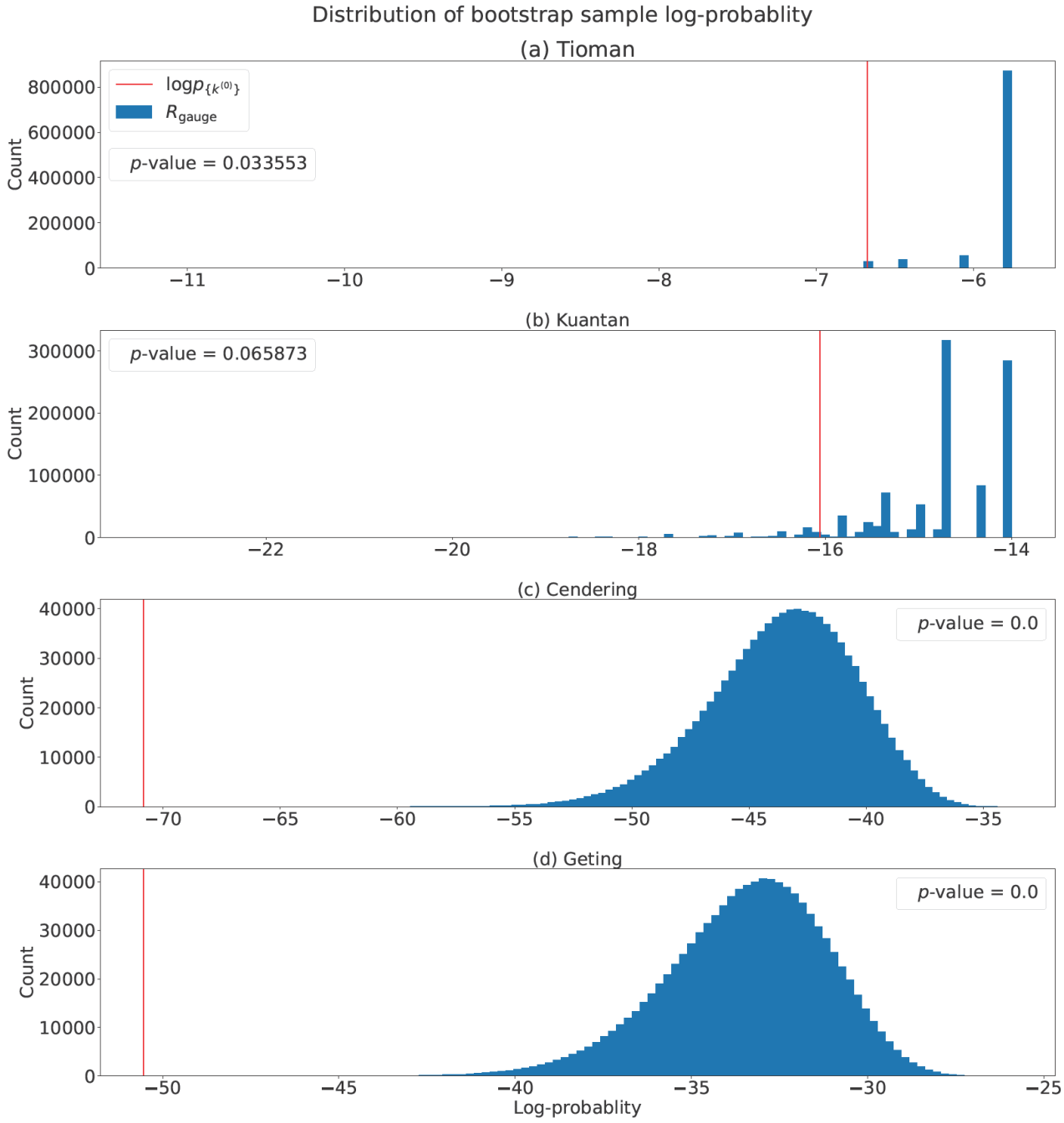


Figure S7: Histogram of 1,000,000 log-probabilities of obtaining a randomly generated bootstrap sample from the normalized No-TSI distribution p_h of R_{gauge} during diurnal tidal cycles. Red vertical lines indicate $\log p_{\{k^{(0)}\}}$, the log-probabilities of obtaining the frequency distribution $k^{(0)}$ from p_h. p-values are obtained by taking the quantile of the $\log p_{\{k^{(0)}\}}$ within the 1,000,000 log-probabilities of bootstrap samples.

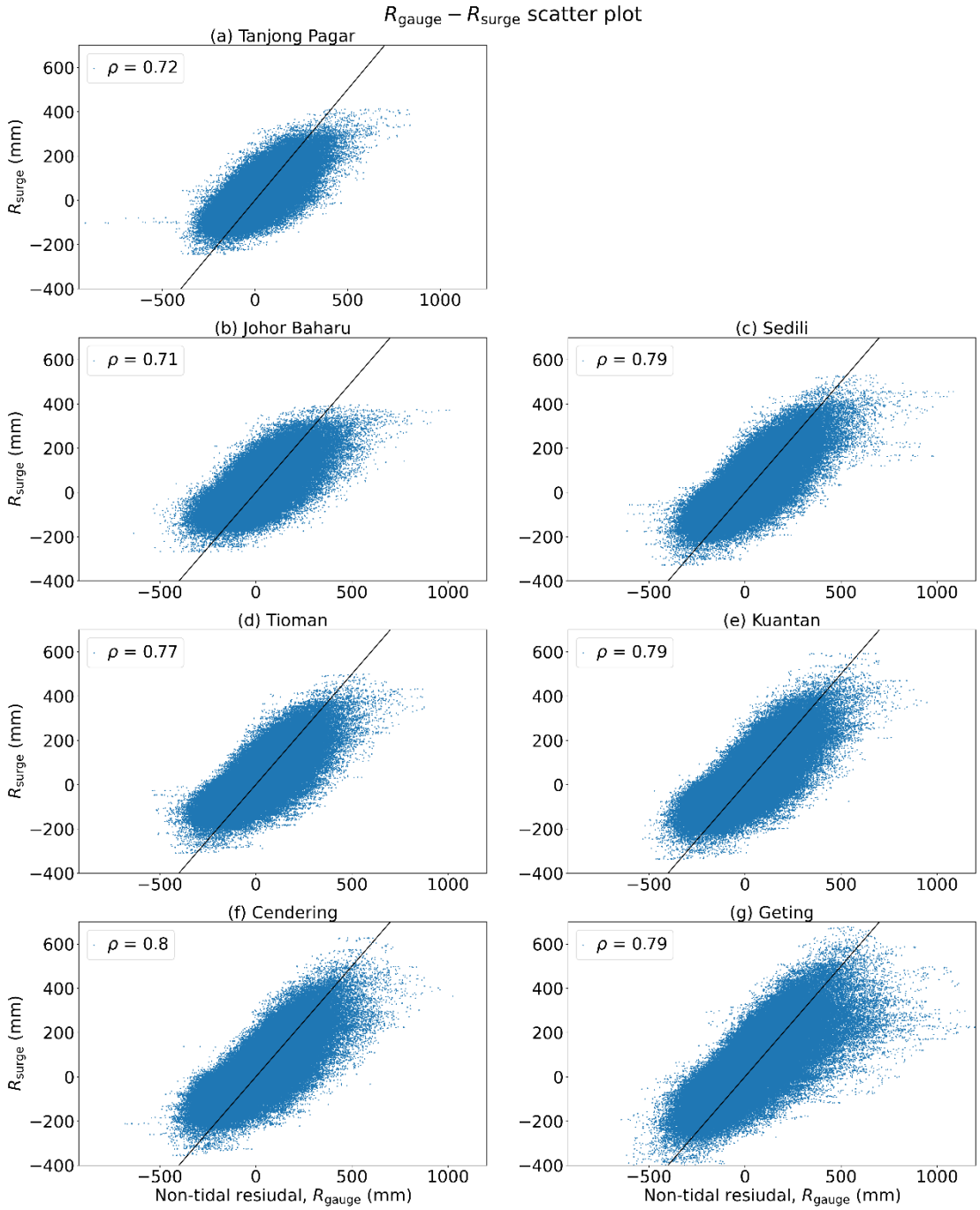


Figure S8: Scatter plots between non-tidal residuals, R_{gauge} and R_{wind} at each tide-gauge location. The correlation coefficients of 0.7–0.8 corresponds to a coefficient of determination of 0.5–0.6.

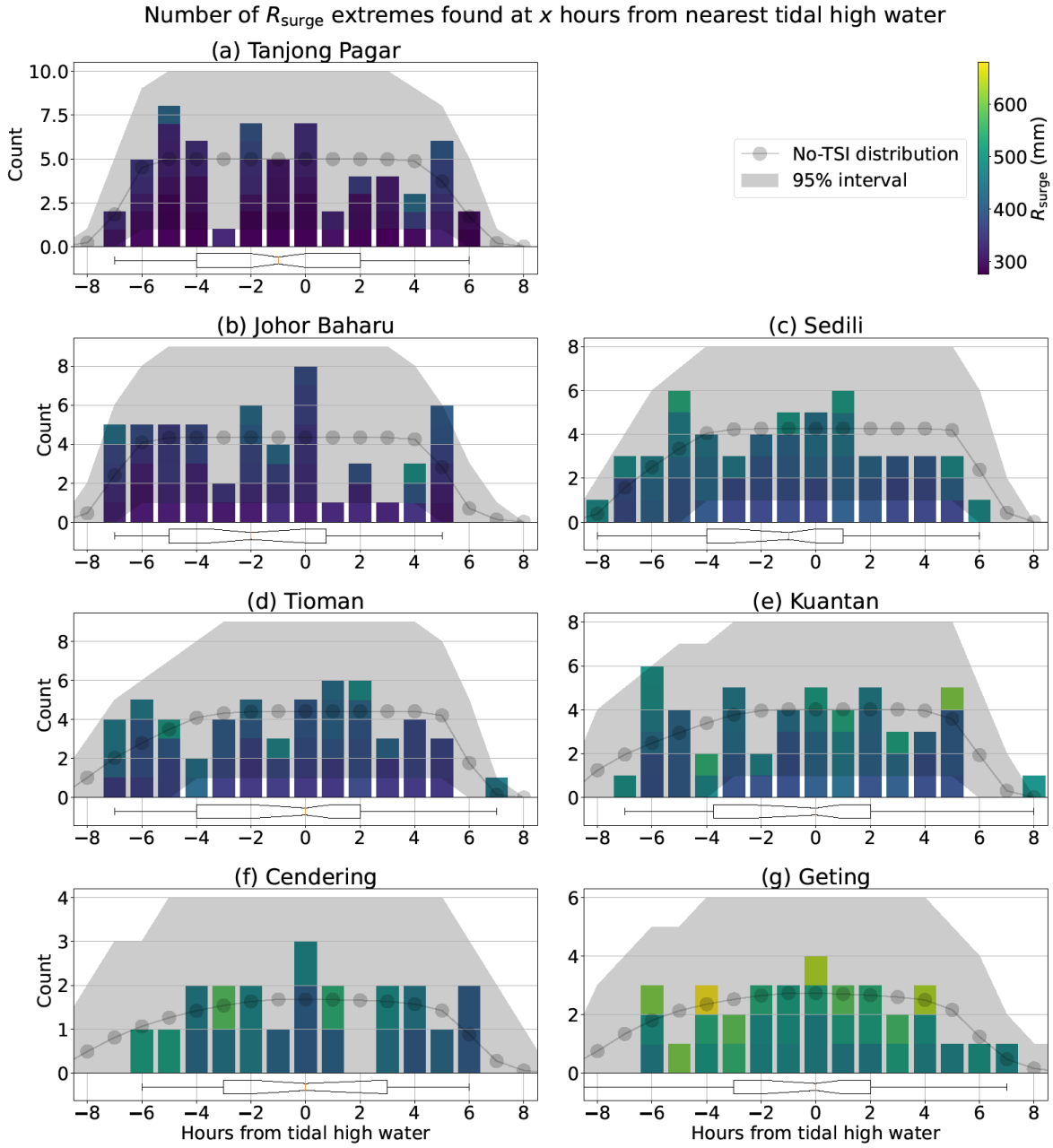


Figure S9: The frequency distribution for extreme values of R_{wind} and the No-TSI distribution during semidiurnal tidal cycles, truncated at ±8 hours from tidal high water. The frequency distribution is compared to the No-TSI distribution to determine the presence of tide-surge interaction. Summary statistics of the frequency distribution are shown using the horizontal notched box plot, where orange lines indicate the medians, notches indicate the 95% confidence interval of the medians, notched rectangles indicate the interquartile range (IQR), whiskers indicate a range that extends up to 1.5×IQR from the limits of the IQR, and black circles (if present) indicate outliers outside this range.

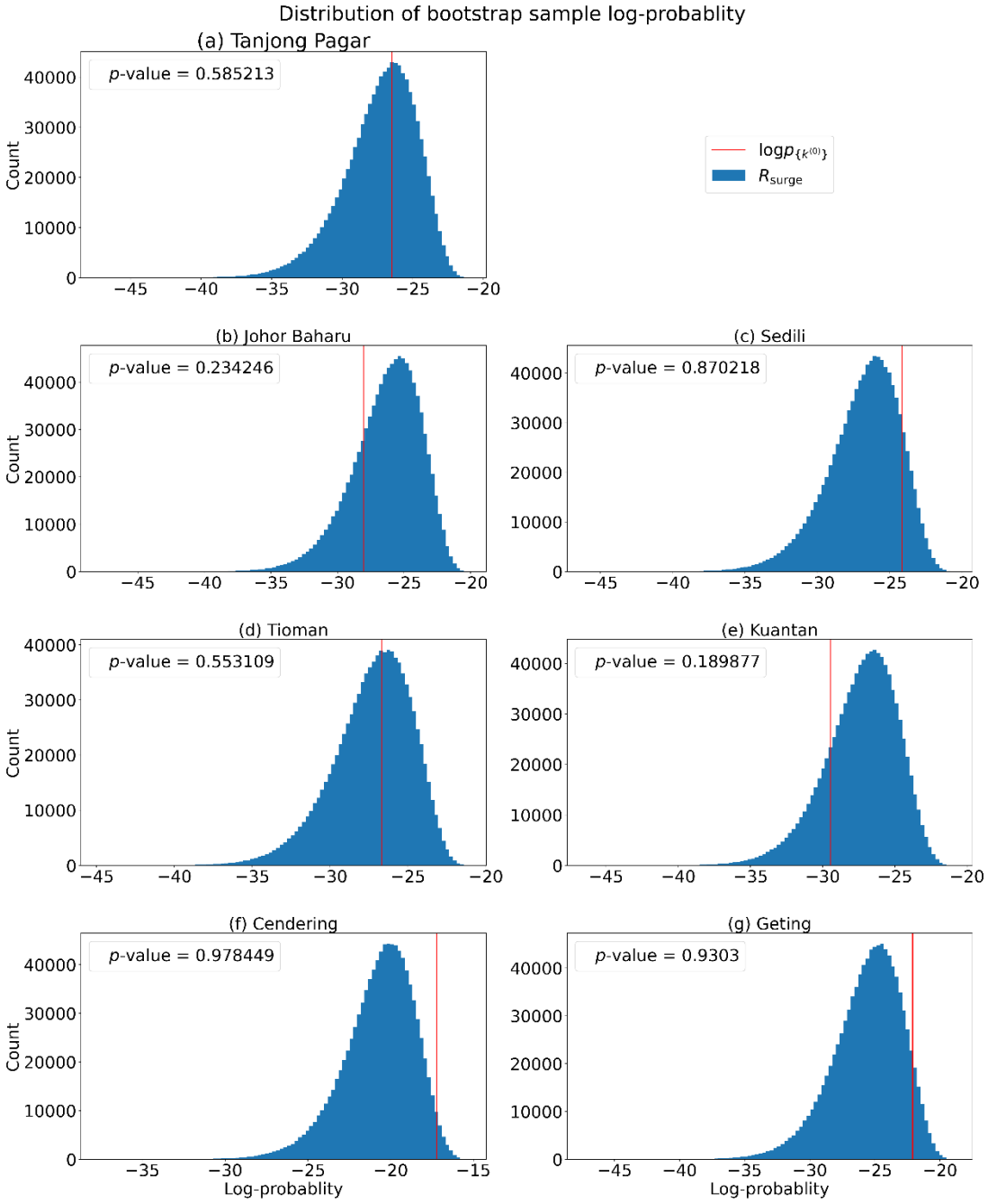


Figure S10: Histogram of 1,000,000 log-probabilities of obtaining a randomly generated bootstrap sample from the normalized No-TSI distribution p_h of R_{wind} during semidiurnal tidal cycles. Red vertical lines indicate $\log p_{\{k^{(0)}\}}$, the log-probabilities of obtaining the frequency distribution $k^{(0)}$ from p_h. p-values are obtained by taking the quantile of the $\log p_{\{k^{(0)}\}}$ within the 1,000,000 log-probabilities of bootstrap samples.

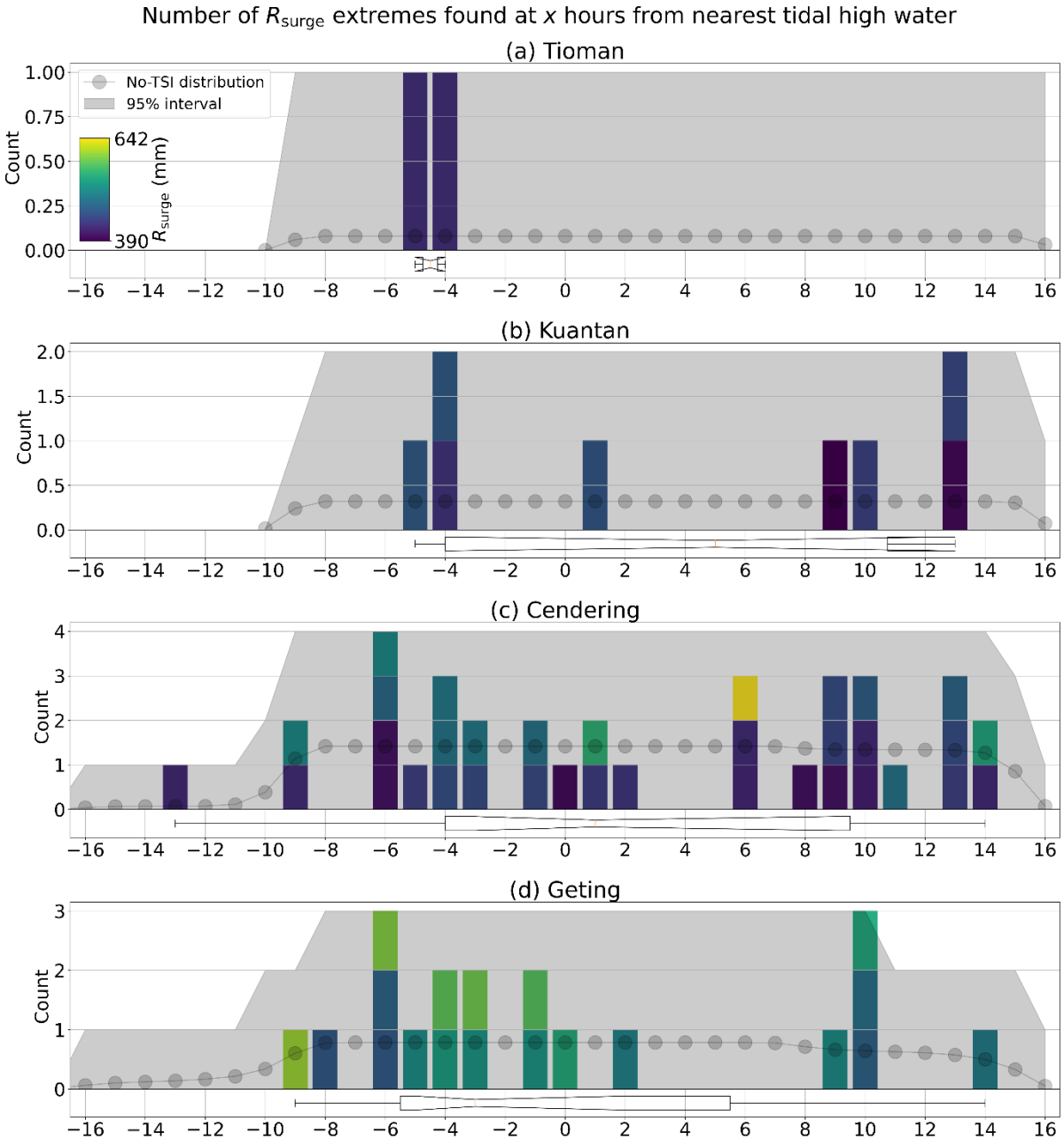


Figure S11: The frequency distribution for extreme values of R_{wind} and the No-TSI distribution during diurnal tidal cycles, truncated at ±16 hours from tidal high water. The frequency distribution is compared to the No-TSI distribution to determine the presence of tide-surge interaction. Summary statistics of the frequency distribution are shown using the horizontal notched box plot, where orange lines indicate the medians, notches indicate the 95% confidence interval of the medians, notched rectangles indicate the interquartile range (IQR), whiskers indicate a range that extends up to 1.5×IQR from the limits of the IQR, and black circles (if present) indicate outliers outside this range.

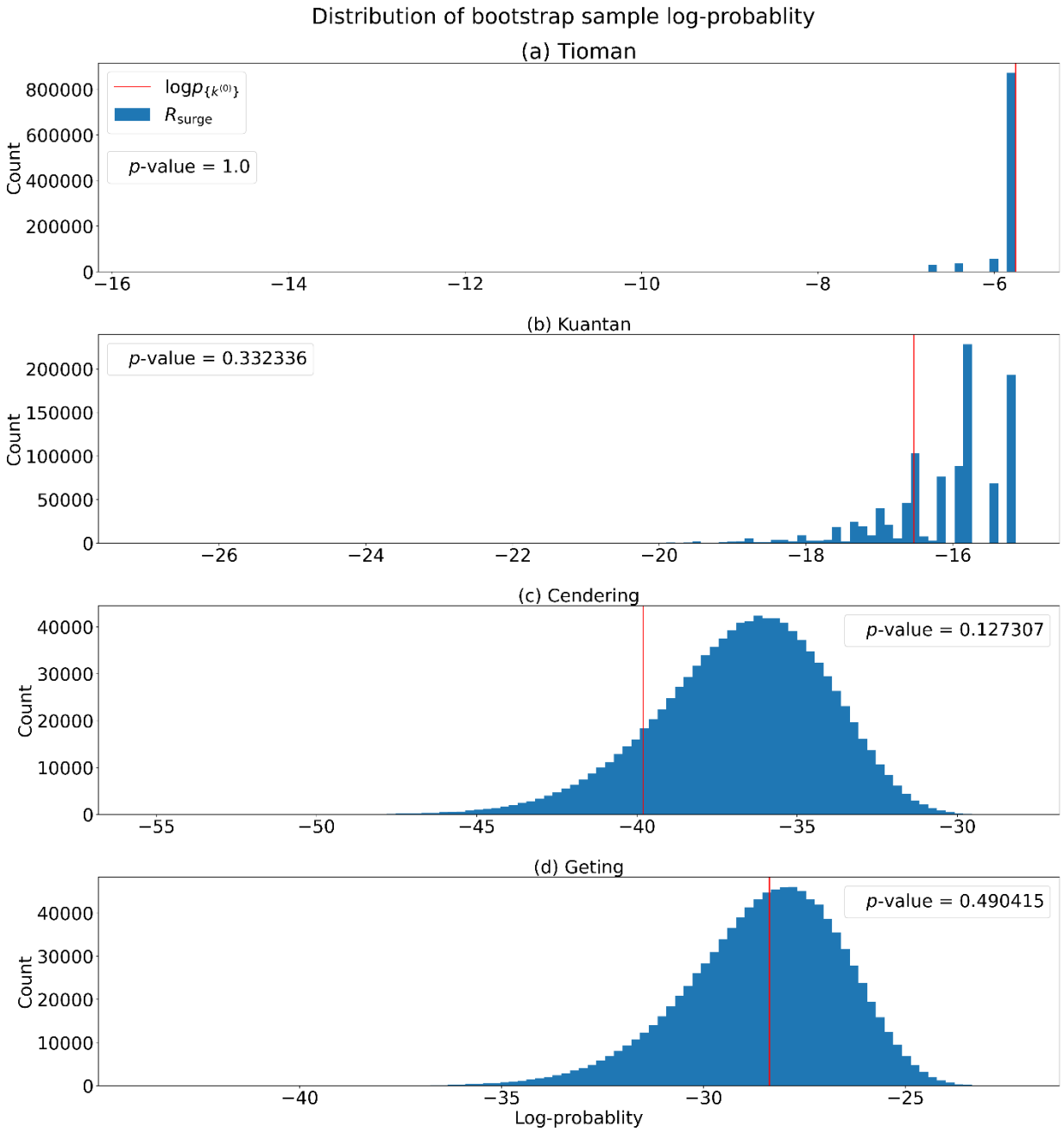


Figure S12: Histogram of 1,000,000 log-probabilities of obtaining a randomly generated bootstrap sample from the normalized No-TSI distribution p_h of R_{wind} during diurnal tidal cycles. Red vertical lines indicate $\log p_{\{k^{(0)}\}}$, the log-probabilities of obtaining the frequency distribution $k^{(0)}$ from p_h. p-values are obtained by taking the quantile of the $\log p_{\{k^{(0)}\}}$ within the 1,000,000 log-probabilities of bootstrap samples.

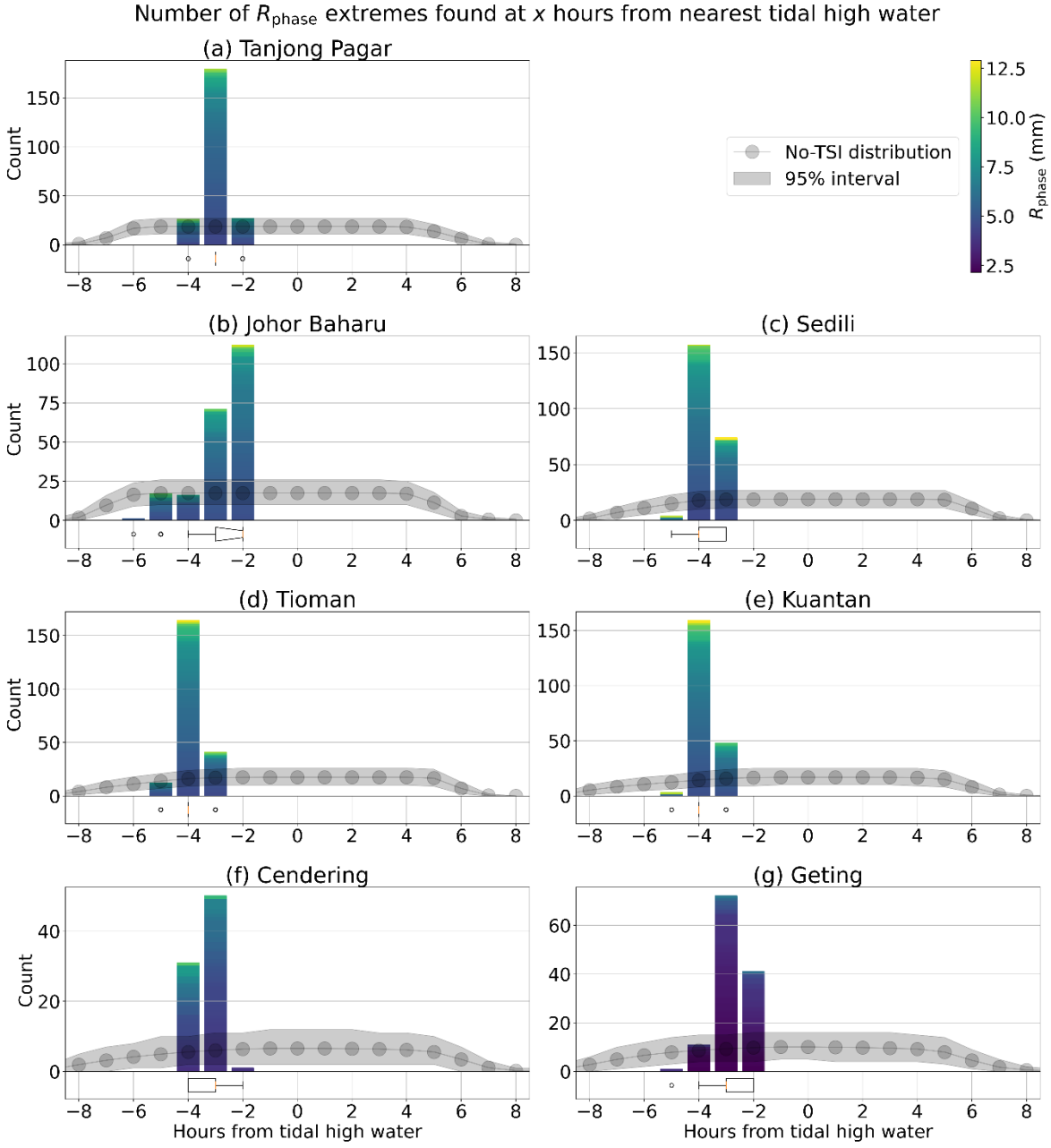


Figure S13: The frequency distribution for extreme values of R_{phase} and the No-TSI distribution during semidiurnal tidal cycles, truncated at ±8 hours from tidal high water. The frequency distribution is compared to the No-TSI distribution to determine the presence of tide-surge interaction. Summary statistics of the frequency distribution are shown using the horizontal notched box plot, where orange lines indicate the medians, notches indicate the 95% confidence interval of the medians, notched rectangles indicate the interquartile range (IQR), whiskers indicate a range that extends up to 1.5×IQR from the limits of the IQR, and black circles (if present) indicate outliers outside this range.

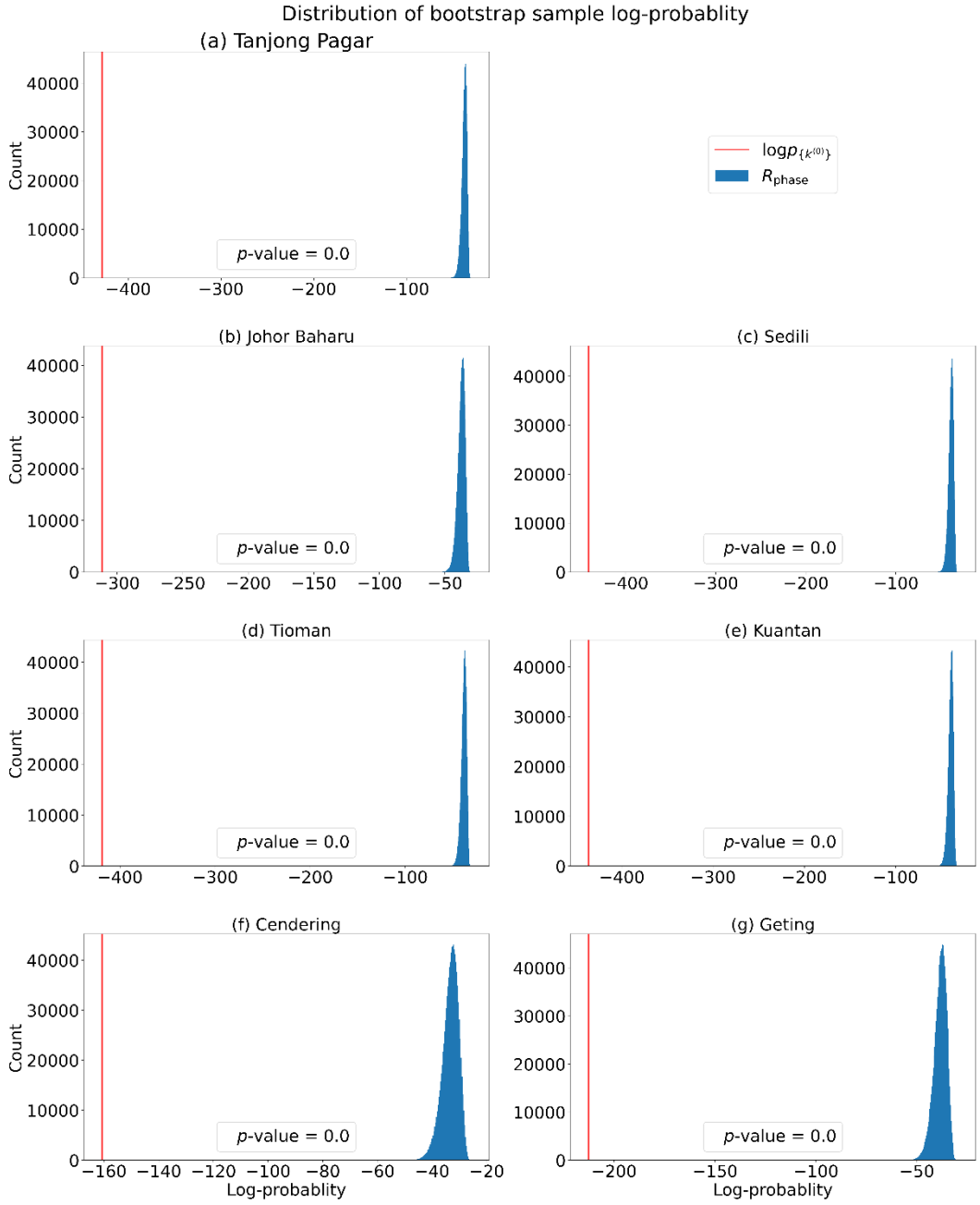


Figure S14: Histogram of 1,000,000 log-probabilities of obtaining a randomly generated bootstrap sample from the normalized No-TSI distribution p_h of R_{phase} during semidiurnal tidal cycles. Red vertical lines indicate $\log p_{\{k^{(0)}\}}$, the log-probabilities of obtaining the frequency distribution $k^{(0)}$ from p_h. p-values are obtained by taking the quantile of the $\log p_{\{k^{(0)}\}}$ within the 1,000,000 log-probabilities of bootstrap samples.

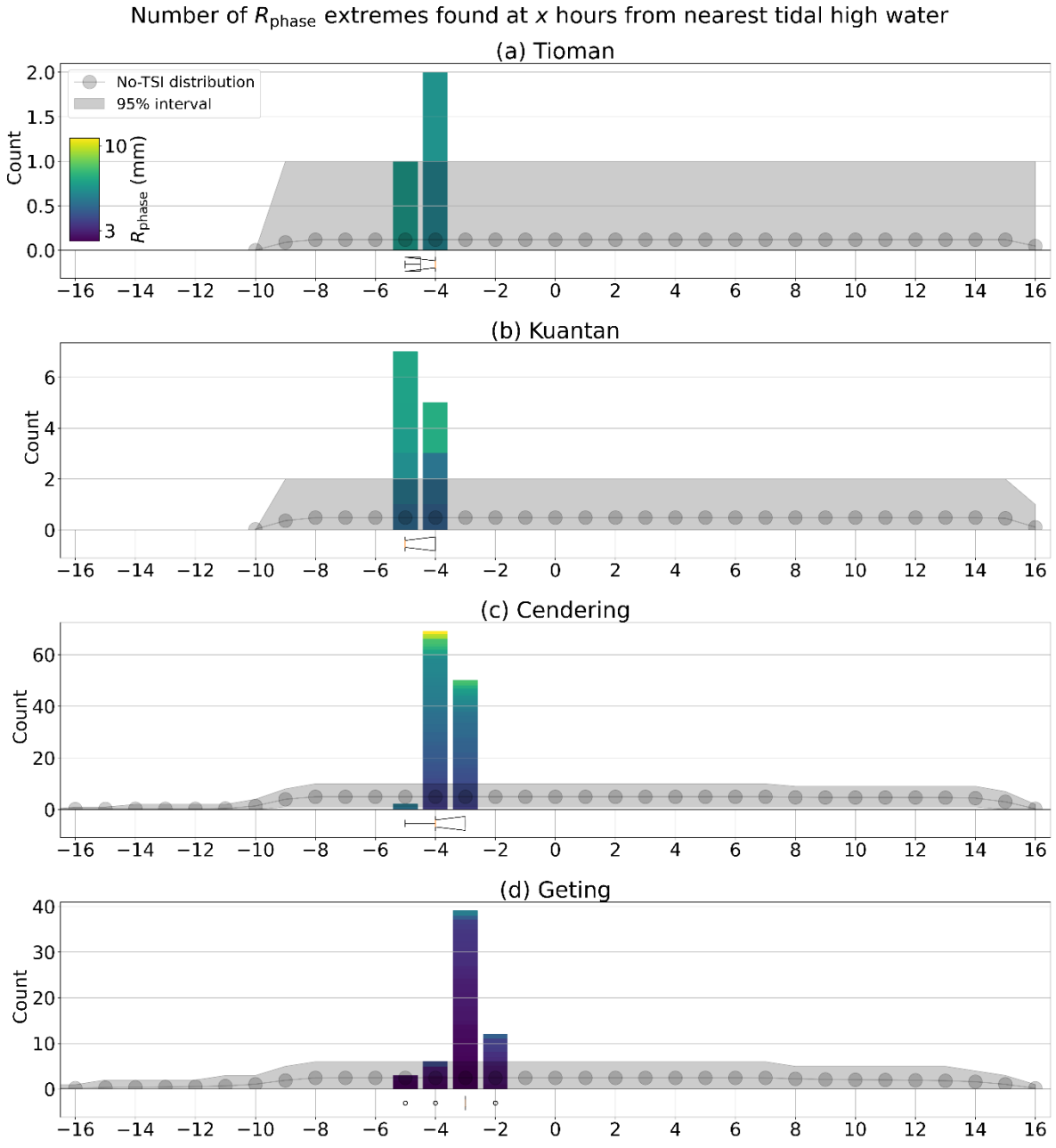


Figure S15: The frequency distribution for extreme values of R_{phase} and the No-TSI distribution during diurnal tidal cycles, truncated at ±16 hours from tidal high water. The frequency distribution is compared to the No-TSI distribution to determine the presence of tide-surge interaction. Summary statistics of the frequency distribution are shown using the horizontal notched box plot, where orange lines indicate the medians, notches indicate the 95% confidence interval of the medians, notched rectangles indicate the interquartile range (IQR), whiskers indicate a range that extends up to 1.5×IQR from the limits of the IQR, and black circles (if present) indicate outliers outside this range.

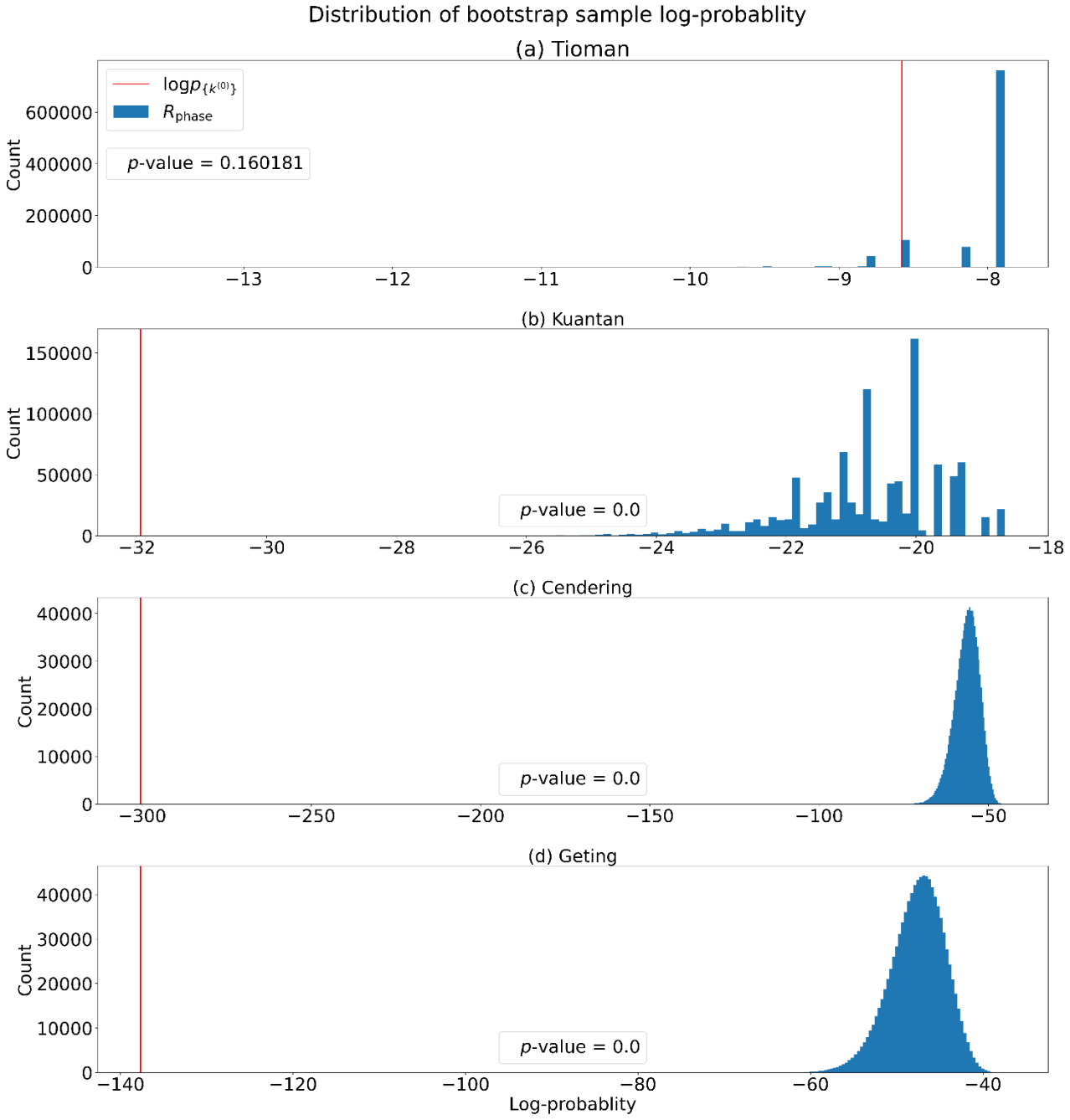
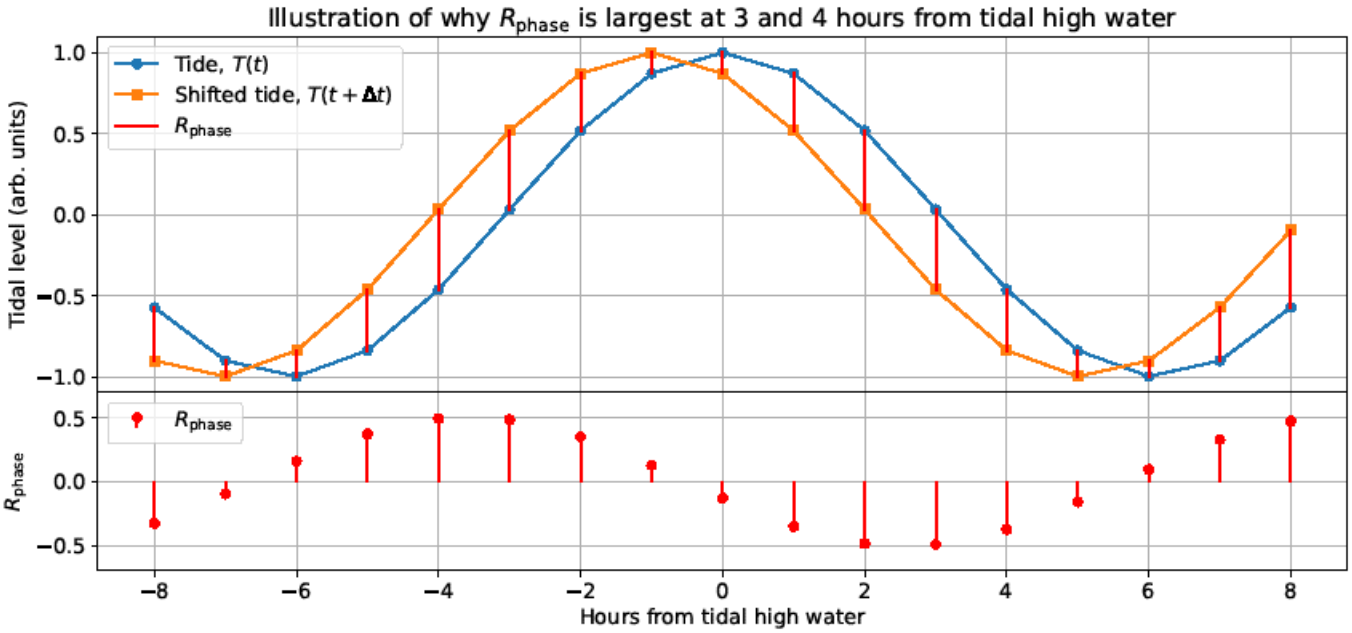


Figure S16: Histogram of 1,000,000 log-probabilities of obtaining a randomly generated bootstrap sample from the normalized No-TSI distribution p_h of R_{phase} during diurnal tidal cycles. Red vertical lines indicate $\log p_{\{k^{(0)}\}}$, the log-probabilities of obtaining the frequency distribution $k^{(0)}$ from p_h. p-values are obtained by taking the quantile of the $\log p_{\{k^{(0)}\}}$ within the 1,000,000 log-probabilities of bootstrap samples.



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113 **Figure S17: The greatest vertical difference between two identical but slightly horizontally-displaced functions are near where the**
114 **function has the steepest gradient. For semidiurnal tides, this corresponds to 3–4 hours from HW. Magnitude of the horizontal**
115 **displacement is an arbitrary amount and exaggerated for the purpose of illustration.**

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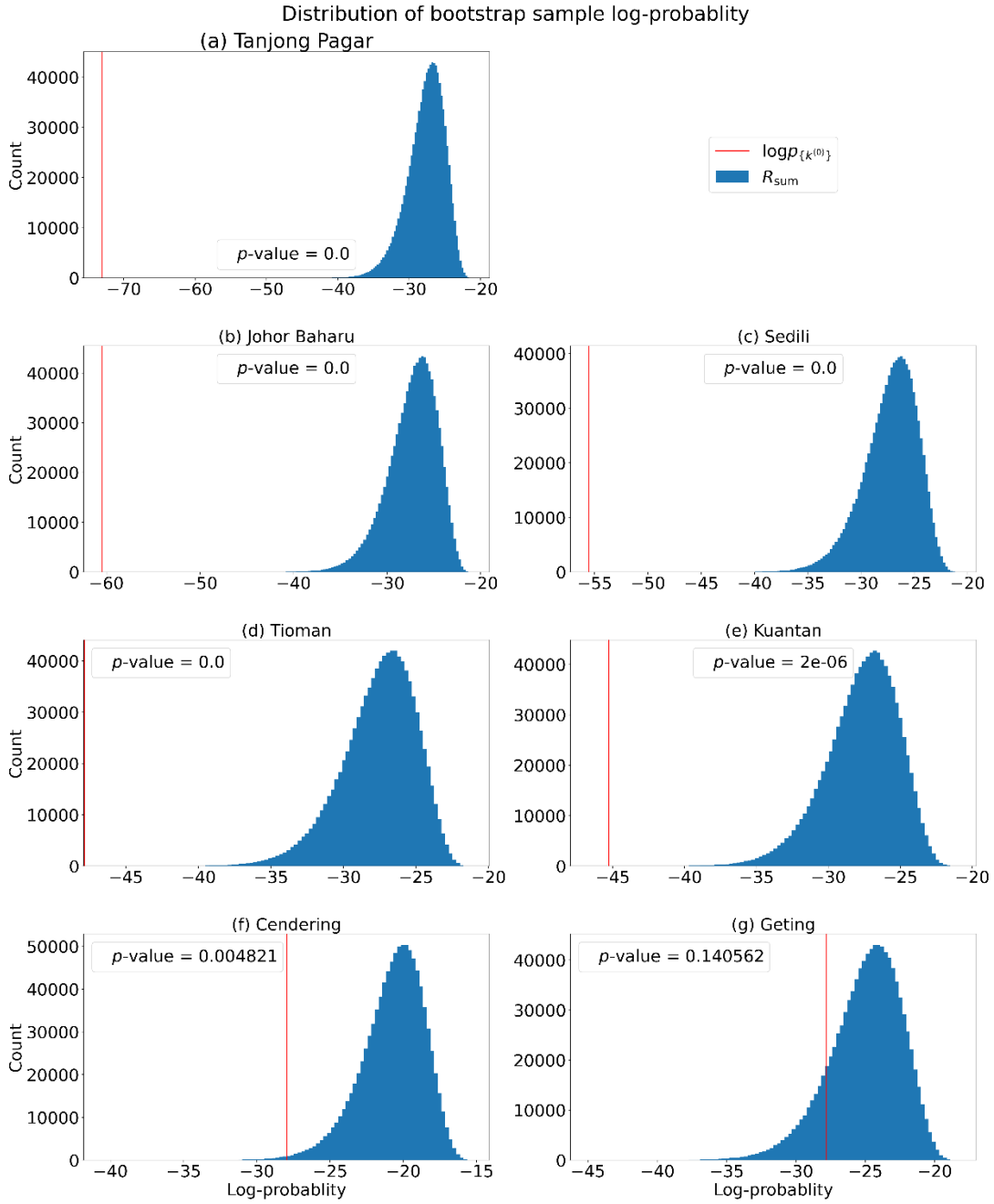

Figure S18: Histogram of 1,000,000 log-probabilities of obtaining a randomly generated bootstrap sample from the normalized No-TSI distribution p_h of R_{sum} during semidiurnal tidal cycles. Red vertical lines indicate $\log p_{\{k^{(0)}\}}$, the log-probabilities of obtaining the frequency distribution $k^{(0)}$ from p_h. p-values are obtained by taking the quantile of the $\log p_{\{k^{(0)}\}}$ within the 1,000,000 log-probabilities of bootstrap samples.

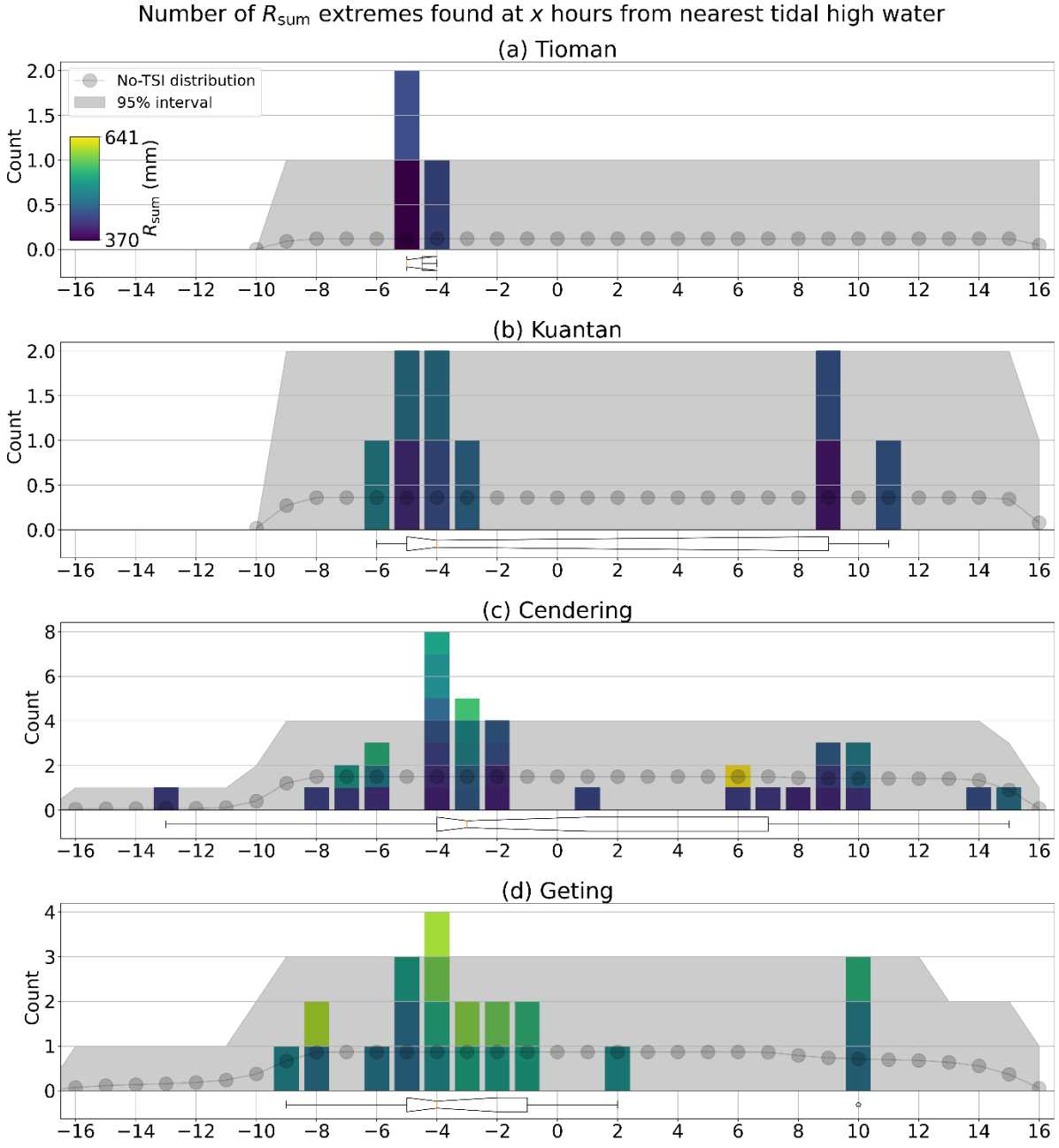

Figure S19: The frequency distribution for extreme values of R_{sum} and the No-TSI distribution during diurnal tidal cycles, truncated at ±16 hours from tidal high water. The frequency distribution is compared to the No-TSI distribution to determine the presence of tide-surge interaction. Summary statistics of the frequency distribution are shown using the horizontal notched box plot, where orange lines indicate the medians, notches indicate the 95% confidence interval of the medians, notched rectangles indicate the interquartile range (IQR), whiskers indicate a range that extends up to 1.5×IQR from the limits of the IQR, and black circles (if present) indicate outliers outside this range.

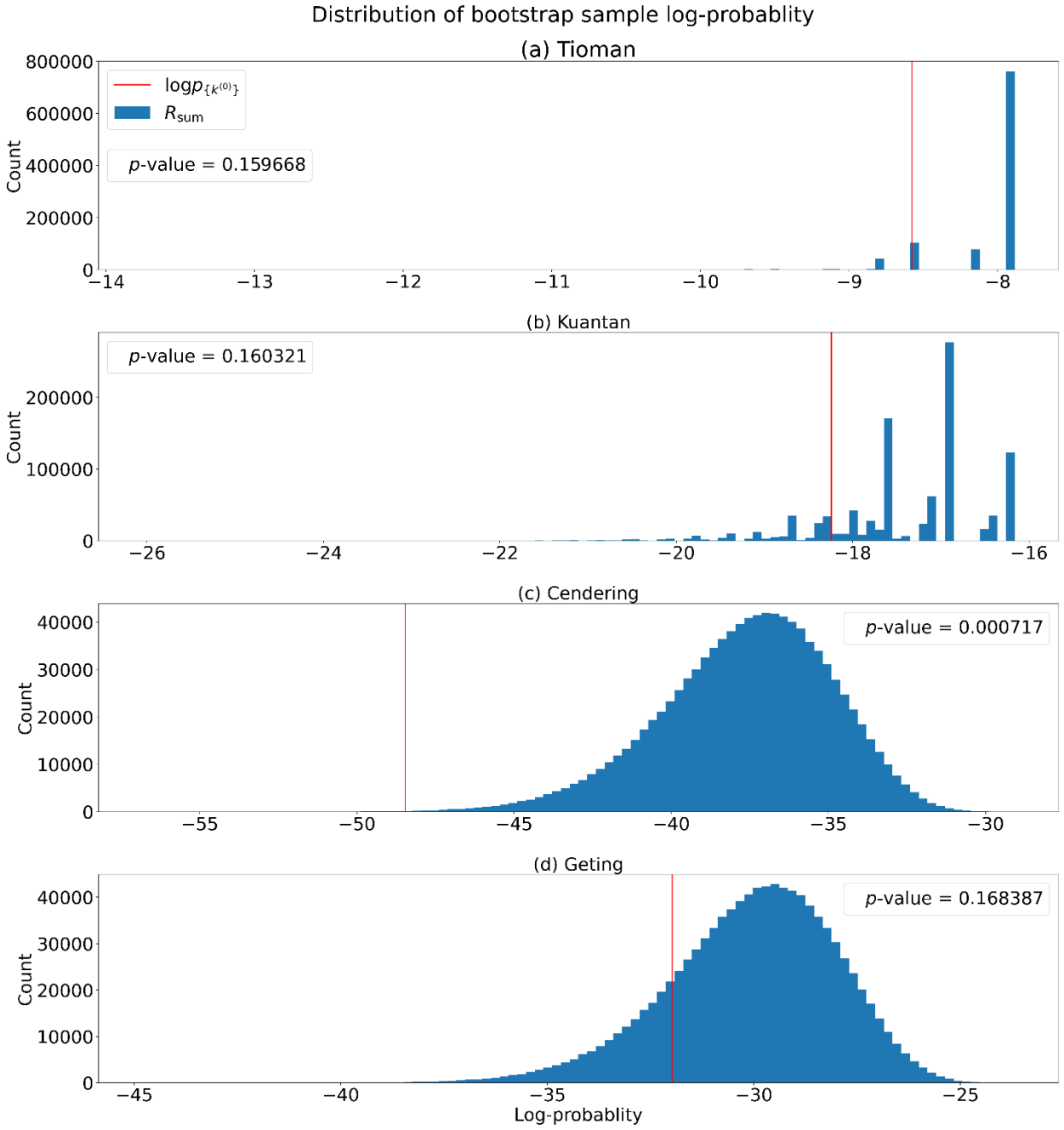

Figure S20: Histogram of 1,000,000 log-probabilities of obtaining a randomly generated bootstrap sample from the normalized No-TSI distribution p_h of R_{sum} during diurnal tidal cycles. Red vertical lines indicate $\log p_{\{k^{(0)}\}}$, the log-probabilities of obtaining the frequency distribution $k^{(0)}$ from p_h. p-values are obtained by taking the quantile of the $\log p_{\{k^{(0)}\}}$ within the 1,000,000 log-probabilities of bootstrap samples.

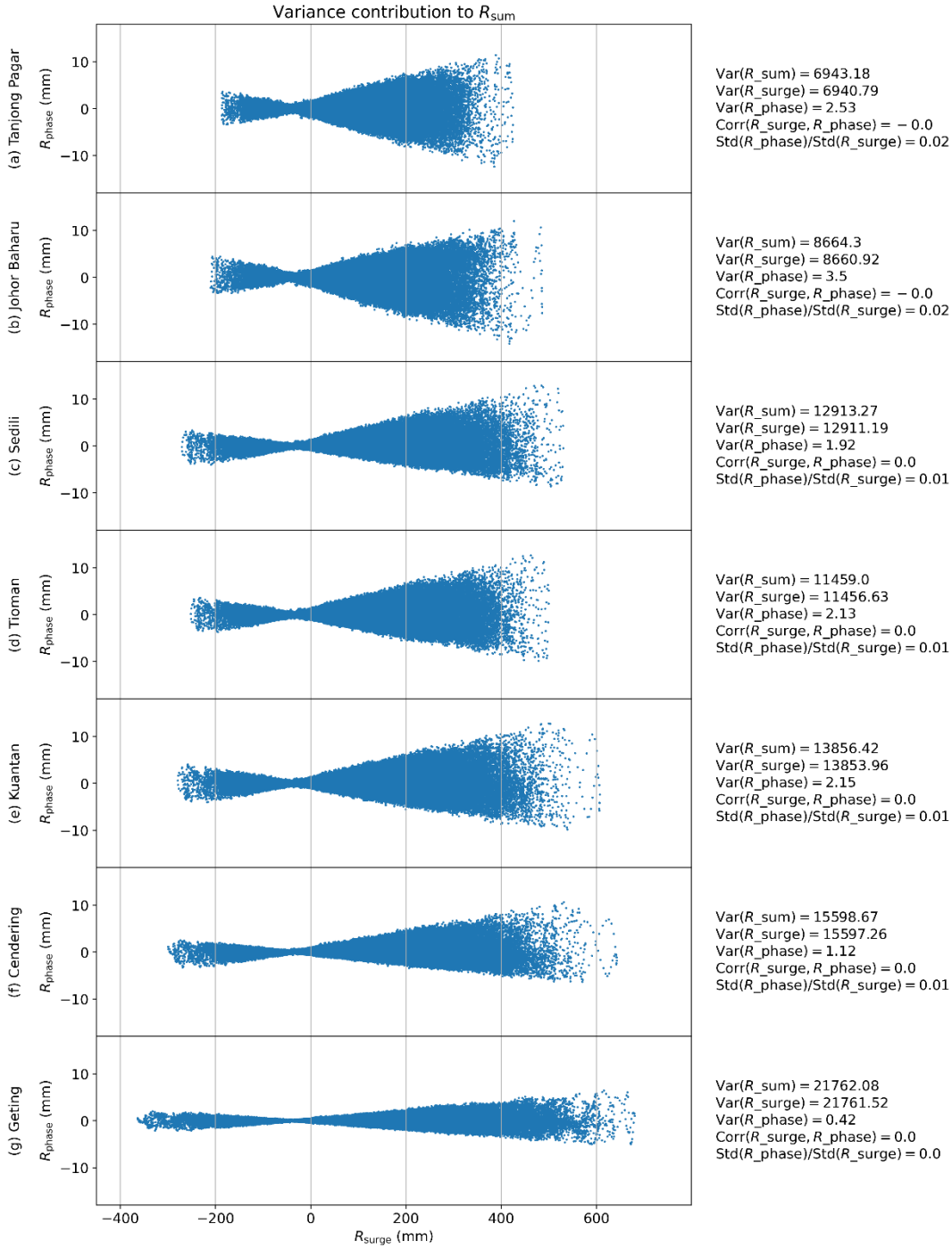

Figure S21: Scatter plots between R_{wind} and R_{phase} at each tide gauge location and how they contribute to R_{sum}. Values of -0.0 is a small negative value between -0.05 and 0.

References

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