

Coastal vulnerability across the Pacific dominated by El Niño/Southern Oscillation

Patrick L. Barnard, Andrew D. Short, Mitchell D. Harley, Kristen D. Splinter, Sean Vitousek, Ian L. Turner, Jonathan Allan, Masayuki Banno, Karin R. Bryan, André Doria, Jeff E. Hansen, Shigeru Kato, Yoshiaki Kuriyama, Evan Randall-Goodwin, Peter Ruggiero, Ian J. Walker and Derek K. Heathfield

Table S1. Climate index times series and matrix of correlation coefficients and p-values corresponding to the plot in Supplemental Figure 1. (PDO=Pacific Decadal Oscillation, IPO= Interdecadal Pacific Oscillation, EMI=El Niño Modoki Index, MEI=Multivariate ENSO Index, ONI=Oceanic Niño Index, SOI=Southern Oscillation Index, SAM=Southern Annular Mode, AO=Arctic Oscillation, NOI=Northern Oscillation Index, NPGO=North Pacific Gyre Oscillation, NPI=North Pacific Index, PNA=Pacific North American)

Table S2. Data inventory for location of study sites and co-located wave buoys, ERA grid cells, tide gauges, and shoreline change data sets.

Table S3. Calculations for Figs. 2-4 and Supplemental Figs. 3-6 for the A) top 5 climate index events, and B) bottom 5 index events from 1979-2012. C) Top and bottom 5 ranked years for each climate index for the boreal winter and annual time periods.

Table S4. Correlation coefficients and p-values corresponding to the wave parameter-climate index relationships presented in Fig. 5 and Supplemental Fig. 7.

Figure S1. Matrix of climate indices analyzed in this study with their correlation coefficients (R) based on monthly time series from 1979-2012 (<http://www.esrl.noaa.gov/psd/data/climateindices/>). Relationships that are statistically significant (p-value < 0.05) are highlighted with a black box. (PDO=Pacific Decadal Oscillation, IPO=Interdecadal Pacific Oscillation, EMI=El Niño Modoki Index, MEI=Multivariate ENSO Index, ONI=Oceanic Niño Index, SOI=Southern Oscillation Index, SAM=Southern Annular Mode, AO=Arctic Oscillation, NOI=Northern Oscillation Index, NPGO=North Pacific Gyre Oscillation, NPI=North Pacific Index, PNA=Pacific North American: all index time series, R and p-values are reported in Supplemental Table 1)

Figure S2. Monthly averaged wave parameters for each region from 1979-2012, based on the ERA Interim Data.

Figure S3 (2 figures, following Fig 2). Annual shoreline erosion relative to the mean for the top 5 index events for all 12 climate indices ranked A) annually, and for B) boreal winter (DJF).

Figure S4 (4 figures, following Fig. 3A). Wave energy divergence from the mean for the top 5 climate index events from 1979-2012 for all climate 12 indices. A) Annual mean. B) Top 5% of annual mean. C) Mean during boreal winter (DJF). C) Top 5% during boreal winter (DJF).

Figure S5 (4 figures, following Fig. 3B). Wave direction divergence from the mean for the top 5 climate index events from 1979-2012 for all 12 climate indices. A) Annual mean. B) Top 5% of annual mean. C) Mean during boreal winter (DJF). C) Top 5% during boreal winter (DJF).

Figure S6 (2 figures, following Fig. 4). Water level divergence from the mean for the top 5 climate index events from 1979-2012 for all 12 climate indices. A) Annual mean. B) Mean during boreal winter (DJF).

Figure S7 (12 figures, following Fig. 5). Correlation between all 12 indices and wave energy flux, upper 5% energy flux and direction from sites across the Pacific Ocean basin for winter (DJF), spring (MAM), summer (JJA), and fall (SON).

Supplementary Figures

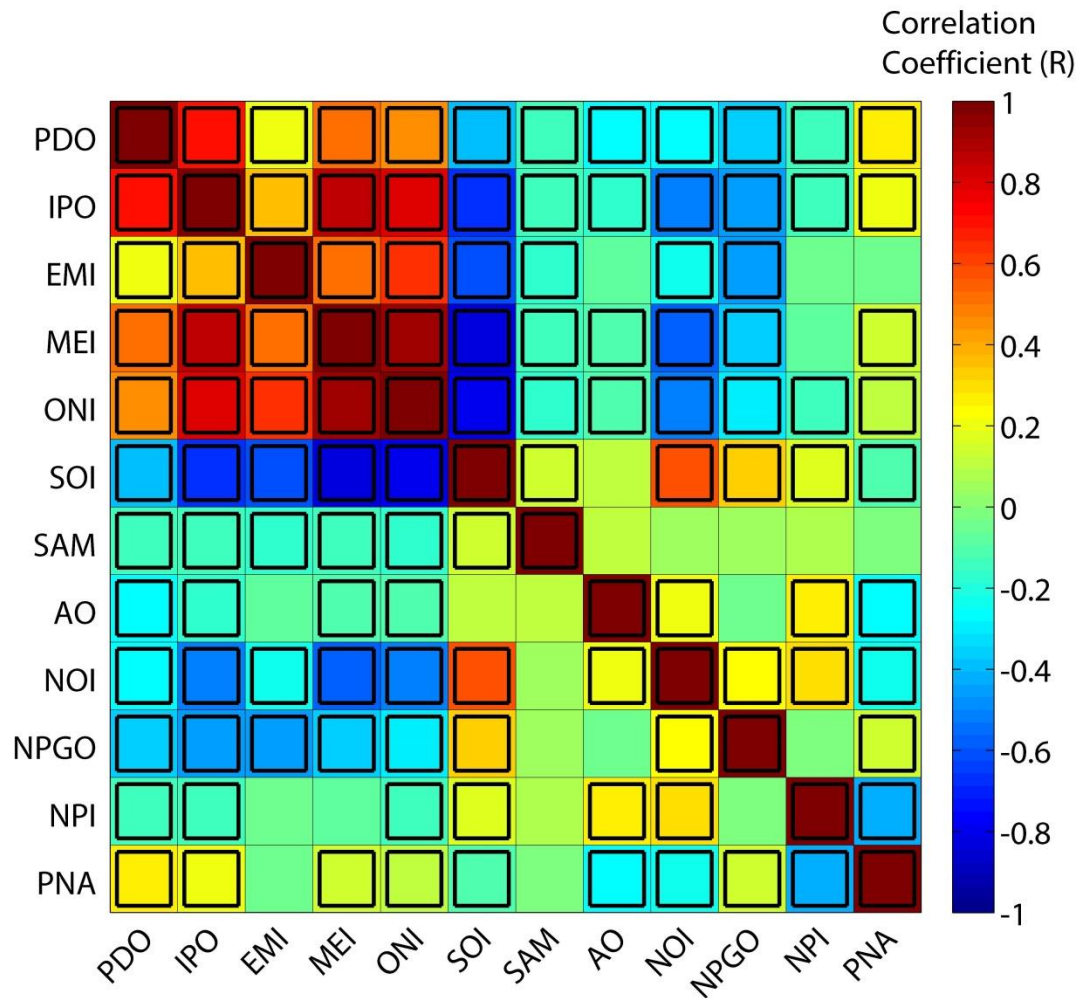


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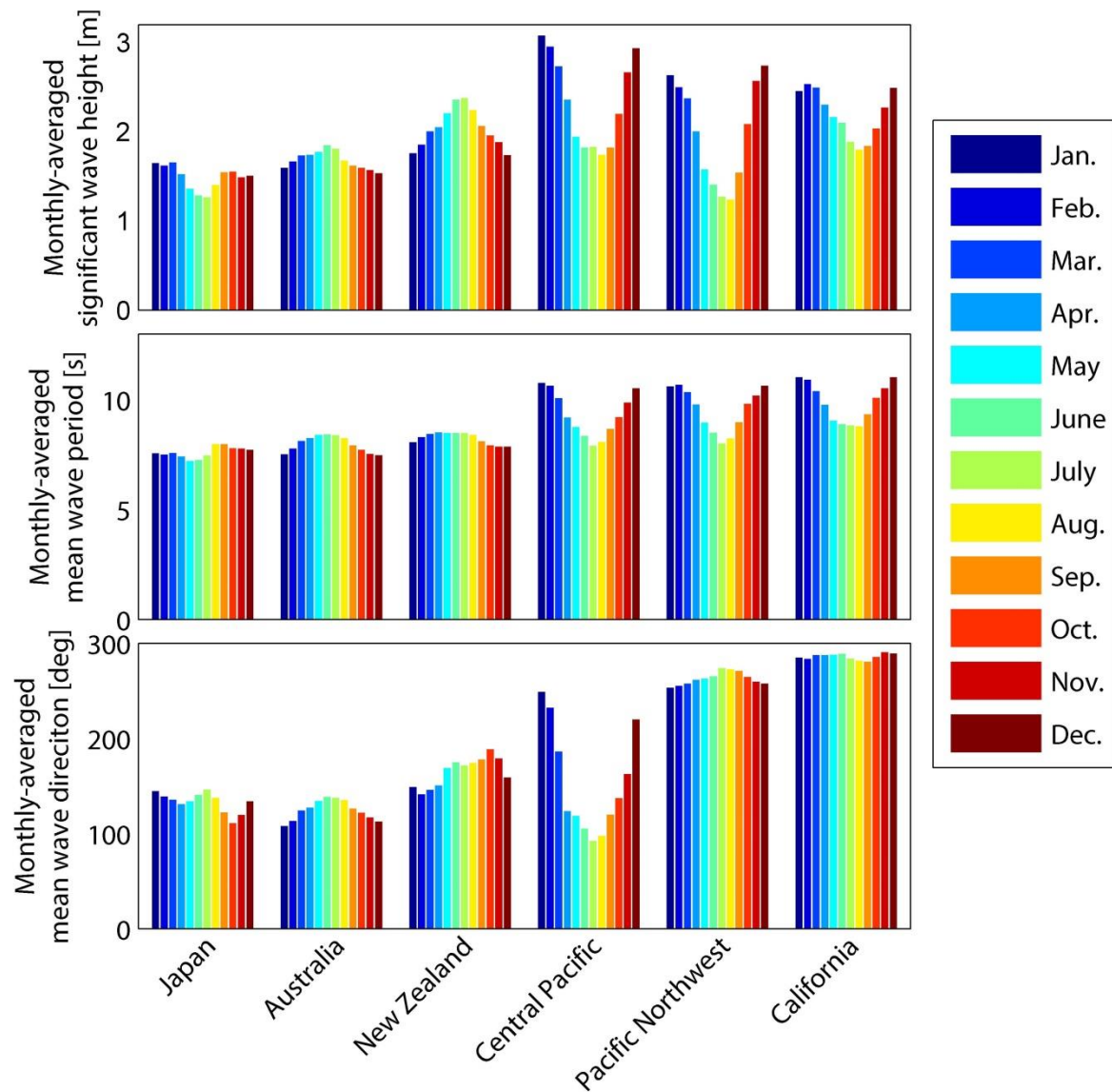
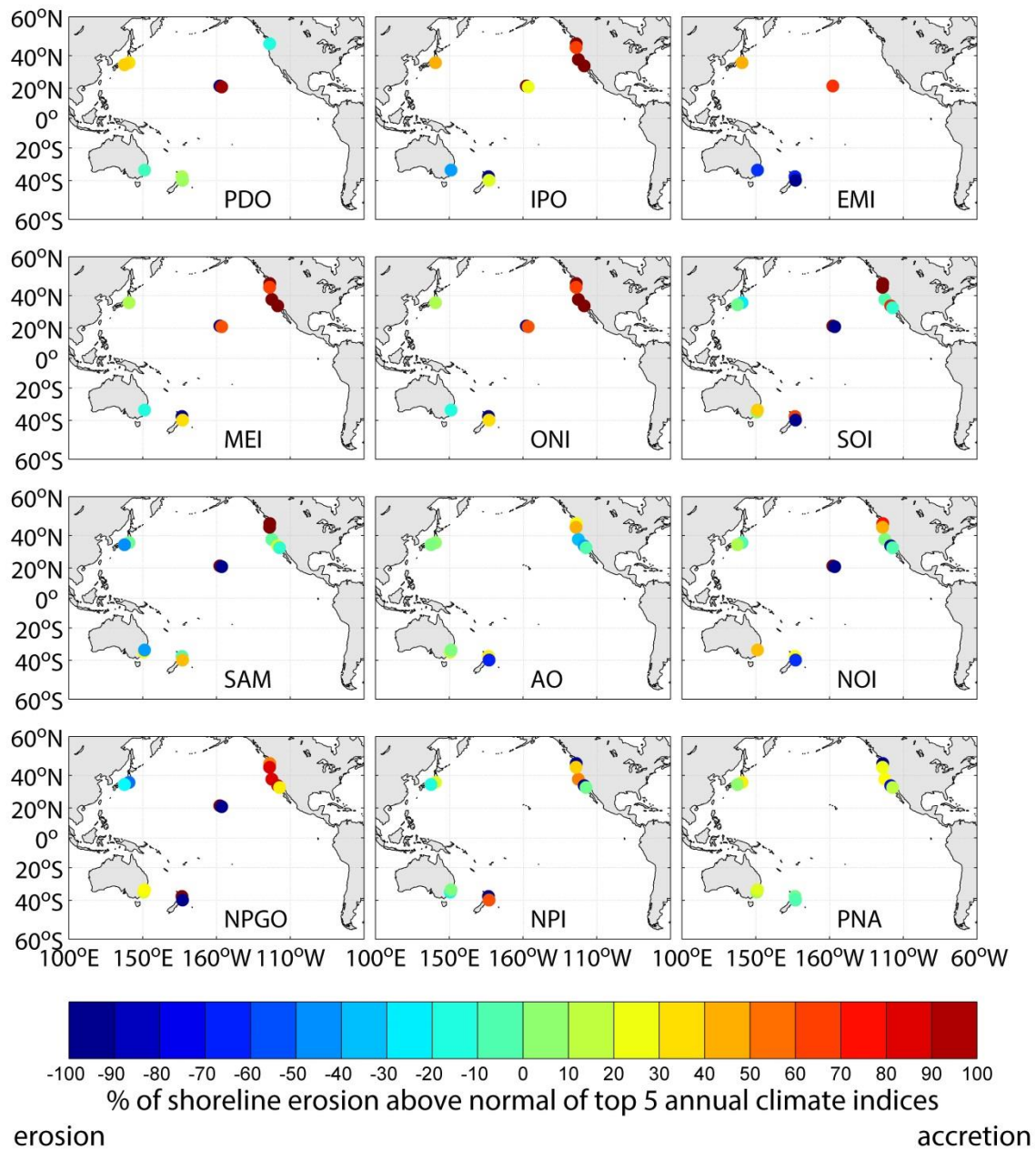


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A)



B)

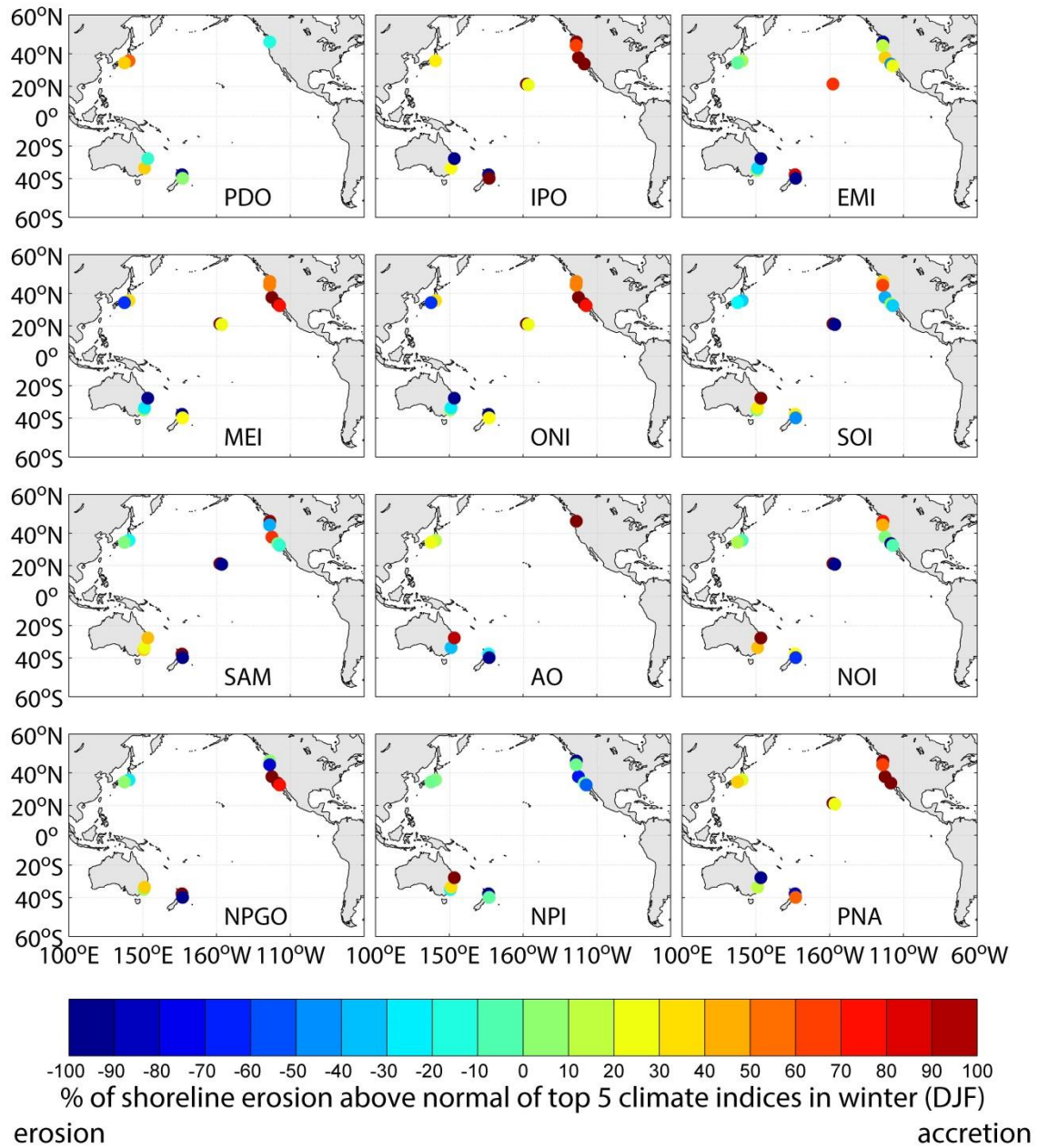
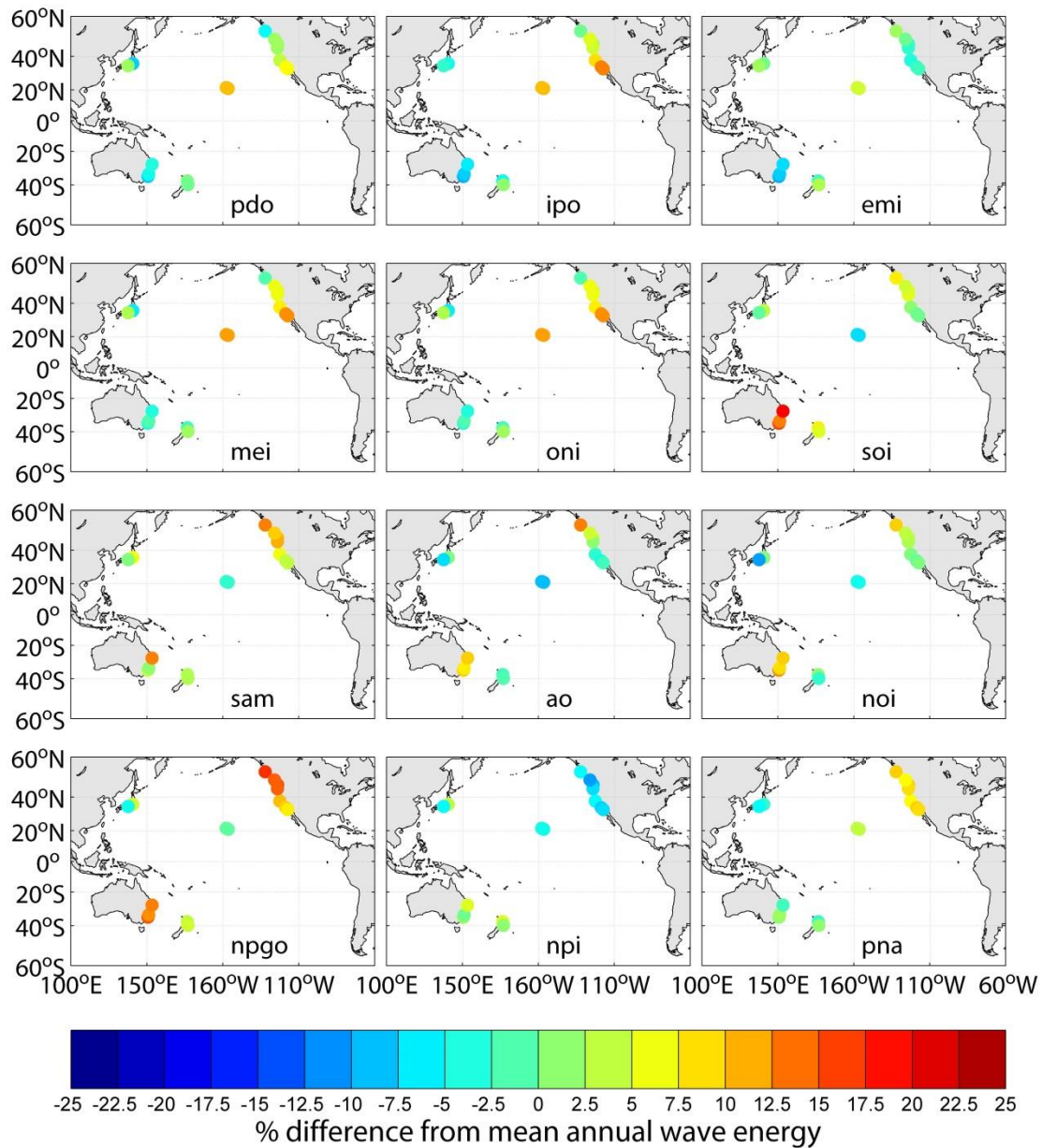
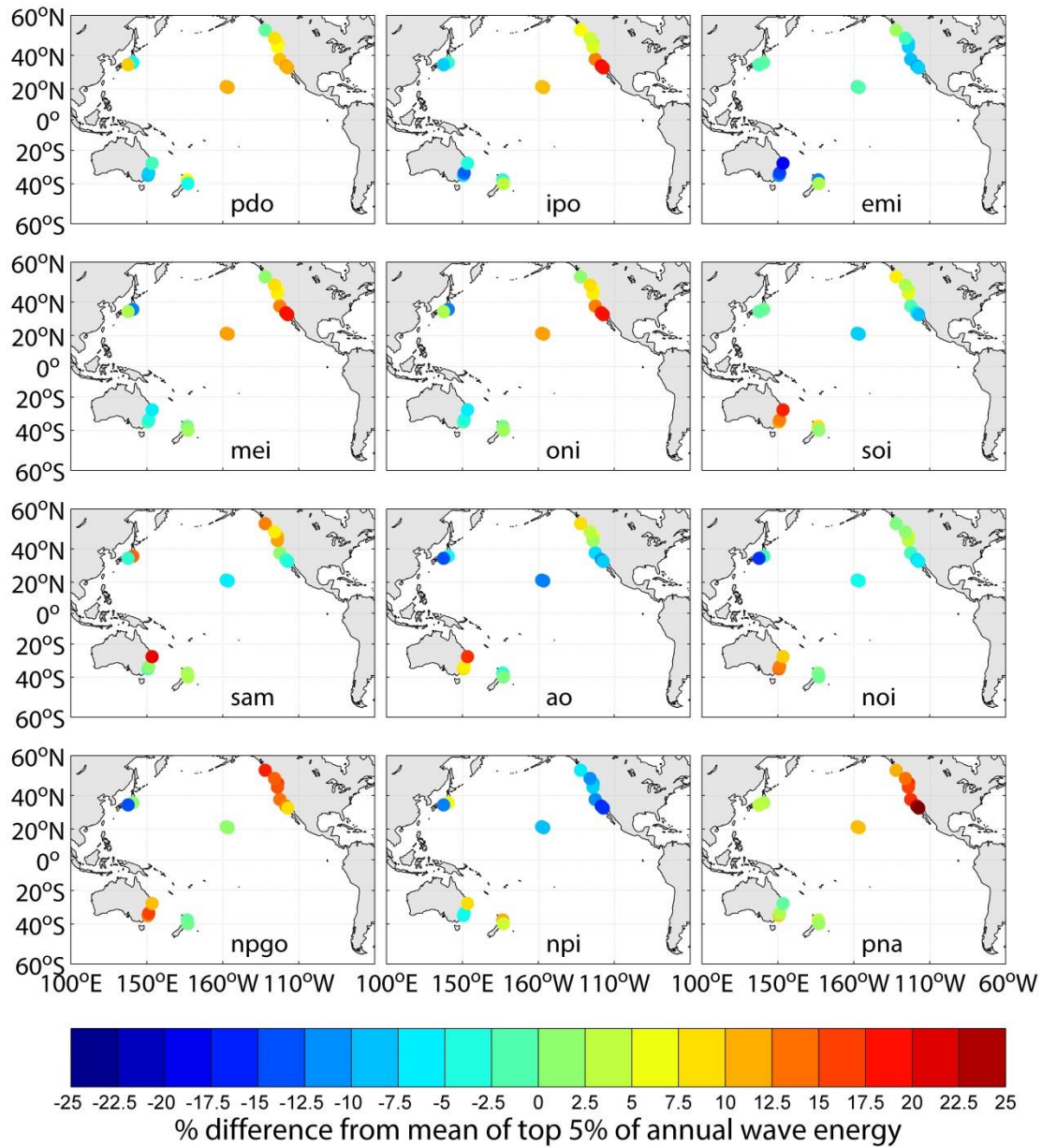


Figure S4 (4 figures, following Fig. 3A). Wave energy divergence from the mean for the top 5 climate index events from 1979-2012 for all climate 12 indices. A) Annual mean. B) Top 5% of annual mean. C) Mean during boreal winter (DJF). C) Top 5% during boreal winter (DJF).

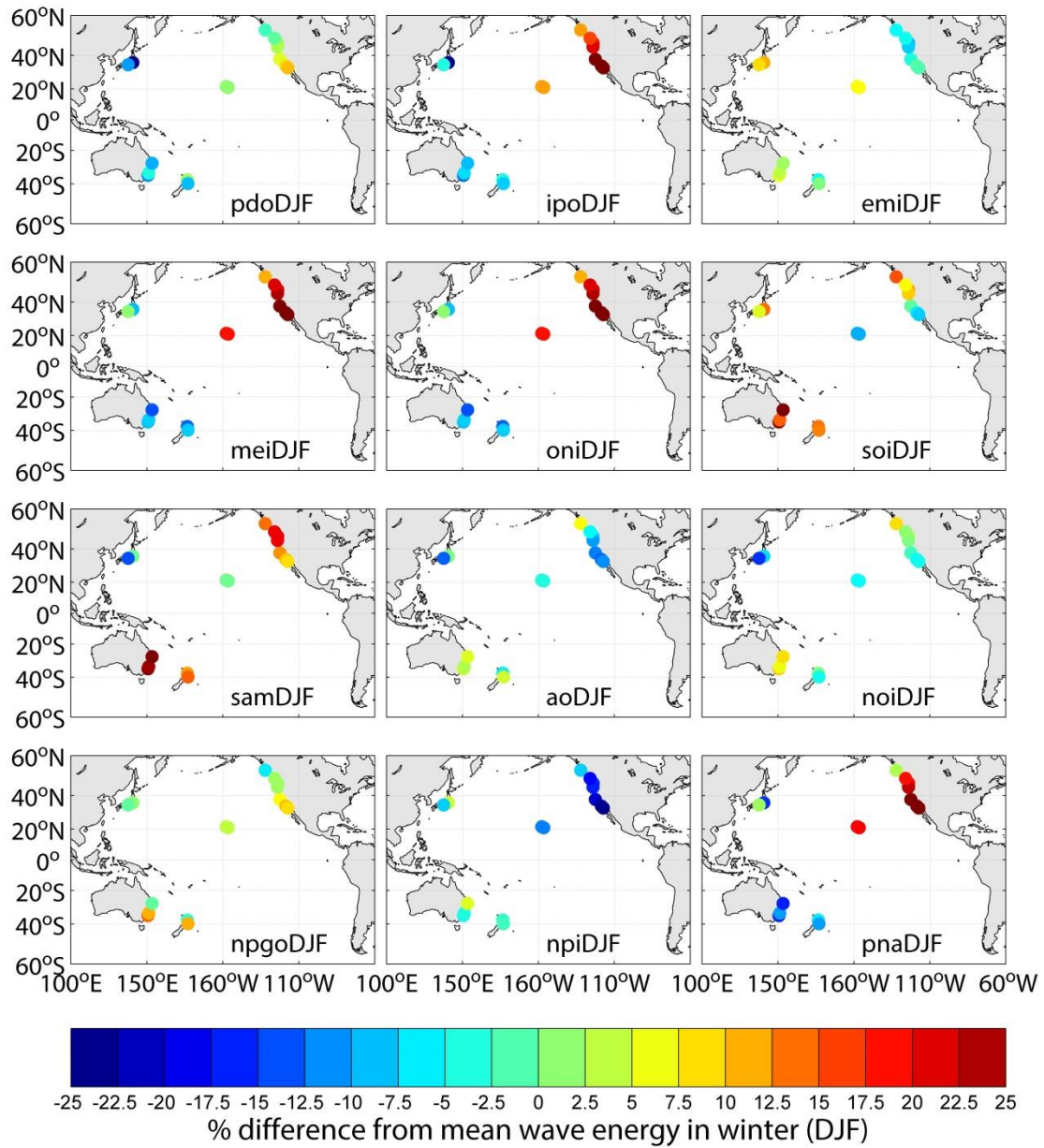
A)



B)



c)



D)

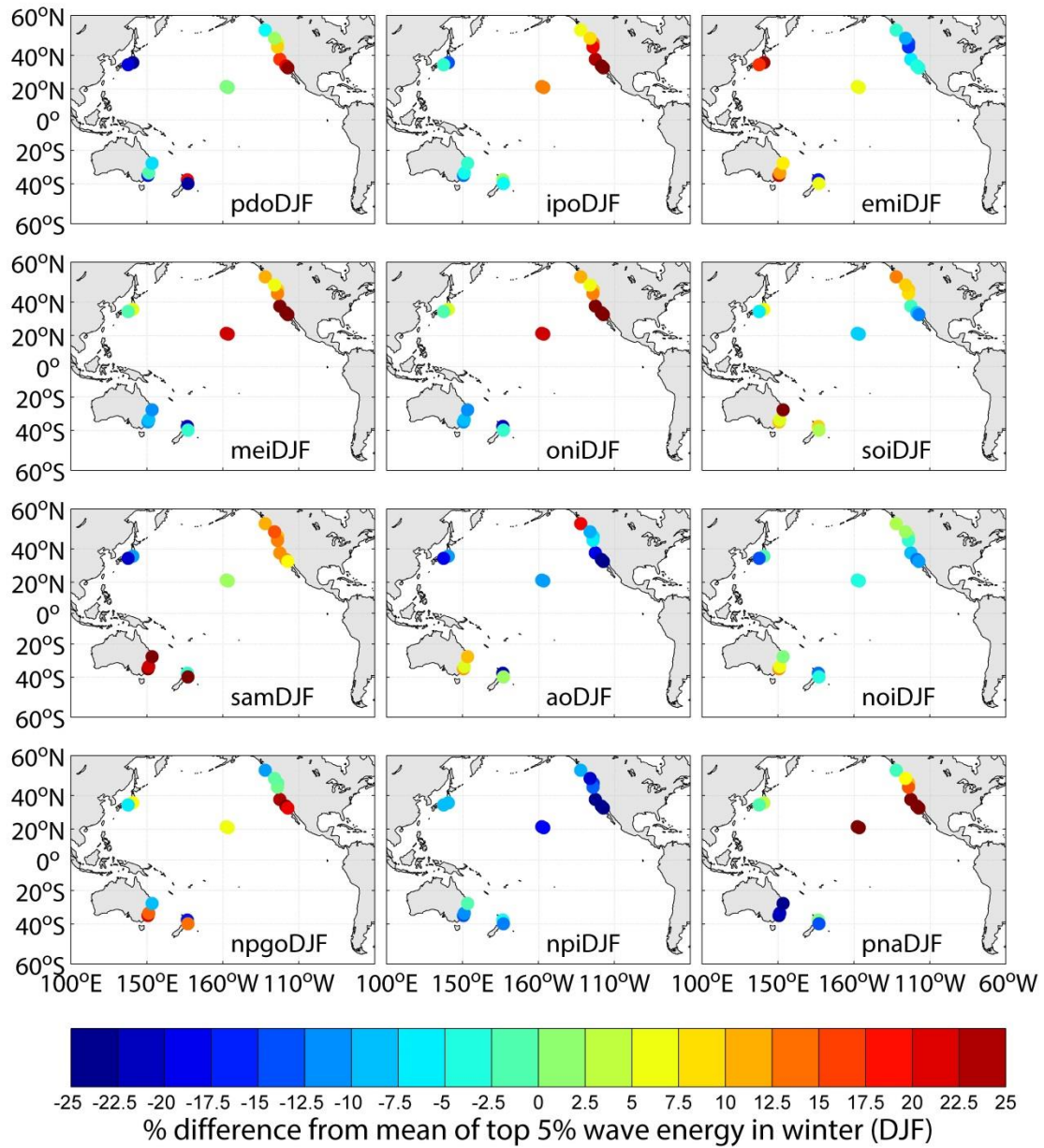
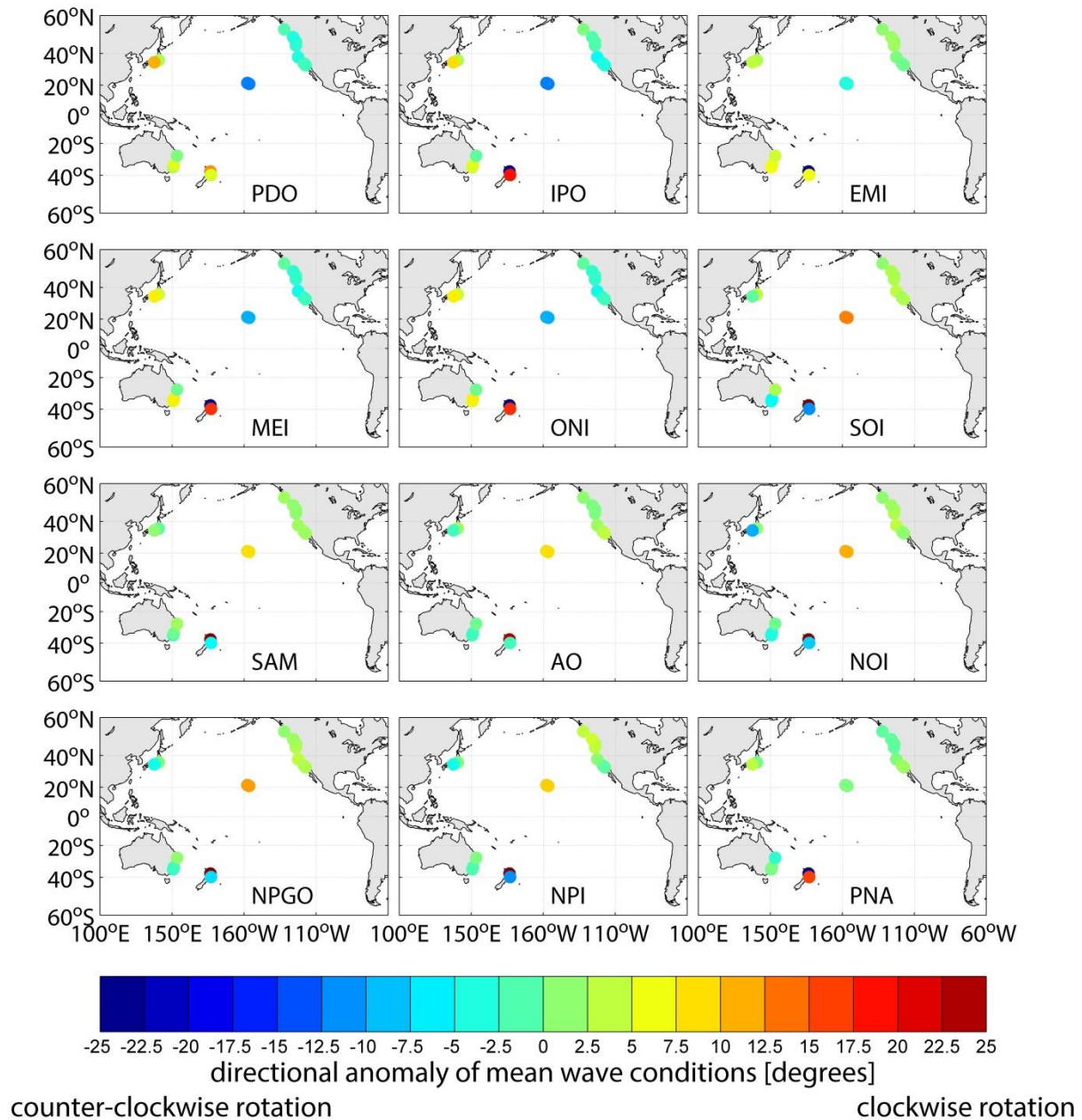
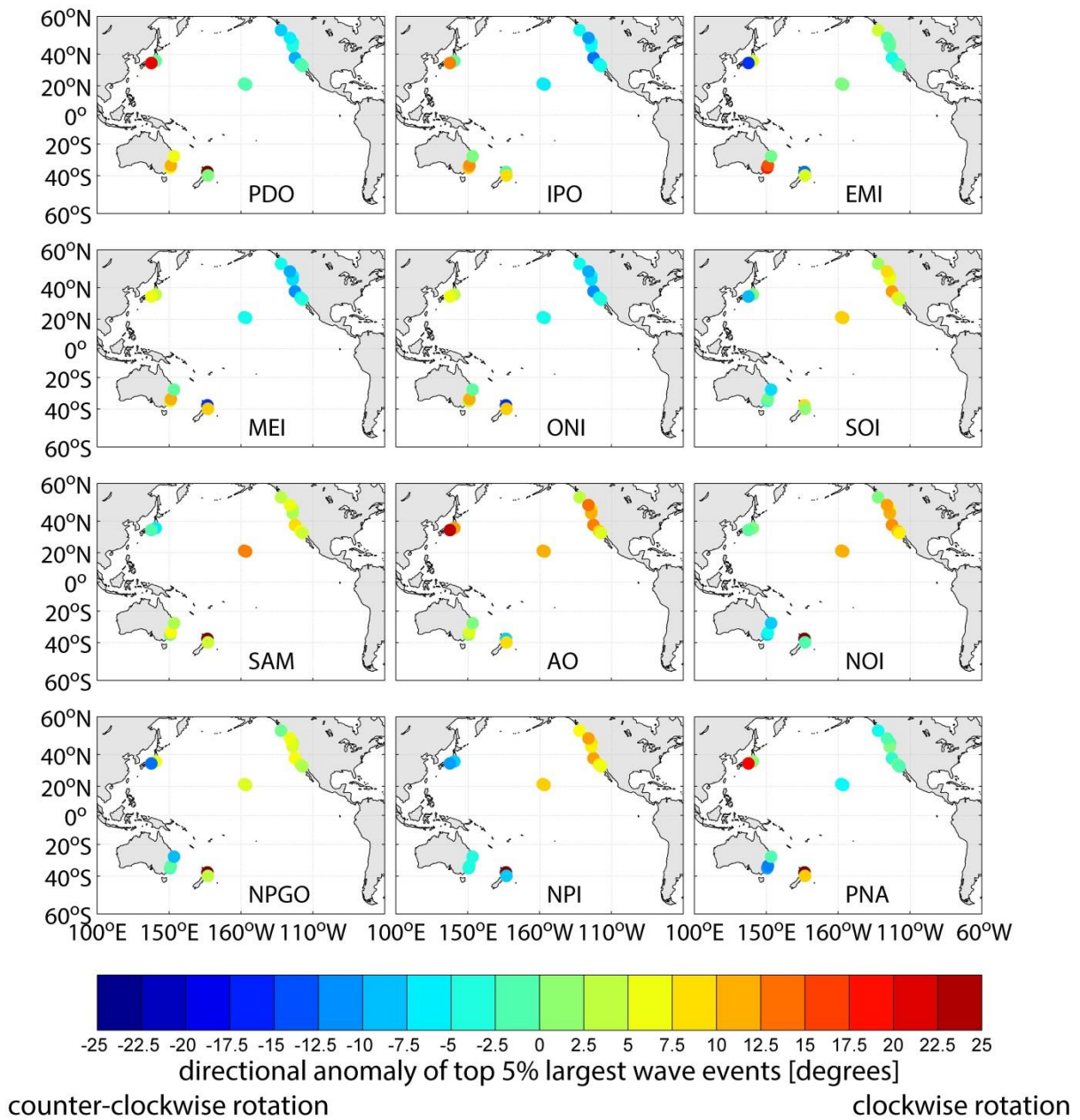


Figure S5 (4 figures, following Fig. 3B). Wave direction divergence from the mean for the top 5 climate index events from 1979-2012 for all 12 climate indices. A) Annual mean. B) Top 5% of annual mean. C) Mean during boreal winter (DJF). C) Top 5% during boreal winter (DJF).

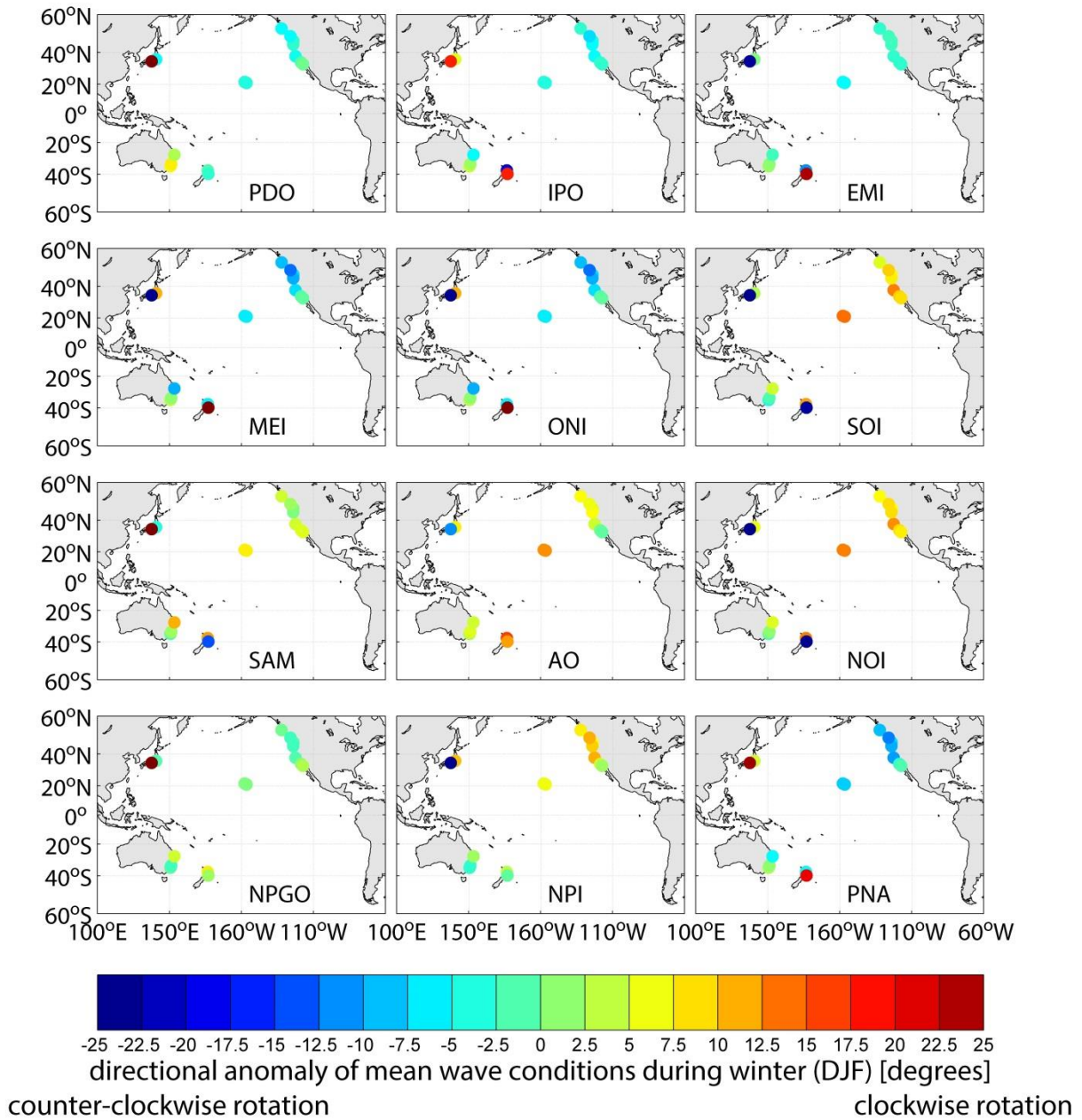
A)



B)



c)



D)

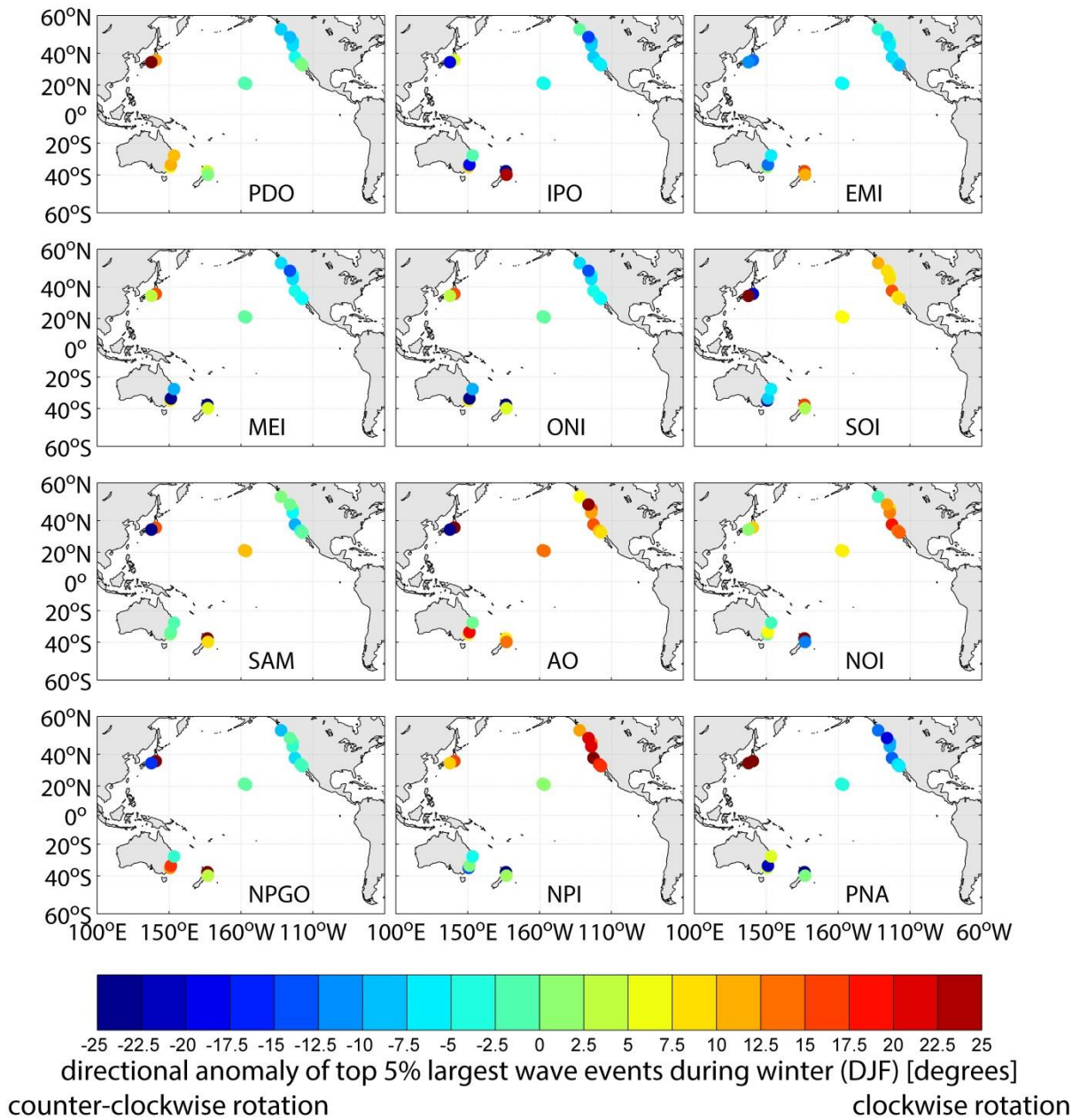
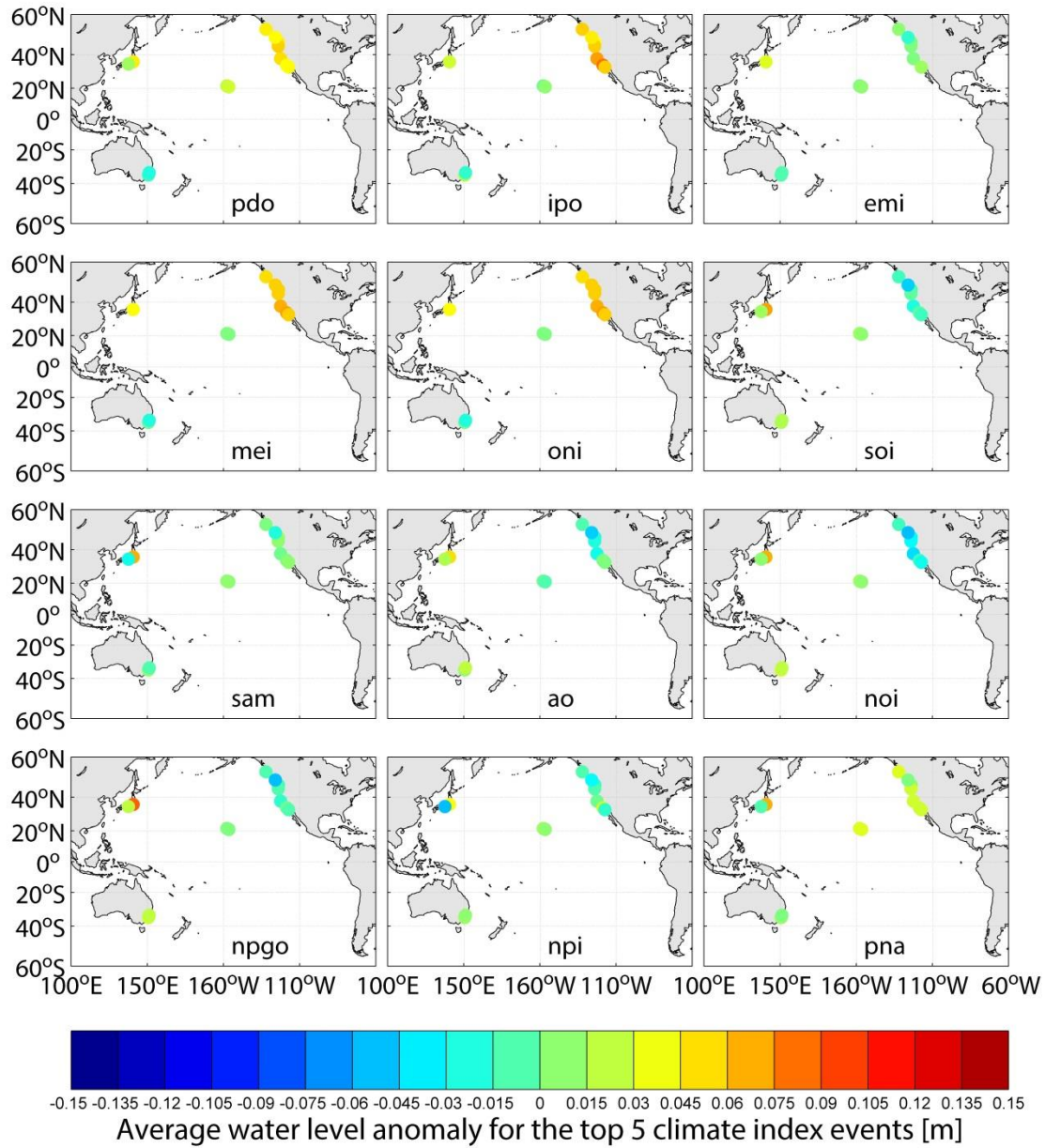


Figure S6 (2 figures, following Fig. 4). Water level divergence from the mean for the top 5 climate index events from 1979–2012 for all 12 climate indices. A) Annual mean. B) Mean during boreal winter (DJF).

A)



B)

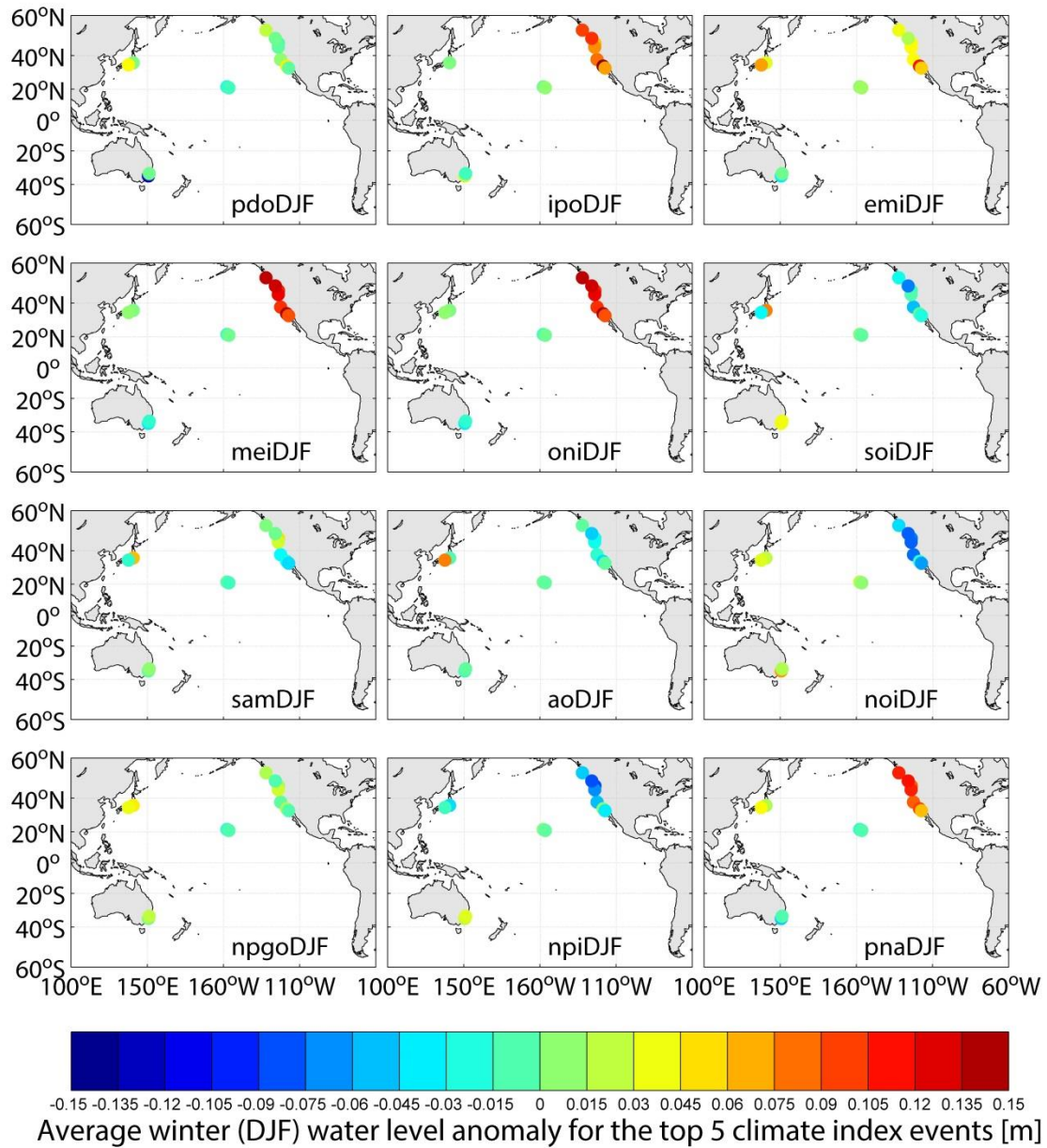


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