Operational Breaker Height Predictions Using Spectral Partitioning

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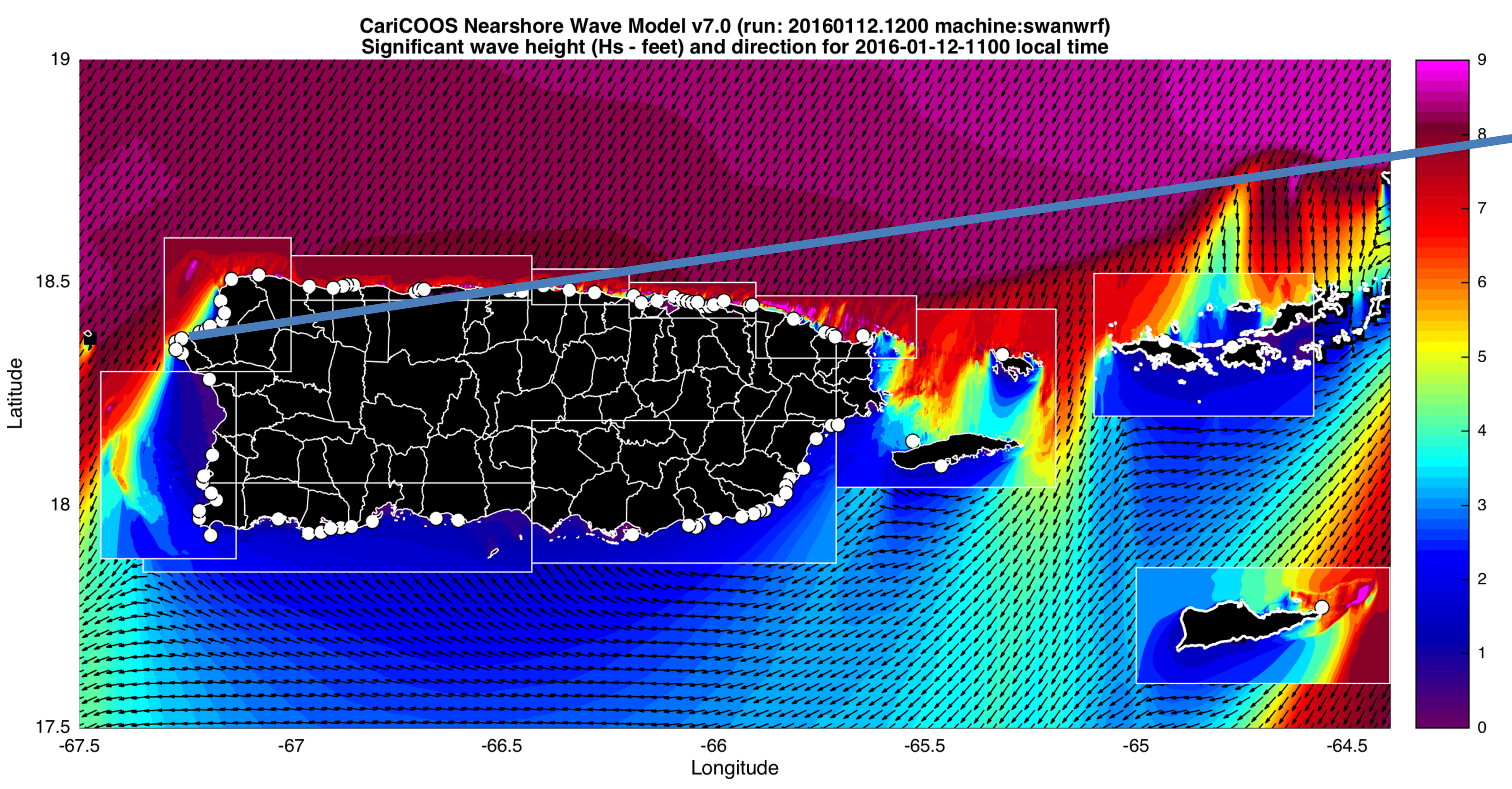
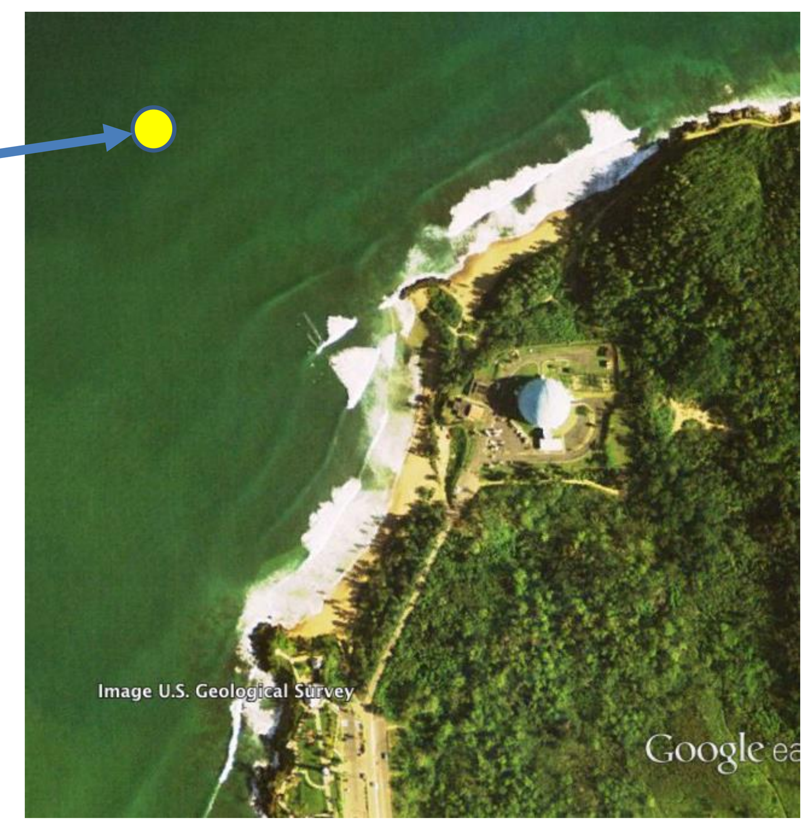
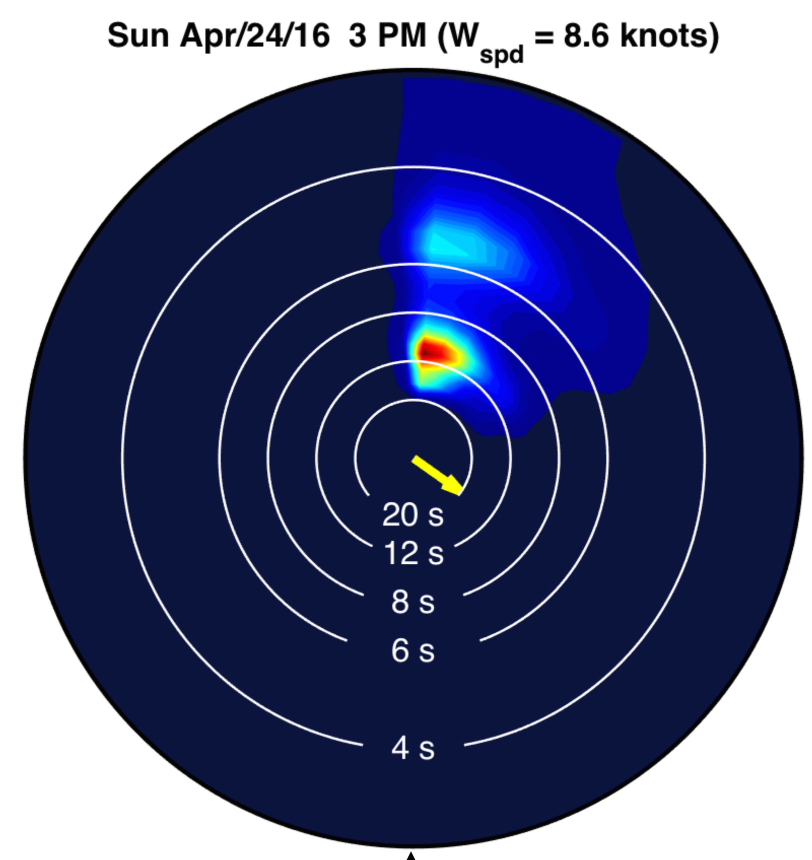
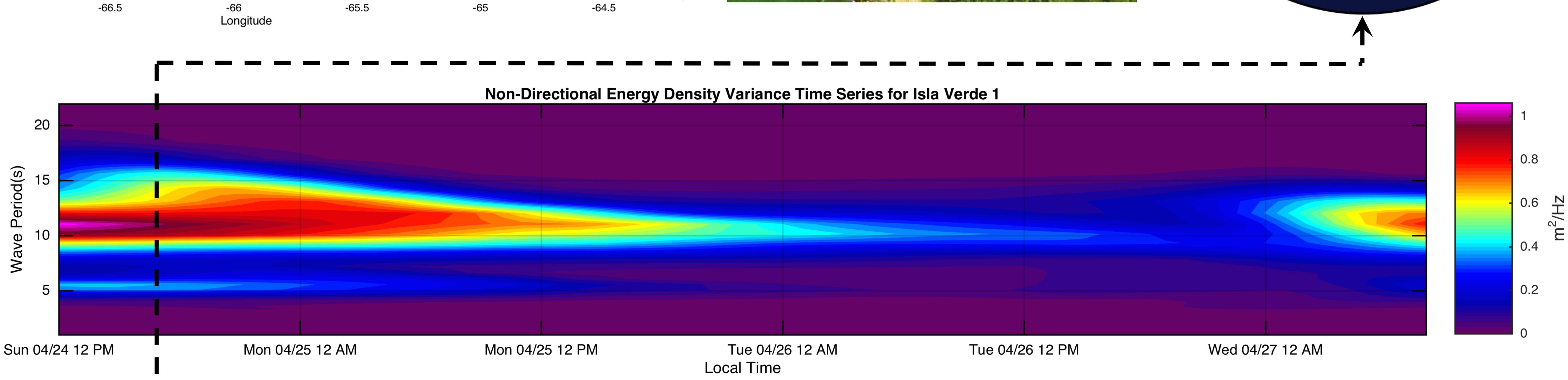
The CariCOOS - Sea Grant Nearshore Breaker Model combines numerical modeling, empirical knowledge, field observations and custom website development to provide the public with an online tool to visualize the presence of potentially dangerous breaking waves at the most popular beaches in Puerto Rico and the United States Virgin Islands. Previous versions of the NBM were based on wave statistics provided by the SWAN wave model, which does not perform online spectral partitioning on wave spectra but rather uses a constant separation frequency between wind seas and swell. In some cases this caused the NBM to overestimate breaking wave heights during multi-modal sea states. The most recent version (updated April 2016) uses 1D spectral partitioning to decompose wave spectra into wind sea and frequency components.



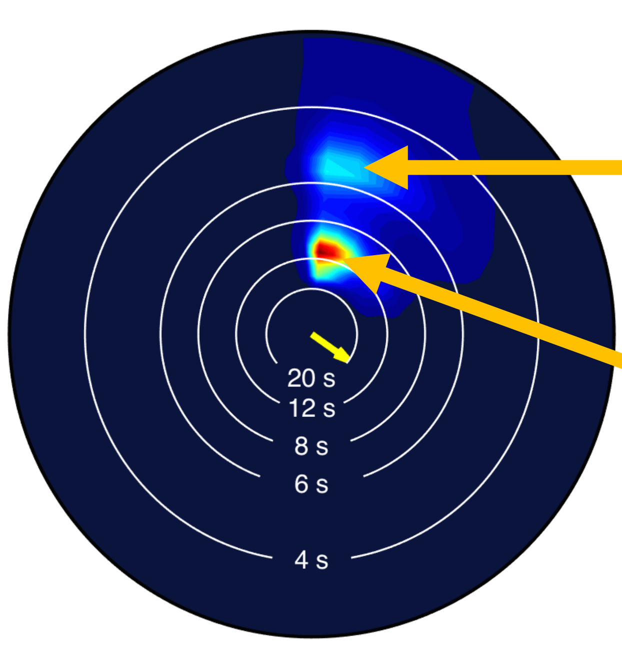




At each time step, the 2D spectrum is collapsed into a 1D frequency spectrum.



The method of Hwang (2012, JOAT) is then used to partition the SWAN spectrum. The method uses a generalized spectrum integration technique to identify a separation frequency in order to divide the spectrum into i-th partitions, usually i=1, 2: wind seas and swell.



Wind sea spectral peak with partition energy e_{sea}

$$H_{sea} = 4\sqrt{e_{sea}}$$

Swell spectral peak with Partition energy e_{swell}

$$H_{swell} = 4\sqrt{e_{swell}}$$

Steps to compute Hb once spectra is partitioned: Get available wave energy flux of each i-th partition at a forecast point

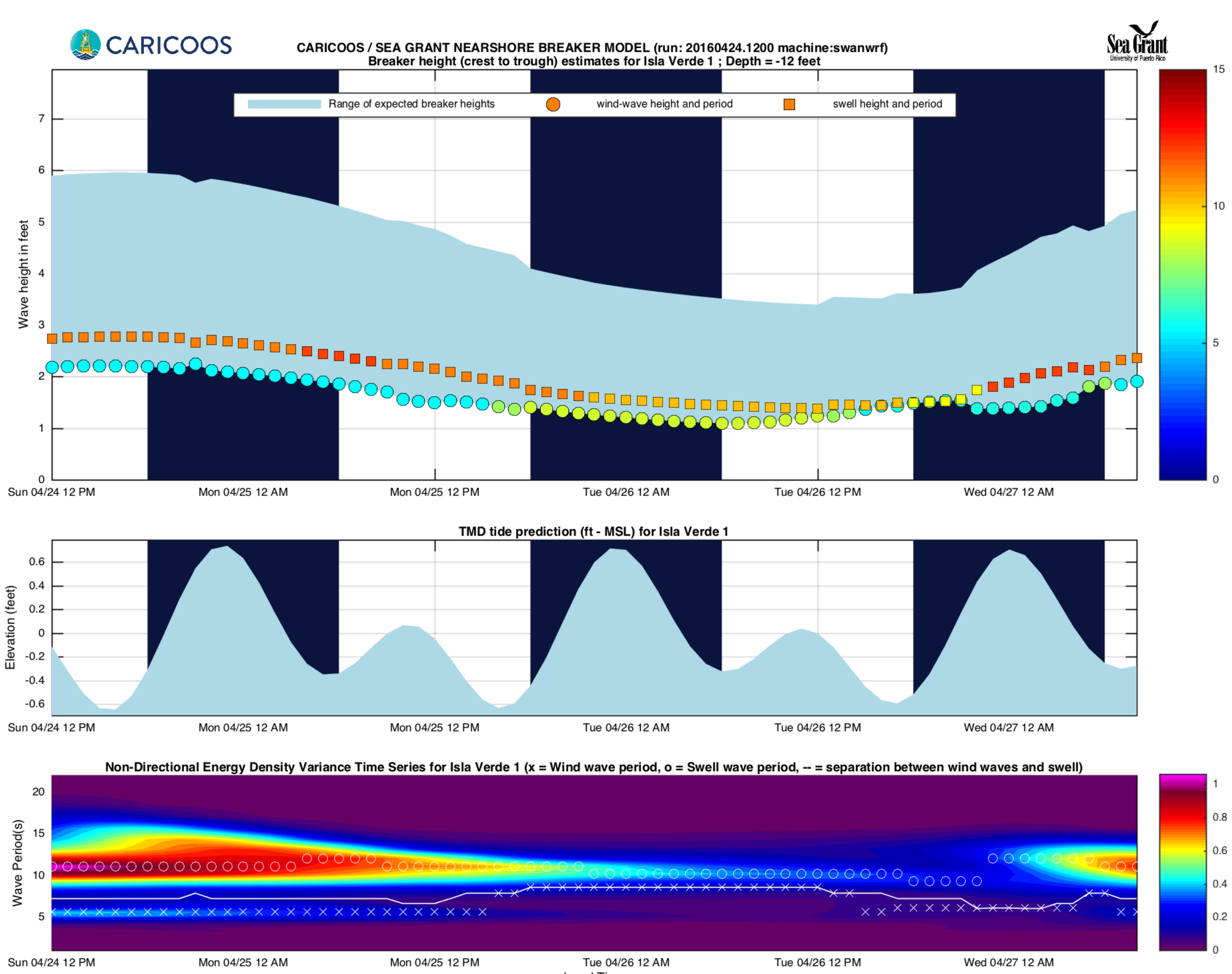
$$P_i(t) = E_i(t)Cg_i(t)$$

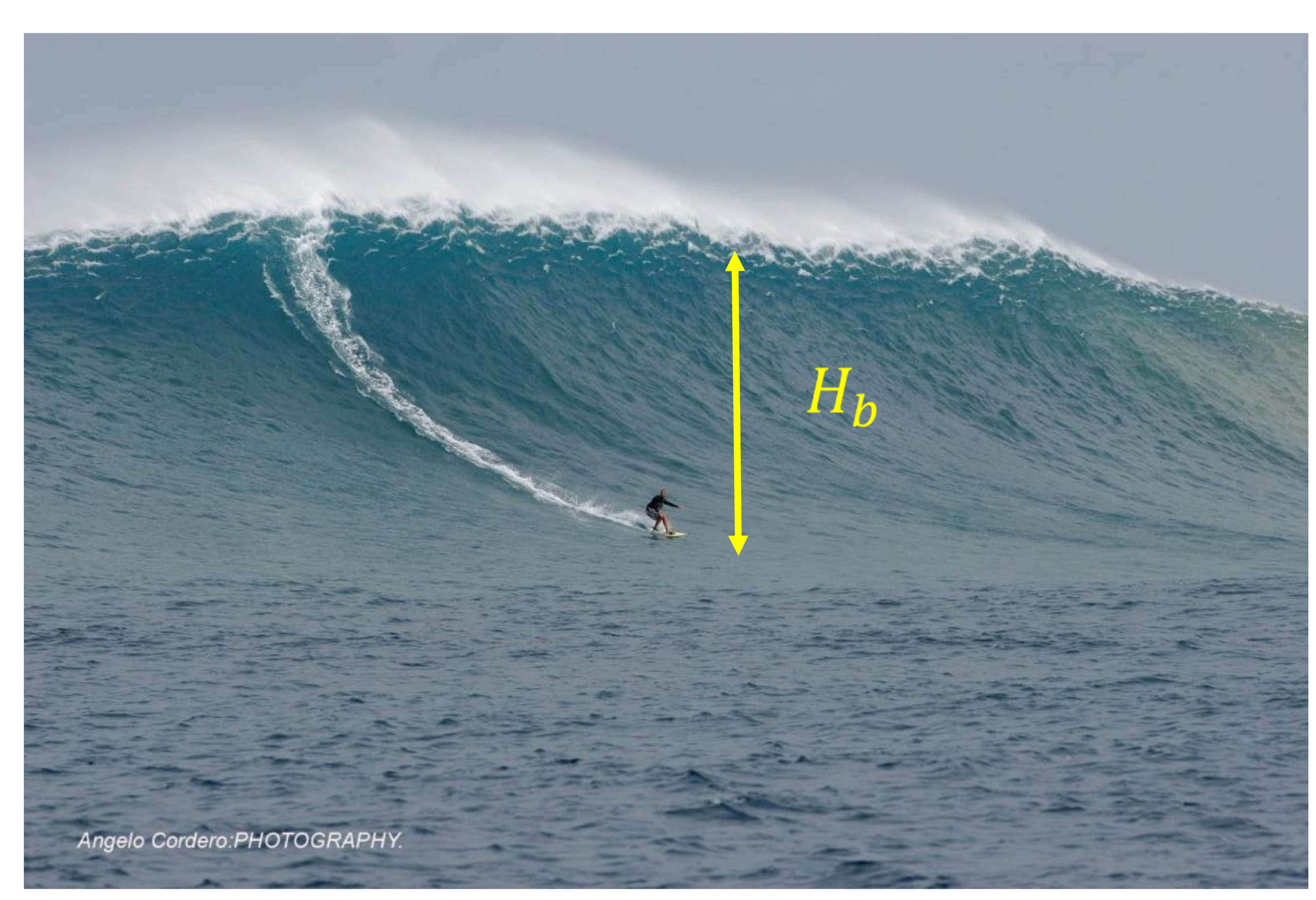
$$E_i(t) = \frac{1}{8}\rho g Hs_i^2 \qquad Cg_i(t) = \frac{1}{2}\left\{1 + \frac{4\pi d_i/L_i}{\sinh(4\pi d_i/L_i)}\right\}\frac{L_i}{Tp_i}$$

The equivalent deep water wave height H_∞ of the partition with an energy flux equal to the energy flux predicted by SWAN at the point forecast location

$$H_\infty = Hs_i\sqrt{\frac{Cg_i}{Cg_\infty}} \longrightarrow Hb_i = 0.39g^{\frac{1}{5}} \cdot (T_i \cdot H_\infty{}^2)^{\frac{2}{5}}$$

Komar and Gaughan (1972)





$$H_{b_{min}} < H_b < H_{b_{max}}$$

THE FUTURE: Breaker height predictions using 2D spectral partitioning...