Breaking Wave Height Predictions Using 2D Spectral Partitioning

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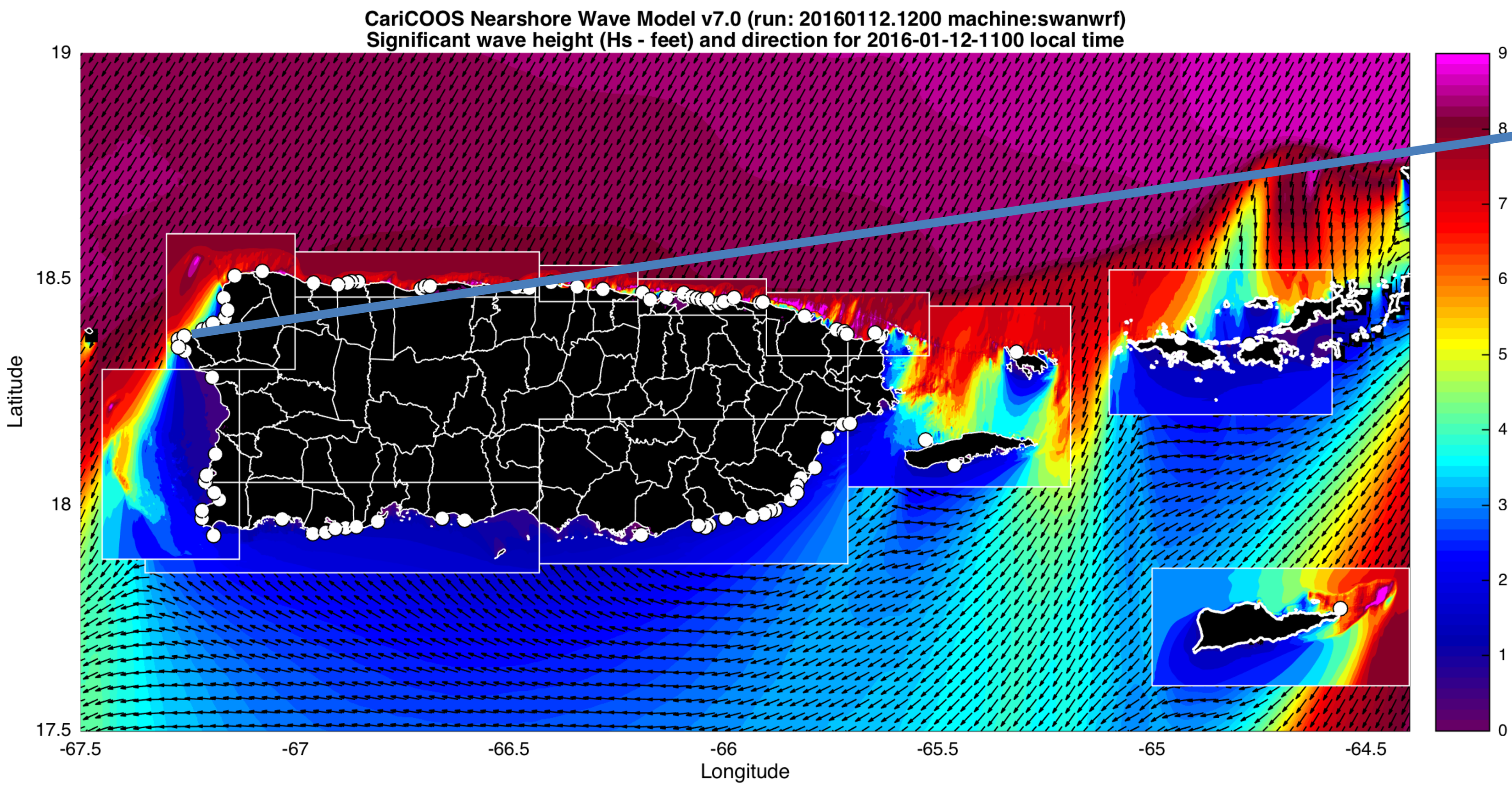
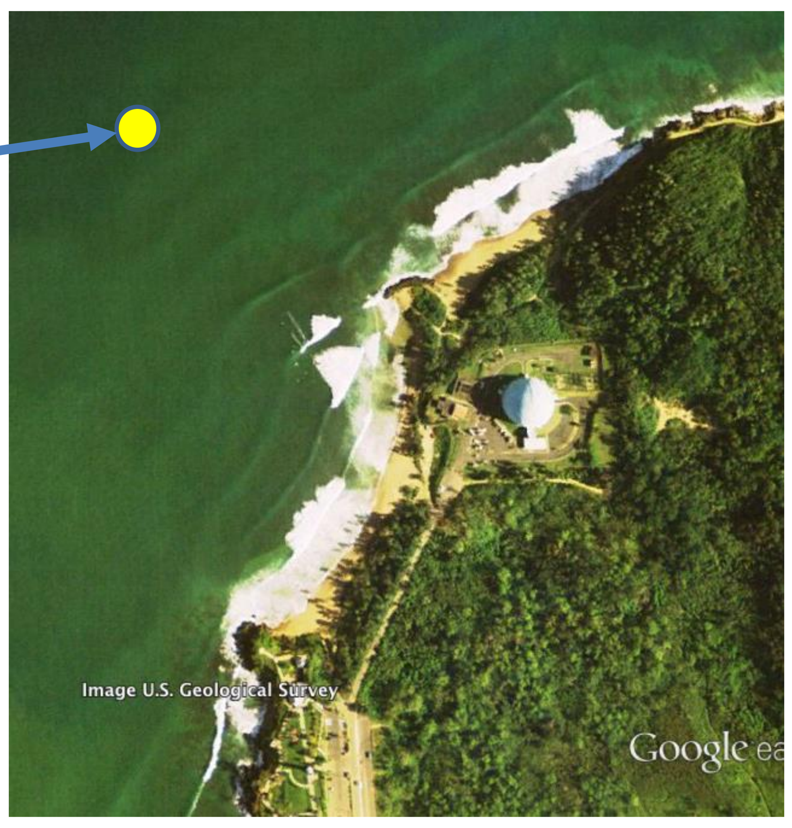
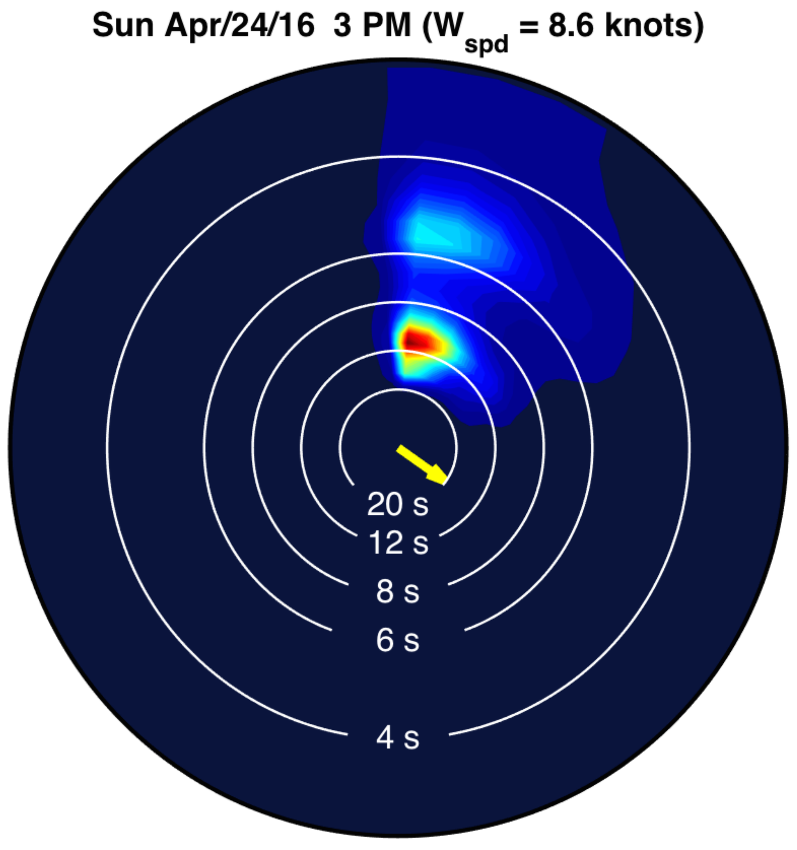
The CariCOOS - Sea Grant Nearshore Breaker Model combines numerical modeling, empirical knowledge, field observations and custom website development to provide the public with an online tool to visualize the presence of potentially dangerous breaking waves at the most popular beaches in Puerto Rico and 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 2018) uses 2D spectral partitioning to decompose wave spectra into individual spectral wave components and estimate the breaking wave heights associated with each spectral component, providing 5-day breaker forecasts.

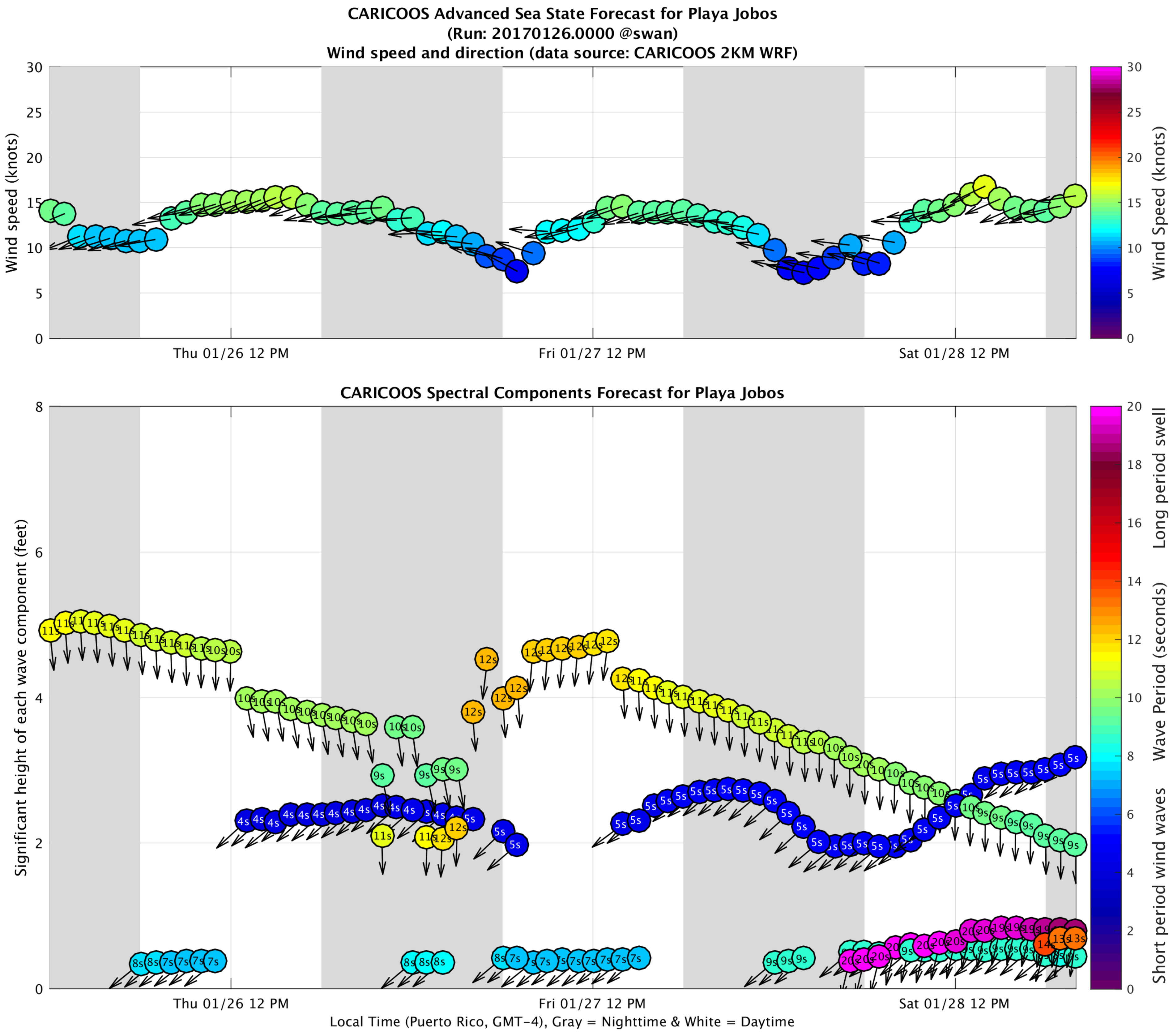


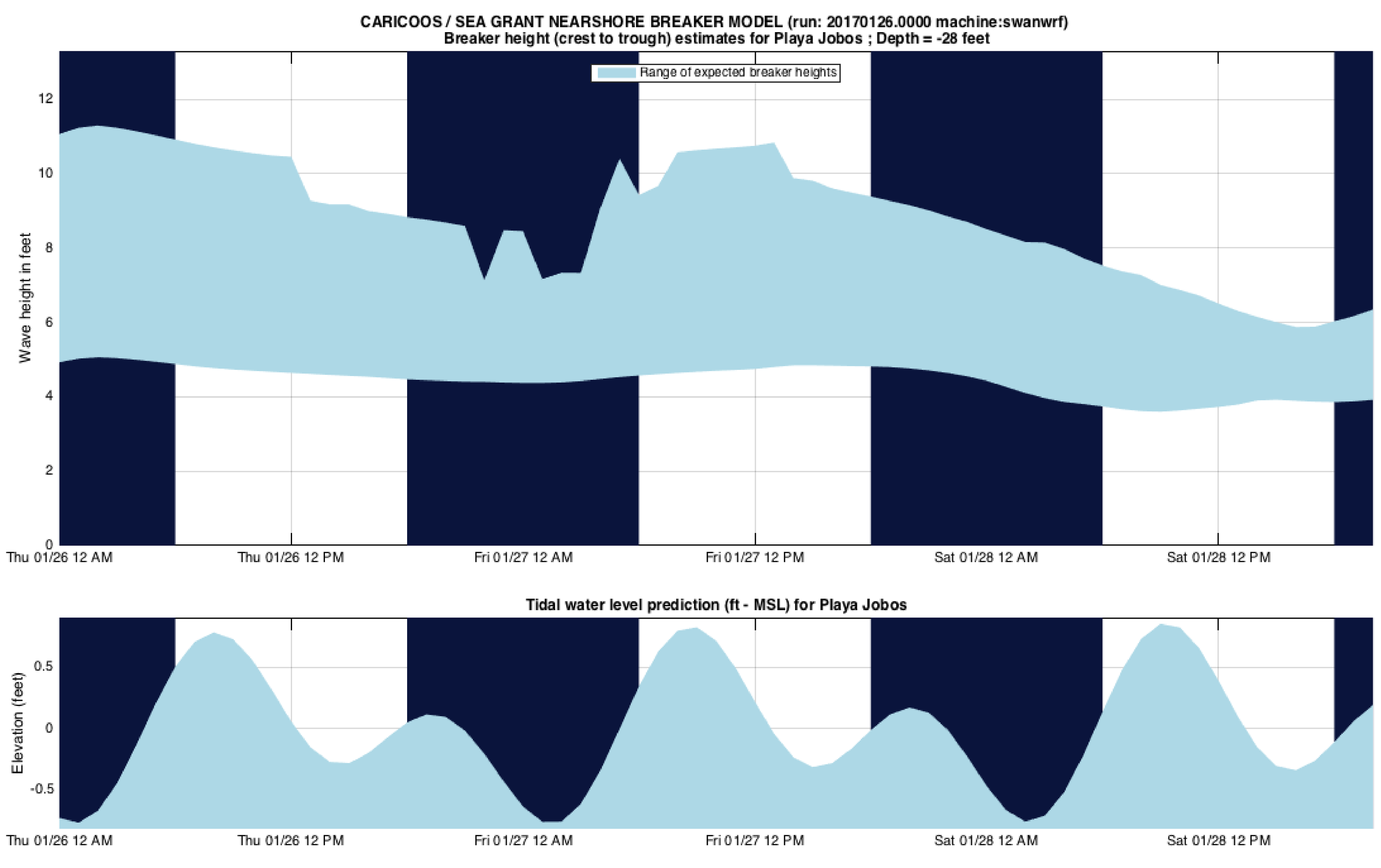




2D SPECTRAL PARTITIONING

During FY17 the CARICOOS Nearshore Wave Model was upgraded to SWAN 41.10, which uses the watershed algorithm of Hanson and Phillips (2001) to decompose 2D wave spectra into individual wave components, as shown in the Figure below.





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

$$P_i(t) = E_i(t) Cg_i(t) \qquad E_i(t) = \frac{1}{8}\rho g H s_i^2$$

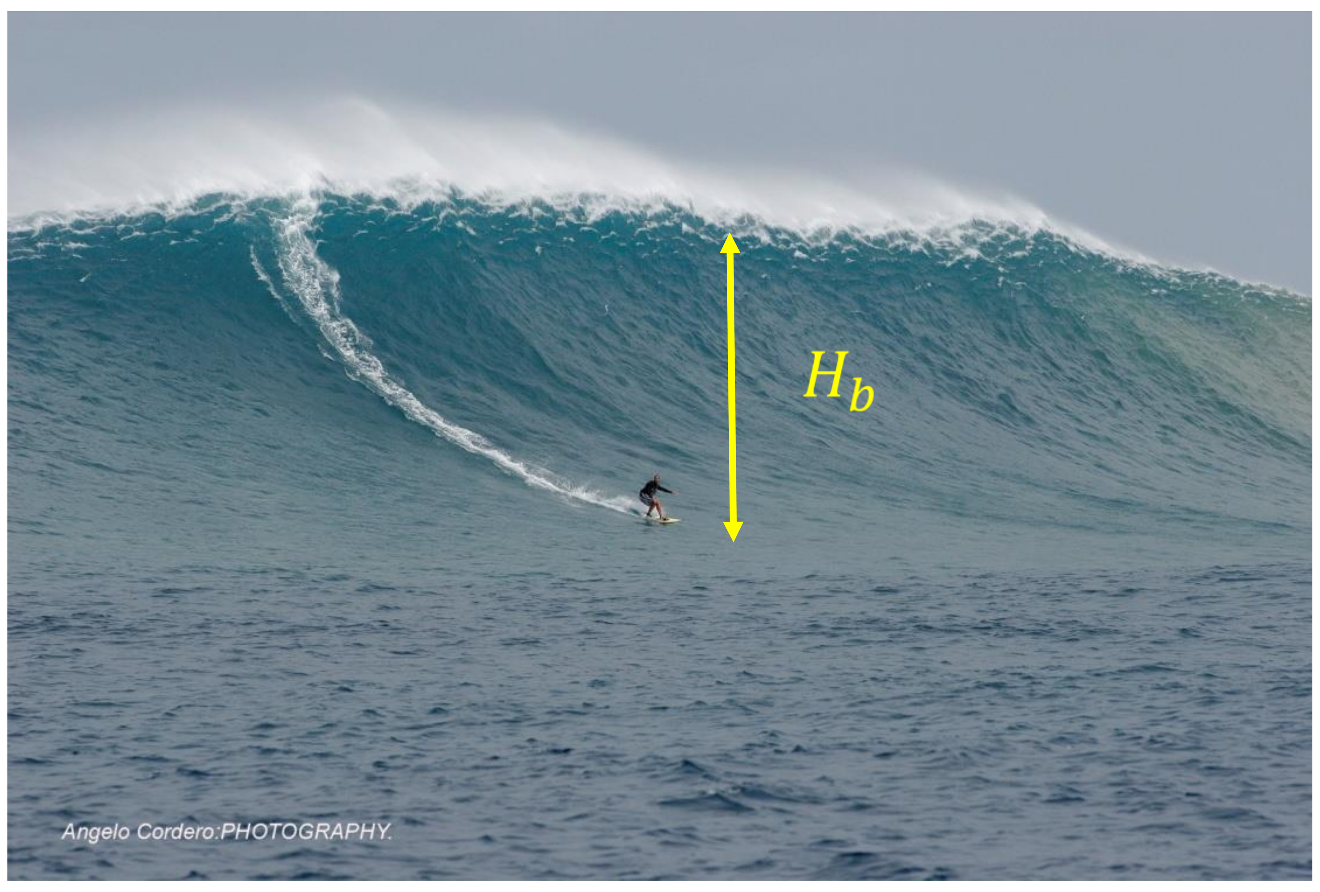
$$Cg_i(t) = \frac{1}{2}\left\{1 + \frac{4\pi d_i / L_i}{\sinh(4\pi d_i / L_i)}\right\}\frac{L_i}{Tp_i}$$

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

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

Komar and Gaughan (1972)

Results are then presented as the envelope of the expected breaker heights, as shown in the figure on the left.



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

Hanson, J. L., and O. M. Phillips, 2001: Automated analysis of ocean surface directional wave spectra. J. Atmos. Oceanic. Technol., 18, 277-293.

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