Tropical Cyclone Destructive Potential by Integrated Kinetic Energy

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Using the concept of integrated kinetic energy, Powell and Reinhold (2007a) proposed two ranking scales: one for wind destructive potential (W_{dp}) and the other for surge/waves (S_{dp}). To compute these ratings, they provided many statistical equations. As shown in Fig. 1, approximately 70% of the variation of W_{dp} can be explained by a single parameter V_{ms}, the maximum sustained wind speed. Similarly, about 84% of the S_{dp} variation is contributed by the radius of tropical storm R_{18}, as shown in Fig. 2.

The maximum open-ocean surge along the storm track induced by the wind stress (S_x) is related linearly

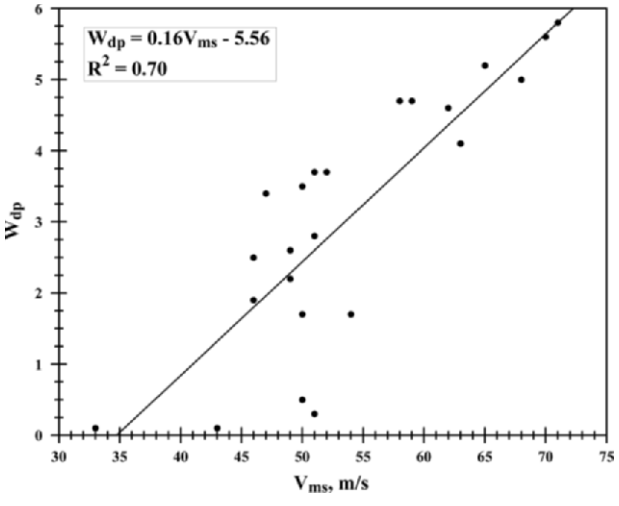

Fig. 1. Variation of W_{dp} with respect to V_{ms}.

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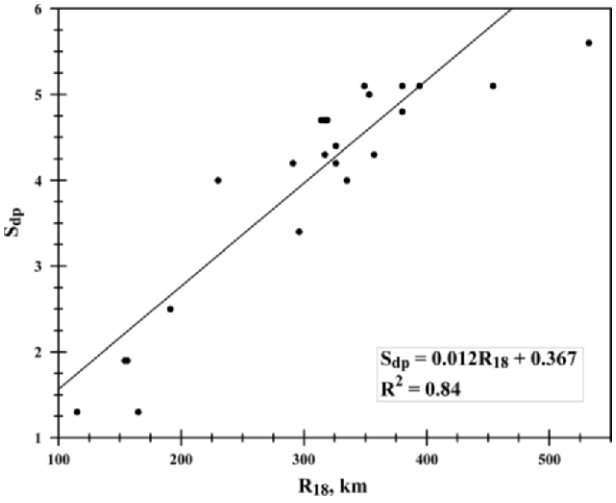

Fig. 2. Variation of S_{dp} with respect to R_{18}.

with the maximum significant wave height (H_{smax}), such that (Hsu 2004)

$$S_{xmax} \propto H_{smax}, \tag{1}$$

and from the Shore Protection Manual (USACE 1984, 3–48)

$$H_{smax} \propto V_{ms}\sqrt{R_{18}}, \tag{2}$$

where V_{ms} (m s^{-1}) is the maximum sustained wind speed at 10 m and R_{18} (m) is the fetch (as a surrogate). In addition, the wave setup is also linearly related to H_{smax} (see, e.g., Dean and Dalrymple 2002). From Eqs. (1) and (2), we postulate that the combined destructive potential by wind, wave, and surge is

$$\frac{1}{2}\left(W_{dp} + S_{dp}\right) \propto V_{ms}\sqrt{R_{18}}. \tag{3}$$

The result is shown in Fig. 3, indicating about 85% of the variation of the combined destructive potential including wind, wave, and surge can be explained by Eq. (3). Since in Fig. 3 the x axis takes into account the contribution of both hurricane intensity (represented by V_{ms}) and its size (by R_{18}) and the y axis of both wind and surge, it may be a foundation toward the evaluation of the enhanced Saffir–Simpson (SS) scale as suggested by Powell and Reinhold (2007b).

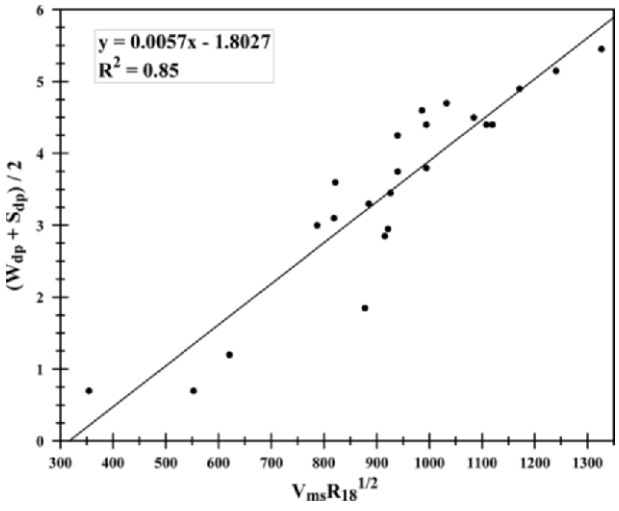

FIG. 3. The combined destructive potential of wind, wave, and surge as a function of wind and fetch [see Eq. (3)].

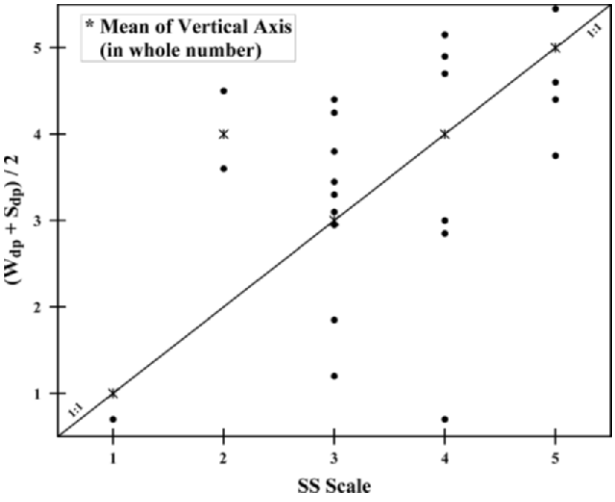

FIG. 4. Variations of the combined W_{dp} and S_{dp} with respect to the SS scale.

Figure 4 shows that one cannot rule out the relationship between this combined destructive potential by wind, wave, and surge and the SS scale. More data are needed to substantiate this relationship (Simpson and Saffir 2007).

Finally, the hurricane intensity index (HII) as proposed in the literature can also be related to the SS scale. Figure 5 shows the comparison. Apparently, from an operational standpoint, the HII and SS scale are nearly the same.

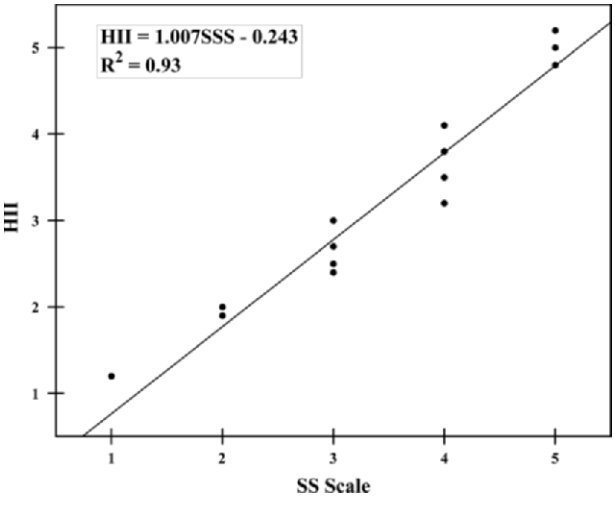

FIG. 5. Variations of the HII with respect to the SS scale.

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