Tropical Cyclone Destructive Potential by Integrated Kinetic Energy

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Powell and Reinhold's (2007) summary and brief discussion of several proposed scale designs as suitable alternatives to the Saffir–Simpson (SS) scale, defining damage potentials in hurricanes, is a useful contribution. Our comment here, however, pertains specifically to the new scale they propose based upon the integration of kinetic energy. While there are a number of procedural questions about the proposed new scale that merit discussion, this comment is primarily concerned with how well their scale may serve operational needs during hurricane crises, not only in warning decisions, but as a tool of communication with both public and private interests. The proposed scale may prove useful in postanalyses of hurricane wind distributions in relating integrated kinetic energy values to the character and scope of wind damage; however, it is unlikely to relate usefully to the processes that created the existing intensity to begin with, much less the significant changes that often defy prediction.

Kinetic energy may relate well to analyses of wind loading on various structures, and possibly to a better identification—if not understanding—of more subtle processes generated from purely dynamic sources. However, the development of hurricane intensity and, more importantly, abrupt changes of intensity, depend significantly on the forcing from thermodynamic as well as dynamic sources. This is not only a critical prediction problem, but one of communicating the consequences of changes to both the public and private interests.

Kinetic energy itself is arguably the least conservative property of any severe storm, exhibiting large variations from point to point, both in space and time, especially in urban coastal areas. The computation of kinetic energy from immediately available observational sources and its spatial integration is time consuming (according to the above-mentioned paper, there is a time lag of 6 hours), yielding numerical results that must be adjusted using arbitrarily derived coefficients of questionable validity when applied universally. These considerations raise serious questions about the applicability of such a scale to the time-sensitive operational requirements of hurricane warnings and evacuations, especially when the new scale does not take into account the thermodynamic contribution to sudden intensity changes that this forcing may invoke.

The SS scale, since its introduction more than three decades ago, has been numerically related in each of its categories to hurricane central pressure, whose values are functionally related to both thermodynamic and dynamic sources of forcing. As such, it is a conservative index for both the stability and any eminent changes of intensity. It is readily measurable from reconnaissance aircraft by dropsonde and with close approximation from satellite observations, which is an asset that any attempt to improve the present scale should incorporate.

It was the intended policy and practice at the time the SS scale was introduced by the National Hurricane Center to relate operationally the assignment of categories primarily in terms of net releases of energy as reflected in either changes or steadiness of central pressure values, remaining wary of individual point values of the highly variable, often ephemeral, reported maximum wind speeds. This proved particularly useful in assessing the transitions from tropical storm stages to hurricane strength. Of course, there are significant fluctuations in central pressure values too. However, in our view and experience these changes tend to usefully reflect the net competing sources of energy releases, for example, vertical shear

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Saffir/Simpson damage potential scale ranges

Scale number (category)	Central pressure (mb)	Central pressure (in.)	Winds (mph)	Surge (ft)	Damage
1	≥980	≥28.94	74–95	4–5	Minimal
2	965–979	28.50–28.91	96–110	6–8	Moderate
3	945–964	27.91–28.47	111–130	9–12	Extensive
4	920–944	27.17–27.88	131–155	13–18	Extreme
5	<920	<27.17	>155	>18	Catastrophic

Simpson and Riehl: *The Hurricane and its Impact*, 1981, LSU Press

and external transports of momentum versus changes in surface water temperatures encountered, and ingestion of drier air, as well as the complex interactions associated with development of double eyes. All of these should be conservatively reflected in central pressure values, frequently foreshadowing changes in wind distributions. We suggest that the design of any successor scale should be careful not to "throw out the baby with the bathwater."

Finally, in view of frequent references to the impact of Hurricane Katrina in New Orleans, Louisiana, the following remarks are appropriate. After a personal early survey of damage and flooding in New Orleans conducted by the second author of this comment, no evidence was observed of excessive wind damage that should not have been expected from a lower category-3 hurricane or less, other than that which occurred in unique combination with wind-driven flooding. Some published reports indicated the highest wind speeds recorded in New Orleans were less than 100 mph. Moreover, this survey concluded that while Lake Ponchartrain water levels were elevated as an indirect result of storm surge, the flooding in New Orleans would have been minimal had the levees not been breached, allegedly "due to faulty design or construction." There was minimum overtopping of levees. Therefore, flooding in the city would have been restricted to rain accumulations with little or no associated water damage. Storm surge, in the classical sense, did not occur in New Orleans. There are many misconceptions by the public as to the Hurricane Katrina disaster, but this uniquely combined impact of winds and flooding still succeeded in generating one of our greatest national disasters—one that probably should be attributed more to human failure than to natural causes.

REFERENCES

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