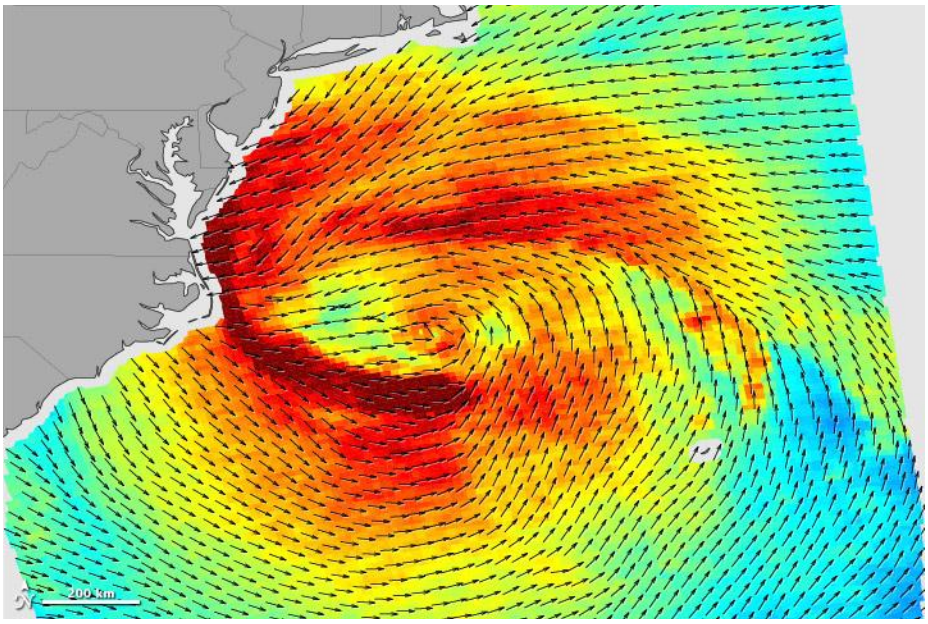
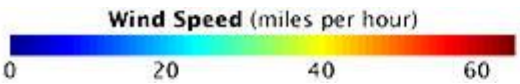
Comparing the Winds of Sandy and Katrina

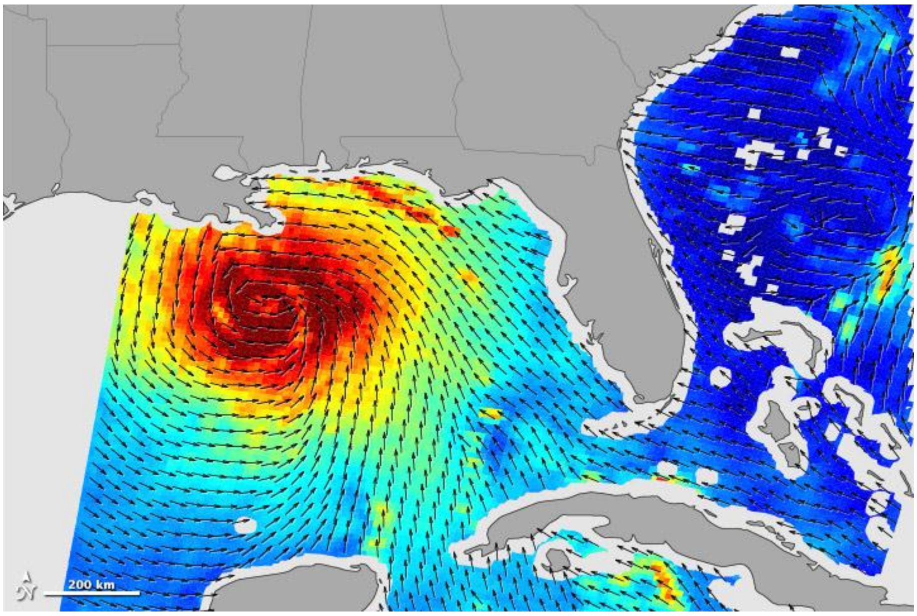
November 6, 2012



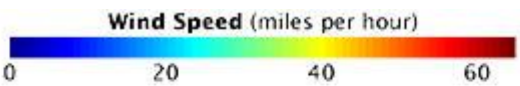
Sandy



acquired October 28, 2012download large Sandy image (2 MB, JPEG, 3001x3001)



Katrina



acquired August 28, 2005download large Katrina image (1 MB, JPEG, 3037x3306)

The scenes of devastation and wreckage that Hurricanes Sandy (2012) and Katrina (2005) left behind were tragically similar. Both storms flooded major cities, cut electric power to millions, and tore apart densely populated coastlines. But from a meteorological perspective, the storms were very different.

Katrina was a textbook tropical cyclone, with a compact, symmetrical wind field that whipped around a circular low-pressure center. Like most tropical cyclones, Katrina was a warm-core storm that drew its energy from the warm waters of the tropical Atlantic Ocean. Sandy had similar characteristics while it was blowing through the tropics. But as the storm moved northward, it merged with a weather system arriving from the west and started transitioning into an extratropical cyclone.

The names sound similar, but there are fundamental differences between the two types of storms. While tropical cyclones draw their energy from warm ocean waters, extratropical cyclones are fueled by sharp temperature contrasts between masses of warm and cool air. Extratropical cyclones also tend to be asymmetric, with broad wind and cloud fields shaped more like commas than circles. So when tropical cyclones become extratropical, their wind and cloud fields expand dramatically. Their strongest winds generally weaken during this process, but occasionally a transitioning storm retains hurricane force winds, as was the case with Sandy.

The pair of wind maps illustrate some of the differences. The map of Sandy's winds (top), produced with data from a radar scatterometer on the Indian Space Research Organization's (ISRO) Oceansat-2, shows the strength and direction of Sandy's ocean surface winds on October 28, 2012. The map of Hurricane Katrina's winds (bottom) was made from similar data acquired on August 28, 2005, by a radar scatterometer on NASA's retired QuickSCAT satellite. In both maps, wind speeds above 65 kilometers (40 miles) per hour are yellow; above 80 kmph (50 mph) are orange; and above 95 kmph (60 mph) are dark red.

The most noticeable difference is the extent of the strong wind fields. For Katrina, winds over 65 kilometers per hour stretched about 500 kilometers (300 miles) from edge to edge. For Sandy, winds of that intensity stretched 1,500 kilometers (900 miles).

"Katrina's winds were more intense, but they covered less area," said Brian McNoldy, a University of Miami meteorologist who authored a *Washington Post* article explaining why Sandy's storm surge caused so much damage. "When that boils down to storm surge, Katrina was capable of generating a locally higher surge, but Sandy was capable of generating a destructive surge over a larger length of coastline."

Another difference is the location of the strongest winds. For tropical cyclones in the northern hemisphere, the strongest winds are usually just east of the eye amidst a ring of violent thunderstorms called the eyewall. "The windfield of Katrina fits this pattern, but for Sandy the *weakest* winds are to the east—a hint that Sandy has already begun interacting with a system to its northeast and a blocking high to its northeast," noted Penn State meteorologist Jenni Evans.

References

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- Alaska Dispatch (2012, Oct. 29) Hurricane Sandy morphs into extratropical cyclone. Accessed November 5, 2012.
- Climate Central (2012, Oct. 26) How hurricane Sandy can become a 'Frankenstorm.' Accessed November 5, 2012.

Further Reading

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2. Earth Observatory (n.d.) Hurricane Sandy event page.
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4. Jones, S. (2003, December) The extratropical transition of tropical cyclones: forecast challenges, current understanding, and future directions. *Journal of Climate.*
5. Masters, J. (2012, Oct. 31) Why did Hurricane Sandy take such an unusual track into New Jersey. Accessed November 5, 2012.

Data courtesy of the Jet Propulsion Laboratory's QuikSCAT and the Indian Space Research Organization OceanSat-2 missions. Caption by Adam Voiland, with information from Jenni Evans, Bryan Stiles, Brian McNoldy, and Alexander Fore.

Instrument: QuikSCAT

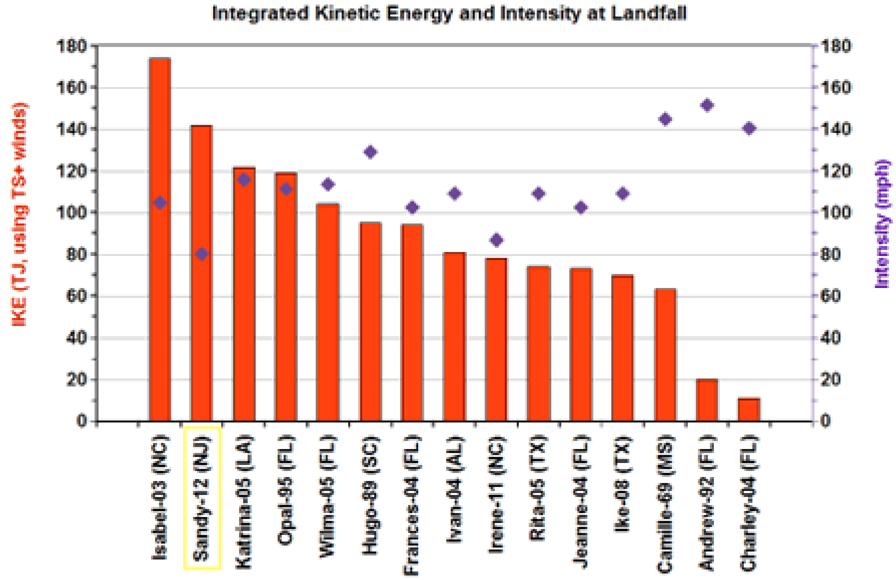
From: http://earthobservatory.nasa.gov/IOTD/view.php?id=79626&src=eoa-iotd

Posted at 11:17 AM ET, 11/02/2012
Nov 02, 2012 03:17 PM EDT

TheWashingtonPost

Superstorm Sandy packed more total energy than Hurricane Katrina at landfall

By Brian McNoldy



Integrated kinetic energy (IKE) and intensity of several historic U.S. landfalling storms. IKE is shown by the red bars, while the intensity is shown in the purple diamonds.

The horrific storm surge flooding in New Jersey and New York caused by Sandy was almost perfectly predicted well in advance, but was more extreme than the average person might expect from a minimal hurricane. That's where Sandy's immense size comes into play.

There is a metric that quantifies the energy of a storm based on how far out tropical-storm force winds extend from the center, known as Integrated Kinetic Energy or IKE*. In modern records, Sandy's IKE ranks second among all hurricanes at landfall, higher than devastating storms like Hurricane Katrina, Andrew and Hugo, and second only to Hurricane Isabel in 2003.

The above chart compares IKE and intensity for storms at the time they struck land (in the U.S.). Not all historic storms can be included because a detailed wind field analysis (required to compute IKE) is unavailable for storms in the distant past. But this chart shows the majority of high-ranking modern cases.

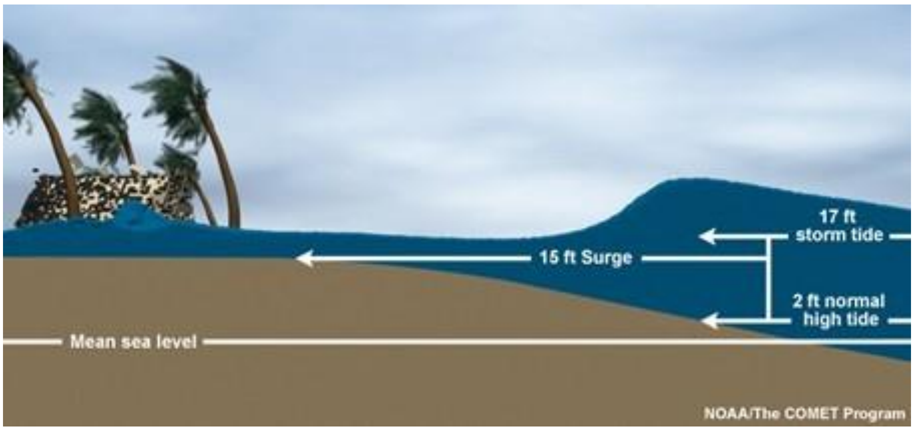
Sandy's IKE was over 140 Terajoules (TJ, 1 TJ = 1 trillion Joules = 277,778 kilowatt hours), meaning it generated more than twice the energy of the Hiroshima atomic bomb. At any given moment, many hurricanes contain more energy than an atomic bomb in their surface winds alone (even excluding winds at higher elevations and latent heat energy).

Though way down on the scale, I include Andrew and Charley in the chart to show how their small IKE contrast their high rankings on the Saffir-Simpson scale which is based solely on peak sustained winds. This demonstrates small intense storms generate far less energy than large weak storms.

Why does IKE matter?

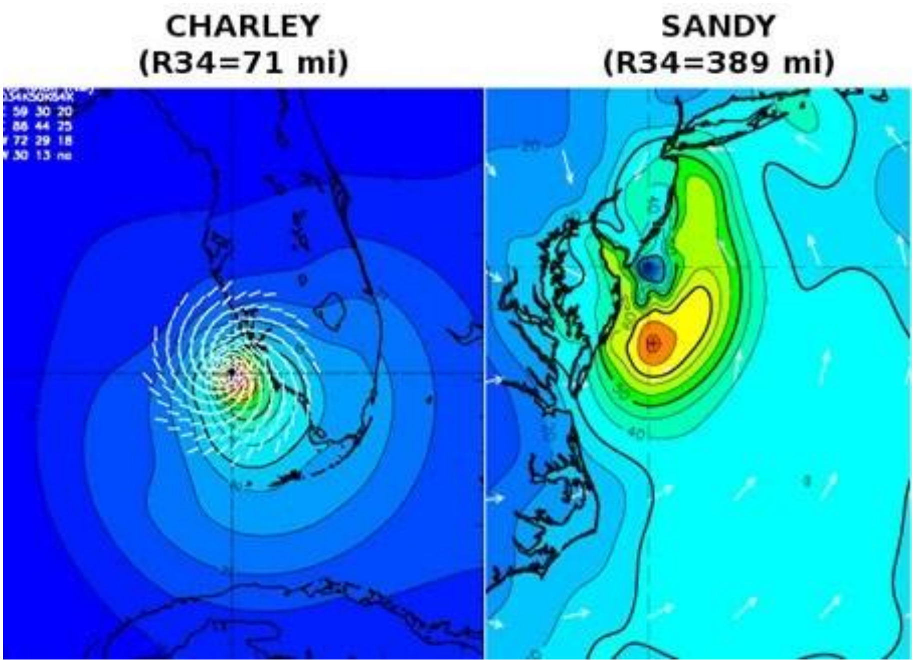
It has been demonstrated time and time again that the storm surge generated by a hurricane is not very well correlated with the storm's intensity or peak winds, but rather the storm's size - which the IKE metric captures. The area over which strong winds blow across the ocean is strongly related to the resulting storm surge potential.

Recall, the storm surge is the increased water level along the coast caused by winds continuously bulldozing the ocean onto the land. It builds long before a storm makes landfall. It simply raises the mean sea level from its normal level by a few to over 25 feet. Large violent waves typically occur on top of the storm surge.



Cartoon showing mean sea level, normal high tide sea level, a 15' storm surge coming between high and low tides, and a 17' storm tide resulting from a 2' lunar high tide plus the 15' storm surge.

In the figure below, two hurricanes (Charley '04 and Sandy '12) are shown side-by-side at the same scale. The color contours highlight wind speed, and are shaded identically. Charley was a Category 4 hurricane, while Sandy was a Category 1 hurricane (technically, it may have just transitioned to an extratropical cyclone an hour before landfall, but that's an academic difference that people on the ground don't care about), but clearly Sandy's wind field extended over a larger area, even though its peak winds were much weaker. As such, Sandy's IKE was 7 times Charley's and had a much more massive storm surge.



Surface wind fields of Category 4 Hurricane Charley and Category 1 Hurricane Sandy at landfall. (HRD)

Of course, IKE is not the only factor in determining storm surge potential. Differences in coastal topography/bathymetry play a large role, so the specific landfall location matters.
The exact same storm hitting Charleston, S.C. will have a completely different surge potential than if it were hitting Miami, Galveston, New Orleans, or New York City (NYC). The stage of the normal lunar tides makes a large difference as well (Sandy made landfall exactly at high tide).

And in terms of human impacts, a landfall on or near a major city will certainly be worse than an identical landfall near a more rural stretch of coastline. Places like New Orleans, NYC, and Tampa are both low-lying AND heavily populated. But hurricanes don't care where we build cities and how vulnerable those cities are.

Hurricane Katrina was "only" a Category 3 storm at landfall, yet ended up being the most costly natural disaster in our nation's history due its impact on a vulnerable, highly populated low lying city. Sandy had Category 1 winds at landfall yet was able to create very significant storm surge over hundreds of miles of highly populated coastline. Katrina's IKE was more concentrated, Sandy's IKE was more spread out. This metric - more than wind speed - encapsulates the respective storms' horrific effects. Sandy may end up as the second most costly storm in U.S. history. Given its top ranking IKE and the area it impacted, that should come as no surprise.

Brian McNoldy is a senior researcher at the University of Miami's Rosenstiel School of Marine and Atmospheric Science.

* To calculate IKE, a high-resolution gridded wind field is created using all available aircraft, satellite, buoy, and ship data. Then, all grid points with surface wind speeds of 35 knots (or about 40 mph) or higher (tropical storm force) are identified. The wind speed at each of those points is squared, summed, and scaled, resulting in a single value, measured in tera-Joules.

By Brian McNoldy | 11:17 AM ET, 11/02/2012

From: http://www.washingtonpost.com/blogs/capital-weather-gang/post/sandy-packed-more-total-energy-than-katrina-at-landfall/2012/11/02/baa4e3c4-24f4-11e2-ac85-e669876c6a24_blog.html