AIRCURRENTS

# HURRICANE IKE: DO WE NEED TO CHANGE OUR THINKING?

12.2008

EDITOR'S NOTE: Of the three landfalling U.S. hurricanes in 2008, Hurricane Ike was by far the costliest. Perhaps because it was the largest loss in the last three seasons, it seemed to have captured the imagination of many in the industry, with estimates of as much as $20 billion or more being bandied about in the storm's early aftermath. In this article, AIR's Dr. Peter Dailey takes a hard look at the reality of Hurricane Ike.

By Dr. Peter S. Dailey, Director of Atmospheric Science

## INTRODUCTION

Hurricane Ike made landfall at Galveston, Texas in the early morning hours of September 13, 2008. It was the third and final hurricane to make landfall in the U.S. this year, preceded by Hurricane Dolly in late July and Gustav just two weeks prior to Ike.

All three landfalling hurricanes arrived on U.S. shores as Category 2 storms on the Saffir-Simpson scale. Yet according to the latest estimates by ISO's Property Claims Services unit, Dolly caused insured losses to onshore properties of $525 million, Gustav caused losses of $2.15 billion and Ike, a staggering $10.66 billion.

Since Ike's landfall, many have expressed surprise that a Category 2 hurricane could have caused more than $10 billion in damage. Some, such as Texas' Jefferson County Emergency Management Coordinator Greg Fountain, suggest that Hurricane Ike has "totally changed the way we are going to have to look at storms."[1] In fact, however, neither catastrophe modelers—nor the industry—should have been taken by surprise by Ike. While the storm displayed some interesting characteristics, and managed to cause damage well inland (long after it had been downgraded to a tropical depression and was no longer tracked by the NHC, the AIR model in fact performed very well in capturing the effects of this storm.

This article traces the history of Hurricane Ike's brief but costly assault on the U.S. It also looks at how the AIR U.S. hurricane model performed in real time and how modeling was used to handle some of Ike's more interesting and unique aspects.

## HURRICANE IKE AT LANDFALL

By the morning of September 11, Hurricane Ike had crossed storm-weary Cuba, passed over the warm waters of the Loop Current and was in the open Gulf of Mexico, heading for Texas. The structure of the storm appeared to have meteorologists at the NHC puzzled. Ike had not one, but two well-defined areas of maximum winds—one near the eyewall and another in an outer wind band. Furthermore, there was a pronounced disparity between central pressure and wind speed data. Reported central pressure—945 millibars—would normally be consistent with a borderline Category 3/4 hurricane, yet both dropsonde and flight-level wind data used by the NHC to estimate maximum sustained surface winds pointed to Category 2-level winds. Meteorologists at the NHC suggested that Ike was absorbing and distributing energy over a large area, rather than concentrating it near the center.

The critical issues on September 11 were twofold: the degree to which (or whether) Ike's wind speeds would catch up with its central pressure, and where on the coast it would make landfall. On September 11, two days before landfall, AIR issued estimates of insured losses to onshore properties in the U.S. ranging from a few hundred million dollars to more than $25 billion—a range that reflected the large range of potential landfall locations (as indicated by the NHC's white "cone of uncertainty" in Figure 1) and intensities. Forecasters at the NHC were at the time assigning a 23% probability to Ike's achieving Category 3 status before landfall and an 8% chance that it would achieve Category 4 status.

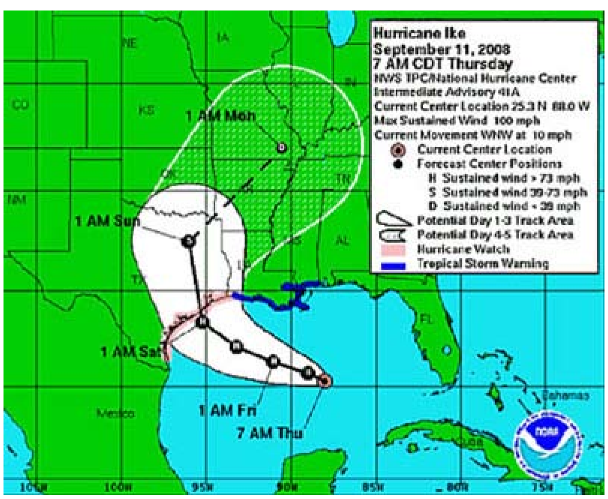


Figure 1. NHC Forecast Track and Cone of Uncertainty for Hurricane Ike Posted on September 11. Source: NHC

One day prior to landfall, the NHC downgraded the projected intensity at landfall to 115 mph. As a result, AIR collapsed its estimated range on September 12 to between $150 million to $15 billion. Again, landfall location would be critical in determining ultimate losses; that, and Ike's size. Radius of maximum winds were estimated at more than 50 miles and, even more significantly, hurricane force winds extended out to about 120 miles—larger, even than Hurricane Katrina. In addition, if the NHC's "expected" track proved to be correct, Texas coastal exposure directly subjected to both storm surge and hurricane force winds would be enormous.

In the end, the NHC's forecast track held, but Ike's intensity at landfall was comparable to Gustav—with sustained winds of 110 mph. However, Ike was a much larger storm than Gustav. Soon after Ike made landfall at Galveston, Texas, on September 13, AIR posted estimated losses of between $8.2 billion and $12.2 billion. Two days later, AIR deployed teams of engineers to survey the damage. What was observed in the field was consistent with output from AIR's damage functions for U.S. hurricane.

How could a Category 2 storm command such a high price tag? The largest concentrations of exposure in Texas are along the northern part of the coast, near Houston. In fact, AIR estimates that total property value in the five northernmost coastal counties, including Houston's Harris County, exceeds $750 billion—a number that continues to increase every year.

Of course, hurricane losses are not confined to coastal counties. The effects of Ike's path inland from Galveston occurred over inland Texas and Louisiana, and north to Arkansas. While Ike dissipated at a rate fairly typical for a Category 2 hurricane, the sheer size of the storm led to greater inland penetration than might be expected of a more compact system.

In fact, it is not unusual for a hurricane to produce significant wind damage well over 100 miles inland from the coast, and this inland penetration of hurricane risk is well represented in AIR's U.S. Hurricane Model. Figure 2 shows modeled hurricane loss costs for residential (left) and commercial (right) properties. Note that AIR modeled hurricane risk extends well inland from the immediate coast, and even extends to non-coastal states like Oklahoma, Kentucky, and Ohio. Models that fail to capture this significant source of loss potential result in a significant underestimation of the risk in non-coastal areas.

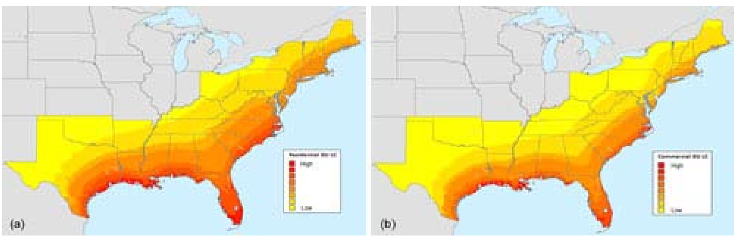


Figure 2. Modeled hurricane loss costs for (a) residential and (b) commercial properties. Source: AIR

## THE EFFECTS OF IKE IN THE MIDWEST

As we now know, there were two components to Ike's footprint of damaging winds inland. The first, as discussed above, resulted from the direct effects on inland areas of Texas, Louisiana and Arkansas while Ike maintained status as a tropical cyclone. In addition, there were the indirect effects that occurred after Ike's residual energy had combined with a pre-existing weather system over the Midwest. The effects of Ike in the Midwest have been the subject of significant interest and even debate. Preliminary estimates issued by ISO's Property Claim Services unit indicate losses of just over $1 billion in Ohio and other, albeit smaller, losses in states across the region.

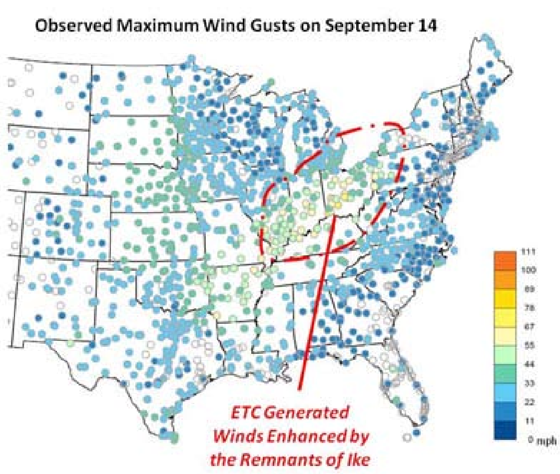


Figure 3. Observed maximum wind gusts on September 14. Source: AIR

These losses resulted from the remnants of Ike combining with and enhancing a moderately strong extratropical cyclone (ETC) that had been stationary over Michigan at the time of Ike's landfall (Figure 3). The ETC linked up with Ike's leftover energy to produce strong winds over Indiana, Illinois and Ohio on the 14th and 15th of September.

While it is unlikely that the ETC alone would have produced the hurricane force gusts that were observed in Ohio and elsewhere, it is also unlikely that the remnants of Ike would have produced such strong winds in the Midwest without the presence of the ETC. That is, these strong winds cannot be solely attributed to the extratropical transitioning of Ike—a common stage in a hurricane's life-cycle as it moves into the mid-latitudes, and one that is captured by the AIR model.[2])

In fact, this particular situation was quite unique in that it had characteristics of tropical (Ike), mid-latitude (ETC), and convective (severe thunderstorm) systems, as is laid out in the following narrative of events.

On September 12, while Hurricane Ike was still in the Gulf of Mexico tracking towards Galveston, TX, an extratropical cyclone was centered over northern Michigan (denoted by an "L" in Figure 4 ), with a cold front (the dark blue line) extending from Iowa to Kansas. In association with the frontal boundary, several tornados were reported in Missouri and Kansas. That same day, tornados near the border of Louisiana with Texas were reported in association with Hurricane Ike. While severe thunderstorms are not uncommon along cold fronts, they are relatively rare in the early months of autumn.

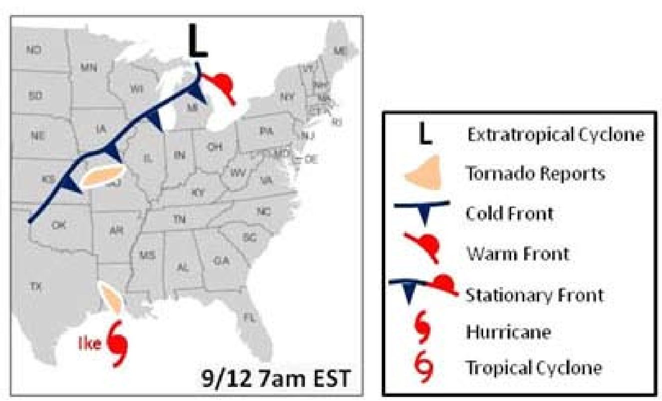


Figure 4. Relative locations of Hurricane Ike and an ETC (and its associated cold front) over the Midwest on September 12.

On September 13, the day Hurricane Ike made landfall along the Texas coastline, the center of the ETC relocated further south along the front, which was moving slowly to the east. Meanwhile, a stationary front (alternating red and blue lines) was positioned along the Great Lakes into New York and New England (Figure 5). A line of severe weather, including several reports of tornados, occurred in association with the stationary front along the southern border of Michigan. On the same day, there were at least 15 reports of tornados in Louisiana and Arkansas as Ike moved inland. Thus on September 13, these two distinct and well separated systems—the ETC and Hurricane Ike—both produced severe weather and damaging winds.

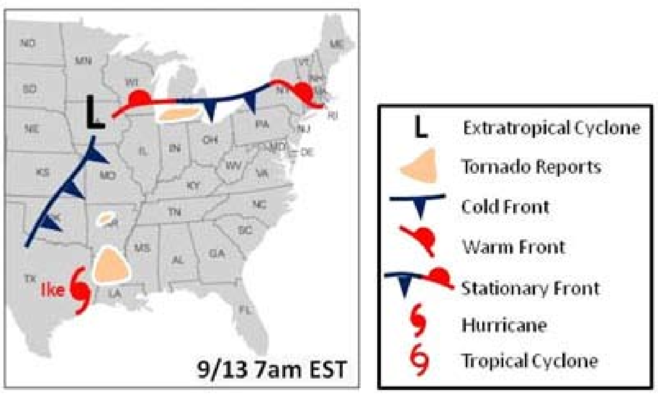


Figure 5. On September 13, Hurricane Ike comes ashore and the center of the etc relocates further south.

On the 14th of September, Ike's sustained winds dropped to below 40 mph and the storm was downgraded to a tropical depression. At this point, the National Hurricane Center (NHC) stopped tracking the system, leaving the end of Ike's track located at the Arkansas border with Missouri. Meanwhile, the ETC re-centered itself north of Michigan as its cold front moved further to the east.

Indeed, in the final advisory issued by the NHC on Ike, forecasters noted the approaching front, which at the time was associated with winds actually stronger than Ike's:

> Surface observations indicate that ike weakened to a tropical depression during the past several hours...with 25 to 30 kt winds and higher gusts occurring well to the southeast of the center. The surface data show a cold front is approaching ike...with an area of 25 to 35 kt winds developing behind the front from southwestern missouri across northwestern arkansas into eastern oklahoma.

By the time the remnants of Ike reached the Missouri border, as shown in Figure 6, the ETC and its associated frontal system were producing strong winds over Indiana, Ohio, and Kentucky. It was on this day—when the center of what remained of Ike was still at some distance to the southwest—that the strongest winds associated with the ETC were observed, with the highest gust of 64 knots (74 mph) recorded in Clinton, Ohio near Akron. Despite these locally strong gusts, there was no severe thunderstorm activity reported on the 14th, indicating the absence of either tropical or severe thunderstorm characteristics.

On September 15th, with the remnants of Ike now fully combined with the passing cold front, the ETC moved further east across northern New York, and continued to produce gusty and at times damaging winds over parts of New England (Figure 7). By the time it was over, the ETC,

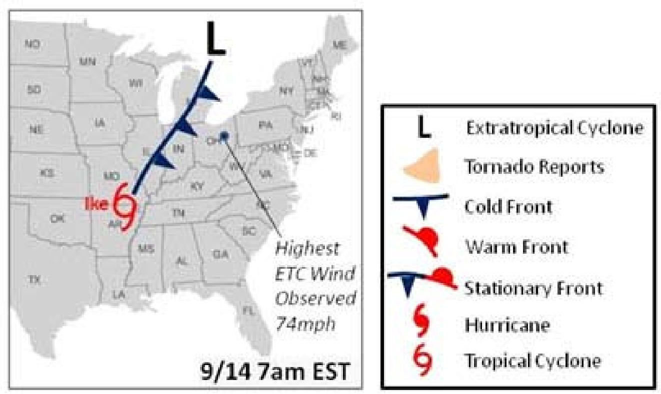


Figure 6. On September 14, as the remnants of Hurricane Ike were centered on the border between Arkansas and Missouri, the highest winds were recorded in Akron, Ohio.

which was fortified by Ike's remnant energy, had produced strong and damaging winds in a band from Illinois east to New York, and south to Kentucky and Tennessee.

How to model this rather unique and rare confluence of events presented AIR scientists with a challenge. Ultimately, it was determined that the most appropriate approach was to use the U.S. Extratropical Cyclone Model to generate an accurate depiction of the wind footprint across the Midwest. The decision was prompted by the fact that Ike had lost its tropical characteristics and the ETC, by the 14th, was no longer accompanied by convective (severe thunderstorm) activity.

After including the modeled losses from the Midwest, AIR posted a final range of insured losses for Hurricane Ike's onshore effects. AIR's final range for onshore losses was between 10 billion USD and 15 billion USD.[3] The current PCS estimate, issued on December 5, stands at 10.7 billion USD.

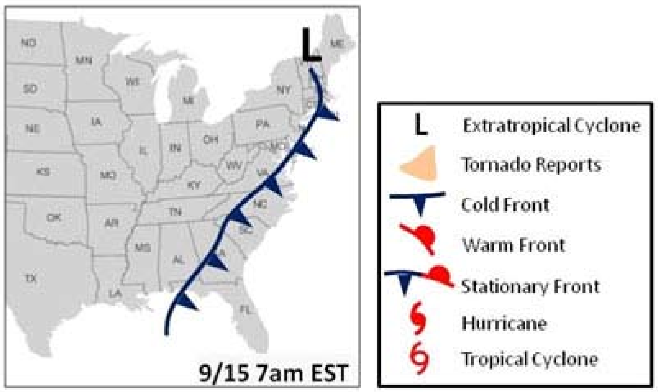


Figure 7. By September 15, the remnants of Ike had fully combined with the passing cold front, which produced gusty winds over parts of New England.

Table 1: AIR Modeled Losses for Hurricane Ike and PCS Current Estimate.

| Component of Loss | AIR Model Used in Estimates | States Affected | Industry Insured Loss Range (USD) | |
|---|---|---|---|---|
| | | | Low | High |
| Onshore Hurricane | U.S. Hurricane | Texas, Louisiana, Arkansas | 8B | 12B |
| Midwest ETC + Ike Remnants | U.S. Extratropical Cyclone | Ohio, Illinois, Indiana, Kentucky, Missouri, Arkansas, Pennsylvania, New York, Tennessee, West Virginia | 2B | 3B |
| ***AIR Total Onshore Estimate (10/21)*** | | | ***10B*** | ***15B*** |
| ***PCS Estimate (12/5)*** | | | ***10.7B*** | |

## CONCLUSION

Catastrophe modelers will undoubtedly further investigate the meteorological sequence of events that led to losses in the U.S. Midwest. However, Ike's large losses were driven not by this rare set of circumstances. Rather, they were driven by the storm's considerable size at landfall and the large—and ever-growing—concentrations of property value in the impact zone. The AIR U.S. Hurricane Model performed well both from a hazard and vulnerability perspective in capturing the effects of this storm—as it has done consistently throughout hurricane seasons since the model's introduction, including the extraordinary seasons of 2004 and 2005. Hurricane Ike's large loss does not—and should not—change AIR's thinking about hurricane risk.

Undoubtedly, AIR meteorologists and wind engineers will learn from Ike and from the analyses of detailed claims data and post-disaster survey findings that are already underway. However, there was nothing about this storm that should lead a catastrophe modeler to radically update its model.

1 HTTP://WWW.BEAUMONTENTERPRISE.COM

2 WHEN THE NHC RELEASES ITS "TROPICAL CYCLONE REPORT " FOR IKE, IT MAY REVISIT IKE'S TRACK AND INTENSITY LIFE CYCLE IN THE MIDWEST. THEIR FINDINGS WILL EVENTUALLY MAKE THEIR WAY INTO THE OFFICIAL HURRICANE DATABASE, HURDAT, AND ULTIMATELY INTO THE AIR U.S. HURRICANE MODEL'S HISTORICAL CATALOG. IT IS POSSIBLE THAT THE NHC WILL RE-CLASSIFY EVENTS IN THE MIDWEST AS A TRANSITIONING HURRICANE IKE.

3 AIR HAS ALSO ESTIMATED TOTAL INSURED LOSSES TO OFFSHORE ASSETS IN THE GULF OF MEXICO AT BETWEEN $1 BILLION AND $2 BILLION.

## ABOUT AIR WORLDWIDE CORPORATION

AIR Worldwide Corporation (AIR) is the scientific leader and most respected provider of risk modeling software and consulting services. AIR founded the catastrophe modeling industry in 1987 and today models the risk from natural catastrophes and terrorism in more than 50 countries. More than 400 insurance, reinsurance, financial, corporate and government clients rely on AIR software and services for catastrophe risk management, insurance-linked securities, site-specific seismic engineering analysis, and property replacement cost valuation. AIR is a member of the ISO family of companies and is headquartered in Boston with additional offices in North America, Europe and Asia. For more information, please visit www. air-worldwide.com.