

showed almost no such correlation between air temperature and the pace of runoff.

The finding is especially salient considering that changes in climate patterns and land use have created dustier conditions in the Southwest and specifically in the Colorado Rockies. Past research involving lake sediments has revealed that an average of 5–7 times more dust is currently falling on Rocky Mountain snowpack compared to before the Industrial Age.

The University of Utah's McKenzie Skiles, a coauthor of the new study, notes that "surface darkening has been observed in mountain ranges all over the world, including the Alps and the Himalaya," so the findings are applicable to other regions besides the Colorado River basin. And because the dark layer of dust that covers snow has a lower albedo, causing it to absorb more solar radiation than bright white snow does, the study has important implications for weather and climate research. [SOURCE: NASA]

USING JET STREAM PATTERNS TO PREDICT HAILSTORMS

Hail is the most costly characteristic of thunderstorms, causing billions of dollars of damage in the United States, particularly to crops and buildings. But forecasting hail is problematic, as there is no obvious difference between storms that produce hail and those that don't. A new study has found a connection between the jet stream and hail frequency that could lead to weeks of advance warning of hailstorms during peak storm seasons. The study was published in *Geophysical Research Letters*.

Victor Gensini of Northern Illinois University and John Allen of Central Michigan University culled hail data from U.S. storm records for the years 1979–2016 and compared it to the global wind oscillation (GWO) index, a compilation of weather and climate information that measures atmospheric angular momentum to determine the waviness of the jet stream. Focusing on the jet stream over the Pacific Ocean, they discovered that out of the GWO's eight distinct phases,

four were reliable indicators of enhanced hail activity during peak storm seasons (spring and fall) in the United States.

"In simple terms, when the jet stream is really wavy, the likelihood of experiencing hail greatly increases," Gensini explains.

The method was found to be less effective for summer months, when small-scale meteorological processes typically have a greater influence over local weather.

The study builds upon past research by Gensini that has shown promise in predicting tornado activity 2–3 weeks in advance, and he notes that there is "a high degree of correlation between environments that produce hail and tornadoes," even though not all storms produce both.

"We're starting to demonstrate more clearly a pathway to increase the lead time for severe weather forecasts, now with both hailstorms and tornadoes," Gensini says. "We keep adding cinderblocks to the methodology, and it's slowly becoming robust." [SOURCE: Northern Illinois University]

CONFERENCE NOTEBOOK

QUANTIFYING STORM SURGE FORECASTS FOR EMERGENCY DECISION-MAKING DURING IRMA

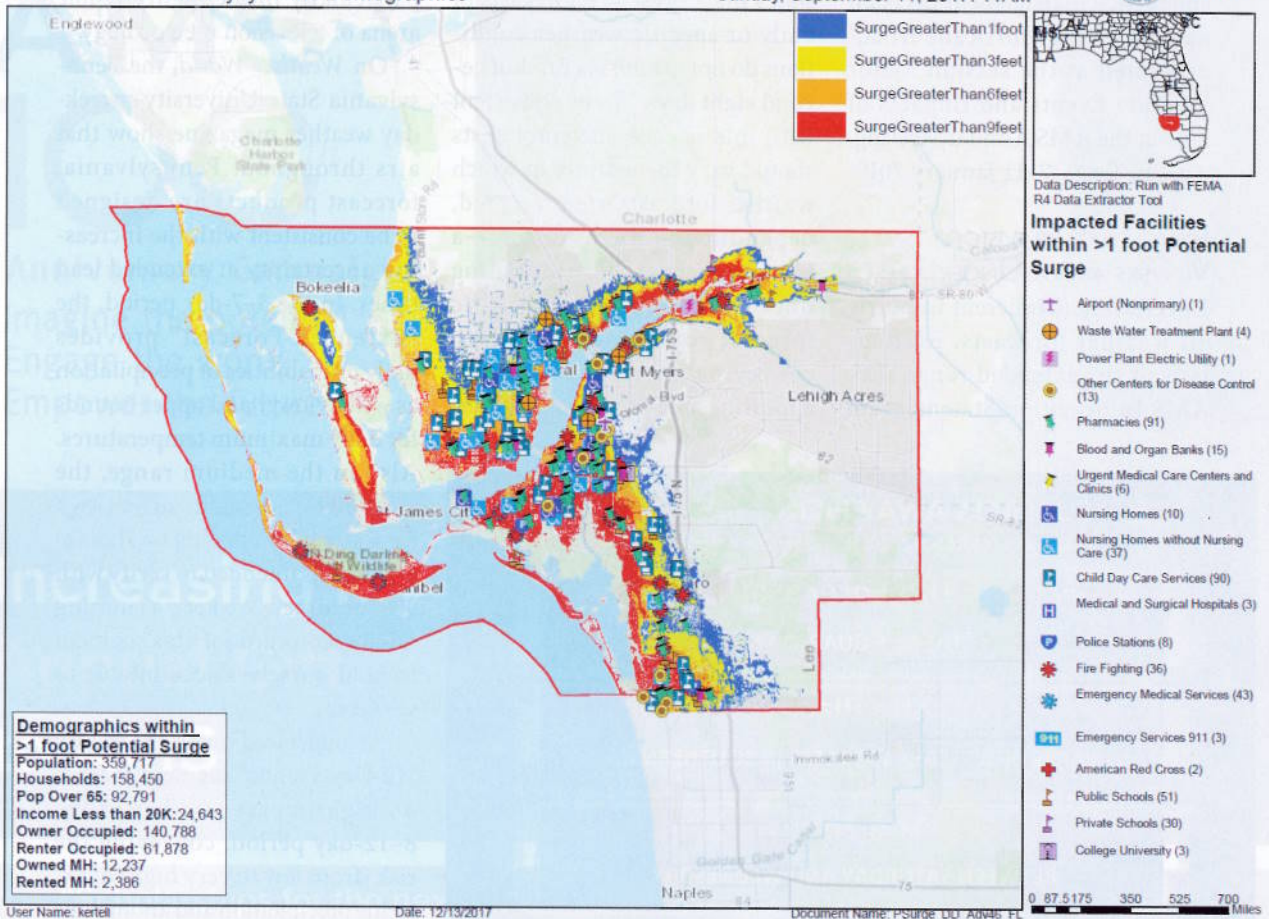
Emergency managers at all levels face the task of preparing for a multitude of hazards their respective communities may experience with a landfalling hurricane. There are many "tried and true" methods to plan for this eventuality in the United States. One of the first steps is understanding and planning for the four main hazards (storm surge, wind,

flooding, and tornadoes) as they specifically relate to the localized infrastructure, vulnerability, and risk in their community. The most variable, and potentially deadly, of these is the storm surge. It is well known, and observed, that vulnerability to this hazard is extremely high in some communities, with great potential for loss of life and property. For these reasons, the storm surge is the primary planning factor for many emergency managers, and quantifying it is essential to decision-making.

One of the better-known methods for understanding the vulnerability of a community to a storm surge is NOAA's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model. Through this model, thousands of community-specific hurricane scenarios, a maximum of maximums (MOMs), have been set for all hurricane intensities (from a tropical storm to a Saffir–Simpson category 5 hurricane). This is used as the basis or starting point for assessing a community's vulnerability and

Hurricane Irma- Lee County, FL Infrastructure and Daysymmetric Demographics

NHC Potential Surge Advisory 46
Sunday, September 11, 2017: 11AM



Hurricane Irma: imminent storm surge. Facilities threatened with at least 1 ft of potential storm surge.

exposure to storm surges from hurricanes. Once there is a hurricane, and a forecast track is issued with more confidence, we can leverage the uncertainty in possible tracks to further break down this “maximum” into similar landfall directions, forward speeds, and tidal levels to create a catalog of the maximum envelope of water (MEOW). These MEOWs can help narrow down the extent of flooding based more on a specific landfall scenario, although every storm is inherently different.

When a hurricane threat is imminent and confidence increases in the forecast, the National Hurricane Center (NHC) issues

products for a storm surge based on the specific storm characteristics. The corresponding product is an exceedance potential (10%) that is based on a probabilistic scheme. This product is issued with every new forecast cycle for areas in a storm surge watch or warning, so as the forecast changes and the storm gets closer (higher confidence) the surge exceedance changes.

Given these powerful storm surge products, emergency managers now have great data at their disposal to analyze their community’s vulnerability.

Using geospatial information science, FEMA Region IV during

Hurricane Irma was able to not only assess a community’s risk to storm surge but also provide leadership with the critical numbers they needed to make decisions about important prelandfall declarations to aid the states at risk with their response efforts. The key was to use the right data at the right time for correct decision-making. This process ensured that the analysis was actually providing emergency managers with a clearer picture of what their communities faced and was a crucial component of decisions when Hurricane Irma threatened.—KATHERINE ERTELL (FEMA), B. BOLINSKI, AND R. MOULTON, “Quantifying

dynamic storm surge forecasts for emergency management decision makers during Hurricane Irma,” presented at the session Major Weather Events and Impacts of 2017 at the AMS Annual Meeting, Austin, Texas, 7–11 January 2018.

EDUCATING TELEVISION VIEWERS ABOUT UNCERTAINTY
 Uncertainty is inherent in nearly all weather forecasts, particularly at the extended range. The AMS Information Statement on

Weather Analysis and Forecasting states that “Presently, forecasts of daily or specific weather conditions do not exhibit useful skill beyond eight days.” To be consistent with this science, meteorologists should vary the manner in which weather forecasts are presented, depending on the lead time—a failure to acknowledge increasing uncertainty implies unrealistic forecast confidence. However, conveying uncertainty without appearing indecisive or ambiguous

remains a significant challenge, particularly in the highly visible arena of television meteorology.

On *Weather World*, the Pennsylvania State University’s week-day weather magazine show that airs throughout Pennsylvania, forecast products are designed to be consistent with the increasing uncertainty at extended lead times. In the 3–7-day period, the “Extended Forecast” provides daily probabilities of precipitation as well as lower and upper bounds for daily maximum temperatures. Also in the medium range, the “SureBets” segment offers two forecasts of interesting or anomalous events intended to verify with 90% accuracy. We keep a running on-air scorecard for this segment to hold ourselves accountable to viewers.

At longer lead times, the weekly “12-Day Trends” segment focuses on high-impact weather in the 8–12-day period, conveying the risk (from low to very high) of extreme precipitation and anomalous warmth and chill. The monthly “Climate Watch” segment peers 4–5 weeks out, attempting to identify the temperature or precipitation trend expected to dominate the period. Finally, “Longshots” segment uses analog forecasting techniques to predict anomalies in the 3–6-month range, for example, a snowier-than-average December or a hotter-than-average June). A running scorecard is also kept for both the Climate Watch and the Longshots segments.

The general increase of forecast uncertainty with lead time necessitates that weather predictions be presented in varying formats. Through its variety of forecast products—many verified on-air—Weather World attempts to educate its viewers on the scientific



SureBets. These medium-range forecasts focus on anomalous events and are worded to be easily verified.



12-day trends. A checkerboard approach conveys the risk of high-impact events farther into the future.

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Kipp & Zone

limits of predictability.—JON M. NESE (PENN STATE), “Educating television viewers about uncertainty,” presented at the 27th Symposium on Education, Austin, Texas, 7–11 January 2018.

NWS KEY WEST OPERATIONS, DECISION SUPPORT BEFORE, DURING, AND AFTER HURRICANE IRMA

The combination of staff training and preparation with core partners, technical upgrades, and streamlining of tropical operations at the National Weather Service (NWS) Weather Forecast Office (WFO) in Key West, Florida, in the months leading up to Hurricane Irma, along with an “all hands on deck” approach with desk staffing and delegation of duties, resulted in seamless operations, consistent messaging, and critical support to key decision-makers for Hurricane Irma’s impact on the Florida Keys.

The uniqueness of the WFO’s Saffir–Simpson Category 5 hurricane-hardened facility enabled



NWS Key West. The WFO in the Florida Keys after Hurricane Irma.

forecasters to remain on duty through the storm and in the days following it. The facility includes a safe room tested to withstand wind gusts of 250 mph and includes an elevated floor base to keep the facility well above storm surge flooding. The team of 17 worked long hours and remained sheltered

on site for up to 5 days following the storm. They performed exceptionally, enduring the challenges of working a stressful event while their families were evacuated and their properties were damaged by the storm.

In the months prior to Irma, meteorologists at the WFO in Key West participated in a number of exercises that helped prepare the team for the intense operations of the event. In April 2017, they simulated a major hurricane impacting the Keys, an activity that included core partner participation. In May and June 2017, several tropical workshops were held to train office staff on changes to the NWS tropical program. The office staff also took lessons learned from Hurricane Matthew the year before and spent a considerable amount of time streamlining operational instructions and technical scripts prior to Irma. Other examples include a media training course that involved emergency management and the office’s first ever Integrated Warning Team workshop.

For Hurricane Irma, it was

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EXTREME WIND WARNING

ASSOCIATED WITH THE EYEWALL OF HURRICANE IRMA

FREQUENT DESTRUCTIVE WIND GUSTS TO AROUND 115 MPH WILL SPREAD ACROSS THE LOWER FLORIDA KEYS

SWATHS OF TORNADO-LIKE DAMAGE

WARNING IN EFFECT THROUGH 9:15 AM

LOCATIONS IMPACTED: ALL THE LOWER KEYS

- KEY WEST
- STOCK ISLAND
- BOCA CHICA
- BIG COPPITT KEY
- SUGAR LOAF KEY
- UPPER SUGAR KEY
- CUDJOE KEY
- SUMMERLAND KEY
- BIG TORCH KEY
- RAMROD KEY
- LITTLE TORCH KEY
- BIG PINE KEY
- NO NAME KEY
- BAHIA HONDA KEY

Florida Keys
WEATHER FORECAST OFFICE

www.weather.gov/key

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September 10,
2017

US National Weather Service Key West, Florida
Updated September 10

HEADS UP LOWER KEYS
EXTREME WIND WARNING IN EFFECT
SWATHS OF TORNADO-LIKE DAMAGE LIKELY

#Irma #LowerKeys

Like Comment Share

100 Retweets 100 Comments

View 10 more comments

Navin Karamia I assume power is out in the keys? Everything has gone silent and dark - no cars or lights to be found. Stay safe!
Like Reply September 10 at 5:28am

Shelly Be Arv update on the keys?
Like Reply September 10 at 5:27am

Andria Aquino Breaux Aquino
Like Reply September 10 at 5:26am

Lobby Nelson this safe everyone?
Like Reply September 10 at 5:25am

Maria Leticia Lopez Praying for your safety from Mexico!
Like Reply September 10 at 5:25am - Edited

Shirley Oshum Baskin Hope God bless the keys!
Like Reply September 10 at 5:25am

WFO's content

Intense winds imminent. An extreme wind warning heralds the arrival of Irma's eyewall and most powerful winds.

an “all hands on deck” approach to operations. A total of seven operational desks were staffed, with clear roles defined for each desk. This included one desk fully dedicated to coordination and another one or two dedicated to social media. The coordination desk aided in a strong, consistent, and well-coordinated message to the office’s partners. The team issued its first partner briefing on 1 September, 9 days before the eyewall struck. The overall message wavered little from day 1. The warning coordination meteorologist was deployed on site with Monroe County emergency management beginning a few days prior to the impact of the storm and aided in the county’s key decisions like evacuations and relocating the emergency operations center (EOC). The office maintained operations as the eyewall approached and issued a rare extreme wind warning for winds in excess of 115 mph.

Social media greatly magnified the message. A single tweet issued from the office on 8 September reached an audience of 13.2 million people. The office is now ranked fourth among all 122 NWS offices in terms of the number of Twitter followers.

Meteorologists participated in critical media interviews with radio stations in the Keys and with several national and international networks. Following the storm, WFO Key West remained a critical hub for decision support activities.

Please RT. #Irma
pic.twitter.com/VWLMEDWoUs

Latitude 22.1 North
Longitude 76.5 West

LOCATION

330 miles ESE of Key Largo, FL
300 miles ESE of Key West, FL

MOVEMENT

To the west at 12 mph

MAXIMUM SUSTAINED WINDS

155 mph with higher gusts

PRESSURE

925 mb or 27.32"

Hurricane and Storm Surge Warnings are in effect for the Florida Keys

Catastrophic life-threatening wind and storm surge impacts expected in the Florida Keys Saturday night and Sunday. Nowhere in the Florida Keys will be safe!

Hurricane Irma
Formed September 05, 2017
11 PM EDT Advisory 26
Public National Hurricane Center

Current information: 11
Center location: 22.1 N 76.5 W
Maximum sustained wind: 155 mph
Movement: W at 12 mph

Forecast positions:
12 PM EDT: 22.1 N 76.5 W
3 PM EDT: 22.1 N 76.5 W
6 PM EDT: 22.1 N 76.5 W
9 PM EDT: 22.1 N 76.5 W
12 AM EDT: 22.1 N 76.5 W

← 1646 ↻ 68174 ❤️ 45776

Top tweet. This tweet reached more than 13 million followers.

The office had three phone lines that never went down in the storm. Key West City Hall is located across the street and in the days after Hurricane Irma federal, state, and local officials (including both the mayor and city manager of Key West) came over to the office several times a day to get weather updates and participate in county coordination meetings and conference calls to make critical decisions. This face-to-face collaboration was critical to support core partner decisions such as when to reopen the Keys to residents, when to open the airports, power and water restoration, and determining the hardest-hit areas where most resources needed to be focused. Management at WFO Key West stayed in close contact with both regional and national headquarters in the NWS to keep leadership updated on the



Emergency operations. In addition to weather service operations, WFO Key West also became the command center for Monroe County emergency management.

office status and to coordinate the arrival of supplies and facility repairs following the storm.—MATTHEW J. MORELAND (NWS), “NWS Key West operations and decision support before, during,

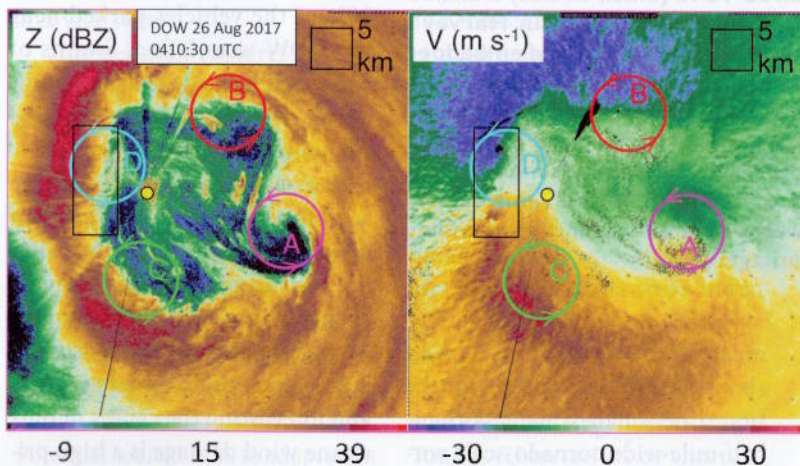
and after Hurricane Irma’s impact on the Florida Keys,” presented at the session Major Weather Events and Impacts of 2017 at the AMS Annual Meeting, Austin, Texas, 7–11 January 2018.

PAPERS OF NOTE

THE ROLE OF SMALL-SCALE VORTICES IN ENHANCING SURFACE WINDS AND DAMAGE IN HURRICANE HARVEY

Intense landfalling hurricanes cause severe, but highly variable, wind damage to homes and the community infrastructure. Some buildings are destroyed while others nearby may survive relatively unscathed. It has been speculated, but never before proven, that damage variability is caused by tornadoes or other small-scale phenomena.

A Doppler on Wheels (DOW) mobile radar and several anemometers were deployed at the Texas coast near the point of landfall of Hurricane Harvey in late August 2017. DOW data revealed and tracked several persistent eyewall



Eyewall mesovortices. Finescale DOW radar imagery collected from inside the eyewall of Hurricane Harvey: (left) radar reflectivity and (right) Doppler velocity. The ring of convection comprising the eyewall is highly perturbed by four MVs (labeled A–D). From inside the eye, the wind perturbations caused by the MVs are especially visible. The yellow dot is the DOW location. The black rectangle is a zoomed-in area shown in the figure on the next page to illustrate tornado-scale vortices.