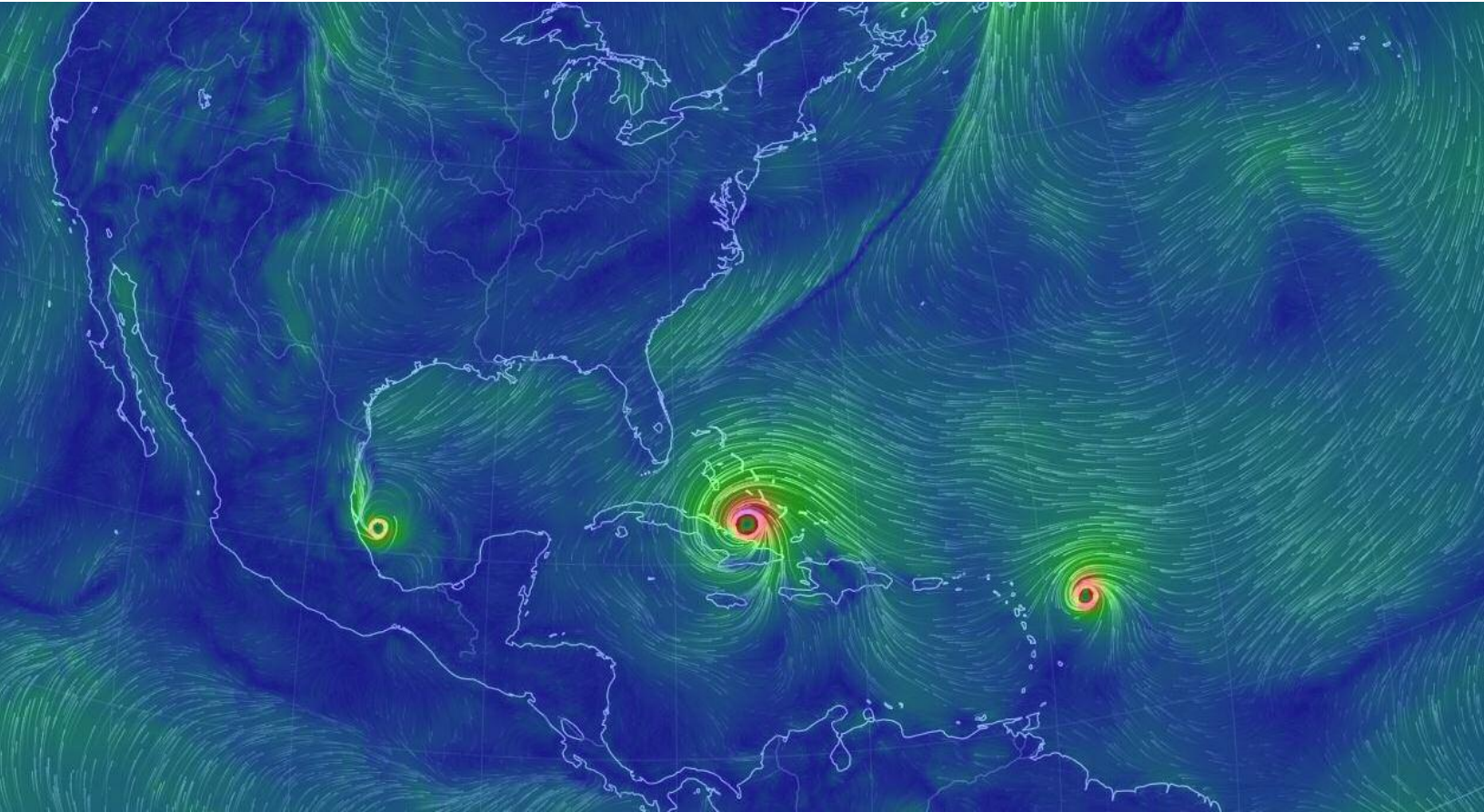


# *Risk Prediction Initiative*

2017 Annual Report



## RPI Member Companies



with additional support from



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Cover image: Model simulation of surface wind in the tropical Atlantic on September 8, 2017. Hurricanes Katia, Irma, and Jose can each be seen approaching land. Source: <https://earth.nullschool.net/>

# RPI 2017 Year in Summary

For over 20 years, the Risk Prediction Initiative (RPI) has helped our Member companies and partner organizations to develop greater insight into the range of possibilities associated with natural disasters. RPI research deliverables assist organizations in the testing, adjustment and calibration of catastrophe models. Desire within industry to assess uncertainties inherent in the quantification of risk is aligned with increasing academic interest in establishing the impact of natural extreme events. At the very heart of RPI's mission is the link between the science community's advancement of knowledge and the industry's need for applications and data.

In 2017, through our academic network, RPI developed more research on wide ranging topics, from tornadoes in Europe to the need for improved analysis of tropical cyclones globally, to the effect of sea level rise on US coastally-exposed housing and populations. We further facilitated academic-industry meetings on hurricane variability, to assess the difference in model outputs of hurricane landfall probabilities.

Included in our deliverables this year were 23 internal reports, 12 data/mapping deliverable packets and 7 publications accepted in peer-reviewed scientific journals. Reports were also compiled for all the major events we participated in.

In terms of locally-based education and outreach, RPI facilitated local events in support of disaster risk reduction and climate change awareness; advised the Bermuda Government and other stakeholders on localized flooding events; mentored an undergraduate student in the basics of hurricane meteorology; and gave talks to community organizations and schools.

Through the generous support of our Member companies, sponsors and collaborative partners, we have once again generated societally beneficial outputs and successfully delivered decision-making tools and data to our partners. We look forward to a productive and busy 2018!



Abnormal high tides in Bermuda during October and November saw water levels over the dock at BIOS. For more, see page 9.

# RPI Research

## Hurricanes



Satellite image of Hurricane Irma on September 8, 2017, near the north coast of Cuba, Source: GOES, NASA

The work of RPI continues to focus heavily on the uncertainties surrounding Atlantic hurricanes. While more is now understood about hurricanes than when RPI was first established, the variability of frequency and intensity of these extreme events remain active areas of ongoing scientific enquiry.

Natural catastrophe industry losses in 2017 were dominated by the Atlantic hurricane season, with Hurricanes Harvey, Irma and Maria wreaking havoc in the US and Caribbean. Amongst risk transfer practitioners, there was much focus on the end of the 'hurricane drought', with this year heralding the first hurricane landfall in Florida since 2005, and the first major (Category 3 or greater) hurricane impact anywhere on the US coast.

Hurricane research supported by RPI in 2017 focused primarily on variability, but also facilitated burgeoning conversations in academia about the benefits of model inter-comparisons and a more cohesive approach to re-analyzing past tropical cyclone activity on a global scale.

Prof. Kevin Walsh and Dr. Sally Lavender of the University of Melbourne worked on the question, "How unusual was the 2005 hurricane season in the Atlantic?". They performed a numerical analysis using multiple climate models to determine whether the conditions that lead to record numbers of Atlantic hurricanes in 2005 were particularly unusual.

Prof. Bob Hart of Florida State University completed his examination of the U.S. hurricane landfall probability, focused on formation location,

steering, and interaction between tropical and extratropical cyclones. This final reporting was the culmination of 2 years' of work that resulted in a highly publicized paper in 2016 on the *Arbitrary Definition of the Major US Hurricane Drought*.

In May 2017, RPI supported a workshop on *Global Tropical Cyclone Reanalysis*, under the leadership of Prof. Kerry Emanuel of the Massachusetts Institute of Technology (MIT). The workshop sought to explore the benefits of applying modern techniques uniformly to develop a more 'robust' storm record globally, with consistency across different tropical cyclone basins. Proceedings of that workshop have since been published in the *Bulletin of the American Meteorological Society*.

In September 2017, RPI was pleased to support the first workshop of the Tropical Cyclone Hazard Model Intercomparison project, established by Columbia University and insurance industry partners. Further developments under this project are expected to be reported at 2018 industry and scientific meetings.



RPI was well represented by researchers at the 6th International Summit on Hurricanes and Climate Change in Crete in June 2017, during which Program Manager Mark Guishard also presented. RPI has been a long-time supporter of this effort to bring together experts to discuss the relationship between climate trends and any changes in tropical cyclone activity.



Multiple states and agencies nationwide were called to assist citizens impacted by the epic amount of rainfall in Texas and Louisiana from Hurricane Harvey. (U.S. Air National Guard photo by Staff Sgt. Daniel J. Martinez)

# RPI Research

## Severe Convective Storms

In 2017, RPI scientists completed and published work on severe convective storms, focused primarily on tornadoes and hail, in the US and Europe. Prof. James Elsner of Florida State University, an RPI collaborator for over a decade, completed statistical modeling work focused on seasonal variability of US Midwest tornadoes. As per his usual insightful approach, he developed and provided model code that can be used by catastrophe analysts in the development of their own view of tornado risk. His research developed a better understanding of the shifts in US tornado activity during different climate regimes (e.g. El Niño), and also helped to elucidate the expected frequency of tornadoes over long time-frames.

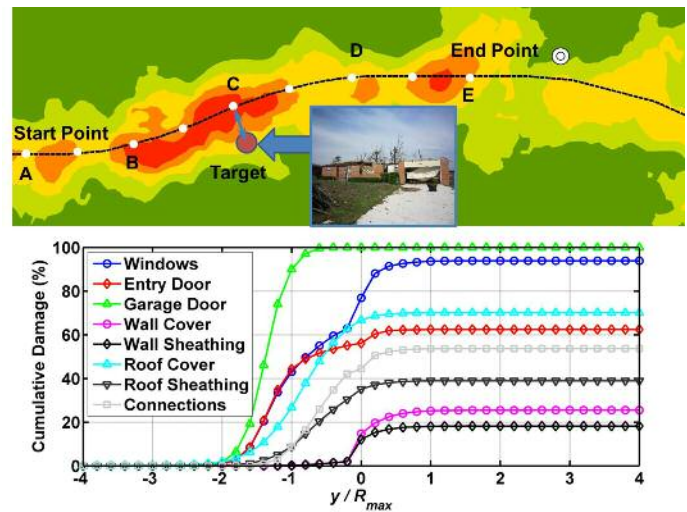
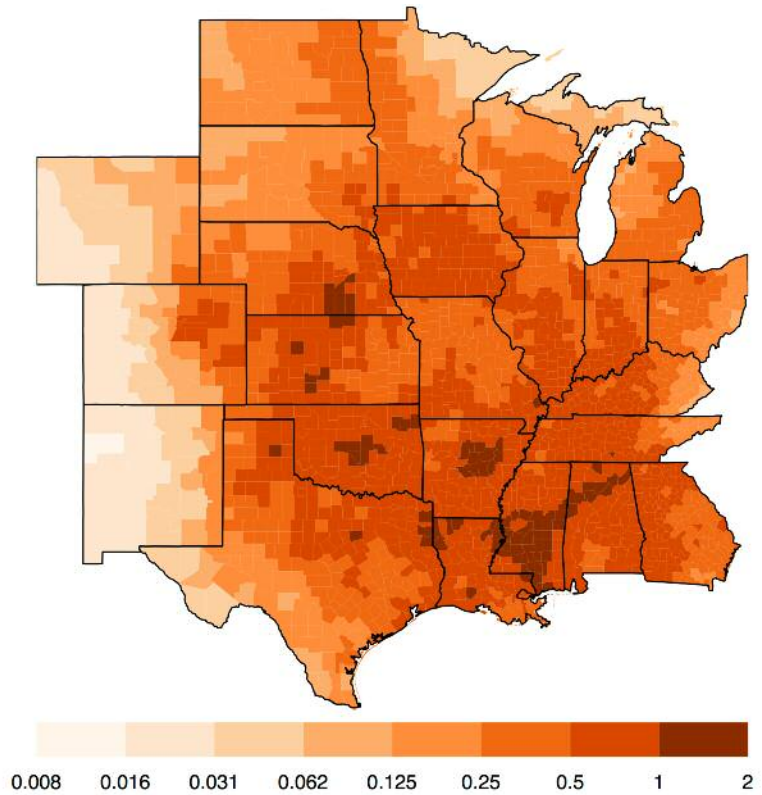


Dr. David Prevatt, of the University of Florida, completed his project on the development of an engineering model of tornado damage, calibrated using on-the-ground surveys and analyses of thousands of damaged properties. This project is a good example of RPI research that examined not only the meteorological hazard, but its impact, in this case via residential property damage. The damage model code and detailed case study surveys were delivered to RPI Member companies via a series of quarterly reports.

Dr. Brian Tang, of State University of New York, Albany, delivered catalogues of the costliest 50 hailstorms since 1995 to better evaluate historical and potential risk due to hailstorm intensity. He then analyzed trends and variability in the frequency of environments supportive of extreme hail losses to assess the meteorological fingerprint on changing and emerging hail risk. In 2017, Dr. Tang developed and delivered datasets containing over 30 years' worth of US hail events including hail kinetic energy, maximum expected size of hail, and storm reports for each catalogued event.

Prof. David Schultz and Dr. Bogdan Antonescu of the University of Manchester in the UK continued to capitalize on RPI-supported work conducted in 2016 by publishing several papers on tornadoes in Europe and even released a coffee table book to highlight the often underestimated risk of this surprisingly frequent phenomenon.

Long term view of tornado risk from RPI-supported analyses by Prof. James Elsner and colleagues. Graphic, Expected annual tornado (EF1+) occurrence rate [per 100 km square region] from Elsner et al., 2016.



(Left) Researcher Dr. David Prevatt conducts a damage survey of a house impacted by a tornado. (Right) preliminary damage functions from hundreds of surveys along a tornado path. Source: David Prevatt.

# RPI Research

## Floods and Climate Change



Flooding in Texas following Hurricane Harvey. Source: NOAA

Damage from Hurricane Harvey's rainfall-induced flooding highlighted implications for the adequacy of the federal National Flood Insurance Program in the US, and devastation in the Caribbean from Hurricanes Irma and Maria revealed the protection gap for under-insured jurisdictions. Harvey's impact has been described in industry press as a new benchmark for flood simulation. RPI has begun to shift more attention to the growing problem of flood, with efforts afoot to develop more research relevant to risk from riverine flooding, extreme rainfall and coastal inundation, each treated equally as 'flood' in risk modeling and underwriting contexts.

A timely piece of work was undertaken in 2017, on the blocking of large scale weather systems

and the resultant propensity for large amount of localized rainfall, by Dr. Shawn Milrad of Embry-Riddle Aeronautical University, along with collaborators Dr. Eyad Atallah and Prof. John Gyakum of McGill University (Canada). This project developed a metric for determining the climate patterns associated with extreme flooding events in the Northern Hemisphere. An additional benefit of this work is that it may be also used to determine the likelihood of other climate extremes associated with 'blocking', such as droughts or favored hurricane pathways.

As a result of previously supported work, Drs. Ben Strauss and Scott Kulp of Climate Central published work in 2017 on "Rapid Escalation of Coastal Flood Exposure in US Municipalities



# Bermuda Risk

from Sea Level Rise". This work developed a large dataset of US coastal populations and housing stock within range of coastal flooding, dating back to 1940, and projected out to 2050.

In 2016, RPI personnel supervised intern Michael Johnston, with his research focus being rainfall extremes in Bermuda. This dovetailed nicely with our Bermuda Risk project, and under collaboration with the Bermuda Weather Service and another former student currently at the Spanish Meteorological Agency (AEMET), we had a peer-reviewed paper accepted in the monthly magazine of the Royal Meteorological Society. The study centered on recent localized flooding events in Bermuda, and an examination of the daily rainfall record to determine trends and variability of rainfall accumulations. The flood catalogue events were related to daily rainfall amounts to develop a threshold for flood events.

In response to industry interest, we have stepped up the profile of flood risk in our engagement with scientists this year, and as a result have received increased interest from collaborators. We envisage a higher number of flood-related projects in 2018.

It is worth noting that more of RPI's publications have been devoted to climate change as an influence on extreme weather and coastal risk, which also reflects the growing interest in the industry. In Bermuda, RPI is at a focal point of the conversation on local impacts of climate change, through our Bermuda Risk project.



As part of our Bermuda Risk project, RPI liaised with Bermuda's Emergency Measures Organization to brief them on a prolonged coastal flooding event associated with a oceanographic feature, and highlighted that, while the feature was transient, it provided insight into the future of flood risk in Bermuda under sea level rise projections.



Flooding in St. George's Bermuda (photo by Ralph Richardson) and (above) contour plot of sea level rise in St. George's. Credit Locus Ltd.

# Events and Education in 2017

As usual, we coordinated in-house science meetings and seminars for Member companies, this year in London, Zurich, Illinois and Bermuda, with many interim meetings to discuss the results of recent research, and provide insights into events as they evolved this year.

In September 2017, RPI was pleased to support the first workshop of the Tropical Cyclone Hazard Model Intercomparison project, established by Columbia University and insurance industry partners.

We were also well-represented at industry and academic meetings, such as the ILS Bermuda Convergence 2017 meeting and the 6th International Summit on Hurricanes and Climate Change. We dovetailed existing travel to more cost-effectively visit with some Member companies, as well as continue to maintain our visibility in the reinsurance marketplace.

## Industry meetings

- Artemis ILS NYC 2017, New York, February 2017
- Impact Forecasting Revealed, London and Zurich, June and July 2017
- GFDL/DFID/UCL/XL Catlin Workshop on Providing Open Access Data, London, August 2017
- ILS Bermuda Convergence 2017, Bermuda, October 2017

## Academic meetings, workshops & seminars

- 6th International Summit on Hurricanes and Climate Change, Crete, June 2017
- Tropical Cyclone Reanalysis Workshop, Asheville, North Carolina, May 2017
- NASA TROPICS Applications Workshop, Miami, May 2017
- Tropical Cyclone Hazard Model Intercomparison Project Workshop, New York, September 2017
- Workshop on Atlantic Climate Variability, Dynamics, Prediction and Hurricane Risk, New York, September 2017

In Fall of 2017, RPI Program Manager Dr. Mark Guishard supervised a National Science Foundation Research Experiences for Undergraduates (REU) intern. Aamna Jangda, from Houston Community College learned firsthand some of the techniques used in meteorology, such as launching weather balloons and analyzing the returned data. Jangda further applied the measurements she collected to an assessment of storm intensity using numerical models and ocean data from other BIOS-based programs.



## Public Outreach, Education, and Events

- Earthquake Insights Field Trip (supported), U.S. April 2017
- National Science Foundation Research Experience for Undergraduates Mentorship, BIOS, September-November 2017
- Probus, Bermuda, October 2017
- Warwick Academy, Bermuda, October 2017
- Lifelong Learning Centre, Bermuda, October 2017
- ThinkFest Lecture "Should Bermuda Care about Climate Change?", Bermuda, November 2017
- Appalachian State University, Risk Management and Insurance Course – Lecture on Reinsurance, Risk and Catastrophe Modelling, BIOS, May 2017
- Oceans and Human Health Course for Furman University – Lecture on Marine Disasters, BIOS, May 2017
- RSMAS University of Miami – Lectures to Masters of Professional Science, Hurricane Research, Risk and Reinsurance, Florida, March 2017

# Program Management and Expertise

The RPI team members have backgrounds in meteorology, geologic risk, catastrophe modelling, marine science, and experience in research, education, policy, communications and management. RPI is ideally suited to source, design and manage scientific research for addressing industry questions on catastrophe risk.

**Dr. Mark Guishard FRMetS, CMet**, BIOS Director of Corporate and Community Relations at BIOS, responsible for the strategic development of the Risk Prediction Initiative.

**Dr. John Wardman FGS**, Science Program Coordinator and point of contact for geologic hazards and geographical information systems.

**Charles King, M.Aq.**, Research Specialist; focusing on web communications and data management.

## Response to a Soft Market

In recent years there has been a renewed focus on cost in the (re)insurance industry in light of disruptive technology, widening non-catastrophe risk markets (e.g. cyber risk), and increasing alternative capital being injected into the risk transfer market via Insurance Linked Securities (ILS). These developments have all evolved during a period of low premiums due to the relative lack of US hurricane impacts.

At RPI, we have responded to these tightening constraints by bringing down the cost of research over the last 5 years, while fostering the increased relevance of our researchers' projects to better meet the needs of industry. Through these efforts, we are proud to have been able to maintain a consistent fee structure for our Member companies, while continuing to deliver societally-relevant research outputs, dataset ap-

plications and peer-reviewed publications in the academic literature.

In 2017, RPI staff also undertook some professional development; Science Program Coordinator Dr. John Wardman was able to spend some time in London, on a 2-month secondment to an RPI member insurance company. John gained insights into the reinsurance marketplace, vendor model efforts and networked with industry practitioners during his time in London. Furthermore, Program Manager Dr. Mark Guishard successfully completed work towards a professional designation, and was accredited as a Chartered Meteorologist by the Royal Meteorological Society.

These initiatives have all positioned RPI to be even more effective in connecting science and industry 2018.

# Membership Levels and Benefits

Member companies of the Risk Prediction Initiative participate in the selection, direction & guidance of research, and gain exclusive access to annual Research Updates, all RPI workshops & seminars, plus in-house events. All past and ongoing research deliverables are available through Member engagement.

- **RPI Bronze Membership - \$65K/year**  
The basic subscription includes Member-only access to current and past research projects and reports, one in-house presentation, data/modelling deliverables, and your corporate logo displayed prominently on the RPI website. These services are also included in Silver and Gold membership.
- **RPI Silver Membership - \$85K/year**  
The Silver Membership facilitates more access to the researchers, with a view to developing more targeted and specific research deliverables and reports. There are two additional in-house events, one of which includes attendance by an independent scientist.
- **RPI Gold Membership - \$125K/year**  
This Membership level includes support for a student, or an internship in a relevant topic. In addition, quarterly visits to your company will be made, two of which include attendance by an independent scientist.

There are also opportunities to sponsor RPI's activities beyond the constraints of Membership. Investor education opportunities and access to selected data output from published work are made available to sponsors. Recognition of sponsors via their logos displayed on our website highlight the contribution to the scientific understanding of natural hazards.

If you are interested in Membership or Sponsorship of RPI, please get in touch directly at [rpimail@bios.edu](mailto:rpimail@bios.edu).

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# Publications

Antonescu, B., D.M. Schultz, A. Holzer, and P. Groenemeijer, 2017: *Tornadoes in Europe: An Underestimated Threat*. *Bull. Amer. Meteor. Soc.*, 98, 713–728, <https://doi.org/10.1175/BAMS-D-16-0171.1>

Antonescu - *Tornadoes and Waterspouts in Europe - Depictions from 1555 to 1910*, Claire Ricketts (editor), © 2017, Bogdan Antonescu and David M. Schultz

Elsner JB, Jagger TH, Fricker T, *Statistical Models for Tornado Climatology: Long and Short-Term Views*. *PLoS ONE* 11(11), e0166895. doi:10.1371/journal.pone.0166895, Dec. 2016.

Emanuel, K., P. Caroff, S. Delgado, C. Guard, M. Guishard, C. Hennon, J. Knaff, K.R. Knapp, J. Kossin, C. Schreck, C. Velden, and J. Vigh, 2017: *Desirability and Feasibility of a Global Reanalysis of Tropical Cyclones*. *Bull. Amer. Meteor. Soc.*, 0, <https://doi.org/10.1175/BAMS-D-17-0226.1>

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Janković, V. and D.M. Schultz, 2017: *Atmosfear: Communicating the Effects of Climate Change on Extreme Weather*. *Wea. Climate Soc.*, 9, 27–37, <https://doi.org/10.1175/WCAS-D-16-0030.1>

Kulp, S. & Strauss, B.H., *Rapid Escalation of Coastal Flood Exposure in US Municipalities from Sea Level Rise*, *Climatic Change* (2017) 142: 477. <https://doi.org/10.1007/s10584-017-1963-7>



Hurricane Irma over north shore of Cuba. Source: NOAA

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