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# HWIND FIELDS IN SUPPORT OF HIGH WIND REMOTE SENSING IN TROPICAL CYCLONES

November 15, 2016 Mark Powell http://www.rms.com/perils/hwind/

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## CATASTROPHE SCIENCE – MODEL AND PERIL COVERAGE



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### WHO WE SERVE

- Insurers
- Reinsurers
- **Capital Markets**
- Brokers and Reinsurance Intermediaries
- Corporations
- Government and NGOs

More than 400 institutions trust RMS models, technology, and services to better understand and manage catastrophe risks throughout the world.

### AN INSURANCE INDUSTRY PERSPECTIVE: THE PROTECTION GAP



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Uninsured losses

- 10-year moving average (Total economic losses)

### THE DISASTER GAP

New financial instruments "insurance linked securities" are designed to use capital markets to address the gap

Risk modeling needed to price them, Hurricane data needed to model, actively trade, and sometimes even trigger payouts



# HWIND METHODOLOGY

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#### HWIND: WHAT IS IT?

A system for real-time tropical cyclone analysis





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## **OBSERVATIONAL DATA SOURCES**

- ~40 different observational data sources included in the HWind database
- On average, tens of thousands of observations for each event, depending on availability of satellites, airborne instruments, and the storm's proximity to land
- Subject to stringent independence and quality control testing





#### Satellites

#### Manned Aircraft

#### C-MAN

## NOISE REDUCTION

- Storm relative framework
  - Helps fill data voids
  - More spatial information than synoptic (all at one time)
- All wind measurements standardized
  - Common height (10 m)
  - Common averaging time (max 1 min, peak 3s gust)
  - Standard upstream fetch roughness regimes
    - Open terrain
    - Marine
- Subject to stationarity assumption



At any time an observation has a unique range and bearing from storm center

Over a time window one location can provide spatial information

#### **Storm-Relative Observation Process**



From Altug Aksoy, HRD-AOML



Over a half of a typical 4h time window for data assimilation systems ~40% of storms move > 1 RMW —> additional variance

Storm relative frameworks reduce variance



From Altug Aksoy, HRD-AOML MWR 2013



### HWIND METHODOLOGY – APPROACH AND OBJECTIVES

Goal is to estimate wind field as accurately as possible based on observations 

Screenshot of HWind platform used to import and QA observational data



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	15:50 UTC			
Track Obser	vations Inspector			
Platform C	Qty S Time Range			
AFRC	642 6 00:00 to 05:23			
ASCAT	2864 3 01:10 to 03:43			
ASOS	1702 6 00:00 to 06:00			
CMAN	5037 6 00:00 to 06:00			
CREWS_BUOY	61 6 00:00 to 06:00			
DRIFTING_B	3 4 01:00 to 05:00			
GFS00	3251 6 00:00 to 06:00			
GF503	1561 0 03:00 to 03:00			
GFS06	3037 6 00:00 to 06:00			
GF509	1477 0 03:00 to 03:00			
GPSSONDE	16 4 01:31 to 04:43			
GPSSONDE	6 3 01:39 to 04:45			
GPSSONDE	7 4 01:33 to 04:45			
GPSSONDE	8 4 01:31 to 04:43			
GPSSONDE	58 4 01:31 to 04:43			
GPSSONDE	8 4 01:33 to 04:45			
MADIS	4227 6 00:00 to 06:00			
METAR	4084 6 00:00 to 06:00			
MOORED_B	1144 6 00:00 to 06:00			
NOAA43	24 1 00:00 to 00:11			
SFMR43	8 0 00:00 to 00:03			
SFMR43_FLAG	16 1 00:04 to 00:11			
SFMR_AFRC	494 6 00:00 to 05:33			
SFMR AFRC	173 6 00:04 to 05:16			
SHIP	128 6 00:00 to 06:00			
SMN	111 6 00:00 to 06:00			
air t Pair t				
•	Height			
🗹 Wspd	🗹 Wdir			
er 06:00z	End 06:00z			
Check New Data Now				

## **REAL-TIME VS. ENHANCED ARCHIVE METHODS - SNAPSHOTS**



Window during HWind Enhanced Archive

Using data on either side of the time step informs a more accurate representation of storm structure



### **REAL-TIME VS POSTANALYSIS POSITIONS**

# Differences between real-time and post storm positions

8 km mean difference 47 Matthew snapshots





### COMPARISON TO NHC PRODUCTS



#### HWind depicts variability, trends, and changes

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### **REAL-TIME MONITORING: HURRICANE NICOLE 10-13**

Nicole was not a Cat 4!

Once intermittent data appeared SFMR peaks were higher than FL peaks and compared poorly to sondes and to ASCAT winds outside the core area





### APPLICATIONS

- Observation-based analysis of record
- Objective input to extreme wind climate
- Evaluation of model performance
- Loss model development and calibration
- Real-time impact assessment
- Response and recovery application
- Claims and Exposure applications







#### Utility and Insurance loss relationships



Figure 3. Prototype curve fit models for damage estimation as a function of wind speed.



#### Hurricane Andrew Insurance Losses\* by Zip Code

Figure 4. Dade insurance ratio of loss claim to insured value from Hurricane Andrew.



#### HWind at the National Hurricane Center



#### R2O didn't happen









## With help from



#### OCEANIC AND ATMOSPHERIC ADMINISTRATION OCEANIC AND ATMOSPHERIC RESEARCH NATIONAL ECHNOLOGY PARTNERSHIPS OFFICE

Promoting Partnership & Commercialization of NOAA Technology and Innovations

### R2B in 2014



## Acquired by RMS Oct. 2015



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# OVERVIEW OF RMS HWIND

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### **RMS HWIND: PRODUCT OVERVIEW**

#### **RMS HWind Products**

#### **Real-Time Solution**





**Enhanced Archive** 



Snapshot

#### **Post-Event Footprint**

Real-Time Views of Wind field Size and Intensity

High Resolution Wind Hazard Footprints Post-landfall **Enhanced Archive** 

Archive Library of Data from Historical Events

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# Old HWind Products that RMS Supports



#### **Legacy Archive**

Archive Library of Data from Historical Events. Created when HWind was still affiliated with NOAA

# HWIND REAL-TIME ANALYSIS

## 2016 HWIND ANALYSES

- 10 Atlantic basin
- 5 East Pacific
- 3 Central Pacific

Storm Name	Basin	# Snapshots
Bonnie	AL	3
Colin	AL	14
Danielle	AL	2
Earl	AL	9
TD8	AL	9
Hermine	AL	67
Julia	AL	14
Karl	AL	11
Matthew	AL	83
Nicole	AL	12
Darby	EP/CP	13
Javier	EP	2
Lester	EP/CP	8
Madeline	EP/CP	5
Newton	EP	2



# **REAL-TIME SOLUTION – SNAPSHOTS**

#### **Hurricane Hermine** September 2016

- 3-6 h frequency (when in aircraft recon range)
- 67 snapshots for Hermine
- 83 snapshots for Matthew
- 12 for Nicole
- 8-16 degree domain
- Continuous field
- 1 km grid
- Grid, GIS, image files
- Data coverage



Maximum 1-minute sustained surface windspeeds (kts). Valid for marine exposures over water, and open terrain exposure over land



# SAMPLE DATA COVERAGE IMAGES – HURRICANE HERMINE (2016)



#### Hurricane Hermine 0300UTC 02 Sep 2016 Data Coverage





RMS

## **REAL-TIME SOLUTION – FOOTPRINTS**

#### 78 snapshots for Matthew

- Detailed storm track
- Snapshots repositioned to revised track
- wind hazard footprint constructed 1-3 days after landfall
- 1 km grid



# HWIND LEGACY ARCHIVE

http://www.rms.com/perils/hwind/legacy-archive/

# LEGACY ARCHIVE

- Created when program was in public domain (NOAA)
- Nearly 250 storms, but stops at the conclusion of the 2013 season
- Inconsistent file formats and subject to different research assumptions/methodologies
- RMS is hosting HWind legacy archive data as a public service to the research and business community
  - http://www.rms.com/perils/hwind/legacy-archive/
  - Available to public
  - "as is" from NOAA-HRD

#### Hurricane Wilma 1430 UTC 24 OCT 2005

Valid for marine exposure over water, open terrain exposure over land Analysis based on CMAN from 1149 - 1729 z; MOORED\_BUOY from 1149 - 1729 z; ASOS from 1146 - 1726 z; QSCAT from 1149 - 1151 z; DRIFTING\_BUOY from 1200 - 1700 z; SHIP from 1212 - 1212 z: MADIS from 1145 - 1730 z; METAR from 1149 - 1730 z; FCMP\_TOWER from 1149 - 1726 z; GPSSONDE\_WL150 from 1213 - 1720 z; MESONET from 1145 - 1730 z; GOES from 1302 - 1302 z; AFRC (User-defined adjusted) from 1145 - 1729 z; 1430 z position interpolated from 1300 User; mslp =



Integrated Kinetic Energy > TS: 133 TJ > Hurricane: 35 TJ Destructive Potential Rating(0-6) Wind: 3.1 Surge/Waves: 5.2 Observed Max. Surface Wind: 99 kts, 65 nm SE of center based on 1723 z AFRC Analyzed Max. Wind: 99 kts, 62 nm SE of center

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#### Max 1-min sustained surface winds (kt)

#### Experimental research product of NOAA / AOML / Hurricane Research Division



# HWIND ENHANCED ARCHIVE

- Post season all analyses and footprints are redone with centered time windows and updated data sources
- e.g. reprocessed SFMR data from HRD using Klotz and Uhlhorn (2014) based on 4200 sonde / sfmr pairs

#### **Enhanced Archive Data**

Academic researchers interested in accessing HWIND enhanced archive data, please send an email to <u>Support@rms.com.</u>

# **19 STORMS IN VERSION 1 OF HWIND ENHANCED ARCHIVE**

Year	Storm Name	Landfall Location(s)
1992	Andrew	Homestead, FL
2004	Charley	Cayo Costa, FL
		North Myrtle Beach, SC
	Frances	Hutchinson Island, FL
		St. Marks, FL
	Ivan	Gulf Shores, AL
	Jeanne	Hutchinson Island, FL
2005	Cindy	Grand Isle, LA and Waveland, Mississippi
	Dennis	Santa Rosa Island, FL
	Katrina	Hallandale Beach, FL
		LA/MS Border
	Rita	Johnson Bayou, LA
	Wilma	Cape Romano, FL
2008	Gustav	Cocodrie, LA
	lke	Galveston Island, TX
2011	Irene	Cape Lookout, NC
		NJ/NY Border
2012	Isaac	Port Fourchon, LA
	Sandy	Brigantine, NJ
2014	Arthur	Shackleford Banks, NC
	Fay	Bermuda
	Gonzalo	Bermuda
2015	Joaquin	Bahamas

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#### Snapshots and footprints for 19 hurricanes, 16 of which made landfall in the U.S.

#### Additional data from 2014-2016 seasons

# Questions?



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