



# Microwave Probability of Eyewall Replacement Cycle (M-PERC)

## Joint Hurricane Testbed Project Update

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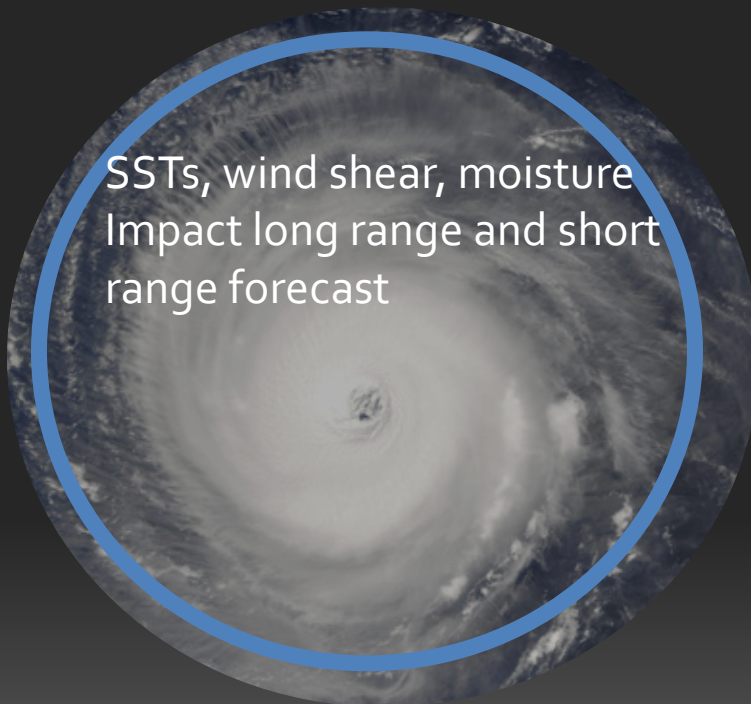
**James Kossin**

NOAA National Centers for Environmental Information (NCEI)  
Center for Weather and Climate, Asheville, North Carolina

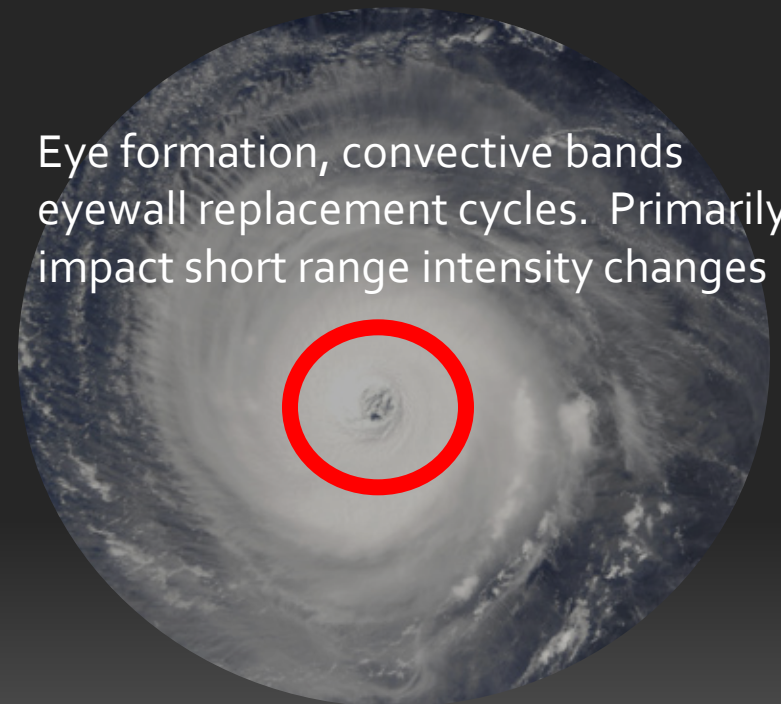
75<sup>th</sup> Interdepartmental Hurricane Conference 2021 (virtual)  
March 3-4, 2021

## TC Intensification

### Environmental Controls



### Internal Controls



“The disparity between SHIPS forecasts and the observed intensity changes during ERCs is strongly suggestive that the typical environmental controls of intensity change, on which SHIPS is largely based, are temporarily **countermanded** while dynamic processes internal to the storm dominate the intensity evolution.”- Kossin



# ERC Onset Guidance: M-PERC



## ERC forecast tools available to forecasters currently

E-SHIPS – ERC adjustments to SHIPS forecast when ERC onset is known

- Our work with M-PERC is helping to inform meaningful updates to E-SHIPS

PERC – Probability of ERC ( based on environment, Vmax and infrared satellite information)

- An Atlantic-only model currently but will be developed to work in East Pacific

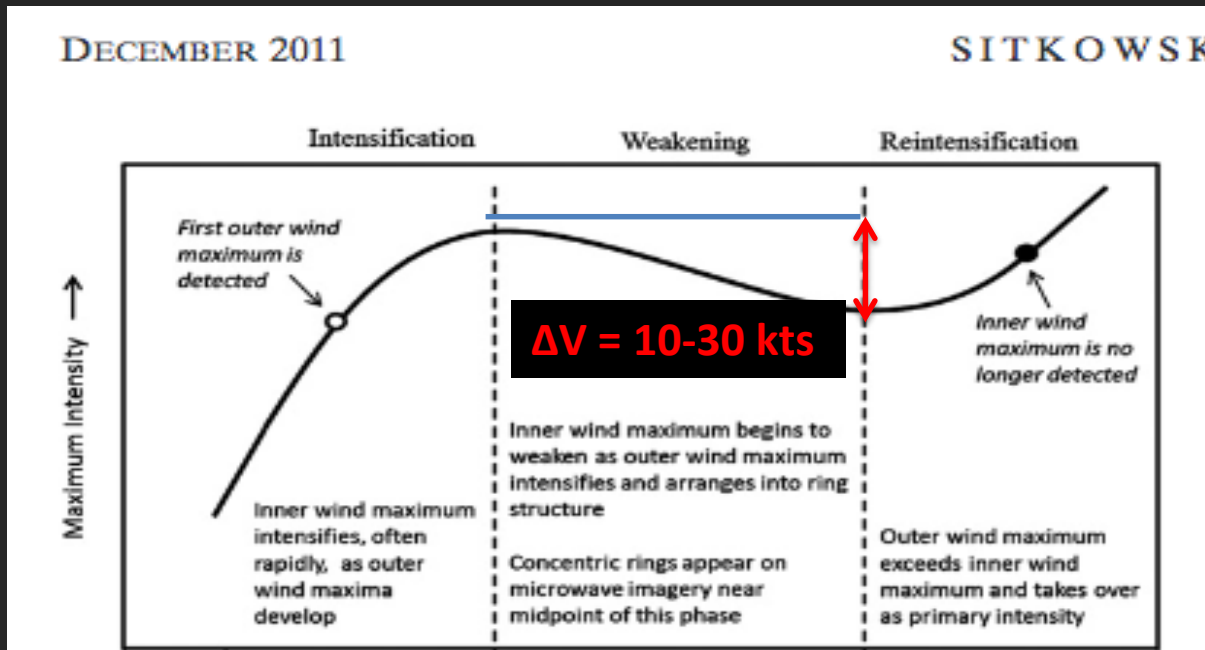
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** PROBLTY OF AT LEAST 1 SCNDRY EYEWL FORMTN EVENT AL142016 MATTHEW    10/01/2016  00 UTC **
TIME(HR)    0-12  12-24(0-24)  24-36(0-36)  36-48(0-48)
CLIMO(%)    48      43( 70)      28( 79)      23( 84)      <-- PROB BASED ON INTENSITY ONLY
PROB(%)     47      51( 74)      92( 98)      97(100)      PC4 UNAVAIL...MODEL SKILL DEGRADED

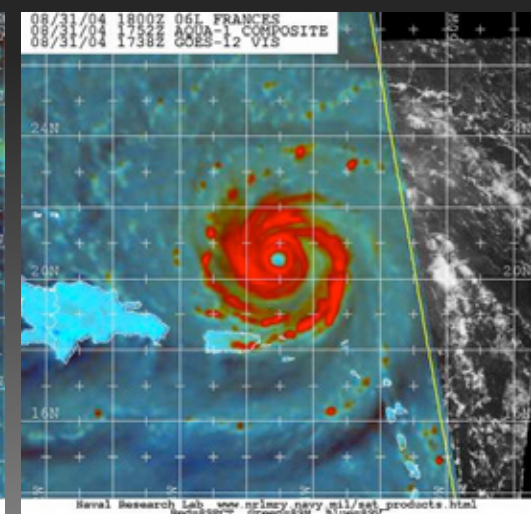
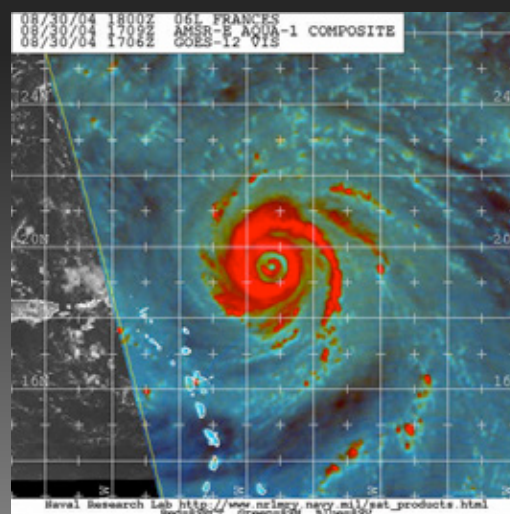
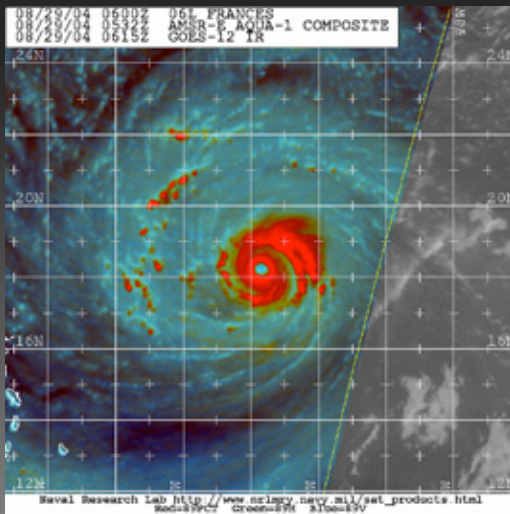
** DSHIPS INTENSITY FORECAST ADJUSTED RELATIVE TO ONSET OF ERC WEAKENING PHASE **
   TIME (HR)      0      6      12     18     24     36     48     60     72     84     96    108    120
>24HR AGO (DSHIPS) 135    136    128    117    108    101    102    107    104    67    71    69    72
 18HR AGO          135    134    126    115    106     99    100    105    102    65    69    67    70
 12HR AGO          135    132    131    120    111    104    105    110    107    70    74    72    75
   6HR AGO          135    129    126    125    116    109    110    115    112    75    79    77    80
   NOW              135    126    120    117    116    109    110    115    112    75    79    77    80
  IN 6HR            135    136    127    121    118    115    116    121    118    81    85    83    86
  IN 12HR           135    136    128    119    113    109    110    115    112    75    79    77    80

```

# ERC Onset Guidance: M-PERC



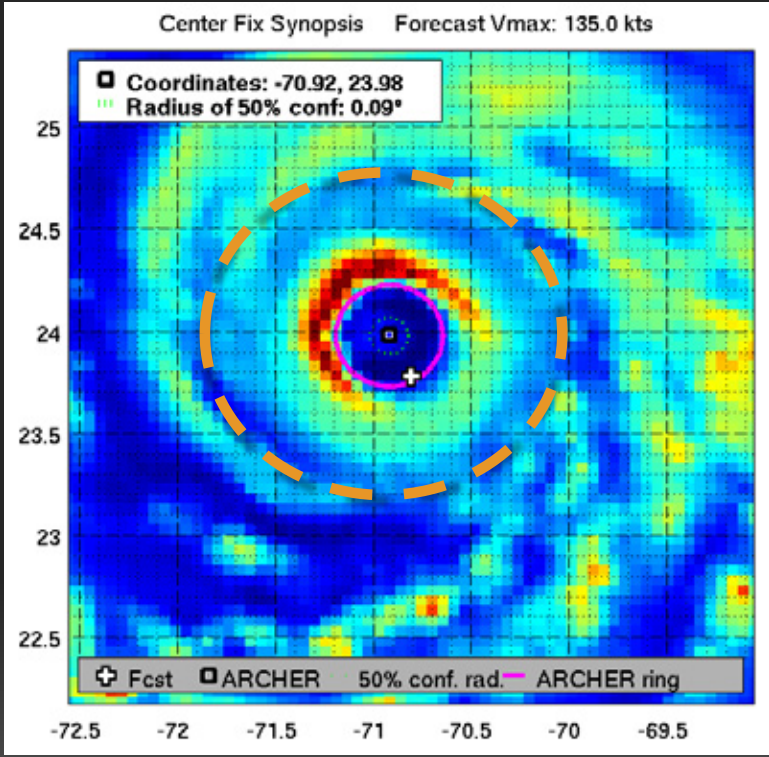
Sitkowski, M., J. P. Kossin, and C. M. Rozoff, 2011: Intensity and structure changes during hurricane eyewall replacement cycles. *Mon. Wea. Rev.*, **139**, 3829-3847.





# ERC Onset Guidance: M-PERC

89 GHz ring scores can be displayed in hovemuller form to show time and space evolution of the features.



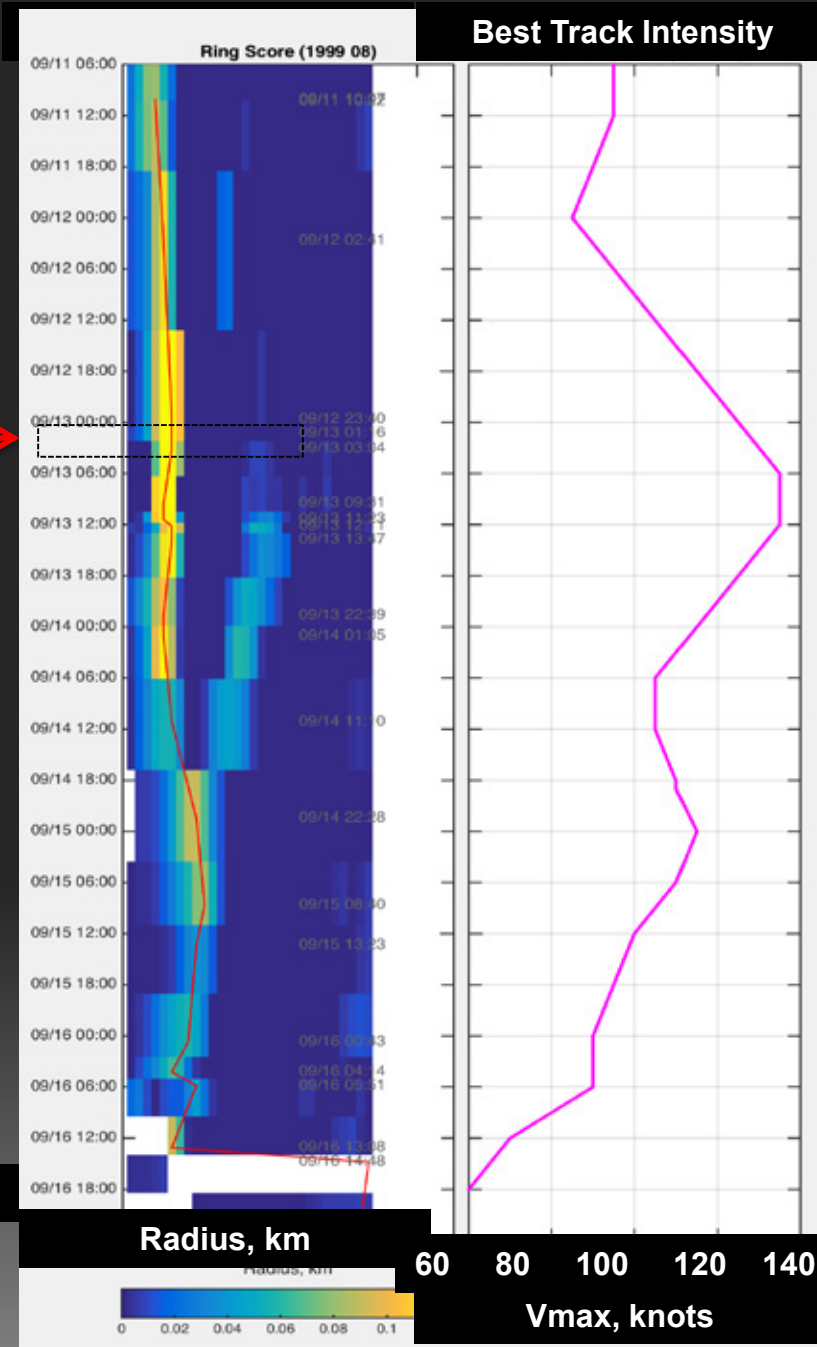
9/12

9/13

9/14

9/15

9/16



\*ARCHER ring score plotted versus time shows a branching/merging pattern during ERCs



# ERC Onset Guidance: M-PERC



Web page output for M-PERC  
On CIMSS ARCHER page

Training Data 1999-2011 -> 41 storms with  
84 ERC events (1787 profiles)

## Completed Work to Date

Develop baseline validation of Atlantic data

Baseline validation of Eastern Pacific cases

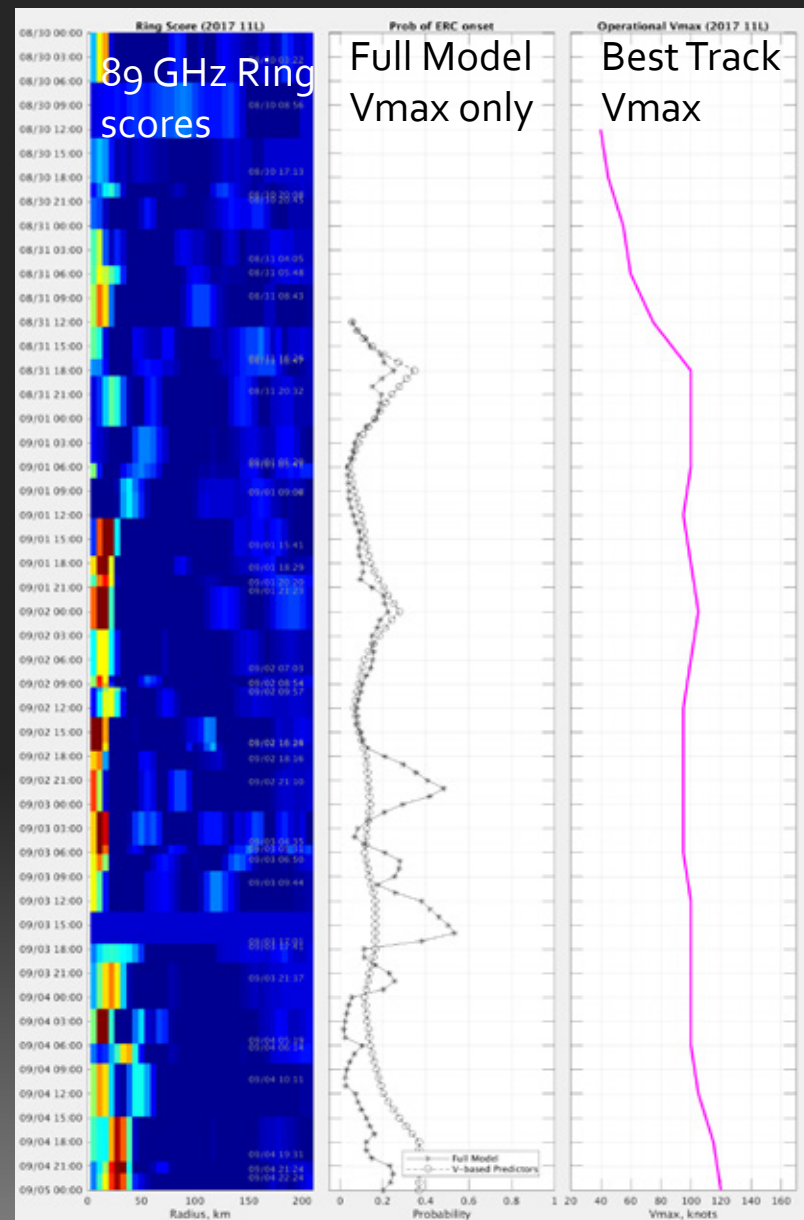
Updated web products

- Incorporate lessons learned to update product description page
- Created archive page for direct links

Held virtual product training for JTWC

Established training dataset for EPac model

Started porting work. Move graphics production away from MATLAB and to Python





# ERC Onset Guidance: M-PERC



## Verification Atlantic data

Verification data 2012-2019 -> 20 storms with 41 events

## Evaluate performance of existing model in Atlantic

Using prob of >25% 37 hits and 11 misses

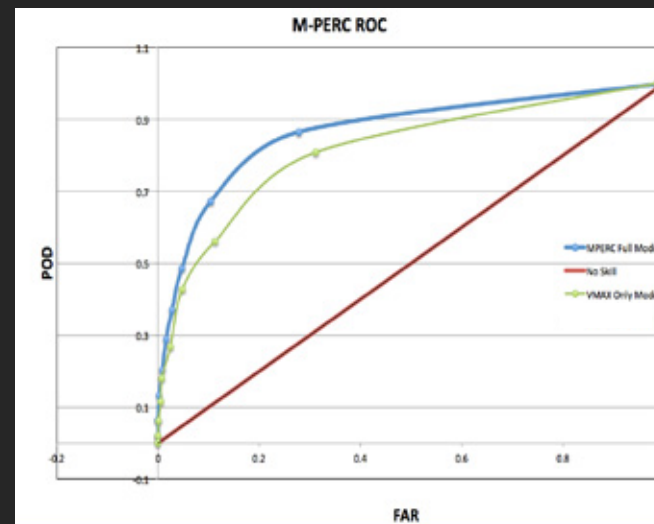
BSS for the sample (climatology of 13%) is 35% vs 27 % for Vmax only model

Average delta-Vmax following SEF is -13 knots  
Average forecast intensification was +4 knots

## Verification East Pacific data

Verification data 2017-2019 -> 17 storms with 27 events

BSS for the sample (climatology of 13%) is 48% vs 38 % for Vmax only model



Atlantic	BSS	FAR	POD
Vmax Only	27%	31%	48%
Full Model	35%	26%	55%

East Pacific	BSS	FAR	POD
Vmax Only	38%	11%	62%
Full Model	48%	23%	65%

# M-PERC

Active 2020 Atlantic season!  
Archive page for direct links  
to M-PERC storm pages

[Return to M-PERC Real-Time Page](#)

[Return to CIMSS TC Homepage](#)

[M-PERC Explanation Page](#)

## References

Search Schwerdtfeger  
Library by typing in search term

[M-PERC Change Log](#)

# UW-CIMSS M-PERC

## M-PERC 2020

### Atlantic

[01L ARTHUR \(TS\)](#)  
[02L BERTHA \(TS\)](#)  
[03L CRISTOBAL \(TS\)](#)  
[04L DOLLY \(TS\)](#)  
[05L EDOUARD \(TS\)](#)  
[06L FAY \(TS\)](#)  
[07L GONZALO \(TS\)](#)  
[08L HANNA \(H1\)](#)  
[09L ISAIAS \(H1\)](#)  
[10L \(TD\)](#)  
[11L JOSEPHINE \(TS\)](#)  
[12L KYLE \(TS\)](#)  
[13L LAURA \(H4\)](#)  
[14L MARCO \(H1\)](#)  
[15L OMAR \(TS\)](#)  
[16L NANA \(H1\)](#)  
[17L PAULETTE \(H2\)](#)  
[18L RENE \(TS\)](#)  
[19L SALLY \(H2\)](#)  
[20L TEDDY \(H4\)](#)  
[21L VICKY \(TS\)](#)  
[22L BETA \(TS\)](#)  
[23L WILFRED \(TS\)](#)  
[24L ALPHA \(TS\)](#)  
[25L GAMMA \(TS\)](#)  
[26L DELTA \(H4\)](#)  
[27L EPSILON \(H3\)](#)  
[28L ZETA \(H2\)](#)  
[29L ETA \(H4\)](#)  
[30L THETA \(TS\)](#)  
[31L IOTA \(H5\)](#)

### West Pacific

[01W YONGFONG \(H3\)](#)  
[02W NURI \(TS\)](#)  
[03W HAGUPTI \(H1\)](#)  
[04W SINLAKU \(TS\)](#)  
[05W JANGMI \(TS\)](#)  
[06W \(TS\)](#)  
[07W MEKKHALA \(H1\)](#)  
[08W HIGOS \(TS\)](#)  
[09W BAVI \(H3\)](#)  
[10W MAYSÁK \(H4\)](#)  
[11W HAISHEN \(H4\)](#)  
[12W \(TD\)](#)  
[13W NOUL \(TS\)](#)  
[14W DOLPHIN \(TS\)](#)  
[15W KUJIRA \(H1\)](#)  
[16W CHAN-HOM \(H1\)](#)  
[17W LINEA \(TS\)](#)  
[18W NANGKA \(TS\)](#)  
[19W SAUDEL \(H1\)](#)  
[20W \(TD\)](#)  
[21W MOLAVE \(H3\)](#)  
[22W GONI \(H5\)](#)  
[23W ATSANI \(TS\)](#)  
[24W ETAU \(TS\)](#)  
[25W VAMCO \(H4\)](#)

### East Pacific

[01E \(TD\)](#)  
[02E AMANDA \(TS\)](#)  
[03E BORIS \(TS\)](#)  
[04E \(TD\)](#)  
[05E CRISTINA \(TS\)](#)  
[06E \(TD\)](#)  
[07E \(TD\)](#)  
[08E DOUGLAS \(H4\)](#)  
[09E ELIDA \(H2\)](#)  
[10E \(TD\)](#)  
[11E FAUSTO \(TS\)](#)  
[12E GENEVIEVE \(H4\)](#)  
[13E HERNAN \(TS\)](#)  
[14E ISELLE \(TS\)](#)  
[15E JULIO \(TS\)](#)  
[16E \(TD\)](#)  
[17E LOWELL \(TS\)](#)  
[18E MARIE \(H4\)](#)  
[19E NORBERT \(TS\)](#)  
[20E ODALYS \(TS\)](#)  
[21E POLO \(TS\)](#)

### Central Pacific

### Indian Ocean

[01B AMPHAN \(H5\)](#)  
[02A NISARGA \(H1\)](#)  
[03A GATI \(H3\)](#)  
[04B NIVAR \(H1\)](#)  
[05B BUREVI \(TS\)](#)

### Southern Hemisphere (2019-2020)

[01P RITA \(H1\)](#)  
[02S BELNA \(H3\)](#)  
[03S AMBALI \(H4\)](#)  
[04P SARAI \(H1\)](#)  
[05S CALVANIA \(H1\)](#)  
[06S BLAKE \(TS\)](#)  
[07S CLAUDIA \(H1\)](#)  
[08P TINO \(H1\)](#)  
[09S \(TS\)](#)  
[10S DIANE \(TS\)](#)  
[11S ESAMI \(TS\)](#)  
[12P \(TS\)](#)  
[13S FRANCISCO \(TS\)](#)  
[14S DAMIEN \(H2\)](#)  
[15P UESI \(H1\)](#)  
[16S GABEKILE \(H1\)](#)  
[17P VICKY \(TS\)](#)  
[18P WASI \(TS\)](#)  
[19P ESTHER \(TS\)](#)  
[20S FERDINAND \(H2\)](#)  
[21S \(TS\)](#)  
[22S HEROLD \(H3\)](#)  
[23P GRETEL \(TS\)](#)  
[24S IRONDRO \(H2\)](#)  
[25P HAROLD \(H5\)](#)  
[26S \(TS\)](#)  
[27S \(TS\)](#)

## Archives

2017

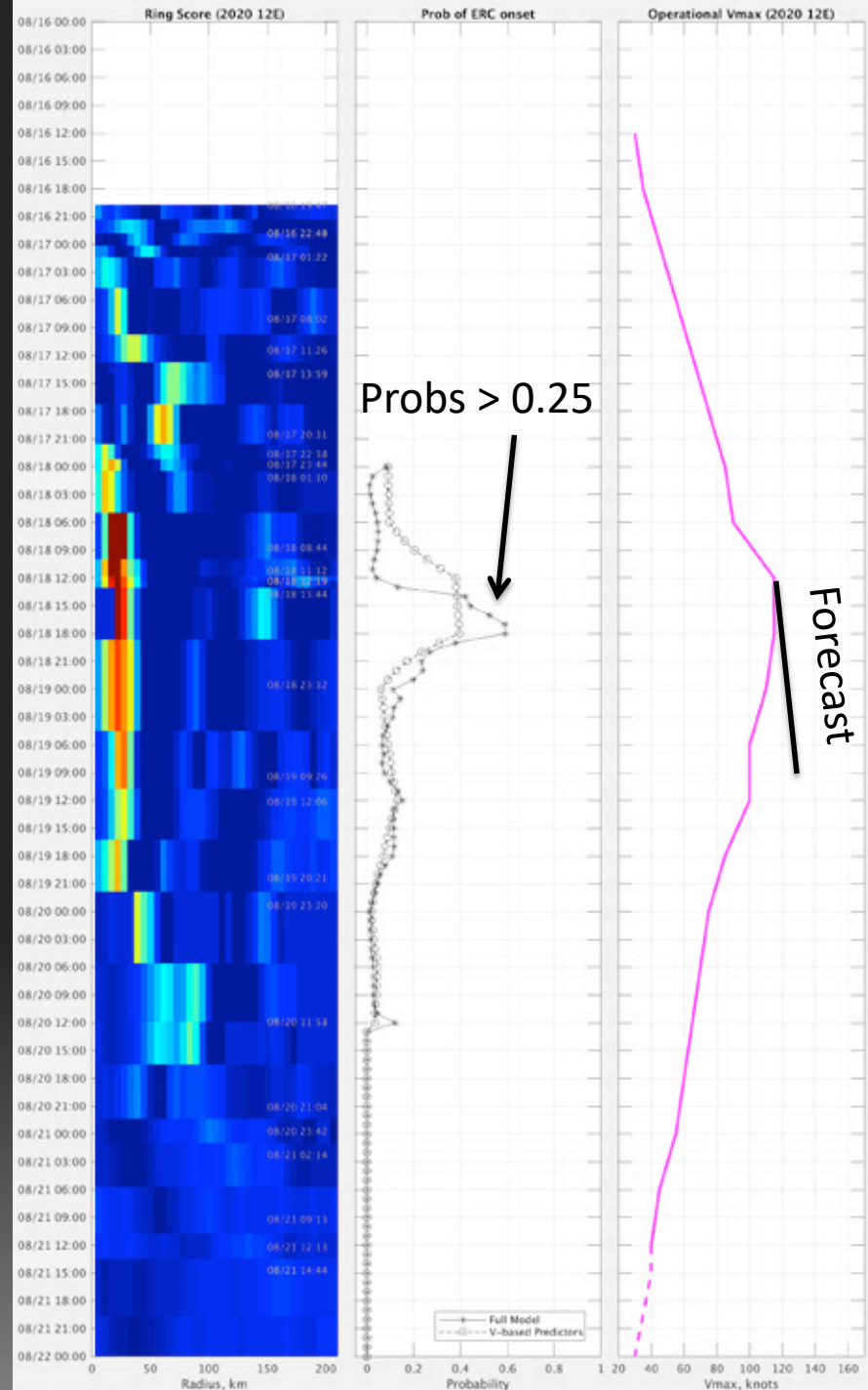
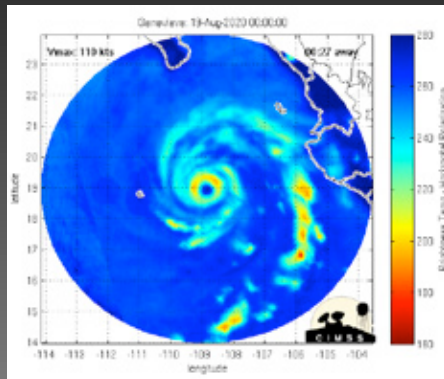
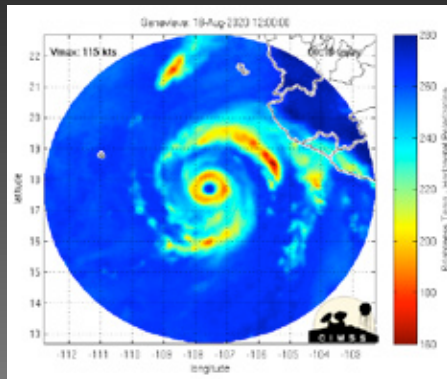


# Hurricane Genevieve 2020

*Hurricane Genevieve Discussion Number 9 NWS National Hurricane Center Miami FL EP122020 900 AM MDT Tue Aug 18 2020*  
*Since the issuance of the last advisory, Genevieve has continued to rapidly intensify. The major hurricane has a very well-defined and clear eye and microwave imagery as recent as 12Z did not show any indication of a secondary eyewall.*

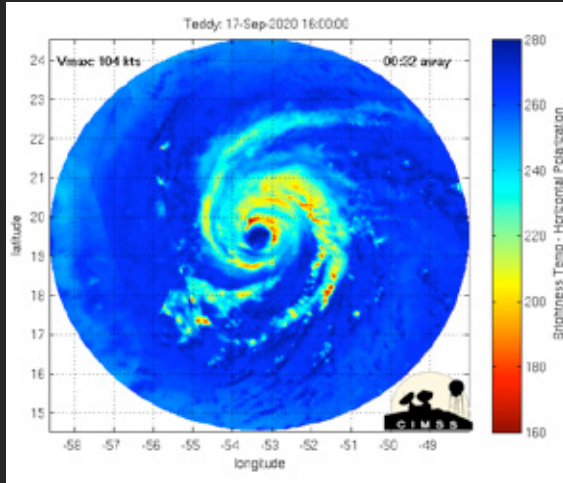


*Additional rapid strengthening is possible for at least the next 12 h given the current structure of the hurricane and the extremely favorable environment it is moving through*

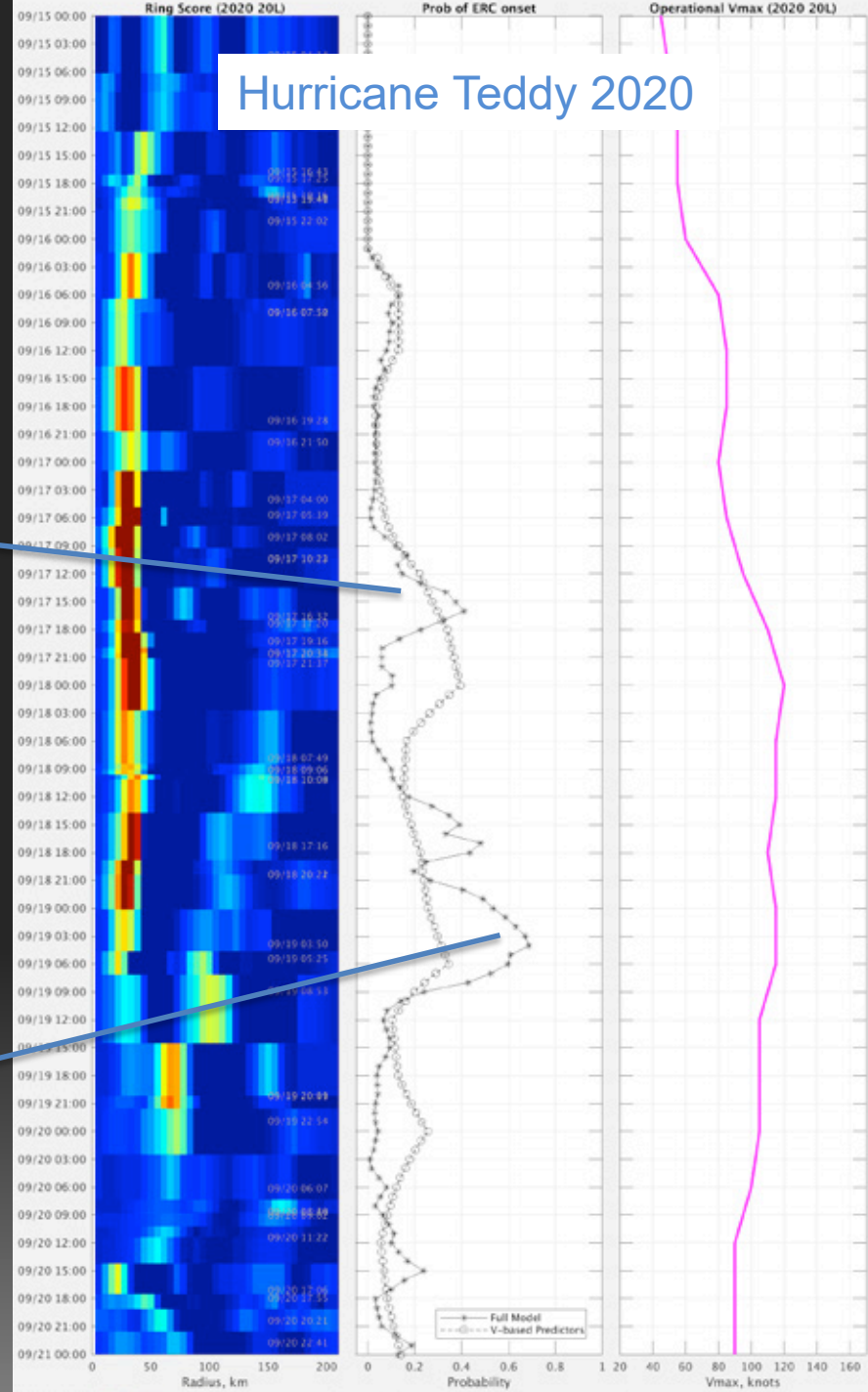
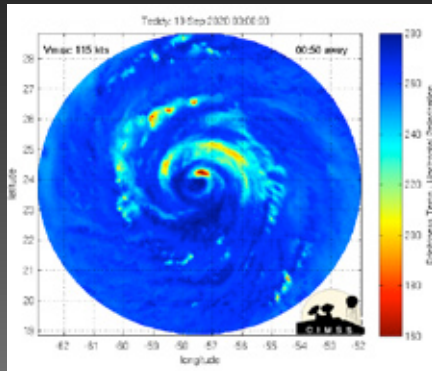
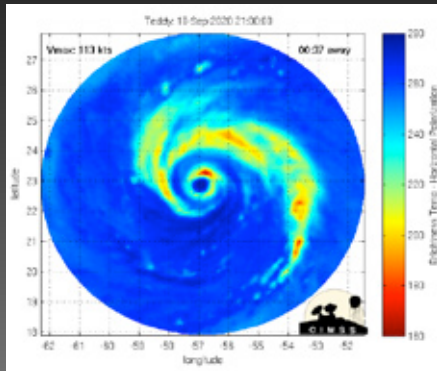


# Types of ERC events

Fast evolving early events with lower probabilities have less impact on Vmax. Intensification rate may decrease briefly



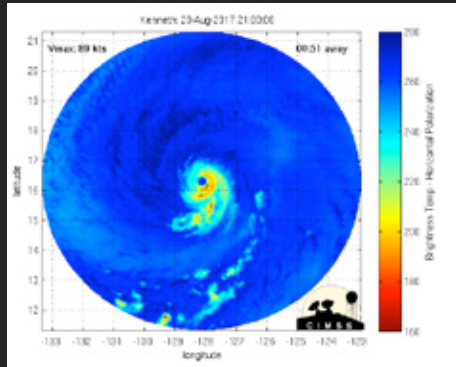
Higher probability events have larger impact on Vmax. More likely to cause weakening



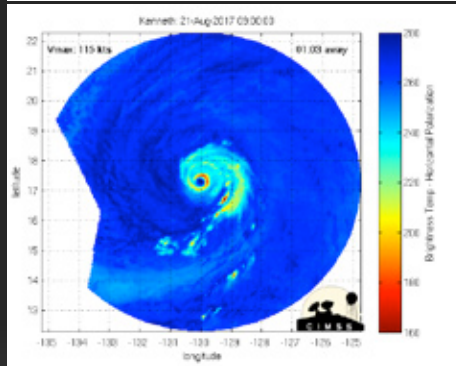
# ERC Onset Guidance: M-PERC

ERC process can aid in RW

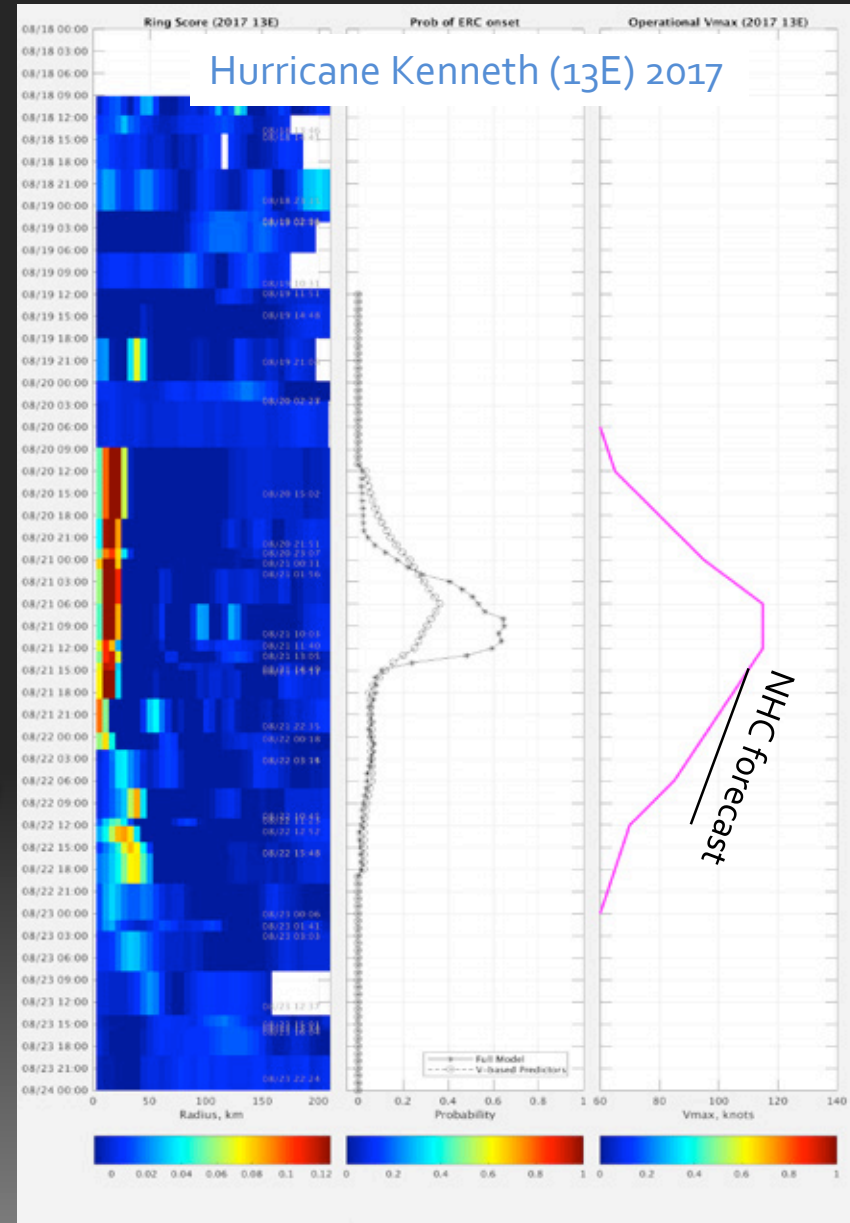
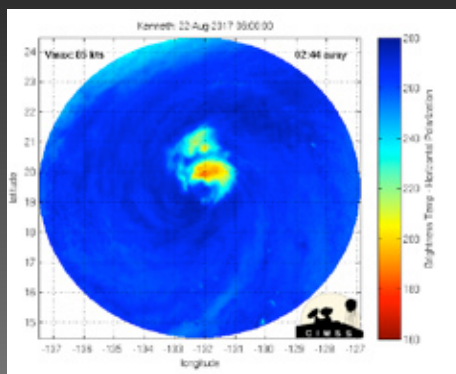
SEF development



SEF development  
Erosion in NW quad



Entrainment of stable air into inner core interrupts ERC process. Core rapidly weakens





## ERC Onset Guidance: M-PERC



Analysis of model performance has improved ability to provide guidance to forecasters.

- Increase attention when probabilities exceed 25%
- Probabilities  $> 70\%$  likely will result in weakening

Model is sensitive to  $V_{max}$ . Probabilities only output for  $V_{max} > 65$  knots. Uncertainty of 10 knots in  $V_{max}$  results in  $\sim 10\%$  change in M-PERC

### Moving Forward

Post-process remaining Epac data back to 1999

Continue building out new Epac model and verify

Develop Epac-based PERC model

Improve web display with environmental data such as shear and sst

Manuscript documenting M-PERC and changes to E-SHIPS submitted soon