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Enhancement of SHIPS RI Index Using Satellite 37 GHz Microwave Ring Pattern: A Year-2 Update

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Outline

- **Project Overview**
- **Updates during Yr-2: Real-time testing at NHC**
- **Works in progress**

Project Overview: Background

- SHIPS RI index (Kaplan and DeMaria 2003; Kaplan et al. 2010) is a well-established RI index which uses the environmental parameters to predict the probability of RI.

- M. Kieper (AMS presentations 2008; Tech. Doc. for NOAA NHC 2009) found that the first appearance of a cyan (or pink) color ring (from NRL 37 GHz color product, Lee et al. 2002; Hawkins and Velden 2011) around the eye could be an indicator of RI when environmental conditions are favorable.

- Kieper's subjective RI forecast method has been unofficially tested in real time for 2008, 2009 and 2010 hurricane seasons.

Decoding the 37 GHz color Product

- The NRL 37 GHz color product: 1) combines 37 GHz Polarization Corrected brightness Temperature (PCT), 37 GHz vertically and horizontally polarized TB's; 2) no quantitative information; 3) pink$\rightarrow$ cloud & precipitation with ice, cyan$\rightarrow$low level clouds/shallow or light rain, green$\rightarrow$ sea surface (Lee et al. 2002).

- To automate Kieper's subjective method into an objective method, we have determined quantitative values of the 37 GHz TB's in different color regions using the TRMM Tropical Cyclone Precipitation Feature (TCPF) database (http://tcpf.fiu.edu; Jiang et al. 2011, JAMC).
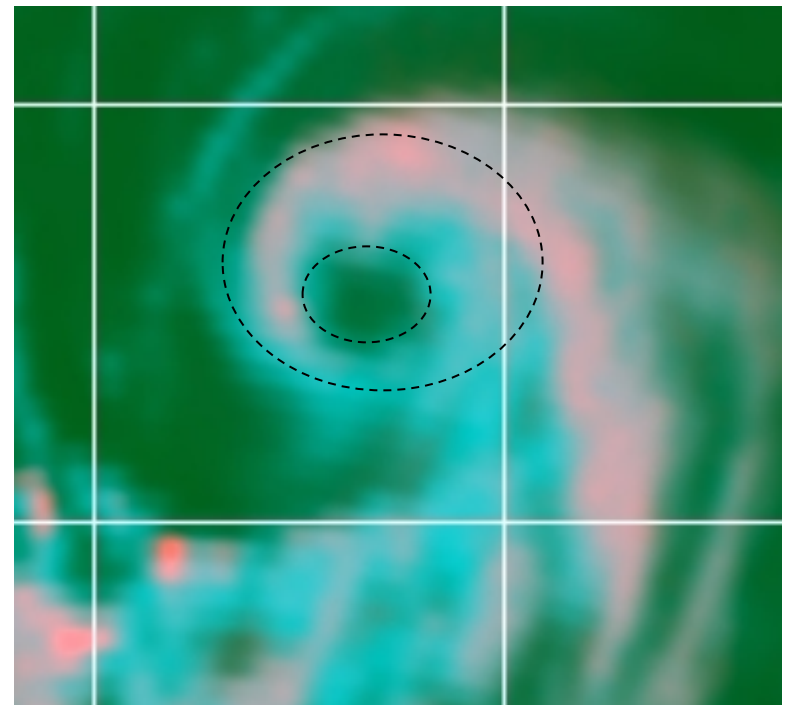
NRL 37 GHz Color Product for Hurricane Ivan (2004), WindSat overpass at 09/04/2004 2043Z. 55 kt intensity increasing during the next 24 hours.

Forecast method developed

The Objective 37 GHz Ring RI Index

- A ring pattern is detected by the automatic 37 GHz ring pattern identification algorithm.

- Initial TC intensity is between ~45 - 100 kt.

- The core of the TC is currently over water and is anticipated to remain over water for 24 hours.

- The past 6 h intensity change >=0.

The Combined Ring+SHIPS RI Index

- Satisfy the Ring index definition
- The SHIPS RI probability >= 20%

Summary of Work During Yr-1 Evaluation 1: Using More TMI Data

- Evaluation of the objective method using TRMM TMI observed TCs from 1998-2010.

- Evaluation of the subjective method using all microwave sensors for Atlantic storms during 2003-2007 (Kieper and Jiang 2012, GRL)

  - RI event based verification results:

# of total RI events	**28**
# of total forecasts	**23**
# of correct forecasts	**21**
# of false alarms	**2**
Probability of detection (POD)	**75%**
False Alarm Ratio (FAR)	**9%**
Probability of RI	**91%**

➢ *The method may miss the first 6-12 h of the onset of RI, but for most cases, the 37 GHz ring is associated with the highest intensity increase.*

Updates During Yr-2: Real Time Testing at NHC (http://tcpf.fiu.edu/JHT/Txt/)

The Atlantic Basin 2012 RI events

- Each RI event is defined as the whole RI period which usually includes several 24-h overlapping RI periods with each of them having 24-h intensity increase >=30kts. Note that more than one RI events for each storm is possible.

| Storm ID/ Name	RI start time & Vmax	RI end time & Vmax	RI period	Max Intensity Change
AL03/Chris	06/20 06:00 40 kt	06/21 12:00 75 kt	30 h	35 kt
AL08/Gordon	08/17 18:00 55 kt	08/19 06:00 90 kt	36 h	35 kt
AL11/Kirk	08/29 18:00 45 kt	08/31 12:00 90 kt	42 h	45 kt
AL13/Michael	09/05 00:00 45 kt	09/06 18:00 95 kt	42 h	50 kt
AL18/Sandy	10/23 18:00 45 kt	10/25 12:00 95 kt (landfall)	42 h	55 kt

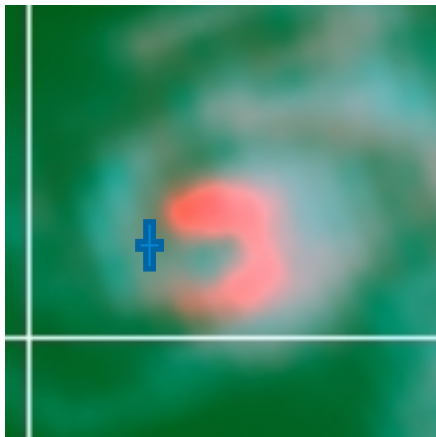# Performance for Atlantic Basin 2012 Season
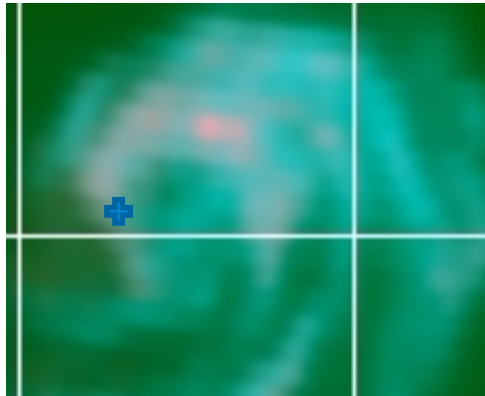
Chris: WindSat
06/20 10:03UTC
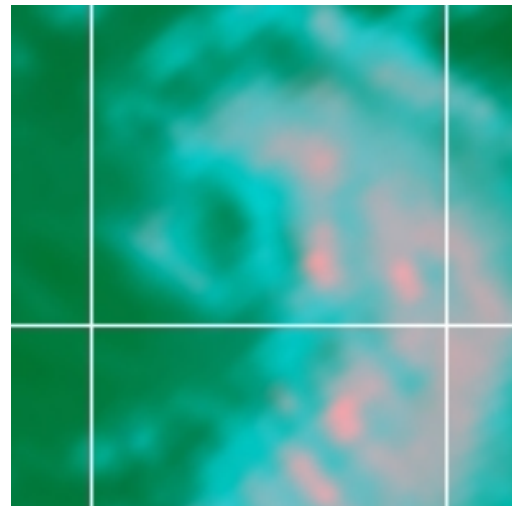(26 h before RI ends)
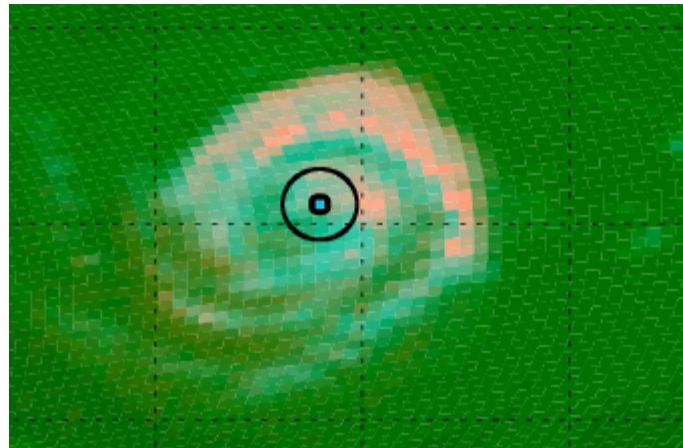
Gordon: TMI 08/18
02:04 UTC (28 h before
RI ends)
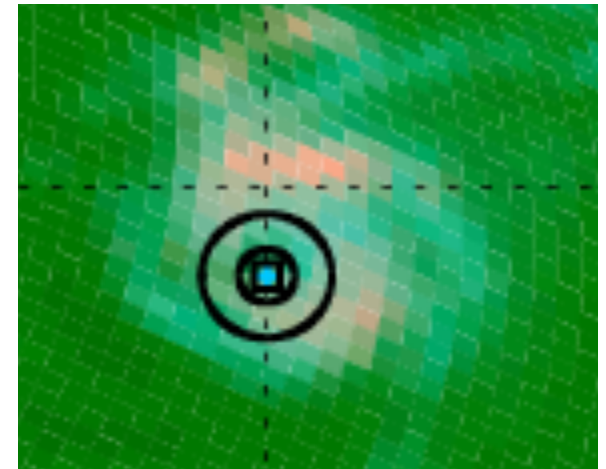
Kirk: TMI 08/30
00:41 UTC (35 h before
RI ends)

Michael: TMI 09/05 15:00UTC
(27 h before RI ends)

Sandy: WindSat
10/23 22:43UTC
(37 h before RI ends)

Performance for Atlantic Basin 2012 Season

Storm ID/ Name	Ring (subjective)	Ring (Objective)	SHIPS 25 kt RI Prob.	New SHIPS RII
AL03/Chris	Yes	No (center fix problem)	12%	11%
AL08/Gordon	Yes	Yes	15%	17%
AL11/Kirk	Yes	Yes	4%	16%
AL13/Michael	Yes	No (center fix problem)	12%	12%
AL18/Sandy	Yes	Server Down (will improve reliability next season)	??	63%

- Subjective method: Miss: 4 out of 5!
- Objective methos: Miss: 5 out 5%

- SHIPS RII values were <20% for these 4 misses.

The East Pacific Basin 2012 RI events

| Storm ID/ Name	RI start time & Vmax	RI end time & Vmax	RI period	Max Intensity Change
EP02/Bud	05/23 06:00 50 kt	05/25 00:00 100 kt	42 h	50 kt
EP03/Carlotta	06/14 18:00 45 kt	06/16 00:00 90 kt (landfall)	36 h	45 kt
EP04/Daniel	07/07 06:00 70 kt	07/08 06:00 100 kt	24 h	30 kt
EP05/Emilia	07/08 12:00 45 kt	07/10 12:00 115 kt	48 h	75 kt
EP13/Miriam	09/23 06:00 45 kt	09/25 00:00 100 kt	42 h	55 kt
EP16/Paul	10/14 12:00 50 kt	10/16 06:00 100 kt	42 h	50 kt

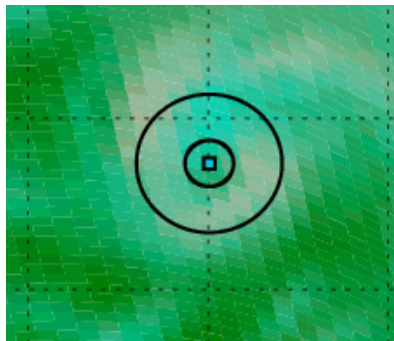# Performance for East Pacific 2012 Season
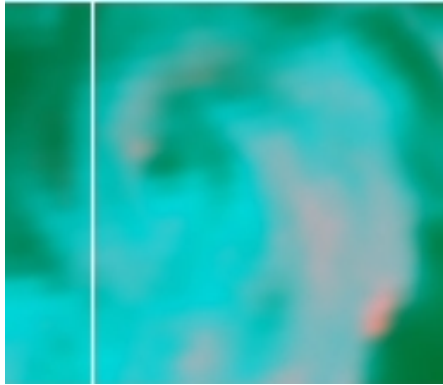
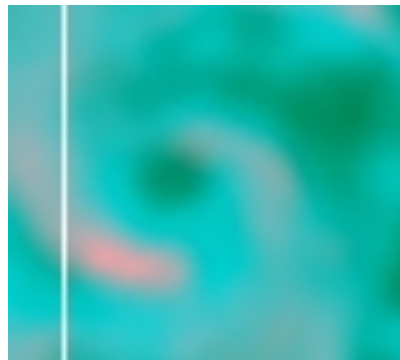**Bud**: WindSat 05/23 13:29UTC (34 h before RI ends)
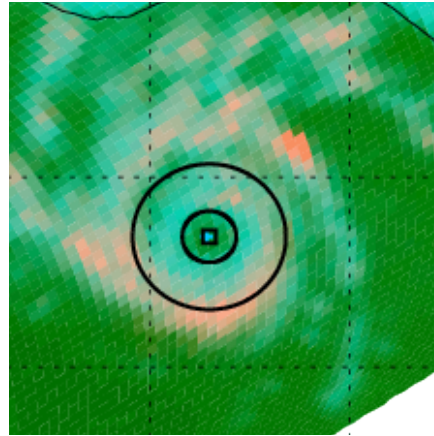
Carlotta: TMI 06/15 10:08 UTC (14 h before RI ends/landfall)
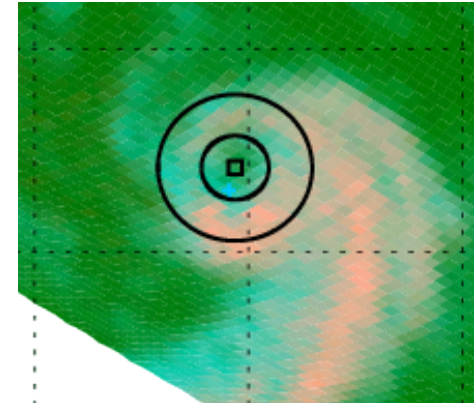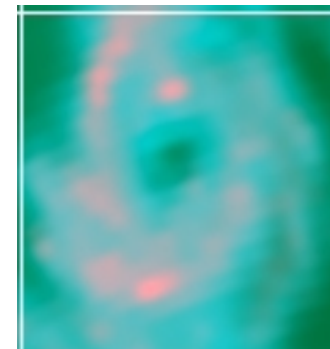

Daniel: TMI 07/07 09:27 UTC (21 h before RI ends)

Emilia: SSMIS 07/09 01:07UTC (34 h before RI ends)

Miriam: WindSat 09/23 13:48UTC (34 h before RI ends)

Paul: WindSat 10/15 01:25UTC (29 h before RI ends)

Performance for East Pacific 2012 Season

Storm ID/ Name	Ring (subjective)	Ring (Objective)	SHIPS 25 kt RI Prob.	New SHIPS RII
EP02/Bud	Yes	No (early season, coding error)	29%	67%
EP03/Carlotta	Yes	Yes	33%	59%
EP04/Daniel	Yes	Yes	24%	25%
EP05/Emilia	Yes	Yes	59%	74%
EP13/Miriam	Yes	No (didn't receive WindSat data)	>20%	No data
EP16/Paul	Yes	Server Down	??	51%

- Subjective method: Hit: 6 out of 6!
- Objective method: Hit: 3 out 6!

- SHIPS RII was correct.

Summary of Yr-2 Real-time Tests

- **Atlantic RI events are harder to predict:**

  - **Hard to get environmental conditions correct; low SHIPS RII values**

  - **TC center fix problem: a linear interpolation was used to determine TC center between NHC track points**

- **East Pacific RI events seem easier to predict:**

  - **Correct SHIPS RII**

  - **The storm track is more linear so that a linear interpolation between track points works OK**

  - **EPAC TCs seem intensify more quickly once ring feature is seen (need one more season to verify)**

Works in Progress

- **For Atlantic storms:**

  - Recalibrate SHIPS RII threshold to increase hits and minimize false alarms

  - **For Atlantic & East Pacific storms:**

  - Using additional methods to determine an accurate center fix

    - We are adapting CIMSS ARCHER algorithm (Wimmers and Velden 2010) to determine TC center using 37 GHz data

    - We are also testing a pattern recognition algorithm

- **Working on West Pacific basin storms:**

  - Margie has been working with JTWC actively. Tie Yuan has developed an algorithm for WPAC.

Future Work

➢ Will do real-time testing again at NHC for 2013 season

➢ Modify the "yes" & "no" type of prediction into "probability" format – by adding additional 85 GHz predictors such as area of 85 GHz PCT < 275 K, 250 K, and 225 K.

Related Publications

➢ Kieper, M., and H. Jiang, 2012: Predicting tropical cyclone rapid intensification using the 37 GHz ring pattern identified from passive microwave measurements. *Geophys. Res. Lett.*, 39, L13804,doi:10.1029/2012GL052115.

➢ Jiang, H., 2012: The relationship between tropical cyclone intensity change and the strength of inner core convection. *Mon. Wea. Rev.*, 140, 1164-1176.

➢ Jiang, H., C. Liu, and E. J. Zipser, 2011: A TRMM-based Tropical Cyclone Cloud and Precipitation Feature Database. *J. Appl. Meteor. Climatol.*, **50**,1255-1274.