Improvement and Implementation of the Probability-based Microwave Ring Rapid Intensification Index (PMWRing RII) for NHC/JTWC Forecast– Year 2 Update

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Acknowledgements:
1) NHC Points of Contact: Stacy Stewart, John Cangialosi, and Chris Landsea
2) JTWC Point of Contact: Brian deCicco
3) This NOAA Joint Hurricane Testbed project was funded by the US Weather Research Program in NOAA/OAR's Office of Weather and Air Quality.
Two Parallel Algorithms

- **37 GHz Ring-Only RI Index (RII, yes & no type)**
  - During the past funding year, ARCHER2 code *(Wimmer and Velden 2016, JAMC)* has been included for better center fixing & ring detection

- **Probability-based Microwave Ring RI Index (PMWRing RII)**
  - Task 1: Collecting historical microwave data from AMSR-E, SSM/I, and SSMIS and calibrating their $T_B$’s to be compatible with TMI $T_B$’s
  - Task 2: (CIRA) Generating the SHIPS RI developmental dataset
  - Task 3: Development of the PMWRing RII for each basin
  - Task 4: Real-time testing at NHC and JTWC
  - **Task 5: Evaluate the real-time testing results and refine the index based on lessons learned.**
2016 Real-Time Testing

- Jun 2016 – Dec 2016
- Run for NHC (AL, EP, & CP) and JTWC (WP & IO) basins
- Problems found during real-time testing in these basins:
  - Sample size problem for PMWRing RII development: We treated each microwave sensor separately to avoid the inter-calibration problem.
  - SHIPS RII threshold problem for PMWRing RII: For different Rl thresholds (25 kt, 30 kt, 35 kt, and 40 kt), we used the corresponding SHIPS RII>15%. This tends to give increasingly favorable environmental condition threshold for increasing RI thresholds, which is not correct.

Example RI forecast:
Mathew 2016093006

```
ATLANTIC 37 GHz Ring Only and PMWRing RI INDICES
MATTHEW AL14 2016 09/30/16 06 UTC
TMI,SSMI,SSMIS,AMSR2 and WINDSAT Total Overpass Orbits: 2
===========RI FORECAST BY THE 37 GHz Ring only and PMWRing RI INDICES DURING PAST 6 HOURS
===37 GHz Ring Only RI Forecast===
FUTURE 24-HOUR INTENSITY INCREASE >= 30 KT (RI): YES
PMWRing RI Forecast (based on 37 GHz Ring and 5 additional 37/85 GHz predictors):===
PROB OF RI FOR 25 KT RI THRESHOLD= 48%
PROB OF RI FOR 30 KT RI THRESHOLD= 75%
PROB OF RI FOR 35 KT RI THRESHOLD= 100%
PROB OF RI FOR 40 KT RI THRESHOLD= 100%
```

2 AL14 MATTHEW 09-30-2016 06:26 UTC
Solution: Algorithm Refinement

- Combine all microwave sensors for algorithm development:

  - Choose SHIPS_RII_30kt ≥ 15% for RI thresholds (25 kt, 30 kt, 35 kt, and 40 kt)

While sensor data is not inter-calibrated,

Each sensor is just as likely to detect PCT≤ 275 K, 250 K, 225 K as the others.
Developmental Results:
Probability of RI for predictors satisfying and not satisfying RI threshold (30 kt/day RI; SHIPS_RII_30kt >=15% )

(a) ATL 30kt RI + SHIPS15
(b) EPA 30kt RI + SHIPS15
(c) NWP+NI 30kt RI + SHIPS15
(d) SH 30kt RI + SHIPS15

Solid line shows the climatology mean. All predictors are skillful in each basin. Similar results for 25, 35, 40 kt/day RI categories.
Developmental Results:

% of Hit (POD, red bar) and % of Miss (FAR, blue bar) for 30 kt/day RI; SHIPS_RII_30kt >=15%

- POD is higher than FAR for all predictors in all basins, except frac225 in SH.
- The ring predictor produces the highest POD (nearly 100%) & lowest FAR (as low as less than 10%) in all basins.
2016 Post-Season Re-run

- Preliminary Results only: No ARCHER was used for center fixing

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ATLANTIC 37 GHz Ring Only and PMWRing RI INDICES

MATTHEW AL14 2016 09/30/16 06 UTC

TMI, SSMI, SSMIS, AMSR2 and WINDSAT  Total Overpass Orbits: 2

RI FORECAST BY THE 37 GHz Ring only and PMWRing RI INDICES DURING PAST 6 HOURS:

37 GHz Ring Only RI Forecast:

FUTURE 24-HOUR INTENSITY INCREASE >= 30 KT (RI): YES

PMWRing RI Forecast (based on 37 GHz Ring and 5 additional 37/85 GHz predictors):

<table>
<thead>
<tr>
<th>Prob of RI for...</th>
<th>Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 KT RI</td>
<td>41%</td>
</tr>
<tr>
<td>30 KT RI</td>
<td>33%</td>
</tr>
<tr>
<td>35 KT RI</td>
<td>25%</td>
</tr>
<tr>
<td>40 KT RI</td>
<td>19%</td>
</tr>
</tbody>
</table>

2 AL14 MATTHEW 09-30-2016 06:26 UTC
Preliminary Results for 2016 Post-Season Re-run: AL

- SHIPS RI thresholds for each basin were based on Kaplan et al. (2010).
- PMWRing RI thresholds were determined similarly as Kaplan et al. (2010).

- AL was tough this year; both ring-only & SHIPS RII had low POD & high FAR
- PMWRing RII was better in POD, but not in FAR
Preliminary Results for 2016 Post-Season Re-run: EP

- SHIPS RII has low POD & low FAR
- Ring-only and PMWRing RII has high POD, but also higher in FAR
Preliminary Results for 2016 Post-Season Re-run: WP

- Performance in WP was much better
- Both ring-only & PMWRing RII had high POD & lower FAR
- But SHIPS RII had a low POD and a higher FAR
Summary of Progress and Next-Step Plan

- PMWRing algorithm refinement is done, preliminary results for 2016 season were promising, especially in WP basin.

- 2016 post-season evaluation needs some more work: adding ARCHER into the code.

- SH real-time testing in 2017: we just received SHIPS RII developmental data from CIRA a few weeks ago. Will finish the code and start testing in April 2017.
Back-up Slides
SHIPS-RH \geq 10\%
SHIPS-RH\geq10\%
SHIPS-RH >= 10%

WP POD

WP FAR
SHIPS-RII ≥ 20%
SHIPS-RH $\geq 20\%$

**EP POD**

<table>
<thead>
<tr>
<th>RI Threshold</th>
<th>Probability of Detection (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 kt</td>
<td>60</td>
</tr>
<tr>
<td>30 kt</td>
<td>50</td>
</tr>
<tr>
<td>35 kt</td>
<td>40</td>
</tr>
<tr>
<td>40 kt</td>
<td>30</td>
</tr>
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</table>

**EP FAR**

<table>
<thead>
<tr>
<th>RI Threshold</th>
<th>False Alarm Ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 kt</td>
<td>80</td>
</tr>
<tr>
<td>30 kt</td>
<td>70</td>
</tr>
<tr>
<td>35 kt</td>
<td>60</td>
</tr>
<tr>
<td>40 kt</td>
<td>50</td>
</tr>
</tbody>
</table>
SHIPS-RII>=20%

WP POD

WP FAR