

NOAA FY 15 Joint Hurricane Testbed (JHT) program

Project Title: Improvement and Implementation of the Probability-based Microwave Ring Rapid Intensification Index for NHC/JTWC Forecast Basins

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Report Term or Frequency: semi-annual

Final Annual Report? No

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1. ACCOMPLISHMENTS

This project is under a one-year no-cost extension. The major proposed goal was to improve the probability-based tropical cyclone (TC) rapid intensification (RI) forecast method under our JHT FY-13 project by adding two additional 37 GHz predictors on top of the original the 37 GHz ring and three 85 GHz predictors. The final product is called the **probability-based microwave ring RI index (hereafter PMWRing RII)**. It was proposed to implement the PMWRing RII in the NHC and JTWC forecast basins, including Atlantic (ATL), Eastern & Central North Pacific (EPA), North Western Pacific (NWP), North Indian Ocean (NIO), and Southern Hemisphere (SH) basins. Under this major goal, there were five tasks proposed. Please see the table below for the planned vs. actuals for these tasks.

Tasks	Planned	Actuals
Task 1	<i>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</i>	Completed, although we made some changes from the original plan. We chose to we choose to treat each sensor differently to avoid the sensor inter-calibration and different sensor resolution issue. The sample size is large enough for each sensor.
Task 2	<i>(CIRA) Generating the SHIPS RI developmental dataset for JHT basins</i>	Completed for North Hemisphere basins (ATL, EPA, NWP & NIO) and Southern Hemisphere(SH) basin
Task 3	<i>Development of the PMWRing RII for each basin</i>	Completed for North Hemisphere basins (ATL, EPA, NWP & NIO) and Southern Hemisphere(SH) basin
Task 4	<i>Real-time testing at NHC and JTWC</i>	Real-time testing has been completed for the 2016 season and is ongoing for the 2017 season for ATL, EPA, NWP & NIO basins; The SH basin's real-time testing code has been implemented. But there is no storm yet. We are waiting for the SH TC season to be started around Nov. 2017.
Task 5	<i>Evaluate the real-time testing results and refine the index based on lessons learned</i>	We have finished evaluation of 2016's real-time results. Problems were identified and the algorithm was refined based on the solution of the problems, as we presented at the IHC.

There were 6 milestones proposed for year-1 and 7 milestones for year-2. All 6 milestones for year-1 have been completed as planned. Please see the table below.

Milestones for year-1	Planned	Actuals
Milestone 1 (Sep 2015)	FIU: Generate the developmental microwave data including TMI, AMSR-E, SSM/I, and SSMIS data for ATL, EPA, NWP and NIO basins; CIRA: Generate the developmental SHIPS RII dataset for NWP and NIO basins	Completed as planned

Milestone 2 (Nov 2015)	FIU: develop RI thresholds for SHIPS RII and microwave predictors for ATL, EPA, NWP and NIO basins	Completed as planned
Milestone 3 (Jan 2016)	Begin development of the PMWRing RII for ATL, EPA, and NWP/NIO basins	Completed as planned
Milestone 4 (Mar 2016)	Present preliminary results at the IHC; Mid-year report	Completed as planned
Milestone 5 (May 2016)	Complete the algorithm development and implement the real-time testing code for 2016 Hurricane/Typhoon season in ATL, EPA, NWP, and NIO basins	Completed as planned
Milestone 6 (June 2016- Nov 2016)	Real-time testing in ATL, EPA, NWP, and NIO basins	Completed as planned
Milestones for year-2	Planned	Actuals
Milestone 1 (Sep 2016)	FIU: Generate the developmental microwave data including TMI, AMSR-E, SSM/I, and SSMIS data for SH; CIRA: Generate the developmental SHIPS RII dataset for SH	Completed as planned
Milestone 2 (Nov 2016)	FIU: develop RI thresholds for SHIPS RII and microwave predictors for SH	Completed as planned
Milestone 3 (Dec 2016)	Complete development of the PMWRing RII and implement the real-time testing code for 2017 TC season for SH;	The SH basin's real-time testing code has been implemented. But there is no storm yet. We are waiting for the SH TC season to be started around Nov. 2017.
Milestone 4 (Jan 2017)	Evaluate the year-1 testing results for ATL, EPA, NWP, and NIO basins	Completed as planned
Milestone 5 (Mar 2017)	Adjust the index based on real-time testing results; Present preliminary results at the IHC	Completed as planned
Milestone 6 (Jun 2017)	Complete the algorithm refinement and implement the real-time testing code for 2017 Hurricane/Typhoon season in all northern hemisphere basins	Not started yet. Will do it after 2017 season's real-time testing in all basins.
Milestone 7 (Jul-Aug 2017)	Year 2 final report	This report

This project has provided training and professional development opportunities for two post-doctoral research scientists (Jon Zawislak and Cheng Tao) and two graduate students (Yongxian Pei and Margie

Kieper). The results of the real-time RI index have been disseminated to NHC & JTWC points of contact through emails and a website at <http://tcpf.fiu.edu/JHT/> during 2016 & 2017 hurricane/Typhoon season. Publications and conference presentations have also been made (please see the following section).

2. PRODUCTS

There were two products/deliverables proposed. See the table below for the planned vs. actuals:

products/deliverables	Planned	Actuals
Product 1	Code (in IDL) that will produce the PMWRing RI index	Not completely finished yet
Product 2	A detailed document of the guidance for running the code, and predicting RI using the 37 GHz index with the SHIPS RI index	The document for predicting RI using the PMWRing RI index with the SHIPS RI index has been completed. The document of the guidance for running the code will be done at the ending period of this project by closely collaborating with NHC/JTWC folks.
Product 3	Not planned	1)A product of the FIU PMWRing RI Index 2) A real-time RI forecast website: http://tcpf.fiu.edu/JHT/ ; 3) Publications (please see the list below)

Publications and presentations from this reporting period:

- Jiang, H., J. P. Zagrodnik, C. Tao, and E. J. Zipser 2017: What type of precipitation is represented by different color regions in the NRL 37 GHz color tropical cyclone product? *J. Geophys. Res.*, in revision.
- Tao, C., H. Jiang, and J. Zawislak 2016: The Relative Importance of Stratiform and Convective Rainfall in Rapidly Intensifying Tropical Cyclones, *Mon. Wea. Rev.*, **145**, 795-809.
- Rogers, R. F., J. Zhang, Zawislak, J., H. Jiang, G. R. Alvey III, E. J. Zipser, and S. Stevenson, 2016: Observations of the structure and evolution of Hurricane Edouard (2014) during intensity change. Part II: Kinematic structure and the distribution of deep convection. *Mon. Wea. Rev.*, **144**, 3355–3376.
- Zawislak, J., H. Jiang, G. R. Alvey III, E. J. Zipser, R. F. Rogers, J. Zhang, and S. Stevenson, 2016: Observations of the structure and evolution of Hurricane Edouard (2014) during intensity change. Part I: Relationship between the thermodynamic structure and precipitation. *Mon. Wea. Rev.*, **144**, 3333–3354.
- Jiang, H., B. You, and C. Tao 2017: Estimation of Tropical Cyclone Intensity Using Satellite Passive Microwave Observations. *71st Interdepartmental Hurricane Conference/2017 Tropical Cyclone Research Forum*, Mar 14-16, 2017.
- Jiang, H., J. Zawislak, Y. Pei, C. Tao, K. Musgrave, and G. Chirokova 2017: JHT Project 3: “Improvement and Implementation of the Probability-based Microwave Ring Rapid Intensification Index for NHC/JTWC Forecast Basins” *71st Interdepartmental Hurricane Conference/2017 Tropical Cyclone Research Forum*, Mar 14-16, 2017.

3. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

Individuals have worked on this project include Haiyan Jiang (PI), Jon Zawislak (research scientist), Cheng Tao (Postdoc Research Associate), Yongxian Pei (PhD student), and Margie Kieper (PhD student). There have been no changes in the PI and senior/key personnel since the last reporting period. FIU is partnering with CSU CIRA on this project. NHC points of contact (Chris Landsea, John Cangialosi, and Stacy Stewart) and JTWC point of contact (Brian DeCicco) have been involved.

4. IMPACT

According to the evaluation results of 2016 real-time testing & post-season re-run, our algorithm was able to provide a higher probability of detection (POD) in AL, EP, and WP basins and a lower false alarm ratio (FAR) in the WP basin than the SHIPS RII. The impact of this project on the prediction of rapid intensification in SH will be assessed later in year 3 as part of the evaluation of real-time testing results. The education and professional training impact is addressed in Section 1. None of the FIU portion of the budget has been spent in foreign countries.

5. CHANGES/PROBLEMS

No significant changes have occurred in the planned/completed work of the project.

6. SPECIAL REPORTING REQUIREMENTS

a. The project's Readiness Level:

Current: RL 6-7

At the start of project: RL 3

b. Transition to operations activities and summary of testbed-related collaborations, activities, and outcomes:

The quasi-real-time testing of the PMWRing RI index (RII) for ATL and EPA basins for NHC and NWP & NIO basins for JTWC has started in June 2016 and is still ongoing. The real-time forecasts are provided to NHC/JTWC points of contact through emails (only when a positive RI forecast is made) and our JHT project webpage (<http://tcpf.fiu.edu/JHT/>).

c. Has the project been approved for testbed testing yet? What was transitioned to NOAA?

Yes, the project has been approved for testbed testing. But it wasn't transitioned to NOAA because NHC and/or JTWC haven't decided to either transition it or not. The final decision will be made after this project is completed.

d. Test plans for the 2017 Hurricane/Typhoon season:

- I. What **concepts/techniques** will be tested? What is the scope of testing (what will be tested, what won't be tested)?

The PMWRing RII is being tested for RI forecasts in AL, EP/CP, WP/IO, & SH basins. We are testing the code for reading different microwave satellite data. We also test the strategy of using SHIPS RII as a criterion in generating our probability output.

- II. **How** will they be tested? What **tasks** (processes and procedures) and activities will be performed, what preparatory work has to happen to make it ready for testing, and what will occur during the experimental testing?

We are running the real-time code separately for each basin and each satellite sensor. The real-time forecasts are provided to NHC/JTWC points of contact through emails (only when a positive RI forecast is made) and our JHT project webpage (<http://tcpf.fiu.edu/JHT/>).

- III. **When** will it be tested? What are **schedules and milestones** for all tasks described in section II that need to occur leading up to testing, during testing, and after testing?

For AL, EP/CP, and WP/IO basins, the 2017 testing started on June 1, 2017. For the SH, the code has been implemented since June 1, 2017, but the formal testing will be starting on Nov. 1, 2017 when the TC season starts in SH. We are on a 1-yr no-cost extension of this funding. That way, we'll continue the real-time testing till the NH 2017 hurricane/Typhoon season ends at around Nov. 1, 2017 and till the SH TC season ends at around Apr. 30, 2017. For the schedules/milestones, please see the table in section 1.

- IV. **Where** will it be tested? Will it be done at the PI location or a NOAA location?

The testing code runs at FIU, the PI's location.

- V. Who are the key **stakeholders** involved in testing (PIs, testbed support staff, testbed manager, forecasters, etc.)? Briefly what are their **roles and responsibilities**?

The PI and her research team will be responsible for maintaining the testing code & running; NHC Points of Contact Stacy Stewart, John Cangialosi, and Chris Landsea and JTWC Point of Contact Brian deCicco will help evaluate the real-time results.

- VI. What **testing resources** will be needed from each participant (hardware, software, data flow, internet connectivity, office space, video teleconferencing, etc.), and who will provide them?

FIU will provide all the hardware & software for testing.

- VII. What are the **test goals, performance measures, and success criteria** that will need to be achieved at the end of testing to measure and demonstrate success and to advance Readiness Levels?

The **goal** is to test the code reliability and evaluate the performance of the algorithm. The **performance measures** are the Brier skill scores (BSSs), which should show the algorithm is at least skillful (better than climatology), and ideally better than the SHIPS RII. The **success criteria** are 1) the algorithm can run smoothly in a quasi-operational environment; 2) the performance measures are met.

- VIII. How will testing **results** be documented? Describe what information will be included in the **test results final report**.

The test results will be presented in IHC 2018. They will also be written in our final report, including the statistics of the algorithm performance for 2017 hurricane/typhoon season, i.e., POD, FAR, and BSS.

7. BUDGETARY INFORMATION

There are some changes in the original budget for the FIU portion of this project. We originally planned for 1.5 months of summer salary for the PI Jiang and 6 months of salary for the research scientist Dr. Zawislak. However, during year-1, only one month of salary for Dr. Zawislak was charged to the project. During year-2, the project is paying 3 months of summer salary (\$64515.13) for the PI Jiang during May 19, 2017-August 20, 2017. Therefore, the estimated remaining funds will be \$73,244.76 at the end of Year 2 (August 30, 2017). Since we are on a one year no-cost extension, we plan to cover 3 months of summer salary (about $\$64515.13 \times 1.03 = \$66,450.58$) for the PI Jiang and about \$5K of travel expenses to IHC and/or AMS Hurricane conferences during the no-cost extension year (year 3).

8. PROJECT OUTCOMES

The milestones of this project and the progress towards them are discussed in Section 1, with the deliverables discussed in Section 2. The outcome of this award will be the implementation of the PMWRing RII if NHC and/or JTWC decide to transition the product, which will be decided after the project is completed (as discussed in Section 6). An additional outcome of this project is the list of products contained in Section 2.