NOAA FY 17 Joint Hurricane Testbed (JHT) program

NOAA AWARD NUMBER: NA17OAR4590142

Project Title: Estimation of Tropical Cyclone Intensity Using Satellite Passive Microwave Observations

PI: Haiyan Jiang, Associate Professor, Ph: 305-348-2984, haiyan.jiang@fiu.edu

Submission Date: Jan. 30, 2018

Recipient Organization: Florida International University,
11200 SW. 8th Street, Miami, FL 33199

Project/Grant Period: 07/01/2017 – 06/30/2019

Reporting Period: 07/01/2017-12/31/2017

Report Term or Frequency: semi-annual

Final Annual Report? No

1. ACCOMPLISHMENTS

The major proposed goal was to develop an operational algorithm to estimate the current intensity of tropical cyclones (TCs) using most of the current available microwave satellite sensors. The developmental dataset will be the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) data during 1998-2013 and Global Precipitation Mission (GPM) 1C-constelation and 2A-GPROF-constellation post-real-time products during 2014-2016. A set of 85 GHz and rain related variables will be used as the input variables of the algorithm. The TC intensity will be estimated from a linear combination of these estimators. Regression models will be developed for the Atlantic and East Pacific basins. The real-time input will be the inter-calibrated 85-91 GHz microwave brightness temperatures and retrieved rain rates from the GPM 1C-constelation and 2A-GPROF-constellation near-real-time products, respectively. The GPM constellation sensors to be used in real-time includes GPM Microwave Imager (GMI), Special Sensor Microwave Imager/Sounder (SSMIS), and Advanced Microwave Scanning Radiometer 2 (AMSR-2). This algorithm will be referred to as the **Passive Microwave Intensity Estimation (PMW-IE)** model.

Under this major goal, there were two tasks proposed. Please see the table below for the planned vs. actuals for these tasks.

Tasks	Planned	Actuals	% completion
Task 1	*Complete a revised version of the model by using more historical microwave data*	1) Data collection of 2009-2013 TMI and 2014-2016 GPM data for AL basin is done. 2) Sensitivity tests have been done for the radius threshold of inner-core for AL	25%
Task 2	*Implement the real-time version of the PMW-IE model, evaluate the real-time testing results, refine the model, and eventually finalize the model*	Has not started yet	0%

There were 7 milestones proposed for year-1 and 8 milestones for year-2. Please see the table below for the planned vs. actuals for these milestones.

Milestones for year-1	**Planned**	**Actuals**
Milestone 1 (Aug 2017)	Collect 2009-2013 TMI and 2014-2016 GPM 1C-constellation and 2A-GPROF-constellation data for the AL basin	Completed as planned
Milestone 2 (Oct 2017)	Conduct the sensitivity tests and determine the fixed radius threshold for inner-core region definition for the AL basin	Completed as planned
Milestone 3 (Dec. 2017)	Year 1 semi-annual report	Completed as planned (*this report*)

Milestone 4 (Jan. 2018)	Begin development of the revised version of PMW-IE model	Just started
Milestone 5 (Mar 2018)	Present preliminary results at the IHC	Not started yet. Will do as planned.
Milestone 6 (May 2018)	Complete the revised PMW-IE model and implement for the AL 2018 Hurricane season (Jun-Nov 2018)	Not started yet. Will do as planned.
Milestone 7 (Jun 2018)	Year 1 final report	Not started yet. Will do as planned.
Milestones for year-2	**Planned**	**Actuals**
Milestone 1 (Jul 2018)	Collect 2009-2013 TMI and 2014-2016 GPM 1C-constellation and 2A-GPROF-constellation data for the EP basin	Not started yet. Will do as planned.
Milestone 2 (Sep 2018)	Conduct the sensitivity tests and determine the fixed radius threshold for inner-core region definition for the EP basin	Not started yet. Will do as planned.
Milestone 3 (Nov 2018)	Evaluate the results from the 2018 AL hurricane season	Not started yet. Will do as planned.
Milestone 4 (Dec 2018)	Year 2 semi-annual report	Not started yet. Will do as planned.
Milestone 5 (Jan 2019)	Adjust PMW-IE model based on 2018 results, rerun AL & EP for 2018 season	Not started yet. Will do as planned.
Milestone 6 (Mar 2019)	Present preliminary results at the IHC	Not started yet. Will do as planned.
Milestone 7 (May 2019)	Complete the algorithm refinement and implement for the AL and EP 2019 Hurricane season	Not started yet. Will do as planned.
Milestone 8 (Jun 2019)	Year 2 final report	Not started yet. Will do as planned.

This project has provided training and professional development opportunities for two post-doctoral research scientists (Drs. Yongxian Pei and Cheng Tao) and one PhD graduate student (Xinxi Wang). The results of the real-time TC intensity estimates will be disseminated to NHC & CHPC points of contact, and the general public through a website at http://tcpf.fiu.edu/JHT/. Publications and conference presentations have also been made (please see the following section). During the next reporting period, we plan to yr-1 milestones # 4-7.

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 **PMW-IE** outputs	25% of the code has been finished. Will continue as planned.
Product 2	A detailed document of the guidance for running the code, and interpreting the intensity estimates	Not started yet. Will do as planned.

Other products:

Datasets:

1) TMI 85 GHz brightness temperature and 2A12 rain data for TCs in the AL basin during 1998-2013
2) GPM 1C-constellation 85 GHz brightness temperature and 2A-GPROF-constellation rain data for TCs in the AL basin during 2014-2016

Publications and presentations from this reporting period:
None.

Website:
http://tcpf.fiu.edu/JHT/ (not updated yet)

3. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

Individuals have worked on this project include Haiyan Jiang (PI), Cheng Tao (Postdoc Research Associate), Yongxian Pei (PhD student previously, postdoc since Dec. 16, 2018), and Xinxi Wang (PhD student). Dr. Cheng Tao has left FIU and will no longer working on this project. There have been no other changes in the PI and senior/key personnel. NHC points of contact (Jack Beven, Dave Roberts, and Chris Landsea) and CHPC point of contact (Bob Ballard) have been involved in the testbed plan. NHC Technology & Science Branch (TSB) branch chief Dr. Mark DeMaria has been involved in the R2O transition plan.

4. IMPACT

The impact of this project on TC intensity estimates and intensity prediction in AL and EP/CP will be assessed later in year 2 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 4-5
At the start of project: RL 4-5

(RL is defined based on the following:
RL1: Basic Research
RL2: Applied Research
RL3: Proof of Concept
RL4: Validation of system in the lab or equivalent
RL5: Validation of the system in a relevant environment
RL6: Demonstration in a test environment
RL7: Demonstration in a relevant environment
RL8: Demonstrated in the actual environment
RL9: Deployment and regular use)

b. Summary of testbed-related collaborations, activities, and outcomes:

Please see the attached testbed test plan in a separate file.

c. Research to operation (R2O) transition plan:

Please see the attached R2O transition plan in a separate file.

d. 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 hasn't decided to either transition it or not. The final decision will be made after this project is completed.

7. BUDGETARY INFORMATION

The spending is delayed a little bit. Currently 0.4 FTE of a graduate student (Xinxi Wang) stipend is charged from this project. The postdoc research associate Dr. Yongxian Pei got some fellowship during Dec. 2018-Aug. 2019. After that, we will charge 0.5 FTE of his effort to this project. The PI Jiang's summer salary will be charged from this project during May-Aug. 2019&2020.

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 PMW-IE model if NHC decides 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.

NOAA FY 17 Joint Hurricane Testbed (JHT) program

NOAA AWARD NUMBER: NA17OAR4590142

Project Title: Estimation of Tropical Cyclone Intensity Using Satellite Passive Microwave Observations

PI: Haiyan Jiang, Associate Professor, Ph: 305-348-2984, haiyan.jiang@fiu.edu

Submission Date: Jan. 30, 2018

Recipient Organization: Florida International University,
11200 SW. 8th Street, Miami, FL 33199

Project/Grant Period: 07/01/2017 – 06/30/2019

Reporting Period: 07/01/2017-12/31/2017

Report Term or Frequency: semi-annual

Final Annual Report? No

Test Plan (Attachment to Section 6 of the mid-yr progress report)

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

The PMW-IE model be tested for TC current intensity estimates in AL and EP/CP basins. We'll test the code for reading a-deck TC track data and GPM 1C and 2A near-real-time microwave satellite data. We'll also test the strategy of using selected microwave predictors in generating our TC intensity estimates.

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'll run the real-time code separately for each basin and each satellite sensor. The real-time output will be provided to NHC/CHPC points of contact through 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 the AL basin, the testing will start on June 1, 2018. For the EP/CP basins, the testing will be starting on June 1, 2020 (we plan to apply for a 1-yr no-cost extension of this funding so that we can complete the EP/CP testing for 2020 hurricane season). 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 will run 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 Jack Beven, Dave Roberts, and Chris Landsea and CHPC point of contact Bob Ballard 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** of success will be based on the error analysis of the real-time testing results, including the analysis of r^2, MAE, RMSE, and standard deviation of residuals relative to the best track intensity. 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 2020. They will also be written in our final report, including the statistics of the algorithm performance for 2019 hurricane/typhoon season, i.e., r^2, MAE, RMSE, and standard deviation of residuals relative to the best track intensity.