TOWARD AN OBJECTIVE SATELLITE-BASED ALGORITHM TO PROVIDE REAL-TIME ESTIMATES OF TC INTENSITY USING INTEGRATED MULTISPECTRAL (IR AND MW) OBSERVATIONS

Chris Velden*, James Kossin, Tim Olander, Derrick Herndon, Tony Wimmers
University of Wisconsin – Cooperative Institute for Meteorological Satellite Studies

Robert Wacker, Kurt Brueske, Brian Kabat
United States Air Force

Jeff Hawkins
Naval Research Laboratory at Monterey, CA

Roger Edson
Anteon Corporation

and Mark DeMaria
NOAA/NESDIS at Ft. Collins, CO

1. INTRODUCTION

Several existing or promising satellite-based methods to estimate tropical cyclone (TC) intensity are available to forecasters today. Some of these, such as the Dvorak Technique (DT), have been utilized operationally for over 30 years. Others, such as those based on microwave (MW) data, are just emerging as new, more capable, meteorological satellite instruments become operational. Each of the methods by themselves represents or promises significant contributions to TC intensity analysis. However, each technique (or instrument that it is based on) also has its limitations.

An effort is underway at CIMSS to build an integrated algorithm that is fully automated and objective, and utilizes a multispectral approach. This system would build on the latest science advances in existing (and emerging) methods. The established components would include geostationary satellite IR/VIS/WV image interpretation methods (featuring the automated Advanced Objective Dvorak Technique (AODT), see Olander et al., this volume), and techniques that estimate TC intensity from polar orbiting satellite microwave sounder observations provided by the NOAA Advanced Microwave Sounding Unit (AMSU, see Herndon and Velden, in this volume).

* Corresponding author address: Chris Velden, UW-CIMSS, 1225 W. Dayton St., Madison, WI 53706; chrisv@ssec.wisc.edu

Additional input will come from techniques being devised (Edson, this volume) to extract TC intensity from passive microwave imagery provided by the NASA Tropical Rainfall Measuring Mission (TRMM) and the DMSP Special Sensor Microwave Imager (SSMI). While still in the conceptual design stages (Figure 1), this computer-based objective system will yield the "current state" of a TC from a unified satellite perspective.

2. METHODOLOGY

As a first step, each one of the currently available satellite-based methods is being characterized in terms of accuracy and consistency in estimating TC intensity. Most importantly, this “method benchmarking” will provide a thorough analysis of the error distribution and characteristics, behavior in specific situations, data refresh and real-time availability issues, and the potential value of time-averaging techniques. Reconnaissance and ground truth reports of TC intensity are being used to validate each tool/method and develop situation-dependent confidence indicators.

To give an example of “method benchmarking”, the overall AODT error distribution (based on ~1600 cases) was broken down by the image scene type employed by the algorithm at the time of each TC analysis. It was found that the AODT performs best in cases with large, clear eyes, or with TCs in high shear regimes (exposed low-level centers). In these cases the average absolute errors (AAE) of estimated TC intensity are 6-8 hPa. The method is less effective in cases with a central dense overcast, and in weak TC cases when a curved band analysis is employed (AAE of 9-10 hPa). The AODT generally performs better in pre-eye cases, and exhibits a small bias (too weak) in post-eye cases.

The CIMSS AMSU intensity estimation method also exhibits performance tendencies, however these are based on different parameters from those of the AODT. Generally speaking, the AMSU performs slightly better than the AODT in a homogeneous sample comparison (AAE is 1-2 hPa lower). TC situations with very small or very large eyes, and centers located towards the limb of the scan swath appear to be the most problematic cases for the AMSU method. Even with recently implemented corrective measures (see Herndon and Velden, this volume), these situations are often lower in confidence. In addition, systems undergoing eyewall replacement cycles are often problematic due to variability in the real and measured radius of maximum wind parameter (AMSU method relies on this as a proxy for TC warm anomaly resolvability).

We can make use of the single method performance characteristics and tendencies to develop the integrated approach. At a given TC analysis time, the final TC intensity estimate will be obtained by employing weighted consensus, decision tree, or "expert system" techniques to resolve or blend the independent estimates. The algorithm will output real time intensity parameters, trends, and possibly short-term outlooks pertinent to the forecaster needs for TC intensity analysis and forecasts. It will also include an interactive visualization package that enables forecasters to view and analyze the individual components of the system along with time histories.

References

Edson, R.: Uses of microwave imagery as a supplement to the Dvorak technique: an integrated technique (this volume).

Herndon, D. and C. Velden: Upgrades to the UW-CIMSS AMSU-based TC intensity estimation algorithm (this volume).

Olander, T., C. Velden and J. Kossin: The AODT: Latest upgrades and future plans (this volume).

Acknowledgements: Research sponsored by NOO173-01-C-2024 SPAWAR PEO C4I&Space/PMW 150 under PE 0603207N

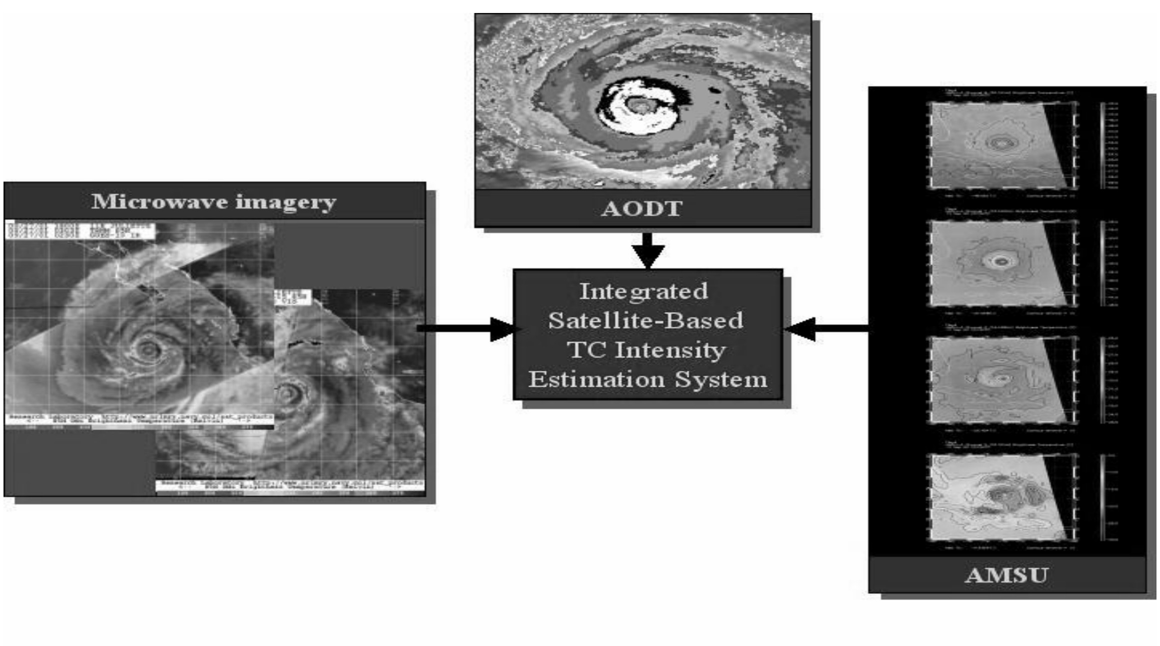

Figure 1: Conceptual illustration of the satellite-based integrated TC intensity estimation algorithm.