P.95 Tropical Cyclone Analysis: Need to Increase the Use of an Integrated Technique Using Microwave Imagery and Scatterometer Data to Supplement the Dvorak Technique

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BASIC PROBLEM: for Tropical Cyclone Satellite Analysis

- (All) Operational Centers still primarily dependent upon the 35-year old IR Dvorak technique (if no aircraft available)…*especially for intensity estimations.*
- *Too often microwave imagery and scatterometer data are being used after-the-fact, and NOT during the initial analysis*
- Need a NEW integrated *real-time* technique using both GEO and LEO sensors!

Dvorak Concern: frequently there is a 'disagreement' same system between agencies evaluating the (Goal: +/- ½ T#)

Many errors in Dvorak because:

Incorrect positioning (Technique is very position dependent)

- During initial/genesis state
- During intensification stage when center is obscured

SOLUTION: A sensor or method to see low level clouds!

** This question can be answered by use of MI and Scatterometer data …AND!! New GEO wavelengths enhancements to see the low level**

WHY are these not being used routinely (in 2016)??

Concern with Dvorak Intensification Estimates

- Start too late (genesis) ('low and slow')
- Use of spiral band curvature, when should be using shear, maybe embedded or eye pattern
- Failing to see the 'peaking time' (or RI)…and use of PLUS or MINUS annotations
- Not using visual imagery when available (maybe new satellite technology will help, here)
- Failing to go back or to re-examine 24-hr analysis

SOLUTION: Training, Mentorship and Managerial Support

(Assumption seems to be: procedure easy to learn and can be automated)

Failing to recognize situations where Dvorak does not work (ADT will 'probably' not help):

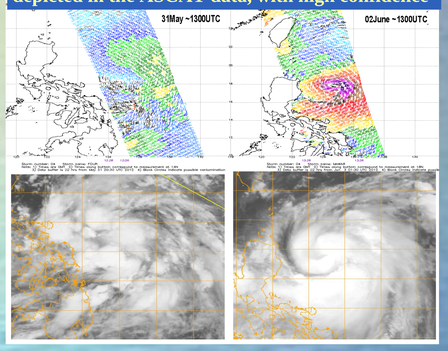
(*here, a new technique or procedure is needed!!*)

- Pin-hole eyes
- Very small and very large circulations
- "Truck Tires"
- Extratropical transition
- Sudden shear with an existing (high) wind pattern in monsoon or strong trades
- Eyewall replacement cycle

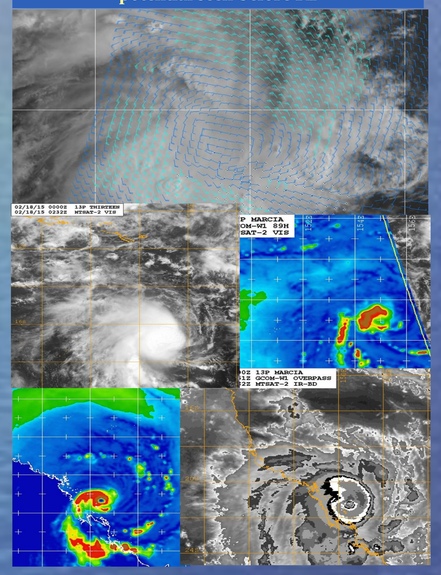
Problems with routinely using MI data

- Not all sites are accessible to all Countries
- Some agencies 'require' their own gridding or calibration
- Unhappy with coverage or timeliness (*forget to use as a 'best position/intensity known' since last pass*)
- Unfamiliar with characteristics of various sensors
- Lack of using multiple frequencies for a particular pass (no time!—*but isn't it worth it…don't we wait for an aircraft fix*?)
- Like to be able to integrate easier with other data
- Do not know how to combine with Dvorak technique
- New training required!

Two day intensification and 'growth' easily depicted in the ASCAT data, with high confidence

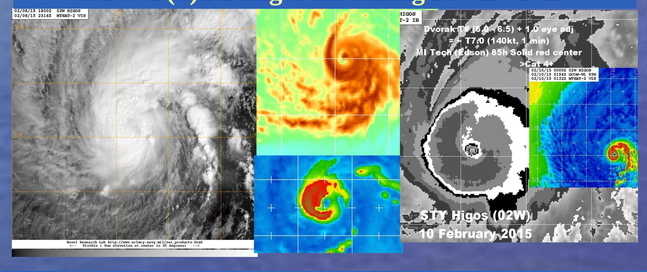


TC Marcia (13P) structure/ potential seen before RI



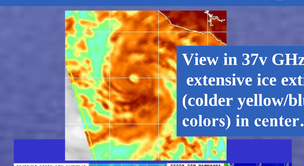
EXAMPLES OF TC INTEGRATED ANALYSIS TECHNIQUES

Case of (S)TY Higos RI during Recurvature

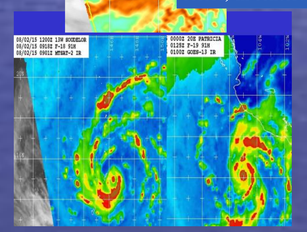


An Integrated Intensification Technique Needed to forecast RI

Pin-hole size eyes and RI systems, in general, are handled better in MI (85 and 37Ghz) than in the Dvorak technique.

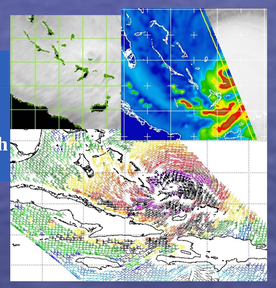


View in 37v GHz shows extensive ice extinction (colder yellow/blue colors) in center…rare.

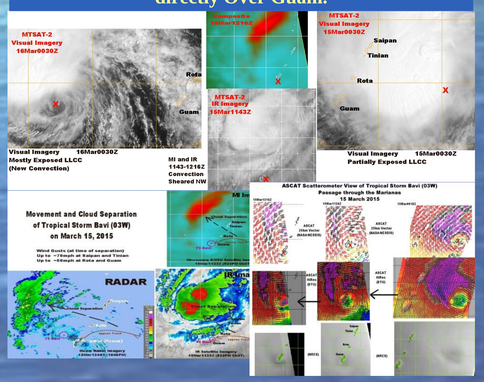


TC Structure

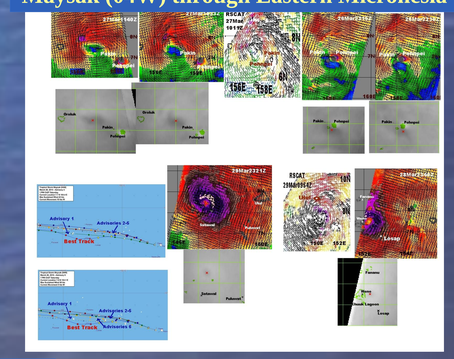
Hurricane Joaquin (ll L) readily depicts extensive storm-force winds in both MI and RSCAT data



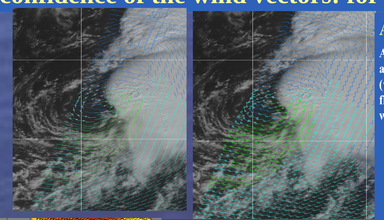
Tropical Storm Bavi shears and unexpectedly crosses directly Over Guam.



Initial Passage and Development of TY Maysak (04W) through Eastern Micronesia

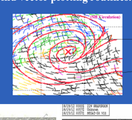


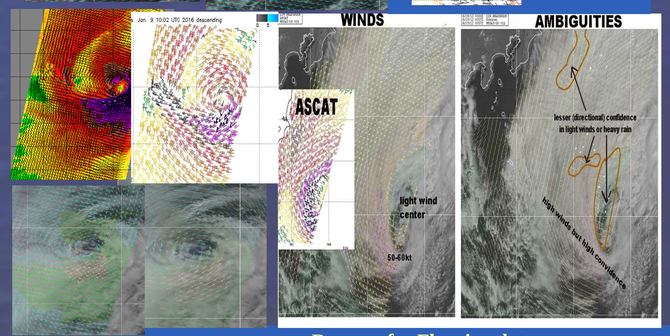
Use of Ambiguities allows the analyst to evaluate the confidence of the wind vectors: for ASCAT 2-way are best.



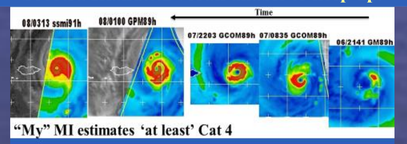
Ambiguity Plotting Convention

Ambiguity convention: 1-4 possible wind directions are plotted from the center of the wind vector cell (wvc) OUTWARDS and towards the direction of the flow (this is opposite of conventional meteorological wind vector plotting routines.





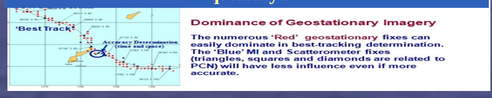
Tropical Cyclone Megh (05A) approaching Socotra Island…Dvorak unable to keep up.



Some agency estimates as low as 70 knots…

The Dvorak method needs to reflect this intensification!

Working Best Tracks and Post-analysis Best Tracks MUST use data with the best quality and not the best quantity!

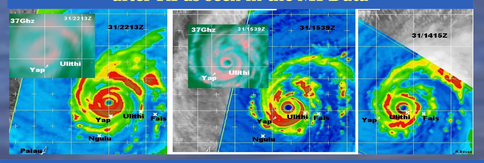


CONCLUSION: Need for Centers and middle managers/mentors to emphasize these NEW techniques into OPERATIONS (Forecasters AND Satellite Analyst)

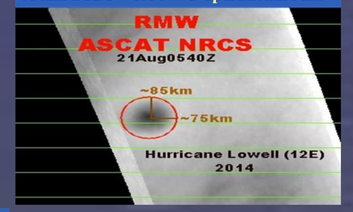
- Hybrid Dvorak can be easily adapted
- **Previous (and current) attempts to use MI or Scatterometer data via automation (neural networks, ect.) not very successful: trust Human Eye (perhaps this takes 'work'…solution not always easy)!**
- NEED to develop techniques for operational people to more easily obtain and view and interrogate the data (to avoid spending precious time 'looking')
- **REMEMBER your last 'good' Analysis Point!**

(This is what an integrated analysis is all about!)

STY Maysak (04W) over Fais and Ulithi in Yap State after RI as seen in the MI Data



Outside of some MI imagery, the NRCS product provides the best opportunity to obtain a RMW for NWP operational runs



Problems with routinely using Scatterometer data

Not familiar with characteristics scat data (good and difficult points…and how to overcome)

- Afraid of using in rain (flagged data does NOT mean do not use)!
- Not routinely available on your site
- Importance of using ambiguity data
- Unfamiliarity of high resolution display and NRCS products

Common Misconceptions with Scatterometer

- Inability to combine with other data
- Importance of knowing 'where the center CANNOT be located'
- Importance of knowing the difference of good 'outer winds' as well as acknowledging good (at least 'this high'…if not more) wind speeds into the center
- Not familiar with the EASE of using to find the center, almost exactly in some cases

Reasons for Flagging data

- **2DVAR spacial consistency (closeness to NWP …ECMWF or GFS, depending on agency)**
- **Too close to land and/or ice**
- **Wind less than 3 m/s or greater than 30 m/s**
- **Noisy signal, bad calculation, ect…**
- **MLE (maximum likelihood estimation) variational control**
  - **(Solution EXISTS…but was not what was expected as compared to closeness to the neighboring wvc)**
  - **May occur in rapidly changing environment with respect to the size of the wvc (winds in a TC may qualify; so may an area around a strong frontal zone, or any high gradient synoptic/mesoscale feature)**
  - **May occur in rain…but difficult to 'reject' the data outright, without examining the data**

References

Edson, Roger T., M.A. Lander, C.E. Cantrell, J.L. Franklin, J.D. Hawkins, and P.S. Chang, 2002: Operational use of QuikSCAT over tropical cyclones. The *25th Conference on Hurricanes and Tropical Meteorology*, San Diego, CA, Amer.Meteor.Soc.,41-42.

Edson, Roger T., 2004: Tropical Cyclone Analysis Techniques from QuikSCAT NRCS, Wind and Ambiguity Data and Microwave Imagery. The *26th Conference on Hurricanes and Tropical Meteorology*, Miami Beach, FL, Amer.Meteor.Soc., 278-279. (email Roger.Edson@noaa.gov)

Lee, T.F., C.S. Nelson, P.Dills, L.P Riishojgaard, A. Jones, S. Miller, L. Li, L.E. Flynn, G Jedlovec, W. McCarty, C Hoffman and G McWilliams, 2010: NPOESS: NEXT GENERATION OPERATIONAL GLOBAL EARTH OBSERVATIONS; Bltn of Am Meteoc. Soc.

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