Further Use of Microwave Data to assess in improving the Tropical Cyclone Dvorak Intensity 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.***

Need a NEW integrated technique using both GEO and LEO sensors!

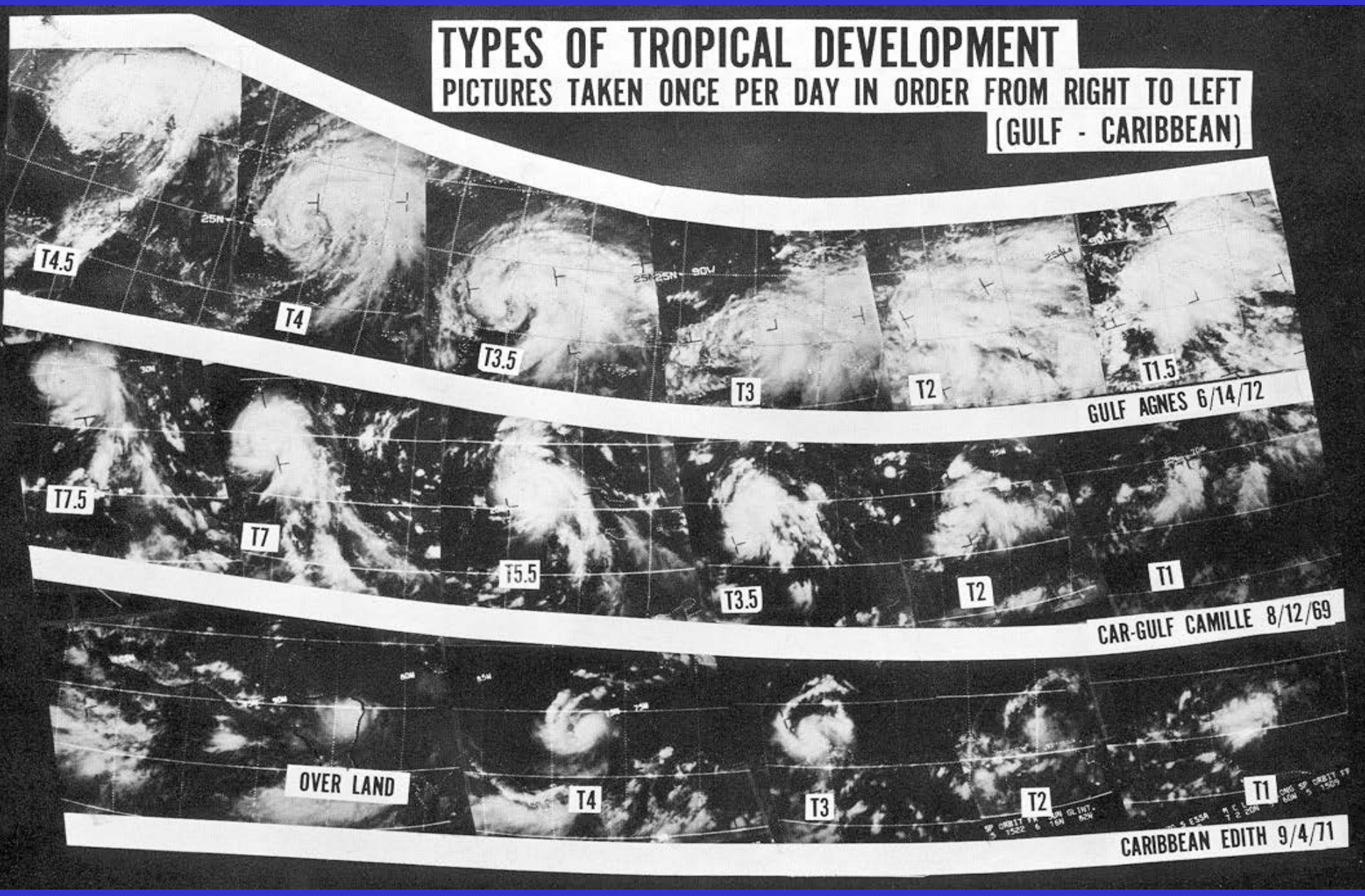
Can the timeliness and high resolution data from the Himawari-8 help?

Discussion:

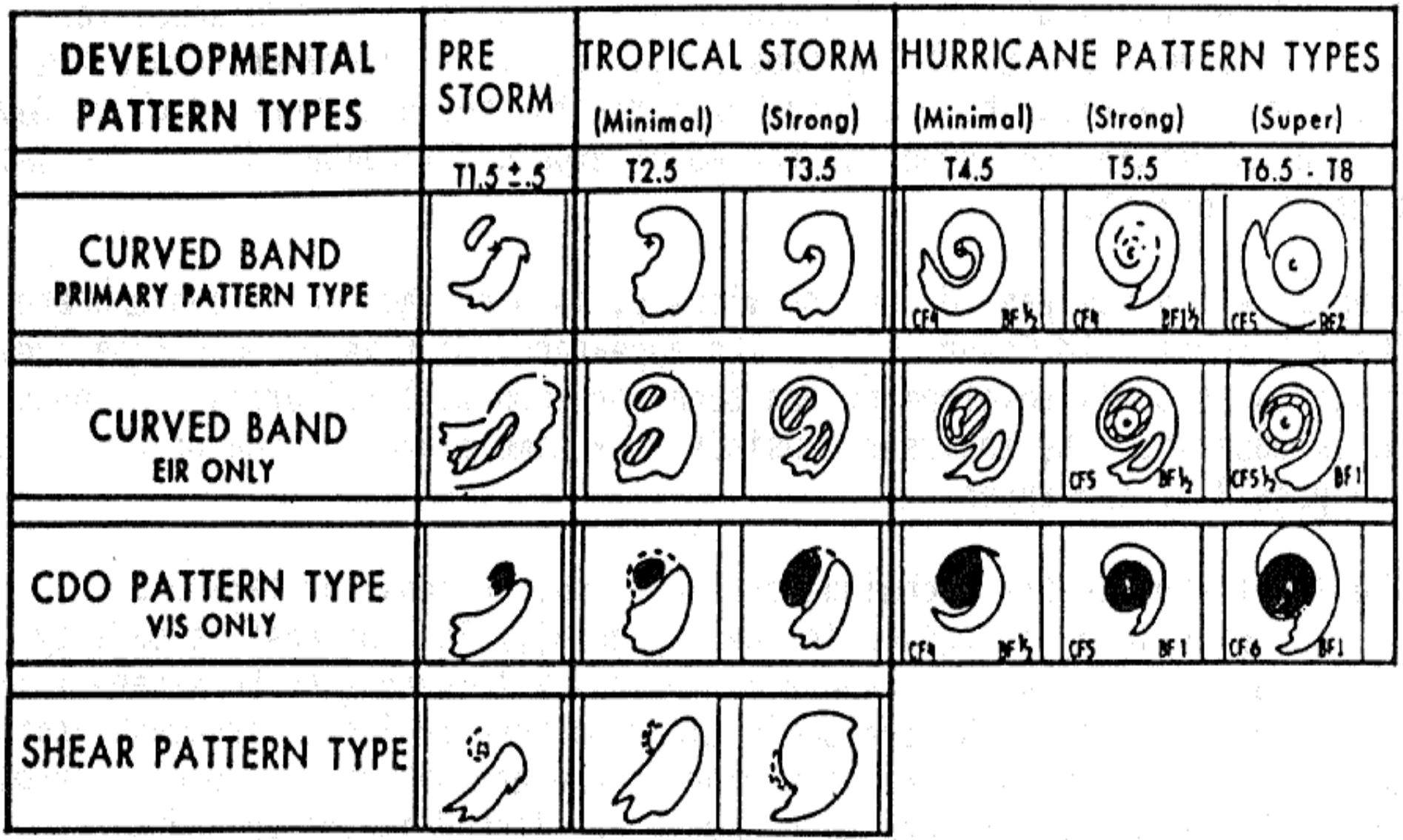
- **What is the Dvorak Intensity Analysis**
- **Typical problems/weaknesses**
- **Can microwave help…integrating with Microwave and Scatterometer Data?**
  (*Why do we not have a new technique by now*?)
- **Are there other concerns to the question??**

(I give 4 points)

Developing Cloud Patterns



Dvorak Technique Cloud Patterns



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

Point #1: Many errors in Dvorak because:

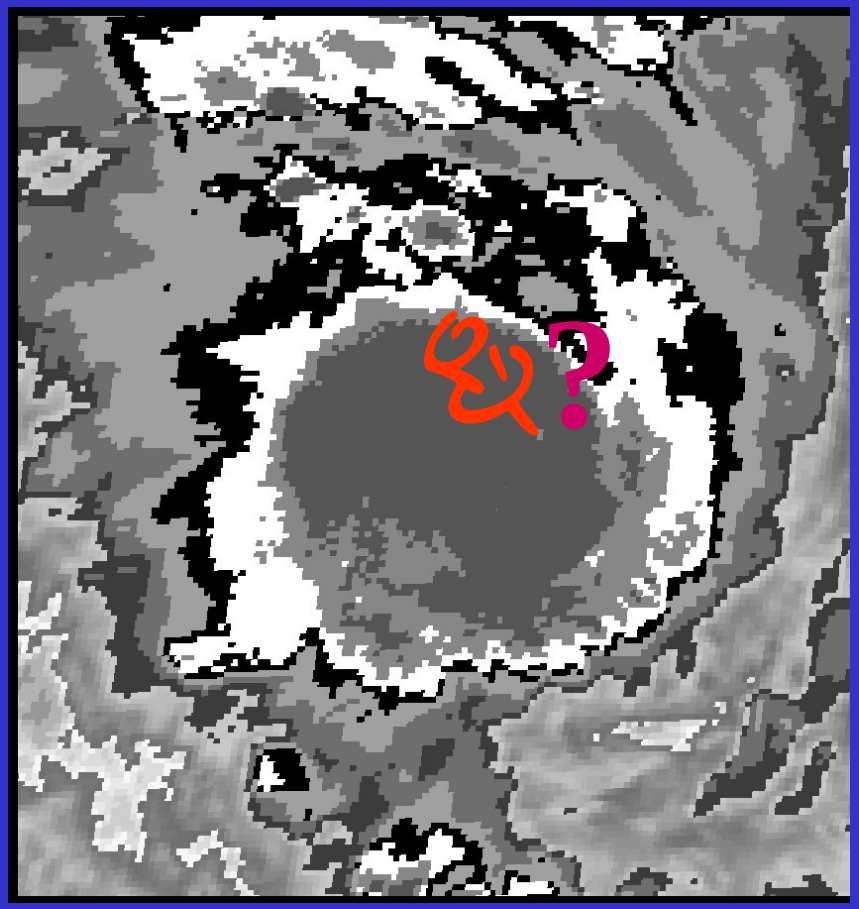
Incorrect positioning (Technique is very position dependent)

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

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

EMBEDDED CENTER
Where is the Center?

- Look for a warm spot.
- Look toward the edge with the tightest temperature gradient.
- *Will higher resolution help?*
- ***** Subject to the most errors in positioning and intensity estimate***



What we need:

A sensor or method to see the Low Level Clouds

Dvorak Intensification Estimates
(not as easy to fix)

- Start too late (genesis) (‘low and slow’)
- Use of spiral band curvature, when should be using shear, maybe embedded or eye
- 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

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

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

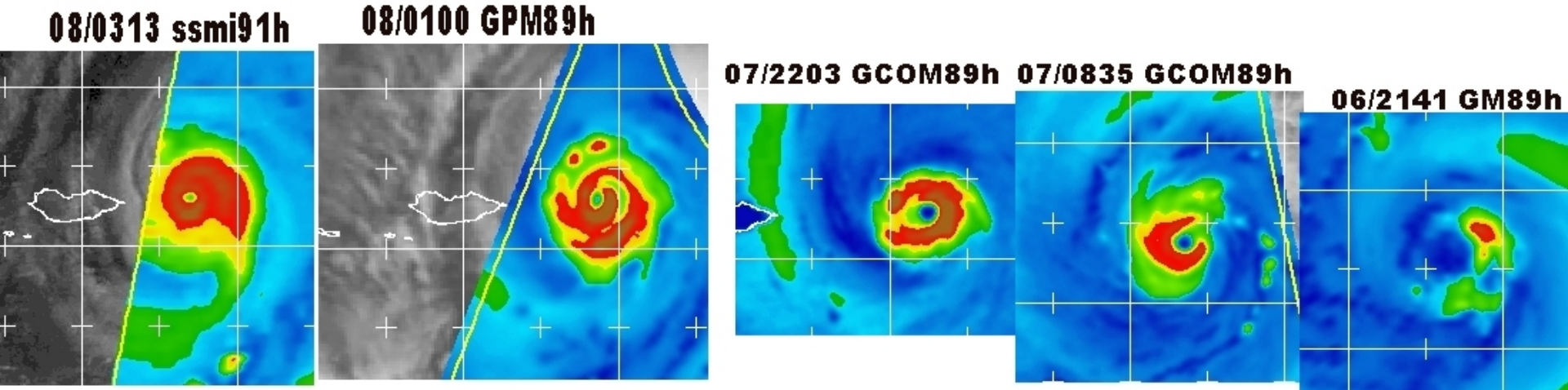
- Pin-hole eyes
- Very small and very large circulations
- "Truck Tires"
- Extratropical transition
- Sudden shear with an existing (high) wind pattern in monsoon or strong trades
- Eyewall replacement cycle

What we need:
A sensor or method to identify the *changes* in the location of Rain and Wind (intensification)

Data Types Used

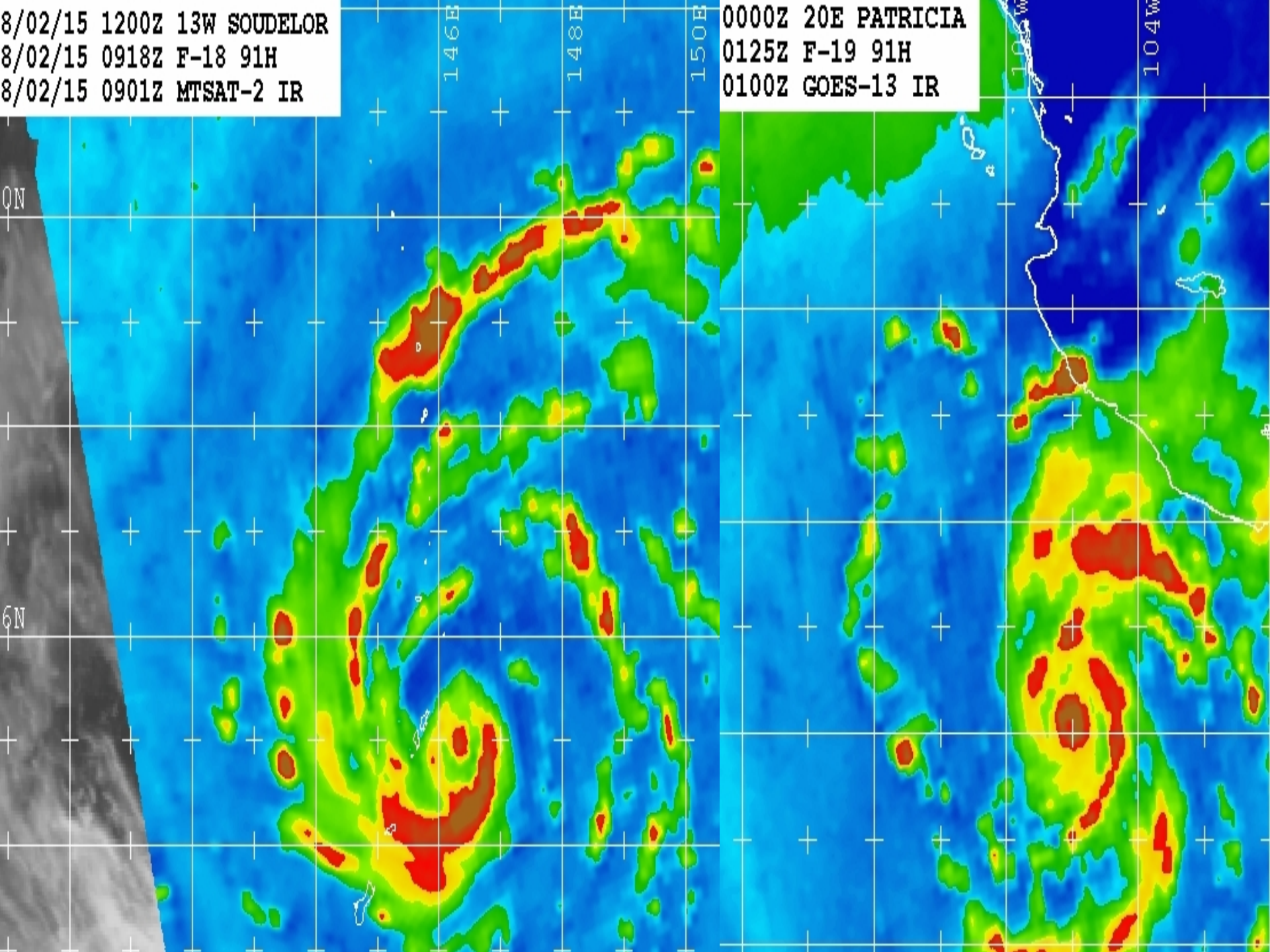
Visual	**High Resolution , Can see the low-level cloud lines, especially in animation**
Infrared	**Easy to see deep convection, 24hr view**
MI (85GHz)	**Deep rain bands and lower atmosphere moisture**
MI (37GHz)	**Early, less developed rain bands, compare with scatterometer**
Scatterometer	**Surface wind field and characteristics (must use ambiguities!)**
New RGB Products	**Perhaps can simulate what the MI ‘sees’**

Tropical Cyclone Megh (05A) Approaching Socotra Is.



“My” MI estimates ‘at least’ Cat 4

Some agency estimates as low as 70 knots…


8/02/15 1200Z 13W SOUDELOR
8/02/15 0918Z F-18 91H
8/02/15 0901Z MTSAT-2 IR
146E
148E
150E
0000Z 20E PATRICIA
0125Z F-19 91H
0100Z GOES-13 IR
104W

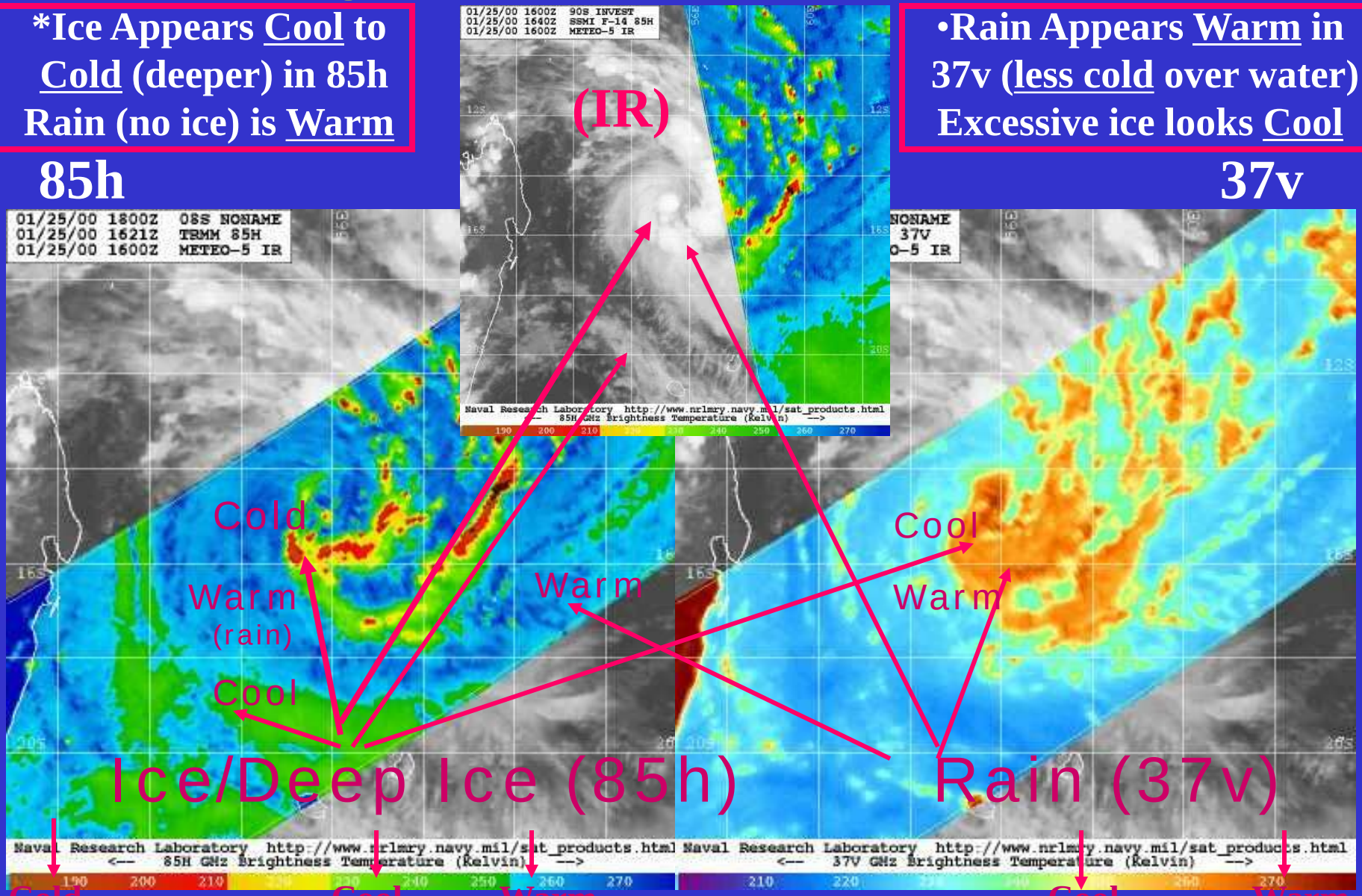
Understanding Microwave Imagery

- ‘Sees’ through clouds
- Able to position TCs in difficult situations (especially in EARLY (and LATE) stages of development)
- View of convective rain bands is more DIRECTLY related to intensity of the TC
- Much better than IR showing eye-wall intensifying/weakening trend
- 37GHz is able to examine clouds and moisture closer to the surface than 85GHz (or IR)

Microwave Imagery **(*Training Required*)**
Viewing Interpretation- *Ice/Deep Ice/ Rain*

*Ice Appears Cool to Cold (deeper) in 85h
Rain (no ice) is Warm

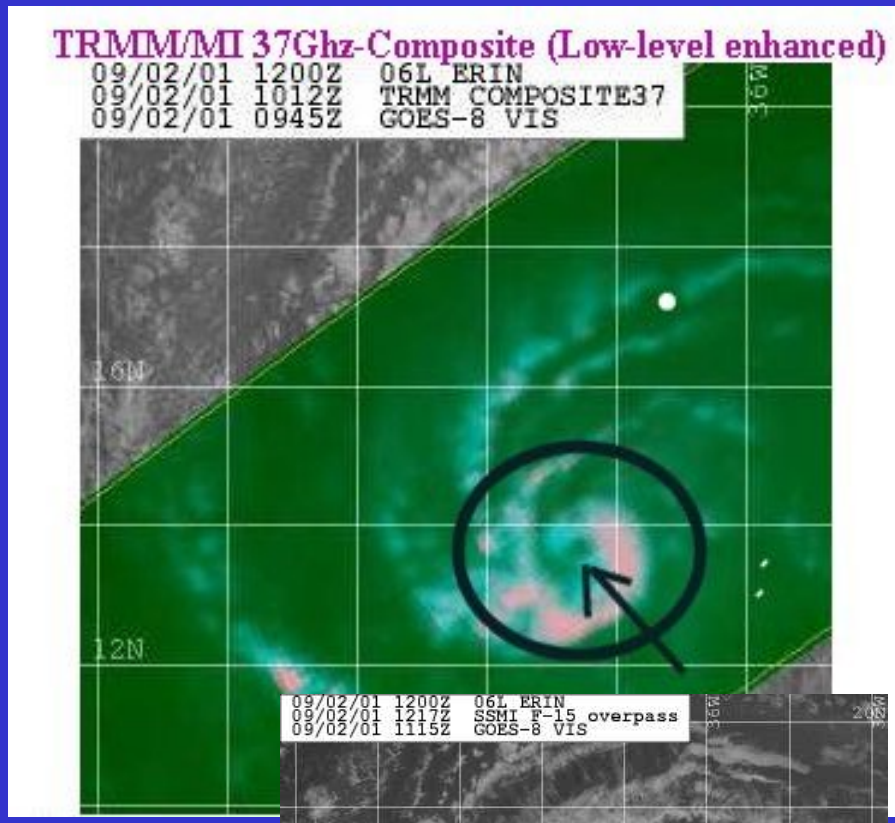
•Rain Appears Warm in 37v (less cold over water)
Excessive ice looks Cool

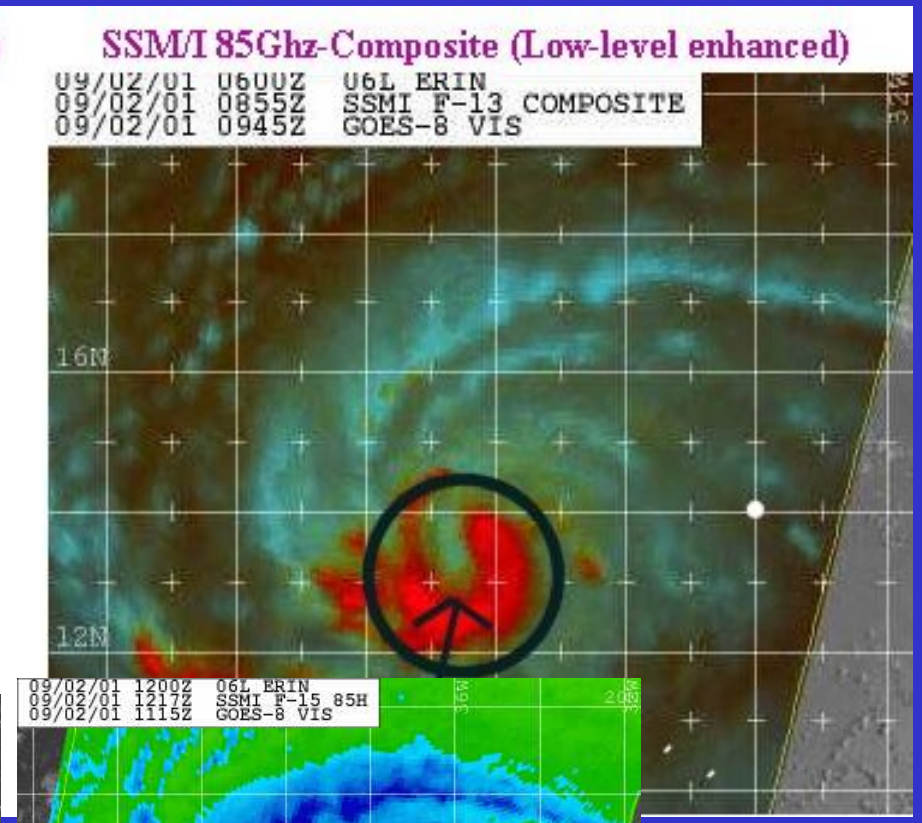


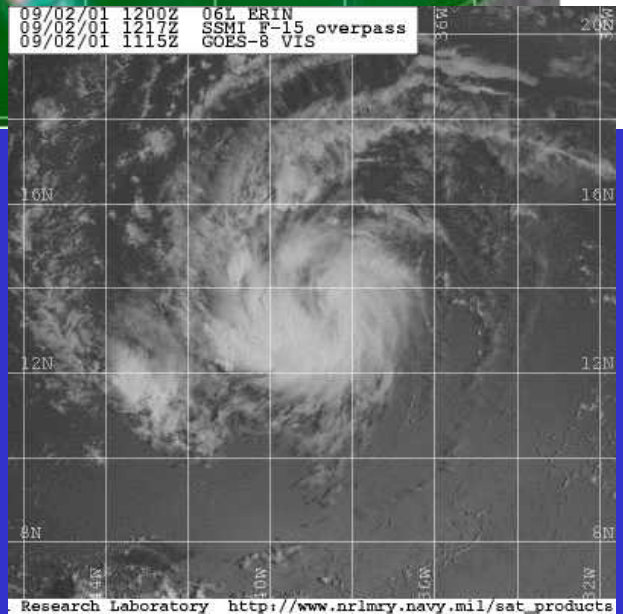
Point #2: Problems with routinely using MI data

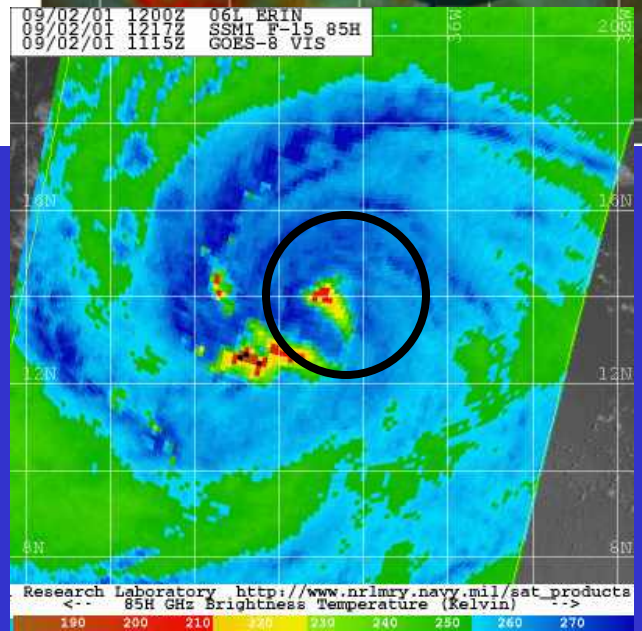
- Not all sites are accessible to all Countries
- Some agencies ‘require’ their own gridding or calibration
- Unhappy with coverage or timeliness (*forget to use as a ‘best position/intensity known’ since last pass*)
- Unfamiliar with characteristics of various sensors
- Lack of using multiple frequencies 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!

Positioning with microwave (use everything you got!)



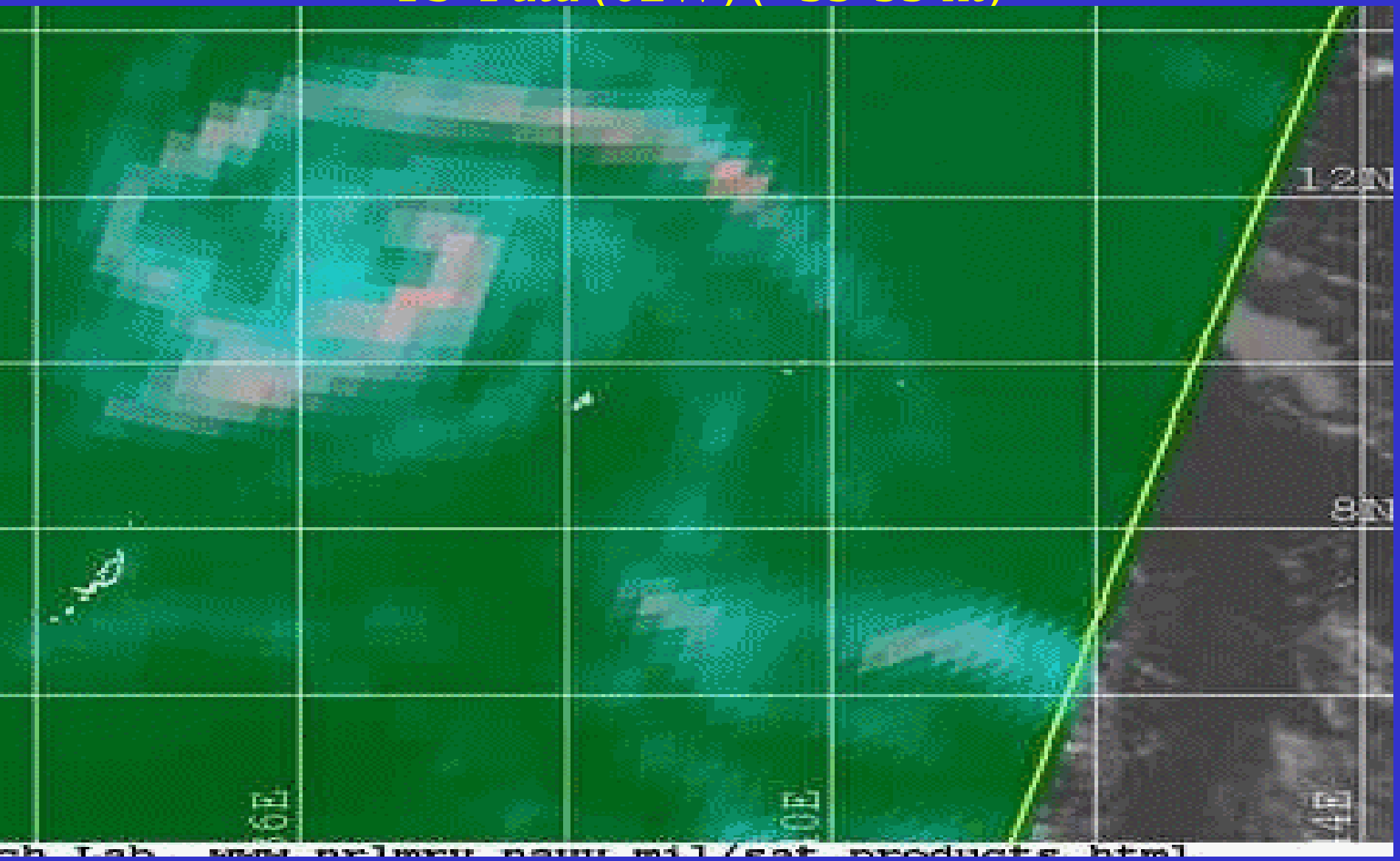






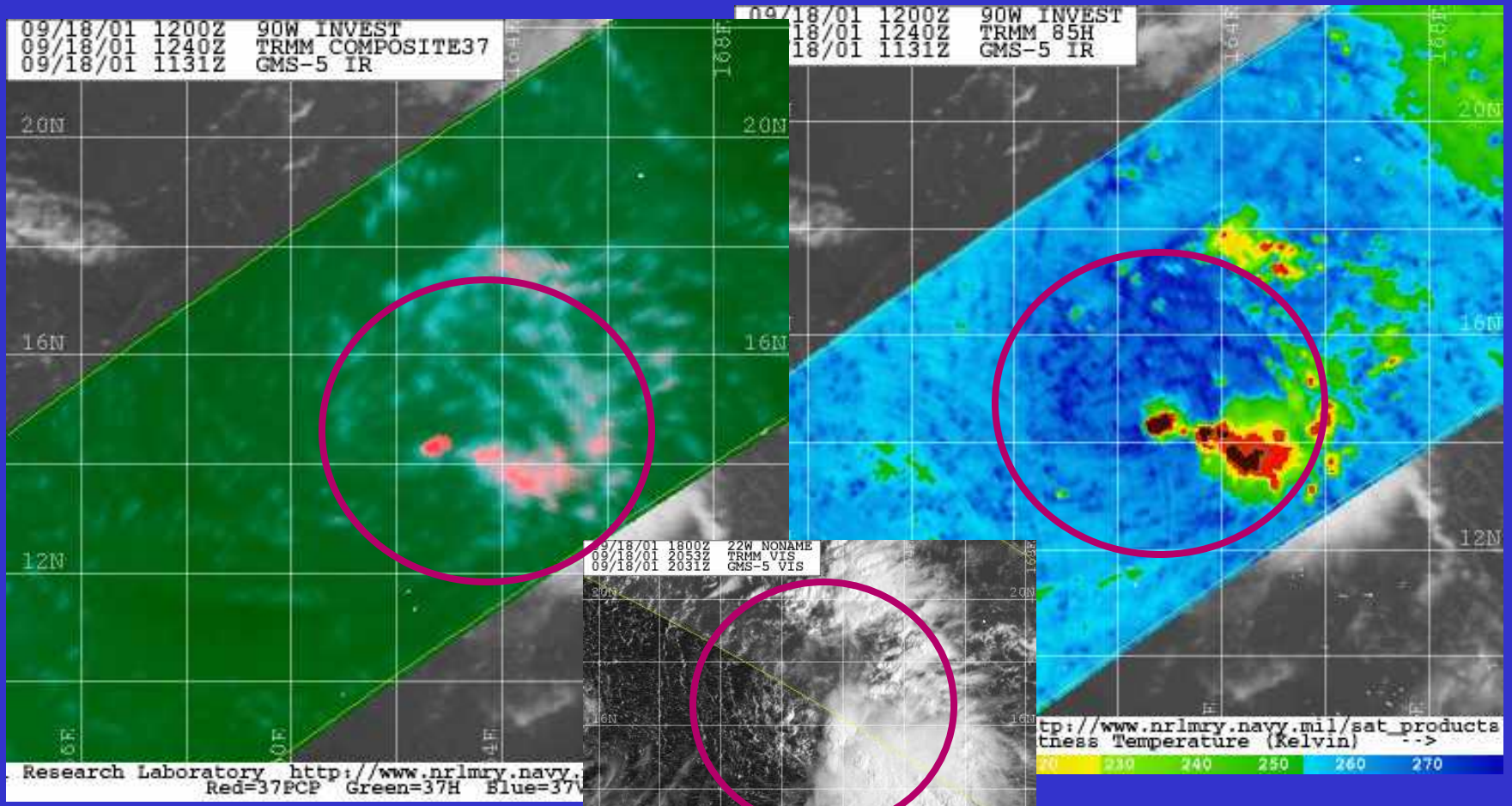
37 GHZ 3-hr Animation

TS Yutu (02W) (~35-55 kt)



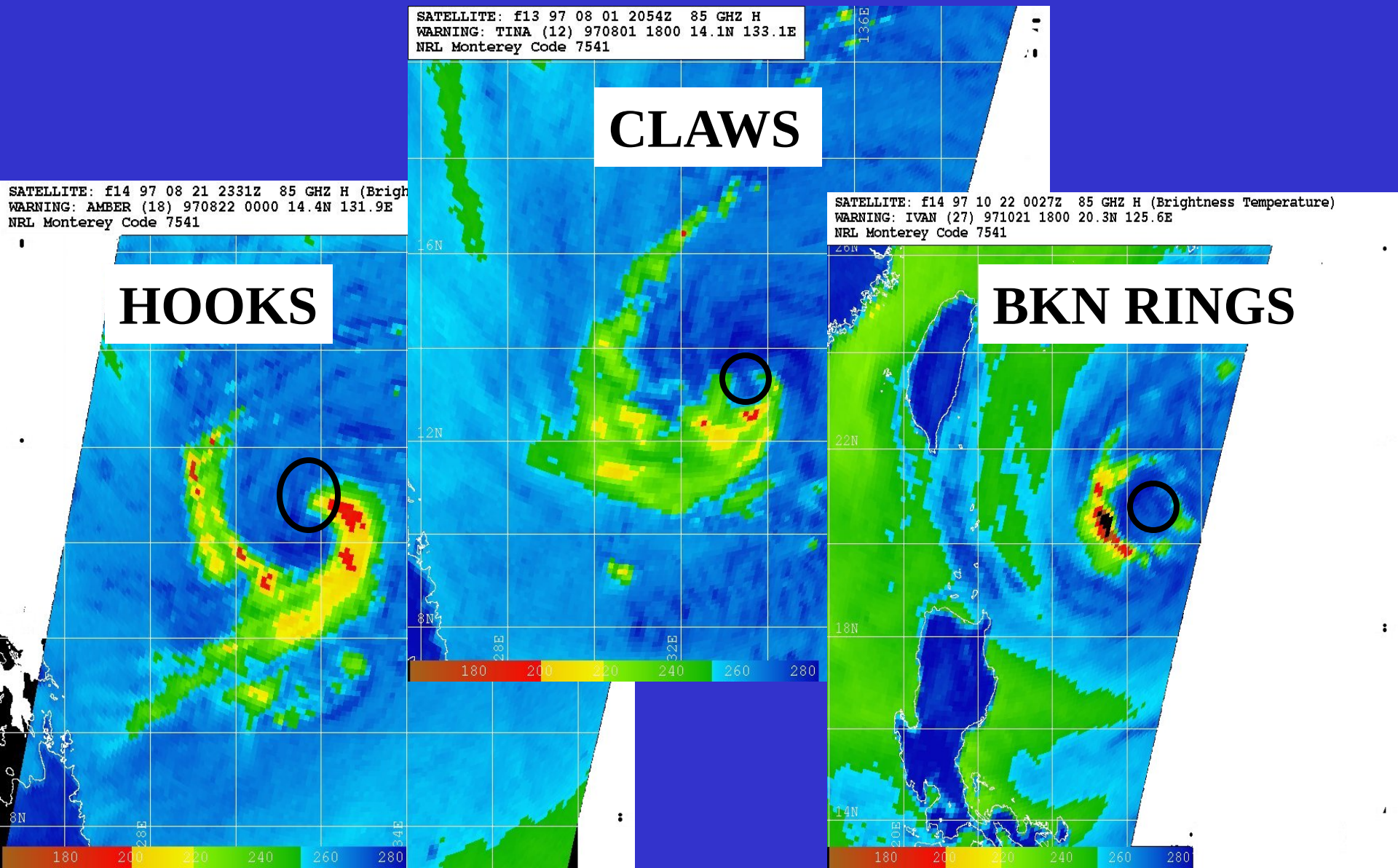
Stage 1

(Pre-Typhoon Francesco-25kts)

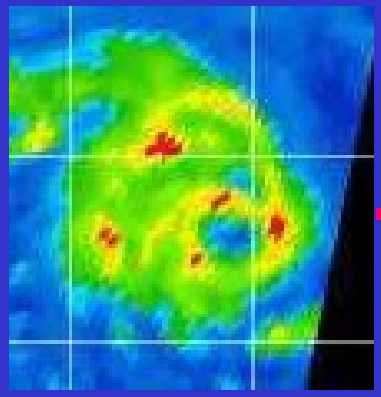


Positioning and Intensity with microwave – 85GHz

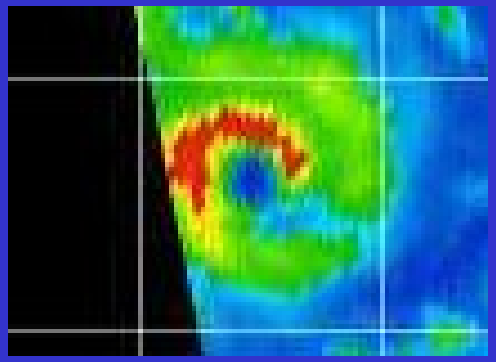
TIP of the HOOK…or within the 'Claw'…or Enclosed



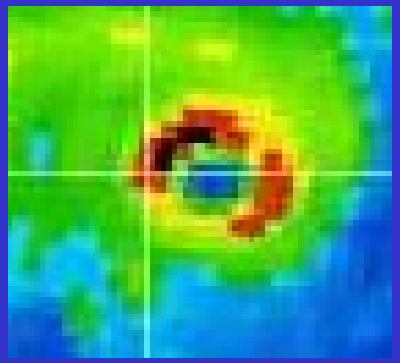
EVALUATIONS OF CAT5/SUPER TYPHOONS (85h)
VIEWS: Time changes in red inner eyes



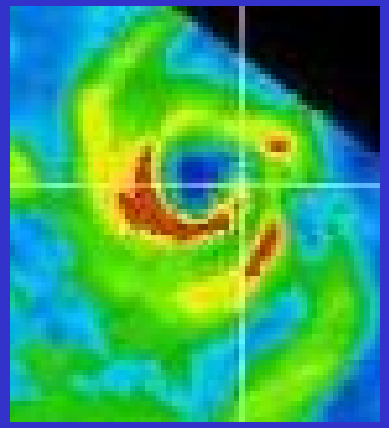
TC Susan 70kt -26hr



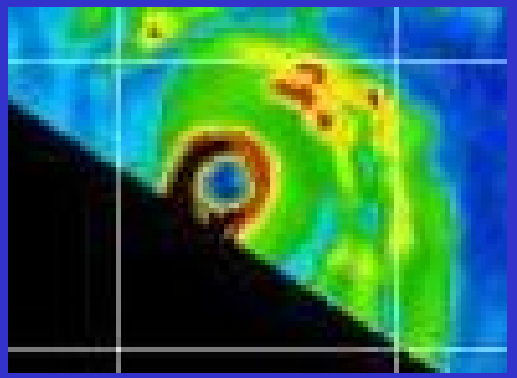
TC Susan 95kt -13hr



TC Susan 120kt -06hr



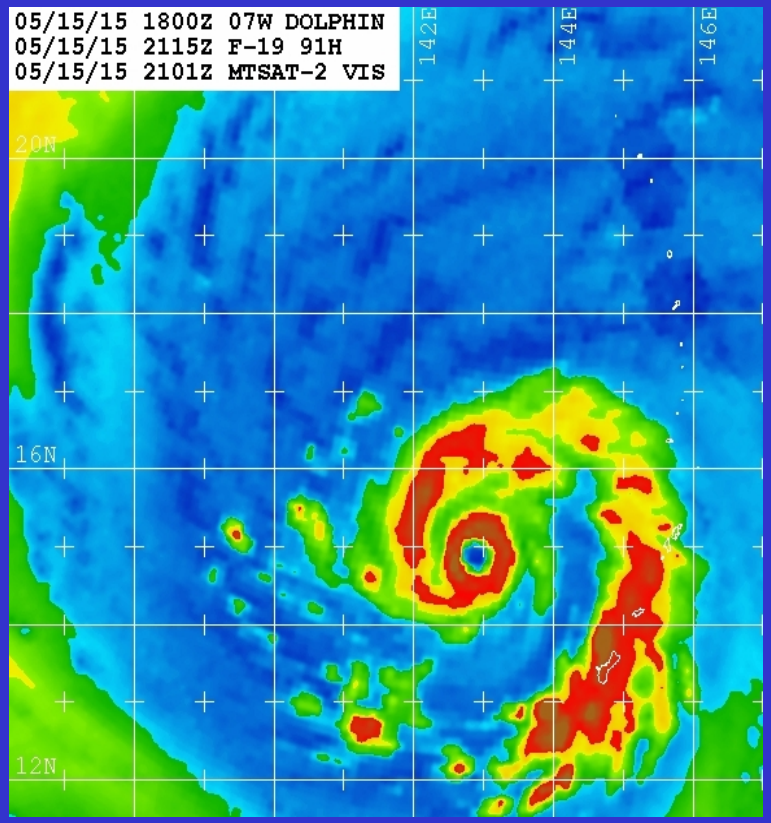
STY Zeb 95kt -24hr



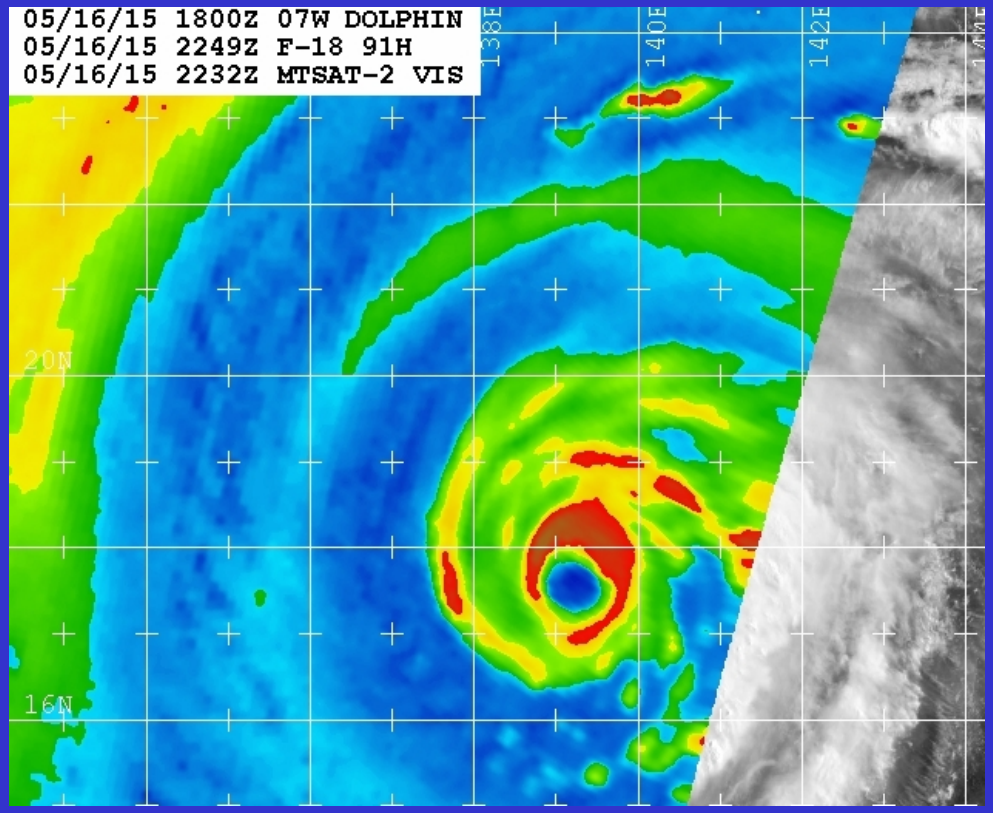
STY Zeb 140kt -00hr

Peaking Tendency
(Dvorak does not tell you this!)

15May 2115Z



16May2249Z

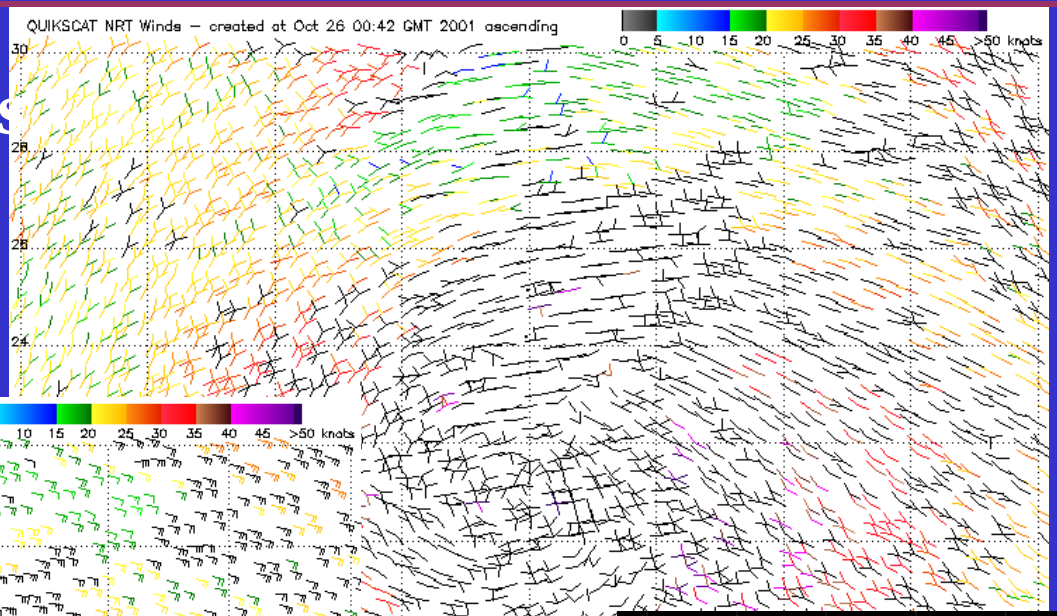


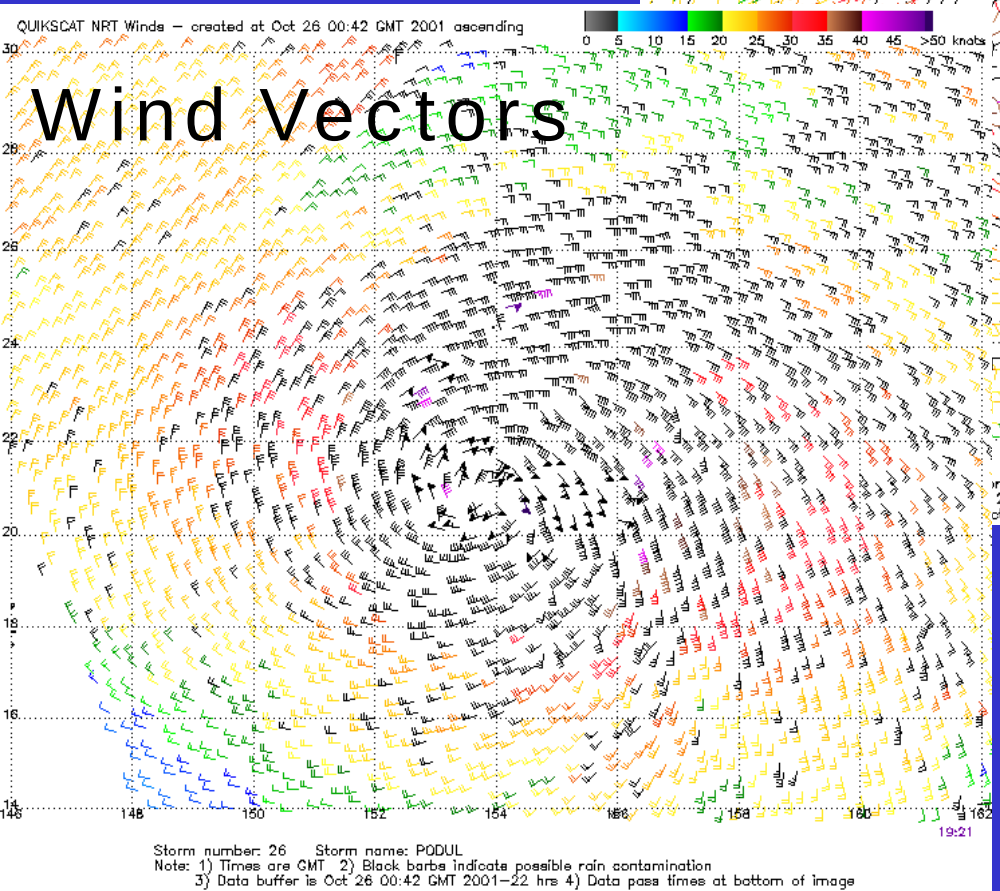
Forecast is for continued intensification

Three Views of Scatterometer

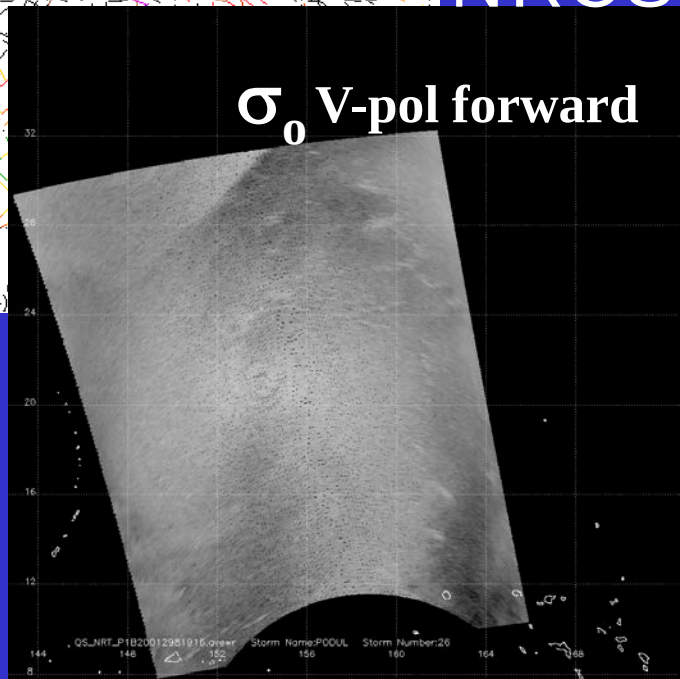
Ambiguity Solutions

Wind Vectors

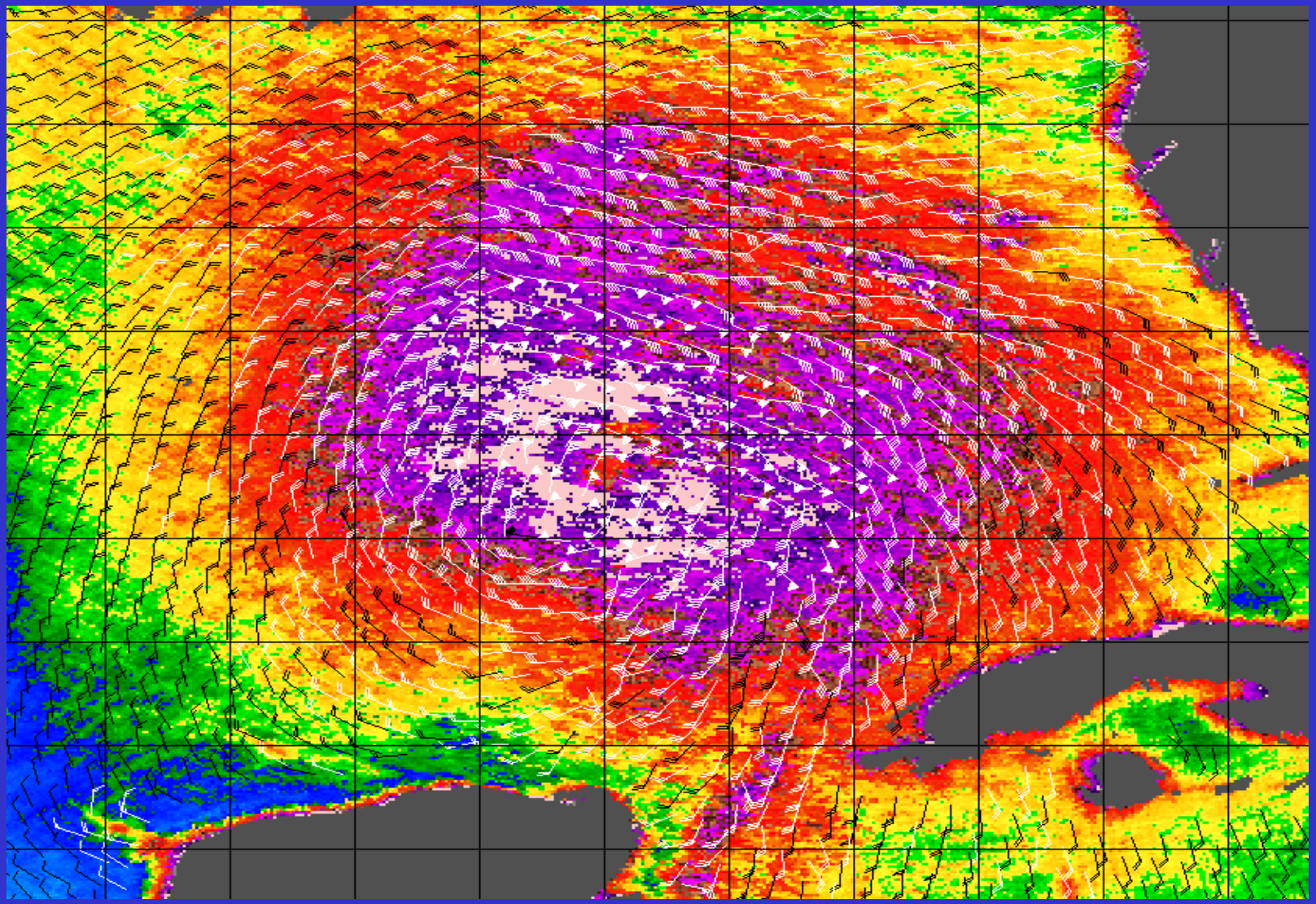




NRCS



Ultra Hi-Res (~6km data)



Point #3: Problems with routinely using Scatterometer data

- Not familiar with characteristics scat data (good and difficult points…and how to overcome)
- Too afraid of using in rain!
- Not routinely available on your site
- Importance of using ambiguity data
- Unfamiliarity of high resolution display and NRCS products

- OSWT Home
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  - OSCAT
  - RapidSCAT
  - ASCAT (METOP-A)
  - ASCAT (METOP-B) >>
  - WindSAT
  - ERS-2
  - SSM/I
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Advanced Search

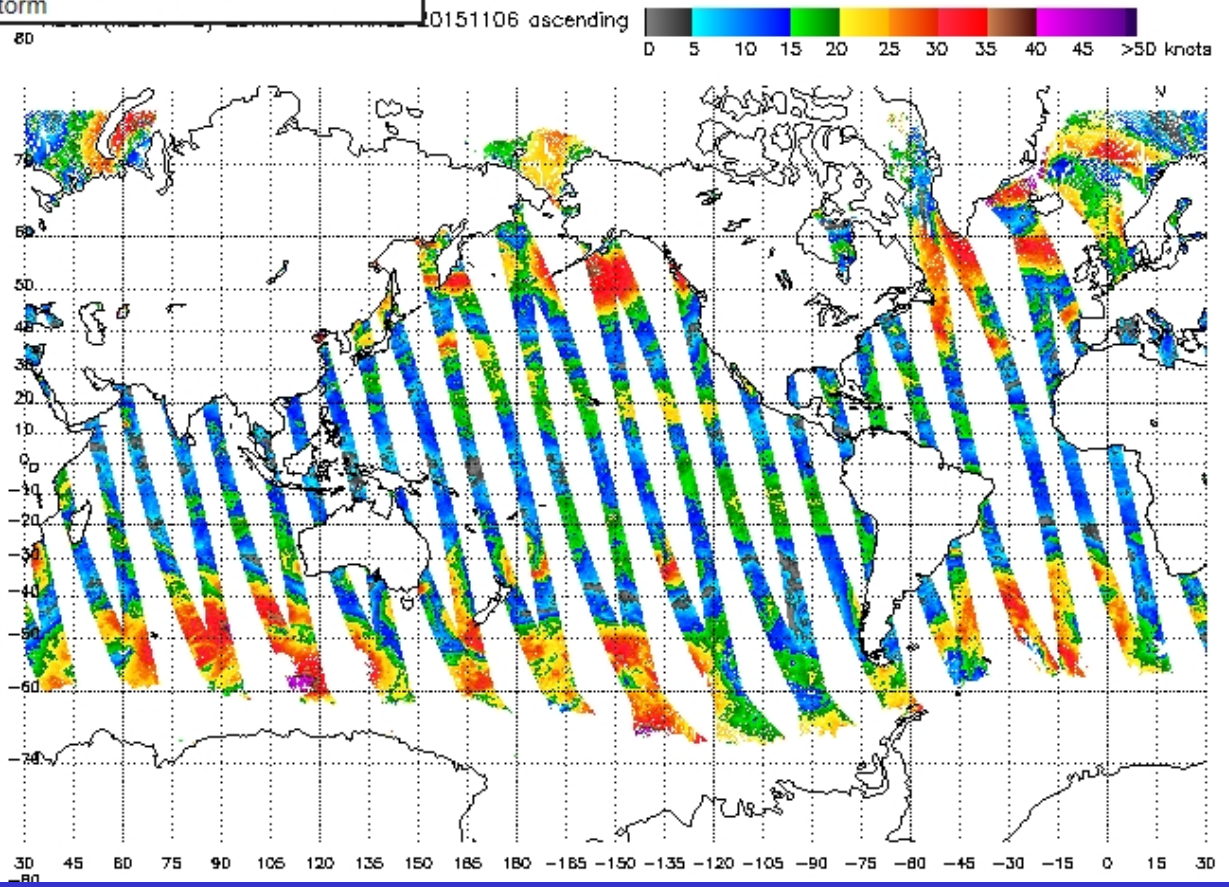
Data from Satellite/Instruments: Advanced Scatterometer (ASCAT METOP-B)

Additional Products: NOAA wind vectors 10x15 (25KM) | Year | Month: 11 | Day: 7 | Get Images

- NOAA wind vectors 10x15 (25KM)
- NOAA wind vectors 20x30 (50KM)
- NOAA Directional Ambiguity (25KM)
- NOAA Directional Ambiguity (50KM)
- Storm

Global(80N80S-180E180W)

Ascending Pass



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Data from Satellite/Instruments: Advanced Scatterometer (ASCAT METOP-B)

Additional Products: Storm | Year: 2015 | Storm_ID: FIVE | Get Images

- ( ) Atlantic ocean
- ( ) Eastern pacific
- ( ) Western pacific
- ( ) Central pacific
- (•) Indian ocean
- ( ) Southern Hemisphere

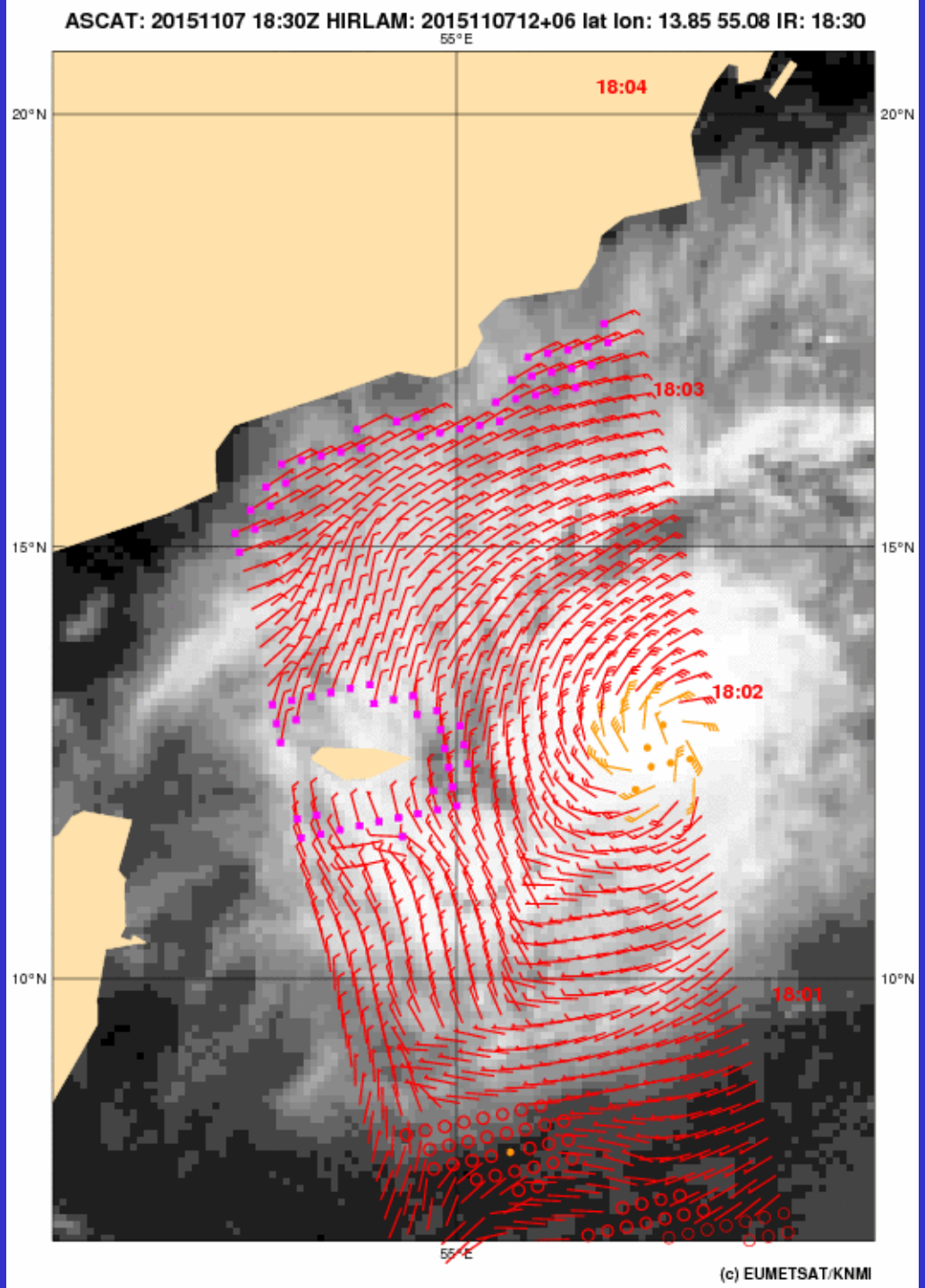
Wind Vector Images:
FIVE_15110507_05_as FIVE_15110507_05_ds
FIVE_15110513_05_as FIVE_15110513_05_ds

Ambiguity Images:
FIVE_15110507_05_as FIVE_15110507_05_ds
FIVE_15110513_05_as FIVE_15110513_05_ds

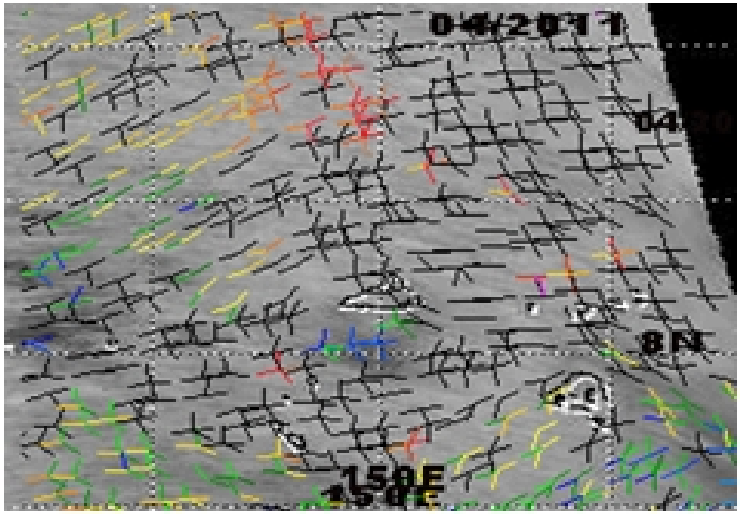
25Km Wind Vector Images:
FIVE_15110507_05_as FIVE_15110507_05_ds
FIVE_15110513_05_as FIVE_15110513_05_ds

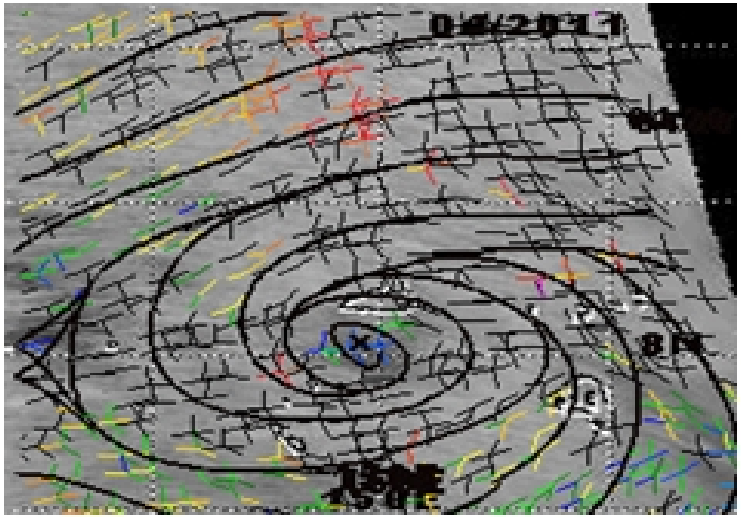
NRCS Images:
16239_FIVE_151105_0600.avewr
16246_FIVE_151105_0600.avewr
16246_FIVE_151105_1200.avewr

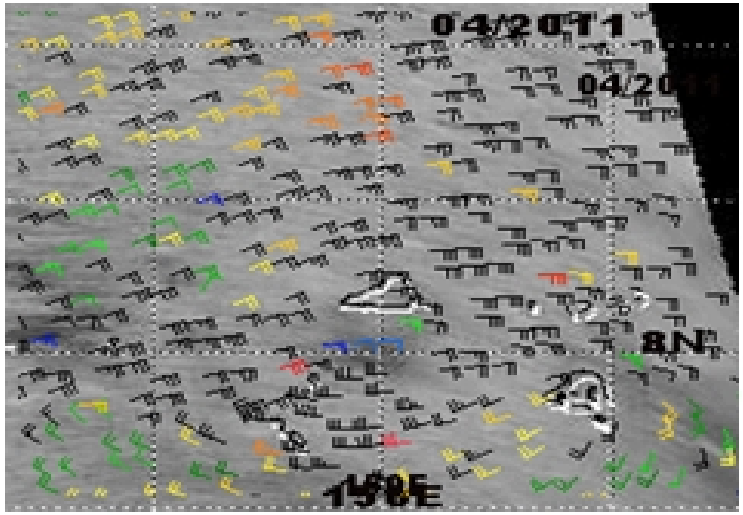
BYU Hires Images:
16239_FIVE_151105_0600.WRave3_map


ASCAT: 20151107 18:30Z HIRLAM: 2015110712+06 lat lon: 13.85 55.08 IR: 18:30
55°E
18:04
20°N
20°N
18:03
15°N
15°N
18:02
10°N
10°N
18:01
55°E
(c) EUMETSAT/KNMI

QuikSCAT Normalized Radar Cross-Section with Winds and Ambiguities







Method of obtaining RMW with Scatterometer

And…almost exact positioning!!

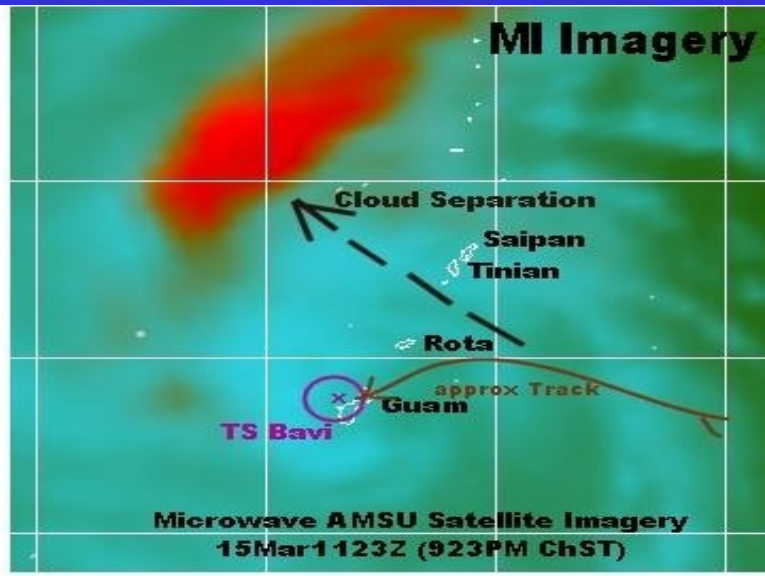
Common misconceptions with Scatterometer

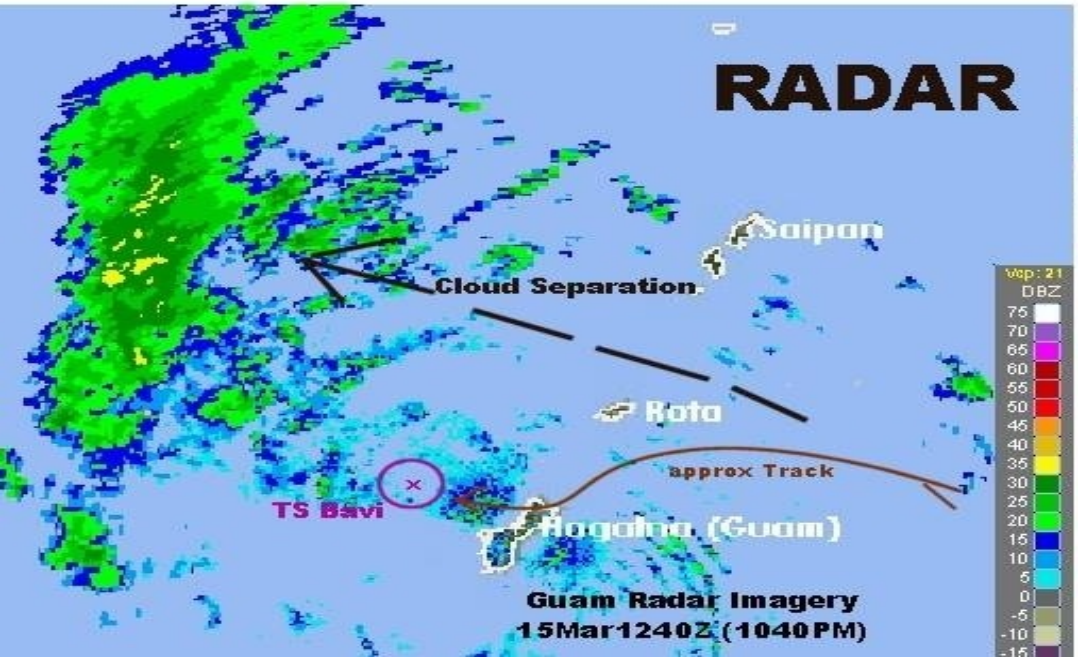
- Inability to combine with other data
- Importance of knowing ‘where the center CANNOT be located’
- Importance of knowing the difference of good ‘outer winds’ as well as acknowledging good (at least this high…if not more) wind speeds into the center
- Not familiar with the EASE of using to find the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

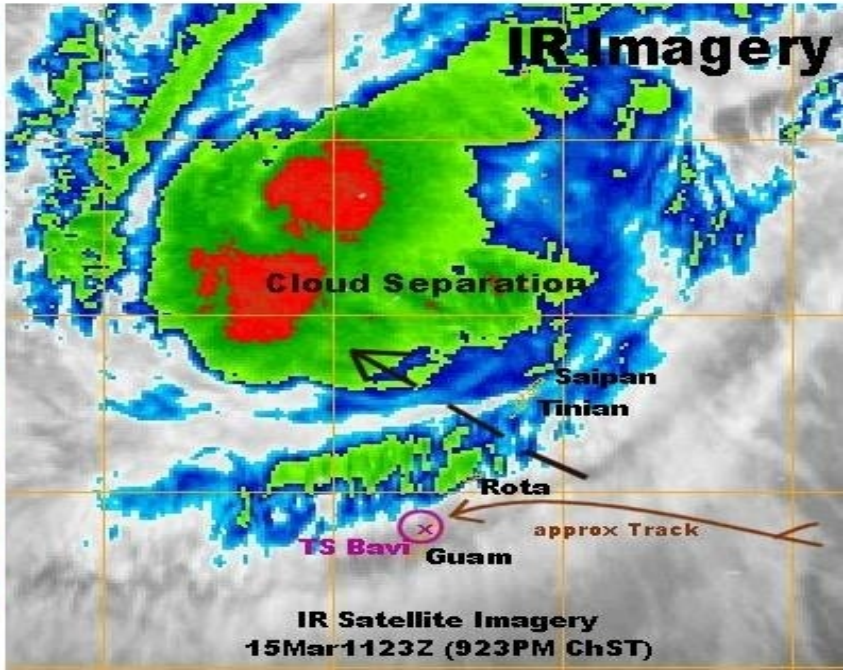
Case Example: TS Bavi

Movement and Cloud Separation of Tropical Storm Bavi (03W) on March 15, 2015

Wind Gusts (at time of separation)
Up to ~70mph at Saipan and Tinian
Up to ~50mph at Rota and Guam







ASCAT Scatterometer View of Tropical Storm Bavi (03W)
Passage through the Marianas
15 March 2015

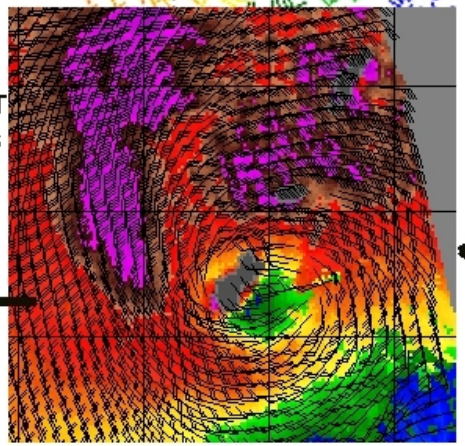
15Mar1216Z

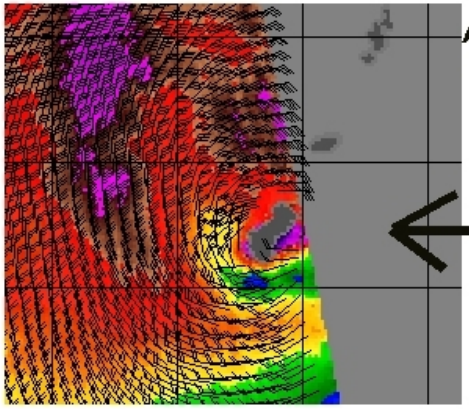
15Mar1124Z

15Mar0018Z

ASCAT
25km Vector
(NASA/NESDIS)

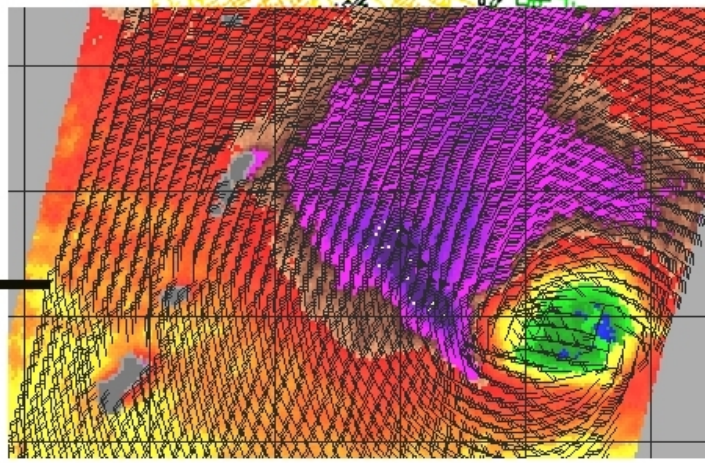
ASCAT
25km Vector
(NASA/NESDIS)

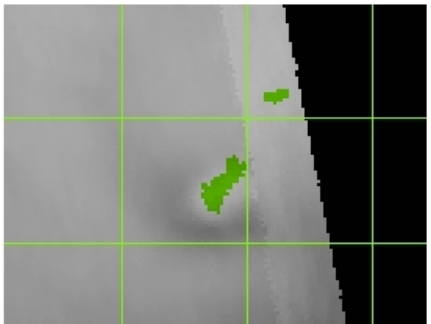




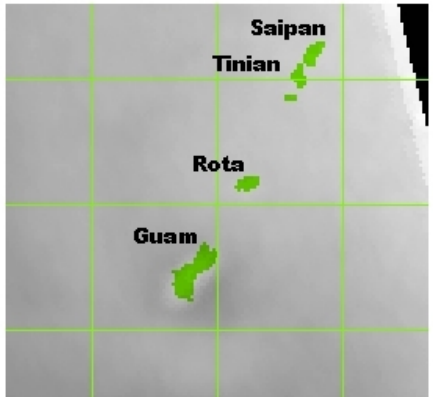
ASCAT
HiRes
(BYU)

ASCAT
HiRes
(BYU)





(NRCS)



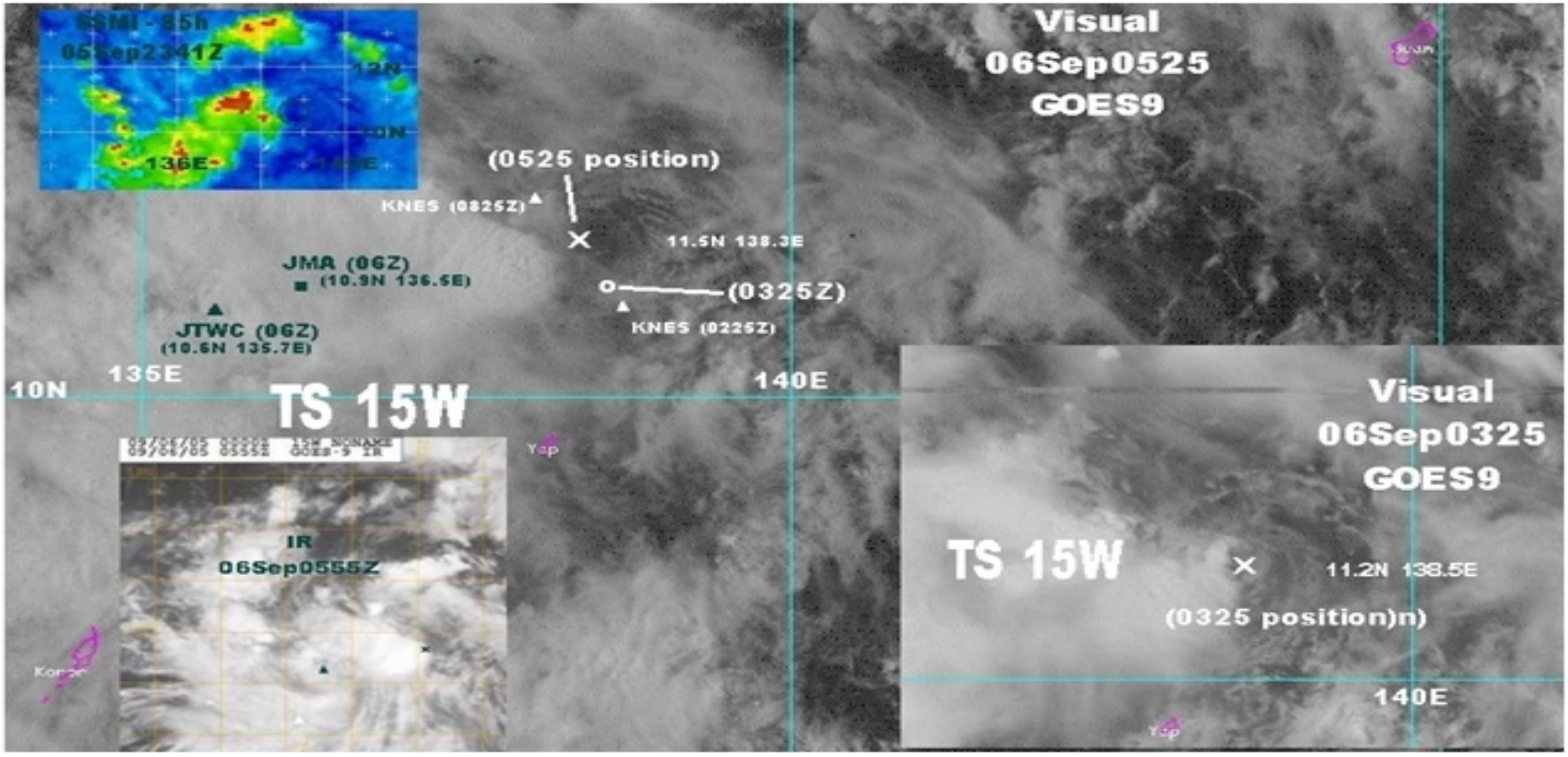
(NRCS)

Point #4: 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)

Integrated Satellite Reconnaissance Using MI--TRMM (85 GHz) and Scatterometer and VIS/IR



Dominance of Geostationary Imagery

The numerous 'Red' geostationary fixes can easily dominate in best-tracking determination. The 'Blue' MI and Scatterometer fixes (triangles, squares and diamonds are related to PCN) will have less influence even if more accurate.

Questions?