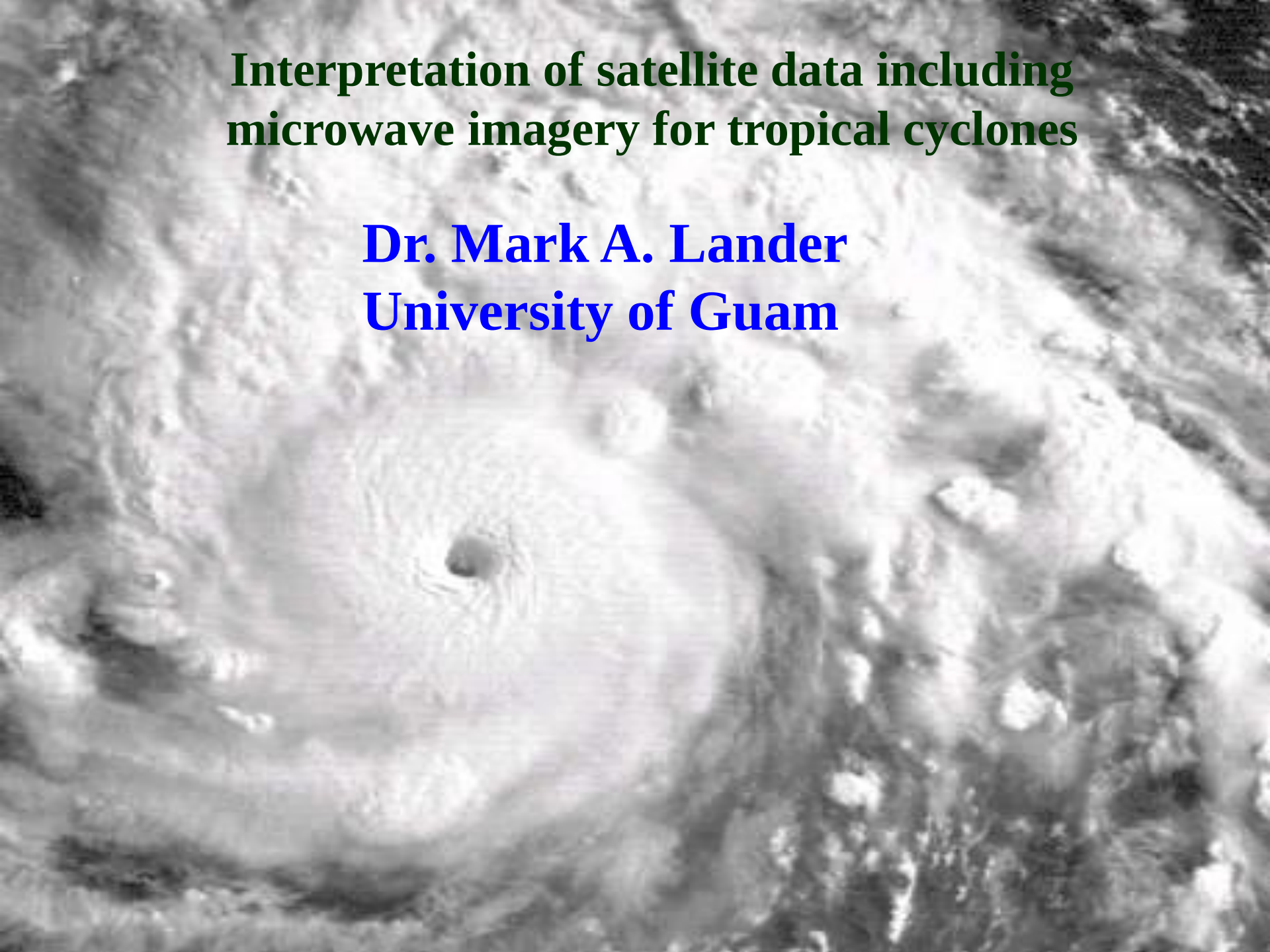
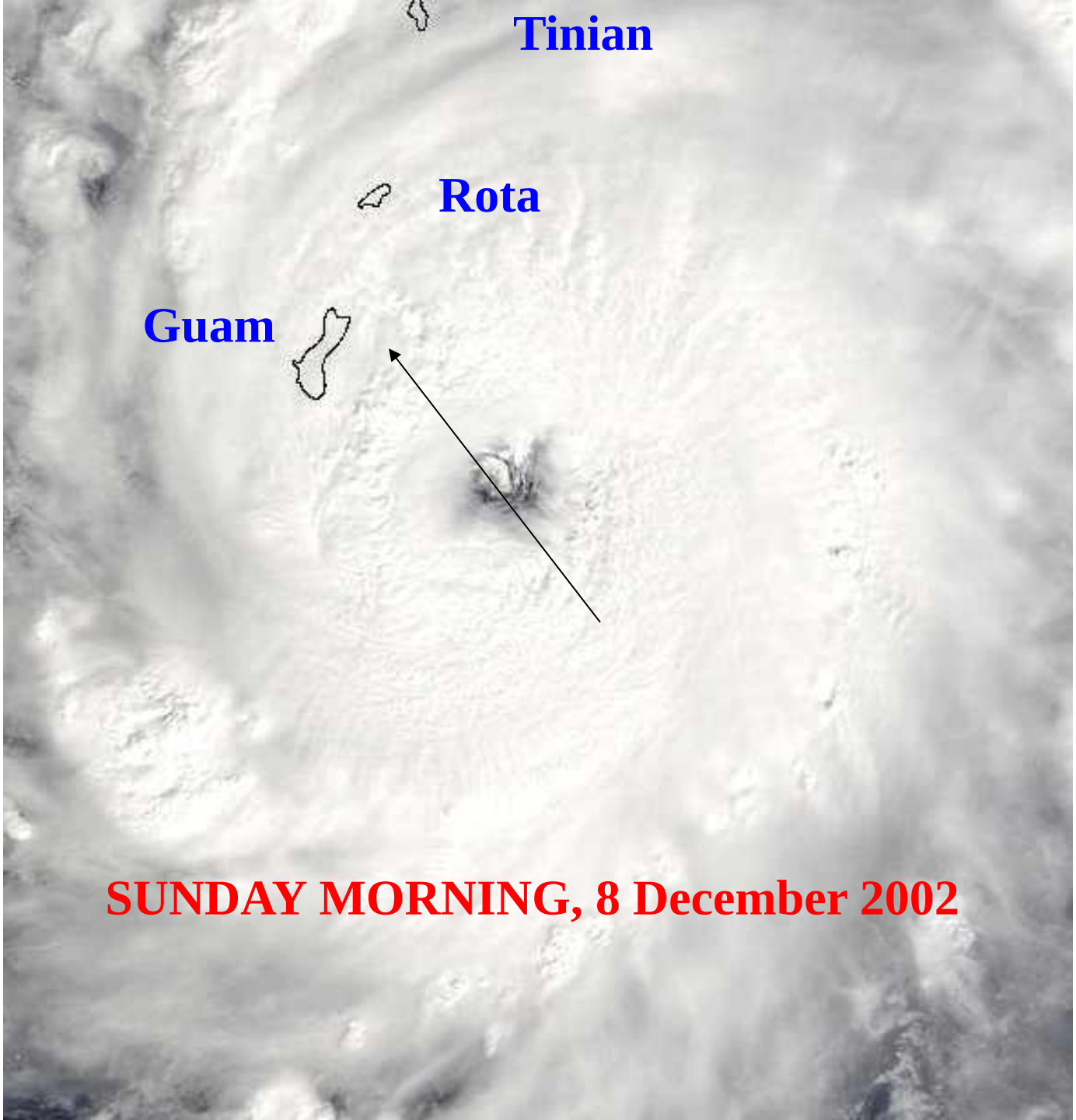


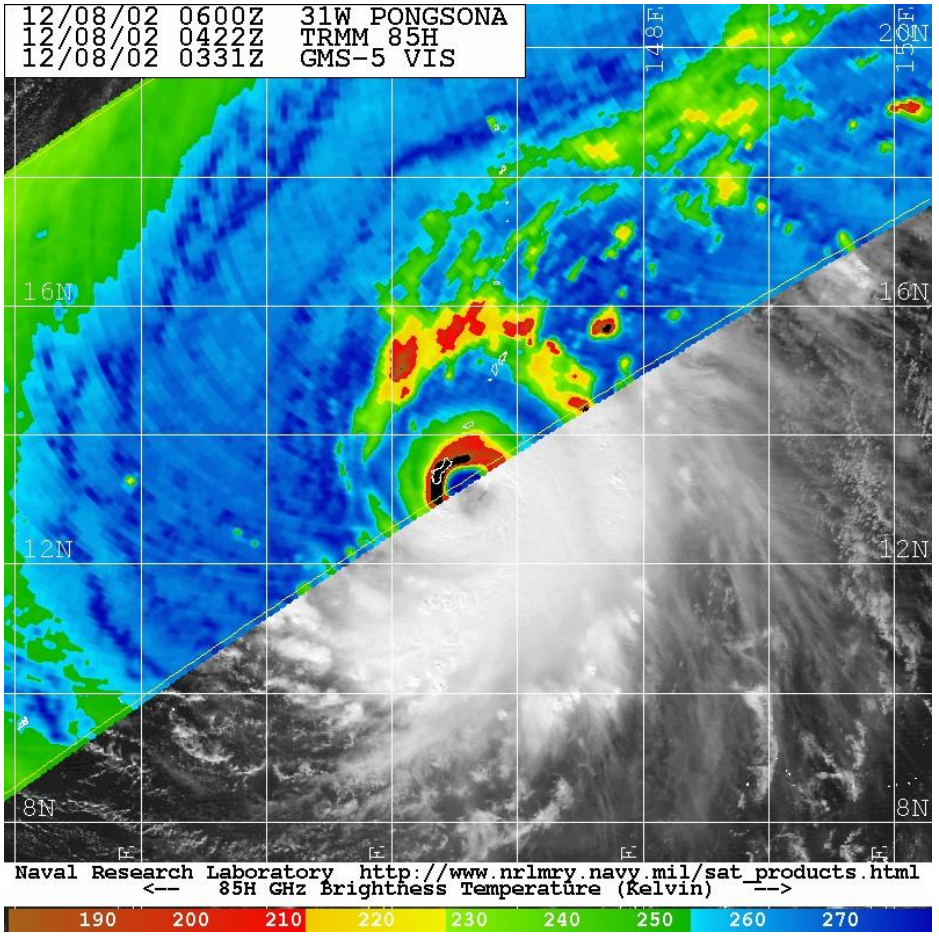
Interpretation of satellite data including microwave imagery for tropical cyclones

Dr. Mark A. Lander
University of Guam

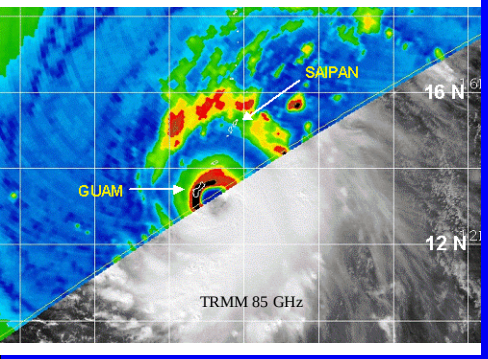

Tinian
Rota
Guam
SUNDAY MORNING, 8 December 2002

Gasoline storage tanks on fire. (Lightning ??)

TRMM 85 GHz
0422 UTC 08 Dec 2002



- **(Left)** Broken glass door at the Guam Memorial Hospital. **(Right)** Dislodged internal wall in the pediatrics ward of the Guam Memorial Hospital. Assessment authors Chip Guard, Art Chiu, and Mark Lander appear from left to right.



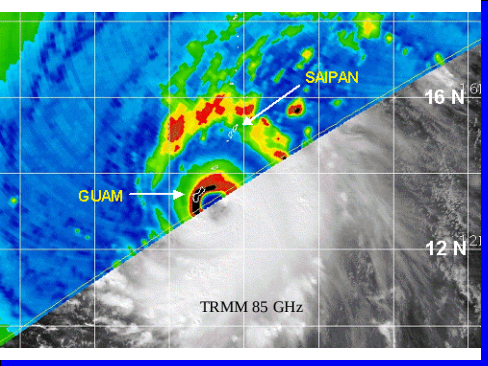
Applications of Microwave Imagery for Tropical Cyclone Diagnostics

APPLICATIONS

*TC POSITION

*TC INTENSITY

* TC WIND DISTRIBUTION



Applications of Microwave Imagery for Tropical Cyclone Diagnostics

Remote Sensing Resources

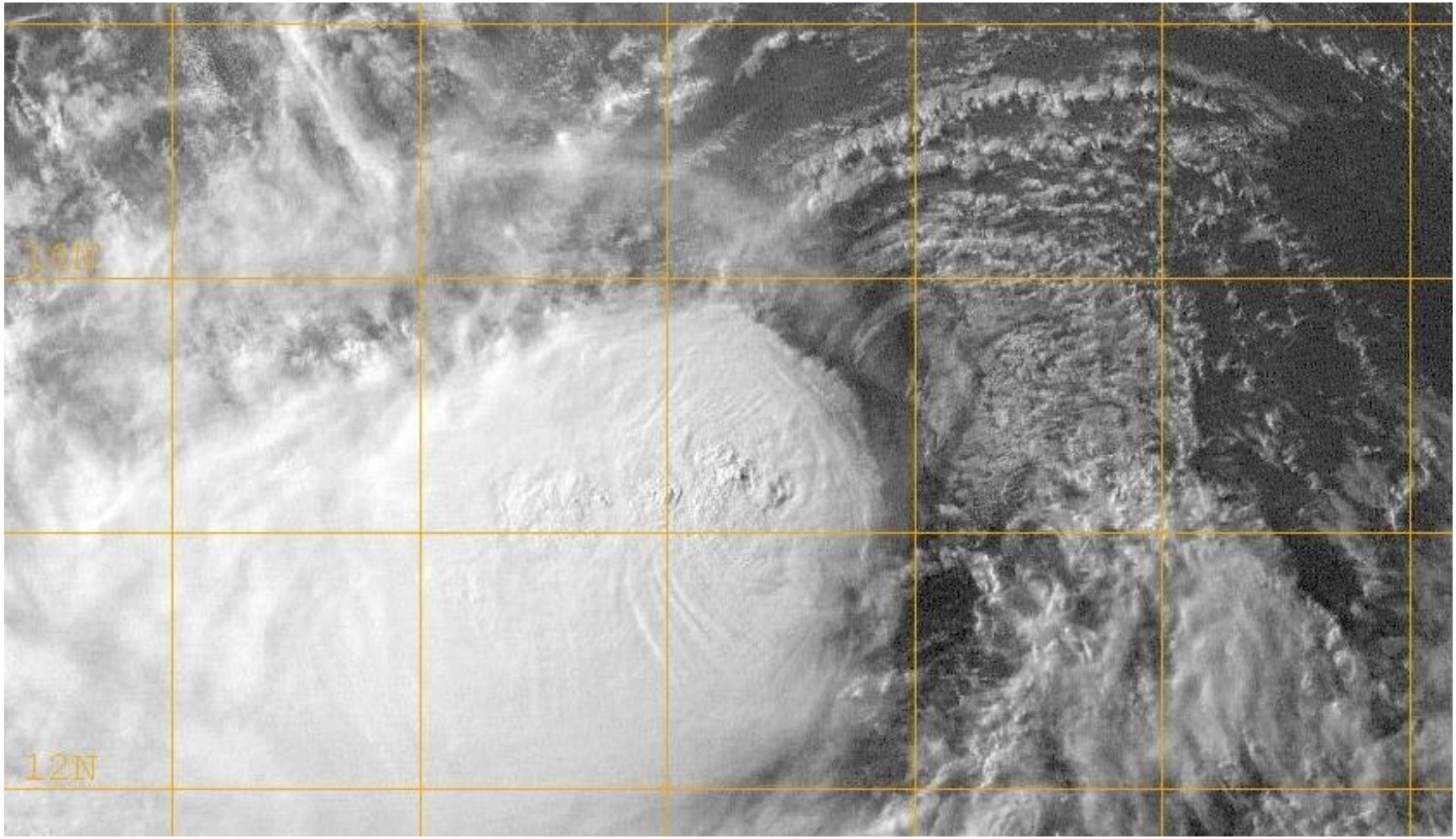
*Defense Meteorological Satellite Program (DMSP): Special Sensor Microwave/Imager (SSM/I)

*Tropical Rainfall Measurement Mission (TRMM): Active and Passive Microwave

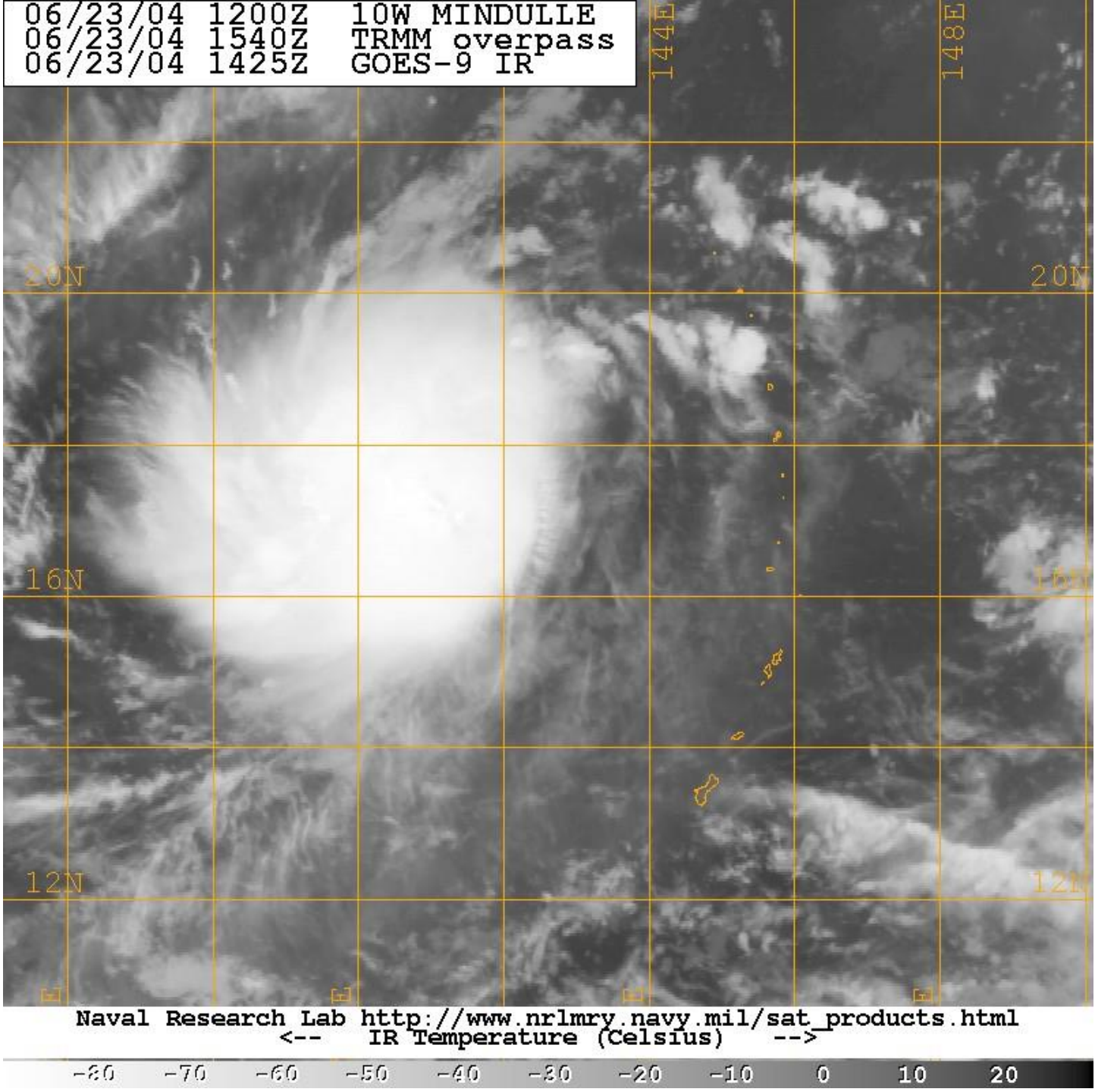
* Quikscat: Active radar

* AMSR-E: Passive Microwave

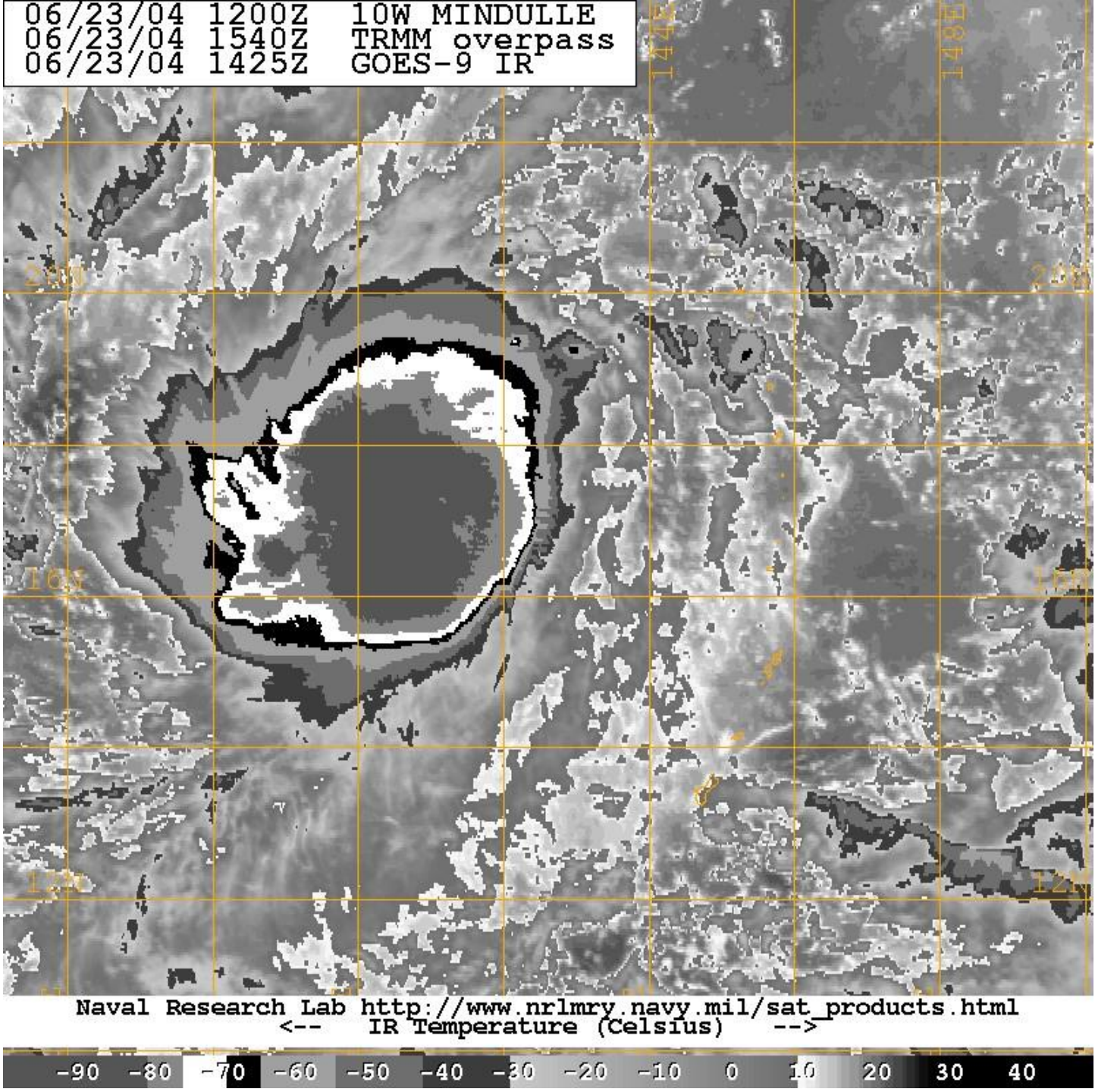
GOES-9
Visible



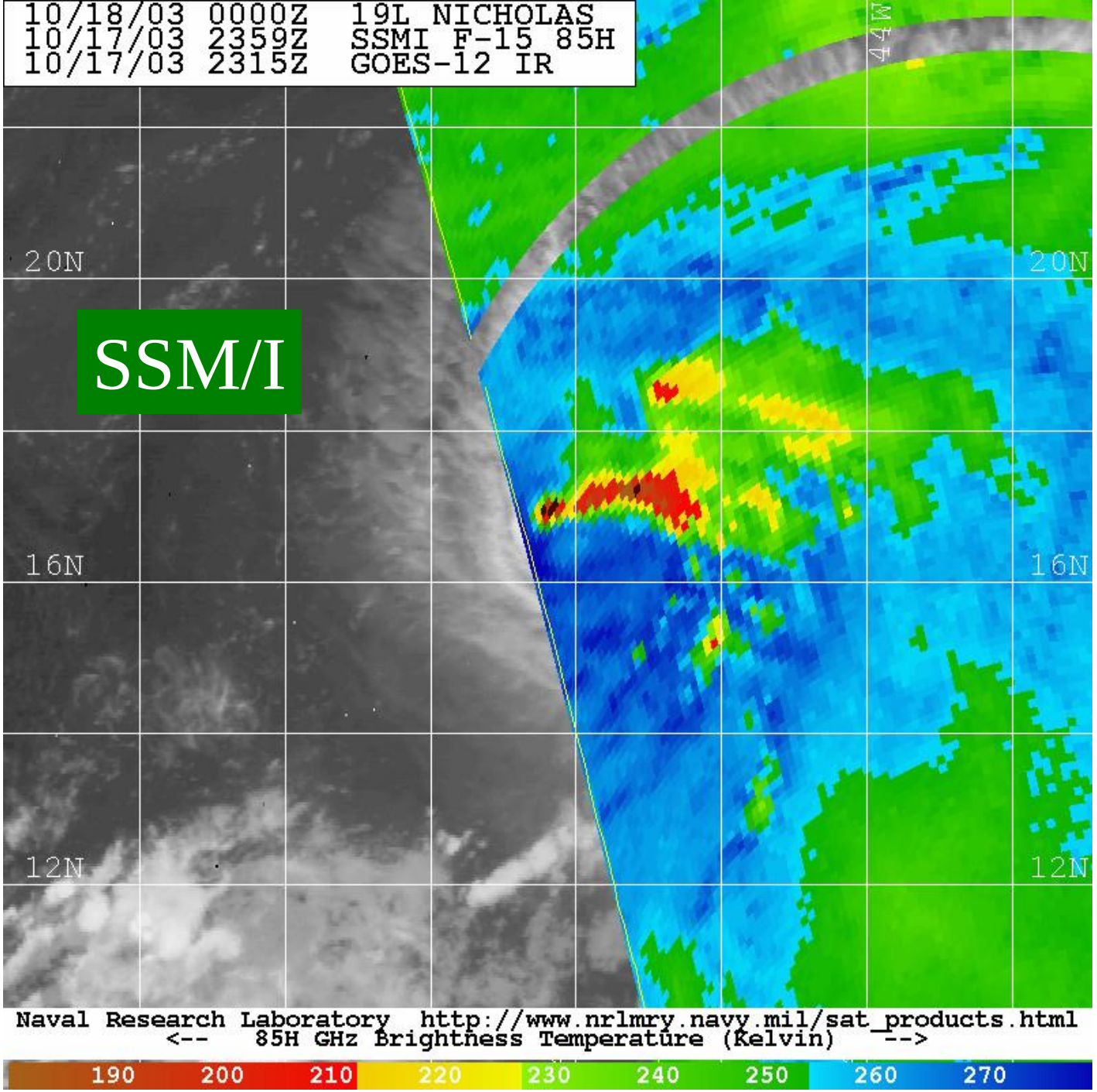
GOES-9
Infrared



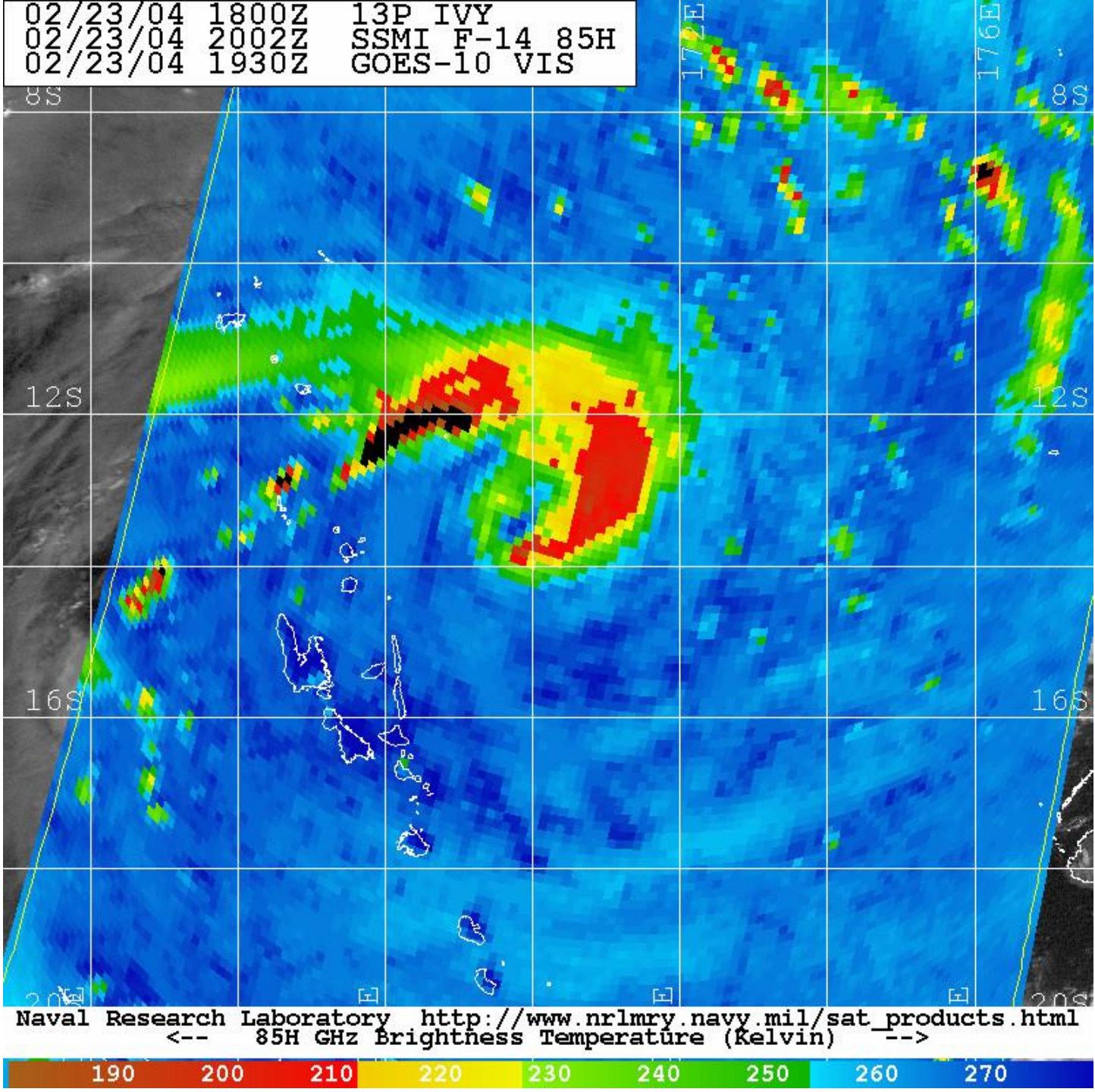
GOES-9 Enhanced Infrared



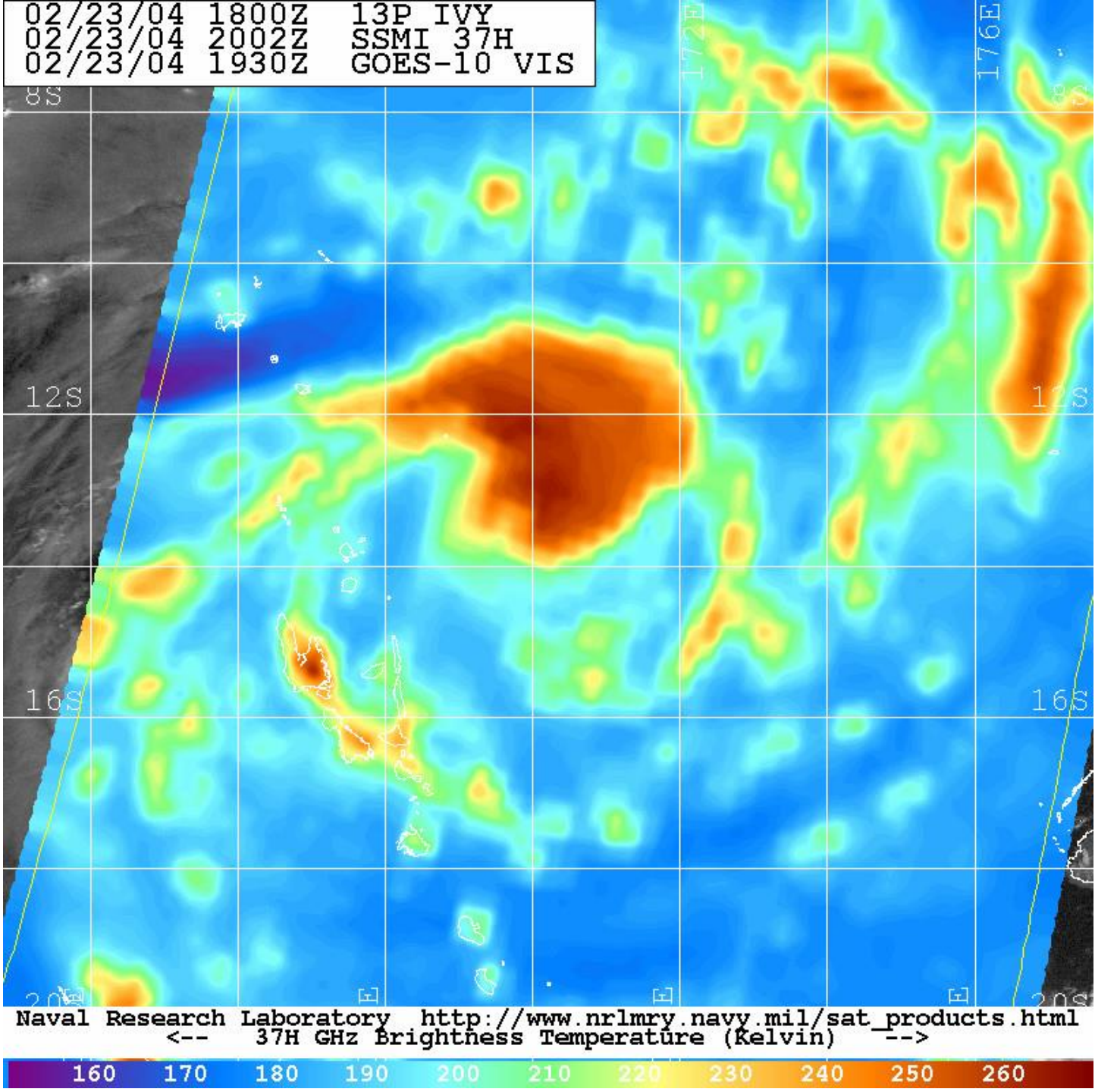
DMSP
SSM/I
85 GHz
Horizontal
Polarization

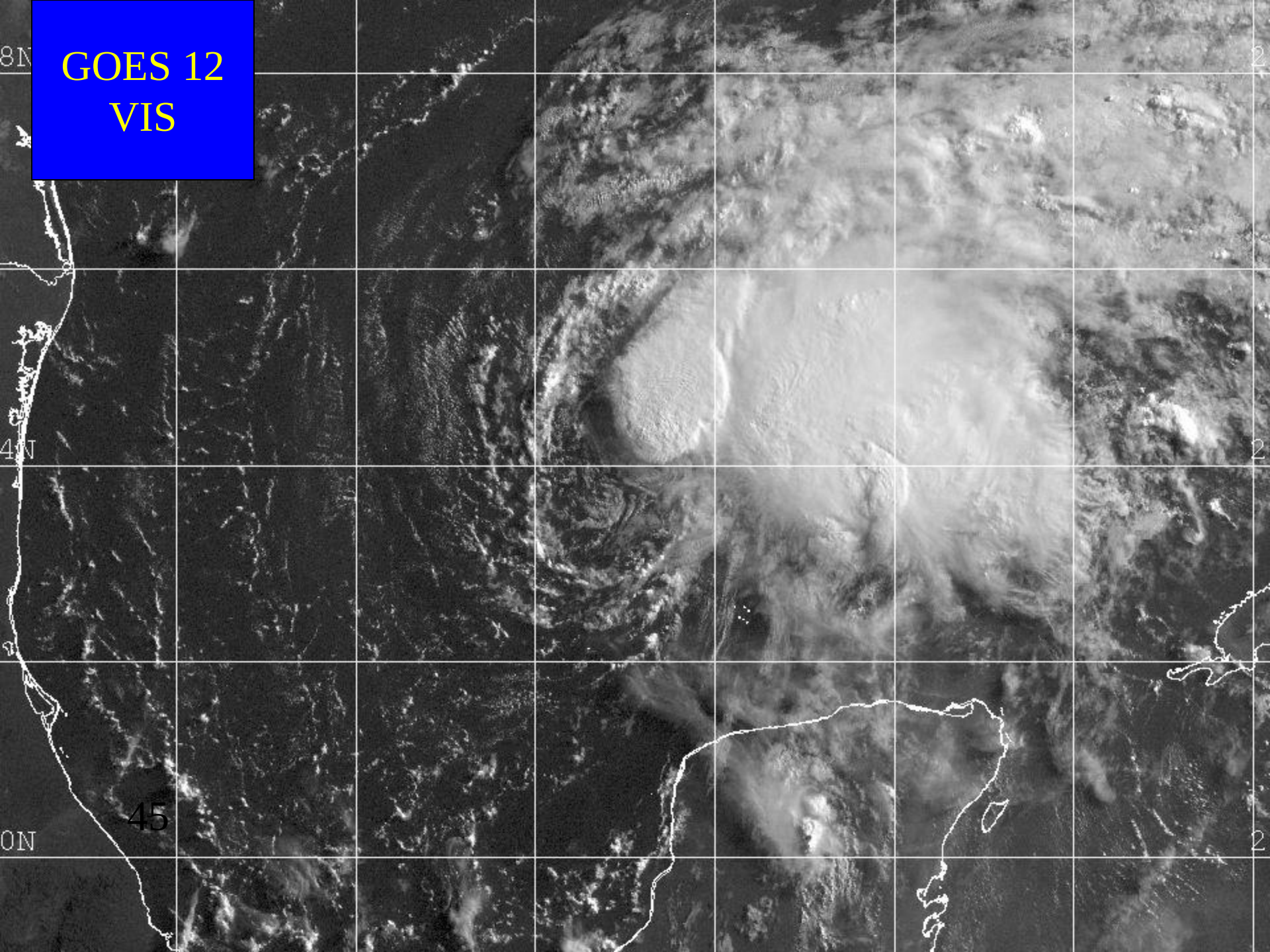


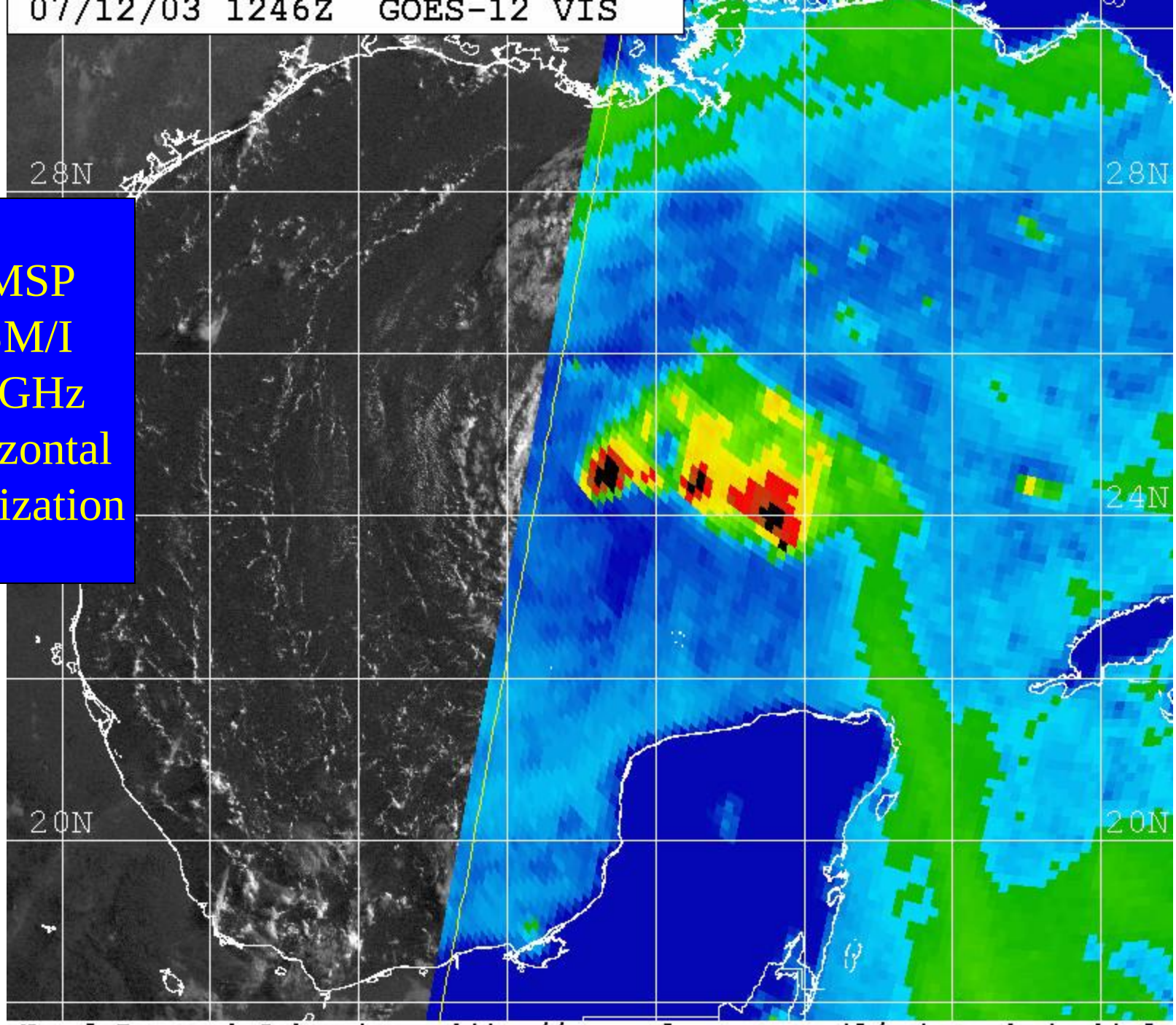
DMSP
SSM/I
85 GHz
Horizontal
Polarization



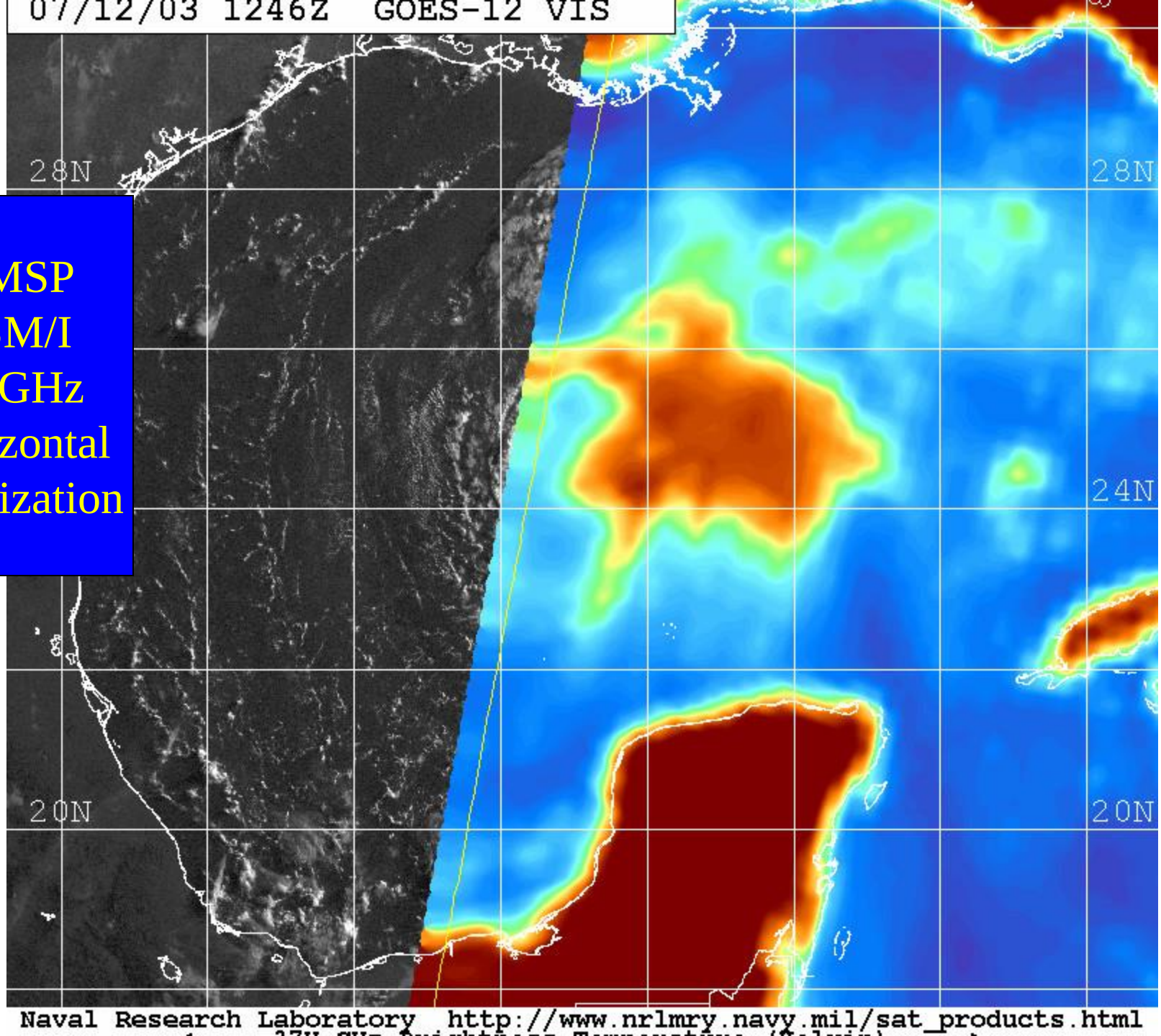
DMSP
SSM/I
37 GHz
Horizontal
Polarization




GOES 12
VIS



DMSP
SSM/I
85 GHz
Horizontal
Polarization



DMSP
SSM/I
37 GHz
Horizontal
Polarization

The Sensors of TRMM Satellite

TMI: TRMM Microwave Imager *
Conical-scanning imager, 9 channels between 10-85 GHz, similar to SSM/I

PR: Precipitation Radar *
First spaceborne radar, 13.8 GHz, incoherent, electronically scanning

VIRS: Visible and Infrared Scanner *
Cross-track imager with 2-km resolution, similar to NOAA AVHRR

LIS: Lightning Imaging Sensor [+]
600 x 600 km staring imager optimized to locate lightning flashes

CERES: Clouds and the Earth's Radiant Energy System [+]
Broadband radiance measurements, also on EOS (Terra and Aqua)

**** TMI, PR and VIRS data subsets are distributed in near-realtime via* TSDIS**
(TRMM Science Data and Information Service)

[+] ***CERES and LIS are designated as EOS instruments***

TMI (TRMM Microwave Imager)

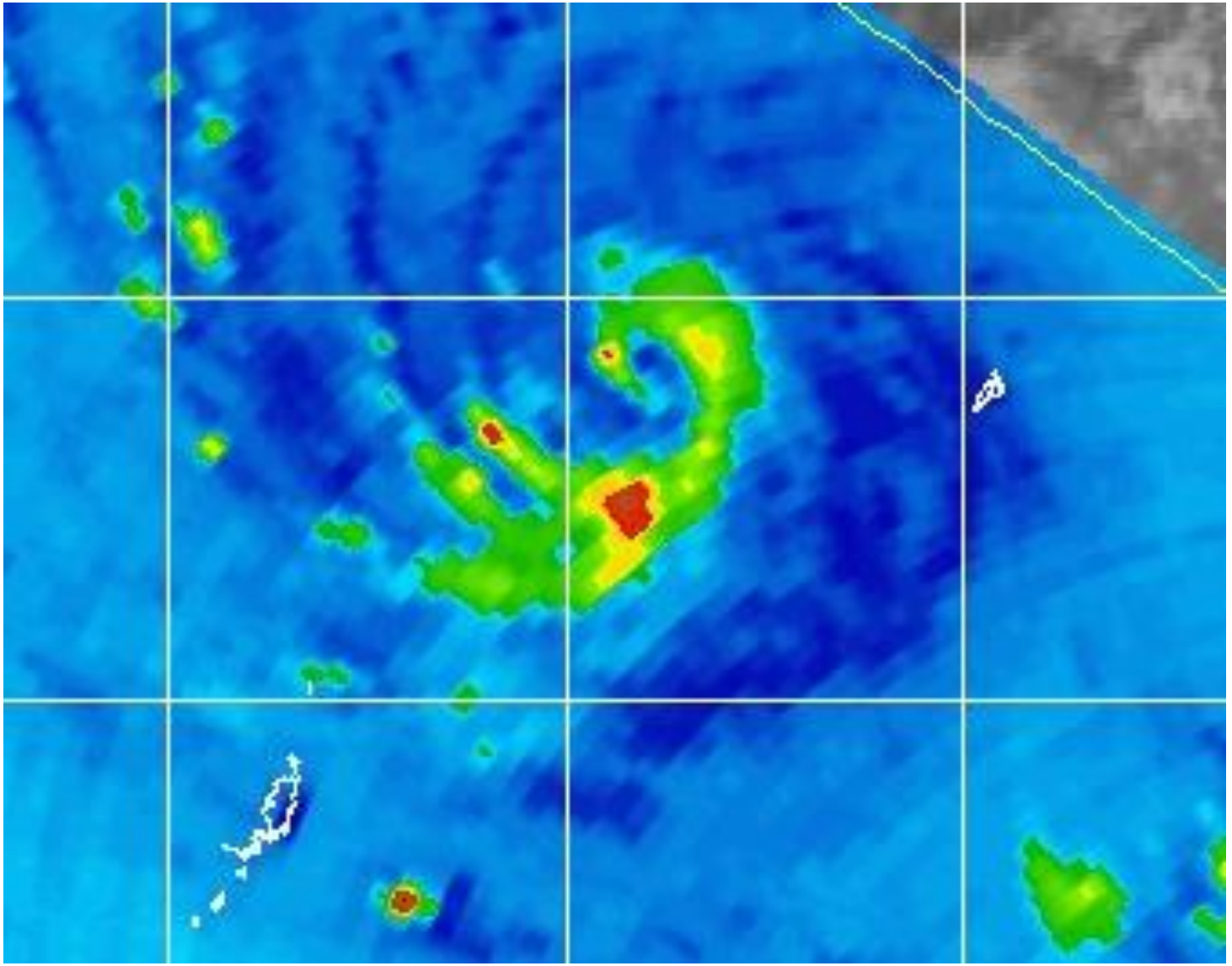
- **Passive microwave sensor designed to provide quantitative rainfall information.**
- **Swath : 780 km**

TMI Observation Characteristics

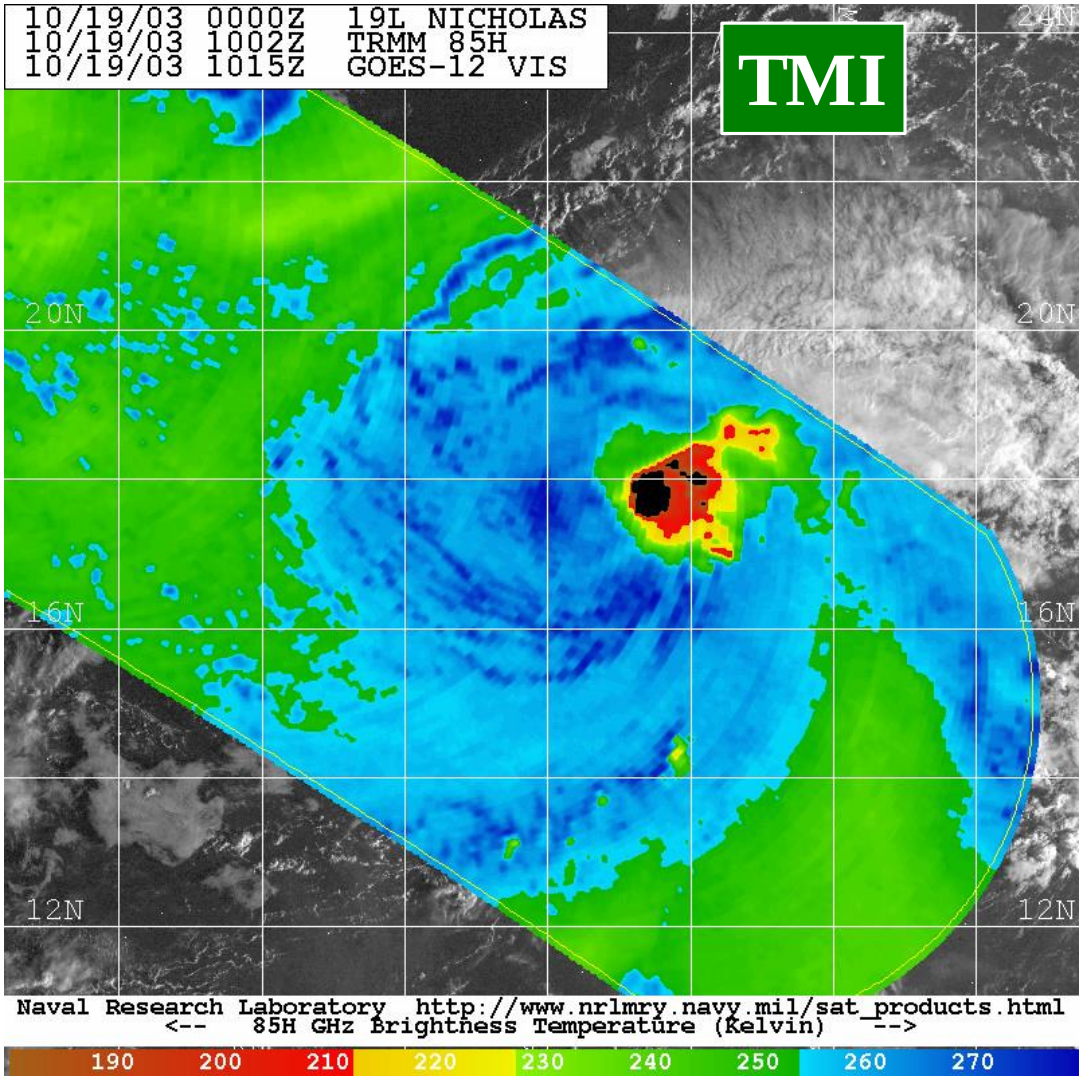
Center Freq. (GHz)	Polarization	Perpendicular to scan direction (km)	Scan direction (km)
10.65	V,H	63.2	36.8
19.35	V,H	30.4	18.4
21.3	V	27.2	18.4
37.0	V,H	16.0	9.2
85.5	V,H	7.2	4.6

Extensive use in subjective TC diagnostics

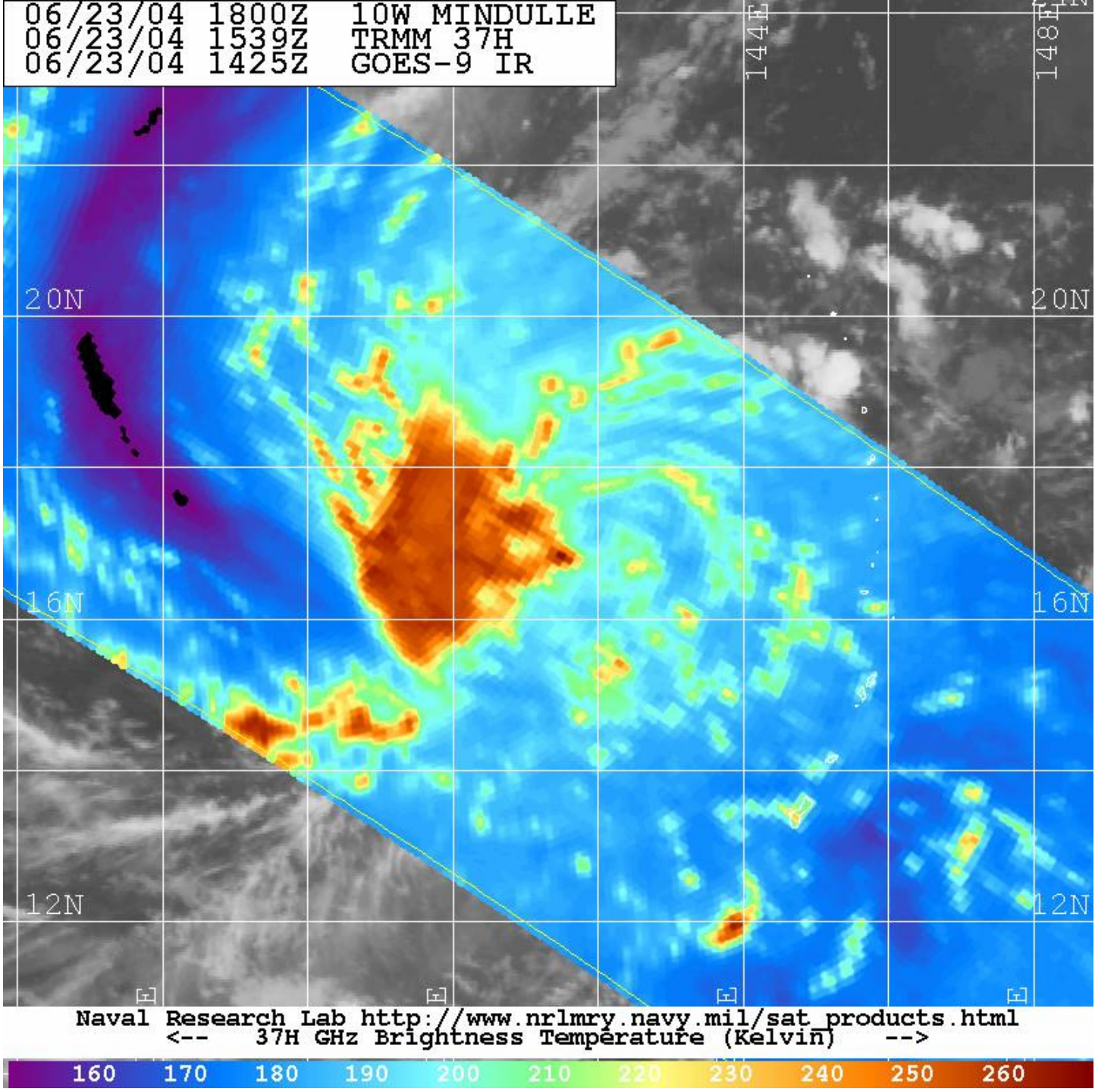
TRMM
85 GHz
Horizontal
Polarization



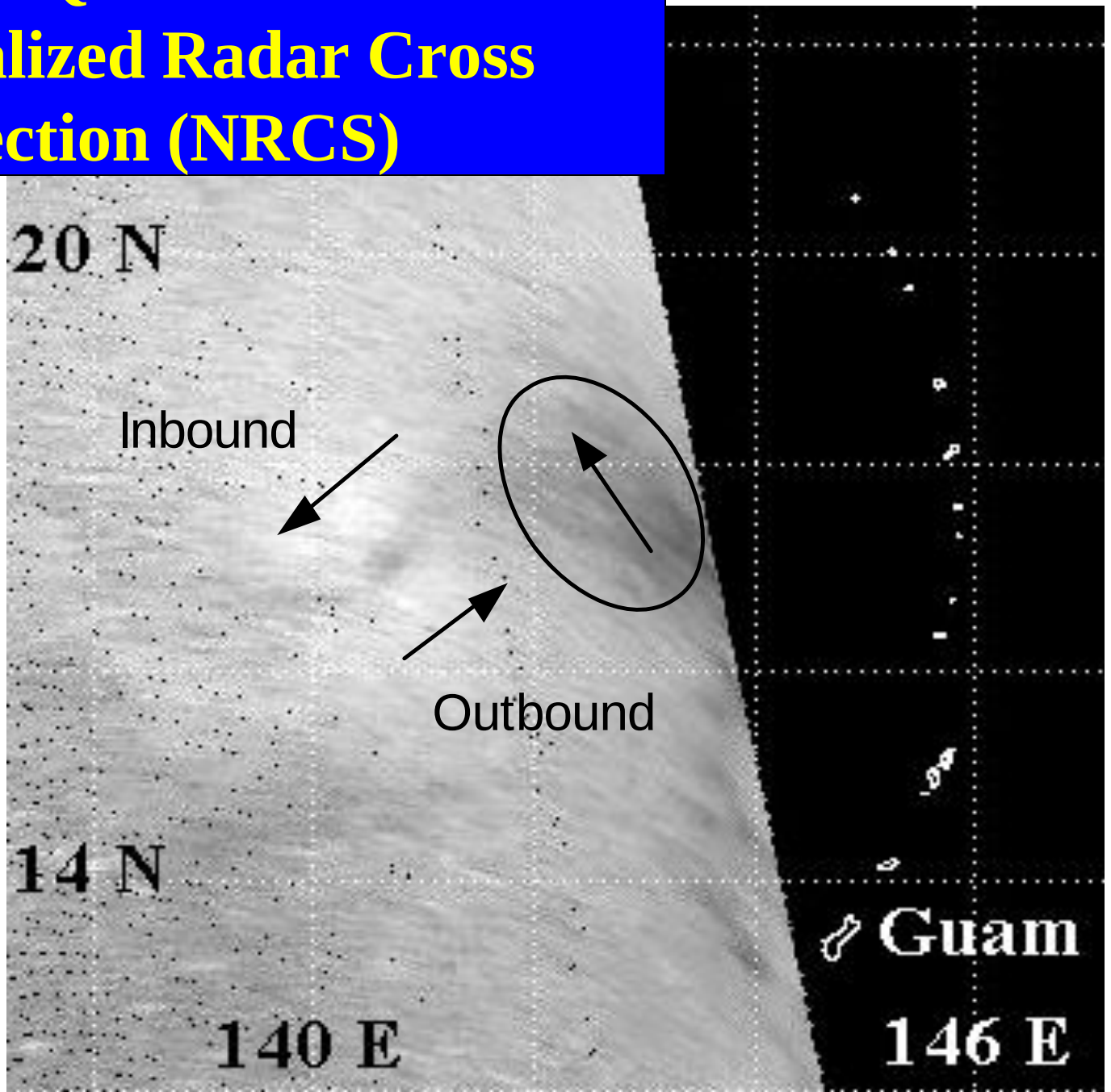
TRMM
85 GHz
Horizontal
Polarization



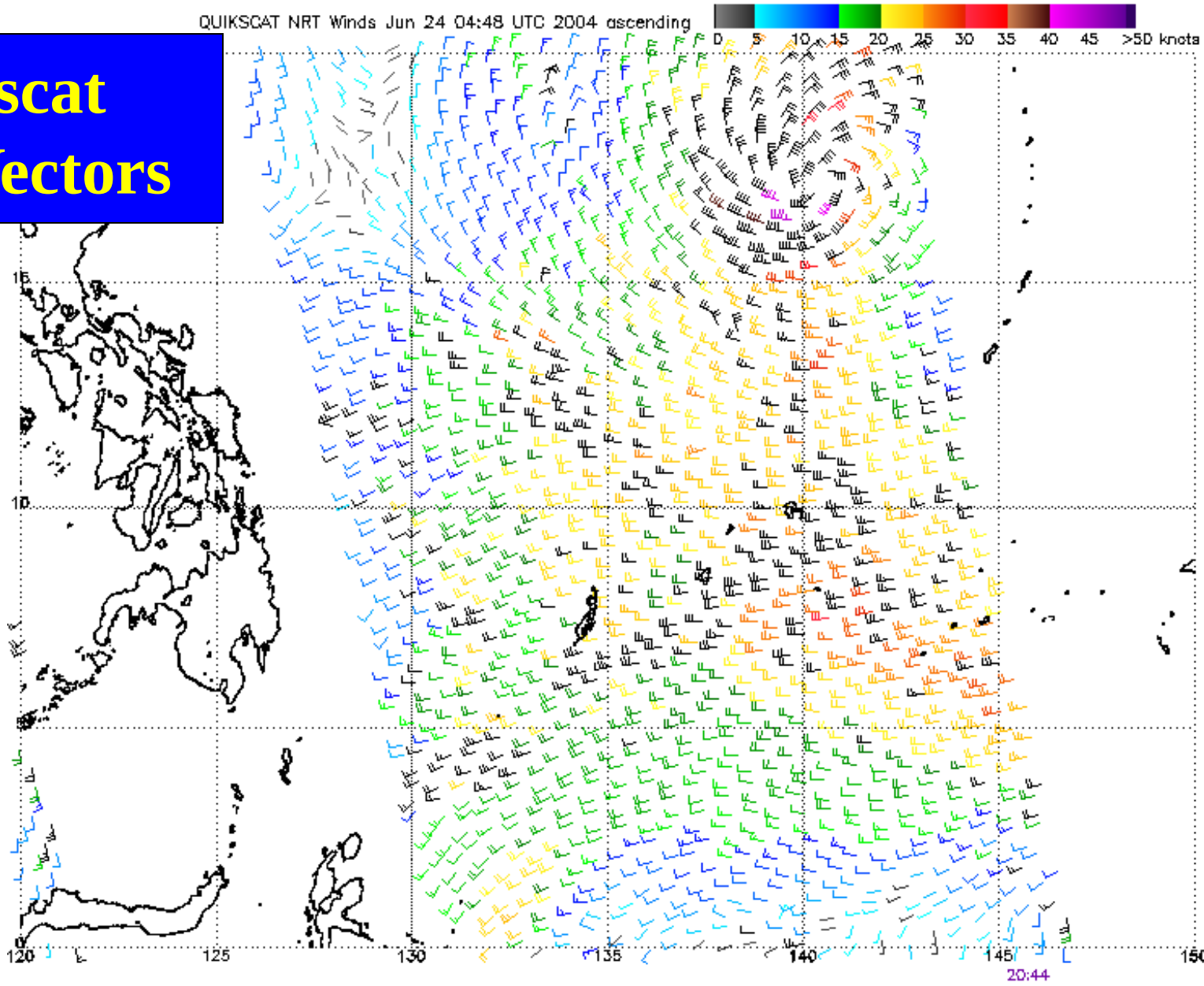
TRMM
37 GHz
Horizontal
Polarization



Quikscat Normalized Radar Cross Section (NRCS)

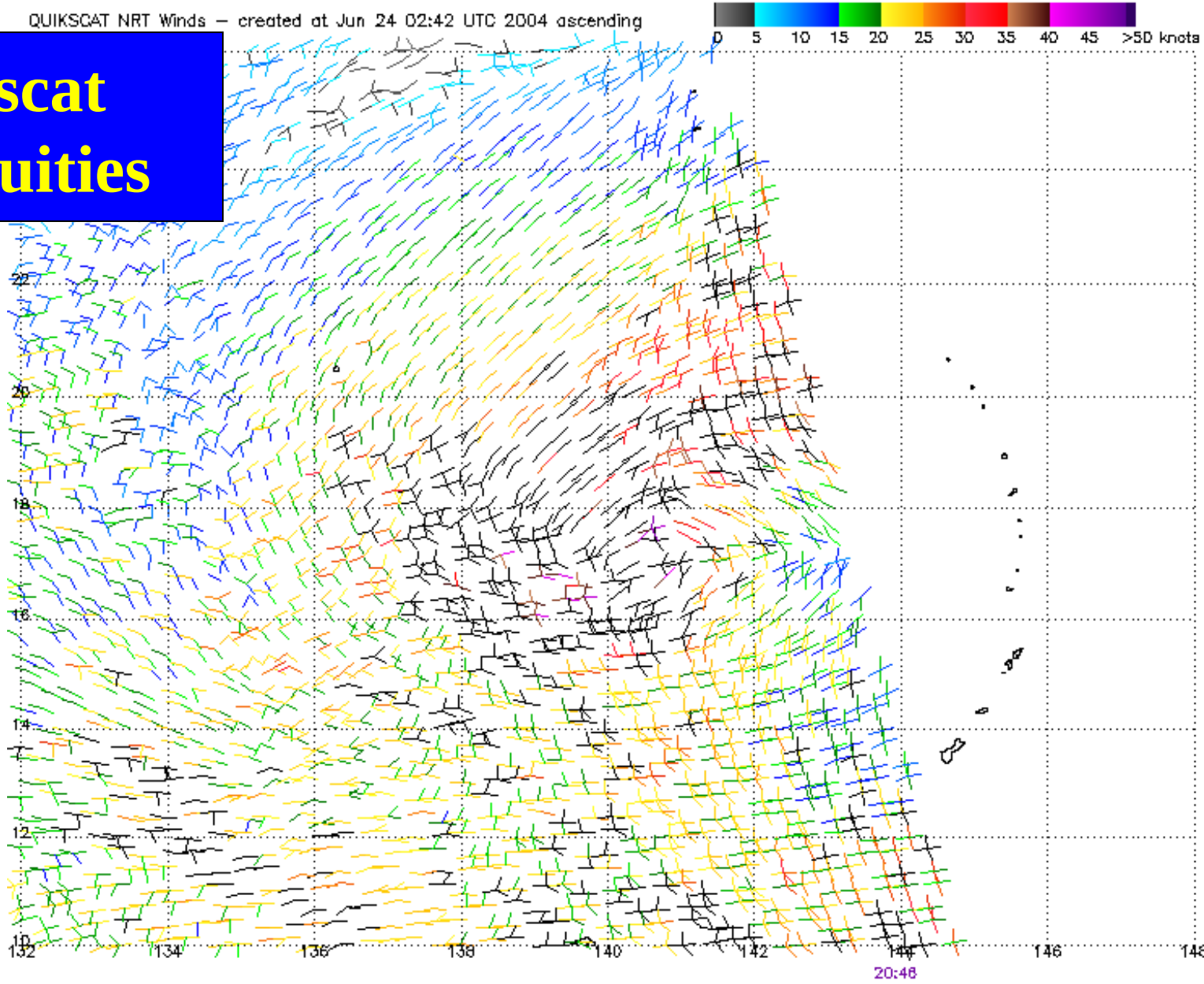


Quikscat Wind Vectors

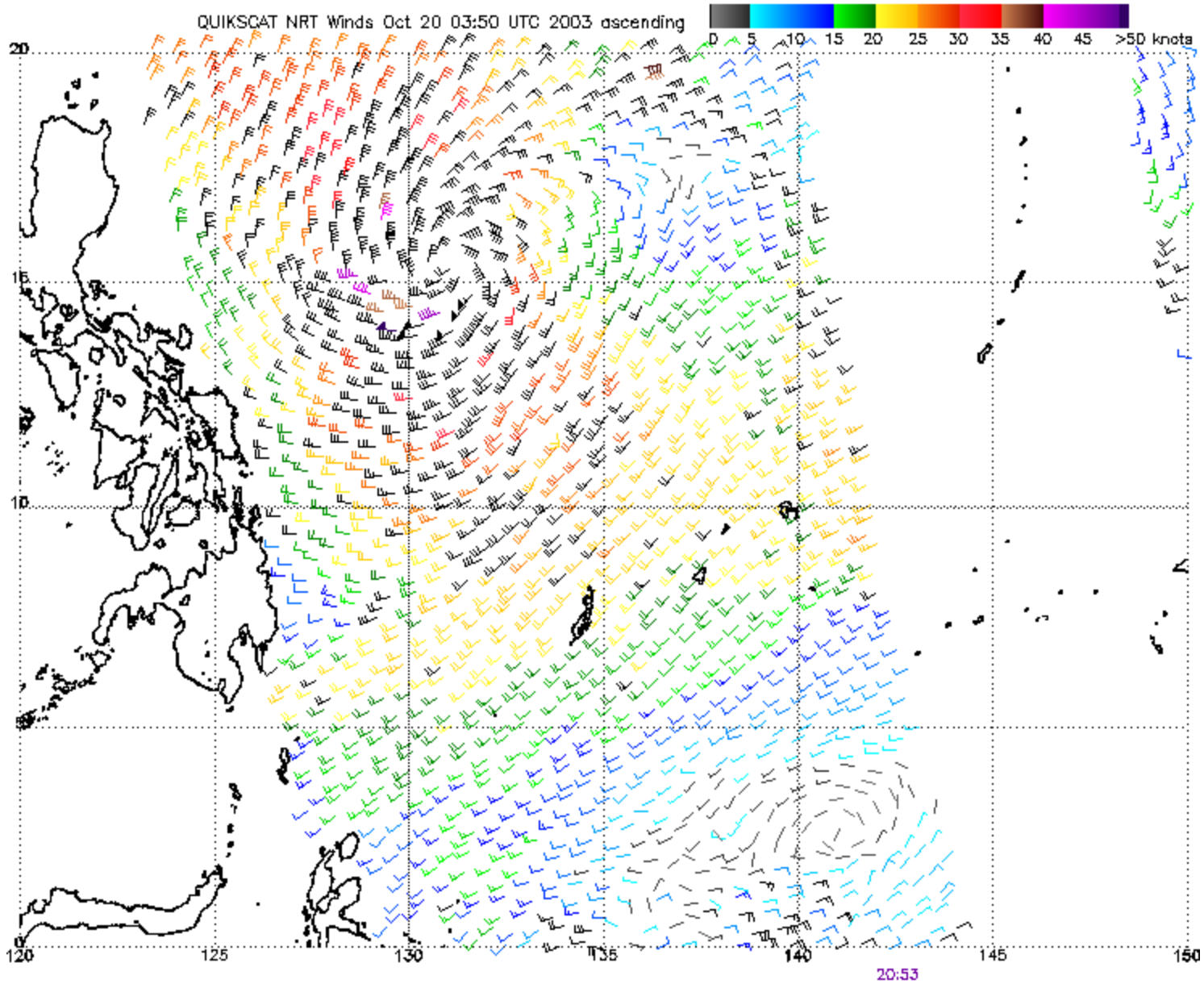


Note: 1) Times are GMT 2)Times correspond to 10N at right swath edge – time is right swath for overlapping swaths at 10N
3)Data buffer is Jun 24 04:48 UTC 2004–22 hrs 4)Black barbs indicate possible rain contamination
NOAA/NESDIS/Office of Research and Applications

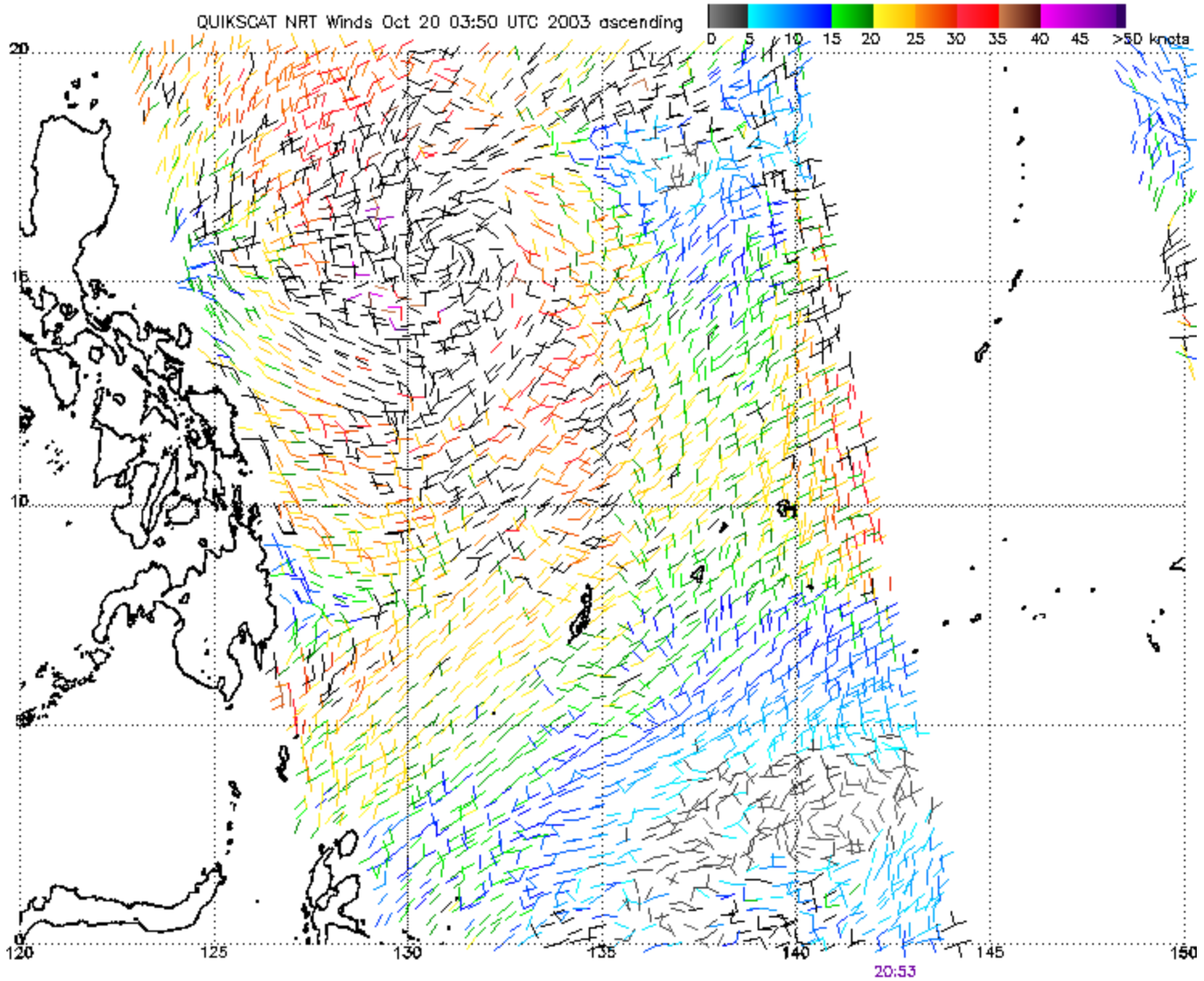
Quikscat Ambiguities



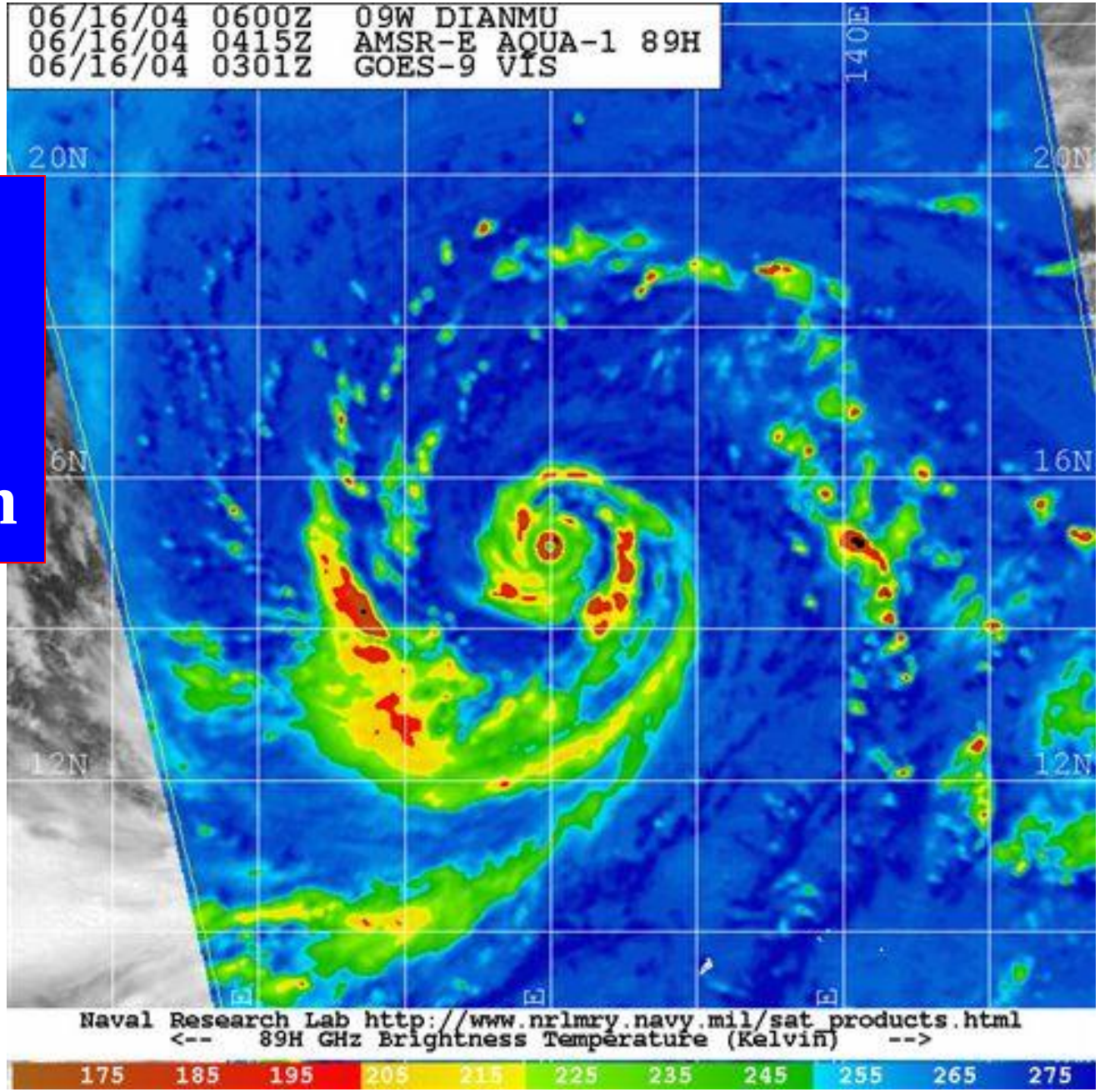
WINDS


QUIKSCAT NRT Winds Oct 20 03:50 UTC 2003 ascending
0 5 10 15 20 25 30 35 40 45 >50 knots
20
15
10
5
120 125 130 135 140 145 150
20:53
Note: 1) Times are GMT 2)Times correspond to 10N at right swath edge – time is right swath for overlapping swaths at 10N
3)Data buffer is Oct 20 03:50 UTC 2003–22 hrs 4)Black barbs indicate possible rain contamination
NOAA/NESDIS/Office of Research and Applications

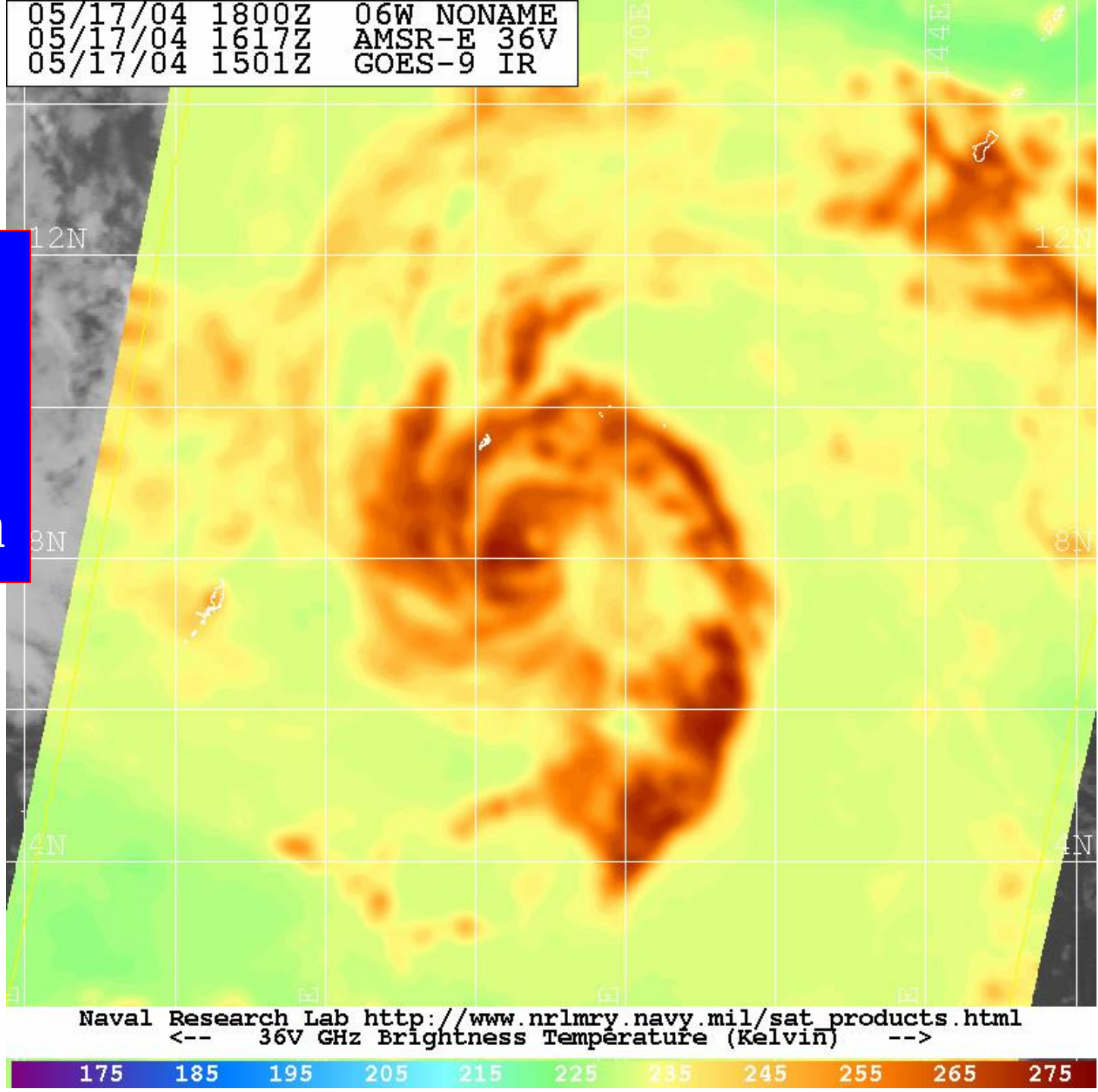
AMBIGUITIES



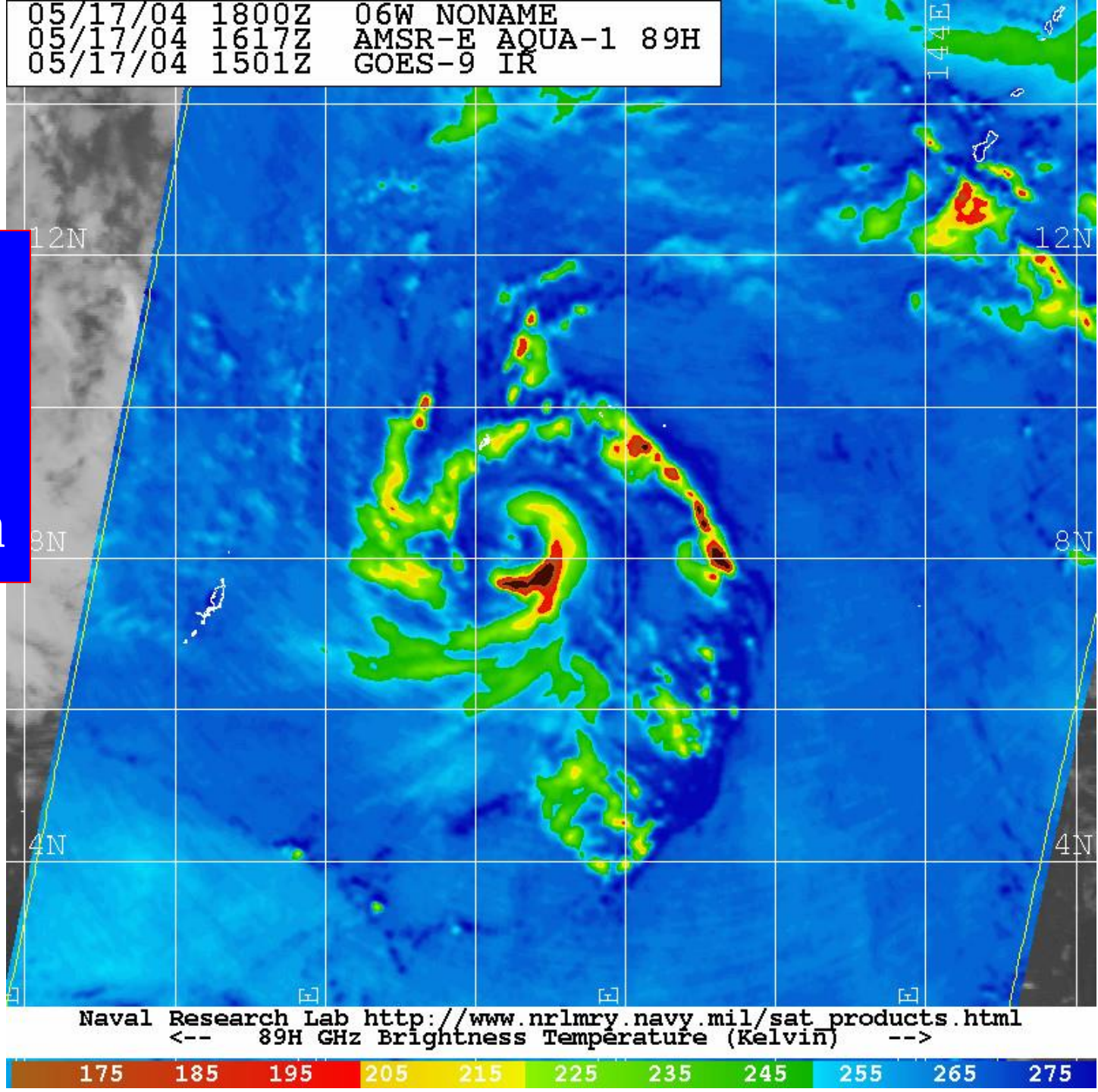
AMSR-E 89 GHz Horizontal Polarization



AMSR-E 36 GHz Vertical Polarization



AMSR-E 89 GHz Horizontal Polarization



PROPERTIES OF MICROWAVE IMAGERY:

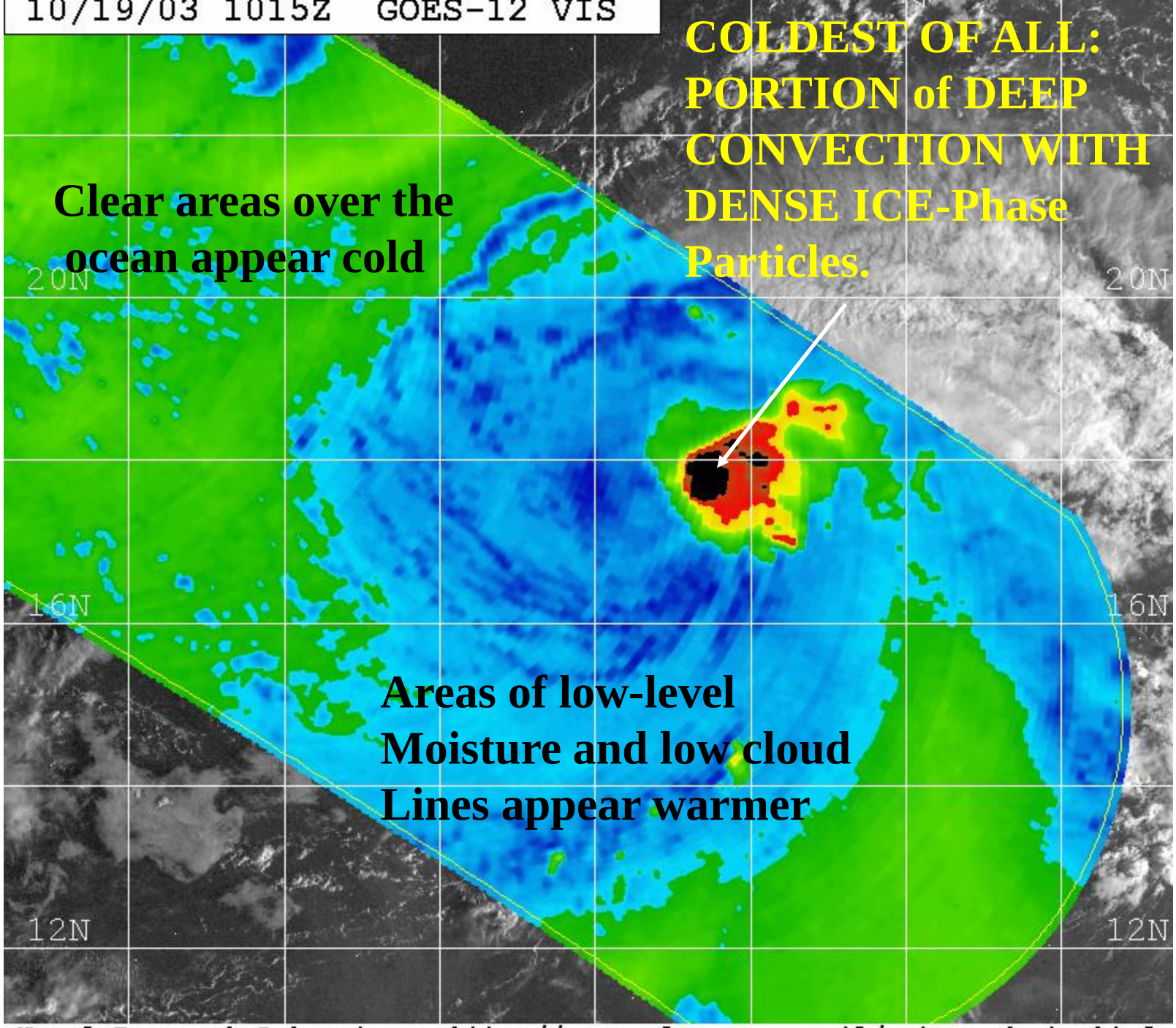
- 85 GHz

THINGS THAT APPEAR COLD:

- Sea Surface and High portions of deep convection with where there are large ice phase precip (e.g., snow)

THINGS THAT APPEAR WARM:

- Land and Low-cloud fields


10/19/03 1015Z GOES-12 VIS
COLDEST OF ALL: PORTION of DEEP CONVECTION WITH DENSE ICE-Phase Particles.
Clear areas over the ocean appear cold
20N
20N
16N
16N
Areas of low-level Moisture and low cloud Lines appear warmer
12N
12N
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html

PROPERTIES OF MICROWAVE IMAGERY:

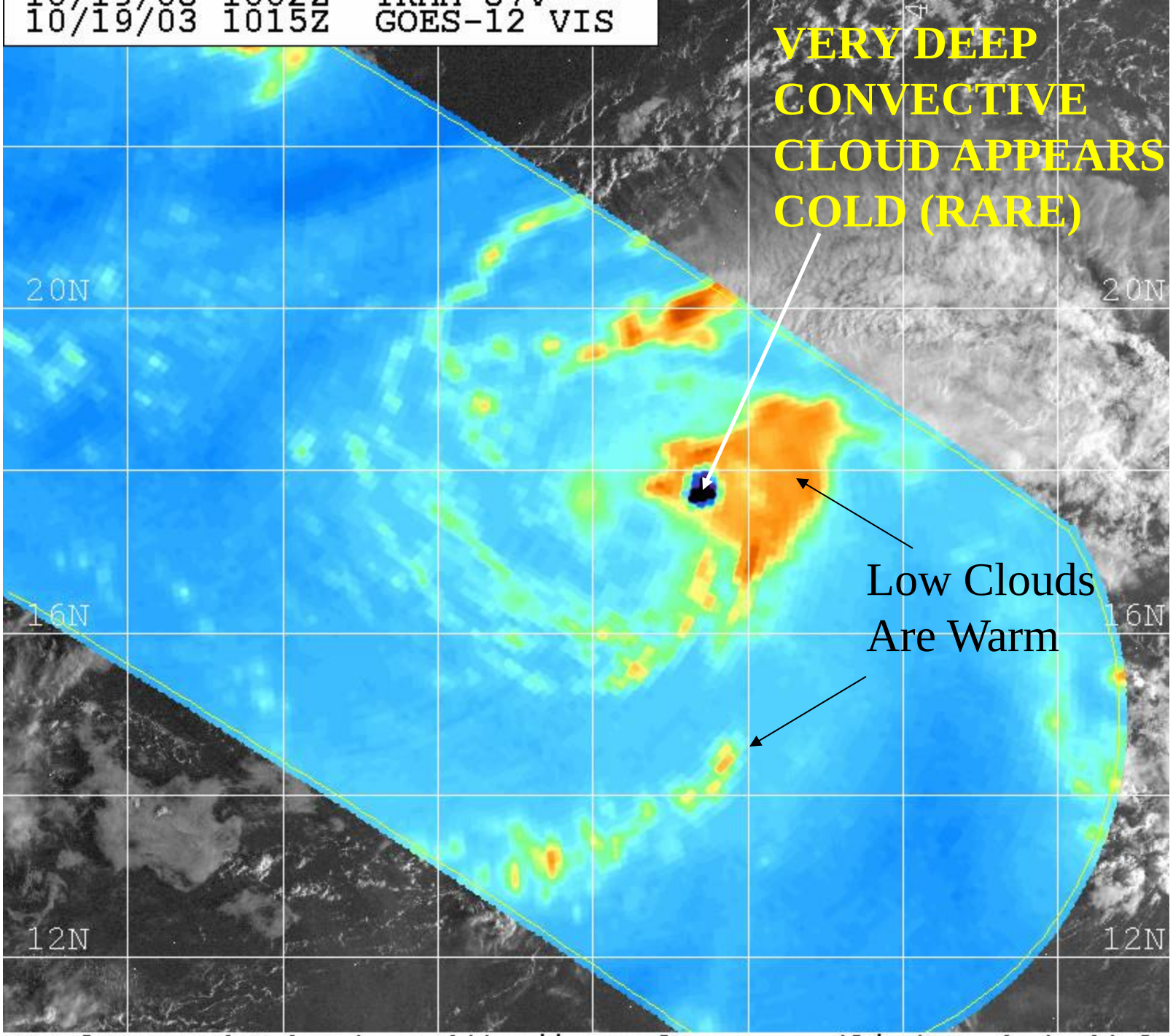
- 37 GHz

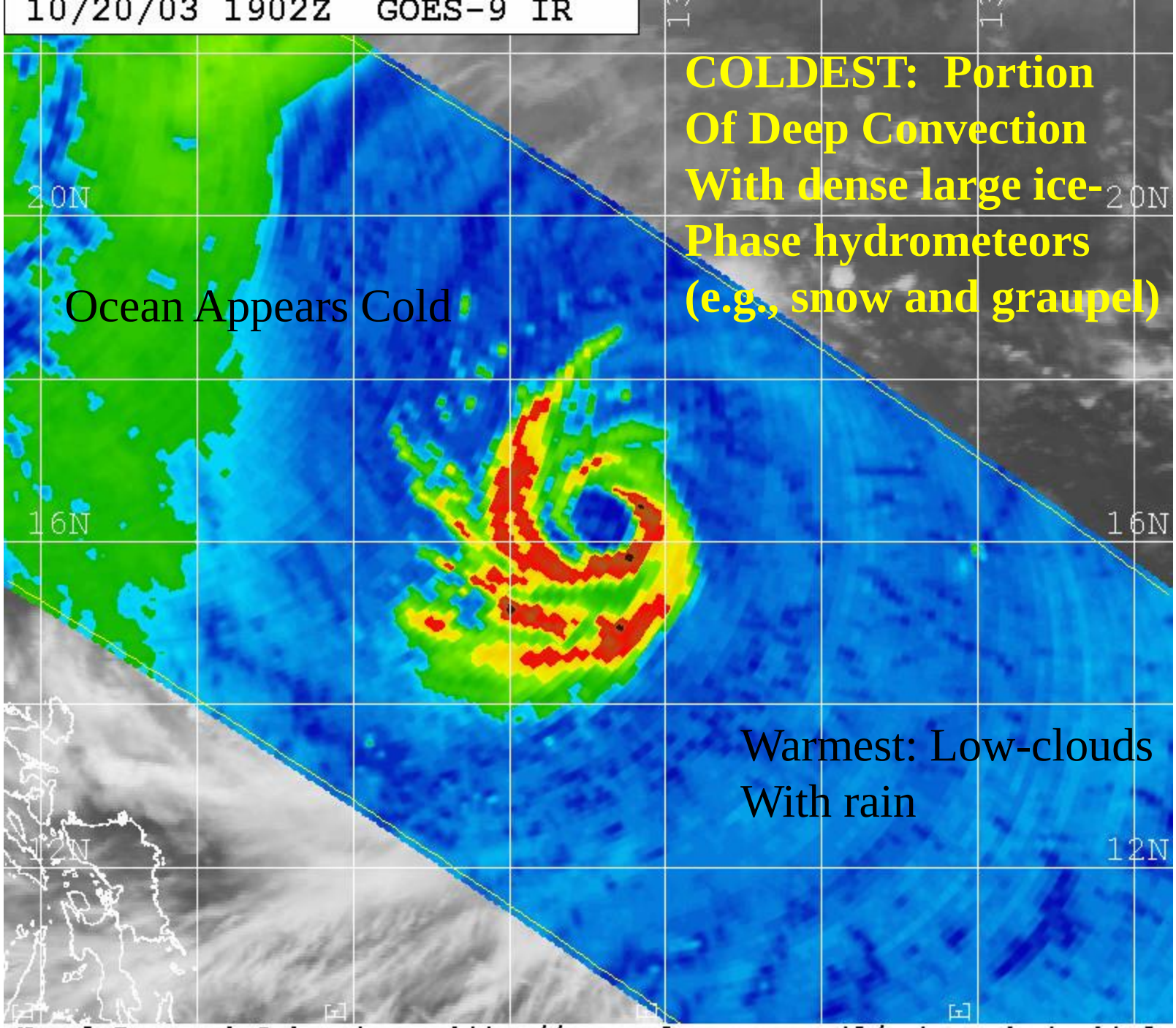
THINGS THAT APPEAR COLD:

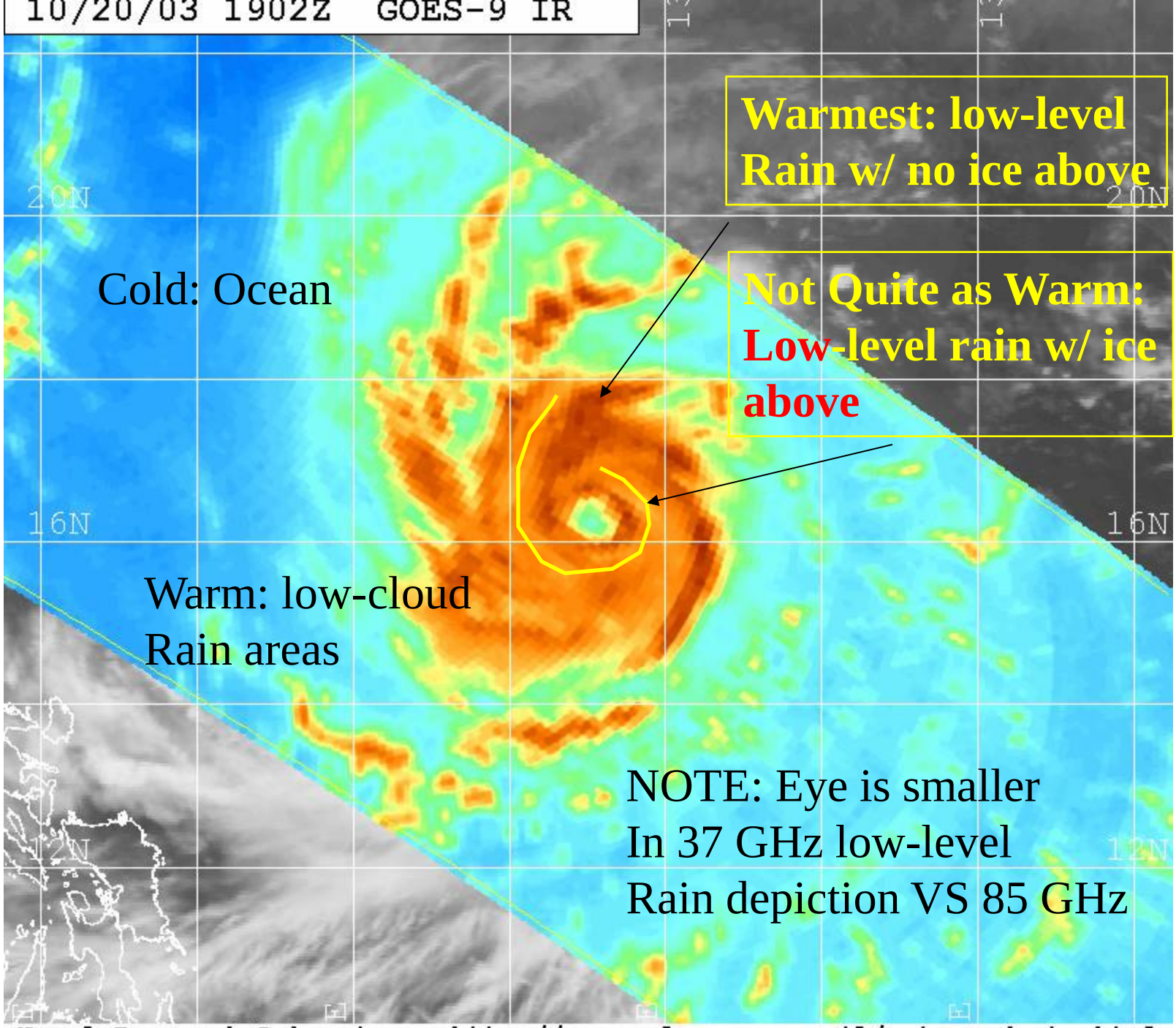
- Sea Surface, but not deep convection: 37 GHz signal largely passes through ice (except when exceptionally dense).

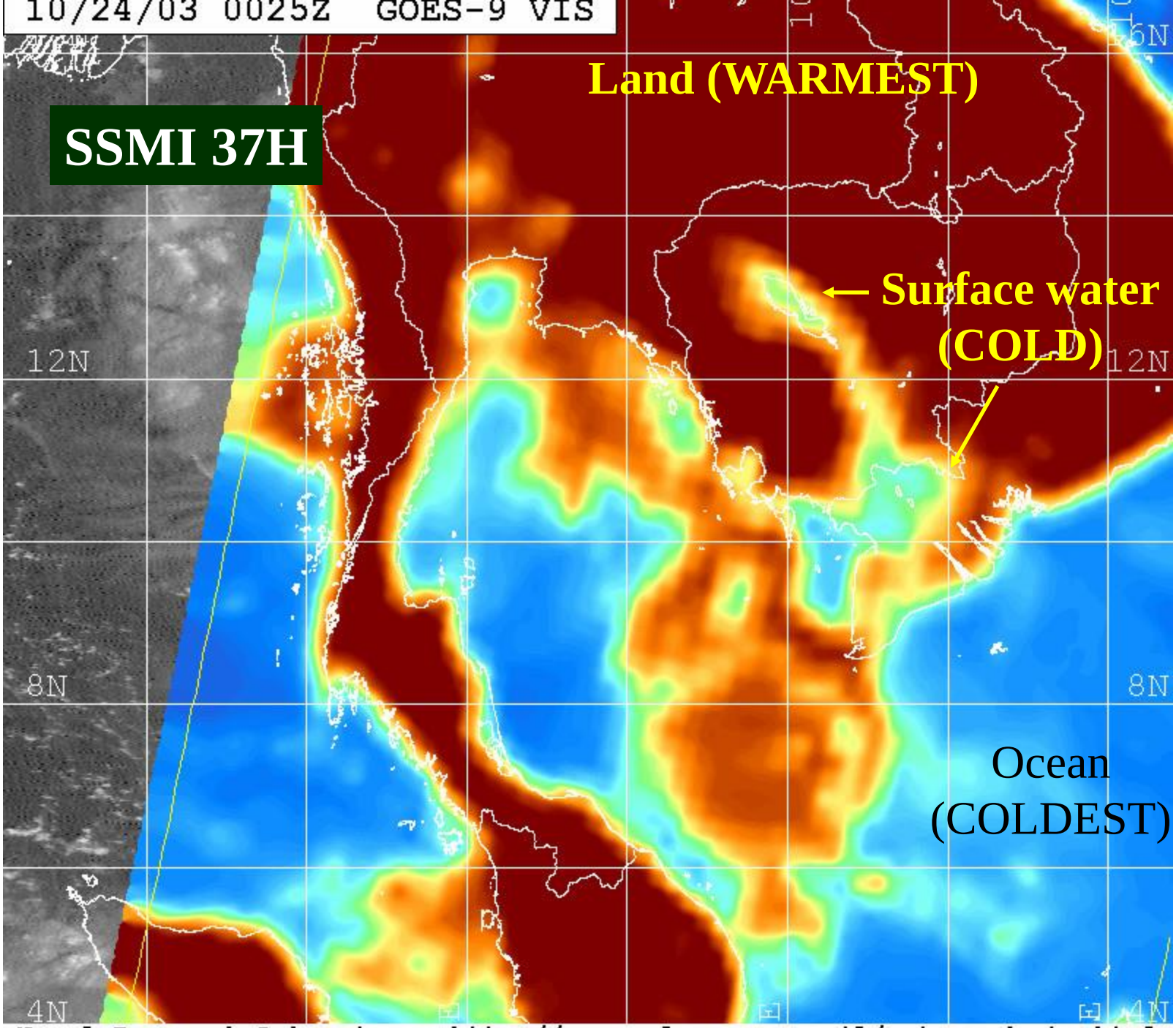
THINGS THAT APPEAR WARM:

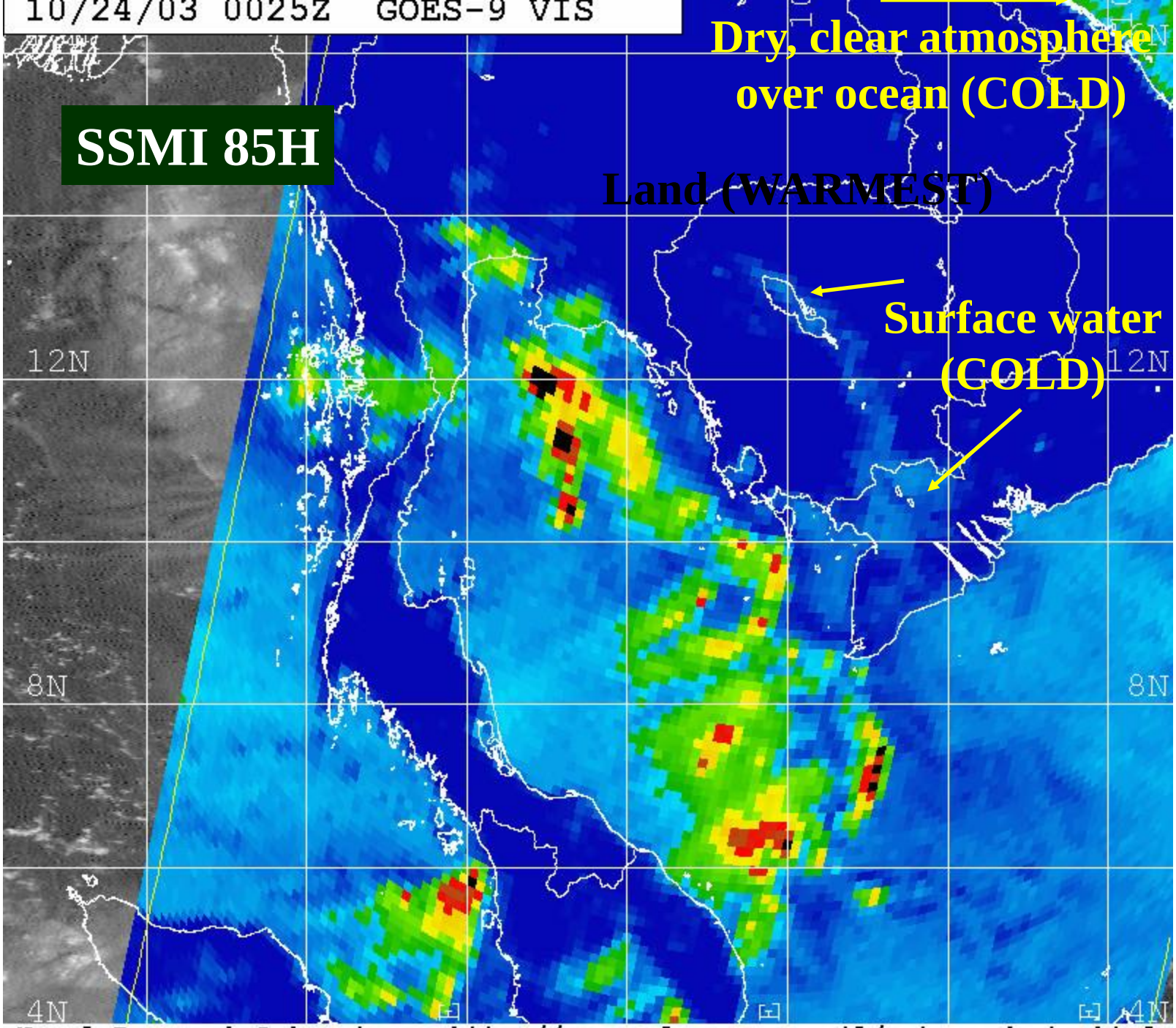
- Land and rain at low level (rain very warm versus 85 GHz).

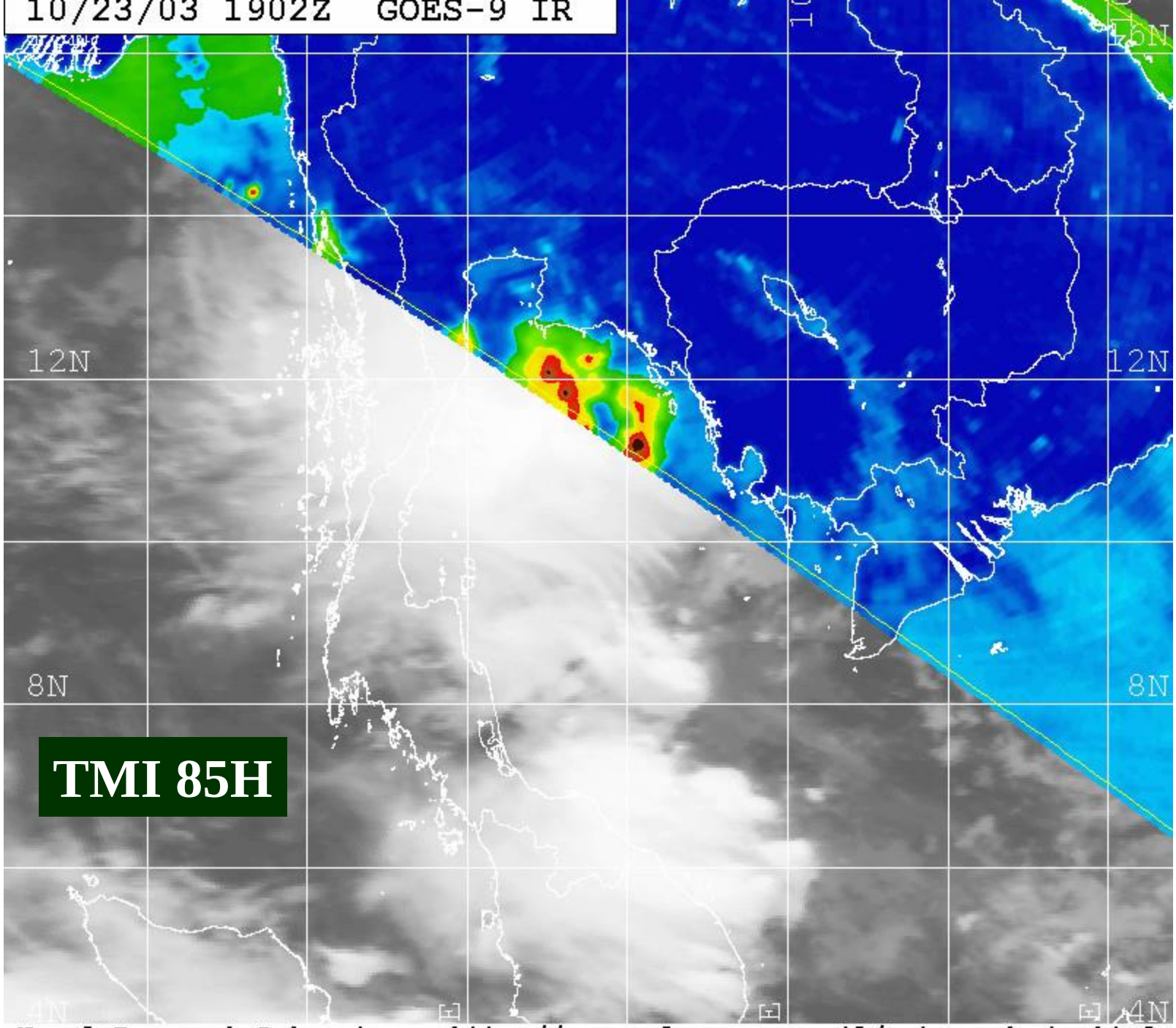

10/19/03 1015Z GOES-12 VIS
VERY DEEP CONVECTIVE CLOUD APPEARS COLD (RARE)
Low Clouds Are Warm
20N
16N
12N
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html

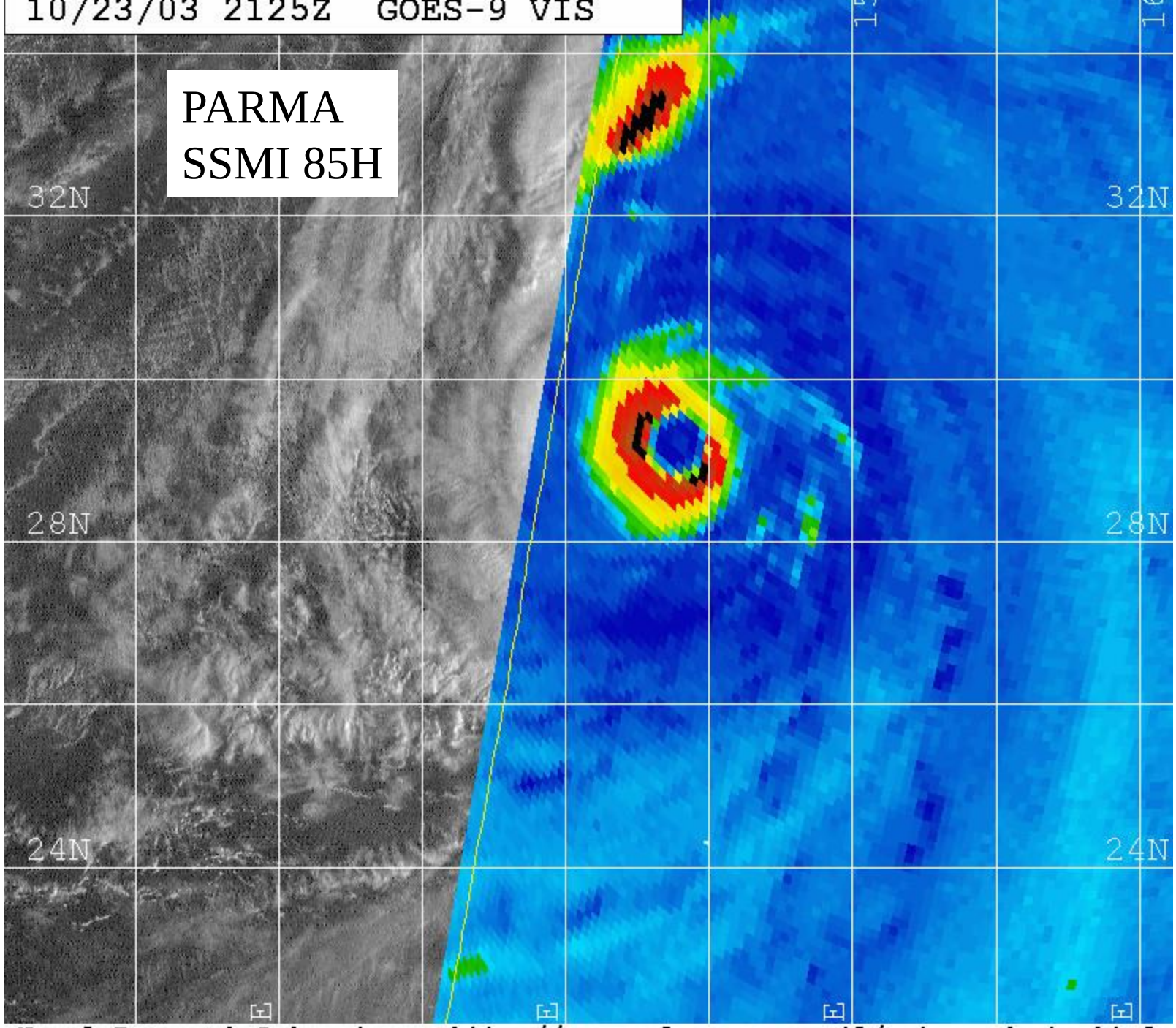

10/20/03 1902Z GOES-9 IR
COLDEST: Portion
Of Deep Convection
With dense large ice-
Phase hydrometeors
(e.g., snow and graupel)
Ocean Appears Cold
Warmest: Low-clouds
With rain
20N
16N
12N
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html

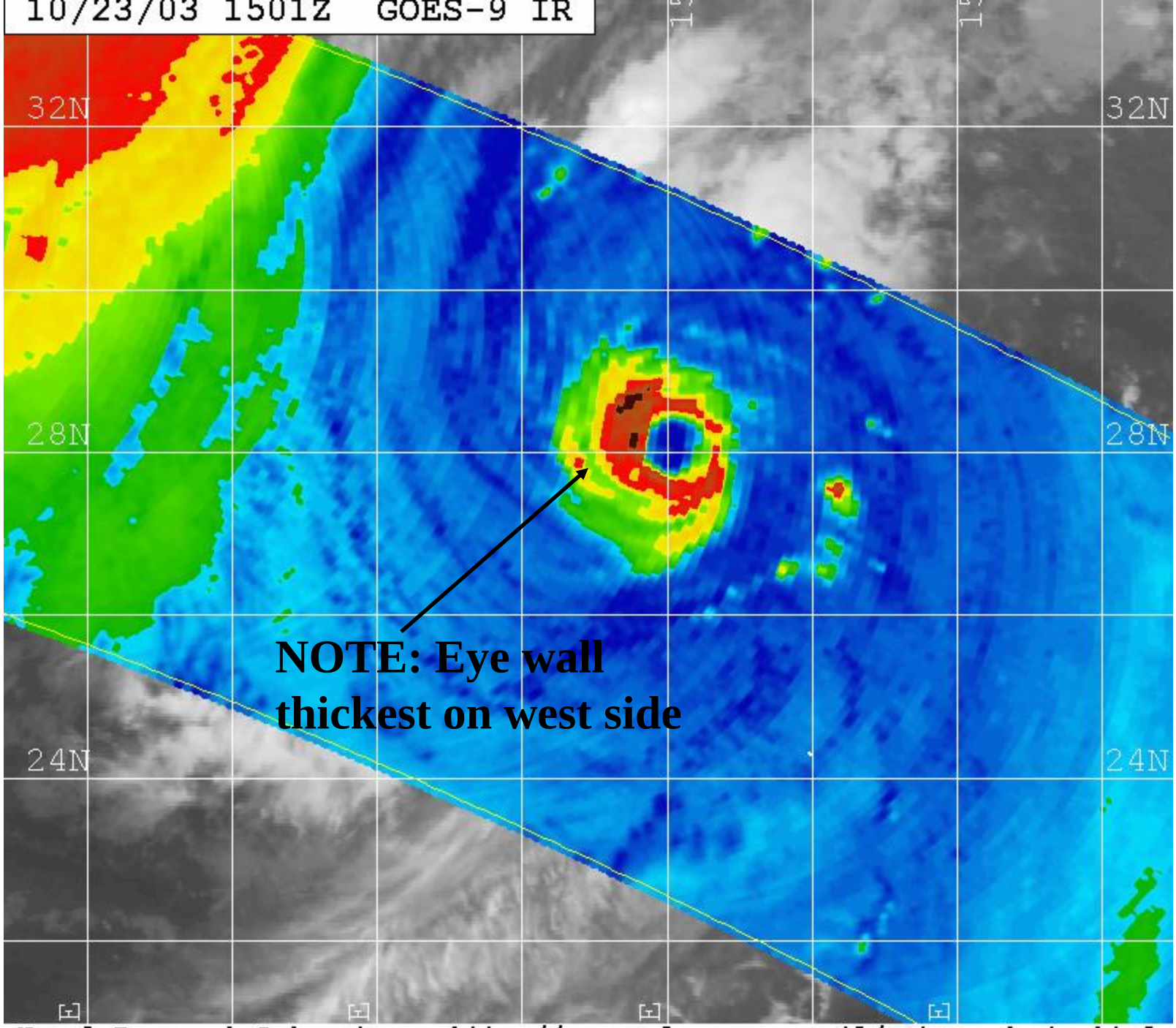

10/20/03 1902Z GOES-9 IR
Warmest: low-level
Rain w/ no ice above
Not Quite as Warm:
Low-level rain w/ ice
above
Cold: Ocean
Warm: low-cloud
Rain areas
NOTE: Eye is smaller
In 37 GHz low-level
Rain depiction VS 85 GHz
20N
16N
12N
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html

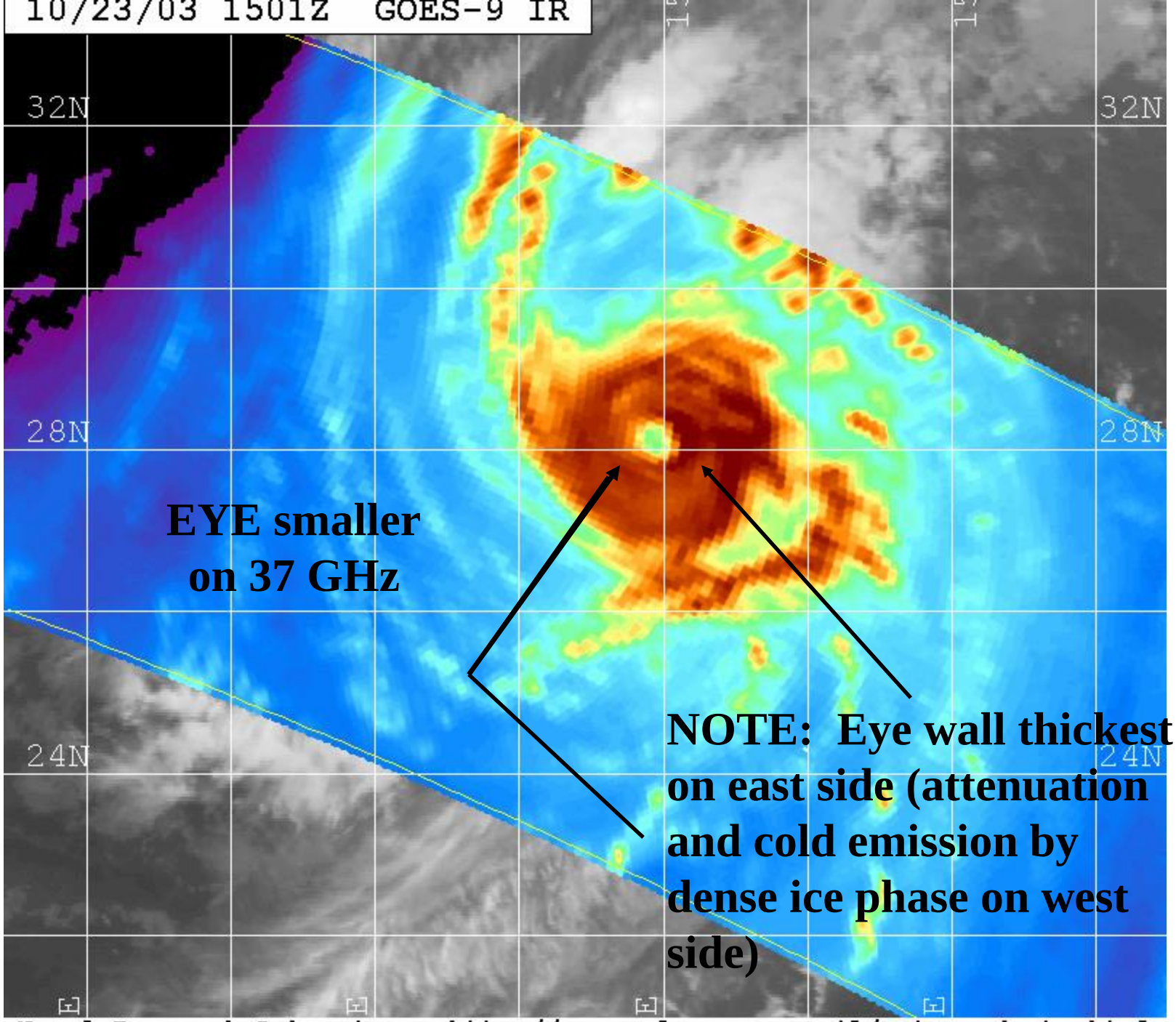

10/24/03 0025Z GOES-9 VIS
SSMI 37H
Land (WARMEST)
← Surface water (COLD)
Ocean (COLDEST)
16N
12N
8N
4N
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html

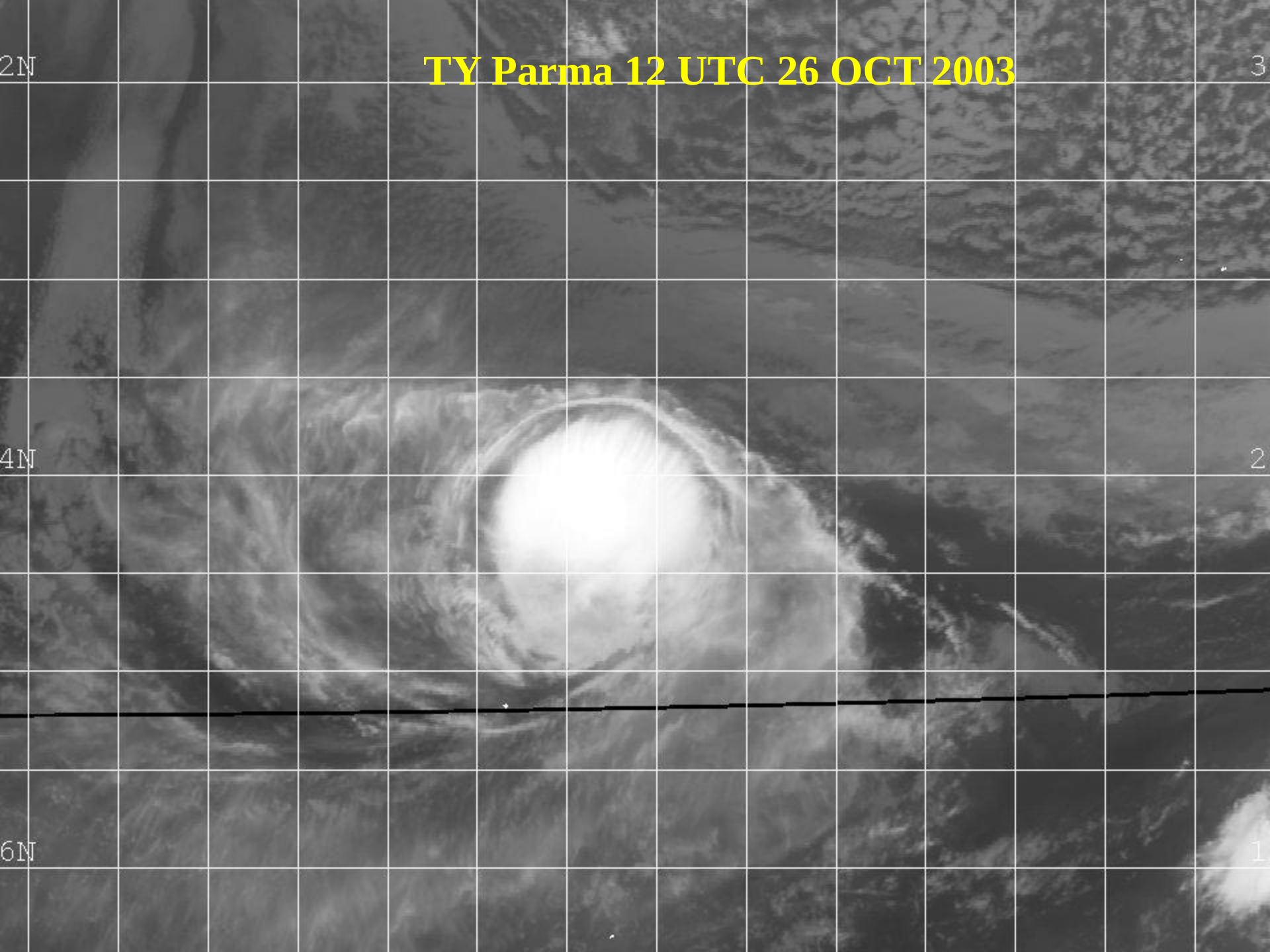

10/24/03 0025Z GOES-9 VIS
SSMI 85H
Dry, clear atmosphere
over ocean (COLD)
Land (WARMEST)
Surface water
(COLD)
12N
8N
4N
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html

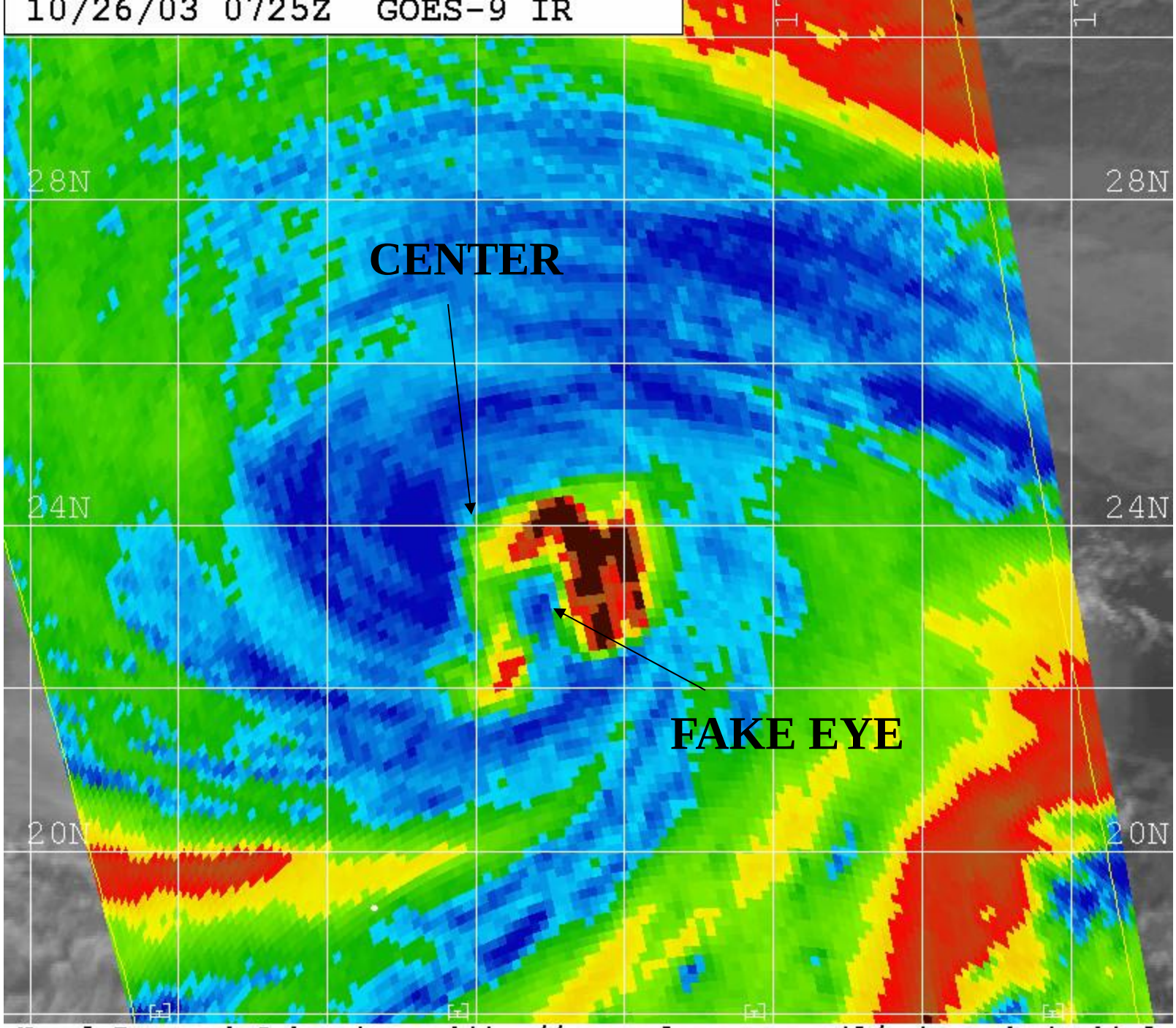

10/23/03 1902Z GOES-9 IR
12N
8N
TMI 85H
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html

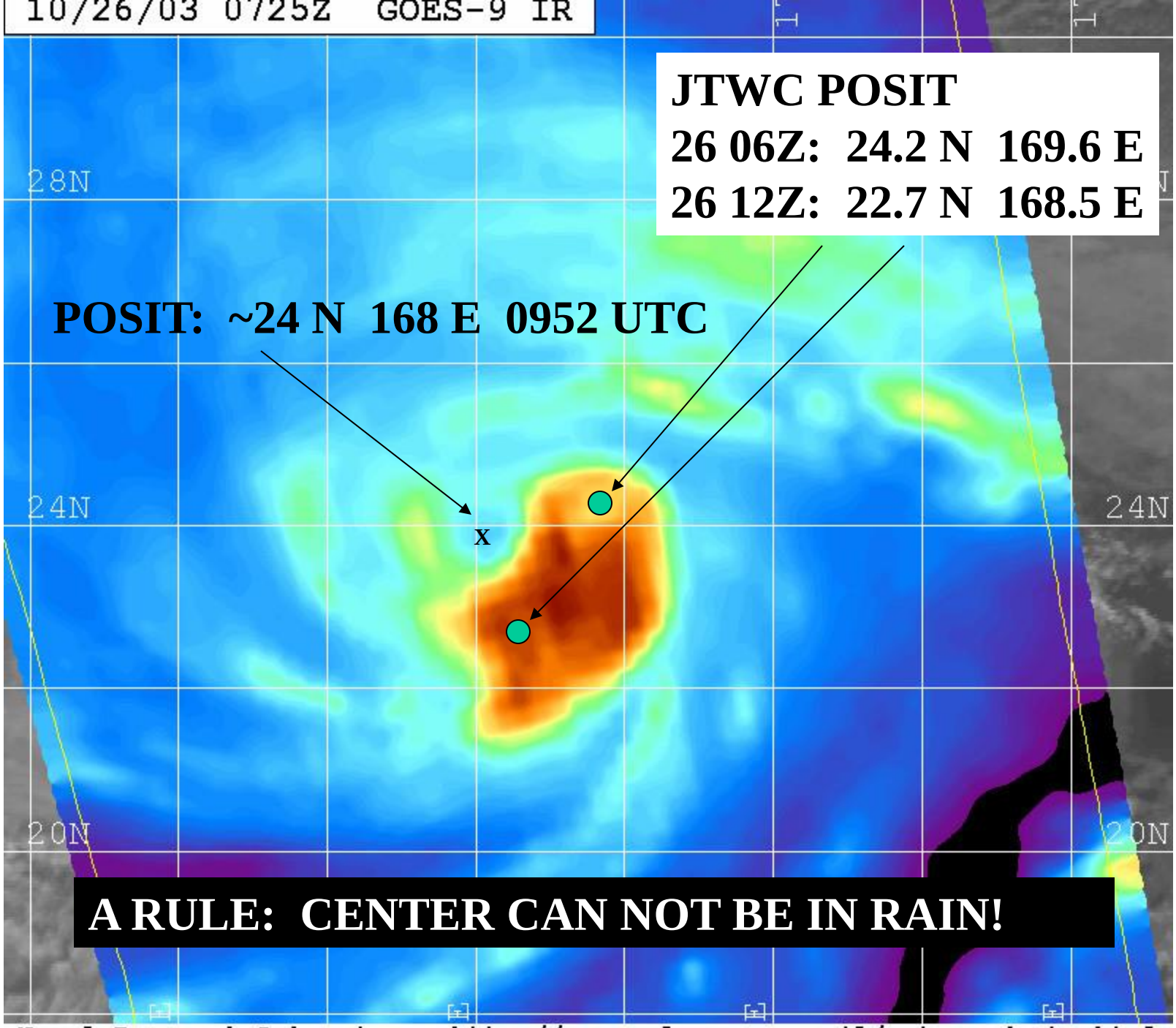

10/23/03 2125Z GOES-9 VIS
PARMA
SSMI 85H
32N
28N
24N
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html


10/23/03 1501Z GOES-9 IR
32N
28N
24N
NOTE: Eye wall
thickest on west side
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html

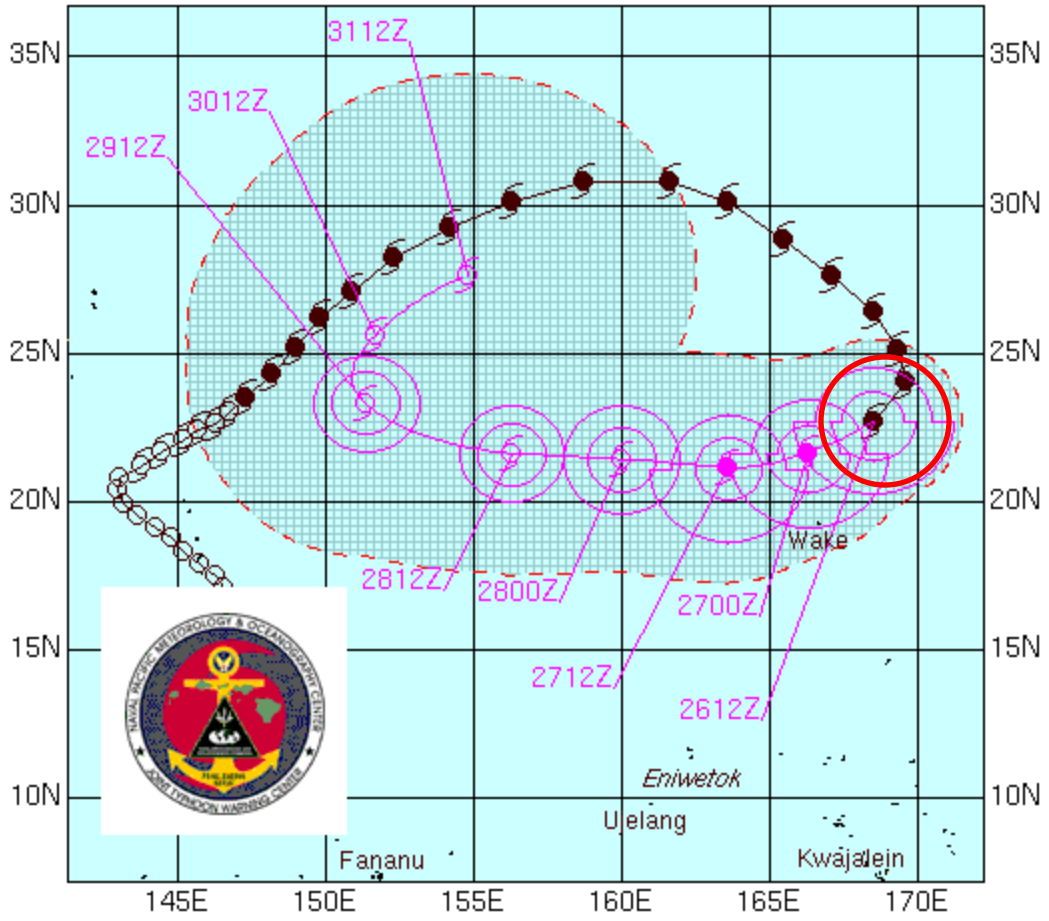

10/23/03 1501Z GOES-9 IR
32N
28N
24N
EYE smaller
on 37 GHz
NOTE: Eye wall thickest
on east side (attenuation
and cold emission by
dense ice phase on west
side)
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html


TY Parma 12 UTC 26 OCT 2003
2N
4N
6N
3
2
1


10/26/03 0725Z GOES-9 IR
28N
24N
20N
CENTER
FAKE EYE
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html


10/26/03 0725Z GOES-9 IR
JTWC POSIT
26 06Z: 24.2 N 169.6 E
26 12Z: 22.7 N 168.5 E
POSIT: ~24 N 168 E 0952 UTC
28N
24N
20N
A RULE: CENTER CAN NOT BE IN RAIN!
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html

BIT-OFF ON FAKE EYE ??

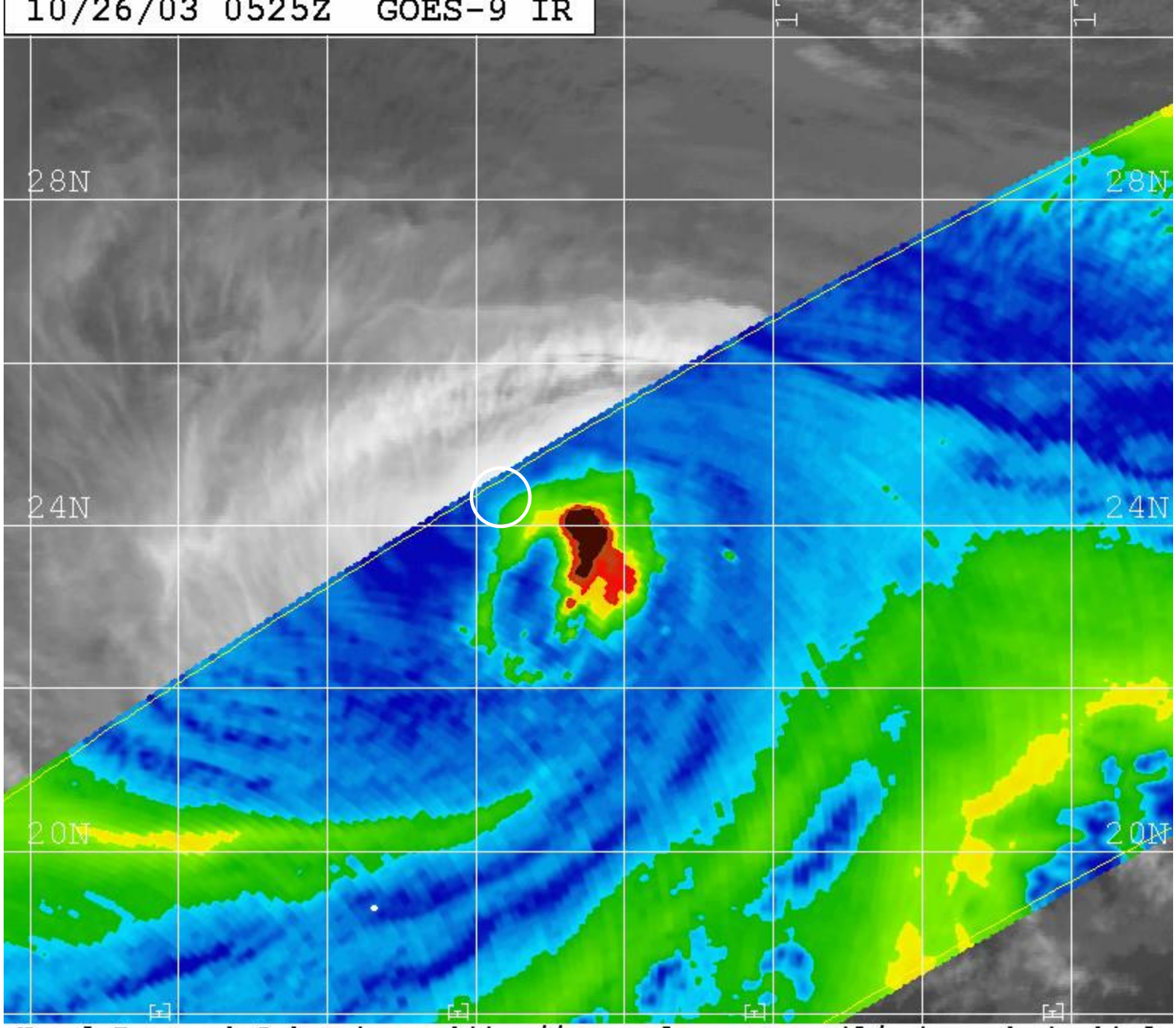


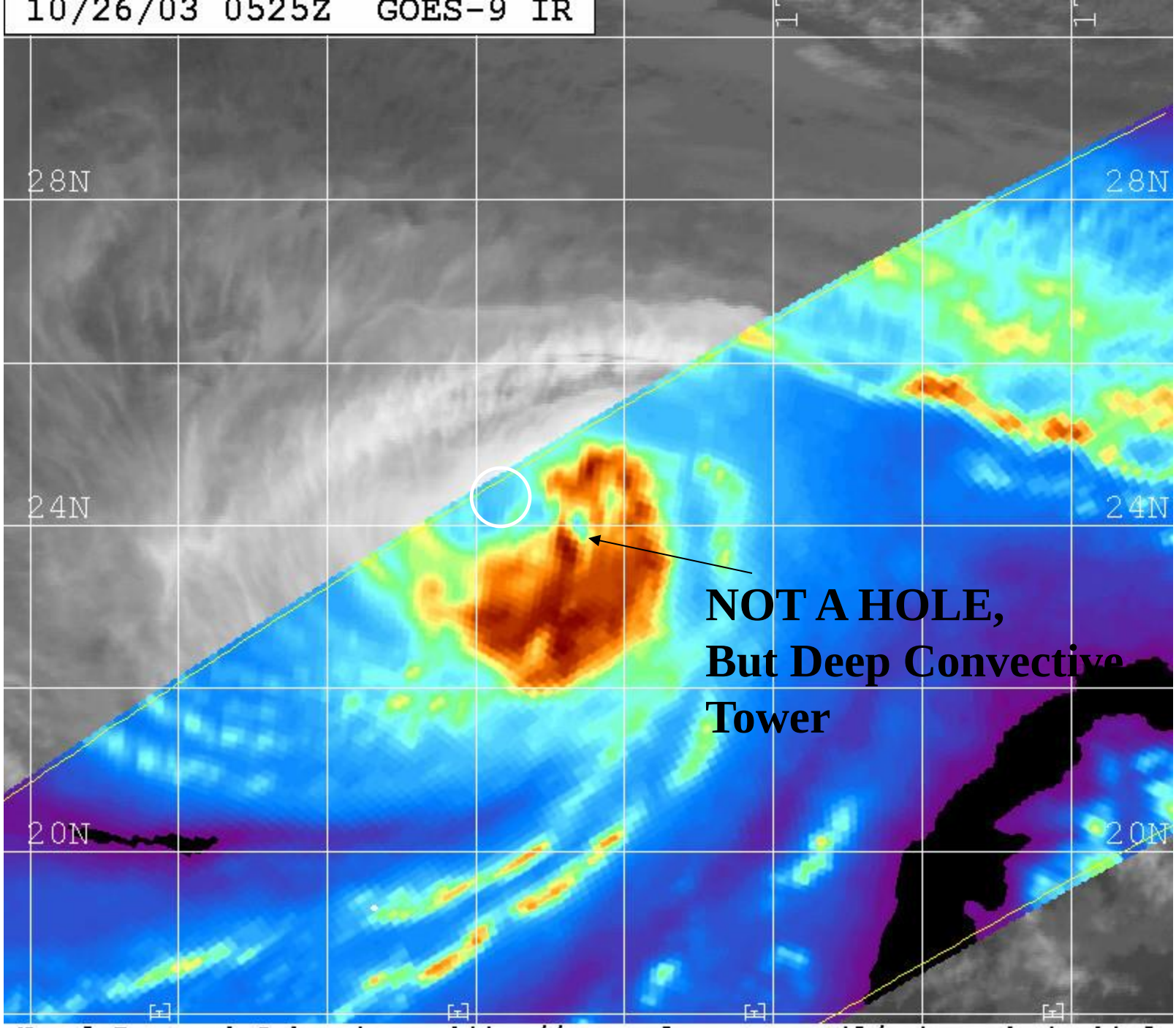
TYPHOON 21W (PARMA) WARNING #25
261200Z POSIT: 22.7N 168.5E
MOVING 220 DEGREES TRUE AT 16 KNOTS
MAXIMUM SIGNIFICANT WAVE HEIGHT: 29 FEET
2612Z, WINDS 080KTS, GUSTS TO 100KTS
2700Z, WINDS 075KTS, GUSTS TO 090KTS
2712Z, WINDS 065KTS, GUSTS TO 080KTS
2800Z, WINDS 060KTS, GUSTS TO 075KTS
2812Z, WINDS 055KTS, GUSTS TO 070KTS
2912Z, WINDS 050KTS, GUSTS TO 065KTS
3012Z, WINDS 050KTS, GUSTS TO 065KTS
3112Z, WINDS 050KTS, GUSTS TO 065KTS

CPA TO:	NM	DTG
MINAMI_TORI_SHIMA	119	29/00Z
WAKE	135	27/02Z

BEARING AND DISTANCE	DIR	DIST (NM)	TAU
WAKE	27	230	0
	353	139	12
	303	200	24
	290	392	36
	285	595	48

○ TROPICAL DEPRESSION
TROPICAL STORM
● TYPHOON
PAST CYCLONE POSITS SHOWN EVERY SIX HOURS.
FORECAST CYCLONE POSITIONS AS LABELED.
HATCHED AREA SHOWS AVG TRACK ERROR.


10/26/03 0525Z GOES-9 IR
28N
24N
20N
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html


10/26/03 0525Z GOES-9 IR
28N
24N
20N
NOT A HOLE,
But Deep Convective
Tower
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html

International Conference on Storms
Brisbane, Australia
(5-9 July 2004)

Problem Areas:

*Diagnostics (Current and Past Information)

- Position, Intensity, Wind Distribution, Motion, Rainfall …

*Forecasts (Future Behavior)

- Track, Intensity, Wind Distribution, Rainfall …

International Conference on Storms
Brisbane, Australia
(5-9 July 2004)

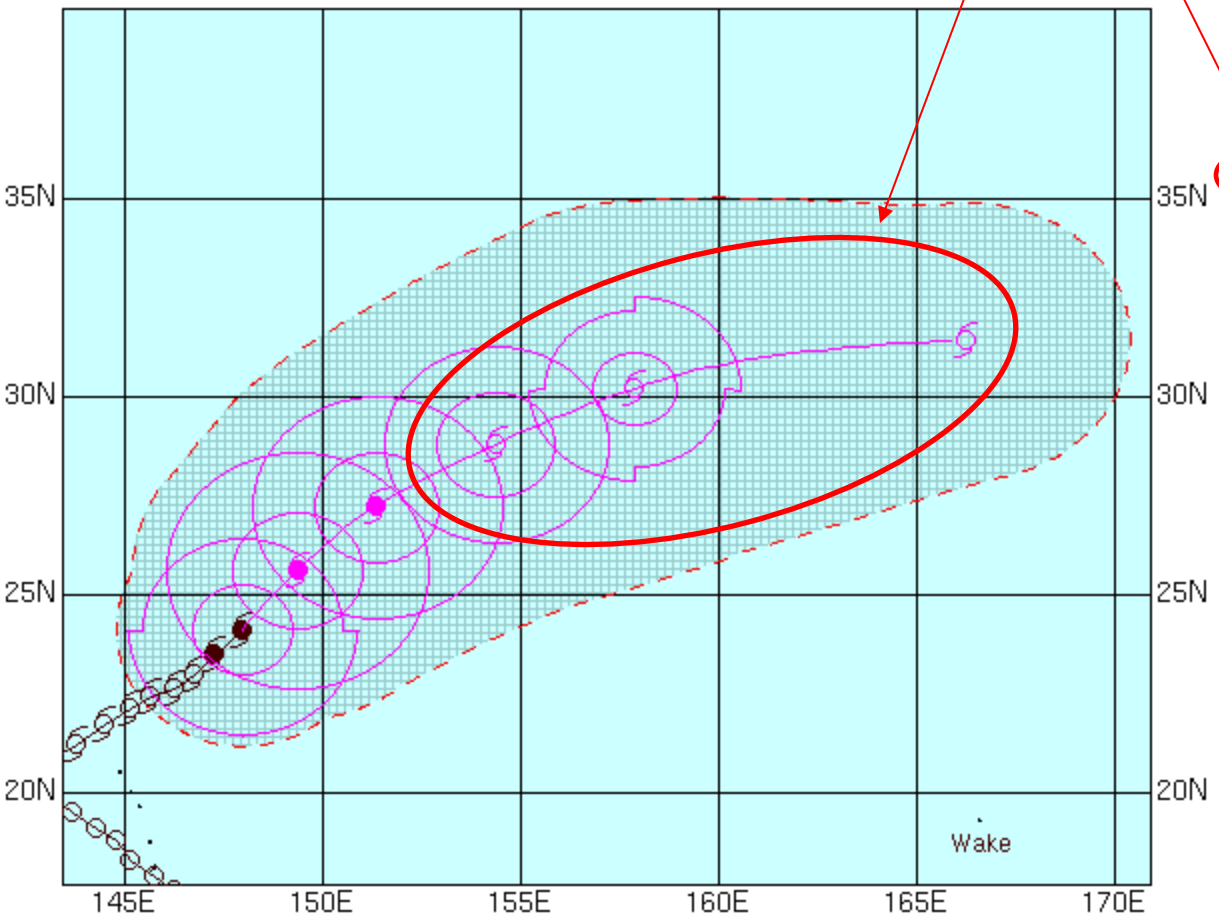
TC INTENSITY FORECASTING

Not much improvement over past 30 years !

Diagnostic information even has problems !

TY Parma
FCST from 18Z
21 October

INTENSITY FORECASTS WAY TOO LOW!



TYPHOON 21W (PARMA) WARNING #10
221800Z POSIT: NER 24.1N 148.0E
MOVING 045 DEGREES TRUE AT 09 KNOTS
MAXIMUM SIGNIFICANT WAVE HEIGHT: 26 FEET
2218Z, WINDS 065KTS, GUSTS TO 080KTS
2306Z, WINDS 075KTS, GUSTS TO 090KTS
2318Z, WINDS 070KTS, GUSTS TO 085KTS
2406Z, WINDS 060KTS, GUSTS TO 075KTS
2418Z, WINDS 055KTS, GUSTS TO 070KTS
2518Z, WINDS 040KTS, GUSTS TO 050KTS

CPA TO:	NM	DTG
WAKE	725	25/17Z

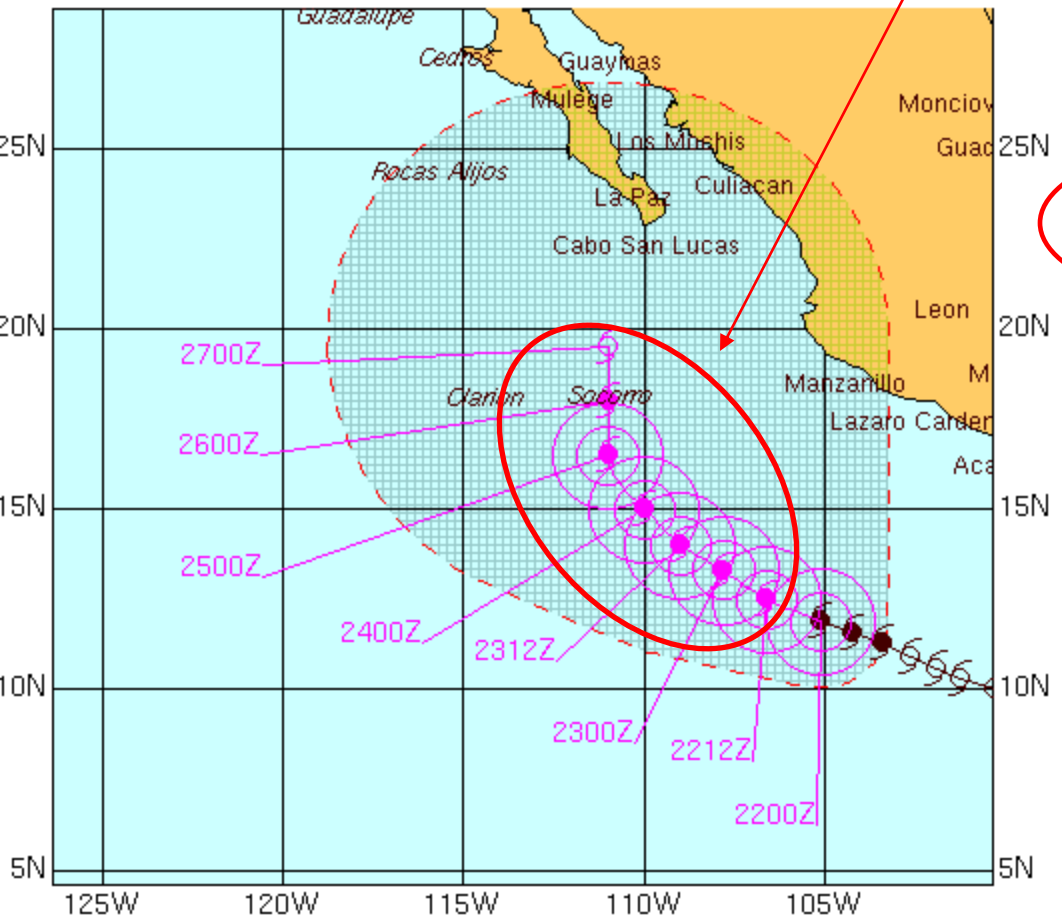
BEARING AND DISTANCE	DIR	DIST (NM)	TAU
WAKE	326	807	48

TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON
PAST CYCLONE POSITS SHOWN EVERY SIX HOURS.
FORECAST CYCLONE POSITIONS AS LABELED.
HATCHED AREA SHOWS AVG TRACK ERROR.

INTENSIFIED TO 130 kt !!

Hurricane Patricia
Fcst from 00Z 22 OCT

INTENSITY FORECASTS WAY TOO HIGH !!



HURRICANE 16E (PATRICIA) WARNING #7
220000Z POSIT: NEAR 11.9N 105.1W
MOVING 290 DEGREES TRUE AT 09 KNOTS
MAXIMUM SIGNIFICANT WAVE HEIGHT: 29 FEET
2200Z, WINDS 070KTS, GUSTS TO 085KTS
2212Z, WINDS 075KTS, GUSTS TO 090KTS
2300Z, WINDS 080KTS, GUSTS TO 100KTS
2312Z, WINDS 085KTS, GUSTS TO 105KTS
2400Z, WINDS 090KTS, GUSTS TO 110KTS
2500Z, WINDS 080KTS, GUSTS TO 100KTS
2600Z, WINDS 070KTS, GUSTS TO 085KTS
2700Z, WINDS 060KTS, GUSTS TO 075KTS

BEARING AND DISTANCE	DIR	DIST (NM)	TAU
MANZANILLO	211	397	24
SOCORRO_ISLAND	150	373	24
	165	229	48
	180	132	72

CPA TO:	NM	DTG
SOCORRO_ISLAND	0	26/11Z

TROPICAL DEPRESSION
TROPICAL STORM
HURRICANE
PAST CYCLONE POSITS SHOWN EVERY SIX HOURS.
FORECAST CYCLONE POSITIONS AS LABELED.
HATCHED AREA SHOWS AVG TRACK ERROR.

WEAKENED TO 45 kt !!

DIAGNOSIS OF TC INTENSITY

GOES/GMS: VIS, IR (1,2), WV 6.7μm

DMSP: SSM/I Passive
19 GHz, 22 GHz, 37 GHz, 85 GHz

TRMM: TMI Passive and Active PR
10.7 GHz, 19 GHz, ….

TC INTENSITY DIAGNOSIS

DVORAK (1975) VIS TECHNIQUES 2-5a

DVORAK (1984) EIR TECHNIQUES 2-4b

accuracy: 5-7 m s^{-1}

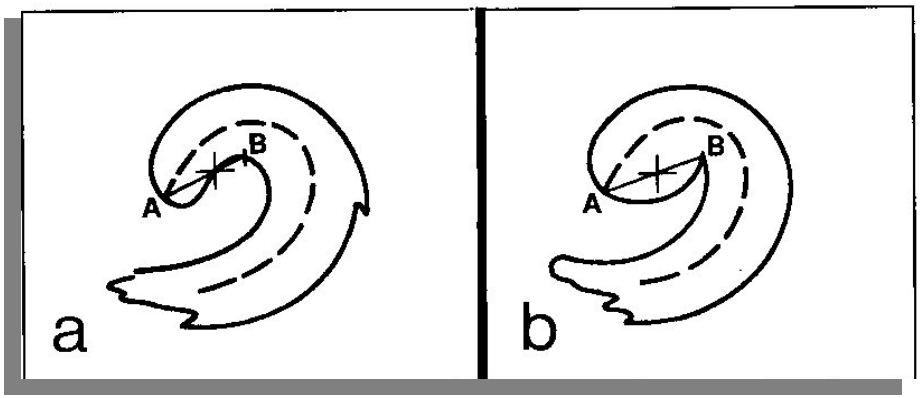
Good for the past 30 yrs

DVORAK ANALYSIS YIELDS 24-HR FORECAST !!!!

DIAGNOSIS OF TC INTENSITY

VIS, IR IMAGERY: USE DVORAK TO GET POSITION* AND INTENSITY.

*Dvorak not a positioning technique, but does give some pointers.



DIAGNOSIS OF TC INTENSITY

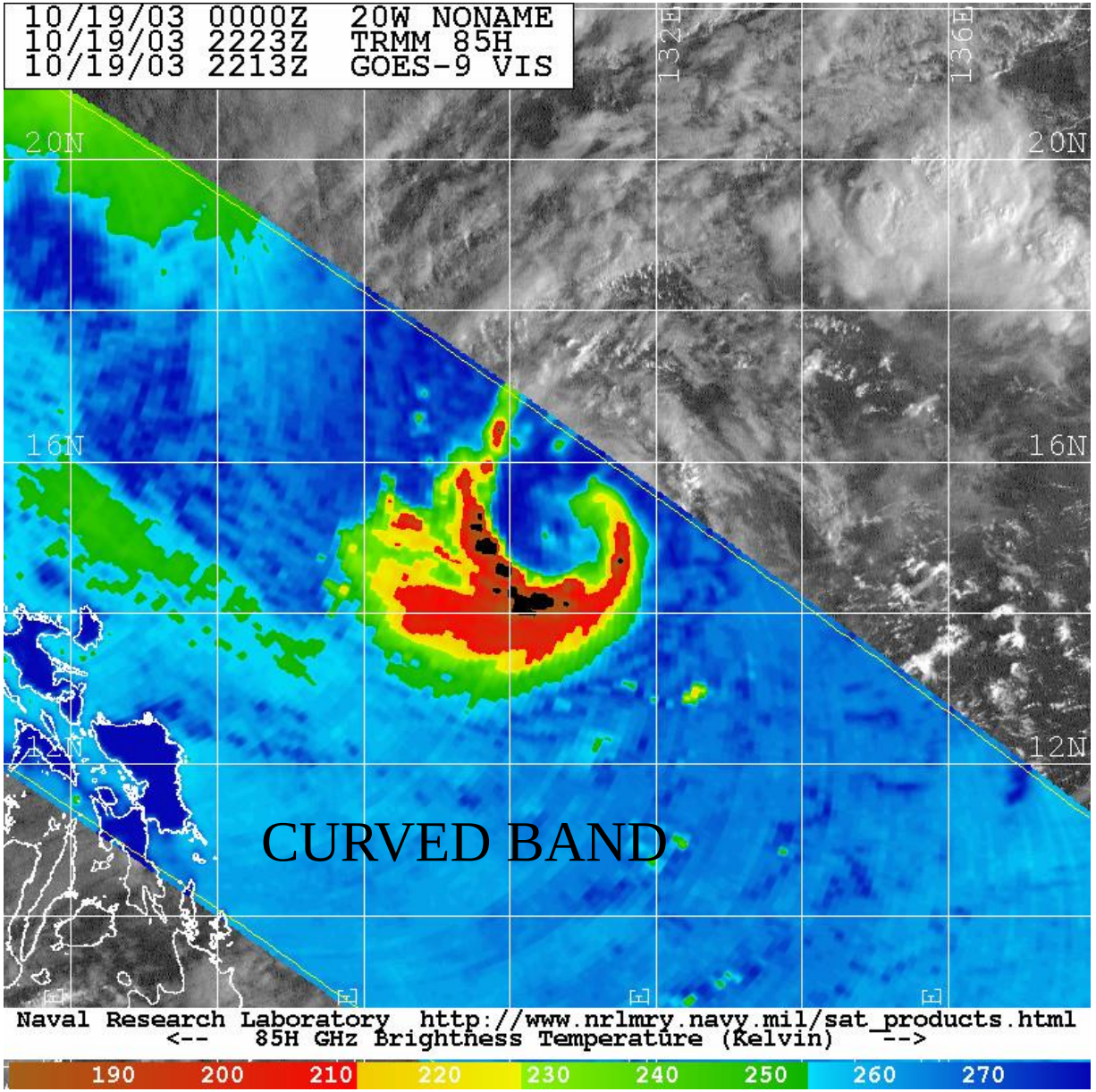
WHAT ABOUT MICROWAVE IMAGERY?

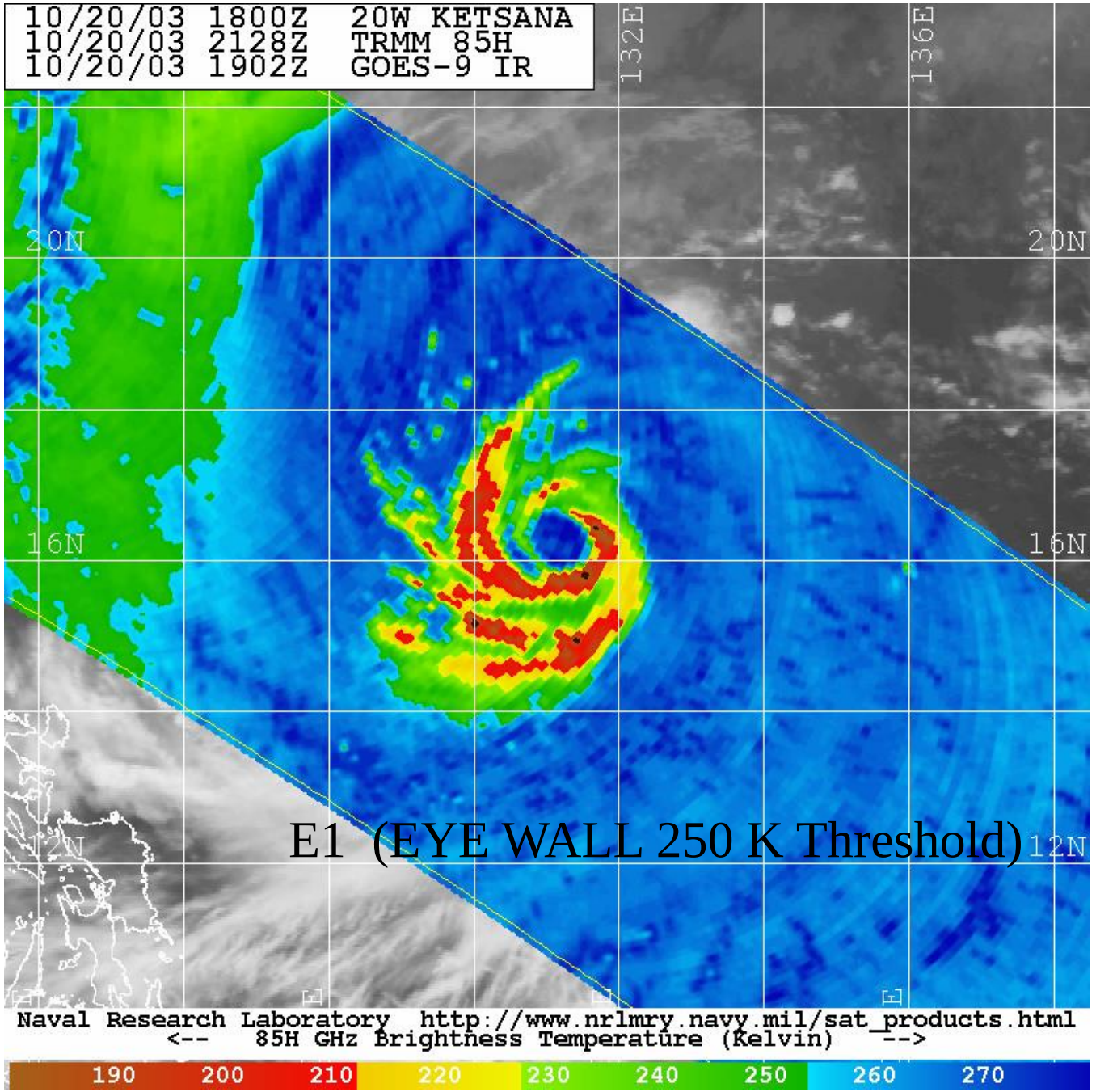
SSMI, TRMM, AMSU, QUIKSCAT ???

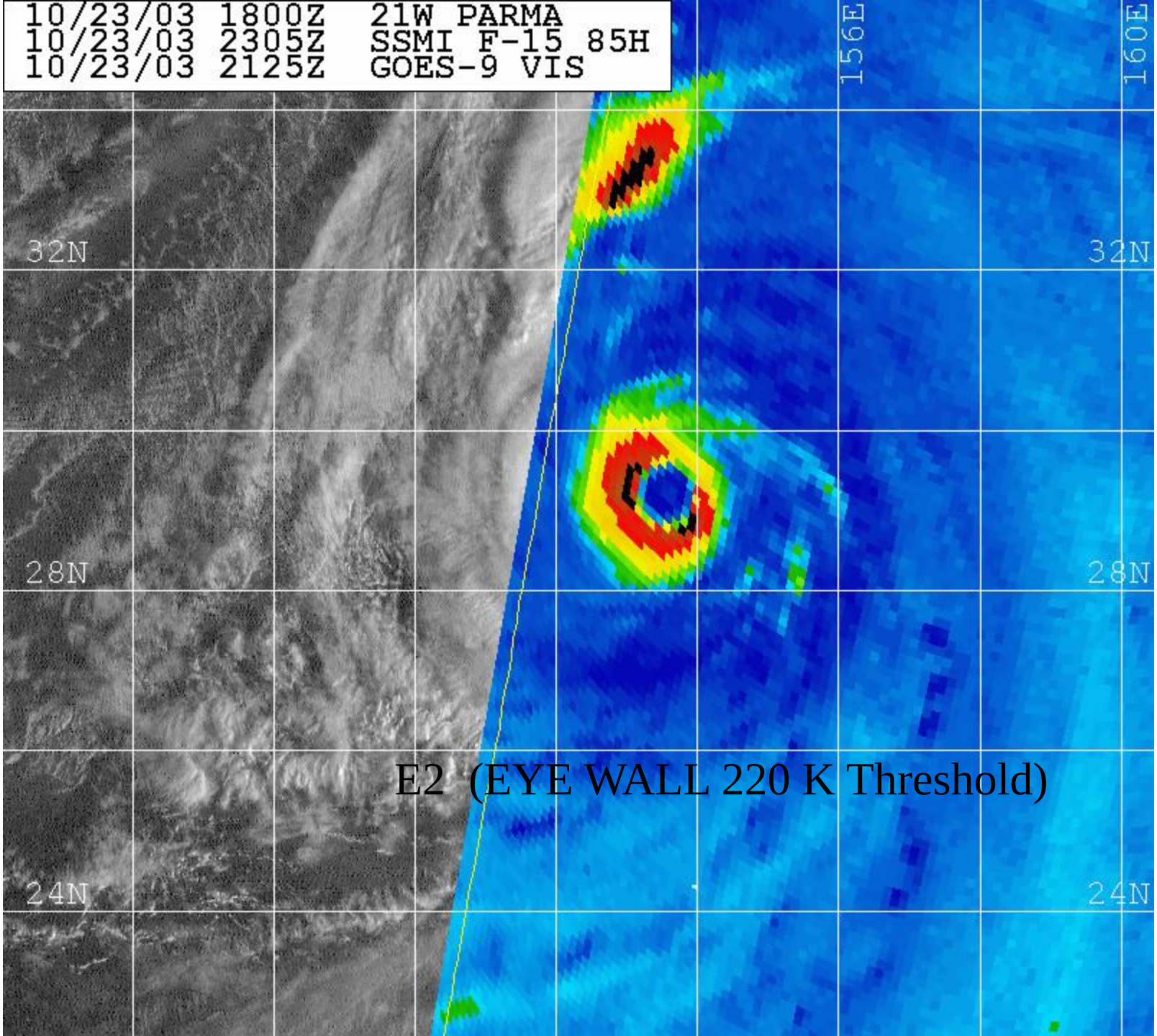
POSITION AND INTENSITY

TC INTENSITY FROM MICROWAVE IMAGERY

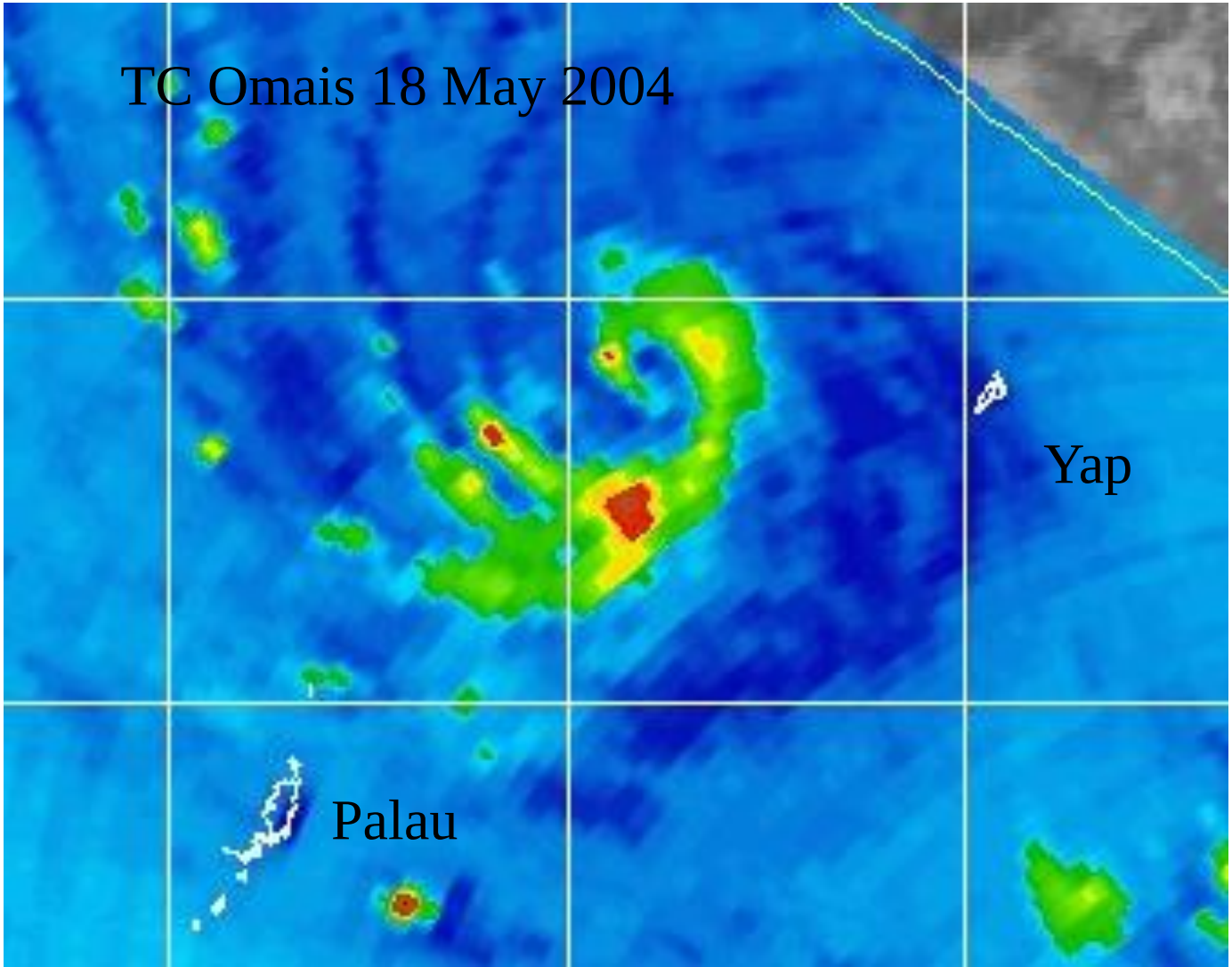
Category:	PLC	ELC	CLC	WCB	SCB	PEW	E1	E2
20-25 kt	6	0	1	0	0	0	0	0
30-40 kt	3	0	9	4	0	2	0	0
45-60 kt	0	0	20	6	3	10	0	0
65-85 kt	0	0	6	5	5	23	4	0
90-105 kt	0	1	2	1	0	14	11	1
110-125 kt	0	0	0	0	0	3	10	3
130-155 kt	0	0	0	0	0	0	17	10

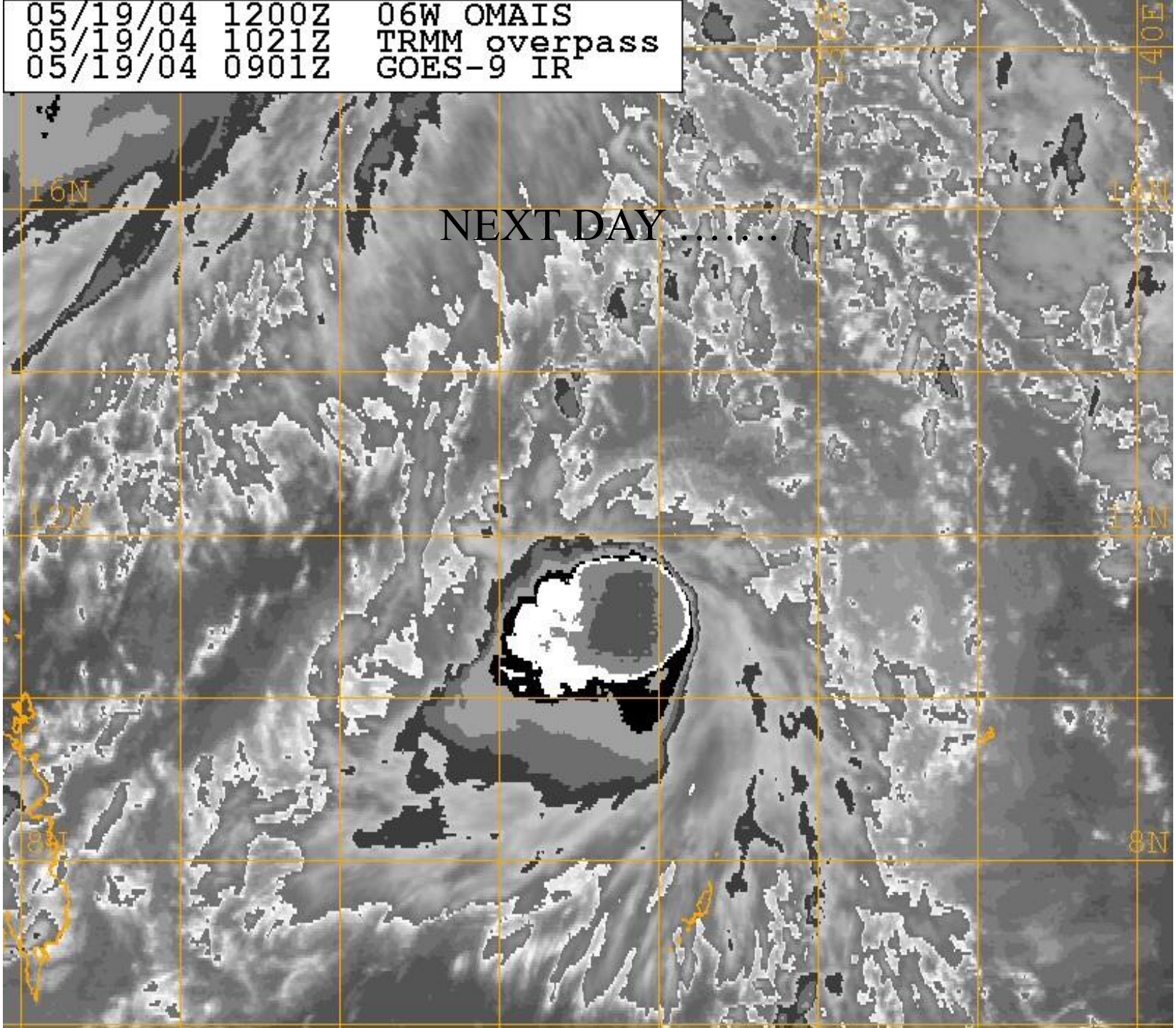

10/19/03 0000Z 20W NONAME
10/19/03 2223Z TRMM 85H
10/19/03 2213Z GOES-9 VIS
132E
136E
20N
16N
12N
CURVED BAND
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html
<-- 85H GHz Brightness Temperature (Kelvin) -->
190 200 210 220 230 240 250 260 270

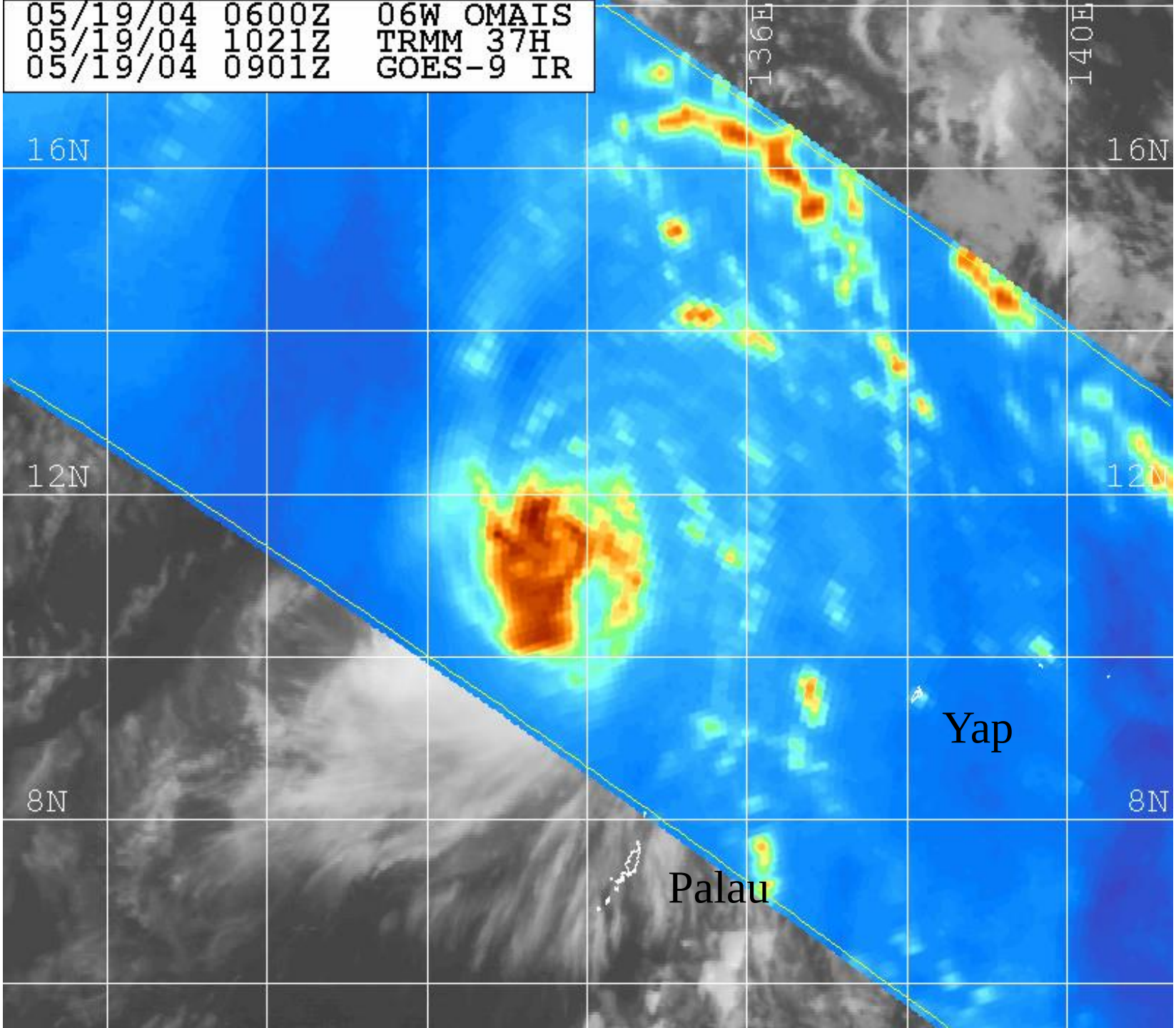

10/20/03 1800Z 20W KETSANA
10/20/03 2128Z TRMM 85H
10/20/03 1902Z GOES-9 IR
132E
136E
20N
16N
12N
E1 (EYE WALL 250 K Threshold)
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html
<-- 85H GHz Brightness Temperature (Kelvin) -->
190 200 210 220 230 240 250 260 270

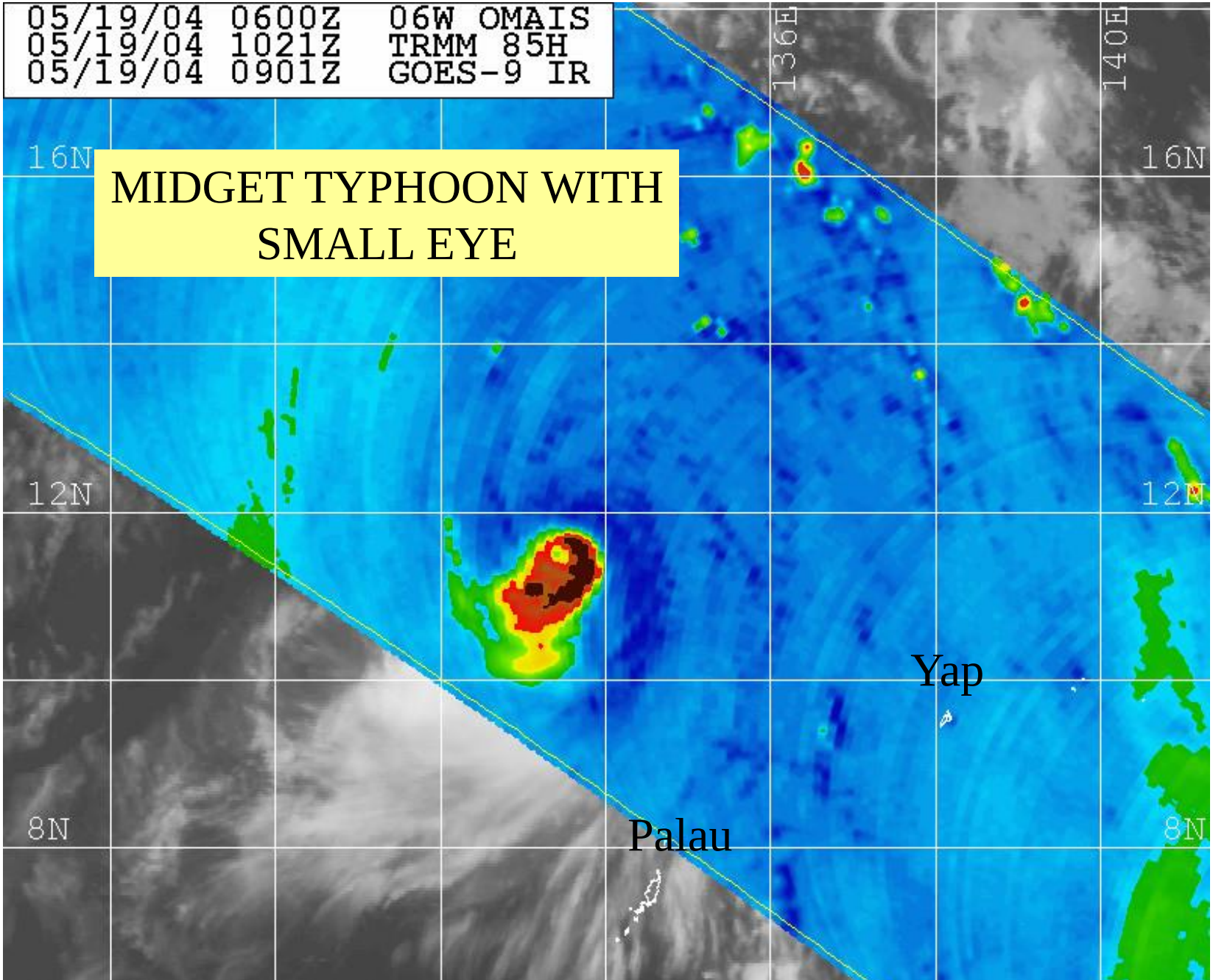

10/23/03 1800Z 21W PARMA
10/23/03 2305Z SSMI F-15 85H
10/23/03 2125Z GOES-9 VIS
156E
160E
32N
28N
24N
E2 (EYE WALL 220 K Threshold)

TC INTENSITY
35 kt or 65 kt??????

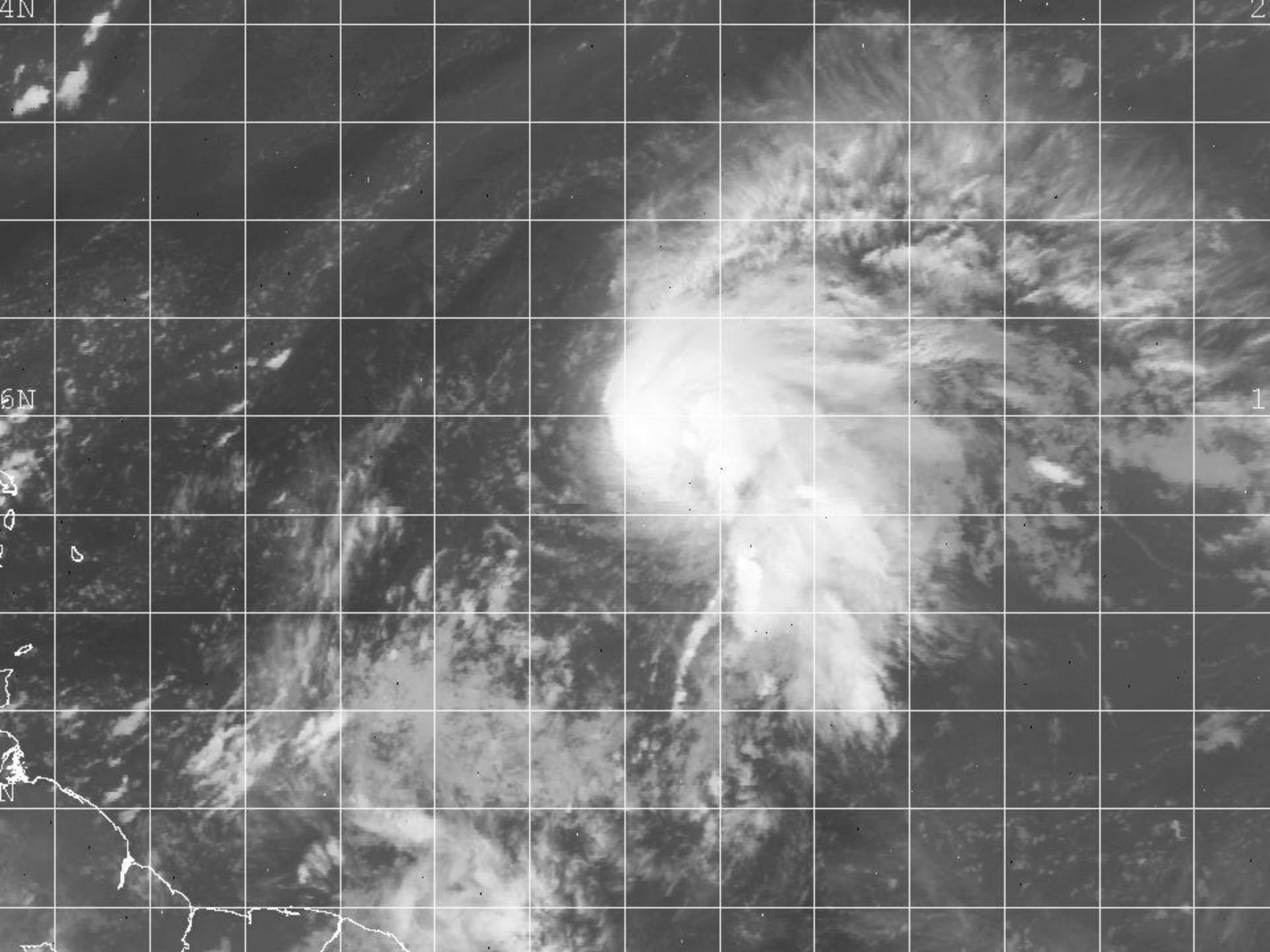


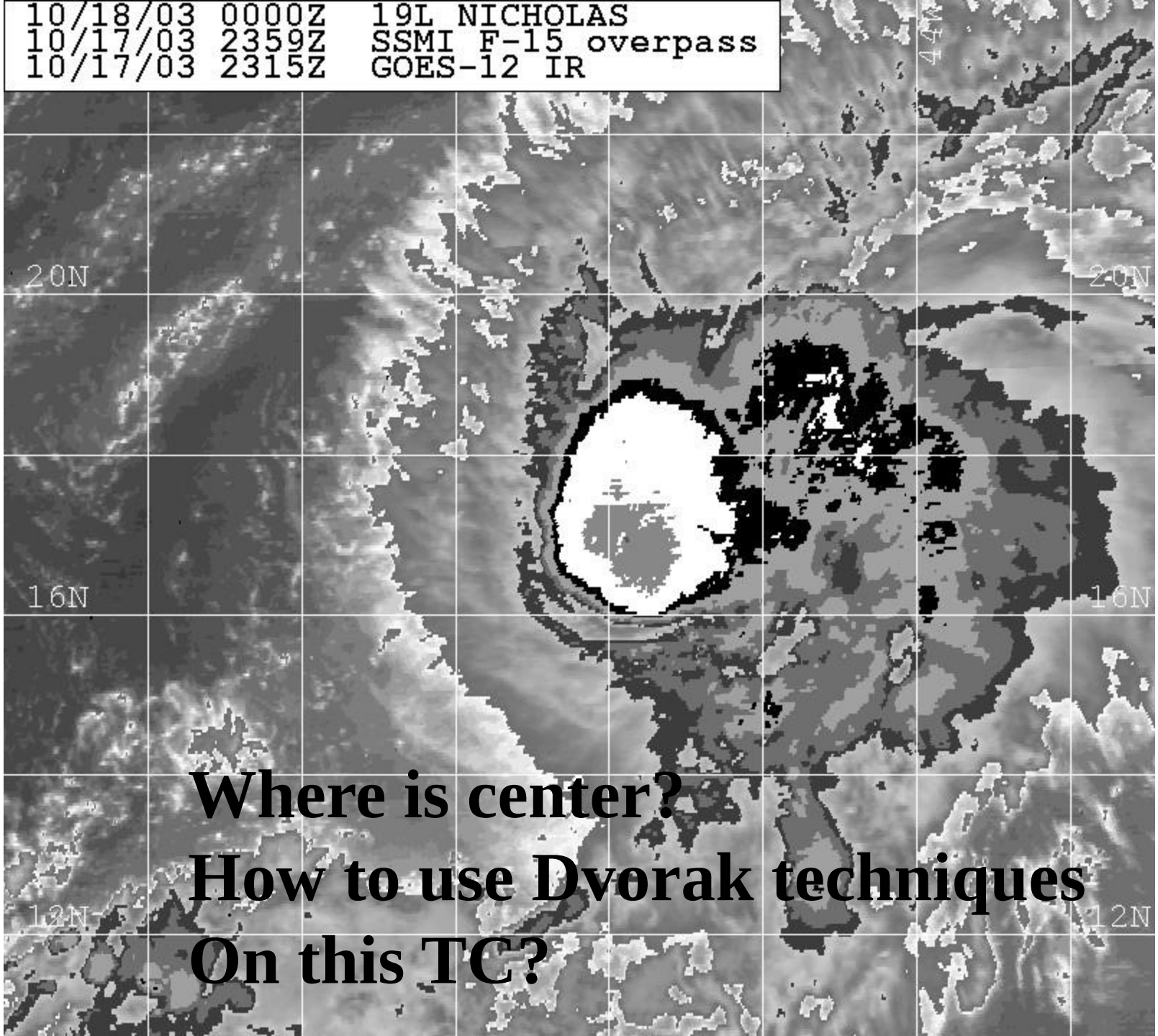

05/19/04 1200Z 06W OMAIS
05/19/04 1021Z TRMM overpass
05/19/04 0901Z GOES-9 IR
NEXT DAY .....
16N
12N
8N
140E

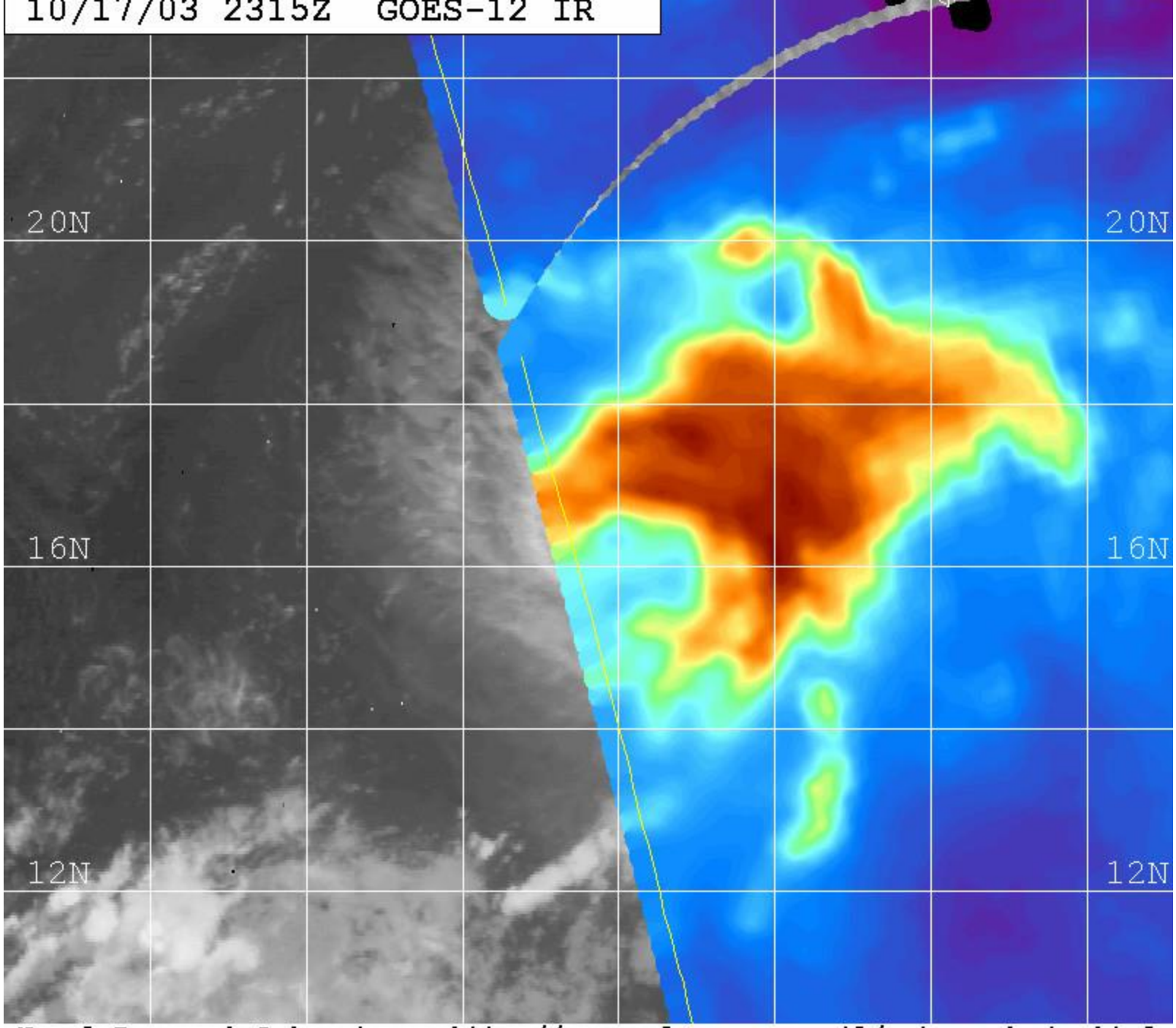

05/19/04 0600Z 06W OMAIS
05/19/04 1021Z TRMM 37H
05/19/04 0901Z GOES-9 IR
136E
140E
16N
12N
8N
Yap
Palau

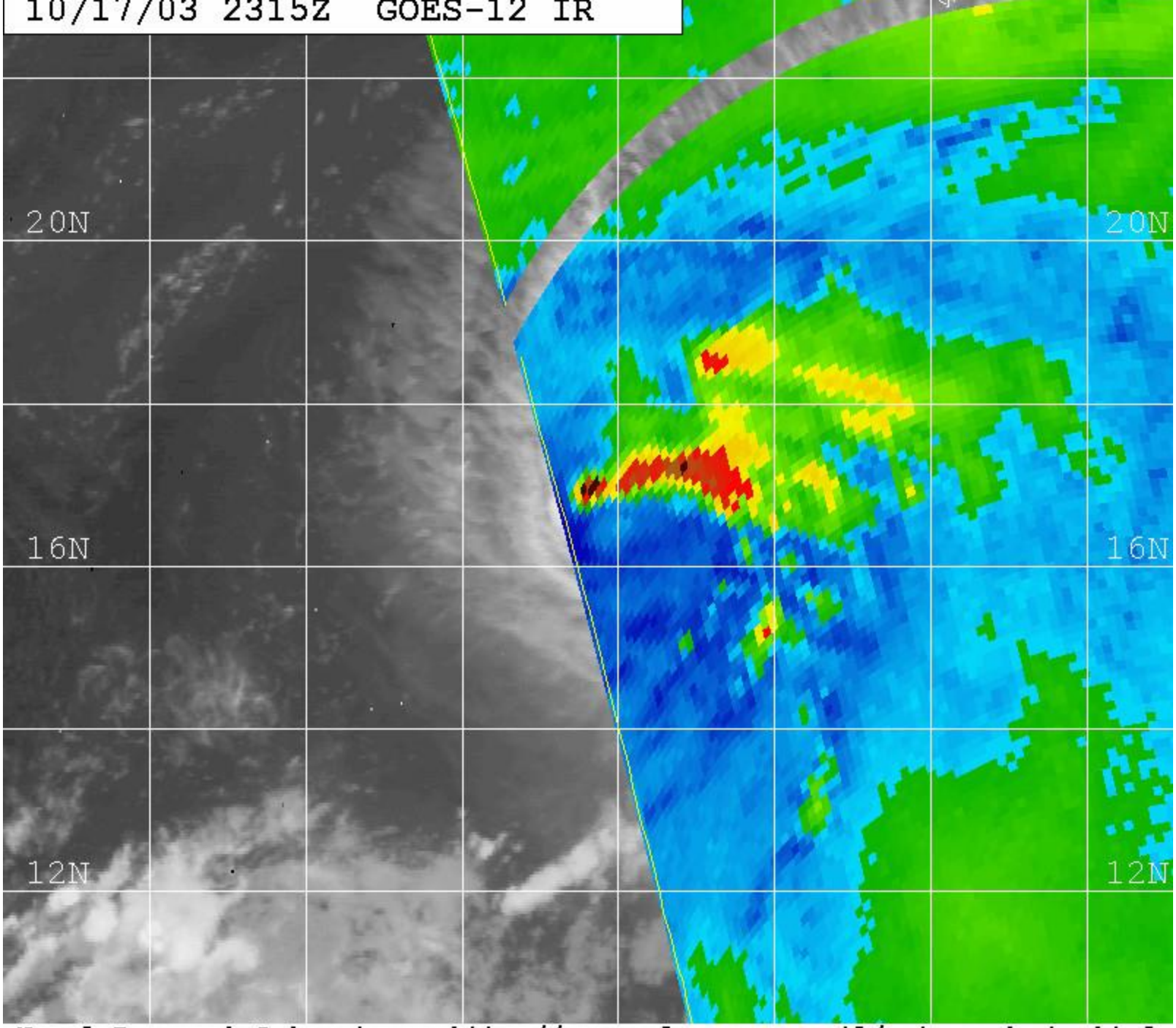

05/19/04 0600Z 06W OMAIS
05/19/04 1021Z TRMM 85H
05/19/04 0901Z GOES-9 IR
136E
140E
16N
16N
MIDGET TYPHOON WITH SMALL EYE
12N
12N
Yap
8N
Palau
8N

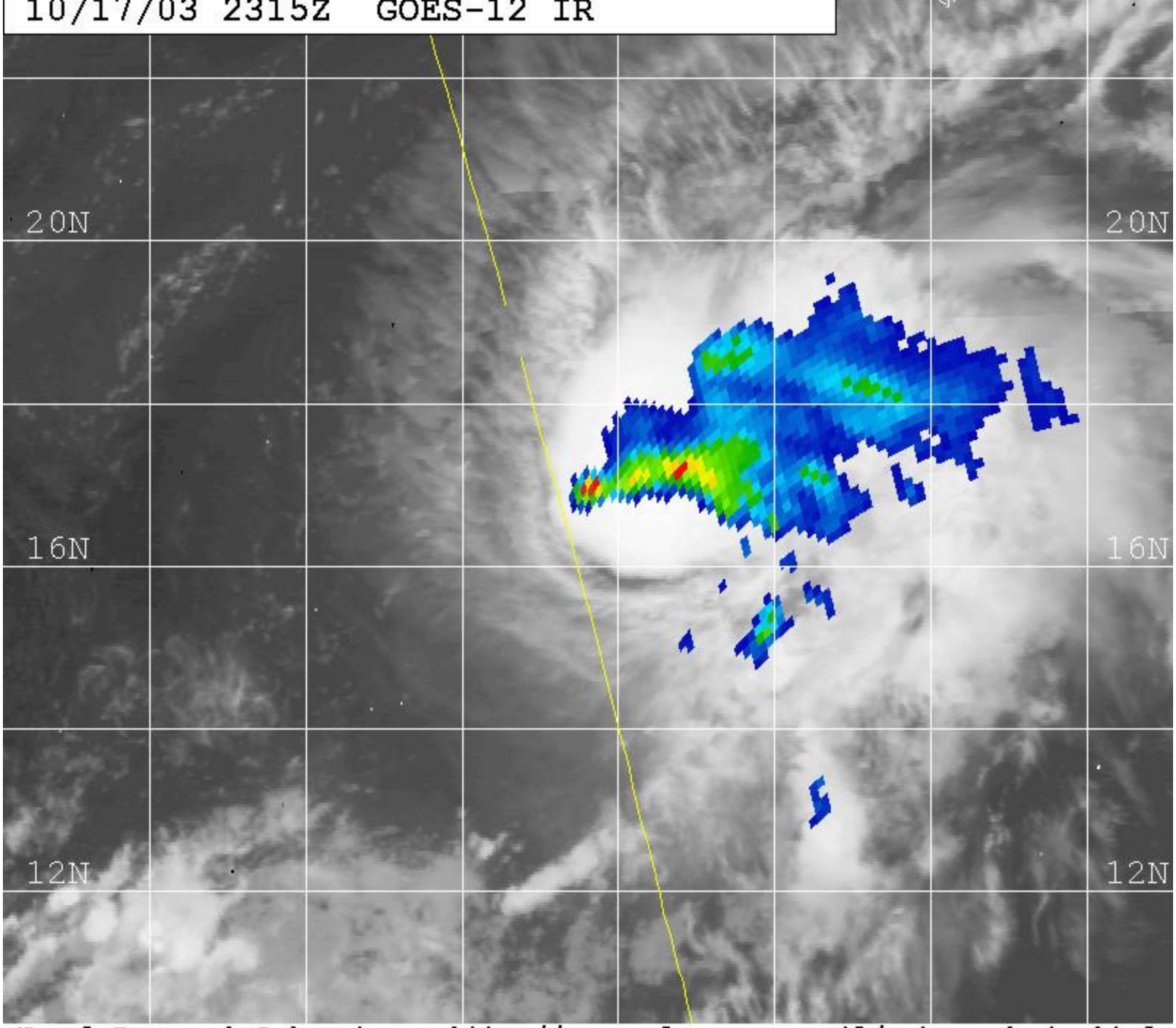
NICHOLAS SEQUENCE

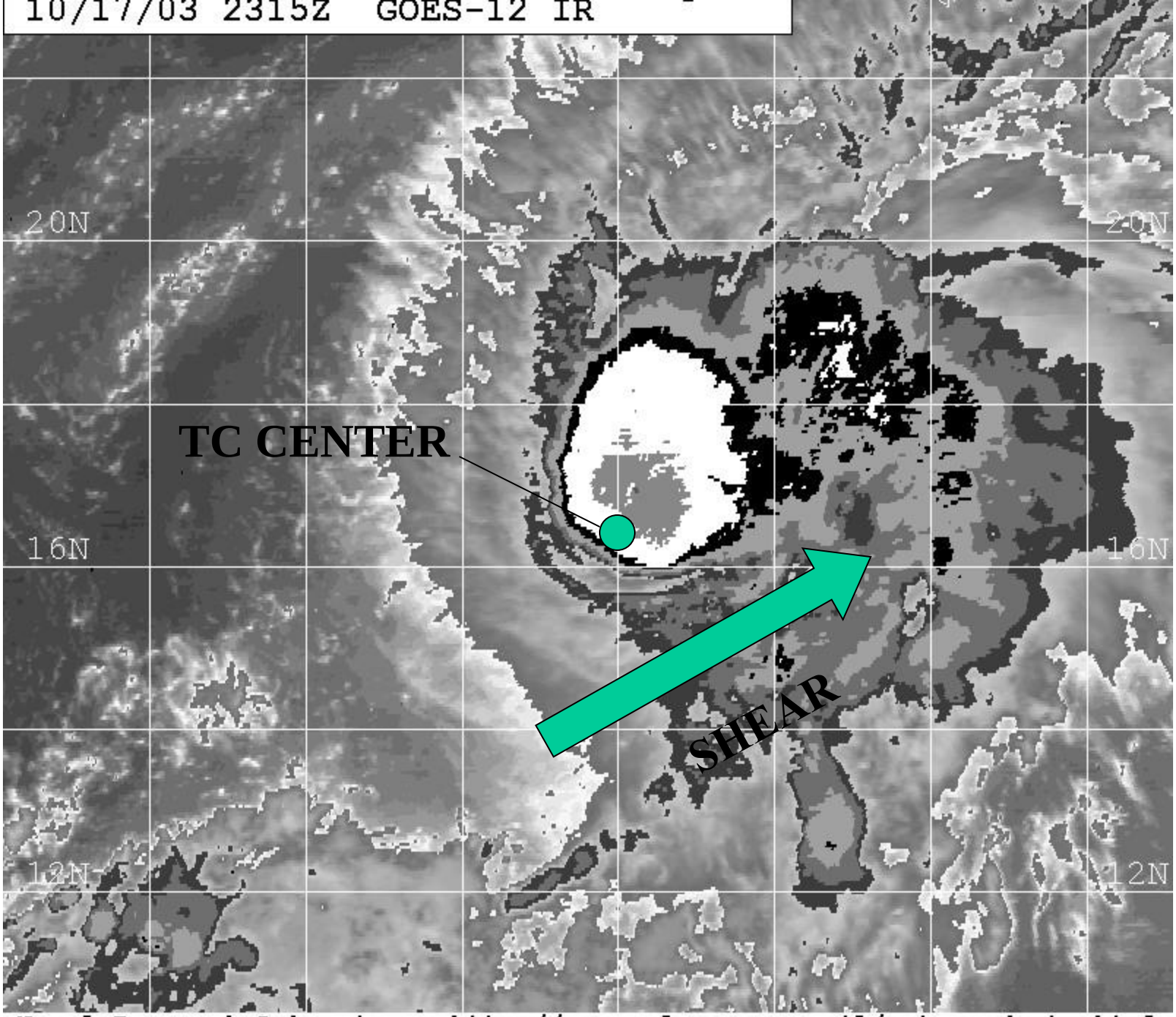

4N
2
6N
1


10/18/03 0000Z 19L NICHOLAS
10/17/03 2359Z SSMI F-15 overpass
10/17/03 2315Z GOES-12 IR
20N
16N
12N
Where is center?
How to use Dvorak techniques
On this TC?


10/17/03 2315Z GOES-12 IR
20N
20N
16N
16N
12N
12N
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html


10/17/03 2315Z GOES-12 IR
20N
16N
12N
20N
16N
12N
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html


10/17/03 2315Z GOES-12 IR
20N
16N
12N
20N
16N
12N
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html


10/17/03 2315Z GOES-12 IR
20N
20N
TC CENTER
16N
16N
SHEAR
12N
12N
Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html
<-- IR Temperature (Celsius) -->

1. **START**
Locate cloud system center.

Locate the "CSC" at the focal point of all the curved cloud lines or bands. For inital development (T1), see Step 1A

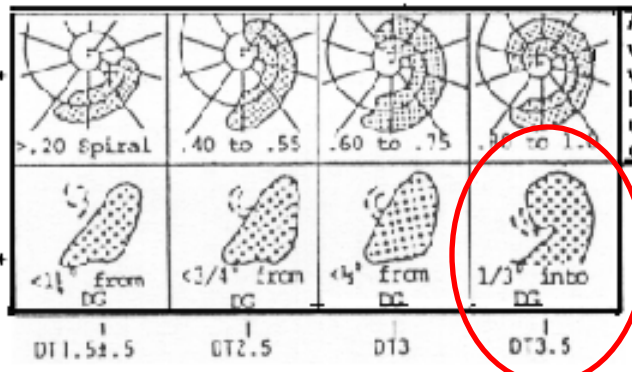
2 Analyze using pattern below when possible; then go to Step 3.

When your storm pattern does not fit the description of any of Steps 2A thru E, do Steps 3, 4, 5, and 6; then return to Step 2 if indicated.

GRAY SHADE CODE (BD CURVE)

WMG	(Warm Medium Gray), > +9°C
OW	(Off White), +9 to -30°C
DG	(Dark Gray), -31 to -41°C
MG	(Medium Gray), -42 to -53°C
LG	(Light Gray), -54 to -63°C
B	(Black), -64 to -69°C
W	(White), -70 to -75°C
CMG	(Cold Medium Gray), -76 to -80°C
CDG	(Cold Dark Gray), ≤ -81°C

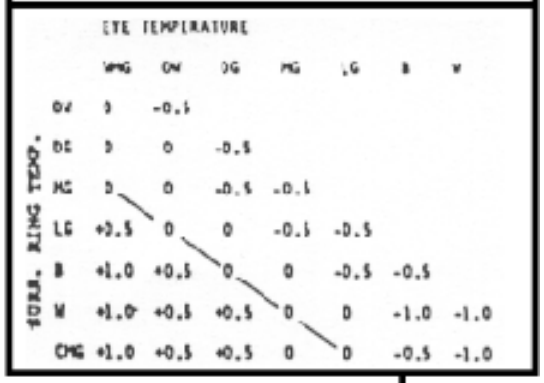
2A "Curved Band" pattern (Use spiral arc distance along 10° long spiral)



Add .0 to DT when band is white. For bands >1.0 use Vis 2A or EIR 2C

2B "Shear" Pattern
Use center definition and center's distance to dense overcast.

T 3.5



2C "Eye" Pattern

Was 24-hr old T-no. ≥T2?

YES

Narrowest Width	≥.5	≥.5	≥.5	≥.4	≥.4	≥.3	≥.3
Surrounding Gray Shade	CHG	W	B	LG	HG	DG	OH
	E6.5	E6.	E5.5	E5	E4.5	E4.5	E4

NO → Step 2A or 4

Eye Adjustment? E-no. + Eye Adj ^ CF

2D "Embedded Center" Pattern (Center within cold ⊕ by ≥0.4)

Was 12-hr old T-no. ≥T3.5?

YES

	≥.6	≥.6	≥.5	≥.5	≥.4	≥.4
	White or Colder	B	LG	HG	DG	OW
	CF5	CF5	CF4.5	CF4	CF4	CF3.5

NO → Step 2A or 4

T 3.5

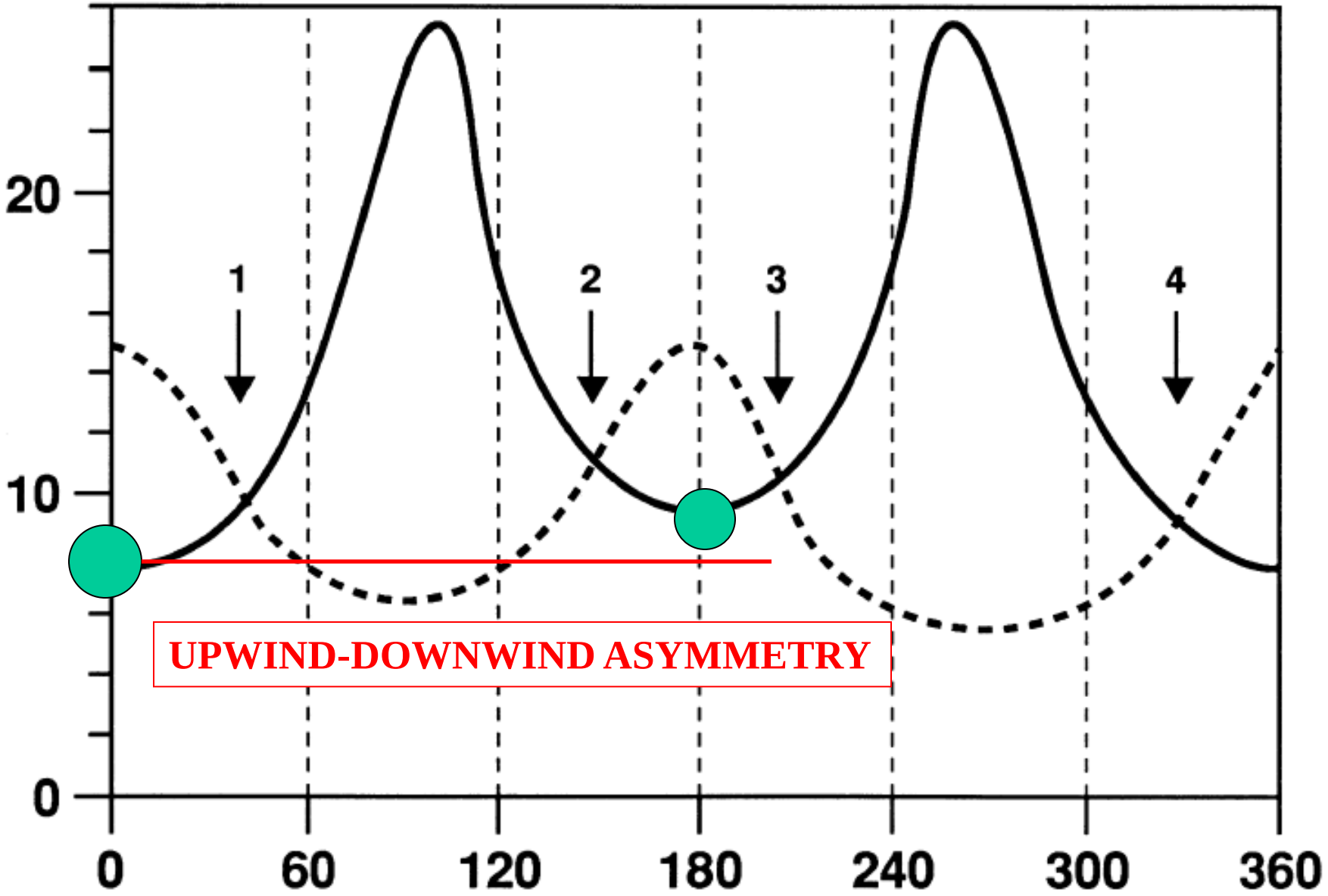
Banding Feature (BF)? CF + BF = DT

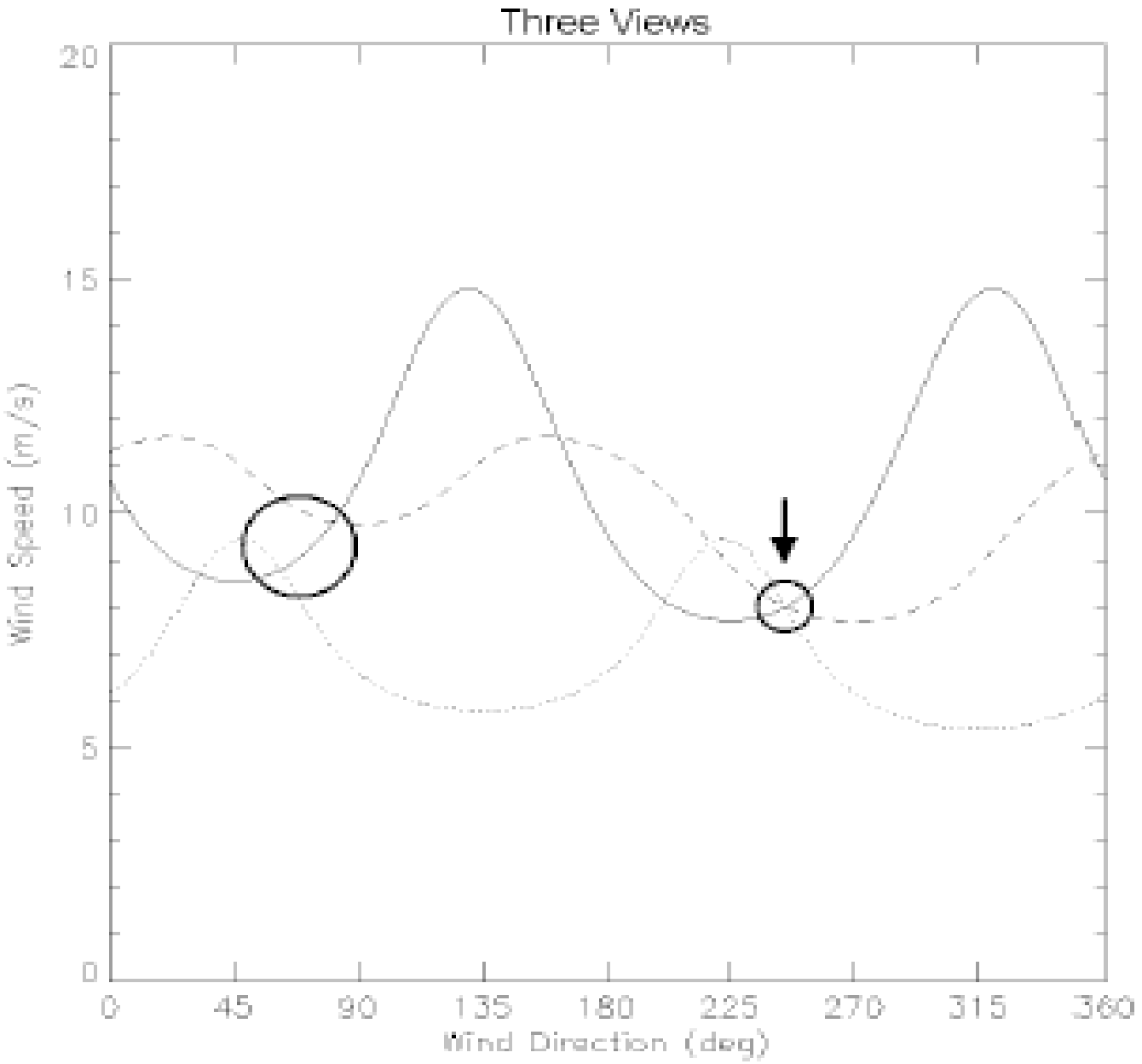
QUIKSCAT PROBLEMS

- RAIN CONTAMINATION

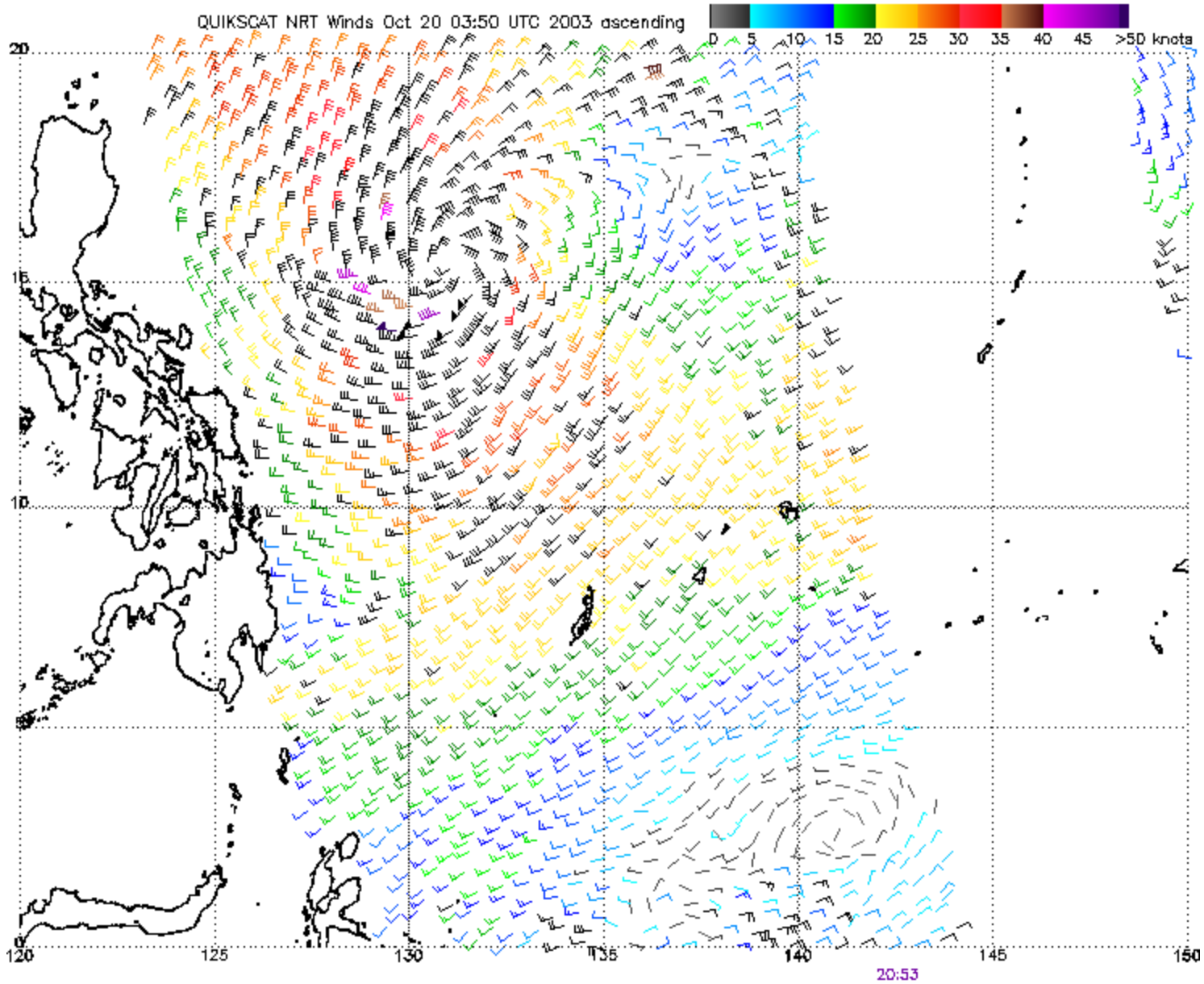
- FALSE CENTERS

- ALONG-SWATH ERRONEOUS WINDS

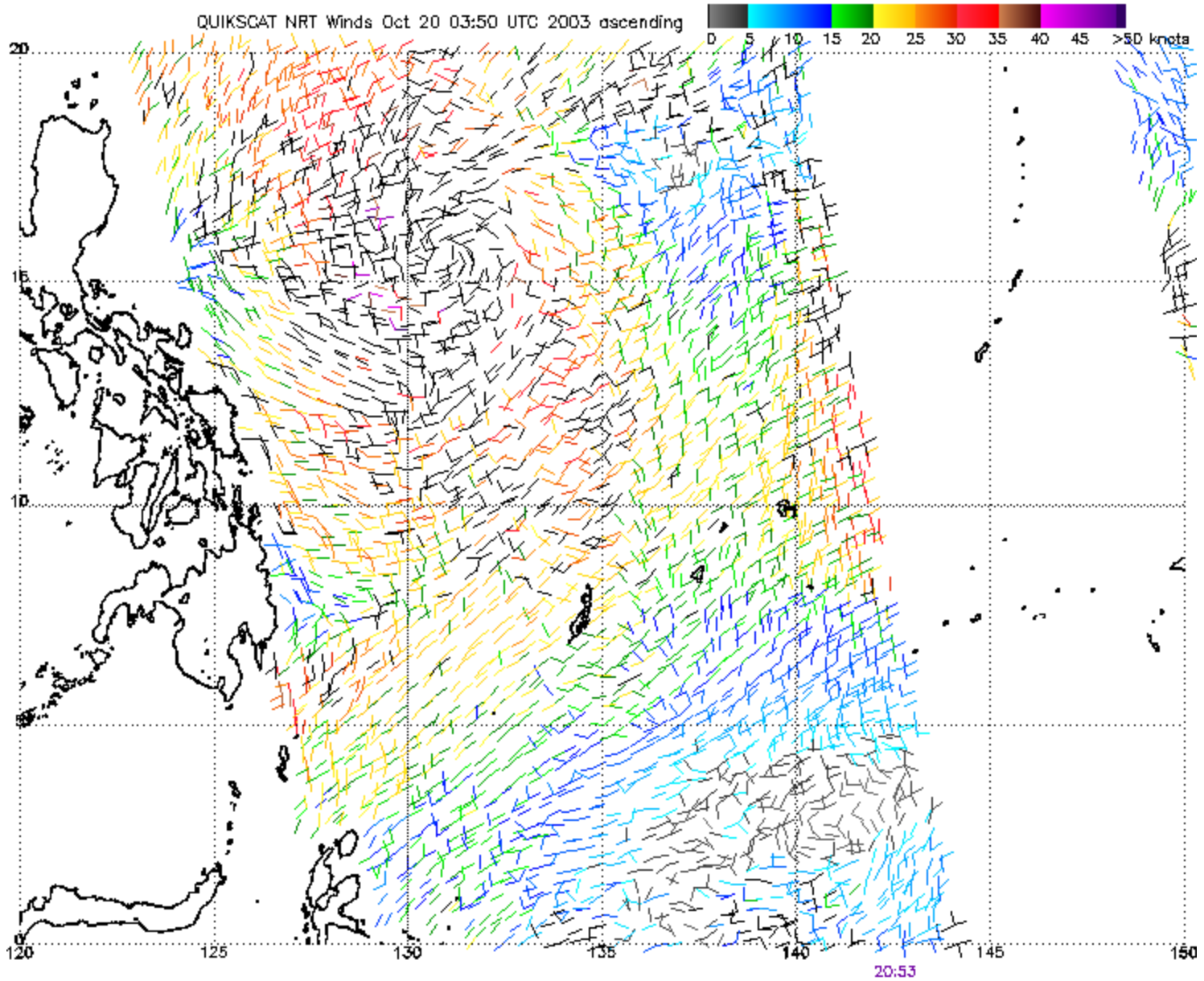

20
10
0
1
2
3
4
0
60
120
180
240
300
360
UPWIND-DOWNWIND ASYMMETRY

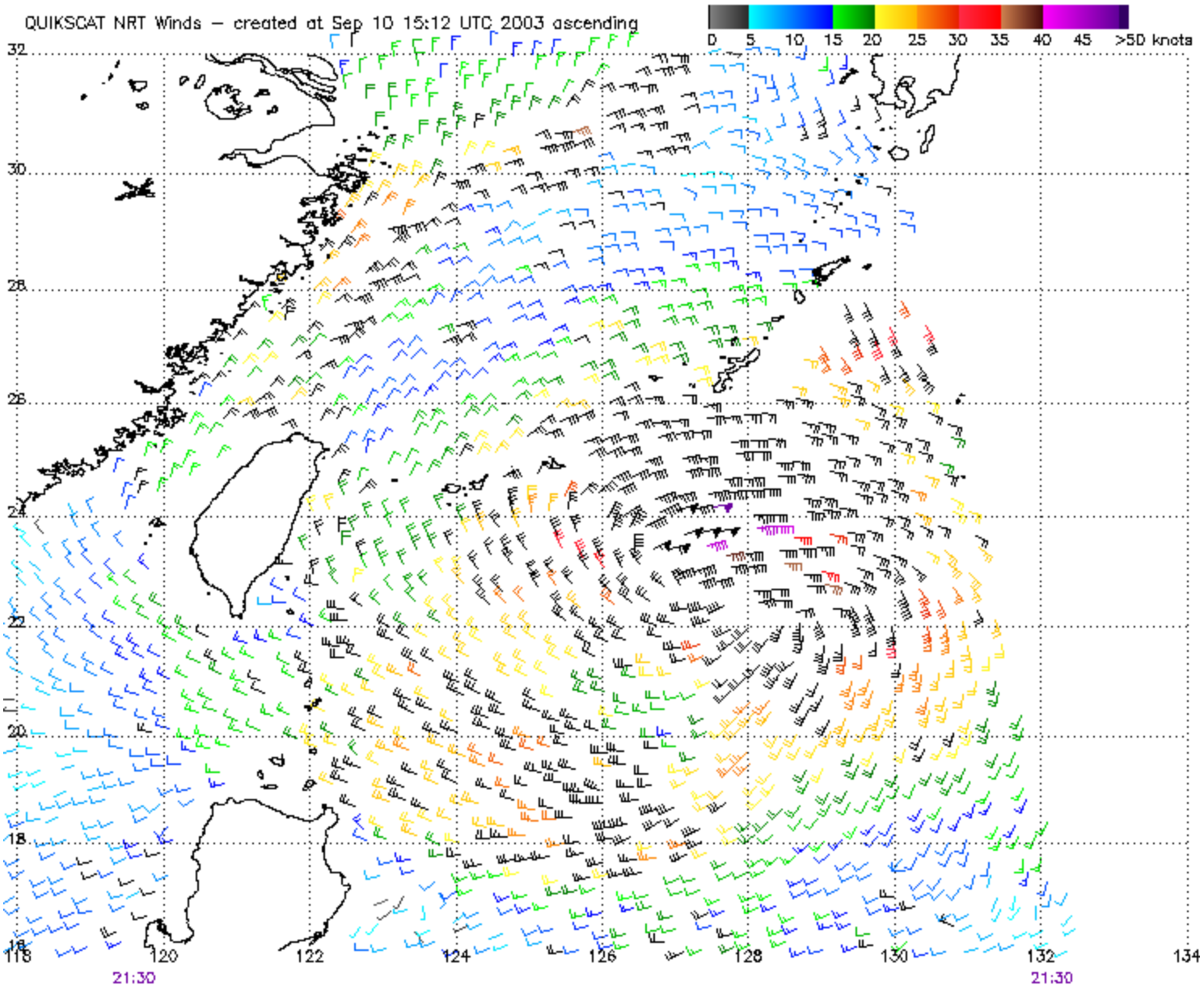

Three Views
20
15
10
5
0
Wind Speed (m/s)
0
45
90
135
180
225
270
315
360
Wind Direction (deg)

WINDS


QUIKSCAT NRT Winds Oct 20 03:50 UTC 2003 ascending
0 5 10 15 20 25 30 35 40 45 >50 knots
20
15
10
5
120 125 130 135 140 145 150
20:53
Note: 1) Times are GMT 2)Times correspond to 10N at right swath edge – time is right swath for overlapping swaths at 10N
3)Data buffer is Oct 20 03:50 UTC 2003–22 hrs 4)Black barbs indicate possible rain contamination
NOAA/NESDIS/Office of Research and Applications

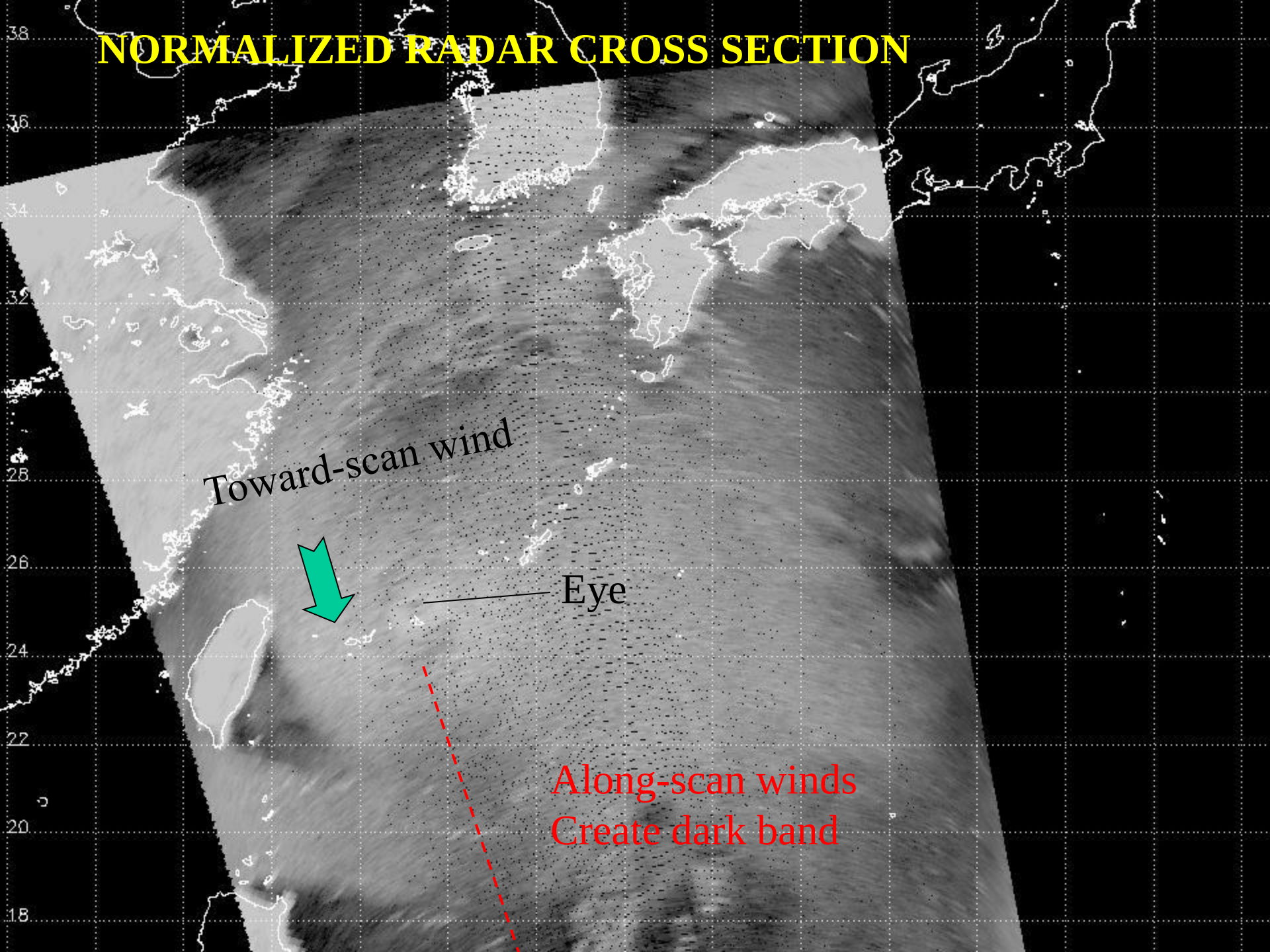
AMBIGUITIES

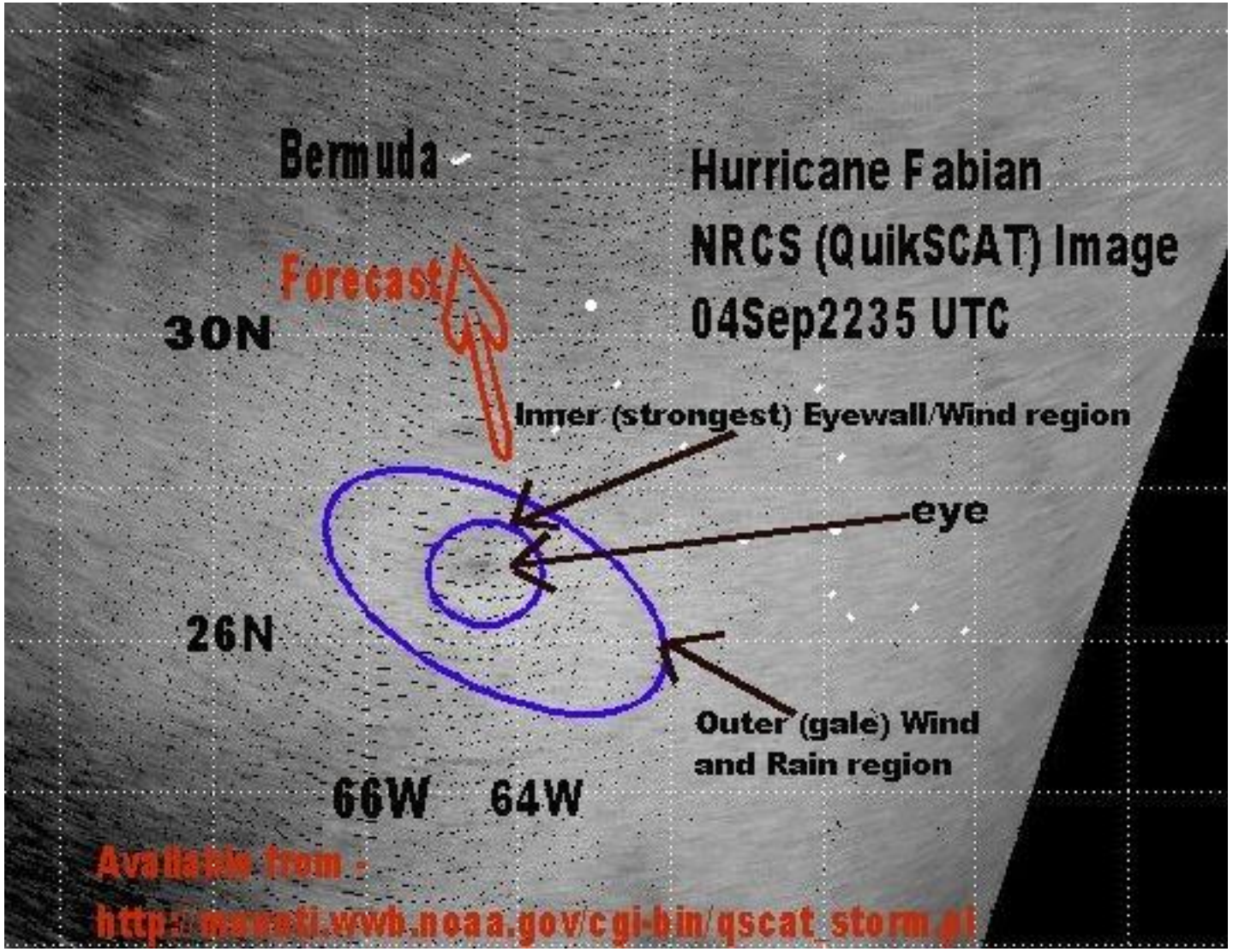




Storm number: 15 Storm name: MAEMI
Note: 1) Times are GMT 2) Black barbs indicate possible rain contamination
3) Data buffer is Sep 10 15:12 UTC 2003–22 hrs 4) Data pass times at bottom of image

NORMALIZED RADAR CROSS SECTION



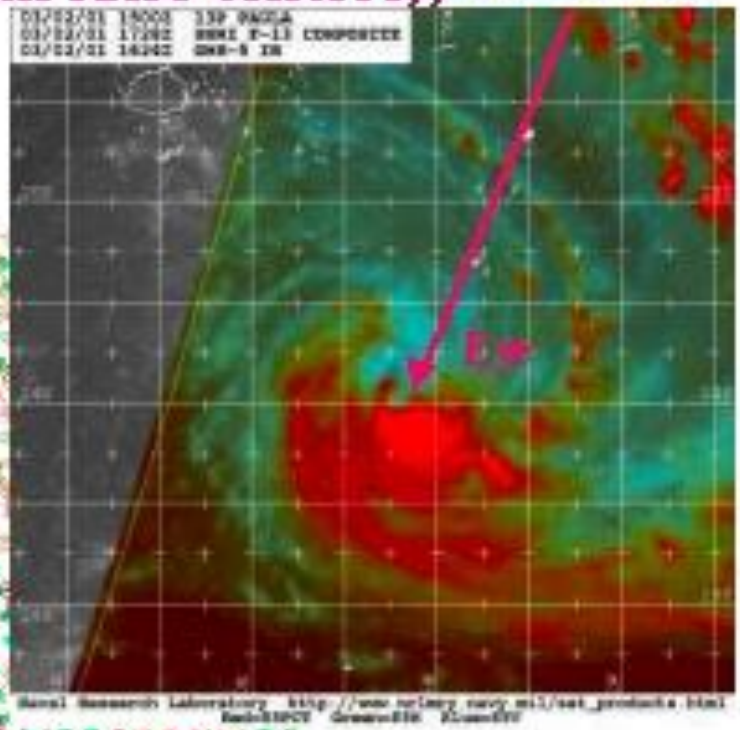

Bermuda
Hurricane Fabian
NRCS (QuikSCAT) Image
04Sep2235 UTC
Forecast
30N
Inner (strongest) Eyewall/Wind region
eye
26N
Outer (gale) Wind
and Rain region
66W
64W
Available from :
http://manati.wwb.noaa.gov/cgi-bin/qscat_storm.pl

Courtesy of Roger Edson

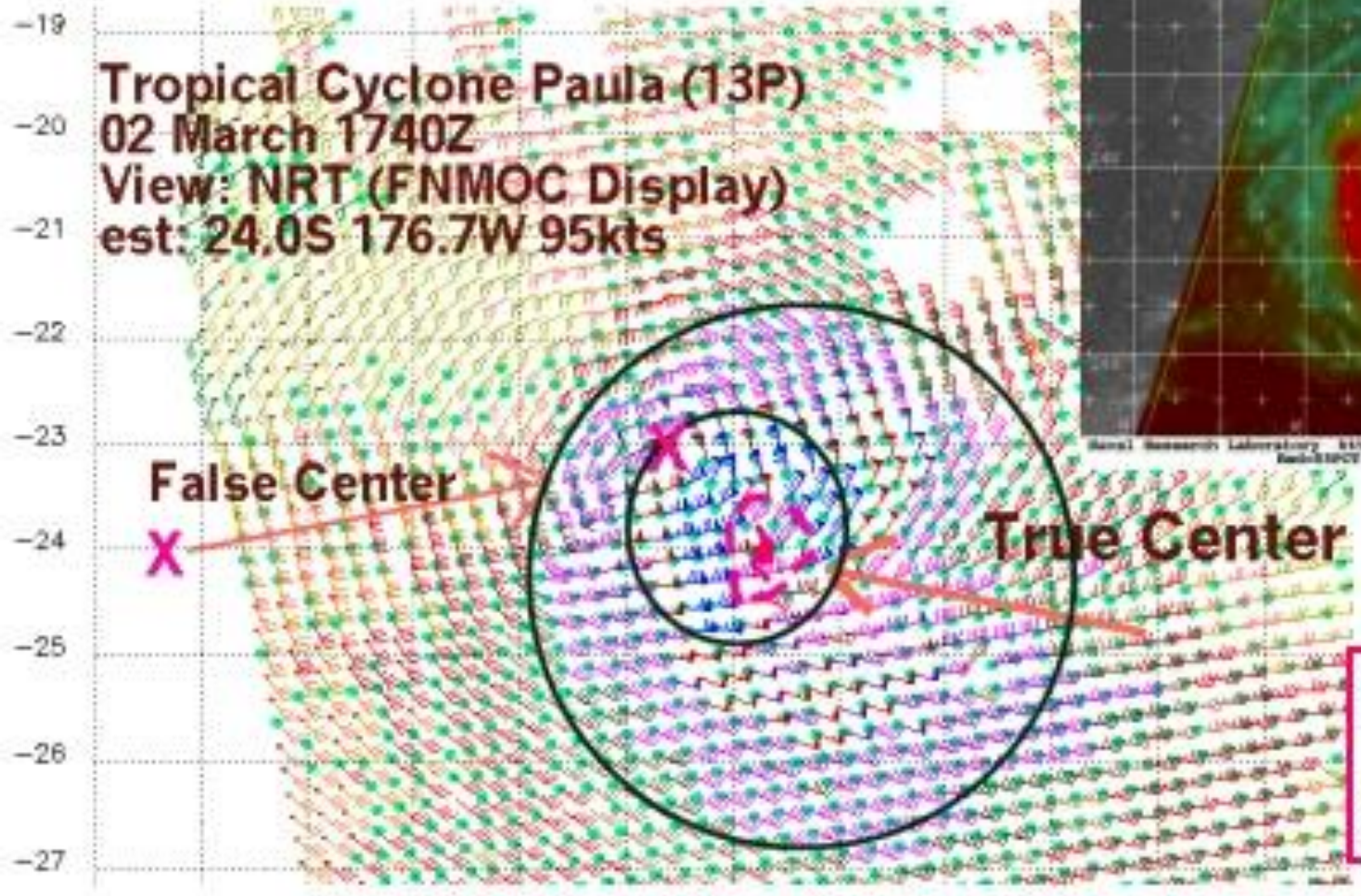
AMBIGUITY SELECTION

(Rain blocks over circulation (with false centers))

DMSP, Color, 02 Mar 1728Z

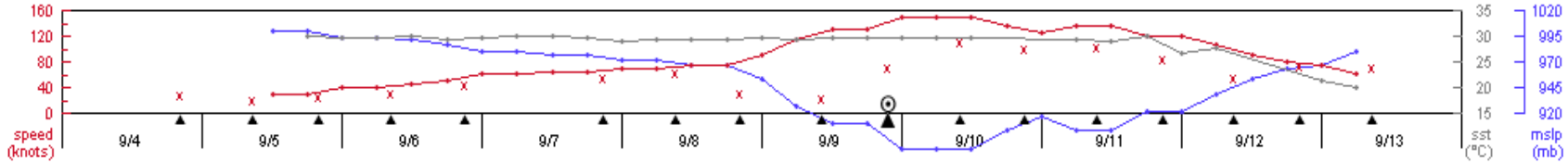


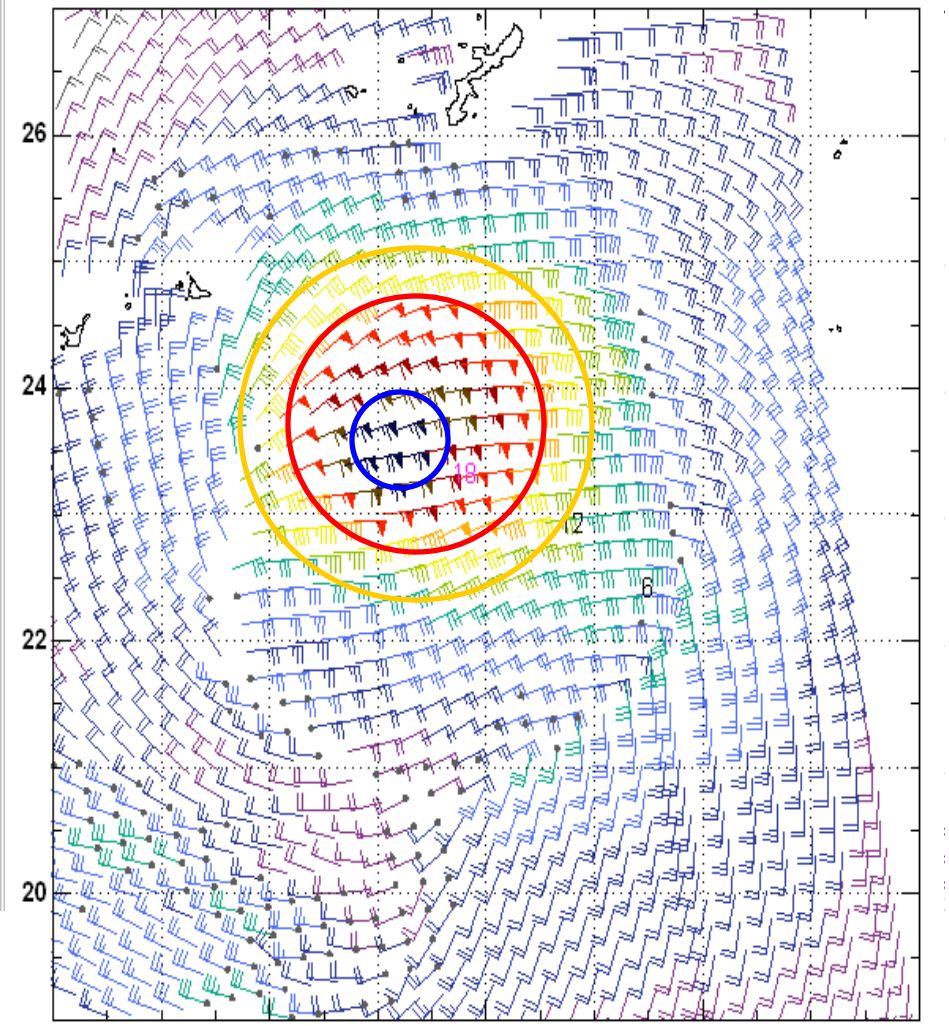
ISOTACH SOLUTION



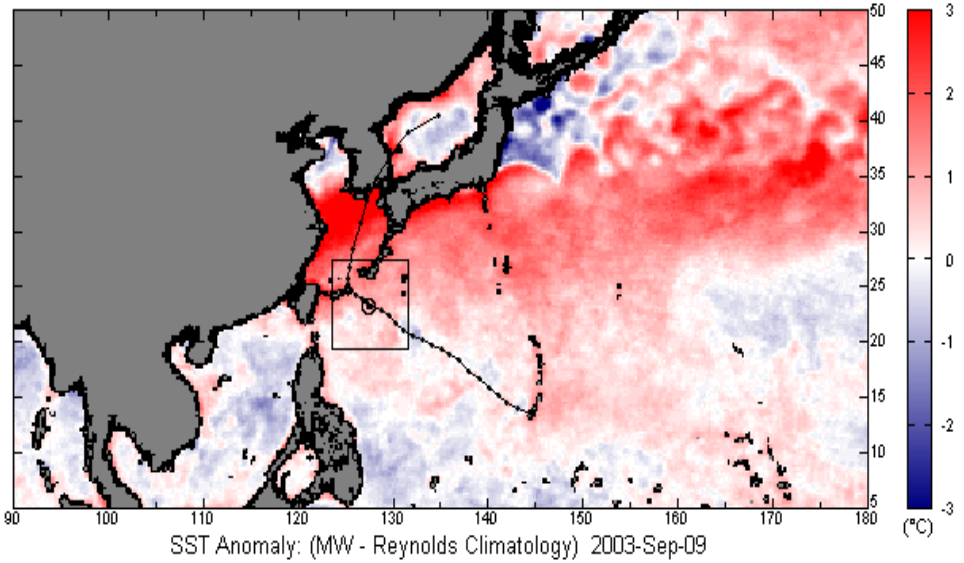
Center found in local, min. of isotach ring.

BACK | 2003 | Maemi | 2003.09.09 21:30 | Show Help

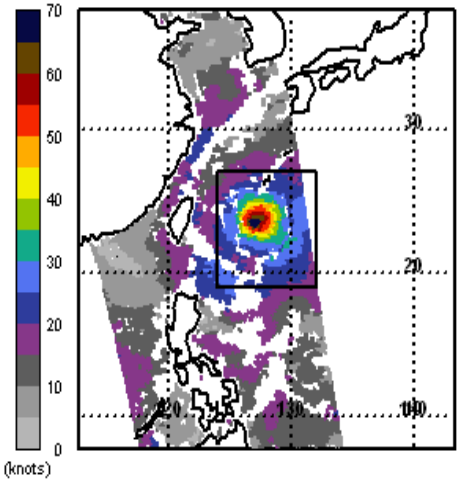




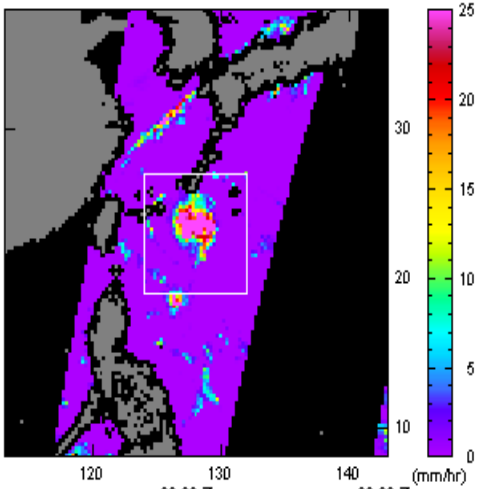
Super Typhoon Maemi 2003-Sep-09 21:30 UTC QSCAT rev 21998



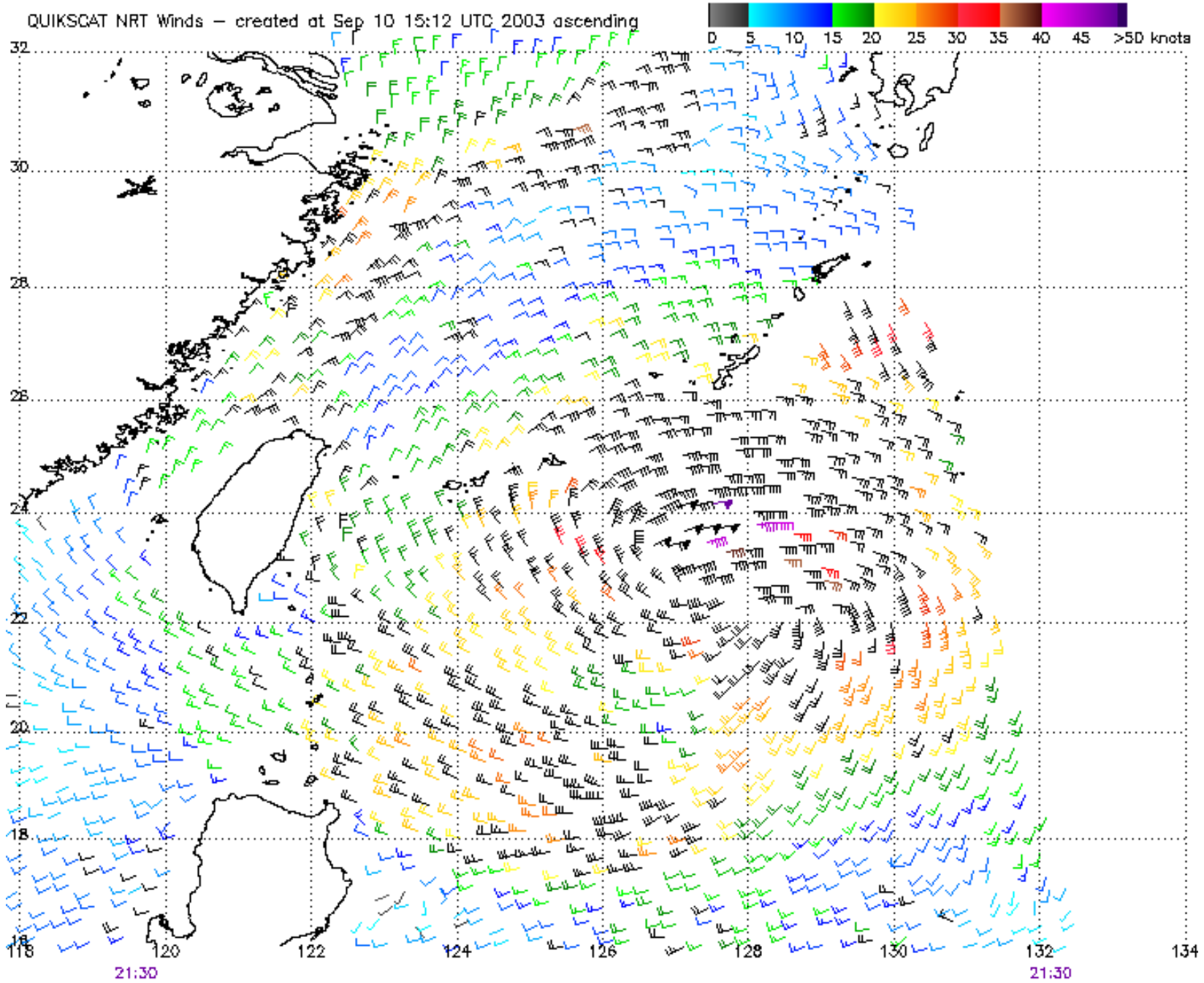
SST Anomaly: (MW - Reynolds Climatology) 2003-Sep-09



QSCAT wind speed 2003-Sep-09



SSMI F13 Rain Rate 2003-Sep-09



Storm number: 15 Storm name: MAEMI
Note: 1) Times are GMT 2) Black barbs indicate possible rain contamination
3) Data buffer is Sep 10 15:12 UTC 2003–22 hrs 4) Data pass times at bottom of image

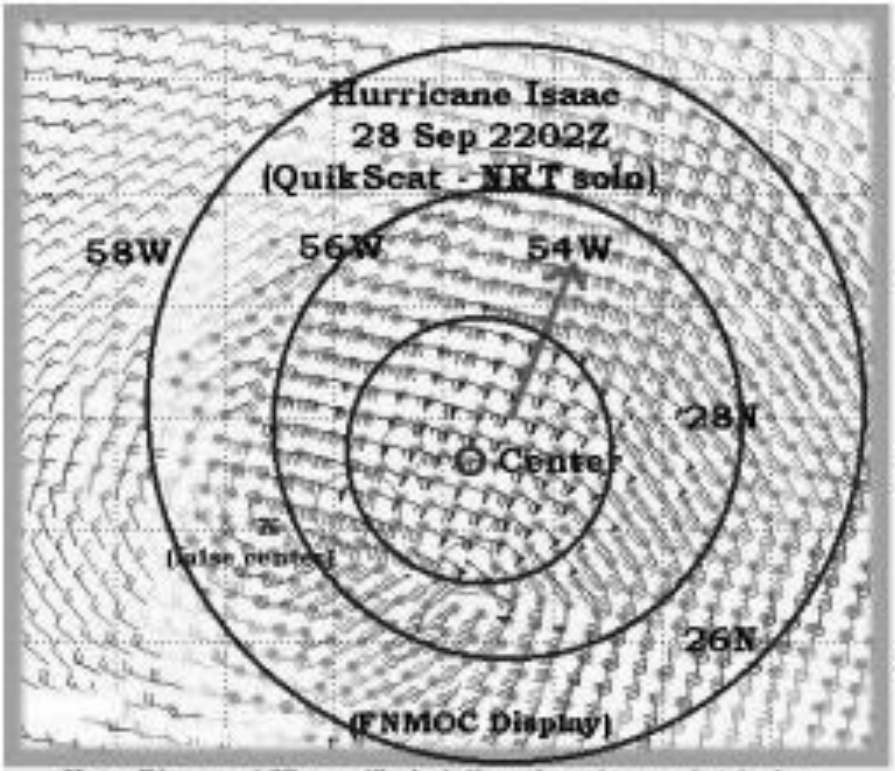
Courtesy of
R. Edson

AMBIGUITY SELECTION

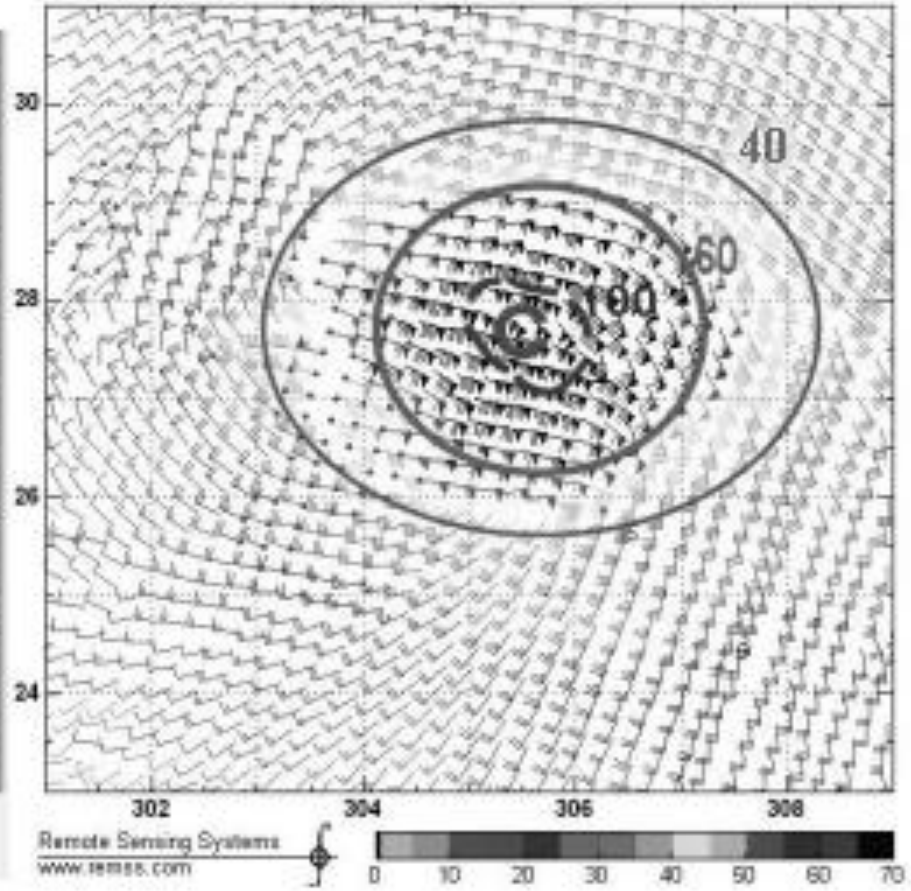
(Rain blocks over circulation (with false centers))

Hurricane Isaac
Psn 27.3N 54.6W
120 knots

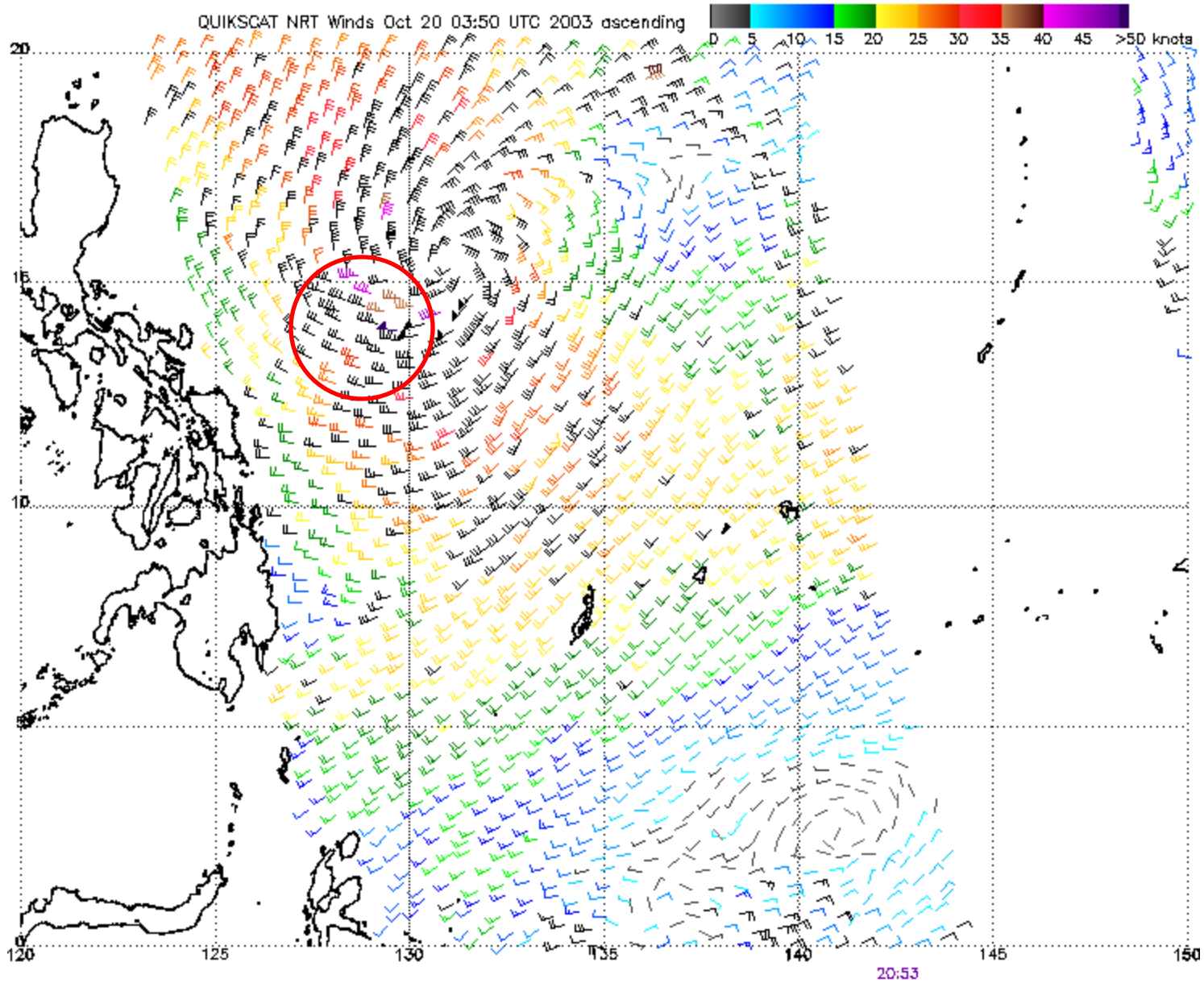
. ISOTACH SOLUTION.
This is NOT used in sheared situations



Note: Disregard "flagged" wind directions (green dots) when perpendicular to swath. Note "rain creep" in this (NRT) solution for non-affected data (circled). Compare to FNOC solution.



Along-Swath Error



Note: 1) Times are GMT 2)Times correspond to 10N at right swath edge – time is right swath for overlapping swaths at 10N
3)Data buffer is Oct 20 03:50 UTC 2003–22 hrs 4)Black barbs indicate possible rain contamination

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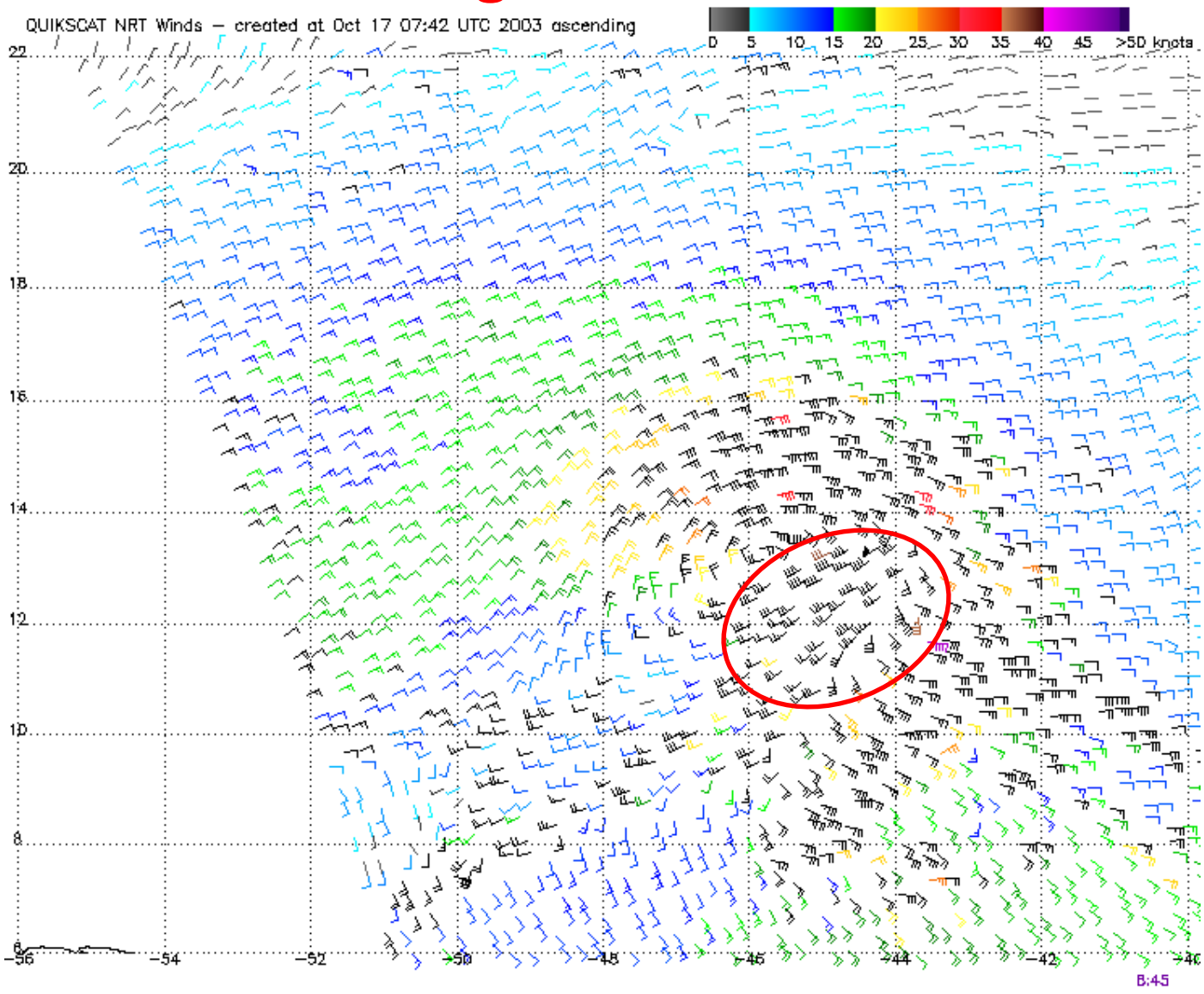
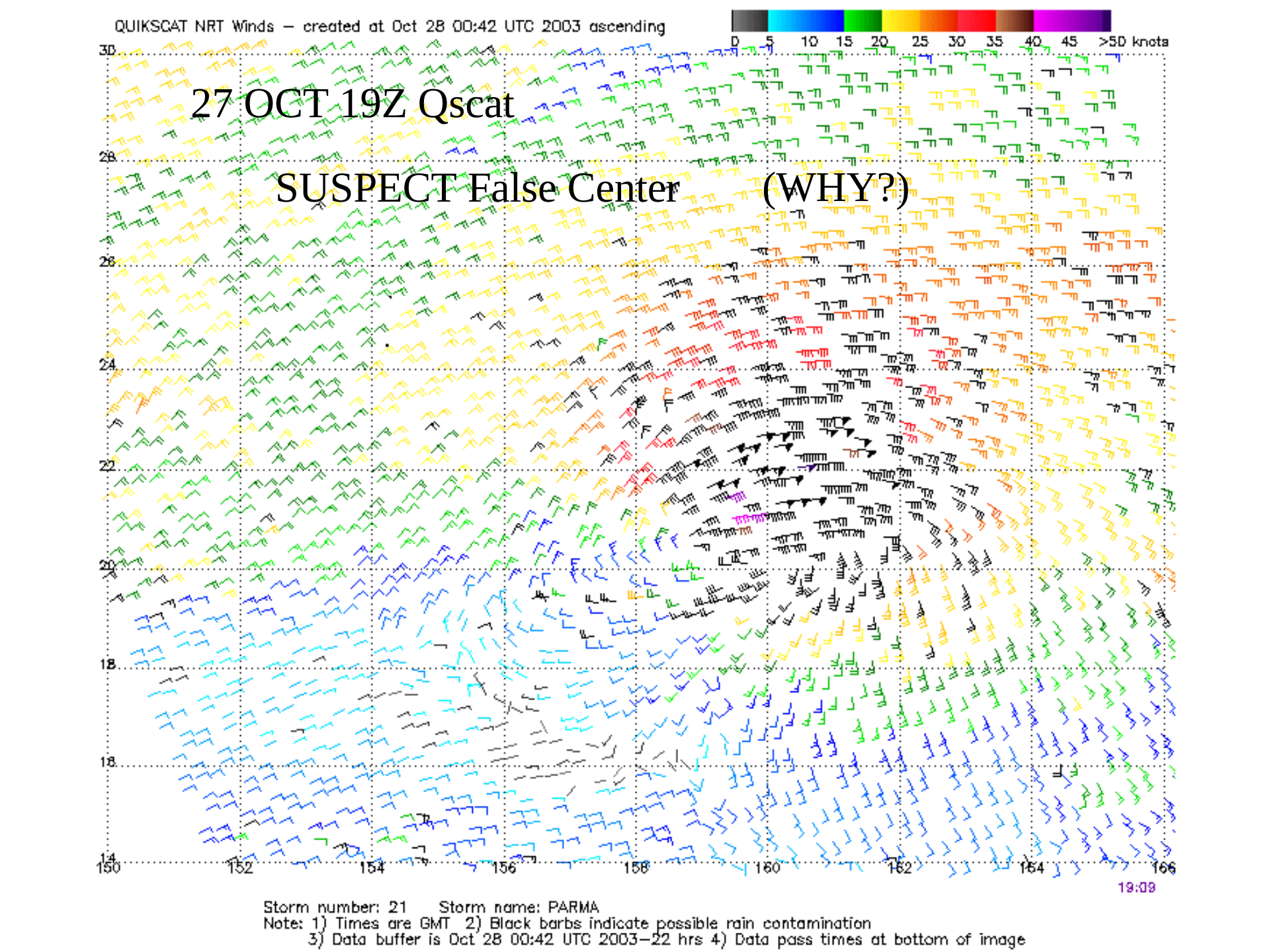
Along-Swath Error



Storm number: 19 Storm name: NICHOLAS
Note: 1) Times are GMT 2) Black barbs indicate possible rain contamination
3) Data buffer is Oct 17 07:42 UTC 2003–22 hrs 4) Data pass times at bottom of image

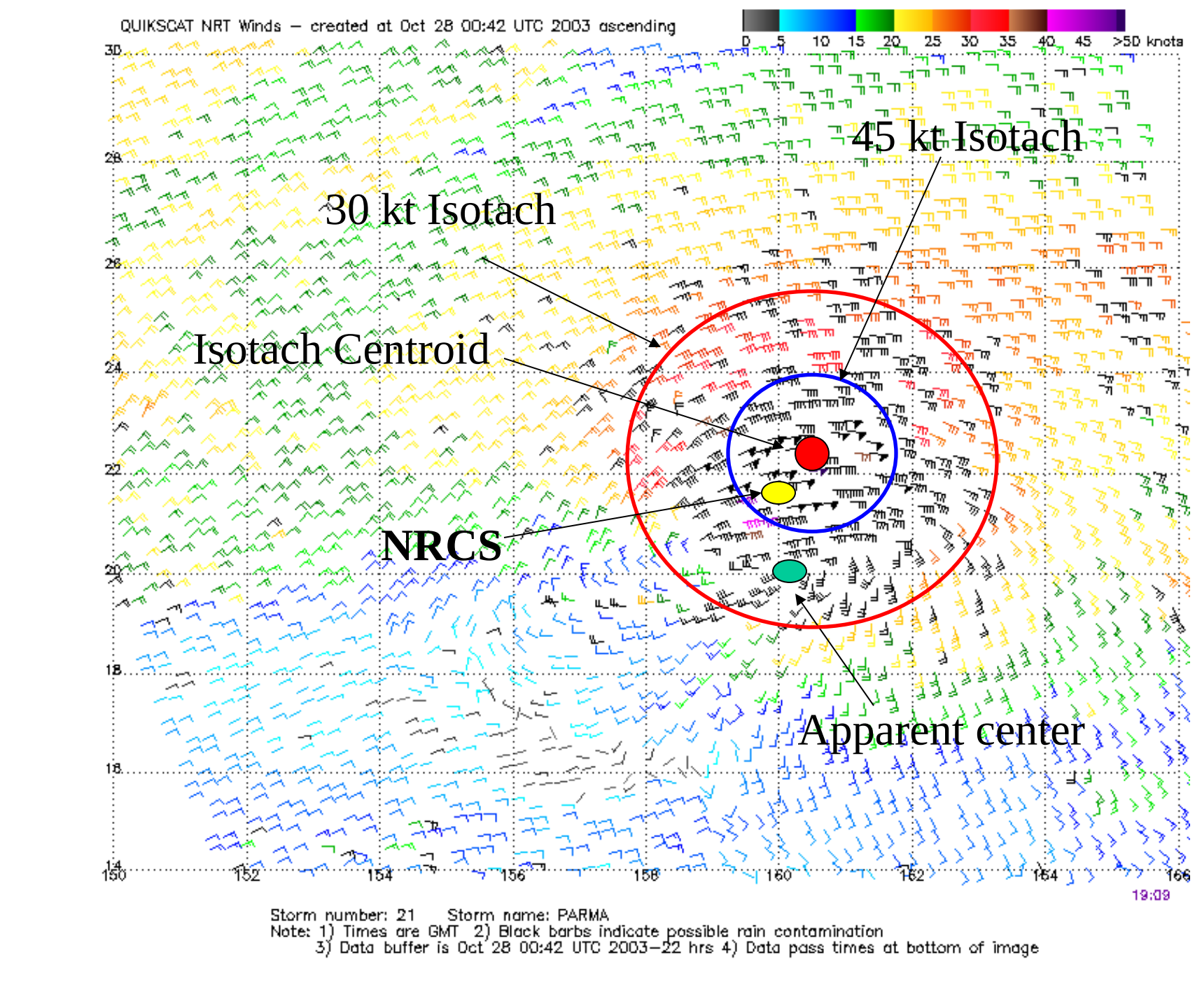

QUIKSCAT NRT Winds – created at Oct 28 00:42 UTC 2003 ascending
0 5 10 15 20 25 30 35 40 45 >50 knots
27 OCT 19Z Qscat
SUSPECT False Center (WHY?)
30
28
26
24
22
20
18
16
14
150
152
154
156
158
160
162
164
166
19:09
Storm number: 21 Storm name: PARMA
Note: 1) Times are GMT 2) Black barbs indicate possible rain contamination
3) Data buffer is Oct 28 00:42 UTC 2003–22 hrs 4) Data pass times at bottom of image

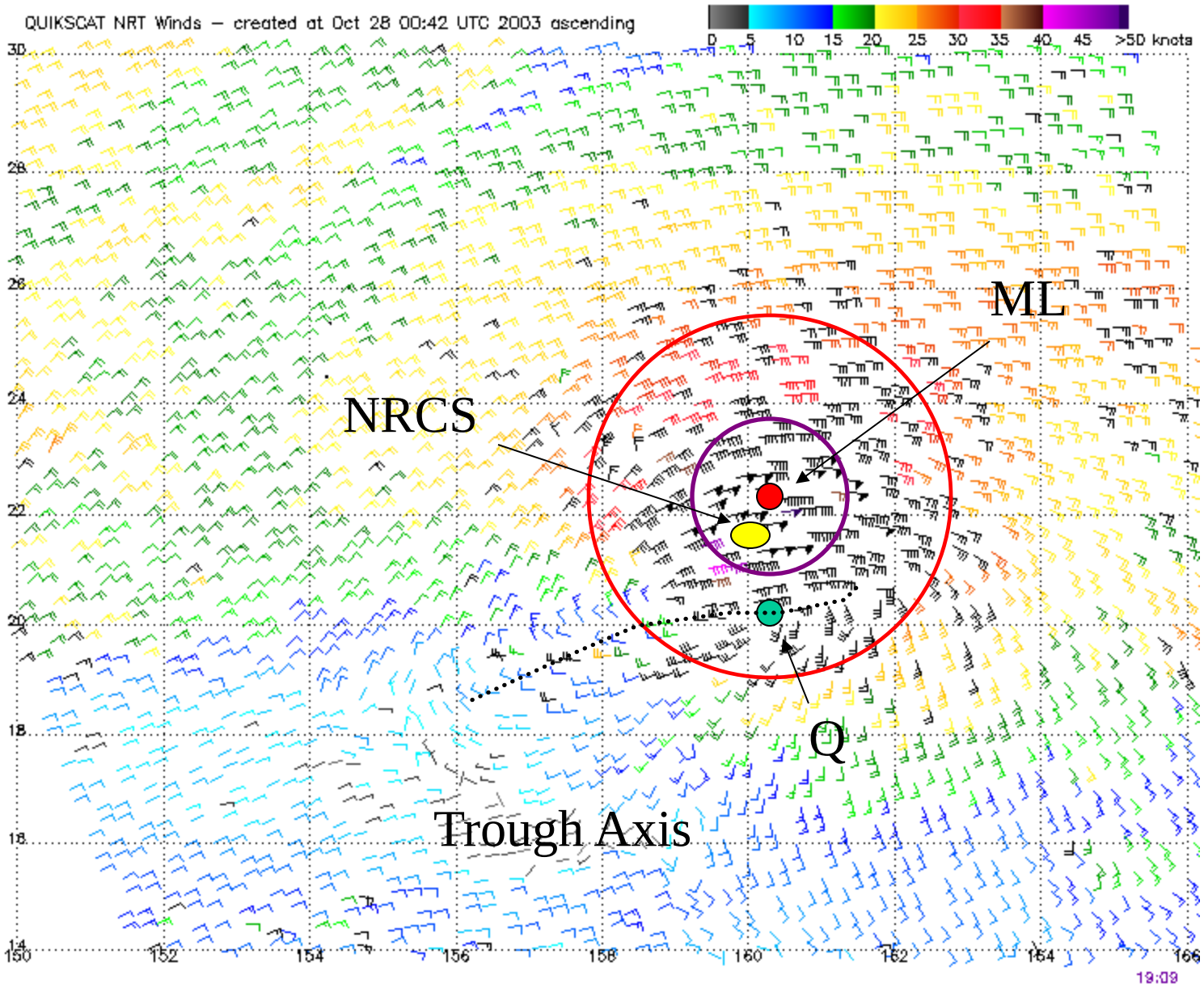
FALSE CENTER

WHY:

1. Huge asymmetry
2. Prior history: moving west along 22 N.

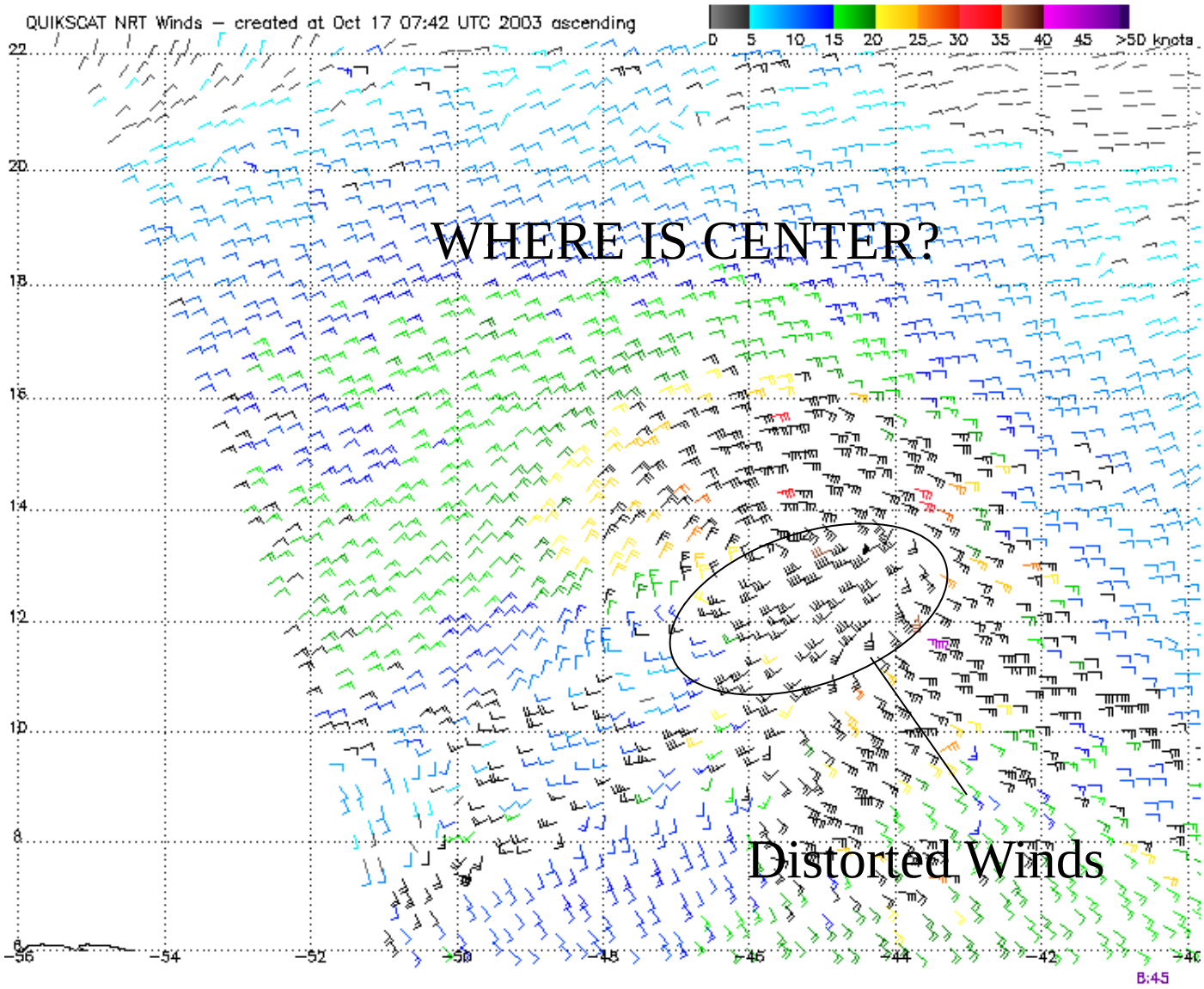
Back

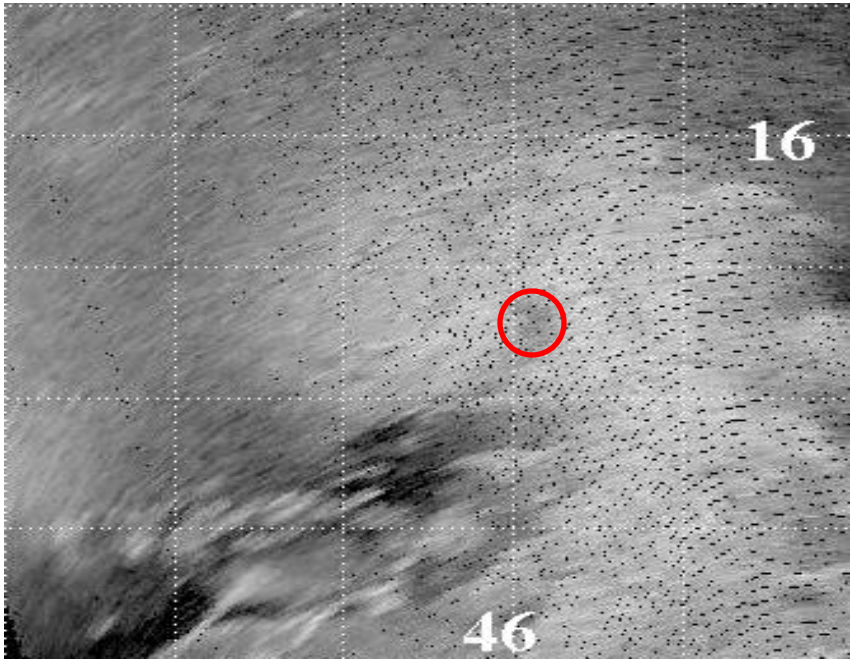

QUIKSCAT NRT Winds – created at Oct 28 00:42 UTC 2003 ascending
0 5 10 15 20 25 30 35 40 45 >50 knots
45 kt Isotach
30 kt Isotach
Isotach Centroid
NRCS
Apparent center
30
28
26
24
22
20
18
16
14
150
152
154
156
158
160
162
164
166
19:09
Storm number: 21 Storm name: PARMA
Note: 1) Times are GMT 2) Black barbs indicate possible rain contamination
3) Data buffer is Oct 28 00:42 UTC 2003–22 hrs 4) Data pass times at bottom of image

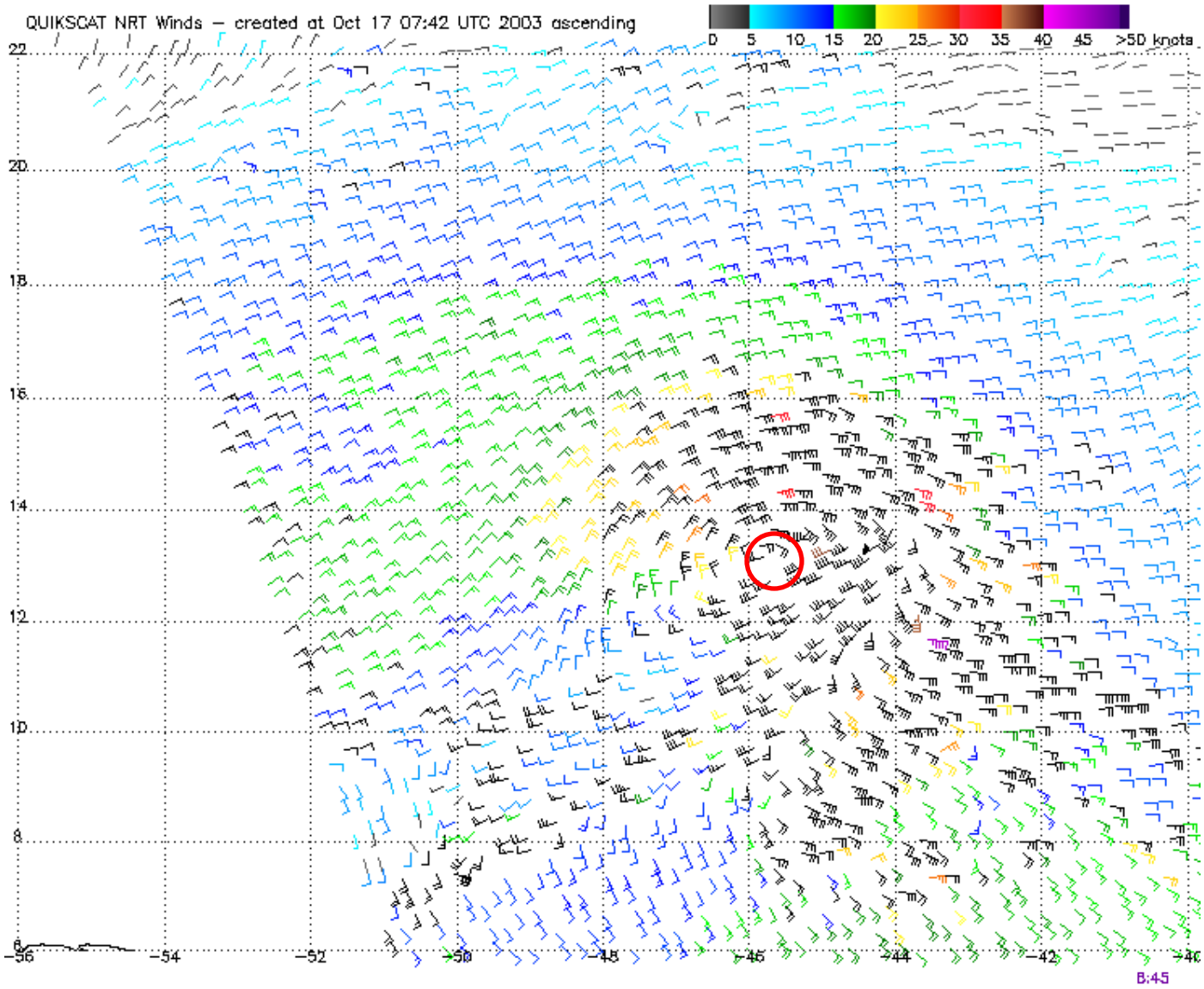


Storm number: 21 Storm name: PARMA
Note: 1) Times are GMT 2) Black barbs indicate possible rain contamination
3) Data buffer is Oct 28 00:42 UTC 2003–22 hrs 4) Data pass times at bottom of image

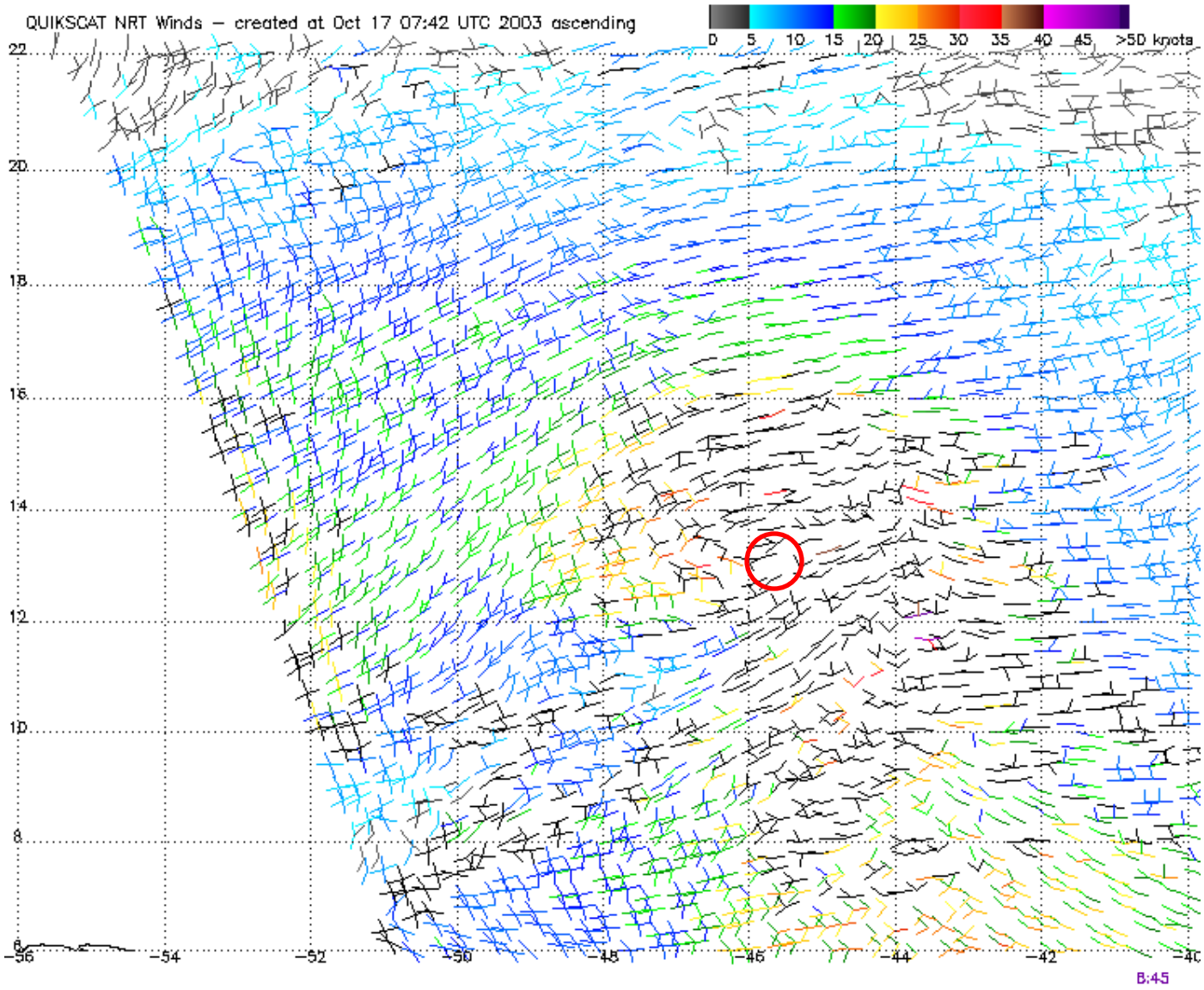
QuikSCAT


QUIKSCAT NRT Winds – created at Oct 17 07:42 UTC 2003 ascending
0 5 10 15 20 25 30 35 40 45 >50 knots
WHERE IS CENTER?
Distorted Winds
22
20
18
16
14
12
10
8
6
-56
-54
-52
-50
-48
-46
-44
-42
-40
8:45
Storm number: 19 Storm name: NICHOLAS
Note: 1) Times are GMT 2) Black barbs indicate possible rain contamination
3) Data buffer is Oct 17 07:42 UTC 2003–22 hrs 4) Data pass times at bottom of image


16
46



Storm number: 19 Storm name: NICHOLAS
Note: 1) Times are GMT 2) Black barbs indicate possible rain contamination
3) Data buffer is Oct 17 07:42 UTC 2003–22 hrs 4) Data pass times at bottom of image



Storm number: 19 Storm name: NICHOLAS
Note: 1) Times are GMT 2) Black barbs indicate possible rain contamination
3) Data buffer is Oct 17 07:42 UTC 2003–22 hrs 4) Data pass times at bottom of image

GO TO PART 2