Tropical Cyclone Intensity Estimation (TCIE) from TROPICS warm-core observations

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CIMSS radiance-based TC Intensity Estimate (TCIE) algorithm update

- **Improved position location**. Updated center location code to address some missed centers.

- **Updated mixing corrections**. To remove lower channel mixing.   Pathfinder/T5 and T3/T6-dependent.

- **Updated intensity coefficients**. Based on new statistical analysis.

- **Added channel 9 contribution**. Convolve 183 GHz to thermal channel scans to determine % of TC eyewall in the scan.
    Values < 0 (in degrees C) indicate likely dominant attenuation.

- **Added quality flags**. Quality flags (0-2) based on TC eye size and convolved 183 GHz signal. 0 = best

- **Addressed unrepresentative cold environmental Tb values used in our TC temp anomaly calculation**.
    Now filters temperatures in the 5-7 degree annulus and removes cold Tb values due to convective attenuation.

- **TCIE now uses L1b ver. 04.01.01 for T6/T3 and 03.04.01 for Pathfinder/T5 for post analysis**
    NRT product still uses L1b version 03.04.01

- **Transition code out of Beta testing -> Provisional**

TCIE Performance (so far)

2021-2023 cases coincident with recon data (some WPac cases using best track)

Highest TCIE errors at larger scan angles. This appears to be regardless of eye diameter (eyewall convection attenuation)

Larger errors for TCs with small eyes. Despite eye size corrections, often the eyewall attenuation effects can dominate the eye warming.

Some too-weak errors are due to erroneous eye size inputs (either from automated sat estimates like ARCHER or from agency ATCF values). ARCHER using TROPICS can help.

Some examples and mitigation efforts follow

N=725
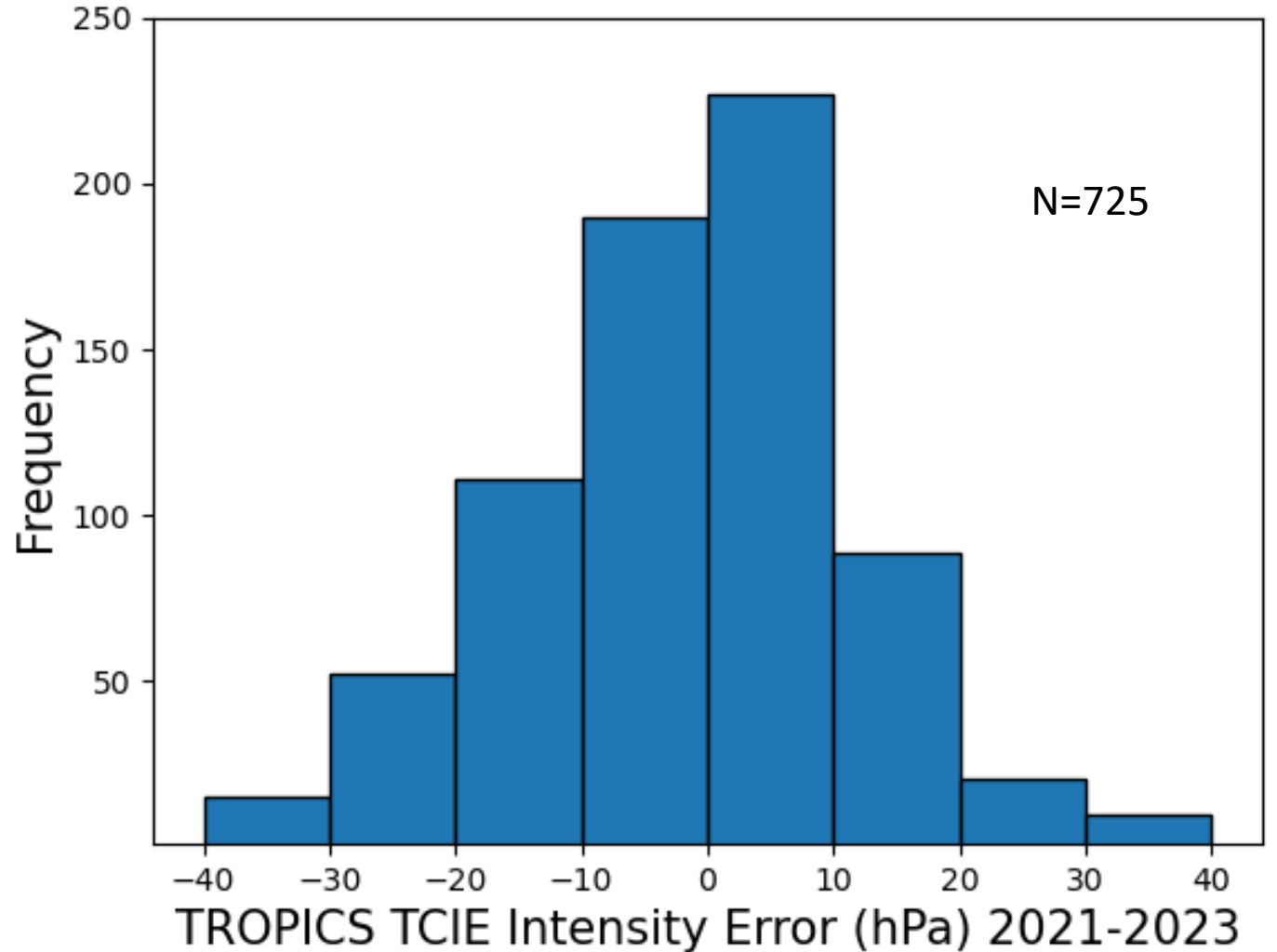
TROPICS Tb Anomalies using AMSU/HNR Proxy Compared to Observered Ch7 2021-2023
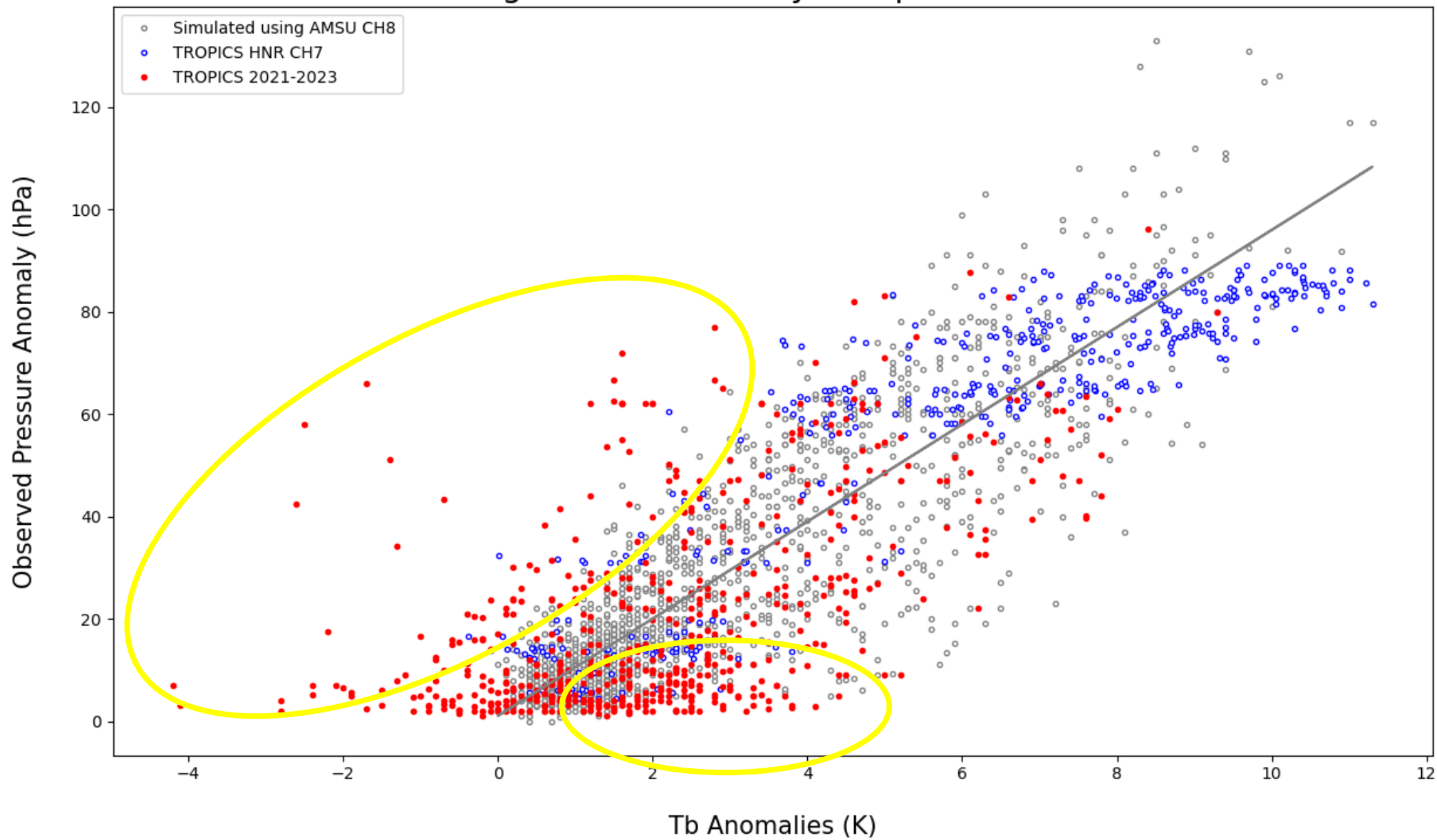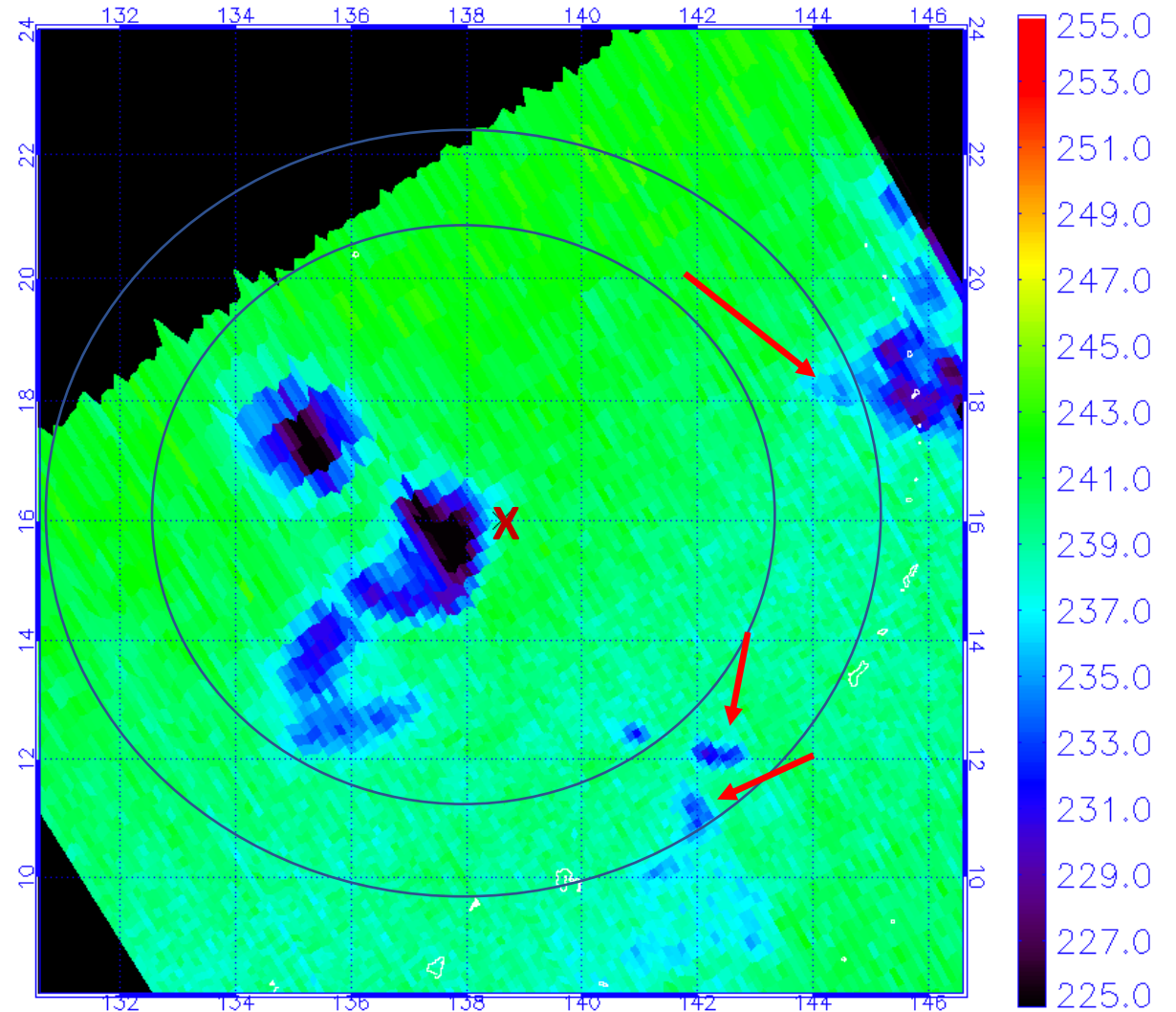
Environmental Tb can be impacted by outer band convective attenuation

This requires filtering to remove spurious values from the env temperature annulus used in computing the TC temp anomaly that TCIE relies on to produce an intensity estimate.

In the example to the right Koinu is in the genesis stage but the temperature anomaly would be artificially inflated by the attenuated Tb values in the environmental Tb annulus leading to a much too strong Tb anomaly
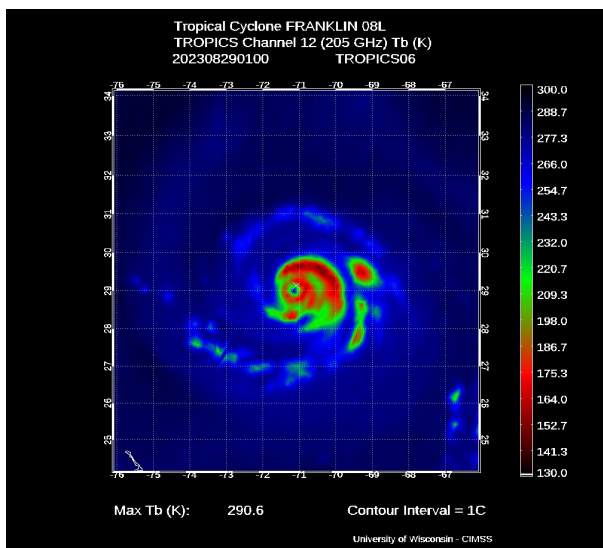

Tropical Cyclone KOINU 14W
TROPICS Channel 6 (117.8 GHz) Tb (K)
202309281301   TROPICS05

Max Tb (K): 243.1   Contour Interval = 1C

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Examples of largest TCIE errors

ATMS CH8 08290641

Tropical Cyclone FRANKLIN 08L
TROPICS Channel 7 (118.25 GHz) Tb (K)
202308290100   TROPICS06

TC Franklin (2023)
Pinhole eye, no warm core detected
Best Track: 925 mb
TCIE ~60 mb weak
qflag = 2 (poor confidence)
   - small eye and lots of attenuation

Tropical Cyclone FRANKLIN 08L
TROPICS Channel 12 (205 GHz) Tb (K)
202308290100   TROPICS06

Max Tb (K):   290.6   Contour Interval = 1C

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Tropical Cyclone LEE 13L
TROPICS Channel 7 (118.25 GHz) Tb (K)
202309111728   TROPICS06
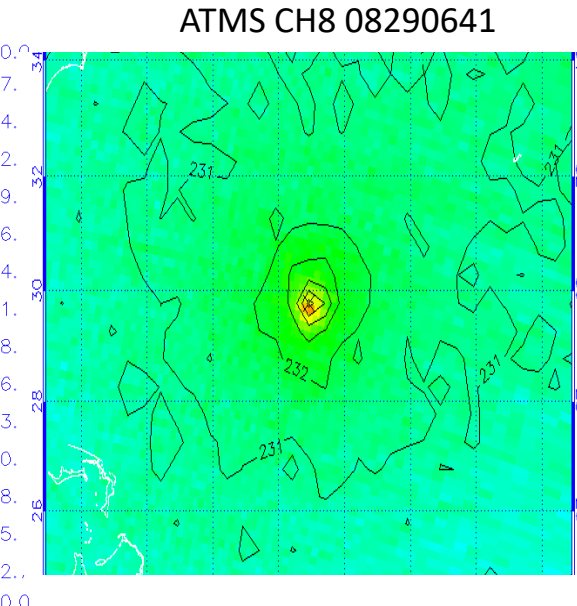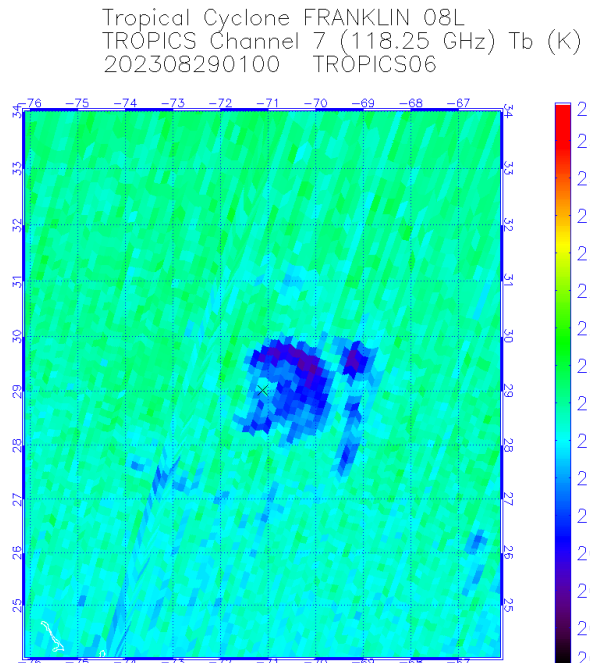
TC Lee (2023)
Edge of swath, Relict Eyewall
Best Track: 949 mb
TCIE ~60 mb weak
qflag= 1 (fair confidence)
   - large eye but near edge of swath

Tropical Cyclone LEE 13L
TROPICS Channel 12 (205 GHz) Tb (K)
202309111728   TROPICS06

Max Tb (K):   292.9   Contour Interval = 1C

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Max Tb (K): 226.9   Contour Interval = 1C

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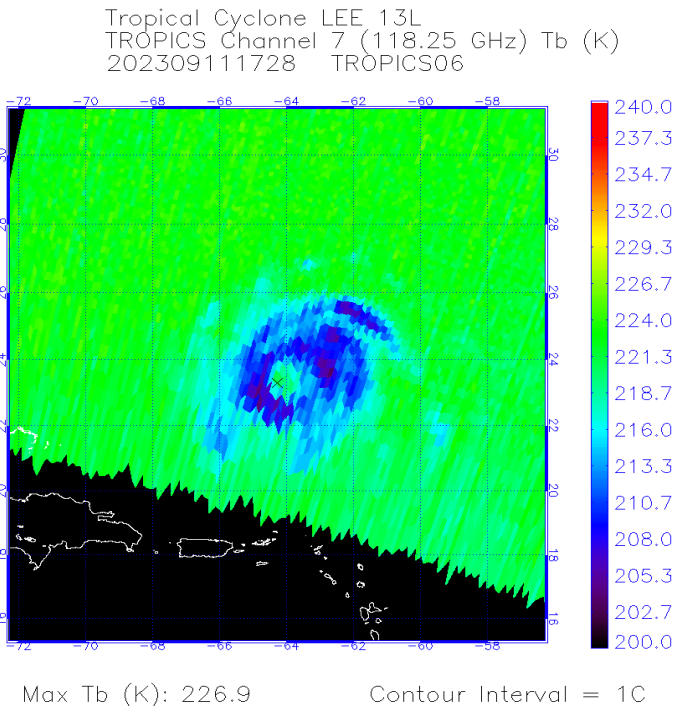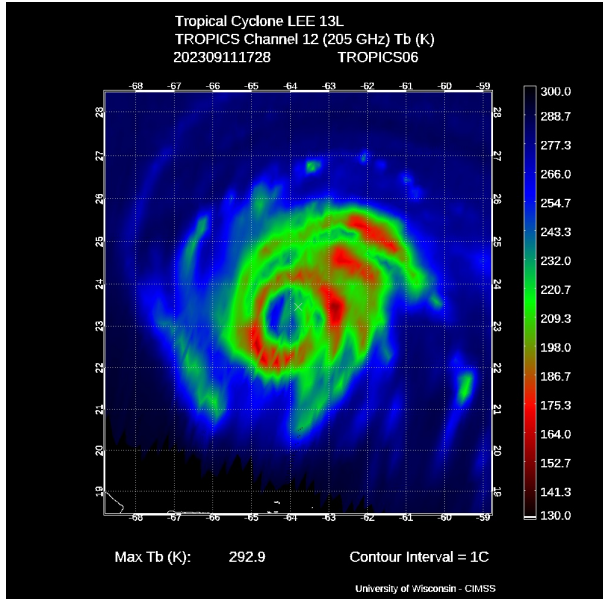
**Note associated quality flags attempt
to provide estimate confidence**

Best cases result for near-nadir passes over well-centered strong TCs with larger eyes such as Cyclone Mocha (01B) 2023

TCIE: 908 hPa

Best Track: 915 hPA

qlfag =1 (Fair confidence)
  - Eye ~ 40 km but convolved 183 GHz suggests caution

Tropical Cyclone   MOCHA 01B
TROPICS Channel 7 (118.25 GHz) Tb (K)
202305132012   TROPICS01

Mocha may be one of strongest North Indian Ocean TCs
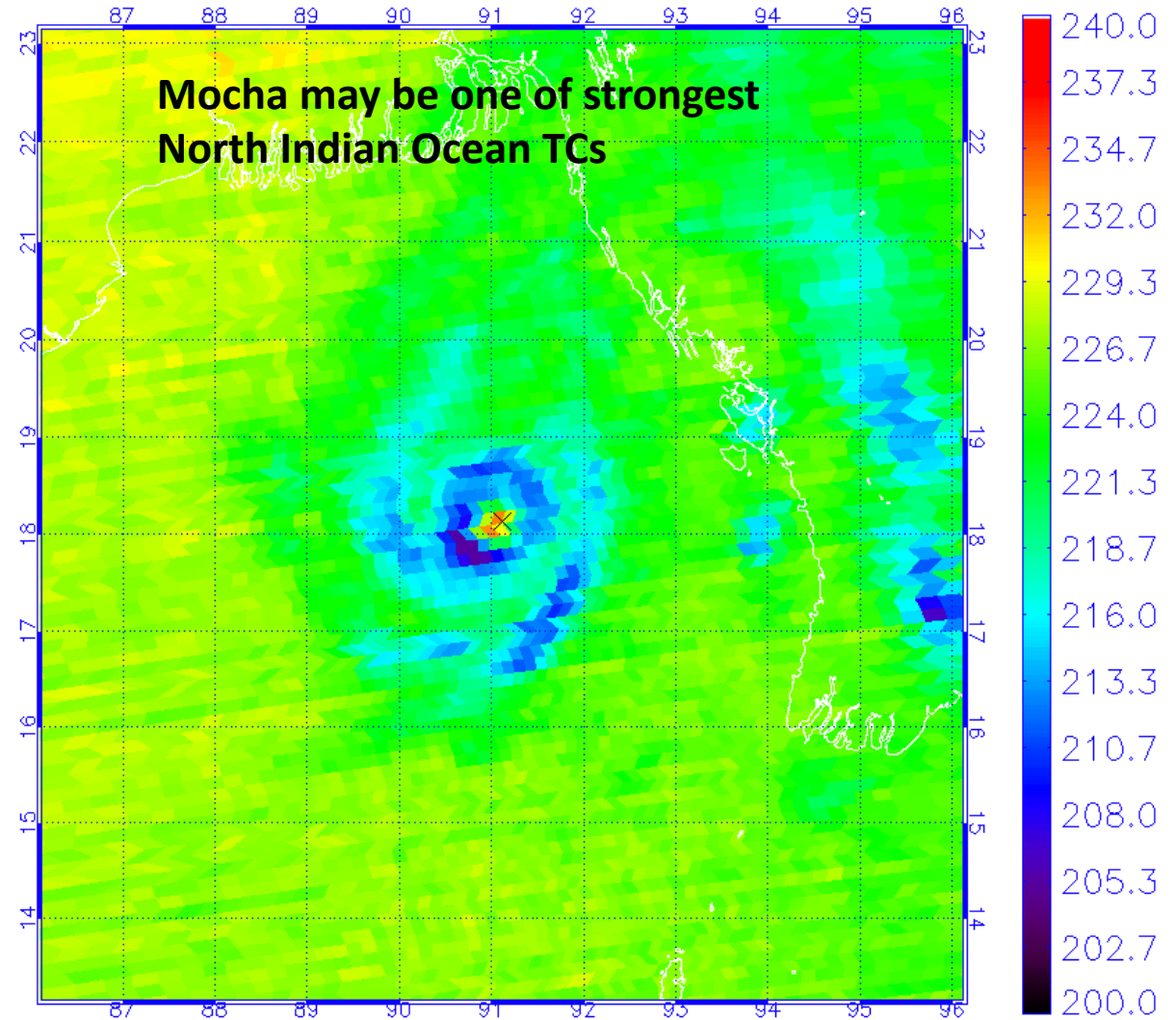
Max Tb (K): 233.2   Contour Interval = 1C

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Another good example:
WestPac Typhoon Mawar (02W) 2023

TCIE: 927 hPa and 125 knots

Best Track: 925 hPA and 130 knots

qflag = 0 (higher confidence)
 - larger eye and no attenuation

Note: This TC had the strongest warm core observed by ATMS a day earlier on 26th of May

Tropical Cyclone   MAWAR 02W
TROPICS Channel 7 (118.25 GHz) Tb (K)
202305271028   TROPICS05
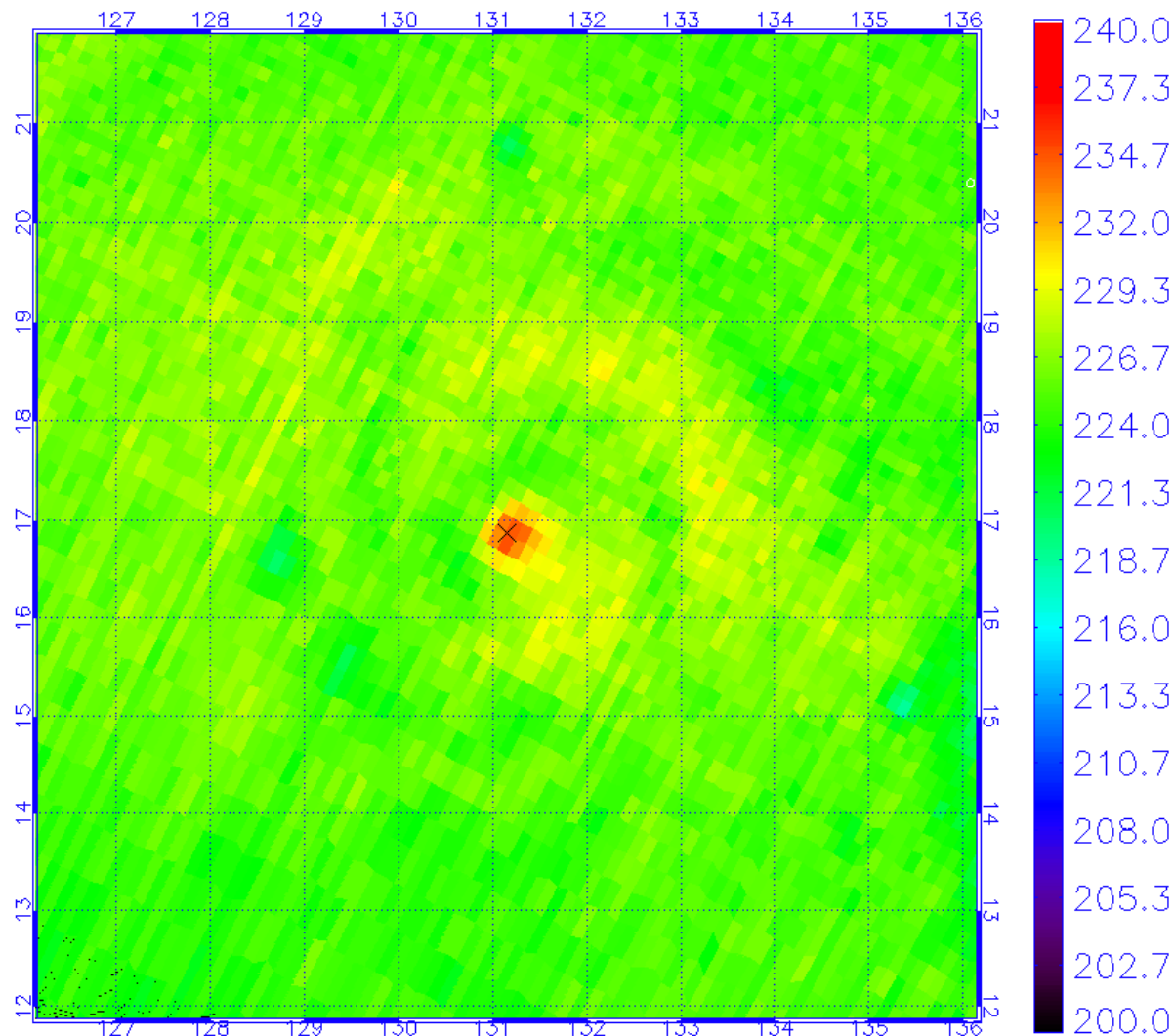
Max Tb (K): 234.7   Contour Interval = 1C

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WestPac Typhoon Mawar (02W) 2023 Extreme Warm Core for ATMS
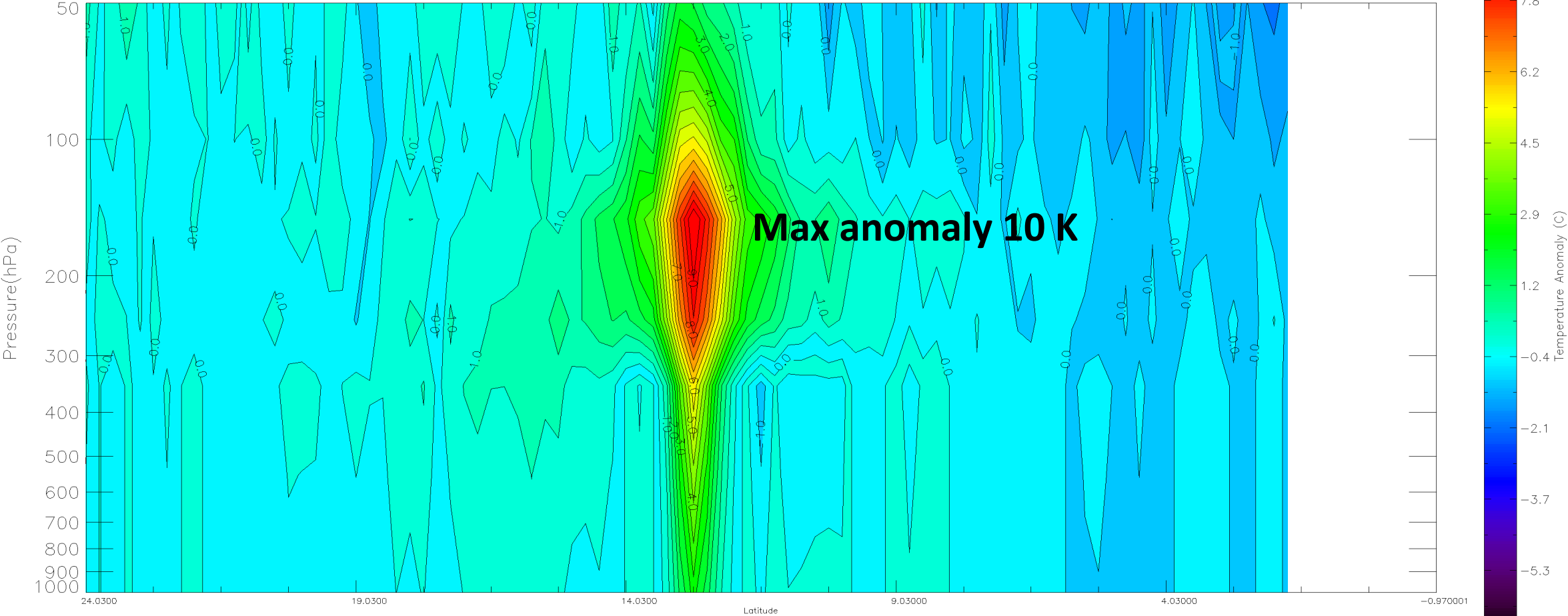
"Warm Core" Extremes from TROPICS (so far)

Tropical Storm Philippe 2023
Best Track intensity 27 knots
Channel 6 anomaly -8.9 K (Brrrrr!)
TCIE yields 21 knots
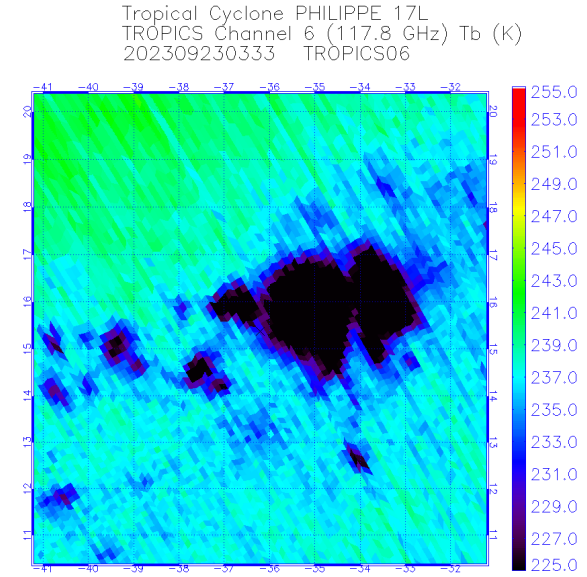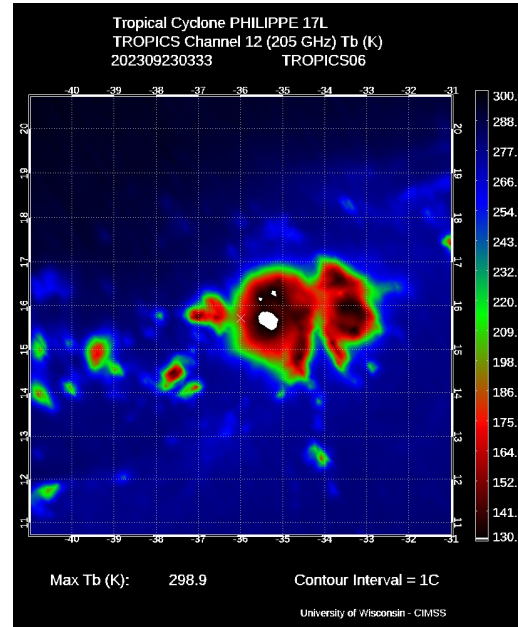
Super Typhoon Mawar (02W)
Best Track intensity 130 knots
Channel 7 anomaly 9.3 K (mmm toasty)
TCIE yields 125 knots
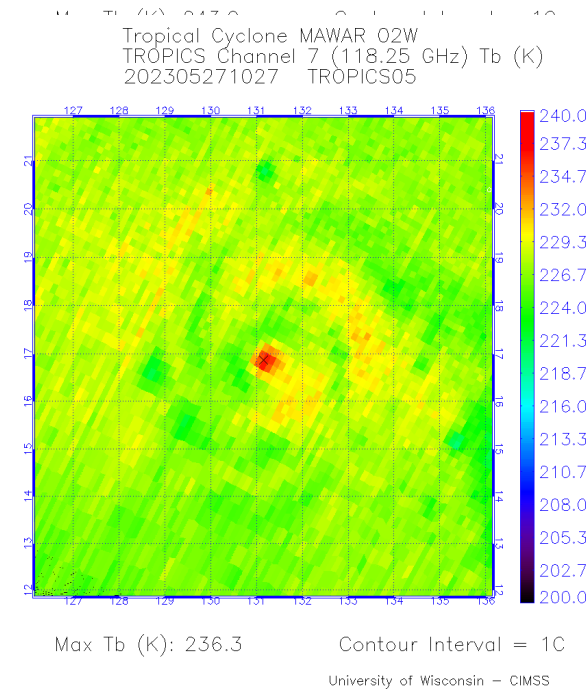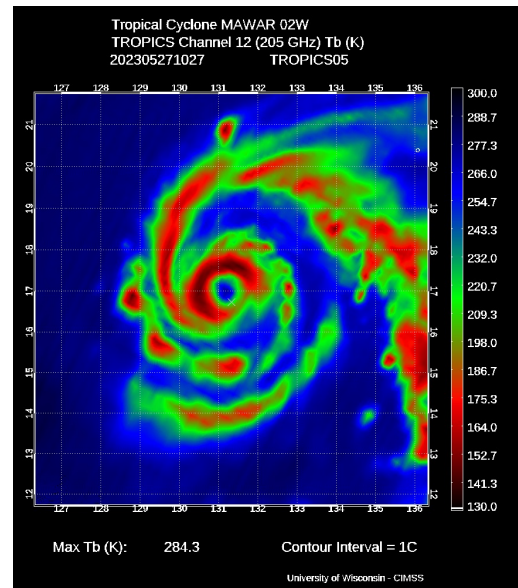
Recent Application of CIMSS Sounder Products

Unnamed Subtropical Storm   15

1747 UTC 16 Jan

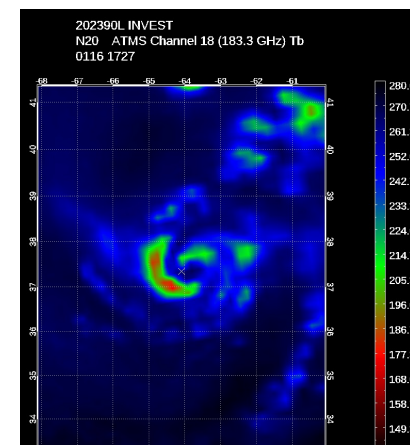ATMS Microwave Sounder

Warm core
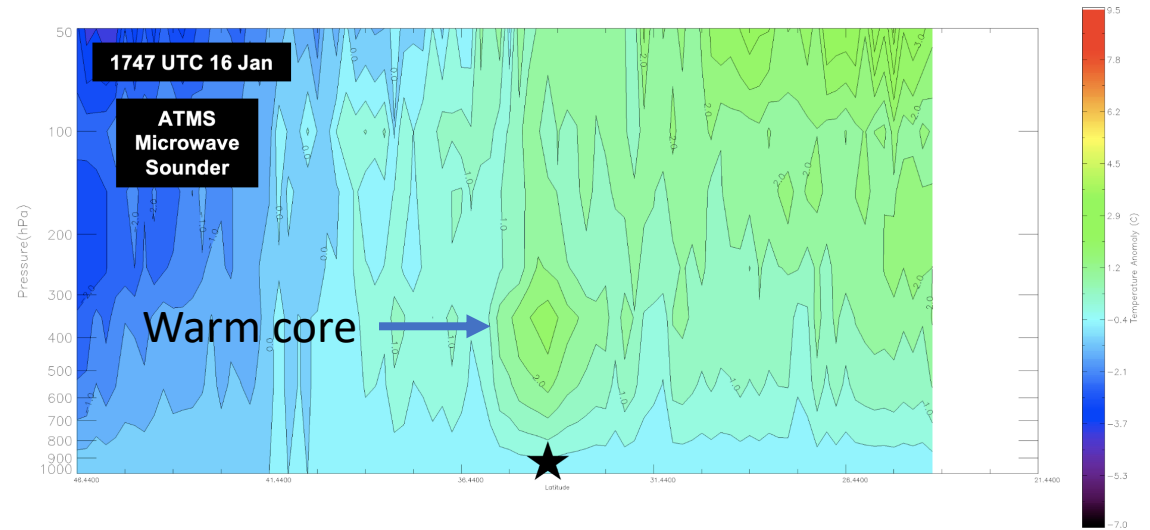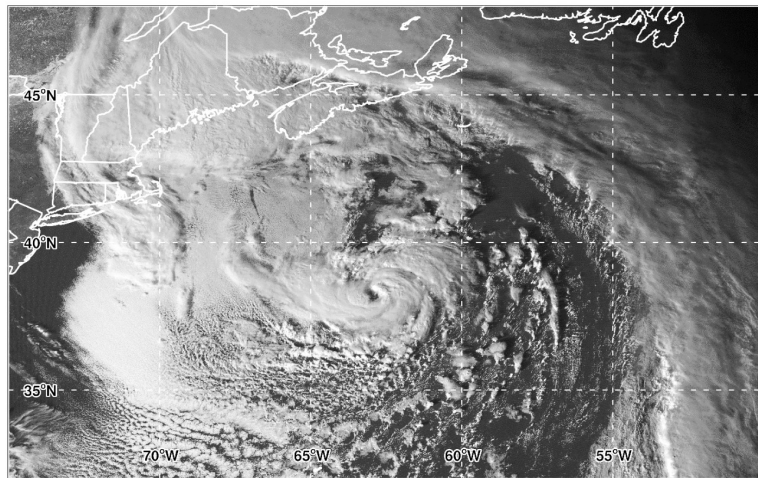
Figure 9.   Advanced Microwave Sounder Unit temperature anomaly north (left) – south (right) cross section at 1747 UTC 16 January 2023. The black star denotes the center of the Unnamed Subtropical Storm at the time the cross-section was available. Adapted image courtesy of the Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin.
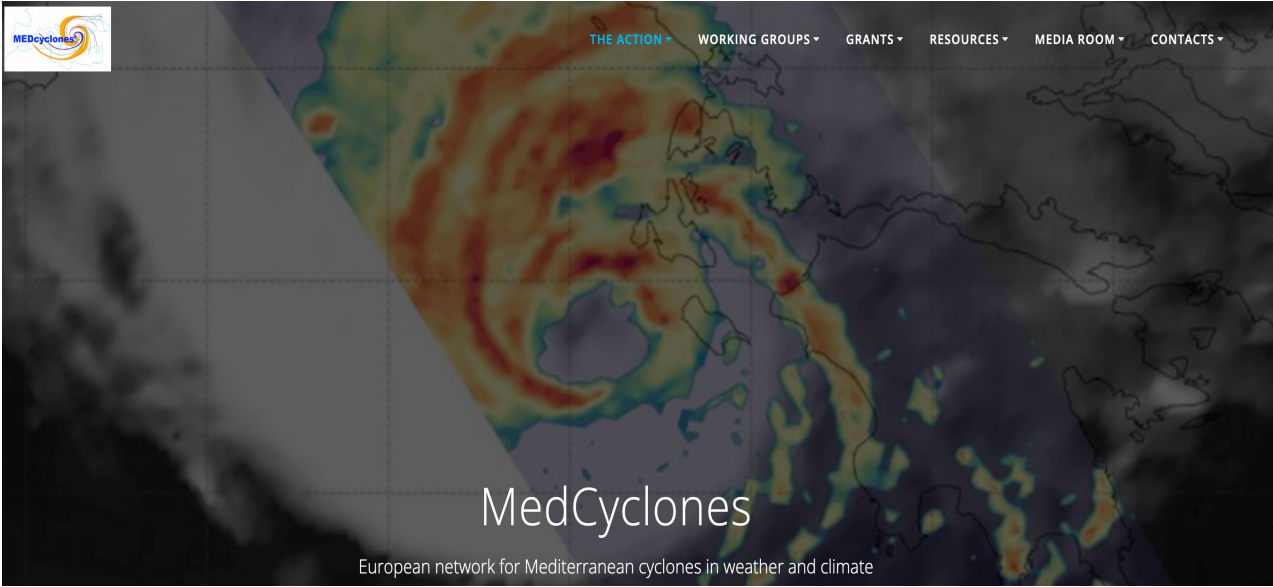
Warm core
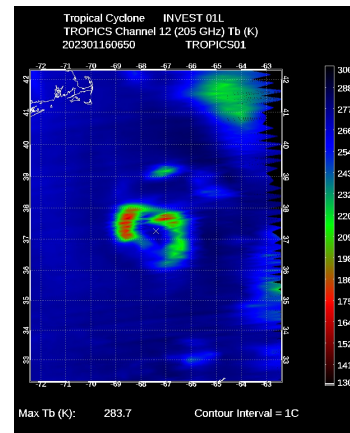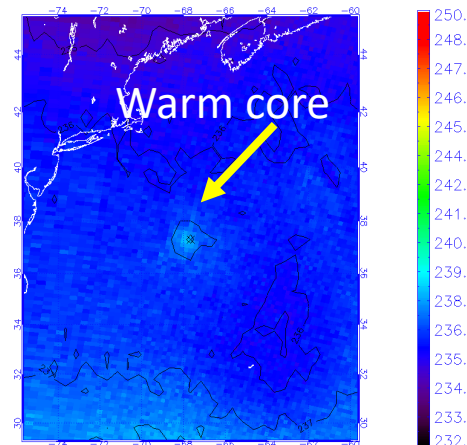
TROPICS Ch12   ATMS Channel 7   ATMS Channel 18

Recent Application of CIMSS Sounder Products

MedCyclones
European network for Mediterranean cyclones in weather and climate

Storm Daniel 'medicane' turns on Libya

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13 September 2023

By the Climate Centre

(Since this story was written, the IFRC Thursday announced an emergency appeal for 10 million Swiss francs to scale up the Libyan Red Crescent's relief efforts in response to Storm Daniel. The appeal says flash floods have devastated north-eastern Libya, with complete or partial destruction of houses, public institutions, power and communications networks, water and sewage systems. Nearly 1.6 million people have been directly affected, with over 5,000 people presumed dead and 10,000 still missing. In addition, over 7,000 families are reported to be stranded and nearly 30,000 people displaced.)

Storm Daniel – the intense Mediterranean hurricane or "medicane" – made landfall in Libya Sunday, wreaking what local authorities there have called a "catastrophic and unprecedented" flood disaster that's claimed thousands of lives and left many more missing.

CIMSS Collaboration with COST group to improve analysis tools established in 2023 including sounder-based warm core observations in medicanes
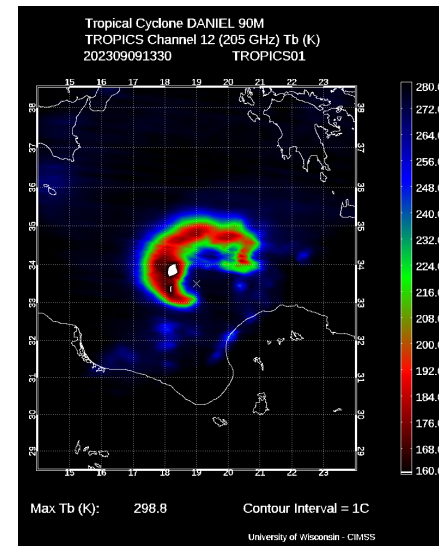
Medicane Daniel 2023
No clear warm core
Deep convective banding suggests transition to sub-tropical

Typhoon Mawar (02W 2023)
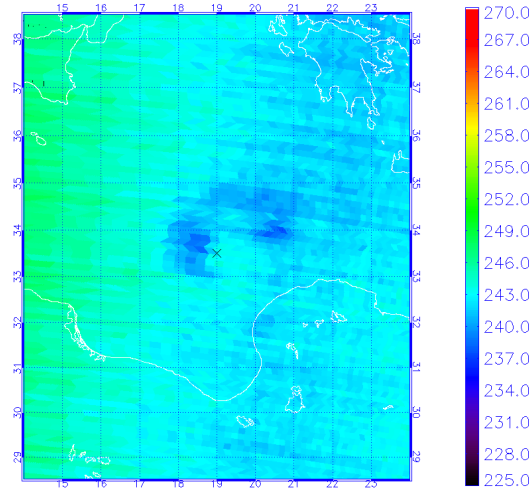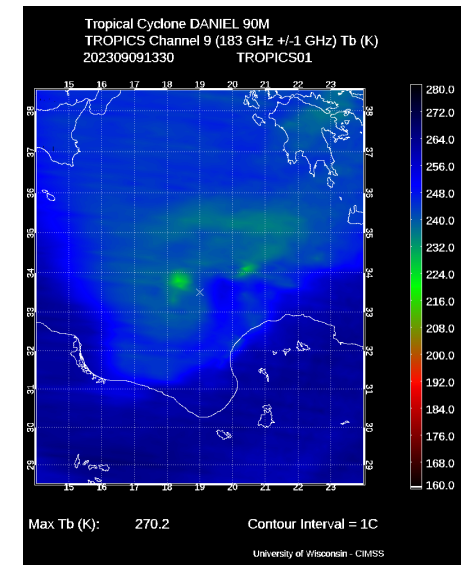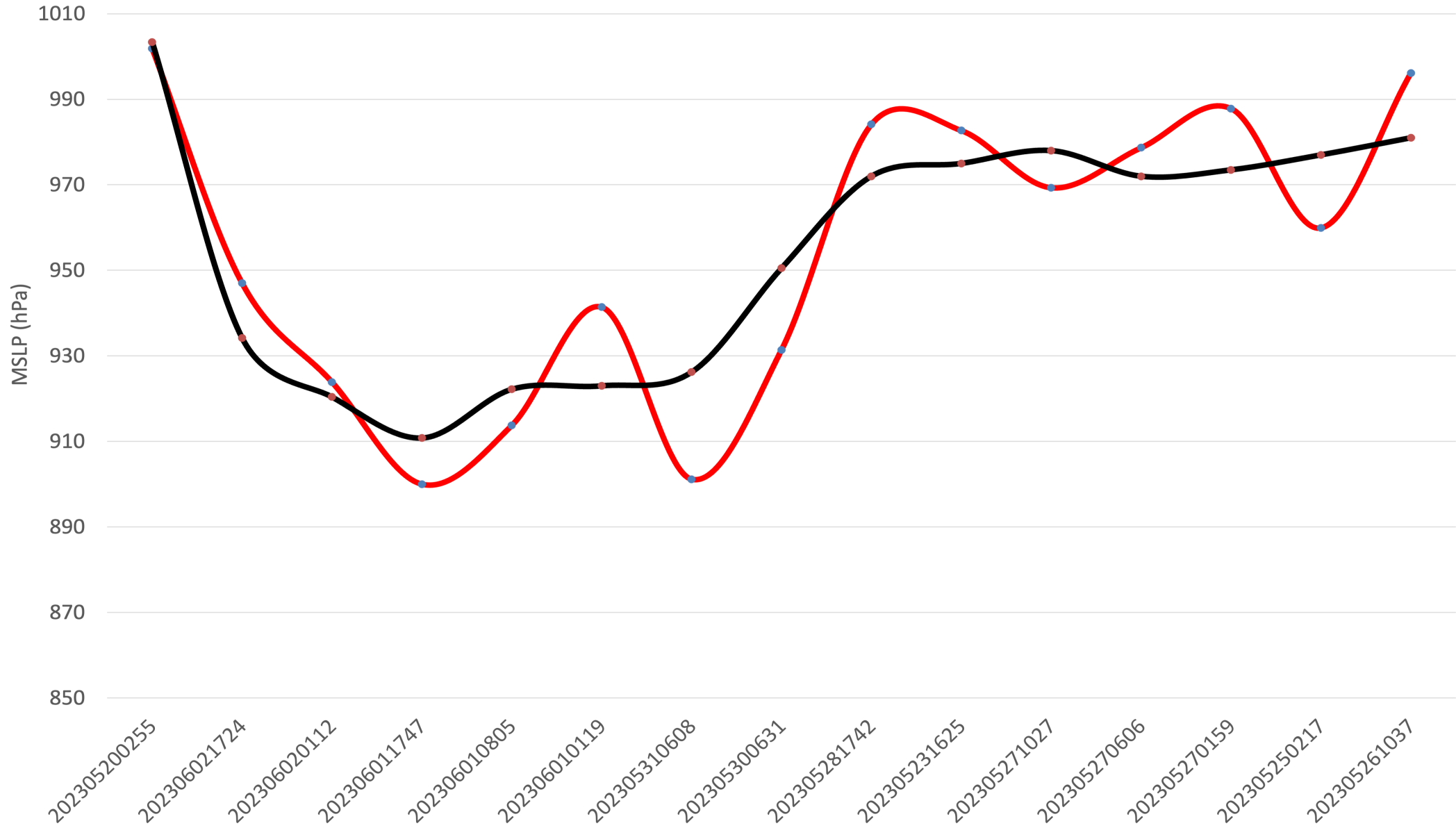
Hurricane Lee 2023

WestPac Typhoon Mawar (02W) 2023 Extreme Warm Core

ATMS CH9

TROPICS CH7

Tropical Cyclone MAWAR 02W
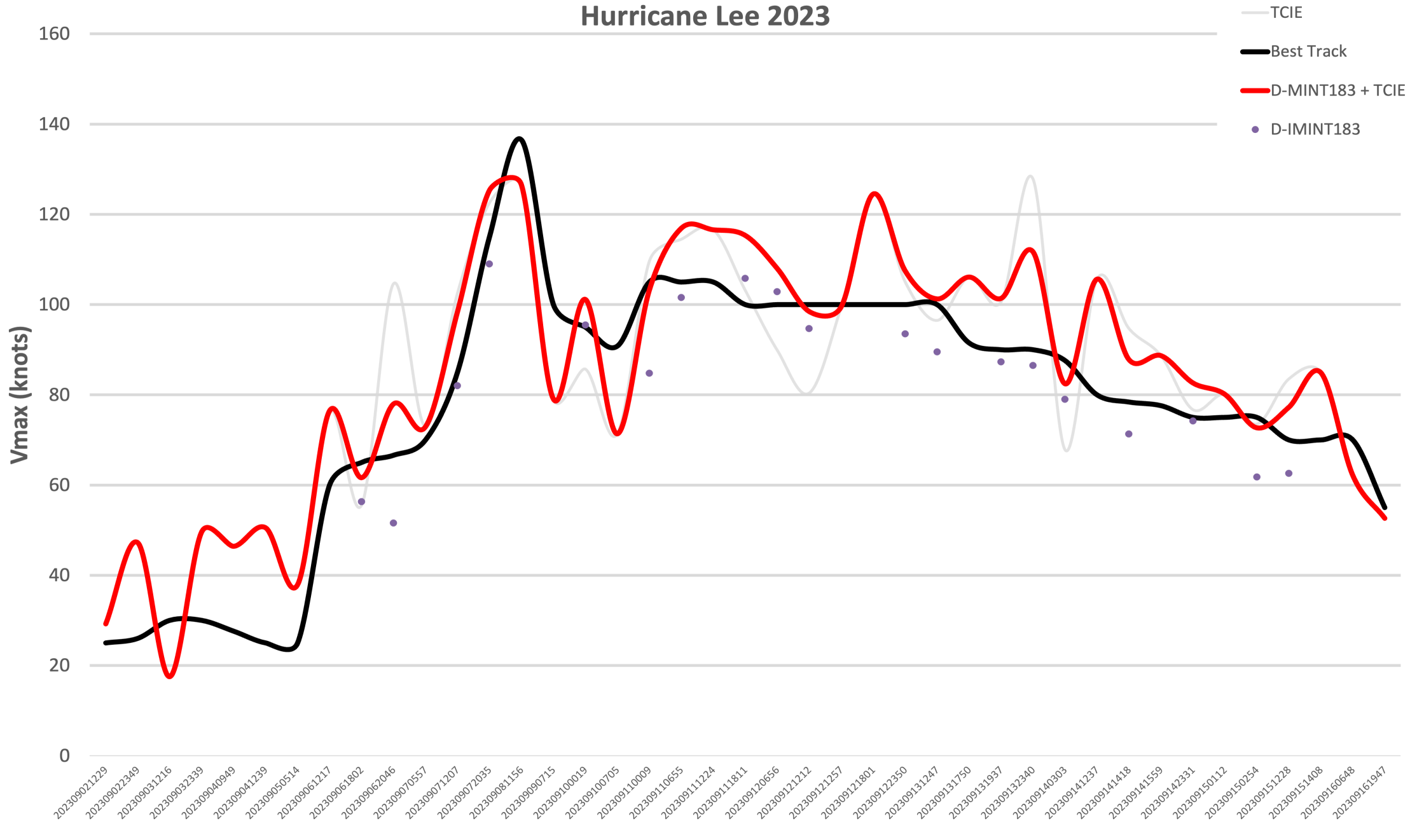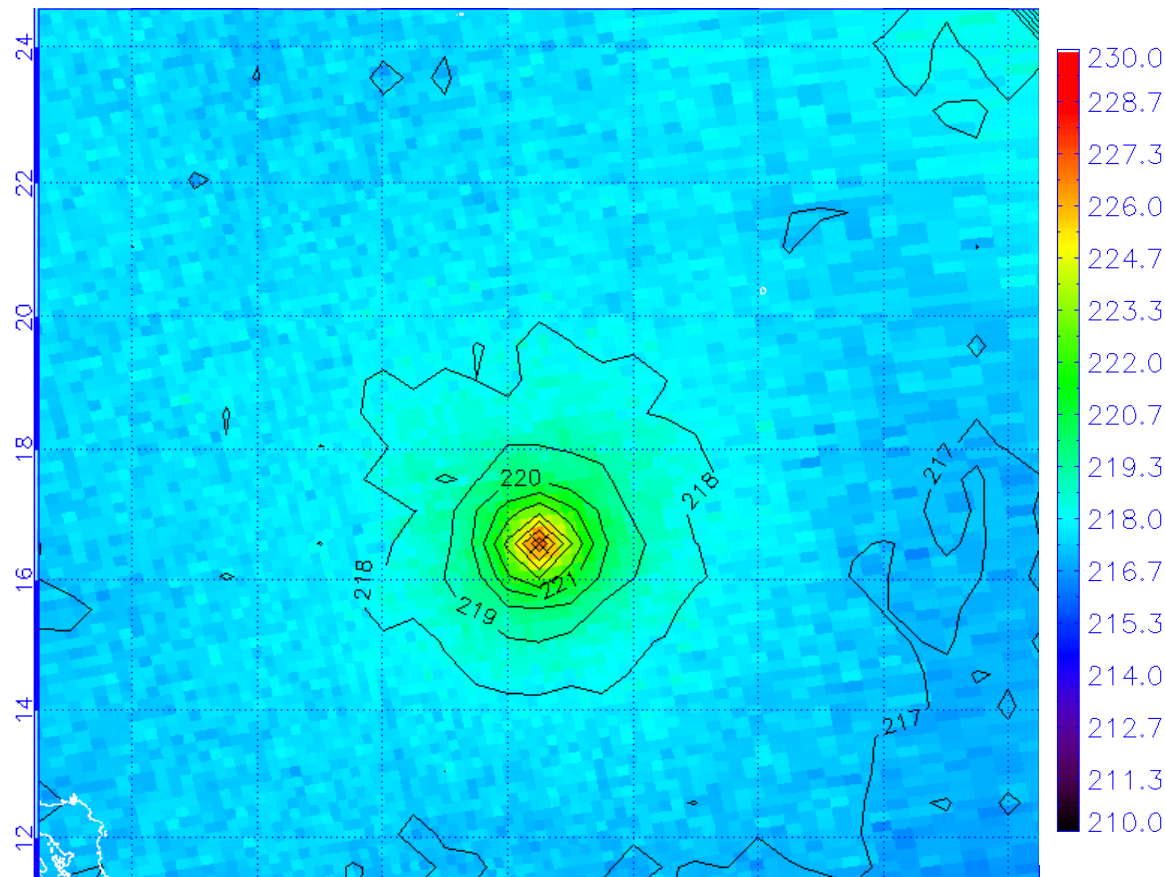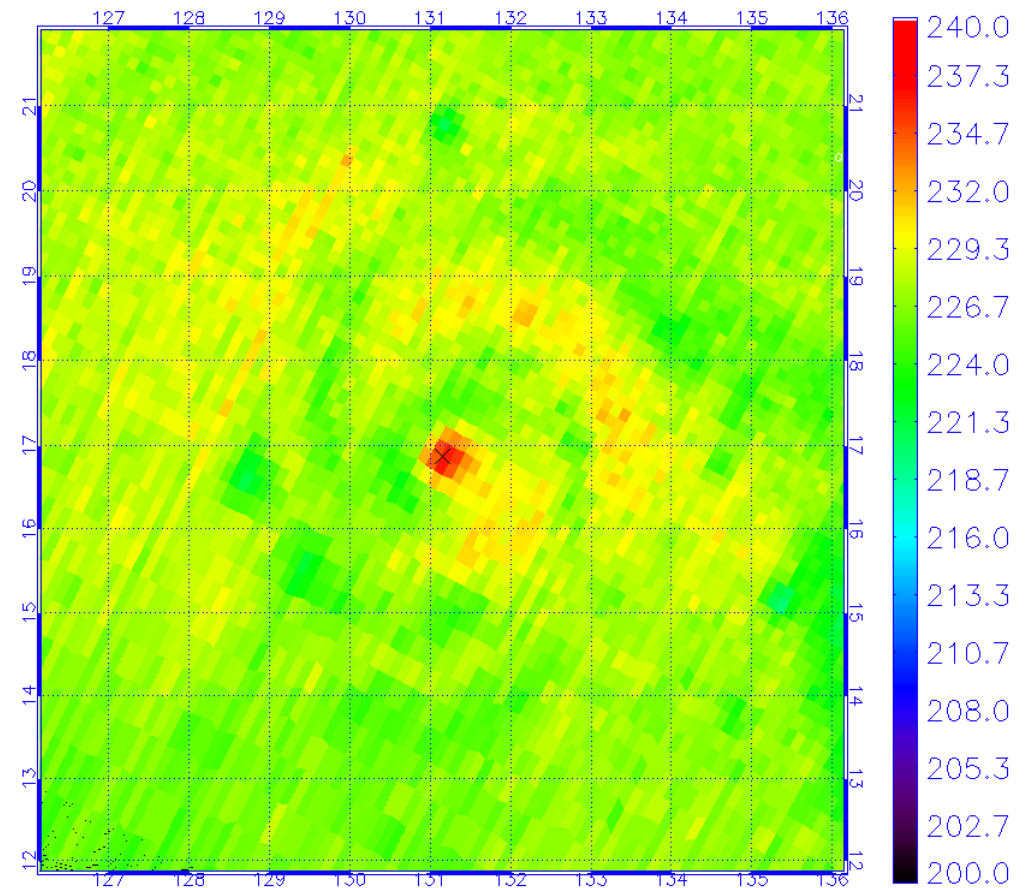TROPICS Channel 7 (118.25 GHz) Tb (K)
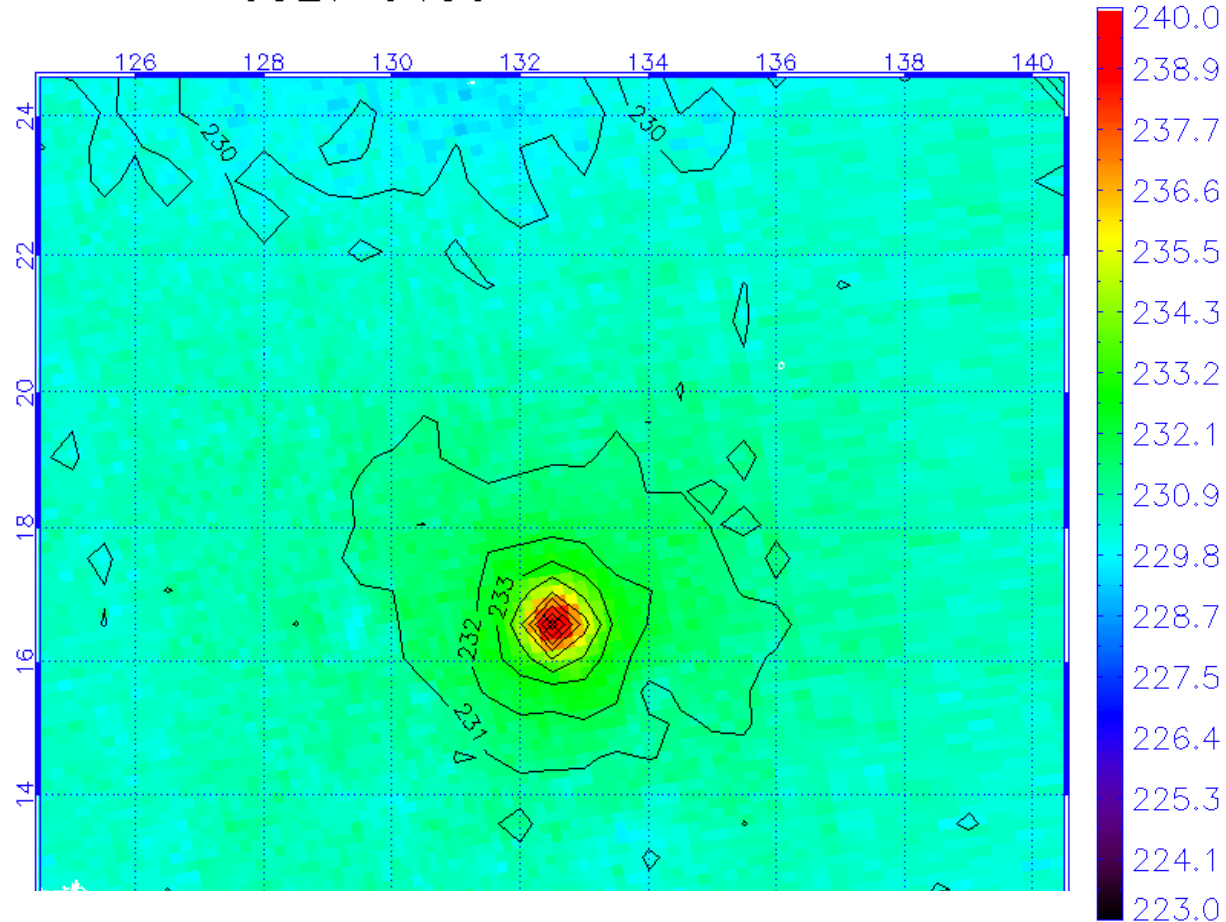202305271027   TROPICS05

Max Tb (K): 236.3   Contour Interval = 1C

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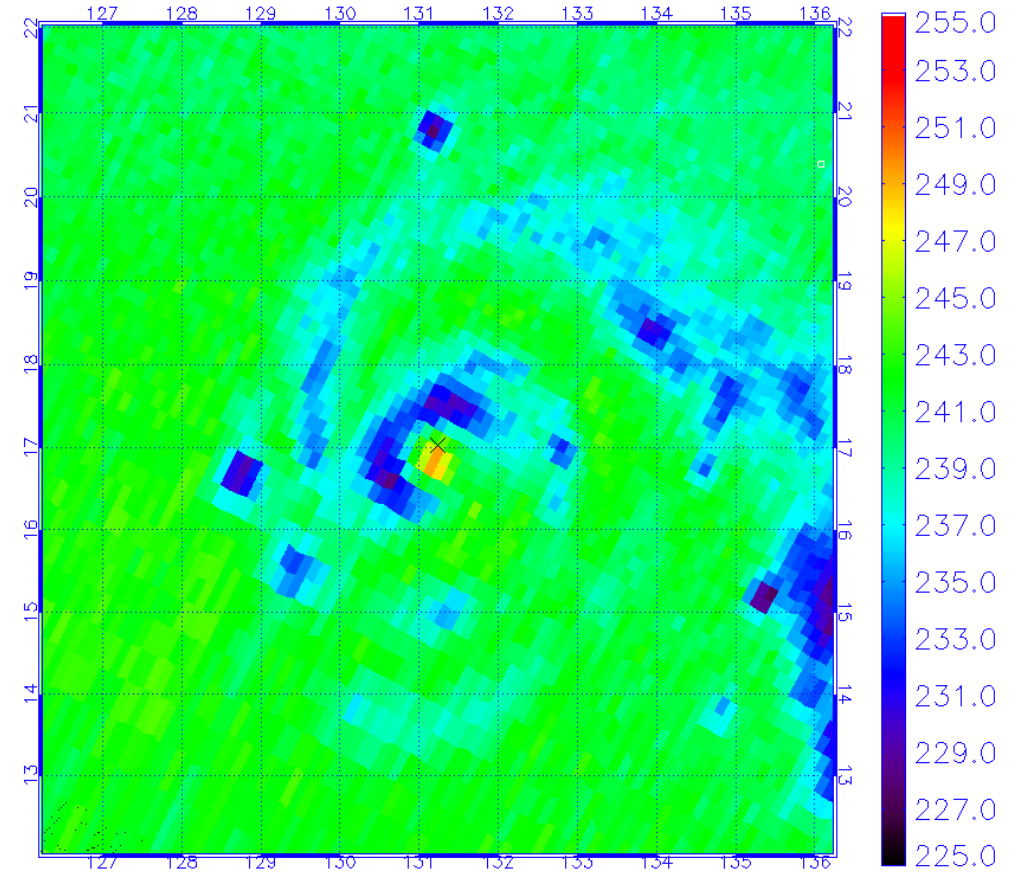# WestPac Typhoon Mawar (02W) 2023 Extreme Warm Core

ATMS CH8

202302W MAWAR
N20 ATMS Channel 8 (54.94GHz) Tb
0527 0436

TROPICS CH6

Tropical Cyclone MAWAR 02W
TROPICS Channel 6 (117.8 GHz) Tb (K)
202305271027   TROPICS05

Max Tb (K): 249.3   Contour Interval = 1C

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