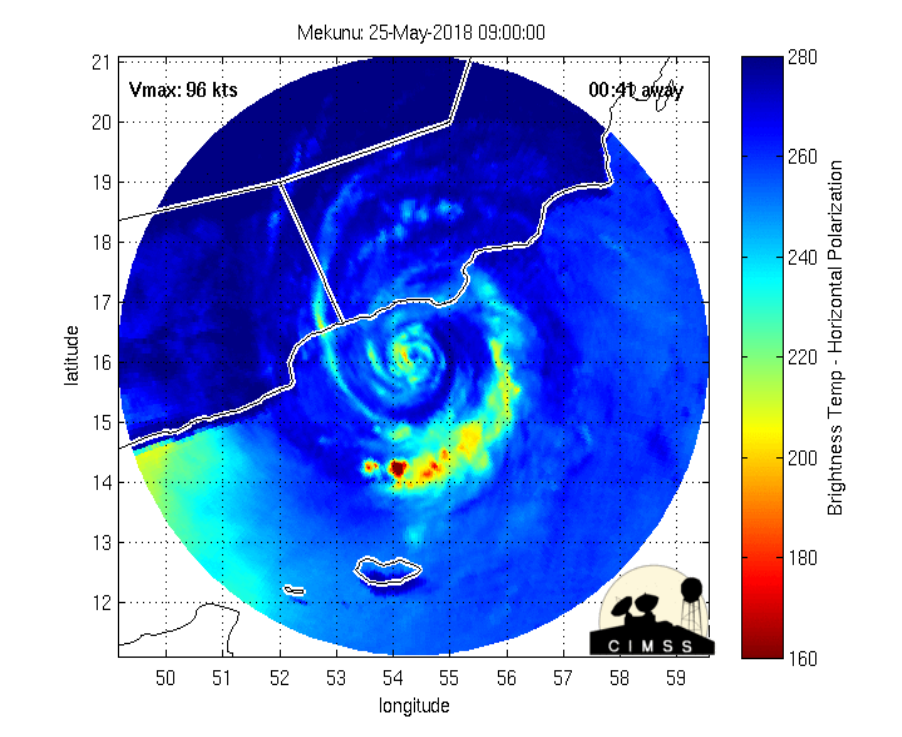
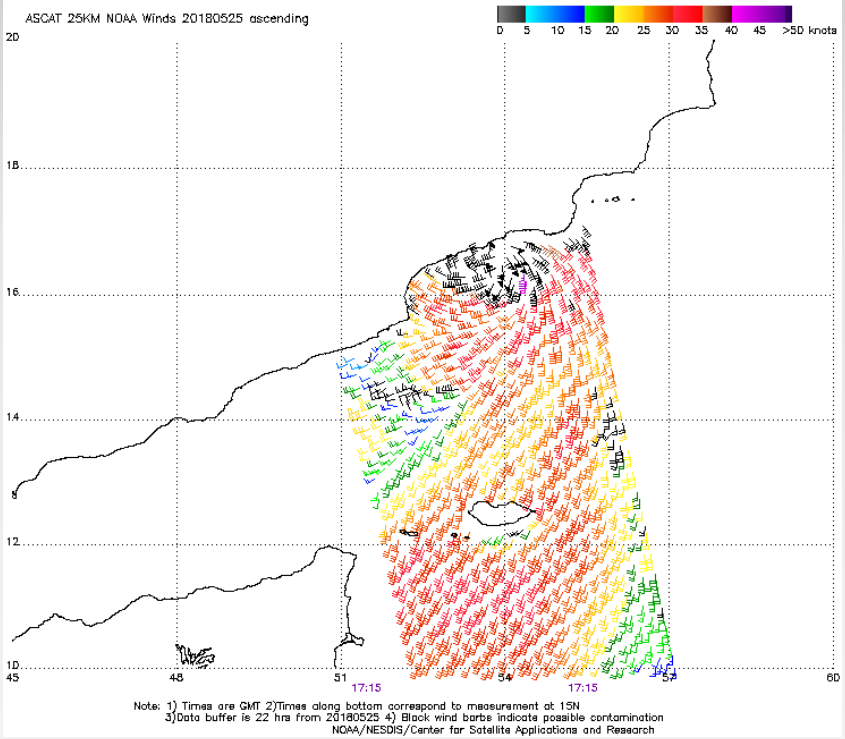
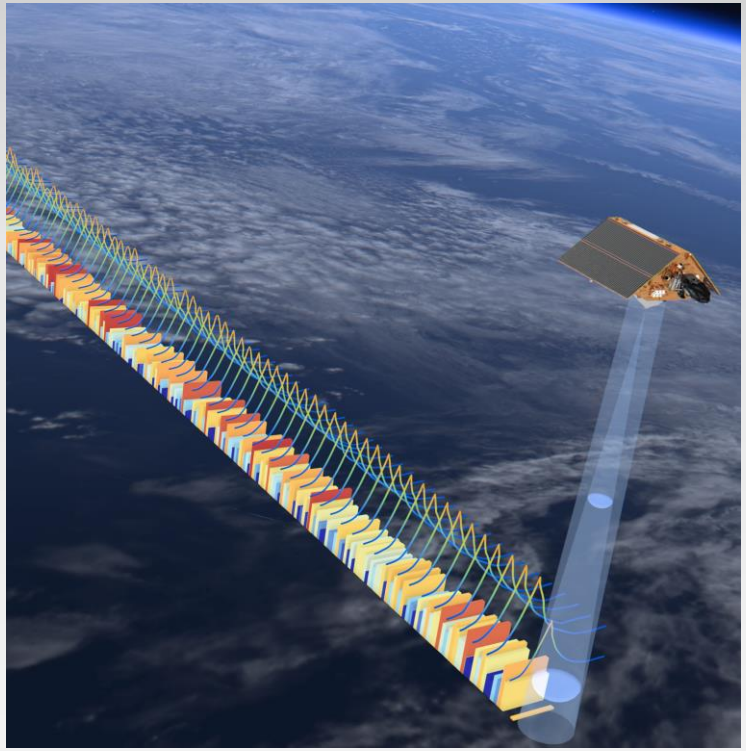
Microwave Remote Sensing



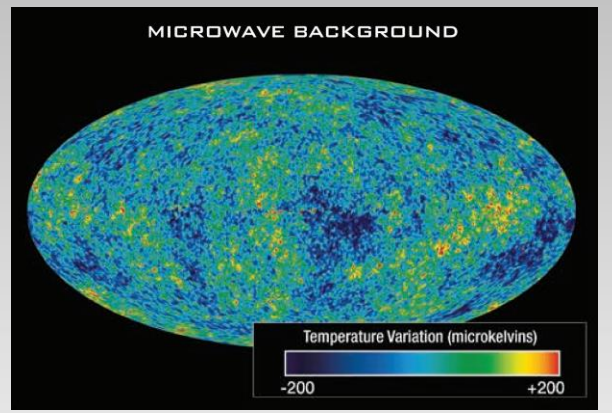


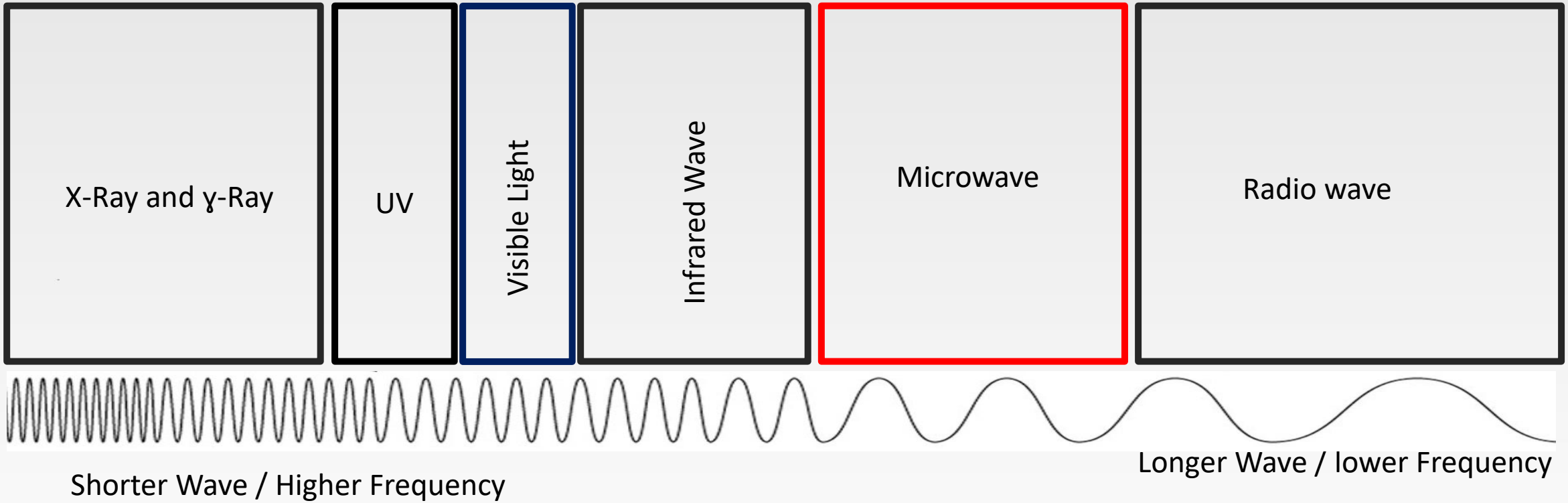


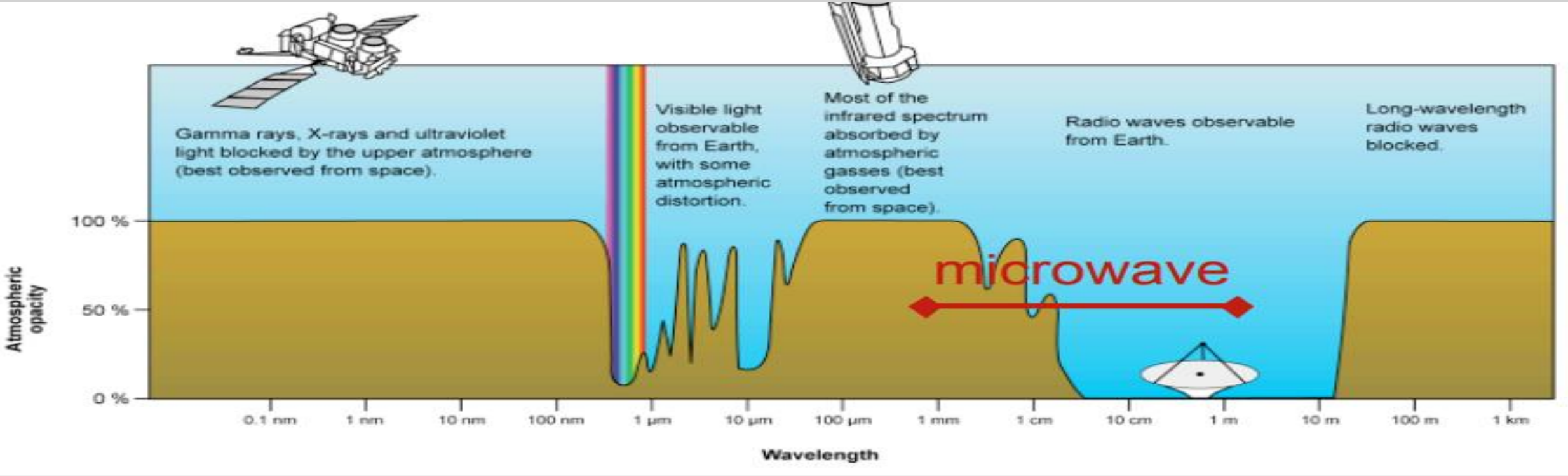
Ibrahim Al Abdulsalam
Meteorologist
Directorate General of Meteorology / Oman

Telecommunication
GPS
Mobile phone
WiFi
Radars
Bluetooth
Traffic Radar

Weather Radar
Satellite Radar
Microwave imagery
satellite Scatterometer
Altimeters

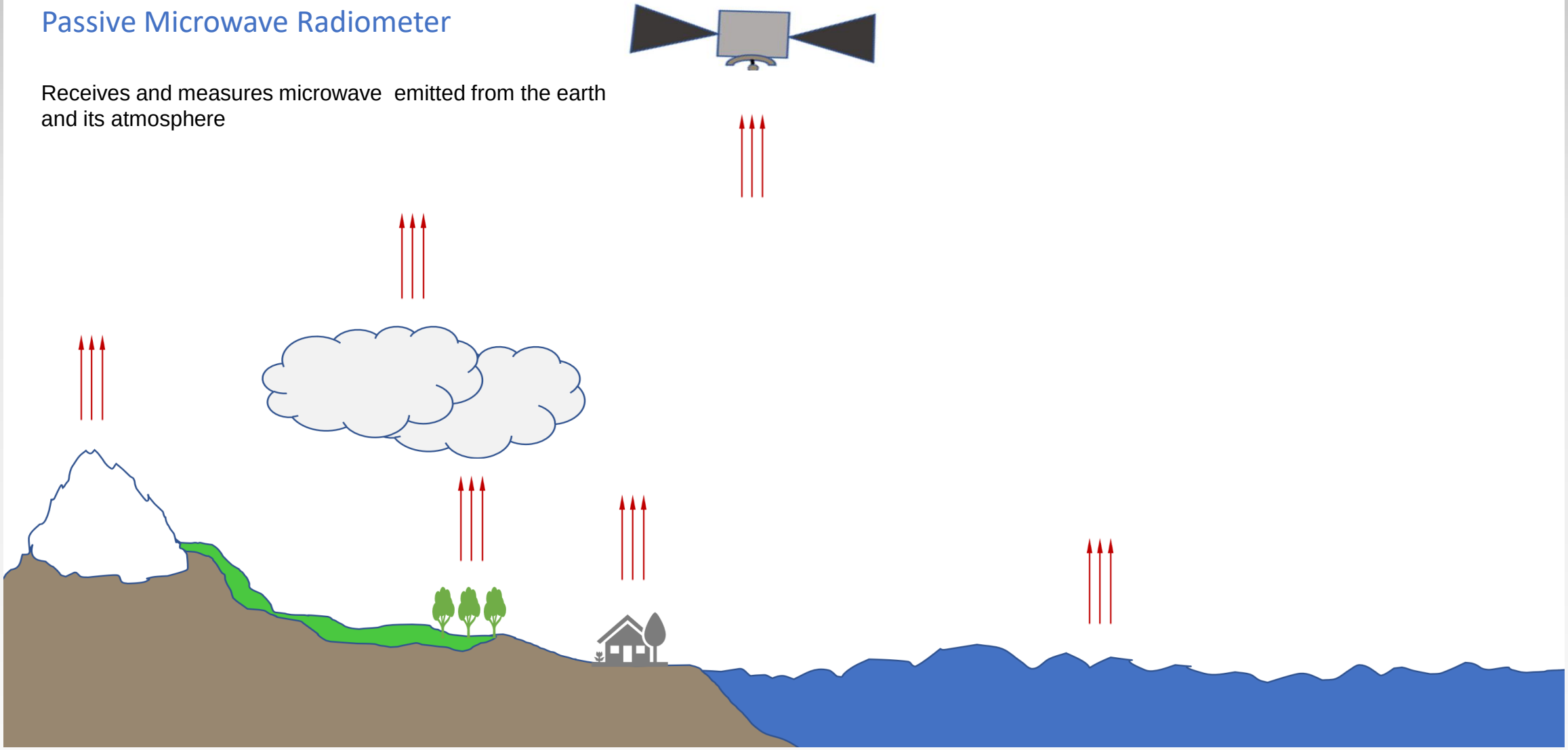


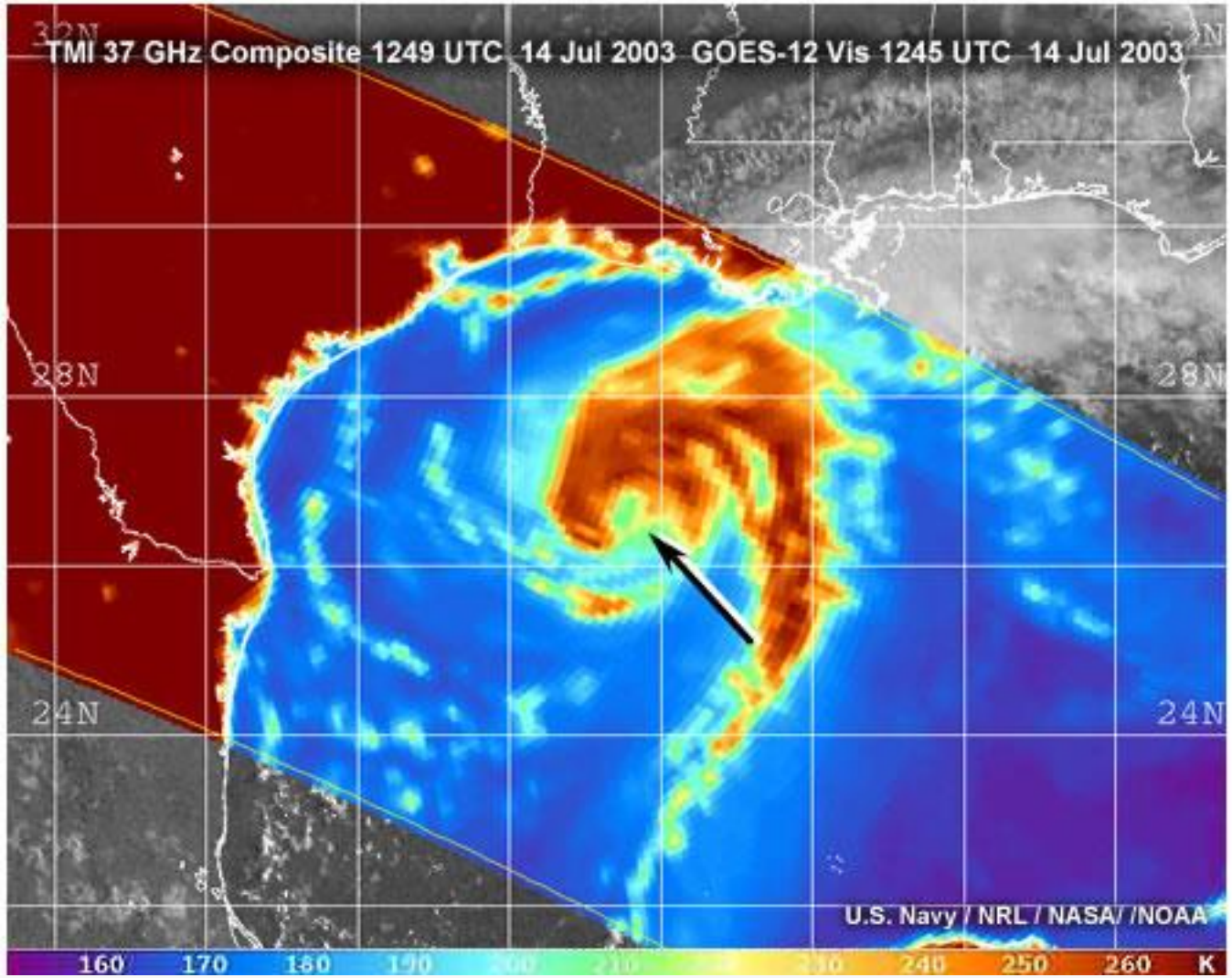



Gamma rays, X-rays and ultraviolet light blocked by the upper atmosphere (best observed from space).
Visible light observable from Earth, with some atmospheric distortion.
Most of the infrared spectrum absorbed by atmospheric gasses (best observed from space).
Radio waves observable from Earth.
Long-wavelength radio waves blocked.
microwave
Atmospheric opacity
100 %
50 %
0 %
0.1 nm
1 nm
10 nm
100 nm
1 µm
10 µm
100 µm
1 mm
1 cm
10 cm
1 m
10 m
100 m
1 km
Wavelength

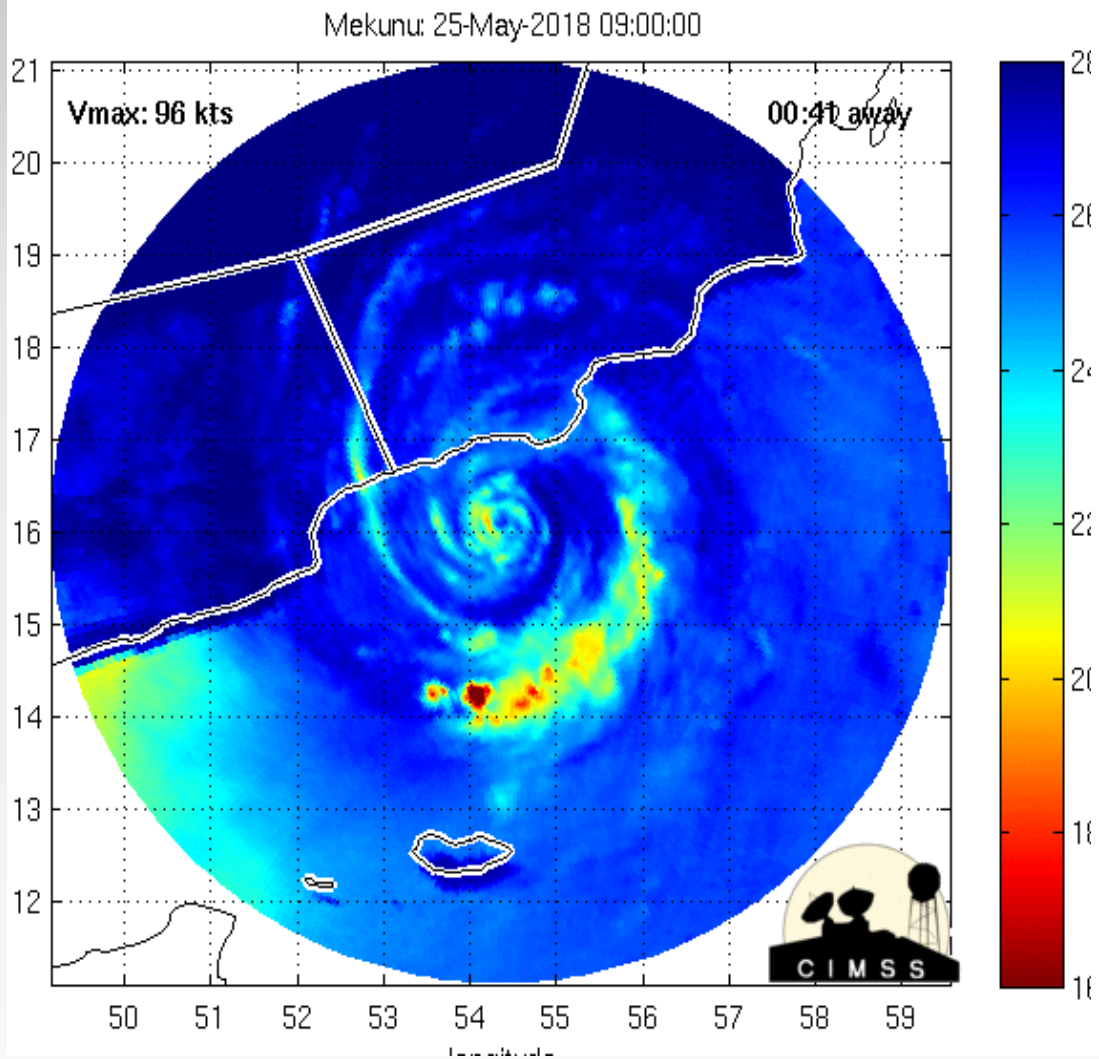
Passive Microwave Radiometer

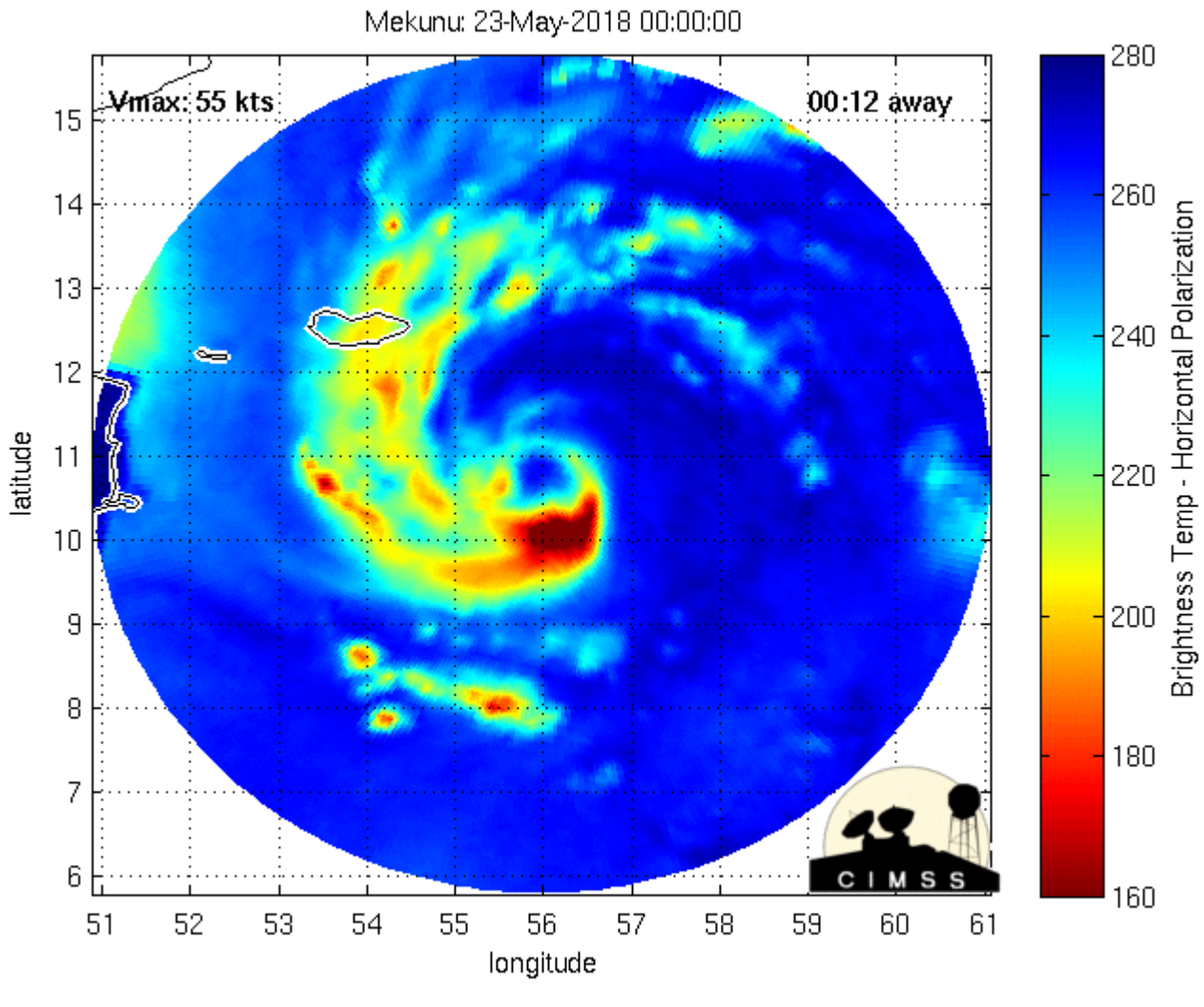
Receives and measures microwave emitted from the earth and its atmosphere

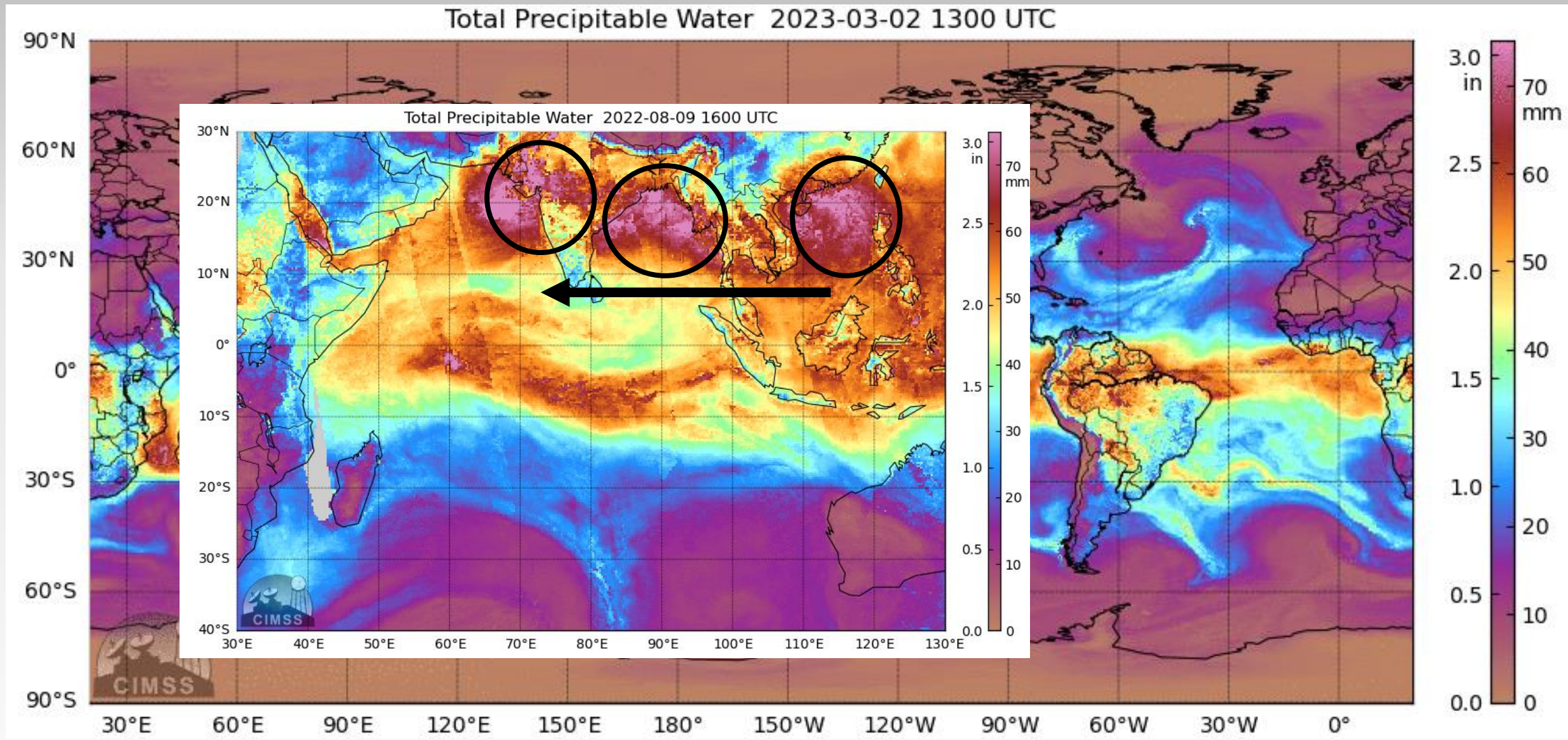



TMI 37 GHz Composite 1249 UTC 14 Jul 2003 GOES-12 Vis 1245 UTC 14 Jul 2003
32N
28N
24N
U.S. Navy / NRL / NASA / NOAA
160 170 180 190 240 250 260 K

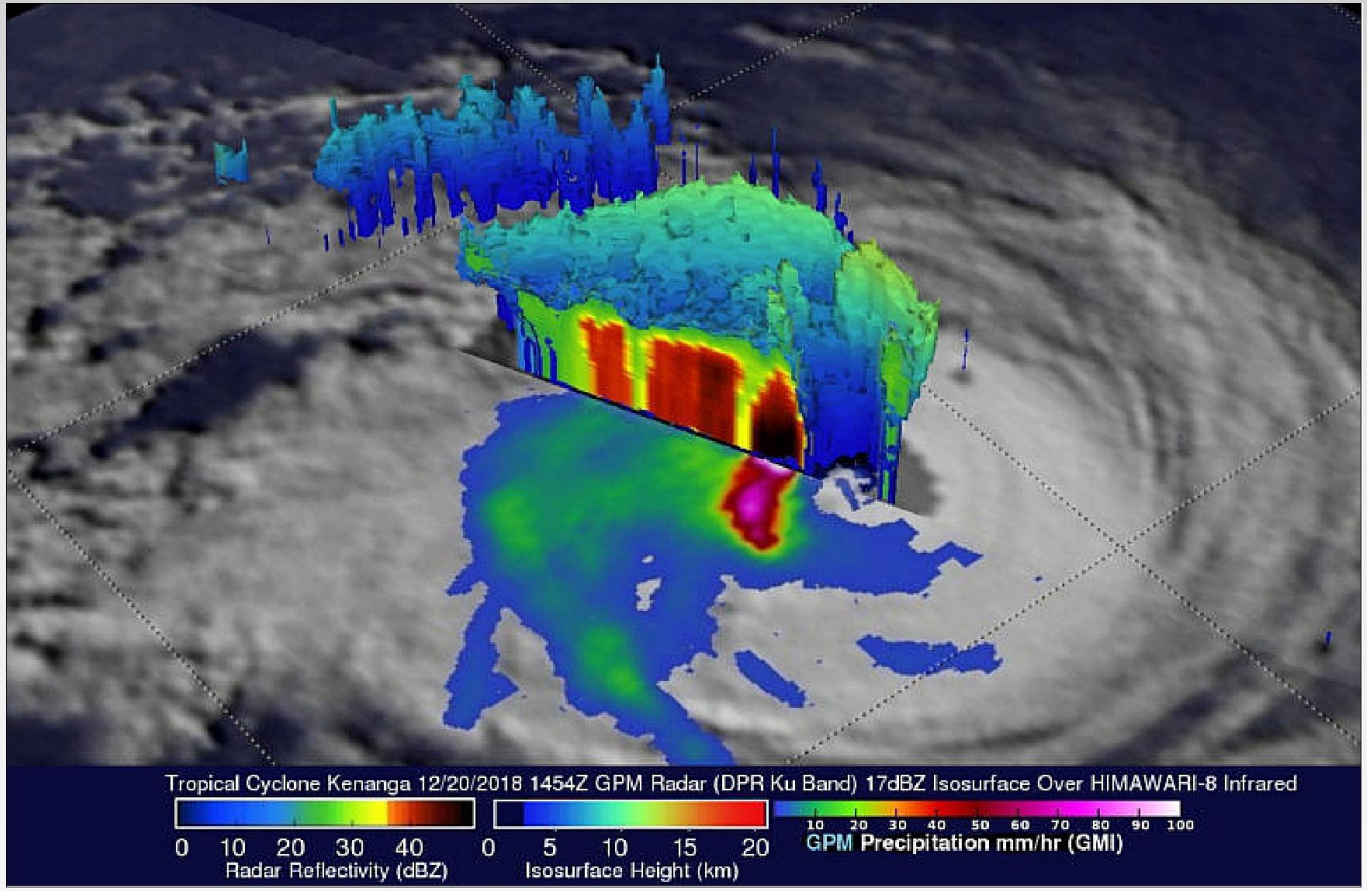
TC Mekunu May 2018

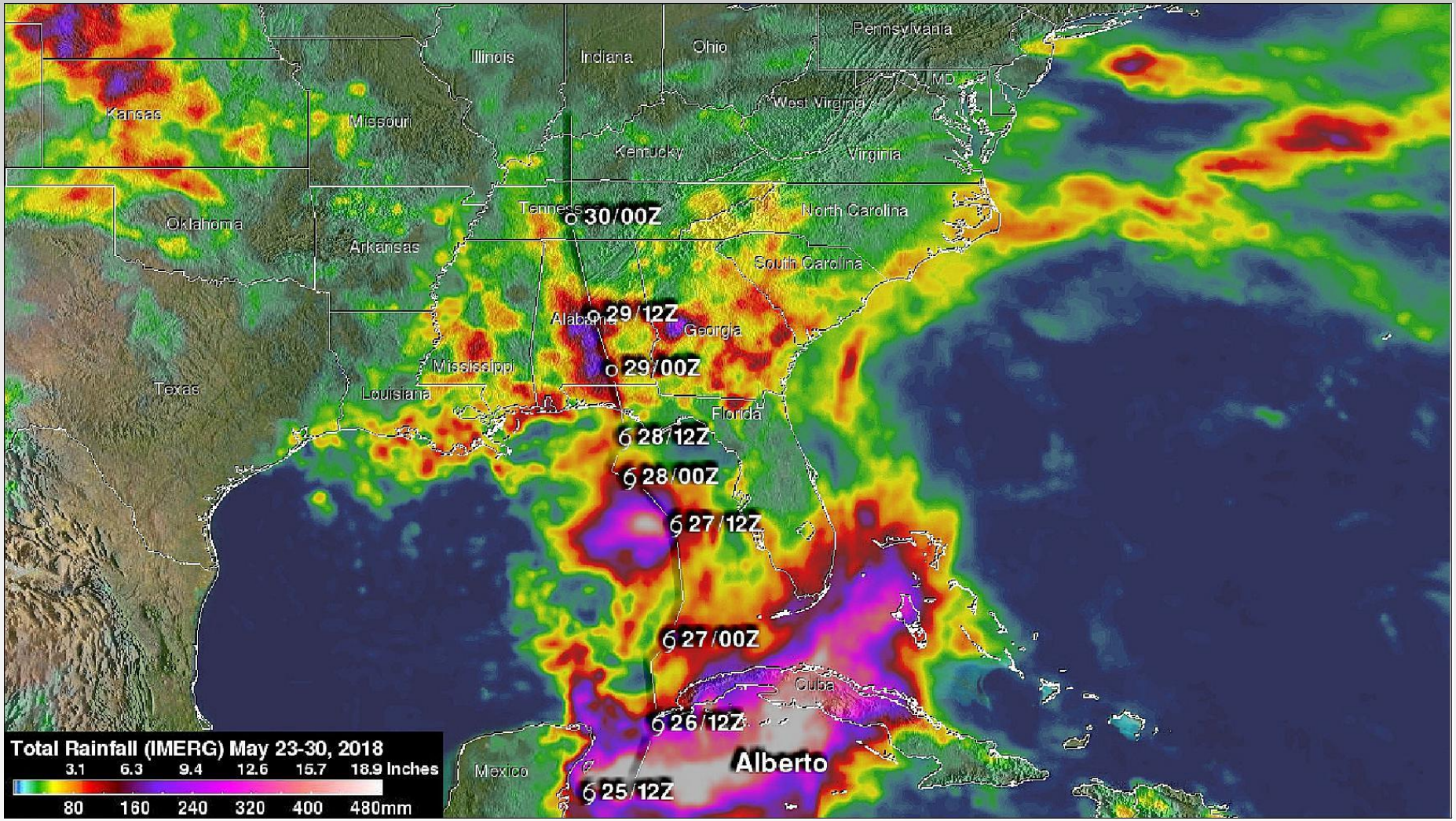


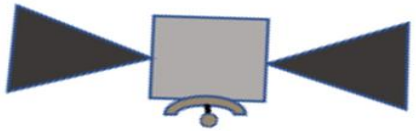



Total Precipitable Water 2023-03-02 1300 UTC
Total Precipitable Water 2022-08-09 1600 UTC
CIMSS
CIMSS
3.0 in
2.5
2.0
1.5
1.0
0.5
0.0
70 mm
60
50
40
30
20
10
0
90°N
60°N
30°N
0°
30°S
60°S
90°S
30°E
60°E
90°E
120°E
150°E
180°
150°W
120°W
90°W
60°W
30°W
0°
30°N
20°N
10°N
0°
10°S
20°S
30°S
40°S
30°E
40°E
50°E
60°E
70°E
80°E
90°E
100°E
110°E
120°E
130°E

TC in 3D

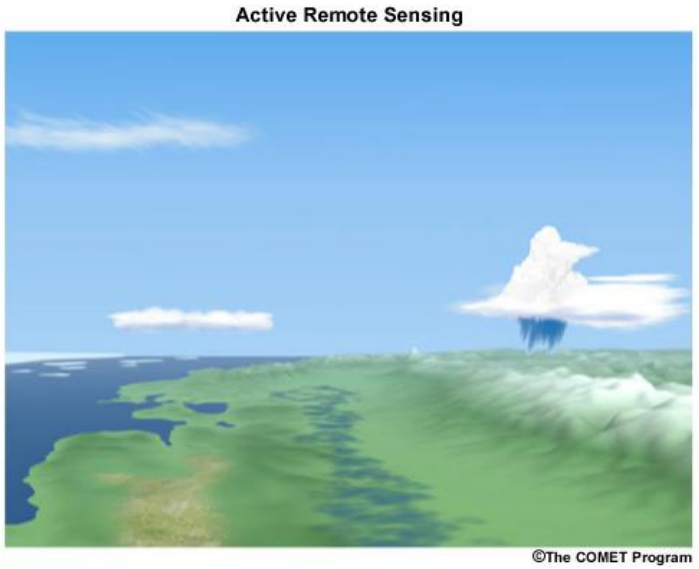

Tropical Cyclone Kenanga 12/20/2018 1454Z GPM Radar (DPR Ku Band) 17dBZ Isosurface Over HIMAWARI-8 Infrared
0 10 20 30 40
Radar Reflectivity (dBZ)
0 5 10 15 20
Isosurface Height (km)
10 20 30 40 50 60 70 80 90 100
GPM Precipitation mm/hr (GMI)

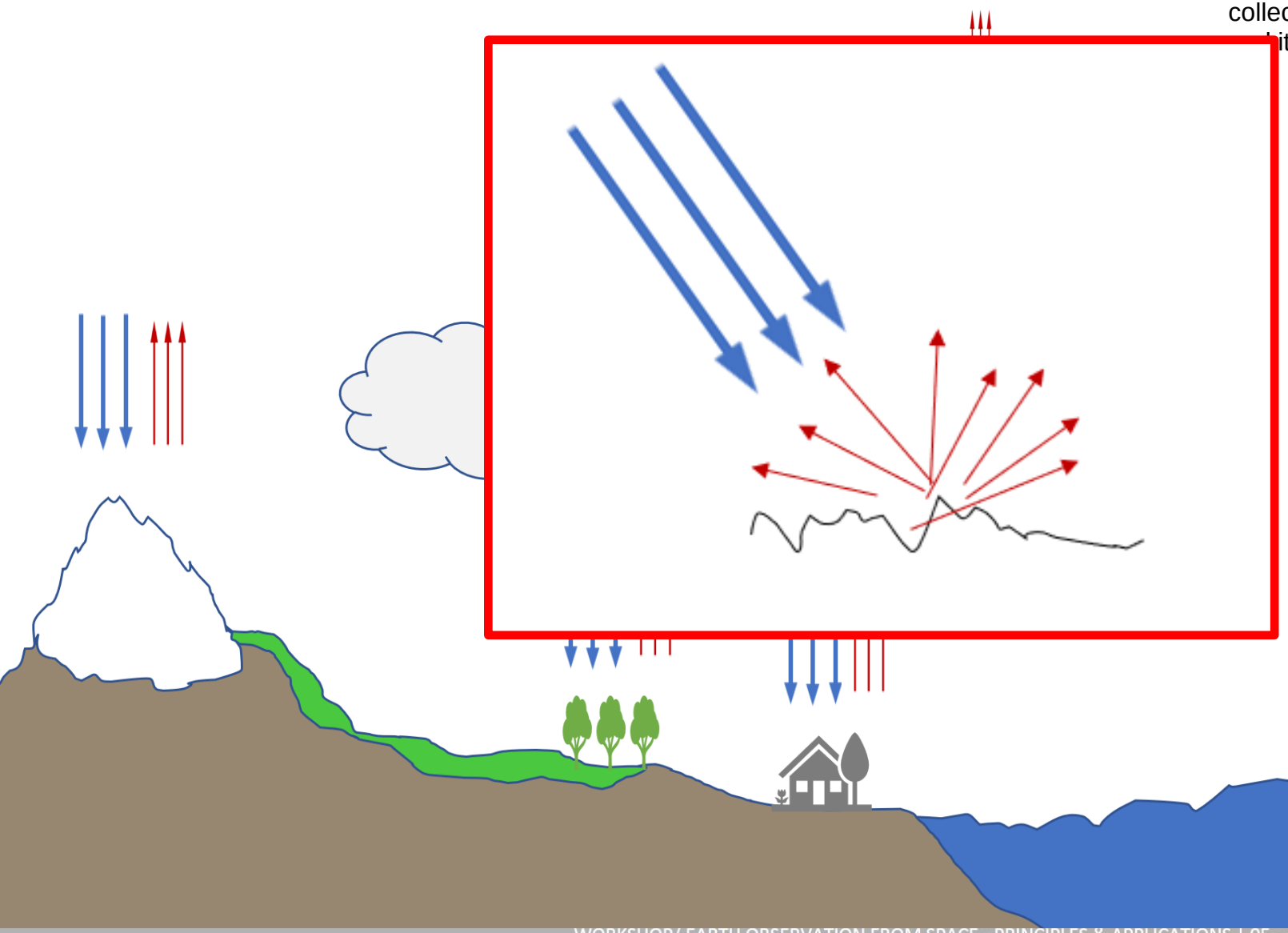

Illinois
Indiana
Ohio
Pennsylvania
MD
West Virginia
Kansas
Missouri
Kentucky
Virginia
Tennessee
North Carolina
Oklahoma
Arkansas
South Carolina
Alabama
Georgia
Mississippi
Texas
Louisiana
Florida
Cuba
Mexico
Alberto
30/00Z
29/12Z
29/00Z
28/12Z
28/00Z
27/12Z
27/00Z
26/12Z
25/12Z
Total Rainfall (IMERG) May 23-30, 2018
3.1 6.3 9.4 12.6 15.7 18.9 Inches
80 160 240 320 400 480mm



Active Instruments:

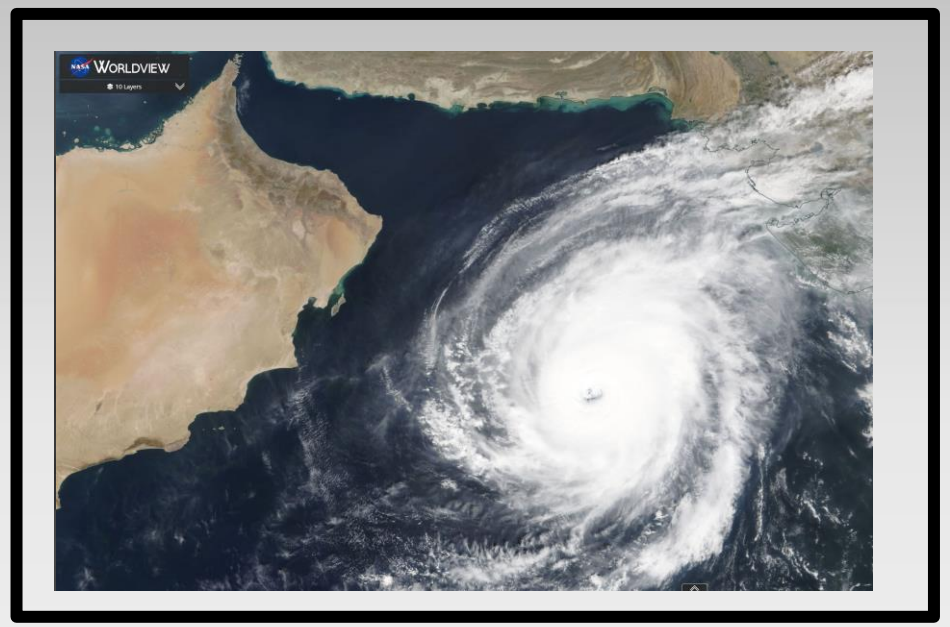
Radar instrument transmits its own radiation and then collects its reflected or scattered signals from the earth and its atmosphere systems

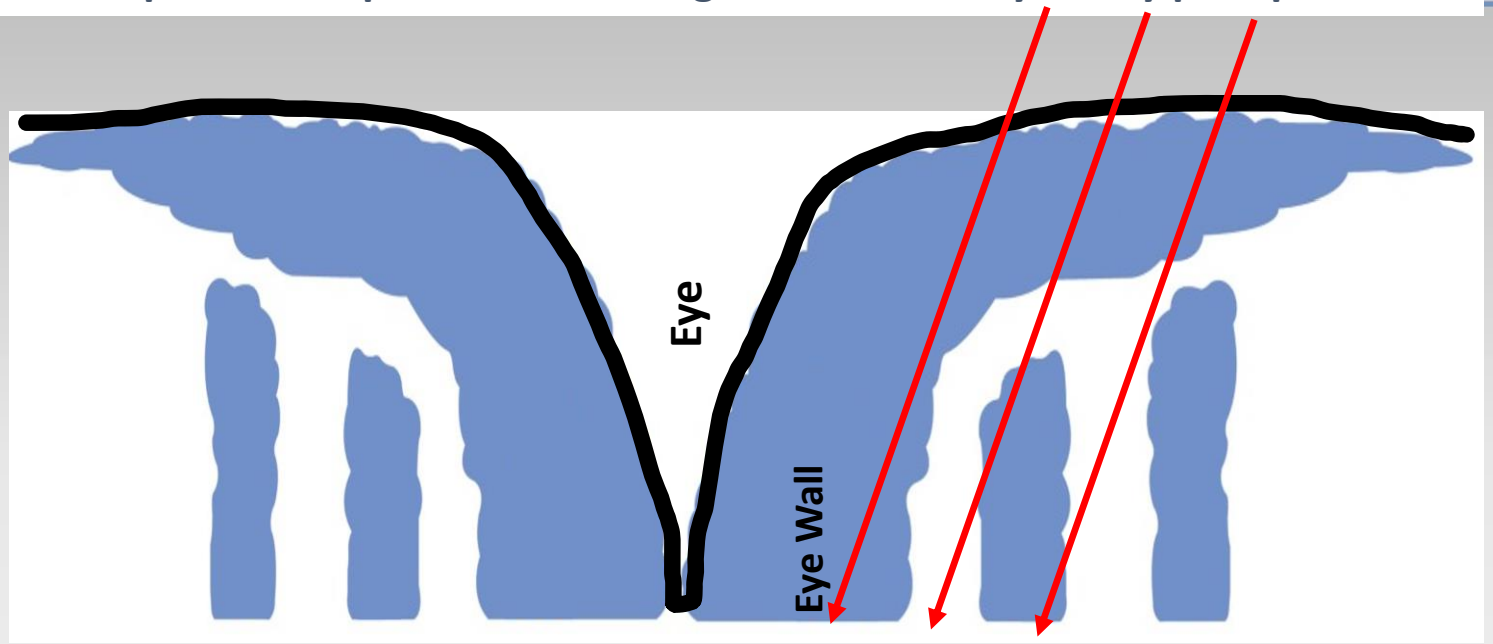




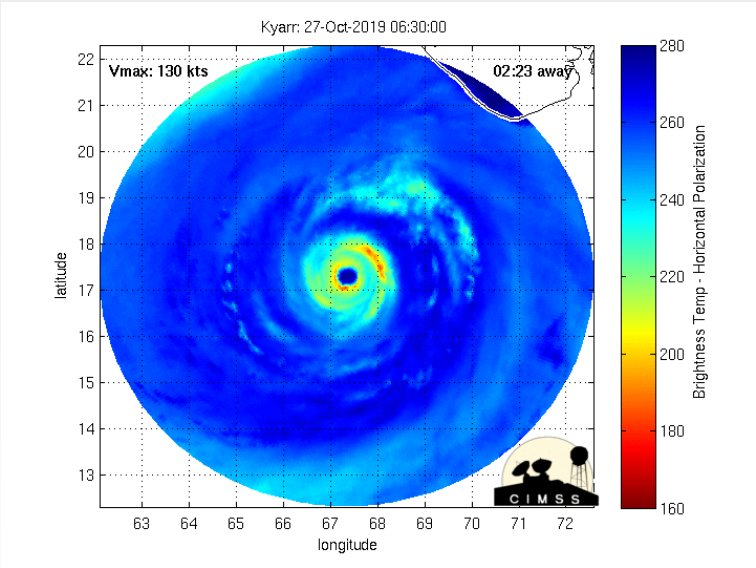
Applications

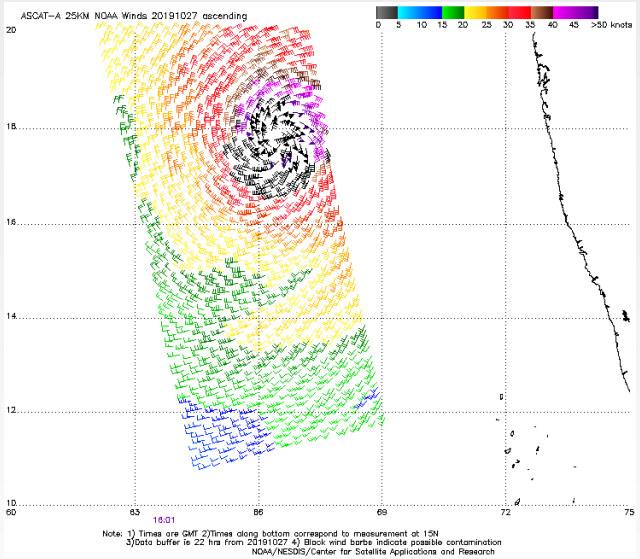
Excellent Capabilities to go through different atmospheric composition including cloud with very heavy precipitation

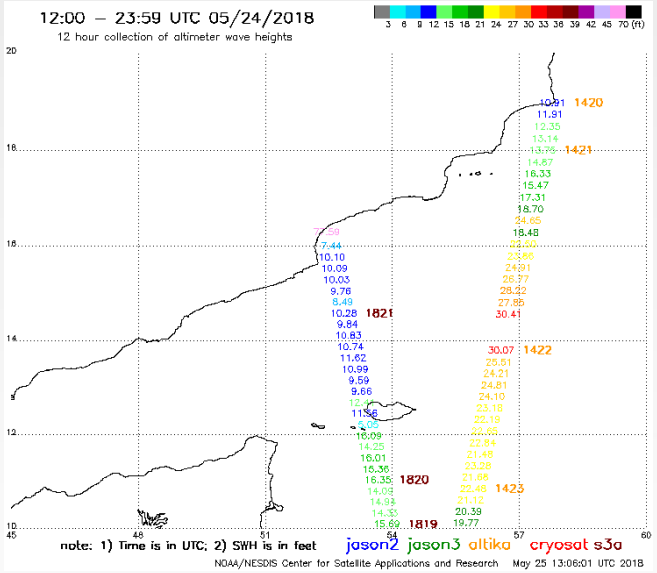




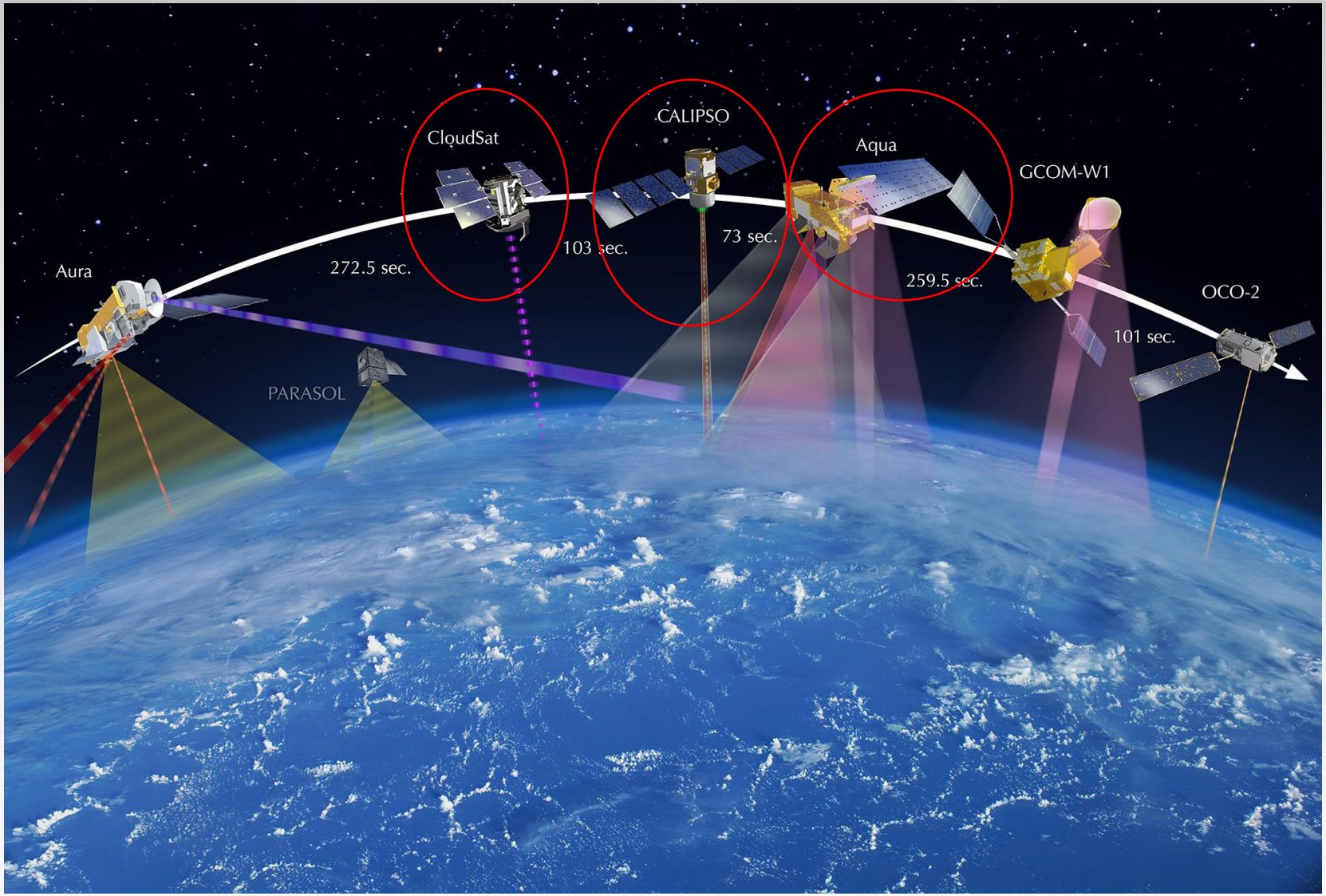
Microwave

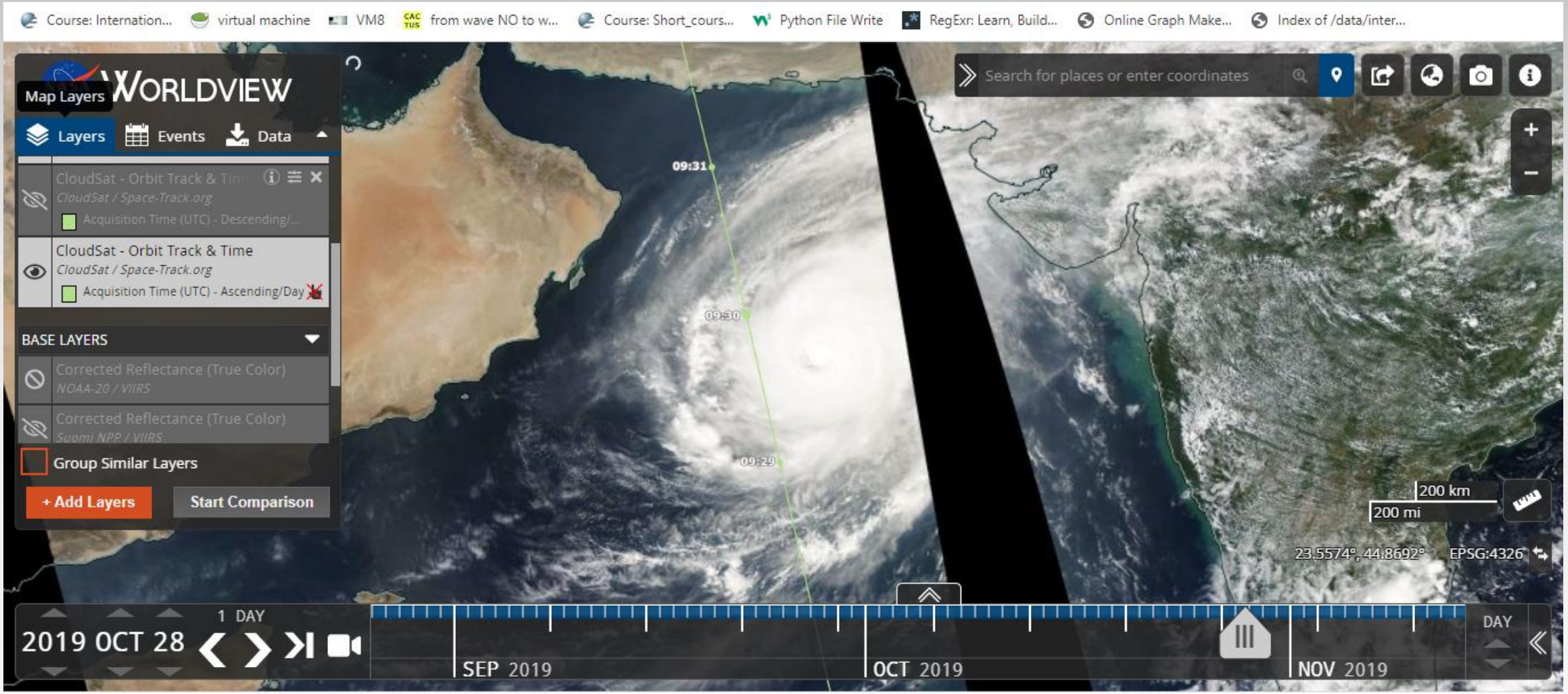


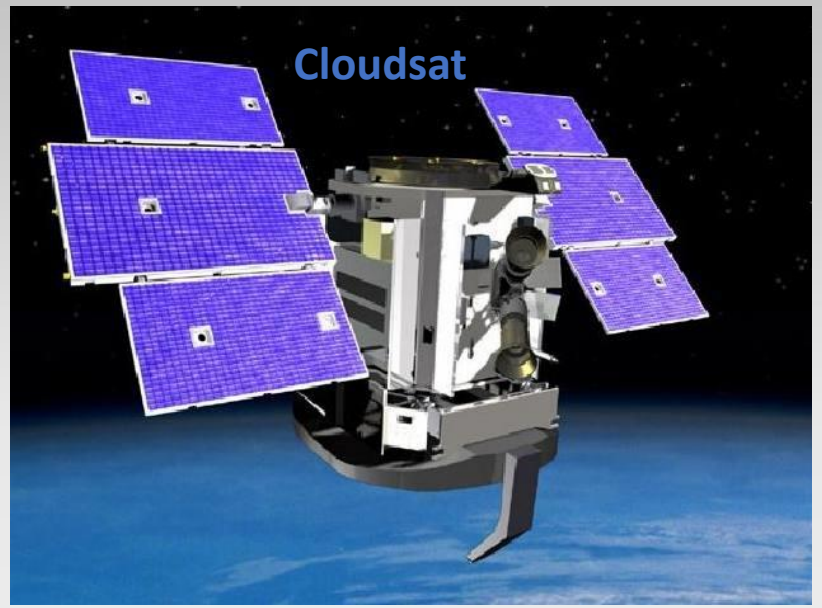




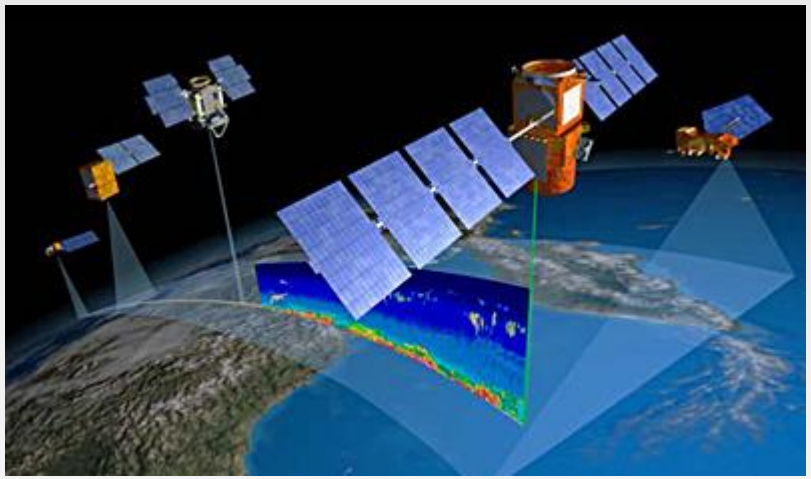
A-train Satellites



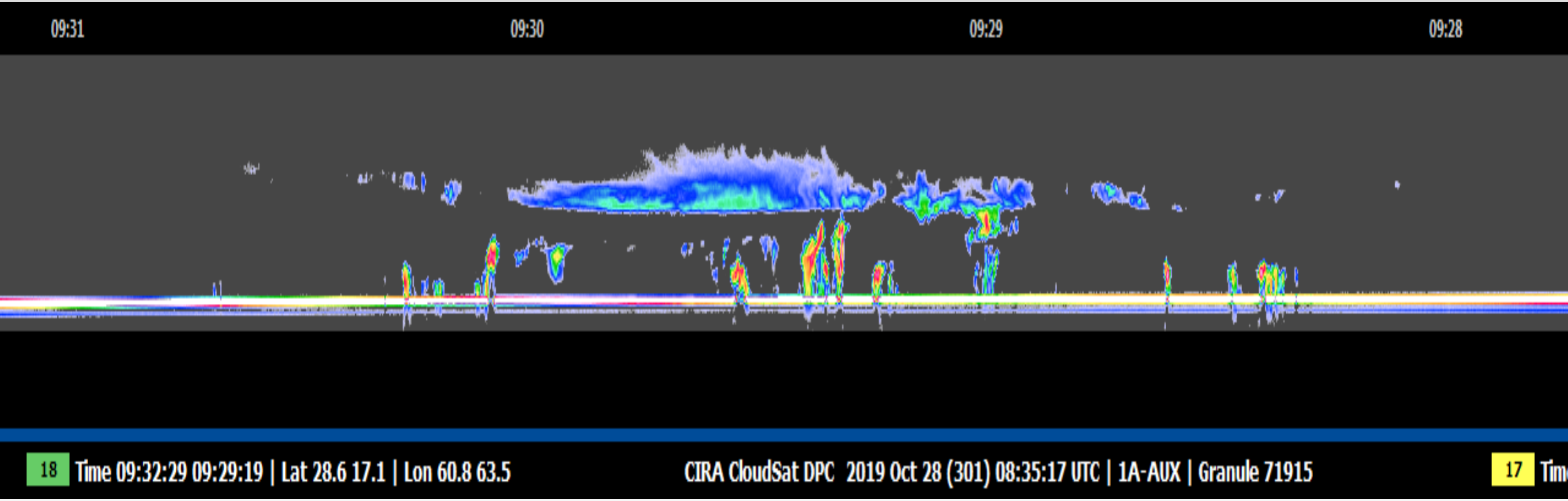

Course: Internation...
virtual machine
VM8
from wave NO to w...
Course: Short_cours...
Python File Write
RegExr: Learn, Build...
Online Graph Make...
Index of /data/inter...
WORLDVIEW
Map Layers
Layers
Events
Data
CloudSat - Orbit Track & Tim
CloudSat / Space-Track.org
Acquisition Time (UTC) - Descending/...
CloudSat - Orbit Track & Time
CloudSat / Space-Track.org
Acquisition Time (UTC) - Ascending/Day
BASE LAYERS
Corrected Reflectance (True Color)
NOAA-20 / VIIRS
Corrected Reflectance (True Color)
Suomi NPP / VIIRS
Group Similar Layers
+ Add Layers
Start Comparison
Search for places or enter coordinates
09:31
09:30
09:29
200 km
200 mi
23.5574°, 44.8692°
EPSG:4326
1 DAY
2019 OCT 28
SEP 2019
OCT 2019
NOV 2019
DAY



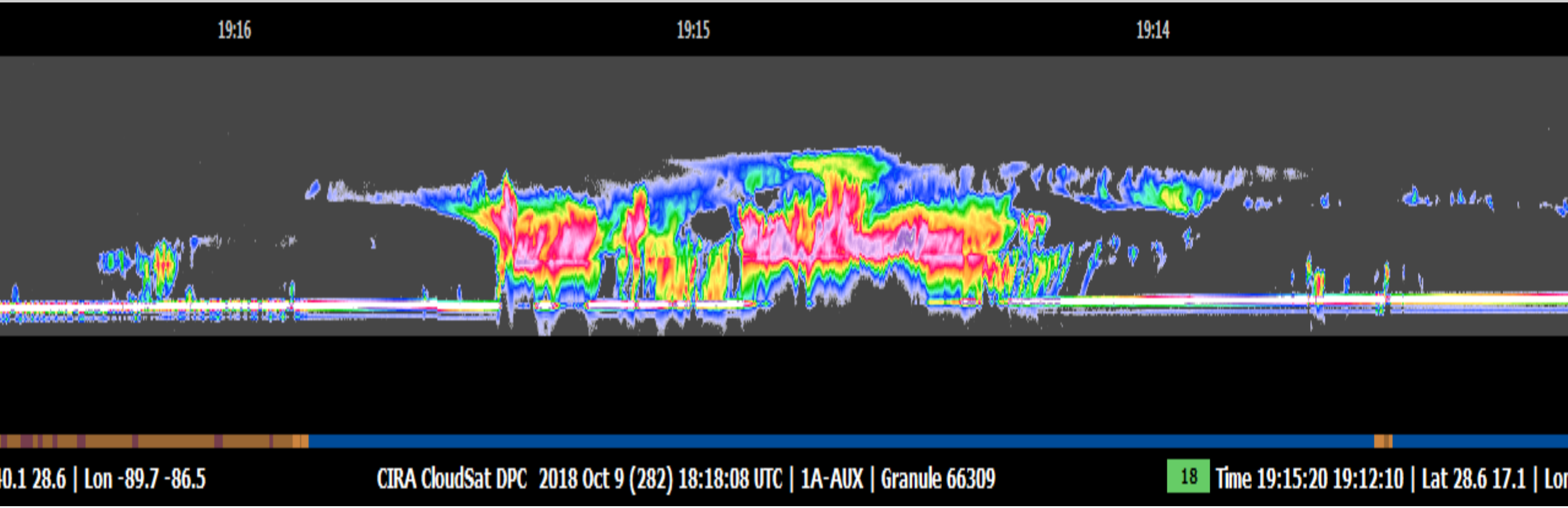
https://www.cloudsat.cira.colostate.edu/quicklooks



https://www-calipso.larc.nasa.gov/products/lidar/browse_images/exp_index.php


09:31
09:30
09:29
09:28
18 Time 09:32:29 09:29:19 | Lat 28.6 17.1 | Lon 60.8 63.5
CIRA CloudSat DPC 2019 Oct 28 (301) 08:35:17 UTC | 1A-AUX | Granule 71915
17 Tim


Oct 09, 2018
19:17:05(GMT)
CLOUDSAT
Low
High
Reflectivity

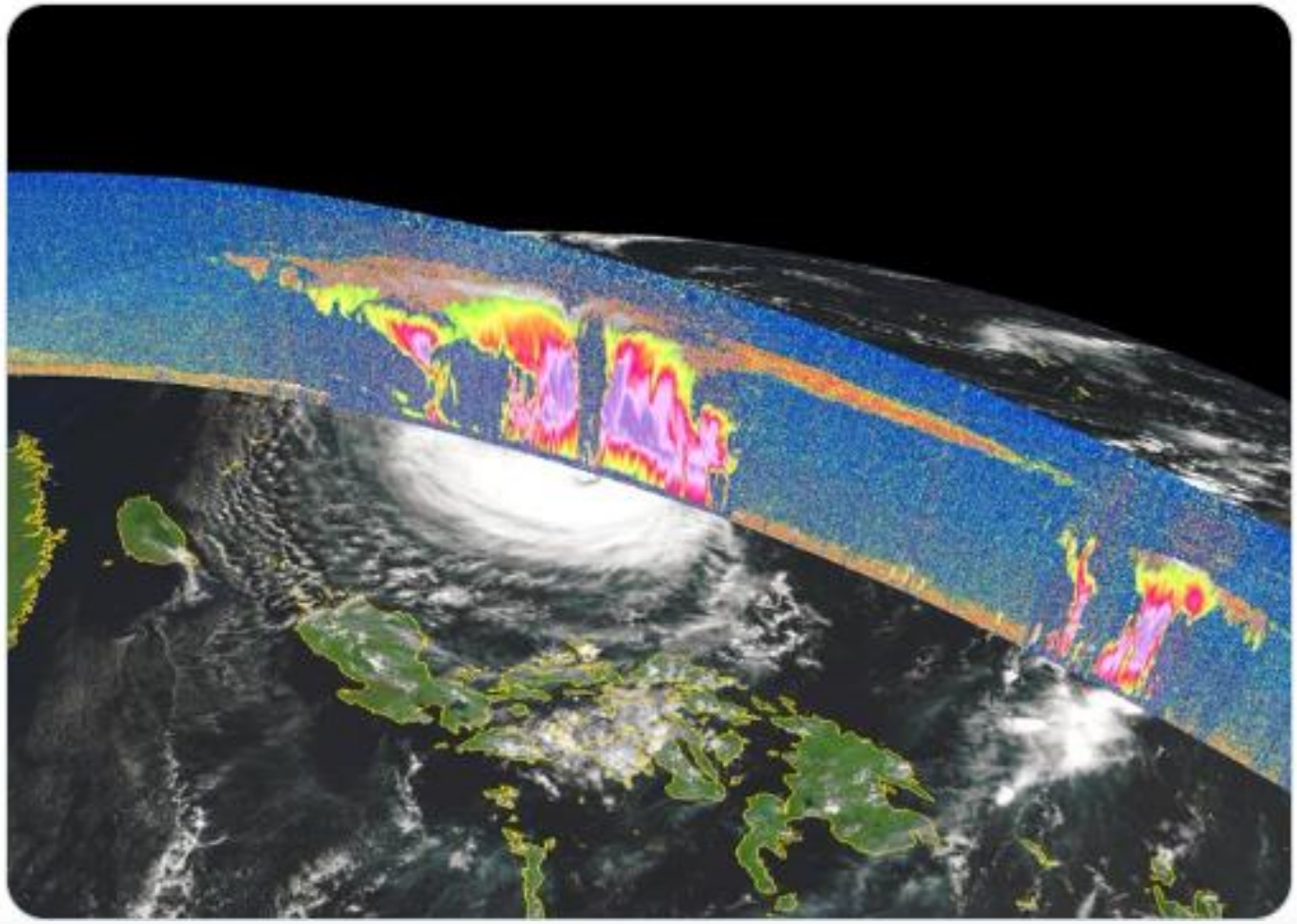

19:16
19:15
19:14
0.1 28.6 | Lon -89.7 -86.5
CIRA CloudSat DPC 2018 Oct 9 (282) 18:18:08 UTC | 1A-AUX | Granule 66309
18
Time 19:15:20 19:12:10 | Lat 28.6 17.1 | Lon

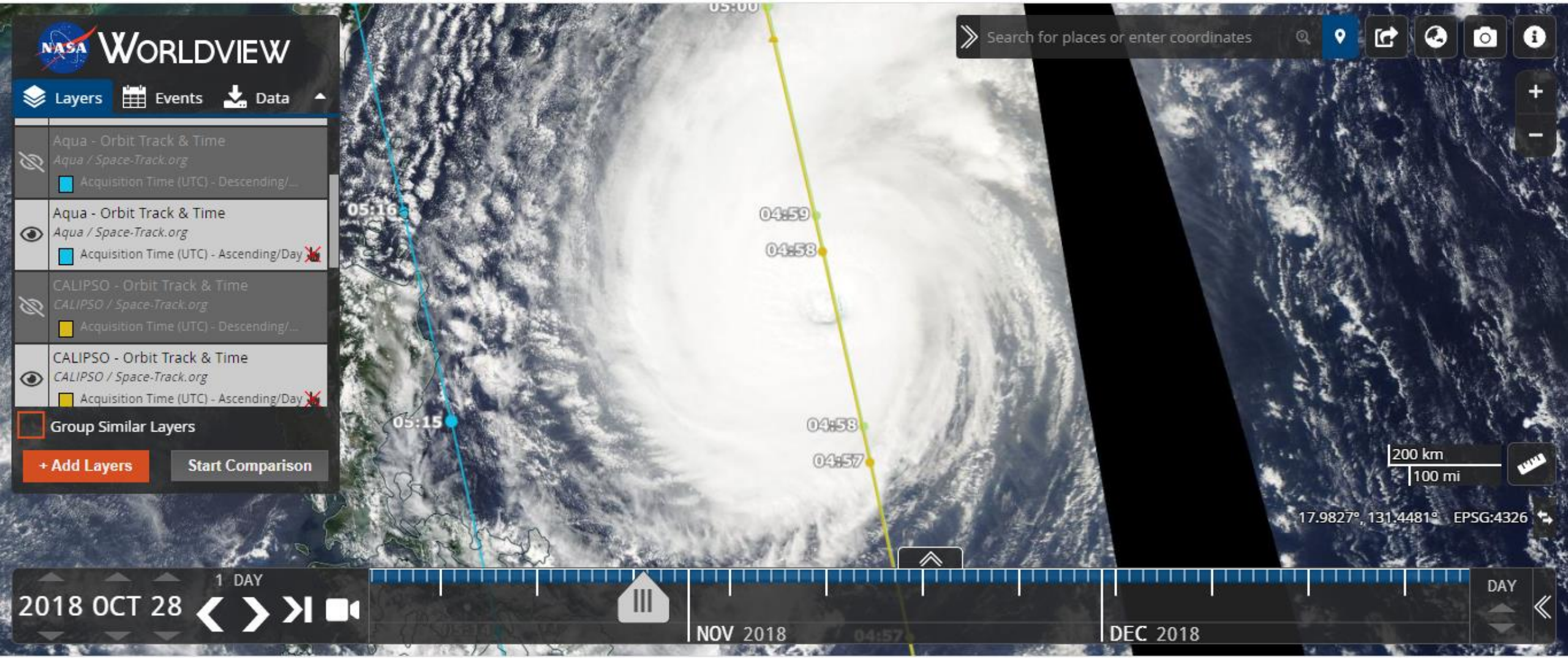
CloudSat

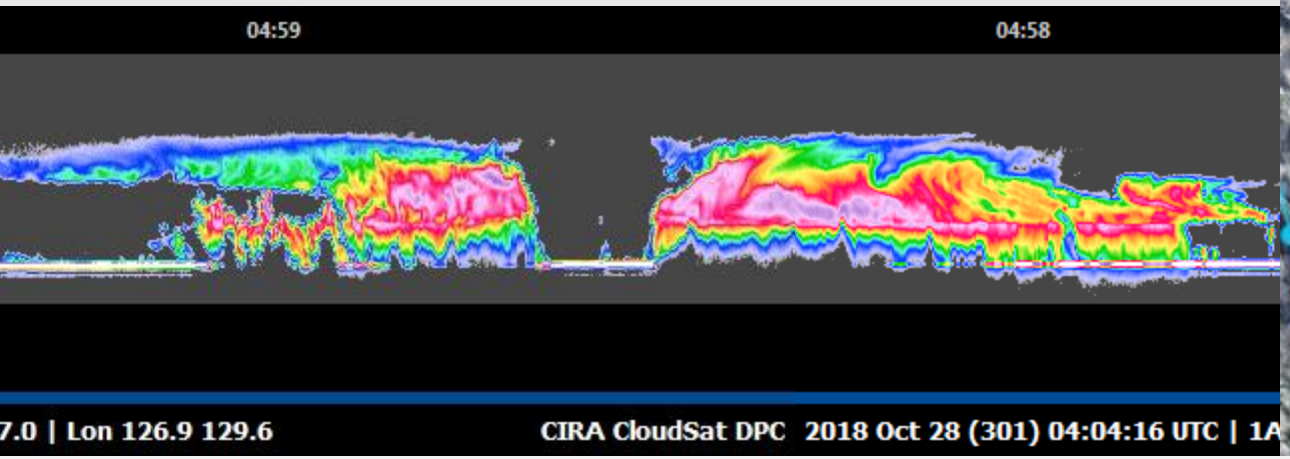
439 Tweets

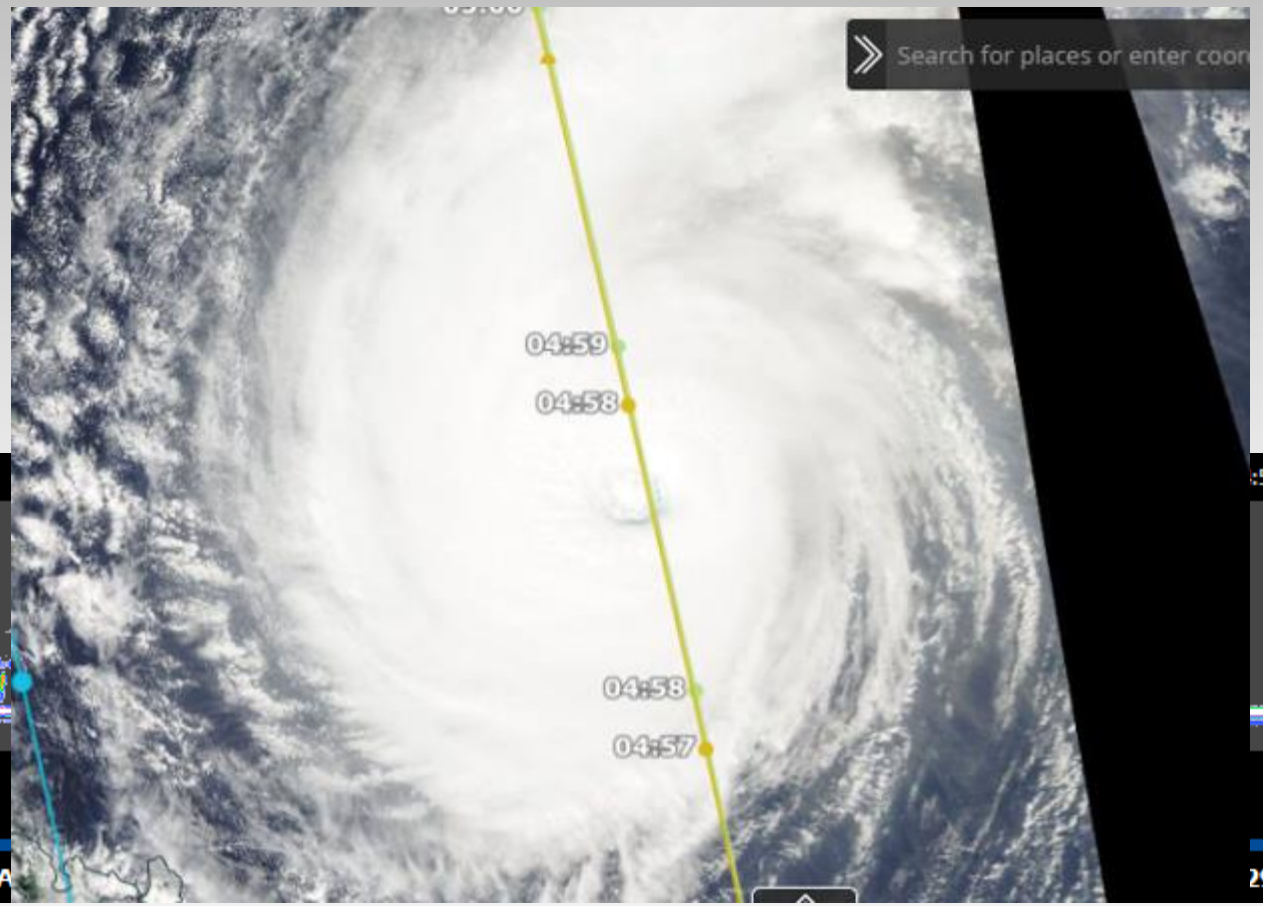
Follow

CloudSat and CALIPSO overpass directly through the eye of Typhoon Yutu on October 28th, 2018!
cloudsat.atmos.colostate.edu/news/Typhoon_Y...




NASA WORLDVIEW
Layers
Events
Data
Aqua - Orbit Track & Time
Aqua / Space-Track.org
Acquisition Time (UTC) - Descending/...
Aqua - Orbit Track & Time
Aqua / Space-Track.org
Acquisition Time (UTC) - Ascending/Day
CALIPSO - Orbit Track & Time
CALIPSO / Space-Track.org
Acquisition Time (UTC) - Descending/...
CALIPSO - Orbit Track & Time
CALIPSO / Space-Track.org
Acquisition Time (UTC) - Ascending/Day
Group Similar Layers
+ Add Layers
Start Comparison
Search for places or enter coordinates
05:16
04:59
04:58
05:15
04:58
04:57
200 km
100 mi
17.9827°, 131.4481° EPSG:4326
1 DAY
2018 OCT 28
NOV 2018
DEC 2018
DAY


04:59
04:58
7.0 | Lon 126.9 129.6
CIRA CloudSat DPC 2018 Oct 28 (301) 04:04:16 UTC | 1A


Search for places or enter coor
04:59
04:58
04:58
04:57

Microwave Bands and Their Satellite Weather Applications

Band	Frequency range	Wavelength range
L	1 - 2 GHz	15 - 30 cm
S	2 - 4 GHz	7.5 - 15 cm
C	4 - 8 GHz	3.75 - 7.5 cm
X	8 - 12 GHz	25 - 37.5 mm
Ku	12 - 18 GHz	16.7 - 25 mm
K	18 - 26.5 GHz	11.3 - 16.7 mm
Ka	26.5 - 40 GHz	5.0 - 11.3 mm
Q	33 - 50 GHz	6.0 - 9.0 mm
U	40 - 60 GHz	5.0 - 7.5 mm
V	50 - 75 GHz	4.0 - 6.0 mm
W	75 - 110 GHz	2.7 - 4.0 mm
F	90 - 140 GHz	2.1 - 3.3 mm
D	110 - 170 GHz	1.8 - 2.7 mm

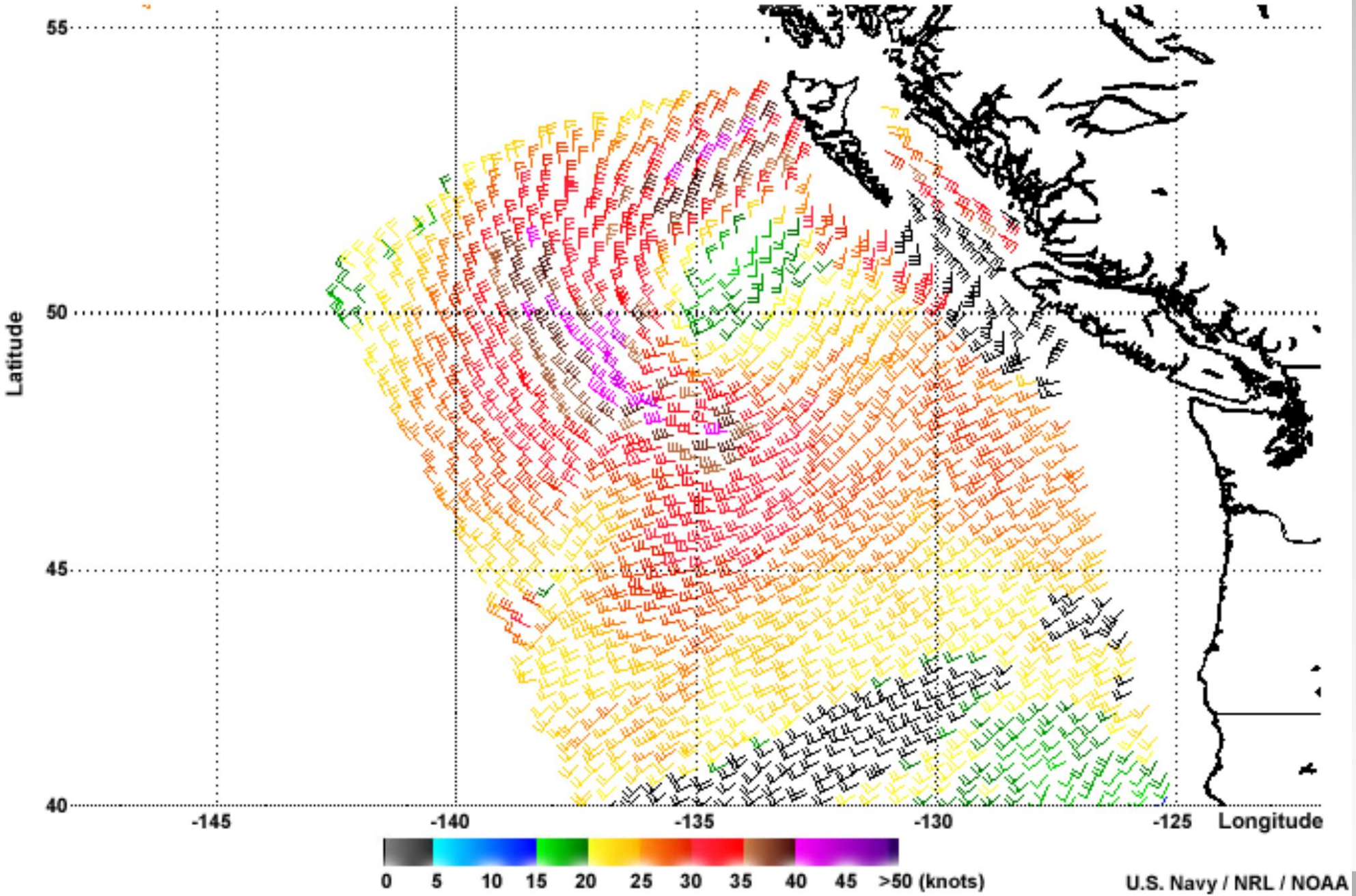
Satellite Instruments

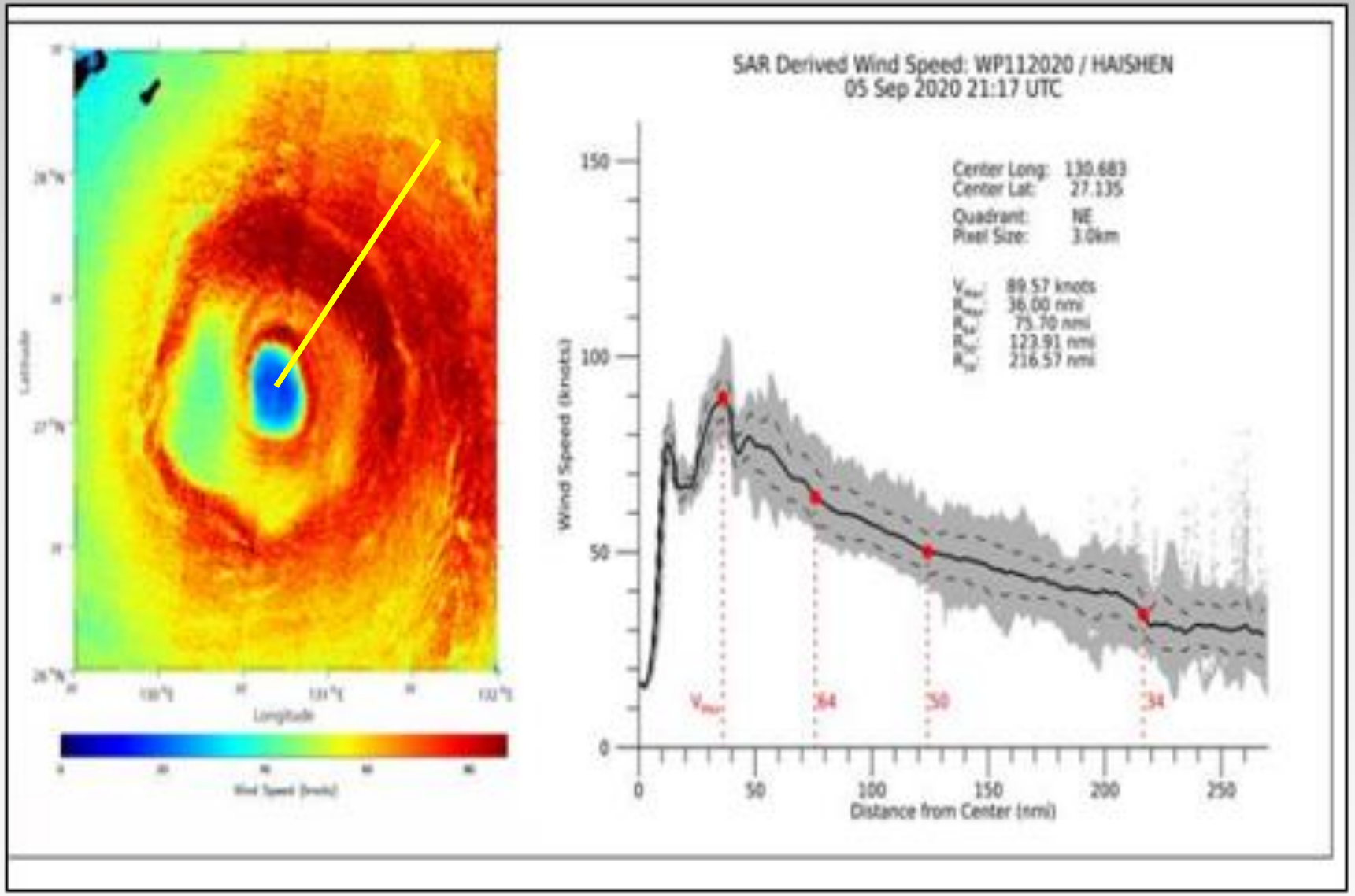
-WindSat
-ASCAT
-Jason
-CloudSat
-TRMM and GPM
-AMSU
-AMSR
-SSMIS
-Sentenal
-ATMS
CryoSat
QuikSCAT
MetOp
-
-
-

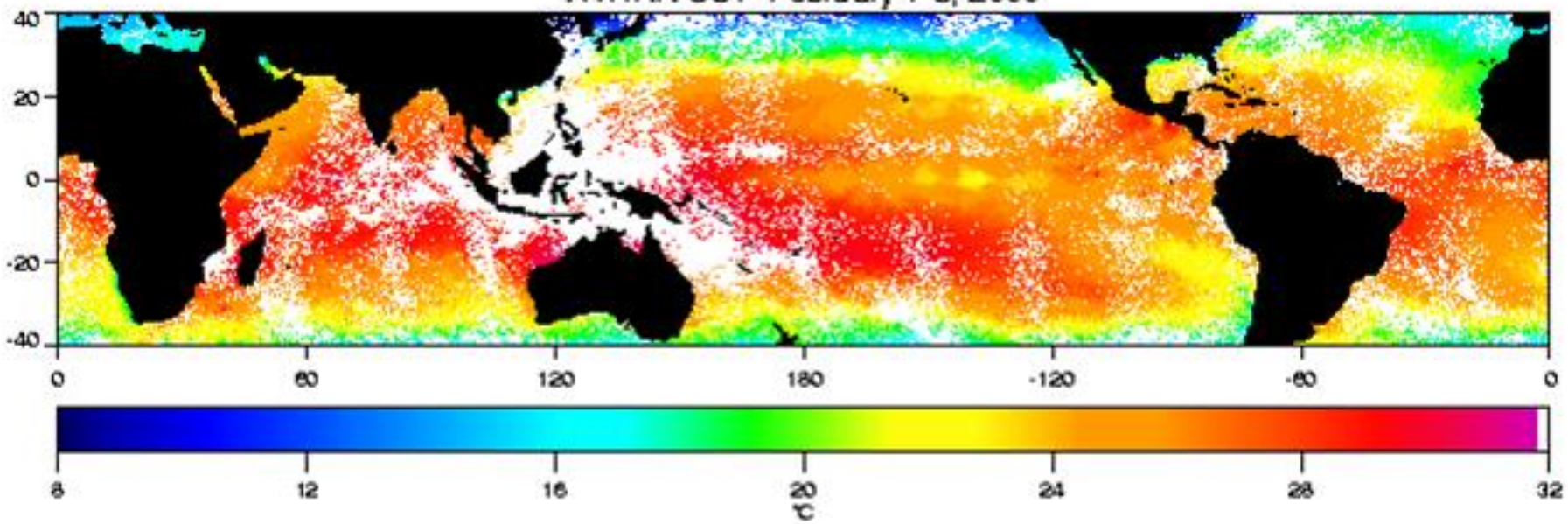
Measurement Capabilities:

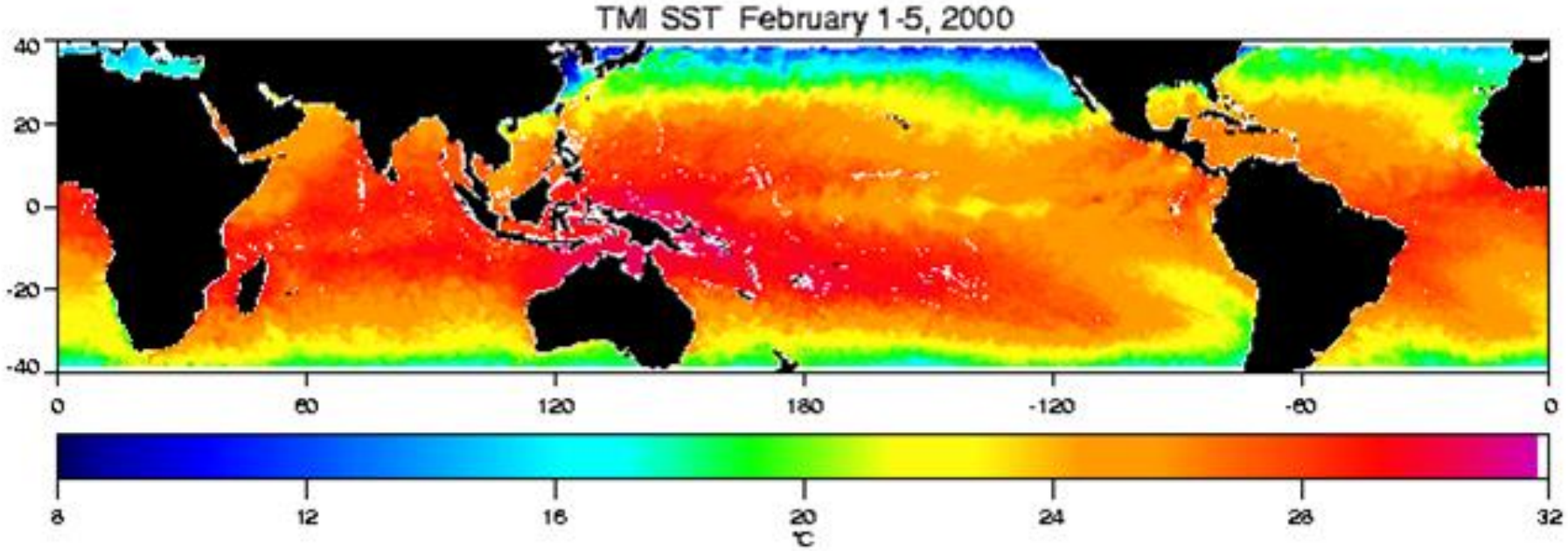
-Cloud and Precipitation information
-Sea Surface Wind
-Atmospheric Sounding
-Snow and Sea Ice
-Soil moisture
- Sea Surface Temperature
-Sea surface height and Sea state
-Land and Oceanic topography and Geology
-Vegetation
-Land use
-
-
-
-
-

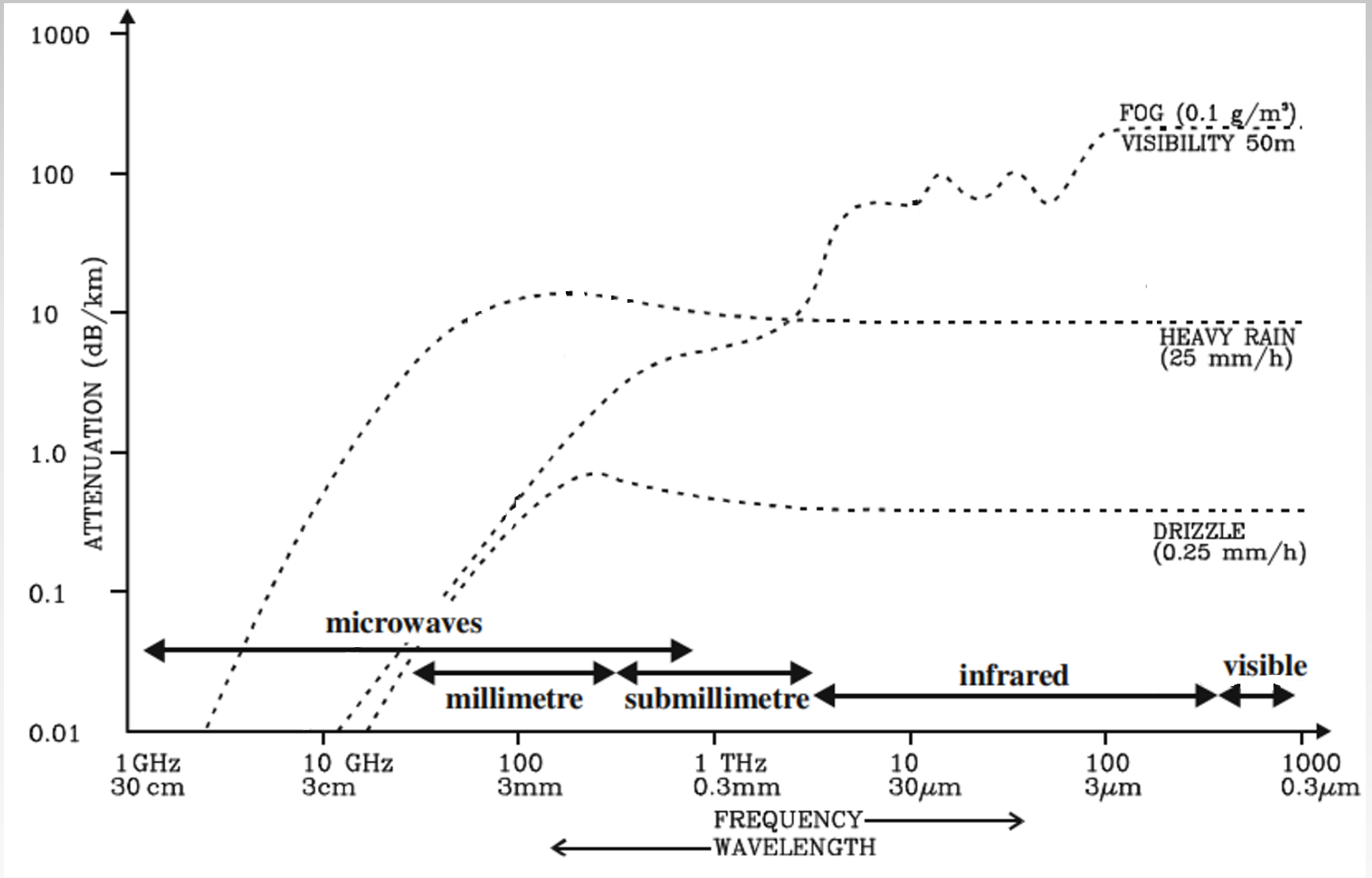
WindSat Ocean Surface Wind Vector, Pacific Northwest
0212 UTC 30 Dec 2011



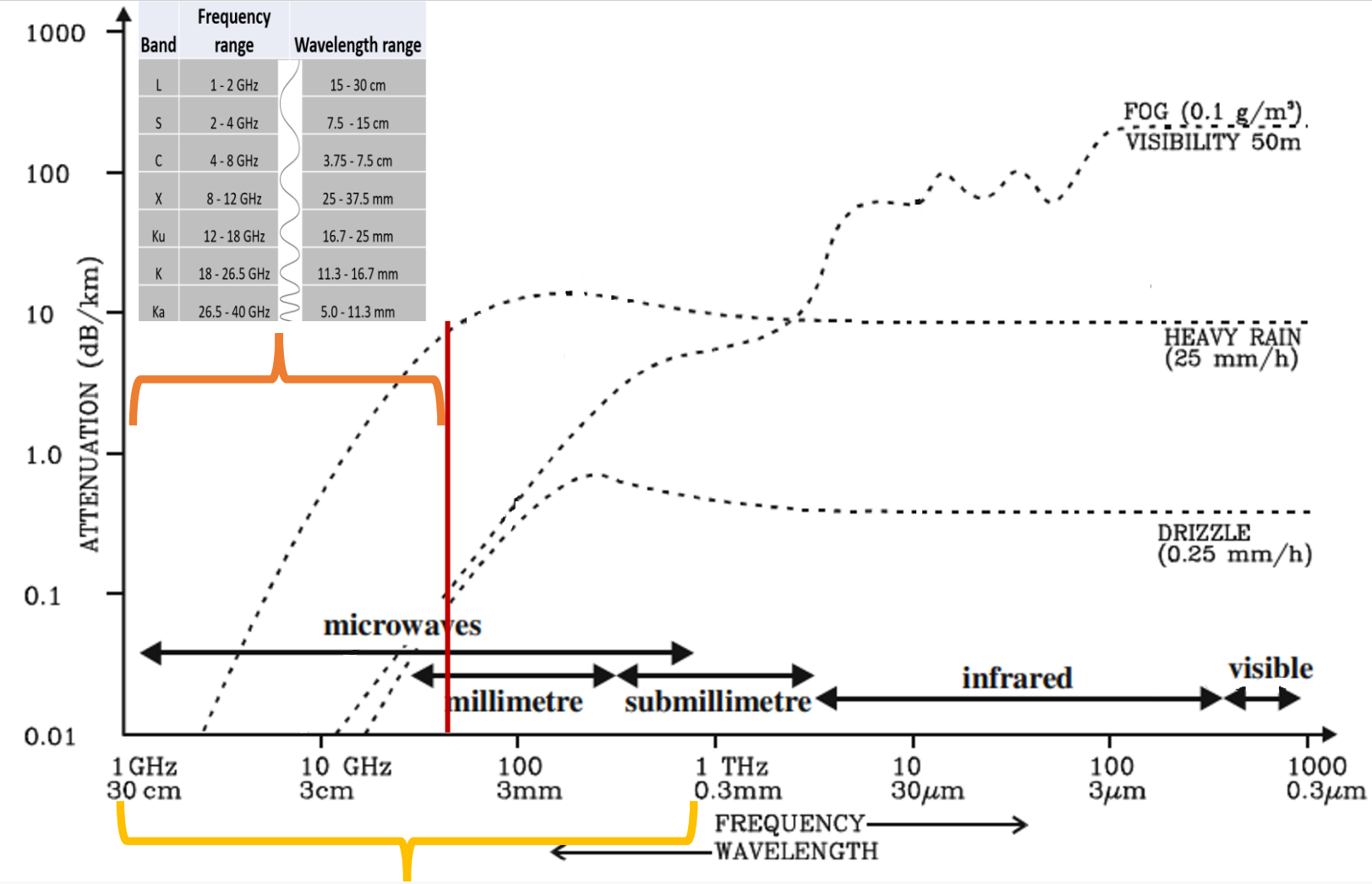

SAR Derived Wind Speed: WP112020 / HAISHEN
05 Sep 2020 21:17 UTC
Center Long: 130.683
Center Lat: 27.135
Quadrant: NE
Pixel Size: 3.0km
89.57 knots
36.00 nmi
75.70 nmi
122.91 nmi
216.57 nmi
Wind Speed (knots)
Distance from Center (nmi)
Longitude
Latitude


AVHRR SST February 1-5, 2000
40
20
0
-20
-40
0
60
120
180
-120
-60
0
8
12
16
20
24
28
32
°C

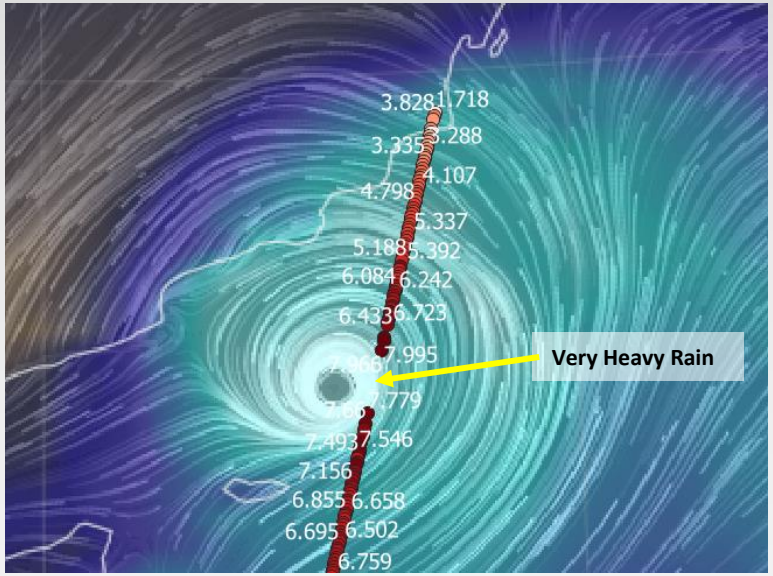

TMI SST February 1-5, 2000
40
20
0
-20
-40
0
60
120
180
-120
-60
0
8
12
16
20
24
28
32
°C


1000
100
10
1.0
0.1
0.01
ATTENUATION (dB/km)
FOG (0.1 g/m³)
VISIBILITY 50m
HEAVY RAIN
(25 mm/h)
DRIZZLE
(0.25 mm/h)
microwaves
millimetre
submillimetre
infrared
visible
1 GHz
30 cm
10 GHz
3cm
100
3mm
1 THz
0.3mm
10
30μm
100
3μm
1000
0.3μm
FREQUENCY
WAVELENGTH

Smaller wavelength higher attenuation but better resolution



Ka Band Altimetry



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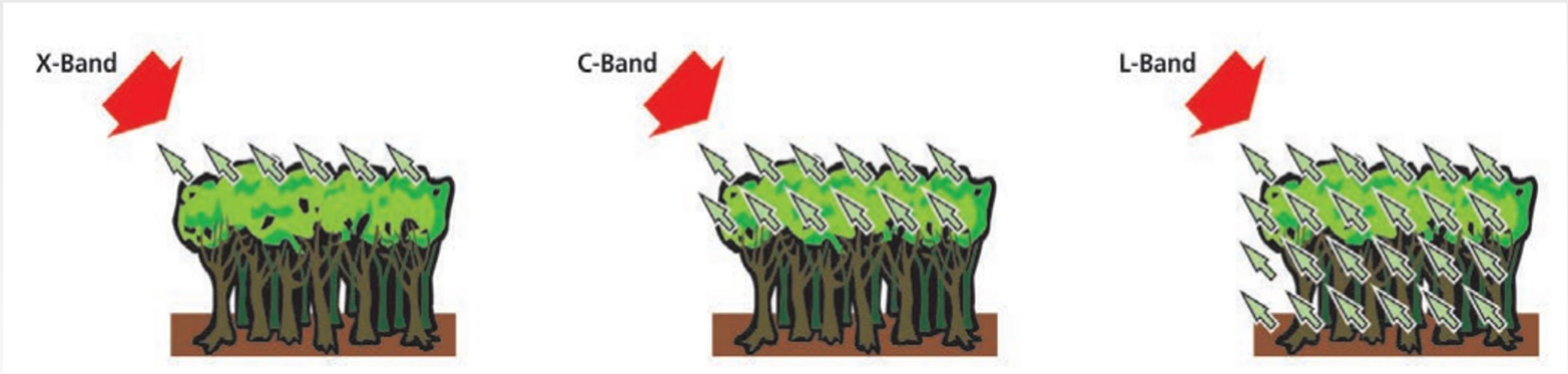
Ka	26.5 - 40 GHz	5.0 - 11.3 mm

Smaller wavelength higher attenuation but better resolution




Etna
Ionian Sea
Ground displacement rate
2015-2020 mean vertical velocity (mm/year)
subsidence
uplift
-80
0
30

Questions

Thank You