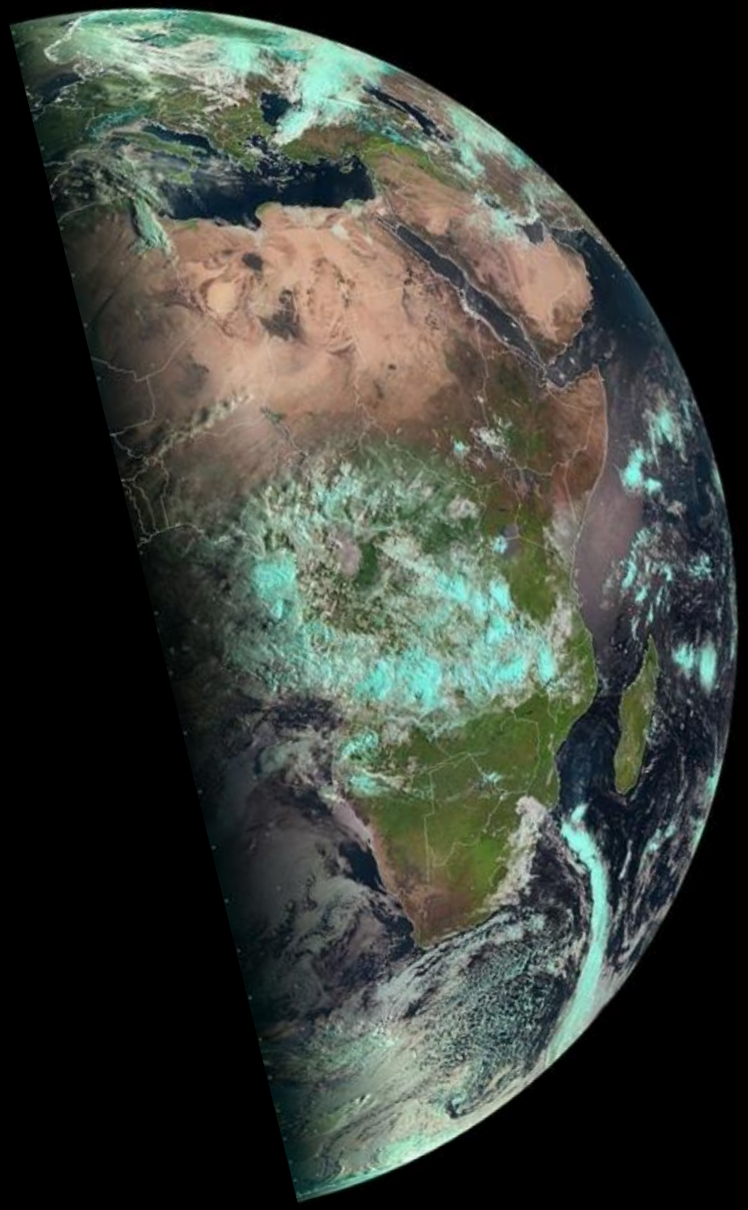
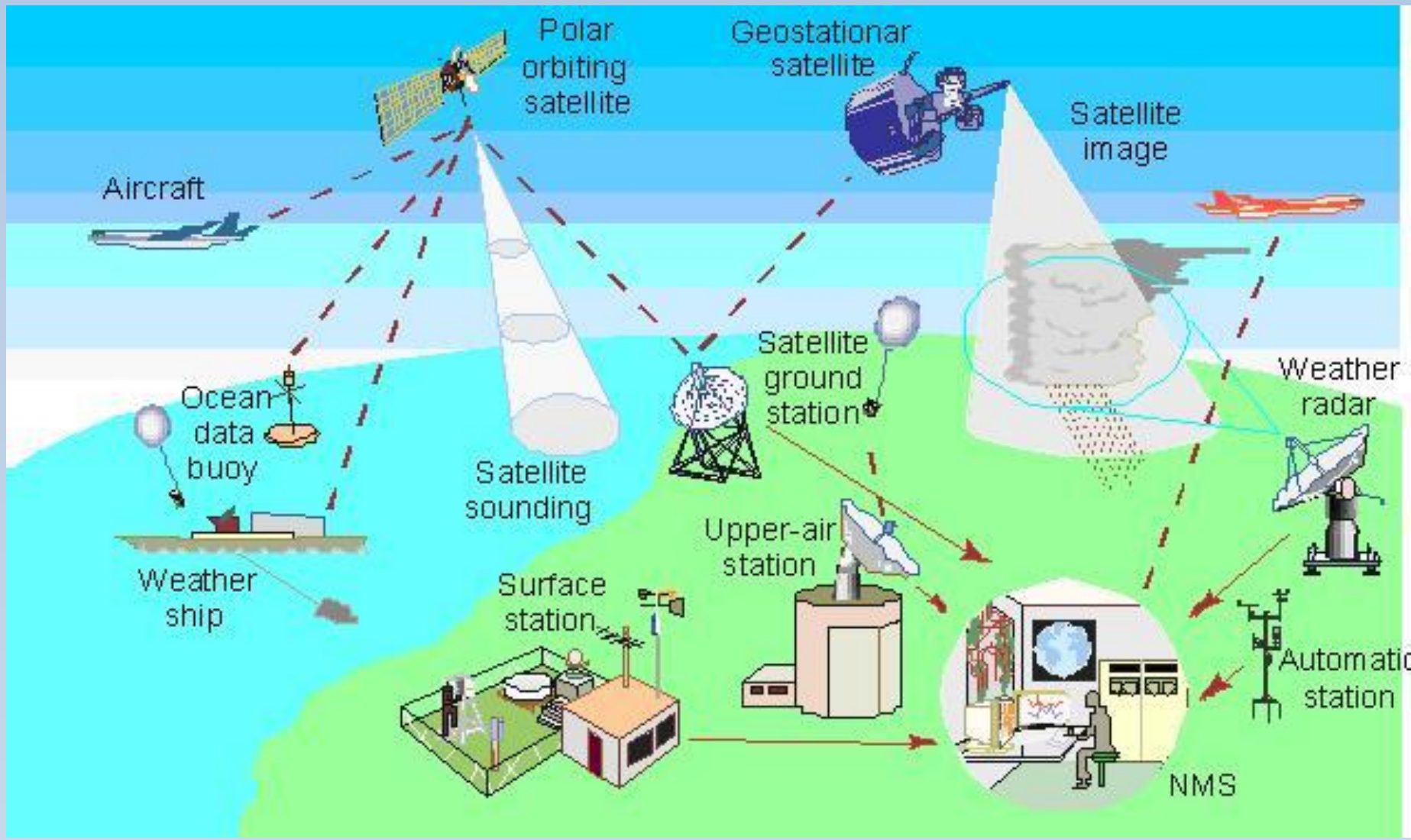


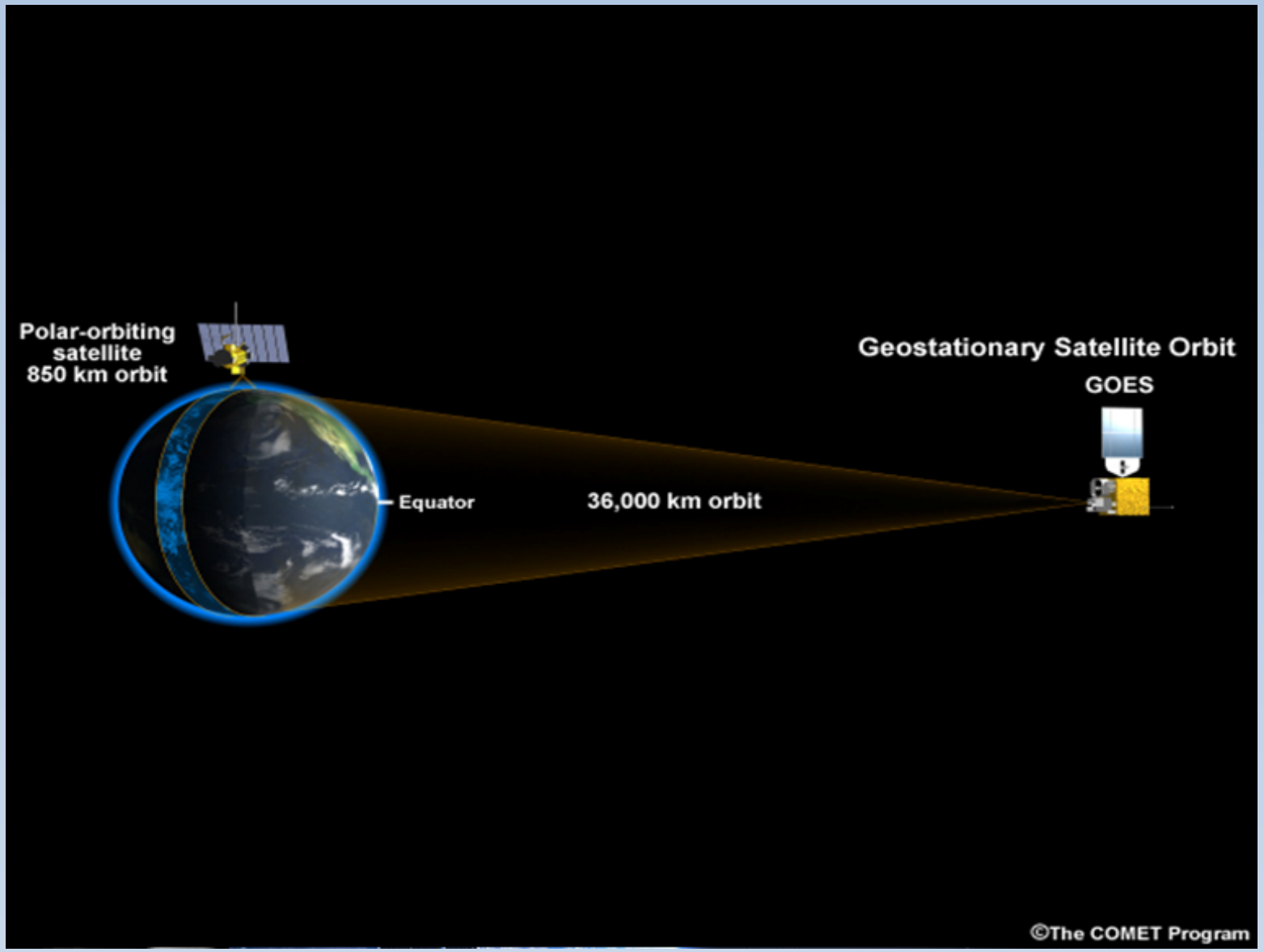
Applications of Weather Satellite

Ibrahim Al Abdulsalam
Meteorologist
i.alabdulsalam@met.gov.om

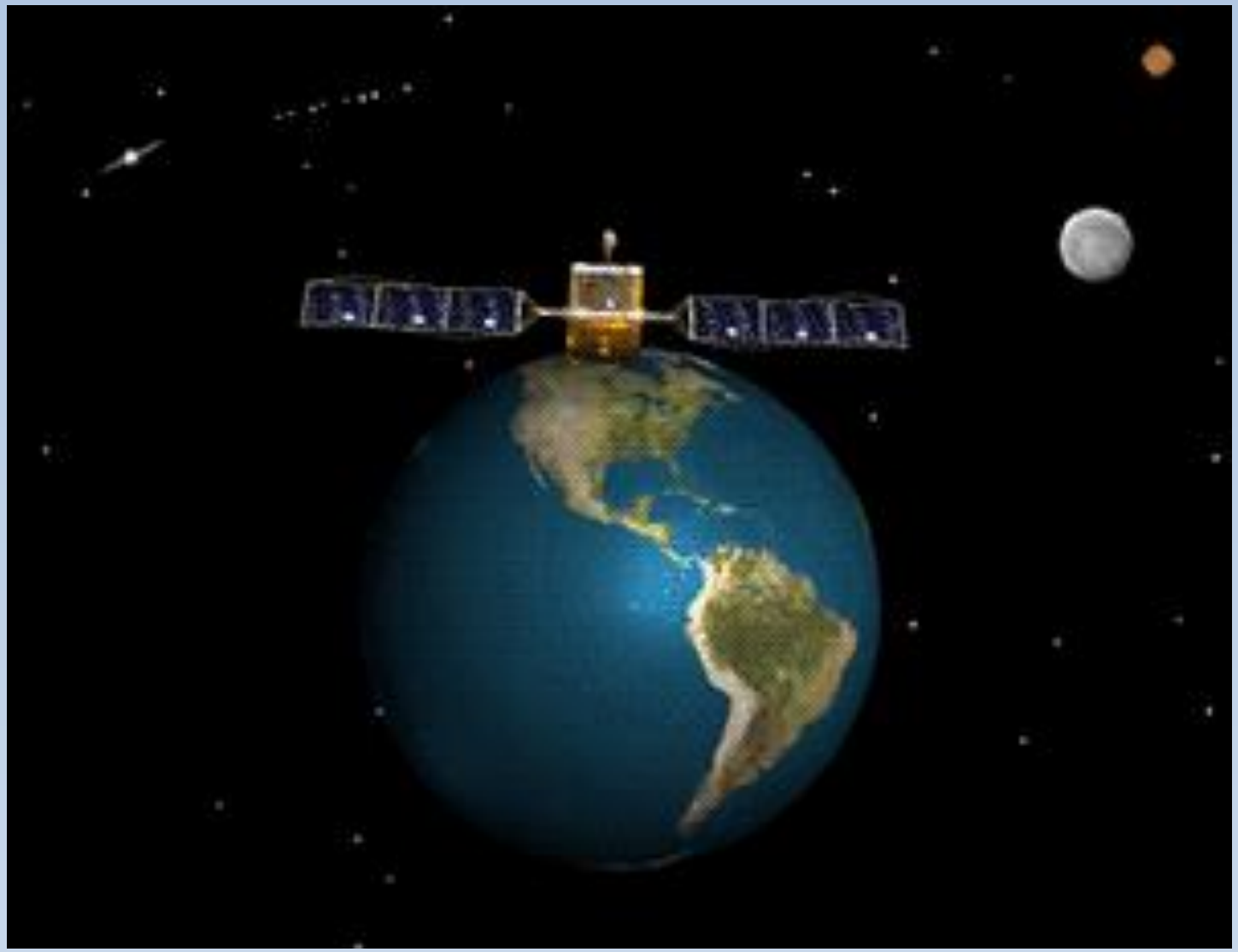
Weather Observation and Forecasting Systems



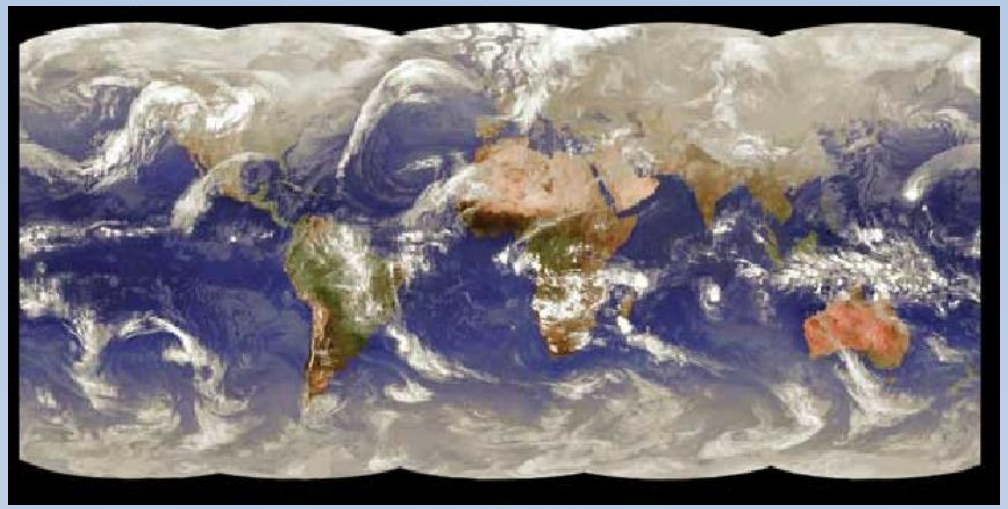
Type of Satellites

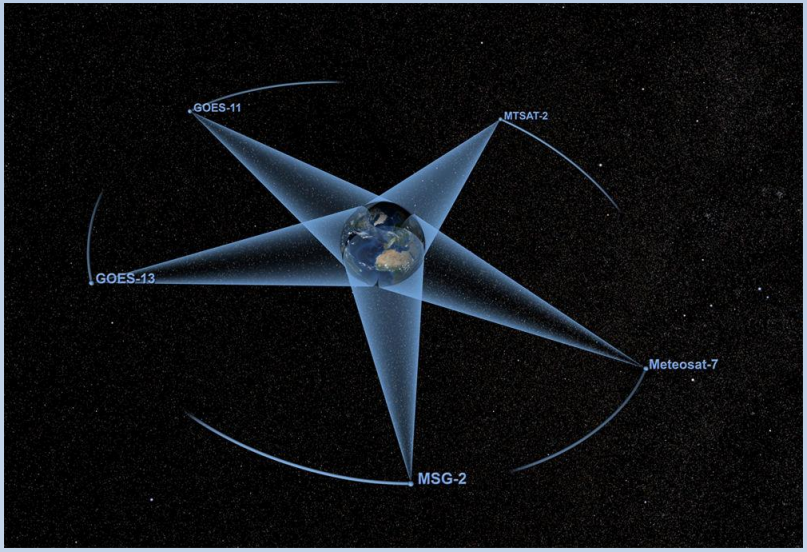


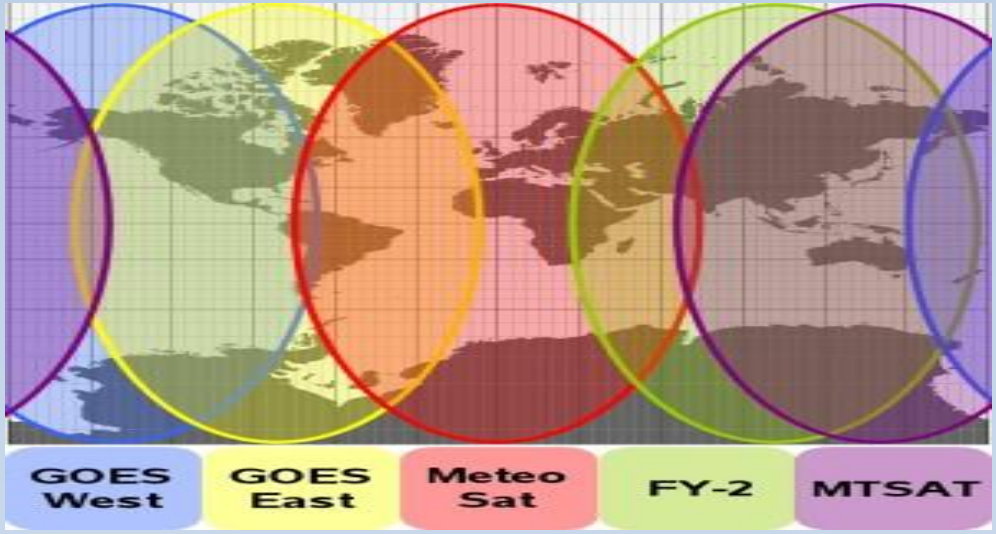
Geostationary

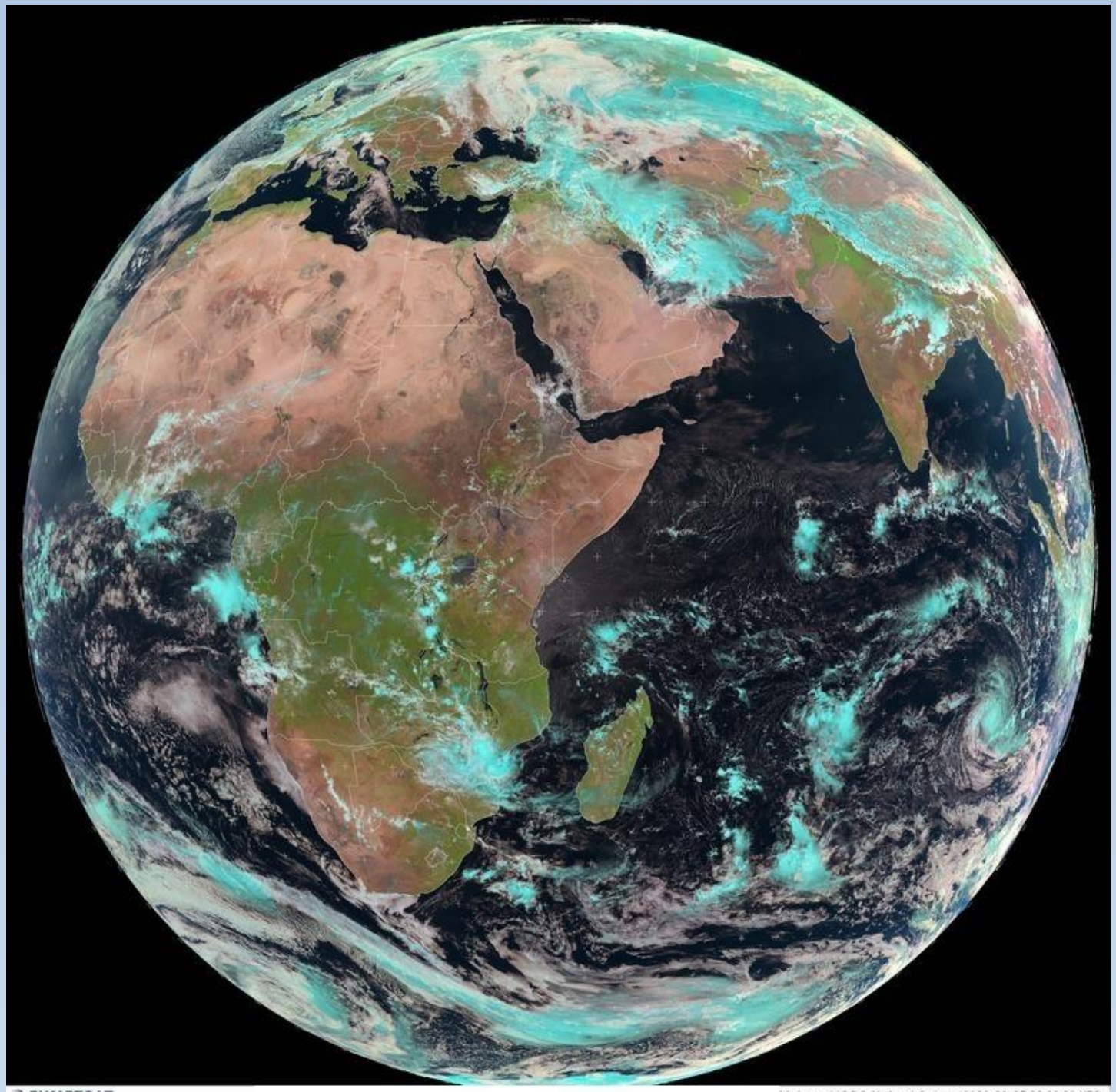


Geostationary Satellite

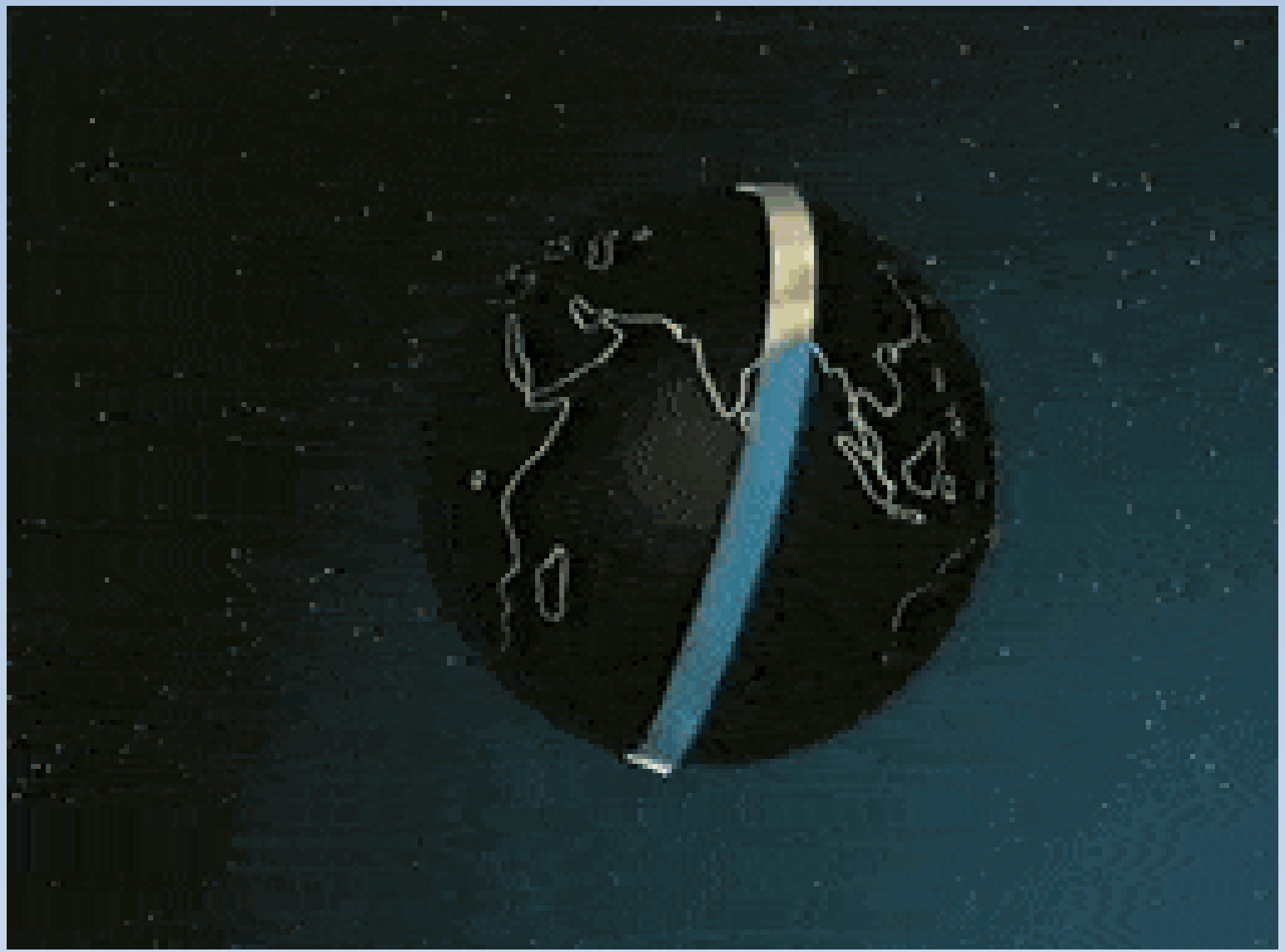






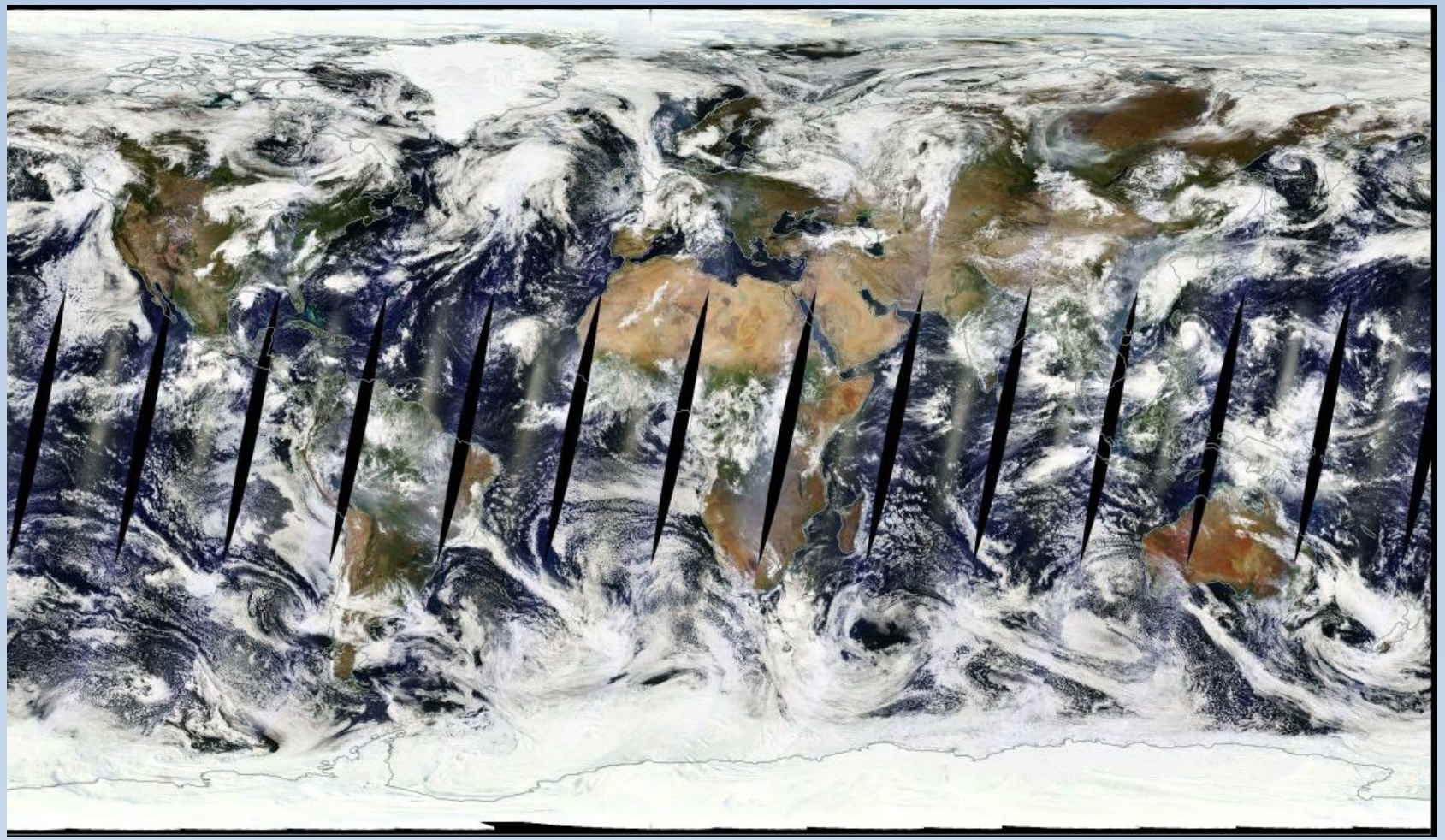


Polar Orbiting Satellite



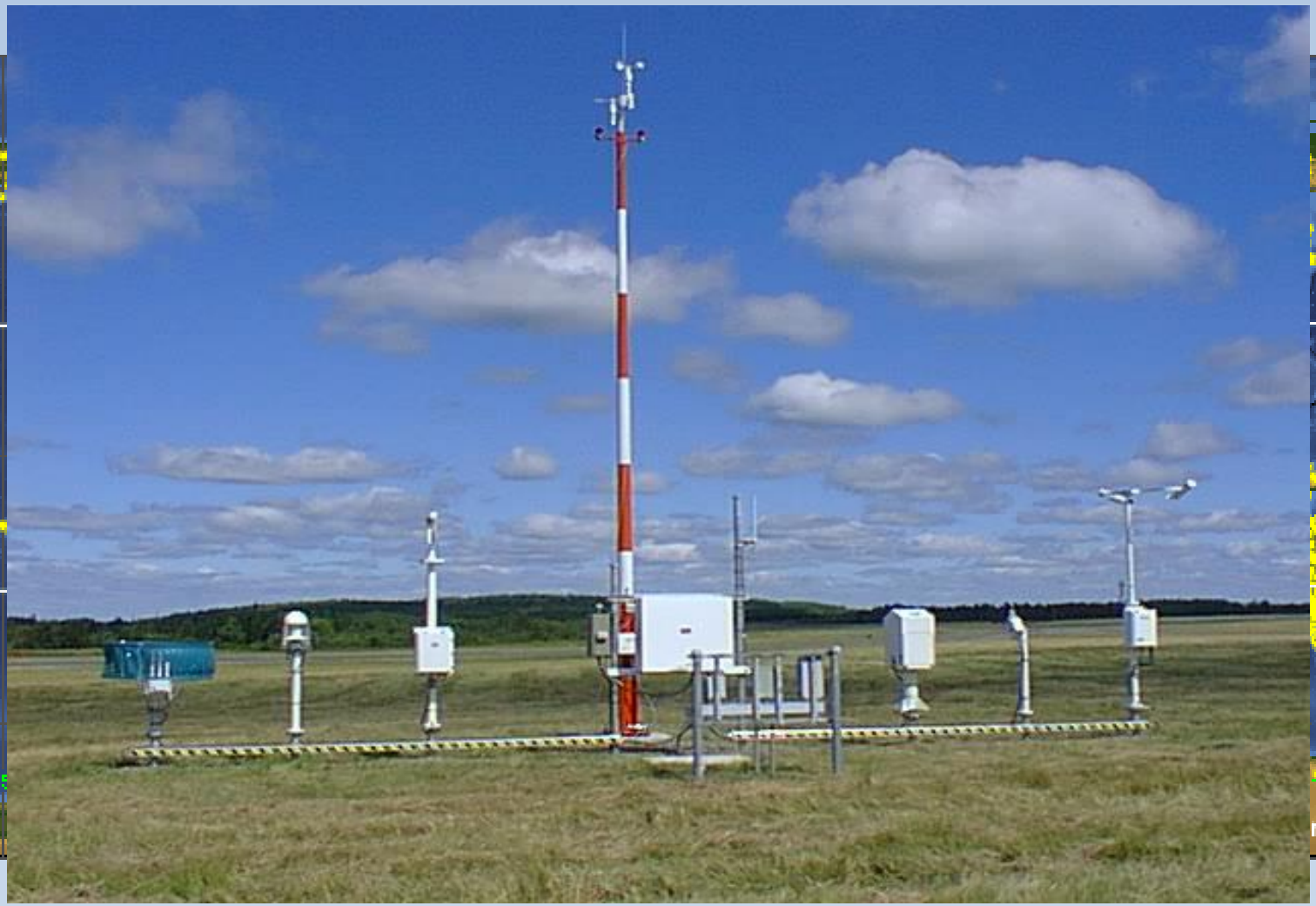
Satellite coverage

One Polar Orbiting Satellite

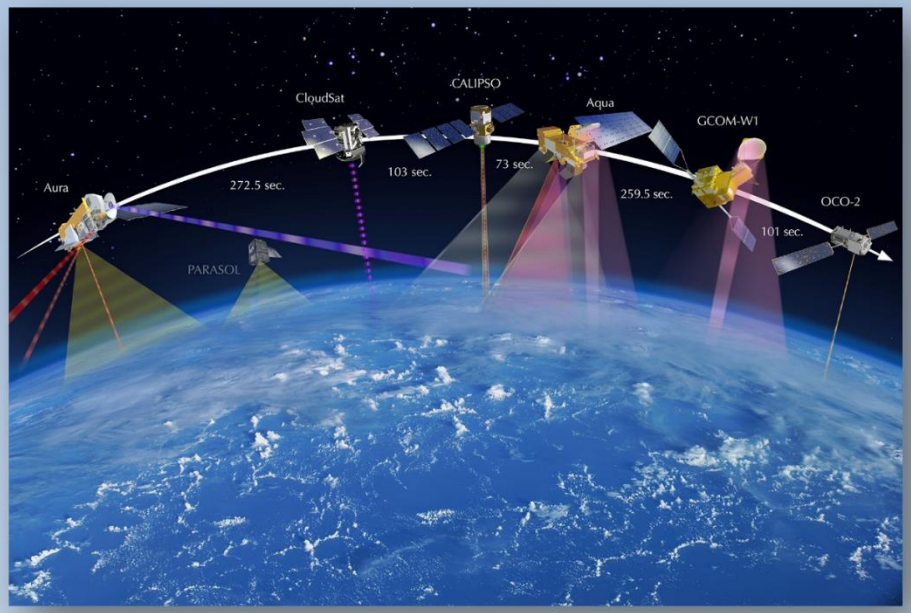


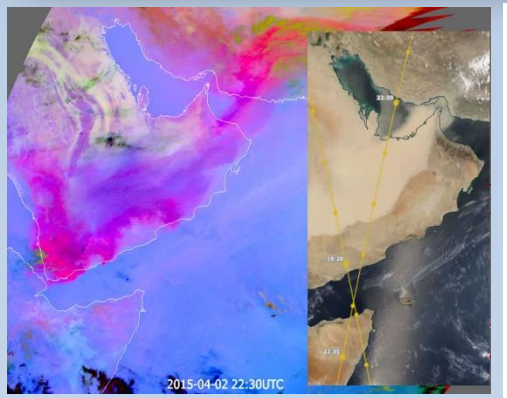
Applications of weather Satellite

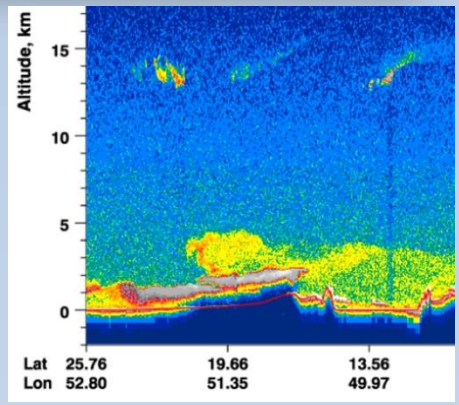
Ground Weather Station!

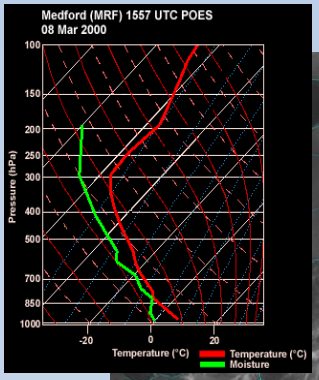


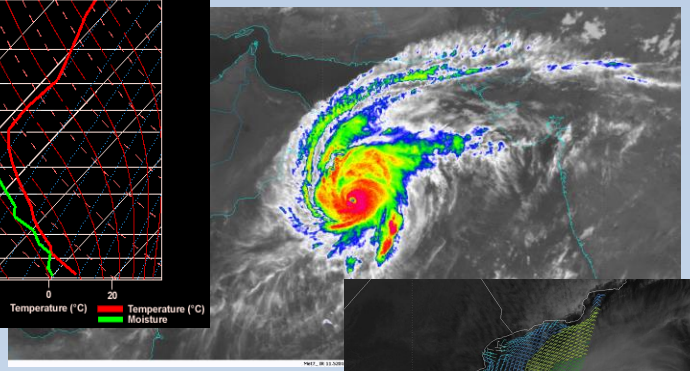
Weather Satellite Now!

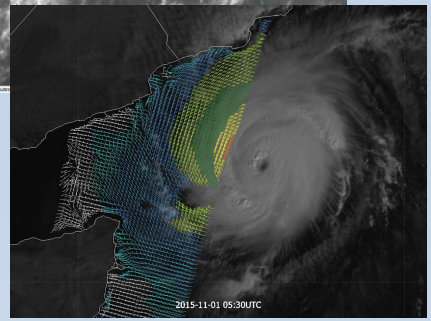


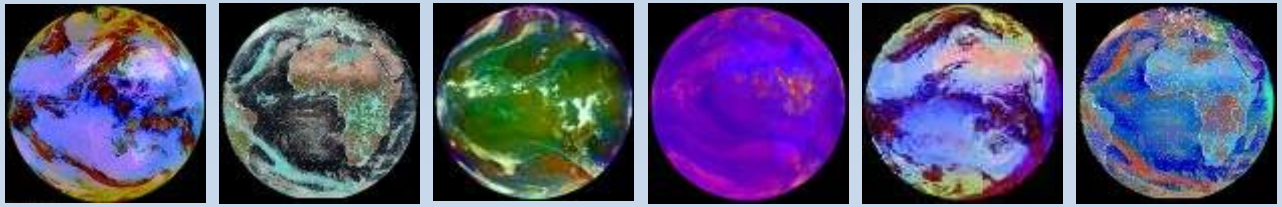


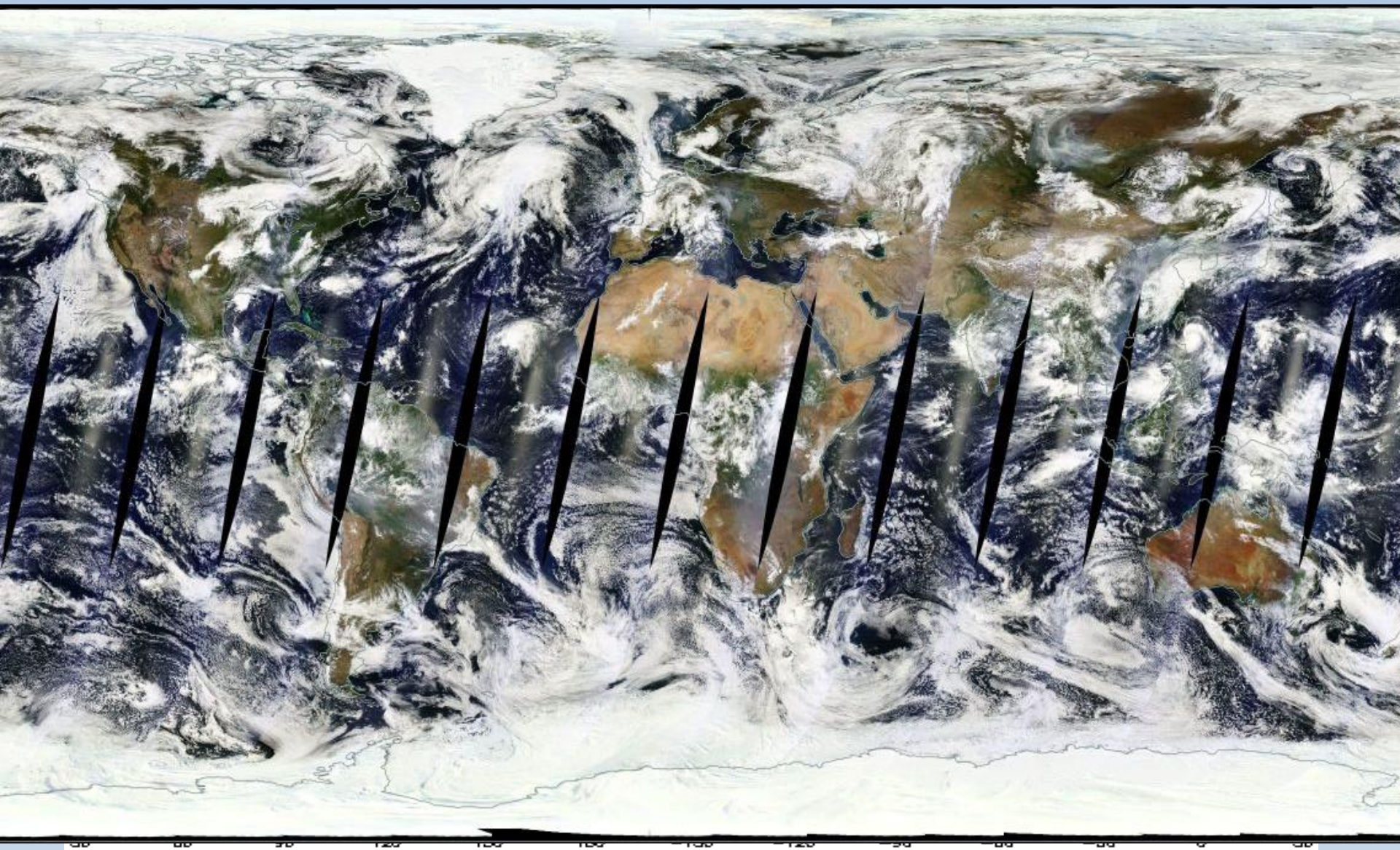




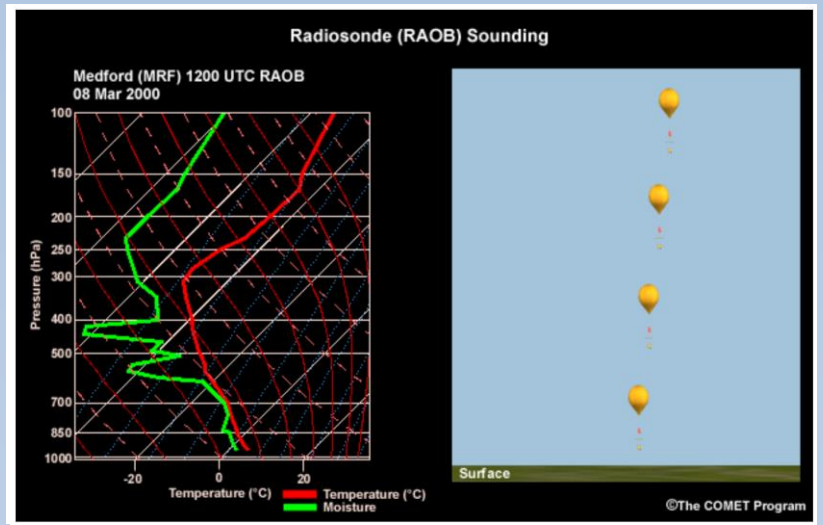


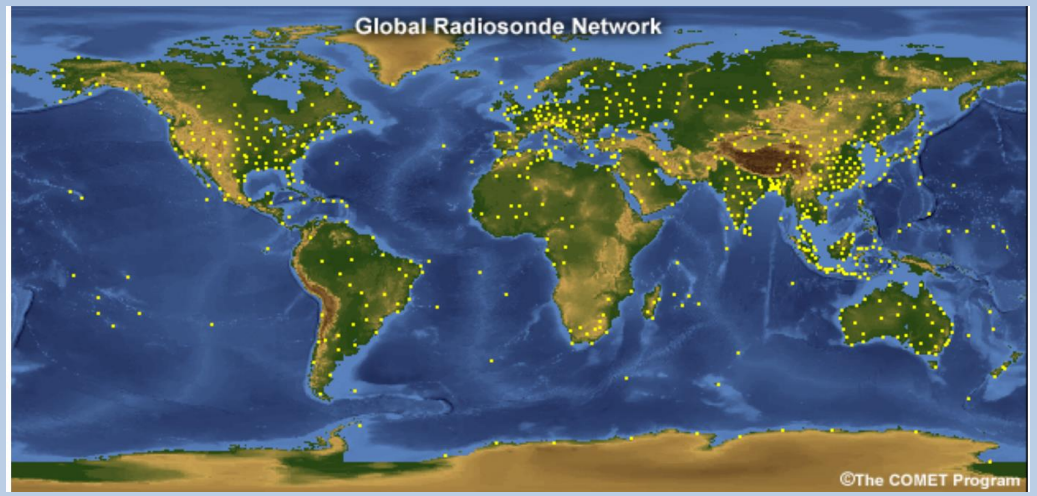


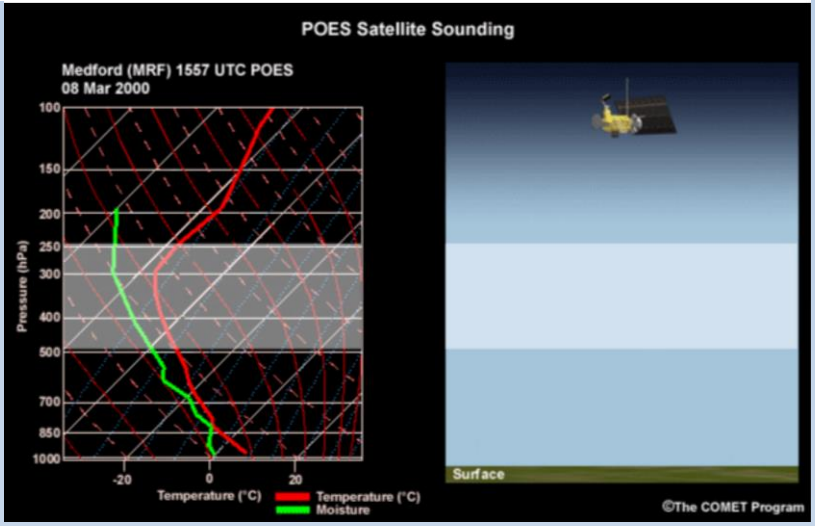


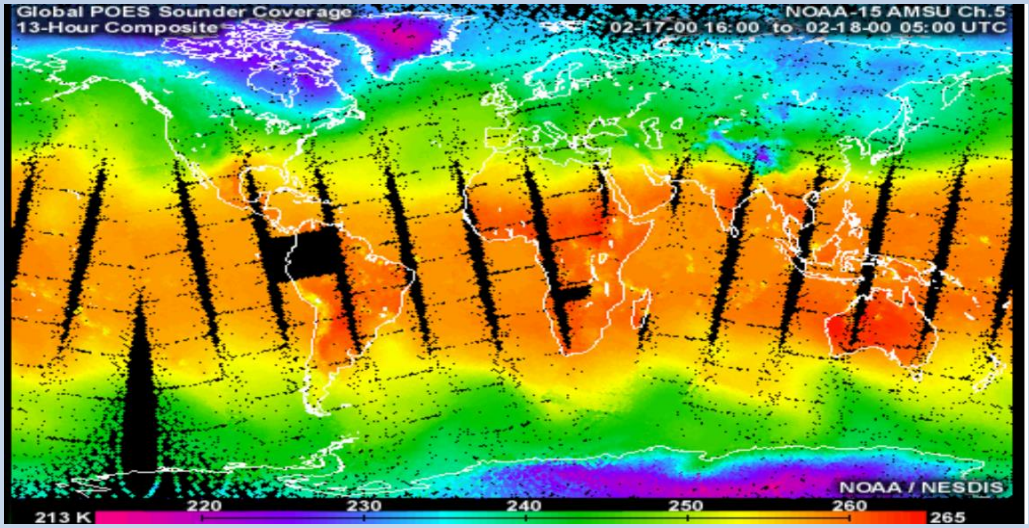


Satellite Sounding



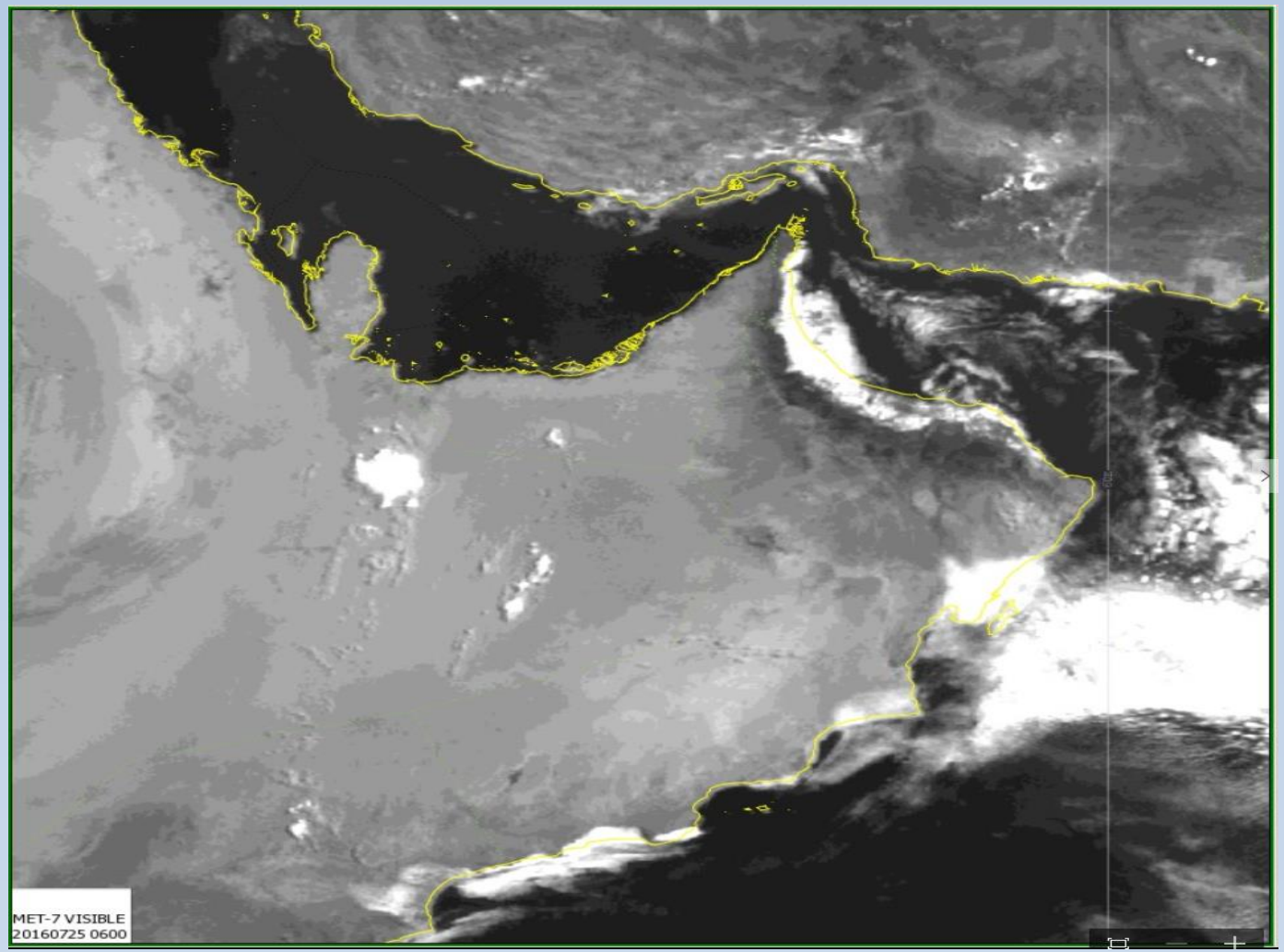






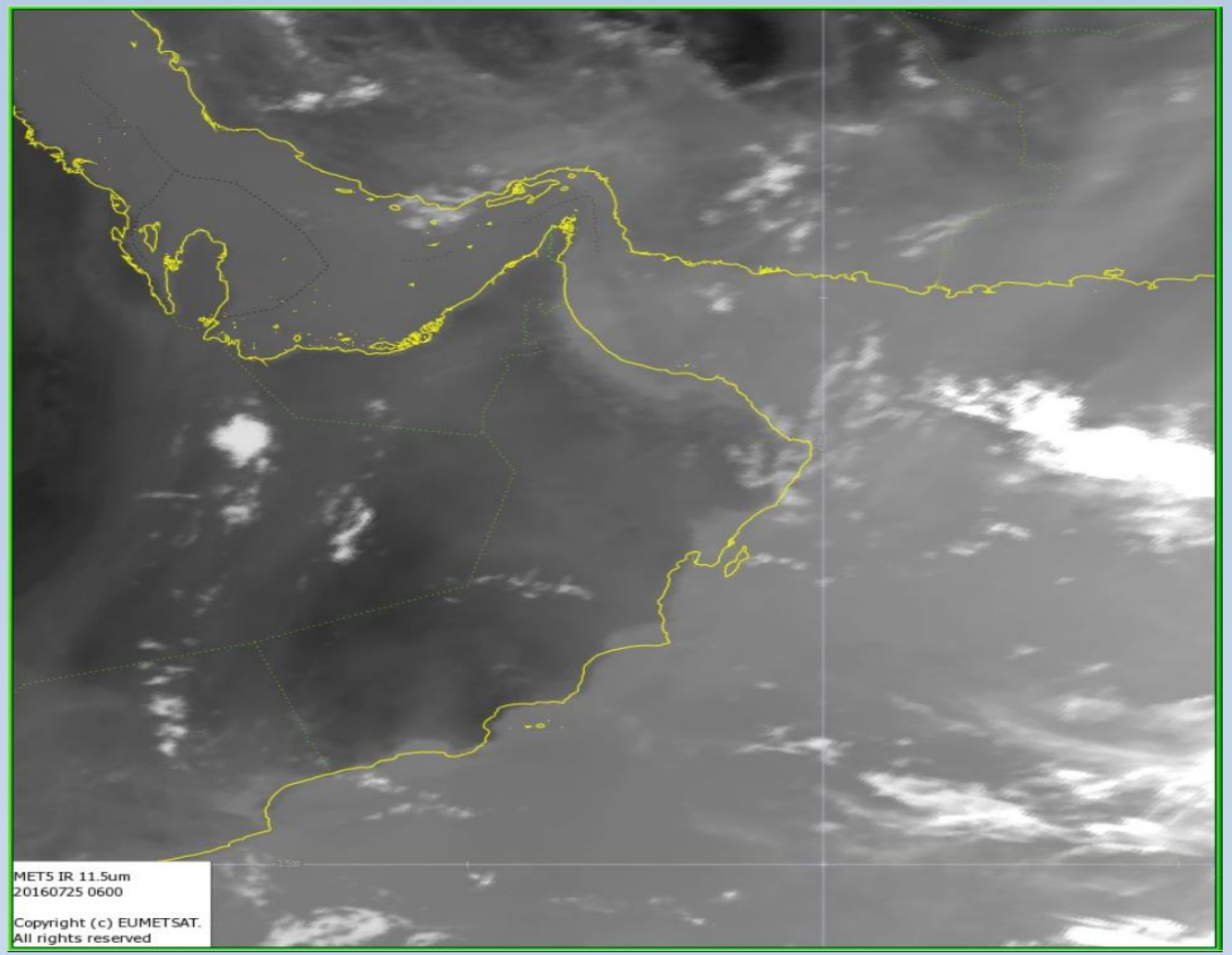
Satellite Channels

- Visible (VIS).



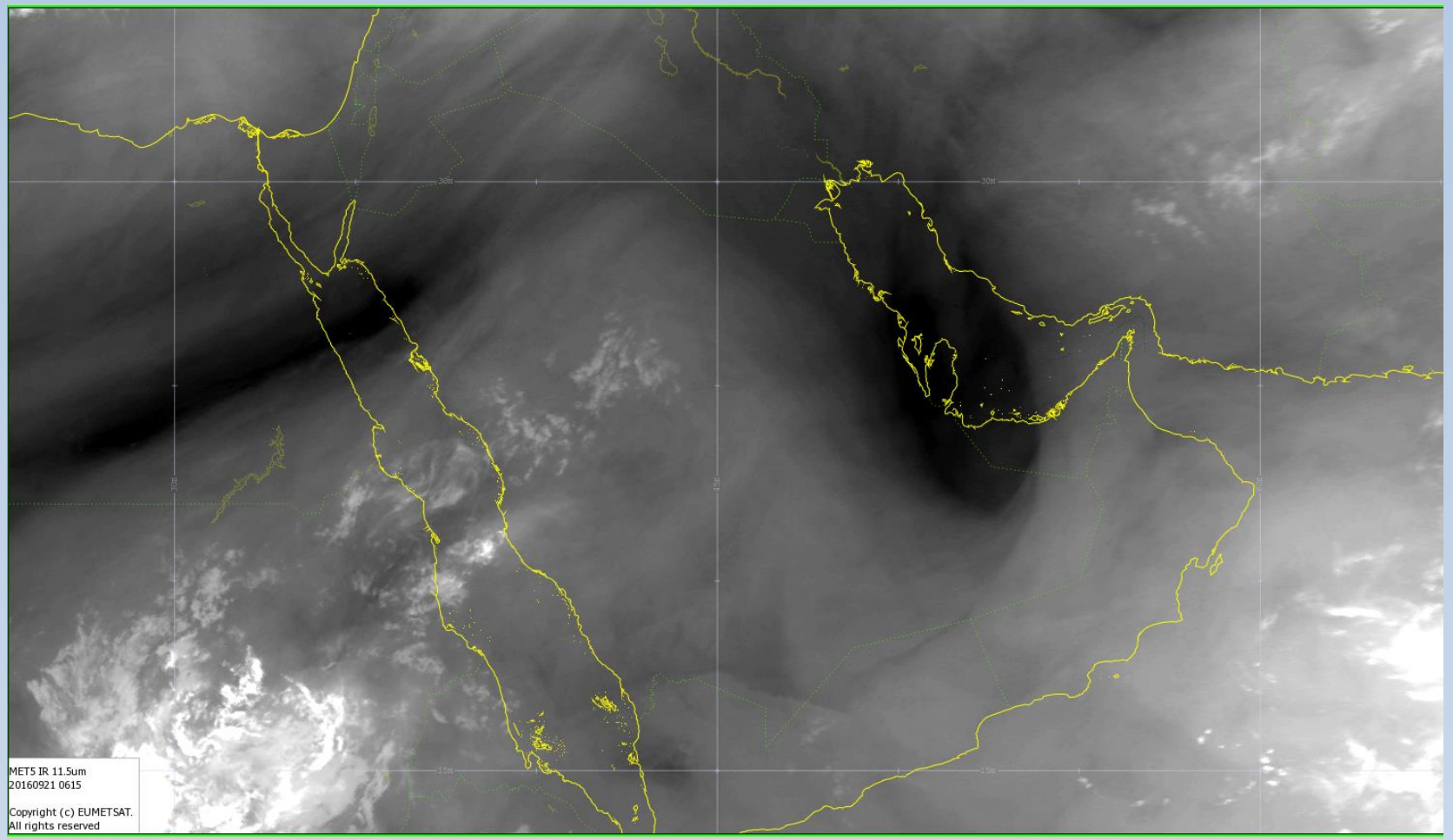
Satellite Channels

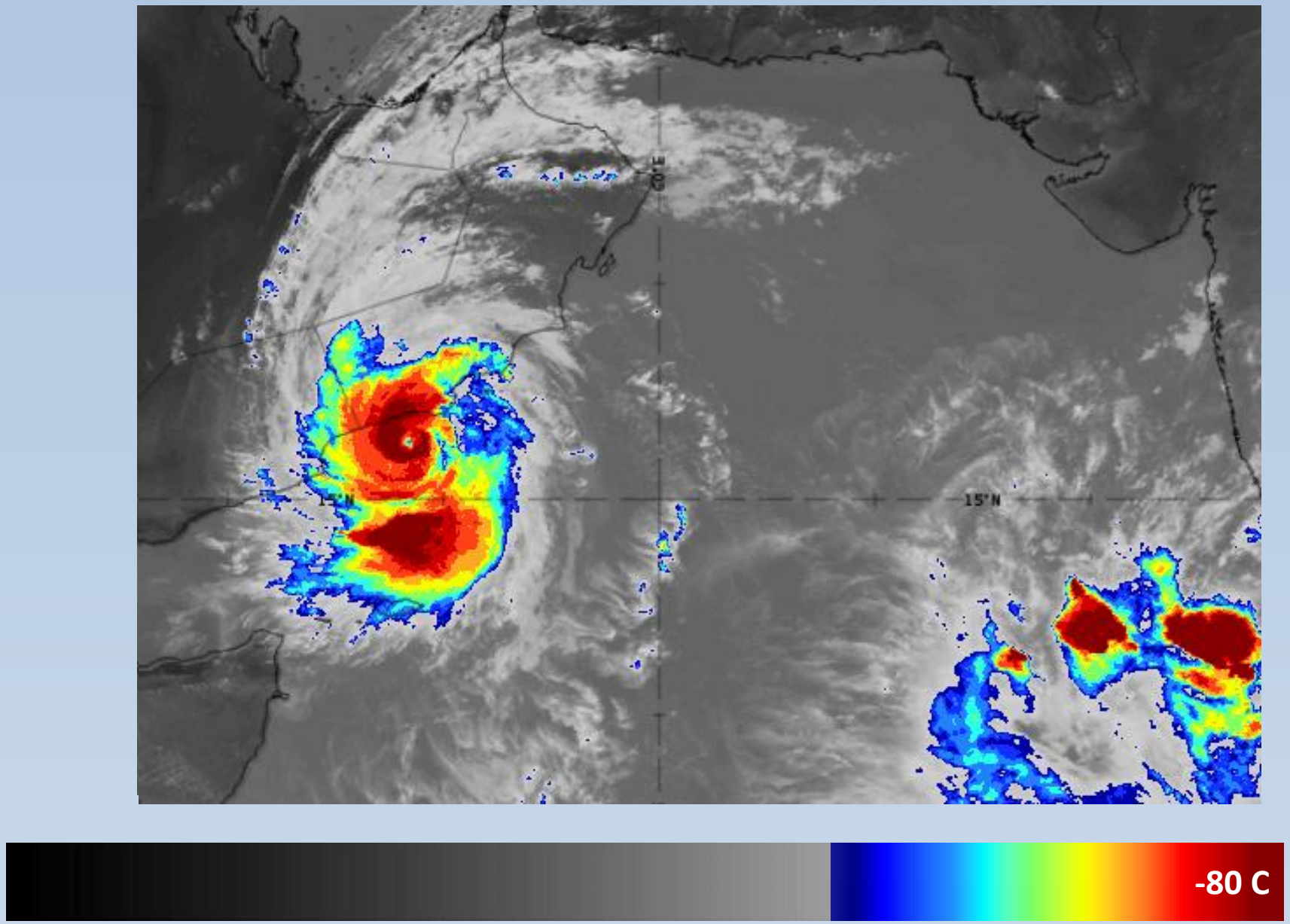
- Infrared (IR).



Satellite Channels

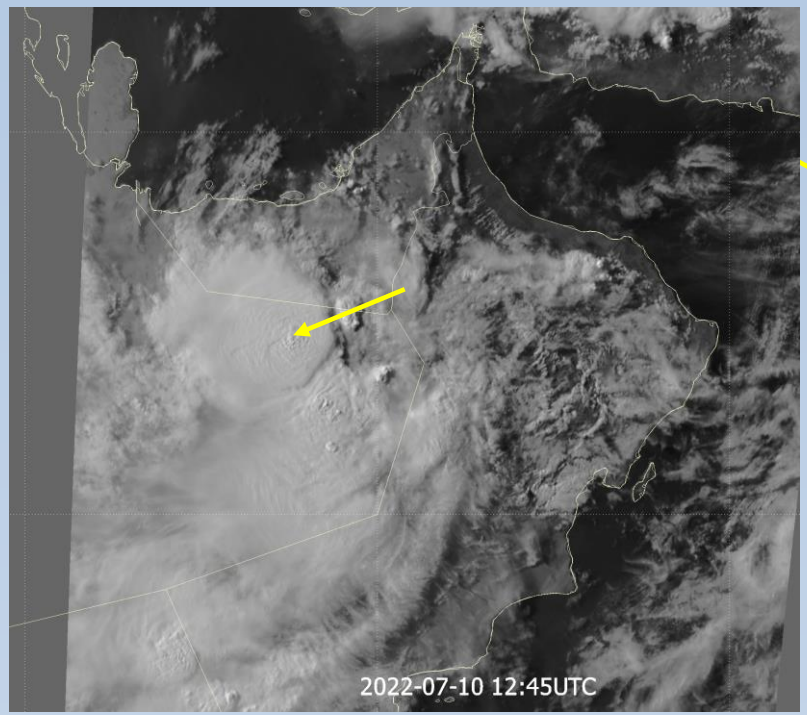
- Water vapour (WV).

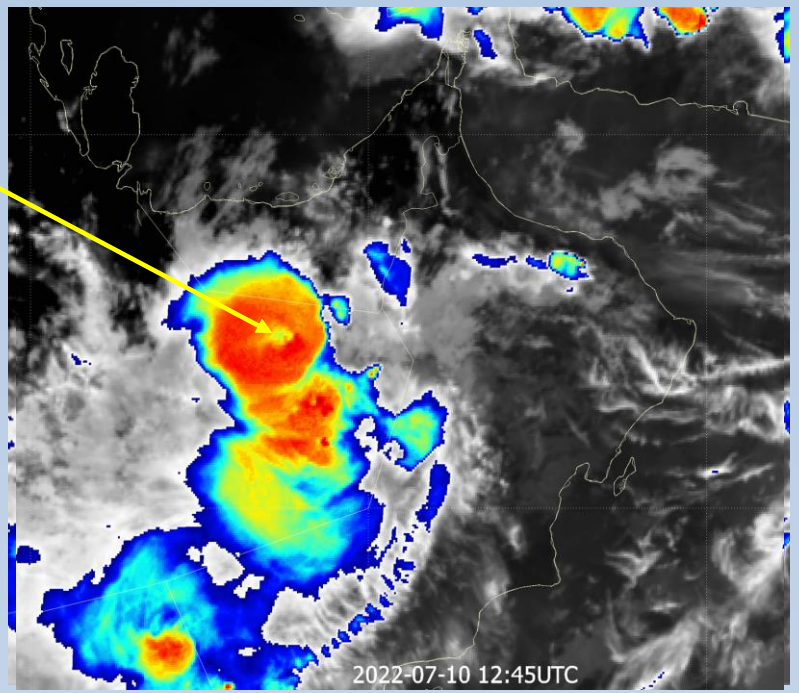



15°N
-80 C

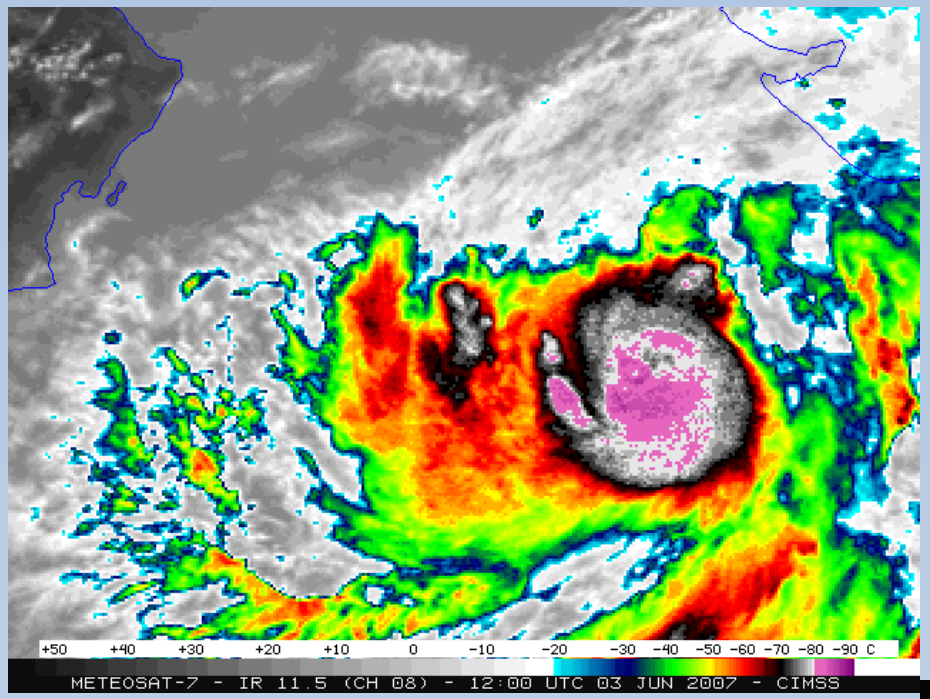
Empty Quarter Storms 10 July 2022

Feature Identification



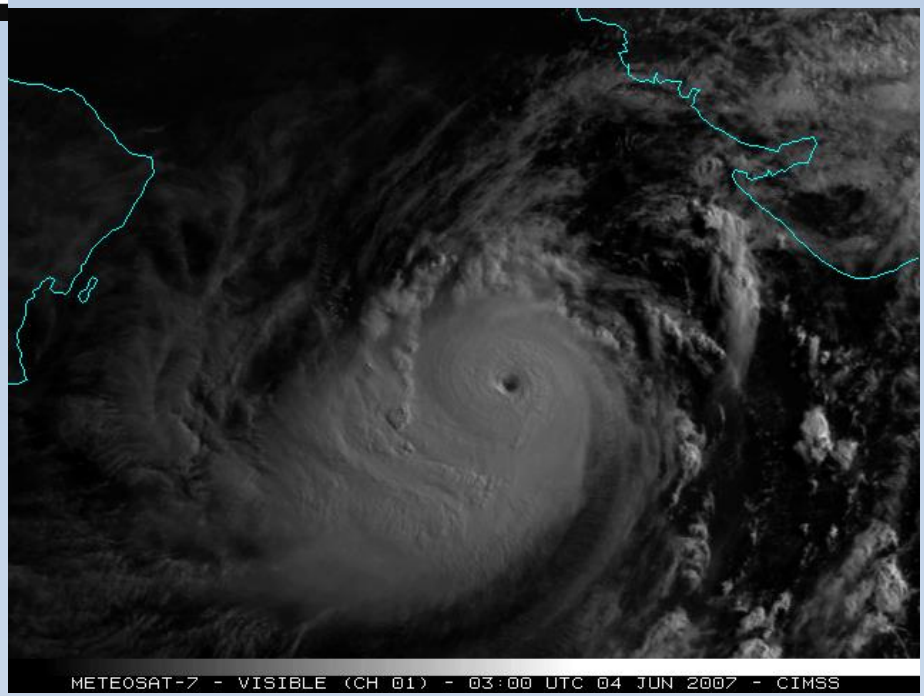


Tropical Cyclone Gonu



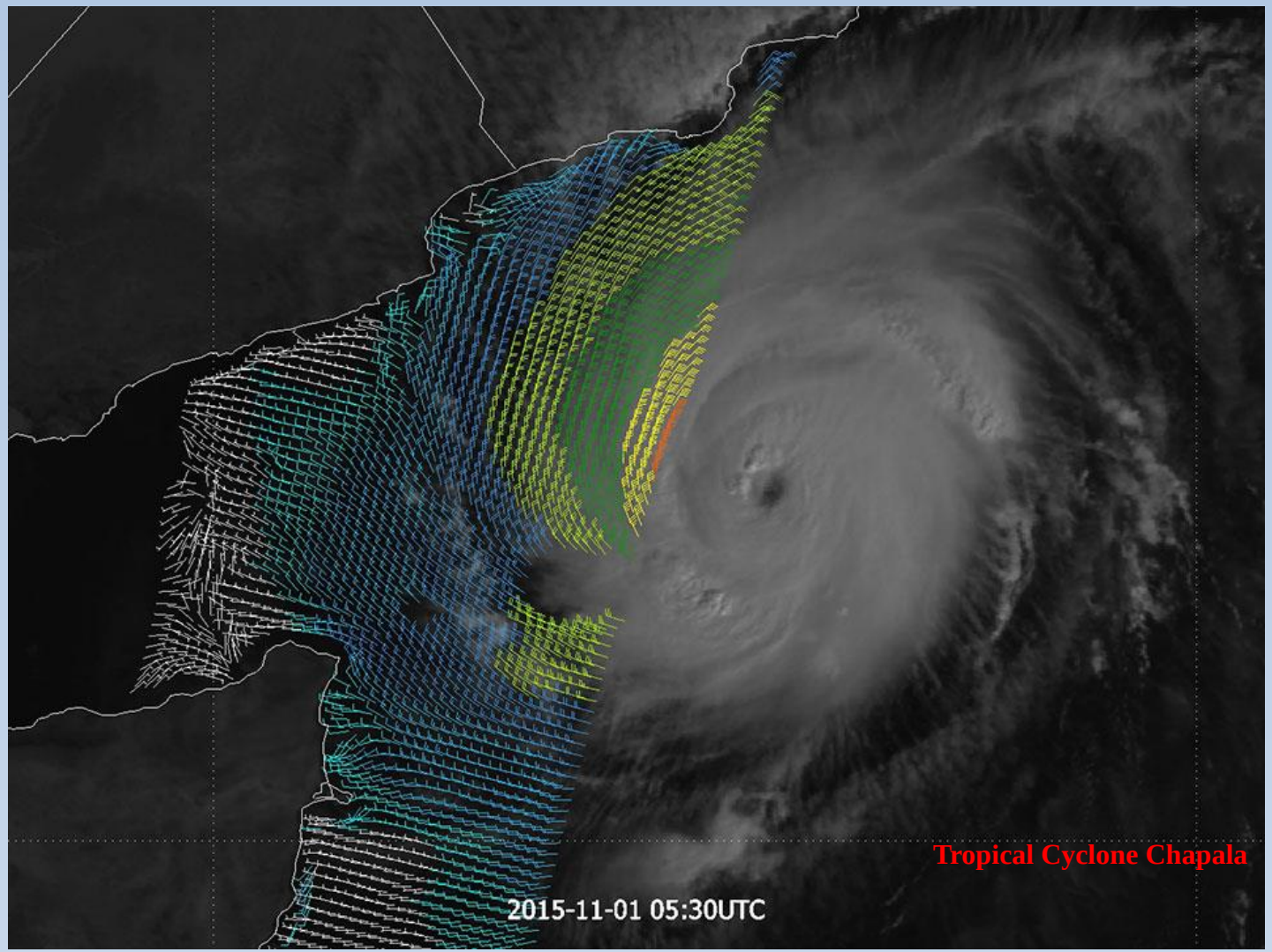
Colour Enhanced IR Image Animation

Visible Channel Animation

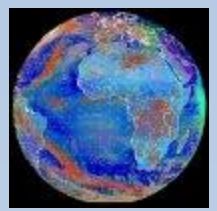


Satellite Products

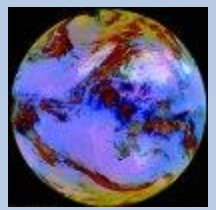
Vis Image and Wind Estimation. (wind Scatterometer)



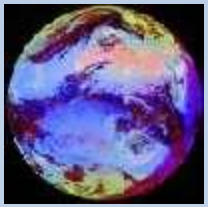
Composite Image (RGB)



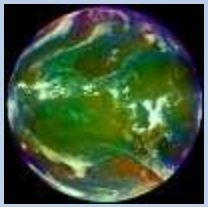
Day Microphysics RGB



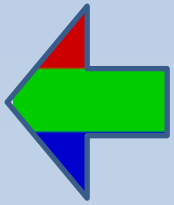
Dust RGB

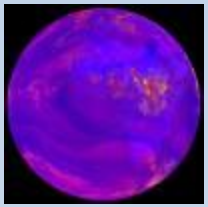


Fog / Low Clouds RGB

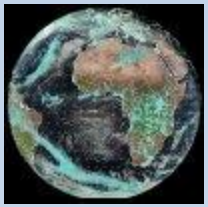


Airmass RGB

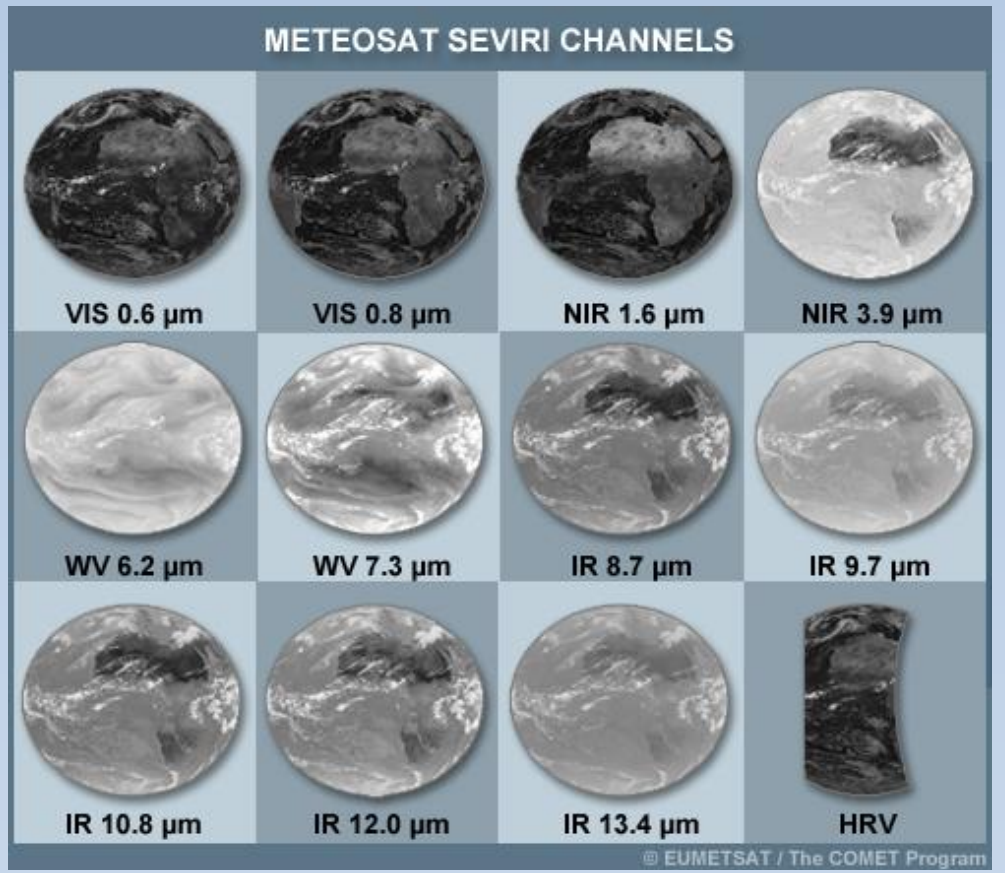


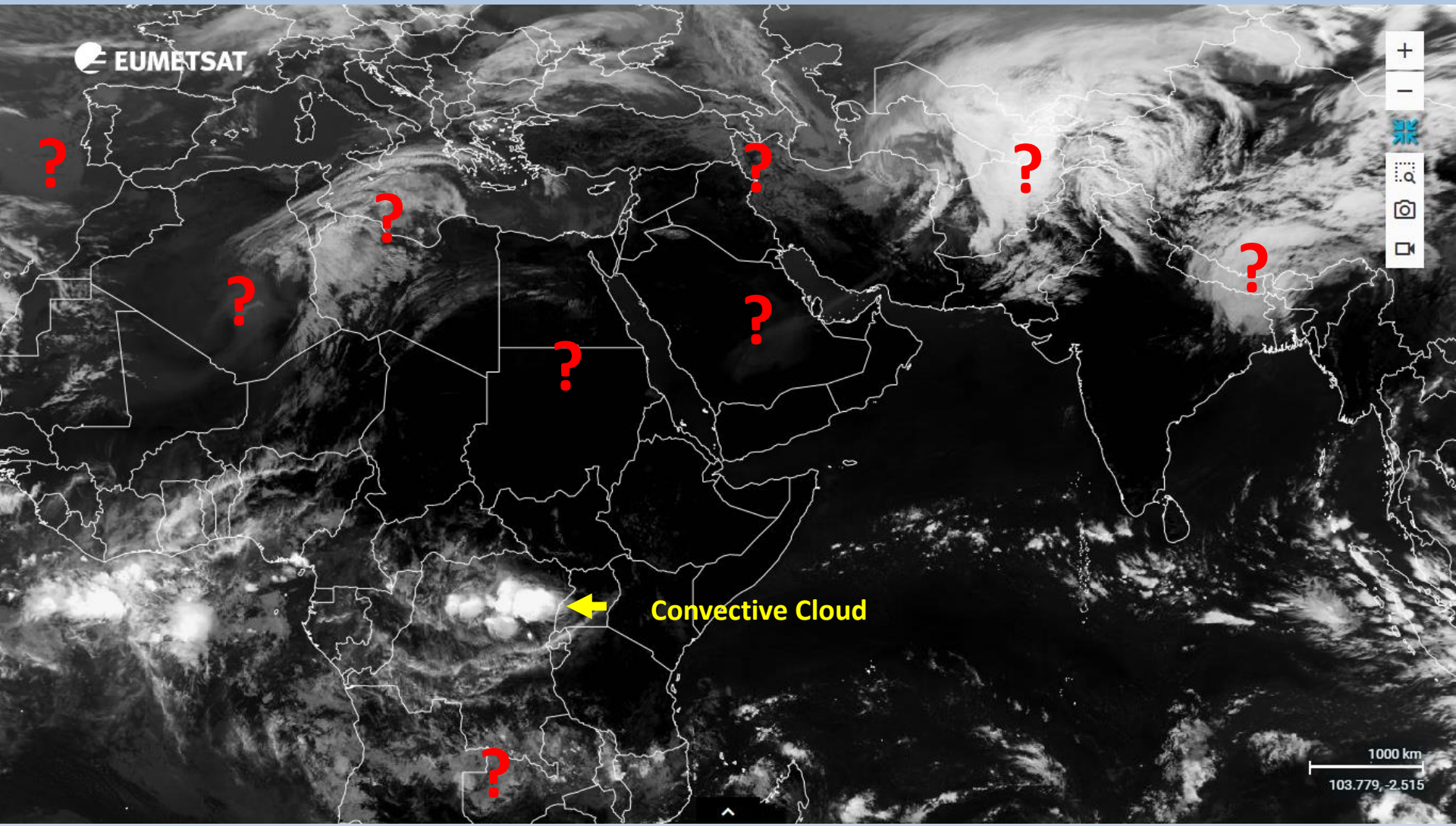


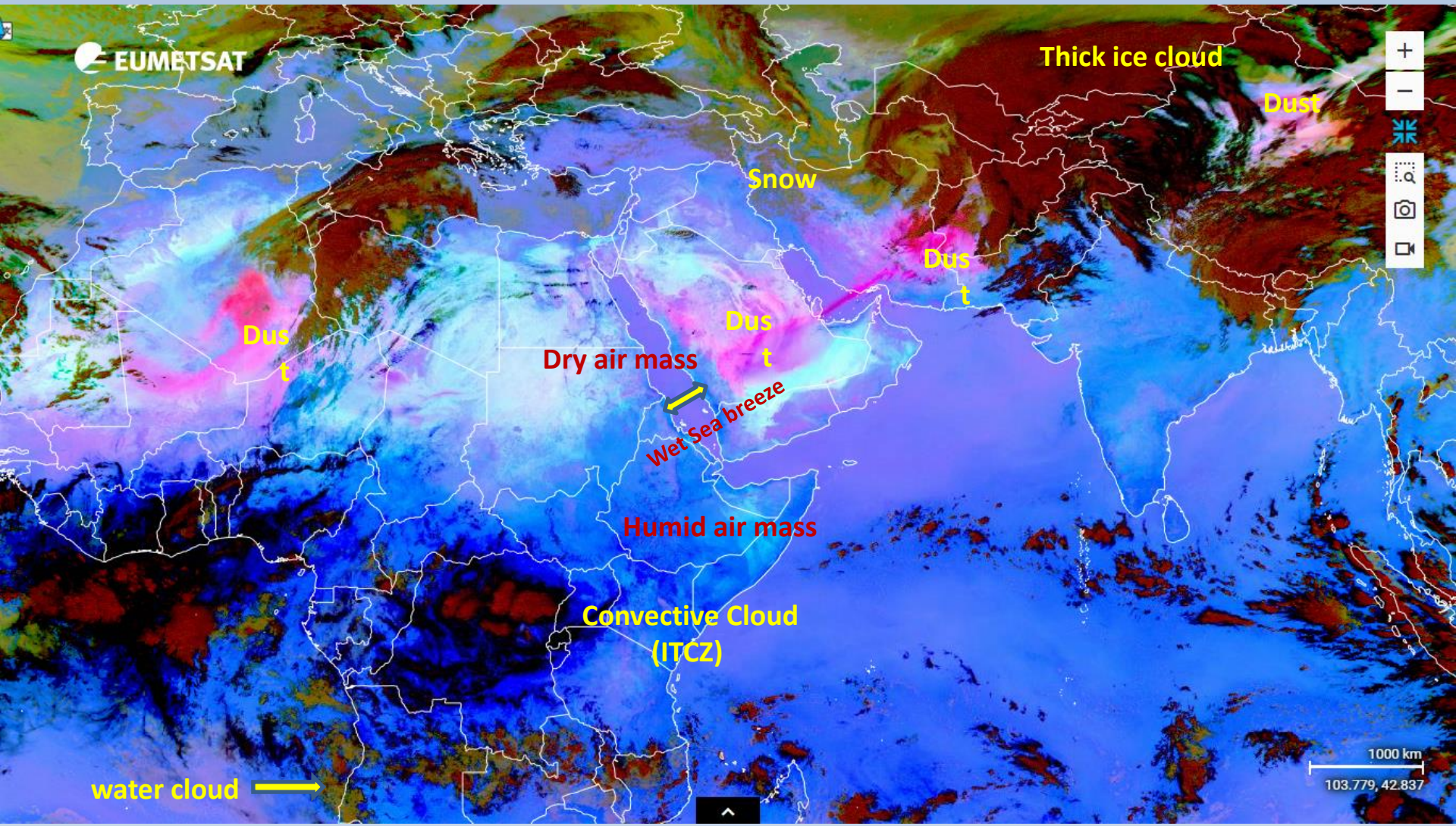
Convection RGB



Natural Color RGB

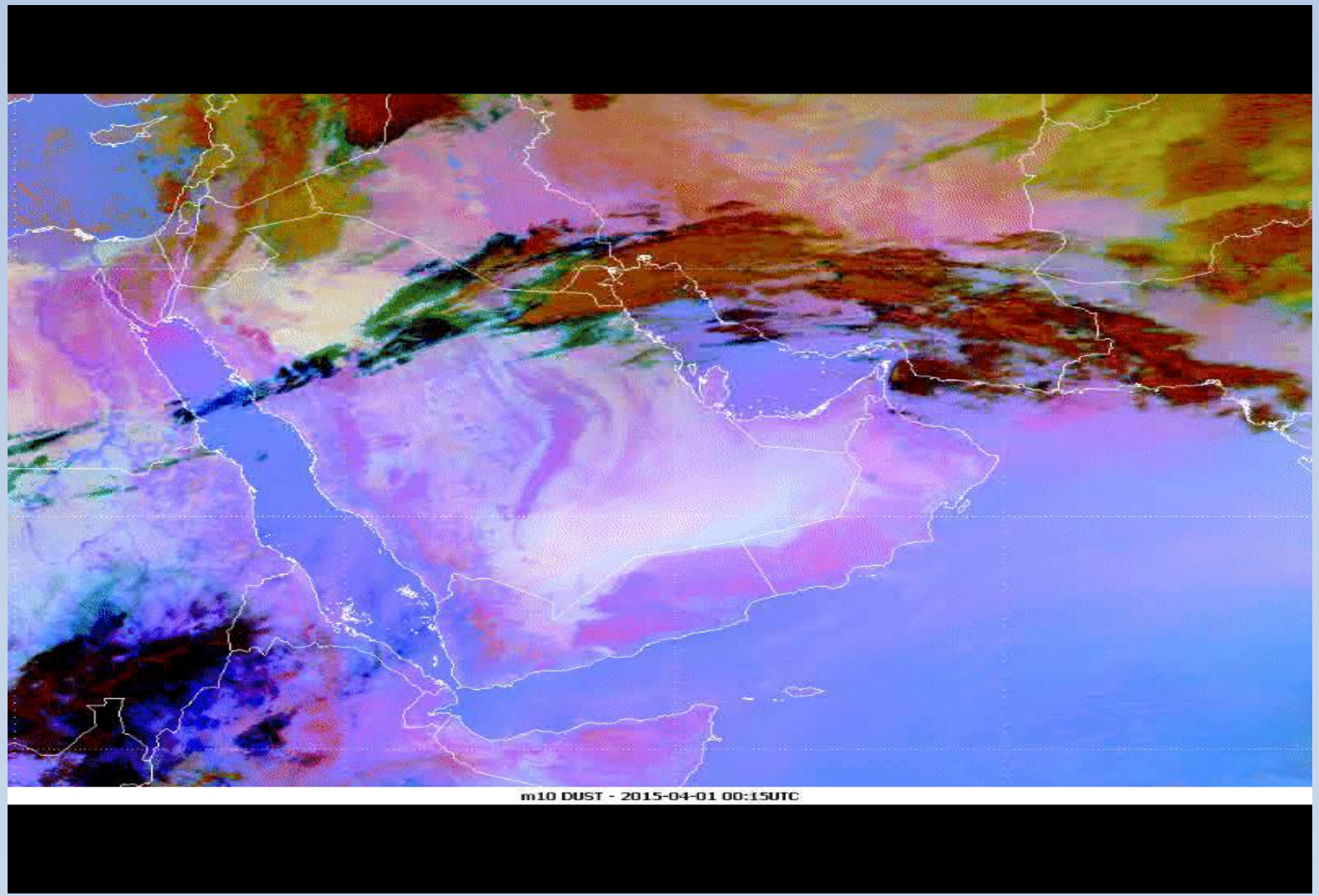


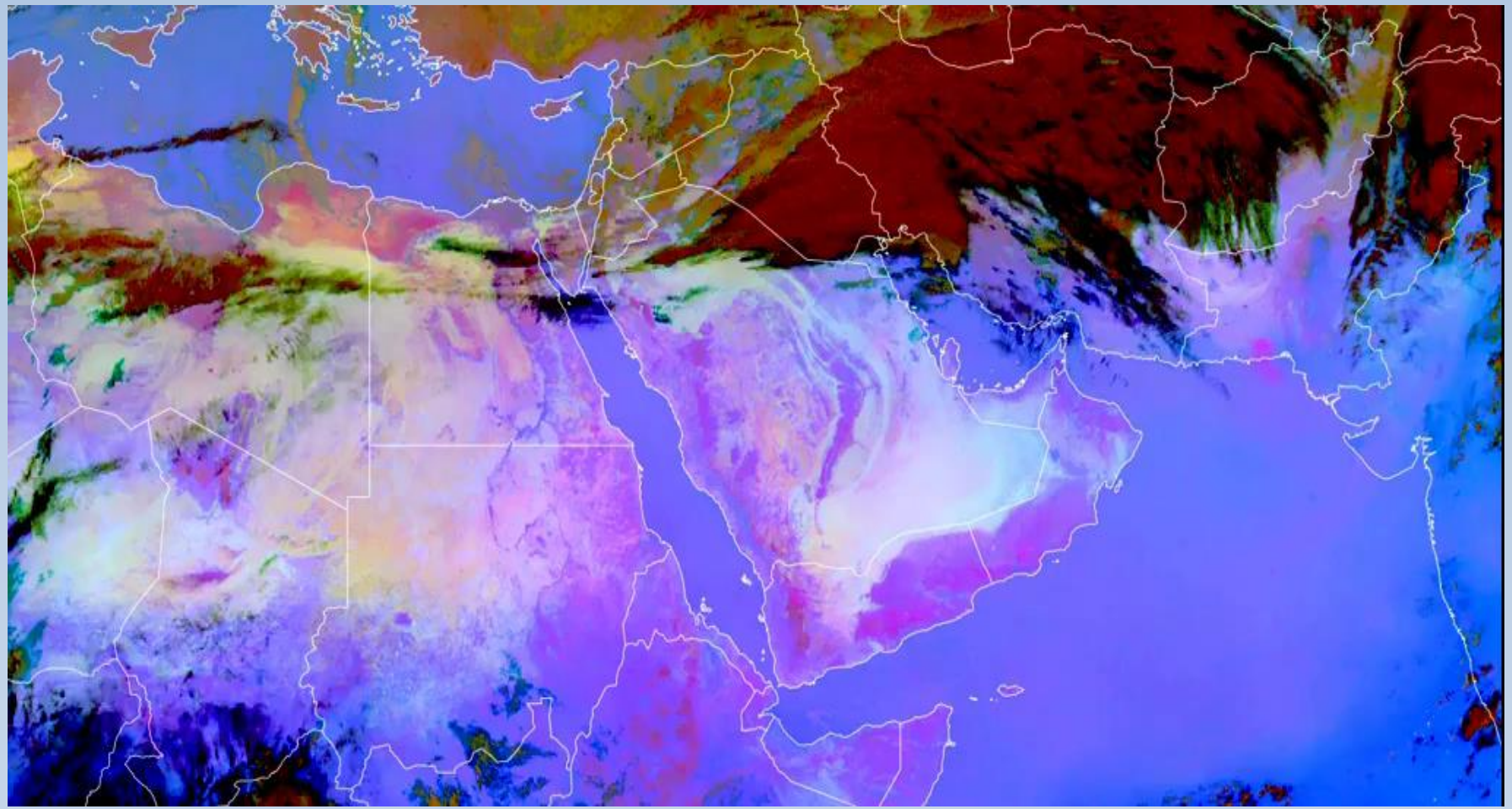

EUMETSAT
?
?
?
?
?
?
?
?
Convective Cloud
1000 km
103.779, -2.515


EUMETSAT
Thick ice cloud
Dust
Snow
Dus
t
Dus
t
Dus
t
Dry air mass
Wet Sea breeze
Humid air mass
Convective Cloud
(ITCZ)
water cloud
1000 km
103.779, 42.837

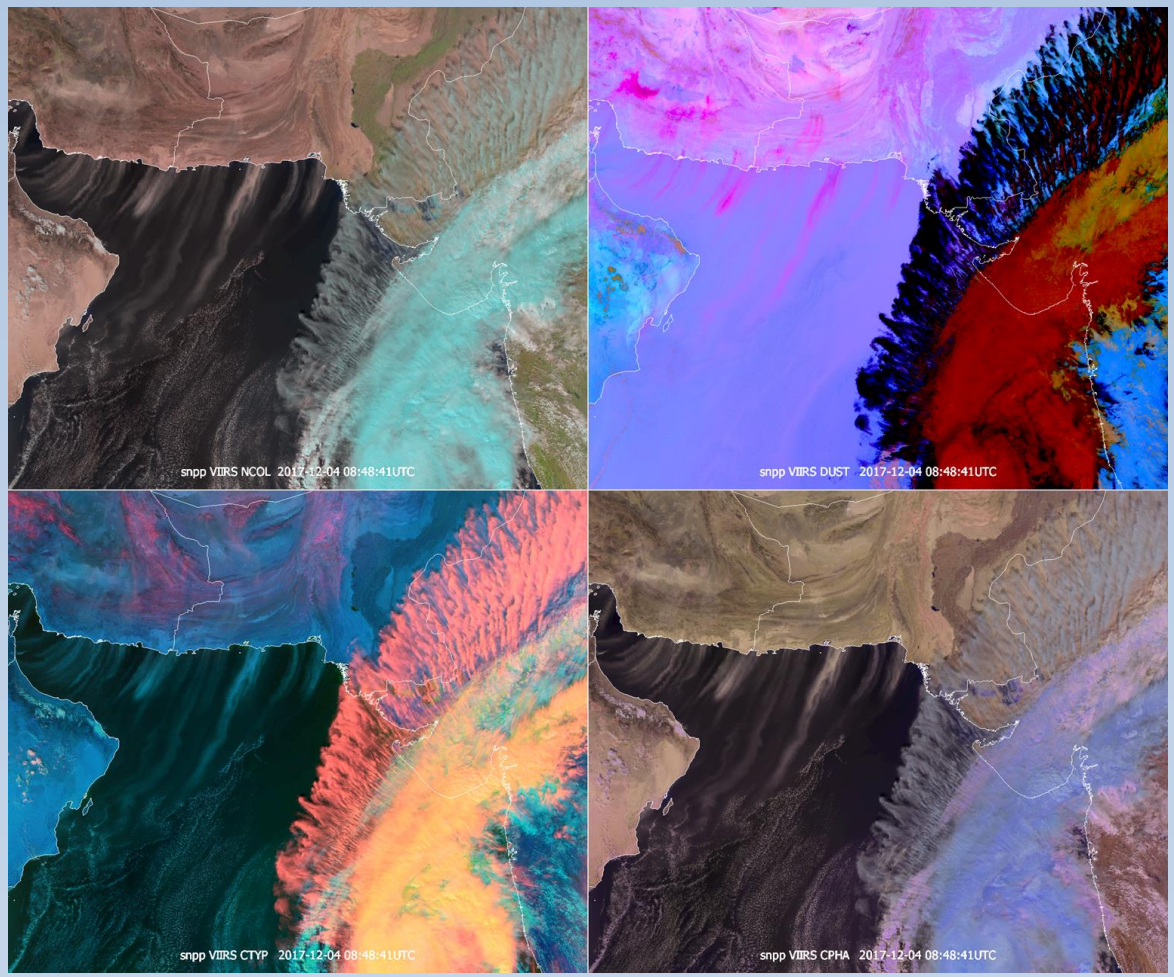
Satellite Products

Dust RGB/ Dust Storm 2015





Number of RGB images

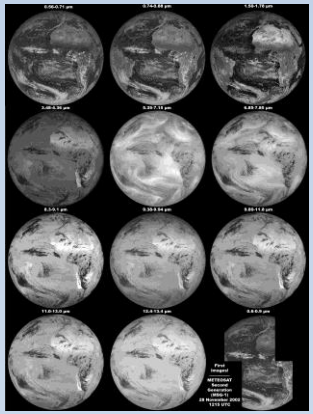


By:
Hans Peter
Eumetsat

THANKS TO EUMETSAT!!

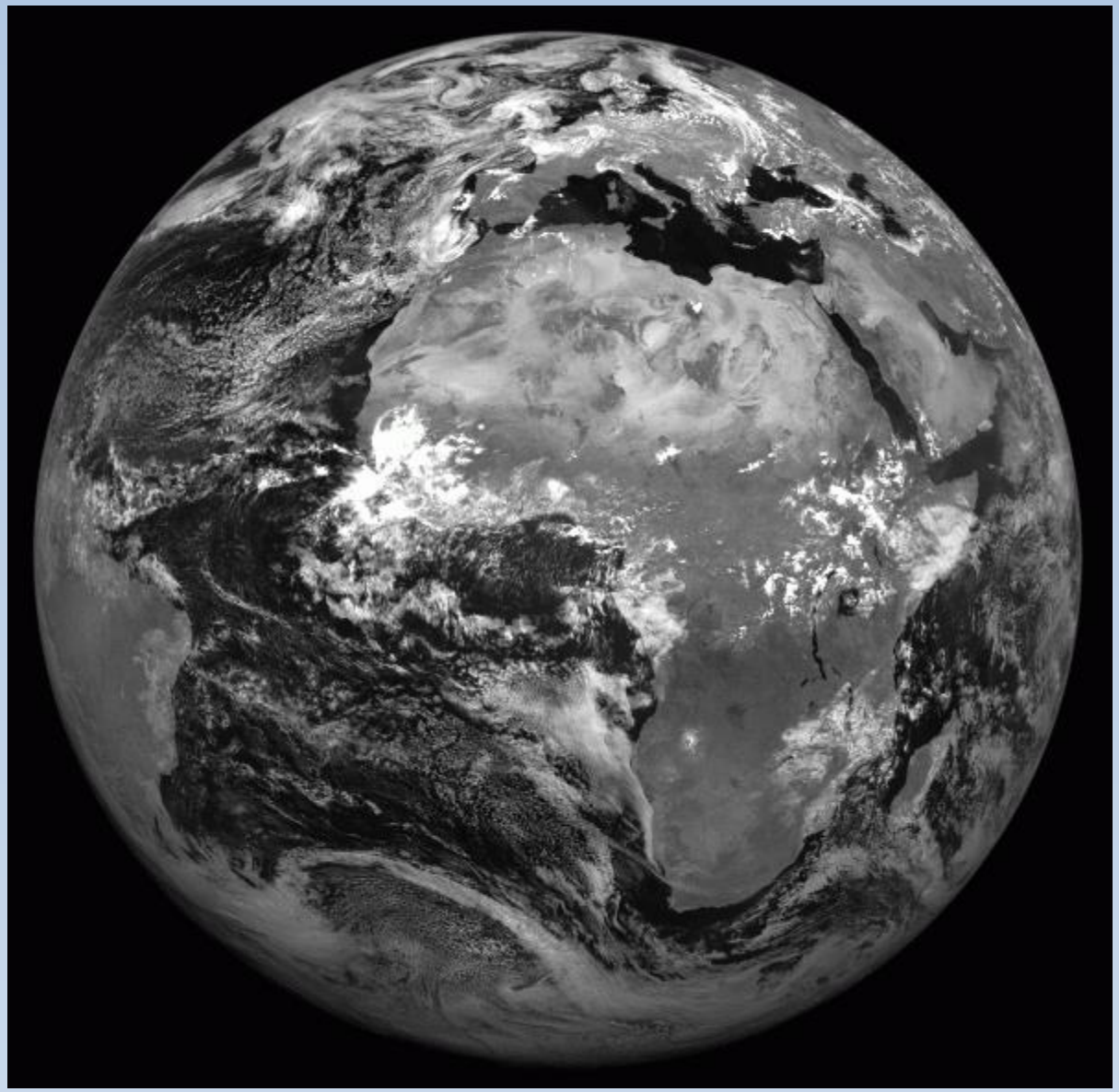
Meteosat-8, one of EUMETSAT's geostationary meteorological satellites, has just completed an 80-day journey from 3.5 degrees East to 41.5 degrees East,

MET 7
3 Ch

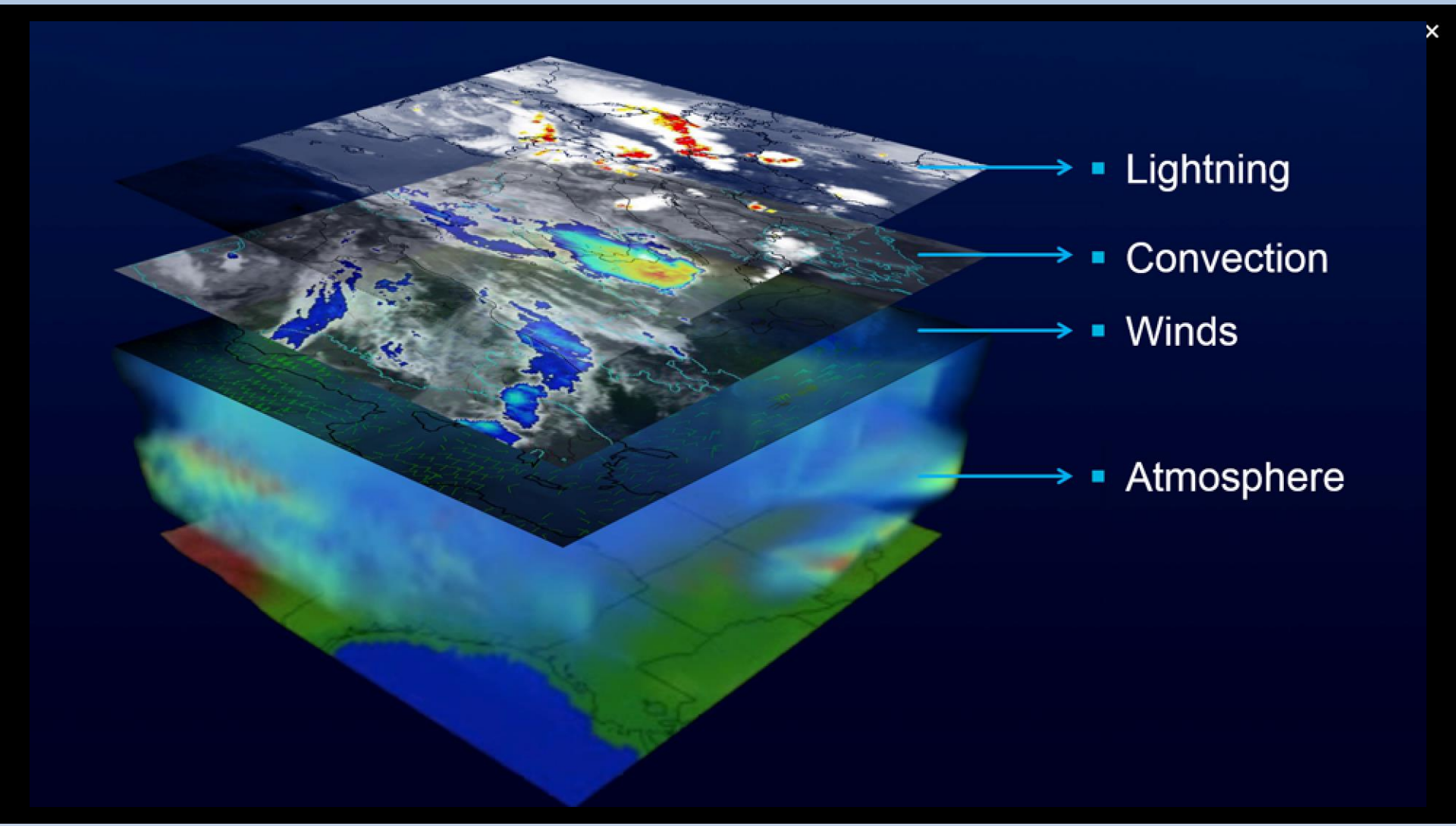


MET 8
12 Ch

MET 9
12 Ch



MTG-I1



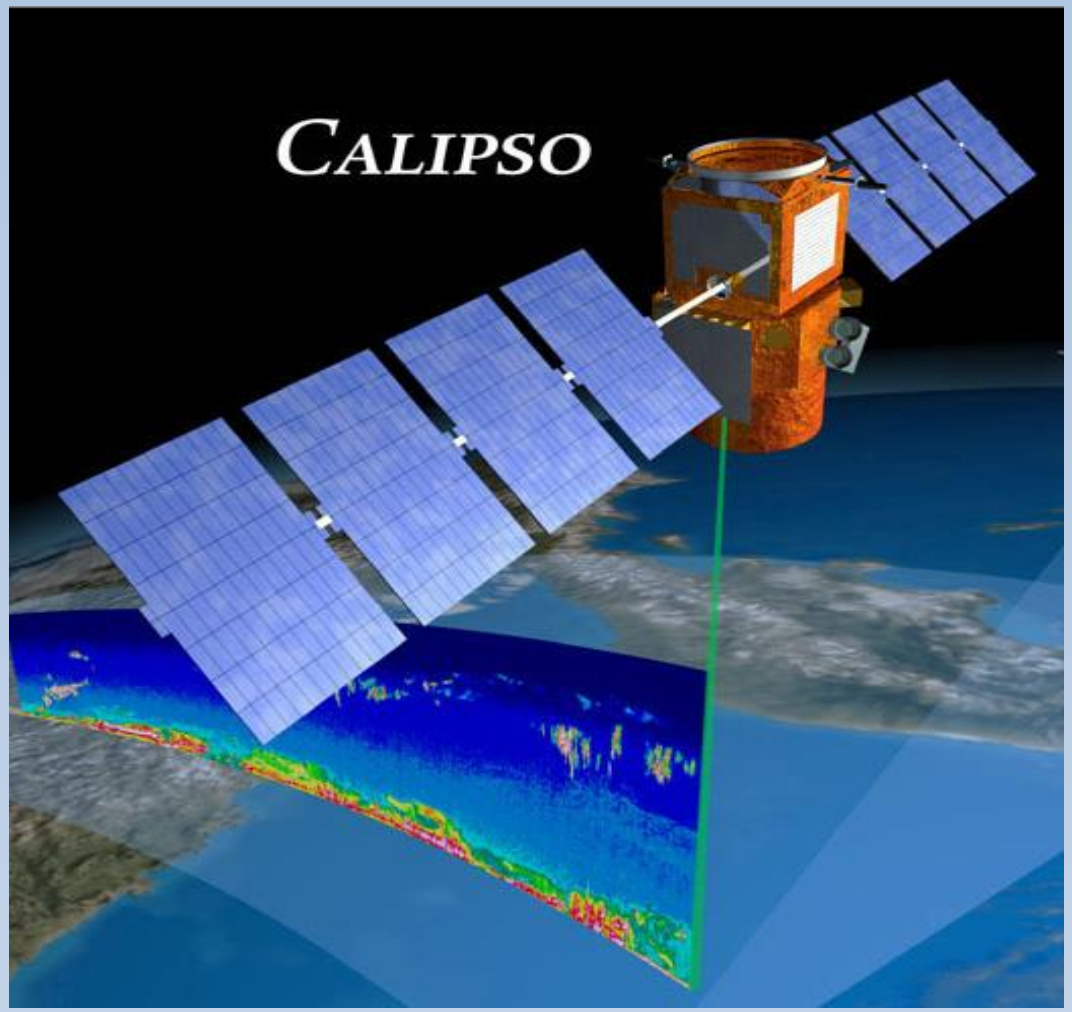
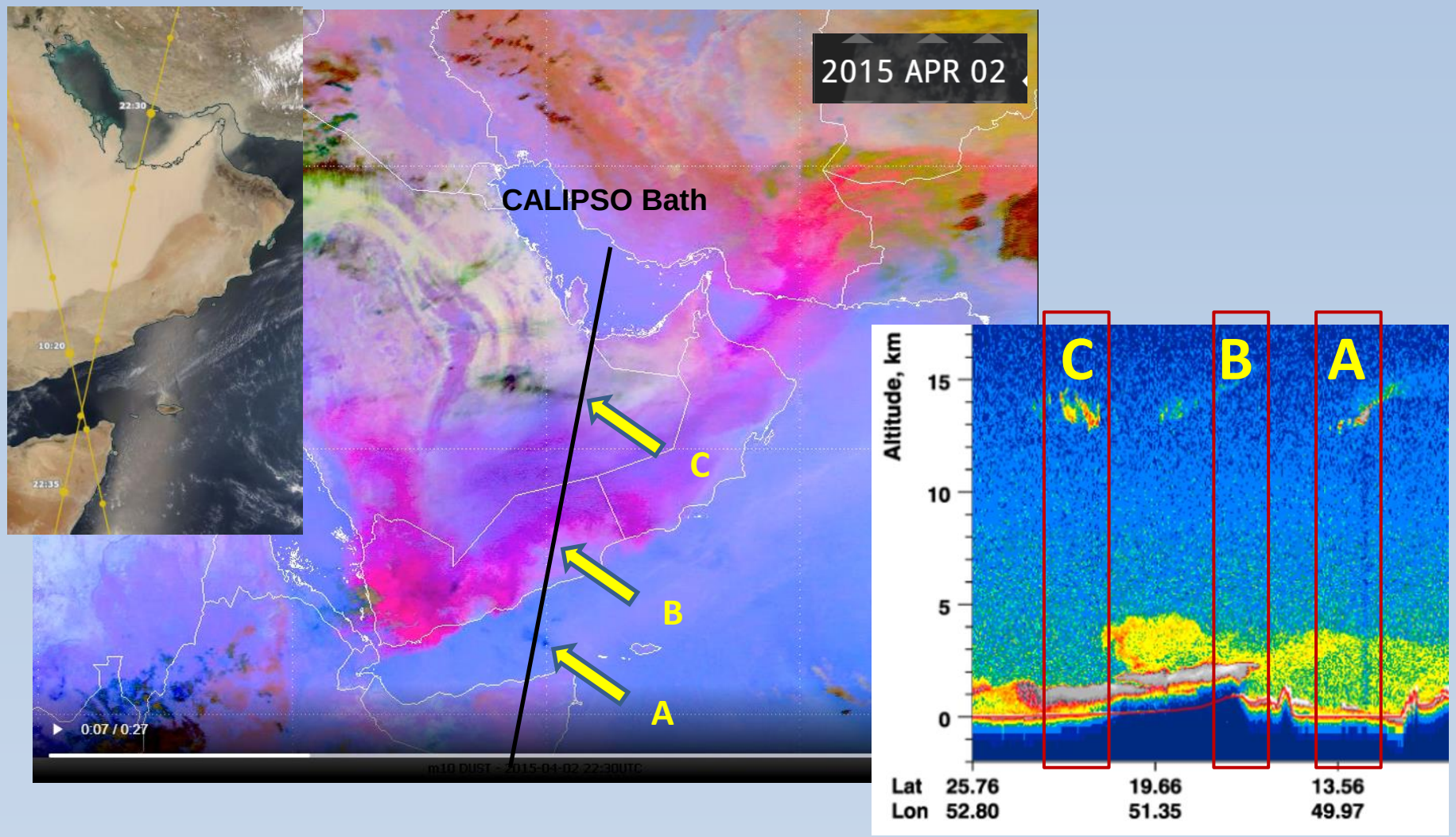
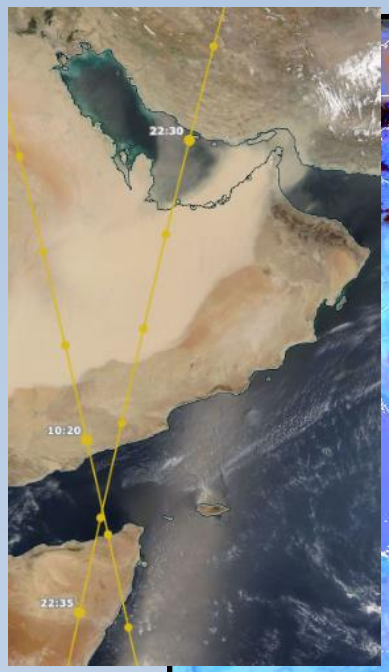
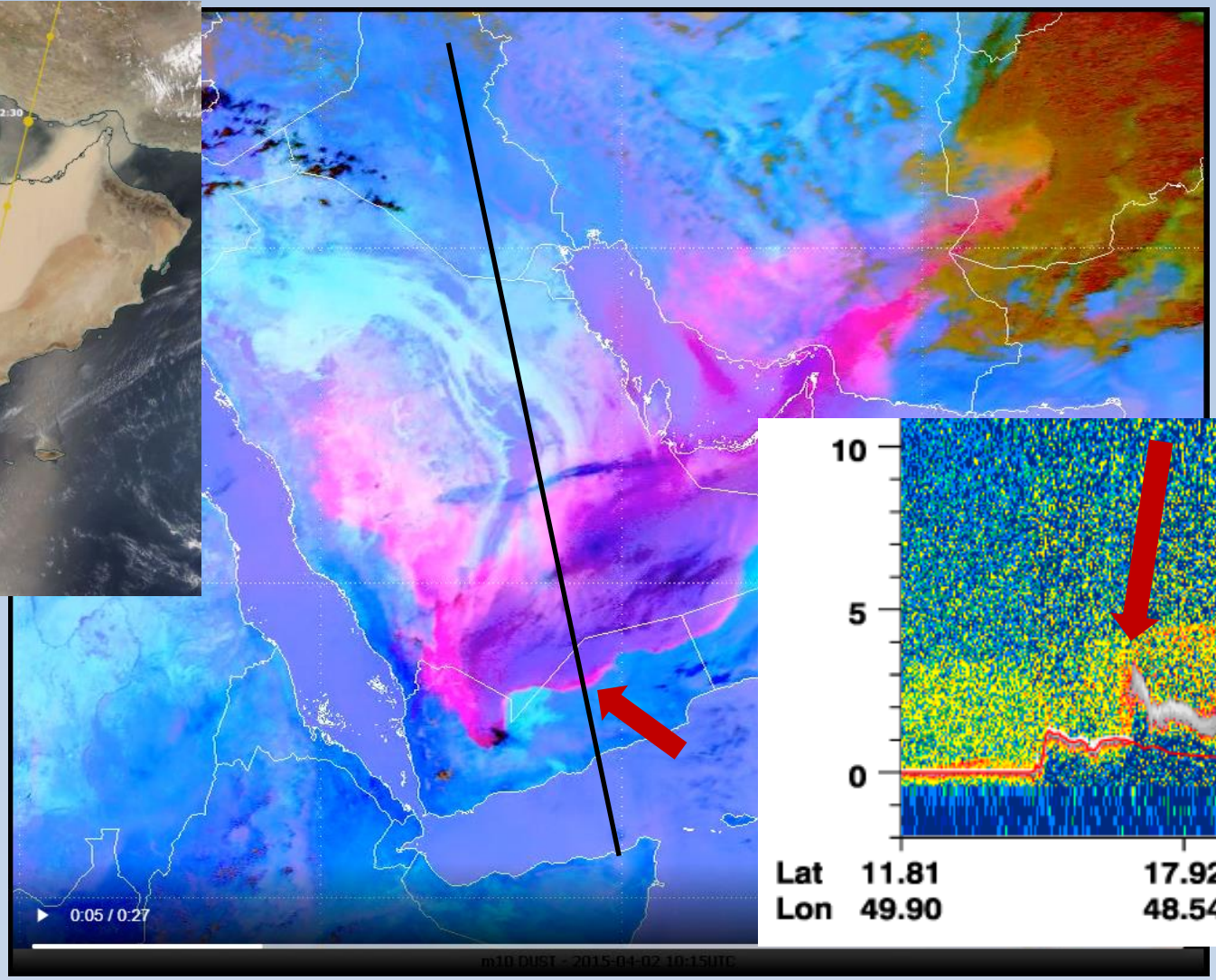
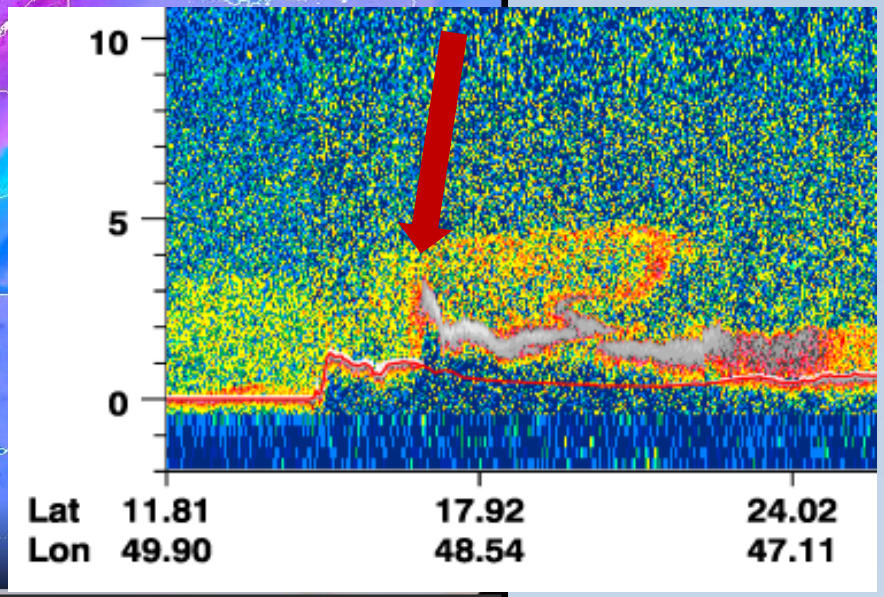


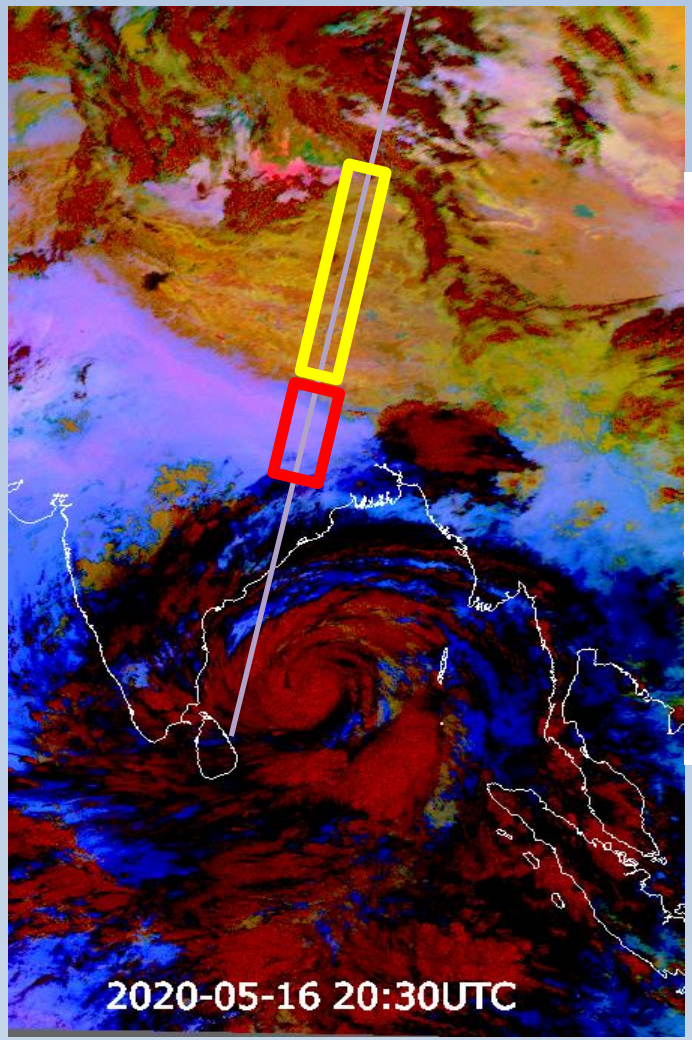
Image above: The CALIPSO spacecraft uses an innovative lidar and imaging system to reveal the secrets of clouds and aerosols. **NASA**

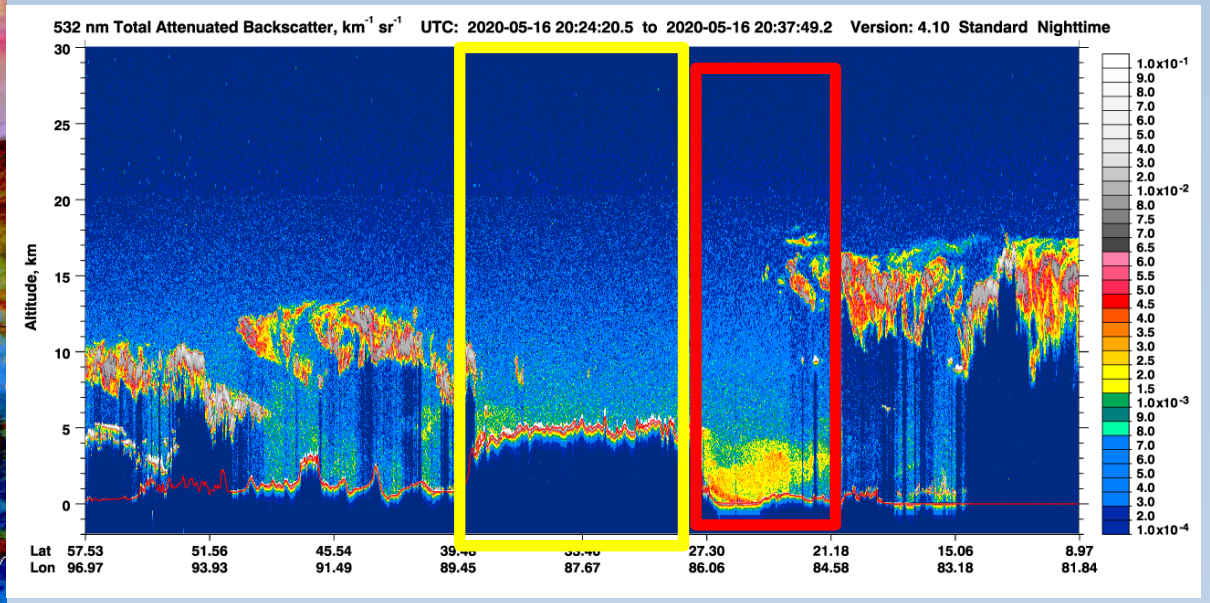

2015 APR 02
CALIPSO Bath
C
B
A
22:30
10:20
22:35
0:07 / 0:27
Altitude, km
15
10
5
0
C
B
A
Lat 25.76 19.66 13.56
Lon 52.80 51.35 49.97

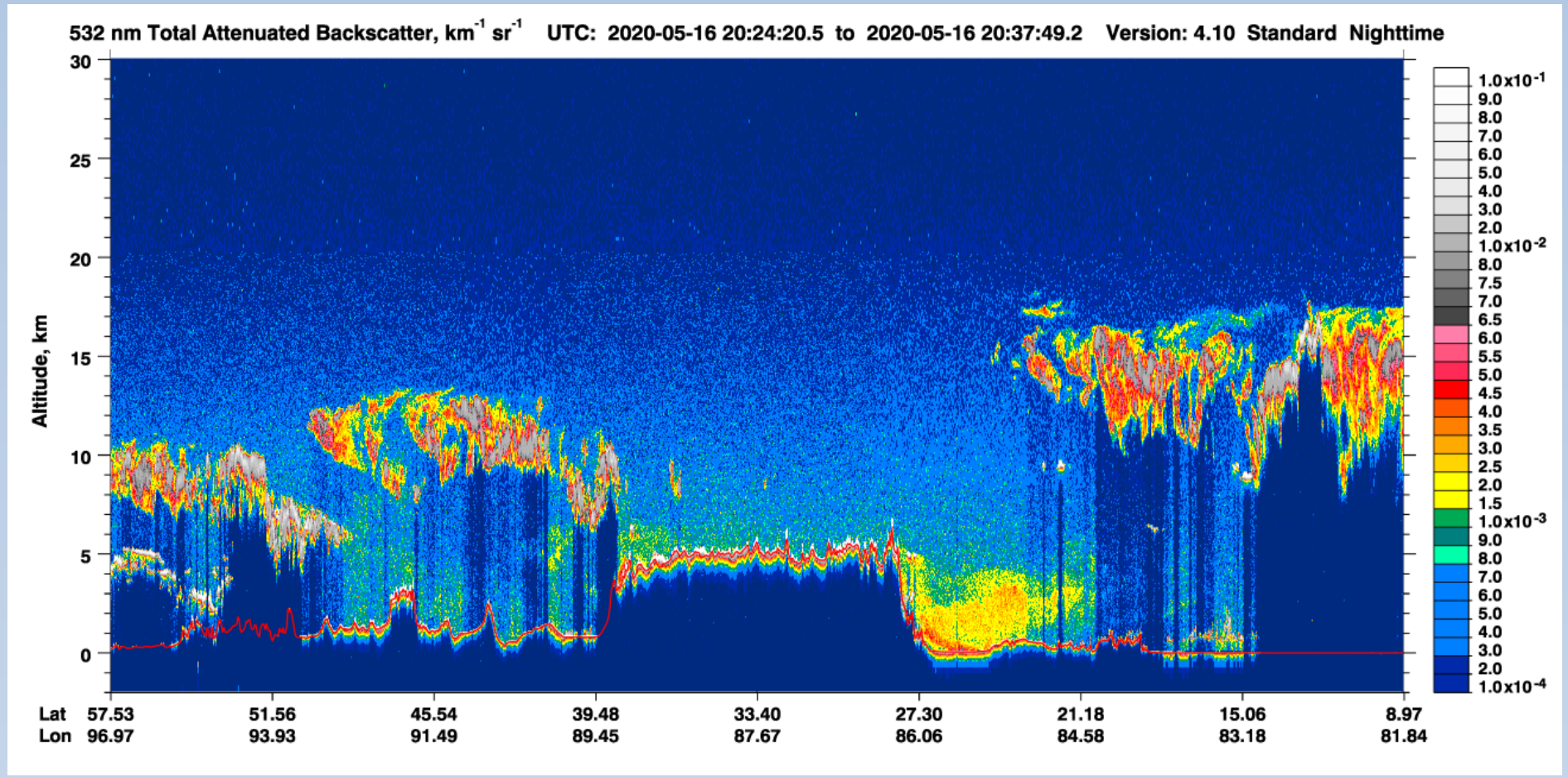

22:30
10:20
22:35


0:05 / 0:27
m10 DUST - 2015-04-02 10:15UTC


10
5
0
Lat 11.81 17.92 24.02
Lon 49.90 48.54 47.11

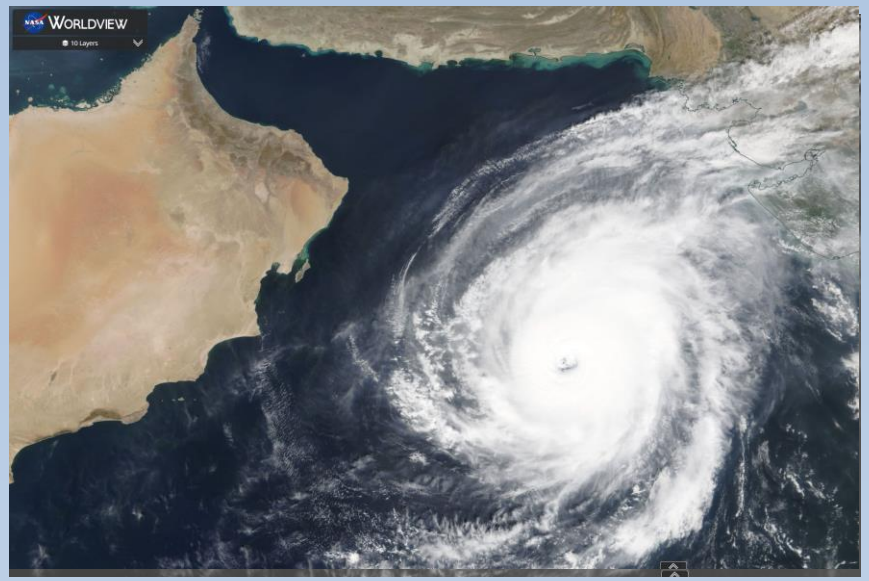

2020-05-16 20:30UTC

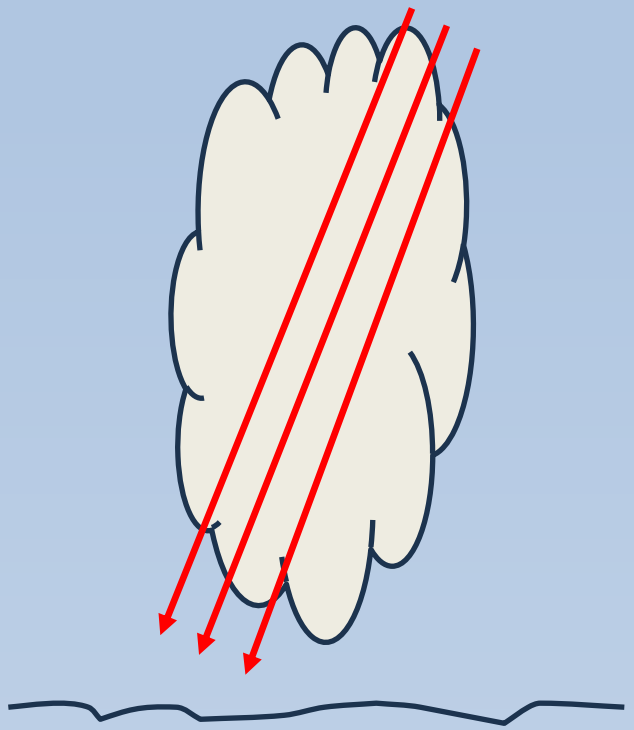

532 nm Total Attenuated Backscatter, km-1 sr-1 UTC: 2020-05-16 20:24:20.5 to 2020-05-16 20:37:49.2 Version: 4.10 Standard Nighttime
Altitude, km
30
25
20
15
10
5
0
Lat 57.53 51.56 45.54 27.30 21.18 15.06 8.97
Lon 96.97 93.93 91.49 89.45 87.67 86.06 84.58 83.18 81.84
1.0x10-1
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0x10-2
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0x10-3
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0x10-4


532 nm Total Attenuated Backscatter, km-1 sr-1 UTC: 2020-05-16 20:24:20.5 to 2020-05-16 20:37:49.2 Version: 4.10 Standard Nighttime
Altitude, km
30
25
20
15
10
5
0
1.0x10-1
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0x10-2
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0x10-3
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0x10-4
Lat 57.53 51.56 45.54 39.48 33.40 27.30 21.18 15.06 8.97
Lon 96.97 93.93 91.49 89.45 87.67 86.06 84.58 83.18 81.84

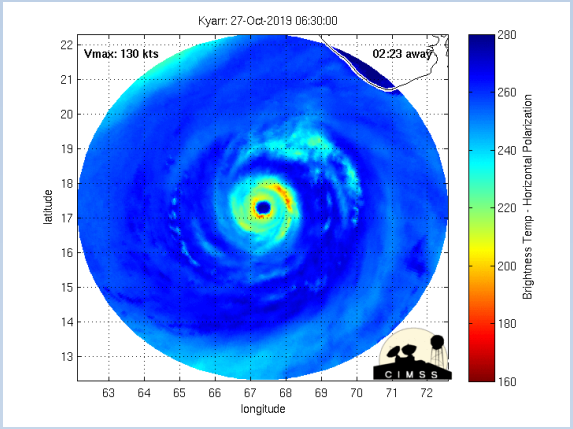
Microwave

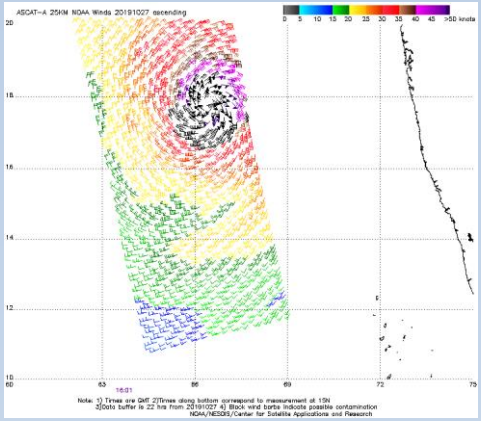
IR and VIS

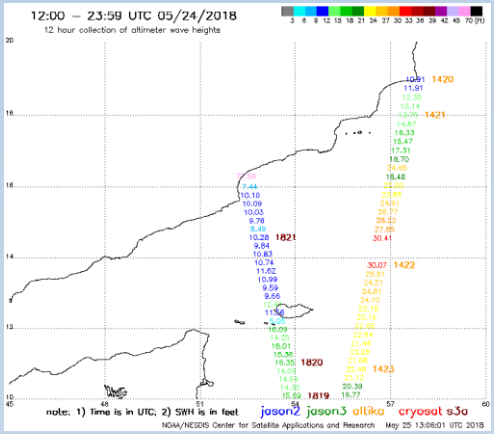




Microwave



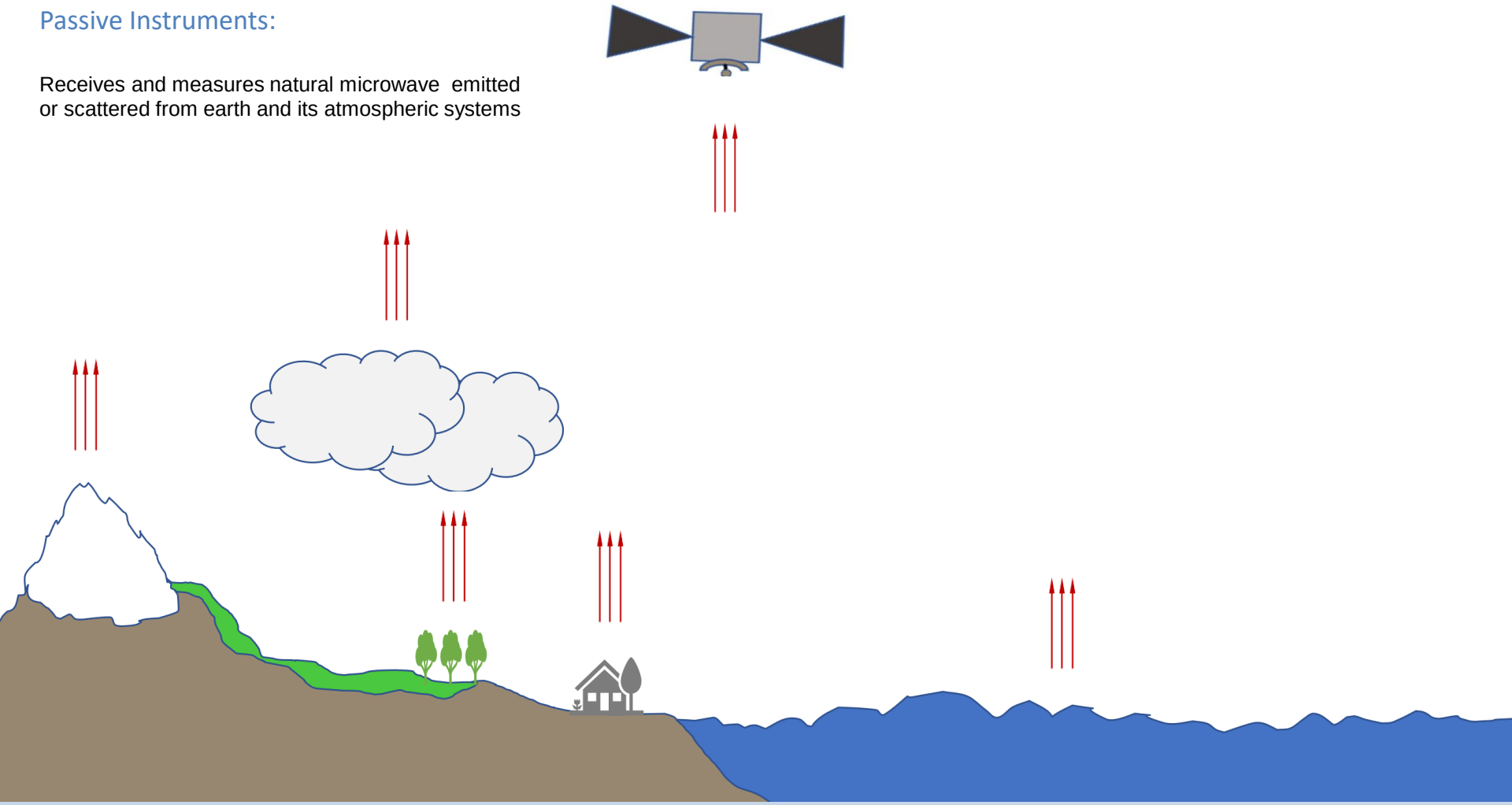




Excellent Capabilities to go through different atmospheric composition including cloud with very heavy precipitation

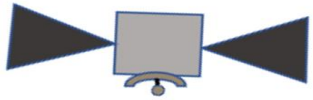
Passive Instruments:

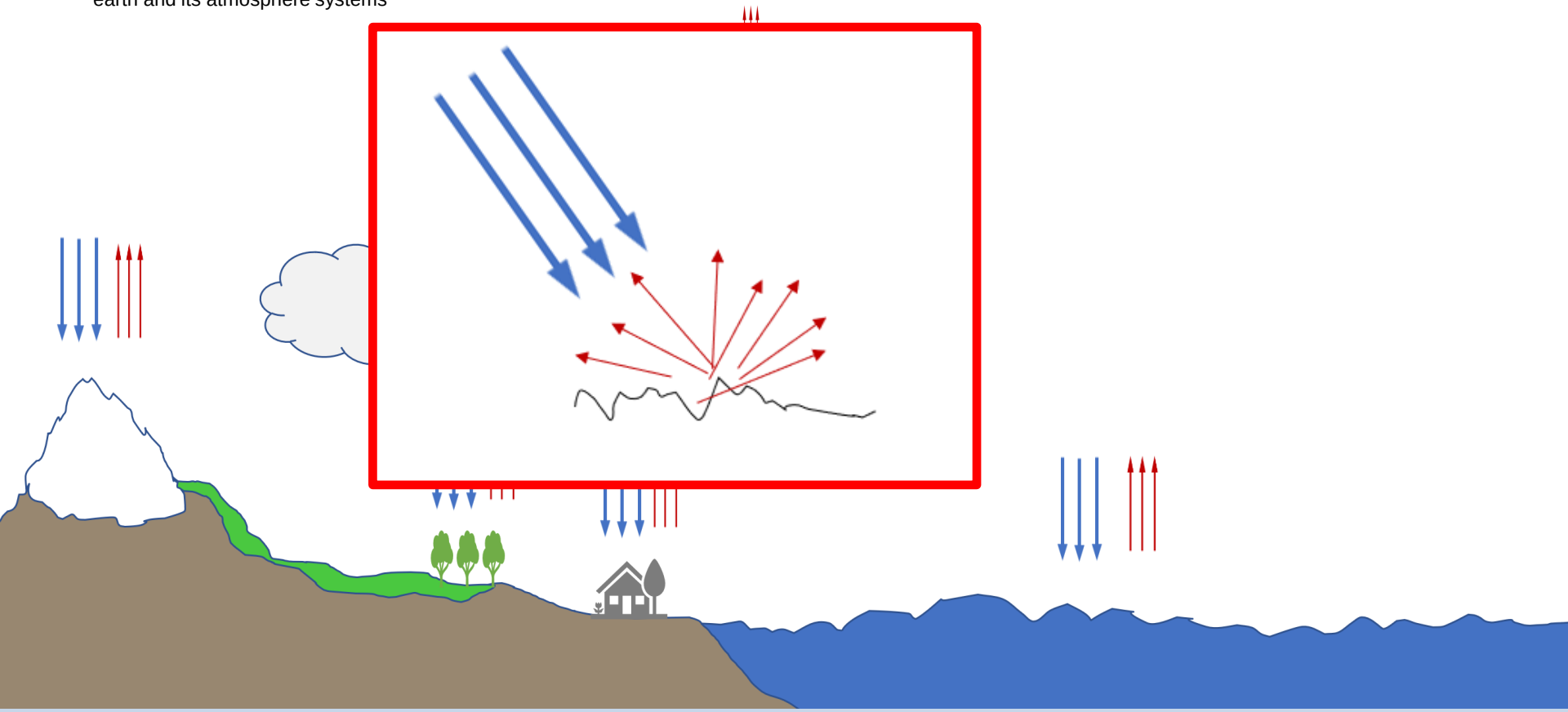
Receives and measures natural microwave emitted or scattered from earth and its atmospheric systems



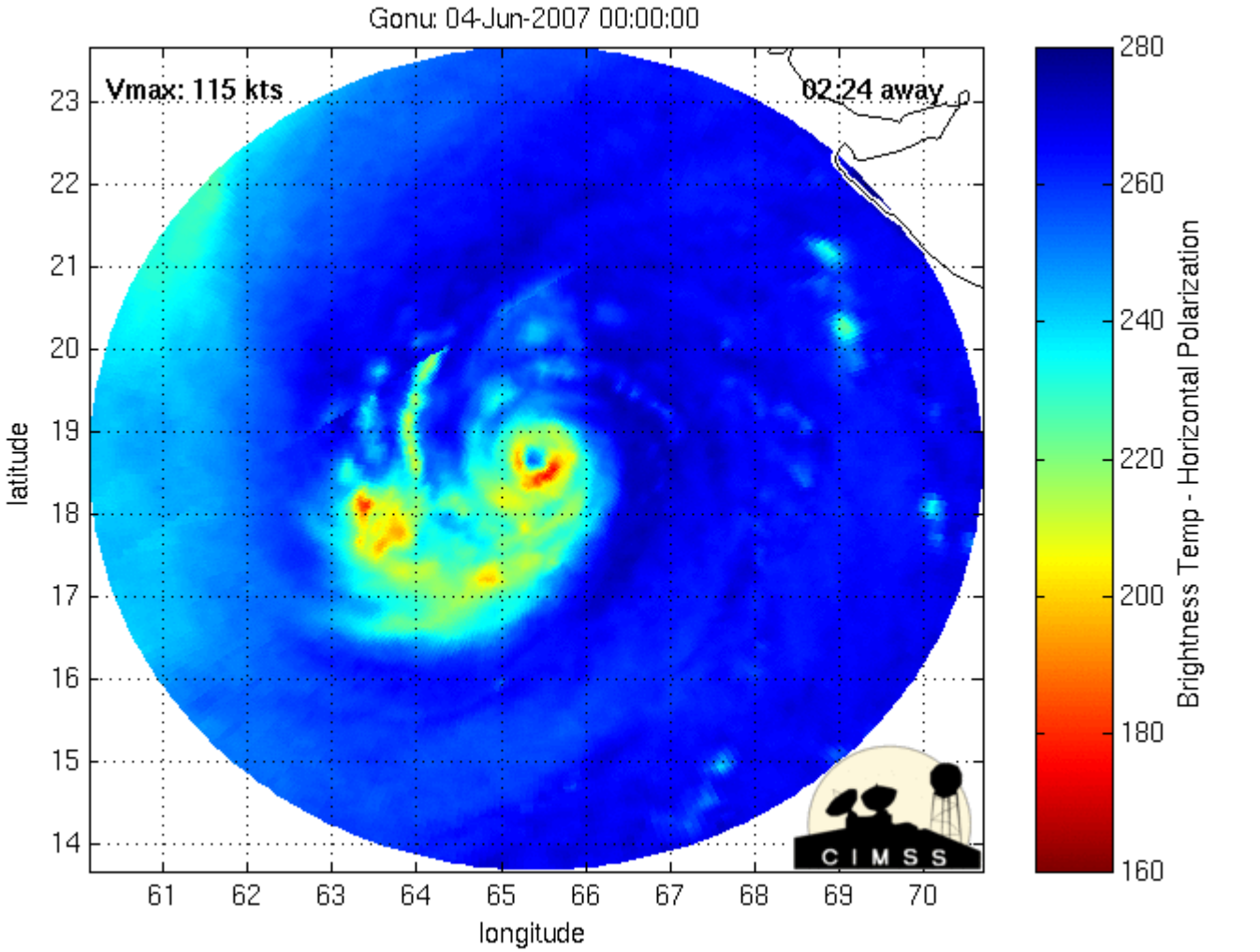
Active Instruments:

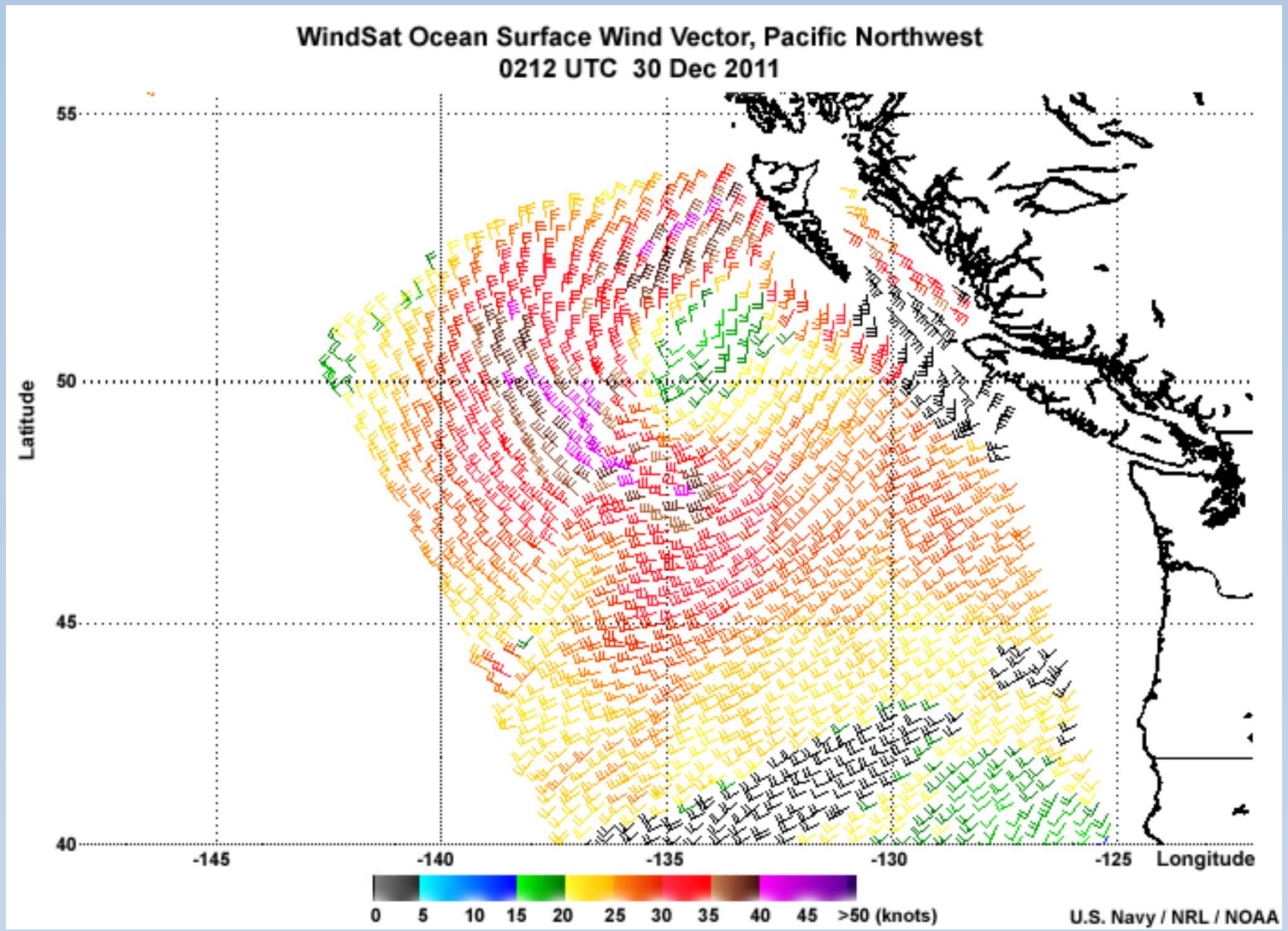
Radar instrument transmits its own microwave radiation and then collects its reflected and scattered signals from earth and its atmosphere systems

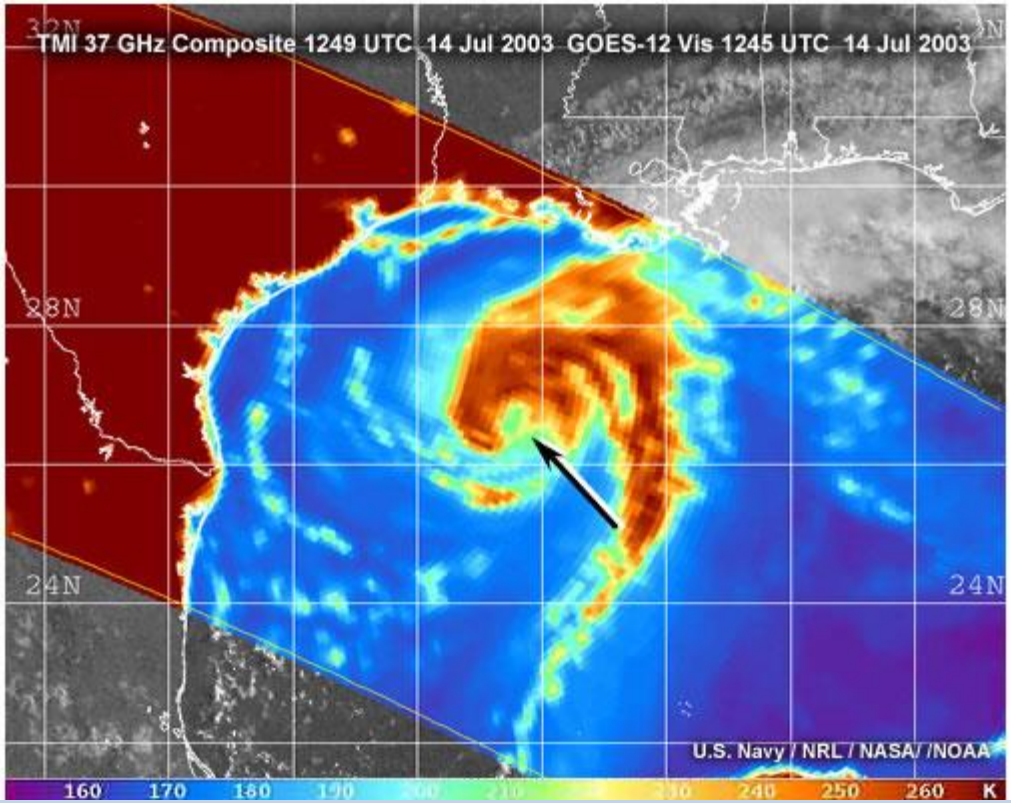




Microwave Applications

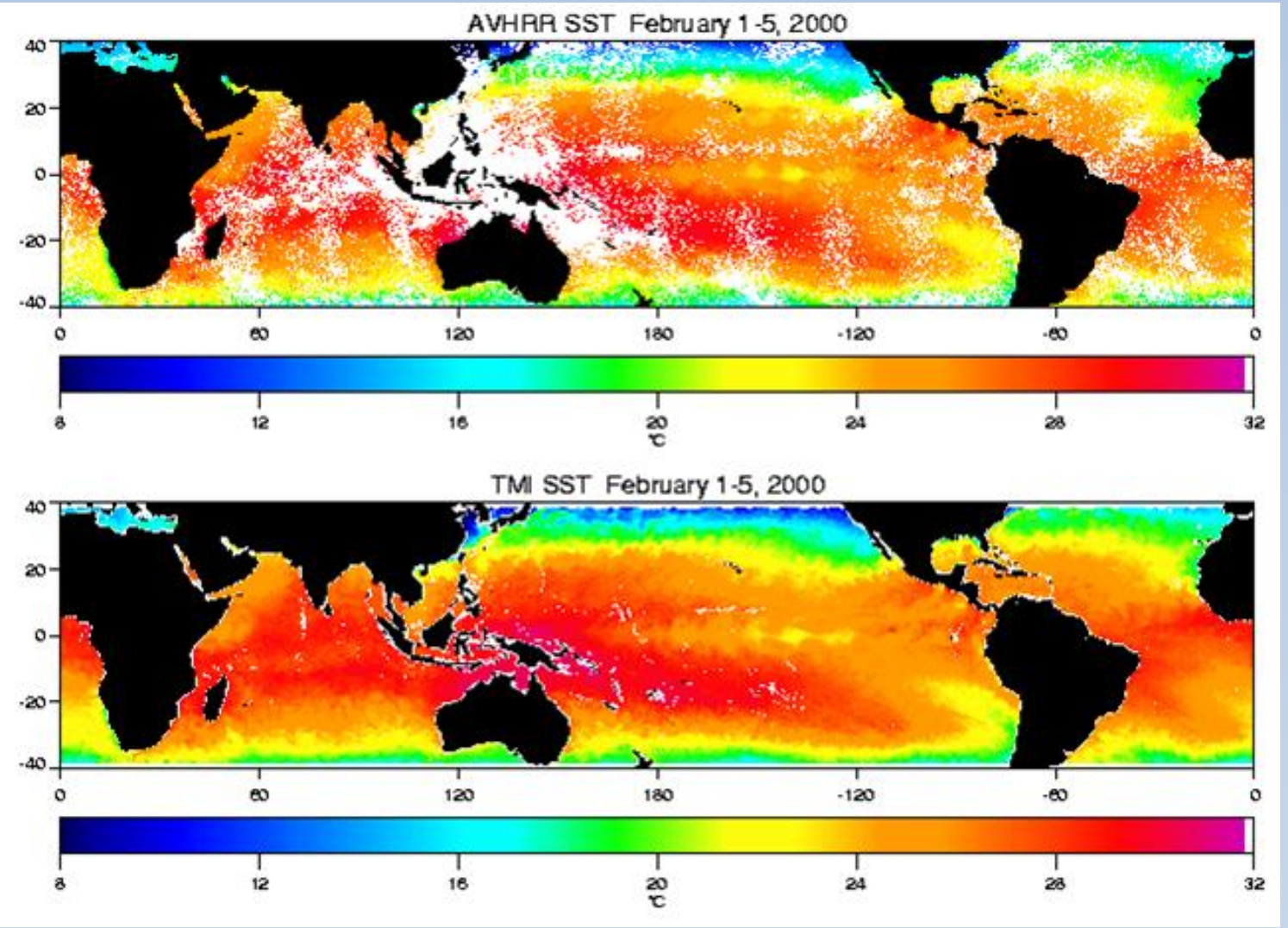


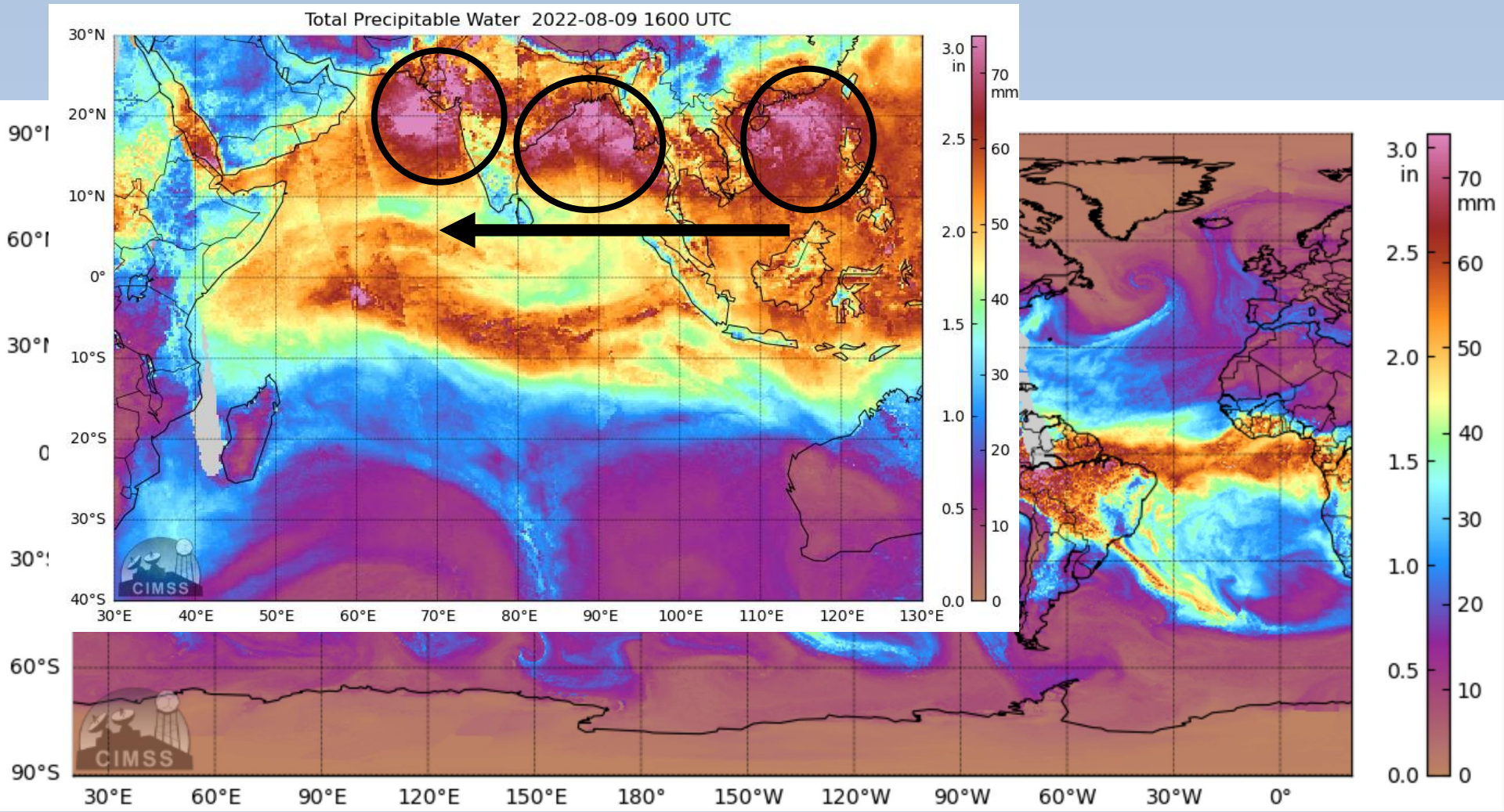

WindSat Ocean Surface Wind Vector, Pacific Northwest
0212 UTC 30 Dec 2011
55
50
45
40
Latitude
-145
-140
-135
-130
-125
Longitude
0 5 10 15 20 25 30 35 40 45 >50 (knots)
U.S. Navy / NRL / NOAA


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

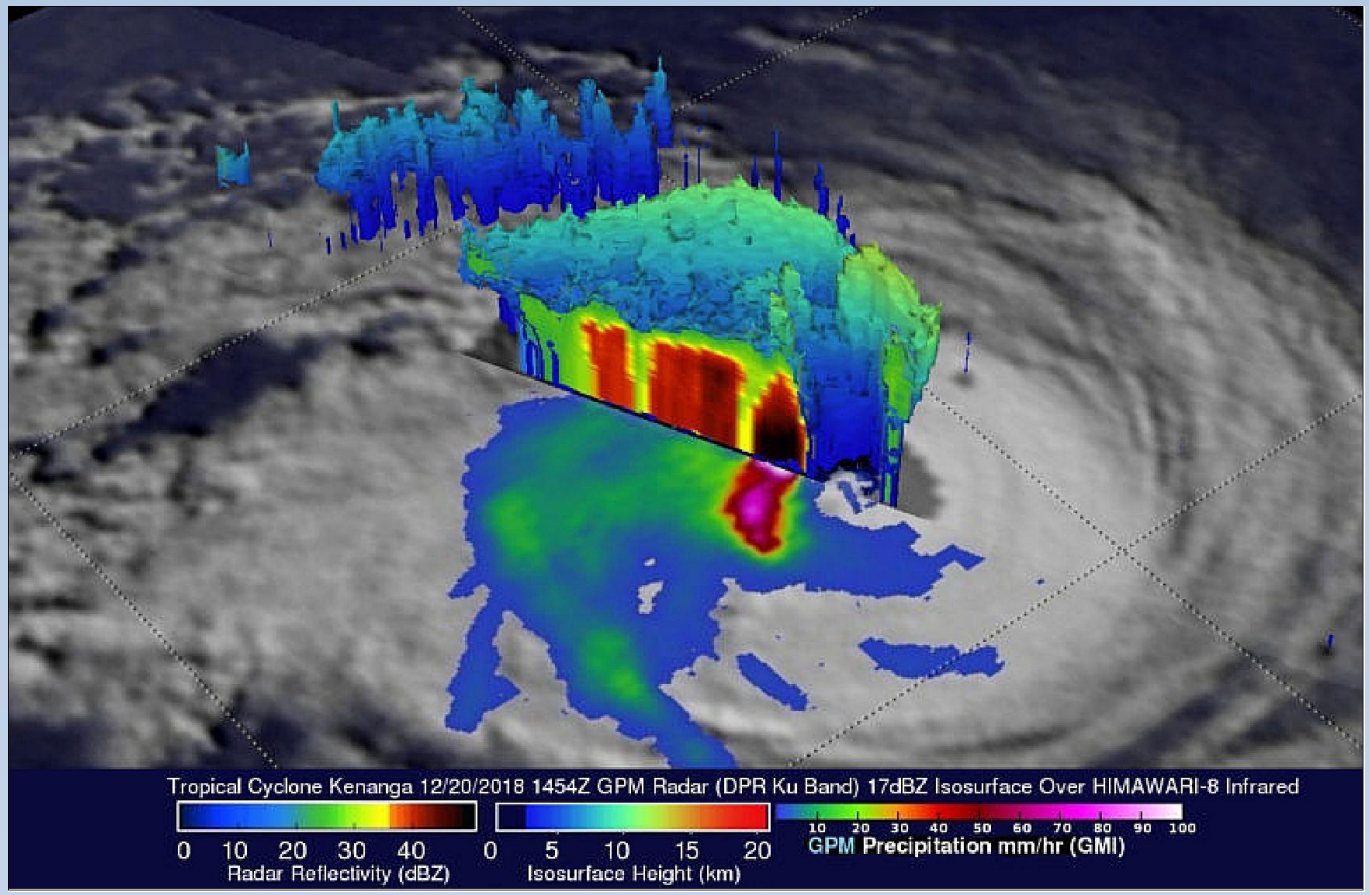
SST by IR

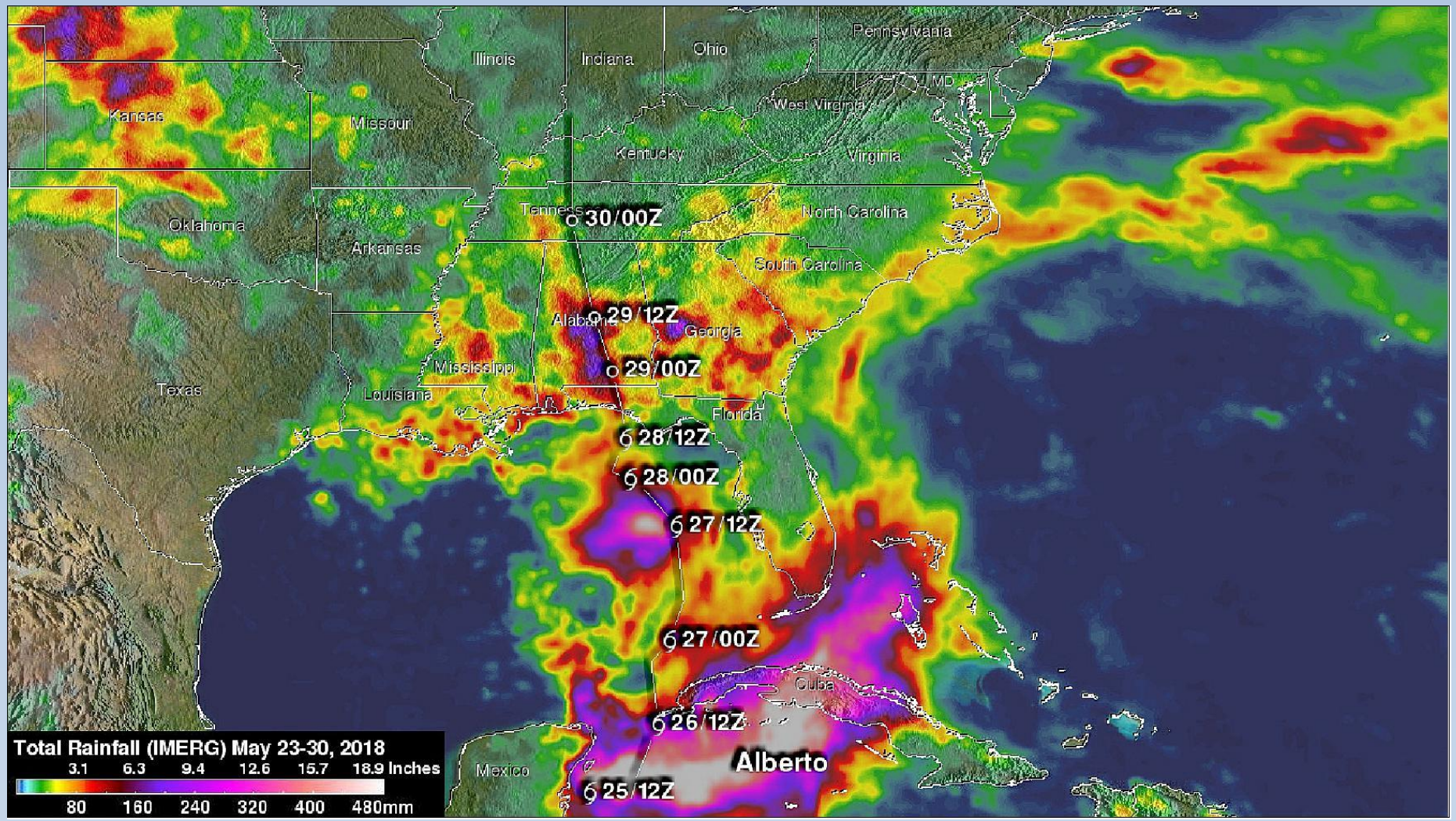
SST by MW



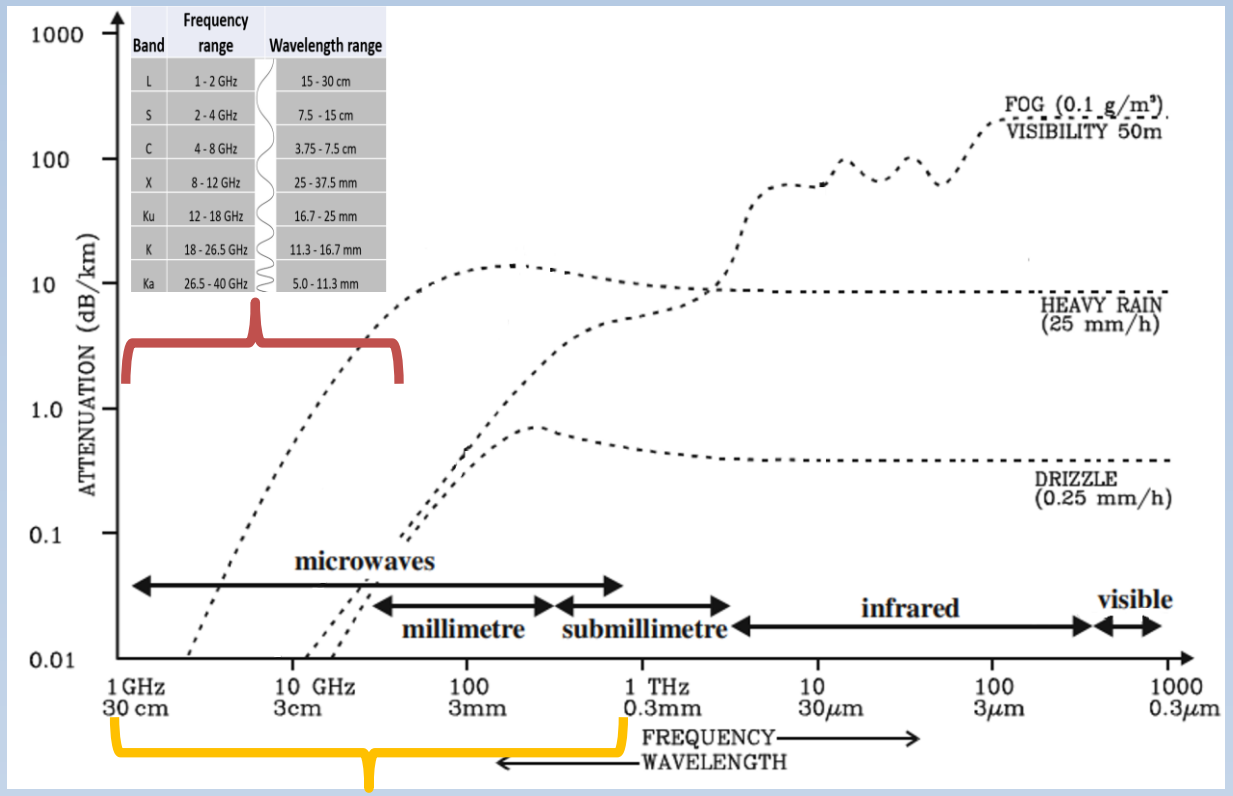

Total Precipitable Water 2022-08-09 1600 UTC
30°N
20°N
10°N
0°
10°S
20°S
30°S
40°S
30°E
40°E
50°E
60°E
70°E
80°E
90°E
100°E
110°E
120°E
130°E
3.0 in
2.5
2.0
1.5
1.0
0.5
0.0
70 mm
60
50
40
30
20
10
0
CIMSS
60°S
90°S
30°E
60°E
90°E
120°E
150°E
180°
150°W
120°W
90°W
60°W
30°W
0°

More information !

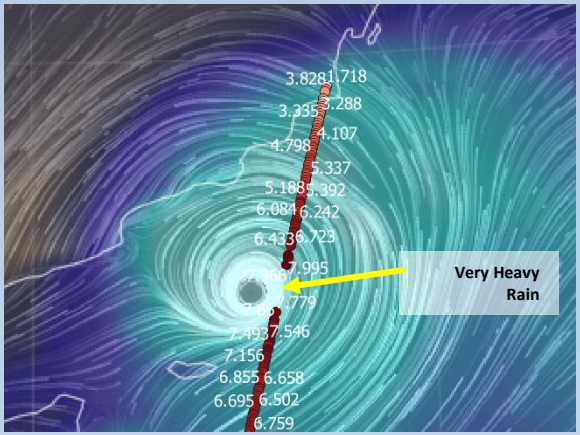



Illinois
Indiana
Ohio
Pennsylvania
Kansas
Missouri
West Virginia
MD
Kentucky
Virginia
Tennessee
North Carolina
Oklahoma
Arkansas
South Carolina
Alabama
Georgia
Mississippi
Texas
Louisiana
Florida
Cuba
Mexico
Alberto
30/00Z
29/12Z
29/00Z
28/12Z
28/00Z
27/12Z
27/00Z
26/12Z
25/12Z
Total Rainfall (IMERG)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

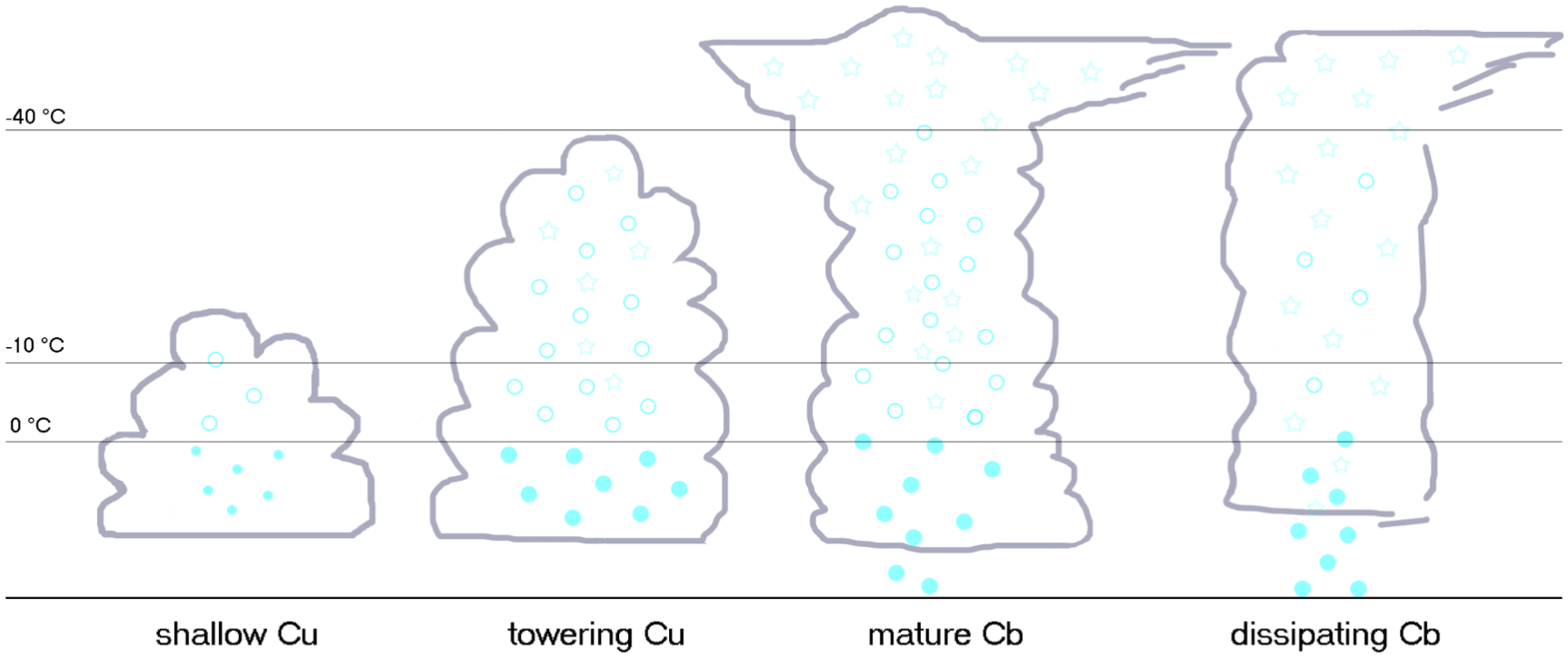
Impact of Rain in EM Waves



Ka Band Altimetry

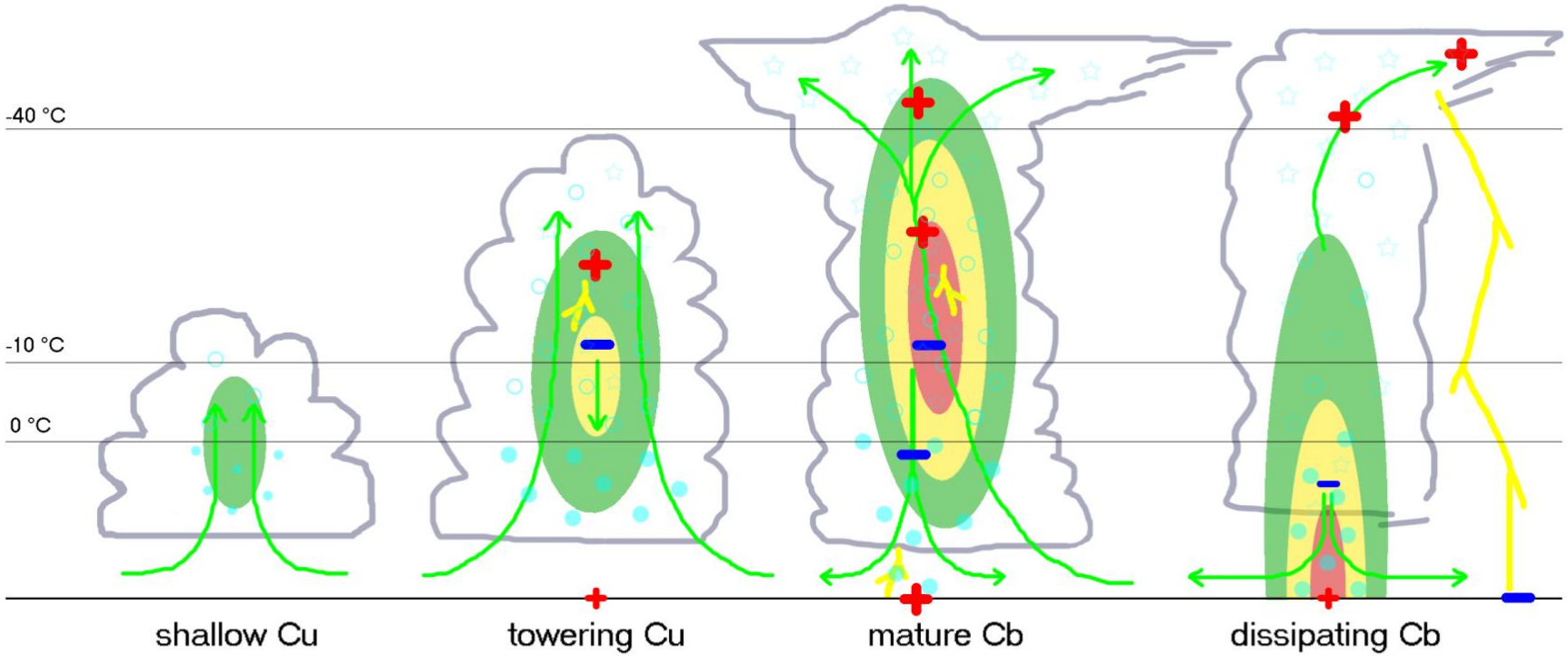


Thunder Storm Life cycle



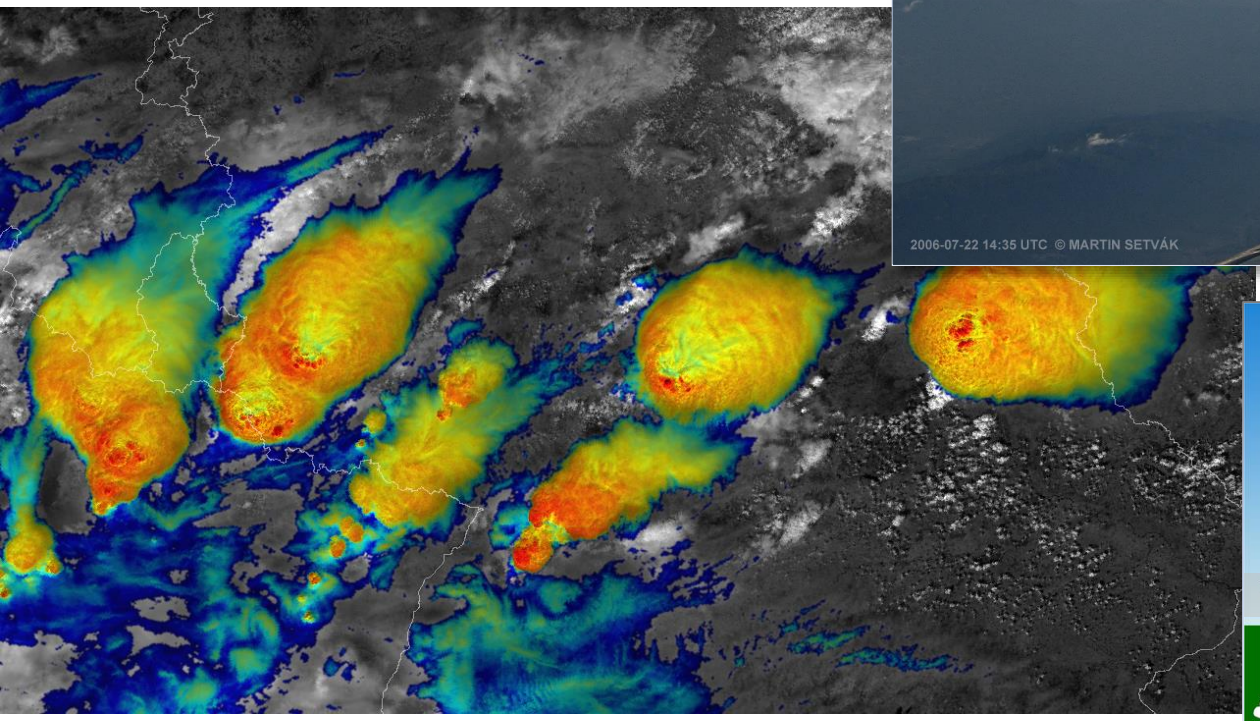
Source: EUMETSAT

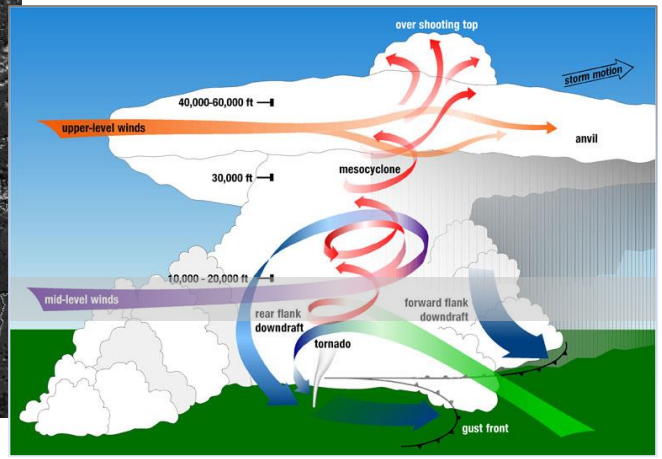
Thunder Storm Life cycle



Source: EUMETSAT

Cloud top features



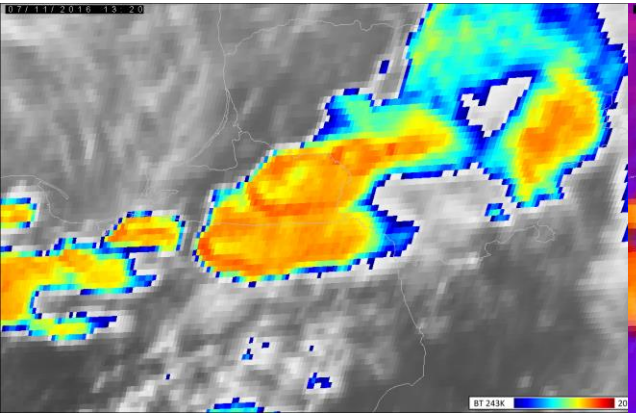


source: Martin Setvák (CHMI)

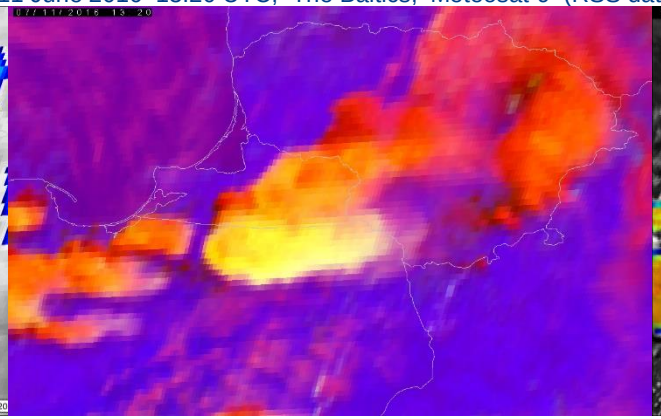
Cloud-top features

- overshooting tops, above-anvil ice plumes, gravity waves
- cold-U or cold-ring shapes
- small ice particles

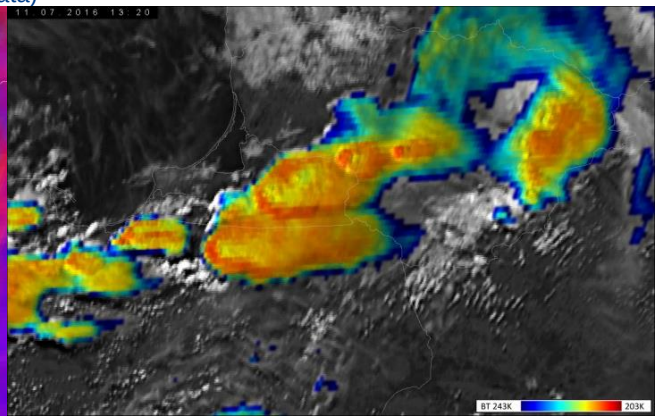
11 June 2016 13:20 UTC, The Baltics, Meteosat-9 (RSS data)



IR 10.8 BT color-enhancement



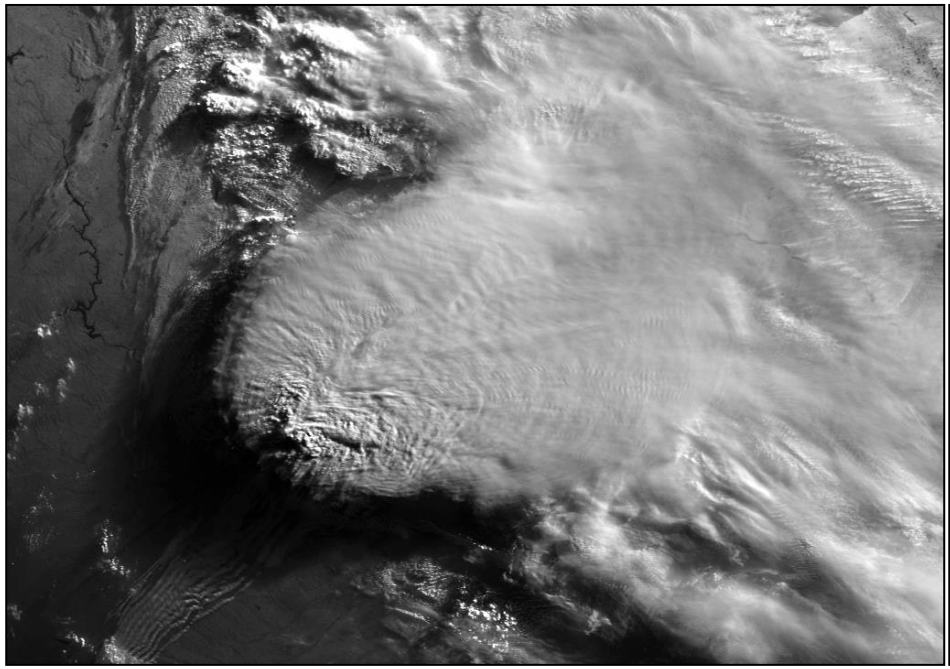
Storm RGB product



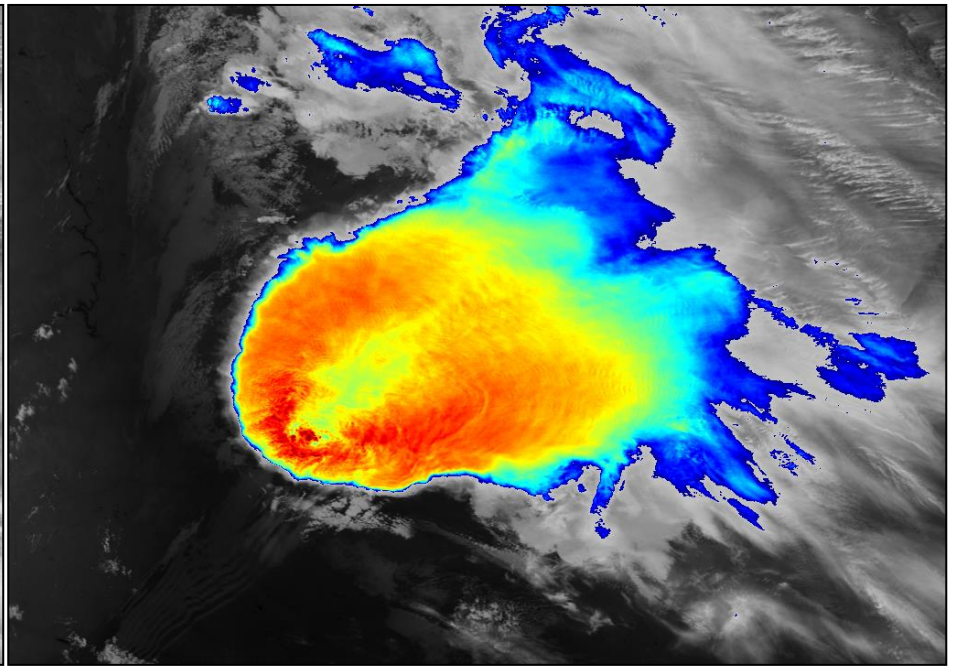
Sandwich product

Source: EUMETSAT

Sandwich product

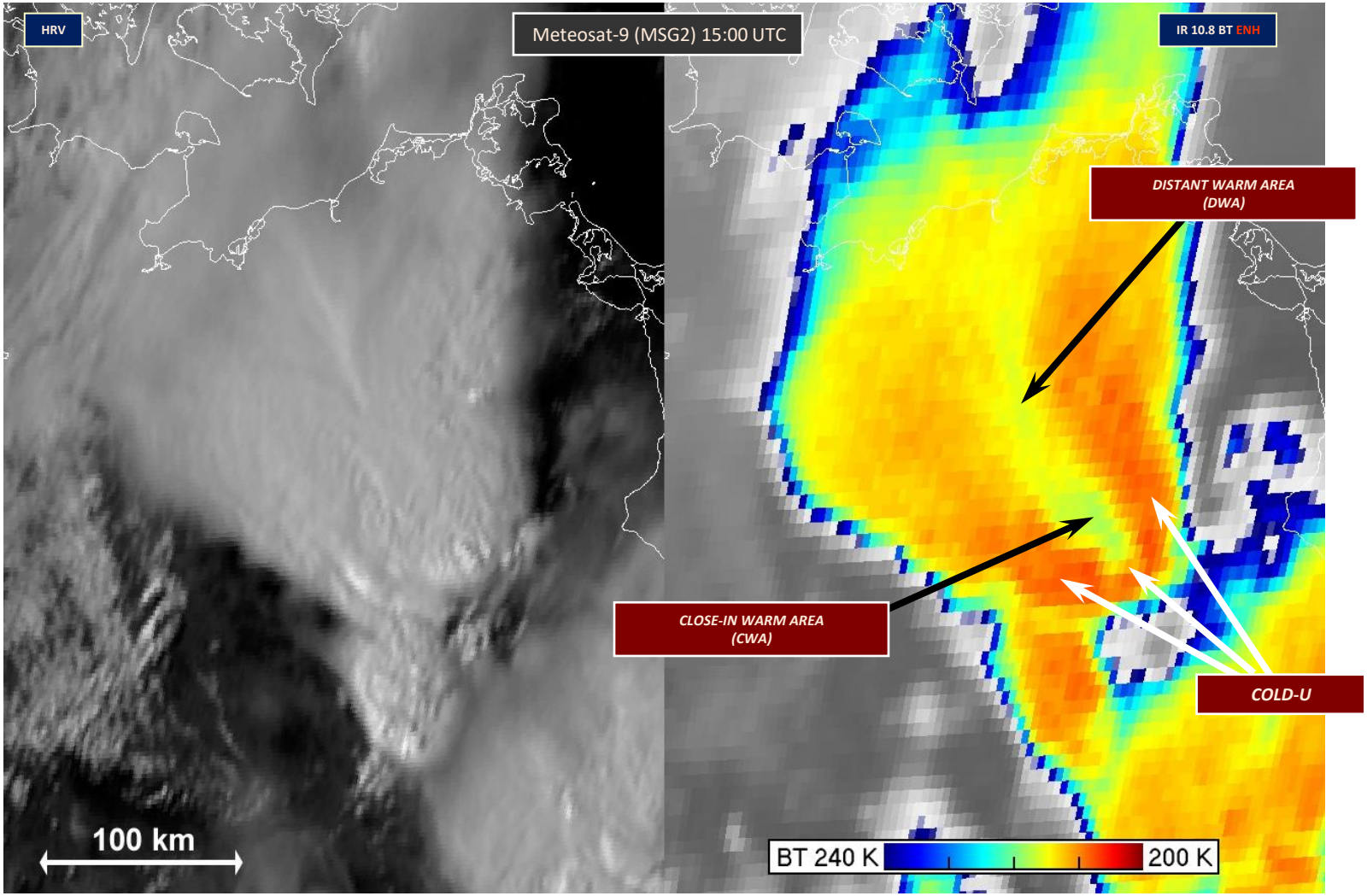


AVHRR band 2

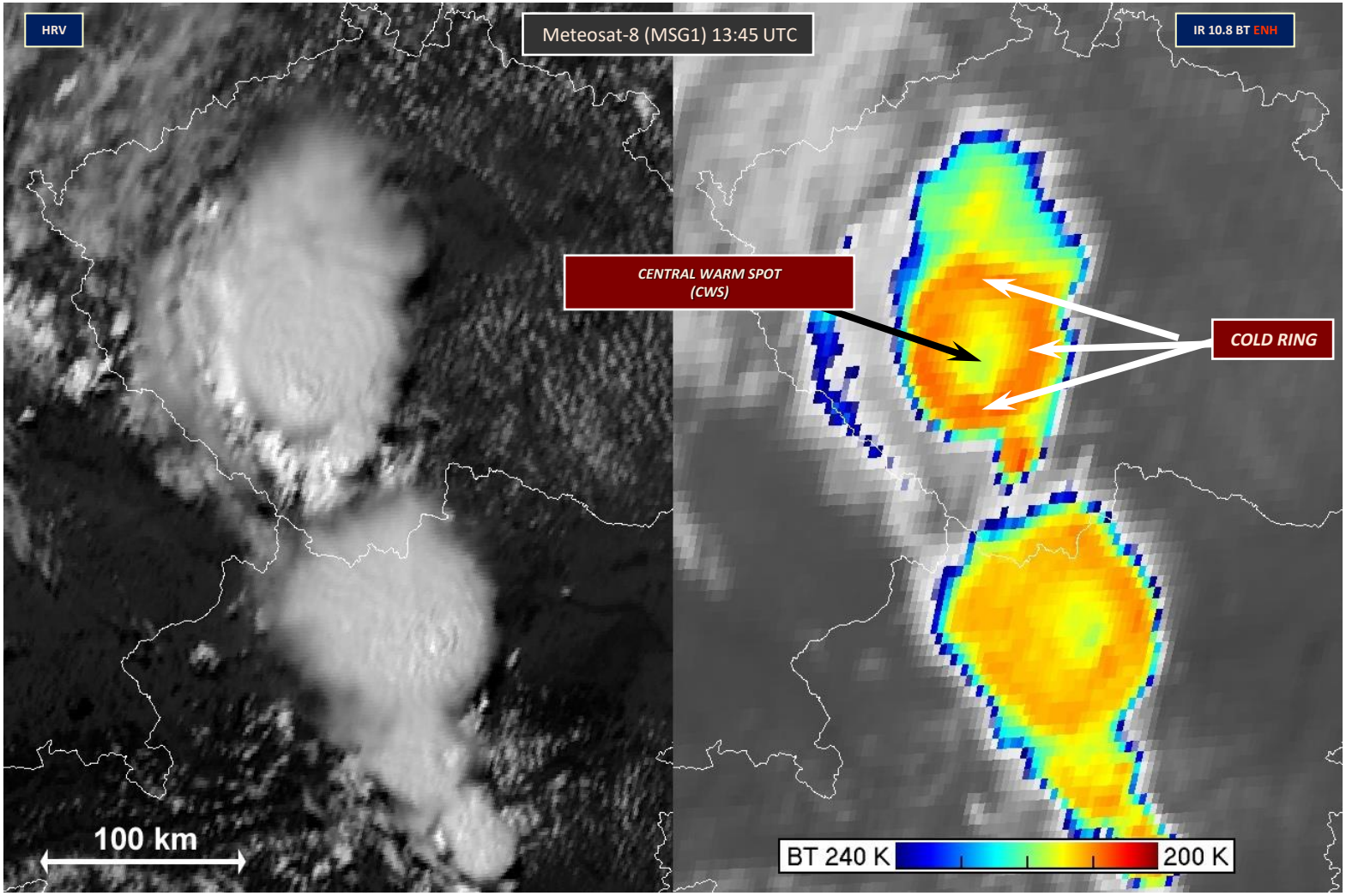


AVHRR band 4 BT (198 – 233 K)

source: Martin Setvák

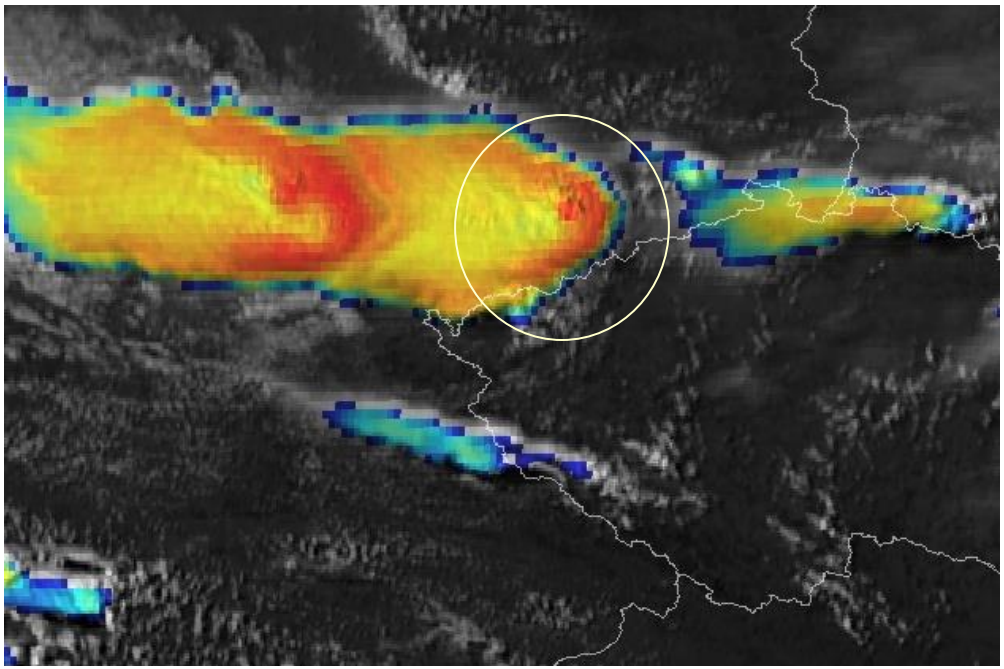


source:
Martin Setvák

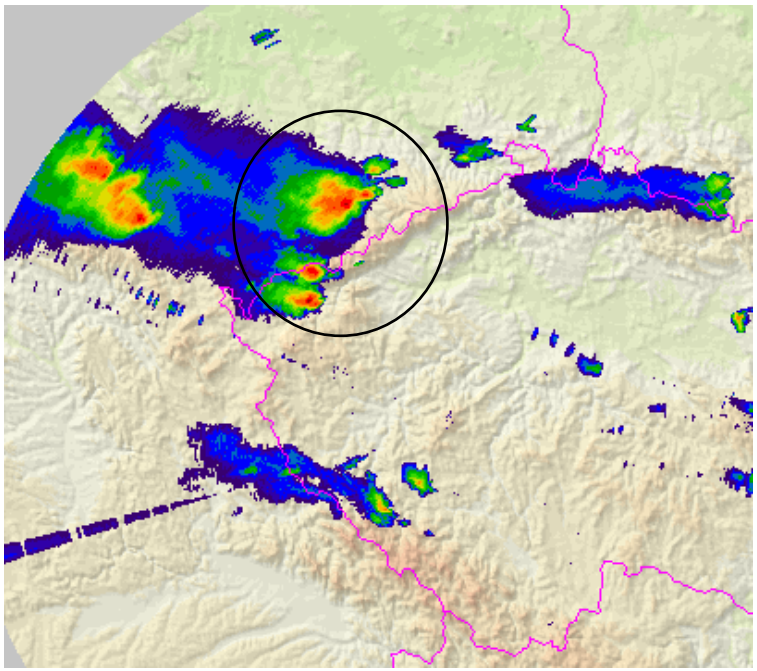


source:
Martin Setvák

Storm-cell as observed by radar and satellite

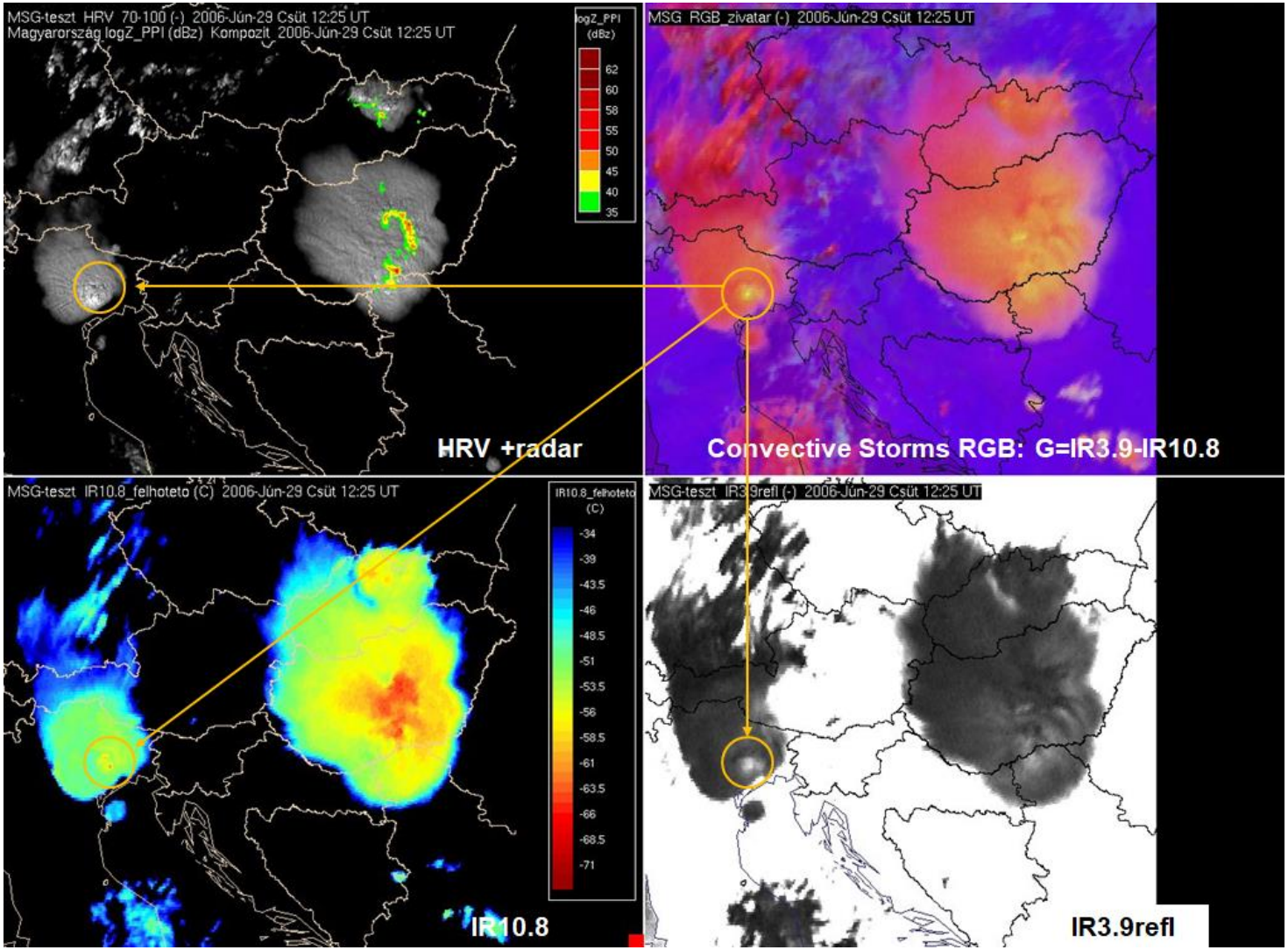


MSG-1 (Meteosat 8) sandwich product



Radar Rrdy (CZRAD), Z_{max}

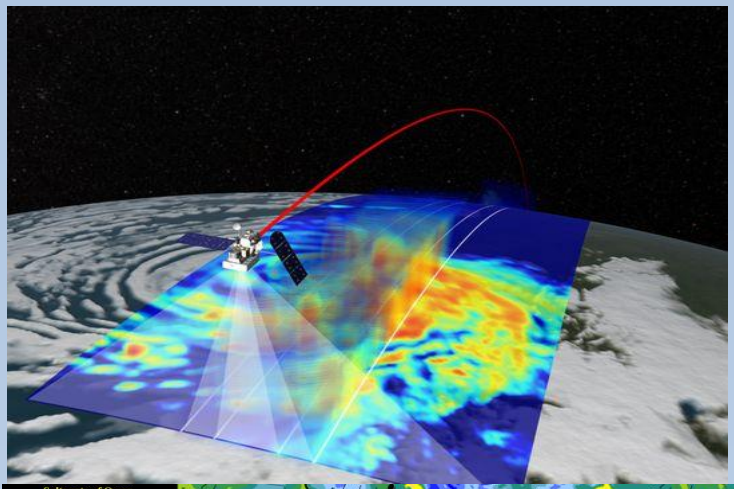
source: Martin Setvák

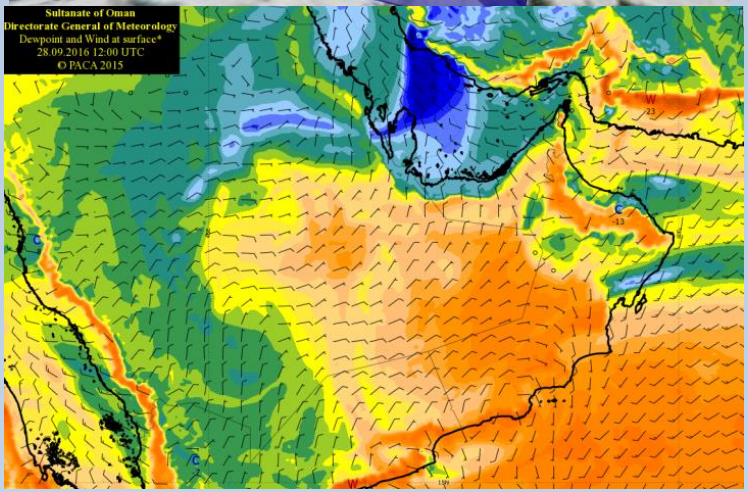


source: Maria Putsay (OMSZ)

Numerical weather prediction(NWP) and Satellite data

- About 70% of NWP models data are coming from satellite data.

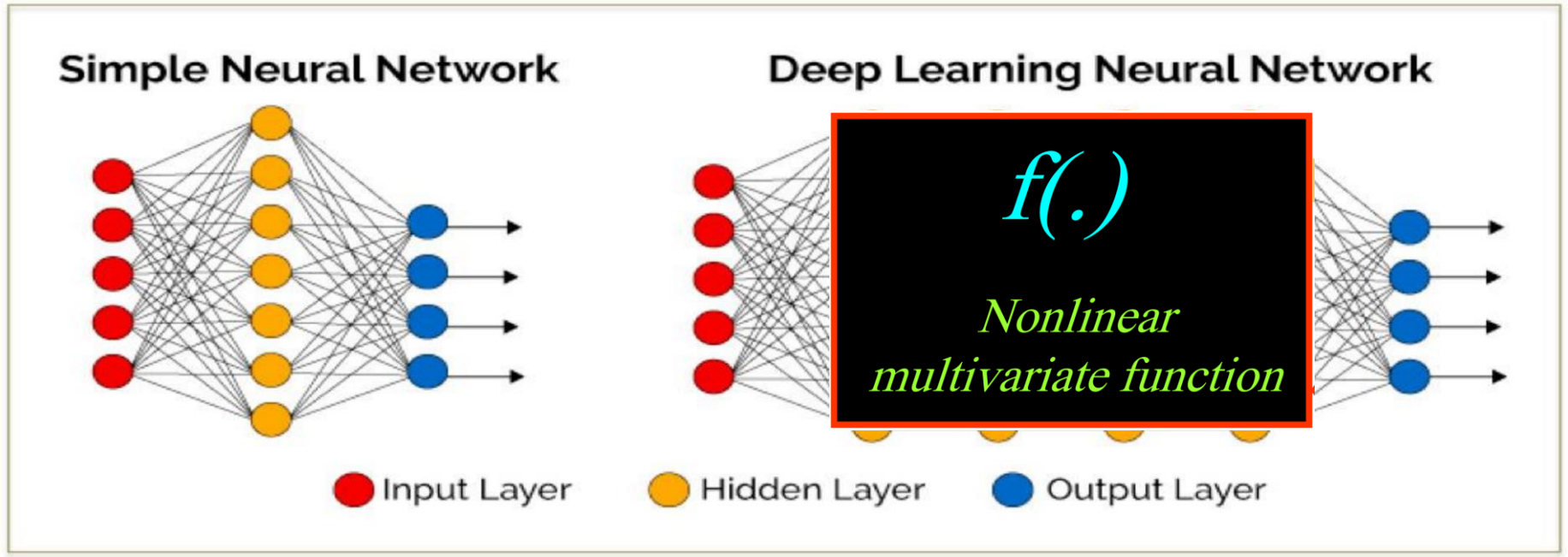




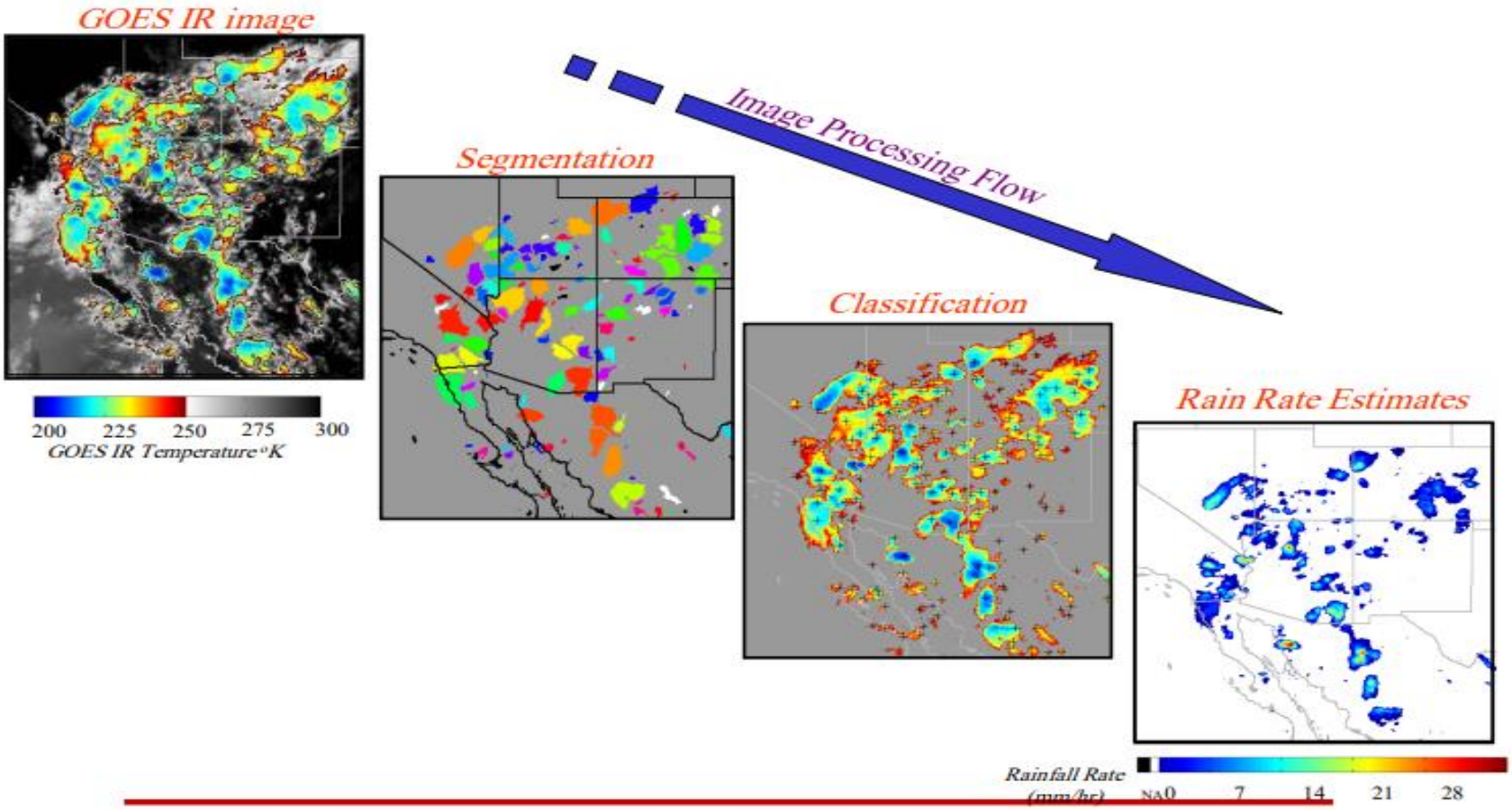
AI and Machine Learning

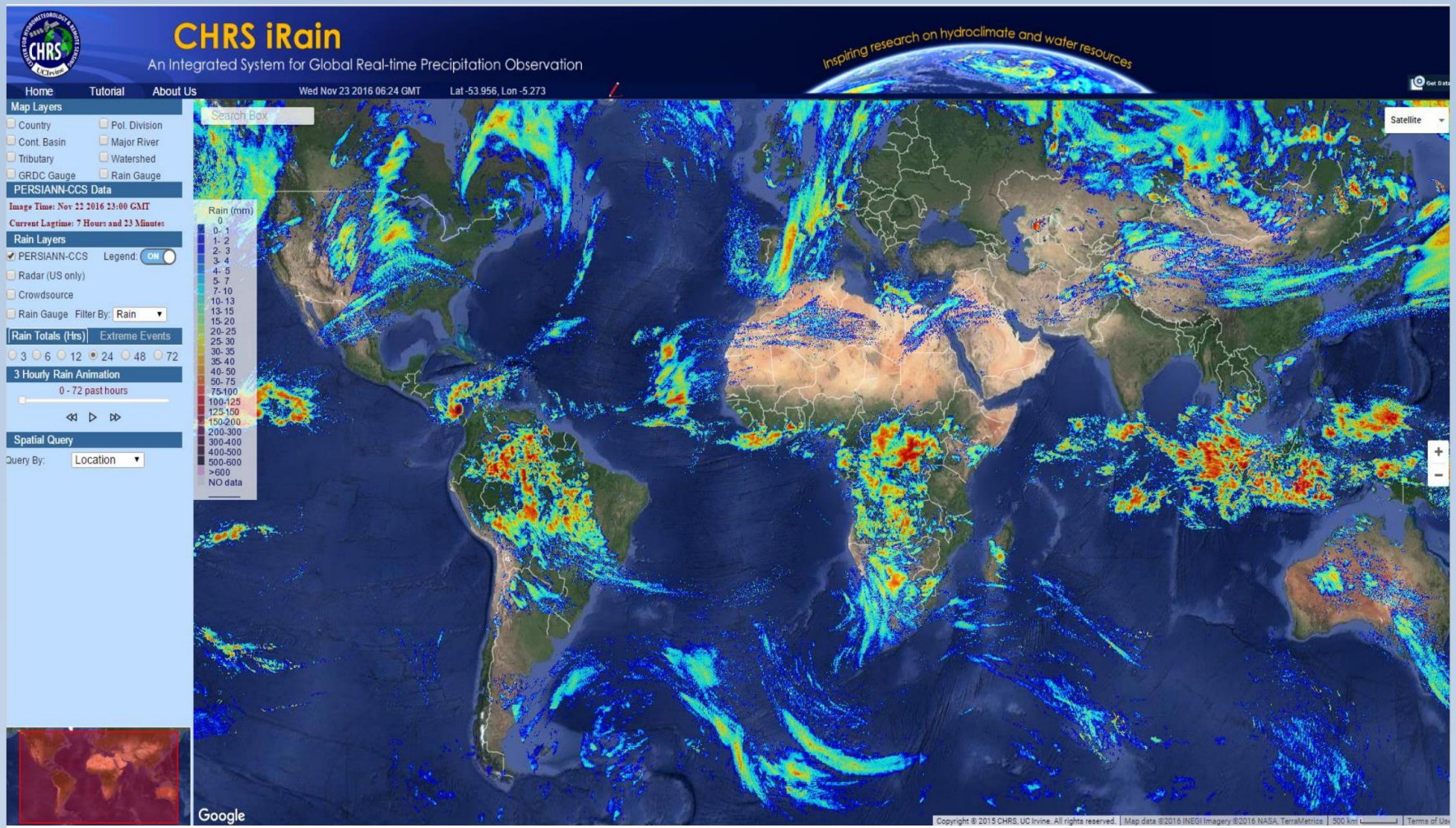
Artificial Neural Networks (**ANNs**), usually simply called **neural networks** (**NNs**) are computing systems inspired by the biological neural networks that constitute human brains.

An ANN is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a biological brain. Each connection, like the synapses in a biological brain, can transmit a signal to other neurons.



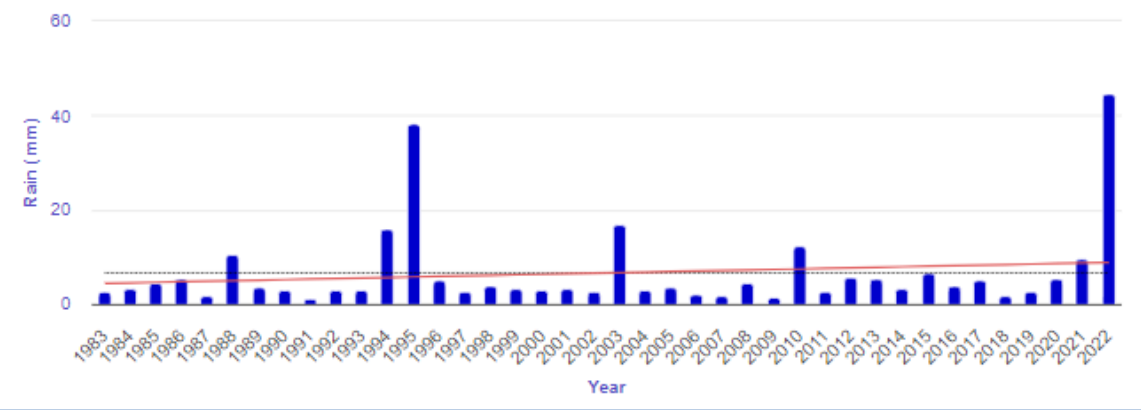
Cloud Classification and Rainfall Estimation

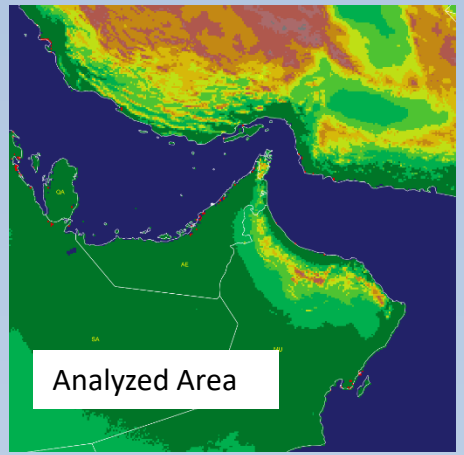




https://irain.eng.uci.edu/

July History





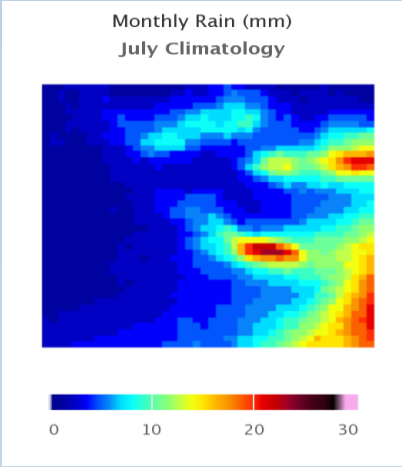
Where did this chart comes from?

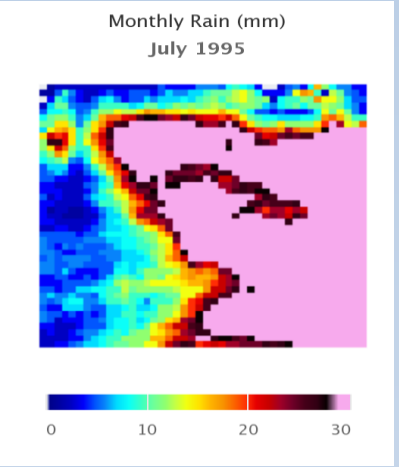
PERSIANN-CDR (Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks - Climate Data Record)

By: Center for Hydrometeorology and Remote Sensing (CHRS) at the University of California.

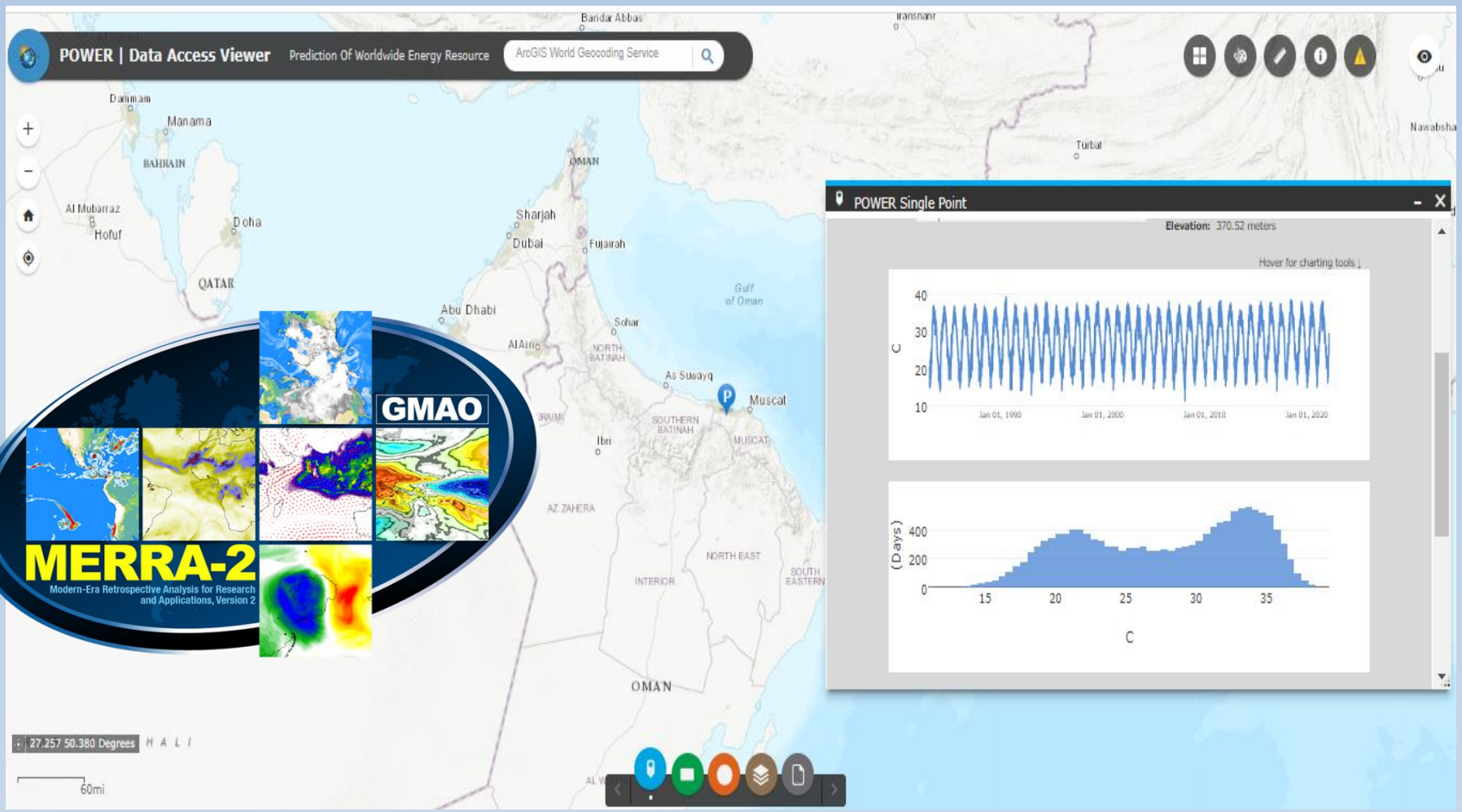
[CHRS RainSphere (uci.edu)]

Resolution:
0.25° x 0.25°
27.8 x 27.8 km

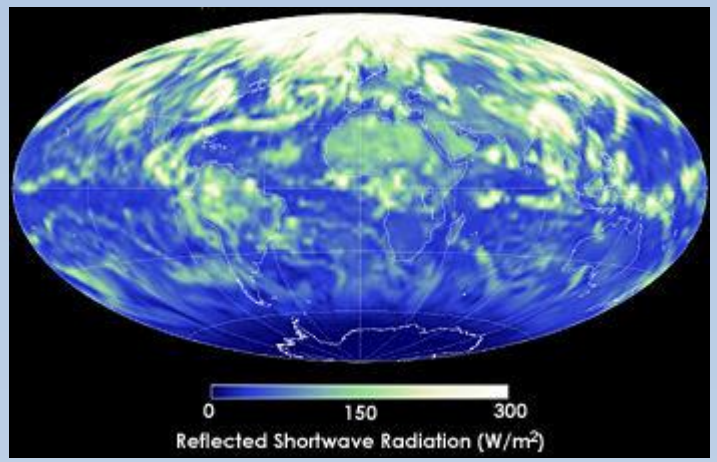


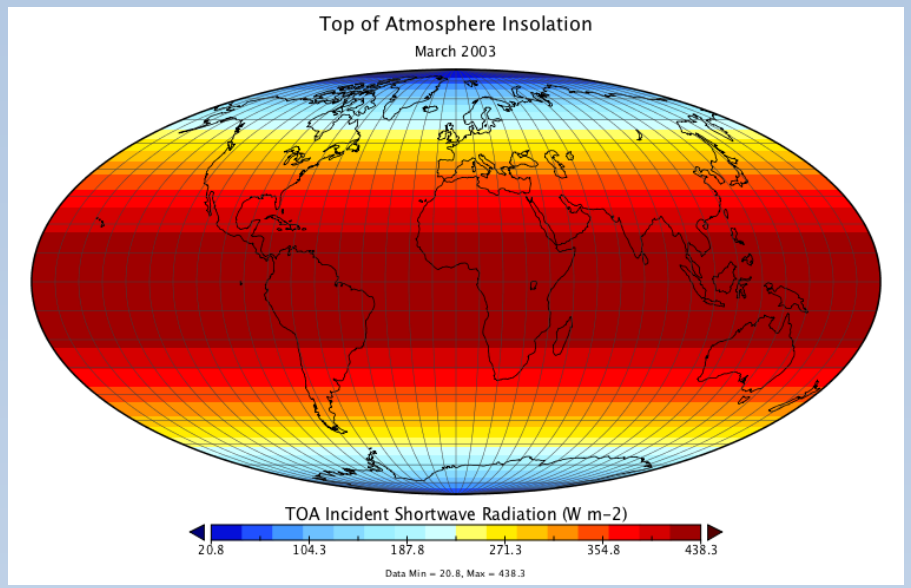


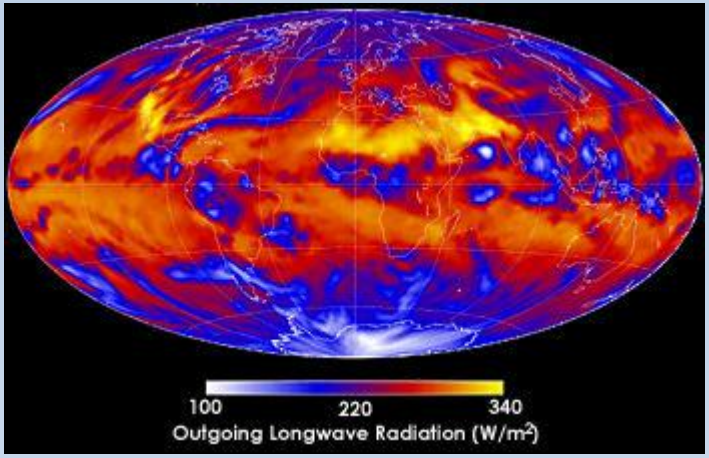
Reanalysis of Satellite Historic Data



Climate


0
150
300
Reflected Shortwave Radiation (W/m²)


Top of Atmosphere Insolation
March 2003
TOA Incident Shortwave Radiation (W m-2)
20.8
104.3
187.8
271.3
354.8
438.3
Data Min = 20.8, Max = 438.3


100
220
340
Outgoing Longwave Radiation (W/m²)

Centre of Excellence

Centre of Excellence/Muscat established: in January 2006

THANK YOU