

Satellite Ground Station at University of Dhaka



Department of Meteorology
Faculty of Earth and Environmental Sciences
University of Dhaka

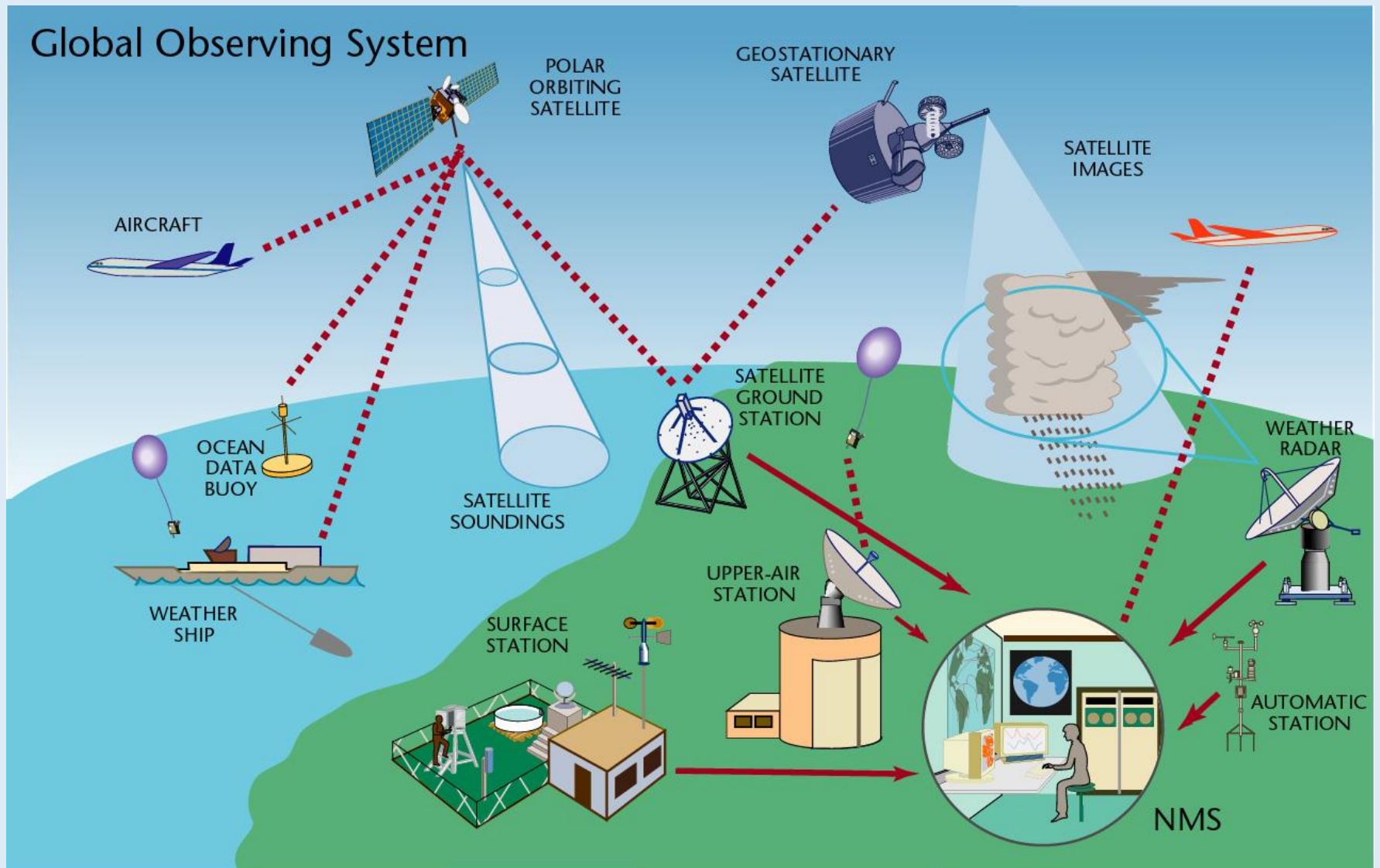
Satellite: Introduction

- *“A satellite is a moon, planet or machine that orbits a planet or star. For example, Earth is a satellite because it orbits the sun. Likewise, the moon is a satellite because it orbits Earth. Usually, the word "satellite" refers to a machine that is launched into space and moves around Earth or another body in space.”* – NASA (2014)
- The then Soviet Union successfully launched ‘SPUTNIK – 1’ on October 4, 1957; which happens to be the world’s first artificial satellite. – NASA (2014)

Satellite: Introduction

- TIROS-1 was launched on April 1, 1960 and is considered to be the first successful weather satellite in history. By 1965, meteorologists combined 450 TIROS images into the first global view of the planet's weather, picking up a line of clouds over the Pacific Ocean barreling toward the United States. – Geospatial World (2016)
- Satellites can be classified by their function since they are launched into space to do a specific job. There are nine different types of satellites on the basis of functionality. But, on the basis of orbital paths satellites could be – Geostationary, Low Earth Orbital, Medium Earth Orbital, Polar Orbital and Sun-synchronous Orbital satellites. Other than that, satellites could have transfer orbits or geostationary transfer orbits and L-point orbits. – ESA (2020)

Satellite: Introduction



Satellite Ground Station at Department of Meteorology

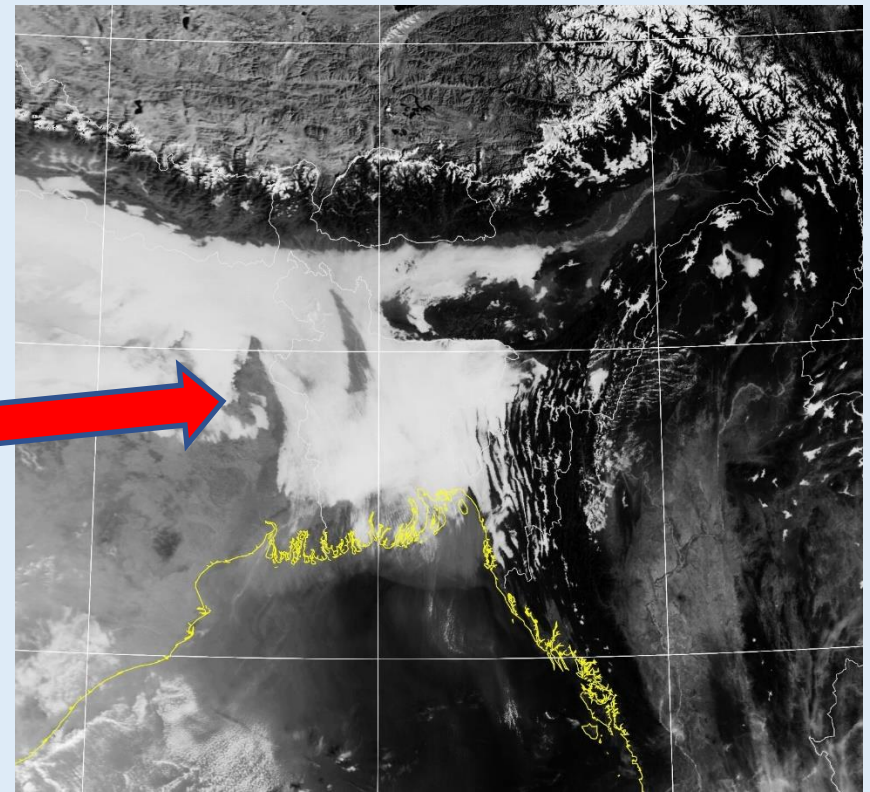
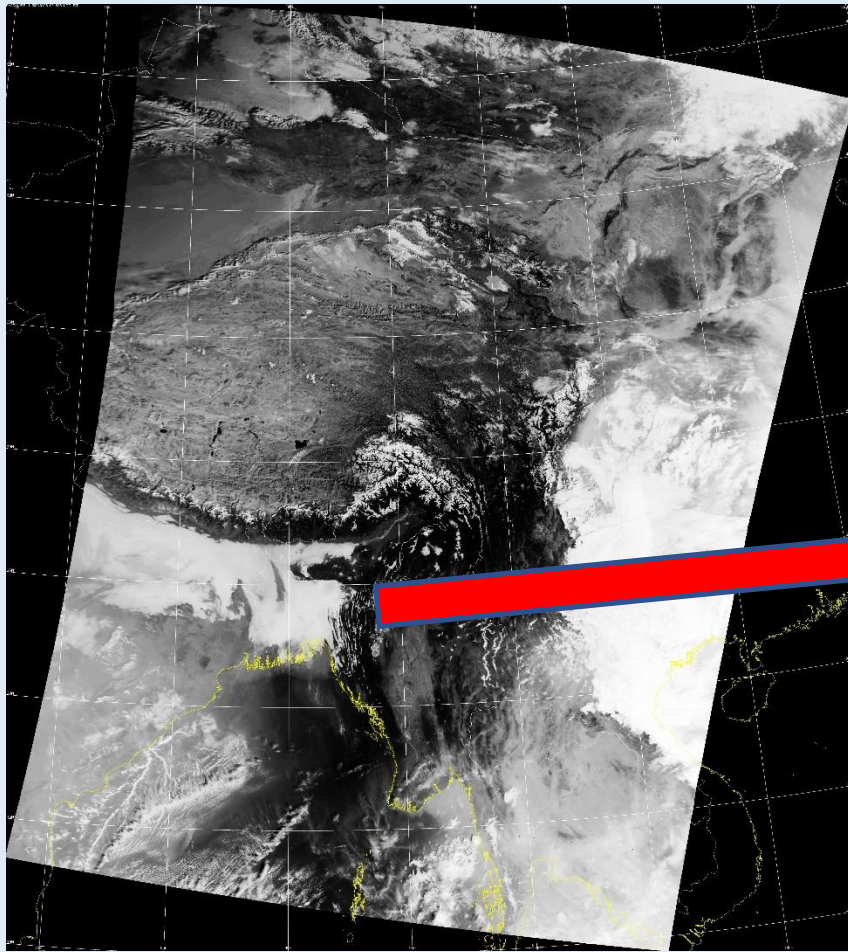
Configuration

1. Enclosed positioner and RF front end - safe from extreme environment
2. Enclosed dehydrator - Dry positive pressured air inserted to the entire antenna system to protect electronics and keep the RF performance at its maximum
3. Lightweight 6061 aluminum structure - can be mounted on most existing Buildings
4. Covers X/L band -
 - X band is used because it provides a compromise between the characteristics of different frequency bands
 - L band waves are used because they are able to penetrate clouds, fog, rain, storms, and vegetation
5. CE “man rated” for safety – with European safety certification

Satellite Ground Station at Department of Meteorology

- At present, the system receives data from 12 satellites of 07 different constellations are available at the Department of Meteorology, University of Dhaka. These numbers will increase in future.
- The available satellites are – NOAA 18 and 19; FENGYUN 3B, 3C and 3D; METOP A, B and C; MODIS TERRA; MODIS AQUA; JPSS 1; and NPP.
- All of them have several sensors on board. The products are very useful for obtaining information about the atmospheric profiles, air quality, vegetation coverage, hydrological observations, observation for natural disasters (e.g. tropical cyclones, drought, winter fog) etc.

Satellite Ground Station at Department of Meteorology



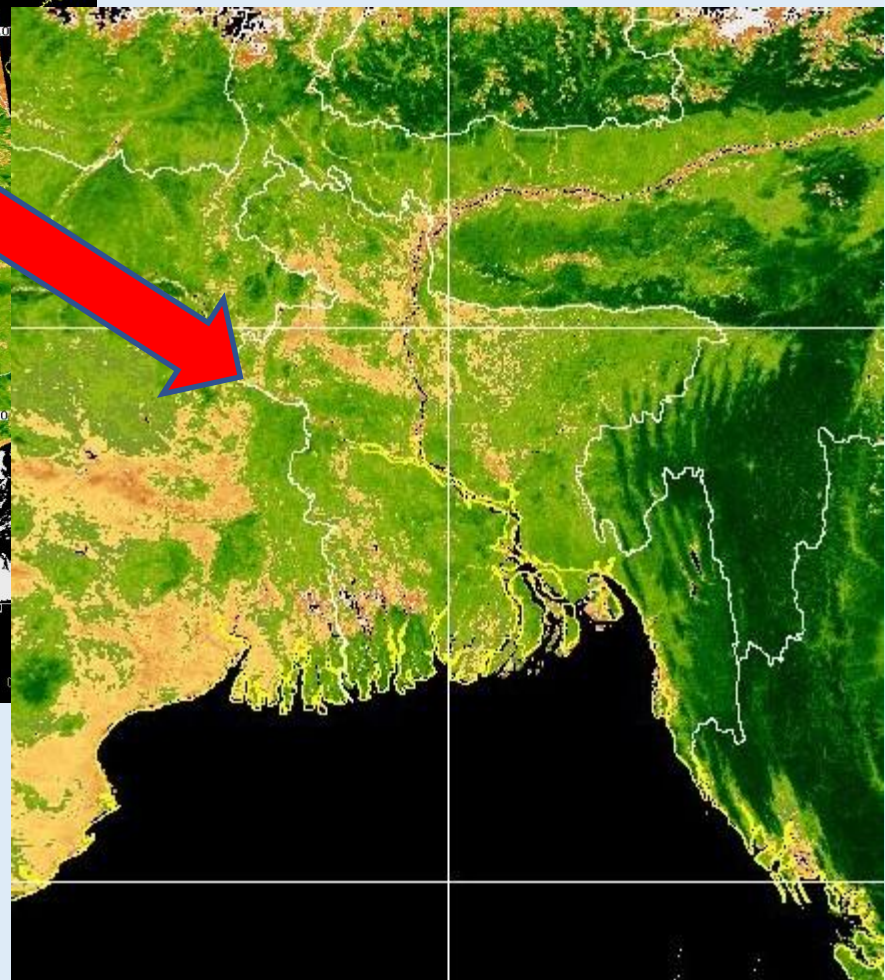
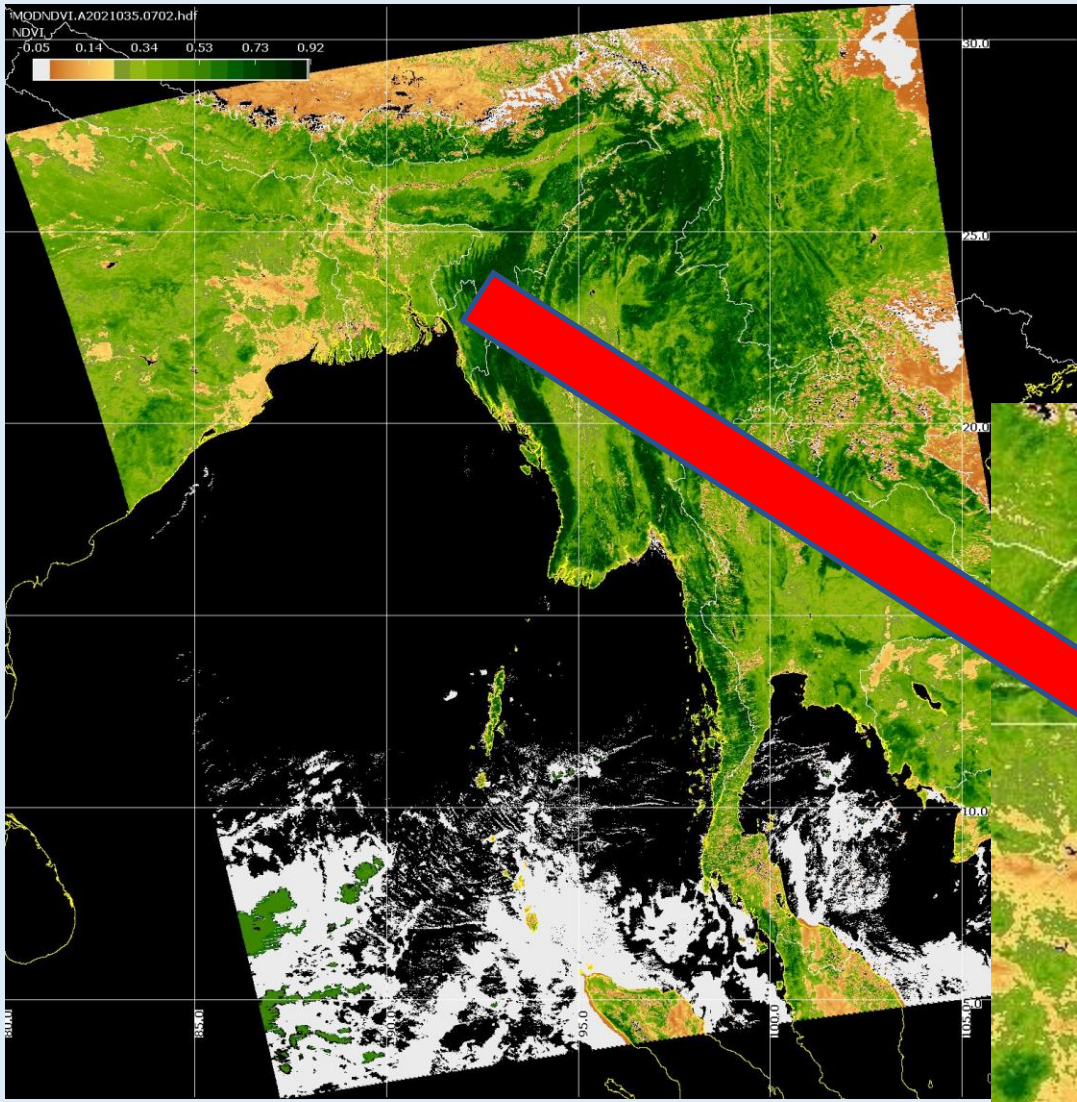
Winter fog event detected through FY3 satellite

Satellite Ground Station at Department of Meteorology

Satellite	Observation Mode	Daily Total Pass
NOAA 18	Both DAY and NIGHT	3
NOAA 19	Both DAY and NIGHT	4
FENGYUN 3B	Both DAY and NIGHT	4
FENGYUN 3C	Both DAY and NIGHT	3
FENGYUN 3D	Both DAY and NIGHT	4
METOP A	Both DAY and NIGHT	3
METOP B	Both DAY and NIGHT	2
METOP C	Both DAY and NIGHT	3
MODIS TERRA	Both DAY and NIGHT	2
MODIS AQUA	Both DAY and NIGHT	4
JPSS 1	Both DAY and NIGHT	4
NPP	Both DAY and NIGHT	4

Major Applications and Benefits

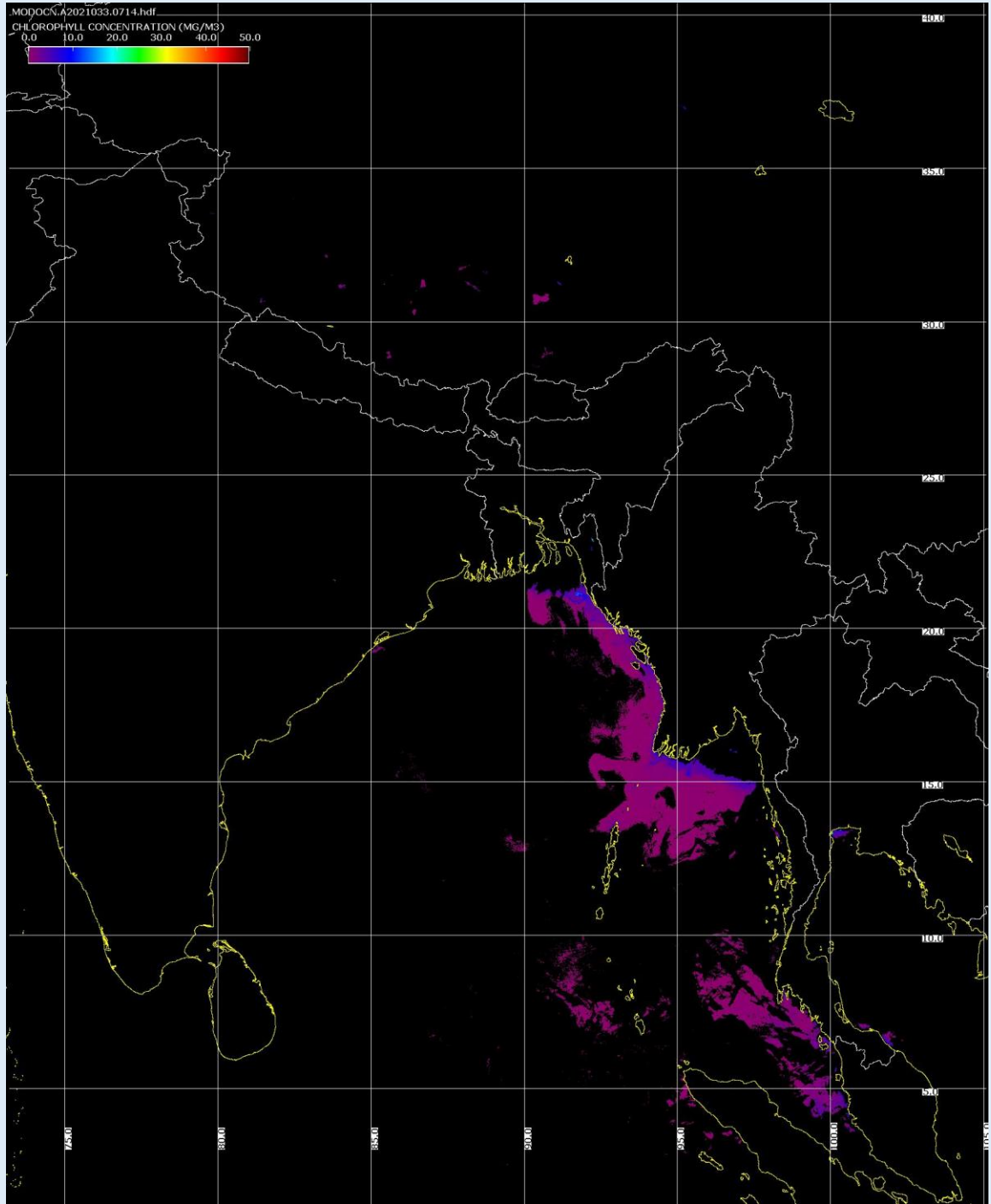
- Meteorological Researches: Application of satellite data in NWP models; application of satellite data in observation for different atmospheric phenomena and disasters (e.g. winter fog, tropical cyclones, thunderstorms, local severe storms etc.).
- Application to navigators, aviation and road transport: Satellite products are highly valuable for maintain regular and uninterrupted transportation.
- Application in Agriculture: Analysis from satellite derived products (e.g. NDVI, surface temperature measurement, intercepted solar radiation measurement, soil moisture measurement etc.) are necessary for several agricultural research related issues; such as – crop assessment, drought monitoring.



NDVI from TERRA MODIS satellite data; available at the Department of Meteorology, University of Dhaka.

Major Applications and Benefits

- Application in Hydrology: The available satellite data are useful for rainfall analysis and synoptic analysis; and therefore has applications in hydrological modelling.
- Application in Climate Science: Different satellite data are available within the system that are good for studying the climate patterns, global warming and relevant issues on climate change.
- Application in Marine Biology and Ocean Dynamics: There are some satellite data available at this system that incorporates Chlorophyll Concentration data and also Sea Surface Temperature data. These are relevant for studying the marine biology and ocean dynamics.
- Application in Atmospheric Chemistry: Several products are available within the system for observations of atmospheric aerosols and particulate matters, concentration of toxic/harmful gases, aerosol optical depth, measurements for atmospheric pollution etc. These are vital information about the atmospheric chemistry.



Chlorophyll Concentration (mg/cubic meter) obtained from MODIS AQUA satellite data. This image for February 02, 2021; and shows a range of values from 0.0 to 10.0 mg/cubic meter.

Satellite Products

Applications

MODIS Level 1B Products

- Quicklook images (visible and infrared; sensor projection)
- Radiances/Reflectances for all 36 MODIS bands at 1000/500/250 meter resolution
- Geolocation at 1000-meter resolution (latitude, longitude, sensor and satellite zenith and azimuth, terrain height, land/ocean flag)
- Destriping corrections for Level 1B 1KM infrared radiances MODIS Level 2 Land Products

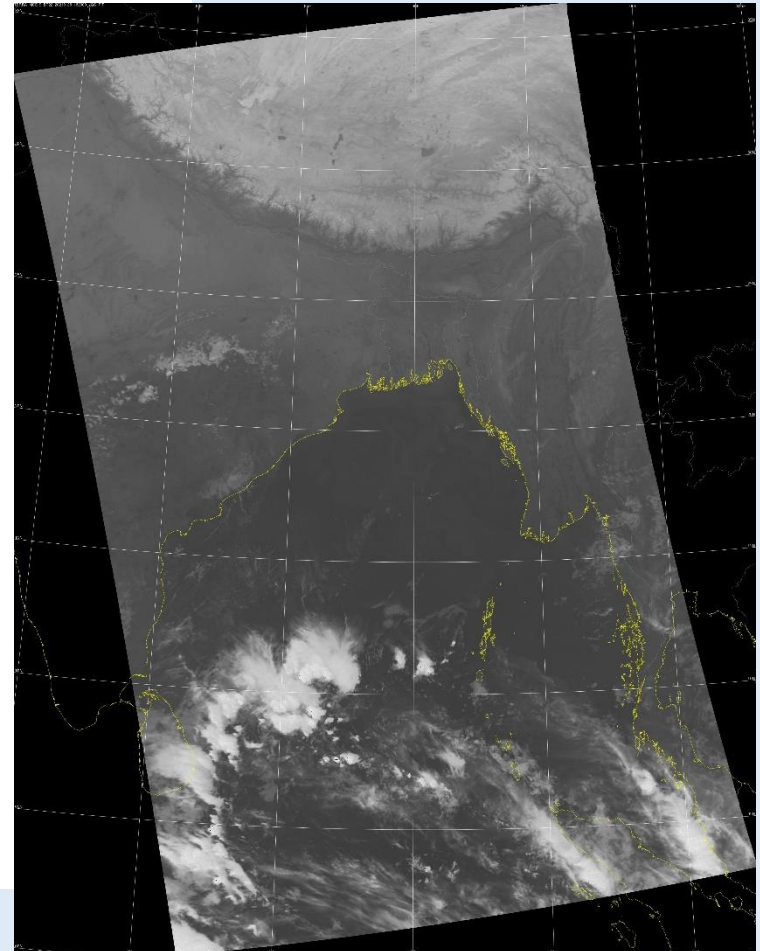
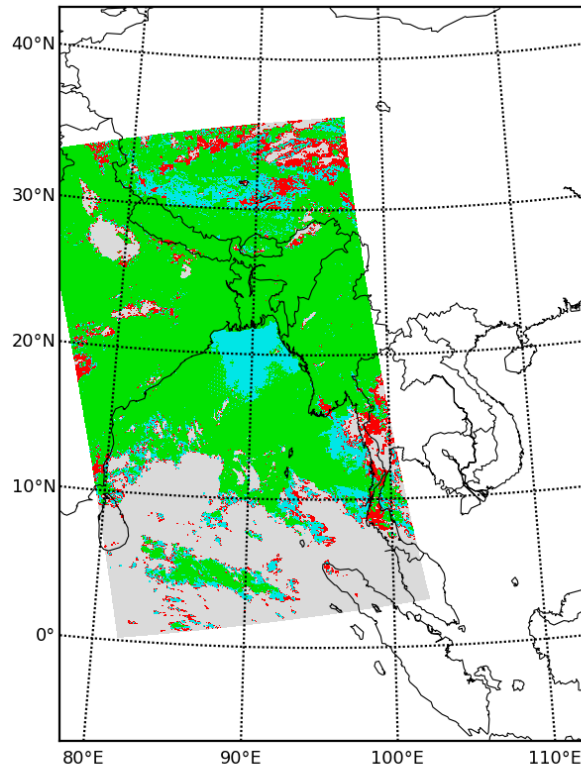
MODIS Level 2 Atmosphere Products

- Cloud Mask
- Cloud Top Pressure, Phase, Effective Emissivity, Optical Depth
- Aerosol Optical Depth
- Temperature and Water Vapor Profiles
- Total Column Precipitable Water Vapor (Infrared, Day/Night)
- Total Column Ozone
- Total Column Precipitable Water Vapor (Near-Infrared, Day only)

The satellite image from MODIS (available at the department) was used to prepare an illustration for showing cloud coverage over Bangladesh

MODIS Cloud Mask

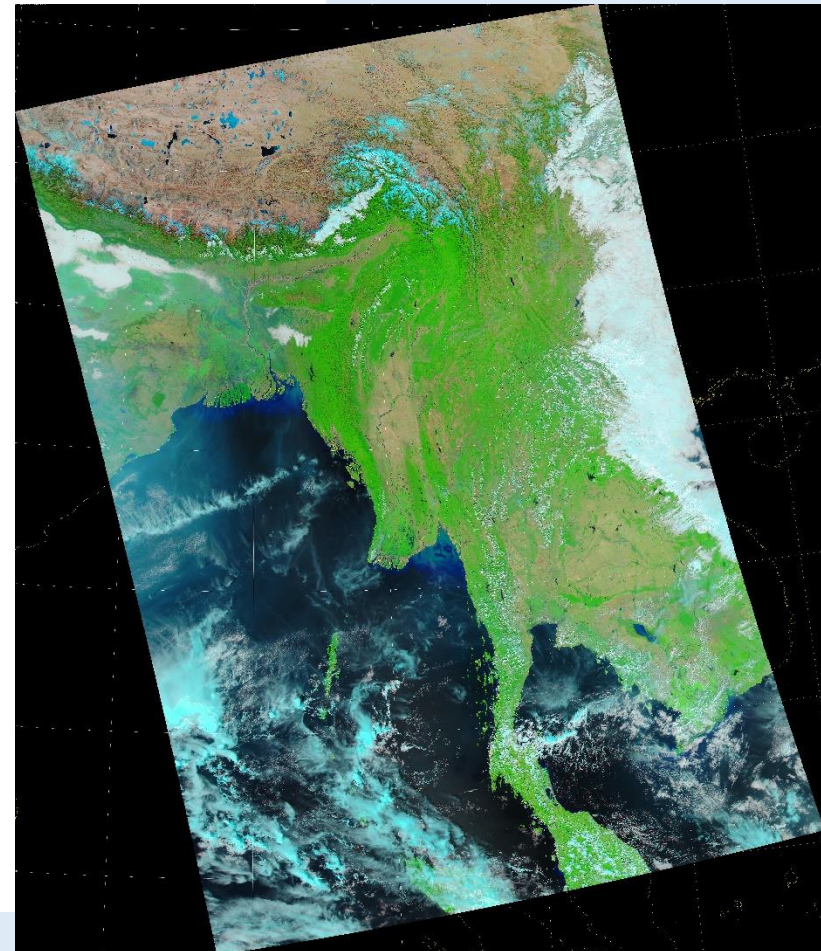
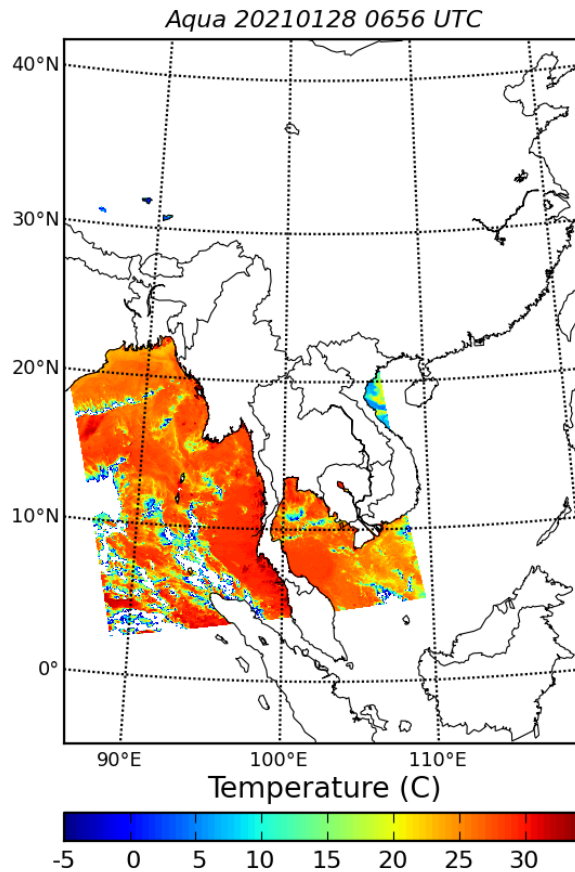
Terra 20210128 1620 UTC



MODIS Level 2 Land Products	<ul style="list-style-type: none"> • Corrected Reflectance • Fire Detection / Thermal Anomalies • Land Surface Temperature (LST) • Normalized Difference Vegetation Index (NDVI) • Enhanced Vegetation Index (EVI) • Land Surface Reflectance
MODIS Level 2 Ocean Products	<ul style="list-style-type: none"> • Atmospherically Corrected Reflectance • Chlorophyll-A Concentration • Sea Surface Temperature • Aerosol Optical Thickness • Epsilon of Aerosol Correction • Diffuse Attenuation Coefficient • Angstrom Coefficient • Photosynthetically Available Radiation • Particulate Organic Carbon • Dissolved Organic Matter • Chlorophyll Fluorescence
Aqua AIRS and AMSU Level 1B Products	<ul style="list-style-type: none"> • Radiance, antenna temperatures, and geolocation
Aqua AIRS/AMSU Level 2 Products	<ul style="list-style-type: none"> • Profiles of Atmospheric Temperature and Moisture • Cloud Top Properties

Sea Surface Temperature has been calculated using the satellite data from MODIS AQUA

MODIS Sea Surface Temperature



**NOAA-20
Suomi
Products**

and VIIRS Level 1B Products: Radiances/Reflectances for all M-bands, I-bands, and Day/Night band at 750/375 meter resolution; Geolocation for M-bands, I-bands, and Day/Night band (latitude, longitude, sensor and satellite zenith and azimuth, terrain height)

VIIRS Level 2 Atmosphere Products: Aerosol Optical Thickness; Cloud Mask, Type, and Fraction; Cloud Top Pressure, Temperature, and Effective Emissivity; Cloud Albedo, Effective Radius, and Optical Depth

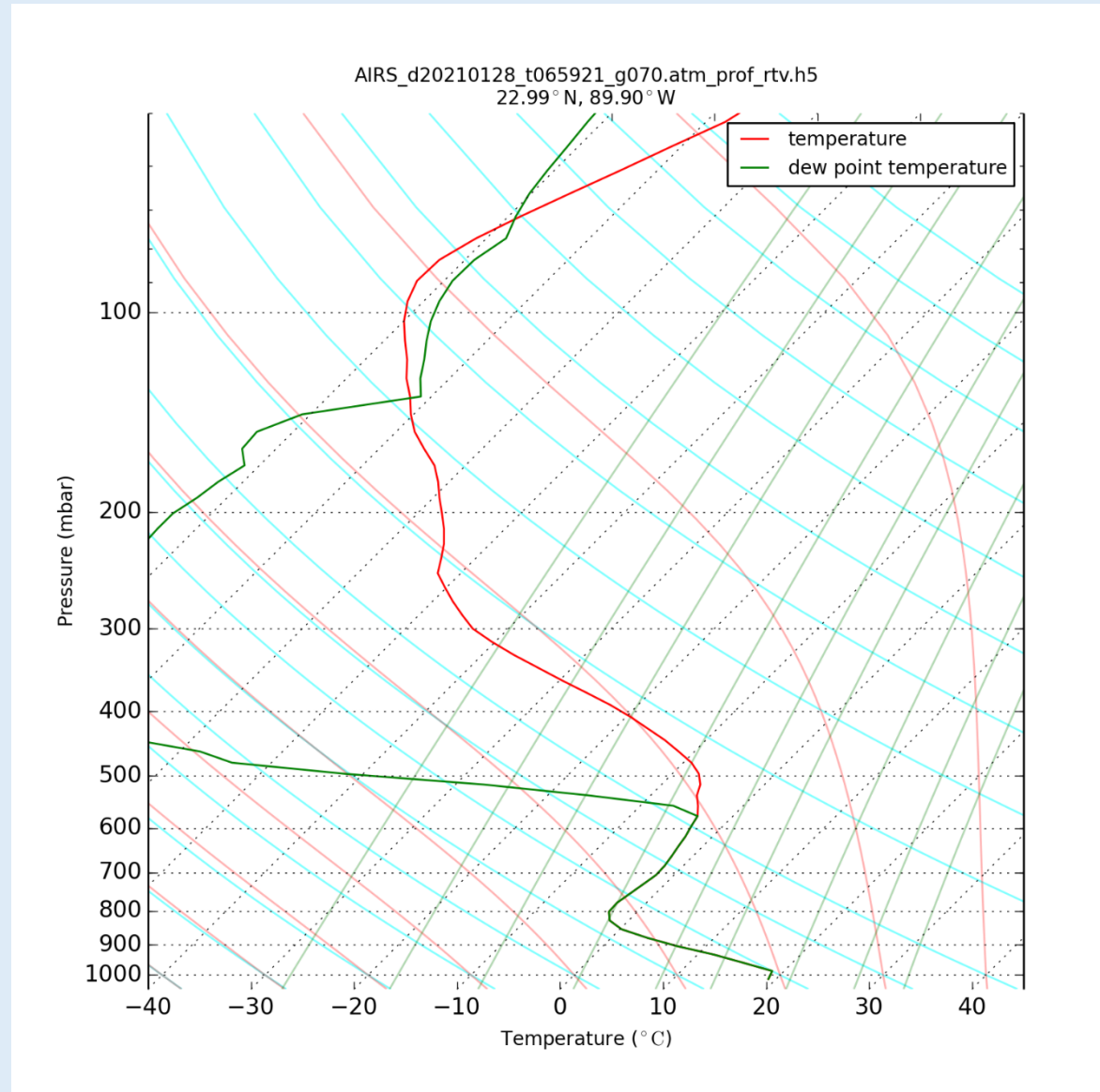
VIIRS Level 2 Ocean Products: Chlorophyll-A Concentration; Sea Surface Temperature; Normalized Water-Leaving Radiances; Aerosol Optical Thickness; Epsilon Of Aerosol Correction; Diffuse Attenuation Coefficient; Angstrom Coefficient; Photosynthetically Available Radiation; Particulate Organic Carbon; Dissolved Organic Matter; Chlorophyll Fluorescence

VIIRS Level 2 Land Products: Land Surface Temperature; Land Surface Reflectance; Normalized Difference Vegetation Index; Enhanced Vegetation Index; Corrected Reflectance; Fire Detection / Thermal Anomalies; Flood Detection

CrIS and ATMS Level 1B Products: Radiances, antenna temperatures, and geolocation; DBNet-BUFR formatted ATMS and CrIS observations

CrIS/ATMS Level 2 Products: Profiles of Atmospheric Temperature and Moisture; Precipitation Estimates

A Skew-T diagram, showing the upper atmospheric condition. This diagram has been calculated with the satellite data available at the Department of Meteorology.



**NOAA-18/19
Products**

AVHRR Level 1B Products: *Quicklook* images (visible and infrared; sensor projection); Radiances/Reflectances for all 5 AVHRR channels at 1000 meter resolution; Geolocation at 1000 meter resolution (latitude, longitude, sensor and satellite zenith and azimuth)

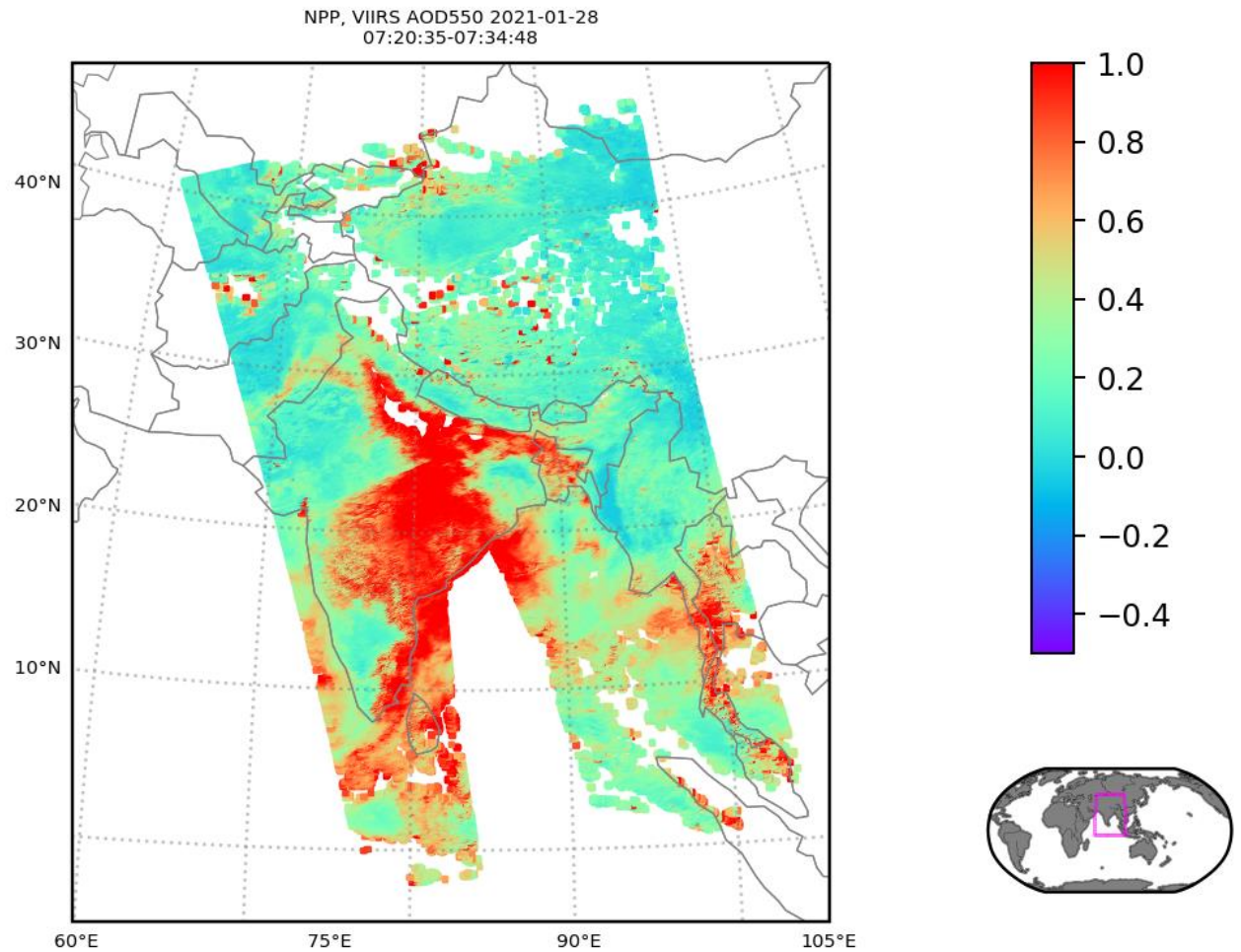
AVHRR Level 2 Products: Sea Surface Temperature; Normalized Difference Vegetation Index (NDVI); Cloud Mask, Type, and Fraction; Cloud Top Pressure, Temperature, and Effective Emissivity; Aerosol Optical Thickness; Cloud Albedo, Effective Radius, and Optical Depth

HIRS, AMSU, and MHS Level 1B products: Radiances, antenna temperatures, and geolocation; DBNet-BUFR formatted HIRS, AMSU, and MHS observations

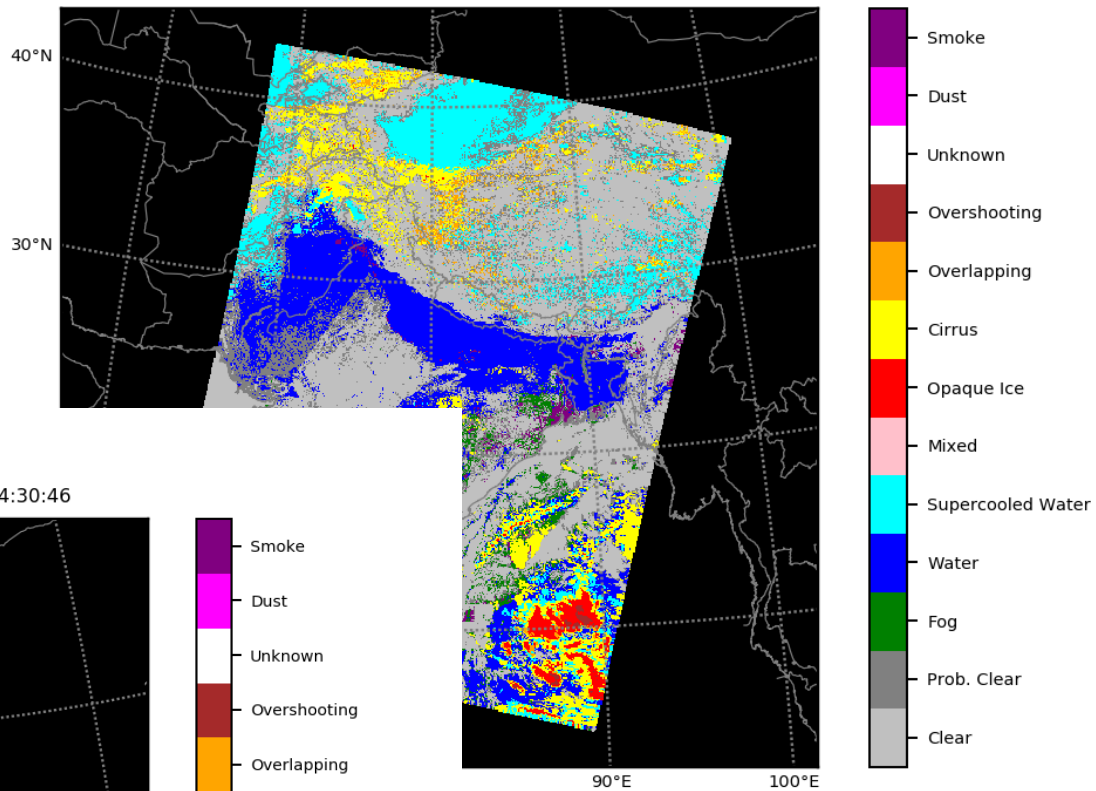
HIRS/AMSU Level 2 Products: Profiles of Atmospheric Temperature and Moisture

AMSU/MHS Level 2 Products: Profiles of Atmospheric Temperature and Moisture; Precipitation Estimates

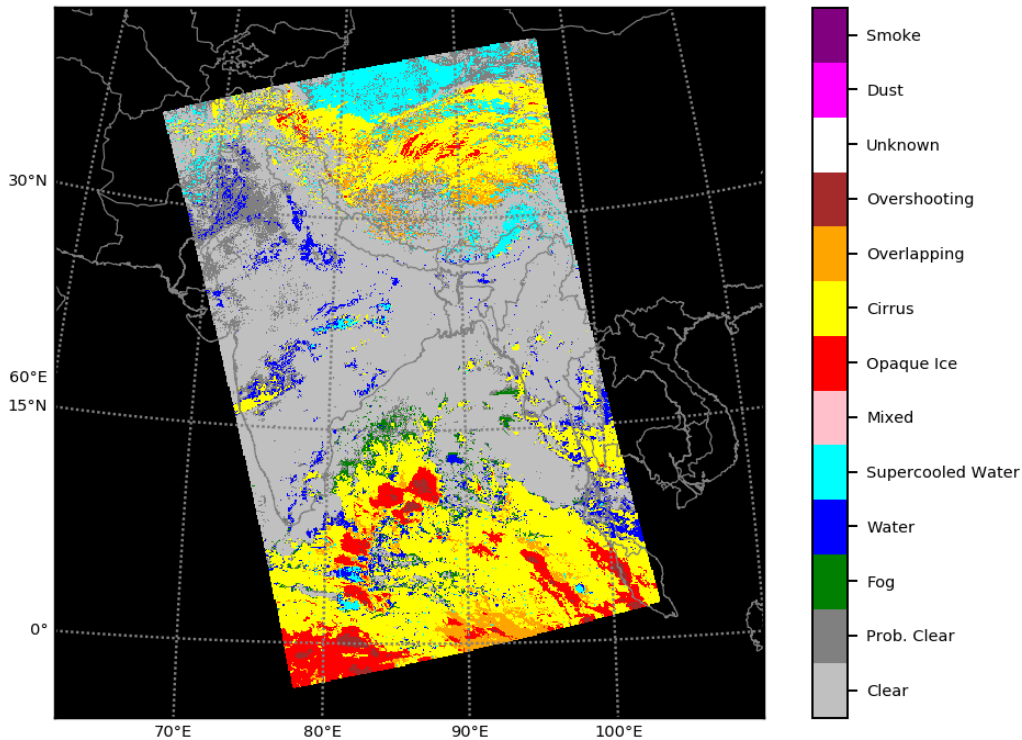
Distribution of Aerosol Optical Depth (AOD) has been illustrated with satellite data from Suomi NPP.



CSPP CLAVR-x Cloud Type 2021-01-28 03:08:51-03:18:26



CSPP CLAVR-x Cloud Type 2021-01-28 14:19:18-14:30:46



Cloud type classification using the JPSS – 1 satellite products.

Opportunities

Researches on Climate Science

Researches in Meteorology

Researches on Agriculture

Researches in Ocean Dynamics

Researches on Marine Biology

Researches in Atmospheric Pollution

Researches in Natural Disasters

Researches for Advancement in
Weather and Forecasting



Opportunities

- The Satellite Ground Station of the Department of Meteorology will be the “first” of its kind to join the WMO DBNet system; which will allow regular transfer atmospheric data to be incorporated with the NWP system.
- The current facilities allow the satellite data to be used for data assimilation and also perform critical analysis of data, mostly through models (WRF-DA, WRF-Chem and MPAS).
- The different products to be found within the system has options to use them as observational data for not only meteorological researches but also researches from atmospheric chemistry, geospatial analysis, geostatistical analysis, ocean dynamics and circulation, and studies related to natural disasters (e.g. floods, cyclones etc.).



Thank You

Specifications of the SAT Ground Station

- ❑ RAID controller supporting RAID-0/1/5
- ❑ 2 x Gigabit Ethernet ports
- ❑ 2 x Power Supplies
- ❑ 24 in. LCD monitor
- ❑ Dual-layer DVD

Specifications of the SAT Ground Station

The DBPS runs on a 64-bit Intel Linux host computer running the CentOS (release 7) operating system. The following computer server specifications for this system:

- ❑ HP ProLiant DL380 Gen10 @U rack mount server
- ❑ 2 x Octo-core Intel Xeon CPUs at 3 GHz or greater
- ❑ 128 GB RAM
- ❑ 2 x 500 GB SATA hard drives in RAID-1 configuration for OS and applications
- ❑ 4 x 4 TB SATA hard drives for data and scratch space in RAID-6 configuration

- TIROS = Television Infrared Observation Satellite
- CE = "Conformité Européenne" (French for "European Conformity")
- RF = Radio Frequency
- NOAA = National Oceanic and Atmospheric Administration
- MODIS = Moderate Resolution Imaging Spectroradiometer
- METOP = Meteorological Operational
- JPSS = Joint Polar Satellite System
- NPP = National Polar-orbiting Partnership
- CrIS = Cross-track Infrared Sounder
- ATMS = Advanced Technology Microwave Sounder
- AIRS = Atmospheric Infrared Sounder
- AMSU = Atmospheric Infrared Sounder
- VIIRS = Visible Infrared Imaging Radiometer Suite
- AVHRR = Advanced Very High Resolution Radiometer
- HIRS = High-resolution Infrared Radiation Sounder
- MHS = Microwave Humidity Sounder
- CSPP = Community Satellite Processing Package
- DBPS = Direct Broadcast Processing System
- CLAVR-x = Clouds from AVHRR Extended
- DBNet = Direct Broadcast Network