Agency Presentation Indian Space Research Organization

B Kartikeyan

Space Applications Centre

bkartik@sac.isro.gov.in

Earth observation capabilities established

By ISRO For

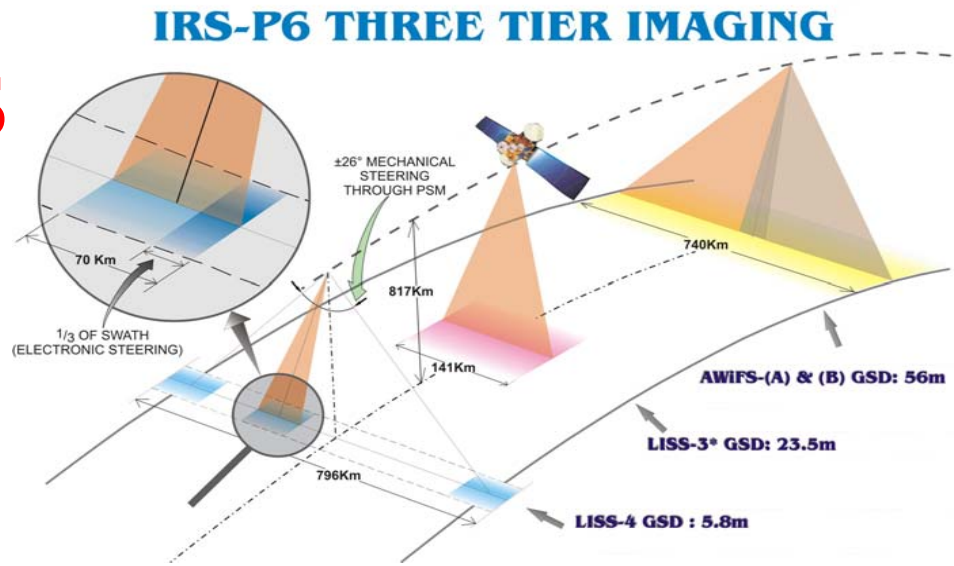
Land

Ocean

Atmosphere

Land observations

Multispectral imaging:



9 Instruments are currently in operation

Spatial resolution : 5.8 meter to 1000 meters

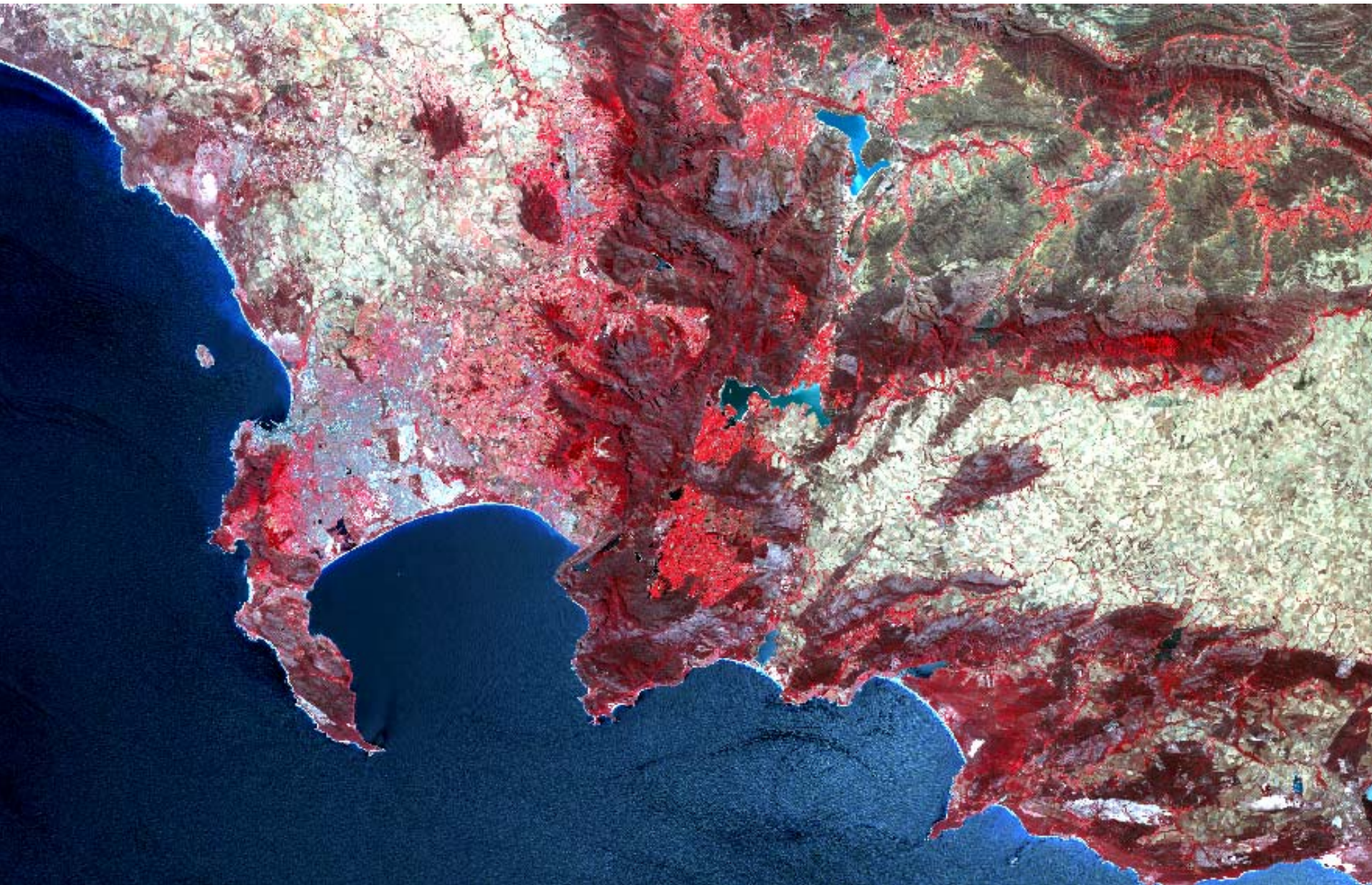
Spectral channels 1 to 8

Radiometric resolution 64 to 4096 levels

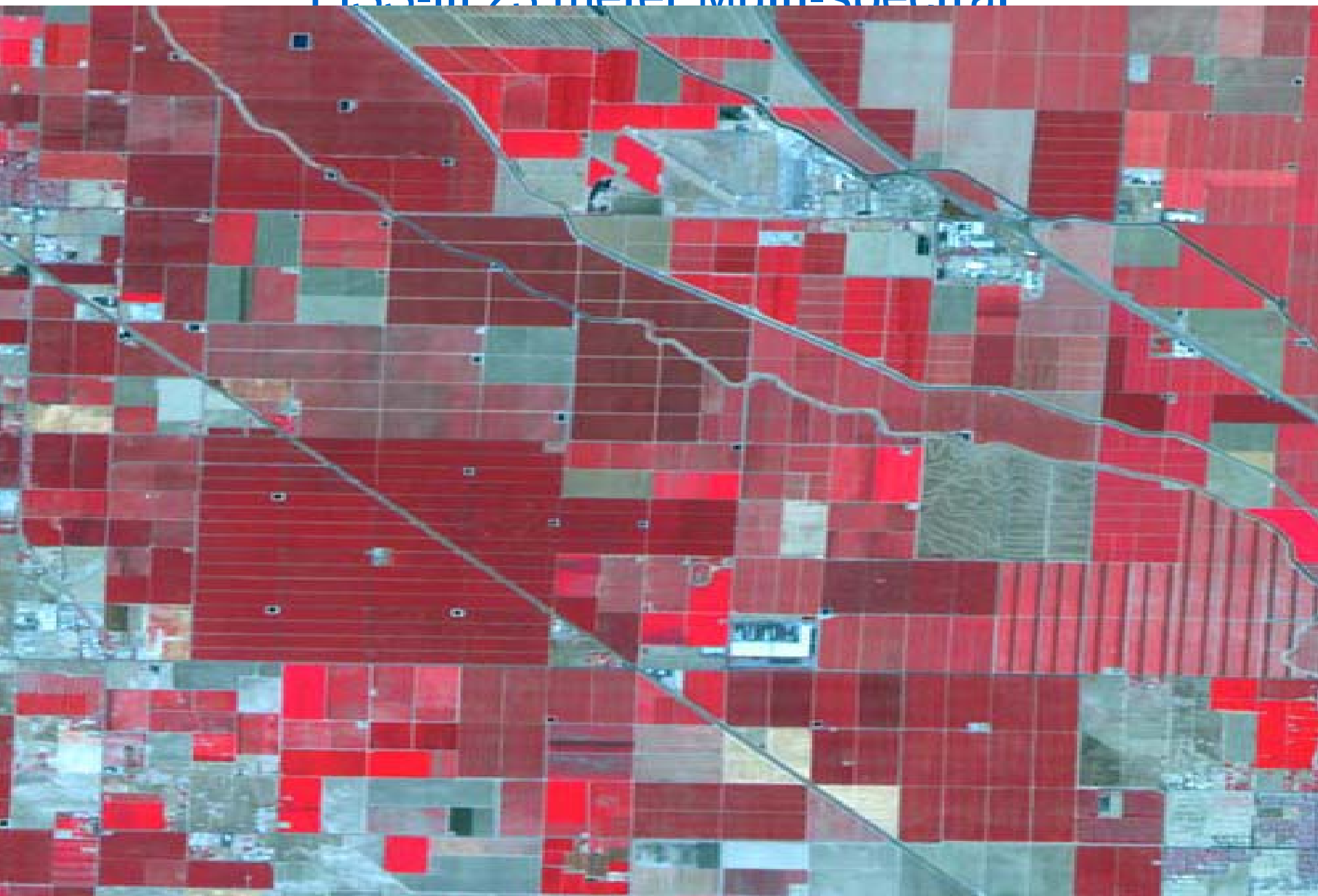
Temporal resolution once in a minute (daytime) to once in 24 days

GSD in meters	Bands	Radiometric range	Swath In km	Revisit In days	S/C Mission	Operational from the year	Expected to be operational till
5.8	b2/b3/b4	7bits	23.5	5	ResourceSat 1	2003	2009
23.5	B2/b3/b4/b5	7bits	140	24	ResourceSat 1	2003	2009
23.5	B2/b3/b4	7bits	140	24	IRS 1C	1995	2006
23.5	B2/b3/b4	7bits	140	24	IRS 1D	1997	2007
56	B2/b3/b4/b5	10bits	740	5	ResourceSat 1	2003	2009
188	B3/b4	7bits	810	5	IRS 1C	1995	2006
188	B3/b4	7bits	810	5	IRS 1D	1997	2007
1000	b3./b4/b5	10bits	300*6000	1 minute	Insat3A	2003	2010

Cape Town, S. Africa- AWiFs



LISS-III 23 meter Multi-spectral



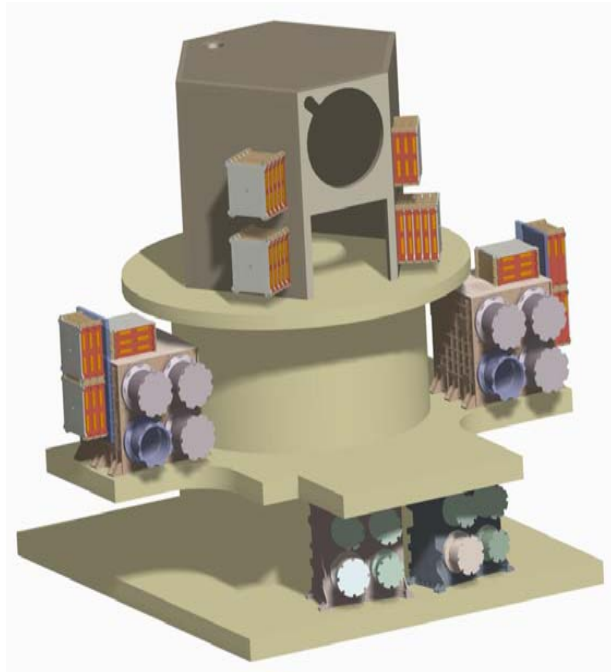
Kuwait City, LISS 4 MX

Palm Island Dubai, L4 MX

RESOURCESAT-2 Improvements

100% albedo coverage in single gain

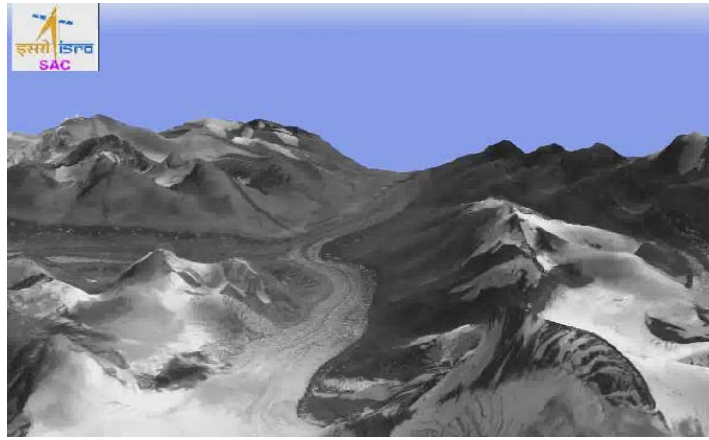
- 10 bit Digitization for LISS 3* VNIR bands as against 7 bit in IRS-P6
  - Multi-linear gain-12 bit to 10 bit in AWiFS
    - Covers full dynamic range with enhanced radiometric resolution
    - Circumvents data rate limitation in present Tx

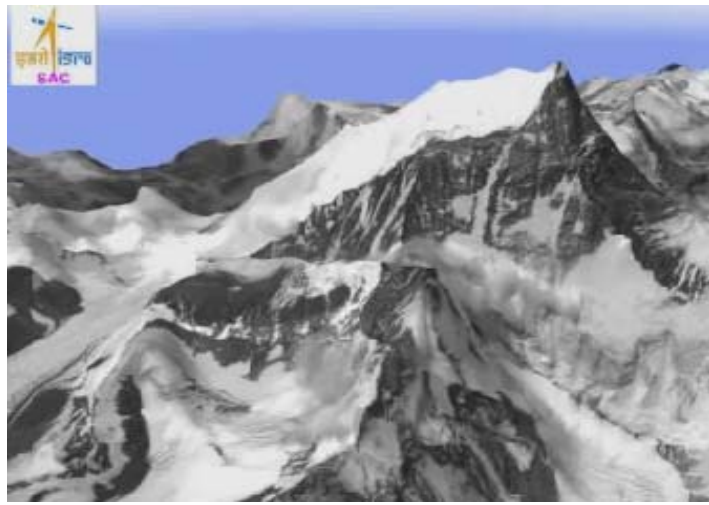


First dedicated high resolution stereo mission

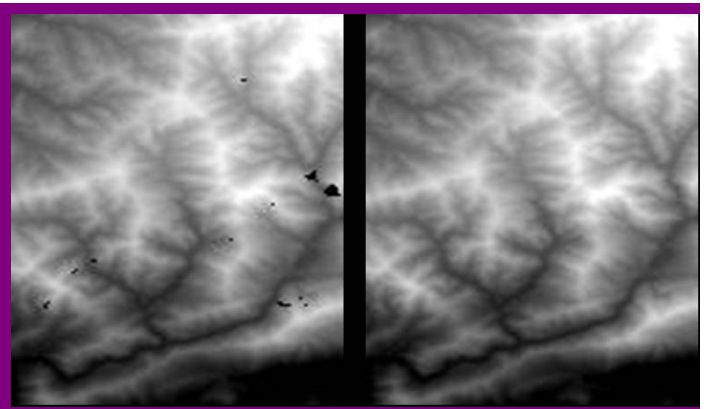
CARTOSAT-1

- Payload: Delivered July 4, 2004, Launched May 5, 2005





- **Carto-DEM**
- **URBAN BASE FEATURES**
- **LAND PARCEL MAPPING**
- **TERRAIN HYDROLOGICAL MODELING**
- **GLACIER MASS BALANCE**

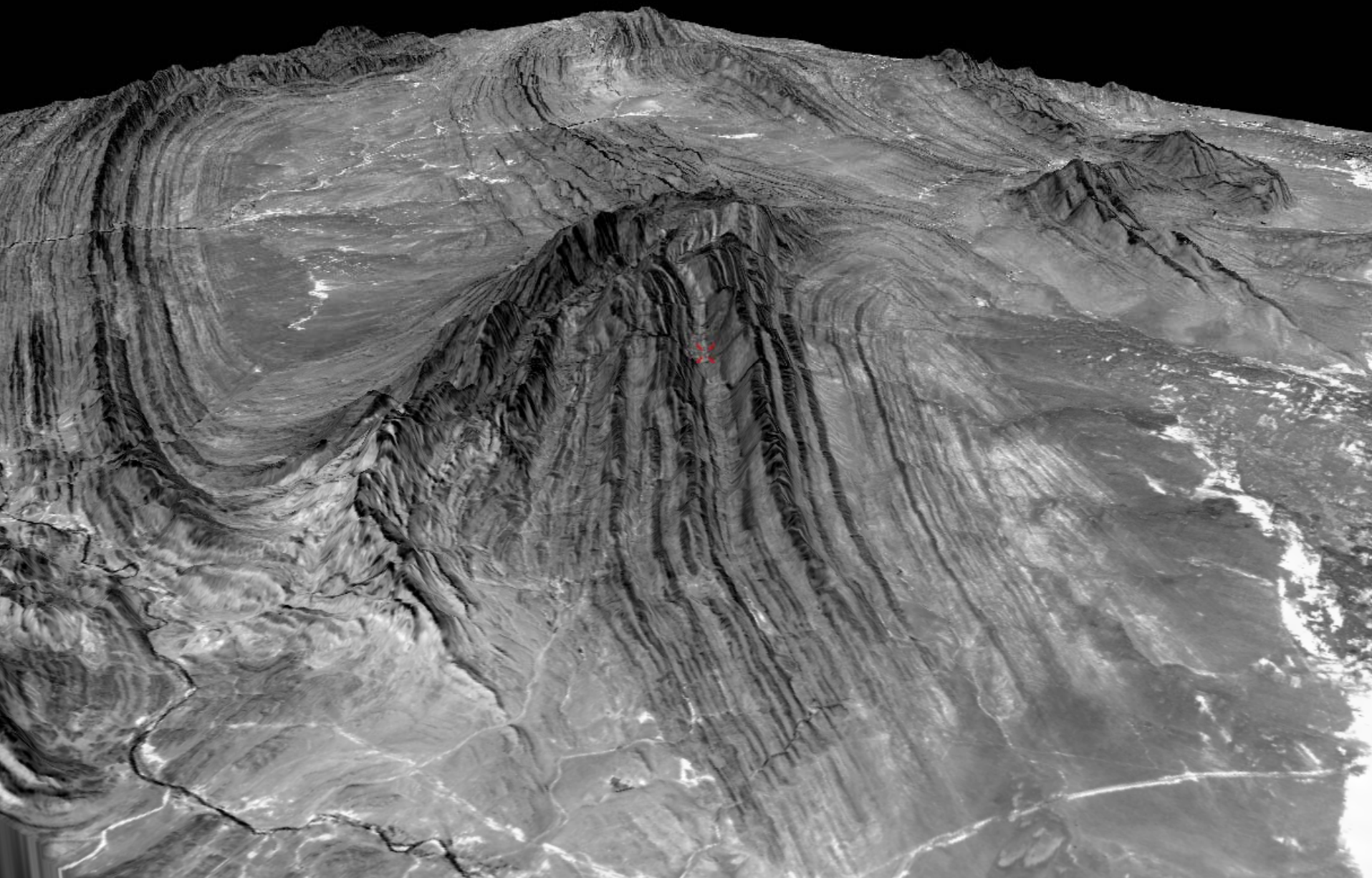


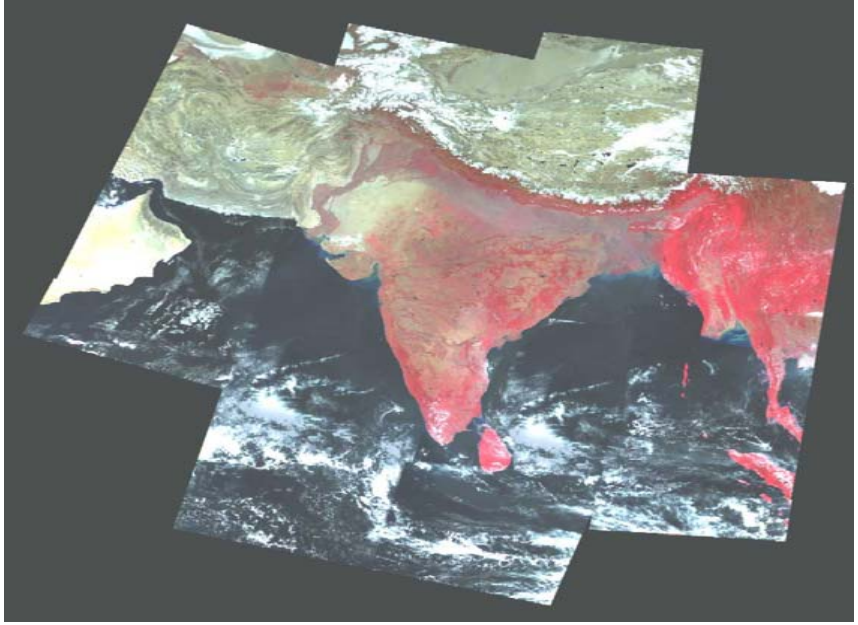
	SPOT-5	ALOS	IRS-P5
GROUND RESOLUTION(m)	10	2.5	2.5
SWATH (km)	120	30	30
B/H	1	1	0.6
STEREO SET	PAIR +20/-20	TRIPLET +26/0/-26	PAIR +26/-5
QUANTISATION	256	256	1024
SNR	120	>70	>400
COMPRESSION	2.8:1	4.5:1 OR 9:1	3.3:1
MTF	25	10	25


P92 R229 15-May-05 Aft

Denver, Downtown, USA

A View of Afghan Terrain





OCEAN-Observation

OCM

- 8 SPECTRAL BANDS
- ~ 360 M RESOLUTION
- 2 DAY REPETITIVITY

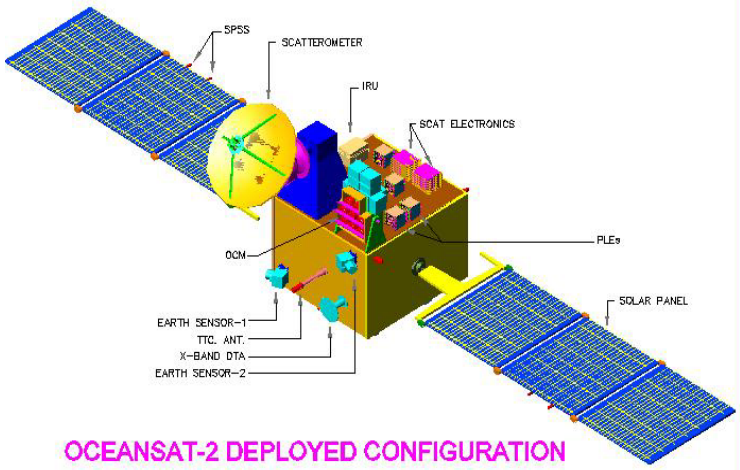
- Water-leaving radiances
- Diffuse attenuation coefficient
- Chlorophyll-a, yellow substance & suspended sediment concentrations
- Aerosol optical thickness

MSMR

- 4 FREQ. DUAL POLARISATION MW RADIOMETER
- GLOBAL COVERAGE, 2 DAY REPETITIVITY

- Antenna temperature data (ATD)
- Brightness temperature data (BTD)
- Geophysical parameter – wind, SST, humidity
- Monthly average product (MAP)

OCEANSAT-II



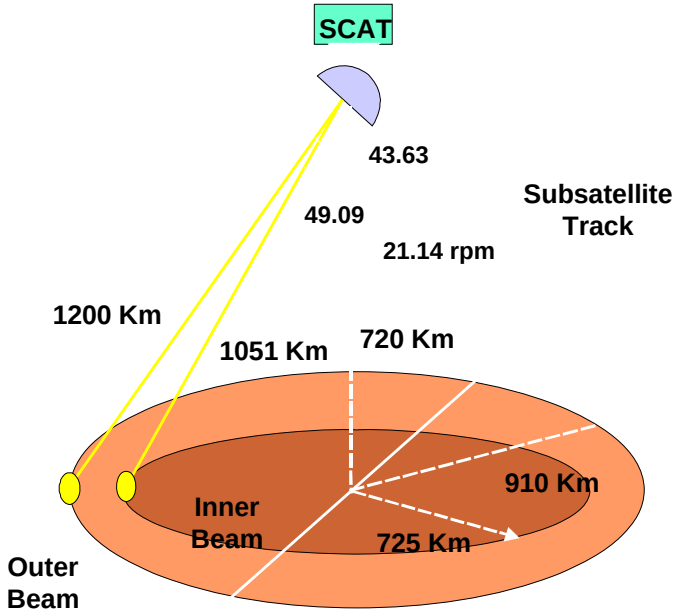
OCEANSAT-2 DEPLOYED CONFIGURATION

OCM

- 8 spectral bands in 400-900 nm with 300-350 m resolution
- Sun synchronous orbit with LT of equatorial crossing at 1200 hrs

"Radio Occultation Sounder for the Atmosphere (ROSA)"
for temperature and humidity profiles and Ionospheric chemistry

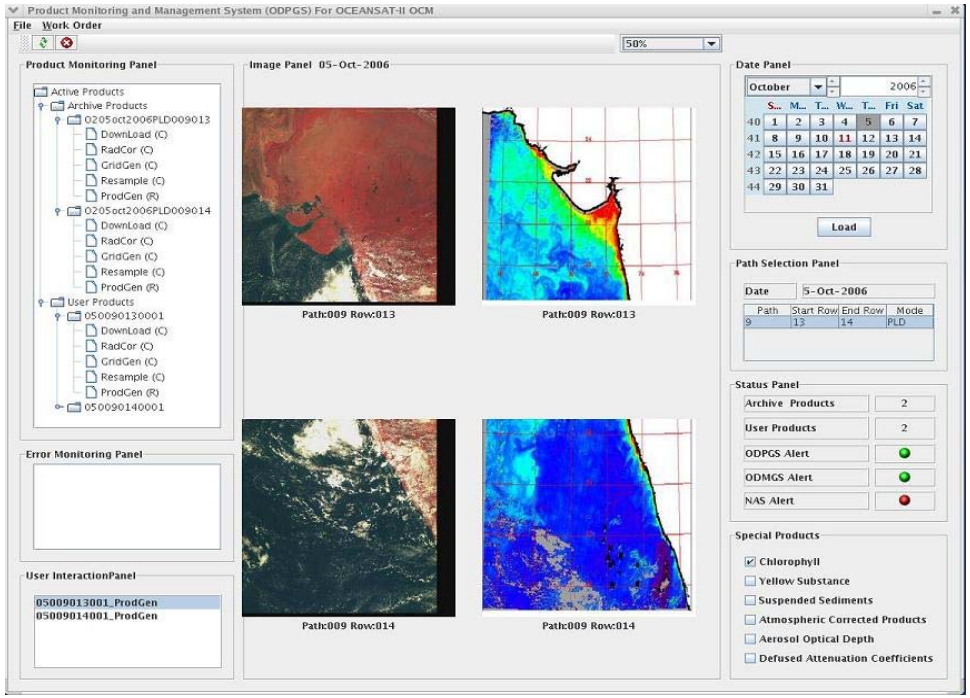
Ku band Scatterometer



Similar to Seawinds / Quickscat

PARAMETER	SPECIFICATION
Frequency	13.73GHz
Wind speed range	4 to 24 m/s
Wind speed Accuracy	Better tan 20% (RMS)
Wind Direction Accuracy	20° rms
Resolution	50 x50 km
Polarisation	HH (inner) VV (outer)
Swath	1450 Km (inner) 1820 km (outer)

OCEANSAT - II OCM



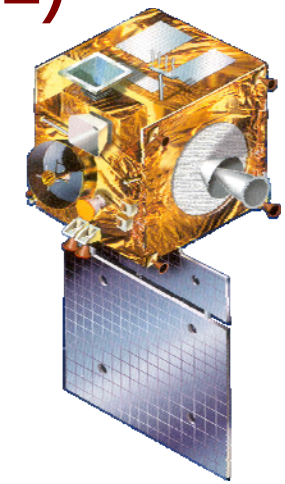
LAC: Local Area Coverage Products
Level-2&3 : 360m x 360m
Level-1 : 246 x 360m

GAC: Global Area Coverage Products
Level-2&3 : 4Km x 4Km
Level-1 : ~4Km x ~4Km

Geo Physical Parameter

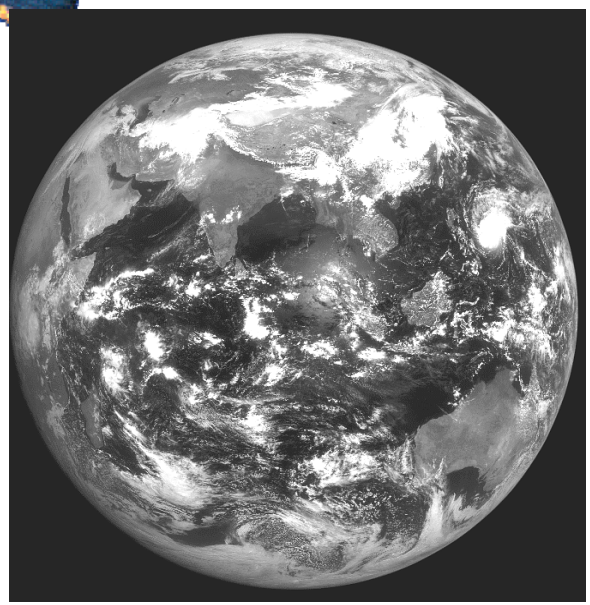
- Chlorophyll Concentration Product
- Total Suspended Sediment Concentration Product
- Aerosol Optical Depth at 865 nm
- Diffused Attenuation Coefficients

Atmospheric observations
INSAT 3A & METSAT (Kalpana-1)

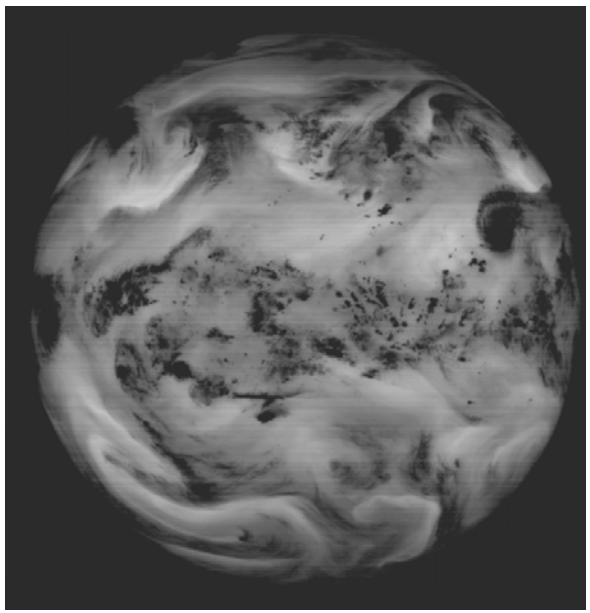


VHRR Bands

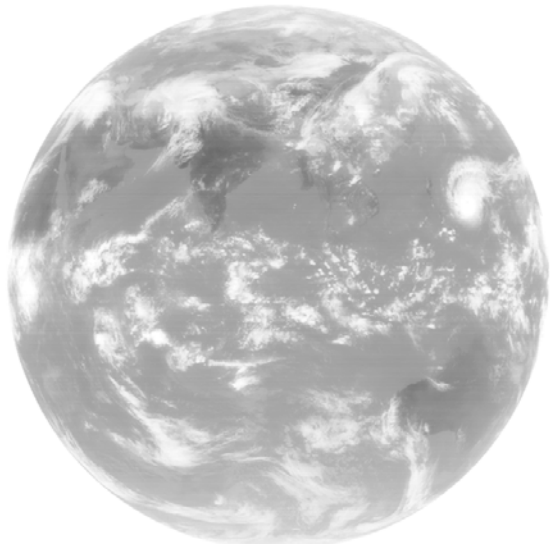
Visible	:	0.55 – 0.75	2 km
Water Vapour	:	5.70 – 7.10	8 km
Thermal Infra Red	:	10.5 – 12.5	8 km



Visible Channel



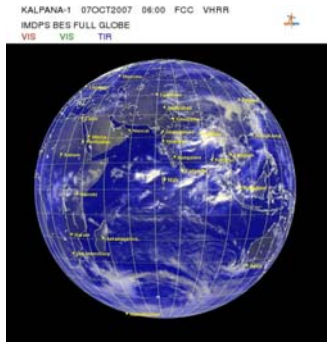
Water Vapour Channel

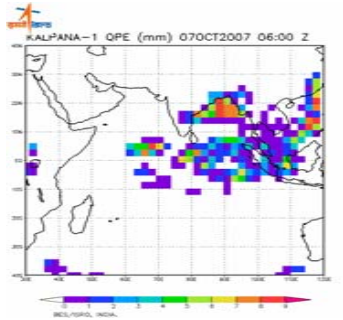


TIR Channel

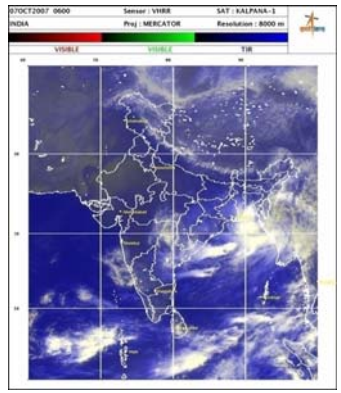
INSAT- 3A/K1/3D Meteorological Data Processing System (IMDPS)

- Kalpana-1 & INSAT-3A
  Installed and operational
  - ➢ at IMD Jan 2006
  - ➢ at BES Jun 2007





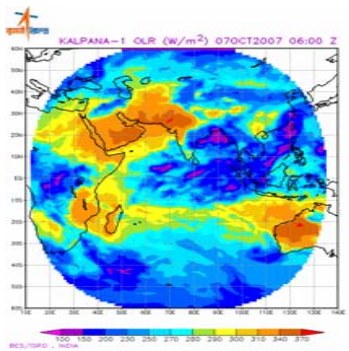
- Products generated
  Data Products FULL GLOBE and SECTOR; movie clip at the end of the day
  Geophysical Parameters
  Limited validation of Geophysical parameters completed

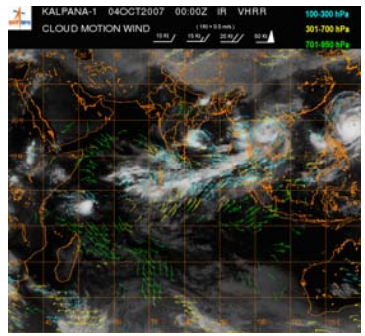


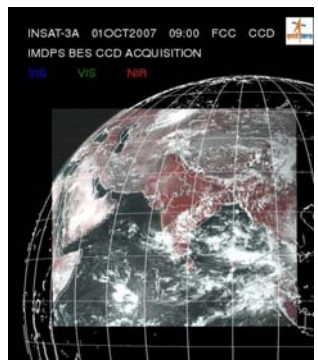
This system is a forerunner of the IMDPS for INSAT 3D

INSAT 3D PDR completed for DAQLS and DP elements in Jan 2007

- ATBD for 23 Geo-physical parameters completed in Mar 2007
- Design and Development of INSAT-3D Software in Progress







CCD Payload

Spatial Resolution : 1km

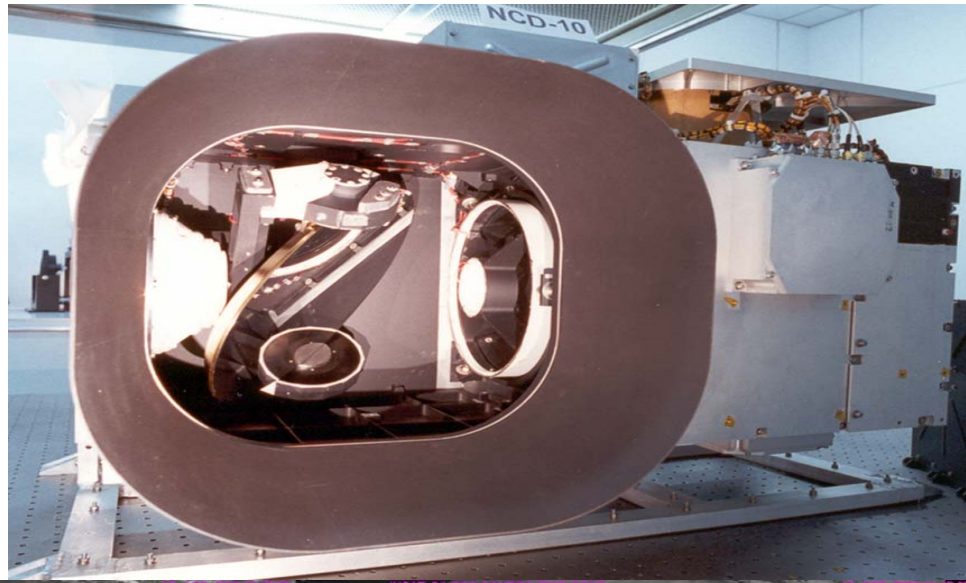
Images 300*6000 km in ONE minute

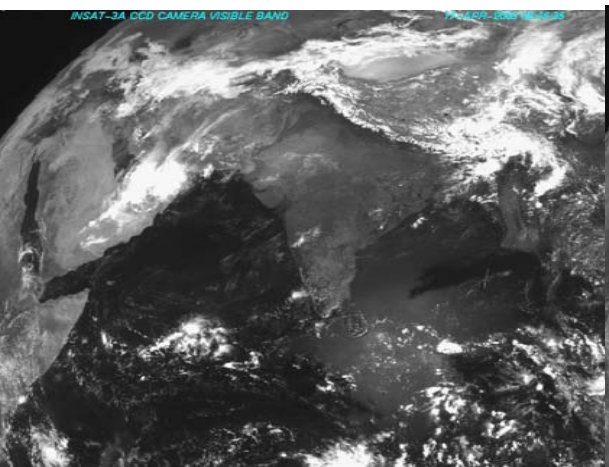
Spectral Bands (μm) :

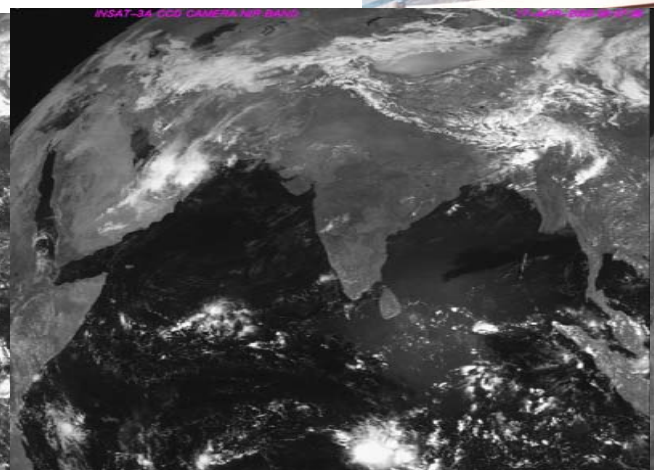
Vis 0.62-0.68,

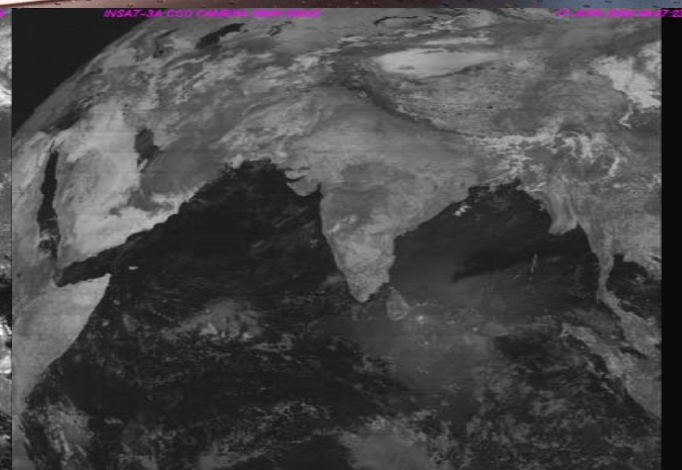
NIR:0.77-0.86,

SWIR:1.55-1.69



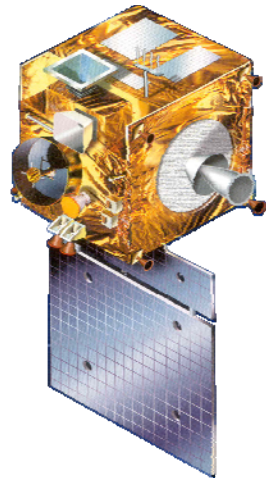




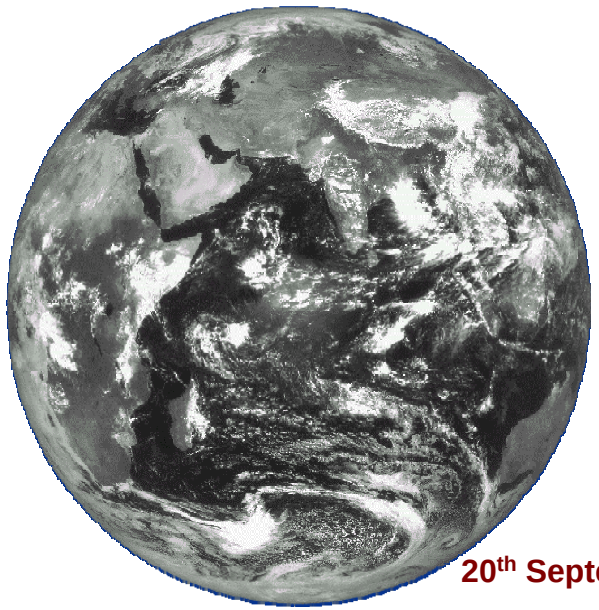


INSAT 3A & METSAT (Kalpana-1)

VHRR Bands	(µm)
Visible	: 0.55 – 0.75
Water Vapour	: 5.70 – 7.10
Thermal Infra Red	: 10.5 – 12.5
Resolution	: 2 km for Visible
	8 km for TIR

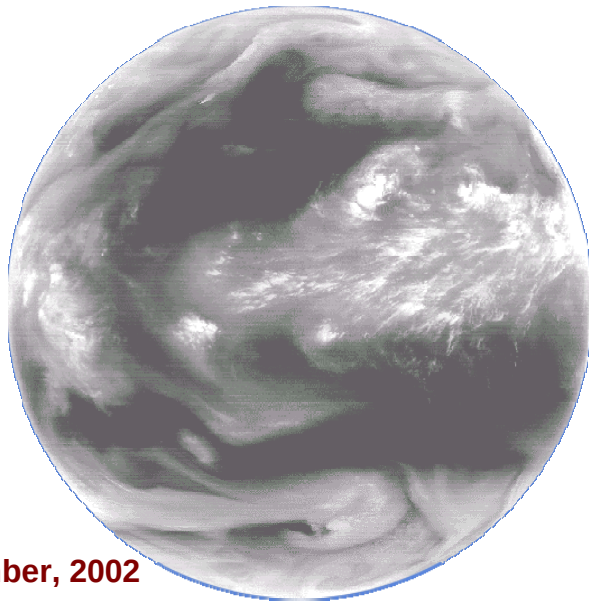


CCD Camera Bands	(µm)
Visible	: 0.62 – 0.68
Near Infra Red	: 0.77 – 0.86
Short Wave IR	: 1.55 – 1.69
Resolution	: 1 km



20th September, 2002

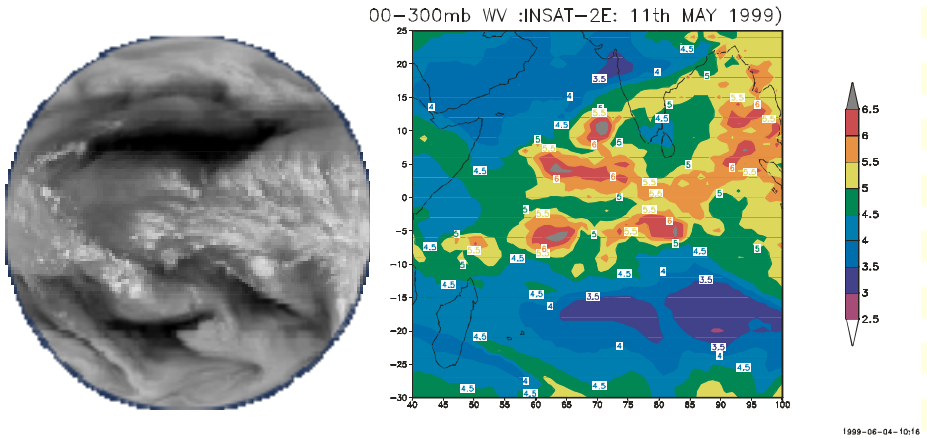
Visible Channel



Water Vapour Channel

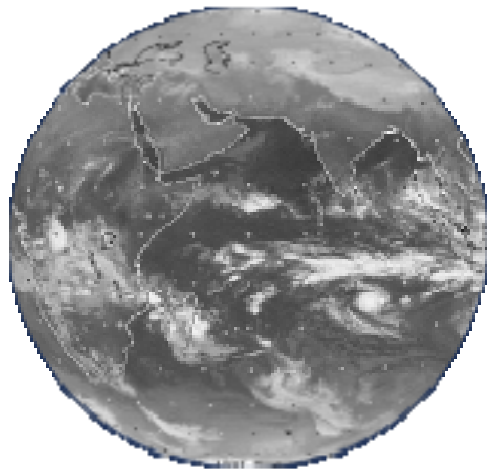
Parameters Observed from Space

Water Vapour



INSAT 2E WV 24 March 1999 14:30 IST

Cloud cover/properties



Cloud observations from INSAT [1/2 hourly and 3 hourly]

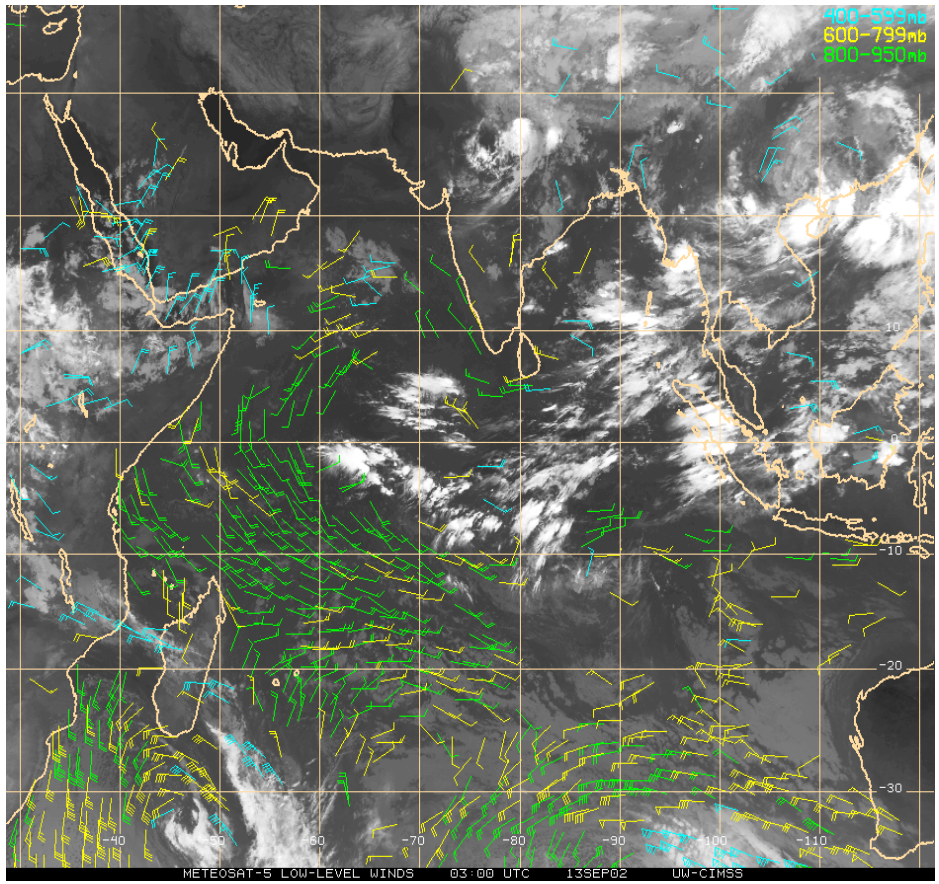
	Required	Achieved
Accuracy(g/kg)	0.5	1.0
Hor. Res.(km)	50	100
Vert.Res.(km)	2	10

Info. derivable:

Cloud types, distribution, liquid water content, total precipitable water & radiative properties

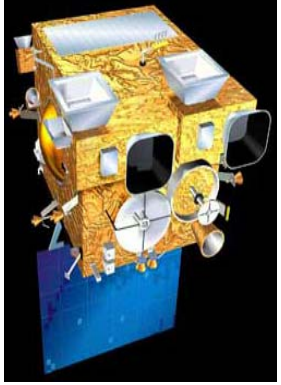
Parameters Observed from Space

Atmospheric Winds



	Required	Achieved
Accuracy(m/s)	2	5-10
Hor. Res.(km)	50	100
Vert.Res.(level)	3	3

Cloud Motion Vectors (CMV) derived from INSAT 1/2 hourly data



INSAT - 3D

Improved Understanding of Meso-scale Systems

6 Channel IMAGER

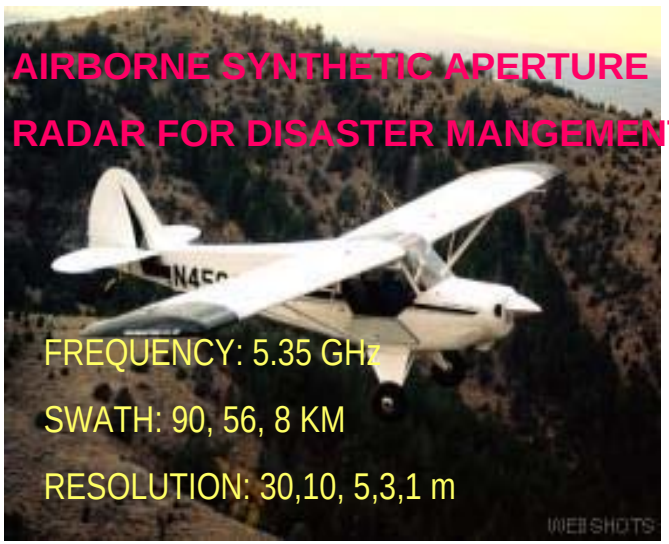
Spectral Bands (µm)		
Visible	: 0.55 - 0.75	1km
Short Wave Infra Red	: 1.55 - 1.70	1km
Mid Wave Infra Red	: 3.70 - 3.95	4 km
Water Vapour	: 6.50 - 7.10	8 km
Thermal Infra Red – 1	: 10.30 - 11.30	4km
Thermal Infra Red – 2	: 11.50- 12.50	4km

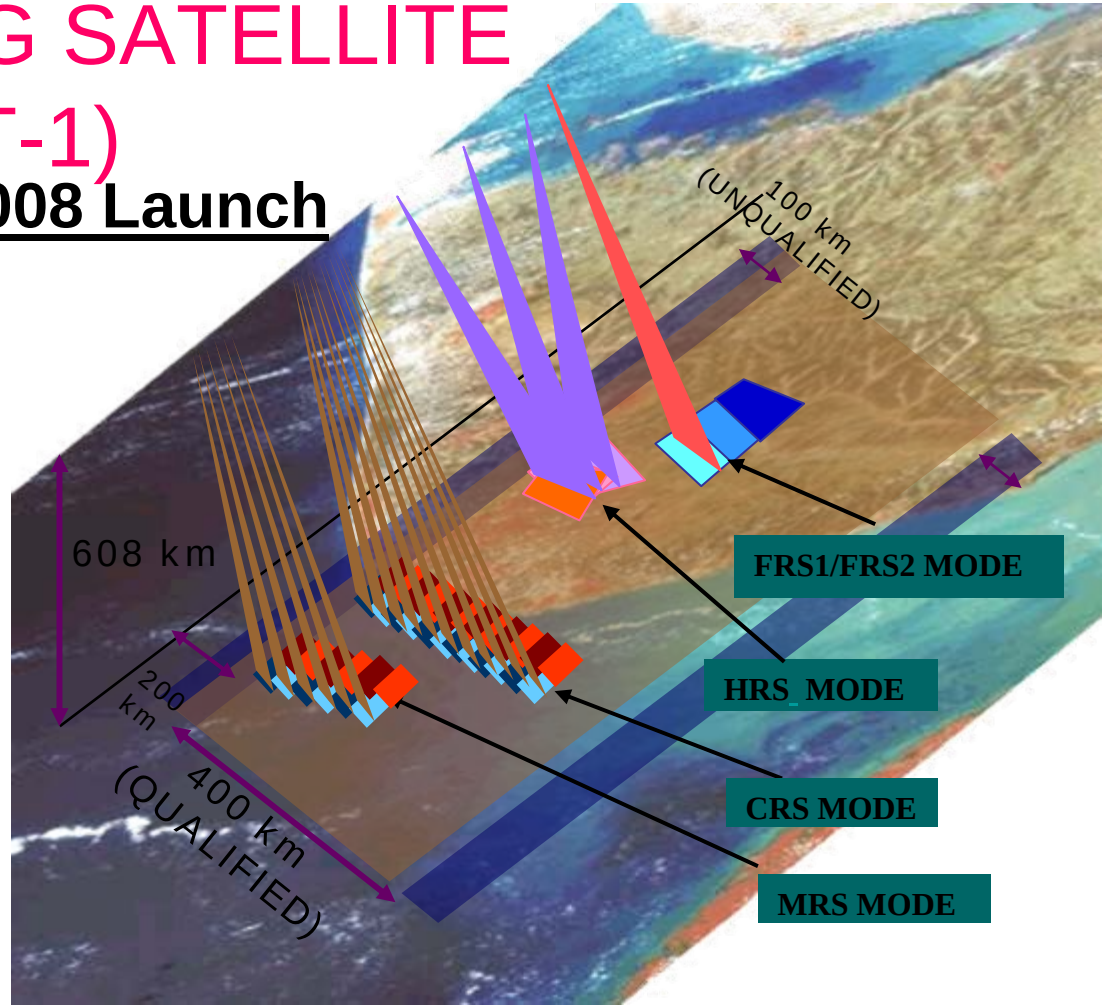
19 Channel SOUNDER

- Spectral Bands (µm)
  - Short Wave Infra Red : Six bands
  - Mid Wave Infra Red : Five Bands
  - Long Wave Infra Red : Seven Bands
  - Visible : One Band
- Resolution (km) : 10 X 10 for all bands
- No of simultaneous : 4 sounding per band

RADAR IMAGING SATELLITE (RISAT-1)

2008 Launch



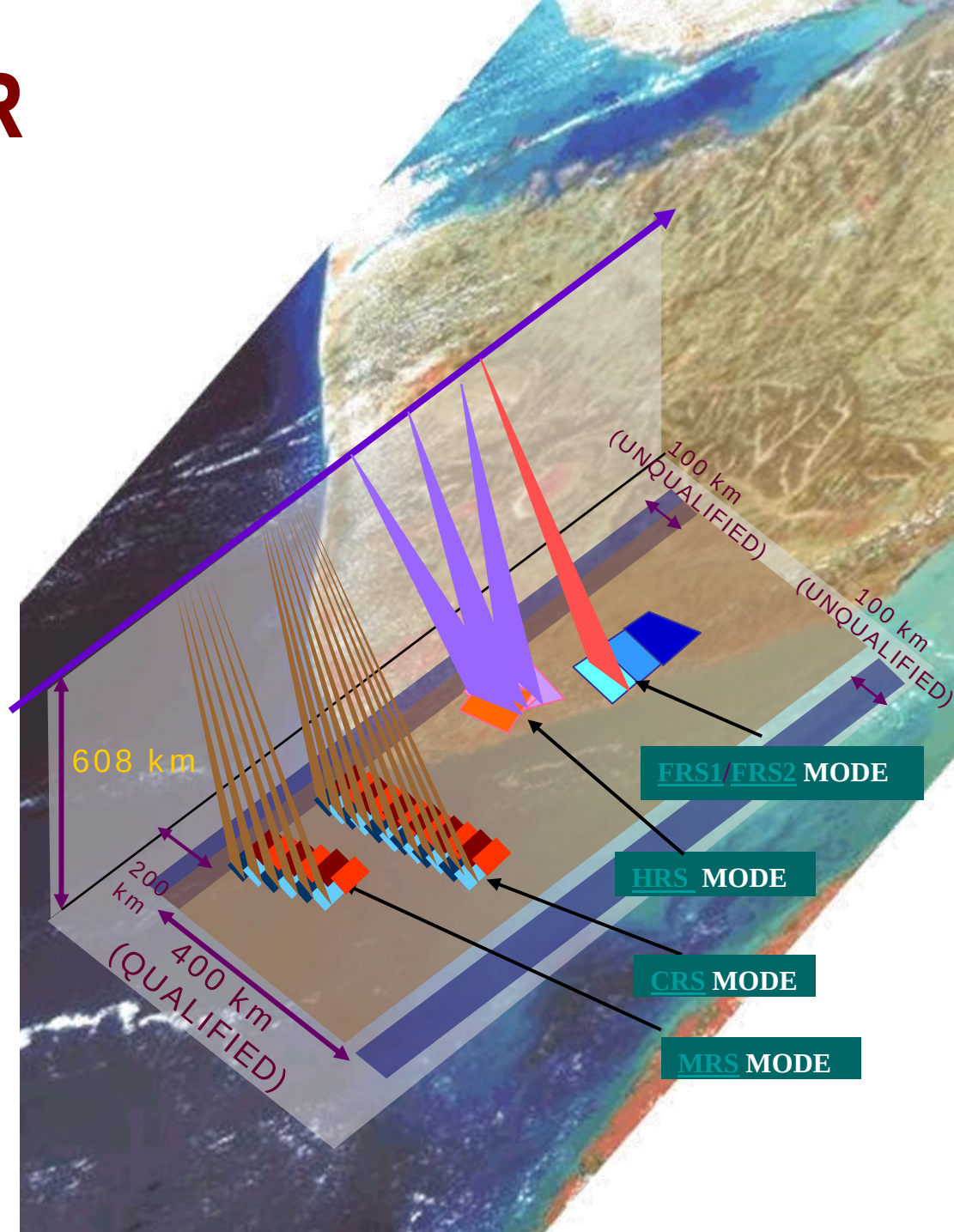


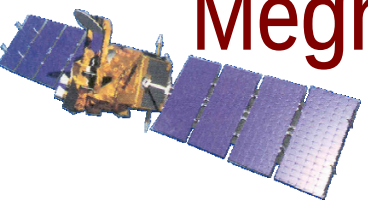
SINGLE/DUAL/QUAD POLARISATION IMAGING WITH 1-50 M RESOLUTION AND 10-240 KM SWATH

Stripmap, ScanSAR , Spotlight & Sliding Spotlight imaging modes.

RISAT SAR

MODE	SWATH /RESOLUTION
HIGH RESOLUTION SPOTLIGHT (HRS)	10X100 KM 1m
FINE RESOLUTION STRIPMAP-1 (FRS-1)	30 KM 3m
FINE RESOLUTION STRIPMAP-2 (FRS-2)	30 KM 12 m
MEDIUM RESOLUTION SCANSAR (MRS)	120 KM 25 m
COARSE RESOLUTION SCANSAR (CRS)	240 KM 50 m





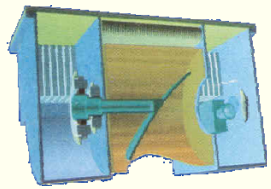
Megha Tropiques - A Joint ISRO-CNES Mission

For studying water cycle and energy exchanges to better understand the life cycles of the tropical convective system

Low inclination (20º) for frequent simultaneous observations of tropics

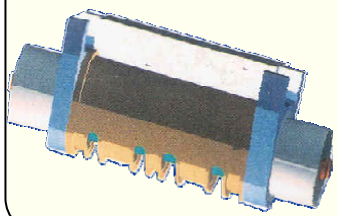
- Water vapour
- Clouds
- Cloud condensed water
- Precipitation
- evaporation

SAPHIR



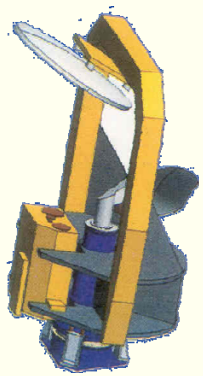
- Water vapour profile
- Six atmospheric layers upto 12 km height
- 10 km Horizontal Resolution

SCARAB



- Outgoing fluxes at TOA
- 40 km Horizontal Resolution

MADRAS



- Precipitation and Cloud properties
- 89 &157 GHz : ice particles in cloud tops
- 10, 18 &37 GHz: Cloud Liquid Water and precipitation; Sea Surface Wind speed
- 23 GHz : Integrated water vapour

Contributing to Global Precipitation Mission (GPM)

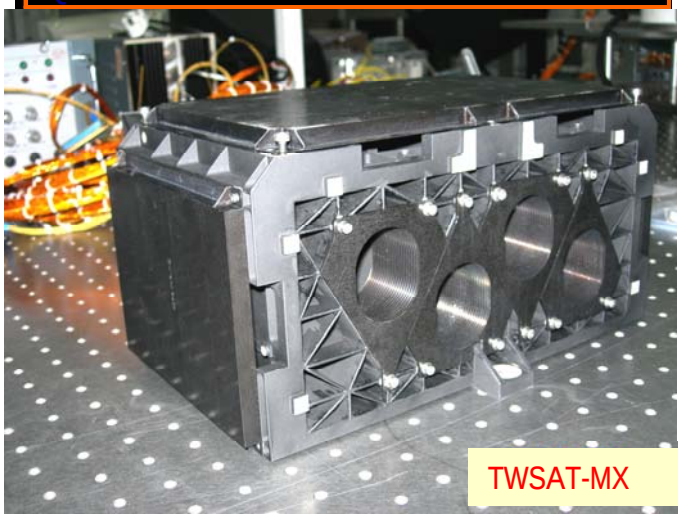
Miniaturised Payloads for TWSAT

MX-T Camera Weight : 5.5Kg (150Kg in IRS-1A)

Size: 0.013m^3 (0.23m^3 in IRS-1A)

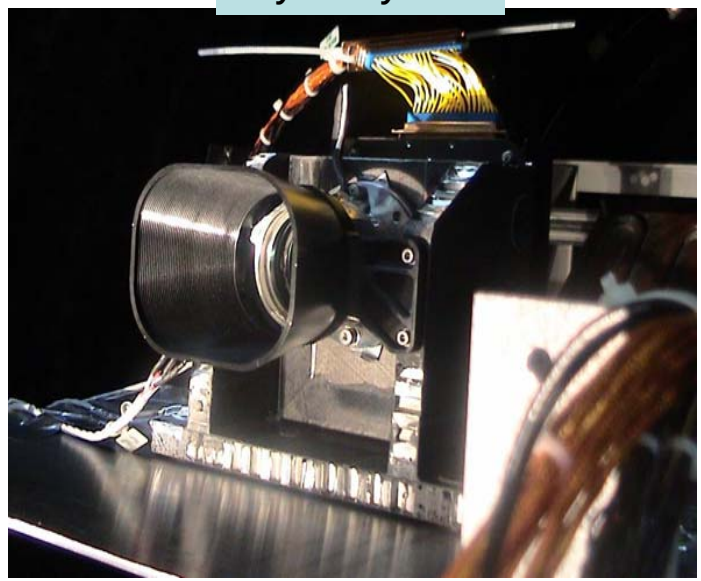
Indigenous Lens, CCD, Clock driver

MX-T PAYLOAD FEATURES	
Spectral bands	VIS1: 0.45-0.52 μm
	VIS2: 0.52-0.59 μm
	VIS3 : 0.63-0.68 μm
	VIS4 (0.75-0.86 μm)
Resolution	36m
Swath	151Km
Quantization	10 bits



TWSAT-MX

HySI Payload



HYSI-T PAYLOAD FEATURES	
No of spectral bands	64
Spectral Range	0.45 to 0.95μm
Spectral BW	15 nm
Sampling interval	8nm
Resolution	500 m
Swath	128 Km
Radiometric range	15 bits

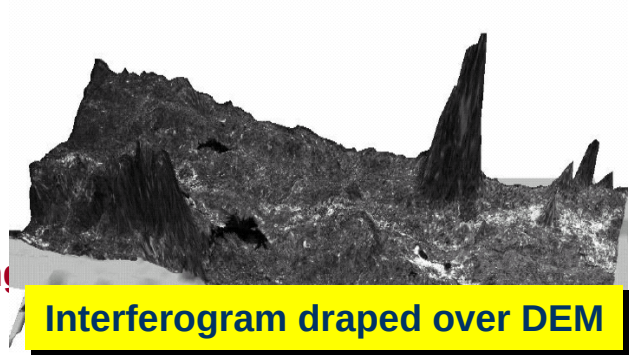

Thank you
12:01

Microwave Remote Sensing

ACTIVE:

Digital Signal processing

- **Image processing of SAR data**
  - **Speckle minimisation (Cauchy's Distn.)**
    - **Adaptive Algo. (Frost, Lee)**
  - **Segmentation**
  - **Image Texture**
  - **Feature identification**
- **SAR Interferometry**
  - **DEM generation (phase unwrappin**
  - **Differential Interferometry**
- **Polarimetry – Stokes Vectors**



Interferogram draped over DEM

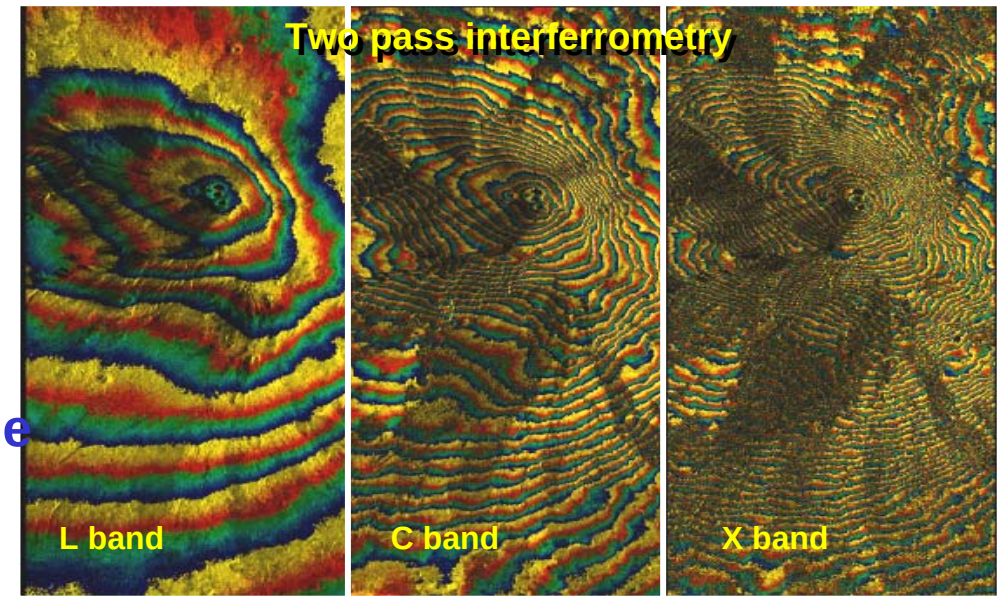
PASSIVE

Sounders

Radiometer

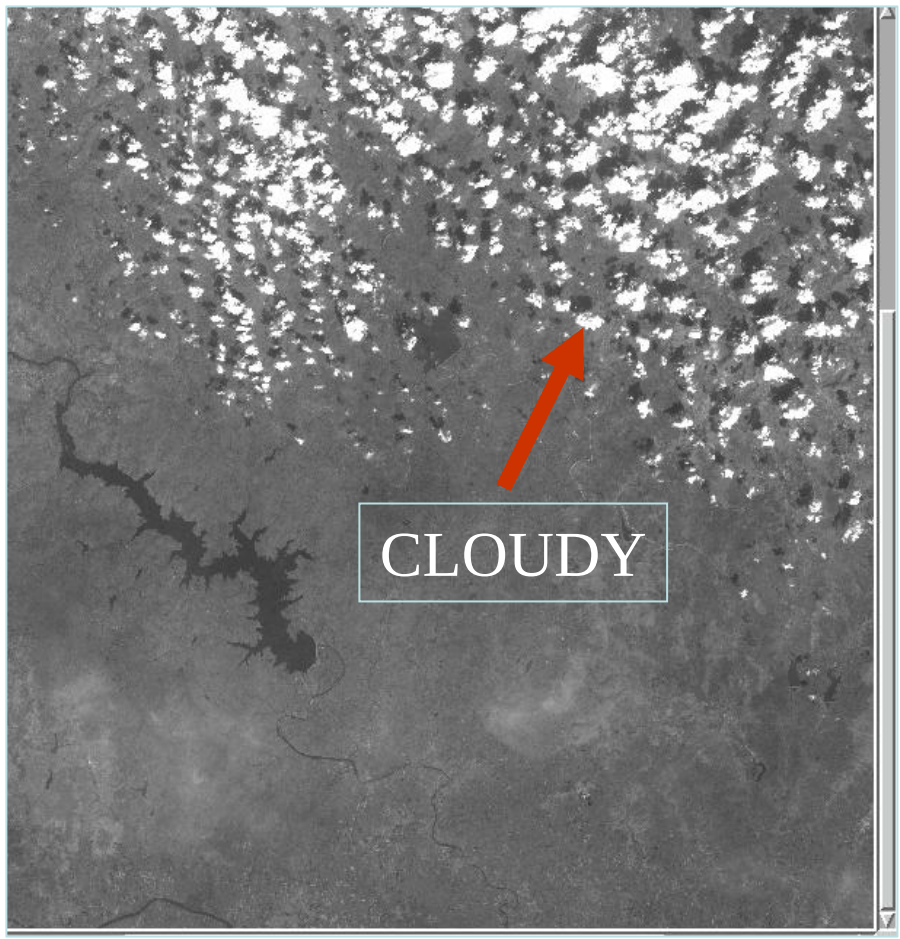
Challenges

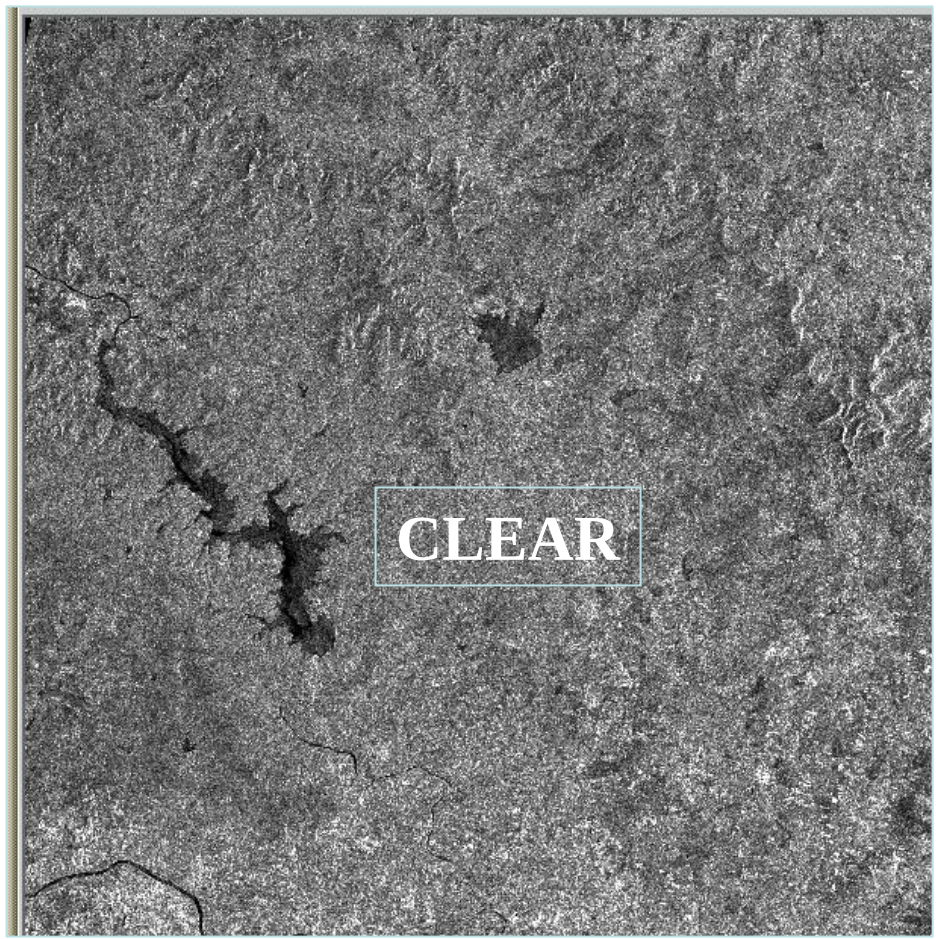
Synergy of Multi-frequency / Multi-polarisation Multi-incidence Angle Microwave systems



Cloud Affected Optical Data

Cloud penetration Possible with Microwave Imaging

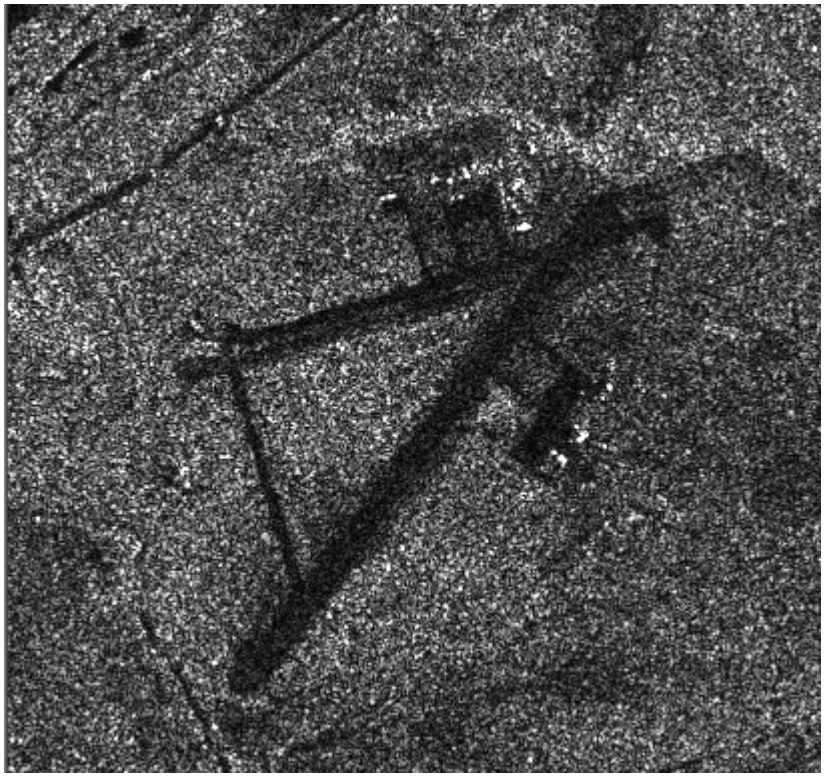




PAN_KARJAT_MAHARASTRA

ERS_KARJAT_MAHARASTRA

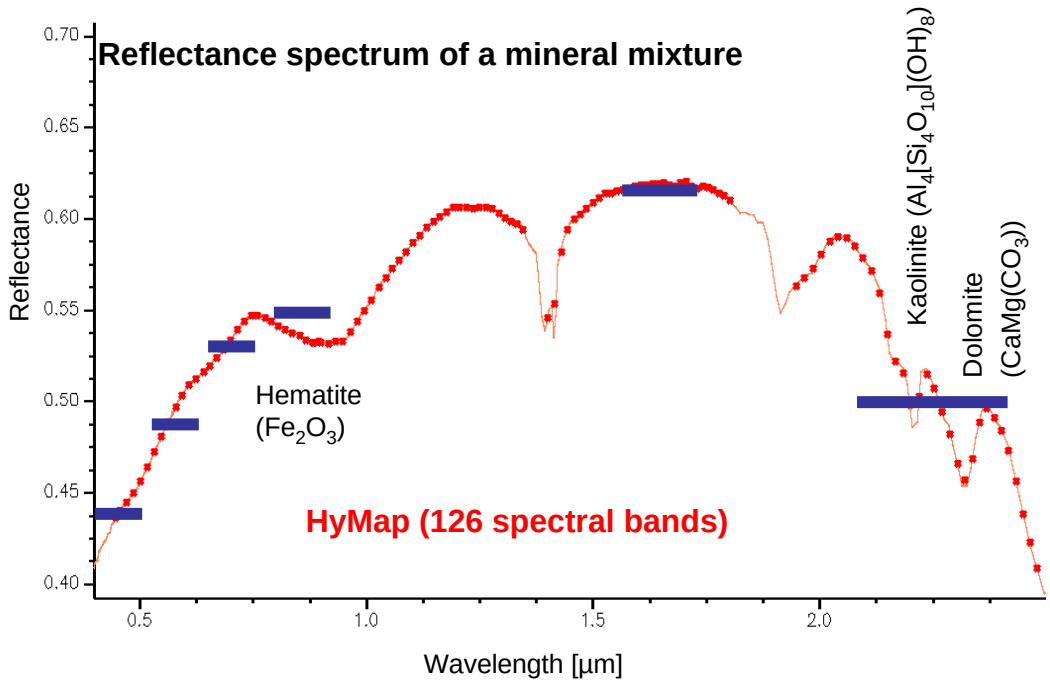
SAR as a complementary source of information



RADARSAT(active/SAR, 8 meter)

IRS-1C(passive/optical, 5 meter)

Why Hyperspectral Observation?



- Radar Sensors are blind for bio-, geochemical absorption processes
- Multi-spectral sensors integrate over broad spectral regions (> 500 nm), Hyperspectral Instruments: spectral bandwidth < 20 nm
- Mineral-Identification and Biochemistry of Vegetation require high contiguous spectral observation

Spectral Signatures