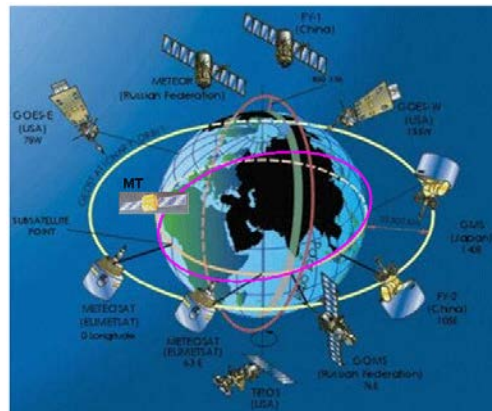




Indian Satellites for Meteorological Observations



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26th March -1st April 2014**



Brief History



Satellite Meteorology branch of IMD really **started in 1982** with the launch of INSAT-1A which was a multipurpose satellite meant for services to Meteorology, Doordarshan and Communication. Before that Indian meteorologists were using analog imageries received from U.S. Polar orbiting satellites series of TIROS-N.

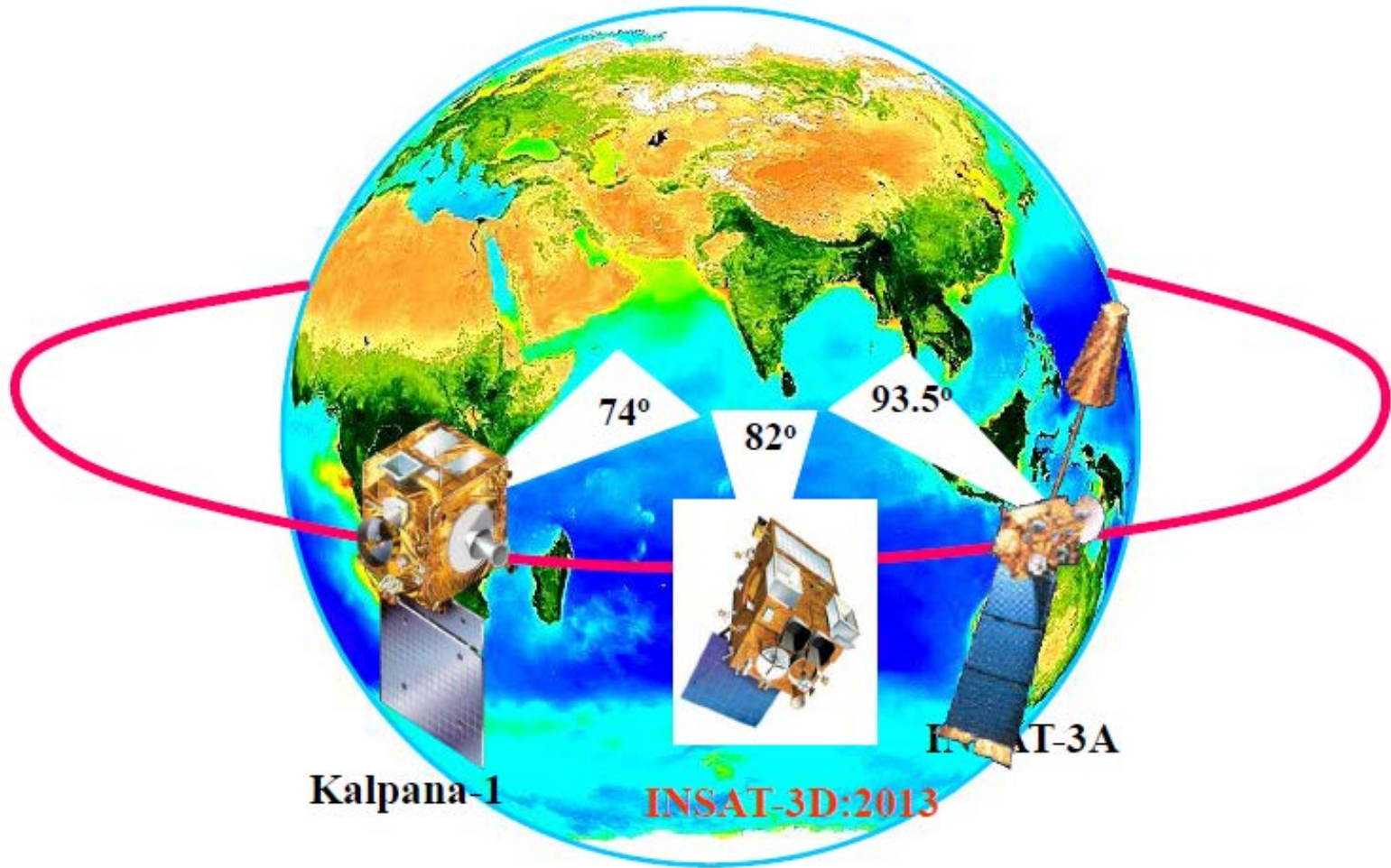
Many satellites for meteorological purposes were launched after the launch of INSAT-1A as given below:

- **INSAT-1A – 10 April 1982**
- **INSAT-1B – 30 Aug., 1983**
- **INSAT-1C – 21 July 1988**
- **INSAT-1D – 12 June, 1990**
- **INSAT-2A – 10 July, 1992**
- **INSAT-2B – 23 July, 1993**
- **INSAT-2E – 03 April 1999**
- **KALPANA-1 – 12 Sept. 2002**
- **INSAT-3A – 10 April 2003**

Two Channel VHRR

Three Channel VHRR

Current Indian Geostationary Meteorological Satellites



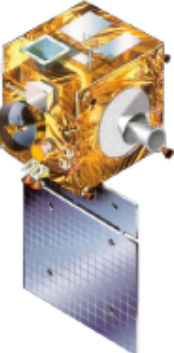
Indian Missions for Weather & Climate Studies

Courtesy: SA



↑ GEO ↓


Kalpana-1
2002



VHRR

CMV, OLR, UTH, Rain

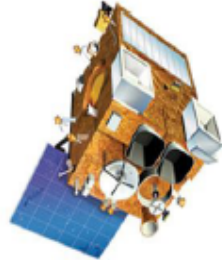
INSAT-3A
(2003)



VHRR, CCD

CMV, OLR, UTH, Rain
Aerosol

INSAT-3D
(2013)



6-Ch VHRR
IR Sounder

SST, CMV, OLR, UTH, Rain,
T, h Profile, Ozone

- INSAT-3D R
- GISAT
- (~2016/17)

The GEO Imaging Satellite (GISAT) will carry a GEO Imager with multi-spectral (visible, near infra-red and thermal), multi-resolution (50m to 1.5 km) imaging instruments.

↑ LEO ↓

OCEANSAT-1/2
(1999/2009-09-23)



MSMR,
OCM,
Scatterometer
ROSA (GPS)

Vector Winds,
Aerosol, T&h Profile

SARAL
(2013)



Altimeter

SSH, Waves, Winds

MEGHA-TROPIQUES
(2011)



MW Imager,
WV Sounder,
ScaRaB
ROSA

SS Wind, TWV, Rainfall
T, h Profile,
Radiation Budget



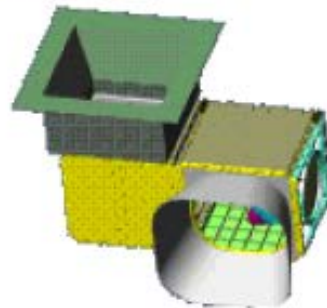
INSAT - 3D : Main sensors

6 Channel IMAGER

- Spectral Bands (μm)
 - Visible : 0.55 - 0.75
 - Short Wave Infra Red : 1.55 - 1.70
 - Mid Wave Infra Red : 3.80 – 4.00
 - Water Vapour : 6.50 - 7.10
 - Thermal Infra Red – 1 : 10.30 - 11.30
 - Thermal Infra Red – 2 : 11.50 - 12.50
- Resolution : 1 km for VIS, SWIR
4 km for MIR, TIR
8 km for WV

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 all bands
- No of simultaneous sounding per band : Four



Launch : July-2013

Location : 82° E

NINETEEN CHANNEL ATMOSPHERIC SOUNDER

with a resolution of 10 km at Sub-Satellite



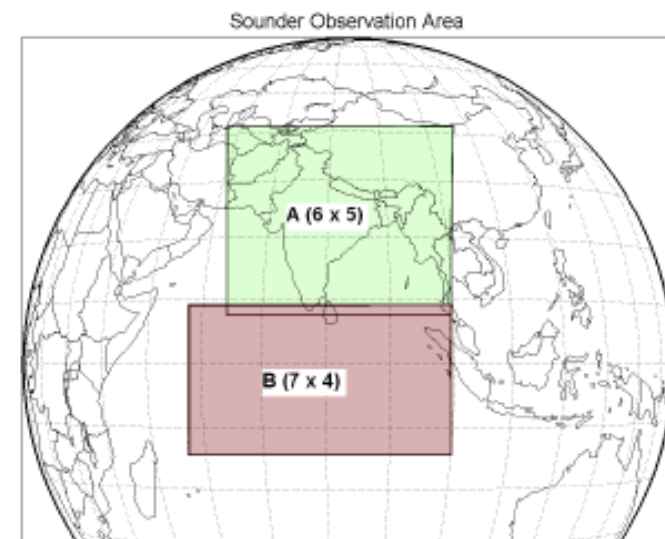
Channel No.	Central Wavelength (in μm)	Principal absorbing constituents
1	14.71	CO ₂ – band
2	14.37	CO ₂ – band
3	14.06	CO ₂ – band
4	13.64	CO ₂ – band
5	13.37	CO ₂ – band
6	12.66	water vapor
7	12.02	water vapor
8	11.03	window
9	9.71	ozone
10	7.43	water vapor
11	7.02	water vapor
12	6.51	water vapor
13	4.57	N ₂ O
14	4.52	N ₂ O
15	4.45	CO ₂
16	4.13	CO ₂
17	3.98	window
18	3.74	window
19	0.69	vis

Only Sounder in Geostationary orbit, after GOES

Temperature and humidity profile

Total Ozone and Ozone profile

Derived products

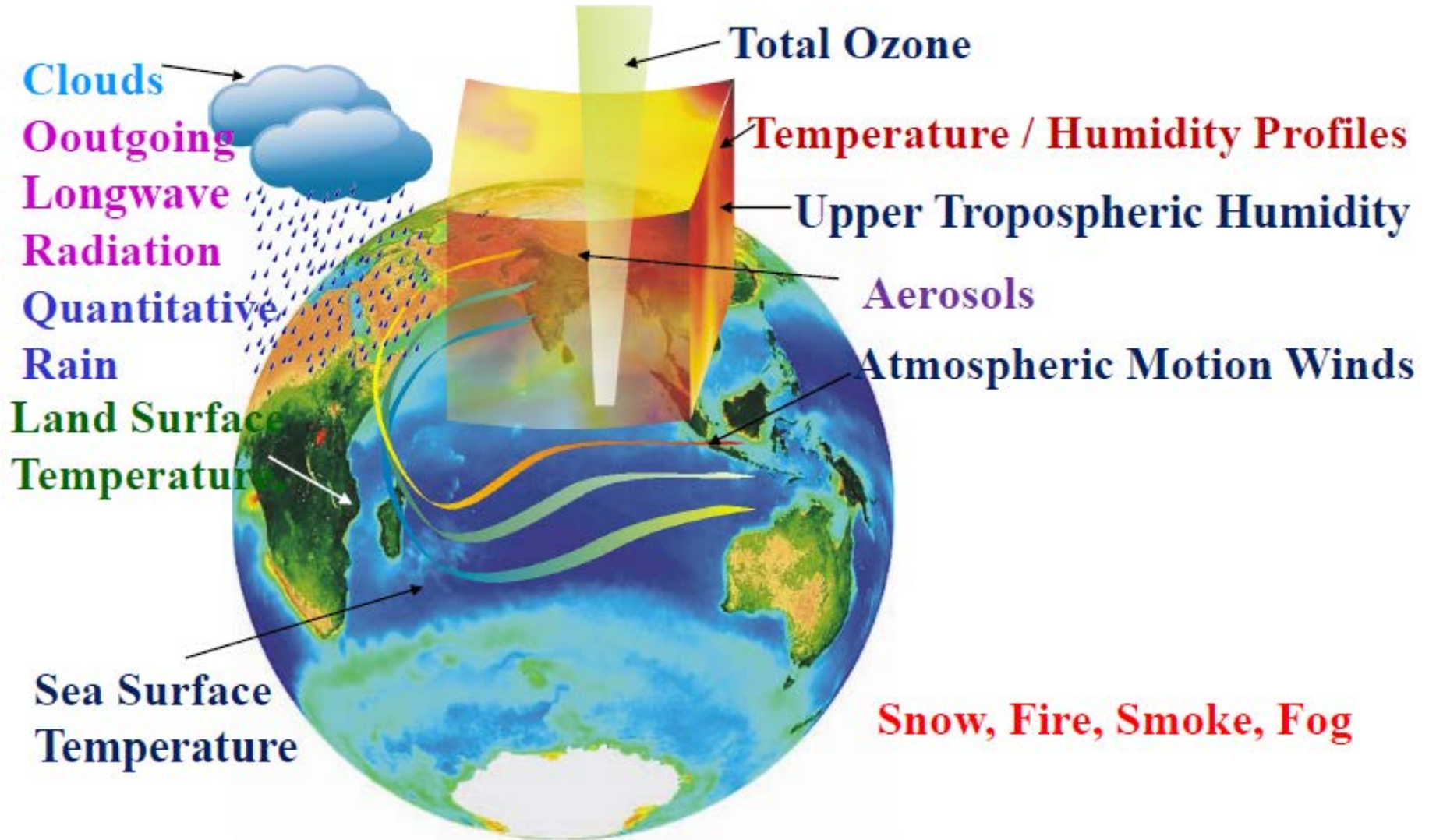


Scan time: A: $6 \times 5 = 30$ Frames $\times 1.8$ min = 54 min
B: $4 \times 7 = 28$ Frames $\times 1.8$ min = 51 min

- This sounding repeated every hour over land (A)
- Every 6th hour sounding over Ocean (B)
- Best suited for nowcasting over land and NWP



INSAT-3D : Science Products





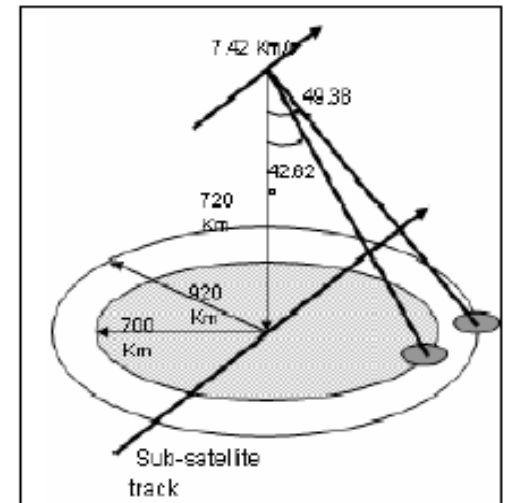
Oceansat -II

- **Instruments:**
 - Scatterometer Ku band
 - Ocean Color Monitor (8 bands 0.4- 0.885 μm)
 - Radio Occultation ROSA
- **Launched**
 - 23 September 2009
- **Applications:**
 - Sea State Forecast: Waves, Circulation and MLD
 - Monsoon and Cyclone Forecast
 - Antarctic Sea Ice
 - Fisheries and Primary productivity estimation
 - Monitoring of Phytoplankton blooms
 - Sediment dynamics

Scatterometer Specifications

Parameter	Inner Beam	Outer Beam
Attitude	720 km	
Frequency	13.515 GHz	
PRF	200 Hz	
Wind speed range	4 to 24 m / sec.	
Wind speed accuracy	Better than 20 % (rms)	
Wind direction accuracy	20° (rms)	
Polarization	HH	VV
Swath	1400 km	1840 km
Elevation angle	42.62°	49.38°
Incidence angle	48.90°	57.60°
Footprint	26 x 46 km	31 x 65 km
Scanning rate	20.5 rpm	

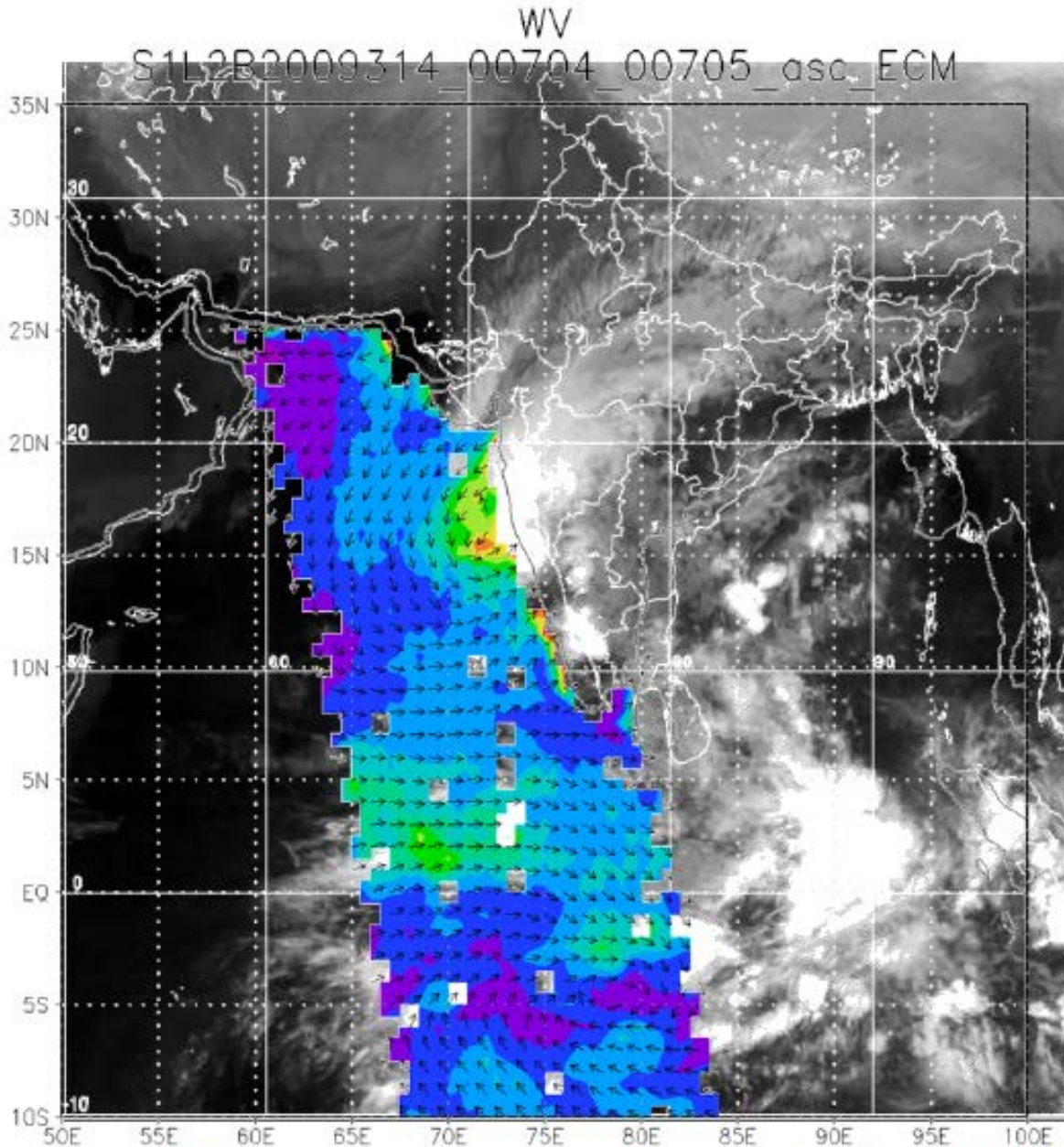
Scatterometer Observational Geometry





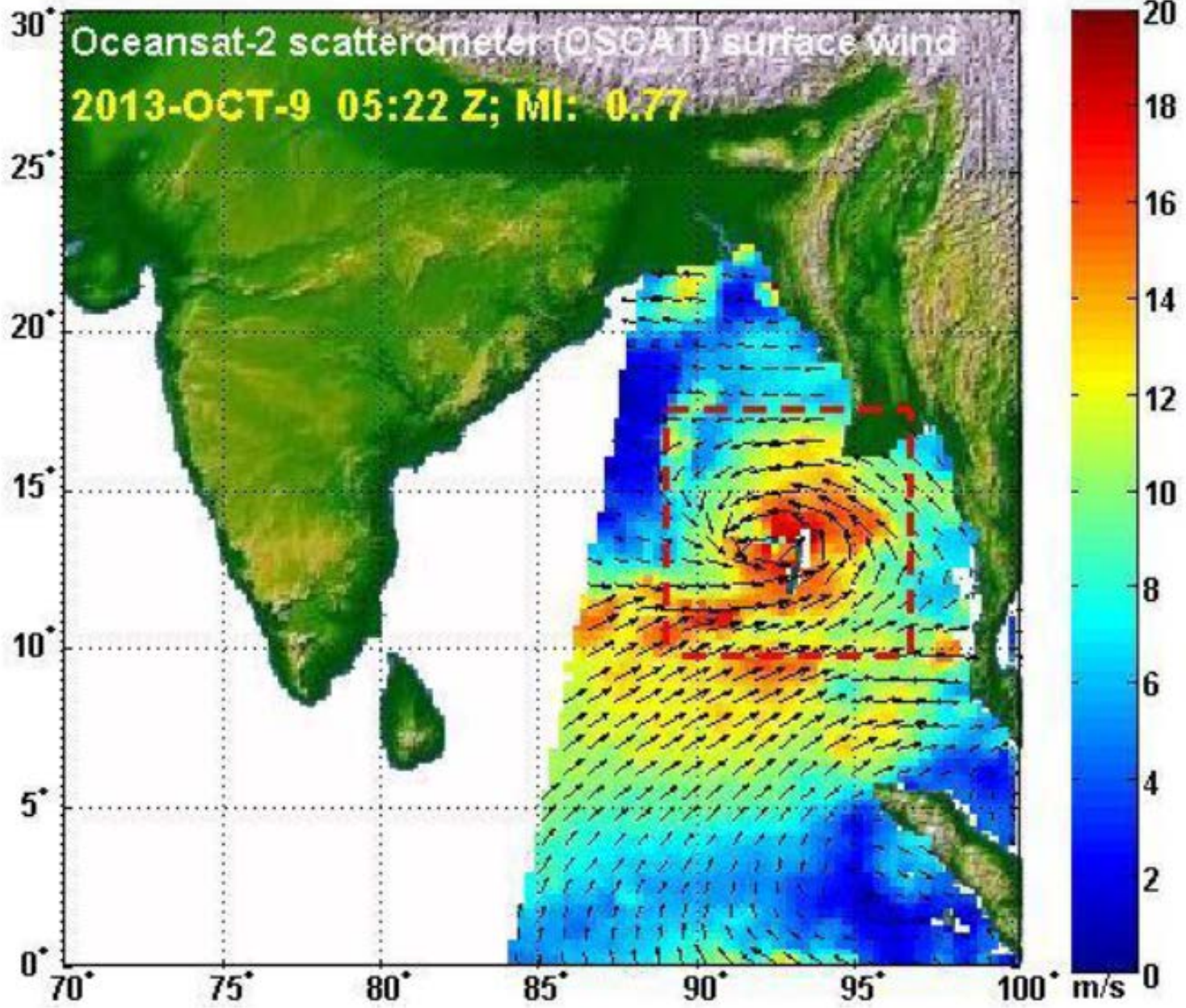
PHYAN Cyclone

10/11/09



Oceansat-2 Scatterometer winds overlaid on KALPANA Image

PHAILIN





SARAL-Altika: An ISRO-CNES collaborative mission (2013)

Altika Mission: Belongs to the global altimetry system for the precise and accurate observations of ocean topography, circulation and sea surface monitoring with same accuracy as ENVISAT and complementary to the JASON-2 mission. Launched in Feb, 2013 by PSLV C-20.

Altika Payload :

- A Ka-band (35.75 GHz, BW 500 MHz) radar altimeter
- A dual-frequency MW radiometer (23.8 and 37 GHz), for tropospheric range correction
- DORIS: For achieving adequate orbitography performances
- LRA: For Orbitography and system calibration

Altika/SARAL central objective :

Ocean meso-scale variability:	Sea state Monitoring & Now Casting
Data assimilation:	Sea state forecasting
Coastal altimetry:	(Bathymetry, coastal upwelling & circulations etc.)

Other Objectives :

Operational oceanography
 Continental waters
 Inland ice sheet monitoring
 Light rainfall and clouds climatology
 Climate Change: Mean sea level
 Geodetic reference system determination
 Geophysical and geological investigations

Satellite Description :

- Sun-synchronous, polar orbiting, inclination: 98.38 Deg.
- Altitude: ~800 km, Repeat cycle: 35 days

Acknowledgment

Authors are very much grateful to Director General of Meteorology, IMD, New Delhi, for his keen interest and providing all facilities to attend the workshop.

The first author thanks Mitchell Goldberg and Neils Bormann for the kind support to attend the workshop.

Thanks

