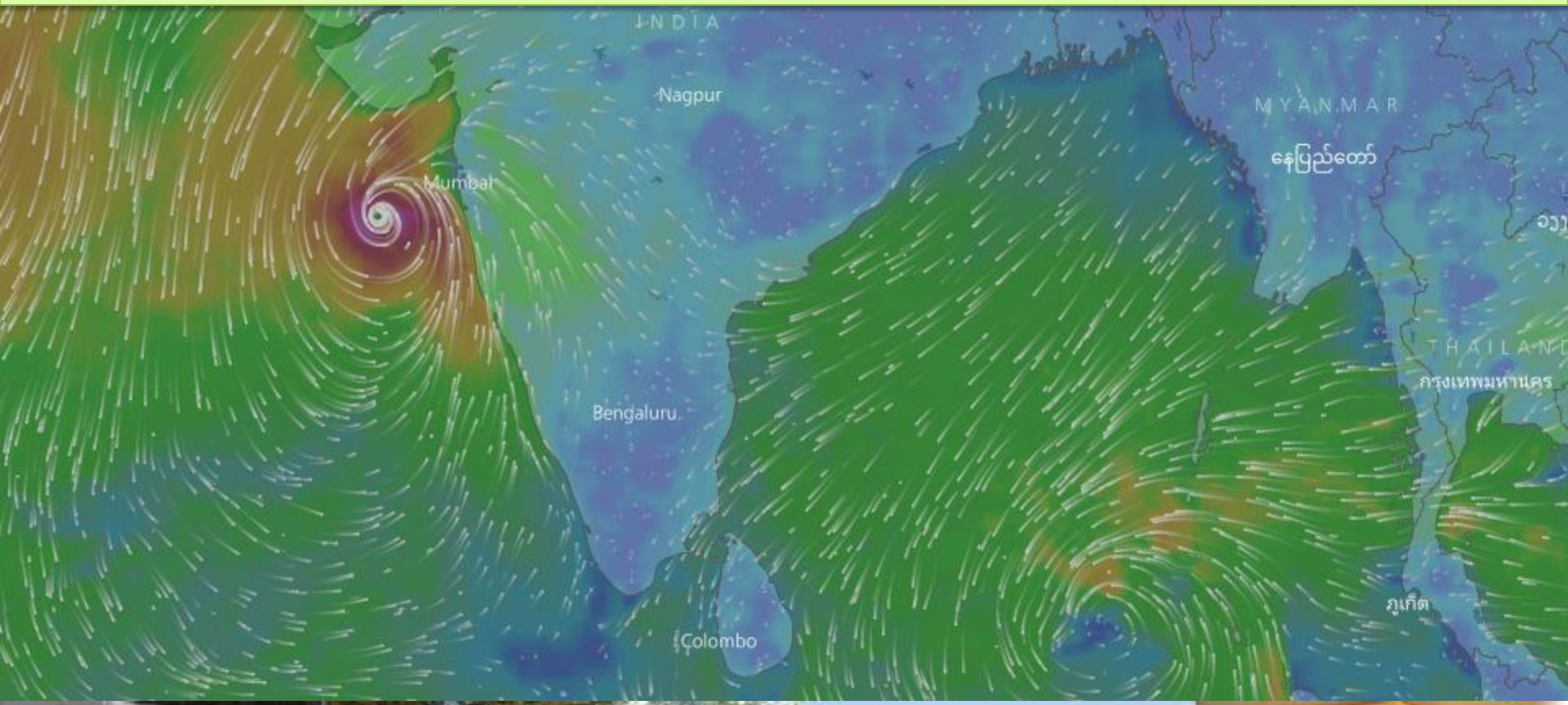
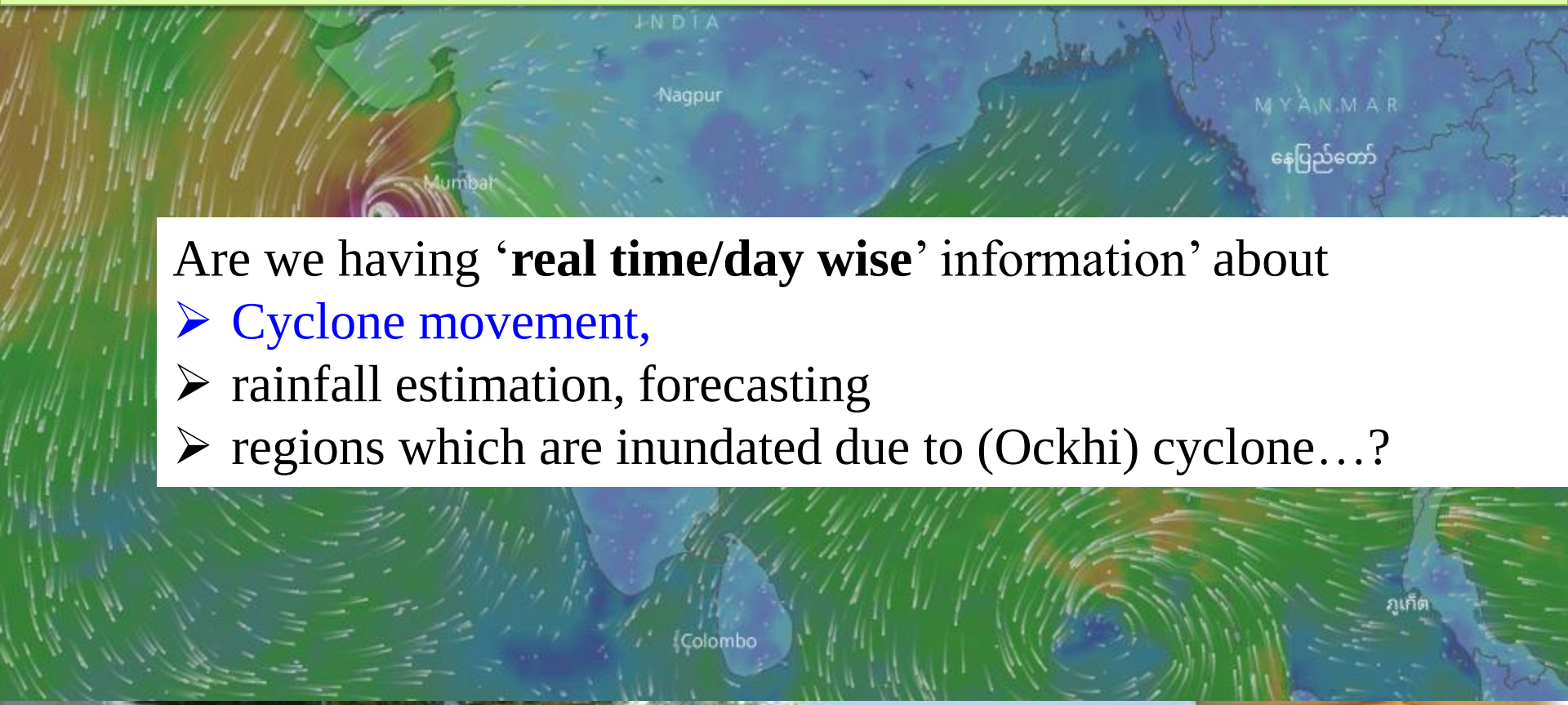
‘Application level’ challenges and issues of processing different frequency, polarization and incidence angle Synthetic Aperture Radar data using distributed computing resources



Dr. R Manavalan, Mangala
C-DAC, Bangalore
Workshop on Software Challenges to Exascale Computing,
HiPC-2017, 17 December 2017, Jaipur.

‘Application level’ challenges and issues of processing different frequency, polarization and incidence angle Synthetic Aperture Radar data using distributed computing resources

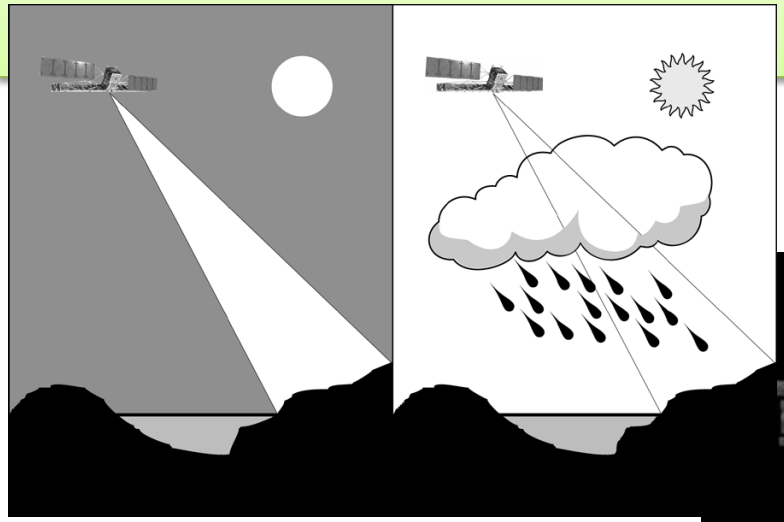


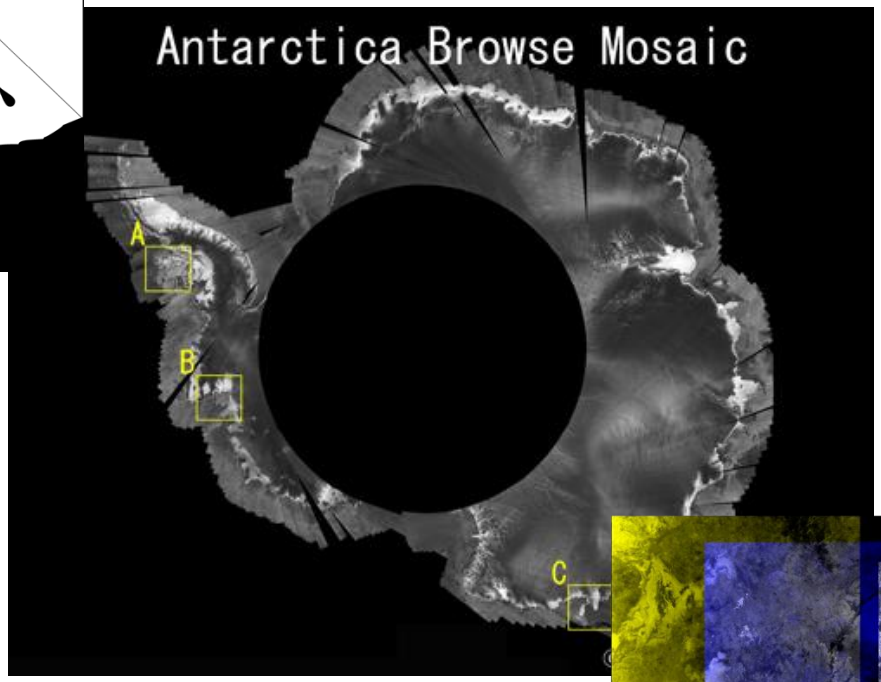
Are we having ‘**real time/day wise**’ information’ about

- Cyclone movement,
- rainfall estimation, forecasting
- regions which are inundated due to (Ockhi) cyclone…?

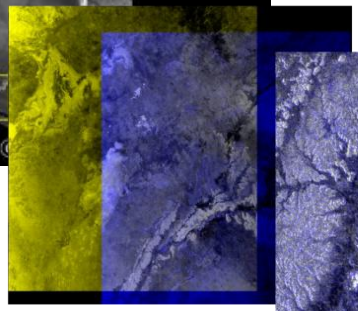
Dr. R Manavalan, Mangala
C-DAC, Bangalore
Workshop on Software Challenges to Exascale Computing,
HiPC-2017, 17 December 2017, Jaipur.

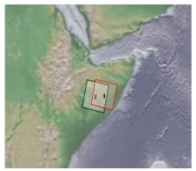
About SAR Technology, Role of SAR in regional scale disaster monitoring, Data volume/dimension of SAR based application models

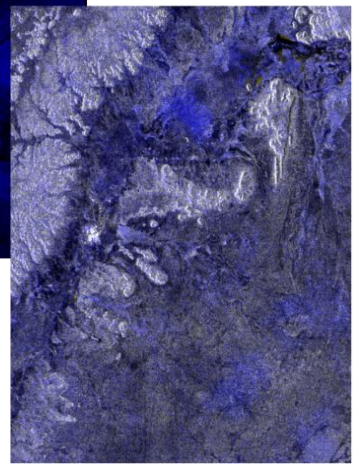




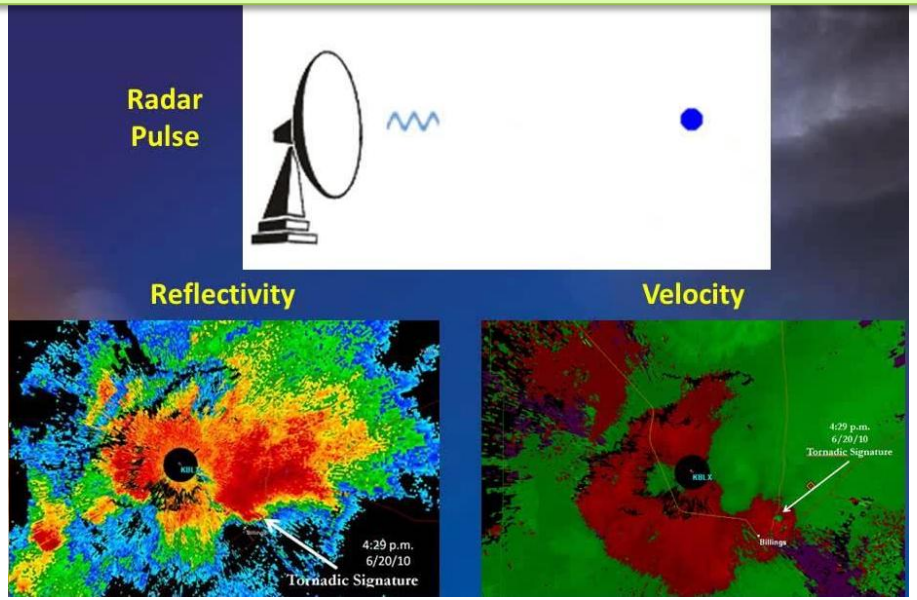
Dec. 8 2007 - Jan. 22 2008

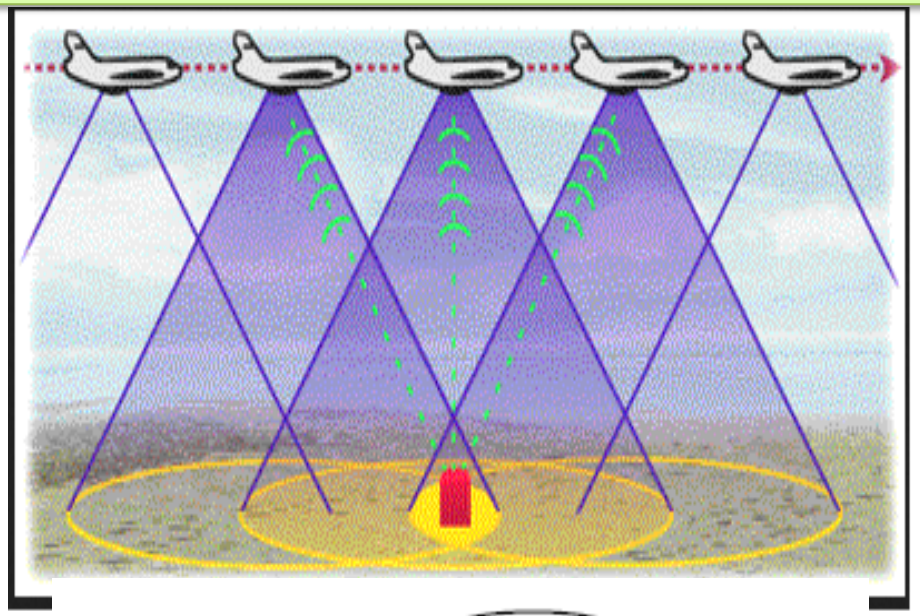




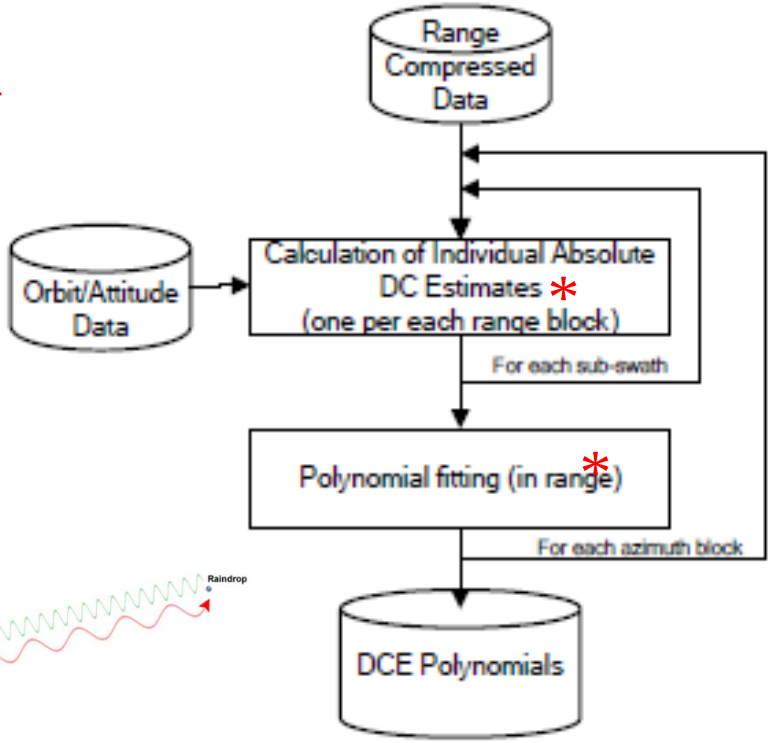


RADAR data Processing - How complex the technology and issues at data capturing level



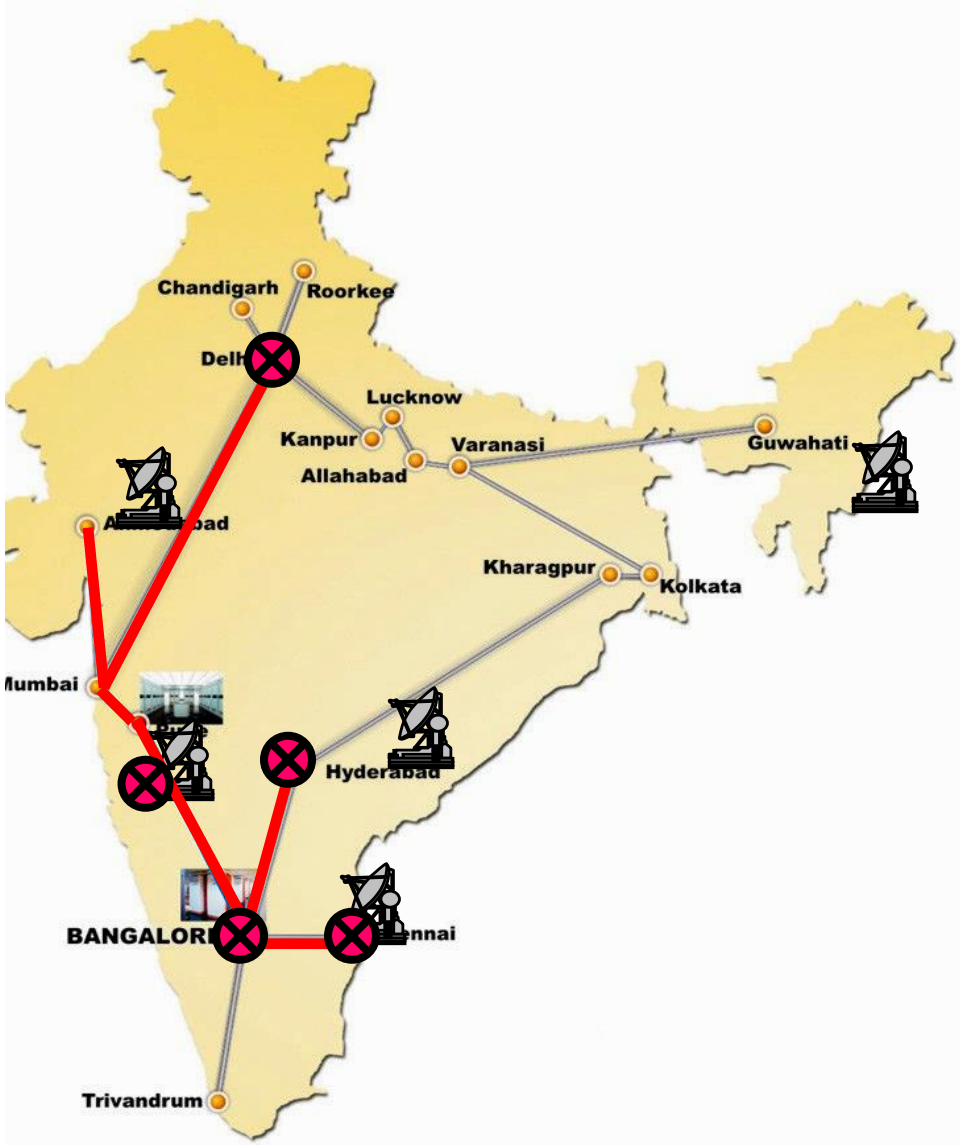


S, C, L, P…



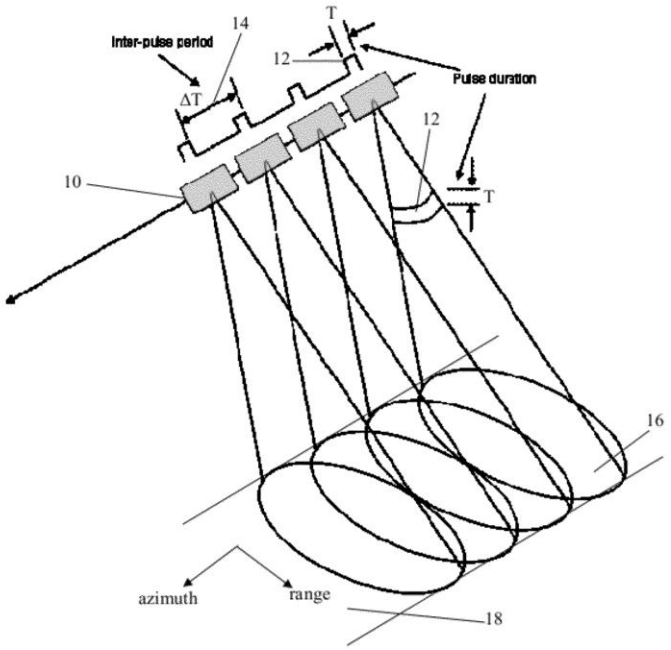
SAR Data Processing (L_0 Level): Issues at computational level

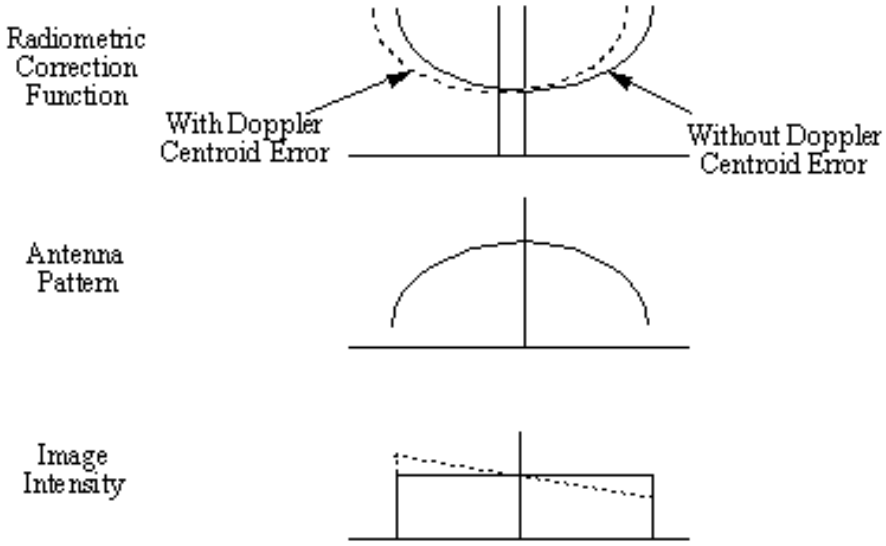
Data dimension: Increase and Decrease



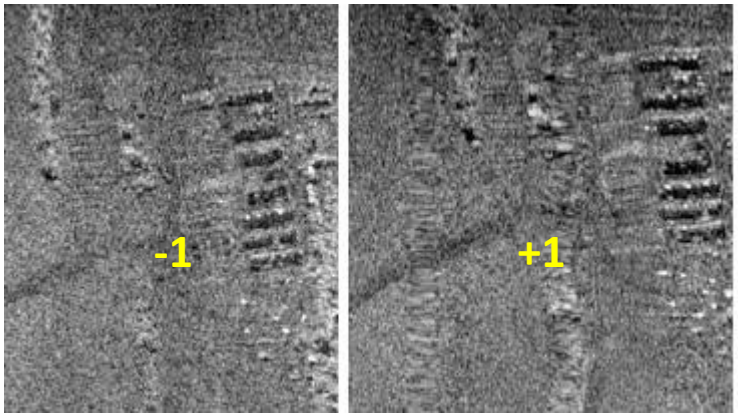
M-1	Synchronization Check Auxiliary data extraction BAQ encoding Range Compression
M-2	Motion sensing
M-3	IQ bias removal STC correction
M-4	Clutter lock
M-5	FDC Estimation PRF slaving
M-6	FDC Estimation & FFT Block Processing Phase Compensation RCM Azimuth Compression & FFT
M-7	Mosaicking & North Orientation

Issues at computational level: Doppler Centroid Estimation



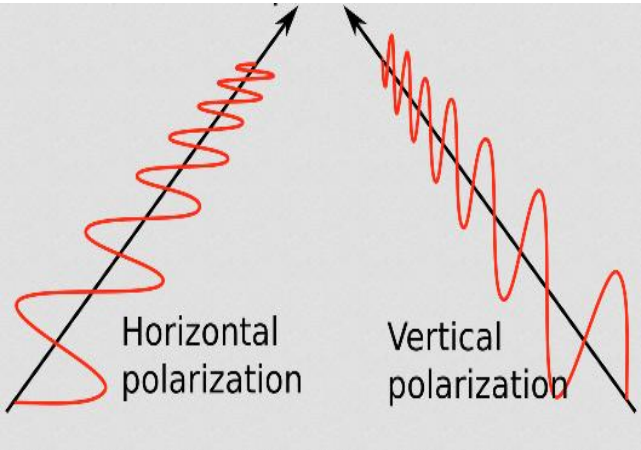


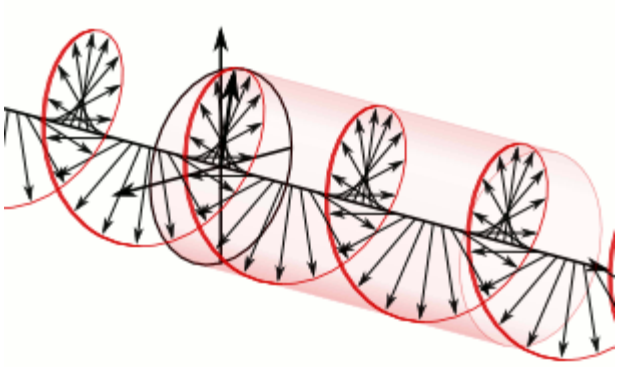
Issues at computational level: Browse Processing
-1 to 0.1 to +1

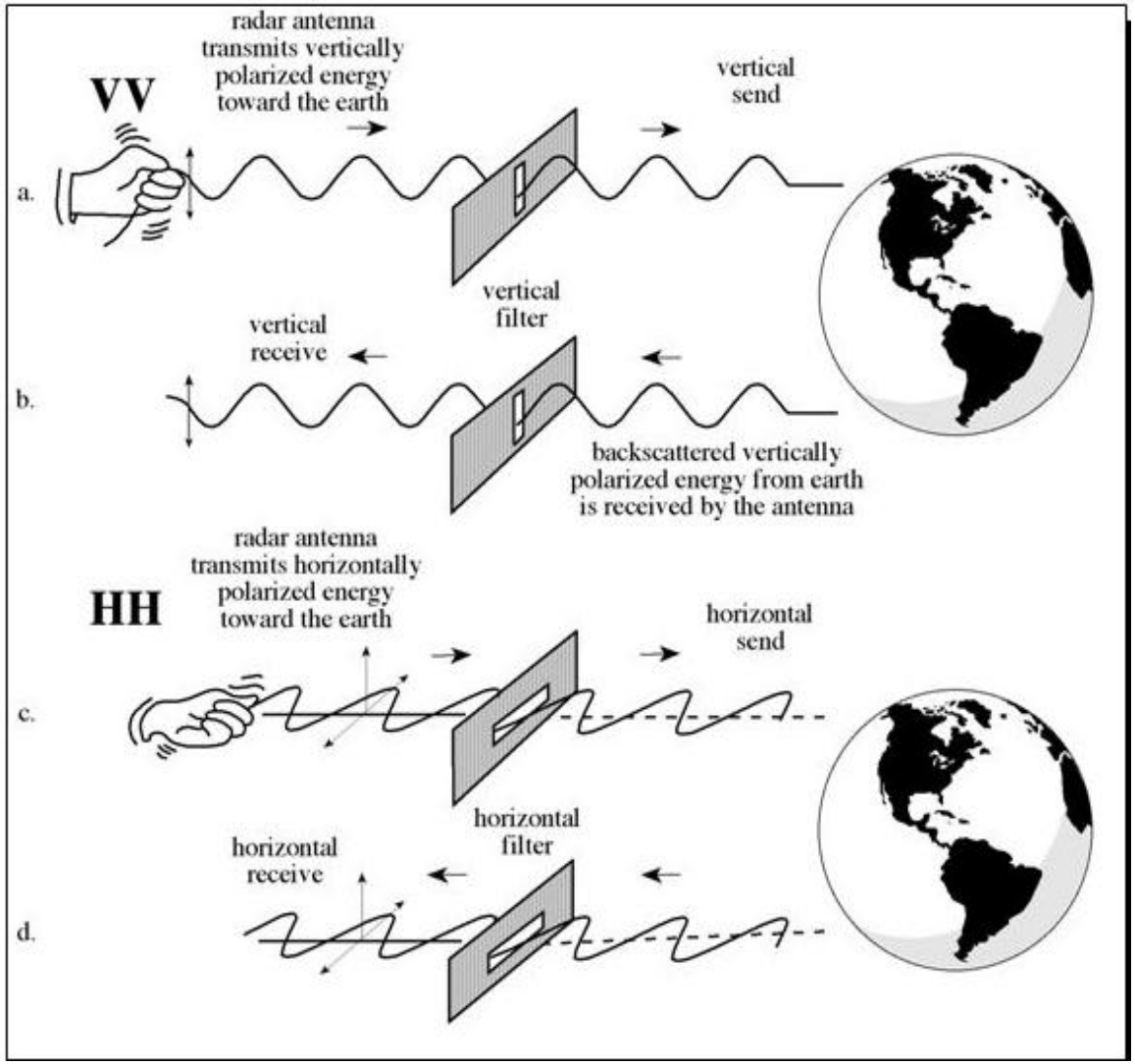


(Clutter Lock)

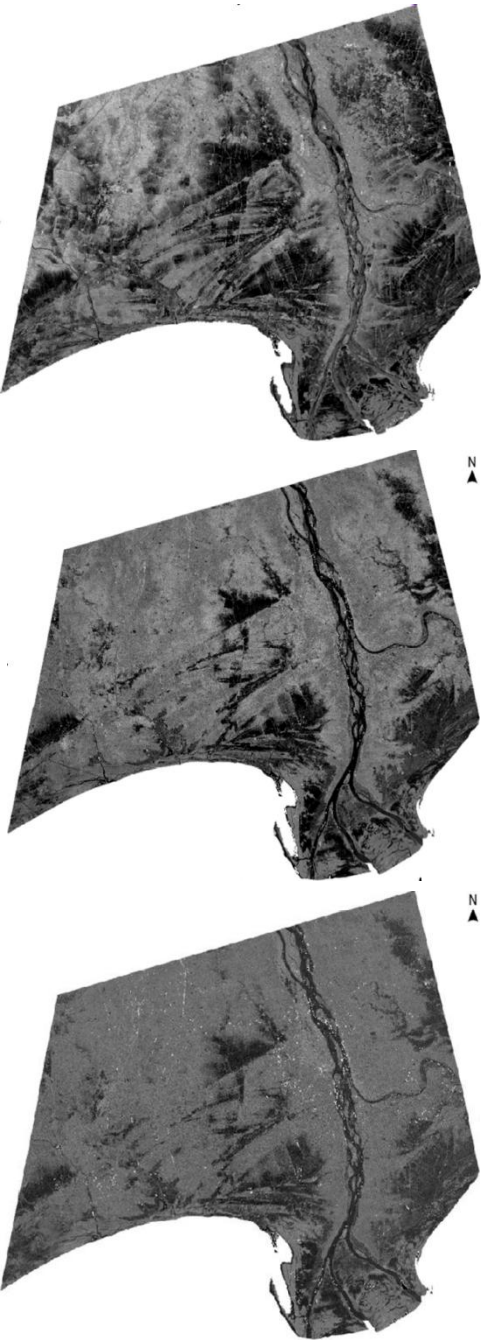
Issues at computational level: ~~Simultaneous~~ extraction different Polarization channels

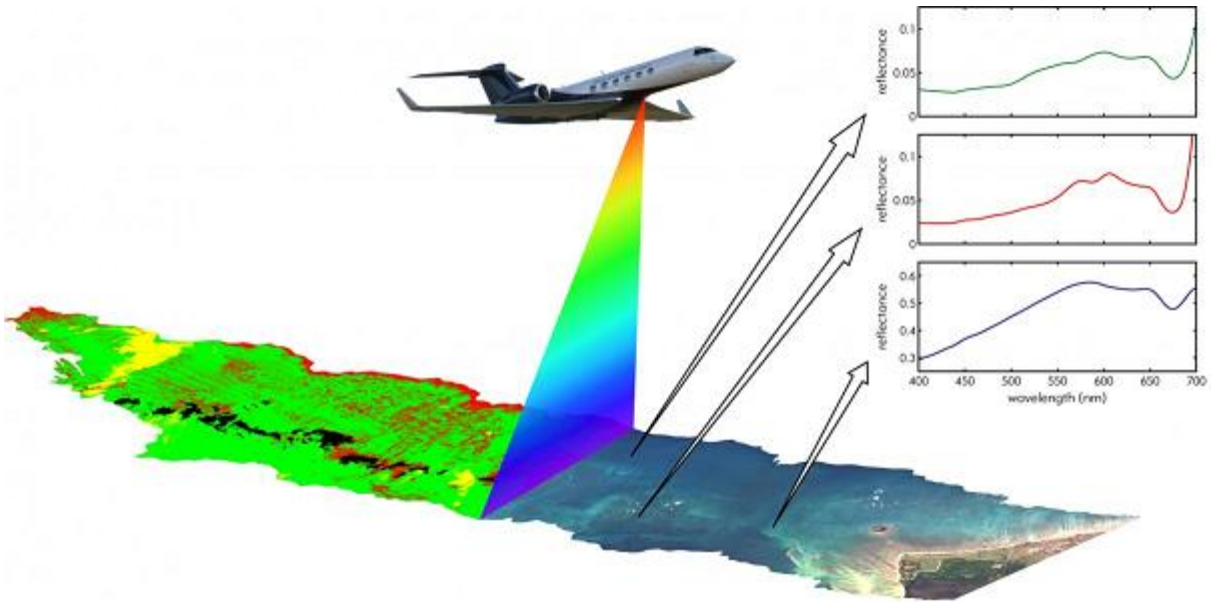






Issues at computational level: 'Simultaneous' extraction different Polarization channels





HH, VH, VV Polarization data of same region affected by flood (~ 3064 Sq.km; 12GB -> 450 MB at 4m, Time taken 6-7 hours/per scene)

Polarization

- Co – HH/VV
- Cross – HV/VH
- Dual Co or Dual Cross: HH+VV, HH+HV or VV+VH
- Quad-polarization imagery (HH, HV, VH &VV)
- Circular (Right or Left)
- Compact

Swath coverage	Selectable within 107 – 659 km off-nadir distance on either side			
Incidence angle coverage	12º – 55º			
Operating mode	Polarization mode			
	Single Pol HH/HV/VV/VH	Dual Pol HH+HV/VV+VH	Circular (Hybrid) Polarimetry TX: CP Rx: V and H (Experimental)	Quad Pol HH+HV+VV+VH
HRS	1 m(Azimuth) x 0.67 m (Range) resolution, 10 km x 10 km (10 x 100 km Experimental) Spot Min σ^0 = -16 dB			
FRS-1	3 m(Azimuth) x 2 m (Range) resolution, 25 km swath Min σ^0= -17 dB			
FRS-2			3 m(Azimuth) x 4 m (Range) resolution, 25 km swath Min σ^0= -20 dB	9 m(Azim m (Ra resolution swa σ^0= -1
MRS	21-23 m (Azimuth) x 8 m (Range) resolution, 115 km swath Min σ^0= -17 dB			
CRS	41-55 m (Azimuth) x 8 m (Range) resolution, 223 km swath Min σ^0= -17 dB			

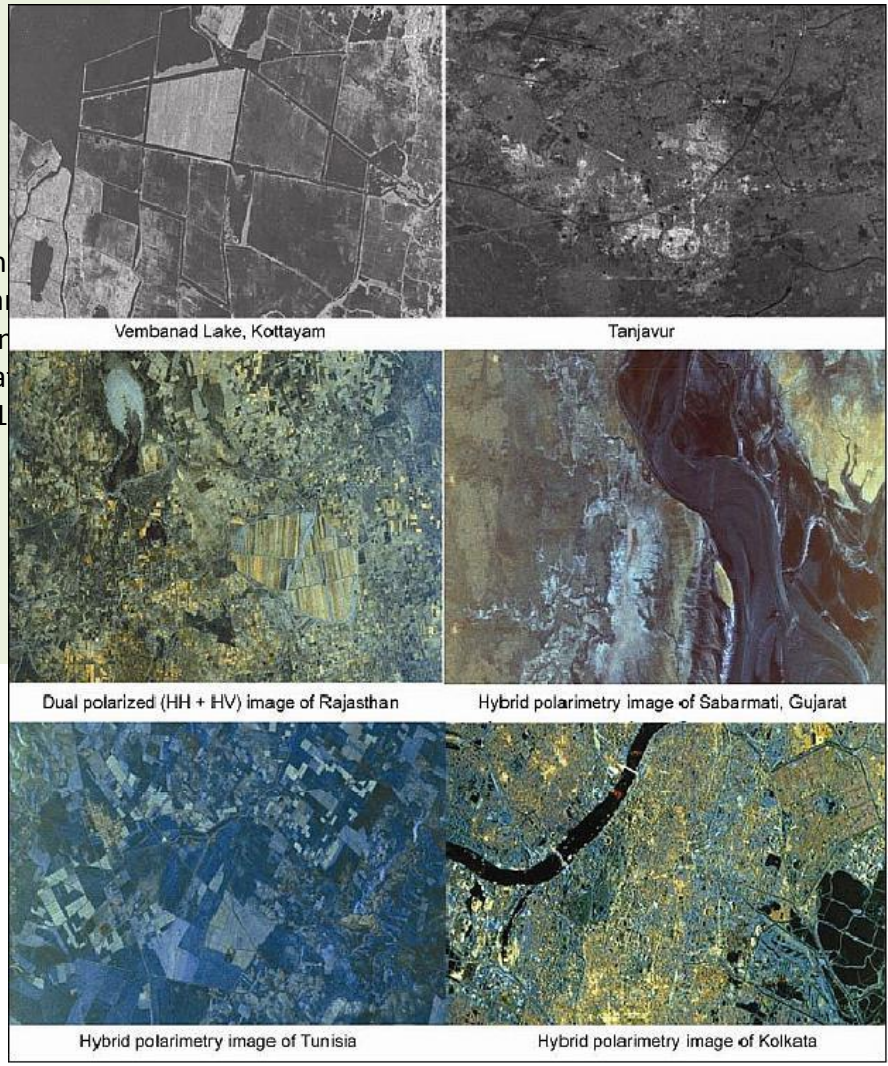
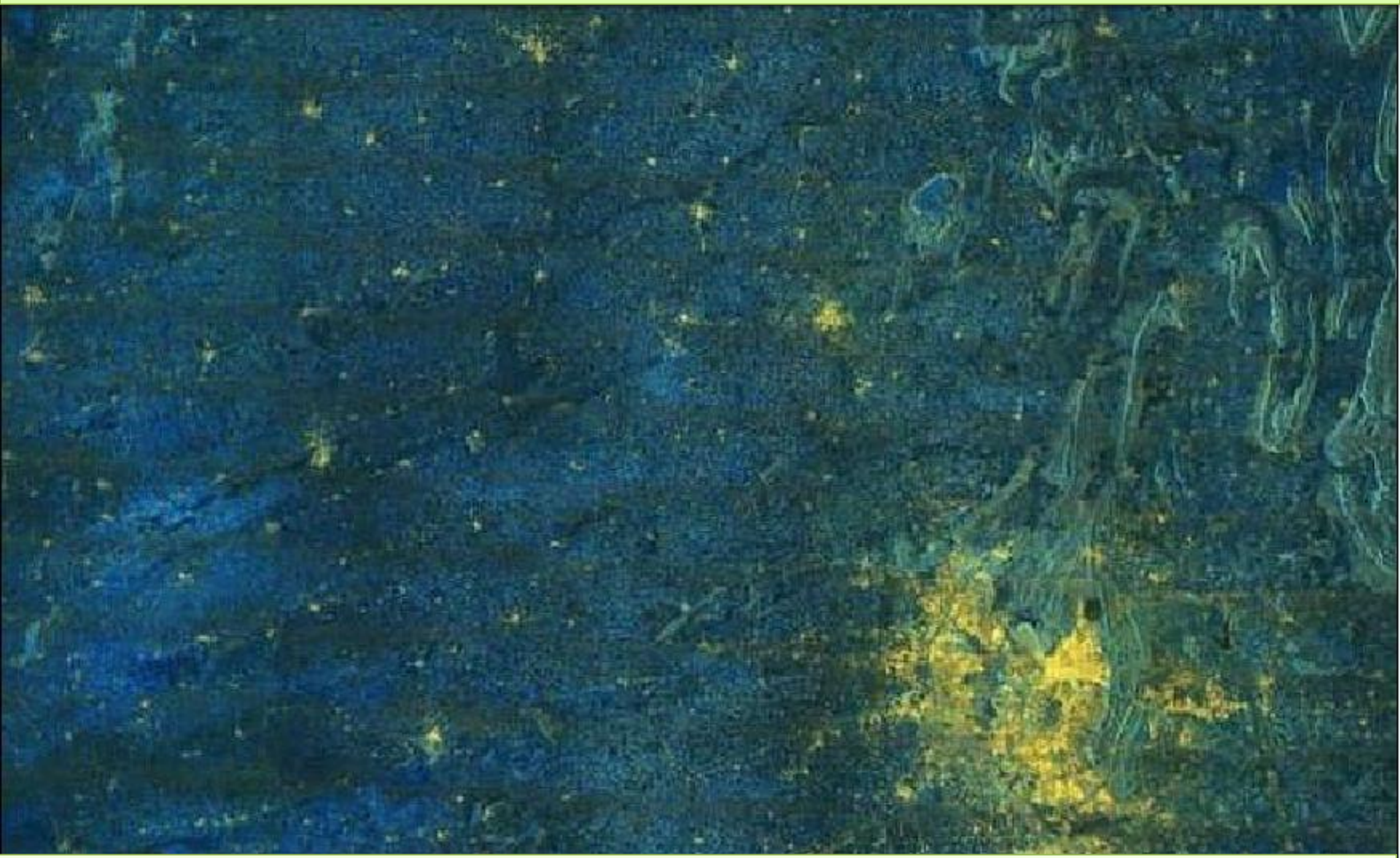


Image credit: ISRO/SAC

Sensor Mode



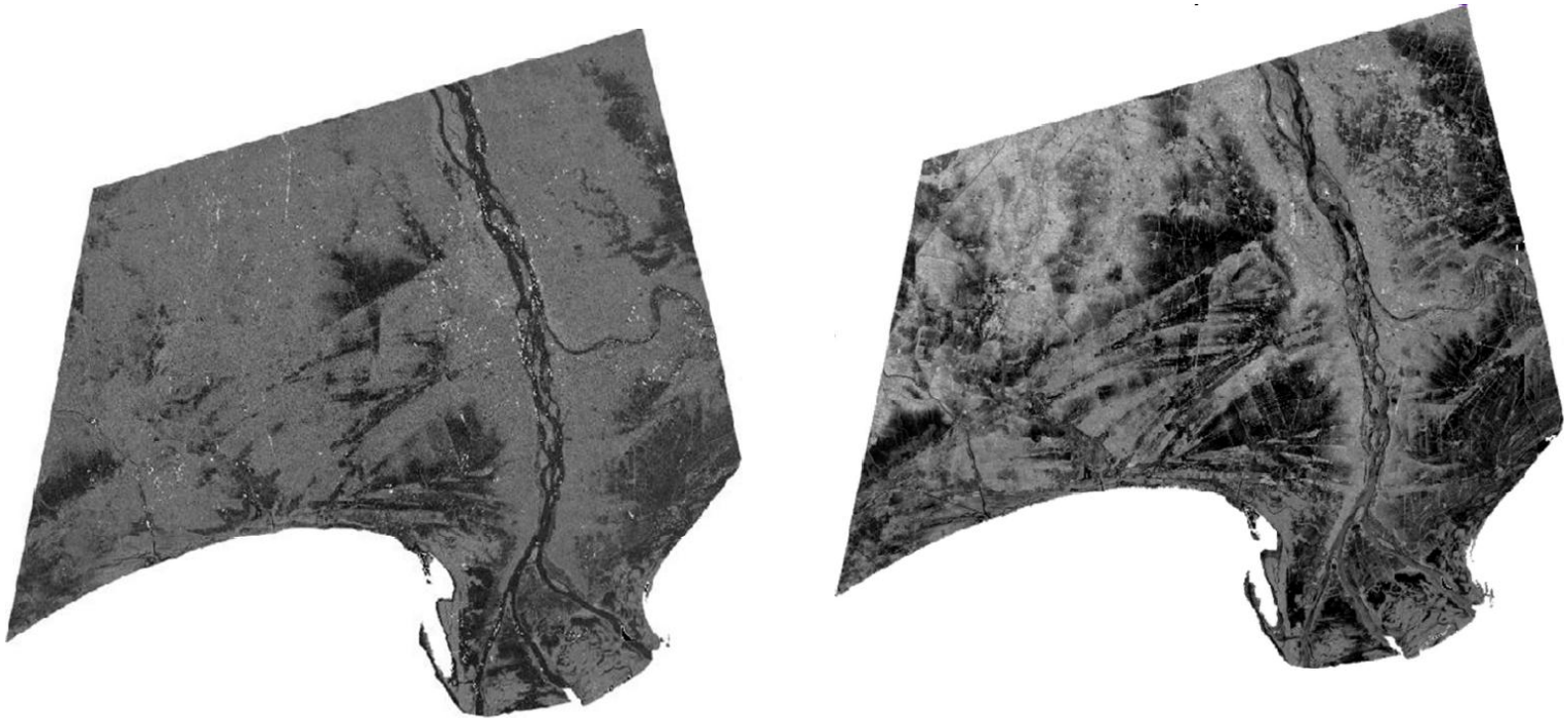
RISAT-1 Hybrid polarimetric image of Jaipur, India in ScanSAR mode (Image credit: ISRO/SAC)

Landsat image of Jaipur, India (Image credit: Google Earth)

Issues at Preprocessing level: Processing of different frequency data

~~(Simultaneous)~~

Different Frequency: C, L, P.. band SAR data



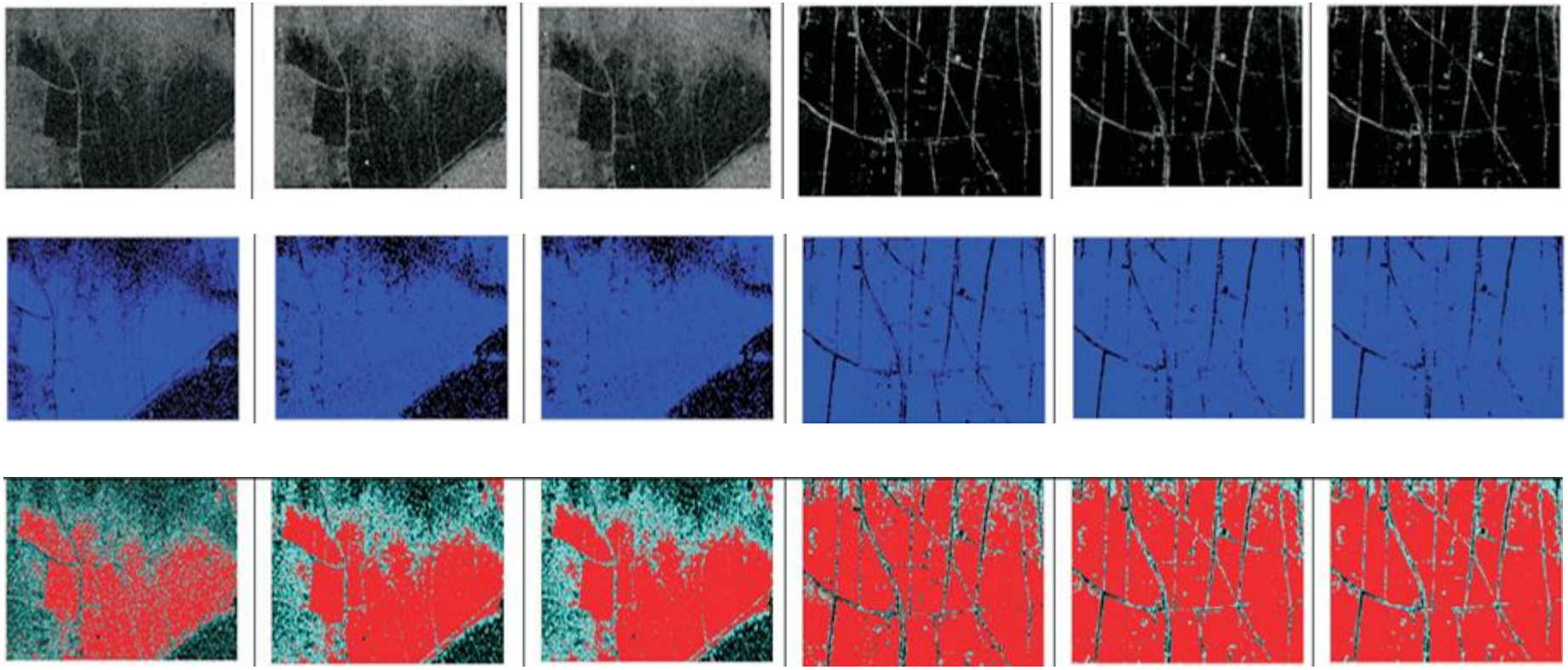
Simultaneous frequency airborne data from

- NASA/JPL: AIRSAR @ C, L, P Frequency
- DLR : F-SAR

Data Processing at different Muti-look (Simultaneous)

C-band Frequency of HH and HV Polarization

L-band Frequency of HH Polarization

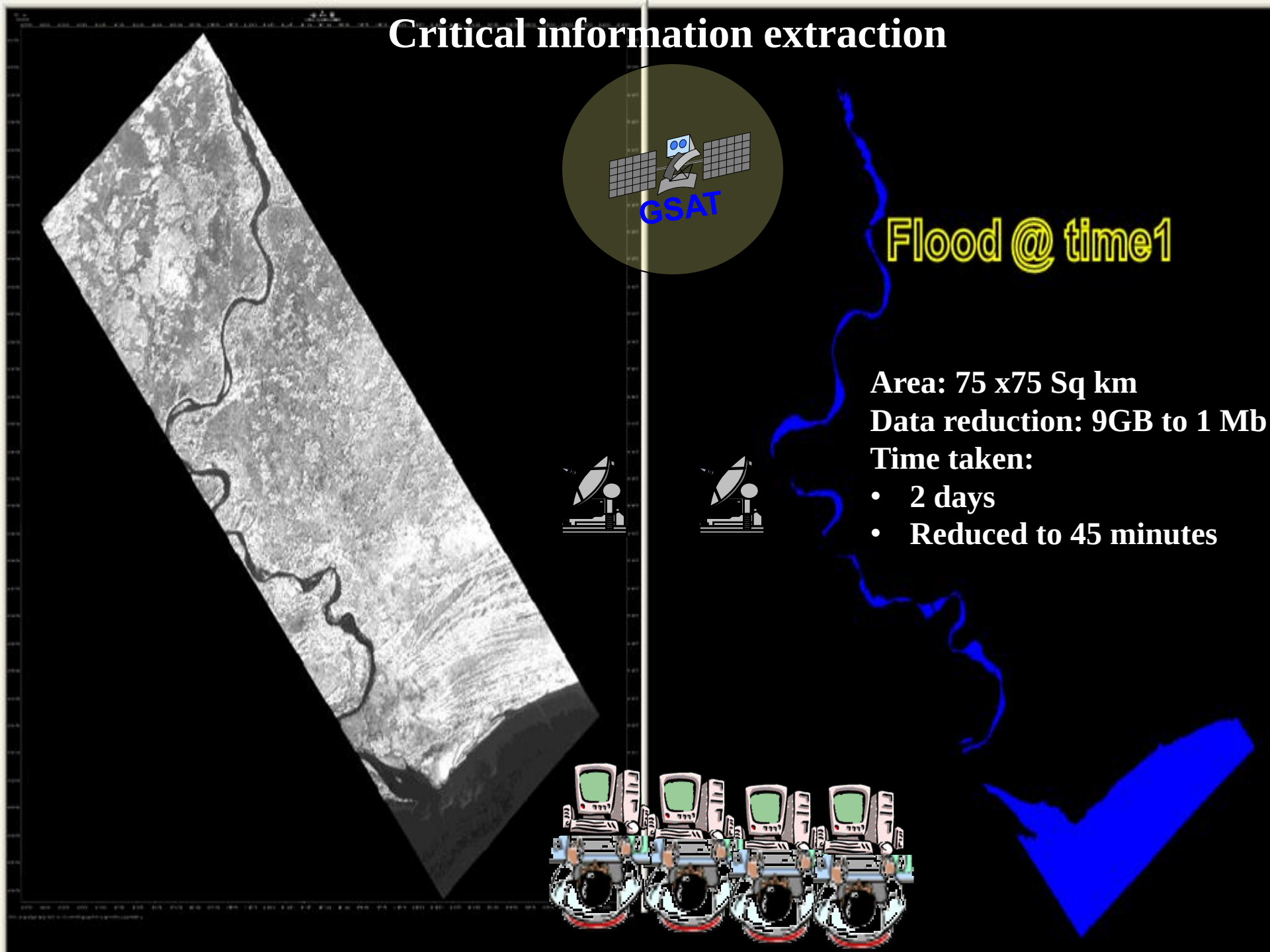


(~ 50 x 50 Sq KM)

Hours: 9 X 3@L_1 Level

Hours: 2 X 3@L_1 Level

Critical information extraction



Area: 75 x75 Sq km
Data reduction: 9GB to 1 Mb
Time taken:

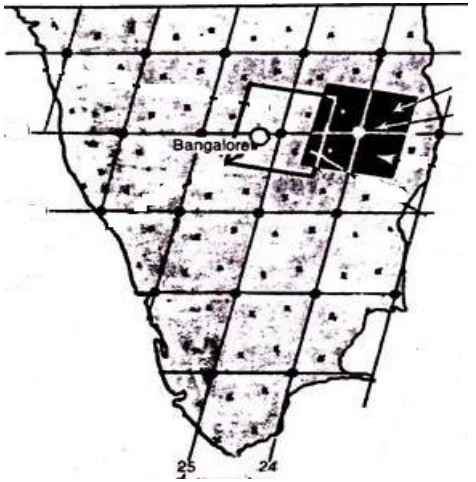
- **2 days**
- **Reduced to 45 minutes**

Why Exascale? - from hardware to fundamental algorithms, programming models, compilers and application codes

- Integrated 'day wise' RT/NRT system that support Cyclone-Rainfall Estimation -Flood area mapping at country level
  - **Ockhi 2017 (Nov 29 to Dec 6, 2017)**

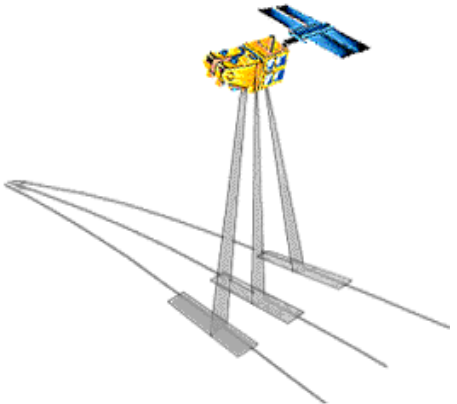
284 boats with 2641 - 462

- Data covering regional scale (country wise) cann't be processed with single cluster or even with few distributed resources
  - **Increase and decreasing nature of data dimension during the run time**



- Simultaneous SAR data processing SW environment
  - Different frequency data (C, L , P…)
  - Different polarization data (HH, VV, HV, VH…)
  - ~~Different mode~~

- Simultaneous multi-look of data and simultaneous post processing SW environment at different levels



Future Work : Need to work for SAR Exascale processing software mainly to meet regional scale real time disaster requirements that can make available day wise critical information

Computational Grids which supports EO simulations

gpod.eo.esa.int

cdac.in

Information don't have value if it has not been derived at right time by right setup

Thanks