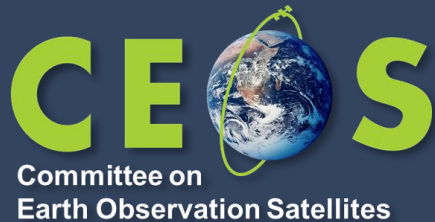




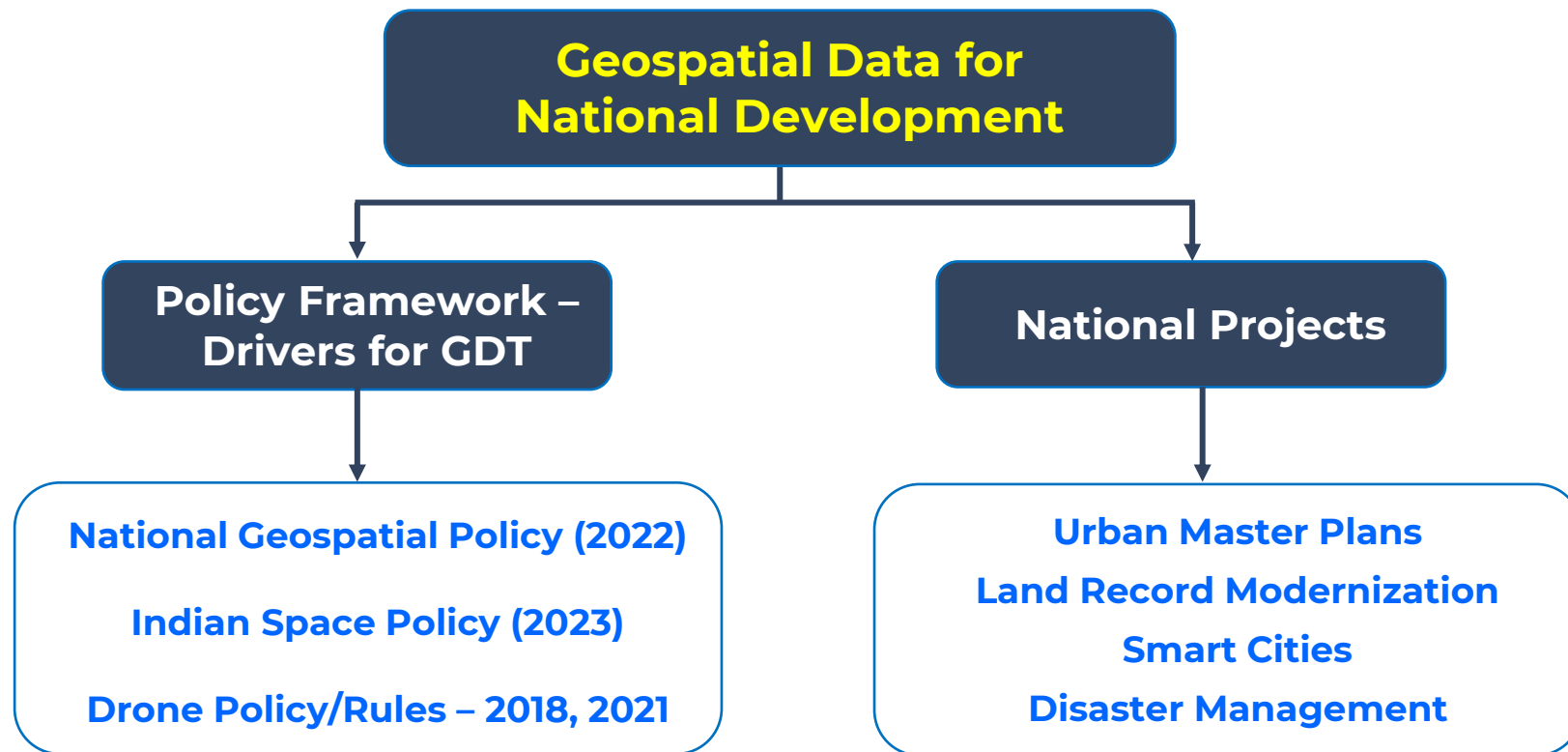
Harmonization of Multi-Resolution Geospatial Data in Geospatial Digital Twin Framework



J. Narendran, ISRO
Agenda Item 15.1
WGISS-60

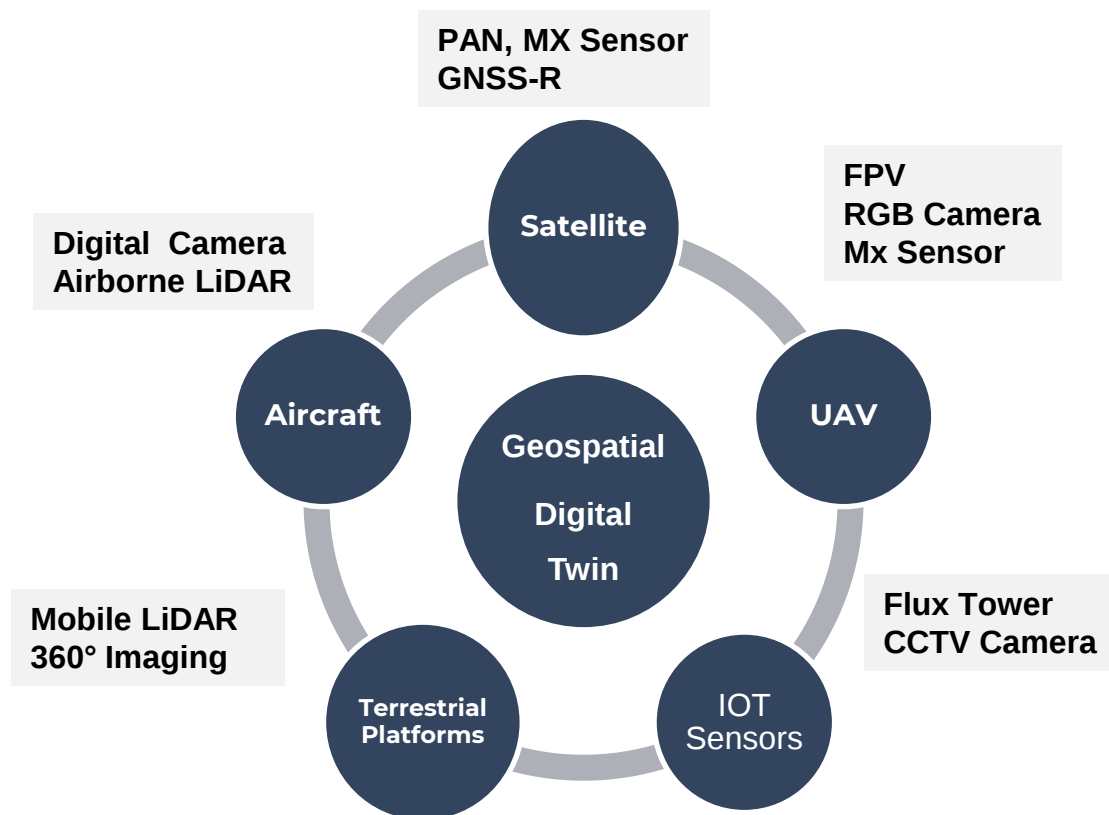
13-17 October, 2025

Oberpfaffenhofen, Germany



To Develop Integrated Geospatial Data Ecosystem

- ❖ Spatial Reference System
- ❖ Spatial Resolution – cm to m
- ❖ Temporal Resolution
 - Satellite Revisit/Repetivity
 - On Demand Flying (Aerial/UAV)
 - Real Time IOT Sensors
- ❖ Heterogenous Formats
 - Raster, Vector, Point clouds
 - Still images, Live Stream, Video
 - 360° Panos, IOT Sensor
- ❖ Area Coverage
- ❖ Data Volume

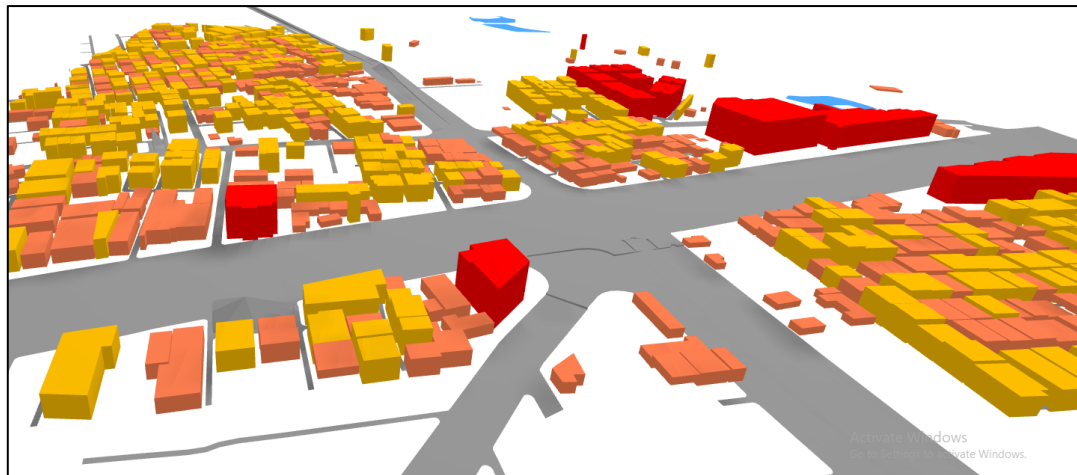
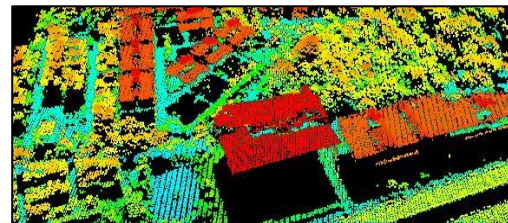


- ❖ Automated 3D reconstruction
- ❖ Open Source Software (3dfier)
- ❖ Input Data –
 - Satellite/Aerial
 - 2D Shapefiles - Building footprints, Water bodies, Road networks
 - Elevation data - LiDAR point cloud (.las files)
- ❖ Extrusion – 2D to 3D
- ❖ Semantic Enrichment
- ❖ 3D City Models
 - CityJSON, LoD1 (Level of Detail-1)

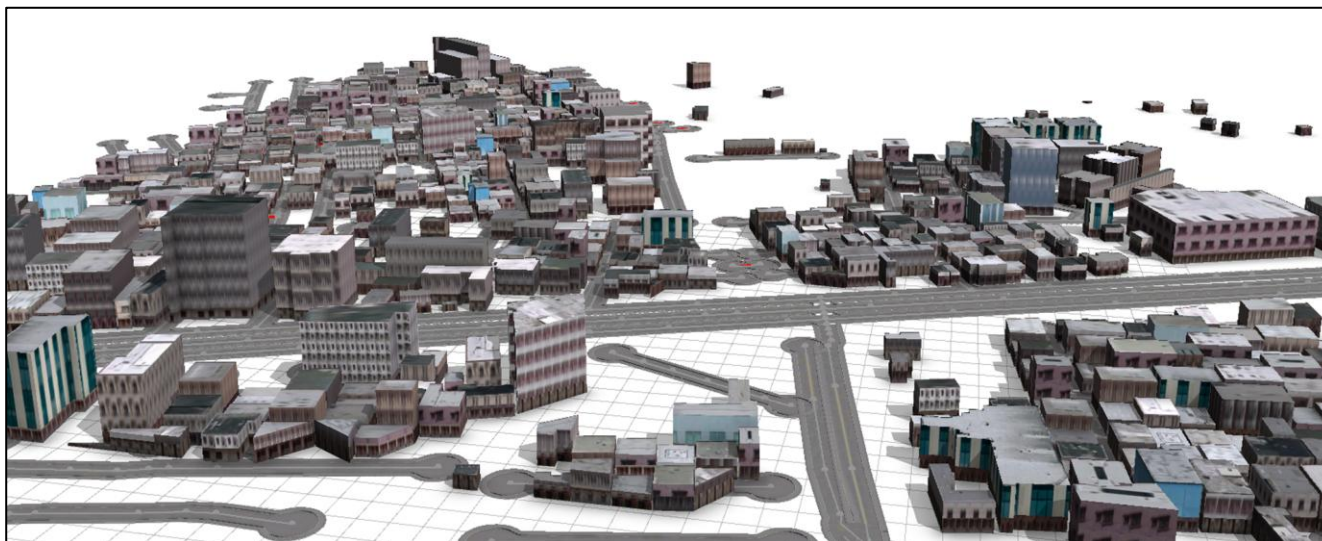
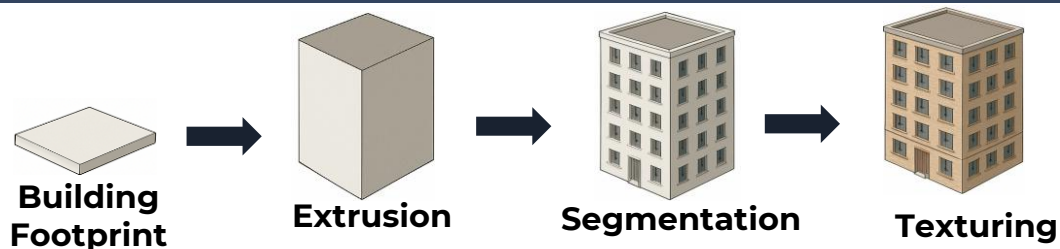
2D Polygons



LiDAR Point Cloud



3D City model, Part of Surat, Gujarat, India



3D City model (Textured), Part of Surat, Gujarat, India

- ❖ Generate Realistic 3D models
- ❖ Multiple view Stereo Images
- ❖ UAV based Nadir/Oblique Cameras
- ❖ Flying Height: 110 m, GSD: 1.5 cm
- ❖ Forward / Side lap: 80% & 70%
- ❖ 3D Mesh: Cesium 3D tiles format



3D Mesh Model

- ❖ UAV based First Person Video (FPV)
 - Dynamic Input & Finer Ground details
 - Complements Satellite & Aerial data
- ❖ High resolution, High definition video from Nadir & Oblique angles
 - Full HD 1920 x 1080, 30fps
- ❖ Disaster Management, Environment Monitoring, Infrastructure Monitoring
- ❖ Limitations
 - Regulatory restrictions for Beyond Visual Line of Sight (BVLOS) flying
 - Drone Endurance



Quadcopter



FPV Camera



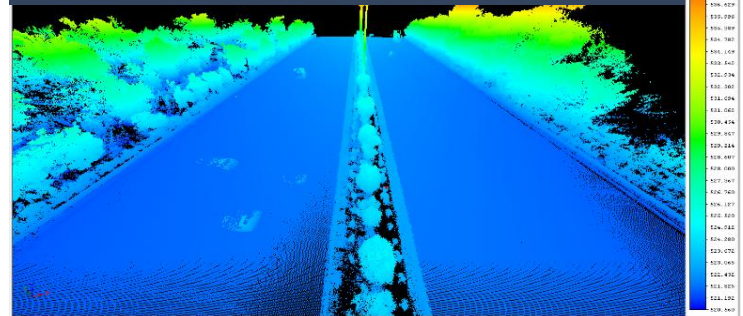
FPV data acquired over Cal-Val site at NRSC

- ❖ Mobile LiDAR (mounted on Vehicle)
 - Outer Ring Road, Hyderabad
- ❖ LiDAR, Position & Orientation System, 360°Camera
- ❖ Road Features/Parameters
 - ❖ Paved road, Lane/Other Markings, Median,
 - ❖ Carriage way, Rumble Strips, Zebra crossing, Signages
 - ❖ Longitudinal, Cross Section, Camber

RGB Colorized Point Cloud



Mobile LiDAR Point Cloud



Data Ingestion

Ground
Filtering

Rasterization

AI DeepLab

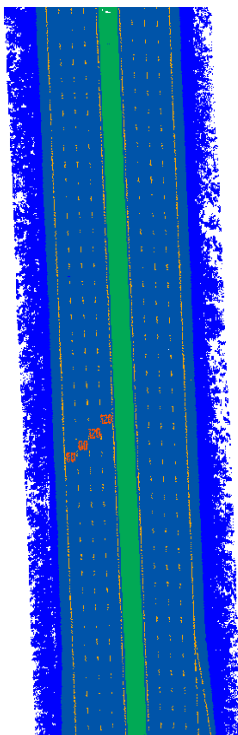
Classification

Extraction of
Road Features

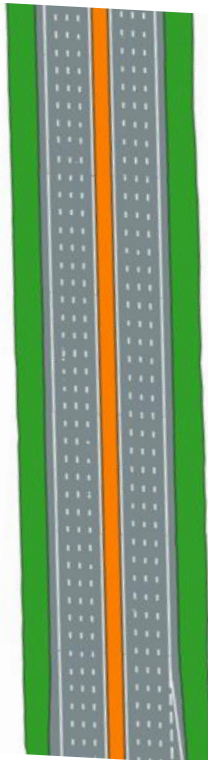
Colorized Point Cloud



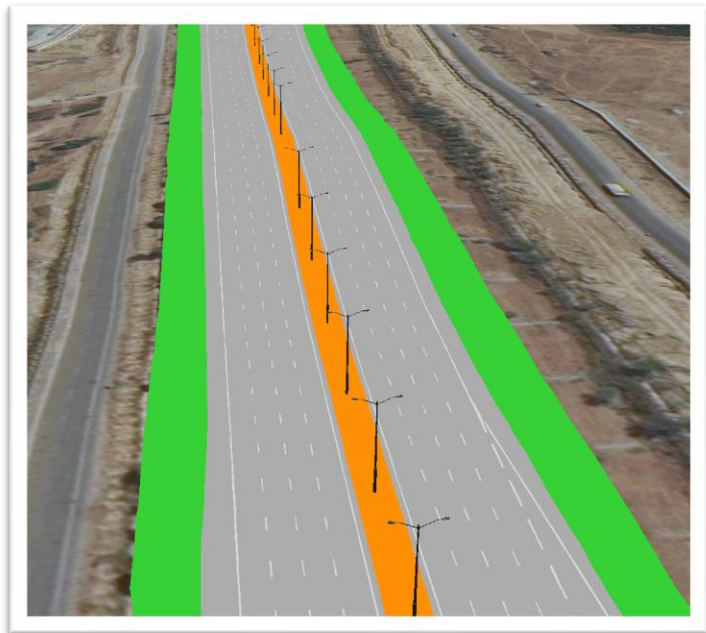
Classified point cloud



Road features Extracted



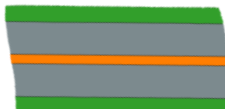
Road Features in DT



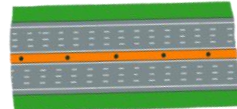
LoD-0



LoD-1



LoD-2



- ❖ CCTV Live Feed Visualization
- ❖ CCTV Feed: RTSP to HLS → OpenCV Python → Python YOLO inference → Annotated MJPEG frames → CesiumJS Browser
- ❖ YOLOv8n - lightweight, real-time detection
- ❖ Python Library: Ultralytics
- ❖ Automatic Extraction of features (“people”, “cars”)



- ❖ Indigenous low cost 360° image acquisition system
- ❖ GAGAN SBAS Coordinates for position (Exterior)
- ❖ Still Images: 12 Mp, Video: 4K (3840 X 2160 pixels)
- ❖ Mountable on UAVs, SUVs/MUVs, Tripod, Backpack
- ❖ Developed for ISRO Geo-portal Bhuvan

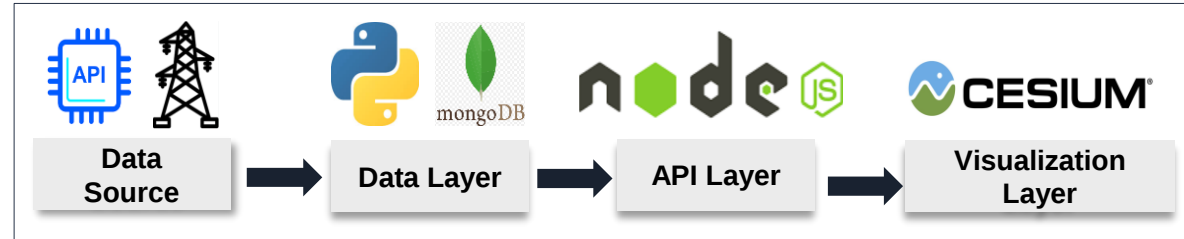


Umaid Palace, Rajasthan
360° Panorama (Mirror View)

- ❖ Validation of Satellite based AET product
- ❖ 10 Open-Path Eddy Covariance (OPEC) Flux tower



- ❖ Real time Measurement
 - ❖ Wind speed, Temperature, Humidity
 - ❖ CO₂, H₂O, Precipitation
 - ❖ Soil Profiling



Flux Tower Dashboard

Date: 2025-09-25 13:45:00

Data

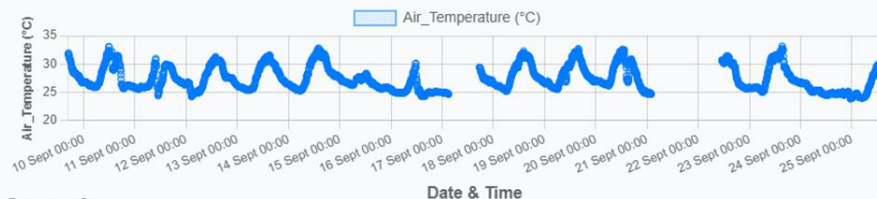
Time Series

Scatter Plots

Raipur

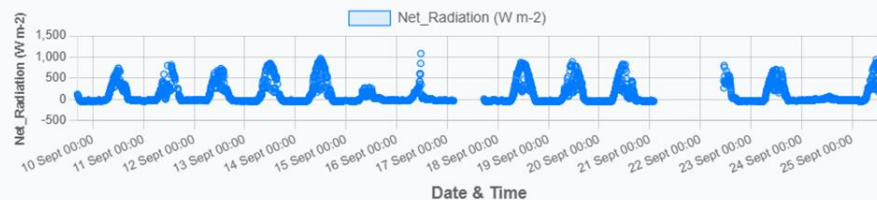
Parameter 1:

Air_Temperature (°C)



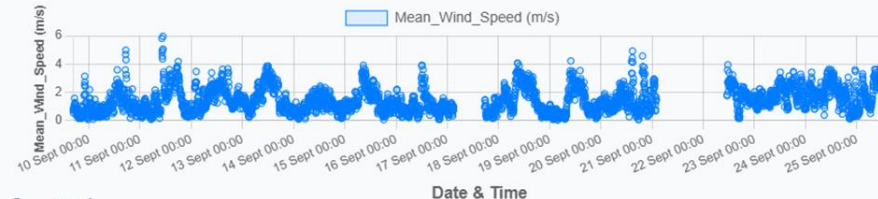
Parameter 2:

Net_Radiation (W m⁻²)



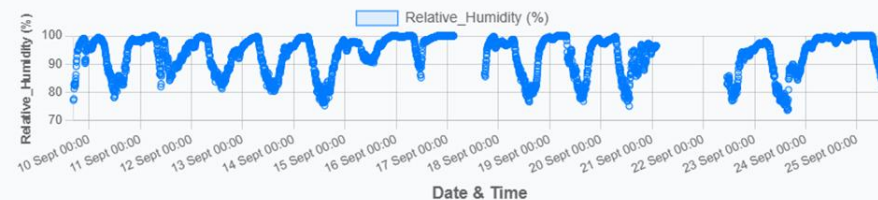
Parameter 3:

Mean_Wind_Speed (m/s)



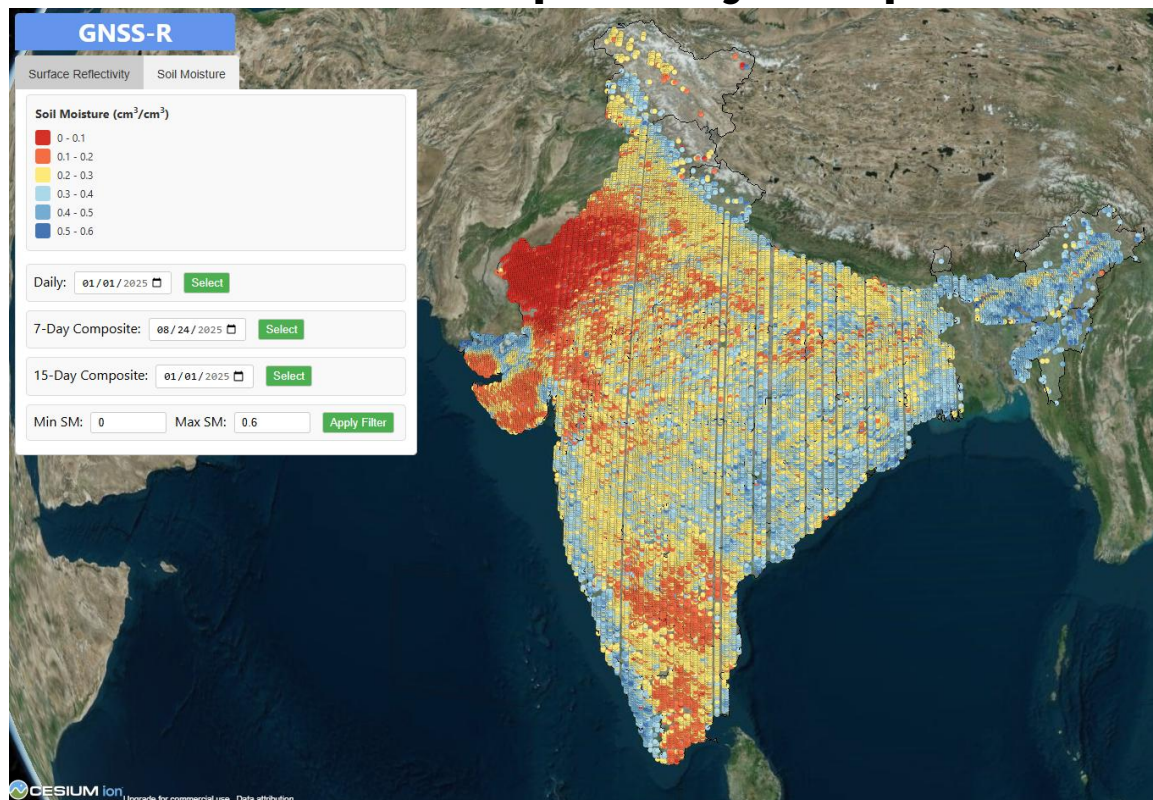
Parameter 4:

Relative_Humidity (%)

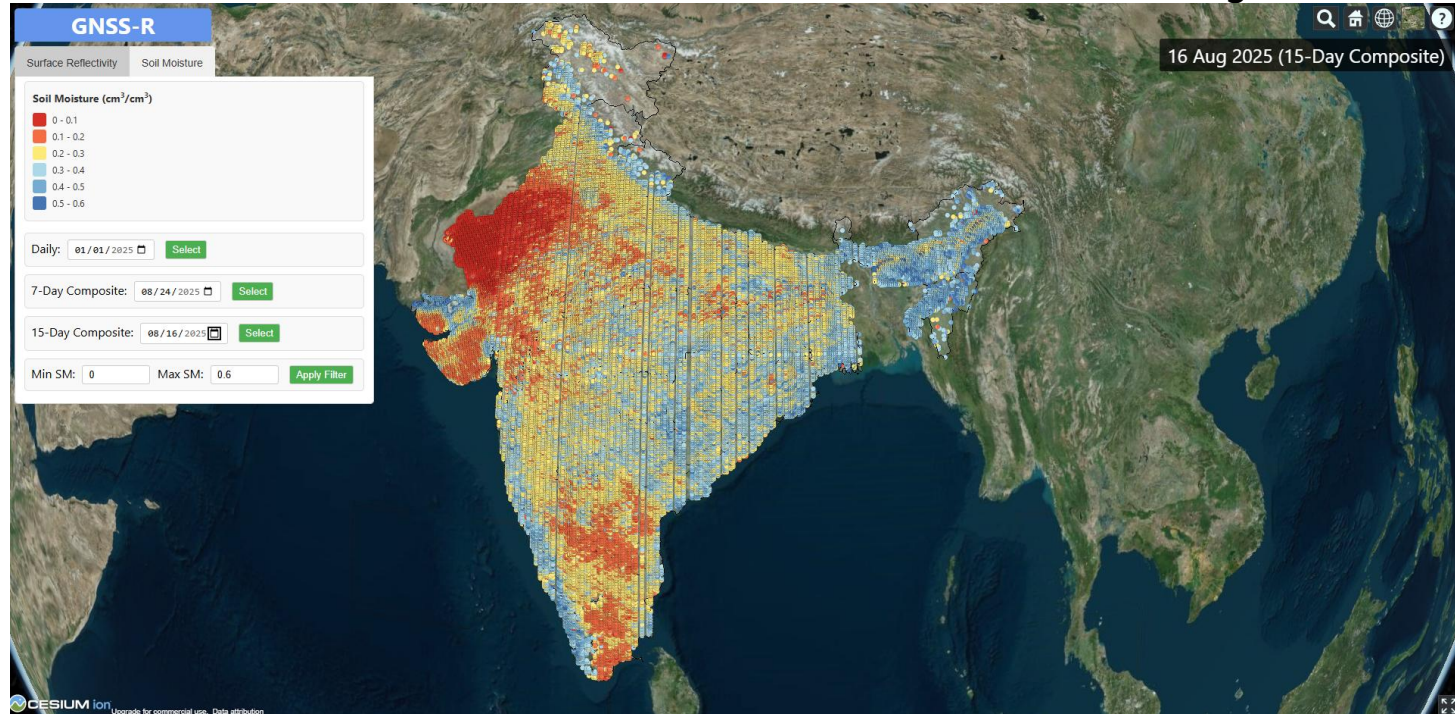


- ❖ GNSS Reflectometry – CYGNSS Data
- ❖ Surface Reflectivity from Delay Doppler Maps
- ❖ Developed linear regression models: CYGNSS Surface Reflectivity & SMAP SM
- ❖ Generated Soil Moisture maps
 - Daily, 7-day and 15-day Time Composite
- ❖ Integrated SM into DT

Soil Moisture Map - 7 Day Composite



15 Day Composite Derived from GNSS-R Surface reflectivity



- ❖ Multi-source geospatial datasets integrated in CesiumJS framework
- ❖ Interactive Geospatial Digital Twin application



- ❖ Integration with Satellite Data
 - IRS – Cartosat, Resourcesat Series
 - Sentinel-1 & 2, Landsat-8 & 9
- ❖ Integration of DT into ISRO Geoportal Bhuvan/ EO Data Hub Bhoonidhi
- ❖ Bathymetry – Underwater Elevation profile
- ❖ Underground Utility Features
- ❖ Simulation – Flood modelling, Air Pollution etc.



Thank you

Contributions: Dheeraj Kumar, Rajdip Paul, M.Udayalakshmi,
N.Madhusudhan Reddy, J.Narendran

Support: S.Muralikrishnan, Nitant Dube