Impact of urban morphology and high-resolution land use land cover for city scale modelling

September 10

Anurose T J

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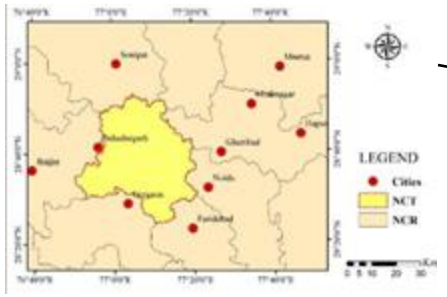
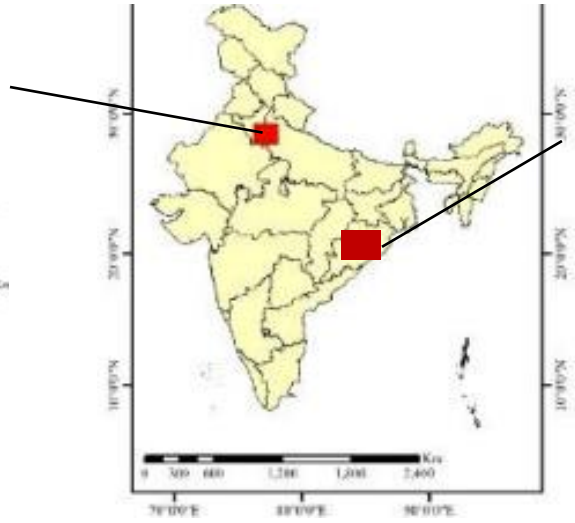
* *Indian Institute of remote Sensing, Indian Space research Organization*

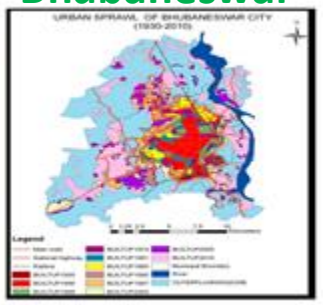
Urban modelling for Indian mega cities

Delhi





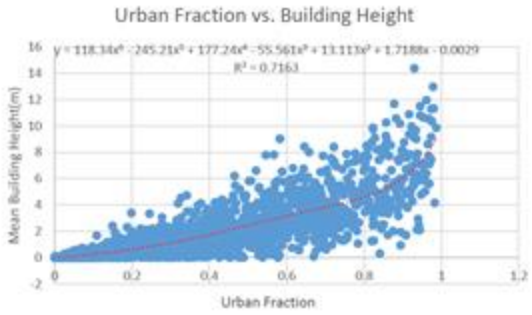
Bhubaneswar



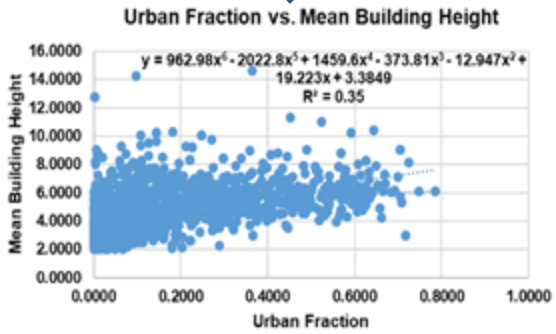
Continental cities

Coastal cities

New empirical relationship is derived based on local urban morphology for Urban canopy paramterization

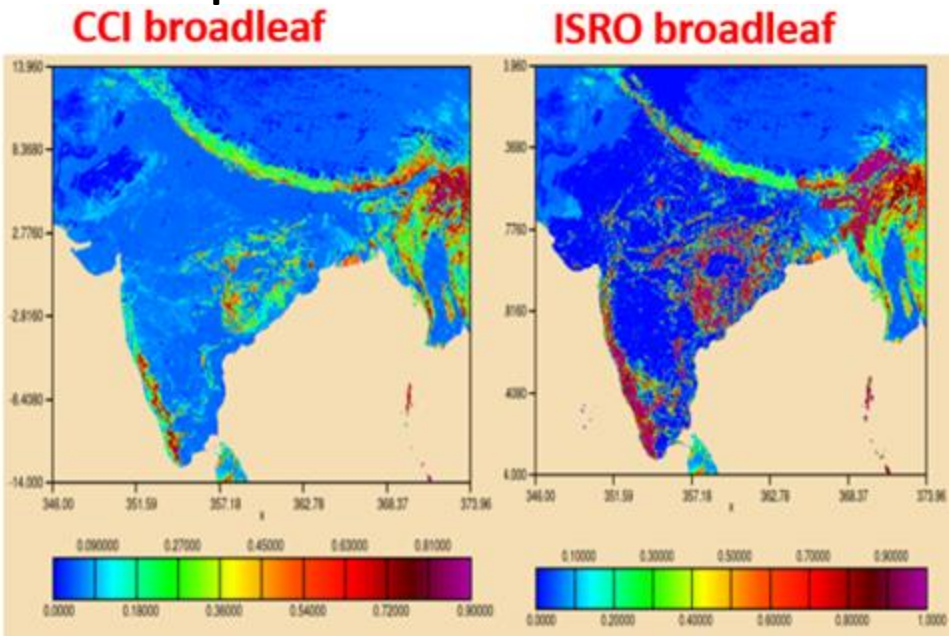


urban morphology parameters on a grid resolution of 330m
(A) Planar Area Index
(B) Building Height
(C) Frontal Area Index



Anurose et al, 2022, QJRMS

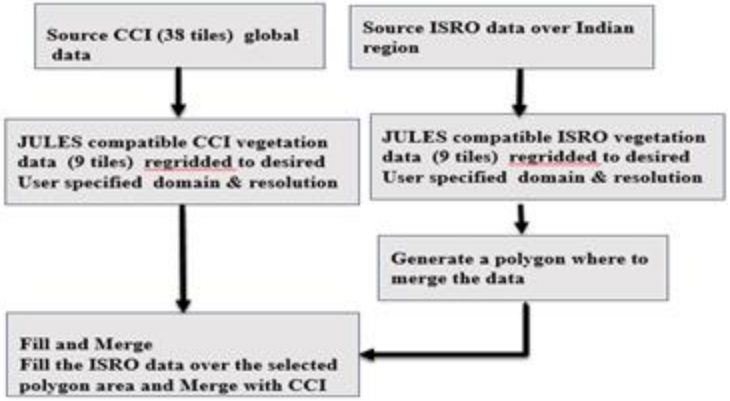
RAS suite to include local high-resolution JULES compatible ISRO LuLc data



ISRO 18 classes are mapped directly into JULES 9 tiles

S.No.	Data	Spatial Resolution (m)	Use	Source
1.	AWiFS LULC 250k (2018-19)	56	Bare soil, Ice, Shrubs, Urban, and Waterbody Tiles	NRSA, 2004
2.	LULC 50k (2015-16)	23.5	Bare soil and Shrubs Tiles	NRSC, 2014
3.	Wasteland map 50k (2015-16)	23.5	Bare soil and Shrubs Tiles	NRSC, 2019
4.	Crop Type (2014-15)	250	C3 and C4 Tiles	ICRISAT
5.	CCI LULC Tiles (2016-18)	0.05°	Comparison with JULES compatible HR LULC	NCMRWF and UK Met Office
6.	Vegetation Type & Land use map of India (2012)	23.5	Broadleaf and Needle leaf Tiles	Roy et al., 2012
7.	Digital Elevation Model	90	Elevation based classification	SRTM

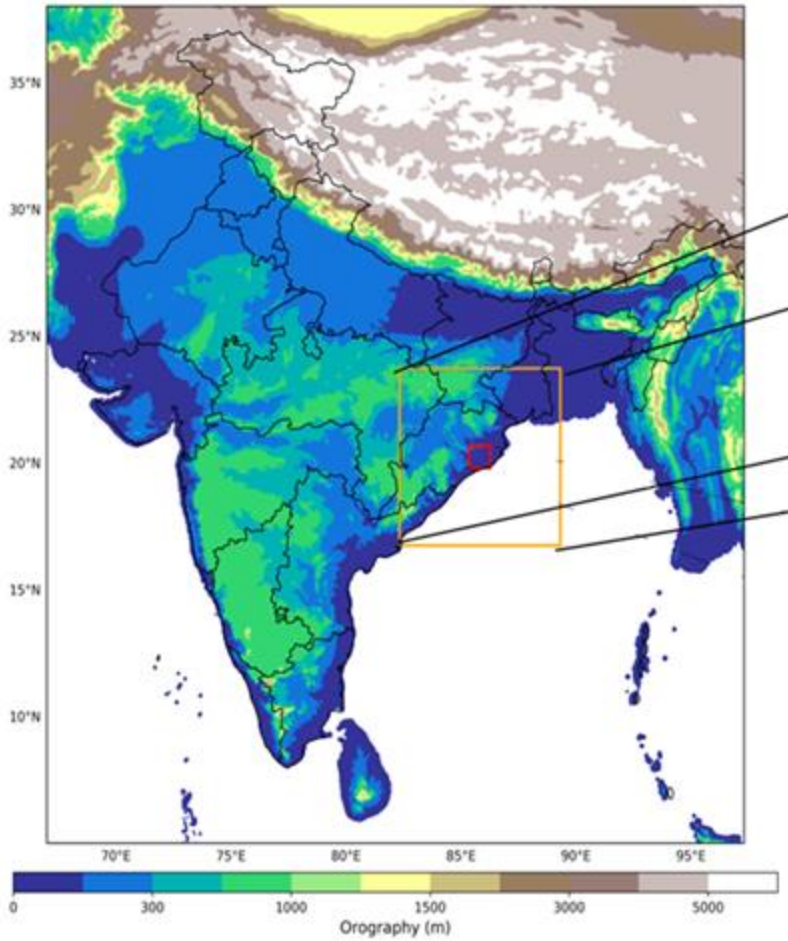
Collaboration with Indian Insitiute of remote sensing, Indian Space research organization, India

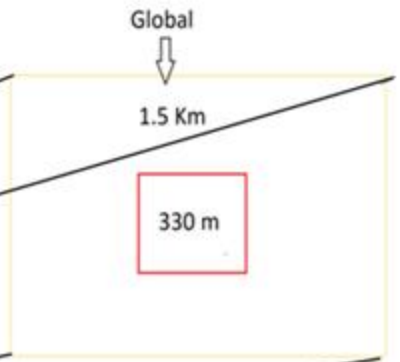


Thanks to Dr. John M. Edward, UK Met office

Rose suite branch to include ISRO data:
https://code.metoffice.gov.uk/svn/roses-u/d/a/4/7/7/RAS-suite-ISRO@279989
The associated contrib branch :
https://code.metoffice.gov.uk/svn/ancil/contrib/branches/dev/anurosetj/r15092_r14227_2030_GLAFO_CO_ISRO@15774
Ants branch:
https://code.metoffice.gov.uk/svn/ancil/ants/branches/dev/anurosetj/r15616_r14744_2030_GLAFO_FRACTION@15775

NWP experiments over Bubaneswar





(1) ISRO, MORUSES
(2) CCI, MORUSES
(3) ISRO, no MORUSES,
(4) CCI, no MORUSES

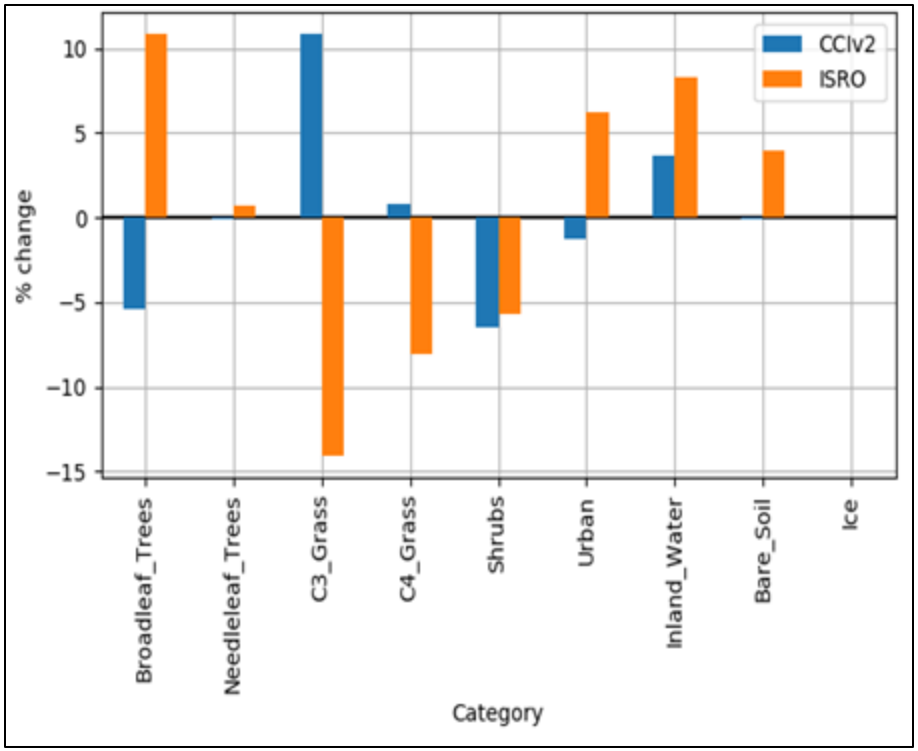
- Science : RAL3.0
- Um version 12.0
- Similar to DM-Chem but no prognostic aerosol
- MORUSES with local urban morphology

Cases: two sets (Nov 2023, Apr2024)

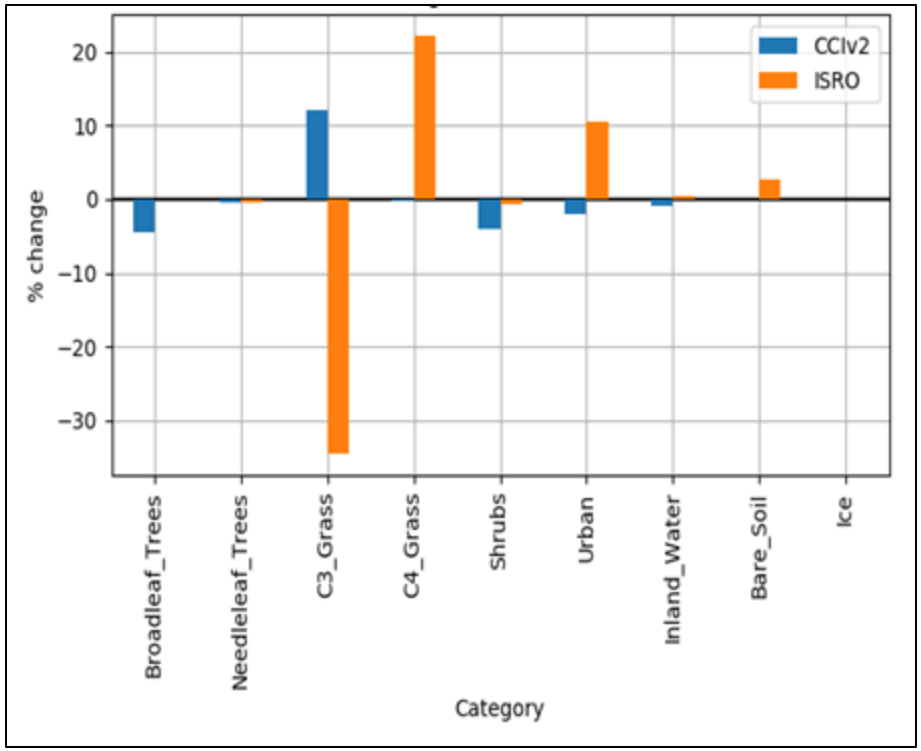
- 5 days : 26-30 Nov 2023 [characterized by regular weather without any precipitation event]
- 5 days: 26-30 Apr 2024 [Heat Wave Period (as per IMD press releases)]

Change in area with respect to CCI LULC

Bhubaneshwar

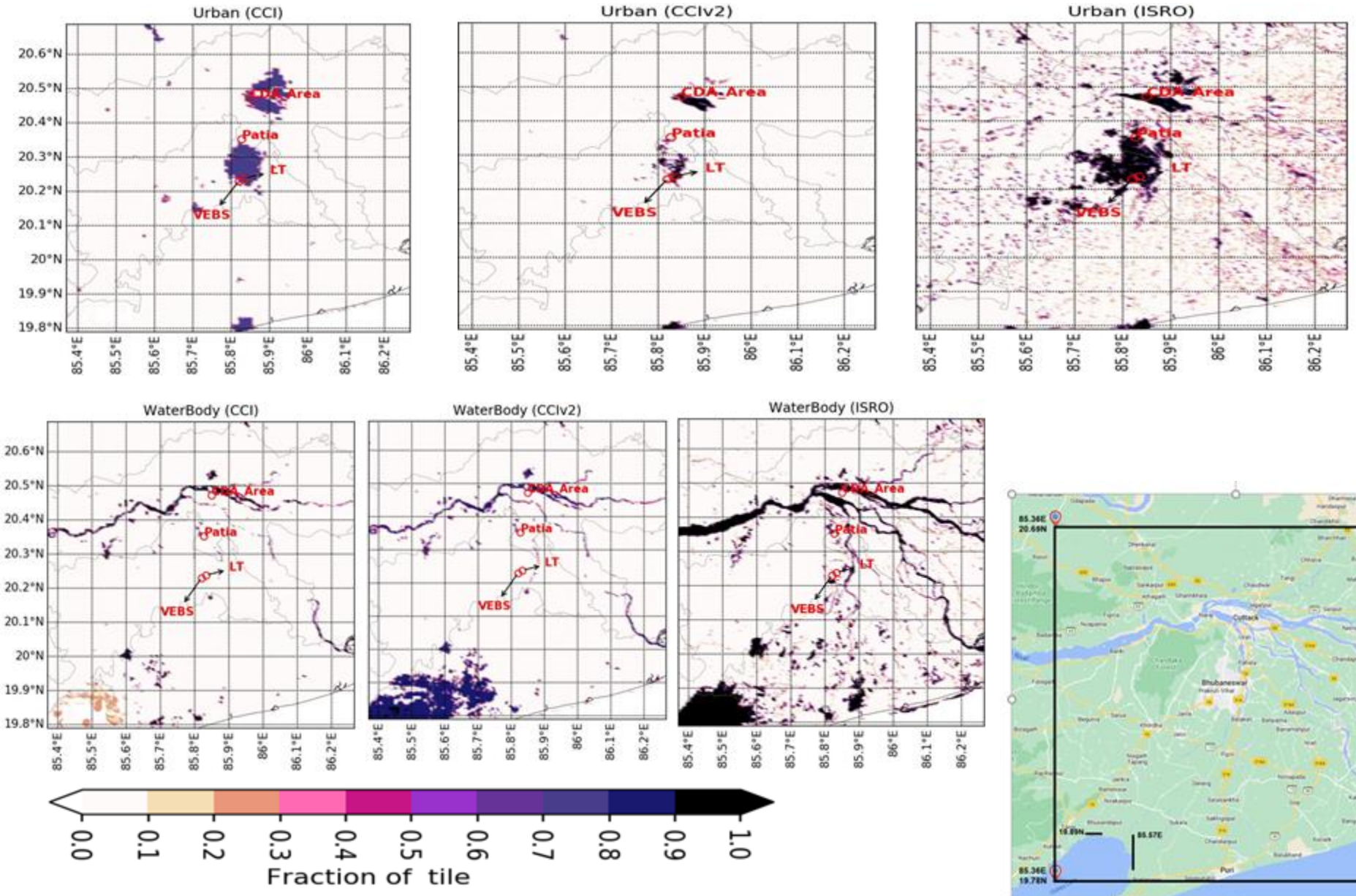


Delhi

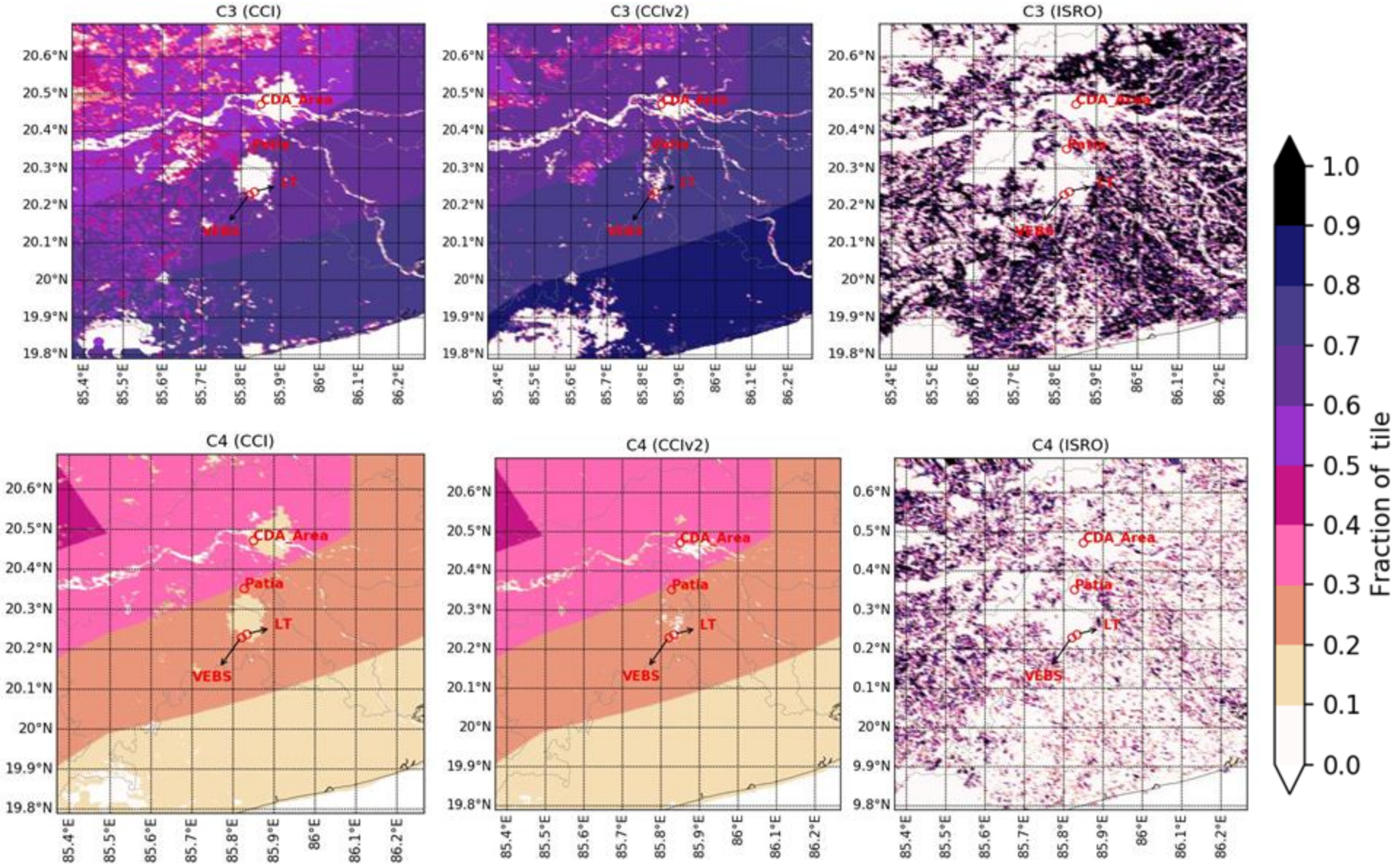


- Major changes in ISRO LuLc are associated with C3 and C4 tiles over Delhi.
- Whereas the most of the tiles shows changes over Bhubaneswar except needle leaf and ice

Change in different LULC tiles of JULES over Bhubaneshwar



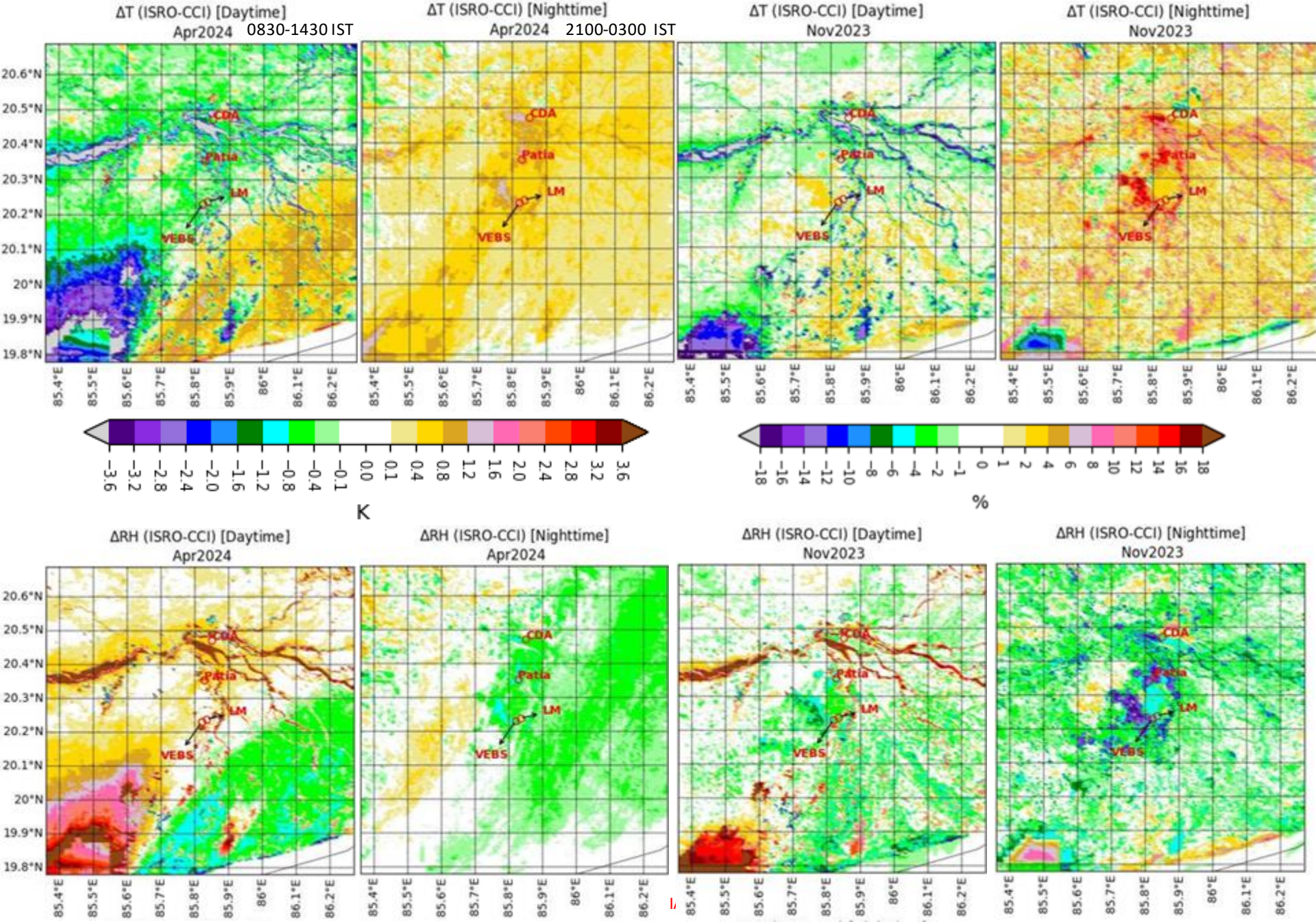
Change in different LULC tiles of JULES over Bhubaneshwar



Mean difference from the simulations, Impact of ISRO

Apr2024

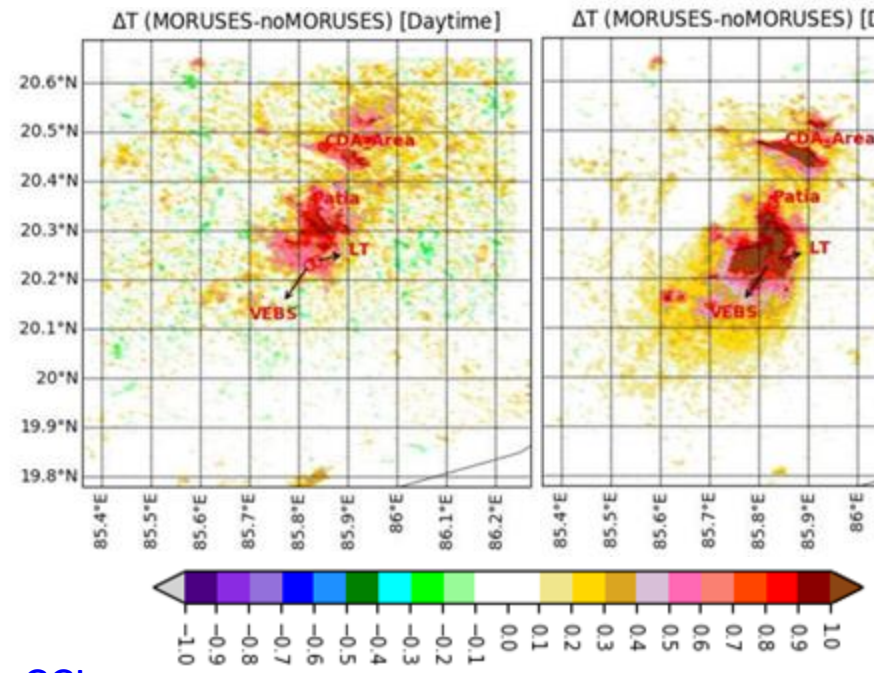
Nov 2023



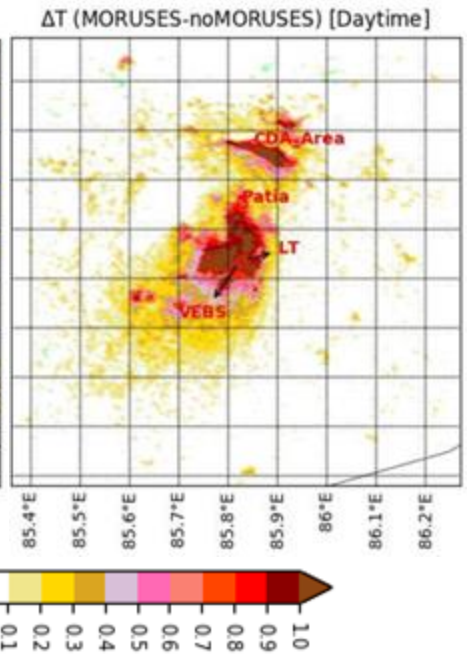
Mean difference from the simulations, Impact of MORUSES

ISRO

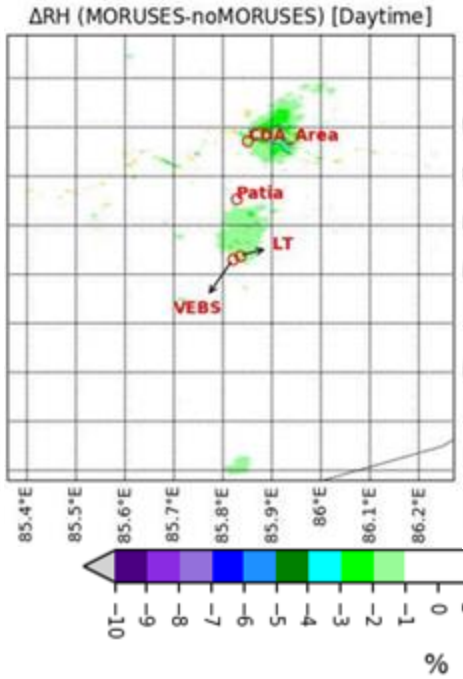
Apr2024



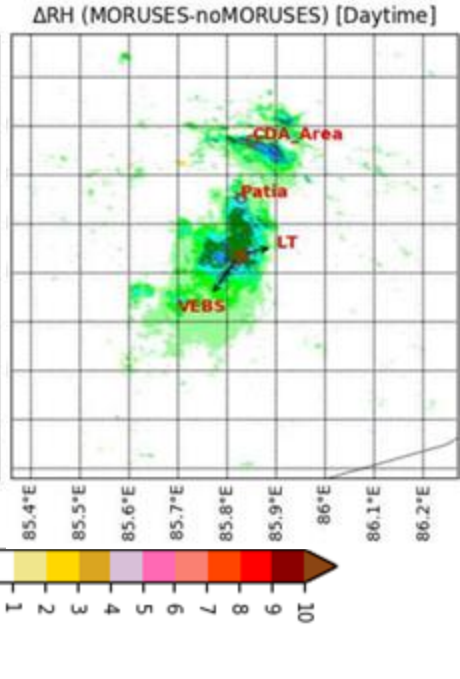
Nov2023



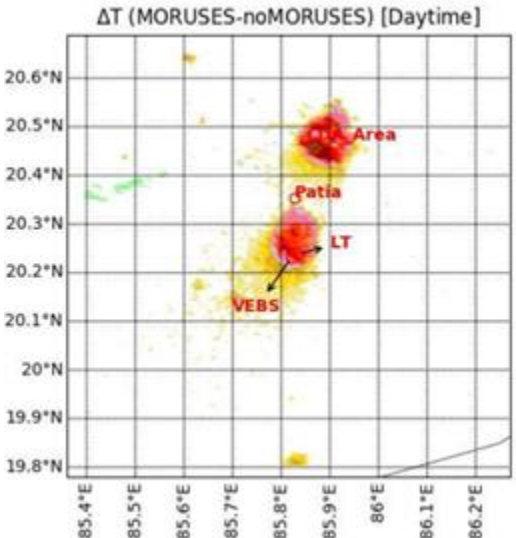
Apr2024

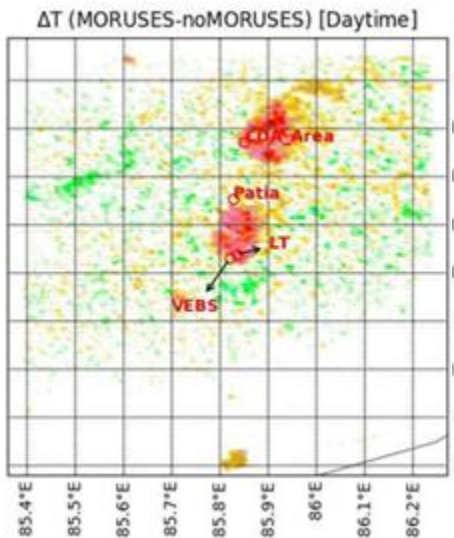


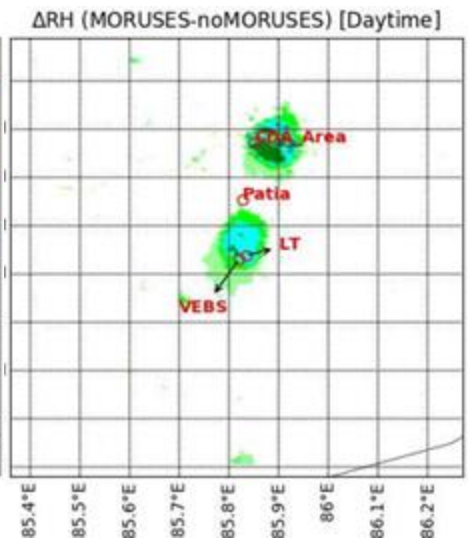
Nov2023

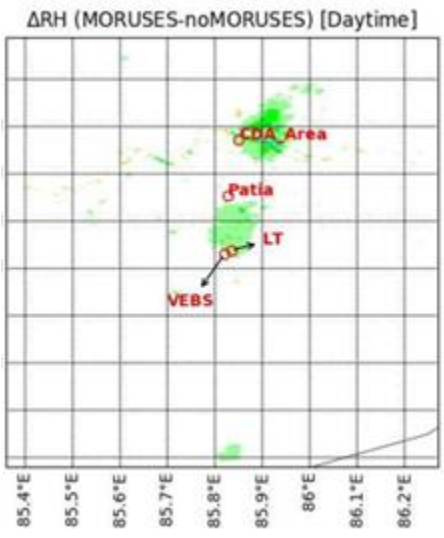


CCI



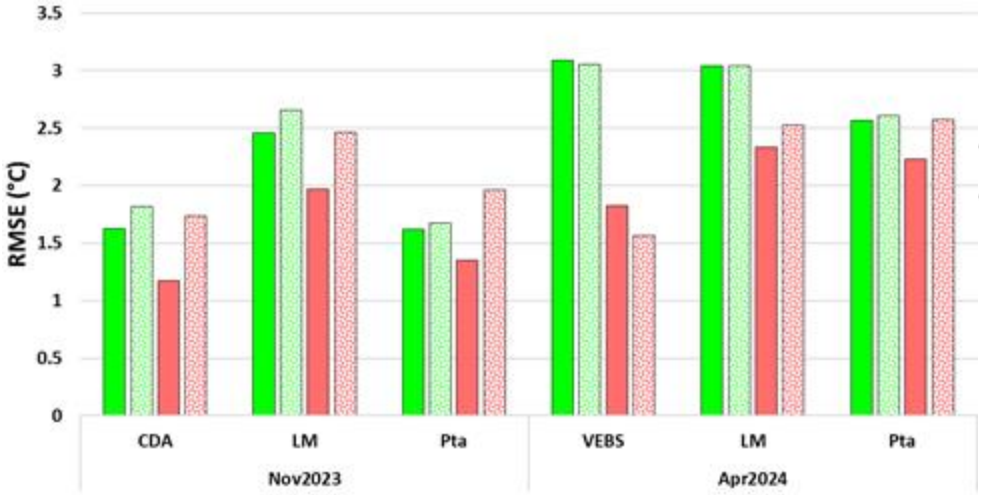




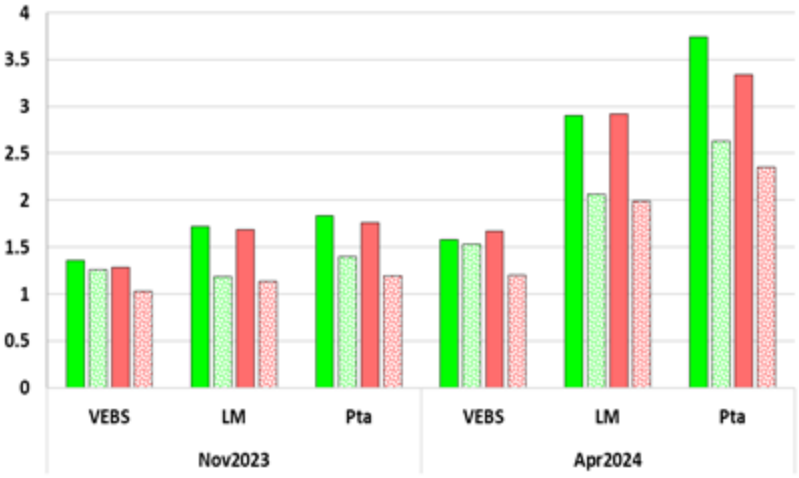


Mean RMSE for near surface parameters

Air temperature _2m

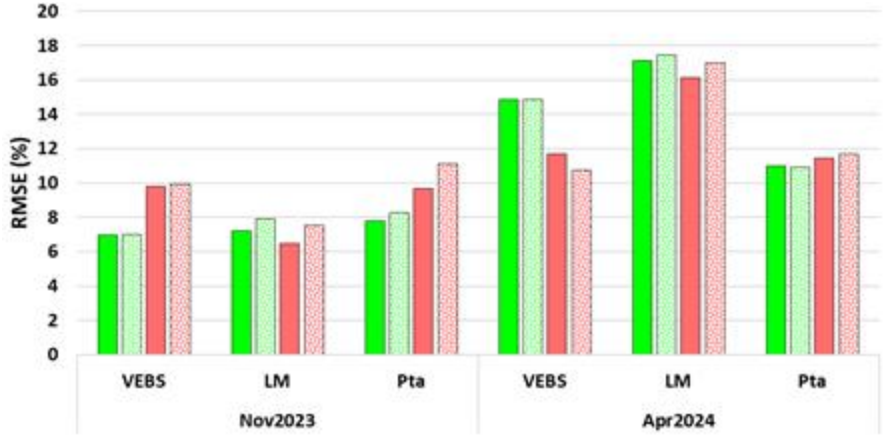


wind speed_ 10 m



CCI_MORUSES CCI_noMORUSES ISRO_MORUSES ISRO_noMORUSES

Relative humidity_2m

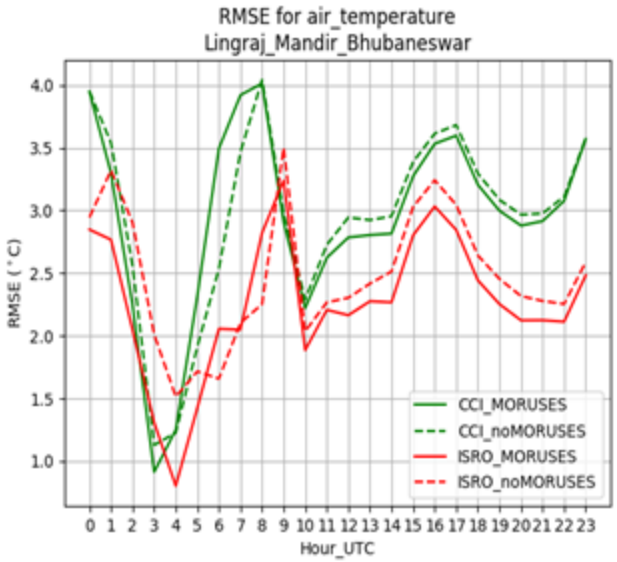


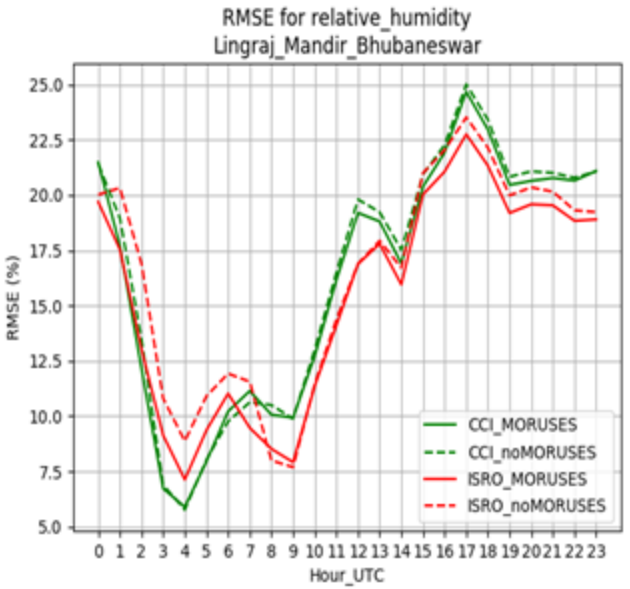
- ISRO LuLc performs better over CCI in majority of the cases
- MORUSES increases the wind speed RMSE in RA3.0

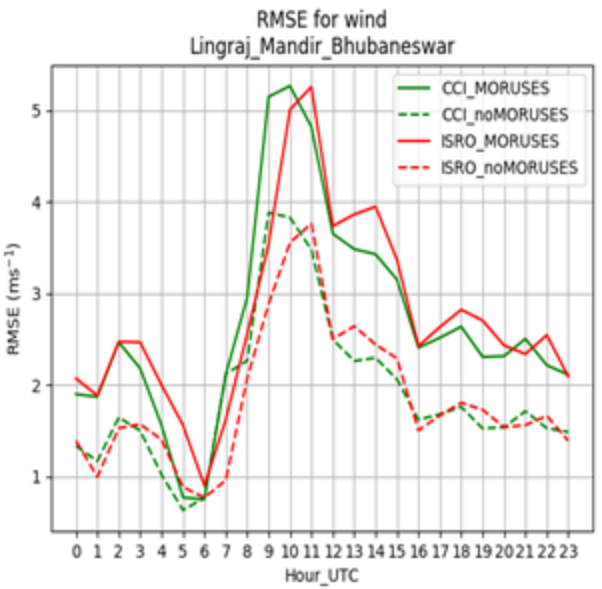
LM: Lingraj Mandir; Pta: Patia; CDA: Cuttak ; VEBS: Bhubaneswar Airport

Diurnal mean RMSE for near surface parameters

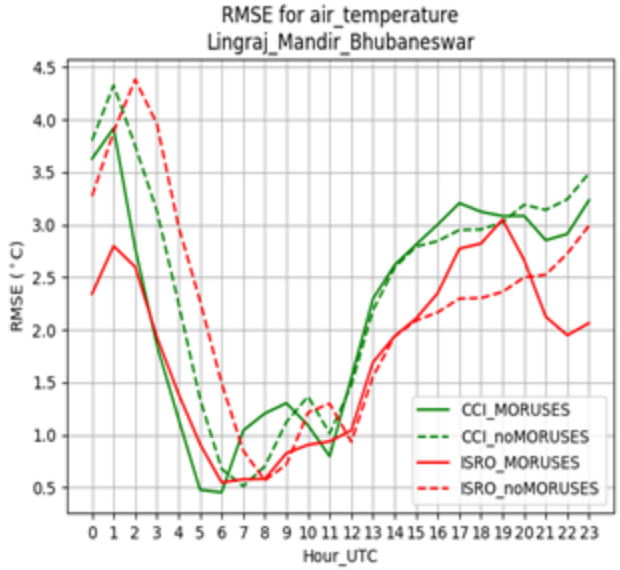
Apr 2024

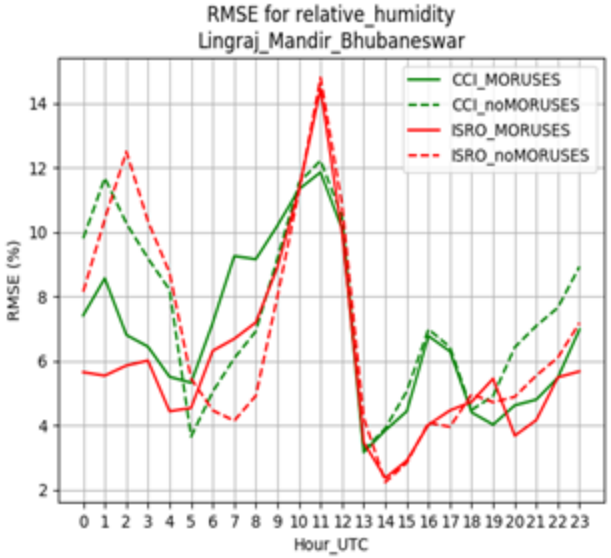


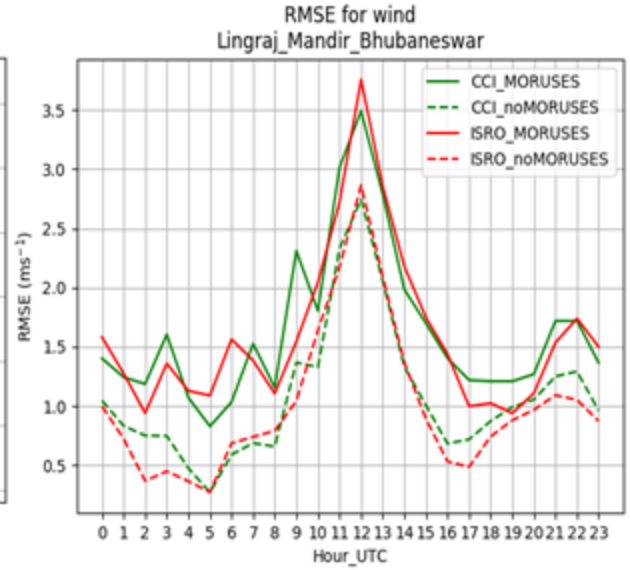




Nov 2023



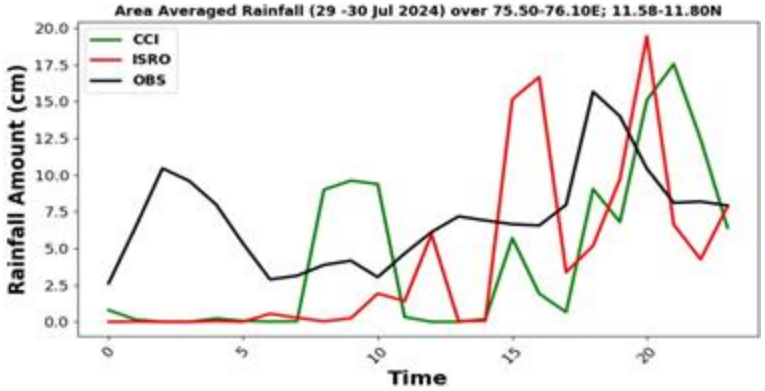


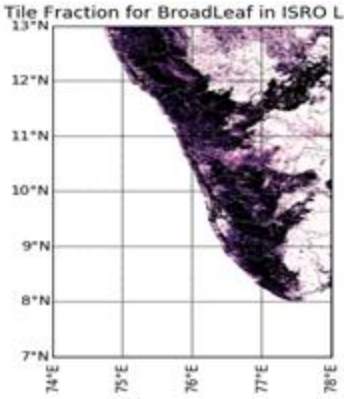


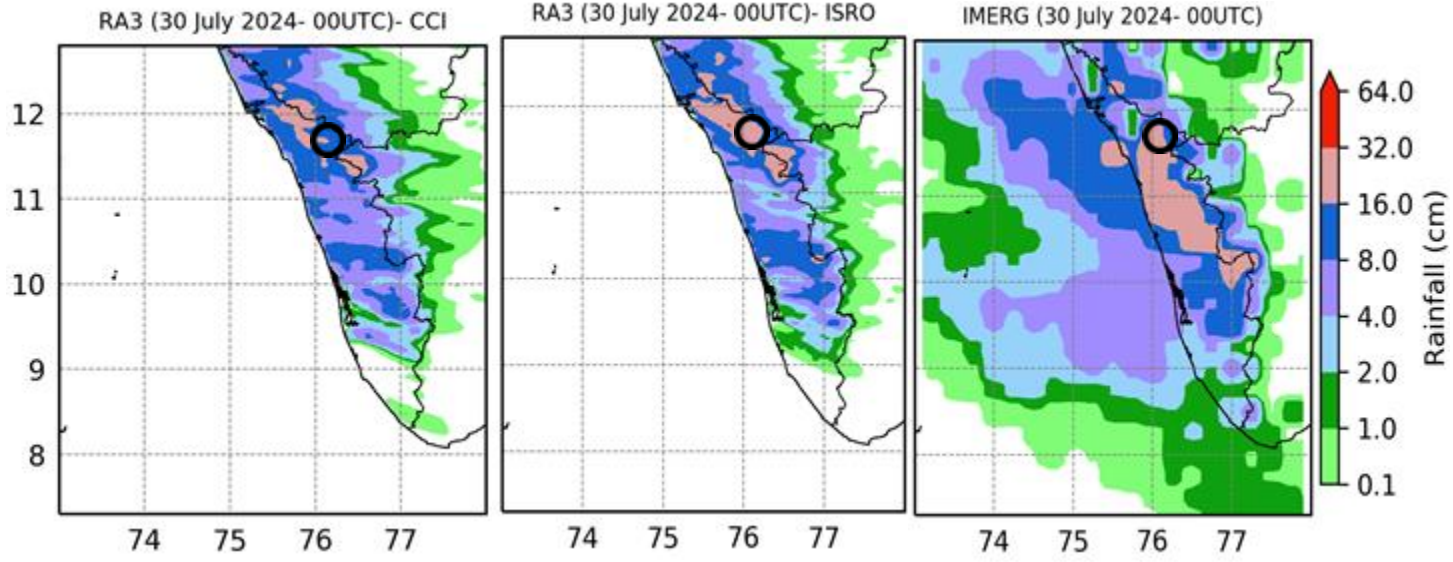
Impact of LuLc on a landslide event

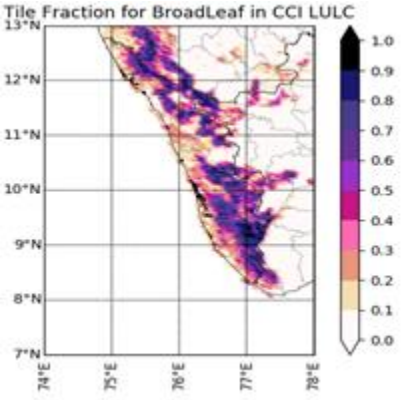
- Multiple landslides hit Wayanad (1.6994° N, 76.0773° E), kerala on July 30, 2024
- More than 140 mm fell in a single day
- 107 People died and several are missing

4 km simulation based on UM regional with RA3.0
IC: 20240728, 00 , Day2 forecast



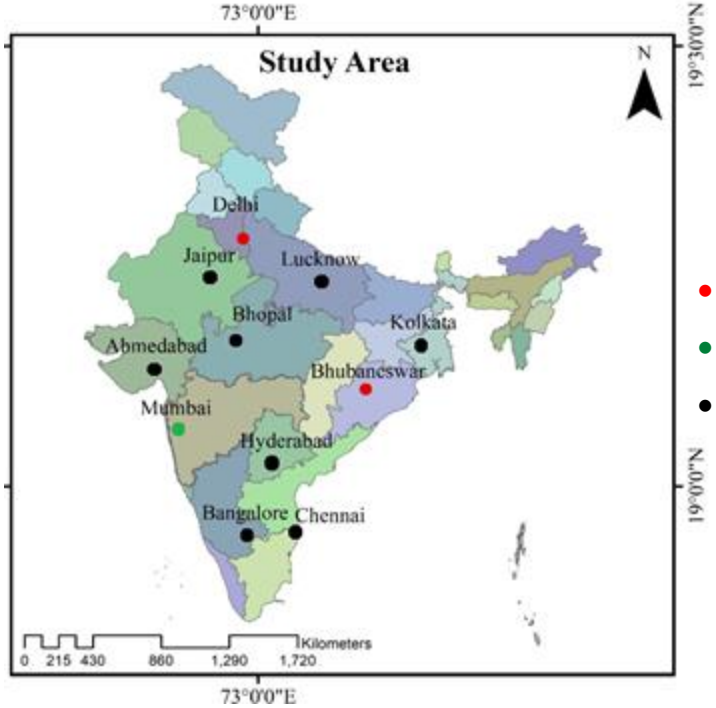






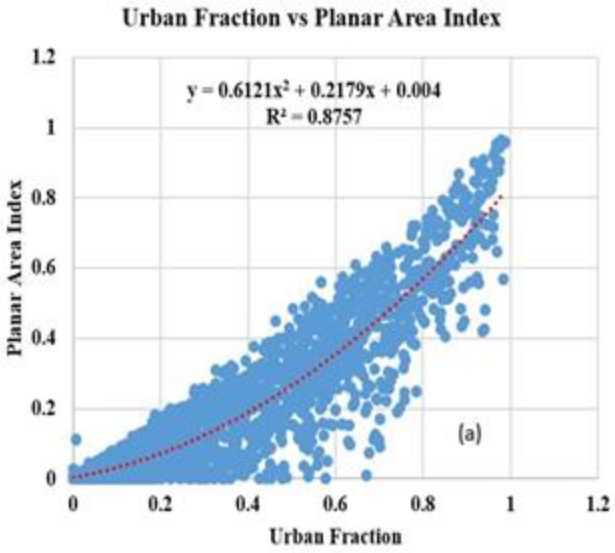
Ongoing & Future Work

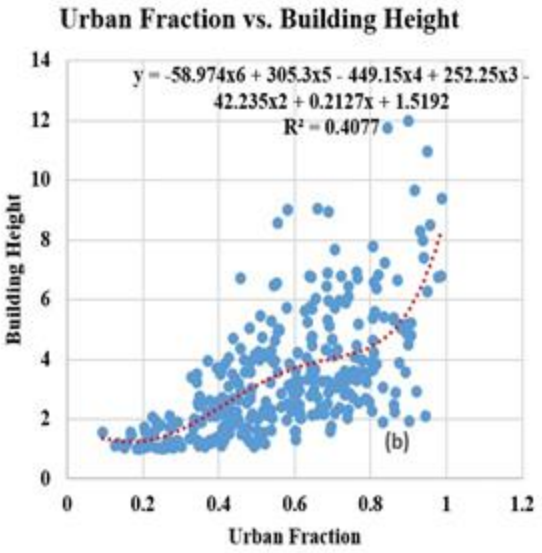
1. Impact of ISRO LuLc over CCI datasets
2. Study different extreme events like heat wave, precipitation over Bhubaneswar
3. Understand the similarities/difference in the impact of urbanization over different Indian cities (Delhi & Bhubaneswar)
4. Extend urban modeling over other cities of India (Mumbai,..)
5. Derive urban morphology data over entire Indian cities (Deep learning algorithms/ techniques) or generalize empirical relationship for regional modeling with MORUSES

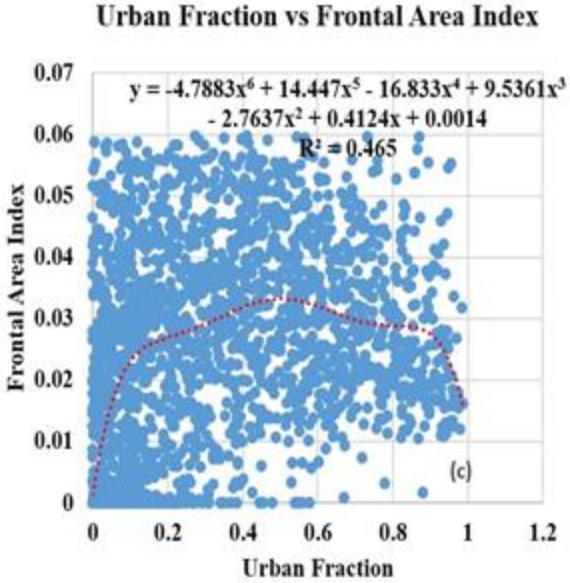


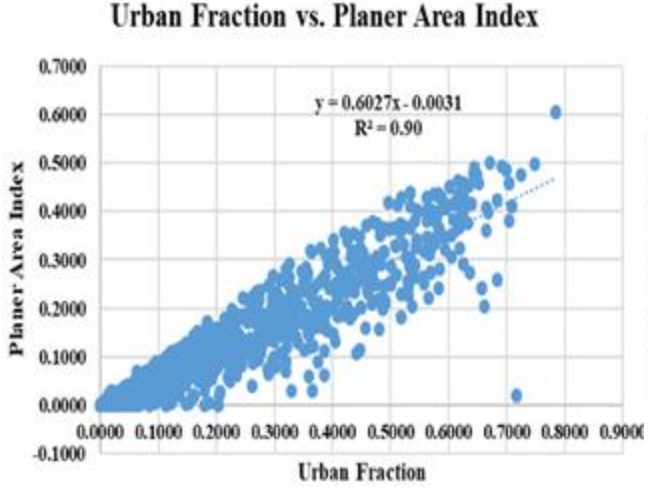
- **Ongoing**
- **Near Future**
- **Long term**

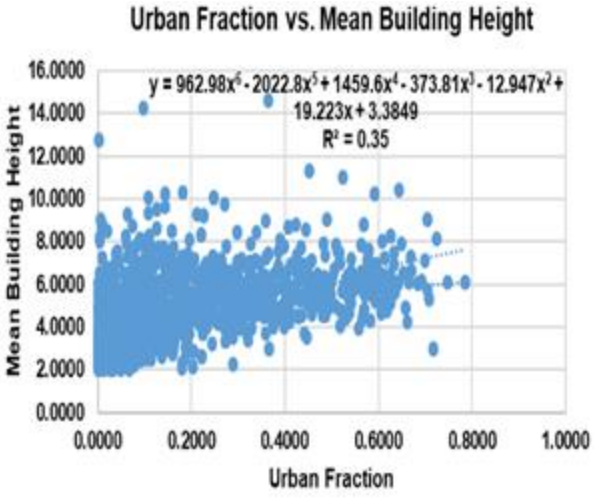
Collaboration with Indian Insitiute of remote sensing, Indian Space research organization, India

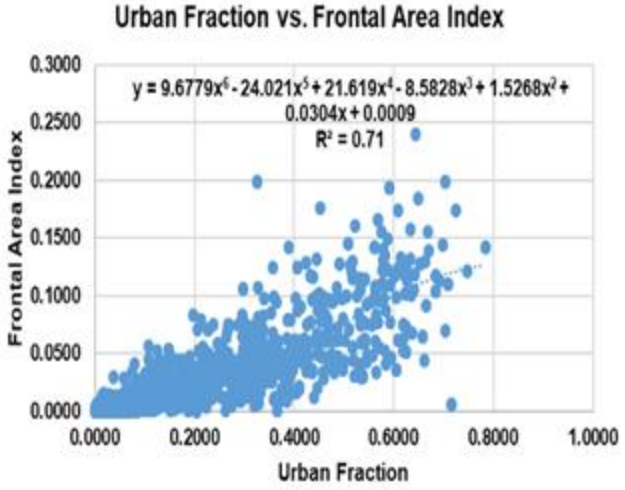

Urban Fraction vs Planar Area Index
y = 0.6121x² + 0.2179x + 0.004
R² = 0.8757
Planar Area Index
Urban Fraction
(a)


Urban Fraction vs. Building Height
y = -58.974x6 + 305.3x5 - 449.15x4 + 252.25x3 - 42.235x2 + 0.2127x + 1.5192
R² = 0.4077
Building Height
Urban Fraction
(b)


Urban Fraction vs Frontal Area Index
y = -4.7883x⁶ + 14.447x⁵ - 16.833x⁴ + 9.5361x³ - 2.7637x² + 0.4124x + 0.0014
R² = 0.465
Frontal Area Index
Urban Fraction
(c)


Urban Fraction vs. Planer Area Index
y = 0.6027x - 0.0031
R² = 0.90
Planer Area Index
Urban Fraction


Urban Fraction vs. Mean Building Height
y = 962.98x⁶ - 2022.8x⁵ + 1459.6x⁴ - 373.81x³ - 12.947x² + 19.223x + 3.3849
R² = 0.35
Mean Building Height
Urban Fraction


Urban Fraction vs. Frontal Area Index
y = 9.6779x⁶ - 24.021x⁵ + 21.619x⁴ - 8.5828x³ + 1.5268x² + 0.0304x + 0.0009
R² = 0.71
Frontal Area Index
Urban Fraction