Signature of LULC induced Regional Climate Change over Eastern India: A Modeling and Observational Approach

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Introduction

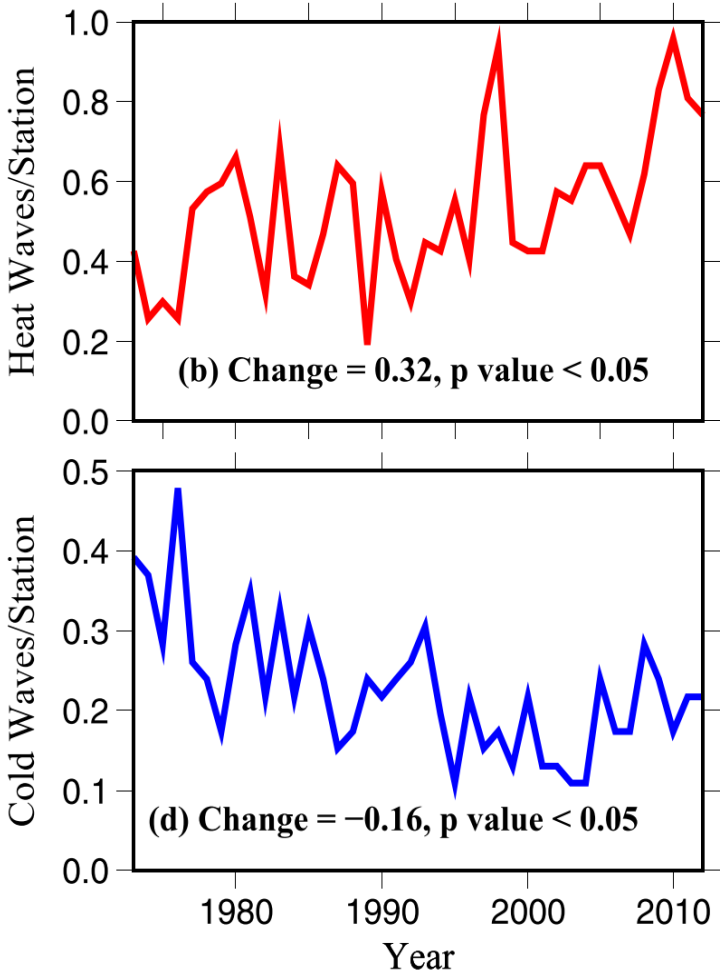
❖ It is reported that more than 50% of the global population already lives in urban areas and by the year 2050, it is expected to be as high as ~70%, which will bring the consequential anthropogenic pressure on the natural environment (United Nations, 2014)

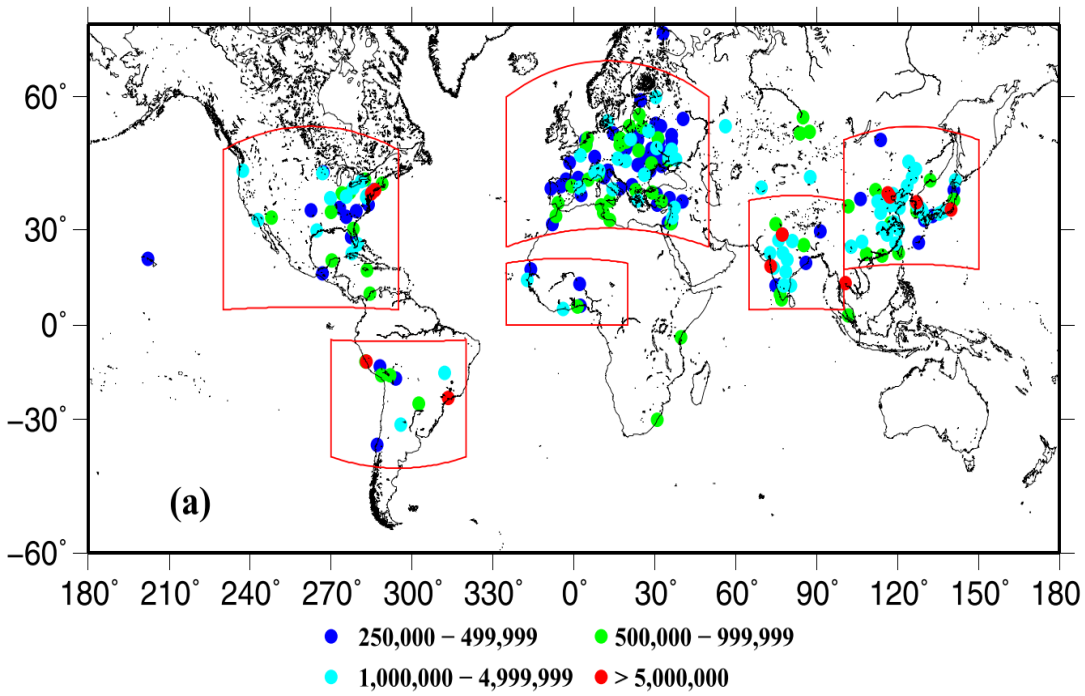
❖The rapid change of Land Use and Land Cover (LULC)/ Urbanization has been one of the important factors which are contributing immensely to the changing climate both in the global as well as in the local scale.

❖ The impact of LULC change in the recent past on the entire climate dynamics is very concerning as it stirs the energy budget of the earth system.

❖ The impact of urbanization/LULC change on temperature is mostly discernible in the regions having higher population as well as in industrialized regions.

Heat Waves per urban station is showing an increasing trend

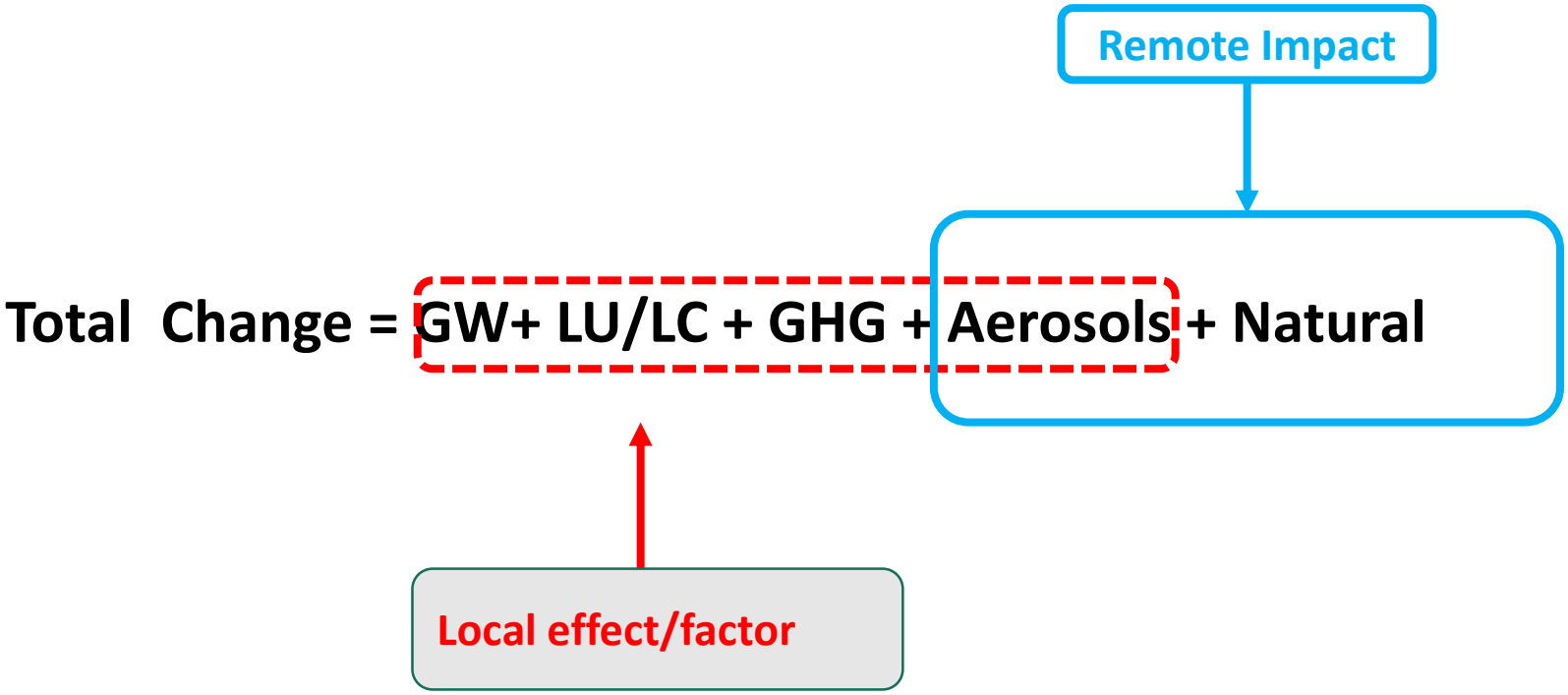




Population in urban stations

Source: Mishra et al., ERL,2015

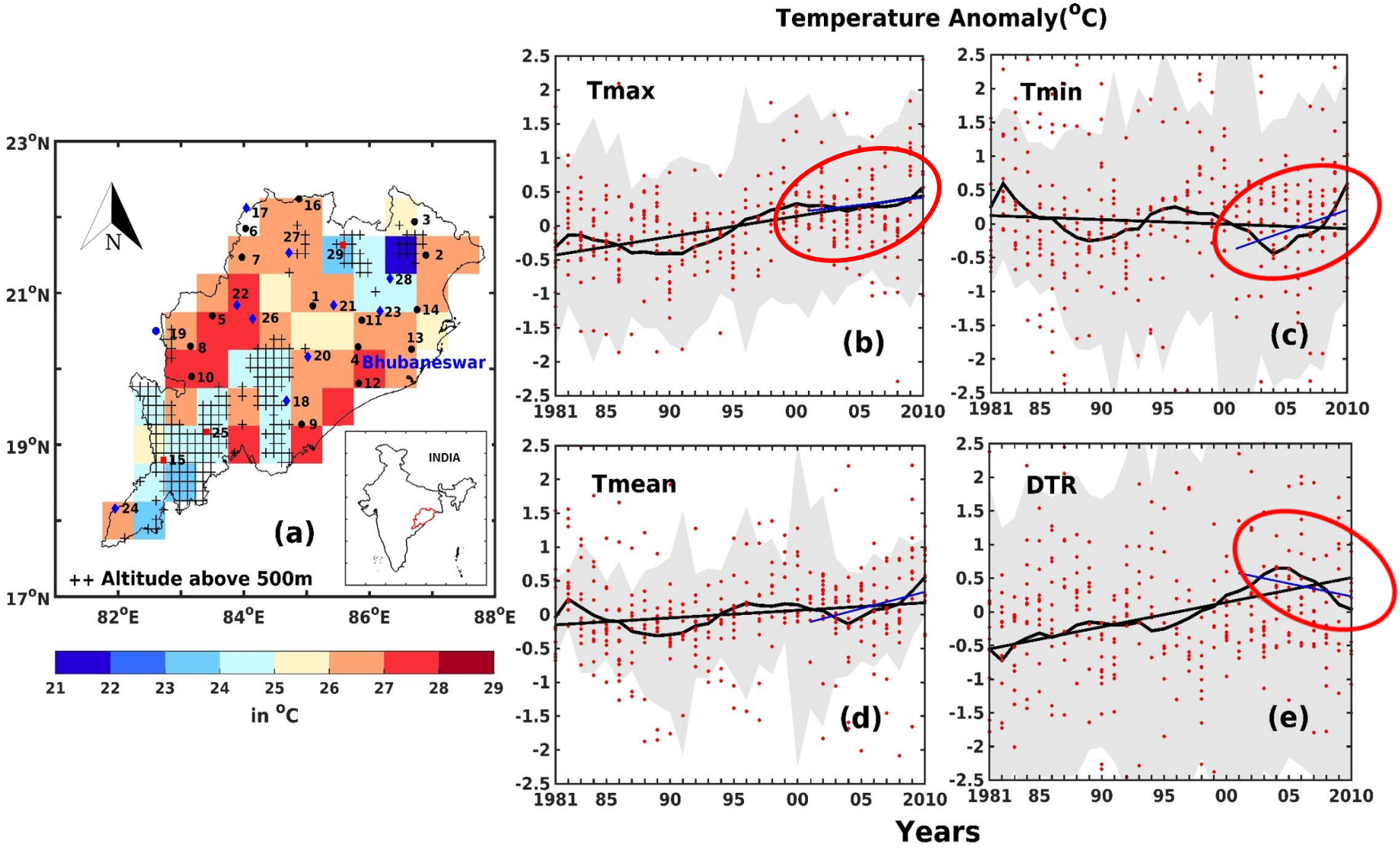
Mishra et al., 2012

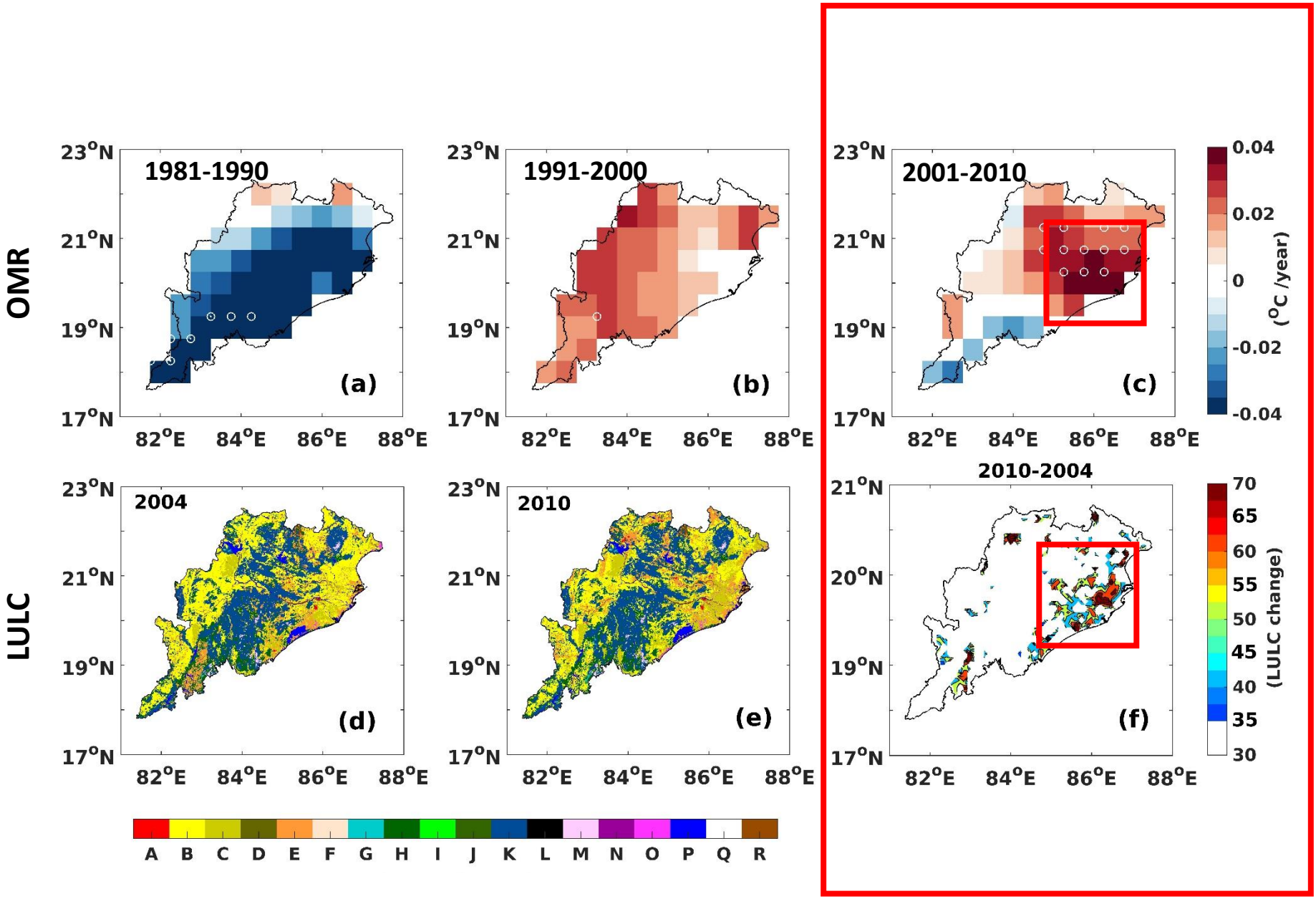

Remote Impact
Total Change = GW+ LU/LC + GHG + Aerosols + Natural
Local effect/factor

Objectives of the study

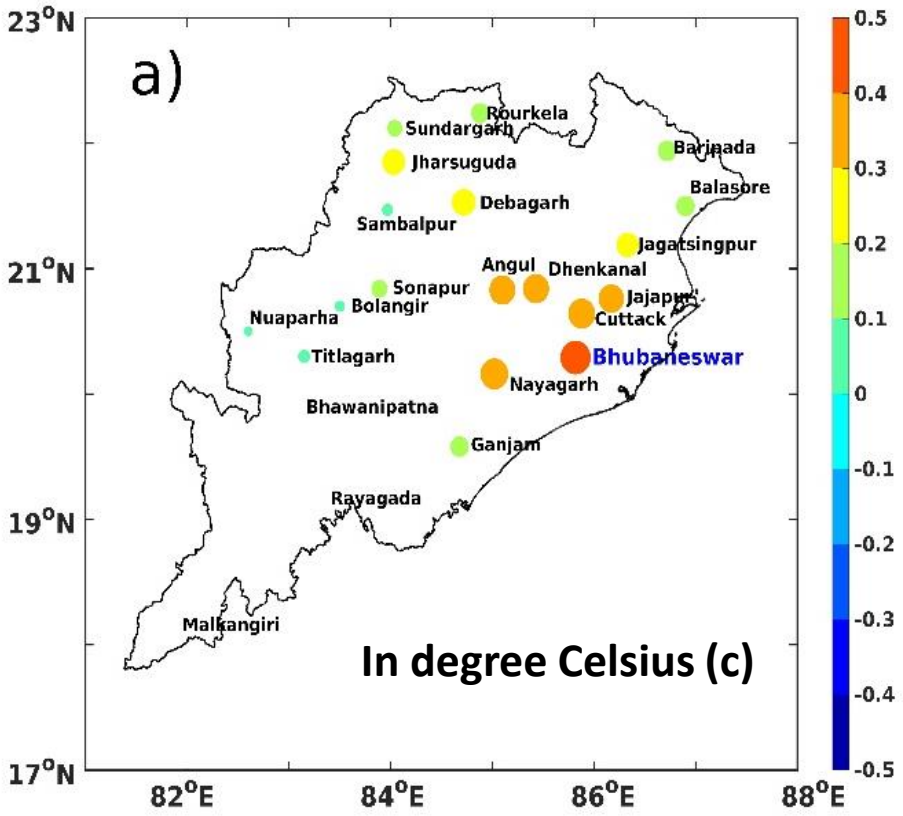
- **Can changes in the LULC pattern lead to a land-atmosphere interaction mechanism?**

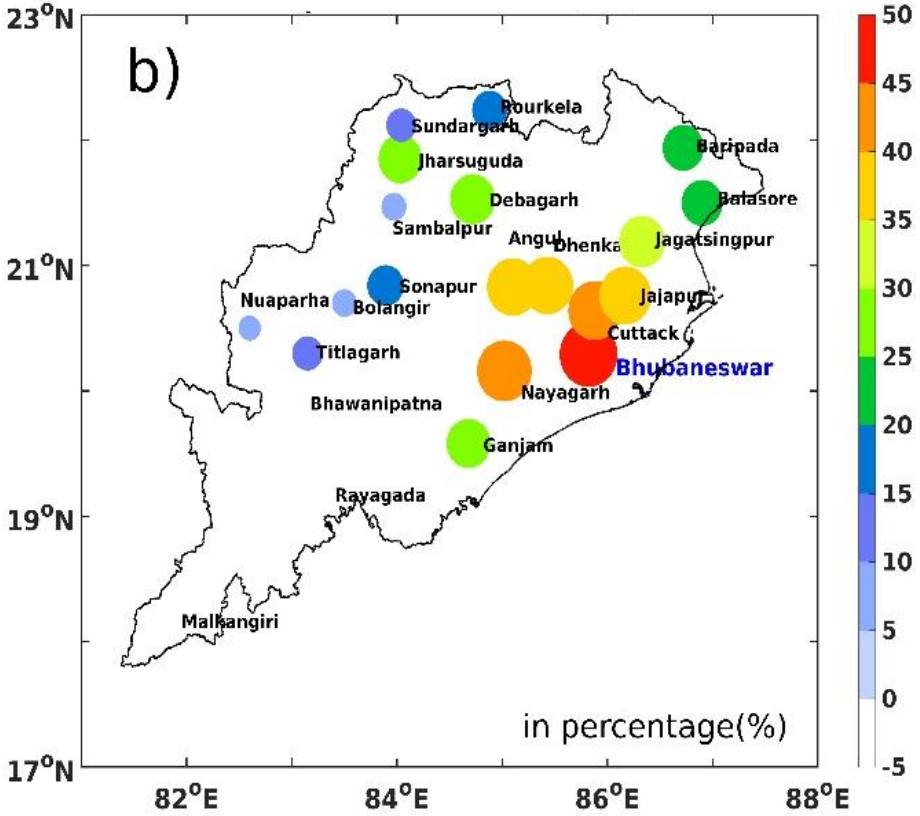
- **How much of the temperature change is due to LULC? What has happened? Urbanization? Deforestation?Agricultural expansion/DIversification?**


Temperature Anomaly(°C)
Tmax
Tmin
Tmean
DTR
(a)
(b)
(c)
(d)
(e)
Bhubaneswar
INDIA
++ Altitude above 500m
in °C
Years
23°N
21°N
19°N
17°N
82°E
84°E
86°E
88°E
1981
85
90
95
00
05
2010



- OMR change and LULC change during the last decade (2001-2010) coincides to be in the eastern part of Odisha

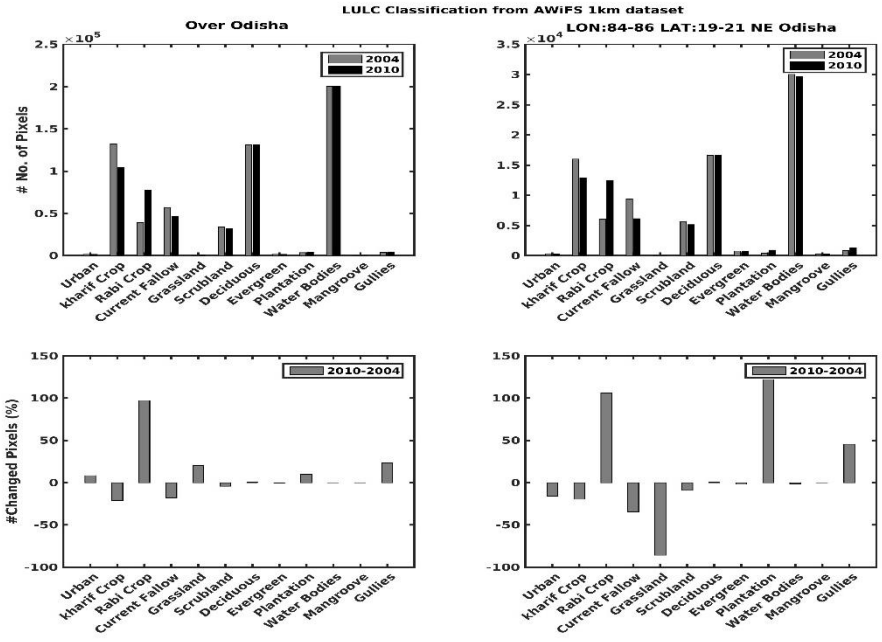




Change in temperature due to LULC change

Rise in temperature is as high as 50 % over the cities like Cuttack and Bhubaneswar

LULC classification and class wise change analysis

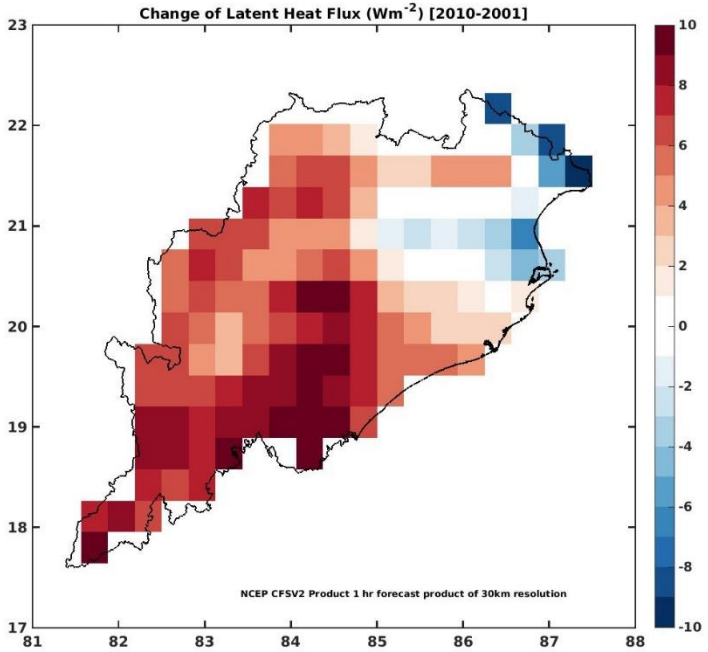


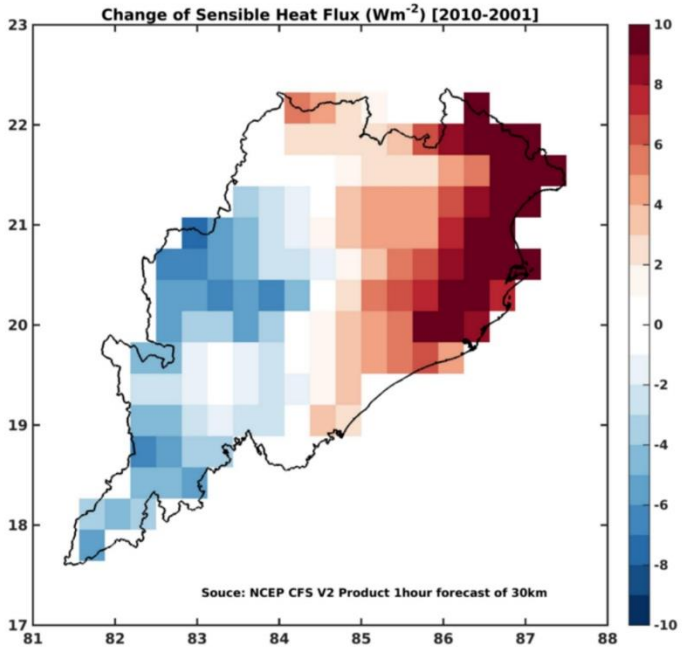
Sl. no.	LULC Classes (AWiFS)	Area Changed (km^2)		Change of pixels (%)	
		Odisha (2010-2004)	NE Odisha (2010-2004)	Odisha (2010-2004)	NE Odisha (2010-2004)
1	Urban	124	-51	8.37	-16.19
2	Kharif Crop	-28043	-3158	-21.24	-19.95
3	Rabi Crop	38109	6400	97.07	106.17
4	Current Fallow	-10981	-3210	-18.02	-34.29
5	Grassland	86	-49	20.37	-85.96
6	Scrubland	-1456	-522	-4.29	-9.20
7	Deciduous	541	72	0.41	0.43
8	Evergreen	-7	-15	-0.43	-1.96
9	Plantation	341	507	9.70	121.87
10	Water Bodies	-267	-362	-0.13	-1.20
11	Mangroove	0	0	0	0
12	Gullies	867	388	22.96	45.43

1. **Grassland over the Eastern Odisha has decreased by ~85%.**
2. **Fallow Land over eastern Odisha has decreased by ~35%.**
3. **Rabi Crop has increased by ~106% whereas Kharif Crop has decrease by ~20%.**

The physical mechanism of these processes

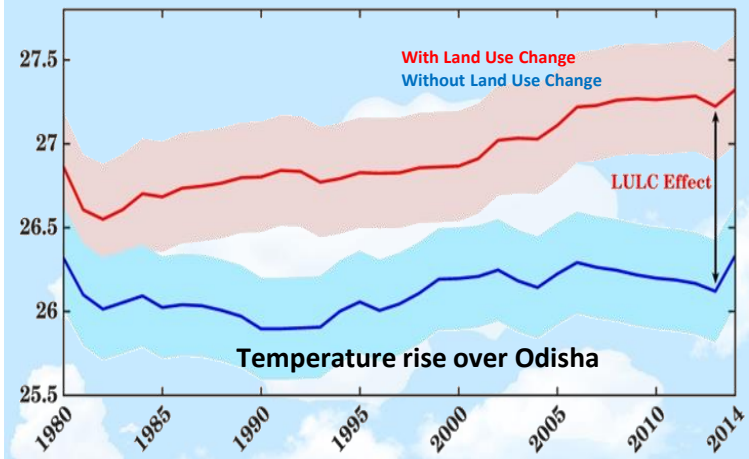
Latent heat Flux and Sensible Heat Flux





1. Decrease of LHF over Eastern part of Odisha.
2. Increase of SHF over the Eastern part of India

Schematic representation of changes in Eastern India



Global warming effect enhanced by 30% to 50% over the state of Odisha due to agricultural diversification and rapid pace of urbanization

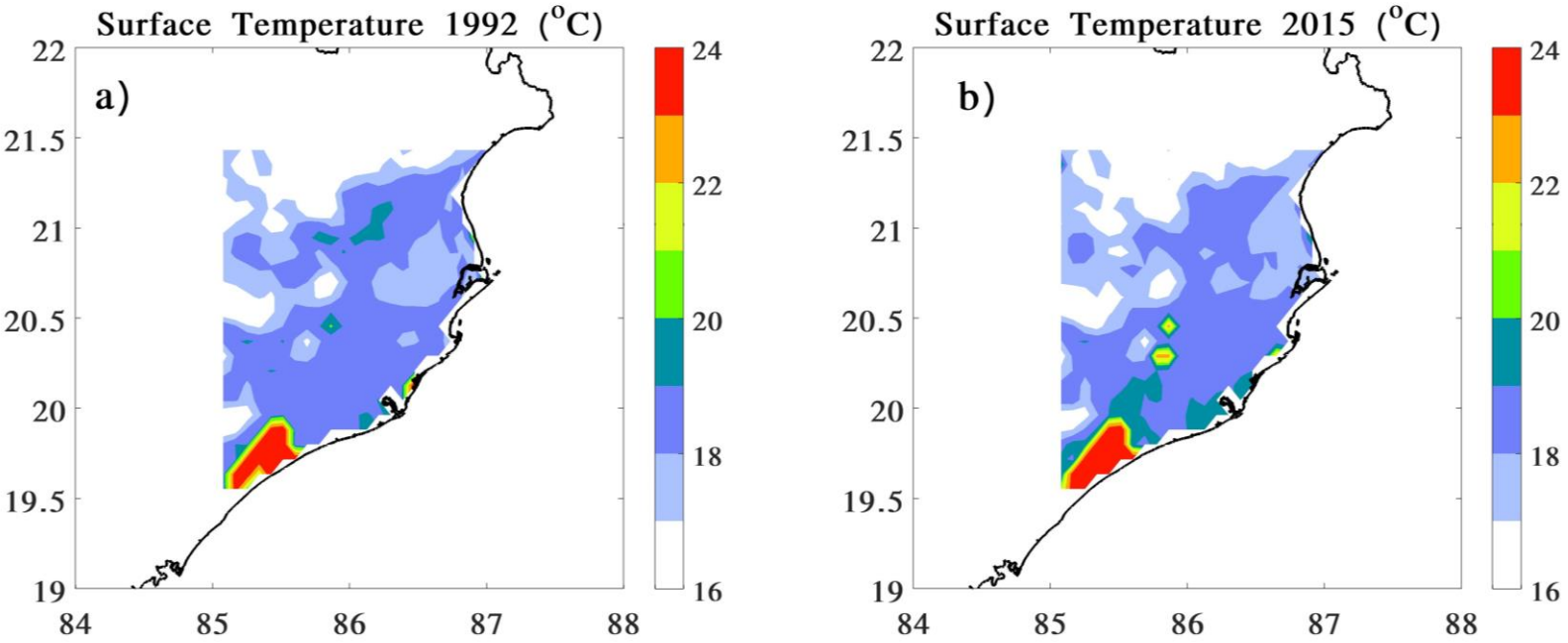
Gogoi et al., 2019, Scientific Reports

LULC change

Enhanced Absorption and hence heating due to changed Sp. Heat Capacity.

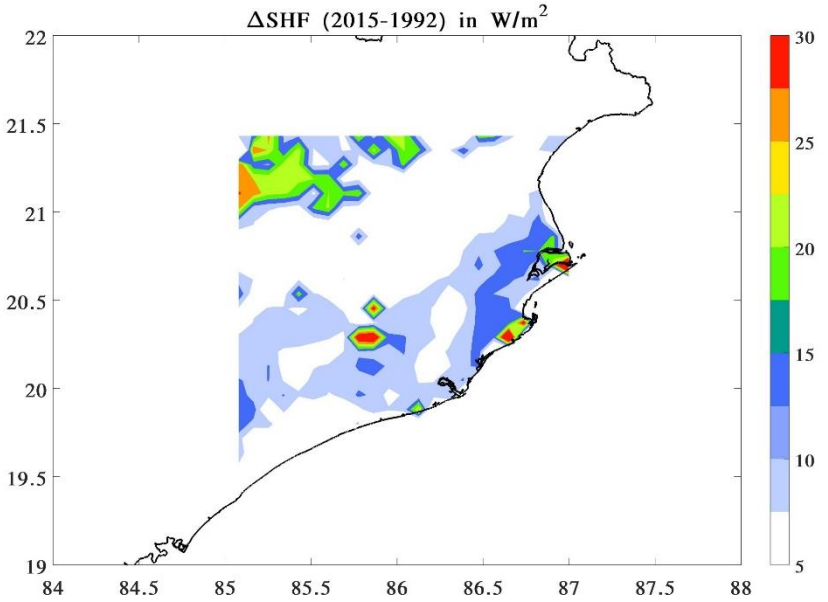
With the rapid rate of LULC changes in the recent years due to urbanization, the abrupt rise in surface air temperature is a manifestation of the enhanced global warming effect accelerated by the changes in surface characteristics. This study published in Scientific Reports in July, 2019 has been receiving global attention with a wide media coverage which includes leading news agencies like The Hindu and The Times of India. This study may create a benchmark for the policy makers to keep in mind the growing challenges of Urban Climate Change for a sustainable future.

Can numerical model (WRF-LSM) approximate this impact of LULC?

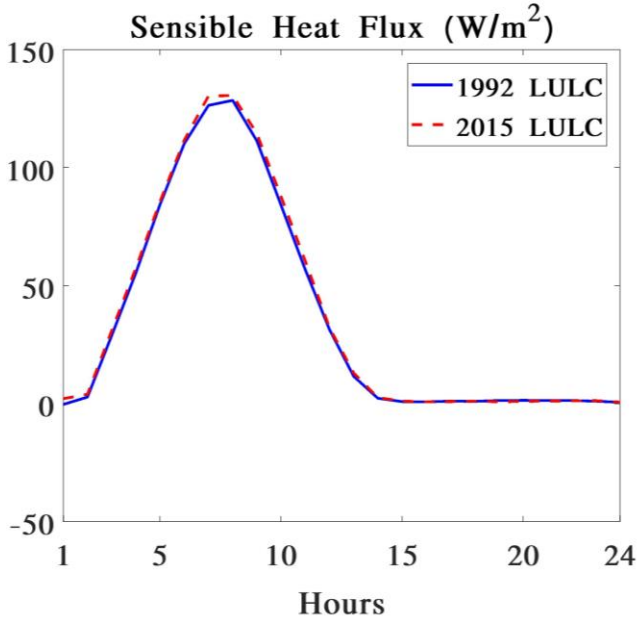


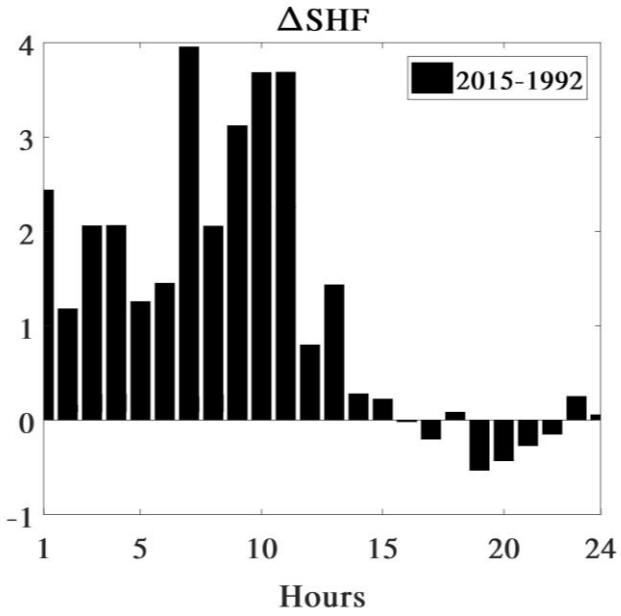
- Surface temperature with 1992 LULC and 2015 LULC.

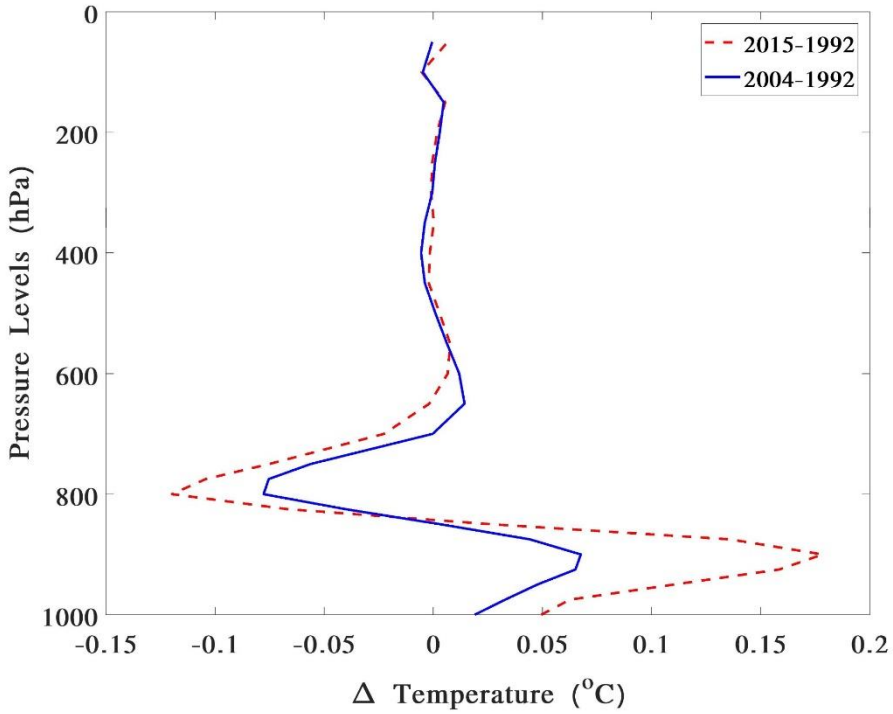
- Surface Temperature over Bhubaneswar and Cuttack shows to be increasing.



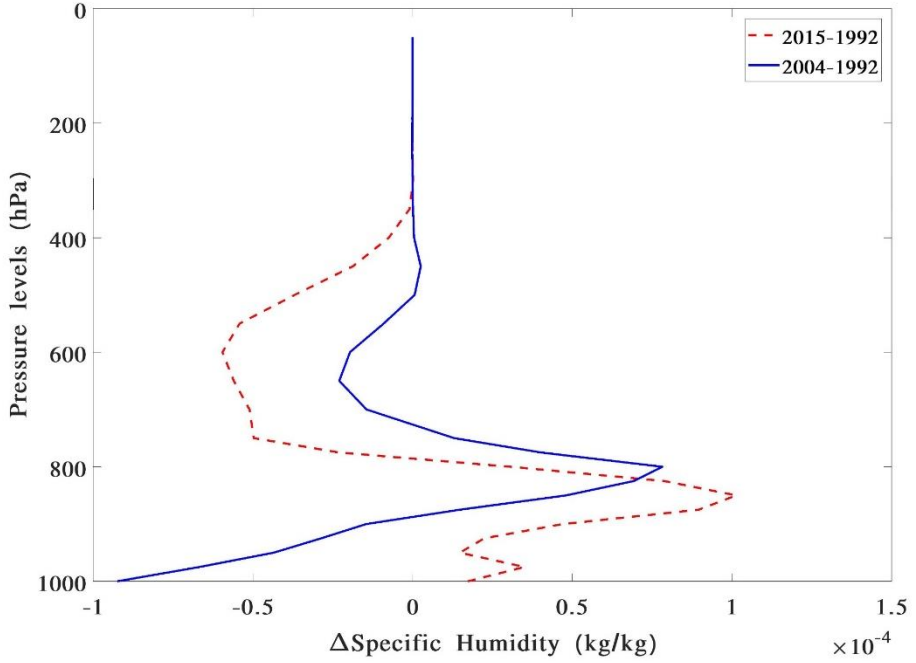
- **Changes in Sensible Heat Flux is seen all over the eastern region with a maximum increase over the cities.**







➢ **Increase is seen in the recent times Both for temperature profile and Sp. humidity profile**



Summary from observational analyses

- ***Rate of increase of Tmin is higher than Tmax.***
- ***2001-2010 is showing a very rapid increase in temperature in comparison to the earlier decades.***
- ***1991-2000- rise is ~0.4^{0}C which is equally in most of the places whereas during the period 2001-2010, the maximum temperature rise is ~0.9^{0}C. 1981-1990- no rise at all.***
- ***Change of LULC pattern and OMR pattern are consistent.***
- ***Rise in temperature in the cities corresponds 50 % to LULC change***

Thus, both Observation and Model outputs are capable of capturing the impact of LULC on the land-atmospheric parameters.

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3) MHRD for the scholarship for pursuing the doctoral research.

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