Land Cover Change:
Does it affect temperature variability?

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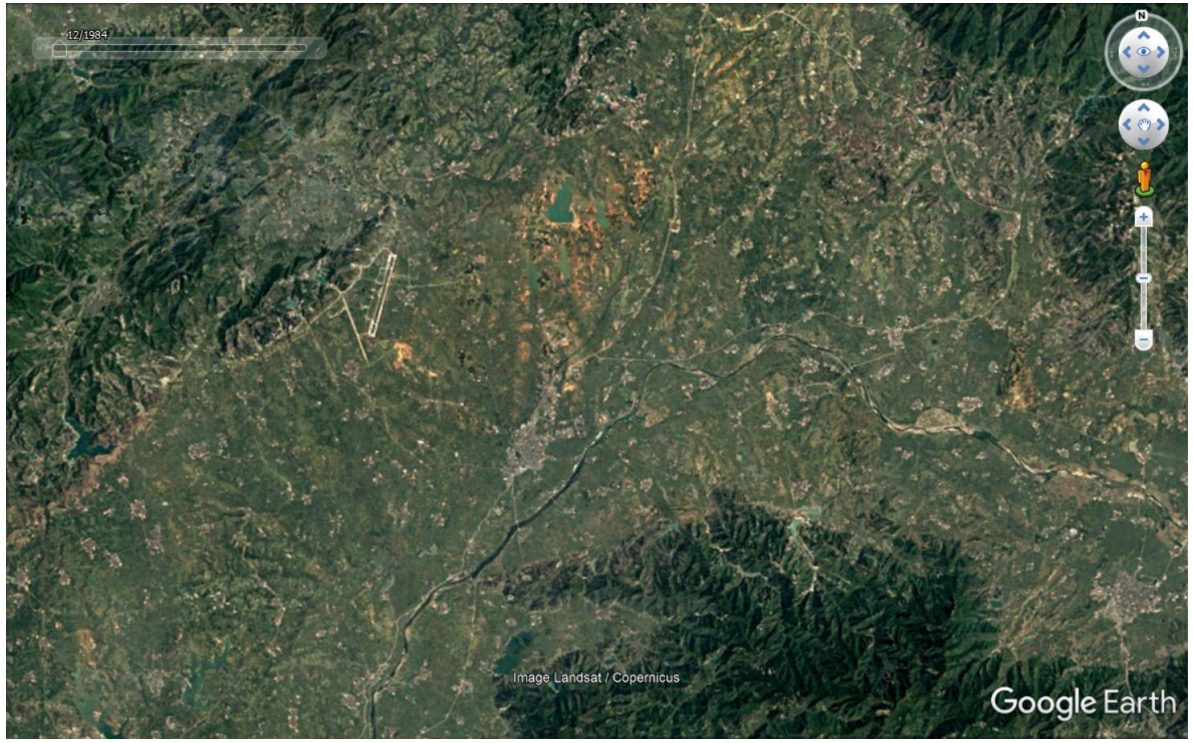
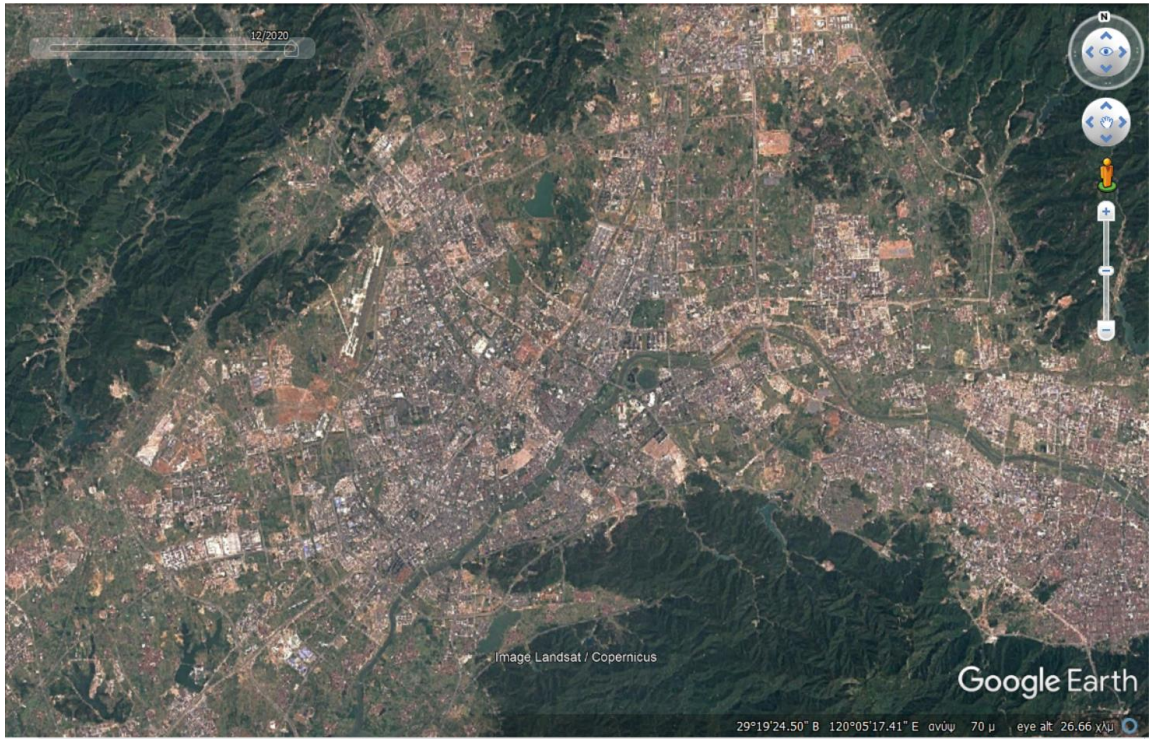
Introduction

- Since urban population growth is projected to continue, with approximately 68% of the world population being urban residents by 2050 (United Nations, 2018), it is imperative to work towards a better understanding of the influence that urbanization has on climate change and temperature variability.



Satellite image of Yiwu (China), 1984 (Google Earth)



Satellite image of Yiwu (China), 2020 (Google Earth)

Objective

- This work examines whether land cover is a parameter affecting temperature increase by employing global datasets of land cover change
- A comparison is specifically made between the rate of temperature increase measured in urban areas, and the same rate measured in nearby non-urban areas.

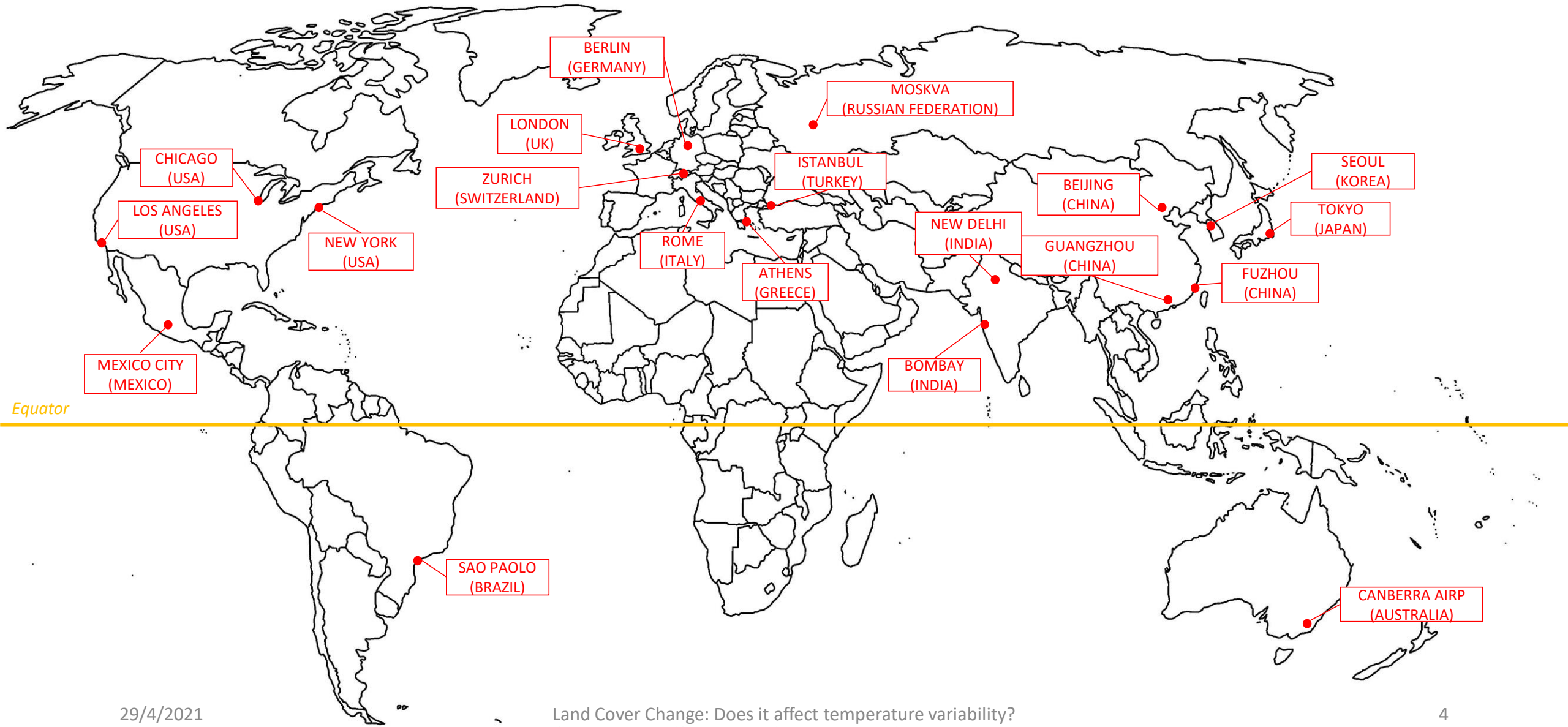
Data

- Mean monthly temperature station data from 40 regions (20 urban & 20 rural) around the world
- World Meteorological Organization (WMO), *KNMI Climate Explorer* database

Data Analysis

- Calculation of *linear trend of mean monthly temperature* for the urban and the nearby rural area for the given time period
- Calculation of *linear trend of each seasons' (three-month average) mean temperature* for the urban and the nearby rural area for the given time period

Urban and Nearby Rural Areas Studied Worldwide



**There is no sufficient data for regions in Africa in the database used, thus they are not taken into consideration in the analysis.*

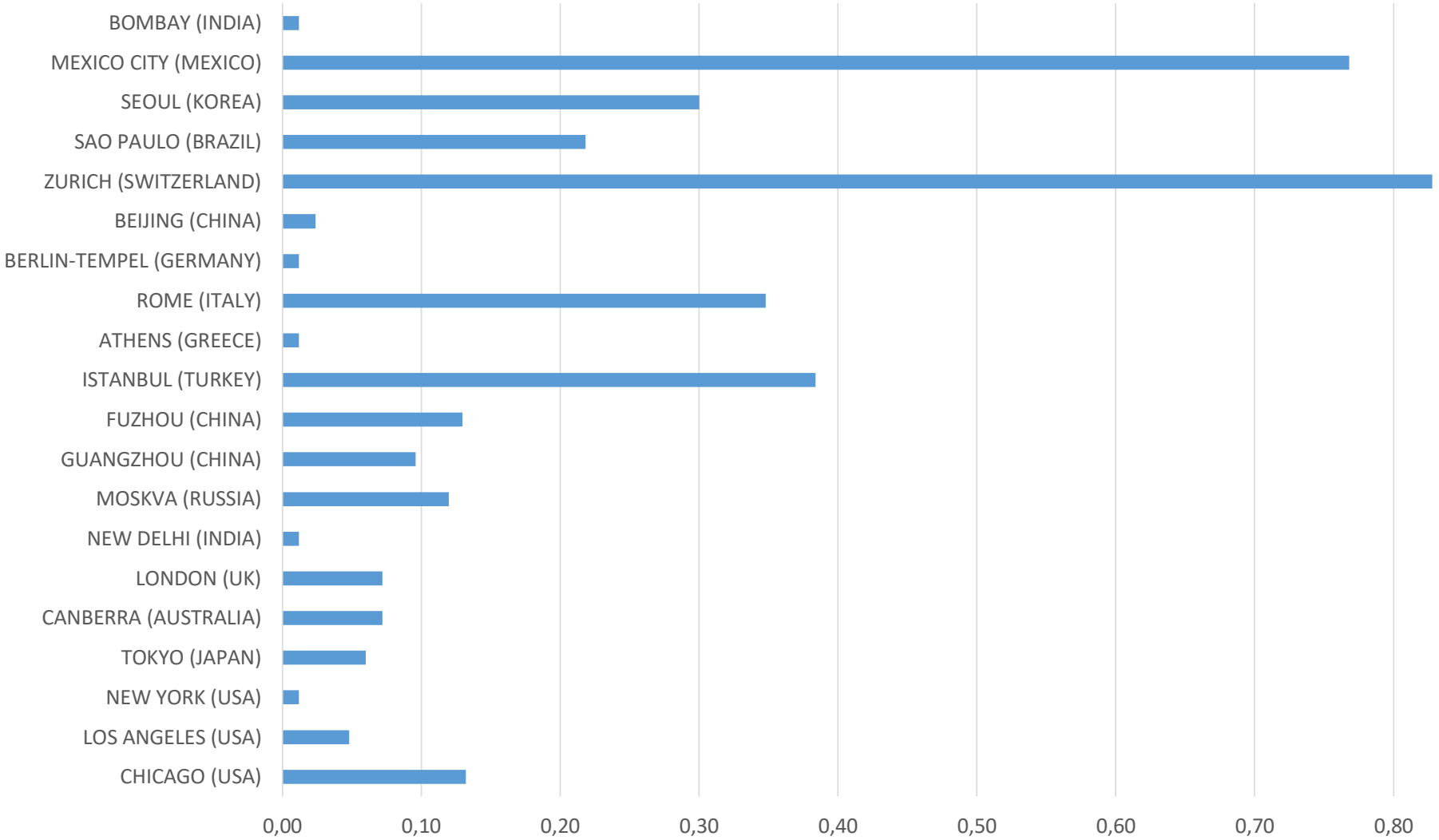
Coordinates and Altitudes of Stations studied

Urban area			Rural Area		
Name	Coordinates	Altitude [m]	Name	Coordinates	Altitude [m]
CHICAGO (USA)	41,78N, 87,75EW	182	RENSSELAER	40,94N, 87,16W	198
LOS ANGELES (USA)	33.70N, 117.75W	94	LEMON COVE	36,38N, 119,03W	258
NEW YORK (USA)	40,78N, 73,77W	22	FLEMINGTON 5 NNW	40,56N, 74,88W	103
TOKYO (JAPAN)	35,68N, 139,77E	13	OSHIMA	34,75N, 139,37E	0
CANBERRA (AUSTRALIA)	35,30S, 149,18E	637	MORUYA HEAD	35,90S, 150,15E	99
LONDON (UK)	51,50N, 0,30W	44	ROSS-ON-WYE	51,90N, 2,60W	96
NEW DELHI (INDIA)	28,58N, 77,20E	221	KOTA AERODROM	25.15N, 75.85E	271
MOSKVA (RUSSIA)	55,83N, 37,62E	150	ELAT'MA	54,95N, 41,77E	122
GUANGZHOU (CHINA)	23.13N, 113.32E	90	WUZHOU	23,48N, 111,30E	141
FUZHOU (CHINA)	26,08N, 119,28E	199	XICHANG	27,90N, 102,27E	1869
ISTANBUL (TURKEY)	40.97N, 29.08E	73	LIMNOS (GREECE)	39.92N, 25.23E	91
ATHENS (GREECE)	37,97N, 23,72E	100	SAMOS	37,70N, 26,92E	73
ROME (ITALY)	41,80N, 12,60E	140	CAPO PALINURO	40,02N, 15,28E	42
BERLIN (GERMANY)	52,47N, 13,40E	41	LINDENBERG	52,22N, 14,12E	78
BEIJING (CHINA)	39,93N, 116,28E	142	GAIXIAN XIONGYUE	40,17N, 122,15E	50
ZURICH (SWITZERLAND)	47,38N, 8,57E	502	SAENTIS	47,25N, 9,35E	1210
SAO PAULO (BRAZIL)	23,50S, 46,62W	883	IGUAPE	24,72S, 47,55W	30
SEOUL (KOREA)	37,57N, 126,97E	88	CHENGSHANTOU (CHINA)	37.40N, 122.68E	0
MEXICO CITY (MEXICO)	19,40N, 99,20W	2307	ZAMORA,MICH	19,98N, 102,32W	1733
BOMBAY (INDIA)	19,12N, 72,85E	31	DWARKA	22,37N, 69,08E	0

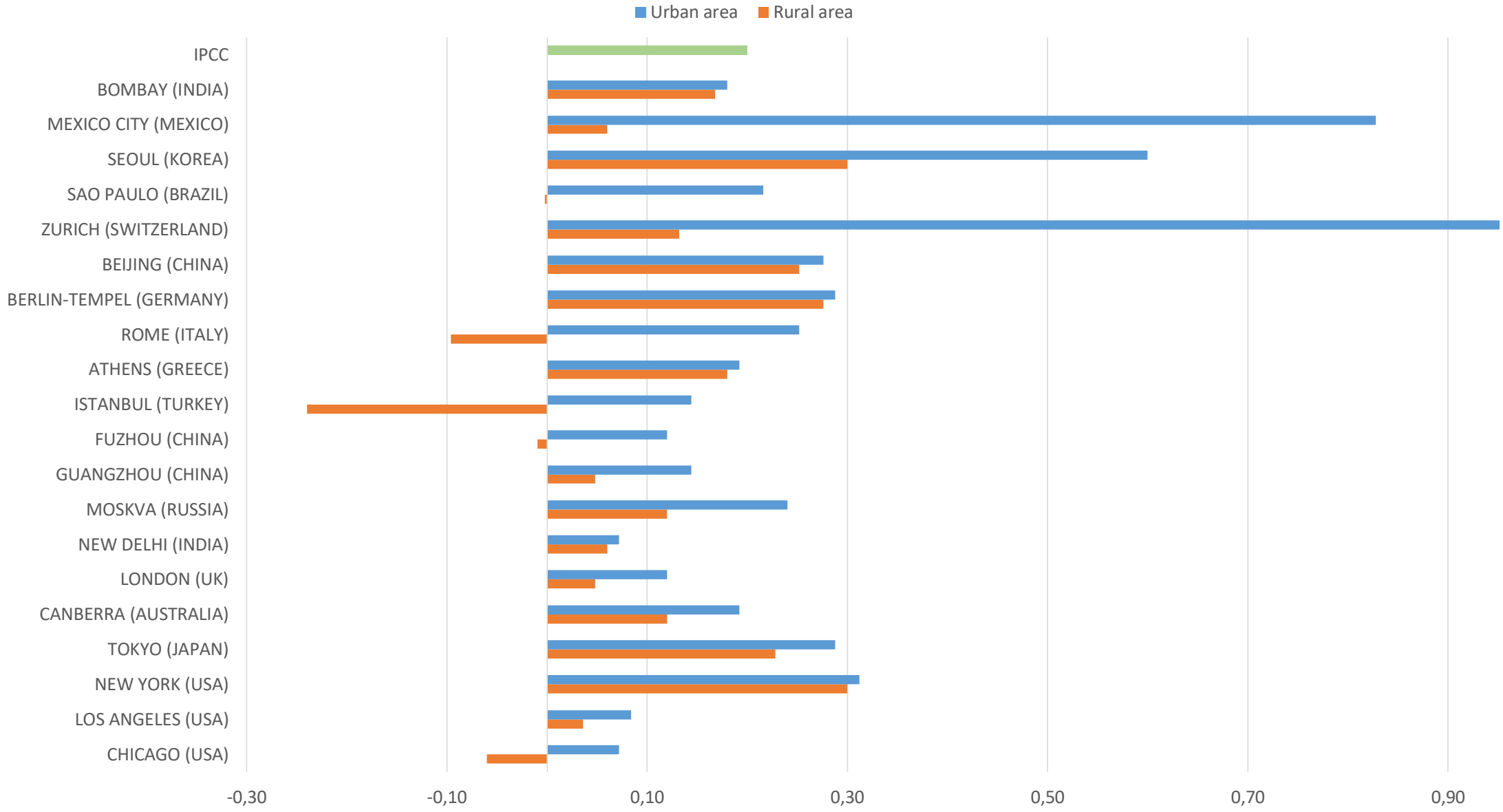
Station selection criteria

1. Distance < 300 km between the urban and the rural station,
2. Availability of at least 50 years of continuous data.

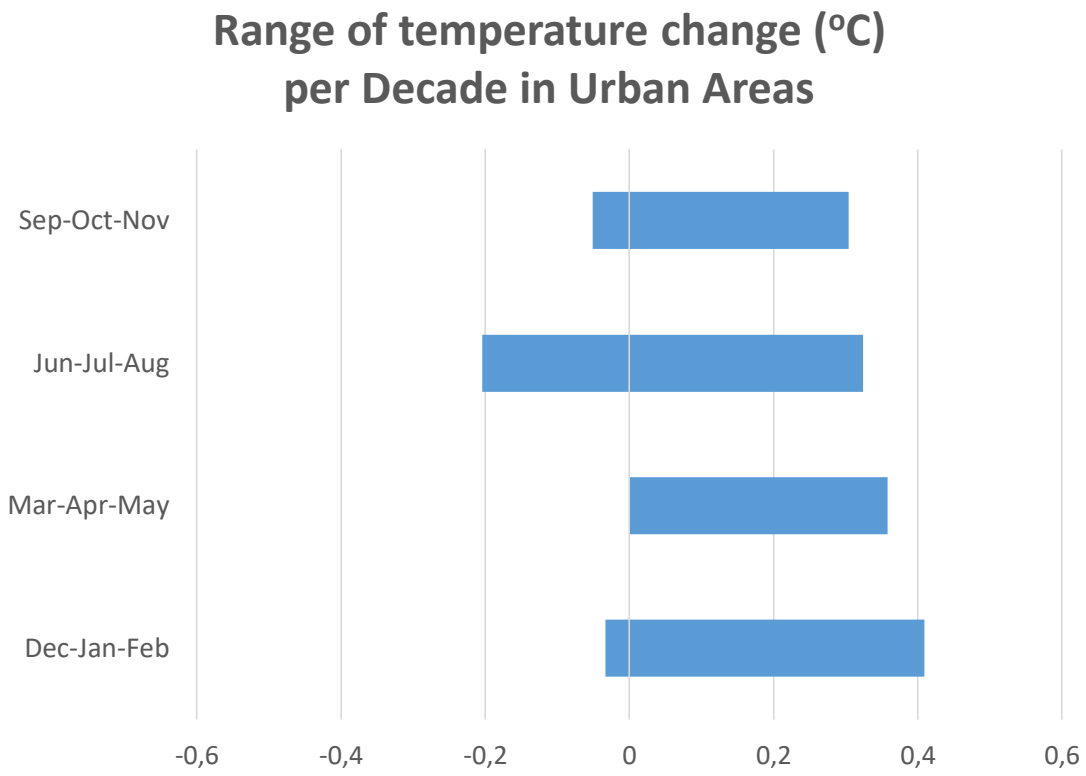
Difference between Urban and Rural Temperature Variability (°C) per Decade

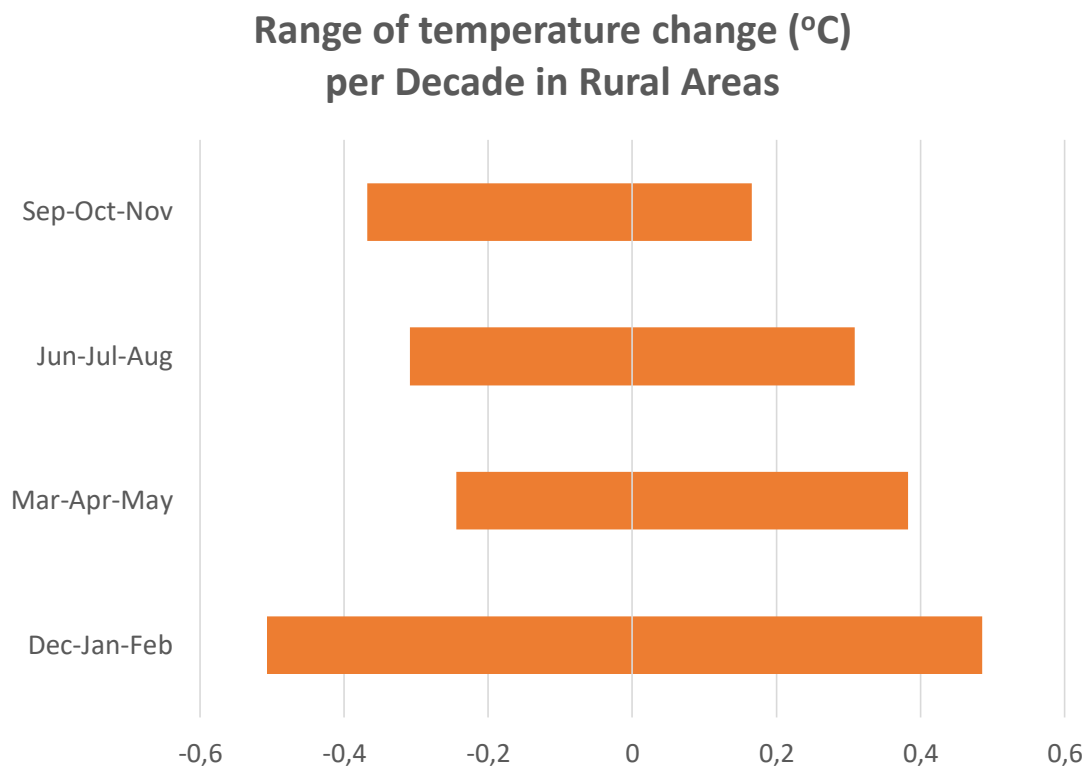


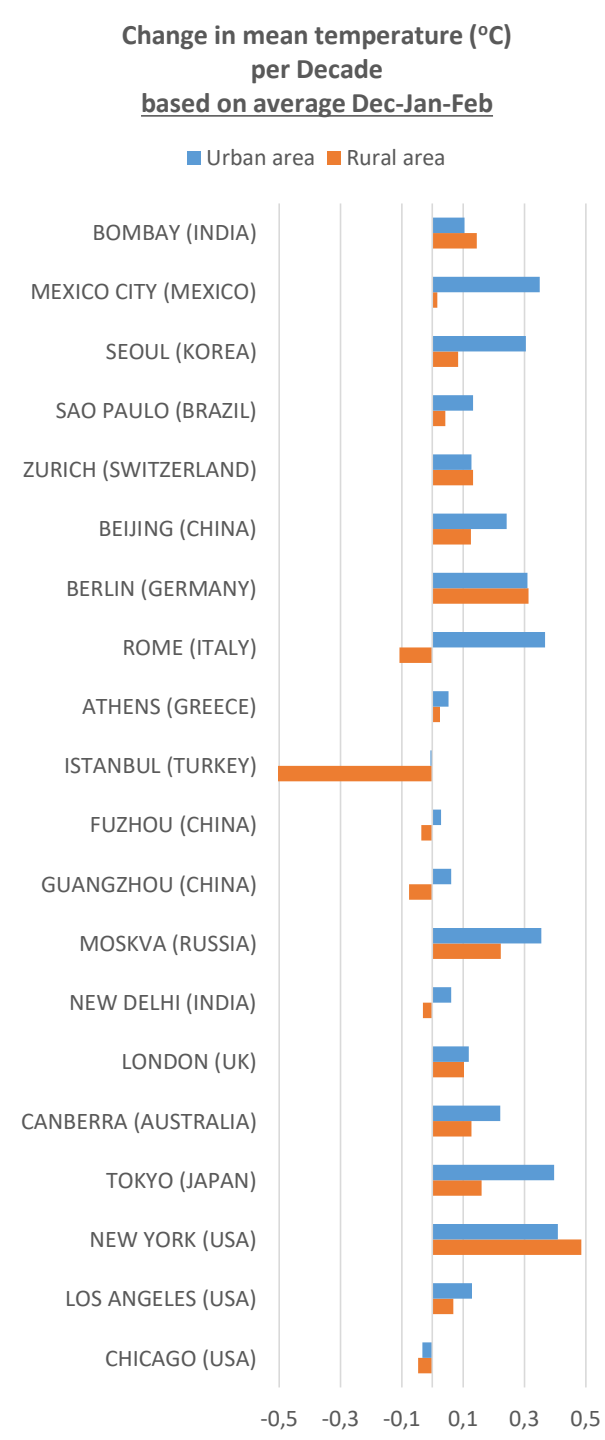
Temperature Change (°C) in Urban and Nearby Rural Areas per Decade

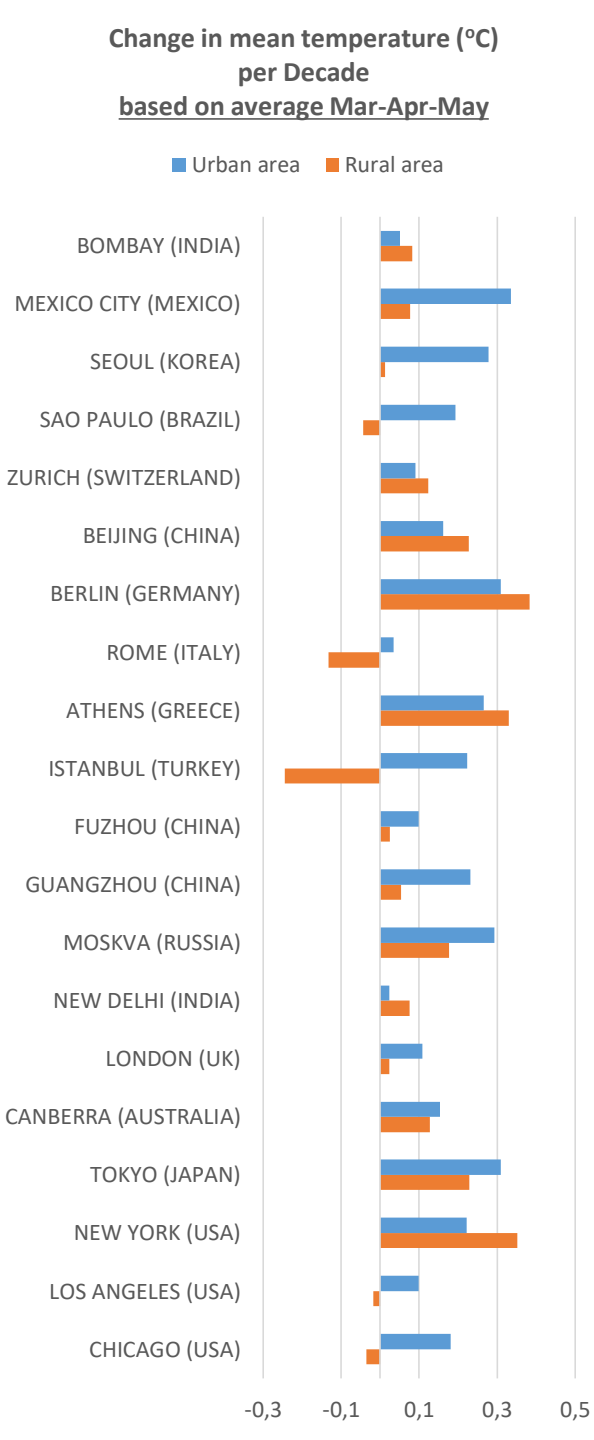


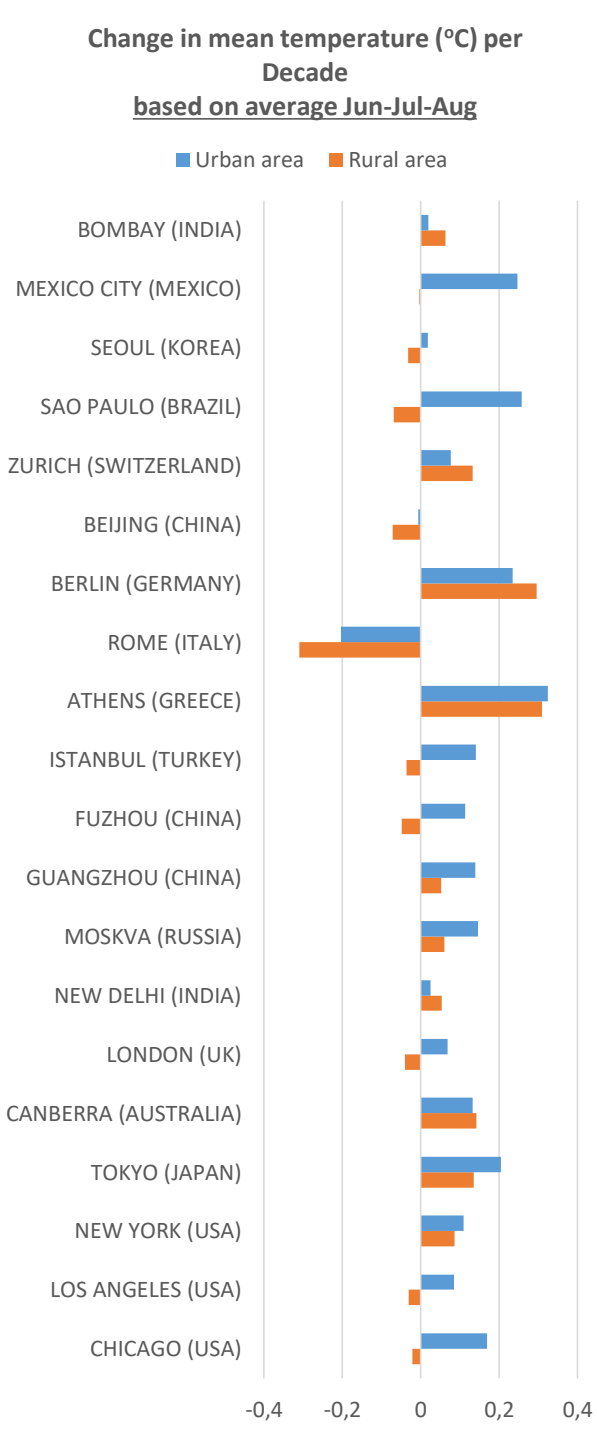
Range of temperature change (°C) per decade based on season's average

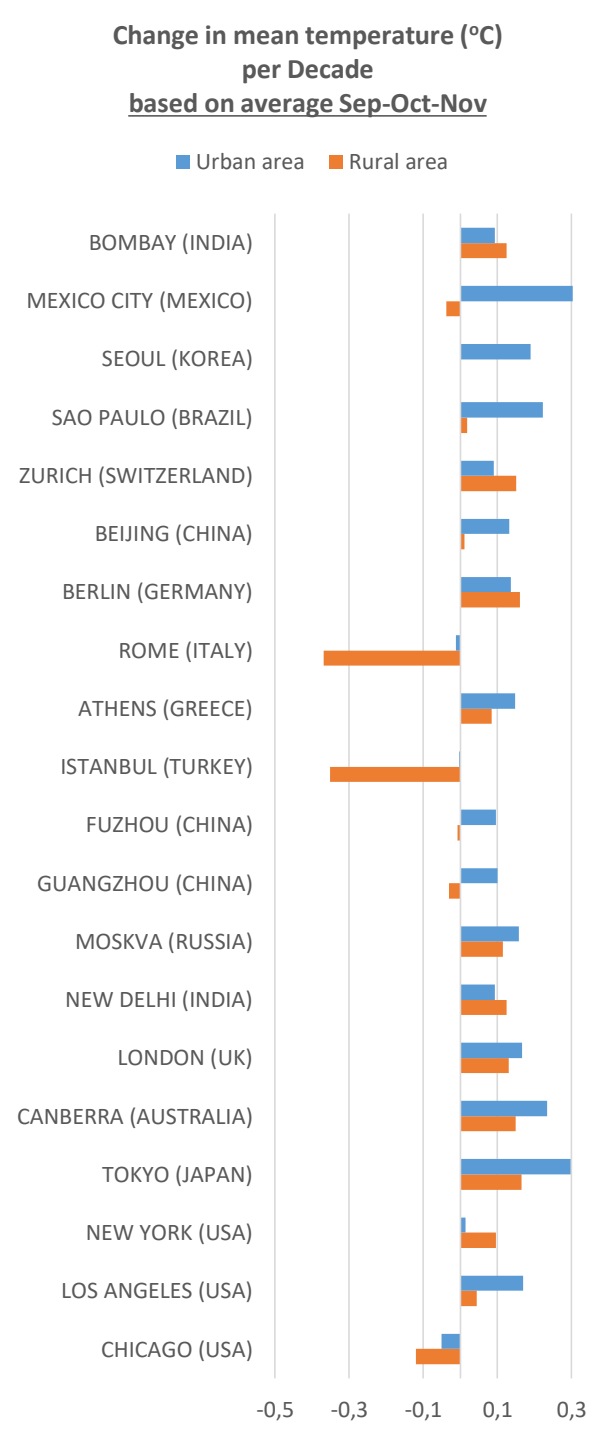





Change in mean temperature (ºC) per Decade based on average Dec-Jan-Feb
Urban area
Rural area
BOMBAY (INDIA)
MEXICO CITY (MEXICO)
SEOUL (KOREA)
SAO PAULO (BRAZIL)
ZURICH (SWITZERLAND)
BEIJING (CHINA)
BERLIN (GERMANY)
ROME (ITALY)
ATHENS (GREECE)
ISTANBUL (TURKEY)
FUZHOU (CHINA)
GUANGZHOU (CHINA)
MOSKVA (RUSSIA)
NEW DELHI (INDIA)
LONDON (UK)
CANBERRA (AUSTRALIA)
TOKYO (JAPAN)
NEW YORK (USA)
LOS ANGELES (USA)
CHICAGO (USA)
-0,5 -0,3 -0,1 0,1 0,3 0,5


Change in mean temperature (ºC) per Decade based on average Mar-Apr-May
Urban area
Rural area
BOMBAY (INDIA)
MEXICO CITY (MEXICO)
SEOUL (KOREA)
SAO PAULO (BRAZIL)
ZURICH (SWITZERLAND)
BEIJING (CHINA)
BERLIN (GERMANY)
ROME (ITALY)
ATHENS (GREECE)
ISTANBUL (TURKEY)
FUZHOU (CHINA)
GUANGZHOU (CHINA)
MOSKVA (RUSSIA)
NEW DELHI (INDIA)
LONDON (UK)
CANBERRA (AUSTRALIA)
TOKYO (JAPAN)
NEW YORK (USA)
LOS ANGELES (USA)
CHICAGO (USA)
-0,3 -0,1 0,1 0,3 0,5


Change in mean temperature (ºC) per Decade based on average Jun-Jul-Aug
Urban area
Rural area
BOMBAY (INDIA)
MEXICO CITY (MEXICO)
SEOUL (KOREA)
SAO PAULO (BRAZIL)
ZURICH (SWITZERLAND)
BEIJING (CHINA)
BERLIN (GERMANY)
ROME (ITALY)
ATHENS (GREECE)
ISTANBUL (TURKEY)
FUZHOU (CHINA)
GUANGZHOU (CHINA)
MOSKVA (RUSSIA)
NEW DELHI (INDIA)
LONDON (UK)
CANBERRA (AUSTRALIA)
TOKYO (JAPAN)
NEW YORK (USA)
LOS ANGELES (USA)
CHICAGO (USA)
-0,4 -0,2 0 0,2 0,4


Change in mean temperature (ºC) per Decade based on average Sep-Oct-Nov
Urban area
Rural area
BOMBAY (INDIA)
MEXICO CITY (MEXICO)
SEOUL (KOREA)
SAO PAULO (BRAZIL)
ZURICH (SWITZERLAND)
BEIJING (CHINA)
BERLIN (GERMANY)
ROME (ITALY)
ATHENS (GREECE)
ISTANBUL (TURKEY)
FUZHOU (CHINA)
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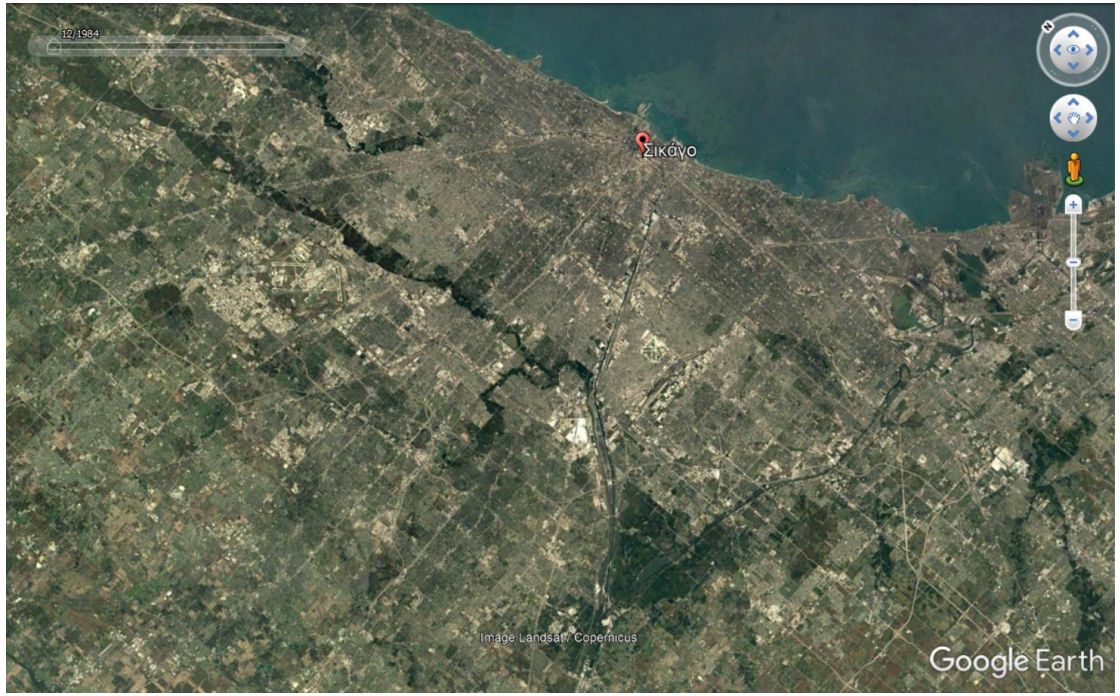
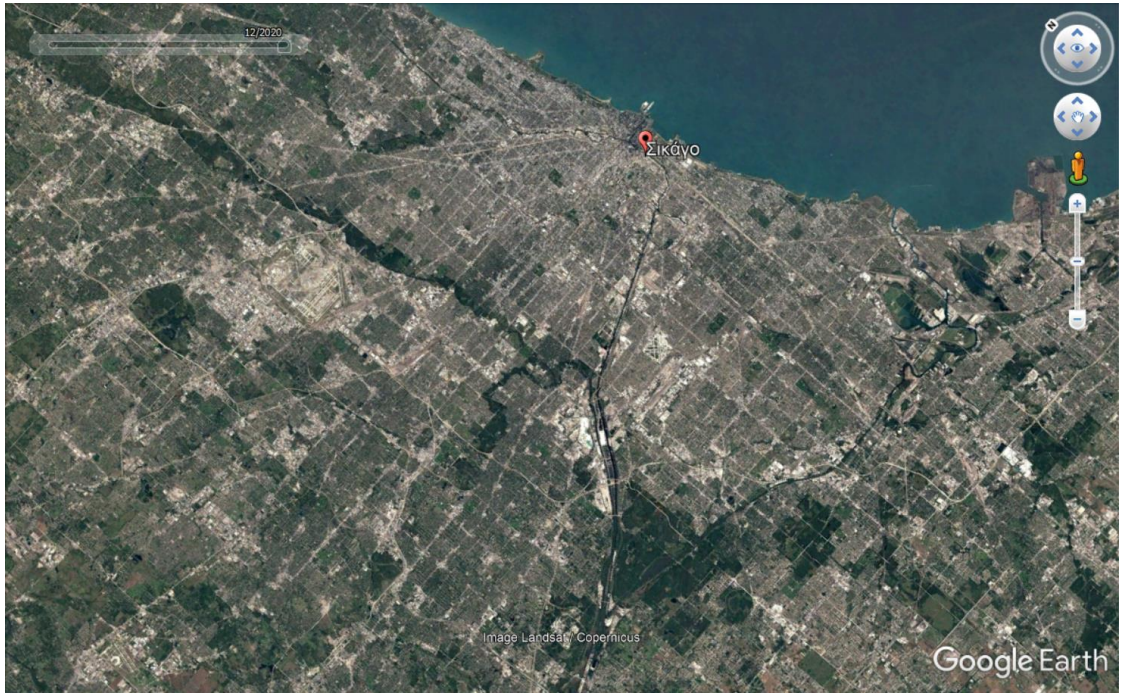
TOKYO (JAPAN)
NEW YORK (USA)
LOS ANGELES (USA)
CHICAGO (USA)
-0,5 -0,3 -0,1 0,1 0,3

Urban Expansion in the last 35 years
The case of Chicago (USA)



Satellite image of Chicago, 1984 (Google Earth)



Satellite image of Chicago, 2020 (Google Earth)

→ *0,07 °C increase* in the urban area, and *0,06 °C decrease* in the nearby non-urban area

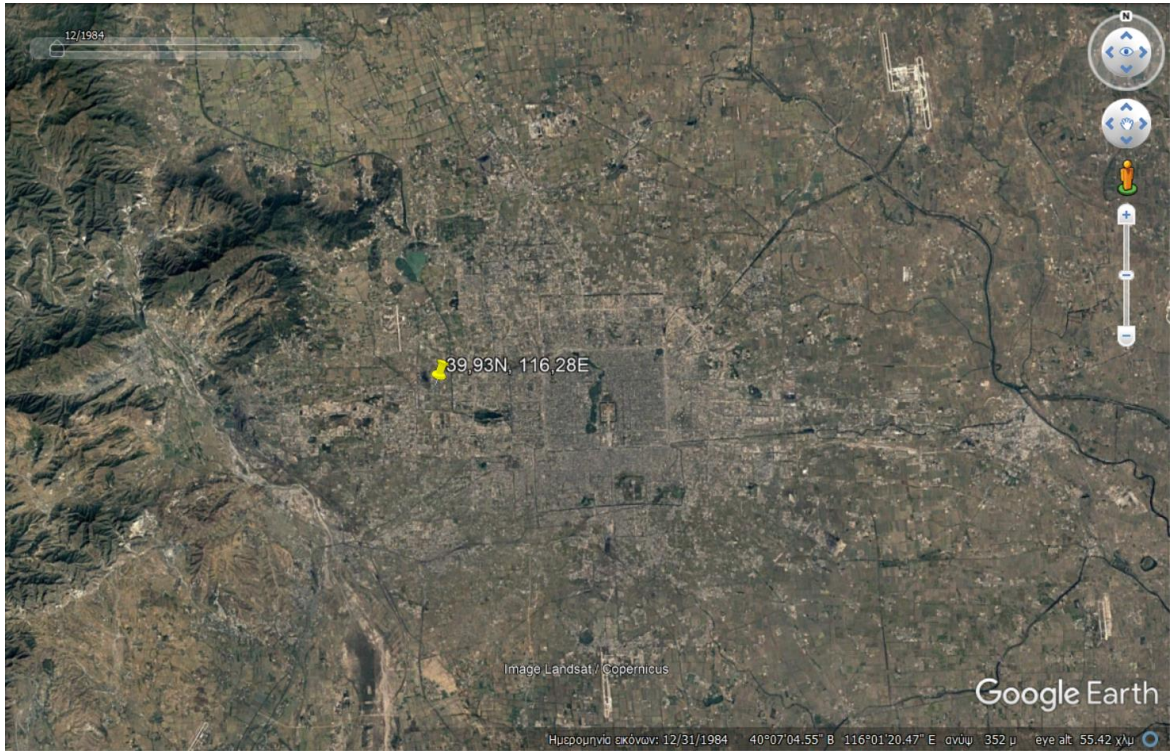
Urban Expansion in the last 35 years
The case of Istanbul (Turkey)

Satellite image of Istanbul, 1984 (Google Earth)

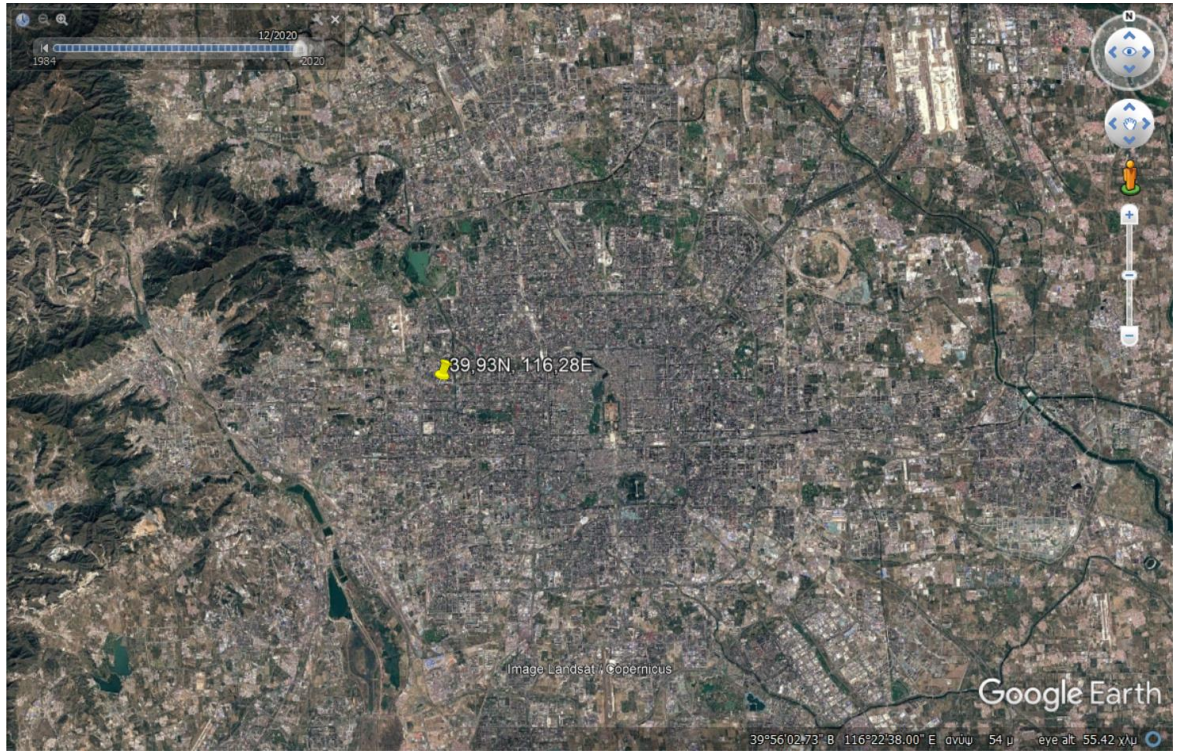
Satellite image of Istanbul, 2020 (Google Earth)

→ *0,14 ºC increase* in the urban area, and *0,24 ºC decrease* in the nearby non-urban area

Urban Expansion in the last 35 years
The case of Beijing (China)



Satellite image of Beijing, 1984 (Google Earth)



Satellite image of Beijing, 2020(Google Earth)

→ *0,28 °C increase* in the urban area, and *0,25 °C increase* in the nearby non-urban area

Conclusions

Based on the data analysis:

1. Temperature is found to be increasing in urban areas, whereas in nearby non-urban areas it does not follow a specific pattern.
2. The rate of temperature increase in urban areas is always higher compared to the one at the nearby non-urban areas.
3. The range of temperature change rates is larger in non-urban areas compared to the urban areas.
4. The winter (Dec-Jan-Feb) exhibits the greatest rate of temperature increase, while summer (Jun-Jul-Aug) has the lowest.

References

Google Earth

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United Nations (2018). World urbanization prospects.
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