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Introduction

'Climate change' refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC).'

'Climate change' refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (UNFCCC).'

https://www.ipcc.ch/publications_and_data/ar4/syr/en/mains1.html

'Urbanization' is the process by which towns and cities are formed and become larger as more and more people begin living and working in central areas. Urbanization refers to the increasing number of people that live in urban areas. It predominantly results in the physical growth of urban areas, be it horizontal or vertical.'

<http://demographicpartitions.org/urbanization-2013/#ZsflHCspQJkt6o7.99>

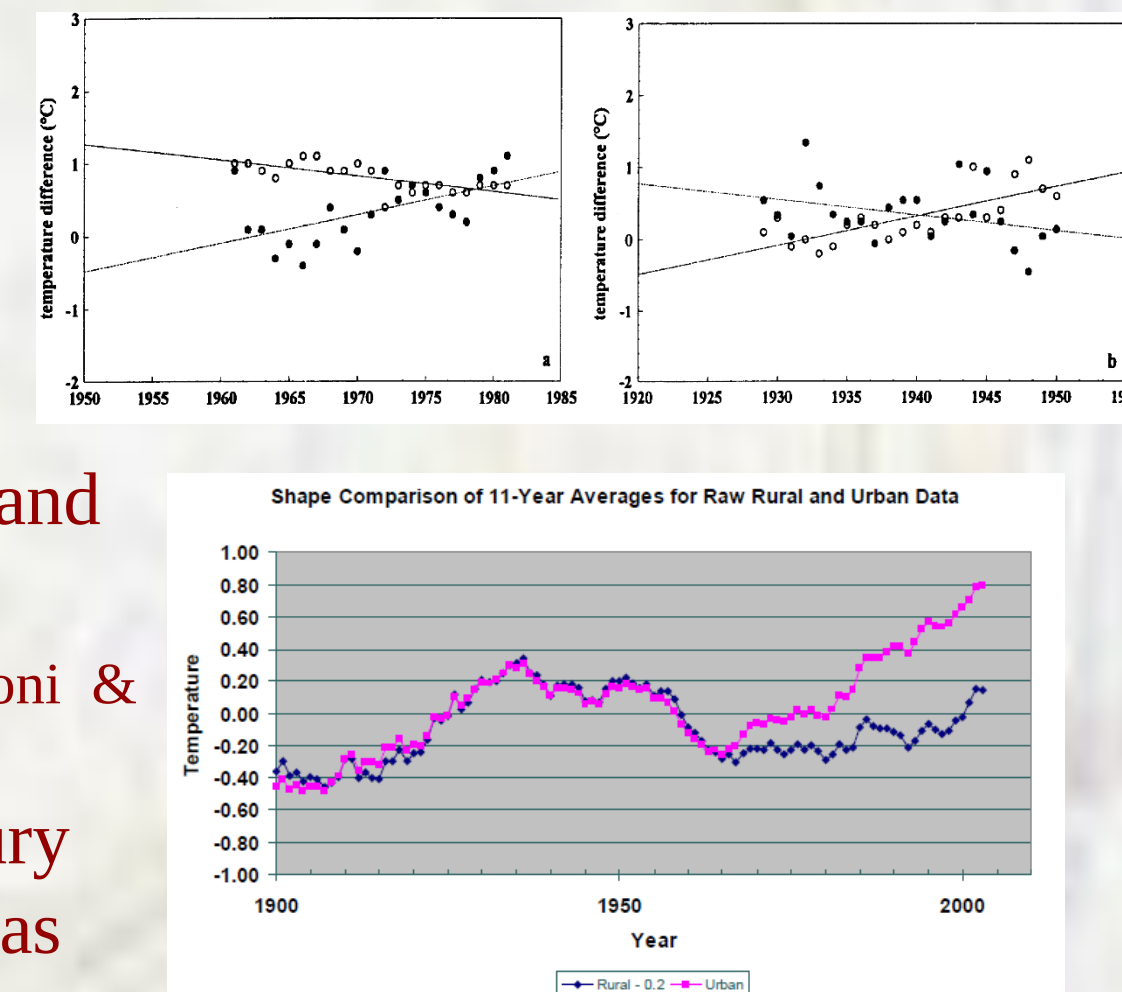
Objective of the study → investigate the effect of urbanization on temperature change using large scale land-cover change geodatabase

Similar works

---Using nighttime light satellite imagery to determine urbanization & meteorological stations (Yang et al, 2011)

---Interannual variation of yearly mean temperature difference between a station located in urban area and a rural station (○) and yearly mean rural temperature Tr (●) for Melbourne (a), and Buenos Aires (b) (Camilloni & Barros, 1997)

---Raw data provides 0,13 and 0,79°C/century temperature increase for rural and urban areas (Long, 2010)



Materials and Methods

Historical Land-Cover Change Global Dataset

netCDF files

HYDE 3.1 (Historical Database of the Global Environment)

(Klein Goldewijk et al., 2011)

HYDE-CHVEG land-use transformations/conversions

area of one land-cover type that was converted to another land-cover type, between two consecutive years

global 0,5° x 0,5° lat/lon grid (≈50 km*50 km) at annual time steps, Years: 1900-2010

Land Cover Changes:

- annual 92 different types of land-use conversions
- 23 types of land-use conversions to urban areas....

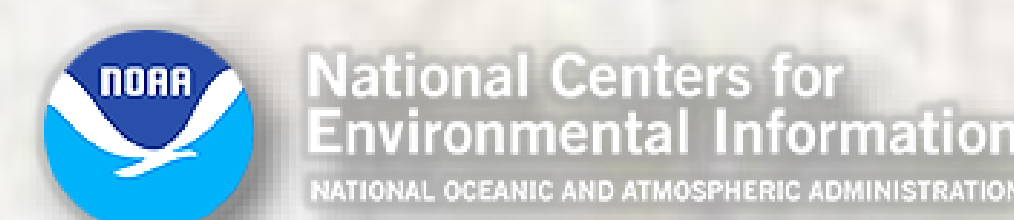
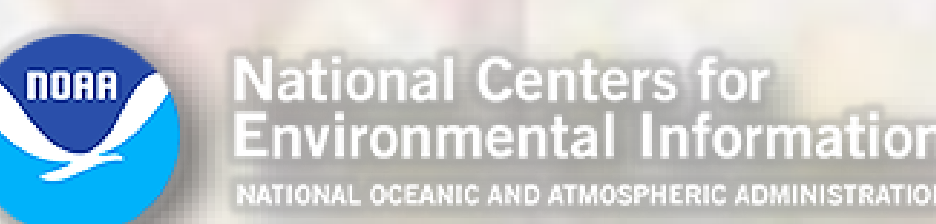
Global Historical Climatology Network (GHCN)

integrated database of climate summaries from land surface stations

yearly mean air temperature data from 7572

meteorological stations across the globe

<https://www.ncdc.noaa.gov/ghcnm/>



Hourly

yearly

Statistical analysis:

- yearly mean air temperature data from 7572 meteorological stations
- cross correlation between cumulative land-use conversions to urban areas and temperature records in Tokyo the longest temperature timeseries

Stochastic analysis:

- calculation of Hurst coefficient

(Dimitriadis and Koutsoyiannis, 2015)

Tokyo	stations	Hurst
urban	2085	0,69
	2086	-
	2096	~0,5
	2105	0,88
non-urban	2095	0,57
	2103	0,78
	2104	0,59

Tokyo	stations	correl
urban	2085	0,48
	2086	0,46
	2096	0,45
	2105	0,44
non-urban	2095	0,19
	2103	0,32
	2104	0,34

Land-Use Conversions

4.TpEBF → Urban Tropical Evergreen Broadleaf Forest → Urban land

8.TpDBF → Urban Tropical Deciduous Broadleaf Forest → Urban land

12.TmpEBF → Urban Temperate Evergreen Broadleaf Forest → Urban land

16.TmpENF → Urban Temperate Evergreen Needle leaf Forest → Urban land

20.TmpDBF → Urban Temperate Deciduous Broadleaf Forest → Urban land

24.BorENF → Urban Boreal Evergreen Needle leaf Forest → Urban land

28.BorDNF → Urban Boreal Deciduous Needle leaf Forest → Urban land

31.Savanna → Urban Savanna → Urban land

34.Grass → Urban Grass → Urban land

37.Denseshrub → Urban Dense Shrub land → Urban land

40.Openshrub → Urban Open Shrub land → Urban land

43.Tundra → Urban Tundra → Urban land

46.Desert → Urban Desert → Urban land

49.PdRI → Urban Polar Desert/Rock/Ice → Urban land

52.SecTpEBF → Urban Secondary Tropical Evergreen Broadleaf Forest → Urban land

55.SecTpDBF → Urban Secondary Tropical Deciduous Broadleaf Forest → Urban land

58.SecTmpEBF → Urban Secondary Temperate Evergreen Broadleaf Forest → Urban land

61.SecTmpENF → Urban Secondary Temperate Evergreen Needle leaf Forest → Urban land

64.SecTmpDBF → Urban Secondary Temperate Deciduous Broadleaf Forest → Urban land

67.SecBorENF → Urban Secondary Boreal Evergreen Needle leaf Forest → Urban land

70.SecBorDNF → Urban Secondary Boreal Deciduous Needle leaf Forest → Urban land

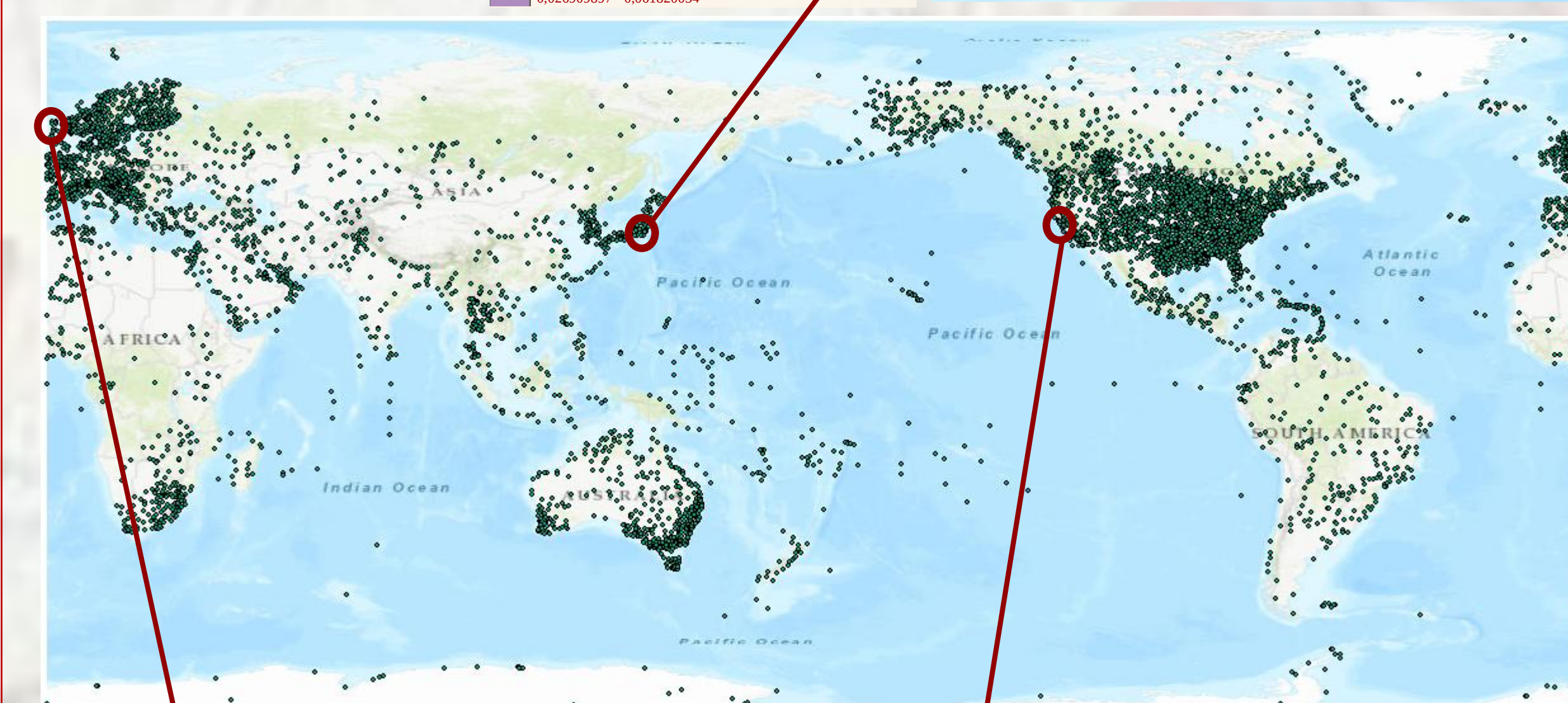
86.Crop → Urban Cropland → Urban land

89.Past → Urban Pastureland → Urban land

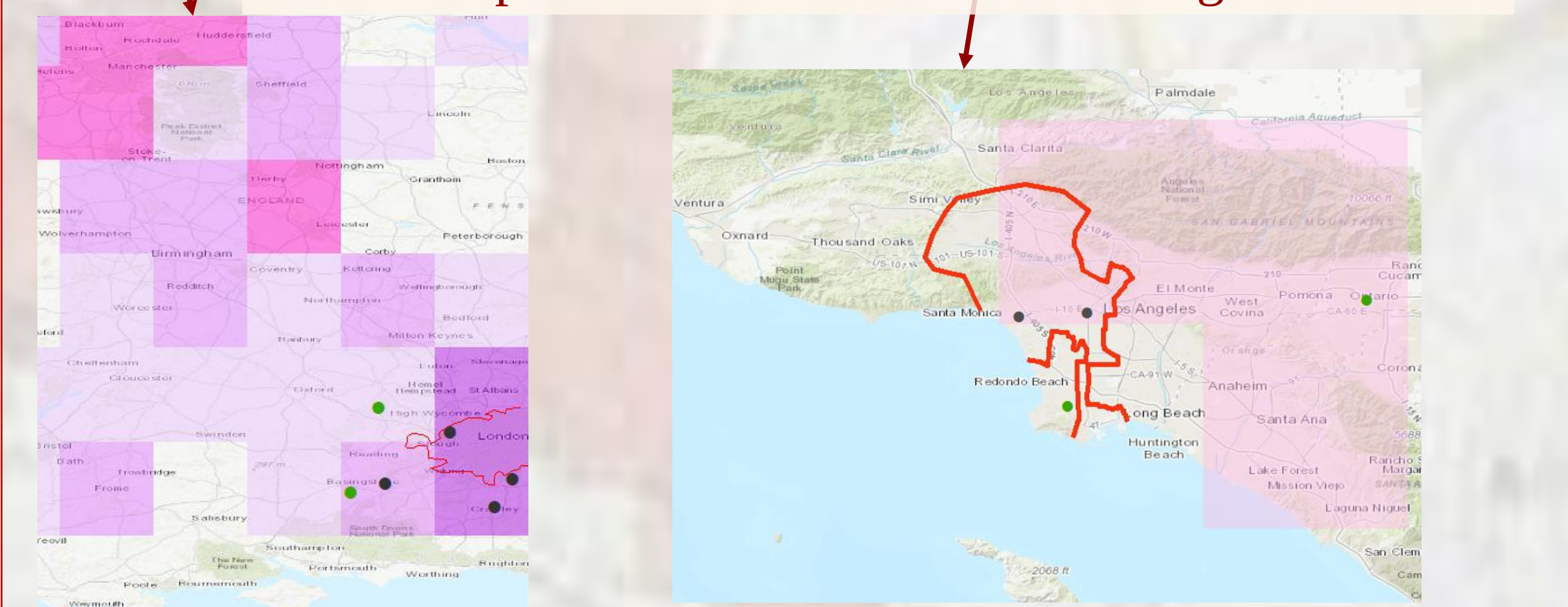
The originality of our research lies in the use of the original time series of a global network of meteorological stations (not reanalysis data) and a long time series of global land-use conversions

Description of study areas

- stations are classified into urban & non-urban stations using different base maps and city boundaries from Google Earth and Open Street map

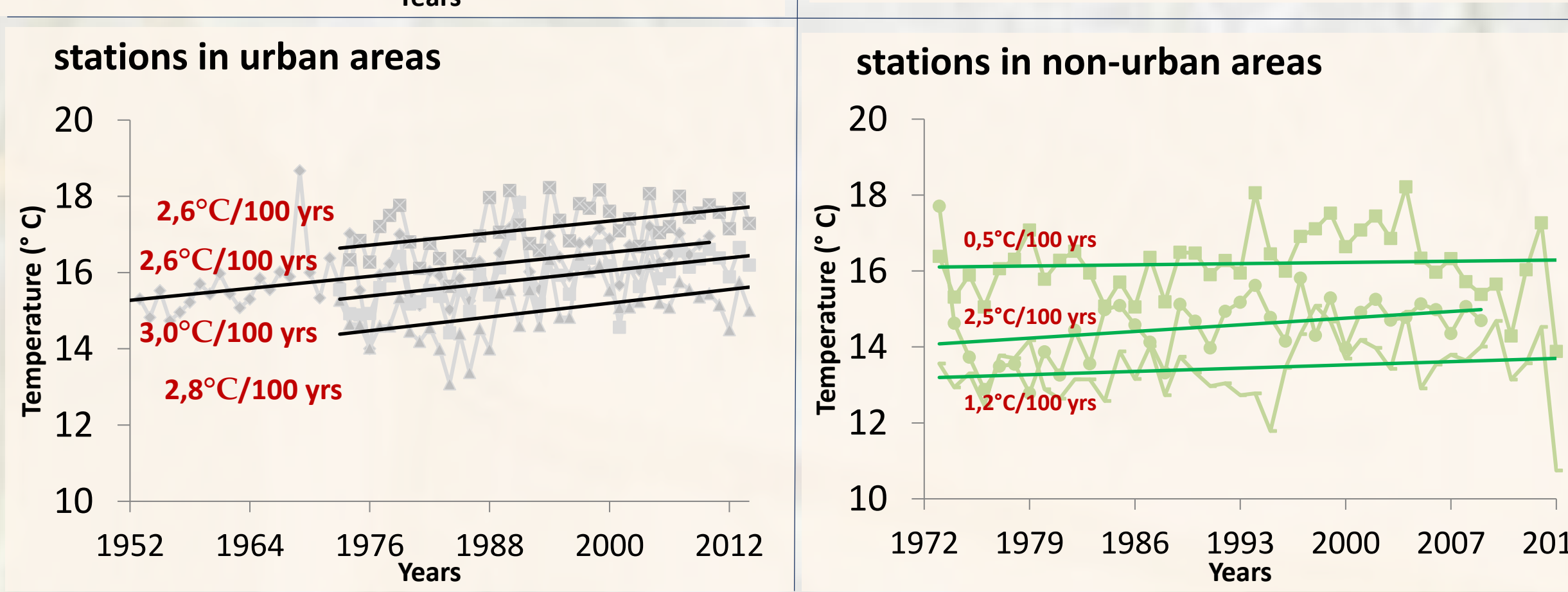
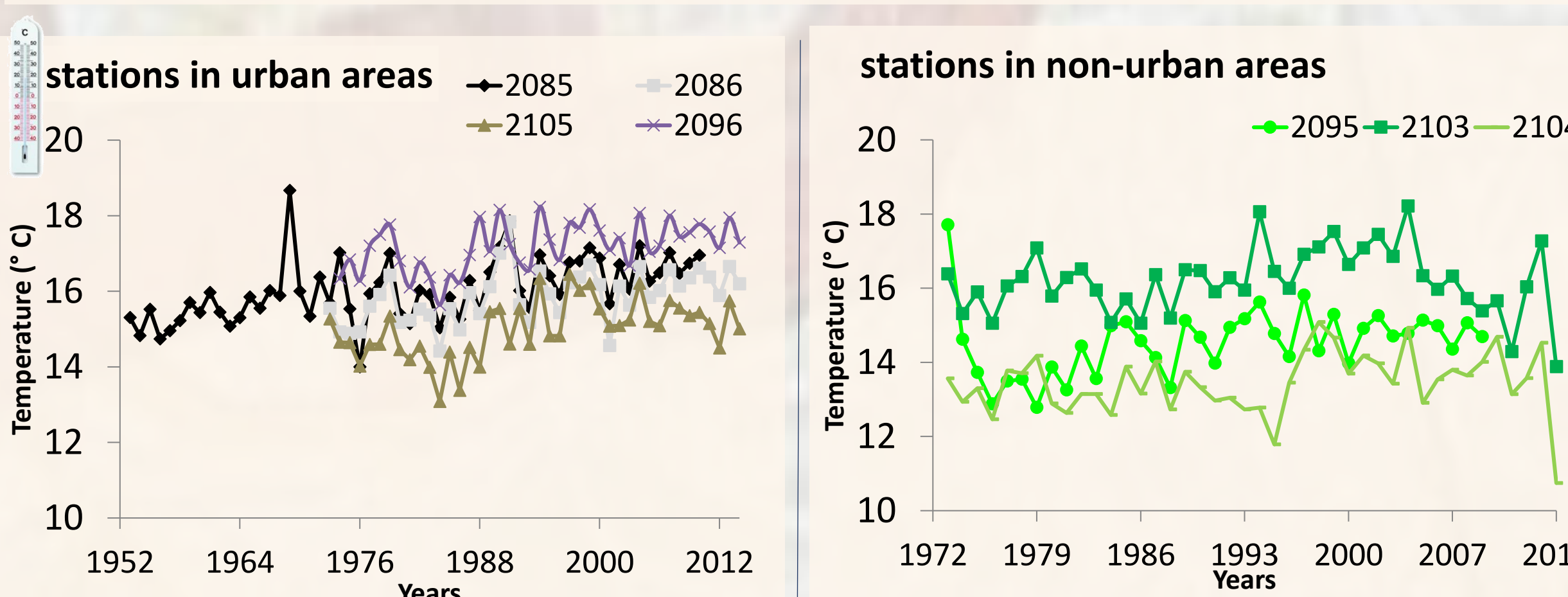
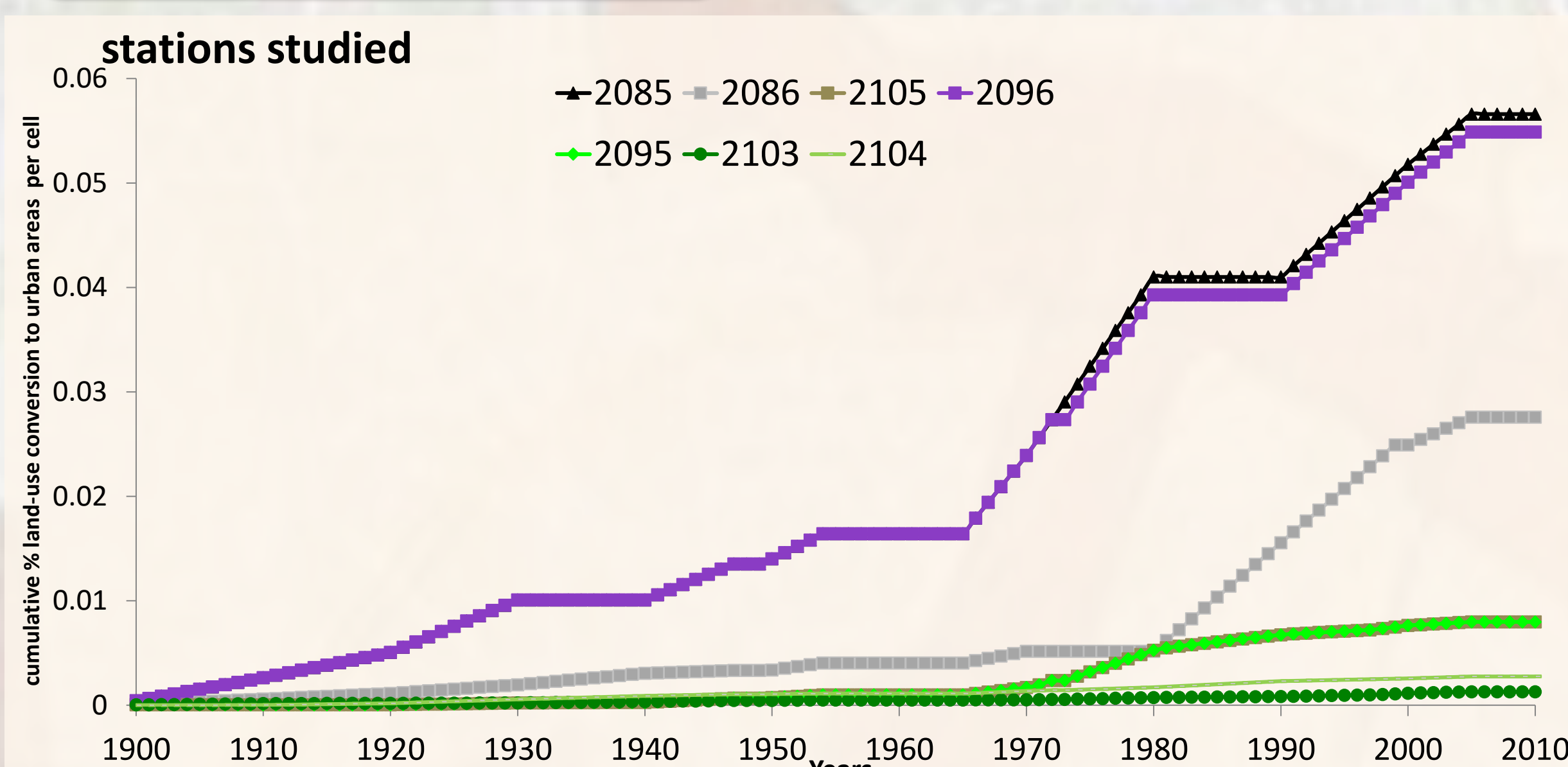


Global Map and the network of meteorological stations

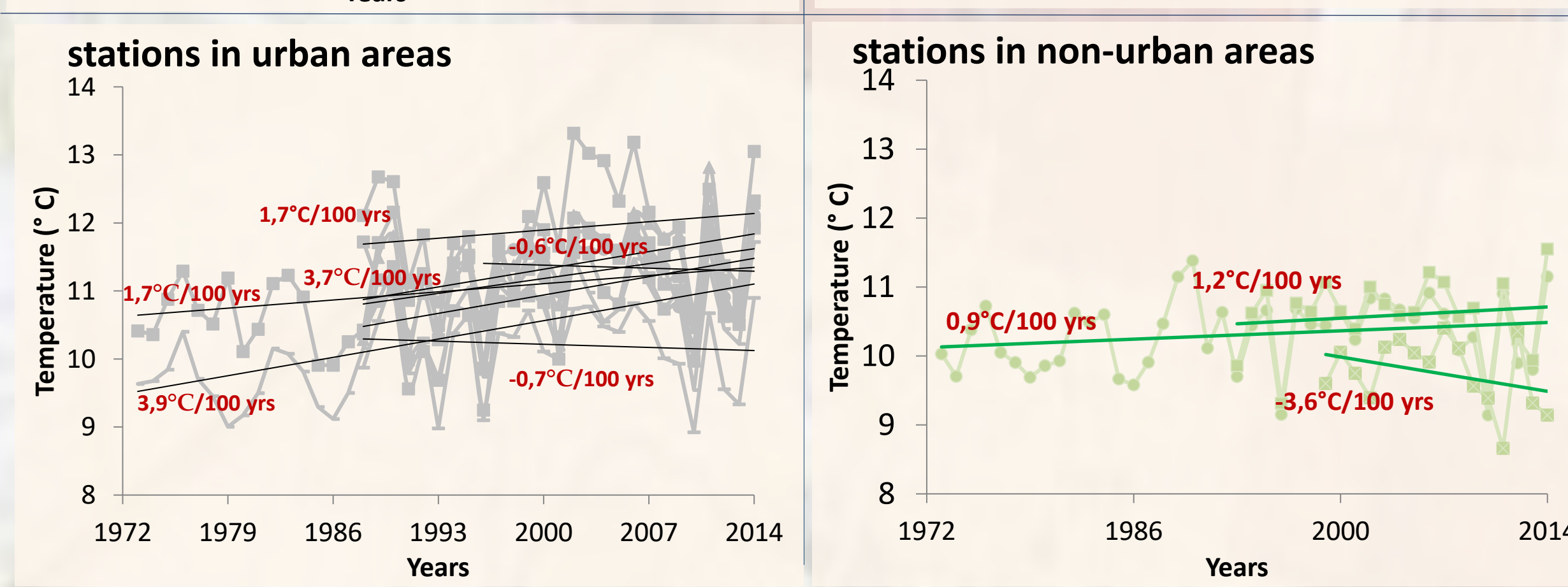
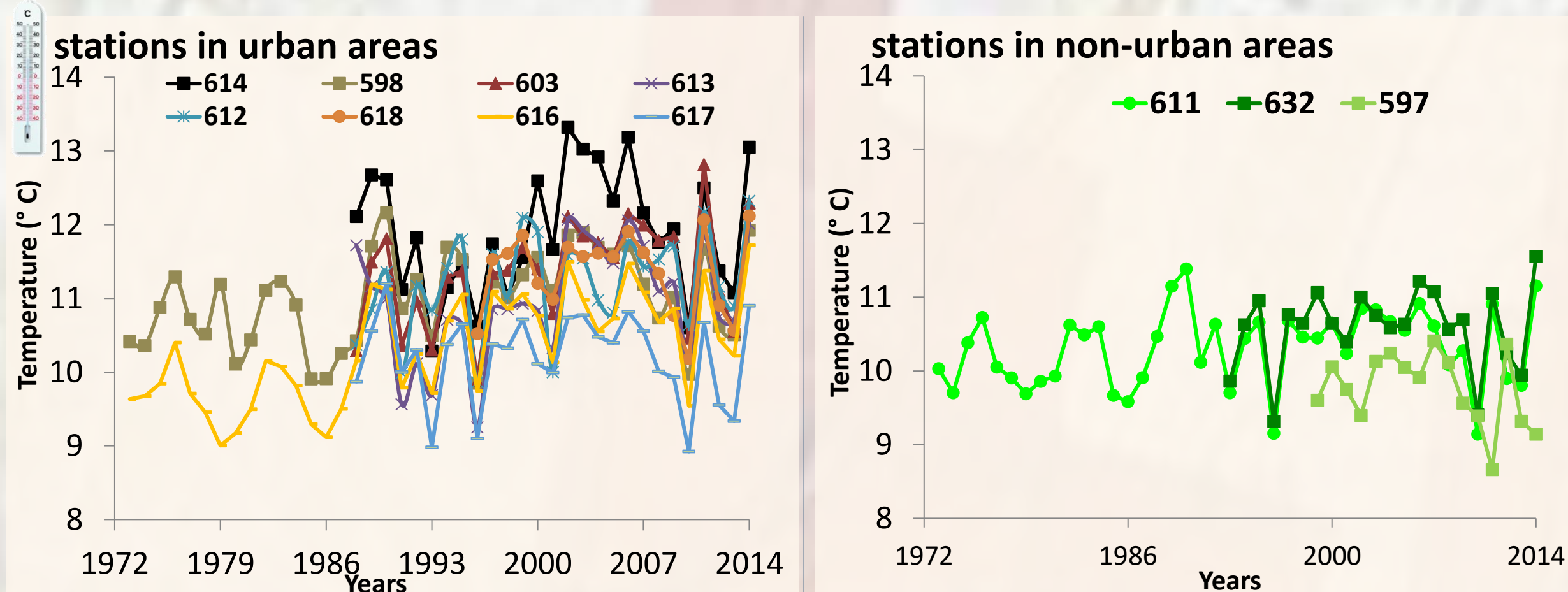
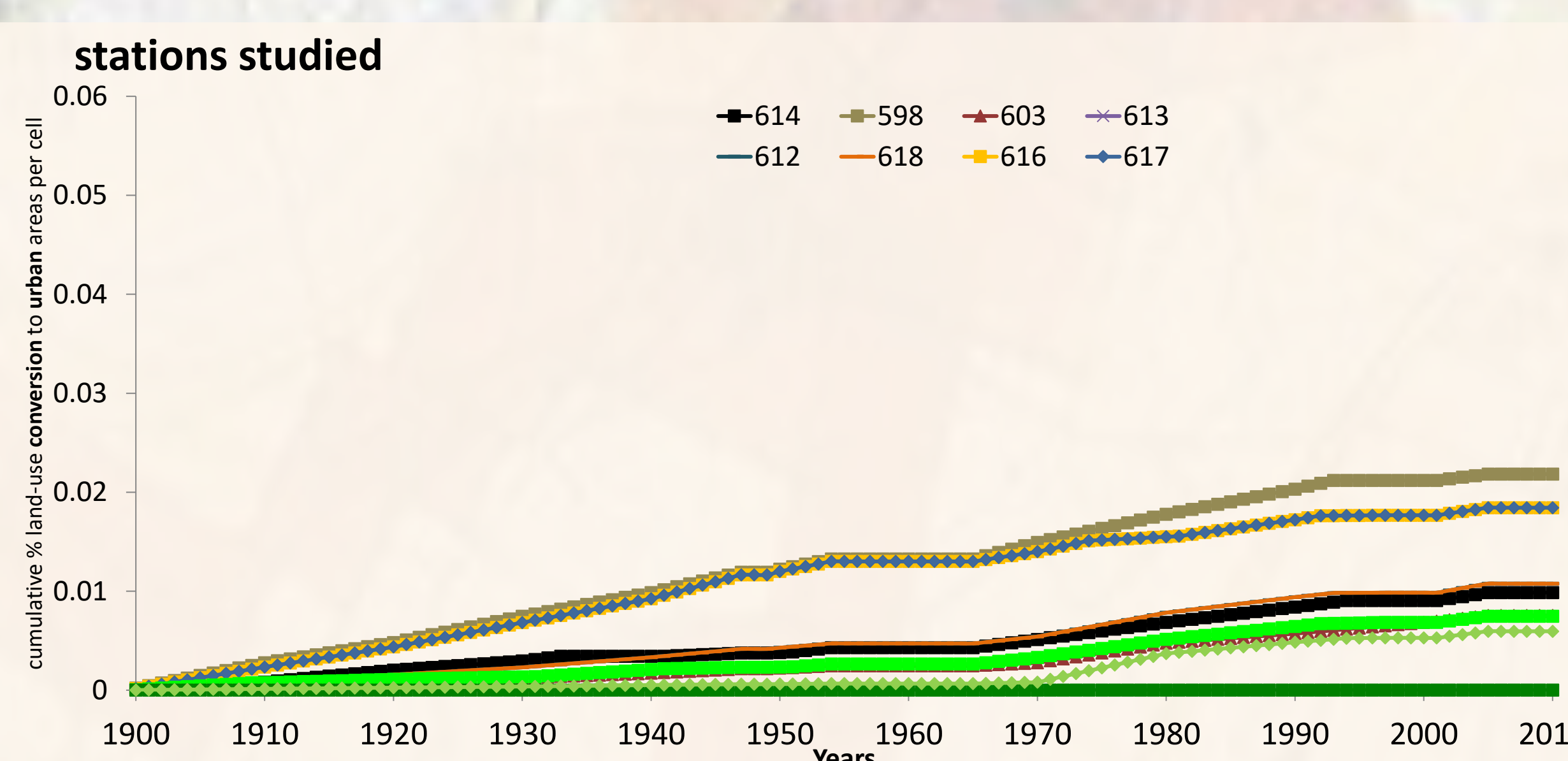


Results

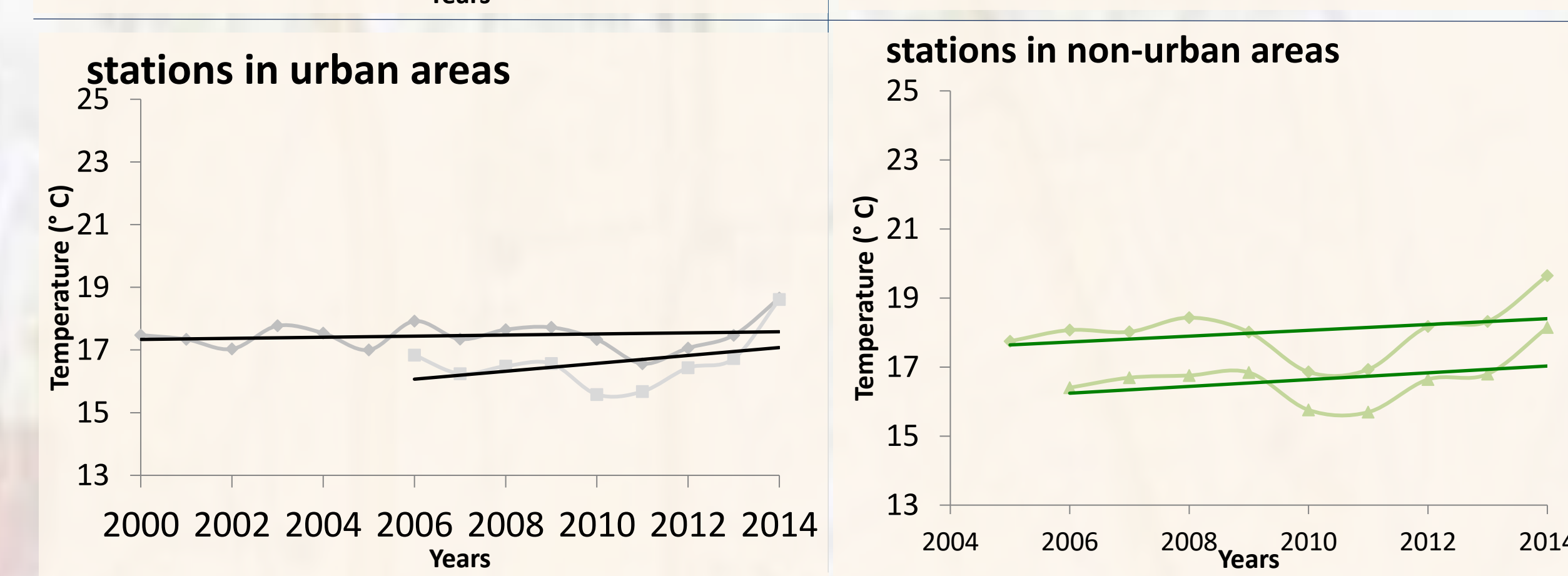
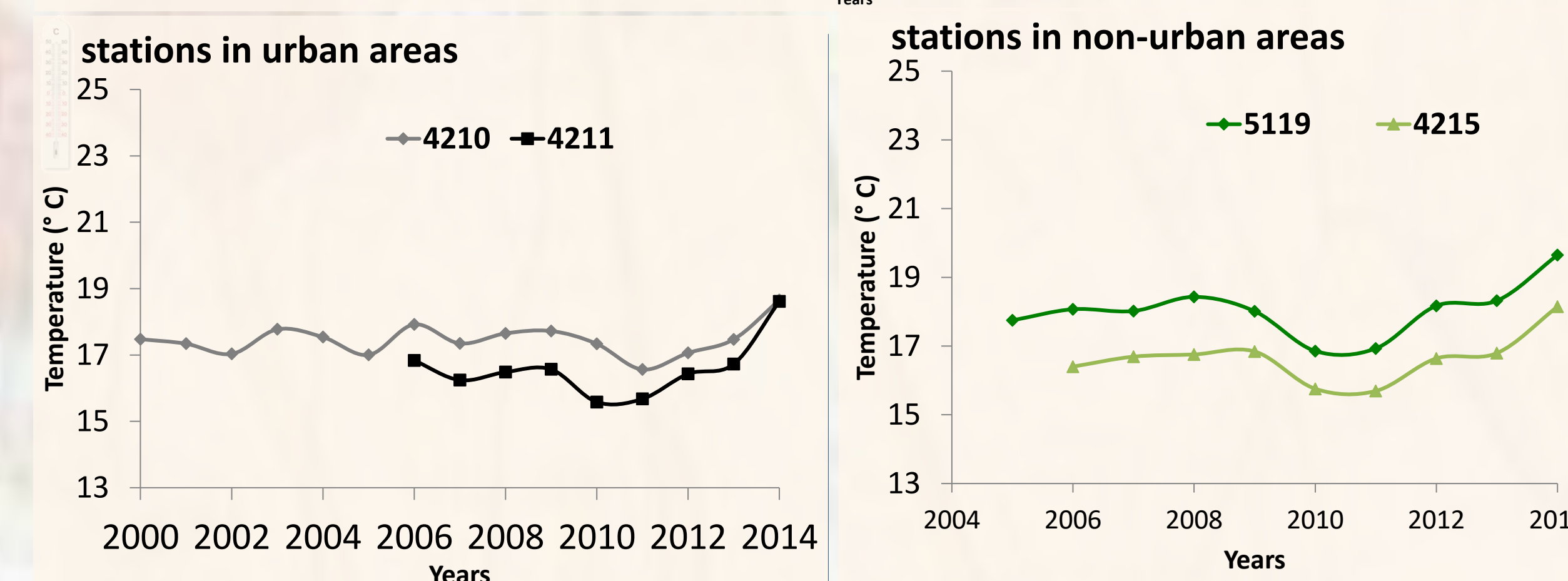
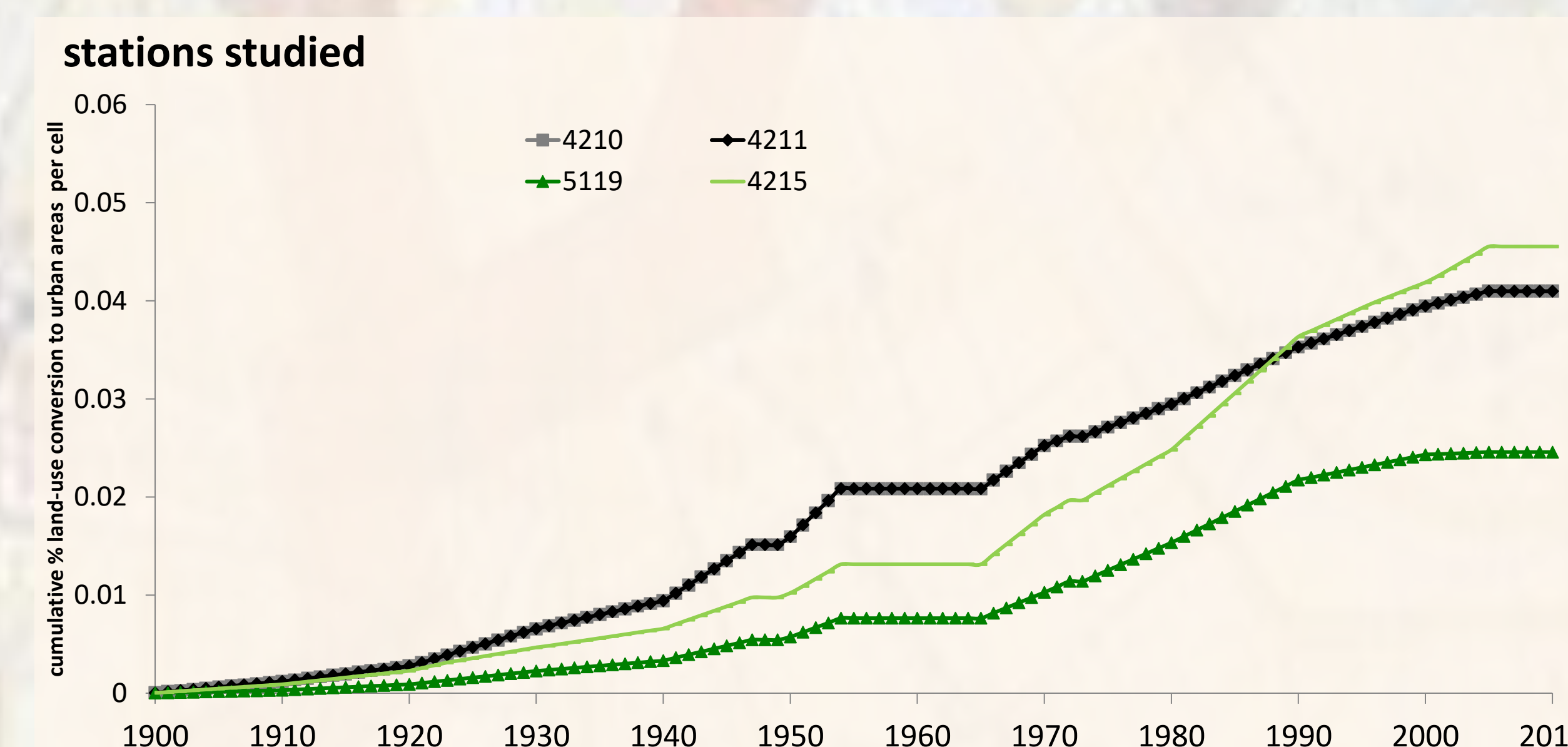
Tokyo



London



Los Angeles



Conclusions

- Urbanization has a significant influence on surface warming over study areas (heavily urbanized cities)
- Regional urban and non-urban temperature trends strongly diverse
- The microclimate of the urban area is not affected by the surrounding rural areas
- The Hurst coefficient is slightly larger in urban than in non-urban areas
- The differences between urban and non-urban temperature trends could be related to the urban heat island effect
- Potential Seasonal behavior → exploratory research
- Is the observed change in climate a really global or a resultant of local ones?

Bibliography

Dimitriadis P., and Koutsoyiannis D., 2015. Climacogram versus autocovariance and power spectrum in stochastic modelling for Markovian and Hurst-Kolmogorov processes, Stochastic Environmental Research & Risk Assessment, 29 (6), 1649–1669, doi:10.1007/s00477-015-1023-7.

Klein Goldewijk, K., Beusen, A., Van Drecht, G., & De Vos, M. (2011). The HYDE 3.1 spatially explicit database of human-induced global land-use change over the past 12,000 years. Global Ecology and Biogeography, 20(1), 73–86.

Lond E. R., 2010. Contiguous U.S. temperature trends using NCDC raw and adjusted data for one-per-state rural and urban station sets. Science & Public Policy Institute.

Yang X., Hou Y., and Chen B. 2011. Observed surface warming induced by urbanization in east China. Journal of Geophysical Research, Vol. 116, D14113.

https://www.ipcc.ch/publications_and_data/ar4/syr/en/mains1.html

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