# THE EFFECT OF THE CORINE LAND COVER CLASS APPLICATION AT MID-RESOLUTION WRF SIMULATIONS ON URBAN HEAT ISLAND

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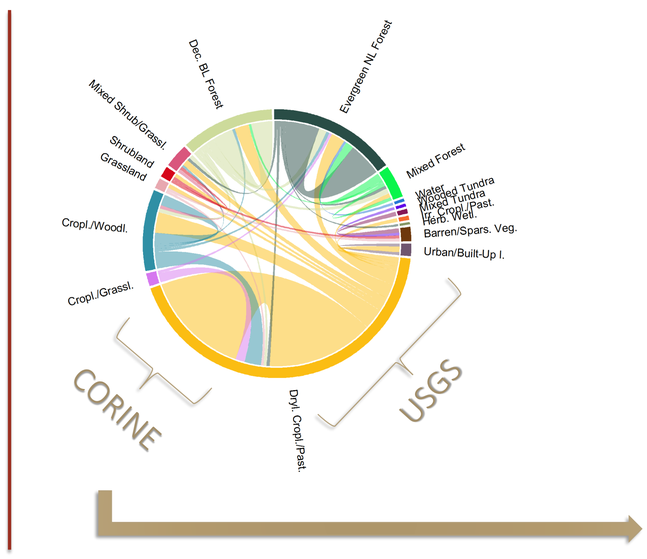
## CORINE LAND COVER

### USGS

- available in WRF
- 1 km resolution
- 28 categories
- 1 type of urban category

### CORINE

- incorporated in WRF
- 250 m resolution
- 44 categories
- 11 types of urban category




Overlap between **USGS** and **recategorized CORINE into USGS** (*Pineda et al., 2004*) land cover types by 2 km resolution for the European region (only where the incidence number of the category pairs is more than 6250).

On the outer band the areas marked in the same color represent in a clockwise direction first the USGS grid point ratio, followed by the CORINE grid point ratio.

The marked CORINE part represents the proportion of all the **USGS** Dryland Cropland and Pasture category that has the same type in the **recategorized CORINE into USGS**.

### CORINE to USGS

USGS Dryland Cropland and Pasture

- 57.3 % Dryland Cropland and Pasture
- 11.1 % Cropland/Woodland Mosaic
- 7.7 % Deciduous Broadleaf Forest
- 7.5 % Evergreen Needleleaf Forest
- 3.0 % Urban and Built Up Land
- 2.3 % Mixed Forest
- 2.1 % Irrigated Cropland and Pasture
- 2.1 % Grassland
- 2.0 % Shrubland

## MODEL SETUP

- WRF 4.2 (*Skamarock et al., 2019*)
- land surface model: Noah-MP
- data: ERA5 Reanalysis (*Hersbach et al., 2020*)
- 5 km horizontal resolution
- one year long (2013)
- **NO** urban parametrization sheme

### SIMULATIONS

- USGS: USGS land cover database
- CORINE: CORINE land cover database

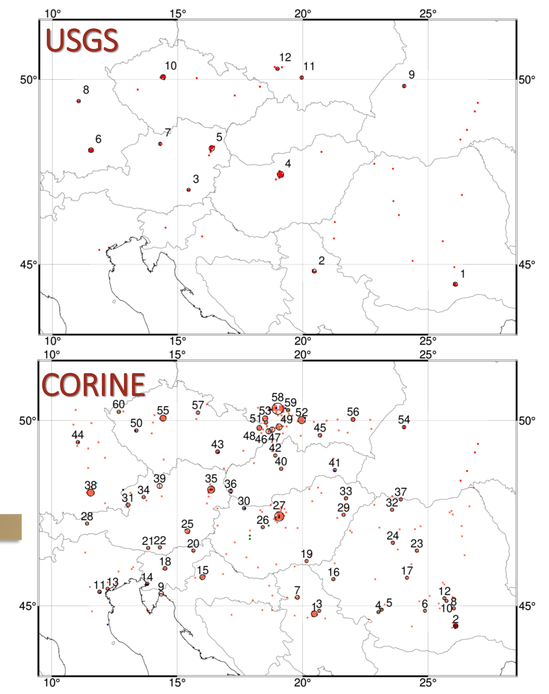
**Urban regions** were selected using the TITAN radar cell tracking method (*Dixon and Wiener, 1993*) with the following rules:

- by dominant land cover category
- a city consists of at least two grid points

**Rural regions** were selected from a double-size circle radius if there were no large altitude differences between the urban average altitude and the rural grid point.

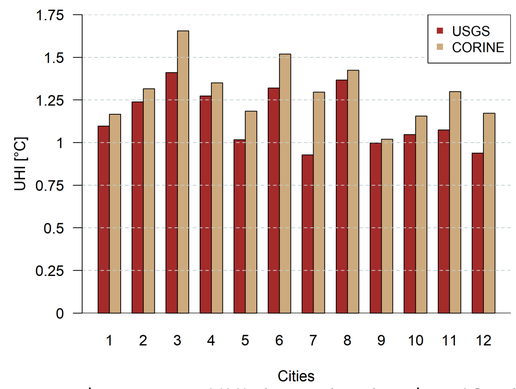
Using the CORINE land cover dataset 60 cities were indentified but only 12 cities from USGS were studied.

Incorporated 38 land cover classes to the WRF model as water classes are not separatable in the WRF routines.



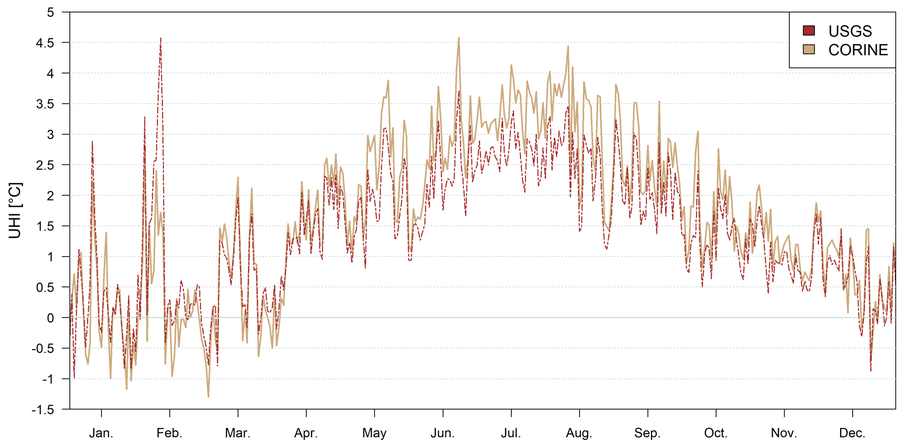

## ANNUAL AVERAGE UHI

UHI = urban mean 2 m temperature - rural mean 2 m temperature (21 UTC)



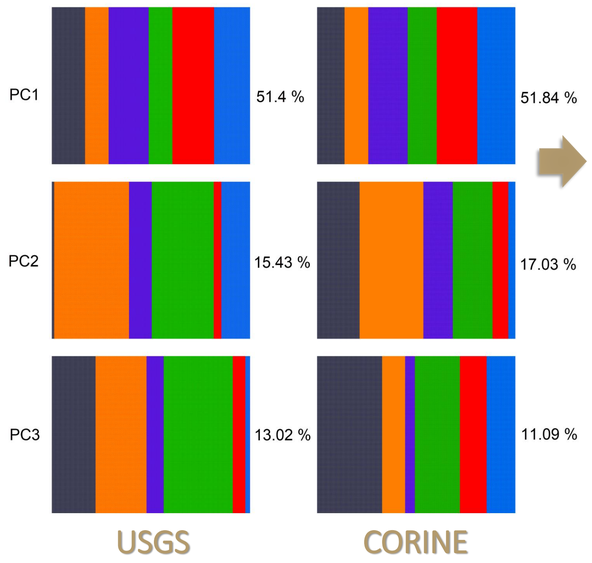

The annual average UHI intensity in the 12 cities according to the USGS and CORINE simulations.

## THE EFFECT OF THE CORINE LAND COVER ON UHI




Differences in the UHI (urban heat island) according to the USGS and the CORINE simulations in #3 city (Graz).

## PRINCIPAL COMPONENT ANALISYS




**Principal component analysis** (PCA) is a dimensionality-reduction method to search for patterns in a data set. Each principal component (PC) expresses the variance of the data set. The 1st PC contains most of the information of the whole data set, the 2nd PC the 2nd largest part etc.

Results of the principal component analysis of the one-year-long simulations. The variables are the differences between the urban and rural regions of the 2 m temperature (UHI), 10 m windspeed, albedo, soil moisture, sensible heat, and leaf area index.

The 1st PC expresses ≈51 % of the variance and the weights of the variables are nearly equal. ➡ **The 1st PC expresses the annual cycle**.

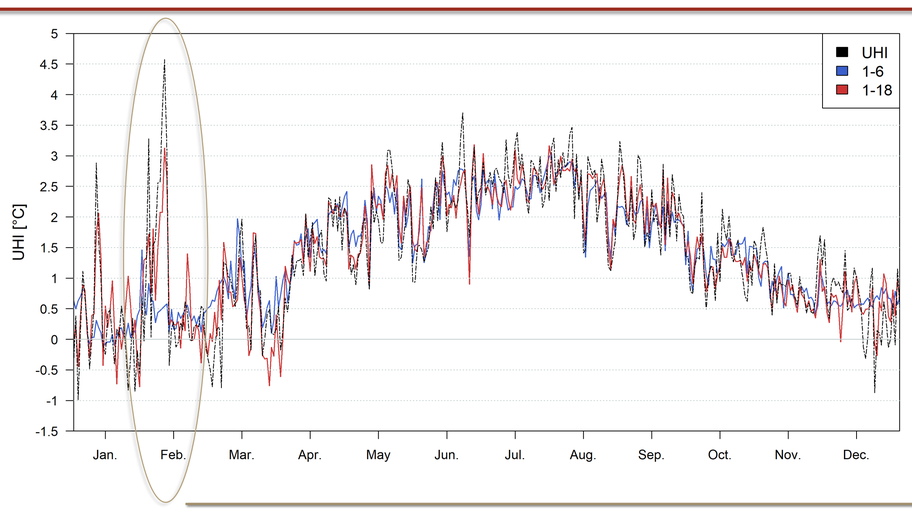
In the 2nd and 3rd PC variables with lower annual pattern (albedo, wind speed, soil moisture) have larger weight.

## PRINCIPAL COMPONENT REGRESSION

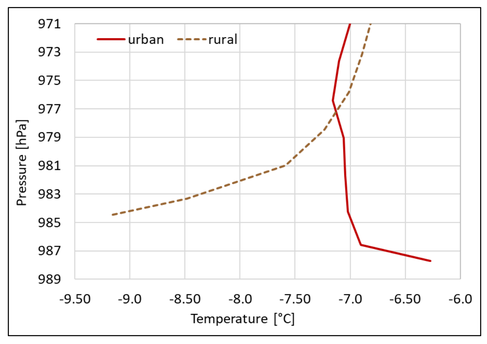
**Principal component regression** (PCR) is a regression method for correlated predictors.

The first step is a principal component analysis of the variables (sensible heat, latent heat, albedo, precipitation, etc.) which leads to uncorrelated predictors.

The second step is the regression: modeling the UHI with the PCs with the method of least squares.




Results of the PCR (for the #3 city from USGS simulation) with considering the first 6 PCs and all of the PCs (1-18). The first 6 PC express more than 90 % of the variance, but the model does not approximate the UHI well. Consideration of the last 10 % of the predictor's variance improves the model a lot.




The temperature profile for #3 city from USGS simulation on 10 February.

**High UHI values** appeared in the winter on days when the surface was covered with snow. The snow was thinner (or not at all) in the urban and thicker in the rural areas, resulting larger inversion in the surrounding regions.


## REFERENCES

CORINE 2012 landcover dataset © European Union, Copernicus Land Monitoring Service 2021, European Environment Agency (EEA)

Dixon, M. and Wiener, G. (1993) TITAN: Thunderstorm identification, tracking, analysis, and nowcasting – A radar-based methodology. Journal of Atmospheric and Oceanic Technology, 10, 785–797.

Hersbach, H., Bell, B., Berrisford, P., et al. (2020) The ERA5 global reanalysis. Quarterly Journal of the Royal Meteorological Society 146, 1999-2049.

Pineda, N., Jorba, O., Jorge, J., Baldasano, J. M. (2004) Using NOAA AVHRR and SPOT VGT data to estimate surface parameters application to a mesoscale meteorological model. International journal of remote sensing 25(1), 129-143.

Skamarock, W. C., Klemp, J. B., Dudhia, J., Gill, D. O., Liu, Z., Berner, J., Wang, W., Powers, J. G., Duda, M. G., Barker, D. M. and Huang, X. Y. (2019) A Description of the Advanced Research WRF Version 4. NCAR Technical Note NCAR/TN-556+STR 145 pp.



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