The impact of urban areas on various meteorological variables: The "urban meteorology island"

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Introduction

Urban Heat Island (UHI) – well-known, many of observation and modelling studies, our previous study

- Changes of wind speed, PBLH (also well confirmed)
- => Changes of dispersion (Fallmann et al., 2016; Huszár et al., 2018; Huszar et al., 2020)
- How about urban induced changes in other variables, e.g. humidity, cloud cover, precipitation, convection?
- Observation studies (Theeuwes et al., 2019; Manola et al., 2020) – cloud cover enhancement and increased precipitation in summer

Aims of study

- Investigate various urban impacts in model simulations (namely on cloud cover and precipitation)
- Show impacts over more cities (see city-independent impact)

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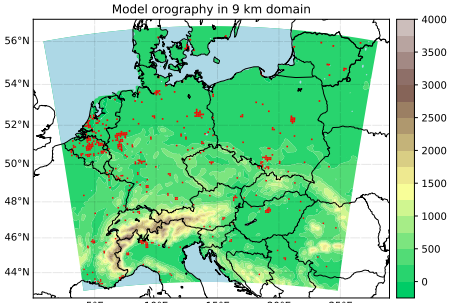
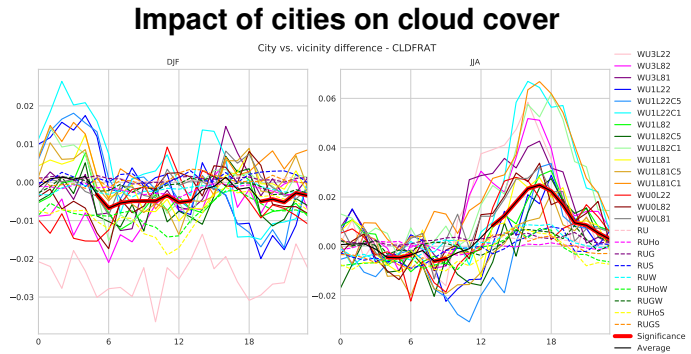
Model setup

- WRF 4.0.3, RegCM v. 4.7
- Domain: 190x166 grid-boxes, 9 km resolution
- 40 (23) vertical levels to 50 hPa
- Simulation timespan: 2015–2016 (2 years)
- Boundary conditions: Era-interim
- LU data – CORINE, v. CLC 2012



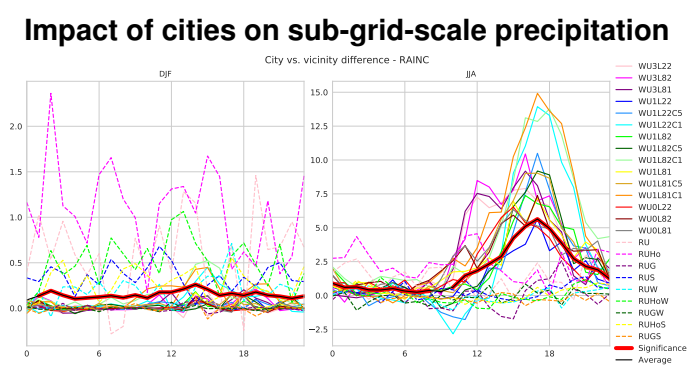
- WRF urban models: Bulk, SLUCM (Kusaka et al., 2001), BEP+BEM (Martilli et al., 2002; Salamanca et al., 2009)
- RegCM urban model: CLMU (Oleson et al., 2008)
- Different convection, PBL, SFL and MP schemes => 15 (WRF) + 9 (RegCM) = multi-model ensemble of 24 simulations

Main results



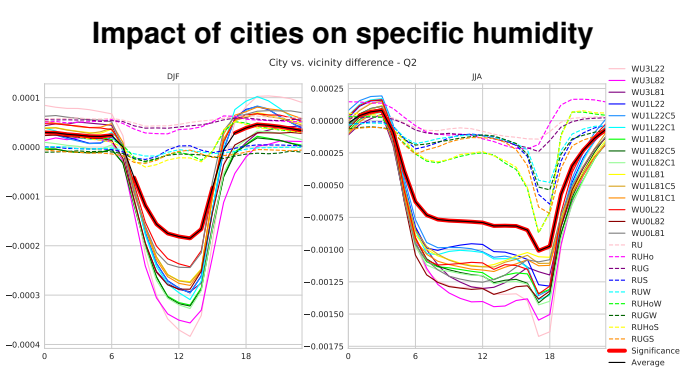
- Clear and statistical significant impact on cloud cover in summer afternoons
- In winter rather cloud cover decrease

Main results



- Very similar to cloud cover in summer afternoons (convection)
- In winter low increase of precipitation

Main results



- Decrease in day-times (lower evapotranspiration and water availability)
- Low increases in night-times (less dew in cities – lower water losses)

Summary

- Nearly all variables are significantly affected by urban surfaces
- Increased summer afternoon clouds and precipitation show to enhanced convection (in-line with observation studies)
- Previous studies – outside of UHI, many of other "islands" defined: **UDI, UCI, SUHI, UWI**
- Nearly all fields affected => generalization => concept of **Urban Meteorology Island (UMI)**, specific defined "islands" (UXI) considered as components of UMI

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Summary

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The "urban meteorology island": a multi-model ensemble analysis

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Abstract. Cities and urban areas are well-known for their impact on meteorological variables and thereby modification of the local climate. Our study aims to generalize the urban-induced changes in specific meteorological variables

1 Introduction

Climate is one of the most important factors that influences the conditions for life at a specific place. Considering the

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