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Evolution of the Viennese Urban Heat Island caused by expected Reduction of Vegetation Fraction in favour of Built-Up Land until 2030/2050

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The urban agglomeration of Vienna expects an increase in population by 10% until 2030 (ÖROK 2017) within a distance of about 50km to the city center. This will result in densification, increasing urban cover and a challenge to human comfort – which is presently already negatively affected by heat stress during the summer months. The aim of this presentation is to estimate the strain on thermal comfort for inhabitants living within the built structure, caused by an expanding and condensing urban agglomeration in the time frame 2030/2050 taking into account different development scenarios.
Simulations with WRF v3.7.1 (Skamarock et al. 2008) and WRF-UCM (Chen et al. 2004) are run for seven urban local climate zones (LCZs). WRF and the Town Energy Balance model TEB (Masson 2000) are coupled and run online for historical heat wave episodes. The coupled runs are used to force SURFEXv8 (Boone et al. 2017) offline simulations using parameter maps to define each grid point. During the year 2017 eight meteorological stations were added to the existing network in Vienna to be able to resolve all local meteorological conditions caused by topography and LCZs existent in Vienna. The comparison of simulations and measurements shows a good agreement in spatial distribution and diurnal cycles.
Urban development scenarios are being developed jointly with the Viennese city authorities considering the whole urban agglomeration reaching more than 50km beyond the administrative city borders. An algorithm is being created using planned development areas and development axes following major traffic routes, available building land, and expected small scale population increases as weighting masks to distribute the expected additional building volume. The first scenario is optimizing the city structure using ambitious position papers published by the city authorities including a dedication to denser buildings structures and permitting >50% green areas within administrative borders. The second scenario follows monetary impulses significantly sealing larger Vienna.
While dense structures are expected to decrease the radiation balance at pedestrian level, widespread urbanisation reduced latent heat flux, while allowing strong solar access, which causes the air masses entering Vienna along the main wind direction during daytime heat wave conditions (south-eastern axis) to heat up considerably. The presentation underlines the importance of a surface energy balance approach when addressing mitigation of urban heat islands.

Boone, A. et al. 2017: The interactions between soil–biosphere–atmosphere land surface model with a multi-energy balance (ISBA-MEB) option in SURFEXv8 – Part 1: Model description, Geosci. Model Dev., 10, 843-872.

Chen et al. 2004: Utilizing the Coupled WRF/LSM/Urban Modeling System with Detailed Urban Classification to Simulate the Urban Heat Island Phenomena over the Greater Houston Area. 5th conference on urban environment held at Vancouver BC, Canada, 23-27 August 2004.

Masson V. 2000: A physically-based scheme for the urban energy budget in atmospheric models. Boundary-Layer Meteorol. 94:357-397.

ÖROK 2017: www.oerok-atlas.at

Skamarock, W.C. et al. 2008: A Description of the Advanced Research WRF Version 3. NCAR. Tech.Note NCAR/TN-475+STR,113pp.