



EMS Annual Meeting Abstracts

Vol. 18, EMS2021-394, 2021

<https://doi.org/10.5194/ems2021-394>

EMS Annual Meeting 2021

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Parameterizing the impact of vegetated urban canopies on wind and temperature fields by using a simple nudging method

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Nudging is a simple method that aims to dynamically adjust the model toward the observations by including an additional feedback term in the model governing equation. This method is widely applied in data assimilation due to its simple implementation and reasonable model results. The basic concept of nudging is similar to that of urban canopy parameterization, in which additional terms are usually added in the conservation equations of momentum and energy aiming to simulate the canopy effects. However, few studies have investigated the implementation of nudging methods in urban canopy parameterizations. In this study we developed a multi-layer urban canopy parameterization (UCP) by using a nudging approach to represent the impacts of vegetated urban canopies on temperatures and winds in mesoscale models.

The difficulty of developing UCP by using a nudging method lies in defining appropriate values for the nudging coefficients and the forcing fields (e.g. indoor temperature fields for temperature nudging). To determine nudging coefficients, we use three major urban canopy morphological parameters: building height, frontal area density and building density. The ranges of these parameters are taken from the values for the Local Climate Zones datasets, in our case for the city of Hamburg. The UCP is employed in the three-dimensional atmospheric mesoscale model METRAS. Results show that this UCP can well simulate wind-blocking effects induced from obstacles as buildings and trees and urban heat island phenomenon for cities. Thus, nudging is an efficient and effective method that can be used for urban canopy parameterizations. However, as well known for nudging, it is not conserving energy. Therefore, we investigated the energy loss by tracking the reduced kinetic energy and internal energy. The UCP and model results will be presented.