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Convective cloud cover above cities of contrasting morphology

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The atmospheric boundary layer (ABL) is the turbulent layer of the atmosphere closest to the earth's surface. As such urban surface conditions (roughness and thermal)induce modifications that can strongly modified the ABL. The urban ABL can be studied using a atmospheric mixed-layer model and the local climate zone classification (LCZ's). These modifications can lead to more optimal formation of clouds which is the central question in our research.
The mixed-layer model assumes an ABL characterized by uniform virtual potential temperature, winds and specific humidity in the ABL. At the ABL top there is a jump in the virtual potential temperature and specific humidity, followed by a linear increase (respectively decrease) in the troposphere. Providing the right conditions, clouds can form a the ABL top. Here, we assume cloud formation to occur when the specific humidity at the top of the ABL is higher than the saturated specific humidity. Using a probability distribution, we account for convective cloud formation due to thermals.
LCZ's are uniform regions in cities, differing in surface cover, structure, material and human activity. By changing the values for the initial boundary-layer height, albedo, vegetation fraction, terrain roughness and anthropogenic heat output, five different LCZ's have been modelled (LCZ B, and LCZ 2, 6, 9,10). Our findings show that the heavily built areas have a relatively deep initial boundary-layer height due to the large sensible heat flux. During daytime, this large volume has to be warmed and this will lead to a lower virtual potential temperature. In consequence, the air will be saturated faster and cloud formation will occur sooner, since the ABL will deepen. A larger sensible heat flux will cause more thermals, that reach higher levels, will become colder, and thus more easily form clouds . For the five modelled LCZ's the cloud cover fraction varied between 6% and 15% and the time difference between the onset was almost 45 minutes.