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Large-Eddy Simulation of Urban induced Cloud Formation

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Cities affect their microclimate and mesoscale meteorology. Since worldwide urbanization is rapidly ongoing, it is key to understand these impacts to ensure environmental quality and provide on time weather forecasts for hazardous weather. Earlier studies found that precipitation patterns are altered by at least two factors, i.e. the urban heat island (UHI) effect and increased surface roughness. Cloud formation is less studied, therefore, this study innovatively utilizes the Large-Eddy Simulation technique to improve the understanding of these effects on cloud formation over and downwind of cities. In total, eleven simulations were conducted for meteorological conditions recorded at the Cabauw research facility during the EUCAARI campaign. Three reference cases considered an homogeneous rural domain for different background wind speeds: free convection (0 m/s), moderate (1.5 m/s) and high (8 m/s) wind speeds. The urban cases involve an UHI, drag parameterization and the combed effect. In the case of free convection the urban breeze circulations (UBC's) enhance cloud growth above the urban area. A moderate wind weakens these UBC's, but enlarges the cloud cover behind the urban area, rather than above the city. At higher wind speeds (3 and 8 ms-1) the UBC's are absent and for these cases no major changes in cloud cover were found. Drag, individually, resulted in higher cloud cover, mainly over the urban area, for the background wind speeds of 1.5 and 8 m/s.