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Impact of urban development on heavy summer precipitation in Hamburg Metropolitan Region

R. Schoetter, M. Linde, P. Hoffmann, and K.H. Schlünzen
Meteorological Institute, University of Hamburg, Germany (robert.schoetter@zmaw.de)

It is well known, that urban areas can modify precipitation due to their different roughness, thermal properties, and evaporation compared to rural areas as well as due to the emission of aerosols (e.g. Shepherd, 2005). In this study, the focus is set on the modification of heavy summer precipitation by the city of Hamburg in Northern Germany. Hoffmann (2009) and Schlünzen et al. (2010) have shown by analysis of rain gauge data that precipitation amounts are higher than the area averaged precipitation amounts at stations downwind of Hamburg. In order to quantify the impact of small scale changes in topography on heavy summer precipitation, the heavy precipitation needs to be simulated with an atmospheric model at a horizontal resolution in the order of 1 km. The mesoscale atmospheric model METRAS (Schlünzen, 1990; Schlünzen et al. 2012) is used for this purpose.
The selected meteorological situations cover all observed heavy summer precipitation events (more than 25 mm/d) in June-July-August within 1982 to 1998. The METRAS model is used to downscale the ERA INTERIM re-analysis data over three nesting steps to a domain covering Hamburg Metropolitan Region at 1 km horizontal resolution. Simulated hourly values of air temperature, specific humidity, wind speed, wind direction as well as simulated daily precipitation values are evaluated against routine station observations made by the German Meteorological Service.
The impact of topography on simulated heavy summer precipitation is investigated. The simulations are repeated without orography and with all non natural surface covers replaced by natural surface covers. Furthermore, the impact of plausible urban development scenarios (e.g. green roofs) developed within the projects KLIMZUG-NORD and CliSAP on heavy summer precipitation is investigated. The differences in heavy summer precipitation due changes in topography are compared to changes of heavy summer precipitation projected by regional climate models.

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