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A detailed radar precipitation analysis from hourly to seasonal time scales for the city of Amsterdam, the Netherlands

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Precipitation formation is an intricate process, influenced among other effects by extensive urbanization. The changes in the surface morphology, temperatures, energy balance, moisture availability, wind and aerosol composition may enhance or hinder the formation, intensities and duration of precipitation. Studies have shown that mostly large, dense cities (∼20 km radius) impact on precipitation (Schmid and Niyogi 2013). However, observational analysis over the Netherlands shows evidence that precipitation is modified even over substantially smaller cities of medium rise architecture with substantial green and open water bodies. The analysis shows that the total precipitation amounts over the Dutch urban areas are higher compared to the rural surroundings, with the largest differences seen in the summer, indicating an intensification of convective activity.

For the city of Amsterdam, a detailed statistical analysis of precipitation climatology is conducted from hourly to seasonal time scales. The data used are the Dutch hourly gauge-adjusted rainfall radar on 1 km resolution for the years 2008-2017, data from WMO weather stations, local urban stations and the 26 daily synoptic weather types (WT) based on the NCEP sea-level pressure data. A comparison of the Amsterdam urban area and two equal-sized rural areas north and South of the city shows that while the total precipitation in the city is higher, no considerable changes are seen in the extreme amounts. The possible urban alternations in the precipitation duration and frequency of occurrence are investigated, as well as the city precipitation patterns for the different wind directions. The diurnal cycle of precipitation does not show significant urban influence, while is interesting to notice that the diurnal cycle of Dutch regions close to the coast, including Amsterdam, differs compared to that of regions further inland, indicating a stronger maritime influence especially in the summer.

The climatological analysis shows that the majority of the extreme events in Amsterdam take place between May and September, with no significant preference on the time of occurrence in the day. The minimum amounts fall in April. The local wind conditions favoring precipitation are mainly of westerly and southerly directions, as those transport moisture from the coast inland. The synoptic conditions favoring extremes include mainly westerly winds over either cyclonic or anti-cyclonic systems, or purely cyclonic systems. This indicates a combination of both convective and frontal precipitation types.

Bibliography

Schmid, P.E., & Niyogi, D. (2013). Impact of city size on precipitation-modifying potential. Geophysical Research Letters, 40, 5263–5267