COM29 Climate in the urban environment

Extreme weather events as heat waves and excessive rainfall (downpours) will likely to become more frequent in the near future (IPCC 2007). This may form an important threat to the liveability in urban areas. Heat stress and flooding are already urgent problems for many cities in the world. At the same time, urbanization will continue. By 2030, more than 60% of the world population will be living in urban areas (80% for Europe). Facing the phenomena of climate change, city planners and architects have to develop adaptation strategies to mitigate the impacts of extreme weather conditions on citizens to ensure human well being outdoors and indoors.

Fig.1. More city 'green' as adaptation measure

Adaptation measures

Several measures to avoid heat stress or flooding in the urban environment have been proposed: for example more 'water' (canals, ponds), more 'city green' (parks, roof vegetation), spatial planning measures (changes in urban configuration and morphology) and adaptations at the building level. However, the effectiveness of these measures still has to be proven, or needs quantification.

Objectives

To assess the effectiveness of proposed adaptation measures, quantitative information is needed. Models designed to simulate the urban climate can serve as valuable tools to provide this information. Urban climate phenomena cover a wide range of spatial scales, varying from the mesoscale (the whole city and surrounding area), to the local scale (city quarter) and to the micro scale (street level) (Fig. 2). The project aims to develop a model framework covering these different scales of the urban environment in The Netherlands, in order to support decision makers, city planners and architects in their design of adaptation measures.

Urban climatology research in the Netherlands

Urban climatology has been studied for more than 30 years in many European countries and in countries like the USA, Japan, China, Singapore and Australia. However, until recently, urban climatology was not an issue in The Netherlands. This changed due to the heat waves of 2003 and 2006, which caused an excess mortality between 1400 and 2200 people. So, urban climatology research is 'new' for The Netherlands.

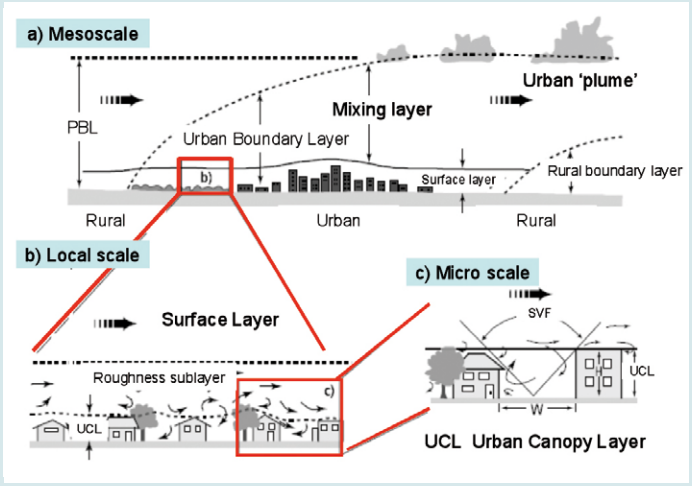

Fig. 2. Schematic of climatic scales and vertical layers found in urban areas. PBL – planetary boundary layer, UBL – urban boundary layer, UCL – urban canopy layer (modified from Oke, 1997).

Research questions

Many different urban climatology models have been developed. Their performance will be evaluated in the present study. Key questions are:

- What is the general model performance with respect to the urban environment?
- Can these models be easily modified to simulate the urban climate under Dutch climatic conditions, urban configuration and morphology?

Fig. 3. Representative meteorological observations at urban sites are needed

- How can useful and repeatable observational data be obtained to validate and parameterize the models?

To ensure realistic simulations, model results have to be verified against observations. Because urban environments are often very inhomogeneous, model validation and development of suitable parameterizations using meteorological observational data will be a challenging task. Therefore, the development of a proper measuring strategy is another important objective of the present study.

First results

The heat wave in July 2006 is an ideal case for the evaluation of models that are designed to simulate the urban climate. Figure 4 shows the first results of a model run in which the temperature and humidity in the city of Utrecht during these extreme conditions were simulated. The conditions in the city are compared with the simulated conditions in the rural environment. A temperature difference of approximately 5 °C between the city and the rural area was simulated. This is in agreement with the observations (Fig. 5). The observations also show a clear difference in humidity between city and surroundings.

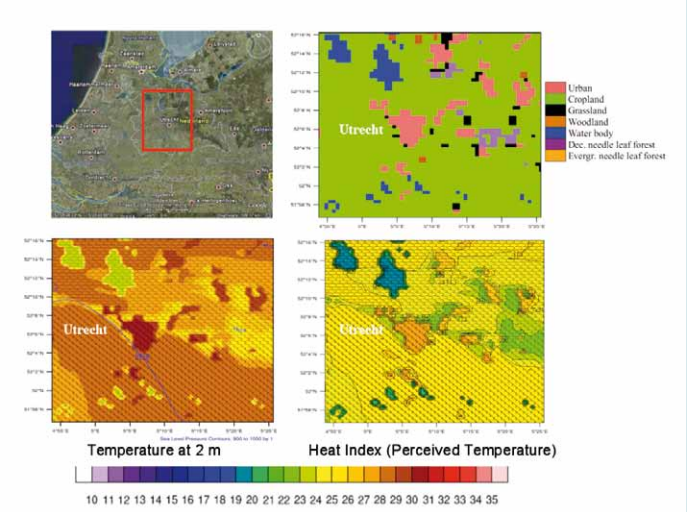

Fig. 4. Modelled temperature and heat index Utrecht area, 19 July 2006, 20.00 UTC

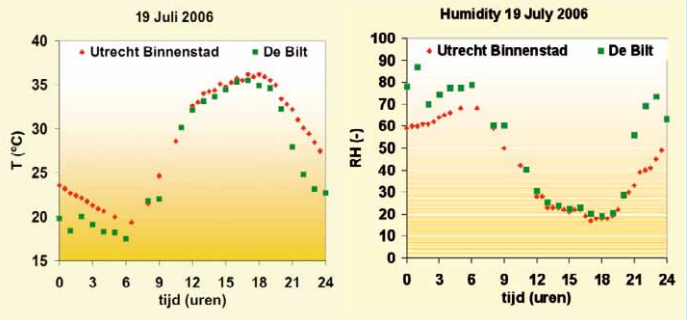

Fig. 5. Observed temperature (left) and relative humidity (right) in Utrecht (city) and nearby De Bilt (rural) for 19 July 2006

Activities

The present study has an explorative character. The main activities are:

- Review of the performance of existing models for urban climatology. We participate in the Urban Surface Energy Balance: Land Surface Scheme Comparison project (PILPS URBAN). This project started in March (2008) and is coordinated by the Department of Geography, King's College London www.kcl.ac.uk/ip/seugrimmond/model_comparison.htm);
- Limited data collection for initial verification purposes;
- Development of a modelling framework;
- An inventory of needs by city planners and architects;
- Development of a measurement strategy to obtain observational data.

Longer term perspective

The results of the study will be the starting point for more extensive research in a following project, in which:

- Meteorological observations at urban sites will be performed;
- The models will be further developed and implemented. It is important that integrated assessments can be made, including heat stress, water stress (excess and shortage) and air pollution.

Consortium

The study is conducted by the Meteorology and Air Quality Group (MAQ) and the Earth System Sciences and Climate Change Group (ESS-CC) of Wageningen University and Research Centre.
www.met.wau.nl, www.ess.wur.nl/UK
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