Royal Netherlands Meteorological Institute
Ministry of Transport, Public Works and Water Management

The application of high resolution weather forecasts in climate proofing

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In support of the Rotterdam Climate Initiative KNMI is studying the use of the next generation numerical weather prediction model HARMONIE for local weather forecasts and climate proofing in combination with a high density meteorological observation network provided by the municipalities in the Rotterdam Rijnmond region. Here the results of a preliminary study into the Urban Heat Island effect of Rotterdam are presented as an example of forecasting at a resolution of 500 meter and the effect of a detailed description of surface conditions.

1. Harmonie

HARMONIE has been developed in a scientific cooperation between the meteorological institutes of 27 European and North African countries. It contains a Town Energy Budget module that models the effect of the built environment on local weather.

The purpose of HARMONIE within a framework of adaptation is:

- to provide local weather forecasts that resolve the effects of the heterogeneity of the landscape;
- to analyze the observations from high density networks through data assimilation;
- to provide boundary conditions for engineering models used in the analysis of adaptation strategies by downscaling regional climate scenarios.

2. Urban Heat Island

2.1. Purpose

The Urban Heat Island effect may present an increasing health risk to citizens in a warming climate unless adaptation measures are taken that diversify the cityscape by the introduction of green and water. To analyze such measures engineering models need realistic forcings from weather models at the scale of a city and its surroundings. The quality of these weather models and their sensitivity to the resolution and accuracy of the description of the surface conditions may be assessed in the current climate.

2.2. Case study

July 20th was the last warm day of the summer of 2010 in the Netherlands. For this day a 24 hour forecast was made with Harmonie, version 36h1, at a resolution of 500 meters on a 1000x1000 grid.

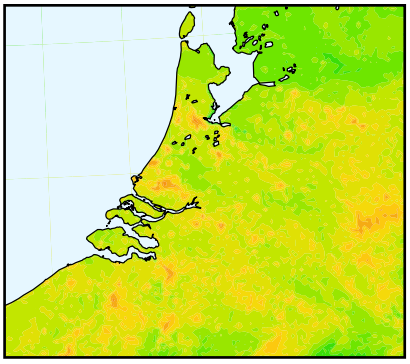
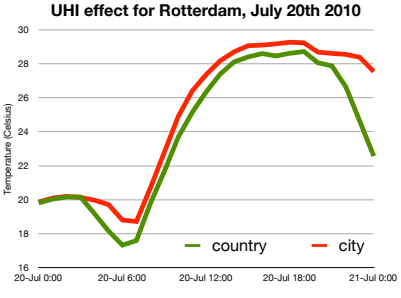


Figure A. *HARMONIE screen level temperatures for 21UT on the 20th of July 2010 (red is hot, green is cool).*

The metropolitan areas release their heat more slowly than the surrounding countryside. In figure A they can be identified by their red color. For the Rotterdam Rijnmond region this slow cooling amounts to 5 degrees Celsius.



3. Surface specification

The American Weather Research and Forecasting Model WRF uses a comparable town energy budget model. It offers greater flexibility in the specification of surface conditions and the use of alternative data sets. The UHI case study was repeated with WRF using two different land use classifications, one given by the US Geological Survey and the other derived from MODIS satellite data. The resulting temperature distributions given in figure B below show that the modeled UHI effect depends strongly on the land classification used and the resolution of the underlying data set. The interdependence of the surface modeling and the available data sets makes model calibration a challenge.

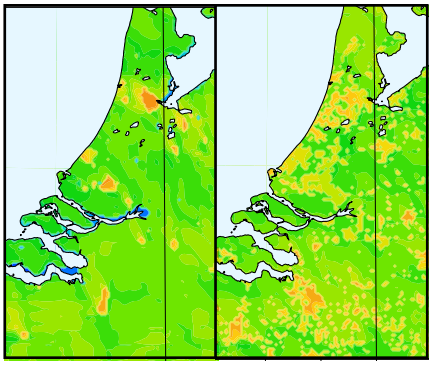


Figure B. *WRF screen level temperatures for 21UT on the 20th of July 2010 (left using the USGS, right using the MODIS land classifcication scheme).*

4. Conclusion

State of the art high resolution numerical weather predictions models are able to model the Urban Heat Island effect by using town energy budget models. An accurate prediction of this effect requires not only a calibration of the city effect modeling, but a thorough evaluation of the land use classification data used. This will also be of importance to the modeling of other weather events affected by surface heterogeneity, e.g. convective rainfall.

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