EMS Annual Meeting Abstracts
Vol. 15, EMS2018-600, 2018

Data assimilation of urban weather observations in WRF to model the urban climate of Amsterdam

Sytse Koopmans (1), Ronald van Haren (2), Gert-Jan Steeneveld (1), Natalie Theeuwes (1), Reinder Ronda (3), Remko Uijlenhoet (4), and Albert A.M. Holtslag (1)

(1) Wageningen University, Meteorology and Air Quality Section, Wageningen, Netherlands (gert-jan.steeneveld@wur.nl), (2) Netherlands eScience Center, the Netherlands, (3) Royal Netherlands Meteorological Institute (KNMI), the Netherlands, (4) Wageningen University, Hydrology and Quantitative Water Management, Wageningen, Netherlands (gert-jan.steeneveld@wur.nl)

Ongoing world-wide climate change and urbanization illustrate the need to understand urban hydrometeorology and its implications for human thermal comfort and water management. Numerical weather prediction models can assist to understand these issues, as they progress increasingly towards finer scales. With high model resolutions (grid spacing of 100m), effective representation of cities becomes crucial. The complex structures of cities, configuration of buildings, streets and scattered vegetation, require a different modelling approach than the homogeneous rural surroundings. The current urban canopy-layer schemes account for these city specific characteristics, but differ substantially amongst each other due to uncertainty in land use parameters and incomplete physical understanding. Therefore, the hindcasting of the urban environment needs improvement.

In this study, we improve the WRF (Weather Research and Forecasting) mesoscale model performance by incorporating observations of a variety of sources using data assimilation (WRF-3DVAR) and nudging techniques on a resolution up to 100 meter. Data assimilation aims to accurately describe the most probable atmospheric state by steering the model fields in the direction of the observations. Assimilated observations consists of WMO synoptic weather observations, volume radar data and urban weather observations recorded by hobby meteorologists.

Specific to urban boundary layers, a novel approach has been developed to nudge modelled urban canyon temperatures with quality controlled urban weather observations. Adjusting the urban fabric accordingly is crucial, because of the large heat storage within urban canopies. The road and wall layers of the urban canopy are adjusted depending on the bulk heat transfer coefficient and urban geometry. In addition, the representation of the anthropogenic heat release within the urban canopy model SLUCM is improved by incorporating this flux predominantly into the canyon instead of the first model layer above the canyon.

The subsequent data assimilation steps are evaluated for hindcasts of July 2014 for the Netherlands. July 2014 is characterized by both a warm dry period and two days with extreme precipitation (more than 100mm in two days). The largest improvement is made by assimilating the air temperature, dew point temperature and pressure from WMO synoptic stations. Assimilating additional radar data, slightly improves the location of the precipitation indicated by the fraction skill score. The data assimilation of urban weather stations, lastly, reduces the cold biases within the urban canopy which appeared in WRF.

Our final goal is to create a 15-year climatological urban re-analysis data archive of (hydro)meteorological variables which is named ERA-urban. This will enable us to trace trends in thermal comfort and extreme precipitation.