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WRF sensitivity to Urban canopy schemes: A Lisbon Case Study

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To study the urban effects in the atmosphere, the coupled modelling system Weather Research and Forecast (WRF)/Urban Canopy Model (UCM) (V3.3.1) was applied. Three simulations were performed using different UCM parametrisations namely, the active urban canopy model in Noah Land Surface Model (LSM), the Single-layer UCM and Multi-layer, Building Environment Parametrisation (BEP) scheme. In order to improve the land use and topography, the Corine Land Cover 2006 data and Shuttle Radar Topography Mission data where used.

These simulation were performed for a period with atmospheric conditions favourable to the development of a large urban heat island over the Lisbon region. The simulation started on July 29th 2010, at 00H00 UTC, and extended for the following four days. During this period, all the troposphere was characterized by strong atmospheric stability, except near the surface in the afternoon, due to intense radiative heating. The combination of stability-instability favours the development of intense gravity wave activity generated by the topography, which may induce instabilities. It is expected that differences in urban canopy parametrisations may give rise to differences in these gravity waves and, therefore, influence temperature and wind velocities fields. The urban generated gravity waves will change pressure gradients and heat fluxes which disturb the turbulent kinetic energy (TKE) budget interacting with the momentum, heat and moisture transport throughout the boundary layer. In fact, the comparison of the obtained results for the different urban canopies show the generation of the above mentioned gravity waves. Taking the LSM as the reference simulation, the Single-layer produces less TKE when compared with BEP results.

It can be observed that the urban canopy will not only affect the boundary layer but may cause perturbations throughout the troposphere up to the tropopause. These gravity waves can interact with the topographically generated waves, changing their phase and amplitude.