Modeling of urban atmospheric boundary layer structure

A.F.Kurbatsky

Institute of the theoretical and applied mechanics of the Siberian Branch of the Russian Academy of Science
Novosibirsk
E-mail: kurbat@nsu.ru

The problems connected to a city climate are examined. They include:

- The urban atmospheric boundary layer (UABL): spatial-temporal scales of the phenomena, city as a source of mechanical and thermal heterogeneity,
- The urban fluid mechanics (UFM): air circulation above the urbanized surface, air pollutant dispersion,
- The mesoscale ABL model: the third-order closure turbulence model, the modeling of urban ABL structure, numerical tests.

Habitats of humans and other forms of life (the 'biosphere') are located within the atmospheric boundary layer, the study of which is of key importance in UFM. The main reason for complexity of urban air quality lies in the distinction of spatial-temporal scales over which the phenomena occur. Two important scales represent:

a) The 'urban' scale of a few tens of kilometers (i. e., a normal city size) where there large amounts of primary air pollutions are emitted,
b) An ‘meso’scale of a few hundreds of kilometers where the secondary pollutions are formed and dispersed.

In this paper, a third-order closure model of thermally stratified turbulence is formulated. The numerical results of modeling of an urban heat island structure in the critical meteorological period (weak wind, stably stratified atmosphere) are presented. The model is able to reproduce the tracer dispersion features that are usually observed in measurements. The new third-order closure model was introduced into a mesoscale model and tested on a simple 2D case characterized by a domain 120 km wide with flat terrain a city 10 km in the centre of the domain. The formation of structural features of wind and potential temperature fields above the city are obtained in agreement with the measurements and calculations.