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COMPUTER MODELLING OF THERMALLY-DRIVEN MICROCLIMATE PHENOMENA

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ABSTRACT. Thermal buoyancy is one of the key factors governing the local microclimate especially over terrains encompassing natural and man-made heat or cold islands in warm climate with prolonged summer heat waves, as well as in temperate areas during winter windless episodes capped by inversion. Eye-catching orderly patterns such as vertically spiralling moisture columns and undulating fog patterns observed over lakes and large rivers at elevated surface temperature arouse public and research curiosity, but the understanding of the underlying physics and identifying the effects of such events on the human comfort and local air quality still pose a challenge. This paper provides a brief overview of the current strategies in computer simulation and modelling of buoyancy-driven microclimate phenomena. The niches and limitations of the large-eddy simulations (LES) are briefly discussed and the focus is turned to the Reynolds-averaged Navier–Stokes (RANS) methods currently prevailing as the most rational approach for predicting microclimate over realistic terrains and urban canopies. A time-resolved ensemble-averaged (T-RANS) three-equation algebraic stress/flux model (ASFM k–ε–θ^2) with the novel buoyancy-accounting functions for the ground boundary conditions, validated in a range of generic and engineering buoyant flows, is shown to reproduces the orderly structures observed over a real urban terrain with a large river acting as a strong localized source of heat and moisture. The model was subsequently applied to study the river-induced seasonal variation of the traffic-emitted CO distribution over the same city showing acceptable agreement with the field measurements.