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Mean radiant temperature modeling, a comparative model evaluation

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As a result of the changing climate with trends of rising temperatures and increasing extreme heat events, urban planners and city officials have recently taken a great interest in improving the climate of cities and maintaining comfortable outdoor conditions in spite of these trends.

In order to meet the demand for this special knowledge and to deliver scientific assistance, several numerical models have emerged with an aim to assess the microclimate of cities and their influence on human thermal comfort over the course of the past decade. While these tools differ both in the human thermal comfort indices they deliver and in their numerical modeling approach, they all rely on the calculation of mean radiant temperature—the driving parameter of outdoor human thermal comfort. While the assessment of models lags behind the perpetual software updates and releases, the documentation of many such models is also lacking or insufficient. In addition, a great deal of existing validation studies assess clear cut situations where the site is either sunlit or in shade, whereas conditions in the urban environment are generally more complex. Given both the growing importance the outdoor thermal environment of cities and the role played by these tools, reporting on their performance is of high importance.

The aim of this study is to assess the ability of several recently emerged or updated microclimate models to reproduce mean radiant temperature (Tmrt) in a complex urban setting. The evaluation is made against field data obtained by integral radiation measurements. Results indicate that most microclimate models underestimate Tmrt both at sunlit locations and at night, whereas in shade Tmrt is generally overestimated. These errors are related to the surface temperature parametrization, the isotropic sky assumption, simplifications in the reflected shortwave radiation calculation and the incorrect representation of a standing person.