

## ***Interactive comment on “Modelling studies of wind field on urban environment” by K. Radics et al.***

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### Introduction

The paper reports on some new data sets on urban wind data from Hungarian stations. As the field of urban meteorology is only relatively young and not too many data sets are available for the purpose of testing models and similar tasks, this paper certainly makes up a welcome contribution. This short comment aims at putting it into some broader context and pointing to some of the pieces of information that could be added to increase its value significantly.

Urban climatology - what is different?

Traditionally, climatology seeks to provide information on the temporal and spatial distribution of climate variables such as temperature, humidity or pressure. Speaking of

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wind speed, any observational strategy to obtain such information is quite straight forward since the World Meteorological Organization has defined the reference height for wind observations to be 10m above ground and a station has to be placed at a spot with an undisturbed fetch of a certain, also well-defined distance. These requirements are obviously impossible to meet in an urban environment and people have used different "tricks" to overcome the problem. As far as the observation height is concerned, some stick to the 10m above ground and some replace it by 10m above roof level. The first choice is obviously difficult if buildings and obstacles are getting higher than a few meters, i.e. in most major cities anyway. And the second choice has the same flaws in principle – but they are less obvious at first sight. As far as the fetch is concerned, most people simply ignore the requirement of an "undisturbed" fetch for observations in urban environments completely. More adequately, some replace the "undisturbed" fetch by a quasi-homogeneous fetch meaning that the city structure should be approximately constant over the fetch of the observation (see Grimmond and Oke 1999 for a detailed discussion on quality of urban data including fetch considerations). Note that the fetch (or footprint) for an observation is dependent on the observation height and the boundary layer stability (e.g. Kljun et al. 2002) and hence different for each level in a profile.

### Height considerations

The problem with urban observations is strongly related to the development of a roughness sublayer (RS) close to the surface. This layer, wherein the flow is directly influenced by individual roughness elements is presently thought to range up to 2 to 5 times the average building height (but its height is equally dependent on the roughness element density – e.g., Raupach et al. 1991). Some of the features of turbulence and flow characteristics are summarized in Rotach (2001). While it would be preferable (since representative) to observe wind speed (and other climate variables) above the RS (Rotach 2002), this is often not practical, at least not if buildings are higher than a few meters. As one of its goals, therefore, Working Group 1 of COST 715 (Meteorology

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applied to urban air pollution problems) seeks to establish a concept for a reference height for wind measurements in urban areas (Rotach et al. 2000). This goal is approached via several pathways. One is to investigate empirical relations between urban wind speed (irrespective of observational height) and rural reference wind speed (at the 10m, undisturbed reference site). First approaches in this direction can be found in Soriano et al. (2003). Another approach tries to employ knowledge on the RS turbulence structure (Rotach 2001) to revise the near-surface log-linear wind relationship (due to Monin-Obukhov scaling) in the urban RS. As for the time being (no suggestion has yet been put forward for a definition of an urban reference height for wind observations), this means that the information on the city morphology has always to be provided when discussing urban wind observations and simulations. In the paper of Radics et al. this means that in order to qualify their data it is necessary to include information on the height and distribution of buildings (and other roughness elements such as trees) in the area of investigation. Together with the information on the observation heights this allows the reader to judge possible influences of RS effects or their importance. For example in Table 2 the built-up category could be supplemented with the information on average building heights and density. Similarly, some comments could be made concerning the actual set-up of a 10m wind observation in the dense built-up environment of Budapest (observations in street canyons or parks?). Concerning the second site (Hegyhàtsàl) it is not even clear to the reader whether this is an urban site and if so, again, what the characteristics of the urban morphology are. If Hegyhàtsàl is a city's name (and I deeply apologize my ignorance in this respect), how far into the city (or how far away from the city) were the measurements performed? Can any statement be made concerning the different fetches at the various levels of observation? Do all the levels see similar urban surface characteristics?

Some more specific comments

I suggest the title to be changed into "Modelling studies of the wind field in urban environments".

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For the discussion of the wind profile: The authors decided to present their data in terms of frequency distributions (Figs. 7 and 8). According to me this is not very helpful to investigate the characteristics of the wind profile. However, it can be used to infer certain statistical properties of the wind at different heights. For example, it is interesting to notice from Figs. 7 and 8 that for 10m-wind  $> 4\text{ms}^{-1}$  (right columns) there is a considerable percentage of observations at higher levels that read clearly lower (on the order of 10% of the readings are below  $3\text{ms}^{-1}$  at the highest level for both months). Can these cases of unusual decrease of wind speed with height be related to certain wind directions? And if so, to certain (upwind) surface characteristics? Or possibly to tower shadowing at certain levels on the tower (clearly, the 48m level must exhibit tower effects in the observations – probably regardless of the direction of the approaching flow)? Would the WASP modelling efforts shed some light on these questions? Are these cases of a low-level jet (which has not, to my knowledge, been observed until now in urban environments)?

Concerning the WASP simulations: In Fig. 9 an additional panel should be added to show the distribution of the mentioned surface categories, in particular the urban part of the surface (due to the overall theme of the paper). Then, the case study should be more clearly identified. What time span does it comprise? What is the averaging? And finally, what is the overall synoptic situation (at least wind direction – interesting relative to the urban area)? And finally: what is the fine resolution of the terrain model (1000m)?

In Fig.10 and 11: again, the information cannot be appreciated if the wind direction is not given.

What is the steepness of the terrain? [obviously, Figures 10 and 11 are exaggerated in the vertical]. WASP is made not for too steep terrain.

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