GMD-2012-31

Response to Referee1's comments

This paper presents a new physical formulation of urban vegetation implemented in the TEB model for better simulation of urban microclimatic conditions. The new physical ingredient is clearly described mainly focusing on radiation partitioning process, and the numerical coupling approach is sound and neat. The new version of TEB was validated comparing with proper field measurements obtained from different urban configurations of artificial and natural surfaces. A key feature of this paper is to include in-canyon vegetation in the TEB as an important factor, suggesting a proper coupling strategy.

This manuscript is well organized and reads well. It also includes valuable scientific information with respect to the effect of the new physical ingredient and model's development strategy. There were only a few studies regarding the effect of in-canyon vegetation in mesoscale modeling. This study might help scientific community of interest to model the microclimatic effects of urban soil and grass surfaces with rather simply (but scientific) way.

It is recommended that this manuscript should be published in GMD subject to minor corrections below.

Specific comments

P1296, L2-6: This part might be moved to introduction.

We did not modified this part of the abstract because this point is already covered in the introduction (1st paragraph) but in a different way.

P1296, L7: Write TEB in full at first appearance. The same is applicable to ISBA.

OK

P1296, L10-11: It seems better to simply describe the coupling between TEB and ISBA as done in the paper, even though the suggested formulation is neat in terms of the coupling.

We modified the text in accordance to the comment. But we left a sentence to specify that another SVAT model than ISBA could be easily plugged into TEB.

P1296, L13-14: The sentence does not read well.

We modified this part.

P1296, L15-20: Some description of quantitative results might be good in this part. In addition, the differences (or model's performance) in simulated surface energy balance fluxes might be useful because the TEB was originally developed for calculation of the surface fluxes required in mesoscale models.

It did not seem necessary to add quantitative values in the abstract not to make it too long/heavy.

P1296, L25: 'varying' □ 'different'

OK

P1296, L26: Short description on what ‘microclimate’, repeated many times in the paper, means will be good for clarity. It seems that the authors intend to specify the air temperature and humidity of an urban canopy in the paper.

We clarified in the text that we were talking about meteorological variables at street level.

P1298, L3-4: What is that important for? The reviewer does not think the comparison between the different approaches only motivate to include in-canyon vegetation parameterization in urban canopy model. Even though that is good reason accepted, it might be quite difficult to canonically (or even physically) quantify the difference between the two approaches due to uncertainties involved both with model physics and measurements. Fig. 4 will be an example that shows difficulty in assigning model parameters (e.g. H/W) for running the separated approach TEB-ISBA version, limiting to draw solid conclusions regarding this issue. As authors described in the manuscript, it might be true that the integrated approach is superior to the separated approach in representing real urban patches if the urban area includes vegetation in the courtyard. Recent studies by Lee and Park (2008) and Lee (2011) show reasonable performance in simulating both in-canyon air conditions and surface energy balance fluxes for vegetated urban areas using an integrated scheme VUCM, implying the importance of realistic representation of urban artificial and natural surfaces in formulation. Though it is interesting that this paper supports the usefulness of an integrated approach in modeling in-canyon atmospheric conditions to some extent through comparison with field measurements, some limitations in the comparison need to be noted.

Lee (2011): Further Development of the Vegetated Urban Canopy Model Including a Grass-Covered Surface Parametrization and Photosynthesis Effects, Bound.-Layer Meteor., 140, 315-342.

It should be quite relevant to study the impact of this new parameterization for other meteorological conditions. We add a comment in the last paragraph of the conclusion.

P1298, L5: Write the acronym SURFEX in full here.

OK

P1299, L7-8: The sentence is not clear.

We clarified the text.

P1299, L14: Put the references (Grimmond et al., 2010, 2011) here, or revise the preceded sentence.

OK

P1300, L4: ‘subgrid-scale mix’ ?

We changed “mix” by “heterogeneity”.

P1301, L13: ‘according’ □ ‘proportional’

OK

P1301, L23-24: Please use references for separation of ‘any versions of ISBA’. Words in the parenthesis do not read well.

OK

P1302, L22-23: ‘coming from the sun finally stored by’□’reached at’, ‘computed in’□’computed in a way shown in’
OK

P1303, L3: ‘infra-red’ □ ‘longwave’
OK

P1305, L13: ‘2009) resolves’ □ ‘2009). It resolves’
OK

P1305, L15-16: What are ‘vertical effects’? Please clarify it, or delete the lines.
We modified the text to explain that we take into account the influence of buildings on the local atmospheric characteristics.

P1307, L13: ‘Obukhov’
OK

P1307, L22: ‘SBL version of TEB’□’TEB-SBL’
OK

P1308, L23-26 and P1310, L10: Meteorological forcing is generally very important in the determination of canopy air temperature and specific humidity in urban canopy models. Fig. 3 shows very different morphological arrangements of obstacles (buildings and trees) near the measurement site and the meteorological station. More explanation on meteorological forcing calculation (say, uncertainty if measureable) would be helpful to interpret the results (ex, specific humidity in Figs. 5 and 6).
The conditions for the synoptic wind are comparable at the two sites (meteorological station and courtyards) : they are about 1 km apart, and the meteorological station is located upwind (with respect to the typical wind direction in the afternoon and evening).
For the other variables, the correction method that is applied here (and described in details by Lemonsu et al. 2012) allows to build the forcings above the roughness sublayer. The forcings are assumed to be in the constant-flux boundary layer and comparable between the two sites.
Finally, the differences in the morphology of the area adjacent to the courtyards and to the meteorological station, especially within the fetch, is accounted for in TEB by means of the aerodynamic characteristics of the sites, such as roughness length and displacement height.

P1310, L8: 0.012 m in Table 2. Please check the value.
OK. The right value is 0.002 m.

P1311, L26: ‘weak’□’small’
OK

P1312, L24: ‘excedd’□’exceed’
OK

P1313, L7: Please revise the sentence clearly.

We clarified this part.

P1313, L8-9: What is the error in the observation? Is that accurate enough to ignore bias attribution?
For this experiment, the humidity measured at the meteorological station is unusually dry between 06 and 16 LST (less than 6 g kg-1). Normal values for summer with wind from the northwest are about 10-12 g kg-1, that corresponds to the values recorded for the other experiments. We cannot explain the sharp drop in specific humidity at the meteorological station except possibly as an error in measurement.
In order to assess the sensitivity of the model to the humidity forcings, we also rerun the experiment by forcing the model by using the specific humidity measured inside the courtyard. There is not significant differences in the results of the model (surface temperatures, air temperature, and wind).

P1314, L1: ‘to’□’too’
OK

P1316, L22: ‘concrete’□’concrete road’
OK

P1316, L23: ‘that’□’than’
OK

P1318, L12: ‘received by’□’flux received at’
OK

P1318, L15: ’irradiation’□’irradiance at the surfaces’
OK

P1320, eqns: In summation notation, $\Sigma\infty=1k$

P1322: In last two equations, multiplication notation (X) can be omitted.
OK

P1323, L24: ‘a average’□’an average’
OK

P1325, L4: Please explain ‘Halstead coefficient’, or put relevant references.

P1325, L19: ‘fellows’□’follows’
OK

P1338, Fig. 6: What are the positive ET from 18 LST to 00 LST and a deep hole around noon in the observation? Are those explainable?
If the air is quite dry - as is often the case in Sde Boqer, and there is a wind blowing, evaporation from the ground may occur well after sunset. This does not imply that there was transpiration from the grass, of course. We are not sure why there was a secondary peak in evaporation at about 19:00: this may be related to the increase in wind speed, which reached a maximum at this time.

The evapotranspiration of the plants is maximum during daytime but a "midday depression" is often observed during a hot and/or dry day because the plants close their stomata to avoid drought stress. This mechanism probably explains the drop observed around noon in the observations.