MS: GMD-2012-31

Title: Inclusion of vegetation in the Town Energy Balance model for modeling urban green areas

General 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.

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

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.

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

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.

P1296, L25: 'varying' → 'different'

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.

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.

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

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

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

P1300, L4: ‘subgrid-scale mix’ ?

P1301, L13: ‘according’ → ‘proportional’

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

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

P1303, L3: ‘infra-red’ → ‘longwave’

P1305, L13: ‘2009) resolves’ → ‘2009). It resolves’

P1305, L15-16: What are ‘vertical effects’? Please clarify it, or delete the lines.

P1307, L13: ‘Obukhov’

P1307, L22: ‘SBL version of TEB’→’TEB-SBL’

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).

P1310, L8: 0.012 m in Table 2. Please check the value.

P1311, L26: ‘weak’→’small’

P1312, L24: ‘excedd’→’exceed’

P1313, L7: Please revise the sentence clearly.

P1313, L8-9: What is the error in the observation? Is that accurate enough to ignore bias attribution?

P1314, L1: ‘to’→’too’

P1316, L22: ‘concrete’→’concrete road’

P1316, L23: ‘that’→’than’

P1318, L12: ‘received by’→’flux received at’

P1318, L15: ’irradiation’→’irradiance at the surfaces’

P1320, eqns: In summation notation, $\sum_{k=1}^{\infty}$

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

P1323, L24: ‘a average’→’an average’

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

P1325, L19: ‘fellows’→’follows’

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?