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Interactive comment on "The GREENROOF module (v7.3) for modelling green roof hydrological and energetic performances within TEB" *by* C. S. de Munck et al.

Anonymous Referee #1

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General comments

The paper addresses the complex question of vegetation-atmosphere fluxes of heat and water in the special case of planted roofs. Such roofs are being promoted as an important means of ameliorating the urban climate, as well as leading to energy conservation in buildings. The contribution this study aims to make is to describe planted roofs in better detail than other modeling schemes used at the city scale, which assume that such roofs behave in a similar manner to vegetation on the ground. The primary differences between roofs and the ground are: a) Planted roofs have a shallow substrate with atypical hydraulic properties; and b) they are typically well-drained,

allowing much greater out-flow of incoming precipitation than would be expected in ground level soils with similar hydraulic properties. The paper seeks to describe these special features by combining the ISBA-DF model to describe the natural layers of the planted roof, coupled with the TEB model to describe the heat exchange with the building. The models are coupled at the interface between the lower surface of the hydraulic drainage layer and the upper surface of the structural roof (which includes thermal insulation and water-proofing). Results of the model simulation are compared with measured data from a full-scale planted roof.

Specific comments

The methodological design of the study is quite clear. The description of model parameters is detailed and meticulous. The statistical analysis of model results is careful and well-presented – both in a table and graphically (the use of the Taylor Diagram is very welcome). The discussion of the results is generally frank, and where results are disappointing, there is a discussion of possible reasons for this. The paper is, in general, well organized, has sufficient references, and is a pleasure to read.

However, the proof of the pudding is in the eating, and where the paper falls a little short is in the actual quality of the model results. This is especially the case with regard to the predicted drainage flow, as well as the soil temperature at a depth of 77mm, where the error in some cases exceeds 10K (Fig. 6). Soil water content is the difference between incoming water (rainfall) and outgoing water (drainage and evapotranspiration). The paper describes only the drainage – it is assumed that ISBA-DF accounts properly for ET. However, drainage flows are not modeled with sufficient accuracy (the error over the whole period is nearly 130% - see p. 1147) – yet soil water content is generally modeled fairly well, despite the disappointing NSE scores, which are barely positive (p. 1146). This can most likely means that ET is not modeled correctly – otherwise the water balance would not add up. However, this part of the model of soil-vegetation matrix is not described in the paper, and there is no report of any measured or calculated ET data to evaluate it. This, too, may be why the calibration procedure for the hydrological

parameters of the soil did not yield a higher NSE rating and why, ultimately, it is likely that the roof-atmosphere coupling may not in fact be better than existing models which were not developed specifically for roofs.

âĂČ Technical comments

p. 1128: The abstract states (lines 7-10) that the "module allows one to describe. . .and to model vegetation-atmosphere fluxes of heat, water and momentum". In fact, the paper itself focuses on hydraulic modeling of the soil. It then states that the model deals with ". . .the thermal coupling with the structural building envelope" (lines 11-12) – but it is not clear whether it is full two-way coupling, or whether the roof temperature is used only to force the soil model.

p. 1129: Planted roofs do not have "increased roof solar reflectivity" (lines 14-15): the albedo of vegetation is in fact very low, at about 0.15-0.2. There is a tendency to exaggerate the thermal benefits of green roofs (lines 17-20), but careful analysis shows these are in fact more modest and nuanced. See for example: Moody & Sailor (2013): Development and application of a building energy performance metric for green roof systems. Energy and Building 60:262-269.

p. 1130: UHI amplitude (line 26) may not, necessarily, be affected a reduction in urban air temperatures, if the reduction occurs during daytime due to, e.g. evaporative cooling, while the UHI is driven by radiant cooling at night.

p. 1134: The term 'spatial' is used to describe time-related variations (line 8), instead of 'temporal'?

p. 1143: In the description of the parameters for equation 5 – "cloud temperature is equivalent to that of the surrounding air" (line 8), add: "and cloud emissivity is equal to '1' ".

p. 1149: In the discussion (lines 9-13) of the temperature trends in Fig. 6, a possible explanation of the change in tendency after about Nov. 1 relates to the rather sharp

drop in external air temperature, which is most likely accompanied by a reduced rate of ET: If the model does not account accurately for this process, this too could lead to the results shown in the figure.

p. 1150: The conclusions state that the "GREENROOF module will allow the impacts of green roof implementation on various types of buildings. . ." (lines 12-13): This was not demonstrated in the paper, and in fact it appears that the coupling is one-way, with building temperature forcing the soil module.

Fig. 2: Please use a larger font in the block diagram – the text is barely legible, especially on the darker background.

Fig. 5: If the blue line (upper graph) represents rainfall, please add it to the legend. It would be better if this information were displayed on a separate part of the chart, with a common time-scale but a better vertical scale (say max of 10, instead of 40).

Interactive comment on Geosci. Model Dev. Discuss., 6, 1127, 2013.