

Interactive comment on “Sensitivity of mesoscale model urban boundary layer meteorology to urban morphology” by D. D. Flagg and P. A. Taylor

Anonymous Referee #2

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General comments The present paper analyses the importance of the sub-grid scale information of the urban sub-grid scale land-use in a mesoscale NWP model (WRF) for the surface energy balance and the boundary layer meteorology. Additionally, a validation against air craft measurements is undertaken. The study is undertaken for the highly urbanised Detroit-Windsor area and shows that small changes in the underlying sub-grid scale land surface cover affect the local and the grid averaged surface energy balance. This result is not surprising or new, but the quantitative evaluation is useful for urban meteorologists who are interested in land surface effects of urban areas at different scales. However, the authors do not isolate the pure impact of changes to the urban morphology - as the title suggests - but evaluate the combined impact of changes to urban morphology and urban land use fraction. Please find more specific comments listed below.

C11733

Specific comments P 25909: The title is slightly misleading. While the paper suggest to investigate the sensitivity of WRF towards urban morphology it actually investigates the sensitivity of WRF towards changing the resolution of the sub-grid scale urban land surface as well as changing the urban morphology (e.g. geometry and density of buildings) via changing the sub-grid scale resolution at the same time. Changes to urban morphology would imply changing the geometry within the urban tiles systematically to determine their impact. Therefore, I suggest using a more appropriate and less misleading title.

Introduction: The introduction is too vague and needs to focus more on the objective of the paper to determine the importance of the resolution of the sub-grid scale urban land cover. The whole paragraph about the roughness sublayer is not needed in the context of the paper and might be shortened substantially. The authors elaborate on the impact of urban geometry and then only add a sentence on the importance of vegetated surface in urban areas. However, a large part of the paper focuses on the impact of the fractioning between urban and vegetated surfaces due to the resolution and only indirectly determines the importance of urban morphology in the sense of geometry. Another sentence on this subject would be useful.

P 25911, L 9-10: The RSL is not subdivided based on the height of the buildings but based on the turbulent properties of the flow. Please correct this sentence.

P 25911 L 14: Not the RSL itself but its properties are sensitive to the urban morphology. Please make this clear.

P 25911 L 16-19: The authors mention the relevance for air quality but do not refer to this later anymore. This comment is not needed here in the context of the paper.

P 25911 L 19: Please remove “also”

P 25911 L 5-18: The authors jump between explanations regarding the RSL and the shear layer and urban canopy layer. Please rewrite this paragraph to enhance clarity.

C11734

P 25911 L15 and L28: The authors use “morphology” in various definitions. Please make clear if morphology is used in the context of building layout and geometry or in the context of land surface heterogeneity and use different words to distinguish between the two in the following.

P 25911 L29: Please elaborate on the importance of latent heat flux a bit more.

P 25912 L 1-15: This paragraph is too vague and not focusing on the parameterisations available in NWP models for describing the urban surface energy balance. Especially, since WRF itself offers a broad range of different urban parameterisations. This is not mentioned here and a justification is missing why the presented parameterisation is chosen and not one of the others. Please rewrite the whole paragraph and concentrate on parameterisations relevant for the paper.

P 25912 L 16-21: Again this paragraph is too vague. The title promises a sensitivity analysis towards the representation of urban morphology but this paragraph only suggest a sensitivity towards the sub-grid scale land surface resolution changing the morphology indirectly via the resolution. Please rewrite this paragraph and point out the objectives of the paper more clearly.

P 25912 L 20: representation of what? This is an incomplete sentence. Please write down explicitly if you refer to the scale of urban morphology or more general land surface heterogeneity.

P 25912 L20: Please provide a reference to justify “the need to understand the nature of the error...” and be more specific about the type of error you expect. This study is more concerned with aggregation of the land surface type properties than actually changes of the urban morphology. Please be more specific about the objectives of the paper and the methodology.

Section 2.1: Since you are investigating the sensitivity towards the resolution in the sub-grid scale land surface please provide information about how the sub-grid scale

C11735

properties or fluxes are aggregated in WRF and refer to the errors that are associated with the method.

P 25914 L 6: Please change “achieved” into “calculated”

P 25914 L 8-10: Awkward wording. Please correct this.

P 25914 L12: This is not the urban heat flux but the mean grid box heat flux. Please correct this.

P 25914 L 21/22: What are these values based on? Please provide more information.

P 25915 L 17: Please provide information about lowest model level.

P 25916 L 23-24: Awkward wording. Please rewrite sentence.

P 25917 L 6-7: This is the case for any land use type like forests, etc. with a fine scale heterogeneity leading to a scale difference between the land surface and the resolution of the NWP model. Please remove this sentence.

P 25917 L 20: Please make clear if all cases still have sub-grid scale land use or if the coarsest case has land surface cover information which is now explicitly resolved by the innermost model domain.

P 25921 L 15-19: What is the error associated with this interpolation method? Please include this when comparing the simulation with the measurements.

Section 3.3: Please indicate if the model bias is larger or smaller than the model uncertainty range for the parameters that are compared with measurements.

P 25921 L 13: Does “significant” mean statistically significant? Please make this clear or otherwise remove this phrase.

P 25921 L 17: Which possible explanation? Please be more specific and clear.

P 25927 L 1-4: Please elaborate more on Figure 8 showing the diurnal cycle of the surface energy balance. For instance, why is the storage term balanced by the radiation

C11736

term at night while there is hardly a difference between the sensible heat flux between urban and rural areas? Normally, urban areas maintain a slightly positive sensible heat flux at night due to the larger thermal inertia of the urban environment. Also you might elaborate more on the phase shift between the rural and the urban surface energy balance in the sensible heat flux term with regard to the air temperatures you analyse later.

Section 4.3: The authors start with mentioning the surface energy balance then jump to temperatures and back to the surface energy balance. Please rewrite this section and make the order more logical.

Section 4.3 2nd sentence: Please make clear if a shift from 10s to 20s reduces or increases the urban intensity and how the urban fractions are changing. This is not clear from Figure 7. Also, a reference to Figure 7 should be included here.

P 25927 L 16-21: The authors mention that the urban sensible heat flux is enhanced. A sentence later they mention that the urban sensible heat flux is reduced. This is confusing and needs to be explained better. Explain if you are referring to $F_{urb} * H$ or just H_{urb} . Again, please indicate if a change from 10s to 20s increases or decreases the urban intensity.

P25929 L 19-22: Please explain why a shift from 10s to 20s with increased urbanisation f_{urb} also favors roof-top ground heat flux over road ground heat flux. Is the urban area more densely built in case of 20s? Please make this clear.

Figure 1: Please use a discrete color bar.

Figure 7: Please use a discrete color bar.

Figure 8: Please indicate evening and morning transition.

Technical corrections Urban canopy layer is a more widely used term instead of urban canyon layer. P 25911 L 16: "within" instead of "with".

C11737

P 25914 L24: "a.g.l." please insert "above ground level"

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 25909, 2010.

C11738