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Geoscientific Model Development Discussions

Interactive comment on "Radiative Transfer Model 3.0 integrated into the PALM model system 6.0" *by* Pavel Krč et al.

Anonymous Referee #1

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This submission describes a number of reasonable and at times elegant developments in the PALM-RTM model to include vegetation and improve the computational efficiency and therefore feasibility for larger or more complex domains. In general the explanations are clear and the assumptions robust. This is a long and detailed submission treating a complex set of problems, and I commend the authors in general for this work. However, improvement is possible. In general, the methods section appears to draw on previous work in a number of instances but does not often make explicit reference to previous work. Second, treatment of shortwave radiation interactions with the plant canopy may omit important processes related to lower absorptivity of leaves in this radiation band, and I think further consideration could be given here. Third, some of the methods section might better be included in an Appendix or Supplementary to

keep the paper more focused and hold it to a more reasonable length.

Abstract and conclusions (Sect. 6): More details should be included. Which new processes, discretization schemes? What, specifically, are the core aspects of this submission that are novel?

Lines 17-20: Urban climate models embedded in mesoscale models typically do include radiation exchange in 2-D, as well as shading and multiple reflections.

Line 84: "around the vertical axis"

Line 87: Explain what the "f-plane" approach is, and give a reference.

Line 101: So the geometry is plane parallel.

Line 122: I don't think this is the case. Please explain.

Line 130: Reflections from plant canopies may substantially affect nearby surfaces/pedestrians.

Line 135-136: What about latent heat flux from leaves?

Lines 171-176: What happened to radiation intercepted by the plant canopy?

Line 178: Which simplifications? Exact calculation for plane parallel rectangles does not require performing any integration.

Line 206-218: But how high can the resolution go and still be computationally feasible?

Line 230: What about the 3rd dimension (e.g., especially in a neighbourhood with tall buildings)? Wouldn't it grow faster if vertical discretization also increased?

Lines 341-343: This is not necessarily a small assumption in the shortwave, where leaf scattering (reflection + transmission) is on the order of 50%. There is evidence that it is an important process.

Sect. 2.3: In general, which assumptions are made (or user controls are available)

related to orientation of leaves? In general in this section, I think additional references backing the decisions being made and relations used would be useful.

Line 352-354: Doesn't the attenuation depend on the direction from which the ray originates, and whether it intersects a small fraction of the PCGB at its edge, or right through the middle of the PCGB?

Eq. 8: Technically, this is the fraction of radiation that is not intercepted by a leaf. In reality, a good fraction of the radiation intercepted by leaves is transmitted forward as well.

Line 361: This assumption will overestimate the absorption of shortwave radiation by leaves, since a large fraction of shortwave radiation incident on leaves is reflected or transmitted through the leaves. The extinction coefficient can be modified to begin to take this fact into account.

Line 364-371: Doesn't this depend on the direction from which the ray originates? Or this is only used for shortwave interactions between faces (not for incident direct shortwave)? -> This appears to be answered in Sect. 2.4.1. Two points: 1) perhaps make this clear here (i.e., lines 364-371), and 2) won't this advance ray tracing of all solar position (line 425) incur a large penalty in terms of memory requirements? In general, it would be helpful if it were stated earlier, e.g. in Sect. 2.3, that treatment of direct shortwave radiation would come later (in Sect. 2.4).

Line 417: "an" -> "and"

Sect. 2.4.2: What about scattering (reflection & transmission) of intercepted direct solar radiation?

Line 482: What shape is this object?

Sect. 3 (and some of Sect. 4): Some of these sections may be better in an Appendix or Supplementary. These are key details, largely related to the computational approach, that are of interest to a select few. In other words, the *main* section of this submission

is overly focused on the computational details, given that it is a geoscientific modelling journal. It is already a very long and detailed paper.

Sect. 4.3: This is an approximate approach for stomatal conductance, best used at the landscape scale. It misses the nonlinear effects of solar irradiance distribution across the vegetation canopy. A better approach at this scale might be the two-big-leaf approach.

Fig. 11: Why are walls grey? They have SW+LW exchange, do they not?

Sect. 6: It could be made more clear that the bolded subheadings are current limitations and/or planned future developments. "New discretization for direct irradiation of plant canopy" – The difference between these two methods is not entirely clear based on this description.

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