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Interactive comment on "Fast matrix treatment of 3D radiative transfer in vegetation canopies: SPARTACUS-Vegetation 1.0" *by* Robin J. Hogan et al.

Anonymous Referee #1

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The manuscript describes a new approach to quickly and accurately calculate the spectral albedo of a vegetation canopy using information on its optical and structural properties. The presented algorithm is a clear advancement compared with the dominating 2-stream approximation as it represent realistic forests and shrublands as consisting of individual trees. The paper addresses a relevant issue and has imminent application potential. The description of the method is sufficiently complete and precise. However, some minor technical modifications are needed for greater clarity.

Minor (technical) comments: Page 1 line 1: I suggest specifying the (geographic) scale where the model can be applied and also the scale of the "regions". line 2: Splitting

"horizontally" is ambiguous. It can be understood as splitting with horizontal planes. I suggest using e.g. "split in the horizontal plane". line 7: I suggest adding some quantitative results, e.g. the number 0.05 mentioned in Conclusions.

Page 2: The description of clumping is misleading. Clumping is also used to describe vegetation structure variation in the vertical direction and at scales smaller than a tree crown. This should be mentioned as the current description can be misleading with respect to the universality of the proposed approach.

Page 3 line 4: add "constant thickness" after "canopy layer". I see no need for quatition marks. line 4: Define what is meant by "domain" line 4: Again, choose an anambigous term instead of "divided horizontally" (although the meaning can be inferred from context). line 4: The concept of "region" should be defined here and not on the following page. It is counterintuitive to have a region consisting of separate parts. line 4: The necessity of up to two vegetated regions is not justified and not followed later in the manuscript. line 7: How would the situation of objects not being cylinders (highly grouped canopies) affect accuracy? In my opinion, this is explicitly assumed here. Although not mathematically, but the results are only provided for canopies with clearly separable crowns. line 8: Define "vegetation element". E.g., is it a leaf or a tree crown? line 9: Unclear what is meant by "same": a canopy layer is first and foremost defined by leaf area density. line 10: Why possible omission is only mentioned for shrubland?

Page 4 line 1: Define what a,b,c stand for (different regions). Probably, it needs to be done earlier as line 13 of previous page already refers to L^{ab}. In hindsight, it is clear that a and b refer to two regions. line 1: In optical radiometry, radiant power is the same as radiant flux. Use only one of these terms consistently. FLux per surface area (flux density) is irradiance. "Domain-mean" flux is a contradictory term. Irradiance can be averaged, but flux being total power can only be added. The correct term would be domain-total flux, the sum all flux components over the domain. (note: in many other fields, flux is power divided by area) line 3: This line contains the definition of a "region". It should be given earlier.

Page 5 line 25: rewrite as LAI/(2 Delta z) line 32: citation needed for the equations.

Page 6 line 8: Give some justifications for this rather arbitrary assumption and also discuss its consequences. line 12: Unclear what is meant by "random" and why it's necessary. Different random processes can dreate very different tree distribution patterns, but very few create non-overlapping crowns. Instead of "random", why cannot the trees in the "idealized forest" be situated on a regular grid?

Page 11 line 4: Choose either PAR or "visible region"; alternatively, add "and" between the two. line 7: Be moerelaborate on the approximation method. line 7: A sphere (or, a single tree crown) does have a LAI value. LAI is only defined for a region which usually includes betweem-element gaps, e.g., a forest stand. It can indeed be defined for the area of a single crown, but this contradicts the common practice. line 8: Clarify what is meant by "upper" and "lower". These do not seem to refer to canopy location (but can be understood to).

Page 12 line 2: Again, "domain-main flux" needs clarification. line 11: Again, I suggest avoiding the use of LAI for a single tree. It is straightforward for ideal cylindrical tree crowns, but can cause much confusion when attempted in a natural situation where tree crowns do not have a clearly distinguishable bounding surface.

Page 14 The section "Conclusions" contains mostly discussion and should be renamed. No new issues should be brought up in Conclusions and citations are unnecessary. Instead, the statements should be based on what was presented earlier, mainly Discussion – a section clearly missing from the manuscript. The current Conclusions contains many new topics and even a value (0.05 on line 11, which should be mentioned in the results section).

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